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TAXONOMY AND ECOLOGY OF CULTIVABLE MOLLUSCS

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The sorting of specimens into various species or sub-species and identifying them is known as taxonomy. The most comprehensive work on this subject has been brought out by Blackweldor (1967). While studying the taxonomy of molluscs one is bewildered by the amount of differences and variations even amongst two individuals belonging to same species. These may be attributed to very often, different age, sex, phases in a life cycle, positions in the colony, physical habitats, different colour due to different back grounds, mode of feeding or living on different hosts, parasitisation, and deformities or diseased condition etc. Therefore, amongst other things to identify and decide a species the taxonomist has to take careful note of the effects of above influences to avoid creating multiplicity of species. Of course, geneticists and evolutionists have other criteria to determine species. As yet there appears to be no satisfactory or accurate definition that encompass all concepts. The "biological species" concept a defined by Ernest Mayre (1942) is difficult to be used extensively in the field of molluscs for malacology is largely in the purely descriptive and cataloguing stages and the majority of the species described today are still based on the "morphological species" concept.

Every population of molluscs is inherently different and these differences, although minute, are morphological, physiological or genetic, whereas the ecotypes, observations and variations may not warrant even a sub-species creation.

It is sometimes possible to find natural populations in various stages of "becoming species". A hierarchy of successive levels of speciation can be found. These are populations which have almost reached species level still others that are full species; sometimes there are allopatric; in other cases the most distinct ones may be overlapping the ranges of their closest relatives. The responsible mechanism for these changes is geographic speciation or speciation by

distance effecting the genctypic and phenotypic divergence or both.

This geographical variation together with isolation and cross-breeding might lead to an evolutionary production of species different from the type species. But this is a slow process taking several hundred years. To cite an instance, Hornell's revision of the Indian species of Meretrix collected from Orissa down to Cape Comorin and along West coast reveals a great diversity of morphological changes in the shell characters because of different environmental parameters and ecological set-up of the various localities in which the clams are found living. While distinct morphological as well as inter-breeding gaps exist between the aggregate of local population of the type species, the differences that are found are overlapping. This makes it difficult to generalise the field identification characters. A widely ranging species like Meretrix may also exhibit a clinal variation in one or more characters usually correlated with some environmental characteristic condition such as climate or latitude of the habitat. In fact a species may exhibit 2 or 3 clines, one going from north to south (climatic), the other east to west (latitudinal) or soil correlated.

Amongst the land, freshwater and marine species of molluscs, 80,000 described so far, well known edible forms throughout the world constitute but a very negligible percentage. In most countries of the world one or more such species are present and exploited from natural beds or by growing them in farms. The resources of edible molluscs along Indian coastal areas are very rich and varied. This offers vast scope for the development and expansion of culturing atleast a few important species. Table 1 not only presents a list of edible molluscan species present but also other species of potential, commercial and culture importance.

CHARACTERS USEFUL IN IDENTIFICATION OF SHELLS

While describing bivalve and gastropod shells several descriptive terms are used by Taxonomists. It is useful to know and understand the exact structures and features referred to in descriptive terminology. In order to avoid confusion and doubt regarding certain expressions commonly come across in shell descriptions the following glossary is given.

Dorsal and ventral sides

Dorsal side is located on the beak or hinge side. Opposite end of dorsal side is the ventral side.

Right and left valves

When a bivalve is placed on table on the ventral margin with dorsal hinge margin up (vertically) with the anterior end away from the observer the right valve is on the right side of the observer and the left valve to the left. Another quick way is to observe the concave interior of a valve with hinge margin away from observer and to locate the pallial sinus impression. If the sinus opens towards the left it is left valve and vice versa.

Dextral and Sinistral

To decide whether a gastropod shell is dextral or sinistral the opercular opening is kept facing the observer with the apex vertically up with the opercular canal resting on the table. If the opercular opening is on the right it is dextral; if it is on the left side it is sinistral.

Ligament: Chitinous region binding the two valves; ligament area in most shells are posterior to the beak.

Hinge: The region which hooks both valves together.

Teeth: The knobs or projections in the hinge interlocking the valves.

Adductor mussels	Muscles helpful in closing the valves
Adductor scar	Impression on the valves showing the position of adductor muscles of the live animal.
Umbo or beak	Apex of the shallow cone of each valve
Umbonal cavity	The interior cavity lying within the umbo
Prodisso-conch	The embryonic shell of the bivalve corresponding to the Protoconch of gastropods usually eroded away in adults.
Proso-gyrate	Term to denote the shells when the umbones curve in anterior direction.
Ophisth-ogyrate	If both umbo point inward towards the umbo of each valve.

Lunule: Heart shaped impression insides, anterior to the beak

Equivalve: Both shells of same nature

Inequivalve: One valve larger or dissimilar

Equilateral: Umbo is midway between anterior and posterior sides.

Gape: When the valves do not fit closely together the opening in the margin.

Resilum: The ligament proper and internal cartilage

Pallial line: The fine single line impression produced by the muscular edge of the mantle.

Pallial sinus: "U" shaped notch on the posterior end of the valve indicating the posterior of a shiphon.

Amongst various molluscs of importance, oysters, pearl oysters, mussels, clams and cephalopods deserve our attention.

EDIBLE OYSTERS

Based on variations in shape, size and colour and texture of adult shell, structure of hinge plate of the larval shell and soft organs of the animal about 100 species of edible and inedible oysters

were originally described. Ranson (1948, 1950) distinguished oyster genera mainly on the basis of larval shell structure.

The Ostreidae family as known today comprises of three genera Ostrea, Crassostrea and Pycnodonte. The last genus is considered as semifossilised or living in deep sea area. Of the other two, Ostrea spp., do not occur in Indian waters.

Amongst Crassostrea the following 17 species are well known.

C. angulata
C. virginica
C. gigas
C. rivularis
C. rhizophorae
C. iredalei
C. commercialis
C. glomerata
C. madrasensis
C. amasa
C. echinata
C. densecarallosa
C. nippon
C. margaritacea
C. gryphoides
C. discoidea
C. tuberculata

There are other species also like

C. folium
C. quercina
C. lacerata
C. cuttackensis (= C. madrasensis ?)
C. cristagalli
C. cornucopia
C. sikamea

Of the above species, as already mentioned in Table 1, many species occur along the Indian coastal, bay and estuarine regions. Out of these only 4 are of any importance.

C. madrasensis

Brackishwater oyster occurs in estuaries, backwaters, at times in open sea. They are found in rocky or solid surface usually, but as in Ennore, Tuticorin and other areas on hard muddy bottom also.

C. gryphoides is mainly a backwater and estuarine species. C. cuculata occurs attached to sand stones, granite boulders, or corals in intertidal regions in brackishwater and estuarine regions. They are also found in open coast where rocks are encountered in the intertidal zones, while C. discoidea grows attached to rocks in deep-water of littoral zone.

MUSSELS

The family Mytilidae consists of several genera like Mytilus, Perna, Mytella, Adula, Semimytilus, Crenomytilus, Chromytilus, Septifer, Brachidontes, Hormomya, Aulacomya and Ischadium.

However, only species of Mytilus and Perna are of importance from the point of view of fishery and culture. The following species of Mytilus are of fishery value.

M. edulis (U.K, France)
M. galloprovincialis (Spain, Mediterranean)
M. californianus (Pacific coast of U.S.A.)
M. smaragdinus (Philippines)
M. viridis (Malaysia, India) (See Perna viridis)
M. canaliculus (Newzealand)

Under the genus Perna, Perna perna (Brazil, Venezeula), P. viridis and P. indica (India) are important.

It has been shown by Kuriakose and Nair (1976) that the mussel species M. viridis occurring in India referred to as belonging to Mytilus genus is actually referable to the genus Perna. The brown mussel has been identified as a new species, P. indica. Mussels live in intertidal rocky areas and also in slightly deeper zones with hard substratum.

CLAMS

In other countries the important species are Mercenaria mercenaria (quahog clam or hard clam or little-neck clam) found in the

Atlantic coast of U.S.A, Virginia and Long island; Mya arenaria (soft clam or long-necked clam) found abundantly from Labrador to North Carolina, Tapes semidecussata (baby clam) T. japonica (Asari clam) found inJapan. The hard clam has been successfully introduced in Britain and France. Apart from the above Attrina japonica, Fulvia mutica, Mactra sachaliensis, M. sulcataria, Venerupis aurea, V. pallastra, V. rhomboides; Venus fasciata, V. striatula, V. verrucosa and Meretrix lusaria are the other clams whose flesh is eaten. The edible species found in India are listed in Table 1. Most of the Indian species fall under the family Veneridae, Donacidae and Solenidae, Satyamurti (1956) has given a detailed statement of the characters of different genera of Veneridae which include Gafrarium, Katelysia, Meretrix and Paphia.

1. Meretrix

Meretrix species live mostly within the influence of land drainage. They are euryhaline. In M. meretrix we come across divergent characters of shell, those of east coast being usually true to type within narrow limits. In west coast, even when living within the same estuary it exhibits as many as three well marked variations connected by intermediary forms merging into one another making it difficult to allocate many to one particular group. Meretrix casta is found in river mouths and Meretrix casta var ovum is generally abundant in west coast backwaters growing to a size of 35.40 mm.

2. Katelysia species

Katelysia opima and K. marmorata are the important species. In K.opima the shell is thick, inflated, smooth and yellowish brown. Inner surface is white, pallial line deeply sinuate; resembles M. casta but differentiated by deeper colouration rayed with number of concentric undulating lines parallel to 3 or 4 purplish markings; anterior tooth of left valve absent and corresponding cavity in the right valve is also absent. Lunule distinct; area behind umbone well defined;

flattened and elongated reaching almost upto the hind margin. Muscular impression well marked.

This clam inhabits estuaries; backwaters; it prefers water edge near river mouth; very rare in low salinities.

3. Paphia species

Elongate shell, concentrically sculptured with a narrow lunule; hinge area short; pallial sinus deep. The distinguishing features of the two important species are:

Surface of shell smooth and polished; pale yellowish while marked with pale purplish grey arrow head markings " " shell elongate with anterior and posterior margins rounded.	P. textile
Concentric grooves, strong throughout the shell surface. Front and hind margin narrowly rounded; ventral margin slightly indented towards hind end; pale yellowish brown colour indistinctly rayed with grey brown bands	P. malabarica

In addition to the above Paphia laterisulca also appears to be an important species. The above species inhabit river mouths where the bottom is sandy mud.

4. Donax species

Shell trangular, elongate, inequilateral, stouter posterior side; surface smooth and scultpured. Pallial sinus deep and rounded. The characters of the important species have been given by Satyamurti (1956).

Razor clams

Elongated bivalve shells; Solen truncatus, S. lamarck. S.linearis, S. asperus, S. aquae dulcioris and S. kempi are the common species in India. Of these S. kempi appears to be of commercial fishery value. The diagnostic characters of various species have been

furnished by Rao et al (1972). Razor clams inhabit intertidal mud flats.

OTHER BIVALVES

Anadara granosa is the most important of the cockles cultured in countries like China, Philippines, Thailand, Borneo and Malaysia. The term cockle has no taxonomic significance.

In India extensive beds of A. granosa are found at Kakinada in the east coast. Elsewhere they are present but not of commercial value.

Gafrarium tumidum, Mesodesma glabratum and Sanguinolaria diphos are not dealt with here because of their comparative insignificance with regard to culture at present.

PEARL OYSTERS

Pearl oysters belong to the genus Pinctada under the family Pteriidae. Members of this genus have long and straight hinge; long axis of shell at right angle to hinge; left valve deeper than right; byssal notch on each valve anteriorily.

In Indian waters P. fucata is the most abundant species but the occurrence of P. margaritifera, P. chemnitzi, P. atropupurea, P. anomioides and P. sugillata is not uncommon.

The field identification characters of these species have been given by Rao (1974).

CHANK

Chanks inhabit only sea beds where the bottom is fine sandy. At time they are seen adjacent to the rocky beds also on coarse sand. They prefer waters of depth beyond 10 metres.

Key to identification of the five varieties Indian chank, Xancus pyrum.

A. Spine elongate; shell fusiform; breadth in length 1.75 to 2	Shoulder angular prominent	var. fusus (Andamans only)
	Shoulder rounded and low	---- 1
1(a) Profile of whorls in spine convex		.var. acuta
(b) Profile of whorls in spine straight		var. comorinensis
B. Spine short; shell either globular or top shaped;breadth in length under 1.75		--- 2
2(a) Spine moderately short; shall globose; periostracum rough and thick		var. globosa
(b) Spine often very short shell top shaped very wide at shoulder, periastracum thin and often sculptured in small shells.		var. obtusa

CEPHALOPODS

The cephalopods (squids, cuttlefish and octopi) are exclusively marine molluscs. Several species have reported but to mention a few of the commonly occuring cephalopods are Sepia pharaonis Ehrenberg, S. aculeata Ferussac & d'Orbigny, S. thurstoni Adam & Rees, S. brevimana Steenstrup and Sepiella inermis (Ferussac & d'Orbigny) among cuttlefish, Sepioteuthis arctipinnis Gould, Loligo hardwickii, Loliolus investigatoris Goodrish and Euprymna stenodactyla Grant among squids and Octopus dollfusi Robson, O. rugosus (Bosc), O. globosus Appellof, O. herdmani Holye and O. hongkongensis Hoyle among octopi (Rao, 1958; Silas, 1968).

Key to the field identification of the different genera of cephalopods to which the common species belong has been given by Sarvesan (1974).

Squids

Squids belong to the order Teuthoidea (Decapoda) which includes the majority of cephalopods, possessing a streamlined soft body with a pair of fins varying in shape, size and disposition. The distinct head in front is with ten circumoral arms provided with toothed suckers or claws or both. An internal shell known as pen or gladius, when present is imbedded in the dorsal mantle skin. The gladius of squids is almost transparent, thin and chitinous in nature. It varies in shape in different species.

Cuttlefish

Cuttlefishes belong to the order Sepioidea. Like squids, they possess well-defined head and ten arms. They have a broad and flattened body with narrow fins running along the sides to the full length of the body. The arms are comparatively short and provided with subequal suckers mostly arranged in four transverse rows. The two long slender tentacles are retractile into special pockets and used at the time of capturing the prey. The characteristic internal shell or the cuttlebone is calcified and differs in shape and size in different species.

Octopi

Octopi belonging to the order Octopoda, possess a short rounded body and a distinct head fringed with eight arms, which are provided with a broad enterbranchial membrane. The saccular mantle lacks fins. The suckers, arranged in two rows, are without stalks and horny rings.

TABLE - 1

1. Group	Edible Scientific name	Commercial or industrial Scientific name	Distribution
Oysters	Crassostrea madrasensis (Madras Oyster)	Preston	Sonapur, Godavari delta, Gokulapalli, Pulicat, Ennur, Madras, Cuddalore, Atharai, Tuticorin, Kerala Coast
	2. C. cucullata (Barn) (Rock Oyster)		All over India
	3. C. gryphoides (Schlothum) (West coast oyster)		Kutch to Karwar
	4. C. discoidea (Gould) (West coast oyster)		North Kanara - Kutch, Dwaraka, Bombay, Ratnagiri, Jaytapur.
		5. Crassostrea cristagalli (Linn)	Tanjore coast, Palk Bay, Gulf of Mannar
		6. C. folium (Gmelin)	Kutch, Pamban
		7. C. cornucopia(Chemnitz)	Marmagoa
		8. C. glomerata (Gould)	Kutch
		9. C. belcheri (Sowedy)	Karachi
		10. C. quercina (Soweby)	Karcahi
		11. C. cuttackensis	Orissa

1	2	3	4
		Pinctada fucata (Gould) (Indian pearl oyster)	Gulf of Mannar, West coast
		2. P. chemnitzii (Philippi)	Palk Bay, Orissa coast, Tuticorin
		3. P. sugillata (Reeve) (flat oyster)	Tuticorin, Vizhingam, Madras
		4. P. anomioides (Reeve) (flat oyster)	Bombay, Madras, Palk Bay, Tuticorin, Vizhinjam
		5. P. atropurpurea (Dunker) (flat oyster)	Madras, Tuticorin, Palk Bay
		6. P. margaritifera (Linnaeus) (Blak lip)	Indo-pacific
		7. Placenta placenta (Window-pane oyster)	Kutch, Kakinada, Orissa, Thana creek, Bombay, Adyar, Pulicat, Chilka, Vellar, Courtalayar, Tellicherry, Malabar coast, South Kanara.
2.	Clams	Meretrix meretrix (Linnaeus)	Bhatya creek, Kalbadevi creek, Myna Bay, Mahaluxmi creek, Mahim creek, Alibagh, Ratnagiri, Kali river, Kodibag, Ankola, Tadri (Agnahasini river) Moorba, Wadgoni. Mirojan, Wadgoni, Mirojan, Harwada, Mudgian, Sanikatta, Adyar, Courtalayar, Vellar, Cooum, Pulicat, Chilka, Tellicherry, (Malabar coast)
		M. casta (Chemnitz)	Pulicat, Adyar, Vellar, Ennore, Pinnakayal, Athankarai
		M. casta var ovum (Hanley)	Kerala coast

1	2	3	4
	Villorita cyprinoides (Gray)		West coast estuaries and backwaters
	V. cyprinoides var cochinensis		Cochin backwaters
	Katelysia opima (Gmelin)		Adyar, Vellar, all important South In estuaries and backwaters.
	Paphia malabarica		Karwar and north Kanara river mouths
	P. textile		Karwar and north Kanara river mouths
	P. marmorata		Karwar and north Kanara river mouths
	Donax cuneatus (Linneaus) (Wedge clam)		East coast, Palk Bay, Gulf of Mannar
	D. incarnatus (Wedge clam)		Palk Bay, Gulf of Mannar, East coast
	Gafrarium tumidum (Roding)		Gulf of Mannar, North Coromandal coast, Gulf of Mannar islands
	Mesodesma glabratum (Lamarck)		North Caromandal coast, Gulf of Manna West coast.
	Solen kempi Preston (Razor clam)		Ratnagiri coast
	S. lamarcki (Razor clam)		Gulf of Mannar
		Tridacna maxima Roding (Giant clam)	Andamans & Nicobar, Lakshadeep
Cockle	Anadara granosa (Linneaus) (Blood cockle)		Kakinada, Coramandal coast

1	2	3	4
Mussel	Perna viridis linnaeus (Green mussel)		East coast and west coast
P.	P. indica Kuriakose & Nair (Brown mussel)		Quilon, Kanyakumari, Vizhinjam, Trivandrum, Periathalai, Colachel, Muttom, Kovalam
Squids, Cuttle fishes, Octopi	Sepioteuthis arctipinnis (Gould) (Palk Bay squid)		South east coast of India
	Loligo duvauceli d' Orbigny		East and West coast
	Sepia pharaonis Ehrenberg		Indian coast
	S. aculeata Ferussac & d' Orbigny		Indian coast
	Sepiella inermis (F & O)		East coast, Indian ocean
	Octopus herdmani Hoyle		Palk Bay
	O. dollfusi		Gulf of Mannar
Chanks		Xancus pyrum var acuta (Sacred chank)	Gulf of Mannar
		X. pyrum var obtusa "	Palk Bay and Coramandal coast
		X. pyrum var comorineses "	Kanyakumari coast
		X. pyrum var globosa "	Trivandrum coast
		X. pyrum var fusus "	Andamans