

**Figure 1.** Zircons from the granitoids of the Palampur area showing twinning (a-e) and parallel growths (f-j). a, b, Geniculate type of twinning along a pyramidal face, c-e, Less regular twinned zircons where two crystals have joined along a pyramidal face, f-h, Parallel composite zircons joined along the prismatic face, i, Two parallel grown zircons along C-axis having a common base, j, Irregular and inclined composition plane joining two individual zircons. Both the crystals show different type of inclusions.

parallel growths in zircons is somewhat puzzling. It is of interest to speculate on the conspicuous rarity of such zircons. Zr is an incompatible element as it is not incorporated into the crystal lattice of other minerals, and forms a separate mineral phase—zircon; the availability of Zr in a magma is also limited. Consequently, the nucleation points for crystallization of zircon are also few and far apart, and, therefore, it

would be difficult for magmatic turbulence to bring the growing crystals together in a granite magma, considering zircon as one of the earliest crystallized minerals. If by any chance, nucleation is relatively very close and the magmatic turbulence is quite strong to drift such growing crystals in parallel position, they would result in parallel growth features or the zircons may rotate in such a position that the faces having least interfacial energy would come in contact with each other and result in synneusis<sup>10</sup>. Nevertheless, these processes are episodic in nature because initially formed zircons may act as nuclei for the growth of other rock-forming minerals.

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## Small shelly fossils of Precambrian–Cambrian boundary beds from the Krol–Tal succession in the Nainital Syncline, Lesser Himalaya

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Small shelly fossils (ssf), including *Coleoloides typicalis* Walcott, *Olivoides multisulcatus* Qian, ?*Hyolithellus* sp. and ?*Turcutheca* sp., were recovered from a 150-m-thick phosphate-bearing section in the Krol Belt succession of Nainital Syncline. The stratigraphic situation of the ssf-yielding interval matches well with that obtaining in the oldest ssf-yielding intervals, represented by the Chert-Phosphorite Member of the Tal Formation, in the Mussoorie and Garhwal Synclines.

THE small shelly fossils include a variety of shell morphologies, usually of microscopic dimensions,

comprising of gastropods, inarticulate brachiopods, hyolithelmenthids, annelids, poriferiids, protoconodonts and a host of problematica. Their potential for the delineation of Precambrian/Cambrian transition beds that manifest a global phosphate event and the definition of a pre-trilobitic Cambrian system has been established in recent years<sup>1-5</sup>.

In the context of the Himalayan sequence, the long vexed problem of chronostratigraphy of the Krol-Tal sequence of Lesser Himalaya has now found an acceptable solution<sup>6,7</sup>, based initially on the recognition of small shelly fossils in the basal Tal sequence in the Mussoorie Syncline<sup>8,9</sup>. Here we report the presence of small shelly fossils in the relatively less studied, southeastern extremity of the Krol Belt sequence, exposed in the Nainital Syncline.

The litho-column measured and investigated for the microfauna is located 7 km from Nainital on the Nainital-Kaladhungi road, near the village Chorkhet (29° 23' N: 79° 26' E), and forms cliff section in the road-cut (Figure 1). In this clearly exposed and easily accessible section, the massive bedded dolomites of Upper Krol (Krol E of Fuchs and Sinha<sup>10</sup> = Sherwood Member of Valdiya<sup>11</sup>) are observed to be gradationally and conformably overlain by a sequence of pyriteferous dark grey to black shale/slate and dolomite interbeds (Krol F of Fuchs and Sinha<sup>10</sup> = Giwalikhet Member of

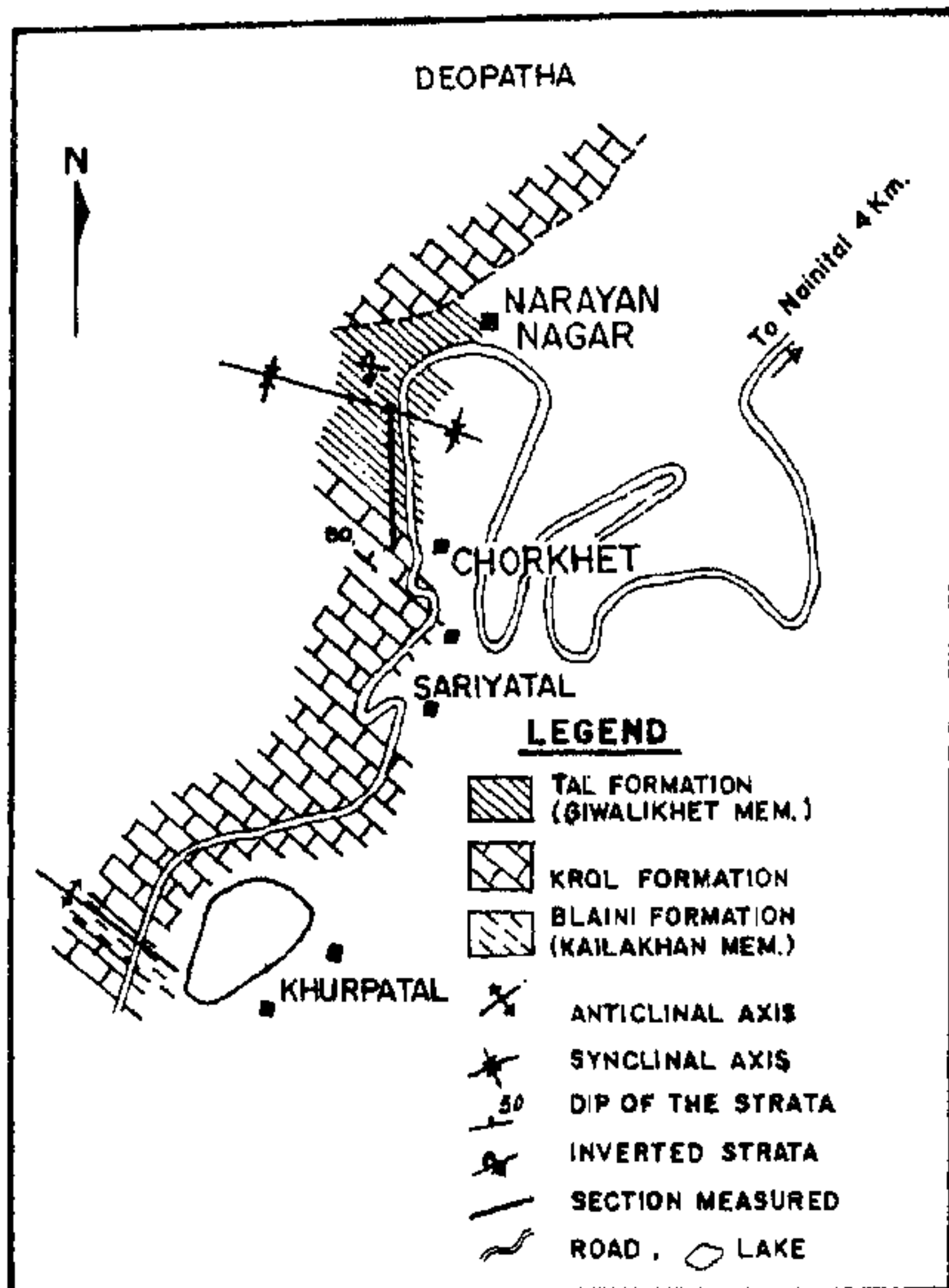


Figure 1. Geological map and section-line of the measured section, Nainital Syncline.

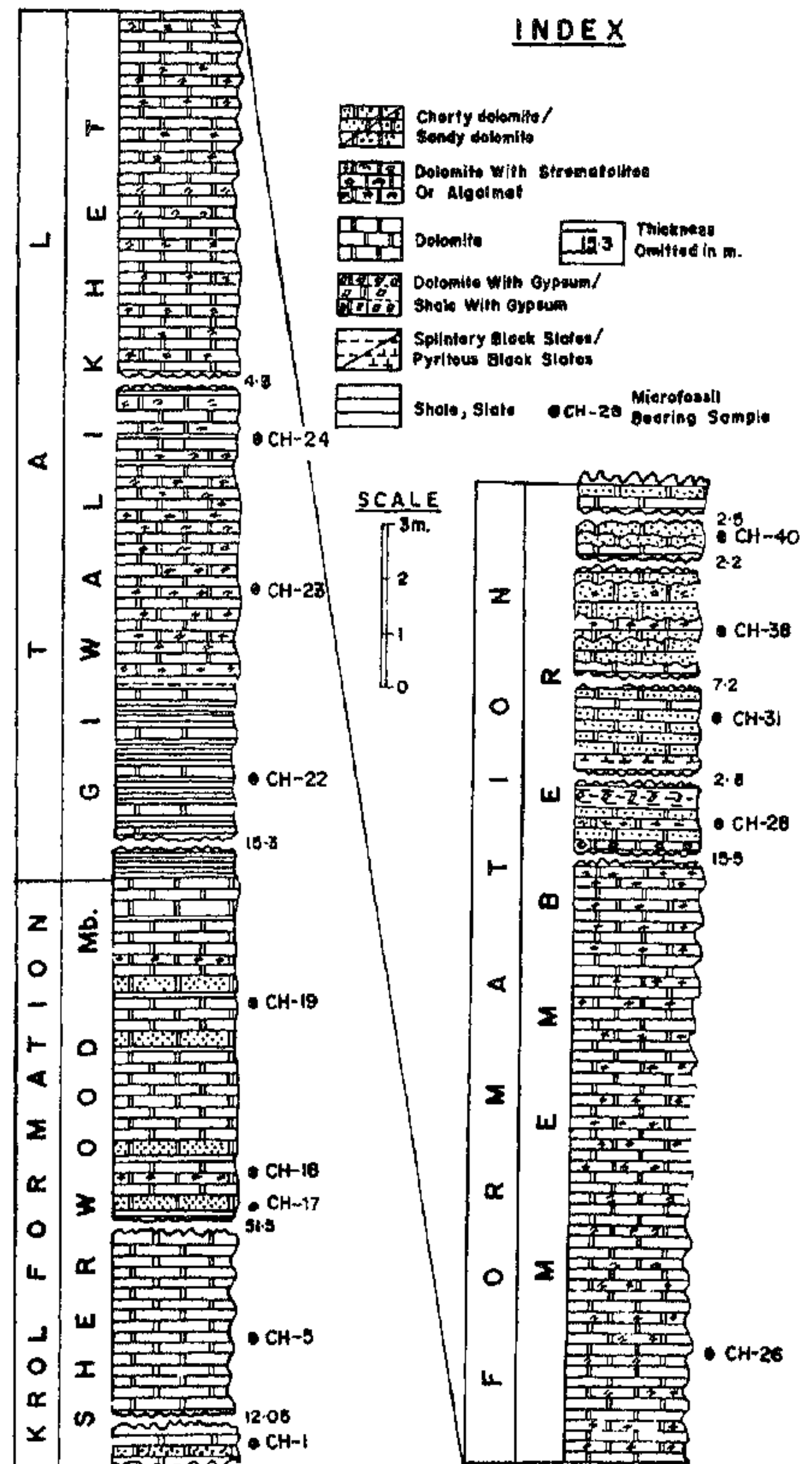


Figure 2. Details of the stratigraphic column measured and microfaunally investigated in the Nainital Syncline, exposed along the Nainital-Kaladhungi road, near Chorkhet.

Tal Formation of Valdiya<sup>11</sup>; Figure 2). The Krol-Tal transition sequence in the Nainital Syncline is phosphate bearing<sup>12-14</sup> and contains a profusion of algal mat-bearing dolomites and occasional layers of laterally linked hemisphaeroidal stromatolites. There is a definite shift in facies at the end of Sherwood Member (of Krol Formation); however there does not appear to be any recognizable sedimentational break with the overlying Giwalikhet Member (of Tal Formation).

A total of 150 m thick section is reported in this study, of which the lower 77 m includes the top part of the Sherwood Member and the rest 73 m falls in the overlying Giwalikhet Member. Nineteen samples from the Sherwood Member and 24 samples from the Giwalikhet Member were examined microscopically after preparation with the usual acetic acid treatment.