A PRELIMINARY REPORT ON COPROLITES FROM THE LATE TRIASSIC PART OF THE KAP STEWART FORMATION, JAMESON LAND, EAST GREENLAND

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Abstract—The basal part of the Triassic-Jurassic (Rhaetian-Sinemurian) Kap Stewart Formation, exposed at Jameson Land, East Greenland, yields an extensive coprolite collection from black, parallel-laminated mudstone ("paper shale"), representing an open lacustrine system. Preliminary investigations show three different types of coprolites: elongated cylindrical masses, composed of irregularly wrapped layers; elongated cylindrical masses with constriction marks; and spirally-coiled specimens.

INTRODUCTION

A new extensive coprolite collection was found in the Late Triassic part of the Kap Stewart Formation exposed along the Westside of Carlsberg Fjord, Jameson Land East Greenland (Fig 1.). The GPS coordinates of the locality are N 71º24.800' and W 22º 33.160'. The coprolite-bearing layers were discovered on July 22, 2012 by members of the Geocenter Møns Klint Dinosaur Expedition, during prospecting for vertebrate fossils in the area. This expedition included a dozen members that prospected and excavated at the localities by Lepidopteris Elv and Macknight Bjerg (Jenkins et al, 1994) between July 12 and August 3, 2012. The collected specimens will after further investigations be stored in the collection of the Natural History Museum of Denmark (MGUH-30357 to 30367). This is a preliminary report describing the principal morphotypes of the coprolites.

GEOLOGICAL SETTING

The Kap Stewart Formation overlies the Upper Triassic (Norian-Rhaetian) Ørsted Dal Member of the Flemming Fjord Formation (Surlyk et al. 1973; Clemmensen 1976, 1980; Dam and Surlyk, 1993). The basal part of the Kap Stewart Formation is considered to be of Rhaetian age, while the upper part is dated to the Sinemurian. The formation is composed of four main facies: open lacustrine mudstones, delta-front sandstones, delta-plain deposits, and alluvial-plain deposits. The open lacustrine mudstones are dark-gray to black, thinly laminated and rich in organic material. The lack of marine indicators and the large amounts of freshwater algal remains suggest deposition under anoxic conditions in a relatively deep freshwater lake (Dam and Surlyk, 1992, 1993). The coprolite-bearing unit is located at the east side of Wood Bjerg (Fig. 1), in an approximately 10-m-thick unit of open lacustrine mudstones, informally named the "Burned Paper-Shale" site because of the similarity in appearance of the weathered shale to burned paper (Fig. 2), some 30 m above the base of the Kap Stewart Formation.

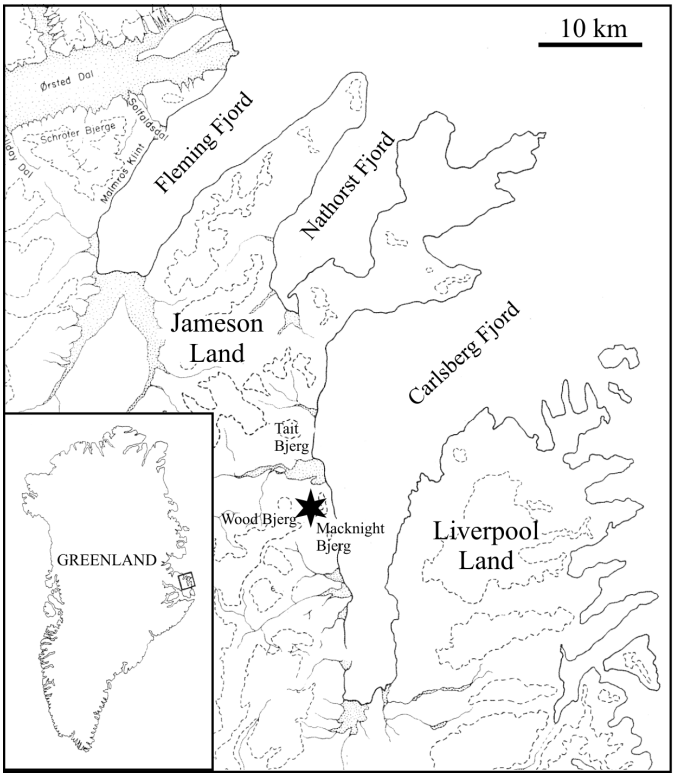

FIGURE 1. The Burned Paper-Shale Site (marked with a star) is located at N71º 24.800', W 22º 34.417' at approximately 572 m elevation, near Wood Bjerg, at Carlsberg Fjord, Jameson Land, East Greenland.

COPROLITES

Several hundred specimens and fragments of specimens were collected at the surface at the newly discovered locality. In addition, a few coprolites were excavated *in-situ*, from small profile trenches dug into the loose, flaky shale. The collected specimens could be sorted into three basic morphotypes. The most abundant type is cylindrical with a constant diameter and is composed of several layers that are irregularly wrapped around each other. The terminations are rounded (Fig. 3A–D). The most common diameter is 2-2.5 cm. All these specimens are broken, making it impossible to determine the total length, but the fragments are up to 5 cm in length (Fig. 3A). A single coprolite of similar morphology is slightly flattened with a maximum diameter of 3.9 cm. (Fig. 3D).

The second morphotype is smaller with typical diameters of 1 -2 cm and is cylindrical in cross section and has constriction marks along its

FIGURE 2. The shale outcrop just below the top of the mountain. The weathered shale is dark and very flaky and gives the impression of burned newspaper (insert).

long axis. The terminations are rounded, tapering to a sharp pinched-off end (Fig. 3E-H).

The third morphotype is only represented by three specimens which are cone-shaped and strongly spirally coiled, with a diameter up to 4.6 cm (Fig. 3I–K), probably representing shark coprolites, Unfortunately, all the specimens are broken, hindering a full morphological description.

About 20% of morphotypes 1 and 2 contain hard tissue remains (scales and bone fragments). Several weathered coprolites of morphotypes 1 and 2 exhibit unusual scale-like structures that commonly cover large parts of their surface. These "scales" have irregular, but rounded outlines and a typical size of 1-4 mm. While they seem to represent an original feature of the coprolites, their appearances may have been enhanced by the severe weathering in the periglacial environment. In addition about 20 percent of them contain hard-tissue remains in form of scale and bone fragments. These features will be the topic of a future study.

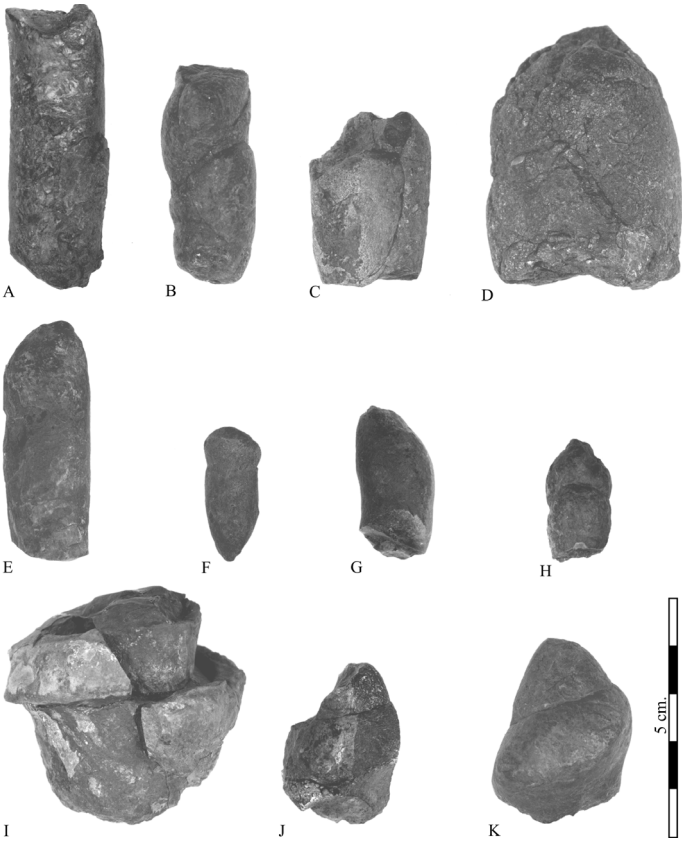

FIGURE 3. The three principal morphotypes of coprolites from the locality. **A-D**, Cylindrical coprolites with constant diameter, composed of irregular layers wrapped around each other with rounded terminations (MGUH 30357 – MGUH 30360). **E-H**, Cylindrical coprolites with constriction marks in the surface and sharp, tapering ends that appear to have been pinched off (MGUH 30361-MGUH 30364). **I-K**, Tightly coiled specimens (MGUH 30365-MGUH 30367).

DISCUSSION

The Triassic Period has an extensive world-wide fossil record of coprolites, with finds from all areas of the Pangean supercontinent (Hunt et al., 2007), and the Late Triassic has yielded abundant coprolites, especially from North America and Europe (see Hunt et al., 2007). Although coprolites have been briefly mentioned by Jenkins et al. (1994, p. 22) in the underlying Ørsted Dal Member of Carlsberg Fjord, coprolites have never been described or figured from the Late Triassic of Greenland until now. The size and morphology of the three types of coprolites described herein is similar to Triassic coprolites from elsewhere in the world. The tightly coiled nature of the three specimens (Fig. 3I–K) suggests that they are in fact enterospria, fecal masses from the valvular intestines of sharks that have not been egested before fossilization (Hunt, 1992). Spirally coiled fecal masses were first described as coprolites by Buckland (1829), from Lyme Regis in England. Later this type was redescribed as fossilized contents of valvular intestines from sharks (Fritsch, 1895; Neumayer, 1904), and termed enterospirae (Fritsch, 1907). However, McAllister (1985) demonstrated that in some cases the tight coiling of the fecal mass can still be present after egestion from the body without distortion, and in that case the spirally coiled masses should be treated as real coprolites.

The elongated specimens, with constant diameter are similar to indeterminate specimens from the Early Triassic of Australia (Northwood, 2005), and from the Middle Triassic of Brazil (Souto, 2001). They are very hard to assign to any specific producers.

Body fossils found at the Burned Paper-Shale locality include bone fragments, vertebrae, scutes and teeth and skull parts of large temnospondyls (maybe capitosaurs, considering the large size and tusk-like teeth), one small hollow longbone, presumably from a pterosaur or theropod, a putative phytosaur scute and some yet unidentified teeth. These, however, require further preparation and will be the topic of further publications on the locality.

As temnospondyl remains are abundant in the shale, we tentatively suggest that the two types of elongated cylindrical coprolites may originate from different temnospondyl groups. However, they could also originate from reptiles that frequented the lacustrine environment, although remains of the latter have yet to be documented at the Paper-Shale locality. The spiral coprolites can clearly be assigned to sharks that inhabited the lacustrine system. Shark remains from the Late Triassic part of the Kap Stewart Formation are hitherto only known from a single find of a hybodontid fin spine (Bendix-Almgreen, 1976).

ACKNOWLEDGMENTS

We are grateful for the generous support from the following foundations that made the expedition possible: Dronning Margrethes og Prins Henriks Fond, Arbejdsmarkedets Feriefond, Oticon Fonden, Knud Højgaards Fond, Louis Petersens Legat, Det Obelske Familiefond, and Ernst og Vibeke Husmans Fond. POLOG provided professional expedition logistics and camp solutions. Nadia Rosendal Nielsen, Geocenter Møns Klint is thanked for her skillfull cooking and contact to the media, Steen Laursen, freelance journalist covered the expedition, and Jakob Søndergaard, POLOG, was in charge of safety during the expedition, and

a great help during the excavations. Gilles Cuny, Natural History Museum of Denmark, helped by searching for relevant literature. Finally, we thank Nils Natorp, Director of Geocenter Møns Klint for his enormous efforts in organizing this expedition. Adrian Hunt and Spencer Lucas provided critical reviews of the manuscript.

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Collecting coprolites in east Greenland. Photo by Nicole Klein.