Davis, J. T., and L. E. Posey. 1958. Length at maturity of channel catfish in Louisiana. Proceedings 12th Annual Conference Southeastern Association of Game and Fish Commissioners. 12:72-75.
DeRoth, G. C. 1965. Age and growth studies of channel catfish in Western Lake Erie. Journal of Wildlife Management. 29(2):280-286.
Lantz, K. E. 1970. An ecological survey of factors affecting fish production in a Louisiana natural lake and river. Louisiana Wild Life and Fisheries Commission, Dingell-Johnson Job Completion Report, Project F-11-R. 92 p.
Perry, W. G. 1966. Distribution and relative abundance of blue catfish, *Ictalurus furcatus*, and channel catfish, *Ictalurus punctatus*, with relation to salinity. Master of Science Thesis, Louisiana State University Library, Baton Rouge. 57 p. (Unpublished).
Schafer, H., L. Posey, and G. Davidson. 1965. The use of cans in harvesting catfish. Proceedings 19th Annual Conference Southeastern Association of Game and Fish Commissioners. 19:210-217.

TEMPERATURE-LIGHT EFFECTS ON GROWTH, FOOD CONSUMPTION, FOOD CONVERSION EFFICIENCY, AND BEHAVIOR OF BLUE CATFISH, *ICTALURUS FURCATUS* (LESUEUR)

Robert E. Tyler and Raj V. Kilambi
Department of Zoology
University of Arkansas
Fayetteville, Arkansas 72701

INTRODUCTION

Temperature and light are two environmental forces that affect the lives of fishes in complex and often interrelated fashion. The growth patterns of fishes are influenced by the seasonal changes in temperature and light as well as the amount of food consumed, the efficiency of conversion, and the behavior of the fish.

A great deal of published information on the effects of temperature and light individually on fish growth is available. Except for the work of Kilambi, Noble and Hoffman (1971) on channel catfish, knowledge on the combined effects of temperature and light on fish growth, food consumption, etc., is meager. This paper reports on the influences of temperature and light combinations on growth, food consumption, food conversion efficiency, and behavior of fingerling blue catfish.

METHODS AND MATERIALS

Experiments were conducted over a two-year period under controlled laboratory conditions. The experimental conditions used in the first year (1969-1970) were 20, 25, 30, and 35 C with 8- and 16-hour photoperiods and total darkness. Due to thermo-regulator malfunctions, all the fish in the experimental conditions 20 C and 25 C - 8-hr photoperiod, and 30 C - total darkness died. The fish at 35 C and all the light conditions showed high incidence of vertebral deformities and therefore the data were not analyzed. The experimental conditions used in the second year (1971) were 20, 25, and 30 C with 8- and 16-hour photoperiods and total darkness. In addition a 25 C - 8-hour photoperiod having one-half the light intensity of the previous conditions, was also used in the second year.

The blue catfish used in the first year and the second year of experiments were obtained from the Centerton State Fish hatchery and the Joe Hogan State Fish Hatchery, respectively. The first year experiments were conducted for 240 days (August 1969 - April 1970) and the second year's for 100 days (February - May 1971). The fish were raised in 63-gallon tanks (30" x 26" x 13") constructed of wood with double walls and coated with fiberglass resin.

Total length in millemeters and weight in grams of fish from a random sample, dissolved oxygen, free carbondioxide, ammonia-nitrogen, nitrate-nitrogen, nitrite-nitrogen, and pH were determined at 15-day intervals the first year and at 30-day intervals the second year. The temperature of the water in the tanks was controlled by thermo-regulators which were the mercury column type the first year and solid state the second year. Full intensity lighting in the tanks was provided by two "Plant Grow" 40 watt cool-white flourescent lights, which emitted 30 foot-candles of light at the water surface. The photoperiods were controlled by automatic timers.

Each day the fish were fed, and the mortalities were recorded. Purina fish chow containing not less than 35% crude protein, 2.5% crude fat and not more than 8% crude fiber was used both years. The amount of food provided daily was always more than the quantity that had been consumed the previous day. The food was placed in bowls with inward-curved sides which helped to keep the food in the bowls during feeding activity. These bowls were placed in metal pans with two-inch sides in order that scattered food might be located and siphoned out of the tanks. Food was placed daily in the tanks at 10:00 a.m. and the remaining food from the previous day was removed. This residual food was filtered through a pre-weighed filter paper and dried for 48 hours and the daily food consumption was estimated.

RESULTS

Growth in Weight

Initial weights of the fish, at the incipience of the study, among the experimental tanks in the first year, and also in the second year were not significantly different ($F_{6.343} = 2.06$ and $F_{13.266} = 0.08$). The average initial weights of the experimental fish in the first year and the second year were 3.78g and 8.69g, respectively.

The relationship between the weights and time periods is expressed as:

$Wt = Woe^{kt}$
Wt = weight at time t
Wo = initial average weight
t = time period
k = instantaneous relative growth rate

The instantaneous relative growth rates expressed as regression coefficients of the above equation are given in Table 1. Differences in growth rates among the experimental conditions are tested (Sokal and Rohlf, 1969) at the 0.05 level and the results are shown in Table 1. In the first year of study, the fish under the conditions 25 C - total darkness and 30 C - 16-hour photoperiod have significantly larger rates than the fish in the rest of the conditions. In the second year, the fish under 25C-total darkness condition again showed the greatest growth rate followed by those under 30C-8-hour photoperiod. The growth rates of fish in the rest of the experimental conditions were not significantly different. It is also to be noted that there were no significant differences among the replicates.

The weight gained by the fish in each experimental condition was calculated and expressed as a percentage of the initial weight. The percentage of weight gained at 100 days was also calculated to facilitate comparison between all of the conditions of both years experimentation and are shown in Table 2. The percent gain was greater the first year than the second year for the same experimental conditions. The 25C-total darkness condition showed the greatest gain both years with a 74.9 per cent gain the first year and a 27.5 per cent gain the second year. No mortalities occurred during the second year of the project.

Table 1. Instantaneous relative growth rates and tests for differences.

Year 1

Experimental Condition	Instantaneous Relative Growth Rate	
25C-Total Darkness	0.08381	
30C-16 hr.	0.06684	*
25C-16 hr.	0.03445	
20C-Total Darkness	0.03418	
30C-8 hr.	0.03949	
20C-16 hr.	0.01716	

Year 2

Experimental Condition	Instantaneous Relative Growth Rate
25C-Total Darkness	0.02698
30C-8 hr.	0.01558
30C-Total Darkness	0.00724
25C-(½) 8 hr.	0.00640
30C-Total Darkness	0.00576
25C-(½) 8 hr.	0.00528
25C-8 hr.	0.00495
25C-16 hr.	0.00327
25C-8 hr.	0.00143
20C-8 hr.	0.00123
20C-Total Darkness	0.00111
20C-16 hr.	0.00038
30C-16 hr.	0.00025
20C-8 hr.	-0.00113

*The values underscored by the same line are not significantly different.

Table 2. Details of weight gain, food consumption, and food conversion efficiency at 100 days and 240 days.

Year	Experimental Condition	Initial Wt.(g)	Weight at 100 days	Weight at 240 days	Gain in Weight 100 days	Gain in Weight 240 days	% Gain at 100 days	Food Consumed Per Fish 100 days	Food Consumed Per Fish 240 days	FCE 100 Days	FCE 240 Days	Number of Fish in Each Tank Initial	Number of Fish in Each Tank Final
1	20C-16	4.28	4.79	5.63	0.51	1.35	11.9	18.08	76.67	.0282	.0176	50	15
	25C-16	3.98	5.00	6.90	1.02	2.92	25.6	19.04	62.74	.0536	.0466	50	20
	30C-16	3.64	5.68	10.60	2.04	6.96	56.0	17.75	57.74	.1149	.1205	50	23
	30C-8	4.10	5.34	7.72	1.24	3.62	30.2	18.19	56.56	.0682	.0639	50	25
	20C-T.D.	3.52	4.33	6.08	0.81	2.56	23.0	12.44	41.12	.0651	.0622	50	23
	25C-T.D.	3.42	5.98	13.06	2.56	9.64	74.9	17.35	55.20	.1476	.1747	50	12
2	20C-8	8.94	8.95		0.01		0.1	6.66		.0008		40	40
	20C-16	8.86	8.89		0.03		0.3	5.67		.0053		40	40
	25C-8	8.90	9.16		0.26		2.9	5.79		.0447		40	40
	25C-16	8.88	9.14		0.26		2.9	5.75		.0461		40	40
	30C-T.D.	9.06	9.60		0.54		6.0	6.69		.0713		40	40
	30C-16	9.06	9.08		0.02		0.2	7.80		.0026		40	40
	20C-T.D.	8.95	9.04		0.09		1.0	4.55		.0198		40	40
	25C-T.D.	8.97	11.44		2.47		27.5	5.64		.4371		40	40
	30C-8	8.97	10.32		1.35		15.1	6.69		.2093		40	40
	25C-(½)8	8.98	9.46		0.48		5.3	5.98		.0811		40	40

Food Consumption

The relationship between the amount of food intake per fish and time period was calculated for each experimental condition as:

$$FC = ae^{bt}$$

where FC = food consumed in grams per fish during sampling period t.
a = intercept
b = regression coefficient
t = sampling period

The regression equations for each of the temperature-photoperiod conditions are given in Table 3 showing the relationships between food consumption and time for the experimental conditions used in the first year and the second year, respectively. The food consumption increased with time for all conditions during the first year, and a positive relationship between consumption and time was observed for all conditions except 20C-8-hour photoperiod, 25C-8 and 16-hour photoperiods, and 30C-16-hour photoperiod during the second year of experimentation. The food consumption per fish for the entire study period for each condition each year is shown in Table 2.

Table 3. Relationship between food consumption and time period.

Year 1

Experimental Condition	$\ln FC = \ln a + bt$
20C-16 hr.	$\ln FC = .4776 + .1131t$
25C-16 hr.	$\ln FC = .7132 + .0703t$
30C-16 hr.	$\ln FC = .6667 + .0670t$
30C-8 hr.	$\ln FC = .7100 + .0601t$
20C-Total Darkness	$\ln FC = .2903 + .0696t$
25C-Total Darkness	$\ln FC = .6502 + .0632t$

Year 2

Experimental Condition	$\ln FC = \ln a + bt$
20C-16 hr.	$\ln FC = -.4249 + .0504t$
25C-16 hr.	$\ln FC = -.4436 + (-0017)t$
30C-16 hr.	$\ln FC = -.0745 + (-.0153)t$
20C-Total Darkness	$\ln FC = -.7612 + .0100t$
25C-Total Darkness	$\ln FC = -.5584 + .0145t$
30C-8 hr.	$\ln FC = -.6980 + .0671t$
20C-8 hr.	$\ln FC = -.2076 + (-.0195)t$
25C-8 hr	$\ln FC = -.4952 + (-.0110)t$
30C-Total Darkness	$\ln FC = -.3354 + .0069t$
25C-(½) 8 hr.	$\ln FC = -.4944 + .0162t$

Food Conversion Efficiency

The food conversion efficiency for each of the experimental conditions was expressed as the weight gain per unit of food intake. The weight gains used were based on the calculated weights obtained from the relationship between weights and time periods from each of the temperature-photoperiod combinations.

The relationship between food conversion efficiency and time was expressed by the equation:

$$FCE = ae^{bt}$$

where FCE = food conversion efficiency
a = intercept
b = regression coefficient
t = sampling period

The regression equations for each of the experimental tanks are given in Table 4.

During the first year the 25C-total darkness condition showed the most favorable food conversion efficiency over the entire 240 day study period. This same condition rendered the most favorable food conversion efficiency over the 100 day period of the second year of study. The conversion efficiency coefficients were 0.1747 and 0.4371, respectively. The food conversion coefficients of all experimental conditions are given in Table 2. The food conversion efficiency of each experimental condition of the first year's experiments were calculated at 100 days to facilitate comparison with the second year of experimentation. The values for weight and food consumption at 100 days were obtained from their respective time relationship equations. It was found that 25C-total darkness was also most favorable at 100 days during both years indicating the desirability of this condition for efficient food conversion by blue catfish.

Table 4. Relationship between food conversion efficiency and time period.

Year 1

Experimental Condition	ln FCE = ln a + bt
20C-16 hr.	$\ln FCE = -3.0988 - .09592t$
25C-16 hr.	$\ln FCE = -2.7814 - .03577t$
30C-16 hr.	$\ln FCE = -2.1143 - .00014t$
30C-8 hr.	$\ln FCE = -2.5492 - .02060t$
20C-Total Darkness	$\ln FCE = -2.4263 - .03538t$
25C-Total Darkness	$\ln FCE = -1.9427 + .02601t$

Year 2

Experimental Condition	ln FCE = ln a + bt
20C-16 hr.	$\ln FCE = -4.9882 - .05085t$
25C-16 hr.	$\ln FCE = -3.0981 + .00453t$
30C-16 hr.	$\ln FCE = -6.0572 + .01038t$
20C-Total Darkness	$\ln FCE = -3.8414 - .01038t$
25C-Total Darkness	$\ln FCE = - .8740 + .01247t$
30C-8 hr.	$\ln FCE = -1.2868 - .05159t$
20C-8 hr.	$\ln FCE = -4.1997 - .00322t$
25C-8 hr.	$\ln FCE = -3.2517 - .0682\ t$
30C-Total Darkness	$\ln FCE = -2.5067 - .00619t$
25C-(½)8 hr.	$\ln FCE = -2.5962 - .01033t$

Behavior Observations

Observations on the behavior patterns of the experimental fish were made to aid in interpreting the effects of the various temperature-photoperiod comibnations on blue catfish. The observations were made 2 hours before the lighting systems came on and at 4-hour intervals during the lighted periods and 2 hours after the lighting systems were switched off. In those tanks where no lighting was used, observations were made at the same time as the observations in the lighted tanks. At various times during the experiments, observations were made during the middle of the non-lighted periods to find the effect of darkness on behavior.

In total darkness, the fish were found randomly dispersed in the tanks, and movement was not coordinated between any group of fish. When disturbed by striking the sides of the tanks, the fish reacted in an independent manner moving in various directions at different depths. Fish were seen to be feeding during most of the observation periods. The fish in the tanks with 25C and 30C were more active than those experiencing 20C. The fish in 20C were sluggish and at times, quite a large amount of mechanical disturbance was required to obtain activity from the fish. The fish under the influence of 35C were very active at all times and even slight disturbance caused a great amount of activity.

The same responses were observed in the tanks with lighted photoperiods during the "lights off" periods as were observed in the total darkness experimental tanks. However, when the lights were switched on, the fish would immediately congregate in one of the corners of the tank. This behavior was true for all lighted experimental conditions. During the lighted periods, the fish would remain in aggregations, occasionally moving from the school and seeking shelter under the pans which held the food bowls. When the fish were disturbed during the lighted periods, they would react by forming two or three compact groups in various corners. Then they would all move to one corner within minutes of the disturbance. While aggregated in a corner, the fish were continually swimming toward the bottom of that corner causing a tightly packed formation sometimes causing injury to each other from their pectoral fin spines. Very little feeding was observed while the lights were on, and the fish were constantly active even though they were in compact schools. When the lights were switched off the fish would again disperse and become randomly distributed throughout the tanks. This behavior was not altered in those tanks providing one-half the light intensity (15 foot-candles).

DISCUSSION

Growth, food consumption, food conversion, endocrine and behavioral activities of fish are affected by environmental factors. The environmental factors considered in the present study are temperature and duration of light. These two factors are of primary importance in seasonal change, and information on their interaction would be of consequence to hatchery operators engaged in the rearing of blue catfish.

In the past, the vast majority of studies on the growth of fish were concerned with either temperature or light, either alone or in conjunction with other environmental factors. Brown (1946) studied the relationship between daylength and growth of brown trout. Eisler (1957) noted the effects of photoperiod on the growth of chinook salmon. Gibson and Hirst (1955) reported on the effects of temperature and salinity on the growth of guppies. Kinne (1960) studied the effects of various temperatures and salinities on the growth, food intake and food conversion of desert pupfish. Stickney and Andrews (1971) reported on the influence of photoperiod on growth and food conversion of channel catfish. Tyron (1943) noted the relationship between photoperiod and growth of cutthroat trout. West (1966) used temperature as a single variable in a study of the growth of channel catfish.

Kilambi, Noble and Hoffman (1970) studied the effects of temperature and photoperiod on the growth, food consumption and food conversion efficiency of channel catfish and reported that the optimum temperature for maximum growth depended on photoperiod. They used length as the indicator of growth. They found maximum growth under 14-hours photoperiod to be at 28C; under 10-hours photoperiod, the maximum growth was at 32C. In this study, the growth in weight was used since fish production is generally expressed in terms of weight gain.

The 25C-total darkness condition produced the greatest growth and growth rate during both years of experimentation. The growth rates for all conditions during the first year were greater than those rates for the same conditions during the second year. This indicates that the growth rate of blue catfish decreases with an increase in age, since the fish used during the first year were younger than those used the second year.

For the first year of experimentation, based on weight gain and food conversion efficiency (Figure 1), the most favorable condition was 25C total darkness. During the second year of study, a condition was studied where the temperature of 25C was combined with an 8-hour photoperiod and one-half the light intensity of all other lighted conditions. The results showed that this condition was comparable to the 30C-total darkness condition in growth rate (Table 1) and weight gain (Figure 2) over the duration of the experiments. This seems to indicate that the subdued intensity photoperiod imposed the same degree of limitation to growth as the additional five degress of temperature.

The amount of food consumed by the experimental fish increased with an increase in the weight of the fish. The food consumption showed trends of direct relationship with either the temperatures or the photoperiods. The condition which showed the greatest consumption was 20C-16-hour photoperiod during the first year of experimentation (Figure 1). The condition showing the greatest consumption the second year was 30C-16-hour photoperiod, followed by 30C-8-hour photoperiod. The condition showing the smallest average food consumption both years was 20C-total darkness (Figure 2).

Kinne (1960) observed an increase in food consumption with temperature for desert pupfish. West (1966), working with channel catfish, also found food intake to increase with temperature. Baldwin (1956) showed that brook trout growth and food consumption were directly related. Gross *et al.* (1965) discovered that green sunfish consumed a greater amount of food in longer photoperiods. The findings of this study are in general agreement with the findings of the above authors.

In considering the food conversion efficiency, the 25C-total darkness experimental condition showed the most favorable food conversion efficiency during both years (Figures 1 and 2). The relationship between photoperiod and food conversion efficiency was inverse for 20C and 25C during both years of experimentation. In the first year of the experiment, at 30C, the 16-hour photoperiod followed by the 8-hour photoperiod showed the highest food conversion efficiencies. During the second year of experimentation, at 30C, the 8-hour photoperiod showed the highest food conversion efficiency followed by total darkness and the 16-hour photoperiod, respectively. These findings conflict with the findings of Gross *et al.* (1965) and Kilambi *et al.* (1970) who found that the conversion efficiency was higher in longer photoperiods for green sunfish and channel catfish, respectively. Kinne (1960) observed that the food conversion efficiency of desert pupfish decreased with an increase in temperature. When the relationship between temperature and food conversion efficiency was studied, it was discovered that for the 16-hour photoperiod a direct relationship existed during the first year. Second year data showed 25C to have the greatest conversion efficiency at the 16-hour photoperiod, followed by 20C and 30C. The experimental conditions having 8-hour photoperiods showed direct relationships between temperature and food conversion efficiency for both years experimentation. At 25C, the best average food conversion efficiency was under total darkness; whereas at 20C, the non-lighted condition proved to be the least favorable with regard to this parameter. The condition with the greatest food conversion efficiency was 25C-total darkness for the entire experiment. This condition would facilitate a greater profit potential for the grower. Kilambi *et al.* (1970) reported a direct relationship between conversion efficiency and photoperiod up to 10 days for 26C, 28C and 32C. Beyond 60 days, the relationship became inverse for 26C and 32C. West (1966) reported the optimum food conversion efficiency for channel catfish to be at 28.9C. Gross *et al.* (1965) reported greater food conversion efficiency for green sunfish in longer photoperiods.

Light was observed to affect the behavior of the experimental fish. During the lighted periods the fish were found in schools in the corners of the tanks. They sought shelter whenever possible under the food overflow pans. The fish fed during the "lights off" period and swam freely about the tanks. As soon as the lights came on in a tank, the fish immediately returned to the corners. Movements of the experimental fish during the lighted hours were restricted to the area in which they had congregated. The observations made indicate clearly that the temperature and photoperiod can greatly affect blue catfish activity. Brown, Inman and Jerald (1970), using circular plastic pools, observed schooling to occur in channel catfish fingerlings during daylight hours; but when the tanks were covered, the fish swam freely, independent of others. They found that no biological clock was involved; this behavior could be noted at any time the observers desired. Darnell and Meterotto (1965), observing bull heads in a pool of a stream, noted that the adult fish were inactive during daylight hours and moved around extensively at night. They found the bullheads to feed at night. Their results concur with the results of this study. This would indicate that the optimum time of feeding blue catfish is at sundown. The addition of shelter to the areas where the fish are kept could possibly aid in growth.

The best condition for the propagation of blue catfish should be selected only after the consideration of growth, food conversion efficiency and food consumption. As shown in Figures 1 and 2, the condition in which the least amount of food was consumed was 20C-total darkness; however, growth in this condition was inadequate. The most efficient food conversion occurred in 25C-total darkness. Additional significance is attributed to this by the fact that 25C-total darkness also resulted in the greatest growth in weight. This indicates that the fish raised under this condition required less food for maintenance while growing at a greater rate to a larger size than the fish raised in all other conditions. The conversion efficiency coefficient was larger for 25C-total darkness than for the other conditions.

While the greatest growth in weight and the most favorable food conversion efficiency were found at the same condition during both years, some differences in the effects of some experimental conditions were noted. During the first year, the 16-hour photoperiod showed a greater growth and a more favorable food conversion efficiency that the 8-hour photoperiod for 30C. The results of the data concerning conditions with a 16-hour photoperiod showed the temperature 30C to be the most favorable for growth and food conversion efficiency followed by 25C and 20C, respectively. However, after the second year's experimentation 25C was shown to be the most advantageous temperature at the 16-hour photoperiod, followed by 20C and 30C, respectively. The reason for these differences is deemed to be the difference in the initial sizes of the experimental fish since all other factors were held constant. The data indicate that the larger blue catfish are more sensitive to extremes of temperature and photoperiod than the smaller fish.

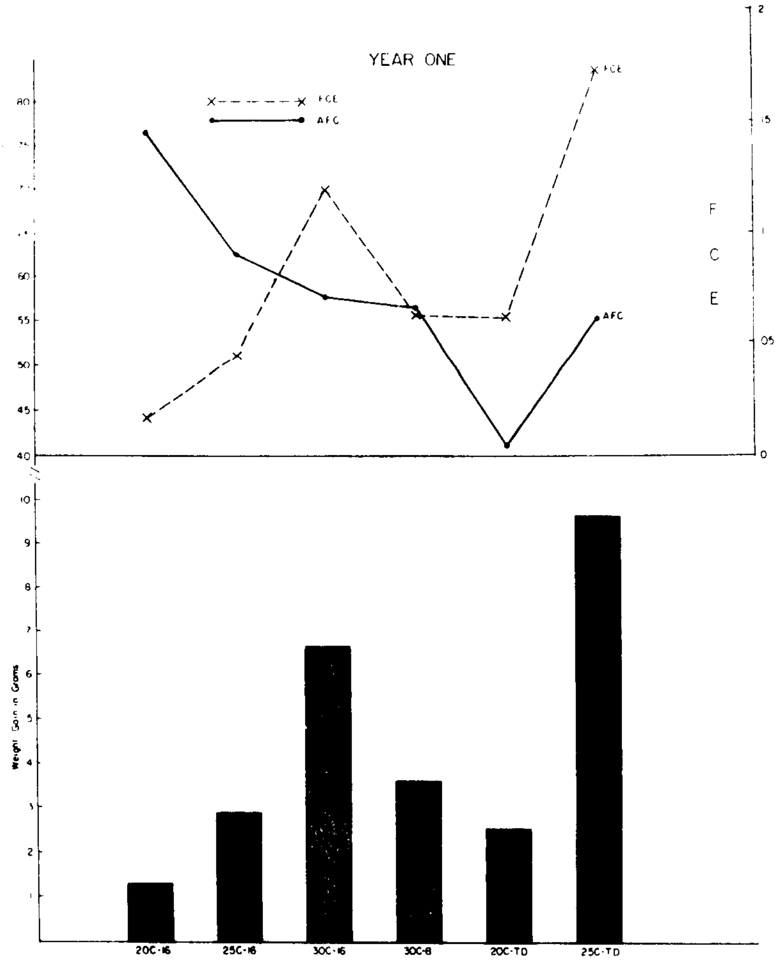

Figure 1. Average food consumption, food conversion efficiency and total weight gain of blue catfish at the completion of the first year's experimentation.

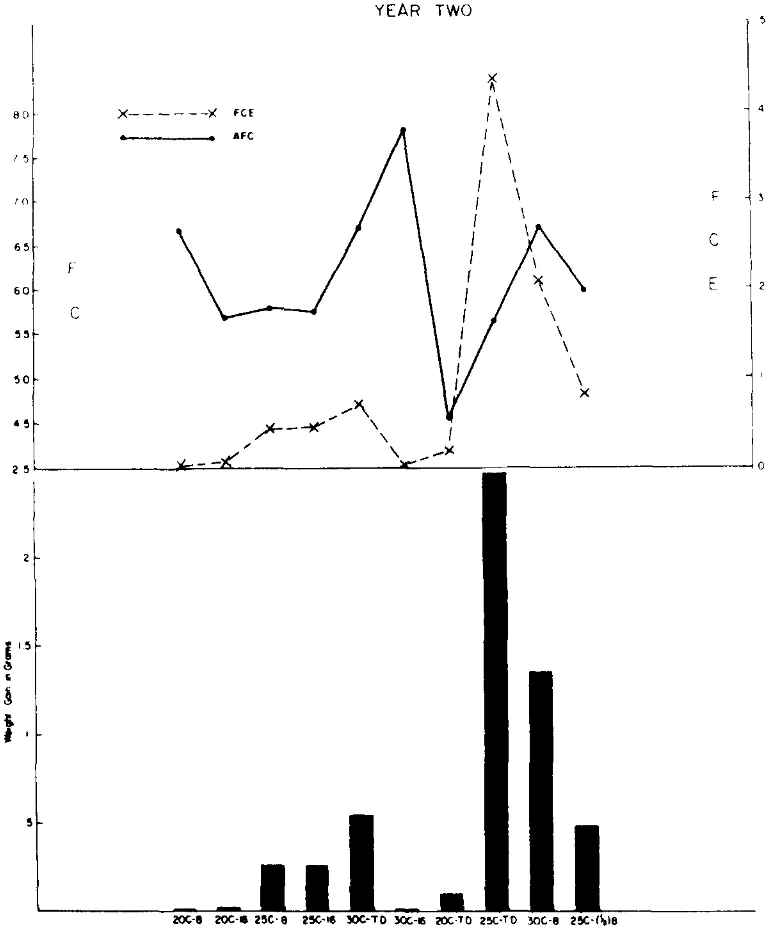

Figure 2. Average food consumption, food conversion efficiency and total weight gain of blue catfish at the completion of the second year's experimentation.

Brown (1957) stated that the growth of fishes is affected by temperature, light, chemical factors, volume of water per fish and the quantity and quality of food. The chemical factors in this study were never allowed to fluctuate in significant amounts. These factors were always well within the recommended ranges for warm water fishes as prescribed in FWPCA (1968). The fish were fed an unrestricted amount of Purina Fish Chow, which guaranteed the uniformity of the diet. An equal number of fish were distributed to each tank providing an equal volume of water per fish. Since temperature and photoperiod were the only manipulated environmental parameters (variables), the differences in growth of the experimental fish must be attributed to the combined effects of these two factors. After consideration of all factors, the optimum condition for blue catfish is 25C-total darkness.

The hatchery operator could obtain the most favorable results by limiting the light entering any indoor facilities containing blue catfish and by maintaining a temperature of 25C. In ponds, some type of shelter from light is recommended as well as feeding at sundown. This should minimize the wasting of food that would dissolve uneaten during the daylight hours.

ACKNOWLEDGEMENTS

The authors express their appreciation to the Arkansas Game and Fish Commission and the National Marine Fisheries Service for providing funds for the research through P. L. 88-309. Acknowledgments are also due Mr. Ramond Martin of the Centerton State Fish Hatchery and Mr. James L. Collins of the Joe Hogan State Fish Hatchery for providing the fish used in this project. Thanks are also extended to the Zoology Department at the University of Arkansas for providing the space and equipment used for this research.

LITERATURE CITED

Baldwin, N. S. 1956. Good consumption and growth of brook trout at different temperatures. Trans. Amer. Fish. Soc. 86:323-328.

Brown, B. E., I. Inman and A. Jerald Jr. 1970. Schooling and shelter seeking tendencies in fingerling channel catfish. Trans. Amer. Fish. Soc. 99(3): 540-545.

Brown, M.W. 1946. The growth of brown trout (*Salmo trutta* Linn.) III. The effect of temperature on the growth of two year old trout. J. Expt. Biol. 22:145-155.

__________. 1957 The physiology of Fishes. Volume I. Academic Press Inc., New York. 447 p.

Darnell, R. M. and R. R. Meterotto. 1965. Diurnal periodicity in the black bullhead. *Ictalurus melas* (Rafineque).Trans. Amer. Fish. Soc. 94(1):1-8.

Eisler, T. 1957. The influence of light on the early growth of Chinook Salmon. Growth, 21:197-203.

FWPCA. 1968. Water Quality Criteria. Federal Water Pollution Control Administration. Washington, D. C. 234 p.

Gibson, M. B. and B. Hirst. 1955. The effect of salinity and temperature on the pre-adult growth of guppies. Copeia, (3):241-243.

Gross, W. L., E. W. Roelofs and P. O. Fromm. 1965. Influence of photoperiod on growth of green sunfish *Lepomis cyanellus*. J. Fish. Res. Board. Canada 22(6):1379-1386.

Kilambi, R. V., J. Noble and C. E. Hoffman. 1970. Influence of temperature and photoperiod on growth, food consumption, and food conversion efficiency of channel catfish. Proc. of the 24th Annual Conf. S. E. Assn. of Game and Fish Comm. 24:519-531.

Kinne, O. 1960. Growth, food intake and food conversion in a euryplastic fish exposed to different temperatures and salinities. Physiol. Zool 33: 288-317.

Sokal, R. R. and F. J. Rohlf. 1969. Biometry: The principles and practice of statistics in biological research. W. H. Freeman and Company. 776 p.

Stickney, R. R. and J. W. Andrews. 1971. The influence of photoperiod on growth and food conversion of channel catfish. The Progressive Fish-Culturist. 33(4):204-205.

Tryon, C. A., Jr. 1943. The effect of covering hatchery troughs on growth of cutthroat trout (*Salmo clarkii*). Trans. Amer. Fish. Soc. 72:145-149.

West, B. W. 1966. Growth, food conversion, food consumption and survival at various temperatures of the channel catfish *Ictalurus punctatus* (Rafinesque). M. S. thesis, Graduate School, University of Arkansas. 65 p.

FOOD HABITS, GROWTH, AND LENGTH-WEIGHT RELATIONSHIPS OF YOUNG-OF-THE-YEAR BLACK CRAPPIE AND LARGEMOUTH BASS IN PONDS

*William H. Tucker**
Department of Fisheries and Allied Aquacultures
Auburn University
Auburn, Alabama

ABSTRACT

Food, growth and length-weight relationships of young-of-the-year largemouth bass (*Micropterus salmoides*) and black crappie (*Pomoxis* nigromaculatus) were studied. Stomachs of 220 bass and 186 crappie were examined. Crappie fed mainly on zooplankton but consumed more aquatic insects as their size increased. Bass fed on zooplankton and aquatic insects, but grew faster when small crappie were available. Crappie grew faster when their numbers were reduced by bass predation. Length-weight relationships were calculated for 601 bass and 496 crappie.

INTRODUCTION

In the southeastern United States, a population of largemouth bass, *Micropterus salmoides* (Lacepede); bluegill, *Lepomis macrochirus*, Rafinesque; and redear, *Lepomis microlophus* (Gunther) can be maintained in a state of balance using the principles described by Swingle (1956). When crappie, *Pomoxis sp.*, are added to this combination, unbalanced conditions often develop. This unbalance usually results from inadequate bass predation due to relative spawning dates.

Crappie frequently overpopulate waters and become stunted (Goodson, 1966). Fishery biologists have observed that good crappie fishing tends to come in 2 to 5 year cycles (Bennett, 1944; Thompson, 1941).

No effective management techniques are known to alleviate the problems caused by crappie in artificial lakes in a bass-bluegill combination. Nail (1963) suggests that lakes smaller than 1,000 acres should not be stocked with crappie. The relationships of crappie in a bass-bluegill combination are not fully understood.

---

*Present address: Game and Fish Division, Department of Conservation and Natural Resources, Montgomery, Alabama.