THE FAUNA OF THE CLIFFWOOD (N. J.) CLAYS[1]

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Several papers have recently appeared in which the beds at Cliffwood Point on the south shore of Raritan Bay, New Jersey, have been discussed, and some difference of opinion as to their correlation has been expressed.[2] For the most part the discussion has been based upon the evidence as shown by the fossil flora, although mention of marine invertebrate fossils has been made in several of the papers. During the past two field seasons extensive collections of these invertebrates have been made by the writer from the locality in question, as well as from the clay pits in the neighboring region which have been opened in the same beds. At Cliffwood Point the fossils were collected from smooth, concretionary nodules, which occur in great numbers along the beach at low tide. Although most of the fossils were collected from nodules not *in s tu* a few similar nodules carrying the same fossils have been found imbedded in the clay, and no doubt can be entertained as to the original source of all the nodules being from the clay at the locality in question, from a horizon near or somewhat below high-water level. Their occurrence in essentially the same beds, or even in beds a little lower

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[2] Arthur Hollick, "The Cretaceous Clay Marl Exposure at Cliffwood, N. J.," *Transactions of the New York Academy of Sciences*, Vol. XVI, pp. 124–36; Edward W. Berry, "The Flora of the Matawan Formation (Crosswick's Clays), *Bulletin of the New York Botanical Garden*, Vol. III, No. 9, 45–103; Edward W. Berry, "New Species of Plants from the Matawan Formation," *American Naturalist*, Vol. XXXVII, pp. 677–84; G. N. Knapp, "The Cliffwood Clays and the Matawan," *American Geologist*, Vol. XXXIII, pp. 23–27; Edward W. Berry, "The Cretaceous Exposure near Cliffwood, N. J.," *ibid.*, Vol. XXXIV, pp. 253–60; W. B. Clark, "The Matawan Formation of Maryland, Delaware, and New Jersey, and its Relations to Overlying and Underlying Formations, *American Journal of Science*, 4th Ser., Vol. XVIII, pp. 435–40; Edward W. Berry, "Additions to the Flora of the Matawan Formation," *Bulletin of the Torrey Botanical Club*, Vol. XXXI, pp. 67–82; Edward W. Berry, "Additions to the Fossil Flora from Cliffwood, New Jersey," *ibid.*, Vol. XXXII, pp. 43–48.

than those containing the plants described by Ho lick and Berry, may be safely assumed.

One of the most notable features of the fauna from these Cliffwood nodules is the great number of Crustacean remains. Nearly every one of the concretions, when broken, yields the remains, more or less fragmentary and crushed, of one of these creatures; indeed, a crab of some sort seems to have been the nucleus around which every one of these concretionary nodules in the clay has been formed. In addition to the crustacean remains, which seem to represent several species, the nodules have yielded a goodly number of mollusca, and the following species have been more or less satisfactorily determined:

PELECYPODA

1. **Ostrea** sp. undet. At least two species of oysters have been recognized in the Cliffwood fauna, neither one of which can be identified with any of the species occurring in the other Cretaceous beds of New Jersey.
2. **Anomia tellinoides** Mort.
3. **Amusium** sp. undet. This species is much larger than either of the members of the genus previously recorded from New Jersey, and it seems to be undescribed. It resembles in general form some specimens of *Camptonectes burlingtonensis* Gabb, but lacks the distinctive ornamentation of that shell.
4. **Mytilus oblivius** Whitf. Although this shell attains a larger size in the Cliffwood clays than any specimens observed from the Wenonah sand, the only other horizon where it has been observed, there seems to be no reason for considering the Cliffwood specimens as specifically distinct.
5. **Modiola** sp. undet. A single imperfect specimen may be referred here. It somewhat resembles the shell described from the West as *Volsella attenuata* M. & H.
6. **Pteria petrosa** Con. Whitfield saw but one imperfect specimen of this species during the preparation of his monograph of the New Jersey Cretaceous pelecypods,[1] and Conrad in his original description mentions seeing but a single specimen from the Delaware and Chesapeake Canal. In the Cliffwood fauna it is one

[1] *Paleontology of New Jersey*, Vol. I, p. 69; also *Monograph*, U. S. Geological Survey, Vol. IX, p. 69.

of the most common forms, and has been seen elsewhere in New Jersey only in the Wenonah sand. It seems to be indistinguishable from *P. linguiformis* E. & S., from the West.

7. **Inoceramus sagensis** Owen. Elsewhere in New Jersey this species occurs most commonly in the Merchantvillle clay marl.
8. **Nemodon brevifrons** Con. This species has been recogn'zed elsewhere in the New Jersey faunas only in the Woodbury clay near Haddonfield and in the same formation in Monmouth County.
9. **Breviarca** sp. undet. This is probably an undescribed form; it is closely allied to, if not identical with, a species occurring in the Woodbury clay fauna of Monmouth County.
10. **Nucula slackiana** Gabb. Specimens of this species in the Cliffwood fauna are indistinguishable from specimens from the Woodbury clay.
11. **Nucula** sp. undet. This species seems to be undescribed, but it is identical with a form which occurs in the Wenonah sand fauna.
12. **Nuculana protexta** (Gabb)? Specimens which seem to be referable to this species are rather common in the fauna.
13. **Nuculana** sp. undet. The specimens here indicated are possibly but a form of the last.
14. **Lucina cretacea** Con. This species, which occurs so abundantly in the Woodbury clay, is one of the rarest forms in the Cliffwood fauna.
15. **Cardium ripleyanum** Con.? Several specimens of a small *Cardium* have been referred questionably to this species, they being too imperfect for certain identification.
16. **Isocardia cliffwoodensis** n. sp. (Figs. 1–3). This is one of the most characteristic, though not the most common, species of

FIG. 1

FIG. 2

FIG. 3

the Cliffwood fauna, being present in every locality where the fauna has been observed. A similar, if not identical, species occurs in the Wenonah sand fauna.

17. **Dosinia gabbi** Whitf. Several fragmentary specimens seem to be referable to this species, although they are too imperfect for certain identification.
18. **Tellina equilateralis** M. & H.? Several incomplete specimens seem to resemble this species originally described from the Fox Hills beds of the West. The specimens are too imperfect for certain identification.
19. **Veleda lintea** (Con.). This is a rather variable shell, but specimens from the Cliffwood clays are indistinguishable from examples occurring in the Wenonah sand, where the species most commonly occurs.
20. **Veleda transversa** Whitf.? Among the specimens of *Veleda* in the Cliffwood fauna several specimens seem to approach this species in form, and have been so identified provisionally.
21. **Pholadomya occidentalis** Mort. A single incomplete impression of a large shell seems to represent this species. Eleswhere it seems to be quite closely confined to the Merchantville clay marl.
22. **Corbula** sp. undet. The internal casts of this species are rather abundant, but it is difficult to identify them with shells which have been described from external characters. The species seems to resemble the shell illustrated by Whitfield under the name *C. foulkei* Lea, which is in reality not that species, but *C. bisulcata* Con.

GASTROPODA

23. **Pyropsis** sp. undet. This shell resembles *P. naticoides* Whitf., and it is possible that it should be so identified.
24. **Pyrifusus erraticus** Whitf. This species is represented by two specimens. It was originally described from a nodule said to have been collected at Cliffwood, N. J.
25. **Volutimorpha gabbi** Whitf.? This species is represented by a single specimen which most closely resembles Whitfield's[1] *fig. 4*, Plate VIII, referred provisionally to *V. gabbi* Whitf. The Cliffwood specimen is a nearly smooth internal cast and does not show the external markings of the shell.

[1] *Paleontology of New Jersey*, Vol. II; also *Monograph* U. S. Geological Survey, Vol. XVIII.

26. **Scalaria** sp. undet. A fragmentary specimen of a member of this genus has been observed. It is too imperfect for identification.

27. **Turritella encrinoides** Mort.? Fragments of the internal casts, as well as impressions of the external markings, of a *Turritella* occur in the Cliffwood fauna, which seem to be referable to this species.

CEPHALOPODA

28. **Placenticeras placenta** De Kay. A single fragment of the cast of the chamber of habitation of a large ammonite resembles in all respects similar specimens known to belong to *P. placenta*, and little doubt can be entertained as to the correctness of this identification of the Cliffwood specimen.

29. **Baculites** sp. undet. A fragment of the cast of the chamber of habitation may certainly be referred to this genus. The specific determination cannot be satisfactorily made. It may belong to the common *B. ovatus* of the New Jersey Cretaceous beds, but it seems to possess stronger, oblique, annular ridges than is usual in that species.

CRUSTACEA

30. **Tetracarcinus subquadratus** n. gen. and sp. (Figs. 4–6). Several species of crustaceans, all of them probably undescribed, are present in the Cliffwood fauna. A single one of these forms, however, may be considered in the present connection, for the

FIG. 4

FIG. 5

FIG 6

reason that it is also a common form in the fauna of the Woodbury clay. It has not been possible to place this little crab in any of the described genera, and therefore it may be called *Tetracarcinus* on account of its subquadrangular form, with the specific name *subquadratus*. The dimensions of an average specimen are: length of carapace, 14.5^{mm}; breadth, 14^{mm}; greatest con-

vexity, 5mm. The regions of the carapace are clearly marked by more or less deeply impressed furrows, as shown in the accompanying illustrations. This is one of the common forms in the Cliffwood fauna, and is the only crustacean which has been observed in the fauna of the Woodbury clay.

A sandstone mass was collected on the beach at Cliffwood, eighteen inches in length by twelve inches in breadth and perhaps three inches thick, completely filled with fossils. This mass of sandstone was not *in situ*, and, being different in its lithologic characters from any material imbedded in the clay at this point, it may have been transported to this locality from elsewhere. It is, however, somewhat similar in its lithologic characters to certain sandy, fossiliferous nodules occurring in the clay at the pits of the Cliffwood Brick Company, a little over a mile distant on Whale Creek. The fauna yielded by this sandstone undoubtedly indicates its Cliffwood age, although several species occur which have not been observed elsewhere. The species of fossils identified are as follows:

PELECYPODA

1. **Breviarca** sp. undet. This is apparently the same species as that noted from the fauna of the crustacean nodules.
2. **Trigonarca** n. sp.? This is one of the common species of the fauna, and is apparently undescribed. It has the form of a small *Idonearca*, but is less convex than most species of that genus and has a different hinge structure.
3. **Trigonarca** n. sp.? This is a larger species than the last, and the hinge bears a much larger number of teeth. Neither of the species has been observed elsewhere.
4. **Nuculana protexta** (Gabb)? The specimens of this species are poorly preserved, but they seem to be specifically identical with those from the crustacean nodules which have been identified as *N. protexta*.
5. **Yoldia** cf. **evansi** M. & H. This is a rather common species in the fauna, and is closely allied to, if not identical with, *Y. evansi* from the Fox Hills beds of the West.
6. **Cardium** sp. undet. This species can be identified with none

of the recognized forms from New Jersey, and is probably an undescribed species.

7. **Isocardia cliffwoodensis** n. sp. This is the same form that occurs in the fauna of the crustacean nodules.
8. **Veleda lintea** Con. This is the most abundant species in the fauna.
9. **Corbula** sp. undet. Two or three unidentified species, and possibly undescribed, seem to be referable to the genus *Corbula*.

GASTROPODA

10. **Pyrifusus** sp. undet. This is apparently an undescribed species, and has not been observed elsewhere.
11. **Volutomorpha** sp. undet. This also seems to be an undescribed form which has not been observed elsewhere.
12. **Gyrodes** sp. undet. This is a small species, which apparently cannot be referred to any of the recognized New Jersey species, and may be new.
13. **Scalaria** sp. undet.
14. **Turritella** sp. undet.

At Geldhaus' clay pits, a little over a mile west of Cliffwood Point, on Whale Creek, crustacea bearing nodules similar to those collected on the beach at Cliffwood, occur *in situ* in the clay. Besides the numerous imperfect crustacean remains, the following species have been recognized at this locality:

PELECYPODA

1. **Pteria petrosa** Con.
2. **Nuculana protexta** Gabb.
3. **Lucina cretacea** Con.
4. **Isocardia cliffwoodensis** n. sp.
4. **Veleda lintea** (Con.)
6. **Corbula** sp. undet.

In the Cliffwood Brick Company's south pits, at the crossing of the New York and Long Branch R. R. over Whale Creek, numerous, sandy, abundantly fossiliferous nodules were obtained *in situ*. In the fauna of these nodules the following species have been recognized:

PELECYPODA

1. **Ostrea** sp. undet. A small undetermined species.
2. **Amusium** sp. undet. This is the same species noted in the fauna of the crustacean nodules from the beach at Cliffwood.
3. **Breviarca** sp. undet. This is the same species as that occurring in the crustacean nodules at Cliffwood Point.
4. **Nuculana protexta** (Gabb) ?
5. **Yoldia** cf. **evansi** M. & H.
6. **Cardium** sp. undet. This is the same species noted from the sandstone slab collected at Cliffwood.
7. **Cymella bella** Con. This species is represented by several specimens. Elsewhere it occurs rarely in the Merchantville, more commonly in the Woodbury, and most abundantly in the Wenonah formation.
8. **Isocardia cliffwoodensis** n. sp.
9. **Cyprimeria** sp. undet. This is a small species which cannot be identified with other New Jersey forms, but it is most like a species in the Woodbury clay, where he genus occurs most abundantly. A form apparently identical with this Cliffwood shell occurs rarely in the Wenonah fauna.
10. **Tellina** sp. undet. Several specimens of a shell apparently referable to this genus are present in the fauna. They seem to belong to an undescribed species.
11. **Linearia metastriata** Con. This species rarely occurs in the Merchantville clay, it is abundant in the Woodbury clay near Haddonfield, and is one of the most abundant species of the Wenonah sand.
12. **Veleda lintea** (Con.). This is the most abundant species in the fauna.
13. **Pholadomya occidentalis** Mort. Several fragments which seem to represent this species have been observed.
14. **Corbula** sp. undet. A species of this genus, apparently undescribed, is represented by several specimens.
15. **Leptosolen biplicata** Con. This species has been recognized elsewhere in the Merchantville clay, the Woodbury clay, and the Wenonah sand, it being most common in the last of these formations.

GASTROPODA

16. **Pyrifusus** sp. undet. A single specimen of an undescribed shell is apparently referable to this genus.
17. **Gyrodes** sp. undet. Fragmentary specimens of a small species of this genus are present in the fauna. They are apparently different from any of the recognized New Jersey forms.
18. **Turritella encrinoides** Mort.? Fragmentary specimens of a species of *Turritella*, probably belonging to this species, occur in this fauna.

Several nodules, not *in situ*, were collected in the same pits of the Cliffwood Brick Company as the fauna last recorded. They undoubtedly had their origin in these same clay beds, and the following species of fossils have been recognized in them:

PELECYPODA

1. **Ostrea** sp. undet. One of the same species noted in the fauna of the crustacean nodules at Cliffwood Point.
2. **Anomia tellinoides** Mort.
3. **Amusium** sp. undet. This is the same as the species recorded in the Cliffwood fauna.
4. **Pteria petrosa** Con.
5. **Inoceramus sagensis** Owen.
6. **Breviarca** sp. undet. This is the same form as that recorded from the crustacean nodules at Cliffwood Point.
7. **Nuculana protexta** (Gabb)?
8. **Cardium** sp. undet.
9. **Isocardia cliffwoodensis** n. sp.
10. **Veleda lintea** (Con.).
11. **Corbula** sp. undet. This is the same species as that numbered 22 in the list of species from the crustacean nodules collected at Cliffwood Point.
12. **Corbula**? sp. undet.

GASTROPODA

13. **Pyrifusus** sp. undet.

CRUSTACEA

14. **Tetracarcinus subquadratus** n. gen. and sp.

The data recorded in the preceding lists of fossils are assembled in the following table in order that they may be more readily analyzed.

A separate column is allotted to each of the preceding groups of species, numbered as follows: (1) nodules collected on the beach at low tide at Cliffwood point; (2) sandstone mass from beach at Cliffwood Point; (3) Geldhaus' clay bank; (4) Cliffwood Brick Company's south pits, nodules *in situ;* (5) Cliffwood Brick Company's south pits, ferruginous nodules not *in situ.* The last three columns are assigned to the three higher formations as follows: Merchantville clay (Mv), Woodbury clay (Wb), and Wenonah sand (W); and the occurrence of the Cliffwood species in these formations is noted.

	1	2	3	4	5	Mv	Wb	W
PELECYPODA—								
1. *Ostrea* sp. 1	x	—	—	—	x	—	—	x
2. *Ostrea* sp. 2.—	x	—	—	—	—	—	—	—
3. *Anomia tellinoides* Mort	x	—	—	—	x	x	—	x
4. *Amusium* sp. undet	x	—	—	x	x	—	—	—
5. *Mytilus oblivius* Whitf	x	—	—	—	—	—	—	x
6. *Modiola* sp. undet	x	—	—	—	—	—	—	—
7. *Pteria petrosa* Con	x	—	x	—	x	—	—	x
8. *Inoceramus sagensis* Owen	x	—	—	—	x	x	—	—
9. *Nemodon brevifrons* Con	x	—	—	—	—	—	x	—
10. *Breviarca* sp. undet	x	x	—	x	x	—	x	—
11. *Trigonarca* sp. 1	—	x	—	—	—	—	—	—
12. *Trigonarca* sp. 2	—	x	—	—	—	—	—	—
13. *Nuculana slackiana* Gabb	x	—	—	—	—	—	x	—
14. *Nucula* sp. undet	x	—	—	—	—	—	—	x
15. *Nuculana protexta* (Gabb)?	x	x	x	x	x	—	—	—
16. *Yoldia* cf. *evansi* M. & H	—	x	—	x	—	—	—	—
17. *Lucina cretacea* Con	x	—	x	—	—	—	x	—
18. *Cardium* sp. 1	x	—	—	—	x	—	—	—
19. *Cardium* sp. 2	—	x	—	x	—	—	—	—
20. *Cymella bella* Con	—	—	—	x	—	x	x	x
21. *Isocardia cliffwoodensis* n. sp	x	x	x	x	x	—	—	x
22. *Cyprimeria* sp. undet	—	—	—	x	—	—	—	x
23. *Dosinia gabbi* Whitf.?	x	—	—	—	—	—	—	—
24. *Tellina equilateralis* M. & H.?	x	—	—	—	—	—	—	—
25. *Tellina* sp. undet	—	—	—	x	—	—	—	—
26. *Linearia metastriata* Con	—	—	—	x	—	x	x	x
27. *Veleda lintea* (Con.)	x	x	x	x	x	x	x	x
28. *Pholadomya occidentalis* Mort	x	—	—	x	—	x	—	x
29. *Corbula* sp. undet	x	—	—	—	x	x	—	—
30. *Leptosolen biplicata* Con	—	—	—	x	—	x	x	x
GASTROPODA—								
31. *Pyropsis naticoides* Whitf.?	x	—	—	—	—	—	—	—
32. *Pyrifusus erraticus* Whitf	x	—	—	—	—	—	—	—
33. *Pyrifusus* sp. undet	—	x	—	—	—	—	—	—
34. *Pyrifusus* sp. undet	—	—	—	x	—	—	—	—
35. *Pyrifusus* sp. undet	—	—	—	—	x	—	—	—
36. *Volutomorpha gabbi* Whitf.?	x	—	—	—	—	—	—	—
37. *Volutomorpha* sp. undet	—	x	—	—	—	—	—	—
38. *Gyrodes* sp. undet	—	x	—	x	—	—	—	—
39. *Scalaria* sp. undet	x	—	—	—	—	—	—	—
40. *Scalaria* sp. undet	—	x	—	—	—	—	—	—
41. *Turritella encrinoides* Mort.?	x	—	—	x	—	x	x	x
CEPHALOPODA—								
42. *Placenticeras placentä* De Kay	x	—	—	—	—	x	x	x
43. *Baculites* sp. undet	x	—	—	—	—	—	—	—
CRUSTACEA—								
44. *Tetracarcinus subquadratus* n. sp	x	—	—	—	x	—	x	—
						10	11	14

A careful analysis of this fauna of the Cliffwood clays brings clearly to view several important facts. In the first place, the large number of species which are common to the fauna, and to one or more of the faunas of the formations above, emphasizes the close relationship between the Cliffwood fauna and these higher faunas. This relationship is, indeed, so close that they constitute essentially but different faunules of one large fauna. There is no sharper distinction between the fauna of the Cliffwood clays and the Merchantville clay than there is between the Merchantville and the Woodbury clays. However, the Cliffwood fauna does possess characteristics which distinguish it somewhat sharply from the Merchantville fauna, among which may be mentioned the abundance of the species *Pteria petrosa* and *Isocardia cliffwoodensis*, which have nowhere yet been recognized in the Merchantville, and the especial abundance, in some cases at least, of *Veleda lintea*, which is sometimes present, although always rare in the Merchantville. None of the crustaceans which are so abundant in the Cliffwood fauna have been recognized in the Merchantville, although claws and other disarticulated joints of crustacean appendages are not uncommon in the higher fauna at some localities. The distinction between these two faunas is not alone emphasized by the species present in the Cliffwood and absent from the Merchantville, but also by the genera and species which are absent from the Cliffwood and almost universally present in the Merchantville fauna. Among such genera may be mentioned *Idonearca*, *Trigonia*, *Panopea*, *Axinea*, and *Leiopistha*.

On making a careful comparison between the Cliffwood fauna and that of the Woodbury clay, the formation immediately above the Merchantville, a much greater resemblance is noted than between the Cliffwood and the Merchantville; the same Merchantville genera mentioned above as being conspicuously absent from the Cliffwood fauna are also conspicuous for their absence from the Woodbury. Furthermore, several forms are common to the Cliffwood and the Woodbury faunas which have not been observed in the intervening formation, among which may be mentioned *Breviarca*, *Lucina cretacea*, and the little crustacean here called *Tetracarcinus subquadratus*. In making this comparison, however, it must not be overlooked that some of the most characteristic Cliffwood species, as *Isocardia*

cliffwoodensis and *Pteria petrosa,* have nowhere been observed in the Woodbury fauna.

It is unnecessary to make comparison between the Cliffwood and the Marshalltown faunas, as there is scarcely anything in common between them; but with the fauna of the Wenonah sand the Cliffwood fauna has more in common even than with that of the Woodbury clay. Among the species listed in the table given above, it will be seen that fourteen species are recorded as being common to the Cliffwood and the Wenonah, eleven to the Cliffwood and the Woodbury, and only ten to the Cliffwood and the Merchantville. These numbers do not fully express the relative proximity of relationship between these several faunas, although they do partially, because no account is taken of the relative abundance of the forms noted. As a matter of fact, when the abundance of the different species in the different faunas is taken into account, the similarity of the Cliffwood and Wenonah faunas is accentuated, while that between the Cliffwood and the Merchantville is diminished. Aside from the crustaceans of the Cliffwood fauna, the two species *Pteria petrosa* and *Isocardia cliffwoodensis* are perhaps the most characteristic forms, and both of these occur in the Wenonah fauna. *Veleda lintea* is another conspicuous Cliffwood species which occurs more frequently in the Wenonah sand than in any other of the New Jersey Cretaceous formations.

It is believed that these comparisons which have been instituted make clear the fact that, however much or however little the Cliffwood fauna has in common with the faunas of the higher formations, it does have a unity of its own. Although many of the species occur also in other horizons, the whole assemblage of species, considered as a faunule, possesses characteristics which serve to distinguish it from any of the other faunules with which it has been compared.

The geographic distribution of this Cliffwood fauna differs notably from that of the Merchantville, it being limited, so far as now known, to a small area between Cliffwood Point and the head of Cheesquake Creek. The distribution of the Merchantville fauna is entirely across the state, from the south shore of Raritan Bay to the shores of Delaware Bay; throughout its entire extent it is remarkably constant in its characters, and the Merchantville beds are everywhere marked

by constant lithologic characters, yielding fossils, usually in abundance, wherever they are well exposed. There is scarcely a formation in the entire Cretaceous series of New Jersey which is more sharply marked, both lithologically and faunally, than the Merchantville clay. The base of the formation constitutes an easily recognizable and perfectly natural geologic horizon, the beds below being characterized by the great heterogeneity of their lithologic characters, while the beds above are just as strongly characterized by the constancy of their lithologic characters.

The heterogeneous assemblage of sands and clays beneath the Merchantville have been called the Raritan formation, and the fossiliferous clays at Cliffwood which are interbedded with sands and are lithologically allied to the subjacent beds, must certainly be considered as a lens-like body included in the Raritan. The Raritan beds for the most part give evidence of a non-marine origin, but there must have been marine conditions present along the Atlantic border at no great distance during the entire period of their deposition. The non-marine, perhaps estuarian conditions of Raritan time were supplanted in Merchantville time by more uniform marine conditions, but, previous to the initiation of marine conditions in the area entirely across New Jersey, we find evidence here in the Cliffwood clays of a slight transgression of the sea from the direction where marine conditions had continuously existed, and the occupation of a small area where non-marine sediments had previously been deposited.

This occurrence at Cliffwood of marine fossils in the Raritan is not the only case of the kind in New Jersey, although it is the most notable one. Whitfield[1] mentions the occurrence of *Turritella encrinoides*, a not uncommon species in the Cliffwood beds as well as in some of the higher formations, in the clays at Sayersville, which are near the very base of the Raritan; and the slab mentioned by him, bearing many examples of this species, is now preserved in the collections of the Geological Survey of New Jersey. Other specimens of marine fossils from near the same locality have recently been acquired by Mr. J. M. Manley, of New Brunswick, N. J. It is altogether possible, and indeed most probable, that faunas more or less closely allied to those of the higher formations were living, throughout the

[1] *Paleontology of New Jersey*, Vol. II, p. 144.

entire period of deposition of the Raritan beds, at no great distance from the present shores of Raritan Bay; and, if that were the case, it is not at all surprising that there should be occasional transgressions of marine conditions within the area where non-marine sedimentation was usually in progress, with the consequent deposition of marine beds with marine fossils.