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DEVELOPMENT OF EGGS AND LARVAE OF MARINE FISHES

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Introduction

For an individual fish, the beginning of development is fertilisation of the egg by spermatozoum. Most marine teleosts have pelagic eggs which drift with the plankton in all water layers between the surface and the bottom. However, fishes like the British herring (*Clupea harengus*) and blennies and gobies have demersal eggs, which attach to substrata like stones, shells and weeds. Usually, pelagic eggs are transparent and spherical, with the exception of the eggs of certain engraulids (*Stolephorus*) which are oblong. When the embryo is fully developed, it hatches out as larva and undergoes further development.

Fertilisation and Embryonic development (Fig. 4.1):

There is an outer egg membrane called chorion. It is slightly thickened at one spot to form what is called the micropyle. Micropyle has a small outer funnel-shaped depression, leading to a canal, connecting with an inner conical elevation. The external surface of the chorion is usually smooth, but in the eggs of certain fishes like *Callionymus* there is an external raised hexagonal sculp-turing and in the eggs of fishes like *Belone* there are fine tendrils. Within the chorion is the spherical yolk mass mixed up with protoplasm and surrounded by a thin delicate layer of protoplasm. The latter contains within it the nucleus in a lens-shaped thickening at the position of the future blastoderm. The sperm enters the egg through the micropyle and at fertilisation it is thought that sea water enters through the pores of the chorion, lifting it from the yolk and forming the perivitelline space, which is usually narrow but in sardines it becomes very large.

Segmentation appears at first vertically to form the blastodisc. The upper cells are fully made of protoplasm while the lowest cells are continuous with the thin protoplasmic acellular layer of the yolk. Nuclei migrate into this acellular layer and increase in number to form a periblastic tissue without distinguishable cell walls, called "syncytium". The blastoderm gradually forms a coating over the yolk, process called <u>Epiboly,</u> leaving an area of yolk not covered by it, called "blastopore", which becomes smaller and smaller until the whole yolk area is covered. Accompanied by the above coverage, the blastodermal layer becomes a cylindrical rod like structure pressing into the surface of the yolk. The outline of the eyes and auditory sacs soon appear, together with formation of the muscle segments called <u>myomeres.</u> About 2 or 3 days after the closure of the blastopore, when the embryo is about half-way round the yolk, pigmentation usually appears as fine dots and the heart becomes functional.

The primordial larval fin membrane arises as a median fold enclosing a space filled with a jelly-like lymph. With further development, the caudal end of the embryo becomes raised up from the yolk. By the time these events happen externally, apart from the notochord (which is formed by movement of cells over the dorsal lip of the blastopore), five organ-forming tubes of tissue appear internally. These are the body covering epidermal tissue, neural tissuegiving rise to the nervous system, endodermal marking the alimentary system and two lateral mesodermal tubes of tissue marking the muscular tissue and body cavity. The mesodermal tubes of the trunk region segregate into dorsal, intermediate and lateral divisions, of which the dorsal division becomes divided vertically into block-like somites. Each somite becomes further subdivided into three regions (Fig.4.2, 7 a and b) called (a) dermatome which is the outer part of the somite and which is responsible for the development of the skin and its derivatives (b) sclerotomes which is the ventral part of the inner somite giving rise to the axial skeleton and (c) myotomes or myomeres which are the dorsal parts of the inner somite resulting in the formation of trunk musculature. In fishes and other lower vertebrates the myomere is the largest part of the somite, the sclerotome being inconspicuous. Their number correspond to the total number of vertebrae in the adults.

By the time the embryo has two eyes, auditory vesicles heart myomeres and larval finfold more or less covers the yolk and shows movements of the body, it is ready for hatching. In certain species with prolonged embryonic period, the eyes get pigmented before hatching and in certain other cases pigments also develope before the event.

<u>Incubation and factors influencing pace of development</u>

Although the period of incubation, i.e.,the time taken from the time of fertilisation to the time of hatching is under genetic control, within each species, there are certain external factors which influence the pace of development and alter the period of incubation. Size of the egg and the quantity of yolk present therein are some initial factors. Temperature is the principal direct and indirect factor influencing these aspects. In temperate countries, the incubation period is longer during winter than in summer Blaxter (1969). Winkler (1986) deals with the relationship between temperature and incubation, the higher the temperature within lethal limits the quicker the rate of development. Blaxter (1969) has shown that the Atlantic herring took about 25 days to hatch at a temperature of 6°C but only about 9 days at a temperature of about 14°C. Temperature is also found to reduce the size and weight at hatching, increase the efficiency of yolk absorption as well as to play an indirect role through oxygen capacity of water, phytoplankton production, etc. Similarly, salinity may accelerate or retard the time of hatching, while lack of oxygen has a retarding effect on the pace of development.

<u>Hatching:</u>

Hatching is controlled specifically as well as environmentally, the latter factors being temperature and oxygen. A softening of the chorion resulting from an enzyme secreted usually from ectodermal glands on the anterior surface of the body takes place, assisted by the activity of the embryo inside result in breaking of the chorion and hatching. It is believed that a part of the nutrient material in the chorion may be utilised by the embryo through the perivitelline fluid, thus resulting in its softening, vide, Blaxter (1969).

<u>Larva</u> (Fig. 4.2, 1-3):

The embryo which comes out of the chorion is called the larva (the newly hatched larva). It is usually transparent with pigments in some cases, the function of which are not understood. Notochord and myomeres are prominent with little development of cartilage or bone. Only the embryonic vertical finfold is present, mouth and jaws not yet developed and the gut is usually a straight tube. Blood is colourless and the circulatory as well as respiratory systems are poorly developed. Yolk is enormous, and it presumably has a hydrostatic function. Eye pigmentation is usually absent in the newly hatched larva, but develops only at the end of the larval phase. The kidney is usually pronephric; and very little is known on the presence of gonads and other organs of the body cavity.

Most species hatch with <- shaped myomeres acting against the notochord as a skeleton. Additional numbers may be added posterior only and the final number is attained during the larval period. The myomeres become more complex as development progresses.

Postlarva (Fig. 4.2, 4-6)

As the yolk is resorbed, the mouth is formed, the eyes are pigmented, branchial arches are developed, the pectoral fins appear and the larva becomes fitted for a change to sources of external food from the yolk available till then. These mark the beginning of the postlarval phase of development. Branchial respiration replaces cutaneous one and the gill arches and filaments appear. The air bladder may or may not be present. One of the systems to develop early is the one for locomotion. The pectoral fins are the first to make their appearance as flap or fan like structures. These remain as such until a very late stage in postlarval development and get ossified much later than all the other fins. The caudal fin is the next to develop through invasion of the caudal end of the larval finfold by skeletogenous tissue which produces fin rays, thus transforming the caudal part of the larval finfold into the adult caudal fin. A similar development takes place for the dorsal fin and the anal fin which develop almost simultaneously appearing first as thickness of the finfold and transforming parts of the larval finfold. The thickenings are the interspace areas which will further split into many such areas. Between each pair of such areas a true fin ray develops. Parts of the larval finfold anterior to the dorsal and anal fins and in between each other disappear gradually in the course of development. In fishes with an anterior and posterior part of the dorsal fin, usually the latter is the one to make its appearance, followed by the former. The pelvic or ventral fin is the last one to make its appearance. Usually the fin rays are the first to appear, followed by spines and their ossification.

Metamorphosis and Juvenile:

Metamorphosis or a change of body form from the larval or postlarval condition to the juvenile stage when the fish resembles the adult in all characters excepting sexual maturity, is rather slow in most of the marine teleosts. This is recently drawn attention to by Russell (1976) who points out that unlike the larval phase of development, the postlarval phase is very much longer, without any sharply demarcated termination. Different adult characters such as the numbers of fin rays and of vertebrae are often already developed, before the developing fish has lost certain postlarval characters such as pigmentation pattern. Although in the flatfishes there is a rotation of the optic region and a change in the normal orientation of the body so that both the eyes come to lie on one side accompanying metamorphosis, many postlarval characters are retained even after the above event. Thus, Russell (1976) points out that in most marine teleosts, it is impossible to determine a decisive point when a postlarva becomes a juvenile. Thus the term "postlarva" may be more appropriately defined as the period after the termination of the larval stage, during which there is a sequence of development leading to the juvenile stage.

References

Balinsky, B.I. 1976. An introduction to embryology. W.B. Saunders Company, Philadelphia, London, Toronto.

Blaxter, J.H.S. 1969. Development: Eggs and larvae. In: Fish Physiology Ed. by Hoar, W.S. and D.J. Randall, Vol.III, Academic Press, New York and London.

Blaxter, J.H.S. 1988. Pattern and variety in development. In: Fish Physiology, Ed. by Hoar, W.S. and D.J. Randall, Vol. XI, Pt. A, Academic Press, Inc., San Diego.

Lagler, K.F., J.E. Bardach and R.R. Miller. 1962. John Wiley & Sons, Inc., U.S.A.

Russell, F.S. 1976. The eggs and planktonic stages of British marine fishes, Academic Press, New York.

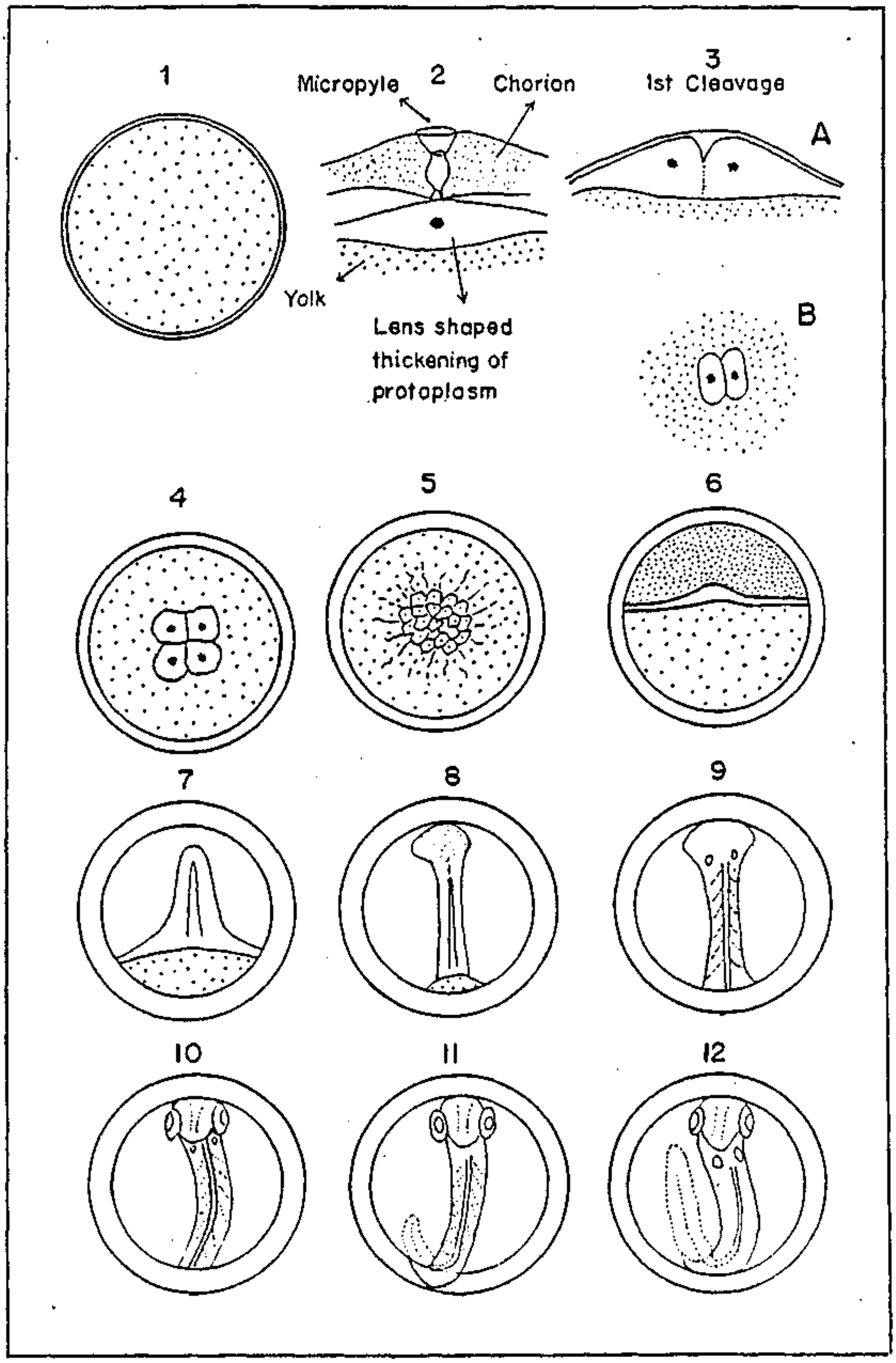
1
2
3
Micropyle
Chorion
1st Cleavage
A
Yolk
Lens shaped
thickening of
protoplasm
B
4
5
6
7
8
9
10
11
12

Fig. 4·1

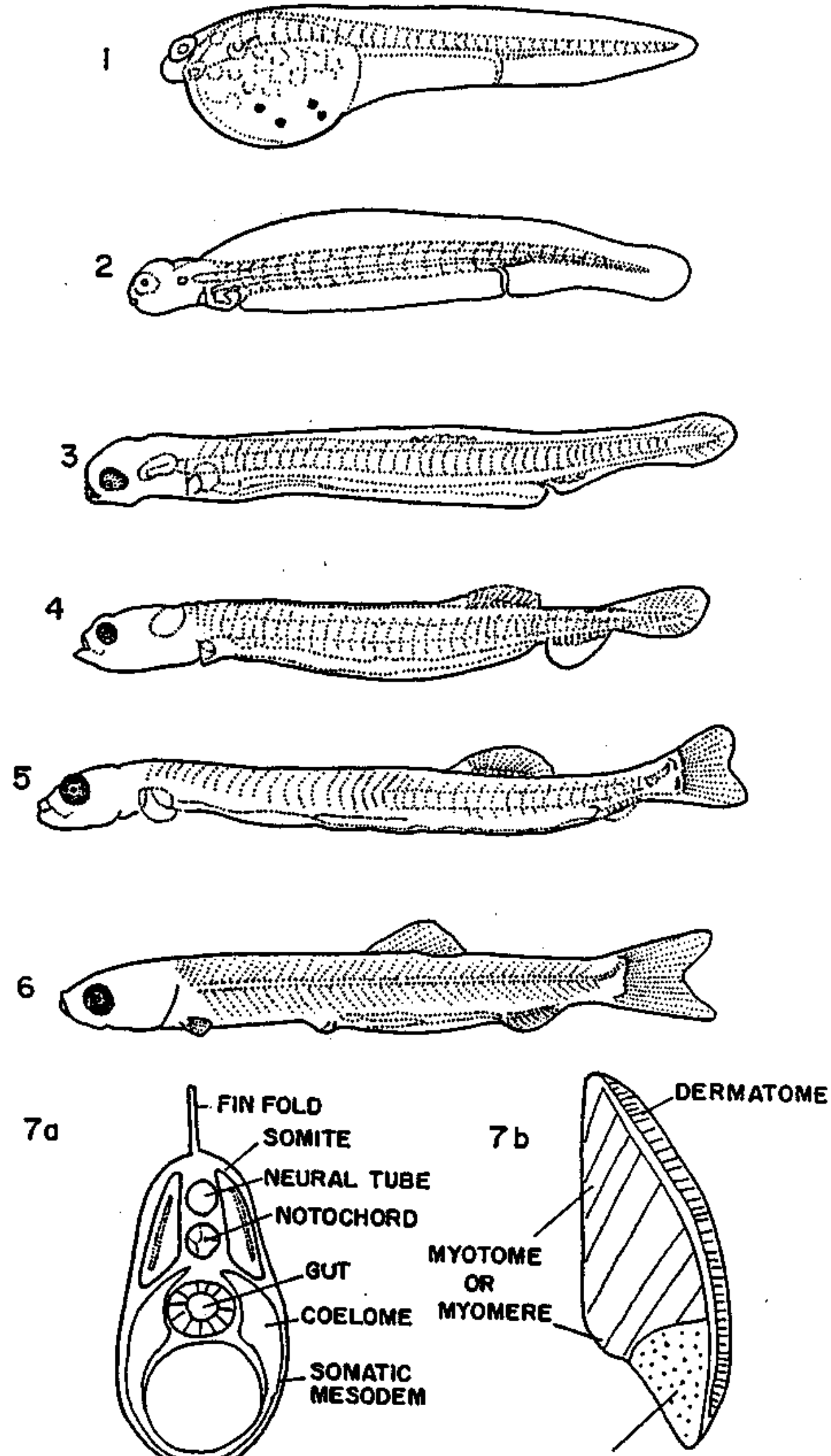
1
2
3
4
5
6
7a
FIN FOLD
SOMITE
NEURAL TUBE
NOTOCHORD
GUT
COELOME
SOMATIC
MESODEM
7b
DERMATOME
MYOTOME
OR
MYOMERE
SCTEROTOME

Fig. 4·2