

LECTURE NOTE ON FIS 503

FIS 503 – PRODUCTION OF OTHER MARINE PRODUCTS (2 UNITS)

This Course is taught by three (3) lecturers - Dr. I.T. Omoniyi, Dr. F.I. Adeosun and Dr. A.A. Idowu

The Course synopsis is further outlined on lecture basis as follows:

Lectures 1 – 4: Ecology, life histories of crustaceans and aquatic molluscs

Lecture 5 – 8: Culture of Shrimps, Oysters, crayfish, crabs, periwinkles and frogs

Lecture 9: Culture of edible sea weeds

Lecture 10 – 11: Sea and Shore farming of some products

Lecture 12: Processing and preservation of marine products.

ECOLOGY AND LIFE HISTORIES OF CRUSTACEANS

At elementary level, crustaceans are a class of primarily aquatic arthropods. The name crustacean is derived from the Latin words 'crusta' meaning hard shell. The class is large (about 26,000 known species) and includes a variety of aquatic animals such as shrimps, crabs, lobsters, barnacles, water fleas etc. Some crustaceans occur in the seas and freshwaters, some are semi-terrestrial. They are mostly free-living, but few are parasitic. The common names shrimps and prawns are used interchangeably but it has now been resolved at FAO Convention to call marine and brackish water forms shrimps and freshwater forms prawns. Technically, the prawns have pleura of 2nd abdominal segment overlapping with 1st and 3rd segments ventrally.

But in shrimps, the somite of 2nd abdominal segment overlaps the 3rd somite. Before commercial importance of crustaceans could be appreciated, the characteristics and the relationships need be mentioned.

The main diagnostic features of the Class are:

- The occurrence of 2 pairs of pre-oral appendages which are antenniform and sensory in functions i.e. possession of 2 pairs of antennae.
- The body consists of the head, the thorax and the abdomen with a tendency for the head and anterior segments of the thorax fusing to form a cephalothorax.
- The head consists of six segments and bears 3 pairs of post-oral appendages which act as jaws; mandibles, the maxillules and the maxilla.
- The trunk appendages vary in number, forms and functions occurring on every segment and they are typically biramous.
- Respiration is usually by means of gills or through the general body surface.
- Excretion is by means of green glands.
- The sexes are usually separate but some members are hermaphroditic e.g. barnacles.
- The typical crustacean larva is the Nauplius which has 3 pairs of appendages – antennules, antennae and mandibles.

Make a well labeled lateral view of Penaeid shrimp.

CLASSIFICATION

Order:

Decapoda

Suborder:

Natantia

Reptantia

Infraorder:

Penaeidea

Caridea

Macrura

Brachyura

Penaeidae

Palaemonidae

Pandalidae

Portunidae

Penaeus

(*Portunus*)

Crabs)

Metapenaeus
(Shrimps)

Astacidae

Nephropidae

Palinuridae

Astacus

Homarus

Panulirus

(FW Crayfish)

(Clawed lobsters)

(Spiny rocky lobster)

The order Decapoda is distinguished by its first 3 pairs of thoracic limbs modified into maxillipeds while the other 5 pairs are walking legs (hence, the name Decapoda meaning 10 legs). The 1st pair of walking legs are often enlarged to form chelae or chelepedes. This order consists of 2 sub-orders.

a. Natantia – swimmers (b) Reptantia – the crawlers. The suborder natantia includes the shrimps and the prawns which are adapted for swimming. They show adaptation for swimming as their bodies are laterally compressed, legs are long and slender, and are of no use for walking. The cephalothorax is prolonged into a rostrum which acts like a keel. The pleopods are fringed with bristles or setae which increase the surface area for swimming. The antennae are usually large and used as a rudder during swimming.

The sub-order Reptantia is more numerous decapods which are highly modified for crawling. They include crabs, lobsters and hermit crabs. The crawling adaptations are:

- (i) bodies tend to be dorso-ventrally compressed
- (ii) have heavy legs that can support the body for crawling
- (iii) pleopods are small and not modified for swimming
- (iv) antennae are small.

The true crabs belonging to the infra-order brachyuran meaning short-tail and flattened dorsoventrally. The abdomen is greatly reduced and flexed tightly beneath the cephalothorax. There is terrestrial crab which burrow and go to sea to breed. Uropods are lacking in both male and female crabs. The hermit crabs differ from true crabs in having receptacle abdomen which is not flexed beneath the cephalothorax. The abdomen in hermit crab is asymmetrical and with thin soft non-segmented cuticle. Hermit crabs occupy mollusk shell to enjoy movement (Phoresy association).

Decapods provide a good source of human protein, even surpassing the bivalve molluscs. The decapods molluscs together comprise the so called shell-fishes. The fishing of decapods constitute an important industry. For example, *Penaeus* shrimps are caught in large numbers off the coast of Nigeria. Shrimps and prawns account for over 1million tons/year in Indian and Pacific oceans. Mexico is said to be the richest shrimp fishing area of the world and the commercially important shrimp include *Penaeus duorarum* (also in Nigeria coast), *P.Schmitti*, *P. aztecus*. In British water, important shrimp include the (*Crangon crangon* (brown shrimp), *Pandalus montagni* (Pink shrimp). Lobsters also contribute to the world crustacean fisheries especially the European lobsters. *Homarus vulgaris* found in the coast of Britain where they are mostly caught in baited pots. The freshwater prawn, *Macrobrachium vollenhoenii* is caught all the year round at Asejire lake near Ibadan.

LIFE HISTORY – Sexes are separate in most cultivated decapods especially Penaeid shrimps. A few species e.g. *Pandalus sp* (caridean) change sex at some time during their lives.

Mating occurs when the female is in a soft shelled condition (i.e. newly moulted) and the mating results into the deposition of one or more spermatophores (containing many sperms) in, on or close to the genital aperture/opening of the female. Note that mating can occur with hard shelled female in spiny lobster (Palinuridae) and penaeid shrimps which have setose genital region (i.e. open thelyca). These crustaceans with open thelyca (the thelycum-singular) rely on bristles or cement to hold the spermatophore in place externally. Lobster and certain species of penaeid shrimps have a closed thelycum or pouch to retain the spermatophores until spawning occurs. Spawning is the release of eggs either directly into the sea especially in the penaeid shrimps or to the brood chamber beneath the abdomen. The eggs are fertilized as they are spawned but in species with internal sperm storage this may occur several hours or even days after mating

according to species. Sperms from one mating are sufficient to fertilize more than one batch of eggs in lobsters and penaeid shrimp with closed thelyca.

Penaeid eggs hatch a few hours after spawning and each larva is left to fend for itself as it develops through about 12 free-swimming planktonic stages of nauplius, protozoa and mysis transforming or metamorphosing into a post-larvae (See Diagram A). The nauplii feed on internal stores of yolk while the protozoa stages filter unicellular algae from the water. The mysis stages feed voraciously on zooplankton (rotifers) and in this respect they are like the larvae of caridean prawns and lobsters (See Diagram B), the phyllosoma larvae of spiny lobster (Diagram C) and crabs (Diagram D). Incubation in non-penaeid decapods lasts from a few weeks in the prawn to as long as 4 months in lobsters. During this period, the female tends and ventilates the clutch until hatching occurs. During incubation, the early nauplius and protozoa stages are often by-passed in the egg so that when hatching occurs, the larvae are almost immediately able to catch and feed on zooplankton. For instance, an extreme case of abbreviated development occurs in freshwater crayfish where there is no free-living larval phase and the post-larvae hatch directly into juvenile (See Diagram E).

Crustaceans especially the penaeid shrimps are cannibalistic and unless the young can escape from the mother they stand the risk of being eaten. It has been reported that neither the presence of shelter nor the availability of adequate food eliminates cannibalism, but the absence may increase it.

Note: as the exoskeleton (ext. shell) of crustaceans is capable only of limited expansion, growth occurs throughout life through moulting or ecdysis i.e. shedding of exoskeleton at intervals. The rate of growth is a function of the frequency of moulting and the increase in size at each moult. The frequency of moulting varies naturally between species, with size and age. Young shrimp

larvae moult 2 or 3 times in a day, juveniles every 3-25days depending on temperature and species, while adult lobsters and crayfish may only moult once every year or two years. Adverse nutritional or environmental conditions can decrease the frequency of moulting and size at each moult. Crustaceans often eat cast shells which is a convenient source of minerals that would have been lost. Mineralization of the new shell is affected by the availability of calcium ions, HCO_3^- and pH in the surrounding water and in the diet.

Attend class for some biological data on life histories of penaeid and caridean shrimps. The diagrams are provided during lectures.

AQUATIC MOLLUSCS (MOLLUSCA)

The Phylum Mollusca constitute the 2nd largest animal phylum. There are about 80,000 living and 35,000 fossil species of molluscs.

Basically, molluscs are triploblastic, bilaterally symmetrical and non-metamerically segmented coelomates. The molluscan body consists of three parts; the head, the foot and the visceral mass. The foot is ventral, muscular, flat and used for creeping. The dorsally situated dome shaped visceral mass is covered by the mantle, a fold of skin which secretes the dome-shaped shell. The mantle overhangs the visceral mass posteriorly to form a mantle cavity. The mantle cavity contains (i) the gills or ctenidia (ii) the hypobranchial gland (iii) the anus (iv) kidney opening and (v) the osphradium-a chemoreceptor. The buccal cavity contains the unique radula, a toothed belt used for feeding. The phylum is divided into classes:

- (i) Class Monoplacophora – deep sea molluscs
- (ii) Class Aplousobranchia – primitive small molluscs
- (iii) Class Polyplacophora - Clutons

- (iv) Class Scaphopoda – Elephant tusk’ molluscs
- (v) Gastropoda – Snails, slugs, abalones
- (vi) Class Cephalopoda – Octopus and Cuttlefish
- (vii) Class Bivalvia or Lamellibranchia – Oysters and mussels.

We are concerned with class Bivalve/Lamellibranchs. This class contains the Clams, Cockles, Oysters, Mussels etc. They are aquatic, occurring in fresh and sea waters. They constitute the 2nd largest molluscs with 30,000 species, more uniform in structure than the gastropods. Most features of bivalve are adapted to burrowing in soft substratum, some have become borers into rocks and wood, mussels and oysters are sessile, while a few swim. Bivalves are the most successful of all the molluscan group based on number of individuals and ecological bioenergetics. Bivalves possess the most efficient mechanism to collect the largest crop of green plants in the world i.e. phytoplankton – which is responsible for their success. Bivalves form the food of bottom living fishes, constitute important source of protein for man. Many are now cultured e.g. Oysters, Clams, Mussels.

The burrowing habit of bivalves into substrates is as a result of modifications of the molluscan plans made as:

1. The body is laterally compressed for easy passage into the substratum
2. The foot is transformed from a flat-soled crawling organ to a tongue or wedge (Hatchet shaped) structure which can be protruded for burrowing into soft substratum.
3. The mantle is enlarged and transformed into two lobes (left & right) that envelope the whole body and enclosing large mantle cavities which are now lateral in position.

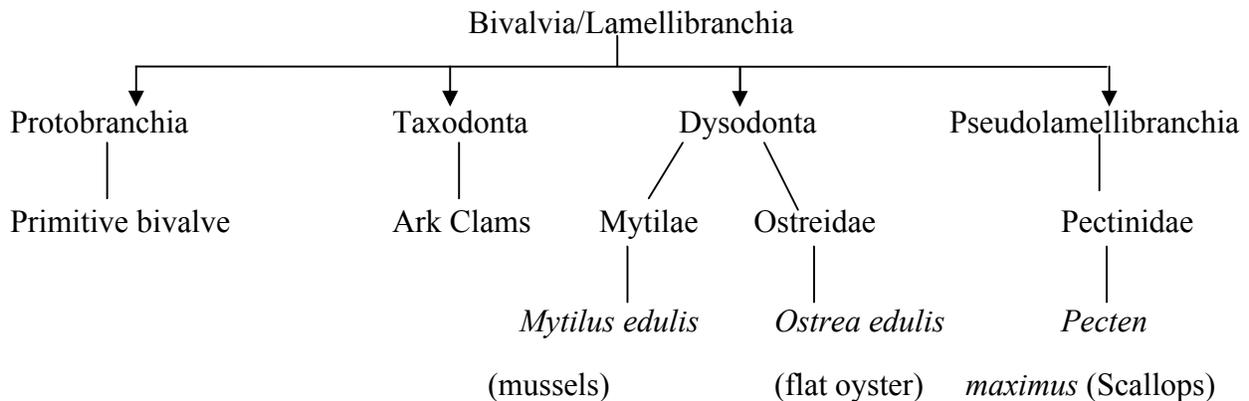
4. It is because the mantle consists of two lobes, the shell secreted by the mantle consists of two valves (Bivalvia) held together by a dorsal ligament. Two adductor muscles run horizontally between the two valves – one anterior, the other posterior.

5. Correlated with the burrowing sedentary habit, bivalves become ciliary feeders. The ctenidia becomes modified into a filtration or food procurement apparatus. The lips are transformed into two ciliated gutters, the labial palps which convey the food particles collected by the ctenidia to the mouth.

6. Also correlated with the adoption of a burrowing mode of life, the posterior edge of the mantle lobes are modified into siphons to maintain contact with the water column while burrowing.

7. The head and the associated sense organs (eyes and tentacles) which are prominent in ancestral molluscs have all disappeared leaving only the mouth. The buccal mass, radula and jaws are also lost. The brain is not well developed.

They have their sexes separate or united and free living Veliger larvae are usually produced.



In Nigeria, some commercial molluscans in the class Bivalvia include *Anadara senilis* (Archidae) and *Crassostrea gasar* (Ostreidae). From the primitive bivalves which were shallow

burrowers, some forms have evolved or radiated to become (a) attached or sessile valve e.g. Oyster and mussels (b) swimmers e.g. *Pecten* (c) deep burrowers e.g. *Tellina*, *Donax* (d) borers e.g. *Teredo* (ship worm).

Crassostrea gasar is a mangrove oyster that is cemented to rocks or *Rhizophora* mangrove roots by large right shell valve. The left valve is smaller and forms a lid. The anterior adductor muscle is completely lost and the posterior adductor is enlarged and becomes central in position. Being sessile, the foot is lost. Some oysters incubate their eggs in the mantle cavity while their larvae are planktonic. Usually collected for food in Nigeria many Oysters are now cultured in Europe and Japan.

Mytilus – Mussel is attached to rocks (hard surfaces) by beard-like byssus threads secreted by byssal gland in the fingerlike foot. The anterior adductor muscle is very small thereby making the anterior end to be narrow. The siphons are short and the mantle lobes are not fused ventrally. Found in Takwa bay (Lagos) in large amount.

Pecten swims by clapping movements of the valve brought about by contraction and relaxation of the striated part of the single adductor muscle. Correlated with its mobility, numerous eyes and tentacles are developed along the mantle edges which are also muscular and control water exit.

Tellina, *Donax* are active deep burrowing clams. Their long, separate siphons are used like vacuum clearers for sucking in detritus from the surface of sea bottom (i.e. deposit feeders)

Teredo (ship worm) – is highly specialized bivalve which burrows into wood. It damages boats and other wooden structures in the sea. The shell is small and used as auger-blades in boring

woods. The enlarged fused siphons dominate the morphology. The siphons are not accommodated within the shell and secrete a calcareous tube that lines the burrow in the wood.

Discussion on some ecological data of Mangrove molluscs and necessary diagrams are to be provided during lecture hours. Attend all.

Life History – Sexes are separate and the reproductive organs occupy the upper portion of the foot and open just in front of the renal aperture on each side. In male, the sperms shed into the mantle cavity pass out with the exhalant current and enter the mantle of female through the inhalant siphon. Eggs discharged into the mantle cavity of female are fertilized. Fertilization is internal. Life history is highly abbreviated. The eggs hatch into free-living Veliger larvae that transform to the juveniles. Salinity is the most crucial factor for their growth while the food preference is an important consideration in molluscs aquaculture. In aquaculture practice, the molluscs rely on natural foods for their growth.

* Internet lecture material is not enough for students to excel very well in examinations. Attend lecture classes punctually and regularly to enhance your performance in this Course.

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