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Ostracods, plant tissues, and other inclusions in coprolites from the Late Cretaceous Lameta Formation at Pisdura, India: Taphonomical and palaeoecological implications

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ABSTRACT

A rich microbiota with distinctive plant fossils has been discovered in Type A morphotype coprolites from the Lameta Formation of Pisdura, in Maharashtra, India. Macerated fractions examined with scanning electron microscopy revealed seven ostracod taxa, (*?Mongolianella* sp., *Cypridea* (*Pseudocypridina*) sp., *Cypridopsis* sp., *Eucypris* sp., *Gomphocythere* sp., *Gomphocythere paucisulcatus*, and *Paracypretta* sp.), diatoms (*Aulacoseira* sp.), a charophyte (*Microchara* sp.), and sponge spicules. Abundant probable chrysophytes were also observed in thin sections of one of the coprolites. Most of the plant debris is unidentifiable, but recognizable tissues include gymnosperm tissues, a spore, cuticle, and leaf laminae replaced with silica. Chemical analyses reveal that the coprolites are phosphatic, with ~12.2 to 16.2 wt.% phosphorus. The microfossils support a Maastrichtian age and fluvio-lacustrine depositional conditions for the Lameta Formation at Pisdura. The unusual combination of a phosphatic composition with plant and microfossil dietary residues suggests that the ancient faecal producers were intentional or inadvertent omnivores.

1. Introduction

Here we report on a detailed analysis of the contents of putative titanosaurid sauropod coprolites from the classic Pisdura locality (Latest Maastrichtian) in central India. The Pisdura locality is situated about 12 km NNE of Warora in the Chandrapur district of Maharashtra (Fig. 1) and has been known to yield numerous coprolites of Maastrichtian age for well over 70 years. The first material was collected by Matley (1939). These coprolites are often associated with other fossils such as titanosaur skeletal elements, pelomedusid turtle's bones and fresh water molluscs (Jain and Sahni, 1983; Ghosh et al., 2003). Matley (1939) classified these coprolites into four types (i.e. Type A, Types B and Ba, and Type C) based on shape, size and ornamentation. Of these four types Matley (1939) assigned Type A of coprolites from Pisdura to sauropod dinosaurs because of their large size (8–10 cm in diameter) and close association with the skeletal remains of titanosaurids. The more recent discovery of abundant plant tissues in the coprolites lent support to the interpretation that the ancient faecal producers were herbivorous (Mohabey and Samant, 2003). According to these authors, Type A coprolites were likely excreted by sauropods because no other large herbivorous vertebrates have been recovered from the Lameta Formation of Pisdura. Ghosh et al. (2003) documented additional Type A coprolites in close association with titanosaurids, turtles, bivalves and gastropods, and also concluded that the main producers were *Titanosaurus*. Although several papers have described specific inclusions in the Lameta coprolites, this study examines the totality of biotic inclusions and the chemical composition of the Type A coprolites from Pisdura (Fig. 2). The results suggest that we may need to reconsider the paleobiological implications of these specimens.

2. Geological setting

Coprolite-bearing Lameta Formation exposed at Pisdura (Fig. 1) rests unconformably on various lithologies (e.g., Precambrian basement, Gondwana Supergroup) and is further overlain by Deccan basalts. The Lameta Formation is 10 m thick and was considered to be non-marine for almost one hundred and fifty years (Hislop, 1859; Medlicott, 1872; Huene and Matley, 1933). The geology of the Lameta Formation in the Pisdura area has now been restudied and reinterpreted by various workers (Mohabey et al., 1993; Mohabey, 1996; Mohabey and Udhoji, 2000; Mohabey and Samant, 2003). They envisage alluvial–limnic environments of deposition for the Lameta Formation sediments under semi-arid conditions. The succession (Fig. 1) here comprises overbank red silty clays, channel-associated sandstone and conglomerate, and

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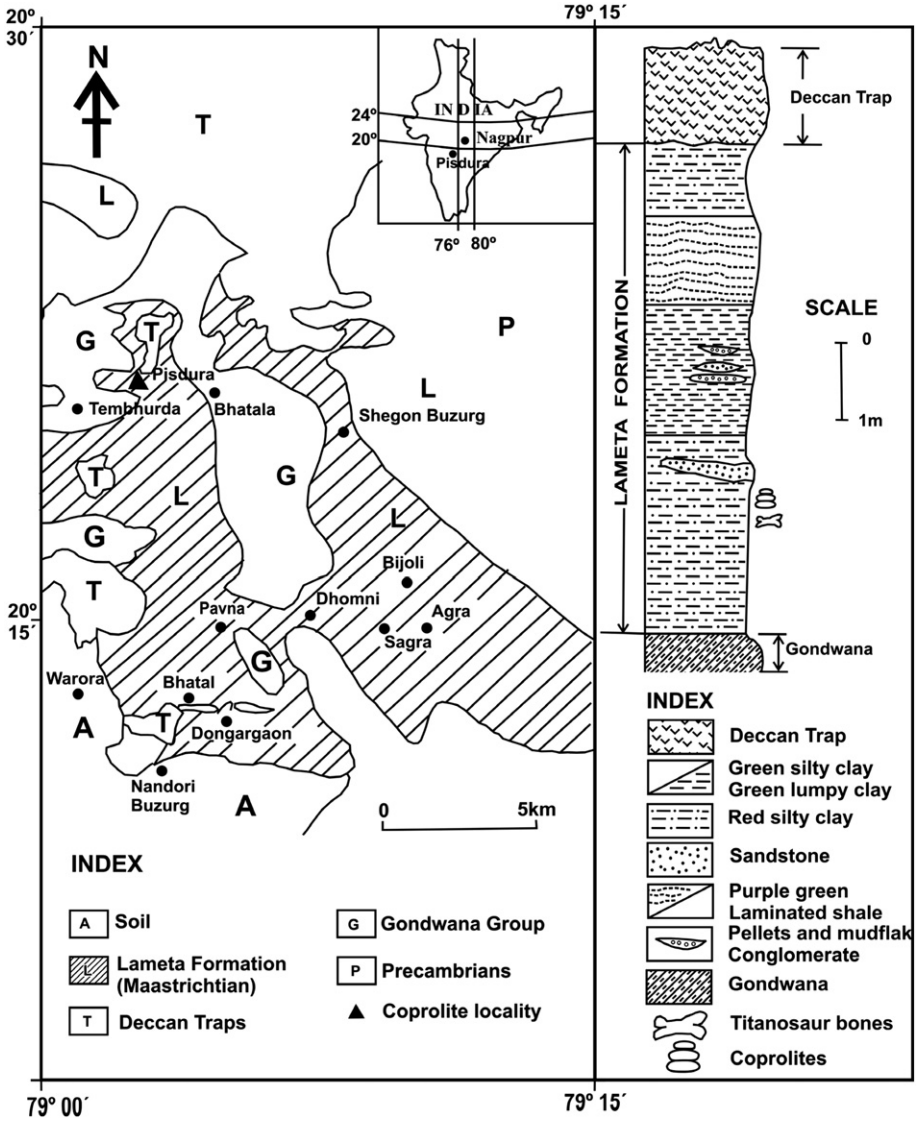

Fig. 1. Map showing the village Pisdura from where the coprolites were collected and a stratigraphic section of the Lameta Formation at this site (Map modified after Mohabey et al., 1993).

upper green clays intercalated with paludal grey nodular marl, carbonates, and laminated green and purple shales.

3. Fossil material and methods

Coprolite specimens of all varieties co-occur with the reworked weathered titanosaurid skeletal remains in a discrete layer in the overbank red silty clays, and become exposed on the surface during ploughing of the fields (Mohabey, 2001). In addition, some of them are found embedded in the rocks of the Lameta Formation (Matley, 1939; Sharma et al., 2005). The coprolites with desiccation features are inferred to have been exposed on the surface for some time after defecation, and then subsequently reworked and deposited probably as float by rivers in the overbank areas (Ghosh et al., 2003).

About 15 Type A coprolites (as designated by Matley, 1939) were collected from the Lameta Formation of Pisdura for this study. Prior to analysis by scanning electron microscopy, coprolites were macerated with 10% H_2O_2 for a few hours and then treated with 10% HCl for a few more hours before being rinsed, sieved and randomly fractured. This revealed various contents that were studied under a JEOL JSM-25S scanning electron microscope at the Centre of Advanced Study in Geology, Panjab University, Chandigarh.

A cut slab of one specimen (DD/Geo/C002/09) was visually inspected for fossil plant material. Thin sections of three additional Type A coprolites (PUAKH 10028, PUAKH 10029, and PUAKH 10030) were made to facilitate petrographic analysis of the coprolites. Two of these thin sections were polished and carbon coated for analysis with a JEOL JXA-8600 electron microprobe in the Department of Geological Sciences at the University of Colorado Boulder. Bulk chemical compositions of these three specimens plus three other small coprolites from the Lameta Formation at Pisdura were determined by optical emissions spectroscopy at the University of Colorado Boulder.

Abbreviations are LPA: Longest polar axis; LED: Largest equatorial diameter; ISI: Isopolarity index; No: Number; PUAKH; Panjab University, Ashu Khosla; PUHA: Panjab University, Habib Alimohammadin; and DDGEO/C002/09: Debi Dutta, Geology. The dimensions are given in millimetres (mm) and micrometres (μm).

4. Results

Numerous mineralized inclusions were revealed by scanning electron microscopy, thin section analysis, and cut slabs of the coprolites. Ostracods are particularly common, and most are identifiable to genus. Other microfossils, sponge spicules, and plant tissues are also evident (Table 1).