PROBABLE CIRRIPEDE, PHORONID, AND ECHIUROID BURROWS WITHIN A CRETACEOUS ECHINOID TEST

by K. A. JOYSEY

ABSTRACT. Natural flint casts representing several different types of burrows were found within the thickness of the test of a Chalk echinoid. They have been compared with the burrows inhabited by various living animals. It is concluded that they indicate the probable presence of an acrothoracican cirripede, a phoronid, and an echiuroid, and the possible presence of a lamellibranch, polychaet and other 'worms', and sponges. No new names are proposed for these burrows because they cannot be regarded as parts of organisms.

THE burrows described in this paper were found within the thickness of the test of a single specimen of the echinoid *Echinocorys*, which was collected from a beach boulder, derived from the Chalk of Culver Cliff, Isle of Wight. The fossil was almost completely filled with flint and completely enclosed in flint, but the echinoid test itself was not silicified.

With the intention of preparing a perfect internal cast of the *Echinocorys*, the flint was broken off the outside and the specimen immersed in hydrochloric acid in order to dissolve the test. When about half of the thickness of the test had been removed the burrows were revealed as natural casts in flint adhering to the remaining inner part of the test. In order to preserve the burrows the original plan to dissolve away the whole of the test was abandoned, and subsequently they were further prepared by dropping on small amounts of dilute hydrochloric acid from a pipette.

DESCRIPTION AND INTERPRETATION

Due to their method of preparation, the burrows have a misleading resemblance to certain adherent organisms, and so it must be stressed that the structures shown on Pl. 70 are casts of excavations. Although the burrows were present before fossilization there is no direct evidence to indicate whether they were constructed before or after the death of their host.

For reference purposes a letter has been allocated to each of the seven different kinds of cast (A–G), but not all of these structures are burrows. They have been compared with figures and descriptions of burrows inhabited by living plants and animals, but all of them are considerably larger than the excavations that are attributed to plants (Bornet and Flahault 1889).

A. These are casts of the pore-pairs in the ambulacral plates of the echinoid (Pl. 70, figs. 2, 3). They now project from the surface of the specimen like rows of miniature factory-chimneys, and the tops of the tallest chimneys indicate the level of the original outer surface of the echinoid test.

B. There is only a single example of this type of burrow (Pl. 70, fig. 1). It commences with a subcircular aperture on the outside of the test, from which it gradually increases in diameter along the greater part of its length, and then narrows slightly in the final

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stage. It is unbranched, but there are three sharp changes in direction, each of which appear to avoid intersection with another burrow of a different type.

At the present time a burrow of this kind could possibly be inhabited by a small lamellibranch comparable with *Gastrochaena dubia* (Pennant), but more probably by a polychaet worm comparable with *Dodecaceria concharum* Oersted (= *Heterocirrus saxicola* Grube) or *Potamilla reniformis* (Müller) (= *Sabella saxicava* Quatrefages), all of which are reviewed by McIntosh (1868, 1908).

Similar burrows in brachiopod shells have been figured from the Devonian of North America (Clarke 1921, figs. 78–82, fig. 101) and from the Permian of Australia (Teichert 1945, pl. 3, fig. 1), and in each case have been attributed to worms.

C. There is only a single example of this type of burrow (Pl. 70, fig. 1) which has a narrow entrance tunnel and an expanded inner chamber. The early part of the entrance tunnel has not been fully exposed, but it appears that the aperture was on the inner side of the echinoid test. The far end of the chamber is divided into several lobes, which appear to represent several unsuccessful attempts to pass above burrow B, which occupies the greater part of the thickness of the test.

At the present time similar burrows are inhabited by echiuroid worms comparable with *Thalassema neptuni* Gaertner, the shape of the burrow reflecting the shape of the worm. Farran (1851) stated that this species 'accurately filled' its burrows within a limestone pebble. Jameson (1899) stated that it generally inhabited burrows which had been made by the lamellibranch *Saxicava*. Although it appears to be uncertain whether echiuroids can entirely construct their own burrows, Lankester (1868) noted that *Bonellia* inhabited cracks in rock which 'was to a certain extent excavated, thus fitting to the body of the worm'.

D. This branched burrow system appears to belong to a colonial organism (Pl. 70, fig. 3). There are several apertures to the outer surface of the test, which are joined by a burrow of approximately the same diameter as the apertures. Burrow D forms the greater part of the H-shaped system shown in fig. 3, but the entire left side of the H-shape is formed by an example of burrow E, which will be described below. The two different kinds of burrow system can be seen lying alongside one another in the top left branch of the H-shape. At the present time, burrows similar to D are inhabited by *Phoronis ovalis* Wright, which has been recorded burrowing within the shell of molluscs from Europe (Harmer 1917), Brazil (Marcus 1949), and New Zealand (Silen 1956).

E. This is the most extensive type of burrow system in the present specimen (Pl. 70, figs. 1, 2, and 3). The burrows run for long distances within the test, and are variable in diameter. Where branching occurs the two branches are sometimes of different diameter. The burrows often cross over one another and lie very close together but no unequivocal

EXPLANATION OF PLATE 70

Figs. 1–3. Natural casts in flint of animal burrows within the thickness of the test of a single specimen of the echinoid *Echinocorys*, derived from the Chalk of Culver Cliff, Isle of Wight. The specimen has been prepared by dissolving away the outer surface of the test with hydrochloric acid. Figs. 1 and 2 are ×6; fig. 3 (oblique view), *c.* ×12. A, casts of pore-pairs of the *Echinocorys*; B, burrow possibly of a polychaet or lamellibranch; C, burrow probably of echiuroid; D, burrow probably of a phoronid; E, burrow possibly of 'worm' or sponge; F, burrow probably of acrothoracican cirripede; G, possible burrow of sponge or possible inorganic artifact.

Photographs by Mr. R. D. Norman.

example of anastomosis has been observed. There are relatively few apertures (in comparison with burrow D), and the apertures sometimes have a smaller diameter than the tunnel from which they surface.

These burrows cannot yet be matched with those of any living organism. Similar burrows in brachiopod shells from the Permian of Australia (Teichert 1945) have been named *Conchotrema* and attributed to worms, but without any indication which of the several Phyla of worms is supposed to be responsible. Teichert (1945) states that the genus *Conchotrema* includes the Pennsylvanian form *Clionolithes canna* Price, which Clarke (1921) regarded as a sponge, and that it is similar to a Mississippian form which Girty (1915) regarded as a burrowing bryozoan.

Burrow system E bears little resemblance to living burrowing bryozoans which have been reviewed by Marcus (1938) and Silen (1947), but the other two hypotheses—sponge or 'worm'—appear to be equally possible interpretations.

F. These are the smallest individual burrows in the present specimen (Pl. 70, fig. 2). The six examples shown are part of a group, and there are seventeen individuals present in this one echinoid. Each of the burrows can be compared in shape with a shoe, although somewhat laterally compressed. The aperture of the burrow corresponds with the opening of a tightly laced shoe, being elongate oval in shape, almost slit-like. The space for the ankle is represented by an oval shaft which leads down into the inner chamber of the burrow.

At the present time burrows similar to F are inhabited by the cirripede *Alcippe lampas* Hancock, although the burrows of this species are relatively broader, and were originally compared with a Roman lamp (Hancock 1849*b*) rather than a narrow shoe. *Alcippe* is one of several genera of minute burrowing cirripedes included in the order Acrothoracica, reviewed by Gruvel (1905).

G. This structure is very variable, and may represent either a burrow system or an inorganic artefact (Pl. 70, figs. 1 and 3). It has an irregular arborescent and dendritic form, which may be centred on either the inner or the outer surface of the test. If these structures are casts of burrows they are comparable with some of the more irregular excavations at present inhabited by sponges (Hancock 1849*a*, Morris 1849, Topsent 1887). On the other hand, these structures may be the result of local replacement of the echinoderm test by silica penetrating from the surrounding flint.

DISCUSSION AND CONCLUSIONS

In order to identify the Cretaceous burrows it has been necessary to study descriptions of the burrows of living organisms. During this work it has emerged that (*a*) different kinds of burrow systems may be constructed by closely related organisms; (*b*) similar burrow systems may be constructed by unrelated organisms; (*c*) some organisms inhabit burrow systems which were originally excavated by a different organism (although the old burrow may be modified by the new occupant).

These observations on the burrows of living organisms are sufficient to explain the controversy which has frequently arisen over the identification of fossil burrow systems. For example, *Palaeosabella prisca* (M'Coy) was originally referred to the sponge genus *Vioa*, then it became the type species of the worm genus *Palaeosabella*, and subsequently it has been suggested that it may be congeneric with *Topsentia devonica* Clarke, and should perhaps be relegated to the sponges (Teichert 1945).

Considering a hypothetical case, the present author would not be prepared to describe a new species of rabbit on the evidence of a fossil burrow in an Interglacial deposit! By analogy, it is not proposed to create new names for the burrows in the Cretaceous echinoid test. They are regarded as indications of the presence of organisms, but cannot be regarded as parts of organisms. The description of new species might be justified if the hypothetical rabbit burrow should subsequently yield bones, or if fossil burrows in shells and echinoids should yield spicules, chaetae, or other non-perishable parts. Otherwise, the system of letters used in the present description is adequate for reference purposes.

In conclusion, some of the burrows in the test of the Cretaceous echinoid indicate the probable presence of an echiuroid (C), a phoronid (D), and an acrothoracican cirripede (F), whereas the less distinctive burrows which allow more than one interpretation indicate the possible presence of a lamellibranch (B), polychaets and other 'worms' (B and E), and sponges (E and G).

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K. A. JOYSEY
University Museum of Zoology,
Cambridge

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JOYSEY, Borings within an echinoid test