Mr. A. Agassiz
with the author
regards

[From the American Journal of Science and Arts, Vol. II, Nov., 1871.]

Brief Contributions to Zoölogy from the Museum of Yale College. No. XVI.— *On the Distribution of Marine Animals on the southern coast of New England;* by A. E. Verrill

In connection with the investigations concerning the fisheries under the direction of Professor S. F. Baird, U. S. Commissioner, thorough explorations of the adjacent waters were undertaken in order to ascertain the character of the bottom, and the distribution of the lower animals, especially of those that furnish food for certain fishes. The Fish Commission had its headquarters at Wood's Hole, Mass., situated on the point of land between Vineyard Sound and Buzzard's Bay. In addition to the shore collections, extensive and systematic dredging operations were undertaken by means of a steam-launch in the waters of Vineyard Sound and Buzzard's Bay, and by the aid of a U. S. Revenue Cutter, the steamer "Moccasin," the dredgings were carried outward to the deeper parts of Muskeget Channel, situated off Martha's Vineyard, and from thence to a point off the mouth of Buzzard's Bay.* These explorations were made by means of dredges of several different sizes, of the usual forms; a rake-dredge of novel construction, especially adapted to soft muddy bottoms; an iron frame to which unraveled ropes, or "tangles," were attached for use on rocky bottoms; a large trawl-net; surface towing-nets for swimming creatures, etc.† The points where dredgings were made were carefully located on Coast Survey charts, and were sufficiently numerous to give a satisfactory knowledge of the nature of the bottom and its inhabitants throughout the region explored. The total number of hauls of the dredges, during the three

* The dredgings in the first part of the season were made under the direction of Mr. S. I. Smith, and later by Professor J. E. Todd, Professor A. Hyatt, Dr. A. S. Packard, and the writer, all more or less aided at various times by other naturalists, and especially by Dr. W. G. Farlow, who collected the algæ.

† Some of these instruments will be described in a future number of this Journal.

months, was about four hundred. The surface dredging also yielded many things of great interest.

At this time I wish to call the attention of zoölogists to one of the most important of the results of these investigations, leaving a full account of the large and valuable collections for another occasion. The discovery referred to is that while the shores and shallow waters of the bays and sounds, as far as Cape Cod, are occupied chiefly by southern forms, or the Virginian fauna, the deeper channels and the central parts of Long Island Sound, as far as Stonington, Conn., are inhabited almost exclusively by northern forms, or an extension of the Acadian fauna.

There is also a corresponding difference in the temperature of the water, the change in some cases amounting to 5° F., both at the surface and bottom, within a distance of two miles and without much change in the depth. And consequently there must be an offshoot of the arctic current setting into the middle of the Sound, although the shores feel the influence of the Gulf Stream, as shown by the occurrence of southern forms of pelagic animals in their waters.

The shores of Buzzard's Bay and Vineyard Sound present nearly all varieties of stations, and are, therefore, favorable for collecting. They are occupied, except on some of the outer islands, by an assemblage of animals characteristic of the coasts farther south, and known as the *Virginian fauna*. A few northern forms occur, however, on the rocky shores, which do not extend as far as New Haven. Among these *Purpura lapillus* is most conspicuous. This shell is associated there with *Eurosalpinx cinereus*, in about equal numbers, but at New Haven the latter occurs alone, while on the northern coasts of New England the *Purpura* is found unaccompanied by the other, which is rarely found north of Cape Cod. But in nearly all other respects the littoral fauna is very similar to that of the vicinity of New Haven, or the coasts farther south, as far as Cape Hatteras, making allowance only for differences in the stations, and especially for the absence of rocks south of New York.

In Vineyard Sound and Buzzard's Bay the water is everywhere shallow, usually from 3 to 8 fathoms deep, and rarely exceeding 12 or 14 fathoms, even in mid-channel. In Vineyard Sound the bottom is generally sandy, and extensive reefs of shifting sand are numerous, and often nearly destitute of life. But extensive regions of gravelly and shelly bottoms occur, and these are often almost completely covered by several species of compound ascidians, growing in large masses. One of these, which forms large hemispherical or irregular masses, made up of an aggregation of long slender colonies, united together at their bases and usually thickly covered

throughout with sand, is very abundant, often entirely filling the dredge with masses up to six inches in diameter. This is the *Amouroucium pellucidum* Verrill. Another one, nearly as abundant, forms smooth, cartilaginous masses in the form of flat lobes, crests, and plates, sometimes two feet long and about an inch thick, the surface covered with stellate colonies, while the color of the masses is of a delicate bluish or sea-green tint by reflected light, although yellow by transmitted light. This is *Amouroucium stellatum* V., described with the last in a former number of this Journal. A third species* of the same genus is also common, although still undescribed. This forms smooth gelatinous masses, varying from light orange to pale yellowish in color, with beautifully stellated colonies over its upper surface. With these were several simple ascidians, chiefly *Cynthia partita*† Stimp., and *Molgula Manhattensis* V., while creeping over them was a beautiful green species of *Perophora*,‡ which is the first representative of the social ascidians discovered on our coast. This species also occurred in abundance on the piles of the government wharf at Wood's Hole, associated with the three last named. In the interstices of *A. pellucidum* were numerous annelids of several species, and growing upon or with the ascidians were many species of hydroids, bryozoa, and sponges. Among the sponges a massive sulphur-yellow species (*Spongia sulphurea* Desor) is very conspicuous. While young this species perforates and destroys dead bivalve shells, but later in life grows up into hemispherical or irregular masses. Upon the same bottoms were found the common southern greenish star-fish (*Asterias arenicola*), *Amphipholis elegans*, *Gouldia mactracea*, *Eulima oleracea* on *Thyone briareus*, *Anachis avara*, *Columbella lunata*, *Cancer irroratus*, *Libinia canaliculata*, *L. dubia*, *Eupagurus pollicaris*, *E. longicarpus*, and many other less common species. On rocky and stony bottoms, and especially in the tide-way of the channel at Wood's

* *Amouroucium constellatum*, sp. nov. Masses thick, turbinate, often encrusting, surface usually convex, smooth, substance firm, gelatinous, translucent, but softer than in *A. stellatum*. Systems stellate, circular, oval or elliptical, often elongated, or irregular and complex. Zoöids much elongated, slender, the branchial tube short with six rounded lobes. Branchial sac elongated. Color of the masses usually light orange-red, varying to yellowish and pale flesh-color; the branchial orifices with six radiating white lines. Zoöids generally orange-yellow; the orifices and tubes with upper part of mantle bright orange, or lemon-yellow; branchial sac usually flesh-color or pale yellow, sometimes bright orange; stomach with bright orange-red glandular ribs; mantle with minute opaque white specks.

† *Cynthia stellifera* V. proves to be a depressed variety of this species.

‡ *Perophora viridis*, sp. nov. Individuals small, about ·10 to ·12 of an inch high, connected by slender stolons, and thickly covering the surfaces over which they creep. Test compressed, seen from the side scarcely higher than broad, oval, elliptical, or subcircular, often one-sided or distorted, with a short pedicle or subsessile at base. Branchial orifice large, terminal; anal lateral or subterminal, both a little prominent, with about 16 angular lobes, alternately larger and smaller. Test transparent; mantle beautifully reticulated with bright yellowish green; intestine yellow.

Hole, the southern purple sea-urchin (*Echinocidaris punctulata*), the orange star-fish (*Cribrella sanguinolenta*), the green star-fish, the coral (*Astrangia Danæ*), and many other interesting species occurred. All the species referred to, excepting the widely diffused species of *Cribrella* and *Amphipholis*, are either characteristic southern forms or else species that are not yet known except from the region explored. Several species were also obtained in Vineyard Sound which had not previously been found so far northward. Among these the flat sea-urchin with five perforations (*Mellita pentapora*) is especially worthy of mention, as it has hitherto been regarded as peculiar to the Carolinian fauna.* The free-swimming forms taken at the surface in this region were also numerous, and are likewise chiefly southern species, or if new they belong to southern types. Among the most interesting were *Salpa Cabotii*, which occurred in vast quantities about the first of September, and was found in abundance off Gay Head, as well as in the Sound; a splendid species of *Saphirina*, reflecting brilliant blue and red colors like a fire opal, which occurred mingled with the *Salpæ;* a new free-swimming crab; *Idotæa robusta* Kr.; innumerable young lobsters, crabs, and shrimp, in the zoea and megalops stages of growth; numerous jelly-fishes, among which *Mnemiopsis Leidyi* was perhaps the most abundant, but a species of *Cyanea* and *Dactylometra quinquecirra* were common, and both frequently gave shelter to several young "butter-fishes" (*Poronotus triacanthus*) of all sizes, from those just hatched up to two inches or more in length. In some cases twenty or more were found together under one jelly-fish. They also occurred, in the evening, under *Zygodactyla Grœnlandica* earlier in the season. The "Portuguese-man-of-war" (*Physalia arethusa*) was met with several times. Two Pteropods not before recorded from the United States coast were obtained,—one of them (*Stiliola* sp.) living, associated with *Salpa;* but of the other (*Cavolina tridentata*) the shells only were dredged, but in a very fresh condition.

In the deeper outer channels, as between Gay Head and Nomans-land, and at nearly all points outside of the latter, where the water is more than ten fathoms in depth, the fauna is very different from that of the sounds and bays, and closely resembles that of Massachusetts Bay and the coast of Maine. The difference in the temperature of the water is also well-marked. The surface temperature, during the latter part of August, was 69° to 71° in Vineyard Sound. On Sept. 9th, in the mouth of Vineyard Sound, west from Gay Head, the surface temperature was 67° F., and the bottom, in 15½ fathoms, was 63°; but pro-

* This and *Lytechinus variegatus* were found by the writer, Mr. S. I. Smith, and Prof. J. E. Todd at Great Egg Harbor, N. J., last spring, but they are very rare at that locality.

ceeding about two miles farther out, off No-mans-land, the surface temperature was 62°, and the bottom, in 18 fathoms, was 58½°, showing a decrease of 5° within this short distance, both at the surface and bottom. A few miles farther out, at the same depth, the bottom temperature was 57°, which was the lowest temperature obtained. A short distance west of No-mans-land, on a gravelly bottom in 11 fathoms, where cod-fish are caught in winter, the temperature was 63° at the surface and 59° at the bottom. Off the mouth of Narragansett Bay, about sixteen miles south from Newport, the depth over a limited area is 29 fathoms, which was the deepest water found. At this locality the surface temperature was 62° and the bottom 59°. The bottom, in these deeper waters, was generally composed of soft mud, filled with innumerable tubes of worms and Amphipod crustacea, among which a species of *Ampelisca*, which makes a soft flabby tube, two or three inches long and covered with mud, is extremely abundant. At the last named locality numerous specimens of the rare and beautiful *Epizoanthus Americanus* V. was found coating the shells inhabited by hermit-crabs (*Eupagurus Bernhardus*) and finally absorbing the shells entirely. This remarkable Actinian has been found previously only on two occasions,—first on a deep bank off the coast of New Jersey, by Capt. Gedney; and since in deep water off Massachusetts Bay. With this was also found a rare Holothurian (*Molpadia oölitica*), previously known only from specimens taken from fish stomachs.

The various muddy bottoms in the deeper and colder areas yielded nearly the same assemblages of animals, most of which are either strictly northern types, many of them not before observed so far south; or else species of wide range extending much farther north as well as south. Among those of special interest are the following: of RADIATA, *Edwardsia farinacea* V., previously known only from the Bay of Fundy, *Thyonidium* sp.; of MOLLUSCA, *Molgula pilularis* V. and *Glandula mollis* Stimp., both known before only from the Bay of Fundy, *Cyprina Islandica*, *Cardita borealis*, *C. Novangliæ*, *Yoldia sapotilla*, *Y. limatula*, *Nucula proxima*, *N. delphinodonta*, *Cardium pinnulatum*, *Astarte quadrans*, *A. castanea*, *A. lutea* (?) Perkins, *Lyonsia hyalina*, *Anatina papyracea*, *Lucina filosa*, *Callista convexa*, *Crenella glandula*, *Modiolaria nigra*, *M. corrugata*, *Pecten tenuicostatus* (young = *P. fuscus* Lins.), *Buccinum undulatum*, *Chrysodomus pygmæus* (large and abundant), *Crucibulum striatum*, *Margarita obscura*, *Cylichna alba;* of ANNELIDS, *Clymene torquata* Leidy, *Ophelia simplex* Leidy?, *Trophonia* sp., *Sternaspis fossor*, *Aphrodite aculeata* (large and common), *Nephthys* (large species), *Sipunculus Bernhardus*, and species of *Nereis*, *Lumbriconereis*, *Aricia*, etc.; of CRUSTACEA, species of *Ampelisca* (abundant),

Unciola irrorata, and several other Amphipods, *Crangon vulgaris*, *Pandalus annulicornis*. On sandy bottoms *Echinarachnius parma* was very abundant, as it was, also, everywhere in the sounds, for it is a widely diffused species, occurring as far south as Great Egg Harbor; *Molgula arenata* St. also occurred, with a few other species of interest. A large species of sandy *Foraminifera*, often a quarter of an inch in diameter, was abundant. In the channel between Gay Head and No-mans-land the bottom is gravelly and stony, and here some very interesting species were found; among the RADIATA were *Alcyonium carneum* Ag., *Edwardsia* (new species), *Grammaria gracilis* St., and many other hydroids, *Cribrella sanguinolenta*, *Asterias vulgaris* V., *Ophiopholis aculeata* Gray, *Euryechinus Drobachiensis* V.; of ASCIDIANS, *Amouroucium pallidum* V., *Molgula papillosa* V., *Cynthia carnea* V., *C. hirsuta* Binney, *C. partita* St., all northern species except the last; of shells many of the northern forms already named and some additional species; of CRUSTACEA, *Eupagurus Bernhardus*, *Cancer borealis* (thrown on shore and fragments dredged), *C. irroratus*, with numerous *Amphipods*.

The brief lists of species given above are quite sufficient to show the marked northern character of the fauna in the deeper waters of this region. Several of the northern shells enumerated above have also been dredged by Mr. Sanderson Smith in Gardiner's Bay, L. I., and some of them have long been known from Montauk Point. Mr. Linsley, in his catalogue of the shells of Connecticut,* also records many of the same northern species with a few additional ones, from Stonington. I have been informed by Mr. H. C. Trumbull, who collected the shells attributed to Stonington, that all these northern species were obtained by him from the stomachs of haddock, &c., which were taken within a few miles of Stonington. This would indicate that the northern cold current has a decided influence as far westward as that locality, beyond which its influence has not yet been traced.

* This Journal, I, vol. xlviii, 1845.