

Two dinoflagellate cyst marker horizons in the Bathonian of the Nettleton Bottom Borehole, Lincolnshire, England

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ABSTRACT—The occurrences of large numbers (floods) of *Meiourogonyaulax reticulata* Dodekova, 1975 in the Blisworth Clay and of *Pareodinia prolongata* Sarjeant, 1959 in the Cornbrash of the Nettleton Bottom Borehole are reported and their biostratigraphical value discussed.

INTRODUCTION

The dinoflagellate cyst floras of the Nettleton Bottom Borehole (Fig. 1) were investigated as part of a Department of Energy-sponsored project undertaken by the Institute of Geological Sciences on the detailed stratigraphical distribution of dinoflagellate cysts in the Jurassic System of Britain. A detailed account of the palynostratigraphy of the Nettleton Bottom Borehole is in preparation, though some palynological information on the Middle Jurassic section of the core (by Dr. J.P.G. Fenton) is already available in a paper concerning the borehole by Bradshaw & Penney (1982). A dinoflagellate cyst zonal scheme for the English Jurassic, incorporating information from the borehole, has been produced (Woollam & Riding, 1983).

This paper deals with the stratigraphically restricted floods of two dinoflagellate cyst species within the Bathonian of the Nettleton Bottom section. *Meiourogonyaulax reticulata* Dodekova, 1975 occurs abundantly within the Blisworth Clay (Bathonian) and *Pareodinia prolongata* Sarjeant, 1959 occurs in high proportions in the Bathonian portion of the Cornbrash (Fig. 2).

LOCATION AND DETAILS OF THE SECTION

The borehole was drilled in 1979 at Nettleton Bottom Quarry, near Caistor, Lincolnshire [Grid. Ref. TF 1252 9820]. The location and its broader geographical and geological framework are shown in Figs. 1a and 1b. It was drilled as part of the Oxford University Heat Flow Project and, after thermal conductivity measurements, the core was handed over to the Institute of Geological Sciences for storage, curation and study. Coring commenced at 33.44 m, several metres below the top of the Upper Jurassic Ancholme Clay, and was terminated at 546.24 m in the Hettangian of the Scunthorpe Mudstones (IGS, 1982).

The *Meiourogonyaulax reticulata* flood

Six samples, at approximately one metre intervals

between 330.4 and 323.3 m in the Blisworth Clay of the Nettleton Bottom Borehole (Fig. 2), were examined. Only one of these (no. MPA 10075; 330.40 m, see Fig. 2) yielded *Meiourogonyaulax reticulata*, which, however, comprises some 75% of the dinoflagellate cyst assemblage. Comparable floods of *M. reticulata* were not found at any other horizon in the borehole, though a few comparable forms (usually poorly preserved) were observed at the top of the Blisworth Clay and in the overlying Cornbrash.

Other dinoflagellate cysts present at this horizon include: *Ctenidodinium sellwoodii* (Sarjeant, 1975) Stover & Evitt, 1978, *Energlynia acollaris* (Dodekova, 1975) Sarjeant, 1978 and *Pareodinia ceratophora* Deflandre, 1947.

The pre-Cornbrash strata of the Middle Jurassic of eastern England are largely marginal marine deposits, representing a regressive régime; sedimentological and micropalaeontological evidence suggests that the Blisworth Clay in north Lincolnshire was deposited under fluctuating nearshore, shallow-water lagoonal and freshwater conditions. It is possible that a sudden marine incursion or transgression into the lagoon brought in the flood of *M. reticulata*. Alternatively, a rapid environmental change (such as reductions in salinity or availability of nutrients) may have caused mass encystment of the dinoflagellates.

M. reticulata has been reported from the late Bajocian to late Bathonian of Europe (Herngreen & de Boer, 1974 and Dodekova, 1975). Bradshaw & Penney (1982, p. 123–124) reported “large numbers of *Lithodinia* (*Meiourogonyaulax*) *reticulata* (Dodekova) and closely allied morphotypes” from the Blisworth Clay of the Nettleton Bottom Borehole, commenting (p. 124) that “similar assemblages characterise the lower Blisworth Clay in the East Midlands”.

Hence, large numbers of *M. reticulata* with its characteristic reticulate autophragm may be a good marker for the base of the Blisworth Clay throughout the East Midlands region.

The *Pareodinia prolongata* flood

Two samples at 321.98 and 320.97 m were examined from the Cornbrash in the Nettleton Bottom Borehole (Fig. 2). The lowermost sample (no. MPA 10070) yielded a relatively restricted dinoflagellate cyst flora. *Pareodinia prolongata* comprises some 35% of the dinoflagellate cyst assemblage in this sample.

Other dinoflagellate cyst taxa present in sample MPA 10070 include: *Ctenidodinium gochtii* (Sarjeant, 1976) Stover & Evitt, 1978, *C. sellwoodii* (Sarjeant, 1975) Stover & Evitt, 1978, *C. combazii* Dupin, 1968, *Energlynia acollaris* (Dodekova, 1975) Sarjeant, 1978 and *Gonyaulacysta jurassica* (Deflandre, 1938) Norris & Sarjeant, 1965.

P. prolongata is also present in the uppermost sample, but as a minor element of an extremely rich and diverse dinoflagellate cyst flora of a Callovian aspect. It is also recorded sporadically, in low numbers from the late Bathonian and early Callovian of the borehole.

P. prolongata is a very distinctive species, with an elongate apical horn and hyaline autophragm. It was described from the Upper Cornbrash (Macrocephalus

Zone) of Yorkshire by Sarjeant in 1959, who stated (p. 336) "representatives of this species were quite abundant"; Riley & Fenton (1982, Fig. 8) also record large numbers of this species from the same ammonite zone. Its total range appears to be late Bathonian to the top of the Callovian.

The Cornbrash is a deposit that represents a major marine transgression, a pulse of which was probably responsible for the large number of *P. prolongata* in this formation. The work of Sarjeant (1959) and Riley & Fenton (1982) suggests that this abundance is stratigraphically significant.

CONCLUSIONS

Horizons with large numbers (or floods) of *Meiourogonyaulax reticulata* at the base of the Blisworth Clay and of *Pareodinia prolongata* in the Cornbrash form two distinct markers in the Bathonian of the Nettleton Bottom Borehole. Despite the fact that these abundances have been commented upon previously, their very restricted stratigraphical intervals and potential use as marker horizons have not. Bathonian palynofloras

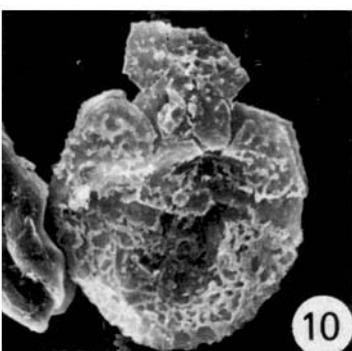
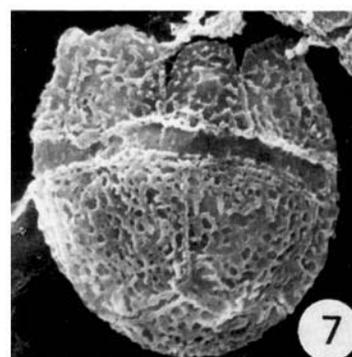
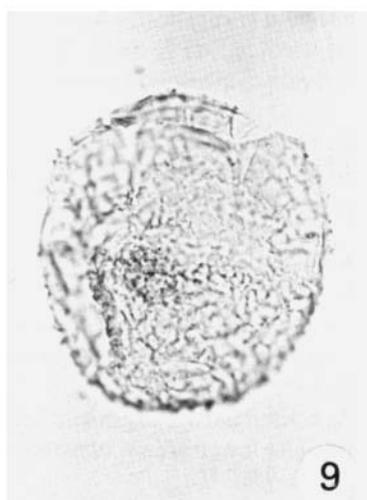
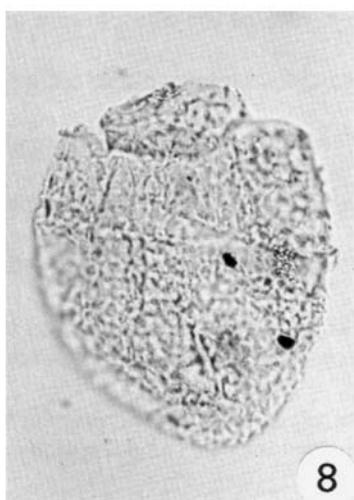
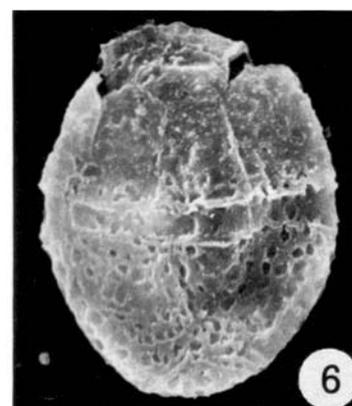
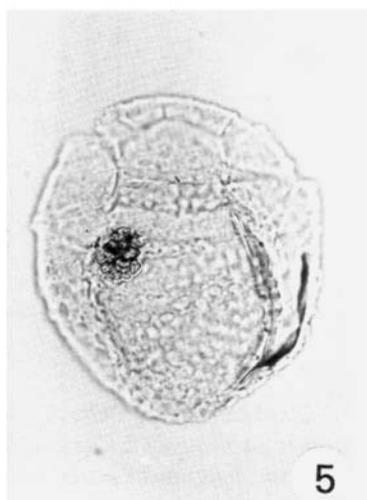
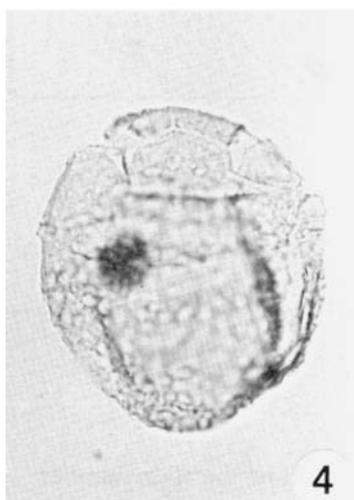
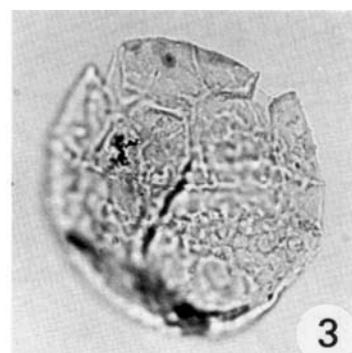
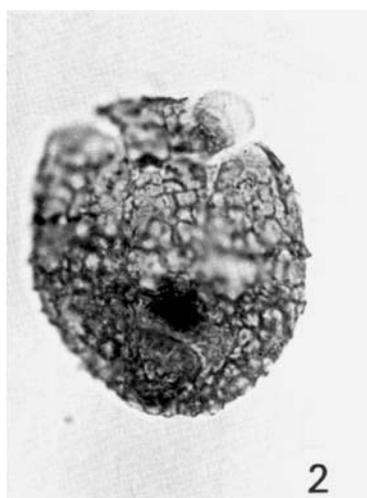
Explanation of Plate 1

Meiourogonyaulax reticulata Dodekova, 1975

All light photomicrographs are $\times 800$, the 'England Finder' co-ordinates follow the slide number.

- Figs. 1, 2. Dorsal view, two focal levels showing the well-developed reticulate ornament of the autophragm, the paracingulum and the apical (type $\bar{t}\bar{A}$) archaeopyle. The archaeopyle has operated, but the operculum is still adherent and is 'hinged' at the parasulcus. MPK 3847, MPA 10075/2, C58/3.
- Fig. 3. Slightly oblique dorsal view. The epicystal paratabulation is perceivable. The apical (type $\bar{t}\bar{A}$) archaeopyle has operated, but the operculum has not detached. MPK 3848, MPA 10075/1, U32/4.
- Figs. 4, 5. Dorsal view, two focal levels. Note the unequal distribution of the reticulation on the autophragm, which is well-developed on the hypocyst, but relatively sparse on the epicyst. The reticulate ornament largely obscures the hypocystal paratabulation. The archaeopyle has operated (note the schism separating the apical and precingular paraplates) however the operculum is 'hinged' at the parasulcus. MPK 3849, MPA 10075/1, J48.
- Fig. 6. Dorsal view. Note the incised nature of the paracingulum, the poorly developed reticulation on the epicyst and the low, discontinuous parasutures. The archaeopyle has operated and the operculum is 'hinged' at the parasulcus. Apical paraplates 2' and 3' are partially obscured as the operculum has begun to fold downwards into the cyst. MPK 3850, MPA 10075, SEM photomicrograph ($\times 1240$).
- Fig. 7. A slightly oblique dorsal view. The archaeopyle has operated and the operculum is detached, note the principal and accessory archaeopyle sutures. Note also the imperfect reticulum on the epicyst (and the hypocyst, bordering the paracingulum), the incised, non-reticulate paracingulum and the well-defined hypocystal paratabulation. MPK 3851, MPA 10075, SEM photomicrograph ($\times 1160$).
- Fig. 8. A ventral view. Note the laevorotatory paracingulum. The reticulate ornament appears to have a uniform distribution. MPK 3852, MPA 10075/1, U41/3.
- Fig. 9. Dorsal view of a relatively squat specimen. The archaeopyle has operated, but the operculum is still attached. MPK 3853, MPA 10075/2, S43/4.
- Fig. 10. Ventral view showing the apical ($\bar{t}\bar{A}$) archaeopyle 'hinged' at the parasulcus. Note the four apical paraplates, the incised nature of the parasulcus, the laevorotatory paracingulum and the very poorly developed ornament on the epicyst (the apical paraplates have only vestiges of ornament). MPK 3854, MPA 10075, SEM photomicrograph ($\times 890$).

Bathonian dinocyst marker horizons



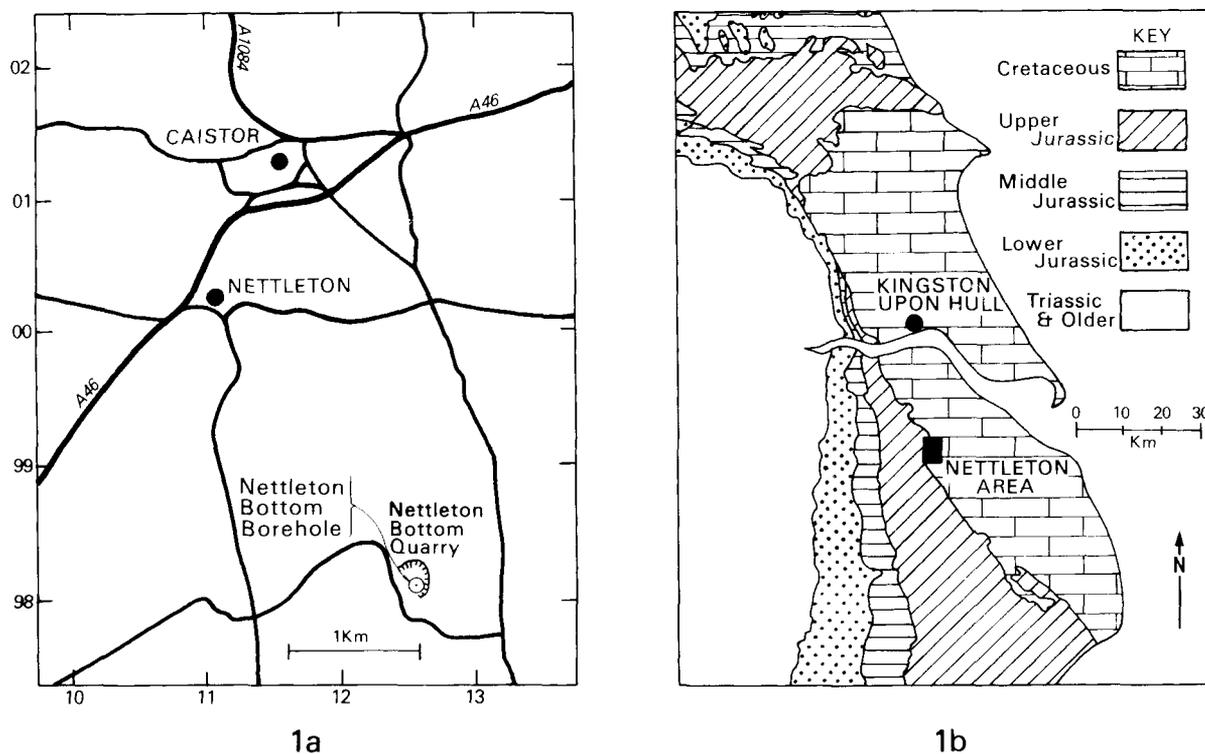


Figure 1 - Location

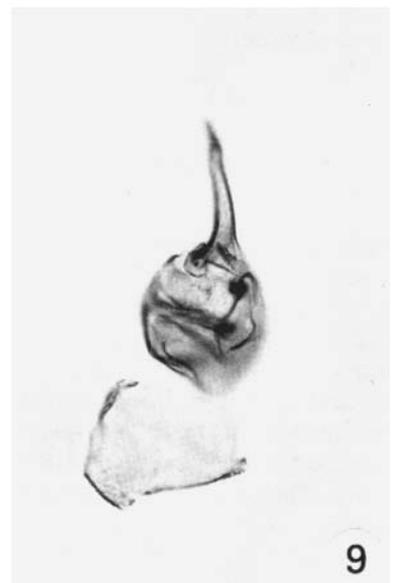
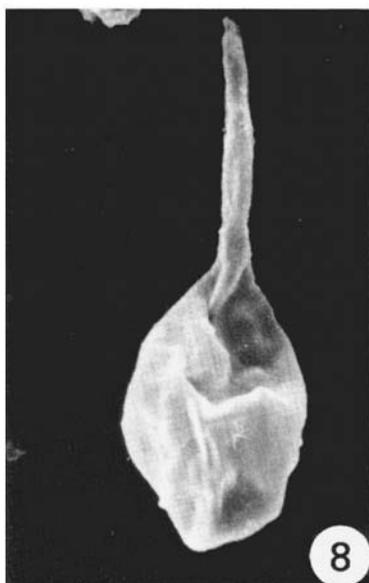
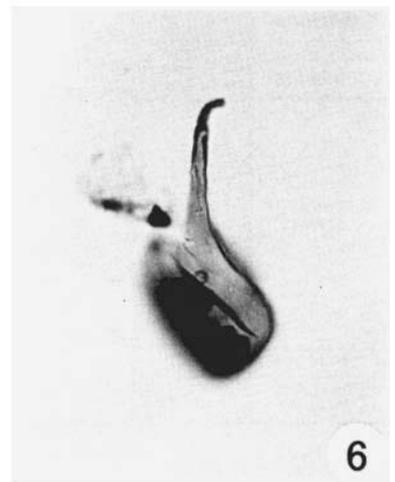
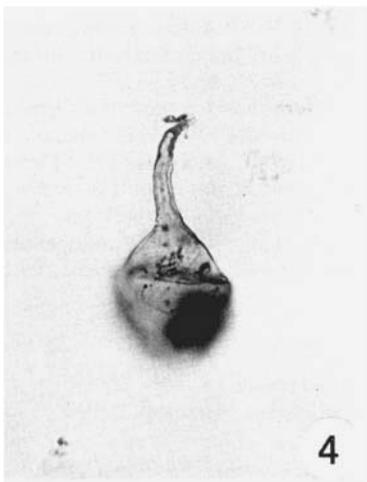
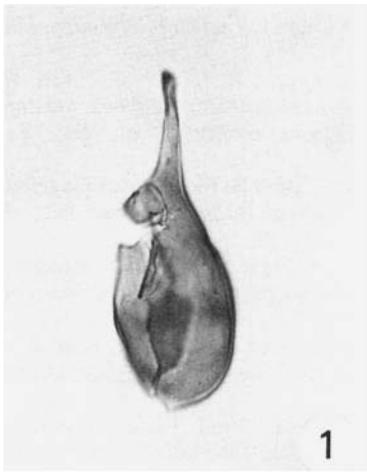
Explanation of Plate 2

Pareodinia prolongata Sarjeant, 1959

All light photomicrographs are $\times 470$, the 'England Finder' co-ordinates follow the slide number.

- Fig. 1. Right lateral view. The intercalary archaeopyle is visible. (It is, however impossible to determine, with certainty, how many plates are involved in archaeopyle formation). Note the hyaline nature of the autophragm and the severe longitudinal folding of the dorsal surface. MPK 3855, MPA 10070/1, L44.
- Figs. 2, 3. Two views of a specimen with a relatively thin, elongate cyst body, which exhibits longitudinal folding. MPK 3856, MPA 10070/2, M33/3.
- Fig. 4. A specimen with a well-developed apicular structure situated on the distal end of the apical horn. The globose cyst-body is impregnated with pyrite. MPK 3857, MPA 10070/2, K50.
- Fig. 5. The transverse furrow (which appears to be a paracingulum) is probably a result of folding of the autophragm. MPK 3858, MPA 10070/1, K43.
- Fig. 6. A right lateral view of a specimen with a prominent, curved apicular structure. Note the pyrite-impregnated cyst body. MPK 3859, MPA 10070/2, F44.
- Fig. 7. SEM photomicrograph showing a specimen in right lateral view. Note the hyaline autophragm and lack of paratabulation apart from the intercalary archaeopyle (which appears to have operated, however the operculum is still in place). MPK 3860, MPA 10070. ($\times 750$).
- Fig. 8. SEM photomicrograph. Note the highly folded autophragm and in this (?ventral) orientation the singular lack of any definite indications of paratabulation. The longitudinal furrow on the hypocyst may be the parasulcus, or the results of folding. MPK 3861, MPA 10070. ($\times 770$).
- Fig. 9. A slightly oblique right lateral view of a highly folded specimen. The archaeopyle has operated; at least two intercalary paraplates seem to have participated in archaeopyle formation (one of which is still adherent). MPK 3862, MPA 10072/2, 050/3.

Bathonian dinocyst marker horizons



are extremely monotonous and dinoflagellate cyst biostratigraphical events are few (Woollam & Riding, 1983), hence these floods may prove useful as marker horizons.

The exact areal extent of the floods is, at the moment unclear, the *M. reticulata* flood, for example, does not extend into southern England (based on investigations by the author and R. Woollam from the Bath area to Dorset), however they may prove useful in the southern North Sea area.

All figured material is housed in the MPK collection of the Institute of Geological Sciences, Leeds.

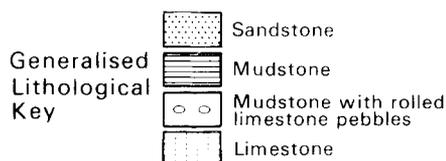
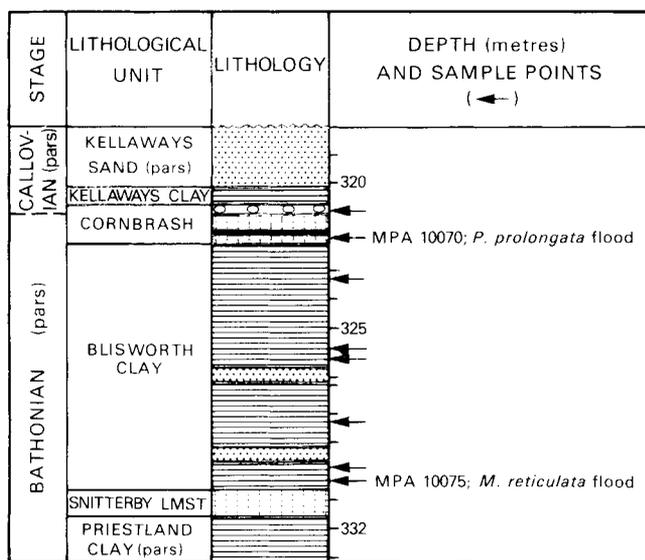


Figure 2 - Sample Details

ACKNOWLEDGEMENTS

This paper is published with the permission of the Acting Director, Institute of Geological Sciences (N.E.R.C.). The author would like to thank Dr. G.F.W. Herngreen for valuable discussion, also Drs. T.P. Fletcher and B. Owens (both Institute of Geological Sciences, Leeds) and Dr. R. Woollam (formerly Institute of Geological Sciences, Leeds, now BP Research Centre, Sunbury-on-Thames) for their comments on the original manuscript.

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APPENDIX

Systematic section

Class Dinophyceae Fritsch, 1929
Order Peridinales Haeckel, 1894

Genus *Meiourogonyaux* Sarjeant, 1966

For taxonomic notes, see Lentin & Williams (1981, p. 180).

Meiourogonyaux reticulata Dodekova, 1975

(Pl. 1, figs. 1–10)

1974 Dinoflagellate sp. 3 Herngreen & de Boer: pl. 5, fig. 9.

1975 *Meiourogonyaux reticulatum* Dodekova: 22–23, pl. 2, figs. 11–13, text-fig. 4.

1976 *Lithodinia reticulata* (Dodekova, 1975) Gocht: 334.

1978 *Meiourogonyaux reticulata* Dodekova, 1975 Stover & Evitt: 63.

Genus *Pareodinia* Deflandre, 1947 emend. Stover & Evitt, 1978

Pareodinia prolongata Sarjeant, 1959

(Pl. 2, figs. 1–9)

1959 *Pareodinia prolongata* Sarjeant: 335–336, pl. 13, fig. 8, text-fig. 4.