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Miocene instead of Jurassic: the importance of sound fieldwork for paleontological data analysis

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Abstract.—A diverse molluscan assemblage dominated by turritellid gastropods found in Kachchh, western India, has been interpreted in the past as Late Jurassic (Oxfordian) in age, based on associated undoubtedly Oxfordian ammonites. Recently, several investigations focused on the assemblage dealing with taxonomic, paleoecological, and evolutionary aspects. An analysis of the associated bivalve fauna, foraminiferal assemblage, and the geological context strongly suggests a Miocene rather than a Jurassic age and invalidates several conclusions drawn from the alleged Jurassic age of the fossils.

Introduction

During Jurassic times, gastropods were generally only subordinate components of benthic communities, which usually were dominated by bivalves (e.g., Fürsich, 1977; Aberhan, 1992; Holzapfel, 1998; Fürsich et al., 2004). There are notable exceptions, for example, the Pliensbachian Buttenheim Formation in southern Germany where gastropods commonly occupy the first two positions in rank abundance of any quantitatively collected sample (Karapunar et al., 2020, table 3). In Lower Jurassic offshore carbonates in South Wales gastropods constitute 30% of the total fauna and are much more diverse when silicified, whereas their diversity and abundance are much lower (1%) where no silicification occurred (Wright et al., 2003). The latter authors argued that the diversity and abundance of Jurassic aragonitic molluscs such as gastropods are grossly underestimated due to early diagenetic dissolution of their aragonitic shells. This view is also shared by studies of other geological time intervals (e.g., Seuss et al., 2009; Foot et al., 2015; Roden et al., 2020), even though the reason for the bias appears to be more complex.

The documentation of a rich gastropod fauna from Oxfordian strata of the Kachchh Basin of western India, which is dominated by turritellids (Mitra and Ghosh, 1979; Das et al., 2018) and comprising more than 20 species (Saha et al., 2021), seems to underpin the point made by Wright et al. (2003) and Cherns and Wright (2000, 2009) that the Phanerozoic record of macrobenthic communities is generally strongly skewed. However, as we demonstrate in the following, the age of the assemblage from Kachchh has been wrongly determined: it is Miocene and not Late Jurassic. This is important, because far-reaching conclusions concerning the taxonomy of gastropods, paleoecology, biostratigraphy, and evolutionary lineages have been drawn from the assemblage based on its "Jurassic" age.

History of research

The Kachchh Basin is a Jurassic rift basin situated at the western margin of the Indian craton (e.g., Biswas, 2016) that contains a predominantly shallow marine succession, parts of which are highly fossiliferous. The micro- and macrofauna of the strata have been documented in numerous papers, starting with J. de C. Sowerby (1840). The discovery and documentation of a locality rich in fossils close to the Jhura Dome on the so-called Kachchh Mainland (see Fürsich et al., 2020, for a geological sketch map of Kachchh) by Mitra and Ghosh in 1979 was therefore not unexpected. The authors failed to provide precise locality information, but determined the age of the strata, which they identified as 'Dhosa Member,' as Oxfordian based on the ammonites *Peltoceras kumagunense* Spath, 1931, and *Parypho-ceras rugosum* Spath, 1928, which had been collected earlier from the locality by Mitra and Ghosh (1964). From their locality they recorded abundant turritellid gastropods and described two new species, *Turritella jadavpuriensis* and *T. jhuraensis*. Several years ago, a group of paleontologists from Kolkata revisited the area and found abundant turritellid gastropods in a small pond section southeast of the village of Jhura (Das et al., 2018, fig. 1; the co-ordinates given do not match the locality sketch map). They bulk-sampled several horizons with turritellids between 2012 and 2016 and obtained more than 13,000 specimens of turritellids (which represented 85% of the total assemblage), as well as other gastropods and bivalves.

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Das et al. (2018) described four turritellinid species, *Turritella jadavpuriensis* Mitra and Ghosh, 1979, *T. jhuraensis* Mitra and Ghosh, 1979, *T. amitava* n. sp., and *T. dhosaensis* Das et al., 2018, and declared them as the oldest members (by 30 million years) of the family Turritellidae. They accepted the lithostratigraphic position of the beds they investigated as part of the Dhosa Oolite Member and found a single belemnite specimen, *Belemnopsis langanensis* (Futterer, 1894) in their section. Based on the ammonite evidence obtained by Mitra and Ghosh (1979) as well as subsequent biostratigraphic studies on the Dhosa Oolite Member and lithological considerations, they placed the *Turritella*-bearing horizons in the upper part of the lower Oxfordian.

Das et al. (2019) published a paper describing two naticid gastropods from the same locality, *Euspira jhuraensis* n. sp. and *Gyrodes mahalanobisi* n. sp., thus pushing back the time of origin of the family Naticidae by 30 million years. A third species, *Euspira lakhaparaensis* Das et al., 2019, is represented by a single specimen and allegedly comes from upper Tithonian rocks in the western part of the basin.

Saha et al. (2021), in an attempt to erect a biostratigraphic scheme of the Jurassic sedimentary successions of the Kachchh and Jaisalmer basins, recognized the Turritella Zone for the upper Oxfordian strata of the Kachchh Rift Basin and correlated it with the Bifurcatus Ammonite Zone.

Finally, Bardhan et al. (2021) published an elaborate ecological study on naticid-molluscan prey interaction during the Late Jurassic based on the bulk samples obtained from the pond locality. Gastropods account for ~90% and bivalves for 9% of the molluscan assemblage. The authors recognized a gastropod community with 19 species, in which turritellinids account for 98% of the individuals. The less abundant bivalves also are represented by 19 species and dominated by nuculids and corbulids. Bardhan et al. (2021) suggested that turritellines and naticids both evolved during the Jurassic and that a predator-prey relationship became established soon thereafter.

Locality information

According to the coordinates given by Das et al. (2018, 2019), the locality with the pond section is in the upper part of the Callovian Jumara Formation, being composed of shales and subordinate sandstones. This area, visited by us repeatedly during the

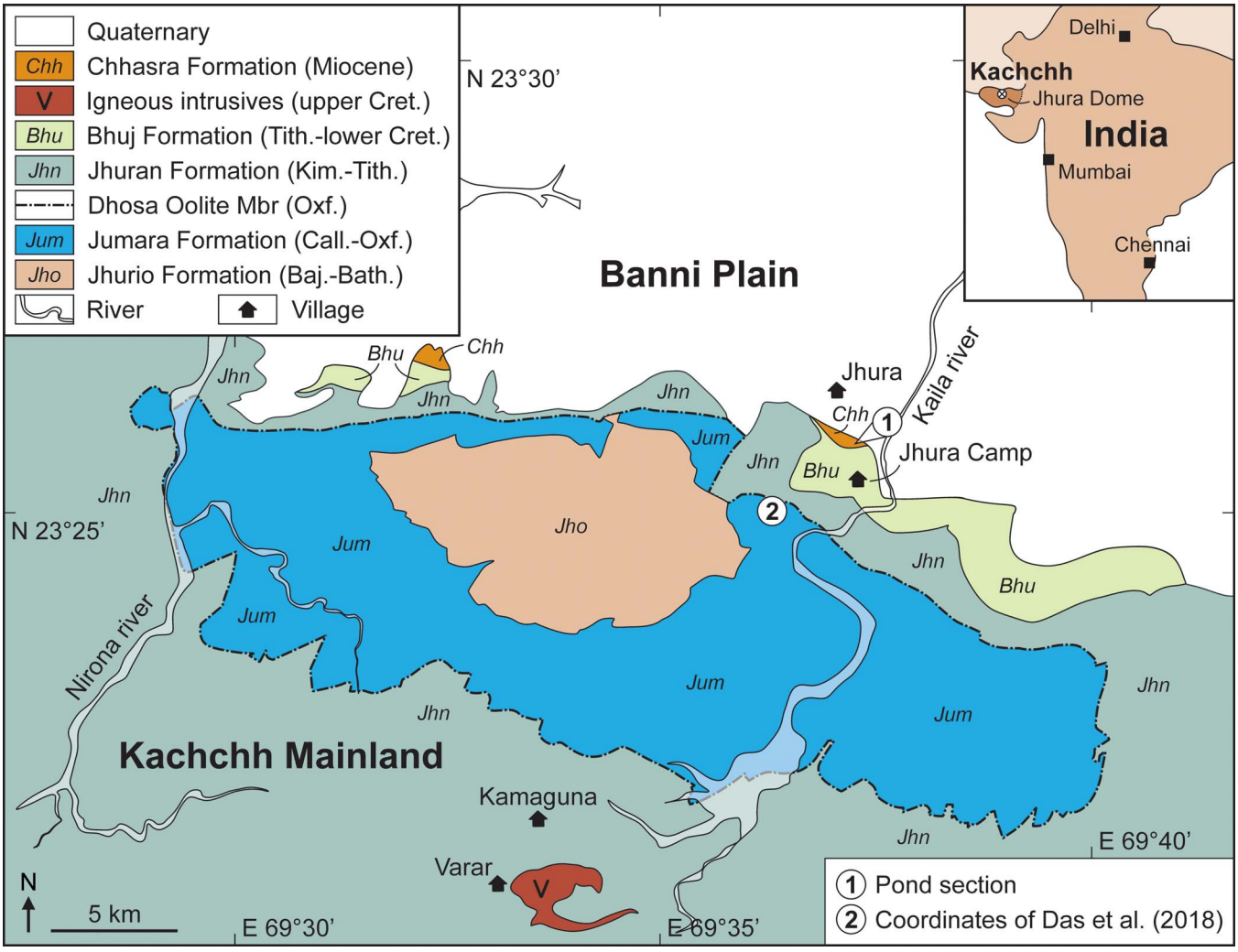

Figure 1. Simplified geological map of the Jhura Dome indicating the turritellid locality (pond section) and the erroneous co-ordinates given by Das et al. (2018) (modified after Biswas and Deshpande, 1970). The inset map shows the position of the Kachch Basin in India. Baj. = Bajocian; Bath. = Bathonian; Call. = Callovian; Oxf. = Oxfordian; Kim. = Kimmeridgian; Tith. = Tithonian; Cret. = Cretaceous.

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last 30 years, has not yielded a single turritellid gastropod, nor are there any ponds. The position of the pond section given by Das et al. (2018, fig. 1) in their locality sketch is correct. Investigation of the area by one of us (S.B.) in February 2022 showed the presence of several small ponds, which yielded abundant turritellids in situ and in dumps of rocks that had been excavated during construction of the ponds. The section shown by Das et al. (2018, fig. 3) could not be verified.

Miocene rocks in the vicinity of the Jhura Dome

The Lower Miocene Chhasra Formation of the Kachchh Basin indicates peak transgression (Biswas, 1993), during which the sea reached distant low-lying areas and the periphery of uplifted highlands. Remains of these sediments are seen between the northern limb of the Jhura (Jhurio) Dome of Kachchh Mainland and the Banni Plain (Fig. 1) (Biswas, 1993, p. 225). One of these outcrops lies 1 km south-southeast of the village Jhura in an artificially constructed small pond (23°25'32.9"N, 69°37'04.2"E).

The beds of the Chhasra Formation at this locality are deformed and tilted at 65–85° towards the north. Miocene strata occur in close vicinity to the Tithonian/Lower Cretaceous Bhuj Formation. The contact between the two stratigraphic units is covered by Quaternary alluvial sediments, which occasionally contain fragments of ammonites and belemnites transported from nearby outcrops of Jurassic strata that form the Jhura Dome. The Miocene lithology is characterized by argillaceous sediments. Six meters above the base, fossiliferous bands with abundant gastropods, bivalves, and echinoid spines occur in thin (up to 4-cm-thick) bioclastic marl bands and argillaceous-silty layers (Figs. 2, 3).

Discussion

Available evidence strongly indicates that the turritellid-dominated molluscan assemblage is Miocene and not Late Jurassic in age.

Ammonite evidence.—The origin of the ammonites recorded by Mitra and Ghosh (1979) clearly is the Oxfordian Dhosa Oolite Member, which seems to contradict the statement made above. Their occurrence at the pond locality can be explained in two ways. (1) They either are allochthonous, derived from the ridge exposing the Dhosa Oolite Member ~1.6–2.1 km away, having been transported during flash floods to the pond area in recent times. Mitra and Ghosh (1979) did not provide any information whether the ammonites were collected from the section or from scree. (2) Alternatively, if the ammonites were collected from the section, they could have been reworked, transported, and become incorporated in younger sediments during deposition of the turritellid-dominated molluscan assemblage. The presence of the single belemnite recorded by Das et al. (2018) can be explained in the same way.

Presence of nearby Miocene strata.—The pond area has been mapped by Biswas and Deshpande (1970). The geological map (Fig. 1) shows outcrops of Miocene strata in the pond area. Lower Miocene rocks (Khari Nadi and Chhasra formations) that occur in the Kachchh area contain rich molluscan assemblages, strongly dominated by turritellids (e.g., Goswami et al., 2020). It is logical to conclude that the pond section contains Miocene sediments that filled topographic depressions in underlying Jurassic rocks. These rocks most likely belong to the Tithonian/Lower Cretaceous

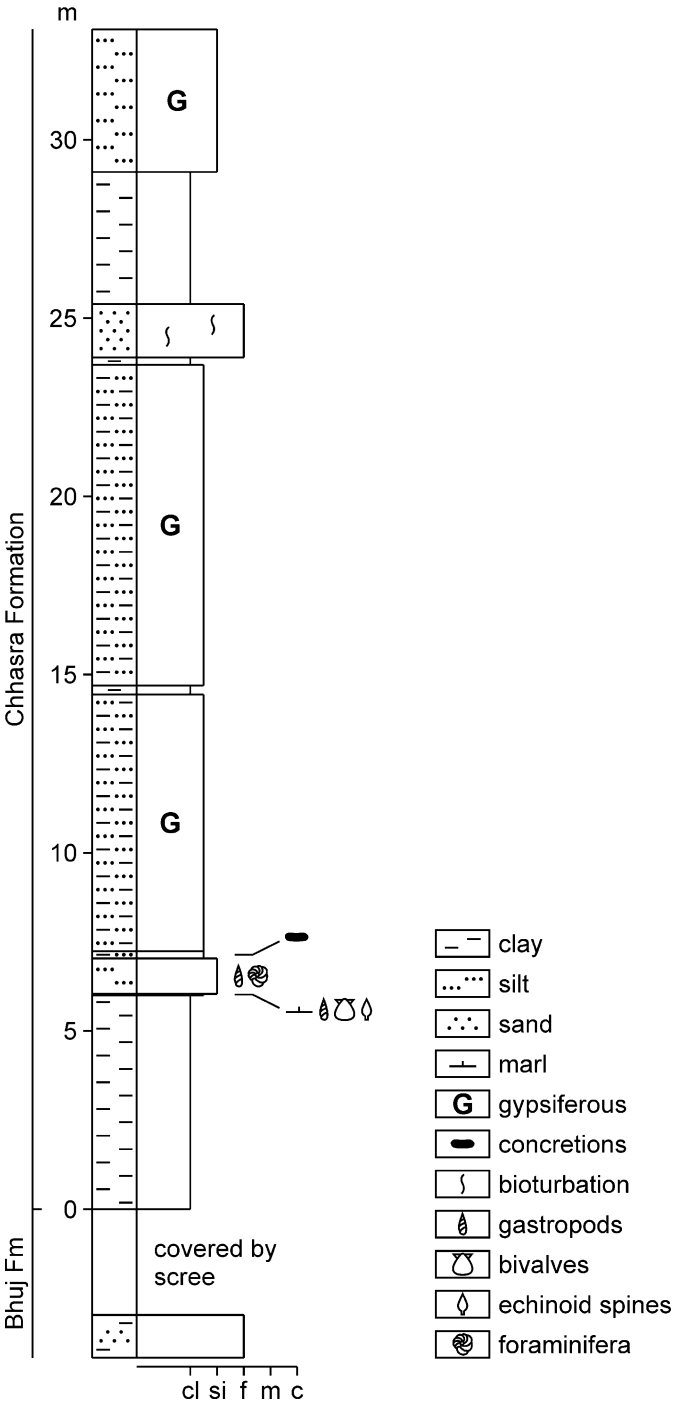

Figure 2. Litholog of the locality SSE of the village Jhura, towards the northern flank of the Jhura Dome. The base of the section is the Upper Jurassic/Lower Cretaceous Bhuj Formation, overlain by the Lower Miocene Chhasra Formation, yielding a rich molluscan assemblage dominated by turritellid gastropods. cl, clay; si, silt; f, fine-grained sand; m, medium-grained sand; c, coarse-grained sand.

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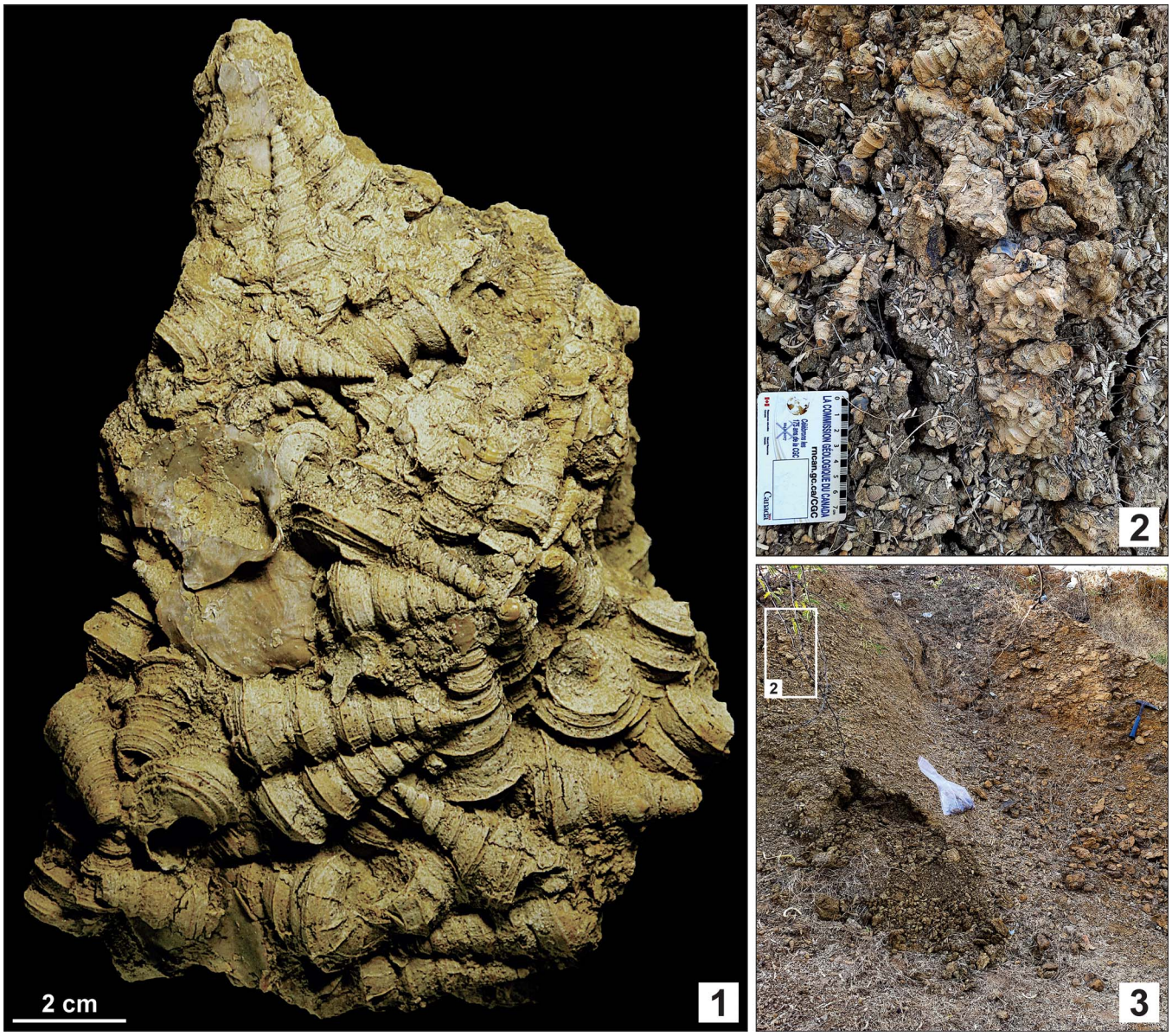

Figure 3. (**1, 2**) Molluscan concentration dominated by turritellid gastropods 6 m above the base of the Chhasra Formation at the pond section; specimen shown in (**1**) reposited in the collections of Kachchh University, Bhuj; repository number KSKV2022/Jhura 1. (**3**) Field photograph of partly indurated, strongly bioclastic argillaceous-marly strata. White rectangle denotes position of (**2**).

Bhuj Formation, which crops out in the vicinity of the pond section.

Characteristic features of the Dhosa Oolite Member.—In the southern Jhura Dome, the Dhosa Oolite Member is a 5.5-m-thick unit composed of brownish thick-bedded, strongly bioturbated, Fe-oolitic, argillaceous-silty and fine-sandy bio-wacke- and bio-packstones with large sandstone slabs floating in the top part (Alberti et al., 2013a). The unit contains abundant bivalves, brachiopods, ammonites, and wood fragments. Gastropods are rare and mainly represented by pleurotomariids (Alberti et al., 2013b). Not a single turritellid gastropod occurs. The fact that at the pond section abundant turritellids occur, but not a single specimen in the Dhosa Oolite Member situated <3 km away, nor anywhere else in the Callovian–Oxfordian rocks of the Kachchh Basin, speaks against a Jurassic age of the molluscan assemblage of the pond section.

Cenozoic character of the associated gastropods and bivalves.—Bardhan et al. (2021) discussed the composition of the molluscan assemblage in some detail and, in their supplementary table 1, provided a comprehensive faunal list with the number of specimens of each taxon and the number of drilled specimens. Apart from the turritellinids and naticids, the remaining gastropod genera listed (e.g., *Murex*, *Scala*, *Cypraeorbis*, *Volutilithes*, and *Pachycymbiola*) are clearly Cenozoic and have not been recorded from the Jurassic anywhere. The list of bivalves contains several Jurassic taxa, but these are apparently misidentifications. For example, the

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abundant *Indocorbula* sp. (Bardhan et al., 2021, figs. 1–9) is a corbulid but not *Indocorbula*. The two species of *Indocorbula* documented from the Kachchh Basin, *Indocorbula lyrata* (J. de C. Sowerby, 1840) and *I. basseae* (Singh and Rai, 1980), differ distinctly in shape and ornamentation (Fürsich et al., 2000). Similarly, no Jurassic nuculid occurring in the basin resembles the specimen figured as *Palaeonucula* sp. by Bardhan et al. (2021, figs. 1–9) (see Jaitly et al., 1995), and genera such as *Tellina*, *Macrocallista*, and *Anadara* are widespread in the Cenozoic but do not occur in the Jurassic. This casts doubt on the identification of taxa that are characteristic of the Jurassic, such as *Chlamys textoria* (Schlotheim, 1820), *Nuculana* (*Praesaccella*) *juriana* Cox, 1940, and *Tancredia*. The dominance of gastropods in the assemblage also points to a much younger age of the fauna than Late Jurassic.

Cenozoic character of the microfauna.—Two samples from the turritellid assemblage have been processed with diluted hydrochloric acid and sieved for microfossils. They contained a well-preserved, moderately diverse foraminifera and ostracode assemblage, composed of taxa such as *Quinqueloculina*, *Cibicides*, *Astacolus*, *Ammonia*, and *Bolivina* or *Brizalina*. This fauna is not Jurassic, but Cenozoic in age—most likely Miocene (P.K. Saraswati, personal communication, 2022).

Conclusions

Based on the arguments and evidence presented herein, the turritellid-dominated molluscan assemblage occurring south-southeast of the village of Jhura cannot be Jurassic in age, but is Cenozoic, most likely Miocene, in age. The new species of turritellinid and naticid gastropods erected on the material need to be re-evaluated within the framework of contemporaneous Miocene faunas. The Jurassic gastropod biozonation proposed by Saha et al. (2021) contains flaws; there is no foundation for the late Oxfordian Turritella Zone. The analysis of gastropod predator-prey interaction based on this material, although correct, does not justify any conclusions about the evolution of such interaction during the Jurassic period. Identification of the molluscan assemblage is partly erroneous. The authors of the studies criticized above made the mistake in accepting the biostratigraphic conclusions of Mitra and Ghosh (1979) without scrutinizing the evidence produced by these authors. As a sideline, the molluscan assemblage does not underpin that Paleozoic and Mesozoic benthic communities are generally skewed with respect to preservation of aragonitic taxa.

In conclusion, the most sophisticated data analysis is bound to fail, if primary data such as stratigraphic position and the autochthony or allochthony of the fossil components are not investigated with the necessary accuracy, and if sampling is not confined to in-situ material. This is particularly important, if the results have far-reaching implications, as in the present case, with respect to paleoecology, taxonomy, and evolution.

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Declaration of competing interests

The authors declare none.

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