this tremendous harvest was accompanied by an average rate of catch of 1.25 fish per hour indicates that there was continuous, rapid recruitment of fish from areas outside the stands of timber.

In Missouri impoundments, the pattern of clearing varies from complete removal of timber (Clearwater Reservoir) to removal of only 5 to 10 per cent of the timber (Table Rock Reservoir). Since the situation in Bull Shoals is unique, we would not expect comparable fishing pressure or harvest of fish per acre in timbered areas of other reservoirs. In Table Rock Reservoir, for example, with 90 to 95 per cent of the timber left standing, these values doubtless would be much lower.

This study, while answering several questions, leaves several others in the realm of speculation. It would be interesting to know more about basic food production in flooded timber, the composition and size of the forage fish population, and the degree to which adult fishes are attracted to timbered areas simply because of the cover found there, to name only a few.

In conclusion, since timbered areas are popular fishing places (for good reason) and clearing large areas is expensive, the current practice of leaving much of the timber in new lake basins seems to be quite reasonable. However, standing timber is so thick in Table Rock Reservoir that it is extremely difficult to reach the upper end of some coves in a boat. Access to these areas could be improved greatly by cutting a strip of trees up the middle of each cove.

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LITERATURE CITED

Kathrein, Joseph W., 1953. An intensive creel census on Clearwater Lake, Missouri, during its first four years of impoundment, 1949-1952. Trans. N. Am. Wildl. Conf. 18:282-295.

OBSERVATIONS ON THE CULTURE OF FLATHEAD CATFISH (Pylodictis olivaris) FRY AND FINGERLINGS IN TROUGHS

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ABSTRACT

Flathead catfish fry were reared to fingerling size in troughs by starting them to feed on shrimp, and marine fish. Other foods that were subsequently eaten by fry and fingerlings included beef liver, spleen, egg-yolk, cheese, canned dog food, canned salmon, and some dry cereal feed. The food was prepared by placing the meats in a blende, adding a small amount of water, and stirring until the food was "creamy" in texture. After approximately three weeks, the fish had increased in size so that they could consume the food passed through a food chopper.

No feeding was attempted until the yolk sac had been absorbed and the fish exhibited feeding behavior. After two or three days, if not fed, the fry will not feed even though food is offered.

The food was placed (with a pipette or by rubbing between fingers) in the water above the fish. Since the fish lost interest in the food as soon as it reached the bottom of the trough, that amount of food that could be consumed before it fell to the bottom and lost was considered the optimum portion. Initially, these fish were fed frequently during the daylight hours; but after about three weeks, the number of feedings was decreased to four daily.

Initial mortalities from non-feeding individuals were estimated to be less than 10 percent, while the total observed mortality up to 110 days

after hatching was estimated to be less than 20 percent, although accurate records were not kept. Unobserved losses may have exceeded 50 percent. Some of these losses were contributed to cannibalism, but the majority were contributed to predators (rats, mink). Since the purpose of the experiment was only to determine if flathead catfish could be raised in troughs on artificial food, the records on age and growth, food conversion, and other experimental data were not kept.

At the conclusion of the experiment, approximately 110 days after the eggs hatched, the fish had reached three to four inches in length and were apparently in "good" condition. However, the rate of growth, degree of cannibalism, and maximum size that can be attained in troughs may be influenced by rate of stocking, frequency of grading, etc. Therefore, if these species proves to be of value in fisheries management, much additional research should be conducted on its culture.

INTRODUCTION

The role of the flathead catfish, *Pylodictis olivaris*, in natural fish populations and the possible value of this species in "balanced populations" in farm ponds is relatively unknown. Some fisheries investigators have desired to conduct research with this species stocked alone and in combination with other fish species. However, this research has been greatly restricted or even prevented by the fact that flathead catfish fingerlings usually are not available in significant numbers.

Since no artificial populations of flathead catfish have been available to fisheries research personnel, some investigators (McCoy, 1953; Jenkins, 1952) have utilized existing natural fish populations for various age and growth studies. Minckley and Deacon (1959) worked on the biology of this species in natural waters. However, these and other studies were dependent on unknown or estimated population compositions and densities. These variables could have been reduced or even eliminated with known numbers of known-age flathead catfish stocked into artificial populations of known species composition.

Because fisheries personnel have recognized the need for large numbers of various sized flathead catfish of known ages, several attempts have been made to propagate this species. Johnson [1] found that the flathead catfish was sexed in the same way as the channel catfish. However, Johnson was unsuccessful in spawning this species in captivity, although Fontaine (1944) and Snow (1959) were successful. Subsequently, we have found from our own research and from personal communications with other investigators and commercial fish hatcherymen that the flathead catfish is apparently less difficulty to spawn than previously thought, and that the same techniques that are practiced to spawn channel catfish can be used to spawn flathead catfish. Previous difficulties may have been due to the condition of the broodstock resulting from improper feed or lack of sexual maturity. Since this species grows rapidly in most lake habitats, large fish (7 to 8 pounds) are often sexually immature, although in some streams small (1 to 2 pounds) fish may be mature.

There are two general methods employed for the rearing of flathead catfish—the trough and the pond method. Snow (1959) was unsuccessful in his attempt to trough-rear flathead catfish fry by offering the fish finely ground beef liver and small amounts of dry meal. However, he reported that when the surviving fry were transferred to screened boxes located in a well-fertilized pond, 607 fish survived from the estimated 10,000 in the original spawn. Russell C. Hornbeck, National Fish Hatchery, Tishomingo, Oklahoma, (personal correspondence) reported similar losses in troughs with fry fed finely ground liver and shrimp. Roy Schoonover, Forestry, Fish and Game Commission, Pratt, Kansas, (correspondence) reviewed the experiments of Mr. Seth L. Way during the period of 1935 to 1940. In one experiment, Mr. Way stocked 5,000 to 6,000 fry into one feeding trough. These fish were fed a diet of *Daphnia* and black fly larvae. With this diet, the flathead catfish attained an average length of 1.5 to 2 inches with no apparent cannibalism. However, at that size, cannibalism and caudal chewing soon reduced the num-

[1] Johnson, M. C. Some experiements in the propagation of the flathead catfish, **Pilodictis olivaris** (Raf.) in ponds. M. S. Thesis. Alabama Polytechnic Institute, Auburn, 1950.

ber in the original stocking to less than 200. Marion Toole, Game and Fish Commission, Austin, Texas, in a recent letter reported his observations on the rearing of this species. He stated that the fry were kept in troughs until the yolk sac was absorbed, and then the fry were stocked into well fertilized ponds. After growth of the fingerlings had ceased in the fertilized ponds, the fish were stocked into bluegill sunfish rearing ponds and into channel catfish rearing ponds. Although the percentage survival and total production data were not included, Toole did state that the flathead catfish "achieved a very excellent growth rate" while "the channel catfish numbers were materially reduced".

The above reports indicate that small numbers of flathead catfish fingerlings have been reared in well-fertilized ponds, while trough culture of this species was usually unsuccessful. If sufficient numbers of fingerlings of this species are to be made available to management biologists, a method more efficient than the reported pond culture is necessary. In order to develop a better method of culturing flathead catfish fingerlings, the following research was conducted on the trough culture of the flathead catfish.

Sexually mature flathead catfish were removed from a 1.3-acre pond, sexed, paired, and placed into spawning pens on May 15, 1961. Of the six pairs stocked, three spawned in barrels (without hormone injections) within six to ten days. On May 25, and May 27, the remaining female fish were injected with human chorionic gonadotropin as described by Sneed and Clemens (1959). Of the three fish injected, two spawned successfully. Also, several female flathead catfish from nearby rivers were purchased from commercial fishermen. After these fish were injected with human chorionic gonadotropin, one spawn was obtained. The eggs of the fish from the pond and from the river were similar in color, size and viability. Since flathead catfish feed mostly on forage fish and other large aquatic animals, it would appear that any body of water that contains sufficient quantities of forage fish, either hatchery ponds or natural waters, is satisfactory for maintaining flathead catfish broodstock.

The eggs were placed in a mechanical hatching trough. The pulsation of the egg masses is accomplished by a series of paddles attached to a motor-driven, rotating shaft suspended above the water. The water, piped from an unfertilized, fish-free source, entered at one end of the trough and exited through an overflow at the other end. The eggs were suspended in wire enclosures between pairs of paddles or positioned on the trough floor under the individual paddles.

All of the eggs appeared normal ,and almost 100 percent hatched, However, the fry in two spawns were dead within several hours after hatching. Although the exact cause of death is unknown, we suspect the malahcite green applied to the channel catfish eggs being incubated in the same trough. Malachite green, a fungicide used to inhibit the growth of fungus on the dead eggs, is extremely toxic to fry and fingerlings of many species of fish; and it is possible that excessive amounts of malachite green (or too many applications) may have adversely affected the flathead catfish eggs. In another spawn, approximately 50 percent of the fry died within five to seven days after hatching. Upon microscopic examination, a "bacterial gill disease" was diagnosed. After a six hour treatment with chloramphenicol (15 ppm) the mortality decreased to insignificant numbers.

The fry were siphoned from the hatching trough and placed in aluminum feeding troughs, also located in the wet laboratory. These troughs were 12 inches wide by 9 inches deep by 6.5 feet in length and were filled with water to the depth of approximately 8 inches. Water entered at the head of the trough at the rate of approximately 100 gallons per hour and exited at a hole at the tail of the trough. A fine-mesh screen was positioned in front of the overflow to prevent the escape of the fish through the overflow hole. The water for these troughs was piped from an unfertilized earthen pond located near the laboratory.

No attempt was made to stock equal numbers of yolk-sac fry in the troughs, but the number of fry in each trough was approximately 5,000. The fry were left undisturbed until the yolk sac was nearly absorbed.

Initially, the food (shrimp and marine fish) was placed in a blender with a small amount of water and stirred until the food was "creamy" in texture. After approximately three weeks, the fish had increased in size so that they could consume the food passed through a food chopper.

When the yolk sac of the fry was nearly absorbed and the fish exhibited feeding behavior, feed was offered. This feeding behavior was exhibited by the fish when they moved along the top and along the sides of the troughs, apparently seeking food. In order to insure a high percentage of survival, it is imperative that the fish receive food at this time. After two or three days, if not fed, the fry will not feed even though food is available.

The food was placed with a pipette or with the fingers in the water above the fish. Since the fish lost interest in the food as soon as it reached the bottom of the trough, only the amount of food that could be consumed before it fell to the bottom was considered necessary. Initially the fish were fed frequently during the daylight hours, but after about three weeks the number of feedings was decreased to four daily. Actively feeding fish will vigorously attack the sinking food particles. Food in the stomach can be seen through the abdominal wall, since the belly skin is quite transparent at this age.

When the fry and fingerlings have learned to eat ground fish and shrimp, they will also eat liver, spleen, egg yolk, cheese, canned dog feed, canned salmon, some dry cereal feed, and perhaps other foods.

Initial mortalities from non-feeding individuals were estimated to be less than 10 percent, while the total observed mortalities, up to 110 days after hatching, were estimated to be less than 20 percent, although accurate records were not kept. However, an inventory about mid-way through the experimental period revealed that more than half of the fish were missing. Speculation as to the cause ranged from cannibalism to predation. Several days later, when 39 of the larger fingerlings (approximately the same size) were placed alone in a trough, 30 disappeared in four days. Since these could not have eaten each other, we presumed that predation from minks or rats might have been the cause. Naturally, the holding house was immediately "varmint-proofed".

Several weeks prior to the conclusion of this experiment, high mortalities due to "chewing" were observed. These mortalities were the greatest immediately after "size-grading" and decreased to negligible numbers within one week. This chewing was observed after each "size-grading". Although an interpretation is somewhat premature, could it be that this species exhibits a "chewing" order similar to the "pecking" order of chickens? If this interpretation is correct, a new "chewing" order was established each time the fish were mixed and regrouped.

On September 27, 1961, approximately 110 days after the start of the experiment, the trough-culture phase of the research with this species was concluded. The fish were apparently in good "condition" and were three to four inches in length. It was observed that the fish in the more heavily stocked troughs were still actively feeding and growing while the fish in the troughs stocked with lesser numbers were passively feeding and not growing. Further, it was observed that most of the fish in the more heavily stocked troughs were more gregarious and compatible than the fish in the troughs stocked with lesser numbers. In fact, in these troughs, six fish (one in each of the four corners and two along the sides) was the maximum number observed for long periods. Doubling this number of fish only resulted in fighting and subsequent mortalities until the number again reached six. This "conquest for territory" behavior did not develop in the more heavily stocked troughs. Most of the surviving fish were given to Auburn University for experimental purposes.

In conclusion, this experiment has shown that the fry of flathead catfish can be fed and grown to fingerling size in troughs. Mortalities due to non-feeding was less than 10 percent. Subsequent mortalities due to disease were minimal. The losses due to "chewing" and "cannibalism" can probably be influenced by the number of fish stocked, the amount of feed and frequency of feeding, size-grading, etc.

Since the extensive production of this species will depend on its value in management of natural and impounded lakes and ponds, this research was conducted in anticipation of a potential need. The pond experiments to determine the value of this species now underway at Auburn University should provide additional useful data concerning the flathead catfish.

Also, additional research concerning flathead catfish culture is planned by our Laboratory for the 1962 season.

LITERATURE CITED

Fontaine, P. A. 1944. Notes on the spawning of the shovelhead catfish, *Pilodictis olivaris* (Rafinesque). Copeia 1944(1):50-51.

Jenkins, Robert M. 1952. Growth of the flathead catfish, *Pilodictis olivaris*, in Grand Lake (Lake O'The Cherokees), Oklahoma, Proc. Okla. Acad. Sci., 33:11-20.

McCoy, H. A. 1953. The rate of growth of flathead catfish in twenty-one Oklahoma lakes. Proc. Oklahoma Acad. Sci., 34:47-52.

Minckley, W. L. and James E. Deacon. 1959. Biology of the flathead catfish in Kansas. Trans. Amer. Fish. Soc., 88(4):344-355.

Sneed, Kermit E. and Howard P. Clemens. 1959. The use of human chorionic gonadotropin to spawn warm-water fishes. Prog. Fish-Cult. 21(3):117-120.

Snow, J. R. 1959. Notes on the propagation of the flathead catfish, *Pilodictis olivaris* (Rafinesque). Prog. Fish-Cult. 21(2):75-80.

A COMPARISON OF PRODUCTION OF ALBINO AND NORMAL CHANNEL CATFISH

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ABSTRACT

Albino (golden) and normal channel catfish were compared in feeding experiments during a 346-day period. There was no difference in rate of growth, but the percentage of survival was 94.2 for the normal catfish and 81.1 for the albinos. Fishing success was similar for the two.

INTRODUCTION

Albino channel catfish, called golden catfish by Nelson [1], have been observed rather frequently among fry hatched at the Auburn University Agricultural Experiment Station during the last 3 years. Although none of the brood fish had the albino appearance, the trait was obviously present among some individuals in this group of fish since some of the pairings produced as high as 25 percent albino fry. These brood fish were raised from fingerlings furnished for experiments by Ben Nelson, Osage Springs Minnow Farm, Rogers, Arkansas, in 1955.

Since there was a considerable amount of interest in albino channel catfish among fishermen, fishery biologists, and commercial producers, experiments were conducted to compare the survival and growth of albino and normal channel catfish. Each of two one-acre ponds was stocked December 4, 1959, with 1,000 albino and 1,000 normal channel catfish fingerlings between 3 and 6 inches total length. Largemouth bass fry were added May 19, 1960, at the rate of 100 for each pond to control possible contamination by other species of fish. No fertilization was used, but pelleted Auburn No. 2 fish feed [2] was added 6 days a week as follows:

Dates	*Pounds Fed Per Acre Per Day*
Feb. 1-Mar. 31	2
Apr. 1-Apr. 30	5
May 2-July 9	10
July 11-July 30	15
Aug. 1-Oct. 3	25
Oct. 4-Nov. 10	30

The ponds were drained November 14-15, 1960. Production data are given in Table 1. The main noticeable difference between the albinos and the normal channel catfish was the lower percentage of survival of

[1] Nelson, Ben. Propagation of Channel Catfish in Arkansas. Proc. Tenth Ann. Conf. Southeast. Assoc. Game and Fish Comm. 1957:165-168.

[2] Prather, E. E. Further Experiments on Feeds for Fathead Minnows. Proc. Twelfth Ann. Conf. Southeast. Assoc. Game and Fish. Comm. (1958), 1959:176-178.