Trans. Ky. Acad. Sci., 55(3–4), 1994, 127–130

Overwintering Channel Catfish, *Ictalurus punctatus*, and Blue Catfish, *Ictalurus furcatus*, in Cages

LAURA GOODGAME-TIU, CAROL D. WEBSTER,[1] JAMES H. TIDWELL, AND EDDIE B. REED, JR.

Aquaculture Research Center, Kentucky State University, Frankfort, Kentucky 40601

ABSTRACT

Channel catfish, *Ictalurus punctatus*, and blue catfish, *I. furcatus*, were overwintered in cages. Fish were fed (1% of body weight) every other day, when water temperatures were greater than 3°C. Fish of both species lost weight during the study. Weight loss in blue catfish (25.9%) was significantly ($P < 0.05$) greater than in channel catfish (8.5%). Percentage survival of channel catfish (97%) was significantly ($P < 0.05$) greater than survival of blue catfish (44%). The large differences in survival may be related to parasite-induced mortality in blue catfish. Channel catfish can be successfully overwintered in cages; however, blue catfish may be prone to high mortality and can lose up to 25% of their body weight.

INTRODUCTION

Channel catfish, *Ictalurus punctatus*, normally require 14–20 months to reach marketable size (450 g). Thus, fish must be overwintered during their first year of life (1, 2, 3). Channel catfish consume less food in winter than in summer months (1, 4). If water temperatures fall below 7°C, fish may not feed at all (2, 5). However, withholding food from fish when water temperature is above 7°C often results in weight loss (1, 2).

Blue catfish, *I. furcatus*, possess several attributes that may make them a desirable culture species in temperate regions of the United States. They have a higher dressing percentage than channel catfish (6), are easier to seine (7), and may have a lower optimum growing temperature than channel catfish (8). However, like channel catfish, they require overwintering during their first year of life in order to reach marketable size.

Cage culture offers some advantages over open pond culture in that it allows fish to be reared in ponds that would be difficult to harvest by seine, and permits easy observation of the condition and feeding habits of the fish (9). It would be advantageous to farmers who use cage-culture methods to be able to overwinter fish in cages. There is little information on rearing channel catfish, and no data on rearing blue catfish, in cages during the winter (4, 10). The purpose of this study was to compare growth and survival of channel catfish and blue catfish overwintered in cages.

MATERIALS AND METHODS

Channel catfish and blue catfish fingerlings were randomly stocked on 9 October 1992 into eight 1.25-m^3 floating cages moored over the deepest area (4 m) of a 1.0-hectare pond (mean depth, 2.0 m) on the Agricultural Research Farm, Kentucky State University, Frankfort, Kentucky. Cages were constructed by attaching 1-cm polyethylene mesh to a wooden frame. Cage lids were removable. To prevent loss of sinking feed, polyethylene net (2-mm mesh) was installed on the sides near the bottom (8 cm high) and covering the bottom of each cage. Cages were anchored to a floating dock and spaced at 2-m intervals.

Cages were stocked with either 300 channel catfish (average individual weight, 26.5 ± 1.9 g) or 300 blue catfish (average individual weight, 16.6 ± 0.4 g). Channel catfish were of the Red River strain and were obtained as eggs from the Delta Branch Experimental Station in Stoneville, Mississippi. The eggs were hatched at the Aquaculture Research Center, Kentucky State University, in late May 1992. The blue catfish were spawned from broodstock collected from the Kentucky River and hatched in late June 1992. The differences in stocking size may reflect the differences in hatching dates or early growth between the 2 species, but would be indicative of the size of fish available for overwintering. Fry of both species were stocked in ponds and fed a crum-

[1] To whom correspondence should be directed.

TABLE 1. Composition of an experimental diet fed to channel catfish and blue catfish overwintered in cages.

Menhaden fish meal (67%)	15.00
Soybean meal (44%)	25.00
Wheat flour	13.00
Meat and bone meal	8.00
Ground corn	28.75
Mineral mix[a]	0.10
Vitamin mix[b]	0.10
Choline	0.05
CMC[c]	5.00
Lignosulfonate	5.00
Chemical analysis	
% Moisture	11.20
% Protein[d]	33.70
% Fat[d]	6.50

[a] Mineral mix contained: Mn, 10.0% (as $MnSO_4$); Zn, 10.0% (as $ZnSO_4$); Fe, 7.0% (as $FeSO_4$); Cu, 0.7% (as $CuSO_4$); I, 0.24% (as $CaIO_3$); Co, 0.10% (as $CoSO_4$)

[b] Vitamin mix contained: thiamin (B_1), 1.01%; riboflavin (B_2), 1.32%; pyridoxine (B_6), 0.9%; nicotinic acid, 8.82%; folic acid, 0.22%; cyanocobalamine (B_{12}), 0.001%; pantothenic acid, 3.53%; menadione (K), 0.2%; ascorbic acid (C), 22.1%; retinolpalmitate (A), 4,409 IU/kg; cholecalciferol (D_3), 2,204,600 IU/kg; alpha tocopherol (E), 66.2 IU/kg; ethoxyquin, 0.66%.

[c] CMC = carboxymethylcellulose

[d] Dry matter basis

bled high-protein trout diet (Purina, St. Louis, Missouri) until stocked into cages.

During the present study, fish were fed (ration of 1% body weight) every other day, when temperatures were greater than 3°C. The amount fed was adjusted every 4 weeks, based on an estimated 3:1 feed conversion ratio (2). All fish were offered food more often than would be recommended for channel catfish (2) due to the lack of growth data for blue catfish during winter and so that feed would not be a limiting factor during the study. The study lasted for 182 d, of which fish could possibly be fed 91 d. During the study, fish were fed 60 days and not fed 31 d due to low temperatures. Fish were fed a diet formulated to contain 32% protein (Table 1). Dietary ingredients were processed into 5-mm sinking pellets by a commercial feed mill (Farmers Feed Mill, Lexington, Kentucky). Dietary protein level was determined using macro-Kjeldahl, dietary fat by acid hydrolysis, and moisture by drying to constant weight in a convection oven at 100°C (11).

Temperature and dissolved oxygen were monitored twice daily (0800 and 1630 hr) outside the cages at a depth of 0.75 m with a YSI model 57 oxygen meter (Yellow Springs Instrument Co., Yellow Springs, Ohio). Dissolved oxygen did not decline below 6.0 mg/liter during the study and no aeration was required. Total ammonia nitrogen, phosphorus, nitrite and nitrate were measured once per week with a DR 700 Colorimeter (Hach Co., Loveland, Colorado), and pH was measured weekly using an Accumet 900 pH meter (Fisher Scientific, Cincinnati, Ohio).

Fish were harvested on 9 April 1993 and were not fed for 24 hr prior to harvest. Total number and weight of fish in each cage were determined at harvest. Twenty five fish were randomly sampled from each cage and individually weighed (g) and measured (total length, cm). Ten fish from each cage were homogenized separately in a blender and analyzed for protein, fat, and moisture. Protein was determined using macro-Kjeldahl, fat was determined using ether extraction, and moisture was determined by drying a 10 g sample in a convection oven (100°C) until constant weight (11).

Data (percentage weight gain and survival) were analyzed using the SAS *t* Test procedure (12) for significant differences between channel catfish and blue catfish. All percentages and ratio data were transformed to arc sine values before analysis (13).

RESULTS AND DISCUSSION

Water quality characters for the duration of the study averaged (±SD): morning water temperature, 6.1 ± 3.8°C; afternoon water temperature, 6.3 ± 4.0°C; morning dissolved oxygen, 11.9 ± 2.5 mg/liter; afternoon dissolved oxygen measured 12.3 ± 2.2 mg/liter; total ammonia nitrogen, 0.34 ± 0.05 mg/liter; phosphorus, 5.15 ± 6.53 mg/liter; nitrite, 0.00 ± 0.00 mg/liter; nitrate, 0.14 ± 0.08 mg/liter; pH, 8.02 ± 0.44. All water quality characters were within accepted values for growth (14).

Fish of both species lost weight during the study. Weight loss in blue catfish (25.9%) was significantly ($P < 0.05$) greater than in channel catfish (8.5%) (Table 2). Since fish lost weight during the study, it was not possible to calculate specific growth rates (SGR) and feed conversion ratios (FCR) for channel catfish or blue catfish. Percentage survival of channel catfish (97%) was significantly ($P < 0.05$) greater than survival of blue catfish (44%).

All fish species are poikilotherms and are thus profoundly affected by water temperature. Channel catfish have a reduced metabolic activity and, consequently, reduced food consumption during colder water temperatures. The weight loss of the fed channel catfish reported in the present study is similar to values reported in Lovell and Sirikul (1), 9%, and Robinette et al. (2), 3–8%, for weight loss of non-fed channel catfish overwintered in ponds. This would indicate that the channel catfish in the present study did not consume much food during the study. Burtle and Newton (10) stated that cooler water temperatures contributed to weight loss of channel catfish when reared in cages compared to warmer water temperatures. The water temperatures reported in the present study averaged 6.22°C. This is colder than temperatures reported in studies conducted in more southerly states (1, 2, 10) and most likely contributed to the greater weight loss of our fed fish.

Conflicting results have been reported regarding the growth of blue catfish. Huner and Dupree (10) suggested that blue catfish may be inferior to the channel catfish as a cultured species due to slower growth at sizes less than 1 lb. In contrast, it has been stated that blue catfish may have a lower optimum-growth temperature than channel catfish (8), and thus perform better in cooler climates. Results of the present study indicate that cage-reared blue catfish do not have higher weight gains than channel catfish during winter. This is in agreement with Grant and Robinette (15), who reported that growth of channel catfish was greater than that for blue catfish during the winter when reared in ponds.

The survival of channel catfish in cages was comparable to the survival of channel catfish overwintered in ponds (1, 3, 15). In April, all blue catfish were infested with an external fungus and with *Trichodina* sp.. Channel catfish showed no sign of either parasite. The parasite infestation is suspected of being responsible for the majority of deaths of blue catfish and thus, lower survival percentage compared to channel catfish. Parasite-induced mortality of cage-reared blue catfish during winter may preclude farmers from attempting this culture practice.

Whole body analysis indicated that blue catfish had significantly ($P < 0.05$) higher percentages of moisture (77%) and fat (29%) compared to channel catfish (75 and 21%, respectively); however, percentage protein was not significantly different between species ($P > 0.05$) (Table 2). Lovell and Sirikul (1) reported that non-fed fish had more body fat than fish fed during the winter, indicating that protein was degraded for energy needs. Grant and Robinette (15) reported no difference in percentage protein between the 2 species when overwintered in ponds.

TABLE 2. Growth and body composition of blue and channel catfish overwintered in cages. Means in rows having different letters are significantly different ($P < 0.05$). Percentage protein and fat are expressed on a dry-matter basis.

	Blue	Channel
Initial stocking size (g)	16.6 ± 0.4	26.5 ± 1.9
Harvest weight (g)	12.6 ± 0.46	24.0 ± 0.94
Harvest length (cm)	12.4 ± 0.06	14.5 ± 0.15
Weight gain (%)	−25.9 ± 1.19a	−8.5 ± 0.55b
Survival (%)	43.9 ± 12.62a	97.2 ± 2.19b
Body composition		
Moisture (%)	77.4 ± 0.30a	74.9 ± 0.42b
Protein (%)	59.3 ± 1.37a	57.4 ± 1.29a
Fat (%)	28.6 ± 0.33a	21.4 ± 0.96b

This study indicates that first-year channel catfish can be successfully overwintered in cages with a high percentage of survival and minimal weight loss. However, first-year blue catfish may be prone to high parasite-induced mortality when reared in cages during winter and can lose up to 25% of their body weight. Further research which examines winter feeding regimes for cage-reared channel catfish should be conducted.

ACKNOWLEDGMENTS

We thank Keenan Bishop, Jackie Lamb, Hank Schweickart, Mac Stone, and Louis Weber for their technical assistance, and Karla Richardson for typing this manuscript. This research was partially funded by a USDA/CSRS grant to Kentucky State University under agreement KYX-80-92-05A.

LITERATURE CITED

1. Lovell, R. T. and B. Sirikul. 1974. Winter feeding of channel catfish. Proc. Southeast. Assoc. Game and Fish Comm. 28:208–216.

2. Robinette, H. R., R. L. Busch, S. H. Newton, C. J. Heskins, S. Davis, and R. R. Stickney. 1982. Winter feeding of channel catfish in Mississippi, Arkansas, and Texas. Proc. Southeast. Assoc. Fish and Wildlife Agencies 36:162–171.

3. Mims, S. D. and J. H. Tidwell. 1989. Winter feeding of fingerling channel catfish in Kentucky. Trans. Kentucky Acad. Sci. 50:174–176.

4. Huner, J. V. and H. K. Dupree. 1984. Nutrition, feeds, and feeding practices. Pp. 141–157. In H. K. Dupree and J. V. Huner (eds.) Third report to the fish farmers. U.S. Fish and Wildl. Ser., Washington, D.C.

5. Webster, C. D., J. H. Tidwell, L. S. Goodgame, J. A. Clark, and D. H. Yancey. 1992. Winter feeding and growth of channel catfish fed diets containing varying percentages of distillers grains with solubles as a total replacement of fish meal. J. Appl. Aquacul. 1:1–14.

6. Dunham, R. A., M. Benchakan, R. O. Smitherman, and J. A. Chappell. 1983. Correlations among morphometric traits of fingerling catfishes and the relationship to dressing percentage at harvest. J. World Maricul. Soc. 14: 668–675.

7. Chappel, J. A. 1979. An evaluation of twelve genetic groups of catfish for suitability in commercial production. Unpublished Ph.D. Dissertation. Auburn University, Auburn, Alabama.

8. Tidwell, J. H. and S. D. Mims. 1990. A comparison of second-year growth of blue catfish and channel catfish in Kentucky. Prog. Fish-Cul. 52:203–204.

9. Schmitton, H. R. 1970. The culture of channel catfish, *Ictalurus punctatus*, in cages suspended in ponds. Proc. Ann. Con. Southeast. Assoc. Game and Fish Comm. 23(1969):226–244.

10. Burtle, G. J. and G. L. Newton. 1993. Winter Feeding Frequency for Channel Catfish in Cages. Prog. Fish-Cult. 55:137–139.

11. AOAC. 1990. Official methods of analysis of the Association of Association of Official Analytical Chemists, Inc., Arlington, Virginia.

12. Statistical Analysis System. 1988. SAS/STAT user's guide. Release 6.03 Edition. SAS Institute, Inc., Cary, North Carolina.

13. Zar, J. H. 1984. Biostatistical analysis. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

14. Boyd, C. E. 1979. Water quality in warmwater fish ponds. Alabama Agricultural Experiment Station, Auburn University.

15. Grant, J. C. and H. R. Robinette. 1992. Commercially important traits of blue and channel catfish as related to second summer, winter, and third summer growth. Aquacult. 105:37–45.