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DISCOVERY OF ARCHAEOCYATHA IN THE UPPER KROL CARBONATES, MUSSOORIE HILLS, UTTAR PRADESH, INDIA

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ABSTRACT

Well-developed Archaeocyatha-bearing carbonates are recorded for the first time from the uppermost part of Krol sediments (Krol-E), mostly in the form of thin lensoid and flat layers interbedded with algal mat carbonates. The Archaeocyatha occur together with calcareous algae and stromatolite-algal mats making a biogenic rock-building biotope. The group Archaeocyatha is restricted only upto Cambrian, mostly Lower Cambrian, making topmost part of Krol-E to belong to Lower Cambrian age. Consequently, the overlying Tal Formation (excluding Shell Limestone = Nilkanth Formation of Late Cretaceous age) also becomes of Cambrian age.

INTRODUCTION

TRADITIONALLY, the Krol belt is supposed to represent a continuous sequence of Palaeozoic – Mesozoic age, wherein the Krol Formation is assigned a Permo – Carboniferous – Triassic age^{1,2}. However, these sediments though representing deposits of well-oxygenated shallow tidal sea, surprisingly lack metazoan fossils, and Singh³⁻⁵ proposed that Krol Formation represented deposits of Late Precambrian age, while Tal Formation may extend into Cambrian^{6,7}. Lately, the stromatolites of Krol sediments of Nainital hills have been assigned a Late Vendian age⁷. Further, shelly microfossils are recorded by several workers from the Lower Tal phosphorite sediments, but given rather contradictory ages by different workers⁸⁻¹². Bhatt *et al*¹³ discuss the age significance of these shelly microfossils of mostly phosphate, and consider them to be of Tommotian age (Lower Cambrian, Trilobite lacking basal part). However, many workers still adhere to the traditional presumed Mesozoic age of Krol – Tal succession¹⁴.

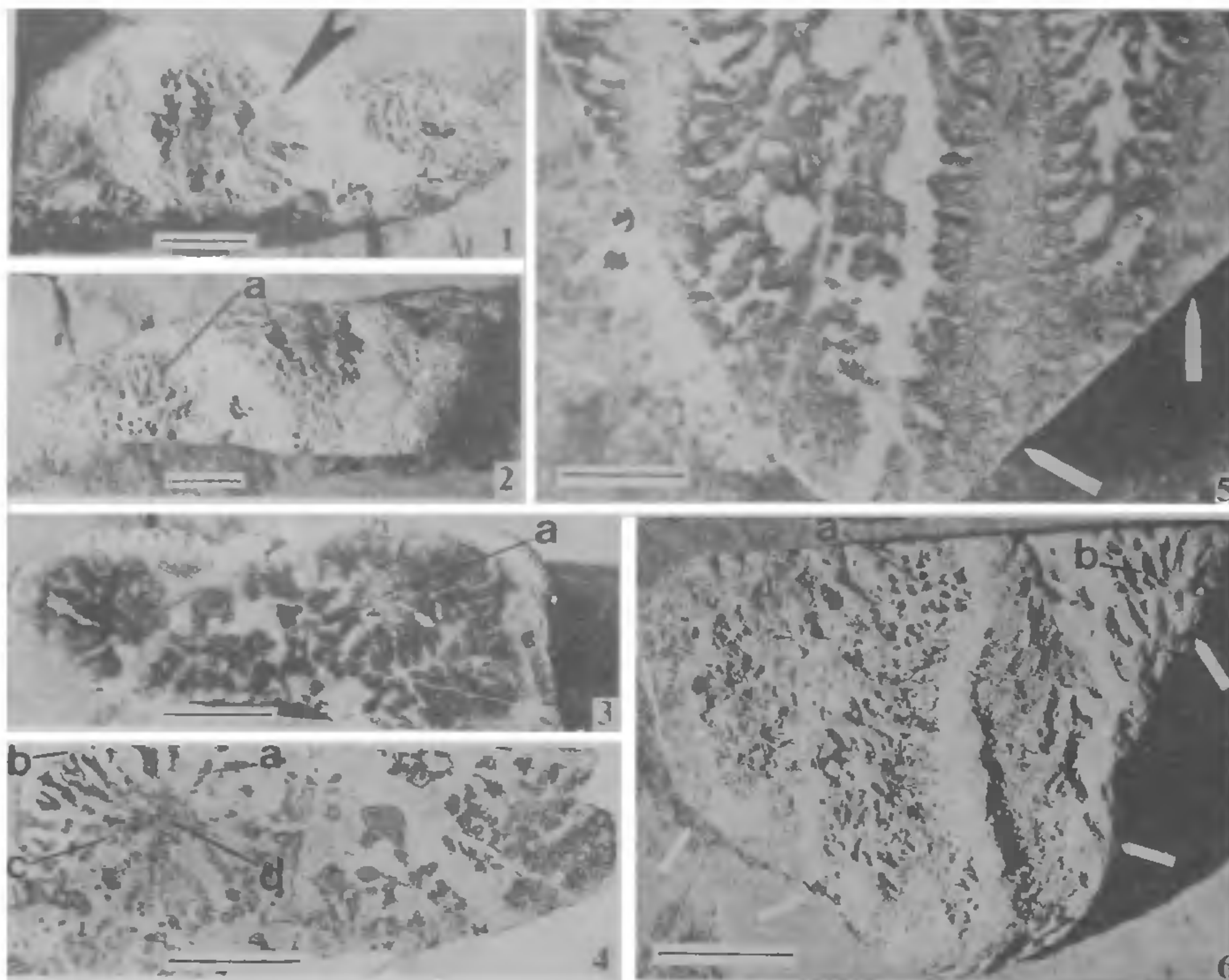
Area

The Archaeocyatha-bearing bands are present in the topmost *ca* 10 m of carbonates just below the Chert Member of Tal Formation in the surface outcrop of Krol sediments near Maldeota phosphorite mine of P P C L, Dehradun (figures 7, 8).

Archaeocyatha of Krol Carbonate

The individual skeleton of Archaeocyatha, the cup is fundamentally an inverted cone, mostly having two fairly widely spaced walls and a central cavity. The walls are perforate and are connected across the inner space (intervallum) by perforate radial longitudinal plates (septa), by radial rods, by perforate transverse plates (tabulae) or dissepiments¹⁵.

Several samples from the bands, containing the Archaeocyatha were sliced and cut at various angles to reconstruct its morphology. In transverse section, the cups show semicircular outline exhibiting a broad intervallum transversed by several perforated septa



Figures 1–6. 1. Surface view of an *Archaeocyatha* cup showing semicircular outline (arrow) and septa arrangement in transverse position in a weathered sample. Another cup is partly visible on the right hand side of the photograph. Diameter of the cup = 1.8 cm., Length of bar = 1 cm. The sample is from Upper Krol sediments of Mussoorie hills. 2. Same sample as in figure 1, slightly inclined in photograph showing radial arrangement of septa and the porous nature of outer wall (a). The pores are about 1 mm in size. Length of bar = 1 cm. 3. Polished transverse section of the sample showing one complete cup in the right hand side. Diameter of the cup = 1.6 cm., Thickness of intervallum = 6 mm., Central cavity = 5 mm. Both inner and outer walls are highly porous (indicated by discontinuous walls). The central cavity is filled with fine dissepiments (a). Length of bar = 1 cm. 4. Photograph of the acetate peel of the *Archaeocyatha* sample. In the left hand side one cup is visible in transverse section. The porous nature of septa is clearly visible (a). The outer (b) and inner walls (c) are also porous, while central cavity is filled with dissepiments (d). Diameter of the cup = 1.7 cm., Length of the bar = 1 cm. 5. Polished slab of *Archaeocyatha* showing cups in longitudinal section. Central cavities of three cups are seen (marked by arrows). The central cavities are filled with fine dissepiments. The *Archaeocyatha* cup of the left hand side shows very clearly the porous nature of inner wall and arrangement of septa. Height of the slab = 3.7 cm., Length of the bar = 1 cm. 6. Weathered surface of the *Archaeocyatha* samples showing pores of the outer walls (a) and radial septa (b). Four cups are present (marked by arrows). Height of the slab = 3.7 cm. Length of the bar = 1 cm.



Figure 7. Photograph of the fossil-yielding rock unit (marked by arrow).

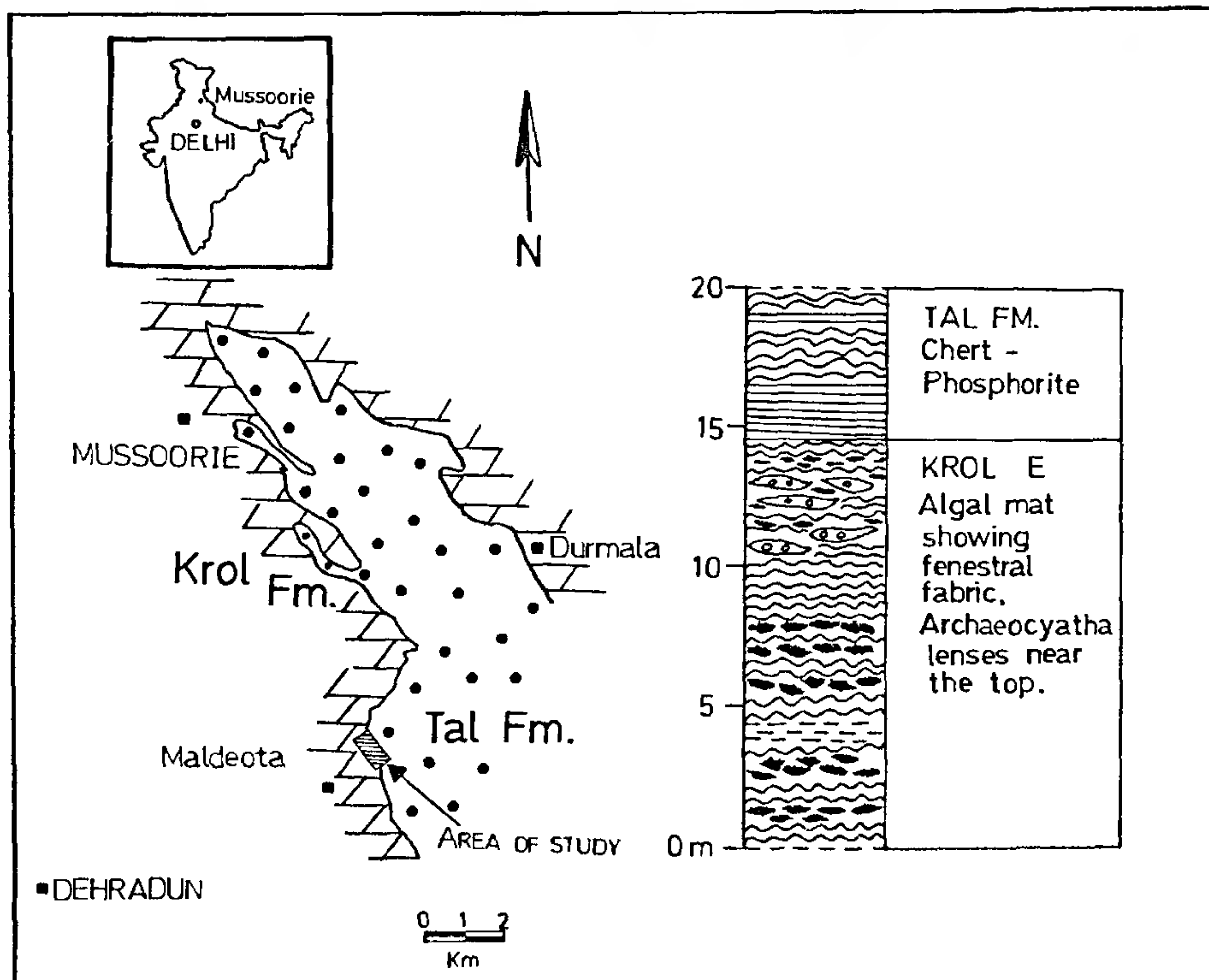


Figure 8. Location map of the area with the litholog of rock units.

(figures 1, 3, 4). The outer wall is highly perforated with large pores; the inner wall is also perforated showing smaller pores. The central cavity is rather narrow, filled with dissepiments (figures 3–5). On the weathered surfaces septa are prominently seen (figure 1), the highly perforated outer wall exhibits prominent pores (figures 2, 6). In longitudinal section the highly perforated nature of inner wall is visible (figure 5). The diameter of individual cups is ca 1–2 cm and about 4–5 cm in length. These general characters of Archaeocyatha from Krol sediments are typical of suborder – Ajacicyathina, superfamily – Ajacicyathacea, family – Ajacicyathidae. Many of the cups show resemblance with genus *Ajacicyathus*, which is restricted to Lower Cambrian (Lower Tommotian – Botomian)^{15, 16}.

There are also other types of Archaeocyatha cups, for example, cups showing narrow intervallum and broad central cavity etc. The Archaeocyatha bearing bands are closely associated and grown together with stromatolites, algal mats and calcareous algae. The present find of Archaeocyatha is the first record from the Himalaya.

DISCUSSION

The Archaeocyatha are a very shortlived animal group that inhabited carbonate shelf of Early Cambrian and Early Middle Cambrian seas¹⁵. They were one of the first organisms to develop mineral skeleton using calcium carbonate. The systematic position of this group has been very controversial ranging from Protista to Porifera and coelentrata; but now they are assigned an independent status as Phylum – Archaeocyatha^{15, 17, 18}.

The record of Archaeocyatha in Upper Krol carbonates show that topmost part of Krol is of Cambrian age. As Archaeocyatha are rock-builders, there is no question of their contamination in the laboratory or reworking or derivation from pre-existing rocks during deposition. There is need for a detailed study of Krol – Tal succession to delineate the Precambrian – Cambrian boundary, which may lie in the topmost part of Krol.

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