of the same size and appearance were observed in the culture, but none were seen behaving in an abnormal way. As I did not realize that I had been witnessing anything unusual until the final catastrophe, the time occupied by the division and the subsequent events up to the disruption of the short-lived half was not noted. The whole operation lasted but a short time, probably little longer than one minute.

Edwin Linton.

HOMING OF FISSURELLA AND SIPHONARIA.

The *Patella* is the only mollusc whose homing powers have been investigated. *Fissurella,* a rhipidoglossate prosobranch, and *Siphonaria,* which stands on the border line between the opisthobranchs and the pulmonates, while differing more or less widely from *Patella* in structure, closely resembles it in the form of the shell and in their littoral habits. It was, therefore, an interesting question whether they resemble it also in the possession of the homing power. A stay at the Bermuda biological station in the summer of 1903 gave an opportunity to answer this question, although a few days only being available for the investigation, it was by no means as complete as could be wished. Such as it is, however, I present it for the benefit of future students of the subject.

The specimens studied were *Siphonaria alternata* Say and *Fissurella barbadensis* Gmelin.[1] Both are abundant at Bermuda, where they live clinging to the exposed faces of the bare rocks between tide marks. Bare rocks, I say, for to a New England eye one of the most striking features of the Bermuda coast is the entire absence of the larger algæ, which upon our own rocky shores shelter so large and varied a fauna. The rocks are calcareous, soft and of irregular surface and the home of *Siphonaria* is recognizable by a greenish spot where the foot has rested. That of *Fissurella,* as my notes show, is also clearly marked, though I have carelessly omitted to note how it may be known. Both species, as will be seen from the following notes, exhibit undoubted though limited homing powers.

[1] These specimens were kindly identified for me by Mr. Charles W. Johnson of Boston.

In marking animals and scars Higgins's water-proof ink was used. White paint, which was used by Davis, was not accessible, but as the ink marks last about three days they are fairly satisfactory. *Siphonaria,* being comparatively small, was readily removed from its scar; *Fissurella* I was seldom able to detach uninjured, and, accordingly, my observations upon this species were limited almost entirely to watching its voluntary departures and returns. As might be anticipated, the animals, unlike *Patella,* remain motionless on their scars during low tide, moving, if at all, only when the incoming water has moistened and cooled their immediate surroundings.

Siphonarias did not home when removed to a distance of more than six inches and were most likely to return when removed not more than two inches. A quiet and shallow tide-pool furnished the most favorable conditions for their return. If the animal, on being transferred, was set down with its head away from the scar, it turned in the proper direction and, so far as I could judge, those headed away were quite as likely to get back as those headed toward the scars. In general, animals which lost their way seemed to crawl restlessly about for two or three days; each time one was visited it was found in a new place. One, however, settled down at once in a new home and at the end of the third day had made a discolored spot. On being transferred to his old home he apparently failed to recognize it and immediately crawled away. Usually the scar was recognized at once by a returning wanderer, and on reaching its edge he would turn about, if necessary, so that his shell might fit the scar, would slip on to it and settle down. *Siphonaria alternata* thus appears to have a sense of direction, the ability to recognize its own recently-left scar, and the power of homing when removed not more than six inches.

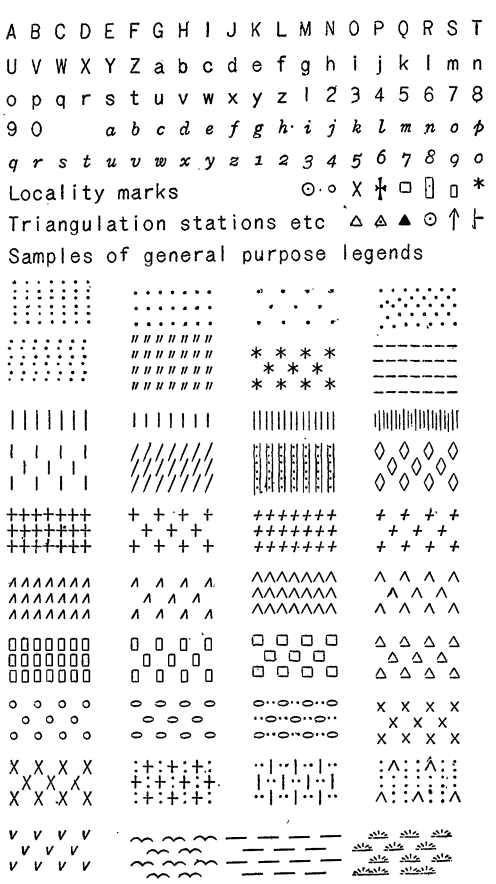
Experiments with *Fissurella,* as I have said, were usually unsuccessful. That these molluscs have the power of homing is seen, however, by watching them. As soon as the tide has so covered him that he is not exposed to the wash of the waves a *Fissurella* is very

likely to start on a brief journey, going only about two inches from the edge of his scar, and returning to settle upon it again, sometimes within fifteen minutes from the time of his leaving it. In no experiment did I find a *Fissurella* homing if he had been removed more than three inches, though one which had been removed six and a half inches was nearly half way back in twenty-four hours. My departure from Bermuda prevented my learning his final fate. *Fissurella,* like *Siphonaria,* recognizes his scar and orients himself properly with reference to it as soon as he reaches it. In one instance I found a scar occupied by two animals; one was the owner, who had evidently returned from his wanderings to find that a usurper had already taken possession of half of his home. He had, however, crawled on to as much of the scar as was still unoccupied and the next day was in sole possession, while the intruder had disappeared. *Fissurella barbadensis,* then, undertakes short voluntary excursions and returns to his scar, but his power of homing when removed by some one else has not been fully tested. M. A. WILLCOX.

MACHINE-MADE LINE DRAWINGS FOR THE ILLUSTRATION OF SCIENTIFIC PAPERS.

IT is safe to say that the majority of persons who from time to time publish scientific papers are seriously hampered in the preparation of text illustrations by the difficulty and expense entailed in the tedious drawing of map, section or diagram. Comparatively few authors can command the services of skilled draughtsmen or have themselves the requisite training to produce satisfactory line drawings. Yet the desirability of greatly increasing the proportion of such illustration in the thousands of scientific articles published each year is manifest. That clearness, precision and conciseness in the exposition of a theme are generally enhanced by the use of abundant, appropriate diagrams is as evident as that the blackboard is the constant friend of the teacher of any branch of natural history or philosophy; the printed page needs its blackboard.

Ideally, the author should himself be able to make the original drawing quickly, neatly and artistically. The usual execution of drawing with the pen is, to the average author, discouragingly slow and expensive, not always neat, and still less often artistic. The following note relates to some experiments made to increase rapidity and neatness in the production of line drawings by the use of a machine. At the outset the experiments were,



for obvious reasons, planned without any idea of rivaling the artistic work of the pen in a skilled hand. The aim has been to secure economy of time in execution and clear-cut precision of legend for the drawing. In both these respects enough success has been attained to warrant the recommendation of the machine method to geologists, geographers and others who desire to prepare useful text