

SMITHSONIAN MISCELLANEOUS COLLECTIONS

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Charles D. and Mary Vaux Walcott
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BLUFF AND LANGLEYS
BLUFF, MARYLAND

(WITH ONE PLATE)

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S. F. BLAKE

U. S. Department of Agriculture



(PUBLICATION 4129)

CITY OF WASHINGTON
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THE PLEISTOCENE FAUNA OF WAILES BLUFF
AND LANGLEYS BLUFF, MARYLAND

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U. S. Department of Agriculture

(WITH ONE PLATE)

The most important Pleistocene locality in Maryland is Wailes Bluff, near Cornfield Harbor, on the eastern bank of the Potomac River about 3 miles above its mouth, in St. Marys County. In the Pliocene-Pleistocene volume of the Maryland Geological Survey (Shattuck et al., 1906) it was referred, like all the other fossiliferous localities of marine origin in Maryland, to the Talbot formation, at that time regarded as the youngest of the Pleistocene formations found in the State. Since that time a younger formation, the Pamlico, defined by a terrace 25 feet above sea level (that of the restricted Talbot formation being at 42 feet), has been recognized on the Atlantic coast, and some writers have referred to it the marine Pleistocene deposits of Maryland. This course was followed, at least as regards the Wailes Bluff deposit, in the Guidebook to the Chesapeake Bay Region prepared by Stephenson, Cooke, and Mansfield for the 16th International Geological Congress in 1933 (Guidebook 5, Excursion A-5), and for all the marine Pleistocene of Maryland by Richards in 1936 (pp. 1612-1618, with references to earlier papers). Richards, whose publication summarized present knowledge of the marine deposits of the southern Atlantic Coastal Plain, considered that all the fossiliferous marine Pleistocene beds from Delaware to Florida, which are all at elevations of 25 feet or less, belong to the Pamlico formation. The late Dr. E. W. Berry, however, informed me not long before his death that he still regarded all the marine Pleistocene of Maryland as referable to the Talbot.

Dr. C. Wythe Cooke, after a trip to the Wailes Bluff and Langleys Bluff localities with Dr. R. W. Brown and the writer in the autumn of 1951, has come to the conclusion that the beds in question are considerably older than had been supposed, probably of Aftonian and

Kansan age, and therefore near the base of the Pleistocene. He has kindly prepared a statement of his views which is given in the immediately following paragraphs. Since the primary purpose of the present paper is to present a record of the known fauna, the determination of the precise age of the deposits may be left to the future. For practical purposes, it seems as well to continue for the present the nominal reference of the beds to the Talbot formation.

AGE OF THE DEPOSITS AT LANGLEYS AND WAILES BLUFF¹

At Langleys the marine Miocene St. Marys formation is overlain unconformably by a marine shell-bearing Pleistocene clay. This merges upward into nonmarine cross-bedded Pleistocene sand. At Wailes Bluff the Miocene deposits are not exposed. The lowest bed there is a marine shell-bearing clay similar to that at Langleys. It passes upward through an oyster reef into fresh-water sand.

Pleistocene time is divided into four glacial stages alternating with three interglacial stages, as follows:

- Wisconsin glacial stage.
- Sangamon interglacial stage.
- Illinoian glacial stage.
- Yarmouth interglacial stage.
- Kansan glacial stage.
- Aftonian interglacial stage.
- Nebraskan glacial stage.

The glacial stages were times of low sea level. In the present coastal region they were characterized by running streams and fresh-water deposits. The succeeding interglacial stages were times of higher sea level because melt water from the ice filled the oceanic basins to overflowing. In the coastal region they were characterized by drowned valleys and marine or brackish-water deposits. So the marine bed at Langleys and Wailes Bluff presumably represents an interglacial stage, and the conformable nonmarine sand represents the immediately succeeding glacial stage.

The oyster bed probably accumulated in shallow brackish water. The overlying sand may have been deposited in an estuary of about the same depth but containing water too fresh for oysters. The fact that there was no erosion of the oyster reef appears to indicate that sea level did not fall quite as low as its present location during the deposition of the fresh-water sand.

If that is true, the marine bed and the fresh-water bed cannot repre-

¹ Contributed by C. Wythe Cooke.

sent the Sangamon and the Wisconsin stages, for sea level during the Wisconsin stage stood at least 25 feet lower than now. Moreover, the surface of the ground at Langleys and Wailes Bluff may have stood above water level during the Sangamon stage; for sea level then is supposed to have been only 25 feet higher than now, and the present rolling topography indicates that some erosion has occurred since the sea withdrew from that region. The surface around Langleys is little, if any, lower than 25 feet.

The Pleistocene beds at Wailes Bluff and Langleys presumably are not Yarmouth and Illinoian, for the shell bed lies directly on the eroded surface of the Miocene St. Marys formation. This would have been the condition if the marine bed were Aftonian, for sea level during the Nebraskan stage was lower than during the Aftonian, and the region must have stood above the water then and probably also during the Pliocene. So the evidence seems to point to an Aftonian age for the shell bed and a Kansan age for the nonmarine sand.

We can speculate as to the depth of the sea in which the shell bed accumulated. The maximum height of sea level during the Aftonian stage was probably 215 feet (in Coharie time); later in the same stage it dropped to 170 feet (in Sunderland time). So, if the shell bed is Aftonian, the depth of the water at Langleys and Wailes Bluff may have been originally as much as 215 feet. From this maximum depth it shallowed to 10 feet, more or less, near the close of the epoch, when the oyster reef grew. The gradual emergence of a land barrier or the growth of a bar presumably caused the water behind it to become brackish and then to freshen, first favoring the growth of oysters and then killing them.

HISTORY OF WAILES BLUFF

Wailes Bluff has been known to paleontologists for more than a century. Its first scientific visitor, apparently, was Timothy A. Conrad (1830), who on May 20 and June 15, 1830, read before the Academy of Natural Sciences of Philadelphia a paper embodying the results of a visit he had "lately"² made, "at the request of several members of the Academy," to the peninsula of Maryland. He collected at Fort Washington, Piscataway, Charlotte Hall, St. Marys River, and the present Wailes Bluff, which he referred to merely as a locality "about three miles north of the low sandy point [Point Lookout] which

² His later reference to this expedition—"Since I discovered the Eocene formation in Maryland in 1830 . . ." (Amer. Journ. Sci., ser. 2, vol. 1, p. 209, 1846)—makes it clear that this trip was made early in 1830.

forms the southern extremity of the peninsula." Conrad's description of the exposure is quoted in large part by Smith (1920, p. 85), and his list of 29 mollusks is reproduced by Richards (1936, p. 1622), with one species, "*Solen ensis* Lin." (= *Ensis directus* (Conrad)), accidentally omitted.

A few years later Conrad (1835, p. 110) published a revised list of Wailes Bluff mollusks, also totaling 29 species, under the heading "List of Fossil Shells of the Newer Pliocene on the Potomac." *Actaeon melanoides* and *Venus* sp. of the first list were omitted, *Turritella alternata* Say and *Ostrea virginica* were added, and some corrections were made in nomenclature. *Bittium alternatum* (Say), the present designation for *Turritella alternata*, has been omitted from the Wailes Bluff lists of all later authors. It does not appear in Conrad's final list of 1842.

Still later, in a general paper on the Tertiary deposits of the Atlantic coast, Conrad (1842) gave a section of the Wailes Bluff deposit with an excellent description, both quoted in full by Mansfield (1928, pp. 129-130), and a third list of species. *Natica interna* Say and the unnamed *Scalaria* and *Venus* of the first list were omitted, *Actaeon melanoides* was restored, and some further changes in nomenclature were made. This list includes only 26 species and, like the first list, omits the *Ostrea*. In his discussion of Conrad's work, Richards (1936) compares the first and third lists, but in citing the latter gives the reference belonging to the second list.

Altogether, Conrad recorded in his three Wailes Bluff lists a total of 31 mollusks, two of which, a *Scalaria* and a *Venus*, were not identified specifically. Five species of *Epitonium* (*Scalaria*) are now recorded from Wailes Bluff, so that the identity of his single species of this genus cannot be ascertained, and as he recorded *Venus mercenaria*, the identity of his unnamed *Venus* is also uncertain. It seems likely that it was merely a form of *V. mercenaria* rather than the rare *V. campechiensis*, which has been found there (in young specimens only) by Richards alone. *Crepidula glauca* is now considered a form of *C. convexa*, and in the Maryland Geological Survey the latter, as to Maryland specimens, was referred to *C. fornicata*. *Natica interna* is a Miocene species, and Conrad's specimens, if really from Wailes Bluff, must have been *Polinices duplicata*, which he also listed. His *Actaeon melanoides* of the first and third lists and *Turritella alternata* of the second list are dubious; both names possibly refer to the same species. Omitting all these from consideration, we find that Conrad recorded 25 identifiable mollusks from Wailes Bluff against 39 in the Maryland Geological Survey volume (Shattuck et al., 1906), which omitted two

of Conrad's species that are now definitely known to occur. Several of the species first recorded in the Maryland Geological Survey are rare, and two (*Aligena elevata* and *Macoma calcarea*) have not been found by any subsequent collector, but it is surprising that Conrad did not mention *Fulgur carica*, *F. canaliculatum*, *Crepidula plana*, and *Actaeocina canaliculata*, all of which are common and the two first conspicuous. Possibly his *Crepidula glauca* was really *C. plana*, which is much more distinct in appearance from *C. convexa* and *C. fornicata* than they are from each other.

The Maryland Geological Survey (Shattuck et al., 1906) reported 1 arthropod (*Balanus crenatus*) as well as indeterminate crab claws, 39 mollusks, 3 Bryozoa, 1 sponge, and 4 Foraminifera from Wailes Bluff; *Pandora trilineata* (= *P. gouldiana*) and *Cytherea sayana* (= *Callocardia morrhua*) of Conrad's 1842 list were omitted, presumably because they had not been found by collectors for the Survey, as was also the problematical *Actacon melanoides*. Aside from the vertebrates, every animal species definitely listed in that volume from the Maryland Pleistocene was recorded from Wailes Bluff except *Callinectes sapidus* and *Odostomia impressa*, both of which are now known to occur there.

The next important contribution was by Ernest R. Smith (1920), who gave an account of the locality with a section and bibliography and a table showing the Recent and Pleistocene distribution, geological range, and depth range of the mollusks known from Wailes Bluff. He added 10 species to the known fauna. Canu and Bassler (1923) added 1 bryozoan, Mansfield (1928) 3 crustaceans, Rathbun (1935) 2 more crustaceans, and Richards (1936) 1 mollusk and 1 bryozoan. Some years ago I (1939) reported a single vertebrate, *Tursiops* sp., of the Delphinidae, which was apparently the first definite record for a member of this family from the Atlantic coast Pleistocene. In his 1928 paper, Mansfield (pp. 129-132) gave sections of the Wailes Bluff and Langleys Bluff localities, with a list of the species known from each arranged by the beds in which they occurred, and an analysis of the faunas. Unfortunately he overlooked Smith's 1920 paper.

Richards (1936, pp. 1622-1624) gave a historical sketch of the work done on the Wailes Bluff fauna, with lists of the species reported by previous writers, and in his table showing the distribution of Pamlico species recorded altogether 57 species from this spot; he omitted the Foraminifera. However, three Mollusca (*Rochefortia planulata*, *Callocardia morrhua*, and *Fulgur canaliculatum*) that were reported from Wailes Bluff in his text were omitted from his table, as were the three Bryozoa listed in the Maryland Geological Survey volume, and the two Crustacea added by Miss Rathbun.

In the Maryland Geological Survey (Shattuck et al., 1906), four Foraminifera were reported from Wailes Bluff. Cushman and Cole (1930), in their account of the Foraminifera known from the Maryland Pleistocene, listed 11 species (and 2 additional varieties) from Wailes Bluff and Langleys Bluff, only one of which was known from Langleys Bluff but not from Wailes Bluff. One of the species reported by Bagg in the Maryland Geological Survey was mentioned but not identified, one was omitted, and a third was doubtfully synonymized with one of the species they reported. Dr. Charles T. Berry several years ago sent the two Foraminifera from Wailes Bluff now remaining in the Maryland Geological Survey collection to Dr. Cushman for examination, and the information thus obtained has been utilized in the list that follows, together with Dr. Cushman's notes on the other species reported by Bagg.

On the basis of these publications, the recorded fauna of Wailes Bluff contains 78 species³ (and 2 additional varieties), distributed as follows: Protozoa (Foraminifera) 12, Porifera 1, Bryozoa 5, Mollusca 53 (Pelecypoda 28, Gastropoda 25), Arthropoda 6, Vertebrata 1. To this list are now to be added 36 species—Coelenterata 1, Echinodermata 1, Bryozoa 4, Mollusca 14 (Pelecypoda 6, Scaphopoda 1, Gastropoda 7), Arthropoda 8, Vertebrata 8—bringing the total to 114 species, divided among the following groups: Protozoa (Foraminifera) 12, Porifera 1, Coelenterata 1, Echinodermata 1, Bryozoa 9, Mollusca 67 (Pelecypoda 34, Scaphopoda 1, Gastropoda 32), Arthropoda 14, Vertebrata 9 (Pisces 8, Mammalia 1). With the exception of *Lyonsia hyalina* and *Odostomia impressa*, all these 36 species are new to the Pleistocene fauna of Maryland as well as to that of Wailes Bluff. The additions include representatives of the Coelenterata, Echinodermata, Scaphopoda, Ostracoda, and Pisces, all groups not previously reported.

HISTORY OF LANGLEYS BLUFF

The second most important Pleistocene exposure in Maryland, that at Langleys Bluff, about 5½ miles below Cedar Point on the western

³ This figure and those that follow do not take into account the 63 species of Pyramidellidae, all but one of which were considered undescribed, mentioned by Smith in 1920 on the authority of Bartsch. As these have not been published, the species here listed to represent this family are only seven, namely the four in the Maryland Geological Survey, the single unnamed species of *Pyramidella* listed by Smith, and two additional species collected by the writer and identified by Dr. Rehder. The unidentified *Elliptio* reported by Richards and the unidentified *Epitonium* mentioned by Smith are also not considered in these figures.

shore of Chesapeake Bay in St. Marys County, below the mouth of the Patuxent River, has received less attention than the Wailes Bluff locality, although perhaps of more interest geologically because it shows the contact with the underlying St. Marys (Miocene) formation. In the Maryland Geological Survey volume only 6 species (all mollusks) were listed and some of the commonest and most conspicuous forms, such as *Ostrca virginica*, *Venus mercenaria*, *Mulinia lateralis*, and *Barnea costata*, were not mentioned, although one of the rarest species (*Unio complanatus*) was reported. Mansfield (1928) added 16 mollusks and Richards (1936) 3 more mollusks. Cushman and Cole (1930) listed 5 species and 2 additional varieties of Foraminifera, all of which were new records. In the present paper 1 sponge, 2 echinoderms, 3 bryozoans, 25 mollusks, and 8 arthropods are added, bringing the total to 69 species (and 2 additional varieties), somewhat less than two-thirds the known total for Wailes Bluff. These 39 additions include 14 species not previously recorded from the Maryland Pleistocene, but 8 of these are also here reported from Wailes Bluff. Although the fauna is much poorer than that at Wailes Bluff there can be no doubt that it will be increased as further collecting is done, since I was able to add about 19 species on 10 visits in 1942. At the base of the section the Pleistocene fauna is often intermixed with the St. Marys, and occasional shells from the St. Marys deposit, particularly *Cardium laqueatum*, *Arca idonea*, and *Turritella*, are found in position fairly high up in the main Pleistocene bed.

In the Maryland Geological Survey (Shattuck et al., 1906, pp. 99, 102) it is stated that this locality, like that at Wailes Bluff, was well known to Conrad. I have been unable to find an indubitable reference to Langleys Bluff in Conrad's writings, but the locality he visited on Chesapeake Bay 5 miles south of the estate of Dr. Robert Neale, which, in turn, was "some miles south of Town Creek," and from which he (1842, p. 188) recorded *Mulinia lateralis*, *Pholas costata*, and *Arca transversa*, can be identified only with Langleys Bluff among Pleistocene localities known at present. The section he gave, however, does not agree at all well with the present exposure.

RECORDS FROM OTHER LOCALITIES

In his discussion and table, Richards included all the known records from marine fossiliferous localities in the Maryland Pleistocene except those for the Foraminifera, aside from a few accidental omissions. Of the 17 localities mentioned besides Wailes Bluff and Langleys Bluff, all but two are insignificant, their recorded faunas consisting of only one

to three species, all of which are found at Wailes Bluff. The same is true of the 15 species recorded from Federalsburg in Caroline County. The only species he reported from the Pleistocene of Maryland which are not known from Wailes Bluff or Langleys Bluff are 9 Mollusca out of a total of 24 which he obtained from fills from hydraulic dredgings from the bottom of Sinepuxent Bay at South Ocean City, about 2 miles south of Ocean City, on the Atlantic coast of the Delmarva Peninsula. The specimens were mixed with recent material and all, with two exceptions (*Modiolus demissus*, now known from Virginia southward, and *Thais floridana*, from North Carolina southward), are known in the living state both north and south of Maryland. These species as listed by Richards are: *Arca campechiensis* Say, *Pecten gibbus irradians* Lamarck, *Anomia simplex* Orbigny, *Modiolus demissus* Dillwyn, *Littorina irrorata* Say, *Thais floridana* Conrad, *Columbella avara* Say, *Nassa vibex* Say, *Melampus lineatus* Say.

The Maryland Geological Survey (Shattuck et al., 1906) recorded also the mastodon, *Mammuth americanum* (Kerr); the northern mammoth, *Elephas primigenius* Blumenbach; the southern mammoth, *Elephas columbi* Falconer; an extinct box turtle, *Terrapene eurypygia* (Cope); the snapping turtle, *Chelydra serpentina* (Linné); and some indeterminable fragments of Coleoptera, all from various non-marine Pleistocene localities in Maryland. Two other vertebrates, the elk, *Cervus canadensis* Erxleben, and the Virginia deer, *Cariacus* [= *Odocoileus*] *virginianus* (Boddaert), listed by Cope as occurring in company with the remains of *Cistudo* (= *Terrapene*) *eurypygia* at Oxford Neck, Talbot County, were omitted by F. A. Lucas from his treatment of the Mammalia in the Pliocene-Pleistocene volume of the Maryland Geological Survey, although incidentally mentioned by O. P. Hay in his account of the *Terrapene* in the same volume. The records of numerous other Pleistocene land vertebrates of Maryland, mostly found in caves or limestone fissures, are summarized in Hay's work (1923, pp. 344-351) on the Pleistocene of eastern North America. The most important recent contribution to this subject is Gidley and Gazin's (1938) monograph of the Pleistocene fauna from Cumberland Cave.

DESCRIPTION OF THE BEDS

In listing the species from Wailes Bluff I have followed Mansfield's (1928) nomenclature for the beds, although I regard his bed 2 as having no real existence. Bed 1 at the base of the cliff, of very compact and sticky greenish-blue clay, is exposed for 4 to 6 feet above the level of the beach and contains essentially the whole Wailes Bluff fauna for

which the details of occurrence are known. Of 114 recorded species, 92 are definitely known from this bed, 1 (*Crepidula fornicata*) is known to me only from bed 3, and the zone of 21 is not recorded. Bed 2, a layer of blue clay 1 foot thick or less, not clearly demarked from the lower bed and not present in all parts of the bluff, may well, as Mansfield suggests, "be considered a part of bed 1." In his paper, Mansfield combined his records from beds 1 and 2 into one list, but definitely reported from bed 2 *Rangia cuneata* and *Venus mercenaria*, both of which are also found in bed 1. Bed 3, the oyster bed, 1 to 2 feet thick, has 21 definitely recorded species, all of which, with the single apparent exception of *Crepidula fornicata*, are also found in bed 1. Bed 3 is capped by 6 to 8 feet of unfossiliferous sands and gravels (bed 4). The beds in which the 12 Foraminifera were found are not reported either in the Maryland Geological Survey or in Cushman and Cole's paper, but from the abundance of Foraminifera in bed 1 in the *Mulinia*-filled borings and inside clam shells, and their comparative rarity in bed 3, where they occur chiefly in *Cliona* borings in oyster shells, it is probable that most, if not all, of the 12 recorded species came from bed 1. The 2 Bryozoa and 7 Mollusca reported by previous authors without indication of bed and not found by me must likewise have occurred mostly, if not entirely, in bed 1.

The Wailes Bluff section given by Smith (1920) was somewhat more detailed than that of Mansfield. He recognized four fossiliferous beds and three nonfossiliferous layers of sand, gravel, and loam above them. His four fossiliferous beds were: the *Mulinia* bed, 6 feet deep or less, corresponding to Mansfield's bed 1; the *Rangia* bed, 1 foot deep to absent, corresponding apparently to Mansfield's bed 2; the *Venus* bed, 1 foot deep to absent, and the *Ostrea* bed, about 1 foot deep, the two latter together equivalent to bed 3 of Mansfield. In listing the fauna I have used Mansfield's system rather than Smith's because I regard the aggregation of *Venus* below the *Ostrea*, observable in parts of the bluff, as a local development rather than a distinct bed. If such local phenomena were to be distinguished with the title of beds, it might be necessary to recognize in addition two *Mya* beds, one below and one above the oyster bed, perhaps also a *Tagelus* bed toward the top of bed 1. On our visit to Wailes Bluff in the autumn of 1942, Dr. R. W. Brown and I made especial search for the *Rangia* bed of Smith and Mansfield and the *Venus* bed of Smith and satisfied ourselves that no such beds are now recognizable in the bluff.

GEOLOGICAL FEATURES OF WAILES BLUFF AND
LANGLEYS BLUFF

The following summary of the geological features of Wailes Bluff and Langleys Bluff, with a generalized sketch (fig. 1) showing the sections at both localities, is contributed by Dr. Roland W. Brown, who accompanied the writer on a 2-day trip in the autumn of 1942 and on another visit in the spring of 1943, as well as on a third trip in the autumn of 1951, when Dr. C. W. Cooke was also present:

The Pleistocene sections at Wailes Bluff and Langleys Bluff are lithologically identical and apparently contemporaneous. That exposed at Langleys, 15 miles north of Wailes, is somewhat thicker and rests unconformably on the bluish, sandy, marine clay of the St. Marys formation (Miocene) which is not exposed at Wailes Bluff. The sections, beginning at the bottom, include the following recognizable zones:

A. This is a compact, sandy, greenish-blue, marine clay that shows little evidence of stratification except at a few spots in the uppermost layers at Wailes. On drying, exposures of this clay develop vertical cracks and columns. Scattered through it at both localities are small, quartzitic pebbles and some large boulders, but the boulders are more abundant at Langleys and are concentrated at the base among a few oysters. These boulders may have been ice-rafted or dropped from floating root clumps. This zone yields practically the whole Wailes Bluff fauna and also some fossil wood of *Taxodium distichum*. A singular feature of the zone is the common occurrence of burrows, one to several feet long and about two inches in diameter, more or less vertical and filled with *Mulinia* shells. The maker of the burrows has not been identified. It is conjectured that this clay was deposited rapidly in relatively shallow water that was not disturbed by strong currents.

B. Oyster-bed zone. The upper boundary of zone A is slightly uneven because an oyster bed rests upon it. Locally this bed is thickened and the weight of the oysters has pressed down the underlying clay as shown by the parallel down-bent curves of layers of *Mulinia* shells. At Wailes the oyster bed can be traced along the greater part of the bluff as irregular, discontinuous lenses, one of which is about 630 feet long and in spots 3 feet thick. The oyster bed may indicate greater agitation of the water than prevailed during the deposition of zone A. In places at Wailes the uppermost layers of zone A are conspicuously stratified, and these, together with the oyster bed, may indicate increased current action.

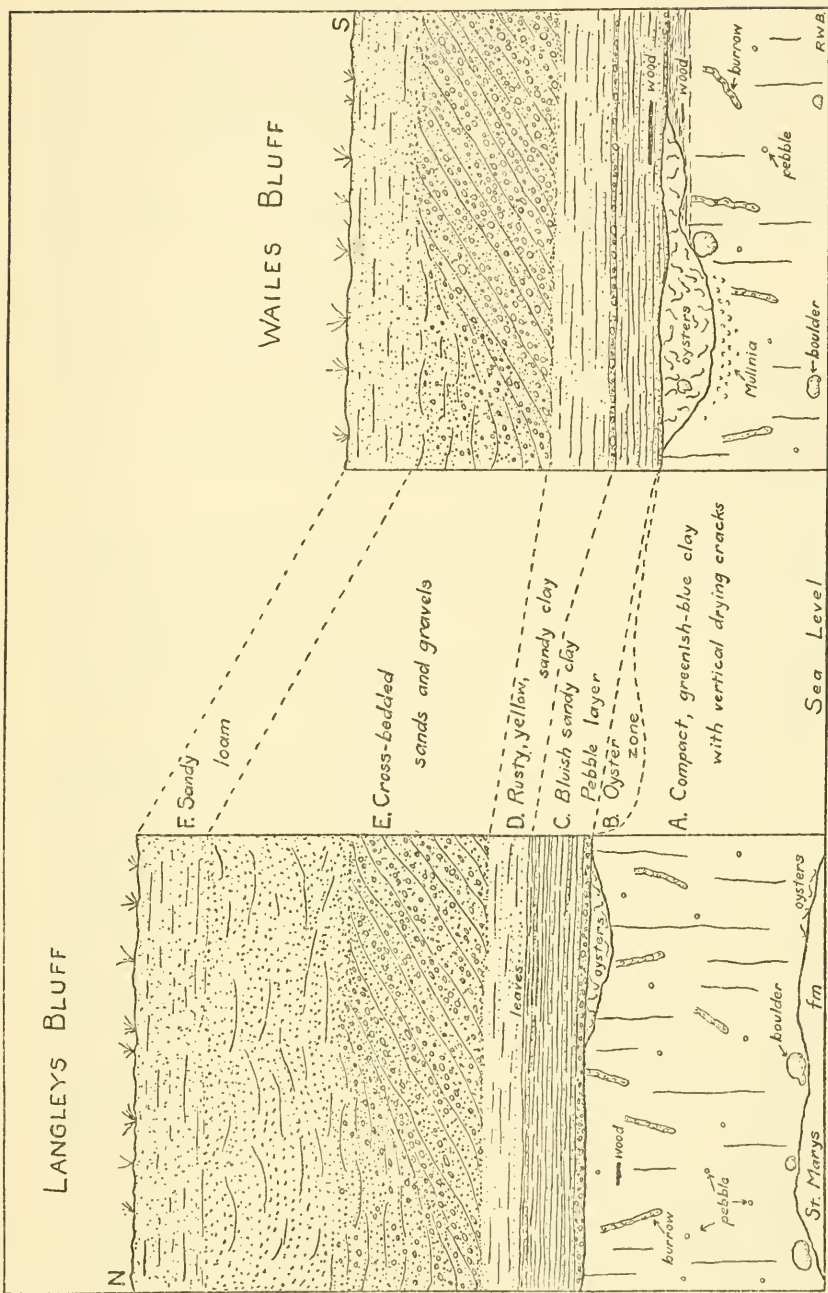


FIG. 1.—Pleistocene sections at Langleys Bluff and Wailes Bluff, Md. The Langleys Bluff section is shown as a mirror image of the actual section. Langleys Bluff is 15 miles north of Wailes Bluff. Vertical scale: $\frac{1}{8}$ inch equals 1 foot.

C. A new phase of deposition, perhaps representing a change to fresher and shallower water, terminated the further development of the oyster bed, and it is possible that some erosion of the oyster bed and preceding strata occurred before the new deposits were laid down. At Langleys this zone begins with a relatively inconspicuous, thin, pebbly and sandy layer overlying the oyster bed and the compact clay at those spots where the oyster bed is not present. At Wailes this pebble layer was seen at only one place and in general is absent. Horizontal, thin-bedded, bluish, sandy clay succeeds the pebble layer. No fossils except pieces of wood have been found in this zone. Most of the wood is *Taxodium distichum*, but one log of *Fraxinus* sp., 2 feet long, was found in 1942 at the southern end of Wailes Bluff in the position marked in the section. The genus is not listed in the Maryland Survey Pleistocene volume, but E. W. Berry (Torreya, vol. 15, p. 208, 1915) has reported leaves of *Fraxinus americana* from the Pleistocene at Indian Head, Md.

D. Sharply separated in color, but of similar texture, is the horizontal, thin-bedded, rusty, sandy clay that overlies zone C. At Wailes this zone begins with a pebble layer and has occasional brownish carbonaceous streaks near the base. At Langleys it yields scattered leaf impressions, including *Juglans* sp., *Salix* sp., and *Pinus* sp. The sharp contrast in color may be a weathering effect, but the pebble layer at Wailes suggests a depositional change of some sort.

E. Overlying the horizontal layers of zone D are cross-bedded sands and gravels that grade upward into the sandy loam of zone F at the top of the terrace. Although the aspect of these sands and gravels seems normal throughout most of the exposures, their attitude locally is suggestive, although, so far as is known, no previous observers of these sections have called specific attention to it. As shown in the sketch (fig. 1), in portions of the outcrops at both localities the gravels dip steeply northward (see Shattuck et al., 1906, pl. 18, fig. 1) and thus indicate deposition by a current from the south, a condition which, unless whirling return currents are assumed, seems contrary to what should be expected if the Potomac and Patuxent Rivers were the responsible transporting agents. It may be that these gravels represent some kind of bar that advanced landward over a shallow lagoon (see Shattuck et al., 1906, pp. 127-134). However, no marine or other fossils have been found in them.

The strata of these sections represent phases of deposition, as pointed out in the description of each zone. If any division of the sections is contemplated it would seem that the appropriate place to draw a line is at the level of the oyster bed, either its base or top, the latter

probably being the better choice. This contact appears to mark a definite change from marine to brackish- or fresh-water deposits. However, this line may not represent any great lapse of time, and without further information should not be construed to mean a temporal or formational boundary.

As these bluffs are retreating rapidly, probably as much as 5 feet locally in some years, the sections present continually new faces. Thus, the features sketched now will likely not be quite the same as those that will be seen in subsequent years. [R. W. B.]

Mansfield distinguished five numbered beds at Langleys Bluff. The bank there is higher than at Wailes Bluff (about 25 feet at Langleys Bluff, 15 or less at Wailes Bluff), but the length of the fossiliferous area is considerably less (about 1,400 feet, as contrasted with about 2,100 at Wailes Bluff; both distances paced). His bed 1 is Miocene (St. Marys), 3 feet deep or less (so far as exposed) and highly fossiliferous, and separated by an unconformity from the four superposed Pleistocene beds. His bed 2, of compact bluish sandy clay 6 to 8 feet deep with a thin oyster zone at the base, contains the same fauna, so far as it goes, as bed 1 at Wailes Bluff and is in all probability (except for the basal oyster zone) equivalent to it. His bed 3, an oyster zone 1 foot thick or less, absent along much of the length of the bluff, is likewise clearly the equivalent of bed 3 at Wailes Bluff, although its species are much fewer. No bed corresponding to his bed 2 at Wailes Bluff was distinguished. The two remaining beds are both unfossiliferous. Bed 4, a layer of dark gray sandy clay 2 feet deep with a pebbly band at base, was not recognized by him at Wailes Bluff but is actually represented there. Bed 5, of cross-bedded sands and gravels 4 to 15 feet deep, corresponds to bed 4 at Wailes Bluff although usually deeper.

The thin oyster zone mentioned by Mansfield at the base of the deep layer of bluish sandy clay is well marked for practically the entire length of the bluff and should be recognized as a separate bed. It is a shallow layer of double valves of *Ostrea*, only 2 or 3 inches thick, in some places accompanied by a very thin layer of sand only half an inch thick and everywhere with abundant rounded pebbles and cobbles, the latter sometimes a foot in diameter. In places complete specimens of *Venus mercenaria* and *Mya arenaria* occur just below the oysters and thus actually in the uppermost part of the St. Marys bed, the *Mya* in its natural vertical position. The total known fauna of this bed is 10 species, of which 6 (*Cliona sulphurea*, *Acanthodesia oblongula*, *Ostrea virginica*, *Venus mercenaria*, *Mya arenaria*, and *Balanus crenatus*) are also known to occur rarely or casually in the *Mulinia* bed, and 5

(*Cliona sulphurea*, *Ostrea virginica*, *Mytilus recurvus*, *Venus mercenaria*, and *Mya arenaria*) occur also in the upper oyster bed. The close proximity to shore when this bed was laid down is indicated by the colony of *Elliptio complanatus* mentioned in the list that follows. I propose to designate this bed as the Basal *Ostrea* bed; the superposed bed of blue sandy clay 6 to 8 feet thick, forming the remainder of Mansfield's bed 2⁴ as the *Mulinia* bed; and the oyster bed on top of it, 1 foot thick or less, Mansfield's bed 3, as the Upper *Ostrea* bed. From the Basal *Ostrea* bed are recorded 10 species, 6 of which, listed above, are also known from the *Mulinia* bed; from the *Mulinia* bed, 60 species, all, except the 6 species mentioned, confined to it; and from the Upper *Ostrea* bed, 5 species, all of which are also found in the Basal *Ostrea* bed, and all but one (*Mytilus recurvus*) in the *Mulinia* bed. The bed or beds in which the five known species of Foraminifera occurred are not recorded, but the abundance of specimens of this group in the *Mulinia*-filled borings, as at Wailes Bluff, makes it very probable that they all came from the *Mulinia* bed.

BORINGS AT WAILES BLUFF

The contact between the base of the Pleistocene at Wailes Bluff and the St. Marys Miocene that should underlie it has never been found. In July and August 1942, with the assistance of William E. Salter, of the U. S. National Museum, I made two attempts to reach it. Our first trial, made with a small spade, showed only that bed 1 was at least 10 feet 3 inches deep, including that part exposed in the bluff, at the point where we dug near the upper end of the fossiliferous part of the exposure. On the second occasion, working again toward the upper end of the bluff and using an auger borrowed from the Geological Survey, we penetrated to a depth of 21 feet without passing through the Pleistocene. As 5 feet of bed 1 were exposed in the bank above, the total depth of the Pleistocene deposit here is over 26 feet (although it is not certain that it all belongs to bed 1), whereas the corresponding *Mulinia* bed at Langleys Bluff is only 6 to 8 feet deep. The following description of the cores, prepared with the assistance of Dr. Julia A. Gardner, may be placed on record. The shell contents of the cores, after washing and sifting, are added in parentheses.

Depth below
beach level

0-5 ft.

Tenacious greenish-blue clay like that exposed in the bluff above, with *Mulinia*, etc. (From our first digging.)

⁴ Mansfield's bed 1 was the St. Marys (Miocene) bed.

Depth below
beach level

- 4-5 ft. Greenish-black finely micaceous silty clay with a few moderately large grains of quartz and a few shell fragments. (Many *Nuculana acuta*; one hinge of *Yoldia limatula*.)
- 5 ft. 8 in.-6 ft. 8 in. Similar, but with sandy pockets. (No shells.)
- 10 ft. Greenish clayey sand. (No shells; a little carbonaceous material.)
- 12 ft. Dark greenish silty clay, very finely micaceous and with some carbonaceous material. (One fragment of *Mulinia*, some small quartz pebbles.)
- 12 ft. 6 in. Similar, but more carbonaceous and with some shell fragments. (Several pieces of *Rangia*, showing the epidermis.)
- 13 ft. Dark greenish, very tenacious silty clay with small specimens of *Rangia cuneata* and *Mulinia lateralis*. (One fragment of *Nucula proxima*; numerous valves of *Rangia*, somewhat worn but still retaining some epidermis.)
- 14 ft. Dark greenish, less tenacious silty clay with small specimens of *Rangia* (fragmentary, somewhat worn, but still retaining some epidermis).
- 17 ft. Brownish-green silty clay, carbonaceous and slightly micaceous, not so heavy as preceding sample. (No shells.)
- 18 ft. Brownish-green sandy clay with occasional irregularly shaped pellets of light buffy sandy clay and large quartz pebbles, also considerable carbonaceous material and one much-worn fragment of *Venus*. (One valve of *Arca transversa*, one or two fragments of *Rangia* (?).)
- 19 ft. Brownish-green sandy clay somewhat mottled with clear green, with a few of the light buffy pellets, considerable carbonaceous material, a few small shell fragments, and one fragment of much worn *Ostrea*.
- 20-21 ft. Same as preceding but extremely tenacious, no carbonaceous material noted except a few well-preserved fine rootlets; one fragment of *Rangia* and an extremely worn and polished fragment of *Ostrea* (?). (One fragment of *Rangia*, two small and much-worn fragments of *Ostrea*, one fragment of *Barnea costata* (?).)
- 21 ft. Tenacious silty greenish clay with occasional rounded masses of clearer green clay of similar character, slightly micaceous and with a few quartz pebbles, with traces of sand pockets; no carbonaceous material noted; a few very much worn shell fragments (*Ostrea*?).

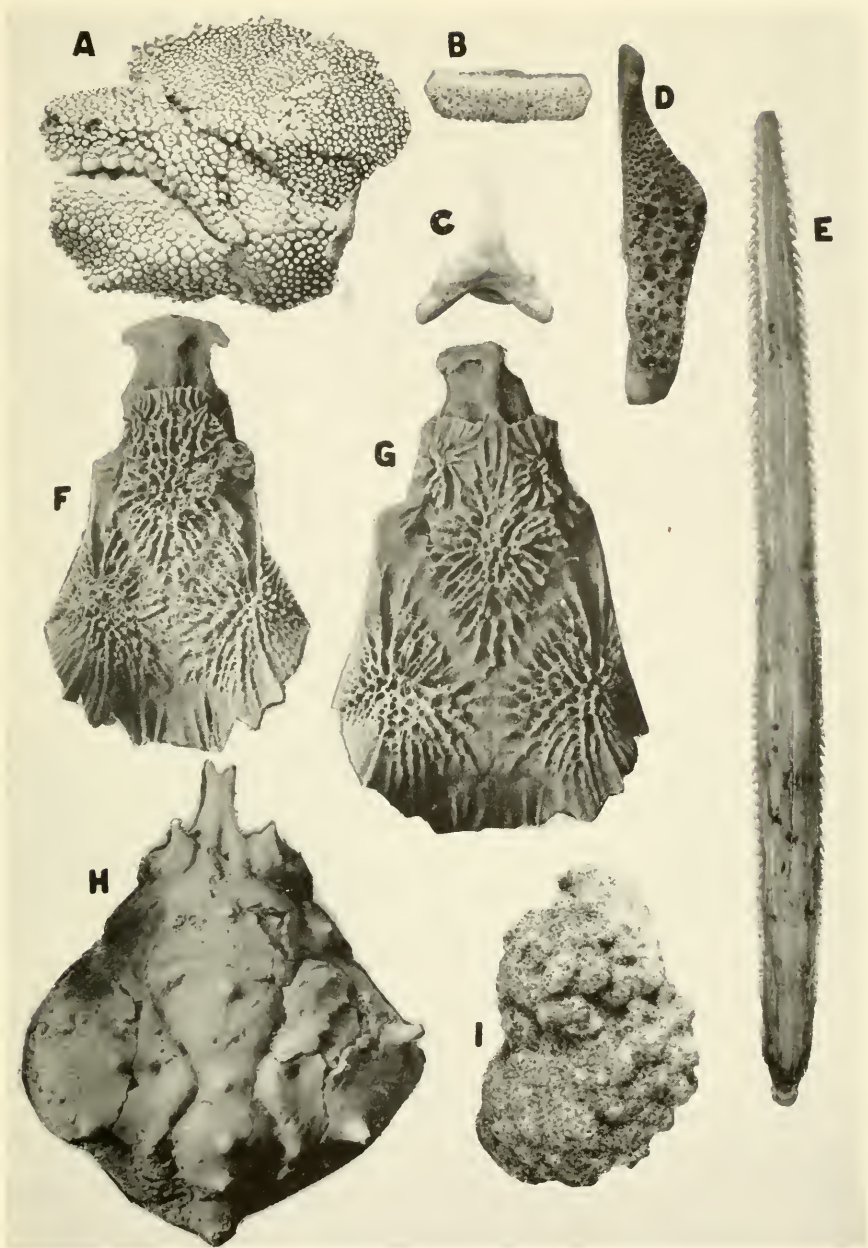
On October 31, 1942, Dr. Roland W. Brown and I made another boring toward the opposite extremity of the cliff, about 150 yards above the lower (southern) end of the fossiliferous part of the exposure. As the pipe came apart at a depth of 16 feet, it was not possible to penetrate as deeply as on the previous attempt, but the results in general were in fairly close agreement with earlier ones. The exposed part of bed 1 in the bank at this point was about 4 feet deep, so that

its total depth was 20 feet and an undetermined amount more. The following description of these cores was prepared with the assistance of Dr. Julia A. Gardner; the shell contents of the cores are given in parentheses.

Depth below
beach level

- 4 ft. Grayish-green clay with a little mica and a few stringers of clear quartz sand. (Several *Actaeocina*, 2 *Nuculana*, 1 each *Arca transversa*, *Mulinia*, *Odostomia disparilis*, *Nassarius trivittatus*, some shell fragments.)
- 6.5 ft. Similar, with a few shell fragments. (Several *Nuculana*, *Actaeocina*, and *Turbonilla interrupta*, 2 *Arca transversa*, 1 each *Nucula*, *Yoldia*, and *Mulinia*; some skeletal remains of *Asterias*.)
- 7 ft. Similar, with slightly more sand and a few more shell fragments. (Many *Nucula* and *Actaeocina*, very many *Nuculana*, more material of *Asterias*, fragments of *Barnca costata*, 1 each *Nassarius trivittatus* and *Crepidula plana*.)
- 8.5 ft. Similar to preceding. (Several *Nucula*, *Nuculana*, *Yoldia*, *Mulinia*, and *Actaeocina*, 1 *Arca transversa*, 1 fragment of *Balanus*.)
- 11 ft. Similar to preceding, but with fewer shell fragments and a few large quartz grains. (Few fragments of *Nucula*, *Nuculana*, and *Mulinia*, and a few *Actaeocina*.)
- 12 ft. Similar but with decidedly more sand. (A very few small shell fragments.)
- 14 ft. Stiff, grayish rather than greenish clay with some carbonaceous material, a few very small specks of mica and a very few clear quartz grains. (Two fragments of *Mulinia*.)
- 15 ft. Similar, but with more carbonaceous material which occurs in streaks. (Numerous fragments of *Rangia*, somewhat worn, and a few tiny fragments of small bivalves.)
- 16 ft. Similar, more greenish, with rather numerous specimens of *Rangia* (including some complete valves) and little or no carbonaceous material. (Several fairly complete valves and several fragments of *Rangia*, not badly worn and with some traces of epidermis remaining, 1 fragment of *Arca transversa*, 1 *Mulinia*, 1 worn *Actaeocina*, a few tiny shell fragments.)

The results of these two borings made toward the two extremities of the fossiliferous part of the cliff at Wailes Bluff are of considerable interest. They reveal, in the first place, the much greater depth of the Pleistocene deposit at Wailes Bluff than at Langleys Bluff—26 feet (plus an undetermined greater depth) as contrasted with 6 to 8 feet (omitting the overlying oyster bed). It has been suggested that our borings may have penetrated one or more of the older Pleistocene formations of Maryland—the Wicomico (if the exposed portion is Talbot) or possibly even the Sunderland. In both borings, at a depth varying from about 10 to 14 feet below beach level, considerable sand



A, *Pagurus pollicaris* (Say); B, tooth of *Myliobatis* cf. *fremoviilli* Le Sueur, viewed from attached surface; C, *Odontaspis littoralis* (Mitchill); D, lower right pharyngeal of *Micropogon undulatus* (Linné); E, tail spine of *Dasyatis* cf. *centrourus* (Mitchill); F, G, skulls of *Prionotus* aff. *evolans* (Linné); H, *Libinia dubia* Milne Edwards; I, *Hippoporidra edax* (Busk). All $\times 1\frac{1}{2}$. All from Wailes Bluff, bed 1.

was encountered, accompanied by more or less carbonaceous material, both features suggesting shallow-water conditions; somewhat similar conditions were found again at about 18 to 19 feet in the deeper boring. However, except for a few small, badly worn, and nonsignificant fragments of *Ostrea* and *Venus*, no material of the species of shallower water such as *Mya arenaria*, *Venus mercenaria*, or *Ostrea virginica* was brought up from these depths, as would certainly have been the case had the auger passed through a bed of them. No marine fossils have been definitely reported from the Pleistocene of Maryland from any formation older than the Talbot and it would be unwarranted to regard those here recorded, in spite of their depth, as representing the older formations. The proper course at present appears to be to consider the 16 to 21 feet so far tapped below beach level, with the 4 or 5 feet exposed in the bank above, as constituting a single bed—bed 1 of Mansfield—unless the *Rangia* zone mentioned in the next paragraph is to be regarded as a separate bed.

The second significant fact revealed by these borings is the presence of abundant whole valves of *Rangia cuneata* at a depth of 12½ to 14 feet (at upper end of cliff) and 15 to 16 feet (at lower end) below beach level, corresponding respectively to depths of 17½ to 19 feet and 19 to 20 feet below the top of bed 1. No paired valves were found, but the comparatively unworn condition of the shells and the presence of epidermis upon them, as well as the occurrence of carbonaceous material in the cores just above those in which they were found, are all points to indicate that they were in or near the situation in which they had lived. Although *Rangia cuneata* is sometimes found, according to Dall, in the sea outside the lagoons, it is by preference an inhabitant of brackish water near the mouths of rivers and creeks at or near tidal level, favoring especially the muddy banks of creeks in brackish marshes. The presence of abundant specimens toward both ends of the cliff at a depth of 12½ to 16 feet below beach level, whether they represent two colonies or, as seems more likely, a continuous bed, definitely indicates a period during which shallow-water estuarine conditions prevailed—an indication reinforced by the occurrence of considerable carbonaceous material both above and below the *Rangia*.

TEMPERATURE OF THE WATER

With the exception of two species, *Vitrinella blakei* and *Rangia cuneata*, all the species definitely recorded from Wailes Bluff and Langleys Bluff are still living along the Atlantic coast.⁵ The first of

⁵ Curiously enough, in Clark's table (Shattuck et al., 1906, p. 147) showing

these, a tiny flattish gastropod little more than a millimeter in diameter, is known from only a single specimen and may well turn up later as a Recent species. The second, *Rangia cuneata*, is an abundant living species on the coast of the Gulf of Mexico. The evidence afforded by this fauna as to the climate at the time of its deposition has been discussed by Conrad, W. B. Clark, Smith, Mansfield, and Richards. Of the mollusks previously recorded from Wailes Bluff, only two have been regarded as indicating colder conditions, *Macoma calcarea* (Gmelin) and *Aligena elevata* (Stimpson). The *Macoma* now ranges from Greenland to New Jersey and has been found in the Cape May formation of New Jersey and the Pamlico of South Carolina, associated in both cases with a warm-water fauna. The *Aligena*, formerly supposed to range only from Massachusetts to New Jersey, is now known to occur as far south as North Carolina, so that its occurrence at Wailes Bluff is not of much significance.⁷ Both species, as Richards points out, must have been very rare, as they have not been found by any collector since the publication of the Maryland Survey volume. The specimen of *Aligena* in the Maryland Survey collection was reexamined by Mansfield, but the fragments of *Macoma* on which the original record was based were not found.

The evidence indicating a warmer climate than prevails at present is more impressive. The most significant species is *Rangia cuneata* (Gray), a colonial brackish-water species common on the Gulf Coast and not known living north of the (west) coast of Florida. It is fairly common at Wailes Bluff, usually in the form of single valves, but rare at Langleys Bluff, and was reported by Conrad (1842, p. 190) as forming a whole bed "on the land of Mr. Ebb, above the mouth of St. Mary's River." Another similar occurrence has been described to me by James E. Benedict, Jr. On July 16, 1933, he found a nearly or quite pure colony of this bivalve occupying the basal 3 or 4 feet of the bluff for a distance of perhaps 25 feet just below the mouth of Blake Creek (i.e., southeast of the mouth, not north of it as stated by Richards, 1936, p. 1625), about 7 miles downstream from Leonardtown, St. Marys County. The tropical cyclone of August 23, 1933, destroyed the bank at this point and wiped out the colony, and in 1935 I was able to find only scattered beach-worn shells. Several specimens of

the geological range of the species known from the Maryland Pleistocene the only species indicated as not found in the Recent are *Callinectes sapidus* and *Ilyanassa obsoleta*. The former, the blue crab, is marketed in tremendous quantities each year from Chesapeake Bay, and the latter is one of the commonest mollusks on the eastern coast.

paired valves given me by Mr. Benedict are the largest and finest I have seen from this region, measuring up to 5 cm. in length by 4.5 cm. in height. The species occurs in the Pleistocene as far north as New Jersey. Several other species of southern range, but much less strikingly so than *Rangia*, are found at Wailes Bluff: *Arca ponderosa* Say, ranging from North Carolina to Mexico, in the Recent⁶; *Venus campechiensis* Gmelin, from Virginia to Texas; *Teinostoma cryptospirum* (Verrill), from North Carolina to Florida; *Epitonium denticulatum* (Sowerby), from North Carolina to West Indies; *Odotomia acutidens* Dall, from North Carolina to Florida; and *Terebra dislocata* Say, from Virginia southward.

Cushman and Cole (1930, p. 94), in their paper on Foraminifera from Wailes Bluff and Langleys Bluff, suggested that possibly "different conditions of temperature prevailed during the deposition. Some of the species are now found in comparatively warm waters while others are now characteristic of very cold waters. A similar condition is shown in the Pleistocene beds of Sankoty Head, Nantucket." In a letter, Dr. Cushman listed *Quinqueloculina seminula*, *Elphidium incertum* and its var. *clavatum*, and *Eponides frigida* var. *calida* as indicative of colder waters, and *Triloculina rotunda*, *Nonion* (both species), *Elphidium discoideale*, and *Rotalia beccarii* (both varieties) as species of more definitely southern range, particularly the *Elphidium*.

Of the 40 species added to the Pleistocene fauna of Maryland in this paper, the only ones of significance in connection with the question of climate are all of southern affinity: *Styloporoma spongites* (Pallas), rare at Wailes Bluff, a bryozoan known in the Recent from the West Indies and the Gulf of Mexico, and in the Pleistocene north to South Carolina; *Hippoporidra edax* (Busk), a bryozoan not previously recorded in the fossil state and not known north of North Carolina in the Recent, which occurs sparingly at Wailes Bluff; *Lucina multilincata* Tuomey and Holmes, a bivalve known in the Recent from North Carolina southward; *Bankia gouldi* Bartsch, not previously recorded as a fossil and not known north of Virginia in the Recent, which is common at Wailes Bluff in pieces of cypress wood; and *Odotomia disparilis* Verrill, known only as a Recent species from North Carolina.

SPECIES NEW TO THE PLEISTOCENE OF MARYLAND

The following 40 species reported in this paper have not previously been recorded from the Pleistocene of Maryland. Material of all these

⁶ See F. S. MacNeil, U. S. Geol. Surv. Prof. Pap. 189, p. 24, 1938.

except *Schizoporella unicornis* and *Xestoleberis* sp. has been placed in the United States National Museum.

COELENTERATA

Astrangia danae Agassiz. Wailes Bluff.

ECHINODERMATA

Asterias cf. *forbesi* (Desor). Wailes Bluff, Langleys Bluff.
?Moiria atropos (Lamarck). Langleys Bluff.

BRYOZOA

Membranipora flabellata Canu. Wailes Bluff.
Stylopora spongites (Pallas). Wailes Bluff.
Schizoporella unicornis (Johnston). Langleys Bluff.
Palmicellaria convoluta Ulrich and Bassler. Wailes Bluff.
Hippoporidra edax (Busk). Wailes Bluff.

PELECYPODA

Volsella modiolus (Linné). Wailes Bluff.
Lucina multilineata Tuomey and Holmes. Langleys Bluff.
Lucinoma filosa (Stimpson). Langleys Bluff.
Spisula solidissima Dillwyn. Wailes Bluff.
Barnea truncata (Say). Wailes Bluff, Langleys Bluff
Martesia cuneiformis (Say). Wailes Bluff.
Bankia gouldi Bartsch. Wailes Bluff.

SCAPHOPODA

Dentalium cf. *entale stimpsoni* Henderson. Wailes Bluff.

GASTROPODA

Teinostoma cf. *reclusum* Dall. Wailes Bluff.
Vitrinella blakei Rehder. Wailes Bluff.
Epitonium angulatum (Say). Langleys Bluff.
Sayella aff. *fusca* (C. B. Adams). Wailes Bluff, Langleys Bluff.
Odotomia disparilis Verrill. Wailes Bluff, Langleys Bluff.
Odotomia cf. *hendersoni* Bartsch. Wailes Bluff, Langleys Bluff.
Seila adamsii (H. C. Lea). Wailes Bluff.
Haminoca solitaria (Say). Langleys Bluff.

OSTRACODA

Cytheridea punctillata Brady. Wailes Bluff, Langleys Bluff.
Cythereis tuberculata Sars. Wailes Bluff, Langleys Bluff.
Loxoconcha impressa Baird. Wailes Bluff, Langleys Bluff.
Xestoleberis sp. Wailes Bluff.

DECAPODA

- Callianassa* cf. *matsoni* Rathbun. Wailes Bluff.
Pagurus pollicaris (Say). Wailes Bluff.
Callinectes ornatus (Ordway). Wailes Bluff.
Libinia dubia Milne Edwards. Wailes Bluff.

PISCES

- Odontaspis littoralis* (Mitchill). Wailes Bluff.
Dasyatis cf. *centrourus* (Mitchill). Wailes Bluff.
Myliobatis cf. *fremenvillii* LeSueur. Wailes Bluff.
Brevoortia cf. *tyrannus* (Latrobe). Wailes Bluff.
Roccus saxatilis (Walbaum). Wailes Bluff.
Micropogon undulatus (Linné). Wailes Bluff.
Pogonias cf. *cromis* (Linné). Wailes Bluff.
Prionotus aff. *evolans* (Linné). Wailes Bluff.

The revised complete list of the fauna of Wailes Bluff and Langleys Bluff here presented, amounting to 121 species and 2 additional varieties, includes the entire known marine Pleistocene fauna of Maryland except the 9 mollusks from dredgings at South Ocean City listed on p. 8. Of this total, 114 species and 2 varieties are known from Wailes Bluff, and 69 species and the same 2 varieties from Langleys Bluff. Seven species are known from Langleys Bluff but not from Wailes Bluff: a foraminifer, *Nonion sloanii* (?); an echinoderm, *?Moiria atropos*; a bryozoan, *Schizoporella unicornis*; 2 bivalves, *Lucinoma filosa* and *Lucina multilincata*; and 2 gastropods, *Epitonium angulatum* and *Haminoca solitaria*. Fifty-two species are known from Wailes Bluff but not from Langleys Bluff; 62 species and 2 varieties are found at both localities.

In the list the asterisk marks species not previously recorded from Wailes Bluff; species not previously recorded from Langleys Bluff are so indicated in parentheses in the annotation. Names used in the Maryland Geological Survey volume have been given in parentheses when they differ from those here adopted. The treatment of Foraminifera is taken entirely from Cushman and Cole's paper (1930), supplemented by Dr. Cushman's notes referred to above. Except where otherwise indicated, the rest of the list is based on my own observations and collections made on 34 visits to Wailes Bluff and 21 to the Pleistocene locality at Langleys Bluff, but reference is made to the reports of other observers when they differ from my own.

My thanks are due to Dr. Paul Bartsch, Dr. R. S. Bassler, Austin H. Clark, Dr. Remington Kellogg, G. S. Miller, Dr. J. P. E. Morrison, Dr. G. S. Myers, the late Mary J. Rathbun, Dr. H. A. Rehder, E. D.

Reid, Dr. L. P. Schultz, Dr. W. L. Schmitt, Dr. W. L. Tressler, and Dr. J. W. Wells for the identification of specimens in their respective groups; to Dr. Arthur Koehler and Dr. W. C. Darrah for the identification of the only wood (*Taxodium* sp.) known from the lower beds at Wailes Bluff and Langleys Bluff; and to Dr. R. W. Brown, Dr. W. S. Cole, Dr. C. Wythe Cooke, the late Dr. J. A. Cushman, Dr. Julia A. Gardner, Dr. H. A. Pilsbry, Dr. H. G. Richards, William E. Salter, Dr. E. R. Smith, and Dr. Richard J. Taylor for information on their work at these localities or for assistance in other ways.

LIST OF THE PLEISTOCENE FAUNA OF WAILES BLUFF AND LANGLEYS BLUFF, MARYLAND

PROTOZOA FORAMINIFERA

(Based on Cushman and Cole's 1930 list, with some additional information supplied by Dr. Cushman.)

- Lenticulina rotulata* (Lamarck)? Dr. Cushman (in litt.) so refers Bagg's record of *Cristellaria rotulata* (Lamarck) from Wailes Bluff. The material on which Bagg's record was based could not be found by Dr. Charles T. Berry in the Maryland Geological Survey collection.
- Quinqueloculina flexuosa* d'Orbigny. Wailes Bluff, very rare.
- Quinqueloculina seminula* (Linnaeus). Wailes Bluff, very rare.
- Triloculina rotunda* d'Orbigny. Wailes Bluff, rare.
- Nonion pompilioides* (Fichtel and Moll). Wailes Bluff, rare.
- Nonion sloanii* (d'Orbigny) (?). Langleys Bluff, a single doubtful specimen.
- Elphidium advenum* (Cushman) var. *margaritaceum* Cushman. Wailes Bluff, a single specimen.
- Elphidium discoidale* (d'Orbigny). Wailes Bluff, "in some numbers."
- Elphidium incertum* (Williamson). Wailes Bluff and Langleys Bluff, much less abundant than the variety.—Var. *clavatum* Cushman. Wailes Bluff and Langleys Bluff, common. (Bagg's record of *Polystomella striatopunctata* (Fichtel and Moll) probably belongs to *Elphidium incertum*.)
- Entosolenia globosa* (Montagu). Dr. Cushman (in litt.) so refers Bagg's record of *Lagena globosa* from Wailes Bluff. The material on which the record was based could not be found by Dr. C. T. Berry in the Maryland Geological Survey collection.
- Entosolenia lucida* (Williamson). Wailes Bluff and Langleys Bluff.
- Eponides frigida* (Cushman) var. *calida* Cushman and Cole. Wailes Bluff and Langleys Bluff, fairly common; type from Wailes Bluff. Described as a warmer-water variety (identical with specimens living on the New England coast) of the Arctic *Eponides frigida*.
- Rotalia beccarii* (Linnaeus) var. *ornata* Cushman. Wailes Bluff and Langleys Bluff, common.—Var. *parkinsoniana* (d'Orbigny). Wailes Bluff and Langleys Bluff, common.

PORIFERA

- Cliona sulphurea* (Desor). Wailes Bluff: Bed 1, scarce; bed 3, common. Langleys Bluff: Basal and Upper *Ostrca* beds, fairly common, 1942; *Mulinia* bed, casual (not previously recorded). A sponge, represented only by its borings in shells of *Venus* and *Ostrca*.

COELENTERATA

- **Astrangia danae* Agassiz. Wailes Bluff: Bed 1, on *Fulgur canaliculatum*, July 9, 1939, Harald A. Rehder and S. F. Blake; on a rock, 1940, R. J. Taylor; loose in the clay, 1943, S. F. Blake. Identified by Dr. J. W. Wells. New to the Maryland Pleistocene.

ECHINODERMATA

- **Asterias* cf. *forbesi* (Desor). (Asteriidae) Wailes Bluff: Bed 1, a few skeletal fragments found in siftings, 1938-42. Langleys Bluff: *Mulinia* bed, 1942-45, more or less complete skeletal specimens of at least 4 individuals, the best one showing much of the central skeleton in connection, including bases of all 5 arms, as well as a large section of the dorsal skeleton of 1 arm and additional fragments of the dorsal skeleton; also skeletal fragments in siftings, 1941-42 (not previously recorded). New to the Maryland Pleistocene. Identified by Austin H. Clark. The specimens were found separately on different occasions, and represented scattered individuals and not a colony.
- ?*Moiria atropos* (Lamarck). (Hemiasteridae.) Langleys Bluff; single fragment, in *Mulinia*-filled boring, *Mulinia* bed, 1942 (not previously recorded). New to the Maryland Pleistocene. A tiny fragment of the test of a heart-urchin, measuring about 2 mm. square, has been identified by A. H. Clark as probably belonging to this species, which is known in the Recent from North Carolina southward.

BRYOZOA

(All my specimens have been identified by Dr. R. S. Bassler.)

- Electra monostachys* (Busk). Wailes Bluff: Bed 1, rather common. Langleys Bluff: Basal *Ostrca* bed, scarce on *Ostrca*, 1941-42 (not previously recorded).
- **Membranipora flabellata* Canu. Wailes Bluff: Bed 1, rare, 1935. Reported by Canu and Bassler from the Miocene but not from the Pleistocene.
- Conopeum germanum* (Ulrich and Bassler). Wailes Bluff; recorded by Ulrich in Maryland Geological Survey (as *Membranipora germana*).
- Acanthodesia oblongula* (Ulrich and Bassler). Wailes Bluff: Bed 1, rather common. Langleys Bluff: Basal *Ostrca* bed, scarce on *Ostrca*, 1941-42; *Mulinia* bed, on a *Mulinia* shell, 1942 (not previously recorded).
- Acanthodesia savartii* (Savigny). Wailes Bluff: Bed 1, scarce.
- Ogivalina parvula* (Ulrich and Bassler). Wailes Bluff; recorded by Ulrich in Maryland Geological Survey (as *Membranipora parvula*).
- **Stylopora spongites* (Pallas). Wailes Bluff: Bed 1, two good-sized colonies, 1942. This is a southern species, known in the Recent from Gulf of Mexico,

the West Indies, and (doubtfully) Malacca. In the Pleistocene it has previously been known north to South Carolina, and I have collected it in Zone 17 of the Choptank Miocene at Jones Wharf, Md.

Schizoporella unicornis (Johnston). Langleys Bluff: Basal *Ostrea* bed, rare on *Ostrea*, 1942. First record for Maryland Pleistocene.

**Palmicellaria convoluta* Ulrich and Bassler. Wailes Bluff: Bed 1, rare, 1938-45. Not recorded from the Pleistocene by Canu and Bassler. My largest specimen is a colony measuring about 12 by 8 by 5 cm.

**Hippoporidra edax* (Busk). Wailes Bluff: Bed 1, scarce, 1935-42. Occurs on the shell of *Nassarius trivittatus*, which it distorts in a characteristic way. Not previously recorded in the fossil state, and not known north of North Carolina in the Recent.

MOLLUSCA

PELECYPODA

Nucula proxima Say. Wailes Bluff: Bed 1, fairly common. Langleys Bluff: *Mulinia* bed, rather common.

Nuculana acuta (Conrad). (*Leda acuta*.) Wailes Bluff: Bed 1, common; bed 3, rare. Langleys Bluff: *Mulinia* bed, common.

Yoldia limatula (Say). Wailes Bluff: Bed 1, not common. Langleys Bluff: *Mulinia* bed, 1942, scarce and small (not previously recorded).

Arca ponderosa Say. Wailes Bluff: Bed 1, fairly common. Langleys Bluff: *Mulinia* bed, rare. I cannot satisfactorily distinguish as a species *Eontia palmerae* MacNeil, described from Wailes Bluff.

Arca transversa Say. Wailes Bluff: Bed 1, abundant. Langleys Bluff: *Mulinia* bed, common. Brown (1946) has reported a small pearl in a valve of this species he collected at Wailes Bluff. He found only two previous records of fossil pearls in the Pleistocene, both from England.

Ostrea virginica Gmelin. Wailes Bluff: Bed 1, scarce; bed 3, abundant, making up the bulk of the bed. Langleys Bluff: Basal and Upper *Ostrea* beds, abundant; *Mulinia* bed, casual.

Mytilus recurvus Rafinesque. (*M. hamatus*.) Wailes Bluff: Bed 1, scarce; bed 3, common. Langleys Bluff: Basal *Ostrea* bed, 1941-42, 3 or 4 fragmentary valves; Upper *Ostrea* bed, 1942, one pair (not previously recorded).

**Volsella modiolus* (Linné). Wailes Bluff: Bed 1, rare, 1938-42, S. F. Blake; 1941, R. J. Taylor. New to the Maryland Pleistocene. The half dozen specimens or fragments, only 2 of which are sufficiently complete for satisfactory comparison, are somewhat intermediate between *V. modiolus* and *V. tulipa* (Linné), resembling the latter in the angularity of the dorsal margin but lacking its inflation and reddish color. *Volsella modiolus* is known from Labrador to North Carolina and the west coast of Florida, and these specimens appear to be closest to those from western Florida. *Volsella tulipa* is definitely known from North Carolina to the West Indies.

Elliptio complanatus (Solander). (*Unio complanatus*.) Wailes Bluff: Bed 1, rare; I have found about 8 imperfect valves. Langleys Bluff; recorded by Maryland Geological Survey, apparently not found by later collectors. On July 4, 1939, while Dr. Julia A. Gardner and I were collecting at Langleys

Bluff, we found a number of imperfect valves in the Basal *Ostrea* bed at the contact with the underlying St. Marys formation, in a thin layer (about $\frac{1}{2}$ inch thick) of gray sand accompanied by many rounded boulders. The thin sandy layer bearing *Elliptio* has not been found on subsequent visits, and evidently represented a very local situation, possibly a stream bed. The contact between the Pleistocene and the St. Marys is not visible at Wailes Bluff, and the few specimens of *Elliptio* I have found there occurred in the middle of the marine clay. In addition to this species, Richards lists an unidentified species of *Elliptio* from Wailes Bluff, Langleys Bluff, and other localities.

Pandora gouldiana Dall. Wailes Bluff: Bed 1, scarce. Langleys Bluff: *Mulinia* bed, half a dozen specimens, 1942-45 (not previously recorded).

**Lyonsia hyalina* Conrad. Wailes Bluff: Bed 1, single valve, 1941. Langleys Bluff: *Mulinia* bed, reported by Richards.

Lucina multilincata Tuomey and Holmes. Langleys Bluff: *Mulinia* bed, 2 valves, 1942 (not previously recorded); found in borings filled with *Mulinia*, the specimens very small, only 1.5 to 2 mm. high. New to the Maryland Pleistocene. Recent range, North and South Carolina.

Lucinoma flosa (Stimpson). Langleys Bluff: *Mulinia* bed, 1 pair, 1942 (not previously recorded). New to the Maryland Pleistocene. Recent range, Maine to Florida.

Divaricella quadrisulcata Orbigny. Wailes Bluff, rare, collected only by Smith, who writes me that he got a single rather depauperate specimen.

Rocheportia planulata (Stimpson). Wailes Bluff: Bed 1, rare. Langleys Bluff: *Mulinia* bed, 2 valves, 1942 (not previously recorded).

Aligena elevata (Stimpson). Wailes Bluff; recorded in Maryland Geological Survey; not found by any subsequent collector.

Callocardia morrhuana Linsley. Wailes Bluff: Bed 1, scarce. (Includes *C. morrhuana* and *C. sayana* of Smith, according to Richards.) Langleys Bluff: *Mulinia* bed, 1940-45, 3 pairs and 7 or 8 single valves (not previously recorded).

Venus mercenaria Linné. Wailes Bluff: Bed 1, common; bed 2, recorded by Mansfield; bed 3, abundant. Langleys Bluff: Basal *Ostrea* bed, common, and occurring even below it in the top of the St. Marys formation; *Mulinia* bed, scarce; Upper *Ostrea* bed, abundant.

Venus campechiensis Gmelin. Wailes Bluff: Bed 1, reported by Richards, who writes me that he got young specimens.

Gemma gemma (Totten). Wailes Bluff: Bed 1, 4 valves; bed 3, rare.

Petricola pholadiformis Lamarck. Wailes Bluff: Bed 1, scarce.

Tellina tenera Say. Wailes Bluff: Bed 1, rare. Langleys Bluff: *Mulinia* bed, 1941-42, rare (not previously recorded).

Macoma balthica (Linné). Wailes Bluff: Bed 1, scarce; bed 3, scarce. Langleys Bluff: *Mulinia* bed, 1942, 2 valves (not previously recorded).

Macoma calcarca (Gmelin). Wailes Bluff; "a few fragments" recorded by Maryland Geological Survey; not found by any subsequent collector.

Cumingia tellinoides (Conrad). Wailes Bluff: Bed 1, rare. I have found only 2 valves.

Tagelus gibbus (Spengler). Wailes Bluff: Bed 1, fairly common toward the top. Langleys Bluff: *Mulinia* bed, rare toward the top.

- Ensis directus* (Conrad). Wailes Bluff: Bed 1, not common. Perfect paired valves are not rare, although the Maryland Geological Survey reported only fragments.
- **Spisula solidissima* Dillwyn. Wailes Bluff: Bed 1, a single perfect left valve measuring 57 by 42 mm., 1947; bed 3, a pair of smaller valves consisting of umbonal region only, 1947, of this genus and presumably of this species. New to the Maryland Pleistocene.
- Mulinia lateralis* (Say). Wailes Bluff: Bed 1, abundant, often concentrated in borings; bed 3, scarce. Langleys Bluff: *Mulinia* bed, abundant, and occurring in great numbers in borings sometimes a couple of feet long, as at Wailes Bluff.
- Rangia cuneata* (Gray). Wailes Bluff: Bed 1, rather common, usually as single valves; bed 2, recorded by Mansfield; bed 3, one valve. Langleys Bluff: *Mulinia* bed, scarce.
- Mya arenaria* Linné. Wailes Bluff: Bed 1, not uncommon in upper part; bed 3, abundant. Langleys Bluff: Basal *Ostrea* bed, common in places below the oysters; *Mulinia* bed, 1 pair in upper part; Upper *Ostrea* bed, common. It is odd that Mansfield did not find this species at Langleys Bluff; it was among the few species recorded in the Maryland Geological Survey (1906).
- Corbula contracta* Say. Wailes Bluff: Bed 1, scarce; bed 3, reported by Mansfield (1 specimen). Langleys Bluff: *Mulinia* bed, 1938-42, a pair and a single valve (not previously recorded).
- Barnea costata* (Linné.) Wailes Bluff: Bed 1, abundant as paired valves in their natural position. Langleys Bluff: *Mulinia* bed, common as paired valves.
- **Barnea truncata* (Say). Wailes Bluff: Bed 1, rather common in pieces of cypress wood (*Taxodium* sp., identified by Dr. Arthur Koehler and Dr. W. C. Darrah), 1938-42, the specimens all small, none over about 2 cm. long; rarely free in the clay and much larger (a pair 4.2 cm. long, 1941, R. J. Taylor; 2 pairs and a single valve up to 5.2 cm. long, 1942-45, S. F. Blake). Langleys Bluff: *Mulinia* bed, several specimens up to 3.2 cm. long in a cypress log, 1942 (not previously recorded). New to the Maryland Pleistocene.
- **Martesia cuneiformis* (Say). Wailes Bluff: Bed 1, rather common in pieces of *Taxodium* wood, 1940. New to the Maryland Pleistocene.
- **Bankia gouldi* Bartsch. Wailes Bluff: Bed 1, rather common in pieces of *Taxodium* wood, 1938-40. Identified by Dr. Paul Bartsch. Not previously recorded as a fossil; Recent range, Virginia southward.

SCAPHOPODA

- **Dentalium* cf. *entale simpsoni* Henderson. Wailes Bluff: Bed 1, one specimen, 1942. New to the Maryland Pleistocene. The specimen, consisting only of a tip 1.5 mm. long, agrees as far as it goes with material of this form, the American representative of the European *D. entale*.

GASTROPODA

- Teinostoma cryptospirum* (Verrill). Wailes Bluff: Bed 1, 7 specimens. Langleys Bluff: *Mulinia* bed, 1 imperfect specimen, 1942 (not previously re-

corded). Otherwise collected only by Smith, who wrote me that he found 2 specimens at Wailes Bluff.

- **Teinostoma* cf. *reclusum* Dall. Wailes Bluff: Bed 1, one specimen, 1941-42. New to the Maryland Pleistocene. *T. reclusum* is known as a Recent species from off North Carolina and from the Gulf of Mexico.
- **Vitrinella blakei* Rehder. Wailes Bluff: Bed 1, 1942, single specimen (the type). New to the Maryland Pleistocene. Closely related to *V. shimeri* Clapp, described from Pleistocene deposits in a subway excavation, Boylston Street, Boston, Mass.
- Epitonium angulatum* (Say). Langleys Bluff: *Mulinia* bed, 2 specimens, 1935-41 (not previously recorded). New to the Maryland Pleistocene. Range in Recent, Connecticut to Texas.
- Epitonium denticulatum* (Sowerby). Wailes Bluff: Bed 1, rare. Langleys Bluff: *Mulinia* bed, one small specimen, 1942 (not previously recorded).
- Epitonium humphreysii* (Kiener). (*Scala sayana*.) Wailes Bluff; reported by Smith as rare. Langleys Bluff: *Mulinia* bed, 1935-41, scarce (not previously recorded).
- Epitonium lineatum* (Say). Wailes Bluff: Bed 1, rather common; bed 3, rare. Langleys Bluff: *Mulinia* bed, scarce.
- Epitonium multistriatum* (Say). Wailes Bluff; reported by Smith as uncommon.
- Epitonium* cf. *samanae* (Orbigny). Wailes Bluff; reported by Smith as rare. An additional unnamed *Epitonium* is listed by Smith from Wailes Bluff.
- Pyramidella* (*Sulcorinella*) sp. Wailes Bluff: Bed 1, scarce. Langleys Bluff: *Mulinia* bed, 1935-42, scarce (not previously recorded). This is presumably the species reported from Wailes Bluff by Smith on authority of Bartsch as an unnamed new species.
- **Sayella* aff. *fusca* (C. B. Adams). Wailes Bluff: Bed 1, rare, 1938-42; bed 3, 2 specimens, 1939. Langleys Bluff: *Mulinia* bed, 1942, rare (not previously recorded). New to the Maryland Pleistocene. Identified by Dr. H. A. Rehder.
- Turbonilla interrupta* (Totten). Wailes Bluff: Bed 1, common. Langleys Bluff: *Mulinia* bed, fairly common (not previously recorded). Smith states that Bartsch had recognized 51 new species of *Turbonilla* among material brought together from various collectors. As these have not been published, I have followed the Maryland Geological Survey in using this specific name.
- Odostomia acutidens* Dall. Wailes Bluff: Beds 1 and 3, rare. Langleys Bluff: *Mulinia* bed, 1935-42, rare (not previously recorded).
- **Odostomia disparilis* Verrill. Wailes Bluff: Bed 1, scarce, 1938-42. Langleys Bluff: *Mulinia* bed, about 40 specimens, 1942 (not previously recorded). New to the Maryland Pleistocene. Identified by Dr. H. A. Rehder. Previously known only from North Carolina.
- **Odostomia impressa* (Say). Wailes Bluff: Beds 1 and 3, scarce. Langleys Bluff: *Mulinia* bed, rare, 1935-42 (not previously recorded). Previously recorded in the Maryland Pleistocene only from Federalsburg, Caroline County.
- Odostomia seminuda* (Adams). Wailes Bluff: Bed 1, rather common. Langleys Bluff: *Mulinia* bed, scarce, 1935-42 (not previously recorded). Smith (1920, p. 86) took up for this species the name *Odostomia melanoides* (Conrad). Dr. H. A. Pilsbry writes me that Conrad's type is not at

- Philadelphia, and as his description is ambiguous and his figure a mere smudge, I prefer to retain the name *O. seminuda*. Smith states that Bartsch had distinguished 10 new species of the genus in Wailes Bluff material, belonging to the sections *Chrysallida* (1 species), *Mencstho* (1 species), and *Evalea* (8 species), but they have not yet been published.
- **Odostomia (Iolaea) cf. hendersoni* Bartsch. Wailes Bluff: Bed 1, single specimen, 1942. Langleys Bluff: *Mulinia* bed, 2 specimens, 1942 (not previously recorded). New to the Maryland Pleistocene. Identified by Dr. H. A. Rehder.
- Polinices duplicata* (Say). Wailes Bluff: Bed 1, common; bed 3, reported by Mansfield (1 specimen). Langleys Bluff: *Mulinia* bed, fairly common.
- Crepidula convexa* Say. Wailes Bluff: Bed 1, fairly common.
- Crepidula fornicata* (Linné). Wailes Bluff: Bed 3, common. Langleys Bluff: *Mulinia* bed, scarce. The specimens of this species and the preceding are always small, the largest I have found being only 15 mm. long.
- Crepidula plana* Say. Wailes Bluff: Bed 1, common. Langleys Bluff: *Mulinia* bed, scarce. Becomes much larger than *C. fornicata*, reaching a length of 42 mm. (Wailes Bluff).
- Triphora perversa* (Linné). Wailes Bluff: Bed 1, rare. Langleys Bluff: *Mulinia* bed, 1935, single specimen (not previously recorded).
- **Scilla adamsii* (H. C. Lea). Wailes Bluff: Bed 1, 1938, a single characteristic fragment consisting of the base of a shell, 2.5 mm. long and 2.2 mm. in diameter. New to the Maryland Pleistocene.
- Eupleura caudata* (Say). Wailes Bluff: Bed 1, common. Langleys Bluff: *Mulinia* bed, common.
- Urosalpinx cinereus* (Say). Wailes Bluff: Beds 1 and 3, common.
- Mitrella lunata* (Say). (*Columbella lunata*.) Wailes Bluff: Bed 1, uncommon. Langleys Bluff: *Mulinia* bed, rare.
- Nassarius obsoletus* (Say). (*Ilyanassa obsoleta*.) Wailes Bluff: Bed 1, common; bed 3, one specimen (reported as rare by Mansfield). Langleys Bluff: *Mulinia* bed, rather common.
- Nassarius trivittatus* (Say). (*Nassa trivittata*.) Wailes Bluff: Bed 1, abundant. Langleys Bluff: *Mulinia* bed, common.
- Fulgur carica* (Gmelin). Wailes Bluff: Bed 1, common, attaining a length of 23 cm. Langleys Bluff: *Mulinia* bed, rare.
- Fulgur canaliculatum* (Linné). Wailes Bluff: Bed 1, common, usually small, my largest being 16 cm. long. Langleys Bluff: *Mulinia* bed, scarce (common according to Mansfield).
- Terebra dislocata* (Say). Wailes Bluff; recorded by Maryland Geological Survey, and Dr. Smith writes me that he got about 3 small specimens. Mansfield, Richards, and I did not find it.
- Mangelia cerina* (Kurtz and Stimpson). Wailes Bluff: Bed 1, abundant. Langleys Bluff: *Mulinia* bed, common.
- Actacocina canaliculata* (Say). (*Tornatina canaliculata*.) Wailes Bluff: Bed 1, abundant. Langleys Bluff: *Mulinia* bed, common.
- Haminoea solitaria* (Say). Langleys Bluff: *Mulinia* bed, about 10 specimens, 1942 (not previously recorded); found in borings filled with *Mulinia*, the specimens all tiny, the largest only 2 mm. long. New to the Maryland Pleistocene. Recent range, Massachusetts to Georgia.

ARTHROPODA

OSTRACODA

(Identified by Willis L. Tressler.)

- **Cytheridea punctillata* Brady. Wailes Bluff: Bed 1, common. Langleys Bluff: *Mulinia* bed, common, 1942. New to the Maryland Pleistocene.
- **Cythereis tuberculata* Sars. Wailes Bluff: Bed 1, 2 specimens. Langleys Bluff: *Mulinia* bed, 2 specimens, 1942. New to the Maryland Pleistocene.
- **Loxococoncha impressa* Baird. Wailes Bluff: Bed 1, single specimen. Langleys Bluff: *Mulinia* bed, single specimen, 1942. New to the Maryland Pleistocene.
- **Xestoleberis* sp. Wailes Bluff: Bed 1, single specimen. New to the Maryland Pleistocene.

CIRRIPEDIA

Balanus crenatus Bruguière. Wailes Bluff: Bed 1, uncommon; bed 3, common; the specimens always small. Langleys Bluff: Basal *Ostrea* bed and *Mulinia* bed, 1942, scarce (not previously recorded).

DECAPODA

(Identified by Mary J. Rathbun and W. L. Schmitt.)

- Callianassa atlantica* Rathbun. Wailes Bluff: Bed 1, scarce.
- **Callianassa* cf. *matsoni* Rathbun. Wailes Bluff: Bed 1, 1934 (imperfect specimen). New to the Maryland Pleistocene. *Callianassa matsoni* is definitely known only from the Miocene of Florida.
- **Pagurus pollicaris* (Say). Wailes Bluff: Bed 1, 1940, R. J. Taylor (small major chela lacking the movable finger); 1941, S. F. Blake (large major chela lacking only tips of the fingers and the extreme base of the hand). New to the Maryland Pleistocene.
- **Callinectes ornatus* (Ordway). Wailes Bluff: Bed 1, 1934 (carapace and abdomen). New to the Maryland Pleistocene.
- Callinectes sapidus* Rathbun. Wailes Bluff: Bed 1, fairly common. Langleys Bluff: *Mulinia* bed, scarce (not previously recorded).
- Cancer irroratus* Say. Wailes Bluff: Bed 1, scarce. Langleys Bluff: *Mulinia* bed, 1 large, much-worn immovable finger, 1942 (not previously recorded).
- Panopeus herbstii* Milne Edwards. Wailes Bluff: Bed 1, not common. Langleys Bluff: *Mulinia* bed, 1935, rare (not previously recorded).
- **Libinia dubia* Milne Edwards. Wailes Bluff: Bed 1, two carapaces, 1942. New to the Maryland Pleistocene.

STOMATOPODA

Squilla empusa Say. Wailes Bluff: Bed 1, common. Langleys Bluff: *Mulinia* bed, 1942, rare (not previously recorded).

The most conspicuous single feature of bed 1 at Wailes Bluff and the *Mulinia* bed at Langleys Bluff is the presence of numerous burrows, usually about 2 inches in diameter and up to 2 feet or more in

length, crammed full of *Mulinia* valves mixed with other small shells and shell fragments. Although sometimes nearly vertical, they are usually on a slant, and none have been observed extending to the top of the bed in which they occur. At the base of the cliff at Wailes Bluff the shells in them are often firmly cemented together. Smith (1920, p. 86) attributed these burrows to *Barnea costata*, but Dr. Rehder informs me that *Barnea* does not construct such burrows. It seems most probable that they were the work of some stomatopodous crustacean of fair size. The only such animal known from Wailes Bluff and Langleys Bluff is *Squilla empusa*, which is common at Wailes Bluff but rare at Langleys Bluff. The description of its burrow given by Brooks (1885, p. 11), however—"in hard muddy bottom, in or on the sides of channels where there is a rapid current . . . a shallow U-shaped burrow, open at both ends"—does not at all agree with any of the burrows actually found. His description of the burrow of *Lysiosquilla* sp.—"a deep cylindrical vertical burrow, which goes down for several feet"—is much more appropriate, but he states that this species lives in pure sea sand on beaches which are directly exposed to the ocean swell, a condition very different from that prevailing when the blue clay beds of Wailes Bluff and Langleys Bluff were formed. The burrows are so abundant that it is hard to believe that their makers could have passed away without leaving some bodily trace of their presence, but so far none has been found.

VERTEBRATA

PISCES

- **Odontaspis littoralis* (Mitchill). Sand shark (Carchariidae). Wailes Bluff: Bed 1, one tooth, 1942. New to the Maryland Pleistocene. Identified by E. D. Reid.
- **Dasyatis* cf. *centrourus* (Mitchill). Sting ray (Dasyatidae). Wailes Bluff: Bed 1, a well-preserved tail spine 9.2 cm. long, essentially complete except for the tip, 1942, S. F. Blake; another specimen 4.8 cm. long, lacking the distal half, 1942, W. E. Salter. New to the Maryland Pleistocene. Identified by Dr. L. P. Schultz and E. D. Reid.
- **Myliobatis* cf. *fremenvillii* Le Sueur. Eagle ray (Myliobatidae). Wailes Bluff: Bed 1, one tooth in *Mulinia*-filled boring, 1942, W. E. Salter. New to the Maryland Pleistocene. Identified by E. D. Reid.
- **Brevoortia* cf. *tyrannus* (Latrobe). Menhaden (Clupeidae). Wailes Bluff: Bed 1, one opercle, 1942. New to the Maryland Pleistocene. Identified by E. D. Reid.
- **Roccus saxatilis* (Walbaum). Rockfish, or striped bass (Serranidae). Wailes Bluff: Bed 1, 1940, R. J. Taylor; bed 1, 1940, S. F. Blake (parts of skull, including 2 dentaries, 2 premaxillaries, 1 maxillary, vomer, and various

other cranial bones). New to the Maryland Pleistocene. Identified by E. D. Reid.

**Micropogon undulatus* (Linné). Croaker, or hardhead (Sciaenidae). Wailes Bluff: Bed 1, 1941 (lower right pharyngeal, a dorsal spine, and some small fragmentary bones). New to the Maryland Pleistocene. Identified by E. D. Reid.

**Pogonias* cf. *cromis* (Linné). Drum (Sciaenidae). Wailes Bluff: Bed 1, 1935 (imperfect skull); two scales, 1943, the larger 3.5 by 2.8 cm. New to the Maryland Pleistocene. Skull identified by Dr. G. S. Myers, scales by Dr. L. P. Schultz and E. D. Reid.

**Prionotus* aff. *volans* (Linné). Sea-robin (Triglidae). Wailes Bluff: Bed 1, two nearly perfect skulls, 1938 and 1940, also fragmentary outer bones of head, 1937. New to the Maryland Pleistocene. Identified by E. D. Reid.

MAMMALIA

Tursiops sp. Bottle-nose dolphin (Delphinidae). Wailes Bluff: Bed 1, toward the bottom of the bank, 1938, S. F. Blake and F. S. MacNeil (3 ribs and 9 vertebrae; Blake, 1939, p. 99); also a single vertebra on beach at or near the same spot, 1938, Blake. Identified by G. S. Miller and Remington Kellogg. This is apparently the only definite record of a member of this family from the Pleistocene of the Atlantic coast.

On July 5, 1942, in the Basal *Ostrea* bed at Langleys Bluff, I collected a broken anterior rib which resembles fairly closely the corresponding ribs of living finback whales (*Balaenoptera*) but is not sufficient for specific identification (Dr. Remington Kellogg). Oysters of the Basal *Ostrea* bed were in contact with the rib above and 2 pairs of *Mya arenaria* in their natural vertical position directly below it, but the state of fossilization is definitely that of a Miocene, not a Pleistocene bone, and there is every reason to believe that it was redeposited from the underlying Miocene.

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