

to the energy evinced by the waves in the particular instance under consideration.

Having learned from Lord Rayleigh that wave-action at the sea-bottom takes the form of reciprocal currents, I was led to make some experiments and observations on the formation of ripple-mark. In the course of this investigation I was soon impressed with the conviction that these alternate currents held at their mercy the marine fauna exposed to their attacks, and that the zoological side of the problem was at least as important as the geological. Accordingly, an outline of the subject in its zoological aspect was included in a paper on ripple-mark read to the Royal Society in 1882 (*Proc. R.S.*, vol. xxxiv. p. 1).

Having come into possession of confirmatory evidence of the action of waves at a depth of forty fathoms in the English Channel, I submitted the facts to the British Association at Southampton in the same year, 1882. This paper, sent in to Section A, was handed on to Section C, a mathematical friend suggesting to me the reason, and a very good reason too, that mathematicians required no evidence on the point contended for. However, the transfer only went to prove that the geologists were as sceptical as to the existence of wave-action at forty fathoms, as the physicists were satisfied as to that fact. This paper, amplified, appeared in the *Transactions* of the Devonshire Association for 1883 (vol. xv. p. 353).

The zoological aspect of the question was submitted to the British Association at Southport in 1883; and again to the Linnean Society in 1884, in a paper "On the influence of wave-currents on the fauna inhabiting shallow seas." In this paper, profiting by experience, I made no attempt to prove the fact of wave-action from observation, but relied entirely on a valuable letter with which I had been favoured by Prof. Stokes, Sec. R.S. Neither at the British Association nor at the Linnean Society was any exception taken to my arguments in support of the importance of wave-action on the fauna affected; nor, so far as I am aware, has my position been shaken since. Now that Prof. Moseley's important lecture has appeared, discussing the fauna of the sea-shore without reference to the ever-regulating wave-currents, there is considerable risk that less experienced students of natural history will in like manner pass over this promising field of research as not worthy of their attention.

Prof. Moseley states, and states truly, that the littoral fauna is adapted in various ways to withstand "the action of the surf, the retreat of the tides, the numerous enemies"; but, beyond the reach of surf and tidal fall, agents which only affect the narrow belt of sea contiguous to the shore, the alternate currents set up by ocean waves search out the armour and test the defences of all small animals living on those extensive marine areas, exposed to the ocean swell, where the depth of water does not exceed fifty fathoms.

With respect to enemies, the waves themselves are perhaps the most formidable, as they attack and occasionally destroy whole colonies at once, whereas predatory foes rather affect the individual. For instance, let such helpless mollusks as *Aplysia* or *Pleurobranchus* wander over the sandy bottom of Torbay, as they sometimes do: the first easterly gale will sweep them out of existence. In fact, the waves so invariably prevent *Aplysia punctata* growing to its full size on the British coast, that a full-grown specimen taken in protected Guernsey waters has been considered a distinct species—viz. *A. depilans*. Similar large specimens have occurred under the shelter of the Torquay harbour works, but these, by a series of odontophores and shells, I have been able to connect with the common *A. punctata*.

Prima facie it would appear that the shells of certain mollusks are more especially adapted to resist animate foes; but a close examination will often prove the contrary. Take the cases of the oyster, mussel, venus, and limpet: these mollusks are all helpless in the presence of their living enemies: the oyster perishes by the attacks of boring-sponges; the mussel is destroyed wholesale by starfishes; the venus is perforated by carnivorous gastropods at their leisure; whilst the limpet, easily detached when taken unawares, is said to be destroyed by birds. All four are, however, admirably adapted to resist wave-currents, each in its respective habitat.

The conclusion that the shells of mollusks are so constructed as to have comparatively but little reference to living foes is supported by the interesting fact mentioned by Prof. Moseley, that hard shells tend to disappear in pelagic and deep-sea regions. That is to say, they disappear where predatory enemies abound, but where the great non-predatory enemies, the waves, are powerless or not existent. Occasionally we find the supposed

protection against living enemies to be greatly in excess of requirements—e.g. the case of the solen, whose power of burrowing is far greater than requisite for escape from birds, but which is none too great for the evasion of waves and currents tearing away the sand in which the mollusk dwells.

Wave-action tends to differentiate species. This can be seen in such obvious cases as *Cardium aculeatum* and *C. norvegicum*, *Venus dione* and *V. chione*. One of each of these pairs has chosen the mooring method of defence with anchor-like spines, the other that of facile penetration with smooth, unresisting shell surfaces. As these two methods are opposite in action and any compromise tends to inefficiency, the wave-currents must necessarily influence the mollusks in the direction of divergence.

Instances of habits and forms protective against wave-currents could be multiplied almost *ad infinitum*, and, as the subject is a very interesting one, I still live in hopes that it may yet be taken up and worked out by trained observers qualified for the task.

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Torquay, September 28

Prehistoric Burial-Grounds

THE account given in this week's *NATURE* (p. 518) of the discovery of a prehistoric burial-ground at Pitcavie has recalled to my memory the description of a similar find made in the eleventh or twelfth century by the monks of Noyon, and related to us by Guibert, who was abbot of this foundation at the time. I believe that it is the earliest detailed account of any such discovery that has come down to our days; and it will be noticed that the leading features of this cemetery are almost exactly identical with those of the Pitcavie one. I am not aware that this passage has attracted the attention of modern writers upon prehistoric times.

Guibert, the author quoted, was born in 1053 and died in 1124, having been Abbot of Noyon for about twenty years. After stating his own conviction that his monastery was extremely old, he continues:—

"Quam opinionem, si nulla litteralis juvaret traditio, suppeteret profecto affatim peregrina, et non, putamus, Christiani nominis sepulchrorum inventa contextio. Circa enim ipsam et in ipsa basilica tantam sarcophagorum copiam conjunxit antiquitas, in multam loci famositatem tantopere expetit, cadaverum inibi congestorum commendat infinitas. Quia enim non in morem nostrorum ordo disponitur sepulchrorum, sed circulatim in modum corollae sepulchrum unius multa ambiunt, in quibus quaedam reperiuntur vasa, quorum causam nesciunt Christiana tempora. Non possumus aliud credere nisi quod fuerunt gentium, aut antiquissima Christianorum, sed facta gentili more."

GUIBERTI Novig. *de Vita Sua*, L. ii. cap. i.

I may add that in Guibert's time there was a very old written tradition which ascribed the foundation of Noyon to a certain "rex insulæ Britanniae," who was (so ran the legend) a contemporary of our Lord's. This tradition is, of course, worthless from a historical point of view, but certainly testifies to the extreme antiquity of the place; and shows that, long before Guibert's time, the inhabitants of Noyon had dim recollections of their prehistoric greatness, which naturally, in an age of Christian credulity, centred around the era of our Lord.

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MARS, JUPITER, AND SATURN

WITH Mars, Jupiter, and Saturn in the morning sky the telescopist has a varied assortment of brilliant objects to which he may devote his attention. The great distance of Mars during the ensuing opposition will have the effect of limiting the apparent diameter to a low value, but the chief markings are so conspicuous as to be visible notwithstanding this inimical effect. Indeed during the preceding opposition, which was equally unfavourable, some of the more delicate features appear to have been recovered. At Milan Signor Schiaparelli has partly confirmed his previous results as to the singular duplication of the "canals," and Mr. Knobel has obtained