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Taxonomical studies on the Edible Bivalve Molluscs Inhabiting the Coastal Zones of Alexandria, Egypt

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Abstract

The molluscs collected from the coastal area of Egypt had sixteen species belonging to eight super families collected bivalve specimens from upon their taxonomic and diagnostic characteristics of the identified species were recorded and then after placed in their taxonomic position according to literature.

Introduction

Bivalvia, the second largest class of Mollusca, comprises several species of economic importance which inhabit the coastal and intertidal regions of the world including the Mediterranean and Red sea. Some creep on the bottom, others are attached to solid objects and many burrow in sand or mud.

As for the recorded edible bivalve species in Egypt, which are most common to the consumers, the oyster *Pinctada radiata* (Al-Seridia) and *P. margaritifera* (Al-Sadaf), the clams *Tridacna* spp. (Al-Bosr), the mussels *Mytilus* spp. and *Modiolus* spp. (Balah Al Bahr), the cockles *Cardium glaucum* (Al-Bakalaweez), different species of the family Veneridae such as *Ciro* spp. (Al-Gandofly) and different species of family Donacidae such as *Donax trunculus* (Om El-Kholool) (Essawy, 1965; Hassan, 1979; Sharabati, 1981; Gabal, 1982).

In addition to the reported great economic and nutritive importance of some species, other groups of bivalves and molluscs may cause economic problems (as snails and slugs which feed on cultivated plants). While others may cause health disturbances being the intermediate hosts for parasitic worms and the Tereidos which damage wooden ships as they bore using their sharp shells causing there to sink (Storer and Usinger, 1965).

In Egypt, studies on marine molluscs are fragmentary and have so far received little attention particularly on the edible species. However, the contribution on the taxonomy of marine molluscs of Egypt are those given by Hassan (1979, 1983) who investigated the bottom molluscs particularly gastropods and bivalves in Abou-Qir bay, the Mediterranean and Red sea and clarified their exchange through the Suez Cannel. Also, the surveillance studies conducted by El-Gamal (1988) presented detailed descriptions ant he edible Mollusca inhabiting the Egyptian coasts. Owing to the problem of overpopulation in Egypt, the improvement of animals protein obtained from water resources as become of great necessity especially with the reported shortage in animal production and limited agricultural area (El-Caryony, 1988).

It has been noticed that the cultivation and consumption of edible marine bivalves is very restricted. The consumption of the edible marine bivalves, as food, is only by people

living close to the coast who used also to use the shells in decoration (Gabal, 1982).

The main objective of the present study is to construct identification key of facilitate future research studies on the most common edible bivalve species inhabiting the mediterranean coastal zone of Egypt.

Materials and Methods

Edible bivalve molluscs were collected from the coastal zones of Alexandria which extends between EL-Mex and Abu-Qir head lands to cover as many of the major sources of samples (Fig. 1).

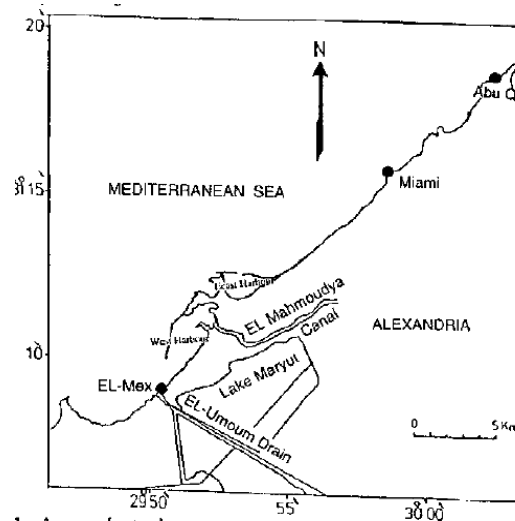


Fig. 1: Area of study

Samples were collected by dredging, grabbing and hand-sorting then preserved in 5 percent solution in the laboratory. The preserved samples were then stored, identified to the species level as far as possible.

Keys and monographs proposed by Pallary (1909), Steur (1939), Melvin (1966), Dance (1974), Lindner (1977), Hassan (1979), Campbell (1980), Monodadori (1980), Eisenberg (1981), Richards (1981), Oliver (1984), Sharabati and Sharabati (1984) and Gaillard (1987) were consulted for species identification.

Results

The detailed description for the collected common edible bivalve molluscs inhabiting the coastal areas of Alexandria are clarified herein. The superfamilies and families to which these species belong are also described. A list of the edible bivalve molluscs are presented in Table 1.

Identification key for the recorded superfamilies:

1. Hinge not taxodont.....2
Hinge taxodont.....5
2. Hinge not desmodont.....3
Hinge desmodont.....Mactracea
3. Hinge not heterodont.....4
Hinge heterodeont.....6
4. Hinge dysodont without ears.....Mytilacea
Hinge dysodont with ears.....Pteriacea
5. Breaks widely separated and anterior; shell trapezoid.....Arcacea
Beaks narrowly separated and central; shell small circular to subtrigonal.....Limopsacea
6. Integripalliate; sculpture mainly radial.....Cardiacea
Sinupalliate; sculpture mainly circular.....7
7. Lower limb of pallial sinus confluent with pallial line.....Tellinacea
Lower limb of pallial sinus not confluent with
Lower limb of pallial sinus not confluent with
pallial line.....Veneracea

I. Superfamily: Arcacea (Pl. I, Fig. 2)

- Hinge:** Taxodont, with a continuous row of small chevron-like teeth and sockets across a straight hinge plate.
- Beaks:** Anterior; widely apart exposing a wide cardinal area with angulated border and ligament grooves.
- Ligament:** External, amphidetic; diplivincular; no relisifer.
- Muscle scars:** Dimyarian ± isomyarian, integripalliate. Shell form: Equivalv; inequilateral; trapezoid; mostly solid & box like. Exterior radially ribbed and with a velvety or bristly dens periostracum, Interior white or porcellaneous.
- Habits:** Mostly intertidal, attached to rocks and stones or in crevices by a massive byssus. Byssiferous and without siphons.

Family Arcidae Lamarck, 1809: Ark shells. Small to medium, shell heavy and usually thick, trapezoid to oval, rounded or oblique, rather oblong, roughly square to rectangular in shape, with inflated posterior and flattened cardinal area, usually aquivalve, some inequilateral with a broad dorsal surface. Sculpture often of radial costae crossed by fie lamellar structures often with brown zebra-like bands.

Ligament external, elongate and striated. Umbones are hooked over and separate from each other; wide, enrolled Of recurved beakes. The straight hinge is taxodont with

Table 1: A list of the edible bivalve molluscs inhabiting coastal zones of Alexandria

I. Superfamily Arcacea		
Family	<i>Arcidae</i>	Lamarck 1809
Genus	<i>Anadara</i>	Gay 1 847
	<i>Anadara uropygmelana</i>	Bory & Vicent 1878
II. Superfamily Limopsacea		
Family	<i>Glycymeridae</i>	Newton 1922
Genus	<i>Glycymeris</i>	Dacosta 1778
	<i>Glycymeris glycymeris</i>	Linn 1758
III. Superfamily Mactracea		
Family	<i>Mactridae</i>	Lamarck 1809
Genus	<i>Mactra</i>	Linn 1767
	<i>Mactra corallina</i>	Linn 1758
IV. Superfamily Cardiacea		
Family	<i>Cardiidae</i>	Lamarck 1809
Genus	<i>Cerastoderma</i>	Poli 1795
	<i>Cerastoderma lamarkii</i>	Reeve 1845
Genus	<i>Fulvia</i>	Gray 1853
	<i>Fulvia papyraceum</i>	Chemnitz 1781
V. Superfamily Tellinacea		
Family	<i>Donacidae</i>	Fleming 1828
Genus	<i>Donax</i>	Linn 1758
	<i>Donax trunculus</i>	Linn 1758
	<i>Donax vittatus</i>	DaCostra 1777
Family	<i>Psammobiidae</i>	Flaming 1828
Genus	<i>Asaphis</i>	Modeer 1793
	<i>Asaphis deflorata</i>	Linn 1758
VI. Superfamily Veneracea		
Family	<i>Veneridae</i>	Rafinesque 1815
Genus	<i>Tapes</i>	Muhlfeld 1811
	<i>Tapes decussatus</i>	Linn 1758
Genus	<i>Venus</i>	Linn 1758
	<i>Venus verrucosa</i>	Linn 1758
Genus	<i>Venerupis</i>	Lamarck 1818
	<i>Venerupis aurea</i>	Gmelin 1791
	<i>Venerupis rhomboides</i>	Pennant 1777
Family	<i>Petricolidae</i>	Deshayes 1831
Genus	<i>Petricola</i>	Lamarck 1809
	<i>Petricola hemprichii</i>	Issel 1869
VII. Superfamily Mytilacea		
Family	<i>Mytilidae</i>	Rafinesque 1815
Genus	<i>Lithophaga</i>	Roding 1798
	<i>Lithophaga lithophaga</i>	Linn 1758
Genus	<i>Mocliolus</i>	Lamarck 1818
	<i>Modiolus auriculatus</i>	Krauss 1848
V111. Superfamily Pteriacea		
Family	<i>Pteriidae</i>	Broderip 1838
Genus	<i>Pinctada</i>	Roding 1798
	<i>Pinctada radiata</i>	Leach 1814

many comb-like teeth in two continuous rows mean below umbones which is a characteristic feature of family. Interior porcellaneous, with interior margin of strongly dentate. Almost isomyarian. Thick, bristly,

brown periostracum. The pallial line integripalliate and shell with or without basal gap.

The body with a pair of gills of filibranch type; the foot is small and less developed but byssus is well developed and the siphons are absent. About 200 species, mostly tropical. These molluscs are found in crevices of intertidal rocks, low on the shore, often burrow or nestle in mud and sand under stone and in dead coral, mainly intertidal, but also shallow to deep water. Most anchor themselves by a byssus of hairs, they live worldwide in temperate to tropical water and are edible,

Genus Anadara

Anadara uropygmelana

II. Super family: Limopsacea (Pl. I, Fig. 3).

- Hinge: Taxodont, with small teeth arranged in an anterior and a posterior row.
- Beaks: Central (Glycymeris) or slightly anterior (Limopsis); Separated, exposing a narrow cardinal area with angulated border; no ears.
- Ligament: Internal in a central triangular resilifer, or external in grooves in cardinal area.
- Muscle scars: Dimyrian; iso-anisomyarian; intergripalliate.
- Shell form: Equivalve; equilateral to strongly inequilateral; circular-obliquely oval and generally pectunculoid; sold; with smoothcrenulate margin. Exterior smooth or with fine concentric and radial lines, usually with a fibrous periostracum. Interior white.
- Habits: Live offshore on soft sea-bottom.

Family: Glycymeridae: Newton, 1922: Bittersweets or Dog cockles have a thick soil shell rounded or rather circular in outline, moderately small about 65 mm in length euvalve, slightly inequilateral. Sculpture smooth or with concentric growth lines crossed by fine radial ribs. The colour is often white or brownish with irregular patches or uniform. External ligament, with chevron-shaped grooves; sometimes partially in front of beaks, flattened cardinal area, beaks are centrally located and curved inward, below the centrally located and curved hinge plate is seen bearing a row of number our large teeth usually slightly V-shaped, chevron-shaped or transverse blunt teeth, larger laterally, the Limbo slightly facing the hind end; is opisthogyral. The two muscle scars are isomyarian, the pallial line integripalliate and the inner shell margin crenulated, with a porcellaneous interior often with brown mottling, thin or velvety periostracum. The body with well developed food used to dig into substratum and the gills are of filibranch type. They live mainly in warm shallow water worldwide.

Genus Glycymeris

Glycymeris glycymeris

III. Super Family: Mactracea (Pl. II, Fig. 4)

- Hinge: Desmodont; with 2-3 cardinals in each valve, but in most species the left valve has 2

cardinals joined to form a A-shaped projection (very characteristic feature) and sometimes with 2 anterior and 2 posterior laminar laterals along the dorsal margin of the right valve and 1 anterior & 1 posterior on the left valve.

- Beaks: Central or just anterior; somewhat curved inward and forward; no ears.
- Ligament: External and also internal, the internal ligament lies inside a characteristic triangular, chondrophore excavated in hinge plate just behind the A-shaped cardinal teeth and beak (very characteristic feature of the group); external ligament thin, deep and opisthodontic; lithodesma never present.
- Muscle scars: Dimyrian, always isomyarian; sinupalliate, with a deep rounded pallial sinus whose lower margin may be confluent with pallial line in some genera.
- Shell form: Equivalve; inequilateral; broadly oval or trigonal to broadly elliptical; solid or thin and brittle; margins always smooth, but often with a slight posterior gape. Exterior mostly with concentric lines, ridges and growth stages. Interior porcellaneous.
- Habits: Common on sandy shores from intertidal zone to deep waters.

Family: Mactridae Lamarck, 1809: The Otter and Trough shells. Shell medium to large, ovate, triangular or longish, thin, smooth and light, euvalve, slightly inequilateral, inflated. Umbones usually directed forward. Porcellaneous shell. Sculpture of fine concentric growth lines. periostracum smooth, buff brown or olive in colour with somewhat gaping valves. Ligament is partly external and partly internal or lacking. The hinge is heterodont, most have a triangular shaped pit in the hinge to which the ligament is attached, beaks near center, bent toward anterior, A-shaped cardinal tooth in left valve, two in right valve; usually with lateral teeth. The two muscle scars are equal, the pallial line sinupalliate and the shell edges are smooth. The body with flexed foot used also in leaping, no byssus. The two siphons are long and fused, the mantle lobes well united and the pair gills of eulamellibranch type. Most live burrowed well into the sand. Some are used for food but they are not as tasty as most of the edible bivalves.

Genus Mactra

Mactra corallina

IV. Superfamily: Cardiacea (Pl. II, Fig. 5)

- Hinge: Heterodont-lucinoid, typical but with 2 conical cardinals short distant laterals and right valve may have more laterals than left valve; teeth never bifid and generally curving out (Cyclodont).

Farang et al.: Edible bivalves, coastal zones, identification keys

Beaks: Anterior to central; almost touching; prosou or orthogyrate.

Ligament: External; opisthodontic, appearing as short prominent dark band in groove behind beaks; parivincular.

Muscle scars: Dimyarian \pm isomyarian and integripalliate but wavy.

Shell form: Equivalve; inequilateral; broadly oval or subcircular; inflated; solid, margins often with deep crenulations which are continuous for short or long distances with furrow running inside shell (important taxonomic character); marginal crenulations of the two valves interlock in forms with deep crenulations. Exterior with principally strong radial ribbing with plates, scales or spines ornamenting the ribs and concentric lines, slites, notches or growth stages. Interior white.

Habits: Live in large numbers in sandy bays and offshore burrowing to a little depth in sand, mud or muddy gravel, Free not byssiferous.

Family: Cardiidae Lamarck, 1809: Cockles or Hear shells are small to very large, usually thin, light, rounded-triangular, ovate, heart-shaped when seen from the side with both valves closed, nearly globular and sometimes elongate. Shell with very convex inflated valves, some gaping at one end, equivalve, inequilateral, Sculpture marked by prominent radial ribs, developed to a varying extent often scaly, spiny or knobby, some smooth and glossy crossed by lamellar structure. Porcellaneous often quite colorful, large, short, external ligament, forming, a deep brown arched band behind the large, rounded beaks. Hinge heterodont with cardinal and lateral teeth. Hinge plate varies in size and shape. The left valve has one anterior and one posterior tooth; the right valve has two anterior and one posterior tooth; the right valve has two anterior and one posterior tooth. Rounded overlapping umbones. The muscle scars are dimyarian; isomyarian, the pallial line integripalliate. Shell edges notched.

Margins crenulate or dentate. Periostracum varies in thickness. The animal leaps by means of long, angled muscular foot. The foot can propel the animal across the surface of the sand in leaps of some centimeters at a time. The posterior edges of the mantle fuse to form two slightly protruding aperture becoming short stout siphons. The gills of eulamellibranch type. Many forms are edible, especially in Europe. Usually they burrow in sand or mud from mid-tide line to deep water. About 200 species in about twenty genera. Worldwide, in most cold and warm seas.

Key for identification of the recorded species:

1. The inner shell margin smooth posteriorly.....*Cerastoderma lamarkii*
2. The inner shell margin wavy

posteriorly.....*Fulvia papyraceurn*

V. Superfamily: Tellinacea (Pl. III, Fig. 6)

Hinge: Heterodont-Lucinoid; mostly with 2 radial cardinals in each valve (tending to be bifid) and 1 or 2 laterals either distinct or weak to wanting and appear only as inward extensions of the dorsal line (Telling & Abrial).

Beaks: Posterior (in Tellinidae), anterior (in Donacidae) and central (in Semelidae).

Ligament: External on a broad nymphal plate (except in Scorbiculidae and some Semelidae which have internal ligament in a pit on hinge plate).

Muscle scars: Dimyarian \pm isomyarian; sinupalliate, with a characteristically deep and wide pallial sinus, its lower limb is usually confluent with pallial line. Two cruciform muscles (crossed-over) are characteristic for this group. probably concerned with the extension and retraction of the long siphons. Their scars lie below the opening of pallial sinus, but may be difficult to see.

Shell form: Mostly equivalve (but may be with a slight twist or curve to the right because the clam lies partly on one side producing a slightly inequivalve condition); inequilateral; small to medium-sized; circular, ovate or trigonal and somewhat compressed, thin and solid or brittle and usually rounded anteriorly and somewhat folded posteriorly. Exterior with principally concentric and/or radial lines. Interior white or tinted with different colours.

Habits: Strong burrowers on various types of bottoms, feeding on organic detritus and bottom sediments which they collect with their 2 long siphons. The have a long flat foot and no byssus.

Identification key for the recorded families:

1. Hinge with two strong cardinal teeth.....Donacidae
2. Hinge with one to three weak cardinal teeth.....Psammobudae

Family: Donacidae Fleming, 1828: The wedge clams, Coquina, Donax or bean clams are usually small solid and wedge-shaped or triangular, equivalve, inequilateral, obliquely truncated at the rear long and pointed in front, more inflated. The thin transparent periostracum gives a gloss to the valves. Sculpture is made up of fine radial ribs or lines some with concentric growth lies often with rays of a second colour. Many quite colourful from the inside. Short, arched, external ligament on platform. The hinge heterodont with two cardinal teeth and two lateral teeth in each valve. Often with flexure on postern dorsal slope. Muscle scars equal and sinupalliate. Pallial sinus is long and deep. Usually with finely crenulate or denticulate internal margin. About 50 species, mostly tropical or live in warm

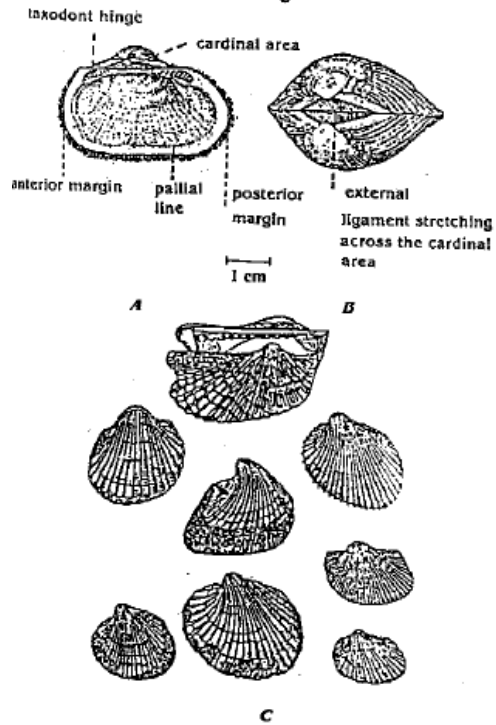


Fig. 2: Superfamily Arcacea. (A) *Arca* sp., view of the inside of the right valve. (B) view of the dorsal region of the shell of two valves. (C) Different views

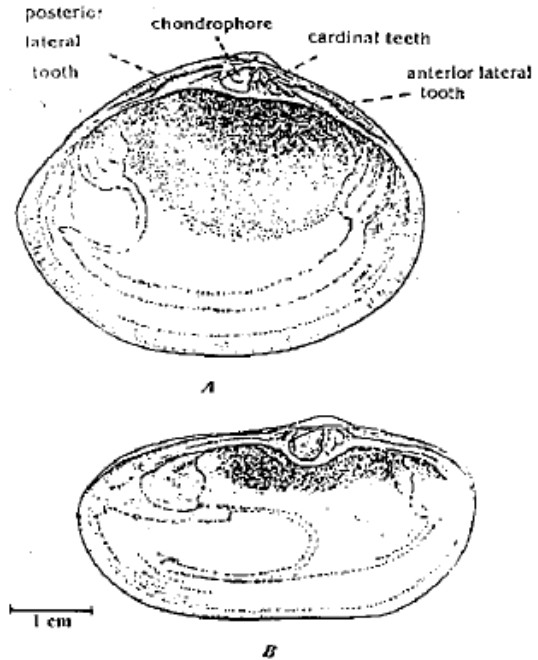


Fig. 4: Superfamily Mactracea. (A) *Mactra* sp., a view of the inside of the left valve. (B) *Lutaria* sp., a view of the inside of the left valve

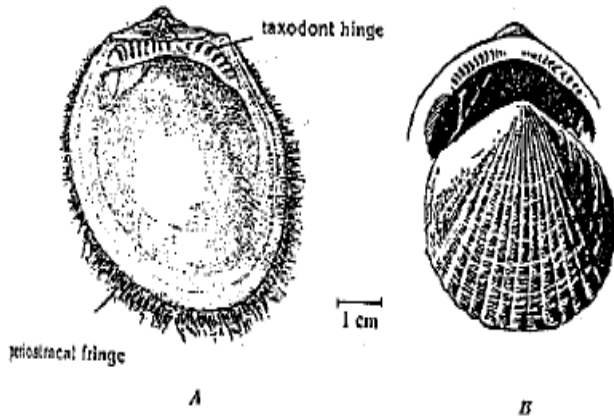


Fig. 3: Superfamily Limposacea. (A) *Limopsis* sp., view of the inside of the right valve and (B) *Glycymeris* sp.

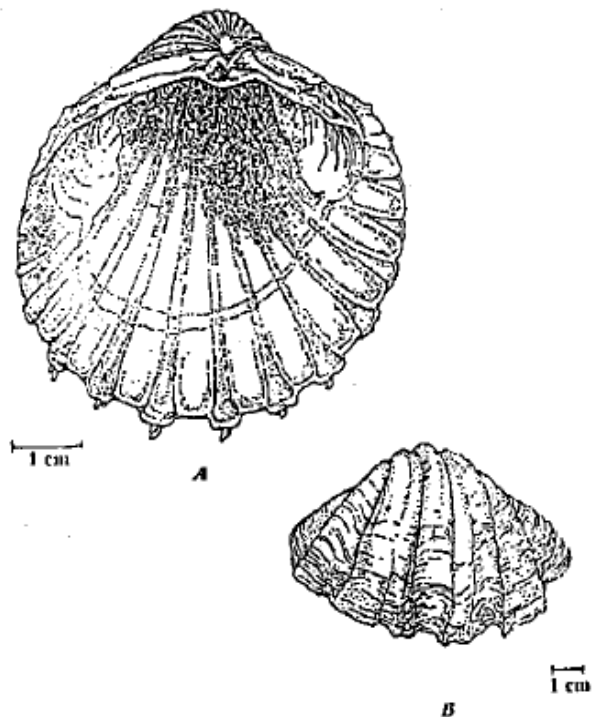


Fig. 5: Superfamily Cardiacea. Different shell forms. (A) *Acanthocardia* sp. Internal and (B) *Tridacna* sp. External view.

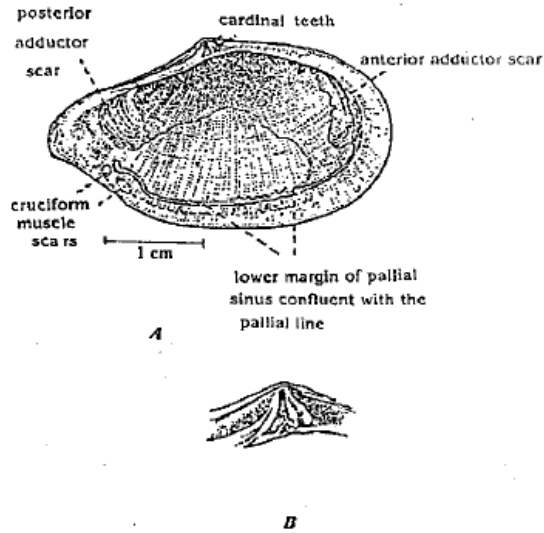


Fig. 6: Superfamily Tellinacea. *Tellina* sp. (A) view of the inside of the left valve and (B) enlarged drawing of the teeth.

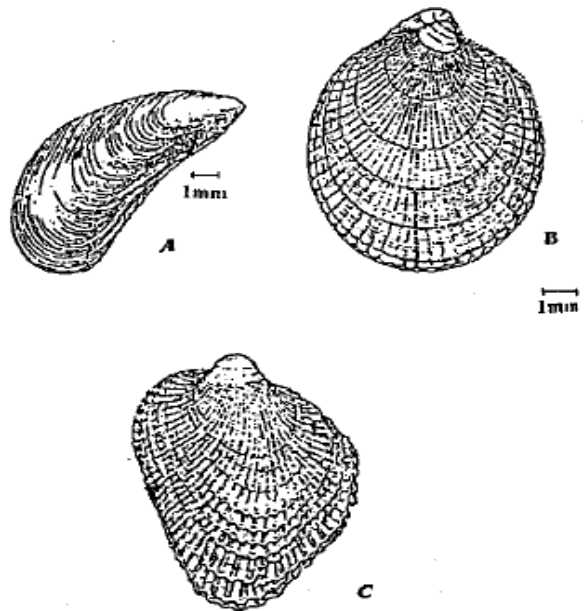


Fig. 8: Superfamily Mytilacea. A) *Mytilus* sp. B) *Crenella* sp. The right valve C) *Crenella* sp. The left valve

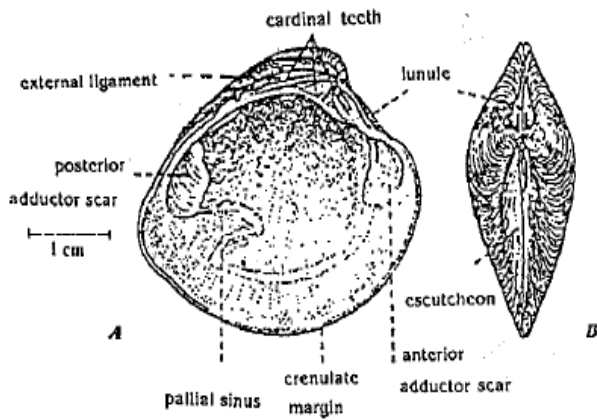


Fig. 7: Superfamily veneracea. *Venus* sp. (A) view of the inside of the left valve and (B) view of the dorsal region of the shell of two valves.

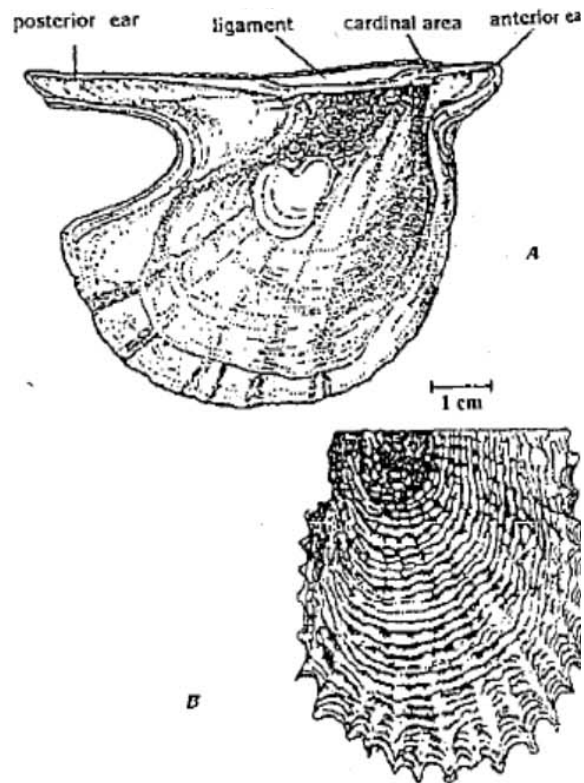


Fig. 9: Superfamily Pteriacea (A) *Pteria* sp., internal view of the left valve. (B) *Pinctada* sp., Internal and external view.

temperature water, living just below the surface of the sediment on beaches pounded by strong surf. The body with a good developed mobile digger foot, the two siphons are separated and very long. The pair gills are eulamellibranch type and the labial pales are very large.

Genus Donax

Identification key for the recorded species:

1. Left valve with two cardinal teeth, the anterior bifid; external side of shell with white colour variegated with irregular rays of violet brown shades.....*Donax trunculus*
2. Left valve with two cardinal teeth, the posterior bifid; external side of shell with creamy colour variegated with broad concentric yellow brown colour band, with glossy surface.....*Donax vittatus*

Family: Psammobiidae Fleming, 1828. The Gori clams are medium-sized, with thin, elongate, oval to trapezoidal shell, some gaping slightly at the ends especially at posterior, slightly inequivalve, inequilateral. Very fine radial lines and/or concentric growth lines. Long, external ligament on platform. Small beaks, hinge is heterodont, the pallial line has a deep pallial sinus. One to three weak cardinal teeth and weak lateral teeth, when present. Thick and glossy periostracum some with rose or purple colour. The body with well developed mobile good digger foot, the siphons are very long and the gills are of eulamellibranch type. They live in sheltered bays burrowing in intertidal sand or mud, but some also live in deep water. About 100 species in eight or more general inhabiting warm or temperate to tropical waters. This family is also known as Gardidae or Sanguinolariidae.

Genus Asaphis

Asphis deflorata

VI. Superfamily Veneracea (Pl. III, Fig. 7)

- Hinge:** Heterodont-cyrenoid, always with 3 radially disposed and subequal cardinals in at least one valve and 2-3 in the other, laterals are present or absent. This hinge forms an efficient interlocking system.
- Beaks:** Anterior; prosogyrate and slightly orhogytae, lunule distinct.
- Ligament:** External, often deeply inset and with nymph (s); always opisthodontic.
- Muscle scars:** Dimyarian ± isomyarian; over and polished; always sinupalliate; lower edge of pallial sinus never confluent with pallial line.
- Shell form:** Equivalve; inequilateral (sometimes almost equilateral); circular, ovate or squarish ovate; mostly solid, very colourful; margins smooth or crenulate; periostracum inconspicuous. Exterior with principally concentric sculpture, but radial sculpture with ridge, scale-like lamellae or

spines especially with ridges, scale-like lamellae or spines especially towards rear is present in some Interior porcellaneous.

Habits: Some live on sea bottom and others inhabit crevices along wide stretches of the coast. The siphons are short, unequal and united and the mantle margins are fringed, the foot is compressed, hatchet and pointed anteriorly. This group represents the most highly advanced bivalves with streamlined efficiency.

Identification key for the recorded families:

1. Hinge with three-cardinal teeth in right valve.....Veneridae
2. Hinge with two-cardinal teeth in right valve.....Petricolidae

Family: Veneridae Rafinesque 1815: The venus shells are solid, thick and strong, ovate, circular, subtriangular or heart-shaped. They are mostly medium-sized, equivalve, inequilateral; beaks anterior to the midline directed forward and inward and more or less central, the umbones may curve over towards the anterior end; a great variety of concentric and/or radial sculpture, most often with rounded, concentric ribs. Ligament external on platform, posterior to beaks. Lunule and escutcheon usually well developed; right valve with three cardinal teeth below the beak and to either side and two lateral teeth feeble or wanting; the anterior lateral found in some species; the two adductor scars are usually equal; with the pallial sinus may be deeply indented posteriorly by pointed pallial sinus varying in size and shape extending just below the mid-point. Porcellaneous surface, often polished; with smooth or crenelate margin. The body has a pair of eulamellibranch gills. The foot well developed and two siphons are of moderate length lacks byssus.

This family included the largest number of investigated edible molluscan forms. They are shallow burrowers, living in intertidal, shallow or deepwater. They burrow slightly below sand or mud. The largest bivalve family, with over 400 species in several dozen genera worldwide in most waters.

Identification key for the recorded species:

1. Shell elongate to ovate, inequilateral, with concentric sculpture.....2
2. Shell with concentric umbonal area, shell inner margin smooth.....3
3. a. Sculpture with concentric grooves over crossed by radial ribs.....Tapes decussatus
- b. Sculpture of wavy concentric sculpture and some radial ribs in the posterior pat.....4
4. a. Sculpture of elevated strong concentric ribs, posterior end with scally divericate radial ribs*Venus verrucosa*
- b. Sculpture with concentric lines, posterior end carrying number of faint ribs.....Venerupis

- i. With pallial sinus leaving a wedge shaped space between its lower limb and the pallial line.....*Venerupis rhomboides*
- ii. With pallial sinus-not reaching the midline-forming a broad wedge-shape space between its lower limb and the pallial line.....*Venerupis aurea*

Family: Petricolidae Deshayes, 1839: The shell is usually thin and fragile, small to medium, oval to elongate, inflated shells gaping at posterior, equivalve, inequilateral, wrinkled or nodulose radial ribs or threads some with concentric growth lines, the umbones placed forward to midline, beaks near anterior end, no lunule or escutcheon, ligament weak narrow, heterodont hinge, three cardinal teeth in left valve, two in right valve, no lateral teeth, the muscle scars roughly equal and dimyarian, the pallial line with deep sinus, thin periostracum, colour white to grey, the body with thick and stout foot and two long siphons. The gills of eularnellibranch type. Nestles in cavities, often boring into clay, peat, wood, limestone and dead coral, they bore into hard surfaces so the shell is sometimes distorted.

Genus Petricola

Petricola hemprichii

VII. Superfamily Mytilacea (Pl. IV, Fig. 8)

Hinge: Dysodont i.e. edentulous or with few crenulations just below beak, or pseudotaxodont (Cunella)

Beaks: Close; anterior-terminal; prosogyrate; triangular, rhomboidal or oval.

Ligament: Internal behind the beaks not in a chondrophore; or external and deeply concealed, generally long.

Muscle scars: Dimyarian-markedly anisomyarian, anterior scar much smaller; integripalliate.

Shell form: Equivalve; inequilateral-very inequilateral; prosocline; oval, elongated oval or irregularly rhomboidal; dark fragile to soil; margin usually smooth. Exterior with prominent thick or spiny periostracum; with concentric and/or radiating lines or ribs. Interior partly iridescent.

Habits: Most common on sea shores attached by strong hairy byssus threads to rocks, stones, piers and ships in large masses. With 2 siphons connected at the base.

Family Mytilidae Rafinesque 1815: They generally have a thin elongate oval or roundly triangular strong shell smooth or radially ribbed and have concentric growth lines. With moderate size (60 mm). Shell more or less equivalve, inequilateral, sharp beaks at anterior, rounded posterior, prosogyrate near anterior end, umbones terminal or near terminal. Outer sculpture of oriented needles, inner surface pearly, anterior margin generally denticulate, the periostracum

is thick and strong, brown or black after hairy, ligament opisthodontic usually external and lunule bent inward; the long hinge is straight to slightly curved (sometimes with a few, very small, weak teeth behind sunken ligament, the muscle scars heteromyarian, the anterior muscle scar small, posterior muscle scar large. The pallial line simple or with shallow posterior concavity. The body with a pair of filibranch type gills, the foot reduced but the basal gland is highly developed and produces strong byssus filaments the foot and byssus have moved to till anterior end restricting the anterior adductor muscle. Mussels live attached by a byssus to hard surfaces partially nestling in sand from intertidal to shallow water. Some bore in clay, rock and coral. Cosmopolitan, some species are eaten especially in the Mediterranean.

Identification key for the recorded species:

- 1. a. Body elongate cylindrical, sculpture of concentric and radial ribs.....*Lithophaga lithopha*
- b. Body more or less triangular, sculpture concentric ribs only.....*Modiolus auricultus*

VIII. Superfamily Pteriacea (Pl. IV, Fig. 9)

Hinge: Dysodont or edentulous; straight elongate; hinge line.

Beaks: Anterior; separated by a narrow carding area; bialate, posterior ear much larger and more or less pointed; right anterior ear with a small basal notch underneath.

Ligament: External; long and extending behind beak (Pteria), or short and compressed in a central pit (Malleus), or divided and lodged in a series of grooves on hinge live (Isognomon).

Muscle scars: Monomyarian in adults (anterior disappears during growth), posterior scales large and nearly central; integripalliate, pallial line discontinuous anteriorly.

Shell form: Inequivalve; inequilateral; obliquely over prosocline; right valve; less convex than valve, brittle; margin smooth and often fragmented. Exterior with home periostracum with concentric scales and minute papillae which roughen the surface and leaves irregular concentric lines with worn away. Interior nacreous with brilliant lusture.

Habits: Live attached by basal threads which protrude through anterior gap in bottom sand, mud and gravel, offshore considerable depth. Right valve of underneath. The foot is small and there is no siphons.

Family: Pteriidae (Broderip, 1839). The pearl oysters or wing oysters are medium to large, thin and fragile, usually flattened and very oblique, inequivalve, inequilateral, by notch in right valve below the anterior ear. The shell surface

is scaly and shows irregular concentric growth lines. The ligament is carried in a groove and the dorsal margin of the valves, beaks are anterior. The hinge line is straight and elongate lengthening to form ears or wings, elongated to the rear, with one or two tooth-like thickening below the umbo, with or without simple blade like teeth. The muscle scar monomyarian, large posterior muscle scar nearly central, small anterior muscle scar at beak, pallial line integripalliate. The internal shell layer is highly nacreous with brilliant mother of pearl and the outer is prismatic with rough or scaly periostracum. The body with a pair of filibranch gill type, the foot is very small but the byssus is well developed.

They live in tropical to temperate or warm shallow waters attached to rocks or mangrove roots; (*Pinctada* prefer muddy reefs). Worldwide in distribution.

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