A PRELIMINARY INVESTIGATION OF KIMMERIDGIAN DINOFLAGELLATES AND OSTRACODES FROM QUERCY, SOUTHWEST FRANCE

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The present paper provides the first account of Kimmeridgian (*Mutabilis- Gravesia* ammonite zones) Dinoflagellates and associated Ostracodes from southwest France. Comparisons with coeval assemblages from Northwest Europe show close similarities. The Dinoflagellates largely correspond to WOOLLAM & RIDING's (1983) *Scriniodinium luridum* Zone and NØRH-HANSEN's (1986) *Stephanelytron scarburghense-Perisseiasphaeridium pannosum* Subzones. There are brief remarks on similar ostracode associations; their affinity to the *Galliaecytheridea elongata* Zone of CHRISTENSEN & KILENYI, *emend.* WILKINSON (1983b), is noted.

Environmental interpretations based on ostracode faunas and assemblages of Dinoflagellates and organic matter are consistent with the present sedimentation picture accepted for the Aquitaine Basin.

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Key words : Dinoflagellates, Ostracods, Biostratigraphy, Paleoenvironment, Lot, Quercy, France.

RÉSUMÉ

Cet article présente les premières données concernant les associations de Dinoflagellés et Ostracodes du Kimmeridgien (Zones d'Ammonites de *Mutabilis-Gravesia*) du Quercy, sud-ouest de la France. Des comparaisons avec des associations de même âge d'Europe du Nord-Ouest montrent de fortes ressemblances. Les Dinoflagellés correspondent en grande partie à la Zone à *Scriniodinium luridum* de WOOLLAM & RIDING (1983) et aux Sous-zones *Stephanelytron scarburghense-Perisseiasphaeridium pannosum* de NØRH-HANSEN (1986). De brèves remarques sont faites sur des associations identiques d'Ostracodes; leur affinité avec la Zone à *Galliaecytheridea elongata* de CHRISTENSEN & KILENYI *emend.* WILKINSON (1983b) est remarquée.

L'interprétation des paléoenvironements, fondée sur les faunes d'Ostracodes et les assemblages de Dinoflagellés et la matière organique, est en accord avec les modèles sédimentaires actuellement acceptés pour le Bassin d'Aquitaine.

Mots-clefs : Flore dinoflagellé, Ostracodes, Biostratigraphie, Paléoenvironnement, Lot, Quercy, France.

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INTRODUCTION

The Quercy area is part of the southern margin of the Central Massif of eastern Aquitaine. It is traditionally known as "Bas Quercy" and "Haut Quercy" (Lower and Upper Quercy). The area of our interest is the Haut Quercy which is situated in the heart of the Lot Valley, some 10 km west of the major city of Cahors (Fig.1).

The Lower Kimmeridgian[1] sedimentation was initiated with a widespread transgression which deposited extensive mudstone sequences associated with Ammonites and *Exogyra* beds. Intercalated thin bands of bituminous shales in the late *Eudoxus* Zone are thought to represent a period of sea level rise. They are probably related to HAQ'S *et al.* (1987) 141.0 Ma event. The sea retreated in the Upper Kimmeridgian (*Gravesia* Zone) during which period carbonate littoral deposits dominate the area (DELFAUD, 1978). A cyclic stratigraphic interpretation was proposed by DELFAUD for the region of Aquitaine. The sediments investigated here largely correspond to DELFAUD's (1978) sequences KII-KIV, and PÉLISSIÉ & PEYBERNÈS' (1982) megasequence III. An alternative sequence stratigraphic interpretation (sensu HAQ *et al.*, 1987) will be presented in the final version of this study.

In the vicinity of Cahors the lower part of the Lower Kimmeridgian (equivalent to *Baylei* and *Cymodoce* Ammonite Zones) essentially consists of basal breccias ("Brèches de Cras"), limestones and bioturbated micritic limestones containing soft pebbles; clays and marls with breccias are interbedded (Formation de Cras). The upper part contains a rich microfauna of *Alveosepta jaccardi* (arenaceous Foraminifera) and Ammonites of the genus *Rasenia* (HANTZPERGUE & LAFAURIE, 1983).

The upper Lower Kimmeridgian (*Mutabilis -Autissiodorensis* Zones) which is the subject of this paper is made up of an alternating sequence of grey marls and limestones and bituminous shaly horizons within bioclastic carbonates in the upper portion of the section (Formation de Francoulès).

The palaeontologic contents have been revised by HANTZPERGUE (1983) and include abundant *Everticyclammina virguliana* (arenaceous Foraminifera), Oysters and Ammonites (*Aspidoceras, Aulacostephanus*).

The lower Upper Kimmeridgian (*Gravesia gigas* Zone) is a sequence of mainly micritic, blocky, cross-bedded, often bioturbated limestones. *Exogyra* is abundant as well as *Nannogyra virgula* (Formation de Peyrilles). The age is based on the extinction of *Aulacostephanus* and appearance of *Gravesia* (HANTZPERGUE & LAFAURIE, 1983).

Sections investigated : Cingle de Parnac, Crayssac Sud, Pont de Rhode.

The approximate geographic locations of the sections are shown in Figure 1; they extend from northeast of Quercy down to the Lot Valley. The section at Cingle de Parnac incorporates both Lower Kimmeridgian (*Mutabilis, Eudoxus* and *Autissiodorensis* Ammonite Zones; approx. 130m in thickness) and Upper Kimmeridgian rocks (*Gravesia gigas* Zone; 9m thick). The lithologies are basically alternating marls, carbonates and minor intercalations of bituminous shales in the Lower Kimmeridgian and mostly limestones in the Upper Kimmeridgian. They have been dated mainly by means of Ammonites which are nevertheless scarce in the area. The section approximates the *Everticyclammina virguliana* Zone established by PÉLISSIÉ & PEYBERNÈS (1982) and PÉLISSIÉ *et al.* (1984) for the area of Quercy, a Foraminifer characteristic of circa- to infralittoral open shelf environments.

Fourteen of the samples were collected from Cingle de Parnac, one sample from south of Crayssac (Fig.2) and two samples from a small exposure northeast of Pont de Rhode (951 and 952 : *Mutabilis* Zone). All samples were collected by one of the writers (R.J.d. C.). Dinoflagellates and to a lesser degree Ostracodes provided additional evidence for the stratigraphic position of these sections. The data obtained are discussed below.

Palynological preparations

The rock samples were prepared by means of standard techniques using hydrochloric and hydrofluoric acids to remove the minerals. Oxidation of the sapropelic residue and the release of the palynomorphs was most effectively achieved through repeated, brief applications of Schulze's solution, and ultrasonic treatment. A base was also used if it was thought to be necessary.

A set of slides as well as the Ostracode specimens are housed in the micropalaeontology

(1) In this paper the subdivisions of the Kimmeridgian are those used in the British sense. Comparisons of local terminologies are shown in Figure 3 (see also DEBRAND-PASSARD *et al.*, 1980).

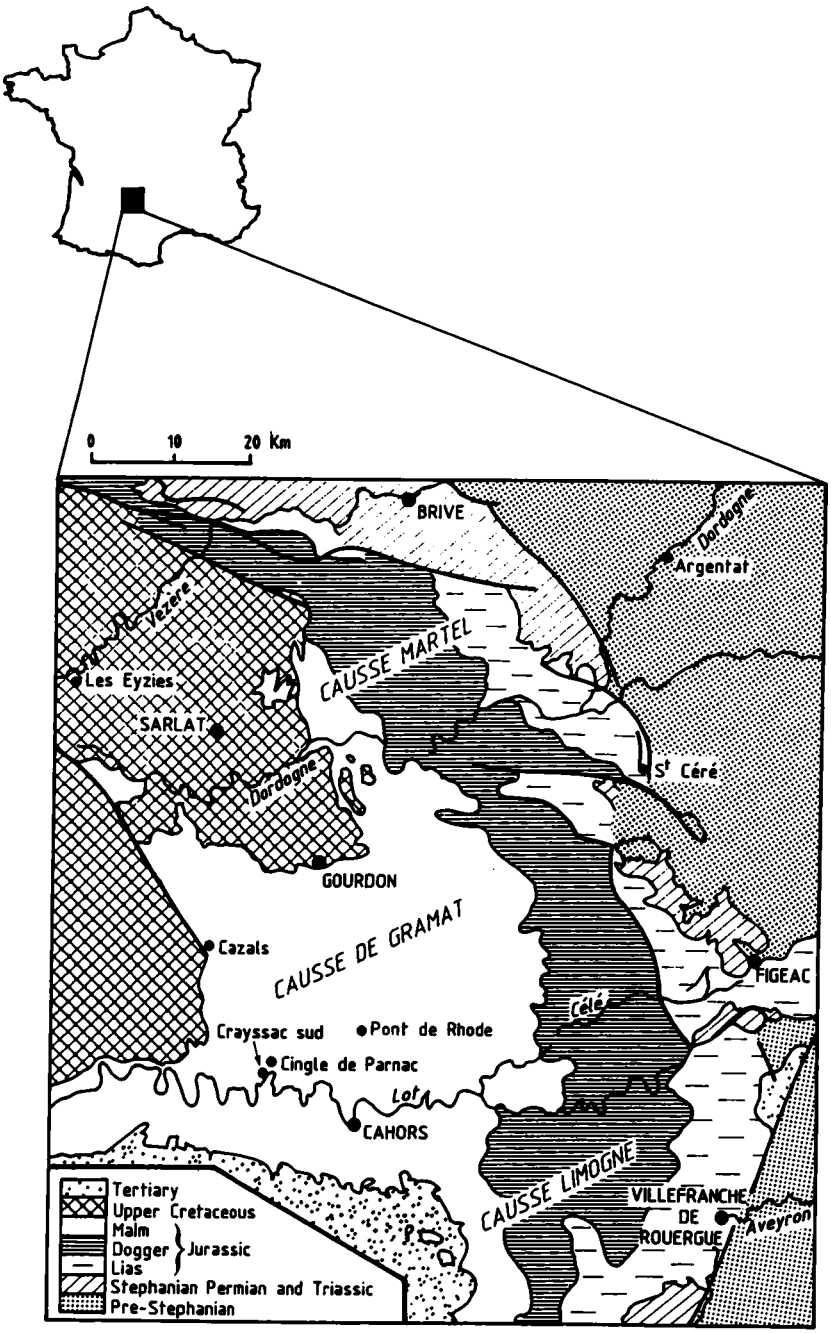
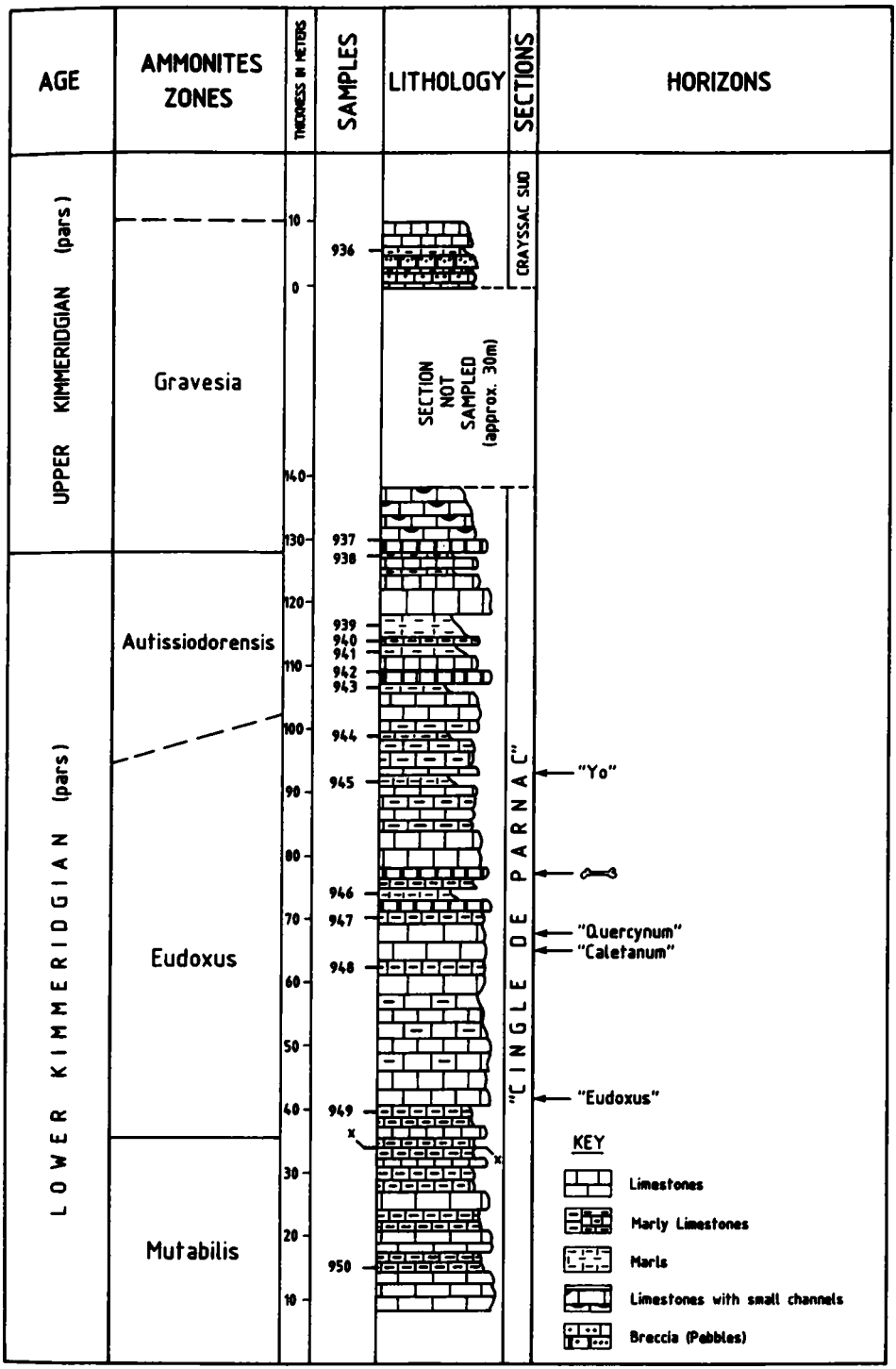


FIGURE 1
Location of sections studied (modified from DELFAUD, 1978)


AGE
AMMONITES ZONES
THICKNESS IN METERS
SAMPLES
LITHOLOGY
SECTIONS
HORIZONS
UPPER KIMMERIDGIAN (pars)
LOWER KIMMERIDGIAN (pars)
Gravesia
Autissiodorensis
Eudoxus
Mutabilis
GRAYSSAC SUD
SECTION NOT SAMPLED (approx. 30m)
"CINGLE DE PARNAC"
10
0
140
130
120
110
100
90
80
70
60
50
40
30
20
10
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
"Yo"
"Quercynum"
"Caletanum"
"Eudoxus"
KEY
Limestones
Marly Limestones
Marls
Limestones with small channels
Breccia (Pebbles)

collection of Esso Production Research-European, Bègles, France. Dinoflagellates were photographed with a Zeiss Axiophot photomicroscope.

Dinoflagellates : General discussion

Kimmeridgian microplankton is entirely unknown in southwest France and only very sporadically known in the rest of the country; most of the studies have originated from northern France (e.g. BITMEZ & SARJEANT, 1972).

The Kimmeridgian of southern and southeast France has been equally neglected although a few records from the French Jura were published by BITMEZ & SARJEANT (1972).

The present study represents the first account from southwest France. The results obtained from Quercy have encouraged the writers to consider further investigation in order to include additional samples from this and other sections in the area of Cahors. Results from these studies will be presented in a separate paper.

Most of the 17 samples analyzed yielded rich and well preserved but not always diversified assemblages. Many of the samples, although seemingly diversified, are dominated by one or two species (e.g. species of the genera *Geiselodinium* or *Dingodinium*); the remaining taxa are subordinate to the assemblages represented by a few specimens only. This type of assemblage is more obvious in the *Gravesia* Zone. Chorate cysts are rare and more so above the late *Eudoxus* Ammonite Zone. Spores and pollen may be intermittently common. The organic matter is largely structureless, often bearing framboidal pyrites.

This type of palynomorph association is thought to reflect shallow and restricted, low energy depositional environments. Levels with high quantities of amorphous and microplankton were probably developed in stratified bottom waters (or restricted environments - very low diversity populations) which contained very little dissolved oxygen. A proliferation of anaerobic bacteria released sulphur which was precipitated in the form of pyrites. This type of assemblage was previously reported from other areas, for instance Dorset and Yorkshire, England, and they are preserved as bituminous beds of variable thickness. They probably represent periods of sea level rise which promoted high productivities of microplankton.

The scarcity of other fossils and the poor preservation of microfossils (Ostracodes, calcareous Foraminifera) are additional evidence for poor oxygenation. In Quercy this environmental inference is consistent with Ostracode information discussed in this paper as well as with DELFAUD's (1978) sedimentological observations on the Aquitaine. Delfaud noted that the entire region is covered with "tidal flat" deposits (vasières *sensu* DELFAUD) on shallow platforms whereas local oolithic developments represent vestiges of a former high energy environment (pre-Kimmeridgian). Despite the relatively quiet environments of deposition which may characterize DELFAUD's "vasières" and littoral lagoons, continued subsidence allowed extensive accumulations of Kimmeridgian sediments in Aquitaine (as much as 300 m). Immense "vasières" on open, occasionally barred platforms are also suggested by PÉLISSIÉ *et al.* (1984).

The stratigraphic distribution of Dinoflagellates is also interesting. Many of the species range through the investigated section but most are restricted to the lower part of the sequence, a few to the upper part. The subtle palaeoenvironmental changes probably played a significant role in the pattern of the dinocyst distribution (e.g. *Gonyaulacysta longicornis*[2] restricted to near the *Mutabilis/Eudoxus* limit). Also the variable success in extracting the palynomorphs must have influenced to a certain degree their apparent distribution. However, the evolutionary changes remain the major factors for their successive regional appearances and extinctions.

Composition and comparisons

As the aim of this short report is not the establishment of a local dinocyst subdivision but

(2) For species citations see LENTIN & WILLIAMS (1985) and STOVER & EVITT (1978).

FIGURE 2

Generalized section showing ammonite zones and stratigraphical positions of samples examined (modified from DELFAUD *et al.*, 1987)

Horizons refer to Ammonites and bone bed

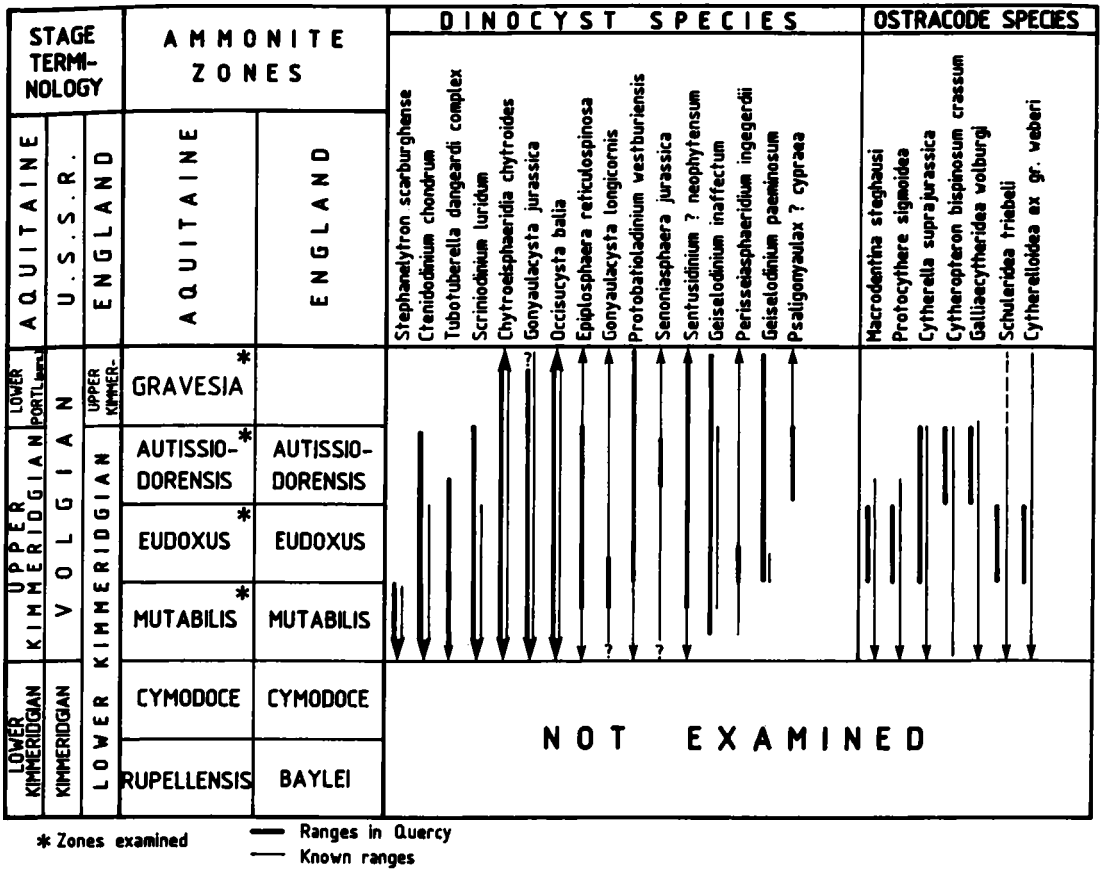


FIGURE 3
Selected dinoflagellate and ostracode ranges plotted against ammonite zones and local stage terminologies

the confirmation of existing ones outside their reported geographic limits, comments on previous zonations are not included here. Details and useful discussions may be found in late Jurassic literature, e.g. NØRH-HANSEN (1986) and WOOLLAM & RIDING (1986).

On the whole, the homogeneity of the assemblages and the stratigraphic ranges of certain species are found to characterize this interval in northwest Europe. Many species are recorded from wide areas (e.g. *Geiselodinium inaffectum*), others are apparently more restricted geographically and are poorly known (geographic/ecologic variants or new species, e.g. *Gongylodinium* sp.).

Amongst important species are *Geiselodinium inaffectum* (common to abundant), *Geiselodinium paeminosum*, *Gonyaulacysta jurassica*, *Occisucysta balia*, *Protobatioladinium westburiensis*, *Valensiella ovula*, *Chytroeisphaeridia chytroides*, *Scriniodinium inritibilum*, *Scriniodinium luridum*, *Sentusidinium ? neophytensum*, *Stephanelytron scarburghense*, *Senoniasphaera jurassica*, *Ctenidodinium chondrum*, *Tubotuberella dangeardii* complex (Fig. 4). Other species also appear to be important components but their stratigraphic significance will be evaluated on the completion of the study. A more complete range chart will then be presented.

The extension of the genus *Geiselodinium* into the *Gravesia* Zone is of great significance for regional correlations; it is similarly recorded from southern England (personal records). The lack of *Scriniodinium luridum* from the *Gravesia* Zone is considered the major qualitative difference bet-

'een this and the subjacent zones. It is recorded ere from one zone higher (*Autissiodorensis* Zone) ıan that indicated by WOOLLAM & RIDING (1983; 'udoxus Zone) and is similarly found in Dorset and orkshire (personal records). Another significant xtinction is that of the genus *Stephanelytron* in ıe *Mutabilis* Zone as is also shown by NØRH-ANSEN (1986). Other similarities with NØRH-'ANSEN's material may be noted.

Specific appearances (bases) are equally im-ortant although less frequently used in biostrati-raphic well interpretation (Fig.3). Notable ones ıclude *Gonyaulacysta longicornis, Geiselodinium ıaffectum, Sentusidinium ? neophytensum* (*Mu-ıbilis* Zone), *Geiselodinium paeminosum, Peris-eiasphaeridium ingegerdii* (*Eudoxus* Zone), *Se-oniasphaera jurassica, Psaligonyaulax ? cypraea* Autissiodorensis Zone).

All the above species were previously recorded om southern and northern England (unpublished ıformation). NØRH-HANSEN's work remains the ıost detailed study for this part of the stratigra-hic column. Some of the above species show the ıme or similar ranges (see range chart). Exclusive ccurrences are also obvious and are almost ertainly caused by lithoecological factors. Impor-ınt are : *Glossodinium dimorphum, Perisseia-phaeridium pannosum* and *Scriniocassis dictyo-ıs*, not yet seen in Quercy and *Senoniasphaera ırassica* and *Psaligonyaulax ? cypraea*, not repor-d from Westbury but seen elsewhere in England. ther differences are also noted but not discussed ere. Detailed comparisons, both numerical and ıalitative with northwest European assemblages ill be presented in the final version of this study. is however already evident that Dinoflagellates ın be extremely effective in correlating Kimme-ıgian rocks on a regional basis.

stracodes

In the area of Quercy Ostracodes are virtually ıknown. As already noted by DÉPÊCHE (1985) ticles on late Jurassic Ostracodes in France are nost exclusive to the Paris basin (OERTLI, 1957). southwest France some information may be ınd in OERTLI (1963) who illustrates Kimmerid-ın to Portlandian Ostracode associations from ıarente and Charente-Maritime. DONZE (1960) blished late Jurrasic Ostracodes from the Ile)léron (Charente-Maritime). Despite the limited mpling and the inadequate preservation of the crofauna, the few Ostracodes extracted for the it time from the Kimmeridgian of Quercy are ırth reporting.

The three samples which yielded Ostracodes are :

941 (*Autissiodorensis* Zone) : *Galliaecytheridea* sp. cf. *G. wolburgi* (STEGHAUS) CHRISTENSEN & KILENYI, *Cytheropteron bispinosum crassum* SCHMIDT.

947 (*Eudoxus* Zone) : *Cytherella suprajurassica* OERTLI

949 (*Eudoxus* Zone) : *Schuleridea triebeli* (STEGHAUS), *Cytherella suprajurassica* OERTLI, *Macrodentina* ex gr. *M. steghausi* KLINGLER, *Cytherelloidea* gr. *C. weberi* STEGHAUS (group of *C. weberi - C. paraweberi*) and *Protocythere* sp. cf. *P. sigmoidea* STEGHAUS.

Black shale facies (organic rich) because of low oxygen availability yielded no Ostracodes. Most of the reported species are known to occur in the Early Kimmeridgian *sensu anglico* in Europe (KILENYI, 1969, 1978; DÉPÊCHE, 1985; OERTLI, 1957, 1958; CHRISTENSEN & KILENYI, 1970; BIELECKA *et al.* 1976).

FERNET (1961) published a similar assemblage which consisted of *Cytherella suprajurassica, Cytherelloidea weberi, Macrodentina steghausi, Protocythere sigmoidea* and *Schuleridea triebeli* from the *Pseudomutabilis* Zone in the borehole St.Felix in Charente (SW France).

In Quercy the association observed in sample 949 (*Eudoxus* Zone) is characteristic of the *Galliaecytheridea elongata* Zone of CHRISTENSEN and KILENYI *emend.* WILKINSON (1983b) for northwestern Europe. Of particular interest is the presence of *Macrodentina* ex gr. *M. steghausi*. Species of this genus with a similar or related ornamentation pattern, as for example the development of vertical ribs and triangular pattern, are restricted to the Late Oxfordian to Early Kimmeridgian interval (MALZ, 1958).

The relatively high diversity and the presence of representatives of the genera *Macrodentina* and *Cytherelloidea* in sample 949 indicate a shallow water, probably inner neritic environment. The former genus is known for its wide tolerance of salinity variations from hypo- to hypersaline environments (KILENYI, 1978; MALZ, 1958); as the genus *Schuleridea* WILKINSON (1983a), *Macrodentina* has also been regarded as a typical "opportunist".

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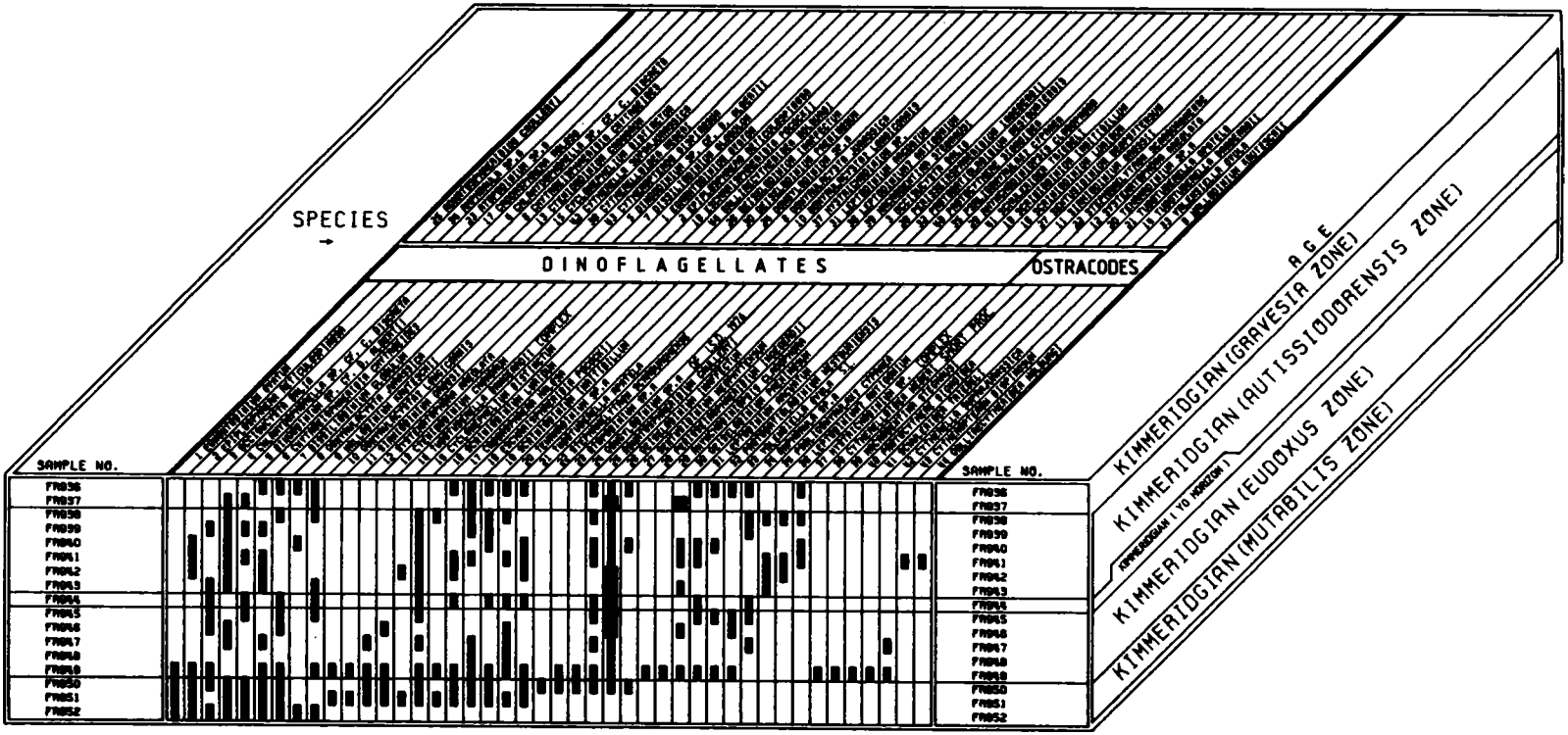

FIGURE 4
Stratigraphic ranges of selected dinoflagellate and ostracode species at Quercy

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PLANCHE / *PLATE* 1

All figures x 600

All species shown are also known from pre-Kimmeridgian rocks

Fig. 1. — *Chytroeisphaeridia chytroeides* SARJEANT, 1962, *emend.* DAVEY, 1979b.
Sample 949.

2. — *Escharisphaeridia pocockii* (SARJEANT, 1968) ERKMEN & SARJEANT, 1980.
Sample 938. The species restricted to granular forms.

3. — *Sentusidinium* sp. A.
Sample 938. Note extremely fine, short pointed processes.

4. — *Caddasphaera halosa* (FILATOFF, 1975) FENTON *et al.*, 1980.
Sample 951.

5, 7, 12. — *Atopodinium* sp. A.
Samples 951, 950 : Note variable ornament confined to hypocyst, mainly on antapex.

6. — *Cleistophaeridium polyacanthum* GITMEZ, 1970.
Sample 950.

8. — *Gonyaulacysta jurassica* (DEFLANDRE, 1938) NORRIS & SARJEANT, 1965.
Sample 949.

9. — *Sirmiodinium grossii* ALBERTI, 1961.
Sample 950.

10. — *Scriniodinium luridum* (DEFLANDRE, 1938) KLEMENT, 1960.
Sample 951.

11. — *Tubotuberella apatela* (COOKSON & EISENACK, 1960) IOANNIDES *et al.*, 1976.
Sample 952. Atypical form; typical specimens are also present.

13. — *Mendicodinium groenlandicum* (POCOCK & SARJEANT, 1972) DAVEY, 1979a.
Sample 949.

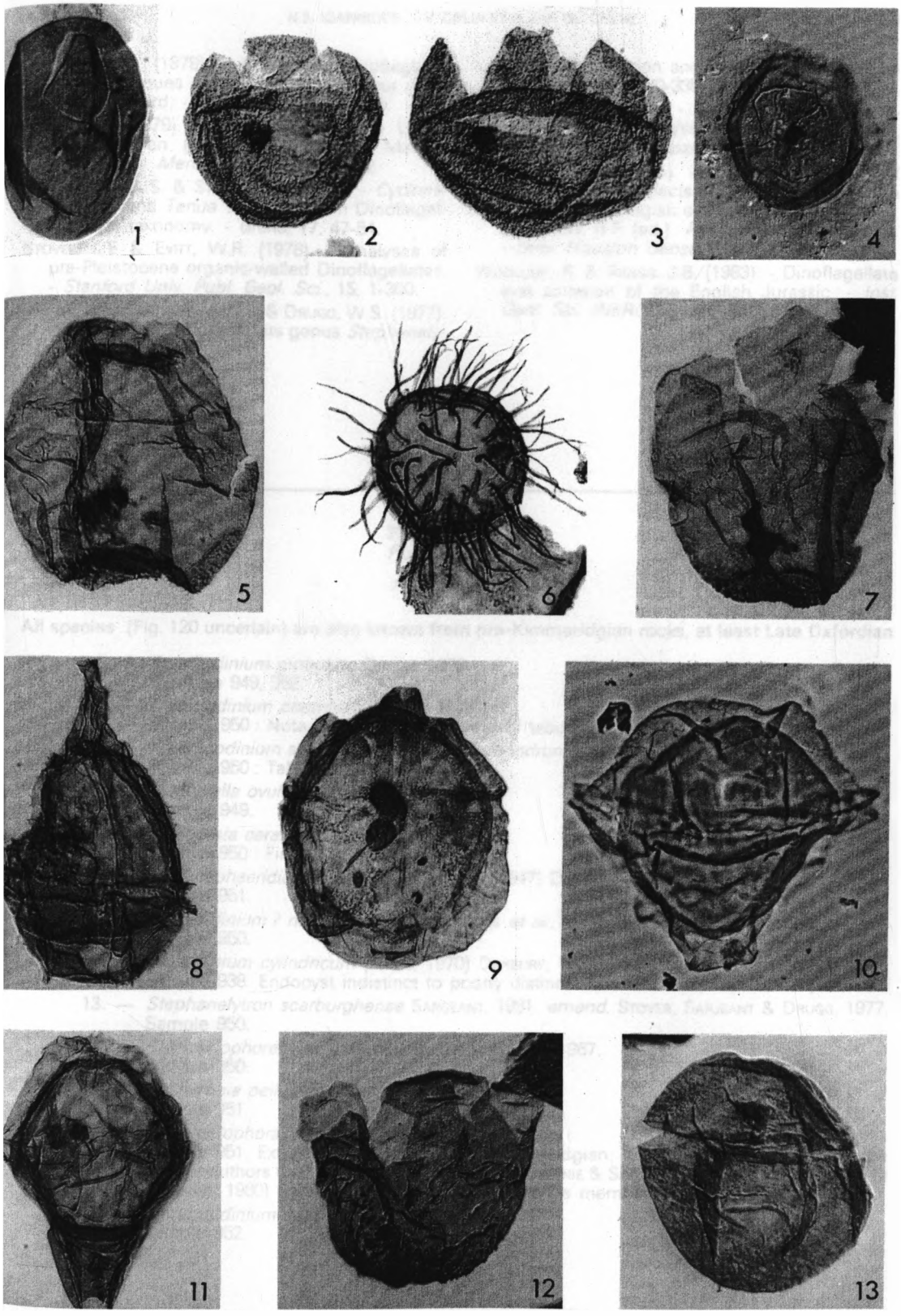
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PLANCHE
PLATE **2**

All figures x 600

All species (Fig. 120 uncertain) **are also known from pre-Kimmeridgian rocks, at least Late Oxfordian**

Fig. 1, 3. — *Dissiliodinium globulum* DRUGG, 1978.
Samples 949, 952.

2, 4. — *Ctenidodinium chondrum* DRUGG, 1978.
Sample 950 : Note variable development of tabulation

5, 6. — *Mendicodinium* sp. A. (*Ctenidodinium chondrum* complex).
Sample 950 : Tabulation not indicated.

7. — *Valensiella ovula* of IOANNIDES *et al.*, 1976.
Sample 949.

8. — *Pareodinia ceratophora* DEFLANDRE, 1947.
Sample 950 : Finely granular form.

9. — *Cleistosphaeridium polytrichum* (VALENSI, 1947) DAVEY *et al.*, 1969.
Sample 951.

10. — *Sentusidinium ? neophytensum* (IOANNIDES *et al.*, 1976) SARJEANT & STOVER, 1978.
Sample 950.

11, 12. — *Wallodinium cylindricum* (HABIB, 1970) DUXBURY, 1983.
Sample 938. Endocyst indistinct to poorly distinct.

13. — *Stephanelytron scarburghense* SARGEANT, 1961, *emend.* STOVER, SARJEANT & DRUGG, 1977.
Sample 950.

14. — *Chlamydophorella* cf. *discreta* CLARKE & VERDIER, 1967.
Sample 950.

15. — *Heslertonia pellucida* GITMEZ, 1970.
Sample 951.

16, 17. — *Systematophora areolata* KLEMENT, 1960.
Sample 951. Extremely variable in Early Kimmeridgian; forms sometimes attributed by various authors to *S. valensii* (SARJEANT, 1960) DOWNIE & SARJEANT, 1965, and *S. iunctispina* (KLEMENT, 1960) STOVER & EVITT, 1978, appear to be members of *S. areolata*.

18. — *Egmontodinium* sp. A.
Sample 952.

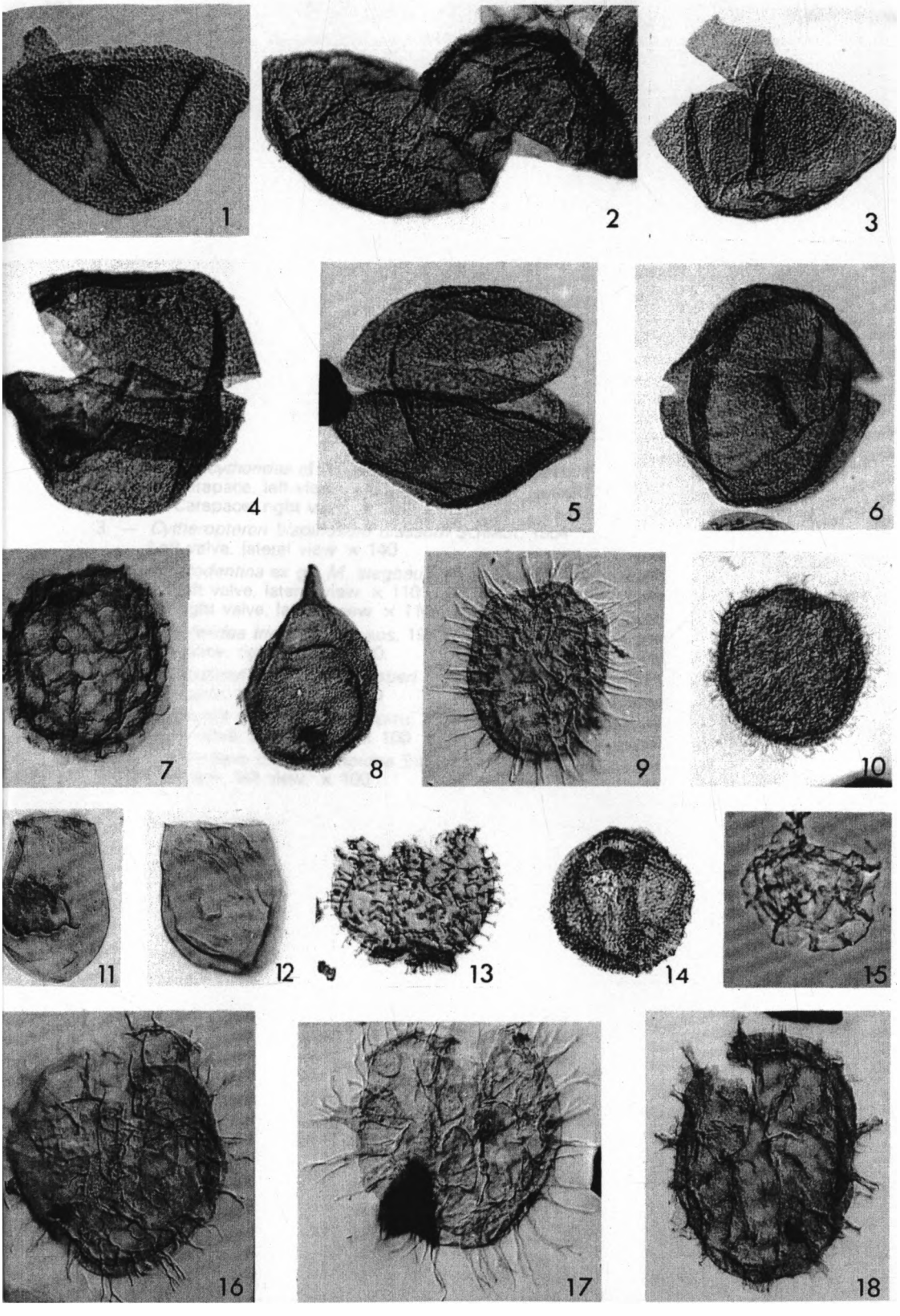
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PLANCHE / *PLATE* 6

Ostracoda

Fig. 1, 2. — *Galliaecytheridea* cf. *G. wolburgi* (STEGHAUS, 1951).
1. Carapace, left view, × 95
2. Carapace, right view, × 95

3. — *Cytheropteron bispinosum crassum* SCHMIDT, 1954
Left valve, lateral view × 140

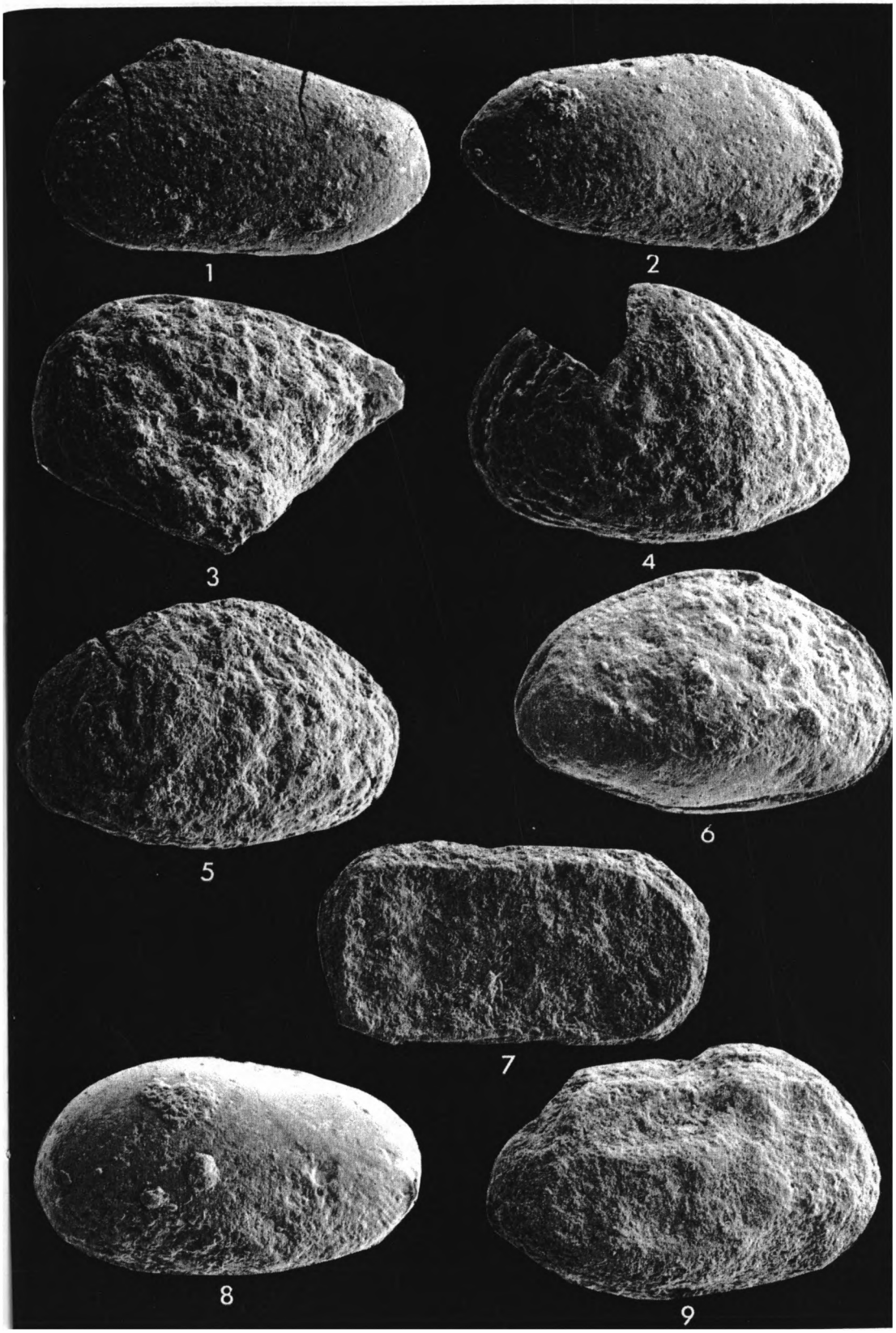
4, 5. — *Macrodentina* ex gr. *M. steghausi* (KLINGLER, 1955).
4. Left valve, lateral view × 110
5. Right valve, lateral view × 110

6. — *Schuleridea triebeli* (STEGHAUS, 1951)
Carapace, right view, × 120.

7. — *Cytherelloidea* ex gr. *C. weberi* STEGHAUS, 1951
Carapace, right view, × 110

8. — *Cytherella suprajurassica* OERTLI, 1957
Right valve, lateral view, × 100

9. — *Protocythere* cf. *P. sigmoidea* STEGHAUS, 1951
Carapace, left view, × 100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