

THE VERTEBRATE COPROLITE COLLECTION AT THE NATURAL HISTORY MUSEUM (LONDON)

ADRIAN P. HUNT¹, SPENCER G. LUCAS² AND JUSTIN A. SPIELMANN²

¹ Flying Heritage Collection, 3407 109th St SW, Everett, WA 98204, e-mail: adrianhu@flyingheritage.com;

² New Mexico Museum of Natural History and Science, 1801 Mountain Road NW, Albuquerque, NM 87104, e-mail spencer.lucas@state.nm.us, justin.spielmann1@state.nm.us

Abstract—The Natural History Museum has a diverse collection of coprolites that represents the second oldest coprolite collection, after the Oxford University Museum of Natural History. The Paleozoic collection includes three Carboniferous coprolites from Europe and three coprolites from the Early Permian of the USA. Early-middle Mesozoic specimens are represented by four Rhaetian coprolites from England, a diverse collection from the Early Jurassic of England and Late Jurassic coprolites from Germany and England. There are three coprolites from the Early Cretaceous of England, including *Costacoprus chinae* ichnogen. et ichnosp. nov., and six coprolites from the Late Cretaceous of India. There is one Cenozoic coprolite from Nigeria. There is need for further study of the collection, notably a description of the large samples from the Oxford Clay Formation and Purbeck Limestone Formation.

INTRODUCTION

The Natural History Museum in London (formerly British Museum of Natural History: NHMUK) apparently has the second oldest collection of coprolites after the University of Oxford Museum of Natural History, which houses many of William Buckland's specimens (Duffin, 1979; 2006, 2009, 2010a-b; 2012a-b; Swift and Duffin, 1999; Hunt et al., 2007; 2012a). The entire trace fossil collection, of which coprolites are a small percentage, in the Department of Palaeontology in London numbers 1810 specimens of which approximately half are from the UK, with others from Europe, North America, the Indian sub-continent, the Middle East and East and West Africa. ([http://www.nhm.ac.uk/research-curation/collections/collections-management/collections-navigator/transform.jsp?rec=/ead-recs/nhm/cld-041007.xml&srch_str=Department of Palaeontology](http://www.nhm.ac.uk/research-curation/collections/collections-management/collections-navigator/transform.jsp?rec=/ead-recs/nhm/cld-041007.xml&srch_str=Department%20of%20Palaeontology)). There are approximately 90 coprolites in the collection from the UK, USA, Germany, India and Nigeria. The collection includes both Paleozoic and Mesozoic coprolites and one from the Tertiary. The purpose of this paper is to provide a brief overview of the vertebrate coprolite collection at The Natural History Museum to make researchers aware of its existence with the hope that further studies will follow. NHMUK refers to the Natural History Museum, London, UK.

PALEOZOIC

Carboniferous

There are three flattened Paleozoic coprolites preserved on pieces of matrix from the Upper Carboniferous of Europe. NHMUK 28490 is a flattened, asymmetrical, pear-shaped coprolite from Saarbrücken, Germany, which is 33.5 mm long with a maximum width of 17 mm (Fig. 1A). NHMUK R 15332 is a coprolite from the "Coal Measures" of Grantham near Edinburgh, Scotland (Fig. 1B). This is an elongate coprolite, approximately 180 mm long, with a slightly arcuate outline. One side (right in Fig. 1B) is clearly defined, whereas the other is more irregular, suggesting decomposition. A second specimen from Scotland is NHMUK R 14054 from the "Ironstone Formation" at Woodside Quarry, Glasgow (Fig. 1C). This coprolite is oblong with a length of 74 mm long and a width of 25 mm.

Permian

There are three coprolites in the collection from the Early Permian of Seymour, Baylor County, Texas, USA. All specimens are under one catalog number, NHMUK R 3464 (Fig. 1D-F). One coprolite has the

shape of a flattened spindle with acute tips (Fig. 1D). This specimen is 91 mm long with a maximum width of 34 mm, and there is a suggestion of a spiral morphology. The second is an incomplete fragment of a heteropolar coprolite with three whorls at the posterior end (Fig. 1E). This coprolite is approximately 80 mm long with a maximum width of 42 mm. This specimen is similar to *Saurocoprus* (e.g., Hunt et al., 2007, fig. 4). The third specimen is a spindle-shaped coprolite covered with small concretionary masses (Fig. 1F). It is 78 mm long and approximately 30 mm in maximum width.

MESOZOIC

Triassic

The collection includes several Rhaetian coprolites from the UK. NHMUK 3117 is a macrospiral coprolite from the Rhaetic bone bed at the classic locality of Aust Cliff near Bristol (Thomas, 1935, pl. 1G; Fig. 2F). This specimen is 68 mm long with a maximum width of 41 mm. It is similar in morphology to *Liassocoprus* (Hunt et al., 2007), but it differs in that the spirals extend for almost the entire length of the coprolite, so that it is almost amphipolar. Duffin (1979) illustrated two specimens representing NHMUK P 23353 from Aust Cliff (Duffin, 1979, pl. 21, figs. 11-12; Swift and Duffin, 1999, figs. 32C-D). Three other specimens derive (NHMUK 47041) from Frome in Somerset and are fragments of small (less than 2 cm long), elongate coprolites. It is unclear whether these specimens are from the Triassic slot fissure at Holwell (Rhaetian-?Hettangian) or the bedded transgressive sequence (Rhaetian) at Vallis Vale (C. Duffin, pers., commun., 2012).

Early Jurassic

The Natural History Museum contains a Hawkins collection from the Lias of the Dorset coast in the UK. Thomas Hawkins (1810-1889) was an eccentric collector with an interest in Rhaetian-Liassic marine reptiles (Duffin, 2010a). He amassed specimens from the Lias of Dorset through his own collecting and by purchases from the famous collector Mary Anning. Hawkins (1834, 1840) published two monographs on plesiosaurs and ichthyosaurs, and parts of his collection, including coprolites, were sold to the British Museum of Natural History in 1834 and 1840 (Duffin, 2010a). The coprolites derive from The Jurassic Coast World Heritage Site, which has yielded abundant specimens (Lord and Davis, 2010; Duffin, 2010a). The coprolites are from the Lower Lias (Hettangian-Lower Pliensbachian; Page, 2010) at Lyme Regis and Charmouth in Dorset. The holotype of NHMUK R. 2102, *Saurocoprus*

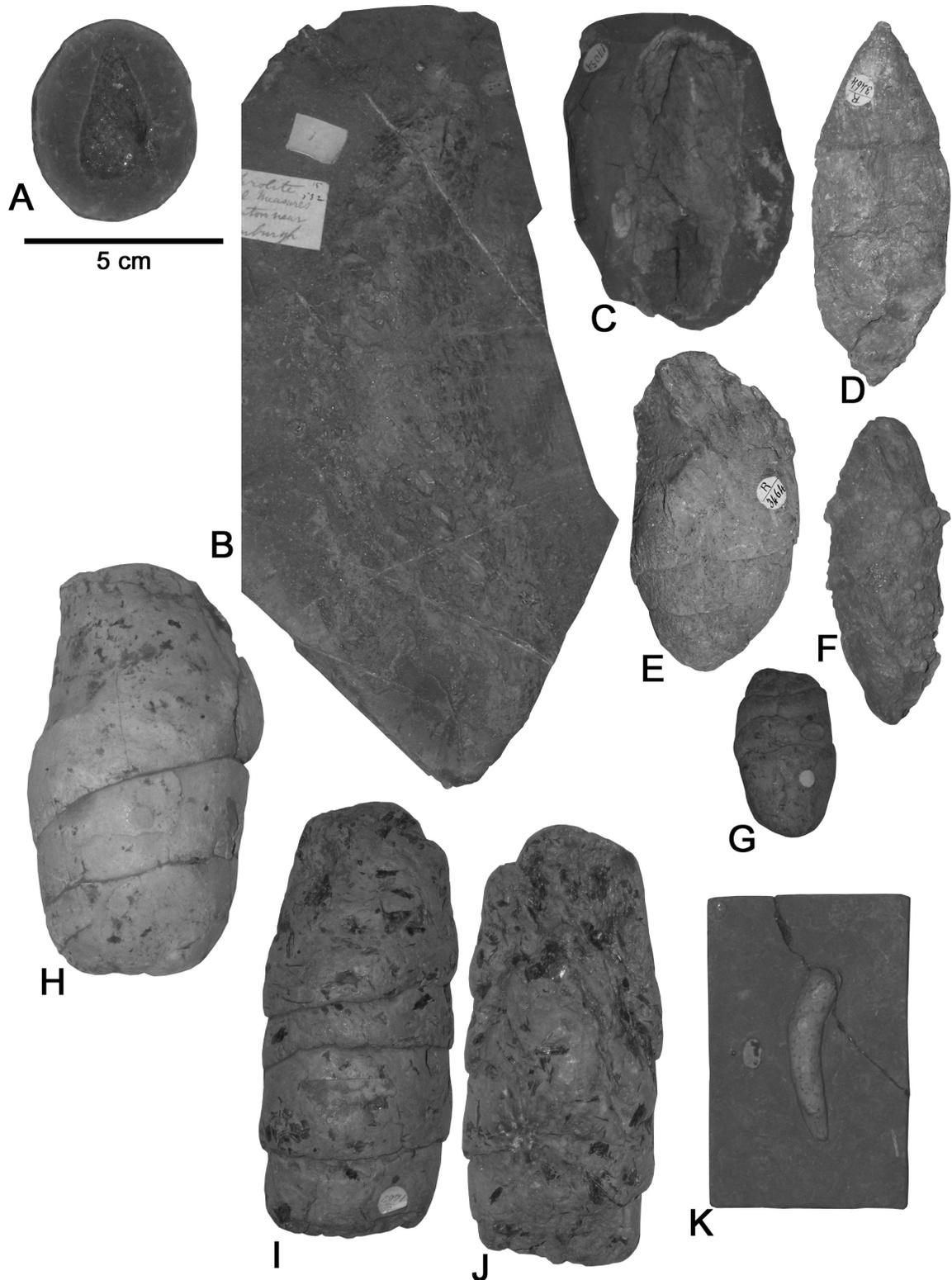
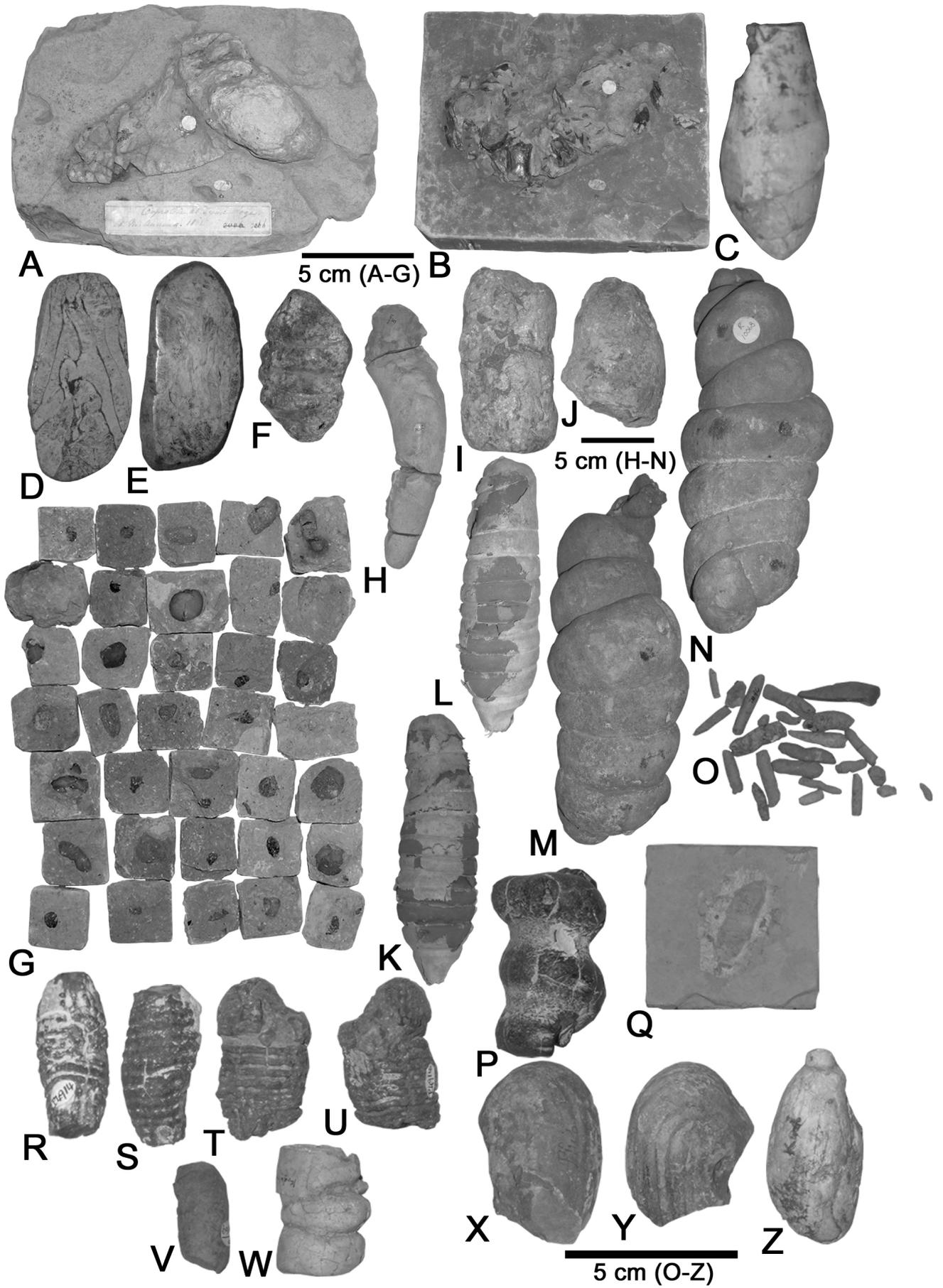


FIGURE 1. Coprolites in the collection of the Natural History Museum, London. **A-F**, Paleozoic coprolites from Europe and North America. **A-C**, Carboniferous coprolites from Europe. **A**, NHMUK 28490, Coprolite from Saarbrücken, Germany. **B**, NHMUK R 15332, Coprolite from Grantham near Edinburgh, Scotland. **C**, NHMUK R 14054, Coprolite from Woodside Quarry, Glasgow, Scotland. **D-F**, Coprolites from the Early Permian near Seymour, Baylor County, Texas, USA – all under catalog number NHMUK R 3464. **D**, Spiral coprolite in lateral view. **E**, *Saurocoprus* sp. in lateral view. **F**, Coprolite in lateral view. **G-K**, Coprolites from the Hawkins Collection from the Lower Lias of the Dorset coast, England. **G**, NHMUK R. 41285, *Saurocoprus bucklandi*, Charmouth (Hunt et al., 2007, fig. 4A). **H**, NHMUK R 2107, *Liassocoprus hawkinsi* holotype in lateral view (Hawkins, 1834, pl. 28, lower right; 1840, pl. 30; Hunt et al., 2007, fig. 5D-E). **I-J**, NHMUK R 1402, *Saurocoprus bucklandi* in lateral views, Lyme Regis (Hunt et al., 2007, fig. 4C-D). **K**, NHMUK R 2110, *Falcatocoprus oxfordensis* referred specimen in lateral view, Lyme Regis (Hawkins, 1840, pl. 30; Hunt et al., 2007, fig. 5G).



bucklandi, from Charmouth (Hawkins, 1840, pl. 29; Hunt et al., 2007, fig. 4A; Fig. 2C), is one of several specimens of this ichnotaxon, including NHMUK R. 41285, *Saurocoprus bucklandi*, also from Charmouth (Hunt et al., 2007, fig. 4A; Fig. 1G) and NHMUK R. 1402 from Lyme Regis (Hunt et al., 2007, fig. 4C-D; Fig. 11-J). NHMUK R 2107 is the holotype of *Liassocoprus hawkinsi* (Hawkins, 1834, pl. 28 lower right; 1840, pl. 30; Hunt et al., 2007, fig. 5D-E; Fig. 1H). NHMUK R 2110 is a referred specimen of *Falcatocoprus oxfordensis* from Lyme Regis (Hawkins, 1840, pl. 30; Hunt et al., 2007, fig. 5G; Fig. 1K).

Other specimens are preserved on matrix. NHMUK R. 2066 is two coprolites from Lyme Regis (Hawkins, 1840, pl. 29; Fig. 2A), and NHMUK R. 2066 is a single coprolite from Lyme Regis that shows evidence of decay (Hawkins, 1834, pl. 28, lower middle; 1840 pl. 29; Fig. 2B). NHMUK R 20564 (Fig. 2D) and NHMUK R 41285 (Fig. 2E) are polished sections of spiral coprolites from Lyme Regis and Charmouth, respectively.

Late Jurassic

The Late Jurassic is represented in the collection by specimens from the Solnhofen Plattenkalk of Germany and the Purbeck Limestone Formation and Oxford Clay Formation of England. There is a single specimen from the Solnhofen Plattenkalk (NHMUK 47453) from the Haberlein Collection, NHMUK R 47543, which is a flattened, rounded cylinder that is 30 mm long on a piece of limestone (Fig. 2Q).

There is a large sample (35) of small coprolites from the Beckles Collection from Durlston Bay (formerly Durdlestone Bay), Dorset, England (NHMUK 48259). These specimens are sub-spherical to cylindrical and preserved flattened on pieces of limestone. A typical cylindrical coprolite is 20 mm long and 8 mm in width, and a sub-spherical one is 15 mm in diameter (Fig. 2G). There are two coprolites from the Oxford Clay Formation from Peterborough (Leeds Collection). One of these, NHMUK 2094, is the holotype of *Falcatocoprus oxfordensis* (Hunt et al., 2007, fig. 5H; Fig. 2H) and the other with the same catalog number is a sample of 24 small coprolites that are principally elongate cylinders (Fig. 2O).

Early Cretaceous

There are three coprolites in the collection from the upper Lower Cretaceous (Albian) Cambridge Greensand at Cambridge, UK. NHMUK 43302 is a 54-mm-long segment of a loosely spiraled coprolite (Fig. 2P). This specimen is similar to one from the Eocene London Clay (Rayner et al., 2009, p. 41, unnumbered fig. upper center). NHMUK 4914 comprises two partial coprolites that are the holotype and topotype of *Costacoprus chinae* described in the Appendix to this paper (Fig. 2R-U).

Late Cretaceous

The Matley Collection at the Natural History Museum includes a number of specimens from the Upper Cretaceous Lameta Formation of India. Matley (1939a,b) had published on other coprolites from the

Lameta (and the Triassic Maleri Formation) in the collections of the Geological Survey of India. Three unnumbered specimens have previously been assigned to *Alococoprus indicus* - a nearly complete coprolite from north of Nagpur (Hunt et al., 2007, fig. 3E; Fig. 2Z), a curved end from north of Kadubana (Hunt et al., 2007, fig. 3C; Fig. 2Y) and another end, also from north of Kadubana (Hunt et al., 2007, fig. 3D; Fig. 2X). Other specimens include NHMUK R12278, a partial cylindrical coprolite from Pijdura that is 128 mm long with a maximum width of approximately 60 mm (Fig. 2H). In addition, there are unnumbered specimens, including a large end of a coprolite from an unknown locality (Fig. 2J) and a portion of a segmented, cylindrical coprolite from Nagpur (Fig. 2W).

CENOZOIC

There is only one Tertiary coprolite specimen in the Natural History Museum collection. NHMUK R11869 is a segment of a cylindrical, 33-mm-long coprolite with a sub-rounded cross section from the Eocene of Ambialla District, South Nigeria (Fig. 2V). The surface texture is irregular and there are small inclusions.

OTHER BROMALITES

NHMUK R 10068 is a sandstone cast from Africa that is reminiscent of a cololite in morphology (Fig. 2M-N). It is approximately 260 mm long with a maximum diameter of 105 mm. This specimen has two of the distinctive features of eviscerolites (cololites preserved outside a body cavity: Hunt and Lucas, 2012a): (1) sinuous shape and (2) prominent tapering at both ends (Seilacher et al., 2001). However, NHMUK R 10068 does not have longitudinal striations that represent taenial muscle bands or more importantly the characteristic composition of siderite (Seilacher et al., 2001). This could represent a helical burrow.

NON-BROMALITES

The collection includes what is apparently a shark spiral intestine that has been injected with "Roman cement" (Fig. 2K-L) in the manner of Buckland (e.g., Buckland, 1836, pl. 15, figs. 1-2).

CONCLUSIONS

The collection at the Natural History Museum includes an important and diverse collection of coprolites. The Jurassic and Cretaceous collections are notable in their extent. There is need for further study of the collection, notably a description of the large samples from the Oxford Clay Formation and Purbeck Limestone Formation.

ACKNOWLEDGMENTS

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FIGURE 2 (Preceding Page). Coprolites and related specimens in the collection of the Natural History Museum, London. **A-F**, Coprolites from the Lias of the coast of Dorset, England. **A**, NHMUK R. 2066, coprolite from Lyme Regis (Hawkins, 1840, pl. 29). **B**, NHMUK R. 2066, coprolite from Lyme Regis (Hawkins, 1834, pl. 28, lower middle; 1840 pl. 29). **C**, NHMUK R. 2102, *Saurocoprus bucklandi*, holotype, Charmouth in lateral view. **D-E**, Polished sections of coprolites from Lyme Regis. **D**, NHMUK R 20564, polished section. **E**, NHMUK R 41285, polished section. **F**, NHMUK R3117, coprolite in lateral view, Rhaetic, Aust Cliff, England. **G**, NHMUK 48259, 35 coprolites in matrix, Middle Purbeck, Durdlestone Bay, Dorset, England (Beckles Collection). **H**, NHMUK R 2094, *Falcatocoprus oxfordensis* holotype, coprolite in lateral view, Oxford Clay, Peterborough, England (Leeds Collection) (Hunt et al., 2007, fig. 5H). **I-J**, Coprolites from the Upper Cretaceous Lameta Formation, India (Matley collection). **I**, NHMUK R12278, partial coprolite in lateral view, Pijdura, Chandra District. **J**, NHMUK unnumbered, coprolite tip in lateral view. **K-L**, NHMUK unnumbered, shark intestine injected with Roman Cement in lateral views. **M-N**, NHMUK R 10068, Sandstone cast of cololite, Africa. **O**, NHMUK R 2094, multiple coprolites in lateral view, Oxford Clay, Peterborough, England (Leeds Collection). **P**, NHMUK 43302, Coprolite in lateral view, Cambridge Greensand, Lower Cretaceous, Cambridge, England. **Q**, NHMUK R 47543, coprolite in matrix, Solnhofen Limestone, Upper Jurassic, Germany (Haberlein Collection). **R-U**, *Costacoprus chinae* (NHMUK R 4914) from the Cambridge Greensand, Lower Cretaceous, Cambridge, England. **R-S**, Holotype coprolite in lateral view. **T-U**, Topotype coprolite in lateral view. **V**, NHMUK R11869, coprolite in lateral view, Eocene, Ambialla District, Nigeria. **W-Z**, Coprolites from the Upper Cretaceous Lameta Formation, India (Matley collection). **W**, NHMUK unnumbered, partial coprolite in lateral view, Nagpur. **X-Y**, NHMUK unnumbered, *Alococoprus indicus*, holotype, coprolite ends in lateral view, Nagpur (Hunt et al., 2007, fig. 3C-D). **Z**, NHMUK unnumbered, *Alococoprus indicus*, coprolite in lateral view, north of Kadubana (Hunt et al., 2007, fig. 3E).

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APPENDIX

SYSTEMATIC PALEONTOLOGY

Costacoprus ichnogen. nov.

Type ichnospecies: *Costacoprus chiniae* Hunt, Lucas and Spielmann, 2012.

Included ichnospecies: Known only from the type ichnospecies.

Etymology: From the Latin *costa* (rib) in reference to the ribbed appearance, and the Greek *kopros* (feces).

Distribution: Early Cretaceous of Cambridgeshire, England.

Diagnosis: Coprolite that differs from other ichnogenera in being cylindrical in shape with closely spaced lateral ridges along its length that average 2-3 mm in width and which are at right angles to the long axis.

Discussion: This ichnogenus is currently only known from the Early Cretaceous of Cambridgeshire.

Costacoprus chiniae ichnosp. nov.

Holotype: NHMUK R 4914, coprolite (Fig. 2R-S).

Etymology: For Karen Chin, to honor her many contributions to the study of coprolites.

Type locality: Cambridge, England.

Type horizon: Cambridge Greensand (Albian).

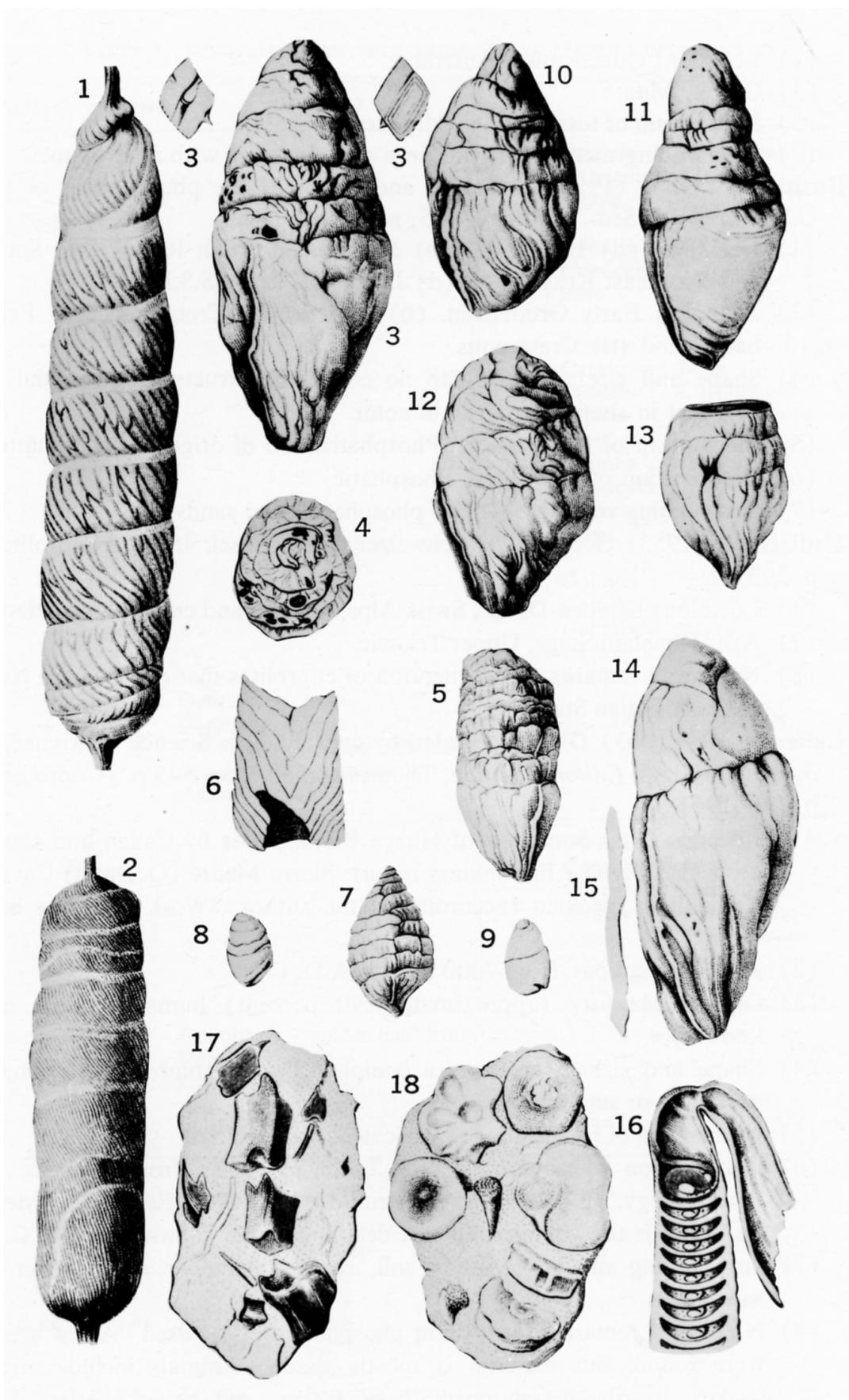
Distribution: As for ichnogenus.

Referred specimens: NHMUK R 4914, partial coprolite (Fig. 2T-U).

Diagnosis: As for ichnogenus.

Description: The holotype specimen (NHMUK R 4914) is an elongate section of a coprolite that lacks both ends (Fig. 2R-S). The coprolite is cylindrical and tapering towards one end, with a rounded cross section. The length of the section is 46 mm, with maximum and minimum diameters of 11 and 22 mm, respectively. The exterior of the coprolite has narrowly spaced (2-3mm) transverse, rounded "ribs."

Discussion: The referred specimen (and presumed topotype) is more flattened than the holotype, with a maximum diameter of 26 mm. One end is broken, and the other has a narrow, rounded tip.



Illustrations of some coprolites from the work of William Buckland.