Exercise 3
Bivalve Fossil Record

This exercise stresses the rich fossil record bivalves possess due to their calcium carbonate shell. The focus of this laboratory exercise is to examine the diversity of fossils from the major eras of geological history and develop an understanding of their evolutionary history.

SUGGESTED ELEMENTS FOR AN INTRODUCTORY LECTURE

- The bivalve fossil record dates back to the Cambrian.
- Until the Permian Extinction brachiopods dominated after which, however, bivalves increased in diversity.
- During the Mesozoic burrowing bivalves with siphons underwent a great adaptive radiation.

ACTIVITIES

1. Examine bivalve fossil species Mesozoic and Cenozoic eras.
2. Develop an appreciation for the rich bivalve evolutionary history as documented by the fossil record.
3. Compare bivalve fossils with brachiopods, a major group of bivalved organisms that thrived during the Paleozoic Era.

VOCABULARY

Adaptive Radiation	Cambrian	Cenozoic
Brachiopod	Fossil	Paleozoic
Calcium carbonate	Mesozoic	Permian Extinction

MATERIALS FOR ALL PROCEDURES

Equipment
- Compound Microscope

Supplies
- Colored pencils
- Lab notebook
- Ruler

Organisms

Bivalve fossils:
- *Chesapecten jeffersonius*
- *Yoldia newcombriare*
- *Chione cancellata*
- *Pycnodonta newberyii*
- *Ilymatogyra arietina*
- *Agerostrea falcata*
- *Ostrea* sp.
- *Ervilia pusilla*
- *Abra subreflexa*
- *Semele subovata*
- *Donax transversa*
- *Rangia lecontei*
- *Sphaerium* sp.
- *Tivela stultorum*

Macoma groelandica
Asaphis coccinea
Corbula sp.
Varicorbula sp.
Agerostrea falcate
Dacryomya ovum
Gryphaea sp.
Exogyra arietina
Texigryphaea roemer
Bakewallia sp.
Cardium sp.

Brachiopod fossils:

Mucrospirifer thedfordensis
Cleiothyridina sp.
Rhynchonella uta

SUPPLEMENTAL MATERIALS

Bishop, A. (1999). *Cambridge guide to minerals, rocks, and fossils*. Cambridge, U.K. New York, NY: Cambridge University Press.

Peterson, C. (2008). *Southern Florida's fossil seashells*. Cocoa Beach, FL: Blue Note Books.

Argenville, D. (2010). *Shells = Muscheln = Coquillages : Conchology or The natural history of sea, freshwater, terrestrial and fossil shells*. New York: Metro Books Koln Taschen.

VENDORS FOR MATERIALS

Fossil shells can be purchased from www.wardsci.com.

Books can be purchased at www.amazon.com and Barnes and Noble

Bivalve Fossil Record

All bivalve shells are composed of calcium carbonate. The presence of a calcareous shell accounts for the rich fossil record. Although not as numerous as arthropods, mollusks have the best fossil record of any living marine invertebrate phylum. The bivalve fossil record ranges from the Cambrian to recent times and can be considered a reliable picture of their evolutionary history.

The purely calcitic shells of oysters and scallops ensures that they have a near-complete record because calcite is stable while aragonite is not, and either converts to calcite or dissolves leaving only an empty space in the rock, which may fill with sediment so that the outline of the shell is preserved as a cast.

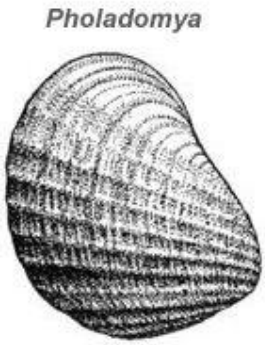
Bivalves were established in the Cambrian, however they played a minor role. They were present throughout the Paleozoic, but were overshadowed by brachiopods, bryozoans, crinoids and corals. After the decline of brachiopods during the Permian Extinction bivalves began to dominate the marine environment. Although bivalves and brachiopods were severely impacted by the mass extinction, bivalves recovered their diversity levels during the Triassic and the brachiopods did not. Can you hypothesize why the brachiopods were unable to regain their dominant role in the marine environment?

Bivalves with siphons also make their first appearance during the Devonian. During the Mesozoic burrowing bivalves with siphons underwent a great adaptive radiation. Swimming scallops make their first appearance during the Triassic. Rudist bivalves became dominant reef building organisms in the tropics during the Cretaceous displacing coral. However, they went extinct at the end of the Cretaceous. The first freshwater bivalves appear in the Devonian.

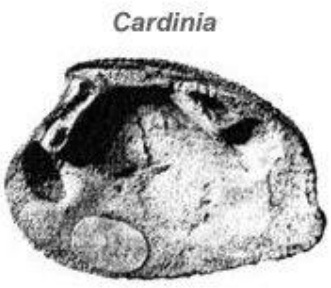
LAB OBJECTIVES:

1. To examine bivalve fossil species Mesozoic and Cenozoic eras
2. To develop an appreciation for the rich bivalve evolutionary history as documented by the fossil record
3. To compare bivalve fossils with brachiopods, a major group of bivalved organisms that thrived during the Paleozoic Era

In today's lab you will examine some representative fossil species of bivalves from a range of geological time periods. As you examine your fossils sketch the details of the shell, measure shell size and identify/label key morphological features that are evident in the fossils. Record notes on how the representative fossil species differ morphologically. Is there a diversity of species documented from the fossil record? What type of lifestyle can you hypothesize that these fossil species had? Shell sculpture such as shell hinge morphology can provide some information about lifestyle. *Pholadomya* possesses a hinge that lacks teeth or dentitions which indicates that it occupied a sessile infaunal habitat. Conversely, a strong hinge with elongated lateral teeth, such as that of *Cardinia*, can indicate the bivalve was an active burrower. The presence of an attachment scar, such as in *Liostrea*, would indicate that the species lived attached or cemented to the substratum.



Edentulous sessile
deep burrower



Strong laterals active
shallow burrower

Epifaunal cemented

Once you have observed the bivalve fossils, examine the available brachiopod fossils. Brachiopods are marine animals that secrete a shell consisting of two valves. Brachiopods have an extensive fossil record, first appearing in rocks dating back to the early part of the Cambrian Period about 525 million years ago. They were extremely abundant during the Paleozoic Era, reaching their highest diversity approximately 400 million years ago, during the Devonian Period. At the end of the Paleozoic they were decimated in the mass extinction that marks the end of the Permian Period about 250 million years ago. This event, known as the Permo-Triassic mass extinction, may have killed more than 90 percent of all living species. It was the largest of all extinction events (larger than the major extinction at the end of the Cretaceous that killed off the dinosaurs).

Although some brachiopods survived the end-Permain extinction, they never achieved their former abundance and diversity. Only about 300 to 500 species of brachiopods are exist today, a small fraction of the perhaps 15,000 species (living and extinct) that make up Phylum Brachiopoda.

Bivalve Fossil Collection

Taxonomic Classification

Subclass Palaeotaxodonta
Order Nuculoida
Yoldia newcombriare (5)
Subclass Pteriomorphia
Order Arcoida
Chione cancellata (11)
Order Pterioida
Pycnodonta newberyii (1)
Ilymatogyra arietina (2)
Agerostrea falcata
Ostrea sp. (3)
Subclass Heterodonta
Order Veneroida

Ervilia pusilla(7)
Abra subreflexa (8)
Semele subovata (9)
Donax transversa(10)
Rangia lecontei (12)
Sphaerium sp. (13)
Tivela stultorum (14)
Macoma groelandica (15)
Asaphis coccinea(16)

Order Myoida

Corbula sp. (4)
Varicorbula sp. (6)

Additional Fossils

Agerostrea falcate
Dacryomya ovum
Gryphaea sp.
Exogyra arietina
Texigryphaea roemer (Mesozoic fossil #15)
Bakewallia sp. (Mesozoic fossil #3)
Cardium sp. (Cenozoic fossil #2)

Representative Bivalve Fossils and the Geological Time Scale

		Species	**Location**
CENOZOIC			
Quaternary	**Holocene**	*Macoma groelandica* *Asaphis coccinea*	Champlainian submergence, Quebec Bahamas
	Pleistocene	*Rangia lecontei* *Sphaerium* sp. *Tivela stultorum*	Imperial County, CA Niagara Falls, NY Palos Verde formation, CA
Tertiary	**Pliocene**	*Chione cancellata*	Caloosahatchee formation, Florida
	Miocene	*Ervilia pusilla* *Abra subreflexa* *Semele subovata* *Donax transversa*	Vindobonien, France Yorktown formation, Virginia Yorktown formation, Virginia Burdigalien, France
	Oligocene	*Varicorbula* sp.	Headon beds, England

	Eocene	*Corbula* sp. *Yoldia newcombriare*	Cook Mt. formation, Texas San Diego, CA
	Paleocene	*Cardium* sp.	Texas
MESOZOIC	**Cretaceous**	*Pycnodonta newberyii* *Ilymatogyra arietina* *Agerostrea falcata* *Ostrea* sp. *Gryphaea* sp. *Exogyra arietina* *Texigryphaea roemer*	Mancos shale, Utah Grayson Marl formation, Texas Marengo County, Alabama Straight Cliffs, Utah Denton County, Texas Washita-Del Rio formation, Texas Grayson, Texas
	Jurassic	*Dacryomya ovum* *Unio* sp.	Upper Lias, England
	Triassic	*Bakewallia* sp.	Wach Co. UT
PALEOZOIC	**Permian**		

Brachiopod Fossils

Paleozoic Era

Devonian: *Mucrospirifer thedfordensis*

Pennsylvanian: *Cleiothyridina* sp.

Mesozoic Era

Triassic: *Rhynchonella uta*