PHENOTYPIC CORRELATIONS BETWEEN COMMERCIAL CHARACTERS IN CHANNEL CATFISH

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Abstract: Estimates of correlation from channel catfish (*Ictalurus punctatus*) sib-families reared in intensively stocked tanks showed that it is possible to predict the family influence in market body weight from body weight data taken as early as 4 weeks. Survival during the first 15 weeks was highly correlated with body weights or lengths from 4 to 12 weeks. Food conversion during the period 20 to 40 weeks was highly correlated with body weights between 16 and 56 weeks. Correlations between survival and food conversion ratio and, also, between 4 to 12 week body size traits and either 16 to 40 or 41 to 56 week survival were not significant.

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Available information on phenotypic correlations between the different characters in channel catfish is very limited. Information about economically important traits which have special interest to aquaculturists and breeders is particularly scarce. Estimates of such correlations were reported between body weight and length at the same age by Muncy (1959), at 2 different ages by Reagan et al. (1976), between different body measurements by Goodman (1973), and between dressing percentage, lipid content, and body size by El-Ibiary et al. (1976).

Phenotype correlations contribute to selective breeding plans by providing the breeder with measurable indicators of the characteristics in which he is interested. They also help by saving labor, feed, and breeding facilities through early prediction of the breeding worth of catfish individuals and families.

The main objective of this investigation was to estimate the coefficients of phenotypic correlation between body size, survival, and food conversion ratio in channel catfish. The estimates were focused on: (1) the correlation between eventual market body weight and body weight at an early age, and (2) the correlation between an easily measurable character such as body weight and relatively difficult ones such as the food conversion ratio and survival.

MATERIALS AND METHODS

The parents of the stock included in the present study originated from 9 different commercial and government hatcheries in Georgia and Alabama. This stock was introduced to the University of Georgia Agriculture Experiment Station to establish a foundation gene pool for selective breeding of channel catfish.

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From 13 May to 23 June 1973, 18 egg masses hatched, each in a separate fiberglass resin coated plywood trough (120 x 30 x 45 cm deep). Water entered at the top of each trough through a flow control nozzle and exited through a standpipe on the opposite end. The fish were separated from the water input and the standpipe areas by wire screens.

The median hatching day for a spawn was arbitrarily designated the hatching date for that spawn family. Since full sibs of each family were not culled until 15 weeks of age, to avoid crowding families with large numbers of fry were distributed over a number of troughs. By the end of 15 weeks, each family occupied 1 or more troughs.

At 15 weeks of age, a random sample of about 150 fry was taken from each family. If the family occupied more than 1 trough, all troughs were equally represented in the sample. Each family sample was divided into 3 equal parts of 50 fry and stocked in a separate 0.4 m^3 fiberglass tank. The distribution of the 3 replicates of 18 family samples into 54 fiberglass tanks was random.

At 40 weeks, the 18 families were divided into 3 age-groups. Each group of 6 families of similar ages was assigned at random to 3 3 m^3 fiberglass tanks. Thus, each 3 m^3 tank was stocked with about 300 fish and all the fish that came from a certain 0.4 m^3 tank went together to the same 3 m^3 tank. In order to maintain individual and family identity, the fish were heat-branded before they were stocked and several times thereafter.

The fish were hand-fed a 40% protein commercial ration 4 times daily while in the troughs and 3 times daily while in the tanks. The water temperature was maintained at 28 ± 0.5 C. The dissolved oxygen level ranged between 7.4 and 8.2 mg/l and ammonia ranged from 0.29 to 0.45 mg/l. The water supply rate in the troughs and 0.4 m^3 tanks was approximately 3.8 l/min and was about 19 l/min in the 3 m^3 tanks. Andrews et al (1971) gave a detailed description of the fiberglass tanks.

The characters studied were as follows:

Body Size: Individual body weights and total lengths were recorded by repeat sampling at 4-week intervals starting at 4 weeks of age and ending at 44 weeks. An additional record of body weight only was taken at 56 weeks.

Percentage Survival: The number of dead fish was recorded daily. From these counts, family survival was estimated for each of 3 age intervals: (1) the first 15 weeks, (2) from 16 to 40 weeks, and (3) from 41 to 56 weeks.

Table 1. Means and coefficients of variation (c.v.) for 18 family means of survival and food conversion ratio.

Characters	*Initial number of fish*		*Percentage survival or food conversion ratio*	*c.v.*
	Total	*Per family*		
0-15 wk survival	21960	1220.0	56.7%	15.0%
16-40 wk survival	2754	153.0	97.1%	0.8%
41-56 wk survival	2656	147.6	98.1%	0.6%
20-40 wk food conversion ratio	2735	151.9	1.58	16.9%

Food Conversion Ratio: This character was estimated for a period of 20 weeks, from 20 to 40 weeks of age, when each family was in three 0.4 m^3 tanks. Food consumption was recorded daily for each tank and dead fish weights were included in estimating the gain. The mean number of fish per family was 151.9 at 20 weeks of age and 147.6 fish at 40 weeks (Table 1).

Estimates of correlation were made between family means. Percentage survival, because it is expressed as a percentage, was transformed to its corresponding angle. Tests for significance of the estimated correlations were made according to Table A-11 by Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

At 56 weeks of age the overall family mean body weight was 546.2 g (Table 2) which was within the conventional limits of channel catfish market weight (from 350 to 700 g). The family variation in body weight was relatively higher than variation in total length, but both kinds of variation decreased with age. Body weight seems to be a better criterion of family variation in body size than total length, even though the latter may be easier to measure.

Table 2. Means and coefficients of variation (c.v.) for 18 family means of live body weight and total length at different ages.

Age in weeks	*Number fish in each family sample*	*Mean Body weight* *g*	*c.v. %*	*Mean Total length* *mm*	*c.v. %*
4	25	0.3	43.2	30.5	13.8
8	25	1.0	38.8	45.7	12.5
12	25	3.7	42.1	72.2	13.2
16	33	8.2	32.7	96.6	10.1
20	33	18.3	37.7	125.6	11.5
24	33	36.6	37.4	157.8	11.1
28	33	64.0	32.8	188.5	9.4
32	33	107.5	30.9	220.5	9.7
36	33	161.8	32.5	251.3	9.9
40	148[a]	201.0	31.2	272.1	8.7
44	147[a]	262.3	32.3	297.7	8.8
56	144[a]	546.2	31.1		

[a]Average numbers

The family mean of 0- to 15-week survival was 56.7% (Table 1). Survival of the 18 families was highly variable as it ranged from 19.1 to 95.5%. During this early age interval, 3 causes of mortality were diagnosed: (1) a pantothenic acid deficiency in the commercial diet fed (Murai and Andrews, 1975); (2) a gill infestation with the trematody *Gyrodactylus*; and (3) a nonspecific bacterial infection. In contrast, higher family survival means and lower variability were obtained in the second and third age intervals. No specific causes of death were diagnosed during these periods.

The overall family mean food conversion ratio was 1.58 g food: 1 g gain (Table 1). The range of the 18 families was from 1.23 to 2.27. In a pond study, Tiemeier and Deyoe (1968) reported ratios which varied from 1.04 to 3.49. In another study in high density tanks, Page and Andrews (1973) reported ratios ranging from 1.24 to 1.80. Both studies were made on populations of mixed spawns.

The estimates of the coefficients of correlation between 4-week body weight and those at each later age ranged from 0.92 at 12 weeks to 0.53 at 56 weeks (Table 3). These estimates had a general, but inconsistent trend to decrease with age. Similar trends were noted on the estimates of correlation between 8- or 12-week weights and those at subsequent ages. Of the 30 correlation estimates between body weights, 26 were statistically significant at the 0.01 level, 2 at 0.05 level and only 2 were insignificant. Evidently, the level of significance became higher with the increase in age gap.

Table 3. Estimates of correlation between family means of body weight, total body length, percent survival and food conversion ratio.

Character X	*Character y*				
	Body weight at:			*Total body length*[1]	*20-40 wk food conversion ratio*
	4 wks.	*8 wks.*	*12 wks.*		
	Coefficients of correlation[2] (rxy)				
Body weight at:					
4 weeks				0.96a	-0.34
8 weeks	0.78a			0.85a	-0.36
12 weeks	0.92a	0.75a		0.94a	-0.53b
16 weeks	0.72a	0.68a	0.85a	0.91a	-0.75a
20 weeks	0.70a	0.65a	0.81a	0.93a	-0.64a
24 weeks	0.72a	0.61a	0.81a	0.93a	-0.70a
28 weeks	0.60a	0.45	0.74a	0.91a	-0.79a
32 weeks	0.70a	0.64a	0.80a	0.91a	-0.80a
36 weeks	0.72a	0.61a	0.80a	0.94a	-0.82a
40 weeks	0.66a	0.59a	0.76a	0.94a	-0.86a
44 weeks	0.64a	0.53b	0.72a	0.95a	-0.83a
56 weeks	0.53b	0.46	0.62a		-0.82a
Percent survival:					
0-15 weeks	0.80a	0.63a	0.62a		-0.13
16-40 weeks	-0.22	-0.07	-0.13		0.08
41-56 weeks	-0.05	-0.28	-0.11	0.01	

[1]At the same age of x
[2]With 16 d.f.
[a]Significant at PO.01 level
[b]Significant at PO.05 level

As expected, all coefficients of correlation between body weights at different ages were higher where the variable y was 12-week weight than where y was 4- or 8-week weights. In contrast, these coefficients were smaller where y was 8-week weight than where y was 4-week weight. Since body weight was relatively less variable at 8 than at 12 weeks of age, this discrepancy apparently was a result of sampling error.

Regan et al. (1976) reported an estimate of 0.34 for the phenotypic correlation between 5- and 15-month body weights. This was smaller than that given in Table 3 between 4- and 56-week weights (0.53) even though the age gap of the latter estimate was wider. Possible causes of this difference might be genetic and/or environmental differences between the 2 catfish populations.

The coefficients of correlation between mean family body weight and total length at the same age ranged from 0.85 to 0.96 and were significant at the 0.01 level (Table 3).

Reagan et al. (1976) reported estimates of 0.79 and 0.90 at 5 and 15 months of age, respectively. Higher estimates were reported by Muncy (1959) on channel catfish in the wild.

The coefficients of correlation between 0 to 15 week survival and body weights (Table 3) or total body length at 4, 8 or 12 weeks (Table 4) were statistically significant and of above medium positive values. In contrast, the coefficients of correlation between survival at 16-40 weeks, or 41-56 weeks, and body weights (Table 3) or body length (Table 4) were insignificant and most of them were negative values. Similarly, the 3 coefficients of correlation between percent survival in any pair combination of the 3 age intervals were small and statistically insignificant.

Table 4. Estimates of correlation between family means of total body length, percent survival, and food conversion ratio.

Character X	*Percent survival at:* 0-15 wks	16-40 wks	41-56 wks	20-40 wk food conversion ratio
	Coefficients of Correlation[1] (rxy)			
Total body length at:				
4 weeks	0.83a	-0.23	0.14	-0.26
8 weeks	0.83a	-0.12	-0.04	-0.23
12 weeks	0.73a	0.15	0.11	-0.47
Percent survived at:				
0.15 weeks		-0.23	-0.13	
16-40 weeks			0.11	

[1]With 16 d.f.

[a]Significant at 0.01 level

The 12 coefficients of correlation between 20-40 week food conversion ratio and body weights were negative and steadily increased with age until they exceeded -0.80 at the 32nd week; and yet, they were not statistically significant before 12 weeks of age (Table 3). Evidently, at later ages these coefficients became higher and significant because the bivariates shared a relatively sizeable common factor—the gain in weight (Sutherland, 1965). Food conversion ratio was not significantly correlated with total body length at 4, 8 and 12 weeks of age (Table 4). Similarly, the coefficients of correlation between food conversion ratio and survival were low and statistically insignificant (Table 3).

Channel catfish breeders should be able to predict the relative family merit in market body weight and fry survival through estimations of the family mean body weight as early as 4 weeks of age. Similarly, the 20-40 week food conversion ratio seems to be predictable through early body weights, but probably not earlier than 16 weeks of age.

What is the significance of these results? It would be a great asset to channel catfish breeders to be able to say with assurance that because a family of fish had a given weight at 4 weeks that it would or would not be economical to feed them to market weight. Think of the possible savings in labor and food if only the fast growers were fed out. Similarly, fish rearing facilities could be greatly reduced if accurate predictions of survival at later dates were possible when the fish were only 4 weeks old.

Projections relating to food conversion ratio from early body weights are not as encouraging. Since food conversion ratio in later weeks of life were not correlated with body weight before the fish were 16 weeks of age, savings derived from less food and facilities requirements would be small.

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