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DISCOVERY OF THE LOWER CAMBRIAN STROMATOLITES FROM THE MUSSOORIE TAL PHOSPHORITE, INDIA.

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LOWER Cambrian stromatolite is recorded for the first time from the Lower Tal Phosphorite at Durmala on the northern limb of the Mussoorie syncline, Lesser Himalaya, India. The stromatolite form reported here is *Collumnaefacta vulgaris* Sidorov, which is known from the Lower Cambrian (Tommotian) deposits of the Pestrotsvet Formation on the Lena River basin USSR[1]. Phosphatic stromatolites were generally found in Proterozoic rocks of India, USSR and China but Cambrian stromatolitic phosphorites were also reported from Georgina Basin, Australia[2]. The age of Tal Formation was considered as Middle Riphean (Proterozoic)[3], Cambro-Ordovician[4], Late Palaeozoic[5-7] and Cretaceous[8-10] by previous workers. *C. vulgaris* suggests a Lower Cambrian (Tommotian) age to the Lower Tal Formation. The recent discovery of Conodonts[11] from the Tal phosphorite also suggest a Tommotian age to the Lower Tal Formation.

The sedimentaries of Krol belt, Nagthat-Blaini-Infra Krol-Krol and Tal represents continuous sedimentation in a single large epicontinental basin. The carbonate succession of Krol belt are tidal flat deposits where algal mat and stromatolitic facies are abundant. The Tal Formation is the uppermost unit of the Krol belt which contains potential phosphorite horizon overlies the Krol Formation. The basal Tal Member consists of black shale, chert bands, phosphate bearing carbonate, stromatolitic limestone and siltstone and quartzites in the Upper Tal. The Krol-Tal contact is gradational where algal mat carbonates of Upper Krol gradually change into the overlying black phosphatic shales and chert bands with bands of algal mat and stromatolitic carbonate. This is a facies change from oxygenated tidal flat of Upper Krol into a sheltered tidal flat or shallow lagoon of Lower Tal with restricted circulation[3].

The stromatolites, small algal structures and oncolites were reported from various localities within the Mussoorie Phosphorite Member of Upper Krol and Lower Tal Formations [5,12,13]. The *C. vulgaris* is discovered from Durmala phosphate deposit of the Mussoorie syncline (figure 1). Smaller isolated phosphatic stromatolitic columns and phosphatic oncolites have also been found in Tal Phosphorite. The systematic description of the stromatolite is given below:

Group: Collumnaefacta Korolyuk, 1960
Form: *C. vulgaris* Sidorov, 1969

C. vulgaris is a columnar stromatolite characterized by having spongy layers. The columns are small, upto 8 cms high, straight, parallel, vertically arranged sub cylindroids with smooth lateral surface (figure 2). Transverse sections are circular sometimes irregular in shape. The columns sub-divide into two to three new columns almost parallel to each other (figure 3). The branching does not widen the diameter of the main column. Columns are very closely-packed and grow densely. The parent columns are always 2 cm thick and the distance between them is not more than 1–3 mm. The laminae are gently convex and the convexity ratio

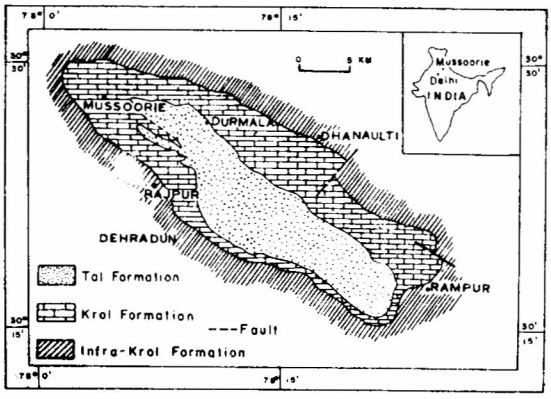

Figure 1. Geological sketch map of Mussoorie syncline showing the location of the Durmala phosphate deposit. (Modified after Rupke and Sharma).

is 0.3. The dark thin layers alternate with light layers and the thickness of the dark laminae is persistent and dark layers are 0.01–0.07 mm thick. Light layers are generally thicker than the dark layers and range in thickness from 0.08 to 0.2 mm. Spongy bands are 1–3 mm thick. The light coloured layers are made up essentially of very fine-grained carbonates and dark layers are phosphatic. The intercolumnar space is occupied by phosphatic grains (collophane) and fine carbonate grains. The simple and complex both arches have been observed and chert is found between the

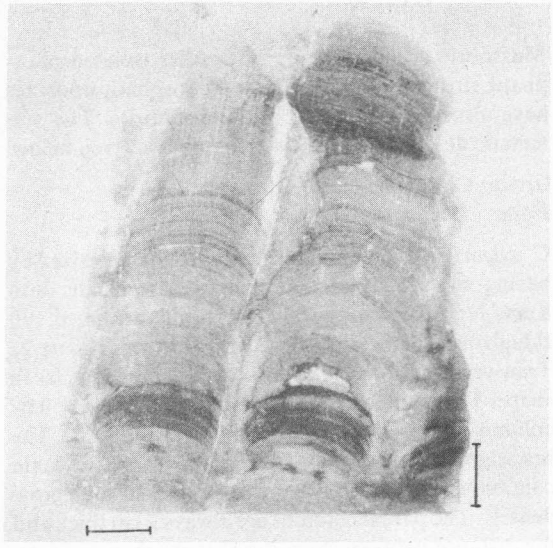

Figure 2. Polished slab of *Collumnaefacta vulgaris*, Sidorov, 1969, showing columns, nature of lamination and lateral surface. Durmala phosphate deposit, scale 1 cm.

arches at places. Thick zonal structures with thinly laminated dark and light layers are found in columns. Wall is even, patchy and single layered formed of dark thin layers.

There are many divergent opinions about the age of the phosphorite bearing Tal Formation *vis-a-vis* Krol belt succession based on fossil records. All these scanty fossil records [14,15] have been questioned and doubt has been cast on identification of fossils and their paleontalogical and biostratigraphic validity[3]. Recently, Tommotian[11] (Lower Cambrian) conodonts have been recorded from the Chert-Phosphorite Member of Lower Tal Formation of Maldeota phosphorite mine. The present author also reports the occurrence of *Conophyton* Maslov from Upper Krol dolomite of Mussoorie area which is a characteristic index fossil of Precambrian (under preparation).

It may be suggested on the basis of the existing fossil records and discovery of *C. vulgaris* that the chert-phosphorite bearing Lower Tal Formation is of Lower Cambrian (Tommotian) age. The underlying Krol belt succession of Krol, Infra-Krol, Blaini etc are pushed below in stratigraphic column and attain Precambrian (Vendian/Yudomian) age. The Krol-Tal contact is placed at Precambrian-Cambrian boundary. A big stratigraphic time gap and sedimentological break

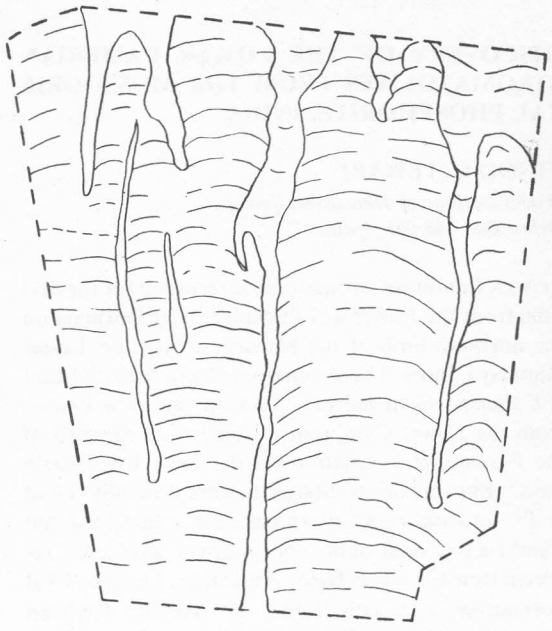

Figure 3. *Collumnaefacta vulgaris* Sidorov, 1969 showing general view of columns and nature of lamination of columns. Durmala phosphate deposit.

(hiatus) between the Lower Tal Chert-Phosphorite and Upper Tal Shell Limestone is already explained by earlier workers[3,4,7]. Hence, the Mussoorie Tal Phosphorite belongs to the Late Proterozoic-Cambrian phosphorogenic province similar to those of China, Vietnam, Iran and Australia.

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PEG. The principle of minimum virus solubility at and near its isoelectric point is used in virus precipitation by acidification. The virus precipitated with acetic acid gave almost typical UV absorption spectrum (figure 1) as compared to potyviruses. The ratio of absorption at 260 nm and 280 nm of 1.29 indicated that the virus contained about 5 % nucleic acids[3]. Flexuous filamentous particles measuring c.730 nm long (figure 2) were observed, a characteristic feature for the members of potyvirus group[4].

Pergularia mosaic virus resembles members of potyvirus group in its shape and length, thermal inactivation point (58°C for 10 min), dilution end point (1:200), and longevity *in vitro* (30 hr at 30–35°C and 23 days at 10–15°C). It resembles a potyvirus of milkweed vine virus in particle morphology and physical properties but the host range of milk weed vine virus is limited to 6 genera in the Asclepiadaceae[5], whereas the present virus has the host range outside the Asclepiadaceae[1]. The present virus was precipitated without losing its infectivity by 4 % PEG + 0.2 M NaCl as of many potyviruses. Hence the present virus is a member of potyvirus group.

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