Humberside Geologist No. 16

An Ancient Mere at Barmston on the Holderness Coast – The Snail's Tale

By A R Speed

Introduction

To the north of Sands Lane, Barmston is an area of low-lying land bounded in the north, south and west by higher ground rising in height to greater than 10m OD. The latter is visible in section from the beach at the end of Sands Lane and its superficial deposits are recorded on the BGS Flamborough and Bridlington Sheet 55/65 (Solid and Drift) map as Quaternary Glacial Sand and Gravel with laminated silt and clay. The low-lying land is exposed by the sea as a cliff about 1m high and is recorded as Quaternary Alluvium and marked on the Ordnance Survey Explorer Map 295 (2013) as "Carrs".

Sheppard (1957) reports evidence for over seventy lakes and ponds remaining in Holderness after the icesheet retreated approximately 15,000 years Before Present (15 ka BP). Only Hornsea Mere remains, but many were drained only recently. Flenley (1990) presents a figure from Sheppard's paper which suggests the possibility of an old mere at Barmston was "well evidenced". Sheppard had used the phrase "possible mere suggested by geological evidence only". The scale of the figures in both Shepard's and Flenley's papers is such that it is not possible to say whether or not they are referring to the low ground to the north of Barmston as the site of the mere.

As part of an investigation into the depositional conditions responsible for post glacial deposits along the coast from Ulrome to Fraisthorpe, the exposed low cliff north of Barmston has been examined. This paper discusses evidence that the low ground north of Barmston was the site of a freshwater mere formed when a slowly melting stagnant ice block protected the area from other post glacial deposits.

Discussion

Between TA 1699 5978 and TA 1694 6030 the cliffs are low (<2m) and comprise Skipsea Till at beach level overlain by bedded clay, laminated sand, an organic layer, massive sand, a peaty layer and topped by soil and sand dunes (Figure 1). This stratigraphy is consistent with deposition in a lacustrine environment in which occasionally vegetation flourished.

Optically Stimulated Luminescence dating by Bateman *et al.* (2015) of sands and gravels overlying the Skipsea Till at Barmston suggests that the retreat of the North Sea lobe of the icesheet was 15.0 ± 1.2 ka BP.

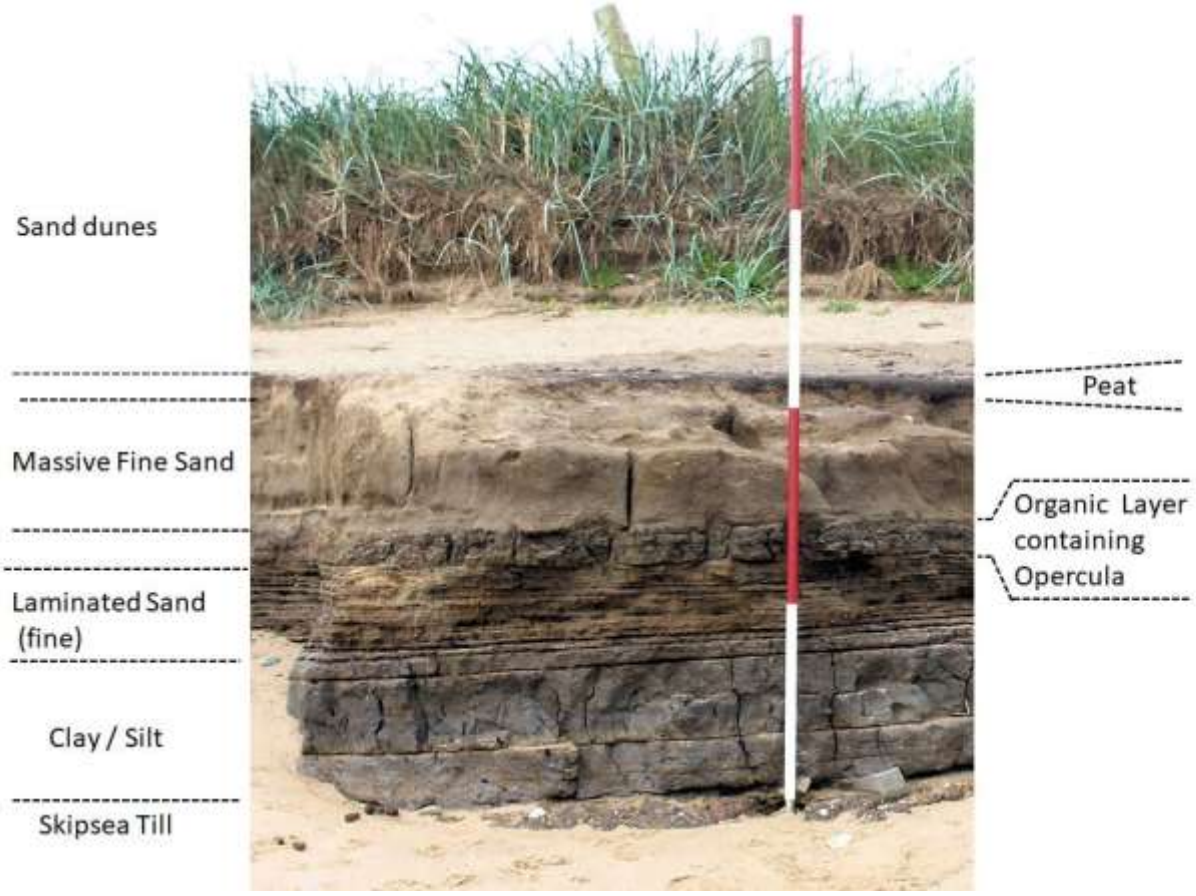

Fig 1. The low cliff at Barmston (TA 16989 59780)
The scale divisions are 50 cm.

Flenley (1990) states that the icesheet began to retreat about 15 ka BP and “the improvement in climate was not steady, but was interrupted at least once and probably twice. The evidence for this is partly in the stratigraphy, which shows oscillations from organic deposits (indicating temperate conditions) to mineral deposits (indicating cold and/or dry conditions)”. Taking the till upper surface to indicate icesheet retreat Flenley’s observation could be a fair description of the low cliff exposure: cold conditions (clay and fine laminated sand) followed by an organic layer deposited under warmer conditions, when vegetation flourished followed by a colder period (massive sand) before warmer conditions (peat) returned.

However, after examining photographs of the exposure Rodger Connell (pers.com. 2021) has suggested that an unconformity possibly lies between the clay and laminated sand: ‘the clay looks quite “massive"-

possibly "glacial" rather than postglacial lacustrine’. The implication is that the lacustrine deposits above the possible unconformity are later than might be inferred from Flenley’s (1990) model.

The organic layer contained small white objects (Figure 2) which Mike Horne (pers. com. 2020) identified as gastropod opercula. Marine, freshwater and terrestrial (land) snails can all have an operculum (the lid or door that closes the shell when the animal is resting), but in marine shelled snails which live sub-tidally, the operculum is greatly reduced in size and no longer serves to seal the shell entrance. Equally, some snails do not have an operculum. While not definitive, this together with the stratigraphic evidence, suggests that the opercula found belonged to freshwater or terrestrial snails.

The presence of an organic layer containing snail opercula suggests damp ground, possibly waterlogged or lacustrine conditions. The description of the area as a “carr” on the OS map supports this, at least in modern times. Collins English Dictionary (2021) offers the definition of “carr” as “an area of bog or fen in which scrub, esp. willow, has become established”. Can the identification of the species of snail reveal more about the depositional environment?

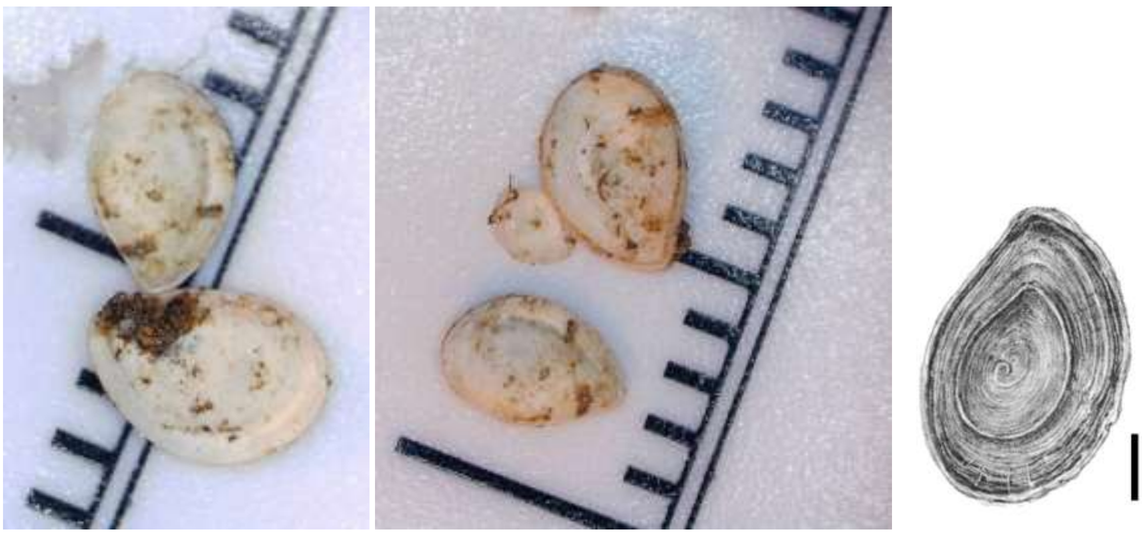

Fig 2. Snail opercula found in the organic layer. The scale divisions and scale bar are 1 mm. Image on the right is a Wikipedia (2020) image of *Bithynia tentaculata*

Eversham (2013) produced a guide to identifying freshwater molluscs. Based on the images and text in this work an analysis has been conducted (Table 1).

Name	Type	Size	Aperture shape	Relative dimensions of shell		Length / Aperture Size	Operculum present?
				Aperture	Length		
Planorbarius corneus	flat-coiled	20mm x 10mm	circular -convex	14	39	2.8	Yes
Gyraulus crista	flat coiled	1mm x 3mm	circular	17	34	2.0	
Gyraulus albus	flat coiled	7mm x 1.8mm		17	49	2.9	
Lymnaea balthica	turret or spire	20mm x 13mm	oval-pointed	24	38	1.6	No
Viviparus contectus	turret or spire	35mm x 30mm		19	33	1.7	Yes
Viviparus viviparus	turret or spire	40mm x 30mm		19	37	1.9	Yes
Potamopyrgus antipodarum	turret or spire	5.5mm x 3mm	oval - pointed	21	48	2.3	Yes
Bithynia tentaculata	turret or spire	15mm x 9mm	oval- pointed	18	43	2.4	Yes
Lymnaea balthica	turret or spire	20mm x 13mm	oval- pointed	29	46	1.6	No
Lymnaea stagnalis	turret or spire	50mm x 25mm	oval	24	50	2.1	No
Lymnaea truncatula	turret or spire	12mm x 6mm	oval	19	44	2.3	No
Lymnaea fusca	turret or spire		oval	20	43	2.2	No

Table 1. Analysis of text and images in Eversham (2013).

This analysis suggests:

- Flat-coiled snails have a circular aperture, while turret or spire shaped snails have an oval or pointed-oval aperture.
- The ratio aperture size to overall shell length varies between 1.6 and 2.4.

These observations allow tentative conclusions to be drawn about the operculum found in the organic layer. Assuming the operculum reflects the aperture in both shape and size, a pointed-oval 4mm operculum belongs to a turret or spire shaped snail, 6 – 10 mm in size.

As highlighted in the table a candidate which has both the correct size and shape of aperture is *Bithynia tentaculata*. Adult *B. tentaculata* possess a white, calcareous, tear-drop to oval-shaped operculum with distinct concentric rings (US Fish and Wildlife Services, 2015). The operculum of juveniles, however, is spirally marked. An image of the operculum is provided by Wikipedia (2020) and is reproduced in Figure 2.

Comparison of the images shows the operculum found at Barmston is that of adult *B. tentaculata.*

Wikipedia (2020) provides the following information about *B. tentaculata*:

- Common names: the mud Bithynia, common bithynia, or faucet snail.
- Distribution is Palaearctic. It occurs in the UK.
- This snail lives in slow-running freshwater habitat such as low-velocity rivers and standing-water bodies such as lakes. The species flourishes in calcium-rich waters.
- Found at depths of up to 5 m.

No shells were found in the small organic layer sample, only opercula. Alexandrowicz (1999) offers a possible explanation: after the death of the animal its shell may for a long time float close to the water surface, whereas the operculum soon falls or sinks and becomes part of the deposit. Alexandrowicz (1999) further suggests that the ratio of shells to opercula can be used as an environmental indicator, as shown in the Table 2.

Shells to Opercula ratio	**BIN**	**Environment**	**Water condition**
Opercula only	1	In lakes with abundant rooted vegitation shells stay on the surface for a long time and are slowly transported to the shore by wind & waves whereas opercula sink to the bottom.	Still water
Equal numbers	0	Slowly flowing rivers transport dead snails as whole depositing in bays. This may also be the case in small still water bodies with sparse vegitation.	Slowly flowing
Shells only	-1	Flowing rivers or episodicc floods transport shells more easily than opercula	Flowing water

Table 2. Ratio of shells to opercula as a proxy for environmental conditions. After Alexandrowicz (1999).

The Bithynia-index (BIN), represents the proportion of opercula and shells of *Bithynia tentaculata* according to the formula described by Alexandrowicz (1999) :

$$BIN = (opercula - shells) / (opercula + shells)$$

The occurrence of opercula only (BIN =+1) among a mass of organic material suggests that the organic layer formed in still water with abundant rooted vegetation.

To the north and south of the low cliff area, the land surface rises (>10m) and there is evidence in the cliffs of post-glacial laminated silts and sands deposited under lacustrine conditions overlain by outwash sands and gravels and prograding deltas (Connell 2018 and Bateman *et al.,* 2015). A possible explanation of why the low cliff area should be so different is provided by the classic explanation of kettle hole formation and associated meres: namely that the area was protected after the icesheet retreated by a stagnant ice block while outwash built up around it. Subsequently the stagnant ice melted leaving a depression which could be filled with water (Bennet & Glasser, 1996).

The possibility that the stratigraphy includes an unconformity (Connell, pers. com. 2021) raises the possibility that the lacustrine deposits, including the lower organic layer, are relatively modern. This could be resolved by aminostratigraphy, a technique employed by Penkman *et al.* (2013) on the opercula of *B. tentaculata*.

Conclusions

The stratigraphic evidence suggests that the low area to the north of Sands Lane, Barmston was protected from the proglacial deposits, present to the north and south, by a stagnant ice block, which when it melted, left a hollow which subsequently became a wet area. The stratigraphy is consistent with a succession of cold, open water, lacustrine conditions interspersed with temperate conditions when vegetation flourished. Evidence for waterlogged or lacustrine conditions is supported by a lower organic layer containing the opercula of the freshwater snail *B. tentaculata.* Snail shells are absent and, following Alexandrowicz (1999), this indicates that the organic layer formed in still water with abundant rooted vegetation. The possibility of an unconformity in the post-glacial stratigraphy makes the dating of the organic layer uncertain. However, this might be resolved by amino-acid dating of the snails' opercula.

References

Alexandrowicz, S. W. (1999). *Bithynia tentaculata* (Linnaeus, 1758) as an indicator of age and deposition environment of Quaternary sediments. *Folia Malacologica*, 7(2), 79-88.

Bateman, M. D., Evans, D. J. A., Buckland, P. C., Connell, E. R., Friend, R. J., Hartmann, D., Moxon, H., Fairburn, W. A., Panagiotakopulu, E. and Ashurst, R. A. (2015). Last glacial dynamics of the Vale of York and North Sea lobes of the British and Irish Ice Sheet. *Proceedings of the Geologists' Association*, 126, 712-730.

Bennet, M. R. & Glasser, N. F. (1996). *Glacial Geology. Ice Sheets and Landforms.* Chichester: John Wiley & Sons Ltd.

BGS (1985). *Flamborough and Bridlington, England and Wales Sheets 55 & 65 (Solid and Drift)*. Keyworth: British Geological Survey.

Collins English Dictionary. (2021). *Collins English Dictionary.* [Online]. Available at: https://www.collinsdictionary.com/ [Accessed 17 July 2021].

Connell, E. R. (2018). Itinerary 16, North Holderness: Barmston South to Mappleton. In P. F. Rawson & J. K. Wright, *Geology of the Yorkshire Coast*, 4th edition. London: Geologists' Association, pp. 151-155.

Eversham, B. (2013). *Identifying Freshwater Molluscs* [Online]. Identifying Freshwater Molluscs. Last Updated: April 2013. Available at: https://www.naturespot.org.uk/sites/default/files/downloads/Pondsnails%20Key%20version%20%202.2%20iv2013%20illustrated%20PDF.pdf [Accessed 17 July 2021].

Flenley, J. R. (1990). Chapter 4, Vegetational History. In S. Ellis and D. R. Crowther (Eds). *Humber perspectives: a region through the ages*. Hull: Hull University Press, pp 43-53.

Ordnance Survey Explorer Map 295 (2013), *OS Explorer Map 295, Bridlington, Driffield & Hornsea,* (2013), Southampton: Ordnance Survey.

Penkman, K. E., Preece, R. C., Bridgland, D. R., Keen, D. H., Meijer, T., Parfitt, S. A., White, T. S. and Collins, M. J. (2013). An aminostratigraphy for the British Quaternary based on *Bithynia* opercula. *Quaternary Science Reviews*, 61, 111-134.

Sheppard, J. A. (1957). The medieval meres of Holderness. *Transactions and Papers (Institute of British Geographers)*, 23, 75-86.
Available at https://www.jstor.org/stable/621157?read-now=1&refreqid=excelsior%3Abd4f5723f297cd95be854c1de5621e2a&socuuid=87fa5e86-df61-41fe-885e-505a47918724&socplat=email#page_scan_tab_contents [Accessed July 16, 2021]

U.S. Fish and Wildlife Service (2015). *Faucet Snail (Bithynia tentaculata) Ecological Risk Screening Summary*, [Online]. Available at https://www.fws.gov/fisheries/ans/erss/highrisk/Bithynia-tentaculata-ERSS-revision-July2015.pdf [Accessed 17 July 2021].

Wikipedia (2020). *Bithynia tentaculata,* [Online]. Available at https://en.wikipedia.org/wiki/Bithynia_tentaculata [Accessed 17 July 2021].

Acknowledgements

Thanks to Mike Horne for identifying that the small white objects in the organic layer were snail's opercula and to Rodger Connell for reading and commenting on the script.