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Review

Ecological and Morphological Aspects of Grass Carp and its Significance in controlling Aquatic Weeds

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Abstract: Aquatic plants are valuable and an essential part in structuring communities of lakes. Macrophytes influence various ecological processes and species diversity of flora and fauna. Inspite of this, overgrown plants may become nuisance and act as an obstacle in utilization of water, endangering the structure and function of various species. Now-a-days to overcome these problems a herbivorous fish *Ctenopharyngodon idella* is used as a biocontrol agent as it consumes massive amount of aquatic weeds. The present study is intended to examine morphological and ecological aspects of grass carp with its significance in controlling aquatic weeds. In this concept an interactive and complete presentation of facts and information is discussed here which will provide a lime light on this biological control agent. Thorough understanding of these impacts is essential as these factors determine the appropriate management of aquatic water bodies.

Keywords: Aquatic weeds, macrophytes, grass carp, biological control.

INTRODUCTION:

Macrophytesare large vasacular plants that play an essential role in structuring communities of lakes. Macrophytes generally colonize shallow ecosystems where they become important components, influencing ecological processes and species diversity of attached assemblages (Thomaz and Cunha, 2010). In spite of this, overgrown plants may become nuisance and act as an obstacle in utilization of water, endangering the structure and function of various species. An excess of decaying plants can lower the amount of oxygen, impede fishing activities, hinder navigation in the water and indirectly influence the other aquatic species (Dhore *et. al.,* 2012). Thus, controlling and eliminating invasive weed or macrophytes from water bodies, is a very tedious work which can be only achieved through proper management. For achieving this aim, there are three management approaches which include mechanical, chemical and biological control (Center *et. al.,* 1999).

Now-a-days biological control technique is the most successful approach as it is cost-

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effective and less laborious in comparison to other vegetation control means. A part from this a long-term control can be achieved by using fishes as the bio-control agent as they have longer life-span (Bozkurt *et. al.*, 2017).

In the tropical and sub-tropical countries about 40 species of fishes in the family Cyprinidae and Chichlidae feed directly on macrophytes (FAO, Repository). Of these fishes, only the *Ctenopharyngodon idella* is able to consume large quantities of macrophytes and under suitable condition it can devour more than its own weight (18 to 14%) of plant material (Gopal et al., 1981; Pipalova, 2006). Greenfield *et. al.* (2004) stated that there are various methods for controlling aquatic vegetation, but using grass carpis the cheapest method. Fromthis point of view, controlling aquatic vegetation with grass carp is one of the most suitable options which is economical as well as have long lasting impacts.

Historical milieu of Grass Carp Introductions

Current data indicates that Grass Carp has been introduced to more than 100 countries in various continental regions, including Africa, Asia, Europe, as well as North, South, and Central America (Chen *et. al.*, 2009). It's is a sub tropical to temperate species and its native place ranges from Vietnam to the Amur River on the Siberia-China border (Jones *et. al.*, 2017). The Yangtze River is the Asia's largest river which harbor's the largest natural population of Grass Carp (Zhao *et. al.*, 2011).

Morphological Aspects

Grass Carp has an elongated, slightly curved lateral line with a wide blunt head and a laterally compressed body. The eyes are small with a terminal mouth and a very short snout without barbells (Ross, 2001). Adult fishes are usually dark grey to brassy green on the dorsal surface, becoming lighter silvery white on the lateral sides (Ross, 2001, Page and Burr, 2011). The body is covered with cycloid scales (34–45 on lateral line), 7–8 dorsal fin, 8–10 anal fin and 15–20 paired pectoral fins (Ross, 2001, Schofield *et al.*, 2005). Pharyngeal teeth are arranged in two rows with sharp ridged grinding surfaces and may count as 2,4–4,2,2.5–4,2 or 2,4–5,2 (Page and Burr, 2011). The length of larvae ranged from 5.1 to 8.0 mm in 6–11 days, whereas, juveniles ranged from 30.0 to 206.6 mm in 20–76 days. Morphological aspects are shown in Fig 1 and 2.

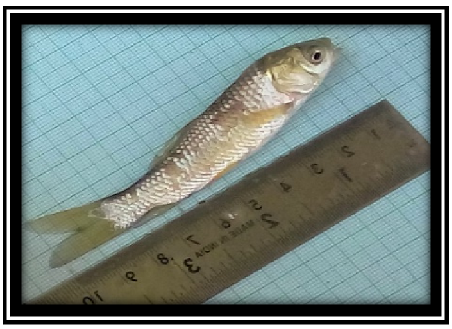

Figure 1: Morphometry of *Ctenopharyngodon idella*

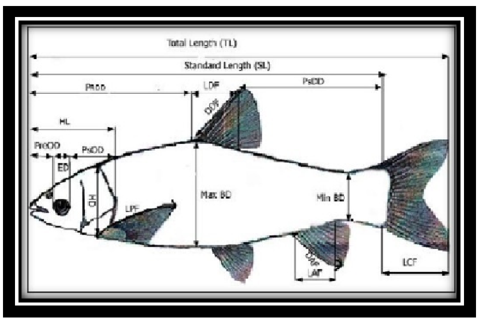

Figure 2: Outline diagram of Ctenophayngodon idella with Morphometic characters (Singla, 2016)

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Reproduction of Grass Carp

Mature grass carp takes about 1500 to 2000 days to grow and develop mature gonads (Beck, 1996). Maturity in tropical climates occurs in the early ages between the age of 1 to 8 years (Shireman, 1983).The water temperature required for the stimulation of sexual maturation and spawning varies from 20 to 30°C, which varies with the location (Bozkurt, 2017). In addition, water levels greater than 122 cm are needed for 12 hours period for stimulation of spawning (Chilton and Muoneke, 1992). Grass carp prefer spawning in water currents of 0.6 and 1.5 m/sec, but usually spawning occurs in currents as low as 0.2 m/sec or even in water bodies that lack currents.

In males, at the onset of maturity sexual differentiation starts occurring with the formation of tubercles on the dorsal and medial surfaces of the pectoral fins (Shireman and Smith, 1983; Cudmore and Mandrak, 2004). Females exhibit temporary tubercles with bulging abdomens and swollen, pinkish vents at onset of maturity (Jones *et. al.*, 2017). The eggs of the fish have a diameter of 2.0–2.5 mm when released, but swell rapidly to 5–6 mm as the water is absorbed (Chilton and Muoneke, 1992). Fecundity is directly proportional to fish length, weight and age and it ranges from 0.001 to 2million eggs, but for a 5kg brood stock it is typically 0.5 million eggs (Chilton and Muoneke, 1992).The eggs are non adhesive and semi buoyant, requiring well oxygenated water and a water current to travel distances about as long as 50-180 km (Stanely,1978).

Feeding and diet

Grass carp mainly feeds on aquatic plants and is able to eat 2-3 times its weight every day and grows up to 2-4 kg in one year (Bozkurt, 2017).The fish prefers low and soft fiber macrophytes such as duckweed while, larger fishes feed on a wide variety of fibrous and tough plants. The five most preferred species are hydrilla, musk grass, *Potamogeton* spp., *Najas guadalupensis* and *Egeria densa* (Dibble and Kovalenko, 2009). In general monocotyledon plants are preferred about 64%, followed by dicotyledon (25.5%), bryophytes and pteridophytes each about 4% and macroalgae about 2% (Mandal *et. al.,* 2010).Factors such as age, length, weight, temperature, stocking density, availability of plant species, and size of the water body may influence grass carp feeding strategies (Opuszynski and Shireman, 1995).

In cultured conditions grass carp can grow up to 1 kg during the first year and in temperate regions, grow around 2-3 kg per annum and in tropical regions 4.5 kg per year (Bozkurt, 2017) Grass carp starts feeding on protozoans and rotifers 3-4 days after hatching, and after 11-15 days it feeds oncladocerans (Federenko, 1978). After 2weeks the fish feeds on larger preys such as daphnia and after 3 weeks, the frequency of plants in the diet increases. Macrophyte feeding begins from 1 to 1.5 months after hatching (Cudmore and Mandrak, 2004). It prefers submerged and floating macrophytes in moderate climates although it consumes almost any kind of vegetation when its favorite food is not available (Lembi *et. al.,* 1978).

Fish fed with the plant diet have considerably higher gut growth in terms of length and weight. The expression of the neuropeptides and leptin receptors and trypsin and amylase in fishes has been increased to improve the consumption and digestion of plant food (He *et. al.*, 2013). Therefore, in India, grass carp were bred artificially for the purpose of weed control and released in the water when attains a weight of 100 gm each (Sushilkumar, 2011). Importantly, these macrophytes may be used as components for fish foods and substitute costly commercial feeding stuffs. About 50% of plant protein has

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been changed to fish protein and even 30% addition of macrophytes into prepared feeds has shown better balance of amino acid. (Kirkagaç, 2003).

Non-Preferential Species

Grass carp cannot control *Pistia*, *Salvinia*, *Nymphaea*, Eurasian milfoil, fragrant water lily, and catails or other large aquatic plants (Colle, 2009). *Elodea* were possibly avoided because it is difficult for fish to remove a single, convenient stem. Hewing is limitable with Typha, as the leaves are too thick, and grass cannot be eaten quickly enough (FAO, Repository).

Eutrophication is caused due to heavy use of chemical fertilizers in agricultural fields and dumping of human and industrial wastes. These situations contribute to the rapid growth of aquatic weeds which cannot be controlled mechanically or chemically. The most likely solution in these cases is the introduction of grass carp in to weed covered water. At this point, several parameters should be considered before introduction such as stocking density of fish, water quality, plankton and plant composition and also the structure of the benthos.

Stocking of grass carp for controlling of aquatic vegetation

The number of fishes required to control aquatic plants varies depending on the level of plant infestations, lake sizes, plant types and the size of fishes stocked. The stocking rates can vary between one to 20 grass carp per hectare, depending on the amount and types of vegetation (Bozkurt *et. al.,* 2017).Stocking rates should be increased as the temperature falls because the consumption of plant by the fish decreases. The densities of stocking should be decided according to the biomass of standing aquatic weeds, therefore, the higher the biomass, the higher stocking rate is required (Bozkurt *et. al.,* 2017).It is well known that "overstocking" is accompanied by complete elimination of all vegetation, while "understocking" leads to selective reduction or it can also result in no vegetation (Blackwell and Murphy, 1996; Bonar *et. al.,* 2002). Intermediate plant control can be achieved by maintaining low stocking densities (Van, 1977). The chances of successful biocontrol increase's if the fish is stocked prior to the rapid growth of vegetation. Grass carp should be stocked larger than 30 cm otherwise; they will be highly vulnerable to predators (Adamek, 2003).

Changes in aquatic plant pattern and plankton composition

The impacts of grass carp have been observed for 15–20 years and it was concluded that the removal of aquatic plant, favoured by the carp is believed to reduce the diversity of the aquatic macrophyte (Catarino *et al.,* 1997). The primary production of the water bodies depends on light and nutrient availability that affect the equilibrium between macrophytes and phytoplankton. Therefore, the degree and speed of macrophyte removal by the grass carp influences the phytoplankton and zooplankton production (Bozkurt *et al.,* 2017).The production of zooplankton and zoobenthos in lakes, is increased by the consumption of macrophytes by fishes and consequently the levels of nutrients and faecal matters (Zhang and Chang, 1994). Eventually, the zooplankton groups shifted from copepod and cladocerandominated communitiesto rotifer and small cladocerans (Bozkurt *et. al.,* 2017).

Changes in water quality and benthos

The effects of grass carp on water quality and plants are highly variable and often unpredictable due to the lack of proper control strategies. Water quality changes are primarily observed in small, non-flowing water bodies due to removal of aquatic weeds by grass carp. In this

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concept, changes in concentration of oxygen and pH were observed after the stocking (Opuszynski, 1997). Grass carps have a positive effect on abiotic factors which was mainly due to the turbidity and a negative influence on biota which was due reduction in biomass of native and non-native species of macrophytes. Grass Carp is also known to affect waterfowl by reducing aquatic vegetation which provides food source as well as nesting habitat (GISD, 2014).

CONCLUSION:

In conclusion, grass carp can be effective in controlling of aquatic plants, but its potential risks and benefits should be considered very well, before stocking the fish in the aquatic environment.

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