Only the fossil-yielding samples are marked in the figure (Figure 2).

Small shelly fossils are noticed throughout the section. Only phosphatic dolomite horizons were examined for microfaunal yield at the first instance, for it is well-established globally that in addition to the bedded phosphates like in China, the small shelly fossils have good facies association with phosphatic limestone/dolomite in the terminal Proterozoic and basal Phanerozoic sequences. The small shelly fossil yield from the Nainital System includes Coleooides typicus Walcott, Olivooides multisulcatus Qian, ?Hyolithelus

![Diagram](image)

Figure 3. a, *Turcosysa* sp., PRF/5994B; b, *Hyolithes* sp., PRF/5982; c and e, Stenkeri fragments of suspected tubular or conoidal shelled organisms, PRF/5994C & PRF/5994D, d, Olivooides multisulcatus Qian, PRF/5994A; f and g, Coleooides typicus Walcott, PRF/5978 & PRF/6017; bar scale represents 0.1 mm; catalogue numbers pertain to the repository of the Palaeontology Division, Northern Region, Geological Survey of India.
sp., and ?Turcutheca sp. All these forms are essentially taxonomically still uncertain and represent tubular or conoidal shelly animals, except for Olinoooides, which is globular in shape (Figure 3d). Coleoloides typicalis is the most persistent fossil element present throughout the section and starts appearing from the oldest sample, viz. CH-1, continuing until the last sample, viz. CH-40. Many of the C. typicalis specimens are curved or sinusoidal (Figures 3f,g) and are invariably diagenetically limonitized, representing internal moulds. The remaining taxa in the assemblage are represented by single specimens, viz. Olinoooides multisulcatus Qian (CH-17), ?Hyolithellus sp. (CH-5) and ?Turcutheca sp. (CH-17).

The frequency of occurrence of the microfossils is 1 or 2 specimens per 1000 g of fossiliferous sample. The shell wall is present only in case of Olinoooides multisulcatus and ?Turcutheca sp. It is characteristically smooth in case of the former. In ?Turcutheca sp. the surface ultrastructure appears to be considerably modified due to diagenetic overgrowth. Nevertheless, the oval cross-section of the shell (somewhat compressed in the present case; Figure 3a) is being taken to denote an important generic character of Turcutheca Missarshkevsky, although the elements of Turcutheca elsewhere in the Lesser Himalaya, viz. the Chert-Phosphorite Member of Tal Formation, has been assigned the time-frame represented by Zone I of the Meishucunian Stage, based on a close similarity of the small shelly fossil assemblage with the Meishucunian type section in South China. Coleoloides typicalis Walcott and Olinoooides multisulcatus Qian form major constituents of the microfaunal yield of the Chert-Phosphorite Member (of Tal Formation) in the Mussoorie Syncline.

The widespread phosphorite horizon overlying the Krol Formation in the Mussoorie Syncline, i.e. the Chert-Phosphorite Member of Tal Formation, has been assigned the time-frame represented by Zone I of the Meishucunian Stage, based on a close similarity of the small shelly fossil assemblage with the Meishucunian type section in South China. Coleoloides typicalis Walcott and Olinoooides multisulcatus Qian form major constituents of the microfaunal yield of the Chert-Phosphorite Member (of Tal Formation) in the Mussoorie Syncline.

Judging from the stratigraphical succession, correlation of the phosphate event and the common yield of the small shelly fossil elements Coleoloiid's typicalis Walcott and Olinoooides multisulcatus Qian, we tentatively infer that the stratigraphical interval defined by the topmost 77 m of the Sherwood Member of Krol Formation and the basal 73 m of the succeeding Givalikhet Member of Tal Formation in the Nainital Syncline represents the same time span as the Chert-Phosphorite Member of Tal Formation in the Mussoorie and Garhwal Synclines.

The strata delineating the Meishucunian Zone I

![Diagram](image)

Figure 4. Tentative chrono-correlation of the Nainital sequence (Krol–Tal) with those of the Mussoorie and the Garhwal Synclines.
RESEARCH COMMUNICATIONS

(\*earliest Tommotian Stage\*) are present in the Nainital Syncline. (According to the tentative decision arrived at in the meeting of Precordian-Cambrian Working Group (IGUS: IGC2 29) in January 1984, Zone I of the Meishucuann Stage is to be taken as the youngest fossil zone of the Late Proterozoic and the Precordian/Cambrian boundary is, for the present, to be marked at the contact of Zones I and II of the Meishucuann Stage.)

The strata chronosтратigraphically equivalent to the Tal Formation are present in the Nainital Syncline.

The small shell fossils start appearing already in the phosphatic dolomites of the uppermost Krol in the Nainital Syncline; similar small shell microfossil assemblage in the Mussoorie Syncline is restricted to the Chert-Phosphorite Member of Tal Formation. This shows a time-transgressive nature of the Krol-Tal contact (Figure 4). (The reported small shell fossil yielding Krol D' horizon of Durnala area, in Mussoorie Syncline, has recently been reassessed as belonging to the Chert-Phosphorite Member of Tal Formation.)

The widespread prevalence of Coledolidae typica Walcott in the Mussoorie and Nainital Synclines of the Lesser Himalaya and its presence also in the sequence of Higher Himalaya in Kashmir, indicates the possibility of the zonal significance of this fossil element in the Late Proterozoic/Early Cambrian strata records of the Himalayan region.

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Biostatigraphic significance of bioeroded gastropod shells from the coastal region of Pondicherry

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Turritella specimens collected from Pondicherry coastal area show strong evidence of bioerosion (caused by polychaeta activity) and abrasion/attrition ( imparted in the high-energy surf zone). The bioerosion may have had a two-fold effect: (i) constructive—the soft-bodied polychaeta are recorded as potential trace fossil on Turritella shells (potential body fossil) with better chance of preservation, and (ii) destructive—Turritella shells become secondarily fragile in high-energy biostatigraphic environments.

**SPECIMENS of Turritella** were collected during a geological study along the coastal region of the Bay of Bengal immediately south of Pondicherry (11°55'30"N, 79°30'0"E). The present study concerns shell damage marks superimposed on the primary morphology of these specimens. The preliminary study was based on random collections. Subsequent collection of 72 Turritella specimens substantiate the present observation. The specimens are preserved in the Geology Department of Durgapur Government College.

The major shell damage marks observed may be broadly classified as scour marks and pit marks. Scour marks (Figures 1a, b) are essentially narrow elongated tunnel-like features showing variable depth of scouring of shell material. The size of scour marks varies widely; the larger marks being more prominent than the smaller ones. Both large and small scour marks are disposed at varying angles with respect to the spiral ornamental features. They occur more prominently on the external shell surface than on the internal surface (Figure 1a). Most scour marks are strikingly shallow at one end and deep at the other. Pit marks are relatively large, circular to subelliptical cavities with irregular peripheral margins, distributed either along sutures or on the whorl surfaces (Figure 1b). Both scour and pit marks are frequently present on a single specimen. They are also generally found distributed on the side with aperture opening. Apart from scour and pit marks, some shells show small circular to subcircular borings on their external surface (Figure 1c).
and/or tunnelling secondarily increases shell fragility. Physical stress may then operate on such fragile shells causing their total destruction. Thus potential trace fossil (of polychaeta), body fossil (of Turritella) and their respective moulds and casts may or may not be represented in the palaeontological world depending upon the degree of epibiotic activity with other conditions of preservation remaining the same. Moreover, intense epibiotic activity as described above is likely to obliterate important biocharacters, rendering the specimens taxonomically less useful.


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![Figure 1](image)

Figure 1. a. *Turritella* specimen with dominant scour marks on internal (X) and external (Y) surface and few pit marks (P). b. Pit marks (P) dominantly present on *Turritella* specimen along with few scour marks on external surface (Y). c. Borings (B) on external surface of *Turritella* specimen.

The above features seem to reflect definite biostratigraphic imprints (epibiotic activities and intense physical stress) on *Turritella* specimens.

Detailed study revealed that the morphology of the scour and boring marks observed on *Turritella* shells is comparable to the illustrations by other authors. Comparative study showed that the scour and boring marks on *Turritella* shells are caused by annelid (Polychaeta) activity. The scour and boring marks are thus evidence of borer erosion. This is the first report of borer erosion from the coastal region of Pondicherry. Polychaeta activity described above is generally considered to serve the primary objective of providing protective domicile to the worms. Knowledge of the detailed process of polychaeta boring/tunnelling is still lacking. However, the prevailing opinion shows that both mechanical (use of parapodia, jaws and setae) and chemical (secreted acidic substance) means are suitable for boring/tunnelling.

Pit marks are believed to develop on the shell surface owing to the action of intense physical stress (attrition and abrasion) in the high energy marine realm (above the normal wave base, especially in the surf zone). A similar hypothesis was given by others to explain the mode of development of features similar to the pit marks.

The potential for preservation of soft-bodied polychaeta is very low. However, the possibility of recording such organisms in the palaeontological world is greatly enhanced by some of their ethological traces left behind particularly on hard substratum, though intense boring.
with 1 ml syringe used as sample holder. The blood contained in this is well mixed by a magnetic stirrer. To avoid the entrance effect the entry length of the tube is kept 20 cm throughout the experiment. For observation and photographic purpose the capillary was placed on the stage of an optical microscope (Hertel and Reuss, W. Germany) and photographed. At the other end of the capillary, the flow is monitored by a pair of optocouplers, connected to a 8085-based microprocessor. The flow was maintained constant for samples of different haematocrits (Figure 1).

The fully developed flow at velocity 2.0 cm/s was photographed with an Agfa Gaevert film of ASA 80. Its densitometer scan was directly fed to a IBM PC-AT through an A/D convertor. An average of three such scans obtained on the same frame of film at different locations was employed as one projection. Due to the symmetric nature of flow 60 such projections were generated and processed to obtain the tomogram of the cell distribution in the tube. By the same procedure the projections of the plasma and of blood at various haematocrits were generated.

From these projections, the cross-section of the image $f(x,y)$ was obtained by a filtered back-projection technique given by

$$f(x,y) = \int_0^\pi Q(\theta, X \cos \theta + Y \sin \theta) \, d\theta$$

where, $\theta$ is the angle subtended by a straight line with x-axis and $Q(-, -)$, the filtered projection obtained from measured projection.

The reconstructed object function was in the form of a two-dimensional array of numbers. This was converted by assigning grey levels from 0 to 255. For printing the original 256 grey level image was scaled down to 32 levels and a $128 \times 128$ image was printed on a dot matrix printer.

Fresh blood samples were obtained in plastic syringes containing acid citrate dextrose (10:1.3) as an anticoagulant and centrifuged at 3000 rpm for 15 min. Thereafter the bulky coat was removed and discarded, and the plasma separated. The plasma and cells were mixed in various proportions to obtain samples of different haematocrits.

Figure 2 shows the tomogram and cell population across the diameter of the tube with plasma. As there are no cells, a uniform intensity over its diameter is observed.

Figure 3 shows the distribution of erythrocytes over the cross-section of the tube at haematocrit 10%. At the edges the cell population is less, which increases towards the centre. The maximum value is obtained at the centre. A similar pattern at haematocrit 20% was also observed. With the increase of haematocrit, the cell population at the axis, compared to other regions, decreases. Figure 4 shows the erythrocyte distribution

![Schematic diagram of the experimental arrangement.](Image)

![Axial and cross-sectional views of the capillary with plasma along with grey scale. The cell population does not show any change due to absence of cells.](Image)