Jurassic palynostratigraphy of Bornholm, Baltic Sea, Denmark

Eva Bundgaard Koppelhus

Material and methods

Samples of the Rønne Formation have been collected from exposures at Munkerup, Sose Bugt and Galgeløkke and two boreholes, Galgeløkke-1 and -2, at Galgeløkke south of Rønne (Fig. 1). The Hasle Formation was sampled at the type section south of Hasle harbour, at Korsodde and from the Levka-1 and Hasle-1 boreholes. The Bagå Formation, that consists of the previously defined Levka, Sorthat and Bagå beds (Gry, 1969; Gravesen et al. 1982), was sampled from two sections within the Hasle Klinkerfabrik clay pit, from the coastal section at Korsodde, and from four cored boreholes the Levka-1, 106, 107 and 109 at the Hasle Klinkerfabrik clay pit (Nielsen & Koppelhus 1989, 1991; Koppelhus & Nielsen 1994). The samples were processed for their palynological content using the standard techniques developed at the Geological Survey of Denmark (Poulsen et al., 1990). They were examined by transmitted light microscopy. All of the slides are stored in the collections of the Department of Stratigraphy at the Geological Survey of Denmark.

Biozones

The palynomorph assemblages from the Rønne Formation are refered to two miospore zones, the *Pinuspollenites-Trachysporites* Zone and the *Cerebropollenites macroverrucosus* Zone (Fig.2) (Koppelhus 1991). These miospore zones were established in a palynological study of the Rhaetian and lower Jurassic sequence penetrated by the Rødby no. 1 well (Lund, 1977). Most of the samples from the Hasle Formation were barren. However, close to the boundaries to the underlying Rønne and overlying Bagå Formations, the Hasle Formation yielded palynomorph assemblages, which can be refered to the *Chasmatosporites* Zone and the *Mendicodinium reticulatum* Zone (proposed in Koppelhus & Nielsen 1994). Six biozones are recognized in the Bagå Formation; three are based on miospores and three on dinoflagellate cysts. The three miospore zones are the *Chasmatosporites* Zone, the *Spheripollenites-Leptolepidites* Zone of Dybkjær (1991) and the *Callialasporites-Perinopollenites* Zone also of Dybkjær (1991) but emended in Koppelhus & Nielsen (1994). The dinoflagellate cyst zones are the *Mendicodinium reticulatum* Zone, and the *Luehndea spinosa* and *Nannoceratopsis gracilis* Zones of Woollam & Riding (1983), emended by Riding & Thomas (1992).

Discussion

The palynological analysis of the lower part of the Bagå Formation showed that beside the previously recognized megaspores (Gry 1969; Koppelhus & Batten 1992) the palynomorph assemblages not only contained miospores, but also dinoflagellate cysts, which added new information to the interpretation of the environment and stratigraphy.
Mendicodinium reticulatum was found in the uppermost part of the Hasle Formation and the lowermost part of the Bagå Formation. This species is known from the Late Pliensbachian (*Margaritatus* zone) in northern Germany (Morgenroth, 1970). It shows an acme in the Bagå Formation, before any other dinoflagellate cysts appears. Further up section in the Bagå Formation several species from the genus *Nannoceratopsis* (*N. senex, N. gracilis, N. triceras)* become common. *Nannoceratopsis gracilis* has its first appearance in the Late Pliensbachian (*Margaritatus* zone) in UK (Woollam & Riding 1983; Wall, 1965). A thin interval in the middle part of the formation contain *Luehndea spinosa* and *Mancodinium semitabulatum.* These two species are also known from Late Pliensbacian in northwest Europe (Morgenroth 1970; Prauss 1989; Poulsen 1992; Riding & Thomas 1992). *L. spinosa* range from the *Margaritatus* to *Tenuicostatus* zone, however the range of *M. semitabulatum* is from the

Margaritatus zone to the upper part of early Bajocian. The recovered assemblages therefore indicate that Late Pliensbachian and Toarcian deposits are present onshore Bornholm.

Conclusions

The depositional environment changed repeatedly between non-marine and brackish-marine during the deposition of the Jurassic section. Thus the first and last appearances of various miospores and dinoflagellate cyst species are influenced by these changes. Therefore, to obtain the best stratigraphic resolution both the miospore and dinoflagellate cyst lowest appearences and acmes are used in the age determinations.
The combined palynological data show that the *Pinuspollenites-Trachysporites* Zone and the *Cerebropollenites macroverrucosus* Zone can be identified in the Rønne Formation and the *Chasmatosporites, Spheripollenites-Leptolepidites* and *Callialasporites-Perinopollenites* miospore Zones and the *Mendicodinium reticulatum, Luehndea spinosa* and *Nannoceratopsis gracilis* dinoflagellate cyst Zones can be identified in the Bagå Formation.
The biozones thus indicate that the Hettangian to Middle Jurassic time intervals are represented on Bornholm. It is not clear, however, how much of the Aalenian, Bajocian and Bathonian stages that are represented. This conclusion differs from that of Gry (1969) who referred both the exposures at Korsodde and the Levka, Sorthat and Bagå beds exclusively to the Middle Jurassic. Our data show that the lower part of the Korsodde section and the examined part of the Levka and Sorthat beds are of Late Pliensbachian-Toarcian age. The palynostratigraphy further confirms that the Levka and Sorthat beds are time equivalent units. The Bagå beds belong to the Middle Jurassic and do not appear to contain Toarcian deposits, contrary to the interpretation of Hoelstad (1985). The upper part of the Korsodde section is also dated as Middle Jurassic.

References

Dybkjær, K., 1991: Palynological zonation and palynofacies investigation of the Fjerritslev Formation (Lower Jurassic -basal Middle Jurassic) in the Danish Subbasin. Danmarks Geologiske Undersøgelse Serie A 30. 150 pp.

Fenton, J. & Riding, J., 1987: *Kekryphalospora distincta* gen. et sp. nov., a trilete spore from the Lower and Middle Jurassic of North-West Europe. Pollen et Spores 19, 427-434.

Gravesen, P., Rolle, F. & Surlyk, F., 1982: Lithostratigraphy and sedimentary evolution of the Triassic, Jurasssic and Lower Cretaceous of Bornholm, Denmark. Danmarks Geologiske Undersøgelse Serie B 7. 51 pp.

Gry, H., 1969: Megaspores from the Jurassic of the Island of Bornholm, Denmark. Meddelelser fra Dansk Geologisk Forening 19, 69-89.

Hoelstad, T., 1985: Palynology of the uppermost Lower to Middle Jurassic strata on Bornholm, Denmark. Bulletin of the Geological Society of Denmark 34, 111-132.

Koppelhus, E.B., 1991: Palynology of the Lower Jurassic Rønne Formation on Bornholm, eastern Denmark. Bulletin of the Geological Society of Denmark 39, 91-110.

Koppelhus, E.B. & Batten D.J., 1992: Megaspore assemblages from the Jurassic and lowermost Cretaceous of Bornholm, Denmark. Danmarks Geologiske Undersøgelse Serie A 32. 81 pp.

Koppelhus, E.B. & Nielsen, L.H., 1993: Palynologisk zonation af Nedre og Mellem Jura på Bornholm. Maringeologisk møde, Århus Universitet, Nordsøens og Skagerraks geologi. Abstract vol., 21.

Koppelhus, E.B. & Nielsen, L.H., MS.: Palynostratigraphy and palaeoenvironments of the Lower to Middle Jurassic Bagå Formation of Bornholm, Denmark. Palynology, 18, 139-194.

Lund, J.J., 1977: Rhaetic to lower Liassic palynology of the onshore south-eastern North Sea Basin. Danmarks Geologiske Undersøgelse II Række 109, 1-129.

Morgenroth, P., 1970: Dinoflagellate cysts from the Lias Delta of Lühnde/Germany. Neues Jahrbuch für Geologie und Paläontologie Abhandlungen, 136, 345-349.

Nielsen, L.H. & Koppelhus, E.B., 1989: Results of the project: Biostratigraphy and organic geochemistry of the Mesozoic on Bornholm. Final report 1.7.1989. Report no. 49. Geological Survey of Denmark, 44 pp.

Nielsen, L.H. & Koppelhus, E.B., 1991: Reworked Carboniferous palynomorphs from Lower Jurassic deposits on Bornholm and their palaeogeographic implications. Bulletin of the Geological Society of Denmark 38, 253-266.

Poulsen, N.E., 1992: Jurassic dinoflagellate cyst biostratigraphy of the Danish Subbasin in relation to sequences in England and Poland; a preliminary review. Rev. Palaeobot. Palynol. 75, 33-52.

Poulsen, N.E. Gudmundson, L., Hansen, J.M. & Husfelt, Y., 1990: Palynological preparation techniques, a new macerationtank-method and other modifications. Danmarks Geologiske Undersøgelse Serie C 10. 22 pp.

Prauss, M., 1989: Dinozysten-Stratigraphie und Palynofazies im Oberen Lias und Dogger von NW-Deutschland. Palaeontographica B 214, 1-124.

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.

Riding, J.B. & Thomas, J.E., 1992: Dinoflagellate cysts of the Jurassic system. *In*: Powell, A.J. (ed.), A stratigraphic index of dinoflagellate cysts. British Micropalaeontological Society Series, Chapman & Hall, London, xii + 290 pp.

Wall, D., 1965: Microplankton, pollen and spores from the Lower Jurassic in Britain. Micropaleontology 11, 151-190.

Woollam, R. and Riding, J.B., 1983: Dinoflagellate cyst zonation of the English Jurassic. Institute of Geological Sciences Report, 83 (2), 42 pp.

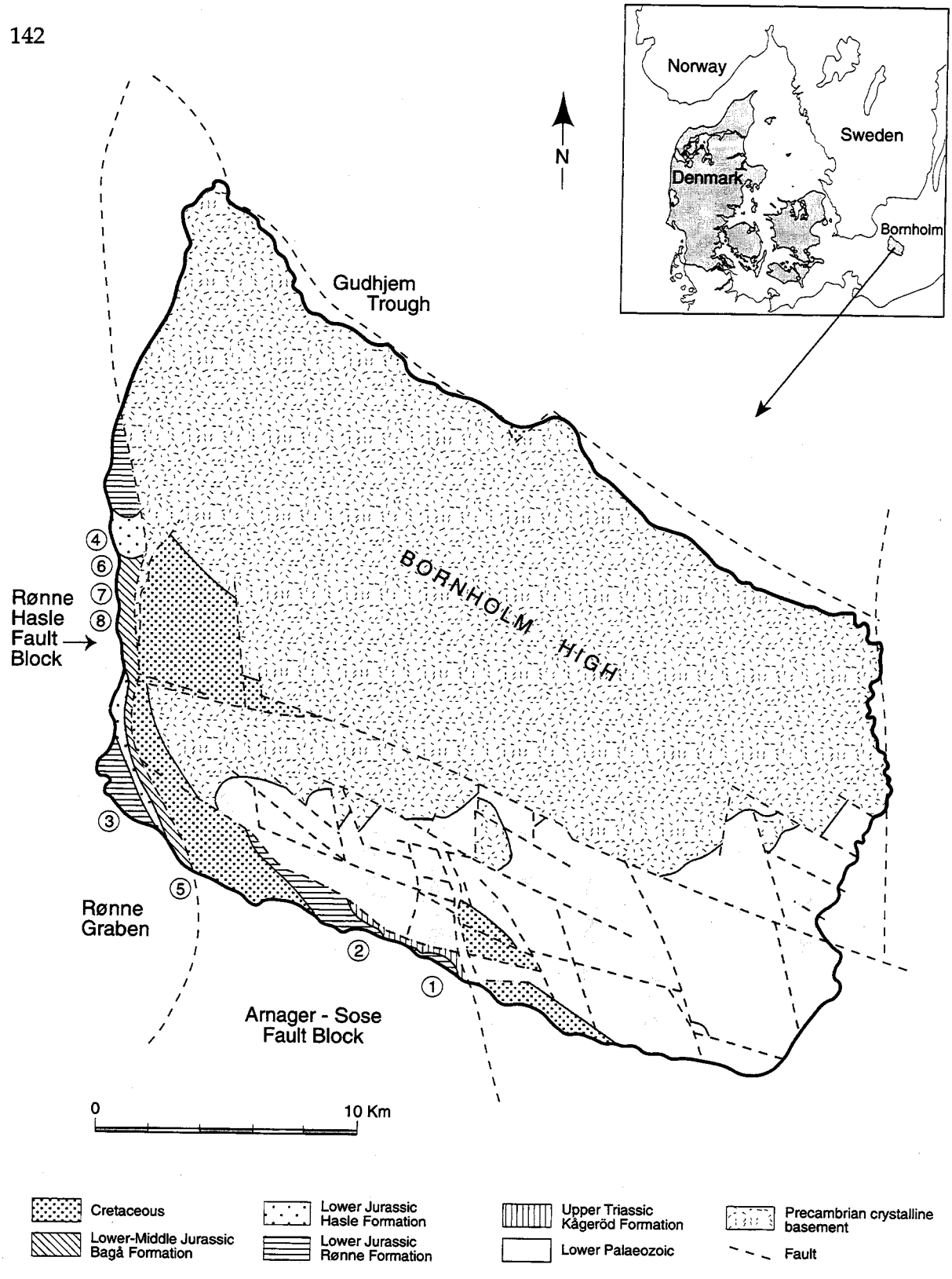

Fig. 1 Geological map of Bornholm with outcrop localities and boreholes indicated. Loc. 1: Type section of the Munkerup Member. Loc. 2: Type section of the Sose Bugt Member. Loc. 3: Type section of the Galgeløkke Member, and well-site of the Galgeløkke-1 & -2 borehole Loc. 4: Type section of the Hasle Formation Loc. 5: The Korsodde section. Loc. 6. The Hasle-1 borehole. Loc. 7: The Levka-1 borehole. Loc. 8: Hasle Klinkerfabrik clay pit, with boreholes 106, 107 and 109. Modified fra Gravesen et al. (1982). Inset map shows Denmark and Bornholm.

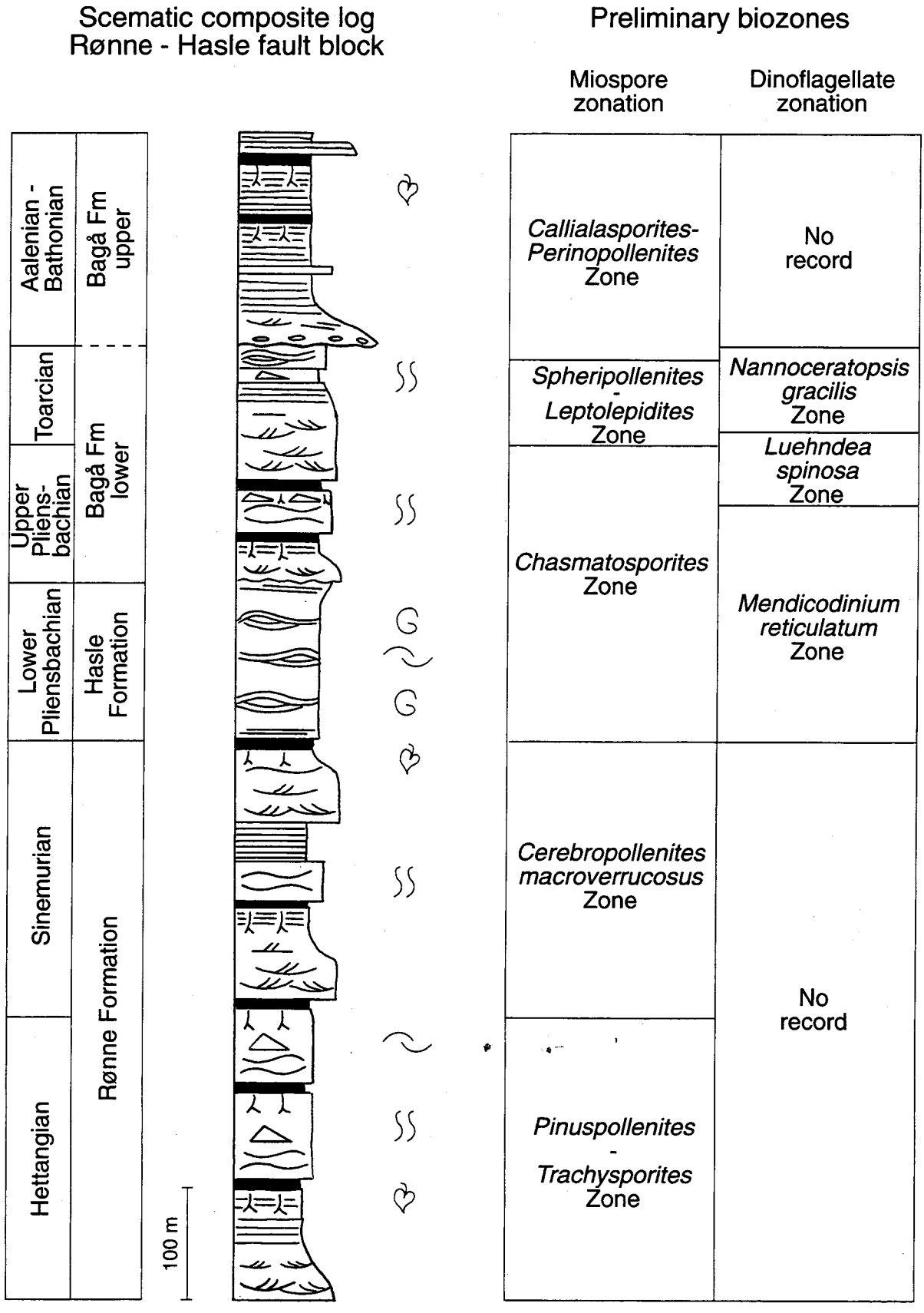

Fig. 2 Schematic composite log representing the Jurassic deposits in the Rønne-Hasle Fault Block, Bornholm.

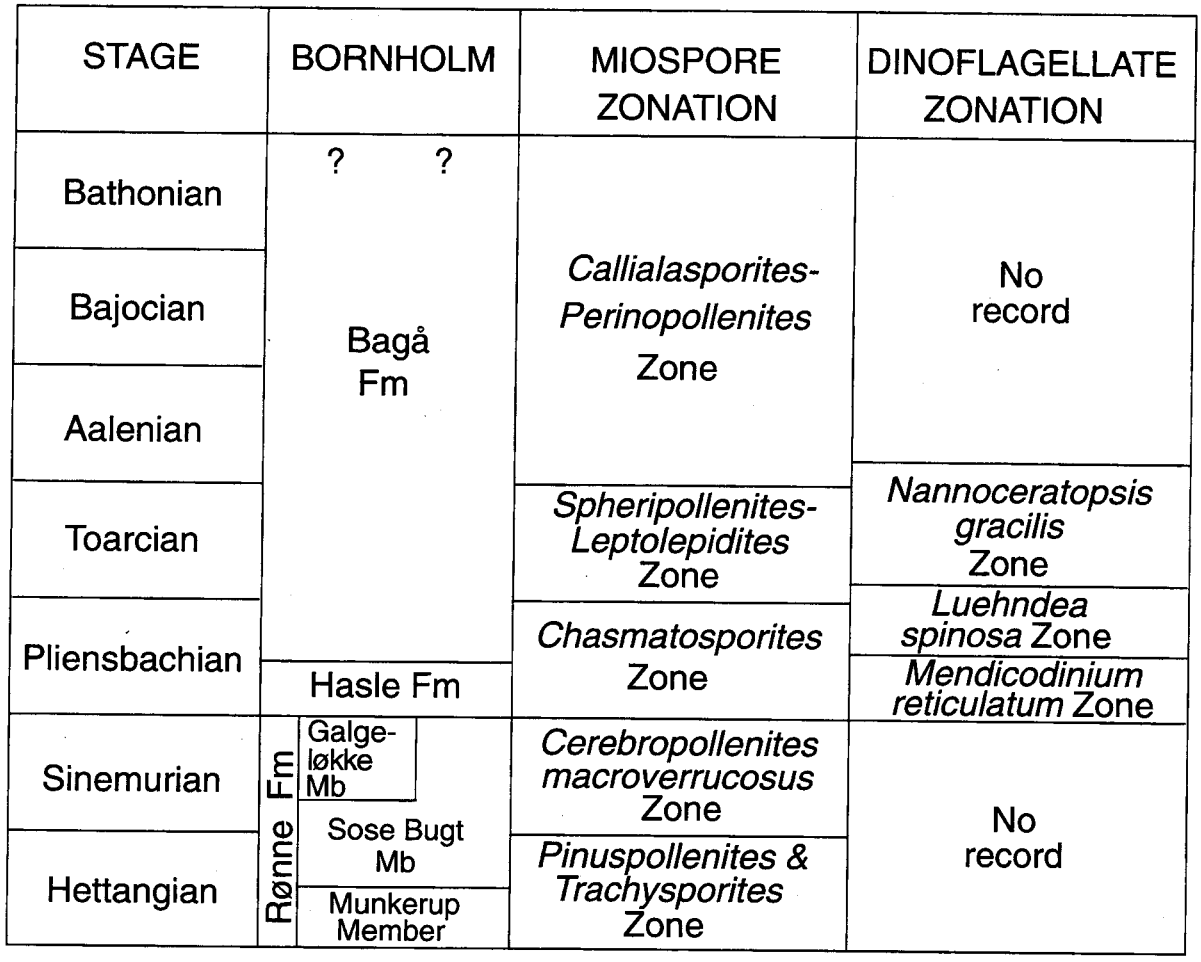

Fig. 3 Preliminary palynozonation on Bornholm.