

Assignment

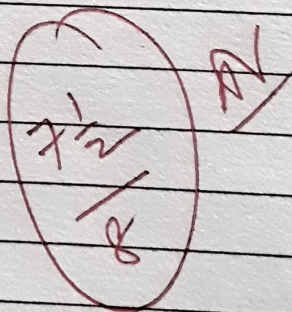
NONCHORDATA : PROTISTS TO PSEUDOCELOMATES

Polymorphism in Phylum Cnidaria

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Zoology (hons.)

Roll no: 23/22001



Assignment

Polymorphism in phylum Cnidaria

• Phylum Cnidaria

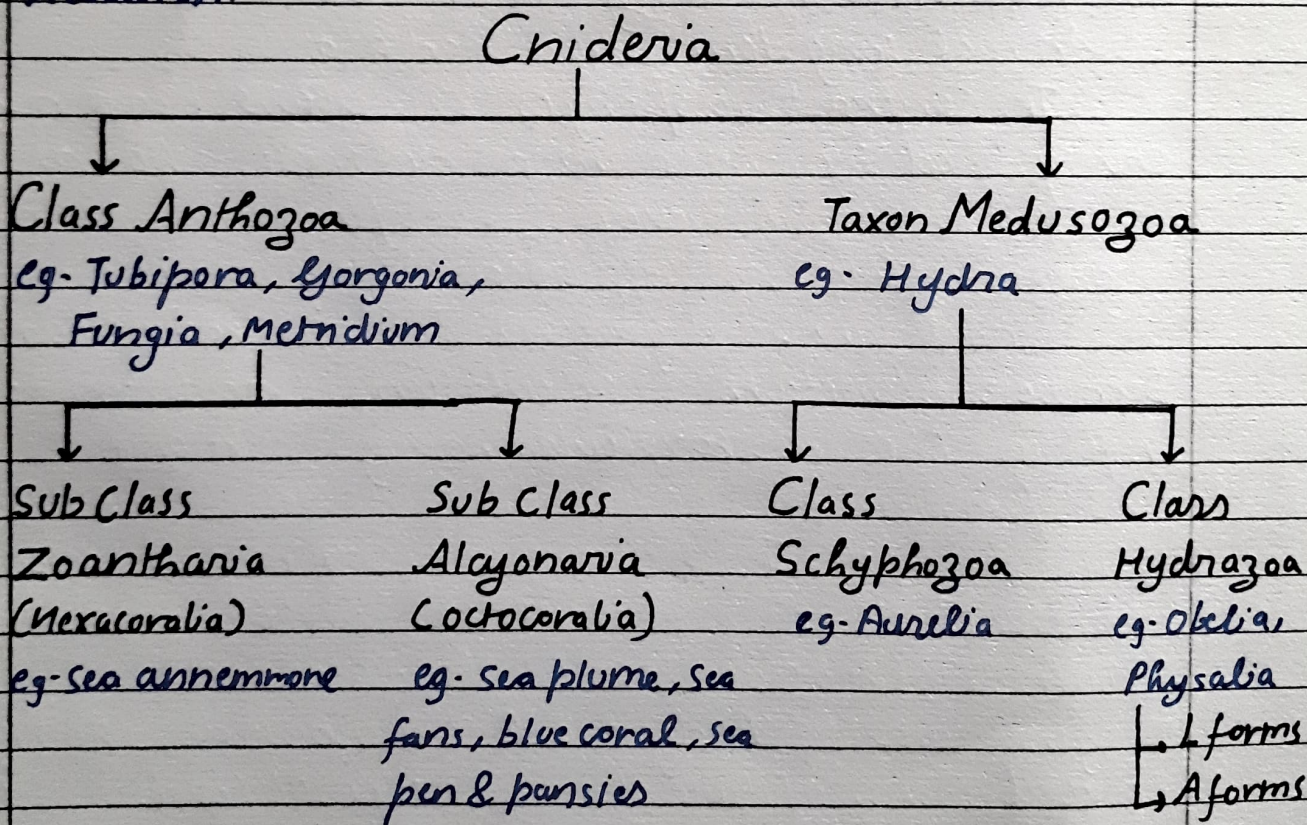
The phylum Cnidaria / Coelentrata includes the familiar hydras, jellyfish, sea anemones & corals and the bright colour of many species combined with their radial symmetry is often incredibly beautiful. Because radial symmetry is clearly primary, it is commonly considered justification for placing the cnidarians within a division of Animal kingdom called Radiata.

In contrast to sponges, cnidarians possess a gut cavity lined by endoderm as do most other animals. In cnidarians, however it's referred to as coelenteron or gastrovascular cavity, because it functions in circulation in addition to digestion. The gastrovascular cavity because it functions in circulation in addition to digestion. The gastrovascular cavity lies along the polar axis of animal & opens to the outside at one end to form a mouth. In cnidarians a circle of tentacles, representing evaginations of body wall, surrounds the mouth. In cnidarians a circle of tentacles representing evaginations of body wall surrounds the mouth to aid in capture & ingestion of food.

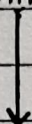
The cnidian body wall consist of 3 basic layers: an outer epithelium: Epidermis; an inner epithelium

gastrodermis, lining the gastrovascular cavity; and between these extra cellular layers is the mesoglea which ranges from thin non cellular basal lamina as in hydras and many other hydrazoans to a thick fibrous, jelly like connective tissue with or without mesenchymal cells. Thus, cnidarians or coelenterates are diploblastic, i.e. their bodies are constructed from only two germ layers, ectoderm & endoderm from which two adult epithelia arise.

Now, let's look at classification of phylum Cnidaria based on recent developments & research.



(Hexacoralia)
[continued.]



→ Order
Zoanthidea
eg. Phalythoa

(Octocoralia)
[continued.]



→ Order
Stolonifera
eg. Tubipora musica

Schizophozoa
[continued.]



→ Order
Sennaeostomae
eg. Aurelia, Rhopalum,
Chrysaora &
Phacellophora

→ Order
Actinaria
eg. Metridium,
Heteractis

→ Order
Helioportacea
eg. Helopora
coerulea

→ Order
Rhizostomae
eg. Cassiopea xamachana,
Stomatophora megaris

→ Order
Scleractinia
eg. Agaricia,
Fungia, Acropora

→ Order
Telestacea
eg. Telesto

→ Order
Cubomedusae
eg. Chironex fleckeri

→ Order
Corallimorpharia
eg. Discosoma

→ Order
Alcyonacea
eg. Alcyonium

→ Order
Coronatae
eg. Linuche unguiculata

→ Order
Antipatharia
eg. Pendrobrachia

→ Order
Gorgonacea
eg. Coralium,
Gorgonia

→ Order
Stauromedusae
eg. Heliclystus,
Lucernaria

→ Order
Ceriantharia
eg. Ceranthus

→ Order
Pennatulacea
eg. Pennatula

Class Hydrazoa

eg. Obelia, Physalia

2 forms

A forms

Order
Limnomedusae
eg. Gonioreus
vestens

Order
Trachylina

Order
Leptothecatae
eg. Obelia

Order
Anthothecatae
eg. Clava, Hydra,
Tubularia

Order
Siphonophora
eg. Physalia

Suborder
Trachymedusae
eg. Aequorea
digitata

Suborder
Nanomedusae
eg. Tiwiplois
nutricula

Suborder
Actinulida
eg. Halimna
Lydia

Sub-order
Capitata
eg. Hydra,
Tubularia,
Ectopleura

Sub-order
Cystonectida
eg. Physalia

Sub-order
Filifera
eg. Clava,
Eudendrium,
Hydractinia

Suborder
Physonectida
eg. Nanomia

Sub-order
Calycephorida
eg. Diphyysis

A brief description of some i.e. all three classes that come under Phylum Cnidaria which are, Anthozoa, Scyphozoa, Hydrozoa respectively.

1. Class Anthozoa



1. Marine & Colonial forms are present.
2. Polyp form present & medusa absent.
3. Velum is absent.
4. Both epidermal & gastrodermal region contain Cnidocytes.
5. Wall of tentacles surround oval mouth give it flower like appearance.

2. Class Scyphozoa



1. All marine individuals.
2. Medusa is dominant stage.
3. Have rudimentary polyp stage & acellular mesoglea.
4. Presence of pseudo-velum.
5. Gonads are of endodermal origin.

3. Class Hydrozoa



1. Mostly marine forms, some are found in freshwater.
2. Mostly colonial forms, some being solitary.
3. Both polyp & medusa forms are seen.
4. True velum is present.
5. Presence of acellular mesoglea.

With the basic structure of Cnidarian classification being clear based on the above mentioned, Let's delve in one

main important feature in phylum Cnidarians is polymorphism on which rest of the text is about.

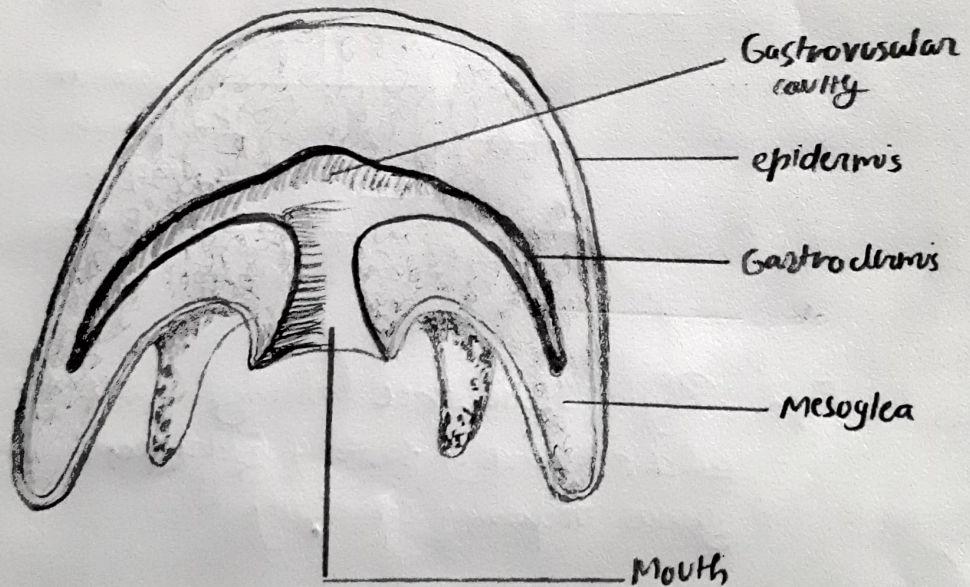
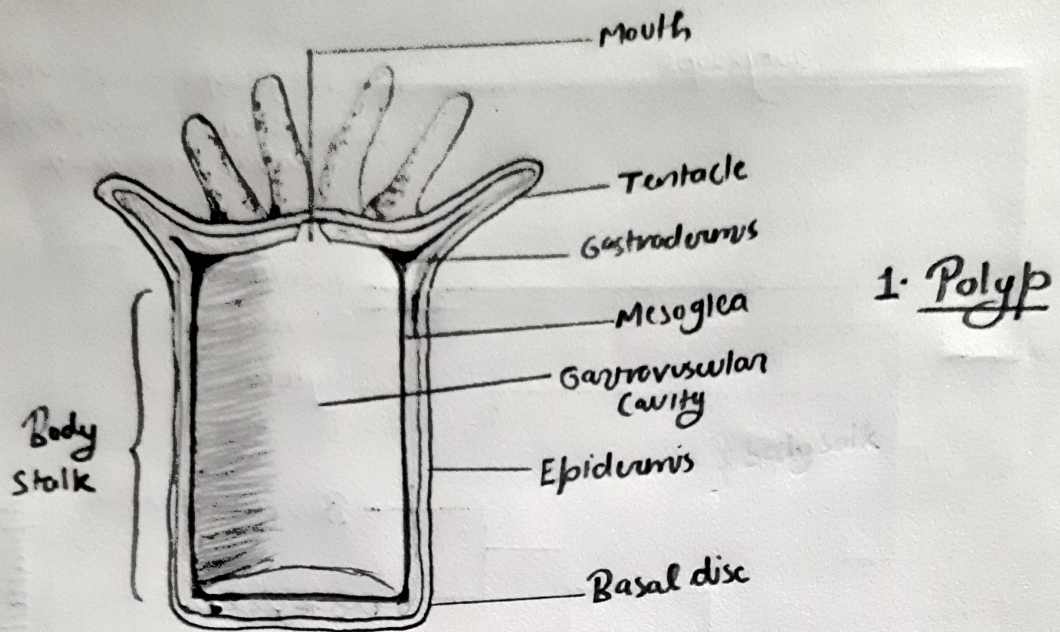
- Polymorphism in Cnidarians

To understand the polymorphism of Cnidaria, one need to know of two different forms: polyps & medusae which are free swimming & sessile respectively.

Both are radially symmetrical, like a wheel & a tube respectively. Since these animals have no heads, their ends are described as oral (near to mouth) & aboral (far from mouth). Most have fringes of tentacles equipped with cnidocytes around their edges, and medusae generally have an inner ring of tentacles around the mouth. Some hydroids may consist of colonies of zooids that serve different purposes such as defense, reproduction etc. The mesoglea of polyps is usually thin & often soft, but that of medusae is usually thick & springy, so that, it returns to its original shape after muscle around the edge have contracted to squeeze water out, enabling medusae to swim by sort of jet propulsion.

- A brief discussion on Colony formation in Cnidarians (Hydrozoans)

Coloniality is a prominent feature of most hydrozoan life cycles, & the emergence of coloniality represent a key event in their evolutionary history. Hydrozoan colonies consist of asexually generated polyps that remain interconnected through continuous epithelia.



2. Medusa

Fig1 Fig of polypoid & Medusoid forms

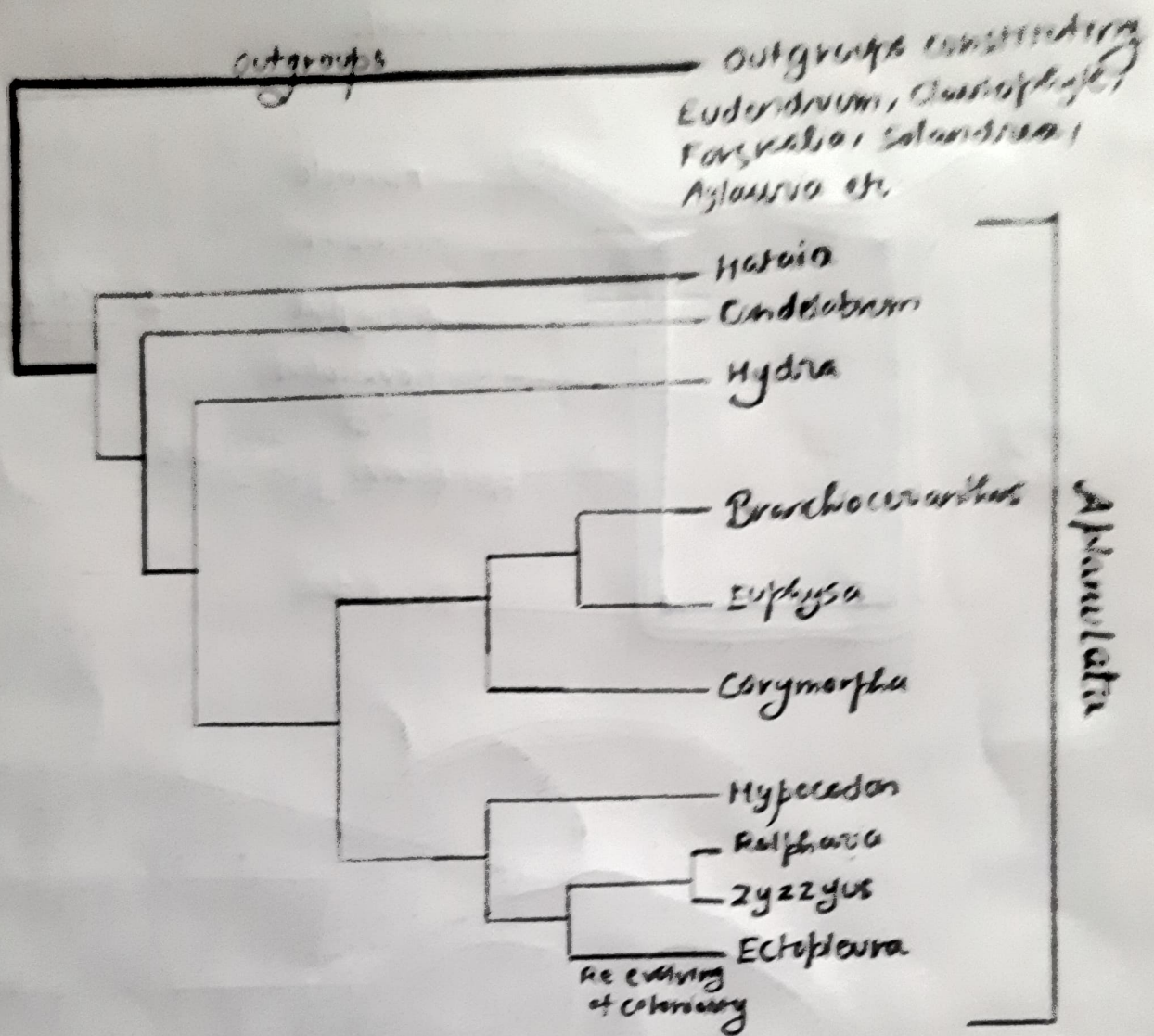


Fig2 Phylogenetic tree showing Clade Aplousobranchia which constitute of solitary hydroids where Ectopleura genus re-evolving coloniality

and a gastrovascular cavity. A typical hydrazoan life cycle consists of a free-swimming or crawling planula larva that metamorphoses into a benthic primary polyp. The primary polyp generates tube-like stolons from its base which buds new polyps & stolons. Upon maturity polyps either bud medusae that disperse in water columns & release gametes or produce gonophores (will be discussed later in text). Based on experimentation & research on the topic, it is found that Ectopleura genus, which displays a variety of colonial organization depending on species where, some form interconnected polyps & some on stolons. Further study concluded that ancestor of clade Aplousobranchia was solitary & coloniality re-evolved in genus Ectopleura. The phylogenetic reconstruction is mentioned in the accompanying figure on left.

→ The concept of zooids

A zooid is a single animal that's part of a colonial animal. This lifestyle has been adopted by animals from separate unrelated taxa. Zooids are multicellular. Their structure is similar to that of other solitary animals. The zooids can either be directly connected by tissue (eg. corals, Ctenophora, siphonophores, Pyrosoma or Ectoprocta) or share common exoskeleton (eg. Bryozoa or Pterobranchia). The colonial organism as a whole is called Zoon.

Zooids exhibit polymorphism, which will be discussed later. Fossil bryozoans are only known by colony structures that zooids formed during life.

Studies have been conducted which showed, a +ve

Correlation between size of zooids and temperature. This has been observed in colonies of same species across a geographic range. It is also found out that temperature is most important factor determining zooid size based on laboratory experiments while other factors like food availability, genotype, oxygen levels, growth rate & energetic allocation to reproduction appeared to have little influence in zooid size. So, variations in zooid size in fossils can be used as indicator of temperature and seasonality of seas in geological past.

Now let's discuss about Polymorphism in Cnidaria. The phenomena of polymorphism is mainly seen in class Hydrozoa. Coelenterates have two basic zooids, polyp & medusa. All other types of zooids are modification of these 2 zooids (basic forms discussed earlier). Cnidarians are known for their polymorphism.

The occurrence of more than one type of structurally & functionally different individuals within a population is called polymorphism. The class Hydrozoa of the phylum includes a large number of colonial species that constitute different zooids. In other words Polymorphism (Gr., Poly - many & Morphism - different varied forms) is occurrence of zooids of a single species during its life cycle / as members of the colony, the members perform different functions so that there is division of labour among the members.

• Patterns of Polymorphism

Degree of polymorphism varies greatly in different groups of Class Hydrozoa.

1. Dimorphic polymorphism

Many hydrozoan colonies like Tubularia, Campanularia etc, have only two types of zooids:

1. Gastrozooids / hydranths for feeding.
2. Gonozooids / blastostyles that bud off from gastrozooids form sexual medusae / gonophores. It's to be noted that, in dimorphic colonies, blastostyles are ~~not~~ present.

2. Trimorphic polymorphism

- Besides Gastrozooids & Gonozooids they also possess, a third type of individuals known as dactylozooids which are used for defense. These dactylozooids are polyps without mouth but with long basal tentacle.

3. Polymorphic polymorphism

Animals having more than three type of individuals are called polymorphic. Some what greater degree of polymorphism is found in encrusting colony of Hydractinia with 5 type of polyps performing their respective specialized function.

1. Gastrozooids for feeding.
2. Dactylozooids for defence.
3. Skeletozooids for protection as there are spiny chitinous projections.
4. Gonozooids that bud off gastrozooids & form sexual medusae.
5. Tentaculozooids for sensory functions.

As we know about two cnidarian forms - Polyp & Medusae, based on earlier discussion now we look at various zooids which are part of these forms mentioned.

1.) Polypoid Zooids

Various polypoid zooids are Gastrozooids, Dactylozooids & Gonozooids

1. Gastrozooids

These are polypoid forms that help in nutrition in the colony. A mouth is present at tip of ~~mouth~~ hypostome. Near the base of a gastrozooid, usually a single long contractile tentacle arises. It shows branches of nematocysts. The lateral branches are tentacles. Gastrozooids with aid of cnidoblast cells catch prey & digest it. The digested food is afterwards thrown to coenosarc canal. Further modifications of gastrozooids are seen which are mentioned below.

① Siphon

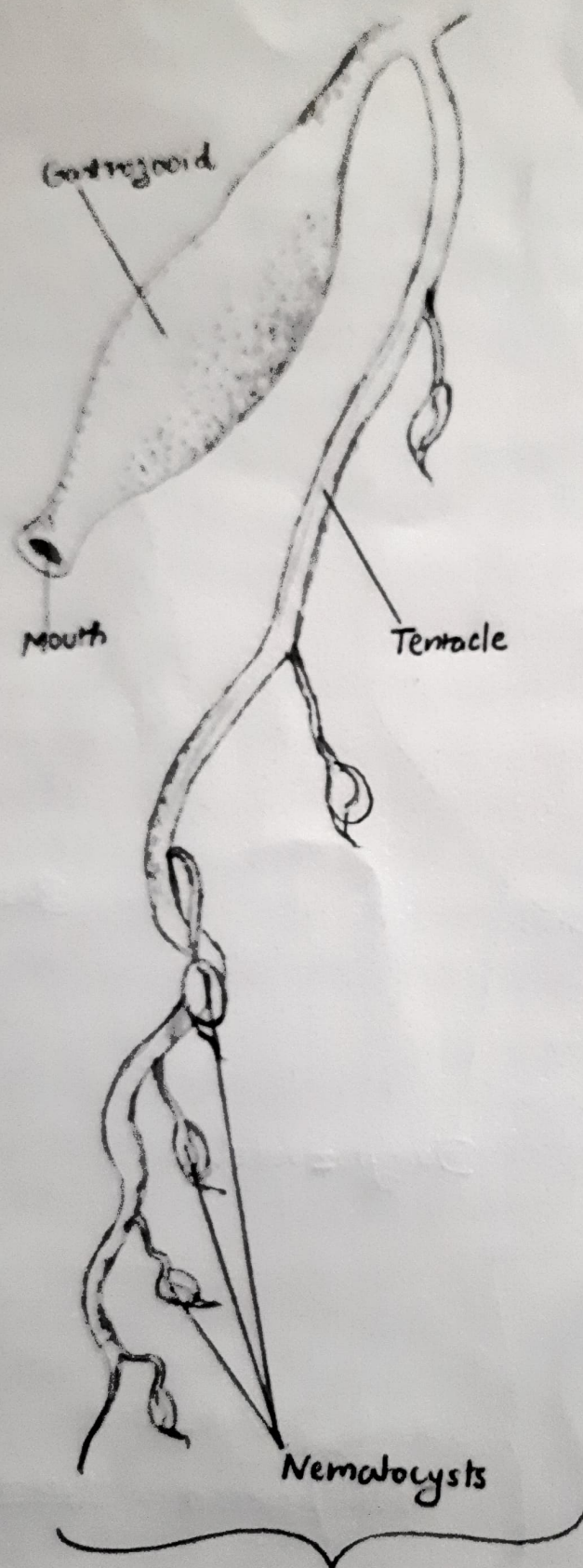
It is a polyp form without normal tentacles. Siphon is only member of colony which can digest food.

② Siphonozooid

They remain scattered or may be limited to rachis. Usually they are located on dorsal side of rachis in between the leaves.

③ Gastrozooids of *Millipora*

In *Millipora* many gastropores protrude out from the polyp. Each polyp with 4-6 tentacles and Cnidoblast buds.



Gastrozooid



Basal Tentacle

Dactylozoid



Spiral Dactylozoid
(Modification ~ Hydractinia)

2. Dactylozooids

They are called Palpons, feelers or tasters. They resemble gastrozooids. They don't show mouth. Their basal tentacle is unbranched. In Physalia, tentacle is very long. In Velella & Porpita the margin of the colony bears a long & hollow tentacles. These zooids are protective in function. They also bear branches of nematocysts. Dactylozooids exhibit structural variations, which are mentioned below:

① Tentaculozooids

These are defensive dactylozooids which are hollow & present at margin of the colony.

② Spiral zooids

These are tubular shaped with cnidocytes and adhesive cells. In Hydactinia, the spiral zooids (dactylozooids) with capitate tentacles remain scattered throughout the colony.

③ Nematophores/sarcastyles

These are usually with club / capitate ends, beset with nematocysts / adhesive cells or both.

④ Palpons

Palpons of Chondrophora constitute simple, hollow tentacle like bodies with spring from margin of body.

⑤ Cyston

In Siphonophora, a distal pore present in the dactylozooid is called cyston. Its excretory in function.

⑥ Dactylozooid of Millipora

Long, filamentous, mouthless dactylozooid with irregularly disposed tentacles.

3. Gonozooids

They are reproductive zooids with no mouth. In *Physalia*, gonozooid shows a branched stalk bearing clusters of gonophores (gonopalpon). Gonozooids produce medusae called gonophores. *Porpita* & *Velilla* are treated as gonodactylozooids.

Gonozooid typically has hardly any function than reproduction to a little more than motile gonad.

Gonozooids also show structural variations

- ① Gonosiphon
- ② Gonodendron

These are grape like clusters of gonozooids

- ③ Gonopalpon

Apart from the above mentioned zooids, some special types or forms of zooids are also present

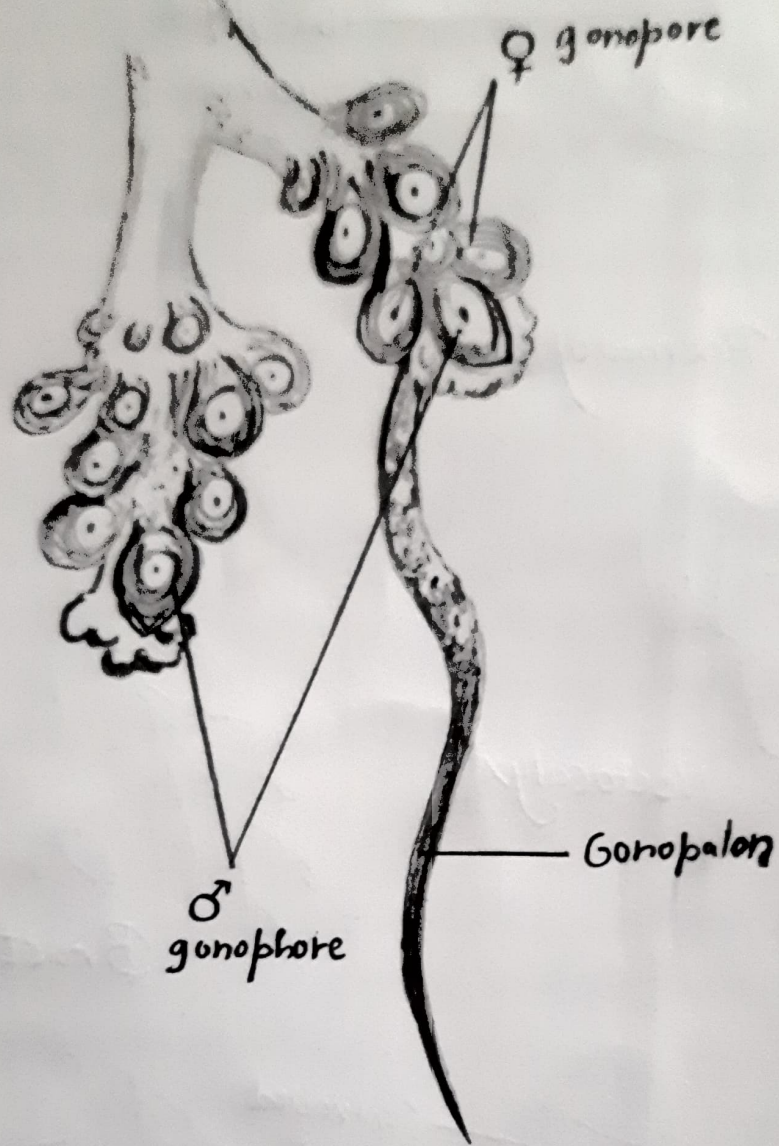
1. Gonostyles on secondary siphonozooids are gonads that remain attached to siphonozooids.
2. Hydrorhiza in *Obelia* acts as organ of attachment for whole colony.
3. Hydrocaulus arising from hydrorhiza bears different zooids & helps to convey the food particles to different parts of the colony.

2.) Medusoid zooids

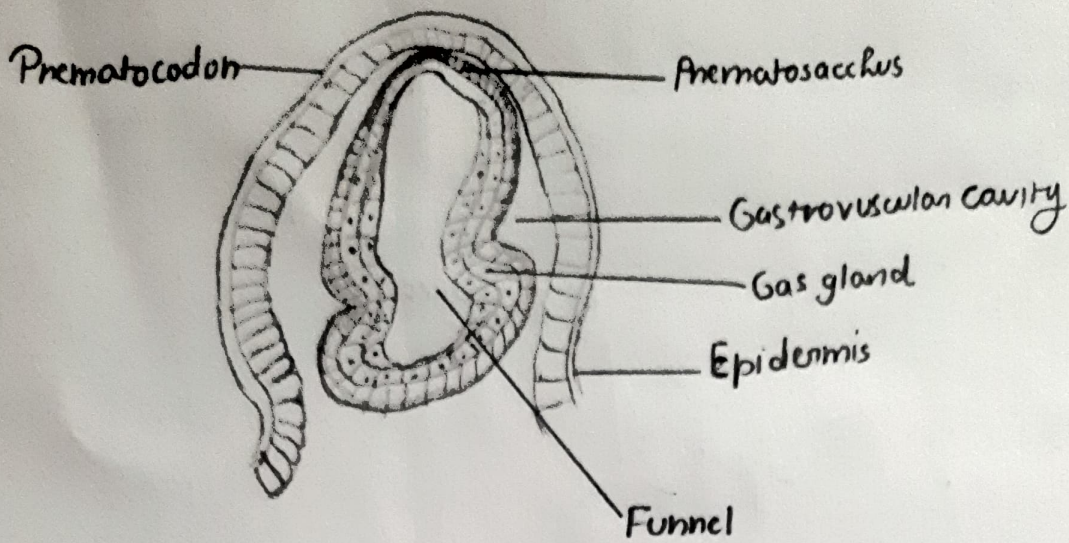
Various Medusoid zooids are pneumatophores, Nectophores, Bracts & Gonophores.

1. Pneumatophores

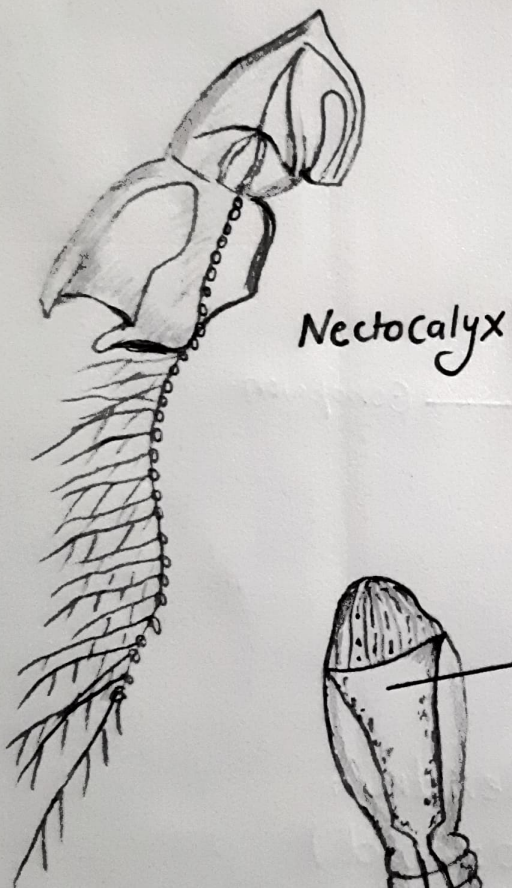
Pneumatophores functions as a float. It's an inverted medusian bell with muscular two layered



Gonodendron
(Gonozooid)



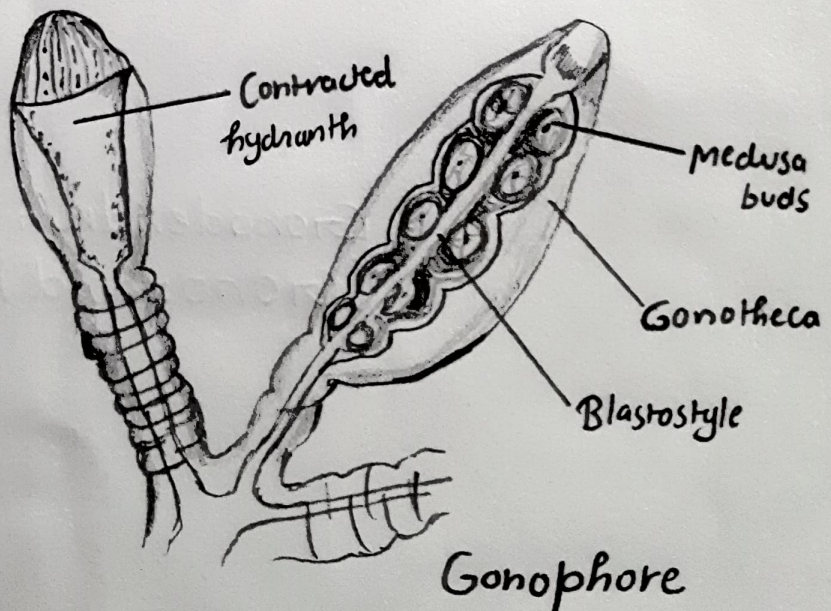
Prematopore



Nectocalyx



Bract



Gonophore

walls. The epidermal lining becomes glandular to form a gas gland. The gas gland secrete air to the gas gland containing air sac. It's small in *Halistemma*, and large in *Physalia* and disk shaped in *Porpita*. In *Agalma*, air sac is chitinous layer secreted by the Epidermis which is also funnel shaped thicker on funnel. The epidermis forms two layers and gas gland secrete gas.

2. Nectopore / Nectocalyx

It's the swimming bell medusoid form with a velum, radial canals & circular canal. No mouth, manbrum, tentacles or sensory organs are present. It's muscular & brings about locomotion of colony. It's also referred as nectophore or nectozooid.

3. Bracts

Also known as *Hydrophyllia*, bracts are leaf like, helmet shaped medusoid forms. They serve to protect & cover other zooids of colony.

4. Gonophores

Medusoid forms bearing gonads. ♂ gonads produce sperms & ♀ gonads produce ova for sexual reproduction in *Cnidarians*.

Some hydrazoans exhibit remarked development of polymorphism. Some of them are *Physalia*, *Halistemma* & *Porpita*.

Examples

1. Physalia

It is commonly called Portuguese man o war. Its free floating pelagic colonial form. This floating hydrazoon colony constitute 4 type of polyps.

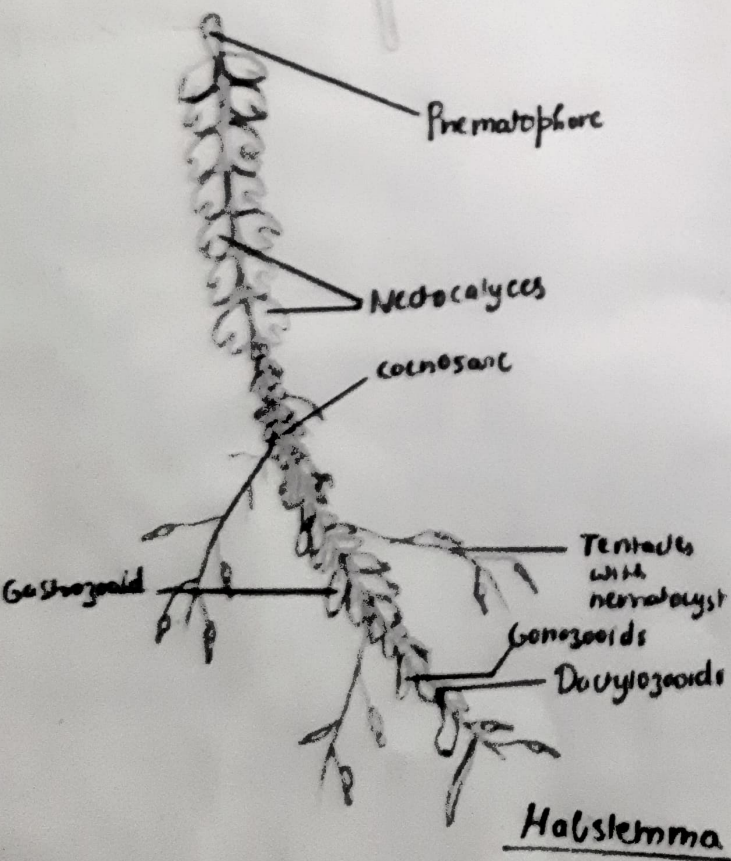
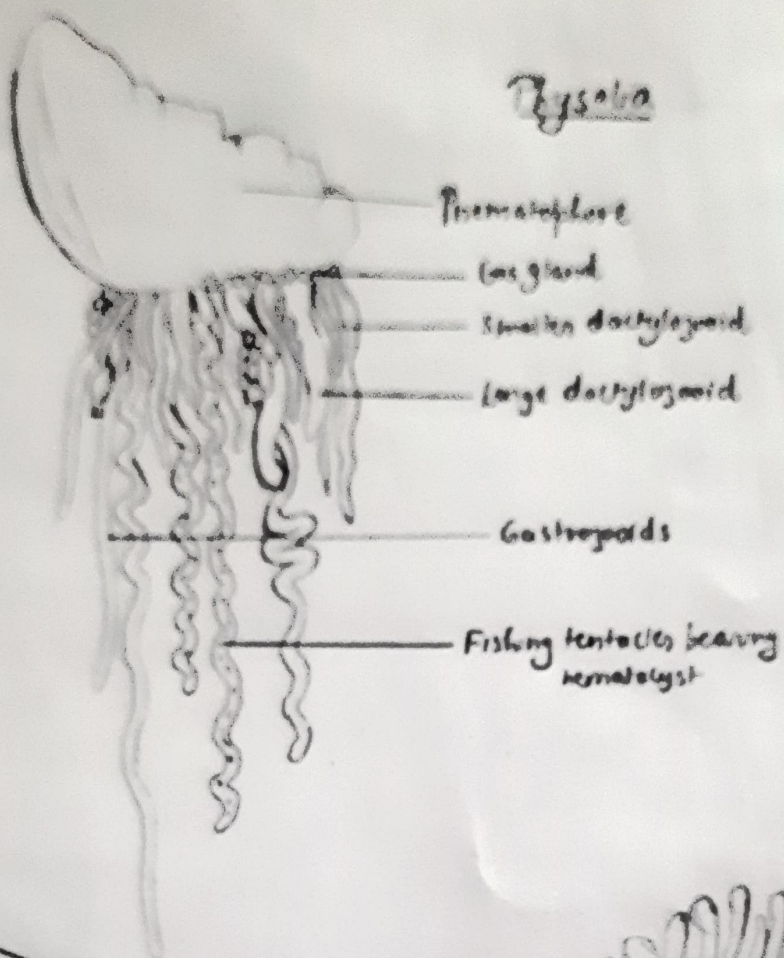
The prematophore functions as the float, dactylozooids as tentacles, gastrozooids for feeding & gonozooids produce gamete for reproduction. It has 2 type of stinging endocyte cells used to obtain food with tentacles. Sensory cells are numerous & located in epidermis of tentacles around the mouth. Movement of physalia is done passively with gas float.

2. Halimeda

This is a floating form with long thin peduncle having different zooid. Prematophore is at first anterior end of peduncle and helps the animal float on the surface of the water. The bottom of the float has asymmetric medusa, which are called nectocalyces which help in locomotion. Each nectocalyces is with nodes & bell shaped. Manubrium is absent.

3. Porpita

It is medusoid disc like large prematophore and chitinous shell with many concentric gas chambers. On the ventro-central region is a single large gastrozooid which is surrounded by clusters of small gonozooids which bear sexual medusae. On the edge of it tentacle like dactylozooid armed with nematocysts.



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 function among diversified individuals and their subsequent modification in cnidarians may have resulted from the initial simple organization & lack of organ specialization. Polymorphism gave the colonies competitive edge in protection & food gathering & eventual survival. Polymorphism: colonies of some species have morphologically differing individuals each specialized for certain roles eg. Feeding, reproduction & defense.

The concept of polymorphism has been a lot debated and various theories have been proposed in order to justify the origin of polymorphism which are,

1. Poly-organ theory: Theory proposed by Huxley (1859), Escholtz (1829), E. Metschnikoff & Muller (1871). According to this theory, a polymorphic colony is supposed to be single medusoid zooid, its various components are regarded to be modified organs of this medusoid zooid. The various parts of zooid, i.e. manubrium, tentacles etc. multiply independently from one another and they have assumed different forms to perform different functions.
2. Poly person theory: This theory was first proposed by Leuckart (1851), Vogt (1848), Gegenbaur (1854)

Kolbker (1853), Claus (1863) & later strongly supported by Huxel (1888), Balfour (1885) & 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 primitive zooid which was poly.
3. Medusoid theory: This theory was proposed by Haeckel (1888) as a compromise between the above theories. The theory says siphonophores formed from gastrula was medusoid individual from which zooids appear by budding from subumbrella.

All these theories laid the groundwork for understanding the diverse cnidarian forms in face of evolution of these wonderful forms.

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