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A reassessment of stratigraphy of Bagh Beds, Barwah area, Madhya Pradesh, with description of trace fossils

R. M. BADVE
Maharashtra Association for the Cultivation of Science, Law College Road, Pune 411 004.

Abstract

A reassessment of the stratigraphy of Bagh Beds in Barwah area, Madhya Pradesh reveals that only the basal member, Nimar Sandstone, is present with calcareous facies resembling the Coralline Limestone developed predominantly towards its top and followed up by sandstone shale alternations. Other younger members i.e., the Nodular Limestone, the Lower and Upper Coralline Limestone or the Deola and Chirakhan Marl are absent in this area.

Alternations of thin bands of sandy shale and sandstone, developed towards the top of the sequence in Kholar river, near Yelam, yield abundant ichnofossils comprising ichnogenera *Brookvalichnus* Webby, *Cylindrichnus* Toots, *Granularia* Pomel, *Gyrochorte* Heer, *Keckia* Glocker and *Palaeophycus* Hall, which indicate shallow sublittoral deposition of sediments with moderate to relatively low energy conditions characteristic of the *Cruziana* facies.

INTRODUCTION

The eastern-most outcrops of the Bagh Beds occur around Barwah, Madhya Pradesh (location map) in association with older metasediments and granitoids (Archaean), dolomite, chert, and breccia (Bijawar), sandstone, limestone, and conglomerate, (Vindhyan), younger sandstone, limestone, conglomerate (Lameta), Deccan Trap and Intertrappean beds (Roy Chowdhury and Sastri, 1958; Ghosh *et al*, 1976).

A few irregular patches of calcareous beds near Barwah comprising sandstone, conglomerate and limestone were assigned to the Bagh Beds by Blanford (1869, p. 55,57), and correlated with calcareous beds at Punassa, Bhorla, Lokurtulla and Ellichpoor. He nevertheless pointed out the difficulty in establishing precise inter-relationship among these outcrops due to extensive alluvial cover. Bose (1984), resurveying the Lower Narmada valley, proposed definite stratigraphic terms to the individual members. However, he separated the Nimar Sandstone from the rest of the younger marine members to form a separate group (Table I). In Barwah area, he noted the Nimar Sandstone to occur at Yelam (5 miles east of Barwah) and the fossiliferous limestone occurring over the sandstone was considered by him to be the 'Coralline Limestone'. While giving general description of the marine rocks in Barwah area, he observed their insignificant extent and thickness and remarked that due to alluvial cover clear distinction was not possible among the individual members. Singh (1952, p. 175) considered that the Bagh Beds exposed along Kholar river near Yelam, were represented by Coralline Limestone with a sandstone parting within it. Roy Chowdhury and Sastri (1954, 1958) concurred with the view of Singh. They also noticed outcrops of limestone at Ghatia, Agarwara, north west of Barwah. Dassarma and Sinha (1975) recorded the occurrence of Nimar Sandstone underlying the Coralline Limestone along the banks of Khola *nala* (=Kholar river) and refuted

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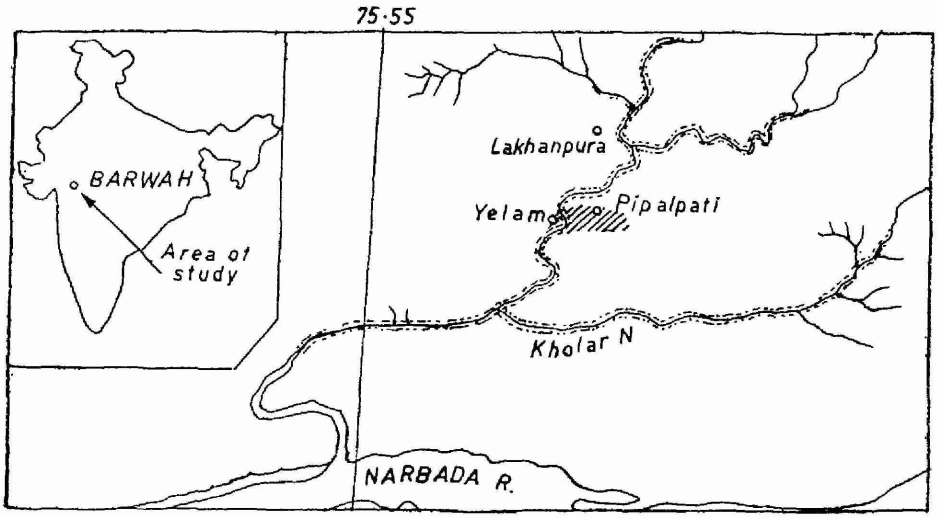
the idea of Roy Chowdhury and Sastri (1958) of the sandstone occurring as lenses in the body of Coralline Limestone.



Location Map.

An attempt is made to reassess the stratigraphic position of the rocks from the Barwah area to determine whether they represent Nimar Sandstone or Coralline Limestone or both.

TABLE I.

Approximate European equivalents	Formations	
UPPER CRETACEOUS	1. Deccan trap (igneous, mostly sub-aerial), inter trappean fresh-water limestone	
	2. Lameta (lacustrine)	(Marine)
	3. Coralline-limestone	
	4. Deola and Chirakhan marl	
	5. Nodular-limestone	
LOWER CRETACEOUS (Neocomian)	6. Nimar Sandstone (estuarine and fresh-water ?) with oyster band at the top	
JURASSIC	7. Mahadeva (Upper Gondwana) sandstone (fresh-water)	
	8. Vindhyan sandstone (lacustrine ?)	
	9. Bijawars, or Transition series (marine)	
	10. Metamorphics (marine)	

After P. N. Bose, 1884

FIELD OBSERVATIONS

The most important outcrops of these rocks occur in the Kholar river near Yelam village. While approaching Yelam from Agarwara, an Intertrappean bed is met with upstream along the eastern bank escarpment where a cart road crosses the river. This escarpment has a height of 5–6 m exposing in section Deccan Traps overlying Intertrappean sediments for a length of about 150 m. The section here comprises highly weathered basalt flow forming the river bed over which occur greyish shale and whitish clay with a thickness varying between 3 m to 5 m (Text Fig. 1a and Pl. I, Fig. 1). The shale particularly abounds in Unionid bivalves and the gastropod *Physa prinsepii* Sow. Contact between the top of the Intertrappean bed and the upper basalt flow is uneven.

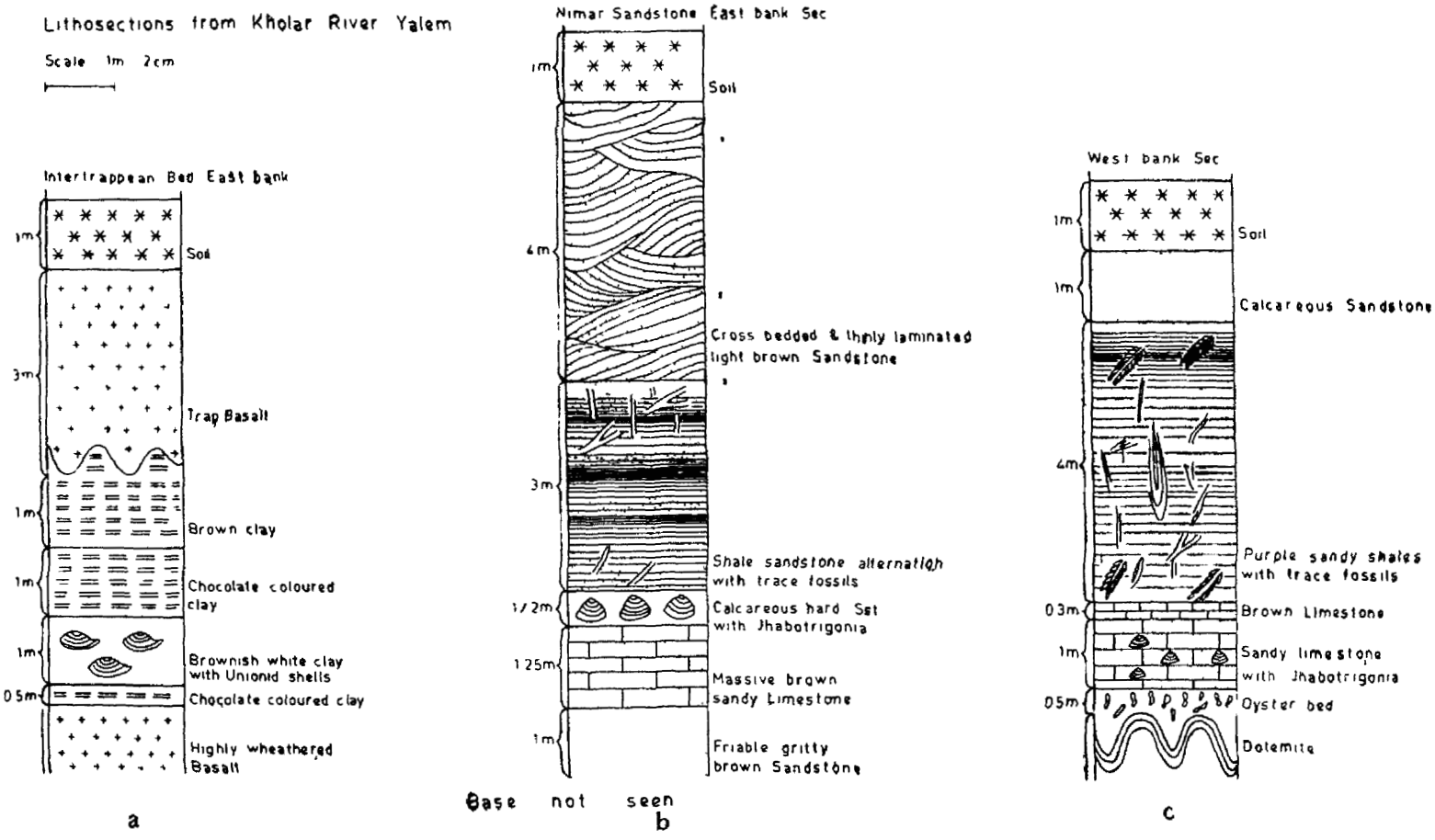
About 100 m further upstream from this Intertrappean bed and on the same bank, an outcrop of marine Cretaceous limestone and sandy shales is met with. The limestone is siliceous and forms the pavement of the river bed. In appearance, this limestone band resembles the limestone bed designated as 'Coralline Limestone'– a younger member of the Bagh Beds (Bose, 1884; Rode and Chiplonkar, 1935). This band has a thickness of about 1m to 1.25 m and is underlain by gritty, friable sandstone of buff colour, and is overlain by a few thin bands alternately of calcareous sandstone and reddish sandy shale, showing burrows at their interfaces. A calcareous sandstone immediately overlying the limestone band contains, in pockets, abundant shells of *Jhabotrigonia*, *Turritella* and fragmentary oysters (Text Fig. 1b, Pl. I, Fig. 2 and Pl. II, Fig. 1).

About 300 m further upstream, three detached outcrops of Bagh Beds are met with. The first of these is seen along the western bank forming an escarpment which has a height of 6–8 m and a length of about 50 m. At the base of the escarpment, calcareous light brown coloured sandstone is exposed of which upper 0.7 m contains *Jhabotrigonia* shells (Text Fig. 1c). This sandstone band is overlain by brown coloured limestone band having 0.3 m thickness, over which a well developed 4 to 5 m thick sequence of thinly laminated sandy shale with clayey partings is present (Pl. II, Fig. 2). This zone contains abundant signs of ichnoactivity and is overlain by 1 m thick coarse-grained sandstone which is followed up by 1 m thick alluvium. The second outcrop is a small patch of brown siliceous limestone exposed on the opposite bank just across the river bed. The third outcrop occurs further 50 m upstream. Here, a small patch of oyster bed mainly comprising genus *Indostrea* (Chiplonkar and Badve, 1976) rests directly on dolomite of Bijawar age.

The rock exposed in the vicinity of village Agarwara is yellowish-brown compact sandy limestone containing *Jhabotrigonia* shells and a few burrows.

INTERPRETATION OF FIELD DATA

Presence of a horizon containing *Jhabotrigonia* and *Turritella* shells, development of oyster beds, lateral variation in calcareous facies and sandy facies are some of the important characters observed in the upper portion of the Nimar Sandstone. These characters help in correlating distant outcrops of Nimar Sandstone. Roy Chowdhury and Sastri (1962) noted calcareous nature of the top of Nimar Sandstone near Seola and Mohanpura in Man river valley. Pipal Dehla, Phata, Dhulia, Motichikli, Mohangad are some of the localities where Nimar Sandstone shows features similar to those observed in Barwah area.



Text Figure 1.

The oyster bed at Ghatia quarries in Choral river section as described by different workers (Medlicot, 1872; Bose, 1884, p. 33; Roy Chowdhury and Sastri, 1958) is unquestionably homotaxial with the oyster bed found at Yelam, Amlipura, Rajla, Phata, Motichikli, etc. The flesh-coloured limestone mentioned by Bose (1884) is nothing but the calcareous portion of the Nimar Sandstone apparently resembling Coralline Limestone. Another significant point which may be mentioned here is that Nimar Sandstone is overlain conformably by the Nodular Limestone, and the former is nowhere succeeded directly by the Upper or Lower Coralline Limestone.

These evidences indicate that the limestone bands from Barwah region, hitherto reported as 'Coralline Limestone', are nothing but the calcareous facies of the Nimar Sandstone developed frequently towards its top and contain the significant bivalve genus *Jhabotrigonia*. In Kholar river section the *Jhabotrigonia – Turritella* bed is succeeded by sandstone and sandy shales full of trace fossils. The Bagh sediments in the Barwah area, therefore, constitute only the Nimar Sandstone. Other younger members including Nodular Limestone are totally absent in this area.

SYSTEMATIC DESCRIPTION OF ICHNOFOSSILS

Brookvalichnus Webby, 1970

Brookvalichnus obliquus Webby

(Pl. III, fig. 2a)

1970 *Brookvalichnus obliquus:* Webby, p. 528, pl. I, figs. 1–g.

1975 *Brookvalichnus obliquus* Webby: Haentzschel, p.w. 49, fig. 30.1.

Material: One slab. Plesiotype no. MASC G 2320 a.

Remarks: The trace is a flat ribbon having 4 mm width and bearing fine cross markings. The outer margins are thick. The trace cuts the sediment obliquely.

The trace has been interpreted by Webby as collapsed two layered dwelling burrows, perhaps of fresh water origin. The present specimen, though small, undoubtely belongs to *Brookvalichnus*. Thus considering the association of other trace fossils described here, *Brookvalichnus* can be regarded as inhabiting tidal flats.

Ichnogenus Type *A*

Pl. IV, fig. 4

Material: One specimen. Figured specimen No. MACS G 2323.

Dimensions: Length of burrow 9 cm
Maximum diameter – 3.75 cm
Length of neck – 4 cm
Diameter of neck – 1.2 cm.

Description: Vase shaped burrow with bulbous body and narrow, elongated neck. Outer surface smooth; opening circular; disposed oblique to the bedding plane.

Remarks: There is no comparable ichnogenus to the present form. Since burrow does not have wall, it is most likely that it had been excavated in the soft but firm sediment, which was subsequently filled up by sediments similar to the adjoining matrix. All the same, the burrow cannot be ascribed to ophisthotruncate bivalves, which live just below the sediment surface, (Schaefer, 1972, pp. 155–156) as the burrow has distinctly developed neck-like opening.

PLATE I

Fig. 1. Intertrappean bed exposed in Kholar river.

Fig. 2. Nimar Sandstone top comprising silicified limestone, friable sandstone and shales abounding in trace fossil, bivalves and gastropods, Eastern bank of Kholar river.

PLATE II

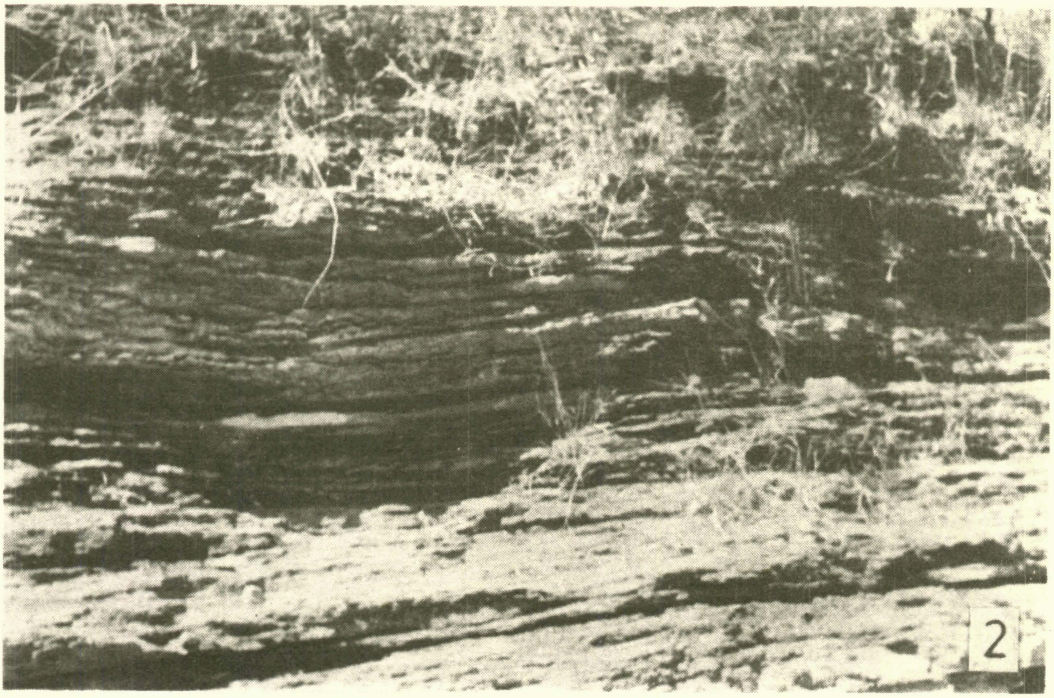
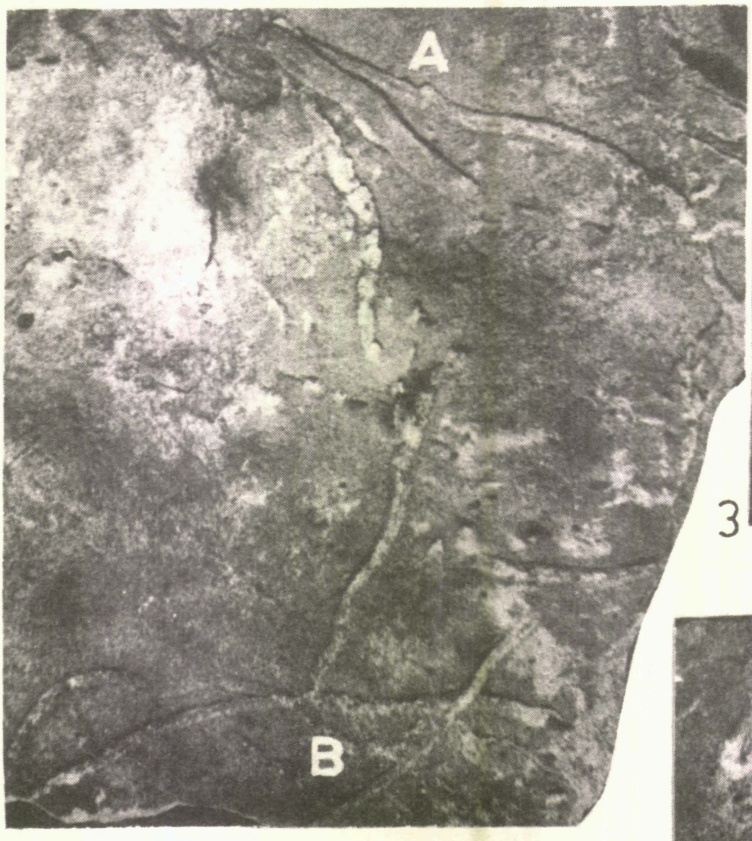


Fig. 1. Close up Nimar Sandstone top showing alternations of shales and sandstone with trace fossils. Eastern banks of Kholar river.

Fig. 2. Thinly laminated shale-sandstone alternations abounding in trace fossils. Western bank of Kholar river.

PLATE III

1



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Figs. 1 and 4. *Palaeophycus annulatus* sp. nov.

Fig. 1. Burrows in cross section. Holotype no. MACS G 2329. ×1.

Fig. 4. Horizontal burrow. Paratype no. MACS G 2330. ×1.

Fig. 2a. *Brookvalichnus obliquus* Webby. Plesiotype no. MACS G 2320a. ×1.

Fig. 2b. *Gyrochorte comosa* Heer. Plesiotype no. MACS G 2320b. ×1.

Fig. 3. *Palaeophycus tubularis* Hall. Plesiotype no. MACS G 2331. ×1.

PLATE IV

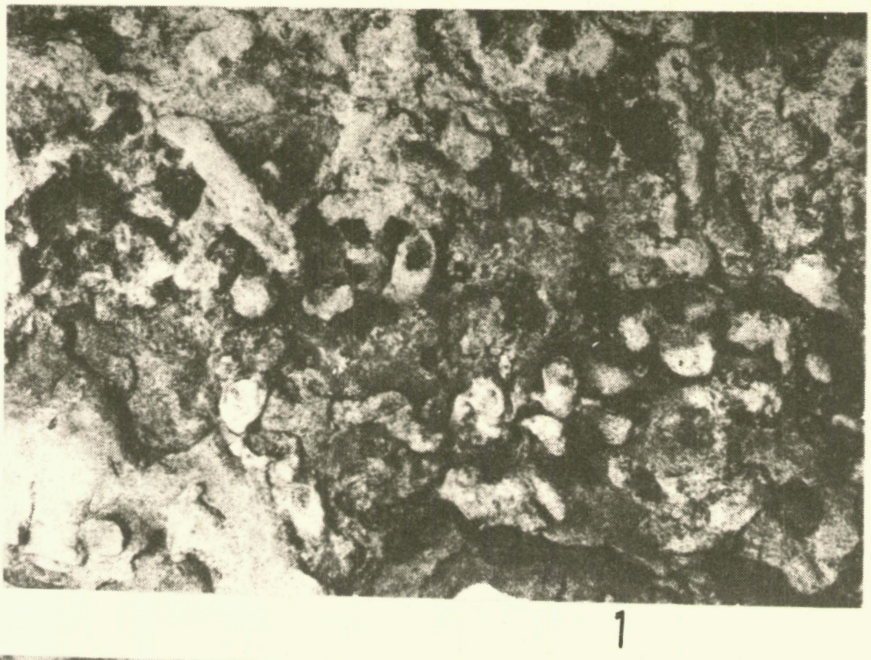

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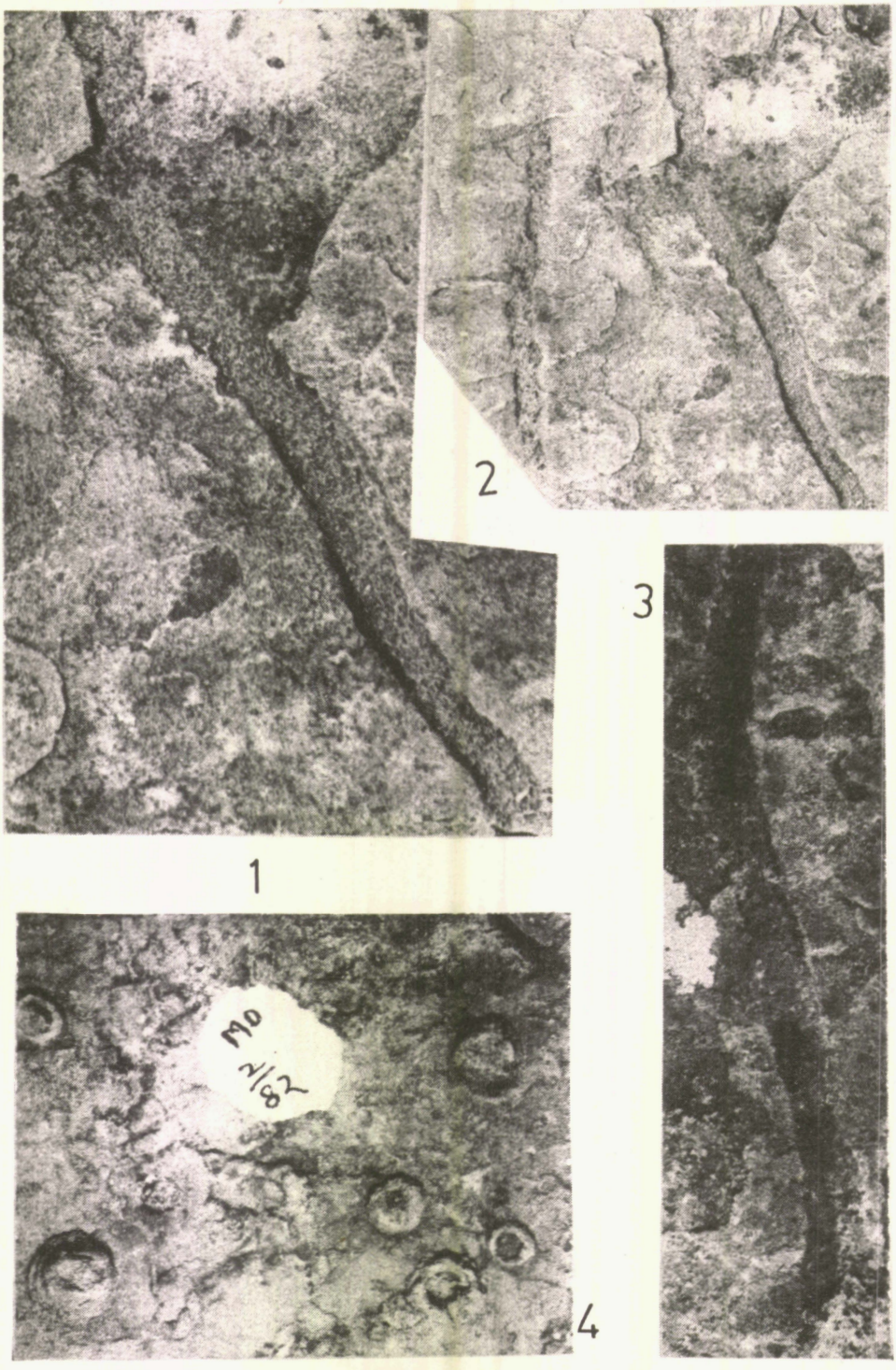
Fig. 1. *Palaeophycus heberti* (Saporta). Plesiotype no. MACS G 2328. ×1.

Fig. 2. *Ichnogenus* Type B. Figured sp. no. MACS G 2327. ×1.

Fig. 3. *Ichnogenus* Type C. Figured sp. no. MACS G 2333. ×1.5.

Fig. 4. *Ichnogenus* Type A. Figured sp. no. MACS G 2323. ×1.

PLATE V



Figs. 1–3. *Granularia yelamensis* sp. nov.

1. Holotype no. MACS G 2321. ×1.
2. Holotype no. MACS G 2321. ×1.
3. Paratype no. MACS G 2322. ×1.

Fig. 4. ? *Cylindrichnus* sp.

Burrows in cross section. Figured sp. no. MACS G 2332. ×1.

Geological horizon: Nimar Sandstone, Bagh Beds, Cenomanian-Turonian.

Ichnogenus: *Cylindrichnus* Toots in Howard, 1966
? *Cylindrichnus* sp.
(Pl. V, fig. 4)

Material: Large number of burrows on slabs. *Figured* sp., no. MACS G 2332

Dimensions: Burrow diameter 10 mm-20 mm. Thickness of burrow wall – 4 mm-5 mm.

Description: Burrows circular or elliptical in cross-section having a thick multi-layered wall; may be vertical, horizontal or inclined; fairly crowded.

Remarks: The burrows have been doubtfully assigned to *Cylindrichnus* as due to poor preservation their subconical form could not be confirmed. Frey and Howard (1970, p. 52, fig. 76) considered these burrows as a form of *Asterosoma.* However, Haentzschel (1975, p. W 43) did not agree with their interpretation, which appears quite reasonable as the latter is a star shaped burrow.

Ichnogenus: *Granularia* Pomel, 1849
Granularia velamensis sp. nov.
(Pl. V, fig. 1-3)

Material: Two slabs. Holotype no. MACS G 2321; Paratype no. MACS G 2322.

Description: Branching burrows parallel to bedding plane; preserved in negative epirelief; width of burrows 5 mm to 10 mm and filled with coarse sand grains cemented together to form elongated pellets aligned along the length of the burrow.

Remarks: Chiplonkar and Ghare (1975a, 1979) described two species of *Granularia.* The first one, i.e. *G. obliqua* comes from the shaly intercalations developed in the upper portion of the Nimar Sandstone, Bagh Beds exposed around Motichkli. It has obliquely filled sediments and thus differs from the present species.

G. utaturensis, their second species, comes from the Utatur Group (U. Albian–Cenomanian) of South Indian Cretaceous and has a distinctly larger burrow diameter than the present species.

This genus occurs typically in flysch deposit in Europe, England and Australia, (Haenzschel, 1975). The species described here and those by Chiplonkar and Ghare occur in sandstone, shale and limestone deposited in near shore shelf region.

Gyrochorte Heer, 1865
Gyrochorte comosa, Heer
(Pl. III, Fig. 2b)

1970 *Gyrochorte comosa* Heer: Hallam, p. 190, pl. 1a–f, figs. 1, 2.

1975 *Gyrochorte comosa* Heer: Haentzschel, p. W65, fig. 40.1.

Material: Several specimens. Plesiotype no. MACS G 2320b, 2325, 2326.

Remarks: Winding and criss-crossing, plaited ridges preserved in positive epirelief represent this species. The specimens from the Bagh Beds, have constant width of 1 mm–3 mm which come well within the range of variation exhibited by *G. comosa* Heer.

Ichnogenus : *Keckia* Glocker, 1841
Keckia annulata Glocker, 1841

1975 *Keckia annulata* Glocker : Haentzschel, p. W. 5, fig. 47.2

1975b *Keckia annulata* Glocker : Chiplonkar and Ghare, p. 583-584, fig. 1.

Material : One slab. Plesiotype no. MACS S 2324

Remarks : Burrows thick-walled. Short in length, frequently branched and stuffed with faecal matter. Burrow diameter 10 mm ; preserved as negative epi-relief in hard sandy limestone.

The earlier discovery of these burrows is also from the top of the Nimar Sandstone (Chiplonkar and Ghare, 1975b).

Ichnogenus : *Palaeophycus* Hall, 1847
Palaeophycus annulatus sp. nov.
(Pl. III, figs. 1 and 4)

Material : A large number of burrows. Holotype no. MACS G 2329 ; Paratype no. MACS G 2330.

Dimensions : Diameter of burrow – 8 mm to 20 mm ; Wall thickness – 1 mm to 1.5 mm.

Description : Burrows circular or elliptical in cross section having a thin wall and a thick core ; may be vertical, horizontal or inclined in disposition, burrow wall distinctly annulated.

Remarks : Pemberton and Frey (1982) gave a key to identify the presently known five species of *Palaeophycus*. Out of those, two ornamented species, viz., *P. sulcatus* (Muller and Dyer) and *P. alternatus* Pemberton and Frey (1982) can be compared with the present species. The former bears anastomosing striae and the latter possesses alternate striae and annulations respectively. While present specimens are distinctly annulated and hence differ from the above two species.

Palaeophycus heberti (Saporta), 1872
(Pl. IV, fig. 1)

1962 *Siphonites heberti* Saporta : Haentzschel, p. W 215 ; text fig. 135, 4.

1975 *Siphonites heberti* De Saporta : Haentzschel, p. W 106 ; fig. 65, 2.

1975 *Palaeophycus heberti* (Saporta, 1872) : Alpert, p. 518.

1982 *Palaeophycus heberti* (De Saporta) Pemberton and Frey, p. 861, fig. 1, figs. 4, 9 ; pl. 4, fig. 4.

Material : One slab. Several burrows. Plesiotype no. MACS G 2328.

Remarks : Burrows show vertical, inclined or horizontal habit, having 1 cm to 2 cm length and 5 mm diameter. Burrow wall is 2 mm thick. The infilled material is same as the burrow walls.

Palaeophycus tubularis Hall, 1847
(Pl. III, fig. 3)

1962 *Palaeophycus tubularis* Hall : Haentzschel, p. W 208.

1970 ? *Palaeophycus* type C : Osgood, p. 377, Pl. 83, figs. 1, 4 ; text fig. 5.

1975 *Palaeophycus tubularis* Hall : Haentzschel, p. W88 – W89. text fig. 54 – 4

1975 *Palaeophycus tubularis* Hall : Alpert, p. 518.

1975 *Planolites montanus* Richter : Alpert, 1975, p. 163, text fig. 7C.

1975 *Planolites beverleyensis :* Alpert p. 513 – 514, Pl. 1, fig. 15, Pl. 3. figs. 1, 7, 8.

1975 *Planolites virgatus :* Alpert p. 517 – 518, pl. 3, figs. 2, 6.

1982 *Palaeophycus tubularis* Hall, 1847 : Pemberton and Frey,

Pl. 1, figs. 1, 2, 5, 6, 8, 10, Pl. 2, fig. 1,
Pl. 3, figs. 3, 6, Pl. 4, fig. 5.

Material : Single specimen. Plesiotype no. MACS G 2331.

Remarks : Single collapsed burrow having 1 cm diameter ; burrow wall thin and distinct, infilled material same as the matrix. By its characters, the present burrow is assignable to *Palaeophycus tubularis* Hall.

Ichnogenus Type B
(Pl. IV, fig. 2)

Material : One slab, figured specimens No. MACS G 2327.

Description : Burrows about 3 cm to 4 cm in length and 5 mm in width with sagitate head like portion of 5 mm exhibiting fine and close spaced annulation prominently on the head and perhaps also on the entire surface.

Remarks : The present burrows differ from *Bijungites* Desio, (Haentzschel, 1975, p. W46) in having sagitate or hemispherical head only at one end. The burrows have been preserved as positive hyporelief.

Ichnogenus Type C
(Pl. IV, fig. 3)

Material : One burrow ; figured specimen no. MACS G 2333.

Description : Burrow subcylindrical, club shaped having a maximum width of 12 mm and preserved length of 35 mm highly characterised by ridge like oblique markings roughly meeting in the median region. Some of the ridges distinctly bifid.

Remarks : The burrow is preserved in full relief and perhaps represents endichnial repichnia. However, more material is necessary to establish the identity firmly ; hence, it is described here without giving any formal name.

DISCUSSION

Out of eleven ichnogenera described here *Gyrochorte, Palaeophycus* and? *Cylindrichnus* are the most dominant. In addition to these, other distinctive but ill preserved ichnogenera found, are *Arthophycus, Ophiomorpha* and *Thalassinoides.* Being characterized by infaunal repichnial traces and variously oriented cylindrical burrows, present trace fossil assemblage belongs to the *Cruziana* facies which indicates shallow sub-littoral environ of moderate to relatively low energy conditions. (Frey, 1975, p. 17).

In western region of the Bagh Beds i.e. in Man river valley and further west, a distinct trace fossil horizon is developed below the *Jhabotrigonia – Turritella* bed in the Nimar Sandstone (Chiplonkar and Badve, 1972). Trace fossils are not totally absent in *Jhabotrigonia – Turrilella* bed itself (Chiplonkar and Ghare, 1975b). However, in Barwah region development of sandy shales and sandstone alternations abounding in trace fossils is seen immediately above the *Jhabotrigonia – Turritella* bed. Thus the present trace fossil assemblage is developed at a stratigraphic position at a little higher horizon than in the western region, but still within the body of the Nimar Sandstone.

REPOSITORY

All the specimens described here have been deposited in the museum of Geology and Palaeontology, M. A. C. S. Research Institute.

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