THE PREHISTORY OF STRATFORD HALL PLANTATION

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Paleo Quest

Two of the hardest concepts for the human mind to process is time and change.

We can observe the process of change and we can see change in the context of our limited life spans.

Time is more difficult for us to observe. We measure time by agreed upon results of change we witness.

Geologists measure time in huge units of years: tens of thousands, hundreds of thousands, millions and billions. Spans of measurement beyond our grasp.

We then need concrete agreed upon units of time.

For the paleontologist and geologist this is the geological time scale.

Geologist use the study of stratigraphy to understand the layers of a rock. This concept deals with the origin, composition, distribution, and succession of one of usually many layers of rock.

It is through the use of stratigraphy that a chronological record of Earth can be determined.

The geological time scale is a system of chronological measurements that relates stratigraphy to time, and is used by geologists, paleontologists, and other Earth scientists to describe the timing and relationships between events that have occurred throughout Earth's history.

The geologic chronological time scale has been developed through the use of direct observation of sequences of fossils. The study of which has been going on for at least 250 years. The use of direct observation to sequence rocks is through the use of fossils is called Relative Dating.

A much more precise method of determining dating is Absolute dating. This is through the use of radiometric dating of rocks that contain radioactive elements. The radioactive elements deteriorate naturally and the rate of this deterioration can be measured and very accurate ages of rocks can be determined.

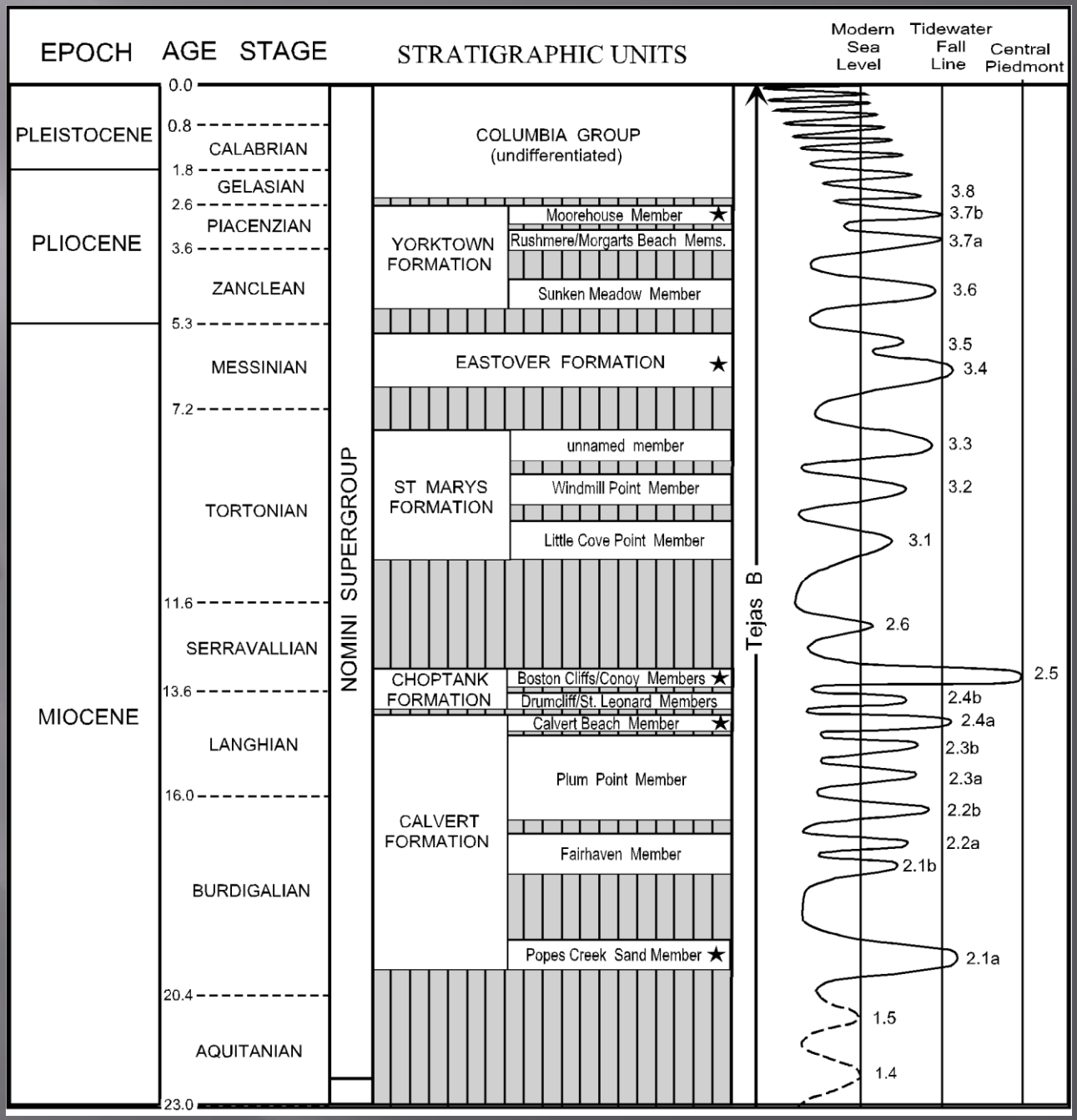
This method can not be used with sedimentary rocks.

Sedimentary rocks cannot be dated *directly* using radiometric dating, which is based on the idea that when rocks are in liquid form, their radiometric clock reset. This technique is generally used to date igneous and metamorphic rock, which are rocks that were once melted due to extreme heat and pressure.

Sedimentary rock on the other hand consists of sedimentary particles which were removed and deposited somewhere else by some sort of fluid (generally wind and water). The sedimentary particles predate the rock which they form.

The cliffs of Stratford are sedimentary, and are part of the Miocene Epoch. They record 16.5 million years of history. The Miocene was named by Sir Charles Lyell. The name comes from the Greek words μείων (*meiōn*, "less") and καινός (*kainos*, "new") and means "less recent" because it has 18% fewer modern sea invertebrates than the next epoch, the Pliocene.

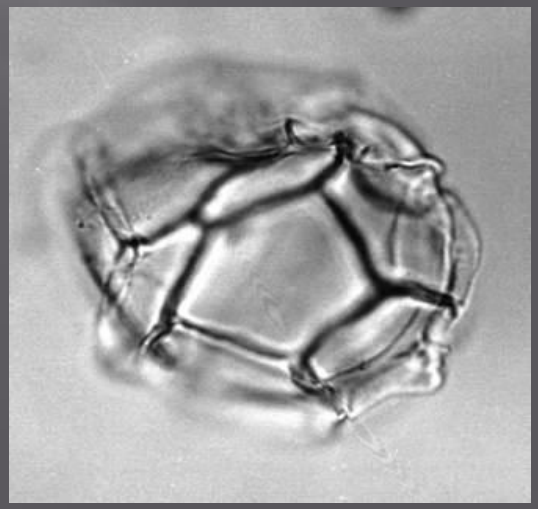
Stratigraphy of the Virginia Neogene and Quaternary



The Neogene started 23 million years ago and ended 2.5 million years ago. The Neogene is subdivided into two epochs, the earlier Miocene and the later Pliocene.

The Quaternary is the period of earth history, forming the last 2 million years, and includes the recent and Pleistocene Epochs.

To identify specific layers of sediments at the Stratford cliffs, paleontologists use microscopic dinoflagellates, a marine plankton to identify layers of the Miocene geology at Stratford Hall. Because they are extremely sensitive to a range of temperatures, salinity , and depth, their fossil remains provide a perfect method to identify specific layers of strata.

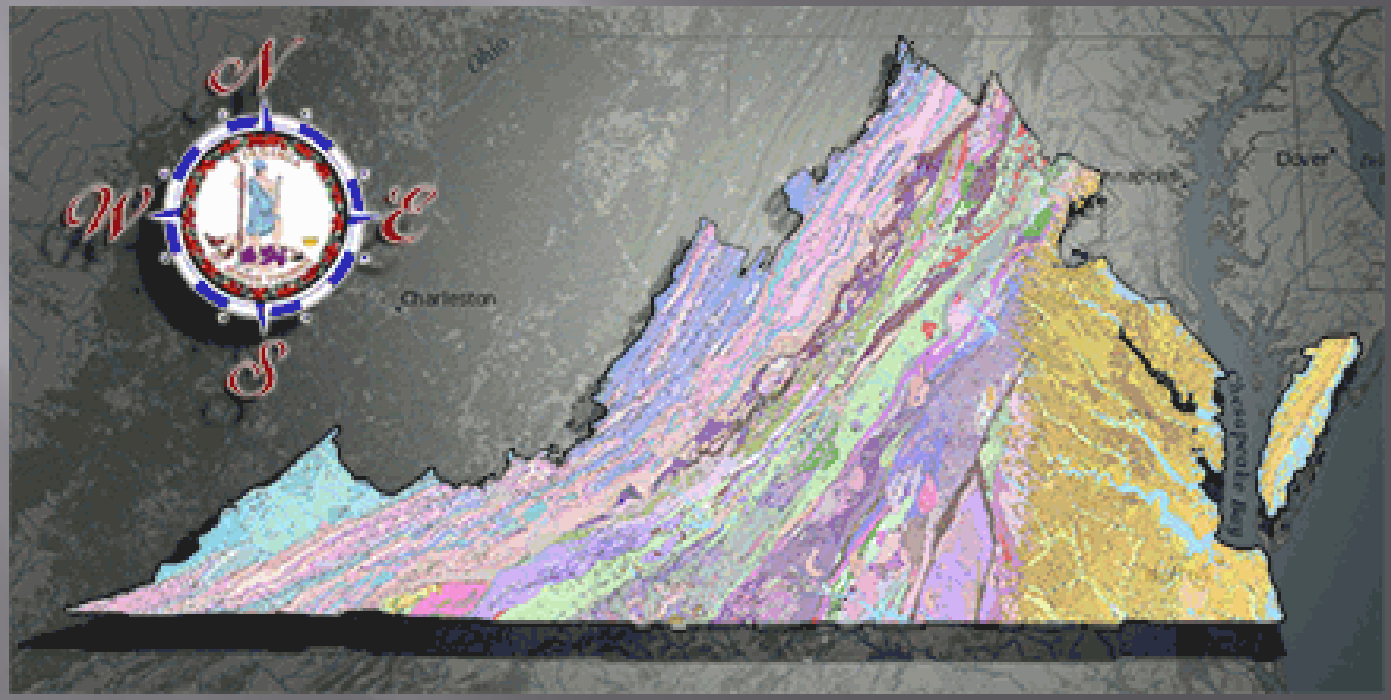


To classify and map layers of rock, geologists created a basic unit called a formation.

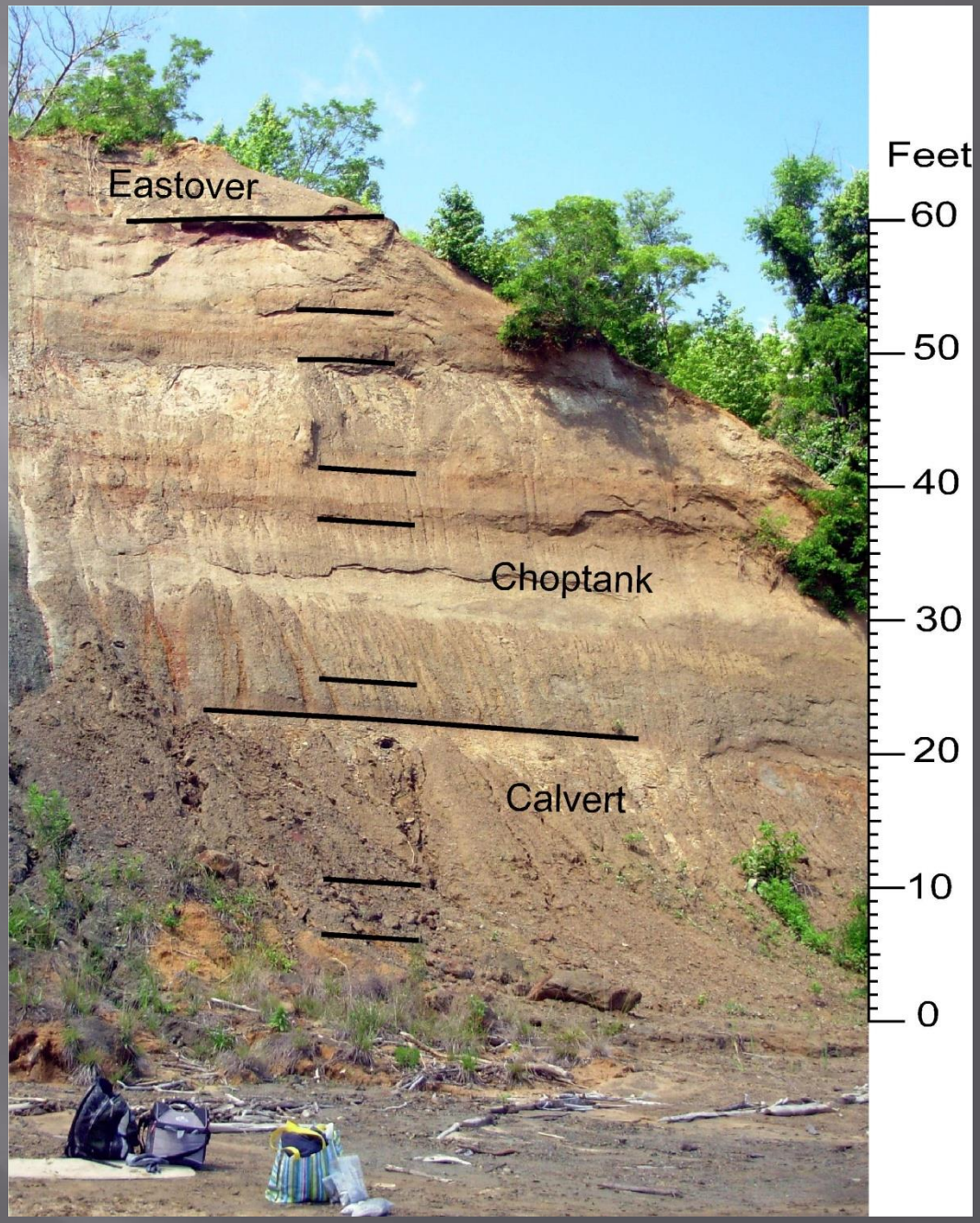
A formation is a rock unit that is distinctive enough in appearance that a geologic mapper can tell it apart from the surrounding rock layers. It must also be thick enough and extensive enough to plot on a map.

Formations are given names that include the geographic name of a permanent feature near the location where the rocks are well exposed.

This is the geological map of Virginia showing large distinctive geologic areas.



Cliffs at and near Stratford Hall expose three Miocene formations.



Calvert & Choptank (middle Miocene) vertebrate fauna

Taxon	Common Name	Museum #	Calvert PP B+	Calvert PP D	Choptank A-B	Choptank C		
Sharks								
Alopias sp.	thresher shark	USNM 337244			X			
Carcharocles megalodon	megatoothed shark	USNM 016365, 475293; 000256						w
X								
Carcharocles chubutensis	megatoothed shark	USNM 025451			X			
Carcharias cuspidata	sand shark	USNM 475332						
X								
Carcharhinus brachyurus	copper shark	USNM 475199			X			
Carcharhinus egertoni	requiem shark	new find					w	g
Carcharhinus cf. *C. macloti*	hardnose shark	new find					w	g
Carcharhinus priscus	extinct sand shark	new find						g
Cetorhinus sp.	basking shark	USNM 476385						
X								
Galeocerdo aduncus	extinct tiger shark	USNM 356960; USNM356960			X		w	
Galeocerdo contortus	longtooth tiger shark	USNM 025454, USNM 356963					X	
Hemipristis serra	weasel shark	USNM 331636, 337241, 356958					X	
w g								
Hexanchus gigas	sixgill shark	USNM 475338					X	

Taxon	Common Name	Museum #	Calvert PP B+	Calvert PP D	Choptank A-B	Choptank C		
Isurus desori	narrow-tooth mako	new find					w	
Isurus hastilis	big-tooth mako	USNM 000475, 024958			X			
Isurus oxyrinchus	shortfin mako	USNM 475276, 024958			X			
Mustelus sp.	smooth-hound shark	new find						g
Negaprion eurybathodon	lemon shark	new find					w	g
Notorhynchus sp.	seven gill shark	USNM 025474, 475340			X			
Odontaspis sp.	sand tiger shark	USNM 025451					X	
Odontaspis ferox	sand tiger shark	USNM 025451					w	
Shyrna laevissima	hammerhead shark	new find					w	
Squalus sp.	spurdog shark	new find					w	g
Squatina sp.	angel shark	USNM 475209			X			
Rays								
Aetobatus sp.	spotted eagle ray	USNM 338797			X		w	g
Dasyatis say	stingray	new find					w	g
Myliobatis sp.	eagle ray	new find					w	
Raja sp.	skate	new find					w	g
Rhinoptera sp.	cownose ray	new find					w	g
Rhynchobatus sp.	wedgefish	new find						g

Most Miocene sharks are essentially modern, but teeth of the extinct shark *Carcharocles megalodon* are impressively prehistoric looking.

Taxon	Common Name	Museum #	Calvert PP B+	Calvert PP D	Choptank A-B	Choptank C		
Bony Fishes								
Acipenser ornatus	sturgeon	USNM 438665				X		
Albula sp.	bonefish	new find					w	
Arius sp.	marine catfish	USNM 336491						
Sciaenops sp.	red drum	USNM 025672						
Chilomycterus sp.	burrfish	new find					w	
Istiophorus sp.	sailfish	USNM 183028						
Labridae indet.	wrasse	new find						
							w	
Lagodon cf. *L. rhomboides*	pinfish	new find					w	g
Lopholatilus sp.	tilefish	USNM 336492, 467776, 467780						
			X	w				
Megalops cf. *M. atlanticus*	Atlantic tarpon	new find						w
Pogonias sp.	black drum	new find					w	g
Protautoga conidens	tautog	new find					w	g
**Ranzania grahami*	giant slender sunfish	USNM 186986				X		
Sphyraena cf. *S. barracuda*	barracuda	new find					w	

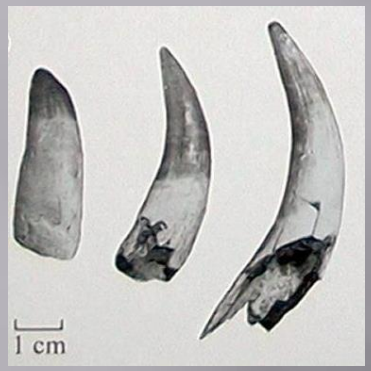
A giant slender sunfish (described from Stratford Plantation) is also remarkable for its size.

Ranzania laevis
Length 3 feet

Ranzania grahami
Probable length 10 feet

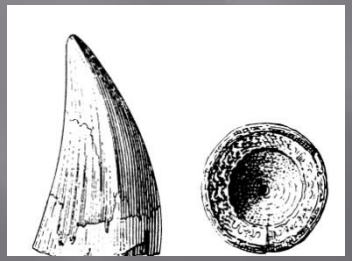
Taxon	Common Name	Museum #	Calvert PP B+	Calvert PP D	Choptank A-B	Choptank C		
Turtles								
Psephophorus calvertensis X	leatherback sea turtle	USNM 025474, 025474; 357848					X	
Trachyaspis lardyi	pseudodont sea turtle	USNM 024870				X	w	
Procolpochelys grandaeva	cheloniid sea turtle	USNM 024888				X		
Crocodilians								
**Thecachampsa antiquus*	giant false gharial	new finds				X		X
Thecachampsa sericodon	giant false gharial	USNM 02543			X	w		
Birds								
Puffinus sp.	small shearwater	not reported						
Miocepphus mcclungi	auk	not reported						
Pelagornis miocaenus	giant pseudodont pelican	not reported						
Morus loxostylus	gannet	not reported						
**Mergus miscellus*	merganser diving duck	not reported				X		

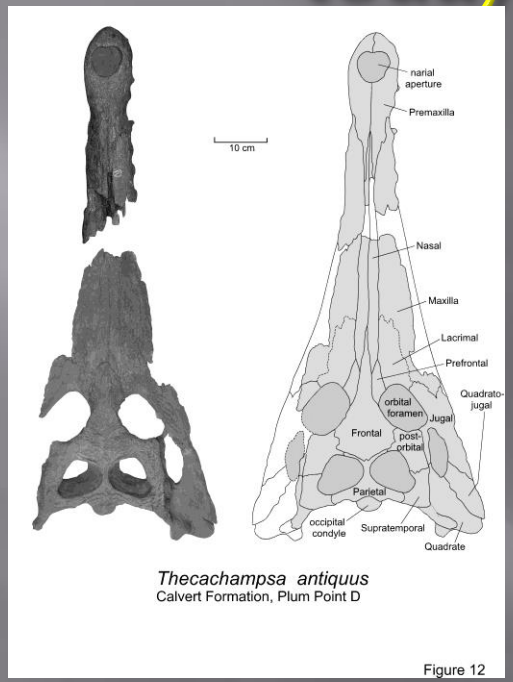
Crocodilians were very different from today.

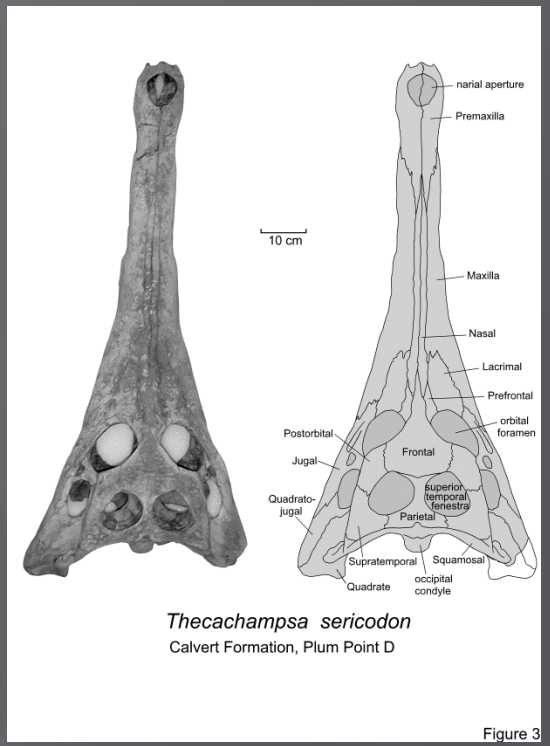


Thecachampsa sericodon

Thecachampsa antiquus



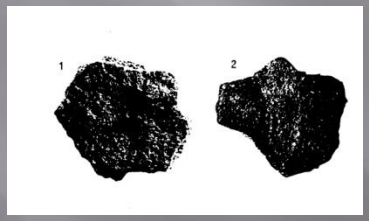




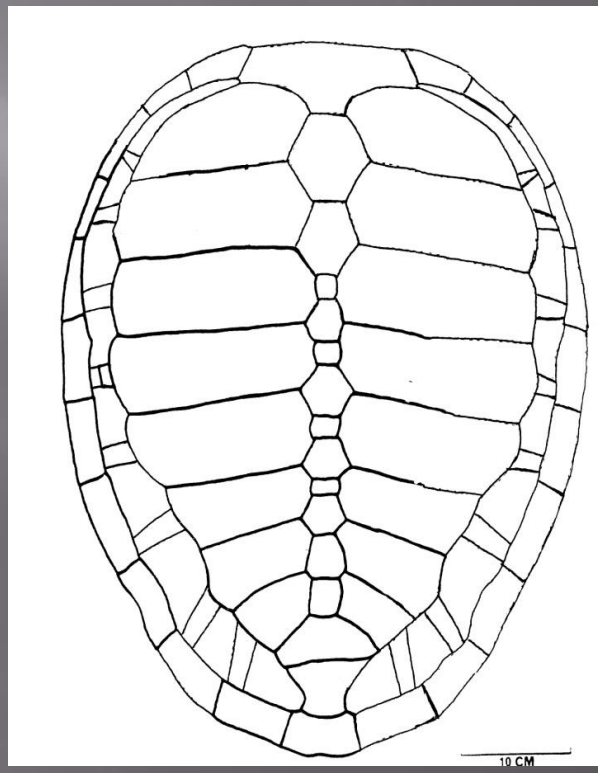
False gharial (*Tomistoma schlegelii*)

Leatherback turtles were much like today, but cheloniid sea turtles were very different.

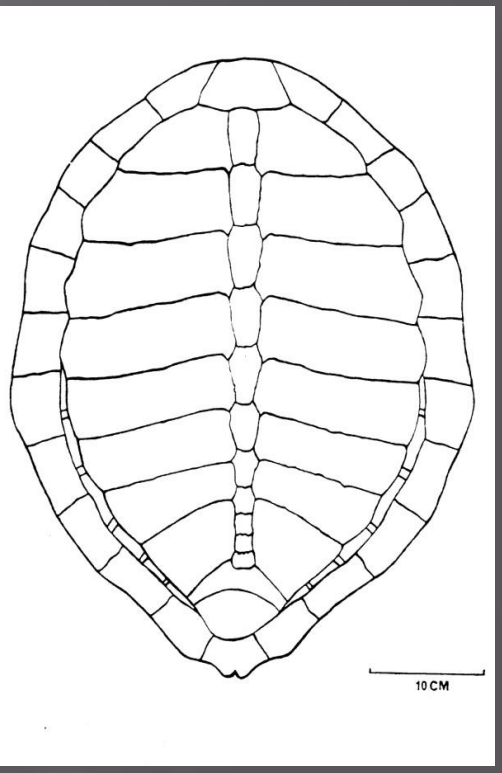
Dermochelys



Psephophorus calvertensis



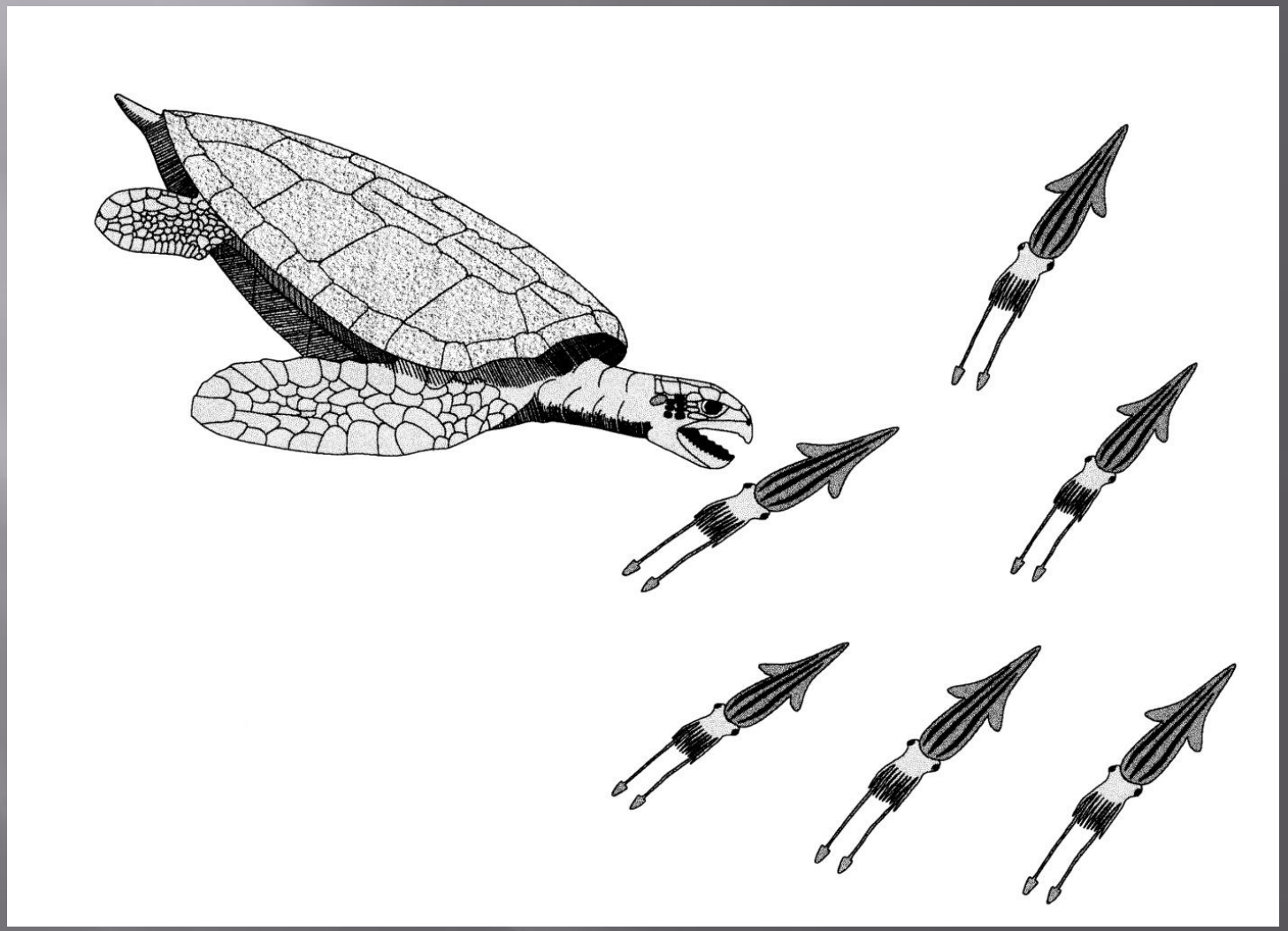
Procolpochelys grandaeva



Trachyaspis lardyi

Chelonioid sea or marine turtles include: green turtles, Ridley, hawksbill, flat back, and olive turtles.

Trachyaspis had strong flippers and tooth-like serrations along its jaw margins.



Birds were a mix of old and new.

Diving duck (*Mergus*)

Shearwater (*Puffinus*)

Gannet (*Morus*)

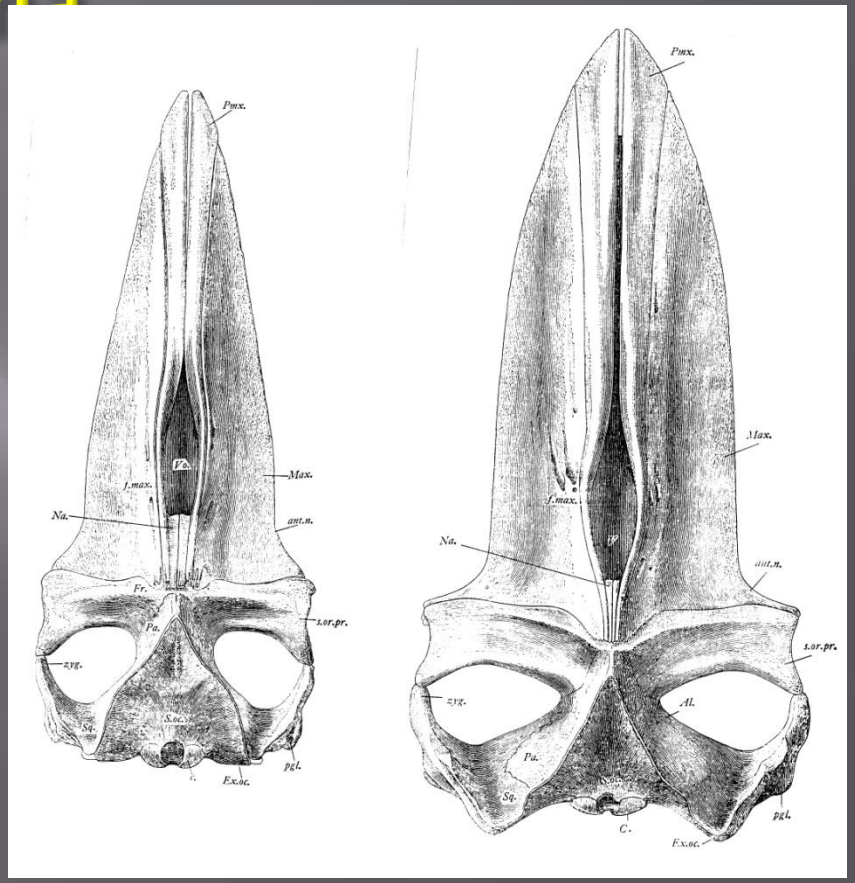
Pseudodont pelican (*Pelagornis*)

Taxon	Common Name	Museum #	Calvert		Choptank		
			PP B+	PP D	A-B	C	
Mammals							
Sirenia							
Metaxytherium sp.	dugong	USNM 377443			X		
Metaxytherium calvertense	dugong	USNM 377443				X	
Mysticeti							
Mesocetus siphunculus	cetothere	USNM 023001; 016759, 022999; 023057			X	X	X
Parietobalaena palmeri	cetothere	USNM 360709; 023203			X	X	
**Aglaocetus patulus*	cetothere	USNM 023130, 023690				X	
Diorocetus hiatus	cetothere	Charleston Museum				X	
Pelocetus calvertensis	cetothere	USNM 023058, 023059				X	
Siphonocetus priscus	cetothere	USNM 023005; 360744				X	X
**Metopocetus durinasus*	cetothere	USNM 008518					X
Thinocetus arthritis	cetothere	USNM 360737					X

Baleen whales are the largest animals known from the Calvert-Choptank fauna

Diorocetus hiatus

Aglaocetus patulus



Parietobalaena palmeri

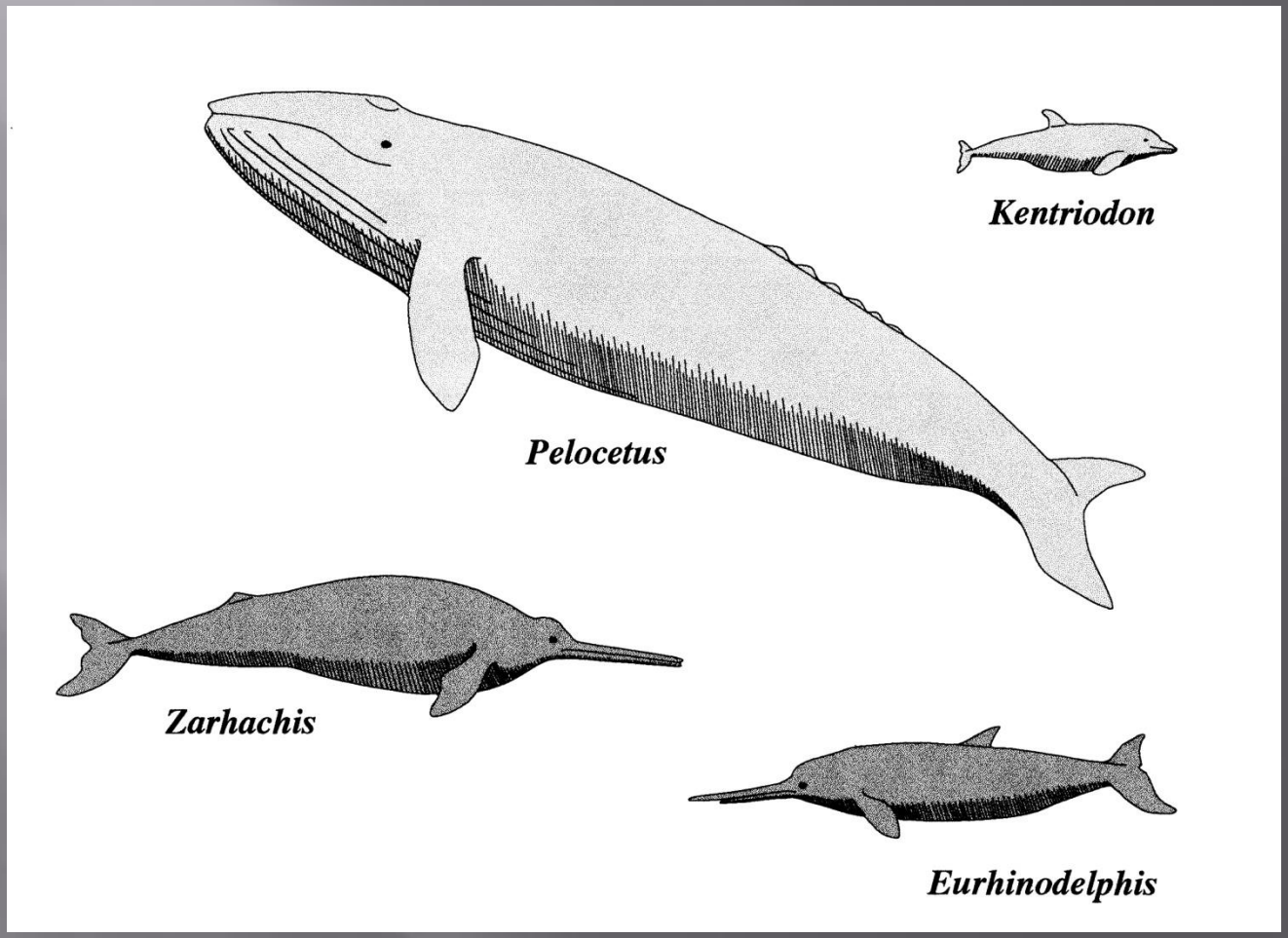
Pelocetus calvertensis


USGS
USGS

The largest fossil baleen whale from the Atlantic coast (Cetotheriid) was discovered June 4, 2013 at Stratford Hall. The skull is currently at the Calvert Marine Museum.

Taxon	Common Name	Museum #	Calvert PP B+	Calvert PP D	Choptank A-B	Choptank C		
Odontoceti								
Squalodon calvertensis	shark-tooth porpoise	USNM 025946, 187315			X			
Orycterocetus crocodilinus	small sperm whale	USNM 183078			X			
Physeterula sp.	large sperm whale	USNM 320357					X	
Tretosphys sp.	extinct porpoise	USNM 310663					X	
Zarhachis flagellator	long-beaked porpoise	USNM 310627			X			
Rhabdosteus longirostris	long-beaked porpoise	USNM 025450, 175379, 187312					X	
Kentriodon pernix	kentriodontid dolphin	USNM 171069, 214438			X			
Schizodelphis crassangulum	long-beaked porpoise	USNM 256505; 025022			X	X		
Eurhinodelphis bossi	long-beaked porpoise	USNM 023038, 171105, 452897; 449612, 244401			X	X		
Delphinodon sp.	kentriodontid dolphin	USNM 317884; 449644			X		X	
Zarhachis sp.	long-beaked dolphin	USNM 020128						X
Priscodelphinus stenus	kentriodontid dolphin	USNM 362129, 362130				X		
Eurhinodelphis sp.	long-beaked porpoise	USNM 453017					X	

Representative examples of Calvert-Choptank whales to same scale.

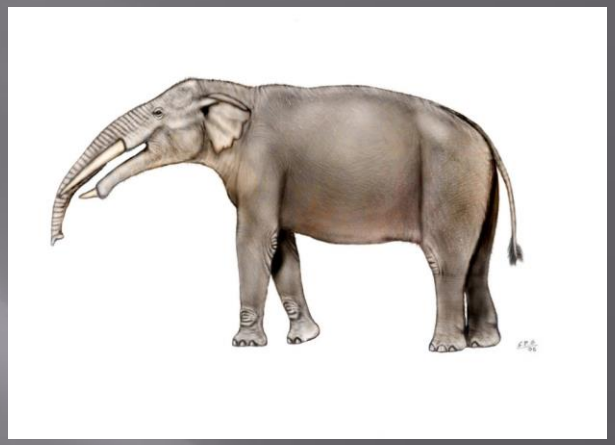


Taxon	Common Name	Museum #	Calvert PP B+	Calvert PP D	Choptank A-B	Choptank C	
Pinnipedia							
Leptophoca lenis X	earless seal	USNM 023061, 284721; 374203					X
Callophoca obscura	earless seal	USNM 170882				X	
Monotherium wymani(?)	earless seal	USNM 347353				X	
Amphicyonidae							
Amphicyon frendens	bear-dog	USNM 026405			X		
Proboscidea							
Gomphotherium calvertensis	gomphothere	USNM 451022				X?	
Tayassuidae							
Cynorca proterva	peccary	USNM 025901, 181418, 214942				X	
Cynorca sp.	peccary	USNM 413627				X	
"Prosthenops" xiphidonticus	peccary	USNM 025795, 214946				X	
		Total Species	32	23	36	16	

5 species were described from material in these bluffs

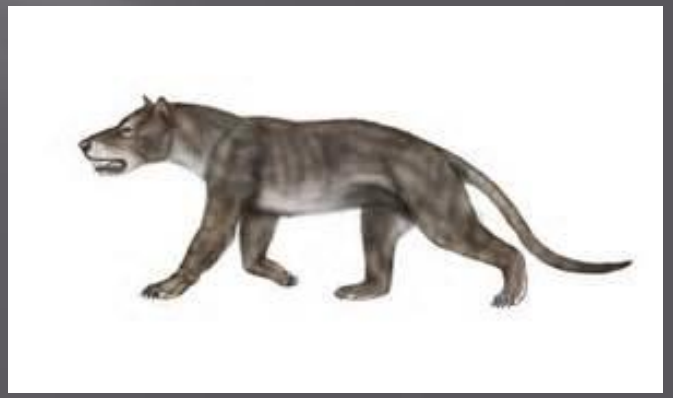
Occasional land animals washed out to sea during Calvert-Choptank time.

Gomphothere
lower jaws



Gomphotherium

Peccary
(like *Cynorca*)



Amphicyon

An onshore flora for the Calvert is known.
(from Berry, 1916, 1934, 1936)

Taxon	Common name	River or estuary swamp	Low bottoms on lower stream floodplains	River bars or behind coastal dunes	coastal dunes or beachstrand
Taxodium dubium	bald cypress	X			
Juglans calvertiana	walnut		X		
Prunus calvertensis	cherry		X		
Podogonium virginianum	extinct legume		X		
Berchemia priscaformis	supplejack		X	X	
Pieris scrobiculata	fetterbush		X	X	
Ulmus basicordata	elm			X	
Cassia toraformis	wild senna			X	X
Pinus collinsi	pine				X
Quercus lehmanni	oak				X
Quercus calvertonensis	oak				X
Quercus chapmanifolia	oak				X
Phyllites cercocarpifolia	extinct rosaceae				X
Caesalpinia ovalifolia	extinct legume				X
Vaccinium cf. *V. textum*	blueberry				X
Dalbergia calvertensis	rosewood				X
Rhus milleri	sumac				X
Ilex calvertensis	holly				X

Eastover (late Miocene) vertebrate fauna

Taxon	Common name	Museum #
Sharks		
Carcharocles megalodon	*megatooth shark*	*w*
Galeocerdo aduncus	extinct tiger shark	w
Galeocerdo contortus	longtooth tiger shark	w
Hemipristis serra	weasel shark	w
Isurus hastilis	big-tooth mako	w
Rays		
Aetobatis sp.	spotted eagle ray	w
Myliobatis sp.	eagle ray	w
Bony Fishes		
Chilomycterus sp.	spiny boxfish	USNM 336496
Pogonias multidentatus	drumfish	USNM 336494
Sphaeroides sp.	puffer fish	USNM 265390
Crocodilians		
Alligator sp	alligator	USNM 299913, USNM 356002
Birds		
Alca n. sp.	razorbill	USNM 242238
Meleagris sp.	turkey	not reported
Miocepphus mcclungi	auk	not reported

Late Miocene reptiles and birds are much like modern forms

alligator

razorbills

turkeys

auk

Mysticeti		
Plesiocetus sp.	rorqual	USNM 299959
Burtinopsis sp.	Rorqual	USNM 023058
Balaena sp.	right whale	USNM 023690, USNM 299708
Odontoceti		
Physeterula sp.	sperm whale	USNM 320357
Scaldicetus sp.	sperm whale	USNM 023310
Kentriodon sp.	kentriodontid dolphin	USNM 025743
Hadrodelphis sp.	kentriodontid dolphin	USNM 170993; USNM 183054
Pinnepedia		
Callophoca obscura	monk seal	USNM 187239
Homiphoca capensis	earless seal	USNM 215069
Equidae		
Merychippus sp.	early grazing horse	USNM 206245
Tayassuidae		
Cynorca sp.	extinct peccary	USNM 181708, USNM 244463
Desmathyus sp.	extinct peccary	USNM 206097

- 26 species so far from Eastover
- Based on modern world, perhaps 200 species were present and potentially discoverable.

By the late Miocene the whale fauna was essentially modern

right whale

rorquals

sperm whale

Seals, horses, and peccaries also were becoming much like modern forms.

Leopard seal
(now Antarctic region only)

monk seal

Merychippus

peccary

Cervidae (deer) and Bovidae (bison) had not yet entered North America from Asia.

The Pliocene epoch is missing from the Stratford Plantation record.

In central and southern Virginia, however, the Yorktown Formation provides a record of parts of the Pliocene.

Little is known of the Pleistocene history of Stratford

Deposits formed during glacial times are hidden far below modern sea level.

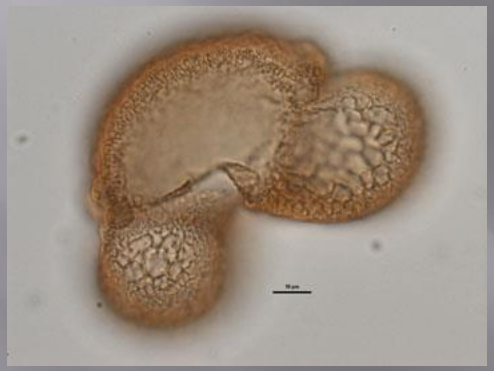
Only two Pleistocene interglacial units are known from the Stratford area:

The Bacons Castle Formation (ca. 1,600 ka)

The Tabb Formation (ca. 100 ka)

The Bacons Castle Formation is very leached, but ironstone beds preserve pollen in this unit

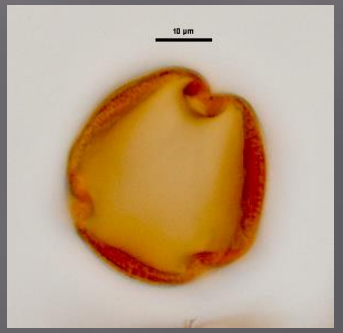
The Bacons Castle flora is dominated by oak and pollen –Absence of "exotic" pollen tells us unit is less than 1.6 Ma.



Pinus
(pine)

Quercus
(oak)

Betula
(birch)



Nyssa
(sweetgum)

Taxodium
(bald cypress)

The Tabb Formation caps low bluffs less than 20 feet above sea level.

Two kinds of vertebrates have been discovered in Tabb deposits.

Equidae

Equus sp. Horse USNM 183029

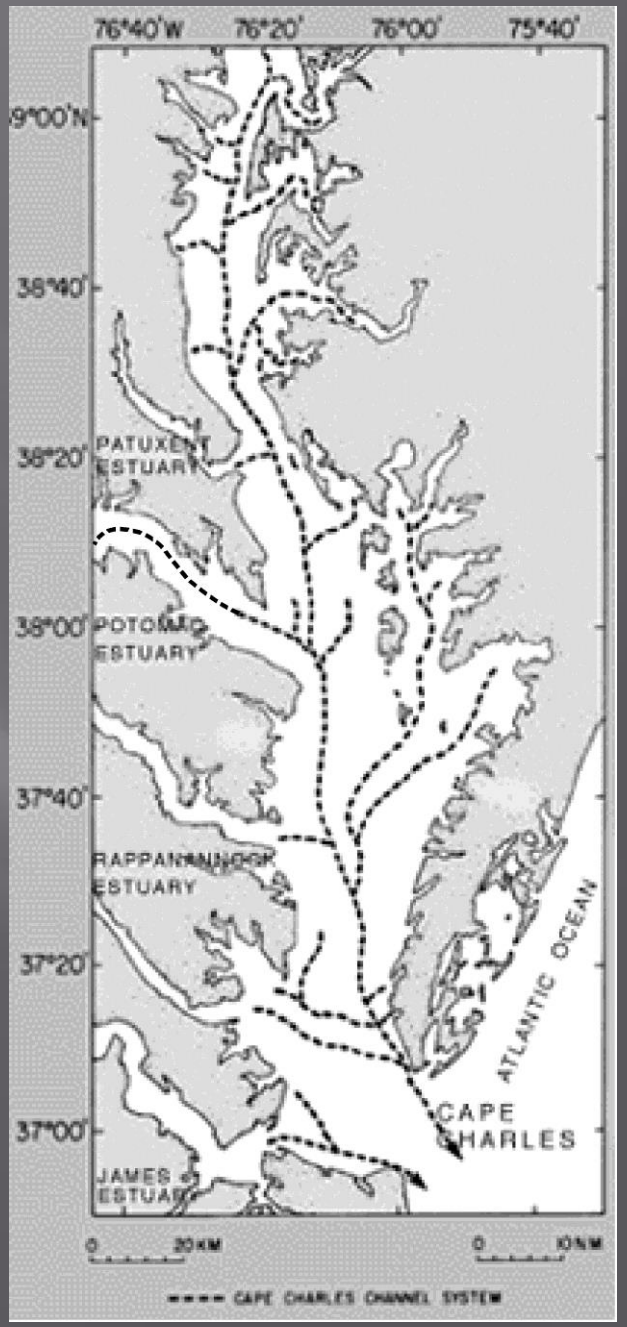
Antilocapridae

Gen. et sp. indet. Pronghorn USNM 244234

Many other kinds of Pleistocene animals probably remain to be found.

During the last glacial maximum (~20,000 years ago) Stratford was very different from today

Sea level was about 400 feet below what it is today at the peak of the last ice age, so Chesapeake Bay did not exist then.



Stratford Plantation then lay about 200 miles south of the glacial ice-front.

The modern Potomac estuary then was a cold climate, meandering coastal plain river system.

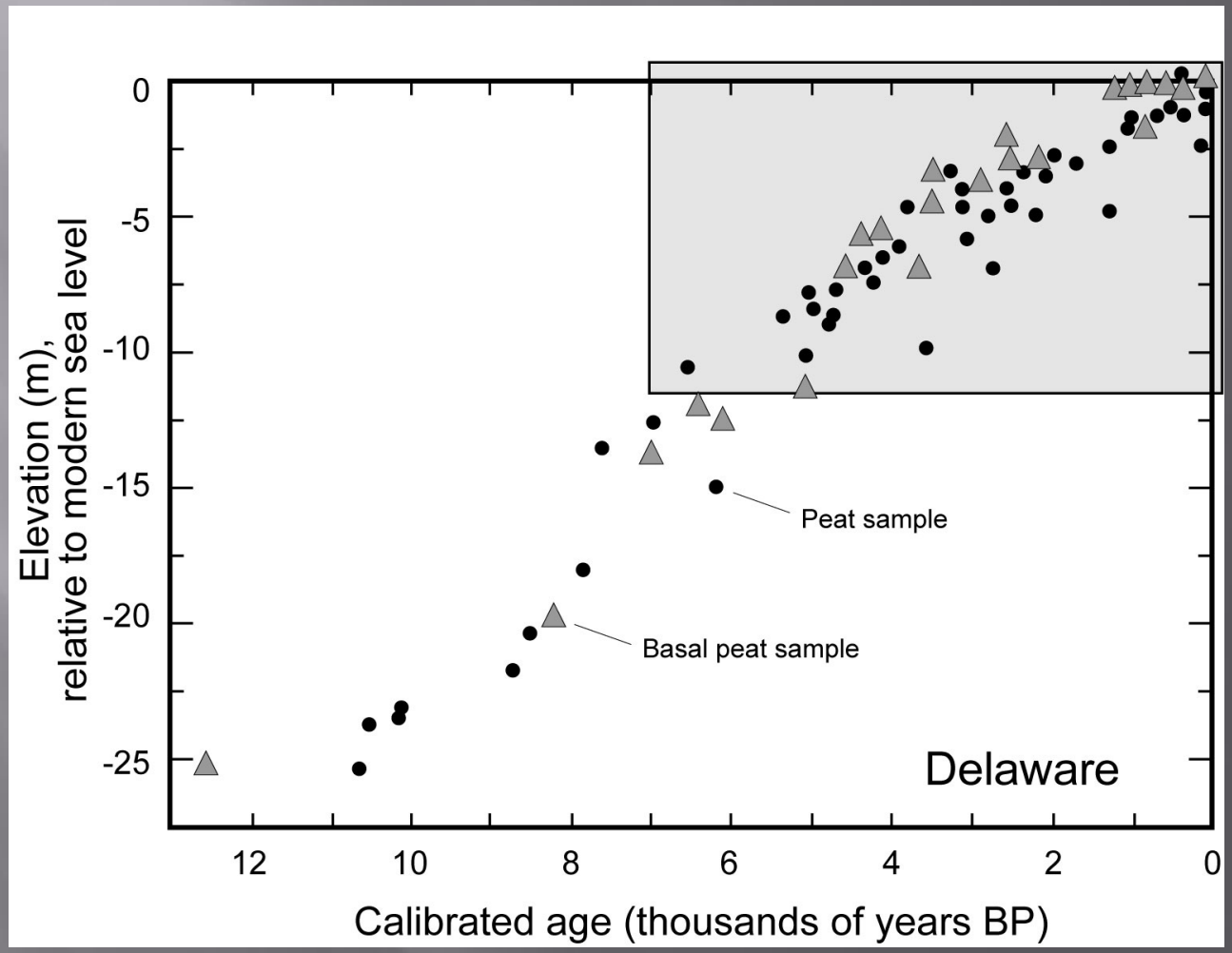
During the last Ice Age Stratford must have been home to many cold-climate animals.

Mammoths are known from Saltville and New Jersey

The Cactus Hill site in southern Virginia indicates that native people were in Virginia by 16,000 years ago, so the last Ice Age saw the arrival of the first humans in North America. Did they kill off the large mammals?

Musk oxen are known from Saltville

As the last ice-age ended, the northern glaciers mostly melted away and sea level rose to its present level.



The rise of sea level has drowned the lower Potomac River beneath tidal salt-water.

The cliffs at Stratford have a cycle of erosion and renewal controlled by wave action eating back at the base of the cliffs.

This cycle will continue indefinitely because there is an eastward longshore coastal current.

Today's Chesapeake Bay is only a "snapshot in time".