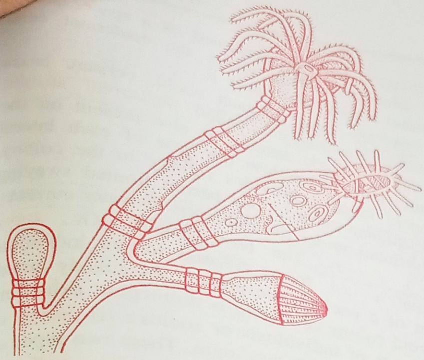
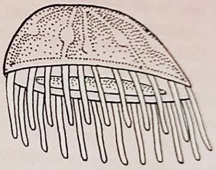


24

Obelia : A Sea-Fur

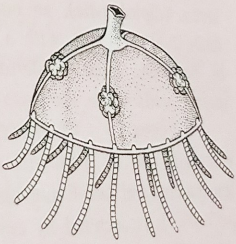
Unlike *Hydra,* which is a solitary freshwater polyp, most hydrozoans are colonial, strictly marine and having both polyp and medusa stages in their life histories. A typical example is *Obelia* which is a marine colonial hydrozoan of very small size. Its most common example is *Obelia geniculata.*

Obelia geniculata



SYSTEMATIC POSITION

Phylum	Coelenterata
Class	Hydrozoa
Order	Hydroida
Suborder	Leptomedusae
Family	Eucopidae
Genus	*Obelia*
Species	*geniculata*



HABITS AND HABITAT

Obelia is a typical sedentary, marine and colonial hydroid having cosmopolitan distribution. It is abundant in both Atlantic and Pacific coastal waters and found up to a depth of 80 meters. It occurs as asexual and sexual forms. The asexual form is a prominent branched **hydroid colony** found attached to rocks, stones, shells of animals, wooden piling, wharves and fronds of large seaweeds like *Laminaria*. It looks like a delicate, whitish or light brown, almost fur-like growth. The sexual form is an inconspicuous bell or an umbrella-like free-swimming stage, called **medusa**.

1. Hydroid Colony

[I] Morphology of Colony

1. External features. Hydroid colony of *Obelia* is delicate, semitransparent, and whitish or light brown in colour. It consists of vertical branching stems, called **hydrocauli** (singular, **hydrocaulus**), rising 2 to 3 cm. above a root-like **stolon** or **hydrorhiza**. Both are of the thickness of an ordinary sewing thread. Growth of the colony is sympodial.

Each vertical stem or hydrocaulus branches are in an alternate manner. Lateral branches may sometimes give rise to the branches of third order. Each ultimate branch terminates in a nutritive zooid, the **polyp** or **hydranth**. In the axils of older polyps are placed cylindrical reproductive zooids, the **blastostyles** or **gonangia**. Thus *Obelia* colony is **dimorphic** (Gr., **dis**, two + **morphe**, form), exhibiting two types of zooids. When blastostyles develop saucer-shaped bodies, called **medusae**, the colony becomes **trimorphic**.

2. Coenosarc. Branches and zooids of colony consists of an inner, tubular and living portion, the **coenosarc**. It consists of a cellular wall enclosing a canal, the **coenosarcal** or **gastrovascular cavity**, which is continuous with those of zooids. The cellular wall consists of two layers (diploblastic), an outer **epidermis** and an inner **gastrodermis**, with a gelatinous mesogloea in between. Both epidermis and gastrodermis include cells as in the case of *Hydra*.

3. Perisarc. Coenosarc is surrounded externally by a yellowish or brown, tough, transparent, and non-living chitinous layer, called **perisarc**. It is secreted by epidermis on its outer side. It protects the colony and serves as a supporting exoskeleton. In young colony, perisarc is in close contact with coenosarc; but in older colony, it becomes separated by a space, except at occasional spots where the epidermal cells extend outwards to meet it.

At the base of each zooid, perisarc bears annular constrictions, called **perisarcal annuli**. Usually a single annulus is also present on the main stem, just below the base of each lateral branch. Perisarc provides rigidity to the colony, but annular constrictions permit limited swaying movements under the influence of water currents.

4. Zooids. The term 'zooid' (Gr., **zoon**, animal + **oid**, form) is used for an individual form of a coelenterate colony. As already noted, hydroid colony of *Obelia* is **dimorphic**, exhibiting two types of individuals or zooids : (i) **polyps** or **hydranths** and (ii) **gonangia**. These two types of zooids differ morphologically as well as physiologically.

(a) Polyp or Hydranth. Polyp (Gr., **polypus**, many-footed) or hydranth (Gr., ***hydra***, water serpent + **anthos**, flower) is the nutritive zooid of colony. A nutritive zooid is also called a **gastrozooid** or **trophozooid**. It is yellowish in colour and has the form of a radially symmetrical and cylindrical or conical hollow sac resembling a miniature *Hydra*. Its narrow proximal end is continuous with coenosarc of hydrocaulus. Its distal end is produced into a conical elevation, the **manubrium** or **hypostome**, which measures about one-third of the total length of hydranth. Hypostome bears a terminal aperture, the **mouth**, which is capable of dilation and contraction. Rising from the base of hypostome is a circlet of upto 30 filiform tentacles which are much longer than hypostome. Tentacles of *Obelia* are solid, unlike those of *Hydra*, which remain hollow.

Perisarc, surrounding the hydranth, dilates to form a loose, cup-like, transparent protective sheath, the **hydrotheca**. It remains open at th distal end. At the base, it is produced internall into a ring-like horizontal **shelf** on which res the base of hydranth. As hydranth is capable contraction through the distal open end hydrotheca, the horizontal shelf checks it fr being withdrawn into the perisarc of hydroca from where it may not be protruded again.

(b) Blastostyle or gonangium. W hydrocaulus has reached full developmer

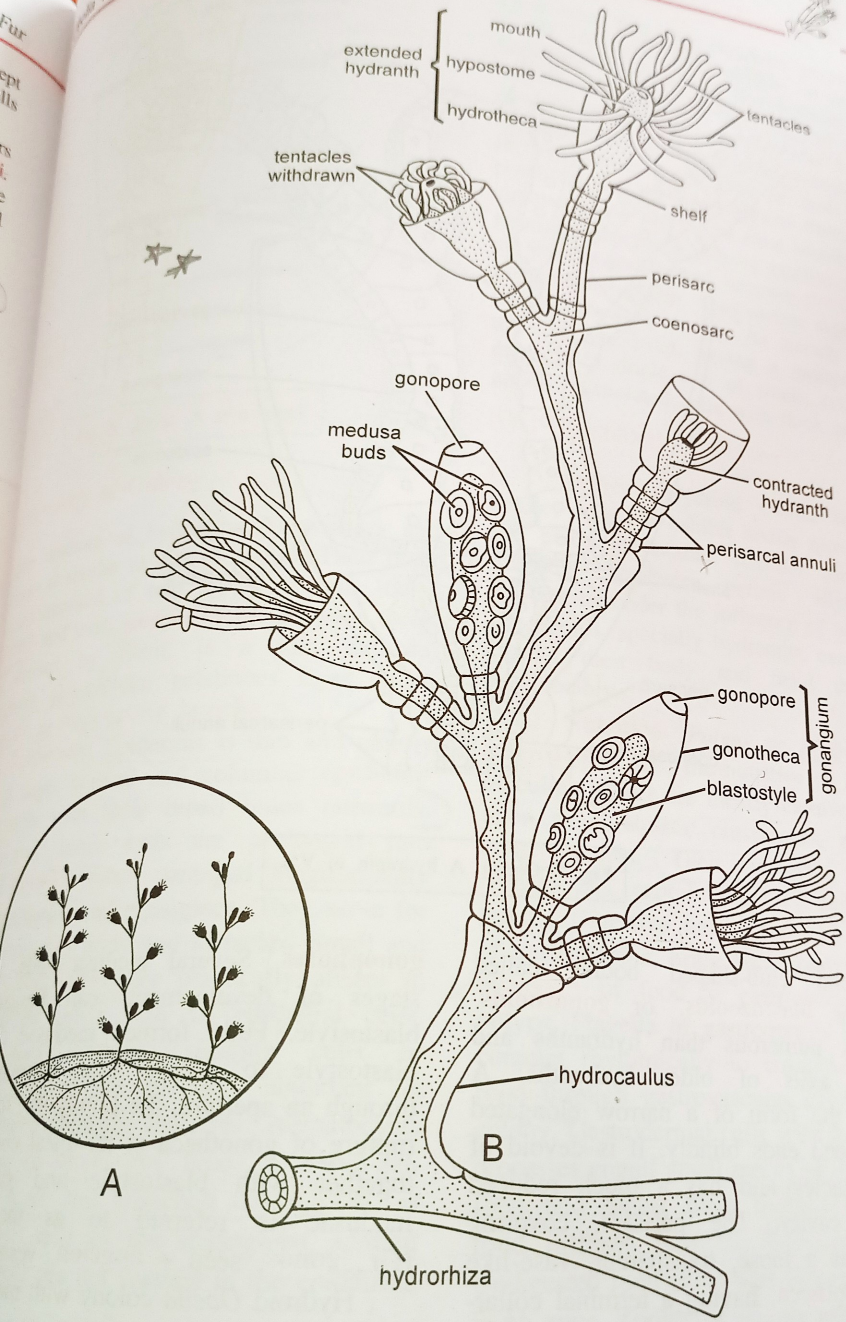


Fig. 1. *Obelia.* **A.** Natural size of colony. **B.** A part of colony under microscope.

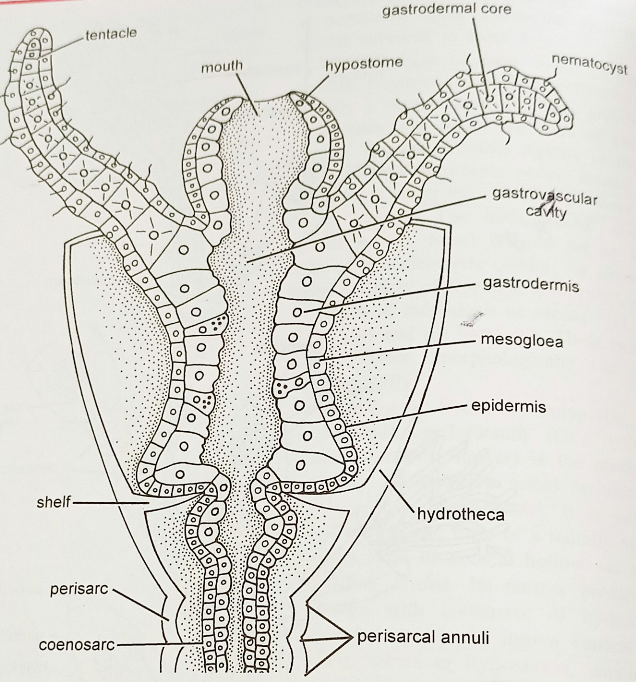


Fig. 2. *Obelia.* A hydranth in V.S.

produces special club-shaped bodies called **blastostyles**, or **blastozooids**, or **gonozooids**. These are less numerous than hydranths and occur in the axils of older hydranths. A blastostyle has the form of a narrow elongated tube. Its distal end ends blindly. It is devoid of mouth and tentacles and has a much reduced gastro-vascular cavity. The perisarc, covering blastostyle, forms a loose, transparent, vase-like capsule, the **gonotheca**, having a terminal collar-like constriction.

The blastostyle, by lateral asexual budding, produces sexual individuals, called **medusae** or **gonophores**. Several medusa buds, in various stages of development, can be seen on a blastostyle. Fully formed medusae detach from blastostyle to escape into surrounding water through an aperture, the **gonopore**, formed by the rupture of gonotheca at its distal end. Gonotheca together with blastostyle and gonophores or medusae is referred to as the **gonangium** (Gr., **gonos**, seed + **angeion**, vessel) (Fig. 3).

Hydroid *Obelia* colony with medusae becomes **trimorphic**, *i.e.*, it bears three types of zooids, namely **hydranths** (gastrozooids), **blastostyles** (gonozooids) and **medusae** (gonophores).

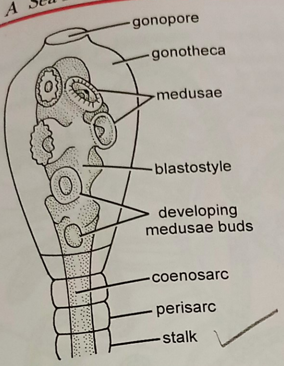


Fig. 3. *Obelia.* A gonangium.

[II] Histology of Colony

Cellular structure of hydranths, blastostyles and coenosarc is similar to that of *Hydra*. Their body wall is composed of two layers of cells, outer **epidermis** and inner **gastrodermis**. Between them, and secreted by them, is a thin delicate, transparent, non-cellular gelatinous layer called **mesogloea** or **supporting lamella**.

1. Epidermis. Epidermis is thin and chiefly made of large, conical and columnar **epithelio-muscle** cells with their broad bases outwards. Their narrow inner ends are prolonged into unstriped **muscle fibres**, arranged longitudinally between epidermis and mesogloea. They serve for rapid shortening of body and tentacles. Small and round **interstitial cells** are practically absent in spaces between inner ends of epithelial cells. Epidermis also contains stinging cells or **nematocysts**, which are specially abundant on tentacles forming annular batteries. Nematocysts of *Obelia* are of **penetrant** type. A nerve-net, composed of large and branched **nerve cells**, is present on each side of the mesogloea. Unlike *Hydra*, germ cells are not formed in the epidermis of polyps.

2. Gastrodermis. Gastrodermis lines the gastrovascular cavity throughout colony. It consists chiefly of large columnar **nutritive-muscle cells**. Their inner free ends can form pseudopodia to engulf and digest food particles, as in *Amoeba*. Sometimes, pseudopodia are replaced by long flagella, which bring about a constant movement of food-particles in gastrovascular cavity and circulation of digested food in coenosarcal canal. In hypostome, outer ends of these cells are produced into unstriped muscle fibres, arranged circularly, and serving to close mouth or reduce gastrovascular cavity. Among nutritive-muscle cells are present smaller and narrower **gland cells** with granular protoplasm. They secrete digestive juices in gastrovascular cavity. As already mentioned, tentacles are solid, having a gastrodermal core made of a single row of small, cylindrical and greatly vacuolated cells with thick cell-walls.

[III] Physiology of Colony

1. Movement. Hydroid *Obelia* colony, being sessile, does not exhibit bodily movements from one place to another. Annular constrictions of perisarc, however, permit slight swaying movements under the influence of water currents. The zooids, specially hydranths, can contract and expand their body and bend their tentacles considerably.

2. Nutrition. *Polyps* or *Hydranths* are the **gastrozooids**, *i.e.*, the nutritive or feeding zooids of colony. They are mostly carnivorous and prey upon small aquatic crustaceans, nematodes and other worms. Their tentacles, armed with nematocysts, capture the prey and transfer it to mouth. Digestive juices, secreted by gland cells of gastrodermis, bring about partial **extracellular digestion** of food in gastrovascular transfer of polyps. Flagella of gastrodermis beat and polyps contract rhythmically to circulate partly-digeste food through gastrovascular cavity of the enti colony. Gastrodermal cells with their pseudopod processes engulf small pieces of the partly diges food and digest them **intracellularly**. Dige food diffuses into the cells of entire col Undigested food is **egested** through mouth as is no anus. Zooids of colony exhibit a grea of **physiological coordination** as food ca by polyps is shared by the entire colony, in blastostyles.

3. Respiration and excretion. There are no special organs of respiration and excretion. Oxygen from surrounding water diffuses directly into cells and carbon dioxide and nitrogenous excretory products (chiefly ammonia) diffuse out. Water regularly enters the gastrovascular cavity of colony through mouths of polyps, thus establishing direct contact with the gastrodermal cells to facilitate the exchange of materials.

4. Asexual reproduction. *Obelia* colony does not reproduce sexually, but it propagates by the asexual method of **budding**. Horizontal roots or hydrorhizae sprout new vertical stems or hydrocauli which increase the number of individuals by budding. Blastostyles are specialized reproductive zooids forming medusae by budding. A special mode of asexual reproduction may occur, when water temperature exceeds 20°C. In this case, buds destined to form gonangia break off, settle on substratum and each gives rise to a new colony by stolon-like growth.

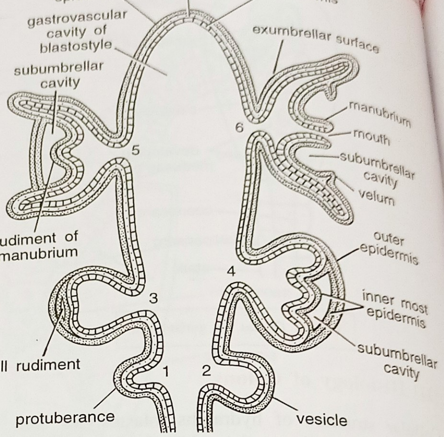


Fig. 4. *Obelia*, Blastostyle in V.S. showing various stages (1 to 6) of development of a medusa.

2. Medusa

Medusae are modified zooids meant for sexual reproduction. They arise from blastostyles by a process of asexual budding.

[I] Development of Medusa

In spring and summer, a large number of medusa buds, in various stages of development, can be seen on a blastostyle (Fig. 4). Medusa-formation begins as a small **outpushing** or hollow **protuberance** on the wall of blastostyle. It soon enlarges into a **vesicle**, connected with blastostyle by a narrow stalk. Its cavity is continuous with that of blastostyle and its wall has same cellular layers as blastostyle, *i.e.*, outer epidermis, inner gastrodermis and an intermediate mesogloea. Apical epidermis of vesicle now splits into two layers. Inner layer again splits and acquires a small cavity called **bell-rudiment**. Innermost epidermis and gastrodermis now evaginate to form the prospective **manubrium**, projecting into bell rudiment which subsequently enlarges to become **sub-umbrellar cavity**. It is lined throughout by epidermis and closed externally by two layers of outer epidermis, running from one margin of umbrella to other. As manubrium elongates the outer epidermis is broken through, leaving a narrow circular shelf, called **velum**, which projects inwards from the margin of umbrella. Velum is permanent and conspicuous in most hydroid medusae, but it diminishes to become vestigial in *Obelia*. Later, the **mouth** opens at the apex of manubrium, **tentacles** arise as finger-like hollow outgrowths from circumference of umbrella and finally the stalk connecting the medusa bud with blastostyle breaks. The young medusa, now fully formed, is free and it escapes through **gonopore** of **gonangium** to lead a free-swimming existence. In a few months it grows to full size.

[II] Morphology of Medusa

1. Shape and size. A full grown medusa of *Obelia* is like a radially symmetrical tiny umbrella, bell or shallow saucer, measuring 1 or 2 mm in diameter. Outer convex surface of the umbrella is known as **ex-umbrella**, while inner concave surface as **sub-umbrella**. Sub-umbrellar surface shows four **radial canals** and a **circular canal**

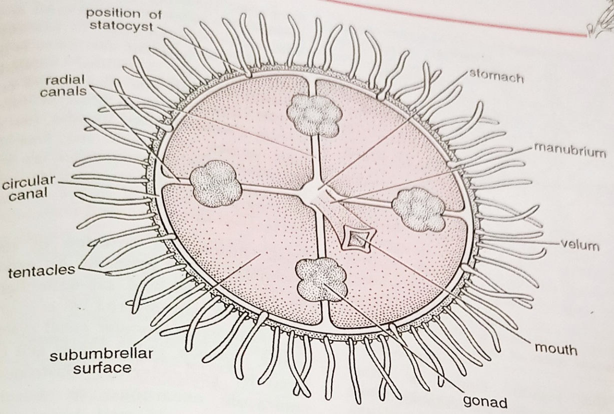


Fig. 5. *Obelia*. A medusa in oral view.

of gastrovascular system. A mature medusa bears four **gonads**, one in the middle of each radial canal.

2. Manubrium. From the centre of concave sub-umbrellar surface hangs down a short, hollow, handle-shaped process, the **manubrium** (L., **manus**, handle), bearing at its free distal end a four-sided **mouth** surrounded by four **oral lobes**. Handle-like manubrium and circular bell together make the medusa appear like a complete umbrella.

3. Velum. Circular edge of umbrella is produced inwards into a very narrow, rudimentary fold or shelf, called **velum** (L., **veil**). It is quite prominent in other hydrozoan medusae, but is insignificant in *Obelia* medusae.

4. Tentacles. Rim or margin of umbrella also bears numerous short **tentacles**. These are highly contractile and beset with nematocysts. Their bases are somewhat swollen to form **tentacular bulbs** that may lodge the sense organs **statocysts** and serve as sites for nematocyst-formation. A freshly budded medusa bears only 16 tentacles, the number of which gradually increases with age. Medusa derives its name due to presence of tentacles which remind of snake-entwined hair of 'Medusa', the female monster of Greek mythology.

5. Gastrovascular cavity. The rectangular **mouth** leads into a narrow passage running through the manubrium, called **gullet**. It is followed by a dilated **stomach** lying at the base of manubrium and occupying the central part of umbrella. Four narrow **radial canals** extend from stomach to the margin of umbrella. Radial canals run equidistant and at right angles to each other. They open into a **circular canal** or **ring canal**, running close and parallel to the free margin of umbrella. Manubrium, stomach and canals are lined by gastrodermis.

6. Nervous system. Nervous system is essentially like that of *Hydra*. On each side of mesogloea, nerve cells belonging to epidermis as well as gastrodermis, form nerve nets. Nerve cells are especially concentrated along the margin of bell forming two **circular nerve rings**, one just above and other just below the base of velum. Formation of nerve rings along the bell margin is correlated with the concentration of muscle-tails (muscle ring) and presence of sense organs

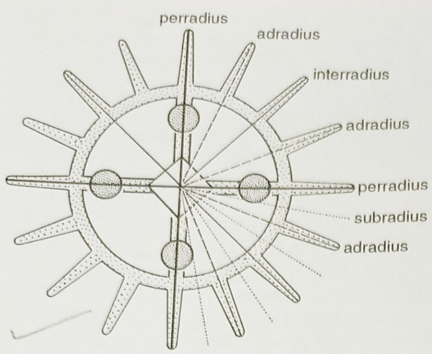


Fig. 6. *Obelia.* A young medusa showing radial symmetry and various orders of radii.

(statocysts) in this region. Upper or inner ex-umbrellar nerve ring supplies the tentacles while lower or outer nerve ring supplies the sub-umbrellar musculature and statocysts.

7. Radial symmetry and radii. Like polyp, medusa is radially symmetrical so that the position of tentacles and other body parts can be shown with reference to particular radii of the bell.

Four radial canals mark out the four principal radii, called **perradii**. Tentacles placed against the four radial canals are thus termed **perradial** **tentacles**. Bisecting the angle between any two perradii is a radius of second order or **interradius** with an **interradial tentacle**. Midway between a perradius and adjacent interradius is the radius of third order or **adradius**. Similarly, midway between adradius and adjacent per or inter-radius is the radius of fourth order or **subradius**.

In a newly budded medusa, four radial canals, four angles of mouth and four tentacles are perradial, four other tentacles are interradial and the remaining eight tentacles are adradial.

[III] Histology of Medusa

Basic histological structure of medusa closely resembles that of hydranth. All exposed parts, that is, ex-umbrellar and sub-umbrellar surfaces and manubrium, are covered by **epidermis**. Similarly, the entire gastrovascular canal system, comprising gullet, stomach, radial canals and circular canal is lined by **gastrodermis**. Gastrodermal cells lack contractile extensions, so muscular system is restricted to epidermal layer only. It is better developed than in *Hydra*. Both epidermis and gastrodermis are continuous along the margin of mouth. Gelatinous **mesogloea**, lying between epidermis and gastrodermis is much thickened, particularly towards ex-umbrella, forming the main bulk of body. It is demarcated from the epidermis and gastrodermis by a thin layer of jelly.

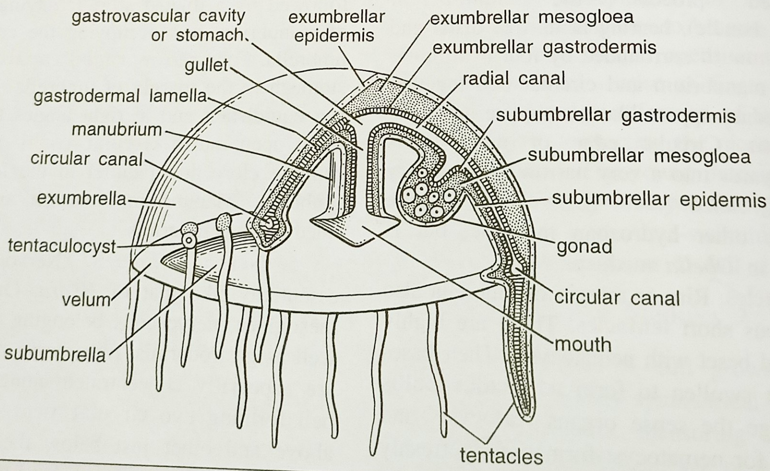


Fig. 7. *Obelia.* A medusa partly cut away to show internal structures and relations of parts.

Mesogloea consists of about 95% water. It is devoid of cells but contains fibre that are secreted by both epidermis and gastrodermis.

Interstitial cells are mainly accumulated at the swollen bases of tentacles and give rise to **cnidoblasts** which are particularly abundant on margin of umbrella, on tentacles and around mouth. **Sensory cells** are most abundant around mouth and tentacles.

Inside the bell, between radial canals and between ex-umbrellar and sub-umbrellar layers of epidermis, there is a thin sheet of gastrodermis, called **gastrodermal lamella**. It is presumbly formed by the fusion of upper and lower layers of gastrodermis. Velum is composed of a double layer of epidermal cells enclosing a middle narrow layer of mesogloea, there being no gastrodermis. This type of velum is called **true velum**. Tentacles are solid, each containing a core of vacuolated gastrodermal cells covered by epidermis.

[IV] Physiology of Medusa

1. **Movement.** Unlike sedentary hydroid colony, medusa usually floats passively in water. It is simply drifted here and there by water currents with manubrium hanging downward and tentacles swaying freely. It also swims actively by muscular contractions started by impulses which originates in the nerve at the umbrellar margin. By rhythmic contraction and expansion of bell, the water in sub-umbrellar cavity is propelled behind (**hydropropulsion**), and medusa moves forward in a series of jerks. Closure of bell is effected by contraction of epidermal muscle-tails that are best developed on sub-umbrellar surface, specially along the margin of bell, where they form a muscle ring, but remain undeveloped on exumbrellar surface. Opening of bell is brought about mainly by the elastic mesogloea regaining its original shape and to some extent due to contraction of muscle tails in the middle of upper surface. During swimming, body may be tilted, thrown aside, or more commonly turned inside out, so that the sub-umbrellar surface becomes outer and convex, with the manubrium springing up from its apex.

2. **Nutrition.** Medusa is strictly carnivorous. Food includes minute worms, nematodes, insects, crustaceans, etc. These are captured by nematocyst-bearing tentacles and ingested by the highly contractile mouth. Prey is digested exclusively in stomach. Digestion is both extracellular and intracellular like that of hydranth. Digested food is distributed to entire medusa through the system of radial and circular canals.

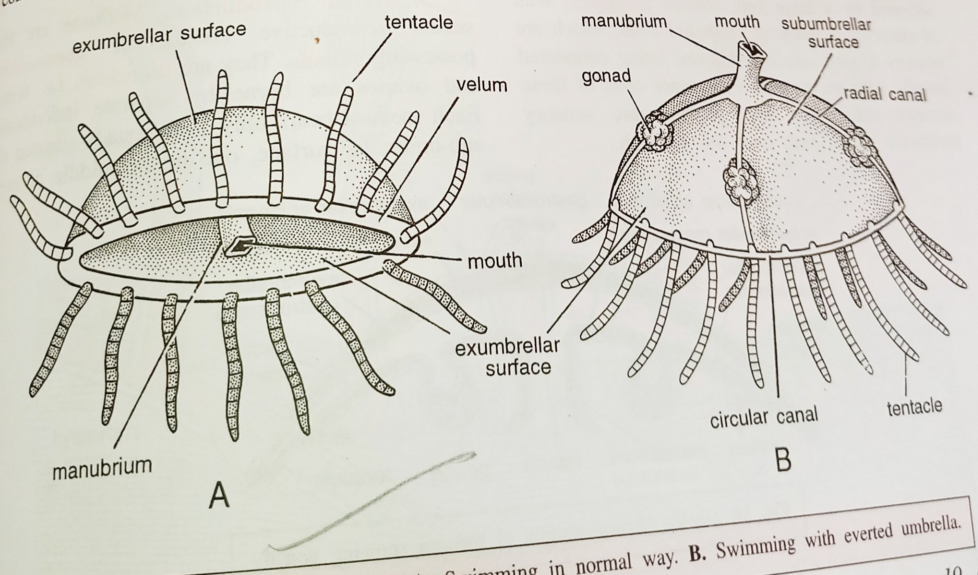


Fig. 8. *Obelia*. A swimming medusa. **A.** Swimming in normal way. **B.** Swimming with everted umbrella.

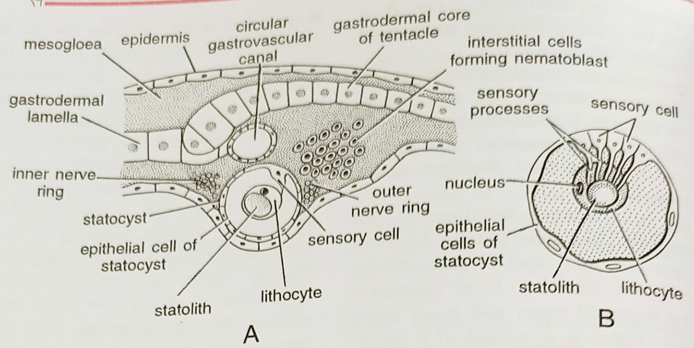


Fig. 9. *Obelia.* **A.** Base of an adradial tentacle in L.S. showing statocyst. **B.** Statocyst magnified.

3. Respiration and excretion. Respiration and excretion are carried on individually by each cell by diffusion, as in hydranth, and special organs are absent.

4. Statocysts and equilibrium. Medusa has eight marginal receptor organs or **statocysts**, situated at the bases of eight adradial tentacles on sub-umbrellar surface, just inside the bell-margin. Each consists of a minute fluid-filled ectodermal sac. Its cavity contains a movable round particle of calcium carbonate, called **statolith** or **otolith**, secreted by a large cell, termed **lithocyte**. Wall of statocyst is made of epithelial cells, which are sensory towards the bell-margin, being connected basally with nerve cells. Free inner ends of these sensory cells bear fine protoplasmic sensory processes which arch over the statolith.

Statocysts are considered to be the organs of **equilibrium** and muscular **coordination**. Their presence in medusae is associated with their active free-swimming habit. During swimming if body becomes tilted, the statolith falls over the tilted side against the processes of sensory cells which become stimulated. In this way, nerve impulse is created and transmitted to the nerve ring. As a result, the muscle tails of the stimulated side contract more rapidly and medusa is brought back to its normal horizontal position.

5. Sexual reproduction. Medusae are the sexual reproductive zooids, or **gonozooids**, possessing **gonads**. They are **dioecious**, *i.e.*, testes and ovaries are borne by separate individuals. Each medusa bears only four gonads situated on sub-umbrellar surface, one in the middle of each

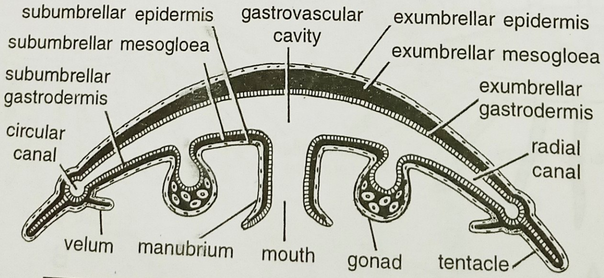


Fig. 10. *Obelia.* Vertical section of medusa showing gonads.

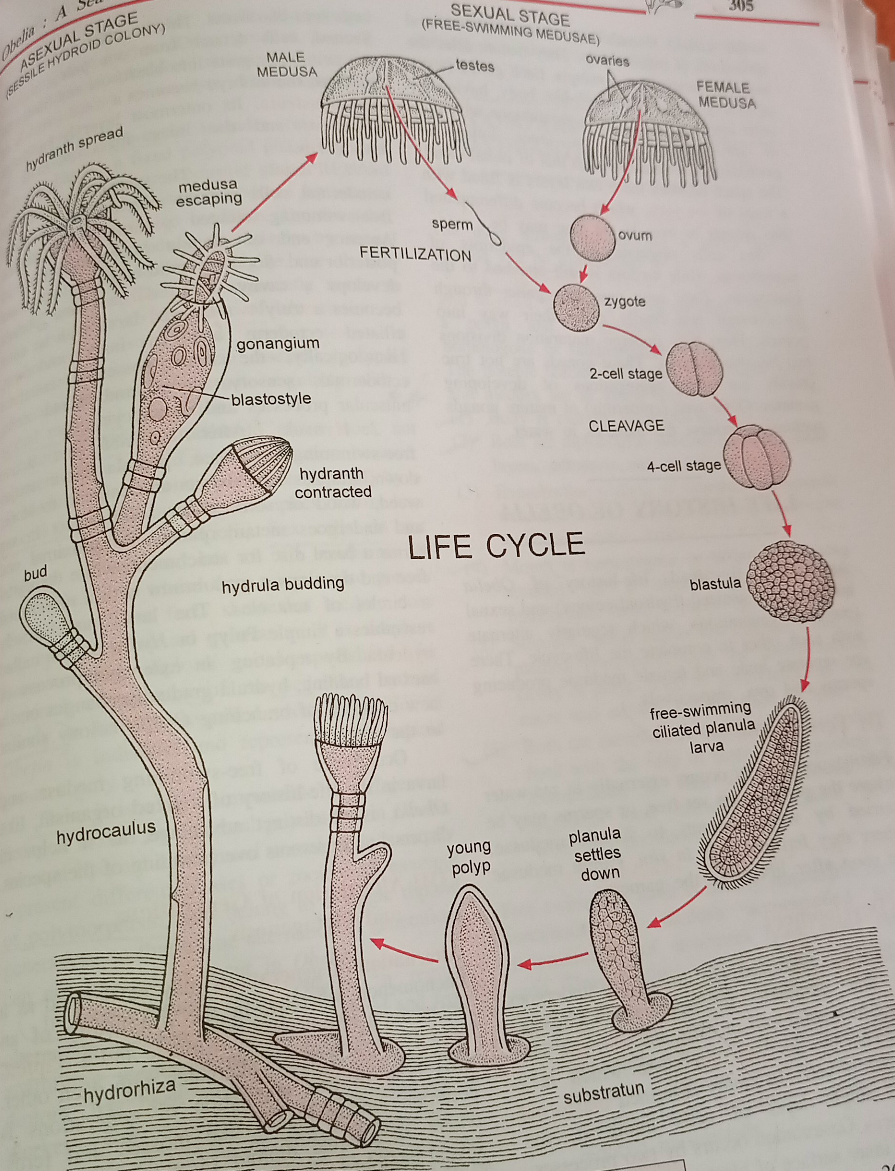


Fig. 11. Stages in the life cycle of *Obelia.*

radial canal. Gonads are formed as ventral diverticula of radial canals. They mature after the medusae escape from gonangia. Each gonad (testis or ovary) is an ovoid, knob-like body, having an outer covering of epidermis, continuous with that of sub-umbrella, and an inner lining of gastrodermis, continuous with that of radial canal. The space between these two layers is filled with a mass of **sex cells**, which become differentiated into sperms or ova, as the case may be.

Sex cells originate in the epidermis of manubrium, while medusa is still attached to the blastostyle. They soon pass into gullet through gastrodermis and finally make their way into gonads. Here they undergo maturation divisions and become gametes. These gonads are not true gonads but only aggregations of developing gametes. Outer wall (epidermis) of mature gonads ruptures to release the gametes in water.

LIFE HISTORY OF *OBELIA*

As already described, life-history of *Obelia* includes both asexual (hydroid colony) and sexual (medusa) generations, which regularly alternate with each other to complete the life-cycle. There are separate male and female medusae producing sperms and ova, respectively.

[I] Fertilization

Fertilization usually occurs externally in sea-water where the gametes are set free, or sperms may be carried by water currents to female medusae, where they fertilize eggs *in situ*. Parent medusae die soon after liberating the gametes.

[II] Development

1. **Cleavage.** Fertilized egg or **zygote** undergoes equal and complete or holoblastic cleavage resulting in a solid ball of cells, the **morula**. This is followed by the **blastula** stage which is a hollow ball of cells. Its cavity is termed **blastocoel** and the single layer of cells lining it, the **blastomeres**. Gastrulation occurs by two processes. First, the inner surface of blastomeres cut off new cells into blastocoel. This is called **delamination**. Second, cells detatch from one pole (**unipolar ingression**), migrate into blastocoel and finally fill it. Thus, the embryo becomes a **solid gastrula** or **stereogastrula**. Its outermost layer is known as **ectoderm** and the inner mass of cells as **endoderm**.

2. **Planula larva.** The gastrula elongates, the ectodermal cells acquire cilia and an elongated free-swimming ciliated **planula larva** results. Anterior end of planula is broader than its posterior end. Soon the solid endoderm splits and develops a cavity, the **enteron**. Now planula becomes a truly **two-layered** larva with an outer ciliated ectoderm and an inner endoderm. Histologically, the larva possesses columnar ectodermal, sensory, nerve and gland cells, muscular processes and nematocysts.

3. **Hydrula.** After a brief and active free-swimming existence, planula larva settles down, attaches itself by its anterior end to stone, weed, wood or some other solid object in sea and undergoes metamorphosis. Its proximal end forms a basal disc for attachment, while the distal free end develops a manubrium with a mouth and a circlet of tentacles. The larva now closely resembles a simple Polyp or *Hydra* and is called **hydrula**. By repeating an extensive process of asexual budding, hydrula gradually changes into a new complex of branching *Obelia* colony similar to the parent.

Occurrence of free-swimming medusa and larva in the life-history of a fixed organism, like *Obelia*, is of distinct advantage, as it helps in dispersal and prevents overcrowding of the species.

[III] Alternation of Generations and Metagenesis

Alternation of generations may be defined as a phenomenon whereby, in the life-history of an organism, a **diploid asexual phase** and a **haploid sexual phase** regularly alternates with each other. This type of true alternation of generations is common among plants, like mosses and ferns where an asexual diploid (**saprophytic**) and a sexual haploid (**gametophytic**) generation alternate regularly in life-cycle. In fern, the plant (**diploid saprophyte**) produces **haploid spores**, which develop into flat, green, small heart-shaped **haploid gametophytes**. These produce **haploid ova and sperms**. After fertilization, they give rise to a new **diploid sporophyte**. Thus completing one life-cycle.

In *Obelia*, life-cycle includes two clearly defined phases : a fixed polypoid phase (hydroid colony) and a pelagic medusoid phase. Hydroid colony has no gonads and reproduces by asexual budding to give rise to medusae. On the other hand, medusae reproduce exclusively by sexual method (ova and sperms) to give rise to new hydroid colonies. This fact apparently seems to have given rise to the idea of **alternation of generations**, also called **metagenesis**, in coelenterates, in which an asexual polypoid generation appears to alternate regularly with a sexual medusoid generation.

But, in *Obelia*, medusoid phase does not represent a true haploid sexual generation, because: (i) Medusa arises from blastostyle (diploid) by a process of asexual budding. It implies that medusa too is a diploid zooid. (ii) Sex cells do not originate in medusa, but in the epidermis of blastostyle, from where they migrate into gonads of medusa. These facts show that medusa does not represent a sexual generation. It is simply a free-swimming diploid zooid specialized for dispersal of gametes of the sedentary hydroid colony. In fact, the so-called sexual generation in *Obelia* is indistinct and represented by haploid gametes only.

Thus, it is clearly impossible to differentiate between sexual and asexual generations in *Obelia*. Asexual hydroid colony and sexual medusa merely represent different phases or zooids, an example of polymorphism, and belong to a single diploid generation, so that a true alternation of generations can not be said to occur in *Obelia*.

In coelenterates (*e.g.*, *Obelia*), a regular alternation between fixed asexual hydroid and free-swimming medusoid phases, both of which are diploid, has been termed **metagenesis** by some workers. But, according to Hyman, concept of metagenesis should be discarded as there are no haploid and diploid generations in coelenterates. According to this view, medusa is regarded to be a completely evolved coelenterate while polyp is probably a persistent larval stage.

COMPARISON OF POLYP (HYDRANTH) AND MEDUSA

1. Dissimilarities between polyp and medusa. The main differences between a polyp and a medusa can be summarised as in *Table 1*.

2. Similarities or homology between polyp and medusa. Striking as is the difference between a polyp and a medusa, they are strictly homologous or fundamentally similar structures. The notable features of similarity between polyp and medusa are as given below :

(1) Body is radially symmetrical.

(2) Both are diploblastic, derived from two germ layers, ectoderm and endoderm.

(3) Exumbrellar surface of medusa corresponds with the base of polyp, providing attachment with the parental stem.

(4) Mouth is homologous in both cases, being situated on a similar process, called manubrium. Anus is absent in both.

(5) Stomach, radial canals and circular canal of medusa correspond with the gastrovascular cavity of polyp, lined by gastrodermis in both cases and serving for digestion of food.

(6) Both are carnivorous, capturing and ingesting food with the help of tentacles. Digestion is extracellular as well as intracellular and digested food diffuses throughout body without a circulatory system.

3. Advancement of medusa over polyp. Free-swimming habit is mainly responsible for the complexity of medusa accompanied by a differentiation of structures lying along certain radii. Thus, medusa shows several morphological advancements over polyp, some of which are as follows :

(1) Epidermis resembles the epithelium of higher Metazoa, forming a thin, protective and sensitive layer, formed by smaller cells with reduced muscle-tails.

(2) Great power of contractility is due to muscle-cells abundantly present in sub-umbrella and velum.

(3) Enormous development of mesogloea adds to the lightness and buoyancy of floating body and also reduces the gastrovascular cavity to a system of canals.

(4) Nervous system shows the beginning of differentiation into a central nervous system in the form of two distinct nerve rings, and a peripheral nervous system, formed by a diffused network of highly branched nerve cells.

(5) Presence of marginal sense organs at the bases of adradial tentacles is of distinct advantage to medusa as a free-swimming organism.

(6) Development of gonads, accompanied by a free-swimming habit, brings about reproduction with greater chances of dispersal.

(7) Physiologically, medusa shows a distinct improvement in swimming freely on the surface of sea by muscular action and is not sessile like polyp.

DERIVATION OF MEDUSA FROM POLYP

Homology and structural similarity of polyp and medusa can be best explained by the fact that one can be readily derived from the other. Suppose a polyp is inverted so that its manubrium is directed downwards. If its tentacular region is pulled out, a disc-like form results. With further differentiation of basal region, the disc will assume a cup or saucer-like form similar to that of a medusa. It will have an outer convex or

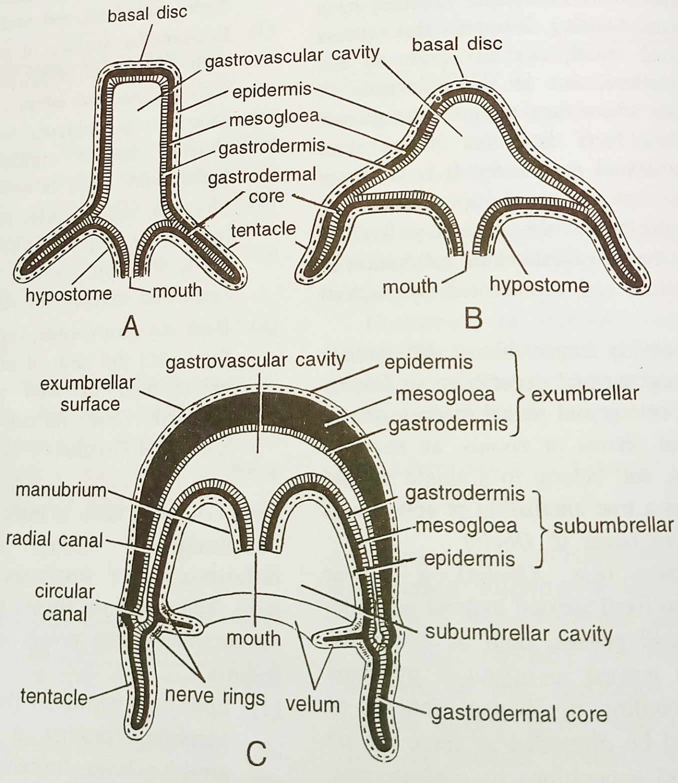


Fig. 12. *Obelia.* Derivation of medusa from polyp. **A.** Polyp in L.S. **B.** Polyp oral-aborally compressed. **C.** Medusa in V.S.

(7) Physiologically, medusa shows a distinct improvement in swimming freely on the surface of sea by muscular action and is not sessile like polyp.

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exumbrellar surface and a lower concave or sub-umbrellar surface with manubrium in its centre and tentacles hanging down from the periphery of the saucer, as in medusa. The saucer has a double wall of epidermis, enclosing a narrow space in continuation of the gastrovascular cavity of the manubrium and lined by gastrodermis. Mesogloea between epidermis and gastrodermis develops enormously to form the jelly. Actual medusa-like condition would be produced by the coalescence of upper and lower layers of gastrodermis so as to form the gastrodermal lamella, except in the region of a central gastric cavity, four radial canals and a marginal circular canal. In this way, a medusa is completely derived from a polyp.

Similarly, if exumbrellar surface of a medusa is pulled out and elongated, the two layers of gastrodermal lamella split apart, and the mesogloea reduced, the cylindrical polyp-like form will result.

Table 1. **Differences of Polyp (Hydranth) and Medusa of *Obelia*.**

Polyp	Medusa
1. Fixed, rarely free.	1. Free-swimming.
2. Body cylindrically elongated.	2. Body saucer-shaped or umbrella-like.
3. Base attached below so that manubrium is directed upwards.	3. Base above so that manubrium hangs downwards.
4. Tentacles usually 24.	4. 16 tentacles in young medusa, numerous in adult.
5. Mesogloea poorly developed.	5. Mesogloea enormously developed.
6. Body structure simple. Muscles and nervous system simple.	6. Body structure complicated. Muscles and nervous system more developed.
7. Velum absent.	7. Velum present around the margin of umbrella.
8. Mouth circular, without oral lobes.	8. Mouth rectangular, with oral lobes.
9. Gastrovascular cavity simple, without radial and circular canals.	9. Gastrovascular cavity represented by stomach, four radial canals and one circular canal.
10. Sense organs absent.	10. Bases of eight adradial tentacles possess marginal sense organs, called statocysts.
11. Without gonads.	11. With four gonads on radial canals.
12. Reproduces asexually by budding.	12. Reproduces sexually by gametes.

Important Questions