Culture And Diet Of Hybrid Grass Carp Fingerlings

J. R. CASSANI, W. E. CATON
AND T. H. HANSEN, JR.

Lee County Hyacinth Control District
P.O. Box 06005
Fort Myers, Florida 33906

ABSTRACT

Hybrid grass carp fingerlings (12.5 to 17.8 cm total length) resulting from the cross of a female grass carp (*Ctenopharyngodon idella* Val.) and a male bighead carp (*Hypophthalmichthys nobilis* Rich.) were maintained outdoors in rectangular concrete tanks (600 l/tank) with 25 fish per tank. Six different feeds or feed combinations were fed daily during a 60 day period. The resultant growth (mean net weight gain (g)) and mean conversion ratio (total dry weight in kg of feed fed/mean weight gain) respectively, were: artificial feed, 247.7 and 8.57; artificial feed and duckweed (*Lemna/Wolffia* 1:1) 550.3 and 2.92; *Wolffia columbiana* 373.0 and 3.76; *Lemna gibba* 137.7 and 6.69; strained frozen brine shrimp, 516.0 and 1.58; strained frozen brine shrimp and duckweed (*Lemna/Wolffia* 1:1), 441.3 and 3.18. The greatest rate of growth (0.45 g/day) occurred during the first 40 days at a mean temperature range of 23 to 28 C on the diet of artificial feed and duckweed (*Lemna/Wolffia* 1:1).

INTRODUCTION

Since the introduction of the grass carp (*Ctenopharyngodon idella* Val.) into the United States in 1963, its use as a biological control agent for aquatic weeds has produced considerable controversy because of its potential for reproduction in native waters (5, 7, 8). Most states either prohibit grass carp introductions or have restrictions for its use (8).

A hybrid from the cross of a female grass carp and a male bighead carp (*Hypophthalmichthys nobilis* Rich.) was produced commercially for the first time in the United States in 1979 by J. M. Malone and Son Enterprises, Lonoke, Arkansas. The hybrid was produced as a possible alternative to the grass carp due to its greatly reduced potential for reproduction. Karyological analysis of gill epithelial cells from a sample of fish produced by Malone, indicated that they were triploid with 72 chromosomes compared to 48 for both parent species (2). Beck et al. (2) speculates that the triploid condition was brought about by the retention of a polar body.

The purpose of this study was to determine the feasibility of rearing hybrid grass carp fingerlings under artificial conditions that would allow easy recovery and to evaluate growth rates under several feeding regimes.

METHODS

The fish used in this study were fingerlings received from J. M. Malone and Son, Enterprises on 15 September 1980. Of approximately 2000 fish received, the total length of about 75% was 5.0 to 11.5 cm, 20% was 12.5 to 17.8 cm total length, and the remainder was 18.0 to 22.0 cm. The fish selected for this study were the larger individuals. Each of 19 concrete tanks (2.25 m long x 0.83 m wide x 0.55 m deep) was filled with about 600 l of well water and 25 fish were placed into each tank.

A single control and three replicates for each of six different feeding regimens were set up for a 60-day period from September through November. The fresh weight quantities and feed sources fed daily were: (1) 750 g *Wolffia columbiana* Karst.; (2) 250 g *Lemna gibba* L.; (3) 40 g of commercially available floating catfish pellets (artificial feed); (4) 20 g artificial feed and 200 g of the duckweed combination (*Wolffia/Lemna* 1:1). (5) 100 ml strained fresh frozen brine shrimp (*Artemia salina*); and (6) 50 ml strained fresh frozen brine shrimp and 200 g of the duckweed combination (*Wolffiia/Lemna* 1:1). Each feed treatment and replicate was assigned to its respective tank in a random fashion. One replicate was set up as a control in which the fish were not fed for the first 40 days. The quantity of feed for each feed source was determined as the maximum amount the fish would consistently consume in a 24 hr period. These pre-test feeding trials were conducted for several days before initiating the study. Hydrophyte fresh weight was determined by spinning the plant material in a net bag for 5 minutes at approximately 500 rpm in a washing machine on the spin cycle.

Each tank was provided with constant aeration by pumping air through a 15 cm long airstone. Also, each tank was flushed with well water (200 to 400 l/hr) for 2 to 3 hours daily and the tanks were cleaned twice a week. The dissolved oxygen concentration and temperature was recorded randomly in eight of the 19 tanks daily during the early morning and late afternoon with a Y.S.I. Model 57 Dissolved Oxygen Meter.

The fish from each replicate were weighed to the nearest gram initially and at the end of each 20 day interval. After weighing, the fish were immediately returned to the tanks and 10 mg/l of oxytetracycline was applied in each tank as a prophylactic treatment.

The dry weight for each feed source was determined by drying 10 samples of a predetermined fresh weight for each feed in an oven at 70 C for 48 hr.

RESULTS

Fish weight and increase over time is presented in Table 1 with respect to the different feed treatments. Table 2 lists the total fresh and equivalent dry weight for each feed

TABLE 1. MEAN WEIGHT (G) AND PERCENT WEIGHT CHANGE FOR 25 HYBRID GRASS CARP FINGERLINGS PER FEED SOURCE AT 20 DAY INTERVALS BETWEEN SEPTEMBER 29 AND NOVEMBER 28, 1980.

Feed source	Initial Wt.	20 Days Wt.	20 Days % Change	40 Days Wt.	40 Days % Change	60 Days Wt.	60 Days % Change	Mean Net[c] Wt. Gain (g)
artificial feed	970.0	1165.0	20.1	1213.6	4.1	1217.6	0.3	247.7 a
artificial feed + duckweed combination[a]	900.0	1146.6	27.3	1351.3	17.9	1450.3	7.3	550.3 b
Wolffia	1033.3	1206.6	16.7	1376.6	14.1	1406.3	2.2	373.0 c
Lemna	1015.0	1063.0	4.7	1139.6	7.1	1152.6	1.1	137.7 d
brine shrimp	1028.3	1155.0	12.3	1351.0	17.0	1544.3	14.3	516.0 be
brine shrimp + duckweed combination[a]	878.3	1006.6	14.6	1176.6	16.9	1319.6	12.2	441.3 ce
control[b]	1620.0	1505.0	−7.1	1433.0	−4.8	—	—	—
x̄ temp. extremes C		24.2 - 28.6		23.7 - 28.3		20.2 - 24.9		

[a]*Lemna gibba* and *Wolffia columbiana*, (1:1 fresh weight).
[b]One replicate only.
[c]Values in this column followed by the same letter are not significantly different at the 5% level as determined by a t-test.

source fed, avg. fish growth (g/day) and the mean conversion (total dry wt. of feed fed (kg)/mean wt. gain (kg)). The mean dry weight percent for *Lemna, Wolffia*, brine shrimp and artificial feed was 6.2 ± 0.3, 3.2 ± 0.2, 14.8 ± 0.6 and 7.0 ± .15, respectively.

Total consumption of the brine shrimp was consistent throughout the study. During the first 20 days, consumption of the artificial feed alone and in combination was complete and is reflected by the relatively high growth rate during this time. During the intermediate and final 20 day interval, feeding and growth on the artificial feed dropped sharply (Table 1).

The use of brine shrimp alone and together with the duckweed combination produced an effect on growth somewhat opposite to that of the artificial feed. The fish fed either feed source having brine shrimp showed an increasing or more stable growth rate throughout the study, especially during the last 20 days.

Those fish that were fed with the artificial feed-duckweed combination showed significantly better growth compared to those fed artificial feed alone. The duckweed combination fed in addition to brine shrimp had no significant effect on growth compared to those fish fed brine shrimp alone (Table 1). Of the two duckweed species fed individually, *Wolffia* produced significantly better growth and a more efficient conversion than did *Lemna* (Tables 1 and 2).

Based on the mean conversion ratios (Table 2), the feed source that produced the most efficient growth was the brine shrimp, followed in decreasing order by the artificial feed-duckweed combination, brine shrimp-duckweed combination, *Wolffia, Lemna* and artificial feed. The difference in the mean conversion ratios between the artificial feed-duckweed combination and the brine shrimp-duckweed combination is not significant. A similar comparison of the *Lemna* and artificial feed mean conversions indicated a non-significant difference as well.

DISCUSSION

A review of the protein content for those feeds utilized in this study indicates that they are relatively high in protein. The protein content of *Lemna* has been reported as 31.0% and 34.8% (6, 9). The packages containing the floating catfish pellets and brine shrimp were labeled as having crude protein contents of 32% and 45%, respectively. Bardach et al. (1) reports that 10 to 15% by weight of protein in the diet should be sufficient for the common carp (*Cyprinus carpio* L.).

The sharp drop in the consumption of the artificial feed during the intermediate and final stage of the study appears to be the result of decreasing temperature. The overall temperature range during the second 20 day inter-

TABLE 2. TOTAL QUANTITIES OF FEED FED PER FEED SOURCE REPLICATE (25 FISH PER REPLICATE), AND GROWTH AND CONVERSION RATIOS DURING A 60-DAY FEEDING PERIOD BETWEEN SEPTEMBER 29 AND NOVEMBER 28, 1980.

Feed source	Fresh wt. (kg)	Dry wt. equiv. (kg)	Total dry wt. equiv. (kg)	Avg. fish growth (g/day)	Mean Conversion[a]
artificial feed	2.28	2.12	2.12	0.17	8.57 a
artificial feed + duckweed combination[b]	1.14 + 11.40	1.06 + 0.54	1.60	0.37	2.92 b
Wolffia	42.75	1.37	1.37	0.24	3.76 c
Lemna	14.25	0.88	0.88	0.09	6.69 a
brine shrimp	5.44	0.81	0.81	0.34	1.58 d
brine shrimp + duckweed combination[b]	5.44 + 11.40	0.81 + 0.54	1.35	0.29	3.18 b

[a]Total dry wt. of feed fed (kg)/mean wt. gain (kg) per feed treatment. Values in this column followed by the same letter are not significantly different at the 5% level as determined by a t-test.
[b]*Lemna gibba* and *Wolffia columbiana* (1:1 fresh weight).

val was similar to that of the first except that during the second 20 days there were two occasions where the water temperature dropped several degrees below the normal low.

A greater decrease in fish growth and feed consumption was recorded during the third 20 day period for all of the feed sources except those having brine shrimp. We assume the decreased temperatures during this time brought about a decrease in fish metabolism and a preference for feeds involving less energy to ingest and utilize.

The relatively good growth of hybrid grass carp fed brine shrimp as a source of animal protein was not unexpected. The male parent of this hybrid, the bighead carp, is a zooplanktivore and other hybrid grass carp fingerlings have been reported to feed readily on mosquito larvae and small leeches (4).

Production of this intergeneric hybrid may have resulted in a fish with a less efficient or specialized pharyngeal grinding apparatus compared to that of the grass carp or bighead. This might explain the rapid consumption and relatively good growth of hybrid fingerlings fed feeds that are of small size and theoretically easier or more efficiently ingested such as *Wolffia* and smaller soft bodied invertebrates such as brine shrimp. Berry and Low (3) report that the growth rate of hybrids from the reciprocal cross, bighead x grass carp, declined after the second or third month when stocked initially in ponds abundant with zoo- and phytoplankton and that water plants such as *Hydrilla verticillata* Royle showed no signs of being consumed. These observations of the reciprocal cross hybrids are similar to ours concerning the grass carp x bighead hybrid. Berry and Low (3) also found that gill rakers of bighead x grass carp hybrids were deformed and clogged with sand grains stuck together by mucus and occupying the spaces between the rows of gill filaments, possibly interfering with the proper filtration of food. In several instances we have found the intestines of grass carp x bighead hybrids (7.5 to 10.0 cm total length) gorged with sand and Cladocera. Recent experiments in our laboratory indicate that larger grass carp x bighead hybrids (25 to 30 cm) will consume at least five species of submersed hydrophytes at temperatures in the range of 22 to 28 C, but these were fish that showed faster overall growth.

The greatest rate of growth achieved during this study was for fish fed the artificial feed-duckweed combination during the first 40 days. These fish increased an average of 0.45 g/day at a mean temperature range of 23 to 28 C and at a stocking density of 0.04 fish/l. Smaller grass carp fingerlings fed *Lemna* and reared at stocking densities of 0.53 to 2.11 fish/l at similar temperatures have shown growth rates as high as 2.27 g/day (6).

Our experience with hybrid grass carp fingerlings during the past 18 months indicates that 70-80% of fingerlings stocked in ponds at 500-600 per hectare, grow at a much slower rate than grass carp. Feeding behavior studies in our laboratory and other field studies show that these slower growing hybrids may not be a practical means for controlling submersed hydrophytes because of predation by predatory fish, birds and an omnivorous feeding tendency.

In summary, the combination of duckweed and artificial feed produced the fastest weight increase at water temperatures generally above 24 C as compared to other plant or animal feed sources fed individually or in combination. Naturally decreasing water temperatures generally below 24 C as experienced in Fort Myers, Florida between September and November, resulted in a decrease in consumption of artificial and natural vegetative feeds while the growth of fish fed brine shrimp during this time, remained relatively high. We feel that culturing hybrid grass carp fingerlings under the conditions described, is not a practical means for culturing fingerlings to an adequate size for aquatic vegetation control due to the relatively high labor input and relatively slow growth. Small ponds where fish might utilize naturally occurring insect larvae and zooplankton during early development, may be of more practical value than culturing fish in smaller artificial enclosures. Other factors (e.g. genetic and or morphological) may have contributed to the overall slow growth of these fish and further research is being conducted in this regard.

LITERATURE CITED

1. Bardach, J. E., J. H. Ryther and W. O. McLarney. 1972. Aquaculture: The farming and husbandry of freshwater and marine organisms. Wiley-Interscience, New York.
2. Beck, M. L. and C. J. Biggers, H. K. Dupree. 1980. Karyological analysis of *Ctenopharyngodon idella, Aristichthys nobilis,* and their F_1 hybrid. Trans. Am. Fish. Soc. 109:433-438.
3. Berry, P. Y. and M. P. Low. 1970. Comparative studies on some aspects of the morphology and histology of *Ctenopharyngodon idellus, Aristichthys nobilis,* and their hybrid (Cyprinidae). Copeia :708-726.
4. Cassani, J. R. 1981. Feeding behaviour of underyearling hybrids of the grass carp, *Ctenopharyngodon idella* ♀ and the bighead, *Hypophthalmichthys nobilis* ♂ on selected species of aquatic plants. J. Fish Biol. 18:127-133.
5. Greenfield, D. W. 1973. An evaluation of the advisability of the release of the grass carp, *Ctenopharyngodon idella,* into the natural waters of the United States. Trans. Ill. Acad. Sci. 66:47-53.
6. Shireman, J. V., D. E. Colle and R. W. Rottmann. 1977. Intensive culture of grass carp, *Ctenopharyngodon idella,* in circular tanks. J. Fish Biol. 11:267-272.
7. Stanley, J. G., W. W. Miley II and D. L. Sutton. 1978. Reproduction requirements and likelihood for naturalization of escaped grass carp in the United States. Trans. Am. Fish. Soc. 107:119-128.
8. Sutton, D. L. 1977. Grass carp (*Ctenopharyngodon idella* Val.) in North America. Aquat. Bot. 3:231-237.
9. Van Dyke, J. M. and D. L. Sutton. 1977. Digestion of duckweed (*Lemna* spp.) by the grass carp (*Ctenopharyngodon idella*). J. Fish Biol. 11:273-278.