

# Grass Carp Hybridization and Observations of a Grass Carp X Bighead Hybrid<sup>1</sup>

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## ABSTRACT

Production of a hybrid from a cross of female grass carp (*Ctenopharyngodon idella* Val.) and male bighead carp (*Aristichthys nobilis* Rich.) may help to mitigate the controversy surrounding the use of grass carp for aquatic weed management purposes. Surviving offspring of the cross appear to be sterile, thus reducing the likelihood of unwanted reproduction. Distinguishing morphological characteristics of the hybrid are described and compared to those reported in the literature from similar hybrids produced in the Union of Soviet Socialist Republics and Hungary.

## INTRODUCTION

Use of the herbivorous grass carp (*Ctenopharyngodon idella* Val.) after its introduction into the United States in 1963 for the biological control of aquatic weeds has become controversial (14). This fish offers the potential for economical, long-term, environmentally safe aquatic weed control (18); however, it potentially is capable of causing ecological damage (8).

Grass carp are often compared to the carp (*Cyprinus carpio* L.) because they are members of the same family (Cyprinidae). The carp has caused adverse impacts on the aquatic ecosystem since its widespread introduction into North America in the late 1800's (9). The influence of mass reproduction and survival of grass carp is the central issue surrounding the controversy with the use of the grass carp (15). Therefore, to avoid unnecessary risks until the grass

carp can be properly studied, transportation and use of the grass carp is restricted or banned in many states (16).

Use of monosex or sterile fish for aquatic weed management in situations where fertile grass carp may escape and reproduce would be one way to minimize possible environmental damage. This paper reviews the production of a sterile hybrid and describes some of its distinguishing morphological traits. This hybrid is a triploid that occurs in a cross between female grass carp and male bighead carp (*Aristichthys nobilis* Rich.).

## PROPAGATION OF THE HYBRID

### Union of Soviet Socialist Republics

Beginning in 1964 hybridizations between herbivorous and other cyprinids were attempted at the Institute of Zoology and Parasitology of the Turkman Academy of Sciences at Karamet-Niyaze, USSR (1, 10, 11). Grass carp (GC) eggs were readily fertilized with sperm from bighead carp (BH) and about 75% survived through incubation (10). Work on hybrids was initiated in 1965 at the Akkurgan Fish Collection in Uzbekistan (10, 11, 17), and the Tsimlyanskii Hatchery (2, 3, 4). Survival of the embryonic offspring of GC X BH was slightly higher (83 to 84%) at Akkurgan than at Karamet-Niyaze, apparently because of more stable temperatures (10) and a greater survival of larval hybrids (10, 11). In the hybridization work by Andriyasheva (2) egg mortality of two crosses was 21.6 and 8.5% compared to 40% in grass carp. A later study (4) with five crosses produced an average hatching of eggs of 69%, compared to 65% for grass carp and 68% for bighead carp; however, 85 to 88% of these hybrid larvae died 12 to 14 days after hatching. Only 300 of 3,000 hybrid fry stocked in a pond survived until the end of the first growing season, and most of these were gynogenetic grass carp rather than hybrids.

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## Hungary

Hybridization of grass carp and bighead carp began in 1968 in Szarvas, Hungary. Bakos et al. (5) reported that 36% of the fertilized eggs from the GC X BH cross produced hybrid fish larvae. Of the hybrids that hatched, 70% were malformed and failed to develop and grow. Malformations included no or only partial development of fins, bent body, head twisted backwards, and incomplete development of the mouth, rendering them unable to breathe or eat.

Crosses of female GC and male BH by Zoltan Krasnai and Terez Márián resulted in a triploid  $F_1$  hybrid with a somatic chromosome number of  $2n=72$  as compared to  $2n=48$  for each of the parental species.<sup>2</sup> This spawn produced approximately 10,000 hybrids but no ponds were available and most were destroyed. However, some of these fish still exist in a 22-ha pond. The cross was again made in 1976. Progeny of the 1975 and 1976 spawn were all uniform in morphology and size. Technical problems arose in 1976, and all of that year's production was lost. The cross was again conducted in July 1979. This spawn was not uniform in morphology or size and had many malformed individuals but karyological investigations showed them to be triploid.

## United States

The first report of production of GC X BH hybrid in the United States was by James Malone, a commercial fish farmer in Arkansas.<sup>3</sup> He reported that in June of 1979 three successful spawns were made. Scott Henderson of the Arkansas Game and Fish Commission, Mayo Martin of the U.S. Fish and Wildlife Service, and Homer Buck of the Illinois Natural History Survey assisted in spawning. Fish from this cross are described by Beck, Biggers, and DuPree (6) and karyological investigations of a sample of 25 individuals from the 1979 spawn confirmed the triploid condition.

Approximately 9.5 million hybrid larvae were produced from a cross of 40 female GC and an equal number of BH males in 1980 by Malone.<sup>4</sup> This successful production of a large number of hybrids indicates the ease with which this cross can be accomplished.

### CHARACTERISTICS OF THE HYBRID

The overall physical appearance of the hybrid is similar to that of the female parent (Figure 1). Shared characteristics include the structure of the pharyngeal teeth, size of the head, position of the eyes, and terminal mouth. Intermediate features are number and size of scales, size of caudal fin, size of mouth, length of gill rakers, and insertion of dorsal in fin relative to ventral fin. Using one or a combination of these morphological traits, the hybrid is easily distinguished from either parent.

Ten specimens each of similar sized grass carp, bighead, and hybrid were examined for morphometric characteristics

<sup>2</sup>Krasnai, Z. 1979. Personal communications with W. W. Miley.

<sup>3</sup>Malone, J. 1979. Annual Meeting of the Aquatic Plant Management Society. Chattanooga, Tennessee. July.

<sup>4</sup>Malone, J. 1980. Personal communication.

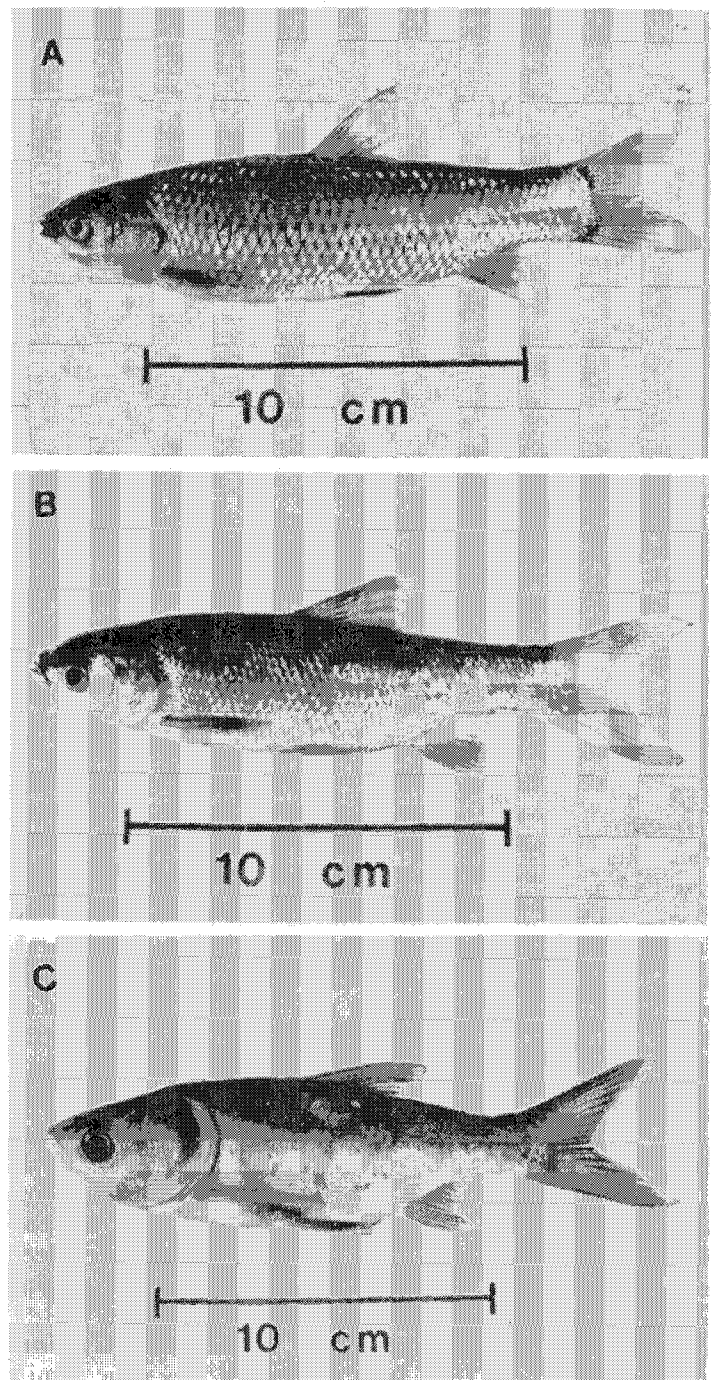


Figure 1. Comparison of overall physical appearance of (A) grass carp, (B) hybrid of a cross between female grass carp and male bighead carp, and (C) bighead carp.

(Table 1).<sup>5</sup> These measurements expressed in percent of standard length show the similarity between the hybrid and its female grass carp parent. The hybrid appears identical to the pictures published by Márián and Krasznai (13); however, it deviates from the description given for the

<sup>5</sup>Specimens of grass carp and hybrids were collected from live populations being reared at Fort Lauderdale. The grass carp were from a 1979 spawn by Mr. Roger Rottman of the University of Florida at Gainesville, and the hybrids from the 1979 production of the Malone Fish Hatchery. Bighead specimens were preserved specimens supplied by the Jim Malone Hatchery, Arkansas.

TABLE 1. MEANS AND RANGES OF MORPHOMETRIC CHARACTERS FOR GRASS CARP X BIGHEAD HYBRIDS AND THE PARENTAL SPECIES. ALL VALUES ARE EXPRESSED IN PERCENT OF STANDARD LENGTH. TEN FISH OF EACH SPECIES WERE USED TO OBTAIN THESE VALUES.

Characters	Grass Carp	Hybrid	Bighead
Length of head	27.2 (26.5-27.9)	28.8 (27.8-29.7)	36.4 (35.2-38.0)
Length of snout	9.56 ( 9.0-10.1)	10.4 ( 9.9-11.1)	12.1 (11.9-12.8)
Length of orbit	5.03 ( 4.5- 5.8)	5.7 ( 4.9- 6.3)	7.0 ( 6.4- 7.5)
Interorbital width	14.5 (13.8-15.2)	13.9 (12.5-14.5)	18.5 (17.5-19.1)
Predorsal fin	53.6 (51.6-55.5)	53.1 (51.5-54.2)	55.8 (53.3-57.8)
Preanal length	79.4 (76.4-82.3)	76.3 (73.6-82.9)	72.8 (71.3-75.2)
Depth of body	22.4 (20.2-23.4)	25.8 (24.2-27.7)	32.0 (29.8-34.2)
Depth of caudal peduncle	12.4 (11.2-13.0)	11.6 (10.9-12.0)	11.8 (11.1-12.1)

same cross by Andriyasheva (4) who described hybrids possessing a ventral keel. A keel is a characteristic of the reciprocal hybrid, BH X GC (7) which as described by Verigin et al. (17) has more intermediate features than those we examined.

Fish surviving the GC X BH cross had 72 chromosomes compared to 48 for the two parents (13). All of the offspring in these crosses in Hungary appeared to be triploid. We believe that the hybrids produced by Andriyasheva (4) were diploid, they were almost identical to the reciprocal cross, namely having a keel. Further, the hybrid described by Andriyasheva (4) grew slowly, reaching only 5 to 9 g by the end of the growing season, compared to 100 to 150 g for grass carp. Hybrids produced by Aliev (1) and also apparently those produced by Márián and Krasznai (13) grew rapidly, similar to those under study at Ft. Lauderdale. Mantelman (12) reported diploid and polyploid embryos among the hybrids of grass carp and silver carp (*Hypophthalmichthys molitrix* Valenciennes) and stated that a similar situation occurred in the GC X BH hybrid. We conclude that in some cases diploid hybrids might be produced and in other cases, triploids. Diploids should be distinguishable from triploids by the presence of a keel and a reduced growth rate.

Another outcome of the hybridization of GC and BC is gynogenesis. Andriyasheva (4) found hundreds of pure grass carp among the hybrid progeny. Thus, three kinds of offspring might result from this hybridization.

The triploid GC X BH hybrid is likely to be sterile, and hence of potential use in aquatic plant management in situations where reproduction is to be avoided. Aliev (1) found the triploid hybrid to feed on aquatic plants. The fish at Ft. Lauderdale have fed on duckweed (*Lemna minor*

L.), *Azolla* (*Azolla caroliniana* Willd.), grass clippings collected from a golf course, and coarsely ground catfish pellets.

Casual observation of hybrids in culture pools at Fort Lauderdale indicate that they are nervous and exhibit more vigorous swimming and jumping as compared to similar size grass carp. Aliev (1) also reported a more nervous disposition and jumping.

#### ACKNOWLEDGMENT

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