

No. 5. — *On the Occurrence of Fossils of the Cretaceous Age on the Island of Martha's Vineyard, Mass.* By N. S. SHALER.

It has long been known that fossils apparently of Tertiary age occur in the peculiar rocks about Gay Head, on the western extremity of Martha's Vineyard. These strata of alternating clays, sands, and occasional lignites occupy the western half of Martha's Vineyard, in which region they rise above the sea level. They probably underlie the glacial deposits throughout much of the area of the island, and may have a yet wider extension. Even where the Tertiary beds lie above the sea level, they are generally covered by a thick coating of glacial débris. Where this débris has the character of true shoved moraine, the accumulations are often a hundred feet or more in depth. Where the detritus exists in the form of a sheet, it is less continuous, but nevertheless covers the greater part of the underlying rocks, which are only exhibited in a clear manner along the gulf-like shores.

In 1870, while engaged in some studies on the erosion of the coast lines of this island, I found several fragments of a coarse sandstone at various points in the drift material, which contained extremely obscure molluscan fossils. Among these were specimens of what appeared to me to be *Exogyra*, a genus which, as is well known, does not extend to the Tertiary period, and is practically limited to the lower portion of the Cretaceous. Although the evidence was extremely imperfect, it was enough to warrant a careful search of the island, with the hope of finding in place the beds whence the fragments were derived. I spent more than a month in this systematic inquiry before attaining to any results whatever. At length I discovered two localities where these sandstone fragments with imperfect molluscan remains were tolerably plenty. These positions are indicated in the descriptive sketch, Plate I. One of them lies on the western shore of what is called Lagoon Pond, immediately west of Cottage City. At this point a skilled collector may in the course of half a day discover half a dozen fragments scattered in the drift, which are clearly referable to Cretaceous rocks. A second and more important locality lies near the centre of the northern shore, at the distance of about three fourths of a mile from the coast line on the

track of the last locality known as the "Woods Schoolhouse." The schoolhouse of the name has disappeared, for its foundations only remain; but the explorer can readily find his way to the spot by passing from the new schoolhouse on the Cedar Tree Neck road westwardly along the serpent kame, the only deposit of this nature on the island, until he passes a stone wall, a little to the west of which, in the roadway and on the bare ground thereabout, he may find an abundance of fragments of this peculiar sandstone. Circumstances prevented my undertaking any careful study of this place until seventeen years after its discovery. In 1887 I returned to the locality, and with the help of my assistant, Mr. Foerste, undertook a careful collection of the abundant fragments which I found at this point, as well as a systematic study of all the area of the island which gave promise of affording similar material. The search for other localities was fruitless, and as this is the only one on the island which has afforded fossils in condition for identification, I shall hereafter limit my account of the bed to what is exhibited at this point.

As is shown in the accompanying section, the Cretaceous fragments found at this locality occur only within a small area. They have been found over a surface having an east and west extension of about 300 feet, and a north and south length of about 200 feet. The position is immediately to the south of a shoved moraine, which extends up to and probably includes this part of the drift accumulations. In this area, from the surface to the depth of four or five feet, or as far as the excavation penetrated, by far the larger part of the fragments are composed of the deposit in question. The rock consists of a very coarse sandstone abounding in quartz pebbles, containing indeed little other material save quartz fragments from an inch in size downward. The largest of the fragments containing fossils are about three feet across and a foot thick; the greater part of them are extremely angular, showing by their form that they have been transported for a very short distance. Moreover the extreme softness of the material would make it impossible for it to endure any distant ice carriage. The sand in which the fragments containing fossils were embedded appears to be to a great extent derived from the destruction of the same rock. This fact is indicated not only in the physical aspect of the sands, but in the character of the vegetation which grows upon them. Generally, in this morainal district, the decomposition of the pebbles containing large amounts of feldspar and mica affords a moderately fertile soil, which maintains grass. In the area where these fragments abound, the sand is evidently far more siliceous than elsewhere in the area of the moraine, and is too lean to support

plants. In part it is covered by a growth of lichens, and in part altogether bare of vegetation.

This assemblage of facts makes it seem clear that the locality whence this Cretaceous material is derived is not more than a few hundred feet to the north of the site where these fossils are found. Were it farther away, there could be no such concentration of the Cretaceous waste. The hypogene material would be more extensive than it is. I have therefore no hesitation in saying that we have in this immediate vicinity a deposit of Cretaceous age. It is probable that this deposit of small area is girdled about by strata of the same age as those about Gay Head. This is indicated by the fact, that, at various points in every compass direction from this locality, the drift contains large amounts of bright-colored clays such as give the name to Gay Head. These clays are not seen in their natural position, but are commingled with the glacial waste, the fact being that when the glacier overrode this area it ground up and commingled a good deal of bed-rock clays over which it moved with the morainal material brought from a distance. A careful study of all the exposures on Martha's Vineyard containing Tertiary clays has failed to show any distinct fragments of Cretaceous rock. This assemblage of facts has led me to the conjecture that some small remnant of the Cretaceous beds projecting through the enveloping clays of later age is the source whence these fragments containing fossils have been derived.

The foregoing conjecture is more probable, for the reason that it will explain in a satisfactory way the origin of much of the sedimentary matter contained in the beds of the Gay Head section. That section is remarkable for the very large amounts of siliceous matter contained in its sandy and pebbly beds. This material is substantially what would be obtained from the erosion of the Cretaceous strata such as are found at this point, and the reassortment of the materials.

The physical conditions of the fragments of Cretaceous rock appear to indicate that the beds were deposited near a shore line. The rock is of a very coarse texture, showing faint indications of cross bedding; the clay element is scanty, and the quantity of lime is very small. It is evident that the bed containing the fossils was accumulated with considerable rapidity, and that only in certain levels was the organic life developed in sufficient quantity to make the bed fossiliferous. All these conditions indicate that the deposit was formed near the coast line.

This opinion is borne out by the character of the fossils. The great prevalence of oysters, and the fact that the two valves are generally

found separate from each other, in some cases appearing to have been worn by wave action before they were fixed in the strata, is almost conclusive proof that the deposits were made in shallow water. Although the *Exogyras* differ in a certain measure from our ordinary oysters, their distribution in this and other countries is always consistent with the hypothesis that, like their living kindred, they did not inhabit the deeper parts of the sea, but were dwellers in the shoal water.

The existing condition of the Cretaceous fragments affords us some light as to the condition of the rock before it was disrupted by glacial action. All the fragments containing fossils are extremely ferruginous, the lime of the shells having been replaced by limonite. This is the ordinary result of atmospheric action on superficial deposits of this nature. It appears to me quite evident that this replacement of the lime was effected while the material was in its original position, and this for the following reasons. The fragments of Cretaceous rock were in many instances found lying upon the surface of the soil, or only partly bedded within it. In these cases the limonation could not have occurred since the fragments came to their present position, for the reason that there would have been no source whence the iron could have been derived. There has evidently been no considerable degradation of the drift on this region since it was abandoned by the glacier. Owing to the position of the deposit it was not subjected to any water erosion. It is evident that the corrosive work since the disappearance of the glaciers has not taken away more than a few inches, if as much, from the surface. If the fragments had come to their present position without having experienced the processes of decay, the replacement of the lime could not have been effected. I therefore am forced to the conclusion, that this material had decayed in its original bed, before it was disrupted by the glacier, and that the iron was derived from superjacent beds in the original stratification. Although this conclusion is hypothetical, it is of certain interest, for the reason that it combines with the other known facts to indicate that the glacial erosion which has taken place in this region has been of slight amount. If it had been great in quantity, if several hundred feet of the section had gone away, we should not only have had this detrital material of Cretaceous age distributed over a larger field, but the fragments would probably have come to this point in an unoxidized condition.

A very severe rain-storm which occurred in the month of September, 1888, disclosed a portion of the sections in the neighborhood of the point where Cretaceous fossils are found. Although the sections are obscurely

exhibited, a tolerable notion can be formed as to the character of the materials along a line having a length of about 2,000 feet. The position of the beds is in general indicated in the accompanying diagram, which gives a somewhat generalized section from the north shore of the island, a little west of Cedar Tree Neck, across to the small brook on the Cedar Tree Neck road. On the north shore the beds occasionally exposed after severe storms consist of grayish green sands, with occasional iron concretions resembling those found in the "Wood Schoolhouse" locality. Some of the fragments closely resemble the material containing fossils at the last mentioned locality, and in one fragment an unrecognizable species of oyster was observed. At the highest point delineated in the section, the shoved frontal moraine is partly interrupted, so that the underlying rocks are exposed. Here we find a section having a length of about 300 feet, showing a deposit of grayish green sands alternating with red and white clayey sand, the dip of the beds being to the northwest, the angle varying from 45° to 60° of declivity. Proceeding south, we find 300 feet of section in which the beds are concealed from view; then a small exposure of red clayey sand with an obscure dip, not more than 60 feet in thickness of beds being exposed to view; then 140 feet of measures hidden by the covering of drift; following that, 70 feet of red and white clayey sand, very micaceous, dip obscure, but apparently in the same northwest direction. Again, southward, a covered section of about 100 feet in length, in which the drift is more or less churned up with grayish sands presumably derived from the underlying beds. This is the point where the fragments containing species of fossils described in this report were obtained. Farther on, 600 feet of the section is unexposed; then, for 180 feet, we have mainly greenish gray sands, having a total thickness of about 80 feet, with traces of yellow and white sands above and below them. At this point the dip is clearly shown. It is to the northwest, at an angle of from 35° to 50° . Following to the southward, 150 feet of the section is concealed; then for the distance of about 125 feet, to near the margin of a small brook, the reddish clays appear at the surface, but the dip is not clear. It appears to be in the same northwest direction. At several points in the greenish measures, some compact ferruginous layers resembling those containing fossils are found; but in none of these beds have I as yet been able to obtain organic remains. They serve, however, to indicate that the material containing fossils is really derived from this section.

Until fossils are actually found in a bedded condition in the deposit, it will not be possible to assert in a positive manner that this section is

of Cretaceous age. It still seems possible that the fragments containing fossils may be in their nature exotic, as are the fossiliferous materials in the beds at Gay Head. It is to be noted, however, that the greenish gray sand in the section containing the fossils differs considerably in its general aspect from the beds at Gay Head. Moreover, there appears to be an absence of lignites in this portion of the Vineyard series.

The prevailing northwest dips of this section are in contrast to the attitude of the Gay Head series. I have carefully examined the bedding with reference to the theory that the dislocation is due to glacial thrust. I find it impossible to accept this view, for the following reasons. In the first place, the dips are everywhere tolerably uniform, except within a foot or so of the glaciated surface. In this uppermost part of the section the thrusting and dragging action of the ice is distinctly exhibited in the somewhat sharp flexure of the beds, as well as the considerable contortion which they present. It seems to me impossible to believe that a steadfast dip such as is shown by these beds could have been produced by the thrust of a glacial sheet. If the dislocation were due to the direct forward movement of the ice, we should have to explain these dips by the supposition either that the beds originally horizontal were thrown into an arched form, and that we have here the northwest side of the anticlinal, or that the beds were completely overturned in order to produce the existing dips. There is no trace of such an arch exhibited in the section. Indeed, the presence of such a fold is contra-indicated by the fact that the dips increase to the southward, and the hypothesis of a complete overturn finds no support whatever in the facts. Last of all, we observe that the surface of this district apparently retains its pre-glacial topography. A system of stream valleys is traceable over all the section where the Vineyard series of deposits rise above the sea level. The persistence of a pre-glacial topography, manifest even in the details of the surface, — a topography on which the drift materials are simply imposed, — is overwhelmingly against the supposition that the dislocations are in any measure due to the action of the ice-sheet.

In a memoir on the Geology of Martha's Vineyard, prepared for the Annual Report of the Director of the U. S. Geological Survey for 1885-86, I have endeavored to show that the deposits at Gay Head, probably of Miocene or early Pliocene age, were formed in a delta at a time when the level of the shore was perhaps not more than 200 feet below its present position. If the evidence from the fossils and the physical condition of these Cretaceous deposits is to be trusted, it indicates that in a much earlier time the shore on this part of the

North American coast was also not far from its present altitude. These fragments lie at the height of about 150 feet above tide-water ; the most elevated point at which I have traced the Tertiary deposits of the Gay Head series is about the same height. Taken together, these two sections afford interesting evidence of the existence of the shore line close to the present coast in two remote stages of the earth's history.

The occurrence of Cretaceous deposits in this part of New England is particularly interesting, for the reason that it indicates the former extension of the deposits of this age to points much farther north than they have hitherto recognized on the eastern versant of the continent. Hitherto, no beds of Cretaceous age have been known on the Atlantic coast north or east of New Jersey. This new locality establishes the existence of such beds about 100 miles farther north, and about 200 farther east than those which occur in the New Jersey area.

The fact that the Martha's Vineyard Cretaceous material was apparently deposited near a shore line, appears to indicate that the Cretaceous section, at least that part which belongs in this particular horizon, never covered the general surface of New England. Therefore we cannot fairly attribute to erosion the absence of this portion of the Mesozoic deposits in the New England area and the region to the northward. It seems to me more likely that these beds were never deposited on that portion of the continental surface.

Palæontology of the Martha's Vineyard Cretaceous.

Although there can be hardly any question as to the general geological position of the beds whence these fossils were derived, their precise place in the section is not readily determinable with the material at hand. As will be seen from the appended figures of fossils, the remains are very imperfectly preserved, revealing the existence of four species which are characteristically Cretaceous in their aspect. The species, however, differs so far from that which has been found in more southern portions of the continent that no sufficient identification of the particular horizon is possible.

The most abundant fossil is the *Exogyra*, shown in Figs. 19 and 20 of Plate II. The specific differences between the several species of *Exogyra* are rarely if ever sharply defined. The Martha's Vineyard form appears to be sufficiently distinct from any others which have been described to warrant the application of a new specific name. So far, no distinct *Exogyras* have been found above the horizon of the Cretaceous

period. Indeed, it seems likely that this genus does not range up to the very summit of that series, but passes out of existence shortly after the Middle Cretaceous section. Therefore the occurrence of this fossil of itself affords fair ground for concluding that the deposit does not belong to a higher level than the Middle Cretaceous. The species of *Camp-tonectes* has never been found above the middle of the Cretaceous series. Indeed, it appears to be characteristic of the lower portion of that section. It may be taken as evidence, that the beds in question do not extend below the horizon of the Cretaceous. The other fossils which are described and figured are less determinative in their value. They are, however, so far as it has been possible to identify them, not inconsistent with the hypothesis that these beds are of Cretaceous age, and that they probably belong in the lower portion of that period.

In the present state of our knowledge concerning the field from which these Cretaceous fossils are derived, it does not appear worth while to undertake any description of the species. Although the material is in fair condition for such work, it seems to me likely that further study of the field will develop much better specimens. I have therefore sought to do no more than refer these species to their genera, with suggestions as to the apparent affinities of certain forms. In preparing this list, I have been so fortunate as to be able to confirm my general determinations by the advice of Dr. C. A. White, Palæontologist of the U. S. Geological Survey. My thanks are due to him, and also to my assistant, Mr. Aug. F. Foerste, for a careful search of the island of Martha's Vineyard, in order to determine whether localities other than those I had found existed on the island. Although the result of this was purely negative, it has been of value to the investigation. I am also indebted to Mr. Foerste for the preparation of the drawings figured on Plate II. of this report.

The foregoing report is intended as a preliminary statement concerning the Cretaceous rocks of this interesting locality. I hope to explore the field by systematic excavations, and thus secure more complete and accurate information than has here been presented.

EXPLANATION OF PLATES.

PLATE I.

This plate gives a sketch map of the island of Martha's Vineyard, intended to afford in mere outline sufficient indications as to the position of the Cretaceous localities which have so far been determined. The principal locality where these fossils are found is shown by the line indicating the position of the section given at the bottom of the plate. From this point the fossils were obtained which are mentioned in the text and figured in Plate II. The locality on Lagoon Pond lies on the eastern face of that sheet of water from one third to one half a mile south of the entrance to the pond. The fossils from this locality are extremely imperfect, and are found in occasional fragments of Cretaceous rock involved in a thick section of drift. A third locality, where a single fragment of a fossil oyster was observed, is on the southern part of the island of Chappaquiddick, which lies to the east of Edgartown.

At various points to the eastward of a line drawn from Great Tisbury Pond to Lombard's Cove the drift is frequently stained with ferruginous sandstone waste, which is probably derived from Cretaceous deposits. It is possible that a portion of the stratified rock deposits lying to the westward of the above mentioned line may also be of Cretaceous age.

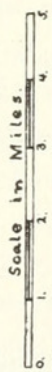
For a further account of the geology and topography of this district, see my Memoir on the Geology of the Island of Martha's Vineyard, in the Seventh Annual Report of the Director of the U. S. Geological Survey.

PLATE II.

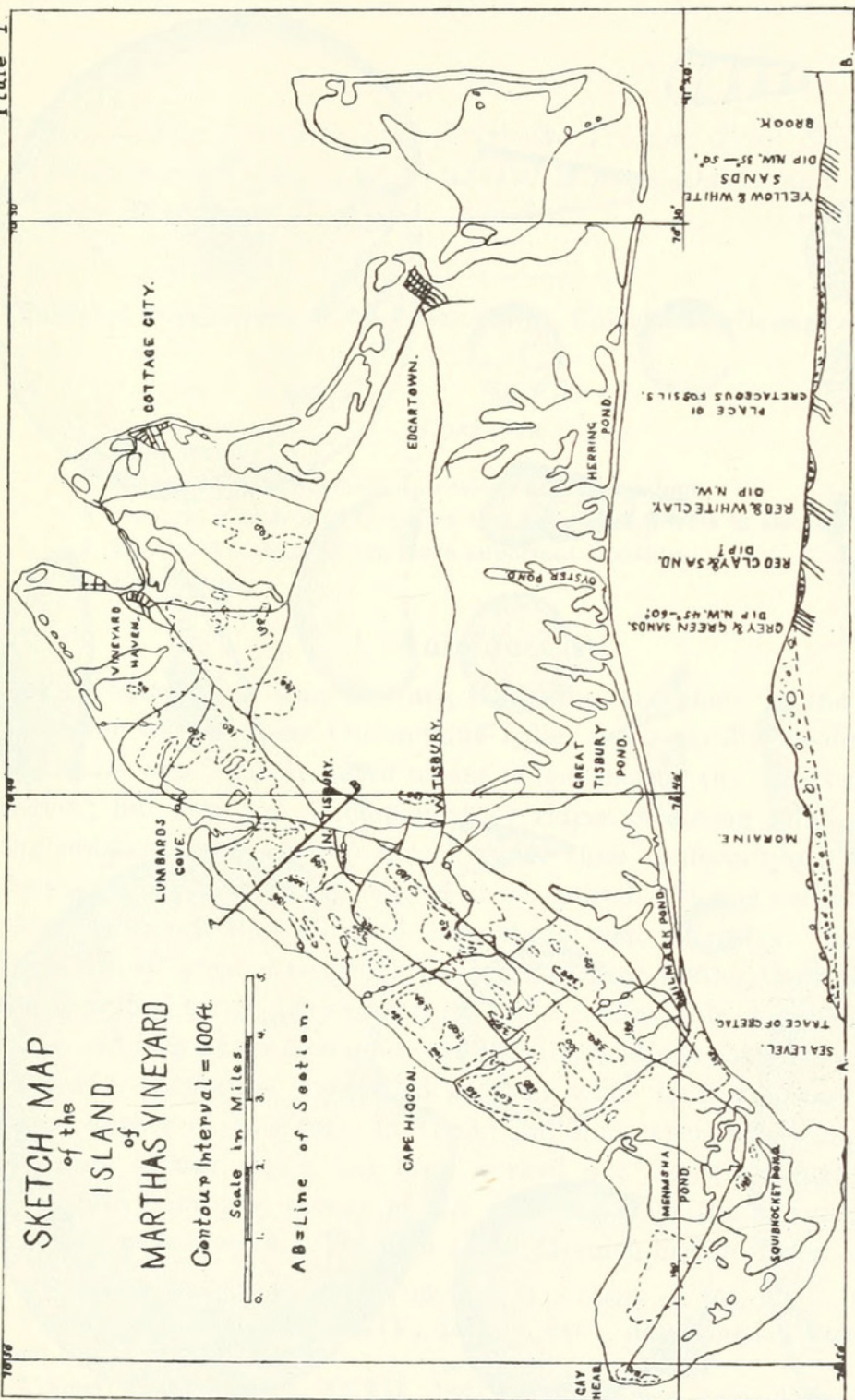
- Fig. 1, 1 a, 1 b. New genus? Compare *Myoconcha*.
- Fig. 2. *Plicatula* or *Ostrea*. Compare *Pl. instabile*, Stol., and *O. lugubris*, Conrad.
- Fig. 3. *Tellina* (*linearia*)?
- Fig. 4. *Cardium*?
- Fig. 5. *Pteria*.
- Fig. 6. *Lucina*?
- Fig. 7. *Turritella* (*nerina*?).
- Fig. 8. *Camptonectes Burlingtonensis*, Gabb.
- Fig. 9. *Camptonectes parvus* (?), Whitfield.
- Fig. 10. *Chemnitzia*.
- Fig. 11. *Lucina*.
- Fig. 12. *Cerithium*.
- Fig. 13. *Anomya*?
- Fig. 14. *Turritella*.
- Fig. 15. *Nuculana*.
- Fig. 16. *Ostrea* or *Exogyra*?
- Fig. 17. *Modiola*.
- Fig. 18. *Modiola*?
- Fig. 19, 20. *Exogyra*. Compare *E. ostracina*, Lam.

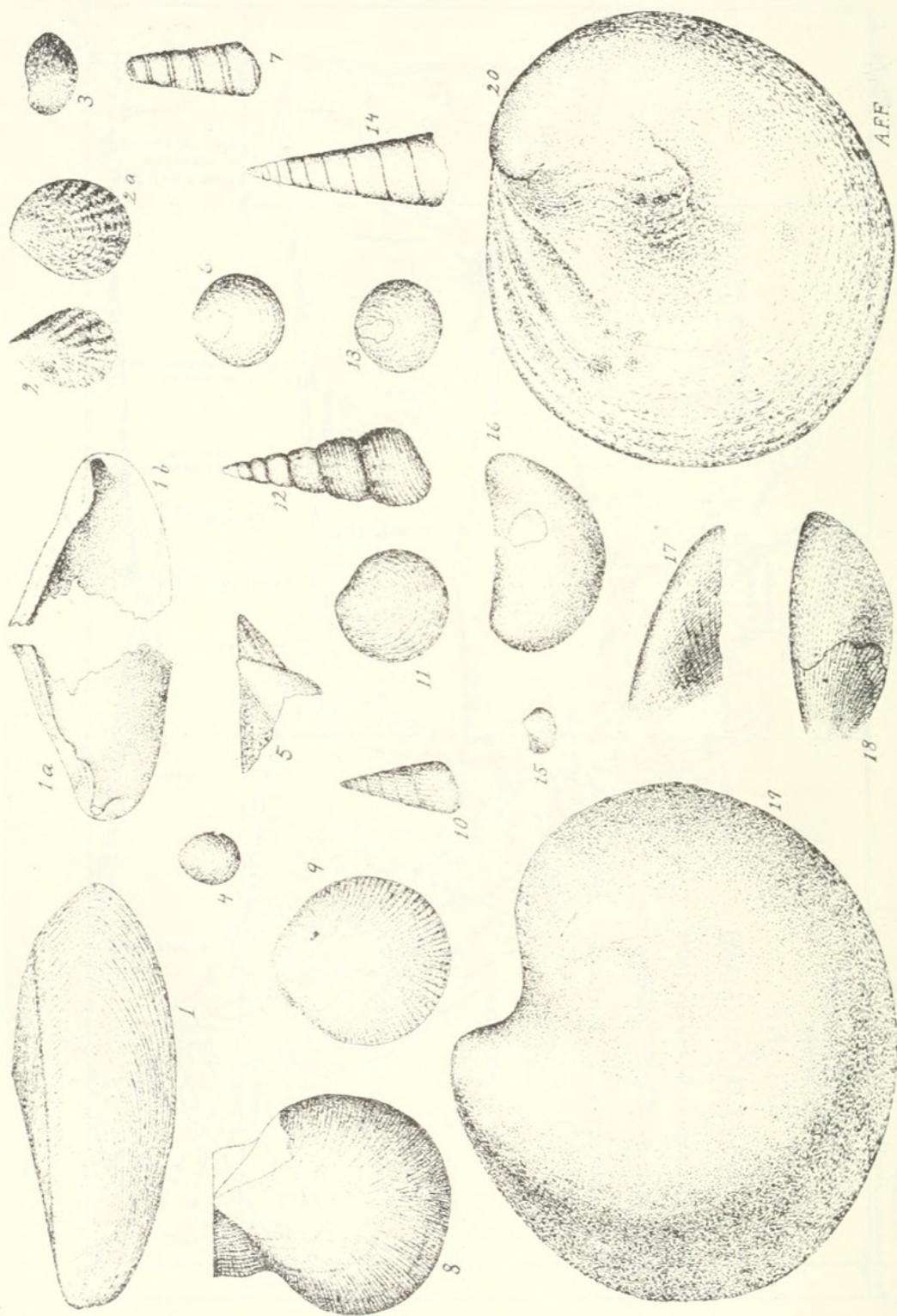
Shaler.
Cretaceous Fossils.

SKETCH MAP
of the
ISLAND
of
MARTHAS VINEYARD
Contour Interval = 100 ft.



AB=Line of Section.







Shaler, Nathaniel Southgate. 1889. "On the occurrence of fossils of the cretaceous age on the island of Martha's Vineyard, Mass." *Bulletin of the Museum of Comparative Zoology at Harvard College* 16(5), 89–97.

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