On the Relative Ages and Classification of the Post-Eocene Tertiary Deposits of the Atlantic Slope.

By ANGELO HEILPRIN.

[*From Proceedings of the Academy of Natural Sciences of Philadelphia, June*, 1882.]

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It may appear surprising that for a period of nearly fifty years after the study of the American tertiary formations was first systematically attempted, there should still have existed among geologists widely varying views, not only relative to the positions occupied by a considerable proportion of the deposits in question in the geological scale, but also relative to the positions occupied by these deposits in respect of each other. Yet such has been the case, and it may still be said to be the case at the present time. The existence of post-eocene deposits along the Atlantic border of the United States has long since been recognized, and their contained fossil remains investigated and delineated by paleontologists of more or less ability. While the opinions expressed by certain geologists as to the age of at least some of these deposits may be said to have been substantially correct, yet in face of the conflicting views of other geologists of no less experience and prominence, which were set forth and maintained with a decisiveness unwarranted by the character of the research upon which they were based, it may be stated that the general outcome of our knowledge respecting the stratigraphy of the deposits here referred to is simply, that they hold a position somewhere intermediate between the eocene and the post-pliocene series.

The post-eocene tertiary deposits have their greatest development, and have been most carefully investigated in the States of Maryland, Virginia, North and South Carolina. In the frequently expressed opinion of Mr. Conrad they represented over the entire area here indicated one geological formation, which that geologist generally asserted to be the miocene, but which, at the same time, he not unfrequently considered to be the equivalent of the British crag, a formation now universally regarded as being of pliocene age.

No attempt appears to have been made to determine whether the deposits were referable to one or several faunal horizons, and the organic remains obtained from them were simply classified as belonging to the miocene or "medial tertiary" period. The circumstance that in North Carolina the proportion of recent to

extinct forms among the imbedded remains was greater than in either Virginia or Maryland did not escape the notice of the observer mentioned, but yet he did not hesitate to conclude (Kerr, Geological Survey of North Carolina, Appendix, p. 25, 1875) that his miocene strata represented "one contemporaneous sea bottom, holding living individuals of certain species throughout its entire length, and which is characterized by some of its species closely resembling existing ones, but many more having no affinity with American shells." How many of the fossil species were by Mr. Conrad considered to be identical with recent forms, it is impossible to determine with any amount of exactitude, since the opinions of that geologist bearing upon this point appear not to have been fixed and to have fluctuated extensively within very brief intervals of time. Thus, while in 1838 (Fossils of the Medial Tertiary Formations, Introduction, p. xvi), it is asserted that of about 200 described species 19 (or less than 10 per cent.) are still among the living fauna, in 1843 (Proc. Phil. Acad. Nat. Sciences, i, p. 328), the number of recent forms is said to be 43 out of a total of 328 described; in 1862, on the other hand, referring to the South Carolina deposits, where the percentage of recent forms had been claimed to be greater than in either of the other three states, Mr. Conrad maintains that "it may be that all the species are extinct" (Proc. Acad. Nat. Sciences, xiv, p. 559). It is further stated (*loc. cit.*) that of the entire number, 581, of miocene shells of the Atlantic stope, the number of forms that could be considered as doubtfully identical with recent species was not more than 30 (or about 5 per cent). The faunal relations existing between these so-called "medial tertiary" deposits and the deposits of the British crag and the faluns of the Loire, at that time supposed to be of nearly equivalent age, were likewise pointed out by Lyell (Journ. Geol. Society, i, pp. 413 *et. seq.*), who also did not fail to notice that in North Carolina "the recent species bore a larger proportion than usual to the extinct" *loc. cit.*, p. 418). But this geologist, with his characteristic acuteness, further remarks: "As, however, it would be very rash to assume that all the miocene deposits of the United States, especially in countries as far apart as Maryland and South Carolina, were of strictly contemporaneous origin, the fossil faunas of each region should be carefully distinguished and considered separately" (p. 418). Of 147 species of mollusca gathered by Mr. Lyell himself, and which

were subsequently studied with the assistance of Mr. Sowerby, twenty-three (or 15½ per cent.) were considered to be identical with recent forms (p. 419). In the later editions of the "Elements of Geology" (1871, 1874) the deposits in question are referred to the pliocene and miocene, but no clearly defined statement is given as to which belonged to the one age, and which to the other.

From a more careful examination of the South Carolina region than had previously been made, Mr. Tuomey arrived at the conclusion (Geology of South Carolina, 1848), that the post-eocene tertiary deposits of that State belonged to the pliocene, and not to the miocene period, and that, consequently, they were not contemporaneous with the deposits (in Virginia) which had now been firmly recognized as typically representing the miocene of the eastern United States. Of about 170 species of mollusca contained by them, somewhat more than 80 (or nearly 50 per cent.), were considered to be still living along the Atlantic and Gulf coasts (*op. cit.*, pp. 206–208). The pliocene age of these deposits was maintained by Professors Tuomey and Holmes in their "Pleiocene Fossils of South Carolina" (1857), where, also, the deposits of North Carolina (miocene of Emmons, North Carolina Geological Survey, 1858), are referred to the same period. Of 203 species of described invertebrate remains (mollusks, echinoderms, and corals), 85 (or 42 per cent.) were considered to have living analogues (*op. cit.*, Introduction, IX.) The determinations of Tuomey and Holmes for both the South and North Carolina deposits are accepted by Dana for the several editions (1863, 1875, 1880) of his "Manual of Geology," where the "Yorktown" period is made to include the post-eocene tertiary beds of Virginia, Maryland, New Jersey, and Martha's Vineyard, and the "Sumter" period, the similar beds of North and South Carolina. In the "Check List of the Invertebrate Fossils of North America," prepared (doubtless from data furnished by Conrad) in 1864 by Mr. Meek, for the Smithsonian Institution (Miscellaneous Collections, VII.), all the non-eocene or oligocene tertiary fossils of the eastern United States are classed as belonging to the miocene period; and finally, Prof. C. H. Hitchcock, in the "Geological Map of the United States" (1881), accepts the miocene determination for the age of the North and South Carolina deposits, as likewise for the Virginia deposits, and those of the peninsula of Maryland. The deposits of the Maryland east-

shore, of Delaware, and the greater portion of those in New Jersey which lie to the east and south of the "upper marl bed," and whose age has not yet been satisfactorily made out, are embraced within the pliocene (newer tertiary).

In order to facilitate the solution of the stratigraphical problem herein involved, the following faunal lists of the several States (Maryland, Virginia, North and South Carolina) have been prepared, and comparisons between them instituted. The utterly desultory and careless manner in which a very considerable portion of the paleontology of the region referred to has been worked up, has rendered their preparation a matter of great difficulty, and, indeed, if absolute accuracy is concerned, a well nigh impossibility. Not only have species been referred to several distinct genera (and families), and catalogued under their respective generic names independently of each other, but in several instances the identical specimen has been figured and redescribed under two or more forms; species, again, originally described from the deposits of one State, have been subsequently credited (and to the exclusion of the first-named locality) to the deposits of another State. Defective illustrations, and in very many cases the absence of illustrations altogether, have still further increased the difficulties, especially where the described specimens themselves are wanting, or where through an unsatisfactory diagnosis their specific (or even generic!) identification is rendered hopeless. Many of the forms here included are therefore taken on faith, and many will doubtless have to be excluded when fresh material is gathered in the field and re-studied. *Per contra*, many forms, seemingly doubtful, have been excluded, which may possibly have to be reinstated on further examination. Where it has been possible (and this has been the case for most of the forms) the original descriptions of the species have been referred to, and the localities of their occurrence there indicated have been those which have been noted; species said to occur in the deposits of several States have been traced back for re-descriptions, or to papers bearing specially on the paleontology of those States, but very little reliance being placed on general enumerations of distribution. By this means it has been hoped to render the lists as complete and free from error as could reasonably be made possible, and while, doubtless, various modifications will eventually have to be introduced, it is

confidently believed by the author that they so far represent the true state of matters as to permit of positive conclusions being drawn from them.

The comparisons here instituted between the molluscan faunas from the deposits of the several States have been made separately for the lamellibranchiata and the gasteropoda; and it may be stated at the outset that the results obtained from the independent examination of these two groups of organisms have been found singularly confirmative of each other. The letters following the name of a species denote that the form is also found in the State or States indicated by their respective characters; but it must be noted in the case of the gasteropoda, that comparisons, as indicated by such initial characters, are made between certain States only, and, therefore, it is not to be concluded from the examination of a single list, that a given form there designated is necessarily wanting in a State whose characters are not indicated in that list. Thus, in the South Carolina list only the North Carolina species are specially indicated, although several of these last, and others, are also found in the Virginia and Maryland deposits; so, again, in the Virginia list, no special reference is made to the Maryland forms.

Tables of the Post-Eocene Tertiary Lamellibranchiata of South Carolina and North Carolina.

South Carolina.

Anomia ephippium, N. C.
Placunomia plicata,
Ostrea Virginiana, N. C.; Va.; M.
" Ravenelliana,
Chama corticosa, N. C.; Va.
" arcinella, N. C.
" congregata, N. C.; Va.
Plicatula marginata, N. C.; Va.; M.
Janira hemicycla,
" affinis,
Pecten Mortoni, N. C.
" eboreus, N. C.; Va.
" comfarilis. N. C.
" Peedeensis, N. C.
" septemnarius, Va.; M.
Mytilus inflatus,
" incrassatus, N. C.
Arca hians = A. propatula? Va.
" incile, N. C.; Va.; M.
" costata, N. C.
" centenaria, N.C.; Va.; M.
" rustica,
" lienosa, N. C.
= A. Floridana,
" scalaris, N. C.; Va.
" incongrua,
" pexata,
" plicatura, N. C.; Va.; M.
(A. improcera,)
(A. æquicostata,)
(A. transversa)
Pectunculus subovatus,
N. C.; Va.; M.
" lentiformis, N. C.; Va.; M.

Pectunculus passus, N. C.; Va.
" quinquerugatus, N. C.
" lævis,
" aratus, N. C.
" transversus,
Yoldia limatula, N. C.; Va.; M.
Leda acuta, N. C.; M.
Nucula proxima,
= N. obliqua, N. C.; Va.; M.
Lucina contracta,
= L. filosa, N. C.; Va.; M.
anodonta, N. C.; Va.; M.
Pennsylvanica, N. C.
radians,
= L. Antillarum, N. C.
squamosa,
= L. pecten, N. C.; Va.
cribraria, M.
divaricata, N. C.; Va.; M.
costata,
crenulata, N. C.; Va.; M.
multilineata, N. C.
trisulcata,
Cardium Carolinense,
= C. magnum? N. C.
" muricatum, N. C.
" sublineatum, N. C.; Va.
Cardita arata, N C.; Va.; M.
" granulata, N. C.; Va.; M.
" tridentata, N. C.?
" carinata, N. C.
" perplana, N. C.
" abbreviata, N. C.
Astarte undulata, N. C.; Va.; M.
" bella, N. C.
Gouldia lunulata, N. C.; Va.
Crassatella undulata, N. C.; Va.; M.
" Gibbesii, N. C.
Cyrena densata, N. C.; Va.
Rangia clathrodonta, N. C.; Va.
Venus Rileyi, N. C.; M.
Venus mercenaria, N. C; Va.?; M.?
" athleta, N. C.
" tridacnoides, N. C.; Va.; M.
" fermagna, Va.; M.?
Cytherea subnasuta, M.
" reposta, N. C.; Va.
" Sayana, N. C.; Va.; M.
" cribraria, N. C.
= C. punctulata?
" cancellata,
Circe metastria, N. C.; Va.
Artemis intermedia, N. C.
Petricola pholadiformis,
Tellina biplicata, N. C.; M.
" alternata, N. C.
" lusoria, N C.; Va.
" polita, N. C.
Strigilla flexuosa, N. C.
Psammocola Pleiocena,
Cumingia tellinoides, Va.
Amphidesma carinata, M.
" equalis, N. C.
" orbiculata,
" æquata, N. C.
Donax variabilis. N. C.?
Standella fragilis, N. C.?
Mactra similis, N. C.
= M. solidissima,
" lateralis, N. C.
" congesta, N. C.; Va.;
Pandora trilineata, N. C.? Va.
Panopæa reflexa, N. C.; Va.; M.
Corbula cuneata, N. C.; M.
" inequale, Va.; M.
Pholadomya abrupta, N.C.; Va.; M.
Solecurtus Caribæus, N. C.
Solen ensis, N. C.; M.
Pholas costata, N. C.; Va.? M.?
" oblongata, N. C.
" Memmingeri, N. C.

North Carolina.

Anomia ephippium, S. C.
Ostrea Virginiana, S. C.; Va.; M.
Pecten comparilis, S. C.
Pecten eboreus, S. C.; Va.
" Clintonius. Va.; M.
= P. Magellanicus.

Pecten Peedeensis, S. C.
" Mortoni, S. C.
" Jeffersonius, Va.; M.
" Madisonius, Va.; M.
" vicenarius.
Plicatula marginata, S. C.; Va.; M.
Mytilus incrassatus, S. C.
Crenella, sp.?
Chama arcinella. S. C.
" corticosa, S. C.; Va.
" congregata, S. C.; Va.
" striata.
Arca lienosa, S. C.
= A. Floridana.
" limula, Va.
" scalaris, S. C.; Va.
" incile, S. C.; Va.; M.
" centenaria, S. C.; Va.; M.
" cælata, S. C.
" idonea, Va.; M.
" plicatura, S. C.: M.; Va.
" brevidesma.
" subsinuata.
Pectunculus subovatus, S. C.; Va.; M.
" lentiformis, S. C.; Va.; M.
" aratus, S. C.
" tricenarius.
" passus, S. C.; Va.
" Carolinensis.
" quinquerugatus, S. C.
Leda acuta, S. C.; M.
Yoldia limatula, S. C.; Va.; M.
Nucula proxima, S. C.; Va.; M.
= N. obliqua.
Lucina Pennsylvanica, S. C.
" contracta, S. C.; Va.; M.
= L. filosa.
" crenulata, S. C.; Va.; M.
" anodonta, S. C.: Va.; M.
" radians, S. C.
= L. Antillarum.
" divaricata, S. C.; Va.; M.
" multilineata, S. C.
" squamosa, S. C.; Va.
= L. pecten.
Loripes elevata.
Mysia Americana (acclinis).
Cardium Carolinense, S. C.
= C. magnum?
" muricatum, S. C.
" sublineatum, S. C.; Va,
Glycocardia granula.
Isocardia fracterna, Va.; M.
Cardita arata, S. C.; Va.; M.
" perplana, S. C.
" granulata, S. C.; Va.; M.
" abbreviata, S. C.
" tridentata, S. C.
" carinata, S. C.
Pleuromeris decemcostata.
Astarte bella, S. C.
" clathra.
" undulata, S. C.; Va.; M.
" curta.
Gouldia lunulata, S. C.; Va.
Crassatella undulata, S. C.; Va.; M.
" Gibbsii, S. C.
" Marylandica. M.
" melina, Va.; M.
Verticordia, sp.?
Cyrena densata, S. C.; Va.
Rangia clathrodonta, S. C.; Va.
Venus mercenaria, S. C.; Va.? M.?
" tridænoides, S. C.; Va.; M.
" Rileyi, S. C.; M.
" alveata, Va.; M.
" latilirata, Va.
" athleta, S. C.
Cytherea Sayana, S. C.: Va.; M.
" reposta, S. C.; Va.
" cribraria, S. C.
= C. punctulata?
Circe metastria, S. C.; Va.
Artemis transversus.
= A. intermedia? S. C.
" acetabulum, Va.; M.
Tellina biplicata, S. C.; M.
" lusoria, S. C.; Va.
" alternata, S. C.
" polita, S. C.
" arctata.

Strigilla flexuosa, S. C.
Amphidesma æquata, S. C.
" equalis, S. C.
Mulinia variabilis.
Mactra congesta, S. C.; Va.
" oblongata, S. C.?
= Standella fragilis?
" lateralis, S. C.
" similis, S. C.
= M. solidissima.
Donax, sp.?
Pandora trilineata? S. C.; Va.
Panopæa reflexa, S. C.; Va.; M.
Corbula cuneata, S. C.; M.
Pholadomya abrupta, S. C.; Va.; M.
Solecurtus Caribæus, S. C.
Solen eusis, S. C.; M.
Pholas costata, S. C.; Va.? M.?
" oblongata, S. C.
" Memmingeri, S. C.

An examination of the preceding lists shows that of about 103 forms of lamellibranchiate mollusks found in the South Carolina deposits no less than 74–78 (or about 74 per cent.) are also found in the deposits of North Carolina; these last being represented by an almost equal number (106) of specific forms, the relative percentages of those common to the two States will necessarily be nearly identical. We have thus *prima facie* evidence that the deposits characterized by these remains belong very nearly, if not absolutely, to the same geological horizon. On the other hand, of the South Carolina forms at most only 43 (or 42 per cent.) are indicated as being found in Virginia, and a still smaller number, 34 (or 33 per cent.) in Maryland. We have here, therefore, strong evidence tending to prove that the deposits of the last mentioned States represent a horizon different from those indicated by the deposits of South Carolina. Similarly, of the 106 North Carolina species, at most only 48 (or 46 per cent.) are common to Virginia, and 36 (or 34 per cent.) to Maryland, a result that strikingly confirms the conclusion that has just been drawn.

Passing now to the examination of the Virginia lamellibranchiates, we find, as is shown in the following table, a total of about 109 specific forms:

VIRGINIA.

Anomia Ruffini.
Ostrea sculpturata.
" disparilis.
" Virginiana, S. C.; N. C.; M.
" subfalcata.
Pecten fraternus.
" Rogersi.
" biformis.
Pecten Virginianus.
" tricenarius.
" Jeffersonius, N. C.; M.
" dispalatus.
" septemnarius, S. C.; M.
" Clintonius, N. C.; M.
= P. Magellanicus.
" eboreus, S. C.; N. C.

Pecten Madisonius, N. C.; M.
" decemnarius.
Plicatula marginata,
S. C.; N. C.; M.
Perna maxillata, M.
Crenella æquilatera.
Arca centenaria, S. C.; N. C; M.
" incile, S. C.; N. C.; M.
" idonea, N. C.; M.
" protracta, S. C.? N. C.?
= A. lienosa?
" scalaris, S. C.; N. C.
" propatula (hians) S. C.
" limula, N. C.
" plicatura, S. C.; N. C; M.
Pectunculus subovatus,
S. C.; N. C.; M.
" tumulus.
" passus, S. C.; N. C.
" lentiformis,
S. C.; N. C.; M.
Yoldia limatula, S. C.; N. C.; M.
Nucula obliqua, S. C.; N. C.; M.
(N. proxima).
Lucina squamosa, S. C.; N. C.
= L. pecten.
" crenulata, S. C.; N. C.; M.
" divaricata, S. C.; N. C.; M.
" anodonta, S. C.; N. C.; M.
" contracta, S. C.; N. C.; M.
= L. filosa.
" Leana (lens).
" edentula.
Mysia Americana, N. C.
Kellia lævis.
" striata.
Erycinella ovalis.
Sphærella subvexa.
Chama corticosa, S. C.; N. C.
" congregata, S. C.; N. C.
Cardium Virginianum.
" laqueatum, M.
" sublineatum. S. C.; N. C.
Isocardia fraterna, N. C.; M.
Cardita arata, S. C.; N. C.; M.
" granulata, S. C.; N. C.; M.
Astarte undulata, S. C.; N. C.; M.
Astarte (Euloxa) latisulcata.
" arata.
" Coheni.
" concentrica.
" lineolata.
" symmetrica.
Gouldia lunulata, S. C.; N. C.
Crassatella undulata,
S. C.; N. C.; M.
" melina, N. C.; M.
Cyrena densata, S. C.; N. C.
Rangia clathrodonta S. C.; N. C.
Venus capax.
" ascia?
" latilirata. N. C.
" mercenaria? S. C.; M.?
" permagna, S. C.; M.?
" alveata, N. C.; M.
" Rileyi, S. C.; N. C.; M.
" tridacnoides,
S. C.; N. C.; M.
Circe metastria, S. C.; N. C.
Cytherea obovata.
" reposta, S. C.; N. C.
" Sayana, S. C.; N. C.; M.
" densata.
" Virginica.
" cortinaria.
Artemis acetabulum, N. C.; M.
Petricola centenaria, M.
Tellina declivis.
" egena.
" lusoria, S. C.; N. C.
Abra subr-flexa.
Cumingia tellinoides, S. C.
Mactra modicella.
" delumbis, M.
" congesta, S. C.; N. C.
" triquetra.
Thracia transversa.
Anatina antiqua.
Pandora crassidens, S. C.; N. C.
= P. trilineata.
" aremosa.
= P. trilineata?
Mya producta, M.
" corpulenta.

Poramya subovata.
Corbula inequale, S. C.; M.
Pholadomya abrupta, S. C.; N. C.; M.
Panopæa reflexa, S. C.; N. C.; M.
Solen magnodentatus?
Saxicava bilineata, M.
= S. rugosa.
Saxicava pectorosa.
Pholas (?) rhomboidea.
" acuminata, S. C.? N. C.? M.?
= P. costata?
Teredo fistula.
Gastrochæna ligula.

NOTE.—The following species described by H. C. Lea (Trans. Amer. Philos. Soc. IX, new series), based upon young shells, or upon such as barely admit of characterization, have been omitted from the enumeration: *Avicula multangula, Anatina tellinoides, Cytherea elevata, C. spherica, Leda acutidens, L. carinata, Modiola spinigera, Mya reflexa, Nucula dolabella, N. diaphana, Panopea dubia, Petricola compressa, Pecten micropleura, P. tenuis, Plicatula rudis, Psammobia lucinoides, Teredo calamus.*

Of these 109 species, as has already been stated, at most only 43 (or 40 per cent.) are common to South Carolina, and about 48 (or 44 per cent.) to North Carolina. Compared with the Maryland deposits the proportion of forms common to the two states is found to be not very different from the proportions just indicated, or about 38 per cent. (about 41 species).[1]

From the so-called "medial tertiary" of Maryland there have thus far been described about 98 species of acephalous mollusks:—

MARYLAND.—NEWER GROUP.

Amphidesma carinata, S. C.
" subovata,
Arca idonea, N. C.; Va.
" incile, S. C.; Va.
" centenaria, S. C.; Va.
" improcera, S. C.; N. C.; Va.
Artemis acetabulum, N. C.; Va.
Astarte vicina?
" cuneiformis,
" perplana,
" obruta,
" undulata, S. C.; N. C.; Va.
Cardita arata S. C.; N. C.; Va.
" protracta,
" granulata, S. C.; N. C.; Va.
Cardium laqueatum, Va.
Corbula cuneata, S. C.; N. C.;
" idonea
" inequalis, S. C.; Va.
Crassatella Marylandica, N. C.
" undulata, S. C.; N. C.; Va.
Cytherea Sayana S. C.; N. C.; Va.
" albaria,
" Marylandica,
" staminea,
Isocardia fraterna, N. C.; Va.
Leda acuta, S. C.; N. C.
" concentrica,
Yoldia lævis, S. C.; N. C.; Va.
= Y. limatula,

[1] The Maryland deposits, in the comparisons thus far, have for convenience been taken to represent one geological horizon; their division into two groups, and the relations of each of these groups with the deposits of the several other States, are specially considered further on.

Nucula proxima, S. C.; N. C.; Va.
= N. obliqua,
Lepton (?) mactroides,
Lucina anodonta, S. C.; N. C.; Va.
" subobliqua,
" cribraria, S. C.
" contracta, S. C.; N. C.; Va.
— L. filosa,
" divaricata, S. C.; N. C.; Va.
Mactra ponderosa,
" fragosa,
" subcuneata,
" delumbis, Va.
Mya producta, Va.
Ostrea Virginica, S. C.; N. C.; Va.
Panopæa Americana,
" reflexa, S. C.; N. C.; Va.
" porrecta,
Pecten Madisonius, N. C.; Va.
" Jeffersonius N. C.; Va.
" Clintonius, N. C.; Va.
" septemnarius, S. C.; Va.
Pectunculus subovatus,
S. C.; N. C.; Va.
Petricola centenaria, Va.
Plicatula marginata,
S. C.; N. C.; Va.
Pholadomya abrupta,
S. C.; N. C.; Va.
Pholas ovalis. S. C.? N. C.? Va.?
= P. costata?
Saxicava rugosa, Va.
Solen ensis, S. C.; N. C.
Tellina æquistriata,
" biplicata, S. C.; N. C.
Venus tetrica,
" permagna? S. C.; Va.
" alveata, N. C.; Va.
" inoceriformis,
" tridacnoides, S.C.; N.C.; Va.
" mercenaria? S.C.; N.C.; Va.?
" Rileyi, S. C.; N. C.; Va.
" cuneata.

Maryland.—Older Group.

Arca callipleura,
" subrostrata,
" Marylandica.
" triquetra,
Artemis acetabulum, N. C.; Va.
Astarte exaltata,
" varians,
Cardium craticuloides,
" leptopleura,
Corbula idonea,
" elevata,
Crassatella melina, Va.; N. C.
" turgidula,
Cytherea subnasuta, S. C.
Isocardia Markoei,
Leda liciata,
Lima papyria,
Lucina Loremani,
Lucina subplana,
" crenulata, S. C.; N. C.; Va.
Modiola Ducatellii,
Mytilus incurva,
Pecten Humphreysianus,
" Madisonius, N. C.; Va.
Pectunculus parilis,
" lentiformis,
S. C.; N. C.; Va.
Perna maxillata, Va.
Pholas costata? S. C.; N. C.; Va.
(P. ovalis.)
Panopæa porrecta,
Tellina lenis,
Venus Mortoni?
(V. cuneata?)
" alveata, N. C.; Va.

Note.—Several species formerly credited to this State have been intentionally omitted, there not being sufficient evidence to prove their occurrence there.

Of these 98 about 34 (35 per cent.) are common to South Carolina, 36 to North Carolina (37 per cent.), and 41 to Virginia (42 per cent.). It has, however, been shown in a previous paper (Heilprin, Proc. Acad. Nat. Sciences, 1880, pp. 20, *et. seq.*) that the Maryland deposits actually represent two distinct horizons—respectively designated (temporarily) as the "newer" and "older" groups—and, therefore, in order to have a proper appreciation of the value of these proportions it will be necessary to consider the two divisions in their relations to the several States separately.

The deposits of the "newer" group, as will be seen from the preceding enumeration, contain 66 species, and those of the "older" group, 32 species. Of the former about 33 (50 per cent.), and a nearly equal number, 32 (49 per cent.), are common respectively to South and North Carolina, whereas of the latter, only 4 (13 per cent.) are found in the first named State, and 7 (22 per cent.), in the second.[1] While the "newer" group shows a considerably higher percentage of forms common to both South and North Carolina than the deposits of the State treated as a whole, this percentage is still less than that which might naturally be expected to exist between formations (removed by about equal distances) representing an equivalent age. The rational inference is, therefore, that the deposits in question are not of contemporaneous formation. Compared with the deposits of Virginia the fauna of the "newer" group shows a somewhat more decided relation than to the deposits of the States just mentioned, for we now find the percentage of common forms increased to 56 (37 species). But even with this figure it would be rash to insist upon an equivalency being proved. Nor is the relation of the "older" group to the Virginian formation much more pronounced than it is to the North Carolinian, but no special deductions from agreements or differences of percentages can be made in this instance, since the number of both common and restricted forms is very limited.

The conclusions reached from the examination thus far of the lamellibranchiate fauna are: That the South and North Carolina formations represent one and the same horizon, and one distinct from the horizon or horizons indicated by the Virginia and Maryland formations. It now remains to be determined what

[1] These proportions strikingly corroborate the author's original assumption of two distinct horizons, based upon an examination of Maryland fossils alone.

support this conclusion receives from the study of the fossil faunas in their relation to the faunas of existing seas, and to ascertain through the same means what relation the various horizons bear toward each other.

Species still living found fossil in the South Carolina deposits.[1]

Anomia ephippium (A. Conradi).
? Placunomia plicata.
Ostrea Virginiana.
Chama arcinella.
Arca lienosa = A. Floridana.
" incongrua.
? " pexata.
Yoldia limatula (Leda lævis).
Leda acuta.
Nucula proxima = N. obliqua.
Lucina contracta = L. filosa.
" Pennsylvanica.
" radians = L. Antillarum.
" squamosa (L. speciosa) = L. pecten.
" divaricata (L. Conradi).
" crenulata.
? Cardium Carolinense = C. magnum ?
" muricatum.
? Cardita tridentata.
Gouldia lunulata.
Pandora trilineata.
Venus mercenaria.
? Cytherea cribraria = C. punctulata ?
Cytherea cancellata (C. cingenda).
Petricola pholadiformis.
Tellina alternata.
" polita.
" lusoria.
Strigilla flexuosa.
Cumingia tellinoides.
Amphidesma (Abra) equalis.
" (Semele) orbiculata.
? Donax variabilis.
Standella fragilis (Mactra oblongata).

[1] The author desires to express his indebtedness to Mr. George W. Tryon, Jr., through whose kind assistance most of the comparisons with recent forms were made.

Mactra similis. = Hemimactra solidissima.
" lateralis.
Salecurtus Caribæus (Siliquaria Carolinensis).
Solen ensis (S. directus).
Pholas costata (P. arcuata).
" (Dactylina) oblongata (P. producta).

NOTE.—About ten other species have been considered by various authors to be equivalents of recent forms, but since their identification as such has been at best but very doubtful, and in most cases strictly erroneous, they have been omitted. Among these are :

Lucina anodonta, at one time considered by Mr. Conrad to be identical with a species living along the Florida coast. Although very closely resembling the *L. Floridana,* it may, nevertheless, be readily distinguished from it by the greater thickness of its shell, and the greater profundity of the lunules.

Cardita arata.—This species differs, as stated by Conrad (Mioc. Foss., p. 12), from the recent *C. Floridana* of the Florida coast in being proportionately longer and broader behind, and in having the ribs crossed by "crowded subsquamose transverse wrinkles," instead of "thick transverse tubercles."

Cardita granulata.—According to Conrad (Mioc. Foss., p. 13), this shell "so nearly resembles *C. borealis,* a recent species of the eastern coast, that I think it will prove to be the same, when more specimens of the latter shall be obtained for comparison." This identification, which was subsequently rejected by Conrad himself, has for its support the very similar general appearance presented by the two shells in question, but closer examination shows the *C. granulata* to be almost invariably a considerably more elevated (less rotund) form than the *C. borealis.*

Artemis intermedia.—Not readily confoundable with either the *A. concentrica* (Born) or *A. Floridana* (Conr.).

Cytherea Sayana.—More produced (less rounded) than the recent *C. convexa.*

Rangia clathrodonta.—More elongated than the recent *R. cyrenoides.*

Admitting both the positive and somewhat doubtful forms from the above list to be recent, then we have as a proportion to extinct forms 40 to 103, or 39 per cent.; or, if the six doubtful ones are omitted, 34 to 103, or 33 per cent.

The following recent species may be considered to occur in the North Carolina deposits.

Anomia ephippium.
Ostrea Virginiana.
Pecten Clintonius = P. Magellanicus.
Arca lienosa = A. Floridana.
Leda acuta.
Yoldia limatula (Leda lævis).
Nucula proxima = N. obliqua.
Chama arcinella.

? Cardita tridentata.
Gouldia lunulata.
? Cardium Carolinense = C. magnum?
" muricatum.
Lucina Pennsylvanica.
" contracta = L. filosa.
" crenulata.
" radians = L. Antillarum.
" divaricata (L. Conradi).
" squamosa (L. speciosa) = pecten.
Venus mercenaria.
? Cytherea cribraria = C. punctulata?
Tellina lusoria.
" alternata.
" polita.
Strigilla flexuosa.
Mactra oblongata = Standella fragilis.
" lateralis.
Mactra similis = Hemimactra solidissima.
Solen ensis.
Solecurtus Caribæus (Siliquaria Carolinensis).
Pholas costata (P. arcuata).
Pholas (Dactylina) oblongata.
? Pandora trilineata.

Of the above 32, which constitute 30 per cent. of the lamellibranchiate fauna of the State, all, with only one exception—*Pecten Clintonius* (*Magellanicus*)—also occur in the South Carolina deposits. Although the percentage of recent forms in the North Carolina formations is thus shown to be considerably lower than in South Carolina, yet in view of the very strong correspondence—one might, indeed, say identity—existing between the two faunas generally, this variation can scarcely be taken to affect the conclusion already arrived at as to the contemporaneity of the two formations.

In Virginia (of 109 forms) the number of recent species, including several doubtful ons, is reduced to 16, as exhibited in the accompanying enumeration:

Ostrea Virginiana.
Pecten Clintonius = P. Magellanicus.
? Arca protracta = A. lienosa (*et* A. Floridana)?
Yoldia limatula.
Nucula obliqua = N. proxima.
Gouldia lunulata.

Lucina squamosa (L. speciosa) = L. pecten.
" crenulata
" divaricata.
" contracta = L. filosa.
? Venus mercenaria.
Tellina lusoria.
Cumingia tellinoides.
Pandora crassidens = P. trilineata.
Saxicava bilineata = S. rugosa.
? Pholas acuminata = P. costata?

The percentage (15) is here, therefore, brought down considerably lower than in either of the preceding States, a circumstance not only strikingly confirming the assumption of non-contemporaneity (as has already been drawn from comparisons made between the different faunas themselves) in the deposits in question, but equally proving that the Virginia deposits are anterior (older) in date to those of both South and North Carolina.

The number of recent species occuring in the Maryland deposits taken as a whole (*i. e.*, as embracing both the "newer" and "older" groups, and comprising consequently 98 specific forms of acephalous mollusks) is somewhat less than in Virginia, namely (including two or three doubtful forms), 13:

Leda acuta.
Yoldia limatula (Leda lævis).
Nucula proxima = N. obliqua.
Lucina crenulata.
" contracta = L. filosa.
" divaricata.
Ostrea Virginiana.
Pecten Clintonius = P. Magellanicus.
Panopea Americana.[1]

[1] I have here provisionally included the *Panopæa Americana* among the recent forms, although I am somewhat doubtful as to its right to a place there. The shell certainly very greatly resembles that of the recent *P. Aldrovandi* from the Mediterranean, from which, in fact, it appears to differ only in the form of the posterior truncature, which in the recent species carries up the hinge line to a higher level than in the fossil. While the form of the American shell is very constant, that of the European is stated to be very varying, and therefore the distinction pointed out may on a closer examination between specimens be found to have no specific value. By Searles Wood ("Monograph of the Crag Mollusca," ii, p. 283, Palæontogr. Soc. Reports) the *P. Americana* (and *P. reflexa*) is considered identical with the *P. Faujasii* (more properly *P. Menardi*), a common

? Venus mercenaria.
Solen ensis.
Saxicava rugosa (S. bilineata).
? Pholas ovalis = P. costata?

Of this number 12 are found in the deposits of the "newer" group, and consequently constitute about 18 per cent. of its lamellibranch fauna; on the other hand, at most, only 2 occur in the deposits of the "older" group. We have here, therefore, not only a further corroboration of the existence in the State of two distinct horizons, but what might almost be considered positive proof that the upper Maryland formation ("newer" group), occupies a horizon very nearly identical with that of the (or the great bulk of the) Virginia formation, and one considerably lower than that indicated by the South and North Carolina deposits, despite the circumstance that the general relations existing between the respective faunas in the two cases are not very different.

The following statement summarizes the results obtained from the examination of the lamellibranch fauna:

Of about 103 South Carolina species—
74–78 are found in North Carolina = 74 per cent.
43 are found in Virginia = 42 per cent.
34 are found in Maryland = 33 per cent.
34–40 are recent = 33–39 per cent.

Of about 106 North Carolina species—
74–78 are found in South Carolina = 74 per cent.
48 are found in Virginia = 46 per cent.
36 are found in Maryland = 34 per cent.
32 are recent = 30 per cent.

Of about 109 Virginia species—
43 are found in South Carolina = 40 per cent.
48 are found in North Carolina = 44 per cent.
41 are found in Maryland = 38 per cent.
16 are recent = 15 per cent.

European fossil, and one which had frequently been confounded with the recent *P. Aldrovandi;* but the American species appears to be at least as much related, if not more so, to the living form. The *P. reflexa* is stated by Mayer (*Catalogue Systématique des Foss. des Terr. Tert.*, ii, pp. 25 and 42) to be living on the coast of New Zealand, and to be identical with the *P. Solandri* of Gray; the angulation on the posterior slope of the latter, however, readily distinguishes the two.

Lucina squamosa (L. speciosa) = L. pecten.
" crenulata
" divaricata.
" contracta = L. filosa.
? Venus mercenaria.
Tellina lusoria.
Cumingia tellinoides.
Pandora crassidens = P. trilineata.
Saxicava bilineata = S. rugosa.
? Pholas acuminata = P. costata?

The percentage (15) is here, therefore, brought down considerably lower than in either of the preceding States, a circumstance not only strikingly confirming the assumption of non-contemporaneity (as has already been drawn from comparisons made between the different faunas themselves) in the deposits in question, but equally proving that the Virginia deposits are anterior (older) in date to those of both South and North Carolina.

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Ostrea Virginiana.
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Solen ensis.
Saxicava rugosa (S. bilineata).
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Of about 98 Maryland species—

34 are found in South Carolina = 35 per cent.
36 are found in North Carolina = 37 per cent.
41 are found in Virginia = 42 per cent.
13 are recent = 13 per cent.

Of about 66 Maryland "Newer" group species—

33 are found in South Carolina = 50 per cent.
32 are found in North Carolina = 49 per cent.
37 are found in Virginia = 56 per cent.
12 are recent = 18 per cent.

Of about 32 Maryland "Older" group species—

4 are found in South Carolina = 13 per cent.
7 are found in North Carolina = 22 per cent.
8 are found in Virginia = 25 per cent.
2 are recent = 7 per cent.

The examination of the gasteropod faunas of the several States, as will be seen from the summary further on, very strongly confirms the results that have been obtained from the investigation of the acephalous mollusks.

The following enumeration exhibits the species that have been described from the deposits of South and North Carolina.

SOUTH CAROLINA.

Cancellaria reticulata, N. C.
" depressa.
" venusta.
Conus adversarius, N. C.
" diluvianus, N. C.
Crucibulum multilineatum, N. C.
" costatum, N. C.
" ramosum, N. C.
" dumosum, N. C.
Cypræa Carolinensis, N. C.
Crepidula fornicata, N. C.
" spinosa, N. C.
= C. aculeata.
" plana, N. C.
= C. unguiformis.
" costata.
Columbella avara.
Dentalium attenuatum, N. C.
= D. dentale.
Dentalium Pliocenum.
" thallus, N. C.
Dolium galea.
Ecphora quadricostata, N. C.
Fasciolaria distans, N. C.
= F. tulipa.
" (?) gigantea.
" Tuomeyi.
Fulgur carica, N. C.
" perversus, N. C.
" canaliculatus, N. C.
" Conradi (incile).
" Carolinensis.
(F. excavatus), N. C.
" pyrum.
(F. spiratus), N. C.
Ficus reticulatus, N. C.
Fusus exilis, N. C.
Fissurilla redimicula, N. C.

Galeodia Hodgei, N. C.
Hipponyx Bullii.
Infundibulum centralis, N. C.
Littorina irrorata.
Marginella limatula, N. C.
" oliviformis, N. C.
Mitra Carolinensis, N. C.
Monodonta Kiawahensis.
Murex umbrifer, N. C.
Natica heros, N. C.
" duplicata, N. C.
" canrena, N. C.
" Caroliniana.
Nassa vibex, N. C.
" trivittata, N. C.
" obsoleta, N. C.
" (?) lunata.
Obeliscus arenosa, N. C.
Oliva literata, N. C.
Pleurotoma lunata, N. C.
Ptychosalpinx porcinum, N. C.
" multirugatum, N. C.
Purpura tridentata.
Petaloconchus sculpturatus, N. C.
Ranella caudata, N. C.
Scalaria multistriata, N. C.
" clathra, N. C.
= S. angulata.
Solarium perspectivum.
Terebra Carolinensis, N. C.
" unilineata, N. C.
Trivia pediculus, N. C.
Turritella striata.
" exaltata.
" Burdenii, N. C.
" Etiwaensis, N. C.
Trochus philantropus, N. C.
" armillatus.
" gemma.
Urosalpinx cinerea.
Voluta mutabilis, N. C.
" Trenholmii, N. C.
Vermetus anguina.

North Carolina.

Cancellaria Carolinensis.
= C. reticulata, S. C.
Cæcum annulatum.
Cerithium moniliferum.
" (Cerithiopsis) annulatum.
Cerithium bicostatum.
Chemnitzia subulata.
Conus adversarius, S. C.
" diluvianus, S C.
Crucibulum multilineatum, S. C.
" costatum, S. C.
" ramosum, S. C.
" dumosum, S. C.
Cypræa Carolinensis, S. C.
Crepidula fornicata, S. C.
" spinosa, S. C.
= C. aculeata.
" plana, S. C.
C. unguiformis.
Carinorbis (Delphinula) quadricostata.
Dentalium attenuatum, S. C.
= D. dentale.
" thallus, S. C.
Dolium octocostatus.
Ecphora quadricostata, S. C.
Eulima (?) lævigata.
Erato lævis?
Fasciolaria distans, S. C.
= F. tulipa.
" elegans.
" Sparrowi.
" alternata.
" nodulosa.
" acuta.
Fulgur carica, S. C.
" contrarius.
= F. perversus, S. C.
" canaliculatus, S. C.
? F. rugosus.
" Carolinensis.
= F. excavatus, S. C.

Fulgur pyrum.
= F. spiratus, S. C.
Ficus reticulatus, S. C.
Fusus exilis, S. C.
" equalis.
" lamellosus.
" moniliformis.
Fissurella redimicula, S. C.
Galeodia Hodgei, S. C.
Infundibulum centralis, S. C.
Littorina lineata.
Marginella limatula, S. C.
" oliviformis, S. C.
" constricta.
" ovata.
" inflexa.
" elevata.
Mitra Carolinensis, S. C.
Murex umbrifer, S. C.
" globosa.
Natica heros, S. C.
" duplicata, S. C.
" canrena, S. C.
" fragilis.
" percallosa.
" Emmonsii.
Nassa vibex, S. C.
" trivittata, S. C.
" obsoleta, S. C.
" (Tritia) multilineatum.
" " moniliformis.
" " bidentata.
Obeliscus arenosa, S. C.
Oliva literata, S. C.
Oliva ancillariæformis.
" canaliculata.
Pleurotoma lunata, S. C.
" limatula.
" communis.
" elegans.
" tuberculata.
" flexuosa.
Ptychosalpinx porcinum, S. C.
" multirugatum, S. C.
Petaloconchus sculpturatus, S. C.
Pyramidella reticulata.
Ranella caudata, S. C.
Scalaria multistriata, S. C.
" clathra, S. C.
" curta.
Terebra Carolinensis, S. C.
" unilineata, S. C.
" neglecta.
Tornatina cylindra.
Trivia pediculus, S. C.
Turritella Burdenii, S. C.
" Etiwænsis, S. C.
" constricta.
Turbonilla reticulata.
Trochus philantropus, S. C.
Voluta mutabilis, S. C.
" Trenholmii, S. C.
" obtusa.
Helix tridentata.
" labyrinthica.
Planorbis bicarinatus.
Paludina subglobosa.

A comparison of the two preceding tables shows, that of the 74 South Carolina forms no less than 52 (or 70 per cent.) are common to the deposits of North Carolina, a proportion very nearly identical with that which obtains in the case of the acephalous mollusks (74 per cent.). This very close agreement leaves but little, if any, room for doubt as to the contemporaneity of the formations of the two States. In North Carolina the number of specific forms described is considerably in excess of that from the former State, and consequently, as must almost necessarily follow, the percentage of common forms is here very materially reduced.

Thus of 100 species—4 of which are non-marine—only 52, as above stated, also occur in South Carolina, or just 52 per cent. It is but fair to presume, however, that were the number of species described from South Carolina equal to that from North Carolina the proportion of forms common to the two States while it would not probably differ very materially from what we now find it in the former State, would be considerably raised for the latter. On the other hand, just the reverse result presents itself when a comparison is made with the Virginia fauna, which comprises a far greater number of species than is to be found in any other State:

VIRGINIA.

Amycla reticulata.
Actæon (?) milium.
Adcorbis (Delphinula) costulata.
" " concava.
(A. lipara).
" " obliqué-striata.
Anguinella Virginiana.
Bela Dædalia.
Buccinum Tuomeyi.
" frumentum.
Crepidula costata, S. C.
" fornicata, S. C.; N. C.
" spinosa, S. C.; N. C.
" ponderosa.
" cornucopiæ.
" cymbiformis.
Crucibulum costatum, S. C.; N. C.
(Calyptrea pileolus).
" ramosum, S. C.; N. C.
" grande.
Cemoria oblonga.
Capulus lugubris.
Cancellaria perspectiva.
" plagiostoma.
Cerithium clavulus.
" curtum.
Cerithiopsis annulatum, N. C.
Chiton transenna.
Cylichna cylindrica.
" Virginiana.
Chemnitzia (Pasithea) subula, N.C.
" " exarata.
" " eburnea.
Dentalium thallus, S. C.; N. C.
" attenuatum, S.C.; N.C.
= D. dentale.
Delphinula trochiformis.
" (Carinorbis) arenosa.
" lyra.
Ecphora quadricostata, S.C.; N.C.
Eulima (Pasithea) lævigata, N.C.
" eborea.
" migrans.
Eulimella (Pasithea) ovulum.
(E. diaphana).
Fasciolaria parvula.
" rhomboidea,
S. C.; N. C.
= F. distans.
Fissurella redimicula, S. C.; N. C.
" catilliformis.
Fulgur carica, S. C.; N. C.
" canaliculatus, S. C.; N. C.
" incile (Conradi), S. C.
" tritonis.
" filosus.
" carinatus.
" maximus.
Fusus (Neptunea) exilis,
S. C.; N. C.
" strumosus.
" (Neptunea) trossula.
Marginella limatula, S. C.; N. C.
" perpusilla.
" conulus.
" exilis.

Marginella eburneola.
Mangelia Virginiana.
Menestho limnea.
Melampus (?) longidens.
Nassa trivittata, S. C.; N. C.
" impressa.
" (Tritia) altilis.
" bilix.
" " laqueata.
Natica duplicata, S. C.; N. C.
" heros, S. C.; N. C.
" aperta, N. C.
(N. fragilis?).
" sphærula, N. C.
(N. percallosa?).
" perspectiva.
Niso lineata.
Oliva canaliculata, N. C.
" ancillariæformis, N. C.
" Carolinensis.
= O. literata, S. C.; N. C.
" eborea.
Obeliscus arenosa, S. C.; N. C.
(Pyramidella suturalis).
Odostomia (Actæon) granulatus.
" (?) globosus.
" " turbinatus.
" " angulatus.
" " glans.
" " sculptus.
" " nitens.
Patella acinaces.
Petaloconchus sculpturatus,
S. C.; N. C.
Pleurotoma lunata, S. C.; N. C.
" pyrenoides.
" (Drillia) multisecta.
" " arata.
" " bella.
" " distans.
" " dissimilis.
" " eburnea.
" " impressa.
" (Surcula) engonata.
" " nodulifera.
Pleurotoma (Surcula) tricenaria.
" " Virginiana.
Pyramidella elaborata.
Ptychosalpinx porcinum,
S. C.; N. C.
Rotella nana.
" subconica.
" carinata.
" lenticularis.
" umbilicata.
Scalaria clathra, S. C.; N. C.
" = S. angulata.
" acicula.
" micropleura.
" microstoma
(S. cornigera?).
" pachypleura.
" procera.
Solarium nupera.
Trochus philanthropus, S.C.; N.C.
" armillus.
" conus.
" lens.
" torquatus.
" Ruffinii.
" bellus.
" labrosus.
" Mitchelii.
Turbo rusticus.
" (Monilea) caperata.
Trophon tetricus.
Turritella variabilis.
" indenta.
" plebeia.
" alticosta.
" flexionalis.
" terstriata.
" bipertita.
Trochita (Infundibulum)
concentrica.
Triforis (Cerithium) monilifera.
Urosalpinx cinerea.
Vermetus convolutus.
Voluta mutabilis, S. C.; N. C.
Vivipara (Turbo) glaber.

NOTE.—Several species described by H. C. Lea (Amer. Philos. Trans.,

new ser., vol. ix), considered to have been founded on insufficiently determined characters, or on the immature forms of previously described species, have been intentionally omitted.

We find that of the 141 species here enumerated only about 26 are found in the deposits of South Carolina, which would give to that State a comparatively low percentage of common forms (35), and one considerably less than that (42) which was found to exist when the acephalous mollusks were taken as the basis of comparison. Nor is the number of Virginia forms (31) occurring in North Carolina much more numerous, and here, likewise, the percentage (31) is markedly lower than was found to be the case (46) in the first method of comparison. Taking these various facts together they are abundantly conclusive as to the correctness of the inference drawn from the testimony of the lamellibranchs, that the Virginia deposits represent a horizon different from that indicated by the South and North Carolina formations.

From the Maryland deposits taken as a whole, *i. e.*, as comprising both the "newer" and "older" groups, there have thus far been described about 105 species of gasteropodous mollusks; of these, as will be seen from the following table, about 21 (20 per cent.) also occur in South Carolina, and 26 (or 25 per cent.) in Virginia. While the proportion of forms common to the two States is thus shown to be very limited in either case, and decidedly less than was found to exist among the lamellibranchs, there is yet (as was also indicated in the lamellibranch comparisons) a slight advantage in favor of Virginia.

MARYLAND—NEWER GROUP.

Actæon ovoides.
" melanoides.
Bulla (?) acuminata.
Cancellaria corbula.
" lunata.
" alternata.
Cassis (Semicassis) cælata.
Crucibulum grande, Va.
" tubiferum.
" costatum, S. C.; N. C.; Va.
Conus diluvianus, S. C.; N. C.
" Marylandicus.
Columbella communis.
" avara, S. C.
Dentalium thalloides.
" attenuatum, S. C.; N. C. Va.; = D. dentale.
Ecphora quadricostata, S. C.; N. C.; Va.
Fusus (Neptunea) parilis.
" " errans (rusticus).
" sulcosus.
" strumosus, Va.
Fissurella alticosta.
" nassula.
" redimicula, S. C.; N. C.; Va.
Fulgur rugosus?

Fulgur coronatus.
" canaliculatus, S. C.; N. C.; Va.
" tuberculatus.
" carica, S. C.; N. C.; Va.
" fusiformis.
" alveatus?
Ficus? (Pyrula) sulcosa.
Marginella denticulata.
Melanopsis (Bulliopsis) ovata.
" integra, Va.?
" Marylandica.
Natica interna.
" duplicata, S. C.; N. C.; Va.
" heros, S. C.; N. C.; Va.
" fragilis, N. C.; Va.
Nassa trivittata, S. C.; N. C.; Va.
" obsoleta, S. C.; N. C.
" lunata, S. C.
" quadrata.
" prærupta.
" porcinum, S. C.; Va.
" arata.
Pleurotoma bicatenaria.
" limatula, N. C
" communis, N. C.
" parva.
" rotifera.
Pleurotoma gracilis.
" dissimilis, Va.
Ranelia centrosa, S. C.? N. C.? = R. caudata?
Scalaria clathra, S. C.; N. C.; Va. = S. angulata.
" expansa.
Terebra simplex.
" curvilineata.
" loxonema.
Trochus humilis.
" reclusus.
" Bryanii.
Turbo (Monilea) distans.
" " eborea.
Turritella plebeia, Va.
" variabilis, Va.
" laqueata.
" solitaria.
" alticosta, Va.
" octonaria.
Turbinella demissa.
Turbonilla perlaqueata.
Trophon tetricus, Va.
Typhis acuticostata.
Urosalpinx cinerea. S. C.; Va.
Voluta mutabilis, S. C.; N. C.; Va.
" solitaria.

Maryland—Older Group.

Buccinum? protractum.
" lienosum.
Bulla subspissa.
Cancellaria bipliciferа.
" engonata.
Crucibulum ramosum, S. C.; N. C.; Va.
" constrictum.
Dentalium thalloides.
Fissurella Marylandica.
Fusus migrans.
" (Neptunea) devexus.
Marginella perexigua.
Niso lineata, Va.
Pleurotoma Marylandica.
" bellacrenata.
" rugata.
Scalaria pachypleura, Va.
Solarium trilineatum.
Sigaretus fragilis.
Trochita (Infundibulum) perarmata.
Turritella indenta, Va.
" exaltata, S. C.
" perlaqueata.
Trochus peralveatus.
Valvula iota.
Voluta mutabilis, S. C.; N. C.; Va.
" solitaria.

Taking each of the two Maryland divisions, already referred to,

by itself, we find that of the 21 forms occurring also in South Carolina, 19 belong to the deposits of the "newer" group, which comprise in all about 78 species; the percentage of forms common to the two formations—25—is thus considerably above that which was found to obtain when the State formation was considered as a whole. And the same increased percentage is determined when the Virginia forms are considered. Of the 26 indicated in the preceding enumeration, 22 belong to the "newer" group, of whose fauna they consequently constitute 28 per cent. The 27 species belonging to the "older" group have only 3 (or 10 per cent.) common with South Carolina, and 5 (or 18 per cent.) common with Virginia. In comparing the gasteropod faunas of the two Maryland divisions with each other, we find that there are only three species whose range embraces the deposits of both series. From the preceding data it will be seen that very strong confirmation is lent to the conclusions derived from the examination of the lamellibranch fauna as to the non-contemporaneity of the South Carolina (*et conseq.*, North Carolina) deposits with those of Virginia and Maryland, and to the existence of two well-marked faunal horizons in the last named State. No conclusive evidence is, however, afforded relative to the position which the Virginia and Maryland deposits hold in respect of each other; for the determination of this point, as well as for the determination of the several horizons, testimony must again be sought in the relations which the extinct faunas bear to the fauna of existing seas.

Species still living found in the South Carolina deposits:

Dentalium attenuatum = D. dentale.
Crepidula fornicata.
" spinosa = C. aculeata.
" plana = C. unguiformis.
Natic heros (N. catenoides).
" duplicata.
" canrena (N. plicatella).
Littorina irrorata (L. Carolinensis).
? Solarium perspectivum.
Scalaria multistriata.
" clathrus = S. angulata.
Obeliscus arenosa.
Trivia pediculus.
Nassa vibex.
" trivittata.
" obsoleta.

Dolium galea.
Columbella avara.
Oliva literata (O. Carolinensis).
Ranella (Bursa) caudata.
Cancellaria reticulata (C. Carolinensis).
Fulgur carica.
" perversum (F. adversarium).
" canaliculatum (F. canaliferum).
" pyrum.
Urosalpinx cinerea (Peristernia filicata).
Fasciolaria distans (F. rhomboidea) = F. tulipa.

NOTE.—Three or four additional species, for several reasons here omitted, may, on further examination, be found to be identical with recent forms.

Thus out of a total number of 74 species about 27 are still found living at the present day; the percentage of recent to extinct species—37—is therefore not very different from that which was found to obtain among the acephalous mollusks.

The following recent species may be considered to occur in North Carolina:

Dentalium attenuatum = D. dentale.
Crepidula fornicata.
" spinosa = C. aculeata.
" plana = C. unguiformis.
Natica heros (N. catenoides).
" duplicata.
Natica canrena (N. plicatella).
Scalaria multistriata.
" clathrus = S. angulata.
Obeliscus arenosa.
Trivia pediculus.
Nassa vibex.
" trivittata.
" obsoleta.
Olva literata (O. Carolinensis).
Ranella (Bursa) caudata.
Cancellaria reticulata (C. Carolinensis).
Fulgur carica.
" perversum (F. contrarium).
" canaliculatum.
" pyrum (F. spirata).
Fasciolaria distans = F. tulipa.

All of the above 22 species, which constitute 22 per cent. of the

gasteropod fauna of the State, are found also in South Carolina. We have here, just as in the case of the lamellibranch fauna, a decided decrease when compared with the last mentioned State in the proportion of living forms, but yet, as before, the very well marked correspondence or identity existing generally between the two faunas would preclude the supposition of the representation by them of two distinct horizons.

In Virginia and Maryland the number of recent species is considerably less than in either South or North Carolina, and the proportion these bear to extinct forms is also very materially reduced. Thus of about 141 Virginia species only 12 (or $8\frac{1}{2}$ per cent.) can be considered as being identical with living forms, namely:

Dentalium attenuatum = D. dentale.
Crepidula fornicata.
" spinosa = C. aculeata.
Natica duplicata.
" heros (N. catenoides).
Fulgur carica.
" canaliculata.
O. Carolinensis = O. literata.
Scalaria clathra = S. angulata.
Nassa trivittata.
Obeliscus arenosa (Pyramidella suturalis).
Urosalpinx cinerea.

The number of recent species occurring in the Maryland deposits is about equal to that from Virginia; but here, owing to the limited extent of the fauna, the proportion to extinct forms is considerably increased. It is a significant fact that all the recent species belong to the "newer" group, and none to the "older." They are as follows:

Columbella avara.
Fulgur carica.
" canaliculata.
Urosalpinx cinerea.
Dentalium attenuatum = D. dentale.
Nassa trivittata.
" obsoleta.
Natica duplicata.
" heros (N. catenoides).
Scalaria clathra = S. angulata.
? Ranella centrosa = R. (Bursa) caudata?

The percentage of recent forms is here, therefore, brought up to fourteen, or very nearly that (15), which obtains among the Virginia lamellibranchs, and 4 per cent. below that which was found to characterize the lamellibranch fauna for the same group of deposits.

Summing up the results obtained from the examination of the gasteropod fauna. we find that—

Of about 74 South Carolina species—
- 52 are found in North Carolina = 70 per cent.
- 26 are found in Virginia = 35 per cent.
- 21 are found in Maryland = 29 per cent.
- 27 are recent = 37 per cent.

Of about 100 North Carolina species—
- 52 are found in South Carolina = 52 per cent.
- 31 are found in Virginia = 31 per cent.
- 18 are found in Maryland = 18 per cent.
- 22 are recent = 22 per cent.

Of about 141 Virginia species—
- 26 are found in South Carolina = 19 per cent.
- 31 are found in North Carolina = 22 per cent.
- 26 are found in Maryland = 19 per cent.
- 12 are recent = $8\frac{1}{2}$ per cent.

Of about 105 Maryland species—
- 21 are found in South Carolina = 20 per cent.
- 18 are found in North Carolina = 17 per cent.
- 26 are found in Virginia = 25 per cent.
- 11 are recent = 11 per cent.

Of about 78 Maryland " Newer " group species—
- 19 are found in South Carolina = 25 per cent.
- 17 are found in North Carolina = 22 per cent.
- 22 are found in Virginia = 28 per cent.
- 11 are recent = 14 per cent.

Of about 27 Maryland " Older " group species—
- 3 are found in South Carolina = 10 per cent.
- 2 are found in North Carolina = 8 per cent.
- 5 are found in Virginia = 19 per cent.
- 0 recent.

It will be readily perceived from the preceding summarized statement, that the general results obtained from the examination of the gasteropod faunas abundantly confirm the conclusions drawn from the study of the acephalous mollusks. Combining the results obtained from the two methods of comparison, we find that:

Of about 177 South Carolina mollusca—
128 are found in North Carolina = 72 per cent.
69 are found in Virginia = 39 per cent.
55 are found in Maryland = 31 per cent.
61–67 are recent = 35–38 per cent.

Of about 206 North Carolina mollusca—
128 are found in South Carolina = 62 per cent.
79 are found in Virginia = 38 per cent.
54 are found in Maryland = 26 per cent.
54 are recent = 26 per cent.

Of about 250 Virginia mollusca—
69 are found in South Carolina = 28 per cent.
79 are found in North Carolina = 32 per cent.
67 are found in Maryland = 27 per cent.
28 are recent = 11 per cent.

Of about 203 Maryland mollusca—
55 are found in South Carolina = 27 per cent.
54 are found in North Carolina = 27 per cent.
67 are found in Virginia = 33 per cent.
24 are recent = 12 per cent.

Of about 144 Maryland "Newer" group mollusca—
52 are found in South Carolina = 36 per cent.
49 are found in North Carolina = 34 per cent.
59 are found in Virginia = 41 per cent.
23 are recent = 16 per cent.

Of about 59 Maryland "Older" group mollusca—
7 are found in South Carolina = 12 per cent.
9 are found in North Carolina = 15 per cent.
13 are found in Virginia = 22 per cent.
2 are recent = 4 per cent.

Summary.

The following points in stratigraphy, it is believed, may be considered as being conclusively demonstrated through the foregoing comparisons:

1. That the South and North Carolina deposits represent approximately the same geological horizon;

2. That the Virginia deposits indicate a horizon lower (older) in the geological scale than that of either of the formations just mentioned;

3. That the Maryland deposits indicate two well-marked faunal horizons, of which the upper one is the correspondent of the Virginian.

REMARK.—It will be seen from the last table that the correspondence existing generally between the Maryland deposits taken as a whole (i. e., including both "newer" and "older" groups) and those of Virginia, is greater than that which obtains between the last and the deposits of the "newer" group (upper Maryland horizon) considered alone, and, hence, it might readily be concluded that the Virginia and Maryland formations are absolutely equivalents of each other. But, as it has already been shown, the Maryland deposits almost unquestionably represent two well-defined faunal horizons, and, therefore, unless such is likewise found to be the case in Virginia—which *appears to be highly probable*, although evidence proving the same is still insufficient—no general correlation can be insisted upon.

Having ascertained the relations which the deposits of the several States hold towards each other, it remains lastly to determine what are the horizons, as generally recognized by geologists, that they represent. The low percentage of living forms which characterizes the molluscan faunas of the Maryland and Virginia deposits leaves no doubt as to the miocene age of these last; the "older" group of Maryland, therefore, represents the base of the miocene series. As for the North and South Carolina deposits, their position is somewhat more difficult to pronounce upon. The percentage of recent forms occurring in South Carolina is

such as to permit, according to the original Lyellian classification of the tertiary strata, of the deposits of that State being referred to the pliocene period. The North Carolina deposits, on the other hand, would according to the same system of classification be relegated to the miocene period, and yet, as has already been seen, the identity existing between the faunas of the two States is altogether too great to admit of any reasonable doubt as to their contemporaneity. Nor is the difficulty of determination lessened when an appeal is made to European deposits of nearly similar age, which have served to elucidate the principles of the Lyellian classification. Thus in what might be considered to be the two typical areas for the occurrence of marine pliocene deposits in Europe—Italy and England—the percentages of recent forms characterizing the contained faunas vary within very broad limits. Foresti has shown (*vide* Fuchs, *Die Gliederung der Tertiärbildungen am Nordabhange der Apenninen von Ancona bis Bologna*, Sitzb. d. k. Akademie der Wissenschaften, lxxi, p. 177, Vienna, 1875) that the so-called pliocene of the Bolognese Apennines may be divided into four faunal horizons, the deposits belonging to which are characterized by the following percentages of recent forms:

	Total number of species.	Living.	Percentage of living forms.
IV.	141	112	79.4
III.	332	144	43.3
II.	183	71	38.8
(Oldest) I.	78	24	30.7

Nos. I and II, therefore, correspond very closely in the proportion of living forms with the North and South Carolina deposits. But just this division of the sub-Apennine formation, or its equivalent, is by many Italian geologists referred to the upper miocene, and, indeed, it would appear more natural, if the percentage of living forms is to remain the principal basis for the classification of the tertiary formations, to group the doubtful deposits here, and thereby increase the latitude of the miocene, than where they have very generally been placed, unless, as would seem from the observations of Pareto (*Les terrains tertiaires de l'Apennin septentrional*, Bulletin de la Société Géologique de France, 2d ser., vol. xxii, 1864–5, p. 237, *et seq.*), and Fuchs (*loc. cit.*), strati-

graphical evidence is decidedly contrary to such an approximation.[1] In the English pliocene faunas the percentages of recent forms are very much higher than in the Italian just referred to.[2] The following table exhibits the numerical relations of the living and extinct species, which together constitute the crag molluscan fauna (Lyell, "Student's Elements of Geology," 1878, p. 183, *emend*):

	Total number of species.	Living.	Percentage of recent forms.
Newer Pliocene.			
Chillesford beds,	88	74	84.1
Norwich, (Fluvio-marine),	112	94	84
Older Pliocene.			
Red Crag, (exclusive of derivatives),	248	179	72.2
Coralline Crag,	396	252	63.6

It will thus be seen that the number of recent forms occurring in the *oldest* division of the British pliocene deposits is, proportionately to the extinct species, very much greater—in fact, not far from twice as great—than that which has been found to exist

[1] A direct continuity between the upper miocene (Tortonian) and the Bolognese sub-Apennine (pliocene of most authors) formations is maintained by Capellini (Sui Terreni Terziari di una parte del versante settentrionale dell 'Apennino, Mem. Accad. Scienze, Istit. Bologna, ser. iii, vol. vi, p. 618, 1876). Under the strata designated as the mio-pliocene ("Messinian" of Mayer), corresponding in a general way with the "Sarmatian" and "Congerian" of the Austrian geologists, and consequently comprising (as generally recognized by geologists) deposits of both miocene and pliocene age, are included I and II of Foresti's faunal horizons—the lower sub-Apennine marls and sands of Capellini (upper Messinian of Mayer). The upper marls and sands (III and IV) are referred to the "Astian" (or pliocene proper of Capellini). This classification appears to be more in consonance with the facts presented by paleontology than the one usually followed.

[2] Foresti has called attention (*Catalogo dei Molluschi Pliocenici delle Colline Bolognesi*, Mem. Accad. Scienze, Istit. Bologna, ser. ii, vol. vii, p. 548, 1867) to the much greater relationship which the fauna of the Bolognese sub-Apennine formations bears to the fauna of the Vienna basin than to that of the British crag, and from this circumstance draws the inference, that the Italian deposits represent a horizon very close to the miocene ("*rapresentano un plano geologico vicinissimo al miocene,*" . . .).

in the case of the South Carolina deposits. While it may be safe to affirm, from this disparity existing between the American and English faunas, that the formations represented by them are in no way equivalents of each other, (an equivalency, as has already been stated, that had been assumed by Lyell), it may yet be rash to conclude from this reason alone that, broadly measured, they do not belong to the same period (pliocene) of geological time, the more especially, since (as will be seen from a comparison of the British and Italian faunal tables) a nearly equal disparity obtains between the faunas of the Crag and some of the sub-Apennine deposits considered to belong to the same period. Nor would it be safe to affirm conclusively, although the evidence in this direction may be considered to be sufficiently strong, that the American deposits in question are correlative of that portion of the sub-Apennine formation, which, by some geologists, has been referred to the upper miocene, or classed as mio-pliocene. While it may thus be difficult to determine *absolutely* whether the South Carolina deposits (and, consequently, also the North Carolinian) ought to be classed as pliocene or miocene, yet, in view of the fact that thus far no tertiary beds have been discovered in that State, nor probably anywhere else along the Atlantic coast, whose fauna more closely approximates that of the present day, and the broad hiatus that is thus created between them and the succeeding post-pliocene, in which, as determined by Holmes ("Post-Pleiocene Fossils of South Carolina," 1860, Introduc., pp. 3 and 4), the recent forms make up fully 99 per cent. of the molluscan fauna,[1] it would appear more natural to group them in the same series with the deposits of Virginia and Maryland, to which, as has been demonstrated by the tables of comparisons, they bear a strong relation. For these reasons the author has preferred to consider them as being of miocene age, and as representing the uppermost member of the series.[2] The miocene deposits of the Atlantic slope would, according to this determination, be divisible into three groups:

[1] I have had no opportunity as yet of verifying this statement.

[2] But very little evidence as to stratigraphical position is afforded by direct comparisons made between the European and American faunas, since the number of equivalent, or even representative forms is comparatively limited, and these are about equally divided between the European miocene and pliocene. The following South Carolina lamellibranchs may

Upper Atlantic miocene, represented by the South and North Carolina deposits.

Middle Atlantic miocene, represented by the whole, or the greater part of the Virginia deposits, and those of the Maryland "newer" group.

Lower Atlantic miocene, represented by the deposits of the Maryland "older" group, and possibly the lower portion of the Virginia formation.

To these three groups, commencing with the oldest, it is proposed to apply the designations of "Marylandian," "Virginian," and "Carolinian," respectively.

The sequence of the tertiary formations along the Atlantic and Gulf slopes of the United States would, therefore, be approximately as follows:

be considered to occur, or to have their analogues in the crag (pliocene) deposits:

Anomia ephippium.
Ostrea Virginiana, represented by O. edulis.
Lucina filosa = L. borealis.
" crenulata.
Lucina dentata?
Nucula obliqua = Nucula nucleus?
Astarte bella, represented by Astarte gracilis.
" undulata, represented by A. Omalii.
Artemis intermedia, represented by A. lentiformis.
Mactra lateralis, represented by Mactra ovalis.
Solen ensis.
Pandora trilineata = P. inequivalvis?

The following may be said to occur, or to have their analogues in the deposits of the Vienna basin:

Anomia ephippium, represented by A. costata.
Arca plicatura, represented by A. diluvii.
Nucula obliqua = N. nucleus?
Lucina squamosa = L. pecten (reticulata).
" filosa = L. borealis.
" anodonta = L. Miocenica?
" divaricata, represented by L. ornata?
Chama corticosa, represented by C. gryphina.
Cardium magnum, represented by C. Kübeckii.
Artemis intermedia, represented by A. lentiformis.
Pandora trilineata = P. inequivalvis?

MIOCENE.	CAROLINIAN (Upper Atlantic Miocene).	Deposits of South and North Carolina ("Sumter" epoch of Dana).	
	VIRGINIAN (Middle Atlantic Miocene).	Deposits of Virginia, and of the "Newer" group of Maryland ("Yorktown" epoch, in part, of Dana).	Probably of the age of the "Second Mediterranean" of the Austrian geologists, and of the faluns of Touraine.
	MARYLANDIAN (Lower Atlantic Miocene).	Deposits of the "Older" group of Maryland, and possibly the lower Miocene beds of Virginia ("Yorktown" epoch, in part, of Dana).	Probably (or at least partially) the equivalent of the "First Mediterranean" of the Austrian geologists, and of the faluns of Léognan and Saucats.
OLIGOCENE.	ORBITOITIC.	Strata characterized by species of *Orbitoides*, etc. Vicksburg beds, Florida beds, etc.	
EOCENE.	JACKSONIAN.	Jackson beds of Mississippi—"White Limestone" of Alabama.	
	CLAIBORNIAN.	Fossiliferous arenaceous deposit of Claiborne, Ala., etc.	Age of the "Calcaire Grosssier" of France (Parisian).
	BUHRSTONE.	Beds below the true Claibornian on the Alabama River. "Chalk Hills" of the southern part of the State, etc. "Siliceous Claiborne" (Hilgard) of Mississippi.	Londonian?
	EO-LIGNITIC.	Lignite, sands, and clays situated at the base of the Tertiary series in Alabama, etc. Eocene beds of Maryland?	Thanetian?

REMARK.—In the above table, in most instances, only the *more prominent* localities for the occurrence of the several deposits have been given, and the absence of reference to certain States, therefore, does not indicate that deposits of a given age are there wanting. The "Jacksonian" beds, which are generally placed at the top of the eocene series, may, on further examination, prove to be oligocene. By some geologists a portion of the post-eocene tertiary deposits of New Jersey, Delaware and Maryland has been referred to the pliocene period, but there does not appear to be as yet sufficient evidence to support such a conclusion. No precise correlation between the entire series of the Atlantic tertiary deposits of the United States and those of Europe can thus far be said to have been determined. There can be no doubt as to the parallelism existing between the Claibornian and the "Calcaire Grossier" (Parisian) of France; but as for the immediately overlying and underlying eocene deposits, their relations can only be approximately fixed from the positions which they occupy in their own series. The "Buhrstone" appears to represent a portion, or perhaps even a greater part of the "Londonian," and the Marlborough and Piscataway beds of Maryland (eo-lignitic?), a horizon probably not far removed from that of the Bracheux sands of the Paris basin, or the Thanet sands of England (Thanetian).[1] The exact equivalents of the "Orbitoitic" have not yet been satisfactorily made out. There can be little or no doubt respecting the position of the "Virginian," whose faunal facies places it at about the horizon of the falums of Touraine, and the "Second Mediterranean" beds of the Vienna basin; nor can there be much more doubt as to the equivalency, at least in part, of the "Marylandian" and the lower miocene beds of the Vienna basin ("First Mediterranean").[2]

[1] Heilprin, Proc. Acad. Nat. Sciences, 1881, p. 446.

[2] The proportions which the recent species of mollusca bear to the extinct forms is larger in the *older* deposits of the Vienna basin than in the newer; the percentages for the two divisions of the "Mediterranean" are twenty-one for the "First," and fifteen for the "Second" (Fuchs, *Geologische Uebersicht der jüngeren Tertiärbildungen des Wiener Beckens.* Führer zu den Excursionen der D. Geolog. Gesellschaft, Vienna, 1877, p. 103). The following species of Virginia and Maryland lamellibranchiata may be con-

The relations of the "Carolinian" have already been fully discussed.[1]

sidered as occurring, or having their analogous in the deposits of the Vienna basin and the British crag:

VIENNA BASIN.

Saxicava rugosa (bilineata) = S. arctica.
Panopæa Americana, represented by P. Menardi.
Venus latilirata, represented by V. scalaris?
Isocardia fraterna, represented by I. cor.
Chama corticosa, represented by C. gryphina.
Lucina anodonta = L. Miocenica?
" contracta (filosa) = L. borealis.
" divaricata, represented by L. ornata.
" squamosa (speciosa) = L. pecten (reticulata).
Nucula obliqua = N. nucleus?
Arca plicatura, represented by A. diluvii.
Myoconcha incurva, represented by Mytilus Haidingeri?
Perna maxillata = P. Soldanii.

CRAG.

Ostrea Virginiana, represented by O. edulis.
Lucina filosa (contracta) = L. borealis.
" crenulata (Conrad) = L. crenulata (Wood)?
" dentata.
Nucula obliqua = N. nucleus?
Erycinella ovalis.
Astarte undulata, represented by A. Omalii.
Panopæa Americana, represented by P. Menardi.
" porrecta = P. gentilis?
Pandora arenosa (trilineata *pars?*), represented by P. pinna.
Saxicava rugosa.
Isocardia fraterna, represented by I. cor.

[1] It is not improbable that the age of the beds of this period will be most nearly represented by that of the deposits of the lower ("Black") Antwerp Crag (Diestian), considered by most Belgian geologists to form the base of the pliocene series of that country (Dewalque, *Prodrome d'une Description Géologique de la Belgique*, 1880, p. 254), and by Lyell ("Student's Elements," p. 185), as the "first links of a downward passage from the strata of the pliocene to those of the upper miocene period." The percentage (46) of recent molluscan forms characterizing the fauna of these Belgian deposits, as determined by Lyell in 1852 "On the Tertiary Strata of Belgium and French Flanders," Journ. Geol. Soc. London, VIII., p. 293), is, however, considerably higher than that which has been shown to be the case with the Carolinian fauna.