

nannofossil is from one of the plant beds of the Lower Member exposed near Jakh temple, 25 km west of Bhuj. Apparently, Rai had not taken note of the precise stratigraphic location of the sampled bed since she followed a classification^{4,6}, which is more concerned with the nomenclature priority than the ground reality described above. This misled Rai to believe that Albian 'Bhuj Member' (Upper Member²) continues eastward in the Bhuj area, and the sample was collected from the lower part of the member, whereas in reality the sample was collected from the Neocomian Lower Member (= Ghuneri Member). Thus, the reported occurrence of Mid-Albian nannofossils in rocks below the Aptian Ukra beds created a stratigraphic anomaly. I would, therefore, suggest that a definite conclusion regarding the Albian age of the Bhuj Formation in the type area should be postponed till all the plant and other shale beds are examined for the nannofossils.

Depositional Environment of Bhuj Formation: Presence of marine fossil in sediments does not necessarily mean that the deposit is holomarine. There are reports of occurrence of micro-fauna in aeolian and fluvial deposits^{7,8}. It is difficult to accept that the Bhuj Formation with well-preserved Upper Gondwana floral assemblage but barren of fossil fauna is holomarine deposit as interpreted by some workers⁹, whose views Rai has tried to validate by the reported single occurrence of marine nannofossils. She does not discuss the contradictory evidence presented by the well-preserved plant fossils and marine nannofossils in the same bed. Proponents of marine deposition^{4,9} based their opinion mainly on the repeated occurrence of trace fossils and the bioturbated ferruginous beds in the formation. They tried to explain the absence of hard-bodied fossils by desolution processes, but do not mention the absence of micro-fauna and preservation of fragile terrestrial plant fossils in the so-called marine sediments. Mere presence of bioturbated zones or trace fossils does not evince a marine origin for the host sediments. Trace fossils represent behavioural traits of organisms and it is an established fact that like behaviour can be seen in all types of environments¹⁰. Detailed study of the trace fossils reveals that they are typically restricted occurrence of ichno assemblage in transitional environments (K. G. Kulkarni, pers. commun.).

The Mesozoic sequence typically represents a transgressive-regressive megacycle^{11,12}. The early Middle Jurassic transgressive sequence is characterized by highly fossiliferous shale–limestone–sandstone litho-association. The upper Late Jurassic–Early Cretaceous, thick regressive sequence (Bhuj Formation) is predominantly sandy and barren of fossil fauna, but rich in fossil flora and ichnofossils. Based on detailed studies and extensive mapping, the Bhuj Formation has been interpreted as a wave-dominated estuarine palaeo-delta with well-developed aggradational/progradational sequences during normal regression of the sea^{11,12}. The delta prograded westward progressively shifting the wavefront, which left the marine (tidal) signatures like bioturbated sediments and occasional mollusk shells (poorly preserved) across the basin. In the delta front zone in Western Mainland, the fossiliferous Ukra Member represents a short transgressive break in the delta progradation during a high stand. In the east, thick sequences characterized by multistoried stacks of current-bedded sandstones with frequent channel cut and fills represent the proximal fluvial facies of the formation¹¹. Therefore, the conclusion by Rai that 'an uninterrupted marine succession from Late Bajocian to Middle Albian occurs in Kutch Basin', is only partially true for the western end of the basin where the transitional facies of the Lower Member grades into the coastal facies of the Ghuneri Member in the delta front.

Once it is understood that the host rocks are deposits of transitional environment, it is not difficult to explain the apparently contradictory occurrence of plant and marine fossils together in a carbonaceous shale bed. In estuarine delta environment tidal currents penetrate deep into the hinterland during high tides. Further, penetration of tidal current is deeper over the prograding delta lobes during sea-level highstands in fluctuating conditions. In the present case, tidal current during high tides carried the planktonic nannofossils towards the hinterland over the swampy lower delta plain, where these tiny fossils were trapped with the leaves and other plant remains in lakes and local pools. In fact, such occurrence is expected in tide-dominated prograding delta front and provides a supporting evidence for deltaic environment of deposition^{11,12}.

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Response:

S. K. Biswas, a name synonymous with Kutch stratigraphy has always been a source of inspiration throughout my research career in the Kutch basin and his comments on my paper are welcome. I wish to add here that the suggestions and corrections by the two referees for the revision of the manuscript were contrasting. I modified the manuscript based on these comments. However, many of the comments were not valid and hence not incorporated. It may be added here that lithostratigraphic mapping of Kutch was done by Biswas¹. Later work on palaeobiology and depositional facies has provided a more precise interpretation on depositional environment². The queries raised by Biswas are addressed point-wise below.

The present rare but important finding throws light on the precise age and environment of part of Umia Formation exposed in this part of the succession.

1. The nannofossil assemblage recorded in my study, although only from one

- sample, gives a precise age for Bhuj sediments in the eastern part of Kutch. Earlier ages were only presumptions without any data.
- The early Middle Albian age for Bhuj Member given by me is based on precise global nannoplankton markers. The age of Ukra Member in the Western Mainland based on ammonoids is Aptian–Albian² and not Aptian only as claimed by Biswas. The lithological boundaries are not time boundaries, hence age of the central mainland succession cannot be determined with precision from a correlation with western Kutch, as suggested by Biswas.
 - The nannofossil-yielding samples of my study come from a carbonaceous shale unit. This lithofacies are interpreted as deposits of a coastal lagoon³. Coastal lagoons mostly contain high content of plant debris along with marine fauna. There is no ambiguity in interpretation. Occurrence of nannofossil along with plant debris supports coastal lagoon depositional environment. Biswas argues that plant fossils are well preserved. My study clearly indicates that the plant debris is poorly preserved (impression and not compression) and shows evidence of high bacterial decay.
 - As mentioned above marine nannofossils and other marine fossils can occur together with plant fossils in a coastal lagoon and near-shore environments, and there is nothing baffling about it.
 - The bioturbated zone and barren shales below are highly oxidized and non-calcareous. Such lithologies do not preserve nannofossils.
 - World over, there are thick coastal sandy sequences deposited in a marine system which do not preserve marine fauna (I. B. Singh, pers. commun.). Preservation of plant fossils within Bhuj Member is in lagoonal deposit. Bhuj sandstone has also yielded marine bivalve *Indotrigonia*⁴.

Age of Umia (Bhuj) Formation: I have followed the traditional names (Patcham, Chari, Katrol and Umia formations)⁵. Later classification (Jhurio, Jumara, Juran and Bhuj formations)¹ has inherent problems as discussed by others. The purpose of the present communication was not to discuss the merits of various classification schemes.

Bhuj Formation has been divided into three members in the western part of

Kutch (Ghuner, Ukra and Upper)¹. The Ghuner and Upper members are similar in character. The Ukra Member contains ammonoids of Aptian–Albian^{2,6}. In the central part of Kutch two informal Lower and Upper members of the Bhuj Formation (= Umia Formation) are erected¹ without a boundary between them. For the sake of convenience and lithological similarity, the Ghuner and Upper members of western Kutch are correlated with the Lower and Upper members of central Kutch with no age control¹. Palynotaxa can be used for palaeovegetation reconstruction and not for precise age determination.

Lithostratigraphic mapping of lithounits and marker beds cannot be taken as time lines. Lithological boundaries are mostly time-transgressive, especially when traced over long distances. Thus lithological correlation between western and central Kutch cannot be taken as time correlation. In this context Ukra Member (Aptian–Albian) now can be considered as time equivalent to nannofossil-yielding horizon (Albian) in central Kutch, as it is based on precise age determination by index fossils. It is now possible to correlate the central and western parts of Bhuj Formation of Kutch using time-marker fossils.

Even if the present study is based on one sample, it can be more precisely used than lithostratigraphic and palynological correlation. I can understand the concern of Biswas, as it strongly changes his correlation scheme of the Bhuj Formation between western and central Kutch, but this is the way science progresses.

Depositional environment of Umia (= Bhuj) Formation: If we try to see things with a pre-conceived notion, then it would be difficult to accept the marine nature of the Umia Formation. Since the Ukra Member contains ammonoids, there is no problem in accepting its age and marine nature. It is only the lower Ghuner and upper Bhuj members, which are normally devoid of marine macro- or micro-fauna, that are considered as fluvial deposits¹. Interpretation of coastal marine environment of Bhuj Formation is based on detailed facies analysis of the succession, emphasizing facies sequences and other sedimentary structures³ (U. K. Shukla, unpublished). Coastal lagoon, estuarine channel, tidal flat and shelf sheet sand depositional domains have been identified and they occur in a predictive cyclic vertical succession³. Biswas uses a term holomarine. It is not used in depositional

environmental studies. In the interpretation of depositional environment all the sedimentary features along with flora and fauna are considered. It is true that in the coastal zone marine microfossils are transported and deposited in coastal aeolian domes, but the nature of sedimentary structures helps identify deposits as Aeolian.

The bioturbated horizons identified⁷ in the Bhuj Formation were earlier interpreted as laterite horizons¹. Now there seems a view that these laterite beds are bioturbated horizons.

The Umia Formation (= Bhuj Formation) has been interpreted as deposits in embayment with many small estuarine channels formed in a tide-dominated shallow sea using detailed facies analysis (U. K. Shukla, unpublished). The need of the hour is to search all the plant beds of Umia Formation for presence of nannofossil, with the hope to find nannofossils and other marine fauna from several horizons.

Biswas negates the use of trace fossils as indicators of depositional environment^{7,8}, but quotes unpublished study supporting use of trace fossils as environmental indicators. Again the term transitional environment is vague. Detailed facies analysis of the Bhuj Formation³ is available, which Biswas seems to have ignored.

Biswas tries to interpret the Bhuj Formation as deposits of delta system with influence of tides and waves. A delta is built mostly by marine processes in a sea and hence is part of a marine depositional system where different coastal facies dominate. This has been already documented^{3,7}.

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