

FECUNDITY & DEVELOPMENTAL STAGES OF FINFISHES



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Fecundity

- The problem of estimating fecundity depends upon several factors such as: the **absolute numbers of eggs produced** the total or partial spawning nature of the fish and **the immature eggs present** which will be carried over to the next spawning season.
- The methods used in fecundity studies fall into three sections: (1) Random sampling of fish, (2) estimating the number of eggs and (3) analyzing the results in relation to other parameters. The fixatives and preservatives used are:
 - Formalin
 - Modified Gilson's Fluid

Gravimetric method

- Based on weighing and counting of eggs
- Random samples of about 500 eggs are counted and weighed
- Total number of eggs in an ovary calculated from the equation $F = nG/g$
where F = Fecundity;
 n = number of eggs in the subsample;
 G = total weight of the ovary;
 g = weight of the subsample.

Volumetric method

- Cleaned eggs are put in a measuring cylinder made up to a known volume with water
- Subsample of known volume is again drawn with a pipette
- Number of eggs in the subsample is counted
- Fecundity is calculated from the equation $F = nV/v$
 - Where, n = number of eggs in the subsample
 - V = volume which contain all the total eggs
 - v = volume of the subsample

Automatic egg counter

- Total count of eggs in an ovary can also be made using automatic egg counters. The advantage of using this machine is that sampling error in any sub-sampling technique is avoided but the only disadvantage is the slowness of this machine.

Advantage

- Error in any sub-sampling technique is avoided

Disadvantage

- Slowness of this machine

- Fecundity can be estimated by removing the ovaries from females in stages III to V in the case of total spawners.
- Fecundity analysis is largely confined to total spawners, because it is difficult to estimate the fecundity of partial spawners.
- All the oocytes to be spawned in one spawning cycle might not have been differentiated in the early stages in the case of partial spawners.
- In later stages, some developing eggs might be the leftover of already occurred spawning.
- Adequate estimate of annual fecundity in such species, depends upon the data on the number of spawning per year, number of eggs shed at each spawning and the relation between these factors and size & age of the fish.

Sex Ratio

- The knowledge of sex composition of catches is of help in understanding whether any differential fishery exists, its possible bearing of fish stocks and whether sexual congregation takes place during spawning.
- It indicates the proportion of males and females in the population.
- The expected sex ratio is 1:1 in the nature.
- Variations from this are often observed in fish because of differential behaviour of sexes, environmental conditions, fishing, etc.
- The number of male to female ratio is observed for a minimum period of one year.

Sex Ratio

- Expected sex ratio is 1:1 in the nature
- Sex ratio is calculated in the following equation

$$\chi^2 = \sum (O - E)^2 / E$$

Where, O – Observed value

E – Expected value

REPRODUCTIVE STRATEGY

Reproductive Strategy

- Different methods are adapted by fishes to ensure the success of reproduction
- Adaptations are seen in the form of
 - Special anatomical
 - Behavioral
 - Physiological
 - Energetic adaptation
 - Habit

Success of reproduction measured by

1. Survival ratio of eggs.
2. younger ones should be placed in the proximity/close to suitable food material.
3. Ensure juvenile to reach the adult stage.

Classification of Reproductive Strategies

- There are 3 categories
 - Non-guarders of eggs and young ones
 - Guardians of eggs and young ones
 - Bearers

Non-Guarders of Eggs and Young Ones

- Non-guarders are divided into 2 groups
 - Simply scatter their eggs in the environment
 1. Open substrate spawners
 2. Brood hiders

Pelagic Spawners

- Known as pelagophils
- Spawn in open waters
- Eggs are buoyant
- Planktonic in nature
- Lot of water content and
- Egg contains oil globules to ensure floatation
- Disadvantages
 - Exposed to variable wild environmental conditions.
 - Eaten by pelagic predators
 - Low survival rate

Benthic spawners

- Deposit the eggs on the substratum
- Eggs are adhesive
- No courtship behaviour
- Do not care for eggs and young ones
- Lay eggs in long strings or thick thread
- Classified into 3 categories

Spawners on coarse bottom

Pelagophils

- Deposited on the rocks
- Young ones or embryos, Drift in the surface water

Lithophils

- Deposited on hard substratum
- Embryos are retained in the bottom

Spawners on Plants

Two categories

Phytolithophils

- Deposited on plants, Stones and logs of wood (Non obligatory)

Phytophils

- Eggs are adhesive and deposited on aquatic plants (Obligatory).

Spawners on sandy bottom (Psammophils)

- Eggs are deposited on the sand

Brood Hiders

- Hide their eggs in one way or another
- No parental care
- Classified further into five categories

1.Lithophils

- Eggs are hidden in natural or constructed hiding places.
- Females build their nest by digging the gravel to form a pit
- e.g: salmon and trout.

2.Speleophils

- Cave spawners exhibit this type of strategy
- Eggs are large, adhesive

3.Ostracophils

- Hide their eggs in the shells of living invertebrates
- For protection and a supply of oxygen.

4.Beach spawners (or Aero- psammophiles)

- Incubate their eggs in the beach

5.Xerophils

- Deposit their eggs in mud & sand
- Capable of withstanding dry and harsh environmental conditions

Breeding modes of bony fish

- **Oviparous**
 - Producing eggs that develop outside the maternal body. e.g.: many bony fishes
- **Ovo-viviparous**
 - Developing larvae (juveniles) within the maternal body in eggs. e.g.: scorpaenidae, cottidae, hexagrammidae
- **Viviparous**
 - Developing Juveniles within the parent body by maternal nutrition supply. e.g.: embiotocidae, poeciliidae.

FISH EGGS

General characteristics of eggs

S.No.	Pelagic eggs	Demersal eggs
1.	Eggs are small in size	Eggs are bigger in size
2.	Eggs laid singly	Eggs are laid in mass
3.	Small yolk content	More yolk content
4.	Prolonged developmental period	Developmental period is short
5.	Egg membrane thin and smooth	Egg membrane thick
6.	Fecundity is more	Fecundity is less

General characteristics of eggs

S.No.	Pelagic eggs	Demersal eggs
6.	Fecundity is more	Fecundity is less
7.	No parental care	Mostly with parental care
8.	The eggs are transparent e.g. <i>Sardina pilchardus</i> <i>Solea solea</i> <i>Gadus morhua</i>	The eggs are opaque e.g. <i>Anguilla</i> sp. <i>Synodus indicus</i> <i>Clupea harengus</i>

Identification keys of isolated pelagic fish eggs

- **Single oil globule**

- Non-smooth egg membrane (*Ilisha elongata*)
- Wide perivitelline space (*Japanese sardine*)
- Narrow perivitelline space (*Carangidae*)

- **Non-oil globule**

- Non-smooth egg membrane (*Synodontidae*)
- Wide perivitelline space (*Anguilliformes*)
- Narrow perivitelline space (*Engraulidae*)

- **Multi-oil globules**

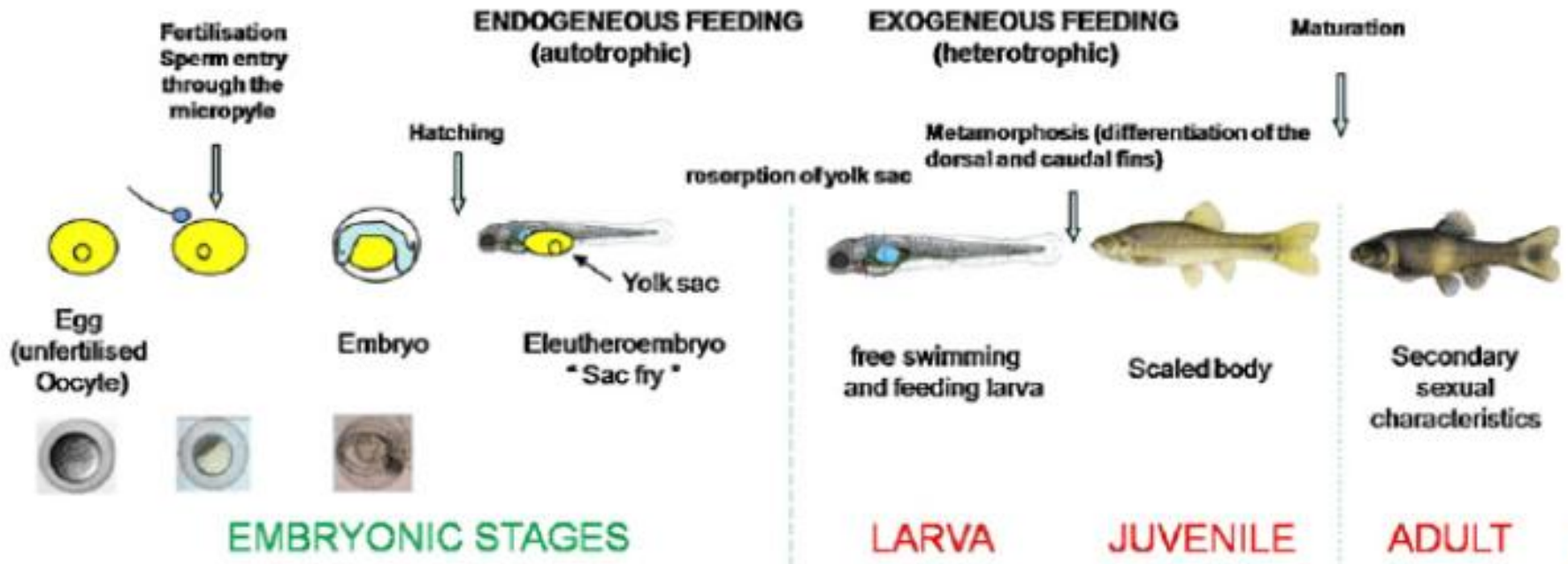
- Non-smooth egg membrane (*Soleidae*)
- Wide perivitelline space (*Anguilliformes*)
- Narrow perivitelline space (*Cynoglossidae*)

DEVELOPMENTAL STAGES OF FINFISHES

Developmental Stages of Finfishes

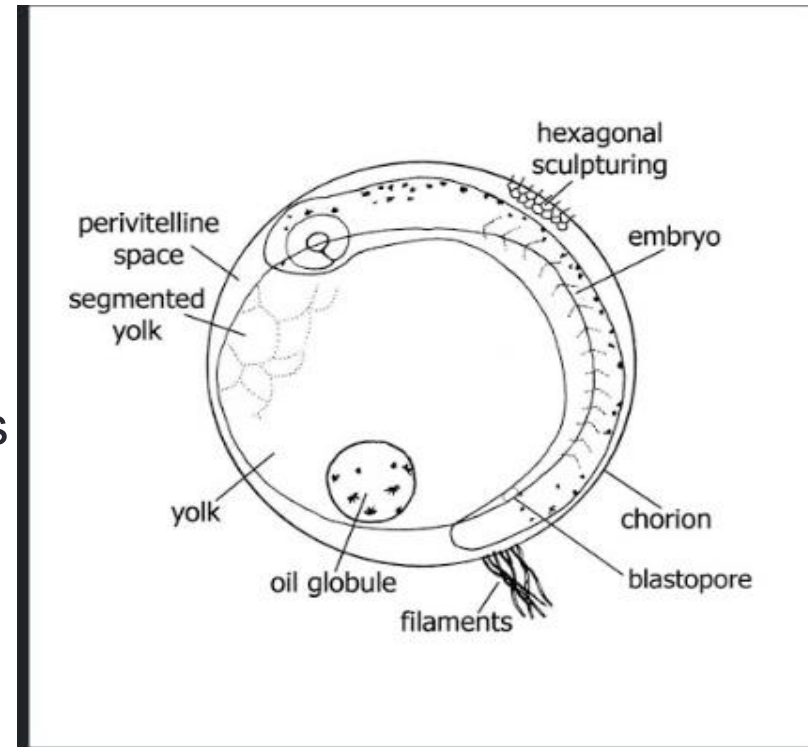
- Development is a process by which an organism reaches its adulthood.
- Development in fish is continuous
- Development starts right from the moment the egg is fertilized.
- After several stages of development, the tiny organism attains the maturity (adulthood).
- The adult organism is capable of producing new life of its own kind.
- And after reaching the adulthood also the growth process does not ceases.

- The development of fish is being discussed here in two heads viz.
- (i) embryonic development and
- (ii) larval development.



Embryonic development

- In a fully ripe egg, a small opening known as **micropyle** appears in the shell.
- Through this micropyle, polar body escape and water from outside enters into it.
- This causes swelling of the egg.
- The swelling may be as much as four times of the original size.
- Now, a gap called **perivitelline space**
- is found in which the embryo is bathed during its development.
- Usually, the water mixes with the yolk and makes the egg to become transparent.
- The fertilized egg is transparent whereas unfertilized one is opaque.



- After fertilization, the **micropyle** is closed and no more spermatozoa and even water can pass through.
- Gaseous exchanges, however, can take place through the vitelline membrane.
- The environmental conditions particularly the temperature and pH of water has greater influence on the developing embryo.
- Embryonic development begins from the moment the egg is penetrated by a sperm i.e. **just after fertilization.**

- . The fertilized egg first undergoes segmentation and thus it passes from one-celled to many celled stage.
- This segmentation is known as **cleavage**.
- It is the process by which the fertilized egg is divided into smaller cells called **blastomeres**.
- In both cartilagenous and bony fishes, the cleavage is incomplete and is confined to the superficial cytoplasmic layer.
- The deeper yolky portion remains unchanged (unsegmented).
- This type of cleavage were only a small disc like part (germinal disc) of the egg which is known as **meroblastic** and the disc of cells thus formed on the upper or animal pole is known as the **blastoderm**.

- Cleavage ultimately result in the formation stage which is characterized by the single layered cells (blastomeres) and having segmentation cavity (called **blastocoels**) formed under the blastoderm.
- A large number of free blastomeres form a layer of cells called the **periblast** and lie just above the yolk.
- Actually, the space between the blastoderm and periblast is the blastocoels.
- The blastoderm ultimately gives rise to future embryo.

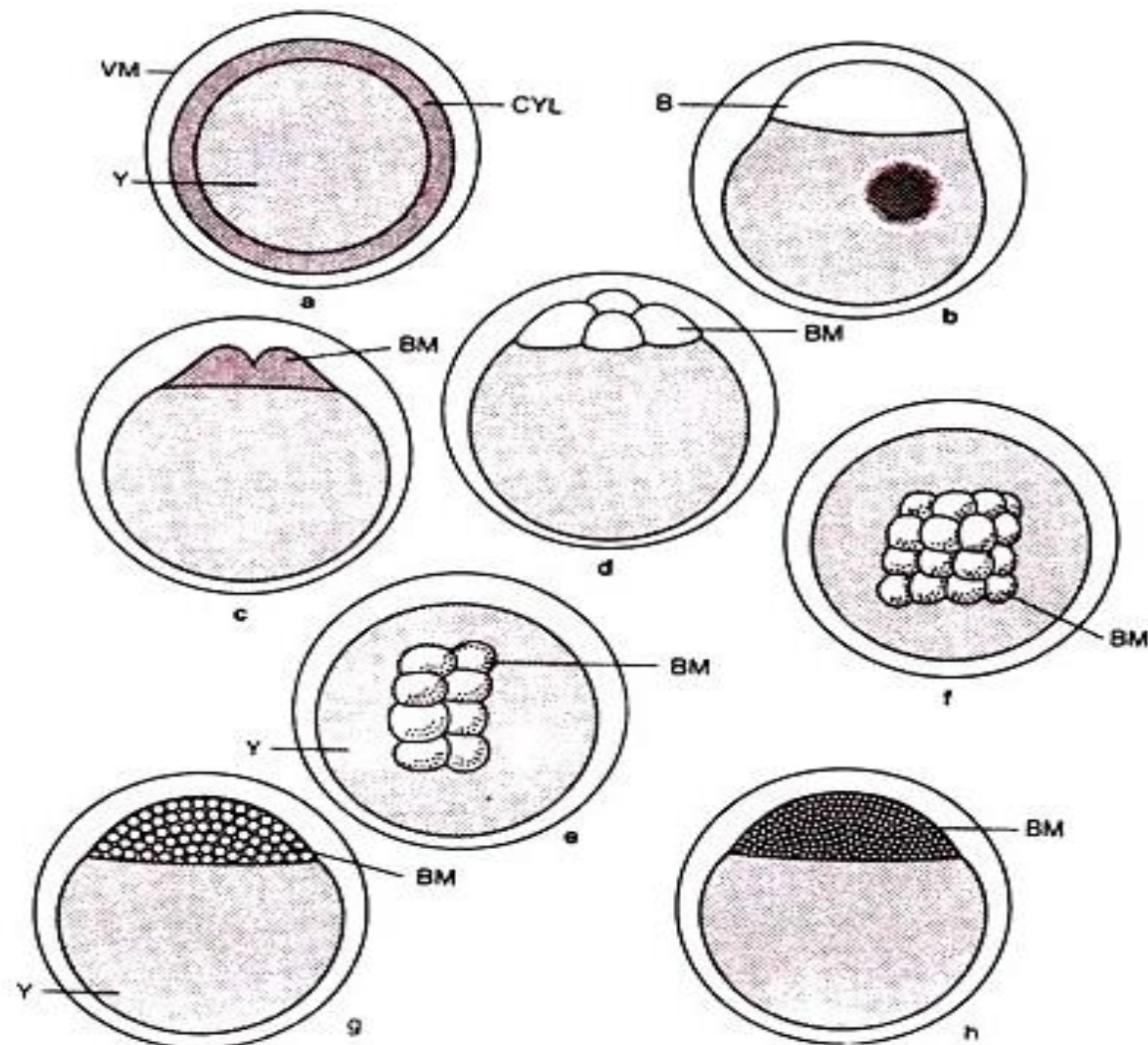


Fig. 21.3a-h : Diagrammatic representation of developmental stages. (a) Fertilized egg. (b) Blastodisc stage. (c) 2-cell stage. (d) 4-cell stage. (e) 8-cell stage. (f) 16-cell stage. (g) Early morula stage. (h) Late morula stage. B, Blastodisc; BM, blastomere; CYL, cytoplasmic layer, VM, vitelline membrane, Y, yolk. Source, Verma (1970).

- The cell of the blastoderm has continued to grow over the yolk. This process is known as **epiboly** .
- The presumptive ectoderm cells grow over and cover the yolk mass from outside, forming a layer of cells called **epiblast**.
- Simultaneously periblast also grows and forms an inner covering of the yolk.
- The periblast and epiblast enclose the yolk in a yolk sac.
- Formation of yolk sac signifies the termination of gastrulation.
- The embryo proper is now distinctly separated from the yolk sac which can be seen from outside.
- The embryo is connected with yolk sac by a yolk stalk.
- Blood vessels develop in the wall of the yolk sac and as the embryo grows the yolk sac is gradually reduced in size.
- This indicates that the yolk sac provides nourishment to the developing embryo.

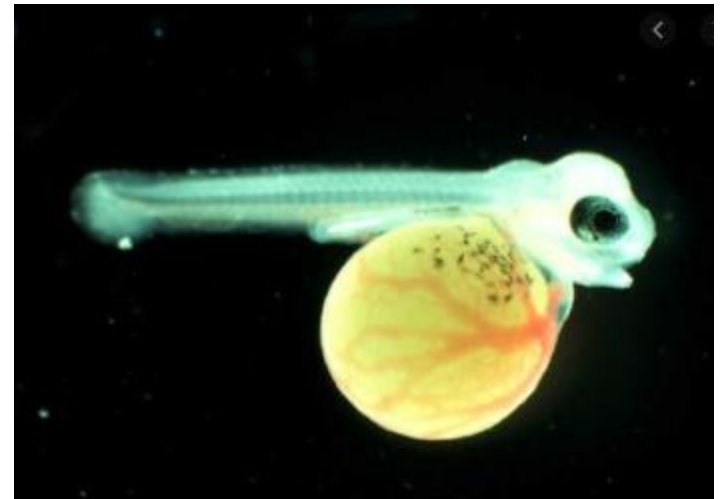
- The characteristic feature of gastrulation in fishes is the formation of primary rudimentary organs which starts in the anterior part of the embryo.
- Various organs of the body are formed from the ectoderm, mesoderm and endoderm.
- The ectoderm gives rise to the epidermis and its derivatives like brain and spinal cord, the lens of the eye and internal ear.
- Similarly, muscles, appendages, axial skeleton, skin, scales etc. develop from mesoderm cells.
- Endoderm cells make up the inner lining of the digestive tract and sex cells.
- Certain endocrine glands such as thyroid and ultimobranchial glands are also derived from endoderm cells.

- The embryonic phase is the interval in which the major organ systems begin to appear.
- It ends in hatching.

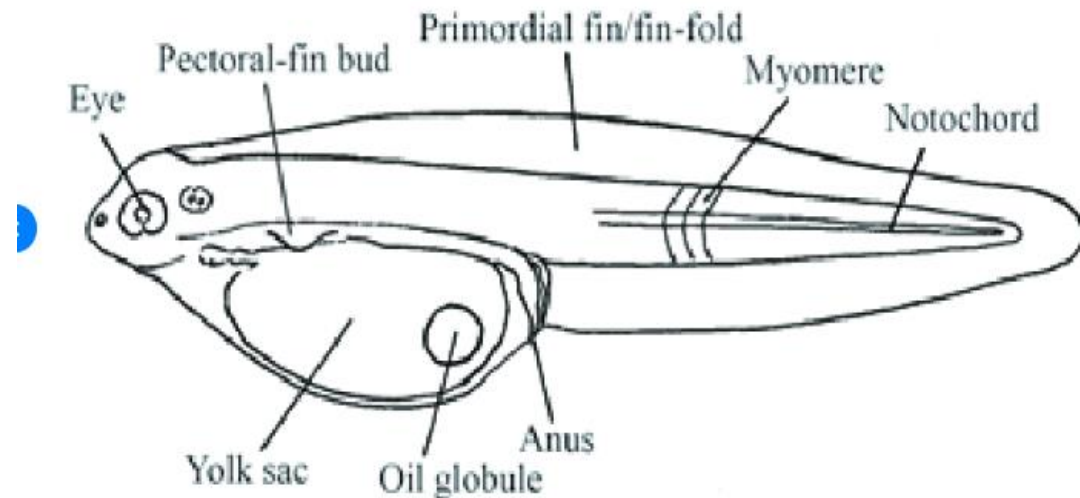


Larval development

- Larval phase begins once the embryo is free
- Becomes increasingly fish like
- Rely on its yolk or mother for nutrition
- Yolk sac is absorbed
- The larva should develop the ability to capture food organisms.
- Carnivorous taking mainly zooplankton
- Larval fish
- Using its stored yolk



- Called prelarva
- Yolk sac fry
- After absorption of the yolk
- It is called post larva (**advanced fry**). Larval development continues until
- Reaches the **fingerling** stage
- Resembles the adult



Main anatomic features of a yolk sac larva. From Russell (1976)

END