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THE OCCURRENCE OF PEDUNCULATE BRACHIOPODS IN SOFT SEDIMENTS

SIR,—Dr. Rudwick has recently drawn attention (1961) to the fallacy of the usual assumption that pedunculate brachiopods necessarily require a hard substratum for their attachment. Whilst completely endorsing Dr. Rudwick's remarks, I should like to draw attention to another possibility which has not received much consideration. This is the likelihood that brachiopods may have attached themselves to floating seaweed of the *Sargassum* type. Attached weed is limited in its range of depth and distance from shore, and its normal environment probably makes little showing in the stratigraphical record; but floating weed could have been much wider in distribution and many organisms are known to live on it at the present day.

I have noted that certain small rhynchonelloids tend to occur in argillaceous sediments more commonly than other brachiopod groups; in such sediments they often occur as scattered individuals rather than in the closely-packed lenses or bands that are commonly found in calcareous and arenaceous rocks. Examples are *Calcirhynchia calcaria* (Buckman) in the Lower Lias, *Rhynchonelloidella spathica* (Lamarck) in the Oxford Clay, and *Thurmanella* (?) *subvariabilis* (Davidson) in the Kimeridge Clay. These rhynchonelloids commonly occur as isolated individuals and are well preserved, with no evidence in themselves or in accompanying fossils, of derivation from another environment. They are characteristically small and thin-shelled and are associated with dominantly pelagic forms or benthonic forms not requiring a hard substratum.

In an account of Upper Jurassic rhynchonelloids in the Cracow-Czestochowa chain of Poland, Rozycki (1948) distinguished three ecological groups: (1) large, often asymmetrical species associated with reefs; (2) species forming layers, associated with other brachiopods; (3) species occurring singly and usually very small. This fits well with my own observa-

tions in Britain and France, and I suggest that the last group may have had the epiplanktonic habits mentioned above.

The same explanation may apply also to the scattered *Orbirhynchia's* and *Cretirhynchia's* of the Chalk which are commonly associated with endobenthonic forms. In Dr. W. E. Smith's recent paper on the Cenomanian west of Beer (1961), he drew attention to the contrast in faunal facies within the Lower Turonian on either side of the contemporary Branscombe Mouth ridge. I suggested in the discussion (op. cit., p. 133) that the western fauna may have been essentially a hard bottom one, whereas that to the east consisted mainly of burrowing forms together with small rhynchonelloids. Again the latter would be anomalous if we do not accept an explanation such as that here proposed.

In the Palaeozoic, there is much comparable evidence. Sardeson (1926, 1929) in fact made this same suggestion for rhynchonelloids in the Ordovician of Minnesota. He noted that the rhynchonelloids alone showed no preferred orientation and may have fallen into the sediment from floating vegetation. He also noted that the same forms were among the first to return to the area after a fall of volcanic ash, before a static benthonic fauna had been re-established.

Ruedemann (1934) recorded a number of usually small, thin-shelled inarticulate brachiopods in graptolitic shales from the Lower Palaeozoic of North America. These were associated with other epiplanktonic forms and remains of supposed brown algae.

Another interesting example comes from the work of N. D. Newell and his associates on the Permian reef complex of Texas and New Mexico (1953). They record that the small rhynchonelloid *Leiorhynchus* (*Nudirostra* auct.) is the only supposedly benthonic form which occurs in the deepest stagnant bottom biotope of the Delaware Basin (op. cit., p. 196). G. A. Cooper (1957) observed that the same genus is abundant in the dark shales of the Middle Devonian in eastern and central U.S.A., but is rare in coarse arenaceous deposits and limestones.

This may also be applicable in the European Devonian. In Belgium, for example, Mr. I. D. Young has recently collected well-preserved specimens of *Leiorhynchus* at Boussu-en-Fagne near Frasnes, in black Upper Frasnian shales of Lecompte's deep-water F 3 facies (1956, etc.). These were associated with the usual fauna of the supposedly nektonic goniatites and conulariids and the supposedly epiplanktonic *Buchiola*. Dr. R. Goldring has also kindly drawn my attention to a paper by A. Rabien (1956) in which he records *Leiorhynchus* cf. *L. planeplicata* (Paeckelmann) and *Camarotoechia rotundata* Münster in the black shales of the Upper Devonian Adorfer Schichten in the German Rhineland. Here they appear to be the only macrofossils apart from the usual *Buchiola*'s and one trilobite.

G. Y. Craig (1956) in a study of a Carboniferous fauna in a silty marine ash near Edinburgh, interpreted all the fossils present as burrowing forms apart from some motile pectiniform lamellibranchs and a few specimens of the rhynchonelloid *Camarotoechia*. The last-named are the only fossils thought to be ecologically out of place in the sediment. Craig noted that eight out of thirteen specimens of *Camarotoechia* were oriented vertically in the sediment and (since he rejected the possibility that they could have been attached in this position in an unconsolidated silt), he suggested that they floated in like this with the anterior end uppermost. The mantle cavity at that end of the shell is thought to have filled with decomposition gases and this provided buoyancy for the shells to float into the area after death from a rocky area elsewhere. It seems unlikely that the shells would have remained airtight in this way, and another explanation might be that the brachiopods simply fell from floating vegetation, with their heavier posterior ends downwards. It should be stated, however, that *Camarotoechia* sensu lata appears to be mainly a fossil of shallow water calcareous sediments. Gekker (1960) has, in fact, recently described it as one of the characteristic fossils of smooth rocky sea floors in the Devonian of Estonia.

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