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Ecological impact and aquaculture significance of *Cyprinus carpio*: A review

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Abstract

Cyprinus carpio, commonly referred to as the common carp, is an exotic species with a widespread introduction across various global regions primarily for aquaculture and ornamental purposes. This paper provides a comprehensive review of the ecological and economic significance of *C. carpio*, focusing on its history of introduction, adaptability to diverse environments, and its substantial impacts on native freshwater ecosystems. The review delves into the factors contributing to the species' successful establishment and proliferation, including its biological traits and environmental tolerance. It further explores how *C. carpio* has influenced local biodiversity, altered habitat structures, and affected the dynamics of aquatic communities. By synthesizing historical data and recent research, this paper highlights the dual role of *C. carpio* as both a valuable aquaculture resource and a significant ecological disruptor. The findings underscore the need for balanced management strategies to harness the benefits of common carp while mitigating its adverse environmental impacts.

Keywords: *Cyprinus carpio*, exotic fish, aquaculture

Introduction

The term "exotic" or "alien" species pertains to organisms that have been introduced into regions outside their native geographical ranges (Harris, 1994) [14]. Among these, *Cyprinus carpio*, commonly known as common carp, is a notable example of an exotic species in India. Originally derived from ornamental variants of East Asian carp, *C. carpio* was selectively bred for its coloration and scale patterns in China and Japan before being widely introduced across various regions.

Today, *C. carpio* has evolved into a critical component of global aquaculture, valued for its versatility and economic importance (Axelrod, 1973; Biro, 1995; Zhou *et al.*, 2003; Pathak *et al.*, 2011a) [1, 2, 26, 18]. Introduced to India between 1939 and 1957, *C. carpio* was initially brought in to enhance aquaculture practices. Its adaptability to a range of environmental conditions and its ability to thrive in diverse aquatic habitats has contributed to its extensive use in both commercial aquaculture and ornamental fish industries. The species' successful integration into various freshwater ecosystems has highlighted its significant role in global aquaculture while also raising concerns about its ecological impacts.

This paper explores the complex interplay between *C. carpio*'s introduction, its biological characteristics, and the consequent effects on native freshwater ecosystems and biodiversity. Common carp were introduced to India between 1939 and 1957 for aquaculture purposes and have since become a significant part of the country's inland fish production, contributing over 7.17% to the total (Forese and Pauly, 2004; Dey *et al.*, 2005) [11, 8]. The species' adaptability to various environmental conditions has facilitated its widespread use in enhancing reservoir fishery production (Sugunan, 1995, 2000) [21, 22].

Biological Characteristics

Cyprinus carpio, or common carp, demonstrates several biological characteristics that have facilitated its success as an introduced species. These include its large size, which enables it to dominate aquatic environments, and its long lifespan, which allows it to establish stable populations over extended periods. The species is noted for its flexible feeding habits, which enable it to exploit a variety of food sources, and its capacity to reach high biomass, contributing to its prominence in aquaculture.

Additionally, *C. carpio* exhibits a remarkable tolerance for varying environmental conditions, making it adaptable to diverse habitats (Bonneau,

1999) [3]. These attributes have led to its widespread introduction and establishment in global freshwater systems, ranking it as one of the most commonly introduced fish species worldwide (Welcomme, 1992) [24] and the second most cultured fish in India, after *Labeo rohita* (Rohu) (Dwivedi *et al.*, 2009) [9].

Ecological impact

However, the ecological impact of *C. carpio* is significant, affecting native fish fauna both directly and indirectly. Direct impacts include predation on smaller fish and invertebrates, competition for resources, disruption of native fish reproduction, and the introduction of parasites and diseases (Courtenay and Meffe, 1989; Ross, 1991) [4, 20].

Indirectly, common carp alters habitat conditions, modifies physical and chemical characteristics of ecosystems, affects primary productivity and food web structure, and shifts community composition through its foraging behavior, and increases water turbidity, which impairs light penetration and aquatic plant growth (Taylor *et al.*, 1984; Flecker and Townsend, 1994; Roberts *et al.*, 1995) [23, 10, 19]. These profound changes in both biotic and abiotic components of freshwater systems underscore the complex ecological transformations induced by the presence of *C. carpio* (Moyle and Nichols, 1973; Leidy and Giedler, 1985; Gehrke *et al.*, 1995; Gido and Brown, 1999) [17, 16, 12, 13].

Conclusion

Cyprinus carpio, commonly known as common carp, is a key species in aquaculture due to its economic value and versatility. However, its introduction into various freshwater ecosystems has had significant ecological repercussions, affecting biodiversity and disrupting ecological balance. The adaptability of *C. carpio* has enabled it to establish itself widely, but this success also brings substantial risks, including negative impacts on native species, habitat degradation, and altered ecosystem dynamics. To address these challenges, it is crucial to implement effective management and monitoring strategies. These measures should aim to mitigate the ecological risks associated with *C. carpio* while optimizing its economic benefits. Balancing the advantages of this introduced species with its potential threats requires a comprehensive approach to ensure the sustainability of both aquaculture practices and the health of freshwater ecosystems.

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