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Ptychodus decurrens Agassiz (Elasmobranchii: Ptychodontidae) from the Upper Cretaceous of India

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ABSTRACT

Although a very high invertebrate faunal diversity is known from the outcrops of the Ariyalur group in the Cauvery Basin, southern India, little is known about its vertebrate fauna. Recent fieldwork in the badland exposures of the Karai Formation (Upper Cenomanian–Lower Turonian) near Garudamangalam in the basin has yielded two teeth belonging to the Late Cretaceous shark *Ptychodus decurrens* (Ptychodontidae). The fossil record of *Ptychodus decurrens* from the southern continents is very poor, being known from a single Late/Middle Albian occurrence in Australia. This finding documents the first record of fossil *P. decurrens* in India and second from a Gondwanan landmass, and provides the first evidence of a cosmopolitan, Pangaean, distribution of the species during the Albian–Turonian and additional insights into the palaeoecology of the Cauvery Basin during the deposition of the Karai Formation.

1. Introduction

Ptychodus is a highly specialized extinct genus of the family Ptychodontidae (Elasmobranchii). It is characterized by distinctive grinding-type (durophagous) dentition and is known from the Albian–Campanian (112–70 Ma) stages of the Cretaceous Period (Cappetta, 1987). It has a global distribution and is well represented in the fossil record by isolated teeth, fragments of dentition, calcified vertebral centra, denticles and associated fragments of calcified cartilage (Cappetta, 1987; Johnson and Lucas, 2003; Hamm, 2008, 2010; Shimada et al., 2009, 2010).

The fossil record of *Ptychodus* is diverse and well documented from the Laurasian continents, with reports known from North America (Macleod, 1982; Cappetta, 1987; Welton and Farish, 1993; Everhart and Caggiano, 2004; Blanco-Piñón et al., 2007; Hamm, 2008), Europe (Herman, 1975; Cappetta, 1987; Trbušek, 1999; Niedźwiedzki and Kalina, 2003) and Asia (Cappetta, 1987; Radwański and Marcinowski, 1996; Cuny, 2008). By contrast, the record from the Gondwanan continents is relatively poor, with reports coming from South America (Reinhart, 1951; Wenz, 1972; Brito and Janvier, 2002) and Africa (Cappetta, 1987; Antunes and Cappetta, 2002). Cretaceous elasmobranchs are rare in India with only a few reports coming from the Upper Cretaceous deposits of peninsular India. These include lamniformes from the Cenomanian–Turonian (99.6–89.3 Ma) Bagh Beds of the Narmada Valley (Verma, 1965) and batoids from the Maastrichtian (70.6–65.5 Ma) Deccan infra- and intertrappean sediments of Jabalpur, Pisdura, Marepalli, Nagpur, Asifabad and Kisalpuri in peninsular India (Jain and Sahni, 1983; Courtillot et al., 1986; Prasad and Cappetta, 1993; Khosla et al., 2004; Verma, 2008). Stoliczka (1873) noted the occurrence of *Ptychodus* in Cretaceous deposits of the Cauvery Basin, but he did not describe the specimens. We report here a definitive occurrence of a ptychodontid in the Karai Formation of this basin and discuss its palaeoecological and palaeobiogeographical implications.

2. Geographic and stratigraphic setting

The fish remains described herein were recovered from the Karai Formation (Late Cenomanian–Early Turonian) of the Uttattur Group in the Cauvery Basin. This basin contains a thick accumulation of Cretaceous–Palaeocene sediments (ca. 6 km) with an approximate aerial extent of 25,000 km^2, resting on the Archaean granites along the southeast coast of the Tamil Nadu, southern India

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(Yadagiri and Govindan, 2000). The basin is considered to be a rift basin that developed in response to the Late Jurassic–Early Cretaceous separation of the Indian subcontinent from Australia and Antarctica (Veevers et al., 1991). These sediments record transgressive and regressive cycles that occurred throughout the depositional history of the basin and represent a variety of palaeoenvironments, including shallow marine, estuarine, lagoonal and fluvial/lacustrine (Tewari et al., 1996; Sundaram et al., 2001).

The Cretaceous sedimentary succession of the basin is well-exposed in five isolated outcrops in the Pondicherry, Vridhachalam, Ariyalur, Tanjavur and Sivaganga areas. The outcrops at Ariyalur are the largest and contain an easily accessible well-preserved sedimentary sequence that includes the Uttattur, Trichinopoly and Ariyalur groups, which have traditionally been distinguished based on lithology and fossils (Blanford, 1862; Tewari et al., 1996; Sundaram et al., 2001).

The Uttattur Group, representing the basal most marine transgressive unit of the succession of basin, overlies the Archaean basement along its western margin and unconformably underlies the basal marine regressive phase of the succeeding Trichinopoly Group. The Uttattur Group attains a maximum thickness of some 820 m (Sundaram et al., 2001). Sundaram et al. (2001) subdivided the Uttattur Group into four formations in chronological order: Terani, Arogyapuram, Dalmiapuram and Karai formations (Table 1).

The Karai Formation is the uppermost unit of Uttattur Group. It contains dirty brown to rust-yellow clays, silty clays, sandy clays, siltstones, calcareous sandstones, phosphatic nodules and superficial concentrations of gypsum. It yields abundant remains of oysters, ammonites, belemnites and foraminifers (Ayyasami, 2006). Based on the presence of the ammonite *Mammites conciliatum* and *Pseudaspidoceras footeanun* assemblages zones, a Cenomanian–Early Turonian age has been suggested for the topmost part of the Uttattur Group (Phansalkar and Kumar, 1983). Venkatachalapathy and Ragothaman (1995) suggested a similar age based on the foraminiferal assemblage *Praeglobotruncana*, *Rotalipora* and *Helvetoglobotruncana*. Narayanan (1977) inferred an Early Turonian age from the presence of the foraminiferal *Marginotruncana helvetica–Marginotruncana sigali* Assemblage Zone. Recently, based on the occurrence of the ostreiid *Rynchostreon suborbiculatum* Zone within the Karai Formation, Ayyasami (2006) proposed an Early Turonian age for this formation.

The Karai Formation consists of beds that accumulated in an offshore, highstand depositional environment. The sediments of the lower part of the formation conformably overlie the Dalmiapuram Formation, which was deposited during a transgressive phase in a shallow marine bay (Sundaram et al., 2001). Based on the abundance of belemnites, ammonites and planktic foraminifera, a deep neritic environment close to the shelf edge in a warm climate is inferred for the mid–upper part of the formation, which consists essentially of gypsum-rich clays and shales. The top of the formation reflects the beginning of a marine regression, an event marked by a sudden, sharp reduction in abundance of planktic foraminifera (Venkatachalapathy and Ragothaman, 1995).

The fish remains described here are surface finds, collected from the badland exposures of the middle part of Karai Formation

Table 1
Lithostratigraphic classification of Uttattur Group, Cauvery Basin (Sundaram et al., 2001).

Group	Formations	Age
Uttattur	Karai Dalmiapuram Arogyapurum Terani	Early Turonian to Albian

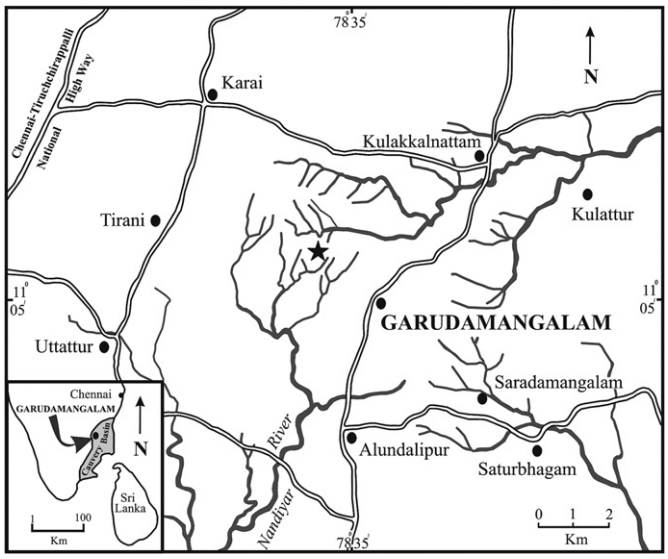

Fig. 1. Location map of the site yielding *Ptychodus decurrens* marked by a star. Inset location map of the Cauvery Basin, Tamil Nadu, southern India.

located some 2.3 km northwest of the village of Garudamangalam, Ariyalur District, Tamil Nadu (Fig. 1). The fish-bearing horizon is thick, and consists of gypsiferous and sandy clays. The fish remains are represented by isolated teeth, scales and vertebrae. The specimens are housed in the Palaeontological Laboratory, Indira Gandhi National Open University, New Delhi, their numbers being prefixed by PL/IGNOU.

3. Systematic palaeontology

Class Chondrichthyes Huxley, 1880
Subclass Elasmobranchii Bonaparte, 1838
Cohort Euselachii Hay, 1902
Subcohort Neoselachii Compagno, 1977
Order *incertae sedis*
Family Ptychodontidae Jaekel, 1898
Genus *Ptychodus* Agassiz, 1835

Ptychodus decurrens Agassiz, 1843
Figs. 2 and 3

Material. PL/IGNOU/101, isolated anterolateral tooth (Figs. 2A, 3A–F); PL/IGNOU/102, isolated tooth (Figs. 2B, 3G–L).

Description. PL/IGNOU/101 is an isolated tooth. Its crown is bilaterally symmetrical and rectangular, possibly indicating that it is one of the anterolateral teeth in the *Ptychodus* jaw (Woodward, 1887; Dilbey, 1911). In occlusal view, the crown is low, broad, slightly inflated, rectangular in shape with gently rounded corners, and projected linguo-distally. The labio-distal margin is rounded. The triturating zone is ornamented by 13 strong, coarse straight to wavy transverse ridges. The marginal area of the tooth is ornamented with much finer anastomosing ridges, which bifurcate on their mesio-distal ends and reach the crown perimeter. There are numerous longitudinal fine ridges on the labial tooth edge perpendicular to the transverse ridges. At the lingual margin, the ridges are bifurcated and branched into numerous finer anastomosing ridges that extend to the edge of the crown. The crown of the tooth overhangs a short, weakly bilobed root. The root is massive, smaller than the crown and pierced by many foramina along the crown-root contact. A shallow labio-lingually