Stage III

The yolk sac is considerably reduced. The gape of the mouth extends backwards. The dorsal fin is almost complete with rays but is still connected with the caudal fin which is now deeply forked and contains 19 rays. The anal fin now has three rudimentary rays. A rudimentary pelvic fin can he seen as a minute bud. Pectoral fin is still without rays. Alimentary canal is now visible and chromatophores are present on the head.

Stage IV

Yolk is completely absorbed and the it resembles the adult fish. The dorsal fin is fully developed and is not connected with the caudal fin. The anal fin contains 7 rays and is still connected with caudal. Pelvic in is further developed. Pectoral fin is still without rays and a black spot is present on the caudal peduncle.

Stage V

It larva is almost like the adult fish and all the fins are fully developed. Anal fin contains 9 rays and is separate from the caudal fin. Pectoral fins are well developed and contain 9-10 rays. Black spot on the caudalpeduncle and the chromatophores on the back of the larva are more prominent.

10.2 Endocrine system of Fish

Endocrine system usually control long-term activities of target organs and also physiologyical processes such as digestion, metabolism, growth, development, reproduction etc. endocrine system includes certain glands known as endocrine glands, which ae distributed in various regions of the bodyof fish.

Animals contain two types of glands, namely exocrine glands and endocrine glands. Exocrine glands have ducts to carry their secretion. The endocrine glands have no ducts to carry their secretions. Hence, the endocrine glands are also called ductless glands. The study of endorcrine glands is called endorcrinology.

A hormone may be defined as a specific product (organic substance) of an endocrine gland secreted into the blood, which carries it to some part of the body where it produces a definite physiological effect. The effect may be excitatory or inhibitory in its action. Hormones act specifically on certain organs. Such organs are referred to as target organs. Thus, the hormones act as chemical messengers.

The hormones do not participate in biochemical reactions and hence they are also called autonomes or autocoids. Hormones maintain internal environmental

factors of the body like temperature regulation, water and ion balance, blood glucose level etc: such maintenance is known as homeostasis.

The components of endocrine system can be classified on the basis of their organization, which is as follows:

(a) Discrete endocrine glands : These include pituitary (hypophysis), thyroid and pineal (Fig. 10.12).

(b) Organs containing both endocrine and exocrine function. In fishes, it is kidney gonads (Fig.10.12) and intestine. Kidney contains heterotophic thyroid follicles, interrenal, and corpuscles of Stannius

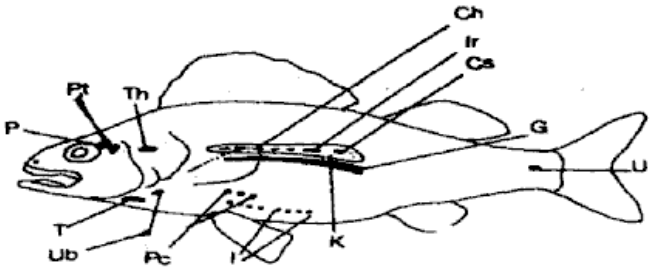

Fig.10.8 Schematic diagram to show position of various endocrine glands in fishes. Ch, chromäffin tissue;Cs, corpuscles of Stannius; G, gonad; I, intestinal tissue; Ir, inter renal tissue; K, kidney, P. pineal: Pc, pancreatic islets; Pt, pituitary; T, thyroid; Th, thymus; U, urohypophysis: Ub, ultimobranchial.

(c) Scattered cells with endocrine function : They are known as diffused neuroendocrines. They are present in digestive tract (Fig.10.12) They are generally called as paracrines (eg. Somatostatin). There are gastrointestinal peptides whose definite classification as hormone or paracrine agent has not yet been established, these are designated as putative hormones.

Hormones

Hormones are classified into four types:

1. Protein or Peptide hormones: Ex: Hormones of pituitary, parathyroid, pancreas, hypothalamus and relax in of ovary.
2. Steroid hormones: These hormones are made up of steroids. Ex: Hormones produced by adrenal cortex, ovaries and testes.
3. Amino acid derivatives or biogenic amines: These hormones are derived from amino acids. Ex: Melatonin and adrenalin of adrenal medulla.

4. Iodinated amino acid: Iodine combines with amino acid and forms different iodinated hormones.Ex: Thyroxine.

Unlikenervous system, the endocrine system is basically related to comparatively slow metabolism of carbohydrate and water by adrenal cortical tissue, nitrogen metabolism by adrenal cortical tissue and thyroid glands and the maturation of sex cells and reproductive behaviour by (lie pituitary gland and gonadal hormones.

The pituitary or hypophysis

Location

The pituitary gland is located below the diencephalon (hypothalamus). behind the optic chiasma and anterior to saccus vasculosus. and is attached to the diencephalon by a stalk or infundibulum (Fig.11.l). The pituitary is an oval body and is compressed dorsoventrally. The pituitary gland is completely enveloped by a delicate connective tissue capsule.

Anatomy of the gland

Microscopically, the pituitary gland is composed of two parts

(i) Adenohypophysis, which is a glandular part originated from the oral ectoderm.

(ii) Neurohypophysis. which is nervous part orginated from th infundibular region of the brain. Both parts are present in close association.

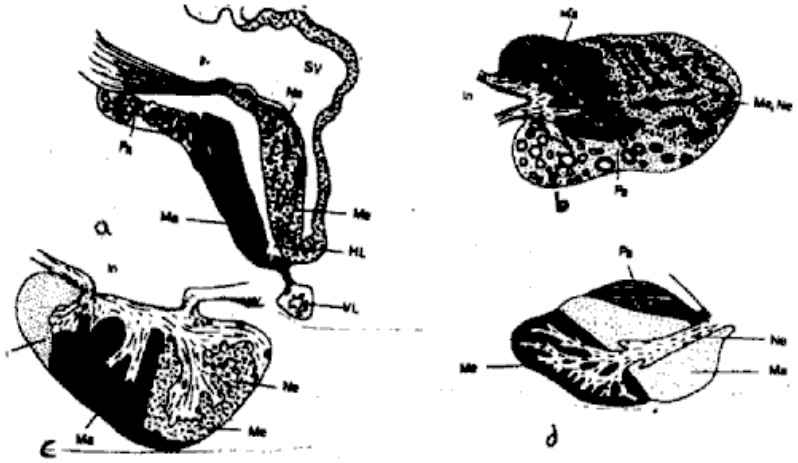

Fig.10.9 Diagrams of pituitary of various fishes. (a) Dog fish shark (Squalus). (b) Trout (Salmo). (c) Perch (Perca). (d) Carp. HL, lumen of hypophysis; In, infundibulum; Ma, mesoadenohypophysis; Me, metaadenohypophysis; Ne, neurohypophysis: Pa, proadenohypophysis: SV, saccus vasculosus; VL, ventral lobe.

Adenohypophysis has three parts (Fig 10.9).

1. Rostral pars distalis (Proadenohypophysis): Lying dorsal to the mesoadenohypophysis in the form of thin strip.
2. Proximal pars distalis (mesoadenohypophysis): Lying almost in between the rostal pars distalis and pars intermedia.
3. Pars intermedia or metaadenohypophysis viz: Lying at the distal tapering end of the pituitary gland.

Pituitary are broadly characterised as platybasic and leptobasic. In platybasic form, the neurohypophysis consists of flat floor of the caudal infundibulum which sends processes into disc shaped adenohypophysis eg. murrels, eels. In leptobasic, the neurohypophysis has a fairly welldeveloped infundibulum stalk and the adenohypophysis is globular or egg shaped. e.g. carps.

Pituitary hormones

There are seven hormones secreted by pituitary (Table 10.1 .). The different hormones secreting cell are spread over in part of the adenohypophysis (Fig.10.14). All hormones secreted by the pituitary are necessarily proteins or polypeptides. There is a slight difference in the pituitary hormones of the different group of fishes.

Tropic or stimulating hormones

The pituitary hormones of fishes are of two types. One which regulates the function of other endocrine glands. Such hormones are called tropics or tropic hormones. These are

1. Thyrotropin activates thyroid
2. Adrenocorticotropic hormones activate adrenal cortex,
3. The gonadotropins (FSH and LH).
4. Growth hormones-somatotropin.

Second which directly regulates the specific enzymatic reactions in the various body cells or tissues. These hormones are melanin hormones (MH) and melanophore stimulating hormone (MSH) etc. Thyrotropin hormone is secreted from proadenohyopophysis and stimulate activity of thyroid hormones. The TRH is secreted under the influence of thyroid releasing hormones from diencephalon in fishes. It is proved that TRH influences the TSR cell activity and thyroid activity in fish.

Gonadotropin

Gonadotropin (GTH) cell are richly found in the proximal pars distalis (PPD), where they may form a solid ventral rim of cells. In fishes there is only one functional gonadotropin is found, which is often regarded as piscian pituitary gonadotropin (PPG).

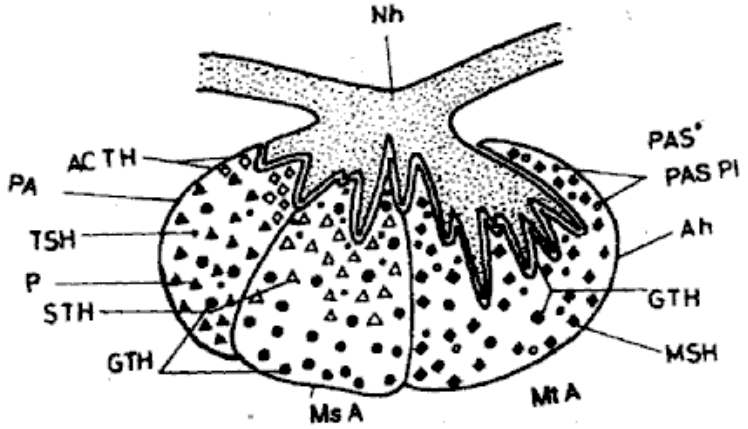

Fig. 10.10 Section of the pituitary to show various hormone secreting cells in the adenohypophysis (Ah). ACTH. adeno corticotropic cell; GTH, gonado tropic cell; MSH melanotropic cell; Nh, neurohypophysis; PAS, periodic acid Schiff— positive cell in pars intermedja; PPD, proximal pars distalis: P. prolactin producing cell; RPD, rortral pars distalis Ce; STH, somatotropic II, TSH;, thyrotropic cell.

Adrenocorticotropic hormone (ACTH)

It is secreted by ACTH cells located between the rostral pars distalis and the neurohypophysis. Secretion of ACTH from pituitary is stimulated by the hypothalamus through corticotropin releasing factor (CRF).

Prolactin

It is a similar hormone that influences lactation in mammals and is released from proadenohypophysis.

Growth hormone (GH)

Mesoadenohypophysis secretes a growth hormone which accelerates increase in the body length of fishes.

Melanocyte stimulating hormone (MSH) or intermedian

MSH is secreted from the meta — adenohypophysis and acts antagonistically to melanin hormone. MSH expands the pigment in the chromatophores. thus take part in adjustment of background.

Table-1: Details of the pituitary gland and its hormones

Divisions	Cell types	Staining Property	ecretion	Action
Pars-Distalis	Somatotrops-(1)Acidophil cells (A type) (ii) Acidophil cells (B type) (in few species)	Orange-G(+) PAS (-) AF (-) A blue (-) Azacarmine (+)	Somatotropins Growth horm-One (GH)	Growth of body. Increase in Basal metabolic rate
Proximal Pars distalis	Thyrotrops (i) Basophils	AF (+)	Thyrotropins e.g. Thyroid stimulating hormone (T S H)	Controls and regulates the growth and secretion from thyroid
	Ganadotrops Secreting cell Initially lie in Proximal pars Distails but also migrate to distal pars distalis during breeding	PAS (+) AF (+) Aniline blue (+) Alcian blue (+)	Ganadotropins e.g. Follicular stimulating harmone (FSH) Leutinizing horomone (LH)	Control secretion of gonadal hormone. oogenesis & spermato-genesis
Rostral pars distalis	Lactotrops Prolactin cells	Azocarmine & Erythro-sine (+)	Prolactin	Probably concerned with osmoregulation and melano-genesis
	Corticotrops ACTH cells lying between neurohypo- physis and pars distalis	Alizarine blue (+)	Corticotropin Adrenocortico-t r o p h i c hormone (ACTH)	Controls secretion of corticotropins from adrenal gland or interrenal cells.
Pars intermedia			MSH & MCH Melanophore dispercing and melanophore contracting hormone	Probably control the concentration and dispersion of pigments within melanophores
Neuro-hypophysis			Vasopressin & Oxytocin	Osmoregulation and salt water balance Mating and egg laying

Oxytocin and vasopressin hormones

In fishes the neurohypophysis secretes two hormones i.e. oxytocin and vasopressin, which are stored in hypothalmic neurosecretory cells. Vasopressin and antidiuretic (ADH) hormones are responsible for the constriction of blood vessels in mammals and thus stimulates retention of water by their action in kidney. Oxytocin stimulates mammalian uterine muscles and increase the discharge of milk from lactating mammae. In fishes this is control osmoregulation by maintaining water and salt balance.

Thyroid gland

Location

In many teleosts the thyroid gland is situated in the pharyngeal region in between the dorsal basibranchial cartilages and ventral sternohyoid muscle. The thyroid surrounds anterior and middle parts of first, second and sometimes third afferent brancial arteries of ventral aorta. In majority of teleosts the thyroid is unencapsulated and thin follicles are dispersed or arranged in clusters around the base of afferent branchial arteries. It is thin walled, saclike, compact dark brownish and enclosed in a thin walled capsule of connective tissue.

Adrenal cortical tissue or interrenal tissue

Location

Among the rays they lie in more or less close association with posterior kidney tissue, including some species possessing interrenal tissue concentrated near the left and in other near the right central border of that organ.

Adrenal cortical tissue or interrenal tissue secretes two hormones. These are (i) mineral corticoids concerned with fish osmoregulation, (ii) glucocorticoids, which regulates the carbohydrate metabolism, particularly blood sugar level.

Chromaffin tissue or suprarenal bodies or medullar tissue

Chromaffin tissue of fishes richly contain adrenaline and noradrenaline. Injection of adrenaline and noradrenaline causes changes in blood pressure, bradycardia, branchial vasodilation, diuresis in glomerular teleosts and hyperventilation.

Ultimobranchial gland

Ultimobranchial gland is small and paired and is situated in the tansverse septum between the abdominal cavity and sinus venosus just ventral to the oesophagus or near the thyroid gland (Fig. 11.1) Embryonically the gland develops from pharyngeal epithelium near the fifth gill arch. It consists of

parenchyma, which is solid and composed of cell cords and clumps of polygonal cells covered by capillary network. The gland secretes the hormone calcitonin which regulates calcium metabolism. The ultimobranchial gland is under the control of pituitary gland.

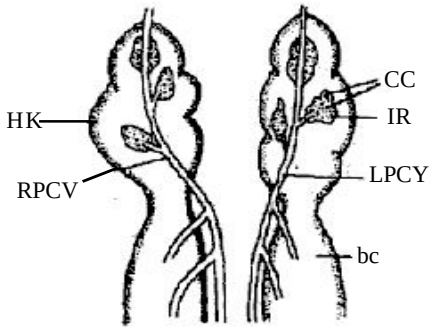

Fig. 10.11 Diagram to show location of interrenal glands in fishes. BC, body kidney; CC, chromaffin cells; HK, head kidney; IR, interrenal tissue; LPVC, left post cardinal view; RPCV, right post cardinal view.

Sex glands as endocrine organs

The sex hormones are synthesized and secreted by specialized cells of the ovaries and testis. The release of sex hormones are under the control of mesoadenohypophysis of pituitary. In fishes these sex hormones are necessary for maturation of gametes and in addition of secondary sex characteristics such as breeding tubercies, colouration and the maturation of gonopodia. In elasmobranchs (Raja) and in salmon the blood plasma contains male hormone testosterone with a correlation between plasma level and the reproductive cycle. Oryzias letipes (medaka) and sockey salmon comprise another gonadal steroid i.e 11- ketotestosteron, which is 10 fold more physiologically androgenic than testosteron. Ovary secretes estrogens of which estradiol -17- has been identified in many species in addition of presence of estrone and estriol. In some fishes progesteron is also found but without hormonal function. There is little information about the influence of gonadial hormones on the reproductive behaviour of fish.

Corpuscles of Stannius

The corpuscles of Stannius (CS) were first described by Stannius in 1939 as discrete gland like bodies inthe kidney of sturgeon. The corpuscles of Stannius are found attached or lodged in the kidneys of fishes particularly holostean and teleosts (fig. 11.4). Corpuscles of Stannius are asymmetrically distributed and often resembles with cysts of parasites but lie different from the latter by higher vascular supply and dull white or pink colour. The corpuscles of Stannius reduces serum calcium level which have environment containing high calcium, such as

seawater. Recently, it has been shown that corpuscles of Stannius work in association with pituitary gland, which exert hypercalceriic effect, in order to balance relatively constant level of serum calcium.

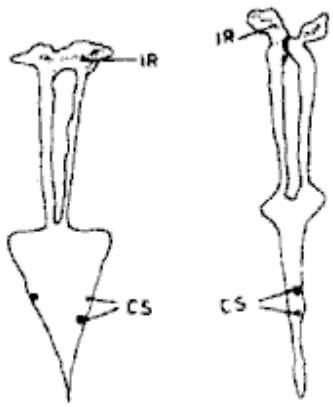

Fig. 10.12 Diagram of kidney of fishes showing corpuscles of Stannius. (a) Cirrhina niri gala. (b) Labeo rohita. CS. corpuscles of Stannius: IF. interrenal corpuseles.

Intestinal mucosa

The intestinal mucosa produces secretin and pancreozymin. which are controlled by nervous system and regulate pancreatic secretion. Secretion affects flow of enzyme carrying liquids from the pancreas. whereas pancreozymin accelerate flow of zymogens. These hormones aie usually synthesized in anterior part of the small intestine. In carnivorous fish these hormones are brought into the stomach, containing acidified homogenate of fish flesh or by injection of secretin into gastric vein which stimulates the secretion of pancreas.

Islets of langerhans

In some fishes like Labeo, Cirrhina, and Channa small islets are present which are separate from pancreas and are found near gall bladder, spleen. pyloric caeca. Such islets are often referred to as principle islets.

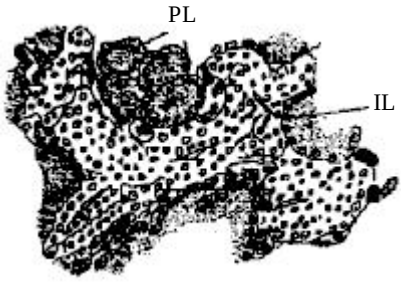

Fig. 10.13 Diagram of pancreas showing endocrine components IL, islets of langerhans, PL, pancratic lobule

But in some species like Clarias batrachus and Heteropneustes fossilis the number of large and small islets are found to be embedded in the pancreatic tissues, similar to the higher vertebrates. In fish the islets are big and prominent and consists of there kinds of cells (Fig. 10.13).

(i) The beta cells which secretes insulin and take aldehyde fuschin stain.

(ii) Another type of cells are alpha cells, which do not take aldehyde fuschin stain and have two types.

A_1 and A, cells, which produce glucagon.The function of the third type cells is not known. Insulin is secreted by beta cells and regulate the blood sugar level in fishes.

Pineal organ

It is situated near the pituitary (Fig. 10.12). Inspite of being a photoreceptor organ the pineal organ shows endocrine nature of doubtful function. Removal of pineal from Lebistes species causes reduced growth rate, anomalies in the skeleton, pituitary, thyroid and corpuscles of Stannius. It has been reported that thyroid and pituitary glands influence the secretion of pineal.

Urophysis

Urophysis is a small oval body, present in the terminal part of spinal cord (Fig. 10.12). It is an organ deposits, which releases materials produced in the neurosecretory cells situated in the spinal cord.

These cells together with the urophysis are called the caudal neurosecretoty system. This neurosecretory system is found only in elasmobranchs and teleosts but it corrosponds to the hypothelamo neurosecretory system present in vertebrates.

10.3 Reproductive System of Prawn

I. Sexual dimorphism

The sexes are separate (dioecious) and sexual dimorphism is well marked:

1. Male is bigger in size than female.
2. The Male possesses a narrower abdomen than female.
3. In Male, bases of thoracic legs are more closely approximated than in female.
4. In Male, second chelate legs are longer, stronger and more spiny than in female.

5. In Male, each second pleoped bears an additional process, the appendix masculina, in between endopodite and appendix interna.

6. In male, epimera of abdominal segments are smaller than in female.

7. In Male, paired genital openings lie on the coxae of 5th pair of legs, while they lie on the coxae of 3rd pair of legs in female.

A pair of gonads are similar in position, shape, size and general disposition in both the sexes. They lie in the posterior region of thorax, dorsally above the hepatopancreas and below pericadium. They extend anteriorly upto the renal sac and posteriorly up to the first abdominal segment.

II. Male Reproductive System

1. Testes: The two testes are soft, white and elongated bodies which fuse at their anterior ends to form a common lobe. They enclose between them a gap for the passage of the cardio-pyloric connecting heart to pyloric stomach.

2. Vasa deferentia: A long, coiled and narrow tube, the vas deferens arises from each testis near its posterior end. On emerging out the vas deferens of each side at once forms a much coiled mass and then runs vertically downwards between the abdominal flexor muslces on the inner side and thoracic wall on the outer side.

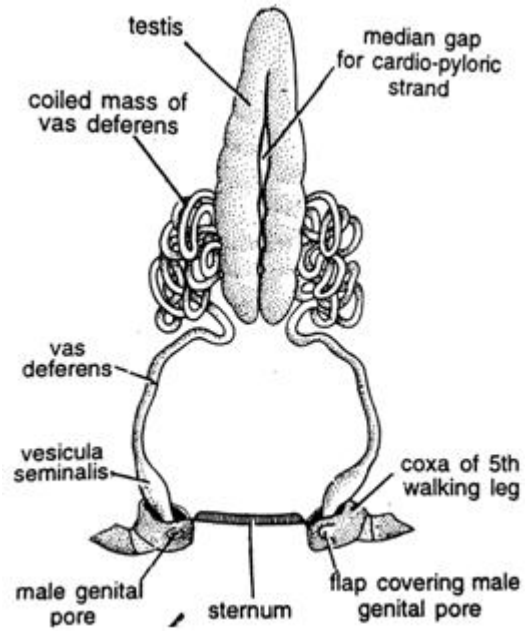

Fig. 10.14 Male Reproductive Organs

3. Vesicula seminalis: Each vas deferens reaching ventrally near the base of fifth leg, swells to forma club-shaped vesicula seminalis. These store spermatozoa in the form of white compact, bodies, called spermatophores.

II. Female Reproductive System

1. Ovaries: The two ovaries are white, compact and sickle-shaped bodies touching each other at both the ends but leaving a gap in the middle for the passage of the cardiophyloric strand. The shape and size of ovaries vary with age and the season of year. Each overy is enclosed within a membranous capsule and is made of numerous radial rows of ova in various stages of development. Immature ova lie towards the centre while mature ova towards the surface of ovary. Matuerova or eggs are large nucleated cells with plenty of yolk material (centrolecithal).

2. Oviducts: A short, wide and thin walled tube, the oviduct, originates from the outer middle border of each ovary. It runs vertically downwards to open through a female genital aperture on the inner side of the coxa of third walking leg of its side.

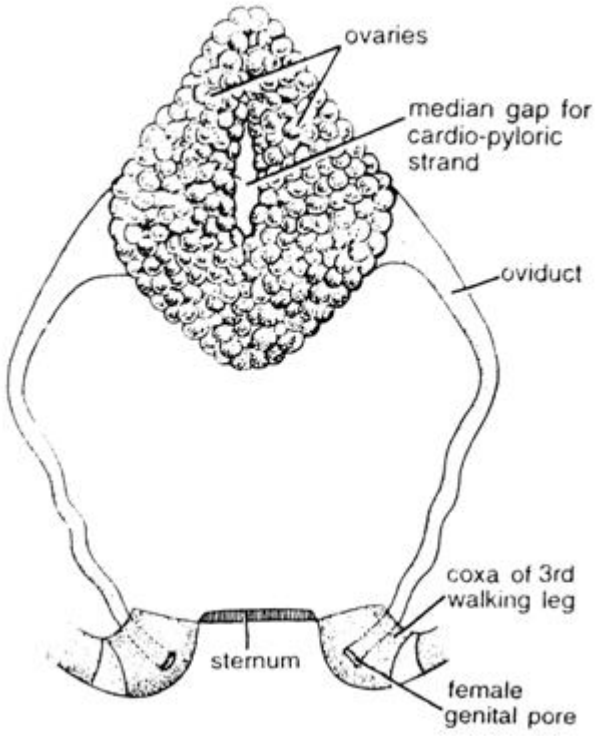

Fig. 10.15 Female Reproductive Organs

Life Cycle and Development

1. Fertilization: P. malcolmsonii breeds during May, June and July. About two to three hundred mature eggs are laid by the female at one time in slimy strings. The male deposits sperms near the genital openings of the female and the eggs are fertilized as they come out. Thus, fertilization is external, or in situ. After fertilization, the eggs are fastened to the pelopods by the sticky secretion of certain tegumental glands. The eggs hanging from pleopods look like berries or bunches of grapes. During breeding season, a female carries hundreds of eggs in this way, until they hatch. She carries them wherever she goes and the eggs are kept aerated by the slow back and forth movement of pleopods. The female is now said to be 'in berry'.

2. Development: Development is direct as there is no free larval from involved. The offspring or juvenile hatching out of the egg resembles the adult except in size. The female bends down her abdomen to protect first the eggs, and later the young, which hatch in 5 to 6 weeks and cling to the pleopods for some time. Growth occurs in short periods between moulting and the adult form is reached after a series of moults. Prawns usually live for 3 to 5 years.

10.4 Endocrine System of Prawn

Palaemon, like other crustaceans, produces a large number of hormones. It is believed that the sinus gland, located at the base of eyestalk, many hormones. They are believed to regulate

(i) The spread of pigment in chromotophores of epidermis and in compound eye.

(ii) Deposition of lime salts in the exoskeleton, and

(iii) Moulting.

Recent investigations have shown that the hormones that regulate moulting are of two types. The moulting-inhibiting hormones are secreted by X organ in the eyestalk and moulting-accelerating hormone by the Y organ beneath the adductor also induces metamorphosis.

Secreation of male sex hormones (androgens) has been reported by H. Charlaux-Cottong (1954) from androgenic glands located between, muscles of coxal segments of the last pair of walking legs. These hormones control themale sex characters.

Summary

Fishes are generally bisexual and sexual dimorphism is exhibited by few fishes. few fishes possess of copulatory organs (eg sharks) and others possess structural pecularities, but not connected with sexual union (eg cichlids). A pair of testes and ovaries are reproductive organs in male and females respectively. Many seminiferous tubules are found in testis. Oocytes are developed inside the ovigerous lamellae of ovary. Seven oocyte stages are found in fishes. Ripe eggs are in largest in size and with large amount of yolk globules. Five maturity stages are found in males and females. Most of fishes are oviparous and external fertilization is found. Cleavage is incomplete and meroblastic development is direct except in Auguilla. The ductless glands are called as endocrine glands. Their secretions are known as hormones. The endocrine glands in fishes are pituitary glands, interrenal tissue, chromaffin tissue, corpuscles of stannous, ultimobranchial glands. islets of Langerhans, thyroid gland, gastro intestinal glands, pineal glands and urophysis.

Short Answer Type Questions

1. Define 'hermophrodite' and 'parthenogenesis'.
2. Define 'sexual dimorphism'.
3. Write the names of developmental stages in fishes seed.
4. What is 'claspers'? Write the uses of claspers.
5. Define spawning.
6. Differentiate between 'Exocrine' and 'Endocrine glands' in the animals with suitable examples.
7. Write the names of different parts of pituatory glands in fishes.
8. Write any two homones secreted from pituatory gland in fish.
9. What is the meaning of "homeostasis'?
10. Mention the name endocrine part in pancreas.
11. What is eye stock ablation in prawn.
12. What is the life span of prawn in general.
13. What is the function of sinus gland in prawn.
14. Write main different between male and female prawns.
15. Write the location of genital openings of male and female prawns.

Long Answer Type Questions

1. Describe the reproductive organs in fishes.
2. Give an account on embryonic development in fishes.
3. Write about the sexual dimorphism in fishes.
4. Write a note on mating and courtship in fishes.
5. Discuss the endocrine system in fishes.
6. Describe the pituitary gland and list out the hormones produced by it in fishes.
7. Explain the thyroid gland in fishes.
8. Describe the male reproductive organs in prawn.
9. Describe the Female reproductive organs in prawn.
10. Discuss the endocrine system in prawn.

UNIT 2

Introduction of Fish

Structure

2.1 Introduction of Fish

2.2 Classification and general characters of Fish

2.3 Classification and general characters of Prawn

2.4 Meristic characters and measurements, Meristic Counts.

2.1 Introduction of Fish

Fishes are the first vertebrates with Jaws. They are cold-blooded animals that breath by means of gills, live in water and move with the help of fins. There are about 36,000 species, which represent the 40% of the total vertebrates present. Fishes have evolved during Ordovician period and widely distributed during Devonian period, which is known as 'Golden age of fishes'.

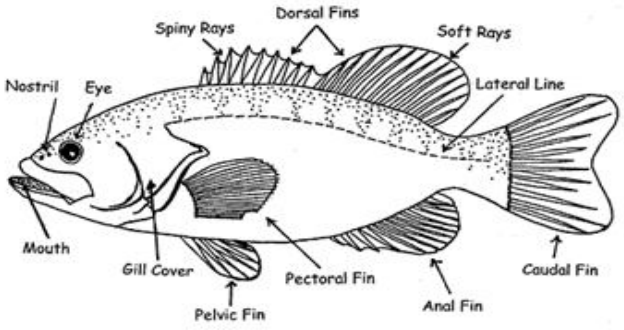

Fig 2.1 Genenral outline of fish to shown fin positions and some body parts

The study of fishes is known as Ichthyology. Fishes differ from each other in size, shape, habits and habitats. The smallest fish is the Phifippine goby, *Paedocypris progenitica* which measures about 1.2 cm. and the largest fish is the whale shark, *Rhinodon* which grows up to 20 meters. They live in all the seas, rivers, lakes, reservoirs, canals, tanks etc. They are economically a very important group of animals. They are used as food throughout the world and the fish liver is the main source of liver oil containing vitamin A and D. Body oils of fishes are externally used in soap industry and tanneries. Beautiful coloured fishes are the present craze to have them in Aquariums. The general characters of fishes are:

2.2 Classification and general characters of Fishes

1. Fishes are aquatic. found in all types of waters. They are found in freshwater (*Labeo*), marine (*Stromateus*), brackishwaters (*Chanos*) and cold waters (‘*Salmo*). Fisheries are colled blooded animals.
2. **Symmetry**: These are bilaterally symmetrical
3. **Coelome**: Fishes are eucoelomates and enterocoelomates
4. These are triploblastic animals
5. **Segmentation** : Fishes are segmented and segmentation is internal
6. **Shape** : Most of the fishes are spindle shaped some are dorso-ventrally depressed (*Narcine*), some are laterally compressed (*Notopterus*), some are snake like (*Mastacembelus*) , some are globe like (*Tetradon*)
7. **Colour**: Different colours are found in fishes. Aquarium fishes are extremely beautiful with glittering colours
8. **Size**: Size of fishes also varies from 1.25 cm *(Mystichthys lozerensis*) to 20 meters (*Rhynodo*) in length.
9. **Exoskeleton** : Fish body is covered with scales and bony plates. Due to their various functions, scales are known as identity card of fish. Scales are mesodermal in origin. Scales are absent in siluriformis fishes (cat fishes). Scales are absent on head region in few fishes (major carps). Bony rings are found in syngnathifromis fishes (*Hippocampus*). Scales are of different types. These are cosmoid (extinct fishes), ganoid (Dipnoi fishes), placoid (Elasmobranch fishes), cycloid (Cypriniformis fishes) and ctenoid (perciformis fishes) scales. Some fishes have spines on body (*Clarias*)

10 **Fins:** Fins are useful for swimmmg and balancing Fins are supported by

rays known as fin rays Fins have both spiny and soft rays. Fins without fin rays are known as adipose fins (*Mystus)* Fins are mainly two types — paired and unpaired fins. Paired fins are pectoral and pelvicdor ventrals. Unpaired fins are dorsal, anal and caudal fins. Fins are mostly normal or modified in few fishes.

11 **Body farm** : Fish body can be divided into head, abdomen and tail

12 **Tail** :Tail is useful for changing the direction during swimming. Tail consists of fin known as caudal fin Tails are of different types — diphycercal (Dipnoifishes), hypocercal (extinct fishes), heterocercal (cartilagenious fishes and homocercal (teleost fishes). Caudal fin is either forked or round or confluent with dorsal and anal.

13. **Endoskeleton**: Mostly autostylic skull, Amphicoelous verterbrae. Appendicular skeleton is poorly developed

14. **Digestive system**: Complete alimentary canal: Mouth is large in carnivorousfishes, small in other fishes. Mouth is terminal (many fishes), upturned (Catla), subterminal (Labeo) and ventral (cartilaginous fishes). Teeth are well developed in carnivorous fishes. Stomach is absent in many fishes. An intestinal bulb is present. Scroll valve is present in cartilaginous fishes. useful for food absorption. Cloaea is present in cartilaginous fishes. Pancrease is well developed. Inter cellular digestion.

15. **Respiratory system** : Branchial respiration by gills. Gills are located in branchial chamber. 5-7 gills are found in cartilaginous fishes and 3-5 gill are found in teleosts. Haemoglobin is respiratory pigment. Accessory respiratory organs are found in few fishes like *Clarias* (respiratory trees), *Channa* (labyrinthin organ), *Heteropneustes* (air sac), dipnoi fishes (lungs), etc, which are useful to live for some time out side water.

16. **Circulatory system**: Closed type of circulatory system is found in fishes. Heart is two chambered, venous, tubular and with either conus or bulbus arteriosus. RBC are biconvex in nature.

17. **Nervous system**: Cerebrum is not much developed Olfactory lobes are well developed, especially in sharks. 10 pairs of cranial nerves are found.

18. **Sensory organs** : Laternal line system is very well developed in fishes. which are useful to detect water currents. Olfactory organs are well developed .Ampullae of Lorenzini are thermoreceptors found in cartilagerious fishes. Barbles are very well developed in catfishes.

19. **Excretory system** : Mesonephric kidneys are found, ammnotelic animals. Marine fishes retain urea in their blood to maintain isotonic condition with seawater.

20. **Reproductive system** : Monosexuals, sexual dimorphism is found. In Few fishes are Coupulatory organs. Oviparous, except sharks and poecilidae fishes. External fertilisation, except in above fishes Megalecithal eggs. Cleavage is holoblastic, determinate. Direct development except in Anguilla, which consists of elever or leptocephalus larval form. Parental care is fond in fishes eg. *Oreochromis*..Life cycle is generally drictect are some times indrict.

21. Electric organs are found in few fishes, which produce current eg. *Tarpedo, Electrphorus*

22. Deep sea fishes exhibit bioluminescence eg, *Blepherodon*

23. Fishes like *Anguilla* and *Salmon* exhibits diadromous migration.

Classification of Fishes

The super class pisces is divided into three classes

1. Placodermi 2. Chondricnthyes 3. Osteicnthyes

Class Placodermi

These are extinct animals, Fossil evidences reveal that they lived in Silurian, Devonian and Carboniferous periods of Paleozoic era.

Endoskeleton and exoskeleton was made up of bony-armor Jaws were primitive.

Eg. *Climatius, Palaeospondylus.*

Class Chondrihcthyes or Elasmobronchii

(Gr. Chondros = Cartilage; icthyos =fish)

1. All are marine animals
2. Endoskeleton is made up of cartilage
3. First gill slit is spiracle
4. Scales are placoid type and are minute
5. Fins are without rays. Tail is heterocercal
6. Mouth is ventral

7. Spiral valve is present along the internal well of the large intestine. Cloaca is present
8. Paired nostrils are present at the ventral side of rostrum
9. Air bladder is absent
10. 5 to 7 pairs of Gills. GilL slits are present and are not covered by operculurn.
11. In the heart, sinus venosus, auricle, ventricle and conus arteriosus with valves are present.
12. These are ureotelie animals and store high levels of urea and trimethylamine oxide (TMO) in their blood and body fluids.
13. A pair of claspers are present in males on either side of cloaca.
14. Eggs are macrolecithal (high amount of yolk) and cleavage is meroblastic
15. Fertilization is internal and many species are viviparous. Development takes place inside the oviduct and in oviparous forms development occurs outside the body.

    Ex.*Scoliodon,Trpido*

Class Osteichthyes (Bony fishes)

(Gr. Osteos = bone; ichthiyes fish)

1. Endoskeleton is made up of bone
2. Inhabits both freshwater as well as marine.
3. Skin is covered by cycloid, ctenoid or gonoid scales
4. Mouth is usually terminal or sub-terminal
5. 4 pairs of gills are present on either side of the pharynx. Their openings are covered by operculum or gill cover.
6. Tail is homocercal, diphycercal or heterocercal
7. Claspers, cloaca and nasobuccal grooves are absent. Separate Oval and urinogenital apertures are present.
8. Heart is two charmbered with an auricle and a ventricle. Conus arteriosus is absent. Lung fishes have an incompletely divided auricle and a ventricle. Pulmonary artery and pulmonary vein are present in lung fishes.