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V. S. R. M

Centre of Advanced Study in B
University of Madras,
Guindy Campus,
Madras 600 025, India

Occurrence of *Actinoporella cretacica* Raineri, an echinod from the Bagh beds, Dhar area, Central India

Actinoporella cretacica Raineri is recorded for the first time from the uppermost horizon of the Bagh beds of Dhar area. This form is an index fossil of the Late Cretaceous and thus its presence in the bed supports Late Cretaceous age for the Bagh beds. The genus *Actinoporella* Gumbel is known from the Upper Jurassic and Cretaceous of Iraq, Hungary, Italy and Guatemala[1]. However, *A. cretacica* is the only form which had been recorded by Raineri[2] and Pia[3] from the Cenomanian/Turonian strata exposed near Tripoli, North Africa. This form is now recorded from the uppermost horizon of the Bagh beds of Dhar area. The small, detached outcrops of marine sedimentary rocks of Cretaceous age are found along the Narmada valley covering a stretch of about 350 km and were named as Bagh bed by Bose[4] after the Bagh township of Dhar District in Madhya Pradesh. In course of palaeontological studies, a rich and well-preserved fossil assemblage has been recovered from this formation by many workers[5–19]. *A cretacica* Raineri has been recorded from the Coralline Limestone.

In the Dhar District, M.P., the Bagh Formation (generally referred to as Bagh beds) represents a thin Cretaceous marine sequence dominated by argillo-calcareous sediments. The Bagh sediments overlie the Nimar Sandstone and is in turn overlain by the Deccan Traps. The stratigraphic succession of the Bagh Formation according to Bose[4] is as follows:

Deccan Trap
Unconformity
Coralline limestone
Deola and Chirakhan Marl
Nodular limestone
Nimar sandstone
Unconformity
Metamorphics.

About 1 km from Zirabad on Zirabad–Dhar motor road, a good section of Bagh Formation is seen (Figure 1). Only

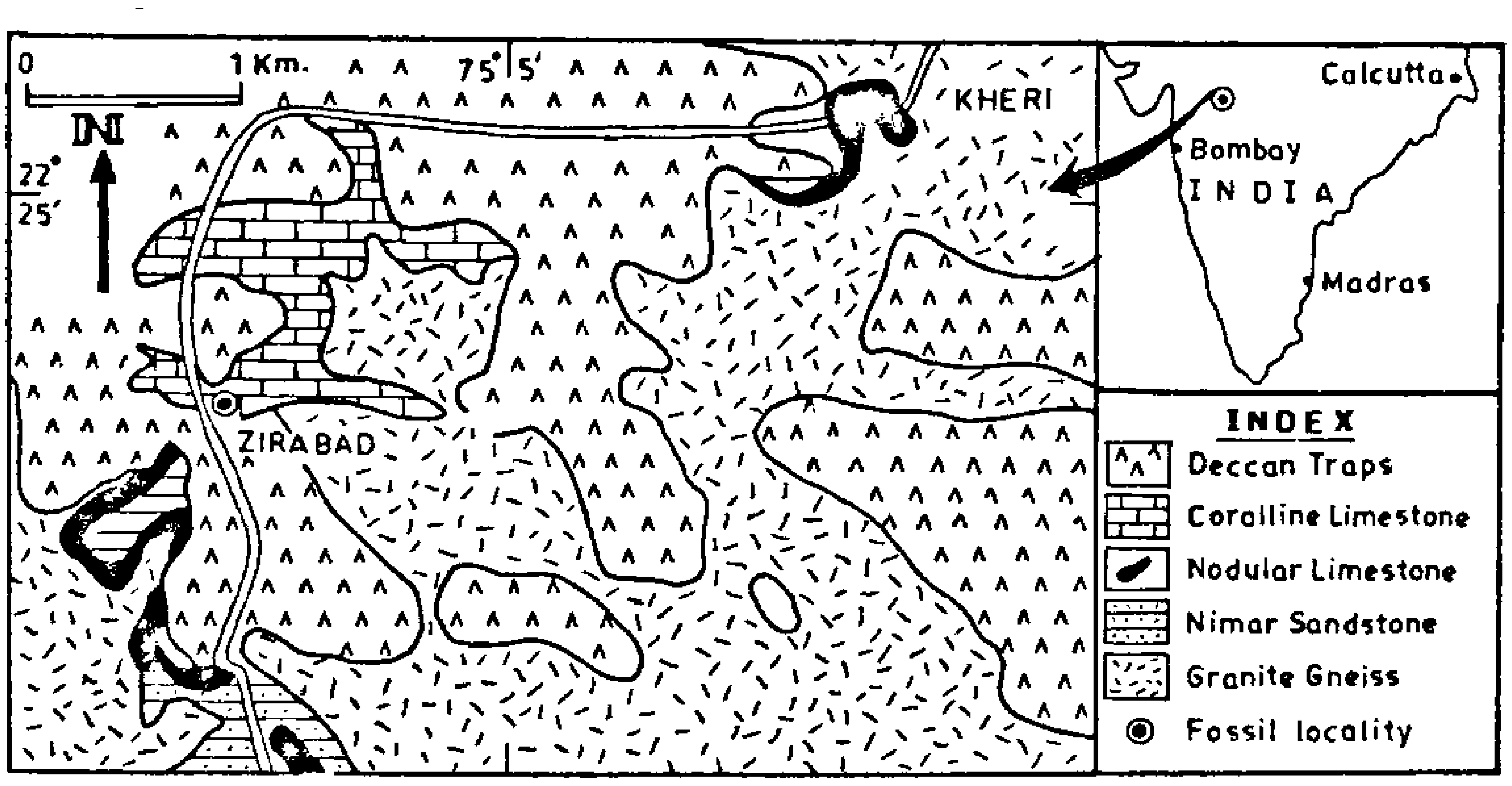

Figure 1. Geological map around fossil locality.

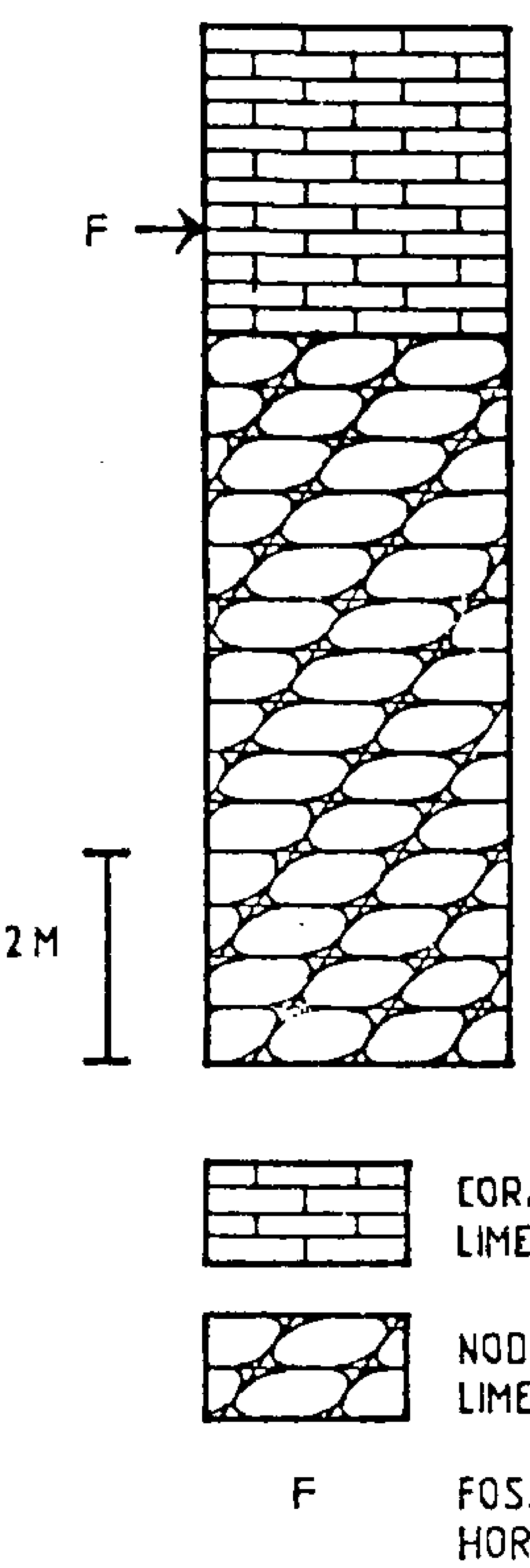

Figure 2. Lithocolumn of foss

two stratigraphic horizons oped here. At the base about nodular limestone is seen in with grey shales. Nodular nat is the characteristic sedimen ture. It grades upwards into thick, hard, compact, lig Coralline Limestone (Figur dominant bedding type is cross bedding. Small-scale

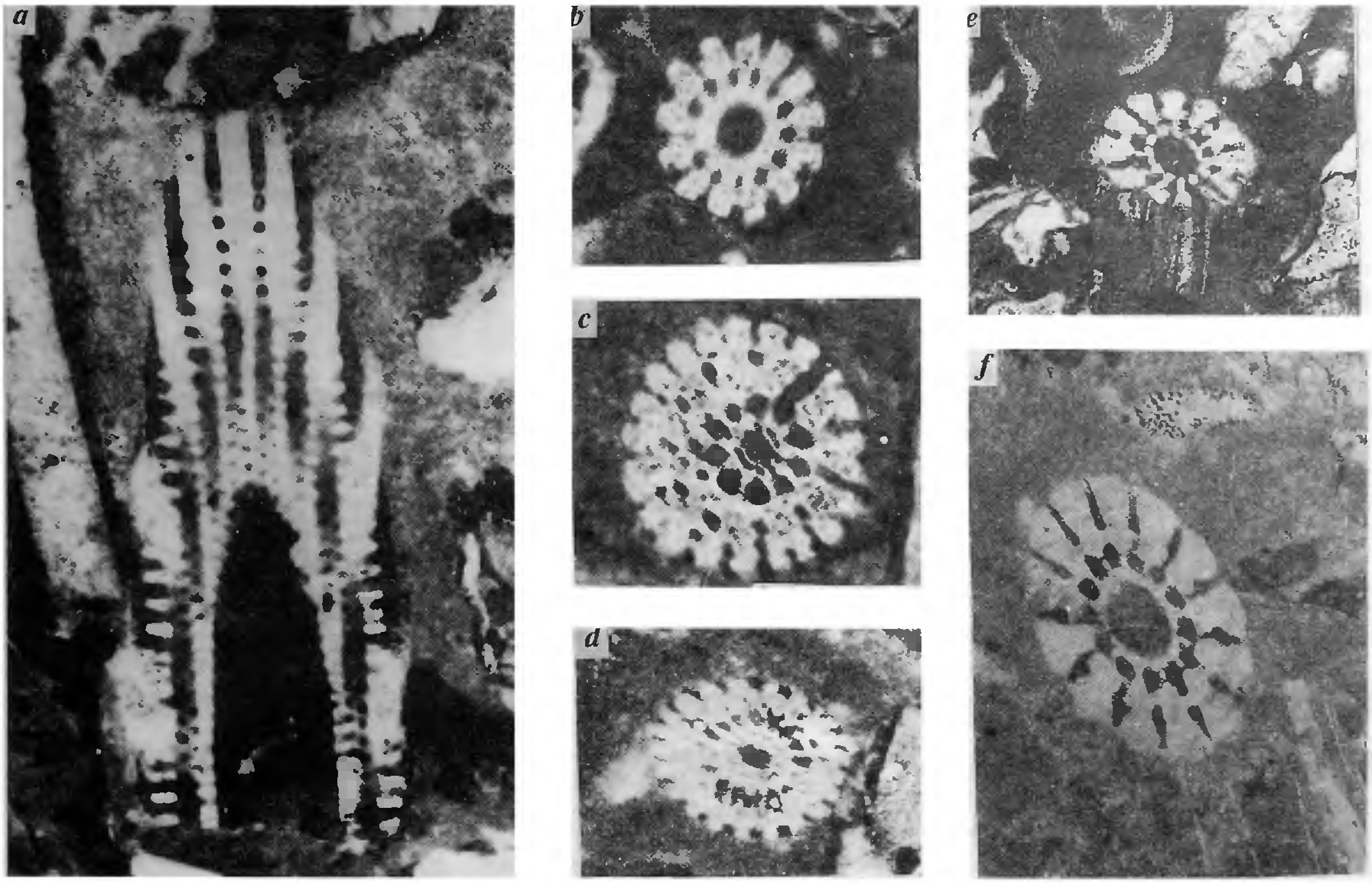

Figure 3. Section through *Actinoporella cretacica* Raineri; ***a***, Longitudinal section of the specimen, × 50, slide no. BSIP 11330; ***b***, Cross section through normal specimens; × 50, slide no. BSIP 11331; ***c***, Cross section through abnormal specimens. × 100, slide no. BSIP 11330; ***d***, Cross section through abnormal specimens. × 50, slide no. BSIP 11332; ***e***, Cross section through normal specimens. × 50, slide no. BSIP 11333; ***f***, Cross section through normal specimens. × 100, slide no. BSIP 11333.

ding and bioturbation structure are also seen.

The discovery of *A. cretacica* Raineri is based on the slides of petrological thin sections of the Coralline Limestone under Wild Stereomicroscope and Leitz petrological microscope. The figured slides have been deposited with the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

The cross section of the specimens is circular, diameter measuring 0.42–0.68 mm; the centre of the section is occupied by calcareous mud which is circular in shape, 0.6–1.2 mm in diameter. The skeletal material of the fossil itself is light in colour, with radiating lateral branches (Figure 3 *b–f*), number of laterals 11–13, the space between the laterals found to be narrowing gradually. In oblique longitudinal section (Figure 3 *a*), the central ring is occupied by a long tube perforated by small circular pores which are arranged in a row, filled with calcareous mud.

The specimens of *A. cretacica* Raineri illustrated in the present paper have close similarity with the specimens illustrated by Pia[3] from Tripoli, Libya in overall shape of the specimens in different sectional views and in the disposition of lateral branches and pores. But the Bagh specimens are relatively larger than the Libyan specimens and also have less number of lateral branches.

The affinity of *A. cretacica* Raineri is controversial. Raineri[2] first recorded *A. cretacica* Raineri from the Cenomanian/Turonian sediments of Tripoli, Libya, North Africa and considered it to be a member of Desycladaceae. Pia[3], however, doubted the Desycladaceaen affinity of *A. cretacica*. He reinvestigated the original slides of *A. cretacica* Raineri under polarized light and confirmed that *A. cretacica* Raineri was not a member of Desycladaceae but the radiole of echinoid. The problems of confusions of some calcareous algal forms with radiole of echinoids in petrological thin section and the ways to differentiate these forms had been dealt with in detail by Horowitz and Potter[20]. Badve and Nayak[21] had discussed the possibilities of misidentification of earlier recorded algal forms from Bagh beds in detail. Our present study has revealed that the material within the body shows same optical orientation both in transverse and lateral sections. Thus our observations support the echinoid nature of *A. cretacica* Raineri made by Pia[3].

So far this form has been commented upon by several authors to be an echinoderm, but no proper placement or transfer was done. We find difficulty in transferring *A. cretacica*. In its overall morphology, it can be placed under clypeasteroid echinoids based upon primary spines and cross sections. However, the form shows overlapping to different families and genera belonging to the order Clypeasteroida, in gross morphology[22]. We are also, therefore, leaving the same in its present position.

The present record of *A. cretacica* Raineri from the Bagh beds supports the Cenomanian–Turonian age connotation for the formation.

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B. N. JANA
S. KUMAR*
P. K. MAITHY

Birbal Sahni Institute of Palaeobotany, Lucknow 226 007, India
**Department of Geology, Lucknow University, Lucknow 226 007, India*

Comments on 'Single-ion activities by a solid ion transmitter bridge and a reference electrode without liquid junction'

The problem of activity coefficients of single ionic species remains one of the most controversial and elusive topics of classical physical chemistry. Although Guggenheim, Gibbs and Taylor shared the opinion that individual ion activities have no physical reality and are inaccessible on the basis of thermodynamic measurements, Pitzer and Brewer, Kirkwood and Openheim etc. had positive opinion, and the experimental measurements were always found to contain some deviation from strict premises of equilibrium thermodynamics such as deviation from electroneutrality, nonisothermal conditions etc[1]. In a recent communication (*Curr. Sci.*, 1995, **69**, 529) Parthasarathy and Ramya have claimed that it is possible to measure thermodynamic values of single ion activity using a solid ion conductor by eliminating liquid junction potentials. On the contrary, a careful analysis of the experimental conditions indicates that phase boundary potentials or liquid junction potentials are not eliminated completely and more importantly, incorrect expressions are used to derive eq. (4) given in their work so as to arrive at inaccurate conclusions.

In this communication, we present evidence to disprove their conclusions and to reinforce the argument that single ion activities are still experimentally inaccessible, although models based on statistical mechanics can be used to compute them theoretically[2].

The 'solid ion transmitter bridge' does not eliminate the liquid junction potential (ljp) because it is only acting as another salt bridge – an inorganic membrane, which cancels two phase boundary potentials and thus minimizing ljp. Probably cations and anions are moving through this solid matrix in opposite directions with equal transport numbers (possible due to Knudson diffusion in microporous membranes) and it is almost impossible to invoke any special role for ionic conduction involving the lattice. Silver ion transport in crystalline silver chloride requires at least few eV at room temperature and any other phenomena such as solvation energy or space charge effects cannot compensate this[3]. Indeed, the formation energies for the predominant cation Frenkel defects require temperature of at least 250–300°C and chloride ion transport through the lattice is almost impossible[4].

A more serious difficulty is encountered when one analyses the cell representations and emf calculations given on page 532 of their article. The ljp of the cell,

$$\text{Ag/AgCl, KCl (satd.)/ bridge/ZnCl}_2\ (m)\text{, AgCl/Ag} \quad (1)$$

is not zero as two specific contributions of ljps can be identified.

(i) Difference in the chloride ion concentration alone can cause a contribution, which can be visualized easily by comparing the concentration cell,

$$\text{Ag/AgCl, KCl (satd.)/bridge/ KCl } (m)\text{, AgCl/Ag} \quad (2)$$

and

(ii) Difference in the nature of the cations, contributing a ljp, which is more difficult to account, although the Henderson equation can be used, at least in principle to calculate this. This can be represented as

$$\text{Ag/AgCl, KCl } (m)\text{/bridge/ ZnCl}_2\ (m')\text{, AgCl/Ag,} \quad (3)$$

where m and m' can be selected to give identical chloride ion activity or concentration. This type of hetero-ion ljp cannot be eliminated, although approximate correction can be included in the experimental emf values. Both these are present in the cell represented by (i) and hence, ljp is not zero as claimed in their text. More importantly, the form of