arouse, such a society might even secure a small fund for its maintenance.

Last, and if such a work be possible, best of all, the association might, through a proper committee, do much to promote science-teaching in the schools of the cities where it each year bides. Every meeting of the association has among its attendants those who have the much-needed skill in the matter of teaching science. There is hardly a public school in the land where there is not a crying need of such help as could best be given at such times. There should be a committee, or even perhaps a section of the association, devoted to the promotion of sound teaching in natural science; for the gravest danger before this branch of learning is to be found in the radical imperfection of the methods of science-teaching in use in our schools. These suggestions may seem to lay heavy burdens of advice on the association, but none of them seem beyond the promise of its strength.

RECENT EXPLORATIONS IN THE REGION OF THE GULF-STREAM OFF THE EASTERN COAST OF THE UNITED STATES BY THE U. S. FISH-COMMISSION.[1]

4. Nature and origin of the deposits.

ALONG part of the Gulf-Stream slope examined by us, the bottom, in 65 to 150 fathoms, 80 to 110 miles from the shore, is composed mainly of very fine siliceous sand, mixed with a little clay, and containing always a considerable percentage of the shells of Foraminifera and other calcareous organisms, and frequently spherical, rod-like, and stellate sand-covered rhizopods, sometimes in large quantities. Among the Foraminifera, Globigerina is abundant; but many other forms occur, some of them of large size and elegant in form. Grains of green sand (glauconite) were frequently met with, but were not abundant. Large quantities of the tubes of annelids frequently occur. Some of these are made of cemented mud, fine sand, or of gravel; others, of parchment-like secretions. On the inshore plateau, and also in the deeper localities on the slope, there is usually more or less genuine mud or clay; but this is generally mixed with considerable fine sand, even in 300 to 600 fathoms. The sand, however, is often so fine as to resemble mud, and is frequently so reported when the preliminary soundings are made. In several localities the bottom was so 'hard,' in 65 to 125 fathoms, that the bulk of the material brought up consisted of sponges, worm-tubes, shells, etc., with some gravel, but with neither mud nor fine sand. Such bottoms were very rich in animal life. In many instances, even in our deeper dredgings (about 700 fathoms), and throughout the belt examined, we have taken numerous pebbles, and small, rounded bowlders of all sizes, up to several pounds in weight, consisting of granite, sienite, mica schist, etc. These are abundant in some localities, and covered with Actiniae, etc. Probably, while frozen into the shore-ice in winter and spring, they have been recently floated out from our shores and rivers, and dropped in this region, where the ice melts rapidly under the influence of the warmer Gulf-Stream water. Probably much of the sand, especially the coarser portions, may have been transported by the same agency.

Another way, generally overlooked, in which fine beach-sand can be carried long distances out to sea, is in consequence of its floating on the surface of the water after it has been exposed to the air, and dried on the beaches. The rising tide carries off a considerable amount of dry sand, floating in this way. In our fine towing-nets we often take more or less fine siliceous sand which is evidently floating on the surface, even at considerable distances from the shore. The vast sand-beaches, extending from Long Island to Florida, afford an inexhaustible supply of this fine sand.

The prevalence of fine sand along the Gulf-Stream slope in this region, and the remarkable scarcity of fine mud or clay deposits, indicate that there is here, at the bottom, a current usually sufficient to prevent, for the most part, the deposition of fine argillaceous sediments over the upper portion of the slope, in 65 to 150 fathoms. Such materials are probably carried along, for the greater part, till they eventually sink to greater depths, nearer the base of the slope, or beyond in the ocean-basin itself, where the currents are less active. Doubtless, there are also belts along which the northern current meets and opposes the Gulf Stream, causing less motion, and favoring the deposition of fine sediments. It is probable that motion of the water along the upper part of the slope may also be caused by tidal currents, which would modify the north-eastern flow of the Gulf Stream, both in direction and velocity. Currents produced by protracted storms might have the same effect. In depths

[1] Continued from No. 19.

greater than 200 fathoms on the outer slope, and in 25 to 60 fathoms on the inshore plateau, there is doubtless a slow, cold current to the south-west. It is not probable that these bottom-currents are strong enough to move even the fine sand after it has once actually reached the bottom; nor is it strong enough to prevent the general deposition of oceanic foraminifera, pteropods, etc.

The existence of actual currents in this region, sufficiently powerful to directly effect an erosion of the bottom, is hardly supposable. Such a result may be effected, however, in consequence of the peculiar habits of certain fishes and crustacea that abound on these bottoms. Many fishes, like the 'hake' (Phycis), of which three species are common here, have the habit of rooting in the mud for their food, which consists largely of Annelida and other mud-burrowing creatures. Other fishes, those with sharp tails especially, burrow actively into the mud or sand, tail first; and in all probability Macrurus, abundant on these slopes, has this habit. Several burrowing species of true eels and eel-like fishes are very abundant on these bottoms. Many of the crabs and other crustacea are active burrowers. Such creatures, by continually stirring up the bottom sediments, give the currents a chance to carry away the finer and lighter materials, leaving the coarser behind.

In many localities there are great quantities of dead shells, both broken and entire. A small proportion of the unbroken bivalves have been drilled by carnivorous gastropods, but there are large numbers that show no such injury. These have, for the most part, undoubtedly served as food for the star-fishes and large Actiniae, abundant on these grounds, and from which I have often taken many kinds of entire shells, including delicate pteropods. Many fishes, like the cod, haddock, hake, flounders, etc., have the habit of swallowing shells entire, and, after digesting the contents, they disgorge the uninjured shells. Such fishes abound here. Species of Octopus are also known to feed upon bivalves without breaking them, and O. Bairdii is common in these depths. The broken shells have probably been destroyed, in large part, by the large crabs and other crustaceans having claws strong enough to crack the shells. The large species of Cancer and Geryon, and the larger Paguri, abundant in this region, have strength sufficient to break most of the bivalve shells. Many fishes that feed on mollusca also crush the shells before swallowing them. Both fishes and crabs have, doubtless, thus helped to accumulate the broken shells that are often scattered abundantly over the bottom, both in deep and shallow water. Such accumulations of shells would soon become far more extensive than they are, if they were not attacked by boring sponges and annelids. Certain common sponges, belonging to the genus Cliona, very rapidly perforate the hardest shells in every direction, making irregular galleries, and finally utterly destroying them. On the outer grounds we dredge up rarely fragments of wood; but these are generally perforated by the borings of bivalves (usually Xylophaga dorsalis) and other creatures, and by them would evidently soon be destroyed.

We very rarely meet with the bones of vertebrates at a distance from the coast. Although these waters swarm with vast schools of fishes, while sharks, and a large sea-porpoise, or dolphin (Delphinus, sp.), often occur in large numbers, we very rarely dredge up any of their bones. In a few instances we have dredged a single example of a shark's tooth, and occasionally the hard otoliths of fishes. It is certain that not merely the flesh, but most of the bones also, of nearly all the vertebrates that die in this region, are very speedily devoured by the various animals that swarm on the bottom. Echini are very fond of fish-bones, which they rapidly consume. Fishes caught on the hooks in this region, and left down an hour or two, were nearly stripped of their flesh by small amphipod crustacea.

Relics of man and his works are of extremely rare occurrence at a distance from the coast, or even at a short distance outside of harbors, with the exception of the clinkers and fragments of coal thrown overboard from steamers with the ashes. As our dredgings are in the track of European steamers, such materials are not rare. A few years ago, even these would not have occurred. A rock forming on this sea-bottom would, therefore, not contain much evidence of the existence of man, nor even of the commonest fishes and cetaceans inhabiting the waters.

5. Fossiliferous magnesian limestone nodules.

At several localities in 234 to 640 fathoms, we dredged fragments and nodular masses or concretions of a peculiar calcareous rock, evidently of deep-sea origin, and doubtless formed at or near the places where it was obtained. These specimens varied in size from a few inches in diameter up to one irregular nodular or concretionary mass taken in 640 fathoms, which was 29 inches long, 14 broad, and 6 thick, with all parts well rounded. These masses differ much in appearance, color, tex-

ture, and fineness of grain; but they are all composed of distinct particles of siliceous sand, often very fine, cemented by more or less abundant lime and magnesia carbonates. Sometimes small quartz pebbles occur in them. The fine-grained varieties of the rock are often exceedingly compact, hard, and tough, usually grayish or greenish in color. They are often bored by annelids, sponges, etc., and are usually weathered brown, due to the presence of iron (probably in part as carbonate, sometimes as pyrite). The sand consists mainly of rounded grains of quartz, with some felspar, mica, garnet, and magnetite. It is like the loose sand dredged from the bottom in the same region. The calcareous cementing material seems to have been derived mainly from the shells of Foraminifera, abundantly disseminated through the sand just as we find the recent Foraminifera in the same region. In some cases, distinct casts of Foraminifera are visible in the rock. In some pieces of the rock, distinct fossil shells were found, apparently of recent species (Astarte, etc.). The larger masses appear to have been originally concretions in a softer deposit, which has been more or less worn away, leaving the hard nodules so exposed that the trawl could pick them up. The age of these rocks may be as great as the pleistocene, or even the pliocene, so far as the evidence goes. No rocks of this kind are found on the dry land of this coast. It is probable, however, that they belong to a part of the same formation as the masses of fossiliferous sandy limestone and calcareous sandstone, often brought up by the Gloucester fishermen from deep water on all the fishing-banks, from George's to the Grand Bank.

The chemical composition of these limestone nodules is of much interest geologically. Analyses made by Prof. O. D. Allen prove that they contain a considerable amount of magnesia. They are, therefore, to be regarded as magnesian limestones, or dolomites, of recent submarine origin. They also contain a notable quantity of calcium phosphate. The presence of the latter is not surprising when we consider the immense number of carnivorous fishes, cephalopods, etc., which inhabit these waters, and feed largely upon the smaller fishes, whose comminuted bones must, in part at least, be discharged in their excrements. In fact, it is probable that the greater part of all the mud and sand that cover these bottoms has passed more than once through the intestinal canals of living animals. The Echini, holothurians, and many of the star-fishes and worms, continually swallow large quantities of mud and sand for the sake of the minute organisms contained in it, and from which they derive their sustenance.

The following partial analysis by Prof. O. D. Allen gives the percentage of the most important constituents. The sample analyzed was a hard, compact, and very fine-grained magnesian limestone. Its color was yellowish green, with a darker green surface, weathered rusty brown in some places. It contained some minute specks of iron pyrite. Its specific gravity was 2.73.

Composition of a deep-water limestone.

	Per cent.
Lime	24.95
Magnesia	14.41
Iron (estimated as protoxide)	2.00
Phosphoric acid (not weighed).	
Insoluble residue (sand)	16.97

WATER-BOTTLES AND THERMOMETERS FOR DEEP-SEA RESEARCH AT THE INTERNATIONAL FISHERIES EXHIBITION.

IT would naturally be expected that at an exhibition of this kind in England, where so much has been done in the past for deep-sea investigations, there would be found a good collection of the apparatus used in deep-sea work. Great Britain has, in fact, shown almost nothing of the kind; indeed, one may say, nothing whatever that especially relates to deep-sea investigation. After spending the not inconsiderable sum of money required to fit out the Challenger, the British government seems to have lost all interest in deep-sea exploration; and other nations are carrying on the work with greatly improved apparatus, while Great Britain rests content with the laurels already won.

The United States exhibit is the most complete of all, as regards apparatus of this kind. Denmark and Sweden have some apparatus for collecting specimens of water and observations of temperature, which, with the later forms used by the U.S. fish-commission and by the coast-survey, will form the main subject of this article.

The Swedish apparatus was devised by Prof. F. L. Ekman, principally for the use of the Swedish expedition of 1877, which carried out very thorough and systematic hydrographic investigations in the waters extending from the North Sea, through the Baltic, to the extreme end of the Gulf of Bothnia. Although the apparatus worked with entire satisfaction, it would scarcely be used at the present time, for it is unnecessarily heavy and large.