FORAMINIFERA FROM THE GREEN AMMONITE BEDS, LOWER LIAS, OF DORSET

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[Plates 1–4]

This paper is a contribution to the long-continued researches on the Dorset Lias by Dr W. D. Lang, F.R.S., who collected the described material.

Some 700 mounted specimens from the Lower Lias (*davoei* zone) of the Dorset coast have been studied. They are ascribed to six families, twenty genera, and fifty-five species; of these, eleven genera and forty-five species belong to the family Lagenidae. One genus and species, *Carixia langi*, and one other species, *Lagena davoei*, are described as new, and two new names are proposed to replace invalid names.

There were studied for comparison certain of the few described English Lias faunas, some described French and German material, and a number of well-preserved but undescribed faunas from various Lias horizons and different English localities. This has yielded provisional evidence of the zonal ranges of the Dorset species. Some forms of *Frondicularia* were found to provide useful horizon markers.

A tentative correlation is given of the zoning of the Lias by various authors of papers on Lias Foraminifera; there are notes on the horizons of some described Lias faunas, and a review of previous work on British Lias Foraminifera.

Study of Jurassic Foraminifera has been comparatively neglected for many years, though there is a recent German revival. Some lengthy synonymies are therefore necessary. Certain less-known forms are discussed in detail; they were inadequately described and figured, so that they have hitherto been wrongly placed. It has thus been possible to rectify the systematic position or status of the genera *Involutina*, *Problematina* and *Bullopora*. The appearance in the Lias of *Bolivina* and *Plectofrondicularia* is demonstrated, genera usually stated not to occur in rocks of age earlier than the Cretaceous.

Foraminifera thrived in the muddy Lias seas in whose clay deposits their shells are well preserved. There was a rapid evolution of new types, particularly of the predominating Lagenidae. In this family there appears to be wide variation within some of the groups, where neither 'species' nor even 'genera' are sharply defined.

The bulk of the paper is taken up by the systematic description of the Foraminiferal fauna; all the recorded forms are figured. There is a reference list of some eighty-nine papers, mainly on Jurassic Foraminifera.

CONTENTS

1. INTRODUCTION

Dr W. D. Lang, F.R.S., kindly gave me the opportunity to describe the Foraminifera collected by him, mainly in 1909, from the Lower Lias of Black Ven and Stonebarrow, near to Lyme Regis, on the Dorset coast. The specimens come from the zone of *Prodactylioceras davoei*, and are restricted to the *maculatum* (horizon 122), *lataecosta* (horizon 123), and *bechei* (horizon 126) subzones, the *figulinum* subzone not being represented.

A proportion of the samples had already been picked over by the late Mr F. Mockler; he mounted some 160 specimens, and several of these he sketched, sometimes adding the generic name. There remained washed samples from five of the six horizons whence collections had been made. These residues were treated by Ozawa's method of flotation in carbon tetrachloride, which sometimes gave good results. The rest of the named material (some 531 further specimens) was obtained from these samples, floated or unfloated.

The specimens are preserved in the Geological Department, British Museum (Natural History), whose register numbers are cited.

Under the description of each species is given Lang's horizon number (1936, *Quart. J. Geol. Soc.* **92**, 430); the precise levels and localities indicated by these, *in this present paper*, are as follows:

		Species and varieties	Specimens
126	'Red Band', Stonebarrow	3	15
123*d–m*	17½ ft. above Belemnite Stone, Stonebarrow	31	360
123*m*	14 ft. above Belemnite Stone, Black Ven	19	84
123*i–m*	13 ft. above Belemnite Stone, Black Ven	5	8
123*a*	10 ft. above Belemnite Stone, Black Ven	22	98
122	5 ft. above Belemnite Stone, Black Ven	20	126
	Total		691

Comparison with the section given by Lang (loc. cit.) shows that the collection of Foraminifera described below was not made systematically to cover the Green Ammonite Beds, in fact only about the lower half of these is represented.

(*a*) New forms and new names

The following are proposed:

Carixia langi gen. et sp.nov.
Lingulina terquemi nom.nov.
Tristix nom.nov.
Lagena davoei sp.nov.

(*b*) Microfauna other than Foraminifera

A few microfossils belonging to groups other than the Foraminifera have been found during the course of the work as follows:

(i) *Pisces*

A few minute fish teeth and otoliths. The former have been kindly identified by Dr E. I. White, who informs me that the otoliths can at present only so be recorded.

Palaeospinax priscus (Agassiz).
Material: One specimen; Brit. Mus. P24413.
Dimensions: 1·67 mm. in width, and 1·20 mm. in height.
Horizon: 122.

Palaeospinax ? sp.
Material: One specimen; Brit. Mus. P24416.
Dimensions: 0·75 mm. in width, and 0·80 mm. in height.
Horizon: 123*a*.

Otoliths.
Material: Three specimens, Brit. Mus. P24414 (two), and P24415.
Dimensions: Greatest diameter 0·50, 0·52 and 0·46 mm.
Horizon: 123*a*, 123*m*.

(ii) *Entomostraca; Ostracoda*

In marked contrast with certain lower horizons of the English Lias, ostracods are rare in the Dorset material, and only very few specimens attributed here to one species have been found.

(?) *Bairdia liassica* (Brodie).
Material: Three specimens, Brit. Mus. In38221–3.
Dimensions: Length 0·53, 0·35 and 0·25 mm.
Horizon: 123*a*, 126.

Remarks: Blake's figures (1876, p. 430, plate 17, figures 1, 1*a*) of Brodie's species appear closely to resemble the present specimens. The identification is provisional, and is made without special knowledge of the group.

(iii) *Echinoderma; Holothurians*

Wheels of *Chiridota.*

Material: Two specimens, Brit. Mus. E27026–7.

Dimensions: Diameter 0·22 and 0·18 mm.

Horizon: 123*a*.

Remarks: The specimens have nine and ten spokes respectively. Mortensen states (1937, *Kgl. Danske Vidensk. Selskab.*, Biol. Meddel., **13**, no. 10, p. 20) that this is of no significance, the number varying from six to ten in the same species. Dr Mortensen, who has seen a photograph of these wheels, kindly confirmed the identification as above.

Holothurian spicules.

Material: Twenty specimens, Brit. Mus. E27028 (four), and E27029 (sixteen).

Dimensions: Diameter 0·17–0·41 mm.

Horizon: 123*a*, 123*d–m*.

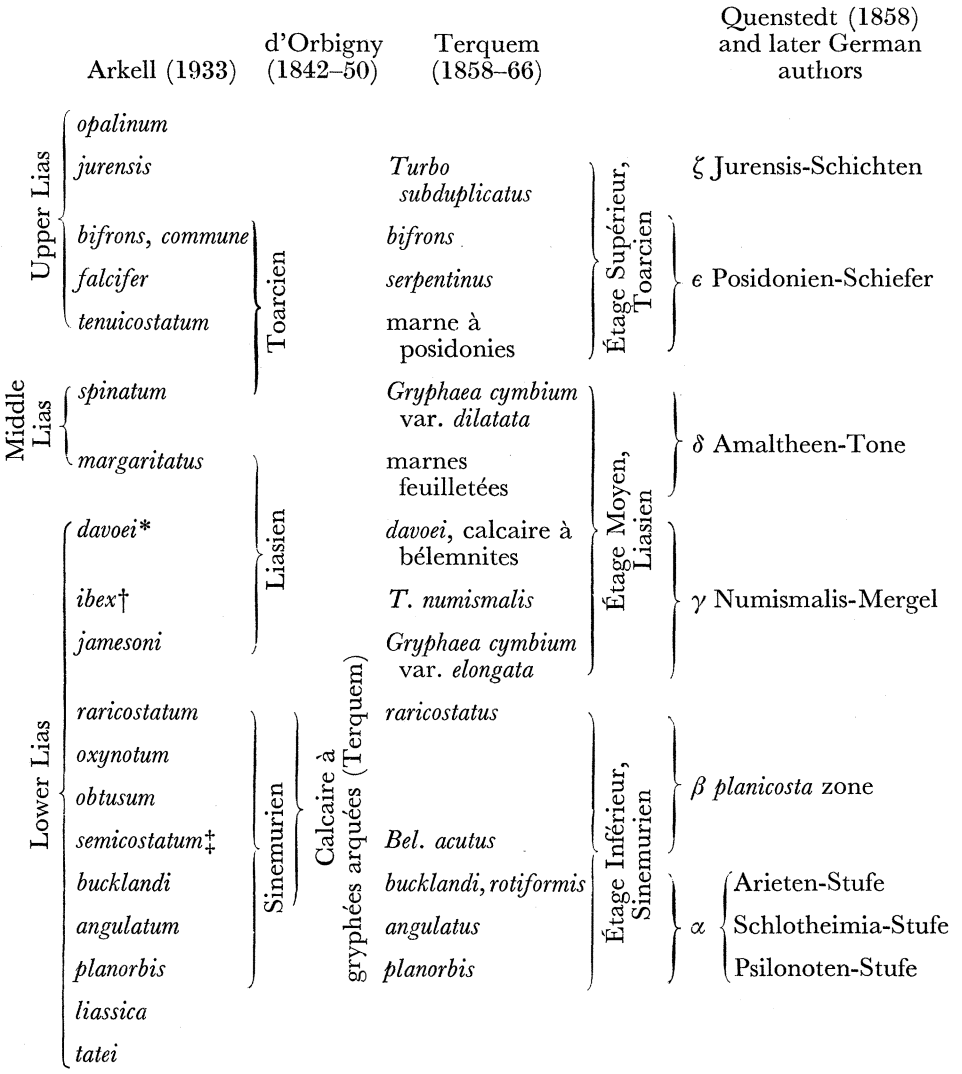
Remarks: Mortensen (op. cit. p. 23) states that material such as this can hardly be more precisely named. There appear to be some three types of the perforated plates present.

(*c*) The zones of the Lias, with an approximate correlation

The Lias has been much subdivided and zoned by authors, and many different schemes have been proposed, often based on local developments. The resulting confusion has been well described by Arkell (1933), but owing to the grave difficulty, if not impossibility, of a precise correlation of many of the terms used, he has not attempted this. Since, however, much time is apt to be wasted in attempting to discover approximate correlations for use in the study of the Lias Foraminifera, no apology is perhaps necessary in offering the following table. It must be clearly understood that it is tentative and approximate, and not an authoritative correlation.

The zoning accepted here is that adopted by Arkell (which is that of Oppel, with some emendations) as the best scheme available into which to fit the record of at least the English Lias. Finer zoning it is at present not necessary to consider here. The criterion of what names to include in the correlation has been their use in important papers on the Lias Foraminifera.

APPROXIMATE CORRELATION OF LIAS ZONES



* Sometimes termed the *capricornu* zone.
† Sometimes termed the *centaurus* zone.
‡ Sometimes termed the *turneri* or *tuberculatus* zone.

(*d*) ACKNOWLEDGMENTS

I have to thank the following gentlemen for their kindness and help in various ways: Dr W. D. Lang, F.R.S., for allowing me to describe his collection; Mr Arthur Earland, for examining specimens of *Carixia langi*, and for sending me Recent material for comparison with Lias species of *Ammodiscus*, *Carixia*, and *Ophthalmidium*; Mr F. R. S. Henson, for his careful examination of specimens of *Problematina liassica*, and his detailed comparison with other genera, particularly the Orbitoids; Mr M. A. C. Hinton, F.R.S., Keeper of the Zoological Department, British Museum (Natural History),

Mr E. Heron-Allen, F.R.S., and Mr C. D. Ovey, for facilities to examine the Lias material now under their charge, mostly in the collections of H. B. Brady and W. K. Parker; Dr E. B. Bailey, F.R.S., Director of the Geological Survey of Great Britain, and Mr C. P. Chatwin, for slides of topotype material containing *Orbis infimus* Strickland; and Professor A. E. Trueman, for sending me his slides of Lias Foraminifera from the Lincolnshire area for comparison, and also for helpful criticism on points of stratigraphy.

2. THE LIAS FORAMINIFERA

In Palaeozoic times the predominant Foraminifera were arenaceous, belonging to families such as the Ammodiscidae, Lituolidae, and Textulariidae. In the later Palaeozoic came the short-lived calcareous Fusulinidae, which appear to have died out about the end of the Permian.

The Triassic Foraminifera are not at all well known, perhaps in part because the conditions indicated by the sediments of that age were often unsuitable for their colonization and preservation. But the precursors of the Lias, as contrasted with the Palaeozoic forms, seem to have been in process of establishing themselves.

The Lias is largely a clay formation, in the muddy conditions of which Foraminifera often thrived. Afterwards their shells were well preserved in the same medium. This favourable environment seems to have led to a rapid evolution of new types, most particularly noticeable in the Lagenidae, which so largely dominate the Lias foraminiferal fauna. As a result of this rapid evolution, with an abundant population, difficulties are found in the naming of many specimens of this family, which seem to show a wider variation within the group than is often the case. In fact, the 'species', and sometimes the 'genera' also, are by no means sharply defined.

Certain authors have endeavoured to describe such Lias faunas by the multiplication of trivial names. By the nature of the problem these forms are generally ill-defined and insufficiently differentiated from neighbouring species both in nature and by their authors. A natural consequence of this is that the greater the number of such similar species that are proposed, the more do intermediate specimens become unnameable.

As explained below (p. 29), the view is here taken that it is preferable to subdivide these ill-defined aggregates of a population rather broadly, using few trivial names, and allowing considerable variation to each species. Even so it is sometimes a matter of opinion as to what name to use for a given specimen. This view is supported by the variability which is found among a group of specimens in a single sample, so that neither peculiar geographical distribution nor time change can be cited in favour of splitting.

The problem of zoning the Lias by the Foraminifera has been seriously studied for perhaps the first time by Brand (Bartenstein and Brand 1937), and his tables XVIII and XIX show the measure of his success. His ranges of certain clearly recognizable

species have been checked with my experience of the English Lias, and so far as the available inadequate information goes there is a considerable measure of agreement, with a few differences. There seems, on the evidence, no doubt that further work will enable the Lias to be reliably, but perhaps not very finely, zoned by its Foraminifera.

For the description and nomenclature of Lias Foraminifera one is mainly dependent on French and German authors. Of outstanding importance are the works of d'Orbigny (1850), Bornemann (1854), Terquem (1858–66), Terquem and Berthelin (1875), Berthelin (1879), Issler (1908), Franke (1936), and Bartenstein and Brand (1937).*

(*a*) The horizons of some described faunas

When consulting the literature on Lias Foraminifera it is often necessary to spend considerable time searching the introduction or other portions of a paper to discover the exact horizon and locality of the described specimens. Further work may then be required to correlate the author's horizons with the zones now accepted as a time scale. There may sometimes be doubt that the correct horizon has been assigned by the author, so that the following notes include such evidence as is available. Much of the correlation is taken from W. J. Arkell, *The Jurassic System in Great Britain* (1933):

Bartenstein and Brand (1937). Upper, Middle and Lower Lias; carefully zoned horizons and localities are given, see plates 17–20 for these, and pp. 11–55.

Beesley (1877). Middle and Lower Lias, mainly from the *margaritatus* and *davoei* zones.

Berthelin (1879). Middle Lias, *margaritatus* zone.

Berz (1931). Upper Lias.

Blake (1876). Upper, Middle and Lower Lias; table on pp. 232–3 gives the distribution of described species.

Bornemann (1854). Lower Lias; all specimens come from his bed *h*, the Belemnitenschichten (pp. 20, 73–4); the horizon of this is given as Lias γ by Issler and by Franke, and as the *capricornu* (= *davoei*) zone by Bartenstein and Brand.

Brady (1867). Upper, Middle and Lower Lias; the approximate localities and horizons can only be got by going through the faunal lists given by Moore in the preceding pages 161, 164–6, 173, 193. From these may be constructed a table showing the distribution of the described species in four horizons:

Upper Lias: Upper Cephalopod Beds = *bifrons*, *commune* and *falcifer* zones;
Leptaena Beds, and the top 10 in. of the Marlstone = *tenuicostatum* zone.

Middle Lias: Remainder of the Marlstone = *spinatum* and *margaritatum* zones.

Lower Lias: 'Middle Lias of Camerton and Radstock districts' = probably *jamesoni-davoei* zones. Moore (p. 120) considered the *raricostatum* zone to be '. . . the highest member of the Lower Lias'.

Burbach (1886). Middle Lias, *Amaltheus* beds.

Burbach and Dreyer (1888). Middle Lias; *Amaltheus* beds.

Crick and Sherborn (1891). Lower Lias; *Am. capricornus* (p. 208) = *davoei* zone.

* Full references are given in § 4 below, p. 69.

Crick and Sherborn (1892). Upper Lias: *Leda ovum* beds = lower part of the *jurensis* and upper part of the *bifrons* zones.

Franke (1936). Upper, Middle and Lower Lias; localities and horizons are given, the latter in Quenstedt's notation, under each individual species.

Haeusler (1881). Lower Lias, Sinemurien = *planorbis-raricostatum* zones; apparently mainly from the *bucklandi* zone.

Haeusler (1887*b*). Upper Lias of Banbury, Oxfordshire.

Henderson (1934). Lower Lias, *semicostatum* and possibly *bucklandi* zones.

Issler (1908). Upper, Middle and Lower Lias; localities and horizons are given on pp. 1–37, and under individual species.

Jones and Parker (1860). Originally described as 'Probably of Upper Triassic age', and 'from Chellaston near Derby'. The species were considered as Lower Lias forms by Terquem (1863, 3FL, pp. (154–5)*). In 1895 a footnote by Jones in the *Monograph of the Foraminifera of the Crag* (p. 161) admitted that the 'Blue Clay probably came from some Lias in Leicestershire'. In the manuscript catalogue of the Parker Collection in the Zoological Department, British Museum (Natural History), in what is believed to be T. Rupert Jones's handwriting, occurs the note: 'Lias—probably from Leicestershire, described by mistake as Triassic Clay from Chellaston near Derby. . . . Probably some Lias Clay brought by the same conveyance (canal-barge?) from a place south of Derbyshire (as the Red Clay came from Chellaston) . . . .' Crick and Sherborn (1892, p. 68) considered that the evidence of their '*Pulvinulina caracolla*' pointed to an Upper Lias age. This is not conclusive, since the same or a very similar form occurs in the *semicostatum* zone of the Lower Lias at Hock Cliff, Fretherne. Yet it undoubtedly occurs rarely in the Lower Lias, so far as I have seen, and on the contrary is very common in the Upper Lias, e.g. of Rudd's Pit, Grantham, and at Bracebridge, Lincoln. Forms that do not appear to occur in the Lower Lias are recorded by Jones and Parker as *Vaginulina strigillata* Reuss, *V. dunkeri* Koch and *Planularia reticulata* Cornuel. I therefore agree, on different grounds, that Crick and Sherborn were probably correct in assigning the fauna to the Upper Lias. Issler (1908, p. 72) was also of this opinion.

Kübler and Zwingli (1866). Upper and Lower Lias; faunas from three carefully designated localities and horizons are described: (1) Turnerithon = *semicostatum* zone, Lower Lias; (2) Posidonienschiefer = *tenuicostatum-bifrons* zones, Upper Lias; (3) Jurensismergel = *jurensis* zone, Upper Lias.

d'Orbigny (1850). Lower Lias; the collection was given to d'Orbigny by Terquem, and the locality of each species is given as 'Metz'. The horizon is given as 'Liasien', which in d'Orbigny's scheme included parts of the present Middle and Lower Lias. Terquem included all d'Orbigny's species in his first Lias memoir, and gave their localities as all near Metz, namely, Saint-Julien-lès-Metz, Magny, and Peltre. From Terquem's notes (1858, 1FL, pp. (15–16)) there seems no doubt that his collections came from the *davoei* zone at all three localities. The specimens described by d'Orbigny must, on this evidence, also have come from the *davoei* zone.

Schick (1903). Upper, Middle and Lower Lias; horizons are given in Quenstedt's notation, and in most cases localities are also given. The table on p. 162 seems to summarize them.

Sellheim (1893). Upper, Middle and Lower Lias; specimens are described from various localities, and from horizons stated as follows: (1) Lower Lias γ, Numismalismergel = *jamesoni-davoei*

* Pagination of Terquem's Lias and Oolite memoirs when placed in brackets indicates that of the offprints, when this differs from that in the periodical, which it does in 1FL, 3FL and 2SO and 3SO.

zones; (2) Middle Lias δ, *margaritatus-spinatum* zones; (3) Upper Lias ϵ, Posidonienschiefer = *bifrons-tenuicostatum* zones.

Strickland (1846). Lower Lias, *planorbis* zone.

Terquem (1858–66). Very few Upper Lias specimens, a few from the Middle Lias, the majority from the Lower Lias. The localities are always given under the species, the horizons only sometimes, but generally in Mémoires 3–6. In Mém. 1 and the first part of Mém. 2, the main locality is Saint-Julien-lès-Metz; this is called by Terquem 'Lias Moyen', but in Mém. 3 (pp. (158–9)) he explains that the horizon of this and several other localities is the *davoei* zone, now included in the Lower Lias. In the table in Mém. 4, p. 275, he shows this also, and further on pp. 285–9 gives the horizons of species described in Mém. 4. In his Mém. 5, pp. 394–6, he gives tables of strata, which appear to serve for obtaining the horizons of species described in both Mém. 4 and 5, and on pp. 397–401 he gives a list of the horizons of the species in his Mém. 5. On pp. 394–5 he gives the horizon of the 'Marnes feuilletées' as the *margaritatus* zone of the Middle Lias. In Mém. 6, pp. 464–6, notes are given of the various localities and their horizons. (See footnote on p. 8 above.)

Terquem and Berthelin (1875). Middle Lias, *margaritatus* zone.

Trueman (1915). Lower Lias, *planorbis* zone.

Trueman (1918). Lower Lias, *planorbis—davoei* zones.

Wright (1871). Middle Lias (?); the fauna listed came from the Ballintoy Marls, Co. Antrim, Ireland, said to be of Middle Lias age by Tate on p. 4 of the same publication. There are included, however, three species which to me suggest the possibility of Upper Lias.

Zwingli and Kübler (1870). This paper is merely a revised version of Kübler and Zwingli (1866) (q.v.), with further species described from the same horizons and localities.

(*b*) Previous work on British faunas

A monograph on the British Lias Foraminifera was offered by H. B. Brady to the Palaeontographical Society, and was accepted by the Council (Minute Book, dated 7 October 1864). It was referred to by Brady and by Moore in the Somerset Lias paper (1867, pp. 165, 220), but it never materialized.* There have been published only four fully illustrated papers dealing with local faunas, namely, those of Jones and Parker (1860), Brady (1867), Blake (1876) and Crick and Sherborn (1891–2). Other papers illustrating a few English Lias species are those by Strickland (1846), Brady (1864), Haeusler (1887 *b*), Henderson (1934) and Franke (1936). The remainder of the literature consists of lists and mentions of Foraminifera by various authors in some twenty papers. These records are now often of not more than, at most, generic value, owing to the differences of identification and nomenclature. These difficulties have already been explained by me in the case of Jurassic Foraminifera generally (1935, pp. 7, 8), and they apply equally to the Lias fauna.

* It is of interest to find that Brady subsequently offered to the same Society a monograph on Rhizopoda of the Chalk, which was also accepted (Minute Book, dated 1 March 1868), but which likewise came to nought. For this and the above information I have to thank Dr C. J. Stubblefield, the present Secretary of the Palaeontographical Society.

(*c*) Some other English faunas compared

For comparison with the described fauna there have been studied a number of other collections of Lias Foraminifera from different parts of England, and from various horizons. Those at present in my collection are referred to in the text under the following slide numbers, which are used as locality indicators. The distribution of the forms common to the Dorset collection may be studied in the Range Table which follows:

Middle Lias.

226. *Amaltheus* beds, Golden Cap, Dorset; the topmost 40 ft.
227. *Amaltheus* beds, Golden Cap, Dorset; 43–63 ft. below the top.

Lower Lias.

davoei zone:

137. Broadway Pit, near Radstock, Somerset.
216. Winchcombe Brick and Tile Co.'s Pit, Greet, near Winchcombe, Gloucestershire.
220. Northwick Brick and Tile Co.'s Pit, Blockley, Worcestershire. This sample may conceivably include material from beds of rather earlier age than the *davoei* zone.
243. Lincoln Brick Co.'s Pit, Bracebridge, Lincoln.

jamesoni zone:

209. Gunny Hole, Robin Hood's Bay, Yorkshire; Bed 519, Bairstow (unpublished).

raricostatum zone:

223. Bowldish Quarry, no. 6,* near Radstock, Somerset.

semicostatum zone:

122. Bowldish Quarry, no. 6, near Radstock, Somerset.
218. Hock Cliff, Fretherne, Gloucestershire.
232. Hodder's Quarry, no. 2, Timsbury, near Radstock, Somerset.
233. Rockhill Quarry, no. 5, Clandown, near Radstock, Somerset.

semicostatum—top of *bucklandi* zone:

217. Hock Cliff, Fretherne, Gloucestershire.

bucklandi zone:

210. Brickyard at Bengeworth, near Evesham, Worcestershire.
222. Keeling's Quarry, Keynsham, near Bristol, Somerset.
234. Bowldish Quarry, no. 6, near Radstock, Somerset.

bucklandi-angulatus zones, undifferentiated:

123. Kaye's Pit, Southam, Warwickshire; 60 ft. below top.
124. Kaye's Pit, Southam, Warwickshire; 20 ft. below top.
219. Brockletop Farm, Staverton, near Cheltenham, Gloucestershire (temporary excavation).
242. New Bilton (= Victoria) Pit, Rugby Portland Cement Co., near Rugby, Warwickshire; 70 ft. below top.

angulatus zone:

63. Durnford's Quarry, near Dundry, Bristol, Somerset.

* Pit and Quarry numbers in the Radstock district of Somerset refer to those assigned by J. W. Tutcher and A. E. Trueman, 1925, *Quart. J. Geol. Soc.* **81**, 595.

3. THE FORAMINIFERA FROM THE GREEN AMMONITE BEDS OF DORSET

So far as I am aware, practically nothing has been published on this subject, though Bartenstein and Brand (1937, p. 92) give a list of sixteen species from a sample of grey marl said to come from the 'Oberster Lias' of Lyme Regis, which they appear to consider as Lias ζ (=*jurensis* zone of the Upper Lias).

In his paper on the Mollusca of the Green Ammonite Beds (1936, *Quart. J. Geol. Soc.* **92**, 456), L. R. Cox notes a previous description of small gastropods from Charmouth '. . .obtained by H. B. Brady in washing material collected by T. Wright for Foraminifera. . .'. In the Brady Collection, which is now wholly in the Zoological Department, British Museum (Natural History), there are preserved a few slides labelled 'Lr Lias, Lyme Regis', which contain some seven species of Foraminifera. They are *Problematina liassica*, *Cristellaria matutina*, *C. varians*, *Marginulina prima*, *Dentalina communis*, *Frondicularia sulcata* and *Pseudoglandulina multicostata* (Bornemann). With the exception of the last, all are recorded in the Lang Collection.

Also in the Brady Collection are four species on slides labelled 'Lower Lias, June 1864. Charmouth T.R.J. from $\frac{1}{2}$''-clay', presumably collected by T. Rupert Jones. The species are *Cristellaria matutina*, *C. münsteri*, *C. varians* and *Marginulina prima*.

A summary of the Foraminifera of the Lang Collection described below shows the following distribution:

Family	No. of genera	No. of species and varieties	No. of specimens
Ammodiscidae	2	2	10
Ophthalmidiidae	4	4	284
Lagenidae	11	45	368
Polymorphinidae	1	1	5
Heterohelicidae	1	1	18
Buliminidae	1	2	6
Total	20	55	691

This shows the overwhelming predominance of the Lagenidae in both genera and species. In numbers of specimens this family is approached only by the Ophthalmidiidae by virtue of a single species, *Ophthalmidium carinatum*, which is by far the most abundant form in the collection.

It is of interest to note that horizons 122 and 123*a* from Black Ven yielded generally the largest specimens of Foraminifera. Horizon 123*d–m* from Stonebarrow yielded the greatest number of species, but many of the specimens are minute.

(*a*) Species distribution

The Foraminifera recorded are distributed as follows:

No.	122	123*a*	123*d-m*	123*i-m*	123*m*	126	Page
1. *Ammodiscus asper* (Terquem)	–	+	–	–	+	–	15
2. *Tolypammina flagellum* (Terquem)	+	–	–	–	+	–	16
3. *Problematina liassica* (Jones)	–	+	–	–	–	+	19
4. *Ophthalmidium carinatum* (Kübler and Zwingli)	+	+	+	–	+	+	23
5. *Bullopora rostrata* Quenstedt	+	–	+	–	–	–	25
6. *Carixia langi* gen. et sp.nov.	+	–	–	–	+	–	28
7. *Cristellaria hyperbolica* Zwingli and Kübler	–	–	–	+	+	–	30
8. *C. matutina* d'Orbigny	+	+	+	–	+	–	30
9. *C. münsteri* (Roemer)	–	–	–	–	+	–	31
10. *C. protracta* Bornemann	–	+	–	+	+	–	32
11. *C. quadricostata* (Terquem)	–	+	–	–	–	–	33
12. *C. similis* Terquem	–	–	+	–	–	–	34
13. *C. terquemi* d'Orbigny	+	+	+	–	+	–	34
14. *C. varians* Bornemann	+	+	+	–	+	–	35
15. *C.* (*Saracenaria*) *inclusa* Schwager	–	+	–	–	+	–	36
16. *Marginulina lamellosa* Terquem and Berthelin	+	–	+	–	–	–	37
17. *M. laxata* Terquem and Berthelin	–	+	–	–	–	–	38
18. *M. prima* d'Orbigny	+	+	–	+	+	–	38
19. *M. spinata* Terquem	–	+	+	–	–	–	39
20. *Dentalina communis* d'Orbigny	+	+	+	–	+	–	39
21. *D. deslongchampsi* (Terquem)	–	+	–	–	–	–	40
22. *D. torta* Terquem	–	–	–	–	+	–	41
23. *D. vetusta* d'Orbigny	–	–	+	–	–	–	41
24. *D. virgata* Terquem	–	–	+	–	–	–	42
25. *Nodosaria dolioligera* (Schwager)	–	+	+	–	–	–	42
26. *N. fontanessi* (Berthelin)	–	–	+	–	–	–	43
27. *N. hortensis* Terquem	–	–	+	–	–	–	43
28. *N. marsupifera* (Schwager)	–	+	–	–	–	–	45
29. *N. octoplicata* (Terquem)	–	–	+	–	–	–	45
30. *N. pyriformis* (Terquem)	–	–	+	–	–	–	46
31. *N. sculpta* (Terquem)	+	–	–	–	–	–	46
32. *N. simplex* (Terquem)	+	–	+	–	–	–	47
33. *Pseudoglandulina oviformis* (Terquem)	–	–	+	–	–	–	47
34. *P. septangularis* (Bornemann)	–	–	–	–	–	+	48
35. *P. tenuis* (Bornemann)	–	–	+	–	–	–	48
36. *P. vulgata* (Bornemann)	–	–	+	–	–	–	49
37. *Lingulina laevissima* (Terquem)	+	–	–	–	–	–	50
38. *L. tenera* Bornemann	–	–	+	–	–	–	51
39. *L. tenera* var. *pupa* (Terquem)	+	+	+	+	+	–	52
40. *L. terquemi* nom.nov.	–	+	–	–	–	–	53
41. *L.* (?) *compressa* (Terquem)	–	+	–	–	–	–	53
42. *Tristix liasina* (Berthelin)	–	–	+	–	–	–	55
43. *Vaginulina constricta* (Terquem and Berthelin)	–	+	–	–	–	–	56
44. *Flabellina centro-gyrata* Terquem	+	–	–	–	–	–	57
45. *F. inaequilateralis* Terquem	+	+	–	–	+	–	58
46. *Frondicularia sulcata* Bornemann	+	+	+	–	+	–	58
47. *F. sulcata* var. *squamosa* Terquem and Berthelin	–	+	+	+	–	–	61
48. *F. terquemi* var. *bicostata* d'Orbigny	–	+	+	–	–	–	61
49. *Lagena davoei* sp.nov.	–	–	+	–	–	–	63
50. *L. hispida* Reuss	–	–	+	–	–	–	63
51. *L. laevis* (Montagu)	–	–	+	–	–	–	64
52. *Polymorphina* (*Eoguttulina*) *liassica* Strickland	–	+	+	–	+	–	65
53. *Plectofrondicularia paradoxa* (Berthelin)	+	–	–	–	–	–	66
54. *Bolivina liasica* (Terquem)	+	–	–	–	+	–	68
55. *Bolivina* aff. *prodromus* (Zwingli and Kübler)	–	–	+	–	–	–	68
Total species	19	25	31	5	19	3	

(*b*) Range table

The table which follows shows the ranges of the Dorset species, so far as they are at present known, in the various Lias zones and in higher Jurassic strata:

Species	Lower Lias zones: *planorbis*	*angulatus*	*angulatus* and *bucklandi*, unseparated	*bucklandi*	*semicostatum*	*Lias β**	*raricostatum*	*jamesoni*	*ibex*†	*davoei*	Middle Lias	Upper Lias	Higher Jurassic
Ammodiscus asper	—	—	—	—	E‡	—	—	—	—	E 137§ 220	E 226	E	—
Tolypammina flagellum	—	63	123 124 219	—	217‖ 218	—	—	—	—	D¶	—	?E	E
Problematina liassica	E	E	219 242	E 210	E 217	E	—	—	—	E	E	—	—
Ophthalmidium carinatum	E	—	—	—	E	E	—	—	—	D	E	E	E
Bullopora rostrata	—	E	—	—	—	E	—	—	—	D	E	E	E
Carixia langi	—	—	—	—	—	—	—	—	—	D	—	—	—
Cristellaria hyperbolica	—	—	—	—	—	—	—	—	—	D	—	—	E
C. matutina	?E	?E	—	E	E 122	E	—	—	—	E 137 216 220	E 226	E	E
C. münsteri	—	—	—	E	—	—	—	—	—	E	E	E	E
C. protracta	—	E	219 242	—	—	E	—	—	—	E	E	—	E
C. quadricostata	—	—	—	—	—	E	—	—	—	E	E	—	—
C. similis	—	—	—	—	—	—	—	—	—	D	—	—	E
C. terquemi	E	—	—	—	—	—	—	—	—	E	226	E	E
C. varians	E	E 63	— 123 124 219 242	E 222	E 122 217 218 232 233	E	—	—	—	E 216	E 226 227	E	—
C. (Saracenaria) inclusa	—	—	—	—	—	—	—	—	—	E	E	—	E
Marginulina lamellosa	—	—	219	E 222	122 218 232	E	223	—	—	220	E	—	—
M. laxata	—	—	—	—	—	—	—	—	—	D	E	—	—
M. prima	—	63	124	—	—	—	—	—	—	E 137 216	E 226 227	E	—
M. spinata	—	E	—	E 222	122 232	—	223	—	—	E 243	E	—	—
Dentalina communis	E	E	123 124 219 242	E 222	122 217 218 232	—	—	209	—	E 137 216 220 243	E 227	E	E
D. deslongchampsi	—	E	—	E	—	E	—	—	—	E	E	—	—
D. torta	—	—	—	E	—	E	—	—	—	E	E	E	E
D. vetusta	—	—	242	—	—	—	—	—	—	E 243	—	—	—
D. virgata	—	—	—	—	—	—	—	—	—	E	E	—	—
Nodosaria dolioligera	—	—	—	—	—	—	—	—	—	D	—	—	E
N. fontanessi	—	—	—	—	232	E	—	—	—	E	E	—	—

* Lias *β* includes the *semicostatum*, *obtusum*, *oxynotum* and *raricostatum* zones undifferentiated.

† The *ibex* zone is not separately represented either in the records or the collections.

‡ E indicates a record of the species in the European literature, which I believe to be a correct identification.

§ For the English localities indicated by these numbers, see above, p. 10.

‖ 217 includes the top of the *bucklandi* zone.

¶ D indicates that the present record from Dorset is apparently the only one from the *davoei* zone.

(*b*) RANGE TABLE (*continued*)

Species	Lower Lias zones										Middle Lias	Upper Lias	Higher Jurassic
	planorbis	*angulatus*	*angulatus* and *bucklandi*, unseparated	*bucklandi*	*semicostatum*	Lias *β**	*raricostatum*	*jamesoni*	*ibex*†	*davoei*			
N. hortensis	E	E	123 124	E 222	E 217 218 232	E	—	—	—	E 220	E	E	E
N. marsupifera	—	—	—	—	—	—	—	—	—	E	E	—	E
N. octoplicata	—	—	—	—	E	—	—	—	—	D	—	—	—
N. pyriformis	—	—	—	—	—	—	—	—	—	E	—	—	—
N. sculpta	—	α**	—	—	E	—	—	—	—	E	E	—	—
N. simplex	—	—	—	—	—	E	—	—	—	E	E	—	E
Pseudoglandulina oviformis	—	—	—	—	—	—	—	—	—	E	E	E	E
P. septangularis	—	—	—	—	—	—	—	—	—	E	—	—	E
P. tenuis	—	—	—	—	—	—	—	—	—	E	?E	E	E
P. vulgata	—	—	—	E	E 122	—	—	209	—	E 216	E 226	E	E
Lingulina laevissima	—	—	—	E	E 217	E	—	—	—	E	E 226	E	E
L. tenera	E	α 63	123 124 219 242	222	E 122 217 218	E	223	209	—	E	E 226 227	—	—
L. tenera var. *pupa*	—	—	—	—	E 122 217 218 232 233	—	223	209	—	E 137 216 220 243	E 226 227	—	E
L. terquemi	—	—	—	—	—	—	—	—	—	E	—	—	—
L. (?) *compressa*	—	—	—	—	E 217 232	—	—	—	—	E	—	—	—
Tristix liasina	—	—	—	—	—	—	—	—	—	D	E	—	—
Vaginulina constricta	E	—	—	—	217	—	—	—	—	E	E	—	—
Flabellina centro-gyrata	E	—	—	E	—	—	—	—	—	E	E	E	E
F. inaequilateralis	—	—	—	—	—	—	—	—	—	E	—	E	E
Frondicularia sulcata	E	E 63	123 124 219 242	E 222 234	E 122 218 232 233	—	E 223	E 209	—	E 220	E	E	—
F. sulcata var. *squamosa*	—	—	—	—	—	—	—	—	—	E	E 226 227	—	—
F. terquemi var. *bicostata*	—	—	—	E	E	E	223	—	—	E 216 243	E	—	—
Lagena hispida	—	—	—	—	—	—	—	—	—	D	E	—	E
L. laevis	E	—	—	E	E	—	—	—	—	E	E	E	E
L. davoei	—	—	—	—	—	—	—	—	—	D	—	—	—
Polymorphina (*Eoguttulina*) *liassica*	E	α	—	—	—	E	—	—	—	E	E	E	—
Plectofrondicularia paradoxa	—	—	—	E 222 234	122 232 233	E	223	—	—	E 137 216 220	E 227	—	—
Bolivina liasica	—	?E	—	—	—	—	—	209	—	E 137 216	E	—	—
Bolivina aff. *prodromus*	—	—	—	—	—	—	—	—	—	D	—	—	—

** α indicates a European record from Lias α, i.e. the *planorbis*, *angulatus* and *bucklandi* zones undifferentiated.

(*c*) Provenance of specimens

The provenance of the specimens whose British Museum register numbers are given in the text is as follows:

P34196–P34197	123*a*	Black Ven	P34823–P34824	126	Stonebarrow
P34695–P34702	123*i–m*	Black Ven	P34825–P34856	123*d–m*	Stonebarrow
P34703–P34718	123*m*	Black Ven	P34857–P34877	123*a*	Black Ven
P34719–P34735	123*a*	Black Ven	P34878–P34881	122	Black Ven
P34736–P34804	122	Black Ven	P34882–P34886	123*m*	Black Ven
P34805–P34822	123*m*	Black Ven			

Any other register numbers that are referred to are of figured specimens whose provenance is given in the plate explanations.

(*d*) Systematic description

Family AMMODISCIDAE

Genus *Ammodiscus* Reuss, 1861

1. *Ammodiscus asper* (Terquem), plate 1, figure 7.

?1862 *Involutina silicea* Terquem, 2FL, p. 450, plate 6, figure 11*a*, *b* (see footnote on p. 17 below).
1863 *I. aspera* Terquem, 3FL, p. 431 (221), plate 10, figure 21*a*, *b*.
1874 *Ammodiscus aspera* (Terquem); Bornemann, p. 710.
1876 *Trochammina incerta* (d'Orbigny); Blake, p. 452, plate 17, figure 17.
?1885 *Ammodiscus incertus* (d'Orbigny); Haeusler, pars, p. 19, plate 2, figure 16; plate 3, figures 1, 2 only.
1891 *A. incertus* (d'Orbigny); Crick and Sherborn, p. 209, plate 1, figure 1.
?1893 *A. asper* (Terquem); Sellheim, pp. 10, 31.
1908 *A. asper* (Terquem); Issler, p. 41, plate 1, figures 9, 10.
1936 *A. infimus* (Strickland); Franke, p. 15, plate 1, figure 14*a*, *b*.

Material: Two specimens; Brit. Mus. P34716 (figured) and P34719.

Dimensions: Diameter 0·57 and 0·58 mm. respectively; maximum thickness of outer whorl about 0·04–0·05 mm.

Horizon: 123*a*, 123*m*.

Remarks: These two specimens are not adequate to investigate the species, but fortunately I have abundant material available from about the same horizon at Blockley, Worcestershire (locality 220), and also from the Middle Lias of Golden Cap, Dorset (locality 226).

The test is constructed of abundant quartz grains, nearly all colourless, and set in little colourless cement, which is non-calcareous, and presumably siliceous, since dilute hydrochloric acid does not affect it. The colour of the test is therefore a light grey, and the surface very rough owing to the projecting sand grains.

The test is formed of an ovoid protoconch, about 0·05 mm. in length, followed by an undivided coiled tube of some four to six whorls, which hardly embrace at all. This makes a circular disk, nearly flat—really extremely flat-biconcave—which is very thin, only up to about 0·05 mm. thick at the outer whorl, though specimens from Blockley range up to 1·1 mm. in diameter. The ratio of thickness to diameter is about 1:15.

The specimens so far found appear to be all megalospheric, even where they are abundant. Deformed specimens with an elongate test are common; this seems in some cases to be due to pressure during fossilization, but in others to have been caused by eccentric growth.

The species was aptly described by Terquem, except where he states '*canal très-irrégulier, loges indistinctes*'. Actually, even in his figure, the tube is fairly regular, without any subdivision into chambers, and no tendency in this direction has been observed in the material now examined. I interpret his remark, that, having assigned the species to a genus which he defined as having partial septation of the tube into chambers, he was too anxious to recognize such an appearance. The very coarse specimens from Golden Cap well illustrate Terquem's statement that with a dry shell only a structureless, bright, crystalline disk can be seen. The coiling is only visible after mounting in a liquid medium.

The species has sometimes been referred to *Ammodiscus incertus* (d'Orbigny) and to *Orbis infimus* Strickland,* in the latter case owing to an incorrect understanding of that species, which is calcareous and not arenaceous, and therefore certainly not an *Ammodiscus*.

Mr Arthur Earland kindly sent me specimens of the Recent *A. incertus* from various oceans of the world for comparison. The microspheric form is quite distinct from *A. asper*, having a smooth, fine-grained shell wall with much cement, and of a bright brown colour; the disk is notably biconcave, and has up to twenty whorls, which sensibly embrace. The megalospheric specimens are more nearly comparable, but they again form a stouter test, with a smoothly finished shell, still with some light brown colouring. Owing to the finer material used the shell walls are much thinner than in the case of *A. asper*. The ratio of thickness to diameter in eight specimens of *A. incertus* varied from 1:3·6 to 1:6·4, with a mean of 1:5·1, being a little less in the A than in the B forms. It is thus a much thicker species than *A. asper*.

A. asper was described as very common from the Lower Lias, 'assise à *Bel. acutus*', which is apparently the *semicostatum* zone, from Queuleu, near Metz.

Genus *Tolypammina* Rhumbler, 1895

2. *Tolypammina flagellum* (Terquem), plate 1, figure 8.

1870 *Webbina flagellum* Terquem, 3SO, p. 375 (273), plate 29, figure 30.

1883*b* *Hyperammina vagans* Brady; Haeusler, pars, p. 58, plate 3, figures (?7), 8, 9 only.

* I have studied the type material of this species at the British Museum (Natural History), and topotype material kindly sectioned for me by the Geological Survey.

?1883*a* *H. vagans* Brady; Haeusler, p. 26, plate 2, figures 2–6.
?1890 *H. vagans* Brady; Haeusler, pars, p. 18, plate 1, figures (?5), 6–18 only; plate 2, figure 1.
?1917 *Tolypammina vagans* (Brady); Paalzow, p. 216, plate 41, figure 3.
?1931 *Nubeculinella* (?) Berz, p. 7, plate 2, figure 6.

Material: Eight specimens; Brit. Mus. P34887 (figured), P34879 (two) and P34884 (five).

Dimensions: Diameter of tubes 0·03–0·23 mm.

Horizon: 122, 123*m*.

Remarks: The specimens are irregular arenaceous tubes adherent to shell fragments, etc. The cement of the wall is calcareous, so that the whole test is disintegrated with effervescence by dilute hydrochloric acid. The present material is poor, but no branching of the tubes is seen. No initial chambers have been recognized.

The assignment to *Tolypammina* seems to be certain, but the question of the specific name is not free from doubt, and the above synonymy is not satisfactory, since the authors concerned have usually not given full details, such as the dimensions of their specimens, and the material of which they are constructed, and sometimes no magnifications are given of the figures. Terquem himself, in my opinion, misinterpreted the species, considering that it was a '*Webbina*', that is, a calcareous form, covered entirely with a rough envelopment which masked the shape of nearly all the chambers. The alternative view adopted here is that it is really an arenaceous species, with undivided tube.

Two other Jurassic forms may be compared, described under the names *Dendrophrya jurassica* Paalzow (1932, p. 90, plate 4, figure 16) and *Tolypammina jurensis* Franke (1936, p. 15, plate 1, figure 11), which may possibly represent one species. These consist of arenaceous tubes adherent to shell fragments, etc., but they are described as branching, and it thus seems that they are best assigned to another genus.

T. flagellum was described as very rare from the *parkinsoni* zone (=Bathonian) of Fontoy, Moselle, eastern France.

Family OPHTHALMIDIIDAE

Genus *Problematina* Bornemann, 1874

When Terquem erected the genus *Involutina* (1862, 2FL, p. 450) the only form mentioned was his new species *I. silicea*, which must therefore clearly be taken as the genotype.* There seems no doubt, however, that he actually described the generic characters to include *I. jonesi* Terquem and Piette, though this species was not men-

* In the Brady Collection, Zoological Department, British Museum (Natural History), is a slide labelled '*Involutina* (*Cornuspira*) *silicea* Terquem, Lias Moyen, Metz', with a note that it was sent [to Brady] by Terquem, and '= *Trochammina*'. It has the original label on the back. On it are several good specimens, all of the form that I have identified as *Ammodiscus asper* (Terquem). Subject to confirmation by the type specimens, *Involutina* is thus a synonym of *Ammodiscus*.

tioned until the second section of the same paper, on p. 461. These two species do not, in fact, appear to be congeneric.

The specific name *jonesi* was really an invalid renaming of *Nummulites liassicus* Jones on its transfer to *Involutina* by Terquem and Piette, as Terquem explains in his introduction (1862, 2FL, p. 425). This explanation has been accepted by, I think, all later authors.

In his revision of 1874 Bornemann invalidly chose *I. jonesi* (=*liassica*) as the type and only species of *Involutina*.

To his new genus *Problematina* Bornemann assigned three of Terquem's species, and the first he mentioned, *Involutina deslongchampsi*, was designated as genotype by Cushman (1927, *Contr. Cushman Lab.* **3**, p. 188). Since, in my opinion, this species is a synonym of *liassica*, the valid generic name for this must be *Problematina*.*

Cushman (1933, p. 143) placed all three genera, *Silicina*, *Involutina* and *Problematina*, in the family Silicinidae, subfamily Silicininae. This arrangement was, according to Thalmann (1935, *J. Paleont.* **9**, 715), invalidated by Earland's proposal (1933, *Discovery Rep.* **7**, 89), which antedated Cushman by two months; Earland erected the subfamily Silicininae to include three other genera (*Miliammina*, *Silicosigmoilina*, *Rzehakina*) identical with Cushman's Rzehakininae. Thalmann thereupon proposed to let Earland's Silicininae stand valid, at the same time suggesting the name Involutininae for the subfamily Silicininae Cushman *non* Earland. But the subfamily name Silicininae Earland is invalid, under Art. 4 of the *International Rules*, since its type is not, nor does it include, the genus *Silicina*. Cushman's arrangement should therefore stand, and the subfamily names Silicininae Earland and Involutininae Thalmann be suppressed.

There has, I believe, been no work descriptive of *Problematina liassica* since that of Bornemann of 1874, and this form and others ascribed by Terquem to *Involutina* are not adequately known. Partly on account of incomplete or inaccurate observations of earlier authors, and partly because they are forms unknown outside the Lias of Europe, erroneous views have gained currency, and been embodied in the text-books.

The test of *P. liassica* dissolves readily and almost completely in dilute hydrochloric acid with evolution of gas, so that it is clearly calcareous and not siliceous. Seven specimens from Bengeworth were dissolved, and a minute residue was left, consisting largely of pyrites, which had infilled some of the shells. There was also a small quantity of fine sand grains, 0·02–0·005 mm. in diameter, partly quartz, partly isotropic matter. Of this sand, part at least was clearly due to dirt adhering to the shells, observed before solution, but not removed. If it be doubted whether the whole was due to dirt, there can be no doubt that any remainder would be quite insufficient to have formed an essential building material, and there was no siliceous cement.

* Terquem's species *Involutina petraea* and *I. nodosa*, also assigned by Bornemann to *Problematina*, were recorded as very rare by Terquem, and have apparently never since been found. Their real nature must await a study of Terquem's types, but judging from his figures and descriptions it seems unlikely that either is a true *Problematina*.

Problematina is therefore a calcareous genus, and it is wrongly placed in the family Silicinidae.* The genus appears to be a development of the simple coiled calcareous tube of *Cornuspira* and it should therefore be placed in the family Ophthalmidiidae, subfamily Cornuspirinae.

The highly developed lateral deposits of shell material, with stout pillars ending at the surface in tubercles, superficially recalls the Orbitoids, and this suggestion of possible relationship was put to Mr F. R. S. Henson. After detailed consideration and comparison of much material, Mr Henson writes (31 March 1939) that *Cornuspira* when well preserved shows the typical wall structure and brown coloration of the Porcellanea, and agrees in this respect exactly with *Orbitolites*, *Dendritina*, etc. In fossil material, however, the brown colouring is often lost, no doubt owing to alteration, and the shell material is then usually colourless, calcareous, and cryptocrystalline.

In thin section, the wall, especially the pillars, of all Orbitoids, Camerinidae, Rotaliidae, Amphisteginidae, and Calcarinidae generally shows pronounced fibrous structure, except where the test is manifestly altered.

The wall structure of *Problematina liassica* is cryptocrystalline and not fibrous or perforate, unless the original material has been replaced. *Problematina* therefore agrees with *Cornuspira* but differs from the Orbitoids, etc., in wall structure.

With regard to the lateral pillars, various genera other than the Orbitoids and Camerinidae possess them, such as *Miscellanea* and *Siderolites*. Finally, in Orbitoids the lateral shell deposits generally seem to follow some degree of specialization of the equatorial layer, but in *Problematina liassica* the lateral pillars are built directly over the primitive *Cornuspira* coil. Thus Mr Henson concludes that *Problematina* is unlikely to be related to the Orbitoids.

3. *Problematina liassica* (Jones), plate 1, figures 9–11; text-figures 1–3.

1853 *Nummulites liassicus* Jones, in Brodie, p. 275.
1862 *Involutina jonesi* Terquem and Piette, in Terquem, 2FL, p. 461, plate 6, figure 22*a–d*.
1863 *I. jonesi* Terquem and Piette; Terquem, 3FL, p. (156).
1863 *I. deslongchampsi* Terquem, 3FL, p. 432 (222), plate 10, figure 22*a*, *b*.
1864 *I. liassica* (Jones); Brady, p. 193, plate 9, figures 1–6.
1874 *I. liasina* (sic) (Jones); Bornemann, p. 713, plate 18, figures 1–3; plate 19, figures 1–7.
1874 *Problematina deslongchampsi* (Terquem): Bornemann, p. 733.
1876 *Involutina liassica* (Jones); Blake, p. 453, plate 18, figure 6 (?6*a*).
1886 *I. liassica* (Jones); Lucy, p. 131.
?1886 *Involutina* Quilter, p. 59.
1906 *I. liassica* (Jones); Richardson, p. 259.

* With *Involutina* most probably a synonym of *Ammodiscus* (see footnote on p. 17 above), and *Problematina* a calcareous genus, *Silicina* is left as the sole representative of the Silicininae. The genotype of *Silicina* is *Involutina polymorpha* Terquem, unsatisfactorily and unconvincingly described and figured, and never since recognized. I saw three of Terquem's slides labelled *I. polymorpha* in Paris museums in 1931, but made no notes that are now of value. It may be doubted whether *Silicina* will prove to be a valid genus.

1908 *I. liassica* (Jones); Richardson, p. 135.
1908 *Ammodiscus infimus* (Strickland); Issler, pars, p. 40, plate 1, figures 7, 8 only.
1913 *Involutina liassica* (Jones); Upton, p. 72.
1918 *I. liassica* (Jones); Trueman, p. 69.
1933 *I. liasina* (Jones); Kuhn, p. 15.
1934 *I. liassica* (Jones); Henderson, p. 553.
1935 *I. liasina* (Jones); Kuhn, p. 466.
1936 *I. liasina* (Jones); Franke, p. 17, plate 1, figure 13.

Material: Two specimens; Brit. Mus. P34720 (figured) and P34910.

Dimensions: Diameter 0·67 and about 0·57 mm.; thickness 0·27 and 0·31 mm. respectively.

Horizon: 123*a*; and fallen block, believed to have come from the Red Band (horizon 126), from Seatown, Dorset.

Remarks: The two specimens found in the collection, one as a vertical section in a sliced rock specimen, gave little opportunity for adequate investigation of this species. Fortunately, another collection was available, material washed from the Lower Lias clay (*bucklandi* zone) from the brickyard at Bengeworth, close to Evesham, Worcestershire (locality 210), Brit. Mus. P5133. This material consists very largely of specimens of *Problematina liassica* in excellent preservation.

Brady in 1864 described the form as follows: 'It consists essentially of a tube, somewhat increasing in diameter, coiled upon itself in a horizontal plane—or perhaps, more correctly speaking, of a tube, with a portion of its periphery cut out, coiled upon itself, as it is only a tent-like covering for the sarcode, increasing in length with the growth of the animal. The shell-wall is not double between the successive coils of the spire, as is the case in the true Rotalinae. Much exogenous deposit of shell-substance takes place upon the disk thus formed, sometimes covering the entire surface, but more usually leaving the outermost circle of the tube bare. This thickening does not occur with evenness or regularity; but, in addition to its general tendency towards the centre of the disk (which gives the bi-convex contour) it takes the form of irregular tubercles, which sometimes almost cover the sides.'

It may be added that the test is free, lenticular in shape, generally fairly symmetrical; the last whorl only is visible externally, the whole of the earlier part of the test being covered with a layer of shell material, ornamented with coarse tubercles. The walls of the test are, according to my observation, generally imperforate. But when the outer whorl in adult individuals becomes pinched out into a flange (see below), this flange usually has a reticulate surface, produced by deep pitting. In a few sections seen, such pitting extends to the wall of the later part of the last coil, which may then appear to be coarsely perforate. Both Brady and Bornemann have illustrated this, but Brady considered that the perforation was characteristic of the whole test, merely being concealed by 'sand' and shell deposit on the sides. So far as I have seen, this coarse pitting does not appear before the fully adult stage is reached. Mr Henson

agrees that the appearance is probably due to superficial pits, as observed in certain other imperforate forms, such as *Miliola saxorum* Lamarck, *Massilina decorata* Cushman, etc. They should not be confused with the true pores of perforate forms.

Measured specimens varied from 0·27 to 1·27 mm. in diameter, and from 0·15 to 0·50 mm. in thickness. The ratio of thickness to diameter in twenty-one measured specimens varied from 1:1·84 to 1:3·38, the average being 1:2·48. Other specimens from Fretherne (localities 217, 218) and Staverton (locality 219) showed pyrites casts up to 1·36 mm. in diameter; the original shells must have measured some 1·5 mm. in diameter.

Sections show that the test is constructed of an ovoid to kidney-shaped protoconch about 0·10 × 0·07 mm. in size, followed by a simple, undivided, apparently imperforate tube (or rather partial tube, as Brady described), of usually four to five whorls. This tube is at first nearly circular in section (figure 1), but as growth proceeds the

FIGURE 1 FIGURE 2 FIGURE 3

FIGURES 1–3. *Problematina liassica* (Jones), × 107, apertural views; all specimens from *bucklandi* zone, Lower Lias clay, Bengeworth Brickyard, Evesham, Worcestershire; Brit. Mus. sample P5133. 1, young specimen; Brit. Mus. P34888. 2, young adult specimen; Brit. Mus. P34889. 3, aged specimen; Brit. Mus. P34890.

shape changes to roughly triangular (figure 2). Later still the apex of the triangle becomes gradually pinched out, and finally the tube becomes semi-lunar or horseshoe-shaped in section, embracing the earlier whorl (figure 3). In juvenile specimens the nearly circular body tube gives a rounded margin to the test, but as the shell grows and the section of the tube becomes triangular, a stout flange appears round the periphery, formed by the pinching out of the peripheral angle of the tube. The diameter of the tube seen in horizontal sections increases steadily from about 0·02 mm. in the first whorl to about 0·10 mm. at the end of the fourth; in vertical sections it similarly increases from about 0·07 to 0·18 mm. The thickness of the tube wall varies from about 0·02 mm. in the first to 0·04 mm. in the fourth whorl.

There are several of Brady's points, however, with which I disagree. He claimed that the outermost wall included arenaceous grains embedded in the calcareous shell substance. I cannot confirm this in my material. He wrote of the 'very partial and irregular development of the septa; indeed many specimens appear to be almost devoid

of any division into chambers', while 'some horizontal sections seem to indicate that the septa or imperfect partitions are not formed on the same plan that prevails in the higher forms of Foraminifera, but that they are essentially plaits [sic? read pleats] or infoldings of the outer shell'. He gave a diagrammatic sketch to explain his meaning.

I have examined some eighty-seven Bengeworth specimens sectioned horizontally, and I have found no support for Terquem's and Brady's claim of partial septa. Blake also stated that he could find no sign of Terquem's semipartitions, and Mr Henson's experience is the same.

Brady further suggests that in specimens from Fretherne, the lateral masses are irregularly crystalline, giving no evidence of structural peculiarity, though he admits traces of a structure similar to pillars in a few transverse sections. In the Bengeworth specimens examined in vertical section, radial pillars ending externally in the surface tubercles are clearly seen to make up most of the lateral shell masses.

Brady states that the species has 'obvious affinities to *Trochammina*', perhaps in the sense that *Trochammina* was used in 1864. In 1884 (p. 66) he placed it in the Lituolidae, subfamily Endothyrinae. One must disagree with this on the ground that *Problematina liassica* is calcareous, practically symmetrical in vertical section, and with the body tube non-septate.

While Bornemann had specimens of *P. liassica* available for study from the Lower Lias of Wadenberg, near Eisenach, Germany, he appears to have relied on Terquem's descriptions and figures for his views on the other species assigned by that author to *Involutina*. Bornemann confirmed the calcareous nature of the test of *Problematina liassica* (which was in fact so described by Terquem for his *Involutina jonesi* and *I. deslongchampsi*), and found a very small residue of sand grains after solution of the test, the origin of which he considered doubtful. He also described and figured (plate 19, figure 7) a section of a portion of the wall of the test, which showed many pores, now interpreted as superficial pits. Since Terquem's descriptions and figures of his *Involutina* species are generally inadequate to define them, and, I believe, sometimes incorrect and misleading, such a revision as Bornemann's is liable to grave errors. Before the group can be adequately revised it will be essential to study Terquem's types, if they are still extant, and probably topotype material for sectioning.

Terquem claims (1862, 2FL, Introduction, p. 426) that, on solution of a specimen of *I. jonesi* in hydrochloric acid, he found a yellow residue which had filled the interior of the shell. This cast showed that the test had numerous chambers separated by partial septa fixed to the external part of each whorl, and he gave drawings of them (plate 6, figure 22*b*, *d*). I have some pyrites casts of specimens which show the phenomenon described by Terquem, but in my view the constrictions visible are due merely to the irregular mode of growth. A similar cast is shown by Issler's figure 8. Prepared sections do not show the partial septa so clearly and abundantly figured by Terquem, and I reluctantly take these to be simply imaginative.

From *I. jonesi* Terquem distinguishes *I. deslongchampsi* by its less numerous, more

elevated tubercles, and by its thick septa *entières et non vitreuses comme le reste de la coquille.* He describes it as *fort rare* from the *davoei* zone of Vieux Pont, between Caen and Bayeux, Normandy. He defines his terms of frequency (1863, 3FL, p. (224)), and states that *très-rare*=one specimen; there is no definition of *fort rare*, but this can hardly indicate a greater number than *très-rare*, so that it seems he had only a single specimen of *I. deslongchampsi.* He figures no section, so that his statement that the septa are complete lacks any evidence. He shows very distinct, thick sutures on the outermost whorl, indicating about twelve chambers. I suspect that these are imaginary. The diameter of *I. deslongchampsi* is given as 0·36 mm., and I have no doubt that it is merely a young specimen of *Problematina liassica.*

Terquem states (1863, 3FL, p. (224)) that the types of the species described in his first three Lias memoirs are in the Geological Museum at Metz. In reply to a query as to these, the President of the Société d'Histoire naturelle de la Moselle kindly wrote (2 April 1932) that his society was in charge of the collections at Metz, and that they possessed a series of plaster models of Foraminifera. He gave no information about Terquem's Lias types. Nevertheless, it may be doubted whether this precludes their presence in that museum at the present time.

In 1931 I examined specimens of five of Terquem's *Involutina* species in museums in Paris, but they were questionable duplicates. I found no specimen of *I. deslongchampsi.* Of *I. jonesi* I saw two specimens, in the Laboratoire de Zoologie (Vers et Crustacés), o the Museum National d'Histoire Naturelle, and in the Schlumberger Collection, Département de Géologie, at the Sorbonne. On these specimens I made no notes that are now of value.

Problematina liassica was described from the Lower Lias of Fretherne and Purton in Gloucestershire. At Fretherne the only strata exposed at Hock Cliff are the *bucklandi* and *semicostatum* zones (Henderson, 1934, p. 560), which I take to be the type horizon.

Involutina jonesi was described from the *angulatus* zone of Jamoigne, Belgium, and from the 'calcaire à *Am. bisulcatus*' (?=*bucklandi* zone) of Fleigneux, Ardennes. It was later recorded by Terquem (1863, 3FL, p. (156)) as abundant from Saint-Julien-lès-Metz, that is, the *davoei* zone.

Genus *Ophthalmidium** Zwingli and Kübler, 1870

4. *Ophthalmidium carinatum* (Kübler and Zwingli), plate 1, figure 12.

1866 *Oculina carinata* Kübler and Zwingli, p. 14, plate 2, figure 19.
1866 *O. nucleus* Kübler and Zwingli, p. 14, plate 2, figure 20.
1870 *Ophthalmidium carinatum* Zwingli and Kübler, p. 16, plate 2 (Blagdenischicht), figures 11, 12; and p. 22, plate 2 (Ornatenthon), figure 6.
1870 *O. okenii* Zwingli and Kübler, p. 18, plate 2 (Parkinsonithon), figures 10, 11.
1870 *O. birmenstorfensis* Zwingli and Kübler, p. 31, plate 3, figure 46.

* The genus *Spirophthalmidium* Cushman, 1927, proves to be an exact synonym of *Ophthalmidium* (Macfadyen, 1939, p. 164).

1875 *Spiroloculina concentrica* Terquem and Berthelin, p. 80, plate 7, figures 1–4.
non 1885 *Ophthalmidium carinatum* Balkwill and Wright, p. 326, plate 12, figures 13–16.
1886 *Spiroloculina concentrica* Terquem and Berthelin; Burbach, p. 501, plate 5, figures 19–23.
?1886 *S. simplex* Burbach, p. 500, plate 5, figure 15.
1887*b* *S. concentrica* Terquem and Berthelin; Haeusler, p. 194, plate 7, figures 38, 41.
1887*b* *Ophthalmidium carinatum* (Kübler and Zwingli); Haeusler, p. 194, plate 7, figures 39, 40, 43–45, 47–51.
?1890 *Spiroloculina carinata* var. *marginata* Wisniowski, p. 188, plate 8, figure 5*a–d*.
1903 *S. concentrica* Terquem and Berthelin; Schick, p. 156, plate 6, figure 24.
non 1903 *Ophthalmidium carinatum* (Kübler and Zwingli); Schick, p. 156, plate 6, figure 23.
1908 *Spiroloculina concentrica* Terquem and Berthelin; Issler, p. 45, plate 1, figures 30–32.
non 1932 *Spirophthalmidium carinatum* (Kübler and Zwingli); Paalzow, p. 99, plate 5, figures 7–10.
1932 *S. tenuissimum* Paalzow, p. 100, plate 5, figures 11–13.
1936 *S. concentricum* (Terquem and Berthelin); Franke, p. 123, plate 12, figures 15, 17.
?1937 *S. concentricum* (Terquem and Berthelin); Bartenstein and Brand, p. 181, with many figures, mostly too small to identify with certainty.
1939 *Ophthalmidium carinatum* (Kübler and Zwingli); Macfadyen, p. 163, text-figure 1.

Material: 143 registered specimens; Brit. Mus. P34708 (twelve), P34740, P34759, P34764 (thirteen), P34805 (seven), P34813 (seven), P34814 (seven), P34823 (fourteen), P34825 (seventy-five), P34857, P34882 (four), P34891 (figured). An additional seventy-two specimens were picked out of the 123*d–m* sample, so that the remarks below are based upon the examination of some 215 specimens.

Dimensions: Length, about 0·18–0·39 mm.; width, 0·09–0·17 mm.; thickness, up to 0·035 mm.

Horizon: 122, 123*a*, 123*d–m*, 123*m*, 126.

Remarks: The species is well described by Zwingli and Kübler in their 1870 paper. The test is calcareous, and there appears to be a chitinous layer, seen as a remainder when the shell is dissolved in dilute hydrochloric acid. The wall appears to be imperforate, even under a magnification of about 350 diameters. The globular protoconch, about 0·01 mm. in diameter, is followed by a second chamber, which is about a half coil of thin tube apparently of uniform diameter; the third chamber forms a complete coil, gradually tapering from its greatest diameter close to the base towards the distal end; the fourth and subsequent chambers are of the adult type, each forming a half coil, each chamber being of greatest diameter close to the base. There are usually about five of these adult chambers. The chambers are joined laterally by a thin plate of calcareous or chitinous material in the median plane of the test. The aperture is simple, often slightly expanded, rarely with a pronounced rounded and thickened lip. In adult individuals it is found at the end of a rather fragile projecting tube about 0·01 mm. in diameter, the distal end of the last chamber. On account of its fragility many shells are found with this projecting tube missing owing to breakage; its internal diameter is only of the order of 0·005 mm.

The outer margin of the final coil is rounded, the keel-like effect being seen only

when mounted in a transparent medium and viewed by transmitted light; it is due merely to the thickness of the chamber wall seen in contrast with the empty chamber.

I have not been able to observe the phenomenon of dimorphism in this species. The size of the shells, and especially of the protoconch, is small, and the latter is only satisfactorily visible when viewed as a transparent object, so dimorphism may possibly be found if sufficient specimens are properly examined.

The differences in the type figures of *Ophthalmidium carinatum* and *Spiroloculina concentrica* appear to be due to the first having been figured as seen mounted in balsam by transmitted light, while the second was figured as seen on a dry mount by reflected light. In addition, there is appreciable individual variation among the specimens, for which allowance must be made.

Ophthalmidium carinatum was described as common from the *opalinus* zone (uppermost Lias or Lowest Bajocian) of Schambelen, Canton Aargau, Switzerland.

Genus *Bullopora* Quenstedt, 1858

Cushman (1933, p. 192) considered *Vitriwebbina* Chapman, 1892 to be a synonym of *Bullopora*. But if Chapman is correct in stating that *Vitriwebbina* has a finely perforate wall, with a polymorphine initial stage, then it is certainly distinct.

Bullopora, on the contrary, has a coiled initial stage followed by a linear series of chambers; there is a simple, terminal aperture, and the wall is calcareous, and appears to be imperforate. This, in fact, seems to be the form described by Cushman in 1929 as *Nubeculinella*, which thus becomes a synonym of *Bullopora*.

In *B. rostrata* the chambers are aludel-shaped, strongly recalling those of *Ophthalmidium*, and suggesting that it is really just an *Ophthalmidium* that has become attached and uncoiled. Its systematic position is clearly in the family Ophthalmidiidae, subfamily Nubeculariinae.

5. *Bullopora rostrata* Quenstedt, plate 1, figures 13–17*a–c*.

1858 *Bullopora rostrata* Quenstedt, p. 580, plate 73, figure 28.
1860 *Nubecularia tibia* Jones and Parker, p. 455, plate 20, figures 48–51.
?1865 *N. rostrata* (Quenstedt); Schwager, p. 93.
1866 *Placopsilina gracilis* Terquem, 5FL, p. 419, plate 15, figure 21*a–d*.
1866 *P. producta* Terquem, 5FL, p. 424, plate 16, figure 7*a–h*.
1866 *Dentalina radicula* Terquem, 5FL, p. 406, plate 15, figure 8*a*, *b*.
1866 *Placopsilina cornuta* Terquem, 6FL, p. 491, plate 20, figures 9–21.
1866 *P. filipendula* Terquem, 6FL, p. 492, plate 20, figure 22.
1866 *P. ovigera* Terquem, 6FL, p. 495, plate 20, figure 30.
?1870 *Webbina acuminata* Terquem (non Terquem and Piette, 1862), 3SO, p. 374 (272), plate 29, figures 27–29.
1875 *Placopsilina gracilis* Terquem; Terquem and Berthelin, p. 34, plate 2, figures 24*a*, *b*.
1875 *Dentalina nodigera* Terquem and Berthelin, p. 25, plate 1, figure 31*a*, *b*.
1875 *Nodosaria* Terquem and Berthelin, p. 18, plate 1, figure 14*a–f*.

1886 *Webbina infraoolithica* Terquem pars (non Terquem, 1870), p. 16, plate 1, figures 43–47 only.
1886 *W. impressa* Terquem, p. 17, plate 1, figure 49.
?1886 *W. rostrata* (Quenstedt); Deecke, p. 313.
1887*b* *Nubecularia tibia* Jones and Parker; Haeusler, p. 190, plate 6, figures 1–6.
?1887*b* *Ophthalmidium walfordi* Haeusler, p. 192, plate 6, figures 7–11.
1890 *Webbina involuta* Wisniowski, p. 191, plate 1, figure 9.
1895 *Nodobacularia tibia* (Jones and Parker); Rhumbler, p. 87.
1908 *Nubecularia tibia* Parker and Jones (sic); Issler, p. 43, plate 1, figures 15–19.
1908 *Webbina gracilis* (Terquem); Issler, p. 92, plate 7, figure 330.
1908 *Ophthalmidium oolithicum* Gaub, p. 586, text-figures 1–3.
1917 *Nodobacularia rostrata* (Quenstedt); Paalzow, p. 219, plate 41, figure 16.
1931 *Nubeculinella infraoolithica* (Terquem); Berz, p. 7, plate 1, figures 3, 4.
1931 *N. filiformis* Paalzow MS.; Berz, p. 7, plate 1, figure 5.
1931 *Nubeculinellen* Berz, plate 1, figures 1, 2; plate 2, figure 7 (pars).
non 1931 *Bullopora rostrata* Quenstedt; Berz, p. 7, plate 2, figure 8.
1932 *Nubeculinella filiformis* Paalzow, p. 97, plate 5, figure 3.
1932 *N. infraoolithica* (Terquem); Paalzow, pars, p. 98, plate 5, figure 1 only.
1932 *Nodobacularia bulbifera* Paalzow, p. 96, plate 5, figures 4–6.
non 1932 *Bullopora rostrata* Quenstedt; Paalzow, p. 137, plate 10, figures 1, 4.
1935 *B. rostrata* Quenstedt; Macfadyen, p. 18, plate 1, figures 23, 24.
?1936 *B. rostrata* Quenstedt; Kuhn, p. 450, text-figure 11.
non 1936 *B. rostrata* Quenstedt; Franke, p. 121, plate 12, figure 11.
non 1937 *B. rostrata* Quenstedt; Silvestri, *Pal. Italica*, **32**, suppl. 2, p. 95, plate 20, figure 1 (? = *Stomatopora* sp., a polyzoan).
non 1937 *B. rostrata* Quenstedt; Bartenstein and Brand, p. 180, 7 figures.
1937 *Nubeculinella infraoolithica* (Terquem); Bartenstein and Brand, p. 180, many figures.

Material: Seventeen specimens: nine of them adherent, Brit. Mus. P34878, P34893 (figured); and eight free ends, P34833, P34892 (figured).

Dimensions: Individuals up to about 0·40 mm. in length; chambers 0·05–0·10 mm. in thickness; free single chambers up to 0·28 mm. long.

Horizon: 122, 123*d–m*.

Remarks: *Bullopora rostrata* is a porcellanous-shelled form, generally found strongly adherent to foreign objects such as shell fragments, pebbles, etc. The young stage is coiled, but the test quickly develops a linear series of typically aludel-shaped chambers. The aperture is simple, formed by the thin open end of the final chamber.

B. rostrata rarely grows in a straight line, the series of adult chambers generally being more or less curved, or irregular, which is partly conditioned by the shape of the foreign body to which the test adheres. It also has a tendency to irregularity of growth, and sometimes becomes so shapeless that single specimens may be specifically indeterminable.

The latest formed chambers sometimes extend beyond the margin of the fragment to which the earlier part of the test is attached, and instead of bending round a sharp corner they continue in a straight line, so that when broken off, as they are usually

found, they appear to be from a free-growing form. I have several specimens from the Oxford Clay of Warboys, Huntingdonshire, which show these free-growing chambers still forming an unbroken part of the adherent test (plate 1, figure 16). Such chambers have been described under a variety of names, such as *Dentalina nodigera* and *Nodobacularia bulbifera*.

Since the description of the British Somaliland material (1935), I have re-examined the types of *Nubecularia tibia* and, in the additional light of abundant and well-preserved material of *Bullopora rostrata* from the Ampthill and Oxford Clays, I have no doubt that *Nubecularia tibia* is a synonym of this species.*

The aludel-shaped chambers are characteristic of *Bullopora rostrata*, and differentiate it in particular from *B. irregularis* (d'Orbigny), based on Cornuel's figures of 1848 labelled *Œufs de mollusques*.

Ophthalmidium walfordi Haeusler, 1887, doubtfully placed in the synonymy above, is possibly intermediate between *Ophthalmidium* and *Bullopora*. Haeusler's type figures seem to represent *Bullopora rostrata*, though with but a single adult chamber. Franke's (1936, plate 12, figure 16) form assigned to *Ophthalmidium walfordi* is, however, figured as having several half-coil chambers, and is essentially an *Ophthalmidium* with a final aberrant chamber.

Bullopora rostrata was described from the Lower White Jura (=approximately Corallian), of Reichenbach, near Geisslingen, Württemberg, Germany (lat. 47° 18′ N., long. 8° 50′ E.).

I have specimens from the Ampthill Clay (Corallian) of Manea, Cambridgeshire, and from Gamlingay, Bedfordshire; also from the Oxford Clay of Warboys, Huntingdonshire, of Sandy, Bedfordshire, and of Wolvercote, Oxfordshire. The species is particularly abundant and well preserved in the collection from Warboys.

Genus *Carixia*† gen.nov.

Genotype *Carixia langi* sp.nov.

Diagnosis: An adherent reticulation of unsegmented, imperforate, calcareous tubes, set in a groundwork of calcareous cement; apertures, the simple open ends of the tubes; early development of the test unknown.

I am much indebted to Mr Arthur Earland for examining specimens of *Carixia langi*. He wrote that he considered that the anastomosing of the tubes pointed to a Rhizopod origin, and kindly sent me specimens of the Recent *Sagenina frondescens* (Brady) and '*S.*' *divaricans* Cushman for comparison.

* *Nubecularia tibia* was the genotype and only described species of *Nodobacularia* Rhumbler, 1895. Since this name proves to be a synonym of *Bullopora* a new generic name is necessary for the free (not attached) forms, generally of Recent age, assigned to *Nodobacularia*, which seem not to be congeneric with *Bullopora*, though of the same family. I have recently proposed for such the name *Nodophthalmidium* (1939, p. 167).

† Carixa has been claimed as the Roman name for Charmouth.

The genotype of *Sagenina* is *Sagenella frondescens* Brady (1879, *Quart. J. Micr. Sci.* **19**, 41, plate 5, figure 1), which is a more or less arenaceous form, and the specimen available shows it to have a wall of sand grains set in calcareous cement.

'*S.*' *divaricans* Cushman (1910, *Proc. U.S. Nat. Mus.* **38**, 437, text-figure 1) has a wall said to be of coral mud; actually the specimens available appear to dissolve quite freely in dilute hydrochloric acid, and might easily be simply calcareous. This species, and perhaps also '*S.*' *regularis* (Douville) (1916, *Samml. Geol. Reichsmus. Leiden*, **10**, 33, plate 5, figure 5; plate 6, figure 4), may thus possibly not be congeneric with the true *Sagenina frondescens*.

The three Recent and Tertiary species referred to above, together with the only other two species I have found ascribed to the genus, namely *S. ramulosa* Cushman (1910, *Bull. U.S. Nat. Mus.* **71**, part 1, p. 72, text-figure 94) and *S. expansa* Yabe (1921, *Sci. Rep. Tôhoku Univ.* ser. 2 (Geol.), **5**, 98, plate 16, figures 3–5), are mainly recorded from the Indo-Pacific region, and occur chiefly in the tropical parts thereof. '*S.*' *divaricans* is also found in the Great Australian Bight and the Red Sea. Bermudez has a record of a Recent form, *Sagenina* sp., which he likens to both '*S. divaricans*' and *S. ramulosa*, from off the north coast of Cuba (1935, *Mem. Soc. Cubana Hist. Nat.* **9**, 148).

With the present lack of knowledge of the early development of the test, the systematic position of *Carixia* must be very uncertain. It is here assigned, very tentatively, to the Ophthalmidiidae, in which family several genera develop attached, unsegmented, calcareous tubes.

6. *Carixia langi* gen. et sp.nov., plate 1, figures 18–20.

Description: The form is composed of an irregular reticulation of thin, fairly straight, non-septate tubes; these are calcareous, with an apparently chitinous substratum, and seem to be imperforate; they are elliptical in section. The reticulation is set in a bed of whitish calcareous cement, which typically covers the whole surface of the foreign body, such as a fragment of shale, to which the specimen is adherent. The early part of the test had not been recognized; the apertures appear to be the simple open ends of the tubes.

Material: Forty-seven specimens; Brit. Mus. P34880 (figured, holotype), P34881 (eight), P34885 (thirty-six), P34886 (figured, paratype), P34896 (figured, paratype).

Dimensions: The tubes are about 0·015–0·03 mm. in greatest diameter; two tubes separated from the cement attachment measured 0·023 by 0·017 mm. and 0·029 by 0·012 mm. in their major and minor cross-sectional axes respectively.

Horizon: 122, 123*m*.

Remarks: The reticulation may be very sparse and open (figure 20), or may form a closely knit mesh (figure 19). The junction of two tubes takes place without thickening.

Portions of the tubes may be detached from the cement foundation by gumming a specimen face downwards upon a slide. After drying, the shale fragment is somewhat

forcibly removed, and part of the reticulation and cement are left isolated, gummed to the slide. The tubes appear glassy, and fairly transparent. They are not completely soluble in dilute hydrochloric acid, but leave a weak brown translucent skeleton, which seems to be of a chitinous nature.

The nearest described forms are species ascribed to *Sagenina*, such as *S. divaricans* Cushman, from Recent deposits off the Philippine Islands, and *S. regularis* (Douvillé), from the Neogene of Java; the latter has been identified by Yabe from the Eocene of the Bonin Islands (1921, loc. cit. p. 98, plate 16, figures 1, 2). *Carixia langi*, however, differs in its style of growth, which is a reticulation, with no definite point yet recognized as the protoconch, whereas *Sagenina divaricans* and *S. regularis* both grow in an essentially arborescent manner, branching out from one or more main stems. The diameter of the tubes also differs. Yabe gives for *S. divaricans* 0·05–0·1 mm., and for *S. regularis* 0·1–0·2 mm.; these are therefore considerably stouter-tubed species.

The basal cement sheet characteristic of *Carixia* may be seen, though less well developed, in some specimens of *Sagenina divaricans*.

Family LAGENIDAE

Genus *Cristellaria* Lamarck, 1812

The naming of forms of this genus in the Lias and other divisions of the Jurassic is often exceedingly difficult. Specimens are frequently abundant, and authors have erected many names on what appear to be inadequate grounds. Individual variation appears to be extreme, so that one is faced with the question—does a population of somewhat similar forms consist of a few true species with considerable individual variations, or of a greater number of allied species, the individuals thereof so overlapping in their characters that many are specifically indeterminable?

In these circumstances the assignment of any trivial name must often be arbitrary, and the greater number of species conceived to be present, the more specimens become unnameable. There are thus definite disadvantages, and probably little if any truth, in conceiving such a population to be made up of many similar species and named varieties, since adequate criteria for their precise definition and discrimination appear to be lacking. Attempts to implement such a conception merely result in encumbering the literature with names that appear to be without either value or significance.

Apart from very detailed statistical studies of large numbers of specimens from varying horizons and localities, which might possibly yield something definite, the best policy seems to be to describe the Cristellarian fauna as the product of a few species fairly broadly conceived.

In the case of the species recorded below, *Cristellaria münsteri*, *C. similis*, *C. quadricostata* and *C.* (*S.*) *inclusa* are well-marked forms not to be confused with others, perhaps partly on account of their rarity. On the contrary, commoner forms such as *C. protracta*, *C. hyperbolica*, *C. matutina*, *C. terquemi* and *C. varians*, though typically

distinct, appear to vary sufficiently for great difficulty to be felt in the precise naming of many individuals in a population containing them; alternative nomenclature would sometimes be possible, but in my opinion rather less reliable, than that assigned. Thus the absence of record of a particular name such as *C. terquemi* from a collection containing *C. varians* cannot invariably be taken as of real significance.

To add to the already present difficulty of discriminating adequately between the genera *Cristellaria*, *Marginulina*, and *Vaginulina*, of late years it has become the fashion in some quarters to distribute the Cristellarian species among several more closely conceived genera or subgenera such as *Lenticulina*, *Robulus*, *Planularia*, *Astacolus* and *Saracenaria*. Here again one is in immediate trouble, since the different species do not fall naturally and clearly into these divisions, and often it is impossible with certainty to place a form in one of these 'genera' rather than in another. Also the concept that a species which is to be placed in one 'genus' in the young adult stage of growth, but in a second 'genus' at a slightly more advanced age seems to be unsatisfactory. To avoid such difficulties and anachronisms the wider generic name *Cristellaria* is retained.

In these circumstances of difficult and controversial nomenclature, figures of each form named are essential.

7. *Cristellaria hyperbolica* Zwingli and Kübler, plate 2, figure 21*a*, *b*.

1870 *Cristellaria hyperbolica* Zwingli and Kübler, p. 35, plate 4 (Impressathon), figure 12.
1870 *C. rhenana* Zwingli and Kübler, p. 35, plate 4 (Impressathon), figure 13.

Material: Seven specimens; Brit. Mus. P34695, P34696 (figured), P34699, P34702, P34703, P34807, P34808.

Dimensions: Length 0·31–0·40 mm.; the mean of seven specimens is 0·36 mm.

Horizon: 123*m*, 123*i–m*.

Remarks: A largely uncoiled and only moderately compressed form, somewhat resembling *Cristellaria matutina*; but this latter is a much larger, coarser, and more robust species. The type of *C. hyperbolica* is only 0·28 mm. in length.

A complete synonymy of such a form as this is an impossibility, since it degenerates merely into a matter of personal opinion.

C. hyperbolica was described as rare from the Impressathon (=Corallian) of Baden in north Switzerland.

8. *Cristellaria matutina* d'Orbigny, plate 2, figure 22.

1850 *Cristellaria matutina* d'Orbigny, **1**, 242, no. 264.
1850 *C. antiquata* d'Orbigny, **1**, 242, no. 265.
1850 *C. vetusta* d'Orbigny, **1**, 242, no. 267.
1858 *C. matutina* d'Orbigny; Terquem, 1FL, p. 620 (59), plate 3, figure 14*a–c*.
1858 *C. antiquata* d'Orbigny; Terquem, 1FL, p. 620 (60), plate 3, figure 15*a*, *b*.
1858 *C. vetusta* d'Orbigny; Terquem, 1FL, p. 622 (62), plate 3, figure 17*a–d*.
1867 *Marginulina ensis* Reuss; Brady, p. 225, plate 2, figure 23.
1876 *Cristellaria recta* d'Orbigny; Blake, pars, p. 465, plate 19, figure 13 only.

1884 *Cristellaria* cf. *impleta* Terquem and Berthelin; Deecke, p. 43, plate 2, figure 6.
1888 *C. matutina* d'Orbigny; Burbach and Dreyer, p. 509, plate 11, figures 35–38.
1888 *C. subarcuatula* (Walker and Jacob); Burbach and Dreyer, p. 509, plate 11, figure 34, (?33).
1891 *C. 'liasina'* Bachelard, p. 68, plate 5, figures 5, 5'.
1891 *C. prima* d'Orbigny; Crick and Sherborn, p. 212, plate 1, figure 27.
1903 'Übergang von *C. plana* Reuss zu *M. ensis* Reuss', Schick, plate 4, figure 22.
1908 *C. matutina* d'Orbigny; Issler, p. 83, plate 6, figures 275–288.
1932 *Lenticulina prima* (d'Orbigny); Paalzow, p. 104, plate 6, figures 16, 17.
1936 *C. matutina* d'Orbigny; Macfadyen, p. 151, plate 1, figure 264.
1936 *C. antiquata* d'Orbigny; Macfadyen, p. 151, plate 1, figure 265*a*, *b*.
1936 *C. vetusta* d'Orbigny; Macfadyen, p. 151, plate 1, figure 267.
1936 *C.* (*Astacolus*) *matutina* d'Orbigny; Franke, p. 106, plate 10, figures 11, 12.
1936 *C.* (*A.*) *vetusta* d'Orbigny; Franke, p. 105, plate 10, figure 13.
1936 *C.* (*A.*) *antiquata* d'Orbigny; Franke, p. 105, plate 10, figure 14.

Material: Twenty-eight specimens; Brit. Mus. P34196, P34707, P34727 (figured), P34735, P34738, P34795, P34840 (thirteen), P34860 (nine).

Dimensions: Length 0·20–0·99 mm.; the mean of twenty-four measured specimens is 0·48 mm. From certain horizons they are much larger than from others.

122, 123*a*: length 0·40–0·99 mm., mean of ten (three broken), 0·57 mm.

123*d–m*, 123*m*: length 0·20–0·54, mean of fourteen, 0·30 mm.

Horizon: 122, 123*a*, 123*d–m*, 123*m*.

Remarks: Typically a large and strongly made form; it has a large and strongly inflated initial coiled portion, followed by a number of uncoiled chambers.

Cristellaria matutina was described from the *davoei* zone of the Metz district where, according to Terquem, it is common.

9. *Cristellaria münsteri* (Roemer), plate 2, figure 23*a*, *b*.

1839 *Robulina münsteri* Roemer, p. 48, plate 20, figure 29.
1839 *R. gibba* Roemer, p. 47, plate 20, figure 30.
1854 *R. gottingensis* Bornemann, p. 43, plate 4, figures 40, 41.
1867 *Cristellaria vulgaris* Schwager, p. 661, plate 34, figure 19.
1867 *C. rotulata* (Lamarck); Brady, p. 227, plate 3, figure 36.
?1881 *Robulina liasica* Haeusler, p. 19, plate 2, figure 6.
1886 *R. vulgaris* (Schwager); Deecke, p. 323, plate 2, figures 3, 3*a*.
1892 *Cristellaria rotulata* (Lamarck); Crick and Sherborn, p. 12, plate 2, figure 14*a*, *b* (?).
?1917 *C. rotulata* (Lamarck); Paalzow, p. 242, plate 46, figure 17.
?1922 *C. münsteri* (Roemer); Paalzow, p. 29, plate 3, figure 16.
1932 *Lenticulina münsteri* (Roemer); Paalzow, p. 101, plate 5, figures 23, 24; plate 6, figures 1, 2.
1935 *Cristellaria münsteri* (Roemer); Macfadyen, p. 13, plate 1, figure 10*a*, *b*.
1936 *C.* (*Lenticulina*) *gottingensis* Bornemann; Franke, p. 116, plate 11, figure 22*a*, *b*.
1937 *C.* (*L.*) *münsteri* (Roemer); Bartenstein and Brand, p. 174, many figures.

Material: One specimen; Brit. Mus. P34705.

Dimensions: Diameter 0·69 mm.; thickness 0·32 mm.

Horizon: 123*m*.

Remarks: *Cristellaria münsteri* is a rather stout, umbonate, wholly close-coiled form, with a fairly acute margin, but no keel. It has some nine to ten chambers visible.

I have compared the Dorset specimen with examples of *C. gottingensis*, which are plentiful in a sample which Herr Franke kindly sent me of Bornemann's original material for his 1854 paper, and I consider that it is the same species.

Crick and Sherborn's figures referred to above are not entirely satisfactory, and it seems possible that their figures 13 and 14 may have been accidentally interchanged.

C. münsteri was described from the Dogger (=Bajocian-Oxfordian) of Wrisbergholzen, north Germany.

10. *Cristellaria protracta* Bornemann, plate 2, figure 24.

1854 *Cristellaria protracta* Bornemann, p. 39, plate 4, figure 27*a*, *b*.
?1863 *Marginulina consobrina* Terquem, 3FL, p. 396 (186), plate 8, figure 5*a–c*.
1865 *Cristellaria subcompressa* Schwager, p. 120, plate 5, figure 4.
1865 *C. manubrium* Schwager, p. 121, plate 5, figure 6.
?1866 *Marginulina parallela* Terquem, 6FL, p. 499, plate 21, figure 3*a*, *b*.
?1870 *Cristellaria ala* Zwingli and Kübler, p. 20, plate 2 (Callovien), figure 8.
1875 *C. impressa* Terquem and Berthelin, pars, p. 46, plate 4, figures ? 3*a*, *b* and 5*b* only.
1876 *C. recta* d'Orbigny; Blake, pars, p. 465, plate 17, figure 24 only.
1886 *Cristellaria* cf. *subcompressa* Schwager; Deecke, p. 319, plate 2, figure 31.
1888 *C. protracta* Bornemann; Burbach and Dreyer, pars, p. 499, plate 10, figure 4 only.
1888 *C. gladius* (Philippi); Burbach and Dreyer, p. 501, plate 10, figure 12 (? 13).
1890 *C. Deeckei* var. *parallela* Wisniowski, p. 211, plate 9, figure 9*a*.
1890 *C. harpa* Reuss; Wisniowski, pars, p. 212, plate 9, figure 7*d*, *e* only.
?1890 *C. angustissima* Wisniowski, p. 212, plate 9, figure 15.
?1890 *C. spatulata* Wisniowski, p. 213, plate 9, figure 16.
1890 *Cristellaria* sp., Wisniowski, p. 213, plate 9, figure 18.
1890 *C. hybrida* Terquem; Wisniowski, pars, p. 214, plate 9, figure 25*bβ* only.
1890 *C. protracta* Bornemann; Wisniowski, p. 216, plate 9, figure 26.
?1890 *C. fallax* Wisniowski, p. 220, plate 9, figure 12.
1890 *C. debilis* Wisniowski, p. 220, plate 9, figure 13.
?1903 *C. parallela* Schwager; Schick, p. 132, plate 4, figure 12.
1904 *C. harpa* Reuss; Brückmann, p. 18 (separate), plate 2, figures 20–22.
1904 *C. manubrium* Schwager; Brückmann, p. 19 (separate), plate 2, figures 23, 24.
1908 *C. protracta* Bornemann; Issler, p. 79, plate 5, figures 239–243.
1922 *C. parallela* Reuss; Paalzow, p. 23, plate 2, figure 24.
1922 *C. protracta* Bornemann; Paalzow, p. 24, plate 2, figure 25.
1922 *C. complanata* Schwager; Paalzow, p. 24, plate 2, figure 28.
1922 *C. limata* Schwager; Paalzow, p. 26, plate 3, figure 6.
?1936 *C.* (*Astacolus*) *protracta* Bornemann; Franke, p. 101, plate 9, figure 35.
?1937 *C.* (*A.*) *protracta* Bornemann; Bartenstein and Brand, p. 171.

Material: Ten specimens; Brit. Mus. P34698, P34718, P34866 (seven), P34897 (figured).

Dimensions: Length 0·24–0·55 mm.; the mean of ten specimens is 0·37 mm.

Horizon: 123*a*, 123*i–m*, 123*m*.

Remarks: This is a slender form, elongate and moderately compressed. It has little initial coiled portion, and is thus a link with *Marginulina*.

Cristellaria protracta was described as very rare from the *davoei* zone of Göttingen.

11. *Cristellaria quadricostata* (Terquem), plate 2, figure 25*a*, *b*.

1863 *Marginulina quadricostata* Terquem, 3FL, p. 400 (190), plate 8, figure 12*a*, *b*.
1875 *Cristellaria nexa* Terquem and Berthelin, p. 49, plate 4, figure 11*a*, *b*.
1875 *C. lacunata* Terquem and Berthelin, p. 50, plate 4, figure 14*a*, *b*.
1936 *C.* (*Astacolus*) *quadricosta* (sic) Terquem; Franke, p. 109, plate 11, figure 4.
1937 *C.* (*A.*) *quadricostata* Terquem; Bartenstein and Brand, p. 173, plate 3, figure 47; plate 4, figure 71; plate 5, figure 57.

Material: Seven specimens; Brit. Mus. P34864 (six), P34898 (figured).

Dimensions: Length 0·35–0·60 mm.; the mean of five measured specimens is 0·43 mm.

Horizon: 123*a*.

Remarks: The present specimens have about three strong, elevated costae visible on each side of the test, though one specimen has four, and two others have two strong costae and a third that is hardly visible. There is a strong keel, continuous round the test with the exception only of the apertural face of the final chamber; in the smaller specimens the keel is sometimes poorly developed on the ventral side of the test. The development of both keel and costae seems to increase with the size of the shell.

I have no specimens of this species from other localities in the English Lias.

Cristellaria nexa and *C. lacunata* I regard as synonyms. The latter is quite distinct from any of the medley of forms figured under the same name by Terquem in 1870 from the French Oolite. *C. bicostata* Terquem and Berthelin (1875, p. 43, plate 3, figure 18) is probably also a synonym.

Somewhat similar forms are *C. fenestrata* Terquem (1866, 5FL, p. 437, plate 18, figure 4*a*, *b*), non Reuss, 1865; and *C. furcifera* Terquem (1866, 6FL, p. 510, plate 21, figure 29), which I regard as one species. They appear to differ chiefly in being more slender, with lesser developed keel and costae.

Forms have been recorded under the name *Marginulina* cf. *lacunata* (Terquem), but referring only to the figure of Terquem and Berthelin, by Sandidge (1933, *Amer. Midl. Nat.* **14**, 180, plate 1, figures 6–8); and by Wickenden as *M.* cf. *lacunata* (Terquem and Berthelin) (1933, *Trans. Roy. Soc. Canada*, third ser., sec. iv, **27**, 162, plate 1, figure 13), and *M.* cf. *sparsa* (Terquem and Berthelin) (1933, loc. cit. p. 161, plate 1, figure 14). These are somewhat similar to, but probably not identical with, *Cristellaria quadri-*

costata. They were found in material of Jurassic age from Montana, U.S.A., and from Alberta and Saskatchewan, Canada, respectively.

C. acuta Terquem (1862, 2FL, p. 446, plate 6, figures 3*a–c*), and *C. cincta* Terquem and Piette (1862, 2FL, p. 460, plate 6, figure 21) are comparable keeled species that have a smooth, non-costate surface.

C. quadricostata was described as very rare from the *Assise à gryphées arquées* (=*raricostatum-bucklandi* zones) of Queuleu, near Metz.

12. *Cristellaria similis* Terquem, plate 2, figure 26.

1870 *Cristellaria similis* Terquem, 2SO, p. 431 (169) plate 9, figure 30.
non 1886 *C. similis* Terquem, p. 30, plate 3, figures 15, 16.

Material: One specimen; Brit. Mus. P34843.

Dimensions: Length 0·35 mm.

Horizon: 123*d–m*.

Remarks: The present specimen is much flattened, and is furnished with a fine keel, particularly along the dorsal margin. The sutures are deeply depressed, making the chambers appear slightly inflated. The megalospheric ovoid protoconch and the lack of any close coiling of the early chambers are characteristic features. *Cristellaria parallela* Terquem (1870, 2SO, p. 430 (168), plate 9, figure 27*a*, *b*) (non Reuss 1863, non Schwager 1865) appears to be a closely similar form, but it is without a keel. The depressed sutures and consequently slightly inflated chambers strongly resemble those of the present specimen; in fact the likeness is closer in this respect than to *C. similis*. Terquem's 1886 record under the same name seems to refer to quite a different form or forms. I have found no later record of it, and have no further specimens.

C. similis was described as rather rare from the *parkinsoni* zone (=Bathonian) of Fontoy, Moselle, eastern France.

13. *Cristellaria terquemi* d'Orbigny, plate 2, figure 27*a*, *b*.

1850 *Cristellaria terquemi* d'Orbigny, **1**, 242, no. 269.
1858 *C. terquemi* d'Orbigny; Terquem, 1FL, p. 622 (62), plate 3, figure 18*a–c*.
?1866 *C. elongata* Kübler and Zwingli (non d'Orbigny), p. 9, plate 1, figure 20.
?1866 *C. rotunda* Kübler and Zwingli, p. 9, plate 1, figure 18.
?1870 *C. turbinoides* Zwingli and Kübler (nom.nov. for *C. elongata* Kübler and Zwingli 1866), p. 9, plate 1 (Posidonienschiefer), figure 6.
?1870 *C. rotunda* Zwingli and Kübler, p. 9, plate 1 (Posidonienschiefer), figure 5.
?1876 *C. recta* d'Orbigny; Blake, pars, p. 465, plate 19, figure 13*a* only.
?1904 *C. baltica* Brückmann, p. 13, plate 2, figure 13.
1936 *C. terquemi* d'Orbigny; Macfadyen, p. 152, plate 1, figure 269.
1936 *C.* (*Astacolus*) *terquemi* d'Orbigny; Franke, p. 104, plate 10, figures 4, 5.

Material: Twenty-four specimens; Brit. Mus. P34712, P34714, P34739, P34754, P34758 (figured), P34771, P34803, P34829 (fifteen), P34871 (two).

Dimensions: Length 0·25–0·85 mm.; the mean of nineteen measured specimens is 0·38 mm. From certain horizons they are appreciably larger than from others:

122, 123*a*: length 0·34–0·85 mm., mean of seven, 0·53 mm.

123*d–m*, 123*m*: length 0·25–0·41 mm., mean of twelve, 0·30 mm.

Horizon: 122, 123*a*, 123*d–m*, 123*m*.

Remarks: This is a strongly compressed, flattened form. On the one hand it resembles *Cristellaria varians*, though it is typically different in that it has several uncoiled chambers; and on the other hand *C. matutina*, from which it differs in its much more compressed habit, and smaller initial coiled stage. From both these species, however, there are specimens not clearly separable.

C. terquemi was described from the *davoei* zone of the Metz district where, according to Terquem, it is rather rare.

14. *Cristellaria varians* Bornemann, plate 2, figure 28*a*, *b*.

1854 *Cristellaria varians* Bornemann, p. 41, plate 4, figures 32–34.
1854 *C. deformis* Bornemann, p. 41, plate 4, figure 35*a*, *b*.
1854 *C. minuta* Bornemann, p. 42, plate 4, figure 37*a*, *b*.
1854 *C. convoluta* Bornemann, p. 42, plate 4, figure 38*a*, *b*.
?1854 *C. major* Bornemann, p. 40, plate 4, figure 31*a*, *b*.
?1860 *C. cassis* (Fichtel and Moll); Jones and Parker, plate 20, figure 41.
1863 *C. acuminata* Terquem, 3FL, p. 420 (210), plate 10, figure 5*a*, *b*.
1866 *C. argovensis* Kübler and Zwingli, p. 9, plate 1, figure 12.
1866 *C. studeri* Kübler and Zwingli, p. 9, plate 1, figure 13.
1866 *C. lunaria* Kübler and Zwingli, p. 11, plate 1, figure 27.
1867 *C. acutauricularis* (Fichtel and Moll); Brady, p. 228, plate 3, figure 38.
1870 *C. aargovensis* Zwingli and Kübler, p. 6, plate 1 (Turnerithon), figure 15.
1870 *C. studeri* Zwingli and Kübler, p. 7, plate 1 (Turnerithon), figure 16.
1870 *C. lunaria* Zwingli and Kübler, p. 11, plate 1 (Jurensismergel), figure 8.
1876 *C. varians* Bornemann; Blake, p. 466, plate 17, figure 27; plate 19, figure 16.
1881 *C. communis* Kübler and Zwingli; Haeusler, p. 24, plate 2, figures 10, 14, 31, 34.
1881 *C. sinemuriensis* Haeusler, p. 17, plate 2, figures 1, 11.
1881 *C. reniformis* Haeusler, p. 27, plate 2, figure 32.
1888 *C. varians* Bornemann; Burbach and Dreyer, p. 502, plate 10, figures 15–21.
1888 *C. subquadrata* Terquem; Burbach and Dreyer, p. 505, plate 10, figure 22.
1888 *C. acutauricularis* (Fichtel and Moll); Burbach and Dreyer, p. 505, plate 10, figures 23, 24; plate 11, figures 25–27.
1888 *C. acuminata* Terquem; Burbach and Dreyer, p. 507, plate 11, figures 28, 29.
1890 *C. crepidula* (Fichtel and Moll); Haeusler, pars, p. 111, plate 14, figures 58–60 only.
?1891 *C. acutauricularis* (Fichtel and Moll); Crick and Sherborn, p. 212, plate 1, figure 25.
1891 *C. rotulata* (Lamarck); Crick and Sherborn, p. 213, plate 1, figure 26.
1891 *C. varians* Bornemann; Crick and Sherborn, p. 213, plate 1, figure 30.
?1892 *C. varians* Bornemann; Crick and Sherborn, p. 70, plate 2, figures 15, 16.
?1893 *C. semidirecta* Sellheim, p. 19, plate 1, figure 11.
1903 *C. gibba* d'Orbigny; Schick, p. 127, plate 4, figures 3, 4.
1908 *C. varians* Bornemann; Issler, p. 86, plate 6, figures 306, 307; plate 7, figures 308–310.

1908 *C. minuta* Bornemann; Issler, p. 89, plate 7, figures 317–320.
1934 *Saracenaria crepidula* (Fichtel and Moll); Henderson, p. 553, text-figure 3*e*.
1934 *S. varians* Bornemann; Henderson, p. 553, text-figure 3*f*.
1936 *Cristellaria* (*Astacolus*) *major* Bornemann; Franke, p. 101, plate 9, figure 36.
1936 *C.* (*A.*) *adunca* Franke, p. 103, plate 10, figure 16.
1936 *C.* (*A.*) *dubia* Franke, p. 107, plate 10, figure 17.
1936 *C.* (*Lenticulina*) *subquadrata* Terquem; Franke, p. 111, plate 11, figure 7.
1936 *C.* (*L.*) *minuta* Bornemann; Franke, p. 112, plate 11, figure 8.
1936 *C.* (*L.*) *varians* Bornemann; Franke, p. 112, plate 11, figures 9–11.
1936 *C.* (*L.*) *varians* f. *recta* Franke, p. 113, plate 11, figure 12.
1936 *C.* (*L.*) *convoluta* Bornemann; Franke, p. 113, plate 11, figure 14.
1936 *C.* (*L.*) *metensis* Terquem; Franke, p. 117, plate 11, figure 24.
1937 *C.* (*L.*) *varians* Bornemann; Bartenstein and Brand, p. 176, many figures.
1937 *C.* (*L.*) *minuta* Bornemann; Bartenstein and Brand, p. 176, many figures.

Material: Fifty specimens; Brit. Mus. P34762, P34766 (ten), P34767 (five), P34773, P34787, P34845 (twenty-four), P34873 (six), P34883, P34905 (figured).

Dimensions: Length 0·13–0·46 mm.; the mean of thirty-five measured specimens is 0·27 mm.

Horizon: 122, 123*a*, 123*d–m*, 123*m*.

Remarks: *Cristellaria varians* is a variable but generally strongly compressed and often rather flat form; the early chambers are close-coiled; the later chambers extend as if endeavouring to uncoil, though their inner margins remain as close to the protoconch as possible. The above synonymy, no doubt far from complete, will give some idea of the names under which it has been recorded.

The specimens from horizon 123*a* are considerably larger than those from other horizons.

C. varians was described as fairly frequent from the *davoei* zone of Göttingen.

15. *Cristellaria* (*Saracenaria*) *inclusa* Schwager, plate 2, figure 29*a–c*.

1865 *Cristellaria inclusa* Schwager, p. 124, plate 5, figure 14.
1865 *C. impleta* Schwager, p. 126, plate 6, figure 2.
1890 *C. triquetra* var. *gümbeli* Wisniowski, p. 217, plate 10, figure 8*a*, *b*.
1936 *C.* (*Saracenaria*) *alata-angularis* Franke, p. 97, plate 9, figure 32.
?1937 *C.* (*S.*) *alata-angularis* Franke; Bartenstein and Brand, p. 170.

Material: Two specimens; Brit. Mus. P34820, P34861 (figured).

Dimensions: Length 0·35 and 0·37 mm. respectively.

Horizon: 123*a*, 123*m*.

Remarks: The figured specimen is smooth, while the other has slight costation. I do not regard this as of consequence in this species, where the tendency to odd costae is great. Both specimens are lightly keeled on all three margins of the test, which is triangular in section.

Notwithstanding the remarks on p. 30 above, it may perhaps be desirable to use the

name *Saracenaria* as a subgenus, since the triangular section of the test is peculiarly characteristic.

It is very difficult to arrive at the valid name for this form. Terquem has described two forms under the names *Marginulina trigona* (1866, 5FL, p. 435, plate 18, figure 1*a–d*) and *M. obesa* (1866, 5FL, p. 436, plate 18, figure 3*a*, *b*), which are similar, though they appear to lack the lateral keels. I examined one of Terquem's specimens labelled *M. obesa* in Paris in 1931. It was a poor, broken specimen of four chambers, and it was apparently not keeled, though my notes are not quite definite.

Schwager (1865) also described as rare a number of shells under the names *Cristellaria collarifera*, *C. comptula*, *C. cristata* and *C. sculptilis* from the same locality as *C. inclusa*. These are similar forms, usually of more attenuated cross-section than the present specimens, and some of the names seem to be redundant.

Berthelin described *C. bononiensis* and *C. vestita* (1880, p. 55, plate 3, figures 22, 23) from the Lower Cretaceous (Albian) of France. These species are very similar to *C. inclusa*, whose descendants they might well be.

C. inclusa was described as rare from the *impressa* Schichten, called by Schwager 'Lower Oxfordian', but apparently Corallian as it is now understood, of Gruibingen, near Boll, 63 km. west-north-west of Lake Constance, in Baden, south Germany.

Genus *Marginulina* d'Orbigny, 1826

16. *Marginulina lamellosa* Terquem and Berthelin, plate 2, figure 30.

1875 *Marginulina lamellosa* Terquem and Berthelin, p. 56, plate 4, figure 22.
?1936 *M. lamellosa* Terquem and Berthelin; Franke, p. 80, plate 8, figure 16.
?1937 *M. lamellosa* Terquem and Berthelin; Bartenstein and Brand, p. 161.

Material: Three specimens; Brit. Mus. P34777, P34793, P34849 (figured).

Dimensions: Length 0·37, 0·35 and 0·30 mm. respectively.

Horizon: 122, 123*d–m*.

Remarks: The specimens, forms ?B, A, and A respectively, have six very high, plate-like costae, which are so thin at the margin that they fracture, giving a ragged appearance. They have ?6, 6 and 5 chambers respectively, and their marginuline irregularity is so slight that they might easily be mistaken for *Nodosaria* unless closely examined.

The smaller specimens, such as those in the Dorset material, are well characterized, but when larger specimens are found there is sometimes doubt whether they are not merely a variety of *Marginulina prima* with higher and thinner costae than normal. The two species in such cases seem to grade into one another, and separation and determination become difficult and controversial.

M. lamellosa was described as very rare from the Middle Lias, *margaritatus* zone, of Essey-lès-Nancy, eastern France.

17. *Marginulina laxata* Terquem and Berthelin, plate 2, figure 31*a*, *b*.

1875 *Marginulina laxata* Terquem and Berthelin, p. 56, plate 4, figure 24*a*, *b*.

Material: One specimen; Brit. Mus. P34876.

Dimensions: Length 0·30 mm.; a broken specimen of only the first three chambers.

Horizon: 123*a*.

Remarks: *Marginulina laxata* is distinguished by the small number of rather low costae, four to six according to the original description, the present specimen having six; the chambers are well marked by the somewhat depressed sutures. I have found no later record of this species.

It may be compared with *M. porrecta* Terquem (1866, 6FL, p. 506, plate 21, figures 19–21), which is a larger, coarser species, with eight or more costae; of this I have excellent series of specimens for comparison (localities 123, 124, 217, 242).

M. dentalina Haeusler (1881, p. 17, plate 2, figure 24), from the Lower Lias of Switzerland, is a similar form, which might prove on examination of the specimens to be identical.

M. laxata was described as rather rare, from the Middle Lias, *margaritatus* zone, of Essey-lès-Nancy.

18. *Marginulina prima* d'Orbigny, plate 2, figure 32*a*, *b*.

1850 *Marginulina prima* d'Orbigny, **1**, 242, no. 262.
1858 *M. prima* var. *acuta* Terquem, 1FL, p. 614 (54), plate 3, figure 7.
1858 *M. prima* var. *gibbosa* Terquem, 1FL, p. 612 (52), plate 3, figure 5*a–d*.
1858 *M. prima* var. *recta* Terquem, 1FL, p. 613 (53), plate 3, figure 6.
1867 *M. raphanus* (Linné); Brady, p. 225, plate 2, figure 21.
1875 *M. prima* var. *praelonga* Terquem and Berthelin, p. 54, plate 4, figure 18.
1875 *M. gibberula* Terquem and Berthelin, p. 55, plate 4, figure 21*a*, *b*.
1875 *M. crassiuscula* Terquem and Berthelin, p. 56, plate 4, figure 23*a–c*.
1903 *M.* (*Nodosaria*) *costata* (Batsch); Schick, pars, p. 137, plate 4, figures 20, ?21 only.
1908 *M. burgundiae* Terquem; Issler, p. 67, plate 4, figures 171–174.
1936 *M. prima* d'Orbigny; Macfadyen, p. 151, plate 1, figure 262*a*.
1936 *M. prima* d'Orbigny; Franke, p. 76, plate 8, figures 1–7; including the vars. *rugosa* Bornemann, *gibbosa*, *recta*, *acuta*, *ornata* Terquem, and *praelonga*, *gibberula* Terquem and Berthelin.
1936 *M. incisa* Franke, p. 78, plate 8, figures 11, 12.
1936 *M. burgundiae* Terquem; Franke, p. 78, plate 8, figure 8.
1937 *M. prima* d'Orbigny; Bartenstein and Brand, p. 161, several figures.

Material: Twenty-six complete specimens, and several broken. Form A: Brit. Mus. P34722, P34732, P34737, P34743, P34765 (two), P34785, P34806, P34816, P34819, P34863 (three), P34900 (figured). Form B: P34697, P34721 (three), P34728, P34733, P34734, P34765. Broken: P34730, P34782, P34822, P34863 (four).

Dimensions: Form A, fourteen specimens, length 0·34–1·03 mm., mean 0·64 mm.;

up to twelve chambers, usually six to nine. Form B, twelve specimens, length 0·35–0·80 mm., mean 0·61 mm.; up to thirteen chambers, usually about ten.

Horizon: 122, 123*a*, 123*i–m*, 123*m*.

Remarks: In the present specimens the costae are high and strong, and vary from seven to ten in number.

Marginulina prima was described from the *davoei* zone of the Metz district where, according to Terquem, it is very common.

19. *Marginulina spinata* Terquem, plate 2, figure 33*a*, *b*.

1858 *Marginulina spinata* Terquem, 1FL, p. 615 (55), plate 3, figure 8.
1936 *M. interrupta* var. *spinata* Terquem; Franke, p. 79, plate 8, figure 10.
1937 *M. spinata spinata* Terquem; Bartenstein and Brand, p. 161, plate 4, figure 61; plate 5, figure 47.

Material: Two specimens; Brit. Mus. P34836, P34874 (figured), both form A.

Dimensions: Length 0·32 and 0·35 mm. respectively.

Horizon: 123*a*, 123*d–m*.

Remarks: Both specimens are megalospheric, the one with six chambers, the other with five. In this species the costae do not run the whole length of the test, but are interrupted at each chamber septum, ending off in small backward-pointing spines. The specimens have about fifteen and thirteen medium to small costae respectively. Their shapes differ considerably, the first being slender and graceful, strongly marginuline, while the second is stocky, and nearly straight.

Marginulina spinata was described as rather rare from the *davoei* zone of Saint-Julien-lès-Metz.

Genus *Dentalina* d'Orbigny, 1826

20. *Dentalina communis* d'Orbigny, plate 2, figure 34.

1826 *Dentalina communis* d'Orbigny, p. 254, no. 35.
?1860 *D. communis* d'Orbigny; Jones and Parker, p. 453, plate 19, figures 25, 26.
1867 *D. communis* d'Orbigny; Brady, pars, p. 223, plate 1, figure 13 only.
?1871 *D. communis* d'Orbigny; Wright, p. 26.
1876 *D. communis* d'Orbigny; Blake, p. 457, plate 18, figure 19.
1891 *D. communis* d'Orbigny; Crick and Sherborn, p. 211, plate 1, figure 13.
1908 *D. communis* d'Orbigny; Issler, pars, p. 62, plate 3, figures 143, 144 only.
?1918 *D. communis* d'Orbigny; Trueman, p. 102.
1937 *D. communis* d'Orbigny; Bartenstein and Brand, p. 136, many figures.

Material: Thirty-three specimens; Brit. Mus. P34197, P34711, P34731, P34742, P34745, P34783, P34811, P34817, P34831 (seventeen), P34858 (seven), P34901 (figured).

Dimensions: Length up to 0·83 mm.

Horizon: 122, 123*a*, 123*d–m*, 123*m*.

Remarks: *Dentalina communis* was described from Recent material from the Adriatic Sea. I have compared topotype specimens from Rimini with the present Lias specimens, and I am not able to differentiate them morphologically. The aperture has been studied with some care; it seems to be generally plain, though some specimens show traces of a radiate structure in both Recent and Lias material. The protoconch may be apiculate or not.

Records which seem to be of this or of very closely allied forms have been made under a variety of names from strata of many ages. As *D. communis* it has been recorded from as early as the Upper Cretaceous by both d'Orbigny and Reuss, authors of much narrower concept of a species than, for instance, Wright, Brady, Blake, Haeusler, or Crick and Sherborn, who have all recorded it from the Lias, and Brady even from the Carboniferous. Above are given only some of the British Lias records, and two later German Lias records of importance.

Franke (1936) has attempted a considerable revision of this and similar forms, and has most kindly sent me named specimens of some of them. I cannot agree with his nomenclature. In my view a number of his species are not adequately differentiated from *D. communis*, and are better included here as mere individual variants. Franke does not appear to find any zonal significance in his revision.

21. *Dentalina deslongchampsi* (Terquem), plate 2, figure 35.

1863 *Marginulina deslongchampsi* Terquem, 3FL, p. 398 (188), plate 8, figure 8*a*, *b*.
1891 *Dentalina multicostata* var. *laevigata* Crick and Sherborn, p. 211, plate 1, figure 16.
1908 *D. communis* d'Orbigny; Issler, pars, p. 62, plate 3, figure 145 only.
1936 *Marginulina deslongchampsi* Terquem; Franke, p. 74, plate 7, figure 19*a*, *b*.
1936 *M. sherborni* Franke, p. 74, plate 7, figure 18*a*, *b*.
1936 *Dentalina nuda* Franke, p. 29, plate 2, figure 18.
1936 *D. gladiiformis* Franke, p. 30, plate 2, figure 22*a*, *b*.
1937 *Marginulina sherborni* Franke; Bartenstein and Brand, p. 160, plate 4, figure 56; plate 5, figure 44.
1937 *Dentalina gladiiformis* Franke; Bartenstein and Brand, p. 139, plate 3, figure 10; plate 5, figure 21.

Material: Three specimens; Brit. Mus. P34875.

Dimensions: Length 0·71 mm. (nine chambers, figured), 1·15 mm. (broken, last nine chambers), 0·46 mm. (doubtful, six chambers).

Horizon: 123*a*.

Remarks: The elongate-ovoid and pointed protoconch is noteworthy; the sutures are flush, but often thickened; the aperture is plain, not radiate.

The species is referred to *Dentalina* rather than to *Marginulina*, since there is no evidence of coiling in the early chambers, though it is recognized that this is not a conclusive point. The two genera seem to run together in such species as this.

Terquem's figure is unsatisfactory since it seems certain that the initial part, which depicts a globular protoconch with rounded base, is wrongly drawn. It is, in fact,

imaginative, for he states in the description: *Nous avons classé cette coquille, bien qu'elle soit incomplète, et que l'extrémité postérieure manque; la disposition des loges et l'épaisseur des cloissons fournissent des caractères suffisants pour la distinguer.*

Bartenstein and Brand (p. 160) note the similarity of some of Franke's species here put into the synonymy. The form never seems to be common, all the records referring to it as rare or very rare.

Dentalina deslongchampsi was described as very rare from the *davoei* zone of Vieux Pont, between Caen and Bayeux, in Normandy.

22. *Dentalina torta* Terquem, plate 2, figure 36.

1858 *Dentalina torta* Terquem, 1FL, p. 599 (39), plate 2, figure 6*a*, *b*.
?1877 *D. torta* Terquem; Beesley, p. 20.
1936 *D. torta* Terquem; Franke, p. 27, plate 2, figure 9*a*, *b*.
?non 1937 *D. torta* Terquem; Bartenstein and Brand, p. 137, plate 3, figure 9; plate 4, figure 24; plate 5, figure 14; plate 10, figure 11.

Material: One specimen; Brit. Mus. P34715.

Dimensions: Length 0·56 mm.

Horizon: 123*m*.

Remarks: This form seems to be separable from *Dentalina communis* mainly in the rather drum-like character of the chambers, which are broader than long, and set somewhat obliquely.

D. torta was described as very rare from the *davoei* zone of Saint-Julien-lès-Metz.

23. *Dentalina vetusta* d'Orbigny, plate 2, figure 37.

1850 *Dentalina vetusta* d'Orbigny, **1**, 242, no. 258.
?1858 *D. vetusta* d'Orbigny: Terquem, 1FL, p. 598 (38), plate 2, figure 4*a*, *b*.
?1891 *D. mucronata* Neugeboren; Crick and Sherborn, p. 211, plate 1, figure 14.
1936 *D. vetusta* d'Orbigny; Macfadyen, p. 150, plate 1, figure 258.
1936 *D. subsiliqua* Franke; pars, p. 30, plate 2, figure 21*a* only.
non 1936 *D. vetusta* d'Orbigny; Franke, p. 25, plate 2, figure 5.
1937 *D. subsiliqua* Franke; Bartenstein and Brand, p. 136, many figures.

Material: One specimen; Brit. Mus. P34848.

Dimensions: Length 0·31 mm.; greatest breadth 0·09 mm.

Horizon: 123*d–m*.

Remarks: *Dentalina vetusta* was described by d'Orbigny without a figure. It was first figured by Terquem in 1858, but the correctness of this figure, as, unfortunately, of others of this author, is doubtful. The study of a specimen which I took to be d'Orbigny's type is referred to above; this is a form with indistinct chambers, so that it was only possible to be reasonably certain of the final chamber; the specimen is poor, and may be a cast.

The present specimen is perfectly preserved, but here again it is almost impossible to make out the individual chambers when mounted dry, or even in a glycerine mount

viewed by transmitted light, or with dark ground illumination. Viewed when wet by reflected light it is seen to have five chambers. The test is moderately pointed at either end, and the final chamber is very large and inflated compared with the rest of the test, and makes up more than half of the total length of the shell. The sutures are flush with the walls of the chambers, and practically invisible.

Herr Franke very kindly sent me specimens of his *D. subsiliqua*, which are, in my opinion, identical with the present specimen; in my view this species must go into the synonymy of *D. vetusta*.

D. vetusta was described from the *davoei* zone of the Metz district, where, according to Terquem, it is rather rare.

24. *Dentalina virgata* Terquem, plate 2, figure 38.

1866 *Dentalina virgata* Terquem, 6FL, p. 489, plate 20, figure 2.
non 1908 *Vaginulina virgata* (Terquem); Issler, p. 71, plate 4, figure 196.
1936 *Dentalina tenuistriata* Terquem; Franke, pars, p. 35, plate 3, figure 7*a* only.

Material: One specimen; Brit. Mus. P34847.

Dimensions: The broken specimen, only the two last chambers remaining, measured 0·25 mm. in length, and 0·11 mm. in maximum thickness.

Horizon: 123*d–m*.

Remarks: The type of *Dentalina virgata* is a specimen 1·52 mm. in length. It is depicted as having six moderately inflated chambers which increase in size very gradually after the protoconch, and are set only slightly oblique to the long axis of the shell. The test is covered with many fine longitudinal costae, which are interrupted by the rather deeply constricted septa.

In the present fragment the characters, so far as they can be seen, agree with the figure and description of *D. virgata*. The fine costae are about thirty in number. The aperture is very small, and appears to be plain, not radiate.

D. sarthacensis Schwager (1866, p. 304, text-figure 6) from the Corallian of Germany, is a closely similar form which may be identical. *D. tenuistriata* Terquem (1866, 5FL, p. 405, plate 15, figure 5*a–c*) seems to be distinguished by the considerably longer and much more obliquely set chambers; in the figure it is shown as having about fifteen costae.

D. virgata was described as rather rare from the *davoei* zone of Magny-lès-Metz.

Genus *Nodosaria* Lamarck, 1812

25. *Nodosaria dolioligera* (Schwager), plate 3, figure 39.

1865 *Dentalina fusiformis* Schwager, p. 99, plate 2, figure 16 (non Gümbel, 1861).
1865 *D. dolioligera* Schwager, p. 109, plate 3, figures 26, 32.
?1881 *Nodosaria chrysalis* Haeusler, p. 34, plate 2, figure 51.
1917 *Dentalina bingi* Paalzow, pars, p. 230, plate 43, figure 9 only.

Material: Two specimens; Brit. Mus. P34729, P34852 (figured).

Dimensions: Length 0·68 mm. (three chambers) and 0·29 mm. (four chambers); both specimens are incomplete.

Horizon: 123*a*, 123*d–m*.

Remarks: This is a well-characterized form with relatively few, elongate, barrel-like chambers increasing rapidly in size. The latest chambers become very long, reaching their extreme form in Haeusler's figure.

Nodosaria dolioligera was described from the *impressa* Schichten (= Corallian), of Baden, south Germany. The other references in the synonymy are from a similar horizon.

26. *Nodosaria fontanessi* (Berthelin), plate 3, figure 40*a*, *b*.

?1875 *Dentalina mitis* Terquem and Berthelin, pars, p. 28, plate 2, figure 9*b* only.
1880 *D. fontanessi* Berthelin, pars, p. 42, plate 2, figure 14*a*, *b* (?15) only.
1908 *Nodosaria raphanus* (Linné); Issler, pars, p. 52, plate 2, figure 74 only.
1936 *N. mitis* (Terquem and Berthelin); Franke, p. 45, plate 4, figure 11*a* (?11*b*).
1937 *N. mitis* (Terquem and Berthelin); Bartenstein and Brand, pars, p. 145, plate 3, figure 18; plate 4, figure 36; plate 5, figure 24 only.

Material: Three specimens; Brit. Mus. P34844.

Dimensions: The two perfect specimens measure 0·58 and 0·40 mm. in length respectively.

Horizon: 123*d–m*.

Remarks: The form identified as above has six or seven very strong plate-like costae. It is clearly of the group of *Nodosaria raphanus* (Linné) as understood by Brady, figures of whose Recent specimens (1884, p. 512, plate 64, figures 6–10) are similar to the present Lias specimens, though these have plain, not radiate, apertures. It seems impossible to be certain of the valid name for the Lias form. Berthelin states that a form similar to *N. fontanessi* occurs in the Lias, but he does not name it, and *N. fontanessi* is the first description and figure that seem satisfactory. Terquem and Berthelin's *Dentalia mitis* is not a satisfactory type for this form, though it has been accepted lately by German authors.

Nodosaria fontanessi was described as common from the Lower Cretaceous, Albian, of Montcley, Doubs, eastern France.

27. *Nodosaria hortensis* Terquem, plate 3, figure 41*a*, *b*.

1860 *Nodosaria raphanus* (Linné); Parker and Jones, plate 19, figure 10 (non Linné).
1866 *N. hortensis* Terquem, 6FL, p. 476, plate 19, figure 13.
?1866 *N. cactus* Kübler and Zwingli, p. 10, plate 2, figure 2.
1866 *N. incongrua* Kübler and Zwingli, p. 13, plate 2, figure 17.
1867 *N. raphanus* (Linné); Brady, p. 222, plate 1, figure 6*a*, *b*.
?1870 *N. cactus* Zwingli and Kübler, p. 10, plate 1 (Jurensismergel), figure 1.
1870 *N. incongrua* Zwingli and Kübler, p. 15, plate 2 (Blagdenischicht), figure 1.
1870 *N. fontinensis* Terquem, 3SO, p. 353 (251), plate 26, figures 1–5.

1870 *N. mutabilis* Terquem, 3SO, p. 353 (251), plate 26, figures 6–12.
1875 *N. variabilis* Terquem and Berthelin, p. 20, plate 1, figure 19*a–f*.
1875 *N. simoniana* d'Orbigny; Terquem and Berthelin, p. 21, plate 1, figure 21.
1876 *N. raphanus* (Linné); Blake, pars, p. 456, plate 18, figure 14*a* only.
1876 *N. raphanistrum* (Linné); Blake, p. 457, plate 18, figure 18 (?18*a*).
1876 *N. mutabilis* Terquem, p. 481, plate 15, figure 3.
?1876 *N. fontinensis* Terquem, p. 482.
1883 *N. prima* d'Orbigny; Uhlig, p. 748, plate 9, figure 8.
1886 *N. fontinensis* Terquem, p. 11, plate 1, figures 22–24.
?1886 *N. mutabilis* Terquem, p. 11, plate 1, figure 21.
?1886 *Dentalina annulata* Terquem, p. 13, plate 1, figure 34*a*, *b*.
?1890 *Nodosaria grojecensis* Wisniowski, p. 192, plate 8, figure 24.
1890 *N. procera* Wisniowski, p. 194, plate 8, figure 17.
1891 *N. mutabilis* Terquem; Crick and Sherborn, p. 210, plate 1, figures 7, 8.
1891 *N. raphanistrum* (Linné); Crick and Sherborn, p. 210, plate 1, figure 9.
1904 *N. prima* d'Orbigny; Brückmann, p. 28, plate 3, figure 27.
?non 1908 *N. hortensis* Terquem; Issler, p. 51, plate 2, figures 67–71.
1908 *N. raphanistrum* (Linné); Issler, p. 53, plate 2, figures 84–93.
1917 *N. corallina* Gümbel; Paalzow, p. 228, plate 42, figure 23; plate 43, figures 2, 6.
1922 *N. mutabilis* Terquem; Paalzow, p. 16, plate 2, figures 1, 2.
1922 *N. fontinensis* Terquem; Paalzow, p. 16, plate 2, figure 3.
1932 *N. mutabilis* Terquem; Paalzow, p. 123, plate 9, figure 3.
?1936 *N. dispar* Franke, p. 47, plate 4, figure 18*a–d*.
1936 *N. fontinensis* Terquem; Franke, p. 50, plate 5, figure 1.
?1936 *N. metensis* Terquem; Franke, p. 47, plate 4, figure 15*a–c*.
1936 *N. mutabilis* Terquem; Franke, p. 51, plate 5, figure 2*a*, *b*.
1936 *N. mutabilis* var. *collaris* Franke, p. 51, plate 5, figure 2*c*.
1937 *N. fontinensis* Terquem; Bartenstein and Brand, p. 148, many figures.
1937 *N. mutabilis* Terquem; Bartenstein and Brand, p. 148, many figures.
1937 *N. variabilis* Terquem; Bartenstein and Brand, p. 148, plate 2B, figure 15.

Material: Twenty specimens; Brit. Mus. P34832 (nineteen), P34902 (figured).

Dimensions: Length up to 0·53 mm. (six chambers); most of these specimens are smaller, and often of only two or three chambers.

Horizon: 123*d–m*.

Remarks: *Nodosaria hortensis* is distinguished by its fairly straight sides. The protoconch is commonly the largest chamber of the whole test, and it is generally apiculate. The final chamber is sometimes the narrowest, with the last portion smooth or nearly so; in such a shell the aperture with an expanded lip is often at the end of a projecting tube. The test is conspicuously covered with commonly eight to ten, or even up to sixteen, costae.

It is not uncommon for one or more chambers in the middle of the test to be of considerably greater or lesser diameter than those next to them, giving a most irregular appearance.

N. mutabilis and *N. variabilis* are, in my opinion, merely young individuals of

N. hortensis which have only two or three chambers; such are often found. The species is outstandingly megalospheric, and the microspheric form has not been definitely recognized.

N. hortensis is a widespread species that seems to be recognizable in the above-quoted synonymy; it appears to be the oldest available name for the Jurassic species of the group of *N. raphanistrum* to which it belongs. Similar forms under various names are recorded from Cretaceous, Eocene, later Tertiary, and Recent deposits, and it is a question how far some of them are really distinct.

A very similar shell is *N. metensis* Terquem (1863, 3FL, p. 377 (167), plate 7, figure 5) which occurs in the English Lower Lias (localities 124, 216, 217, 220, 242, 243), sometimes in company with *N. hortensis*; the former seems only to be distinguished by the larger number of finer costae, some twenty-three to twenty-five in number, but it is clearly separable.

N. hortensis was described as very rare from the 'assise à *Bel. acutus*', presumably the *semicostatum* zone, from an excavation in the town of Metz.

28. *Nodosaria marsupifera* (Schwager), plate 3, figure 42.

1865 *Dentalina marsupifera* Schwager, p. 110, plate 3, figure 27; plate 4, figures ?7, 9.
1908 *Nodosaria calomorpha* Reuss; Issler, pars, p. 47, plate 1, figure 49 only.
1936 *N. subcalomorpha* Franke, p. 42, plate 4, figure 3.

Material: One specimen; Brit. Mus. P34859.

Dimensions: Length 0·51 mm.

Horizon: 123*a*.

Remarks: *Nodosaria marsupifera* is somewhat similar to *N. calomorpha* Reuss, but it is perhaps distinct, particularly in the very elongate, rounded protoconch, and the chambers deeply constricted at the sutures. It has generally only two or three chambers. The present specimen has a slightly marked radiate aperture.

Schwager's first figure is unrecognizable, but the species is defined clearly enough by the description and the two other figures. It seems best referred to *Nodosaria* since the axis of the test is practically straight, and the sutures transverse, not oblique.

N. marsupifera was described as rather rare from the *impressa* Schichten (=Corallian), of Baden, south Germany.

29. *Nodosaria octoplicata* (Terquem), plate 3, figure 43.

1866 *Dentalina octoplicata* Terquem, 6FL, p. 489, plate 20, figure 3*a*, *b*.

Material: Four specimens; Brit. Mus. P34830.

Dimensions: Length up to 0·58 mm.; the longest (figured) is an incomplete shell of nine chambers.

Horizon: 123*d–m*.

Remarks: This is a very elongate form, which at first sight appears practically

smooth; closer inspection shows that there is, in fact, longitudinal costation, which is inconspicuous because the ribs are very low and broad.

I have found no later record of this species, and have no other specimens of it.

Nodosaria octoplicata was described as rare from the Lower Lias, apparently the *semicostatum* zone, of Vallières-lès-Metz.

30. *Nodosaria pyriformis* (Terquem), plate 3, figure 44.

1858 *Dentalina pyriformis* Terquem, 1FL, p. 608 (48), plate 2, figure 22.
?1870 *Nodosaria eichbergensis* Zwingli and Kübler, p. 25, plate 3, figure 7.

Material: One specimen; Brit. Mus. P34856.

Dimensions: Length 0·21 mm. (broken fragment of two chambers); maximum breadth 0·05 mm.

Horizon: 123*d–m*.

Remarks: One very minute and fragmentary specimen may be referred to this species.

Although Terquem's figure shows a curved form, it seems better referred to *Nodosaria*, as does the present specimen. Without better material it is impossible adequately to discuss the species, and I have found no later record of it under Terquem's name. As Terquem remarks, it resembles the Miocene *Dentalina guttifera* d'Orbigny. It also invites comparison with *D. lateralis* Terquem (1858, 1FL, p. 605 (45), plate 2, figure 15*a–c*), which is a stouter form, and with *D. acuminata* Terquem (1863, 3FL, p. 383 (173), plate 7, figure 9). It may be noted that although the present figure may resemble a free end of *Bullopora rostrata*, the specimen itself is quite distinct. It has a clear, glassy shell, whereas *B. rostrata* is opaque and porcellanous.

Nodosaria pyriformis was described as very rare from the *davoei* zone of Saint-Julien-lès-Metz.

31. *Nodosaria sculpta* (Terquem), plate 3, figure 45.

1866 *Dentalina sculpta* Terquem, 6FL, p. 484, plate 19, figure 24.
1886 *D. radiata* Terquem, 6FL, p. 490, plate 20, figure 5*a*, *b*.
1936 *D. quadrilatera* var. *quinquelatera* Franke, p. 35, plate 3, figure 8*a*, *b*.
1936 *D. mitis* Terquem and Berthelin; Franke, p. 35, plate 3, figure 10*a* (?10*b*, *c*).

Material: Three specimens; Brit. Mus. P34751 (figured), P34763, P34784.

Dimensions: Length 0·58, 0·50 and 0·54 mm. respectively.

Horizon: 122.

Remarks: This rather variable form has some six to seven costae, and Franke's form with only five may perhaps be properly included. The initial chamber or chambers are characteristically slightly deflected from the vertical axis of the test, but because of the transverse sutures and central aperture I refer it to *Nodosaria*.

Dentalina sculpta was described by Terquem with ten costae, *D. radiata* with six; I do not consider that there is sufficient difference between them to warrant separate names.

Nodosaria sculpta was described as very rare from the *davoei* zone of Vic, Indre, and *Dentalina radiata* from apparently the *semicostatum* zone of Vallières-lès-Metz.

32. *Nodosaria simplex* (Terquem), plate 3, figure 46.

1858 *Dentalina simplex* Terquem, 1FL, p. 599 (39), plate 2, figure 5*a*, *b*.
1908 *Nodosaria simplex* (Terquem); Issler, pars, p. 47, plate 1, figures 42–44 only.
1936 *N. simplex* (Terquem); Franke, p. 44, plate 4, figure 6.
1937 *N. simplex* (Terquem); Bartenstein and Brand, p. 144, plate 13, figure 8.

Material: Ten specimens; Brit. Mus. P34776, P34791, P34827 (seven), P34903 (figured).

Dimensions: P34776 (of three chambers only) is 0·55 mm. in length and 0·16 mm. in width; the other specimens range up to 0·34 mm. in length, and 0·08 mm. in width.

Horizon: 122, 123*d–m*.

Remarks: This, as its name implies, is a simple form of *Nodosaria*, to which it would appear that many names have been given. In view of the difficulty of certain identification, it is hardly feasible to obtain an idea of the range, though very similar forms are described from higher Jurassic and even later strata.

The curious difference in size between the large specimen and the others is noteworthy. It is, however, not uncommon to find specimens of Foraminifera apparently of the same species but of very different dimensions.

Specimen P34797 from horizon 122, a fragment of three chambers, 0·50 mm. in length, seems to be the '*D. simplex* var.' of Terquem (1862, 2FL, p. 441, plate 5, figure 17*a*, *b*). His figure seems to show a distinct form, but there is nothing to be done with the present fragment except to record it here.

N. simplex was described as very rare from the *davoei* zone of Saint-Julien-lès-Metz.

Genus *Pseudoglandulina* Cushman, 1929

33. *Pseudoglandulina oviformis* (Terquem), plate 3, figure 47.

1860 *Nodosaria humilis* Roemer; Jones and Parker, plate 19, figure 6.
1860 *N. glans* d'Orbigny; Jones and Parker, plate 19, figure 7.
1863 *Glandulina oviformis* Terquem, 3FL, p. 378 (168), plate 7, figure 4*a*, *b*.
non 1878 *G. oviformis* Terquem, *Mém. Soc. Géol. France*, ser. 3, **1**, 12, plate 1, figures 1, 2.
?1891 *G. laevigata* d'Orbigny; Crick and Sherborn, p. 209, plate 1, figure 4.
1908 *G. metensis* Terquem; Issler, p. 50, plate 2, figure 66.
?1936 *G. oviformis* Terquem; Franke, p. 55, plate 5, figure 11.
1937 *Pseudoglandulina oviformis* (Terquem); Bartenstein and Brand, p. 149, plate 4, figure 40.

Material: One specimen; Brit. Mus. P34837.

Dimensions: Length 0·16 mm.

Horizon: 123*d–m*.

Remarks: This seems to be a forerunner of such forms as *Pseudoglandulina pygmaea* (Reuss) from the Upper Cretaceous, which become increasingly common in the

Tertiary; but these all appear to be distinguished by a radiate aperture, which *P. oviformis* has not got.

Glandulina pygmea Terquem (non Reuss), (1866, 6FL, p. 478, plate 19, figure 6) and *G. turbiniformis* Terquem (1870, 3SO, p. 342 (240), plate 25, figure 9) are both similar but more inflated forms that may be compared.

Pseudoglandulina oviformis was described as very rare from the *davoei* zone of Vieux Pont, between Caen and Bayeux, Normandy.

34. *Pseudoglandulina septangularis* (Bornemann), plate 3, figure 48*a*, *b*.

1854 *Glandulina septangularis* Bornemann, p. 33, plate 2, figure 8*a*, *b*.
1854 *G. abbreviata* Bornemann, p. 33, plate 2, figure 10*a*, *b*.
1884 *Nodosaria pistilliformis* Schwager; Deecke, p. 26, plate 1, figure 12*a–c*.
1936 *Glandulina septangularis* Bornemann; Franke, p. 58, plate 5, figures (?22), 23.
1936 *G. abbreviata* Bornemann; Franke, p. 59, plate 5, figure 24*a*, *b*.
non 1937 *Pseudoglandulina abbreviata* Bornemann; Bartenstein and Brand, p. 151, plate 4, figure 44; plate 5, figure 31.

Material: One specimen; Brit. Mus. P34824.

Dimensions: Length 0·17 mm.

Horizon: 126.

Remarks: A very well-characterized form of few, elongate chambers—the present specimen has only three—which increase in size very rapidly, with consequently strongly marked septation. The last chamber thus accounts for about half the whole length of the test. The ornamentation consists of seven strong costae which run the whole length of the test. The aperture projects slightly, and is not striate; the costae of the test end against the plain raised ring of the aperture.

Franke's records are merely repetitions of Bornemann's, so that the form does not seem to have been found in the Lias since its original description. Deecke's specimen came from the Bajocian of Alsace, and though intermediate between *Pseudoglandulina septangularis* and *P. pistilliformis* may perhaps be included under the former. It had ten costae over its four chambers.

Nodosaria pistilliformis Schwager in Oppel (1866, p. 304, text-figure 5) from the Corallian of Germany may possibly be a descendant of *Pseudoglandulina septangularis*, but it is certainly not identical. The figured specimen has six shorter chambers ornamented with apparently some twelve to fourteen costae.

P. septangularis was described as rather rare from the *davoei* zone of Göttingen.

35. *Pseudoglandulina tenuis* (Bornemann), plate 3, figure 49.

1854 *Glandulina tenuis* Bornemann, p. 31, plate 2, figure 3*a*, *b*.
?1870 *Dentalina minutissima* Zwingli and Kübler, p. 25, plate 3, figure 11.
1891 *Nodosaria radicula* var. *annulata* Terquem and Berthelin; Crick and Sherborn, p. 210, plate 1, figure 6.
1908 *Glandulina humilis* (Roemer); Issler, pars, p. 49, plate 2, figure 60 only.

1936 *G. tenuis* Bornemann; Franke, p. 55, plate 5, figure 13*a* (? *b*).
1937 *Pseudoglandulina tenuis* Bornemann; Bartenstein and Brand, pars, p. 150, plate 4, figure 41; plate 8, figure 19; plate 15A, figure 15.

Material: One specimen; Brit. Mus. P34855.

Dimensions: Length 0·31 mm. (specimen incomplete); maximum breadth 0·10 mm.

Horizon: 123*d–m*.

Remarks: According to Bartenstein and Brand this species ranges throughout the Lias and Dogger; but it is difficult to be certain that one is always dealing with the same form. Zwingli and Kübler's specimen referred to above, came from the Oxfordian.

Pseudoglandulina tenuis was described as rare from the *davoei* zone of Göttingen.

36. *Pseudoglandulina vulgata* (Bornemann), plate 3, figure 50.

1854 *Glandulina vulgata* Bornemann, p. 31, plate 2, figures 1*a*, *b*, 2 (*G. rotundata* in text in error).
1854 *G. major* Bornemann, p. 31, plate 2, figure 4*a*, *b*.
1865 *G. immutabilis* Schwager, p. 114, plate 4, figures 13, 14, 18.
1866 *Nodosaria primitiva* Kübler and Zwingli, p. 7, plate 1, figure 16.
1867 *N. humilis* Roemer; Brady, p. 222, plate 1, figure 5.
1870 *N. primitiva* Zwingli and Kübler, p. 5, plate 1 (Turnerithon), figure 1.
1870 *Glandulina dubia* Terquem, 3SO, p. 342 (240), plate 25, figures 10, 11.
?1875 *G. hybrida* Terquem and Berthelin, p. 22, plate 1, figure 26.
1876 *G. humilis* Roemer; Blake, p. 454, plate 18, figure 11.
?1886 *G. obtusa* Terquem, p. 10, plate 1, figure 18 (non Costa).
1890 *G. mitis* Wisniowski, p. 197, plate 8, figure 27*a*, *b*.
1891 *G. humilis* (Roemer); Crick and Sherborn, p. 209, plate 1, figures 2, 3.
1908 *G. humilis* (Roemer); Issler, pars, p. 49, plate 1, figures (?55), 56 only.
1917 *G. major* Bornemann; Paalzow, p. 225, plate 42, figure 9.
1936 *G. vulgata* Bornemann; Franke, p. 54, plate 5, figure 9*a*, *b*.
1936 *G. major* Bornemann; Franke, p. 57, plate 5, figure 17.
1936 *G. metensis* Terquem; Franke, p. 56, plate 5, figure 12.
1936 *G. irregularis* Franke, p. 57, plate 5, figure 15*a*, *b*.
1937 *Pseudoglandulina humilis* (Roemer); Bartenstein and Brand, p. 150, plate 6, figure 15; plate 8, figure 18.
1937 *P. irregularis* (Franke); Bartenstein and Brand, p. 151, plate 4, figure 43; plate 8, figure 21.
1937 *P. tenuis* (Bornemann); Bartenstein and Brand, pars, p. 150, plate 6, figure 16 only.
?1937 *P. vulgata* (Bornemann); Bartenstein and Brand, p. 150.

Material: One specimen; Brit. Mus. P34854.

Dimensions: Length 0·16 mm.

Horizon: 123*d–m*.

Remarks: A form of few chambers, three or four in the type figures, though six in *Pseudoglandulina major* which I include in the synonymy. The width of the later chambers is about one-and-a-third times their length.

A variety of names has been applied to specimens which appear to belong here. One

or two additional chambers give the test a rather different appearance (*Glandulina major*, *G. hybrida*), while slightly irregular or pathological specimens have also been given separate names (*G. irregularis*, *G. dubia*). Different names have also been applied to the megalospheric forms (*G. obtusa*, *N. primitiva*).

Owing to the kindness of Herr A. Franke, I have what he states to be some of Bornemann's original material, in which the species is not uncommon. Most of the specimens seem to be microspheric, but one is megalospheric, like the present specimen.

G. humilis, an Upper Cretaceous species, is most probably distinct. It seems to be a form having rather more chambers, which are considerably shorter, more depressed, than those of *Pseudoglandulina vulgata*, their width being over twice their length.

P. vulgata was described as frequent from the *davoei* zone of Göttingen.

Genus *Lingulina* d'Orbigny, 1826

37. *Lingulina laevissima* (Terquem), plate 3, figure 51*a*, *b*.

1866 *Frondicularia laevissima* Terquem, 6FL, p. 481, plate 19, figure 19*a*, *b*.
1866 *F. tenerrima* Kübler and Zwingli, p. 8, plate 1, figure 9.
1866 *F. irregularis* Kübler and Zwingli, p. 9, plate 1, figure 17.
?1866 *F. nodosaria* Kübler and Zwingli, p. 10, plate 2, figure 1.
1870 *F. tenerrima* Zwingli and Kübler, p. 6, plate 1 (Turnerithon), figure 13.
1870 *F. irregularis* Zwingli and Kübler, p. 8, plate 1 (Posidonienschiefer), figure 1.
?1870 *F. nodosaria* Zwingli and Kübler, p. 10, plate 1 (Jurensismergel), figure 2.
1870 *F. ovulus* Zwingli and Kübler, p. 24, plate 3, figure 5.
?1881 *F. lanceolata* Haeusler, p. 18, plate 2, figure 3.
1890 *F. varians* Wisniowski, pars, p. 199, plate 8, figure 30*d*, *f*, *g* only.
?1903 *F. longiscata* Terquem; Schick, p. 152, plate 6, figure 13.
1908 *F. lanceolata* Haeusler; Issler, pars, p. 55, plate 2, figure 103 only.
1908 *F. nitida* Terquem; Issler, pars, p. 56, plate 2, figures 107, 108 only.
1935 *F. laevissima* Terquem; Macfadyen, p. 11, plate 1, figure 6*a*, *b*.
1936 *Lingulina lanceolata* (Haeusler); Franke, p. 62, plate 6, figure 10.
non 1936 *L. laevissima* (Terquem); Franke, p. 62, plate 6, figure 11.
non 1937 *L. laevissima* (Terquem); Bartenstein and Brand, p. 151, plate 8, figure 23.
1937 *L. lanceolata* (Haeusler); Bartenstein and Brand, p. 151, plate 2B, figure 17.

Material: One specimen; Brit. Mus. P34761.

Dimensions: Length 0·71 mm.

Horizon: 122.

Remarks: Although practically a smooth form, there are traces of obsolete striation just visible on the surface of the present specimen. It compares in this respect, as in others, very closely with my specimen from the Corallian of British Somaliland.

Several figures of forms described in the literature are inadequate, and there is no certainty, other than their assignment by the author to the genus *Frondicularia*, that some are not really examples of *Nodosaria*, e.g. those described by Kübler and Zwingli, and by Haeusler. Terquem's figure is the earliest that is at all satisfactory, since an

adequate end view is given, though details of the chambers may possibly not be exact, as is the case in many of Terquem's figures.

Lingulina taenioides Franke (1936, p. 62, plate 6, figure 12) is a very similar form, possibly identical. It seems to be differentiated only in the small backwardly directed spinous processes at the base of some of the chambers. This may perhaps be due merely to the slightly irregular fitting together of the chambers in course of growth; a slight abnormality rather than a distinct form.

L. laevissima was described as very rare, presumably from the *semicostatum* zone of Magny-lès-Metz.

38. *Lingulina tenera* Bornemann, plate 3, figure 52*a*, *b*.

1854 *Lingulina tenera* Bornemann, p. 38, plate 3, figure 24*a–c*.
1858 *Frondicularia tenera* (Bornemann); Terquem, 1FL, p. 595 (35), plate 1, figure 14*a–d*.
1858 *F. hexagona* Terquem, 1FL, p. 594 (34), plate 1, figure 13*a–c*.
1867 *Lingulina tenera* Bornemann; Brady, p. 223, plate 1, figure 11.
1875 *Frondicularia tenera* (Bornemann); Terquem and Berthelin, p. 36.
?1876 *Lingulina tenera* Bornemann; Blake, pars, p. 455; the figures are var. *pupa*.
non 1891 *L. tenera* Bornemann; Crick and Sherborn, p. 210, plate 1, figure 10.
?1903 *L. tenera* Bornemann; Schick, p. 151, plate 6, figure 10.
?1918 *L. tenera* Bornemann; Trueman, pp. 71, 102.
1921 *Frondicularia tenera* (Bornemann); Klähn, pars, p. 27, plate 6, figures 11, 12, 14, 18, ?20, 21, ?22 only.
1934 *Lingulina tenera* Bornemann; Henderson, p. 553, text-figure 3*b*.
1936 *L. tenera* Bornemann; Franke, p. 64, plate 6, figure 18.
?1936 *Frondicularia pygmaea* Franke, p. 70, plate 7, figure 5*a*, *b*.
1937 *F. tenera tenera* (Bornemann); Bartenstein and Brand, p. 156, many figures.
?1937 *F. tenera octocosta* Brand, in Bartenstein and Brand, p. 157, plate 3, figure 27, and text-figure 15*c*.

Material: Fourteen specimens; Brit. Mus. P34839 (thirteen), P34904 (figured).

Dimensions: Length up to 0·46 mm.

Horizon: 123*d–m*.

Remarks: The present specimens of this variable and very common Lias species are mostly of the long and narrow form, but without constricted sutures separating the latest chambers.

Klähn and Bartenstein and Brand refer the species to *Frondicularia* on the ground that the chambers are chevron-shaped rather than transverse. In my experience these differences tend to vanish in such a species as this, and no sharp dividing line is possible. The matter may be one of opinion, and I prefer to refer such forms to *Lingulina*.

The test of *L. tenera* is typically hexagonal in section. It may be short and broad, when the chambers are more markedly frondicularian. Such specimens have been described as *Frondicularia tenera octocosta* by Brand, while a variety characterized by raised sutures is *F. occidentalis* Berthelin (1879, p. 34, plate 1, figures 9–11). The test of *Lingulina tenera* may, on the other hand, be elongate and slender, with the chambers

more typically linguline, and often with the sutures of the latest chambers constricted. Finely striate forms of this type have been described as *L. striata* Blake (1876, p. 455, plate 18, figures 16, 16*a*).

Other marked varieties are also found, sometimes in abundance. In var. *pupa* Terquem the test becomes covered with finer costation and striation, the six strong costae weakening, and the hexagonal section becoming elliptical. In var. *excavata* Terquem (1866, 5FL, p. 403, plate 15, figure 4*a*, *b*) the test becomes somewhat elliptical in section, but with excavated faces, and all costation vanishes leaving a smooth shell.

A close study of these forms would be of interest, and might prove of value for zonal purposes.

Frondicularia tenera prismatica Brand (1937, in Bartenstein and Brand, p. 156, plate 3, figure 34*a–c*, and text-figure 15*a*, *b*) appears to me to be a form unconnected with *Lingulina tenera*, none of my numerous specimens of this species and its varieties being apiculate. On the contrary, I have similar apiculate specimens, which may be Brand's form, but I consider them certainly specifically, and perhaps generically, distinct.

L. tenera was described as abundant from the *davoei* zone of Göttingen.

39. *Lingulina tenera* var. *pupa* (Terquem), plate 3, figure 53*a*, *b*.

1866 *Marginulina pupa* Terquem, 5FL, p. 429, plate 17, figure 7*a–f*.
1875 *Frondicularia pupa* Terquem and Berthelin, pars, p. 36, plate 3, figure 1*a*, *b*, *d*, *f*, *k*, *l* only.
1876 *Lingulina tenera* Bornemann; Blake, pars. p. 455, plate 18, figures 15, 15*a*.
1883 *Frondicularia pupa* Terquem, 5SO, p. 346, plate 38, figure 7*a*, *b*.
?1883 *F. abbreviata* Terquem, 5SO, p. 347, plate 38, figure 8.
1891 *Lingulina tenera* Bornemann; Crick and Sherborn (?pars), p. 210, plate 1, figure 10.
1921 *Frondicularia tenera* (Bornemann); Klähn, pars, p. 27, plate 6, figures 9, 10, 13, 15, 17, 23 only.
1936 *Lingulina pupa* (Terquem); Franke, p. 63, plate 6, figures 16*a*, *b*, 17.
1937 *L. pupa* (Terquem); Bartenstein and Brand, p. 152, many figures.
1937 *L. pupa* (Terquem), Form *a*; Bartenstein and Brand, p. 152, plate 4, figure 53*a*, *b*; plate 5, figure 33.

Material: Forty specimens; Brit. Mus. P34700, P34713, P34778, P34781, P34812 (figured), P34815, P34828 (thirty-three), P34868.

Dimensions: Length 0·15–0·57 mm.

Horizon: 122, 123*a*, 123*d–m*, 123*i–m*, 123*m*.

Remarks: This variety is closely related to *Lingulina tenera*, and in some collections distinction between them is difficult, the two forms running together. It thus seems best to regard *pupa* as a variety of *L. tenera*.

L. tenera has typically six strong costae which emphasize the hexagonal section of the test. Var. *pupa* also has these six costae, particularly on the early chambers, but later they become reduced in size, while a number of subsidiary costae come in, so that in

the final chambers there may be as many as twenty fine costae, some hardly more than striae, which do not affect the elliptical section of the test. Megalospheric specimens greatly predominate, but the size of the protoconch varies considerably. Normal specimens commonly have up to six or seven chambers. Microspheric individuals are rare, and have up to ten chambers.

The development of a few late chambers, markedly constricted at the sutures, is a commonly observed phenomenon. Bartenstein and Brand term such specimens 'Form *a*', but without giving a distinctive name. It does not seem to me desirable to make such distinction in the material that I have seen, though these authors state that 'Form *a*' is restricted to Lias γ and δ, that is from about the *jamesoni* zone to the top of the Middle Lias. The common form, they state, is found from Lias γ up to the top of the Dogger (top of the Oxfordian). Klähn also (1921, pp. 27, 28) considers that *L. tenera* (in which name he includes *L. pupa*) ranges from Lower Lias to the Corallian in Germany; but his figures are not convincingly adequate.

With the present information of the English distribution it would seem that whereas *L. tenera* is found in the *planorbis* zone upward, I have not certainly recorded var. *pupa* earlier than the *semicostatum* zone. This agrees with the German distribution given by Franke and by Bartenstein and Brand, but further confirmation is required.

L. tenera var. *pupa* was described as very common from presumably the *semicostatum* zone of Vallières-lès-Metz, and from the *davoei* zone of Venarey, Semur, and Vic, Indre, in France.

40. *Lingulina terquemi* nom.nov., plate 3, figure 54*a–c*.

1862 *Frondicularia rhomboidalis* Terquem, 2FL, p. 439, plate 5, figure 19*a*, *b* (non d'Orbigny, 1826).

?1937 *F. rhomboidalis* Terquem; Bartenstein and Brand, p. 154.

Material: One specimen; Brit. Mus. P34872.

Dimensions: Length 0·42 mm.

Horizon: 123*a*.

Remarks: This is a long and slender form, rhomboidal in section; it seems quite distinct from other described species. In the text Terquem states that it is 2·1 mm. long, but his figured (? and only) specimen works out at only 1·6 mm. if its magnification is correctly given. Generically it seems better placed under *Lingulina*.

Terquem's name is preoccupied by d'Orbigny, so that a new one is required.

L. terquemi (i.e. *Frondicularia rhomboidalis* Terquem) was described as very rare from the *davoei* zone of Montigny-lès-Metz.

41. *Lingulina* (?) *compressa* (Terquem), plate 3, figure 55*a*, *b*.

1863 *Dentalina compressa* Terquem, 3FL, p. 383 (173), plate 7, figure 10*a*, *b*.

Material: One specimen; Brit. Mus. P34869.

Dimensions: Length 0·50 mm.

Horizon: 123*a*.

Remarks: The protoconch is practically circular in section, and it is followed by three chambers that are compressed, and rapidly increase in size; the final chamber is very long, accounting for practically half of the total length of the test. The last two sutures are strongly depressed, so that the later chambers appear to be appreciably inflated. The terminal aperture is very small, but it is slightly elongate, and clearly radiate. The axis of the test is slightly curved. The ascription to *Lingulina* is not certain, though it seems better placed here than in *Dentalina*, on grounds of both the compression of the test and the elongate and central, terminal, aperture. The present specimen is infilled with pyrites.

Terquem's figures show a rather more slender form, and he states that the sutures are barely visible, though they are very clearly shown in the figures. The aperture he neither figured in detail nor described. I consider that these slight differences may be simply due to individual variation, assuming that Terquem's figures are reasonably accurately drawn.

I have found no later record of this form.

There are somewhat similar species that may be compared, but all possess straight axes. *Lingulina stillula* Berthelin (1880, p. 64, plate 4, figure 8*a*, *b*) differs in its more slender form, the chambers increasing in size in definite steps. Under the name *Frondicularia dentaliniformis* Terquem (1870, 3SO, p. 319 (217), plate 23, figures 1–8) a very mixed bag of specimens is figured, but the first may be taken as the type, and this resembles the present specimen, differing in the shorter chambers and generally more slender build. The specific name is preoccupied for *Lingulina* by Terquem himself for a rather different form (1870, 3SO, p. 339 (237), plate 25, figures 1–3).

Lingulina (?) *compressa* was described as rather rare from the *davoei* zone of Pouillenay, and apparently from the *semicostatum* zone of Queuleu, near Metz.

Genus *Tristix*, gen.nov.

Genotype, *Rhabdogonium liasinum* Berthelin, 1879

Triplasia Reuss, pars, of authors.
Rhabdogonium Reuss, pars, of authors.

Diagnosis: Test free, hyaline, consisting of a number of chambers, generally triangular in section, joined in a straight series; aperture terminal, simple.

It is often impossible to determine from the literature which species should be assigned to this genus. Authors have referred their hyaline species to *Triplasia* or its synonym *Rhabdogonium*, but about 1932 Cushman found that the type species, *Triplasia murchisoni* Reuss, was an arenaceous form. This left the isomorphous hyaline species without a generic name, and *Tristix* is now proposed for them.

Definite hyaline species that should be included here seem to be: *Rhabdogonium excavatum* var. *exilis* Chapman, 1899 (*Ann. Mag. Nat. Hist.* ser. 7, 3, 305, figure 2); *R.*

carinatum Sidebottom, 1918 (*J. Roy. Micr. Soc.* p. 138, plate 4, figures 20–25); *Triplasia wilcoxensis* Cushman and Ponton, 1932 (*Contr. Cushman Lab.* **8**, 58, plate 7, figure 19*a*, *b*); *T. temirica* Dain (1934, pp. 29, 57, plate 3, figure 25*a–c*); *T. somaliensis* Macfadyen (1935, p. 11, plate 1, figure 7*a*, *b*).

Probably various other older species, mostly described as *Rhabdogonium*, should also be included, but at present there is doubt as to whether the tests are arenaceous or hyaline.

Certain species quadrangular instead of triangular in section may possibly be found to be congeneric. The aperture of *Triplasia temirica* is figured as radiate, so that possibly forms with both plain and radiate apertures may have to be included.

From the above list, the genus *Tristix* would appear to range at least from the Lias to the present day.

No indication of its ancestry is given by species of *Tristix* so far described, the protoconch of each being spherical or ovoid, followed immediately by the adult triangular-sectioned series of chambers. Specimens of this genus seem to be usually rare, only a few being generally recorded. It is possible that the microspheric forms have not yet been found. The genus differs from *Trifarina* Cushman, which has the early chambers 'in an irregular spire or triserial', while the aperture in the adult has a short neck and lip.

The systematic postion of the genus *Tristix* is apparently in the family Lagenidae, near to *Nodosaria*.

42. *Tristix liasina* (Berthelin), plate 4, figure 56*a*, *b*.

1879 *Rhabdogonium liasinum* Berthelin, p. 35, plate 1, figures 18, 19.

Material: One specimen; Brit. Mus. P34835.

Dimensions: Length 0·17 mm.; greatest width 0·09 mm.

Horizon: 123*d–m*.

Remarks: The wall is hyaline, the test composed of a linear series of six chambers increasing regularly in size; in section it is triangular; the margins are not keeled but are fairly acute in the early chambers, more rounded in the latest; the sides of the test are only very slightly concave, in fact nearly plane; the aperture is central and terminal, very small, roughly circular, and apparently plain, not radiate; the protoconch was unfortunately broken before figuring, but it was, it is believed, ovoid.

Berthelin's figure shows a specimen with eleven chambers, which appear to be shorter than those of the present specimen; but the general shape of the test, seen from the side as well as from above, and the shape of the individual chambers, show that the present specimen is practically identical, though with fewer chambers. I have found no later record of this species, and have no other specimens of it. Berthelin's figured specimen was about 0·19 mm. in length.

Rhabdogonium excavatum Reuss (1862, *S.B. Akad. Wiss. Wien*, **46**, Abt. 1, p. 91, plate 12, figure 8*a–c*), described from the Gault of Germany, is of somewhat similar appearance,

though the excavation of the sides of the test is much more pronounced. The nature of the wall is not without doubt, and the size is much greater, 0·77 mm. in length.

Triplasia temirica Dain (1934, pp. 29, 57, plate 3, figure 25*a–c*) from the Volgian (=Portlandian) of Russia differs in the outline and section of the test, and the much longer chambers; it is figured with a well-marked radiate aperture.

T. somaliensis Macfadyen (1935, p. 11, plate 1, figure 7*a, b*), from the Corallian of British Somaliland, differs in the less embracing nature of the chambers, and the fully keeled test, while the aperture is more conspicuous.

T. liasina was described as rare from the Middle Lias, *margaritatus* zone, of St Vincent-Sterlange, Vendée, western France.

Genus *Vaginulina* d'Orbigny, 1826

43. *Vaginulina constricta* (Terquem and Berthelin), plate 4, figure 57*a, b*.

1875 *Marginulina constricta* Terquem and Berthelin, p. 58, plate 5, figure 3*a–f*.
?1876 *Vaginulina anomala* Blake, p. 464, plate 17, figure 23, 23*a*.
1936 *V. constricta* (Terquem and Berthelin); Franke, p. 83, plate 8, figure 24.
1937 *V. constricta* (Terquem and Berthelin); Bartenstein and Brand, p. 163, six figures.

Material: One specimen; Brit. Mus. P34877.

Dimensions: The length of the last three chambers of the broken specimen is 0·41 mm.

Horizon: 123*a*.

Remarks: The present specimen is strongly compressed in the earlier part of the test, as are, apparently, the specimens illustrated by the type figures; the form is therefore assigned to *Vaginulina*.

It seems probable that a number of records of somewhat similar forms, under a variety of names, should be included here, but owing to the lack of precise description and adequate figures this cannot be certain without seeing the specimens. Examples are: *Marginulina pauliniae* Terquem (1866, 5FL, p. 427, plate 17, figure 5*a–h*); *M. solida* Terquem (1868, 1SO, p. 122, plate 8, figures 1–12; 1876, p. 488, plate 16, figures 8, 9; and 1886, p. 24, plate 2, figures 34–43); *M. contracta* Terquem (1868, 1SO, p. 125, plate 8, figures 13–24; 1876, p. 489, plate 16, figures 10–13; 1886, p. 25, plate 2, figures 44–54); *M. minuta* Terquem (1868, 1SO, p. 129, plate 8, figures 27–30); *Vaginulina clava* Zwingli and Kübler (1870, p. 6, plate 1 (Turnerithon), figure 8).

Vaginulina constricta was described as very common from the Middle Lias, *margaritatus* zone, of Essey-lès-Nancy, eastern France.

Genus *Flabellina* d'Orbigny, 1839

When d'Orbigny described this genus, in de la Sagra, *Hist. phys. polit. nat. Cuba*, 1839, p. 42, no species were given, but his 'Modèles, no. 103, 5^{e} livraison' was referred to in illustration. According to Heron-Allen (1917, *J. Roy. Micr. Soc.* p. 91) nothing

more is known of this fifth series of models, which seem never to have been produced. Later d'Orbigny described and figured three species from the Chalk of the Paris Basin (1840, *Mém. Soc. Géol. France*, **4**, 23), and Cushman designated the first of them, *Flabellina rugosa*, as the type species (1927, *Contr. Cushman Lab.* **3**, 189).

Howe (1936, *J. Paleont.* **10**, 415) has recently endeavoured to show that *Flabellina* d'Orbigny is invalidated by *Palmula* Lea, 1833, the original specimens of which, *Palmula sagittaria* Lea, he has studied.

Lea referred to two specimens on which he proposed to found the genus, but figured only one, Howe's figure 2. This shows a form which would certainly be referred to *Frondicularia*, since nothing more than a slight asymmetry of the first two chambers is shown, the protoconch being represented as a large, more or less ovoid, chamber. Of this specimen Howe states 'its thickness is slightly greater near the initial end than in the fan-shaped later portion, and *it is evidently coiled*, but the shell material was too cloudy to make out the exact chamber arrangement. I made camera lucida drawings of the chamber arrangement of both specimens which are given as figures 1, 2.' The only evidence, therefore, that the figured type specimen has a coiled initial portion is Howe's statement quoted above (my italics), since his figure shows none. If, however, he be correct in his statement, then the specimen, depicted as megalospheric, must in fact be microspheric. The second, larger, specimen referred to by Lea is figured by Howe as microspheric, with a small initial coil, though again it seems not clear enough to figure without some broken lines.

The genus *Frondicularia* is described by Cushman (1933, p. 182) as '. . .in the early stage in the microspheric form, sometimes partially coiled, megalospheric form not coiled. . . .' As the generic position of Lea's *Palmula sagittaria* is not yet wholly free from elements of doubt, it seems at present preferable to continue the use of the well established name *Flabellina*.

44. *Flabellina centro-gyrata* Terquem, plate 4, figure 58.

1863 *Flabellina obliqua* Terquem, 3FL, p. 427 (217), plate 10, figure 15 (non (Münster), 1838).
1867 *F. rugosa* d'Orbigny; Brady, pars, p. 229, plate 3, figure 45 only.
1870 *F. centro-gyrata* Terquem, 3SO, p. 332 (230), plate 24, figure 21.
1876 *F. rugosa* d'Orbigny; Blake, p. 467, plate 19, figure 19.
1937 *F. obliqua* Terquem; Bartenstein and Brand, p. 168, plate 4, figure 64; plate 5, figure 51.

Material: Six specimens; Brit. Mus. P34741, P34750, P34756, P34760, P34790 (figured), P34800.

Dimensions: Length 0·38–1·15 mm.

Horizon: 122.

Remarks: A shell of eight to ten cristellarian chambers followed by one or two frondicularian chambers; P34741 exceptionally has seven frondicularian chambers.

This species differs from *Flabellina inaequilateralis* in that the cristellarian chambers

are obliquely transverse; the inner margins make no attempt to embrace the previous chambers as in *F. inaequilateralis*, where even the later chambers of the cristellarian series come near to touching the protoconch.

F. semicristellaria Schwager (1867, p. 656, plate 34, figure 11), from the Bajocian of Germany, may be compared, but it differs in the marked absence of coiling in the early cristellarian chambers.

The Upper Cretaceous *F. rugosa* with which Brady and Blake identified their specimens is, in fact, unmistakably distinct. According to Cushman (1935, *Contr. Cushman Lab.* **11**, 83, plate 13, figures 1–6), it was defectively figured by d'Orbigny.

I have no further specimens of this form from the English Jurassic.

F. obliqua Terquem was described as very rare from the *davoei* zone, of Vieux Pont, between Caen and Bayeux, in Normandy; while *F. centro-gyrata* was described as very rare from the *parkinsoni* zone (Bathonian), of Fontoy, near Metz.

45. *Flabellina inaequilateralis* Terquem, plate 4, figure 59*a*, *b*.

1860 *Flabellina rugosa* d'Orbigny; Jones and Parker, pars, p. 453, plate 19, figure 21 only.
1863 *F. inaequilateralis* Terquem, 3FL, p. 428 (218), plate 10, figure 16.
1870 *F. jurassica* Zwingli and Kübler, p. 16, plate 2 (Blagdenischicht), figure 10.
1870 *F. eichbergensis* Zwingli and Kübler, p. 22, plate 2 (Ornatenthon), figure 5.
1870 *F. primordialis* Terquem, pars, 3SO, p. 323 (221), plate 23, figure 19 only.
1870 *F. triquetra* Terquem, 3SO, p. 325 (223), plate 23, figures 26–28.
1870 *F. hybrida* Terquem, 3SO, p. 330 (228), plate 24, figure 16.
1876 *F. primordialis* Terquem, p. 489, plate 16, figure 14.
1876 *F. triquetra* Terquem, p. 490, plate 16, figure 15.
1883 *F. triquetra* Terquem, pars, 5SO, p. 348, plate 38, figure 11 only.
non 1883 *F. primordialis* Terquem, 5SO, p. 349, plate 38, figures 15–17.
1886 *F. primordialis* Terquem, p. 44, plate 4, figure 38.

Material: Nine specimens; Brit. Mus. P34768 (two), P34769 (figured), P34774, P34792, P34821, P34862 (three).

Dimensions: Length 0·38–0·55 mm.

Horizon: 122, 123*a*, 123*m*.

Remarks: This species is similar to *Cristellaria varians* Bornemann, with from one to three frondicularian chambers completing the test. The cristellarian chambers vary from six to eleven in the present specimens, and they embrace the earlier chambers on the inner margin, so that the base of each reaches down towards the protoconch.

I have no further specimens of this species from the English Jurassic.

Flabellina inaequilateralis was described as very rare from the *davoei* zone of Saint-Julien-lès-Metz.

Genus *Frondicularia* Defrance, 1824

46. *Frondicularia sulcata* Bornemann, plate 4, figure 60*a*, *b*; text-figure 4.

1854 *Frondicularia sulcata* Bornemann, p. 37, plate 3, figure 22*a–c*.
1858 *F. pulchra* Terquem, 1FL, p. 592 (32), plate 1, figure 10*a–c*.

1860 *F. striatula* Reuss; Jones and Parker, p. 453, plate 19, figures 16, 17, ?18.
?1862 *F. multicostata* Terquem, 2FL, p. 438, plate 5, figure 14*a*, *b*.
non 1862 *F. sulcata* Terquem, 2FL, p. 438, plate 5, figure 13.
1866 *F. pulchra* Terquem, 6FL, p. 481, plate 19, figure 16.
?1867 *F. striatula* Reuss; Brady, p. 229, plate 3, figure 48.
?1875 *F. venusta* Terquem and Berthelin, p. 37, plate 3, figure 2*a*, *b*.
1876 *F. sulcata* Bornemann; Blake p. 469, plate 19, figure 23.
?1877 *F. sulcata* Bornemann; Beesley, p. 20.
?1879 *F. pulchra* Terquem; Berthelin, p. 32.
1886 *F. multicostata* Terquem; Burbach, p. 50, plate 2, figures 42, 43.
1886 *F. pulchra* Terquem; Burbach, p. 51, plate 2, figures 45, 46.
1891 *F. rugosa* Crick and Sherborn, p. 213, plate 1, figure 34.
1891 *F. sulcata* Bornemann; Crick and Sherborn, p. 213, plate 1, figure 35.
?1903 *F. pulchra* Terquem; Schick, p. 153, plate 6, figure 15.
1908 *F. sulcata* Bornemann; Issler, p. 61, plate 3, figures 140–142.
1908 *F. pulchra* Terquem; Issler, p. 59, plate 3, figures 130–136.
1921 *F. pulchra* Terquem; Klähn, pars, p. 28, plate 5, figures 38, 39, ?40 only.
1936 *F. pulchra* Terquem; Franke, p. 71, plate 7, figure 7.
?1936 *F. interrupta-costata* Franke, p. 72, text-figure 1.
?1936 *F. sulcata* Bornemann; Franke, p. 71, plate 7, figure 8.
?1936 *F. pulchra* Terquem; Brotzen, p. 119.
1937 *F. sulcata* Bornemann; Bartenstein and Brand, pars, p. 158, plate 2A, figure 19*a*, *b*; plate 2B, figure 20; plate 4, figure 50 only.
?1937 *F. multicostata* Terquem; Bartenstein and Brand, p. 158, plate 5, figure 39.

Material: Sixteen specimens; Brit. Mus. P34706, P34723 (two), P34736, P34744, P34850 (nine), P34867, P34895 (figured).

Dimensions: Length up to 0·80 mm. (broken); ratio of width to length about 1:3·1 to 1:4·0.

Horizon: 122, 123*a*, 123*d–m*, 123*m*.

Remarks: The megalospheric form of *Frondicularia sulcata* is typically flat but robust, of up to about twelve chambers, well covered by some twelve to sixteen usually fairly strong, nearly parallel costae. The final chamber is often partly smooth. In the microspheric form the test often becomes much more slender and elongate; in section it may be elliptical, eventually passing into the var. *squamosa*. A slight keel is often developed on both forms A and B, but specimens are as often found without.

The forms recorded in the synonymy above are a variable series which in practice I am quite unable to separate under distinctive names. But it would be easy to pick out single specimens that would appear, by themselves, as strikingly distinct; so that on paper there would be little question that they were not different species. This view has been arrived at after studying, for the present work, some 150 specimens assigned to this species, from over twenty different horizons and localities, including one topotype specimen from Bornemann's original material.

For some years I have tried in vain to find criteria to separate *F. sulcata* and *F. pulchra*. In 1931 I found in Paris museums six of Terquem's specimens on five slides

labelled *F. pulchra*, three labelled plate 1, figure 10, and two plate 19, figure 16, referring to the plates of his First and Sixth Lias Mémoires respectively. In my opinion these specimens are identical with *F. sulcata*. One specimen was carefully drawn by camera lucida, and the figure is reproduced here (figure 4). Both species were described from the *davoei* zone, F. *pulchra* from Saint-Julien-lès-Metz, and *F. sulcata* from Göttingen; these two places are about 400 km. apart.

That these two species are identical is supported by the views of other authors. Blake (1876) placed *F. pulchra* and *F. multicostata* in the synonymy of *F. sulcata*. Klähn (1921, p. 28) put *F. sulcata* into the synonymy of *F. pulchra*, ignoring the priority of the former. Bartenstein and Brand (1937, p. 158), writing of *F. sulcata*, state: F. pulchra *trennen wir nicht hiervon ab, da beiden Arten im gleichen Lager vorkommen, und des Unterscheidungs-Merkmal "sichtbare Kammern"* (Franke 1936) *nicht stichhaltig ist.*

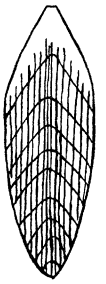


FIGURE 4. *Frondicularia pulchra* Terquem [=*F. sulcata* Bornemann], × 25, from *davoei* zone, Vic, Indre, France. Drawn from a specimen on one of Terquem's slides labelled [plate] xix, [figure] 16 [of his 6*th Mém. Foram. Lias*], preserved in the Département de Zoologie (Vers et Crustacés), Mus. Nat. Hist. Nat., 61 Rue Buffon, Paris.

On a broader basis of comparison, *F. sulcata* with *F. bicostata* and *F. terquemi* of d'Orbigny form a very closely related group. It is of interest to note that Berthelin (1879, p. 32) came to the same conclusion, calling the two last mentioned varieties of *F. pulchra*. Specimens of these three forms are sometimes differentiated with difficulty, since the basic form of the test is identical, and the only real difference lies in the varying amount of costation, *F. sulcata* being fully costate, *F. bicostata* having lesser, incomplete, costation, while *F. terquemi* is completely smooth. Keels may be present or absent on each.

All three forms seem to be confined to the Lias; *F. sulcata* appears first in the *planorbis* zone, but *F. bicostata* and *F. terquemi* not until about the *bucklandi* zone. Another form, *F. sulcata* var. *squamosa*, is recorded and discussed below.

The question of nomenclature is difficult. Because of the very clear distinctions between the end forms *F. sulcata* and *F. terquemi*, and because the latter does not seem to appear until a later date, it is proposed to retain *F. terquemi* as a distinct species. *F. bicostata* seems best treated as a variety of *F. terquemi*, though some specimens are found grading into *F. sulcata* so clearly that individually they might seem better recorded as a variety of that species.

F. sulcata is generally a common species in the English Lower Lias. It was described as very rare from the *davoei* zone of Göttingen.

47. *Frondicularia sulcata* var. *squamosa* Terquem and Berthelin, plate 4, figure 61.

1875 *Frondicularia squamosa* Terquem and Berthelin, p. 37, plate 3, figure 3*a*, *b*.
1937 *F. mesoliassica* Brand, in Bartenstein and Brand, p. 158, plate 4, figure 66; text-figure 16.

Material: Twelve specimens; Brit. Mus. P34701, P34726, P34842 (nine), P34908 (figured).

Dimensions: Length up to 0·88 mm.; ratio of width to length, 1:5·0 to 1:5·9.

Horizon: 123*a*, 123*d–m*, 123*i–m*.

Remarks: The test is long, narrow, and rounded-elliptical in section; in the later portion, the sutures are so deeply sunk that the chambers appear inflated, while the lower part only of each chamber is striate, the upper part being smooth or practically so. The final chamber is often dwarfed.

A single specimen of this form found by itself would unhestitatingly be considered as specifically distinct from *Frondicularia sulcata*. It is therefore of much interest to find that in the collection from horizon 123*d–m* typical *F. sulcata* pass into var. *squamosa* by a series of intermediate links, leaving no doubt that the two are very closely akin.

Brand redescribed the form as *F. mesoliassica* from Lias γ and δ, approximately the *davoei* zone and the Middle Lias of Germany. In addition to the present specimens I have examples from the Middle Lias of Golden Cap, Dorset (localities 226, 227), but none from other collections from the English Lower Lias. This is of interest because the records indicate that so far as is yet known its range is confined to about the *davoei* zone and the Middle Lias.

F. sulcata var. *squamosa* was described as very rare from the Middle Lias, *margaritatus* zone, of Essey-lès-Nancy, eastern France.

48. *Frondicularia terquemi* var. *bicostata* d'Orbigny, plate 4, figure 62*a*, *b*.

1850 *Frondicularia bicostata* d'Orbigny, **1**, 242, no. 256.
1858 *F. bicostata* d'Orbigny; Terquem, 1FL, p. 593 (33), plate 1, figure 11*a–c*.
?1866 *F. Heerii* Kübler and Zwingli, p. 8, plate 1, figure 4.
?1870 *F. Heerii* Zwingli and Kübler, p. 6, plate 1 (Turnerithon), figure 9.
?1875 *F. bicostata* d'Orbigny; Terquem and Berthelin, p. 35.
1876 *F. Terquemi* d'Orbigny; Blake, p. 468, plate 19, figure 22.
1886 *F. bicostata* d'Orbigny; Burbach, p. 53, plate 2, figures 56, 57.
?1886 *F. octocostata* Burbach, p. 50, plate 2, figure 44.
?1886 *F. Baueri* Burbach, p. 52, plate 2, figures 48–52.
?1886 *F. procera* Burbach, p. 52, plate 2, figures 54, 55.
?1891 *F. Terquemi* d'Orbigny; Crick and Sherborn, p. 213, plate 1, figure 36.
?1903 *F. Baueri* Burbach; Schick, p. 153, plate 6, figures 16, 17.
?1903 *F. Heeri* Kübler and Zwingli; Schick, p. 154, plate 6, figure 18.
1908 *F. bicostata* d'Orbigny; Issler, p. 60, plate 3, figures 138, 139.
?1908 *F. Baueri* Burbach; Issler, p. 60, plate 3, figure 137.
1936 *F. bicostata* d'Orbigny; Macfadyen, p. 149, plate 1, figure 256.
1936 *F. bicostata* d'Orbigny; Franke, p. 70, plate 7, figure 9.

1936 *F. sulcata* Bornemann; Franke, p. 71, plate 7, figure 8.
1936 *F. baueri* Burbach; Franke, p. 70, plate 7, figure 10.
1936 *F. terquemi* d'Orbigny; Franke, pars, p. 69, plate 7, figure 11*a* only.
?1936 *F. bicostata* d'Orbigny; Brotzen, p. 119.
1937 *F. bicostata* d'Orbigny; Bartenstein and Brand, p. 158, plate 2B, figure 23; plate 3, figure 35; plate 4, figure 48; plate 5, figure 40.
1937 *F. baueri* Burbach; Bartenstein and Brand, p. 158, plate 3, figure 36; plate 4, figure 49.
1937 *F. sulcata* Bornemann; Bartenstein and Brand, pars, p. 158, plate 1A, figure 12 only.
1937 *F. dubia* Bornemann; Bartenstein and Brand, pars, p. 158, plate 3, figure 41; plate 5, figure 41*a*, *b* only.
?1937 *F. multicostata* Terquem; Bartenstein and Brand, p. 158, plate 5, figure 39.

Material: Nine specimens; Brit. Mus. P34724, P34725 (two), P34841 (figured), P34865 (five).

Dimensions: Length 0·51–1·15 mm.; the protoconch varies in six megalospheric specimens from 0·046 to 0·069 mm. in diameter; in one possibly microspheric specimen of P34865 it is only 0·029 mm.

Horizon: 123*a*, 123*d–m*.

Remarks: The general form of the test is variable but fairly well characterized, and closely similar to those of *Frondicularia terquemi* and *F. sulcata*. It is typically a long, rather slender shell, with some eight to twelve or more chambers; it is flatly elliptical in section, sometimes with a slight keel extending round the margin, except in the neighbourhood of the aperture. The surface is ornamented with more or less costation; this is a very variable feature, and has no doubt led to the records being made under so many specific names. Typically there are few, if any, main costae, and these are often incomplete or irregular. There is some subsidiary costation, which may cover only a few chambers. On the one hand, in some specimens the test is nearly smooth, and so grades into *F. terquemi*; while on the other hand, specimens are not uncommon where the costae become more numerous and stronger, so that six or eight costae are visible over much of the test. In these cases new names have been assigned, such as *F. octocostata*, *F. baueri*, *F. procera*, or the specimens have been recorded under *F. sulcata* or *F. multicostata*. The form is, in fact, as noted above under *F. sulcata*, an intermediate link between the fully costate *F. sulcata* and the smooth *F. terquemi*, and with many specimens it becomes merely a matter of personal opinion under which of two names they are recorded.

The above somewhat wide interpretation of var. *bicostata* is supported in that neither Burbach, nor Franke, nor Bartenstein and Brand, all of whom record several of the 'species' here put into the synonymy, make any real attempt to diagnose their characters, or adequately to differentiate them one from another. It is of interest to note that the completely smooth *F. terquemi* has not been recorded in the present material.

F. terquemi var. *bicostata* was described from the *davoei* zone of the Metz district where, according to Terquem, it is fairly common.

Genus *Lagena* Walker and Boys, 1784

49. *Lagena davoei* sp.nov., plate 4, figure 63*a*, *b*.

Diagnosis: Test globular, with a short, stout, produced neck, with well-marked circular lipped aperture; ornamented with six very low, broad, inconspicuous ribs covering the test to the base of the produced neck.

Material: One specimen; Brit. Mus. P34851.

Dimensions: Length 0·12 mm.

Horizon: 123*d–m*.

Remarks: The spherical test is preserved in translucent material, and there appears to be a long entosolenian tube, visible when the specimen is mounted in glycerine, but this is not clear enough for one to be quite certain about it. The costae are best seen when viewed from above the aperture; viewed from the side they are difficult to see, as they are weakly developed.

I have not been able to identify this specimen with any described species. It may be compared with various, rather rare, striate Jurassic species such as *Lagena natrii* Blake (1876, p. 453, plate 18, figure 8), which is a much more elongate form with more numerous striae. *Lagenulina sexcostata* Haeusler (1881, p. 16, plate 2, figure 15) is both elongate and apiculate, and has no produced neck. *Lagena tenuicostata* Franke (1936, p. 90, plate 9, figure 9) is a similar globular form, but it has no produced neck, and much more numerous and finer striae. *L. laticosta* Terquem and Berthelin (1875, p. 15, plate 1, figure 11) has twelve costae, but these do not reach the aperture, and there is no produced neck. The shape of the test is not dissimilar to that of *L. davoei*.

L. davoei is described from 17½ ft. above the Belemnite Stone, Stonebarrow, Dorset.

50. *Lagena hispida* Reuss, plate 4, figure 64*a*, *b*.

1858 *Lagena hispida* Reuss, p. 434.
1862 *L. hispida* Reuss, p. 335, plate 6, figures 77–79.
1875 *L. hispida* Reuss; Terquem and Berthelin, p. 14, plate 1, figure 9*a–c*.
?1875 *L. aspera* Reuss; Terquem and Berthelin, p. 15, plate 1, figure 10.
1886 *L. hispida* Reuss; Terquem, p. 7, plate 1, figures 8, 9.
1890 *L. hispida* Reuss; Haeusler, pars, p. 88, plate 13, figures 21, 22, 24 only.
1893 *L. hispida* Reuss; Haeusler, pars, p. 16, plate 1, figures 38, 39, 41–45 only.
non 1937 *L. hispida* Reuss; Bartenstein and Brand, p. 167, plate 14A, figure 4*a*, *b*; plate 14B, figure 9.

Material: Four specimens; Brit. Mus. P34826 (three), P34906 (figured).

Dimensions: Length up to 0·16 mm.

Horizon: 123*d–m*.

Remarks: This is an almost globular form covered with short spines, with, in the present specimens, a smooth, produced neck, with a hardly appreciable lip to the aperture.

I have no other specimens from the English Jurassic. *L. hispida* is an Oligocene species, and is living at the present day. The Jurassic specimens seem to be morphologically indistinguishable from those of Tertiary and Recent age; they have been recorded from strata ranging from Lower Lias to about the Kimeridgian. In these circumstances it is possible that it may be merely a 'form species', as seems to be the case with *L. laevis*.

L. hispida was described from the Oligocene of Pietzpuhl, Germany.

51. *Lagena laevis* (Montagu), plate 4, figure 65*a*, *b*.

1784 *Serpula* (*Lagena*) *laevis ovalis* Walker and Boys, p. 3, plate 1, figure 9.
1803 *Vermiculum laeve* (Walker and Boys); Montagu, p. 524.
1870 *Lagena helvetica* Zwingli and Kübler, p. 24, plate 3, figure 1; p. 33, plate 4 (Impressathon), figure 1.
1870 *L. vulgaris* Williamson; Terquem, 3SO, p. 349 (247), plate 25, figures 20, 21 (21, 22 in error).
1875 *L. vulgaris* Williamson; Terquem and Berthelin, p. 13, plate 1, figure 6*a*, *b*.
?1876 *L. laevis* (Montagu); Blake, p. 453, plate 18, figures 7, 7*a*.
1886 *L. vulgaris* Williamson; Terquem, p. 6, figure 1, plate 4.
1887*a* *L. laevis* (Montagu); Haeusler, p. 181, plate 4, figures 31–50; plate 5, figures 31–35, ? 53.
1890 *L. laevis* (Montagu); Haeusler, pars, p. 86, plate 13, figure 20 only.
1893 *L. laevis* (Montagu); Haeusler, p. 13, plate 1, figures ?14, 15, 16, ?23, ?24.
1903 *L. laevis* (Montagu); Schick, p. 149, plate 6, figures 5, 6.
1936 *L. vulgaris* Williamson; Franke, p. 89, plate 9, figure 1.
1937 *L. laevis* (Montagu); Bartenstein and Brand, p. 166, plate 6, figure 22; plate 8, figure 32*a*, *b*; plate 10, figure 28; plate 13, figure 17.

Material: Three specimens; Brit. Mus. P34838, P34907 (figured).

Dimensions: Length up to 0·14 mm.

Horizon: 123*d–m*.

Remarks: A simple, smooth-surfaced, slight elongate-globular shell, having a broad plain projecting neck with a slight lip.

Described from Recent material, it was considered by Brady (1884, p. 455) to range as far back as the Silurian. The possibility must be borne in mind that *Lagena laevis* may be merely a 'form species', similar specimens arising at different geological periods from different immediate ancestors.

I have no further specimens from the English Jurassic.

L. laevis was described as very rare from Recent shore sand, from Sandwich, Kent.

Family POLYMORPHINIDAE

Genus *Polymorphina* d'Orbigny, 1826

Subgenus *Eoguttulina* Cushman and Ozawa, 1930

52. *Polymorphina* (*Eoguttulina*) *liassica* Strickland, plate 4, figure 66.

1846 *Polymorphina liassica* Strickland, p. 30, text-figure *b*.
1930 *Eoguttulina liassica* (Strickland); Cushman and Ozawa, p. 17, plate 1, figure 2*a–c*.
1937 *E. liassica* (Strickland); Bartenstein and Brand, p. 178, many figures.

Material: Four specimens; Brit. Mus. P34709 (figured), P34846 (three), P34870.
Dimensions: Length 0·16–0·39 mm.
Horizon: 123*a*, 123*d–m*, 123*m*.

Remarks: P34709 and P34870 are poorly preserved, apparently as casts. The three specimens of P34846 are better preserved, but are so small that none appears to have more than two chambers. In none are the sutures sufficiently marked for the arrangement of the chambers to be clearly seen from the basal view. The specimens seem to agree with *Polymorphina liassica*, so far as can be determined, and little more can be done than to record them under this name.

Since Cushman and Ozawa have recently monographed the family Polymorphinidae on the basis of a very large and comprehensive collection of specimens from strata of all ages from Jurassic to Recent, their views are accepted provisionally as regards the name *Eoguttulina*, which, however, is given here as a subgenus rather than with full generic rank.

Polymorphina (*E*). *liassica* was described as a single specimen from apparently the *planorbis* zone of Cleeve Bank, between Evesham and Bidford, Warwickshire.

Family HETEROHELICIDAE

Genus *Plectofrondicularia* Liebus, 1903

This genus was erected for a form identified as *Flabellina striata* Hantken (Liebus, 1902 (1903), *Jb. geol. ReichsAnst., Wien*, **52**, 76). Perhaps because this identification may have been considered doubtful, Cushman in 1928 chose as genotype the next species, *Plectofrondicularia concava*, described as new by Liebus on p. 94 of the same paper, from the Oligocene of Bavaria. It is distinguished from *Frondicularia* by having the early chambers bolivine, only the later chambers becoming frondicularian. The aperture of the genotype was not described, the specimens being broken, but most adequately figured species later assigned to this genus have plain, not radiate, apertures.

Hitherto the genus has apparently not been recognized in strata older than the Cretaceous according to Chapman and Parr, but *Frondicularia paradoxa* Berthelin, described from the Lias, appears to be morphologically indistinguishable in its generic

characters. *F. brizaeformis* Bornemann is another Lias species that appears to be congeneric with '*F.*' *paradoxa*.

53. *Plectofrondicularia paradoxa* (Berthelin), plate 4, figures 67, 68; text-figures 5, 6.

1879 *Frondicularia paradoxa* Berthelin, p. 33, plate 1, figures 12–17.
1908 *F. paradoxa* Berthelin; Issler, p. 58, plate 3, figures 119–121.
1936 *Flabellina paradoxa* (Berthelin); Franke, p. 91, plate 9, figures 10, 11.
1937 *F. paradoxa* (Berthelin); Bartenstein and Brand, p. 168, plate 4, figure 63*a–e*.

Material: Eighteen specimens. Form A: Brit. Mus. P34747, P34748 (figured), P34752, P34753, P34770, P34772, P34775, P34779, P34786 (figured), P34788, P34794, P34796, P34798, P34799, P34804 (figured). Form B: P34746, P34789 (figured), P34802.

FIGURE 5

FIGURE 6

FIGURES 5, 6. *Plectofrondicularia paradoxa* (Berthelin), Form A, × 130. From *davoei* zone, horizon 122, 5 ft. above Belemnite Stone, Black Ven, Dorset. Figure 5. Brit. Mus. P34804; figure 6. Brit. Mus. P34786. Diagrams to show arrangement of chambers, which in both specimens are mainly filled with pyrites.

Dimensions:

	Form A (15 specimens)	Form B (3 specimens)
Length (mm.)	0·31–0·54, mean 0·39	0·28–0·41, mean 0·33
Width (mm.)	0·11–0·19, mean 0·15	0·10–0·17, mean 0·14
Diameter (mm.) of protoconch	0·025–0·05, mean 0·033	0·01 in each specimen
No. of bolivine chambers, excluding protoconch	3–4, mean 3·4	7, 8 and ?8 respectively
No. of frondicularian chambers	1–5, mean 3	4, 2 and 2 respectively

For comparison details may be given of specimens from the *semicostatum* zone (locality 122), near Radstock, as follows:

	Form A (47 specimens)	Form B (7 specimens)
Length (mm.)	0·21–0·54, mean 0·36	0·31–0·43, mean 0·36
No. of bolivine chambers, excluding protoconch	0–4, mean 2	About 8
No. of frondicularian chambers	0–4, mean 2	1–3, mean 2

Horizon: 122.

Remarks: The surface of the flattened test is fairly smooth and unornamented, or occasionally has a trace of costation; the sutures are sometimes slightly limbate. The aperture is terminal, rounded or elongate, a simple hole situated in a trough formed by two parallel ridges, which continue for a little way down either side of the margin of the final chamber; these ridges sometimes appear to form a part of, or to run into, the thickened margins of the test.

The species was very well described and figured by Berthelin who, however, apparently had only megalospheric specimens. The microspheric form now seems to be recognized for the first time. Berthelin compared it with various species assigned to *Polymorphina*, particularly with *P. frondiformis* Searles Wood, from the Pliocene of Suffolk; and also with an Italian Pliocene *Frondicularia*, '. . .*voisine des* F. striata (*d'Orb.*), laevigata (*Karr.*). . . .'.

Bartenstein and Brand found *Plectofrondicularia paradoxa* restricted in Germany to their Lias γ, *jamesoni-davoei* zones, but this is not, in general, the case. I have it fairly commonly in English Lias from the *bucklandi* up to the *davoei* zones, and it was described from the Middle Lias of France.

In ascribing the form to the genus *Flabellina*, Franke misinterpreted the early chambers as an irregular spiral, instead of an alternating series, and this seems to have been accepted by Bartenstein and Brand.

Plectofrondicularia paradoxa was described as rather rare from the Middle Lias, *margaritatus* zone, of St Vincent-Sterlange, Vendée, western France.

Family BULIMINIDAE

Genus *Bolivina* d'Orbigny, 1839

The genus *Bolivina* is stated by Cushman (1933, p. 221) and by Chapman and Parr (1936, *Proc. Roy. Soc. Victoria*, **49**, 142) to range from Cretaceous to Recent. But Haeusler recorded two species from the Corallian, and of recent years both Franke and Bartenstein and Brand have recorded it from the Lias. A study of Terquem's work shows that he also described species from the Lias under the generic name *Textularia*. *Bolivina* seems, however, to be generally uncommon in the Lias. I have specimens from four localities in the English Lias, and at one (locality 216) it is fairly common.

In addition to the forms included below in *B. liasica*, Haeusler (1890, p. 79, plate 12, figures 38, 39) recorded *B. nitida* Brady from the Corallian of Switzerland, and noted a second form similar to *B. punctata* d'Orbigny from the same beds. It may be doubted whether his specific identification would now be acceptable.

From the inadequate figures and descriptions given it is often impossible to decide, without seeing the specimens, whether various forms recorded as *Vulvulina* or *Textularia* should be in fact transferred to *Bolivina*, e.g. in Schwager (1865) and Zwingli and Kübler (1870).

54. *Bolivina liasica* (Terquem), plate 4, figure 69*a*, *b*.

1858 *Textularia liasica* Terquem, 1FL, p. 634 (74), plate 4, figure 12*a*, *b*.
?1866 *T. breoni* Terquem, 5FL, p. 450, plate 18, figure 10*a*, *b*.
?1866 *T. pikettyi* Terquem, 6FL, p. 527, plate 22, figure 23*a–c*.
1936 *Bolivina rhumbleri* Franke, p. 126, plate 12, figure 21.
1937 *B. rhumbleri rhumbleri* Franke; Bartenstein and Brand, p. 184, plate 4, figure 73*a–c*; plate 5, figure 72*a*, *d* (?*b*, ?*c*).

Material: Five specimens; Brit. Mus. P34704, P34710, P34755, P34757, P34801 (figured).

Dimensions: Length 0·30–0·39 mm.

Horizon: 122, 123*m*.

Remarks: This is a *Bolivina* with about five or six pairs of chambers; the lateral margins of the test are angular in varying degree. The present specimens seem to be all casts; in these, the apparent depression of the sutures causes a slightly serrated periphery, neither of which features are present in the perfect shell. In some of the present specimens, also, the inner part, particularly of the septa, appears to be irregularly covered by a rough growth of shell substance. In the perfect shell (locality 216) this only shows as an irregular thickening of parts of the sutures below the surface of the test. It is unfortunately easy either to ignore or to over-emphasize this feature in depicting the species.

Terquem described and figured the aperture of *Textularia liasica* as '*semi-lunaire, bordée, aussi haut que la dernière loge*', that is, typically bolivine, and not textularian. Although his descriptions as to the nature of the wall are not precise, in *T. liasica* it is described as '*terne, comme sableuse*', which I translate as 'dull, as if sandy', and with a smooth border. In *T. metensis*, which Terquem appears to separate only because of its keel, the test is described as '*lisse, vitreuse*'.

T. pikettyi is a similar form which perhaps may be properly placed in the synonymy, though the thickening of the sutures is not shown. *T. breoni* is depicted with the lateral margins of the test more rounded than in the case of *T. liasica*. The figure is unsatisfactory, but the species may also possibly go into the synonymy. *Bolivina rhumbleri* is not fully figured, but from the single view and description it seems to be the same species.

B. liasica was described as very abundant from the Middle Lias, *margaritatus* zone, of Saint-Julien-lès-Metz.

55. *Bolivina* aff. *prodromus* (Zwingli and Kübler), plate 4, figure 70*a*, *b*.

The reference to the type is:

1870 *Textilaria prodromus* Zwingli and Kübler, p. 7, plate 1 (Turnerithon), figure 17.

Material: One specimen; Brit. Mus. P34834.

Dimensions: Length 0·12 mm. (test incomplete).

Horizon: 123*d–m*.

Remarks: It is impossible certainly to identify the single damaged specimen with the inadequate and rather poor figure of Zwingli and Kübler taken from their unique specimen. The general outline of the test, the shape and arrangement of the chambers, and the size, are all similar; in the present specimen the sutures are noticeably depressed. The Swiss specimen lacks both figure and description of the lateral view and of the aperture. The present specimen has a thick, bluntly square-edged test, and a roughly semicircular aperture, almost suggestive of *Gümbelina*. I have found no later record of this species, and have no other specimens.

Bolivina prodromus was described from the *semicostatum* zone, of Schambelen, Canton Aargau, Switzerland.

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Description of Plates

Plate 1

Unless otherwise stated all specimens are from the *davoei* zone, Lower Lias, of Dorset.

Figure 7. *Ammodiscus asper* (Terquem), × 55, Brit. Mus. P 34716; 14 ft. above Belemnite Stone, Black Ven; p. 15.

Figure 8. *Tolypammina flagellum* (Terquem), × 15, Brit. Mus. P 34887; 14 ft. above Belemnite Stone, Black Ven; p. 16.

Figures 9–11. *Problematina liassica* (Jones); p. 19.

Figure 9. × 55, Brit. Mus. P 34720; 10 ft. above Belemnite Stone, Black Ven.

Figure 10. × 25, Brit. Mus. P 34911; *bucklandi* zone, Bengeworth, Worcestershire; equatorial section, coil partially infilled with pyrites.

Figure 11. × 50, Brit. Mus. P 34912; *bucklandi* zone, Bengeworth; vertical section.

Figure 12. *Ophthalmidium carinatum* (Kübler and Zwingli), × 90, Brit. Mus. P 34891; 17½ ft. above Belemnite Stone, Stonebarrow; mounted in balsam; p. 23.

Figures 13–17. *Bullopora rostrata* Quenstedt; p. 25.

Figure 13. × 50, Brit. Mus. P 34893; 5 ft. above Belemnite Stone, Black Ven; adherent to shale fragment.

Figure 14. × 50, Brit. Mus. P 34894; *mariae* zone, Upper Oxford Clay, Warboys, Huntingdonshire; adherent to shell fragment.

Figure 15. × 50, Brit. Mus. P 34899; *mariae* zone, Upper Oxford Clay, Warboys; adherent to echinoid spine.

Figure 16. × 50, Brit. Mus. P 34909; *mariae* zone, Upper Oxford Clay, Warboys; specimen coiled round a small shale fragment, and showing free growth of last two chambers. The antepenultimate chamber is hidden behind the fragment.

Figure 17. × 65, Brit. Mus. P 34892; 17½ ft. above Belemnite Stone, Stonebarrow; free-growing ends, found detached.

Figures 18–20. *Carixia langi* gen. et sp.nov.; p. 28.

Figure 18. × 25, Brit. Mus. P 34880, holotype; 5 ft. above Belemnite Stone, Black Ven; adherent to shale fragment.

Figure 19. × 25, Brit. Mus. P 34886, paratype; 14 ft. above Belemnite Stone, Black Ven; showing closer network covering shale fragment.

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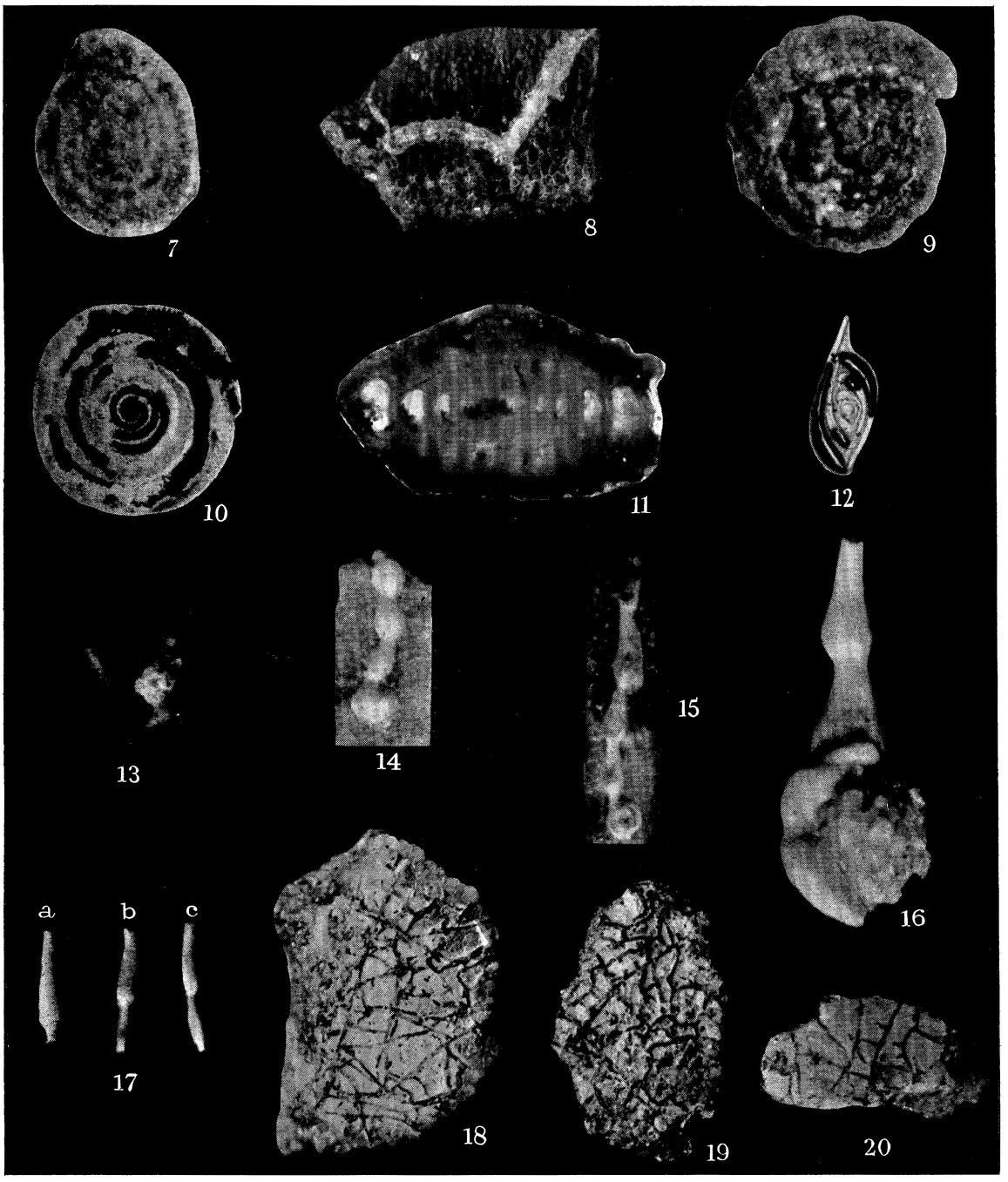


M. G. Sawyers photo.

Dorset Lias Foraminifera

Plate 2

Unless otherwise stated all specimens are from the *davoei* zone, Lower Lias, of Dorset.

FIGURE 21*a*, *b*. *Cristellaria hyperbolica* Zwingli and Kübler, × 100, Brit. Mus. P34696; 13 ft. above Belemnite Stone, Black Ven; p. 30.

FIGURE 22. *Cristellaria matutina* d'Orbigny, × 50, Brit. Mus. P34727; 10 ft. above Belemnite Stone, Black Ven; p. 30.

FIGURE 23*a*, *b*. *Cristellaria münsteri* (Roemer), × 50, Brit. Mus. P34705; 14 ft. above Belemnite Stone, Black Ven; p. 31.

FIGURE 24. *Cristellaria protracta* Bornemann, × 100, Brit. Mus. P34897; 10 ft. above Belemnite Stone, Black Ven; p. 32.

FIGURE 25*a*, *b*. *Cristellaria quadricostata* (Terquem), × 50, Brit. Mus. P34898; 10 ft. above Belemnite Stone, Black Ven; p. 33.

FIGURE 26. *Cristellaria similis* Terquem, × 100, Brit. Mus. P34843; 17½ ft. above Belemnite Stone, Stonebarrow; p. 34.

FIGURE 27*a*, *b*. *Cristellaria terquemi* d'Orbigny, × 100, Brit. Mus. P34758; 5 ft. above Belemnite Stone, Black Ven; p. 34.

FIGURE 28*a*, *b*. *Cristellaria varians* Bornemann, × 100, Brit. Mus. P34905; 5 ft. above Belemnite Stone, Black Ven; p. 35.

FIGURE 29*a–c*. *Cristellaria* (*Saracenaria*) *inclusa* Schwager, × 100, Brit. Mus. P34861; 10 ft. above Belemnite Stone, Black Ven; p. 36.

FIGURE 30. *Marginulina lamellosa* Terquem and Berthelin, × 100, Brit. Mus. P34849; 17½ ft. above Belemnite Stone, Stonebarrow; p. 37.

FIGURE 31*a*, *b*. *Marginulina laxata* Terquem and Berthelin, × 100, Brit. Mus. P34876; 10 ft. above Belemnite Stone, Black Ven; p. 38.

FIGURE 32*a*, *b*. *Marginulina prima* d'Orbigny, × 100, Brit. Mus. P34900; 10 ft. above Belemnite Stone, Black Ven; p. 38.

FIGURE 33*a*, *b*. *Marginulina spinata* Terquem, × 100, Brit. Mus. P34874; 10 ft. above Belemnite Stone, Black Ven; p. 39.

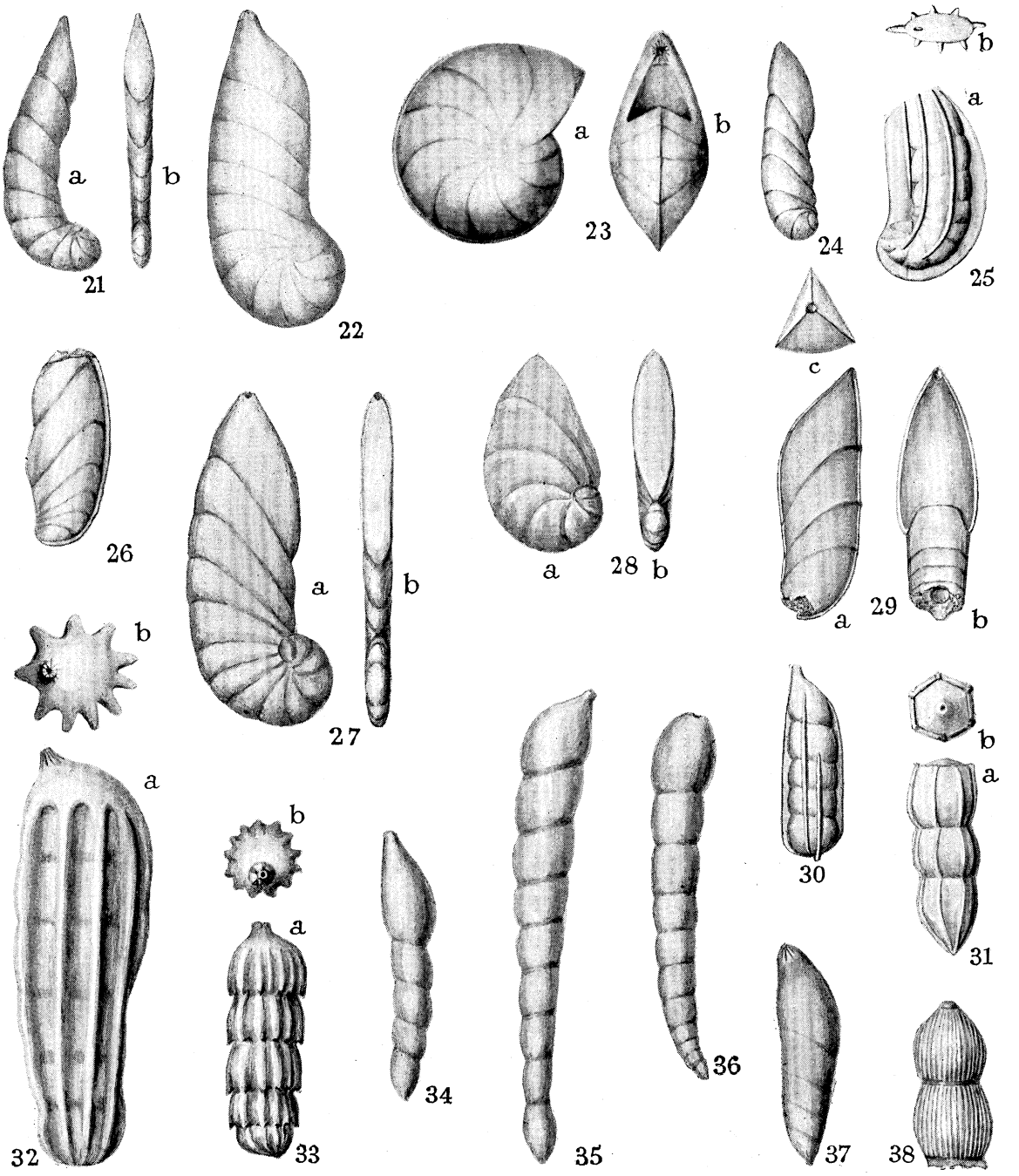
FIGURE 34. *Dentalina communis* d'Orbigny, × 100, Brit. Mus. P34901; 17½ ft. above Belemnite Stone, Stonebarrow; p. 39.

FIGURE 35. *Dentalina deslongchampsi* (Terquem), × 100, Brit. Mus. P34875; 10 ft. above Belemnite Stone, Black Ven; p. 40.

FIGURE 36. *Dentalina torta* Terquem, × 100, Brit. Mus. P34715; 14 ft. above Belemnite Stone, Black Ven; p. 41.

FIGURE 37. *Dentalina vetusta* d'Orbigny, × 100, Brit. Mus. P34848; 17½ ft. above Belemnite Stone, Stonebarrow; p. 41.

FIGURE 38. *Dentalina virgata* Terquem, × 100, Brit. Mus. P34847; 17½ ft. above Belemnite Stone, Stonebarrow; p. 42.



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Dorset Lias Foraminifera

Plate 3

All specimens are from the *davoei* zone, Lower Lias, of Dorset.
All figures are × 100 (approximately).

FIGURE 39. *Nodosaria dolioligera* (Schwager), Brit. Mus. P34852; 17½ ft. above Belemnite Stone, Stonebarrow; p. 42.

FIGURE 40*a*, *b*. *Nodosaria fontanessi* (Berthelin), Brit. Mus. P34844; 17½ ft. above Belemnite Stone, Stonebarrow; p. 43.

FIGURE 41*a*, *b*. *Nodosaria hortensis* Terquem, Brit. Mus. P34902; 17½ ft. above Belemnite Stone, Stonebarrow; p. 43.

FIGURE 42. *Nodosaria marsupifera* (Schwager), Brit. Mus. P34859; 10 ft. above Belemnite Stone, Black Ven; p. 45.

FIGURE 43. *Nodosaria octoplicata* (Terquem), Brit. Mus. P34830; 17½ ft. above Belemnite Stone, Stonebarrow; p. 45.

FIGURE 44. *Nodosaria pyriformis* Terquem, Brit. Mus. P34856; 17½ ft. above Belemnite Stone, Stonebarrow; p. 46.

FIGURE 45. *Nodosaria sculpta* (Terquem), Brit. Mus. P34751; 5 ft. above Belemnite Stone, Black Ven; p. 46.

FIGURE 46. *Nodosaria simplex* (Terquem), Brit. Mus. P34903; 17½ ft. above Belemnite Stone, Stonebarrow; p. 47.

FIGURE 47. *Pseudoglandulina oviformis* (Terquem), Brit. Mus. P34837; 17½ ft. above Belmnite Stone, Stonebarrow; p. 47.

FIGURE 48*a*, *b*. *Pseudoglandulina septangularis* (Bornemann), Brit. Mus. P34824; Red Band, Stonebarrow; p. 48.

FIGURE 49. *Pseudoglandulina tenuis* (Bornemann), Brit. Mus. P34855; 17½ ft. above Belemnite Stone, Stonebarrow; p. 48.

FIGURE 50. *Pseudoglandulina vulgata* (Bornemann), Brit. Mus. P34854; 17½ ft. above Belemnite Stone, Stonebarrow; p. 49.

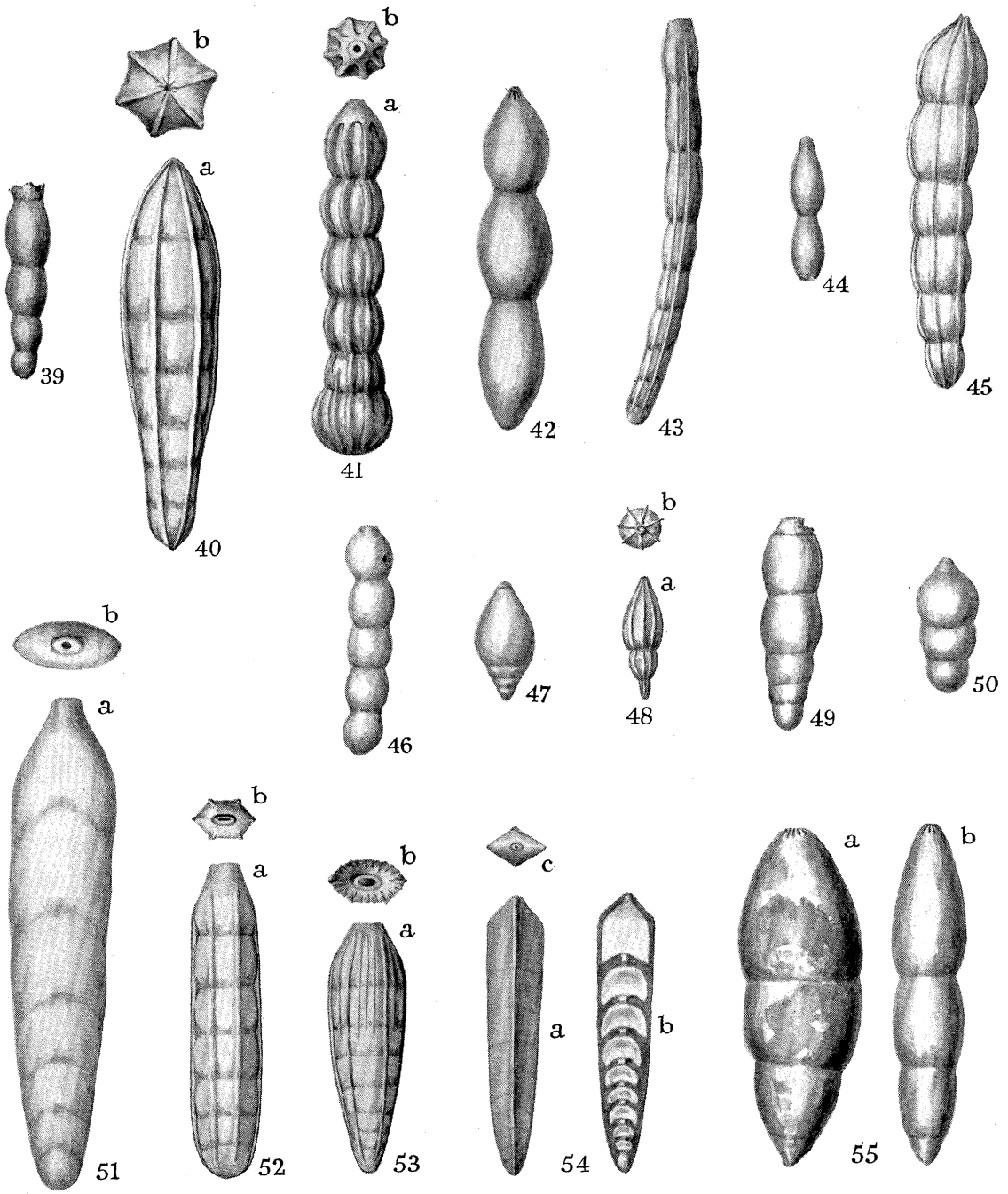
FIGURE 51*a*, *b*. *Lingulina laevissima* (Terquem), Brit. Mus. P34761; 5 ft. above Belemnite Stone, Black Ven; p. 50.

FIGURE 52*a*, *b*. *Lingulina tenera* Bornemann, Brit. Mus. P34904;17½ ft. above Belemnite Stone, Stonebarrow; p. 51.

FIGURE 53*a*, *b*. *Lingulina tenera* var. *pupa* (Terquem), Brit. Mus. P34812; 14 ft. above Belemnite Stone, Black Ven; p. 52.

FIGURE 54*a–c*. *Lingulina terquemi* nom.nov., Brit. Mus. P34872; 10 ft. above Belemnite Stone, Black Ven; p. 53. *a*, external view; *b*, mounted in glycerine as a transparency; *c*, apertural view.

FIGURE 55*a*, *b*. *Lingulina*(?) *compressa* (Terquem), Brit. Mus. P34869; 10 ft. above Belemnite Stone, Black Ven; p. 53.



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Dorset Lias Foraminifera

Plate 4

All specimens are from the *davoei* zone, Lower Lias, of Dorset.
All figures are × 100 (approximately).

FIGURE 56*a*, *b*. *Tristix liasina* (Berthelin), Brit. Mus. P34835; 17½ ft. above Belemnite Stone, Stonebarrow; p. 55.

FIGURE 57*a*, *b*. *Vaginulina constricta* (Terquem and Berthelin), Brit. Mus. P34877; 10 ft. above Belemnite Stone, Black Ven; p. 56.

FIGURE 58. *Flabellina centro-gyrata* Terquem, Brit. Mus. P34790; 5 ft. above Belemnite Stone, Black Ven; p. 57.

FIGURE 59*a*, *b*. *Flabellina inaequilateralis* Terquem, Brit. Mus. P34769; 5 ft. above Belemnite Stone, Black Ven; p. 58.

FIGURE 60*a*, *b*. *Frondicularia sulcata* Bornemann, Brit. Mus. P34895; 17½ ft. above Belemnite Stone, Stonebarrow; p. 58.

FIGURE 61. *Frondicularia sulcata* var. *squamosa* Terquem and Berthelin, Brit. Mus. P34908; 17½ ft. above Belemnite Stone, Stonebarrow; p. 61.

FIGURE 62*a*, *b*. *Frondicularia terquemi* var. *bicostata* d'Orbigny, Brit. Mus. P34841; 17½ ft. above Belemnite Stone, Stonebarrow; p. 61.

FIGURE 63*a*, *b*. *Lagena davoei* sp.nov., Brit. Mus. P34851; 17½ ft. above Belemnite Stone, Stonebarrow; p. 63.

FIGURE 64*a*, *b*. *Lagena hispida* Reuss, Brit. Mus. P34906; 17½ ft. above Belemnite Stone, Stonebarrow; p. 63.

FIGURE 65*a*, *b*. *Lagena laevis* (Montagu), Brit. Mus. P34907; 17½ ft. above Belemnite Stone, Stonebarrow; p. 64.

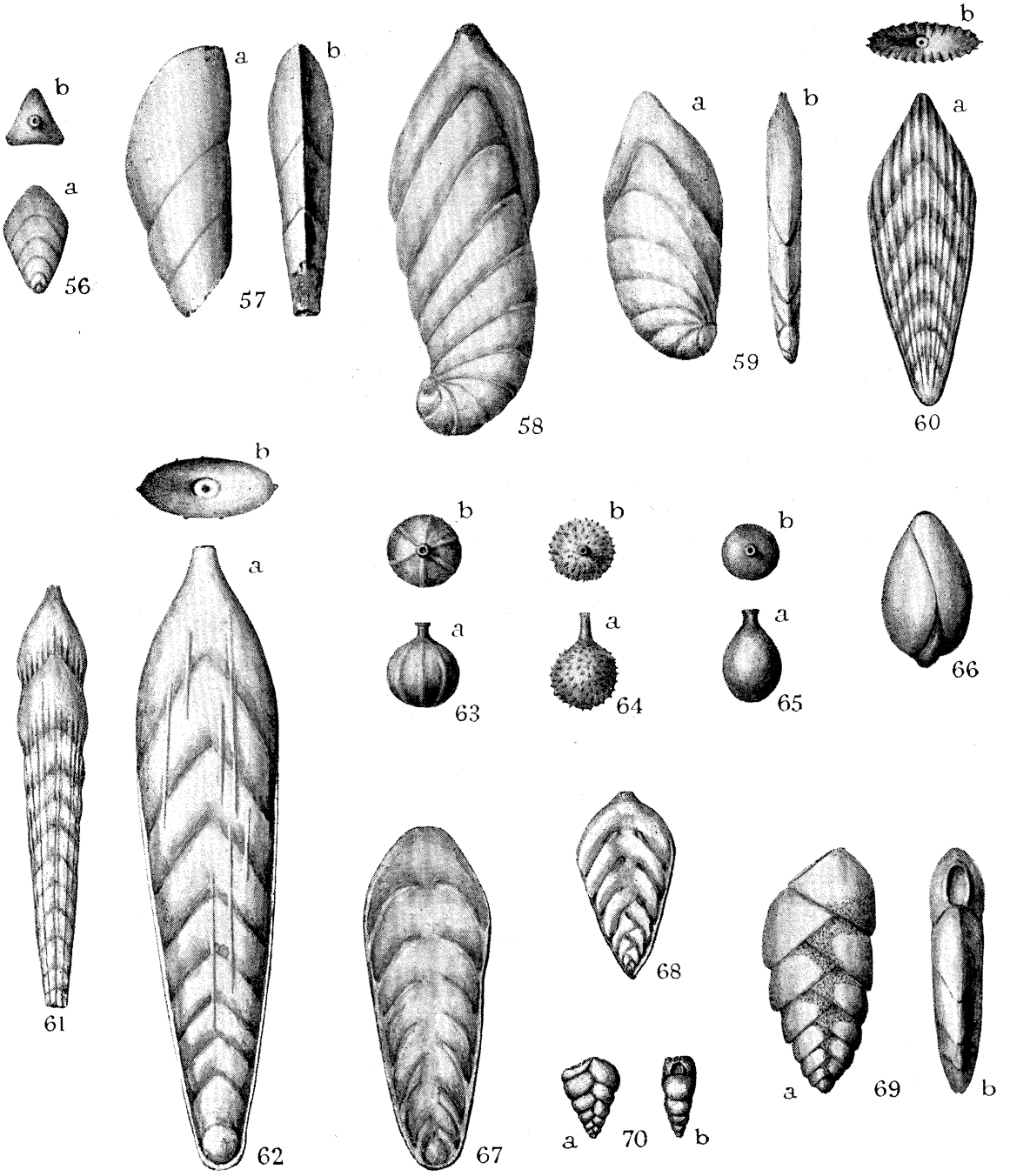
FIGURE 66. *Polymorphina* (*Eoguttulina*) *liassica* Strickland, Brit. Mus. P34709; 14 ft. above Belemnite Stone, Black Ven; p. 65.

FIGURE 67. *Plectofrondicularia paradoxa* (Berthelin), Form A, Brit. Mus. P34748; 5 ft. above Belemnite Stone, Black Ven; p. 66.

FIGURE 68. *Plectofrondicularia paradoxa* (Berthelin), Form B, Brit. Mus. P34789; 5 ft. above Belemnite Stone, Black Ven; p. 66.

FIGURE 69*a*, *b*. *Bolivina liasica* (Terquem), Brit. Mus. P34801; 5 ft. above Belemnite Stone, Black Ven; p. 68.

FIGURE 70*a*, *b*. *Bolivina* aff. *prodromus* (Zwingli and Kübler), Brit. Mus. P34834; 17½ ft. above Belemnite Stone, Stonebarrow; p. 68.



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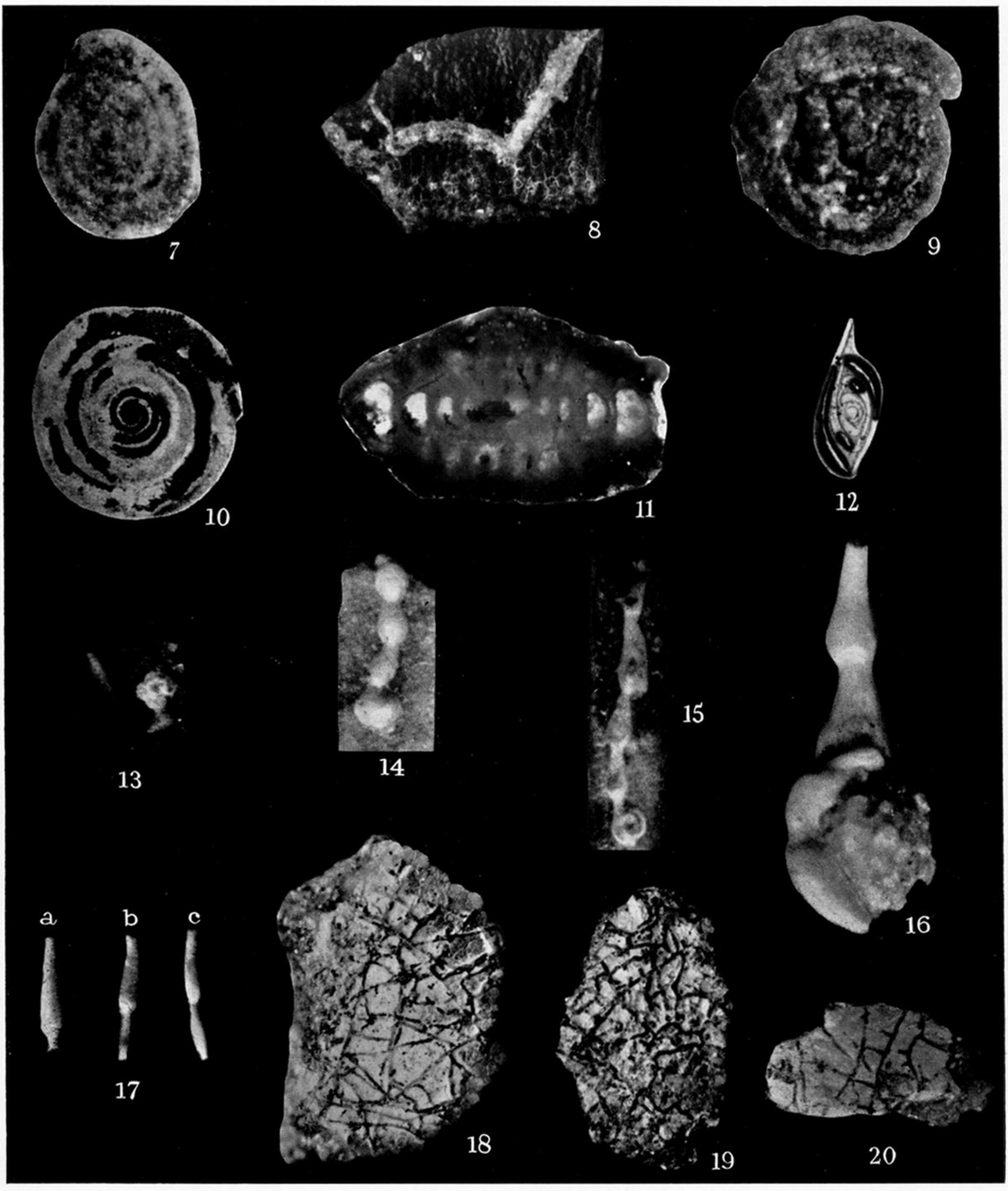

Dorset Lias Foraminifera

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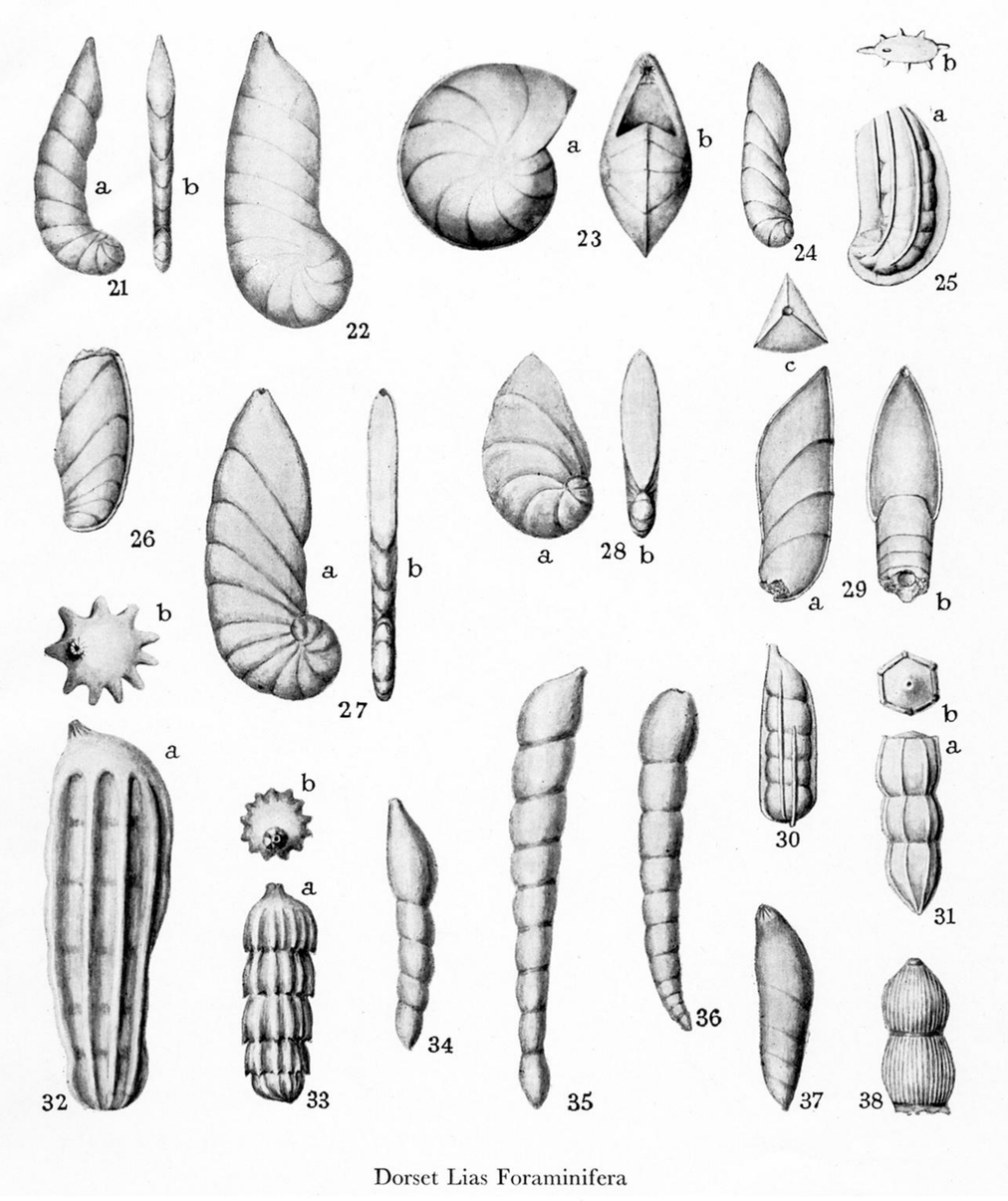

Dorset Lias Foraminifera

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FIGURE 25*a*, *b*. *Cristellaria quadricostata* (Terquem), × 50, Brit. Mus. P 34898; 10 ft. above Belemnite Stone, Black Ven; p. 33.

FIGURE 26. *Cristellaria similis* Terquem, × 100, Brit. Mus. P 34843; 17½ ft. above Belemnite Stone, Stonebarrow; p. 34.

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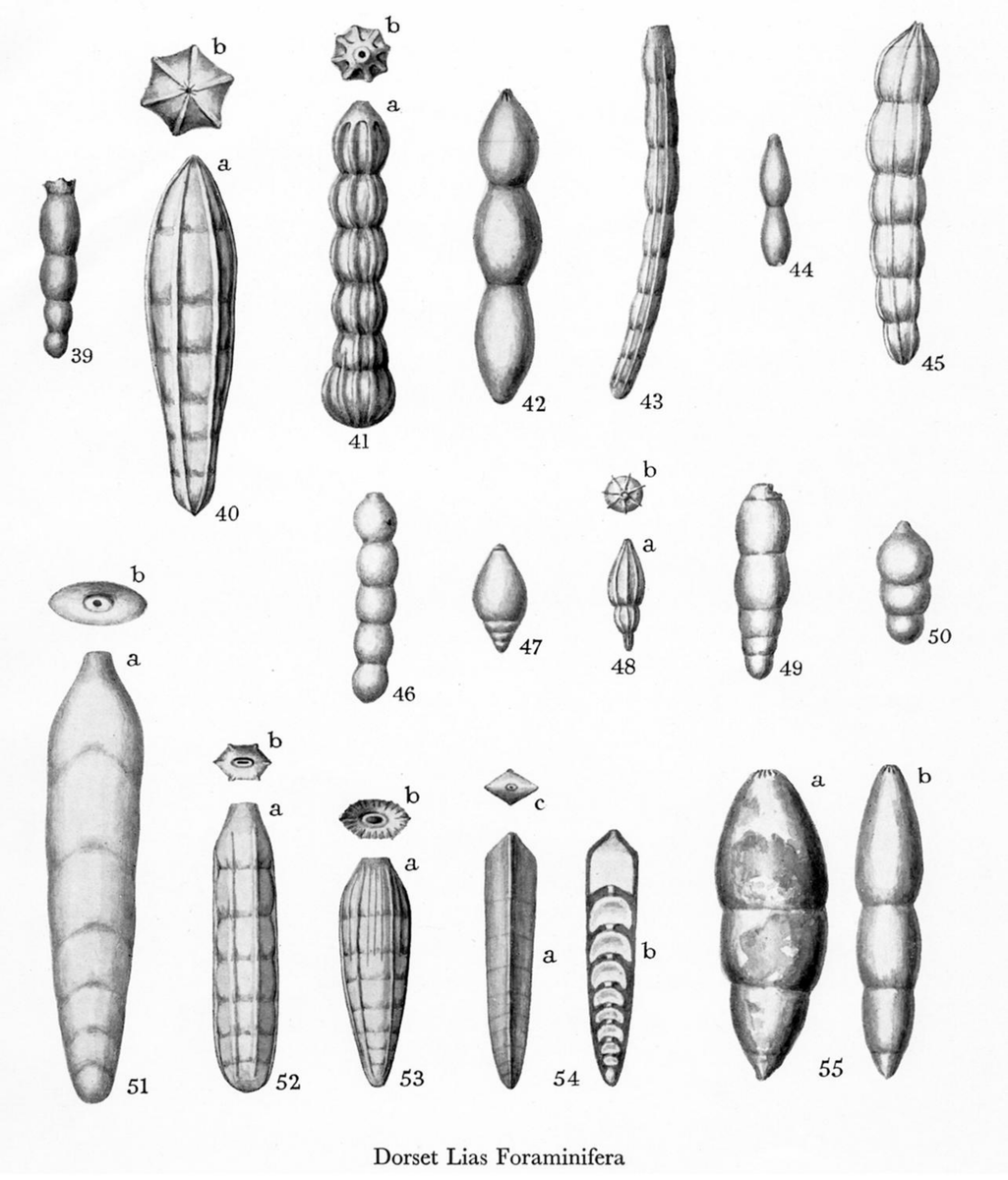

Dorset Lias Foraminifera

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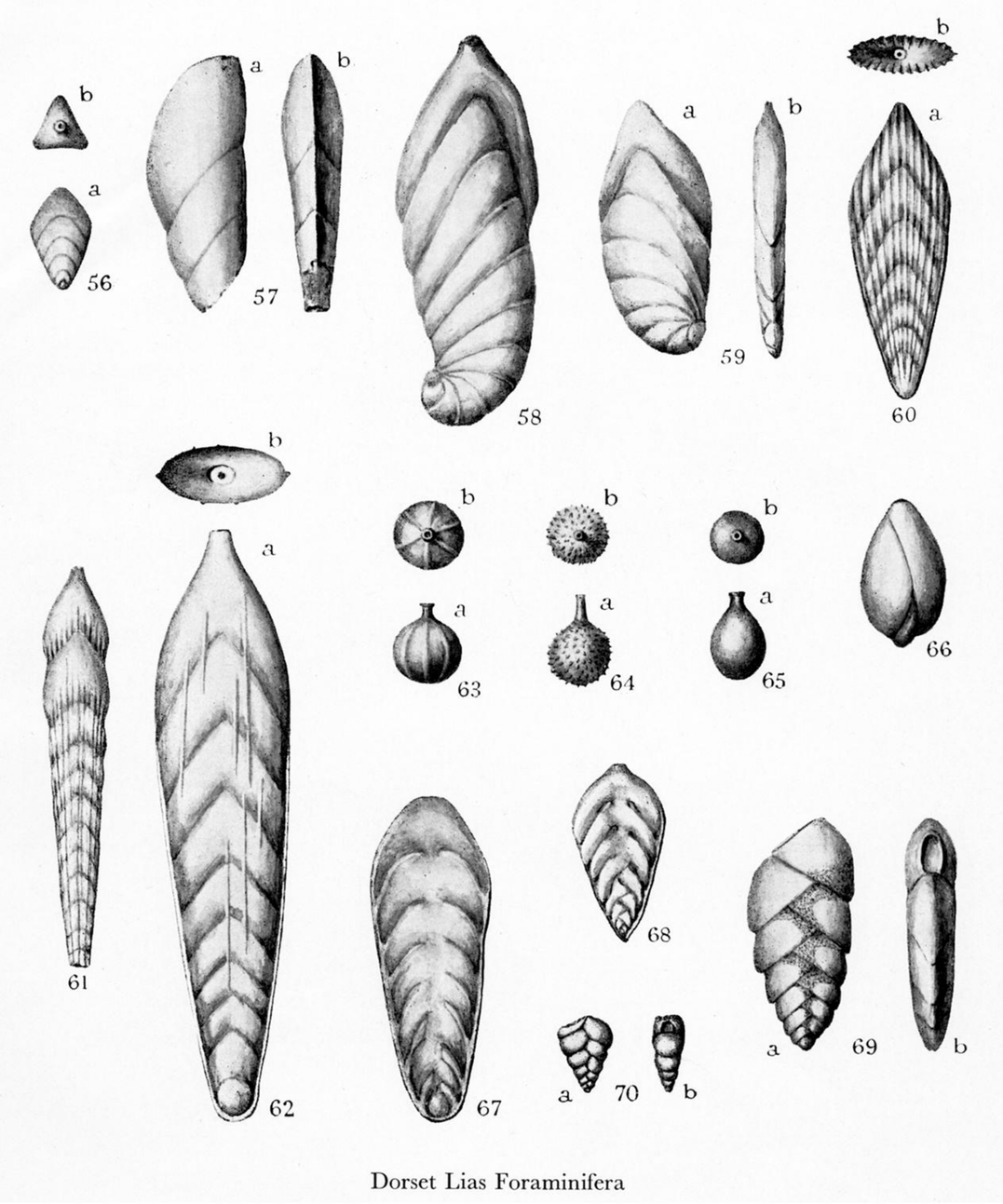

Dorset Lias Foraminifera

Plate 4

All specimens are from the *davoei* zone, Lower Lias, of Dorset.
All figures are × 100 (approximately).

FIGURE 56*a*, *b*. *Tristix liasina* (Berthelin), Brit. Mus. P34835; 17½ ft. above Belemnite Stone, Stonebarrow; p. 55.

FIGURE 57*a*, *b*. *Vaginulina constricta* (Terquem and Berthelin), Brit. Mus. P34877; 10 ft. above Belemnite Stone, Black Ven; p. 56.

FIGURE 58. *Flabellina centro-gyrata* Terquem, Brit. Mus. P34790; 5 ft. above Belemnite Stone, Black Ven; p. 57.

FIGURE 59*a*, *b*. *Flabellina inaequilateralis* Terquem, Brit. Mus. P34769; 5 ft. above Belemnite Stone, Black Ven; p. 58.

FIGURE 60*a*, *b*. *Frondicularia sulcata* Bornemann, Brit. Mus. P34895; 17½ ft. above Belemnite Stone, Stonebarrow; p. 58.

FIGURE 61. *Frondicularia sulcata* var. *squamosa* Terquem and Berthelin, Brit. Mus. P34908; 17½ ft. above Belemnite Stone, Stonebarrow; p. 61.

FIGURE 62*a*, *b*. *Frondicularia terquemi* var. *bicostata* d'Orbigny, Brit. Mus. P34841; 17½ ft. above Belemnite Stone, Stonebarrow; p. 61.

FIGURE 63*a*, *b*. *Lagena davoei* sp.nov., Brit. Mus. P34851; 17½ ft. above Belemnite Stone, Stonebarrow; p. 63.

FIGURE 64*a*, *b*. *Lagena hispida* Reuss, Brit. Mus. P34906; 17½ ft. above Belemnite Stone, Stonebarrow; p. 63.

FIGURE 65*a*, *b*. *Lagena laevis* (Montagu), Brit. Mus. P34907; 17½ ft. above Belemnite Stone, Stonebarrow; p. 64.

FIGURE 66. *Polymorphina* (*Eoguttulina*) *liassica* Strickland, Brit. Mus. P34709; 14 ft. above Belemnite Stone, Black Ven; p. 65.

FIGURE 67. *Plectofrondicularia paradoxa* (Berthelin), Form A, Brit. Mus. P34748; 5 ft. above Belemnite Stone, Black Ven; p. 66.

FIGURE 68. *Plectofrondicularia paradoxa* (Berthelin), Form B, Brit. Mus. P34789; 5 ft. above Belemnite Stone, Black Ven; p. 66.

FIGURE 69*a*, *b*. *Bolivina liasica* (Terquem), Brit. Mus. P34801; 5 ft. above Belemnite Stone, Black Ven; p. 68.

FIGURE 70*a*, *b*. *Bolivina* aff. *prodromus* (Zwingli and Kübler), Brit. Mus. P34834; 17½ ft. above Belemnite Stone, Stonebarrow; p. 68.