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The Role of Exotic Species in Indian Aquaculture

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INTRODUCTION

Introducing alien fish species has become a significant aspect of human activities concerning aquatic ecosystems (Garcia-Berthou, 2007). These exotic aquatic organisms, including plants, animals, and fishes, are introduced into new habitats where they are not native, leading to habitat alteration and degradation on a global scale. With the ease of global transportation due to globalization, there has been a notable increase in the establishment of exotic species in regions beyond their natural habitats. According to the IUCN, the cost of controlling these invasive alien species (IAS) and the economic impacts of their persistence amount to thousands of dollars annually. A study from 2020 suggests that the number of established IAS is projected to rise by 30% between 2005 and 2050 (IUCN, 2021). In India, evidence shows that approximately 13.6% of fish species are exotic, introduced (Joshi *et al*., 2021) either intentionally or unintentionally for various purposes such as aquaculture, game fishing, therapeutic benefits, research and aquarium trade (Singh *et al*., 2008). Despite India's already rich fish genetic resources, over 300 alien species have been introduced into the country so far. While many of these exotic species are ornamental fishes confined to aquariums, others have been introduced into aquaculture and open waters with varying degrees of success. The expansion of aquaculture in India over the past few decades has made it challenging to prevent the introduction of alien species, as they often fetch higher prices in international markets but are priced lower for domestic consumption (DeSilva *et al*., 2009). Consequently, the riverine resources of the country are facing a concerning decline in fish biodiversity due to various environmental factors, with the invasion of new alien species being a significant contributor to this decline (Singh and Lakra, 2011; Sarkar *et al*., 2012).

AQUACULTURE OF EXOTIC FISHES

- Approximately 31 alien fish species have been identified in Indian aquaculture systems, including *Pangasianodon hypophthalmus*, *Oreochromis niloticus*, *Piaractus brachypomus*, *Aristichtys nobilis*, *Clarias gariepinus* and *Litopenaeus vannamei*, which have been introduced in recent years.
- Exotic species have significantly contributed to the growth and commercialization of aquaculture. In 1996, only nine species represented 78% of the total global freshwater fish culture.
- There is a rising trend in introducing crustacean species globally, particularly for brackishwater shrimp culture. The introduction of *Litopenaeus vannamei*, commonly known as Pacific white shrimp, in India has notably fueled the expansion of aquaculture in the region.
- The African catfish, *Clarias gariepinus*, was clandestinely introduced into Andhra Pradesh in the early 1990s from Bangladesh through West Bengal. Despite being unauthorized, it has gained popularity among aquaculturists in Telangana and Andhra Pradesh.
- Among popular alien fish species, *Pangasianodon hypophthalmus*, commonly known as pangas catfish, was illegally introduced in 2004 from West Bengal. It was later permitted by the Government of India for aquaculture in 2009 and is now commonly cultured in ponds, yielding high production with pelleted feed.
- The culture of GIFT tilapia and pangas fish species began on a pilot basis in five selected reservoirs in Telangana state in 2015 and proved to be successful.

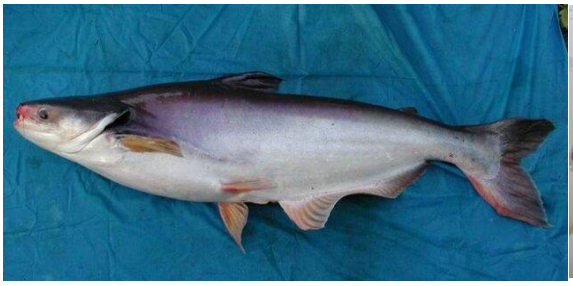

Fig:- *Pangasianodon hypophthalmus*

Source- Potting and Bosma (2008)

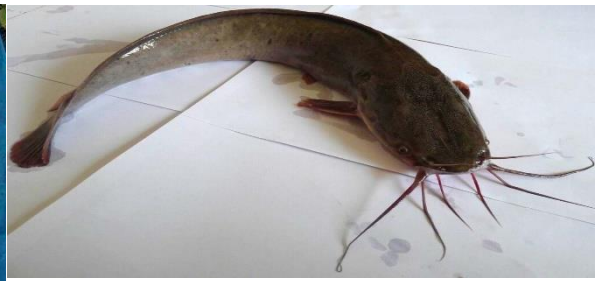

Fig:- *Clarias gariepinus*

Source: Ibraheim and Khater (2013)

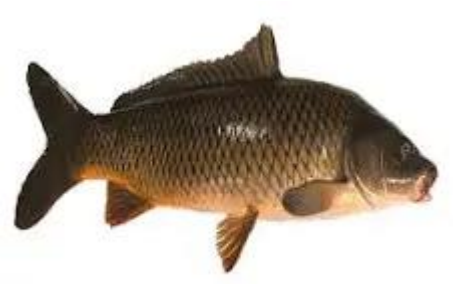

Fig:- *Cyprinus carpio*

Fig:- *Litopenaeus vannamei*

TRAITS OF EXOTIC FISH SPECIES: Numerous characteristics are associated with invasive species and the ecosystems they invade. The common traits attributed to invasive species include:

- Rapid growth: Invasive species often exhibit fast growth rates, allowing them to quickly outcompete native species for resources and establish themselves in new habitats.
- Rapid reproduction: Invasive species have high reproductive rates, enabling them to produce large numbers of offspring quickly, further enhancing their ability to spread and colonize new areas.
- Phenotypic plasticity: Invasive species demonstrate phenotypic plasticity, meaning they can adapt to different environmental conditions and habitats, allowing them to thrive in diverse ecosystems.
- Tolerance of wide range of environmental conditions: Invasive species are often able to tolerate a broad range of environmental conditions, including variations in temperature, pH, salinity, and moisture levels, which enables them to invade and establish in diverse habitats.
- Ability to utilize a wide range of food types: Invasive species have the ability to consume a variety of food types, allowing them to exploit different food resources and outcompete native species for food, further contributing to their successful establishment and spread in new environments.

GENERAL IMPACTS OF EXOTIC SPECIES:

The introduction of exotic aquatic organisms into ecosystems can have both positive and negative impacts on biodiversity and the aquatic environment (DeSilva *et al*., 2009). These impacts are outlined below:

1. Ecological Impact: The presence of exotic fishes can increase the prey available to native predators. However, competition for food resources may arise due to dietary overlap, potentially reducing natural food availability for native species. Competition may extend beyond feeding habits to other ecological factors like breeding and space.

2. Alteration of Habitat: Exotic aquatic organisms may negatively affect native habitats. For example, herbivorous fishes may consume plant material, leading to the uprooting of macrophytes through digging for food or for nesting sites and organic enrichment, which can reduce light penetration and photosynthesis, ultimately displacing aquatic vegetation. The common carp, known for rooting around in the bottom, can muddy waters, shade out macrophytes, disturb benthic invertebrates, and contribute to accelerated eutrophication.

3. Transmission of Diseases: Exotic species may introduce new pathogens into the ecosystem, increasing uncertainty about potential disease outbreaks. Diseases such as Epizootic ulcerative syndrome, Epizootic haemorrhage necrosis, Taura syndrome and Yellow head disease have been introduced from other countries to India.

4. Genetic Dilution: The introduction of exotic fishes can lead to genetic impacts on native species. This includes a reduction in effective population size due to the introduction's ecological and genetic effects and alteration or extinction of gene pools through crossbreeding, hybridization, and backcrossing.

5. Socio-economic Impact: Introductions can directly or indirectly affect socio-economic factors. For instance, the replacement of highly valuable native fish by undesirable introduced species can impact local economies. In this regard, the fishery sector cannot forget the devastating effect of white spot disease which has shown heavy mortality in *P. mondon* and *P. indicus* the two native species of India. Introduction of disease can lead to significant financial losses for farmers

and have social repercussions, such as food insecurity and unemployment.

BENIFITS OF EXOTIC SPECIES INTRODUCTION

- Exotic species contribute to boosting aquaculture output, fetching high prices in the market, and bolstering foreign exchange reserves.
- They play a crucial role in ensuring food security for impoverished communities by being a staple in local diets. Furthermore, they can increase farmer income and create job opportunities.
- The development of hybrids from exotic species presents the potential for faster growth rates compared to native fish.
- Additionally, exotic species offer the chance for domestic brood stock development, facilitating stock enhancement efforts. Some species also hold aesthetic and cultural value.
- Around 17% of global finfish production stems from exotic species.

CONTROL AND MANAGEMENT OF INTRODUCTION

- A comprehensive understanding of the ecology, morphology, reproductive biology and physiology of exotic species is crucial for their effective management.
- The management of introductions needs to involve multiple stakeholders and be approached at various levels, ranging from individual homeowners to large government agencies like state fisheries directorates, ICAR, NBFGR, NFDB, etc., at state and national levels respectively.
- Ultimately, it requires collaboration with major intergovernmental organizations such as FAO, NACA, WORLD FISH CENTER, ICES, EIFCS, etc., to coordinate, monitor and manage species transfers and introductions at an international scale.
- Scientists have explored methods such as inducing sterility, particularly through producing triploid stocks, to mitigate the risks associated with the release or escape of exotic species.

CONCLUSION

The introduction of exotic species can be seen as a means to enhance species diversity in aquaculture systems and generate economic benefits. The recent decision by the Indian government to introduce only specific pathogen-free (SPF) *L. vannamei* shrimp and to regulate the culture of *P. hypophthalmus* represents a new approach in this regard. India, being rich in biodiversity with over 2700 fish species, already boasts a wide array of cultivable species. However, further introductions of exotic fish species could pose a threat to this existing diversity. Species like Tilapia, Common carp, Pangasius and White leg shrimp, which have been introduced previously, have had significant adverse impacts on the aquatic ecosystem and aquaculture practices. Introducing exotic species often leads to competition for limited resources such as food and space, disrupts ecological niches, and can result in genetic erosion, predation, and the entry of pathogens. Efforts must be made to minimize the risks associated with introductions, especially in aquaculture, where genetic material exchange is common. The fishery sector must remain vigilant, considering the devastating effects of diseases like white spot disease on native species and local communities.

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