fractionated carbonatite, with relatively high normalized ratios for La, Ce, Nd and Ba but with a relatively lower ratio for Sr as shown by Clarke *et al.*[3]. Nb, Zr and Ti have smaller ratios as appropriate to elements that occur in minerals commonly fractionated early from carbonatite magma, i.e. pyrochlore, ziron and titaniferous magnetite. P is also usually much reduced in fractionated carbonatite owing to the early separation of apatite, but in Figure 1, P is only slightly lower than that of the average carbonatites plotted. This surprised us because there is no apatite in the dyke.

The P in this dyke is associated with the britholite–(Ce) (the silicate analogue of apatite which contains minor P) as well as rare monazite–(Ce) (30 wt% P_2O_5) and daquingshanite[2].

The mineral assemblage reported above and its texture has not been previously recorded. The Sr content of the strontian-calcite in the dyke reaches 13 wt% which is believed to be highest ever reported. The texture and mineral compositions indicate primary crystallization from a carbonatite magma rich in REE, Sr and Ba. The coexisting composition of the calcian-strontianite and strontian-calcite suggests subsolidus exsolution at 500° C and 2 kbar pressure.

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First record of marine macroinvertebrate from Bhuj Sandstone (Lower Cretaceous) of eastern Kachchh

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The record of shell impressions (external moulds) of *Indotrigonia*, a marine bivalve from Bhuj Sandstone, the youngest lithostratigraphic unit of Kachchh Mesozoic, supports the marine depositional environment of Bhuj Sandstone. This finding also supports the contention that during deposition of Bhuj Sandstone a rich benthonic population was present (as evidenced by the presence of rich trace fossil assemblage). However, the highly porous nature of sand caused dissolution of shells during diagenesis, destroying the body fossils but preserving the trace fossils.

THE Mesozoic rocks of Kachchh are well-known for their fauna and flora[1–7]. Bhuj Sandstone (Bhuj Formation ≃ Umia Formation) is the youngest lithostratigraphic unit of Mesozoic sequence of pericratonic Kachchh basin (Table 1). It is extensively developed in the Kachchh mainland and represented mainly by sandstones with occasional silt and clay horizons. Bhuj Sandstone is mostly devoid of animal body fossils, except in western part where few horizons rich in macroinvertebrates are present[8]. Recently, trace fossils have been recorded from Bhuj Sandstone[9–12]. Absence of animal body fossils and presence of plant fossils in Bhuj Sandstone are considered as main argument to support a fluvial or continental origin of Bhuj Sandstone[8]. However, facies association and trace fossil studies suggest a coastal marine environment of deposition for Bhuj Sandstone[11–14].

During regional facies study of Bhuj Sandstone, three shell impressions of marine bivalve are recorded from a fine-grained sandstone unit of Bhuj Sandstone, exposed in the vicinity of Bhuj township along Bhuj–Mandvi road (Figures 1 and 2). This is the first record of animal body fossils from the eastern part of Kachchh mainland. These body fossils are described in the following and their significance is discussed.

Classification

Phylum: Mollusca
Class: Bivalvia Bonnani, 1681
Sub-class: Palaeohetrodonta Newell, 1965
Order: Trigonoida Dall, 1889
Superfamily: Trigoniacea Lamark, 1819
Family: Trigoniidae Lamark, 1819
Genus: *Indotrigonia* Dietrich, 1933

Indotrigonia smeei (Sowerby)
Plate I–a, b & c

Trigonia smeei Sowerby[15], 1840 Plate III, Fig. 9.
Plate IV, Fig. 1–3, Medlicott and Blandford[16] 1879
Plate XII, Fig. 11 Kitchin, 1903, p. pl. III, Fig. 9, 9a (ref. 3).

Indotrigonia smeei (Sowerby)–Dietrich[17], 1933, p. 30, pl. III, Fig. 48–51, 54–56.

Material. Three external moulds.

Diagnosis. The shells of *Indotrigonia* are characterized by an elongated oval form with well incurved and

Table 1. Stratigraphic classification scheme for Kachchh Mesozoic. The subdivisions of Bhuj ≃ Umia Formation are developed only in western part. In eastern Kachchh (study area) the sequence is developed as sandstone facies and the whole sequence can be designated as Bhuj Sandstone (Bhuj Formation ≃ Umia Formation).

After Biswas (1977)		After Jaikrishna, *et al.* (1983). Howard & Singh (1985), based on older classifications		Ages
Bhuj Formation	Upper Member Ukra Member Ghuneri Member Katesar Member	Umia Formation	Bhuj Member Ukra Member Ghuneri Member Katesar Member Umia Member	Upper Tithonian to Albian
Jhuran Formation	Upper Member Middle Member Lower Member	Katrol Formation		Kimmeridgian to Middle Tithonian
Jumara Formation	Member IV Member III Member II Member I	Chari Formation	Dhosa Oolite	Upper Bathonian to Oxfordian
Jhurio Formation	Member G Member F Member E Member D Member C Member B Member A	Patcham Formation		Bajocian to Middle Bathonian

slightly recurved, umbones, situated at about one-fifth of the shell's length from the anterior margin. The external surface shows regular, concentric ornamentation of flank with costae ranging in number from 20 to 25 (in fully grown individuals). The shell shows well marked marginal carina and the highly differentiated area with fine longitudinal ornaments, median carina and groove, the inner carina and well-marked escutcheon[3].

Description. The shell impressions are oval and elongated, and represent the negative impression of outer surface (external mold) of the left valve of *Indotrigonia* shell (Figure 3).

The specimens as now preserved are broken along all the margins. The umbo, situated at about one third of the shell's length from anterior margin, is angular and not prominent. The flanks are ornamented by rounded concentric costae numbering in one case to 12 (Figure 3 *a*). The costae of the flank are separated from one another by spaces as broad as the costae themselves and seem to terminate posteriorly at antecarinal groove which is not very prominent and is represented only by a slight constriction of flank costae or a depression. In contrast, the costae of the area are narrower and more numerous, eighteen in number. The increase in the number of costae of the areas is because of the fact that some of the flank ribs give rise to more than one costae (costellae) in the region of area.

Dimensions

	Specimen-1	Specimen-2
Greatest length	90 mm	60 mm
Height measured from the umbo	40 mm	30 mm

Remarks. Originally described by Sowerby[15], *Indotrigonia* is reported to occur in the Umia Group (Oomia Group) in beds both below as well as above the horizons containing plant fossils. It does not show any specific association with other *Trigonia* forms of Umia Group and occurs in abundance in separate localities.

According to Kitchin *Trigonia smeei* occurs in association with *Trigonia ventricosa* Krauss, and also shows some affinity with European representatives *Indotrigonia* is also known to occur in Uitenhage Series of South Africa.

Repository. The material is deposited in the Department of Geology, Lucknow University, under GEOLU/B.F. 201,GEOLU/B.F. 202, GEOLU/B.F. 203.

Occurrence. The shell impressions identified as *Indotrigonia* are recovered from interbedded sandstone–siltstone lithofacies of Bhuj Sandstone exposed about 4 km south of Bhuj town (Figure 2) on the western side of Bhuj-Mandvi road. The locality is situated about 100 m from the Bhuj–Mandvi road behind the hillock. The

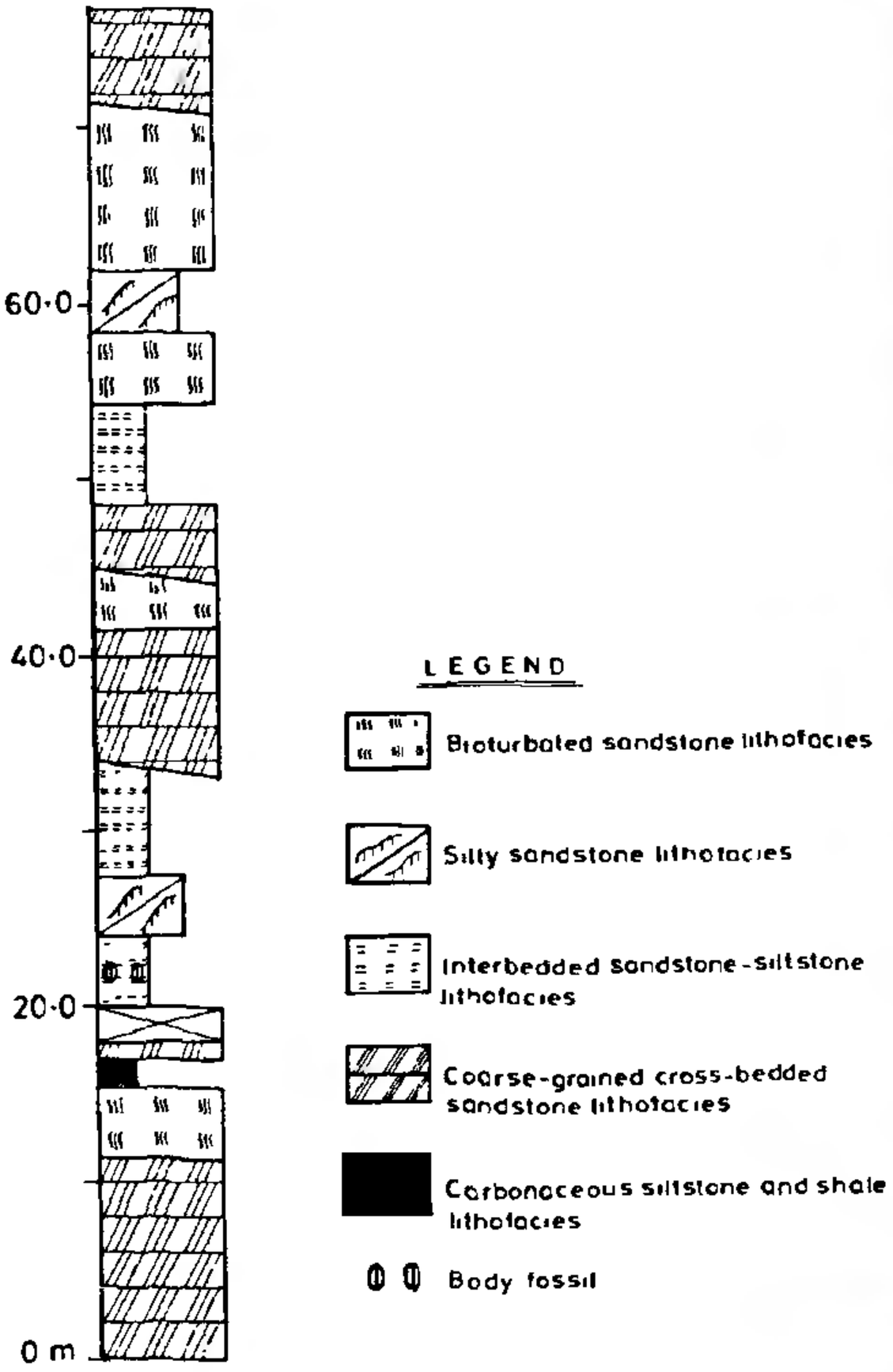

Figure 1. Sedimentological log of Bhuj Sandstone showing major lithofacies and stratigraphic position of body fossil near Bhuj township

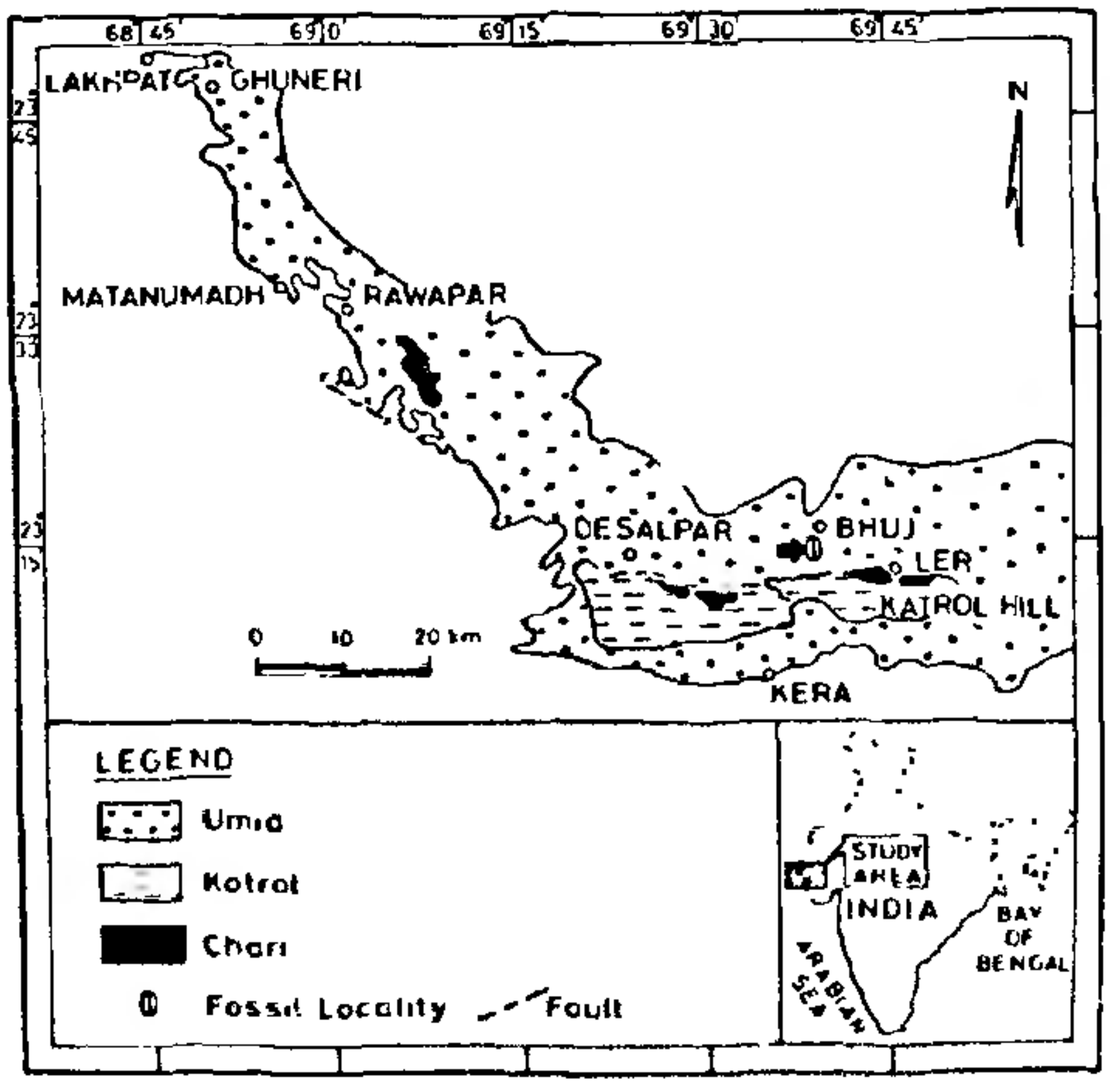

Figure 2. Map showing outcrop pattern of Bhuj Sandstone in Kachchh basin. Arrow mark shows the fossil locality (modified after Howard and Singh, 1985).

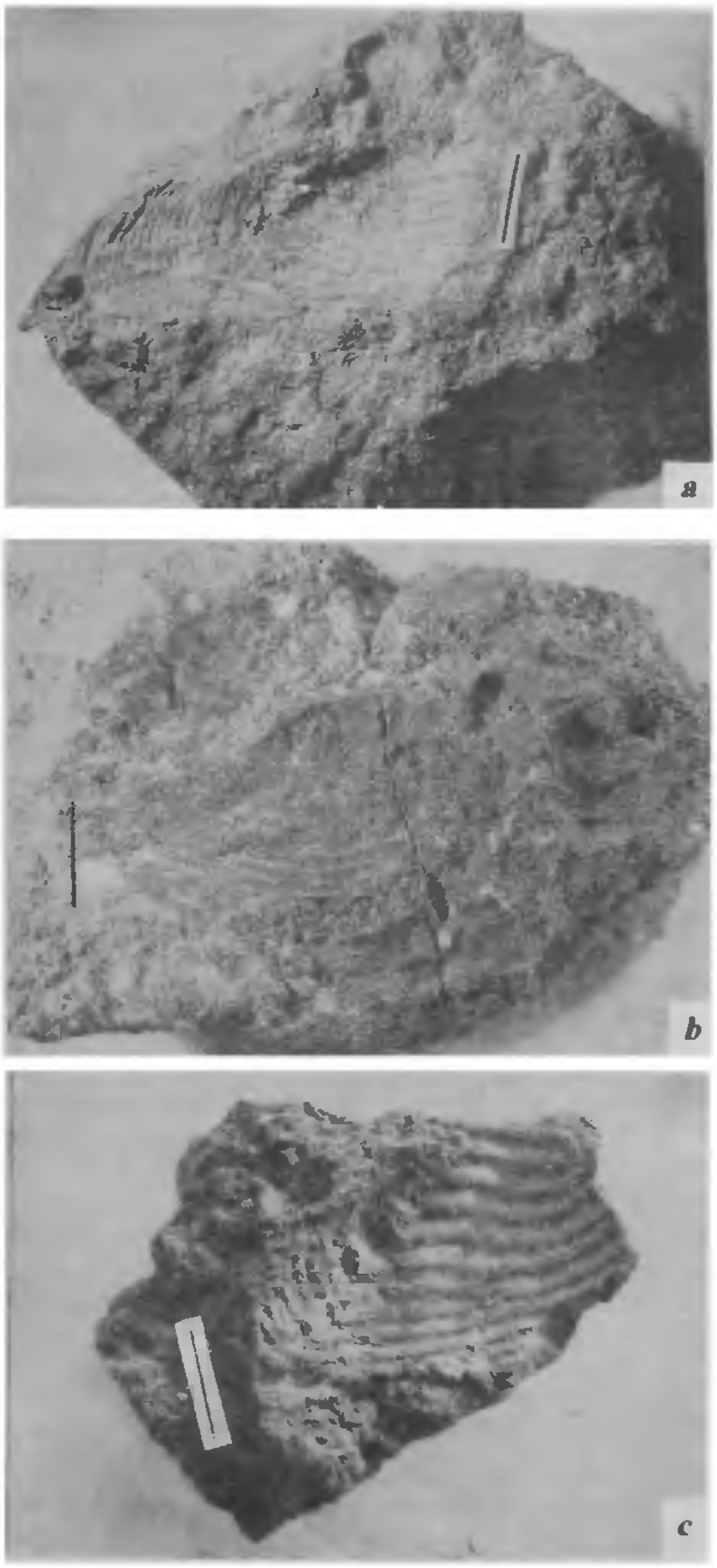

Figure 3. *a*, Photograph of a rock specimen showing a complete external mould of left valve of *Indotrigonia smeei*. Note the different pattern of costae on either side of ante-carinal groove. Bar = 2.0 cm. *b*, Photograph showing *Trigonia* shell impressions preserved in coarse-grained bioturbated sandstone Bar = 2.0 cm. *c*, Photograph of a rock specimen showing external mould of *Indotrigonia smeei*. Note the branching nature of costae. Bar = 2.0 cm

sediments containing the fossil impressions are fine- to medium-grained, bioturbated sandstone, somewhat ferrugenous. One of the impressions is found preserved in gravelly coarse-grained sandstone, which is highly ferrugenous and bioturbated.

Significance of shell impressions. As already pointed out, due to absence of animal body fossils, the entire succession of Bhuj Sandstone in eastern part of Kachchh mainland is mostly considered to be fluvial or deltaic deposits[18].

However, systematic study of Bhuj Sandstone in eastern part, using lithofacies analysis[13,19] and trace fossils studies[12] points to a tide-dominated shallow marine setup for the deposition of Bhuj Sandstone. Bhuj Sandstone shows a varied trace fossil assemblage and many densely bioturbated horizons[12,19]. It is argued that at the time of deposition of Bhuj Sandstone, a dense population of benthonic animals was present which produced varied trace fossils. Some of these benthonic organisms were soft-bodied hence they are not preserved. Further, the shells of molluscan population also got dissolved by percolating pore waters. Many ancient porous, clean, coarse-grained sediments of coastal origin do not preserve animal hard parts, as they are dissolved during diagenesis[20–22], but show preservation of trace fossils.

The record of external moulds of *Indotrigonia* in poor state of preservation lends support to the hypothesis that during deposition of Bhuj Sandstone a good population of benthonic community existed, but their hard parts have been destroyed during diagenesis. It appears that fine-grained matrix-rich facies of Bhuj Sandstone may yield more animal body fossils, as due to low permeability such horizons are more suitable for the preservation of shells. *Indotrigonia* is a marine bivalve living mainly in the coastal zone of a shallow sea. This supports a coastal depositional environment for Bhuj Sandstone.

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In vitro developed desirable somaclone of upland rice (*Oryza sativa* L.) cultivar, Halubbalu

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Somaclonal plants regenerated under stress from rice calli of cv. Halubbalu, which had the same height as seedstock material, showed significantly higher tiller and leaf numbers and leaf area per plant. Above ground biomass, grain weight and number per plant and assimilation (A) and conductance (gs) rates and germination per cent and seedling vigour were greater than those of seedstock plants.

SOMACLONAL selection, a novel technique, has helped develop crops with desirable characters[1,2]. Somaclonal plants with desired traits have been developed in sugarcane[3], potato[4] and tomato[5]. Tissue culture-derived plants of wheat[6] differing in height, tiller number and other yield attributes and maize[7] plants differing in useful morphological characters were obtained by *in vitro* selection. Rice[8] calli on redifferentiation gave different phenotypic plants. Plants obtained from callus cultures[9,10] exhibited differences in height, number of total and fertile tillers and panicle length. Male sterile (ms) indica rice[11] lines and fertile revertants in ms maize[11] and phenotypic varients in basmati rice[12] were obtained by this technique. Attempts to develop submergence tolerant[13] and rice water weevil resistant[14] rice lines show the potentiality of this