

# **Factors Triggering Maturation and Spawning**

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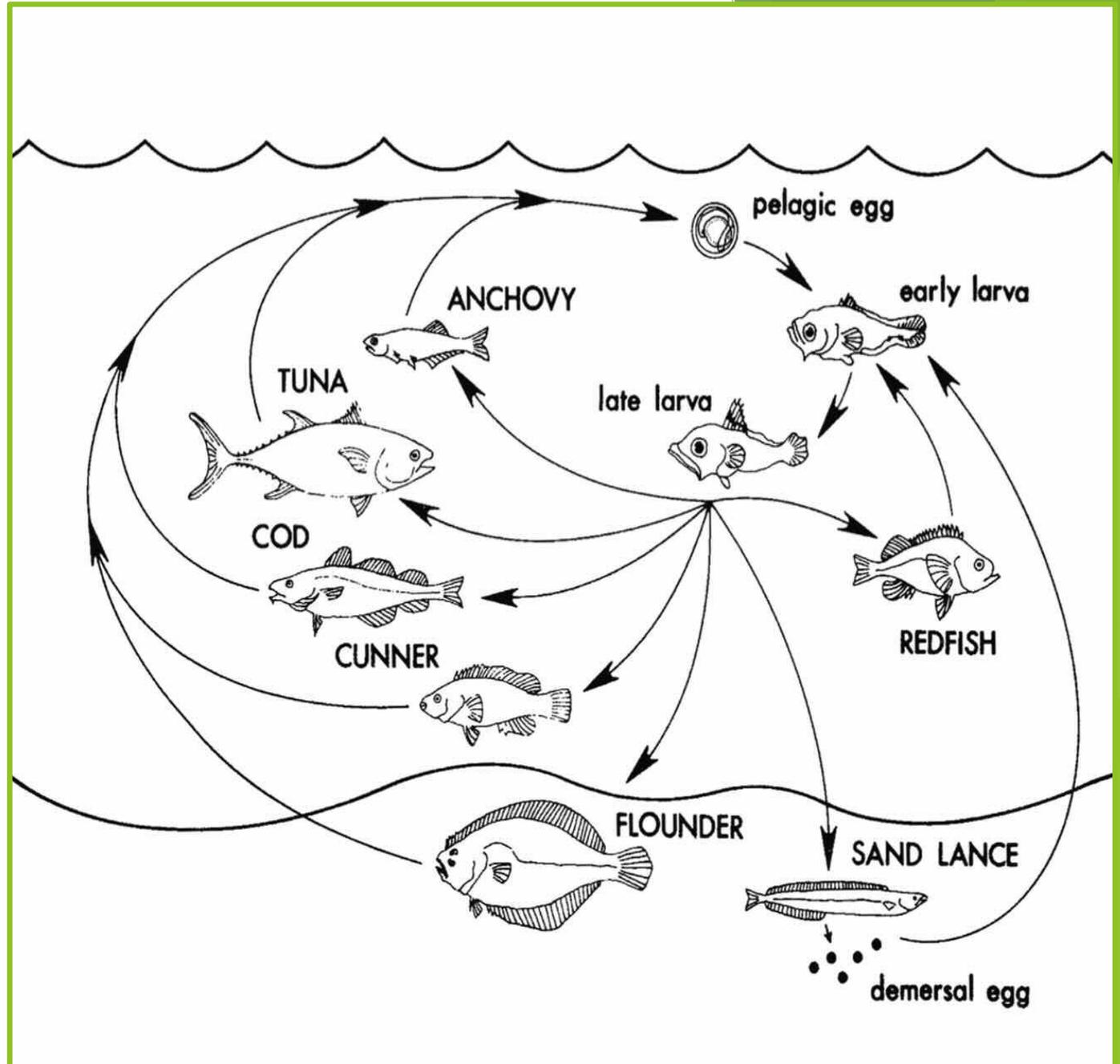
## Introduction:

- Each fish species has evolved in response to a unique set of selective pressures, hence species often differ in their life-history strategies; each life-history strategy is a set of developmental adaptations that allows a species to achieve evolutionary success.
- Each life-history stage (i.e., egg, larval, juvenile, adult) has a number of possible alternative states, but the life history of a given species consists of only one of these states for each life-history period.
- The reproductive process allows species to perpetuate themselves. Almost all fishes reproduce sexually, thus permitting mixing of the genes of the two sexes. The reproductive processes of fishes form the basis for early life-history studies. The great variety of these processes among fishes make their study worthwhile.

***Note: We will focus on bone fish in particular on this subject***

Maximum egg sizes in bony fishes are up to 10 mm in salmons and 15 mm in sea catfishes (ariids). Besides the skeletal features that distinguish bony fishes, they generally share the same basic early life-history pattern of producing small unfertilized eggs that undergo indirect larval development before becoming juveniles. Exceptions to this pattern have arisen in several lineages within the bony fishes.

❖ Diagram representing some of the variety of reproductive patterns of marine fishes. Objects are not to scale. Most fishes regardless of adult size or habitat spawn pelagic eggs that develop into pelagic larvae (e.g., flounders, cunner, cod, tuna, anchovy). Other species (e.g., sand lance) spawn demersal eggs that hatch into pelagic larvae. A few species (e.g., redfish) have internal fertilization and incubation followed by a pelagic larval stage.



# TYPES OF EGGS:

## Pelagic (planktonic) eggs

These eggs float on or near the surface of the water or at any depth of the water column. Pelagic eggs are spawned mainly by marine species but also by some freshwater fish.

According to the functional significance of eggs floating at the surface or in midwater is to guarantee the presence of a high oxygen concentration. Pelagic eggs are transparent whereas demersal ones are not.

Eggs of pelagic fish are colorless without any trace of pigment in contrast to demersal eggs. Pelagic eggs are produced in great numbers; (e.g. *Mola mola*, the Atlantic sunfish), is reported to produce 300 million eggs. The pelagic eggs of most marine spawners are usually small and develop in the upper layers while large eggs develop at considerable depths (bathypelagic).

## Divided buoyant ova into several types:

- 1) Those in which the specific gravity of the yolk is diminished, as in the egg of the cod
- 2) Those in which large oil-drops in an eccentric position aid in causing the eggs to float
- 3) Those in which very large oil-drop causes the ovum to float even in fresh water.

### The other conditions for buoyancy

- a) that the egg be free (not adhesive), with a thin membrane
  - b) that it be immersed in water having a greater density than (1.014).
- ❖ Eggs are held together in considerable number by thin threads as observed in some flying fishes. they are found entangled in floating seaweeds and, if detached, the eggs will sink.

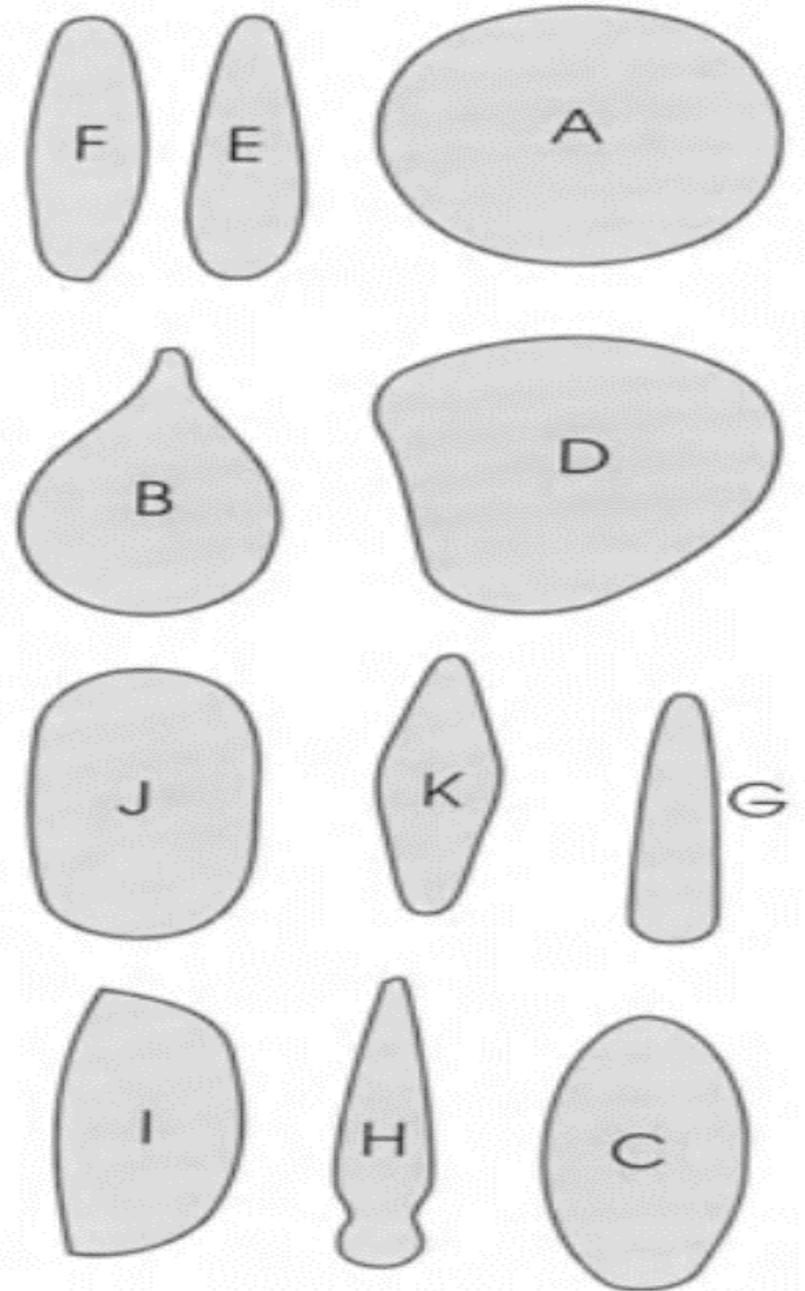
## Demersal eggs:

- ❖ Demersal eggs sink to the bottom where they rest. They are found mainly in freshwater fishes and in marine fishes spawning in the littoral zone. They are found mainly in freshwater fishes and in marine fishes spawning in the littoral zone.
- ❖ The eggs are called benthonic (or benthic) when they are found at the bottom of the ocean or lake. Benthic eggs have a relatively high specific gravity, due to their low water content (60-70%) and a small perivitelline space.
- ❖ The colour of the eggs varies from yellow to whitish orange (many Cyprinidae) to crimson (Salmonidae) and orange-violet (Cyclopteridae) and depends on the amount of carotenoid pigment contained in the yolk and the oil-droplets. However, in some fish, which live in favourable respiratory conditions, such as herring, the carotenoids are concentrated in the blastodisc while there is hardly any in the yolk.

## Shape of eggs:

Shape of teleostean eggs (after Breder, 1943).

- ❖ A - Anchoviella.
- ❖ B - Stolephorus.
- ❖ C- Engraulis.
- ❖ D,E,F - Gobius.
- ❖ G- Glossogobius.
- ❖ H- Bathygobius.
- ❖ I - Lepadogaster.
- ❖ J - Pomacentrus.
- ❖ K - Indetermined species.



## Numbers of eggs:

- ❖ The number of eggs produced varies according to the age and weight of the female.
- ❖ Therefore, the number of eggs is calculated per body weight.
- ❖ The number is greatly reduced in ovoviviparous teleosts (in which yolk furnishes all the food) or viviparous teleosts (in which a greater amount of food is furnished by the ovary).

Species	Number of eggs per kilogram body mass of the female
<i>Scophthalmus maximus</i>	1 200 000
<i>Molva molva</i>	1 000 000
<i>Lota lota</i>	1 000 000
<i>Scomber scombus</i>	800 000
<i>Tinca tinca</i>	600 000
<i>Gadus aeglefinus</i>	300 000
<i>Gadus morrhua</i>	500 000
<i>Lucioperca lucioperca</i>	200 000
<i>Pleuronectes platessa</i>	150 000
<i>Perca fluviatilis</i>	100 000
<i>Cyprinus carpio</i>	100 000
<i>Clupea harengus</i>	100 000
<i>Osmerus eperlanus</i>	50 000
<i>Abramis brama</i>	50 000
<i>Esox lucius</i>	30 000
<i>Acipenser sturio</i>	25 000
<i>Thymallus thymallus</i>	8 000
<i>Barbus barbus</i>	6 000
<i>Phoxinus phoxinus</i>	5 000
<i>Salmo salar</i>	2 000
<i>Salmo fario</i>	2 000

# Factors Triggering Maturation and Spawning:

There are three primary factors that influence the events leading up to spawning:

- ❖ nutritional state of the female.
- ❖ physiological factors (hormones).
- ❖ ecological factors.

# 1- Nutrition of the Female

The feeding condition of the mother can have an important effect on the final maturation of the eggs.

**Two examples Hempel (1979) show that:**

A- in some of the Atlantic herring populations spawning may occur only every other year if environmental conditions particularly those affecting food supply, are poor.

B- it has been found in the laboratory that in Atlantic sole (*Solea solea*) no spawning occurred when the flatfish were fed a diet (mussels only) deficient in certain amino acids.

## 2- Physiological factors

- ❖ Hormones govern migration and timing of reproduction, morphological changes, mobilization of energy reserves, and elicit intricate courtship behavior.
- ❖ The pituitary is the major endocrine gland that produces gonadotropin, which controls gametogenesis, the production of gametes, namely sperm (spermatogenesis) and eggs (oogenesis), by the gonads.
- ❖ The pituitary also controls the production of steroids (steroidogenesis) by the gonads; once the gonads are stimulated by the pituitary they begin producing steroids, which in turn control yolk formation (vitellogenesis) and spawning.
- ❖ The control of spawning by the pituitary is often used in fish farming such as in the production of caviar from sturgeon where spawning is induced by injecting pituitary extract at a late stage of gonadal development, usually in combination with changes in temperature and light periodicity.

## 3- Ecological factors

- ❑ Often ecological factors are associated with timing so that food availability is optimal for the larvae. Some ecological factors important to spawning are temperature, photoperiod, tides, latitude, water depth, substrate type, salinity, and exposure.

### A- Temperature

- ❖ An important factor in determining geographical distributions of fishes. Although little is known about the mechanism by which temperature controls maturation and spawning in fishes, for many marines and freshwater fishes the temperature ranges in which spawning occurs is rather narrow, so that in higher latitudes the minimum and maximum temperature requirement for spawning is often the limiting factor for geographical distribution and for the successful introduction of a species into a new habitat.

## **B-Photoperiod and periodicity:**

❖ The daylength (photoperiod), in some cases at least, is thought to influence the thyroid gland and through these the fishes' migratory activity, which is related to gonadal development (maturation).

❖ In the northern anchovy, by combining the effects of temperature and daylength, continued production of eggs under laboratory conditions was brought about by keeping the fish under constant temperature conditions of 15°C and a light periodicity of less than 5 hours of light per day (Lasker personal communication).

## **C- Tides:**

- ❖ **The dependence of spawning on moon cycles in California grunion spawning on California beaches is an extreme example of external factors controlling reproduction in fishes. Grunion are adapted to spawning on the beach every two weeks in the spring during a new or full moon. Spawning is just after the highest high tide (Figure 1.5); therefore, eggs deposited in the sand are not disturbed by the surf for 10 days to a month later.**

## E-Water Depth:

- ❖ Pacific herring spawn along beaches, marine grasses, and algae. Atlantic herring do not spawn along shore but in deeper water up to 200 m (the clearest difference between the Pacific and Atlantic herring, which are usually designated distinct species on the basis of genetic analysis).
- ❖ Of course, fishes often spawn at one depth but live at different depths during other times of the year. For example, (*Eopsetta jordani*), in which spawning occurs in a specific offshore area 300-400 m deep, were found by fishermen and eventually had to be protected with regulations to prevent overfishing.

## F-Spawning substrate type:

- ❖ Pacific herring spawn on vegetation whereas Atlantic herring spawn on a solid substrate (e.g., gravel). (Lingcod) spawn on rocks, pilings, and cracks in the solid substrate this species protects the egg mass. Some species such as (*Enophrys bison*) and (*Porichthys notatus*) spawn intertidally and will stay with the egg mass even when they are exposed at a low tide.

## G-Salinity:

- ❖ Also, a factor affecting spawning. There are varying salinities in many areas of estuaries. Some species will shift spawning sites because of salinity changes. Various degrees of mixing, precipitation, and freshwater runoff may alter spawning habits.

## H-Exposure and temperature:

- ❖ A clear example of shifting spawning sites in response to temperature and exposure is the (*Xiphister atropurpureus*), where spawning is shifted from winter in protected areas to spring in exposed areas. The complex effects of lower or higher wave action and lower or higher temperatures on courtship, gonadal development and spawning behavior that result in the spawning site shift.

## I-Sites:

- ❖ Many fishes use only a portion of their overall range for reproduction. Many species return to natal areas to reproduce, the Pacific salmon being the best known and most extreme example of this pattern.
- ❖ Adult salmon spend from one to several years in the open Pacific Ocean, and return to their natal streams, which may be hundreds of kilometers from the ocean, to spawn. Even fishes that spend their entire life in the ocean, or a freshwater stream or lake, often select a particular part of their habitat for reproduction.

## J-Migrations:

- ❖ Spawning migrations may require fish to move hundreds of kilometers, or from one depth range to another. The anadromous pattern of salmon and striped bass (*Morone saxatilis*) where the fish move from the marine environment to the estuarine or freshwater environment for spawning, is contrasted to the catadromous pattern of American and European freshwater eels (Anguillidae), which descend rivers and migrate to the Sargasso Sea in the North Atlantic for spawning.
- ❖ Aside from these extremes, most fish move from feeding areas to congregate in spawning areas. Presumably, these areas have been selected through evolution to provide a suitable environment for the survival of the eggs and larvae.

## K-Habitats:

- ❖ The habitats utilized by fishes for reproduction and development are quite varied. The essentials of the habitat for eggs and larvae are that it remains oxygenated and within temperature and water quality requirements suitable for development. Ecological considerations include protection from predators and microbes and production of adequate food for the larvae.
- ❖ Most marine fishes produce planktonic eggs and larvae that drift in the upper 200 m of the ocean, although some regularly occur much deeper. Many fishes that occupy much greater depths
- ❖ Various species of fishes build nests or deposit eggs in a wide variety of places. Many fishes dig a nest in the bottom where they deposit and sometimes guard their eggs. Species may have very specific substrate requirements for nest building. Many freshwaters and some marine fishes deposit adhesive eggs on the surface of the bottom (gravel or rocks) or plants.
- ❖ The depth chosen for deposition of demersal eggs may be very specific, especially in fishes that spawn intertidally where there is the danger of desiccation or exposure to temperature and salinity extremes. Some deposit their eggs in other animals such as clams or crabs in a parasitic relationship.

## **L-Behavior:**

❖ Reproductive behavior of fishes generally involves some sort of courtship, which may aid in species and spawning-readiness recognition. Communication among potential mates may include visual, olfactory, and auditory cues. As courtship proceeds, the mates eventually swim together with their genital openings touching.

❖ Male and female gametes are then released simultaneously. In the case of nesting fishes, the female often deposits a number of eggs, which the male then swims over as he releases sperm, in fishes with internal fertilization the male possesses an intromittent organ to deposit sperm into the female, either directly into the ovary, or into a sperm storage area.

## REFERENCES:

Kunz-Ramsay, Y. (2013). Developmental biology of teleost fishes (Vol. 28). Springer Science & Business Media.

Miller, B., & Kendall, A. W. (2009). Early life history of marine fishes. University of California Press.



*Thank you for Listening*