ART. L.—*Brief Contributions to Zoology from the Museum of Yale College.* No. XXXVI.—*On the Post-pliocene fossils of Sankoty Head, Nantucket Island*; by A. E. VERRILL; with a note on the Geology; by S. H. SCUDDER.

AN account of the beds at Sankoty Head, with a list of the fossils obtained, was published by Messrs. Desor and Cabot in 1849,* and most of our knowledge of the locality has hitherto been derived from their description.

During the past summer the headquarters of the U. S. Fish Commission were at Wood's Hole, Mass., where an excellent and permanent biological station has been established under its auspices. In connection with the investigation of the marine invertebrates it was considered desirable to examine the fossiliferous deposits to ascertain the facts in regard to the former distribution of the species, and the physical changes that have occurred on our coast. Accordingly one of our dredging parties, consisting of Prof. A. Hyatt, Mr. Sanderson Smith, Mr. C. H. Merriam, and others, visited the locality, while on one of the excursions to Nantucket Shoals, and made a collection of the fossils. Later Mr. S. H. Scudder, of Cambridge, Mass., with the kind coöperation of Mr. W. J. Flagg, made an excavation into the cliff, so as to expose the fossiliferous beds more fully, and Mr. Richard Rathburn visited the locality, and made for the Commission, a large and very valuable collection of the fossils, in which the specimens from the lower and upper beds were kept distinct. Some of our most interesting results have been due wholly to the care with which he made and labelled this collection. From it we learn that the two layers, though only a few inches apart, contain very different assemblages of fossils and were deposited under quite different circumstances; the lower bed contains only such southern species as now inhabit the warm quiet waters of sheltered bays on the southern coasts of New England and farther south; while the upper bed contains many northern species, many of them fragmentary and beach-worn, and all of them, with one unimportant exception, the same species that are now found cast upon the outer beaches of Nantucket and Cape Cod by storms, and living in the colder outer waters, off the same coasts.

In the list published by Desor and Cabot seventeen species were enumerated, and those from the different beds were not kept separate. In our collections there are about sixty species,

* *Quarterly Journal of the Geological Society of London*, vol. v, p. 340, Feb., 1849. An abstract of the article has been printed by Dr. Packard in the *Memoirs of the Boston Soc. of Nat. History*, vol. i, p. 252, 1866. See also *Proc. Boston Soc. Nat. Hist.*, vol. iii, p. 79, and this *Journal*, II, xiv, 50.

nearly all of which can now be assigned to their actual positions in the strata.

Mr. Scudder made a study of the stratification, and as his observations do not agree perfectly with the account given by Desor and Cabot, he has kindly furnished the following description of the locality. The most important point from which it differs from the former one is his conclusion that the fossiliferous beds are conformable to the strata of sandy clay, forming the base of the cliff. Mr. Desor stated that they are unconformable, and referred the clays to the Miocene Tertiary, like those of Martha's Vineyard.

Note on the Post-pliocene Strata of Sankoty Head; by S. H. SCUDDER.

"The sands and gravels forming the bluff at Sankoty Head, Nantucket, rest at base upon a thick bed of light brown sandy clay of uncertain thickness, but extending upward to about twenty feet above the sea-level. As the beds which rest upon it dip to the southwest, and as the anchor brings up clay from Sankoty Head eastward for half a mile, this clay bed is probably of great thickness.

The brown clay is overlaid by four feet of gravel and coarse sand, the coarser parts mostly confined to three or four inches of the uppermost levels; the upper bed is more or less ferruginous and hardens on exposure into a rather compact conglomerate. To this stratum must doubtless be referred a single specimen of a bivalve (probably a *Mactra*), with valves half open, picked up on the bluff, imbedded in a gravel conglomerate, and like it strongly impregnated with iron. The gravel is followed by about four feet of sands, subdivisible into separate beds, viz: at base, an inch or two of a very fine loose white sand, followed by nearly two feet and a half of a little less fine, closely packed, white sand, with irregular ferruginous streaks through its mass; this is covered by nine inches of a coarse beach sand, with a still coarser sand in pockets; and this again by nine inches of a very fine white sand. Above this comes a foot of ferruginous sand closely packed with masses of tough blue clay, much exceeding the sand in bulk, and forming the floor of the fossiliferous beds.

These consist first, at base, of twenty-two inches of coarse sand in which the oyster, quohog, and common clam are the prevailing forms, the first predominating to such a degree as to make the name of oyster-bed the most appropriate. This merges into a serpula-bed, about twenty-eight inches in thickness, made up almost altogether of large masses of serpula, packed in sand and almost wholly devoid of other fossils. The bed of worn shells superimposed on this is about twenty-two inches in thickness and closely resembles *coquina*, except in the entire want of adhesion between the fragments.

This bed is followed by about ten feet of fine white thinly bedded sand, and this by the stratified drift of the island, to a

depth, as estimated by Desor and Cabot, of forty-two feet; the foot of peat mentioned by them is wanting at this exact locality, (though present a few hundred feet farther south,) leaving the drift covered by five or six feet of dune-sand, more or less intermixed with loam below.

On following the bed of broken shells along the face of the cliff it was found to thin out to about a foot in thickness twenty-five feet on either side of the most prominent point, where the section was made,* and which has doubtless been longer protected than the other parts of the bluff by the former presence of a great mass of clay next the water's edge, called "Antony's Nose"; beyond these twenty-five feet, the bed of broken shells becomes more or less obscured by an admixture of sand, gravel and serpula, and is entirely lost at forty feet distance on either side.

The strata, from the lowermost clay to the bed of worn shells, all dip to the southwest. The uppermost beds incline along the face of the cliff three (3) degrees to the south, while the inclination to the west (along the section dug out of the cliff) is eleven (11) degrees, making a dip of nine (9) degrees to the southwest. All the beds below this also incline eleven (11) degrees to the west, but the inclination of their face toward the south increased gradually in passing downward, until that of the upper edge of the lower clay reaches eleven (11) degrees, making a southwesterly dip of this bed seventeen (17) degrees to the southwest. There is no evidence of any thinning out of the gravel-bed, as stated by Desor and Cabot, nor of any unconformability between this bed and the underlying clays; but, on the contrary, every appearance that the latter belong to the same continuous series as the former.

It is worthy of note that the fossils of this locality lie above the clays, instead of in the clays, as in most of the New England localities of post-pliocene marine shells."

Mr. Rathburn informs me that in the lower shell-bed the shells are extremely abundant and mostly entire, but generally break in pieces when the matrix is removed, and that when first taken out they appear to be soft, but harden on exposure to the air. The matrix is a coarse yellowish ferruginous sand with small pebbles, and the shells have a rusty stain. None of the specimens give any evidence of having been worn by the waves, and many of the most delicate, like *Cumingia tellinoides*, *Angulus tener*, etc., are entire, and sometimes have the valves still united. This is the case, also, with some of the oysters. A large proportion of the quohog-clams (*Venus mercenaria*) are broken into angular fragments with sharp edges and angles. I have ascertained by an examination of large numbers of specimens, both entire and broken, that the breaking is due wholly to lines of fracture developed in the shell by drying or weath-

* I must here express my indebtedness to William J. Flagg, Esq., of New York, who freely gave me the unlimited assistance of his workmen, and enabled me to make a much more thorough exploration than could otherwise have been possible.

ering, just as similar shells often crack into angular fragments in the dry heated air of our museums. Many of the entire specimens of the fossil quohogs, etc., show such fractures extending in different directions across the shell, so that they are ready to break up into several angular fragments under the least strain, or even by a change in the moisture or temperature. This condition of fossil shells is a very frequent one in other localities, and will account for very many cases where the shells are found broken into angular fragments in rocks of other periods. It is evident, both from the condition of the shells in the lower bed and from the peculiar assemblage of southern species, that it was deposited in the very quiet waters of a sandy sheltered bay, entirely protected from the action of the oceanic waves. The assemblage of species is similar to that now living in the protected bays of Southern New England at the depth of 3 to 5 fathoms.* The quohog-clam, oyster, *Modiola hamatus*, *Cumingia tellinoides*, *Arca transversa*, *Urosalpinx cinerea*, and the three species of *Crepidula* are the most abundant and characteristic shells.

The *Serpula* bed consists mainly of convoluted masses of the tubes of *Serpula dianthus* V., mixed more or less with sand, but without many other fossils. This *Serpula* is still abundant all along the coasts of Southern New England, and southward to the Carolinas, in all sheltered bays and harbors where the water is not brackish, from low-water to 8 fathoms or more. It is often particularly abundant on oyster-beds, and in such localities often completely overgrows the shells, if neglected for a year or two.

The upper shell-bed, according to Mr. Rathburn, consists almost wholly of broken shells, with a little quartzose sand, which is light colored, and not at all ferruginous, so that the shells from this bed are not stained rusty yellow by the oxide of iron, like those of the lower one. Many of the fragments are distinctly water-worn and rounded, and most of them have the appearance of those shells thrown on the outer beaches by the surf, or of the dead shells often dredged up in large quantities on sandy bottoms in shallow waters near the shore, or in the vicinity of sand-shoals, where the waves break during storms. The abundance of northern forms, such as *Buccinum undatum*, *Ceronia arctata*, *Astarte castanea*, *Cyclocardia borealis*, *Mya truncata*, *Balanus porcatus*, etc., shows that the bed was

*That the depth could not have been less than 3 fathoms is probable because those species that abundantly inhabit the eel-grass (*Zostera*), which grows in sheltered localities at all depths down to about $2\frac{1}{2}$ fathoms, are either rare or entirely absent, viz. *Bittium nigrum*, *Astiris lunata*, *Triforis nigrocincta*, *Lacuna vineta*, *Littorina rudis*, *Pecten irradians*, etc. That the depth was probably not above 5 or 6 fathoms, I infer because the quohog and oyster, when adult, are seldom found in any abundance below 5 fathoms.

deposited by the cold waters of the outer coast, and their water-worn condition proves that the deposit was made in very shallow water near the shore, or near sand-shoals, swept by the waves. Such deposits may be made at any depth less than about 12 fathoms, but are more commonly made in 2 to 8 fathoms, on our coast.

This locality shows, therefore, that although important changes in the distribution of the land and water, as well as in the level of the land, must have occurred in this region during the time when these strata were being deposited, and subsequently, the temperature of the waters must have been nearly the same then as it is now, and that there must have been, at that time, the same contrast that now exists* between the coldness of the waters on the outer shores and the heat of the sheltered bays and harbors. The fossils of the lower bed indicate, for the water, a summer temperature of 70° to 75° F., while those of the upper bed correspond to a temperature of 55° to 60°, thus showing plainly the influence of the Arctic current along the coast. All the species still inhabit the waters of Southern New England, except *Diodora Noachina* found in the upper bed, but this occurs in Massachusetts Bay, and will probably be found hereafter in the deeper channels among the Nantucket Shoals, where we found this year many northern species that had not

*The nature of the changes that caused the alteration of the temperature and difference of the life indicated by these two beds of fossils will be discussed elsewhere more fully. It may be well, however, to state that my conclusion is that when the lower shell-bed and serpulæ-bed were forming, a shallow bay existed at this place, from which the outer waters were excluded, either by an island to the eastward of the site of Nantucket, or else by a southward prolongation of Cape Cod. The extensive submerged shoals south of Cape Cod and east and southeast of Nantucket may be the remnants of such lands. Some of these shoals are now covered with stones and rocks (probably drift boulders). Before the deposition of the upper bed some portion of the dry land eastward of the locality must have been submerged by subsidence, or else washed away by the encroachment of the sea (the latter most probably, to judge from the nature of the fossils), thus allowing the cold outer waters to occupy the bay, and the Atlantic surf to fill it with broken shells and beach sand. The protecting land must have been at least 50 feet higher, in its lowest parts, than the present level of the sea. As the shoals east of Nantucket have now several fathoms of water over them a vast amount of denudation must have taken place since that time. This is also shown by the great thickness of the strata of sand and gravel resulting from that denudation, and still remaining above the fossiliferous beds, and doubtless these strata have themselves also suffered great denudation during the period of their emergence from the sea, and subsequently. The partial destruction of islands formerly existing in the region of Nantucket Shoals would also result in partially filling the channels and deeper depressions between them, the final result of surf-action being a levelling one, and this would have been the case both during the period of submergence, and subsequently during that of emergence, but during the period of greatest depression (100 feet or more below the present level) there would have been comparatively little denudation of the deeply submerged islands, but there may have been islands high enough to have been out of water even then, which have since disappeared by denudation. The same reasoning will also apply to St. George's Bank and the great shoals adjacent, all of which are probably islands which have been worn down by the waves below the level of the sea.

previously been found south of Cape Cod. *Modiola hamatus*, which occurs in considerable numbers in the lower bed, is a southern shell, common in the Gulf of Mexico, and on the southern coast as far north as Virginia, but occurring on the southern coast of New England, only locally, in harbors, etc., and generally on beds of oysters that have been transplanted from farther south. For this reason it has been generally supposed that it is not indigenous but has in all cases been introduced with the oysters. However this may be now, it is evident that it was a native species in Post-pliocene times.

The only species that shows any noteworthy variation, when compared with the modern shells from the same region, is the quohog (*Venus mercenaria*). Most of the specimens of this species differ considerably, in the rounder form, thicker shell, and in the greater development of the concentric ridges, from the ordinary quohog-clams seen in our markets. In a lot of large shells of this species obtained from a fisherman at Nantucket, this season, there are many that are equally massive and have the same rounded form, and although the concentric sculpture is not so strongly developed as in many of the fossil shells, there is a decided approach toward them in this respect also. These living Nantucket quohogs certainly resemble the fossil ones more closely than do those from any other locality known to me. But among the fossil specimens (as also among the recent ones from Nantucket) there are some specimens that are as smooth, thin and elongated as the ordinary variety found in our harbors; and intermediate specimens also occur, so there is no reason to suppose that the variation in the fossil shells was anything more than a local variation, such as often occurs in many species at the present time. Nevertheless it may be convenient to designate such special conditions of a species by a particular variety-name. The general absence of such variations in the Post-pliocene shells of the New England coast, as compared with those now living upon it, is certainly very remarkable, considering their great antiquity and the many important changes that have since taken place in the physical conditions of the land and water. Such instances give us the best evidence in regard to the constancy and stability of true specific characters, even when apparently of little or no importance in the economy of the animal itself.

List of Species from the lower Shell-bed.

The names of the species are those used in the Report on the Invertebrata of Southern New England, by the author and Prof. S. I. Smith, in 1st Report of the United States Commissioner of Fish and Fisheries, 1874.

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In each case the relative abundance is indicated. I have also added the present distribution on the American coast, in a general way, as well as a few notes on the geological distribution of each species. Fuller information on the distribution of the species has been given in the Report referred to.

MOLLUSCA.

Tritia trivittata Adams. Common.

Florida to Gulf of St. Lawrence; low-water to 40 fathoms. Fossil in the Post-pliocene of Point Shirley, Gardiner's I., Virginia and southward; in the Miocene of Maryland, South Carolina, etc.

Ilyanassa obsoleta Stimpson. Common.

Florida and Gulf of Mexico to Southern Maine; local in the southern part of the Gulf of St. Lawrence; littoral to 2 fathoms. Fossil in the Post-pliocene of Point Shirley, Virginia, South Carolina, etc.

Urosalpinx cinerea Stimpson. Common.

Tampa Bay and Eastern Florida to Massachusetts Bay, and local farther north to Gulf of St. Lawrence; littoral to 10 fathoms. Post-pliocene fossil at Point Shirley, Gardiner's I., Virginia and southward; in the Miocene of Maryland.

Eupleura caudata Adams. One fine specimen.

Gulf of Mexico and Eastern Florida to Cape Cod; low-water to 8 fathoms. In the Post-pliocene from Virginia to Florida; Miocene of Maryland and South Carolina.

Astyris lunata Dall. One specimen.

Alabama and Florida to Massachusetts Bay; low-water to 14 fathoms. Fossil in the Post-pliocene of Gardiner's I. and South Carolina.

Cerithiopsis Greenii Verrill. Four specimens.

South Carolina to Massachusetts Bay; two to 10 fathoms.

Crepidula fornicata Lamarck. Abundant.

Gulf of Mexico to Southern Maine, and local in the southern part of the Gulf of St. Lawrence; low-water to 15 fathoms. Post-pliocene fossil at Gardiner's I., South Carolina, etc.; and Miocene in Maryland and South Carolina.

Crepidula plana Say. Common.

Distribution same as the preceding, from which, however, it is very distinct.

Crepidula convexa Say. Not common.

Distribution like the two preceding, from both of which it is perfectly distinct (although confounded with *C. fornicata* by Tryon and others). Fossil in the Post-pliocene of Virginia and South Carolina.

Odostomia trifida Gould. Common.

New Jersey to Massachusetts Bay; low-water to 5 fathoms.

Odostomia impressa Stimpson. Common.

South Carolina to Vineyard Sound; low-water to 5 fathoms.

Turbonilla interrupta Adams. Several specimens.

South Carolina to Cape Cod; local farther north to the southern part of the Gulf of St. Lawrence, near Prince Edwards' Island; low-water to 15 fathoms. Post-pliocene fossil at Gardiner's I. and in S. Carolina.

Saxicava arctica Deshayes. Rare and small.

Arctic Ocean to Georgia, local and rare south of Long Island; low-water to 50 fathoms. Fossil in the Post-pliocene of Maine and everywhere northward.

Mya arenaria Linné. Abundant.

Arctic Ocean (lat. 78° N.) to South Carolina; low-water to 40 fathoms. Post-pliocene fossil from South Carolina and Virginia to Greenland and Northern Europe.

Corbula contracta Say. One valve.

Florida to Cape Cod.

Ensatella Americana Verrill. Common.

Labrador to Florida; low-water to 25 fathoms. Fossil in the Post-pliocene of Portland, Me., Point Shirley, Gardiner's I., Virginia and South Carolina; Miocene of Maryland, etc.

Angulus tener Adams. Several specimens.

Florida to Gulf of St. Lawrence; low-water to 12 fathoms.

Cumingia tellinoides Conrad. Common.

Florida to Cape Cod; three to 12 fathoms. In the Post-pliocene and Miocene of South Carolina, etc.

Petricola pholadiformis Lamarck. Rare.

Gulf of Mexico to Massachusetts Bay; local in Casco Bay and southern part of the Gulf of St. Lawrence; low-water to 4 fathoms. In the Post-pliocene and Pliocene from Florida to Virginia.

Venus mercenaria Linné. The variety abundant; a nearly typical form not uncommon.

Florida to Massachusetts Bay; local on the southwestern coast of Maine and southern shores of the Gulf of St. Lawrence and Bay of Chaleur; low-water to 8 fathoms. In the Post-pliocene of Point Shirley, Gardiner's I., Virginia, Florida; Miocene from Maryland to South Carolina.

Var. antiqua Verrill. By this name I propose to designate the unusually massive and strongly sculptured variety to which most of the fossil shells belong, and which has been already discussed on a previous page.

The shell is rather obtusely rounded posteriorly, and is thickly covered with prominent concentric lamelliform ridges, which mostly extend entirely across the shell, but are often reflexed, appressed and more or less confluent over the middle region, where the ordinary variety is nearly smooth (except

when young). The violet color can still be traced in some specimens entirely around the inner margin, as in many recent Nantucket examples.

Tottenia gemma Perkins. Few specimens obtained.

South Carolina to Labrador; low-water to 4 fathoms.

Gouldia mactracea Gould. One specimen.

Florida to Cape Cod; 3 to 15 fathoms.

Scapharca transversa Adams. Very abundant and large.

Florida to Cape Cod; low-water to 15 fathoms. In the Post-pliocene of Cape Cod, Gardiner's I., Virginia, South Carolina; Miocene of Virginia and North Carolina.

Mytilus edulis Linné. Common.

Circumpolar; Arctic Ocean to North Carolina; littoral to 50 fathoms. In the Post-pliocene from Florida to Greenland and Northern Europe.

Modiola hamatus Verrill. Common.

Gulf of Mexico to Long Island Sound and Naragansett Bay; littoral.

Crenella glandula Adams. Few specimens obtained.

Labrador to Long Island; 5 to 60 fathoms. In the Post-pliocene of Montreal.

Anomia glabra Verrill.

Florida to Cape Cod; and locally farther north to Nova Scotia; littoral to 20 fathoms. In the Post-pliocene and Pliocene of South Carolina.

Ostrea Virginiana Lister. Abundant and well-grown.

Gulf of Mexico to Cape Cod, and locally farther north, at Damariscotta, Me., and in the southern part of the Gulf of St. Lawrence; low-water to 5 fathoms. In the Post-pliocene of Point Shirley, Gardiner's I., South Carolina, etc. Both the short, rounded specimens and the much elongated and narrow forms occur, as well as all the intermediate states, just as in many modern oyster-beds, showing that in Post-pliocene times the same kind of individual variations prevailed that have perplexed many modern systematists, but they have not yet become specific, nor even definite varietal characters.

BRYOZOA.

Hippothoa variabilis V. (*Escharella variabilis* Verrill, in Report on Invert.) Common on *Serpula*, etc.

Florida to Massachusetts Bay; low-water to twenty fathoms.

Biflustra tenuis V. (*Membranipora tenuis* (Desor); Verrill, in Report on Invert.) Common on shells.

Delaware to Massachusetts Bay; low-water to 15 fathoms.

Membranipora catenularia Smitt. Common on shells.

Arctic Ocean to Long Island Sound; low-water to 50 fathoms; northern Europe.

CRUSTACEA; ANNELIDA; PORIFERA.

Panopeus, sp. Several claws were found.

Eupagurus pollicaris Stimpson. A claw, probably from this bed, is recorded by Desor.

Florida to Massachusetts; 2 to 15 fathoms.

Balanus eburneus Gould. Common.

West Indies to Massachusetts Bay; littoral to 3 fathoms.

Balanus crenatus Bruguière. Common.

West Indies to the Arctic Ocean; 3 to 15 fathoms.

Serpula dianthus Verrill. Very abundant.

North Carolina to Cape Cod; low-water to 15 fathoms.

Cliona sulphurea Verrill. The excavations are abundant in oyster shells.

Florida to Massachusetts Bay; 1 to 15 fathoms.

*List of Species found only in the upper Shell-bed.**

Buccinum undatum Linné. Common.

Arctic Ocean to New Jersey; northern coasts of Europe; low-water to 100 fathoms. In the Post-pliocene, Maine to Labrador and Northern Europe.

Neptunea curta Verrill. Several specimens, one of large size.

Labrador to Massachusetts Bay, and in deep water farther south, to Long Island.

Lunatia heros Adams. Common, but badly broken.

Georgia to Gulf of St. Lawrence; low-water to 40 fathoms. Post-pliocene, Canada, S. Carolina; Pliocene, S. Carolina; Miocene, Maryland to S. Carolina.

Var. triseriata. One specimen occurred.

Neverita duplicata Stimpson. One broken specimen.

Yucatan to Massachusetts Bay; low-water to 10 fathoms. Post-pliocene, Virginia to Florida; Pliocene, S. Carolina; Miocene, Maryland to S. Carolina.

Crucibulum striatum Adams. One large specimen.

New Jersey to Bay of Fundy; low-water to 40 fathoms.

Scalaria Grœnlandica Perry. Recorded by Desor, and doubtless from this bed.

Arctic Ocean to Block Island; 10 to 109 fathoms; Northern Europe. Fossil in Post-pliocene of Northern Europe.

Diodora noachina Gray. Two good specimens.

Arctic Ocean to Cape Cod; 8 to 70 fathoms; northern Europe.

Mya truncata Linné. Several large specimens.

Arctic Ocean to Nantucket Shoals; low-water to 10 fathoms; northern Europe. In the Post-pliocene, Maine to Labrador.

Thracia truncata Mighels and Adams. A few valves, special bed not indicated.

Greenland to Long Island; 10 to 60 fathoms.

* A valve of *Saxicava Norvegica* was found after this list was put in type. Arctic Ocean to Massachusetts Bay.

Clidiophora trilineata Carpenter. One valve.

Florida to Gulf of St. Lawrence; low-water to 30 fathoms.

Mucoma fragilis Adams, *var. fusca* (Say). A few valves.

Greenland to Georgia; littoral to 6 fathoms. In Post-pliocene from S. Carolina to Greenland.

Ceronia arcata Adams. Abundant and large.

Gulf of St. Lawrence to Long Island.

Mactra solidissima Chemnitz. Common, fragmentary.

Florida to Labrador; low-water to 12 fathoms. Post-pliocene of Point Shirley, Mass.

Cyclocardia borealis Conrad. Common.

Labrador to New Jersey; 3 to 80 fathoms. In the Post-pliocene of Gardiner's I.; Point Shirley; Labrador.

Cyclocardia Novangliæ Morse. A few valves.

Gulf of St. Lawrence to Long Island Sound; 3 to 40 fathoms.

Astarte undata Gould. One worn valve.

Long Island Sound to Northumberland Straits in Gulf of St. Lawrence; low-water to 100 fathoms. In the Post-pliocene of Gardiner's Island and Point Shirley.

Astarte castanea Say. Abundant.

New Jersey to Nova Scotia; 5 to 40 fathoms. In the Post-pliocene at Point Shirley.

Modiola modiolus Turton. Many worn valves.

Circumpolar; Greenland to New Jersey; low-water to 80 fathoms. In the Post-pliocene of Point Shirley, Canada, and northern Europe.

Anomia aculeata Gmelin. Common.

Arctic Ocean to Long Island Sound; low-water to 100 fathoms.

BRYOZOA.

Eschara verrucosa Esper. On shells of *Ceronia*.

Arctic Ocean to Nantucket Shoals; 3 to 45 fathoms. Northern Europe. In the fossil examples the surface of the cells is covered with radiating ridges, often rising into an eminence in the middle, and is perforated with numerous pores in the grooves. Orifice somewhat semicircular with a median avicularium in front of the proximal edge.

Celleporaria incrassata Smitt (?). Several.

Off Martha's Vineyard to Spitzbergen; 10 to 160 fathoms. The specimens are thick, irregular masses. The apertures are small, rounded, oblong, constricted on the sides by small points projecting inward near the middle, and sometimes with a small proximal spine.

CRUSTACEA AND ECHINODERMATA.

Balanus porcatus. Very abundant and large, but broken.

Arctic Ocean to Long Island Sound; 2 to 90 fathoms.

Strongylocentrotus Dröbachiensis A. Agassiz. Spines only.
Arctic Ocean to New Jersey; circumpolar; low-water to 480
fathoms. Post-pliocene of Maine and northward.

List of Species found in both Shell-beds.

	Lower Bed.	Upper Bed.
<i>Urosalpinx cinerea</i>	Common.	One.
<i>Tritia trivittata</i>	Few.	Common.
<i>Ilyanassa obsoleta</i>	Few.	Few.
<i>Crepidula fornicata</i>	Abundant.	Few.
<i>Crepidula plana</i>	Common.	Few.
<i>Ensatella Americana</i>	Abundant.	Few.
<i>Mya arenaria</i>	Abundant.	Few.
<i>Saxicava arctica</i>	Few.	Common.
<i>Venus mercenaria</i>	Abundant.	Few.
<i>Scapharca transversa</i>	Abundant.	Few.
<i>Mytilus edulis</i>	Few.	Common.
<i>Crenella glandula</i>	Few.	Several, large.
<i>Ostrea Virginiana</i>	Abundant.	Few.

Most of these belong to the fauna of the warm sheltered bays, and their occurrence in the upper bed may have been accidental in many cases. The few worn shells of such species, though found in the upper bed, may have been originally deposited in the lower one and afterward washed out by the waves and redeposited in the upper one.

The absence of many species ordinarily abundant in the clay-beds of our New England Post-pliocene, (e. g., the species of *Nucula*, *Yoldia*, *Leda*, etc.), is doubtless due to the fact that such species lived only on muddy bottoms, while both of these deposits were made on sandy bottoms. They are, in fact, characterized by the nearly complete absence of all true muddy-bottom species.