

Ecosystems: Concept, Structure and Functions of Ecosystems

BSc. Part I Zoology (Hons) Paper II

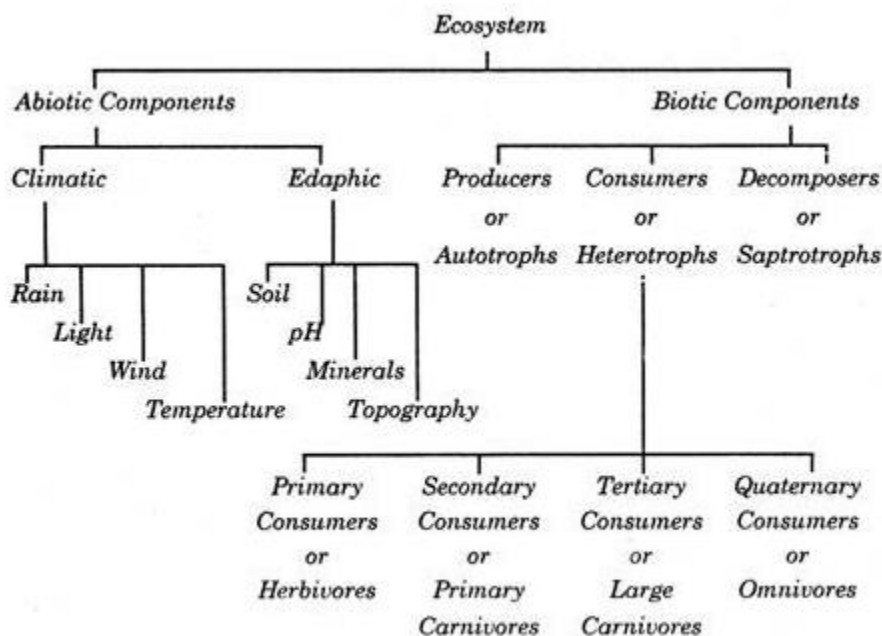
Ecology is the science that deals with the relationships between living organisms with their physical environment and with each other. Ecology can be approached from the viewpoints of (1) the environment and the demands it places on the organisms in it or (2) organisms and how they adapt to their environmental conditions. An ecosystem consists of an assembly of mutually interacting organisms and their environment in which materials are interchanged in a largely cyclical manner. An ecosystem has physical, chemical, and biological components along with energy sources and pathways of energy and materials interchange. The environment in which a particular organism lives is called its habitat. The role of an organism in a habitat is called its niche.

Concept of an Ecosystem:

Living organisms cannot live isolated from their non-living environment because the latter provides materials and energy for the survival of the former i.e. there is interaction between a biotic community and its environment to produce a stable system; a natural self-sufficient unit which is known as an ecosystem.

An ecosystem is, therefore, defined as a natural functional ecological unit comprising of living organisms (biotic community) and their non-living (abiotic or physio chemical) environment that interact to form a stable self-supporting system. A pond, lake, desert, grassland, meadow, forest etc. are common examples of ecosystems.

Structure and Function of an Ecosystem:



Schematic Representation of the Structure of an Ecosystem.

Each ecosystem has two main components:

(1) Abiotic

(2) Biotic

(1) Abiotic Components:

The non living factors or the physical environment prevailing in an ecosystem form the abiotic components. They have a strong influence on the structure, distribution, behaviour and inter-relationship of organisms.

Abiotic components are mainly of two types:

(a) Climatic Factors:

Which include rain, temperature, light, wind, humidity etc.

(b) Edaphic Factors:

Which include soil, pH, topography minerals etc.?

The functions of important factors in abiotic components are given below:

Soils are much more complex than simple sediments. They contain a mixture of weathered rock fragments, highly altered soil mineral particles, organic matter, and living organisms. Soils provide nutrients, water, a home, and a structural growing medium for organisms. The vegetation found growing on top of a soil is closely linked to this component of an ecosystem through nutrient cycling.

The atmosphere provides organisms found within ecosystems with carbon dioxide for photosynthesis and oxygen for respiration. The processes of evaporation, transpiration and precipitation cycle water between the atmosphere and the Earth's surface.

Solar radiation is used in ecosystems to heat the atmosphere and to evaporate and transpire water into the atmosphere. Sunlight is also necessary for photosynthesis. Photosynthesis provides the energy for plant growth and metabolism, and the organic food for other forms of life.

Most living tissue is composed of a very high percentage of water, up to and even exceeding 90%. The protoplasm of a very few cells can survive if their water content drops below 10%, and most are killed if it is less than 30-50%.

Water is the medium by which mineral nutrients enter and are trans-located in plants. It is also necessary for the maintenance of leaf turgidity and is required for photosynthetic chemical reactions. Plants and animals receive their water from the Earth's surface and soil. The original source of this water is precipitation from the atmosphere.

(2) Biotic Components:

The living organisms including plants, animals and micro-organisms (Bacteria and Fungi) that are present in an ecosystem form the biotic components.

On the basis of their role in the ecosystem the biotic components can be classified into three main groups:

(A) Producers

(B) Consumers

(C) Decomposers or Reducers.

(A) Producers:

The green plants have chlorophyll with the help of which they trap solar energy and change it into chemical energy of carbohydrates using simple inorganic compounds namely water and carbon dioxide. This process is known as photosynthesis. As the green plants manufacture their own food they are known as Autotrophs (i.e. auto = self, trophos = feeder)

The chemical energy stored by the producers is utilised partly by the producers for their own growth and survival and the remaining is stored in the plant parts for their future use.

(B) Consumers:

The animals lack chlorophyll and are unable to synthesise their own food. Therefore, they depend on the producers for their food. They are known as heterotrophs (i.e. heteros = other, trophos = feeder)

The consumers are of four types, namely:

(a) Primary Consumers or First Order Consumers or Herbivores:

These are the animals which feed on plants or the producers. They are called herbivores. Examples are rabbit, deer, goat, cattle etc.

(b) Secondary Consumers or Second Order Consumers or Primary Carnivores:

The animals which feed on the herbivores are called the primary carnivores. Examples are cats, foxes, snakes etc.

(c) Tertiary Consumers or Third Order Consumers:

These are the large carnivores which feed on the secondary consumers. Example are Wolves.

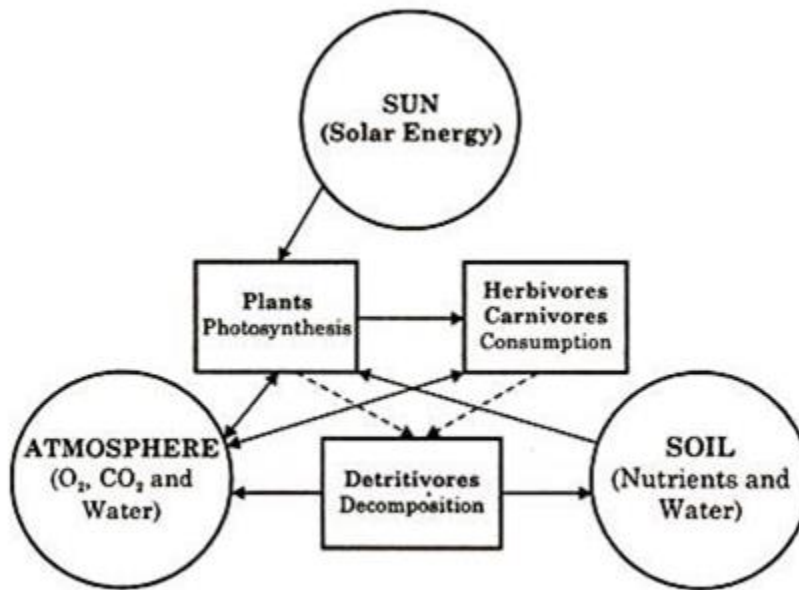
(d) Quaternary Consumers or Fourth Order Consumers or Omnivores:

These are the largest carnivores which feed on the tertiary consumers and are not eaten up by any other animal. Examples are lions and tigers.

(C) Decomposers or Reducers:

Bacteria and fungi belong to this category. They breakdown the dead organic materials of producers (plants) and consumers (animals) for their food and release to the environment the simple inorganic and organic substances produced as by-products of their metabolisms.

These simple substances are reused by the producers resulting in a cyclic exchange of materials between the biotic community and the abiotic environment of the ecosystem. The decomposers are known as Saprotrophs (i.e., sapos = rotten, trophos = feeder)



Relationship within an Ecosystem.

Parental Care in Fishes | Vertebrates | Chordata

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Parental care can be defined as an association between the parents and the offsprings, to increase the chances of the survival of the young ones, and in fishes it includes all the post-spawning care of the offsprings by the parents. Most fishes do not care for their eggs or young and leave the spawning grounds soon after fertilization.

The lack of parental behavior is correlated with production of great numbers of eggs and sperms. However, there are many fishes where definite parental care has been evolved. Various devices have been adopted to ensure proper development of the eggs into adults. One or both the sexes may participate in the process. These include selection of a suitable site, nest building and various other methods of protection of the larvae.

Species that do not exhibit any special device for safety of the ova generally produce a very large number of eggs to increase the chances of survival of at least a few of them. Eggs of many species possess various mechanisms for attachment to stones, pebbles or aquatic vegetation, so that they are prevented from being washed away with the current of water.

Nest Building:

Some fishes prepare crude nests for egg laying. At first, a suitable place for preparing the nest is selected and some species may defend the place until death. Males of many species like the Darters (*Etheostoma*), sunfishes and cichlids, prepare a shallow basin- like nest for laying eggs by females. The stones and pebbles are removed from such nest and male keeps close watch over the eggs until hatching.

A few species, however, leave the nest unprotected. Many freshwater fishes prepare crude nest with aquatic vegetation where eggs are laid. *Protopterus* and *Lepidosiren* prepare deep hole into which the females lay eggs. Males protect the nest till development is complete. *Amia calva* (bowfin) prepare a crude circular nest among aquatic vegetation.

The fertilized ova are protected by male who keeps guard over the nest till the young ones are hatched. The young ones are allowed to leave the nest in a body under the protection of father. Both the male and female of some cat fishes of North America prepare a crude nest in the mud for egg-laying. The nest is sometimes provided with protective cover of logs, stones, etc.

Most interesting example is provided by the male stickleback *Gasterosteus aculeatus*, a small freshwater fish of North American lakes and ponds. The male fish actually builds a nest of dead aquatic weeds which are joined together by a sticky secretion produced from the kidneys.

When the nest assumes a considerable size, the male makes a small tunnel. After the formation of tunnel and an elaborate courtship ritual, the male drags a mature female into the tunnel for laying eggs. After laying eggs, the female swims away and the male keeps watch over the fertilized eggs till development is over.

In addition, foamy nest prepared by blowing of bubbles of air and sticky mucus are also encountered in many fishes. The bubbles of air and mucus adhere to form a floating mass of foam. The eggs are collected by the male in his mouth cavity and he throws them in such a way that the eggs can adhere to the lower surface of foamy nest. This type of caring for eggs is found in *Betta*, *Macropodus* and many other fishes.

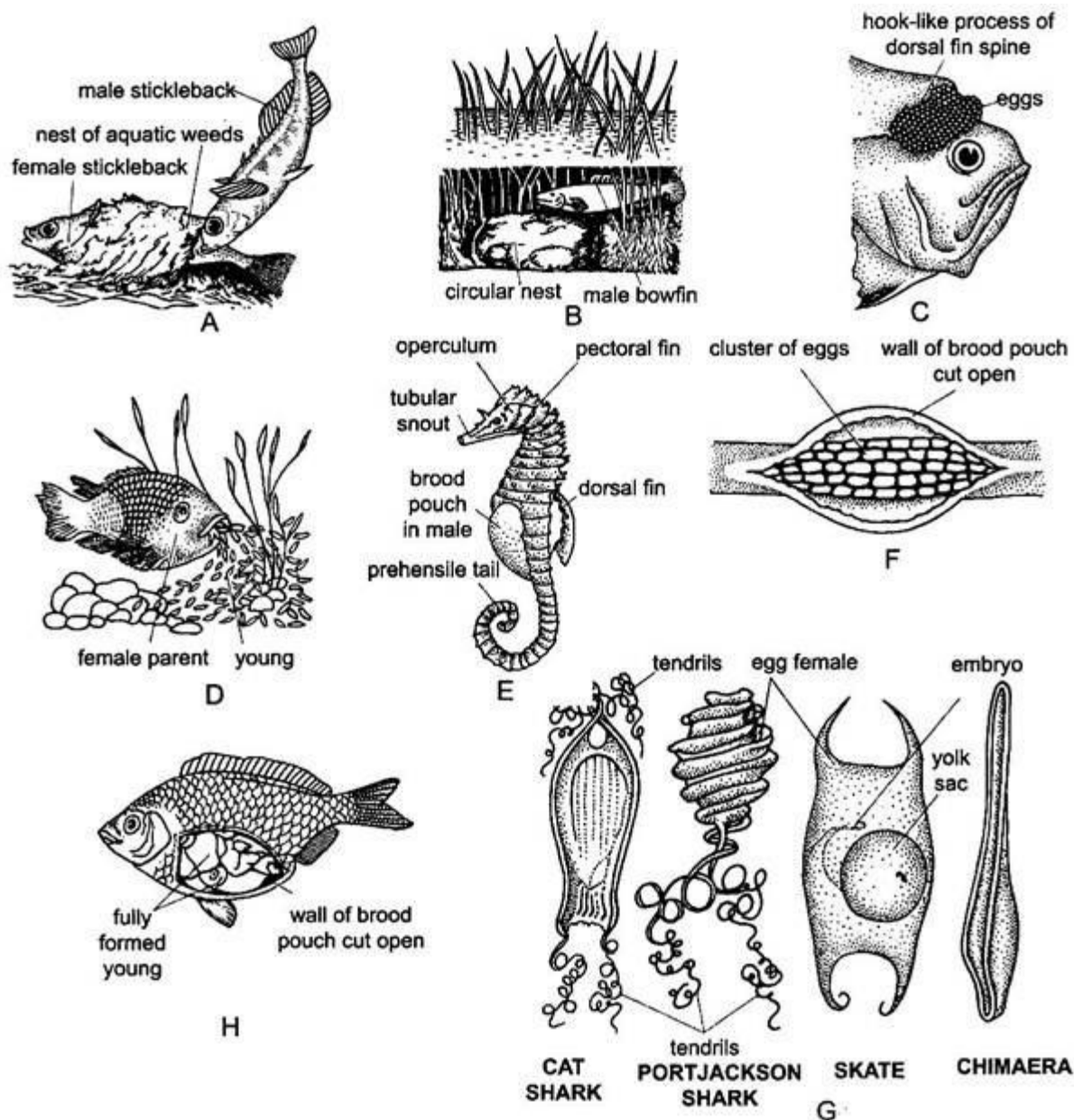


Fig. 17.9. Some interesting examples of parental care in fishes. A—Male stickleback (*Gasterosteus aculeatus*) muzzles female at the base of tail to stimulate her to lay eggs in a nest of dead aquatic plants; B—Male bowfin (*Amia calva*) guarding over circular nest; C—The male Australian *Kurtus* incubates eggs on its forehead; D—Very young of *Tilapia massambica* take refuge in female parents buccal cavity in times of danger; E—A male *Hippocampus* carrying brood pouch; F—Brood pouch of male *Syngnathus* opened to show eggs; G—Mermaids purses for eggs; H—Body cavity of *Cymatogaster aggregatus* cut open to show a fully formed young ready for hatching.

Mouth Cavity as Shelter:

In some species, eggs develop within the mouth of the parent. In many cichlids, the female carries the eggs in her oral cavity. After hatching, the young fry do not leave the shelter for some time, and swim about in water very near the mouth, so that they can return to it in case of danger (found in *Tilapia*). In the catfish, *Arius* the male carries the eggs and young ones in his mouth, and does not take food during this period.

Coiling Round Eggs:

In butterfish, *Pholis* rolls the eggs into a rounded ball and then one of the parent's remains on guard, possibly male, guards the egg-ball by coiling round it.

Attachment to Body:

In *Kurtus indicus* (Perciformes) the male develops a bony hook projecting from the forehead and is supported by a special process of skull bone. The eggs are grouped in two bunches with the help of filamentous processes of the egg membrane. The eggs are attached to the hook of the forehead; in such a way that one bunch of eggs lies on either side of the head of the male, as he swims in water.

Formation of Integumentary Cups:

In a catfish, *Platystacus* of Brazil, shows an interesting method of parental care. During breeding season, the skin of lower surface of the body of the female fish becomes soft and spongy. Immediately after fertilization of the eggs, the female presses her body against the eggs in such a way that each egg becomes lodged in a small integumentary depression. Each egg is attached inside the cup by an inconspicuous stalk. The eggs remain in this position until hatching.

Development of Brood Pouches:

In the pipefish, *Syngnathus* and the sea horse, *Hippocampus* the eggs develop within the broad pouch of the male. The female transfers the eggs into the brood pouch and development takes place within the brood pouch.

Mermaid's Purses:

Oviparous sharks (e.g., *Scyllium*) lay fertilized eggs inside the protective horny egg capsules or mermaid's purses, which remain anchored to the seaweeds by their long tendrils. The young hatch out after rupturing the egg case.

Viviparity:

The highest degree of parental care is found in viviparous fishes where young develop within the oviduct of the female. A few species are viviparous, such as the dog-fish, *Scoliodon* and the surf fish *Cymatogaster aggregatus*. Both fertilization and development are internal. Mostly a yolk sac placenta nourishes developing embryos and the young are born with the characteristic of the adult. Viviparity provides maximum protection and represents the highest degree of parental care.