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Jurassic palynomorphs below the main central thrust of East Bhutan (Himalayas)

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ABSTRACT

Palynological investigations of the Barsong Formation, eastern Bhutan (Himalaya), indicate a Jurassic age for these sediments. The known stratigraphic ranges of some of the recorded dinoflagellate cysts suggest an Oxfordian age. The Barsong Formation consists of well-bedded siliceous and calcareous slates squeezed in between the Shumar-Daling group (late Precambrian) and the main crystalline thrust of the Himalaya (Tashigang unit). The formation represents a rare Mesozoic deposit between the Tethyan and the Gondwana facies.

ZUSAMMENFASSUNG

Palynologische Untersuchungen der Barsong-Formation in Ost-Bhutan ergaben ein jurassisches Alter dieser Sedimente. Die bisher bekannten stratigraphischen Reichweiten der nachgewiesenen Dinoflagellaten-Zysten deuten auf Oxfordian-Alter hin. Die Barsong-Formation besteht aus einer Wechsellagerung gutgebankter quarzitischer und kalkiger Schiefer. Sie liegt eingeklemmt zwischen der Shumar-Daling-Einheit (jüngeres Präkambrium) und der kristallinen Hauptmasse des Himalaja (Tashigang-Einheit). Die Formation repräsentiert somit bisher unbekannte mesozoische Ablagerungen zwischen Tethys- und Gondwana-Fazies.

Introduction

During geological investigations in the eastern Bhutan-Himalayas a particular rock formation was found, intercalated within a complex section of metasediments of a higher green schist facies. These sediments occur just below the Main Central Thrust, the base of a pile of high grade metamorphic crystallines over 15 km thick (Fig. 1, 2).

This intercalated rock formation consists of very well-bedded (1 cm layers) siliceous, light and dark grey banded calcareous slates. The formation is about 100 m thick and contrasts with the intensely sheared and higher metamorphic metasediments. The slates outcrop just below the crystalline overthrust, separated only by several meters of mylonitized quartzites and biotite-sericite phyllites, with biotites as post-kinematic porphyroblasts. The sediments dip towards the northwest below the main crystallines, which are known as the Tashigang crystalline unit, while the underlying well-bedded sediments are called the Barsong Formation after a small village to the south (GANSSER 1982). The Barsong Formation has been separated with a tectonic contact from the over 5000 m thick Shumar-Daling group

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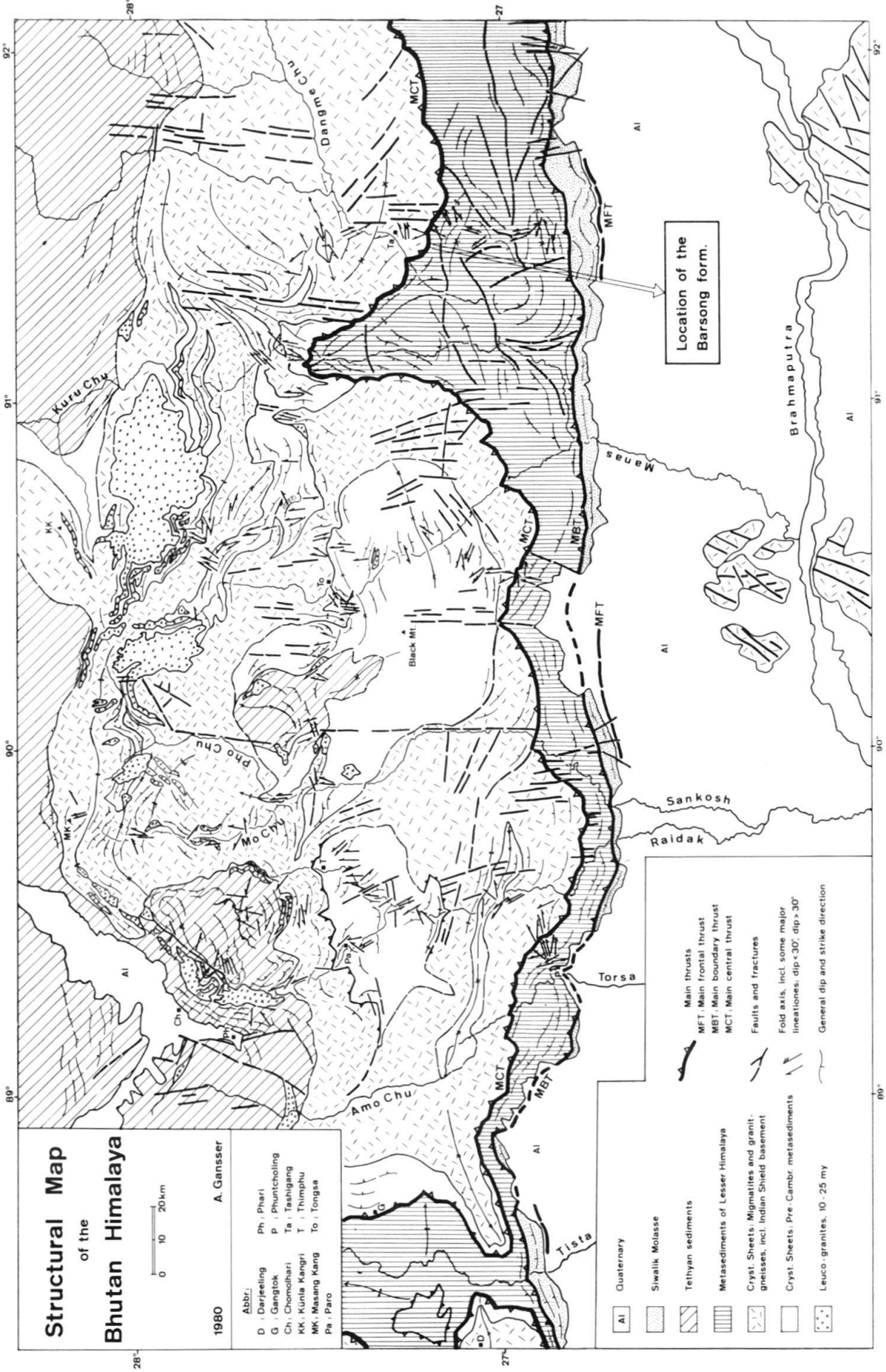


Fig. 1. Structural map of the Bhutan Himalaya.

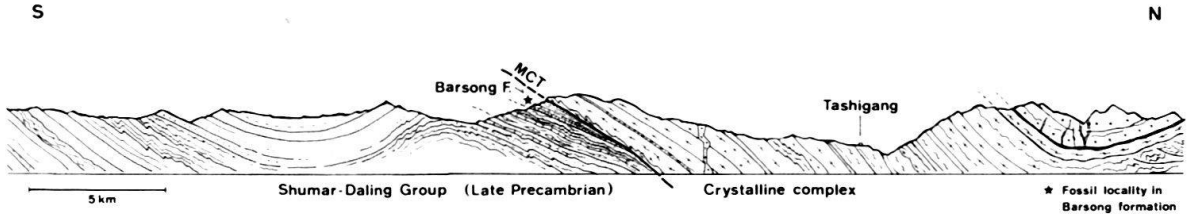


Fig. 2. Generalized section through part of southeastern Bhutan.

of late Precambrian age (below stromatolite bearing limestones), which includes tilloid sections of doubtful age (JANGPANGI 1974; GANSSER 1982).

In the area of interest, which belongs to the eastern Himalayas, we recognize the same major subdivisions which have been accepted for the complete range: from south to north, the Siwalik Molasse in the Sub-Himalayas separated by the Main Boundary Thrust (MBT) from the Lower Himalayas, which is overthrust along the Main Central Thrust (MCT) by the crystalline High Himalayas. The latter forms the base of the Tethyan sediments (GANSSER 1964).

The Barsong Formation is a tectonic slice on the top of the Shumar-Daling group belonging to the Lower Himalayas and is overthrust by the more than 15 km thick crystalline unit of the Higher Himalayas, here referred to as Tashigang crystalline.

Five samples from the Barsong Formation have been prepared for palynological investigations. One sample (GH428) yielded badly preserved organic material. Beside opaque carbonized particles without any visible structure, some fragments of dinoflagellate cysts and chitinozoans have been found. Two additional preparations with a greater amount of sediment yielded some determinable palynomorphs. All preparations showed the same results and contamination in the laboratory can therefore be excluded. The palynomorphs taken into consideration in this paper are from one sample (GH428). Generally, the state of preservation of the palynomorphs is very poor, though a few Jurassic palynomorphs are quite well preserved.

A great number of fragments are not assignable to any group. Furthermore, the specimens are carbonized and hardly translucent. Only by examining a great number of slides was it possible to find some dinocysts sufficiently well preserved to

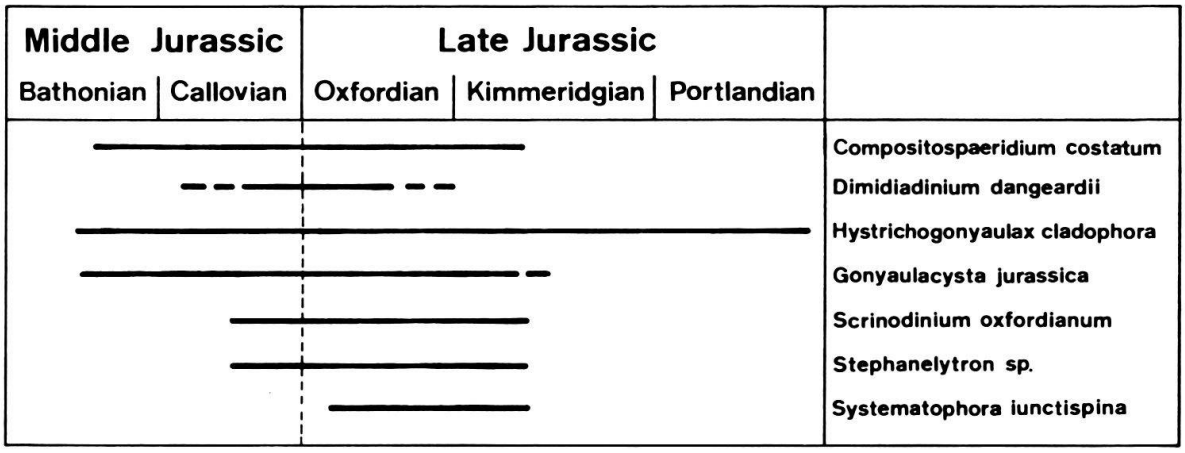


Fig. 3. Known ranges of stratigraphically useful taxa, encountered in sample GH428.

allow a generic or specific determination. Beside dinocysts we found microforaminifera and spores. Acritarchs and fragments of chitinozoans also present give evidence for reworking from the older Paleozoic (Silurian, Devonian).

Jurassic palynomorphs

Dinocysts proved to be of particular significance for the biostratigraphic interpretation. Completely preserved specimens are extremely rare, most specimens are partly broken. In some cases their determination remains therefore debatable especially on the specific level. Land-derived palynomorphs are comparatively rare and only a few more or less completely preserved spores could be found.

Floral list

Dinoflagellate cysts

About 80% of the palynomorphs found are dinocysts. Most of them belong to the *Gonyaulacysta* group.

Compositosphaeridium cf. *costatum* (DAVEY & WILLIAMS) DODEKOVA 1974

Fig. 4K

Fragment of the hypocyst. Arrangement and morphology of the polytubular processes are typical for the genus. The assignment to the only described species has to be regarded as questionable.

Dimidiadinium dangeardii (SARJEANT) BRIDEAUX 1977

Fig. 4C, 5C

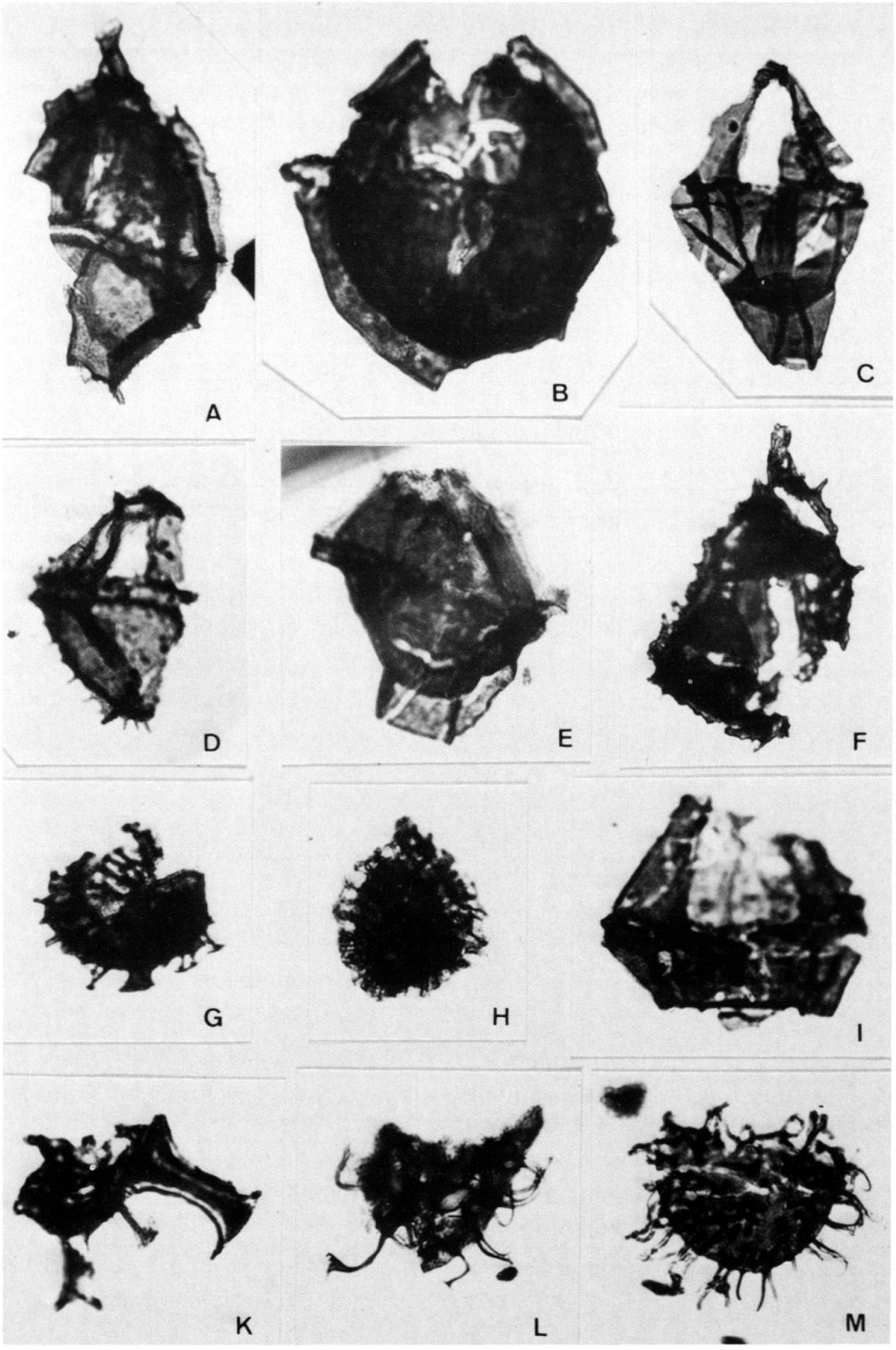
Complete specimen. The tabulation as well as the form of the apical and antapical pericoel correspond with the type of *D. dangeardii.*

?*Dimidiadinium* sp.

Fig. 4E

Badly preserved specimen. Apical part missing. The morphological features of the hypocyst suggests affinity with *Dimidiadinium.*

Fig. 4. Magnification: ×750. A = *Gonyaulacysta jurassica* (DEFLANDRE) NORRIS & SARJEANT 1965, B = *Scriniodinium* cf. *oxfordianum* SARJEANT 1962, C = *Dimidiadinium* cf. *dangeardii* (SARJEANT) BRIDEAUX 1977, D = *Hystrichogonyaulax* cf. *cladophora* (DEFLANDRE) STOVER & EVITT 1978, E = ?*Dimidiadinium* sp., F = *Gonyaulacysta* sp., G = *Stephanelytron* sp., H = *Chlamydophorella* sp., I = Dinocyst with precingular archeopyle, K = *Compositosphaeridium* cf. *costatum* (DAVEY & WILLIAMS) DODEKOVA 1974, L = *Surculosphaeridium* sp., M = *Systematophora* cf. *iunctispina* (KLEMENT) STOVER & EVITT 1978.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Dinocyst with precingular archeopyle

Fig. 4I

Only the precingular and the postcingular part of the cyst are preserved. The missing plate P 3″ indicates the position of the archeopyle.

Gonyaulacysta jurassica (DEFLANDRE) NORRIS & SARJEANT 1965

Fig. 4A, F

Partly preserved specimen. Parts of the hypocyst are broken off. The arrangement of the plates and the development of the septae are typical for *G. jurassica.* A very badly preserved specimen (Fig. 4F) is also comparable to *G. jurassica.*

Hystrichogonyaulax cf. *cladophora* (DEFLANDRE) STOVER & EVITT 1978

Fig. 4D

Incompletely preserved specimen. Parts of the epicyst and hypocyst are missing. The pattern of the tabulation is partly recognizable. The development of the septae corresponds to that of *H. cladophora.*

Scriniodinium cf. *oxfordianum* SARJEANT 1962

Fig. 4B

Endocyst almost completely preserved. Periphragm partly missing. The hardly visible septae on the endocyst allow a comparison with *S. oxfordianum.*

Stephanelytron sp.

Fig. 4G

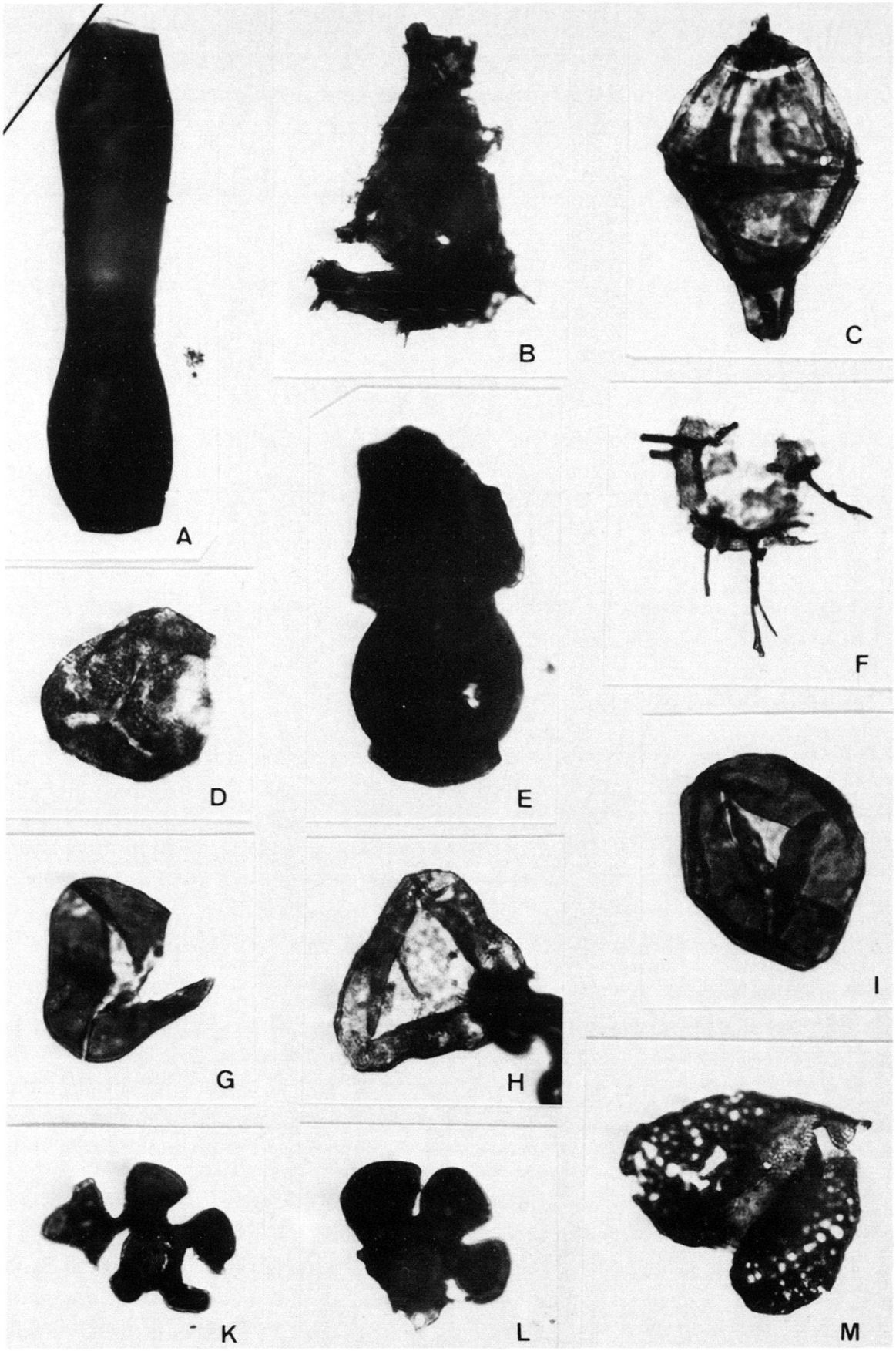
Almost completely preserved specimen. The form and the arrangement of the processes as well as the antapical corona are typical for *Stephanelytron.* Because of the state of preservation, it is not possible to determine this specimen specifically.

Chlamydophorella sp.

Fig. 4H

Completely preserved specimen. The operculum of this cyst is in place and bears an apical horn. The cyst is densely covered with processes of uniform length. In some parts they are still connected distally by the membrane. There is no indication of a corona in the antapical part.

Fig. 5. A = ?*Angochitina* sp., B = ?*Desmochitina* sp., C = *Dimidiadinium dangeardii* (SARJEANT) BRIDEAUX 1977, D = *Punctatisporites* sp., E = ?*Desmochitina* sp., F = Acritarch, G, H, I = *Deltoidospora* sp., K, L = Microforaminifera, M = *Alisporites* sp.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Surculosphaeridium sp.

Fig. 4L

The arrangement of the solid processes makes it possible to assign this fragment to *Surculosphaeridium.*

Systematophora cf. *iunctispina* (KLEMENT) STOVER & EVITT 1978

Fig. 4M

Complete specimen. The morphology of the cyst and the penitabular arrangement of the slender processes is closely comparable to *S. iunctispina.*

Spores

Spores occur rarely in the sample. They can be assigned to the genera *Deltoidospora* (Fig. G, H, I) and *Punctatisporites* (Fig. 5D). The state of preservation does not allow specific determination.

Pollen

Only one kind of vesiculate gymnosperm pollen (*Alisporites;* Fig. 5M) was found in the sample.

Biostratigraphic interpretation

The palynomorphs known so far from the Barsong Formation permit a quite precise dating of these sediments. Dinocysts are of special importance for the biostratigraphic interpretation. Most of the determinable cysts are known from the Middle and Upper Jurassic (Fig. 3). Two of the species (*Dimidiadinium dangeardii*, *Scriniodinium* cf. *oxfordianum*) found in our material have their main occurrence in the Callovian and Oxfordian (compare compilation, SARJEANT 1979). The genus *Stephanelytron* shows also a quite restricted stratigraphic range from the middle Callovian up to the lower Kimmeridgian (STOVER et al. 1977). *Systematophora iunctispina* has been found in the Oxfordian and the lower Kimmeridgian only. If these restricted stratigraphic ranges should be confirmed, the assemblage could be assigned to the lower part of the Upper Jurassic (Oxfordian).

The spores (*Deltoidospora* and *Puncatisporites*) recorded from the Barsong Formation have a very long stratigraphic range through the entire Mesozoic and therefore have little stratigraphic value. Representatives of both genera are commonly found in Jurassic sediments.

The strong predominance of dinoflagellate cysts in relation to pollen and spores suggests and offshore sedimentary realm. A conspicuous feature of the assemblage is the extremely rare occurrence of vesiculate pollen which could be expected more frequently even in offshore sediments. Although representatives of the *Classopollis* group are known to be one of the most corrosion-resistant pollen, not a single specimen could be found in the assemblage.

Reworked palynomorphs

Together with the Jurassic palynomorphs some fragments of chitinozoans and acritarchs were found. The state of preservation of the acritarchs does not allow generic determination. The recorded chitinozoans are strongly carbonized. Three of the fragments can be assigned with some reservation to the genera *Angochitina* and *Desmochitina* (Fig. 5A, B, E). The genus *Angochitina* is mainly found in the Silurian and Devonian. *Desmochitina* appears in the Ordovician and ranges into the Devonian. These reworked forms indicate an erosion of Paleozoic sediments before or during Jurassic time.

Conclusions

The presence of an Oxfordian florula just below the Main Central Thrust and above a thick, mostly Precambrian section representing a northern facies of the Indian shield is of particular interest. It differs from the Tethyan facies to the north (Tethyan Himalaya) as well as from the Gondwana type sediments in the south (GANSSER 1964, p. 289).

We may have here a rare example of sediments and fossils from an intermediate facies (between Gondwana and Tethys), normally covered by the large crystalline thrust, which have been transported to the south along the Main Central Thrust and have been locally preserved along the frontal thrustmass.

The reworked Lower Paleozoic fossils suggest erosion and subsequent reworking, most probably during the late Paleozoic epiorogenetic movements. The nearest corresponding sediments outcrop in the Tang Chu basin of central Bhutan (TERMIER & GANSSER 1974).

Some of the Jurassic fossils are reasonably well preserved. One specimen of *Chlamydophorella* (Fig. 4H) for example even shows parts of the membrane connecting the distal ends of the processes. This delicate membrane may be missing even in well preserved material. One specimen of *Dimidiadinium dangeardii* is completely preserved, with the operculum in place (Fig. 5C). Normally, recognizable palynomorphs can be expected only to a depth of burial of 7000 m (STAPLIN 1969). The state of preservation is a most striking fact, considering the position of the outcrop below a crystalline thrust mass over 15 km thick, and which has moved in the order of 100 km to the south.

Acknowledgments

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