

A PRELIMINARY REPORT ON SPAWNING AND REARING OF GRASS CARP (*CTENOPHARYNGODON IDELLA*) IN ARKANSAS

by

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ABSTRACT

Previous attempts to artificially spawn the grass carp have been unsatisfactory, with complete failure or insignificant success using the Russian method described by A. G. Konradt (1965). The same basic procedure, with variations in hormone, size of dose, and number of injections, proved to be successful in our attempt to spawn four year old fish.

The following significant observations were made:

- I. Human chorionic gonadotropin, used as stimulating injections, and dry, whole carp pituitary, used as the resolving injection, produced a high percent of viable eggs.
- II. Extending the period of development within the female from 36 hours to 60 hours proved to be more effective in producing mature eggs.
- III. The Spawning season is approximately one month in Arkansas.
- IV. Mechanical factors and physical conditions such as water temperature, density of eggs in jars, suspended clay particles, and rate of water exchange (rolling rate) effect the success of hatching in jars.
- V. Paddle wheels used to roll the eggs proved to be highly successful for hatching grass carp eggs.
- VI. Grass carp fry show rapid growth and feed well on plankton and commercial minnow meal.

Two hundred and seventy thousand (270,000) fry were produced during these experiments.

INTRODUCTION

The Asian grass carp has been the recipient of considerable interest in Arkansas because of its reported success in controlling various species of aquatic vegetation. Arkansas has many shallow, clear lakes in which vegetation presents a potential threat to the largemouth bass - bluegill sunfish balance and makes sport fishing difficult. The Israeli strain of *Cyprinus carpio* has been used with some success. Numerous species of aquatic weeds may be controlled either by increased turbidity due to rooting or by their feeding habits, but Israeli carp are of limited value to the sport fishery. The grass carp does not create a muddy condition or produce increased plankton blooms as a result of its feeding habits yet is reported to give excellent control of many of our common, problematic submerged weeds and filamentous algae (Avault 1966). The rapid growth rate, swimming and jumping ability, potential size and feeding habits make the grass carp desirable, not only as a biological agent for vegetation control, but also as a sport fish which anglers should seek with great anticipation and enthusiasm.

Problems with artificial ovulation of this fish have been a major obstacle in evaluating the desirability of *Ctenopharyngodon idella*, and in determining potential effects on aquatic ecosystems. In 1966, Dr. Fred P. Meyer and Mr.

Kermit Sneed succeeded in producing fry from one three year old female at the Fish Farming Experimental Station, Stuttgart, Arkansas. These fry were reared at the Joe Hogan State Fish Hatchery, Lonoke, Arkansas, and were used as broodstock in our experiments in 1969 and this year, 1970.

In 1969, attempts to spawn three year old brood were unsuccessful but this year a high rate of success was attained in viable egg production and a high rate of hatch was noted in specific small experiments.

METHODS AND DISCUSSION

Basically, the procedure for spawning the grass carp followed the method described by A. G. Konradt (1965).

Broodstock were collected and held in covered, concrete tanks. Quinaldine at the rate of 7-12 p.p.m. was used to narcotize the fish for injections and stripping.

All injections of acetone dried-whole carp pituitary and fresh carp pituitary were administered intra-peritoneally immediately posterior to the pelvic fins. Injections of human chorionic gonadotropin were administered intra-muscularly.

Selecting Brood Fish

Broodstock was selected at random. Difficulty in seining made it necessary to use all adult stock collected regardless of the appearance, however, during the first experiment, beginning May 4, 1970, only the most gravid females were selected, basically on the degree of abdominal distention and flaccidity of the abdomen and vent. Males were selected on the basis of milt production only.

A very few females had developed naturally to an acceptable condition by May 4, however, by mid-May a large portion of the females had developed to such a degree that artificial ovulation was attempted.

Stimulating Injections

Five separate stimulation experiments were conducted. Konradt (1965) reported that single dose injections were not as successful as fractional injections, either in stimulating ovulation or in producing high quality eggs. In some cases one stimulating dose plus one resolving dose was given. In other cases, two stimulating doses plus a resolving dose was given and in one case, one female spawned after a single stimulating injection.

Ovulation of Eggs

After stimulating development for either 24 or 48 hours, a resolving dose was used which induced ovulation, in most cases, in 10 to 16 hours. Table 1 shows the relative effectiveness of injections in inducing ovulation.

Stripping Females

Eggs were stripped from females 10 - 16 hours following the resolving injection. Ovulation was relatively complete in all spawning females except those stimulated with fresh carp pituitary and those that spawned in mid-June. Those stimulated with fresh whole carp pituitary developed only about one-fourth of a cup of eggs by spawning time, then an insignificant number could be stripped each hour. During the June experiment only 50% of the eggs developed in one female and 85% in the other.

Eggs flowed freely from all females without applying force except for the final cup of eggs. The females were narcotized and dried off, then held with the head higher than the vent. Gravity and flexing of the muscles of the female caused eggs to flow. Eggs were caught in a dry container and held until milt could be added (2 or 3 minutes).

TABLE I

Date	Number of Females	Females's Average Weight	Hormone First Injection	Hormone Second Injection	Hormone Third Injection	Interval Between Injection	Number Females Spawmed	Percent Viable Eggs
May 4-6	2	12 lb	.25mg*/lb	.25mg/lb	1mg/lb	24 hrs	none	--
May 4-6	1	12 lb	.25mg/lb	--	--	--	1	none
May 6-7	5	12 lb	.1 mg/lb	1½ mg/lb	--	24 hrs	4	none
May 18-19	4	12 lb	.1 mg/lb	1 mg/lb	--	24 hrs	3	none
May 18-21	4	11 lb	100 IU/lb	**HCG	850 IU/lb HCG	24 hrs	4(1 only 50%)	98%
May 18-20	1	12 lb	.1 mg/lb	4 whole fresh pituitary glands from 4 lb carp	4 whole fresh glands	24 hrs	1% of ovary	none
May 18-20	1	12 lb	100 IU/lb HCG	4 whole fresh glands from 4 lb carp	1 fresh gland from 16 lb carp	24 hrs	1% of ovary	none
June 16-17	3	11 lb	.1 mg/lb	1 mg/lb	--	24 hrs	none	--
June 16-18	5	14 lb	100 IU/lb HCG	850 IU/lb HCG	1 mg*/lb	24 hrs	2	20%-1 female 1%-1 female

*Dry pituitary

**HCG - Human Chorionic Gonadotropin

Fertilization

Males ranging from five to eleven pounds were used. No injection was necessary to produce sufficient milt in most males. Two males that produced no milt were injected with 0.2 mg/lb. acetone dried pituitary but no significant effect was noted. Males of most species need not be injected (Clemens and Sneed, 1962). Males were narcotized at the same time as the females, dried off and milt stripped into the eggs. In some cases two males were used to fertilize eggs from one female but usually only one male was used per female. After the addition of milt, the eggs were stirred by hand to mix sperm and eggs and a small amount of water was added (just enough to assure that sperm around each egg would be suspended in water). This mixture was then swirled to assure that sperm would contact all eggs, then more water was added and allowed to stand, with occasional swirling, until water hardening was observed (about 10 - 15 minutes). It was noted that eggs which later developed into fry water-hardened much faster than non-viable eggs.

Hatching

Eggs were placed in two separate hatching facilities—McDonald jars and screen boxes with paddle wheels (see Figure 1). Temperature was varied and two water sources were used. Table 2 shows hatching success of all eggs taken. *Only* eggs from the females stimulated with human chorionic gonadotropin and acetone dried pituitary hatched.

It is important to note that eggs of grass carp are semibuoyant and must be rolled slowly and not over-crowded in the jars. In the group where a 98% hatch was accomplished (Table 2), the eggs were taken from saran boxes which caught the eggs as they floated out of the jars during the first two hours while water-hardening. These were previously thought to be mostly dead eggs. They came from all four females which were spawned at that time. The 80% hatch (Table 2) came from one female and it is interesting to note that other eggs from the same female, rolled at the same rate and in similar jars, hatched at the rate of 2%. The differences were 80% hatch was attained in clear, 68 - 73° F. water; 2% in very turbid 78° F. water. Yet the same 78° F. turbid water gave a 98% hatch in the paddle wheel screen boxes. It seems that the suspended clay particles, along with high temperatures, were the cause of discrepancy. Clay settled to the bottom, away from eggs, in the paddle wheel but high temperatures and clay particles seemed to cause the eggs to float out of the jars badly.

The June experiment produced a low hatch percentage wise with the same conditions as the May experiment in jars; and no hatch at all with paddle wheels at 80° F. This along with the low number of females which spawned indicates that this was the end of the spawning season and re-absorption of eggs had already begun. Successful spawning cannot be induced if degeneration of eggs has begun (Clemens and Sneed, 1962).

Fry Development

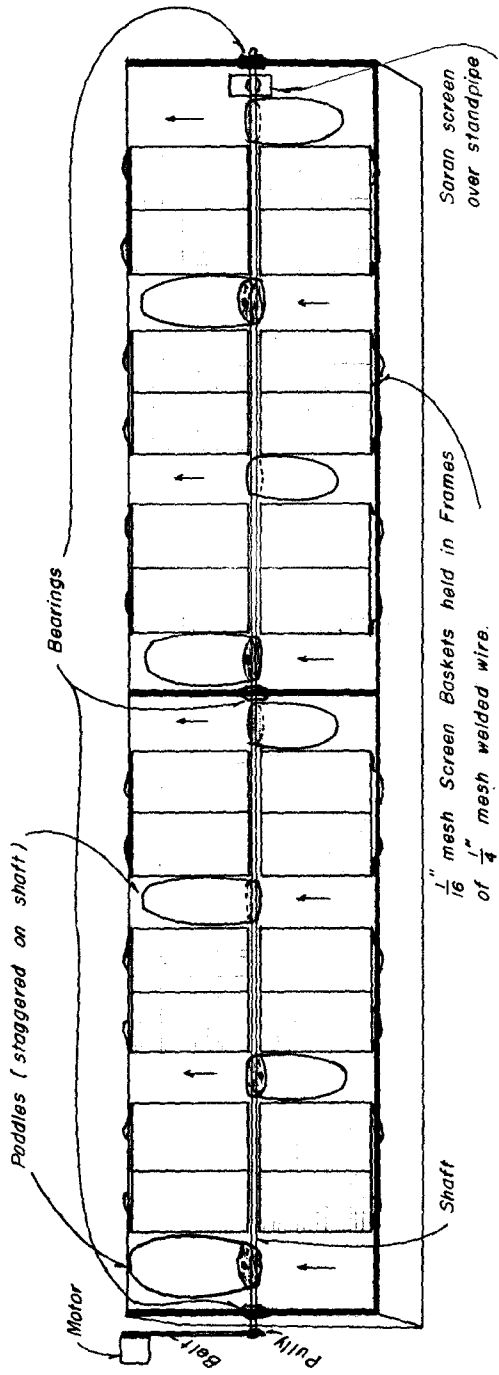
Water temperature affects the time required for hatching. Higher temperatures accelerate the development and may cut the time required for hatching by one-third. At 78° F. hatching began 26 hours after fertilization, was complete in 30 hours in paddle wheel baskets and was complete in 32 hours in McDonald jars. In jars held at 68° F. then slowly raised to 73° F. after 26 hours, the first movement was noted at 29 hours. Hatching began 34 hours post fertilization and was complete in 38 hours. Eggs taken in June and held at 71° F. exhibited movement of the fry at 29 hours. At 33 - 34 hours the temperature was slowly raised to 78° F., by adding heated well water, to temper eggs to water in the holding tank. Hatching began at 36 hours and was complete in 43 hours.

One jar, maintained at 71° F., began hatching at 41 hours and was complete in 44 hours. The following drawings show the stages of development in detail. Time indicated will be fairly accurate if held at 75° F.

TABLE 2

Date	Approximate Number of Eggs	Water Temp. °F.	Water Source	Type of Container	Number of Fry	Percent of Hatch
May 5	600	76	Pond	Jars	none	none
May 8	2,000	73	Pond & Well	Jars	none	none
May 20	1,800	75	Pond & Well	Jars	none	none
May 21-22	80	68-73	Well	Jars	64,000	80%*
May 21-22	75	78	Pond	Paddle Wheel	73,500	98%*
May 21-22	1,500	78	Pond	Jars	30,000	2%*
June 18-19	930	71-78	Well	Jars	102,300	11%*
June 18-19	200	81	Pond	Paddle Wheel	none	none

*See Table 1 - Note: All viable eggs were produced by females stimulated with fractional injections of human chorionic gonadotropin and ovulated with a single injection of acetone dried whole carp pituitary.



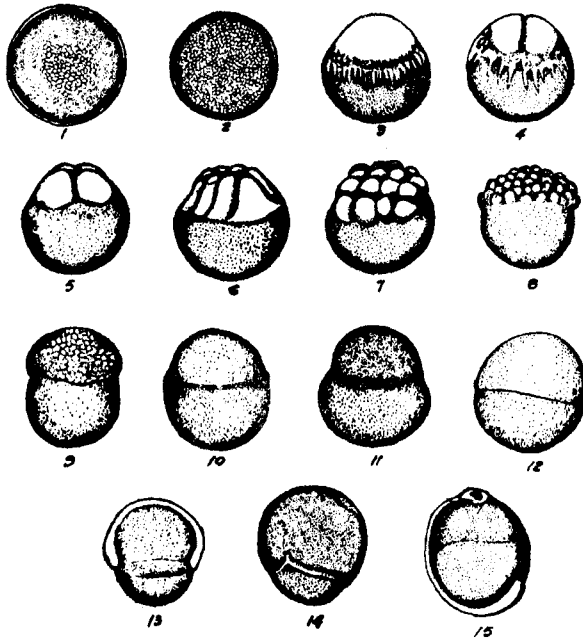
Paddle Wheel Hatching Apparatus

Fig. 1

Rearing the Fry

One hundred fifty thousand fry were placed in a one acre pond at the Joe Hogan State Fish Hatchery on May 27, 1970. The pond was very fertile and a heavy phytoplankton bloom was maintained. They were fed small amounts of commercial minnow meal each day and soon were observed feeding regularly on the meal. At one month of age the young grass carp had attained an average length of just under two inches. Stomach analysis revealed that phytoplankton was being utilized readily. Konradt (1965) reported that for the first month and a half, fry feed on animal food, mostly zooplankton, then become phytophagous when three inches long. On June 22-26, 45,000 were moved to another pond to maintain desirable stocking rates. At 67 days of age, fingerlings had attained an average length of 4.8 inches.

About 90,000 of the fry hatched on June 19th died in the rearing trough, the day following hatching. No explanation was apparent, however, mortality of weakened fry may have been due to water problems, high temperatures or spawning season cessation. The remaining 12,000 fry were reared at the Joe Hogan State Fish Hatchery.

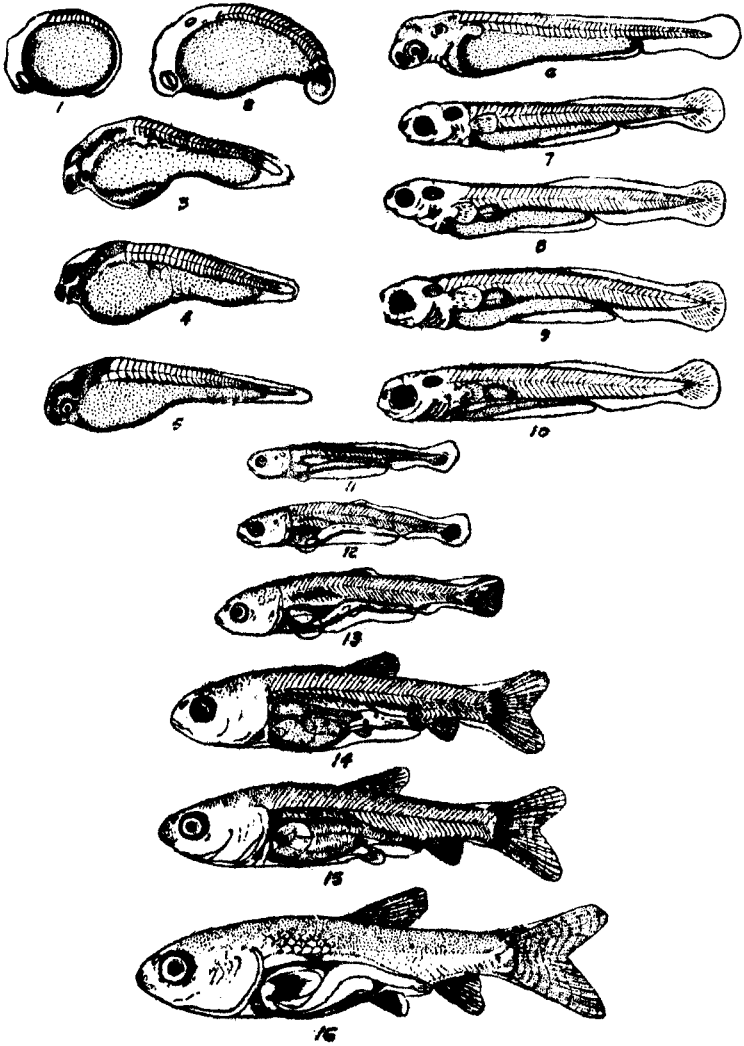


DEVELOPMENT OF FERTILIZED EGG

prepared by: *W. H. G. S.*

1. Mature egg		2. Fertilized egg
	Post fertilization	
3. 35 minutes	8. 2 hours	13. 9 hours
4. 55 "	9. 3 hours	14. 11 "
5. 1 hour, 5 min.	10. 4 "	15. 14 "
6. 1 " 20 min.	11. 5 "	
7. 1 " 48 min.	12. 7 "	

DEVELOPMENT OF EMBRYO AND FRY OF GRASS CARP.



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Post fertilization		Post hatching	
1.	15 hours	7.	1 day
2.	17 "	8.	2 days
3.	20 "	9.	2.5 "
4.	22 "	10.	3 "
5.	25 "	11.	3.5 "
6.	32 " (hatch)	12.	4 "
		13.	5 days
		14.	7 "
		15.	10 "
		16.	15 "

SUMMARY AND CONCLUSION

Although this study is of a preliminary nature, several important conclusions and projections can be assumed. Spawning was successful during the month of May, beginning soon after water temperatures reached 75° F. and little success was attained after water temperatures reached 87° F. Spawning season lasts from April to August in Chinese rivers but only part of the stock spawns at a time (Konradt, 1965). Early high temperatures probably shortened this year's spawning season which in actuality may last two or three months in some areas. However, females checked in late July revealed that re-absorption of eggs was complete. Konradt (1965) reported a decrease in egg quality from 13 to 20 June which was explained as over-ripening of eggs in the body of the female due to the increase in temperature. Reduction of the dosage and earlier examination eliminated the unfavorable effect. For all practical purposes the optimum season for fry production lasted one month in 1970.

At our latitude, two intra-muscular injections of human chorionic gonadotropin at the rate of 100 international units per pound of body weight, followed in 24 hours by 850 international units per pound, induces the desired stage of egg development. One milligram acetone dried whole carp pituitary per pound of fish injected intra-peritoneally 24 hours following the last human chorionic gonadotropin injection induces spawning in mature females in ten to sixteen hours. This produces viable eggs which are successfully incubated at 68° - 78° F., either in jars or a paddle wheel hatchery. Water of low turbidity and temperatures of 74° F. are conditions recommended by the authors. Eggs should not be crowded together.

Eighty thousand eggs per jar gave good results at low temperatures and a low rolling rate. It appears that fewer eggs can be contained in jars at higher temperatures because of their tendency to float out even when the amount of water running through the jars is a mere trickle.

Water hardening the eggs in McDonald jars for one to two hours, then transferring them to 1/16 inch screen boxes in the paddle wheel hatching apparatus has some advantages. Since eggs water harden to about five times their initial size, those that do not hatch are retained by the screen but the fry pass through into the tank after hatching. Non-fertile eggs can be removed immediately after fertile eggs hatch (if left too long, they disintegrate and fall into the tank with fry) and fry can be reared until they begin feeding without being moved. If fry are allowed to hatch in jars, many swim up and are carried out into the tank but eggs also float out, resulting in a mixture of dead eggs and fry in the tank. Also, many fry do not swim out and must be poured into the tank. If a low percent of eggs hatch many dead eggs settle onto the fry when water exchange stops and may cause mortality. Decaying eggs provide media for potential problematic bacteria or fungi.

Fry begin feeding when two to three days old and grow rapidly during the first few months of life, feeding on planktonic algae and commercial minnow meal.

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SPAWNING BEHAVIOR, AGE AND GROWTH, AND SPORT FISHERY FOR THE SILVER REDHORSE, *MOXOSTOMA ANISURUM* (RAFINESQUE), IN THE FLINT RIVER, ALABAMA

by

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ABSTRACT

Spawning behavior, age and growth, and sport fishery for the silver redhorse, *Moxostoma anisurum* (Rafinesque), in the Flint River, Madison County, Alabama, were studied in 1969 and 1970. Spawning silver redhorse were first observed on April 1, 1969, and April 8, 1970, at a water temperature of 14.4°C. (58° F.) Females appeared to mature between the sixth and seventh year at a length of 548-600 mm. Males appeared to mature at 510-530 mm., but most seemed to mature at the same age. Growth of males and females was approximately the same until age group VI. After this age, males grew slower than females. Mature specimens moved into Flint River from Wheeler Reservoir to spawn during February through April. Immature silver redhorse returned to Wheeler Reservoir where they remained until sexually mature. The most important fishery on the Flint River during early spring is for silver redhorse.

INTRODUCTION

A sport fishery of local importance exists each year from February through April for the silver redhorse, *Moxostoma anisurum* (Rafinesque), in the Flint River, a tributary of the Tennessee River in Alabama. This fishery is heavily utilized by local anglers and to a lesser degree by nonresident anglers. Little has been published concerning the biology and sport fishery utilization of the silver redhorse. Meyer's (1962) study is the only comprehensive report on the biology of this species, although the silver redhorse is commonly found in both reservoirs and streams (Robins and Raney, 1956). A need for a study of the

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