CHAPTER 36
Taxonomy of Bivalves

1. Introduction

Bivalves - General Remarks

Most bivalves are marine and there are no terrestrial forms. Bivalve is the second most dominant class in the phylum Mollusca. Bivalves are characterized by a laterally compressed body with an external shell of two halves that is hinged dorsally. The bivalve hinge has sets of interlocking teeth that prevent valves from sliding along each other. The valves are united dorsally by elastic, a partially calcified or chitinous external or internal ligament and are held together by one or two adductor muscles. The head is rudimentary and have lost the buccal or radular apparatus. The mantle lobes are either connected or free ventrally. They are mostly ciliary feeders, with sieving and sorting mechanisms on labial palps and leaf-like ctenidium. The mantle cavity includes a pair of ctenidia suspended laterally. The mouth and anus are located at opposite ends of the body and the gut is typically convoluted. The foot is compressed and adopted for burrowing, except in sedentary forms where it is rudimentary.

Main Features of Bivalves

Muscle scars	Ligament	Dentition	Lunule	Pallial line	beak
Homomyar Heteromyar Monomyar	Internal External amphidetical Prosodetic opisthodetic	Cardinalia lateralia	escutcheon	Sinupalliate integripalliate	Orthogyrate prosogyrate opisthogyrate

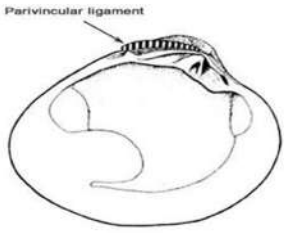
Orientation of Shell

- Ligament typically posterior
- posterior adductor muscle scar stronger developed
- pallial sinus posterior / shell gaps posterior
- posterior part of shell typically better developed
- umbo (beak) typically points anterior (prosogyre)
- byssal notch anterior
- Oysters: left valve bigger/cemented

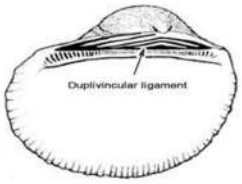
Ligament

The ligament may lie symmetrically between the beaks "amphidetic" or more often behind the beaks "opisthodetic" and very occasionally in front of the beaks "prosodetic. Examples of Parivincular ligament are Veneridae

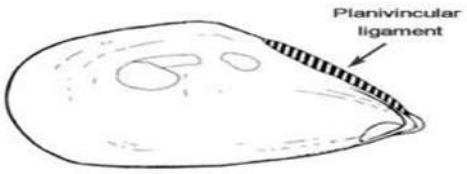
Examples of Alivincular amphidetic are *Limopsis* & *Ostrea* &Tellinidae



Examples of Parivincular ligament are Veneridae &Tellinidae



Examples of Duplivincular ligament are Arcidae and Glycymeridae &Tellinidae

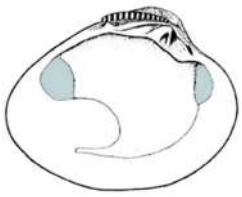


Examples of Planivincular ligament are Mytiloidea

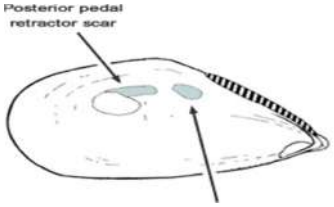
Beak

The beaks may face each other across the dorsal margin, i.e. **orthogyrate** but more commonly they point in the anterior, **prosogyrate** or posterior **opisthogyrate** directions. In a few bivalves, they may actually be **coiled.**

Muscle Scar



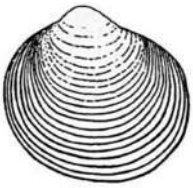
Dimyarian & Homomyarian **Heteromyarian**



Monomyarian **Posterior Pedal Retractor Scar**

Sculptures

Radial



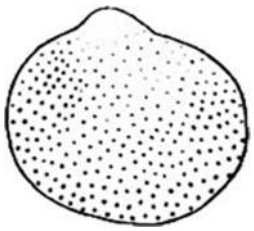
Co-marginal" or "Concentric

"Oblique" or "acentric

Scissulate

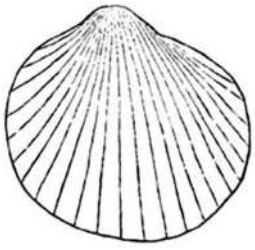
Divergent

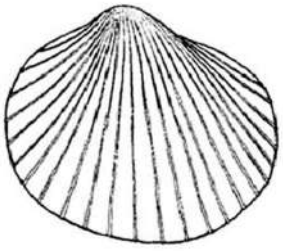
Divaricate



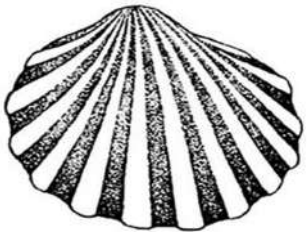
Non linear - granular or pustulose/pitted

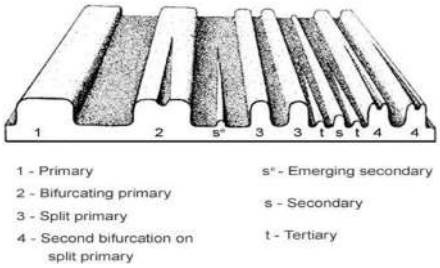
Radial Patterns





Lines **Threads** **Riblets**

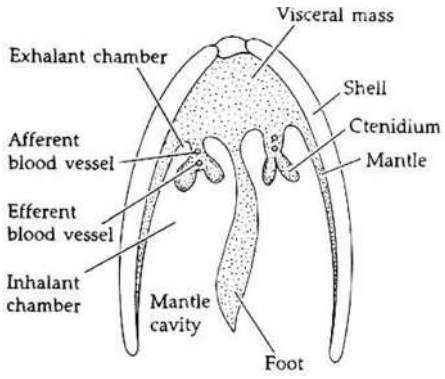




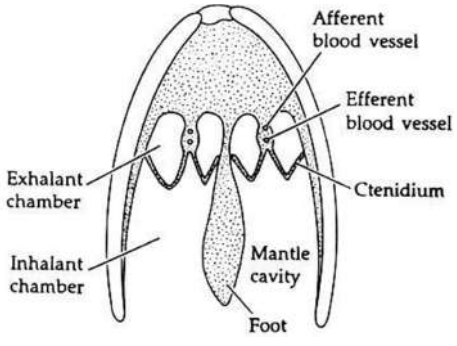
Ribs **Secondary Ribbin**

Basic for systematics are the gill type and the hinge dentition

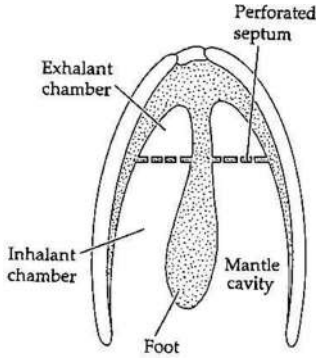
GILL TYPE	DESCRIPTION
Protobranch (deposit feeders, most primitive)	This gill structure tends to occur in primitive groups, demibranchs are comparatively small and consist of a series of ciliated leaf-like discs e.g. *Nucula* species
Filibranch (suspension feeders)	Demibranchs are considerably longer and consist of extended parallel structures - the filaments—rather than parallel discs. This gill structure consists of individual filaments forming 'W'-shaped structures that come together to form lamellar sheets. *Mytilus edulis*
Eulamellibranch (suspension feeders)	The filament structure also appears on the surface of the demibranch in these gills; however, their demibranchs are much more complex organs, because the filaments are connected by various tissue junctions. These form 'W'-shaped gills with cross-partitions joining the filaments to create water-filled cavities in between them. *Corbicula* sp.
Septibranch (carnivores, most derived)	These gills are only found in Poromyacea a super-family of the rock borer. They run transversely across the mantle cavity, enclosing the inner chamber, with only a small connection to the outer cavity.



Protobranch Gill



Eulamellibranch Gill

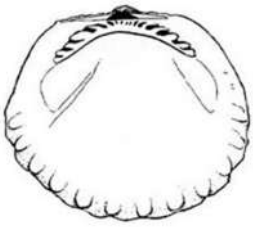


Septibranch Gill

Transverse Illustrated Section of Bivalves Showing Different Types of Gills

Dentition: Various Types and Subtypes

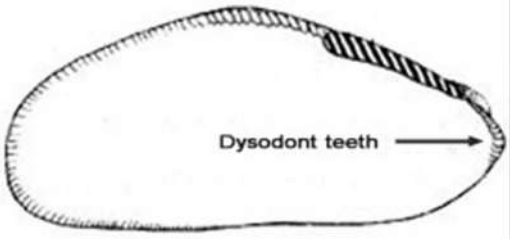
Taxodont: many small similar teeth & sockets all along hinge plate (e.g., *Glycimeris sp. and Arca sp.*)

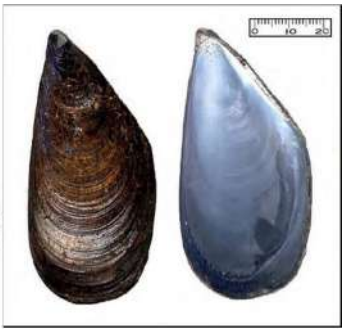


Glycimeris sp

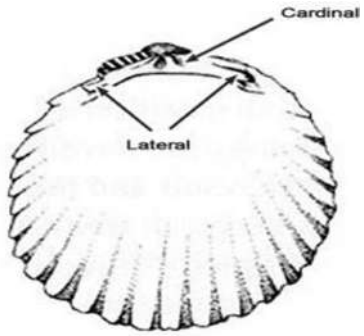
Arca sp

Dysodont: small simple teeth near the edge of the valve. It's no teeth just crenulation (eg.*Mytilus)*

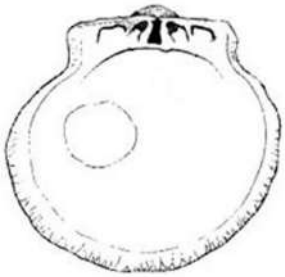




Heterodont: few teeth varying in size and shape, distinguished as cardinal teeth, beneath the umbo, and lateral teeth which lie obliquely along the hinge plate (e.g., most recent bivalves) Corbiculidae



Isodont: teeth very large and located on either side of a central ligament pit. *i.e*. two grooves two teeth correspond (e.g., *Spondylus*).



Desmodont: teeth very reduced or absent (e.g., *Mya)* with a large internal process (the chondrophore) carrying the ligament.

Schizodont: two or three thick teeth with prominent grooves *i.e.* teeth have crenulations ("teeth with teeth") (e.g., *Trigonia*).

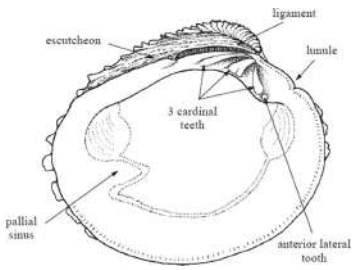
Pachydont: large, heavy and massive teeth (e.g., rudists)

Guide to Families/Species of Commercially Important Species

The following guide can be used for identification of marine or brackish water bivalve families regularly exploited from Indian waters.

VENERIDAE – Venus Clams

Shell usually solid, umbones anterior to midline, lunule and escutcheon usually present, sculpture usually concentric, sometimes lacking. Ligament external. Hinge with 3 or rarely 2 cardinal teeth in each valve. Adductor muscles (and their scars) usually equivalent in size.



Commercially important species under this family are

- *Paphia malabarica* (Dillwyn, 1817)/ *Protapes gallus* (Gmelin, 1791)
- *Meretrix meretrix* (Linnaeus, 1758)
- *Meretrix casta* (Gmelin, 1791)
- *Marcia opima* (Gmelin, 1791)
- *Gafrarium tumidum* (Roding, 1798)/ *Gafrarium pectinatum* (Linnaeus, 1758)
- *Sunetta scripta* (Linnaeus, 1758)

***Paphia malabarica* (Dillwyn, 1817)**

FAO names: En – Short neck Clam
Description

Shell is slightly inflated, triangularly ovate and surface is concentrically grooved. The anterior and posterior margins are narrowly rounded. Hinge area is short with narrowly diverging teeth. Pallial sinus is 'U' shaped and very deep. Lunule is relatively short. Shell length is only one and one third times longer than height. The outer shell valves are yellowish brown in colour indistinctly rayed with greyish brown bands or blotched with brownish angular markings.

***Meretrix casta* (Gmelin, 1791)**
FAO names: En – Backwater Hard Clam
Description
Shell is thick, moderately large with a brown horny periostracum. Shell is also smooth and triangularly ovate with devoid of any sculpture. Outer surface of the valves is very fainted rayed with greyish radial lines or pale yellowish brown tinted with dark grey posteriorly.

***Meretrix meretrix* (Linnaeus, 1758)**
FAO names: En – Asiatic Hard shell
Description
Shell varies from *M. casta* in having less elongated lateral tooth, more ovate shell and larger size. Periostracum is thin and of grey or straw colour. Postero-dorsal margin of the outer shell is greyish blue or bluish brown band.

***Marcia opima* (Gmelin, 1791)**
FAO names: En – Fertile Venus
Description
Shell is thick, inflated, smooth, and triangularly ovate. Pallial line is deeply sinuate. Tip of the pallial sinus is bluntly angular. Lunule is distinct, flattened, and rather broad. Area behind the umbones is clear, flattened and deeply elongated reaching almost upto the hind margin of the shell. Outer surface of shell is pale yellowish brown or straw

coloured variously blotched and rayed with purplish grey markings. The inner surface of the valve is white.

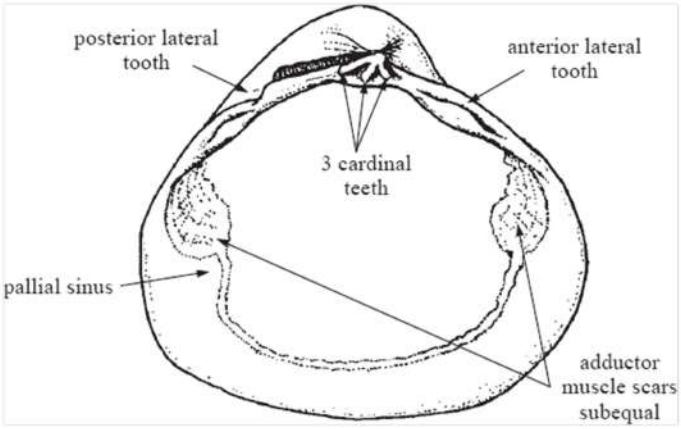
***Sunetta scripta* (Linnaeus, 1758)**
FAO names: En – Broad Hinged Venus
Frequent synonyms: *Donax Scriptus* **(Linnaeus, 1758)**
Description:

Rounded-trigonal, compressed shell with well produced anterior end and steeply sloping slightly arched anterior slope. Strong, smooth concentric ridges with narrow, deep grooves between. Inner margins stained with pale purple. Creamy, with small, purplish brown blotches which are often arranged in a zig zag pattern. Inside white stained with pale purple.

***Gafrarium tumidum* (Roding, 1798)**
FAO names: En – Tumid Venus
Description

Shell is thick, strongly inflated and sculptured with thick, nodular radial ribs which tend to bifurcate towards the ventral margin. The interstitial spaces between some of the main ribs, there are secondary rows of nodules. The pallial line is full and well developed. The outer surface is white with irregular dark spots posteriorly and near the umbo.

CORBICULIDAE/CYRENIDAE – Marsh clams
Shell oval to triangular. No lunule or scutcheon. Hinge with 3 cardinal teeth in either valve. Pallial sinus short to absent.
Commercially important species occurring in India are



- *Geloina bengalensis* (Lamarck 1818)
- *Geloina expansa* (Mousson, 1849) /*Geloina erosa* (Lightfoot, 1786)
- *Villorita cyprinoides* (Gray, 1825) *Geloina bengalensis* (Lamarck 1818) **FAO names:** En- Bengali Geloina

Red List Category & Criteria: Least Concern
Frequent synonym(s):

- *Cyrena bengalensis*
- *Polymesoda (Geloina) bengalensis*
- *Polymesoda (Geloina) galatheae*

Distribution: The species is common in the Indo-Pacific region; recorded from coastal areas in the Bay of Bengal (Bangladesh, India (West Bengal (Gangetic Delta), Orissa (Mahanadi estuary), Andra Pradesh and the Nicobar Islands

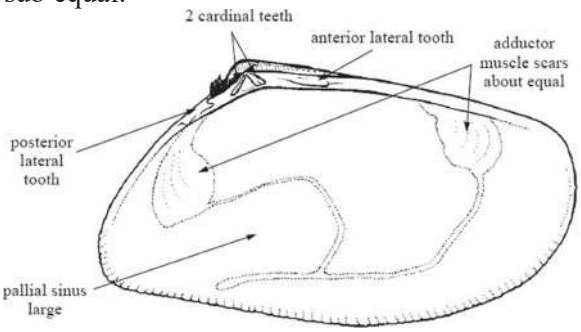
Description

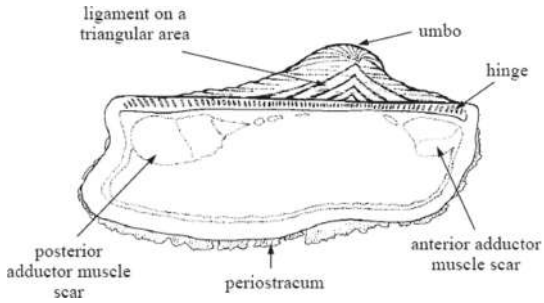
The shells are ovato-subcircular, inequilateral, strong and heavy, with concentric striations; umbones directed anteriorly; hinge area very thick; teeth well-developed.

***Villorita cyprinoides* (Gray, 1825)**
FAO names: En- Black Clam
Red List Category & Criteria:
Least Concern

Description
Shell is thick, ovately triangular with strong concentric ridges. Hinge border is very short and thick, always with three oblique cardinal teeth; the anterior in the right valve and posterior in the left valve are less developed. Ridges are more strongly developed in the anterior half. Umbones are prominent and well elevated. Pallial sinus is small. Lunule is narrow and ligament is large. Shell is dark olive brown to blackish brown in colour.

DONACIDAE – Donax Clams
Shell wedge-shaped, usually with an angled (keel-like) posterior surface. Ligament external. Hinge with 2 cardinal teeth on each valve. Adductor muscle scars sub equal.





- *Donax cuneatus* (Linnaeus, 1758)
- *D. scortum* (Linnaeus, 1758)
- *Donax cuneatus* (Linnaeus, 1758)

FAO names: En- Cuneate Donax
Description
Shell is trigonal, inequilateral. Shell possesses a curved keel extending from the umbo to the postero-ventral corner; there are sharp concentric and fine radiating ones which are

conspicuous in the anterior and posterior regions only. The anterior end is broad and rounded while the posterior end is narrow and rounded. Pallial sinus is deep. The outer surface of shell is white covered with pale violet especially towards umbo and the posterior region is darker. The inner surface is of deep violet colour

***D. scortum* (Linnaeus, 1758)**
FAO names: En- Leather Donax /Asian Wedge Clam
Frequent synonym(s): *Venus scortum* (Linnaeus, 1758)

Description

Shell ovate with fine concentric striae; keel between the umbo and the posterior margin absent; colour pattern variable; outer shell pale bluish grey or greyish blue with greyish concentric bands and brown rays or patches; ventral margin with slight indentation at posterior end; pallial sinus moderately deep; two primary teeth; ligament external, short and inserted at the posterior impression.

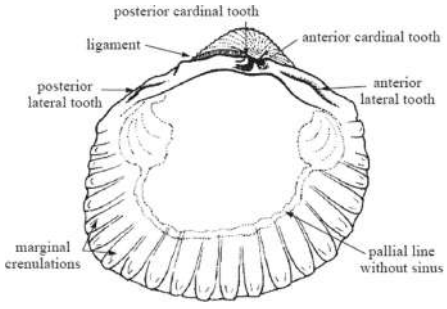
ARCIDAE - Ark Shells
Shells very thick, heavy, box-like. Hinge with a large number of teeth perpendicular to main shell axis, usually of equal size and perpendicular to main shell axis. Usually with thick, dark periostracum.

Commercially important species under this family are

- ✓ *Anadara granosa* (Linnaeus, 1758) /*Tegillarca granosa* (Linnaeus, 1758)
- ✓ *Anadara rhombea* (Born, 1778)/*Tegillarca rhombea* (Born, 1778)
- ✓ *Anadara granosa (Linnaeus, 1758)*

Frequent synonyms: *Arca granosa* Linnaeus, 1758

CARDIIDAE- Cockles
Shell round, large, inflated, usually with strong radial sculpture that yields crenulated shell margins; scales or spines sometimes present along radial sculpture elements. Foot long and strong



Commercially important species under this family are

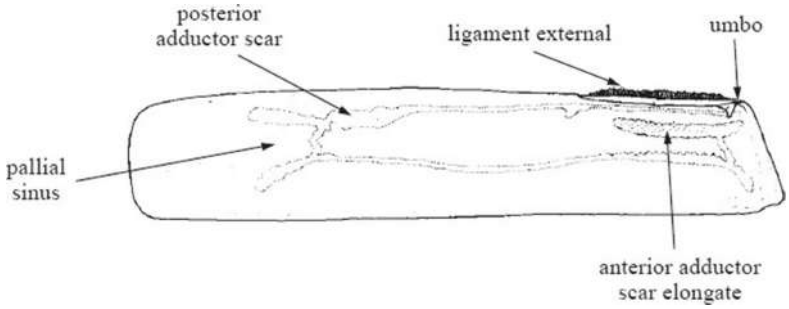
- *Tridacna maxima* (Roding, 1798)
- *T. crocea* (Lamarck, 1819)
- *T. squamosa* (Lamarck, 1819)

***Tridacna maxima* (Roding, 1798)**
FAO names: En – Elongate Gaint Clam
Frequent synonyms:

Description

Shell is strongly inequilateral. The shell is similar to that of *T. crocea* except that the 6-12 broad radial ribs have better developed concentric scales. Large byssal gape with distinct plicae is at edges. Ventral border of the valve often deeply scalloped. Shell is greyish white, sometimes tinged with yellow or pinkish orange.

SOLENIDAE – Knife and Razor Clams
Shell narrowly elongate, very inequilateral; umbones near the anterodorsal end of valves; pallial sinus relatively shallow; siphons generally quite short, fused at their base.



***Solen kempi* Preston, 1915**
FAO names- Kemp's Razor shell

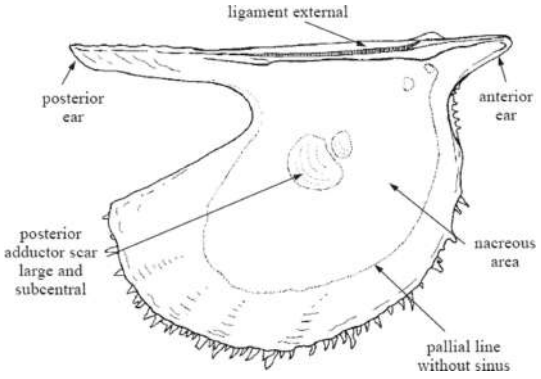
Description

Shell is small, about six times as long as high. Anterior region is obliquely truncate while posterior region rounded. Cardinal tooth is in right valve with a shallow groove all over its breadth. Dorsal margin of soft body is somewhat concave in the anterior region and convex in the posterior region. Siphon is long and segmented. Foot is long flattened and about half the length of body. Periostracum is yellowish brown and glossy.

PTERIIDAE – Pearl Oysters

Shell compressed, usually gaping, with concentric, often scaly, sculpture; hinge lacking teeth, straight, projecting at both ends as wing-like expansions; posterior expansion usually longer; ligament external, sunken; anterior muscle scar very reduced or absent, posterior muscle scar large, central; pallial sinus absent.

FAO names: En – Akoya Pearl Oyster



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Shell compressed, usually gaping, with concentric, often scaly, sculpture; hinge lacking teeth, straight, projecting at both ends as wing-like expansions; posterior expansion usually longer; ligament external, sunken; anterior muscle scar very reduced or absent, posterior muscle scar large, central; pallial sinus absent.

Commercially important species under this family are

- *Pinctada fucata* (Gould, 1850)/*P. imbricata* (Roding, 1798)
- *Pinctada margaritifera* (Linnaeus, 1758)
  Pinctada fucata (Gould, 1850)

***Pinctada fucata* (Gould, 1850)**
FAO names: En – Akoya Pearl Oyster

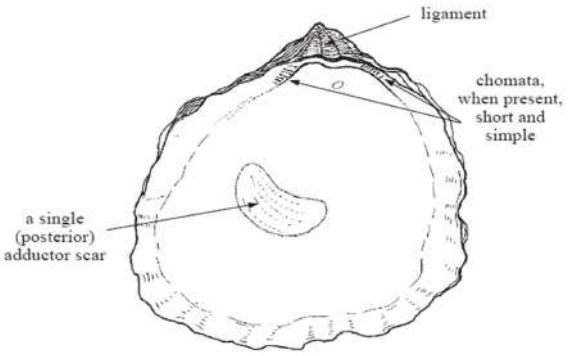
Description

The hinge is nearly as wide as the width of the shell, left valve is deeper than the right, byssal notch slit-like, left valve greatly convex, posterior ear well developed with fairly developed sinus, anterior margin of shell just far in advance in front of anterior ear. Hinge teeth are present in both valves, one each at the anterior and posterior ends of the ligament. The anterior ear is larger than in the other species. The posterior ear is fairly well developed. The outer surface of the shell valves with 6 - 8 radial bands of reddish brown on a pale yellow background. The nacreous layer is thick and has a bright golden, pink or ivory colour with metallic lustre. The non-nacreous margin on the inner surface of valves has reddish or brownish patches.

***Pinctada margaritifera* (Linnaeus, 1758)**
FAO names: En – Black-lip Pearl Oyster

Description
The hinge is nearly as wide as the width of the shell, left valve is deeper than the right, byssal notch slit-like, left valve greatly convex, posterior ear well developed with fairly developed sinus, anterior margin of shell just far in advance in front of anterior ear. Hinge teeth are present in both valves, one each at the anterior and posterior ends of the ligament. The anterior ear is larger than in the other species. The posterior ear is fairly well developed. The outer surface of the shell valves with 6 - 8 radial bands of reddish brown on a pale yellow background. The nacreous layer is thick and has a bright golden, pink or ivory colour with metallic lustre. The non-nacreous margin on the inner surface of valves has reddish or brownish patches.

OSTREIDAE – Oysters
Shell irregularly shaped, attached (cemented) to hard substrate by the left valve. Ligament external, in shallow depression. Only posterior adductor muscle scar present.



Commercially important species under this family are

- *Crassostrea madrasensis* (Preston, 1916)/*C. bilineata* (Roding, 1798)/ *Magallana bilineata* (Roding, 1798)
- *Saccostrea cucullata* (Born, 1778)
- *C. gryphoides* (Schlotheim, 1813)
- *C. rivularis* (Gould, 1861)/ *Magallana rivularis* (Gould,1861)

***Crassostrea madrasensis* (Preston, 1916)**
FAO names: En – Indian Backwater Oyster

Description
Shell valves are irregular in shape usually straight/elongate. Shell valves are covered by numerous foliaceous laminae. Left valve is deep while right one slightly concave. Hinge is narrow and elongated. Adductor muscle scar is kidney-shaped and sub central; dark purple in colour. Inner surface of valve is white, glossy and smooth with purplish black colouration on the inner margin.

***Saccostrea cucullata* (Born, 1778)**
FAO names: En – Hooded Oyster

Description
Shell more or less trigonal, sometimes oblong, extremely hard and pearshaped. The margins of the valves have well developed angular folds sculptured with laminae. Small tubercles present along the inner margin of the right valve and there are corresponding pits in the left valve.
Adductor muscle scar is kidney shaped.

Placunidae

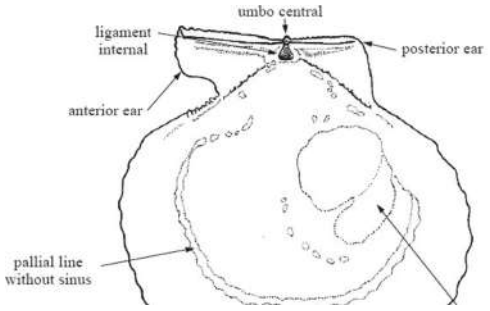
Placuna placenta (Linnaeus, 1758)
Frequent synonym(s):

- *Ephippium transparens* Roding, 1798
- *Placenta communis* Megerle von Muhlfeld, 1811
- *Placuna placentis* (Linnaeus, 1758)
- *Anomita placenta* Linnaeus, 1758
- *Placuna ovalis* Blainville, 1826
- *Placuna orbicularis* Philipsson in Retzius, 1758
- *Placenta auriculata* Morch, 1853

FAO names- Windowpane Oyster
Description
Placuna placenta is a highly asymmetrical bivalve with a characteristically thin, translucent shell. The almost-flat concave shells can grow to over 150 mm in diameter, a V-shaped ligament. Male and female oysters are distinguished by the color of the gonads. It lives mostly on mangrove coasts, preferring a muddy substrate. Lacking a byssus, *P. placenta* does not anchor itself to its substrate, but lies free at the mercy of the currents.

PECTINIDAE- Scallops

Shell oval to circular, umbones centrally located, hinge typically with wing-like expansions. In some genera (e.g., *Euvola*) top valve is flattish and bottom valve deeply convex. Ligament internal. Hinge without teeth. Single adductor muscle, pallial sinus absent.

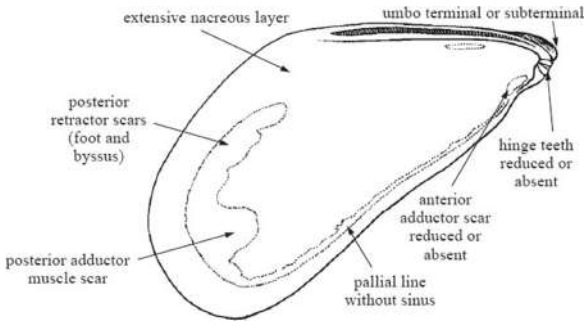


Commercially important species under this family are

- *Volachlamys tranquebaria* (1791)
- *Mimachlamys* sp
  Volachlamys tranquebaria (1791)

MYTILIDAE – Sea Mussels

Shell elongate, with umbones near or at anterior end. Ligament in anterior margin. Hinge without teeth or with tiny denticles. Internal surface nacreous. Adductor muscle scars differing in size, the anterior small or absent.



Commercially important species under this family are

- *Perna viridis* (Linnaeus, 1758)
- *Perna indica* (Linnaeus, 1758)
  Perna viridis (Linnaeus, 1758)

FAO names: En - Asian Green Mussels

Description

The outer shell surfaces and mantle margin are respectively green and yellowish green in colour. Shell is large, elongate sub-trigonal. Anterior end of the shell is pointed with the beak turned down. Ventral shell margin is slightly concave. Middle dorsal margin is angularly convex while posterior margin is broadly rounded. Two small hinge teeth on the left valve and one on the right valve, foot is tongue shaped with byssal threads.

***Perna indica* (Linnaeus, 1758)**
FAO names: En - Brown Mussels

Description

The outer surfaces of the shell valve and mantle margin are respectively dark brown and brown in colour. Anterior end of the shell is pointed and straight. Ventral shell margin is more or less straight. Middle dorsal margin has a distinct angle/lump while posterior margin is broadly rounded. One large hinge teeth on the left valve and

a corresponding depression on the right valve, foot is tongue shaped with byssal threads.

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