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Nile Tilapia(Oreochromis niloticus) as a successful biological invader in Jammu (J&K) and its impacts on native ecosystem

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Abstract

The Nile tilapia is considered an omnivorous species and it ingest zooplanktons, phytoplanktons, or debris present in rivers. As a consequence, the release of Nile tilapia into non-native aquatic ecosystems may result in competition for food and space, thereby damaging native species. The wide environmental tolerance and high reproductive rate of Nile tilapia facilitate its use for aquaculture, but also render the species highly invasive. Here, we review the high frequency of Nile tilapia in non-native biodiversity and indicate the existence of the species under feral conditions and there impacts on the non-native ecosystem.

Keywords: Nile tilapia, biological, invader, Jammu, J&K

Introduction

Although debated recently, it has historically been accepted that successful biological invasions detrimentally affect the structure and function of native ecosystems. Introduction of non-native fish species can reduce biodiversity and modify local community dynamics in freshwater systems. Exotic species have been identified as the third leading cause of extinction of vertebrate species in aquatic environments. Introductions of exotic species generally threaten the stability of ecosystems, resulting in extinction through long term predation and competition and leading to replacement of native species by exotic species. Other documented effects are hybridization with native species, disruption of the food chain and environmental degradation.[1,2] The accidental or deliberate spread of fish species by humans threatens the biodiversity and character of freshwater ecosystems. The study of invasive fishes has thus far concentrated on understanding the biological traits of potential invasive fish,[3] predicting the outcomes of invasions at local and larger scales [4,5,6] and assessing the impacts of invasions on ecosystems .[7] Tilapia is the second world wide cultured species after carps. They are also known as "Aquaculture Chicken" as they are present in all continents except Antarctic. The species is favoured among aqua culturists due to its ability to tolerate a wide range of environmental conditions, fast growth, successful reproductive strategies, and ability to feed at different trophic levels. The Nile tilapia, Oreochromis niloticus is responsible for reducing local biodiversity, through competition with other aquatic species for available food resources. Lack of predation and adaption to changing environmental conditions increase the impact of Nile tilapia on the icthylogical composition.[8,9] In some cases, the introductions have been accidental; tilapia fish have managed to escape from fish farms or ornamental fish breeders. In other cases, the introduction has been deliberate, e.g. to combat mosquito or aquatic weeds. Tilapia has also been introduced as food fish to lakes and other bodies of water. Nile Tilapia is native to the Nile River and to Africa in general. In general, tilapias have been introduced into over 100 tropical and subtropical countries worldwide, with a global distribution second

only to common carp to improve fishing productivity and facilitate the development of aquaculture. Furthermore, the Nile tilapia constitutes a rough species, which occurs in a wide range of environmental variations, tolerating extreme limits of temperature and oxygen, as well as the presence of various pollutants.

Material and Methods

Study Area

The State of Jammu &Kashmir is the northernmost and sixth most largest state of India covering an area of 2,22,236 sq.km. The state lies between $32^0$15 to $37^0$05'North latitude and 72'$2^0$35' to $83^0$20' East latitude. The state ranks 6^{th} in area and 17^{th} in population among the states and Union Territories of India. Jammu is one of the three regions comprising India's northernmost area of Jammu and Sandwiched between the Vale of Kashmir to the north and the Daman Koh Plains to the south, the Shivalik Range comprises most of the region of Jammu. The Pir Panjal Range, the Trikuta Hills and the low-lying Tawi River of the branch Chenab River basin add beauty and diversity to the terrain of Jammu. Jammu's altitude ranges from 300 meters to 4200 meters. The climate in Jammu is tropical. Due to extreme whether in summers and winters it is also known as the City of Rocks.

Methodology

The fish fauna was collected using cast net, with the help of local fisherman on monthly basis. Specimens so collected were identified using various morphometric and meristic characters i.e. general body shape, structure of fins and parameters like total length, standard length, length of caudal fin, dorsal fin , pelvic and pectoral fin; body depth, head length, eye diameter, pre-dorsal and post-dorsal distance.

Results and Discussion

Preliminary exploration of Jammu region revealed this region to be quite rich so far as aquatic resources are concerned and also found to be more susceptible for the invasion of alien species which may come across through agricultural waterways or through aquacultural outlets. Ichtyolofaunal investigation of various streams of Jammu region reveals the presence of non-native and highly invasive tilapia species (O.niloticus) which is native of Africa but due to high aquacultural demand has being introduced to many non-native countries of the world.

Distribution

Nile tilapia Oreochromis niloticus are members of the Family Cichlidae, is native to the Nile River and to Africa in general ranging from the upper Nile River south to the equator and west to the Atlantic coast [10].O. niloticus is one of the top ten introduced species of the world.[11] Which were then introduced to many countries in the 1950's and 1960's as a "wonder fish widely distributed in Africa, the Middle East, South and Central America, southern India and Sri Lanka with a global distribution second only to common carp. It contains approximately 1,300 species, of which approximately 150 can be called tilapia. China alone produces nearly half of the world tilapia production followed by Egypt, Indonesia, Philippines, Thailand and Taiwan, new farms coming online in Malaysia, Brazil.

Morphological character

The Nile tilapia Oreochromis niloticus is a deep-bodied fish with cycloid scales. Silver in colour with olive/grey/black body bars, the Nile tilapia often flushes red during the breeding season (Fig.1) .Their mouths are protrusible, usually bordered with wide and often swollen lips. The jaws have conical teeth. Typically tilapia have a long dorsal fin, and a lateral line which often breaks towards the end of the dorsal fin, and starts again two or three rows of scales below. Dorsal fins have anywhere from 7-25 spines and 5-30 soft rays and anal fins display 3-15 spines and 4-15 soft rays. It grows to a maximum length of 62 cm, weighing 3.65 kg (at an estimated 9 years of age).[12] The average size (total length) of O. niloticus is 20 cm .[13]

Environmental tolerance ranges

Nile tilapia is a tropical species that prefers to live in shallow water. The lower and upper lethal temperatures for Nile tilapia are 11-12 °C and 42 °C, respectively, while the preferred temperature ranges from 31 to 36 °C. Nile tilapia will reportedly thrive in any aquatic habitat except for torrential river systems and the major factors limiting its distribution are salinity and temperature .The concentration of dissolved oxygen is not a major limiting factor for Nile tilapia, as they can tolerate levels as low as 3-4 mg/l .

Feeding Behaviour

Tilapias are famous for their opportunistic feeding style. Adult Nile tilapia feed predominantly on phytoplankton, periphyton, aquatic plants, small invertebrates, benthic fauna, detritus and bacterial films associated with detritus and even other fish and fish eggs. Depending on the food source, they will feed either via suspension filtering or surface grazing , trapping plankton in a plankton rich bolus using mucus excreted from their gills .Nile tilapia can filter feed by entrapping suspended particles, including phytoplankton and bacteria, on mucous in the buccal cavity, although its main source of nutrition is obtained by surface grazing on periphyton mats. O. niloticus have been observed to exhibit trophic plasticity according to the environment and the other species they coexist with. Sexual maturity in ponds is reached at an age of 5-6 months. Spawning begins when the water temperature reaches 24 °C.

Reproductive behaviour

The breeding process starts when the male establishes a territory, digs a craterlike spawning nest and guards his territory. Tilapia are mouth brooders, which means eggs hatch in the mouth of the female, and the female protects the hatched young from predators in her mouth. The female incubates the eggs in her mouth and broods the fry after hatching until the yolk sac is absorbed. Incubating and brooding is accomplished in 1 to 2 weeks, depending on temperature. After fry are released, they may swim back into her mouth if danger threatens. Being a maternal mouth brooder, the number of eggs per spawn is small in comparison with most other pond fishes. Egg number is proportional to the body weight of the female. A 100 g female will produce about 100 eggs per spawn, while a female weighing 600-1 000 g can produce 1 000 to 1 500 eggs. The male remains in his territory, guarding the nest, and is able to fertilize eggs from a succession of females. If there is no cold period, during which spawning is suppressed, the female may spawn continuously. While the female is brooding, she eats little or nothing. Nile tilapia can live longer than 10 years and reach a weight exceeding 5 kg.

Adaptive characters for invasion

Many species of tilapia are amazingly adaptable and this makes them especially prone to becoming problematic invasive species. Quite a few tilapias can adapt to brackish conditions and some are even capable of living

where the salinity is 35 ppt, the average salinity of sea water. Tilapias are tolerant of wide fluctuations in salinity, dissolved oxygen, and temperature. This tolerance to environmental variability, along with their high fecundity, rapid growth rates, and omnivorous feeding habits further contribute to successful invasions in estuaries. These same traits allow them to be an extremely successful invasive species in subtropical and temperate environment. Suggested thermal refugia coupled with the characteristic oligomesohaline habitats of many estuarine areas would increase the likelihood of survival and establishment of non-native Nile tilapia.

Impact on native biodiversity

Every invasive species have some positive and negative impact on the native biodiversity and ecosystem.

Positive Impacts

The fish help purify the water by consuming vegetation and detritus, greatly reducing purification costs. O.niloticus is also used for aquaculture, commercial aquarium trade, as a weed control agent, and as a recreational fishery for many countries throughout the world . In a study investigating the feeding preferences of O.niloticus among four species of aquatic plants, it was determined that Chara sp. and Najas marina could be controlled by them in small lakes and Tilapia has also been used as biological controls for certain aquatic plant problems. It has a preference for a floating aquatic plant, duckweed (Lemna sp.) but also consume some filamentous algae. In many countries tilapia were introduced to control mosquitoes which were causing malaria, because they consume mosquito larvae, consequently reducing the numbers of adult female mosquitoes, the vector of the disease .These benefits are, however, frequently outweighed by the negative aspects of tilapia as an invasive species. It is also clear that tilapias, as a group of alien species, have made a significant contribution to food production, poverty alleviation and livelihoods support in Asia and the Pacific.

Negative impacts

Tilapia can cause problems for native flora and fauna in several ways. They will compete with other species for food and can disrupt the ecological balance and also leads to Eutrophic water conditions due intensive production. Tilapia can also cause turbidity in clear waters since they are fond of digging. Turbidity will reduce the amount of available light in the water, which affects all organisms relying on photosynthesis. O. niloticus selective feeding regime can also unbalance algal constituents of the water column. Since they are considered to be voracious herbivores, often decreasing plant density and changing the composition of native plants which can threaten many native aquatic organisms that depend on such plants for forage, protection, or spawning. They also lead to extinction of native species by predation of eggs and young of other fish species. Other than that there is always a high likelihood that hybridisation will occur within indigenous species (especially other tilapia species); and tilapia also lead to transfer and spread of certain Diseases or parasites. Tilapia may compete with native fish for nesting space or food and thus have the potential to negatively impact native populations in warm environments. Recreational fisheries could also be negatively affected by aquaculture production of O. niloticus if parasites or diseases from farmed populations are allowed to spread to established wild stocks.

Conclusion

As a consequence of its wide environmental tolerance, high reproductive rate, rapid population growth and ease of cultivation, the Nile tilapia has become a model of livestock farming in several countries. However, the same characteristics that make the species attractive for aquaculture render it highly invasive, with considerable potential for becoming a pest in aquatic environments where it is introduced. The risks of tilapia introduction must therefore be rigorously evaluated and weighed against the potential socio-economic benefits.

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Figure

Fig 1: *Oreochromis niloticus*