Citizen Scientist Publishing Harnessing Paleontological Knowledge – North Carolina Fossil Club's Four Part Series

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myFOSSIL

Fossil Clubs/Societies

70+ clubs/societies nationwide – 14,000+ members

Members in the Field

Finding new Specimens













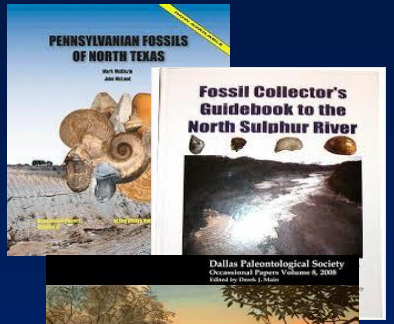
Outreach

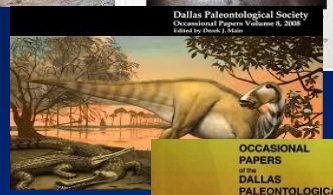
How do we capture all this raw data??

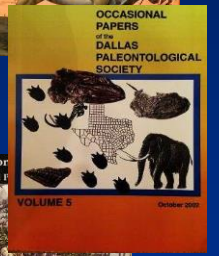
Publishing!

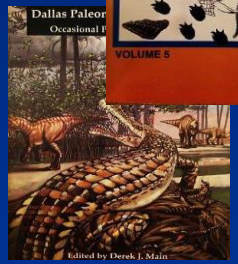

TEXAS CRETACEOUS BIVALVES 2
TEXAS CRETACEOUS GASTROPODS
TEXAS PENNSYLVANIAN BRACHIOPODS
TEXAS CRETACEOUS AMMONITES and NAUTILOIDS
TEXAS CRETACEOUS ECHINOIDS


A FIELD GUIDE TO
FOSSI
CHARLES
The Collector's Guide to
Fossil Shar
and Rays
From the Cretaceous of T
Bruce J. Welton, Ph.D.
Roger F. Farish
A Pictorial Guide to Fossils
Gerard R. Case
Oklahoma
Fossil Localities
Mark G. McKinzie


PENNSYLVANIAN FOSSILS OF NORTH TEXAS
Fossil Collector's Guidebook to the North Sulphur River


Dallas Paleontological Society
Occasional Papers Volume 8, 2008
Edited by Derek J. Main


OCCASIONAL PAPERS of the DALLAS PALEONTOLOGICAL SOCIETY
VOLUME 5
October 2002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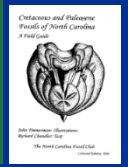
Fossil
Fish
Volume III of IV
North Carolina Fossil Club
Fossil
Mollusks
Fossil
Invertebrates
Plants
Volume I of IV
North Carolina Fossil Club


Seal/Dolphin
Phoca/Stenella


Cretaceous and Paleocene Fossils of North Carolina
A Field Guide


Neogene Fossils of North Carolina
A Field Guide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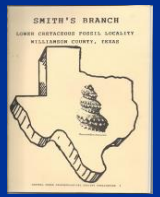
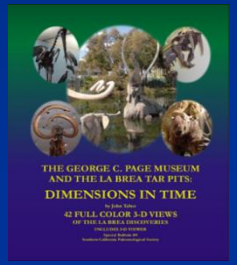
VOLUME 1
VOLUME 2
VOLUME 3


SMITH'S BRANCH
LOWER CRETACEOUS FOSSIL LOCALITY
WILLIAMSON COUNTY, TEXAS


THE GEORGE C. PAGE MUSEUM
AND THE LA BREA TAR PITS:
DIMENSIONS IN TIME
42 FULL COLOR 3-D VIEWS

3 Things You Need

- Interesting
- Relevant
- Accurate

For both the general public and for professionals

Interesting

- Eye Candy
  - Flashy specimens
  - Great photography
- Easy to understand for general public
- Technical enough for professionals

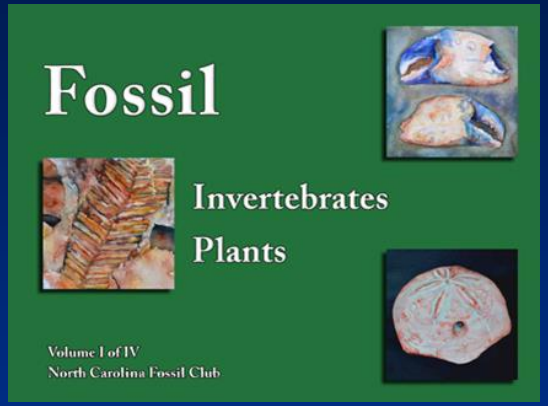
Relevant

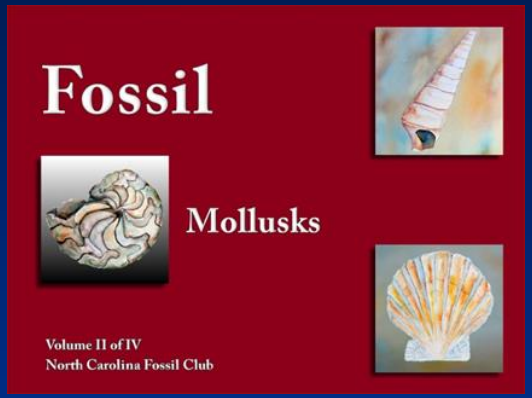
- General public
  - Easy Identify for general public
    - Lots of pictures, common language, terminology
  - Table of Contents – Diagrams – Index, etc.
- Professionals
  - Comprehensive
  - Include technical language/terms
  - Charts
  - Geology section w/stratigraphy

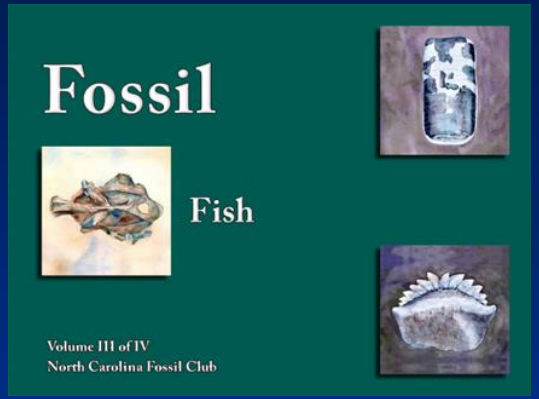
Accurate

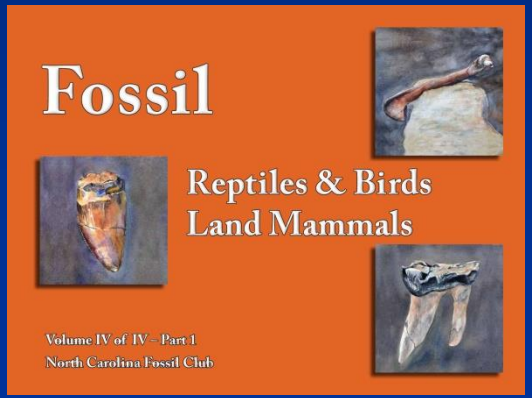
- Specimens correctly identified
- References cited
- Acknowledgements given
- Edited to be seamless
  - especially when multiple authors are involved
- Reviewed by professionals

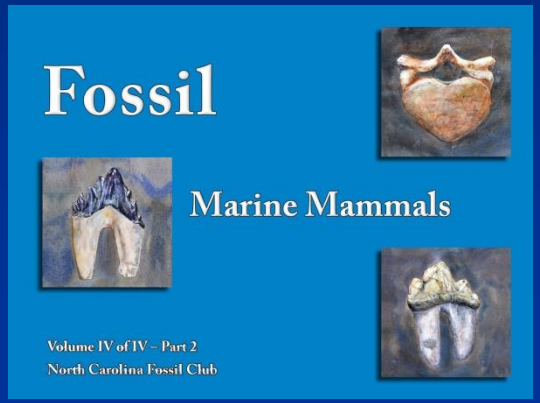
NCFC FOSSIL Series









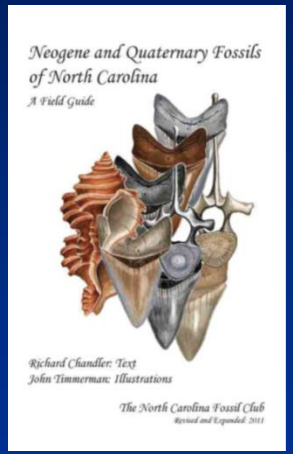


300 members

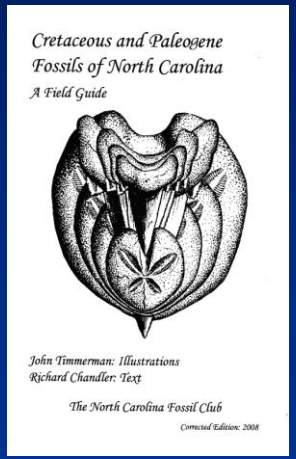
Lots of raw data

NCFC Early Publications

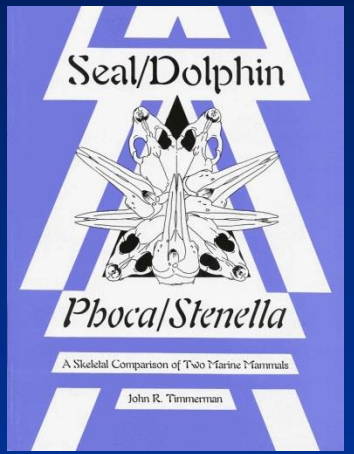
- 1992



1994



1997



- Basic black and white line drawings and generally common species

The Project History

- 1998 NCFC Richard Chandler, a math professor at NC State (most of us have day jobs outside of paleontology…)
  - had the idea to create a photo record of all the different types of fossils found in North Carolina
  - "It will be a substantial project, but I think it is doable in less than a years time" (1st meeting in January 2000)
    - Vol I published March 2014
    - Vol IV published Sept 2017
  - Years visiting other members and photographing their collections
  - Years spent travelling to various institutions and photographing their collections (NC Museum of Natural Sciences, the Aurora Fossil Museum, Smithsonian)
    - frequently specimens photographed had been donated BY amateur collectors – sometimes by our own members

The Project Results

- Nearly 2 decades of research / work
- Tens of thousands of volunteer hours
  - Photography – Writing – Reviewing – Editing – Travelling
- 16 different member authors (all but one with day jobs outside of paleontology)
- 5 volumes
  - 1400 pages
  - 4400 photographs / illustrations (over 25,000 photographs taken)
  - 1000+ species occurring in North Carolina
- ~1000 copies sold in 19 states, Canada, Hong Kong, Japan, Netherlands and the United Kingdom

Did We Get It Right?

- Interesting
- Relevant
- Accurate

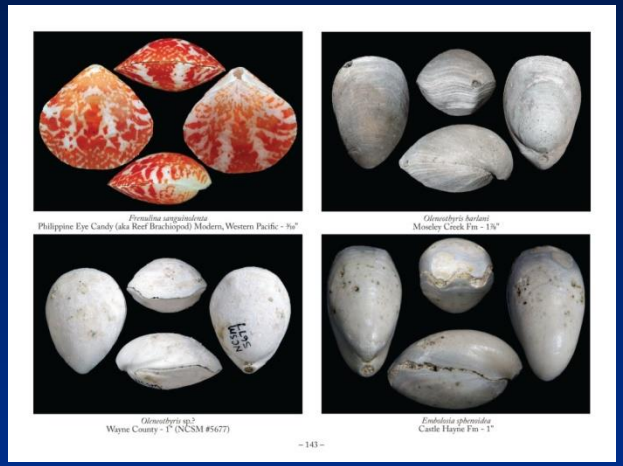
For both the general public and for professionals

Interesting

Eye Candy – Flashy Specimens – Great Photography

Interesting / Relevant

Easy Identification



Frenulina sanguinolenta
Philippine Eye Candy (aka Reef Brachiopod) Modern, Western Pacific - ⅝"

Glenobyris harlani
Moseley Creek Fm - 1⅜"

Glenobyris sp.?
Wayne County - 1" (NCSM #5677)

Embolotia gibbonsida
Castle Hayne Fm - 1"

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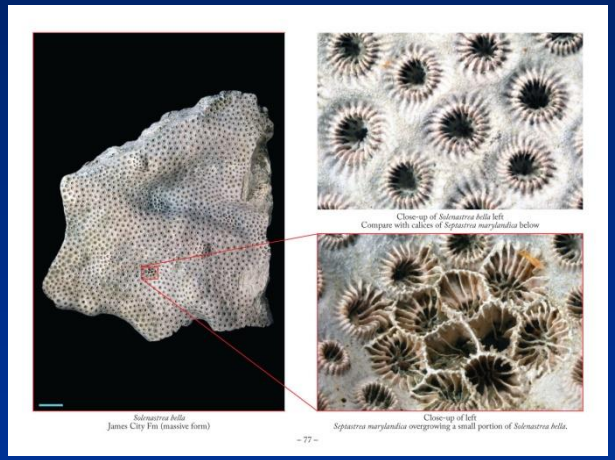

Solenastrea bella
James City Fm (massive form)

Close-up of *Solenastrea bella* left
Compare with calices of *Septastrea marylandica* below

Close-up of left
Septastrea marylandica overgrowing a small portion of *Solenastrea bella*.

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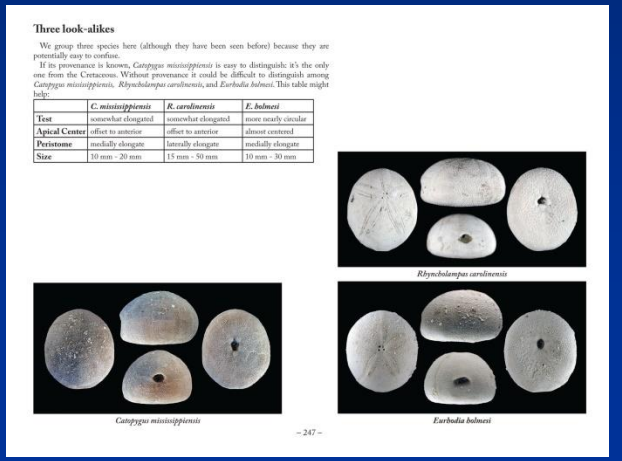

Three look-alikes

We group three species here (although they have been seen before) because they are potentially easy to confuse.

If its provenance is known, *Catopygus mississippiensis* is easy to distinguish: it's the only one from the Cretaceous. Without provenance it could be difficult to distinguish among *Catopygus mississippiensis*, *Rhyncholampas carolinensis*, and *Eurhodia holmesi*. This table might help:

	C. mississippiensis	*R. carolinensis*	*E. holmesi*
Test	somewhat elongated	somewhat elongated	more nearly circular
Apical Center	offset to anterior	offset to anterior	almost centered
Peristome	medially elongate	laterally elongate	medially elongate
Size	10 mm - 20 mm	15 mm - 50 mm	10 mm - 30 mm

Rhyncholampas carolinensis

Catopygus mississippiensis

Eurhodia holmesi

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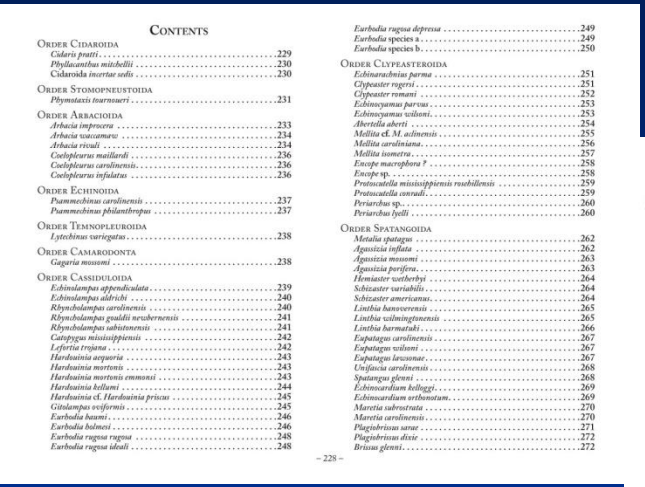
Interesting / Relevant

Table of Contents



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Visual Key Charts

KEY TO THE FAMILIES OF FOSSIL BIVALVES

Using this key: try to match your specimen's shape with one or more of those below, being cognizant of the size range. The page number indicated is that of the Family with some specimens approximating that shape. Try to find a silhouette similar to your specimen. Disclaimer: some species have wide variation in shape and juveniles are frequently different from adults.

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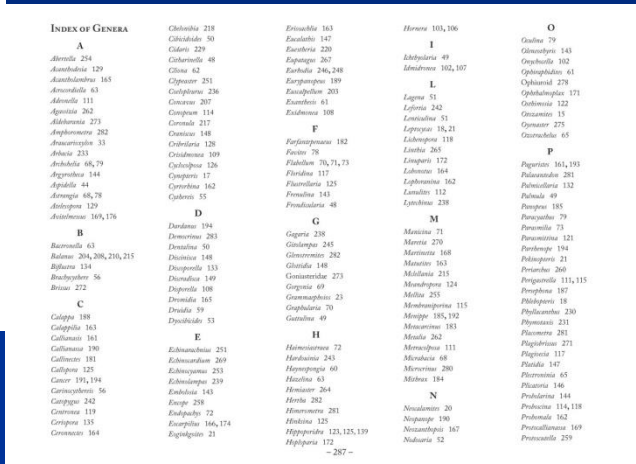

INDEX OF GENERA

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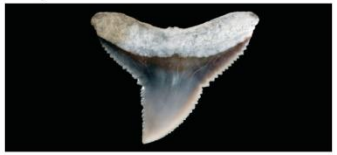
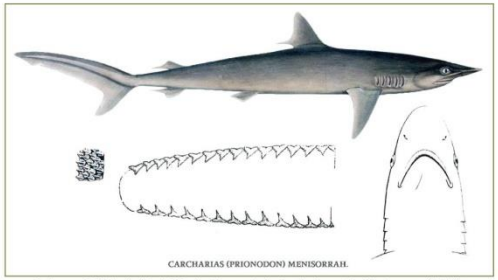
Interesting / Relevant

Depiction of Organism When Alive, Multiple Examples / Views

Carcharhinus falciformis
Silky
[falci < sickle; form < shape]

The third of the large Carcharhinids, the silky shark, has the most distinctive upper teeth: there is a distinct notch about midway on each cutting edge (below). The lower teeth sometimes have a spatulate tip with cutting edges which extend only about half-way down the crown.





Johannes Müller & Jakob Henle: *Systematische Beschreibung der Plagiostomen* (1841)
Plate 17: Carcharias (Prionodon) Menisorrah (now *Carcharhinus falciformes*)

Carcharhinus falciformis representative teeth - to 12 mm
Pungo River & Yorktown Fms

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Order Scorpaeniformes

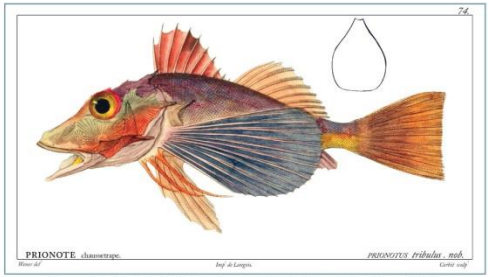
Family Triglidae (Searobins)
Prionotus evolans Linnaeus, 1766

[skorpios < scorpion (the dorsal spines can inflict a very painful wound); trigla < the red mullet; prion < saw; notos < back; (e)volans < flying]

NC Stratigraphic Range: Pliocene

Prionotus species frequently exhibit hyperostosis, especially on the back of the skull (see below). The dorsal surface of the skull frequently shows a wonderful, characteristic pattern of symmetric ridging which makes these fossils easy to identify. Other remains include the caltrop-shaped preopercle. Note in the illustration to the right: chaussetrape (literally *shoe-trap*), which Cuvier and Valenciennes use as the common name for *Prionotus tribulus*, means caltrop, as does the Latin specific name *tribulus*.

16th Century Russian caltrop



Georges Cuvier & Achille Valenciennes: *Histoire Naturelle des Poissons* (1828)
Pl. 74: *Prionotus tribulus*, the bighead searobin

Prionotus cf. *P. evolans* partial right dentary - 14 mm
Yorktown Fm (NCSM #3106)

Prionotus cf. *P. evolans* opercle (left) & preopercle - 15 mm & 13 mm
Yorktown Fm (NCSM #3109, #12713)

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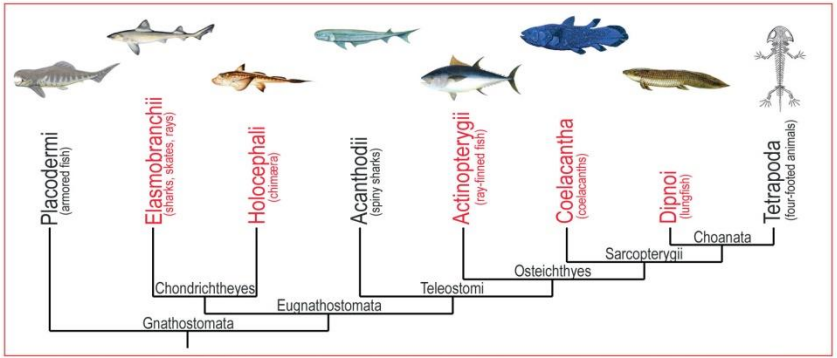
Interesting / Relevant

Easy to Understand / Technical Enough for Professionals

FISH: RICHARD CHANDLER AND PAT YOUNG



An Evolutionary Tree of Fish (The groups of interest here, from Chondrichthyes & Osteichthyes, are the five shown in red.)

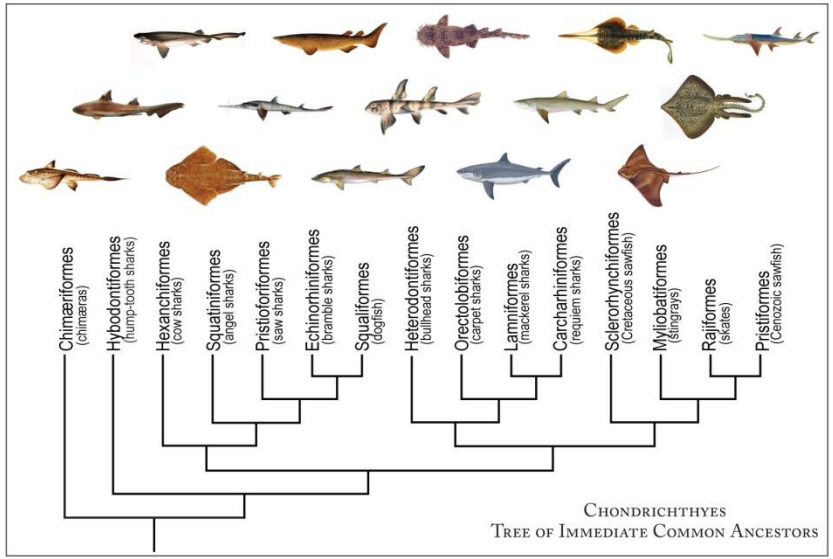
Each T- shaped fork represents a (usually unknown) immediate common ancestor for the vertical branches coming up from each horizontal end of the fork. Thus Dipnoi and Tetrapoda have an immediate common ancestor which has an immediate common ancestor with Coelacantha. Illustrations are Public Domain or from Wikipedia.

NAVIGATION WITHIN THIS CHAPTER (CD VERSION ONLY).

The blue section headings to the left are linked to their respective section. If you hover the mouse cursor over one of these links, the arrow should change to a pointing hand. Left clicking should take you to the first page of that section. To return here, left click any CONTENTS you see (lower right corner).

There are Tables of Contents within each of the two major sections (Chondrichthyes & Osteichthyes). Each entry there is hyperlinked to the first page devoted to that entry. Left clicking any TOC CHONDRICHTHYES or TOC OSTEICHTHYES (lower left corner) within either of those sections returns you to the Table of Contents of that section.

One very useful .pdf keyboard shortcut is that Alt + ← (PC) or Cmnd + ← (MAC) returns you to your previous view; *i.e.*, hold down the Alt (Cmnd) key and hit the left arrow key.



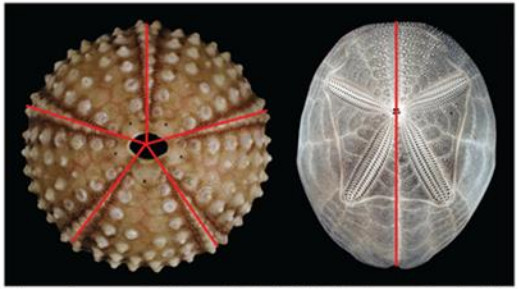
Each T- shaped fork represents a (usually unknown) immediate common ancestor for the vertical branches arising from each horizontal end of the fork. Thus, Pristiformes and Rajiformes have an immediate common ancestor which has a immediate common ancestor with Myliobatiformes. The representative illustrations are not to scale.

Interesting / Relevant

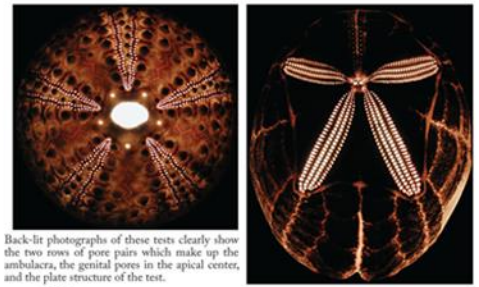
Terminology and Misc.

Echinoid Terminology

Aboral: The upper surface of the test ("from the mouth").
Adoral: The undersurface of the test ("near the mouth").
Adapical: The upper surface of the test ("near the apical").
Ambitus: The "equator" of a regular echinoid.
Ambulacrum: One of the 4-5 "petals" on the aboral surface (plural, ambulacra). They are created by the pore pairs. In irregular echinoids the anterior ambulacrum is frequently depressed for channeling food toward the mouth.
Apical Disk: The ambulacral "center" on the aboral side. In regular echinoids this consists of 5 ocular plates (at the ends of the ambulacra) and 5 genital plates (containing the genital pores) surrounding the periproct. In irregular echinoids there are 5 ocular plates but only 4 genital plates.
Aristotle's Lantern: The complex jaw apparatus of an echinoid. It is rarely recovered as a fossil.
Genital Pores (Gonopores): Small openings (usually 4 or 5) within the apical disk for emitting ova or sperm.
Interambulacrum: Region between pairs of ambulacra.
Irregular Echinoid: One having its periproct outside the apical disk; hence, possessing bilateral symmetry only.
Lunule: A naturally occuring hole through the test of several species of Clypeasteroida ("sand dollars").
Madreporite: A filter for the water vascular system.
Periproct: The opening in the test containing the anus.
Peristome: The opening in the test containing the mouth.
Phyllodes: The five leaf-like structures near the peristome.
Plastron: The posterior adoral interambulacral zone behind the peristome on some species of irregular echinoids.
Pore Pairs: The small paired openings within the ambulacra for the tube feet.
Regular Echinoid: One having its periproct within the apical disk; hence, possessing pentameral radial symmetry.
Test: The shell of an echinoid; it is made up of small plates.
Tube Feet: Fluid-filled extensions which protrude through the pore pairs and are used by echinoids for locomotion, feeding, burrowing, respiration, etc.
Tubercles: Raised "bumps" on the surface of the test which serve as attachment points for spines.



Symmetry in extant species *Arbacia punctulata* (regular, left) and *Metalia spatagus* (irregular, right)



Back-lit photographs of these tests clearly show the two rows of pore pairs which make up the ambulacra, the genital pores in the apical center, and the plate structure of the test.

Name	Order	Size	Incidence	Age
Abertella aberti	Clypeasteroida	3" – 5"	Exceptional	Mi
Agassizia inflata	Spatangoida	½" – 1"	Rare	Eo
Agassizia mossomi	Spatangoida	1" – 2"	Exceptional	Ol
Agassizia porifera	Spatangoida	¾" – 1"	Very Rare	Pl-Ps
Arbacia improcera	Arbacioida	1" – 1¾"	Rare	Pl
Arbacia waccamaw	Arbacioida	½" – 1¾"	Occasional	Pl-Ps
Arbacia rivuli	Arbacioida	1" – 2"	Very Rare	Pl
Brissus glenni	Spatangoida	4"	Exceptional	Ps
Catopygus mississippiensis	Cassiduloida	½" – ¾"	Exceptional	Cr
Cidaroida *incertae sedis*	Cidaroida	?"	Exceptional	Cr
Cidaris pratti	Cidaroida	¼" – 1½"	Rare	Eo
Clypeaster rogersi	Clypeasteroida	1½" – 3"	Exceptional	Ol
Clypeaster romani	Clypeasteroida	4" – 6"	Very Rare	Pl-Ps
Coelopleurus carolinensis	Arbacioida	½" – 1½"	Rare	Eo
Coelopleurus infulatus	Arbacioida	½" – 1½"	Rare	Eo
Echinarachnius parma	Clypeasteroida	2"	Exceptional	Ps-Pr
Echinocardium kelloggi	Spatangoida	1½" – 3"	Rare	Pl
Echinocardium orthonotum	Spatangoida	1" – 3"	Occasional	Pl
Echinocyamus parvus	Clypeasteroida	½" – ½"	Occasional	Eo
Echinocyamus wilsoni	Clypeasteroida	¼" – ½"	Very Rare	Ol
Echinolampas aldrichi	Cassiduloida	1½"	Exceptional	Ol
Echinolampas appendiculata	Cassiduloida	¼" – 2"	Plentiful	Eo
Encope macrophora ?	Clypeasteroida	1¼"	Exceptional	Pl
Encope sp.	Clypeasteroida	2" – 4"	Common	Ps
Eupatagus carolinensis	Spatangoida	1" – 3"	Ocasional	Eo
Eupatagus lawsonae	Spatangoida	1" – 4"	Exceptional	Eo
Eupatagus wilsoni	Spatangoida	1½" – 2"	Exceptional	Eo
Eurhodia baumi	Cassiduloida	1" – 1½"	Very Rare	Eo
Eurhodia holmesi	Cassiduloida	¼" – 1"	Rare	Eo
Eurhodia rugosa depressa	Cassiduloida	1" – 2"	Occasional	Eo
Eurhodia rugosa ideali	Cassiduloida	1" – 2"	Occasional	Eo
Eurhodia rugosa rugosa	Cassiduloida	1" – 1½"	Very Rare	Eo
Eurhodia sp. a	Cassiduloida	1" – 1½"	Ocasional	Eo
Eurhodia sp. b	Cassiduloida	¾" – 1¼"	Rare	Eo
Gagaria mossomi	Camarodonta	1" – 1½"	Exceptional	Ol
Gitolampas oviformis	Cassiduloida	½" – 1½"	Very Rare	Eo
Hardouinia aequoria	Cassiduloida	½" – 1"	Very Rare	Cr
Hardouinia kellumi	Cassiduloida	2" – 3"	Rare	Cr
Hardouinia mortonis	Cassiduloida	½" – 2"	Common	Cr
Hardouinia cf. Hardouinia priscus	Cassiduloida	1¾"	Exceptional	Cr
Hemiaster wetherbyi	Spatangoida	¾" – 1"	Exceptional	Cr
Lefortia trojana	Cassiduloida	½" – 1½"	Very Rare	Cr

Name	Order	Size	Incidence	Age
Linthia hanoverensis	Spatangoida	1" – 3"	Rare	Eo
Linthia harmatuki	Spatangoida	3" – 5"	Very Rare	Eo
Linthia wilmingtonensis	Spatangoida	1" – 3"	Occasional	Eo
Lytechinus variegatus	Temnopleuroida	1" – 1½"	Exceptional	Pl-Pr
Maretia carolinensis	Spatangoida	1" – 2"	Exceptional	Ol
Maretia subrostrata	Spatangoida	1" – 2"	Occasional	Eo
Mellita cf. M. aclinensis	Clypeasteroida	2" – 3"	Occasional	Pl-Ps
Mellita caroliniana	Clypeasteroida	3" – 4"	Rare	Pl-Ps
Mellita isometra	Clypeasteroida	3"	Plentiful	Ps-Pr
Periarchus lyelli	Clypeasteroida	½" – 4"	Plentiful	Eo
Periarchus sp.	Clypeasteroida	½" – 2"	Rare	Eo
Phyllacanthus mitchellii	Cidaroida	½" – 1½"	Exceptional	Eo
Phymotaxis tournoueri	Stomopneustoida	1½"	Rare	Cr
Plagiobrissus dixie	Spatangoida	3" – 3½"	Exceptional	Eo
Plagiobrissus sarae	Spatangoida	5½" – 7½"	Very Rare	Pl
Protoscutella conradi	Clypeasteroida	½" – 2"	Common	Eo
Protoscu. mississippiensis rosehillensis	Clypeasteroida	1½"	Occasional	Eo
Psammechinus carolinensis	Echinoida	¼" – ¾"	Occasional	Ol
Psammechinus philanthropus	Echinoida	1" – 2"	Very Rare	Pl
Rhyncholampas carolinensis	Cassiduloida	½" – 1½"	Plentiful	Eo
Rhyncholampas gouldii newbernensis	Cassiduloida	¾" – 1¾"	Very Rare	Ol
Rhyncholampas sabistonensis	Cassiduloida	1" – 2½"	Rare	Pl-Ps
Schizaster variabilis	Cassiduloida	⅜" – 1½"	Very Rare	Cr
Schizaster americanus	Cassiduloida	1½"	Exceptional	Ol
Spatangus glenni	Spatangoida	3" – 4½"	Very Rare	Pl
Urnifascia carolinensis	Spatangoida	1" – 3"	Occasional	Eo

Size is a range of typically encountered lengths (largest dimension). With the Exceptional species however, this is mostly a guess, based on the size of the one or two examples known to us.

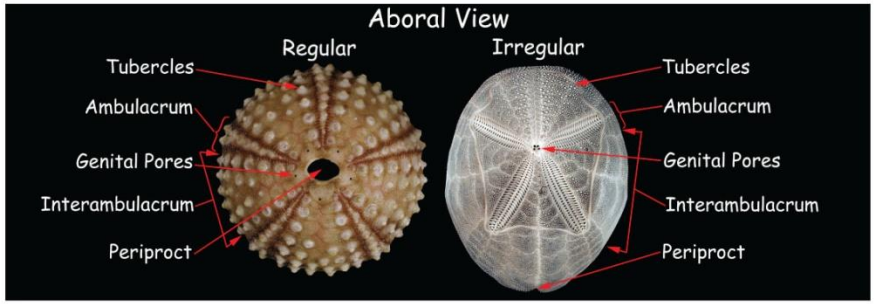
Incidence is based on personal and anecdotal experiences of finding nearly complete specimens and depends on the collecting environment: the chance of finding an Eocene species in Pliocene sediments is very unlikely, barring redeposition or hoax. A species might be relatively common in one locality and scarce in another, even of similar age. Fragments of fragile species such as *Echinocardium kelloggi* and *Mellita* cf. *M. aclinensis* can be quite common, indicating a greater abundance during life than is preserved as nearly complete specimens in the fossil record.

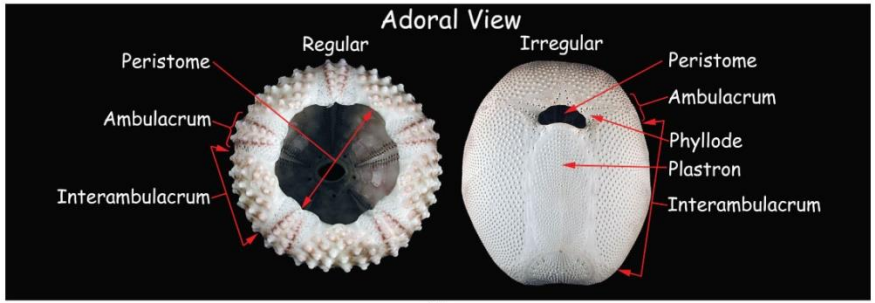
Exceptional:	Fewer than 10 ever found in North Carolina
Very Rare:	1 or 2 per year
Rare:	A half-dozen per year
Occasional:	Can be found with persistence
Common:	Everyone finds some
Plentiful:	You eventually quit picking them up

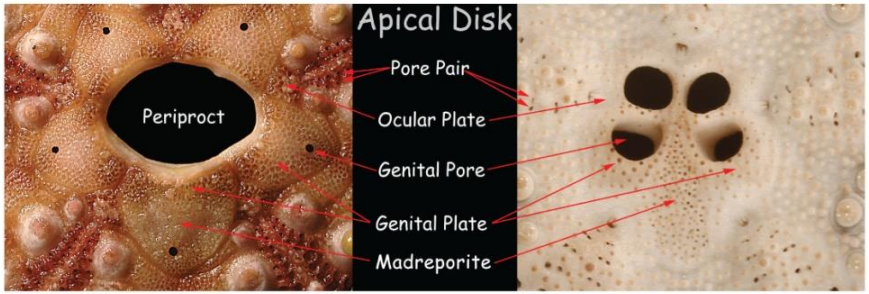
Ages: Cr = Cretaceous Eo = Eocene Ol = Oligocene Mi = Miocene Pl = Pliocene Ps = Pleistocene Pr = Present

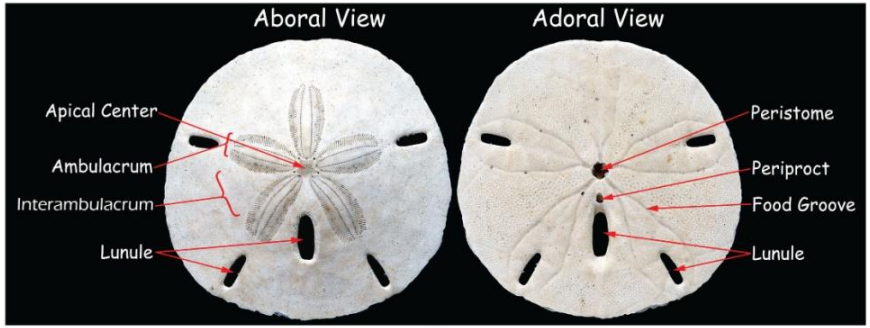
Interesting / Relevant

Detailed Diagrams









Relevant

Geology Section

Geology

Richard Olsen, Vince Schneider
Chris Tacker, Richard Chandler

Fossils and the Geological History of North Carolina

Introduction

Fossils, simply defined, are remnants of prehistoric life. Common wisdom holds that fossils must be 'petrified' or 'turned to stone' to qualify as a true fossil. This is untrue. Though many fossils are chemically altered or mineralized during or after burial, others, particularly some teeth and bones can be preserved virtually intact. Some fossils are casts or molds created by chemical dissolution and/or replacement of the original organism after burial. Footprints, trails and burrows also qualify as fossils. In this volume you will view many fine examples of fossils found in North Carolina. Though fossil deposits may differ greatly with respect to rock type, fossil abundance and diversity, state of preservation, or age, all have certain common attributes. All fossil deposits provide clues to the ancient environments and associated fauna and flora once present surrounding their location. Fossil deposits also provide clues to the unique circumstances that supported preservation of the fossils they contain. It is the job of historical geology, particularly the sub-disciplines of paleontology, paleoecology, biostratigraphy and stratigraphy, to assemble the clues from fossils and from the deposits that contain them into a comprehensive picture of how past life and environmental conditions varied over geologic time. Over the past 150 years geological specialists have learned much about the environmental conditions and life forms present in North Carolina during much of geologic time. Using publications resulting from this geological research provides amateur collectors with an opportunity to add new dimensions to their search for and appreciation of fossils. A list of some publications of potential interest appears at the end of this section.

Map of the Deep River Coal Field
Ebenezer Emmons: *Geological Report of the Midland Counties of*

Geological Limits on Fossil Occurrences in North Carolina

Fossil occurrences of interest to collectors usually consist of surface or near surface exposures of unaltered sedimentary rock originally deposited in an environment with abundant life and high preservation potential. The best depositional environments for fossil creation and preservation are low to moderate energy marine (ocean-related), lacustrine (lake-related), and fluvial (stream or river related) environments. While the eastern third of North Carolina hosts numerous sites fitting the above criteria, fossils are rare to non-existent in the west central and western portions of the state. The geological reasons for this are as follows.

Today, most of the central and western portions of North Carolina contain exposures of either non-sedimentary (igneous and/or metamorphic) crystalline rocks (central area) or extremely ancient, heavily altered sedimentary rocks (western Smoky Mountains area) in which most fossil remains have been destroyed by geologic processes. Generally accepted plate tectonics

studies indicate th
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and associated mou
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Neoproterozoic Era
at the end of the P
fossil-bearing strata
these violent events
erased by later uplift
map, page 3).

Near the end of th
Permian (285 millio
compression and col
of the super-contine
being assembled on
break up on the othe
as North Carolina w
the super-continent
Triassic a series of ri
North America betw
a result of crustal str
basins run northeast

References

Carter, J.G.; Gallagher, P.E.; Valone, E.V.; and Rossbach, T.J. [1988]: Fossil Collecting in North Carolina, *North Carolina Geological Survey Bulletin* **89**, 88 pp.

Chandler, R. and Timmerman, J. [2011]: *Neogene and Quaternary Fossils of North Carolina: A Field Guide (Revised & Expanded)*, The North Carolina Fossil Club, Inc., vi + 58 pp.

Emmons, E. [1856]: *Geological Report of the Midland Counties of North Carolina*, George P. Putnam, New York, 351 pp.

Emmons, E. [1858]: *Report of the North-Carolina Geological Survey: Agriculture of the Eastern Counties; Together with Descriptions of the Fossils of the Marl Beds*, Henry D. Turner, Raleigh, 314 pp.

Horton, J.W., Jr. and Zullo, V.A. editors [1991]: *The Geology of the Carolinas: Carolina Geological Society Fiftieth Anniversary Volume*, The University of Tennessee Press, 406 pp.

Ray, C.E. editor [1983]: Geology and Paleontology of the Lee Creek Mine, North Carolina I, *Smithsonian Contributions to Paleobiology* **53**, 529 pp.

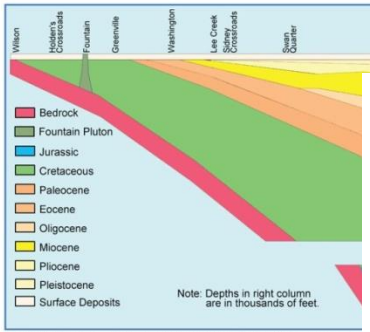
Ray, C.E. editor [1987]: Geology and Paleontology of the Lee Creek Mine, North Carolina II, *Smithsonian Contributions to Paleobiology* **61**, 283 pp.

Ray, C.E. and Bohaska, D.J. editors [2001]: Geology and Paleontology of the Lee Creek Mine, North Carolina III, *Smithsonian Contributions to Paleobiology* **90**, 365 pp.

Ray, C.E.; Bohaska, D.J.; Koretsky, I.A.; Ward, L.W.; and Barnes, L.G. editors [2008]: Geology and Paleontology of the Lee Creek Mine, North Carolina IV, *Virginia Museum of Natural History Special Publications* **14**, 515 pp.

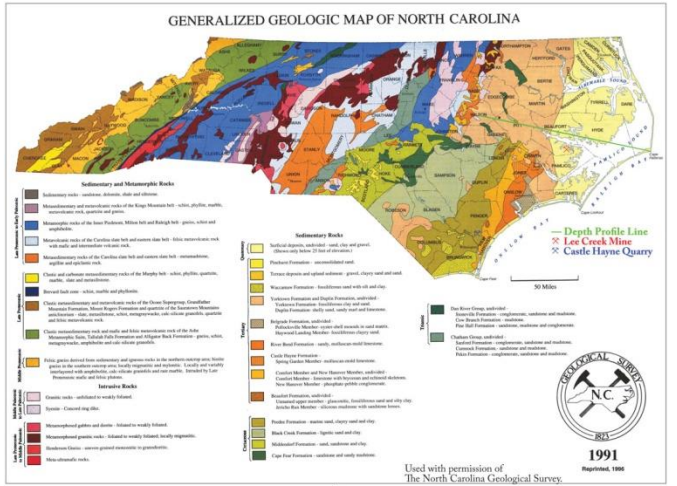
Timmerman, J. and Chandler, R. [2008]: *Cretaceous and Paleogene Fossils of North Carolina: A Field Guide (Corrected Edition)*, The North Carolina Fossil Club, Inc., vi + 70 pp.

Geological Formations



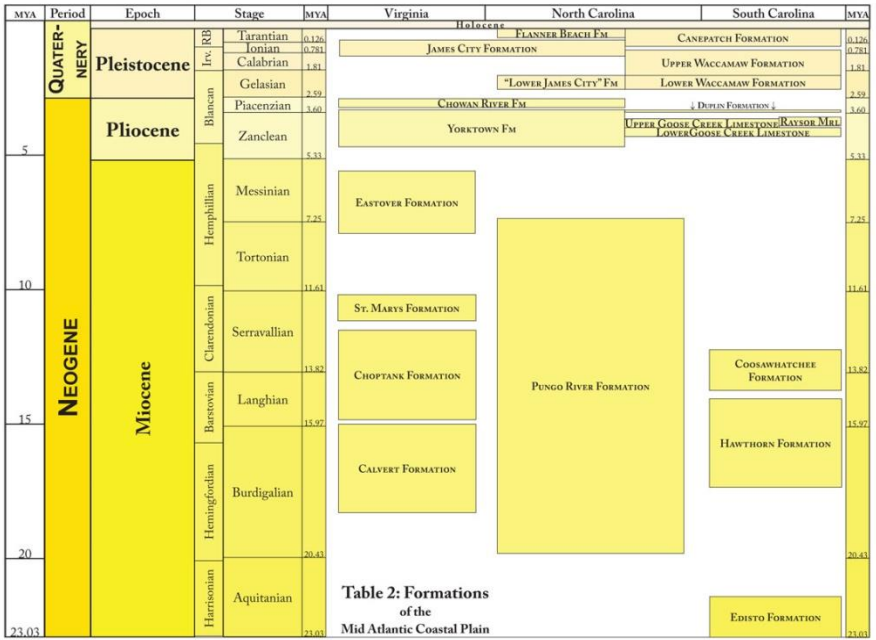
Depth profile on a line from Cape Hatteras to Wilson (see Geologic Map, next page,

Note: The Generalized Geologic Map (opposite page) is easier to interpret if you unde
for much of the east coast of the United States, including North Carolina, surficial rock
generally get progressively older from as you move from east to west.

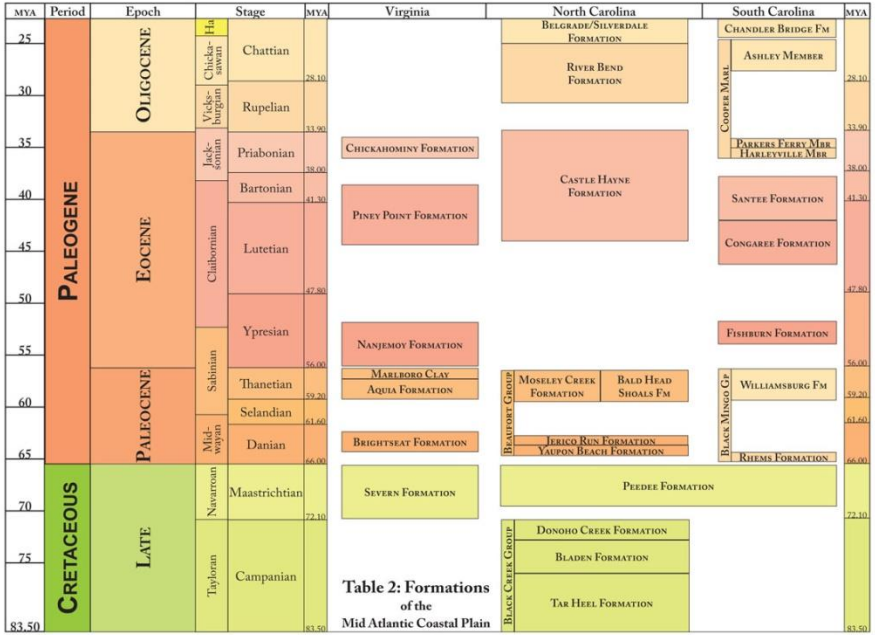


Relevant

Stratigraphy



– 8 –



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Relevant

Stratigraphy with Common Marker Fossils

Table 3: Quaternary and Neogene Fossil Exposures of Eastern North Carolina

MYA	Epoch	European Stage	N. American Stage	Formation	Lithology	Representative Fossils: Shark Teeth	Other Vertebrates	Invertebrates
.01	Pleistocene	Millazian Sicilian Emmilian Calabrian	Hallian Wheelerian	Flanner Beach James City/Waccamaw	Estuarine sand and mud Very shelly marine sand and shell hash	*Carcharodon carci* *Carcharhinus* spp *Galeocerdo cuvier*		
1.8	Pliocene	Piacenzian Zanclian	Venturian Repettian Delmontian	Chowan River/ Bear Bluff Yorktown/Duplin	Marine sands Marine sand, clay with basal fossil lag deposits	*Hemipristis serra* *Carcharocles mega* *Galeocerdo cuvier* *Parotodus benedeni* *Hexanchus griseus* *Megachasma* cf. *M.* *Carcharodon hasta* *Carcharhinus* spp. *Carcharodon hasta* Various skate & r		
5.3	Miocene	Messinian Tortonian Serravallian Langhian Burdigalian Aquitanian 23	Mohnian Luisian Relizian Saucesian	Eastover Pungo River Belgrade	Marine sand, mud and marls	*Carcharocles chub* *Hemipristis serra* *Physogaleus contu* *Notorhynchus cep* *Carcharhinus* spp *Isurus oxyrinchus* *Alopias vulpinus* *Carcharias taurus* *Echinorhinus blak* *Carcharoides catti* *Rhinoodon* cf. *R.* *Myliobatis* sp.		

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Table 5: Cretaceous, Triassic, and Ediacaran Fossil Exposures of North Carolina

MYA	Period	European Stage	N. American Stage	Formation		Lithology	Representative Fossils
65.5	Cretaceous	Maastrichtian	Peurcian Lancian	Peedee		Grey to greenish sand	*Exogyra costata, Flemingostrea subspat mortoni, Ischyrhiza mira, Cretolamna* Mosasaurs
		Campanian	Edmontonian Judithian	Donoho Creek	Black Creek Group	Clayey sand with quartz and phosphate pebbles	*Exogyra cancellata, Anomia tellensides,*
				Bladen		Mixed layers of dark clays and light sand	*Flemingostrea pratti, Flemingostrea bl*
			Aquilian	Tar Heel		Delta plain deposit	*Exogyra ponderosa, Ostrea whitei, Tur*
		Santonian		Middendorf		Fluvial delta plain	*Ostrea cretacea, Hadrosaurus, Hypsiben* Petrified wood
145		Coniacian		Cape Fear		Feldspathic quartz sand	Petrified wood
↕	J	↕	↕	↕		↕	Ostracods (from deep well cores)
200	Triassic	Norian		Sanford/ Lithofacies Association 2 Cow Branch		Flood plain, overbank, and minor pond or lake deposits	*Rutiodon*, Rauisuchia, Diplostraca, O
				Cumnock		Clastic deposits; thin coal seams	*Tanytrachelos* *Rutiodon*, Metoposaurs, *Zamites*, Pele
251		Carnian		Pekin		Fluvial clastic rocks	*Rutiodon*, Rauisuchia, Dicynodonts, *Phlebopteris, Neocalamites*
↕	↕	↕	↕	↕		↕	
542	Ediacaran			Carolina Terrane Floyd Church Formation Cid Formation		Metamorphic siltstone and mudstone	*Pteridinium carolinaense, Swartpuntia*
635							

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Table 4: Paleogene Fossil Exposures of Eastern North Carolina

MYA	Epoch	European Stage	N. American Stage	Formation		Lithology	Representative Fossils: Shark Teeth	Mollusks	Echinoids
23	Oligocene	Chattian	Zemorrian	Belgrade		Shelly marine sands and shales with lenses of moldic limestones	*Carcharocles angustidens* *Galeocerdo casei* *Hemipristis serra* *Myliobatis* sp. *Aroxyspristis fajumensis*	*Pecten trentensis* *Crassostrea gigantissima* *Panopea* sp. *Busycon spiniger* *Calyptraea (Trochita) aperta* *Donax idoneus*	*Psammechinus carolinensis* *Gagaria mossomi* *Agassizia mossomi* *Echinolampas aldrichi*
		Rupelian		River Bend		Moldic, sometimes sandy limestones			
33.9	Eocene	Priabonian	Refugian	Castle Hayne		Light colored, highly fossiliferous limestones	*Carcharocles auriculatus* *Isurus praecursor* *Striatolamia macrota* *Galeocerdo latidens* *Odontaspis carolinensis* *Abdounia recticona* *Hemipristis curvatus* *Hexanchus agassizi* *Serratolamna hoerti* *Brachycarcharias lerichei* *Nebrius thielensis* *Myliobatis* sp. *Pristis lathami*	*Eutrephoceras carolinensis.* *Aturia alabamensis* *Conus* sp. *Phalium brevicostatum* *Phalium taiti* *Ficus* sp. *Mitra* sp. *Entemnotrochus nixeus* *Clavilithes* sp. *Xenophora* sp. *Spondylus lamellacea* *Pecten membranosus* *Plicatoria wilmingtonensis*†	*Protoscutella conradi* *Echinocyamus parvus* *Periarchus lyelli* *Echinolampas appendiculata* *Eurhodia rugosa* *Rhycholampas carolinensis* *Maretia subrostrata* *Eupatagus carolinensis* *Coelopleurus carolinensis* *Lintbia harmatuki* *Lintbia hanoverensis* *Lintbia wilmingtonensis* *Unifascia carolinensis*
		Priabonian Bartonian Lutetian Ypresian	Refugian Narizian Ulatizian Penutian						
55.8	Paleocene	Thanetian Danian	Bulitian Ynezian Danian	Beaufort Group	Moseley Creek Jerico Run Yaupon Beach	Reworked marine sands and shales in poor exposures Siliceous mudstone with sandstone lenses	*Palaeocarcharodon orientalis* *Otodus obliquus*	*Haustator zulliei* *Oleneothyris harlani*† †Brachiopod	
65.5									

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Reviewed and Endorsed by Professionals

"There are fossil clubs all over the world, but few have taken the time to educate their membership—and the community—about the fossil history of their home state like the NCFC has done with this wonderfully illustrated guide. This project would have been a monumental undertaking even for professional paleontologists. The clarity of information and images makes this long-awaited guidebook a must-have for every collector on the East Coast."

George Phillips
Curator of Paleontology
Mississippi Museum of Natural Science

Other Endorsements:

- Dr. Lyle Campbell
  University of South Carolina
- Dr. Gordon Hubbell
  Jaws International
- Dr. David Bohaska
  Collections Management,
  Vertebrate Paleontology
  Smithsonian Institution

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References / Acknowledgements

References

Echinoids

Agassiz, Alexander [1872-1874]: Revision of the Echini, *Memoirs of the Museum of Comparative Zoology*, **3**, p. 1-762, pl. 1-38.

Agassiz, Louis and Desor, Pierre Jean Édouard [1846–1847]: Catalogue raisonné des familles, des genres, et des espèces de la classe des échinodermes. *Annales des Sciences Naturelles, Troisième Série, Zoologie*, **6**(1846): 305–374, pls. 15–16, **7**(1847): 129–168, **8**(1847): 5–35, 355–380.

Bell, F. Jeffrey [1889]: On the relative claims to recognition of the generic names Arbacia, Gray, and Echinocidaris, Des Moulins. *The Annals and Magazine of Natural History*, **III**, 290.

Ciampaglia, Charles N. and Weaver, Patricia G. [2007]: Maastrichtian (Cretaceous) regular echinoids from the Rocky Point Member, Peedee Formation southeastern North Carolina, *Southeastern Geology*, **45#1**: 43-49.

Clark, W. B. and Twitchell, M. W [1915]: *The Mesozoic and Cenozoic Echinodermata of the United States:* United States Geological Survey Monograph **54**, 341 pp.

Cooke, C. Wythe [1941]: Cenozoic regular echinoids of Eastern United States, *Journal of Paleontology* **15**: 1-20.

Cooke, C. Wythe [1942]: Cenozoic irregular echinoids of Eastern United States, *Journal of Paleontology* **16**: 1-62.

Cooke, C. Wythe [1954]: *American Upper Cretaceous Echinoidea*, United States Geological Survey Professional Paper, **254A**.

Cooke, C. Wythe [1955]: *Some Cretaceous Echinoids from the Americas*, United States Geological Survey Professional Paper, **264E**.

Cooke, C. Wythe [1959]: *Cenozoic Echinoids of Eastern United States*, United States Geological Survey Professional Paper, **321**.

Desor, Pierre Jean Édouard [1855-1858]. *Synopsis des Échinides Fossiles*, Chez Charles Reinwald, Paris.

Desor, Pierre Jean Édouard. and de Loriol, Perceval [1868-72]: *Echinologie Helvétique: Description des Oursins Fossiles de la Suisse*, Editeurs Kreidel, Wiesbaden.

Duncan, P. Martin [1891]: A revision of the genera and great groups of the Echinoidea, *Journal of the Linnean Society. Zoology*, **XXIII**, 1-311.

Emmons, Ebeneezer [1858]: *Report of the North-Carolina Geological Survey: Agriculture of the Eastern Counties; Together with Descriptions of the Fossils of the Marl Beds*, Henry D. Turner, Raleigh.

Gray, John Edward [1835]: On the Genera distinguable in Echinus, *Proceedings of the Zoological Society of London*, **III**, 57-59.

Gray, John Edward [1851]: Descriptions of some new genera and species of *Spatangida* in the British Museum, *The Annals and Magazine of Natural History*, **VII**(2), 130-134.

Harold, A.S. & Telford, M. [1990]: Systematics, phylogeny and biogeography of the genus *Mellita* (Echinoidea: Clypeasteroida), *Journal of Natural History*, **24**, 987–1026.

Harvey, Ethel Browne [1956]: *The American Arbacia and Other Sea Urchins*, Princeton University Press, Princeton NJ.

Kellum, Lewis Burnett [1926]: Paleontology and Stratigraphy of the Castle Hayne and Trent Marls in North Carolina, U.S. Geological Survey Professional paper, **143**.

Kier, Porter M. [1962]: *Revision of the Cassiduloid Echinoids*. Smithsonian Miscellaneous Collections, **144(3)**.

Kier, Porter M. [1963]: *Tertiary Echinoids from the Calossahatchee and Tamiami Formations of Florida*. Smithsonian Miscellaneous Collections, **145(5)**.

Kier, Porter M. [1972]: *Upper Miocene Echinoids from the Yorktown Formation of Virginia and Their Environmental Significance*, Smithsonian Contributions to Paleobiology, **# 13**, Smithsonian Institution Press, Washington.

Kier, Porter M. [1980]: *The Echinoids of the Middle Eocene Warley Hill Formation, Santee Limestone, and the Castle Hayne Limestone of North and South Carolina*, Smithsonian Contributions to Paleobiology, **# 39**, Smithsonian Institution Press, Washington.

Kier, Porter M. [1983]: Upper Cenozoic echinoids from the Lee Creek Mine, *Geology and Paleontology of the Lee Creek Mine, North Carolina, I*, Ray, Clayton E. Ed., Smithsonian Contributions to Paleobiology, **# 53**, Smithsonian Institution Press, Washington: 499-507.

Kier, Porter M. [1984]: *Fossil Spatangoid Echinoids of Cuba*, Smithsonian Contributions to Paleobiology, **# 55**, Smithsonian Institution Press, Washington.

Kier, Porter M. [1997]: *Oligocene Echinoids from North Carolina*, Smithsonian Contributions to Paleobiology, **# 83**, Smithsonian Institution Press, Washington.

Kier, Porter M. and Lawson, Mary Hurd [1978]: *Index of Living and Fossil Echinoids 1924-1970*. Smithsonian Contributions to Paleobiology **# 34**, Smithsonian Institution Press, Washington.

Lambert, J. & Thiéry, P. [1909–1925]: *Essai de Nomenclature Raisonnée des Echinides*, L. Ferrière, Chaumont.

Lewis, D.N., Donovan, S.K., & Clements. D. [2006]: Morphology of the Large Cenozoic Spatangoid Echinoid *Brissus* Gray from North and South Carolina, *Southeastern Geology* **44**, 129-135.

Mooi, Rich [1990]: Living Cassiduloids (Echinodermata: Echinoidea): a key and annotated list, *Proceedings of the Biological Society of Washington* **103**, 63-85.

Mortensen, Theodor [1928-1951]: *A Monograph of the Echinoidea*, C.A. Reitzel, Copenhagen, 5 volumes in 17 parts.

Moulins, Charles des [1835]: *Actes de la Société Linnéenne de Bordeaux*, **7**(41), 200.

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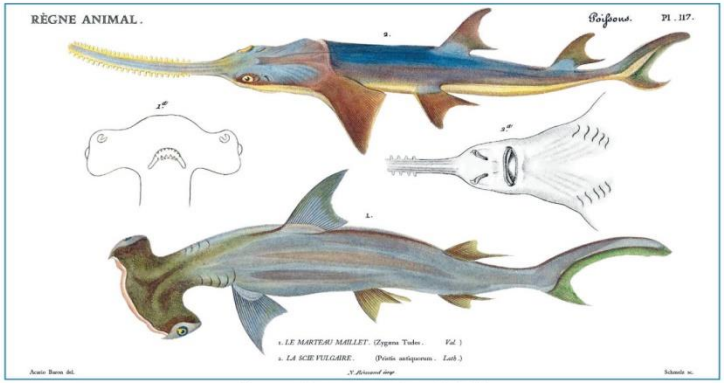
Cite Members who had Specimens Photographed

50% Members

50% Institutions



Georges Cuvier, *Règne Animal* (1817)
Poissons Pl. 117: 1. Zygæna Tudes (now *Sphyrna mokkaran*), 2. Pristis antiquorum (now *Pristis* ?†)

† John Latham [1794] identified five species of modern sawfish: *Pristis antiquorum*, *P. pectinatus*, *P. cuspidatus*, *P. microdon*, and *P. cirratus* (although this last is clearly a sawshark). During the 19th Century *P. antiquorum* became a catch-basket for many modern sawfish, to the extent that it is unclear for which of the currently accepted seven species it is a synonym. Fishbase.org identifies it as a synonym for *P. pectinata*, *P. microdon*, and *P. pristis*.

Photographed Specimens provided by:

Steve Ames
Paul Borodin
Suzanne Chandler
Terry Anne Denny
George Fonger
Joy Herrington
Bill Ivory
Vance McCollum
Bryant Paris
Melinda Spiron
Judy Stiles
John Timmerman
Rick Bennett
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Terry Cirrincione
Alexandra Dubrock
Eric Fritz
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Trish Kohler
Richard Olsen
Heather & Todd Power
Hope C. Squires
Andrea Stilley
Pat & Ken Young
North Carolina Museum of Natural Sciences
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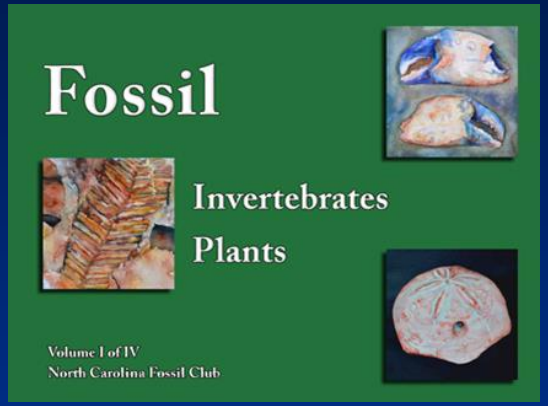
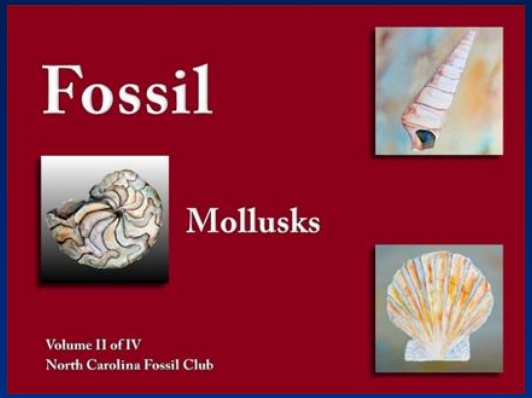
John Everette
Kim Greene
Gordon Hubbell
Ramona Krailler
Adrian Overly
Eric Sadorf
Tom Stafford
Michael Taggert
Aurora Fossil Museum
Glenn Bolick
Richard Chandler
Cindy Crane
John Fitez
Bill Heim
Becky Hyne
Linda McCall
Joanne Panek-Dubrock
David Sanderson
John Steffensen
Richard Tellekamp

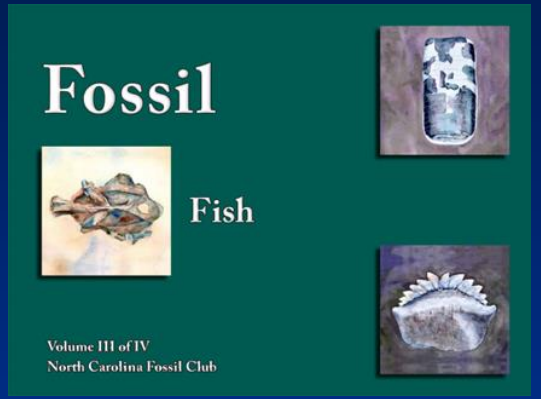
Until recently the huge treasury of micro teeth in North Carolina had only occasionally been sampled. Thanks to the efforts of Don Clements, Joy Herrington, Ramona Krailler, Joanne Panek-Dubrock, and especially Eric Sadorf, this document is far richer in specimens in the 5 mm and under range than it would have been if finished even two years ago. The examples available for photography of several of these species consist only of a single specimen. Hopefully, that may change in the future as more collectors realize what is out there.

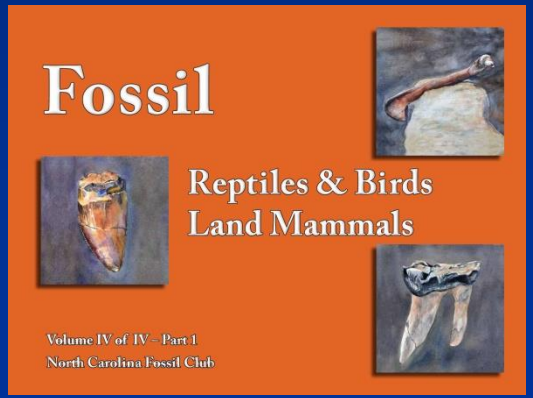
Above and Beyond

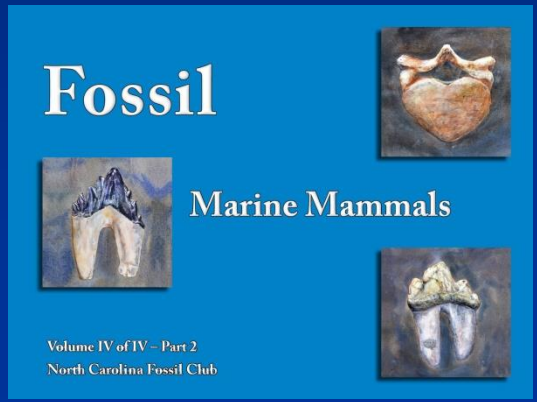
Cover Art by Member Rick Bennett





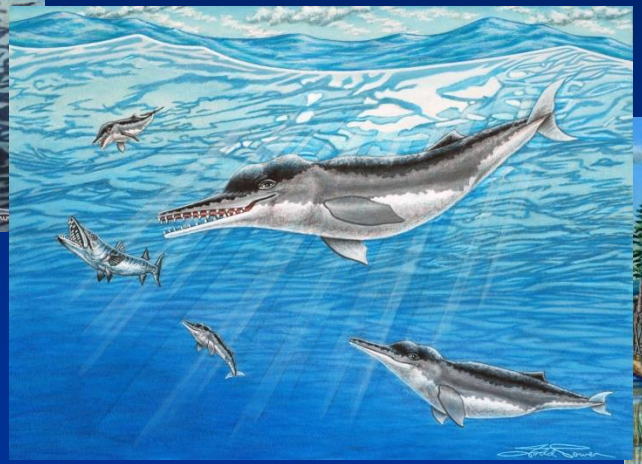






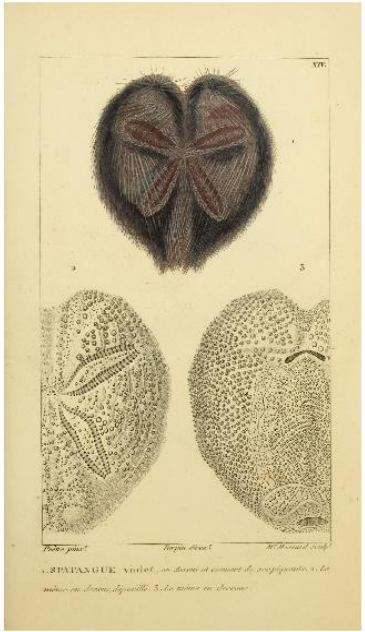
Above and Beyond

Original Artwork by Member Todd Power



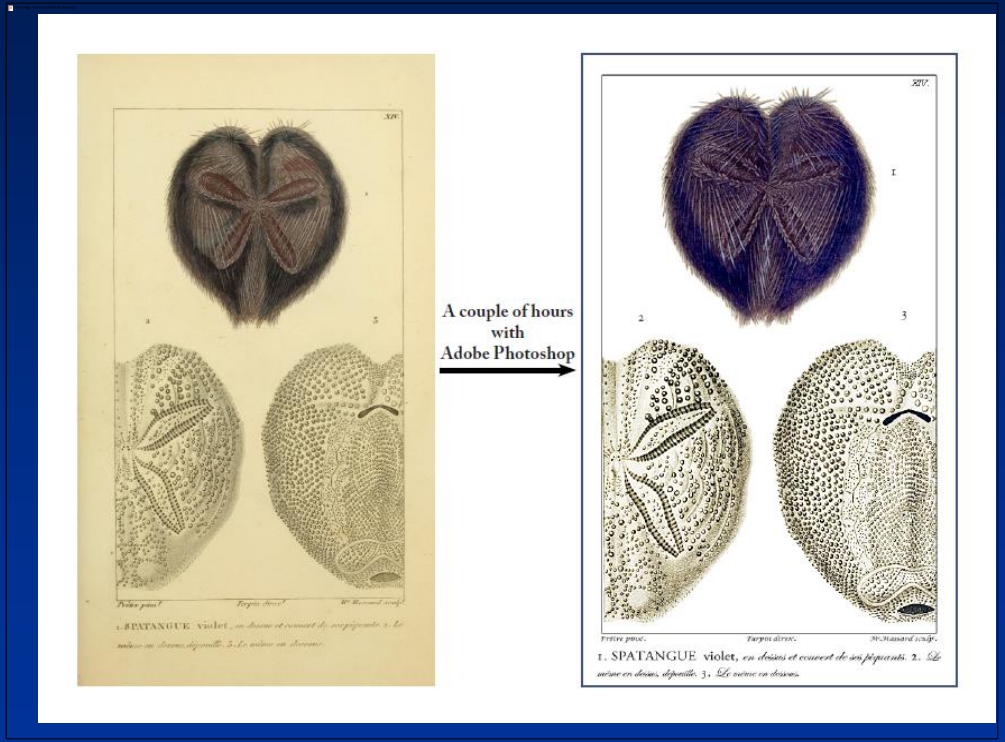
Above and Beyond

Vintage Internet Art



Above and Beyond

Cleaning up Vintage Internet Art



Above and Beyond

Inserted into Book

Echinoids

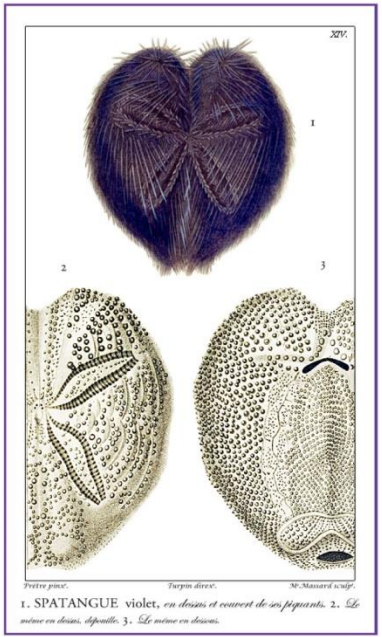
Judy Schneider

Echinoids are an interesting group of invertebrates from several perspectives. Modern species are commonly known as sea urchins and sand dollars, the former being an Asian culinary delicacy and the latter being a prized beach find for children and shell collectors. Fossil species lend themselves well to preservation, both by structure and habitat. Echinoids are, by definition, free-living organisms with a test built of interlocking calcareous plates. They compose a Class within the Phylum Echinodermata (other Classes in this phylum include sea stars and crinoids). In life, echinoids inhabit shallow marine environments, moving about and feeding by using their spines, tube feet, mouth parts, and internal water vascular system. Some species burrow into the substrate. The calcareous tests and spines are common in North Carolina fossil marine deposits.

The echinoids described in this text are grouped by Order, and are comprehensive of neither the genera within the orders, nor the orders within the class, but rather seek to classify the fossil echinoids found in North Carolina. The text attempts to describe distinguishing characteristics of species that are similar in appearance to aid collectors in identifying their specimens.

The Orders of regular echinoids here represented are Cidaroida, Stomopneustoida, Arbacioida, Echinoida, Temnopleuroida, and Camarodonta. The irregular echinoids are represented by Orders Cassiduloida, Clypeasteroida, and Spatangoida.

Natural scientists have studied echinoids for centuries and, over that time, have established a very technical and highly specialized vocabulary to describe these wonderful animals. We first give illustrated definitions of the most important terminology and include a list of the fossil echinoids found in North Carolina.

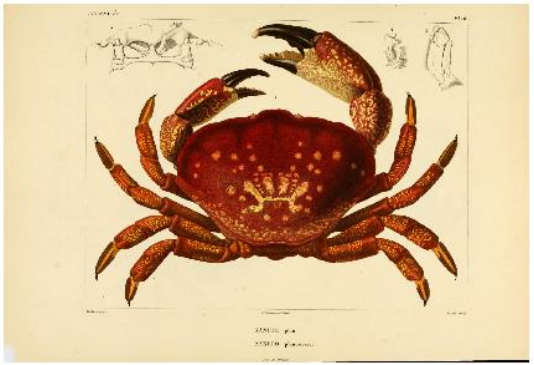


1. SPATANGUE violet, *en dessus et couvert de ses piquants.* 2. *Le même en dessus, dépouillé.* 3. *Le même en dessous.*

H.-M. Ducrotay de Blainville, *Manuel d'Actinologie ou de Zoophytologie* (1834) Planche XIV: Spatangue violet (*Spatangus purpureus*, the purple heart urchin).

Above and Beyond

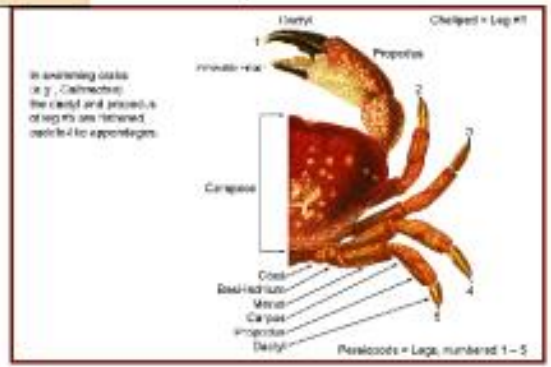
Vintage Art for a Diagram



Above and Beyond

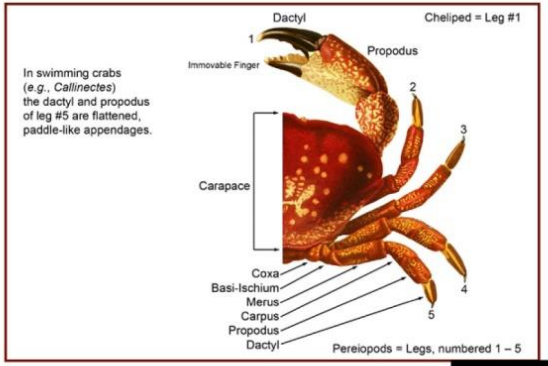
Cleaned up and terms added

Several hours with
Adobe Photoshop



Above and Beyond

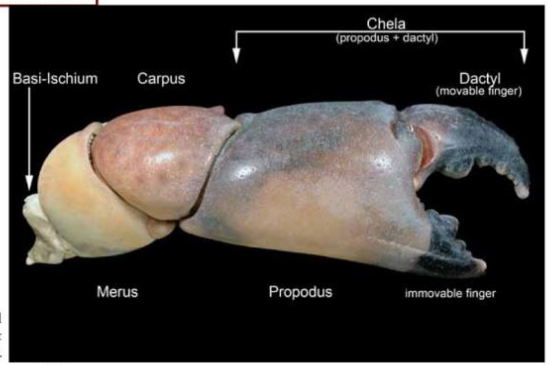
Inserted into Book



Crab anatomists use many esoteric names which are simply Latin or Greek words for rather mundane body parts:

Carapace	Shield (top shell of the cephalothorax)
Pereiopod	Walking leg (literally, carrying foot)
Cheliped	Claw-foot (pereiopod #1)
Chela	Claw (= dactyl + propodus)
Dactyl	Movable finger (literally, finger/toe)
Propodus	Hand and fixed finger (literally, forward foot)
Carpus	Wrist
Merus	Thigh
Basi-Ischium	Base of the hip
Coxa	Hip
Telson	The central portion of the tail of a crab, lobster, shrimp, or mantis shrimp (literally, edge)

Alcide d'Orbigny, *Voyage dans l'Amérique Méridionale . . .* (1835 - 47), Crustacés, Plate 6, *Xantho planus.*



The cheliped here (minus its coxa) was found on Shackleford Banks in February, 2011. It is from the commercially important stone crab, *Menippe mercenaria.*

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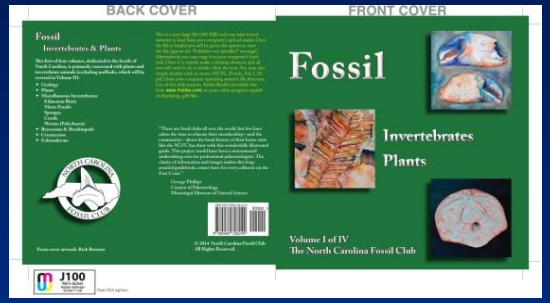
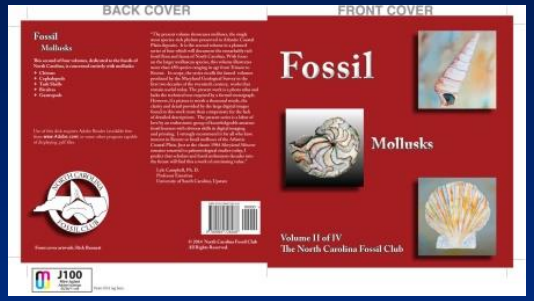
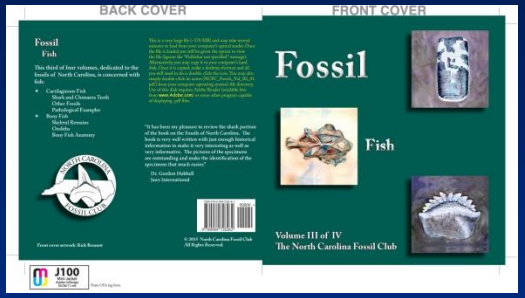
Above and Beyond

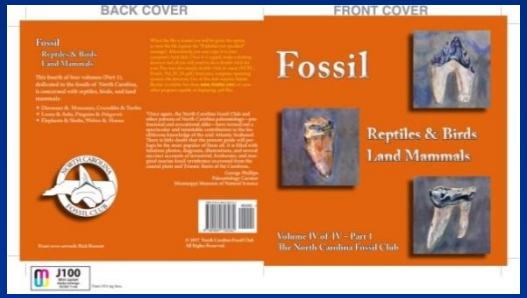
CD Version

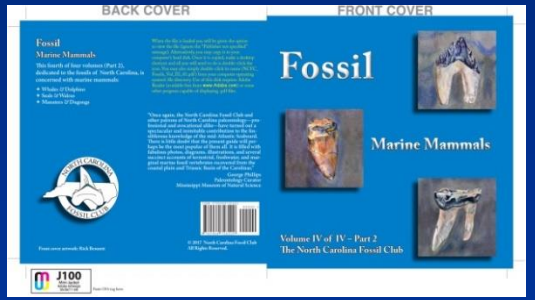






Print on demand

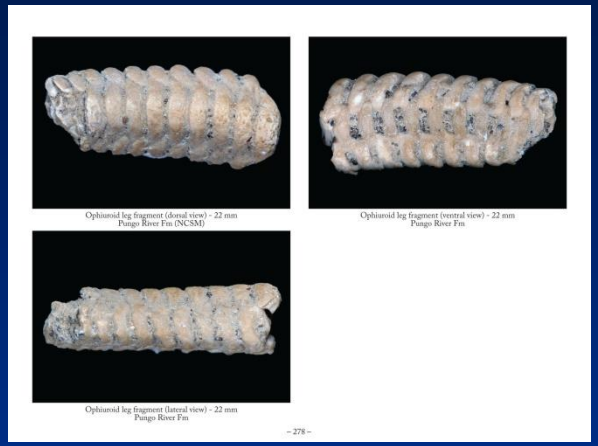




CDs cheaper

Many donated to local schools

Ongoing Updates


Ophiuroid leg fragment (dorsal view) - 22 mm
Pungo River Fm (NCSM)

Ophiuroid leg fragment (ventral view) - 22 mm
Pungo River Fm

Ophiuroid leg fragment (lateral view) - 22 mm
Pungo River Fm

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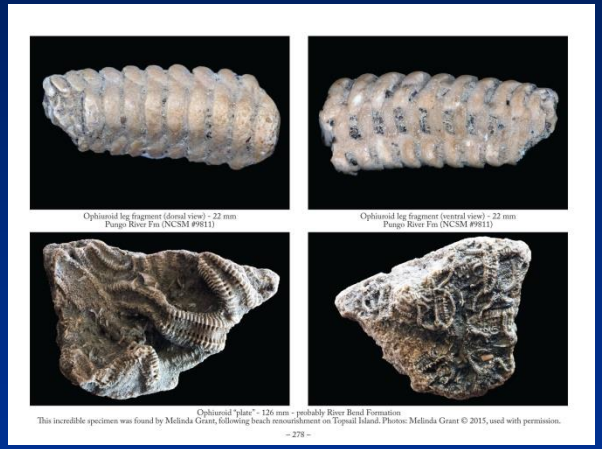
Ophiuroid leg fragment (dorsal view) - 22 mm
Pungo River Fm (NCSM #9811)

Ophiuroid leg fragment (ventral view) - 22 mm
Pungo River Fm (NCSM #9811)

Ophiuroid "plate" - 126 mm - probably River Bend Formation
This incredible specimen was found by Melinda Grant, following beach renourishment on Topsail Island. Photos: Melinda Grant © 2015, used with permission.

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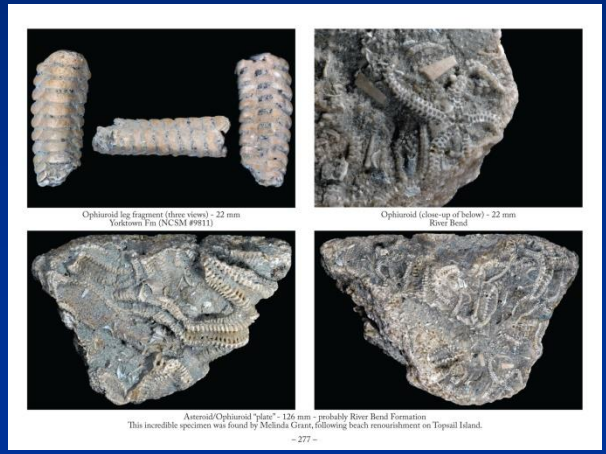
Infinitely updatable


Ophiuroid leg fragment (three views) - 22 mm
Yorktown Fm (NCSM #9811)

Ophiuroid (close-up of below) - 22 mm
River Bend

Asteroid/Ophiuroid "plate" - 126 mm - probably River Bend Formation
This incredible specimen was found by Melinda Grant, following beach renourishment on Topsail Island.

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Volumes prompt
new and better

Summary

- Amateurs, you can do it! Club/Society Challenge!
  - Get out there and mine that untapped knowledge!
  - Authors, Editors, Photography, Artwork
- Professionals – take a second look at your local club
  - they have a lot to offer
- Created a valuable product for both
  - Day jobs from all walks of life
  - We all learned valuable things along the way
  - All on volunteer time and with volunteer dollars

Acknowledgements

- FOSSIL Project
- North Carolina Museum of Natural History
- Aurora Fossil Museum
  Smithsonian
- Museum of Cape Fear
- North Carolina Forestry Museum
- Lake Waccamaw State Park
- Gordon Hubble's fossil shark collection (now at University of Florida)
- North Carolina Fossil Club members
  - Joy Herrington, Gary Lewis, Jerry Case
- Paleontological Society of Austin
- Southern California Paleontological Society
- Dallas Paleontological Society
  - Roger Farrish, Charles Finsley, Mark McKinzie
- Houston Gem and Mineral Society

Questions?