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A Review of Structure, Origin, Purpose & Impact of Common Carp (Cyprinuscarpio) in India

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Abstract
In India, common carp were introduced for composite fish farming. Cyprinuscarpio (L.1758) is a hardy, fast-growing fish that is often referred to as a "natural specialist" or "ecological engineer" due to its adaptability to a wide range of ecological conditions. The growth rates of common carp vary greatly depending on temperature, food availability, and population density in different regions. Except for some communications on food and feeding, age, and fecundity, no such thorough investigation into the science and social aspects of this exotic species has been conducted under these agro-climatic conditions since its arrival. This paper examines the role of Cyprinuscarpio in the aquatic environment, as well as the distribution, morphology, breeding and feeding habits, feeding niche, genetic changeability, and behaviour of common carp in response to changing food resources, as well as the impact of common carp on fish creation.
Keywords: Common carp, distribution, breeding & feeding, and limitations.

1. Introduction

The common carp (Cyprinuscarpio), first described by Linnaeus (1758), and belongs to the order Cypriniformes and the family Cyprinidae, which has seven subfamilies, 220 genera, and roughly 20,000 described species (Howes, 1991). It lives in freshwater environments, especially ponds, lakes, and rivers, and only rarely in brackish water environments (Barus et al. 2001). Shallow wetlands, streams, and slow-moving rivers are all good places to look for it. Taxonomically, Cyprinuscarpio is a perplexing genus. The majority of the ambiguity stems from the use of quasi-taxonomic names for feral specimens or populations. Zhou & Chu (1986) list 12 species from Yunan Province, China, and Barus et al. (2002) cite more than 30 synonyms and over 10 sub-species, varieties, and morphs, compared to 15 sub-species and eight varieties and morphs provided by Kottelat (2007). According to Barus et al., (2002), there are only three subspecies of Cyprinuscarpio: European, Central Asian, and Asian common wild carp.

The common carp, Cyprinuscarpio (L., 1758), is a hardy and fast-growing fish that can endure harsh conditions (MD DNR, 2008). In the dry season or winter, it burrows in mud and can withstand frost, organic contaminants, and low oxygen levels in the water (Weber et al, 2010). It has been introduced into freshwaters all over the world with great success (Seegers et al. 2003; Golemi et al, 2013). This is also a common cultural fish due to its omnivorous habits, rapid growth rate, and ease of breeding in confined water (Ram et al 2015), making it a significant year-round food fish. It is being considered as a possible candidate for commercial aquaculture in Asia and some European countries due to its extremely high

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adaptability to both climate and food (Soltani et al. 2010; Manjappa et al. 2011; Rahman 2015). As a result, this unusual fish has become abundant in both natural and man-made bodies of water, accounting for a significant portion of the commercially valuable fish species. Cyprinuscarpio (L., 1758) is one of the world's most widely farmed and distributed commercially important and oldest domesticated freshwater fish. The Common carp, also known as the German carp or European carp, is a species of Cyprinuscarpio.

Systematic Position of Cyprinuscarpio	
Kingdom:	Animalia - Linnaeus, 1758 - animals
Subkingdom:	Bilateria - (Hatschek, 1888) Cavalier-Smith, 1983
Phylum:	Chordata - Bateson, 1885 - Chordates
Subphylum:	Vertebrata - Cuvier, 1812 - Vertebrates
Class:	Osteichthyes - Huxley, 1880 - Bony Fishes
Subclass:	Actinopterygii - Ray-Finned Fishes
Order:	Cypriniformes
Family:	Cyprinidae - Minnows and Carps
Subfamily:	Cyprininae
Genus:	Cyprinus - Linnaeus, 1758
Specific name:	C. Carpio - Linnaeus, 1758
Scientific name:	Cyprinuscarpio Linnaeus, 1758

2. Distribution

The common carp is found in almost every country in the world, accounting for 91 of the 120 countries (Casal, 2006). The natural range of common carp was originally limited to Central Asia (Jhingran and Pullin, 1998), and then to a few European countries (Weber & Brown 2011; Kloskowski 2011; Parkos& Wahl 2014). C. Carpio is a native of Asia, but due to its widespread popularity, it has been widely spread by humans across Europe, and is now found on all continents except Antarctica and northern Asia (Froese and Pauly, 2002; Nelson, 1984). It is now found from Western Europe to China and Southeast Asia, as well as from

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Siberia to the Mediterranean and India. They are found all over the world and have formed populations on all continents except Antarctica (Lever, 1996).

In India, the common carp was introduced to increase fish production in ponds, tanks, lakes, and reservoirs by composite fish farming. India is a major producer of common carp as well. India is the world's sixth-largest fish producer (6.41 million tonnes) and second-largest aquaculture producer (2.22 million tonnes) (Basavaraja, 2006). They are suitable for aquaculture because they are fecund and durable, and as a result, they are widely farmed (Zambrano et al., 2001). Following independence, several exotic species were introduced into India with proper government approval and for particular purposes. C. Carpiocommunis (Chinese stock), also known as scale carp, was first introduced in 1957 and is now found throughout the world (Reddy, 1999). However, several other exotic fish species have already made their way into the region (Goswami, 2000).

Carps are the most frequently cultured freshwater fish in India, and they are one of four fish species that are commonly farmed alone or in combination with IMCs, as well as Chinese carps, grass carps, and silver carps. Scale carp Cyprinuscarpiocommunis, mirror carp Cyprinuscarpio specular, and leather carp Cyprinuscarpio are the three types of common carps found in India. Due to their ability to thrive in a hot environment, nudes, the scale, and mirror carps have become common in India. Mirror carp was introduced from Ceylon to the Nilgiris in 1939, then to Bangalore in 1947, and Scale carp was carried from Bangkok to Cuttack in 1957. (Shetty et al., 1989). All of these varieties are mostly restricted to cold upland waters and do not breed in the plains (Alikunhi, 1957), but Chinese stock that breeds freely in the plains was introduced in Cuttack in 1957. (Alikunhi, 1966). Grass carps and silver carps were introduced into lakes and reservoirs for their ability to manage overgrowth of vegetation and plankton blooms, respectively. The Ganga River has seen an increase in common carp incidence due to naturally spawning populations, which is now causing an invasion in other areas (Singh et al., 20008).

Common carp were introduced to Kashmir in 1959 to increase fish yield (Sehgal, 1989). The common carp grown in India today is the result of two introductions, one in 1939 (German strain) and the other in 1957 (Indian strain) (Bangkok strain). Around three decades ago, a cold-water stock (German strain) of common carp (Cyprinuscarpio) was introduced into the flatland temperate waters of Kashmir, and they quickly became a major fishery in the area (Fotedar and Qadri 1974; Vass et al 1984). It has been classified as eurythermal, which means it can withstand a large range of temperature fluctuations, making it ideal for culture in the Kashmir Valley's climatic conditions. In Dal Lake, Kashmir, Cyprinuscarpio is cultured and readily available, and this fish is economically significant in terms of local consumption. However, due to heavy exploitation and neglected fisheries policies, the population of this species has declined significantly, necessitating immediate scientific attention because it is currently the only cheap protein available and well-accepted by the common man in the Kashmir Valley.

Due to a substantial loss of genetic diversity in domesticated races, breeds, and strains mixing with the pure wild type, common carp are currently classified as susceptible in most of their

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native areas of distribution, despite their adaptability to a broad range of environmental conditions (Balon, 2006). (Khalili and Amirkolaie, 2010).

Except for some communications on food and feeding, age and fecundity (Das and Subla 1970 and Raina 1978), no detailed study of this exotic species' biology and culture under these agro-climatic conditions has been conducted since its introduction, even though the literature on various aspects of biology and culture of its allied 'Bangkok' strain in tropical conditions are in existence

3. Morphology and Coloration

Carp have a deep body and a dorsal spine that is serrated (Nelson 1984). On the adult, the mouth is the terminal, while on the young, it is the subterminal (Page and Burr 1991). Depression can be found in both domesticated and feral carp in this region. The head is very thin (27-32 percent SL). The body is elongated and slightly compressed, and the lips are thick and extendable. The maxillary barbels are shorter than the mandibulary barbels and are located at the angle of the mouth. Dorsal fin base is long, with 17-22 branched rays and a strong, toothed spine in front; anteriorly, the dorsal fin outline is concave. Anal fin with 6-7 soft rays; sharp spinules on the posterior edge of the 3rd dorsal and anal fin spines. The pectoral fin has 15-18 rays, while the pelvic fin has 7-9 rays. Scales range from 32 to 38 on this lateral line. The number of gill rakes is 22-28/29-34 (outside/inside) (36). Teeth with flattened crowns, pharyngeal teeth 5:5. The number of vertebrae ranges from 36 to 38. (Source: FAO, 2008.) Peter's text on Cyprinus carpio, A. multilingual).

The colour and proportions of the scales vary greatly, but they are often broad and dense. There are three subspecies, each with slightly different scale patterns. C. carpio communis (scale carp) has concentric scales, C. carpio specularis (mirror carp) has broad scales running around the side of the body in many rows with the rest of the body bare, and C. carpio coriaceous (leather carp) has little to no scales on the back and a thick skin (McCrimmon, 1968; Nelson, 1984; Page and Burr, 1991; Tomelleri and Eberle, 1990). Although several colour and size variations exist in both wild and cultivated populations, the species is usually full-scaled and coloured silvery-black or grey, olive-green or yellow-brownish on their backs, softening to pale yellow or cream on their bellies (Balon 1995a; Lintermans, 2007).

While the colour of common carp is determined by genetics, environmental factors such as water colloid content and the age of the fish affect the shading of inherited colouring. The colour of wild carp varies; on the back and upper sides, they are brownish-green, shading to golden yellow ventrally. The fins are dusky, with a reddish tinge ventrally. Golden carp are bred primarily for display. Golden, red, blue, orange, steel, green, albino, purple, lemon-yellow, green, violet, and brown are some of the colour variations found in both wild and domestic carp populations (Kirpitchnikov, 1981; Wang and Li, 2001). Furthermore, in Japan, selective breeding has resulted in the creation of fancy carp, or koi, which are now available in a variety of colours, scale morphologies, and body shapes. The coloration of fish may also be affected by the environment (water, soil, etc.). Albino and coloured strains exist (koi carps, Indonesian coloured carps). The scale pattern of domesticated races can be scaled, mirror, linear ("royal carp"), leather, or dispersed (Wohlfarth, 1983; Balon, 1995). Fish can

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grow up to 1 metre in length and weigh up to 37.3 kilogrammes. The longest life expectancy has been recorded to be 47 years. Popular carp in the wild are torpedo-shaped, full-scaled, and coloured silvery-black or grey on the dorsal surface, olive-green or yellow-brownish on the ventral surface, and light yellow or cream on the flanks (Kirpitchnikov, 1981; Lintermans, 2007). Wild populations and domestic strains, on the other hand, have a wide range of scale morphology, colour, and body form. Wild carp are usually rounder and plumper-bodied than domestic common carp. The feral population of domestic common carp, on the other hand, quickly reverts to a wild-type body form (Balon, 1995). In both wild and domestic populations, dwarfism, the absence of ventral fins, the appearance of an additional fin, elongated fins, and a dolphin-like head have been identified (Kirpitchnikov, 1981; Wang and Li, 2001). There are many varieties of C. carpio (USGS, 2005) that exhibit morphological variation due to their wide geographic range, long history of culture, and artificial selection by humans for aquaculture and ornamental purposes. Cyprinus carpio (Europe), C. c. aralensis (Central Asia), C. c. haematopterus (East Asia), and C. c. viridiviolaceus (East Asia) were identified by Kirpitchnikov (1981). (South East Asia). However, according to Balon (2006), only two subspecies can be identified: C. c. carpio (Europe) and C. c. haematopterus (East Asia). The validity of C. c. viridiviolaceus was then challenged by Kirpitchnikov (1981). Kottelat (2001) recently proposed that the common cultured carp in Southeast Asia be classified as a separate species, C. rubrofuscus. When wild carp types have an elongated body, the connection between the head and the dorsal part of the body is nearly straight. There are two types of common carp in terms of physical appearance: one with a large stomach and the other with a slender body. Other characteristics include a forked tail (caudal fin); no teeth in the mouth; and three rows of pharyngeal teeth on the lower element of the last gill arch, with the outer two rows having one tooth each and the inner row having three teeth (1, 1, 3:3, 1, 1), which distinguishes common carp from many other Cyprinid species.

In Europe, there are approximately 30-35 strains of domesticated common carps. In China, several strains are kept alive. There are several strains of Indonesian carp that have yet to be scientifically studied and described. Cyprinus carpio (FAO, 2009). The qualitative characters that determine the external features of strains, as well as taxonomic classification, are included in the morphological analysis of strains (FAO, 2005). Scaliness is a deciding factor in common carp, and there are four basic types: scaly, mirror (scattered), linear, and leather (naked) varieties.

4. Habitat and Breeding of Cyprinuscarpio

The Cyprinuscarpio is a versatile freshwater species that thrives in temperate, tropical, and freshwater environments. Low oxygen levels, high turbidity, moderate salinity (14 percent), a broad range of temperatures (2 - 40.6 °C), and high levels of toxicants are all tolerated by common carps (Koehn 2004). They prefer slower-moving bodies of water with soft sediments, but they are adaptable and hardy fish that excel in a variety of aquatic environments (Froese and Pauly, 2002; Page and Burr, 1991). When the water temperature is between 23 and 30 degrees Celsius, the best growth occurs. In the temperate region, growth is much slower: the fish attain a body weight of 1 to 2 kg after 2 to 4 rearing seasons. Carp mature during their first year in tropical and subtropical regions, and they can spawn multiple

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times in a single year (Sivakumaran et. al., 2003). Cyprinuscarpio can live in a variety of environments, including benthic, lakes and ponds, rivers and streams (aquatic biomes), and marsh wetlands.

Cyprinuscarpio has a polyandrous mating scheme. Depending on the area, carp spawn in the spring and early summer. In temperate waters, common carp breeds once a year in the spring, but spawns all year in tropical waters, with peaks in January-March and July-August (Linhart et al., 2002). It is for this purpose that the induced breeding technique can be used in temperate waters. In India, common carp can have up to five spawnings each year, and it only takes three months for both sexes to be ready for the next spawning after the previous one (Vilizzi and Walker, 1999).

The rate of growth of common carp varies greatly depending on temperature, food availability, and population density in different regions. Carp congregate in shallow waters with dense macrophyte cover to spawn, and they prefer shallow waters with dense macrophyte cover. Males fertilise eggs externally, which females disperse over macrophytes in a frenetic fashion. The eggs adhere to the layer they are strewn over.

Common carp can also be stocked in natural waters, lakes, and temporarily flooded areas, and they can be grown in large, natural food and supplementary feed-based monoculture production systems in stagnant water ponds. In pens, irrigation reservoirs, running water ponds and tanks, or recirculation systems, artificial feed-based intensive monocultural development can be carried out. In hapas, cement tanks, or small ponds, breeding takes place. Submerged aquatic plants are used as an egg-laying substrate. The fry are stocked into nursery ponds when they are 4 to 5 days old. One-summer old fish (20-100 g) must be reared up to 250-400 g in the second year in temperate areas. If only cereals are fed, the stocking rate is 4 000-6 000 per hectare, plus around 3 000 Chinese carp per hectare.

According to statistics, common carp production may have decreased. However, the majority of carp are consumed domestically, and the species will continue to be important in areas where it is historically grown (FAO. 2009, Cyprinuscarpio).

5. Food and Feeding of Cyprinuscarpio

The common carp is primarily a bottom dweller, but it will also search the middle and upper layers of a water body for food (Billard, 1999; Koehn et al., 2000). Food is sucked into the mouth, along with water and sediments, at the pharyngeal or throat's entry, or by sieving food products from the bottom sediments (McCrimmon 1968), sucking sediments into their mouths and expelling indigestible particles through opercular openings behind the gills (McCrimmon 1968). (Koehn et al., 2000). This behaviour can cause fine sediments to be stirred up and turbidity to rise (Koehn, 2004). In shallow waters, carp feeding galleries are easily identified as depressions in the sediment (Cahn, 1929; Lammens and Hoogenboezem, 1991; McCrimmon, 1968).

The common carp has mechanisms to improve its health by changing its food preferences as well as its feeding niche and behaviour. The classical optimal foraging theory states that

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common carp expands its feeding niche to optimise its food intake (Rahman & Meyer 2009). When food is scarce, the common carp alters its eating habits, feeding niche, and behaviour. Other fish species are influenced by common carp to change their eating habits and behaviour, which can have a positive or negative impact on their growth and behaviour. When there isn't enough food, the common carp has exceptional adaptability. There is evidence that when other natural foods are scarce, common carp consumes the fry of other fish in large numbers (Weber & Brown 2011). When common carp and crayfish (Cambarellusmontezumae) live in the same area, there is evidence that the common carp preys on the larvae of the crayfish (Cambarellusmontezumae) (Hinojosa-Garro& Zambrano 2004).

They are omnivorous, according to Eder and Carlson (1977), feeding primarily on benthic species (e.g., chironomid larvae and pupae), detritus, and algae. Tiny planktonic species, crustaceans, and insect larvae are the primary foods of juvenile carp. Carp have a strong preference for animal foods like fish, shells, aquatic crustaceans, and water insects, as well as insect larvae, worms, mollusks, and zooplankton. In fish ponds with high stocking density, zooplankton consumption is dominant. As common carp mature, they begin to consume larger crustaceans, aquatic insects, and plant matter. The carp also eats aquatic and terrestrial plant stalks, roots, tubers, nuts, leaves, seeds, algae, and microalgae, as well as decayed aquatic plants (Lammens and Hoogenboezem 1991). Carp that have just hatched feed primarily on zooplankton, such as rotifers, copepods, and algae (McCrimmon 1968). Yearling carp eat chironomids, caddis flies, mollusks, ostropods, and crustaceans, among other macroinvertebrates (McCrimmon 1968). Adult carp have been observed eating insects, crustaceans, annelids, mollusks, fish larvae, fish remains, and plant tubers and seeds, among other things (McCrimmon 1968, Lammens and Hoogenboezem, 1991).

6. Genetic variability of Cyprinuscarpio

Common carp have been cultured for decades, initially in temperate waters, and have undergone major genetic changes as a result of deliberate and unintentional genetic changes over this period (Basavaraju et al., 2002). Unconscious selection, genetic drift, and inbreeding help common carp adapt to local environments, but this also leads to a decline in culture output in tropical areas.

When domesticated fishes enter wild stocks, they have a higher propensity for active hybridization without sterility, which contributes to complex introgression (Arthington, 1991). The environmental effect of such degradation is obvious since aquaculture facilities are related to the hydrographic system (rivers, lakes) except in very rare circumstances, and both accidental stocking and encounters with wild populations can occur very frequently. Introgressive hybridization and genetic diversity loss are the most common problems. Hybridization can also result in chromosome number (ploidy) variations, resulting in lineages of one or two complete sets of chromosomes from two different organisms (allopolyploid lineages). These lineages may or may not be capable of asexual reproduction (parthenogenesis). As a result, they may have significantly increased reproductive output, as all individuals are capable of producing offspring (Billington and Hebert, 1991).

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7. Importance

In many Asian and European countries, common carp (Cyprinuscarpio) is a very popular aquaculture species, and exotic carp is the backbone of Indian aquaculture. Common carp accounts for more than 80% of total fish output in some European countries (Woynarovich et al. 2010; Anton-Pardo et al. 2014). Human introduction has greatly expanded its distribution due to its high popularity. Common carp are commonly reared in polyculture ponds; however, monoculture of common carp is more popular in cold climate regions, especially in Europe (Szucs et al. 2007).

By increasing phytoplankton productivity, which releases nutrients such as soluble phosphorus from the soil, common carp speeds up nutrient fluxes to the next trophic stage. Rahman (Rahman, 2015). Increased nutrients promote photosynthesis, resulting in an increase in phytoplankton biomass in the water column. Low PO4-P concentrations in most freshwater ponds and lakes restrict phytoplankton development. Popular carp-driven resuspension reduces this restriction by increasing P flux from the sediment to the water column (Rahman 2015). Fish species, size, density, food availability, and foraging activity (benthic feeding) are all major determinants of sediment resuspension. Several species resuspend bottom sediment, the most well-known of which is the common carp, which has a significant impact on the aquatic ecosystem due to its browsing behaviour for benthic macroinvertebrates in the sediment (Rahman et al. 2008a). It causes bottom soil resuspension during the digging and sieving of sediments, which increases oxygen availability in the bottom soil.

Bioturbation of benthic soil during feeding on benthic species impacts aerobic decomposition of organic matter and nutrient availability in the water column. During aerobic decomposition, the amount of dissolved oxygen is decreased. Decomposition also releases carbon dioxide, which leads to a lower pH and lower alkalinity (Rahman et al. 2008c). The transfer of nitrogen and phosphorus from the bottom sediment into the water column is also significantly accelerated by common carp excretion (Morgan & Hicks 2013).

Because of its ability to alter the ecological features of aquatic environments, the common carp is sometimes referred to as a "ecological engineer" (Matsuzaki et al. 2009; Bajer & Sorensen 2015). It is widely identified as a nuisance fish in some western countries because it causes significant ecological disturbance to both the marine environment and ecosystem.

The ecological consequences of common carp's specific feeding method are important. When carp eat nutrient-rich benthic sediments and then excrete those nutrients back into the water column in a form that is accessible to other species, they serve as "nutrient pumps" (Drenner et al. 1996). This leads to a general decline in water quality, and the carp's high fecundity has earned them a reputation as a nuisance (Brabrand, et al., 1990; Drenner, et al., 1996; McCrimmon, 1968; Page and Burr, 1991).

Carp has been cultivated for over 2500 years as a common game, food, and ornamental fish. It quickly established itself in most natural inland waters, including rivers, lakes, streams, canals, wetlands, and even village ponds, due to its high temperature and turbidity tolerance

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and prolific pond breeding habit. Popular carp farming has enormous potential for improving people's livelihoods and the country's gross domestic product (GDP). Still, there is a need to change fish farming practises in order to meet world-class demands, which can only be accomplished with the active participation of policymakers and stakeholders, as well as better management (Khan, M. N et al,. 2016)

8. Conclusion

The most serious threat to the biodiversity of wetland and shallow lake habitats in the United States is common carp. As opportunistic omnivores with varying dietary preferences depending on food availability, common carp is known as the world's most ecologically destructive invasive species (Lowe et al., 2004). Exotic fish impacts can result in habitat changes, trophic structure changes, and hybridization over time (De Silva et al., 2006; Lakra et al., 2008). Exotic fish were intended primarily for aquaculture, but accidentally or due to ignorance, they found their way into open waters, potentially causing significant ecological problems (King and Hunt, 1967).

Animal density is a key factor that has a significant impact on the marine environment (Soundarapandian&Kannan 2008; Rahman et al. 2012; Khatune-Jannat et al. 2012; Amira et al. 2015). Popular carp populations that are too big have a variety of negative consequences for aquatic environments (Kloskowski 2011a; Rahman 2015).

Both Australia and New Zealand consider common carp to be the worst freshwater pest fish (Chadderton et al. 2003, Koehn, 2004). Its effects are mostly due to its ability to change marine environments (Zambrano and Hinojosa, 1999; Parkos et al., 2003; Matsuzaki et al., 2007). It was discovered that introducing exotic fish could reduce the diversity of native fish species and disrupt the ecosystem's food web work. Common carp habitat changes (e.g., increased turbidity and loss of macrophytes) may have an effect on small native fish and other benthic fauna (Llewellyn, 1974).

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