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MIGRATION IN FISHES: A REVIEW

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ABSTRACT
A review of migratory activity in fishes reveals that migration is important for the completion of life cycle. Recent studies have increasingly demonstrated the wide spread existence of spatio-temporal variations in the abundance and distribution of species of freshwater fishes, previously assumed not to move between habitats. These movements are often for spawning, feeding and refuge, and in many cases are fundamental for the successful completion of life cycles. Chemical and physical changes in water environment affect the migration of fish. Most fish undertake feeding, breeding or wintering migrations. A number of studies have documented the influence of freshwater and ocean conditions, climate variability and human impacts resulting from impoundment and aquaculture on fish migration.

Keywords: Fish, Migration

INTRODUCTION

Migratory journeys are widespread throughout the animal kingdom (Dingle and Drake, 2007). Most migration occurs for the purpose of food gathering, reproduction or adjustment to temperature, and sometimes referred to simple as feeding, breeding, and wintering migrations, respectively (Barton, 2007). Reasons advanced by Binder *et al* (2011) include variability in the habitat conditions or the changing need of the population itself. According to Bond (1996), migration enables fish to take advantage of additional habitat and to avoid adverse conditions. The objective of this paper is review of migratory activity in fishes.

Fish migration

In many fishes migration takes place on an annual basis, but in others, individuals are involve in certain changes of habitat only at certain developmental stages. Other migrations are of diurnal nature, such as the vertical or tidal migrations of mesopelagic fishes in the deep layer (Barton, 2007). Lucas and Batley (1996) reported the movement of inland fish species to substantial distance within waterways for reproduction and feeding. Radio tagging studies have reported migrations to natal spawning ground to range between 100km and 300km (Lucas and Baras, 2001). Migratory habits of fishes may vary with latitude; the three-spine stickleback (*Gastrosteus aculeatus*) is marine in the cold waters of the north but to the south, it becomes predominantly a freshwater dweller (Lagler *et al*., 1977).

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Direction of migratory movement

The first is denatant/downstream movement, swimming or migrating with the current. Behaviour and ecological factors influencing variability of downstream migration of fish larvae and fry are still poorly understood (Pavlov *et al*., 2008). The second is contranatant/upstream movement, swimming or migrating against the current. Upstream phased of migration are activities with high-energy demands and are directed by a variety of cues (Northcote, 1998). Johnson and Hasler (2006) examined the role of imprinted chemical cues in the homing migration. Methods of migratory movement include drifting, random locomotive movements, and oriental swimming. The types of migration are feeding (alimentary) migration, spawning (gametic) migration, weathering (climatic) migration and osmoregulatory migration.

Terminology used to describe fish migration

i) Oceanodromous fishes

These are migratory fishes which live and migrate wholly in the sea such as those performed by tunas, white sharks (*Carcharodon carcharias*), and plaice (*Pleuronectes platessa*). Migrations of this sort are usually pursued by pelagic species of the open ocean. Many large marine fishes move in schools north and south on an annual basis, following seasonal temperature profiles (Barton, 2007).

ii) Potadromous fishes

These are migratory fishes whose migration occurs solely in lakes (for example lake trout, *Salvelinus namaycush*), rivers and streams (for example brook lampreys *Lampetra* spp), or can span both lake and fluvial habitats (for example white suckers, *Catostomus commersoni*).

***iii)* Diadromous fishes**

Are migratory fishes which migrate between seas and freshwater to breed for example Pacific salmonids, *Onchorynchus* spp. According to Barton (2007) diadromous migrations are remarkable because fishes move from one medium to another and the distance often require amazing feats of orientation, navigation, and precise recognition of home spawning areas. Diadromy is said to occur in about 230 species of fish (McDowall, 1988). Diadromous fishes are divided into three namely anadromous fishes which feed and grow in salt waters, fully grown adults move back into the freshwater to spawn (for example Pacific salmon). Secondly, catadromous fishes most of their feeding and growth take place in freshwaters and the fully grown adults move back into the salt water to spawn (example eels of the genus *Anguilla*). Thirdly amphidromous fishes, which carryout brief excursion from freshwater to seawater during the juvenile stage, but the majority of feeding and growth and spawning occurs in freshwaters. This is common with fishes inhabiting islands in the tropics and subtropics (examples *Sicydiine gobies, Sicydium* spp).

The result from a study by Chino and Arai (2010) suggest that *Anguilla marmorata* has a flexible pattern of migration with an ability to adapt to various habitats and salinities. Lucas and Baras (2001) reviewed migratory behavior of arctic, subarctic, temperature and tropical freshwater fishes for 44 taxonomic groupings. Some 36 species of fish, probably representing over 350 species, show well documented migration in inland waters. Over 64 of these species (mainly sharks, rays, mullets, and goboids) are diadromous, over 84 (mainly lampreys, sturgeons, anchovies, northern smelt and salmonids) are anadromous, and over 25 (mainly freshwater eels) are catadromous. Potadromy occurs in over 169 species and no doubt this form of migration is greatly underestimated in minnows, characins and catfishes. Twenty-nine of the 36 species of fish (81%) have migrant species in temperate inland waters.

Osmoregulation and fish migration

Many marine fishes, especially from tropical families, frequently move into and out of freshwater, some at certain life history stages, but some in a more spontaneous fashion. These fishes must be able to switch abruptly from water conserving water to filtering out large volumes through the kidney, and must turn from the excretion of excess salt to their conservation. There are freshwater species of pipefishes and toadfishes, which apparently are impermeable and can increase their urine flow through a mechanism that is not well known (Barton, 2007).

Orientation and migration

A mechanism whereby fishes position themselves in a particular direction in response to an external stimulus is termed orientation. Navigation is a mechanism whereby fishes plot a course to a particular location. Tunas have a well-developed pineal "eye" on top of the skull that may function in orientation (Barton, 2007). It is well known that Pacific salmon orient to their natal stream largely by smell. Johnstone *et al.,* (2001) identified seven differentially expressed olfactory related genes in juveniles anadromous salmon compared to returning adults in both populations of anadromous Atlantic Salmon. Vrieze (2010) reported that migratory *Petromyzon marinus* rely heavily on olfactory cues, of which a larval pheromone is presumably one, to locate river mouths and to a lesser to promote upstream movement within rivers. According to Barton (2007) fishes may orient using information derived from changes in the sun's azimuth, angle of the sun in the horizontal plane, and /or altitude, angle of the sun in the vertical plane. Migrant salmon can memorize the complex odours of a natal stream for their entire seaward migration, which can last for several years (Hickman *et al.,* 2008). Differences in water temperature and salinity create vertical layers and each layer has a distinct origin, presumably with its own unique home stream 'olfactory bouquet', which plays a dominant role during the final stages of locating the natal streams (Binder *et al.,* 2011). The tendency to orient in a current is called rheotaxis.

Energetics of migration

Long-distance migrations are energetically demanding; and feeding during this migration is rare. The reason for this is that feeding imposes several constraints on migration. Migrating fishes use reserved energy to fuel their upstream migration (Hinch *et al.,* 2006). Standen *et al.* (2002) observed that very little is known about the mechanisms responsible for high levels of energy use. Energy exhaustion is believed to be a factor causing post-spawning mortality in some stocks (Rand *et al.,* 2006). Binder *et al.,* (2011) noted that there are no repeat spawners among American shad (*Alosa sapissima*) migrating upstream the fish which deplete as much as 75-82% of their total stored energy reserves. Energy for migratory activities is stored as proteins, lipids and carbohydrates. Tudorache *et al.,* (2007) listed protein lipid and glycogen as energy stores of migrating Stickle backs studied.

Environmental impact of migration

Animals use the length of the day or photoperiod to time their seasonal development, reproduction, migration and dormancy (Bradshaw and Holzapfel, 2007). Moreover, the relative importance of each environmental factor may be dependent on the local characteristic of the habitat in which migration is occurring. Photoperiod has been shown to have significant effect on maturation, spawning time and development in salmonids (Stanewskey, 2003). Pavet (2000) demonstrated that circadian rhythms are fundamental features of all living organisms. According to Rand *et al.,* (2006) high water temperatures or increased river velocity may create particular challenging conditions with potential impact on migration success. Temperature can trigger and synchronize migratory activity in fishes. When temperature acts as trigger, migration can be viewed as a form of behavioral thermoregulation. (Binder *et al.,* 2011)

Anthropogenic impact on migration

Human activities have a long history of interfering with fish migration. Probably the most obvious way in which our activities disrupt migration is through the construction of dams and other structures (for example weirs) that acts as a barrier to migration in streams and rivers (Lucas and Bara, 2001). Humans have constructed dams for variety of reasons: water storage, flood prevention, electricity generation, irrigation, navigation, and recreation (Fracisco, 2004). Barriers disrupt stream continuity, may reduce the abundance and quality of suitable stream habitat (Baxter, 1977). Some species may also be exposed to additional predators (Fracisco, 2004). Another problem caused by dam is genetic isolation (Neraas and Spruell, 2001). Toxicants and other chemical contaminants may mask the odours that some fishes use to identify the home stream (Binder *et al.,* 2011).

Conclusion

Fishes are widely distributed in both fresh and marine environment. Most authors believe that fishes like any other animal move from one habitat to another. A good understanding of the migratory behaviour of fishes is an important means of controlling over exploitation of fish stock whereby young and brood fish are caught at their spawning grounds or along their migratory route. Catches in the feeding area may increase following reduction of harvesting at the spawning area. Dam construction should be provided with bye-passes and ways, which enable fish change habitat thereby completing life cycle.

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