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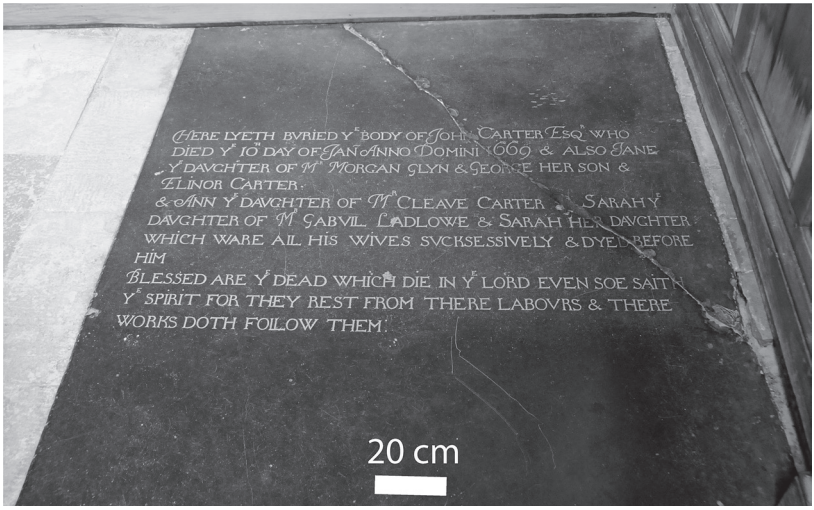

Frontispiece: Ledger stone for John Carter Esq., died January 10, 1669, located in chancel inside Christ Church, Irvington, VA.

Historical Geoarchaeological Approach to Sourcing Seventeenth- to Eighteenth-Century Black "Marble" Ledger Stones From the Chesapeake Bay Region, U.S.A.

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THE ORIGINAL GOAL OF THIS PROJECT was to determine the source of John Carter's (1613–1669) black limestone ledger stone in Christ Church, Irvington, Virginia, U.S.A. (Fig. 1A). John Carter was a member of the Virginia governor's Council and the House of Burgesses who founded one of the great the colonial Virginia families. Due to the observation that most of the social elites from the seventeeth and eighteenth centuries in the English colonies of Maryland and Virginia around the Chesapeake Bay were buried beneath seemingly identical stones, we decided to expand the study to all of the Chesapeake Bay.[1] The stones are actually fossiliferous black limestones, not marbles. The peak abundance of the use of these stones was in 1700. Thin section analysis revealed a variety of fossils that lived 332–343 million years ago in Western Europe, not in North America. We interpret the lithological and historical evidence as indicating they were imported from present day Belgium. We argue the ledger stones were shipped from Belgium to London and then to the Chesapeake Bay. This study contributes to our understand of colonial Atlantic trade routes.

Various terms have been used over the years to refer to the rectangular flat stone slabs used to cover graves (e.g., tablet, table marker, grave cover, grave slab, box tomb, tomb slab, tomb table, memorial slab, slabstone, gravestone, ledger stone, and tombstone). They can be found inside churches or in churchyard or family cemeteries. They were either placed flush with the ground (Fig. 1A) or above ground on a low brick base or mounted on a stone box or table (i.e., chest/altar (Fig. 1B) or table tomb, respectively).[2] This study uses the term ledger

stone for the inscribed rectangular flat stone slabs used to cover graves, regardless if they are on the ground, a box, or table.

A dimension stone is a natural rock that has been worked to a specific size and shape such as a building stone or monumental stone or in this case a ledger stone. The provenance of a dimension stone refers to its geologic source, usually a quarry, mine, or rock outcrop. Knowing the source of stone materials helps understand ancient trade routes.[3] It is also important to know the provenance of dimension stones as it assists in finding suitable replacement stone for conservation. Identifying the source of building stones helps determine the factors that cause stone decay and assists in recognizing and thus reducing the problems of poor substitute stone selection.[4] This has become an essential component of the work of conservators as they attempt to find suitable replacement material for preservation and restoration work.

We limited this study to black "marble" ledger stones as they were the most common type of ledger stone in the colonial cemeteries around the Chesapeake Bay and they had the most abundant fossils, which allowed the determination of their provenance. Although the ledger stones in this study are black limestone, they are often described as "marble" in historical documents as a reflection of the commercial stone industry, which applies the term marble to any carbonate rock capable of being polished.[5] This contrasts with the Earth sciences where a marble refers to a recrystallized metamorphosed limestone.[6] The ability of these limestones to take a polish is a function of their fine-grained, well-cemented, homogeneous composition.

Historical and archaeological evidence reveals the importation of manufactured goods into colonial Maryland and Virginia from Europe, mainly England, starting in the seventeenth century.[7] One of the best documented examples can be found in the building stones, hardware, glass, and paint imported from England for use in Virginia's colonial capital in Williamsburg.[8] Expensive manufactured items such as ledger stones were more likely to be imported from England than cheaper and more locally obtainable items such as bricks.[9] In Virginia, up to 1780, tombstones were largely imported from England, whereas in Maryland, after 1740, more started coming from quarries near Philadelphia.[10] It is hoped that this study will help refine the geography and timing of the North Atlantic trade routes between Continental Europe, England, and colonial Maryland and Virginia. The objective of this study is to apply historical geoarchaeological techniques to determine the source

of seventeenth- and eighteenth-century black "marble" ledger stones from the Chesapeake Bay region. Based on a variety of historical and geological observations below, our hypothesis is that they were most likely quarried in present day Belgium, transshipped in London, and exported to the English Chesapeake Bay colonies.

Materials and Methods

Geoarchaeologists use paleontological, lithological, geochemical, and geophysical parameters to determine the provenance of artifacts and building stones, including tombstones.[11] A variety of geochemical techniques have been recently used to determine the provenance of black "marble" dimension stone.[12] We used a different approach, focusing on the fossils in the stones themselves. Due to the evolutionary process, fossils are generally more unique through time and space on the planet than chemical compositions and this makes them especially effective at sourcing lithic artifacts and dimension stone.[13] Using fossils in this study was possible because unlike a true marble where the constituent fossils in the original limestones are normally destroyed by the heat and/or pressure of metamorphism, these black "marbles" are technically limestones and preserve their fossils. They only reached diagenetic to at most anchizone grade (i.e., lowest temperature and pressure) alteration.[14]

To find colonial-era cemeteries in the counties surrounding the Chesapeake Bay, we queried databases at the Virginia Department of Historic Resources and the Maryland Historical Trust Medusa Cultural Resource Information System. We defined the American colonial-era as pre-1776. We augmented results from these databases with earlier published surveys of colonial tombstones in Maryland and Virginia.[15] We filled any remaining gaps by contacting local museums, historical societies, and churches around the Chesapeake Bay, the Association for Gravestone Studies, and Findagrave.com. Some of the previously reported cemeteries could not be found for two reasons. First, as land use patterns have changed around the Chesapeake Bay due to widespread post-colonial development, many smaller remote individual family farm grave plots have been relocated to churchyards or museums or have been completely lost to history.[16] Second, some cemeteries are now underwater due to coastal erosion, subsidence, and rising sea level.[17]

We initially determined the lithology of these colonial-era ledger stones visually, classifying each as either black "marble" (i.e., organic rich limestone), white

marble, sandstone, Portland Stone, or Purbeck Stone. Most, if not all, of the sandstones were Cretaceous aged Aquia Creek Sandstone. This is the Virginia sandstone commonly used around the Chesapeake Bay in the eighteenth and nineteenth centuries, especially in the early federal buildings in Washington, DC.[18] This sandstone was distinguished by its lithology (i.e., subarkose sandstone rich in the mineral feldspar) and distinctive sedimentary bedding (i.e., trough cross bedding). Portland Stone is from the Jurassic period of the south coast of England and was distinguished by its lithology (i.e., oolitic grainstone), pitted weathering, and presence of fossilized oysters.[19] Purbeck Stone is from the Cretaceous of the south coast of England and was distinguished by its lithology (i.e., packstone) and fossilized bivalves.[20]

For each colonial-era black "marble" ledger stone we identified, we recorded the name and death date on the tombstone. When possible, we measured the length, width, and thickness of each ledger stone to the nearest 1 mm. Length and width were determined with a metal tape measure, and thickness was measured with metal, long-jaw calipers. Three replicate measurements were made of each when possible and averaged: one toward the head, one in the middle, and one toward the foot of each stone. We could not make some of these measurements on reconstructed, incomplete, or partially buried ledger stones. When possible, we avoided cracks in otherwise complete stones or took them into account while measuring. As a result, in a few cases it was not possible to obtain three replicate measurements.

The standard Munsell rock color classifications of both weathered and fresh surfaces were determined as the oxidation of the finely disseminated organic carbon within the rock's matrix alters the original internal black color to a light grey patina on the exterior.[21] The type of limestone was determined using Dunham's standard hand sample-based carbonate classification system.[22] We examined each stone for macrofossils and distinctive sedimentary structures and photographed any fossils visible on the surfaces of the ledger stones for later identification.

As indicated in the acknowledgements, images of the fossils were sent to specialists in the various fossil groups. They were identified to the genus or species level for the highest resolution paleobiogeographic and biostratigraphic ranges in the Paleobiology Database (PBDB).[23] Polished petrographic thin sections were made of each ledger stone for which we received permission to sample. Ideally, we took ~1.0×1.0×0.5 cm^3 samples from a fragment of the stone

already broken off. If that was not possible, we used a Dremel tool micro-saw to sample the bottom of the stone that would not ordinarily be visible to the public. If that was not possible, we took a sample from the side of the stone below ground level. The ~0.5 cm^3 samples were set in vacuum-evacuated epoxy plugs to prevent fracturing during the thin sectioning process. The lithology of each polished thin section was determined using Folk's standard thin section-based limestone classification system.[24] There undoubtedly is more lithologic and paleontologic variation that was undetected by our small samples as they represent only a small volume of each ledger stone. This drawback was non-negotiable as these stones have great historical value, and therefore, we wanted to minimize this method of destructive sampling. The thin sections and remnants from this study are housed at Historic Christ Church and Historic Jamestowne.

When using tombstone dates, several issues must be kept in mind. (1) The transition from the Julian to Gregorian calendar in England and its American colonies in 1752 could add at most one year of error to the death date.[25] For example, Rev. Mr. Leigh Massey's ledger stone at St. George's Episcopal Church in Valley Lee, Maryland, lists the death date as 10 January "1732/3." (2) For ledger stones listing multiple burials (e.g., husband and wife) with different dates, we used the first date assuming the second burial resulted in an addition to the inscription of the original stone. (3) As ledger stone are exposed to the natural elements, they weather.[26] It is possible we misread the dates of the more badly weathered inscriptions. To minimize this, we had multiple people read each stone independently and agree on the most likely date. (4) Badly weathered stones of more famous people are often replaced as their engraved text becomes more illegible. The replacement slabs tend to be of roughly the same size and shape as the original but fortunately not necessarily the same lithology. (5) The death date engraved on a ledger stone does not necessarily equal the date of procurement of the stone. There could be a significant lag time between the death, burial, execution of any will, ordering of the stone, ~1.5 month trans-Atlantic transport of the order to London, filling the order, carving of the customized inscription, ~2 month trans-Atlantic shipment of the stone back to the Chesapeake Bay, and finally placement of the stone.[27] Extreme delays of 12–20 years have been documented.[28]

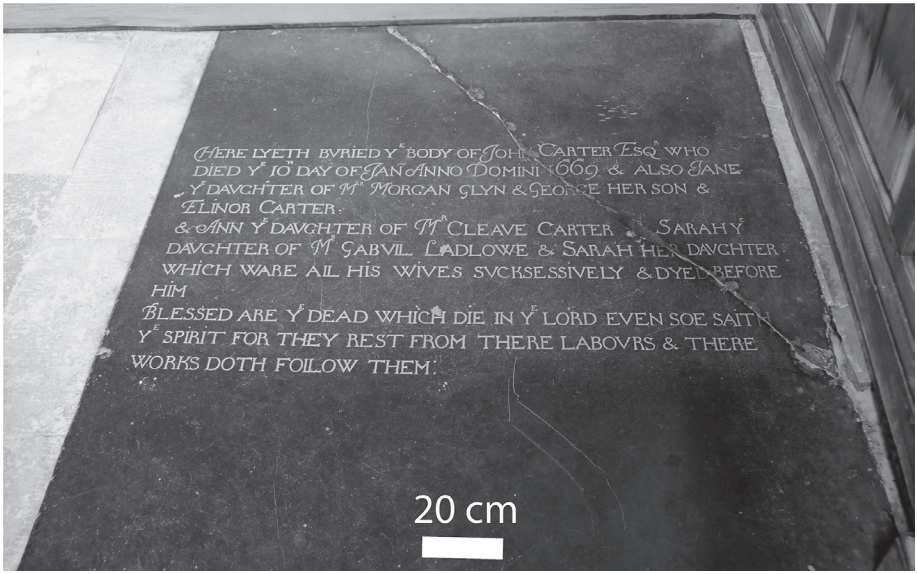

Fig. 1A. Photograph of the black "marble" limestone ledger stone for John Carter Esq., died January 10, 1669, located in chancel inside Christ Church, Irvington, VA.

Results

We were able to examine 57 cemeteries for ledger stones of the target age (Table 1). Of those, 31 (54%) cemeteries were in the northern part of the Bay (i.e., Maryland) and 26 (46%) were in the southern part of the Bay (i.e., Virginia) (Fig. 2). The east-west distribution was dominated by the western shore of the Bay with 50 (88%) cemeteries as opposed to the eastern shore with seven (12%) cemeteries (Fig. 2).

We examined a total of 150 ledger stones (Table 1). Of these, the most common were black "marble" limestone (i.e., 65 = 43%). The next most common lithology was white marble (i.e., 44 = 29%). These were followed by sandstone (i.e., 25 = 17%), Portland Stone (i.e., 14 = 9%), and Purbeck Stone (i.e., 2 = 1%). The southern part of the Bay was dominated by black "marble" limestone ledger stones (i.e., 60% of the stones in Virginia), followed by sandstone (17%), white marble (14%), Portland Stone (6%), and Purbeck Stone (3%). In contrast, the northern part of the Bay had more white marble ledger stones (i.e., 46% of the stones in Maryland), followed by black "marble" limestone (24%), sandstone (17%), and Portland Stone (13%). We did not find any slate ledger stones, but others have.[29]

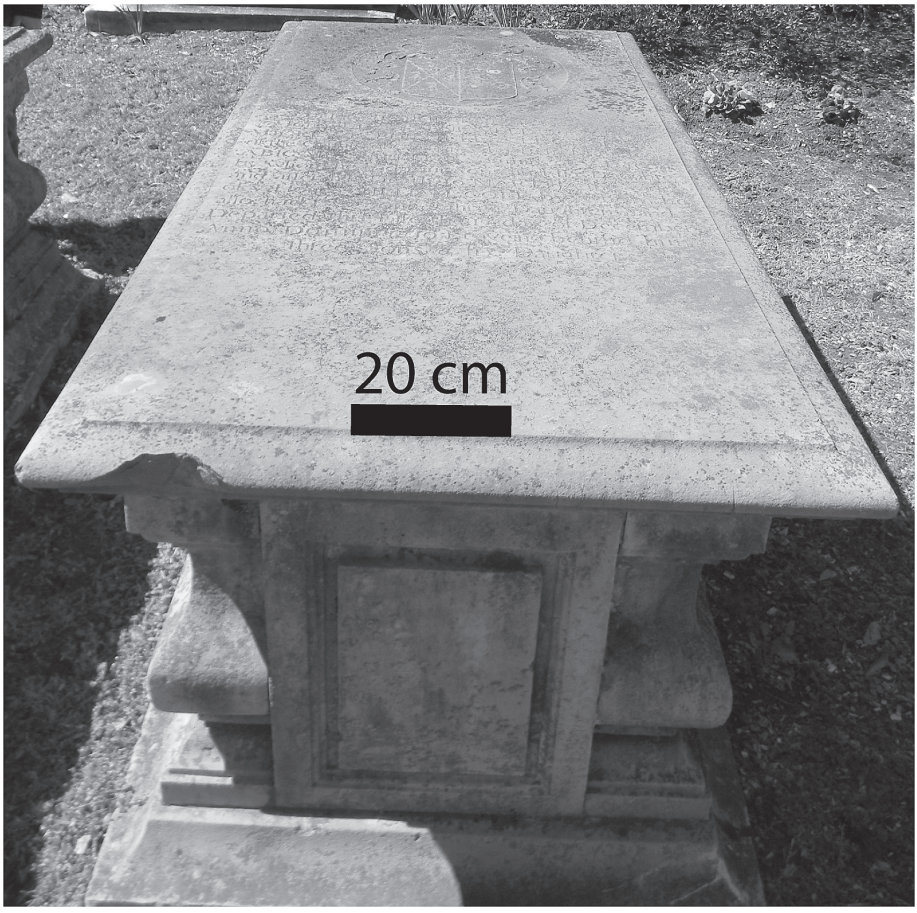

Fig. 1B. Photograph of the black "marble" limestone box tomb of Lewis Burwell, died September 17, 1696, located outside of Abingdon Episcopal Church, White Marsh, VA.

Of the 65 black "marble" ledger stones found, we were able to measure 58 (Table 2). They ranged in death date from 1627 to 1772 (mean = 1717; standard deviation = 31.2 years) with a peak at 1700 (Fig. 3A). Most of the interior polished ledger stones (Fig. 1A) were black, whereas the exterior, weathered ones (Fig. 1B) were grey. Their lengths ranged from 122.9 to 229.5 cm (mean = 195.4 cm; standard deviation = 19.7 cm) (Fig. 3B). The widths of the ledger stones ranged from 71.8 to 143.5 cm (mean = 99.9 cm; standard deviation = 12.4 cm) (Fig. 3C). Their thickness ranged from 8.0 to 16.4 cm (mean = 12.9 cm; standard deviation = 1.7 cm) (Fig. 3D). All but one were rectangular with a 2.0:1 mean length:width ratio. Mann Page Esq.'s ledger stone, located in the

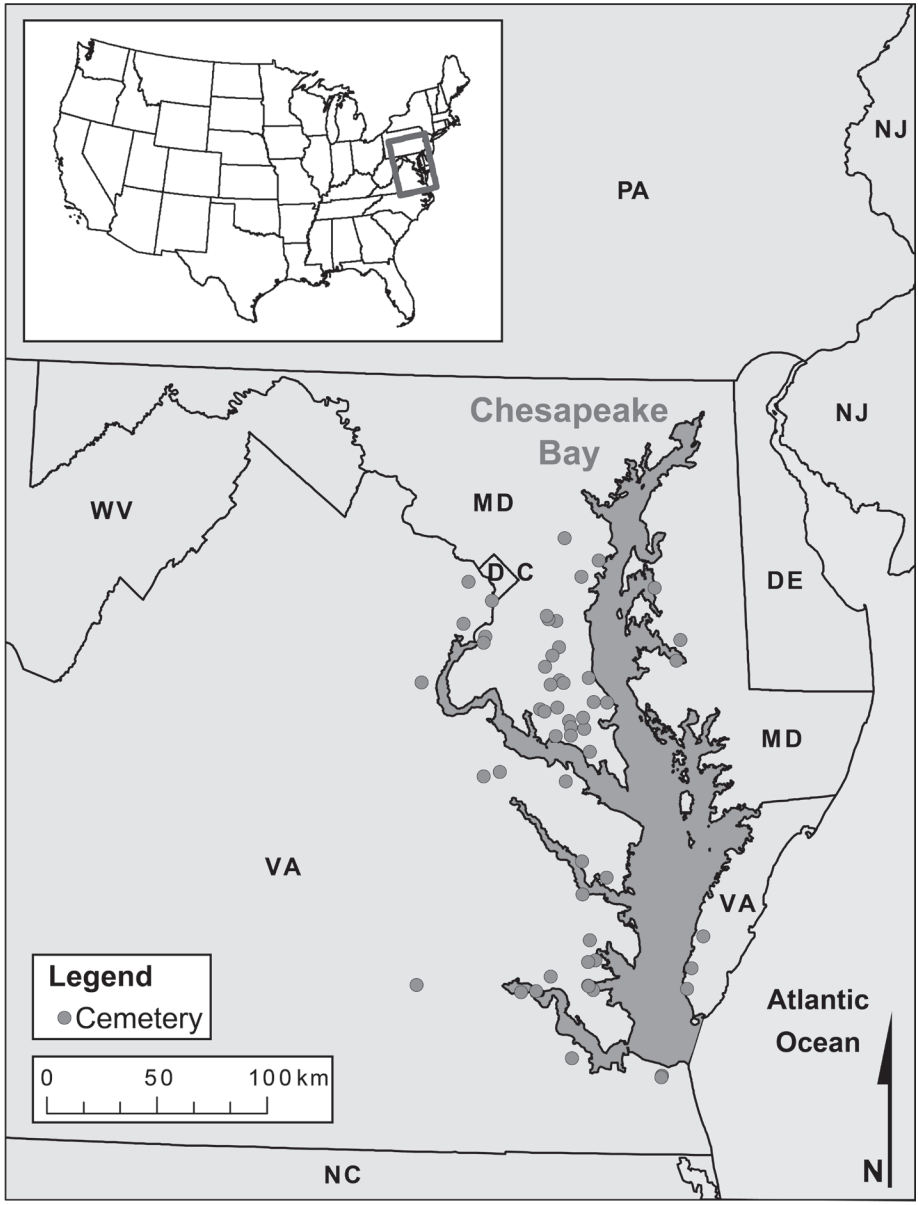

Fig. 2. Map showing the distribution of cemeteries included in this study. US state abbreviations are as follows: Pennsylvania (PA), New Jersey (NJ), West Virginia (WV), Delaware (DE), Maryland (MD), District of Columbia (DC), Virginia (VA), and North Carolina (NC).

Fig. 3A–3F. Frequency distributions of black "marble" limestone ledger stones included in this study from the Colonial Era in the Chesapeake Bay. Year data grouped in 10 year bins (i.e., by decade). Length and width data grouped in 10 cm bins. Thickness data grouped in 1 cm bins.

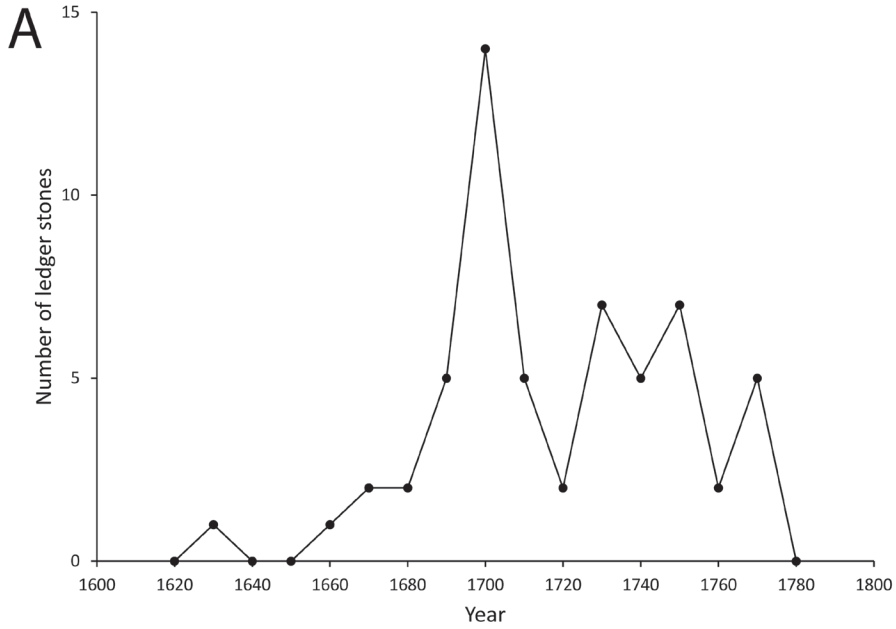

Fig. 3A. Year of death.

churchyard at Abingdon Episcopal Church in Gloucester County, Virginia, has a unique octagonal shape. The smallest ledger stones belonged to children (Table 2). The largest belonged to John Carter Esq., located inside the chancel at Christ Church, Lancaster County, Virginia (Fig. 1A).

Lithologically, the ledger stones were all limestones. Based on Dunham's classification system, they were either wackestones (72%) or mudstones (28%). This means the limestone was mud-supported (i.e., the fossils were not touching), and the macrofossils usually made up more than 10% of the rock volume. We received permission to sample 11 of the tombstones for thin sectioning. Using Folk's classification scheme, 10 of the limestones were classified as packed biomicrite with one classified as sparse biomicrite. A biomicrite is a fossiliferous limestone with a fine-grained calcite matrix. Thus, the composition of the ledger stones can be summarized as dark, fine grained limestones.

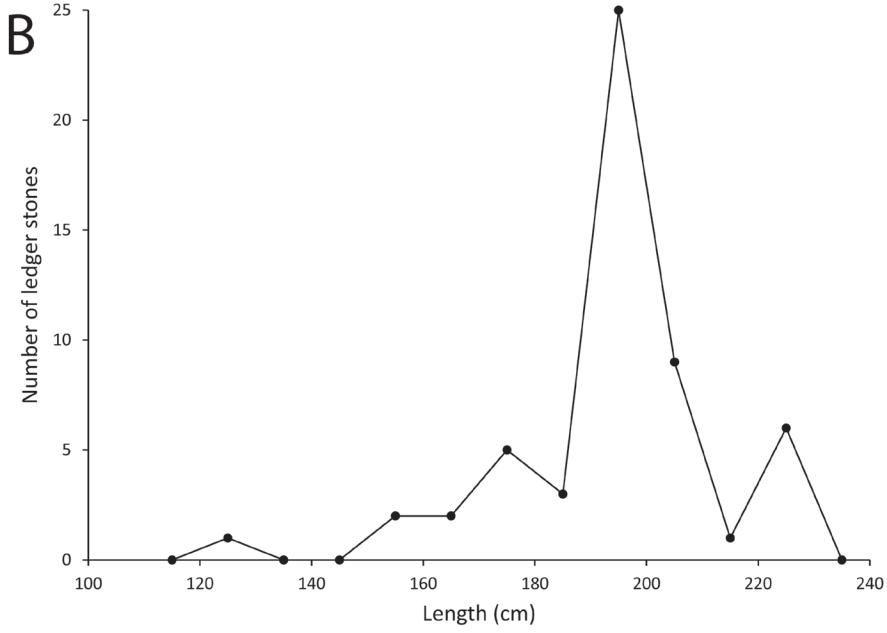

Fig. 3B. Stone length.

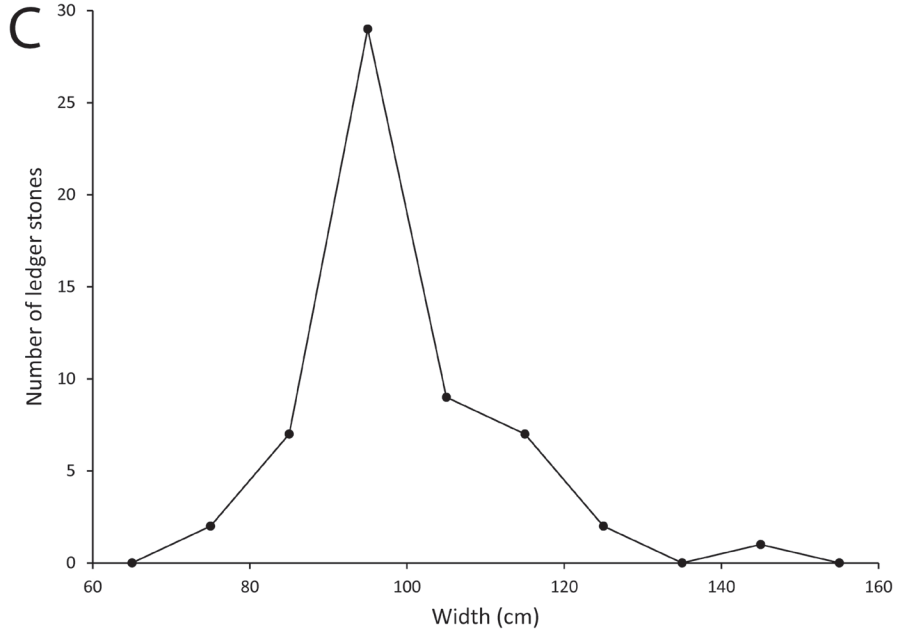

Fig. 3C. Width.

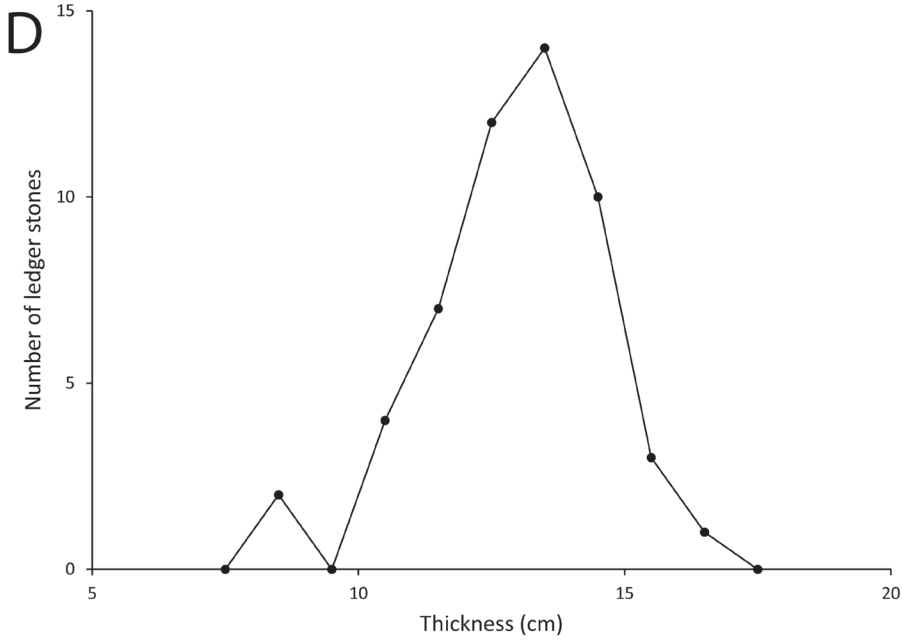

Fig. 3D. Thickness.

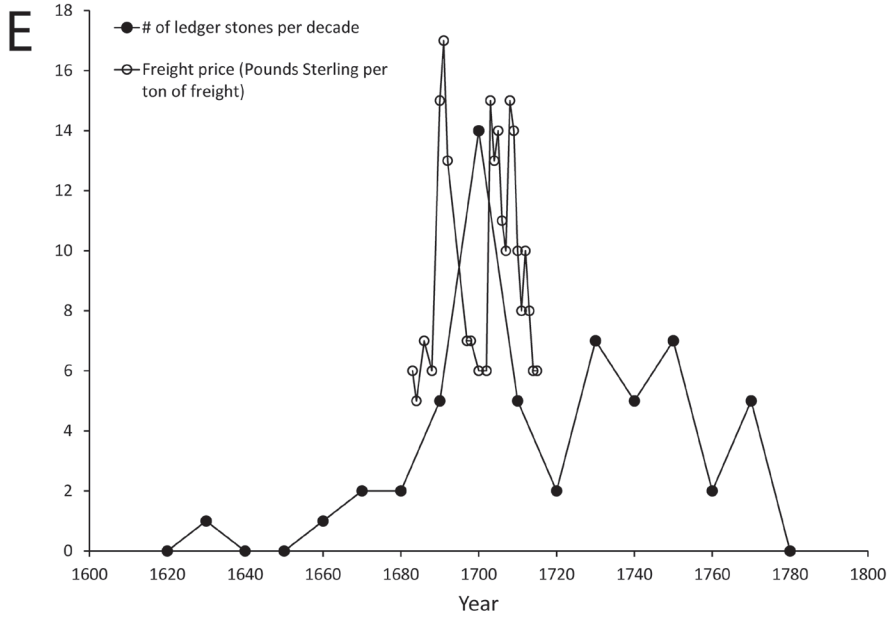

Fig. 3E. Trans-Atlantic freight shipping prices (from Bradburn, 2011, fig II).

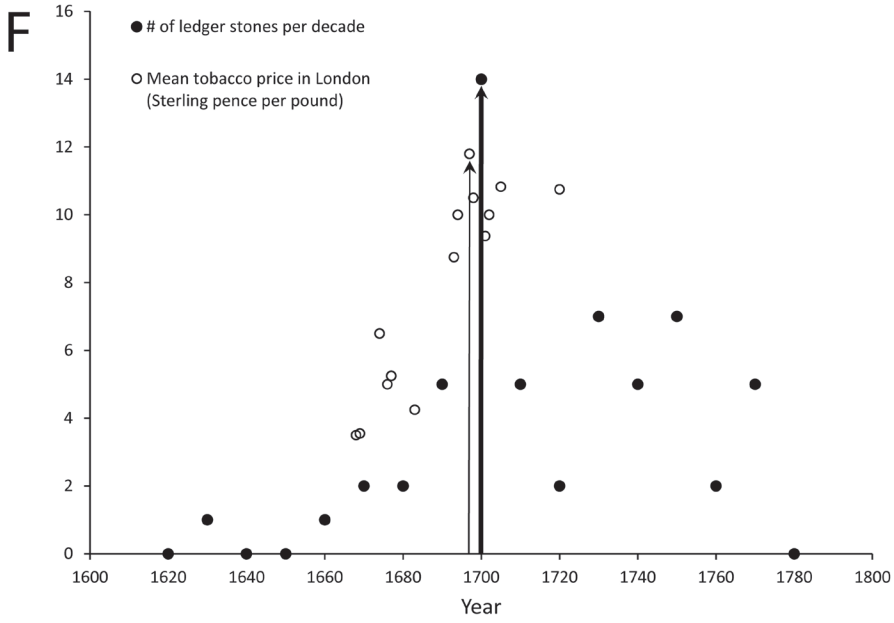

Fig. 3F. Tobacco price in London (from Bradburn, 2011, table I).[124]

Macrofossils identified on the surfaces of the ledger stones include the branching rugose colonial coral *Siphonodendron* sp., the tabulate colonial coral *Syringopora* sp., the rugose solitary coral *Axophyllum* sp., the brachiopod *Nucleospira* sp., and the gastropod *Straparolus* sp. (Fig. 4). We received permission to sample for destructive thin sectioning only 11 (19%) of the 58 colonial-era ledger stones (Table 3). Microfossils identified in thin section include the dasyclad calcareous green alga *Koninckopora inflata*, the foraminiferans (i.e., single celled amoeboid protists) *Earlandia moderata*, *Endothyra bowmani*, *Eostaffella* sp., *Globoendothyra* sp., *Omphalotis minima*, *Tetrataxis* sp., *Paraarchaediscus angulatus*, *P. concavus*, and *P. involutus*, as well as the bryozoan (i.e., colonial marine sessile lophophorate invertebrate animal) *Pseudonematopora* sp. (Fig. 5).

Based on the PBDB, the fossils we found indicate the ledger stones in aggregate are 330.34–346.73 million years old (i.e., from the middle Viséan stage in the Middle Mississippian of the lower Carboniferous period) (Table 3).[30] The most likely source is in Western Europe. Of the 19 species, 17 of them occur in Ireland, 13 occur in present day Belgium, and 11 in England (Table 3). It is im-

Figs. 4A–4D. Diagnostic coral macrofossils found in black "marble" ledger stones in this study. The four fossils are from the ledger stone of Colonel John Page, died January 23, 1692, inside Bruton Parish Church in Williamsburg, VA with cm scale bars.

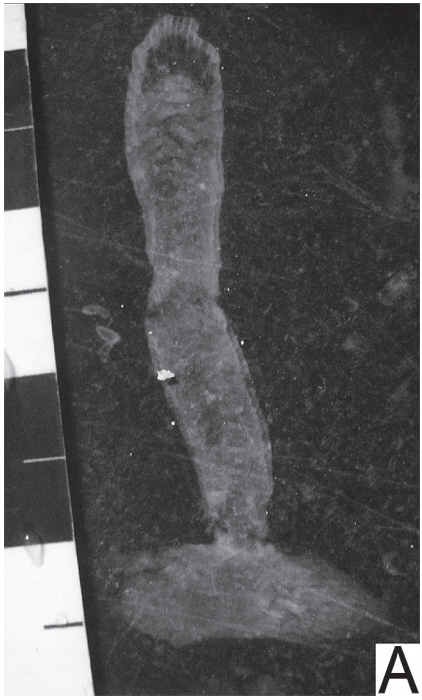

Fig. 4A. Branching rugose colonial coral *Siphonodendron*.

possible to distinguish the faunas from Belgium, England, and Ireland as they have virtually identical assemblages (i.e., no endemic Viséan taxa to either country). This was due to the connectedness of the marine basins of northwestern Europe during high sea level stands in the Dinantian epoch (i.e., middle Mississippian).[31] The faunas in these basins belonged to the same cosmopolitan Palaeotethyan marine realm in the Lower Carboniferous.[32] Regardless of the exact source in Western Europe, a local Chesapeake Bay source must be ruled out as only three of the 19 taxa occur in Maryland or Virginia (Table 3).

The Western European stratigraphic distribution can be further refined by using the primary literature as the Paleobiology Database excludes the finer resolution of the following five foraminiferan species: *Earlandia moderata*, *Omphalotis minima*, *Paraarchaediscus angulatus*, *P. concavus*, and *P. involutus*. Based on all the fossils, the age of the assemblage is most likely 332–343 million years old (i.e., from the Holkerian to Asbian substages of England and Ireland and their Belgian equivalents, the Livian to lower Warnantian substages).[33]

Discussion

Due to the cost of quarrying, shaping, and polishing the ledger stones, transporting them to London, carving the inscriptions, and transporting them to the Chesapeake Bay for installation, imported ledger stones were expensive and only accessible to the wealthiest colonists.[34] But Maryland and Virginia dominated trade between the English colonies in America and Great Britain, so

Fig. 4B. Colonial tabulate coral *Syringopora*.

there would have been money available among the upper class to buy imported ledger stones.[35] At this time, products from the Chesapeake Bay accounted for 60% of the value of American exports to Great Britain and 90% of that value was tobacco.[36]

Though the fossils indicate a source in Western Europe, stone transportation costs suggest a local source should have been more likely. In the stone industry, transportation costs are often the biggest expense, not the stone itself.[37] The ledger stones were heavy. Based on the measured length, width, and thickness dimensions and assuming a limestone density of 2.693 g/cm^3, the ledger stones weighed on average 693 kg (range: 244–1240 kg, standard deviation: 166 kg).[38] Transportation costs are a limiting factor in the delivery range of the stone industry today, and Europe is an ocean away. The transportation costs would have been reduced by 1) using cheaper marine shipping compared to land-based shipping (which wasn't even an option), and 2) by using the stones, which were paid cargo, as ballast.

The use of ledger stones in the English colonies around the Chesapeake Bay peaked in the decade around 1700 (Fig. 3A). This peak coincides with a decade-long drop in shipping freight prices between the Chesapeake Bay and England (Fig. 3E). This suggests that when the cost of shipping a ledger stone to the Chesapeake Bay was lower, English colonists were importing more of them. Of course, this correlation may be due to some other variable such as changes in population/mortality rate among the wealthy colonial planters. The former cause is supported by the fact that the 1700 peak in ledger stone abundance closely matches a 1697 peak in tobacco prices in London (Fig. 3F). This suggests that when Chesapeake Bay tobacco was selling for more in London, the English colonists were able to afford to import more ledger

stones. Similarly, Ross attributed the contemporaneous increase in construction of colonial Virginia mansions to increased tobacco prices.[39]

What can we learn from the dimensions of the ledger stones (Figs. 3B–D)? The coefficient of variation (CV) of ledger stone length and width (i.e., 10.1 and 12.4, respectively) were on average 15% less than that for ledger stone thickness (i.e., 13.0). The lower CVs for length and width reflect the fact that these dimensions can be cut to the desired size dictated by corpse/casket dimensions. In contrast, thickness cannot as easily be trimmed to size, and thus, is controlled more by the naturally varying thickness of the sedimentary layer of rock before being extracted from the ground. This is evident in the length:width ratio, which was tightly constrained with a mean of 2.0 (n: 54, range: 1.4–2.4, standard deviation: 0.2). In contrast to length and width, ledger stone thickness is controlled by bed thickness as well as the necessity to make it as thick as needed so it does not break and to make it as thin as possible to reduce weight for transportation.

In the seventeenth and eighteenth centuries in Maryland and Virginia, most manufactured goods, wines, iron, luxury items, and other materials were imported from England.[40] This is also true for paving stones in the Tidewater of Virginia.[41] More pertinently, previous

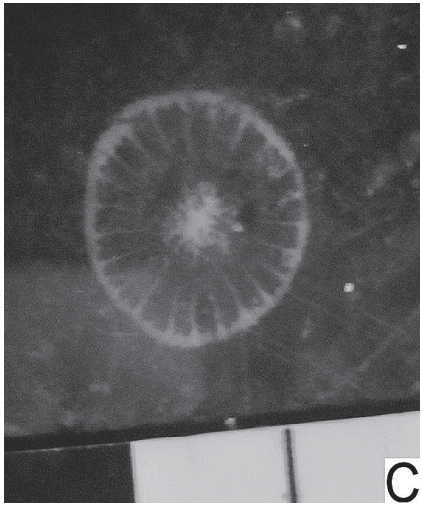

Fig. 4C. Immature corallite of solitary rugose coral *Axophyllum*.

Fig. 4D. Mature corallite of solitary rugose coral *Axophyllum*.

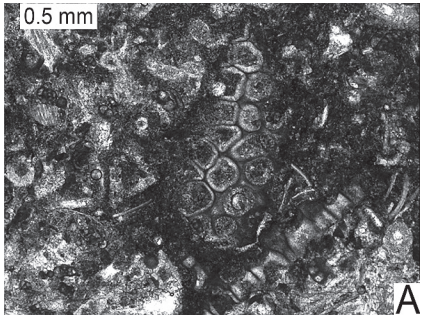

Fig. 5A. Tangential view of the bryozoan *Pseudonematopora* in the ledger stone of Edward Porteus, died 1696.

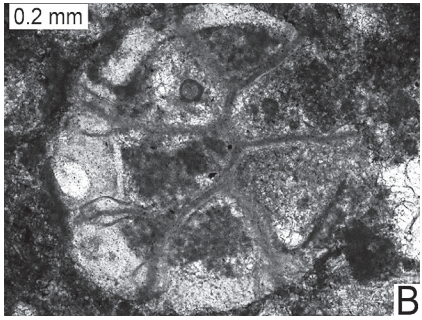

Fig. 5B. Transverse view of the bryozoan *Pseudonematopora* in the ledger stone of Edward Porteus, died 1696.

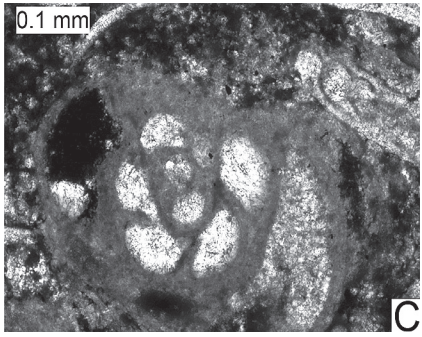

Fig. 5C. Foraminiferan *Paraarchaediscus involutus* in the ledger stone of Doctor Richard Edward, died March 8, 1721.

Figs. 5A–5F. Diagnostic microfossils found in black "marble" ledger stones in this study.

studies based on historical evidence alone argued ledger stones in both Maryland and Virginia were usually imported from England, the dominant market source available at the time.[42] Additional pertinent historical evidence we found for them being imported includes 18 primary wills/letters as well as secondary sources (Table 4). Ranging from 1657 to 1773, these documents record requests for tombstones including black "marble" ledger stones from England. We found no historical evidence for ledger stones being imported from other American colonies, Ireland, or Belgium, directly. For example, John Carter in a codicil he added to his will in September 1669, requested that "a black marble stone be bought to be laid upon my grave in the chancel of Christchurch parish."[43] After ruling out a local North American source with lower transportation costs, we therefore next looked to England.

Evidence against a British Isles source

The three main Lower Carboniferous black "marble" producing areas in Western Europe were England, Ireland, and present-day Belgium.[44] If the Chesapeake Bay ledger stones were from an English limestone, the four most likely candidates are the Frosterly, Purbeck,

Derby Black, and Ashford Black as they were the most commercially widespread "marbles" in their use.[45]

Purbeck "marble" can be ruled out due to its Cretaceous age and wrong lithology (i.e., packstone).[46] Moreover, after ~1200, Purbeck "marble" forced Belgian black "marbles" out of the English market, except for ledger stones which continued to be imported into England from Belgium.[47] The Lower Carboniferous Frosterley "marble" is the right age, and lithologically it is an organic rich, black, fine grained limestone, similar to the Maryland and Virginia ledger stones.[48] It was used for ledger stones as early as 1260 and so would have been a source of black "marbles" in the seventeenth and eighteenth centuries.[49] The Frosterley marble contains numerous individuals of the solitary coral *Dibunophyllum bipartitum*.[50] Our ledger stones lack this distinctive coral, so the Frosterley marble must be ruled out as the source.

The other source of black "marbles" from England come from Ashford-in-the-Water in Derbyshire.[51] The Derby Black "marble" contains abundant crinoids which are absent in the Chesapeake ledger stones. The Ashford Black "marble" is lithologically similar to ours, but it was used for inlay work, not tombslabs.[52] Regardless, it and the Derby Black are geologically too young (i.e., late Viséan).[53]

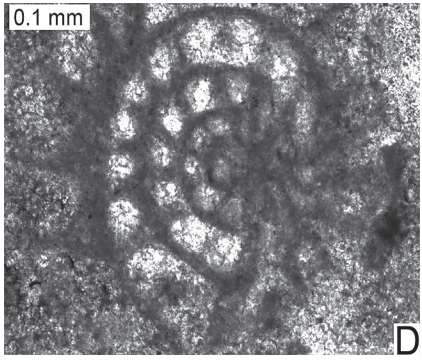

Fig. 5D. Foraminiferan *Eostaffella* in Edward Porteus's ledger stone.

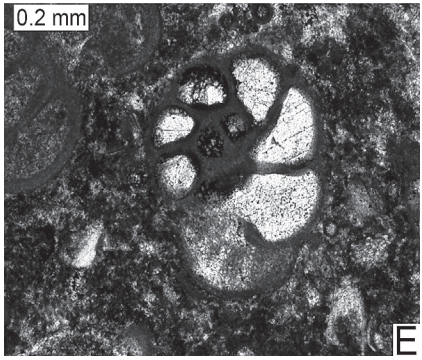

Fig. 5E. Foraminiferan *Paraarchaediscus concavus* in the ledger stone of John Carter Esq., died January 10, 1669.

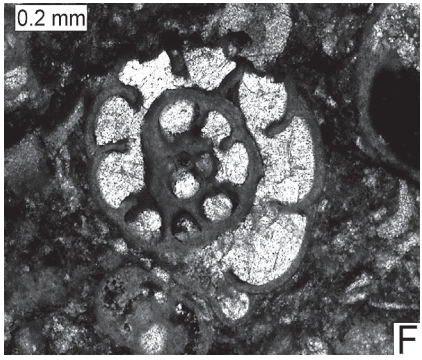

Fig. 5F. Foraminiferan *Endothyra* in the ledger stone of Coll. Augustine Warner, died June 19, 1681.

This lithologic evidence against an English source is supported by the fact that the higher cost of labor in England resulted in most ledger stones there being imported as opposed to being locally quarried, cut, and polished.[54] So if not England, what are the possible sources of Lower Carboniferous black limestones elsewhere in Western Europe? They are Ireland and present-day Belgium.[55]

Irish black "marbles" from Kilkenny, Galway, Limerick, and Kildare were used extensively in Victorian times, including in England.[56] There are five arguments against the Chesapeake ledger stones being imported from Ireland:

1) Irish black "marbles" can be distinguished from those from Belgium or England based on lithology. Irish black "marbles" are typically speckled with small white spots that become more conspicuous when exposed to air.[57] They usually have such abundant and attractive fossils that they were sometimes referred to as "Black Fossil marble" due to the fossils that "stood proud of the surface of the stone."[58] The beds with white macrofossils were the most in demand.[59] The Chesapeake ledger stones generally lack such visible spots and macrofossils. Galway black "marble" has a more similar lithology to the ledger stones in this study, but it was not exported until the 1820s, well after the ledger stones in this study (Fig. 3A).[60]

2) As stated above, the age of the fossil assemblage in the ledger stones is most likely from the Holkerian to Asbian substages of Ireland. The Kilkenny black "marble" is part of the Ballyadams Formation. It was deposited during the Mississippian Foraminiferal Zone (MFZ) 14 in the upper Asbian and is thus too young.[61] Galway black "marble" is part of the Burren Formation. It was deposited during MFZ 13–14 in the late Asbian.[62] Therefore, its age better matches the fossils in the Chesapeake ledger stones, but, as noted, was not exported until the 1820s, well after the ledger stones in this study (Fig. 3A).[63]

3) Irish black "marbles" were not considered to be of the quality of the Belgian black "marbles" in the English dimension stone industry, not because of their color, but due to the inability of the quarries to yield larger slabs free from faults.[64] Therefore, as with the English black "marbles," the Irish black "marbles" were mostly used for chimney/mantel pieces and other smaller items such as candlesticks, vases, and inlay work, not as much for large ledger stones.[65] Kilkenny black "marble" was occasionally cut into ledger and head stones, but they were mostly used locally in Ireland.[66]

4) The timing of commercial production of Irish black "marble" for export does not match the ages of the Chesapeake ledger stones (Fig. 3A). Though

a Kilkenny black "marble" chimneypiece was sent to London in 1664, the extraction, cutting, and polishing of Kilkenny black "marble" really intensified after 1730 when the Kilkenny Marble Works was founded.[67] Assuming Kilkenny black "marble" was already shipping dimension stone to London in 1730 and was available for shipping to the English Chesapeake colonies that same year, only 37% of the ledger stones in this study could have come from Ireland. A Kilkenny chimneypiece was imported for Col. Samuel Washington (brother of George) for his mansion at Harewood, West Virginia, built in 1771.[68] All but one of the Chesapeake ledger stones predate this. By 1842, a hundred tons of Irish black "marble" per year were being shipped to England.[69] Exports of Galway black "marble" began in the 1820s.[70] Thus, Irish black marbles were mainly a Victorian product readily available in London for export, but largely after the ledger stones in this study were purchased. On top of that, shipping costs from Ireland to London were three times higher than Belgium to London.[71]

5) No Irish black "marbles" are listed in the 1734 *Builder's Dictionary* even though marbles throughout the British Isles and continental Europe are listed.[72] Those involved in constructing houses or public buildings like churches or courthouses around the Chesapeake would have known this book. John Carter's grandson John referred to it in a 1738 letter to his brother Charles Carter while discussing building projects at several family seats. Thomas Jefferson had a copy in his personal library at Monticello, Virginia.[73] Thus, it is unlikely architects in Maryland and Virginia would have known of the availability of Irish black "marbles" even if they were for sale in London.

Historical evidence for a source in present day Belgium

If not the British Isles, the next most likely source in Western Europe is Belgium, as it is the most common source of Lower Carboniferous black "marbles" and has been since Roman times.[74] Fossils can only constrain the source of the black "marble" ledger stones to the general area of Western Europe (Table 3), but the historical evidence indicates a more specific source in Belgium.

Belgian black "marble" dimension stone was exported across western and northern Europe (i.e., France, The Netherlands, England, Germany, Luxemburg, Denmark, Norway, Sweden, Poland, Lithuania, Ukraine, Portugal, Italy, and Hungary).[75] More pertinently, it was also used for ledger stones which were exported to Sweden, Poland, Madeira, France, Scotland,

and most notably, to England.[76] From the Middle Ages and into the mid-seventeenth century followed by a later resurgence in the eighteenth and nineteenth centuries, black "marble" was in vogue among the English who were wealthy enough to afford it to commemorate their dead.[77] The jet black Belgian "marbles" were the most in demand and expensive.[78] Successful Chesapeake tobacco planters like John Carter, who had lived in or traveled to London, would have been familiar with the latest English fashions and tried to replicate these in the colonies. For colonists like Carter, these black marble ledgers not only commemorated their accomplishments and virtues but boldly proclaimed their family's elite position in colonial life.[79]

Trade of Belgian black "marble" was controlled by shipping routes down rivers and across the English Channel to London because weight was the principal limitation on the exploitation and transportation of the heavy ledger stones.[80] Belgian black "marble" was quarried in the southern (Wallonia) part of Belgium in the Meuse River valley, shipped downstream on barges to the transshipment port in Dordrecht where the Meuse and Rhine rivers join and where it was reloaded on to sea vessels and shipped throughout the North Sea, including England.[81]

Though we found no historical evidence for the export of Belgian black "marble" directly to the English colonies in America, there are references to international exports of black "marble" from the Meuse Valley to London in the seventeenth century via commercial stone merchants in Amsterdam.[82] Belgian black "marbles" from both Dinant and Namur were known in Maryland and Virginia at this time as they were listed as stones commercially available in the 1734 *Builder's Dictionary*.[83] In contrast, no black "marbles" are listed in the dictionary from the other black "marble" producing region of Belgium, Tournai.[84]

From the second half of the sixteenth century to the eighteenth century, there was a large group of Dutch and Flemish merchants involved in the export trade of Belgian black "marble."[85] By the seventeenth century, nearly all the tombstone workers in London used imported black "marble" shipped from Amsterdam.[86] By the 1630s, English traders were shipping these tombstones to Virginia.[87] We know stones for other purposes were imported from London merchants into the colonies such as stone for steps and floor pavers.[88] Except for the more elaborately carved ledger stones (e.g., the tomb for Thomas Nelson (1677–1747) at Grace Episcopal church in Yorktown, Virginia), the basic ledger stones were stock items provided by London shops for the colonial trade.[89] A

good example would be John Carter's at Christ Church in Lancaster County, Virginia.[90] Belgian black "marble" was also imported into Virginia for use in the floor of the Governor's Palace in Williamsburg.[91]

Geological evidence for a source in Belgium

Belgian black "marbles" formed from the Frasnian stage of the Devonian period to the Late Viséan stage of the Carboniferous period.[92] The most abundant are from the Lower Carboniferous Dinantian limestones which are subdivided by age into the older Tournasian from the Tournai-Doornik area and the younger Viséan from the Dinant-Namur area.[93] "Marbre Noir de Dinant" quarried in the main stonecutting centers of the Meuse Valley (i.e., Dinant, Namur, Liège, and Theux) yielded larger, more cohesive blocks more suitable for ledger stones compared to the "Marbre Noir de Namur."[94] The fossils found in the Chesapeake Bay ledger stones suggest a source in the younger limestones from the Livian to lower Warnantian substages of Belgium in the Meuse River Valley (Table 3).[95] In particular, black "marbles" from the Lives part of Namur were traded more broadly than other Belgian black "marbles" as they could be shipped down the Meuse River to the Netherlands and from there to the North Sea, providing easy access to London.[96] Additionally, the types of limestones we identified (i.e., Dunham's wackestone and mudstone, Folk's biomicrite) matched those described by Tourneur's proposal for Belgian black "marble" as a Global Heritage Stone.[97]

In addition to the historical evidence mentioned above, we reject the Tournai source and hypothesize that the Dinant-Namur limestones were the source based on the following eight pieces of geologic evidence in the Chesapeake Bay ledger stones. The Tournai "marble" is a dense, fine grained, silicified, bioclastic packstone with abundant crinoid allochems but lacking foraminifera.[98] In contrast, our ledger stones are more similar to the Dinant-Namur limestones which 1) have less silicification, 2) lack crinoids, 3) have abundant foraminifera, and 4) have a biomicrite lithology that is indicative of the facies outcropping around the Dinant-Namur area of the Meuse River Valley. 5) The Tournai "marbles" have a more bluish-black color compared to the purer black color of the Chesapeake Bay ledger stones and the Dinant-Namur "marbles."[99] 6) The Belgian black "marbles" from the Dinant-Namur area and the fossils from our ledger stones are Viséan in age, whereas those from the Tournai area are Tournaisian.[100] 7) Unlike the Dinant-Namur "marbles" and the indoor

Chesapeake Bay ledger stones, those from Tournai do not take a shining polish.[101] 8) Unlike the Dinant-Namur "marbles" and the outdoor Chesapeake Bay ledger stones, those from Tournai weather into a crumbly slate-like appearance due to schistose delamination.[102]

Conclusion

A survey of black "marble" ledger stones from seventeenth and eighteenth century cemeteries in the English colonies of Maryland and Virginia surrounding the Chesapeake Bay, U.S.A., indicate they are technically not marble but compact organic rich limestone. The ledger stones were on average 2 m long, by 1 m wide, by 10 cm thick. They reached a peak in use around 1700. Their pre-revolution temporal abundance is positively correlated with tobacco prices and inversely correlated with shipping costs from England. Petrographic thin sections from the ledger stones allowed identification of fossil algae, foraminiferans, corals, brachiopods, gastropods, and bryozoans. The biostratigraphic ranges of the fossils indicate they lived during the middle Viséan stage in the Middle Mississippian of the lower Carboniferous period. The paleobiogeographical distributions of the fossils indicate a Western European source. Lithological and historical evidence suggests they are specifically from the Meuse River Valley, Belgium. Primary historical sources from English colonists provide additional evidence in the form of requests for black "marble" ledger stones to be sent from England. We argue the ledger stones were shipped from Belgium to London and then to the Chesapeake Bay. Knowing the geologic source of the ledger stones will permit more effective future conservation or replacement.

This study also contributes another piece to our understanding of the broader Atlantic World history of colonial trade routes. Our study shows that the English colonists were not solely restricted to importing English manufactured goods. English trade with continental Europe gave the English colonists around the Chesapeake Bay access to a much broader suite of non-English goods such as black "marble" tombstones from what is today known as the country of Belgium.

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Table 1

Colonial era cemeteries around the Chesapeake Bay that were examined for ledger stones for this study and the number of the various lithologies found at the site

N - (Northern, i.e., MD) or S - (Southern, i.e., VA) part of the Bay	E - (Eastern) or W - (Western) side of the Bay	Name	Address	black "marble" limestone	white marble	sandstone	Portland Stone	Purbeck Stone	Sum
N	E	Lloyd Family at Wye House	26080 Bruffs Island Road, Easton, MD 21601	0	0	0	0	0	0
N	E	Old White Marsh	Manadier Road, immediately east of US Route 50, Trappe, MD 21673	0	3	0	0	0	3
N	E	Bennett's Point	101-199 Ice House Point Road, Queenstown, MD 21658	2	1	0	0	0	3
N	E	Great Choptank Parish, Christ Church Episcopal	601 Church Street, Cambridge, MD 21613	2	0	7	2	0	11
N	W	Hammond Family	100 Dairy Lane, Gambrills, MD 21054	0	0	0	0	0	0
N	W	Contee Family/ Brookefield	11704 Fenno Road, Upper Marlboro, MD 20772	1	0	0	0	0	1
N	W	Covington Family	17160 Aquasco Farm Road, Aquasco, MD 20608	0	0	0	0	0	0
N	W	Marshall Hall	Marshall Hall Road Landing, Bryans Road, MD 20616	0	0	1	4	0	5
N	W	Stoddert Family (a.k.a., Wicomico House at West Hatton Estate)	~5420 Sir Douglas Drive, Bryans Road, MD 20616	0	0	0	0	0	0

N - (Northern, i.e., MD) or S - (Southern, i.e., VA) part of the Bay	E - (Eastern) or W - (Western) side of the Bay	Name	Address	black "marble" limestone	white marble	sandstone	Portland Stone	Purbeck Stone	Sum
N	W	Sothoron Family (a.k.a., The Plains)	~29748 Allen Road, Mechanicsville, MD 20659	0	6	4	2	0	12
N	W	Middleham Chapel	10210 H.G. Trueman Road, Lusby, MD 20657	0	1	0	1	0	2
N	W	St. Aloysius Gonzaga Catholic Church	~41640 Cemetery Road, Leonardtown, MD 20650	0	0	0	0	0	0
N	W	Ellenborough (a.k.a., Harris Family)	22855 Cedar Lane Road, Leonardtown, MD 20650	0	1	0	0	0	1
N	W	St. Andrews Episcopal Church	44078 St. Andrews Church Road, California, MD 20619	0	0	0	0	0	0
N	W	Our Lady's Church at Medley's Neck	41410 Medley Neck Road, Leonardtown, MD 20650	0	0	0	0	0	0
N	W	St. Joseph's Catholic Old Cemetery	~40015 Busy Corner Road, Leonardtown, MD 20650	0	1	0	0	0	1
N	W	Christ Episcopal Church	25390 Maddox Road, Chaptico, MD 20621	0	3	0	0	0	3
N	W	Deep Falls cemetery	??? Deep Falls Road, Chaptico, MD 20621	0	4	0	0	0	4
N	W	St. John Francis Regis Catholic Parish	43950 St. John's Road, Hollywood, MD 20636	0	0	0	0	0	0
N	W	Oldfields Episcopal Chapel of Trinity Parish	15837 Prince Frederick Road, Hughesville, MD 20637	0	0	0	0	0	0
N	W	All Faith Episcopal Church	38885 New Market Turner Road, Mechanicsville, MD 20659	0	0	0	0	0	0

N - (Northern, i.e., MD) or S - (Southern, i.e., VA) part of the Bay	E - (Eastern) or W - (Western) side of the Bay	Name	Address	black "marble" limestone	white marble	sandstone	Portland Stone	Purbeck Stone	Sum
N	W	St. Mary's Aquasco Episcopal Church	~22204 Aquasco Road, Aquasco, MD 20608	0	1	0	0	0	1
N	W	Bowie Family cemetery	Our Lady of Mattaponi Retreat Center, 11000 Mattaponi Road, Upper Marlboro, MD 20772	0	0	0	0	0	0
N	W	St. Thomas' Episcopal Parish Church	14300 St Thomas Church Road, Upper Marlboro, MD 20772	0	0	0	0	0	0
N	W	St. Francis Xavier Catholic Church	21700 Newtowne Neck Road, Newtowne, MD 20650	0	1	0	0	0	1
N	W	Christ Church Calvert County	3100 Broomes Island Rd, Port Republic, MD 20676	1	2	0	0	0	3
N	W	Trent Hall Farm family cemetery	29350 Trent Hall Road, Mechanicsville, MD 20659	1	0	0	0	0	1
N	W	Rousby Family	Jefferson Patterson Park and Museum, 10515 Mackall Road, St. Leonard, MD 20685	1	0	0	0	0	1
N	W	St. George's Episcopal Church	19167 Poplar Hill Lane, Valley Lee, MD 20692	2	0	0	0	0	2
N	W	St. Anne's Episcopal Church	Church Circle, Annapolis, MD 21401	4	5	0	0	0	9
N	W	All Hallows Brick Church	3604 Solomons Island Road, Edgewater, MD 21037	4	4	0	0	0	8
S	E	Hungars Episcopal Church	10118 Bayside Road, Machipongo, VA 23405	0	0	0	0	0	0
S	E	Custis Family at Arlington	2161 Arlington Chase Road, Cape Charles, VA 23310	1	1	0	0	0	2

N - (Northern, i.e., MD) or S - (Southern, i.e., VA) part of the Bay	E - (Eastern) or W - (Western) side of the Bay	Name	Address	black "marble" limestone	white marble	sandstone	Portland Stone	Purbeck Stone	Sum
S	E	Eyre Hall	3215 Eyre Hall Drive, Cheriton, VA 23316	3	1	0	0	0	4
S	W	Falls Church Episcopal Church (a.k.a., Old Falls Church)	115 East Fairfax Street, Falls Church, VA 22046	0	0	0	0	0	0
S	W	Historic Christ Church	118 N. Washington Street, Alexandria, VA 22314	0	0	0	0	0	0
S	W	Pohick Episcopal Church	9301 Richmond Hwy, Lorton, VA 22079	0	0	2	1	0	3
S	W	Aquia Episcopal Church	2938 Jefferson Davis Highway, Stafford, VA 22555	0	3	3	0	0	6
S	W	Vauter's Episcopal Church	3661 Tidewater Trail, Loretto, VA 22438	0	0	2	0	0	2
S	W	Leedstown (a.k.a., Birkett-Hungerford-Griffith cemetery)	373 Resolutions Road, Leedstown, VA 22443	0	0	2	0	0	2
S	W	Cople Parish Episcopal Yeocomico Church	72 Coles Point Road, Hague, VA 22469	0	0	0	0	0	0
S	W	Four Mile Tree Plantation	7741 Swanns Point Road, Surry, VA 23881	0	3	0	0	0	3
S	W	Lynnhaven House	4405 Wishart Road, Virginia Beach, VA 23455	0	1	0	0	0	1
S	W	Gooch Tomb	1 U.S. Coast Guard Training Center, Yorktown, VA 23690	1	0	0	0	0	1
S	W	Bruton Parish Church	201 West Duke of Gloucester Street, Williamsburg, VA 23185	1	0	0	0	0	1

N - (Northern, i.e., MD) or S - (Southern, i.e., VA) part of the Bay	E - (Eastern) or W - (Western) side of the Bay	Name	Address	black "marble" limestone	white marble	sandstone	Portland Stone	Purbeck Stone	Sum
S	W	Blandford Church	319 South Crater Road, Petersburg, VA 23803	1	0	3	0	0	4
S	W	Old Donation Episcopal Church	4449 N. Witchduck Rd, Virginia Beach, VA 23455	1	0	1	0	0	2
S	W	Bellfield Plantation	Colonial National Historic Parkway, Yorktown, VA 23691	2	0	0	1	0	3
S	W	Grace Episcopal Church	115 Church Street, Yorktown, Virginia 23690	2	0	0	1	2	5
S	W	St. Luke's Historic Church	14477 Benn's Church Boulevard, Smithfield, VA 23430	2	0	0	0	0	2
S	W	St. Mary's Whitechapel Episcopal Church	5940 White Chapel Road, Lively, VA 22503	3	0	0	2	0	5
S	W	Jamestown Memorial Church	1368 Colonial Parkway, Jamestown, VA 23081	3	0	0	0	0	3
S	W	Historic Christ Church	420 Christ Church Road, Irvington, VA 22576	4	0	0	0	0	4
S	W	Warner Hall	4750 Warner Hall Road, Gloucester, VA 23061	4	0	0	0	0	4
S	W	Ware Episcopal Church	7825 John Clayton Memorial Highway, Gloucester, VA 23061	5	0	0	0	0	5
S	W	Christ Church Parish	56 Christchurch Lane, Saluda, VA 23149	7	0	0	0	0	7
S	W	Abingdon Episcopal Church	4645 George Washington Memorial Highway, White Marsh, VA 23183	7	2	0	0	0	9

Table 2

Name, location, death date, dimensions, color, and lithology of ledger stones used in this study. Sorted by death date.

Name on Ledger Stone	Cemetery Location	Death Date	Length (cm)	Width (cm)	Thickness (cm)	Color Code Weathered Surface †	Color Semantic Equivalent Weathered Surface †	Color Code Fresh Surface †	Color Semantic Equivalent Fresh Surface †	Dunham (1962) Lithology
Knight's Tomb*	Jamestown Memorial Church, Jamestown, VA	13 NOV 1627	171.9	80.4	12.2	1 for gley 5/N	gray	1 for gley 2.5/N	black	wackestone
Major William Gooch	U.S. Coast Guard Training Center, Yorktown, VA	29 OCT 1655	202.8	83.0	15.7	1 for gley 6/N	gray	*****	*****	wackestone
John Carter Esq.	Christ Church, Irvington, VA	10 JAN 1669	229.2	143.5	14.0	****	****	1 for gley 2.5/N	black	wackestone
Mr. Edward Thompson	Christ Church Parish, Saluda, VA	29 APR 1674	155.4	72.4	***	****	****	1 for gley 3/N	very dark gray	wackestone
Coll. Augustine Warner	Warner Hall, Gloucester, VA	19 JUN 1681	198.1	99.2	14.2	1 for gley 6/N	gray	1 for gley 3/N	very dark gray	wackestone

Xpher Rousbie Esquire	Jefferson Patterson Park and Museum, St. Leonard, MD	31 OCT 1684	168.0	119.0	13.4	1 for gley 7/10Y	light greenish gray	1 for gley 2.5/N	black	wackestone
Col. William Burgess Esq.	All Hallows Brick Church, Edgewater, MD	24 JAN 1686	229.0	109.0	8.9	1 for gley 6/N	gray	1 for gley 2.5/N	black	wackestone
Augustine Warner	Warner Hall, Gloucester, VA	17 MAR 1686	170.1	85.2	13.8	1 for gley 6/N	gray	1 for gley 3/N	very dark gray	wackestone
Hon. Joseph Bridger Esq.	St. Luke's Historic Church, Smithfield, VA	15 APR 1686	189.6	106.5	13.6	1 for gley 6/10GY	greenish gray	1 for gley 2.5/N	black	mudstone
Colonel John Page	Bruton Parish Church, Williamsburg, VA	23 JAN 1692	217.4	129.9	14.6	****	****	1 for gley 2.5/N	black	wackestone
John Mann	Abingdon Episcopal Church, White Marsh, VA	7 JAN 1694	182.5	90.3	16.4	2 for gley 7/10G	light greenish gray	*****	*****	mudstone
John Custis	Custis Family at Arlington, Cape Charles, VA	29 JAN 1696	200.9	99.8	14.5	2 for gley 5/5BG	greenish gray	*****	*****	wackestone
Edward Porteus	Ware Episcopal Church, Gloucester, VA	1696	176.5	99.6	12.2	1 for gley 5/10Y	greenish gray	1 for gley 3/N	very dark gray	wackestone
Anne Randall	St. Luke's Historic Church, Smithfield, VA	23 JUL 1696	208.9	108.1	13.6	1 for gley 6/10GY	greenish gray	1 for gley 2.5/N	black	mudstone
Lewis Burwell	Abingdon Episcopal Church, White Marsh, VA	17 SEP 1696	157.1	71.8	8.0	1 for gley 6/10Y	greenish gray	*****	*****	mudstone
Anne Sparrow	All Hallows Brick Church, Edgewater, MD	25 JUL 1697	**	97.6	10.6	1 for gley 6/N	gray	*****	*****	wackestone

Name on Ledger Stone	Cemetery Location	Death Date	Length (cm)	Width (cm)	Thickness (cm)	Color Code Weathered Surface †	Color Semantic Equivalent Weathered Surface †	Color Code Fresh Surface †	Color Semantic Equivalent Fresh Surface †	Dunham (1962) Lithology
William Sherwood	Jamestown Memorial Church, Jamestown, VA	18 AUG 1697	166.5	83.7	14.6	1 for gley 5/10Y	greenish gray	1 for gley 3/N	very dark gray	wackestone
Colln. Nicholas Greenberry	St. Anne's Episcopal Church, Annapolis, MD	17 DEC 1697	226.1	127.0	***	1 for gley 7/N	light gray	*****	*****	wackestone
Mrs. Ann Greenberry	St. Anne's Episcopal Church, Annapolis, MD	27 APR 1698	198.5	97.6	***	1 for gley 6/N	gray	*****	*****	mudstone
William Burgess	All Hallows Brick Church, Edgewater, MD	28 JUN 1698	195.6	96.8	11.3	1 for gley 7/N	light gray	*****	*****	wackestone
Mr. Henry Ridgely	St. Anne's Episcopal Church, Annapolis, MD	19 MAR 1699	229.5	114.9	12.1	1 for gley 7/N	light gray	*****	*****	wackestone
Samuel Holt	St. George's Episcopal Church, Valley Lee, MD	29 MAR 1701	122.9	89.6	***	****	****	1 for gley 3/N	very dark gray	wackestone
Col. Mathew Page	Abingdon Episcopal Church, White Marsh, VA	9 JAN 1703	198.3	111.2	14.4	2 for gley 5/10G	greenish gray	*****	*****	wackestone
Mary Mann	Abingdon Episcopal Church, White Marsh, VA	18 MAR 1703	197.9	99.5	14.9	2 for gley 5/5BG	greenish gray	*****	*****	mudstone

John Herbert	Blandford Church, Petersburg, VA	17 MAR 1704	**	97.2	13.8	2 for gley 6/5PB	bluish gray	*****	*****	wackestone
Mary Page	Abingdon Episcopal Church, White Marsh, VA	24 MAR 1707	198.5	98.6	11.9	1 for gley 5/N	gray	*****	*****	wackestone
Major Generall John Hammond	St. Anne's Episcopal Church, Annapolis, MD	24 NOV 1707	199.7	99.1	11.5	2 for gley 6/5PB	bluish gray	*****	*****	wackestone
Col. Dudley Digges	Bellfield Plantation, Yorktown, VA	18 JAN 1710	200.7	99.3	13.8	1 for gley 5/N	gray	*****	*****	wackestone
Lewis Burwell	Abingdon Episcopal Church, White Marsh, VA	19 DEC 1710	225.8	111.5	14.5	1 for gley 7/N	light gray	*****	*****	mudstone
Mrs. Sarah Blair	Jamestown Memorial Church, Jamestown, VA	5 MAY 1713	**	**	13.8	1 for gley 5/N	gray	*****	*****	mudstone
Doctor Richard Edwards	Ware Episcopal Church, Gloucester, VA	8 MAR 1721	202.1	100.5	11.0	1 for gley 5/N	gray	1 for gley 2.5/N	black	wackestone
James Clack	Ware Episcopal Church, Gloucester, VA	20 DEC 1723	170.6	84.3	13.4	1 for gley 5/N	gray	1 for gley 3/N	very dark gray	wackestone
Johanness Wormley	Christ Church Parish, Saluda, VA	7 FEB 1727	199.3	96.3	13.1	2.5Y 7/1	light gray	*****	*****	mudstone
Mann Page Esq.	Abingdon Episcopal Church, White Marsh, VA	24 JAN 1730	198.4	113.4	13.4	2 for gley 7/10B	light bluish gray	1 for gley 2.5/N	black	mudstone
Mary Conway Ball	St. Mary's Whitechapel Episcopal Church, Lively, VA	15 SEP 1730	199.9	100.3	12.7	1 for gley 6/N	gray	1 for gley 3/N	very dark gray	wackestone

Name on Ledger Stone	Cemetery Location	Death Date	Length (cm)	Width (cm)	Thickness (cm)	Color Code Weathered Surface †	Color Semantic Equivalent Weathered Surface †	Color Code Fresh Surface †	Color Semantic Equivalent Fresh Surface †	Dunham (1962) Lithology
Catherine Walker	Christ Church Parish, Saluda, VA	15 OCT 1730	**	100.5	15.2	1 for gley 7/N	light gray	1 for gley 3/N	very dark gray	mudstone
Mrs. Lucy Dixon	Ware Episcopal Church, Gloucester, VA	22 NOV 1731	199.2	99.2	13.4	1 for gley 5/N	gray	1 for gley 3/N	very dark gray	wackestone
Rev. Mr. Leigh Massey	St. George's Episcopal Church, Valley Lee, MD	10 JAN 1732	183.4	91.4	***	****	****	1 for gley 2.5/N	black	mudstone
Bartholomew Yates	Christ Church Parish, Saluda, VA	26 JUL 1734	191.6	96.5	12.3	1 for gley 6/10Y	greenish gray	*****	*****	mudstone
Reverend Mr. Jonathan Cay	Christ Church Calvert County, Port Republic, MD	19 MAY 1737	198.3	99.3	11.1	1 for gley 5/N	gray	1 for gley 2.5/N	black	mudstone
Joanna Edwards	Ware Episcopal Church, Gloucester, VA	8 FEB 1739	174.4	86.4	11.3	1 for gley 5/N	gray	1 for gley 2.5/N	black	wackestone
Thomas Gassaway	All Hallows Brick Church cemetery, Edgewater, MD	12 SEP 1739	199.3	100.0	14.8	2 for gley 6/5PB	bluish gray	*****	*****	wackestone
Elizabeth Bennett	Bennett's Point, Queenstown, MD	3 APR 1740	206.2	114.0	14.6	2 for gley 6/5PB	bluish gray	*****	*****	wackestone

Col. Cole Digges	Bellfield Plantation, Yorktown, VA	1744	199.6	96.2	10.1	1 for gley 6/N	gray	*****	*****	wackestone
Thomas Nelson	Grace Episcopal Church, Yorktown, VA	7 OCT 1745	201.8	99.6	12.6	1 for gley 6/N	gray	*****	*****	wackestone
Coll. Leonard Hollyday	Contee Family/Brookefield, Upper Marlboro, MD	6 MAY 1747	198.3	99.2	15.2	2.5Y 7/1	gray	1 for gley 2.5/N	black	mudstone
Jesse Ball Gent.	St. Mary's Whitechapel Episcopal Church, Lively, VA	14 AUG 1747	199.5	100.3	13.0	1 for gley 6/N	gray	*****	*****	wackestone
John Grymes	Christ Church Parish, Saluda, VA	2 NOV 1748	198.5	98.9	13.4	1 for gley 5/N	gray	*****	*****	wackestone
Lucy Grymes	Christ Church Parish, Saluda, VA	3 MAR 1749	199.3	99.5	13.2	1 for gley 6/5GY	greenish gray	*****	*****	wackestone
Mr. Jeduthan Ball	St. Mary's Whitechapel Episcopal Church, Lively, VA	5 MAR 1749	198.3	98.2	12.4	1 for gley 7/N	light gray	*****	*****	wackestone
Richard Bennett Esq.	Bennett's Point, Queenstown, MD	11 OCT 1749	227.9	111.9	12.8	1 for gley 5/N	gray	*****	*****	wackestone
Rebbeca Caile	Great Choptank Parish Christ Church Episcopal, Cambridge, MD	AUG 1758	200.5	98.5	11.8	1 for gley 7/N	light gray	1 for gley 2.5/N	black	wackestone
Sarah Bowdoin	Eyre Hall, Cheriton, VA	19 DEC 1760	199.0	98.7	11.0	1 for gley 6/N	gray	*****	*****	mudstone
John Calie Esq.	Great Choptank Parish Christ Church Episcopal, Cambridge, MD	27 APR 1767	203.3	100.0	12.1	1 for gley 7/N	light gray	1 for gley 3/N	very dark gray	wackestone

Name on Ledger Stone	Cemetery Location	Death Date	Length (cm)	Width (cm)	Thickness (cm)	Color Code Weathered Surface †	Color Semantic Equivalent Weathered Surface †	Color Code Fresh Surface †	Color Semantic Equivalent Fresh Surface †	Dunham (1962) Lithology
Littleton Eyre	Eyre Hall, Cheriton, VA	26 JUN 1768	198.1	94.4	12.1	1 for gley 7/10Y	light greenish gray	*****	*****	wackestone
Bridget Harmanson Eyre	Eyre Hall, Cheriton, VA	1768	197.9	96.6	12.3	1 for gley 7/10Y	light greenish gray	*****	*****	wackestone
Col. Anthony Walke	Old Donation Episcopal Church, Virginia Beach, VA	8 NOV 1768	198.7	98.5	10.7	1 for gley 6/N	gray	1 for gley 3/N	very dark gray	wackestone
Honorable William Nelson Esquire	Grace Episcopal Church, Yorktown, VA	19 NOV 1772	193.4	98.9	12.1	2 for gley 6/10BG	greensh gray	*****	*****	wackestone

* Brass-inlay presumably containing name is missing, but the burial has long been attributed to Sir (Gov.) George Yeardley.[103]
** Could not be measured as the stone was incompletely exposed.
*** Could not be measured as the bottom of the stone was inaccessible.
**** Could not be measured as the stone was inside a church.
***** Could not be meausred as there was no access to interior of stone.
† Munsell (2009)

Table 3

Geographic and stratigraphic ranges of fossils identified in the ledger stones in this study. Data are from the Paleobiology Database unless augmented by the primary literature*

Taxon	Geographic Range	Stratigraphic Range	Name on Ledger Stone Containing Taxon
Axophyllum sp.	Mid-western North America, Europe (including Belgium, England, and Ireland)	Middle Mississippian (Viséan) - Upper Pennsylvanian (Gzhelian)	Colonel John Page
Earlandia sp.	Mid-western North America, Europe (including Belgium, England, and Ireland)	Lower Devonian (Pragian) - Lower Cretaceous (Hauterivian)	Col. William Burgess Esq., James Clack, Doctor Richard Edwards, Xpher Rousbie Esquire
*Earlandia moderata**	Mid-western and Western North America, Europe (including France and Russia)	Middle Mississippian (Viséan)	Col. William Burgess Esq., William Sherwood
Endothyra sp.	Mid-western North America, Europe (including Belgium, England, and Ireland)	Lower Mississippian (Tournaisian) - Upper Triassic (Rhaetian)	Col. William Burgess Esq., John Carter Esq., Doctor Richard Edwards, Knight's Tomb, Augustine Warner, Coll. Augustine Warner
Endothyra bowmani	Western North America, Europe (including England)	Middle Mississippian (Viséan) - Middle Pennsylvanian (Moscovian)	Col. William Burgess Esq., William Sherwood
Eostaffella sp.	Mid-western North America, Europe (including Belgium and Ireland)	Middle Mississippian (Viséan) - Permian (Sakmarian)	Edward Porteus

Taxon	Geographic Range	Stratigraphic Range	Name on Ledger Stone Containing Taxon
Globoendothyra sp.	Western North America, Europe (including Belgium and Ireland)	Middle Mississippian (Viséan) - Middle Pennsylvanian (Moscovian)	John Carter Esq., Xpher Rousbie Esquire
Koninckopora sp.	Europe (including Belgium, England, and Ireland)	Middle Mississippian (Viséan) - Upper Mississippian (Serpukhovian)	Edward Porteus
Nucleospira sp.	North America (including western Maryland), Europe (including Belgium, England, and Ireland)	Silurian (Rhuddanian) - Permian (Kungurian)	Major General John Hammond
Omphalotis sp.	Europe (including Belgium, England, and Ireland)	Middle Mississippian (Viséan) - Upper Mississippian (Serpukhovian)	Col. William Burgess Esq., Doctor Richard Edwards, William Sherwood
*Omphalotis minima**	Europe (including Belgium and Ireland)	Middle Mississippian (Viséan)	Doctor Richard Edwards
*Paraarchaediscus angulatus**	Europe (including Ireland)	Middle Mississippian (Viséan)	Knight's Tomb
*Paraarchaediscus concavus**	Europe (including Ireland)	Middle Mississippian (Viséan)	John Carter Esq., Knight's Tomb
*Paraarchaediscus involutus**	Europe (including Ireland)	Middle Mississippian (Viséan)	Doctor Richard Edwards
Pseudonematopora sp.	Europe (including Ireland)	Lower Mississippian (Tournaisian) – Middle Mississippian (Viséan)	Edward Porteus

Taxon	**Geographic Range**	**Stratigraphic Range**	**Name on Ledger Stone Containing Taxon**
Siphonodendron sp.	Western North America, Europe (including Belgium, England, and Ireland)	Middle Devonian (Givetian) - Lower Pennsylvanian (Bashkirian)	Colonel John Page
Straparolus sp.*	North America (including western Maryland), Europe (including Belgium, England and Ireland)	Upper Ordovician (Sanbian) - Lower Cretaceous (Albian)	John Carter Esq.
Syringopora sp.	North America (including southwestern Virginia), Europe (including Belgium, England, and Ireland)	Upper Ordovician (Sandbian) - Permian (Changhsingian)	Colonel John Page
Tetrataxis sp.	Mid-western North America, Europe (including Belgium, England, and Ireland)	Lower Mississippian (Tournaisian) - Upper Triassic (Rhaetian)	Doctor Richard Edwards, Xpher Rousbie Esquire

Table 4

Historical evidence for tombstones imported from England to the Chesapeake Bay area during the colonial era

Name of person requesting tombstone	Year requested	Type of historical source	Location	Further descriptors of the tombstone	Location from where the stone was ordered	Reference
Sarah Yardley	1657	primary letter	Lynnhaven Church, Lower Norfolk County, VA	black	England	104
Colonel John Carter	1669	primary will	Christ Church, Irvington, VA	black "marble"	England	43
Richard Cole	1674	primary will	Westmoreland County, VA	black "marble"	England	105
Edward Thompson	≥1674	primary tombstone, secondary book	Christ Church, Middlesex County, VA	black	?	106
Governor Edward Digges	1676	primary tombstone, secondary book	Bellfield plantation, York County, VA	"iron" stone/black "marble"	England	107
Lieutenant Colonel Adam Thoroughgood II	1679	primary will	Lynnhaven Church, Lower Norfolk County, VA	"marble"	none	108
Captain Francis Page	1692	primary will	Yorktown, VA	black polished "marble"	?	109
Colonel John Page	1692	primary will	Bruton Parish Church, Williamsburg, VA	polished black "marble"	England	110
Mrs. John (Alice) Page	1694-1698	primary will	York County, VA	polished black "marble"	England	111
William Sherwood	1697	primary will	Jamestown Church, Jamestown, VA	"marble"	London	112
Colonel Matthew Page	1703	secondary book	Abington Parish Church, Gloucester County, VA	heavy "iron"stone	none	113

Name of person requesting tombstone	Year requested	Type of historical source	Location	Further descriptors of the tombstone	Location from where the stone was ordered	Reference
Governor Edward Nott	1718-1720	primary Virginia Assembly Records	Bruton Parish Church, Williamsburg, VA	"marble"	London	114
Paul Micou	1736	secondary book	Port Micou Estate, Essex County, VA	heavy "iron"stone/ black "marble"	none	115
Commissary James Blair and Mrs. Blair	1743	secondary book	Jamestown Church, Jamestown, VA	dark "iron" stone/black "marble"	none	116
John Washington	1744	primary letter	Gloucester County, VA	none	London	117
John Custis	1749	primary will	Arlington plantation, Northampton County, VA	"marble"	England	118
John Blair	1751	primary diary	Jamestown Church, Jamestown, VA	none	England	119
Catesby Cocke	1753	primary letter	Bruton Parish Church, Williamsburg, VA	"marble"	England	120
Colonel William Beverley	1756	primary will	Blandfield plantation, Essex County, VA	"marble"	England	121
John Ambler	1766	letter	Jamestown Church, Jamestown, VA	none	London	122
General Thomas Nelson, Jr.	1773	primary letter	Grace Church, Yorktown, VA	black "marble"	London	123

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