First Workshop
Arenaceous Foraminifera

MARGINAL MARINE MICROFAUNAS OF THE JURASSIC (BAJOCIAN) YONS NAB BEDS OF THE YORKSHIRE COAST.

by

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ABSTRACT

The Middle Bajocian Yons Nab Beds of the Yorkshire coast is an unit of shale, siltstone and sandstone up to 7,5 m thick: Its foraminiferal sequence is subdivided into a basal *Citharina* assemblage and an overlying, more extensive, *Ammodiscus* assemblage. This subdivision seems to correspond to the ostracod distribution pattern.

The Yons Nab Beds were deposited under brackish bay conditions with foraminiferal faunas generally dominated by Textulariina, with subordinate amounts of Nodosariacea and Spirillinacea. Increased marine influence in the middle part of the sequence is indicated by increase of the latter two groups.

A total of 28 foraminiferal and 12 ostracod species are recognized. Of the foraminiferal species 15 are identified as known species, while for 12 species open nomenclature is used. *Ammodiscus yonsnabensis* is new. A short systematic treatment of the foraminifera is given with most of the species illustrated.

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INTRODUCTION

The present study is based on sediment samples collected from the type locality of the Yons Nab Beds, located at the southern headland of Cayton Bay (Fig. 1). This is the first detailed study of foraminifera published from these deposits. The sequence is here exposed along the foreshore and has a thickness of around 7.5 m. It consists of sandstone and mudstone with some claystone and clay-ironstone, and contains invertebrate faunas, mainly bivalves, concentrated to the middle of the sequence. The age of the Yons Nab Beds is middle Bajocian.

STRATIGRAPHICAL SETTING

The Yons Nab Beds, together with the underlying Millepore Bed, represent one of the three marine intercalations occurring in the Middle Jurassic Deltaic Series of Yorkshire (Fig. 2). For more details on the stratigraphy of the Series the reader is referred to Hemingway & Knox 1973, Hemingway 1974 and Hancock & Fisher 1980. The Millepore Bed consists typically of calcareous sandstone and richly fossiliferous sandy oolite with large-scale cross-bedding. This facies is well developed at Yons Nab and Osgodby Nab, and represents shallow marine sand-wave environments (Hancock & Fisher 1980). From the Fordon borehole, to the south near Bridlington, the thickness of the Millepore Bed decreases northwards through Yons Nab and Cloughton Wyke, and north of the latter locality its calcareous lithology is replaced by a sandy, shoreline facies. Thus, the Millepore Bed represents a marine transgression coming from the south into the Yorkshire delta area (Kent 1980).

The stratigraphy of the Yons Nab Beds is discussed in detail by Bate (1959). As shown by this author, the sequence decreases in thickness northwards and disappears totally just north of Cloughton Wyke, ca. 11 km north of the type locality. At Osgodby Nab, ca. 2 km north of the type locality, the Yons Nab Beds are replaced by cross bedded sandstone apparently associated with a distributary channel.

According to Hemingway 1974 the Yons Nab Beds were deposited during the regressive period which followed the Millepore Bed. New information on the depositional conditions of the Deltaic Series of Yorkshire are given by Hancock & Fisher 1980, on the basis of a combined sedimentological and palynofacies study. According to this paper the Yons Nab Beds were deposited in an interdistributary bay environment, and the sequence shows a gradual transition upwards from marine conditions to essentially freshwater swamps.

MATERIAL AND METHODS

The samples were collected from two sections through the Yons Nab Beds. The south-eastern section is located on the foreshore just outside Yons Nab, while the other lies ca. 200 m north-west from it.

In the laboratory the samples were disintegrated by soaking in hydrogen peroxide. The sediment was washed through a sieve of 0,1 mm mesh and the material remaining on the screen was hand-picked for foraminifera and ostracods. The fraction >0.1

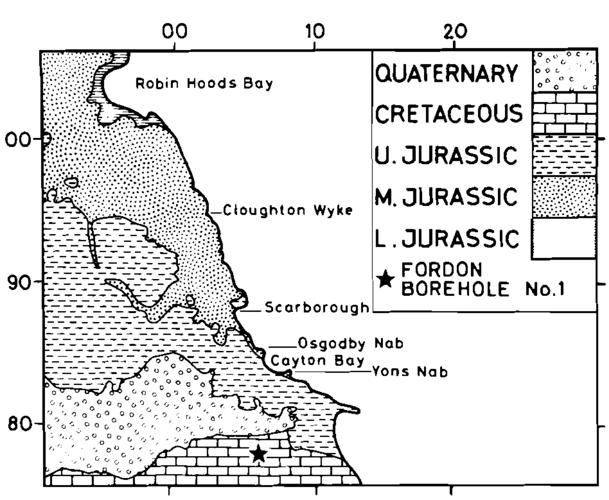

Fig. 1. Geological sketch map of part of the Yorkshire Coast showing the places mentioned in the text. (Redrawn from Bate 1959).

BAJOCIAN	Scalby Beds	Delta plain
	Scarborough Beds	Marine embayment
	Gristhorpe Beds	Delta plain
	Yons Nab Beds	Brackish embayment
	Millepore Bed	Marine embayment
	Sycarham Beds	Delta plain
	Ellerbeck Bed	Marine embayment
	Saltwick Beds	Delta plain
	Dogger	Delta progradation
TOARCIAN	Blea Wyke Beds	Open marine

Fig. 2. Middle Jurassic stratigraphy of Yorkshire showing subdivision of the deltaic rocks. (Based on Hancock & Fisher 1980). Modern formation and member names are given in Hemingway 1974.

mm contained large amounts of sand and comparatively few microfossils in nearly all samples.

FORAMINIFERAL AND OSTRACOD ASSEMBLAGES

The Citharina assemblage
This assemblage is present in the basal part of the Yons Nab Beds both in the south-eastern and north-western section. It consists almost exclusively of calcareous foraminifera belonging to Nodosariacea and Spirillinacea. Textulariina are nearly totally absent. The maximum number of species is 12. The most common genera are *Citharina, Vaginulina, Planularia, Conicospirillina* and *Turrispirillina* (Figs. 3 and 4).

The Ammodiscus assemblage
This assemblage is totally dominated by *Ammodiscus yonsnabensis* n. sp., which occurs in strongly variable quantities, up to 160 specimens per 100 grams of sediment. Other arenaceous foraminifera are diagenetically deformed *Trochammina* sp. and single specimens belonging to *Lagenammina* and *Ammobaculites*.

The assemblage occurs through most of the Yons Nab Beds. In the south-eastern section it is found from the lower part of the sequence and up to the middle of the coarsening-up sandstone bed forming the top of the sequence. In the north-western section it is well-developed in the lower mudstone bed while higher up *A. yonsnabensis* n.sp. is common only at one horizon. Calcareous foraminifera form in most samples a quantitatively subordinate part of the assemblage, and occur with highest concentrations at the middle of the south-eastern section. Spirillinids are somewhat more common than Nodosariids. The most common calcareous forms are *Conicospirillina pictonica, Turrispirillina punctulata* and *Spirillina infraoolithica*.

Ostracod assemblages
Ostracoda occur generally more sporadically than foraminifera. The richest assemblages are found in the basal and middle parts of both sections. The maximum number of carapaces found in one sample is 179, and the maximum number of species is 7.

The most abundant form is *Praeschuleridea subtrigona magna* which occurs both in the basal and middle part of the sequence. *Micropneumatocythere globosa* is only found in the basal claystone bed in both sections, while *Pneumatocythere bajociana, Eucytheridea ? astricta* and *Progonocythere cristata* are only found above the basal part of the sequence in both sections. As it appears from this discussion and from Figs. 3 to 6 the faunal subdivision made on the basis of the foraminifera seems to correspond also to the ostracod distribution pattern.

FACIES INTERPRETATION

Transition from marine to brackish environment
As mentioned previously, the Millepore Bed is interpreted as a sand-wave sequence deposited in a shallow marine embayment. The thin (35 cm) claystone bed at the base of the Yons Nab Beds contains a poor foraminiferal fauna consisting almost exclusively of Nodosariacea and Spirillinacea, while Textulariina are rare (Figs. 5 and 6).

In recent faunas *Spirillina* occurs under normal marine, inner shelf conditions (Murray 1973), and Jurassic Nodosariid dominated assemblages are generally referred to normal marine environments. In this connection it is of interest to note that *Micropneumatocythere globosa* is common in the underlying marine Millepore Bed (Bate 1964) but occurs also in the basal part of the Yons Nab Beds in both sections.

Brackish bay conditions
The *Ammodiscus* assemblage indicates brackish conditions as shown by the strong dominance of this arenaceous species, and the low diversity (number of species 8 or less). This interpretation supports the view of Hancock & Fisher 1980 on the basis of palynofacies studies. A weak marine influence is indicated by the generally low number of Nodosariacea and Spirillinacea.
The amount of foraminifera and ostracods is extremely variable from horizon to horizon within the Yons Nab Beds (Figs. 5 and 6). Their numbers in 100 grams of sediment range from 0 to 172 for foraminiferal tests and from 0 to 179 for ostracod carapaces. This variability is in accordance with microfaunas of recent coastal lagoons, which commonly show large local changes in the size of standing stocks, at least of foraminifera as shown by Phleger (1976).
The *Ammodiscus* assemblage is comparable to the faunas occurring in a sand-silt sequence with some coal seams recently described from the Lower Jurassic of Kongsøya (Svalbard) by Løfaldli & Nagy 1980. Parts of this sequence contain arenaceous assemblages with low diversity and strong dominance of *Ammodiscus*. Calcareous species were not found and the faunas were ascribed to brackish lagoonal conditions.
An increased marine influence in the Yons Nab Beds seems to have taken place around the middle of the sequence at the bivalve shell horizons (Fig. 5). It is indicated by a marked increase of the number of Nodosariacea and Spirillinacea. The amount of ostracods also shows an increase at this horizon. This interval with calcareous foraminifera is only developed in the south-eastern section. But in addition, the whole upper half of this section is generally richer in foraminifera than the corresponding parts of the north-western section. It is therefore reasonable to assume that the marine influx came from a southerly direction.

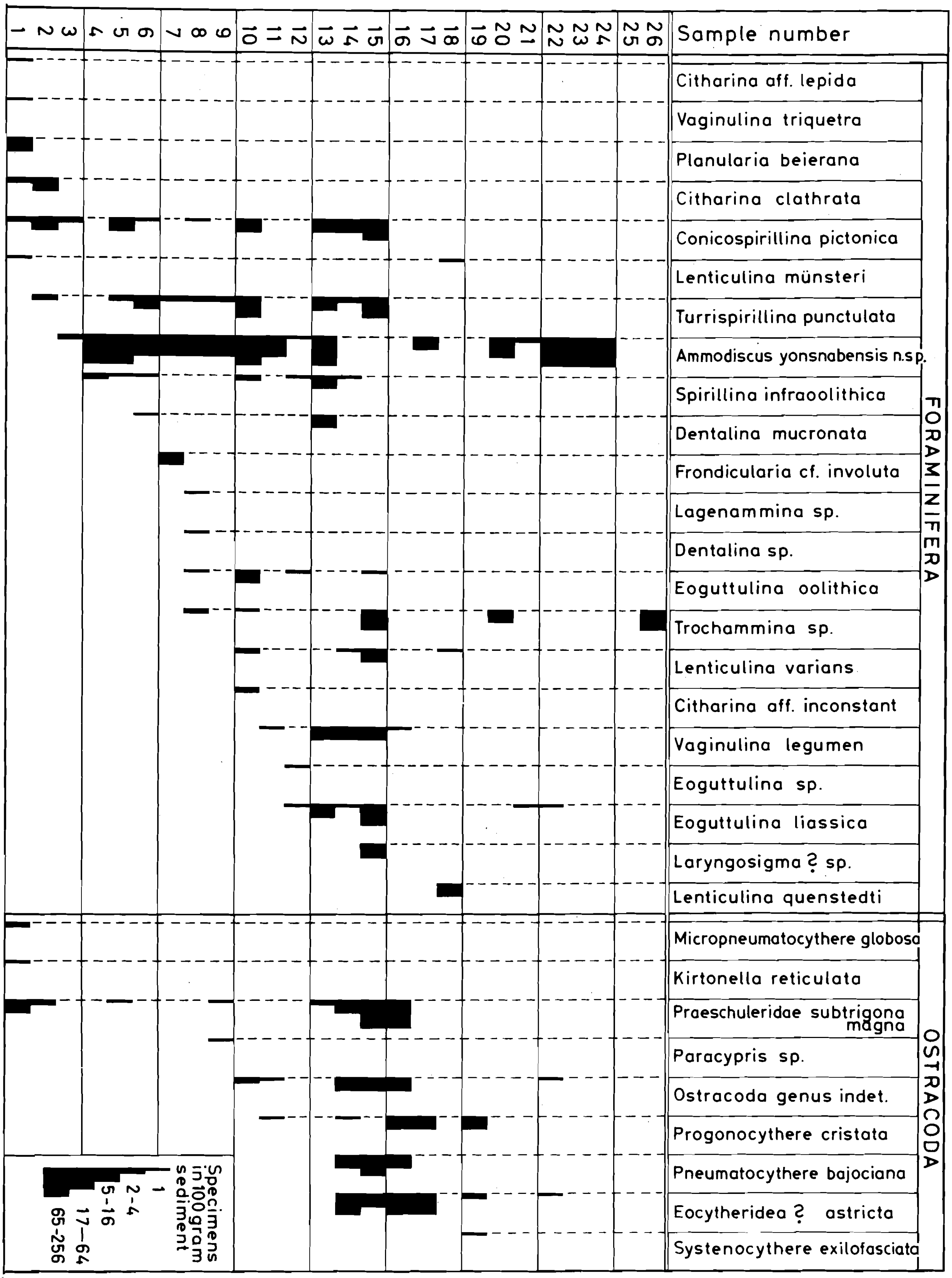

Fig. 3 Distribution chart of foraminifera and ostracoda in the Yons Nab Beds, south-eastern section.

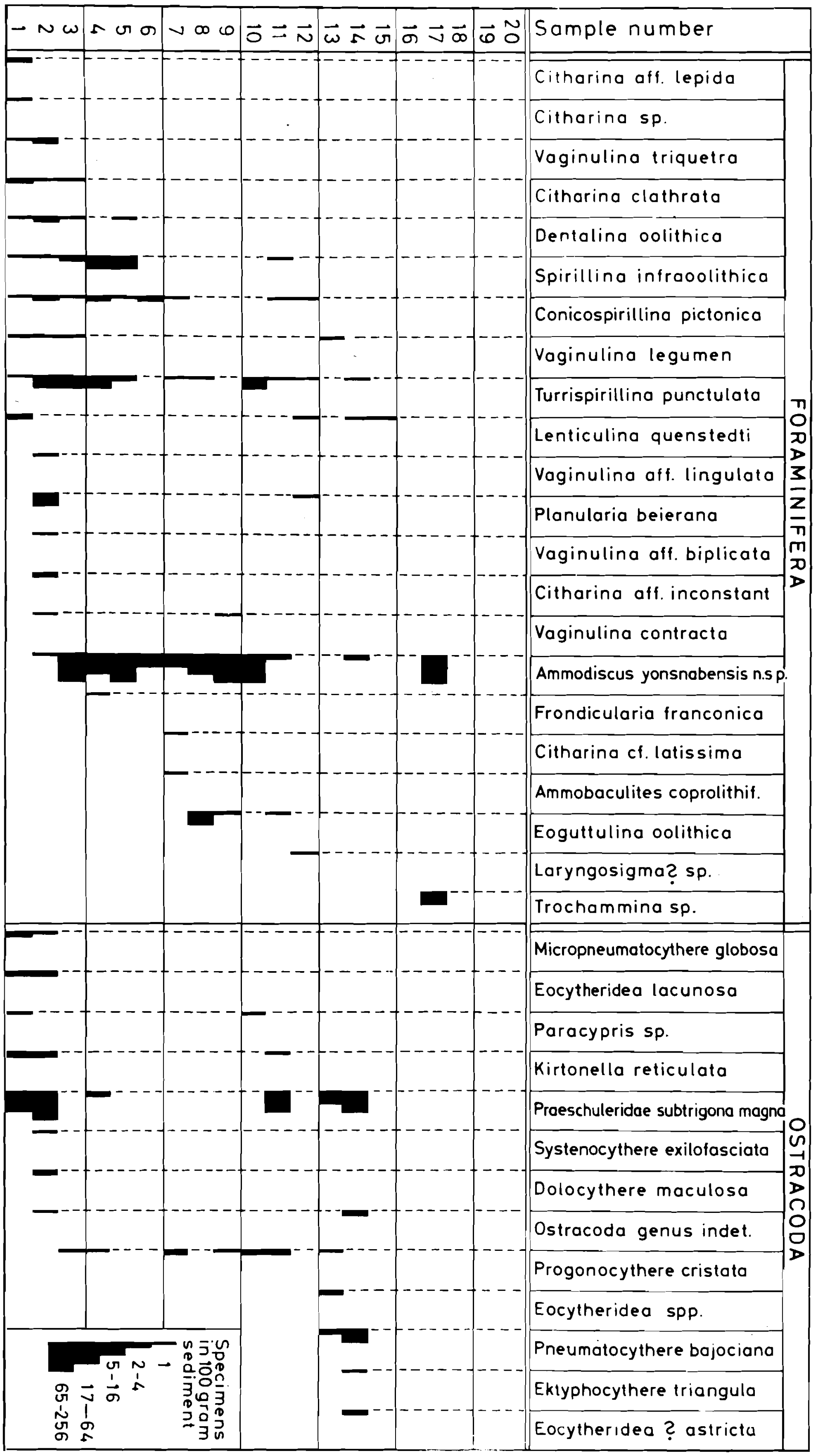

Fig. 4 Distribution chart of foraminifera and ostracoda in the Yons Nab Beds, north-western section.

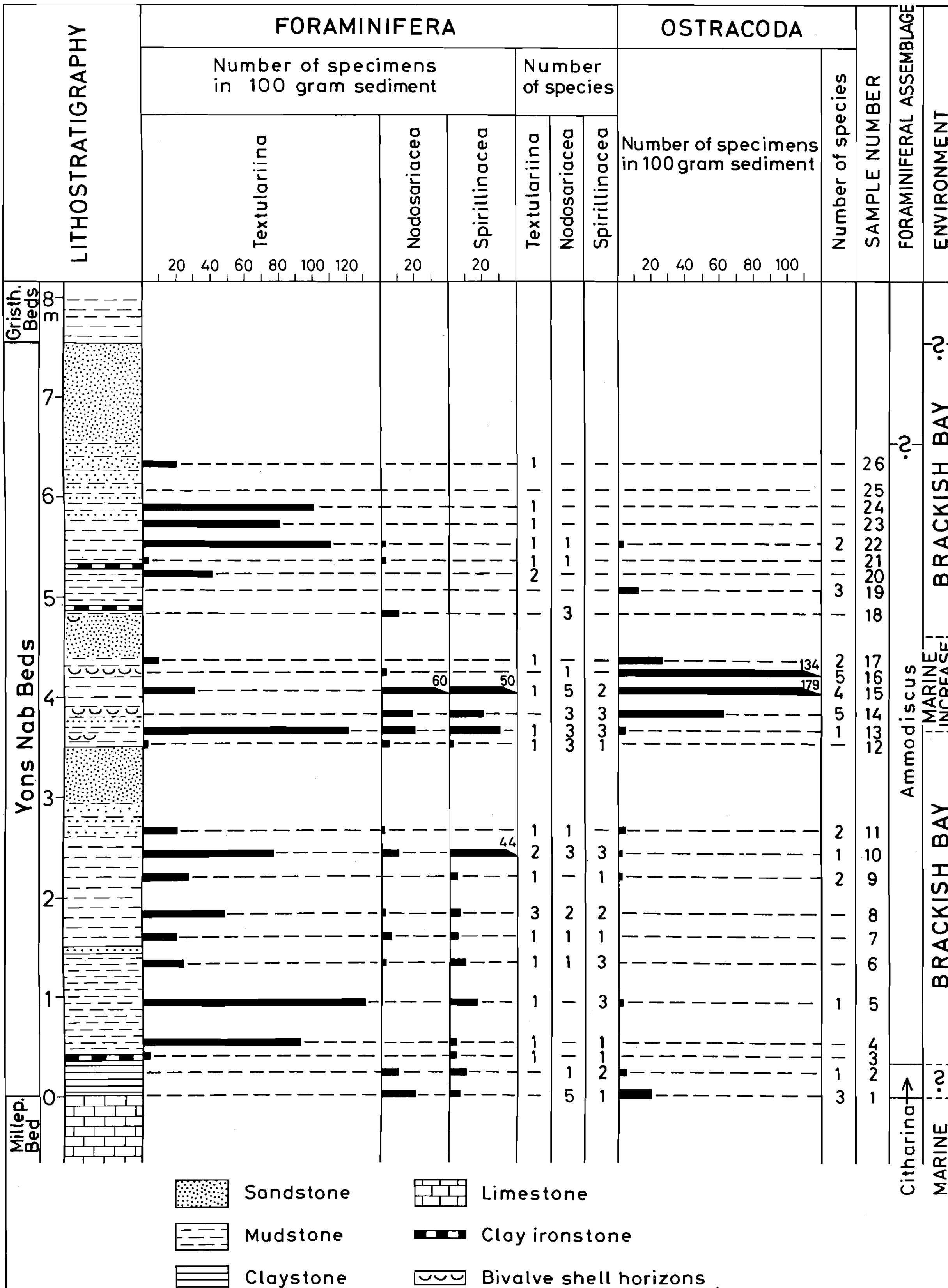

Fig. 5. Distribution of main faunal parameters in the Yons Nab Beds, south-eastern section.

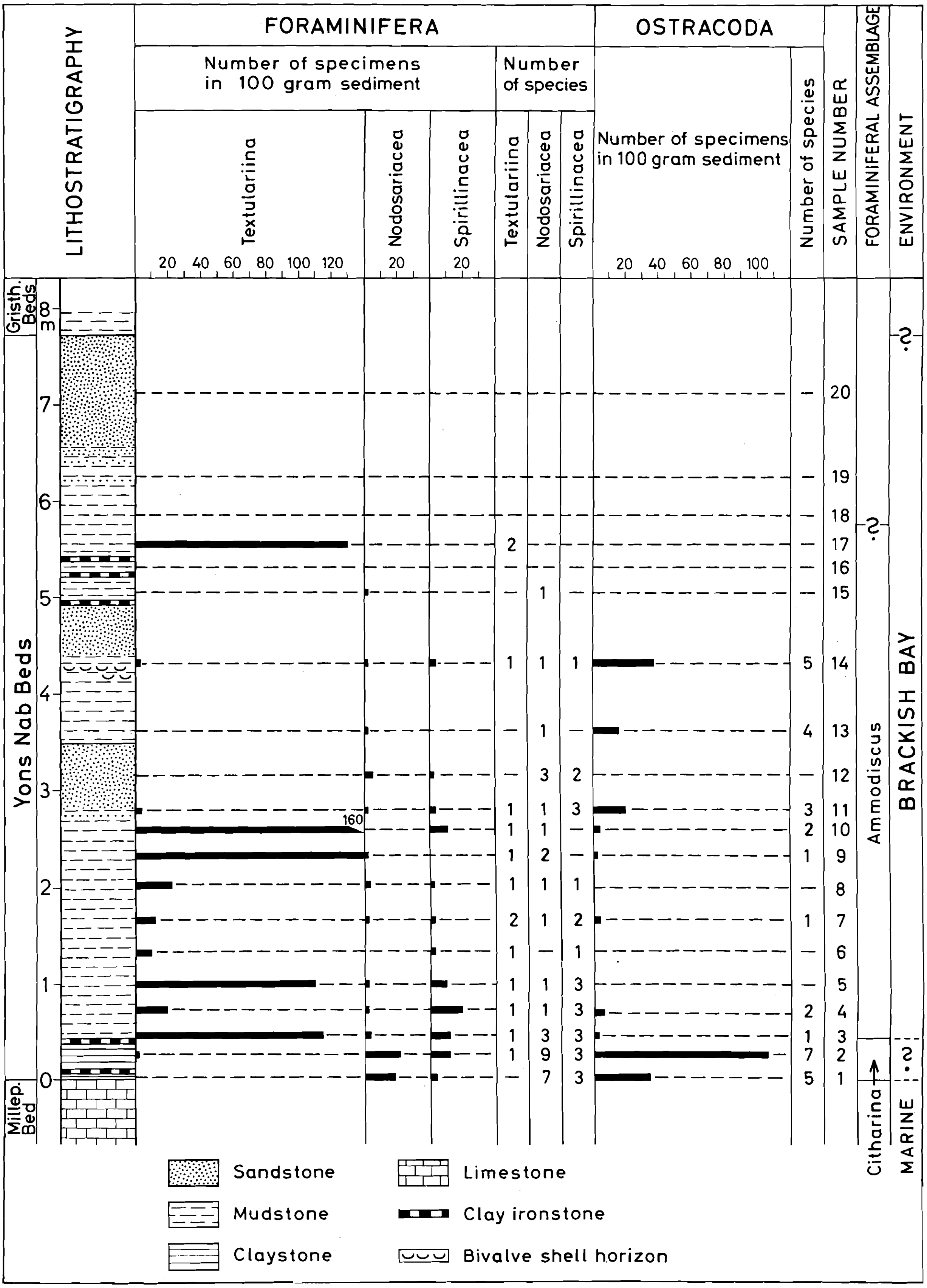

Fig. 6. Distribution of main faunal parameters in the Yons Nab Beds, north-western section.

SYSTEMATIC PART

In the present material 28 foraminiferal species are recognized, 4 of which belong to Textulariina, 21 to Nodosariacea and 3 to Spirillinacea. For 12 species open nomenclature is used. The following synonymy lists contain reference to the original description and to a newer publication for each identified species. Illustrations of 24 species are given on Plate 1 and 2. The classification employed follows the "Treatise on Invertebrate Paleontology", Part C (Loeblich & Tappan 1964).

At least 12 ostracod species occur in the present material. The ostracod faunas of the Yons Nab Beds are described earlier by Bate. The determinations given in the present paper are based on his publications (1963a, 1963b and 1964).

Family SACCAMMINIDAE Brady 1884

Lagenammina sp.
Pl. 1, fig. 1.

Remarks: The Yons Nab material contains a single compressed specimen. It differs from *Lagenammina jurassica* as figured by Exton (1979) in having a less slender neck.

Family AMMODISCIDAE Reuss 1862

Ammodiscus yonsnabensis n. sp.
Plate 1, figs. 2-8.

Description: Test small,discoidal, planispiral, composed of proloculus and a long undivided tube making 3 to 5 whorls around proloculus, increasing gradually in diameter during early whorls and widening slightly in the final whorl; coiling regular with spiral sutures distinct and depressed; central area of test equally depressed on both sides; proloculus fairly prominent in well preserved specimens; wall finely arenaceous with small amount of cement; aperture formed by the open end of the tube; colour white to greyish white.

Dimensions: Greatest diameter of the holotype 0.21 mm; least diameter 0.19 mm; thickness 0,04 mm.

Greatest diameter of paratype (pl. 1, figs. 6,7) 0,19 mm; least diameter 0,17 mm; thickness 0,03 mm.

Maximum diameter of 35 specimens from the type locality ranges from 0,15 to 0,29 mm with an average of 0,19 mm. The specimens are compressed to a varying degree.

Remarks: The shape of wholly planispiral variants of *Spirillina infima* (Strickland 1846) and *Spirillina infraoolithica* (Terquem 1870) is similar to the present species. It is, therefore, possible that specimens of *A. yonsnabensis* n.sp. have in the past been partially referred to these, or related small species of *Spirillina* if the arenaceous nature of the former was not ascertained by e.g. hydrochloric acid. On the other hand, Barnard 1952 suggests that *S. infima* has been referred earlier to *Ammodiscus* among other planispiral genera.

From the measurements given above *A. yonsnabensis* is very uniform in size and is one of the smallest species of *Ammodiscus*. *Ammodiscus francisi* described by Wall 1960 from the Jurassic of Saskatchewan is larger, having an average maximum diameter of 0.27 mm measured on the type material. Furthermore, it has a greater thickness and its ultimate volution widens more rapidly than in the present species.
Another species from Saskatchewan, *Ammodiscus southeyensis* Wall 1960, has larger diameter, greater thickness, more volutions and less distinct spiral sutures than *A. yonsnabensis* n.sp. The average maximum diameter of A. southeyensis is 0.33 mm.

The holotype of *Ammodiscus orbis* from the Jurassic of Montana has a maximum diameter of 0.38 mm (Lalicker 1950). All specimens of *A. yonsnabensis* n.sp. in the present material are much below this size.

Occurrences and types: *A. yonsnabensis* n.sp. is the most common foraminifer in the two sections presented here from Yons Nab. The type species (Pl. 1. figs. 2,3) is from sample 10 in the northwestern section (Fig. 4).

Family LITUOLIDAE de Blainville 1825

Ammobaculites coprolithiformis (Schwager)
Pl. 1, fig. 9.

1867: Haplophragmium coprolithiformis Schwager, p. 654, pl. 34, fig. 3.

Family TROCHAMMINIDAE Schwager 1877

Trochammina sp.

Remarks: Several samples contain small flattened specimens which seem to belong to the same species.

Family NODOSARIIDAE Ehrenberg 1838

Citharina clathrata (Terquem)
Pl. 1, fig. 15.

1864: *Marginulina longuemari* var. *clathrata* Terquem, p. 192, pl. 8, figs. 16, 19a-b.
1969: *Citharina clathrata* (Terquem), Brouwer, p. 31, pl. 2, figs. 11-14.

Citharina aff. *inconstans* (Terquem)
Pl. 1, figs. 12-13.

1868: aff. *Marginulina inconstans* Terquem, p. 66, pl. 2, figs. 1-2.
1962: *Citharina* aff. *inconstans* (Terquem), Brand & Fahrion, p. 156, tab. 9, taf. 20, fig. 34.
Remarks: The original illustrations of this species given by Terquem 1868 show a more triangular shape than the specimens from the Yons Nab Beds. The latter are very close to *Citharina* aff. *inconstans* described by Brand & Fahrion from the Bajocian of north-western Germany.

Citharina cf. *latissima* Loeblich & Tappan
Pl. 1, fig. 11.

1950: cf. *Citharina latissima* Loeblich & Tappan, vol. 40, no. 1, p. 14, pl. 1, figs. 40a-b, text-figs. 2a-h.
1960: cf. *Citharina latissima* Loeblich & Tappan, Wall, p. 100, pl. 7, figs. 5-8.
Remarks: Only a small, single specimen is found in the Yons Nab Beds. It is similar to the smallest specimens of *Citharina latissima* figured by Loeblich & Tappan 1950 and Wall 1960 but differs from them in having fewer and less overhanging chambers.

Citharina aff. *lepida* (Schwager)
Pl. 1, fig. 10

1867: aff. *Cristellaria lepida* Schwager, p. 657, pl. 34, fig. 9.
1960: aff. *Citharina lepida* (Schwager), Lutze, p. 461, pl. 30, figs. 2-4, 7,8; Abb. 14.
Remarks: The specimens from the Yons Nab Beds are broader, and more rounded on the proximal end than it appears from the illustration given by Schwager 1867.

Citharina sp.

Remarks: This robust form with its evenly expanding shape and irregular ribbing differs clearly from other Jurassic species of *Citharina*.

Dentalina mucronata Neugeboren
Pl. 1, fig. 17.

1856: *Dentalina mucronata* Neugeboren, p. 83, pl. 3, figs. 8-11.
1959: *Dentalina mucronata* Neugeboren, Cifelli, p. 309, pl. 4, figs. 1-2, text-fig. 4.

Dentalina oolithica Terquem
Pl. 1, fig. 16.

1870b: *Dentalina oolithica* Terquem, p. 366, pl. 28, figs. 5-6 only.
1959: *Dentalina oolithica* Terquem, Cifelli, p. 310, pl. 4, fig.10.

Dentalina sp.

Remarks: Several fragments are found but a closer determination is not possible because of bad preservation.

Frondicularia franconica Gümbel
Pl. 1, fig. 19.

1862: *Frondicularia franconica* Gümbel, p. 219, pl. 3, fig. 13a-c.
1962: *Frondicularia franconica* Gümbel, Cordey, p. 387, pl. 47, figs. 20-21, text-figs. 31-36.

Frondicularia cf. *involuta* Terquem
Pl. 1, fig. 18.

1866: cf. *Frondicularia involuta* Terquem, p. 403, pl. 15, fig. 3a-b.
1959: cf. *Frondicularia involuta* Terquem, Cifelli, p. 329, pl. 7, figs. 1-3.
Remarks: Only a few fragments are found, but the shape of the chambers resembles *Frondicularia involuta* figured by Cifelli 1959.

Lenticulina münsteri (Roemer)

1839: *Robulina münsteri* Roemer, p. 48, pl. 20, fig. 29.
1975: *Lenticulina münsteri* (Roemer), Jendryka-Fuglewicz, p. 149, pl. 8, 9, 10, 11, figs. 1-6; pl. 19, pl. 20, figs. 1-2.

Lenticulina quenstedti (Gümbel)
Pl. 1, fig. 22.

1862: *Cristellaria quenstedti* Gümbel, p. 226, pl. 4, fig. 2a-b.
1951: *Lenticulina quenstedti* (Gümbel), Cifelli, p. 292, pl. 2, figs. 6-7.

Lenticulina varians (Bornemann)
Pl.1, figs. 20-21.

1854: *Cristellaria varians* Bornemann, p. 41, pl. 4, figs 32-34.
1959: *Lenticulina varians* (Bornemann), Cifelli, p. 297, pl. 2, figs. 11-13.

Planularia beierana (Gümbel)
Pl. 1, figs. 23-24

1862: *Marginulina beierana* Gümbel, p. 221, pl. 3, fig. 20a-b.
1962: *Planularia beierana* Gümbel, Cordey, p. 380, pl. 46, fig. 11, text- figs. 10-20.
Remarks: The Yons Nab material contains specimens both with flush and raised sutures. Large variability within the species is reported by Cifelli 1959 both with regard to this and other features.

Vaginulina aff. *biplicata* Terquem
Pl. 2, fig. 3.

1864: aff. *Vaginulina biplicata* Terquem, p. 395, pl. 8, fig. 3.
Remarks: The specimens from the Yons Nab Beds have more rounded proximal ends and have fewer chambers than those figured by Terquem 1864.

Vaginulina contracta (Terquem)
Pl. 2, figs. 7-8.

1868: *Marginulina contracta* Terquem, p. 125, pl. 8, figs. 13-24.
1959: *Vaginulina contracta* (Terquem), Cifelli, p. 321, pl. 5, fig. 17.

Vaginulina legumen (Linné)
Pl. 2, figs. 1-2, 5.

1758: *Nautilus legumen* Linné, p. 711, pl. 1, figs. 7g-i.
1959: *Vaginulina legumen* (Linné), Cifelli, p. 322, pl. 5, figs. 15-16.

Vaginulina aff. *lingulata* Paalzow
Pl. 2, fig. 4.

1917: aff. *Vaginulina lingulata* Paalzow, p. 236, pl. 45, fig. 2.
Remarks: The Yons Nab specimens have less oblique sutures than the original illustration of Paalzow 1917.

Vaginulina triquetra (Terquem)
Pl. 2, fig. 6

1870a: *Cristellaria triquetra* Terquem, p. 168, taf. 9, figs. 25, 26.
1936: *Vaginulina triquetra* (Terquem), Franke, p. 84, taf. 8, figs. 28, 29.

Family POLYMORPHINIDAE d'Orbigny 1839

Eoguttulina liassica (Strickland)
Pl. 2, figs. 10-12.

1846: *Polymorphina liassica* Strickland, p. 30, tf. b.
1962: *Eoguttulina liassica* (Strickland), Cordey, p. 391, pl. 48, fig. 37.

Eoguttulina oolithica (Terquem)
Pl. 2, figs. 13-15.

1874: *Polymorphina oolithica* Terquem, p. 299, pl. 32, figs. 1-10.
1962: *Eoguttulina oolithica* (Terquem), Cordey, p. 392, pl. 48, fig. 36.

Eoguttulina sp.
Pl. 2, fig. 18.

Remarks: A single specimen is found in the Yons Nab material. It shows the chamber arrangement of *Eoguttulina*, and has a striated surface.

Laryngosigma? sp.
Pl. 2, figs. 16-17

Remarks: The chamber arrangement of the Yons Nab specimens is similar to *Sigmomorphina* but they have an entosolenial tube as the recent genus *Laryngosigma*. The shape of the specimens is similar to *Pealerina rhom boidalis* Wall 1960. *Pealerina* is a synonym of *Sigmomorphina* according to Loeblich & Tappan 1964. In this connection it must be noted that Cifelli 1959 mentioned the presence of an entosolenial tube in polymorphinids which he referred to *Eoguttulina liassica*.

Family SPIRILLINIDAE Reuss, 1862

Spirillina infraoolithica (Terquem)
Pl. 2, fig. 19.

1870b: *Cornuspira infraoolithica* Terquem, p. 345, pl. 25, fig. 13.

Conicospirillina pictonica (Berthelin)
Pl. 2, figs. 26-31.

1879: *Placentula pictonica* Berthelin, p. 36, pl. 1, figs. 23-25.

Turrispirillina punctulata (Terquem)
Pl. 2, figs. 20-25.

1870b: *Cornuspira punctulata* Terquem, p. 345, pl. 25, figs. 14-16.

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REFERENCES

Barnard, T., 1952. Notes on *Spirillina infima* (Strickland) foraminifera. Ann. Mag. Nat. Hist., London, ser. 12, vol. 5, no. 58, 905-907.

Bartenstein, H., Brand, E., 1937. Mikropaläontologische Untersuchungen zur Stratigraphie der nordwestdeutschen Lias und Doggers. Abh. Senckenb. Naturforsch. Ges., No. 439, 1, 1-224. Frankfurt a.M.

Bate, R.H., 1959. The Yons Nab Beds of the Middle Jurassic of the Yorkshire Coast. Proceedings of the Yorkshire Geol. Soc. 32, 2, 153-164.

Bate, R.H., 1963a. Middle Jurassic Ostracoda from North Lincolnshire. Bull. Brit. Mus. (Nat. Hist.) Geol., London, 8, 4, 173-219.

Bate, R.H., 1963b. Middle Jurassic Ostracoda from South Yorkshire. Bull. Brit. Mus. (Nat. Hist.) Geol., London, 9, 2, 19-46.

Bate, R.H., 1964. Middle Jurassic Ostracoda from the Millepore Series, Yorkshire. Bull. Brit. Mus. (Nat.Hist.) Geology, London, 10, 1, 1-33.

Berthelin, G., 1879. Foraminifères du Lias moyen de la Vendée. Rev. Mag. Zool., Ser. 3, vol. 7, 24-41.

Bornemann, J.G., 1854. Über die Liasformation in der Umgegend von Göttingen und ihre organischen Einschlüsse. 77 pp. (A.W. Schade). Berlin.

Brand, E., Fahrion, H., 1962. Dogger NW-Deutschlands. pp. 123-153. In. Leitfossilien der Mikropaläontologie. Berlin.

Brouwer, J., 1969. Foraminiferal assemblages from the Lias of North- Western Europe. Ver.K.Ned. Akad. Wet., Afd. Natuurk. 1, 25, No. 4. 64 pp.

Bulynnikova, S.P., Dain, L.G., Kosyreva, V.F., Komissarenko, V.K., Levina, V.I., Tylkina, K.E., 1972. Foraminifera of the Upper Jurassic deposits of western Siberia. In. Dain, L.G. (Ed.) All-Union Petroleum Scientific-Research Geological-Prospecting Inst. (VNIGRI), Trans. (Trudy) 317. 273 pp. (Russian).

Cifelli, R., 1959. Bathonian foraminifera of England. Bull. Mus. Comp. Zool. Cambridge, vol. 121, No. 7, 265-368.

Cordey, W.G., 1962. Foraminifera from the Oxford Clay of Staffin Bay, Isle of Skye, Scotland. Senckenb. Leth. vol. 43, No. 5, 375- 409.

Exton, J., 1979. Pliensbachian and Toarcian microfauna of Zambujal, Portugal. Systematic paleontology. Carleton University, Ottawa, Geological paper 79-1, 1-103.

Franke, A., 1936. Foraminiferen des deutschen Lias. Abh. Preuss. Geol. Landesanst., N.F.Ht. 169, 140 pp. Berlin.

Gümbel, C.W., 1862. Die Streitberger Schwammergel und ihre Foraminiferen-Einschlüsse. Jahresh. Ver. Vaterl. Naturk. Württemberg, Jahrg. 18, 192-238.

Hancock, N.J., Fischer, M.J., 1980. Middle Jurassic North Sea deltas with particular reference to Yorkshire. Proc. Conf. Petroleum Geology of the Continental Shelf of North West Europe. London, March 1980. Heydon & Son Limited. 186-195.

Hemingway, J.E., 1974. Jurassic. In: D.H. Rayner and J.E. Hemingway (editors), The geology and mineral resources of Yorkshire. Yorks. geol. Soc. 161-223.

Hemingway, J.E., Knox, R.W., 1973. Lithostratigraphical nomenclature of the Middle Jurassic strata of the Yorkshire basin of north-east England. Proc. Yorks. geol. Soc. 39, 527-535.

Jendryka-Fuglewicz, B., 1975. Evolution of the Jurassic and Cretaceous smooth-walled *Lenticulina* (Foraminiferida) of Poland. Acta Palaeont. Pol. 20, 2, 99-197.

Kent, P.E., 1980. Subsidence and uplift in East Yorkshire and Lincolnshire: a double inversion. Proc. Yorks. Geol. Soc. 42, 505-524.

Lalicker, C.G., 1950. Foraminifera of the Ellis Group, Jurassic, at the type locality. Univ. Kansas Paleont. Contrib., Protozoa, 2, 3-20.

Linné, von C., 1758. Systema naturae, ed. 10. Holmiae, Suecia (Sweden), impensis L. Salvii, tomus 1.

Loeblich, A.R., Tappan, H., 1950. North American Jurassic foraminifera. II. Characteristic western interior Callovian species. Washington Acad. Sci., Jour. 40, 5-19.

Loeblich, A.R., Tappan, H., 1964. Sarcodina, chiefly "Thecamoebians" and Foraminiferida. In. Moore, R.C., Ed., Treatise on Invertebrate Paleontology, Part C, Protista 2, I-II. Geol. Soc. Amer. and Univ. Kansas Press. 900 pp.

Lutze, G.F., 1960. Zur Stratigraphie und Paläontologie des Callovien und Oxfordien in Nordwest-Deutschland. Geol. Jahrb. 77, 391- 532.

Løfaldli, M., Nagy, J., 1980. Foraminiferal stratigraphy of Jurassic deposits on Kongsøya, Svalbard. Norsk Polarinstitutt, Skrifter nr. 172, 63-95.

Murray, J., 1973. Distribution and ecology of living benthic foraminiferids. Heinemann Educational Books, 48 Charles Street, London. 274 pp.

Neugeboren, J.L., 1856. Die Foraminiferen aus der Ordnung der Stichostegier von Ober-Lapugy in Siebenbürgen. K. Akad. Wiss., Math. - Naturw. Cl., Denkschr., Wien, Bd. 12, Abth. 2.

Paalzow, R. 1917. Beiträge zur Kenntnis der Foraminiferenfauna der Schwammergel des Unteren Weissen Jura in Süddeutschland. Naturhist. Ges. Nürnberg, Abh., vol. 19, 203-248.

Phleger, F., 1976. Benthic foraminiferids as indicators of organic production in marginal marine areas. I.Int. Symp. on Benthonic Foraminifera of Continental Margins. Part A. Ecology and Biology. Maritime Sediments Special Publication No. 1, 107- 117.

Roemer, F.A., 1839. Die Versteinerungen des norddeutschen Oolithen- Gebirges. (Hahnschen Hofbuch-handlung). Hannover. 59 pp.

Schwager, C. in Waagen, W., 1867. Über die Zone des Ammonites sowerbyi. Geogn. - Paläon. Beiträge v. Bennecke, v. 1, 654-668.

Strickland, H.E., 1846. On two species of microscopic shells found in the Lias. Quart. Jour. Geol. Soc. London, v. 2, 30-31.

Terquem, O., 1864. Troisième mémoire sur les foraminifères du Lias des Départements de la Moselle, de la Côte d'Or, du Rhône, de la Vienne et du Calvados. Mém. Imp. Acad. Metz, v. 44, 147- 228.

Terquem, O., 1866. Cinquième mémoire sur les foraminifères du Lias des Départements de la Moselle, de la Côte d'Or et de l'Indre, avec un apercu stratigraphique et pétrologique des environs de Nohant. Mém. Imp. Acad. Metz. 309-454.

Terquem, O., 1868. Premier mémoire sur les foraminifères du système Oolithique Étude de Fullers-Earth de la Moselle. Soc. Hist. Nat. Moselle Bull., vol. 11, 1-138.

Terquem, O., 1870a. Deuxième mémoire sur les foraminiferes du système Oolithique. Ménæ .imp. Acad. Metz. v. 50.

Terquem, O., 1870b. Troisième mémoire sur les foraminifères du système Oolithique, comprenant les genres *Frondicularia, Flabellina, Nodosaria*, etc., de la zône à *Ammonites parkinsoni* de Fontoy (Moselle). Mém. Imp. Acad. Metz. v. 51, 299-380.

Terquem, O., 1874. Quatrième mémoire sur les foraminifères du système Oolithique, comprenant les genres *Polymorphina, Guttulina, Spiroloculina, Triloculina* et *Quinqueloculina* de la zône a *Ammonites parkinsoni* de Fontoy (Moselle). Paris.

Wall, J.H., 1960. Jurassic Microfaunas from Saskatchewan. Dept. Mineral Resources, Rept. 53, 1-229.

PLATE 1

Fig. 1.	*Lagenammina* sp. South-eastern section sample 8 (X85).
Figs. 2-8.	*Ammodiscus yonsnabensis* n. sp. 2: (X110), 3: (X114), 4-5: holotype (X114), 6-7: (X105); NW section sample 10. 8: (X108); NW section sample 5.
Fig. 9.	*Ammobaculites coprolithiformis* (Schwager) NW section sample 7, (X49).
Fig. 10.	*Citharina* aff. *lepida* (Schwager) NW section sample 1, (X88).
Fig. 11.	*Citharina* cf. *latissima* Loeblich & Tappan NW section sample 7, (X85).
Fig.s 12-13.	*Citharina* aff. *inconstans* (Terquem) NW section sample 2, (X50).
Fig. 14.	*Citharina* sp. NW section sample 1, (X50).
Fig. 15.	*Citharina clathrata* (Terquem) NW section sample 2, (X89).
Fig. 16.	*Dentalina oolithica* Terquem NW section sample 2, (X97).
Fig. 17.	*Dentalina mucronata* Neugeboren SE section sample 6, (X148).
Fig. 18.	*Frondicularia* cf. *involuta* Terquem SE section sample 7, (X75).
Fig. 19.	*Frondicularia franconica* Gümbel NW section sample 4, (X90).
Figs. 20-21.	*Lenticulina varians* (Bornemann) 20: SE section sample 18, (X80); 21: SE section sample 15, (x75).
Fig. 22.	*Lenticulina quenstedti* (Gümbel) SE section sample 18, (X88).
Figs. 23-24.	*Planularia beierana* (Gümbel) NW section sample 2, (X50).

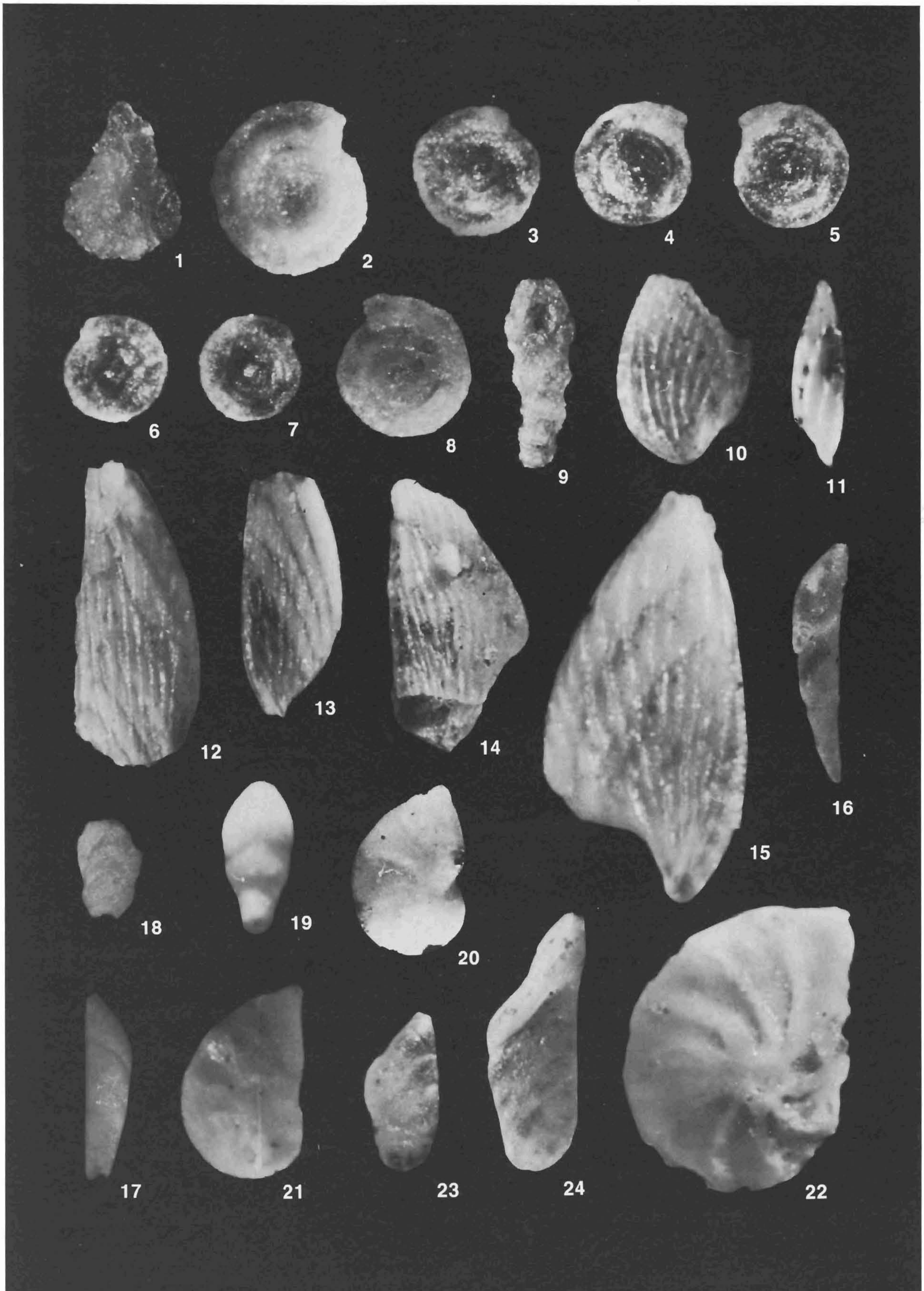
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PLATE 2

Figs. 1-2. *Vaginulina legumen* (Linné)
1: SE section sample 11, (X92); 2:SE section sample 15, (X92).

Fig. 3. *Vaginulina* aff. *biplicata* Terquem
NW section sample 2, (X50).

Fig. 4. *Vaginulina* aff. *lingulata* Paalzow
NW section sample 2, (X48).

Fig. 5. *Vaginulina legumen* (Linné)
NW section sample 13, (X50).

Fig. 6. *Vaginulina triquetra* (Terquem)
NW section sample 1, (X48).

Figs. 7-8. *Vaginulina contracta* (Terquem)
7: NW section sample 9, (X90); 8: NW section sample 2, (X90).

Fig. 9. *Planularia beierana* (Gümbel)
NW section sample 2, (X48).

Figs. 10-12. *Eoguttulina liassica* (Strickland)
10-11: opposite sides of the same specimen, SE section sample 15, (X79);
12: SE section sample 12. (X87).

Figs. 13-15. *Eoguttulina oolithica* (Terquem)
13-14: opposite sides of the same specimen, NW section sample 8, (X95);
15: NW section sample 8, (X87).

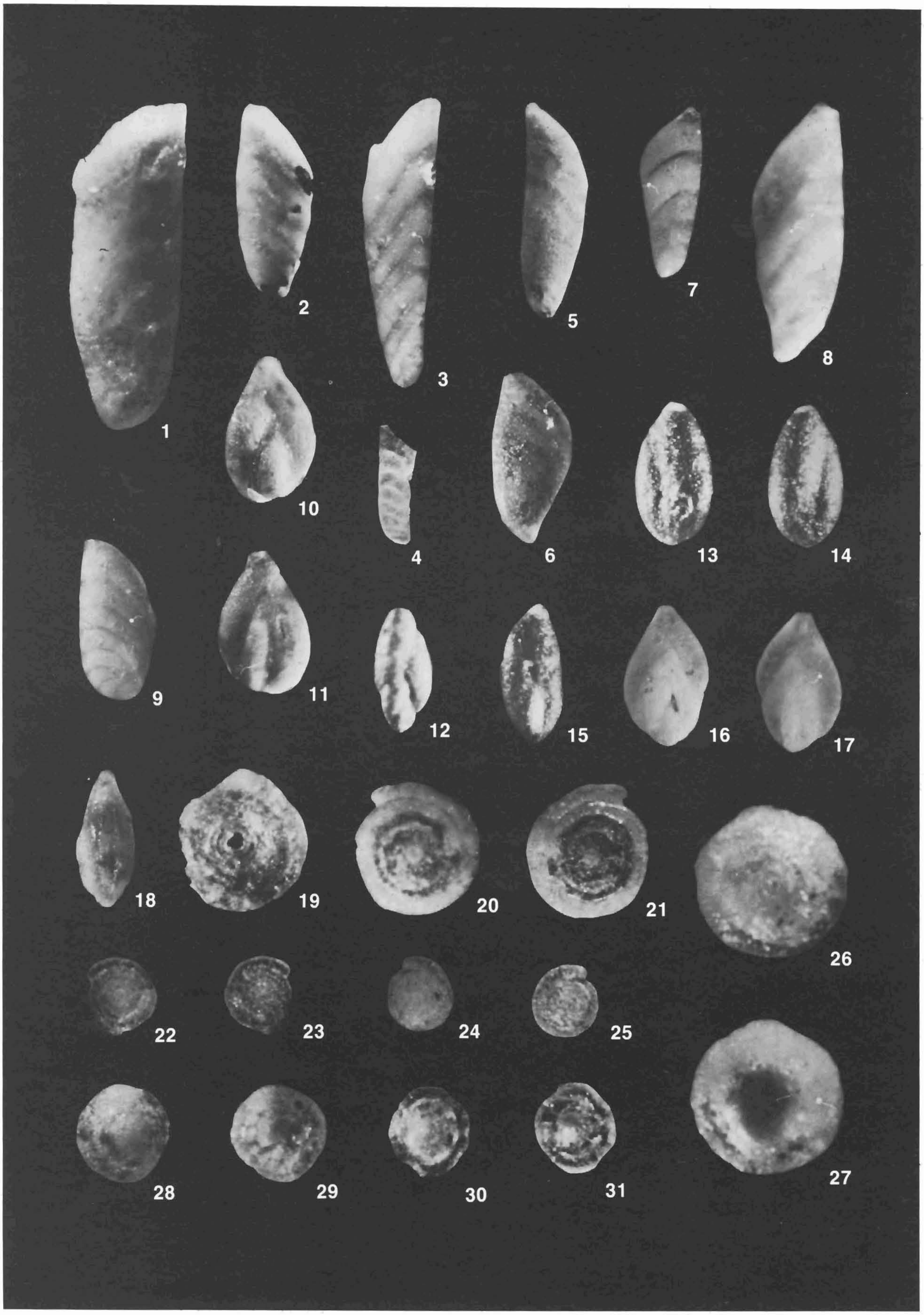
Figs. 16-17. *Laryngosigma?* sp.
Opposite sides of a specimen from NW section sample 12, (X100).

Fig. 18. *Eoguttulina* sp.
SE section sample 12, (X89).

Fig. 19. *Spirillina infraoolithica* (Terquem)
NW section sample 1, (X137).

Figs. 20-25. *Turrispirillina punctulata* (Terquem)
20-21: dorsal and ventral side, respectively, of a specimen from NW section sample 7, (X109);
22-23: dorsal and ventral side, respectively, of a specimen from NW section sample 1 (X76);
24-25: dorsal and ventral side, respectively, of a specimen from NW section sample 1, (X74).

Figs. 26-31. *Conicospirillina pictonica* (Berthelin)
26-27: dorsal and ventral side, respectively, of a specimen from NW section sample 11, (X142);
28-29: dorsal and ventral side, respectively, of a specimen trom NW section sample 2, (X112);
30-31: dorsal and ventral side, respectively, of a specimen from NW section sample 2, (X81).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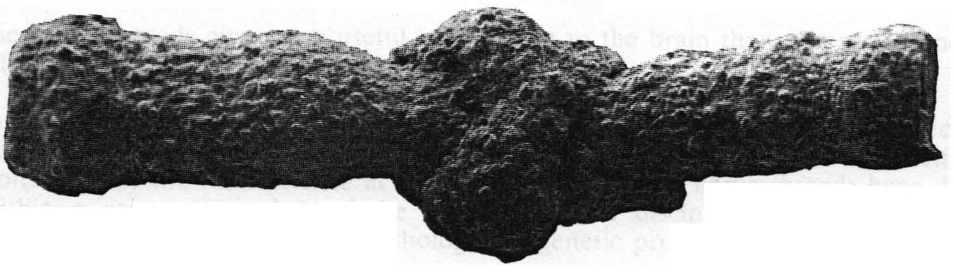

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