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Dinoflagellate cyst biostratigraphy of the Oxfordian and Kimmeridgian of Poland

ABSTRACT: The dinoflagellate cyst biostratigraphy of ammonite-dated Oxfordian and Kimmeridgian samples from Central Poland is presented. The dinoflagellate cysts are correleted with the Danish/English zonation established by DAVEY (1979, 1982), WOOLLAM & RIDING (1983) and emended by NØHR-HANSEN (1986), RIDING & THOMAS (1988), and the Author (POULSEN 1991a). Dinoflagellate cysts from the Bimammatum and Planula Zones in Poland confirm the correlation of these two zones with the Rosenkrantzi and Baylei Zones. Kimmeridgian dinoflagellate cysts from an upper part of the Divisum Zone to a lower part of the Mutabilis Zone in Poland indicate correlation with the mid-Mutabilis Zone of England.

INTRODUCTION

This paper presents partial results from a palynological and biostratigraphic study of the Late Jurassic of Poland. Here is the analyses of the Oxfordian — Kimmeridgian interval described. The study was part of a Ph.D. project to establish a dinoflagellate cysts zonation for the Jurassic deposits in Denmark (*i.e.* the Danish Subbasin *sensu lato*).

Detailed dinoflagellate cyst zonations of the Jurassic published so far have been mainly from the British Isles. The English Jurassic zonation established by DAVEY (1979), WOOLLAM & RIDING (1983) and NØHR-HANSEN (1986), and later emended by RIDING & THOMAS (1988) and the Author (POULSEN 1991a), was applied by POULSEN (1992a) to the marine sequences in Denmark. The zonation was further correlated with the Late Jurassic rocks of Poland and several of the established zonal units were recognized there.

The purpose of this paper is to describe the dinoflagellate cyst assemblages recorded from the Oxfordian and Kimmeridgian of Poland, to correlate them with the zonation established for the Danish/English area, and compared them to those recorded from Denmark (POULSEN 1991a, 1992b, c).

THE STUDIED MATERIAL

The dinoflagellate cysts described in this paper come from outcrops and boreholes in the Mesozoic margin of the Holy Cross Mountains, the Cracow-Wieluń Upland, and the north-western part of the Kujawy Sector of the Mid-Polish Anticlinorium, which are areas amongst the most suitable for the study of the Oxfordian and Kimmeridgian sequence in Poland (*see* Text-fig. 1). Details of the samples are given separately (POULSEN 1989).

About 90 Oxfordian and Kimmeridgian samples from outcrops and borehole cores were collected with reference to the standard ammonite zonation for the area. The lithologies include limestones, marls and marly siltstones. The preservation of the dinoflagellate cysts is usually good. However, 38 outcrop samples from the Oxfordian were barren, probably due to weathering.

The studied material has been obtained using the preparation technique presented by the Author elsewhere (POULSEN & *al.* 1990).

The standard ammonite zones are here treated as chronostratigraphic units (*see* CALLOMON 1984, WIMBLEDON & COPE 1978). The ammonite zones are referred to by the species name alone, *e.g.* Tenuiserratum Zone, but where the dinoflagellate cyst zones are used, this is indicated by the full binom, *e.g.* the Endoscrinium luridum Zone.

DINOFLAGELLATE CYST ZONATION

In this study two of the Oxfordian-Kimmeridgian Danish/English zones and most the subzones of these two zones were recognized.

The Scriniodinium crystallinum Zone (Sc) and its subzones were defined by WOOLLAM & RIDING (1983) and emended by RIDING & THOMAS (1988). The upper boundary of the zone was emended by POULSEN (1991a).

The Endoscrinium luridum Zone (El) was defined by WOOLLAM & RIDING (1983) and two subzones, the Stephanelytron scarburghense Subzone and the Perisseiasphaeridium pannosum Subzone introduced by NØHR-HANSEN (1986). The zone and its subzones were emended by RIDING & THOMAS (1988) and POULSEN (1991).

The base of the Volgian Glossodinium dimorphum Zone (Gd) is mentioned here fore the sake of completeness in the Błogie-Nadzieja borehole. The zone and its subzones are defined by WOOLLAM & RIDING (1983) and emended by RIDING & THOMAS (1988).

ASSEMBLAGE CHARACTERISTICS

BARCIN-PAKOŚĆ

The Barcin-Pakość-*3* borehole is located in the north-western part of the Kujawy Sector of the Mid-Polish Anticlinorium, about 30 km south of Bydgoszcz. The stratigraphy of the area is described in MATYJA & WIERZBOWSKI (1981), and MATYJA & *al.* (1985). The studied interval of the borehole is dated by

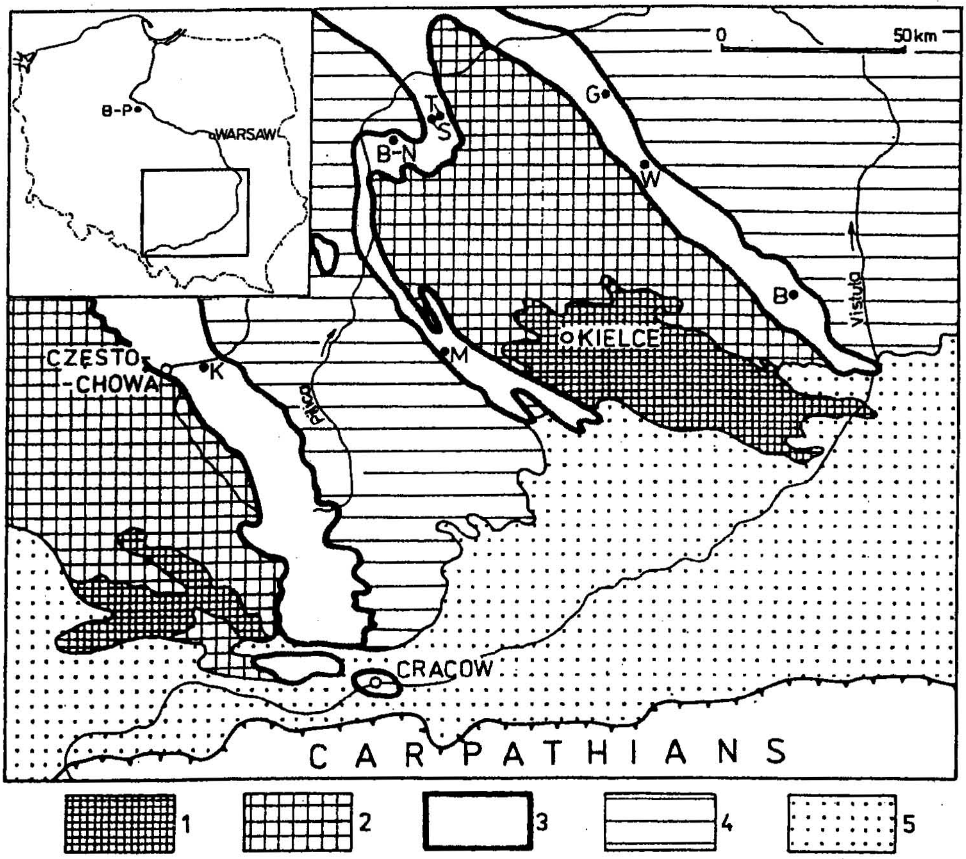


Fig. 1. Map of Central Polish Uplands (inset offers their location in Poland, the Barcin-Pakość borehole including)

1 — Paleozoic, 2 — Mesozoic, older than Upper Jurassic, 3 — Upper Jurassic, 4 — Cretaceous, 5 — Middle Miocene (Badenian) of the Fore-Carpathian Depression

HOLY CROSS MOUNTAINS: M — Małogoszcz Quarry, B-N — Błogie-Nadzieja borehole, S — Szadkowice borehole, T — Trojanów borehole, G — Guzów borehole, W — Wierzbica Quarry, B — Bałtów

CRACOW-WIELUŃ UPLAND: K — Kobyłczyce borehole ammonites as the Hypselum Subzone of the Bimammatum Zone (MATYJA & *al.* 1985).

The *Systematophora* group, composed mainly of *S. areolata, Gonyaulacysta jurassica,* and *Sentusidium rioultii* dominates the dinoflagellate cyst assemblage. The *Epiploshaera* group and *Rhynchodiniopsis cladophora* constitute also common elements of the assemblage.

The presence of *Ctenidodinium ornatum* together with *Occisucysta balia* indicates the Scriniodinium crystallinum Zone, Subzone *c*, and the abundant occurrence of *G. jurassica* is also characteristic of this age.

The sample (at 137.4 m) is from marly-siltstones of the Łyna Formation. It yielded the following cyst-assemblage:

Adnatosphaeridium caulleryi	Endoscrinium luridum	Occisucysta balia
Barbatacysta brevispinosa	Epiplosphaera areolata	Prolixosphaeridium anasillum
Barbatacysta creberbarbata	Epiplosphaera bireticulata	Prolixosphaeridium parvispinum
Barbatacysta pilosa	Epiplosphaera gochtii	Rhynchodiniopsis cladophora
Barbatacysta verrucosa	Epiplosphaera reticulospinosa	Scriniodinium crystallinum
Chytroeisphaeridia chytroeides	Escharisphaeridia pelionense	Sentusidinium rioultii
Cleistosphaeridium polytrichum	Escharisphaeridia pocockii	Sirmiodinium grossi
Cleistosphaeridium? tribuliferum	Foraminiferans innerlinings	Stiphrosphaeridium sarjeantii
Cometodinium sp. 1	Glossodinium dimorphum	Systematophora areolata
Compositosphaeridium polonicum	Gonyaulacysta eisenackii	Systematophora penicillata
Cribroperidinium granulatum	Gonyaulacysta jurassica jurassica	Systematophora valensii
Ctenidodinium ornatum	Heslertonia? pellucida	Taeniophora iunctispina
Ellipsoidictyum cinctum	Hystrichosphaerina orbifera	Tubotuberella apatela
Endoscrinium galeritum	Mendicodinium groenlandicum	

BŁOGIE-NADZIEJA

The Błogie-Nadzieja borehole is situated in the north-western margin of the Holy Cross Mountains, about 25 km west of Opoczno. The Autissiodorensis Zone and the Klimovi Zone are recorded by MATYJA & *al.* (1988), the major part except for the top of the Autissiodorensis Zone is however only tentatively recorded as corresponding to the Autissiodorensis Zone and/or the Eudoxus Zone in the middle to lower part of the studied interval.

The species *Subtilisphaera*? *inaffecta* occurs regularly in all of the samples and at 110.7 m it accounts for more than 50% of the assemblage, whereas *Subtilisphaera*? *paeminosa* only occurs sporadically, and *Gonyaulacysta jurassica* does commonly up to a level just below the top of the Autissiodorensis Zone. The species *Rhynchodiniopsis cladophora* is recorded infrequent to frequent in the assemblages. The *Cribroperidinium* suite, including related genera, e.g. *Tehamadinium*, quantitatively represent a large percentage of the assemblages. The *Sentusidinium* suite, *Escharisphaeridia* spp., and *Epiplosphaera* spp. are also commonly represented. Chorate cysts including *Systematophora* spp., *Perisseiaspaerdium* spp., *Cleistosphaeridium* spp. occur regularly in the assemblages. The presence of several specimens of the Australian species *Dollodinium sinuosum* is noteworthy as this species has not hitherto been recorded in Europe.

The species *Endoscrinium luridum* has its last occurrence latest in the Autissiodorensis Zone, indicating the top of the E. luridum Zone.

The last occurrence of *S.*? *inaffecta* is found in the early part of the Klimovi Zone. In the southern part of the North Sea this species is recorded in the early part of the Elegans Zone (COX & *al.* 1987), equivalent to the Glossodinium dimorphum Zone, Subzone *a* indicating that the base of Klimovi and Elegans Zones correlate.

The highest samples are from marly siltstones of the Klimovi Zone (at 37.5 m) and of the Antissiodorensis Zone (at 49.8 m). Still lower, the samples have been taken from marls and marly limestones of the Autissiodorensis and Eudoxus Zones (samples at 87.5 m, 96.1 m, 110.7 m and 117.4 m). These samples yielded the following cyst assemblages:

Aldorfia dictyota (22.0 m)
Aldorfia spp. (117.4 m)
Ambonosphaera spp. (28.2 m)
Ambonosphaera? staffinensis (7.0, 28.2, 37.5, 49.8, 117.4 m)
Amphorula metaelliptica (87.5 m)
Amphorula spp. (49.8 m)
Apteodinium granulatum (28.2 m)
Apteodinium nuciforme (22.0, 28.2, 37.5, 49.8, 87.5, 96.1, 117.4 m)
Apteodinium spp. (7.0, 22.0 m)
Barbatacysta brevispinosa (37.5, 110.70, 117.4 m)
Barbatacysta creberbarbata (22.0, 28.2, 49.8, 87.5, 96.1, 110.70, 117.4 m)
Barbatacysta lemoignei (37.5, 110.70 m)
Barbatacysta pilosa (22.0, 28.2 m)
Barbatacysta verrucosa (22.0, 37.5 m)
Chlamydophorella membranoidea (7.0, 22.0 m)
Chlamydophorella spp. (7.0, 22.0, 28.2 m)
Chytroeisphaeridia chytroeides (7.0, 22.0, 28.2, 37.5, 49.8, 87.5, 96.1, 117.4 m)
Cleistosphaeridium deflandrei (37.5, 87.5 m)
Cleistosphaeridium lumectum (7.0, 96.1, 117.4 m)
Cleistosphaeridium polytrichum (7.0, 22.0, 117.4 m)
Cleistosphaeridium polytrichum
Cleistosphaeridium? polyacanthum (7.0, 22.0, 28.2, 37.5, 96.1, 117.4 m)
Cleistosphaeridium? tribuliferum (7.0, 49.8 m)
Cometodinium sp. 1 (37.5, 49.8, 87.5 m)
Cribroperidinium globatum (28.2, 87.5, 96.1, 110.7, 117.4 m)
Cribroperidinium granulatum (7.0, 22.0, 37.5, 49.8, 87.5, 110.7, 117.4 m)
Cribroperidinium muderongense (22.0, 28.2, 87.5, 117.4 m)
Cribroperidinium sarjeantii (87.5 m)
Cribroperidinium spp. (7.0, 22.0, 28.2, 37.5, 49.8, 87.5, 96.1, 110.7, 117.4 m)
Cribroperidinium? longicorne (87.5, 96.1, 110.7 m)
Cribroperidinium? murochoratum (87.5 m)
Ctenidodinium tenellum (37.5 m)
Cyclonephelium densebarbatum (37.5, 49.8 m)
Cyclonephelium spp. (7.0, 22.0, 28.2 m)
Dichadogonyaulax chrondra (7.0, 22.0, 37.5, 87.5, 117.4 m)
Dichadogonyaulax pannea (28.2 m)
Dingodinium jurassicum (28.2, 37.5, 117.4 m)
Dingodinium minutum (7.0, 22.0, 28.2, 37.5, 49.8, 87.5, 96.1, 117.4 m)
Dollidinium sinuosum (7.0, 22.0, 28.2, 49.8 m)
Egmontodinium expiratum (7.0, 22.0, 28.2 m)
Egmontodinium ovatum (28.2, 49.8, 87.5, 96.1 m)
Ellipsoidictyum cinctum (37.5, 49.8, 110.7, 117.4 m)
Endoscrinium anceps (7.0, 117.4 m)
Endoscrinium galeritum (117.4 m)
Endoscrinium luridum (49.8, 96.1, 117.4 m)
Endoscrinium pharo (7.0 m)
Epiplosphaera areolata (28.2, 87.5, 96.1 m)
Epiplosphaera bireticulata (87.5 m)
Epiplosphaera gochtii (110.7, 117.4 m)
Epiplosphaera reticulospinosa (87.5 m)
Escharisphaeridia pelionense (110.7, 117.4 m)
Escharisphaeridia pocockii (7.0, 22.0, 28.2, 37.5, 49.8, 87.5, 96.1, 110.7, 117.4 m)
Glossodinium dimorphum (7.0, 22.0, 28.2, 37.5, 49.8, 87.5, 110.7, 117.4 m)
Gochteodinia mutabilis (7.0 m)
Gonyaulacysta dualis (87.5 m)
Gonyaulacysta jurassica jurassica (87.5, 96.1, 110.7, 117.4 m)
Gonyaulacysta jurassica jurassica longicornuta (96.1 m)
Gonyaulacysta tuberculata (7.0, 22.0, 28.2, 37.5, 49.8, 87.5, 96.1, 110.7, 117.4 m)
Heslertonia? pellucida (7.0, 37.5, 49.8, 87.5 m)
Histiophora ornata (49.8 m)
Hystrichodinium pulchrum (7.0, 22.0, 28.2, 37.5, 49.8 m)
Hystrichosphaerina orbifera (7.0, 22.0, 28.2, 37.5, 49.8 m)
Kalyptea diceras (37.5 m)
Lanterna bulgarica (37.5, 49.8, 87.5, 110.7, 117.4 m)
Leptodinium ambiguum (22.0, 28.2 m)
Leptodinium deflandrei (7.0, 28.2m)
Leptodinium spp. (22.0 m)
Leptodinium subtile (7.0, 49.8, 87.5, 96.1 m)
Leptodinium? antigonium (7.0, 22.0, 28.2 m)
Lithodinia arcanitabulata (22.0, 28.2, 37.5, 49.8 m)
Lithodinia jurassica (28.2 m)
Mendicodinium groenlandicum (28.2, 87.5 m)
Neuffenia willei (22.0, 28.2, 37.5, 87.5, 117.4 m)
Occisucysta balia (7.0, 22.0, 28.2, 37.5, 87.5, 117.4 m)
Occisucysta sp. 1 (22.0, 37.5 m)
Oligosphaeridium patulum (28.2, 37.5 m)
Oligosphaeridium pulcherrimum (28.2, 87.5 m)
Oligosphaeridium spp. (7.0, 37.5 m)
Omatidium spp. (117.4 m)
Pandadinium spinosum (49.8 m)
Pareodinia antennata (96.1 m)
Pareodinia asperata (7.0, 22.0, 28.2, 117.4 m)
Pareodinia ceratophora (7.0, 22.0, 28.2, 37.5, 49.8, 87.5, 117.4 m)
Pareodinia halosa (7.0, 22.0, 37.5, 49.8, 87.5, 96.1 m)
Perisseiasphaeridium pannosum (28.2, 49.8, 87.5, 96.1 m)
Perisseiasphaeridium sp. 1 sensu Davey (1982) (49.8, 87.5, 96.1 m)
Perisseiasphaeridium spp. (28.2 m)
Pilosidinium fensomei (7.0, 22.0, 28.2, 37.5 m)
Pilosidinium myriatrichum (22.0, 28.2, 37.5, 49.8, 87.5, 96.1 m)
Prolixosphaeridium anasillum (7.0, 22.0, 28.2, 37.5, 49.8, 117.4 m)
Prolixosphaeridium mixtispinosum (7.0, 87.5, 110.7, 117.4 m)
Prolixosphaeridium parvispinum (28.2, 37.5 m)
Protobatioladinium imbatodinense (22.0, 28.2, 37.5, 49.8 m)
Protobatioladinium westburiensis (22.0, 28.2, 37.5, 49.8 m)
Rhynchodiniopsis cladophora (37.5, 87.5, 96.1, 110.7, 117.4 m)
Scriniodinium attadalense (7.0 m)
Scriniodinium inritibilum (7.0, 22.0, 28.2, 37.5, 49.8, 87.5, 117.4 m)
Senoniasphaera jurassica (22.0 m)
Sentusidinium erythrocomum (87.5 m)
Sentusidinium rioultii (28.2, 49.8, 87.5, 96.1, 110.7, 117.4 m)
Sentusidinium sparsibarbatum (37.5, 110.7 m)
Sirmiodinium grossi (7.0, 22.0, 28.2, 37.5 m)
Stephanelytron scarburghense (117.4 m)
Subtilisphaera? inaffecta (37.5, 49.8, 87.5, 96.1, 110.7, 117.4 m)
Subtilisphaera? paeminosa (49.8, 87.5 m)
Systematophora areolata (7.0, 22.0, 28.2, 49.8, 87.5, 96.1, 110.7, 117.4 m)
Systematophora daveyi (7.0, 22.0, 28.2, 37.5, 49.8, 87.5, 96.1 m)
Systematophora palmula (96.1 m)
Systematophora penicillata (49.8, 87.5, 96.1, 117.4 m)

Systematophora spp. (28.2, 110.7 m)
Tehamadinium aculeatum (49.8, 96.1, 117.4 m)
Tubotuberella apatela (7.0, 22.0, 28.2, 37.5, 87.5, 96.1, 110.7, 117.4 m)
Tubotuberella egemenii (96.1, 110.7, 117.4 m)
Valensiella ovula (49.8, 96.1, 117.4 m)
Valensiella spp. (7.0, 22.0, 28.2, 37.5 m)
Wallodinium cylindricum (7.0, 28.2, 87.5 m)
Wallodinium krutzschii (7.0, 87.5 m)

GUZÓW

The Guzów borehole is located on the north-eastern margin of the Holy Cross Mountains, about 15 km south of Radom. The pierced sequence is referred to the Upper Kimmeridgian (?Eudoxus Zone) by GUTOWSKI (1992).

The assemblage is dominated by *Subtilisphaera*? spp. together with common *Systematophora* spp., *Cribroperidinium* spp., and *Escharisphaeridia* spp.

Based on the abundant occurrence of *Subtilispaera*? *inaffecta* and *S.*? *paeminosa* the sample is correlated with the Perisseiasphaeridium pannosum Subzone.

The sample is from marls, representing the upper part of the Guzów Clays and Lumachelles (GUTOWSKI 1992). It yielded the following cyst assemblage:

Barbatacysta creberbarbata
Chytroeisphaeridia chytroeides
Cleistosphaeridium polytrichum
Cleistosphaeridium polytrichum
Cribroperidinium globatum
Cribroperidinium granulatum
Cribroperidinium spp.
Cribroperidinium? longicorne
Endoscrinium/Scrinodinium spp.
Escharisphaeridia pocockii
Glossodinium dimorphum
Gonyaulacysta jurassica jurassica
Gonyaulacysta tuberculata
Lithodinia spp.
Mendicodinium groenlandicum
Occisucysta balia
Rhynchodiniopsis cladophora
Subtilisphaera? inaffecta
Subtilisphaera? paeminosa
Systematophora areolata
Systematophora penicillata
Tubotuberella apatela

KOBYŁCZYCE

The Kobyłczyce-*VI-10* borehole is situated in middle of the Cracow-Wieluń Upland, about 15 km east of Częstochowa. The section studied is referred to the Planula Zone (MATYJA & WIERZBOWSKI 1988; *see also* WIERZBOWSKI 1978).

The dinoflagellate cyst assemblages comprise a rich and diverse spectrum with *Dingodinium* spp., *Valensiella ovula*, *Cribroperidinium* spp., *Epiplosphaera* spp., *Escharisphaeridia pocockii*, *Gonyaulacysta jurassica*, *Lanterna bulgaria*, *Meiourogonyaulax* spp., *Rhychodiniopsis cladophora*, and *Systematophora* spp., all being numerically dominant.

The first occurrence of *Dichadogonyaulax chodra* is recorded within this zone. ZOTTO & *al.* (1987) described the first appearance of this species in the Baylei Zone. The last appearance of *G. eisenacki* is recorded here in the Planula Zone. According to SARJEANT (1979) its last appearance is in the Baylei Zone, and together with the absence of *Ctenidodinium ornatum* the Scriniodinium crystallinum Zone, Subzone *d*, is indicated.

The samples (at 8.5 m, 20.5 m, 30.5 m) are from marls of the Lower Marly Unit (*see* WIERZBOWSKI 1978) attributed to the Planula Zone. They yielded the following cyst assemblages:

Acanthaulax venusta (8.5 — 30.5 m)
Aldorfia dictyota (8.5, 20.5 m)
Ambonosphaera spp. (30.5 m)
Amphorula metaelliptica (8.5 m)
Apteodinium nuciforme (8.5, 30.5 m)
Atopodinium haromense (8.5 m)
Barbatacysta creberbarbata (8.5, 20.5, 30.5 m)
Barbatacysta lemoignei (8.5, 20.5 m)
Barbatacysta verrucosa (8.5, 20.5, 30.5 m)
Batiacasphaera spp. (8.5 m)
Chytroeisphaeridia chytroeides (8.5, 20.5, 30.5 m)
Cleistosphaeridium deflandrei (30.5 m)

Cleistosphaeridium lumectum (30.5 m)
Cleistosphaeridium? tribuliferum (20.5 m)
Cometodinium sp. 1 (20.5, 30.5 m)
Cribroperidinium granulatum (8.5, 20.5, 30.5 m)
Cribroperidinium spp. (8.5 m)
Dichadogonyaulax chrondra (8.5, 20.5, 30.5 m)
Dingodinium jurassicum (30.5 m)
Dingodinium minutum (8.5, 20.5, 30.5 m)
Egmontodinium ovatum (8.5 m)
Ellipsoidictyum cinctum (8.5, 20.5, 30.5 m)
Endoscrinium galeritum (8.5, 30.5 m)
Endoscrinium luridum (8.5, 20.5 m)
Epiplosphaera areolata (8.5, 20.5, 30.5 m)
Epiplosphaera bireticulata (30.5 m)
Epiplosphaera gochtii (8.5, 20.5, 30.5 m)
Epiplosphaera reticulata (30.5 m)
Epiplosphaera reticulospinosa (20.5, 30.5 m)
Escharisphaeridia pelionense (8.5, 20.5 m)
Escharisphaeridia pocockii (8.5, 20.5, 30.5 m)
Glossodinium dimorphum (8.5, 20.5 m)
Gonyaulacysta dualis (20.5 m)
Gonyaulacysta eisenackii (8.5 m)
Gonyaulacysta jurassica jurassica (8.5, 20.5, 30.5 m)
Gonyaulacysta spp. (20.5 m)
Gonyaulacysta tuberculata (8.5, 20.5, 30.5 m)
Heslertonia? pellucida (20.5 m)
Hystrichosphaerina orbifera (8.5, 20.5, 30.5 m)
Netrelytron stegastum (30.5 m)
Lanterna bulgarica (8.5, 20.5, 30.5 m)
Leptodinium millioudii (8.5, 30.5 m)
Leptodinium mirabile (30.5 m)
Leptodinium subtile (8.5, 30.5 m)
Lithodinia bejui (8.5, 20.5 m)
Lithodinia bulloidea (8.5, 20.5, 30.5 m)
Lithodinia cf. valensii (8.5 m)
Lithodinia ghermanii (8.5, 30.5 m)
Lithodinia pila (8.5, 20.5, 30.5 m)
Mendicodinium groenlandicum (8.5 m)
Neuffenia willei (8.5 m)
Pareodinia ceratophora (20.5, 30.5 m)
Pilosidinium myriatrichum (30.5 m)
Prolixosphaeridium anasillum (30.5 m)
Rhynchodiniopsis cladophora (8.5, 20.5, 30.5 m)
Sentusidinium rioultii (20.5, 30.5 m)
Sentusidinium spp. (30.5 m)
Systematophora areolata (8.5, 20.5, 30.5 m)
Systematophora daveyi (8.5 m)
Systematophora penicillata (8.5, 20.5, 30.5 m)
Systematophora valensii (30.5 m)
Tubotuberella apatela (8.5, 20.5 m)
Tubotuberella egemenii (8.5, 20.5, 30.5 m)
Tubotuberella spp. (30.5 m)
Valensiella altomurata (30.5 m)
Valensiella ovula (30.5 m)
Wallodinium cylindricum (30.5 m)

MAŁOGOSZCZ QUARRY

The Małogoszcz Quarry is situated on the south-western margin of the Holy Cross Mountains, about 15 km west of Chęciny. The section exposed comprises the Hypselocyclum, Divisum, and Mutabilis Zones, as recorded by KUTEK (1968) and KUTEK & *al.* (1992).

Most of the samples have rich and diverse assemblages, especially the samples from the upper part of the quarry. Samples from the middle part of the section contain only a few dinoflagellate specimens. Species of *Cribroperidinium* and of the *Sentusidinium* suite are more common in the lower part of the section, whereas those of *Systematophora* are such in the upper part where also *Subtilisphaera*? are common.

The first occurrence of *Perisseiasphaeridium pannosum* and the common occurrence *Subtilisphaera*? *inaffecta* is recorded in the upper part of the section, together with the highest occurrence of *Stephanelytron scarburghense* observed in Poland. The first appearance of the *P. pannosum* together with common *S.*? *inaffecta* indicates the P. pannosum Subzone. The Stephanelytron scarburghense Subzone with the index species *S. scarburghense* underlies the P. pannosum Subzone. In this section a minor overlap of the ranges of these index species was observed. The boundary between the two subzones is therefore drawn at the first appearance of *P. pannosum*, *i.e.* in a lowermost part of the Top Clays in the Małogoszcz section, corresponding approximately to a lower part of the Mutabilis Zone (*see* KUTEK 1968, KUTEK & *al.* 1992).

The samples come from several lithostratigraphic units of the section studied (KUTEK 1968; KUTEK & *al.* 1992, Fig. 5) and are localized in meters in relation to the top of the Upper Oolite, as follows:

— sample from marls of the lowermost part of the Oolite Platy Member (at 1.5 m), with the following cyst assemblage:

Amphorula metaelliptica
Apteodinium nuciforme
Atlantodinium jurassicum
Barbatacysta verrucosa
Barbatacysta creberbarbata
Chytroeisphaeridia chytroeides
Cribroperidinium globatum
Cribroperidinium granulatum
Dichadogonyaulax chrondra
Dingodinium jurassicum
Dingodinium minutum
Endoscrinium galeritum
Endoscrinium luridum
Epiplosphaera bireticulata
Epiplosphaera areolata
Escharisphaeridia pocockii
Escharisphaeridia pelionense
Glossodinium dimorphum
Gonyaulacysta jurassica jurassica
Gonyaulacysta tuberculata
Heslertonia? pellucida
Lithodinia bejui
Pareodinia ceratophora
Senoniasphaera? rioultii
Stephanelytron scarburghense
Wallodinium cylindricum
Xenicodinium densispinosum

— sample from marls of the lower part of the Shaly Limestones and Underlying Shales (at 26 m), with the following cyst assemblage:

Amphorula metaelliptica
Barbatacysta brevispinosa
Barbatacysta creberbarbata
Barbatacysta verrucosa
Chytroeisphaeridia chytroeides
Cleistosphaeridium deflandrei
Cribroperidinium granulatum
Dichadogonyaulax chrondra
Egmontodinium spp.
Ellipsoidictyum cinctum
Endoscrinium/Scriniodinium spp.
Epiplosphaera areolata
Epiplosphaera bireticulata
Escharisphaeridia pocockii
Escharisphaeridia pelionense
Glossodinium dimorphum
Gonyaulacysta tuberculata
Gonyaulacysta jurassica jurassica
Hystrichodinium spp.
Hystrichosphaerina orbifera
Leptodinium subtile
Pareodinia ceratophora
Pareodinia asperata
Subtilisphaera? inaffecta
Systematophora daveyi
Systematophora penicillata
Systematophora areolata

— sample from marls of the upper part of the Skorków Lumachelle (at 65 m), with the following cyst assemblage:

Cribroperidinium granulatum
Glossodinium dimorphum

— sample from marls of the lower part of the Upper Platy Limestones (at 69 m), with the following cyst assemblage:

Aldorfia dictyota
Amphorula metaelliptica
Atopodinium haromense
Barbatacysta brevispinosa
Barbatacysta creberbarbata
Cleistosphaeridium lumectum
Cribroperidinium spp.
Cribroperidinium granulatum
Cribroperidinium? longicorne
Dichadogonyaulax chrondra
Dingodinium minutum
Egmontodinium polyplacophorum
Egmontodinium spp.
Ellipsoidictyum cinctum
Endoscrinium galeritum
Endoscrinium luridum
Epiplosphaera spp.
Epiplosphaera areolata
Escharisphaeridia pelionense
Escharisphaeridia pocockii
Glossodinium dimorphum
Gonyaulacysta jurassica jurassica
Hystrichosphaerina orbifera
Komewuia glabra
Lithodinia bejui
Occisucysta balia
Oligosphaeridium spp.
Pareodinia ceratophora
Perisseiasphaeridium pannosum
Rhynchodiniopsis cladophora
Scriniodinium inritibilum
Senoniasphaera? rioultii
Systematophora daveyi
Systematophora valensii
Systematophora areolata
Systematophora penicillata
Tehamadinium aculeatum

— samples from the Top Shales (at 110 m, 122 m, 135 m, 140 m, 144 m); the cyst assemblages are as follows:

Sample 144 m

Ambonosphaera? staffinensis
Amphorula metaelliptica
Barbatacysta creberbarbata
Barbatacysta brevispinosa
Chytroeisphaeridia chytroeides
Cribroperidinium spp.
Cribroperidinium globatum
Cribroperidinium granulatum
Dichadogonyaulax chrondra
Egmontodinium ovatum
Ellipsoidictyum cinctum
Endoscrinium/Scriniodinium spp.
Epiplosphaera bireticulata
Epiplosphaera gochtii
Epiplosphaera areolata
Escharisphaeridia pocockii
Glossodinium dimorphum
Gonyaulacysta jurassica jurassica
Occisucysta balia
Pareodinia ceratophora

Pilosidinium myriatrichum
Rhynchodiniopsis cladophora
Scriniodinium inritibilum
Stephanelytron scarburghense
Subtilisphaera? inaffecta
Subtilisphaera? paeminosa
Systematophora areolata
Systematophora penicillata
Systematophora daveyi
Taeniophora iunctispina
Tehamadinium aculeatum
Tubotuberella apatela

Sample 140 m

Amphorula metaelliptica
Barbatacysta brevispinosa
Chytroeisphaeridia chytroeides
Cribroperidinium granulatum
Dichadogonyaulax chrondra
Dingodinium minutum
Epiplosphaera areolata
Escharisphaeridia pocockii
Escharisphaeridia pelionense
Glossodinium dimorphum
Pareodinia ceratophora
Rhynchodiniopsis cladophora
Sentusidinium sparsibarbatum
Subtilisphaera? paeminosa
Subtilisphaera? inaffecta
Systematophora areolata
Systematophora penicillata
Tubotuberella apatela

Sample 135 m

Amphorula metaelliptica
Barbatacysta creberbarbata
Barbatacysta verrucosa
Chytroeisphaeridia chytroeides
Cleistosphaeridium polytrichum
Cleistosphaeridium? tribuliferum
Cribroperidinium sarjeantii
Cribroperidinium globatum
Cribroperidinium granulatum
Cribroperidinium? longicorne
Cymatiosphaera spp.
Dichadogonyaulax chrondra
Dingodinium minutum
Ellipsoidictyum cinctum
Epiplosphaera areolata
Escharisphaeridia pelionense
Escharisphaeridia pocockii
Gonyaulacysta tuberculata
Gonyaulacysta jurassica jurassica
Heslertonia? pellucida
Lithodinia bejui
Occisucysta balia
Pareodinia ceratophora
Prolixosphaeridium mixtispinosum
Rhynchodiniopsis cladophora
Sentusidinium rioultii
Subtilisphaera? paeminosa
Subtilisphaera? inaffecta
Systematophora daveyi
Systematophora areolata
Systematophora penicillata
Valensiella ovula

Sample 122 m

Amphorula metaelliptica
Chytroeisphaeridia chytroeides
Cribroperidinium globatum
Cribroperidinium granulatum
Cribroperidinium spp.
Dingodinium minutum
Dingodinium harsveldtii
Ellipsoidictyum cinctum
Endoscrinium luridum
Escharisphaeridia pocockii
Escharisphaeridia pelionense
Glossodinium dimorphum
Gonyaulacysta jurassica jurassica
Leptodinium spp.
Occisucysta balia
Pareodinia ceratophora
Scriniodinium inritibilum
Sentusidinium rioultii
Stephanelytron scarburghense
Subtilisphaera? inaffecta
Subtilisphaera? paeminosa
Systematophora areolata
Tehamadinium aculeatum

Sample 110 m

Amphorula metaelliptica
Chytroeisphaeridia chytroeides
Cleistosphaeridium polytrichum
Cleistosphaeridium? polyacanthum
Cribroperidinium granulatum
Cribroperidinium globatum
Cribroperidinium sarjeantii
Cribroperidinium spp.
Cymatiosphaera spp.
Dichadogonyaulax chrondra
Egmontodinium ovatum
Endoscrinium/Scrinodinium spp.
Endoscrinium luridum
Escharisphaeridia pelionense
Escharisphaeridia pocockii
Glossodinium dimorphum
Gonyaulacysta jurassica jurassica
Gonyaulacysta tuberculata
Netrelytron stegastum
Leptodinium mirabile
Lithodinia bejui
Occisucysta balia
Pareodinia ceratophora
Perisseiasphaeridium ingegerdii
Rhynchodiniopsis cladophora
Sentusidinium rioultii
Subtilisphaera? paeminosa
Subtilisphaera? inaffecta
Systematophora penicillata
Systematophora daveyi
Systematophora areolata

The boundary between the Hypselocyclum Zone and the Divisum Zone runs in the lower part of the Skorków Lumachelle, about 50 m above the top of the Upper Oolite, and boundary between the Divisum Zone and the Mutabilis Zone runs approximately close to the boundary of the Upper Platy Limestones and Top Shales (KUTEK 1968, KUTEK & *al.* 1992).

SZADKOWICE

The Szadkowice borehole was drilled on the north-western margin of the Holy Cross Mountains, about 11 km north-west of Opoczno. The Divisum to Eudoxus Zones are recorded in the core-section studied of this borehole (MATYJA & *al.* 1988).

The dinoflagellate cyst flora is very rich and diverse in most of the studied samples, but two lowermost samples have reduced assemblages. A comparison between this and the Małogoszcz

Quarry shows that *Epiplosphaera* spp. are common in the lower part of the section referred to the Divisum Zone, however in the overlying section, *Systematophora* spp. are not as frequent as in the Małogoszcz Quarry.

The samples come from marls and marly limestones, and their biostratigraphic position in relation to ammonite zones is as follows (*see* MATYJA & *al.* 1988):

Eudoxus Zone — samples from 13.0 m and 24.0 m,
Eudoxus Zone and/or Mutabilis Zone — samples from 35.0, and 45.1 m,
Mutabilis Zone and/or Divisum Zone — samples from 72.2 m, 87.7 m, 98.0 m,
Divisum Zone — samples from 106.5 m, 111.0 m, 115.8 m, 135.4 m, 146.6 m, 152.2 m.

The cyst assemblages at these depths are as follows:

Aldorfia dictyota (35.0 — 115.8 m)
Ambonosphaera? staffinensis (24.0 — 152.2 m)
Amphorula metaelliptica (13.0 — 152.2 m)
Apteodinium nuciforme (24.0 — 152.2 m)
Atlantodinium jurassicum (35.0 — 146.1 m)
Atopodinium haromense (35.0 m)
Barbatacysta brevispinosa (72.2 — 115.8 m)
Barbatacysta creberbarbata (13.0 — 152.2 m)
Barbatacysta lemoignei (98.0 — 152.2 m)
Barbatacysta verrucosa (24.0 — 115.8 m)
Chlamydophorella membranoidea (87.7 m)
Chytroeisphaeridia chytroeides (13.0 — 115.8 m)
Cleistosphaeridium lumectum (13.0 m)
Cleistosphaeridium? polyacanthum (87.7 m)
Cleistosphaeridium? tribuliferum (111.0 m)
Cometodinium sp. 1 (106.5 m)
Cribroperidinium globatum (13.0 — 111.0 m)
Cribroperidinium granulatum (13.0 — 152.2 m)
Cribroperidinium muderongense (72.2 — 98.0 m)
Cribroperidinium sarjeantii (13.0, 98.0 m)
Cribroperidinium spp. (24.0 — 135.4 m)
Cribroperidinium? longicorne (35.0 — 106.5 m)
Cyclonephelium spp. (87.7 m)
Dichadogonyaulax sp. 1 (98.0 — 115.8 m)
Dichadogonyaulax chrondra (35.0 — 135.4 m)
Dingodinium jurassicum (24.0 m)
Dingodinium minutum (13.0 — 152.2 m)
Dingodinium tuberosum (45.1 m)
Ellipsoidictyum cinctum (106.5 m)
Endoscrinium galeritum (45.1 — 111.0 m)
Endoscrinium luridum (111.0 — 146.1 m)
Epiplosphaera areolata (24.0 — 152.2 m)
Epiplosphaera gochtii (35.0 — 152.2 m)
Epiplosphaera reticulospinosa (115.8 m)
Escharisphaeridia pelionense (111.0 — 146.1 m)
Escharisphaeridia pocockii (13.0 — 152.2 m)
Glossodinium dimorphum (24.0 — 115.8 m)
Gonyaulacysta dualis (24.0 — 111.0 m)
Gonyaulacysta jurassica jurassica (24.0 — 152.2 m)
Gonyaulacysta spp. (146.1 m)
Gonyaulacysta tuberculata (13.0 — 111.0 m)
Heslertonia? pellucida (13.0 — 72.2 m)
Hystrichodinium pulchrum (45.1 — 87.7 m)
Hystrichosphaerina orbifera (106.5 — 135.4 m)
Netrelytron stegastum (152.2 m)
Lanterna bulgarica (115.8 m)
Lanterna spp. (135.4 m)
Leptodinium mirabile (98.0 m)
Leptodinium spp. (24.0 — 87.7 m)
Leptodinium subtile (13.0 m)
Lithodinia pila (45.1 m)
Mendicodinium groenlandicum (35.0 — 152.2 m)
Neuffenia willei (13.0 — 152.2 m)
Occisucysta balia (13.0 — 115.8 m)
Occisucysta monoheuriskos (135.4 m)
Oligosphaeridium patulum (87.7 m)
Pareodinia antennata (135.4 m)
Pareodinia asperata (24.0 — 135.4 m)
Pareodinia ceratophora (13.0 — 152.2 m)
Pareodinia halosa (87.7 m)
Pareodinia robusta (87.7 m)
Perisseiasphaeridium ingegerdii (111.0 — 115.8 m)
Perisseiasphaeridium pannosum (13.0 — 115.8 m)
Pilosidinium echinatum (98.0 m)
Pilosidinium myriatrichum (13.0 — 87.7 m)
Prolixosphaeridium anasillum (87.7 m)
Prolixosphaeridium parvispinum (135.4 m)
Protobatioladinium imbatodinense (13.0 — 152.2 m)
Protobatioladinium westburiensis (111.0 — 152.2 m)
Rhynchodiniopsis cladophora (24.0 — 135.4 m)
Scriniodinium inritibilum (35.0 — 152.2 m)
Senoniasphaera jurassica (87.7 m)
Sentusidinium erythrocomum (115.8 m)
Sentusidinium rioultii (35.0 — 146.1 m)
Sentusidinium spp. (24.0 — 87.7 m)
Sentusidinium villersense (87.7 — 111.0 m)
Subtilisphaera? inaffecta (13.0 — 152.2 m)
Subtilisphaera? paeminosa (13.0 — 45.1 m)
Subtilisphaera? sp. 2 (115.8 — 146.1 m)
Systematophora areolata (13.0 — 135.4 m)
Systematophora daveyi (24.0 — 135.4 m)
Systematophora penicillata (13.0 — 146.1 m)
Systematophora valensii (72.2 m)
Tchamadinium aculeatum (35.0 — 135.4 m)
Tubotuberella apatela (13.0 — 111.0 m)
Tubotuberella egemenii (111.0 — 146.1 m)
Tubotuberella rhombiformis (87.7 m)
Tubotuberella spp. (35.0 m)
Valensiella ovula (13.0 — 152.2 m)
Wallodinium cylindricum (24.0 — 152.2 m)
Wallodinium krutzschii (87.7 m)
Xenicodinium densispinosum (111.0 m)

Such forms as *Cribroperidinium* spp., *Escharisphaeridia* spp., *Gonyaulacysta jurassica*, *Pareodinia* spp., *Protobatioladinium* spp., *Subtilisphaera*? spp., and species of the *Sentusidinium* suite are among the more abundant components of the assemblages, whilst *Perisseiasphaeridium pannosum* becomes abundant at the top of the section.

The first appearance of *Perisseiasphaeridium pannosum* permits a correlation with the P. pannosum Subzone. However, the first occurrence of common *Subtilisphaera*? *inaffecta* is recorded below the first appearance of P. pannosum at this location, and may indicate some uncertainty in the position of the lower boundary of the P. pannosum Subzone.

TROJANÓW

The Trojanów-*83* borehole was drilled on the north-western margin of the Holy Cross Mountains, about 12 km north-west of Opoczno. The section studied is referred to the Hypselocyclum Zone and Hypselocyclum-Divisum Zones (MATYJA & *al.* 1988).

The recognized cyst assemblages, rich and diverse, are characterized by common *Cribroperidinium* spp., *Dichadogonyaulax chrondra*, *Epiplosphaera* spp., *Gonyaulacysta jurassica*, *Pareodinia* spp., *Protobatioladinium* spp., and species of the *Sentusidinium* suite.

The samples come from marls and marly limestones, and their biostratigraphic position in relation to ammonite zones is as follows (*see* MATYJA & *al.* 1988):

Divisum Zone and/or Hypselocyclum Zone — samples from 50.3 m.
Hypselocyclum Zone — samples from 57.5 m, 62.5 m, 67.7 m, 73.5 m, 81.4 m, 92.7 m and 97.5 m.

The cyst assemblages at these depths are as follows:

Aldorfia dictyota (67.7 — 86.5 m)
Aldorfia spp. (57.5 m)
Ambonosphaera? staffinensis (57.5 — 86.5 m)
Amphorula dodekovae (86.5 m)
Amphorula metaelliptica (50.3 — 97.5 m)
Apteodinium nuciforme (50.3 — 97.5 m)
Atlantodinium jurassicum (67.7 m)
Atopodinium haromense (67.7 — 97.5 m)
Barbatacysta brevispinosa (81.4 m)
Barbatacysta creberbarbata (50.3 — 97.5 m)
Barbatacysta lemoignei (50.3 — 81.4 m)
Barbatacysta pilosa (67.7 m)
Barbatacysta verrucosa (57.5 — 86.5 m)
Chytroeisphaeridia chytroeides (57.5 — 92.7 m)
Cleistosphaeridium lumectum (81.4 m)
Cleistosphaeridium polytrichum (50.3 — 81.4 m)
Cleistosphaeridium? polyacanthum (81.4 — 86.5 m)
Cometodinium sp. 1 (50.3 — 86.5 m)
Cribroperidinium globatum (50.3 — 97.5 m)
Cribroperidinium granulatum (50.3 — 97.5 m)
Cribroperidinium muderongense (50.3 — 62.5 m)
Cribroperidinium sarjeantii (81.4 — 92.7 m)
Cribroperidinium spp. (50.3 — 97.5 m)
Cribroperidinium? longicorne (50.3 — 92.7 m)
Ctenidodinium tenellum (57.5 m)
Dichadogonyaulax sp. 1 (50.3 — 81.4 m)
Dichadogonyaulax chrondra (50.3 — 97.5 m)
Dingodinium jurassicum (97.5 m)
Dingodinium minutum (67.7 — 97.5 m)
Ellipsoidictyum cinctum (50.3 — 81.4 m)
Endoscrinium galeritum (81.4 m)
Endoscrinium luridum (57.5 — 92.7 m)
Epiplosphaera areolata (57.5 — 92.7 m)
Epiplosphaera bireticulata (57.5 — 81.4 m)
Epiplosphaera gochtii (50.3 — 92.7 m)
Epiplosphaera reticulospinosa (73.5 — 81.4 m)
Escharisphaeridia pelionense (57.5 — 86.5 m)
Escharisphaeridia pocockii (50.3 — 92.7 m)
Glossodinium dimorphum (57.5 — 92.7 m)
Gonyaulacysta dualis (57.5 — 97.5 m)
Gonyaulacysta jurassica jurassica (50.3 — 97.5 m)
Gonyaulacysta tuberculata (50.3 — 97.5 m)
Heslertonia? pellucida (73.5 — 81.4 m)
Hystrichosphaerina orbifera (50.3 — 81.4 m)
Lanterna bulgarica (50.3 — 97.5 m)
Lanterna emitecta (57.5 — 73.5 m)
Leptodinium mirabile (97.5 m)
Leptodinium spp. (86.5 m)
Lithodinia bejui (81.4 m)
Lithodinia spp. (73.5 — 97.5 m)
Mendicodinium groenlandicum (97.5 m)
Neuffenia willei (57.5 — 73.5 m)
Occisucysta balia (57.5 — 81.4 m)
Omatidium amphiacanthum (62.5 m)
Pareodinia asperata (73.5 m)
Pareodinia ceratophora (50.3 — 97.5 m)
Perisseiasphaeridium ingegerdii (62.5 — 97.5 m)
Pilosidinium myriatrichum (67.7 m)
Prolixosphaeridium parvispinum (57.5 — 92.7 m)
Protobatioladinium imbatodinense (57.5 — 97.5 m)
Protobatioladinium westburiensis (50.3 — 97.5 m)
Rhynchodiniopsis cladophora (62.5 — 97.5 m)
Scriniodinium inritibilum (50.3 — 86.5 m)
Sentusidinium erythrocomum (81.4 m)
Sentusidinium rioultii (62.5 — 97.5 m)
Sentusidinium sparsibarbatum (62.5 m)
Subtilisphaera? inaffecta (57.5 — 62.5 m)
Systematophora areolata (50.3 — 97.5 m)
Systematophora daveyi (50.3 — 97.5 m)
Systematophora penicillata (57.5 — 97.5 m)
Systematophora valensii (67.7 — 73.5 m)
Tehamadinium aculeatum (57.5 m)
Tubotuberella apatela (57.5 — 86.5 m)
Tubotuberella egemenii (62.5 — 86.5 m)
Valensiella ovula (50.3 — 81.4 m)
Wallodinium cylindricum (81.4 — 97.5 m)
Xenicodinium densispinosum (50.3 — 73.5 m)

The presence of *Cribroperidinium*? *longicorne* indicates the Endoscrinium luridum Zone. *Subtilisphaera*? *inaffecta* has a rare occurrence in the uppermost part of the section. The lack of *Perisseiasphaeridium pannosum* and the rare occurrence of *S.*? *inaffecta* are correlated to the lower subzone of the E. luridum Zone, the Stephanelytron scarburghense Subzone.

The presence of *Perisseiasphaeridium ingegerdii* in the lower part of the section below the first occurrence of *P. pannosum* is stratigraphically significant.

WIERZBICA QUARRY

The Wierzbica Quarry is situated in the north-western margin of the Holy Cross Mountains, about 15 km south of Radom. The section exposed has recently been correlated to the Hypselocyclum and Divisum Zones by GUTOWSKI (1992).

The samples are fairly rich in dinoflagellate cysts. However, only the samples near the boundary between the Hypselocyclum and Divisum Zones have diverse assemblages. The samples at the base and top of the section have less diverse assemblages, in which *Cribroperidinium* spp., *Dingodinium* spp., *Systematophora* spp. and species of the *Sentusidinium* suite are commonly represented. The species *Gonyaulacysta jurassica* occurs infrequently in these assemblages. The uppermost sample has a notable dominance of *Subtilisphaera*? spp.

The index species (i.e. *Cribroperidinium*? *longicorne*) for the base of the Endoscrinium luridum Zone are not recorded in this section, but as *Scriniodinium crystallinum* (indicating the S. crystallinum Zone), is not recorded either, a correlation with Stephanelytron scarburghense Subzone of the E. luridum Zone is reliable. The common occurrence of *Subtilisphaera*? *inaffecta* in the top of the section permits a possible correlation with the *Perisseiasphaeridium pannosum* Subzone, although the index species *P. pannosum* is not recorded. A single *S. crystallinum* recorded at the base of the Divisum Zone is regarded as reworked.

Two lower samples come from Platy Limestones representing the uppermost part of the Wierzbica Oolites and Platy Limestones which are referred to the Hypselocyclum Zone (GUTOWSKI 1992). The position of the samples is 50 m and 63 m above the base of the section, respectively.

Three higher samples come from the Wierzbica Oyster Lumachelle (GUTOWSKI 1992), as follows:

— directly above the base of the unit from marls (63 m above the base of the section),
— about 70 m above the base of the section from marls and marly limestones representing the lowermost part of the Divisum Zone,
— about 90 m above the base of the section from marly lumachelle representing the Divisum Zone, just at the top of the Wierzbica Oyster Lumachelle presently exposed in the quarry (*cf.* GUTOWSKI 1992).

The total content of the cyst assemblages from the Wierzbica Quarry is as follows:

Acanthaulax venusta (63.0, 70.0 m)
Ambonosphaera spp. (62.0, 63.0 m)
Barbatacysta brevispinosa (50.0, 62.0, 63.0, 70.0, 0 m)
Barbatacysta creberbarbata (50.0, 62.0, 63.0, 70.0, 90.0 m)
Barbatacysta verrucosa (50.0, 63.0, 70:0, 0 m)
Chytroeisphaeridia chytroeides (63.0, 70.0 m)
Cleistosphaeridium polytrichum (70.0 m)
Cribroperidinium globatum (62.0, 70.0 m)
Cribroperidinium granulatum (50.0, 62.0, 63.0, 70.0, 90.0 m)
Cribroperidinium sarjeantii (62.0, 70.0 m)
Dichadogonyaulax chrondra (62.00 m)
Dingodinium minutum (50.0, 62.0, 70.0, 90.0 m)
Egmontodinium ovatum (62.0, 63.0, 70.0 m)
Egmontodinium polyplacophorum (70.0 m)
Ellipsoidictyum cinctum (70.0, 90.0 m)
Endoscrinium galeritum (70.0 m)
Endoscrinium luridum (70.0 m)
Epiplosphaera areolata (50.0, 62.0, 63.0, 70.0, 90.0 m)
Epiplosphaera gochtii (70.0 m)
Epiplosphaera reticulospinosa (70.0 m)
Escharisphaeridia pelionense (70.0 m)
Escharisphaeridia pocockii (50.0, 62.0, 63.0, 70.0, 90.0 m)
Glossodinium dimorphum (63.0, 70.0 m)
Gonyaulacysta jurassica jurassica (50.0, 62.0, 63.0, 70.0, 90.0 m)
Gonyaulacysta tuberculata (70.0 m)
Heslertonia? pellucida (70.0 m)
Hystrichosphaerina orbifera (50.0, 90.0 m)
Leptodinium subtile (62.0 m)
Pareodinia ceratophora (62.0, 63.0, 70.0, 90.0 m)
Pilosidinium myriatrichum (50.0, 63.0, 70.0 m)
Rhynchodiniopsis cladophora (50.0, 63.0, 70.0, 90.0 m)
Scriniodinium crystallinum (70.0 m) (reworked?)
Sentusidinium rioultii (62.0, 63.0, 70.0 m)
Subtilisphaera? inaffecta (50.0, 62.0, 70.0, 90.0 m)
Subtilisphaera? paeminosa (70.0, 90.0 m)
Subtilisphaera? sp. 2 (70.0, 90.0 m)
Systematophora areolata (50.0, 62.0, 63.0, 70.0, 90.0 m)
Systematophora daveyi (70.0 m)
Systematophora penicillata (62.0, 63.0 m)
Tubotuberella apatela (63.0, 70.0 m)

BAŁTÓW

The Bałtów outcrop is located on the north-eastern margin of the Holy Cross Mountains, about 15 km south of Radom. The section exposed has recently been correlated to the Transversarium Zone by GUTOWSKI (1992).

The dinoflagellate cyst flora is relatively diverse with abundant *Epiplosphaera* spp., common *Gonyaulacysta eisenacki*, *Rhynchodiniopsis cladophora*, *Sirmiodiniopsis orbis*, and *Systematophora* spp.

The last occurrence of *Compositosphaeridium polonicum* allows a correlation with the Scriniodinium crystallinum Zone, Subzone *a*.

The sample comes from the uppermost part of the Bałtów Platy Limestones (GUTOWSKI 1992). It yielded the following cyst assemblage:

Amphorula spp.
Barbatacysta creberbarbata
Barbatacysta pilosa
Chytroeisphaeridia chytroeides
Cleistosphaeridium lumectum
Cometodinium sp. 1
Compositosphaeridium polonicum
Ctenidodinium ornatum
Ellipsoidictyum cinctum
Endoscrinium galeritum
Endoscrinium luridum
Epiplosphaera bireticulata
Epiplosphaera gochtii
Epiplosphaera reticulata
Epiplosphaera reticulospinosa
Escharisphaeridia pelionense
Escharisphaeridia pocockii
Gonyaulacysta eisenackii
Leptodinium subtile
Parcodinia ceratophora
Rhynchodiniopsis cladophora
Scriniodinium crystallinum
Sentusidinium rioultii
Sirmiodiniopsis orbis
Systematophora areolata
Systematophora penicillata
Systematophora valensii
Systematophora vestita
Tubotuberella apatela
Valensiella ovula

CORRELATION

The stages of the Upper Jurassic of northwestern Europe have been placed into provinces, basins, platforms and transitional areas between the Boreal Realm and the Tethyan or Mediterranean Realms. However, there has been no consistency in the biogeographic name applied to any one locality. The main reason for this is the variation in spreading and migration routes of faunas and floras, and the interpretation of these events by successive authors.

In the present study the southern part of England and the Central Trough in the Danish North Sea area is called the Northwest European Subprovince. The northern part of the Central Trough and the Norwegian-Danish Basin is called the Boreal-Subboreal Subprovince. Together these two subprovinces are referred to as the Subboreal Province.

The territory of Poland corresponds to a passage area between the Subboreal and the Submediterranean Provinces, and is referred to as the Submediterranean Provinces in the Oxfordian to Early Kimmeridgian, and as the Subboreal Province in the Late Kimmeridgian. In the present study Poland is referred to as the Polish Subprovince.

AMMONITE ZONATION

The Oxfordian ammonite zonation (Text-fig. 2) and the correlation [illegible]e Subboreal Province (Boreal-Subboreal Subprovince and North-western European Subprovince) and the Submediterranean Province is given by SYKES & SURLYK (1976) and SYKES & CALLOMON (1979). The ammonite zonation for the Submediterranean Province, given by SYKES & CALLOMON (1979), is used for the Polish Subprovince. MATYJA & WIERZBOWSKI (1988) correlated almost the entire Bimammatum Zone of the Polish Subprovince with the Rosenkrantzi Zone of the Boreal Province. However, the boundary between the Bifurcatus and the Bimammatum Zones was only tentatively correlated with the boundary between the Regulare and the Rosenkrantzi Zones by these authors (MATYJA & WIERZBOWSKI 1988).

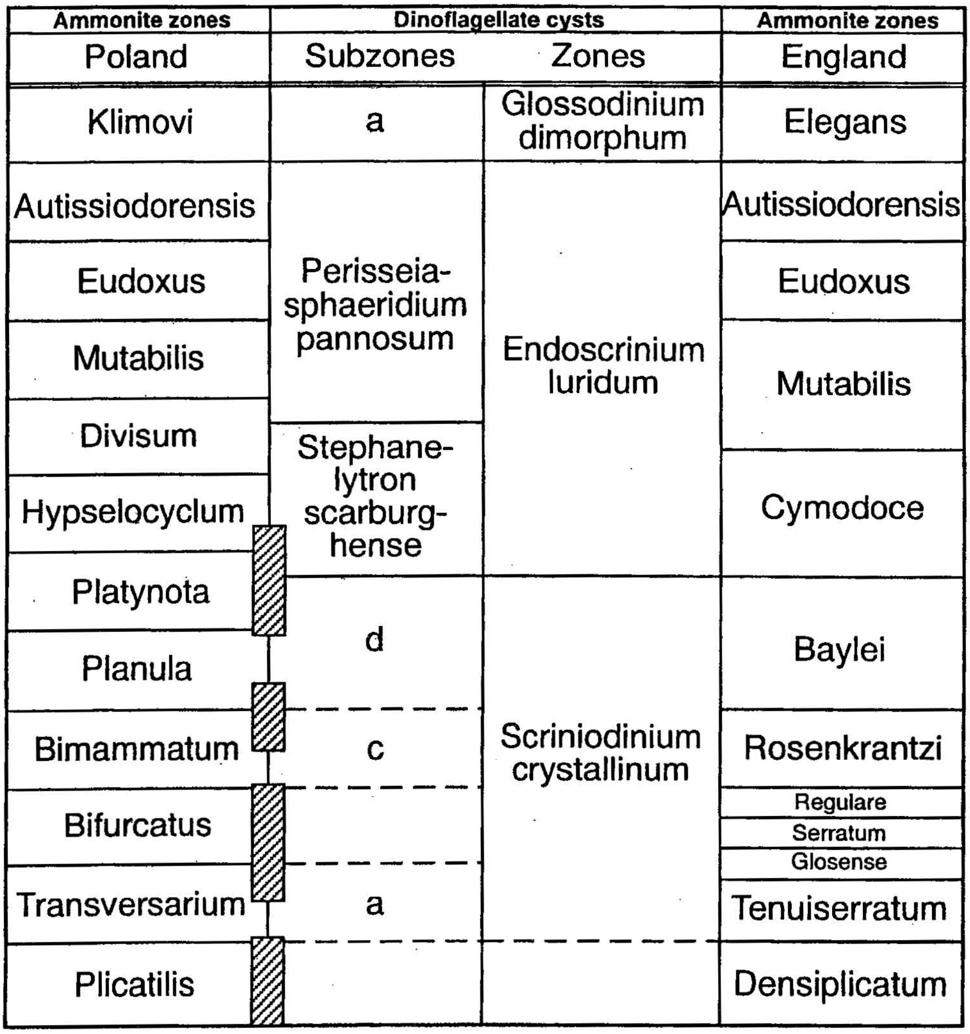


Fig. 2. Correlation chart for the Oxfordian to Kimmeridgian successions in Poland and England, as based on dinoflagellate cyst assemblages; *stippled blocks* indicate intervals of uncertain correlation

The precise stratigraphic correlation of the Oxfordian/Kimmeridgian boundary from the Submediterranean Province to the Subboreal Province is difficult (*see e.g.* SYKES & CALLOMON 1979). The stratigraphic position of the Oxfordian/Kimmeridgian boundary is discussed by BIRKELUND & CALLOMON (1985, pp. 15-19) and by BIRKELUND (*in* AARHUS & *al.* 1989, p. 53). Recently, MATYJA & WIERZBOWSKI (1988) more conclusively correlated the Submediterranean Planula Zone with the Baylei Zone, the lowermost zone of the Boreal Kimmeridgian.

The ammonite scheme used for the Lower Kimmeridgian of the Polish Subprovince (*see* Text-fig. 2), is the Submediterranean zonation, but that of the Upper Kimmeridgian is similar to the Subboreal zonation.

IMPLICATIONS FROM THE DINOFLAGELLATE CYST BIOSTRATIGRAPHY

The oldest dinoflagellate cyst assemblage identified in this study is from the Transversarium Zone. It correlates with the Scriniodinium crystallinum Zone, Subzone *a*, which in England is dated as the Tenuiserratum Zone (WOOLLAM & RIDING 1983). Although only based on a single sample, the dinoflagellate cysts confirm the time relationship betwen the Tenuiserratum and Transversarium Zones as proposed by SYKES & CALLOMON (1979) and CALLOMON (*pers. comm.*, 1989).

The dinoflagellate cyst assemblage described from the Hypselum Subzone (Bimammatum Zone) is correlated with the S. crystallinum Zone, Subzone *c*, which is referred to the Rosenkranzi Zone in England (RIDING & THOMAS 1988). The occurrence of Subzone *c* in the section referred to the Hypselum Subzone suggests therefore a time link from the Hypselum Subzone to the Rosenkrantzi Zone, and therefore, the correlation of at least part of the Hypselum Subzone to the early part of the Rosenkrantzi Zone by MATYJA & WIERZBOWSKI (1988) seems to be confirmed by the dinoflagellate cyst biostratigraphy.

There are in this study no records of dinoflagellate cysts from the succeeding Platynota Zone. The record of the Endoscrinium luridum Zone in the Hypselocyclum Zone does therefore not indicate the exact base of the E. luridum Zone. In England, its base is considered as equivalent to the base of the Cymodoce Zone. The Stephanelytron scarburghense Subzone, the lower subzone of the E. luridum Zone, is identified in the present study.

The boundary between the S. scarburghense Subzone and the Perisseiasphaeridium pannosum Subzone, the upper subzone of the E. luridum Zone is recorded in an upper Divisum Zone to a lower Mutabilis Zone of the Polish Subprovince. In the British Isles, this stratigraphic level corresponds to the mid-Mutabilis Zone (NØHR-HANSEN 1986, POULSEN 1991a). This event is recorded in Małogoszcz and Wierzbica quarries and in the Szadkowice borehole. If this conclusion is correct, then the interval close to the Divisum/Mutabilis boundary in the Submediterranean (Polish) succession is believed to correlate with the mid-Mutabilis Zone of the Subboral succession.

The P. pannosum Subzone is recorded in the overlying Mutabilis, Eudoxus, and Autissiodorensis Zones. Both in the Polish Subprovince and in the Subboreal Province is the stratigraphic top of E. luridum referred to the latest Autissiodorensis Zone, suggesting that the boundary between the Kimmeridgian and the Volgian is isochronous from England to Poland.

Beds of the Klimovi Zone, earliest Volgian, in Poland is correlated to the Glossodinium dimorphum Zone, Subzone *a*, which in England is correlated to the earliest Subboreal zone of the Lower Volgian (=Upper Kimmeridgian *sensu anglico*), the Elegans Zone, suggesting a correlation between these two first zones of the Subboreal Province, and the Polish Subprovince respectively.

COMPARISON

A comparison of Polish dinoflagellate cyst assemblages with those from Denmark, the North Sea area or England, shows that most of the recorded species are common to all areas but their frequencies in assemblages is varied throughout the discussed regions.

The Oxfordian and Kimmeridgian sequence in Poland begins with the bedded, sponge carbonate deposits. Carbonate sedimentation with algal sponge bioherms was established during the Middle to Late Oxfordian in Central Poland, and carbonate sedimentation platform facies persisted during the Kimmeridgian. The Oxfordian/Kimmeridgian carbonate sequence includes cross-bedded deposits laid down in a high-energy environment with oolites, mixed with low-energy micritic limestones, marls and calcareous claystones.

The Oxfordian to earliest Kimmeridgian deposits in Denmark comprise deltaic beds at the base and marine sands and clays in the middle and upper part of the interval. In the Kimmeridgian, marine conditions prevailed and clayey marine mudstones are present in the main part of the basin from the base of the Endoscinium luridum Zone, although the lithology becomes more sandy towards the margins of the Baltic Shield. During the Late Kimmeridgian, marine mudstones were deposited over the entire area.

OXFORDIAN

The Middle Oxfordian in Poland is characterized by assemblages relatively rich in *Epiplosphaera* species, *Gonyaulacocysta eisenacki*, *Rhynchodiniopsis cladophora*, *Sirmiodiniopsis orbis*, and *Systematophora* species are also commonly represented in the dinoflagellate cyst assemblages. The *Epiplosphaera* group and *Rhynchodiniopsis cladophora* which occurred commonly in the Middle Jurassic are also fairly common in the Late Oxfordian assemblage.

Assemblages from Denmark are characterized by dominant *Cribroperidium* species, associated with *Systematophora* species.

The *Cribroperidinium* species appear to have preferred the shallow and, perhaps, brackish-marine, silici-clastic environment. Notably *Epiplosphaera* species, *Gonyaulacysta eisenacki*, and *Sirmiodiniopsis orbis* appear to prefer the shallow, high-energy carbonate platform.

KIMMERIDGIAN

The Kimmeridgian dinoflagellate cyst assemblages are rich, especially in the Late Kimmeridgian, and have probably the maximum diversity for the Jurassic reflecting the high sea-level. The Polish Kimmeridgian samples contained numerically abundant assemblages with high species diversity in common with the assemblages from Denmark, the North Sea area, and the British Isles. The dinoflagellate cyst assemblages of the Endoscrinium luridum Zone are especially rich, containing many of the species common to the North Sea area. Many species have also been described from other parts of Europe, e.g. *Amphorula metaelliptica, Atlantodinium jurassicum, Protobatioladium westburiense,* and Australia, e.g. *Dollidinium sinosum.*

The rich occurrence of *Subtilisphaera*? species is notable. In Denmark, species of this genus are only common in the nearshore areas of the Baltic Shield, and in England *Subtilisphaera*? species are also rare (Riding, *pers. comm.* 1990) as they are in the deepwater facies of the Central Trough. The occurrence of the two species, *S.*? *inaffecta* and *S.*? *paeminosa*, may indicate that they had a low-energy, shallow marine preference, suggested by the clay-rich sediment of the Danish records of this occurrence.

Species of the *Lanterna* — *Lithodinia* — *Meiourogonyaulax* — *Sentusidinium* suite occur frequently in Poland, as they do in Germany (Brenner 1988, Durr 1988) and in France (Courtinat 1989). Of these, only the *Sentusidinium* suite occurs commonly in Denmark.

Other common taxa in the Kimmeridgian were *Cribroperidinium* and *Systematophora* species which, as in the Oxfordian, are most common in the nearshore environments.

Some of the stratigraphic index species differ in abundance in comparison to Denmark or the British Isles. For instance, *Nannoceratopsis pellucida* was not recorded in this study in the Kimmeridgian of Denmark and Poland. The subspecies *G. jurassica jurassica* which became a common species in the latest Oxfordian, is abundant in the Planula — earliest Hypselocyclum Zones, and it is common to the end of the Kimmeridgian of Poland, where it disappears. It should be noted that it is only a local last occurrence datum for this species. In the Danish and British areas it occurs in the Lower Volgian, whereas in more northerly localities, it occurs in the higher parts of the Volgian (*see* POULSEN 1991b).

The species *Dichadogonyaulax chondra* is present from the beginning of the Kimmeridgian and to the Middle Volgian in Poland. On the other hand, *Subtilisphaera*? *inaffecta* and *S. paeminosa* are very common in the Late Kimmeridgian in comparison to the North Sea area and the British Isles.

The data presented indicate that the Late Jurassic dinoflagellate cyst flora of Poland can be correlated to those of similar age from Denmark and England, and that most of the Oxfordian and Kimmeridgian zonal units from the Danish/English area can be recognized in Poland. If the zonation scheme is isochronous, it supports recent correlation proposals by MATYJA & WIERZBOWSKI (1988). The early part of the Bimammatum Zone correlates, according to dinoflagellate cyst data, to the earliest Rosenkrantzi Zone. The Planula Zone corresponds to the Baylei Zone, and the presently accepted boundary between the Oxfordian/Kimmeridgian of the Submediterranean Province is placed later than in the Subboreal Province.

The Kimmeridgian dinoflagellate cysts from an upper part of the Divisum to a lower part of the Mutabilis Zone of the Submediterranean succession indicate a correlation with the middle Mutabilis Zone of England. It is suggested that the interval at the boundary of the Divisum Zone and the Mutabilis Zone of Poland correlates with the middle Mutabilis Zone of England, indicating a diachronous base of the Mutabilis Zone from the Subboreal Province to the Submediterranean Province.

PLATE 1

1 — *Ctenododinium ornatum* (EISENACK, 1935) DEFLANDRE, 1938; DGU Catalogue No. 1992-NEP-3; Barcin-Pakość-3 borehole (137.4 m), Łyna Formation, Hypselum Subzone, Bimammatum Zone

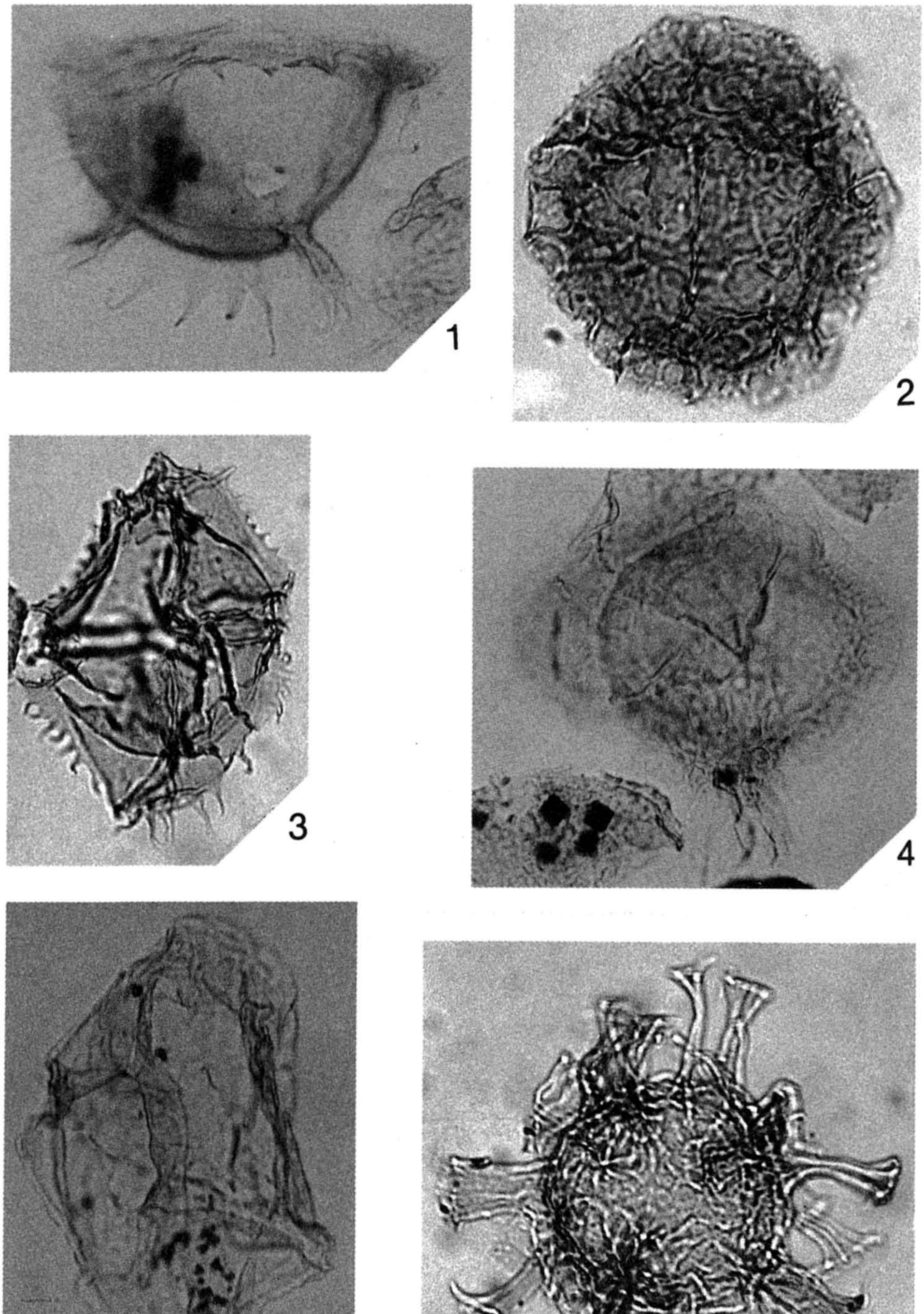
2 — *Epiplosphaera bireticulata* KLEMENT, 1960; DGU Catalogue No. 1991-NEP-22; Bałtów, Transversarium Zone

3 — *Gonyaulacysts eisenacki* (DEFLANDRE, 1938) DODEKOVA, 1967, emend. SARJEANT 1982; DGU Catalogue No. 1991-NEP-173; Bałtów, Transversarium Zone

4 — *Glossodinium dimorphum* IOANNIDES & *al.*, 1977; DGU Catalogue No. 1992-NEP-4; Małogoszcz Quarry, Top Clays, Mutabilis Zone

5 — *Endoscrinium galeritum* (DEFLANDRE, 1938) VOZZHENNIKOVA 1967; DGU Catalogue No. 1992-NEP-5; Małogoszcz Quarry, Top Clays, Mutabilis Zone

6 — *Compositosphaeridinium polonicum* (GÓRKA, 1965) ERKMEN & SARJEANT, 1980, emend. ERKMEN & SARJEANT, 1980; DGU Catalogue No. 1991-NEP-41; Bałtów, Transversarium Zone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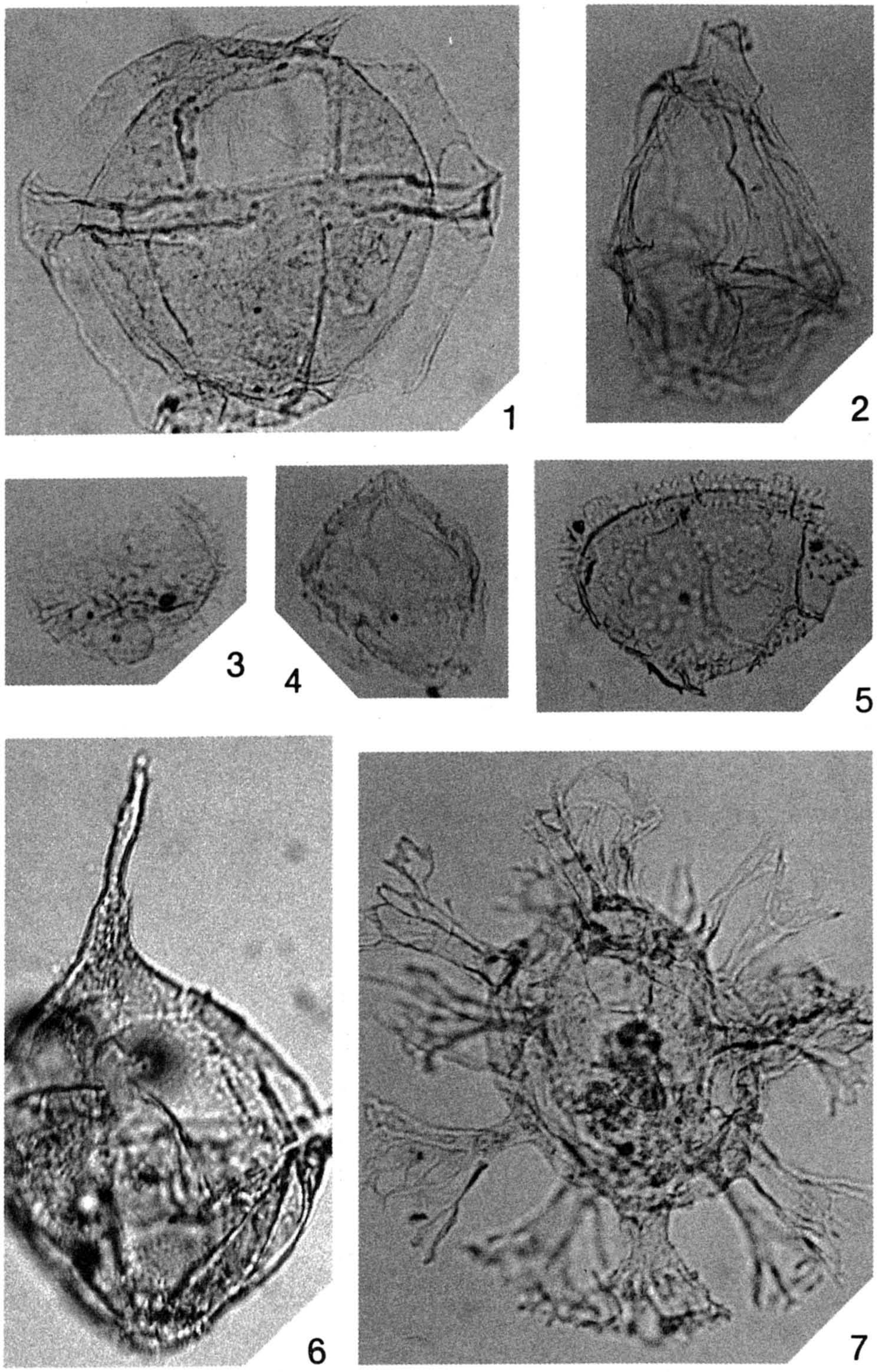

SYSTEMATIC ACCOUNT

Almost all taxa recognized in this study are the dinoflagellate cysts (Division *Pyrrhophyta* PASHER 1914, Class *Dinophyceae* FRITSCH 1935, Order *Peridiniales* HAECKEL 1894). The generic allocation of dinoflagellate cyst species encountered in this study follows that of LENTIN & WILLIAMS (1989). Newer taxa and revisions, not treated by LENTIN & WILLIAMS (1989), are described by BRENNER (1988), COURTINAT (1989), DURR (1988), and POULSEN (1991b; 1992a, b).

The name *Sentusidinium* suite is used for species of the genus *Sentusidinium* and species previously attributed to this genus, but now transferred to *Barbatacysta*, *Pandadinium*, or *Pilosidinium*.

Some new species and subspecies occur in the material studied from Poland, and some species, which may be reattributed to other genera. However, these new proposals are not executed here, and their proper description is in preparation by the Author. These new forms recorded are briefly described below.

Cometodinium sp.

REMARKS: A sphaerical cyst having an autophragm densely covered with short slender spines, which may be divided at the base, No indication of paratabulation except for archeopyle. Archeopyle apical, type [tA]a. Operculum attached.

RECORDED OCCURRENCE: Transversarium — Klimovi Zones (Middle Oxfordian — Early Volgian) of Bałtów (sample B-JG-7) Barcin-Pakość-*3* borehole (137.4 m), Kobyłczyce-*VI-10* borehole (20.5-30.5 m), Trojanów-*83* borehole (50.3-86.5 m), Szadkowice borehole (106.5 m), and Błogie-Nadzieja borehole (37.5-87.5 m).

PLATE 2

1 — *Endoscrinium luridum* (DEFLANDRE, 1938) GOCHT, 1970; DGU Catalogue No. 1992-NEP-2; Błogie-Nadzieja borehole (49.8 m), Autissiodorensis Zone

2 — *Gonyaulacysta jurassica jurassica* (DEFLANDRE, 1938) emend. SARJEANT, 1982, emend. POULSEN, 1991; DGU Catalogue No.1992-NEP-6; Trojanów-83 borehole (57.5 m), Hypselocyclum Zone

3 — *Stephanelytron scarburghense* SARJEANT, 1961, emend. STOVER & *al.*, 1977; DGU Catalogue No. 1992-NEP-7; Małogoszcz Quarry, Mutabilis Zone

4 — *Subtilisphaera*? *paeminosa* (DRUGG, 1978) BUJAK & DAVIES, 1983; DGU Catalogue No. 1992-NEP-1; Szadkowice borehole (24.0 m), Eudoxus Zone

5 — *Occisucysta balia* GITMEZ, 1970, emend. JAN DU CHENE & *al.*, 1986; DGU Catalogue No. 1992-NEP-8; Trojanów-83 borehole (57.5 m), Hypselocyclum Zone

6 — *Cribroperidinium*? *longicorne* (DOWNIE, 1957) LENTIN & WILLIAMS, 1985; DGU Catalogue No. 1991-NEP-89; Małogoszcz Quarry, Top Clays, Mutabilis Zone

7 — *Perisseiasphaeridium pannosum* DAVEY & WILLIAMS, 1966; DGU Catalogue No. 1991-NEP-245; Błogie-Nadzieja borehole (87.5 m), Eudoxus or Autissiodorensis Zone

Dichadogonyaulax? sp.

REMARKS: A dinoflagellate cyst, known from the Oxfordian to Early Kimmeridgian of Germany, the Early Kimmeridgian of Poland, and the earliest Volgian of Denmark, is a spherical form may be slightly compressed in the apical-antapical direction. The paratabulation is generally not indicated or vaguely reflected as low ridges in an uniformly reticulate surface. The reticulatum is of almost no height. There is no paracingular or parasulcal depressions. The archeopyle is epicystal, type [tAtP]a, the epicyst and hypocyst are connected at the ventral side as the opening is never complete. The archeopyle divides the cyst into almost equal halves.

RECORDED OCCURRENCE: Hypselocyclum — Divisum Zones of Trojanów-*83* borehole (50-81 m), and Divisum — Mutabilis Zones of Szadkowice borehole (98-116 m).

Netrelytron stegastum SARJEANT, 1961

REMARKS: The transfer of this species to the genus *Pareodinia* by BELOW (1990) is here rejected.

RECORDED OCCURRENCE: Divisum Zone.

Occisucysta sp.

REMARKS: A species of *Occisucysta* which bears a small blunt apical horn. The autophragm is ornamented with scattered granules on the paraplates. The parasutural crests are smooth to finely denticulate and low except for the paracingular ridges, the posterior paracingular suture is often the widest and is developed as a septum. Distinct subtriangular claustra are developed adjacant to the parasutural triple junctions. The antapical plate is small and asymmetrical.

This species of *Occisucysta* differs from other species of *Occisucysta* in having a paracingular flange with distinct subtriangular claustra. In antapical view it resembles *Limbodinium absidatum* in having a small asymmetrical paraplate and a similar paracingular flange with subtriangular claustra. It differs from *L. absidatum* in having an apical horn and a precingular archeopyle; *L. absidatum* has a hemicystal archeopyle and no apical horn.

RECORDED OCCURRENCE: Klimovi and Sokolovi Zones (Early Volgian) of Błogie-Nadzieja borehole (22-38 m).

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REFERENCES

AARHUS, N., BIRKELUND, T. & SMELROR, M. 1989. Biostratigraphy of some Callovian and Oxfordian cores off Vega, Helgeland, Norway. *Norsk Geol. Tidsskrift*, **69**, 39-56. Oslo.
BELOW, R. 1990. Evolution und Systematik VON Dinoflagellaten-Zysten aus der Ordnung Peridiniales; III. Familie Pareodiniaceae. *Palaeontographica, Abt. B*, **220**, 1-96. Stuttgart.
BIRKELUND, T. & CALLOMON, J.H. 1985. The Kimmeridgian ammonite faunas of Milne Land, central East Greenland. *Grønl. Geol. Unders., Bull.*, **153**, 1-104. København.
BRENNER, W. 1988. Dinoflagellaten aus dem Unteren Malm (Ober Jura) VON Süddeutschland; Morphologie, Ökologie, Stratigraphie. *Tübinger Mikropal. Mitteilungen*, **6**, 1-158. Tübingen.
CALLOMON, J.H. 1984. Biostratigraphy, chronostratigraphy and all that — again! *In*: O. MICHELSEN & A. ZEISS (*Eds*), International Symposium on Jurassic Stratigraphy. *Geol. Surv. of Denmark*, **3**, 611-624. København.
COURTINAT, B. 1989. Les organoclastes des formations lithologiques du Malm dans le Jura Méridional. Systematique, biostratigraphie et éléments d'interpretation paléoécologique. *Doc. Lab. Géol. Lyon*, **105**, 1-362. Lyon.
COX, B.M., LOTT, G.K., THOMAS, J.E. & WILKINSON, I.P. 1987. Upper Jurassic stratigraphy of four shallow cored boreholes in the U.K. sector of the southern North Sea. *Proc. Yorkshire Geol. Soc.*, **46**, 97-109.
DAVEY, R.J. 1979. The stratigraphic distribution of dinocysts in the Portlandian (Latest Jurassic) to Barremian (Early Cretaceous) of Northwest Europe. *Amer. Ass. Strat. Palynol., Contr. Ser. B.*, **5**, 49-81.
— 1982. Dinocyst stratigraphy of the latest Jurassic to Early Cretaceous of the Haldager No. 1 borehole, Denmark. *Geol. Surv. Denmark, Ser. B*, **6**, 1-58. København.
DURR, G. 1988. Palynostratigraphie des Kimmeridgium und Tithonium VON Süddeutschland und Korrelation mit boreholen Floren. *Tübinger Mikropal. Mitteilungen*, **5**, 1-160. Tübingen.
GITMEZ, G.U. 1970. Dinoflagellate cysts and acritarchs from the basal Kimmeridgian of England, Scotland and France. *Bull. British Mus. (Nat. Hist.), Geol.*, **18** (7), 231-233. London.
GUTOWSKI, J. 1992. Górny oksford i kimeryd północno-wschodniego obrzeżenia Gór Świętokrzyskich. *Unpublished Ph.D. thesis*; Faculty of Geology, University of Warsaw.
KUTEK, J. 1968. The Kimmeridgian and Uppermost Oxfordian in the SW margins of the Holy Cross Mts (Central Poland); Part 1. Stratigraphy. *Acta Geol. Polon.*, **18** (3), 493-586. Warszawa.
—, MATYJA, B.A., RADWAŃSKI, A. & WIERZBOWSKI, A. 1992. Large quarry of cement works at Małogoszcz; Kimmeridgian. *In*: B.A. MATYJA, A. WIERZBOWSKI & A. RADWAŃSKI (*Eds*), Oxfordian & Kimmeridgian Joint Working Groups Meeting: Guide Book & Abstracts, pp. 30-34. Warszawa.
LENTIN, J.K. & WILLIAMS, L.W. 1989. Fossil dinoflagellates: Index to genera and species, 1989 edition. *Amer. Ass. Strat. Palynol., Contr. Ser.*, **20**, 1-473.
MATYJA, B.A. 1977. The Oxfordian in the south-western margin of the Holy Cross Mts. *Acta Geol. Polon.*, **27** (1), 41-64. Warszawa.
— , KUTEK, J. & WIERZBOWSKI, A. 1988. Opracowanie litologii, stratygrafii i map utworów jurajskich z obszaru wierceń w skrzydłach synkliny tomaszowskiej. *Unpublished Report*, pp. 1-110 [*in Polish*]; Faculty of Geology, University of Warsaw.
—, MERTA, T. & WIERZBOWSKI, A. 1985. Stratygrafia i litologia utworów jurajskich struktury Zalesia. *In*: Utwory jurajskie struktury Zalesia na Kujawach i ich znaczenie surowcowe, pp. 19-29. *Wyd. Geol.*; Warszawa.
— & WIERZBOWSKI, A. 1981. The Upper Jurassic rocks at Barcin and Piechcin; their stratigraphy and facies as compared with neighbouring areas. *Kwart. Geol.*, **25** (3), 513-526. Warszawa.
— & — 1988. The two *Amoeboceras* invasions in Submediterranean Late Oxfordian of Poland. *2nd International Symposium on Jurassic Stratigraphy, Lisboa*, 421-432. Lisboa.
— & — 1989. Opracowanie stratygraficzne i mineralogiczno-petrograficzne utworów górnej jury z wierceń i kamieniołomów pomiędzy Krasicami, Kobyłczycami, Mokrzeszą i Żurawiem. *Unpublished Report*, pp. 1-60 [*in Polish*]; Faculty of Geology, University of Warsaw.
NØHR-HANSEN, H. 1986. Dinocyst stratigraphy of the Lower Kimmeridgian Clay, Westbury, England. *Bull. Geol. Soc. Denmark*, **35** (1/2), 31-51. København.
POULSEN, N.E. 1985. Dinocyststratigrafien i den nedre del af Hareelv Formation (Ovre Jura), Jameson Land, Ostgrønland. *Dansk Geol. Foren. Aarskr.*, 1984, 133-137. København.
— 1986. Callovian-Volgian dinocyst-stratigraphy of the Central Trough in the Danish North Sea Area. *Bull. Geol. Soc. Denmark*, **35** (1/2), 1-10. København.
— 1989. Sample-catalogue of samples collected in Poland, 1988. *Geol. Surv. Denmark, Int. Rep.*, **33**, 1-27. København.

— 1991a. Upper Jurassic dinocyst stratigraphy in the Danish Central Trough. *In*: O. MICHELSEN & N. FRANDSEN (*Eds*), Jurassic stratigraphy in the southern Central Trough. *Geol. Surv. Denmark, Ser. B*, **16**, 7-15. København.

— 1991b. *Gonyaulacocysta jurassica desmos*, a new subspecies of dinoflagellate cysts from the Early Oxfordian (Late Jurassic) of north-west Europe and East Greenland. *Palynology*, **15**, 211-217. Dallas, Texas.

— 1992a. The dinoflagellate cyst genus *Epiplosphaera* KLEMENT 1960 — a re-appraisal. *J. Micropal.*, **11** (1), 65-72.

— 1992b. Jurassic dinoflagellate cysts biostratigraphy of the Danish Subbasin in relation to sequences in England and Poland; a preliminary review. *Rev. Palaeobot. Palynol.*, **75**, 33-52.

— 1992c. Dinoflagellate cysts from marine Jurassic deposits in the Danish Subbasin and from Poland. *Unpublished Ph.D. thesis*; University of Copenhagen.

POULSEN, N.E., GUDMUNDSSON, L., HANSEN, J.M. & HUSFELDT, Y. 1990. Palynological preparation techniques, a new maceraliontank-method and other modifications. *Geol. Surv. Denmark, Ser. C*, **10**, 1-122. København.

POULSEN, N.E. & RIDING, J.B. 1992. A revision of the Late Jurassic dinoflagellate cysts *Ambonosphaera*? *staffinensis* (GITMEZ 1970) comb. nov. and *Senoniasphaera jurassica* (GITMEZ and SERJEANT 1972) LENTIN & WILLIAMS 1976. *Palynology*, **16**, 25-34. Dallas, Texas.

RIDING, J.B. & THOMAS, J.E. 1988. Dinoflagellate cyst stratigraphy of the Kimmeridge Clay (Upper Jurassic) from the Dorset coast, southern England. *Palynology*, **12**, 65-88.

SARJEANT, W.A.S. 1979. Middle and Upper Jurassic dinoflagellate cysts; The world excluding North America. *Amer. Ass. Strat. Palynol., Contr. Ser.*, **5B**, 133-157.

SYKES, R.M. & CALLOMON, J.H. 1979. The *Amoeboceras* zonation of the Upper Oxfordian. *Palaeontology*, **22** (4), 839-903 London.

SYKES, R.M. & SURLYK, F. 1976. A revised ammonite zonation of the Boreal Oxfordian and its applications in Northeast Greenland. *Lethaia*, **9**, 421-436. Oslo.

WIERZBOWSKI, A. 1978. Ammonites and stratigraphy of the Upper Oxfordian of the Wieluń Upland. *Acta Geol. Polon.*, **28** (3), 299-333. Warszawa.

WIMBLEDON, W.A. & COPE, J.C.W. 1978. The ammonite faunas of the English Portland Beds and the zones of the Portlandian Stage. *J. Geol. Soc. London*, **135**, 183-190. London.

WOOLLAM, R. & RIDING, J.B. 1983. Dinoflagellate cyst zonation of the English Jurassic. *Inst. Geol. Sci., London, Rep.*, **83** (2), 1-44.

ZOTTO, M., DRUGG, W.S. & HABIB, D. 1987. Kimmeridgian dinoflagellate stratigraphy in the southwestern North Atlantic. *Micropaleontology*, **33** (3), 193-213.