

The end phase of sedimentation of Krol Belt succession in Nainital syncline – Stratigraphic analysis and fossil levels

D. K. Bhatt

Lithofacies considerations coupled with fossil evidences suggest a rational argument for presence of the strata of Tal Formation in Nainital area, though considerably reduced in thickness. A critical appraisal shows that the data on lithological configuration on basinal scale put forth by some to negate the above contention is insufficient. The report of 'Ediacaran Fossils' from Nainital is shown not to fulfil basic palaeontological requirements to make it acceptable.

ABOUT 150 m thick siliciclastic strata, overlying the thickly bedded calcareous sequence (phosphatic dolomite) of Krol E (Sherwood Member)¹ forming the topmost lithounit in the core of Nainital syncline, are considered by some¹ to form a part of Tal sequence.

In the northwestwardly located synclines of Krol Belt (e.g. Garhwal syncline, Mussoorie syncline, Korgai syncline and Nigalidhar syncline), where thicker sequences of Tal Formation are developed, the Tal sedimentary event basically characterizes a change-over from an overwhelmingly carbonate lithofacies of Krol Formation to siliciclastic lithofacies of Tal Formation – a change that is also observed in the Nainital syncline. It is significant to note that the sequence from Blaini Formation to Krol Formation, developed in Nainital syncline, is closely comparable to those in Garhwal and Mussoorie synclines, both in terms of thickness and lithofacies. However, the Tal Formation that marks the end phase of sedimentation of Krol Belt succession, appears to lose this remarkable uniformity of facies that is observed in the underlying sequence. It is probably related to the location of Nainital syncline in the marginal part of Blaini–Krol–Tal basin and the thinly developed Tal strata there may represent product of quick regressive phase of the Krol sea. In Garhwal and Mussoorie synclines, where the Tal sedimentation was prolonged, the thickness and lithofacies of stratigraphic units have greatly differing parameters. It emanates from this that the Tal strata developed in Nainital cannot be related in pattern of sedimentation and, therefore, in lithofacies to any of the defined stratigraphic units of Tal Formation in Garhwal and Mussoorie synclines and, as a consequence, require unique stratigraphic definition and terminology,

e.g. Giwalikhet and Narain Nagar Members of Tal Formation¹.

A recent record of new fossil data from the contact zone of Sherwood Member (of Krol Formation) and Giwalikhet Member (of Tal Formation) in Nainital syncline² amply supports the possibility of the presence of Tal sequence in the Nainital area, in the chronostratigraphic terms as well. The presence of small shelly fossil (ssf) *Coleoloides typicalis* Walcott throughout the upper part of Sherwood Member and the Giwalikhet Member is significant inasmuch as this fossil, originally described from Lower Cambrian of Newfoundland, also forms an appreciable proportion of the ssf-yield of Chert-Phosphorite Member (of Tal Formation) in Mussoorie syncline, where it was described as *Coleoloides ? sp.*³. However, later studies reveal that this cylindrical microfossil element of various dimensions typically occurs fossilized as limonitized *steinkerns*, with minute, but well-etched, longitudinal furrows and ridges on the surface and likewise is known globally from several sections. All these characters are very well observed in specimens from Krol–Tal strata. Numerous illustrations of *Coleoloides typicalis* Walcott from Krol–Tal strata are available in the literature (see Pl. II, 1–7, 11–13 and 17 in ref. 3) and (Figures 3f and g in ref. 2). Reference of *Coleoloides typicalis* Walcott² earlier as *Coleoloides ? sp.*³ may have created scepticism^{4,5} about the validity of the identification. However, the ssf described earlier as *Coleoloides ? sp.*³ is now considered as *Coleoloides typicalis* Walcott².

A fair abundance of *C. typicalis* Walcott along with record of *Olivoides multisulcatus* Qian and other shelled forms (the last, fragmentary though) in Sherwood Member (Krol Formation) and *C. typicalis* Walcott in Giwalikhet Member (Tal Formation) favours correlation of the ssf-

bearing horizon of the Nainital syncline with the Chert–Phosphorite Member (Tal Formation) of the Mussoorie syncline. *O. multisulcatus* Qian forms a fairly abundant constituent of ssf of Chert–Phosphorite Member in Mussoorie syncline, described earlier as *Olivoides sp.*³. The specimen from the Nainital material (Figure 3d in ref. 2) closely resembles the illustrated specimens from Mussoorie (Pl. III, 1–3 in ref. 3).

Therefore, both in terms of lithofacies¹ and chronostratigraphy², the presence of Tal sequence in the Nainital syncline appears to be a valid proposition.

The commonality of phosphate event, which is considered a time-specific geoevent at this level in global perspective in respect of ssf-bearing horizons in Mussoorie⁶ (then considered as younger Phanerozoic) and Nainital^{7–9}, supports fossil-based correlation. Less differentiated microfaunal record from Nainital in comparison to Mussoorie may be related to: (i) lack of as thorough a search in the Nainital syncline as in the Mussoorie syncline and, (ii) differing lithofacies of microfossil-yielding horizons in the two areas (phosphate rock in Mussoorie and phosphatic dolomite in Nainital) having differing potential for the preservation of ssf.

It may be significant to highlight that the present ssf-based correlation indicates chronostratigraphic equivalence of at least the topmost 75–80 m of Sherwood Member at the top of Krol Formation in Nainital syncline to Chert–Phosphorite Member (of basal Tal Formation) in Mussoorie syncline, pointing to the time-transgressive nature of the Krol–Tal contact across the Krol Belt (see Figure 4 in ref. 2). This indicates persistence of carbonate sedimentation (within the stratigraphic framework of Krol Formation) for a longer period in the Nainital

area than in the Mussoorie area. It is, however, to be remembered that, according to thickness and lithofacies data, there is overwhelming indication of a considerable shift in the loci of sedimentation of Krol and Tal formations, resulting in appreciable modification in geographical and geometrical attributes of the basin at the change-over from the Krol sedimentary episode to the Tal sedimentary episode. Similar inferences have already been drawn also on the basis of lithofacies considerations¹.

An attempt has been made to trace the extent of litho-stratigraphic horizons in the Krol-Tal basin with the help of isopach maps⁵, which indicated the absence of Tal strata in the Nainital syncline⁵. This aspect of stratigraphic analysis was originally attempted for a single stratigraphic unit (which had economic potential) in a limited part of the Krol-Tal basin (Chert-Phosphorite Member or Chert Member in Mussoorie and Korgai synclines)¹⁰. Moreover, Krol Belt succession was then considered as a part of the Phanerozoic set-up in the Lesser Himalaya¹⁰. In the present revised time-frame of the Krol-Tal succession in Late Proterozoic-Early Cambrian, the extent of the lithostratigraphic units regionally in the basin may be of limited value for the purpose of correlation. For in the considerably enlarged time-frame of the Krol-Tal basin now, the probability of lateral facies variations will be enhanced for the co-eval strata to show differing lithological set-up across the basin. Another factor that would render the above approach redundant is the tectonic history of Krol-Tal basin. Forming the frontal part of Himalayan orogen, the Krol Belt has undergone repeated tectonic mobility in the geologically recent past¹¹—a process that may still be on. This resulted, in addition to large-scale over-thrusting of the whole belt, in massive disruption of stratigraphic fabric. Isopach maps in such geological terrains obviously cannot be utilized with precision for drawing specific and refined stratigraphical inferences even in the case of smaller Phanerozoic basins.

Report of 'Ediacaran' soft body animal fossils from Nainital syncline

The Ediacaran fauna comprising mega-fossil impressions of well-developed

marine animal community characterized by the absence of hard parts in its members is restricted in occurrence to the Ediacaran time interval¹². The Ediacaran time interval, defined by the 'Ediacaran Stage', is restricted in global stratigraphy to the period prior to the proliferation of animals with hard parts on the globe. Although the soft-bodied animal fossils in the stratigraphical record persist as remains of some straggling forms even after the proliferation of shelled metazoa, the unique assemblage of Ediacaran fauna precedes the advent of shelled fossils or small shelly fossils of Tommotian or Meishucunian age in the stratigraphical column and thus the Ediacaran fauna and the Meishucunian shelly fauna are mutually exclusive in time and space. In this context the suggestion by some¹³ (p. 121) that the Ediacaran soft-bodied fauna and the Meishucunian shelly fauna can co-exist seems to be untenable.

As a sequel to the above, the report of Ediacaran soft body animal fossils from siliciclastic strata (of Narain Nagar Member, Tal Formation)¹ in the topmost part of Nainital section^{14,15} is inexplicable, reported as they are at least some 150 m above the oldest record of small shelly fossil elements that characterize Meishucunian Zone I strata elsewhere in the Krol Belt, i.e. Mussoorie syncline². It is, therefore, not surprising that 'Ediacaran fossil' reports fell under controversy immediately after they were published¹⁶⁻¹⁸.

The workers¹⁶⁻²⁰, who do not believe in the occurrence of Ediacaran fossils in the strata at Nainital, are unanimous in their opinion that the supposed fossil impressions are non-biogenic structures and are related to tectono-sedimentary processes. Azmi and Tewari²⁰ have dealt on this aspect in detail.

A later report⁵ records 'additional Ediacaran fossils' from Nainital. A few of the accompanying illustrations again lack clarity of fossil outline and the others do not exhibit morphological details sufficiently to make it acceptable as part of a first fossil report from an area. Describing the 'fossil'-yielding bedding surface, the authors⁵ state (p. 28) that 'Superimposed on sedimentary features are signatures of post-depositional deformation. These incorporate records of additional Ediacaran fossils.' Commenting on their specimens of *Pteridinium* and *Charniodiscus*, two of the most prolific 'frond-like forms' in their collection, the authors⁵

state (p. 34) 'The non-availability of well-preserved complete form so far could be due to the intense deformation of the area.' Under these stated conditions of preservation of fossils, where not a single 'well-preserved complete form' is available for morphological studies, imparting precise systematics to a new and first record goes against accepted practice in palaeontology, drawing from it also, at the same time, serious and significant conclusion, viz. presence of Ediacaran fossil horizon. The authors⁵ further state (p. 36) that 'we may mention that many frond-like features which do not show morphological consistency and bilateral symmetry cannot be grouped conclusively with the forms described by us'. This creates a situation wherein one may have to pick and choose 'Ediacaran fossils' from amongst a variety of near-identical bed-surface structures present, depending upon one's perception of 'bilateral symmetry' and 'morphological consistency'. Obviously, in a marginal case the validity of a 'fossil' may be upheld by one and negated by other, leading to subjective approach to fossil identification, which is conceptually not tenable. This situation is illustrated by the reply of the authors¹³ (p. 121) to the comment¹⁸ (p. 119) on their earliest report¹⁴, wherein they state 'we had an opportunity to examine the collection of Bhatt and Mathur, A. K., made subsequent to the publication of our paper. We fully agree that their collection contains only sedimentary structures and are entirely different from those described by us.' Thus, fossil-like structures for one become 'only sedimentary structures' for the other.

The burden, therefore, still lies on the authors^{5,14,15} to record convincing fossil material from Nainital. Until then labelling some of the bedding surface structures subjectively as impressions of soft body animal fossils, that too with an Ediacaran time-tag, remains highly hypothetical.

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D. K. Bhatt is in the Geological Survey of India, 15-16, Jhalana Dungari, Jaipur 302 004, India.

OPINION

Molecular marker-based conservation – An appraisal

P. Balakrishna

In the last two decades, researchers and planners have demonstrated the essential link between biodiversity and future food security. This is evidenced by the sudden increase of growth in the number of genetic resource conservation programmes all over the world from about 10 in 1972 to over 100 in 1992. Many of these programmes aim at looking into variations that occur within germplasm, based on mostly biochemical (isozymes), molecular (Restriction Fragment Length Polymorphisms, RFLPs; Random Amplified Polymorphic DNAs, RAPDs) and other data. The application of these techniques in conservation is the best spoken topic of the day. Unfortunately there has been very little attention paid to answer the question of how the variations are to be used and what kind of studies in evaluating the variations are relevant.

Generally, almost all germplasm conservation programmes aim at documenting variability both at inter and intra-specific levels. Data is gathered for as many accessions as possible and relationship patterns (dendrograms) will be constructed based on different statistical packages. Definitely we would expect variability and sensitive techniques like RAPDs will pick up differences between individuals also. This will not help much but add

on to the already confusing studies of biodiversity, especially genetic conservation.

What is often forgotten in these conservation programmes are the utilitarian aspects. Variations if not used are lost. But using variability is only a possibility if we understand where they will be useful. Our efforts on conservation will succeed only if we are to understand the characteristics of the population or species, dynamics of the ecosystem. Character-based selection and subsequent molecular analysis would greatly help us identify specific individuals and markers for characters. This will not only aid marker-aided selection but will also help us adopt suitable conservation strategies. But often variability data pertaining to individual differences will be of little use, except in telling us if there are variants. Variants identified as such cannot be used as it is difficult to relate it to performance.

Looking at genetic variability for conservation need to take into account the sampling methodology and account for characters of performance in the field. Recently we studied genetic variations in traditional rice germplasm tolerant to salinity, using molecular markers. Molecular variation, in relation to salt tolerance has helped us generate suitable methods based on the genetic distances

between varieties and variants within varieties, to recommend them in breeding programmes. Another point of interest to discuss is to evaluate the construction of dendrograms. Our experience shows that with different statistical packages, we can generate different dendrograms from the same data-set. So we should be careful to consider one analytical package that will be common and uniform to evaluate the results relating to genetic variability.

What is important in scientific research is not to generate data but to carefully plan an experiment using appropriate tools and discuss the results with the logic of its application. At least for conservation genetics the programmes will fail if we only look at generating variability data completely forgetting that characters are better manifestations of differences and more useful practically. Maybe that is where our farmer-breeders are more intelligent than us in selecting and breeding besides maintaining and using variability, through on-farm conservation.

P. Balakrishna is in the M. S. Swaminathan Research Foundation, 3rd Cross Street, Taramani Institutional Area, Madras 600 113, India.