JOURNAL OF THE PALAEONTOLOGICAL SOCIETY OF INDIA
VOLS. 21 & 22, 1978 pp. 116—119. (*For* 1976-77).

DINOFLAGELLATES AND RADIOLARIANS FROM THE TETHYAN SEDIMENTS, MALLA JOHAR AREA, KUMAON HIMALAYA : A PRELIMINARY REPORT

K. P. JAIN*, RAHUL GARG*, S. KUMAR**, I. B. SINGH** AND S. K. SINGH**

*BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY, LUCKNOW
**DEPARTMENT OF GEOLOGY, LUCKNOW UNIVERSITY, LUCKNOW

ABSTRACT

The paper reports the occurrence of dinoflagellate cysts from the Spiti Shale and radiolarians from the Giumal Sandstone, Jhangu Formation and Balcha Dhura Formation exposed in Malla Johar area, Pithoragarh district.

INTRODUCTION

In the Trans-Himalayan region there is an impressive succession of sedimentary rocks designated as Tethys sediments. These show almost uninterrupted sequence from Pre-cambrian to Early Eocene (Kumar *et al.*, 1977). The upper part of the Mesozoic succession of the Tethyan sediments is considered as geosynclinal in nature but due to lack of much needed detailed micropalaeontological and sedimentological data, the evolution of the Tethyan geosyncline, vis-a-vis the sedimentary tectonics is still not well understood.

The Tethyan succession of the Malla Johar area is exposed in a very unfriendly terrain showing juvenile landscape in which the height varies from 3,000m to 6,000m. The rocks of the area are highly disturbed and deformed. Their structure and stratigraphy were established by Heim and Gansser (1939). Recently Kumar *et al.* (1977) have presented a modified lithostratigraphic scheme for the Tethyan sequence of this area. The Sancha Malla Group which has been assigned Lower Jurassic to ? Lower Eocene age (Kumar *et al.*, 1977), has been subdivided lithostratigraphically into four formations, viz., Spiti Shale, Giumal Sandstone, Jhangu Formation and Balcha Dhura Formation (Table-1).

Table-1—(Modified by Kumar *et al.*, 1977, after Heim and Gansser, 1939)

GROUP	FORMATION	LITHOLOGY	AGE
	EXOTIC FORMATION	White Oolitic Limestone	
		.....THRUST.....	
SANCHA MALLA GROUP	BALCHA DHURA FORMATION 90M	Basic volcanic rocks interbedded with reddish brown and greyish green shales and radiolarian chert.	?Lower Eocene
	JHANGU FORMATION 400 M	Dark greyish green graywacke, shales, red foraminiferal limestone, calcareous sandstone, orthoquartzite and thin bands of radiolarian cherts.	Upper-Cretaceous
	GIUMAL SANDSTONE 400 M	Glauconitic sandstone, siltstone, shales and radiolarian cherts.	Lower-Cretaceous
	SPITI SHALE 200 M	Black friable shales and siltstone with abundant nodules containing ammonites.	Oxfordian-Portlandian
REWALI BAGAR GROUP	FERRUGINOUS OOLITE FORMATION 10 M	Ferruginous oolitic limestone and shale with abundant ammonites.	Callovian

The samples which have yielded the microplankton were collected along Laptal-Balcha Dhura and Laptal-Chojan La mule tracks during an expedition organised by the Department of Geology, Lucknow Universty in 1974. Dinoflagellates have been recorded from the Spiti Shale whereas sediments belonging to the Giumal Sandstone, Jhangu Formation and Balcha Dhura Formation have yielded a rich radiolarian fauna.

DINOFLAGELLATES

The Spiti Shale sequence is about 200 metres thick. The samples from lower 50 metres did not yield any palynofossil except for some organic detritus. The palynoflora recorded from the Spiti shale samples are highly oxidised. The very friable nature of the palynomorphs might be due to the highly disturbed nature of the rocks, as the entire Tethyan sequence was subjected to intense tectonic disturbances during the uplift of the Himalaya. The preservation of the palynofossils is therefore, unsatisfactory. Attempts have been made to procure, as complete as possible, the individual specimens by following various variations during the chemical analysis.

The dinoflagellates and other palynofossils were recovered by the conventional acid/alkali method. However, the complete oxidation of the organic matter took a very long time and the final recovery of dinocysts and miospores was very poor due to heavy breakage. To avoid this, the material was therefore, treated comparatively for a lesser time. Only the under-macerated material furnished better results. Alkali treatment and acetolysis were completely avoided.

The dinocysts and miospores have been recovered from different levels. The assemblages show marked differences suggesting the possibility of biozonation of Spiti Shale in this area.

The present preliminary report records some of the important dinocysts listed below and only a few have been illustrated (Pl. I—1-9) :

Oligosphaeridium anthophorum (Cookson & Eisenack) Davey ; *Oligosphaeridium pulcherrimum* (Deflandre & Cookson) Davey and Williams ; *Lithodinia* sp.; *Sentusidinium* sp. ; *Sentusidinum* sp. *?* ; *Pareodinia ceratophora* Deflandre ; *Prolixosphaeridium* sp. cf. *torynum*(Cookson & Eisenack)Eisenack & Kjellström; *Gonyaulacysta jurassica* (Deflandre) Norris & Sarjeant; *Tubotuberella apatela* (Cookson & Eisenack) Ioannides *et al.*, *Adnatosphaeridium aemulum* (Deflandre) Williams & Downie ; *Oligosphaeridium dictyophorum* (Cookson & Eisenack) Davey & Williams ; *Omatia montgomeryi* Cookson & Eisenack.

Apart from these, the palynological assemblage also contains a few specimens of pteridophytic spores and acritarchs at particular levels. A perusal of the Upper Jurassic dinoflagellate assemblages described from different parts of the world reveals that the Spiti Shale dinocysts are comparable to those of Australia and New Guinea (Cookson & Eisenack, 1958), England, Scotland and France (Ioannides *et al.*, 1970 ; Gitmez and Sarjeant, 1972). The dinocyst flora supports an Upper Jurassic age of the Spiti Shale.

RADIOLARIANS

The occurrence of radiolarians in the Tethyan sequence of Malla Johar was first made by Heim & Gansser (1939) followed by Mamgain & Sastry (1975), but no detailed taxonomic attempt was made. It has been noticed during the study of petrographic thin sections of the rocks of the Sancha Malla Group that the radiolarians are particularly abundant in three horizons, viz., (i) in the bedded cherts, at the gradational contact between Spiti Shale and Giumal Sandstone ; (ii) greywacke and siltstones of the uppermost Jhangu Formation (Upper Flysch of Heim & Gansser, 1939) and (iii) the bedded cherts of the Balcha Dhura Formation.

The radiolarians have been investigated in thin sections only, as attempts to extract them through chemical analysis were partially successful due to the fact that the radiolarian shells have undergone large scale glauconitization. However, in several of the thin sections of the cherts and sandstones, well preserved radiolarian shells are found allowing a more or less satisfactory generic identification.

The radiolarian assemblages show both qualitative and quantitative differences in composition within the three horizons. Some of the important and significant constituents of these assemblages are listed below and a few have been illustrated (Pl. I—10-19).

GIUMAL SANDSTONE

In general the radiolarian assemblage is dominated by cryptothoracic and multisegmented Theoperid Nassellaria and single shelled spherical spumellarians (*?Cenosphaera*). A few forms referable to pseudoaulophacid and/or spongodiscid spumellarians also constitute a significant part of this assemblage. Glauconitization is very distinct.

Following nassellarian genera have been identified: *Sethocapsa* spp., *Lithocampe* sp. cf. *L. elegantissima*, *Lithocampe* sp. *Eucyrtis* sp., *Zhamoidellum* or (*?Cryptamphorella*), *Holocryptocapsa* and *Williriedellum*.

This radiolarian assemblage resembles with the Upper Jurassic-Cretaceous assemblage recorded by Dumitrica (1970) from Romania in having common abundance of cryptothoracic nassellarians. Some of the forms (*Lithocampe* sp. cf. *L. elegantissima*, *Eucyrtis* sp. and *Sethocapsa* sp.) are similar to those recorded from the Lower Cretaceous of Rotti Island near Timor, Point Sal. Califorina, DSDP Leg 26 (Riedel & Sanfilippo, 1974) and DSDP,

Leg 20 (Foreman, 1973). Therefore, an uppermost Jurassic-Lower Cretaceous age is tentatively suggested for the present radiolarian assemblage.

JHANGU FORMATION

The samples yielding Radiolaria belong to the greyish green graywackes in the upper part of this formation.

At this level multisegmented Theoperid Nassellaria dominate the assemblage, though Cryptothoracic nassellarians and single shelled spherical spumellarians (*?Ceno sphaera*) are also fairly well represented. A few unidentifiable spumellarians are also present in good number. Glauconitization of the radiolarian shells is also very clearly marked in these rocks, though the forms are better preserved here than in the cherts of the basal Giumal Sandstone. The radiolarian taxa identified are listed below :

Lithocampe sp. cf. *L. chenodes*, *Lithocampe* sp. cf. *L. elegantissima*, *Lithocampe* sp., *Dictyomitra* sp. cf. *D. pseudomacrocephala*, *Eucyrtis* sp. cf. *E. tenuis*, *Eucyrtis* sp., *?Eucyrtidium*, *Sethocapsa* spp., *Zhamoidellum* (or *?Cryptamphorella*), cf. *Gongylothorax*, *Holocryptocanium* sp. cf. *Holocryptocapsa*, cf. *Amphipyndax*.

BALCHA DHURA FORMATION

The hard brownish red radiolarian cherts occur in association with basic volcanic rocks and minor shales. Heim & Gansser (1939) included these rocks with the thrusted blocks of the Exotic Formation.

The radiolarian assemblage at this level differs from the assemblages encountered at lower levels, in that the spherical single-shelled spumellarians profusely dominate the assemblage. These forms could not be satisfactorily assigned to any genus. In contrast, a few nassellarians present in the assemblage, though significantly outnumbered by the spumellarians, are somewhat better preserved. The radiolarian shells at this level show no effect of glauconitization. The nassellarians encountered in these cherts have been referred to the following genera :

Gongylothorax, *Theocapsomma*, *Lithocampe*, *?Dictyomitra*, *?Eucyrtidium*, cf. *Cryptamphorella*, cf. *Sethocapsa*.

The presence of Coccolithophorids belonging to the *Tetralithus trifidus* Zone in the lowermost member of the underlying Jhangu Formation, indicating latest Campanian-Maestrichtian age for the formation, has led Kumar *et al.* (1977) to assign doubtfully a Palaeocene or even Lower Eocene age to the Balcha Dhura Formation on stratigraphical grounds. Present radiolarian assemblage recovered from the upper part of the Balcha Dhura Formation, however, suggests a Cretaceous affinity.

CONCLUSION

1. The Spiti Shale sequence shows a number of palynologically productive horizons. Palynomorphs suggest an Upper Jurassic age.

2. The Giumal Sandstone, Jhangu Formation and Balcha Dhura Formation show moderately well preserved radiolarian fauna. All the three formations have a characteristic assemblage.

3. The radiolarian fauna of the Balcha Dhura Formation suggests Cretaceous affinity.

4. Present study indicates that the dinoflagellates can be significantly used in deciphering the precise zonation of the Spiti Shale formation.

ACKNOWLEDGEMENT

The authors are thankful to Prof. S. N. Singh, Head, Department of Geology, Lucknow University and the Director, Birbal Sahni Institute of Palaeobotany for allowing this collaborative work. We express our sincere thanks to Mr. D. C. Joshi, B. S. I. P. for chemical processing of the samples.

REFERENCES

COOKSON, I. C. and EISENACK, A. 1960. Upper Mesozoic microplankton from Australia and New Guinea. *Palaeontology*. **2** : 243-261.

DUMITRICA, P. 1970. Cryptocephalic and cryptothoracic *Nassellaria* in some Mesozoic deposits of Romania. *Rev. Roum. Geol., Geophys., Geogr.* Ser. de *Geol.* **14** : 45-124.

FOREMAN, H. P. 1973. Radiolaria from DSDP Leg. 20. *In* Heezen, B. C., MacGregor, I. D. *et al.*, *Initial Reports DSDP* **20** : 249-305.

GITMEZ, G. U. and SARJEANT, W. A. S. 1972. Dinoflagellate cysts and acritarchs from the Kimmeridgian (Upper Jurassic) of England, Scotland and France. *Bull. Br. Mus. nat. Hist. (Geol.)*. **21** : 171-257.

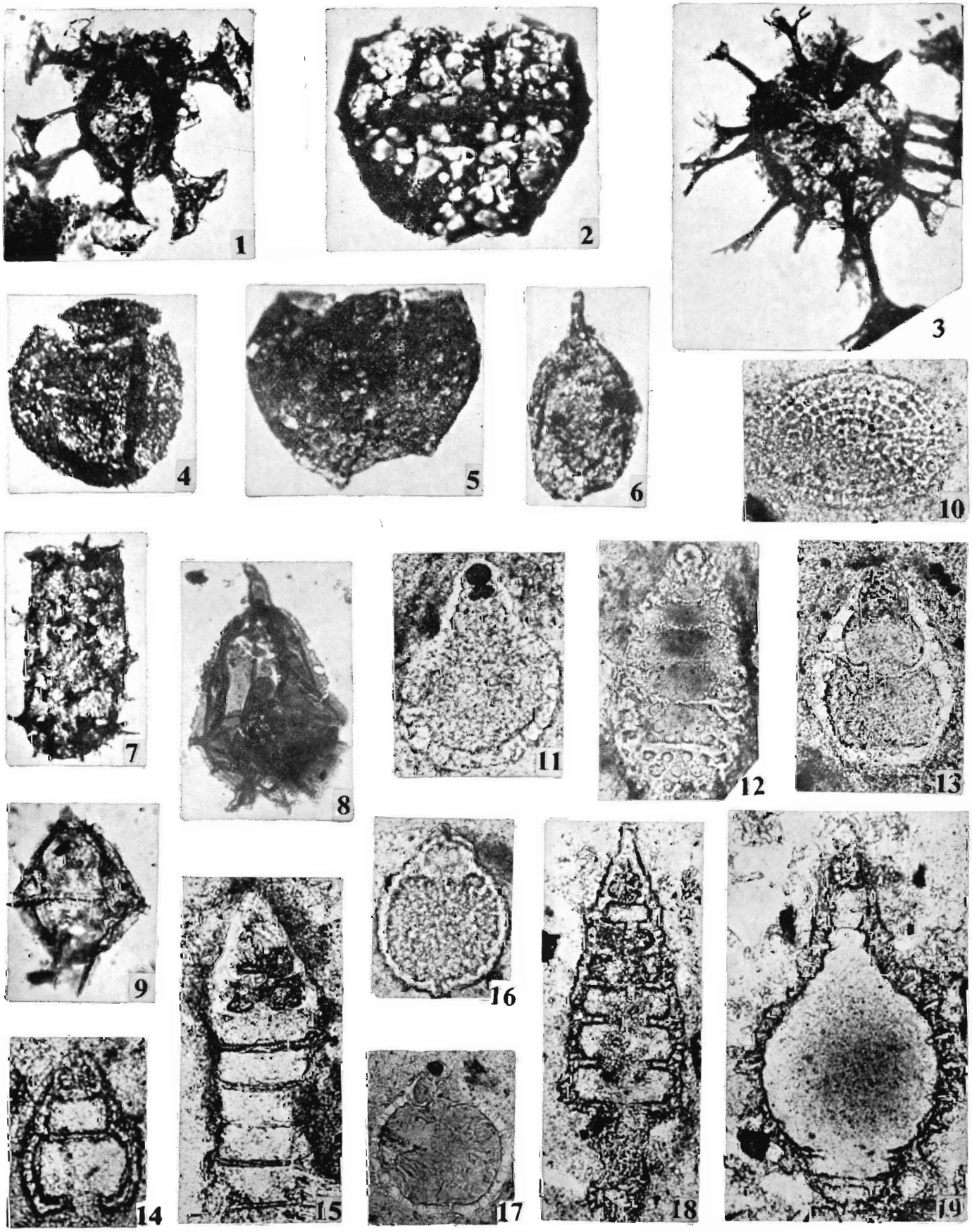
HEIM, A. and GANSSER, A. 1939. Central Himalaya, geological observations of the Swiss expedition 1936. *Mem. Soc. Helv. Sci. Nat.* **73** (1) : 245 p.

IOANNIDES, N. S., STAVRINOS, G. N. and DOWNIE, C. 1976. Kimmeridgian microplankton from Clavel's Hard, Dorset, England. *Micropaleontology*. **22** : 443-478.

KUMAR, S., SINGH, I.B. and SINGH, S. K. 1977. Lithostratigraphy, structure, depositional environment, Palaeo-current and trace fossils of the Tethyan sediments of Malla Johar area, Pithoragarh-Chamoli Districts, Uttar Pradesh, India. *Jurij A. Orlov Memorial Number, Jour. Pal. Soc. India.* **20** : 396-435.

MAMGAIN, V. D. and SASTRY, M. V. A. 1975. The Upper Cretaceous microfauna of the Spiti and Niti areas of the Himalaya. *Mem. Geol. Surv. India, Pal. Ind. N. S.* **43**: 1-49.

RIEDEL, W. R. and SANFILIPPO, ANNIKA. 1974. Radiolaria from the southern India Ocean, DSDP Leg 26. *In* Davies, T. A., Luyendyk, B. P. *et al.*, *Initial Reports DSDP* **26** : 771-814.


1
2
3
4
5
6
10
7
8
11
12
13
9
16
14
15
17
18
19

EXPLANATION OF PLATE

PLATE I

1. *Oligosphaeridium anthophorum* (Cookson & Eisenack) Davey, 1969 ; Slide no. BSIP 6040 ; coordinates 129.7×6.7 ; ×500.
2. *Lithodinia* sp., Slide no. BSIP 5913 ; coordinates 108.9×10.0 ; ×500.
3. *Oligosphaeridium pulcherrimum* (Deflandre & Cookson) Davey & Williams 1966 ; Slide no. BSIP 5913 ; coordinate 112.5×10.3 ; ×500.
4. *Sentusidinium* sp., Slide no. BSIP 6041 ; coordinates 104.5×3.7 ; ×500.
5. *?Sentusidinium* sp., Slide no. BSIP 5912 ; coordinates 114.5×3.7 ; ×500.
6. *Pareodinia ceratophora* Deflandre emend. Gocht, 1970 ; Slide no. BSIP 6042 ; coordinates 96.8×13.2 ; ×500.
7. *Prolixosphaeridium* cf. *toryanum* ; Slide no. BSIP 5912; coordinates 121.8×16.5 ; ×500.
8. *Gonyaulacysta jurassica* (Deflandre) Norris & Sarjeant 1965 ; Slide no. BSIP 6043 ; coordinates 121.9×13 ; ×500.
9. *Tubotuberella apatela* (Cookson & Eisenack) Ioannides *et al.* 1977 ; Slide no. BSIP 5911; coordinates 112.2×8.8 ; ×500.
10. *Spumellaria indet* ; Slide no. BSIP 5914 ; coordinates 107.0×8.0 ; ×300.
11. *Sethocapsa* sp., Slide No. BSIP 5917 ; coordinates 104.5×13.5 ; ×300.
12. *Eucyrtis* sp., Slide No. BSIP 5916 ; coordinates 101.5×12.8 ; ×300.
13. *Lithocampe* sp., Slide no. BSIP 5914 ; coordinates 104.5×10.6 ; × 250
14. *cf. Eucyrtidium* sp., Slide no. BSIP 6044 ; coordinates 98.7×13.2; × 250
15. *Dictyomitra* sp. cf. *D. pseudomacrocephala* ; Slide no. BSIP 6044 ; coordinates 109.7×18.5 ; ×250.
16. *Williriedellum* sp., Slide No. BSIP 5914 ; coordinates 105.2×11.4 ; ×300.
17. *Zhamoidellum* (or ? *Cryptamphorella*) ; Slide No. BSIP 5916 ; coordinates 107.0×13.0 ; ×300.
18. *Eucyrtis* sp. cf. *E. tenuis* (?) ; Slide no. BSIP 6046 ; cooridnates 116.6×12 ; ×250.
19. *Lithocampe* sp. cf. *L. chenodes* Renz (in Riedel & Sanfilippo, 1974) ; Slide no. BSIP 6046 ; coordinates 102.3×10.1 ; ×250.