DEEP SEA ADAPTATIONS

Deep sea is characterized by a set of environmental conditions, which in turn determine the adaptations of deep-sea forms. Usually lightless sea bottom is referred to as deep sea, i.e., from lower limit of littoral zone (200 metres deep) to the ocean floor.

The benthic division includes Bathyal (200 m – 400 m), Abyssal .(4000 m – 6000 m), and Hadal (from 6000 m and below) zones, Pelagic division includes Mesopelagic (200 m – 1000 m), Bathypelagic (1000 m – 4000 m) and Abyssopelagic (4000 m and below) zones. The physical characterization of deep sea conveys the nature of adaptation of animals.

Of all the oceanic zones, light penetrates only into the euphotic zone; the remaining zones are aphotic or devoid of light (bathyal, abyssal and hadal zones).

The term hadal zone is used to designate the perpetually cold and dark supreme depths of the ocean.

CHARACTERISTICS OF DEEP SEA:

It is characterized by high pressure, low temperature, absence of light, calmness of water, absence of phytoplankton and other producers, scarcity of food and resulting competition and soft bottom.

i. Temperature: Below 3000 ft. the temperature in about 37° F or less. In the great 'deeps' the water is ice cold, averaging about 32° F. There is no diurnal and seasonal fluctuation.

ii. Quiescence: Below the limit of disturbance caused by the storm wave, i.e., about 600 ft. and below the average depth of the tidal action all movements of sea wave are exceedingly slow.

iii. Darkness: The distance to which light penetrates varies with the angles of the sun rays and the clarity of the water. Generally below 1200 ft. light does not penetrate. So there is endless darkness in deep-sea.

iv. Pressure: The atmospheric pressure at sea level is about 7 kg/sq inch. This increases enormously to about 1 ton/sq inch for every 6000 ft. Therefore, in greater depth, the pressure is unbelievably high.

v. Green Plants: Beyond the light zone green plants are totally absent, i.e., ecologically, no producer is present in deep-sea.

vi. Other Characters: Deep-sea water possesses uniform salinity (3.5 – 3.7%), as no external factors can affect its water qualities. Oxygen content is comparatively low (3.29 – 5.9 c.c/litre of water), because there are no producers, which generally contribute oxygen during day-time.

vii. Sea Floor: The ocean floor generally is a vast undulating plain with occasional volcanic and other elevations. The floor of the sea is usually carpeted with mass of land material and organic materials. Organic materials are either excretory and secretory products or carcasses of the upper inhabitants. The organic remains are known collectively as oozes. The oozes are of following types.

(a) Pteropod Ooze: This layer consists of lime shells of pteropod mixed with other organic remains ranging at a depth of 3000 – 9000 ft.

(b) Globigerina Ooze: This layer includes shells of foraminifera's and other organic material and ranging from 9000 – 15000 ft. Beyond 12000 ft Radiolarian and Diatom oozes are evident.

(c) Red Clay: Beyond 15000 ft. red clay is found.

viii. Food Supply: Oozes constitute the sole food supply to the depth, i.e., dead organisms of upper level, when die, come down to the deep sea and provide food for the deep-sea organisms. Sometimes decomposers, like bacteria and fungus are also used as food. So deep-sea animals are either oozivorous or carnivorous due to lack of vegetation.

Adaptations:

Apart from containing bacteria and perhaps fungi, the community of aphotic zones is characteristically animal. Because of lack of cues like light and temperature change, it was once thought that there was no seasonality in the deep sea, but this is not so. The amount of detritus coming into deeper waters depends on seasonal production cycles at the surface. Due to extreme pressure the bodies i deep-sea fish and other animals are very much compressed. Some bathypelagic fishes are economy' designs showing reduction of bony skeletons except for their jaws and contain watery muscles.

In some of them e.g., angler fish (Melanocetus) and gulper eel (Eurypharynx) the water content is very high, about 95%. Even without gas-filled swim bladders, they are near neutral buoyancy. Their hearts are very small, they have very little red muscle and low haematocrit values.

Some deep-sea fishes exhibit greatly enlarged eyes or the so-called telescopic eyes, which are highly effective in visioning lights of very low intensity. In some deep-sea fishes the retina is composed of a number of tiers of rods, presumably arranged to absorb all the limited light that enters the eye (Nicol, 1989). In some other deep-sea fishes, eyes are very small as they are of little apparent use, and still others are without eyes.

Many deep-sea animals produce their own light by means of luminous organs, e.g., lantern fish. In anglerfish, Linophryne (Fig 2.4), the light is used as a bait to attract prey. Besides attracting and seeing the prey, luminescent display may also serve for species and sex recognition. Another interesting adaptation of deep-sea fish is the enormous mouth enabling them to swallow prey larger km themselves (e.g., the gulper, Eurypharynx, whale fish, Cetomimus).

All benthic fishes lack pnm bladders and rest on the bottom, sometimes like tripod fishes (Bathypterois spp.) on stiff elongate fin rays (Fig 2.4). Correlated with soft substratum, many of the deep-sea animals have long appendages, abundant spines, stalks or other means of support, as illustrated by tripod fish, lampshells and crinoids. Perhaps these appendages are very useful in the darkness and serve for contact reception, or compensate for the difficulties of vision.

Other Adaptations of Deep-sea Animals

We've described many of the unique adaptations that animals of the deep-sea have evolved to cope with their harsh environment. Let's look at some others, not all of which are fully understood.

1. **Body Color:** This is often used by animals everywhere for camouflage and protection from predators. In the deep sea, animals' bodies are often transparent (such as many jellies and squids), black (such as blacksmelt fish), or even red (such as many shrimp and other squids). The absence of red light at these depths keeps them concealed from both predators and prey. Some mesopelagic fish such as hatchetfish have silvery sides that reflect the faint sunlight, making them hard to see.

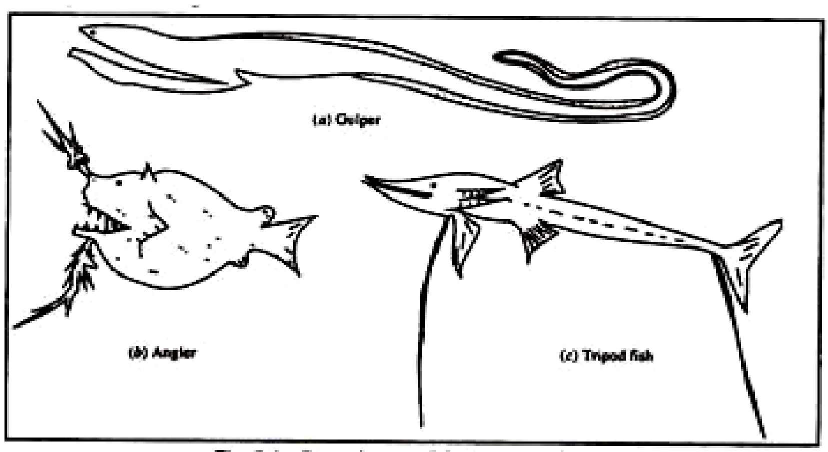

Fig. 2.4. Some deepsea fish. (not to scale)

2. **Reproduction:** Consider how hard it must be to find a mate in the vast dark depths. For most deep sea species, we do not know how they achieve this. Earlier we noted that unique light patterns may aid in this. Deep-sea anglerfish may use such light patterns as well as scents to find mates, but they also have another interesting reproductive adaptation. Males are tiny in comparison to females and attach themselves to their mate

using hooked teeth, establishing a parasitic-like relationship for life. The blood vessels of the male merges with the female's so that he receives nourishment from her. In exchange, the female is provided with a very reliable sperm source, avoiding the problem of having to locate a new mate every breeding cycle.

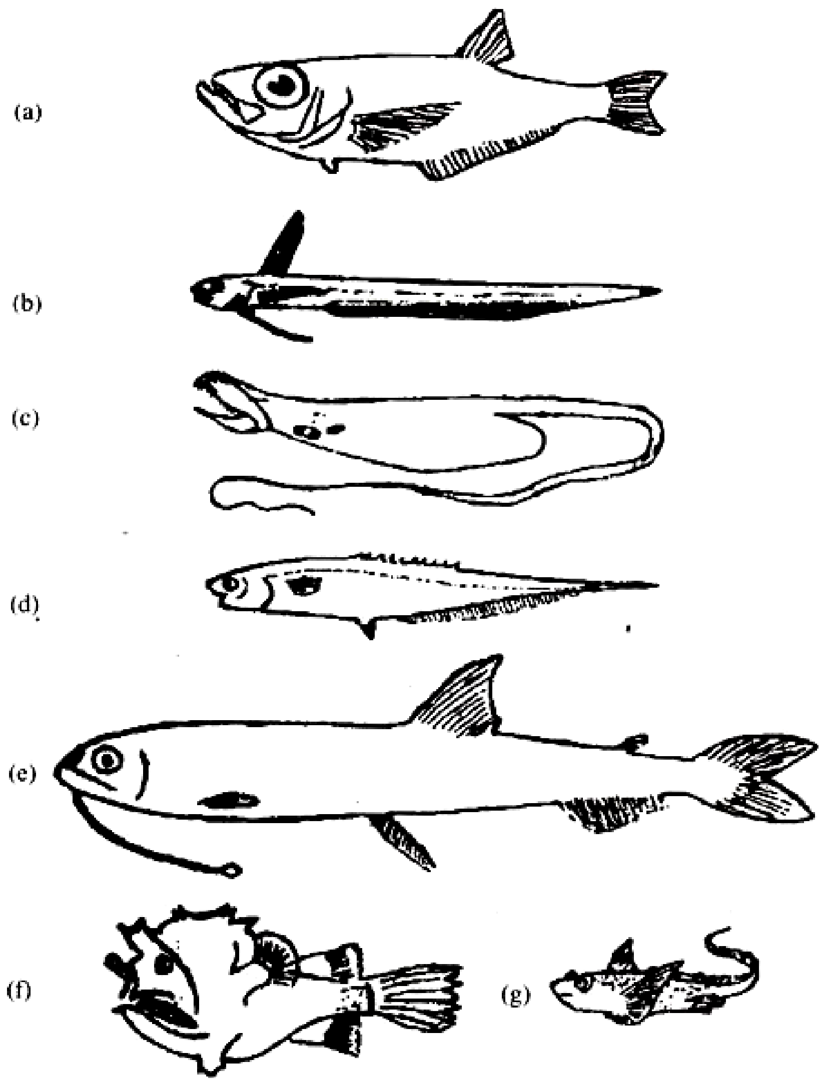

Fig. 4.31 : Some deep-sea fishes : (a) deep-sea herring (*Bathyclupea*), (b) ateleopid (*Ateleopus*), (c) swallower (*Saccopharynx*), (d) deep-sea spiny eel (*Notacanthus*), (e) deep-sea snaggletooth (*Astronesthes*), (f) deep-sea anglerfish (*Photocorynus*) and (g) ratfish (*Chimaera*).

1. **Gigantism:** Another possible adaptation that is not fully understood is called deep-sea gigantism. This is the tendency for certain types of animals to become truly enormous in size. A well-known example is the giant squid, but there are many others such as the colossal squid, the giant isopod, the king-of-herrings oarfish (which may be the source of sea-serpent legends), and the recently captured giant amphipod from 7,000 m in

the Kermadec Trench near New Zealand. While the giant tubeworms of hydrothermal vents (see below) grow well due to abundant energy supplies, the other gigantic animals live in food-poor habitats, and it is not known how they achieve such growth. It may simply be a result of the feature we examine next: long lives.

2. **Long Lives:** Many deep-sea organisms, including gigantic but also many smaller ones, have been found to live for decades or even centuries. Long-lived fishes include rattails or grenadiers and the orange roughy, which are of special concern as they are targets of deep-sea fisheries. These species reproduce and grow to maturity very slowly, such that populations may take decades to recover (if at all) after being overfished. This has happened repeatedly to the orange roughy, a deep-sea fish easily found congregating around seamounts in the southern oceans. Once fisheries have wiped out one seamount population, they move on to another seamount. [see Rough seas for orange roughy: Popular U.S. fish import in jeopardy]

Examples of Deep-sea Vertebrates:

(i) Swallower (Snccopharynx): They have very long slender body with enormous jaws.

(ii) Linophryne: In this animal pelvic fins and scales are absent, colour is black, the fin rays are tipped with luminous organs to attract the pray.

(iii) Silver Sharks: They have huge eyes, long body and tail.

(iv) Ipnops: They have no eyes but two large luminescent organs are present on the head.

(v) Cryptosaras: They have fusiform shape with elongated luminescent organ on the head region while the broadest trunk region bears another luminescent organ.

(vi) Raffish (Chimaera): It is also called as ‘king of Herrings’. It possess short nose and elongated shark-like body