



# FIRST RECORD OF MESOZOIC SCROLL COPROLITES: CLASSIFICATION, CHARACTERISTICS, ELEMENTAL COMPOSITION AND PROBABLE PRODUCERS

by NIBEDITA RAKSHIT<sup>1</sup> , MOHD SHAFI BHAT<sup>1</sup> , DEBARATI MUKHERJEE<sup>2</sup>  and SANGHAMITRA RAY<sup>1</sup> 

<sup>1</sup>Department of Geology & Geophysics, Indian Institute of Technology, Kharagpur, 721302, India; nibeditarakshit91@gmail.com, shafalig@gmail.com, sray@gg.iitkgp.ac.in

<sup>2</sup>Department of Biological Sciences, University of Cape Town, Private Bag X3, Rhodes Gift, 7701, Cape Town, South Africa; mdebarati.iitkgp@gmail.com

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**Abstract:** Multiple, small, cylindrical scroll coprolites having rounded and tapering ends and pertaining to a new ichnotaxon have been recovered from the Upper Triassic Tiki Formation of India. This is the first record of scroll coprolites from the Mesozoic. Based on cross-sectional geometry, external surface textures, and internal morphology, these coprolites are subdivided into three morphotypes. The coprolites contain several kinds of undigested food material in the form of ganoid fish scales, teeth, lower jaw and skeletal remains of various osteichthyans, chondrichthyans, archosauriforms and indeterminate reptiles. These inclusions are embedded in the groundmass separated by thin mucosal layers. The groundmass contains abundant gas vesicles, and secondarily-filled shrinkage cracks. EDS analysis shows that the overall composition of

the coprolites reflects Ca, P, C and O, suggesting calcium phosphate mineralogy, though other elements such as Fe, Mn, Al, Si are present in lesser proportions. Based on their similarity with the scrolled faeces of extant euryhaline hammerhead sharks, it is deduced that these coprolites were produced by euryhaline hybodontid sharks. At least two hybodontid taxa, *Lonchidion* and *Pristrisodus*, show high prevalence in the Tiki vertebrate fauna, suggesting that these were the possible producers. As the coprolite inclusions contain remains of other aquatic animals, these carnivorous hybodonts constituted the dominant predators of the Tiki aquatic ecosystem.

**Key words:** Carnian, coprolite, Gondwana, India, Mesozoic, Tiki Formation.

COPROLITES are fossilized excretory materials of prehistoric organisms. These comprise pulverized undigested or partly digested food material that have passed through the digestive system of an animal and subsequently defaecated (Hunt *et al.* 1994). These coprolites provide direct insights into the digestive processes, diet, prey-selection behaviour and physiology of their producers by shedding light on the biodiversity and the interaction of animals within an ecological system (Hunt *et al.* 1994; Chin & Gill 1996; Chin *et al.* 1998, 2009; Prasad *et al.* 2005; Richter & Wedmann 2005; Matsukawa *et al.* 2006, 2014; Chin 2007; Eriksson & Terfelt 2007; Eriksson *et al.* 2011; Hunt & Lucas 2012; Khosla *et al.* 2015; Niedźwiedzki *et al.* 2016; Luo *et al.* 2017). Unequivocal attribution of coprolites to a specific producer is difficult, though there are multiple approaches involving examination of morphology, inclusions, geochemical composition and associated body fossils that may result in the deduction of the coprolite-producing animal (Northwood 2005; Bajdek *et al.* 2014; Zatoń *et al.* 2015).

Morphologically, coprolites show wide variation and can be broadly categorized as non-spiral cylindrical (without any internal structure), spiral (external appearance resembling a ribbon coiled around a long axis, but internally consisting of stacked and spiraling cones) or scroll (similar to a rolled sheet of paper) based on their outer and inner morphology (Hunt & Lucas 2012, p. 154, fig. 3). The non-spiral cylindrical types are mostly produced by a wide variety of land vertebrates (Romer 1966; Stringer & King 2012). The different morphologies of spiral and scroll coprolites are the consequences of different intestinal architectures (Parker 1885; McAllister 1987; Hunt & Lucas 2012), which are *valvula spiralis* and *valvula voluta*, respectively (Hunt & Lucas 2012, p. 154, fig. 2). Most of the agnathans, dipnoans, actinistians and chondrichthyans have valvular intestines (McAllister 1987).

Worldwide there is a profound record of different types of vertebrate coprolites throughout the Phanerozoic, both in the marine and terrestrial realm, with the earliest