Wimpole coprolites

During our 2014 test pitting activity at Wimpole over the summer, one of the more interesting findings was the large amount of small coprolites recovered. For example, test pit D in the field north of the Brick End cottages produced over 1.8kg of coprolites of the type shown in Photo 1 below.

Photo 1. A selection of small coprolite pieces from Test Pit D. (Author's photograph)

But what are coprolites, where were they found and why were they important in 19th C Cambridgeshire?

What are they?

The popular misconception is that coprolites were fossilised "dinosaur poo or dung". This stems, in part, from the term's derivation – it comes from the Greek words "kopros" which means dung and "lithos" which means in stone. The term was coined

by the Reverend William Buckland (first professor of geology at Oxford University) who discovered ichthyosaur fossil remains in Dorset which still contained their stomach contents. This term was then extrapolated to describe any indistinguishable, rounded lumps of fossilised material.

Professor Henslow of the Botany Department at St John's College, Cambridge found similar material at Felixstowe and delivered a paper in 1845 dealing with their potential as fertilizer. Students and professors of the then recently created Cambridge University Geology Department became interested in the fossils associated with the material. True dinosaur faeces were found to represent but a very small proportion of most local coprolite beds, especially in the Cambridge Greensand deposits, and it was suggested the material should be called pseudo-coprolites or simply phosphatic nodules. When the fossil beds were being exploited, the workers collected the best examples to sell and Harry Govier Seeley (assistant to Professor Sedgwick) collected many fine examples that became the basis of the excellent collection in the Sedgwick Museum, one part of which is shown below.

Photo 2. A small part of the Sedgwick coprolite display in Bay 13, showing examples of a form of ammonite called Turrilites. (Author's photograph)

Photo 3 shows some fossils recovered from Test Pit D (located north of Brick End cottages), they are mostly the internal casts of Terebratula but two in the central row still have some of their external shell present. One (lower right) is part of an ammonite.

Photo 3. Fossil brachiopods called Terebratula, some showing their external shell, and, lower right, piece of an ammonite - all recovered from Test Pit D. (Author's photograph)

So if true dinosaur excreta are mostly missing in Cambridge, what fossils are to be found? There are abundant marine fauna, particularly the bivalve molluscs (like the Terebratula), brachiopods, ammonites and belemnites. In addition to these smaller fossils, there are larger land and marine reptiles, such as ichthyosaurs, pterosaurs and a variety of often poorly preserved dinosaurs, together with many fish.

Where were they found?

The coprolites were mined from the Cambridge Greensand strata which outcrop in this area. The phosphatic nodule beds occur close to the Glauconitic or Chalk Marl layer that extends for around 80km from Harlington in East Bedfordshire to Soham, Burwell,

Swaffham and Upware in Cambridgeshire. An equivalent strata occurs at West Dereham and Crimplesham near King's Lynn in Norfolk.

The following map (Figure 1) shows the extent of the Greensand exposure (shown in green) in and around the Cambridgeshire region. The belt of Greensand is about 8km wide at its maximum.

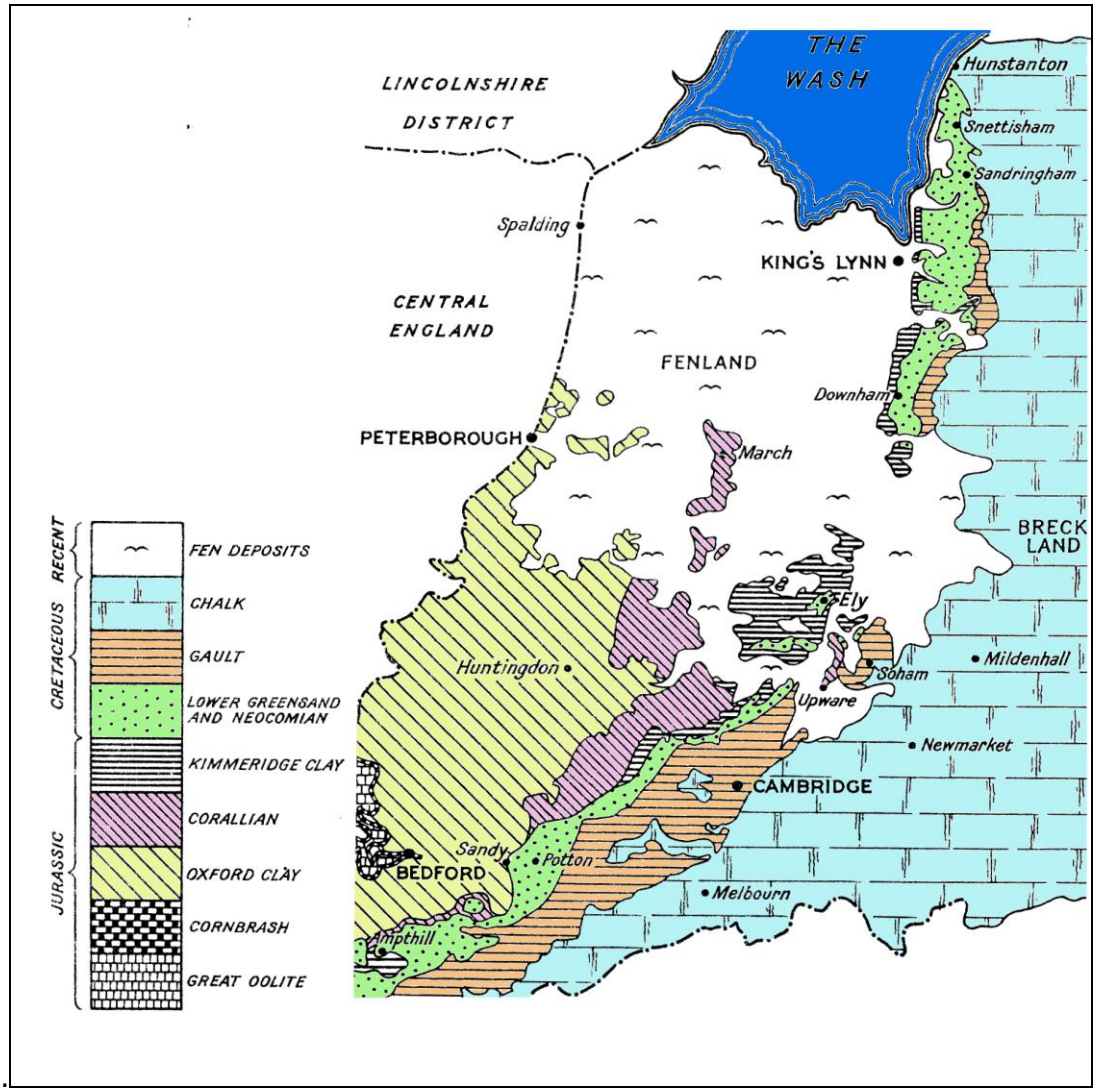

Figure 1. Geological formations in Cambridgeshire (adapted from Chatwin, 1961, 1)

How were the beds formed?

At the end of the Jurassic Period (~145Ma) the land was gradually sinking and a series of clays were being deposited. In the following Cretaceous Period (~ 113 to 110Ma) the Gault Clay was being deposited, reaching 45 metres in thickness in the Cambridge area. There then followed a local upward movement of the sea-bed which caused the Upper Gault layers to be eroded by the action of the sea. The heavier

material, including the fossils, was rolled around and re-deposited so that fossils of different ages became intermingled and coated in a hard phosphate coating. A pebble or bone bed of worn fossils formed, which became the Cambridge Greensand. Here the nodule beds were on average 25cm thick but, where hollows in the Gault occurred, local depths of over a metre could accumulate.

Further falls in the land height and a deepening sea coverage then caused the deposition of the Lower Chalk to occur, with a base layer of Chalky Marl. Figure 2 represents the general stratigraphy of the layers concerned in a typical coprolite pit in the Cambridge area, with the coprolite layers shown in green. The Chalk Marl overburden was between 3 – 8m in depth.

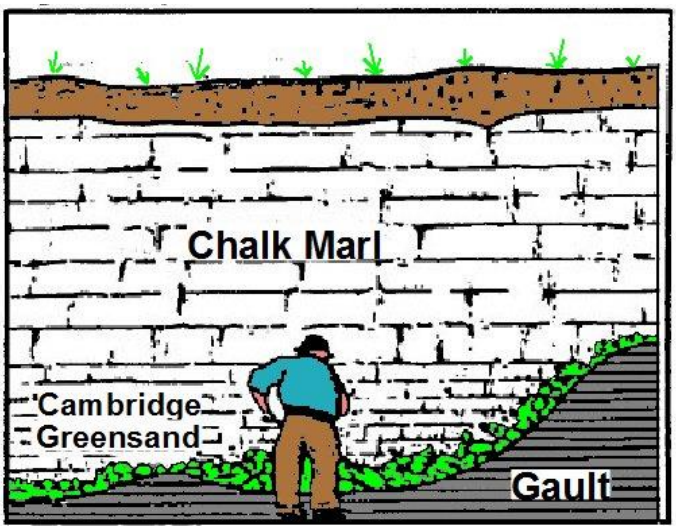

Figure 2. Cross section of a coprolite pit at Horningsea (adapted from Chatwin, 1961, 27)

Why were the beds important?

As the Industrial Revolution became established in Britain, there was a shift of people from the countryside to the cities and industrial towns to man the factories. This created a demand for agricultural products to feed them. As farming at this time was relatively inefficient, there was a need to improve crop yields. Addition of bone meal was found to do this and scientific studies showed that it was the phosphate content that was responsible. This then created a demand for sources of phosphate which rapidly exhausted supplies of bones from knacker's yards. Dried bones from abroad helped fill the gap, some 30,000 tons were imported annually in the late 1830's/early 1840's, but bones were found to release their phosphate content only slowly. Thick

deposits of phosphate-rich bird dropping (guano) in South America were then imported, at some cost, but by 1870's were largely exhausted.

Meanwhile in Cambridgeshire, a miller in Burwell, named John Ball, was reported to have dug up "coprolites" in 1851 while "claying" the land (a procedure where clay dug from under the peat is mixed with the peat to improve the soil tilth. He ground them up and treated them with sulphuric acid (the same treatment used with waste blood and bones) to form what was called "super phosphate of lime" – this was found to rapidly release its phosphate, was taken up rapidly by plants and dramatically improved crop yields. It was also half the price paid for guano. Ball abandoned his milling activities to become a full-time provider of artificial manure but seems to have found it difficult, probably due to the inate conservatism of farmers and difficulties in transporting the coprolites and the final product.

The next recorded work was in 1858 on Coldham's Common, where pits dug for brick making turned up the coprolites. This sparked a rush into artificial manures and the so-called "Cambridgeshire Coprolite Rush". The peak year was 1876, when 258,150 tons was produced from coprolite sources. Thereafter, gradual exhaustion of the shallower seams and increased difficulty in extracting the coprolite, together with competition from rock phosphate imported from abroad, saw production plummet. In 1880 production fell to 30,500 tons, by 1900 it was only 620 tons – the rush was over.

The effect on Cambridgeshire

The effect was quite dramatic in many ways. The rapid rise (and subsequent fall) in population due to the influx of temporary labourers can be seen by comparing census reports for 1861 to 1891 (O'Connor, 2008, 69), see Table 1 for just some results.

	1861	1871	1881	1891
Barrington	0	155	120	4
Haslingfield	6	105	49	17
Meldreth	0	39	11	0
Orwell	0	1	58	6
Whaddon	0	73	17	8
Wimpole	0	3	7	0

Table 1. Population figures for people described as working in coprolite areas. (selected from O'Connor 2008, 69).

The Wimpole figures suggest very few workers in the parish were involved in coprolite works, as the 1871 total population was stated to be 319 people at this time. It seems likely that more people were employed in the diggings but chose not to call themselves as such.

Figure 3 shows the main areas of coprolite diggings during the period 1850 to 1919.

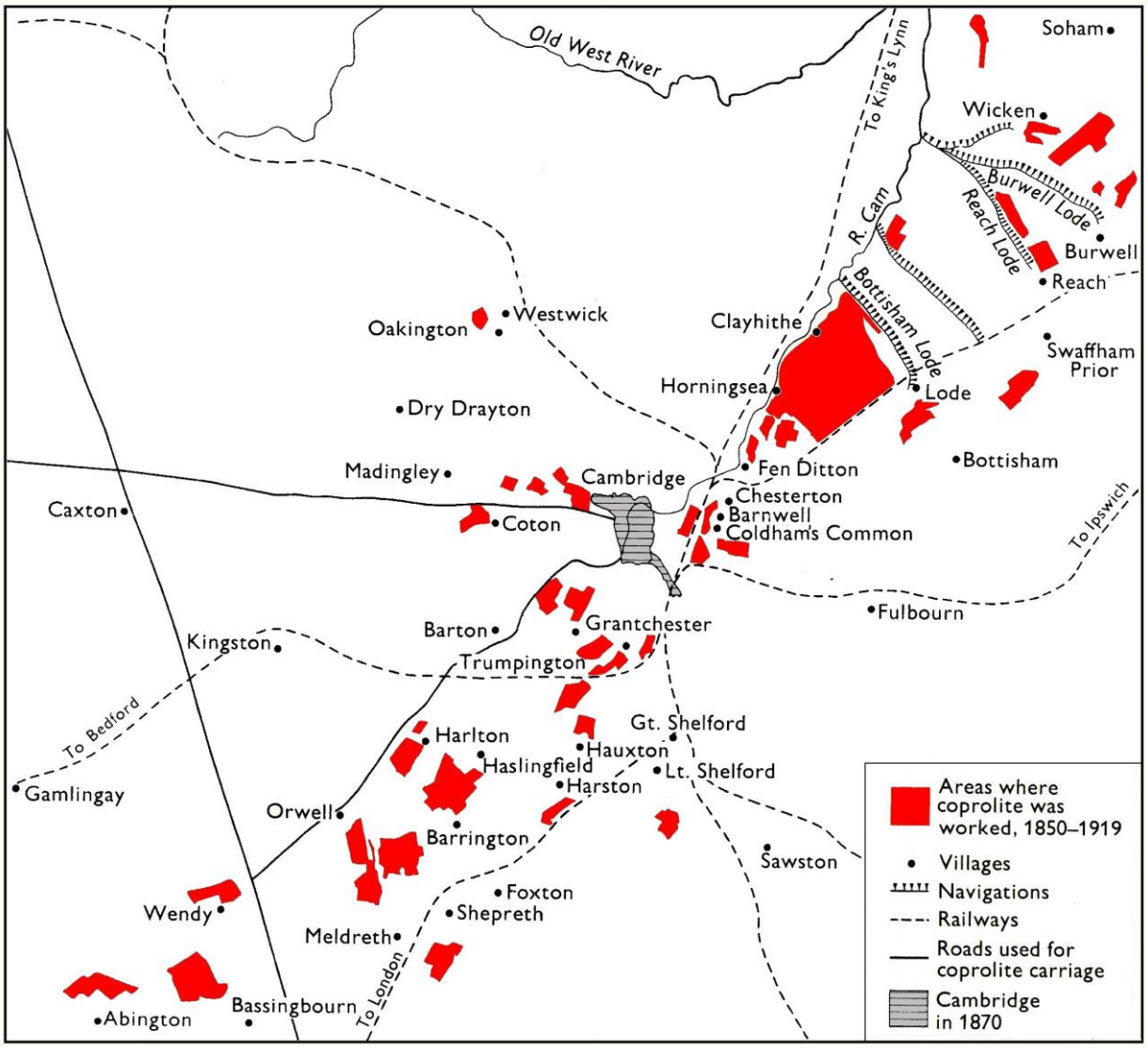

Figure 3. The major areas of coprolite working in Cambridgeshire over the period 1850 – 1919 (taken from a Sedgwick Museum illustration).

The narrow nature of the coprolites belt is made clear from this map. The Greensand seam in Wimpole ran approximately NW from St Andrews Church in Orwell to the north of Home Farm at Brick End, with an outlier SW of the Folly which was being worked in the 1870's (O'Connor, 2008, 76). It also runs SW from west of the Hall itself and onwards to Arrington (see Bernard O'Connor, 2008 for more information).

It is interesting that Wimpole is not shown as an important coprolite digging area, although there are plenty of references to coprolite extraction there. The Rev A C Yorke (nephew of the 5th Earl of Hardwicke) stated in his history of the parish that coprolite digging had "*somewhat about 1865 forced its way onto the Wimpole estates*" (O'Connor, 2008, 23). He suggested the 5th Earl made over £5000 royalties per annum from coprolite digging on the Wimpole Estate. It did not, however, help cover his gambling debts and in 1884 he lost the Wimpole Estate to Lord Robarts as a result of his gambling. By the time the Estate was sold in 1891 the coprolite diggings had mostly finished. (O'Connor, 2008, 96).

The social impact was seen differently, depending where you were in the structure. The arrival of hundreds of (mostly) young men with money to spend (average weekly wages were 20 – 25 shillings which was two - three times those of an agricultural labourer) enriched some, appalled others. The local economy certainly received a boost from the coprolite industry, while it lasted. Farmers and landowners sold licences to extract coprolites from often poor agricultural land for large sums of money compared to their agricultural worth. For example annual rents could be up to £2.50 per acre per annum, while coprolite yields could be about 250 tons per acre on average. At the selling price of over £2 per ton of coprolite, the economic advantage was clear.

It was not only the owners who benefitted. Others put up cheap accommodation to rent out at high prices, brewing and pubs increased to satisfy the drinking habits of workers (a small village like Orwell had 8 pubs during this period) and also to feed them. Prostitution was a money earner for some. In addition there were transport requirements, coprolite washing facilities and grinding mills that turned a good profit over the period. Blacksmiths, carpenters, carters, iron founders, engineers, horse traders and many more were all to benefit.

The downside was the drunkenness, violence and the death rate in the unsafe conditions, especially as deeper pits were dug to extract the more difficult seams of coprolites.

The end in Cambridgeshire

The industry was effectively ended by the importation of large quantities of rock phosphate from North America, Spain and Northern Africa and depletion of the easily

extractable coprolite beds. Not only was the phosphate rock cheaper but it was also available in greater quantities. Another factor was the gradual importation of more and more grain and meat from places like America and Argentina, thus suppressing the need for ever more home production and hence requiring less fertiliser. The last coprolite pit to be worked in Cambridge was the Swann & Grey's Pit in Barnwell which closed in 1898. Some pits re-opened during the First World War but only for a short time.

Version 1.0

TCD

References

Chatwin, C.P., 1961, *British Regional Geology: East Anglia and adjoining areas*, London, HMSO.

Grove, R, 1976, *The Cambridgeshire Coprolite Mining Rush,* Cambridge, Oleander Press.

O'Connor, B, 2008, *The Wimpole Fossil Diggings,* Cambridge, Bernard O'Connor.

Acknowledgements

Thanks to the National Trust, Angus Wainwright (Trust Archaeologist) and Richard Morris (Farm Manager) for permission to carry out the test pitting on the Wimpole Estate.

Thanks to the staff at the Sedgwick Museum for their help in identifying specimens and providing useful information about the Museum displays relating to the Cambridge Greensand.

Appendix – Finding and processing coprolites

(1) Finding coprolites.

The way that many early coprolite seams were found was as a result of normal ploughing activity when outcrops were close to the surface. They were also uncovered when people were digging for clay at brick works etc.

When coprolite activity increased, the typical method was to use an auger to explore the sub-surface deposits. A geological survey of the region was carried out in the late 1850's.

Finally, when coprolite diggings spread across the county, merely watching what was happening on neighbouring land could provide a very good clue to the likelihood of them being on your land.

(2) Digging the coprolites.

The coprolite band was typically 3 – 6m below an overburden of Greensand, Gault Clay or Chalk Marl. The average thickness of the band was 0.75m but could be up to 1.8m, however, dead areas with no coprolites also existed. The bands were usually mined by open-cast methods, although conventional mining was occasionally used. Often the work was carried out by the farmer's own labourers during the low season, after the harvest had been brought in, over winter up till the spring farming work recommenced. Often, though, gangs of labourers were brought specifically for the job.

(3) How was it dug?

To start with a narrow strip was dug across the field to expose the coprolite seam, with the topsoil put to one side or used to build the washing mill base. The diggers then shovelled the coprolites into wheel barrows or (later on) trucks which were pushed by hand or pulled by horses along a tramway out of the pit. Later on steam power took over.

Then the soil above the next area of coprolites was removed, often by undercutting the overburden using crowbars, pick axes or shovels. This soil was then shovelled into the trench area just finished and the new coprolites removed. This back filling carried on so that the labourers gradually progressed across the field and, at the end, the field was left ready to be returned to agricultural use. In really big fields two gangs of labourers could start at opposite ends and eventually met somewhere near the middle.

Where trenches were very deep the sides were mostly stepped to improve safety and access. The undercutting process was the most dangerous part of the activity and resulted in many casualties.

(4) Washing

The raised coprolites were then washed to remove the sticky clay and marl to prepare the coprolites for processing and to reduce transport costs. In the beginning washing took place in water-filled trenches but, with time, more efficient ways were utilised employing wash-mills.

Here, a mound of about 30 feet diameter, with a central post about 10 – 12 feet tall inserted in it, was constructed from topsoil and subsoil. On the top of this mound, an iron circular tank of 6 – 8 feet diameter and lined with bricks was laid. Nearby was a tank pumped full of water from a nearby source such as a well or river (the Greensand was an ideal aquifer to sink wells in). A pipe let the water into the iron tank and opposite this was a sluice exit leading down the hill to a pan formed with an earth retaining wall. To the central post was attached a 12 – 14 foot pole which was yoked to a horse. To this pole were attached two iron harrows that reached down to the brick surface in the iron tank.

The coprolites were barrowed up the mound and tipped into the iron tank, water was let in and the horse rotated the harrows by walking around the base of the mound. The coprolites dropped to the bottom while a creamy slurry formed above them. The sluice was opened and the slurry drained down the hill into the pan. This process was repeated several times after which the washed coprolites would be barrowed away to be transported for processing. The slurry dried in the pan into a cake which was either put back into the coprolite trenches or shipped away for use in brick works and other processes.

(5) Processing

The washed coprolites were transported by road, rail and river to the processing plants. From Wimpole, some went to Lord’s Bridge Station and on to Cambridge, more went to Meldreth or Royston stations to be taken to Ipswich, London and elsewhere. Cambridge coprolites were taken to Silver Street Wharf and shipped by barge to Kings Lynn and thence round the coast.

The coprolites were ground to a powder in bone mills, local ones were located on East Street and Histon Road in Cambridge. These mills were often originally corn mills but the hardness of the coprolites meant that a change to harder grindstones was required. With the advent of steam power, this process was more efficient.

The ground coprolites were then treated with warm sulphuric acid to form the super phosphate fertiliser. Chemical manure works were opened locally in Burwell (on Burwell Lode for river access) Duxford, Shepreth, Royston, Bassingbourn and Odsey (all taking advantage of the Cambridge to Hitchin railway line).