DINOFLAGELLATE CYST BIOSTRATIGRAPHY OF THE LATE JURASSIC OF POLAND

NIEL E. POULSEN

POULSEN N.E. 1994. Dinoflagellate cyst biostratigraphy of the Late Jurassic of Poland. [Biostratigraphie des kystes de Dinoflagellés du Jurassique supérieur de Pologne]. GEOBIOS, **M.S. 17** : 401-407.

ABSTRACT

Polish Upper Jurassic dinoflagellate cyst assemblages have been examined from outcrop and borehole samples and related to the Standard ammonite zonation for the area. These dinoflagellate cyst association have been correlated to corresponding associations in Denmark and the British Isles. In general this correlation suggests a stratigraphic range for the dinoflagellate cyst biozonation similar to those established for the British Isles and Denmark. The Oxfordian sections yielded dinoflagellate cyst associations that are different in composition from those of the Danish Subbasin, the North Sea area, and the British Isles. The Kimmeridgian and Volgian dinoflagellate cyst associations of Poland are very rich, and comprise many species described from the North Sea area together with many other species. In the Kimmeridgian, however, the boundary between the *Stephanelytron scarburghense* Subzone and the *Perisseiasphaeridium pannosum* Subzone occurs in the middle Divisum Zone. In the British Isles, this boundary corresponds to the middle Mutabilis Zone. The boundary in Poland is marked by first or last occurrences of four of the index species, allowing possible correlation of the middle Divisum Zone with the middle Mutabilis Zone. The uppermost Volgian beds of the Holy Cross Mountains-Krakow-Wielun area are dated as Scythicus Zone and are marked by dinoflagellate cyst species, which indicate the *Dichadogonyaulax culmula* Zone, Subzone **a** and a possible correlation to the Albani Zone.

KEY-WORDS : POLAND, LATE JURASSIC DINOFLAGELLATE CYST, CORRELATIONS.

RÉSUMÉ

Les assemblages de kystes de Dinoflagellés du Jurassique supérieur de Pologne ont été examinés en échantillons de coupes et sondages datés par ammonites. Les associations de kystes de Dinoflagellés ont été correlées avec des associations correspondantes au Danemark et en Grande-Bretagne. Généralement, la corrélation indique que les répartitions ressemblent beaucoup à celles du Danemark et de Grande-Bretagne. Les associations oxfordiennes sont différentes de celles du Sous-bassin Danois, de la Mer du Nord et de Grande-Bretagne. Les associations kimméridgiennes et du Volgien de Pologne sont très riches et comprennent, entre autres, beaucoup d'espèces décrites en Europe du Nord-Ouest. Mais dans le Kimméridgien la limite entre les sous-zones à *Stephanelytron scarburghense* et à *Perisseiasphaeridium pannosum* est placée dans la partie moyenne de la zone à Divisum. En Grande-Bretagne, cette limite est placée au milieu de la zone à Mutabilis. En Pologne, la limite est marquée par l'apparition ou la disparition de quatre-espèces index, ce qui rend possible une corrélation entre la partie moyenne de la zone à Divisum et celle de la zone à Mutabilis. Le Volgien le plus supérieur de Pologne central, daté de la zone à Scythicus est marqué par des espèces de kystes de Dinoflagellés qui indiquent la zone à *Dichadogonyaulax culmula*, sous-zone **a**, et une correlation avec la zone à Albani est possible.

MOTS-CLÉS : POLOGNE, KYSTES DE DINOFLAGELLÉS DU JURASSIQUE SUPÉRIEUR, CORRÉLATIONS.

INTRODUCTION

Dinoflagellate cysts from ammonite-dated samples from the Upper Jurassic of Poland were studied during a research project carried out during 1988-1990. The purpose of the project was to investigate the application of the Jurassic dinoflagellate cyst biozonation currently used for British sections to those of the Danish Subbasin. Dinoflagellate cysts from ammonite-dated samples from the Upper Jurassic of Poland were studied during the project to provide correlation and further biostratigraphic control of the Danish dinoflagellate cyst zonation to other

biostratigraphic zonations besides the British Isles.

The dinoflagellate cyst biozonation established by Davey (1979, 1982), Woollam & Riding (1983), Nøhr-Hansen (1986), Riding & Thomas (1988) and Poulsen (1991a) have been applied to the studied Polish material. (See also Poulsen, herein).

AMMONITE BIOZONATION

The Oxfordian ammonite zonation and correlation in the Boreal-Subboreal subprovince, the northwestern European subprovince, and the Submediterranean province is given in 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.

The precise stratigraphical correlation from the Submediterranean province to the Boreal Realm of the Oxfordian-Kimmeridgian boundary is difficult (e.g. Sykes & Callomon 1979). The stratigraphic position of the Oxfordian-Kimmeridgian boundary is discussed in Birkelund & Callomon (1985, p. 15-19) and by Birkelund (*in* Aarhus *et al.* 1989, p. 53). Recently Matyja & Wierzbowski (1988) correlate more conclusively 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, is the Submediterranean zonation. The four zones, Planula, Platynota, Hypselocyclum and Divisum Zones correspond to the Baylei and Cymodoce Zones of the Subboreal province.

The zonation for the Upper Kimmeridgian of the Polish subprovince is similar to the Subboreal zonation.

The correlation of the Lower Volgian zones between the Volga Basin, including the Polish subprovince, and the Subboreal province has not been established. The boundary between the Lower-Middle Volgian of the Volga Basin and the Polish subprovince is doubtfully placed at the top of the Tenuicostata Zone (Callomon & Birkelund, 1982). Even more tentative is the correlation of the Middle Volgian Zones (Callomon & Birkelund 1982 ; Callomon, personal commun. 1989).

MATERIAL

Material was studied from Polish outcrops and boreholes in the Holy Cross Mountains and their flanks, the Kraków-Weilun upland, and the eastern part of the Pomeranian Trough. Some of the information concerning the deposits and the content of macrofossils in the Polish localities is

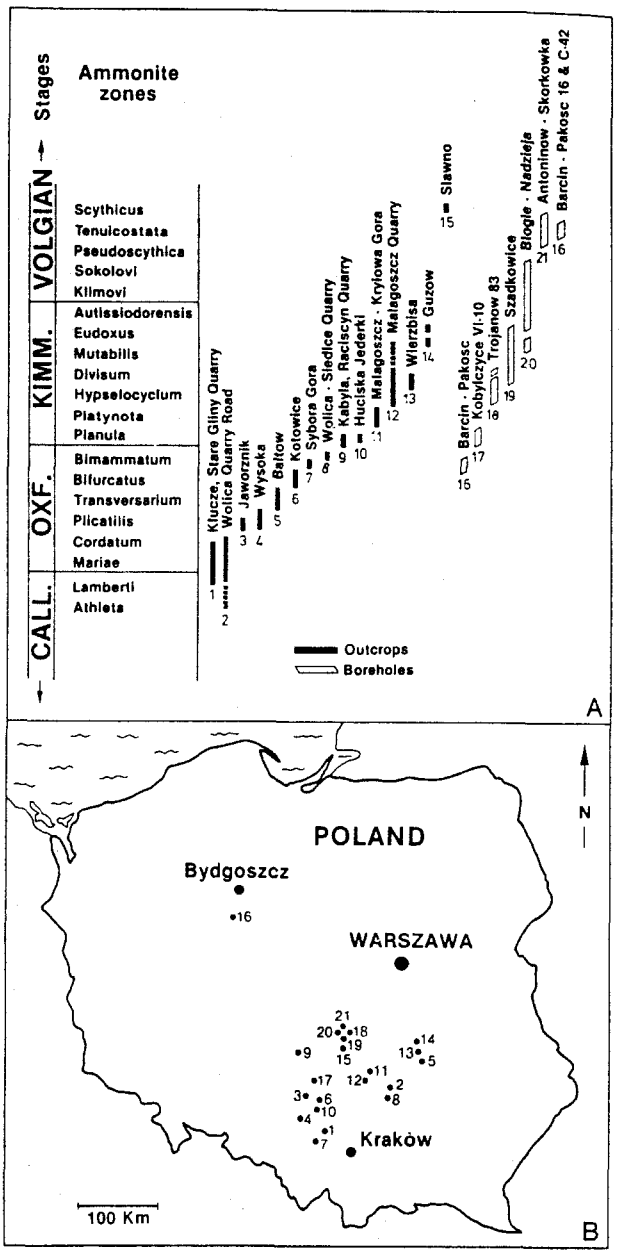

Figure 1 - **A**. Stratigraphic extent of the Polish sections studied. Numbers below sections are the locations shown on Fig. 1B. **B**. Map of Poland showing the locations of the sections studied. Numbers refer to the sections locations on Fig. 1A. No. 16 is the three boreholes Barcin-Pakosc 3, Barcin-Pakosc 16 and Barcin-Pakosc C-42. ***A.*** *extension stratigraphique des coupes polonaises étudiées. Les numéros sous les coupes indiquent la position géographique précisée Fig. 1B.* ***B.*** *Carte géographique simplifiée du secteur d'étude. Les numéros indiquent la position des coupes de la Fig. 1A. No. 16 correspond aux trois sondages Barcin-Pakosc 3, Barcin-Pakosc 16 et Barcin-Pakosc C-42.*

found in Kutek (1968), Kutek & Zeiss (1974), Matyja (1977), Matyja & Wierzbowski (1981), and Wierzbowski (1978). The details of the Polish samples are given in Poulsen (1989). The geographical and stratigraphical positions of the localities are shown in Fig. 1. The was prepared following the preparation method of Poulsen *et al.* 1990.

DINOFLAGELLATE CYST BIOSTRATIGRAPHY

Most of the studied samples from the Upper Jurassic of Poland were rich in dinoflagellate cysts, except for some of the Oxfordian-Lower Kimmeridgian samples, which were unproductive, probably due to weathering, (only productive zones are discussed below). All the samples were collected with reference to the Standard ammonite zonation for the area.

OXFORDIAN

The Oxfordian is characterized by dinoflagellate cyst assemblages different in composition from those in the Danish subbasin, North Sea area and the British Isles, i.e. with other species dominating the assemblages (see below). These species may be present in the areas northwest of Poland, but only infrequently.

Transversarium Zone

The oldest assemblage identified is from the Transversarium Zone. It contained abundant *Epiplosphaera* sp. and *Gonyaulacysta eisenackii*. The occurrence of both *Compositosphaeridium polonicum* and *Glossodinium dimorphum* allows a correlation to the *Scriniodinium crystallinum* Zone, Subzone **a**.

The identification of this subzone in the Transversarium Zone, which mainly corresponds to the Tenuiserratum Zone (Boreal-Subboreal subprovince) (Sykes & Callomon 1979 ; Callomon, personal commun. 1989) indicates an isochronous development of this subzone.

Bimammatum Zone

The lower subzone, the Hypselum Subzone, also contained abundant *Epiplosphaera* sp., but *G. eisenackii* occurs only infrequently. *Gonyaulacysta jurassica jurassica* occurs frequently. *Ctenidodinium ornatum* and *Occisucysta balia* are present, which indicates the *S. crystallinum* Zone, Subzone **c** (the latter, however, only doubtfully identified).

Samples from the two overlying subzones of the Bimammatum Zone were unfortunately unproductive and the precise top of Subzone **c** is not identified. However, the Bimammatum Zone is now regarded as the uppermost Oxfordian Zone, and the identification of Subzone **c** within this level suggests isochrony of this subzone from Poland to England.

KIMMERIDGIAN

The Kimmeridgian samples produced very rich assemblages with many species in common with the assemblages from the Danish Subbasin, the North Sea area and the British Isles. Especially the dinoflagellate cyst flora of the *Endoscrinium luridum* Zone in Poland is very rich, containing many of the species described from the North Sea area. Also many species described from other part of Europe e.g. *Amphorula metaelliptica, Atlantodinium jurassicum, Protobatioladinium westburiense*, and Australia, e.g. *Dollidinium sinuosum* were recognized in this stage.

The flora is rich in *Subtilisphaera? inaffecta* and *Subtilisphaera? paeminosa*, which in the Danish Subbasin and the Skagerrak - Kattegat platform area are only common near the Baltic Shield (Skagen-2 and Sound-1a boreholes). In England *Subtilisphaera?* sp. are also infrequent (Riding, personal commun. 1990) as they are in the Central Trough.

Some of the stratigraphic index species differ in abundance compared with the Danish subbasin and the Skagerrak-Kattegat platform area or the British Isles. *Nannoceratopsis pellucida* and *Scriniodinium crystallinum* are not recorded in this study in the Kimmeridgian of Poland. *G. jurassica jurassica* which is a common species in the latest Oxfordian, is abundant in the Planula-earliest Hypselum 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 later parts of the Volgian (Poulsen 1991b). *Dichadogonyaulax chondra* is present from the base of the Kimmeridgian and almost to the top of the Jurassic in Poland.

Planula Zone

The first occurrence of *D. chondra* is found within this zone. Zotto *et al.* (1987) described the first appearance of this species to be in the Baylei Zone. The first occurrence of this species

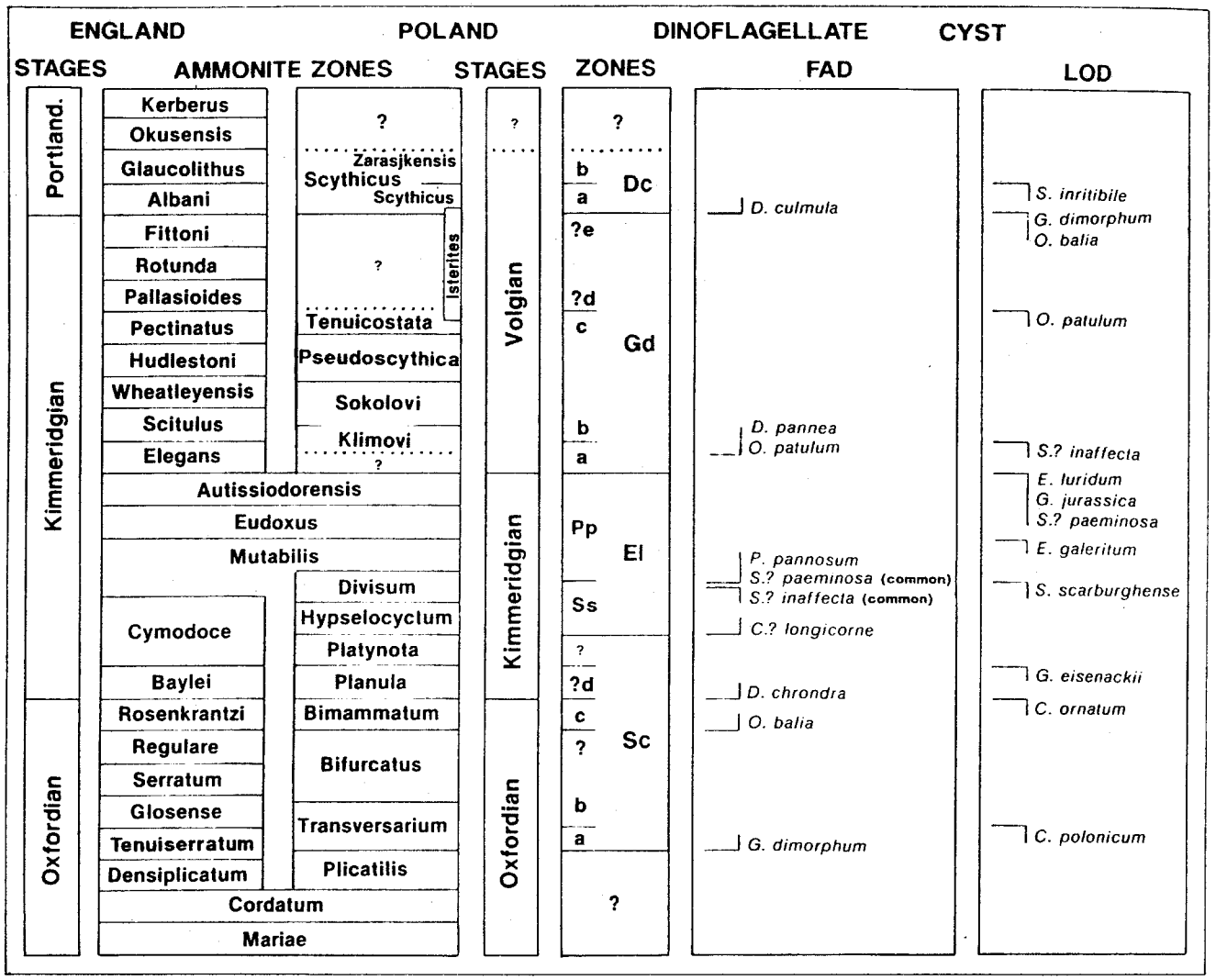

Figure 2 - Correlation chart for the Late Jurassic successions in Poland and in boreal areas. Correlation of the Scythicus Zone in accordance with conclusions from this study. **FAD** : First appearance datums. **LOD** : Last occurrence datums. *Corrélations dans le Jurassique supérieur entre le secteur polonais et le domaine boréal. Corrélation de la zone á Scythicus selon les conclusions de l'étude. **FAD** : Première apparition. **LOD** : Dernière présence.*

in the Polish subprovince supports the correlation of the Planula Zone to the Baylei Zone. The last appearance of *G. eisenackii* is found in the Planula Zone. According to Sarjeant (1979) its last appearance is in Baylei Zone. Together with the absence of *C. ornatum* this indicates the *S. crystallinum* Zone, Subzone **d**.

Hypselocyclum Zone

The first occurrence of *Cribroperidinium? longicorne* allows a correlation to the *E. luridum* Zone (there is in this study no record of dinoflagellate cysts from the underlying Platynota Zone). In England this is equivalent to the base of the Cymodoce Zone. *Stephanelytron scarburghense*, the index species of the *S. scarburghense* Subzone, is present. *G. jurassica jurassica* is common, but less common than in the zones below.

Divisum Zone

The boundary between the *S. scarburghense* Subzone and the *Perisseiasphaeridium pannosum* Subzone is marked by the last occurrence of *S. scarburghense* and the first appearance of *P. pannosum, S. paeminosa* and common *Subtilisphaera? inaffecta* ; this boundary is recorded in the middle Divisum Zone. In the British Isles, this stratigraphic level corresponds to the middle Mutabilis Zone (Nøhr-Hansen 1986 ; Poulsen 1991a).

This event is recorded in Wierzbica, Malogoszcz Quarry and Szadkowice boreholes. The middle Divisum Zone is believed to correlate with the middle Mutabilis Zone.

Mutabilis Zone

This zone is not characterized by the appearance or disappearance of dinoflagellate cyst species, except for the last occurrence of *Epiplosphaera gochtii* at the top of the zone. *Subtilisphaera?* sp. is less common than in the underlying Divisum Zone or in the overlying Eudoxus Zone.

Eudoxus Zone

Endoscrinium galeritum disappears at the base of the zone. *S.? inaffecta* is common from the base to the middle of the zone, whereas *S.? paeminosa* is common for the first time in the middle of the zone. *P. pannosum* is also very common in the middle of the zone.

Autissiodorensis Zone

The base of the zone is marked by the first occurrence of *Oligosphaeridium pulcherrimum* and the common occurrence of *G. jurassica jurassica*. The latter species is not recorded above this level in Poland. *S.? paeminosa* disappears at the top of the zone, whereas *S.? inaffecta* is very common. *Endoscrinium luridum* disappears at the top of the Autissiodorensis Zone, indicating that the top of the *E. luridum* Zone is isochronous from England to Poland.

Volgian

Most of the Volgian samples also produced rich assemblages with high diversity (about 40 - 60 species per sample). Most species recorded, however, occur in low numbers of specimens, except for *Dingodinium minutum*, which is a common species throughout the Volgian. The assemblages are comparable to those recorded in the Danish subbasin and the Skagerrak - Kattegat platform area, the Central Trough, and England. The assemblages are similar to those described from the Subboreal province of e.g. Ioannides *et al.* (1976), Raynaud (1978), Barron (1989), except for the absence of some of the index species.

Klimovi Zone

The last occurrence of *S.? inaffecta* is in the lower part of this zone. In the southern part of the North Sea this species is recorded in the lower part of the Elegans Zone (Cox *et al.* 1987), equivalent to the *Glossodinium dimorphum* Zone, Subzone **a**.

Within the Klimovi Zone the first appearance of *Oligosphaeridium patulum* and *Dichadogonyaulax pannea* is found. In England both species occur in the Upper Kimmeridgian.

Sokolovi Zone

Endoscrinium anceps, Endoscrinium pharo and *Gochteodinia mutabilis* make their first appearance in this zone.

Pseudoscythica-Tenuicostata Zones

The boundary between these two zones is not clearly differentiated in the samples studied.
The index species of the *G. dimorphum* Subzone **b**, *Cribroperidinium? longicorne* is not recorded above the Kimmeridgian in Poland.

The last occurrence of *Oligosphaeridium patulum* in England is at the top of the Pectinatus Zone, indicating the *G. dimorphum* Zone, Subzone **c**. In Poland, it is found sporadically in the Lower Volgian up to and including the *Isterites* horizon, which terminates the Tenuicostata Zone. Using *O. patulum* for correlation, this may indicates that the suggested boundary between the Lower and Middle Volgian in the Polish subprovince correlates to that of the Subboreal province.

Subzone **d** and/or **e** are questionably recorded in the small interval of the studied section, which is only dated as strata intermediate between the *Isterites* horizon and the Scythicus Zone. *Glossodinium dimorphum* constitutes about 15% of the dinoflagellate cyst assemblage. Raynaud (1978) recorded *G. dimorphum* as most common in the Rotunda and Albani Zones. *Occisucysta balia* is recorded up to the base of the Scythicus Zone, which may indicate, that it is questionable if either one or both subzones are present.

Scythicus Zone

Scythicus Subzone : the base of this subzone is marked by the first appearance of *Dichadogonyaulax culmula* and the last occurrence of *Occisucysta balia*, which indicates the boundary between the *G. dimorphum* Zone and the overlying *Dichadogonyaulax culmula* Zone. *Scriniodinium inritibilum* occurs to near the top, but, not at the actual top of the Scythicus Subzone, which allows a correlation of the major part of the Scythicus Subzone to the *D. culmula* Zone, Subzone **a** (see also below). *Dichadogonyaulax pannea* occurs to

the top of the Scythicus Subzone dating the top as no younger than the *Dingodinium spinosum* Zone.

Zarajskensis Subzone : the uppermost Jurassic beds of the Holy Cross Mountains area were deposited under high energy, low salinity or brackish lagoonal conditions with *Pinnae* bivalves. These beds yielded an assemblage of a new *Fromea* sp. (56%), *Pterospermella* sp. (39%), Leiospheres, *Pareodinia halosa, Sentusidinium* spp. and *Tasmanites*. The biostratigraphic position of the Zarajskensis Subzone cannot be established from this assemblage and the upper boundary of the Scythicus Zone cannot be correlated to the Subboreal province using dinoflagellate cysts.

CONCLUSIONS

The investigation of Late Jurassic dinoflagellate cysts from ammonite-dated samples from Poland has proved it possible to use many of the dinoflagellate cyst zones and subzones of the Danish-English area in Poland, and that the zonation appears to be isochronous.

Kimmeridgian dinoflagellate cysts from the middle Divisum Zone indicates a correlation to the middle Mutabilis Zone of England. It is suggested that the middle Divisum Zone of Poland correlates to the middle Mutabilis Zone of England, indicating a diachronous base of the Mutabilis Zone from the Boreal subprovince to the Submediterranean province.

Volgian dinoflagellate cysts in the Scythicus Zone of Poland allows a reliable correlation of this zone with the Albani Zone of Denmark and England.

REFERENCES

AARHUS N., BIRKELUND T. & SMELROR M. 1989 - Biostratigraphy of some Callovian and Oxfordian cores off Vega, Helgeland, Norway. *Norsk Geologisk Tidsskrift*, **69** : 39-56.

BARRON H.F. 1989 - Dinoflagellate cyst biostratigraphy and palaeoenvironments of the Upper Jurassic (Kimmeridgian to basal Portlandian) of the Helmsdale region, east Sutherland, Scotland. *In* BATTEN D.J. & KEEN M.C. (eds) : Northwest European micropalaeontology and palynology. Ellis Horwood Limited : 193-213.

BIRKELUND T. & CALLOMON J.H. 1985 - The Kimmeridgian ammonite faunas of Milne Land, central East Greenland. *Grønlands geologiske Undersøgelse, Bulletin*, 153 : 104 p.

CALLOMON J.H. & BIRKELUND T. 1982 - The ammonite zones of the Boreal Volgian (Upper Jurassic) in East Greenland. *In* A.F. EMBRY & H.R. BALKWILL (eds) : Arctic Geology and Geophysics. *Canadian Society of Petroleum Geologists, Memoir*, **8** : 339-369.

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. *Proceedings of the Yorkshire Geological Society*, **46** : 97-109.

DAVEY R.J. 1979 - The stratigraphic distribution of dinocysts in the Portlandian (latest Jurassic) to Barremian (Early Cretaceous) of Northwest Europe. *American Association of Stratigraphic Palynologists, Contributions Series No.*, **5B** : 49-81.

DAVEY R.J. 1982 - Dinocyst stratigraphy of the latest Jurassic to Early Cretaceous of the Haldager No. 1 borehole, Denmark. *Geological Survey of Denmark Series, B*, 6 : 58 p.

IOANNIDES N.S., STAVRINOS G.N. & DOWNIE C. 1976 - Kimmeridgian microplankton from Clavell's Hard, Dorset. *Micropalaeontology*, **22** : 443-478.

KUTEK J. 1968 - Kimeryd i najwyz szy oksford po ludniowo-zachodniego obrzezenia mezozoicanego Gór Swietokrzyskich. Czesc I - Stratygrafia. *Acta Geologica Polonica*, **18** : 493-584.

KUTEK J. & ZEISS A. 1974 - Tithonian-Volgian ammonites from Brzóstowka near Tomaszów Mazowiecki, Central Poland. *Acta Geologica Polonica*, **24** : 505-542.

MATYJA B.A. 1977 - The Oxfordian in the south-western margin of the Holy Cross Mts. *Acta Geologica Polonica*, **27** : 41-64.

MATYJA B.A. & WIERZBOWSKI A. 1981 - The Upper Jurassic Rocks at Barcin and Piechin ; Their stratigraphy and facies as compared with neighbouring areas. *Kwartalnik geologiezny*, **25** : 513-526.

MATYJA B.A. & WIERZBOWSKI A. 1988 - The two *Amoeboceras* invasions in Submediterranean Late Oxfordian of Poland. *2nd International Symposium on Jurassic Stratigraphy*, Lisboa : 421-432.

NØHR-HANSEN H. 1986 - Dinocyst stratigraphy of the Lower Kimmeridge Clay, Westbury, England. *Bulletin of the geological Society of Denmark*, **35** : 31-51.

POULSEN N.E. 1989 - Sample-catalogue of samples collected in Poland, 1988. Geological Survey of Denmark, Internal report, **33** : 27 p.

POULSEN N.E. 1991a - Upper Jurassic dinoflagellate cyst stratigraphy in the Danish Central Trough. *In* O. MICHELSEN & N. FRANDSEN (eds) : Jurassic stratigraphy in the southern Central Trough. *Geological Survey of Denmark, Series B*, **16** : 7-15.

POULSEN N.E. 1991b - *Gonyaulacysta 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.

POULSEN N.E. 1994 - Dinoflagellate cyst biostratigraphy of Rhaetian-Ryazanian (uppermost Triassic-lowermost Cretaceous) deposits from the Danish Subbasin. *Geobios*, **M.S. 17** : 409-414.

POULSEN N.E., GUDMUNDSSON L., HANSEN J.M. & HUSFELDT Y. 1990. Palynological preparation tech-

niques, a new macerationtank-method and other modifications. *Geological Survey of Denmark, Series C*, **10** : 22 p.

RAYNAUD J.F. 1978 - Principaux dinoflagellés caractéristiques du Jurassique Supérieur d'Europe du Nord. *Palinologia, núm. extraordinario*, **1** : 387-405.

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. *American Association of Stratigraphic Palynologists Contributions Series*, **5B** : 133-157.

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

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

WIERZBOWSKI A. 1978 - Ammonites and stratigraphy of the Upper Oxfordian of the Wielun Upland. *Acta Geologica Polonica*, **28** : 299-333.

WOOLLAM R. & RIDING J.B. 1983 - Dinoflagellate cyst zonation of the English Jurassic. *Institute of Geological Sciences Report*, **83/2** : 44 p.

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

N.E. POULSEN
Geological Survey of Denmark
Thoravej 8
DK-2400 Copenhagen NV, Denmark