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FOOD PREFERENCE AND GROWTH OF GRASS CARP, *CTENOPHARYNGODON IDELLA*, AND HYBRID CARP, *C. IDELLA* FEMALE X *ARISTICHTHYS NOBILIS* MALE

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ABSTRACT

Hybrid carp of the cross between female grass carp, *Ctenopharyngodon idella* Val., and male bighead carp, *Aristichthys nobilis* Rich., and grass carp were raised in 227 litre indoor tanks at 27°C temperature and stocking density of six fish per tank. They were fed on three food categories, small leaf pond weed, *Potomegeton pussilus*, coontail, *Ceratophyllum demersum*, and mixed vegetation of 1:1 ratio of pond weed and coontail. Both hybrid carp and grass carp showed preference to pond weed. For a given diet, food consumption rates were similar between the fishes (pw: 46.1 per cent, mixed: 56.3 per cent, ct: 7.6 per cent). Daily growth rates were similar among the fishes on pond weed and mixed vegetation (0.21 per cent) but on coontail diet hybrid carp and grass carp exhibited negative growth.

INTRODUCTION

Aquatic vegetation is an important integral component of the ecosystem as they play a vital role in the trophic character and water purification. They provide shelter and spawning and feeding grounds for many fishes; however, excessive vegetation can be a nuisance to fisheries, navigation and water supply systems and may lead to disruption of the biocoenotic relationships (Vinogradov and Zolotova 1974). Mechanical and chemical methods are commonly used in controlling aquatic vegetation. Although weeds can be selectively removed to the desired levels by mechanical means, causing no harmful effects to the water or biota, this method is relatively expensive (Thompson and Hartwig 1973, Frye 1972). Herbicides may leave residues in water deleteriously affecting aquatic soil, fish and game, and may contaminate public water supplies (Blackburn 1968).

Biological means of aquatic weed control by phytophagous fishes has recently received considerable attention as it is less expensive and the fishes used for such control will also provide protein to human nutrition. Of the many phytophagous fishes used in weed control, the grass carp *Ctenopharyngodon idella* Val. (Cypriniformes:Cyprinidae) is considered an ideal fish as it feeds on a wide range of aquatic plants and can tolerate a wide range of temperatures with low oxygen requirement (Opuszynski 1972). Hickling (1960), Strogonov (1963), Cross (1969), van Zon (1973), Colle *et al.* (1978), Lembi *et al.* (1978), Mitzner (1978), Kilambi and Robinson (1979), and Kilambi (1980) reported on growth, food consumption and usefulness of grass carp in controlling vegetation. There has been a great deal of concern and controversy regarding its release into new habitats. Some of the concerns are that grass carp may reproduce naturally, establishing itself as an undesirable fish and it may denude a body of water of its vegetation thereby adversely affecting other fishes and ducks (Vance 1975).

Recently, a hybrid carp, resulting from a cross between female grass carp and male bighead carp, *Aristichthys nobilis* Rich. (Cypriniformes:Cyprinidae), was developed in Hungary (Marian and Krasznai 1978), and this hybrid is currently produced at the Joe Hogan State Fish Hatchery and Malone's Fish Farm located in Lonoke, Arkansas. This triploid hybrid is reported to be sterile and to show overwhelming dominancy of the female parent, including the feeding habits

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(Buck 1979). At this time, there is no published scientific information on the efficacy of hybrid carp in controlling and utilizing aquatic weeds compared to the grass carp. In order to compare the grass carp and the hybrid carp in their relative effectiveness in controlling vegetation, it is ideal to raise these fishes under controlled laboratory conditions at similar stocking densities. The objective of this investigation is to compare grass carp and hybrid carp relative to vegetation preference, and food consumption and growth rates.

METHODS AND MATERIALS

Grass carp and hybrid carp hatched in May 1979 were obtained from the Joe Hogan State Fish Hatchery, Arkansas in October 1979, and were kept in indoor holding tanks. One group of each of the fishes was fed on small leaf pond weed, *Potomegeton pussilis*, the second group on coontail, *Ceratophyllum demersum*, and the third group on mixture of these two weeds to acclimate them to the experimental feeds. During the holding period the fishes developed red spots on body and at the base of the fins, fin rot and body lesions, and were given Terramycin injections (25 mg active per pound of body weight) intraperitoneally (Wellborn 1979).

The experiments were conducted from 13 December 1979 to 23 March 1980 in 12 indoor tanks (103 x 66 x 36 cm) each with 227 litres of water maintained at a constant temperature of 27°C and 12-hr photoperiod. The tanks were aerated by air stones. Grass carp and hybrid carp were raised in separate tanks at a stocking rate of six fish per tank (av. wt: grass carp 163 g, hybrid carp 70 g). The experimental fishes were fed one of three types of vegetation: small leaf pond weed, coontail, or 1:1 mixture of pond weed and coontail. Each of the experimental conditions was replicated. The fishes were fed daily in excess of previous day's consumption. The fishes were finclipped and the fish that died during the study were replaced to maintain stocking density. At 10-day intervals, the Quinaldine anaesthetized fish were weighed to the nearest gram and the tanks were cleaned and new water added every 20 days. The fish were given Terramycin injections periodically when symptoms of infection appeared.

Daily food consumption and growth rates were estimated as:

$$\text{Food consumption (per cent/day)} = \frac{FC}{0.5\,(W_2 + W_1)\,t} \times 100$$

$$\text{Growth (per cent day)} = \frac{\ln W_2 - \ln W_1}{t} \times 100$$

where, FC = weight of food consumed, W_2 and W_1 = weights of fish at two time periods, and t = number of days. Fish that survived for 20 days or more were used in growth estimates.

Statistical analyses were performed by HP65 programable desk calculator. Significance of statistics was expressed at the 0.01 level.

RESULTS AND DISCUSSION

Food consumption and vegetation preference

Food consumption rates by the grass carp and the hybrid carp on the experimental vegetation are given in Table 1. For a given vegetation type grass carp and hybrid carp had similar consumption rates ($F_{1,112} = 0.03$), but daily food consumption was different between the feeds ($F_{2,112} = 123.41$). The least

Table 1. Per cent daily food consumption by grass carp and hybrid carp.[1]

Fish	Vegetation		
	Pond weed	Mixed	Coontail
Grass carp	39.9[a]	56.1[c] (48.8 pw; 7.3 ct)	8.2[b]
Hybrid carp	49.0[a]	56.5[c] (48.8 pw; 8.0 ct)	7.1[b]
Weighted mean	46.1	56.3 (48.8 pw; 7.7 ct)	7.6

[1] Values having the same letter are not significantly different.

significant difference (l.s.d.) test (Steel and Torrie 1960) showed the fish consumed significantly more mixed vegetation followed by pond weed and coontail. Both the fishes consumed significantly more pond weed than coontail when the weeds were provided as a mixture ($F_{1, 77} = 179.54$). Pond weed was consumed at similar rates when supplied alone or in combination with coontail and similar results were obtained for coontail. Therefore, highest food consumption on mixed vegetation was due to both feeds being consumed at the same rates as when the vegetation was provided separately. The food consumption data indicated that both the fishes showed preference to pond weed over coontail. It is also of interest to note that while the entire plant of pond weed was consumed, only the leaves of the coontail were eaten by both the fishes.

Several studies reported on the selectivity of food types by grass carp. Stott (1967) and Verigin *et al.* (1963) reported that coontail was consumed at slightly more than the body weight of grass carp but was lower than the intake of pond weed (*P. pectinatus*). Singh *et al.* (1969) data showed that grass carp (690 g) consumed coontail at a daily rate of 102 per cent. Bailey (1972) reported that coontail was completely controlled by grass carp (4994 g) in Lake Greenlee, Arkansas. A food habit study by Colle *et al.* (1978) reported that grass carp (63 to 220 mm) diet was dominated by macrophytes; but the coontail was not noted in the gut contents although it covered 26.1 per cent of the pond. The pond weed, *P. illinoensis*, covering 4.1 per cent of the pond contributed to 10.1 per cent by weight to the diet. Hestand and Carter (1978) stated that of the six species of aquatic macrophytes (no pondweed), coontail was a very poor competitor as food for grass carp (av. size: 240 mm, 190 g). Mitzner (1978) reported that *P. pectinatus* and the coontail along with other aquatic macrophytes were effectively controlled by grass carp in Red Haw Lake, Iowa. From Mitzner's data it was apparent that coontail appeared in the diet more frequently as pond weed biomass decreased which also coincided with increase in size of grass carp from 380 g (310 mm) at stocking to more than 4000 g (710 mm). Edwards (1974) found that coontail was not consumed until grass carp reached about 350 mm.

Grass carp of our study, averaging 221 mm in length and 163 g in weight showed preference to pond weed whether it is provided alone or in combination with coontail. Hybrid carp (159 mm; 70 g) also showed preference to pond weed. From our study and the earlier mentioned literature it appears that small

grass carp, probably less than 350 mm, prefer less fibrous vegetation such as pond weed, and as fish become large, they are able to feed on fibrous weeds. Since hybrid carp of the size used in our study had the same food consumption rates and vegetation preferences as that of grass carp, it is safe to say that hybrid carp food habits are similar to grass carp. However, the shift in vegetation type as food can only be ascertained by future studies with different size or age groups of hybrid carp. Throughout the study period, neither grass carp nor hybrid carp exhibited trends in consumption rates or preference with progression of time.

Table 2. Per cent daily growth of grass carp and hybrid carp.[1]

Fish	Vegetation		
	Pond weed	Mixed feed	Coontail
Grass carp	0.20[a]	0.28[a]	-0.01[b]
Hybrid carp	0.21[a]	0.15[a]	-0.48[c]
Weighted mean	0.21	0.21	–

[1] Values having the same letter are not significantly different.

Growth

Growth rates (Table 2) were significantly different between the types of vegetation ($F_{2, 68} = 36.66$) and between the fishes ($F_{1, 68} = 15.94$). Further analysis by the l.s.d. test showed that grass carp and hybrid carp fed on pond weed and mixed vegetation had similar growth rates, with an average weight gain of 0.21 per cent per day. Both the fishes lost weight on coontail, and hybrid carp lost significantly more weight than grass carp. Similarities of growth of grass carp and hybrid carp fed on pond weed and mixed vegetation are due to both the fishes having the same food consumption rates on pond weed.

In Red Haw Lake, Iowa, biomass of grass carp increased when pond weed contributed more to the diet than coontail (Mitzner 1978). He further found that as coontail became most important in the diet, growth rate and biomass decreased, and mortaility became more important. Mitzner's (1978) study and our findings indicate that coontail is not efficiently utilized for growth. Since both grass carp and the hybrid carp lost weight on coontail diet, it is assumed that this vegetation did not contribute to growth even when consumed along with pond weed. This explains why the growth rates were not different between pond weed and mixed weed diets although significantly more mixed vegetation was consumed.

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