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Migration of Fishes- A Spectacular Event of Nature

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Abstract: *Migration is a natural and common phenomenon seen in both aquatic and terrestrial organisms. They migrate for feeding, spawning, escaping from predators or avoiding extreme climatic conditions. Many fish species wander annually from one area to another. Migratory fishes either alone or in schools make drifting migration from spawning area to nursery area for recruitment, feeding migration from nursery area to feeding area for growth and spawning migration from the feeding area to spawning area for reproduction. The migratory patterns of fishes are very much related to oceanographic factors and currents. Unfortunately, during the migration, several migratory fish species are severely threatened. Every migration of fishes involves a wide range of threats, frequently caused by man-made obstacles, mainly dams, weirs and sluices gate, which disturb the natural flow of rivers and prevent successful migration. If these migratory fishes cannot reach their breeding ground, the species will decline and ultimately become extinct.*

Key words: **Drifting migration, shoaling, spawning oceanographic factors**

1. INTRODUCTION

Fishes account for one-half of all the species of living vertebrates. This kind of diversity is present in large part due to its high number of niches and habitats available all across the planet covered by mainly water bodies. The reason for the great diversity of habitats is high spatial and temporal heterogeneity in resources. This led to the evolution of a remarkably rich suite of migratory behaviors that allow fishes to productively exploit nearly all aquatic environments on earth (*Grubbs and Kraus, 2019*). The term migration refers to predictable movements between areas or habitats, related to resource availability, in which the migrants are compelled to return to their place of origin, *(Heape 1931*). Migration is the movement of a large number of animals, birds, reptiles from one place to another for feeding, reproduction or climate change. When large numbers of fishes like herring, sardine, anchovies, etc come together and move socially it is called shoaling. But sometimes migrating fishes exhibit a high degree of coordination in their movements and carry out synchronized maneuvers to produce different types of shapes. This type of behavior is called schooling which is mainly observed in tunas and sardines *(Anon 2020)*[1]. However, most of the migratory fishes are valuable fishery resources and contribute to economic development to the fisherman and fishing industry.

2. What is Migration?

Animal migration is one of nature's most amazing events that have fascinated humans for long. The movement of a large number of fishes from one place to another for the purpose of feeding, spawning, sometimes refuge seeking from predators and to escape weather extremities in a certain period of the time interval is termed as "migration". Approximately 2.5% of all fishes undergo migration at least once in their life cycle (*Binder et al. 2011)*. According to Baker (1998), it is 'the act of moving from one spatial unit to another'. Usually, fishes live in a constant habitat and restrict their movement to that particular territory but, there are few species of fish that wander from one place to another. Actually, they are the marathoners of the fish world, just like the Atlantic salmon, which migrate 6,000 miles annually to go back to the freshwaters where they reproduce to generate new salmons. They can cover the range from hundreds of meters, as in some coastal and stream-dwelling fishes, to thousands of kilometers, as in eels (*Anguilla spp.)*. It is one of the most essential phenomena for their existence because a single habitat cannot provide sufficient food for long term survival. There are several fish species which migrate for spawning and feeding such as Cod (*Gadus morhua*), Herring *(Clupea harengus*), and Salmon *(Salmo sp.*) Eel *(Anguilla anguilla)*, Hilsa (*Hilsa ilisa*), three-spined stickleback (*Gasterosteus aculeatus*), lampreys (*Petromyzon marinus*), tunas (*Thunnus thynnuss*)

3.0 Classification of fish migration

Fish migration is typically classified into three main categories based on their relationships with the environment (*Binder et al., 2011*).

3.1 Oceanodromous migration

These fishes are truly migratory fishes that live entirely and migrate to the sea. Some fish species like cod, herrings, mackerels, tunas, travel a long distance in the sea to deposit their eggs and later return to their feeding ground. Atlantic herrings take long journeys in the sea from deeper hotter ocean water to the shallow colder shores for the purpose of spawning.

3.2 Potamodromous migration

Fish migration remains confined to the freshwater such as carps, trout, teleosts, catfishes and perches that travel long distances in the freshwater in search of spawning ground. After laying eggs at suitable places they return back to their feeding area.

3.3 Diadromous migration

The migration of fishes that crosses the boundary of freshwater and seawater is called as diadromous e.g., Pacific salmonids. There are further three sub-categories of diadromous- anadromous, catadromous and amphidromous.

3.3.1 Anadromous - These are the diadromous fishes that live a major of their life in the saline water and fully grown adults migrate to the freshwater during spawning season e.g., Pacific salmon. Salmon and Hilsa have been found to cover several kilometers of distances in the sea. They migrate in pairs. During the journey, black spots develop on the body of female Salmon and red spots on the body of male Salmon.

3.3.2 Catadromous - This includes those diadromous fishes which live in freshwater but when they become fully mature, they migrate to the sea for breeding purposes. Freshwater eel is the best example of this type of migration as they cover thousands of km of distances to reach the spawning ground in the sea. There are about sixteen species of freshwater eel. The yellow color of European eel represents the feeding and growing phase but when their color changes to silver, it represents the breeding phase. It is also believed that eel breeds at the depth of about 400-500 meters below the low surface at 14-16 degrees Celsius.

3.3.3 Amphidromous- This is the last subcategory of diadromous migratory fishes. This happens when there is a brief excursion from freshwater to saltwater and vice-versa during their juvenile stage, but the majority of feeding, growth, and spawning occurs in freshwater. It is most commonly seen in the fishes inhabiting islands in the tropical and subtropical regions (e.g., *Sicydiine gobies, Sicydiums spp*.)

Migration can also be classified on the basis of temporal scale over which the migratory cycles occur. Most freshwater fish migration is "seasonal", and population movements occur in response to changes to seasonal shifts in food availability, predation risk, or spawn in habitats which are optimal for sexual maturity and survival. However, a number of fish species perform migrations at a much smaller temporal scale.

3.4 Diel vertical migration

The migration of fishes to the up and down the water column has been seen in a number of freshwater fish species *(Mehner 2012*). For example, juvenile Bear Lake sculpin *(Cottus extensus Bailey and Bond, 1963*) of <30 mm in length spend the day at the bottom of lakes and then vertically migrate 30–40 m to the surface waters during the night *(Neverman and Wurtsbaugh 1994).* The most plausible general explanation for such a regular event is that phytoplankton is to be found in the euphotic zone, near the surface.

3.5 Diel horizontal migrations

Furthermore, many fish species perform a "diel horizontal migration", where they migrate from the littoral zone of lakes into offshore areas at dusk and then return to the littoral zone at dawn (e.g., Gliwicz et al. 2006; Muška et al. 2013). Much larger seasonal horizontal migrations occur that are related to spawning and feeding. These are often depicted in the form of oscillatory triangular movements. Matured Atlantic cod migrate to the Norwegian coast to breed in the spring. After spawning they return back to the offshore feeding grounds to recover.

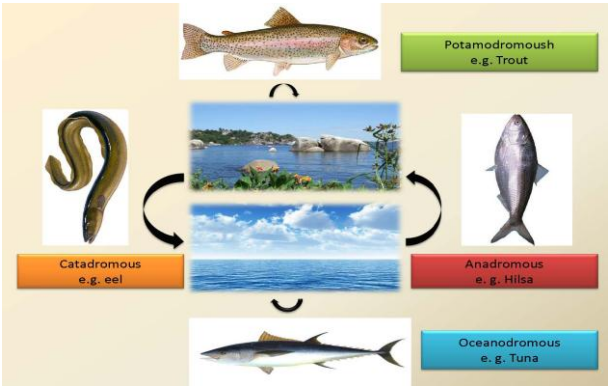

Fig: Types of migration

4.0 Purpose of migration

The purpose of migration varies from animal to animal. Migratory behavior in fishes is a regular phenomenon. They travel to feed, breed and seek refuge from their enemies.

The following are the possible reasons for the basis of migration of fish-

4.1 ***Alimentary or Feeding migration:*** Fish migrates in search of feeding ground. It occurs when food resources get exhausted or limited in a particular region.

4.2 ***Gametic or spawning migration:*** It occurs during the breeding season in search for the suitable spawning ground. They migrate to the breeding ground and after laying eggs they return back to their place.

4.3 ***Climatic or seasonal migration:*** Sudden changes in temperature either extremely hot or cold, it causes the fish species to migrate in search for suitable climatic conditions. They live and get adapted to that particular environment.

4.4 ***Osmo-regulatory migration:*** Migration for water and electrolytes balance from sea to fresh water and vice-versa to maintain their metabolic activities and proper growth development.

4.5 ***Juvenile migration:*** It is the larval migration from spawning ground to the feeding habitats of their parents.

5.0 Factor influencing migration

The influence of environmental factors on migration is one of the most important themes to study where every factor is correlated to one another. Migrations in fishes are affected by several factors that can be classified into extrinsic and intrinsic factors.

5.1 Extrinsic Factors

Migration is triggered by various extrinsic factors such as precipitation, water level, current and discharge, lunar cycle -it has been noted that maturing adult eels migrate downstream while juvenile eels migrate upstream during the new moon (*Helfman et al., 1997*), photoperiod, temperature, dissolved oxygen concentration, turbidity, and watercolor, salinity, pH, the smell of water fish density, hunger and apparition of certain insects all contribute to the physical factors.

5.2 Intrinsic Factors

Migration requires sexual maturity, blood, food, memory, physiological clock, hormones secretions. It is an innate and instinctive behavior in organisms and is a genetic makeup that develops this instinct in the concerned species. The intrinsic factors include thyroxin, prolactin, growth hormone, somatostatin, insulin-like growth factor -1(IGF-1), gonadotropin-releasing hormone (GnRH), luteinizing hormone, follicle-stimulating hormone (FSH), testosterone (T) etc has either a direct or indirect role in triggering fish migration (*Nabi Ghulam et al.,2014*).

5.3 Anthropogenic Impacts on Migration

Humans have a long history of interference with nature. Fish migration is no more exception to this problem. Probably, the most obvious way in which our activities disrupt fish migration is through the construction of dams, weirs, culverts, etc that act as barriers to migration in streams and rivers and break stream continuity. Today's era is a machinery era where rapid development is taking place all across the globe. Due to industrialization, the ecosystem is getting disturbed. Certain toxicant substances from the factories or industries are thrown into the water bodies which are ultimately deteriorating the physical and chemical nature of water. These pose negative impacts on the olfactory, lateral line organ, metabolism, and swimming performance leading to delay or failure in the migration of fishes (*Ghulam Nabi et al., 2014)*. Damming is one of the most widespread environmental alterations of rivers that affect about half of all large river systems across the globe *(Nilsson et al., 2005; Grill et al., 2015).* The consequences include habitat fragmentation, loss and degradation, and changed hydrological regimes. Damming results in fragmentation is particularly troublesome as the aquatic organisms are very much limited to linear routes and cannot find different pathways to reach their destination point. River ecosystems comprise diverse communities of fish with many migration modes, partaken on different spatial and temporal scales and between different habitats (*Tamario Carl et al., 2019*).

6.0 CONCLUSION

Migration delay or failure is a key factor for species extinction and reduces the availability of fish for human consumption. It is very unfortunate that many migrating fish species are under increasing threats by exploitation, pollution, habitat destruction, dispersal barriers, overfishing and ongoing climate change that brings modified, novel, more variable and extreme conditions and selection regimes. This raises a question on their survival.

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