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CLOSE-PACKED PATTERNED ARRANGEMENT OF STONES AND SHELLS ON SHORE-LINE PLATFORMS

KOSTYAEV (1973), in a discussion of „some rare varieties of stone circles”, described as *stone rosettes* the roughly circular arrangements of vertically packed stones oriented around larger boulders, that are found on the shores of lakes and seas and on river beds. He illustrates stone rosettes with an example from northern Norway, photographed by TROLL (1944). In discussion, KOSTYAEV notes the reference by GREGORY (1930) to such features in slate debris on the shores of a lake, Loch Lomond, in central Scotland. TRICART (1963, 1970, transl. WATSON) termed this form of patterned ground *stone roses* or *stone packings*, observing (1970) that „they are found entirely on Arctic coasts near sea-level”.

As the main factors in forming these features, GREGORY proposed alternate freezing and thawing of water-saturated material; TROLL attributed their origin in part to frost heave; and TRICART says that frost shattering with the action of piprake ice produces *stone roses*. KOSTYAEV, on the other hand, emphasises the importance of hydrodynamic conditions in the formation of these close-packed arrangements of stones. In particular he notes the greater stability which is achieved by platy stones in strong water currents when they have been turned into an on-edge position with their long axes in the direction of water flow, and also the role of obstacles to flow, such as massive boulders, in creating turbulent water currents that orient smaller stones around the obstacle. GREGORY himself acknowledged some doubt as to the universality of his proposed frost origin for his “stone polygons beside Loch Lomond” when he noted that “similar stone rings” had been recorded by J. S. TURNER in slate quarry debris between tide marks in Bantry Bay, Eire and concluded that frost could not be effective there.

The purpose of this note is to report occurrences which support a hydrodynamic cause, such as put forward by KOSTYAEV, as providing a sufficient explanation for the production of these patterned ground features in suitable material in areas devoid of any frost action.

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Tightly packed stones with closely fitting mutual interfaces (termed *fitting boulders*), have been described from shore platforms in Britain, New Zealand and Australia (BAKER, 1959; SHELLEY, 1968, 1970; HILLS, 1970). Opposing suggestions for their formative factors were salt or ice crystallisation perhaps combined with biological weathering, or mechanical movement caused by wave action. Comparable close-packing found in flat platy material is closely relevant to the original descriptions by GREGORY (*op. cit.*) and to general considerations of the origin of this patterned ground form.

Such arrangements were seen in 1970 to have formed in flat platy marine shell debris. By analogy with *fitting boulders* these patterned arrangements can be called *fitting shells*. The example illustrated (Plates 1 and 2) is from the beach at Ness of Duncansby, John o' Groats, Caithness, Scotland (grid ref. ND 388737). The beach platform here is cut in sandstones of Middle Old Red Sandstone (Devonian) age, and the unconsolidated material on the platform is almost entirely shell debris. At the high tide line there is a thick loose packed deposit of shells, fully mobile and moved at every tide with every wave. Between the tides, depressions in the platform contain patches, several square metres in extent, of tightly packed arrangements of flat pieces of broken shells. The shelly plates are vertically aligned and are arranged in sinuous curving patterns, which swirl in circular orientations around rare boulders. Occasional small sandstone pieces, of similar size range to the shell fragments, are included (as seen in the photographs) in the packing arrangement. The patterned fitting shells were so tightly interlocked that individual pieces were not easily withdrawn by hand nor was the arrangement dislodged by walking on it. Comparison of the present illustrations with those of GREGORY (*op. cit.*) shows the essential similarity of the packing arrangement in both the shell and slate debris.

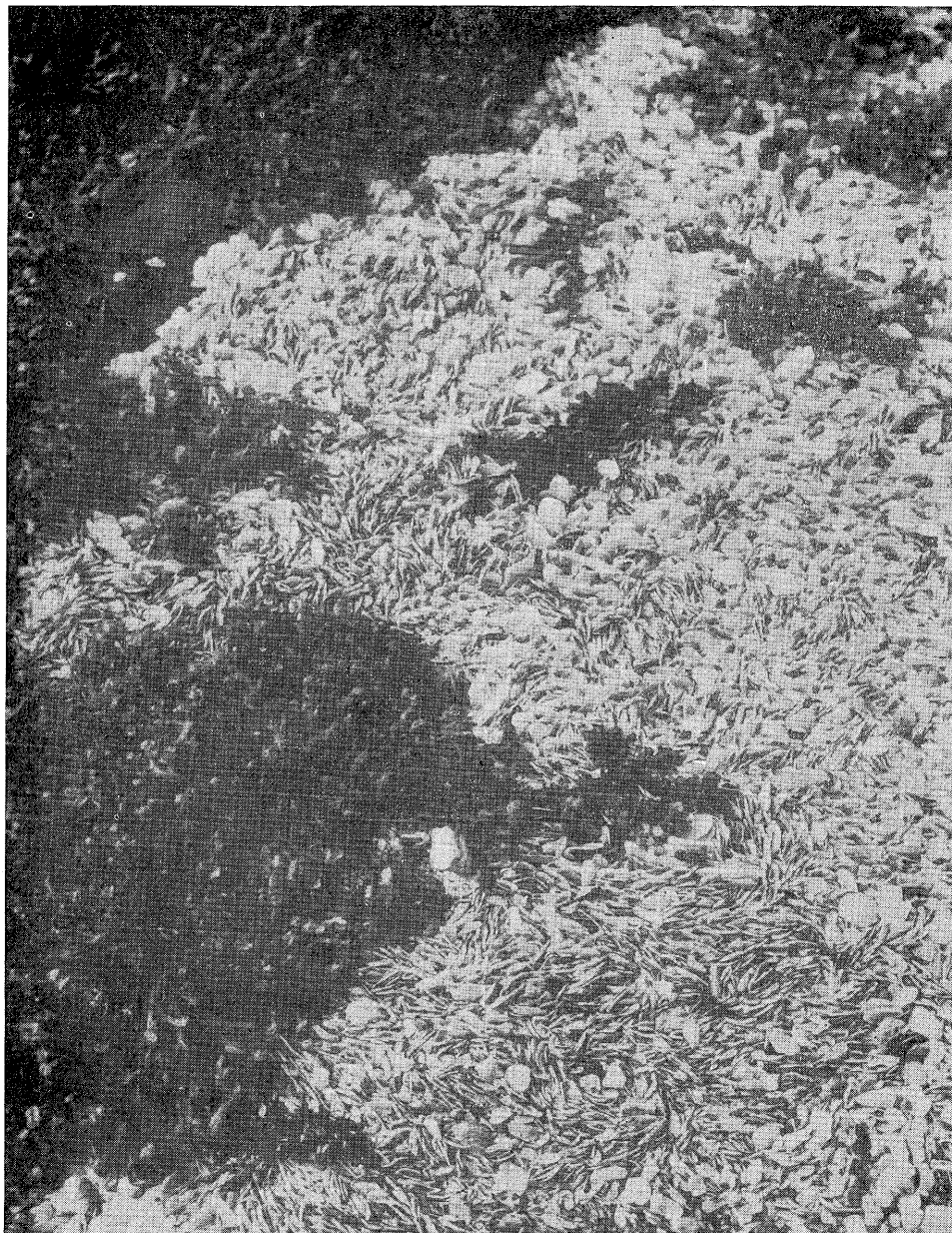
Subsequently to recording the fitting shell features, my attention was drawn by Mr. I. ELLIS WILLIAMS (Nature Conservancy Council, Bangor) to a significant local occurrence on the shore line immediately seaward of the quay at Port Penrhyn, Bangor (grid reference SH 593732), where tipped slate waste has become packed in arrangements of fitting stones and stone rosette type. Similar arrangements in beach pebbles apparently occur in Cornwall (Rev. B. CLARKE, *pers. comm.*).

Frost action is completely out of the question as a cause of close-packing and vertical stone orientation at Bangor, in view of the relatively mild winter climate there, and although the climate is colder in Caithness, frost is unlikely to have any major influence on the Caithness beach either. The widespread distribution of fitting shell and stone accumulations, occurring as rosettes where occasional boulder-disrupt a continuous bed of platy debris, supports KOSTYAEV's emphasis on hydrodynamic causes for such features. Although morphologically similar arrangements can doubtless be produced in specific cases by cryoturbation, it is unnecessary and misleading to invoke frost-action for the widely scattered occurrences of such close-packed features on shore lines and in river beds. A combination of particular hydrodynamic conditions, whatever these may be, and of suitable shaped material,

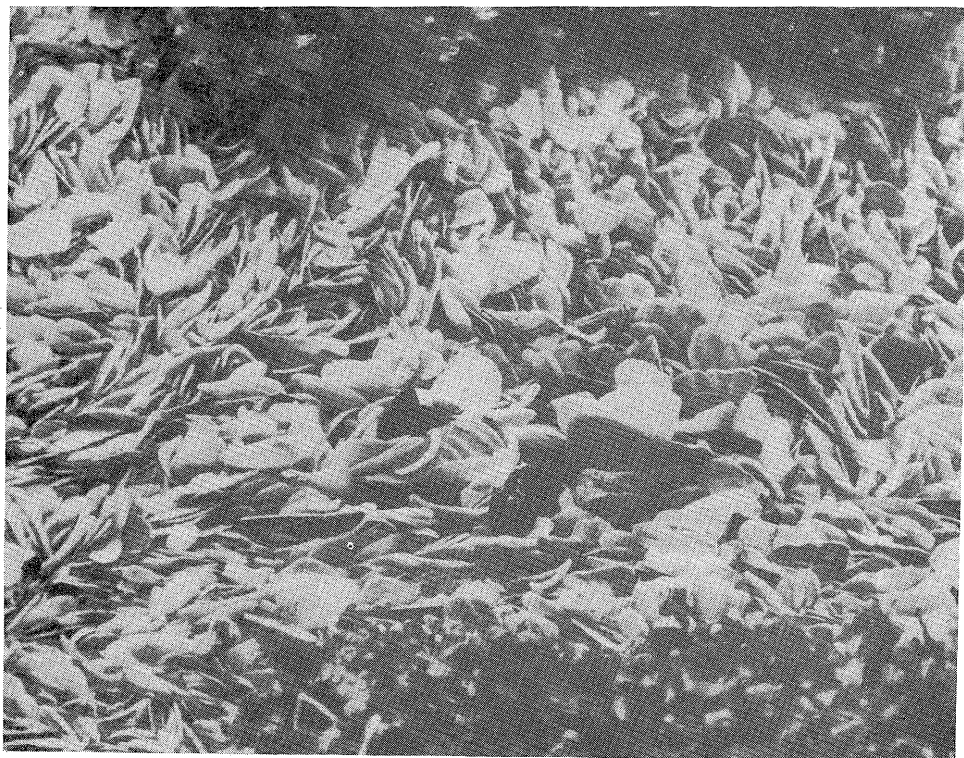
will produce this patterning. It is also seen that geologically diverse materials can be packed in rosette and close-fitting arrangements, since shell and slate debris can react in the same way in appropriate hydrodynamic conditions.

References

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Pl. 1. Fitting shells in hollow on shore platform, Ness of Duncansby, Caithness



Pl. 2. Close packing of fitting shells, site of Pl. 1