is one of great difficulty, I will only repeat what I formerly said, that "additional observations are much wanted at high levels," and I might have added, at small elevations also.

I have tabulated as above the results given by my two formulæ and by that of Mr. Archibald, from which it appears that my first formula, viz. $v = V \sqrt{\frac{h}{H}}$, agrees more nearly with the recorded results of velocity at Arthur's Seat than any of the others, while my second formula, $f = \frac{Fh}{H}$, agrees best with my first observations of pressure.

Edinburgh, February 17

THOMAS STEVENSON

The Supposed Coral-eating Habits of Holothurians

IN glancing through my back numbers of NATURE my attention has been drawn to a letter on the above subject by Mr. H. B. Guppy, published in the issue dated November 2, 1882. Quoting the late Mr. Charles Darwin's famous work on "Coral Reefs," where it is stated at p. 14, on the authority of Dr. J. Allan, that Holothurians subsist on living corals, he recounts the results of his investigations made on the reefs of Santa Anna and Cristoral, with the object of putting such statement to the test. As the upshot of his experiences he writes that he has by no means satisfied himself that Holothurians do subsist on living coral. In no instance did he meet with a single individual browsing on the patches of living zoophytes, the two species observed being indeed found living only in the plots of detritus or dead coral matter that flanked the growing masses. Mr. Guppy gives an approximate estimate of the amount of coral sand daily voided by an individual Holothurian, but adduces no evidence as to the manner in which such hard matter is taken into its body. This phenomenon indeed he apparently did not witness; nor, so far as I am able to ascertain, has any other investigator brought forward any positive testimony in this direction.

Through my cultivation of Holothurians in company with various other Echinoderms a few years since in the tanks of the Manchester Aquarium, and also more recently in the Channel Islands, I find myself in a position to supply this hiatus in our knowledge of their life economy. The two species that were more particularly the subject of my observations included the large, dark purple *Cucumaria communis*, derived from the Cornish coast, attaining, in its fully extended condition, a length of from eight to twelve inches, and the white or dirty yellow variety of *Cucumaria pentactes*, that rarely exceeds half these dimensions. The oral tentacula in both of these species are largely developed, taking the form of ten extensively ramifying pedunculate plumose or dendriform tufts stationed at equal distances around the oral opening. It is with these organs that the food substances are seized and conveyed to the alimentary system, though in a manner totally distinct from what obtains in other tentaculiferous animals, such as a sea-anemone, tubiculous annelid, or cuttlefish. When on the full feed it was observed indeed that the tentacles of the Holothurian were in constant motion, each separate dendritic plume in turn, after a brief extension, being distally inverted and thrust bodily nearly to its base into the cavity of the pharynx, bearing along with it such fragments of sand and shelly matter as it had succeeded in laying hold of. No consecutive order was followed in the inversion of the separate tentacles, that which at the moment had secured the most appetising morsel gaining seemingly the earliest entrance. But little time was lost in this feeding process, for no sooner was one tentacle everted than another was thrust into the gullet, and so the meal continued, as not unfrequently observed, for several hours together. To furnish a fitting simile for this anomalous phenomenon of ingestion, one might imagine a child provided with ten arms, after the manner of ancient Buddha, grasping its food with every hand and thrusting it in a quick and continuous stream down its throat, the hands and arms with every successive mouthful, not stopping at the mouth, but disappearing up to or above the elbow within the visceral cavity. That the Holothurians are not devourers of living corals is shown not only in connection with the data just recorded, but from the fact also that several of these animals were kept in a tank containing sea-anemones and corals (*Balanophyllia verrucosa*) without their interfering with them in any way, or manifesting alimentative functions other than those just described. All that they require for their nutrition is evidently derived then from the coral or shell debris

with which they are customarily associated. At first sight this material would appear to be in the last degree adapted for the sustenance of such highly-organised animals, but, as may be confirmed at any time by the investigation of like conditions in aquaria, it will be found that shell-sand, gravel, and all other debris forming the superficial layer at the bottom of the water, when exposed to the light, is more or less completely invested with a thin pellicle of Infusoria, Diatoms, and other microscopic animal and vegetable growths. It is upon these minute organisms that the Holothurians feed, swallowing both them and the shelly or other matter upon which they grow, much in the same way as we might subsist on cherries, swallowing stones and all—the nutritious matter in the case of the cherries being in much greater ratio—and the Echinodermata having the advantage over us that they have no vermiform appendage to their alimentary system to jeopardise their safe indulgence in such stone-swallowing propensities. Most probably, but this as a fact I did not at the time take steps to determine, the shell or coral debris, with its investing organisms conveyed to the mouth, is triturated by the characteristic teeth that arm the pharynx into one homogeneous mass, which, after the extraction of all nutritious substances, is discharged in the form of sandy pellets at the opposite extremity. At all events, the phenomenon of food ingestion as witnessed and here described amply accounts for the relatively prodigious quantities of shell- or coral-sand that the Holothurians have been observed to void by Mr. H. B. Guppy and other writers.

Data of interest concerning the feeding processes of various other Echinodermata were noted by me at the Manchester Aquarium. Two species of Echini—*E. miliaris* and *E. lividus*—throve well, and devoured large quantities of the seaweed, *Ulva latissima*, thus demonstrating their essentially herbivorous tastes, while the common Sand-star, *Ophiura texurata*, exhibited peculiarly interesting habits. These were kept in a shallow tank with a sandy bottom, and, except at feeding-time, were but rarely visible. No sooner, however, had a few small pieces of chopped fish been dropped into the water and settled to the bottom than their snake-like arms appeared above the sand in all directions, next their entire bodies, then a general scramble ensued for the provided food. This was conveyed to the creatures' mouths with the aid of the flexible arms, one of which was dexterously twisted round the selected fragment—as an elephant might use its proboscis—and the morsel then dragged beneath the body with its central oral aperture, or rather the body dragged on top of it. Phenomena of corresponding interest, did space permit, might be related of numerous other species, but the foregoing will suffice to illustrate the amount of knowledge that may be gained, and gained in no other way, concerning the habits and life-histories of marine organisms by their intelligent study in the tanks of an aquarium.

Apud of this subject of aquaria, it will interest all biologists to know that the long-hoped for opportunity has at last arrived, or is about to arrive, of securing to the nation an aquarium suited in all ways, in both position and equipments, for the conduct of scientific pisciculture and biological research. Included in the buildings now in course of erection for the forthcoming International Fisheries Exhibition is a fine series of marine and freshwater tanks, having such substantial construction and perfect mechanical arrangements, that it is proposed to leave them standing after the close of the Exhibition, their final destiny having alone to be decided on. The close contiguity of these tanks in the Western Arcade of the Horticultural Gardens to the existing Museum of Economic Pisciculture immediately suggests the appropriateness with which they might be incorporated and more fully developed in conjunction with that Museum, or with the biological department of the Science Schools on the opposite side of the road. As an appanage of the last-named institution, it is indeed almost impossible to prognosticate the important rôle it is an aquarium might be adapted to fulfil. Leaving a sufficiency of tanks for public exhibition, the remainder might form an efficient depot or inland zoological station for both supplying the class-rooms and for placing at the disposal of original investigators facilities hitherto unprecedented in this country for making themselves acquainted with the structure, habits, and developmental histories of organisms pertaining to every branch of marine biology. It is at all events most earnestly to be desired that steps will be taken at the right time by the proper authorities to turn to good account so magnificent and rarely recurring an opportunity.

W. SAVILE KENT

Buckland Fish Museum, South Kensington, February 21