Significance of the Meso-Neoproterozoic microfossil assemblage from the Deoban Limestone, Garhwal Lesser Himalaya

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The microfossil assemblage from the Deoban Limestone comprises 75 morphotaxa which have been recognised from the study of petrographic thin sections of black bedded cherts. The assemblage consists of cyanobacterial, bacterial, algal, fungal, acritarchean forms along with forms possibly of animal affinity, and has a significant bearing for palaeobiological, palaeogeographical and palaeoecological studies. The dominance of cyanobacterial population suggests conservatism in cyanobacterial community in the microbial setting. In diversity and level of preservation, the assemblage is comparable to the Kheinjua Formation of the Vindhyan Supergroup. If animal affinity of the Deoban microfossil assemblage is accepted, it would indicate herbivore or heterotrophs dominated food chain in contrast to earlier producer or autotrophs dominated food chain.

Key-words — Microfossils, Proterozoic, Lesser Himalaya, Deoban Limestone, Garhwal, India.

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सारांश

गढ़वाल लघु हिमालय में देवबन चूना पत्थर से प्राप्त मीसो-निओप्रोटीरोजोइक सूक्ष्मजीवाश्मों का महत्व

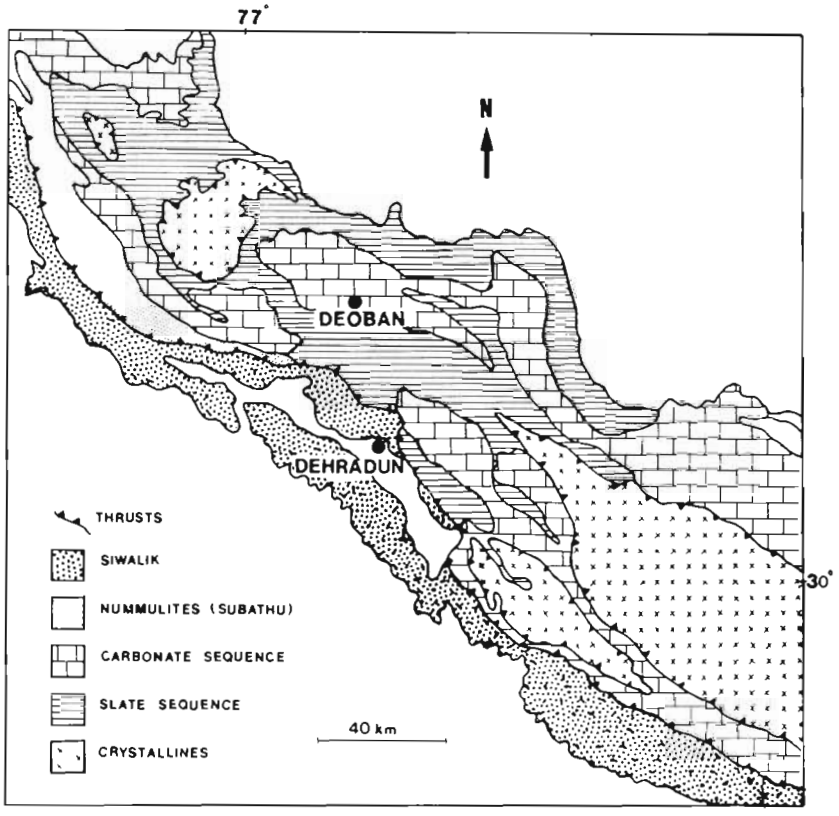
पूर्णिमा श्रीवास्तव एवं सुरेन्द्र कुमार

देवबन चूना पत्थर से प्राप्त सूक्ष्मजीवाश्म समुच्चय में 75 वर्गक विद्यमान हैं जिनका अभिनिर्धारण काले संस्तरित रामसैकाश्मों की पतली काटों के अध्ययन द्वारा किया गया है। इस समुच्चय में सियॅनोजीवाणुओं, जीवाणुओं, शैवालों, कवकों, एक्रीटार्को तथा सम्भवतया जन्तुओं से सजातीयता व्यक्त करने वाले प्ररूप सम्मिलित हैं जिसके कारण इसका पुराजैविकीय, पुराभौगोलिक एवं पुरापारिस्थितिक दृष्टि से विशेष महत्व है। सियॅनोजीवाणुओं की बाहुल्यता से इस समुदाय की पुरातनता प्रदर्शित होती है। विविधता एवं परिरक्षण के आधार पर यह समुच्चय विन्ध्य महासमूह के खेंजुआ शैल-समूह से तुलनीय है। यदि देवबन सूक्ष्मजीवाश्म समुच्चय की जन्तुओं से सजातीयता मान्य है तो इससे स्वपोषी भोजन प्रणाली के स्थान पर विषमजीवी भोजन प्रणाली की विद्यमानता इंगित होती है।

LIFE during the Proterozoic Eon was typified by the hypobradytelic evolution of dominantly microscopic, asexual, unicellular or colonial prokaryotes, e.g., cyanobacteria, bacteria. Algae, fungi, acritarchs, trace fossils, stromatolites and soft bodied animals also represent Proterozoic life (see Glaessener, 1983a, 1983b; Awramik *et al.*, 1985; Schopf & Klein, 1992; Zhang & Walter, 1992). Any report about these fossils is significant for the better understanding of evolution of early life. Exceptional preservation of Meso-Neo-proterozoic microfossil assemblage, comprising taxonomically and morphologically varied taxa and morphotaxa, reported from the petrographic thin sections of black bedded chert of the Deoban Limestone (Kumar & Singh, 1979; Shukla *et al.*, 1987; Kumar & Srivastava, 1992; Srivastava & Kumar, 1995, 1997a & unpublished data), can be taken as one of the most diversified and advanced microfossil assemblage. In all, 75 morphotaxa have so far been described representing bacteria, cyanobacteria (prokaryotes), algae, fungi and acritarchs (eukaryotes) of plant kingdom and soft bodied animals (?) or multicellular organisation of animal affinity.

GEOLOGICAL SETTING

A thick carbonate horizon, about 500 m thick in northern part of Chakrata, Dehradun District, Garhwal Lesser Himalaya, was designated as the Deoban Limestone by Oldham (1883) (Text-figure 1). This sedimentary sequence shows low grade metamorphism and is tectonically much disturbed. The sedimentary features are still discernible. The



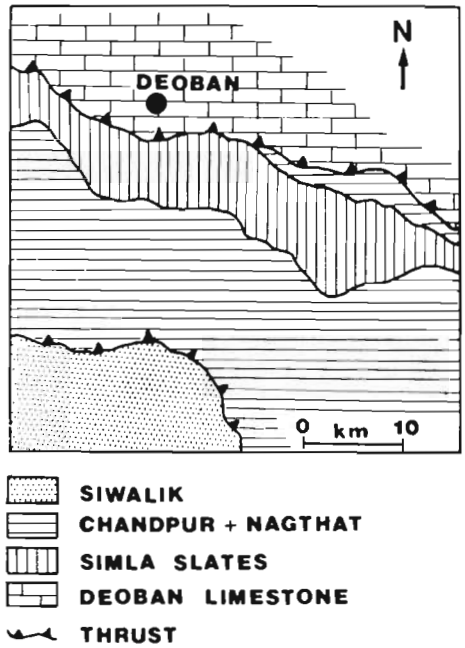
Text-figure 1—Location and geological map of Garhwal region of Uttar Pradesh (simplified after Gansser, 1964).

lithology is dominated by dolostone with thin lenses and bands of cherts, and intercalations of shales. No megafossil has so far been described from this horizon. The stromatolites are well reported from this area.

Stratigraphic position of the Deoban Limestone is still a matter of debate, there being no general agreement on this particular aspect (Auden, 1934, 1937; West, 1939; Gansser, 1964; Rupke, 1974; Prashra, 1977; Valdiya, 1980). Some workers consider that the Deoban Limestone overlies the Simla Slates and is underlain by the Mandhali Formation, while others consider it to be underlying the Simla Slates and overlying the Mandhali-Chandpur sequence (Table 1). In Chakrata area, it physically overlies the Simla Slates and is underlain by the Mandhali Formation (Text-figure 2). The Deoban Limestone is folded and faulted, the fossil bearing chert occurs within 3 meter thick horizon of micritic dolostone in the lower part of the Deoban Limestone (Text-figure 3) on the

Table 1—Stratigraphic position of the Deoban Limestone according to different workers

Auden (1934, 1937)	Gansser (1964)	Bhargava (1972)	Rupke (1972)	Prashra (1977)	Valdiya (1980)	Singh & Rai (1983)
	Krol Infra Krol Blaini					
Chandpur Nagthat (Jaunsar)	Nagthat	Nagthat Chandpur Mandhali		Mandhali Simla Slates	Nagthat Chandpur Mandhali	Simla Group Shali Group
Deoban	**Deoban**	**Deoban**	**Deoban**	**Deoban**	**Deoban (Gangolihat)**	**Deoban Gp.**
Simla	Shali Chandpur Mandhali Kakarhatti	Tiuni	Damtha	Atal Quartzite	Rautgara Fm Chakrata Fm	Garhwal Group

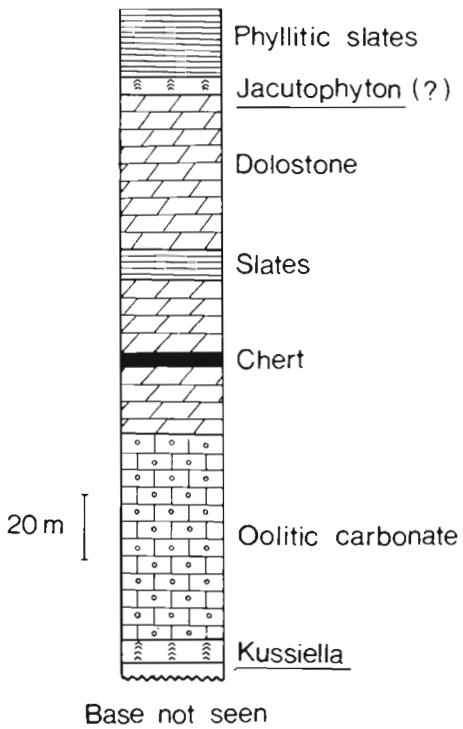


Text-figure 2 — Geological map showing distribution of stratigraphic units in Chakrata area, Garhwal Himalaya (after Sinha & Raaben, 1981).

northern limb of an anticline on Chakrata-Deoban mule track (Kumar & Srivastava, 1992).

AGE

Stromatolites are well developed in this sequence and are used for age estimation. Stromatolite



Text-figure 3 — Position of fossiliferous cherts in the litholog of the Deoban Limestone (after Kumar & Srivastava, 1992).

assemblages reported from the Deoban Limestone are: *Collenia-Baicalia baicalica* assemblage (Valdiya, 1969), *Kussiella-Boxonia-Collenia columnaris-Collenia symmetrica-Stratifera* assemblage (Prashra, 1977), *Jacutophyton* (Kumar & Singh, 1979), *Iliсta deobanica* (Sinha & Raaben, 1981) and *Kussiella-Conophyton-Baicalia* assemblage (Tewari, 1983). Sinha and Raaben (1981) suggested a Cambrian age on the basis of a new stromatolite form *Iliсta deobanica;* though no Cambrian megafossil has been reported so far. Later, Tewari (1983) suggested an Early to Middle Riphean age. On the basis of microfossil assemblage, an Upper Riphean age is suggested (Srivastava & Kumar, 1997a).

DEOBAN MICROFOSSILS

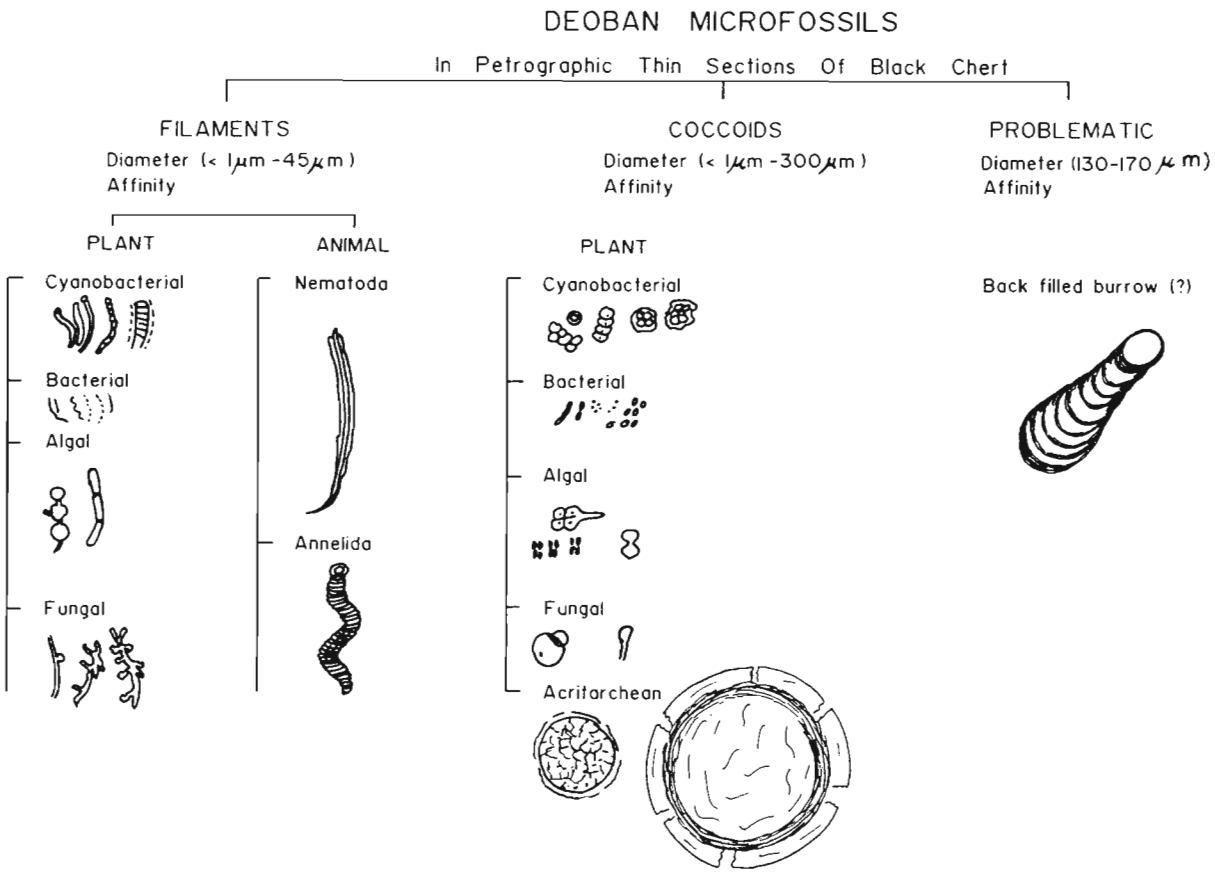
The Deoban microfossil assemblage comprises 75 morphotaxa (see Kumar & Singh, 1979; Shukla *et al.*, 1987; Kumar & Srivastava, 1992; Srivastava & Kumar, 1995, 1997a & unpublished data). The assemblage is grouped into filamentous forms, coccoid forms, acritarchs and problematic forms (Text-figure 4) which are as follows.

Filamentous forms

Filamentous forms are assignable to cyanobacterial, bacterial, algal, fungal and few forms possibly assignable to animal (?) affinity (Srivastava & Kumar, 1997a). These forms are : *Siphonophycus robustum, S. inornatum, S. kestron, Ramacia carpentariana, Oscillatoriopsis perornata, O. obtusa, Oscillatoriopsis* sp. 1, *Oscillatoriopsis* sp. 2, *Cyanonema* sp., *Rhicnonema* sp., *Obruchevella* sp., *Circulinema jinningence, Biocatenoides* sp., *Palaeoscytonema* sp., *Eomicrocoleus crassus, Polytrichoides* sp., *Palaeolyngbya* sp., *Archaeotrichion contortum, Tolypothrix* sp., *Cylindrospermum* sp., *Cladophora* sp. Two forms possibly of animal affinity are comparable to the extant members of Phylum Annelida and Nematoda, respectively.

Coccoid forms

Coccoid forms comprise morphologies assignable to the cyanobacterial, bacterial, algal, fungal and acritarchean affinities. These forms are : *Myxococcoides minor, M. inornata, M. grandis,*



Text-figure 4 — Categorization of the Deoban microfossil assemblage.

Glenobotrydion majorinum, *G. aenigmatis*, *Huroniospora psilata*, *H. microreticulata*, *Sphaerophycus parvum*, *S. minor*, *Eoentophysalis belcherensis*, *E. cumulus*, *E. magna*, *Tetraphycus major*, *T. cunjunctum*, *Palaeopleurocapsa* sp., *Eosynechococcus isolatus*, *E. medius*, *E. moorei*, *E. grandis*, *Scissilisphaera gradata*, *Conjunctiophycus* sp., *Coccus*, *Bacillus*, *Spirellum* sp., *Diplococcus* sp., *Chlorogloeopsis* sp., *Oedogoniopsis* sp., *Crucigenia* sp., *Gloeodiniopsis lamellosa*, *G. gregaria*, *G. micros*, *Gloeodiniopsis* sp., *Archaeophycus* sp., *Eophycomyces* sp., *Enterococcus lamellosus*, *Deobanisphaera trisecta*, *Polysphaeroides* sp., *Clonophycus* sp., *Desmidioideae* sp., *Ermosphaera* sp., *Germinosphaera* sp., *Myxosarcina* sp., *Garhwalia indica*, *Globophycus* sp., cf. *Fucus vesiculus*, cf. *Nostoc* Ball.

Acritarchs

Trachysphaeridium sp., *Mycrhystridium* sp., *Leiosphaeridia crassa*, *L. jacutica*, *Favosphaeridium* sp., *Baltisphaeridium* sp.

Problematic forms

A single specimen exhibiting some resemblance to a form described as a back filled burrow (Srivastava & Kumar, 1997a).

SIGNIFICANCE AND CONCLUSION

1. The assemblage comprises very small-sized (1μm) bacteria to large-sized (up to 300 μm) acritarchs and filamentous sheaths up to 80 μm thick.
2. Morphological diversity among filamentous forms varies from simple thin unornamented tubular sheaths to thick, septate or segmented forms, which may or may not be attenuated or dilated at ends. Straight to sinuous and at times helically coiled filamentous forms are with or without enveloping sheaths.
3. Helically coiled tubular sheaths assignable to *Obruchevella* suggest the initiation of coiling during the deposition of Deoban Limestone (Srivastava & Kumar, 1995).

4. Among coccoids, morphology varies from very simple organic-walled unornamented small-sized spheroids to well ornamented large-sized acritarchs.

5. Few division stages strikingly similar to some chlorophycean forms (like a form comparable to some extent *Fucus vesiculus*) and typical cellular organisation where small cells grouped in four, arranged in a rectangular colony as in extant chlorophycean form *Cructgenia*, support the presence of eukaryotes (Fritsch, 1965).

6. Considering the palaeoecological distribution of micro-organisms, mat building community is exclusively represented by the cyanobacterial population., whereas the mat dwelling community represents mixed population of variable affinities (including acritarchs). Planktic population is largely represented by acritarch and at places by thick sheaths of oscillatoriacean affinity.

7. Different mode of occurrences indicate two generations of microfossils. First generation is highly diversified and seen within algal clasts or oncolites, whereas the second generation occurs in interstitial spaces between the algal clasts or in between the coated grains. The second generation is dominantly represented by filamentous forms and rare occurrence of coccoids is noticed.

8. Specimens showing some resemblance with a pleurocapsalean form *Polybessurus* and also with an already reported form described as back filled burrow (Awramik *et al.*, 1985) like structure, enhance the complexity of the Deoban assemblage (Srivastava & Kumar, 1997a). If it is a burrow, it confirms the presence of animal life.

9. A nonseptate tubular form comparable with a living nematodean form and another annulated, sinuous and tubular body showing some resemblance with members of extant invertebrate Phylums Annelida and Nematoda are indicative of animal life in the Deoban assemblage.

10. In India, the only Proterozoic microfossil assemblage comparable to the Deoban assemblage is from the Kheinjua Formation of the Vindhyan Supergroup in Son Valley area, central India. All mentioned affinities except the forms possibly of animal affinity are well documented from this Formation (McMenamin *et al.*, 1983; Kumar & Srivastava, 1995; Srivastava & Kumar, 1997b; and unpublished data).

11. In diversity the Deoban assemblage is comparable with two other established Proterozoic microfossil assemblages; one from China, i.e., Changcheng Group (1850 Ma) and another Miroedikha Formation, USSR, 850 Ma (Schopf & Klein, 1992).

12. The dominance of cyanobacterial population is a common feature of Deoban microbial community as well as the modern microbial mats from Spencer Gulf, Shark Bay of Australia and Baja California, Mexico (Schopf & Klein, 1992). This suggests conservatism in the algal mat ecosystem since Proterozoic times.

13. If the presence of animal life in the Deoban assemblage is accepted then it would indicate relatively complex producer herbivore or heterotrophs dominated food chains. On the contrary, the earlier producer autotrophs dominated food chains based ecosystems were quite common and dominated the global scene for hundreds of millions of years. It can be inferred that the heterotrophy might have accelerated the pace of evolution of still unsolved and complicated living system, which gave rise to complex and much advanced multicellular animal organization in Late Proterozoic times (Srivastava & Kumar, 1997a).

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