Alimentary Canal and Its Modifications In Relation To Feeding Habits of Fishes

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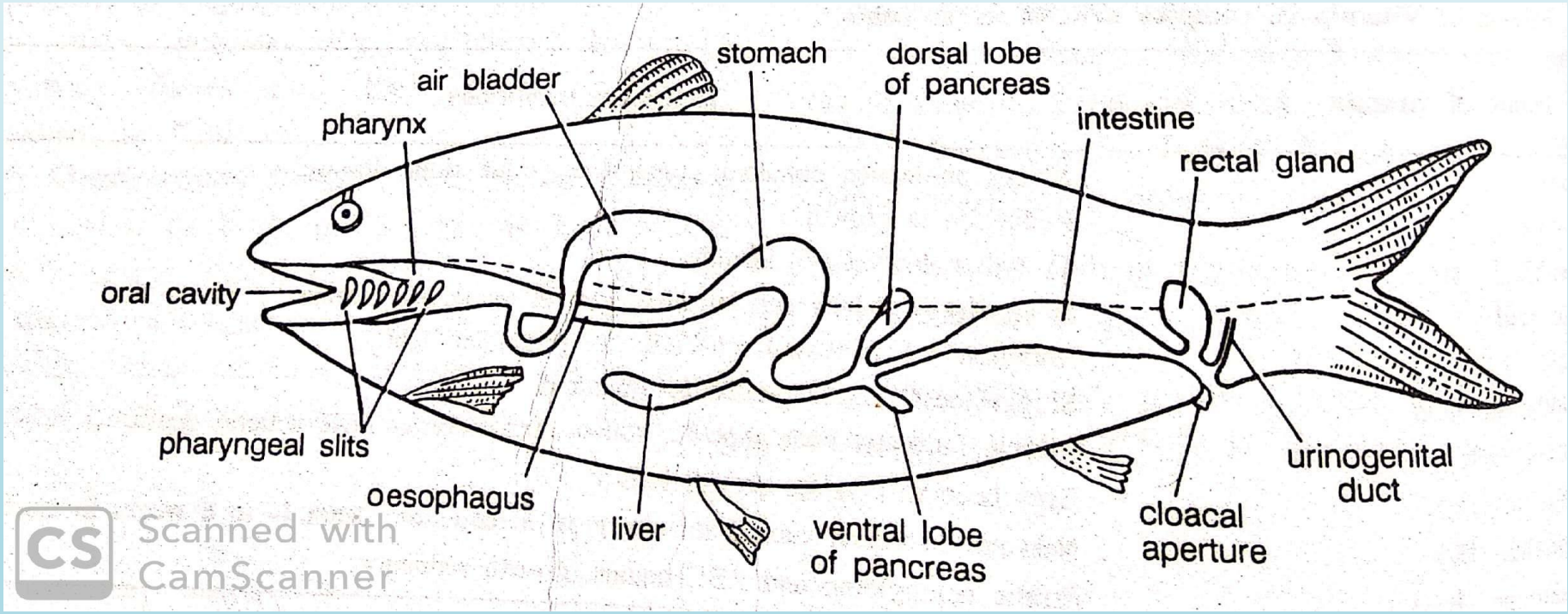
INTRODUCTION

- The digestive system of fish includes the digestive tract & various glands found associated with it. It is concerned with the elimination of undigested wastes.
- The digestive tract or alimentary canal comprises three major parts- the foregut , midgut and the hindgut. Each of the parts undergo further differentiation to include different parts like mouth , buccal cavity, pharynx, oesophagus and stomach. Midgut differentiates into small intestine and the terminal aperture. A large no. of accessory organs like the tongue, oral glands, pancreas, liver, gall bladder and the air bladder evolve from the digestive tract to assist its functioning (Figure 1,2 & 3).

Figure 1. Alimentary Canal of a Fish



PARTS OF ALIMENTARY CANAL

- Teeth: Like placoid scales, the teeth of fishes are essentially the hollow cones of dentine containing the pulp cavities. They are continuously produced along the inner margin of the jaws in the form of specialized denticles (the placoid scales) . As the new generations are added from behind , the older ones are pushed in front so that when older ones are worn off, they are replaced by the new ones from behind. However, the number, distribution (within the oral cavities) degree of permanence , shape & mode of attachment of teeth varies among the different species of fishes.
- Tongue: The tongue arises as a fold from the floor of buccal cavity. It is devoid of any muscles but supported by the hyoid arch that often extends into it . Small papillae, sensory receptors and the teeth are variably found on this structure scarcely called tongue.

PARTS OF ALIMENTARY CANAL

- Buccal Cavity & Pharynx : The buccal cavity and the pharynx are not clearly marked off from each other. A number of perforations of gill slits are found on each side of the pharyngeal wall. These, at their openings into pharynx are supported by gill rackers which assist in the process of digestion. Pharynx, however is largely a structure for respiration than for digestion.
- Oesophagus : The pharynx opens into the oesophagus and the latter in turn passes almost imperceptibly into the stomach . These 3 parts viz. the pharynx, oesophagus and the stomach are not clearly marked form each except histologically . Oesophagus commonly bears longitudinal fold to permit a greater distensibility and its mucosal lining comprises largely the squamous cells .

Figure 2. Diagram of Alimentary Canal (A) Scoliodon and (b) Hydrolagus

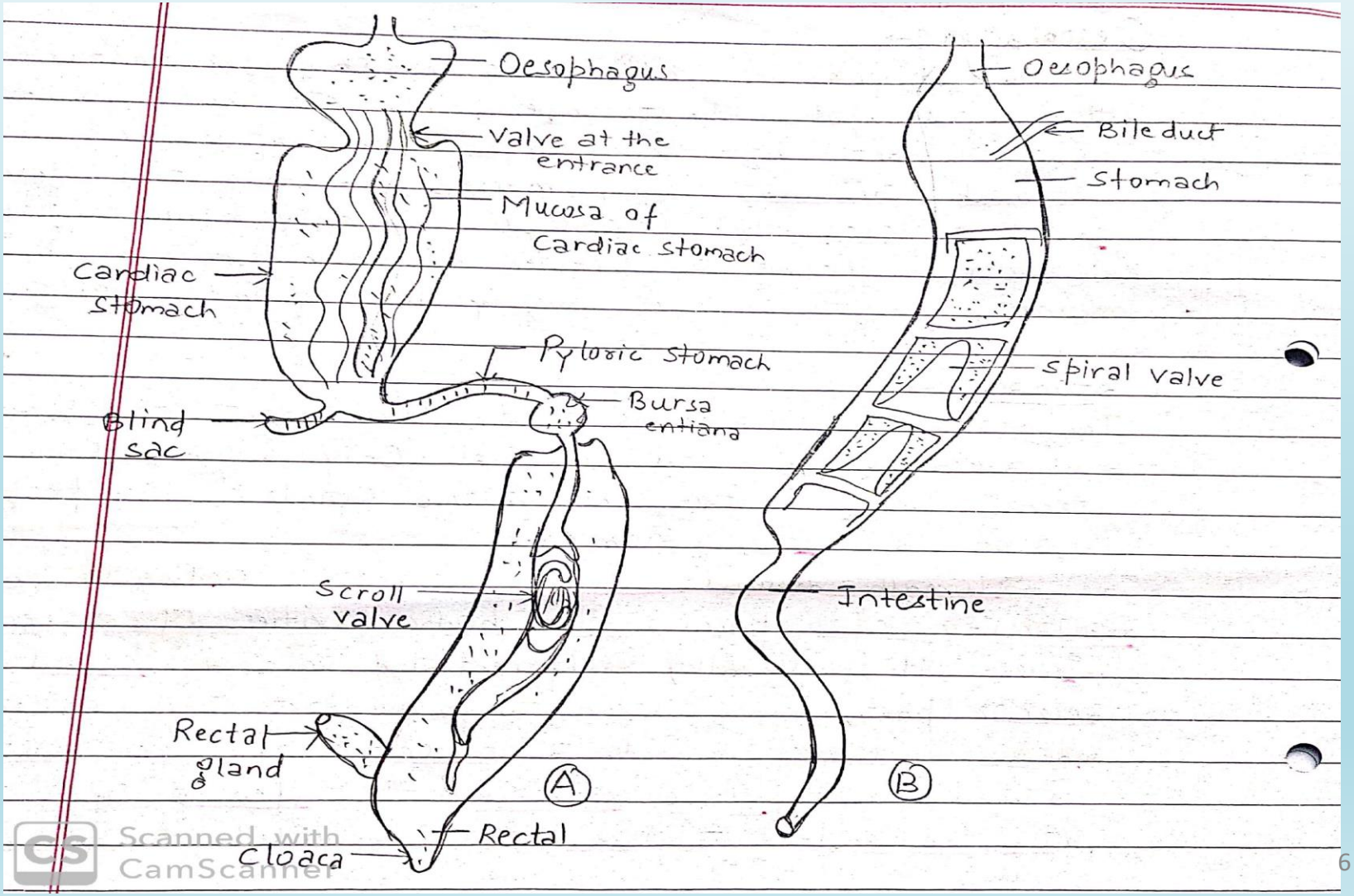
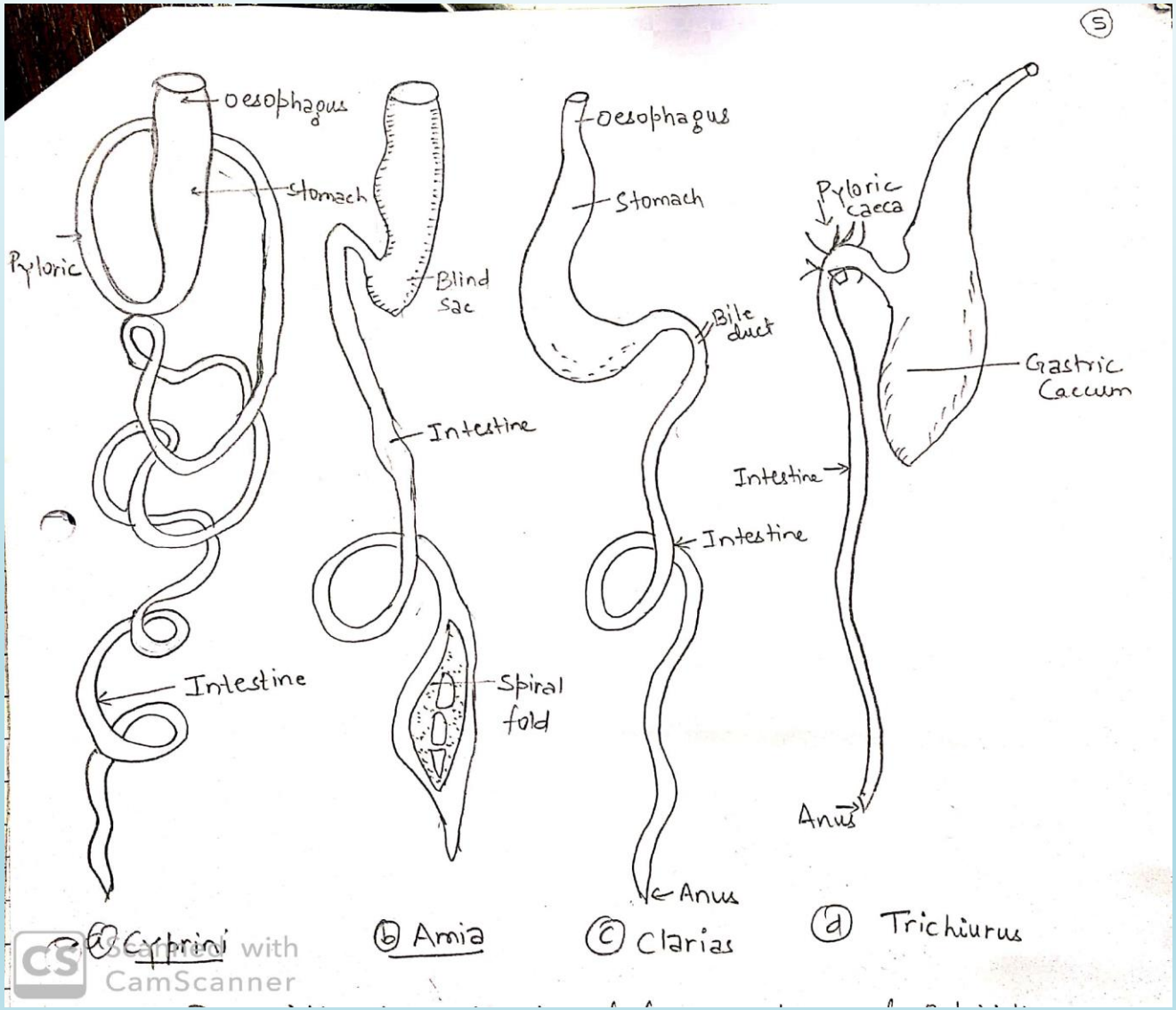


Figure 3. Alimentary Canal of Four Members of Osteichthyes



PARTS OF ALIMENTARY CANAL

- Stomach : The stomach , basically is a structure meant for storage & maceration of food material. Only when, its internal lining contain the gastric glands it is called a true stomach.

Stomach assumes different shapes according to the availability of space in the body cavities of different fishes. It is usually differentiated into a broad intestine part , lying closer to the heart and called cardiac stomach & into a posterior narrower part called the pyloric stomach. The opening of latter into the midgut is usually guarded by a valve.

- Intestine : Following the stomach , the part of alimentary canal is called intestine. It is divisible into two main parts, an anterior long but narrower part called the small intestine and a posterior short but broader part called the large intestine. The part of small intestine lying immediately behind the stomach receives ducts from the liver & pancreas called duodenum while the rest of it is ileum.

PARTS OF ALIMENTARY CANAL

These various intestinal parts are usually differentiated histologically by only a gradual change in the nature of mucosal layer . Only in certain groups, there is a folding marking in the posterior region of intestine.

The length of intestine however depends upon the feeding habit of the fishes. It is relatively shorter in carnivorous than in herbivorous fishes. Generally, the intestine of the fish is shorter & runs a relatively straight course. The short length is compensated by the development of scroll valve in some fishes.

- Pyloric Caeca: Many fishes have pyloric caeca, given off from the portion of the midgut , lying immediately behind the pylorus. These caeca may be blind, tubular or sac like diverticula of uncertain functions. They do not follow any definite arrangement or the organization and vary in numbers in different fishes. Only a single such caecum is found in *Polypterus* , while the number may go upto two hundred in mackerel .

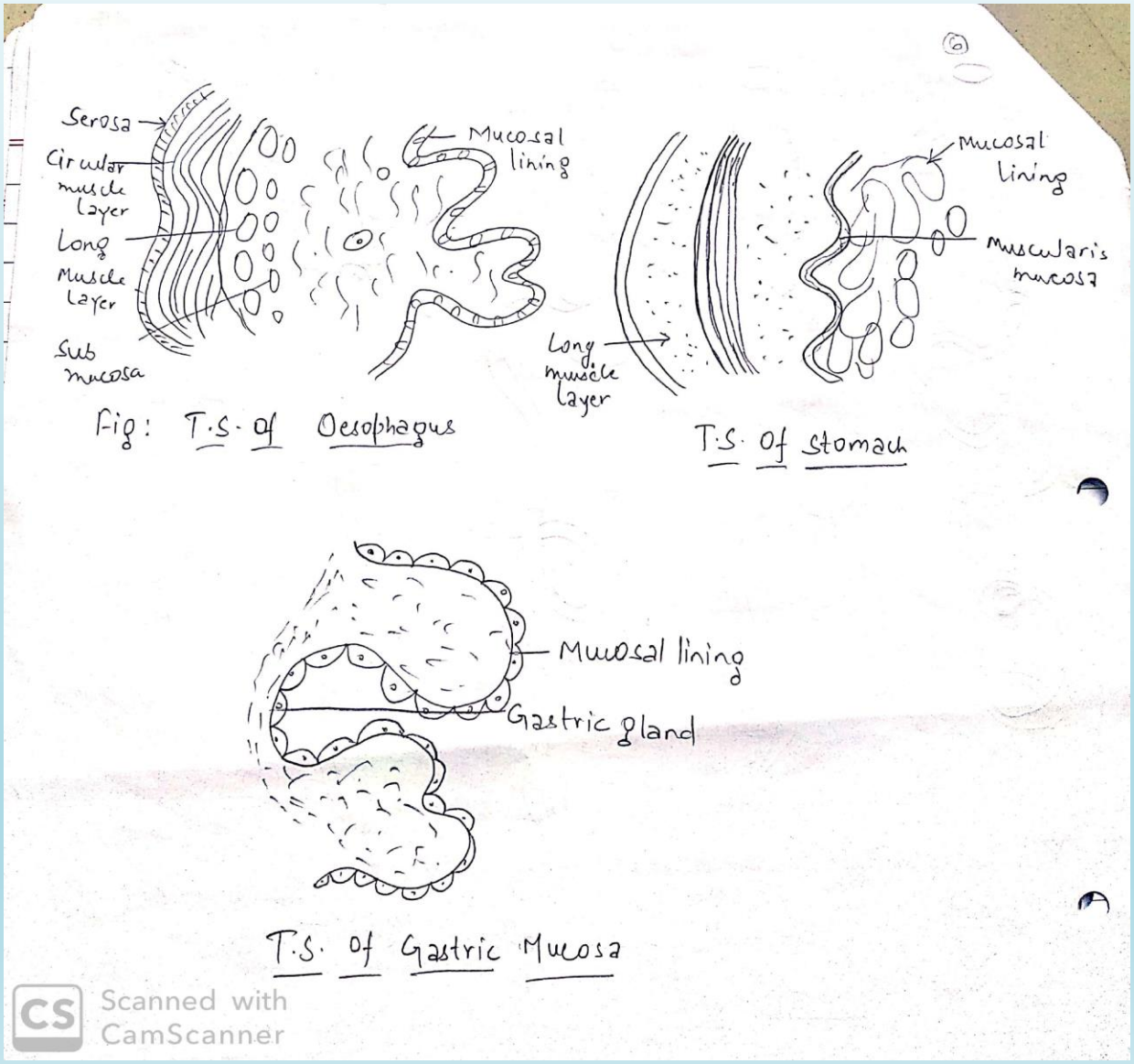
HISTOLOGY OF GUT

Typically the digestive tract of fish comprises the following four layers:

1. Serosa: This is outermost serous membrane of visceral layer of peritoneum. It is usually absent form the part of oesophagus.
2. Muscle Layer: A layer of circular and another longitudinal muscle fibre lie just under the serosa. In stomach, muscle layer is thicker than in other parts.
3. Sub mucosa & Lamina Propria: This layer lies on the inner side of the muscle layer and consists of loosely packed connective tissue.
4. Mucosa Lining: This layer constitutes the innermost lining of the gut. It is composed of stratified squamous epithelium in many fishes and of columnar epithelium in many others (Figure 4).

- ASSOCIATED GLANDS: Main associated glands are associated with liver , pancreas and gastric glands . Pharynx is devoid of glands. Stomach and intestine contain gastric glands. Rectum is almost completely devoid of digestive glands in in fishes.

Figure 4. T. S. of Different Parts of Alimentary Canal



Food and Feeding Habits of Fishes

(A) TYPES OF FOOD

Fishes consume different kinds of food. The food and feeding behavior , therefore , varies characteristically in different species of fishes. Nikoloskii (1963) recognized four categories of fish food.

1. Basic Food: Such food which is preferred most by the fishes. This food is ,therefore , included in large quantities in the diet of the fish.
2. Occasional or Secondary Food: Fish consumes small quantities of food items occasionally that are next to the basic food . This food constitutes the secondary food of the fish.
3. Incidental Food: The articles that enter rarely in the digestive tract of the fish, constitutes the incidental food.
4. Obligatory Food: The food which is consumed during unfavorable condition of non-availability of the basic food is called the obligatory food of the fishes.

(B) Types of Fishes Differentiated on the Basis of Type of Food

1. Plankton Feeders : Some fish species like, *Catla catla, Hilsa ilisha, Gudusia chapra ,Cirrhina reba, Hypopthalymichthyes molitrix* , feed upon phytoplankton and zooplankton, which they obtain by filtering water through their gill rakers .
2. Herbivorous Fishes: These fishes feed upon different vegetations comprising leaves, pieces of stem of vascular and non-vascular plants, flowers etc. including algae. The greatest degree of diversity of herbivores live in the sea and have various type of feeding adaptations. Certain sturgeon fishes ,rabbit fishes and parrot fishes etc. browse and graze the phycobionts (algae) growing over rocks, with the help of their closely set cusped or serrated teeth. Parrot fishes apply their beak and rabbit fishes apply the incisors set in their jaws to browse off hard surfaces.

3. Carnivorous Fishes: These fishes such as *Wallago attu, Mystus seenghala, Channa marulius , Clarias batrachus* etc. feed upon the materials of animal origin like molluscs, crustaceans, fish fry, fingerlings and small fishes etc. present in the aquatic habitat. The carnivorous fishes often behave like predators.
4. Omnivorous Fishes: These fishes consume food materials of both the animal as well as vegetable origin. Sand or mud is also taken in small quantities by several species of fishes along with other items of food. Important fishes of this category are *Cirrhina mrigala. Anabas testudineus, Heteropneustes fossilis Cyprinus carpio Tor tor, Noemacheilus montanus, Barilius bar*ana etc.

(C) Types of Fishes Differentiated on the Basis of Selection of Food

Based upon the extent of variation in the selection of food, Nikolskii (1963) recognized following three categories:

1. Monophagic fishes: feeding upon single type of food
2. Stenophagic fishes: feeding upon certain selected kinds of food
3. Euryphagic fishes: feeding upon a variety of different types of food.

(D) Types of Fishes Differentiated on the Basis of Trophic Niche (occupying in aquatic habitat)

1. Surface Feeders: Fishes mainly feeding upon plankton floating on the surface of aquatic body ex. *Catla catla, Puntius ticto, Hypopthalmichthyes molitrix, Oxygaster bacalia, Chanda nama, C. ranga , Hilsa ilisha, Gudusia chapra etc.*
2. Column or Mid feeders: Fishes which feed along the longitudinal column of an aquatic body ex. *Labeo rohita, Puntius sophore, Tor tor , Wallago attu, Mystus cavasius, M. vittatus etc.*
3. Bottom feeders: Fishes feeding at the bottom of water . These fishes along with the food also happen to consume little amount of mud into their digestive tract. Ex. *Labeo calbasu, L. bata, L. gonius, Cirrhina mrigal, C. reba, Puntius sarana ,Channa marulius, C. striatus etc.*

(E) Types of Fishes on the Basis of Manner of Capture and Ingestion

1. Grazers of Browsers : Fishes which feed either singly or by continual bites made in succession. Salient examples are Blue gill (*Lepomis macrochirus*), Parrot fish, Butterfly fish and various bottom feeders
2. Strainers: Some fishes filter a great amount of water by their specially adapted gill rakers. This device enables them to swallow large amount of food in short time. Ex. Basking shark (*Cetrohinus*), whale shark (*Rhinodon*), teleosts like *Catla catla, Hilsa ilisha, Gudusia chapra and Cirrhina reba.*
3. Parasites : Few fishes derive their nutrition from other fishes and become parasites. Ex. Hag fishes, Lamprey, sucker fish, angler fish(*Ceraties*) etc.
4. Suckers: Fishes sucking the food materials into their buccal cavity and opercular cavities. Ex. *Anguilla anguilla, Tilapia marie, Carassius auratus , Macropodus opercularis* etc.

Food and Feeding Habits of Fishes

- According to Schaperclaus (1933) , the natural food of fishes are classified under three groups:
  - Main Food,
  - Occasional Food ,
  - Emergency Food
- According to Das and Moitra (1955) , surface, column and bottom feeder have been sub-grouped into
  - herbivores ,
  - carnivores and
  - omnivores.
- Hora and Pillay (1962) put plankton and detritus feeding fishes into a separate class as plankton feeder.
- Lagler et al (1977) classified fishes , according to their feeding habits as follows:
  - Predators
  - Grazers
  - Strainers
  - Suckers
  - Parasites

Modifications of Alimentary Canal

The modifications in the digestive tract of fishes are mainly due to various kinds of food and feeding habits of fishes.

❖ Mouth & Jaws:

- The cyclostomes being parasites have a circular jawless mouth. ⟹
- In gnathostomes , the opening of mouth is bordered by jaws. The necessity for the development of true jaws is closely related to the change from microscopic to larger units of food.
- The position of mouth varies in different fishes . Generally it is terminal. Bottom feeders have mouth on the ventral surface, the surface feeders on dorsal side and the column feeders have them terminally placed.

Modifications of Alimentary Canal

- With regards to the shape of mouth , there is also great variation.
- The mouths of grazers and suckers are converted into long flutes by elongation of their jaws.
- *Fistularia villosa*, the pipe fish (*Syngnathus*), the needle fish (*Xenedodon cancila*) & the butterfly fish (*Forcipiger longirostris* have long beak like mouths.
- Highly protractile mouth of *Nandus nadus* and various species of *Channa* & the slightly protractile mouth of Anabas are the adaptations for the increasing gap of the mouth

Modifications of Alimentary Canal

❖ LIP : The mouth is usually guarded by lips. These are fleshy in suctorial fish such as Sturgeon, sucker fishes, *Labeo, Cirrhinus and Puntius*. The lips are very thin or entirely lacking in fishes which consume large particles of food such as carnivorous and omnivorous fishes.

❖ TEETH:

- A few species of fishes are naturally toothless (The sturgeons, sea horse & pipe fishes). In others, a strong correlation between the character of foods, feeding habit and structure of teeth exist.
- The suckers and most of herbivores fishes possess pharyngeal teeth, which may be simple comb like, pointed or curved type or have occlusal molariform surface used in grasping ,tearing or grinding the object of food.
- The teeth of skates (Rajidae, Chimaeras & certain drum fishes) have flattened moniliform teeth to grind the food contents.
- Carnivorous fresh water fishes like cat fishes, air breathing cat fishes have sharply pointed teeth for grasping, puncturing and holding the prey.

Modification of Alimentary Canal

❖ GILL RAKERS :

- The structure of gill rakers gives an indication of the type of food consumed by fishes. In feeder fish(ex. *Hippoglosssus*) , they are large to prevent the prey to escape. Gill rakers of strainers are comb or feather like structure , filtering a large amount of food from water and best developed in plankton feeders(ex. *Hilsa ilisha*)
- In herbivore fishes (ex. *Labeo*) are in the form of broad sieve and those of carnivores like *Mystus* are in the form of hard rasping organs.

❖ OESOPHAGUS: Any modification of oesophagus are generally not found . The oesophagus of carnivores may however be equipped with well developed longitudinal folds distensibly.

Modification of Alimentary Canal

❖STOMACH:

- Various herbivorous species (e.g. *Labeo, Hippocampus* and more commonly the cyprinids lack a true stomach and their intestine seems to start almost from behind the oesophagus. In *Labeo*, a sac like structure behind oesophagus is present which is devoid of any gastric glands.
- The carnivores and predatory fishes (e.g. Amia, Wallago, Mystus, Channa etc.) usually possess a true stomach having tubular gastric glands.
- Certain carnivores and plankton feeder (e.g. Scomberosox, Syngnathus) lack a true stomach.
- Stomach in many other carnivores exhibit modification in relation to the size of their food.
- In Swallowers and Gulpers, it is a highly distensible structure that allows huge sized prey. The stomach of holocephalans and dipnoans is represented by a simple straight tube that has no digestive functions.

Modification of Alimentary Canal

❖ INTESTINE:

- The length of intestine is variable in fishes. It is largely longer in herbivorous fishes than in carnivorous fishes.
- The vegetable matters are more complex than the animal matter and require a long time for digestion.
- Longer intestine are therefore of great advantage to herbivorous fishes.
- In cyprinids ,comprising a wide majority of herbivorous and in stomach less fishes, the intestine is of relatively greater length.
- The spiral fold in the intestine of chondrichthyans is assumed to be structure compensating for the short length of intestine.

CONCLUSION

It can thus be concluded that the adaptive modification of alimentary canal , not only depend on the kind of food and feeding habit of fishes, but also on the availability of various other accessory adaptive features. They are however, species specific.

Suggested Readings:

1. Jhingran VG (1982).Fish and Fisheries of India . Hindustan Publishing Corp. Delhi.
2. Lagler KF, Bardach JE, Miller RR and Passino DM (1977). Ichthyology. John Wiley and Sons, New York.
3. Khanna S S (1970) . An Introduction to Fishes. Central Book Depot. Allahabad, India
4. Pandey K and Shukla JP (2012) Fish and Fisheries. Rastogi Publications, Meerut.

Thanks