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Oldest known gobiids from Vastan Lignite Mine (early Eocene), Surat District, Gujarat

The family Gobiidae (order Perciformes) constitutes the most diversified of all Recent fish families, represented by nearly 2000 species in the world today. Gobiids popularly called gobies, are the smallest known fishes (usually less than 10 cm in size) that live mostly in shallow marine coastal waters and around coral reefs. Presently, they occur in most parts of the world in the coastal areas of the tropics and the subtropics. The origin and early evolutionary diversification of gobiids have attracted interest in recent years^{1,2}.

In the fossil record, gobiids occur rather abruptly at the Eocene–Oligocene boundary and are extremely scarce in the Eocene. The few known Eocene occurrences include a skeleton from the late Eocene (Priabonian) of southern England³; a poorly preserved skeleton from the early middle Eocene (Lutetian) of Catalonia, Spain⁴; a single otolith from the middle Eocene (late Lutetian) of Kutch, western India; two otoliths from the middle Eocene (Bartonian) of Java⁵ and, more recently, over 50 otoliths from the late Eocene (Priabonian) Yazoo Clay, Louisiana, USA². Here we report the globally oldest occurrence of gobiids on the basis of a large number of otoliths, numbering over 200, from the early Eocene (Ypresian) sediments at Vastan lignite mine, Surat District, Gujarat, western India. This open pit mine, located about 3 km northeast of the village Nani Naroli, Surat District (Figure 1), is managed by the Gujarat Industrial Power

Corporation Limited (GIPCL). Otoliths from the same area were recently reported by one of the authors⁶, but that assemblage came from a limited sample of borehole clays and the gobiids were not discovered by then. The present collection was recovered by screenwashing dark-green shales that occur about 3 m below the base of the first (or uppermost) lignite seam exposed in the northern side

of the lignite mine at Vastan (Figure 1). This collection occurs in association with a large number of other teleost otoliths. Ongoing study suggests that ambassids form the most dominant family in this assemblage. Other associated biota comprise a diverse assemblage of rays, molluscs as well as a large number of benthic foraminifera, including the age diagnostic species *Nummulites burdigalensis*, which

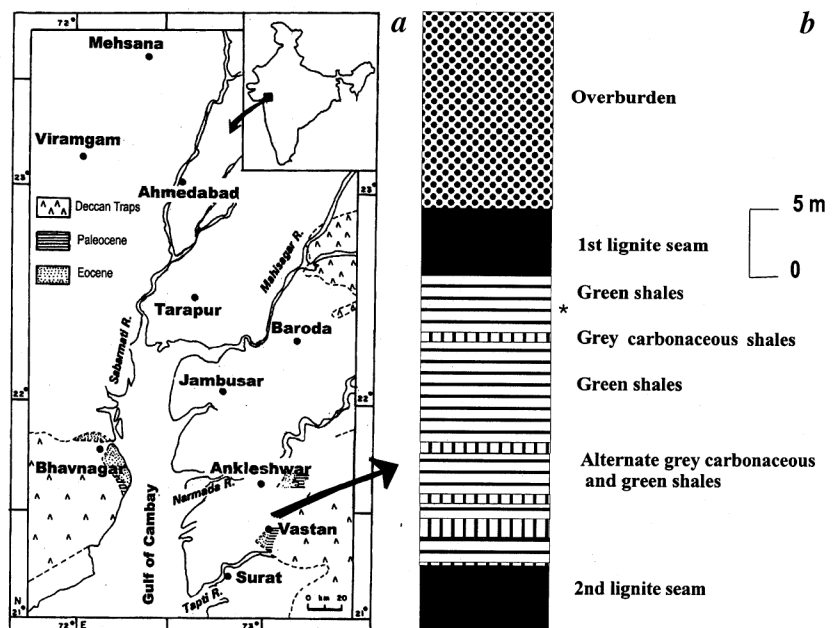


Figure 1. a, Location map of fossil locality. b, Lithostratigraphic section at Vastan showing otolith-bearing horizon (marked by *).

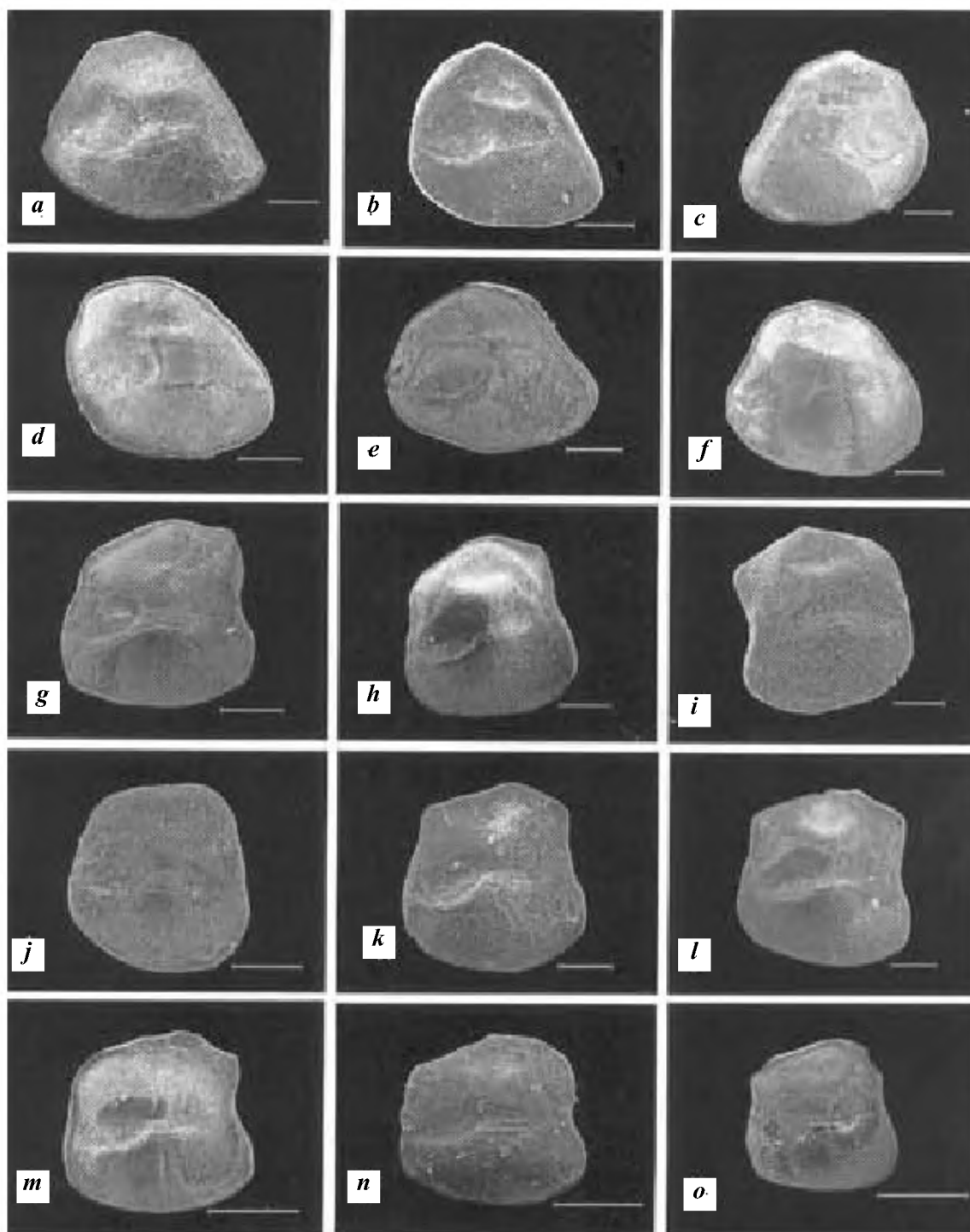


Figure 2. Gobiid otoliths from Vastan lignite mine, Surat district. *a-f*, Genus *Gobiidarum nolfi* n.sp. (IITR/SB 251-256); *g-o*, Genus *Gobiidarum vastani* n.sp. (IITR/SB 257-265). Bar equals 150 μ m for *a-l*, and 300 μ m for *m-o*.

indicates a Ypresian age, probably corresponding to the Shallow Benthic Zone SB 10 or the planktonic foraminiferal zone P7 (ca. 52 Ma)⁷.

Two new species encountered in the present assemblage are genus *Gobiida-*

rum nolfi n.sp. and genus *Gobiidarum vastani* n.sp. The latter is much more common and is represented by nearly 150 specimens (Figure 2).

Systematic Paleontology

Order Perciformes
 Suborder Percoidei
 Family Gobiidae
 Genus *Gobiidarum nolfi* n.sp.
 Material: Over 50 otoliths.
 Holotype: IITR/SB/251, right otolith.

Paratypes: Four otoliths (IITR/SB/252-256).

Horizon and locality: Dark-green shale below the top lignite seam, Vastan lignite mine, Surat District, Gujarat.

Etymology: Named after Dr Dirk Nolf (Belgium), in recognition of his research on fossil otoliths.

Diagnosis: Overall shape somewhat trapezoidal with extended postero-ventral region; inner face slightly convex; outer face much more convex; greatest thickness at the centre; ventral rim somewhat rounded and characteristically longer than dorsal rim; posterior rim oblique; anterior rim obliquely straight; sulcus with a larger ostium than cauda; anterior end of sulcus close to, but totally disconnected from ostial rim; shallow but distinct depression above the sulcus.

Remarks: This species is not closely comparable to any known fossil gobiids and probably belongs to an extinct genus.

Genus *Gobiidarum vastani* n.sp.

Material: Approximately 150 otoliths.

Holotype: IITR/SB/257, right otolith.

Paratypes: Eight otoliths (IITR/SB/258-265).

Horizon and locality: Dark-green shale below the top lignite seam, Vastan lignite mine, Surat District, Gujarat.

Etymology: Named after the type locality Vastan, Surat District, Gujarat.

Diagnosis: Shape sub-quadrangular; height and length nearly equal; maximum thickness of otoliths in the lower half; outer

face markedly more convex than inner face; ventral rim broadly rounded and slightly longer than dorsal rim; prominent postero-dorsal angle present on the dorsal rim; upper half of both anterior and posterior rims with a characteristic notch; posterior constriction more prominent; sulcus located anteriorly along the midline but totally disconnected from anterior margin; ostium expanded antero-ventrally; shallow depression present just above the sulcus.

Remarks: This species resembles 'Gobiidae sp.2' from the Middle Eocene Nangulan Formation of Java⁵, but the latter species can be easily distinguished by its centrally located sulcus.

The present find is paleobiogeographically significant because it represents the oldest record of the family Gobiidae in the world. Taken together with the presence of gobiids in the middle Eocene of Kutch and Java, it clearly shows that the traditional idea of an 'explosive' appearance of this family at the Eocene-Oligocene boundary was probably an artifact of the fossil record, and that the gobiids were already an important group in the early Eocene coastal marine fish ecosystems in India. This probably holds true for several other groups of perciform fishes whose otolith-based fossil records have so far been known mainly from Europe, but which are strikingly diverse in modern Indo-West Pacific marine faunas. Ongoing study of the Vastan and Kutch otolith associations is expected to

provide further insight into the nature of early history of these groups.

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Abundance of pollution indicator and pathogenic bacteria in Mumbai waters

Besides translocating commercial goods, the shipping trade inadvertently spreads many animal, plant and microbial species around the world. Ballast water pumped in from coastal waters mediates translocation of alien biota to new destinations. Wide physiological adaptability, species diversity and invidiousness of some bacteria to cause diseases in animals and plants call for investigations to decipher the deleterious effects brought about through ballast water exchange. From the ca. 12 billion tones of annual translocation of

ballast water by bulk cargo ships, increasing numbers of non-indigenous organisms have become established in new locations around the world¹. Despite growing concern of bioinvasion and perceptible threats of disease-causing pathogens, direct studies on translocation of bacteria through ballast are rare, as well as the extent and implicit effects of the transfer of microorganisms in ballast water are not studied. In addition to a variety of macro-bio-invaders^{2,3}, many bacteria can survive long duration in the ballast tanks⁴.

Upon ballast release, alien species/strains capable of competing with their resident counterparts become established. Therefore, concerns on locations where exchange takes place and the possible effects of alien organisms taken in during exchanges on the receiving port (including the open ocean), need critical evaluation.

With ca. 5000 ships berthing annually, the Mumbai Port is among the busy ones. Bulk cargo importing/exporting and oil-importing ships possibly exchange ca. 50