BURROWS AND BORING IN HARDGROUNDS

By

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Abstract

A variety of well-preserved trace fossils is present in many chalk hardgrounds. In these beds it is important to distinguish burrows, which were constructed before the cementation of the sediment, from borings, which post-date hardening. Examples of both are described from the Turonian Chalk Rock of England, the Lower Danian hardground at Stevns Klint, Denmark, and the Campanian summit-hardground near Vise, Belgium.

Introduction

In the large majority of Chalk and Danian hardgrounds, early diagenetic cementation extends to about 30 cm beneath the erosion surface. Greater thickness of hardening can occur, however, in multiple hardgrounds where several erosion surfaces follow one another less than 30 cm apart. The Turonian »Chalk Rock« of south-east England, for example, reaches in places a thickness of over 2 m, and comprises up to seven hardgrounds in close succession. (BROMLEY, 1965).

Thalassinoid Burrows

The calcite-cemented chalk beneath the erosion surface of a hardground shows traces of burrows which were constructed before and during the cementation of the sediment. A network of large, branching burrows is the most widely distributed type of burrow, recognizable in all well developed hardgrounds. Details vary in different hardgrounds, but the networks resemble *Thalassinoides* EHRENBERG, differing from that ichnogenus in possessing a very variable diameter, lacking inflations, and in some hardgrounds showing considerable irregularity or contortion. (BROMLEY, 1967).

In the complex hardground at the base of the Danian in Stevns Klint, Denmark, these »thalassinoid« burrow networks are well preserved, both in the Danian and the Maastrichtian parent sediment, and show several noteworthy features. This hardground contains an unusually large amount of flint most of which is the result of a silicification of the unconsolidated fill of the burrows. The flint in the burrows is of two types: grey flint, which is comparable to flint in burrows in some English hardgrounds; and black flint, possibly representing later additional silicification of the earlier, grey, embryo flint (BROMLEY, 1965). Northeast of Rødvig, at the south end of Stevns Klint, the burrow fill is incompletely silicified and takes the form of delicate tubes of grey chalcedonic flint lining the burrow walls. The remaining fill is silicified to a variable extent, the flint tending to be porous like the loose sediment it has replaced. The flint, cleaned of unsilicified sediment, can closely resemble a siliceous sponge, for which it has been mistaken in the past (ROSENKRANTZ and RASMUSSEN, 1960, p. 6). Further north at Højerup and Kulstirende, more solid, black flint partially fills the burrow-system.

In addition to the flint in burrows, large nodules of flint occur in places in the Stevns Klint hardground. These nodules appear to have formed by diagenetic replacement of cemented sediment, a process which is highly unusual in hardgrounds.

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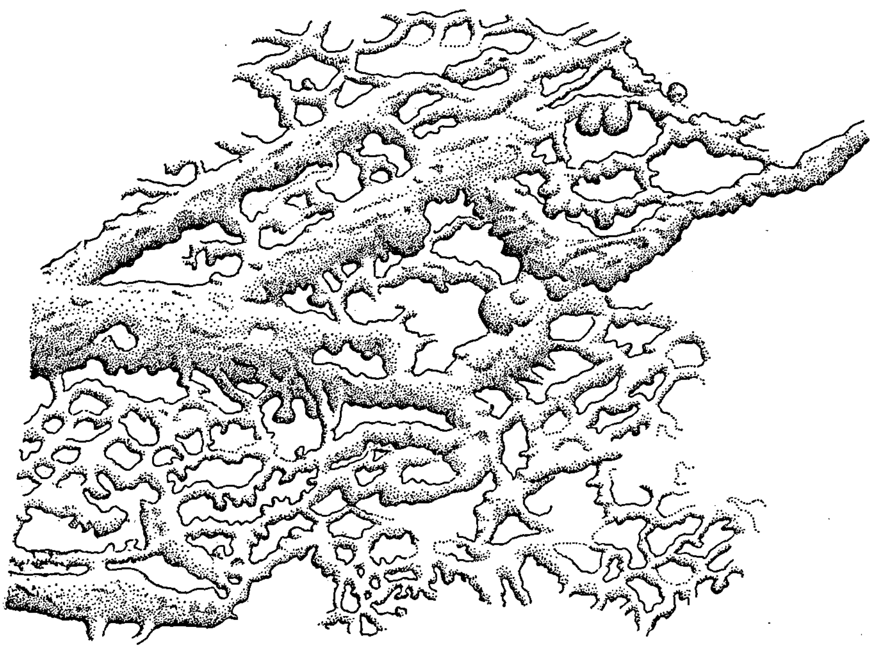

Fig. 1. Burrow paterns in the erosion surface of the hardground at the base of the Danian at Kulstirende, Stevns Klint, Denmark, moulded on the under side of the superjacent bed of Bryozoan Limestone. Networks of thalassinoid burrows 2–3 cm in diameter fuse with larger burrows 8–12 cm in diameter. From photographs.

The thalassinoid burrows in the hardground at Stevns Klint show various degrees of contortion. Those burrows which were constructed in soft sediment before or at an early stage of its cementation follow more or less evenly curved or straight paths. The hard sediment around these, however, is riddled with deformed burrows which were constructed at a later stage of cementation when soft sediment was becoming increasingly restricted (BROMLEY, 1967).

The erosion surface of the Stevns Klint hardground cuts through the remains of horizontal burrow networks destroying the upper half. These are seen most clearly in the counterpart of the erosion surface, moulded on the under side of the superjacent bed. They are thalassinoid networks, but they anastomose to form large major burrows which are generally straight and reach a diameter of 12 cm (Fig. 1). The large major burrows are present only at the erosion surface and are not seen in the hardground itself. However, they bear a resemblance to the much smaller, least contorted of the other thalassinoid burrows within the hardground.

Other Burrows

In addition to thalassinoid systems the Stevns Klint hardground contains another type of burrow, which branches, but which has a smaller diameter (1 cm) and straighter course than the thalassinoid burrows. Within the hardground the smaller burrow type can in most cases be seen to be confined within the fill of the thalassinoid burrows. However, in the soft sediment beneath the hardground the organism responsible for the small burrows was free to leave the thalassinoid burrow system and here the two types of burrow cross at random. The walls of these burrows, particularly those at the north end of Stevns Klint near Kulstirende, are coloured light to dark brown, by a wall-cement applied by the inhabitant to harden the unconsolidated sediment. The colouration continues to affect the burrow walls to 60 cm beneath the erosion surface. This is in contrast to the mineralization of the walls of the thalassinoid burrows in this and other hardgrounds, which is simply an extension to a few centimetres into the burrow of the early diagenetic mineralization of the erosion surface. In some respects the small, brown-walled burrows resemble the small, phosphatized burrows confined within thalassinoid burrows in the Mulatto hardground (Campanian) near Belfast, Northern Ireland (BROMLEY 1965, p. 224, fig. 23).

The hardground capping the Campanian at Carrière North near Visé, Belgium, is characterized by very long vertical penetrations passing down from the erosion surface through the hard chalk and into the soft chalk below, reaching a length of more than 2 m, but with a diameter of only 2–3 mm. Their course is diverted when they encounter hard shells in their path, which indicates that they are burrows which pre-dated the hardening of the hardground rather than post-hardening borings. Their extraordinary dimensions are similar to those of some members of the Pogonophora which appear to live vertically in soft sediment (SOUTHWARD, 1963, pp. 411, 422, 424). The name *Tasselia ordam* has been given to some Lower Pleistocene structures in Belgium by HEINZELIN (1965) who considers it possible that they are the remains of Pogonophora. However, the Campanian examples show a tendency to branch in places, which renders such a determination doubtful in their case.

Borings

It might be assumed that the carbonate cementation of the sea floor at hardground horizons would have provided an unlimited environment for the activity of boring organisms. However, the degree to which the niche is exploited varies considerably in different hardgrounds. In some hardgrounds, such as that at Stevns Klint, the cemented chalk is generally not attacked, and organic borings are restricted to the larger shells, especially oysters.

The hardground at Carrière North and Hallembaye near Visé, Belgium, is riddled by vermiform borings and borings of pholadid molluscs.

The English Chalk Rock hardgrounds have been extensively bored by animals and plants, which have attacked both cemented chalk and shells (BROMLEY, 1965). Vermiform borings are common, but are usually indeterminate. Rarely shells contain U-shaped borings resembling those of the annelid *Polydora*. Undoubted polyzoan borings have not been recognized, and those attributable to lamellibranchs are uncommon and their identification rarely certain. Both shells and hard chalk pebbles commonly contain borings of acrothoracic cirripedes. The

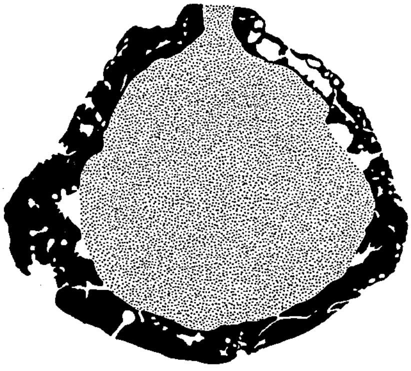

Fig. 2. A chalk pebble from the uppermost Chalk Rock hardground at High Wycombe, Buckinghamshire, England, cut in half to show the large boring (dotted) within. The section has passed through a pore connecting the boring with the exterior. The remainder of the pebble (black) contains later borings (white), mostly of sponges. Natural size.

extremely slender borings of thallophytes are common in shells and their excellent preservation renders it possible in some cases to distinguish the work of algae from that of fungi. The most conspicuous borings in the Chalk Rock are those of sponges; they include the type known as *Cliona cretacea* PORTLOCK with large rounded crypts and small pores, but other types are also present. Both hard chalk and shells have been attacked by sponges.

In additon there is in the Chalk Rock a boring of very large size which is probably likewise the work of a sponge. Where it attacked the erosion surface this organism produced a large, rounded crypt up to 5 cm in diameter with circular pores 2–3 mm across communicating with the exterior (BROMLEY 1965, p. 235). Many chalk pebbles on the erosion surface have been hollowed out to such an extent as to leave a remnant »shell« of hard chalk of only 2–3 mm thickness surrounding the crypt and pierced by circular pores (Fig. 2). The destruction brought about by this organism, in conjunction with other boring sponges, in some cases determines the sculptural form of the erosion surface of the Chalk Rock hardgrounds.

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