Length Variation in Species and Hybrid Populations of Blue, Channel, and White Catfishes

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Abstract: Blue catfish (*Ictalurus furcatus*), channel catfish (*I. punctatus*), white catfish (*I. catus*), and their hybrids channel x blue, blue x channel, channel x white, and white x blue were produced and grown to an average total length of 150 mm and weight of 30 g in earthen ponds. Blue catfish ($P < 0.01$) and white catfish ($P < 0.02$) were more uniform in length than channel catfish. The channel x blue hybrid was more uniform in length than its reciprocal blue x channel hybrid and channel catfish ($P < 0.02$). Uniformity of channel x white and white x blue hybrids was not different from that of channel catfish ($P > 0.05$). Paternal predominance for length uniformity found in reciprocal channel-blue hybrids was not found in hybrids involving white catfish. Skewness in length distribution were zero or slightly negative, indicating catfish fingerling populations were normally distributed. More competitive environments increased skewness ($P < 0.05$).

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Growth variability in farm-raised catfish is important to the aquaculture industry. When catfish farmers harvest a fish crop, it is desirable that the fish be of relatively uniform size for processing. The extent and causes of variation in different genetic groups need to be determined. Such factors as social hierarchy, behavior, food habits and culture conditions could affect variation singly or in combinations.

Growth variation is also important for mass selection programs. The amount of progress made equals heritability x selection differential. Heritability could be very high but economic progress not obtained if the initial variability were small. If heritability were small but variation large, much progress would still be possible.

The amount of skewness in the size distribution is important. Nakamura and Kasahara (1955, 1956, 1957, 1961) and Moav and Wohlfarth (1973) found carp populations exhibited a high degree of skewness. Absolute skewness values of 1.0 or less represent normally distributed populations. Values of 1.5 show moderate skewness. Populations having a value of 2.0 or greater are heavily skewed. The largest individuals in skewed populations of carp gain their position through environmental advantages (Nakamura and Kasahara 1955, 1956, 1957, 1961; Moav and Wohlfarth 1973). Selecting the largest individuals reared under such conditions results in little genetic improvement and the culture environment should be altered before selection is practiced.

The purpose of the present study was to compare the variability and skewness of fingerling populations of channel catfish, blue catfish, white catfish and some of their hybrids grown in similar earthen-pond environments. If either uniformity or variability are desired different groups may be more appropriate for culture. If skewness exists, experimental culture techniques should be changed to insure a more equal opportunity for individuals to obtain food.

Methods

Experimental catfish (blue, channel, white, channel x blue, and blue x channel, ; female x male) were spawned at the Southeastern Fish Cultural Laboratory, Marion, Alabama, and the Fisheries Research Unit of the Auburn University Department of Fisheries and Allied Aquacultures, Auburn, Alabama. Two interspecific hybrids, white x blue and channel x white were produced artificially in aquaria at Marion according to methods described by Dupree et al. (1966). Other pairings and spawns were accomplished in pens in earthen ponds. Eggs were hatched in paddlewheel troughs, and sac fry were stocked in ponds within 48 hours of hatching.

Channel, blue, white, and channel-blue hybrid catfish fry were stocked in 2–7 separate 0.04- and 10.0-ha earthen ponds each and reared for 6 months at the Auburn University Fisheries Unit, Alabama Agricultural Ex-

Table 1. Length Variability (mm) in 6-Month-Old Blue, Channel, White and Hybrid Catfish Fingerlings Stocked at 150,000/ha in Earthen Ponds

Cross (female x male)	N	Mean (mm)	CV % (SD)	Range (mm)	Skewness Coefficient (SD)
Channel x Channel	1,690	149.0	14.4 (2.6)	41–271	−0.16 (0.26)
White x White	528	145.5	9.4 (0.9)	78–178	−0.47 (0.10)
Blue x Blue	600	155.7	8.7 (0.1)	99–183	−0.48 (0.08)
Channel x Blue	600	154.5	9.6 (0.9)	58–227	−0.42 (0.71)
Blue x Channel	800	152.5	15.9 (2.4)	57–225	−0.10 (0.25)
Channel x White	400	143.6	15.7 (—)[a]	71–194	−0.11 (—)
White x Blue	300	152.7	13.5 (—)	98–200	−0.15 (—)

[a] Only one replication due to poor survival of these hybrids; therefore no standard deviation between replications.

periment Station. Limited numbers of channel x white and white x blue were allowed 1 pond for each cross. Ponds were stocked with 150,000 fry/ha. Stocking of all ponds was completed within a week in June 1976.

Fry were fed twice daily with ground, 36% protein catfish chow (5.6 kg/ha/day) for the first month. During the second month, feed was increased to 11.2 kg/ha/day. Subsequently, feed allowances were adjusted monthly from growth data obtained by seine sampling each pond with a 25-m fingerling seine. Daily rations were based on weight gains with the purpose of rearing the fingerlings in all ponds to a common size.

Two hundred fish were randomly sampled from each pond and measured for total length. Total weights of the samples were recorded and mean weight calculated. Data used in this study were from the November 1976 sampling at the end of the growing season. Variance, standard deviation, coefficient of variation, range and skewness coefficient for total length were calculated for each sample. Skewness equals: $[n \Sigma (X-\bar{X})^3/(n-1)\ (n-2)]/[\Sigma (X-\bar{X})^2/n-1]$ $[\sqrt{(X-\bar{X})^2/n-1}]$. Data were analyzed using SAS (Barr et al. 1976).

Results and Discussion

Variability in Species and Hybrids

Blue catfish and white catfish were more uniform ($P < 0.02$) than channel catfish (Table 1, Fig. 1). Uniformity in the blue catfish and white catfish could have application in a hybridization program with channel catfish. In fact, uniformity in blue catfish exists for a number of traits (Dunham et al. 1982) and is transmittable to channel x blue progeny.

The coefficient of variation for the channel x blue cross was lower than that for the blue x channel cross ($P < 0.02$, Table 1). Variation of reciprocal hybrids was similar to that of the male parent. This paternal predominance

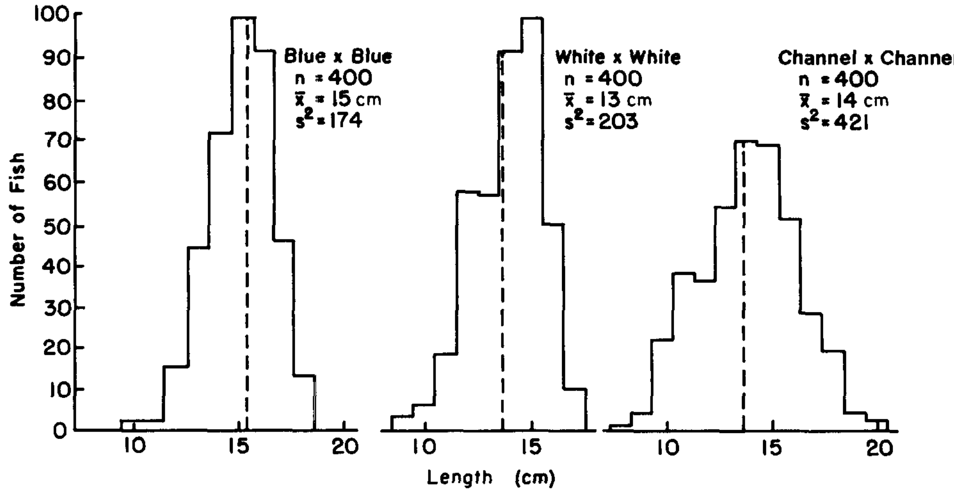

Figure 1. Length-frequency distributions of blue, white and channel catfish grown in earthern ponds (*dotted line* = *mean*)

is discussed by Dunham et al. (1982). The channel x blue is a superior culture fish (Chappell 1979, Dunham et al. 1982) and its uniformity is another culture advantage. The variabilities in the distribution of white x blue and channel x white crosses were similar to that of the channel catfish (Table 1). No paternal predominance was expressed in hybrids with white catfish.

The large variation in channel catfish growth should allow much progress to be made through mass selection and Dunham and Smitherman (1983) showed that channel catfish growth rate could be improved through 1 generation of mass selection. Blue and white catfish have a number of desirable culture characteristics (Chappell 1979, Dunham and Smitherman 1981, Dunham et al. 1982). However, blue and white catfish are seldom cultured because of their slow growth rate (Chappell 1979). If growth rates of blue and white catfish could be improved, their use in commercial culture might increase. However, since their growth variability is less than that of channel catfish, growth rates of blue and white catfish probably cannot be increased as much as that of channel catfish.

Based on their ecology, the large variation in channel catfish might be expected. Their natural geographic range is larger than that of blue catfish and white catfish (Moyle 1976) possibly indicating that increased variability was effective for invasion of new habitats. Channel catfish are believed to be more omnivorous than blue and white catfish, again suggesting adaptability through variability.

Skewness of Length Distribution in Catfish Populations

Skewness of the length of distribution was low, −0.10 to −0.48, in all catfish groups (Table 1). Typical values for carp range from 2.0–3.0 (Nakamura and Kasahara, 1955, 1956, 1957, 1961; Moav and Wohlfarth 1973). Mean skewness in this experiment was −0.26 indicating a near normal distribution. This indicates larger individuals are less likely to be "jumpers" or "shooters," individuals which gain much larger size than the rest of the population through environmental advantage (Nakamura and Kasahara 1955, Moav and Wohlfarth 1973), and more confidence can be placed in the selection procedure. Any skewness was slightly negative indicating a small part of the population was not getting sufficient food in competitive situations and lagging behind in growth. An alternative explanation would be that most populations contain a few individuals which grow extremely slowly even when sufficient food is available because of genetic inferiority. When survival increased, skewness was more negative ($P < 0.05$, $r = -0.47$, 17 d.f.). At higher stocking densities, skewness could become a problem for research geneticists, hatchery managers and farmers practicing selection. This could be overcome by increasing feeding rate or feed size since food availability is the primary cause of skewness (Nakamura and Kasahara 1955, 1956, 1957, 1961; Moav and Wohlfarth 1973; McGinty 1980).

Literature Cited

Barr, A. J., J. H. Goodnight, J. P. Sall, and J. T. Helwig. 1976. A User's guide to SAS 76. Sparks Press. Raleigh, N.C. 494pp.

Chappell, J. A. 1979. An evaluation of twelve genetic groups of catfish for suitability in commercial production. Ph.D. Diss., Auburn Univ., Auburn, Ala. 74pp.

Dunham, R. A., and R. O. Smitherman. 1981. Growth in response to winter feeding by blue, channel, white and hybrid catfish. Prog. Fish-Cult. 43:63–66.

———, and ———. 1983. Response to selection and realized heritability for body weight in three strains of channel catfish *Ictalurus punctatus* grown in earthen ponds. Aquaculture 33:In press.

———, ———, M. J. Brooks, M. Benchakan, and J. A. Chappell. 1982. Paternal predominance in channel-blue hybrid catfish. Aquaculture. 29:389–396.

Dupree, H. K., O. L. Green, and K. E. Sneed. 1966. Techniques for the hybridization of catfish. Southeastern Fish Cult. Lab. U.S.D.I., Marion, Ala. Mimeo. 13pp.

McGinty, A. S. 1980. Survival growth and variation of channel catfish fry and fingerlings. Ph.D. Diss. Auburn Univ., Auburn, Ala. 63pp.

Moav, R., and G. Wohlfarth. 1973. Carp breeding in Israel. Pages 295–318 *in* R. Moav, ed. Agricultural Genetics. John Wiley and Sons, N.Y.

Moyle, P. B. 1976. Inland fishes of California. Univ. Calif. Press, Los Angeles. 405pp.

Nakamura, H., and S. Kasahara. 1955. A study on the phenomenon of the Tobi Koi or shoot carp. I. On the earliest stage at which the shoot carp appear. Bull. Jap. Soc. Sci. Fish. 21:73–76. (In Japanese with English summary.)

———, and ———. 1956. A study on the phenomenon of the Tobi Koi or shoot carp. II. On the effect of particle size and quantity of food. Bull. Jap. Soc. Sci. Fish. 21:1022–1024. (In Japanese with English summary.)

———, and ———. 1957. A study on the phenomenon on the Tobi Koi or shoot carp. III. On the result of culturing the modal group and the growth of carp fry reared individually. Bull. Jap. Soc. Sci. Fish. 22:674–678. (In Japanese with English summary.)

———, and ———. 1961. A study on the phenomenon of the Tobi Koi or shoot carp. IV. Effects of adding a small number of larger individuals to the experimental batches of carp fry and of culture density upon the occurrence of shoot carp. Bull. Jap. Soc. Sci. Fish. 22:958–962. (In Japanese with English summary.)