Ostracods from the Albian/Cenomanian boundary in the Achterhoek area (eastern part of The Netherlands)

L. Witte, Th. Lissenberg & H. Schuurman

L. Witte, Th. Lissenberg & H. Schuurman. Ostracods from the Albian/Cenomanian boundary in the Achterhoek area (eastern part of The Netherlands). — Scripta Geol., 102: 33-84, 7 figs., 7 pls, Leiden, December 1992.

The only outcrop of the Cenomanian in The Netherlands is found in the eastern part of the country, near the town of Winterswijk. Here, in the bed of a brook, the Oossinkbeek, white chalks are exposed. Not far from this locality, just a few hundred metres to the NE, the only exposure of the Albian in The Netherlands is found as well, represented here mainly by greensands and greyish siltstones. Samples from both localities were examined for their microfaunal content (ostracods and foraminifera). In addition, samples from a few wells in the surrounding area were included in the study. The recovered ostracod faunas are described in this paper. They prove that, with the exception of the top layers exposed in the Oossinkbeek, the chalks of Kotten are primarily of Early Cenomanian age rather than of Middle Cenomanian age, as was generally accepted until now. One of the wells is believed to contain, at a depth of 10 m, the Albian/Cenomanian boundary; the formal boundary between Early and Late Cretaceous.
To provide a basis for comparison, samples from the Middle Cenomanian chalk of the nearby Schenking Quarry (Wettringen, Germany) were also examined for their ostracod content, and are included in this study.

L. Witte, Th. Lissenberg and H. Schuurman, Geological Survey of The Netherlands, P.O. Box 157, 2000 AD Haarlem, The Netherlands.

Introduction

With the exception of the Maastricht Formation in the south of The Netherlands, out-

crops of Mesozoic rocks are extremely scarce, and almost completely confined to the Achterhoek area. Here, east of the town of Winterswijk, all three Mesozoic periods are represented in various exposures, the most prolific being the Triassic (Muschelkalk) quarry in the Vossenveld.

The Albian and Cenomanian sediments – incidently jointly referred to as 'Mid Cretaceous' for convenience sake – in the study area are hidden under a thin layer of Quarternary, but rocks of both ages are exposed locally in the beds of the picturesque winding brooks. Where the Bekerinkbeek cuts into the landscape, the Middle Albian is exposed over a distance of some tens of metres. Unfortunately, the sediments are highly decalcified and the samples we collected here contained no calcareous microfossils and only very few arenaceous foraminifera. Sofar, the age assigned to these sediments was based mainly on lithological comparison with rocks cropping out in Germany, in particular the Oelbach near Frankenmühle (see also Stapert, 1974). From this locality, which is situated less than 20 km from the Dutch Albian outcrop, time-significant macro- and microfaunas were recorded (see Kemper, 1976). Recently, two samples from the Bekerinkbeek were analysed palynologically and these data confirm the earlier assumptions, albeit that an age near the Middle/Late Albian boundary seems more probable (Herngreen, 1992).

The Cenomanian of the Achterhoek is found in the Oossinkbeek, a mere five minutes' walk from the locality of the Middle Albian outcrop. Here, in the bed of the brook, the white limestone, for which the informal name 'Kottense Kalksteen' has been used in literature, is clearly visible, whereas in other places along its course the chalk is covered by a layer of sand which is only a few centimetres thick. At the time we collected our samples the size of the actual outcrop was less than a square metre.

Acknowledgements

The 'Nationaal Natuurhistorisch Museum' (National Museum of Natural History) in Leiden is thanked for making available for study material from wells 41F125 and 41E198. M. van den Bosch, who drilled these wells, is thanked for his cooperation in various stages of this project and for the numerous discussions on the geology of the Achterhoek area. We thank the director of the Geological Survey of The Netherlands for permission to publish these results. We also wish to express our gratitude to John van Delft and Peter Kessels for their assistance in preparing the plates. We are indebted to our colleague G.F.W. Herngreen for critically reading the manuscript.

Material and methods

To improve our understanding of the development of the 'Mid-Cretaceous' in the Achterhoek, several wells drilled into the Mesozoic were studied. Unfortunately, samples resulting from a drilling campaign that was undertaken in the late fifties/ early sixties were no longer available for micropalaeontological analysis. Moreover, the core descriptions – the wells were cored over their entire length – were not detailed enough and thus inadequate to draw any stratigraphical conclusions. However, we

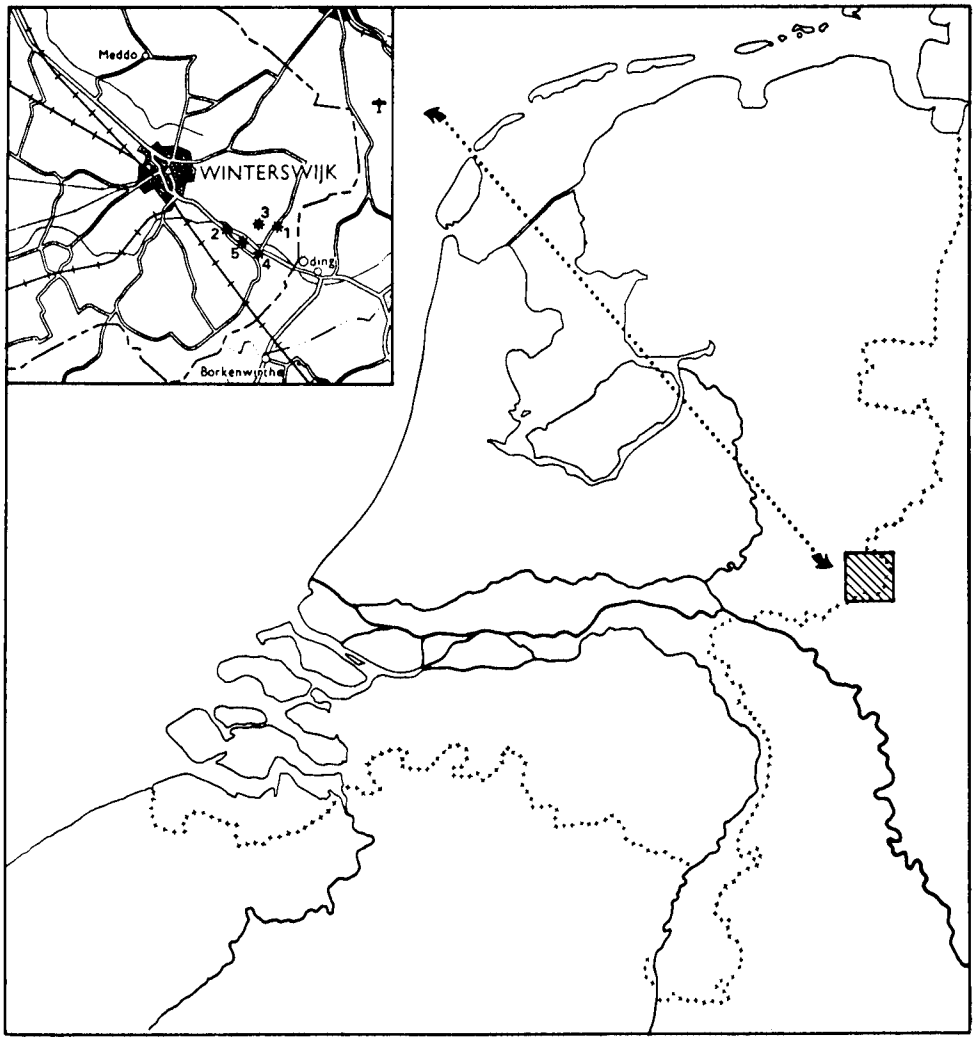


Fig. 1. Sketch map of the eastern Achterhoek, showing the locations of outcrops and wells discussed in the text.
1: well 41E167 'Craelius IX'; 2: well 41F125 'Renskers'; 3: well 41E198 'Grijsen'; 4; Middle Albian outcrop Bekerinkbeek; 5: Middle Cenomanian outcrop Oossinkbeek.

were able to track down some washed material from one of these wells, which had probably been used for earlier foraminiferal analysis. We have picked out these residues for ostracods, and included this well (41E167 'Craelius IX') in our study.

Fortunately, Mr M. van den Bosch of the 'Nationaal Natuurhistorisch Museum' in Leiden could provide us with samples from a number of wells he drilled in the Kotten area during the past few years, using the so-called 'air-lift' system. Two of these wells, 41E198 'Grijsen' and 41F125 'Renskers', both covering part of the Lower Cenomanian, are used in this study.

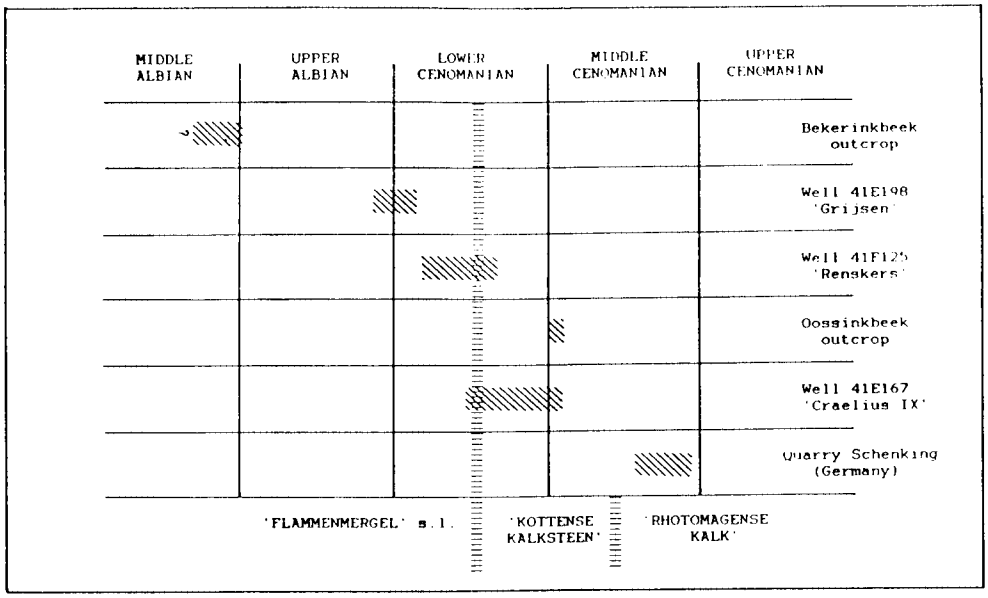


Fig. 2. Approximate stratigraphical correlation of the discussed wells and outcrops. The boundary between the 'Flammenmergel' and the 'Kottense Kalksteen' is, lacking proper criteria, only indicated approximately.

None of the studied wells reach a depth of over 55 m, and our original objective – to fill the gap in our knowledge of the stratigraphical development between the greensands exposed in the Bekerinkbeek and the chalk in the Oossinkbeek – was accomplished only to a very limited extent. In the available wells, rocks older than Cenomanian were just reached; the deepest samples of well 41E198 contained Late Albian faunas.

In our research we also included some samples collected in the quarry of Schenking & Co, Wettringen in Germany. This quarry is situated some 50 km to the NE from the Oossinkbeek exposure and shows a well-developed succession of Cenomanian chalk, representing a higher stratigraphic level. The white chalk in this quarry – long considered to be of Late Cenomanian age – could now, with the help of ostracods and foraminifera, be dated as Middle Cenomanian.

Since the amount of raw material used for micropalaeontological analysis was quite variable, or – in case of the already prepared residues – even of unknown quantity, absolute numbers are of very little value and will therefore not be included in this study. In general, the ostracod faunas were poor, but, with the exception of the Bekerinkbeek outcrop, no sample we found was completely barren of ostracods. The highest number of specimens in one sample was 25, the majority of which were cytherellas. With only a few exceptions, the faunas were poorly preserved; shells were often overgrown with calcite, but only in a few cases to such an extent that identification was not possible.

For the preparation of the samples, standard techniques were used: crushing, soaking in hydrogen peroxide for several days, and washing in nylon sieving cloth under running water. Afterwards the residues were dried and handpicked for ostracods and foraminifera. These faunas were stored in micropalaeontological slides. The specimens illustrated in the plates are kept in the 'Nationaal Natuurhistorisch Museum' (National Museum of Natural History) in Leiden, under storage numbers RGM 293 400-293 498; the material not illustrated has been added to the micropalaeontological collections of the Geological Survey of The Netherlands in Haarlem.

Geological setting

The 'Mid Cretaceous' was a period of a changing geological regime in the Achterhoek area. The area is regarded to have been a part of the Alstätter Bucht, a marginal basin forming the westernmost extension of the Lower Saxony Basin, during the Late Jurassic and Early Cretaceous. The question whether this extension formed a direct connection with the Central Netherlands Basin (as was suggested by Heybroek, in Nederlandse Aardolie Maatschappij b.v., 1974) or at periods even with the Roer Valley Graben (as suggested by Herngreen et al., 1984) still remains unanswered. Most authors accept the idea that, during the Late Cretaceous, the area was part of the Münster Basin (also known as 'Münsterländer Becken'), a Cretaceous basin extending eastward as far as Paderborn. At the onset of the Late Cretaceous this Münster Basin may have been part of an even larger chalk sea which had its extensions farther to the west.

The first serious geological survey of the area was carried out in the first decade of this century by the R.O.D. ('Dienst voor de Rijksopsporing van Delfstoffen' or 'State Service for the Exploration of Mineral Resources'). As early as that, it was commonly known that a range of Mesozoic and Tertiary sediments came to the surface; this had given ground to continuous speculations about riches in the deep. For the Cretaceous rocks that were outcropping in the Achterhoek – or that were encountered in the numerous shallow hand-drilled wells – names were adopted that were already in use in the Lower Saxony Basin (in particular the Harz foreland). Thus, since then the names 'Pläner Kalkstein' and 'Minimuston' have been commonly used for respectively the Cenomanian rocks exposed in the Oossinkbeek and the Albian greensands etc. in the Bekerinkbeek.

During its survey, the R.O.D revealed the presence of 'Gault'-like glauconitic marls and greensands stratigraphically below the chalks of the Oossinkbeek. In analogy with Eastern Saxony, these rocks were called 'Flammenmergel', and were subdivided by the R.O.D in 'bovenste Flammenmergel' and 'onderste Flammenmergel'. By 'bovenste Flammenmergel' the light-grey marls with dark streaks (flames) were meant, which are directly overlain by the white chalks. In the German literature the names 'Untercenomanmergel' or 'Cenomanmergel' are commonly used for these layers. The name 'onderste Flammenmergel' refers to the Flammenmergel sensu stricto, a Late Albian, marly rock with different shades of grey – and according to some authors with even more flamboyant colours.

The stratigraphic model proposed by the R.O.D. was later confirmed by the

results of oil exploration wells drilled in the western part of Germany, closer to the Dutch border. Here, Flammenmergels may reach considerable thicknesses, 100 m being no exception. It is unknown whether this formation reaches comparable thicknesses in The Netherlands, and this study does not answer this question either. Although the presence of Upper Albian marls below the Lower Cenomanian could be proven in well 41E169, the modest depth of this well – for the moment – only permits the conclusion that the total thickness of these sediments exceeds 8 m. To clarify the development of the 'Flammenmergel' in The Netherlands, additional wells at specific locations are needed.

Stratigraphy and distribution

In addition to the ostracods, the subject of this paper, the foraminifera were examined as well, and the results of that analysis will be published separately. Age assignments based on foraminifera and ostracods are in agreement. The faunas recovered from the Achterhoek wells show the ages of the rocks from which they were extracted to vary from the latest Late Albian to the early Middle Cenomanian.

Important markers for the lowest part of the succession, reached only in well 41E198, are the ostracods *Cytheropteron nanissimum fenestratum* Kaye, 1965 and *Phodeucythere trigonalis* (Jones & Hinde, 1890), both restricted to the Albian. This age is confirmed by the presence of agglutinated foraminifera such as *Arenobulimina sabulosa* (Chapman, 1892) and *Arenobulima chapmani* Cushman, 1936. The lower Cenomanian, present in all three wells, is identified by 'Albian' species that range into

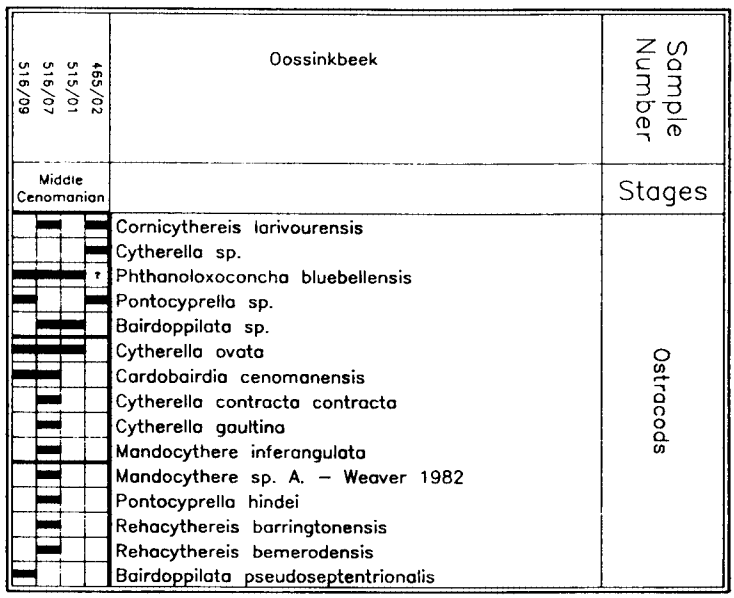


Fig. 3. Distribution of ostracod species in the Oossinkbeek exposure.

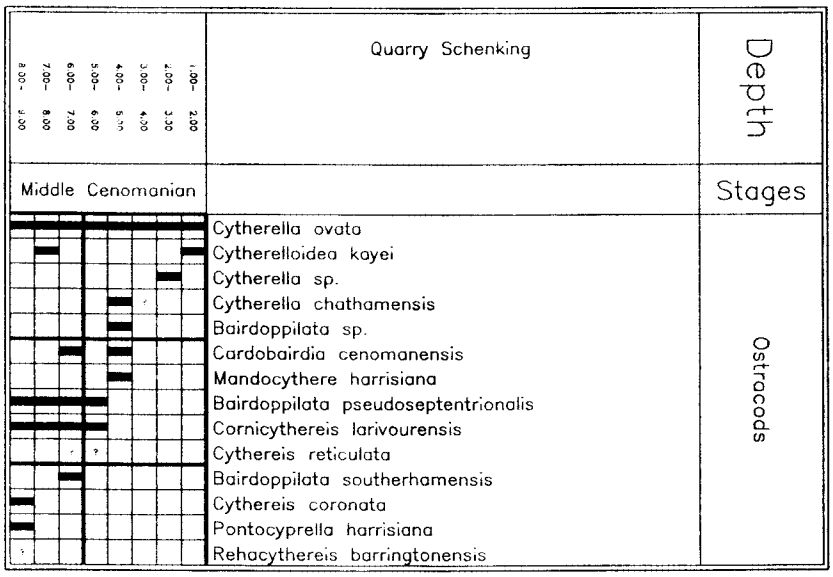


Fig. 4. Distribution of ostracod species in the Schenking Quarry, Wettringen, Germany.

the Cenomanian in combination with forms that first appear at the base of the Cenomanian and persist in higher levels. Examples of late Albian/early Cenomanian markers are, among others, the ostracod *Physocythere steghausi* (Mertens, 1956) and the benthic foraminifer *Lingulogavelinella jarzevae* (Vassilenko, 1961). Strictly Cenomanian forms are, for instance, the agglutinated foraminifera *Crenaverneuilina intermedia* (Ten Dam, 1950) and *Arenobulimina advena* (Cushman, 1936) and the ostracod *Platella icknieldensis* Weaver, 1982. A marker confined to the Early Cenomanian is the ostracod *Bythoceratina umbonata glabra* Weaver, 1982.

An age younger than Early Cenomanian is indicated unequivocally by the presence of the planctonic foraminifer *Rotalipora cushmani* (Morrow, 1934), a marker for the Middle and Late Cenomanian in Northwest Europe. This species was sporadically found in the highest levels of well 41E167, in the Schenking Quarry and in the Oossinkbeek exposure. In England *Rotalipora reicheli* Mornod, 1949 occurs from around the Lower/Middle Cenomanian boundary; we found a few specimens near the top of Well 41E167 and in the Schenking Quarry. *Pseudotextulariella cretosa* (Cushman, 1932) also points to Middle Cenomanian, but is also found in the upper part of the Lower Cenomanian. It was absent from Well 41E198 and from the lower part of Well 41F125.

Until recently, the 'Pläner Kalkstein' in Germany was considered Middle Cenomanian. The 'Kottense Kalksteen', its Dutch equivalent in the Achterhoek, was therefore – by most authors – also assigned to this age, if not to the Turonian on the basis of a lithological similarity to the so-called *lamarcki* and *labiatus* beds. These Turonian chalks are quarried near Ahaus in Germany, not far from the Achterhoek.

The micropalaeontological analysis shows the bulk of the chalks of Kotten to be slightly older – Early Cenomanian – than had been estimated before (see Figs. 3-7).

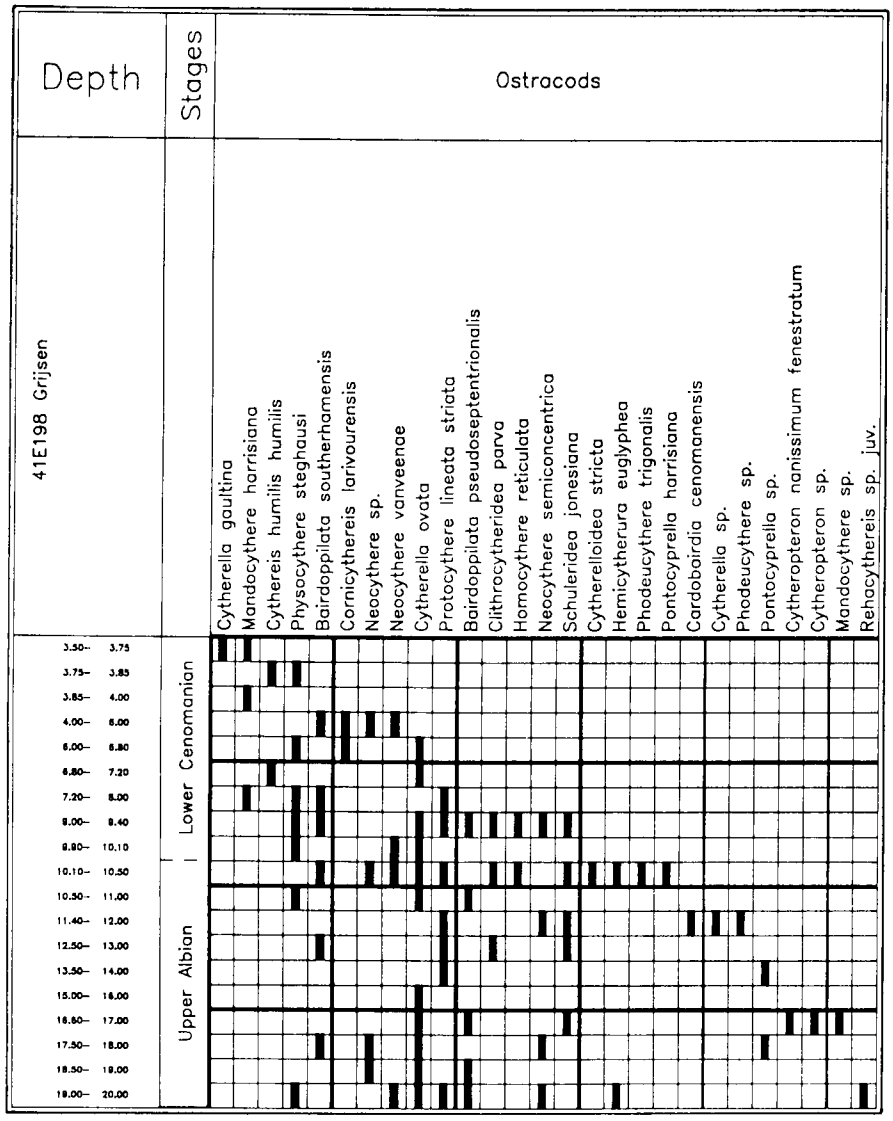


Fig. 5. Distribution of ostracod species in well 41E198 'Grijsen'.

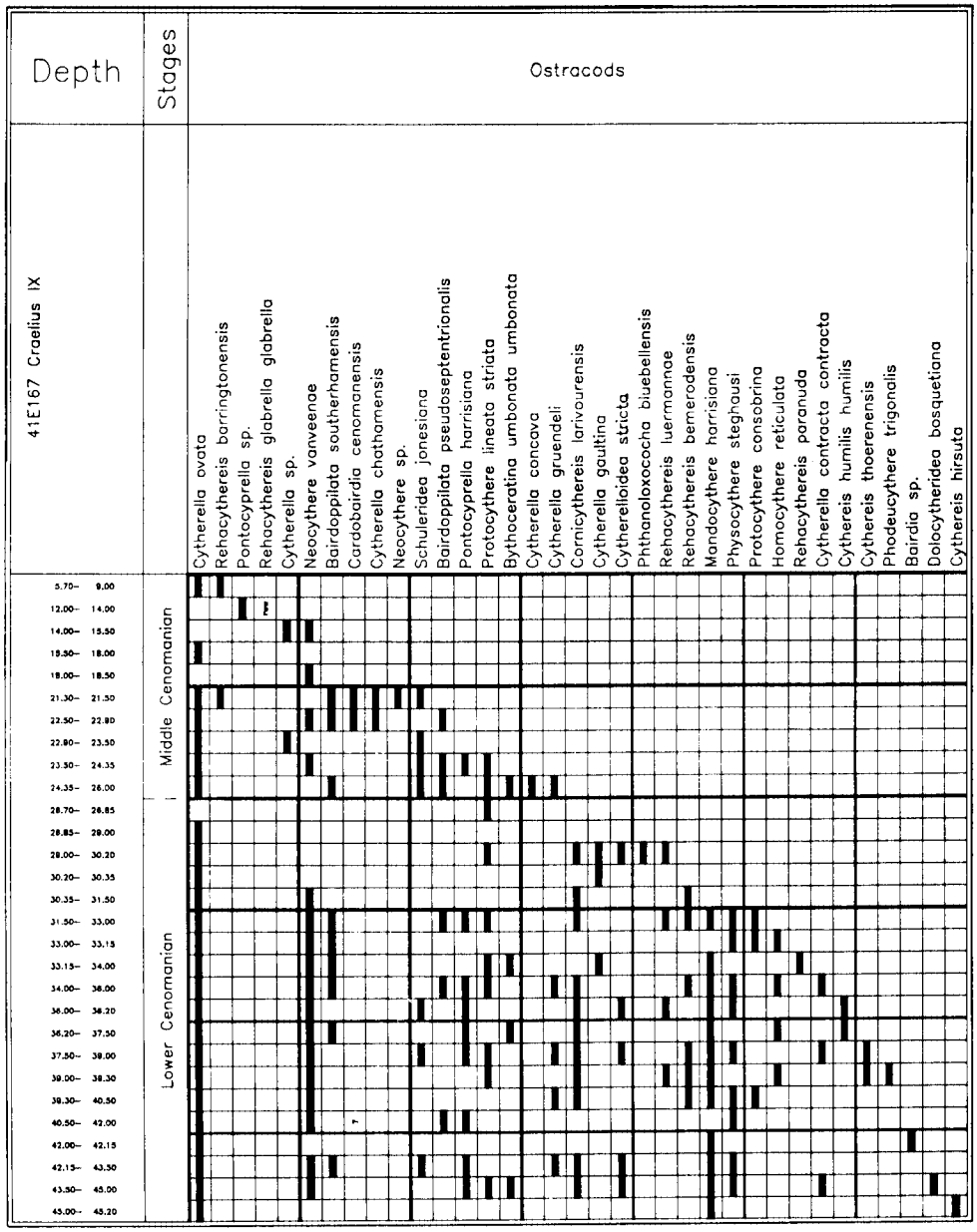


Fig. 6. Distribution of ostracod species in well 41E167 'Craelius IX'.

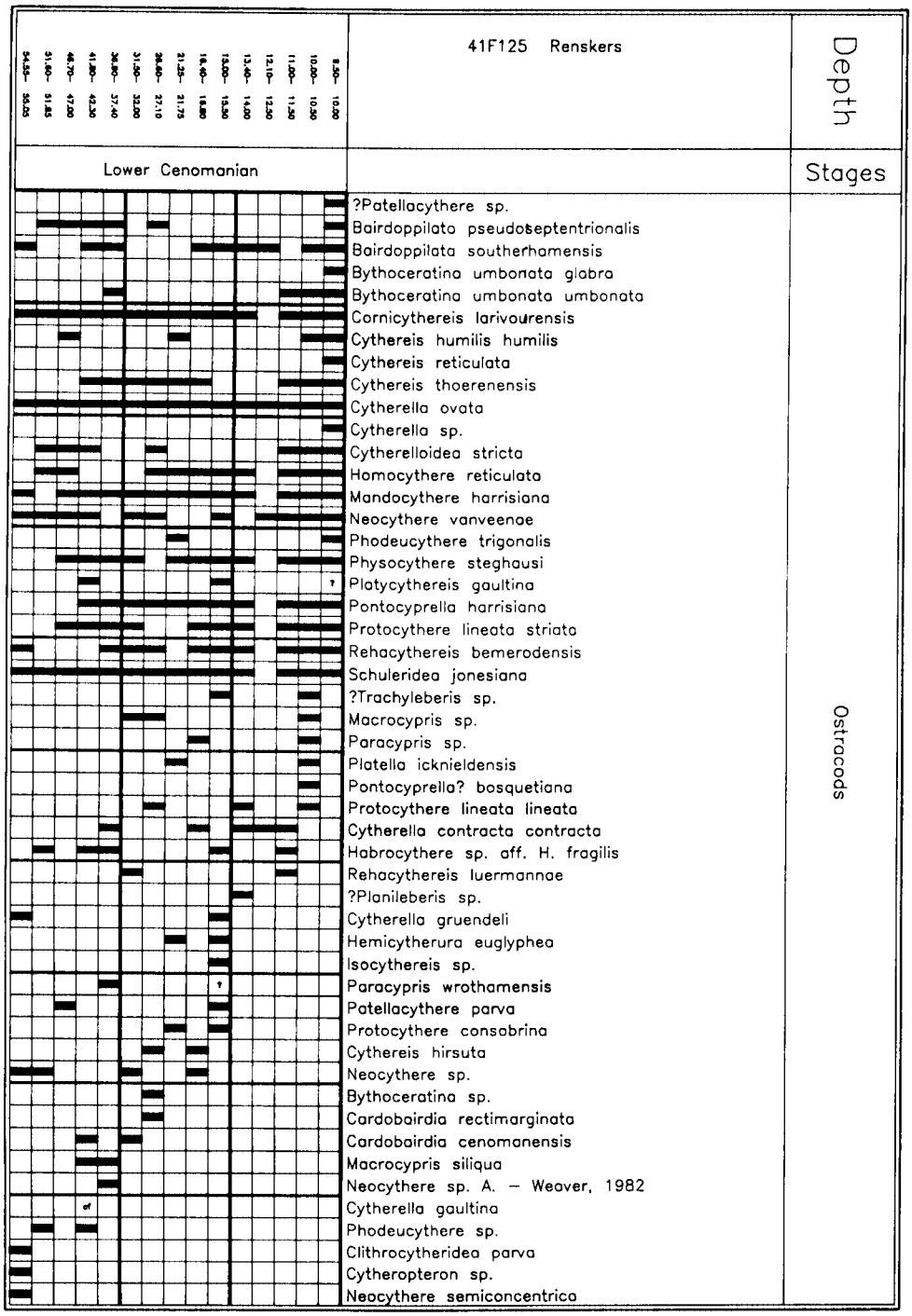


Fig. 7. Distribution of ostracod species in well 41F125 'Renskers'.

This confirms earlier correlations of these beds with the 'Pläner Kalkstein' of Germany, which is now also assigned to this age (Ernst, Smid & Klischies, 1979).

Systematics

This section systematically describes the species found in the Achterhoek samples. Each discussion contains a short list of references and synonyms. Here, we have restricted ourselves to listing only those references that have a special significance within the context of this study. We mainly refer to those papers that have our consent with respect to the species concept, and that are of more recent date. For additional information the reader is referred to the references listed.

An exception is made for *Cornicythereis larivourensis* (Damotte & Grosdidier, 1963), which has a very confusing taxonomy. For that reason, the species was treated in more detail, and all reports known to us are included.

Subclass Ostracoda Latreille, 1806
Order Podocopida G.W. Müller, 1894
Suborder Platycopina Sars, 1866
Family Cytherellidae Sars, 1866
Genus *Cytherella* Jones, 1849

Cytherella chathamensis Weaver, 1982

Pl. 1, figs. 1-2.

1982 *Cytherella chathamensis* sp. nov. – Weaver, p. 14, pl. 2, figs. 15-18.
1988 *Cytherella* sp. cf. *C. chathamensis* Weaver, 1982 – Jarvis et al., p. 34, figs. 13, 14, 15b.

Remarks — The species is characterized by the presence of a pronounced muscle pit and, in the left valve, a highly arched dorsal margin. These features, although clearly present in our material, are more pronounced in the specimens illustrated by Weaver (1982). *C. chathamensis* is reported from southern England where it ranges throughout the Cenomanian and up into the Turonian.

Occurrence — Well 41E167, Schenking Quarry; Middle Cenomanian.

Cytherella concava Weaver, 1982

1982 *Cytherella concava* sp. nov. – Weaver, p. 14, pl. 1, figs. 13-17, pl. 2, fig. 22, textfig. 9.
1988 *Cytherella concava* Weaver, 1982 – Jarvis et al., p. 34, figs. 13, 14, 15c.

Remarks — Males of *Cytherella concava* have a concave ventral margin, while the dorsal margin is straight in the left valve and gently rounded in the right. In this respect the species, which is known from the Cenomanian and Turonian of southern

England, differs from other species in the genus. In our material, only one specimen that most probably belongs to this species, was found.

Occurrence — Well 41E167; Middle Cenomanian.

Cytherella contracta contracta van Veen, 1932
Pl. 1, figs. 3-5.

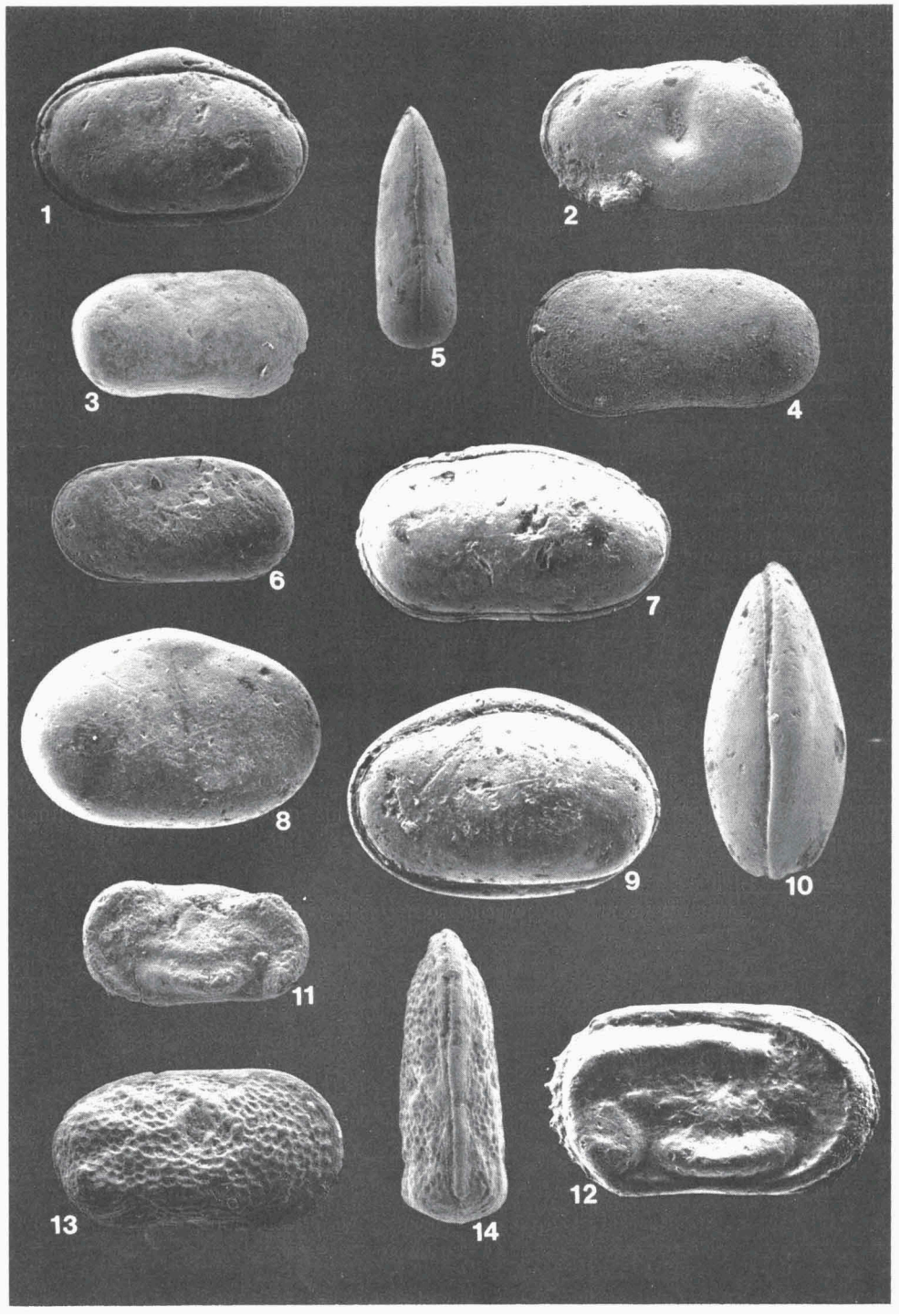
1932 *Cytherella contracta* nov. spec. – van Veen, p. 342, pl. 8, figs. 1-18.
1966 *Cytherella contracta contracta* Veen, 1932 – Herrig, p. 709, textfigs. 4-8, pl. 1, figs. 1-3.
1969 *Cytherella contracta contracta* van Veen, 1932 – Gründel, p. 83, pl. 1, figs. 8-9.
1982 *Cytherella* aff. *C. contracta contracta* van Veen, 1932 – Weaver, p. 16, pl. 2, figs. 9-14, textfig. 10.
1988 *Cytherella* sp. cf. *C. contracta* van Veen, 1932 – Jarvis et al., p. 34, pl. 13, 14, 15d.

Remarks — This species has affinities with *C. concava*, but it differs in being somewhat smaller, and having a more fragile appearance. *C. contracta contracta* has a very long stratigraphic range and is found as late as the Maastrichtian. The older specimens are generally smaller and more slender, but a general lack of diagnostic features makes it hard to decide whether or not the earlier and later forms are conspecific.

Occurrence — Exposure Oossinkbeek, wells 41E167 and 41F125; Lower to Middle Cenomanian.

Plate 1

Figs. 1-2. *Cytherella chathamensis* Weaver, 1982
1. Carapace, left view, x 65, well 41E167 (22.50-22.90 m), RGM 293 400.
2. Left valve, x 66, well 41E167 (21.30-21.50 m), RGM 293 401.
Figs. 3-5. *Cytherella contracta contracta* van Veen, 1932
3. Carapace, right view, x 54, well 41E167 (34-36 m), RGM 293 402.
4. Left valve, x 53, well 41F125 (12.10-12.50 m), RGM 293 403.
5. Carapace, dorsal view, x 54, well 41E167 (34-36 m), same specimen as 3.
Fig. 6. *Cytherella gruendeli* Weaver, 1982, left valve, x 66, well 41F125 (54.55-55.05 m), RGM 293 404.
Fig. 7. *Cytherella gaultina* Wilkinson, 1990, carapace, left view, x 39, well 41E167 (30.20-30.35 m), RGM 293 405.
Figs. 8-10. *Cytherella ovata* (Roemer, 1840)
8. Carapace, right view, x 55, well 41F125 (10-10.50 m), RGM 293 406.
9. Carapace, left view, x 52, well 41F125 (15-15.50 m), RGM 293 407.
10. Carapace, dorsal view, x 53, well 41F125 (10-10.50 m), RGM 293 408.
Fig. 11. *Cytherelloidea kayei* Weaver, 1982, left valve, x 65, Schenking Quarry, sample nr. 59, RGM 293 409.
Fig. 12. *Cytherelloidea stricta* (Jones & Hinde, 1890), carapace, right view, x 68, well 41F125 (9.50-10 m), RGM 293 410.
Figs. 13-14. *Platella icknieldensis* Weaver, 1982
13. Carapace, right view, x 69, well 41F125 (10-10.50 m), RGM 293 411.
14. Carapace, dorsal view, x 69, well 41F125 (10-10.50 m), RGM 293 412.


1
2
3
4
5
6
7
8
9
10
11
12
13
14

Cytherella gaultina Wilkinson, 1990
Pl. 1, fig. 7.

1971 *Cytherella* cf. *ovata* (Roemer) – Keen & Siddiqui, p. 62, pl. 1, figs 1, 9.
1979a *Cytherella* cf. *parallela* (Reuss) – Damotte, p. 276, pl. 6-1, fig. 1.
1982 *Cytherella* cf. *truncata* (Bosquet) – Weaver, p. 18, pl. 1, figs 6-12, pl. 2, fig. 21, textfig. 12.
1985 *Cytherella parallela* (Reuss, 1846) – Babinot et al., p. 196, pl. 48, fig. 2.
1990 *Cytherella gaultina* sp. nov. – Wilkinson, p. 254, pl. 1, figs. 1-2.

Remarks — The species is known from the Upper Aptian to the Lower Cenomanian of England, from the Albian of the Paris Basin and the Provence and from the Albian to Lower Cenomanian of Germany. The males have a characteristic posterodorsal obliquity and subparallel dorsal and ventral margins. It is this last feature that makes it rather similar to *Cytherella parallela*, a species widely reported from the younger Chalk.

Occurrence — Exposure Oossinkbeek, wells 41E167, 41E198 and 41F125; Lower to Middle Cenomanian.

Cytherella gruendeli Weaver, 1982
Pl. 1, fig. 6.

1969 *Cytherella* sp. – Gründel, p. 83, pl. 1, figs. 6-7.
1982 *Cytherella gruendeli* sp. nov. – Weaver, p. 16, pl. 2, figs. 3-8.

Remarks — This relatively small species, of which we found only a few specimens, is reported to be extremely numerous in the Lower Chalk and Plenus Marl of southern England (Weaver, 1982). It is also reported from the Plenus Marl in Germany. Although somewhat similar in outline to *C. chathamensis*, it lacks the deep muscle pit and is more weakly calcified.

Occurrence — Wells 41E167 and 41F125; Lower to Middle Cenomanian.

Cytherella ovata (Roemer, 1841)
Pl. 1, figs. 8-10.

1978 *Cytherella ovata* (Roemer, 1841) – Neale, p.333, pl. 1, figs. 1-2.
1978 *Cytherella ovata* (Roemer 1841) – Van der Wiel, p. 250, pl. 1, figs. 2-3.
1985 *Cytherella ovata* (Roemer) – Babinot et al., p. 196, pl. 48, fig. 1.
1985 *Cytherella ovata* (Roemer) – Babinot, Colin & Damotte, p. 218, pl. 55, figs. 1, 2.
1987 *Cytherella* gr. *C. ovata* (Roemer, 1840) – Ainsworth, p. 150, tab. 7.
1988 *Cytherella ovata* Roemer, 1841 – Jarvis et al., p. 34, figs. 13, 14, 15a.
1990 *Cytherella ovata* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — A large ostracod with strongly calcified valves; the most numerous species in our samples, sometimes present with as much as ten specimens. The species is known from numerous localities in Western Europe and ranges in age from the Aptian to the Late Maastrichtian. There are also reports from the Tertiary and from

other parts of the world, probably reflecting a lack of diagnostic features rather than a true distribution.

Occurrence — Exposure Oossinkbeek, Schenking Quarry, wells 41E167, 41E198 and 41F125; Lower and Middle Cenomanian.

Genus *Cytherelloidea* Alexander, 1929

Cytherelloidea kayei Weaver, 1982
Pl. 1, fig. 11.

1982 *Cytherelloidea kayei* sp. nov. – Weaver, p. 22, pl. 3, figs. 4-9.
1988 *Cytherelloidea kayei* Weaver, 1982 – Wilkinson, p. 1236. pl. 1, fig. 9.
1988 *Cytherelloidea kayei* Weaver, 1982 – Jarvis et al., p. 34, figs. 13, 14, 15h.
1990 *Cytherelloidea kayei* Weaver, 1982 – Horne et al., p. 125, pl. 2, fig 1.
1990 *Cytherelloidea kayei* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — Of this species only a few poorly preserved specimens were found. This form does not possess a pronounced dorsal rib, like e.g. *C. stricta*, instead this dorsal rib is short. On the whole, ornamentation is more modest in character. For a *Cytherelloidea*, the species is relatively small in size. *C. kayei* is reported from the uppermost Upper Albian to the Turonian of southern England only.

Occurrence — Schenking Quarry; Middle Cenomanian.

Cytherelloidea stricta (Jones & Hinde, 1890)
Pl. 1, fig. 12.

1973 *Cytherelloidea stricta* Jones and Hinde – Hart, p. 281, fig. 4.
1978 *Cytherelloidea stricta* (Jones & Hinde) – Neale, p. 334, pl. 1, fig. 6.
1978 *Cytherelloidea stricta* (Jones & Hinde 1890) – van der Wiel, p. 251, pl. 1, fig. 5.
1981 *Cytherelloidea stricta* – Wilkinson & Morter, p. 167, pl. 13.2, fig. 3.
1982 *Cytherelloidea stricta* (Jones & Hinde, 1890) – Weaver, p. 23, pl. 3, figs. 1-3.
1985 *Cytherelloidea stricta* (Jones & Hinde) – Babinot et al., p. 171.
1988 *Cytherelloidea stricta* (Jones and Hinde, 1890) – Wilkinson, p. 1236, pl. 1, fig. 10.
1988 *Cytherelloidea stricta* (Jones and Hinde, 1890) – Jarvis et al., p. 34, figs. 13, 15i.
1990 *Cytherelloidea stricta* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — This large species is characterized by the presence of posterior spines and the absence of a central rib, resulting in a smooth central part of the valve. This last feature, however, is not very conspicuous in our specimens, because the central part of the valve has a faint reticulation and the bordering ribs are well-developed. Neale (1978) considers this species to be characteristic for the Middle and Upper Albian. It is, however, not very age-significant: there are records from the Upper Albian to Turonian of Western Europe: England, Germany and France.

Occurrence — Wells 41E167, 41E198 and 41F125; Lower Cenomanian.

Genus *Platella* Coryell & Fields, 1937

Platella icknieldensis Weaver, 1982
Pl. 1, figs. 13-14.

1982 *Platella icknieldensis* sp. nov. – Weaver, p. 24, pl. 3, figs. 17-19.
1988 *Platella icknieldensis* Weaver, 1982 – Wilkinson, p. 1236, pl. 1, fig. 13.

Remarks — A very characteristic species, so far only reported from the Lower Cenomanian of southern England, where it is very rare in general.

Occurrence — Well 41F125; Lower Cenomanian.

Suborder Podocopina Sars, 1866
Superfamily Bairdiacea Sars, 1888
Family Bairdiidae Sars, 1888
Genus *Bairdoppilata* Coryell, Sample & Jennings, 1935

Bairdoppilata pseudoseptentrionalis Mertens, 1956
Pl. 2, fig. 1.

1956 *Bairdoppilata pseudoseptentrionalis* n. sp. – Mertens, p. 182, pl. 8, figs. 7-10. pl. 13, figs. 89, 90.
1971 *Bairdia pseudoseptentrionalis* (Mertens) – Keen & Siddiqui, p. 63, pl. 1, fig. 2.
1973 *Bairdia pseudoseptentrionalis* (Mertens) – Hart, p. 281, fig. 4.
1978 *Bairdia pseudoseptentrionalis* (Mertens 1956) – van der Wiel, p. 250, pl. 1, fig. 6.
1981 *Bairdia pseudoseptentrionalis* (Mertens 1956) – Wilkinson & Morter, p. 167.
1982 *Bairdoppilata pseudoseptentrionalis* Mertens, 1956 – Weaver, p. 24, pl. 4 figs. 1-3.
1985 *Bairdia pseudoseptentrionalis* (Mertens) – Babinot et al., p. 171, pl. 51, fig. 1.
1987 *Bairdoppilata pseudoseptentrionalis* Mertens, 1956 – Ainsworth, p. 145, tab. 7.
1987 *Bairdoppilata pseudoseptentrionalis* Mertens — Ainsworth et al., p. 612.
1988 *Bairdoppilata pseudoseptentrionalis* Mertens, 1956 – Jarvis et al., p. 34, fig. 15j.
1989 *Bairdoppilata pseudoseptentrionalis* Mertens – Frieg, Kemper & Owen, p. 30.
1989a *Bairdop. pseudoseptentrion* – Kemper, p. 209, fig. 6.
1989 *Bairdoppilata pseudoseptentrionalis* Mert. – Keller et al., p. 275.
1989 *B. pseudoseptentrionalis* – Frieg & Kemper, p. 141, fig. 15.
1990 *Bairdoppilata pseudoseptentrionalis* – Wilkinson in Bristow, p. 12, fig. 5.
1991 *Bairdia pseudoseptentrionalis* (Mertens, 1956) – Shahin, p. 136, pl. 1, figs. 16-17.

Remarks — *B. pseudoseptentrionalis* is widely recorded from Albian and Cenomanian sediments in England, France and Germany. It is very close to *Bairdoppilata septentrionalis* (Bonnema), which ranges from Coniacian to Late Maastrichtian. Jarvis et al. (1988) report *B. pseudoseptentrionalis* from rocks as young as the Plenus Marl, but it is absent from the overlying Turonian. In southern England, the substantial increase in numbers in the upper part of the *M. inflatum* Zone is of stratigraphical importance (Hart, 1973).

Occurrence — Exposure Oossinkbeek, Schenking Quarry, wells 41E167, 41E198 and 41F125; Upper Albian to Middle Cenomanian.

Bairdoppilata southerhamensis Weaver, 1982
Pl. 2, figs. 2-4.

1982 *Bairdoppilata southerhamensis* sp. nov. – Weaver, p. 25, pl. 4, figs. 4-6.
1988 *Bairdoppilata southerhamensis* Weaver, 1982 – Jarvis et al., p. 34, fig. 16a.

Remarks — The species has a distinct caudal process and a characteristic outline in frontal view; seen from the front, the greatest width is clearly below the middle, in contrast to *B. pseudoseptentrionalis*, where the greatest width is at midheight. Before, the species had been reported only from southern England, where it is restricted to rocks of Cenomanian age.

Occurrence — Schenking Quarry, wells 41E167, 41E198 and 41F125; Upper Albian to Middle Cenomanian.

Genus *Cardobairdia* van den Bold, 1960

Cardobairdia cenomanensis Nuyts, 1990
Pl. 2, figs. 5-7.

1982 *Cardobairdia minuta* (van Veen, 1936) – Weaver, p. 26, pl. 19, figs. 15-19.
1990 *Cardobairdia minuta* – Wilkinson in Bristow, p. 12, fig. 5.
1990 *Cardobairdia cenomanensis* sp. nov. – Nuyts, p. 66, pl. 1, figs. 1-4.

Remarks — Nuyts (1990) proved the name *Krausella minuta* Triebel, 1940, to be a nomen nudum. Subsequently, most of the earlier reports by this name were attributed to either *Cardobairdia cenomanensis* Nuyts, 1990 or *Cardobairdia triebeli* Nuyts, 1990. Unfortunately, the ostracods reported by van Veen (1936) belong – according to Nuyts (1990) – to neither one of these new species and the initial *Krausella minuta* from The Netherlands is now unnamed. *C. triebeli* has a more plump shape and a more curved outline than *C. cenomanensis*. In addition, the right valve shows a distinct posterodorsal corner, whereas a smoothly rounded end is seen in *C. cenomanensis*. This species is probably restricted in age to the latest Albian and the Cenomanian.

Occurrence — Exposure Oossinkbeek, Schenking Quarry, Wells 41E167, 41E198 and 41F125; Upper Albian to Middle Cenomanian.

Cardobairdia rectimarginata Nuyts, 1990
Pl. 2, figs. 8-9.

1940/41 *Cytherideis bemelenensis* van Veen – Bonnema, p. 115, pl. 3, figs. 35-38.
1966 *Cardobairdia* sp. – Herrig, p. 774, pl.15, figs. 5, 6, textfigs. 46-47.
1990 *Cardobairdia rectimarginata* sp. nov. – Nuyts, p. 67, pl. 1, figs. 5-8.

Remarks — The stratigraphic range of this rather new species is still somewhat obscure, because confirmed records are lacking. Bonnema's (1940/41) reports are from the Coniacian to Santonian, that of Herrig (1966) from the Lower Maastrichtian. Our report is from the Lower Cenomanian, suggesting an extensive stratigraphic range for this species and a very limited stratigraphical applicability.

Occurrence — Well 41F125; Lower Cenomanian.

Family Macrocyprididae G.W. Müller, 1912
Genus *Macrocypris* Brady, 1867

Macrocypris siliqua (Jones, 1849)
Pl. 2, fig. 11.

1964 *Macrocypris siliqua* (Jones) – Kaye, p.43, pl. 4, figs. 11, 14, 15, 18.
1982 *Macrocypris siliqua* (Jones, 1849) – Weaver, p. 28, pl. 4, figs. 9-10.
1988 *Macrocypris siliqua* (Jones, 1849) – Wilkinson, p. 1233, pl. 3, fig. 5
1989 *Macrocypris siliqua* (Jones) – Frieg et al., p. 30.
1990 *Macrocypris siliqua* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — Long-ranging species (Albian to Campanian), characterized by its very large size, elongate shape, and reversed overlap. Numerous records from England, fewer from Ireland and Germany.

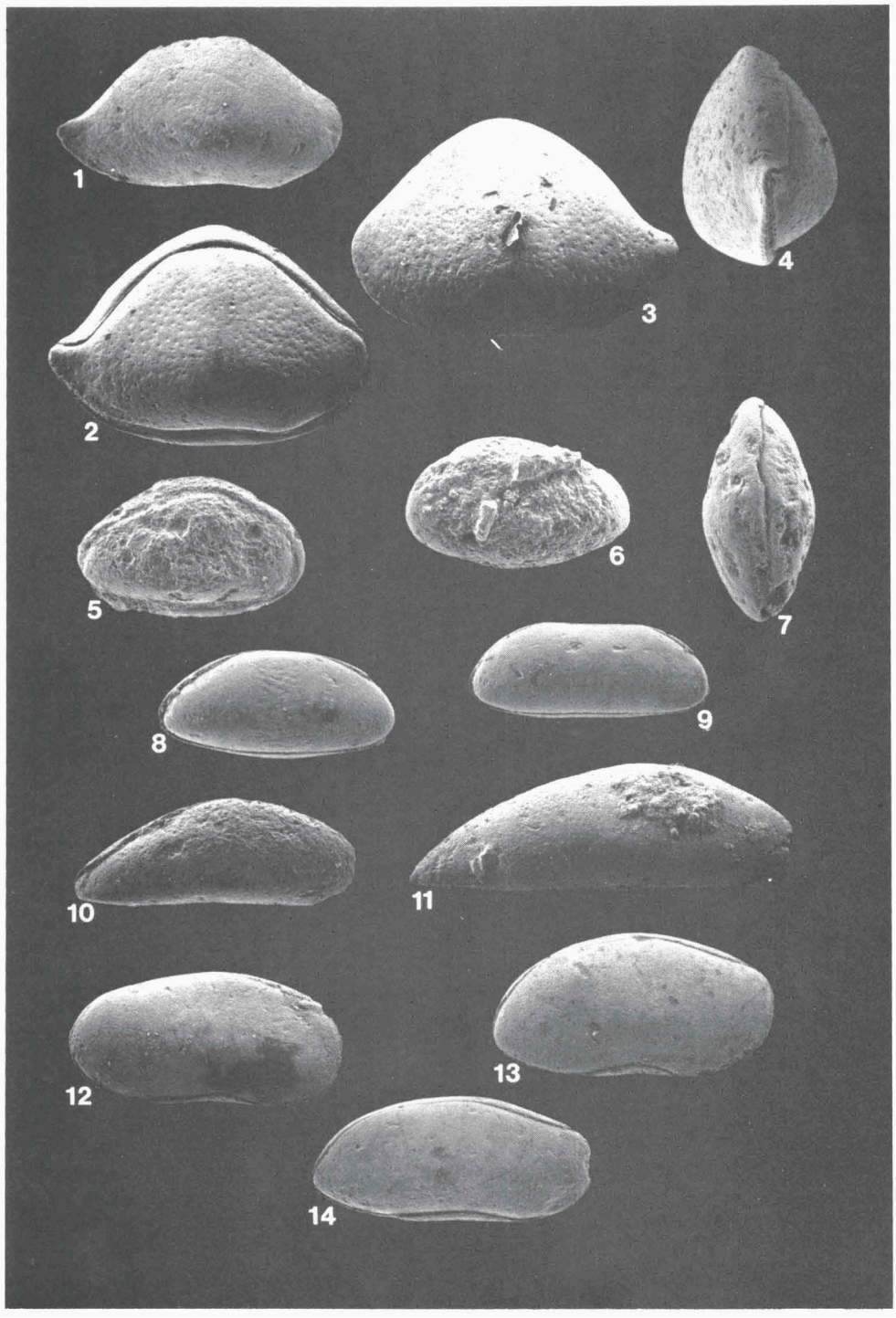
Occurrence — Well 41F125; Lower Cenomanian.

Superfamily Cypridacea Baird, 1845
Family Paracyprididae Sars, 1923
Genus *Paracypris* Sars, 1866

Paracypris wrothamensis Kaye, 1965
Pl. 2, fig. 10.

Plate 2

Fig. 1. *Bairdoppilata pseudoseptentrionalis* Mertens, 1956, right valve, x 41, well 41E198 (10.50-11 m), RGM 293 413.
Figs. 2-4. *Bairdoppilata southerhamensis* Weaver, 1982
2. Carapace, right view, x 40, well 41E125 (10-10.50 m), RGM 293 414.
3. Carapace, left view, x 40, well 41E125 (9.50-10 m), RGM 293 415.
4. Carapace, posterior view, x 40, well 41E125 (10-10.50 m), RGM 293 416.
Figs. 5-7. *Cardobairdia cenomanensis* Nuyts, 1990
5. Carapace, right view, x 67, Schenking Quarry, sample no. 60, RGM 293 417.
6. Carapace, left view, x 67, Schenking Quarry, sample no. 62, RGM 293 418.
7. Carapace, dorsal view, x 67 well 41F167 (22.50-22.90 m), RGM 293 419.
Figs. 8-9. *Cardobairdia rectimarginata* Nuyts, 1990
8. Carapace, right view, x 66, well 41F125 (26.60-27.10 m), RGM 293 420.
9. Carapace, right view, x 69, well 41F125 (26.60-27.10 m), RGM 293 421.
Fig. 10. *Paracypris wrothamensis* Kaye, 1965, carapace, right view, x 96, well 41F125 (36.90-37.40 m), RGM 293 422.
Fig. 11. *Macrocypris siliqua* (Jones, 1849), right valve, x 48, well 41F125 (36.90-37.40 m), RGM 293 423.
Fig. 12. *Pontocyprella? bosquetiana* (Jones, 1849), carapace, right view, x 54, well 41F125 (10-10.50 m), RGM 293 424.
Fig. 13. *Pontocyprella hindei* Weaver, 1982, carapace, right view, x 84, exposure Oossinkbeek, sample no. 516/07, RGM 293 425.
Fig. 14. *Pontocyprella harrisiana* (Jones, 1849), carapace, right view, x 68, well 41F125 (10-10.50 m), RGM 293 426.


1
2
3
4
5
6
7
8
9
10
11
12
13
14

1965a *Paracypris wrothamensis* sp. nov. – Kaye, p. 226, pl. 9, figs. 9-14.
1981 *Paracypris wrothamensis* – Wilkinson & Morter, p. 167.
1982 *Paracypris* aff. *P. wrothamensis* Kaye, 1965 – Weaver, p. 28, pl. 4, figs. 13, 14.
1985 *Paracypris wrothamensis* Kaye – Babinot et al., p. 173.
1990 *Paracypris wrothamensis* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — In England, *P. wrothamensis*, a thin-shelled species, occurs from the Middle Albian, and it is known to range up to the Upper Cenomanian. In France, it first appeared in the Upper Albian. Our specimens differ slightly from those illustrated by Kaye (1965a) and Weaver (1982) in having a more evenly arched dorsal line, with a less marked posterodorsal angle.

Occurrence — Well 41F125; Lower Cenomanian.

Family Pontocyprididae G.W. Müller, 1894
Genus *Pontocyprella* Ljubimova, 1955

Pontocyprella? bosquetiana (Jones, 1849)
Pl. 2, fig. 12.

1890 *Cythere? bosquetiana* (Jones) – Jones & Hinde, p. 15, pl. 2, figs. 35-37.
1982 *Pontocyprella? bosquetiana* (Jones, 1849) – Weaver, p. 29, pl. 5, figs. 3-5.

Remarks — This form can easily be distinguished from more typical representatives of *Pontocyprella* by the absence of a pointed posterior. Reported before only from southern England, where it is very rare. In our material it only occurred in one sample.

Occurrence — Well 41F125; Lower Cenomanian.

Pontocyprella harrisiana (Jones, 1849)
Pl. 2, fig. 14.

1962 *Pontocyprella harrisiana* (Jones) – Neale, p. 431, pl. 6, fig. 12a-b.
? 1965b *Pontocyprella rara* – Kaye, p. 74, pl. 5, fig. 14.
non 1965b *Pontocyprella harrisiana* (Jones, 1849) – Kaye, p. 73, pl. 5, figs. 3-4.
1966 *Pontocyprella harrisiana* (Jones 1849)? – Gründel, p. 17, pl. 2, fig. 9.
1966 *Pontocyprella harrisiana* (Jones, 1849) – Herrig, p. 788, pl. 14, figs. 2a-b, textfig. 58.
1982 *Pontocyprella harrisiana* (Jones, 1849) – Weaver, p. 29, pl. 4, figs. 17-20.
1990 *Pontocyprella harrisiana* – Wilkinson in Bristow, p. 12, fig. 5.
1991 *Pontocyprella harrisiana* (Jones 1849) – Schwarzkopf, p. 161.

Remarks — Long-ranging, widely distributed species. Earliest records are from the Albian, but known to occur as young as the Maastrichtian. Easily recognized by the acute posterior and the characteristic difference in outline between left and right valve. Similar, in this respect, to Recent *Bythocypris*, a genus to which this species has also been ascribed by some authors.

Occurrence — Schenking Quarry, Wells 41E167, 41E198 and 41F125; Lower to Middle Cenomanian.

Pontocyprella hindei Weaver, 1982
Pl. 2, fig. 13.

non 1965b *Pontocyprella rara* – Kaye, p. 74, pl. 5, fig. 14.
1966 *Pontocyprella rara* Kaye 1965 – Gründel, p. 16, pl. 2, figs. 5-6, pl. 9, fig. 1.
1982 *Pontocyprella hindei* sp. nov. – Weaver, p. 30, pl. 4, figs. 15-16.

Remarks — This species differs from *P. harrisiana* in being relatively higher and having a less pointed posterior. Ranging from Lower Albian to Upper Cenomanian.

Occurrence — Exposure Oossinkbeek; Middle Cenomanian.

Superfamily Cytheracea Baird, 1850
Family Cytherideidae Sars, 1925
Subfamily Cytherideinae Sars, 1925
Genus *Clithrocytheridea* Stephenson, 1936

Clithrocytheridea parva Weaver, 1982
Pl. 3, figs. 2-3.

1982 *Clithrocytheridea parva* sp. nov. – Weaver, p. 32, pl. 5, figs. 14-17.

Remarks — Only a few specimens were found, and it was not possible to verify the internal features. Before, the species had been reported only from the Cenomanian of southern England.

Occurrence — Wells 41E198 and 41F125; Lower Cenomanian.

Genus *Dolocytheridea* Triebel, 1938

Dolocytheridea bosquetiana (Jones & Hinde, 1890)
Pl. 3, fig. 1.

1966 *Dolocytheridea bosquetiana* (Jones & Hinde 1890) – Gründel, p. 18, pl. 2, fig. 14.
1971b *Dolocytheridea bosquetiana* (Jones et Hinde) – Damotte, p. 110, pl. 7, fig. 16.
1971 *Dolocytheridea (Puracytheridea) bosquetiana* (Jones & Hinde, 1890) – Gründel, p. 36, pl. 4, figs. 7-11, textfig. 9.
1981 *Dolocytheridea bosquetiana* (Jones & Hinde, 1890) – Wilkinson & Morter, p. 163, pl. 13.1, figs. 7, 9.
1982 *Dolocytheridea (Puracytheridea) bosquetiana* (Jones & Hinde, 1890) – Weaver, p. 33, pl. 5, figs. 6-9.
1985 *Dolocytheridea (Puracytheridea) bosquetiana* (Jones & Hinde) – Babinot et al., p. 171.
1987 *Dolocytheridea (Puracytheridea) bosquetiana* (Jones and Hinde) – Ainsworth et al., p. 612.
1989 *Dolocytheridea bosquetiana* (Jones & Hinde) – Elstner & Kemper, p. 58.
1989a *Dolocytheridea bosquetiana* – Kemper, p. 209, figs. 6-7.
1989 *Dolocytheridea bosquetiana* – Keller et al., p. 275.
1990 *Dolocytheridea bosquetiana* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — *D. bosquetiana* is widely distributed in northwestern Europe and is an important marker for the Middle and Upper Albian, although it may range up to the lower part of the Lower Cenomanian.

Occurrence — Wells 41E167; Lower Cenomanian.

Subfamily Schulerideinae Kollman, 1960
Genus *Habrocythere* Triebel, 1940

Habrocythere sp. aff. *H. fragilis* Triebel, 1940
Pl. 3, fig. 9.

aff. 1940 *Habrocythere fragilis* n. sp. – Triebel, p. 166, pl. 1, figs. 10-13, pl. 9, fig. 101.
aff. 1981 *Habrocythere fragilis* – Wilkinson & Morter, p. 67.
aff. 1982 *Habrocythere fragilis* Triebel, 1940 – Weaver, p. 34, pl. 6, figs. 1-2.
aff. 1990 *Habrocythere fragilis* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — This small but very distinct form was found in one well only. It is highly reminiscent of *H. fragilis* Triebel, 1940, but differs in having more evenly rounded anterior and posterior ends.

Occurrence — Well 41F125; Lower Cenomanian.

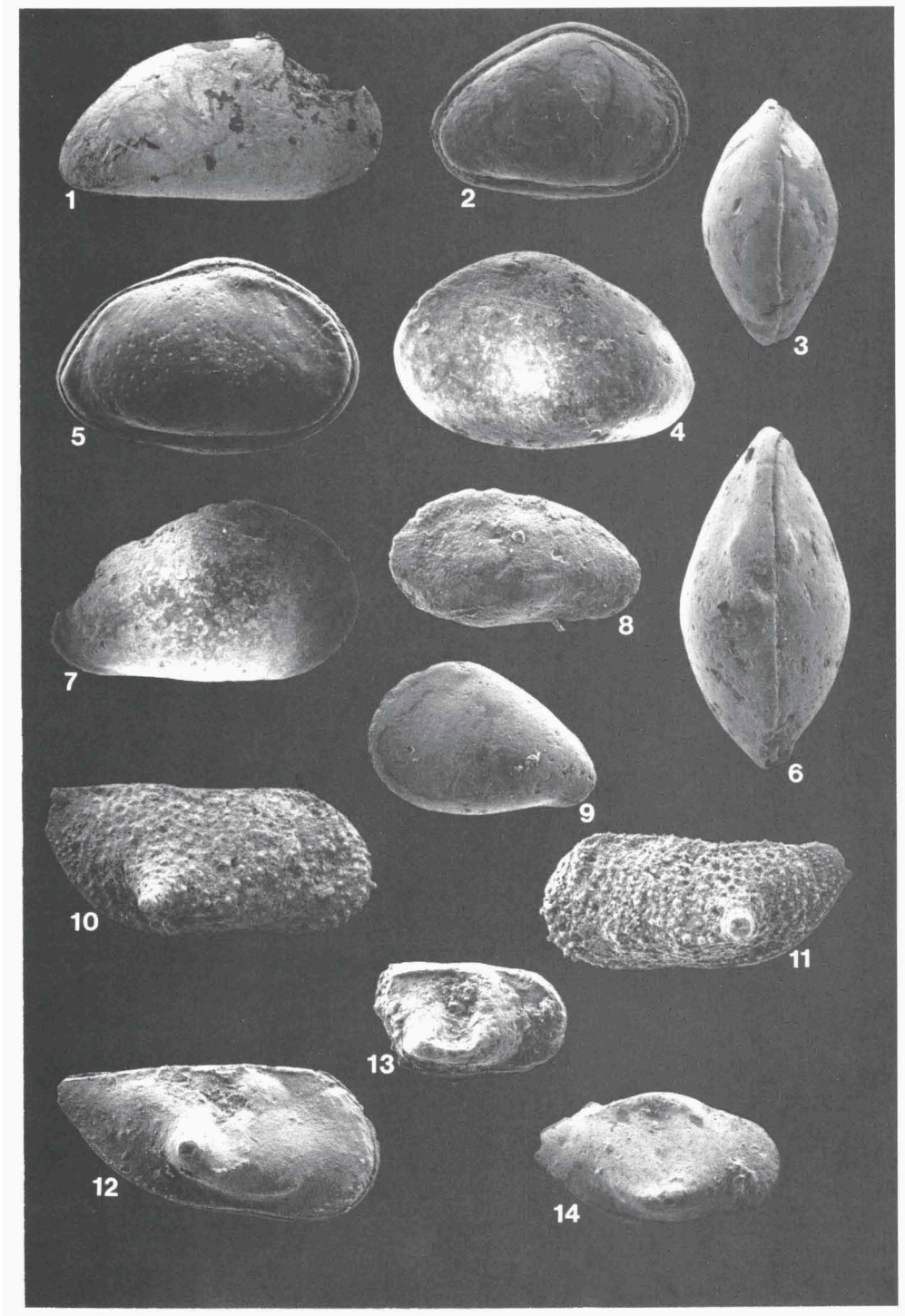
Genus *Schuleridea* Schwarz & Swain, 1946

Schuleridea jonesiana (Bosquet, 1852)
Pl. 3, figs. 4-6.

1966 *Schuleridea jonesiana jonesiana* (Bosquet 1852) – Gründel, p. 22, pl. 3, figs. 12-13, textfig. 5.
1977 *Schuleridea jonesiana* (Bosquet, 1852) – Charollais et al., p. 687, pl. 1, figs. 9-10.
1977 *Schuleridea jonesiana* (Bosquet) – Neale, p. 254, pl. 2, fig. 7.

Plate 3

Fig. 1. *Dolocytheridea bosquetiana* (Jones & Hinde, 1890), right valve, x 66, well 41F167 (43.50-45 m), RGM 293 427.
Figs. 2-3. *Clithrocytheridea parva* Weaver, 1982
2. Carapace, right view, x 102, well 41F125 (54.55-55.05 m), RGM 293 428.
3. Carapace, dorsal view, x 102, well 41E198 (12.50-13 m), specimen lost.
Figs. 4-6. *Schuleridea jonesiana* (Bosquet, 1852)
4. Carapace, left view, x 54, well 41F167 (37.50-39 m), RGM 293 430.
5. Carapace, right view, x 54, well 41F167 (37.50-39 m), same specimen as 4.
6. Carapace, dorsal view, x 60, well 41F167 (23.50-24.35 m), RGM 293 431.
Fig. 7. *Phodeucythere trigonalis* (Jones & Hinde, 1890), right valve, x 75, well 41F167 (39-39.30 m), RGM 293 432.
Fig. 8. *Phodeucythere* sp., left valve, x 98, well 41E198 (11.40-12 m), RGM 293 433.
Fig. 9. *Habrocythere* sp. aff. *H. fragilis* Triebel, 1940, left valve, x 67, well 41F125 (15-15.50 m), RGM 293 434.
Figs. 10-11. *Bythoceratina umbonata umbonata* (Williamson, 1847)
10. Right valve, x 84, well 41F125 (9.50-10 m), RGM 293 435.
11. Left valve, x 80, well 41F125 (10-10.50 m), RGM 293 436.
Fig. 12. *Bythoceratina umbonata glabra* Weaver, 1982, carapace, right view, x 79, well 41F125 (9.50-10 m), RGM 293 437.
Fig. 13. *Patellacythere parva* Weaver, 1982, carapace, right view, x 67, well 41F125 (15-15.50 m), RGM 293 438.
Fig. 14. ?*Patellacythere* sp., juvenile, right valve, x 67, well 41F125 (9.50-10 m), RGM 293 439.


1
2
3
5
4
7
8
6
9
10
11
13
12
14

1978 *Schuleridea jonesiana* (Bosquet, 1852) – Neale, p. 348, pl. 8, fig. 14, pl. 9, figs. 1-3.
1981 *Schuleridea jonesiana* – Wilkinson & Morter, p. 166.
1982 *Schuleridea jonesiana* (Bosquet, 1852) – Weaver, p. 34, pl. 5, figs. 18-19.
1985 *Schuleridea jonesiana* (Bosquet, 1852) – Babinot et al., p. 171, pl. 51, figs. 6-7.
1988 *Schuleridea jonesiana* – Ascoli, p. 11, fig. 2.
1989 *Schuleridea jonesiana* (Bosquet) – Frieg et al., p. 32.
1989 *Schuleridea jonesiana* (Jones & Hinde) [sic] – Elstner & Kemper, p. 56.
1989a *Schuleridea jonesiana* (Bosquet) – Kemper, p. 208, figs. 5-7.
1989 *Schuleridea jonesiana* (Bosq.) – Keller et al., 273.
1990 *Schuleridea jonesiana* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — This large species has a wide distribution and a long stratigraphic range. It is reported from the upper part of the Lower Albian to the Middle Cenomanian throughout Western Europe and Eastern Canada.

Occurrence — Wells 41E167, 41E198 and 41F125; Upper Albian to Middle Cenomanian.

Subfamily Eucytherinae Puri, 1954
Genus *Phodeucythere* Gründel, 1978

Phodeucythere trigonalis (Jones & Hinde, 1890)
Pl. 3, fig. 7.

1978 *Eucythere trigonalis* (Jones and Hinde, 1890) – Neale, p. 334, pl. 1, fig. 10.
1981 *Eucythere trigonalis* – Wilkinson & Morter, p. 167.
1981 *Phodeucythere trigonalis* (Jones & Hinde, 1890) – Colin et al., p. 127, pl. 11.1, fig. 7.
1985 *Eucythere trigonalis* (Jones & Hinde) – Babinot et al., p. 171.
1986 *Eucythere trigonalis* (Jones and Hinde) – Ainsworth, p. 162, fig. 13.7.
1987 *Eucythere trigonalis* (Jones and Hinde, 1890) – Ainsworth, p. 145, tab. 7.
1987 *Eucythere trigonalis* (Jones and Hinde) – Ainsworth et al., p. 612.
1988 *Eucythere (Phodeucythere) trigonalis* (Jones and Hinde, 1890) – Wilkinson, p. 1231, pl. 3, fig. 7.
1990 *Eucythere trigonalis* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — This species has been recorded from the Upper Aptian to the Lower Cenomanian, but is considered diagnostic for the Albian (or Upper Albian) by most authors.

Occurrence — Wells 41E167, 41E198 and 41F125; Upper Albian to Lower Cenomanian.

Phodeucythere sp.
Pl. 3, fig. 8.

Remarks — This form shows some affinities with *P. trigonalis*, but is smaller and has a lower anterior.

Occurrence — Wells 41E198 and 41F125, Upper Albian to Lower Cenomanian.

Family Bythocytheridae Sars, 1926
Genus *Bythoceratina* Hornibrook, 1952

Bythoceratina umbonata glabra Weaver, 1982
Pl. 3, fig. 12.

1982 *Bythoceratina (Bythoceratina) umbonata glabra* subsp. nov.– Weaver, p. 40, pl. 6, figs. 17-19.
1988 *Bythoceratina (B.) umbonata glabra* – Wilkinson, p. 1232, textfigs. 2-3.

Remarks — This subspecies differs from the nominate form in having more strongly calcified, less ornamented valves. It is only reported from the lowermost Cenomanian of southern England. We found it in only one sample from the Lower Cenomanian.

Occurrence — Well 41F125; Lower Cenomanian.

Bythoceratina umbonata umbonata (Williamson, 1847)
Pl. 3, figs. 10-11.

1973 *Monoceratina umbonata* (Williamson) – Hart, p. 280, fig. 4.
1978 *Monoceratina umbonata* (Williamson, 1847) – van der Wiel, p. 250, pl. 2, fig. 8.
1981 *Monoceratina umbonata* – Wilkinson & Morter, p. 167.
1982 *Bythoceratina (Bythoceratina) umbonata umbonata* (Williamson, 1847) – Weaver, p. 39, pl. 6, figs. 10-13.
1983 *Bythoceratina umbonata umbonata* (Williamson, 1848) [sic] – Clarke, p. 146, pl. 15, figs. 11-12.
1985 *Monoceratina umbonata* Williamson – Babinot et al., p. 171.
1988 *Bythoceratina (B.) umbonata umbonata* – Wilkinson, p. 1234, textfig. 3.
1988 *Bythoceratina umbonata* (Williamson, 1847) – Jarvis et al., p. 34, fig. 16f.
1989 *Bythoceratina umbonata* (Williamson) – Frieg et al., p. 30.
1990 *Bythoceratina umbonata umbonata* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — This subspecies is known to have a considerable stratigraphic range and horizontal distribution. It is reported from France, Germany, England, Belgium, The Netherlands, Poland and even from the U.S.A. The age varies between Late Albian (France, England) and Late Maastrichtian (Germany, The Netherlands).

Occurrence — Wells 41E167 and 41F125; Lower to Middle Cenomanian.

Genus *Patellacythere* Gründel & Kozur, 1971

Patellacythere parva Weaver, 1982
Pl. 3, fig 13.

1982 *Patellacythere parva* sp. nov. – Weaver, p. 44, pl. 7, figs. 8-10.

Remarks — This species was found in two samples from one of the wells, at a level dated as Early Cenomanian. The only previous record is from the Middle to Upper Cenomanian of southern England.

Occurrence — Well 41F125; Lower Cenomanian.

?*Patellacythere* sp.
Pl. 3, fig. 14.

Remarks — One valve, with a peculiar shape, was found in the highest sample from well 41F125, Early Cenomanian in age. Because of the poor preservation, not all details could be studied. It is reminiscent of *Patellacythere*, but the dorsal line is arched rather than straight, as seen in the previous species.

Occurrence — Well 41F125; Lower Cenomanian.

Family Progonocytheridae Sylvester-Bradley, 1948
Genus *Neocythere* Mertens, 1956

Neocythere semiconcentrica (Mertens, 1956)
Pl. 4, fig. 6.

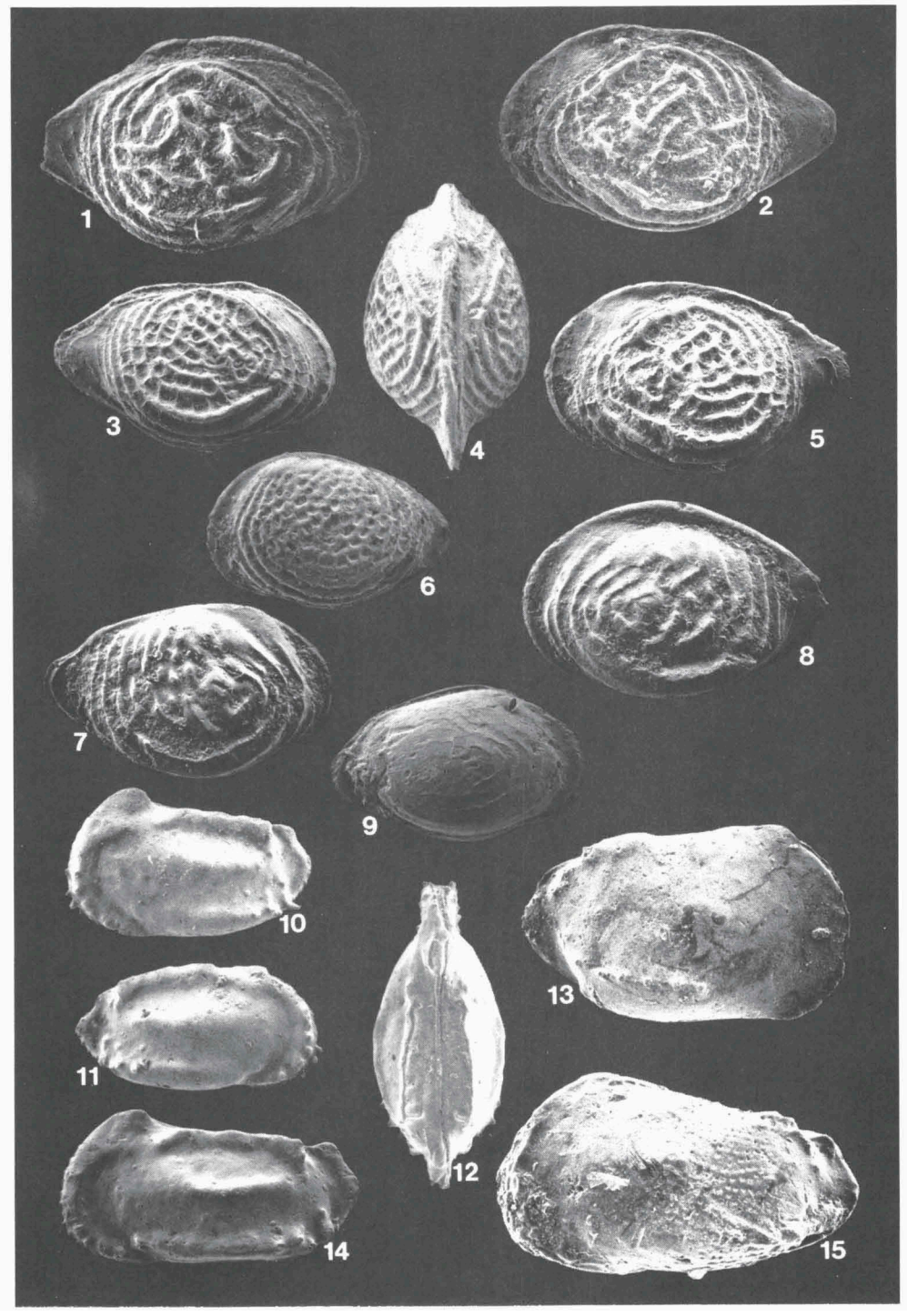
1956 *'Cythere' semiconcentrica* n. sp. – Mertens, p. 186, pl. 9, figs. 15-18.
1962 *Cythere semiconcentrica* Mertens – Ellerman, p. 397, pl. 4, figs. 5-6.
1966 *Physocythere semiconcentrica* (Mertens, 1956) – Gründel, p. 31, pl. 5, figs. 19-20.
1982 *Neocythere (Neocythere) semiconcentrica* (Mertens, 1956) – Weaver, p. 48, pl. 8, figs. 10-11.
1990 *Neocythere (P.) semiconcentrica* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — This species is clearly distinguished by its ornamentation which consists of spines regularly distributed in a concentric pattern. It has a wide stratigraphic range including the Albian and Cenomanian.

Occurrence — Wells 41E198 and 41F125; Upper Albian to Lower Cenomanian.

Plate 4

Figs. 1-5. *Physocythere steghausi* (Mertens, 1956)
1. Carapace, right view, x 70, well 41F125 (13.40-14 m), RGM 293 429.
2. Carapace, left view, x 68, well 41F125 (46.70-47 m), RGM 293 440.
3. Carapace, right view, x 69, well 41F125 (10-10.50 m), regular ornamentation, RGM 293 441.
4. Carapace, dorsal view, x 67, well 41F125 (9.50-10 m), regular ornamentation, RGM 293 442.
5. Left valve, x 65, well 41F125 (9.50-10 m), regular ornamentation, RGM 293 443.
Fig. 6. *Neocythere semiconcentrica* (Mertens, 1956), left valve, x 67, well 41E198 (9-9.40 m), RGM 293 444.
Figs. 7-8. *Neocythere vanveenae* Mertens, 1956
7. Right valve, x 84, well 41F125 (15-15.50 m), RGM 293 445.
8. Left valve, x 82, well 41F125 (11-11.50 m) RGM 293 446.
Fig. 9. *Neocythere* sp. A Weaver, 1982, carapace, right view, x 67, well 41F125 (36.90-37.40 m), RGM 293 447.
Figs. 10-15. *Mandocythere harrisiana* (Jones, 1870)
10. Left valve, x 54, well 41F125 (9.50-10 m), RGM 293 448.
11. Right valve, x 53, well 41F125 (9.50-10 m), RGM 293 449.
12. Carapace, dorsal view, x 54, well 41F125 (15-15.50 m), RGM 293 450.
13. Juvenile, right valve, x 83, well 41F125 (9.50-10 m), RGM 293 451.
14. Left valve, x 53, well 41F125 (9.50-10 m), RGM 293 452.
15. Juvenile, carapace, left view, x 87, well 41E198 (7.20-8 m), RGM 293 453.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

Neocythere vanveenae Mertens, 1956
Pl. 4, figs. 7-8.

1975 *Neocythere vanveeni* Mertens – van Hinte et al., p. 1490.
1978 *Neocythere (Neocythere) vanveeni* Mertens 1956 – van der Wiel, p. 250, pl. 2, fig. 12-13.
1978 *Neocythere (Neocythere) vanveeni* Mertens, 1956 – Neale, p. 352, pl. 10, fig. 8.
1981 *Neocythere (Neocythere) vanveeni* Mertens – Wilkinson & Morter, p. 166, pl. 13.2, fig. 8.
1982 *Neocythere (Neocythere) vanveeni* Mertens, 1956 – Weaver, p. 46, pl. 7 figs. 17-19.
1985 *Neocythere (Neocythere) vanveeni* Mertens, 1956 – Babinot et al., p. 171, pl. 51, fig 10-11.
1988 *Neocythere vanveeni* – Ascoli, p. 11, fig. 2.
1989 *Neocythere vanveeni* Mert. – Frieg & Kemper, p. 127, figs. 12, 15, 16.
1989a *Neocythere vanveeni* – Kemper, p. 210, fig. 7.
1990 *Neocythere (Neocythere) vanveenae* Mertens – Wilkinson, p. 256.
1990 *Neocythere (N.) vanveenae* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — Species of *Neocythere* with a pattern of smooth, concentric ribs. Recorded from the Albian to Middle Cenomanian of France, Germany and England.

Occurrence — Wells 41E167, 41E198 and 41F125; Upper Albian to Middle Cenomanian.

Neocythere sp. A Weaver, 1982
Pl. 4, fig. 9.

1982 *Neocythere (Neocythere?)* sp. A – Weaver, p. 49, pl. 8, figs. 4-6.

Remarks — Lateral surface has a very weak pattern of concentric ribs. On account of its size this could very well be a juvenile specimen of *N. vanveenae*.

Occurrence — Well 41F125; Lower Cenomanian.

Genus *Physocythere* Kaye, 1963

Physocythere steghausi (Mertens, 1956)
Pl. 4, figs. 1-5.

1978 *Neocythere (Physocythere) hieroglyphica* Kaye, 1963 – Neale, p. 352, pl. 10, fig. 11.
1981 *Neocythere (Physocythere) steghausi* Mertens – Wilkinson & Morter, p. 166, textfig. 13.3, pl. 13.2, fig. 9.
1988 *Neocythere (Physocythere) steghausi* (Mertens, 1956) – Wilkinson, 1988, p. 1232, pl. 3, fig. 6.
1989 *Physocythere steghausi* (Mertens) – Frieg & Kemper, p. 125, pl. 23, figs. 1-8.
1989b *Physocythere steghausi* (Mertens) – Kemper, p. 456, fig. 2.
1990 *Neocythere (P.) steghausi* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — Surface ornamentation consisting of strong, irregular to concentric ribs characterizes this species. Frieg & Kemper (1989) demonstrated the extensive variation in rib patterns of *P. steghausi*, and, as a consequence, consider *P. hieroglyphica* Kaye, 1963 to be a synonym. In our material, a similar variation in ornamentation was found.

Occurrence — Wells 41E167, 41E198 and 41F125; Upper Albian to Lower Cenomanian.

Family Protocytheridae Ljubimova, 1955
Genus *Mandocythere* Gründel, 1964

Mandocythere harrisiana (Jones, 1870)
Pl. 4, figs. 10-15.

1978 *Protocythere (Mandocythere) harrisiana harrisiana* (Jones 1870) – van der Wiel, p. 250, pl. 2, figs. 1-4.
1978 *Mandocythere harrisiana* (Jones, 1870) – Neale, p. 340. pl. 4, figs. 1 -3.
1982 *Mandocythere harrisiana* (Jones, 1870) – Weaver, p. 51, pl. 9, figs. 13-16.
1985 *Protocythere (Mandocythere) harrisiana* (Jones) – Babinot et al., p. 171.
1985 *Protocythere (Mandocythere) harrisiana harrisiana* (Jones & Hinde, 1890) [sic]; Babinot et al., pl. 54, figs. 4-6.
1987 *Mandocythere harrisiana* (Jones) – Ainsworth et al., p. 612.
1988 *Mandocythere harrisiana* (Jones) – Ascoli, p. 29.
1989 *Mandocythere harrisiana* (Jones) – Elstner & Kemper. p. 56, figs. 3-4.
1989 *Mandocythere harrisiana* (Jones) – Keller et al., p. 273.
1990 *Mandocythere harrisiana* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — This species has a confusing taxonomy, this applies in particular to juveniles. Strongly reticulate specimens in our material are assigned to *Homocythere reticulata*, while less reticulate specimens, showing in essence the adult features of *Mandocythere harrisiana*, are included in this species. *M. harrisiana* is a commonly found species, which ranges from the Albian into the Cenomanian of France, England and Germany.

Occurrence — Schenking Quarry, Wells 41E167, 41E198 and 41F125; Lower to Middle Cenomanian.

Mandocythere inferangulata (Donze, 1972)
Pl. 5, fig. 4.

1972 *Veenia inferangulata* n. sp.– Donze, in Donze & Porthault, p. 368, pl. 2, figs. 3-9.
1982 *Mandocythere inferangulata* (Donze, 1972) – Weaver, p. 51, pl. 9, figs. 6-9.

Remarks — A single right valve was found in one of the samples from the Oossinkbeek. It shows the characteristic low posterior end as described by Donze (in: Donze & Porthault, 1972) and Weaver (1982). The species is commonly found in the Middle and Lower Cenomanian of England and France; in England it makes its first appearance in the top of the Lower Cenomanian.

Occurrence — Exposure Oossinkbeek; Middle Cenomanian.

Mandocythere sp. A Weaver, 1982
Pl. 5, fig. 5.

1982 *Mandocythere* sp. A – Weaver, p. 53, pl. 9, figs. 17-19.

Remarks — A few specimens were found that meet the description of *Mandocythere*

sp. A. by Weaver (1982). However, the possibility that this species is in fact a pre-adult stage of *M. harrisiana* has to be considered.

Occurrence — Exposure Oossinkbeek; Middle Cenomanian.

Genus *Homocythere* Kaye, 1963

Homocythere reticulata Kaye, 1963
Pl. 5, figs. 1-3.

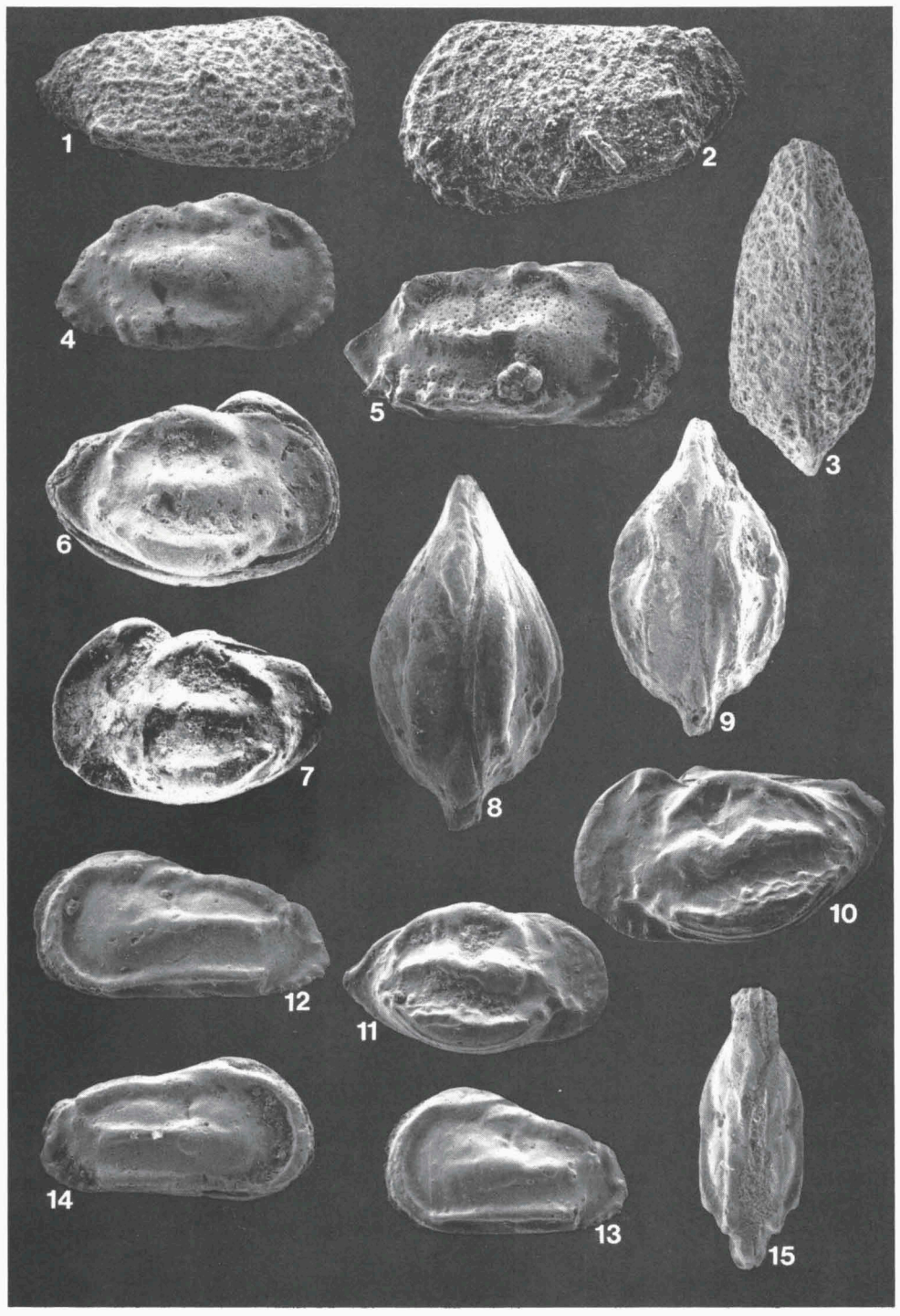
1963 *Homocythere reticulata* sp. nov. – Kaye, p. 234, pl. 18, figs. 8-9.
1966 *Homocythere reticulata* Kaye – Gründel, p. 40, pl. 7, fig. 23.

Remarks — This form was considered a juvenile of *Mandocythere harrisiana* by Kaye (1964), Malz (1974) and Weaver (1982). In our material, juvenile specimens that belong undoubtedly to *M. harrisiana* have been found, and they differ considerably from the present form. It seems unlikely that two forms that are so dissimilar can develop into identical adults. Therefore, we agree with Kaye (1963) and Gründel (1966) in considering this a separate species.

Occurrence — Wells 41E167, 41E198 and 41F125; Lower Cenomanian.

Plate 5

Figs. 1-3. *Homocythere reticulata* Kaye, 1963
1. Right valve, x 82, well 41F125 (10-10.50 m), RGM 293 454.
2. Left valve, x 83, well 41F125 (10-10.50 m), RGM 293 455.
3. Carapace, dorsal view, x 83, well 41F125 (10-10.50 m), RGM 293 456.
Fig. 4. *Mandocythere inferangulata* (Donze, 1972), right valve, x 67, exposure Oossinkbeek, sample no. 516/07, RGM 293 457.
Fig. 5. *Mandocythere* sp. A Weaver, 1982, right valve, x 67, exposure Oossinkbeek, sample no. 516/07, RGM 293 458.
Figs. 6-8. *Protocythere consobrina* Triebel, 1938
6. Carapace, right view, x 57, well 41F167 (31.50-33 m), RGM 293 460
7. Carapace, left view, x 53, well 41F167 (31.50-33 m), same specimen as 6.
8. Carapace dorsal view, x 68, well 41F167 (33-33.15 m), RGM 293 461.
Figs. 9, 11. *Protocythere lineata striata* Gründel, 1966
9. Carapace, dorsal view, x 55, well 41F167 (39-39.30 m), RGM 293 462.
11. Right valve, x 53, well 41F167 (43.50-45 m), RGM 293 464.
10. *Protocythere lineata lineata* (Chapman & Sherborn, 1893). Carapace, left view, x 56, well 41F125 (10-10.50 m), RGM 293 463.
Figs. 12-15. *Cornicythereis larivourensis* (Damotte & Grosdidier, 1963)
12. Carapace, left view, x 81, well 41F125 (10-10.50 m), RGM 293 465.
13. Left valve, x 81, well 41F125 (9.50-10 m), RGM 293 466.
14. Carapace, right view, x 83, well 41F167 (37.50-39 m), RGM 293 467.
15. Carapace, dorsal view, x 83, well 41F167 (37.50-39 m), RGM 293 468.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

Genus *Protocythere* Triebel, 1938

Protocythere consobrina Triebel, 1938
Pl. 5, figs. 6-8.

1938 *Protocythere consobrina* n. sp. – Triebel, p. 184, pl. 1, figs. 6-7.
non 1964 *Protocythere consobrina* Triebel – Kaye, p, 57, pl. 5, figs. 17-19 (= *P. albae* Damotte & Grosdidier).
1973 *Protocythere consobrina* Triebel – Hart, p. 280, fig. 4.
1989 *Protocythere consobrina* Triebel – Frieg & Kemper, p. 184, pl. 19, fig. 4.
1989b *Protocythere consobrina* Triebel – Kemper, p. 456, fig. 2.

Remarks — This species has so far been reported from very few localities in Germany, where it is restricted in age to the Early Cenomanian. It is more or less similar in appearance to *P. lineata striata*, but it lacks the ventral riblets, is more compact and has a higher anterior.

Occurrence — Wells 41E167 and 41F125; Lower Cenomanian.

Protocythere lineata lineata (Chapman & Sherborn, 1893)
Pl. 5, fig. 10.

1893 *Cythereis triplicata* Röm., var. *lineata* var. nov. – Chapman & Sherborn, p. 348, pl. 14, fig. 5.
1938 *Protocythere jonesi* – Triebel, p. 186, pl. 1, figs. 8-10.
1956 *Protocythere jonesi* Triebel – Deroo, p. 1514.
1966 *Protocythere lineata* (Chapman & Sherborn 1893) – Gründel, p. 26.
1973 *Protocythere lineata* (Chapman and Sherborn) – Hart, p. 280, fig. 4.
1981 *Protocythere lineata* (Chapman & Sherborn) – Wilkinson & Morter, p. 169, pl. 13.2, fig. 10.
1989 *Protocythere lineata lineata* (Chapman & Sherborn) – Frieg & Kemper, p. 125, pl. 22, figs. 1, 3, 6.
1990 *Protocythere lineata lineata* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — An irregular reticulation between the ribs is diagnostic of this subspecies, whereas in *P. lineata striata* this feature is absent. Weaver (1982) stated that some specimens of *P. lineata striata* in his samples from southern England have a faint reticulation in the dorsal area. Kemper (1989a) reports transitional forms as well, and our material also shows variation in the intensity of the reticulate pattern. In one of the wells, however, a few specimens were found that are considered true *P. lineata lineata*. Recorded from the Upper Albian to Cenomanian of England, Germany and northern France.

Occurrence — Well 41F125; Lower Cenomanian.

Protocythere lineata striata Gründel, 1966
Pl. 5, figs. 9, 11.

1964 *Protocythere lineata* (Chapman & Sherborn) – Kaye, p. 58, pl. 5, figs. 2, 4-8.
1966 *Protocythere lineata striata* n. subsp. – Gründel, p. 26, pl. 4, figs. 7-8, 14-15.
1981 *Protocythere lineata striata* – Wilkinson & Morter, p. 167.
1982 *Protocythere lineata striata* Gründel, 1966 – Weaver, p. 54, pl. 8, fig. 19, pl. 9, fig. 1.

1985 *Protocythere (Protocythere) lineata striata* Gründel – Babinot et al., p. 173.
1989 *Protocythere lineata striata* Gründel – Elstner & Kemper, p. 60, fig. 5.
1989 *Protocythere lineata striata* Gründel – Frieg & Kemper, p. 124, pl. 22, figs. 2, 4-5, 7-8.
1989a *Protocythere lineata striata* Gründel – Kemper, p. 209, figs. 6-7.
1989b *Protocythere lineata striata* – Kemper, p. 456, fig. 2.
1990 *Protocythere lineata striata* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — This subspecies, recognized by the absence of reticulation between the ribs, is known from England, France and Germany. It is found from the Upper Albian to the Middle Cenomanian. Locally, its range may be more restricted (Babinot et al., 1985; Kemper, 1989b).

Occurrence — Wells 41F125, 41F167 and 41F198; Upper Albian to Middle Cenomanian.

Family Trachyleberididae Sylvester-Bradley, 1948
Genus *Cornicythereis* Gründel, 1973

Cornicythereis larivourensis (Damotte & Grosdidier, 1963)
Pl. 5, figs. 12-15.

1849 *Cythereis quadrilatera* Roemer – Jones, p. 18, pl. 4, figs. 10j-j'.
1890 *Cythereis quadrilatera* (Roemer) – Jones & Hinde, pl. 1, figs. 74-75.
1893 *Cythereis Lonsdaleana*, Jones – Chapman & Sherborn, p. 347.
1898 *Cythereis quadrilatera* (Roemer) – Chapman, p. 339.
non 1925 *Cytherina Lonsdaleana* Jones – Franke in Böhm, p. 203. (= *Cornicythereis bonnemai*).
1963 *Cythereis? larivourensis* n. sp.– Damotte & Grosdidier, p. 59, pl. 3, figs. 9a-9i.
1971b *Cythereis larivourensis* Damotte & Grosdidier – Damotte, p. 65, pl. 2, fig. 12.
1975 *Cythereis larivourensis* D. & G. – Damotte, p. 266, tables 1-2.
1976 *Cythereis larivourensis* Damotte & Grosdidier – Damotte, p. 296, pl. 1, fig. 1.
1978 *Cythereis (Cornicythereis) larivourensis* Damotte & Grosdidier, 1963 – van der Wiel, p. 250, pl. 1, figs. 9-10.
1978 *Cythereis larivourensis* Damotte et Grosdidier, 1963 – Babinot et al., p. 22, table 1.
1978 *Cythereis larivourensis* D. & Grod. [sic] – Damotte in Amedro et al., p. 9, fig. 2.
1981 *Cornicythereis larivourensis* Dam. et Gr. – Damotte in Amedro et al., p. 7, fig. 2.
1982 *Praephacorhabdotus erici* sp. nov.– Malz, p. 222, pl. 3, figs. 9-14.
1982 *Cornicythereis larivourensis* (Damotte & Grosdidier, 1963) – Weaver, p. 61, pl. 10, figs. 15-18.
1983 *Cornicythereis larivourensis* – Damotte, p. 315, tab. 1.
1985 *Cornicythereis larivourensis* (Damotte & Grosdidier, 1963) – Babinot et al., p. 204, pl. 52, figs. 12-15.
1988 *Cornicythereis larivourensis* – Wilkinson, p. 1235, textfig. 3.
1988 *Cornicythereis larivourensis* (Damotte and Grosdidier) – Ascoli, p. 29.
1989 *Cornicythereis larivourensis* Dam. & Grosd. – Frieg & Kemper, p. 123, pl. 20, fig. 1-2, 6; pl. 21, fig. 1, p. 141, figs. 15-16.
1989a *Cornicythereis larivourensis* – Kemper, p. 209, figs. 6-7.
1990 *Cornicythereis larivourensis* – Wilkinson, p. 250, textfigs. 7, 9.
1990 *Cornicythereis larivourensis* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — There is a strong similarity between the species *Cornicythereis bonnemai* (Triebel, 1940) and *C. larivourensis* (Damotte & Grosdidier, 1963), which has led to much confusion in the past. The first species was described from the Middle and Upper Albian of the central part of the Lower Saxony Basin, the second species from the Lower Cenomanian of the eastern part of the Paris Basin. Unfortunately, when the second species was described by Damotte & Grosdidier (1963), they did not mention Triebel's (1940) species and no differential diagnosis was given. This omission was

later corrected by Damotte (1971b), who, on this occasion, clearly established the differences between the two species. Her comments were a reaction to the suggestion by Gründel (1966) of a possible synonymy. Numerous differences were recited, such as *C. larivourensis* being smaller in size, and having a more quadrangular outline. It can also be distinguished by its posterodorsal dentitions, a knotted anterior margin and ventral stripes, while in dorsal outline the sides are more or less parallel. *C. bonnemai*, which is larger and more elongate, was also said to differ in its hinge configuration. This extended diagnosis, however, did not prevent the confusion to continue. Unfortunately, Damotte (1971b), failed to draw attention to the shape and the course of the riblets, a feature that was considered to be of prime importance by later authors dealing with these species (Malz, 1982; Weaver, 1982). From Triebel's (1940) description and figures it may be concluded that *C. bonnemai* has a rather thin median rib. The presence – and importance – of this feature was confirmed by Malz' (1982) description and illustration of topotypic material. This last author distinguishes two species, the first being *C. bonnemai*, the second being a smaller form from England with a swollen median rib, and a more inflated outline in dorsal view. However, Malz (1982), does not link this form, which he described as *Praephacorhabdotus erici*, to *Cornicythereis larivourensis*, described earlier from France. The type horizon and locality of *P. erici* – regarded by Malz as a descendant of *C. bonnemai* – is the Upper Albian of Folkestone in southern England. At the same time, Weaver (1982) recognized *C. larivourensis* in his Cenomanian samples from several localities, also in southern England. He mentions *C. bonnemai* as a separate species, very similar to *C. larivourensis*, but apparently restricted to the Albian of West Germany. Some important differences between the two species were clearly stated, confirming *C. larivourensis* to be smaller and less elongate. Weaver (1982) also correctly combines the French reports of *C. larivourensis* as Upper Albian to Middle Cenomanian, and for England, the same range is given. *C. larivourensis* was originally described from the Lower Cenomanian of the Boulonnais, the western part of the Paris Basin (Damotte & Grosdidier, 1963). In that area it is not restricted to this level; later van der Wiel (1978) found the species in the Middle and Upper Albian as well. This observation was confirmed in a later paper by Damotte (in: Amedro et al., 1981). Babinot et al. (1985) also present *C. larivourensis* as an Upper Albian species.

Although Triebel originally described *C. bonnemai* from the German Albian, Bartenstein & Bettenstaedt (1962) indicated that *C. bonnemai* occurs up to the Lower Cenomanian. Gründel (1966), in his review of East German Lower Cretaceous ostracods, also gives a range from Middle Albian to Lower Cenomanian, and includes Poland as a place of occurrence. Ellermann (1962) reported the species from westernmost Germany, not far from the Achterhoek, and remarks that the species ranges from the Middle Albian into the Cenomanian. In the light of the present knowledge, however, Cenomanian occurrences probably refer to *C. larivourensis* exclusively. It is possible, however, that the oldest occurrences of the species should be ascribed to *C. oweni* Kemper, 1989a, a species recently segregated from *C. larivourensis* and reported to be restricted to the Middle Albian of Germany.

Donze (in: Donze & Porthault, 1972) reports *Cythereis* aff. *bonnemai* from the Upper Albian to Lower Cenomanian in the southwestern corner of France, close to the

Italian border. This form is characterized by a connection between the median and dorsal ribs. It ranges from the Upper Albian to Lower Cenomanian, but it is clearly stated that the Early Cenomanian specimens from some localities have a more elongate carapace, are more inflated and have a less pronounced ornamentation, in particular at the posterior junction between the median and dorsal ribs. This last feature is considered reminiscent of *C. larivourensis* from the Lower Cenomanian of the Paris Basin. This suggests that the absence or presence of a connection between dorsal and central ribs is an important clue in separating the two species, a view explicitly or implicitly shared by a number of authors to follow.

More recently, Frieg & Kemper (1989) suggested that the two species may in fact be ecotypical variants of one species, possibly related to the relative position within the basin configuration. Our observations from the eastern Netherlands, where both species are found, can neither deny nor confirm this interesting suggestion. We think, however, that their conclusion that *C. larivourensis* is a junior synonym of *C. bonnemai* is premature. Judging from the differences given by Damotte (1971b), and the differences in course and development of the median and dorsal ribs, there is more than sufficient ground to uphold the distinction between the two species.

Whether or not each species has its own ecological preferences, their stratigraphic ranges do not match, although there is a long overlap. In England and France *C. larivourensis* ranges from the upper Middle Albian to the Middle Cenomanian. In Germany the (lower and upper) Middle Albian specimens are attributed to *C. oweni* Kemper, 1989, while *C. bonnemai* starts off at the same time, but remains restricted to the Albian. Also in England and offshore southern Ireland *C. bonnemai* is restricted to the Albian (Neale, 1978; Colin et al., 1981; Ainsworth 1987; Ainsworth et al., 1987).

Co-occurrence of the two species in one sample has been reported only from the Albian of southern England (Wilkinson, 1990; Wilkinson in Bristow, 1990). In our Achterhoek material, ranging in age from latest Albian to Middle Cenomanian, only true *C. larivourensis* were found. Typical *C. bonnemai*, however, are also known from The Netherlands, both from wells in the Twente Area (eastern part of The Netherlands, N of the Achterhoek) and from wells in the Dutch North Sea sector. Here too, *C. bonnemai* was never found in rocks younger than Late Albian.

The history of the generic assignment of the species is also peculiar. *Cythereis bonnemai* Triebel was designated type species of *Praephacorhabdotus*, Gründel, 1974. The fact that the same author in an earlier paper (Gründel, 1966) questionably placed the two species in synonymy may be taken as proof of their implicit assignment to the same genus. Neale (1978), however, included *C. bonnemai* in the genus *Cornicythereis* Gründel, 1973. For this genus Gründel (1973b) designated *Cythereis cornueli* Deroo, 1956 type species, without mentioning either *C. bonnemai* nor *C. larivourensis*. Damotte (in: Amedro et al., 1981) included *C. larivourensis* in *Cornicythereis*, after discussing (in: Amedro et al., 1977) the arguments pro and contra. These days, there seems to be a consensus about the position of both species in *Cornicythereis*, which makes the genus *Praephacorhabdotus*, having *C. bonnemai* as type species, a synonym.

Occurrence — Exposure Oossinkbeek, Schenking Quarry, wells 41E167, 41E198 and 41F125; Lower to Middle Cenomanian.

Genus *Cythereis* Jones, 1849

Cythereis coronata Weaver, 1982
Pl. 6, fig. 11.

1982 *Cythereis coronata* sp. nov. – Weaver, p. 63, pl. 12, figs. 15-19, pl. 13, fig. 1.
1989 *Cythereis corona* Weaver [sic] – Frieg et al., p. 31.

Remarks — This large species was reported before from England where it is known from the latest Early Cenomanian and Middle Cenomanian only. More recently, Frieg et al. (1989) found the species also in the Cenomanian of the Münsterland in Germany. It can be distinguished from *C. thoerenensis* mainly in being larger and having valves that are almost smooth in the anterior part. *C. hirsuta* is smaller and has a well-developed reticulation over the entire lateral surface. The muscle node in that species is less pronounced.

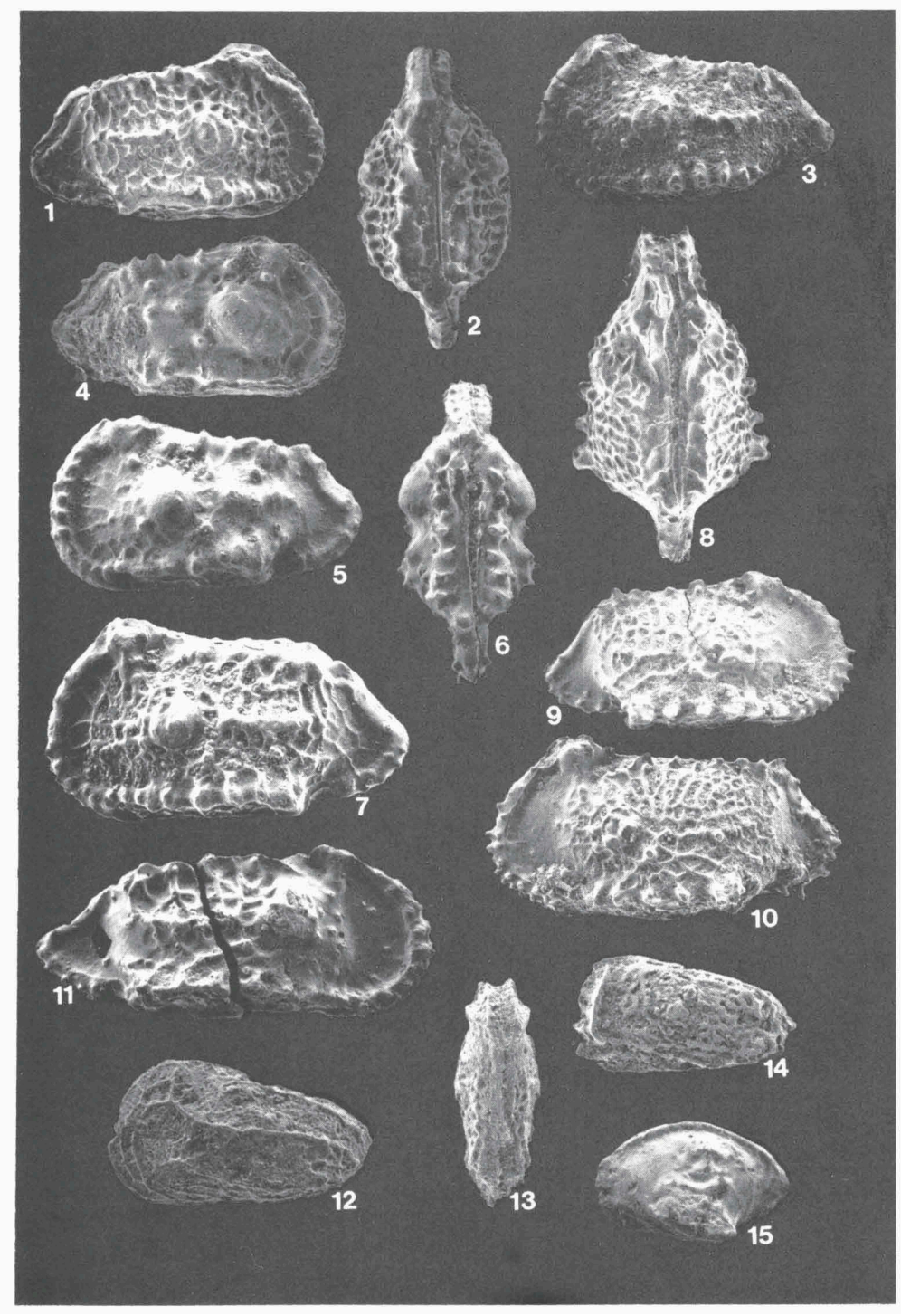
Occurrence — Exposure Oossinkbeek; Middle Cenomanian.

Cythereis hirsuta Damotte & Grosdidier, 1963
Pl. 6, figs. 1-3.

1977 *Cythereis hirsuta* Damotte & Grosdidier, 1961 – Charollais et al., p. 687, pl. 2, fig. 11.
? 1978 *Cythereis (Cythereis) hirsuta* Damotte & Grosdidier, 1963 – van der Wiel, p. 256, pl. 3, figs. 5-15.
1981 *Cythereis hirsuta* – Wilkinson & Morter, p. 167.

Plate 6

Figs. 1-3. *Cythereis hirsuta* Damotte & Grosdidier, 1963
1. Carapace, right view, x 51, well 41F167 (45-45.20 m), RGM 293 459.
2. Carapace, dorsal view, x 54, well 41F167 (45-45.20 m), same specimen as 1.
3. Left valve, x 54, well 41F125 (16.40-16.80 m), RGM 293 469.
Figs. 4-6. *Cythereis humilis humilis* Weaver, 1982
4. Carapace, right view, x 81, well 41F125 (9.50-10 m), RGM 293 470.
5. Carapace, left view, x 80, well 41E198 (3.75-3.85 m), RGM 293 471.
6. Carapace, dorsal view, x 82, well 41F125 (9.50-10 m), RGM 293 472.
Fig. 7. *Cythereis reticulata* Jones & Hinde, 1890, carapace, left view, x 57, well 41F125 (9.50-10 m), RGM 293 473.
Figs. 8-10. *Cythereis thoerenensis* Triebel, 1940
8. Carapace, dorsal view, x 56, well 41F125 (9.50-10 m), RGM 293 474.
9. Right valve, x 54, well 41F125 (9.50-10 m), RGM 293 475.
10. Left valve, x 55, well 41F125 (10-10.50 m), RGM 293 476.
Fig. 11. *Cythereis coronata* Weaver, 1982, right valve, x 52, Schenking Quarry, sample no. 66, RGM 293 477.
Fig. 12. *Isocythereis* sp., juvenile?, carapace, left view, x 92, well 41F125 (15-15.50 m), RGM 293 478.
Figs. 13-14. *Platycythereis gaultina* (Jones, 1849)
13. Carapace, dorsal view, x 71, well 41F125 (15-15.50 m), RGM 293 479.
14. Left valve, x 69, well 41F125 (41.80-42.30 m), RGM 293 480.
Fig. 15. *Cytheropteron nanissimum fenestratum* Kaye, 1965, left valve, x 97, well 41E198 (16.60-17 m), RGM 293 481.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

1982 *Cythereis hirsuta* Damotte & Grosdidier, 1963 – Weaver, p. 64, pl. 12, figs. 7-11, textfig. 14.
1985 *Cythereis (Cythereis) hirsuta* Damotte & Grosdidier, 1963 – Babinot et al., p. 171, pl. 51, figs. 12-14.
1989 *Cythereis hirsuta* Dam. & Grosd. – Frieg et al., p. 31, pl. 4, figs. 1-2; pl. 5, fig. 8.
1990 *Cythereis (C.) hirsuta* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — Considerable variation is observed within this species of *Cythereis*. Transitional forms with related species — in particular *Cythereis thoerenensis* and *C. reticulata* — may occur. Weaver (1982) considered some of the specimens attributed to *C. hirsuta* by van der Wiel (1978) as rather belonging to *C. thoerenensis*. The species has only limited stratigraphical applicability; it ranges in age from Middle Albian to Middle Cenomanian, and has an extensive area of distribution.

Occurrence — Wells 41E167 and 41F125; Lower Cenomanian.

Cythereis humilis humilis Weaver, 1982
Pl. 6, figs. 4-6.

1982 *Cythereis humilis humilis* sp. nov. – Weaver, p. 65, pl. 11, figs. 12-16.
1988 *Cythereis (Cythereis) humilis humilis* Weaver – Wilkinson, p. 1232, pl. 2, fig. 3.
1989 *Cythereis humilis* Weaver – Frieg et al., p. 30.
1990 *Cythereis (C.) humilis* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — This rather small, coarsly spinose form ranges in England from the (upper part of the) Upper Albian to the Middle Cenomanian. In Germany it has been reported from the Cenomanian only.

Occurrence — Wells 41E167, 41E198 and 41F125; Lower Cenomanian.

Cythereis reticulata Jones & Hinde, 1890
Pl. 6, fig. 7.

1972 *Cythereis reticulata* Jones & Hinde – Donze in Donze & Porthault, p. 367, pl. 3, figs. 11-14.
1977 *Rehacythereis reticulata* (Jones & Hinde, 1890) – Charollais et al., p. 685, pl. 2, fig. 10
1978 *Cythereis (Cythereis) reticulata* Jones & Hinde, 1890 – van der Wiel, p. 250, pl. 3, figs. 1-4.
1978 *Rehacythereis reticulata* (Jones and Hinde, 1890) – Neale, p. 356, pl. 12, figs. 1-2.
1982 *Cythereis* aff. *C. reticulata* Jones & Hinde, 1890 – Weaver, p. 67, pl. 13, figs. 2-4.
1985 *Cythereis (Rehacythereis) reticulata* (Jones & Hinde, 1890) – Babinot et al., p. 171, pl. 52, figs. 4-6.
1988 *Rehacythereis reticulata* (Jones and Hinde) – Ascoli. p. 11, fig. 2, p. 29.
1989 *Cythereis reticulata* Jones & Hinde – Keller et al., p. 275.
1989 *Cythereis reticulata* – Frieg & Kemper, p. 135, fig. 13.
1989a *Cythereis reticulata* – Kemper, p. 208, fig. 5.
1990 *Cythereis (C.) reticulata* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — A widely distributed species (Western Europe and Eastern Canada) recognized by its strong hinge ear and pronounced reticulation, which, unlike *C. hirsuta*, bears no spines. Another difference is the central rib, which is more compound in *C. reticulata* and not a row of separate spines as in *C. hirsuta*. Stratigraphic range from the Middle Albian (Germany, France) to the Late Cenomanian (Canada).

Occurrence — Well 41F125, probably also Schenking Quarry; Lower to Middle Cenomanian.

Cythereis thoerenensis Triebel, 1940
Pl. 6, figs. 8-10.

1940 *Cythereis thörenensis* n. sp. – Triebel, p. 195, pl. 5, figs. 57-59.
1962 *Cythereis thörenensis* Triebel, 1940 – Ellerman, p. 404.
1964 *Cythereis thorenensis* Triebel [*sic*] – Kaye, p. 68, pl. 7, figs. 14-15, 17.
1966 *Cythereis thoerenensis* Triebel, 1940 – Gründel, p. 37, pl. 6, fig. 22.
1982 *Cythereis thoerenensis* Triebel, 1940 – Weaver, p. 68, pl. 12, figs. 12-14, textfig. 14.
1989 *Cythereis thoerenensis* – Frieg & Kemper, p. 141, fig. 15.
1990 *Cythereis (C.) thoerenensis* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — *Cythereis thoerenensis* has been recorded before from the Albian to Middle Cenomanian of southern England and western Germany. According to Weaver (1982) some of the specimens from the Upper Albian of northern France attributed to *C. hirsuta* by van der Wiel (1978) may belong in this species. See also remarks on *C. coronata.*
Occurrence — Wells 41E167 and 41F125; Lower Cenomanian.

Genus *Planileberis* Deroo, 1966

?*Planileberis* sp.
Pl. 7, fig. 17.

Remarks — Of this form, only one specimen, probably a juvenile, was found. Because of its poor preservation it could only be identified tentatively. Its assignment to *Planileberis* was prompted by the shape of the carapace and the surface of the shell, which are reminiscent of *P. foveata* Weaver, 1982.

Occurrence — Well 41F125; Lower Cenomanian.

Genus *Platycythereis* Triebel, 1940

Platycythereis gaultina (Jones, 1849)
Pl. 6, figs. 13-14.

1977 *Platycythereis gaultina* (Jones) – Neale, p. 254, pl. 2, fig. 8.
1978 *Platycythereis gaultina* (Jones, 1849) – Neale, p. 354, pl. 11, fig. 4.
1978 *Platycythereis gaultina* (Jones 1849) – van der Wiel, p. 250, pl. 1, figs. 16-17.
1982 *Platycythereis* cf. *gaultina* (Jones, 1849) – Weaver, p. 78, pl. 14, figs. 16-19.
1985 *Platycythereis gaultina* (Jones, 1849) – Babinot et al., p. 171, pl. 53, figs. 9-10.
1988 *Platycythereis gaultina* (Jones, 1849) – Wilkinson, p. 1233, textfig. 2, pl. 2, fig. 9.
1989 *Platycythereis gaultina* (Jones) – Frieg et al., p. 32.
1990 *Platycythereis gaultina* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — An easily recognized species characteristic of the (Middle and Upper) Albian of western Europe (southern England, Germany, France and offshore south of Ireland). Considered a good marker for parts of its total range, depending on the area.

Oldest records are from the Upper Aptian, youngest from the lower part of the Lower Cenomanian. Specimens reported by Weaver (1982) from the British Cenomanian are slightly smaller and differ in details of the ornamentation.

Occurrence — Well 41F125; Lower Cenomanian.

Genus *Rehacythereis* Gründel, 1973

Rehacythereis barringtonensis Weaver, 1982
Pl. 7, figs. 1, 3.

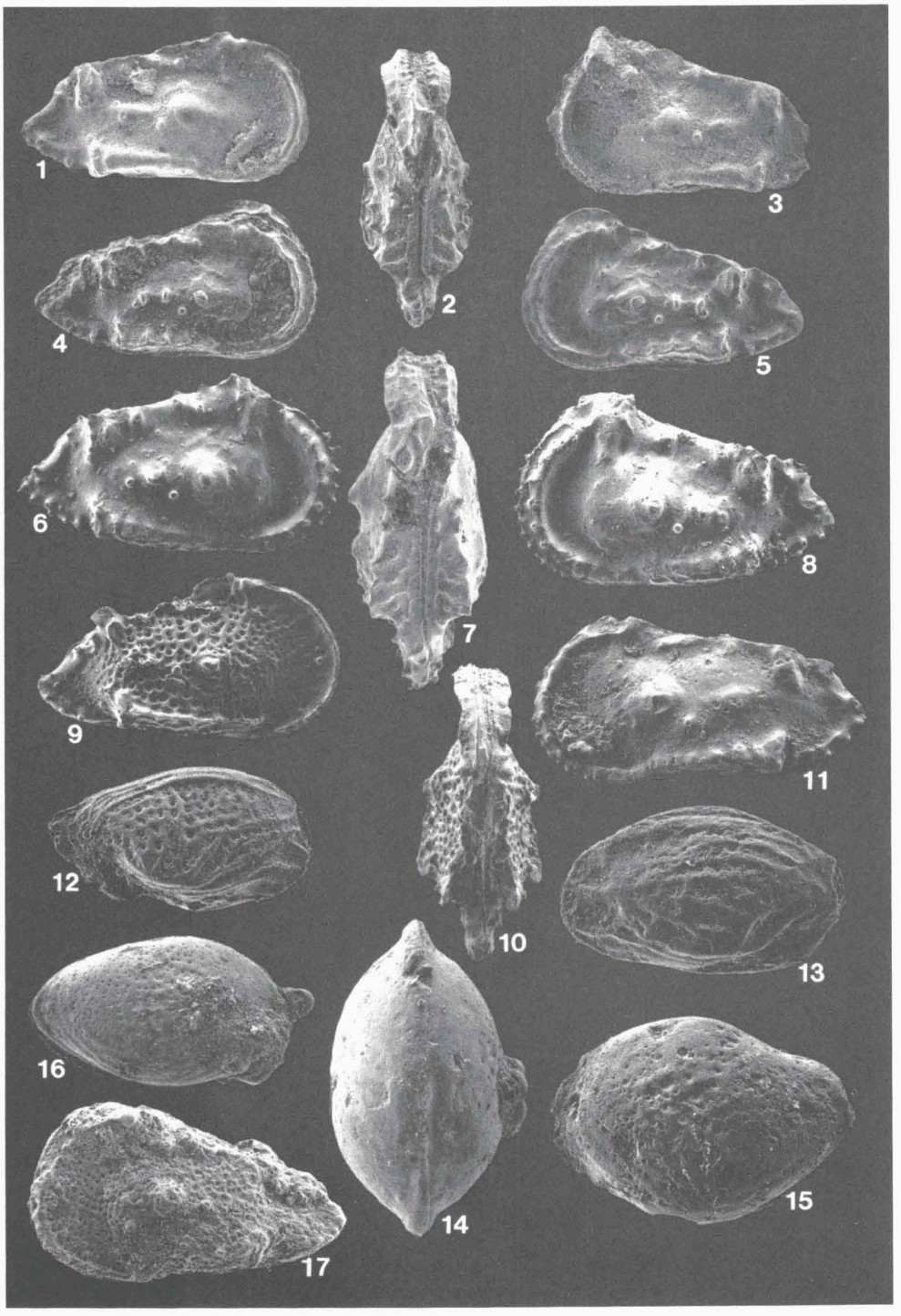
1982 *Rehacythereis barringtonensis* sp. nov. – Weaver, p. 80, pl. 11, figs. 5-7.

Remarks — This species has only been recorded once before, ranging from the highest Lower Cenomanian to lowest Upper Cenomanian of southern England. In our material, it was only found in the younger samples, that we consider to belong to the Middle Cenomanian. This suggests that the species is a potential marker for this age range.

Occurrence — Exposure Oossinkbeek, Schenking Quarry, well 41E167; Middle Cenomanian.

Plate 7

Figs. 1, 3. *Rehacythereis barringtonensis* Weaver, 1982
1. Right valve, x 69, exposure Ossinkbeek, sample no. 516/07, RGM 293 482.
3. Left valve, x 67, well 41F167 (5.70-9 m), RGM 293 484.
Figs. 2, 4, 5. *Rehacythereis luermannae* (Triebel, 1940)
2. Carapace, dorsal view, x 56, well 41F125 (31.50-32 m), RGM 293 483.
4. Carapace, right view, x 56, well 41F125 (31.50-32 m), RGM 293 485.
5. Carapace, left view, x 53, well 41F125 (31.50-32 m), RGM 293 486.
Figs. 6-8. *Rehacythereis bemerodensis* (Kemper, 1971)
6. Right valve, x 70, well 41F125 (11-11.50 m), RGM 293 487.
7. Carapace, dorsal view, x 69, well 41F125 (11-11.50 m), RGM 293 488.
8. Left valve, x 66, well 41F125 (11-11.50 m), RGM 293 489.
Figs. 9-10. *?Trachyleberis* sp.
9. Right valve, x 79, well 41F125 (15-15.50 m), RGM 293 490.
10. Carapace, dorsal view, x 80, well 41F125 (10-10.50 m), RGM 293 491.
Fig. 11. *Rehacythereis paranuda* Weaver, 1982, carapace, left view, x 52, well 41F167 (33.15-34 m), RGM 293 492.
Figs. 12-13. *Hemicytherura euglyphea* Kaye, 1965
12. Carapace, right view, x 148, well 41F125 (21.25-21.75 m), RGM 293 493.
13. Carapace, left view, x 155, well 41F125 (15-15.50 m), RGM 293 494.
Figs. 14-16. *Phthanoloxoconcha bluebellensis* (Weaver, 1982)
14. Carapace, dorsal view, x 104, exposure Oossinkbeek, sample no. 515/01, RGM 293 495.
15. Left valve, x 97, well 41F167 (29-30.20 m), RGM 293 496.
16. Right valve, x 102, exposure Oossinkbeek, sample no. 516/07, RGM 293 497.
Fig. 17. *?Planileberis* sp., juvenile?, left valve, x 82, well 41F125 (13.40-14 m), RGM 293 498.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

Rehacythereis bemerodensis (Kemper, 1971)
Pl. 7, fig. 6-8.

1971 *Cythereis luermannae bemerodensis* n. subsp.– Kemper, in Bertram & Kemper, p. 39, pl. 1, figs. 3-4.
1981 *Cythereis luermannae bemerodensis* – Wilkinson & Morter, p. 169.
1982 *Rehacythereis luermannae bemerodensis* (Kemper, 1971) – Weaver, p. 80, pl. 12, fig. 1-2.
1988 *Cythereis (Rehacythereis) bemerodensis* Bertram and Kemper, 1971 – Wilkinson, p. 1234, pl. 2, fig. 2.

Remarks — This species was originally described as one of three subpecies within *Cythereis luermannae* Triebel. For two of these subspecies, the grounds to uphold a subspecific separation are only very limited, and we have included both of them in the nominate species. This third form is sufficiently different to warrant a separate taxonomic entity. *Cythereis bemerodensis* ranges in age from the latest Late Albian to the Lower Cenomanian, although Weaver (1982) also reports this form from the lower Middle Cenomanian.

Occurrence — Exposure Oossinkbeek, Wells 41E167 and 41F125; Lower to lower Middle Cenomanian.

Rehacythereis luermannae (Triebel, 1940)
Pl. 7, figs. 2, 4-5.

1971 *Cythereis luermannae luermannae* Triebel – Kemper, in Bertram & Kemper, p. 38, pl. 1, figs. 1-2, 5-6.
1971 *Cythereis luermannae hannoverana* n. subsp. – Kemper, in Bertram & Kemper, p. 38, pl. 1, figs. 7-8.
1978 *Cythereis (Cythereis) luermannae* Triebel 1940 – van der Wiel, p. 250, pl. 1, fig 7-8.
1981 *Cythereis luermannae luermannae* Triebel – Wilkinson & Morter, p. 163, pl. 13.1, fig. 8.
1981 *Cythereis luermannae hannoverana* Bertram & Kemper – Wilkinson & Morter, p. 166, pl. 13.2, fig. 12.
1982 *Rehacythereis luermannae luermannae* (Triebel, 1940) – Weaver, p. 79, pl. 11, figs. 20-21.
1985 *Cythereis (Rehacythereis) luermannae* Triebel, 1940 – Babinot et al., p. 171, pl. 52, figs. 1-3.
1988 *Cythereis (Rehacythereis) luermannae hannoverana* Bertram and Kemper, 1971 – Wilkinson, p. 1233, textfigs. 2-3, pl. 2, fig. 1.
1988 *Rehacythereis lürmannae* (Triebel) – Ascoli, p. 28.
1989 *Cythereis luermannae* Triebel – Frieg & Kemper, p. 122, pl. 18, figs. 1-9.
1989a *Cythereis luermannae luermannae* Triebel – Kemper, p. 208, fig. 5, pl. 3, fig. 3.
1989 *Cythereis luermannae* Trieb. – Keller et al., p. 275.
1990 *Cythereis (R.) luermannae hannoverana* Bertram and Kemper, 1971 – Wilkinson, p. 244, textfigs. 3-5, 7.
1990 *Cythereis (R.) luermannae* s.s. – Wilkinson, textfigs. 3-5, 7.
1990 *Cythereis (R.) luermannae hannoverana* – Wilkinson in Bristow, p. 12, fig. 5.
1990 *Cythereis (R.) luermannae luermannae* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — Kemper (in: Bertram & Kemper, 1971), divided *Cythereis luermannae* Triebel, 1940 into three subspecies that show differences in the development of the reticulation, the height/length ratio and the outline. These subspecies were thought to be useful stratigraphic markers; as a consequence, a zonation was based on this subspecific division (Wilkinson & Morter, 1981; Wilkinson, 1988). More recently, Kemper (1989a) concluded that the stratigraphic use of subspecies *R. l. luermannae* and *R. l. hannoverana* is only very limited. There is sufficient reason to join the two forms within *R. luermannae* – as has been done by a number of authors – in particular since transitional forms are common and the more typical specimens of both taxa may occur

together in the same samples. The third subspecies, *R. l. bemerodensis* , elevated to the species level by Wilkinson (1988), is sufficiently different to warrant a separate status.

C. luermannae is widely recorded from the Middle Albian to Middle Cenomanian of Germany, England and France, and also from Canada.

Occurrence — Wells 41E167 and 41F125; Lower Cenomanian.

Rehacythereis paranuda Weaver, 1982
Pl. 7, fig. 11.

1956 *Cythereis nuda* Jones & Hinde – Deroo, p. 1519, pl. 4, figs. 62-64.
1982 *Rehacythereis paranuda* sp. nov. – Weaver, p. 82, pl. 12, figs. 3-6.
1988 *Cythereis (Rehacythereis) paranuda* Weaver, 1982 – Wilkinson, p. 1232, pl. 2, fig. 4.
1990 *Cythereis (R.) paranuda* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — In southern England, from where this species was reported before, it ranges from the late Late Albian to the Middle Cenomanian, to become more rare in the Late Cenomanian. Apparently, this species is also found in France, where it was reported under a different name from Lower and Middle Cenomanian deposits (see Weaver, 1982).

Occurrence — Well 41E167; Lower Cenomanian.

Genus *Isocythereis* Triebel, 1940

Isocythereis sp.
Pl. 6, fig. 12.

Remarks — Of this form only one specimen was found. In general appearance, it shows affinities to Albian species of *Isocythereis*. It may be a juvenile, but diagnostic features were not visible in this poorly preserved carapace.

Occurrence — Well 41F125; Lower Cenomanian.

Genus *Trachyleberis* Brady, 1898

?*Trachyleberis* sp.
Pl. 7, figs. 9-10.

Remarks — Although this form, of which only a few specimens were found in one well, lacks the anterior spines that are characteristic of *Trachyleberis*, it is tentatively placed in this genus. In lateral view, the tapering outline, converging towards the posterior, is conspicuous. The shell surface is finely reticulate, the muri are swollen. The anterior end is gently arched, the anterior margin bordered by a thin but strong, elevat-

ed bar. The hinge-ear is high and elongate. A rather small, but clearly protruding, muscle node is present; posterodorsally another protruding node is seen. Ventrally, a narrow, ala-like rib is developed. Due to lack of sufficiently well-preserved material internal characteristics could not be described.

Occurrence — Well 41F125; Lower Cenomanian.

Family Cytheruridae G.W. Müller, 1894
Subfamily Cytheropterinae Hanai, 1957
Genus *Cytheropteron* Sars, 1866

Cytheropteron nanissimum fenestratum Kaye, 1965
Pl. 6, fig. 15

1965a *Cytheropteron (C.) nanissimum fenestrata* subsp. nov. – Kaye, p. 234, pl. 7, figs. 14, 16, 19.
1981 *Cytheropteron (Cytheropteron) nanissimum fenestrata* Kaye – Wilkinson & Morter, p. 170, fig. 13.3.

Remarks — This form has previously only been reported from the *H. spathi* Subzone (early Middle Albian) in southern England. In the Achterhoek we found it in one of the deepest samples of well 41E198, representing a Late Albian age. The subspecies can easily be recognized by the fenestrate ornamentation on the ventral alae.

Occurrence — Well 41E198; Upper Albian.

Subfamily Cytherurinae G.W. Müller, 1894
Genus *Hemicytherura* Elofson, 1941

Hemicytherura euglyphea Kaye, 1965
Pl. 7, fig. 12-13

1965a *Hemicytherura euglyphea* sp. nov. – Kaye, p. 231, pl. 8, figs. 1-4.
1975 *Hemicytherura euglyphea* Kaye – van Hinte et al., p. 1490.
1978 *Hemicytherura euglypha* Kaye, 1965 [sic] – Neale, p. 338, pl. 3, fig. 6.
1981 *Hemicytherura euglyphea* Kaye, 1965 – Colin et al., p. 127, pl. 11.1, fig. 9.
1982 *Hemicytherura euglyphea* Kaye, 1965 – Weaver, p. 89, pl. 17, figs. 1-3.
1986 *Hemicytherura euglyphea* Kaye, 1965 – Ainsworth, p. 165, fig. 13.13.
1987 *Hemicytherura euglyphea* Kaye, 1965 – Ainsworth, p. 145, table 7.
1990 *Hemicytherura euglyphea* – Wilkinson in Bristow, p. 12, fig. 5.

Remarks — This species is recorded from Britain and Germany, as well as from a DSDP site off Labrador (van Hinte et al., 1975) and from offshore southern Ireland. Although it ranges from Middle Albian to Late Cenomanian, it is generally considered a diagnostic form for the Albian.

Occurrence — Wells 41E198 and 41F125; Upper Albian to Lower Cenomanian.

Family Loxoconchidae Sars, 1925
Genus *Phthanoloxoconcha* Wilkinson, 1988

Phthanoloxoconcha bluebellensis (Weaver, 1982)
Pl. 7, figs. 14-16.

1982 *Loxoconcha? bluebellensis* sp. nov.– Weaver, p. 94, pl. 18, figs. 1-17.
1988 *Loxoconcha? bluebellensis* Weaver, 1982 – Jarvis et al., p. 34, figs. 13, 19i-j.
1988 *Phthanoloxoconcha bluebellensis* (Weaver, 1982) – Wilkinson, p. 1242.

Remarks — Wilkinson (1988) introduced the genus *Phthanoloxoconcha* to accommodate two species from the British Lower Chalk, that were questionably assigned to *Loxoconcha* before. *Phthanoloxoconcha* differs from the latter genus in lacking the typical amphidont, 'loxoconchoid' type of hinge. Instead, the hinge is lophodont and consists of smooth elements only. It ranges from the upper part of the Lower Cenomanian to probably the Plenus Marl (top Cenomanian).

Occurrence — Exposure Oossinkbeek, well 41E167; Lower to Middle Cenomanian.

References

Ainsworth, N.R., 1986. Upper Jurassic and Lower Cretaceous Ostracoda from the Fastnet Basin, offshore Southwest Ireland. — Irish J. Earth Sc., 7: 145-168, 3 pls.

Ainsworth, N.R., 1987. Upper Jurassic and Lower Cretaceous Ostracoda from the Fastnet Basin, offshore Southwest Ireland. — Irish J. Earth Sc., 8: 139-153.

Ainsworth, N.R., M. O'Neill, M.M. Rutherford, G. Clayton, N.F. Horton & R.A. Penney, 1987. Biostratigraphy of the Lower Cretaceous, Jurassic and uppermost Triassic of the North Celtic Sea and Fastnet Basins. In: J. Brooks & K. Glennie (eds), Petroleum Geology of North West Europe. — Graham & Trotman: 611-622.

Amedro, F., R. Damotte, H. Manivit, F. Robaszynski & J. Sornay, 1978. Echelles biostratigraphiques dans le Cénomanien du Boulonnais. — Géol. Méditerr., 5, 1: 5-18.

Amedro, F., R. Damotte, F. Magniez-Jannin & H. Manivit, 1981. Échelles biostratigraphiques dans l'Albien du Boulonnais. — Bull. Inf. Géol. Bass. Paris, 18, 2: 3-19.

Ascoli, P., 1988. Mesozoic-Cenozoic foraminiferal, ostracod and calpionellid zonation of the north Atlantic margin of North America: Georges Bank-Scotian basins and northeastern Grand Banks (Jeanne d'Arc, Carson and Flemish Pass basins). Biostratigraphic correlation of 51 wells. — Geol. Surv. Canada Contr., open file no. 1791: 1-41.

Babinot, J.F., J.P. Colin & R. Damotte, 1985. Crétacé Supérieur. In: H.J. Oertli (ed.), Atlas des Ostracodes de France. — Bull. Centres Rech. Explor.-Prod. Elf-Aquitaine, 9: 211-255, 16 pls.

Babinot, J.F., J.P. Colin, R. Damotte & P. Donze, 1978. Les Ostracodes du Cénomanien français: mise au point biostratigraphique et paléogéographique. — Géol. Méditerr., 5, 1: 19-26.

Babinot, J.F., R. Damotte, P. Donze, E. Grosdidier, H.J. Oertli & G. Scarenzi-Carboni, 1985. Crétacé Inférieur. In: H.J. Oertli (ed.), Atlas des Ostracodes de France. — Bull. Centres Rech. Explor.-Prod. Elf-Aquitaine, 9: 163-209, 14 pls.

Bartenstein, H. & F. Bettenstaedt, 1962. Marine Unterkreide (B7). In: W. Simon & H. Bartenstein (eds), Leitfossilien der Mikropalaeontologie. — Gebr. Borntraeger, Berlin: 225-297, 9 pls.

Bertram, H. & E. Kemper, 1971. Das Alb von Hannover. — Beih. Ber. Naturh. Ges., 7: 27-47, 3 pls.

Böhm, J., 1925. Zur Fauna des Oberen Alb mit *Mastigoceras adpressum* Sow. sp. bei Ootmarsum (Holland). — Zeitschr. Deutsch. Geol. Ges., 77, 2: 198-205, 1 pl.

Bonnema, J.H., 1940/41. Ostracoden aus der Kreide des Untergrundes der nordöstlichen Niederlande. — Natuurh. Maandbl., 29-30: 1-35, 7 pls.

Bristow, C.R., 1990. Geology of the country around Bury St Edmunds. — Mem. Br. Geol. Surv., Sheet 189 (England and Wales): 1-99.

Chapman, F., 1898. On Ostracoda from the 'Cambridge Greensand'. — Ann. Mag. Nat. Hist., 7, 2: 331-346.

Chapman, F. & C. D. Sherborn, 1893. On the Ostracoda of the Gault at Folkestone. — Geol. Mag., 10, 350: 345-349, 1 pl.

Charollais, J., M. Moulade, H.J. Oertli & F. Rapin, 1977. Découverte de Microfaunes de l'Albien Moyen et Supérieur dans la Vallée de Joux (Jura Vaudois, Suisse). — Géobios, 10, 5: 683-695, 2 pls.

Clarke, B., 1983. Die Cytheracea (Ostracoda) im Schreibkreide-Richtprofil von Lägerdorf-Kronsmoor-Hemmoor (Coniac bis Maastricht; Norddeutschland). — Mitt. Geol.-Paläont. Inst. Univ. Hamburg, 54: 65-168, 15 pls.

Colin, J.P., R.A. Lehmann & B.E. Morgan, 1981. Cretaceous and Late Jurassic biostratigraphy of the North Celtic Sea Basin, offshore Southern Ireland. In: J.W. Neale & M.D. Brazier (eds), Microfossils From Recent and Fossil Shelf Seas. — E. Horwood, Chichester: 122-155, 10 pls.

Damotte, R., 1971a. Quelques ostracodes du Cénomanien de Dordogne et de Touraine. — Revue Micropal., 14, 1: 3-20, 3 pls.

Damotte, R., 1971b. Contribution à l'étude des Ostracodes marins dans le Crétacé du Bassin de Paris. — Mém. Soc. Géol. France, N.S. 50: 1-152, 8 pls.

Damotte, R., 1975. Ostracodes Cénomaniens du bassin de Paris: Quelques résultats d'ordre Paléoécologique et Paléogéographique. — Bull. Am. Paleont., 65: 263-269.

Damotte, R., 1976. Sur le problème de l'évolution des empreintes musculaires chez les Trachyleberidinae albiennes et cénomaniennes du Bassin de Paris. — Abh. Verh. Naturwiss. Ver. Hamburg, NF, 18/19 (Suppl.): 295-303, 3 pls.

Damotte, R., 1977. Sur les genres crétacés : *Rehacythereis*, *Veeniacythereis*, *Cornicythereis*, *Parvacythereis* et *Chapmanicythereis* (Trachyleberididae, Ostracoda) créés par J.Gruendel en 1973. — Revue Micropal., 19, 4: 200-210, 2 pls.

Damotte, R., 1979a. Les ostracodes du stratotype de l'Albien. Biozonation-systématique. — Bull. Centre nat. Rech. Sci., 5: 266-305.

Damotte, R., 1979b. Faunes d'Ostracodes du Stratotype de l'Albien (Aube, France). — Proc. VII Int. Symp. on Ostracodes, Beograd, 1979: 119-123.

Damotte, R., 1983. Les Ostracodes du Cénomanien et du Turonien des régions stratotypiques. Relations avec les faunes mésogéennes. — Zitteliana, 10: 313-316.

Damotte, R. & E. Grosdidier, 1963. Quelques ostracodes du Crétacé de la Champagne Humide. 1. Albien-Cénomanien. — Revue Micropal., 6, 1: 51-66, 3 pls.

Deroo, G., 1956. Études critiques au sujet des ostracodes marins du Crétacé Inférieur et Moyen de la Champagne Humide et du Bas Boulonnais. — Revue Inst. Fr. Pétr., 11, 12: 1499-1535, 5 pls.

Deroo, G., 1966. Cytheracea (Ostracodes) du Maastrichtien de Maastricht (Pays-Bas) et des régions voisines; résultats stratigraphiques et paléontologiques de leur étude. — Med. Geol. Stichting, C, 2, 2: 5-197, 27 pls.

Donze, P. & B. Porthault, 1972. Les Ostracodes de la sous-famille des Trachyleberidinae dans quelques coupes de référence du Cénomanien du Sud-est de la France. — Rev. Esp. Micropal., 4, 3: 355-376, 3 pls.

Donze, P. & G. Thomel, 1972. Le Cénomanien de La Foux (Alpes de Haute-Provence) Biostratigraphie et faunes nouvelles d'Ostracodes. — Eclogae Geol. Helv., 65, 2: 369-389, 3 pls.

Ellermann, C., 1962. Neue Alb-Vorkommen in der Münsterschen Kreidebucht und ihre Mikrofauna. — N. Jb. Geol. Paläont. Mh., 1962: 385-408, 2 pls.

Elstner, F. & E. Kemper, 1989. Die Gliederung der Schichtenfolge Ober-Apt/Unter-Cenoman in Bohrungen des Emslandes. — Geol. Jb., A, 113: 51-71, 4 pls.

Ernst, G., F. Schmid & G. Klischies, 1979. Multistratigraphische Untersuchungen in der Oberkreide des Raumes Braunschweig-Hannover. In: Aspekte der Kreide Europas. —Internat. Union Geol. Sci., A, 6: 11-46.

Frieg, C. & E. Kemper, 1989. Mikropaläontologische Gliederung und Abgrenzung von Ober-Alb und Unter-Cenoman in Nordwestdeutschland. — Geol. Jb., A, 113: 73-193, 23 pls.

Frieg, C., E. Kemper & H.G. Owen, 1989. Die stratigrafische Gliederung des Alb und Cenoman im südwestlichen Münsterland nach Ammoniten, Foraminiferen, Ostrakoden und Bohrlochmessungen. — Geol. Jb., A, 113: 7-49, 5 pls.

Gründel, J., 1966. Taxionomische, biostratigraphische und variationsstatistiche Untersuchungen an den Ostracoden der Unterkreide in Deutschland. — Freiberger Forschungshefte, C 200: 1-105, 10 pls.

Gründel, J., 1969. Ostracoden aus der *plenus*-Zone (Oberkreide) Sachsens. — Freiberger Forschungshefte, C 245: 83-87, 1 pl.

Gründel, J., 1971. Zur Taxionomie und Entwicklung der Gattung *Dolocytheridea* Triebel, 1938 (Crustacea, Ostracoda) in der Unterkreide Mittel- und Westeuropas. — Ber. deutsch. Ges. geol. Wiss., A.: Geol. Paläont., 16, 1: 19-43, 4 pls.

Gründel, J., 1973a. Zur Fassung der Gattung *Lophocythere* (Ostracoda, Crustacea). — Z. geol. Wiss. Berlin, 1, 5: 581-585.

Gründel, J., 1973b. Zur Entwicklung der Trachyleberididae (Ostracoda) in der Unterkreide und in der tieferen Oberkreide. Teil I: Taxonomie. — Z. geol. Wiss. Berlin, 1, 11: 1463-1474.

Hart, M.B., 1973. A correlation of the macrofaunal and microfaunal zonations of the Gault Clay in southeast England. In: R. Casey & P.F. Rawson (eds), The Boreal Lower Cretaceous. — Seel House Press, Liverpool: 267-288.

Herngreen, G.F.W., 1992. Palynologisch onderzoek van een tweetal handstukken uit de bedding van de Bekerinkbeek, omgeving Winterswijk. — Rijks Geol. Dienst, Biostrat. (Palynol.) Mesozoicum, Rapport Nr 2246 (internal report R.G.D.).

Herngreen, G.F.W., K.F. de Boer, B.J. Romein, Th. Lissenberg & N.C. Wijker, 1984. The Middle Callovian beds in the Achterhoek, Eastern Netherlands. — Meded. Rijks Geol. Dienst, 37-3: 95-123, 6 pls.

Herrig, E., 1966. Die Ostracoden aus der Weissen Schreibkreide (Unter-Maastricht) der Insel Rügen. — Paläont. Abh., A, II, 4: 693-1024, 45 pls.

Hinte, J.E. van, J.A.S. Adams & D. Perry, 1975. K/AR Age of Lower-Upper Cretaceous Boundary at Orphan Knoll (Labrador Sea). — Canadian Journ. Earth Sc., 12, 8: 1484-1491.

Horne, D., I. Jarvis & A. Rosenfeld, 1990. Recovering from the effects of an Oceanic Anoxic Event: Turonian Ostracoda from S.E. England. In: R. Whatley & C. Maybury (eds), Ostracoda and Global Events. — Chapman & Hall, London: 123-138, 2 pls.

Jarvis, I., G.A. Carson, M.K.E. Cooper, M.B. Hart, P.N. Leary, B.A. Tocher, D. Horne & A. Rosenfeld, 1988. Microfossil Assemblages and the Cenomanian-Turonian (late Cretaceous) Oceanic Anoxic Event. — Cretaceous Research, 9: 3-103.

Jones, T.R., 1849. A monograph of the Entomostraca of the Cretaceous formation of England. — Palaeontograph. Soc., London: 1-40, 7 pls.

Jones, T.R., & G.J. Hinde, 1890. A supplementary Monograph of the Cretaceous Entomostraca of England and Ireland. — Palaeontograph. Soc., London: 1-70, 4 pls.

Kaye, P., 1963. Ostracoda of the subfamilies Protocytherinae and Trachyleberidinae from the British Lower Cretaceous. — Paläont. Z., 37, 3/4: 225-238, 2 pls.

Kaye, P., 1964. Revision of British Marine Cretaceous Ostracoda with notes on additional forms. — Bull. Br. Mus. (Nat. Hist.), Geol., 10, 2: 37-79, 9 pls.

Kaye, P., 1965a. Some new British Albian Ostracoda. — Bull. Brit. Mus. (Nat. Hist.) Geol., 11, 5: 217-253, 11 pls.

Kaye, P., 1965b. Further ostracoda from the British Lower Cretaceous. — Senckenb. Leth., 46, 1: 73-81, 1 pl.

Keen, M.C. & Q.A. Siddiqui, 1971. Cenomanian Ostracoda from the Carr's Glen Shell Bed of Belfast, Northern Ireland. — Revue Micropal., 14, 1: 62-68, 2 pls.

Keller, S., E. Kemper, R. Koch, J. Mutterlose, Th. Nöltner, H.G. Owen, Chr. Spaeth, P. Stoffers, P. Walter & W. Zimmerle, 1989. Das Unter- und Mittel-Alb von Alfeld (Leine). — Geol. Jb., A, 113: 223-316, 13 pls.

Kemper, E., 1976. Geologischer Führer durch die Grafschaft Bentheim und die angrenzenden Gebiete, mit einen Abrisz der emsländischen Unterkreide. — Verlag Heimatverein Grafschaft Bentheim e.V., Nordhorn, 5. Auflage: 1-206, 34 pls.

Kemper, E., 1989a. Das Mittel-Alb im östlichen und mittleren Niedersächsischen Becken. — Geol. Jb., A, 113: 195-221, 4 pls.

Kemper, E., 1989b. Vorschlag einer mikropaläontlogische Gliederung von Apt und Alb in Mitteleuropa. — Geol. Jb., A, 113: 451-469, 2 pls.

Malz, H., 1974. *Homocythere howei* n. sp.: A contribution toward retaining a 'juvenile genus'. — Geosc. & Man, 6: 41-45, 1 pl.

Malz, H., 1982. New data on Indopacific Hemikrithe. In: R.H. Bate, E. Robinson & L.M. Sheppard (eds), Fossil and Recent Ostracods. — E. Horwood, Chichester: 219-230, 3 pls.

Mertens, E., 1956. Zur Grenzziehung Alb/Cenoman in Nordwestdeutschland mit Hilfe von Ostracoden. — Geol. Jb., 72: 173-230, 7 pls.

Neale, J.W., 1962. Ostracoda from the type Speeton Clay (Lower Cretaceous) of Yorkshire. — Micropaleontology, 8, 4: 425-484, 13 pls.

Neale, J.W., 1977. Cretaceous Ostracoda of the North Atlantic Basin. In: F.M. Swain (ed.), Stratigraphic Micropaleontology of Atlantic Basin and Borderlands. — Elsevier, Amsterdam: 245-270, 3 pls.

Neale, J.W. 1978. The Cretaceous. In: R. Bate & E. Robinson (eds), Stratigraphical index of British Ostracoda. — Seel House Press, Liverpool: 325-384, 17 pls.

Nederlandse Aardolie Maatschappij B.V., 1974. Explanation to Tectonic Maps of The Netherlands, compilation and comments by P. Heybroek. — Geol. & Mijnbouw, 53, 2: 43-50.

Nuyts, H., 1990. *Krausella minuta*, a nomen nudum in ostracodology, and three new species of *Cardobairdia* Bold, 1960 from the Campanian of Belgium and the Cenomanian of southern England. — J. Micropal., 9, 1: 65-70, 1 pl.

Schwarzkopf, J., 1991. Palökologie der Ostracoden-Faunen des Santons und Campans der Bohrung Metelen 1001 (NW-Deutschland). — Facies, 24: 159-182, 2 pls.

Shahin, A., 1991. Cenomanian-Turonian ostracods from Gebel Nezzazat, southwestern Sinai, Egypt, with observations on ∂13C values and the Cenomanian/Turonian boundary. — J. Micropal., 10, 2: 133-150, 4 pls.

Stapert, D., 1974. Over het Onder Krijt in de omgeving van Winterswijk. — Grondboor & Hamer, 4: 62-77.

Triebel, E., 1938. Ostracoden-Untersuchungen. 1. *Protocythere* und *Exophtalmocythere*, zwei neue Ostracoden-Gattungen aus der deutschen Kreide. — Senckenbergiana, 20: 179-200, 3 pls.

Triebel, E., 1940. Die Ostracoden der deutschen Kreide. 3). Cytherideinae und Cytherinae aus der Unteren Kreide. — Senckenbergiana, 22: 160-227, 10 pls.

Veen, J.E. van, 1932. The Cytherellidae der Maastrichter Tuffkreide und des Kunrader Korallenkalkes von Süd-Limburg. — Verh. Geol.-Mijnbouwk. Genootsch. Nederl. Kol., Geol. Ser., 9: 317-364, 25 pls.

Veen, J.E. van, 1936. Nachtrag zu der bis jetzt erschienenen Revision der Ostracoden der Maastrichter Tuffkreide und des Kunrader Korallenkalkes von Süd-Limburg. — Natuurh. Maandbl., 25: 170-188, 2 pls.

Weaver, P.P.E., 1982. Ostracoda from the British Lower Chalk and Plenus Marls. Monogr. Palaeontogr. Soc., 562: 1-127, 20 pls.

Wiel, A.M. van der, 1978. Ostracodes from the Albian of Petit Blanc-Nez (NW-France) with emphasis on evolution in the *Cythereis reticulata-hirsuta-folkstonensis*-group — Proc. Kon. Ned. Akad. Wetensch. Amsterdam, B, 81, 2: 248-262, 4 pls.

Wilkinson, I.P., 1988. Ostracoda across the Albian/Cenomanian Boundary in Cambridgeshire and Western Suffolk, Eastern England. In: T. Hanai, N. Ikeya & K. Ishizaki (eds), Evolutionary biology of Ostracoda, its fundamentals and applications. — Elsevier, Amsterdam: 1229-1244. 3 pls.

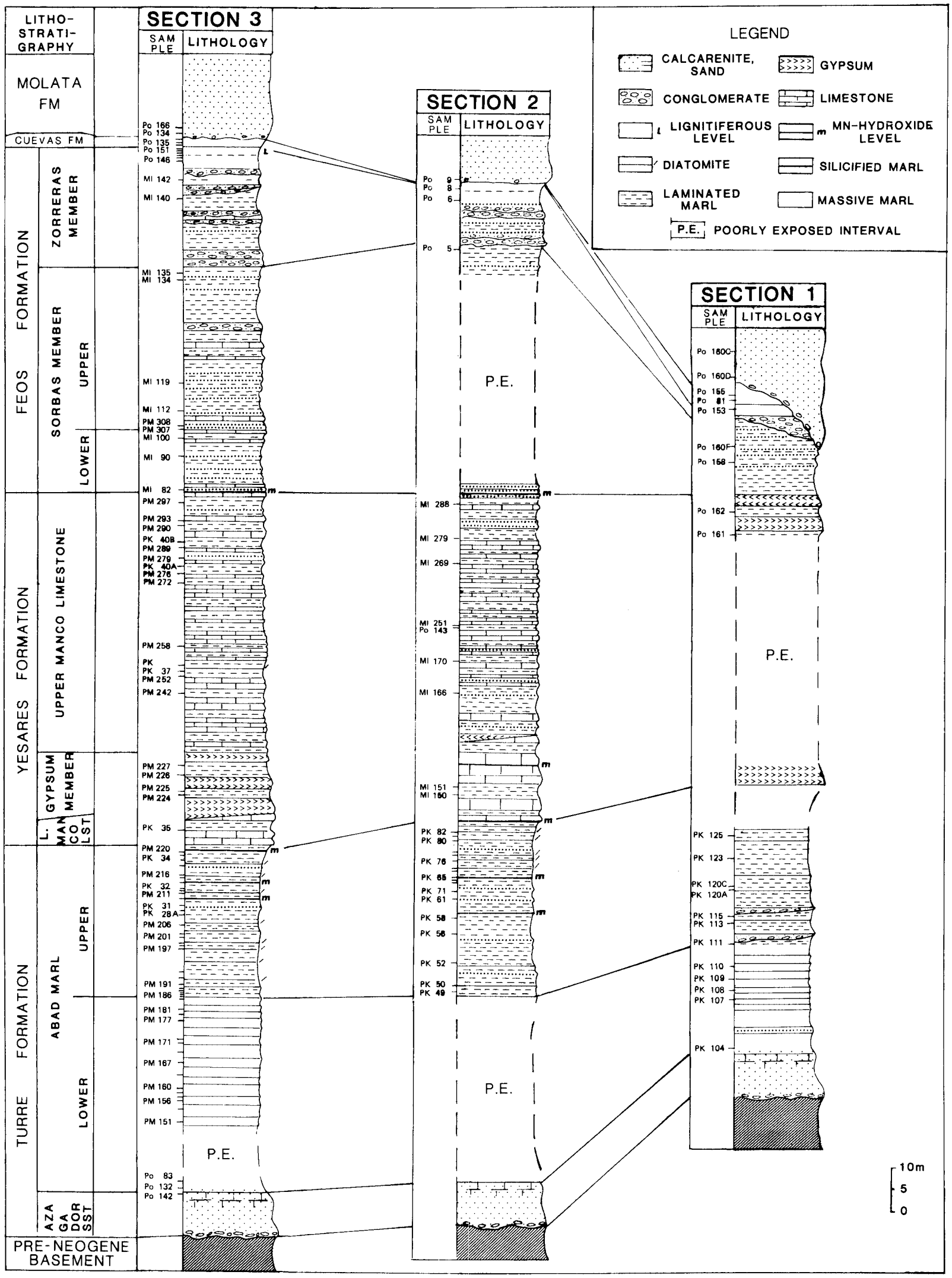
Wilkinson, I.P., 1990. The biostratigraphical application of Ostracoda in the Albian of eastern England. — Cour. Forsch.-Inst. Senckenberg, 123: 239-258, 1 pl.

Wilkinson, I.P. & A.A. Morter, 1981. The biostratigraphical zonation of the East Anglian Gault by Ostracoda. In: J.W. Neale & M.D. Brasier (eds), Microfossils From Recent and Fossil Shelf Seas. — E. Horwood, Chichester: 163-176, 2 pls.

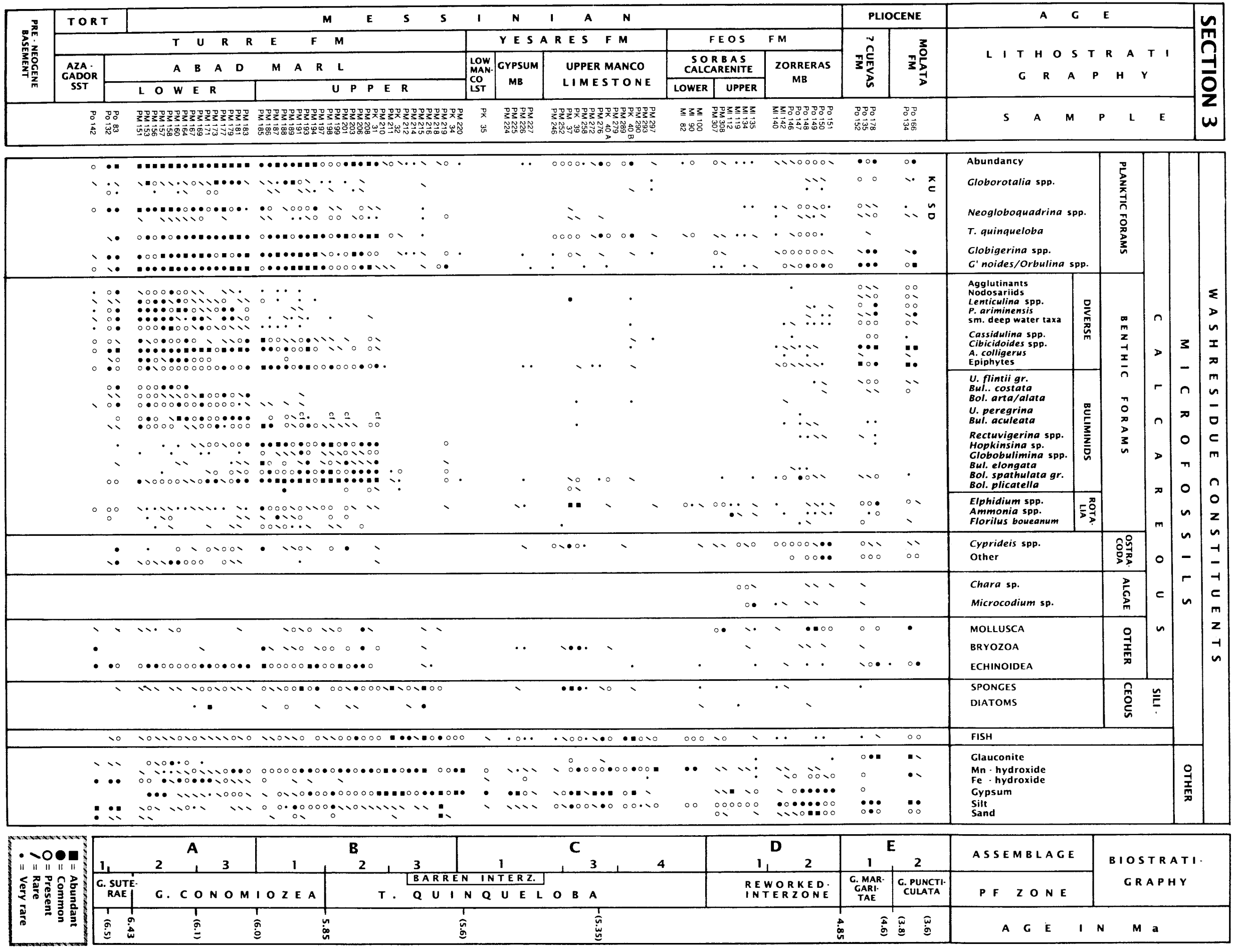
Manuscript received 16 March 1992.

Index of species and genera

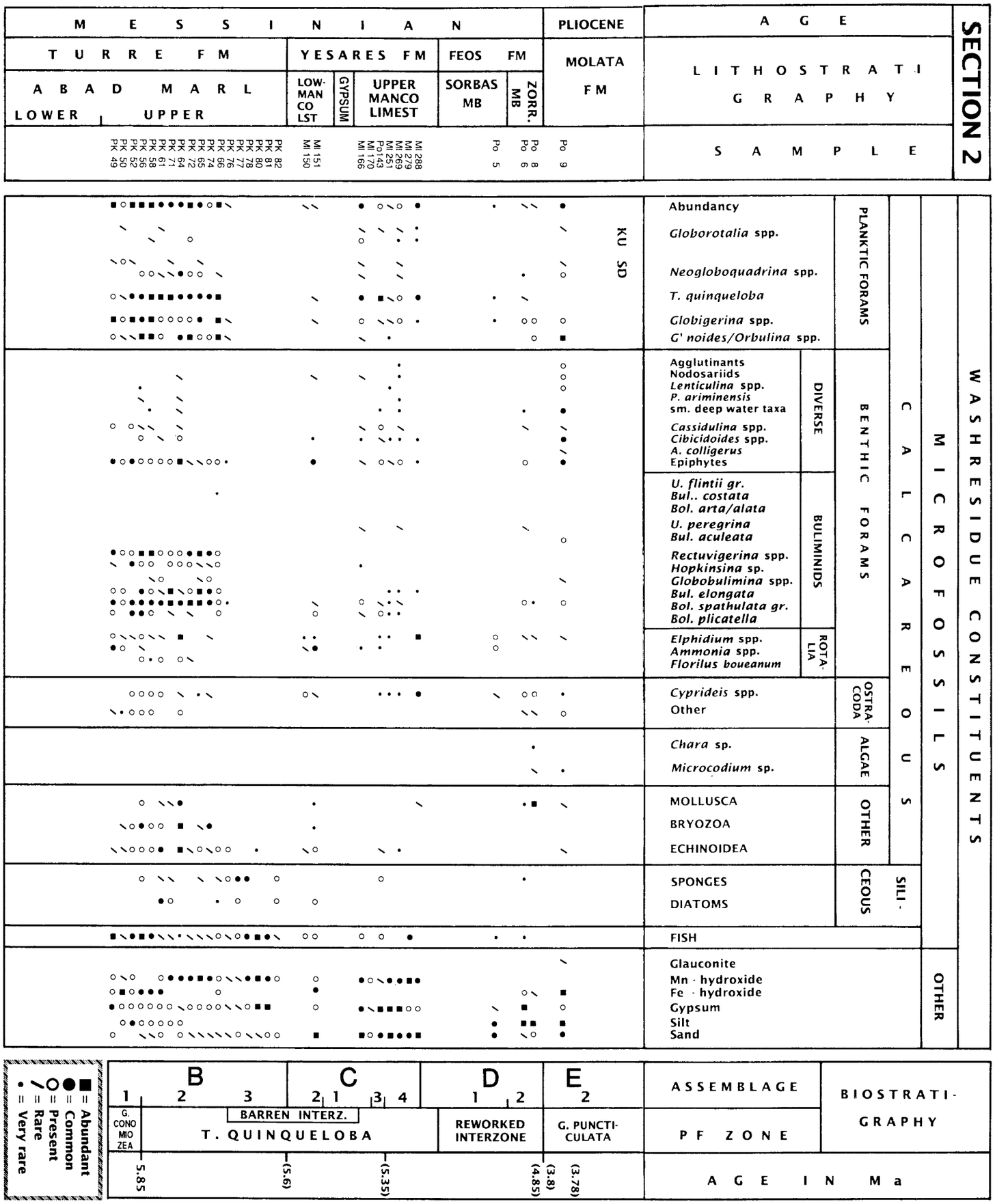
Enclosure 1. Lithology, lithostratigraphic subdivision, correlation and sample position of measured composite sections 1-3.



Enclosure 2. Microfossil distribution chart and zonation of section 3. Under *Globorotalia:* K = keeled, U = unkeeled; under *Neogloboquadrina* S = sinistral, D = dextral.



Enclosure 3. Microfossil distribution chart and zonation of section 2. Under *Globorotalia:* K = keeled, U = unkeeled; under *Neogloboquadrina* S = sinistral, D = dextral.



Enclosure 4. Microfossil distribution chart and zonation of section 1. Under *Globorotalia*: K = keeled, U = unkeeled; under *Neogloboquadrina* S = sinistral, D = dextral.