(ZOO-102CR-1.4)POLYMORPHISM IN COELENTERATA

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The occurrence of more than one type of structurally and functionally different individuals within a population is called polymorphism. The class Hydrozoa of phylum Coelenterata includes a large number of colonial species that contain more than one form of individuals which are called zooids

Coelenterates have two basic zooids, polyp and medusa. All other types of zooids are modifications of these two types of zooids.

Polyp has a tubular body with a mouth surrounded by tentacles at one end. Other end is blind and usually attached by a pedal disc to the substratum. Polyps are typically sessile.

Polyps are concerned with feeding, protection and asexual reproduction.

Medusa has a bowl or umbrella shaped body with marginal tentacles and mouth is centrally located in a projection called manubrium on the ventral concave surface. Medusae are generally motile and concerned with sexual reproduction.

Polyp and medusa are in fact homologous structures and from one another can easily be derived.

Modifications of Polyp

Gastrozooids or feeding zooids are typical polyps with a mouth and surrounding tentacles.

Dactylozooids which are used for defence are polyps without mouth and usually with a long basal tentacle.

Gonozooids are reproductive zooids derived from polyp, which produce sexual medusae or gonophores.

Modifications of Medusa

Nectophore or *nectocalyx* or swimming bell is a medusa modified for sexual reproduction.

Pneumatophore or *float* is a bladder-like modified medusa filled with mixture of gases and helping the colony to float on the surface.

Phyllozooid or *bract* is leaf-like zooid, studded with nematocysts and serving to protect the colony.

TYPES OF POLYMORPHISM

A few coelenterates, such as *Hydra* and sea anemone are **monomorphic** in which only polyp stage is found but other coelenterates exhibit polymorphism.

Dimorphism: Many hydrozoan colonies like *Tubularia* and *Campanularia* have only two types of zooids, the feeding zooids or *gastrozooids* and *medusae* or *nectophores* that bud off from the stem or gastrozooids. These are dimorphic colonies in which blastostyles are not present.

Trimorphism: Some species like *Obelia* and *Plumularia* are trimorphic because besides *gastrozooids* and medusa, they also have medusa-producing *gonozooids* or *blastostyle*.

Polymorphism: Coelenterates having more than three types of individuals are called polymorphic, e.g. *Hydractinia* which has five types of zooids, each performing a specialized function. *Gastrozooids* are for feeding, spiral *dactylozooids* for protection, long *tentaculozooids* have sensory function. *Skeletozooids* are spiny projections of chitin for protection and *gonozooids* are reproductive zooids that produce male or female medusae.

Highly modified polymorphism: In order *Siphonophora*, such as *Diphyes, Halistemmia, Stephalia* and *Physalia,* zooids are so much modified that they appear like organs of a single

body rather than individuals of a colony. They are mostly pelagic in habit. In *Physalia*, zooids are in units called *cormidia*, which bear *gastrozooids*, small and large *dactylozooids* with long and short tentacles and branched gonozooid with gonophores. In *Diphyes* colonies are linear with one or more *nectophores* located at the apical end. Cormidia are also repeated in a linear succession. In *Velella* and *Porpita*, there is a single large central *gastrozooid* with a mouth, around which are arranged concentric rows of *gonozooids* and *dactylozooids*. The whole colony looks like a single individual.

ORIGIN OF POLYMORPHISM

There are two theories to explain the origin of polymorphism in coelenterates.

Polyorgan theory: This theory was proposed by Huxley (1859), Eschscholtz (1829), E. Metschnikoff (1874) and Muller (1871), according to which individuals of a colony are actually organs of a medusoid individual, which have multiplied and migrated from their primitive positions to the current evolved positions.

Polyperson theory: This theory was first proposed by Leuckart (1851), Vogt (1848), Gegenbaur (1854), Kolliker (1853), Claus (1863) and later strongly supported by E. Haeckel (1888), Balfour (1885) and Sedgewick (1888). According to this theory colony is not a single individual but various parts of the colony are modified individuals which have changed their structure due to division of labour. They have all modified from the primitive zooid which was a polyp.

Medusome theory: This theory was proposed by Haeckel (1888) as a compromise between the above theories. The theory says that the siphonophore larva formed from gastrula was a medusoid individual, from which zooids or persons appeared by budding from the subumbrella.

SIGNIFICANCE OF POLYMORPHISM

The phenomenon of polymorphism is essentially one of division of labour in which specific functions are assigned to different individuals. Thus, polyps are modified for feeding, protection and asexual reproduction, while medusae are concerned with sexual reproduction. This distribution of functions among diversified individuals and their subsequent modifications in coelenterates may have resulted from their initial simple organization and lack of organ specialization. Polymorphism gave the colonies competitive edge in protection and food gathering and eventual survival.

Polymorphism in the Cnidarian order Hydrozoa

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Amongst the coelenterates, hydrozoans provide very good examples of polymorphism. The phenomenon is essentially for division of labour. Division of labour is first seen in the cells of Hydra where the cells are specialized to perform different functions of individual as a whole. Physiological differentiation of this type had its effect upon the morphology of cells which led to cells specialization and give rise to cells of different structures. In *Obelia* this specialization is earned still further. In it not only cells are specialized but individuals get specialized to perform different functions. The polyp performs different functions. The polyp performs vegetative function such as feeding, respiration, etc. and the free swimming medusae are reproductive nature.

There are different types of polypoids and medusoids specialized for different functions. There are three types of polypoid and four types of medusoids individuals as given below :

I. Popypoid Zooids

1. Gastrozooids

The gastrozooids or the siphons are the nutritive or food-ingesting individuals of the colony. Each gastrozooid is a tubular or seccuLar structure with a large mouth. A single, long, contractile and hollow tentacle arises from the base of the gastrozooid. It bears numerous lateral contractile branches called the tentilla, each ending into a knob or coil of nematocytes.

2. Dactylozooids

These are the protective polyps of the colony and are variously known as palpons, tasters or feelers. Typically they resemble the gastrozooids except that they lack a mouth and their basal tentacle is unbranched. In Vallela and Porpita the dactylozooids arise from the margin of the colony in the form of long, hollow and tentacle-like fringing bodies called tentaculozooids. When associated with gonophores, the tentacle-like dactylozooids are known as gonopalpons. In Physalia the dactylozooids become excessively long.

3. Gonozooids

They are reproductive zooids which are also known as blastostyles. They are without mouth and tentacle. They reproduce asexually by budding and form medusae. In Vallela and Porpita, they resemble a gastrozooid and possess a mouth. Usually, the gonozooids take the form of branched stalks, called the gonodendra. These bear grape-like clusters of gonophores and are often provided with gonopalpons as in Physalia.

II. Medusoid Zooids

1. Swimming Bell

The swimming bells which are also known as nectocalyces, nectophores or nectozooids are medusoid form with a bell, velum, four radial canals and a ring canal. But these are devoid of mouth, manubrium, tentacles and sense organs. Its shape is variable and may be bilaterally symmetrical, prismatic, elongated or flattened. Due to well developed musculature, swimming bells act as excellent swimming organs and help in the locomotion of the colony.

2. Pneumatophores

The pneumatophores or the floats are bladder or vesicle-like structures filled with gas, and keep the colony floating. Each pneumatophore represents an inverted medusa bell, devoid of mesogloea and consisting of an external exumbrellar wall, pneumatocodon, and an internal subumbrellar wall, the pneumatosaccus or air-sac. The walls of both these are double-layered and are highly muscular. The space between the two walls is known as gastrovascular cavity.

A great degree of variation in shape and size is observed in different siphonophores. In *Agalima*, the float is simple and its air sac is lined by a layer of chitin secreted by the epidermis.

The shape of pnematophore is variable and may or may not be divided into a number of concentric chitinous chambers arranged in one plane. These communicate with each other and with the central chambers by pores in their walls. The air sac may open or closed. The air sac may be perforated by a single or several pores. In some cases a portion of the float is partly constricted off and assumes the form of an ovoid medusa-like, called aurophore.

3. Bracts

The bracts which are also known as the phyllozooids or hydrophyllia are thick, gelatinous and curved plates of mesogloea. These may be prism-like, leaf-like, shield-like or helmet like in appearance. They are unlike meduase and contain a simple or branched gastrovascular canal.

4. Gonophores

The gonophores or the reporductive medusoids occur singly on separate stalks or in clusters on polypoid gonozooids as in *Velella* or on simple or branched gonodendra. The gonophores may be medusa-like with bell, velum, radial canals and a manubrium bearing gonads. But the mouth, tentacles and sense organs are always absent. In number of hydrozoans e.g. *Physalia*, the female gonophores are medusa-like while the male ones are sac-like. In animals, like *Physalia* (male), the gonophores may remain attached to the colony or are set free as in female *Physalia*, *Porpita* and *Velella*. Since they cannot feed, they perish after the discharge of sex-cells. The gonophores are dioecious but the colonies are hermaphrodite bearing both types of gonophores in the same or separate clusters. Gonophores may be budded off from the pedicel of the gastrozooid as in *Diphys*, or from a blastostyle as in *Velella* or from coenosarc as in *Agalmopsis*.

Types of colonics in siphonophora

Hydrozoa belonging to the orders siphonophora and chondrophora are exclusively marine, planktonic or pelagic and polymorphic colonies. The colonies are usually delicate, transparent and beautiful The zooids in each colony are attached to the coenosarc or coenosome and their arrangement exhibits diversity in different colony. Because of great diversity of colonics in siphnophora and chondrophora can be illustrated only by some examples of the colonies such as *Halistemma*, *Physalia* and *Porpita*.

(A) *Halistemma*: It belongs to suborder Physophorida of the order Siphonophora. This genus occurs in mediterranean and other seas. The colony exhibits great degree of polymorphism, coenosarc is modified into a long, slender, floating axial tube or stem, to which polymorphic zooids are attached all along its length. The upper end of the stem is expanded to form small pneumatophore filled with gas. It serves to keep the colony's right side up in water. Below the pneumatophores are several closely set transparent

swimming bells or nectocalyces which contract rhythmically to take in water and pump it out, thus propelling the colony through water. Below the last nectocalyx on the stem, at regular intervals are similar groups of closely set individuals cormidia together forming a linear cormidium.

Each group of cormidium consists of four types of zooids (i) tubular gastrozooids with mouth and long branched tentacle bearing batteries of nematocysts (ii) mouthless dactylozooids with an unbranched sensory tentacle (iii) shield-shaped leaf hydrophyllium or bract which partially covers and protects the cormidium and (iv) unisexual gonozooids or sporosacs bearing male or female medusae or gonophores. *Halistemma* shows bilateral symmetry. Its life history includes a ciliated planula larva, one end of the planula invaginates to form pneumatophore while the other lower end forms polyp. The first polyp by elongation and budding forms the colony.

(B) *Physalia*: *Physalia* is a polymorphic colony of bright blue colour belonging to suborder Physophorida of the order Siphonophora. It is one of the most dreaded and most beautiful pelagic coelenterate found floating in tropical and subtropical oceans. The members of the colony develop from coenosarc. It has, on the aboral side a large gas-filled pneumatophore formed by several medusoids. It floats above the surface of water. Dorsally the pneumatophore forms a crest or sail for manoeuvering the wind. It contains a gas gland which secretes a gas having the similar composition as that of air, but with a large proportion of carbon monoxide. Below the pneumatophore hangs a colony of several non-linear cormidia. Each cormidium is a group of polymorphic individuals which are modified polyps such as gastrozooids, dactylozooids and gonozooids. Gastrozooids are tubular with mouth. Each gastrozooid possesses a long tentacle which may hangdown several metres below the pneumatophore or float. The gastrozooid feeds on fish. It applies its lips to the fish and partially digested food is sucked in liquid form. Dactylozooids are of various sizes. Each is a tubular mouthless individual with a long tentacle (may reach a length of 30 metres) having strong muscles and twisting ribbon of ncmatocysts. They form a drift net for capturing fish for food which is drawn upto the gastrozooid by the contraction of tentacles.

These tentacles can inflict serious and sometimes fatal injuries to man. Swimmers can be severely poisoned or even paralysed by contact of these tentacles. Gonozooids or gonodendra are branching blastostyles having leaf-like gonopores and male and female medusae or gonophorea of deep blue colour. The male mcdusoids are reduced and remain attached but the female mcdusoids become detached and swim freely. Pneumatophores and gonophores are modified medusoids. The members of the colony show a division of labour.

(C) *Porpita*: It is a polymorphic colonial hydrozoa belonging to order chondrophora. The colony resembles a medusa. It has a large disc-like body with a chambered, chitinous aboral pneumotophore containing air. Each chamber communicates with exterior by two

pores. The stem is shortened to a flat coenosarc. From the disc-shaped body hangs ventrally a single large central gastrozooid bearing mouth and stomach of the colony.

Surrounded by cluster of closely set tubular gonozooids or blastostyles, each having mouth and bearing medusae. The rim of the disc bears numerous dactylozooids with nematocysts.

A thick cellular mass the so-called liver is present in between the gastric cavity of gastrozooid and the pneumatophore. This cellular mass is believed to have an excretory function. It is traversed by two systems of canals. The endodernal canals communicate with the enteron of the zooids throughout the colony. The ectodermal or tracheal canals, internally lined by chitinous layer, communicate through the air chambers with the exterior. Air chambers thus perform the function of respiration. Nectocalyces are absent in this colony.