A STUDY OF THE SOUTHERN SPOTTED CHANNEL CATFISH,

ICTALURUS PUNCTATUS (RAFINESQUE)

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A STUDY OF THE SOUTHERN SPOTTED CHANNEL CATFISH, *ICTALURUS PUNCTATUS* (RAFINESQUE)

THESIS

Presented to the Graduate Council of the
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by

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CHAPTER I

INTRODUCTION

The fish hatcheries of the State of Texas were originally established to replenish the population of the natural wafers of the state where the fish population had been reduced by drought or excessive harvesting of the fish crop.[1] Later the policies of the fish hatcheries were changed to include the stocking of private lakes and ponds as there was no other source for obtaining the needed stock fish. This practice is justified in that any additional fishing water available reduces the fishing pressure on the public waters.

At first, the demand for stock fish for these lakes and ponds was in the category of the scale fish. The average farmer or rancher was not financially able to any extent to build lakes or ponds and those who did so were usually wealthy landowners with a sportsman's liking for fishing. The demand for stock fish was therefore for the sporting type. Within recent years, though, the Soil Conservation Service has extended financial aid to farmers and ranchers for the construction of ponds and lakes, thereby increasing greatly the number of such bodies of waters on the farms of the state. Many of

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[1]Information obtained from Marion Toole, Chief Aquatic Biologist, Texas Game and Fish Commission.

these farmers and ranchers desired to stock their ponds and tanks with fish but they were more interested in fish for size than for sport, and in those that were easily caught by the pole and line method. Pole fishermen consider the channel catfish the most desirable of the fish normally caught by the use of a line and the pole, therefore, consideration began to be given by the hatcheries to the propagation of this fish for stock for lakes and ponds. Once the need was established for this type of fish, attempts were made to produce it.

Purpose of the Study

The state fish hatcheries of Texas had little precedent to follow in the propagation of the channel catfish, but had to work more or less on an experimental basis. The purpose of the present study is to present research data on the propagation of the southern spotted channel catfish.

Source of Data

Research made in the field revealed that very little of the early information has been written out. The majority of the historical data used in the study, therefore, had to be taken from field notes and observations of the men operating the fish hatcheries and charged with the responsibility of catfish production.

History of the Attempts to Propagate Channel Catfish

Little of the history of the early attempts to propagate channel catfish has been recorded. The first report of delivery of the channel catfish in Texas is recorded in the Yearbook on Texas Conservation of Wildlife for 1929-1930.[2] This report shows that the Heart of the Hills Hatchery at Kerrville, Texas, produced and delivered 2,665 channel catfish during this period. The Yearbook did not state the name of the hatchery supervisor who was responsible for the propagation of the channel catfish, but hatchery employees still at Heart of the Hills report that Chet Brady was one of the first who aided in the production of channel catfish at the Kerrville hatchery.

At the same time that propagation of catfish was successfully accomplished at the Kerrville fish hatchery, efforts were under way at the Dallas hatchery to propagate the channel catfish. According to W. D. White, who was assistant to Superintendent Wilkerson of the Dallas hatchery, spawn from the channel catfish were taken and placed in concrete pools. The small catfish did not live well in these pools, and the total recovery of the first experiment was one channel catfish.

The following year the attempt to propagate the channel catfish was more successful at the Dallas hatchery. Much

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[2]State Game, Fish, and Oyster Commission, Texas Conservation of Wild Life, 1929-1930, p. 14.

credit is given W. D. White, who later became superintendent of the Dallas and Lake Dallas hatcheries, for the success of the undertaking. In his early attempts to raise catfish, he found that the fertilized eggs were comparatively easy to hatch but that the recovery rate of young was very poor. Observation of the ponds where the catfish fry were placed revealed that dragonfly nymphs were eating the flesh of the small catfish and accounting for the major portion of the losses. Study was then made of ways and means of preventing this destruction. Through observation, Superintendent White learned that it takes several days for these dragonfly nymphs to hatch out in a pool after water has been placed in it. Water in fresh-filled pools was found to be comparatively free of this insect. Superintendent White then tried out a plan whereby the newly-hatched fish were placed in ponds directly after they had been filled. In this way, the small catfish had a chance to grow, and by the time the nymphs were hatched the catfish were large and strong enough to elude them.

The plan was successful to the extent that by 1931 the Dallas hatchery was leading in the propagation of catfish by a wide margin. By 1932, four out of nine of the other fish hatcheries in operation were producing catfish. The accumulated knowledge gained from the experiments was shared with other hatcheries and with additional ones created by the

State, and eventually all of them began the propagation of this type of fish. The 1947 report of the hatchery operations shows a total production and distribution of 1,242,372 fingerling catfish.[3]

Thus, in the short space of eighteen years, the fish hatcheries of the State have been successful in learning how to propagate and raise the channel catfish in sufficient quantities to supply the need for stock fish of this type. This study is an effort to record in written form the data accumulated by the hatcheries and by the writer in their combined efforts to make a success of this enterprise.

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[3] Annual Report of Texas Game, Fish, and Oyster Commission, 1947, p. 32.

CHAPTER II

LIFE HISTORY OF THE CHANNEL CATFISH

In culturing any organism, it is essential that the biologist have a knowledge and understanding of the organism being cultured or propagated. Such knowledge is important in order that a suitable habitat may be provided which will satisfy the needs of the organism in all of the stages of its life history. The purpose of this chapter is to present the life history of the channel catfish as completely as it is known.

Research made by the writer failed to discover any written report of the life history of the channel catfish. The following account of this animal's life history, therefore, is based upon observations made by the writer during his experience in the propagation of this fish in the fish hatcheries of Texas.

Under normal conditions the male catfish prepares the spawning area in a stream bank by fanning his tail until the current which he has generated washes a hole in the side of the bank. However, in fish hatcheries the spawning area is prepared beforehand, and consists most frequently of a pan or keg turned on its side. In any event, once the spawning area has been prepared, the male catfish will attempt to

entice the female catfish into the area. If this gentle persuasion fails, he will take more drastic measures and often bite the female in the region of the caudal peduncle, and the caudal fin.

Spawning activities of the catfish depend largely upon the temperature of the water in which they live. Production records kept by the writer in the north-central area of Texas over a three-year period yield data indicative of water temperatures favorable to fish spawning. In the year of 1951, the channel catfish in the pens at the Lake Dallas hatchery were checked for spawning activities over a period extending from May 17 to July 16. Fifty pens were stocked on April 10, and after May 17 these pens were checked for spawn every two or three days. The observations along with the temperature of the water for the corresponding date were recorded. Table 1 shows these data.

According to the data in Table 1, no spawns were found at a water temperature of less than seventy degrees Farenheit, and at a higher temperature than eighty degrees. The greatest period of activity, as denoted by the number of spawns observed, was on May 22 with a water temperature of seventy-one degrees Farenheit. In a number of instances, no spawns were recorded in the table when the water temperature was favorable to spawning activities, but this may be

TABLE 1

SPAWNING ACTIVITIES OF CHANNEL CATFISH STOCKED IN PENS AT LAKE DALLAS FISH HATCHERY ON APRIL 10, 1951, AND OBSERVED FROM MAY 17 THROUGH JULY 15, 1951

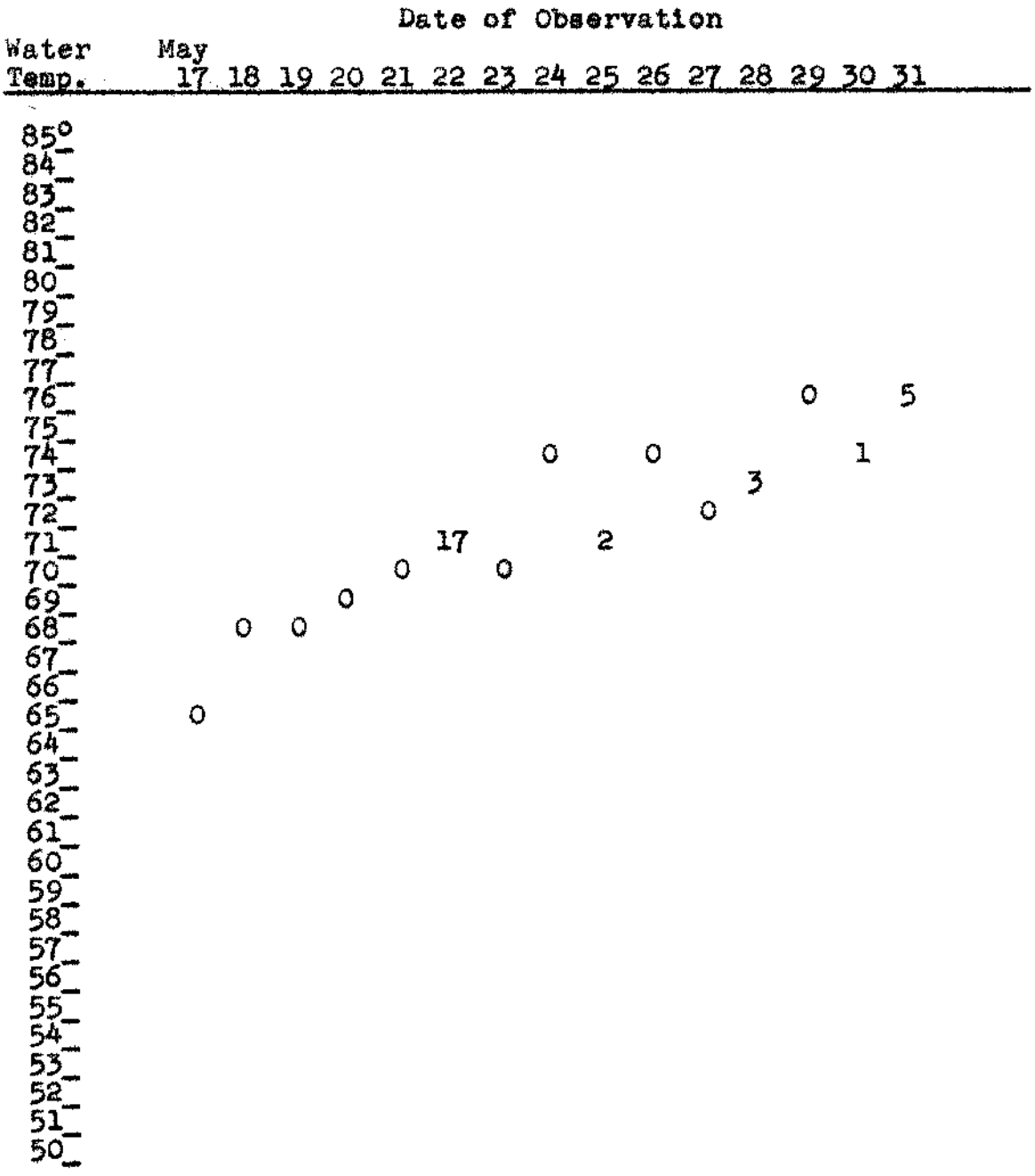

TABLE 1--Continued

Water Temp.	Date of Observation: June 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
85°															
84															
83															
82															
81															
80															
79															
78		0							4				0	0	8
77												7			
76	0							0		0	0				
75															
74			0				4								
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72						0									
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TABLE 1--Continued

Water Temp.	Date of Observation: June 16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
85°															
84															
83															
82															
81															
80		0	2	0	0	0	2	0	0	0	0	0	0	0	1
79															
78	0														
77															
76															
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50															

TABLE 1--Continued

Water Temp.	Date of Observation July 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
85°															
84												0	0	0	0
83															
82											0				
81								0	0	0					
80	0	0	3	0	0	0	0								
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78															
77															
76															
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74															
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ascribed to the fact that the receptacles were not checked every day. At this time, too, fifty pens were in use and the catfish were not re-paired rapidly as the number of spawns needed for the desired production could be obtained without immediate re-pairing in each pen. Thus the number of possible spawns decreased as the season progressed. Some re-pairing was done, however, and sixty spawns were placed in rearing ponds.

The records kept in 1952 show that the ponds were stocked with brood channel catfish on April 25. During May the receptacles were checked every two or three days, but during June and July daily checking was instigated. Data on the water temperatures and number of spawns are shown in Table 2.

As shown in Table 2, spawns were observed at a water temperature of sixty degrees in one instance, and at sixty-four, sixty-five, and sixty-nine degrees in other instances. These temperatures were below the normal starting temperature, but unusually warm temperatures prevailed that spring and the temperature had risen above the seventy-degree mark, and then dropped back to lower levels. Spawning had started before the temperature drop and was not checked altogether by the change to lower temperatures. Fifty-one spawns were taken during the observation period, five of which were found when the water was below the normal temperatures for spawning.

TABLE 2

SPAWNING ACTIVITIES OF CHANNEL CATFISH STOCKED IN PENS AT LAKE DALLAS ON APRIL 25, 1952, AND OBSERVED FROM MAY 1 THROUGH JULY 30, 1952

Water Temp.	Date of Observation: May 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
85°															
84															
83															
82															
81															
80															
79															
78															
77															
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75															
74			0												
73															
72				0	0	0	1								
71															
70								0	0						
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TABLE 2--Continued

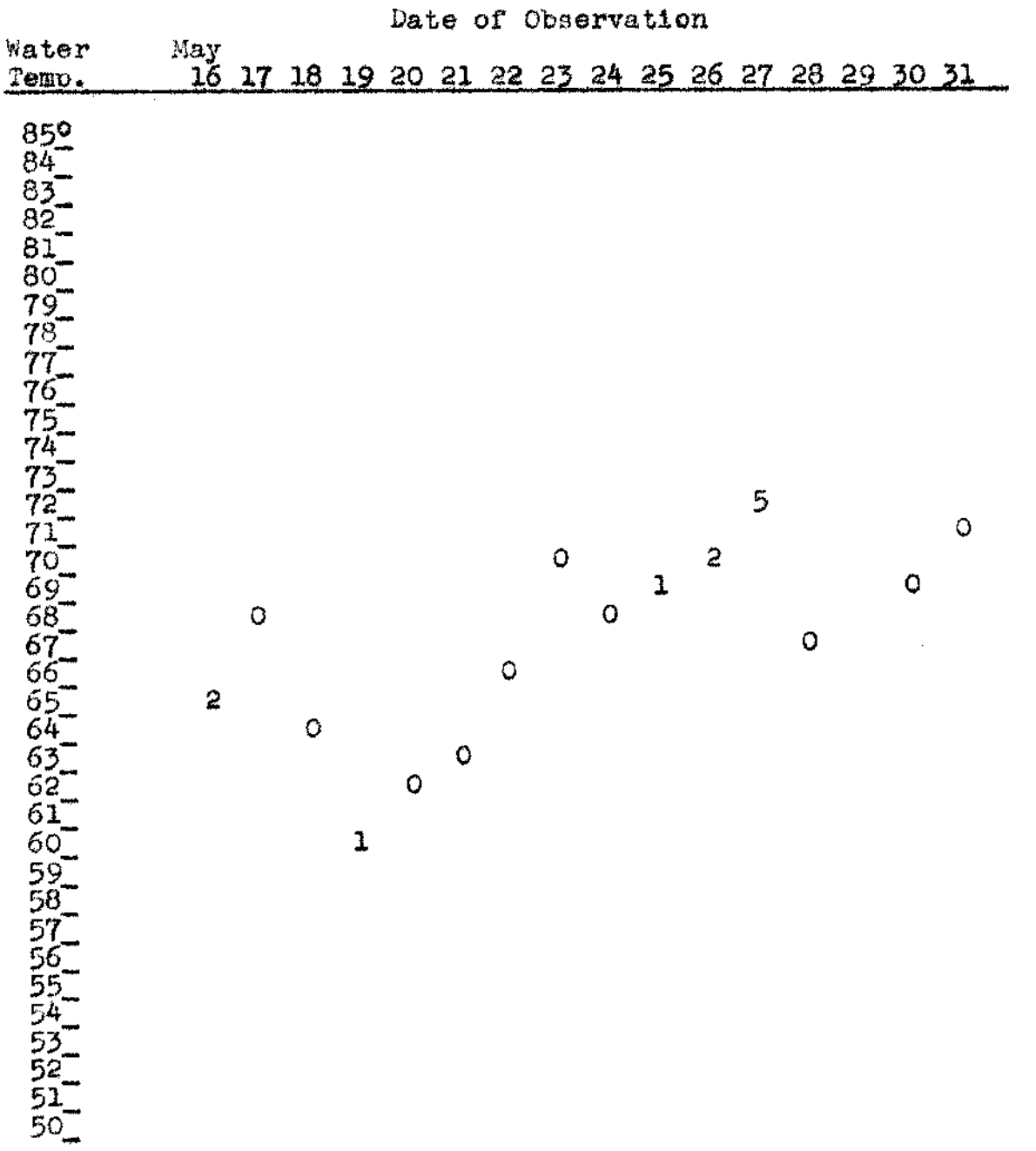

TABLE 2--Continued

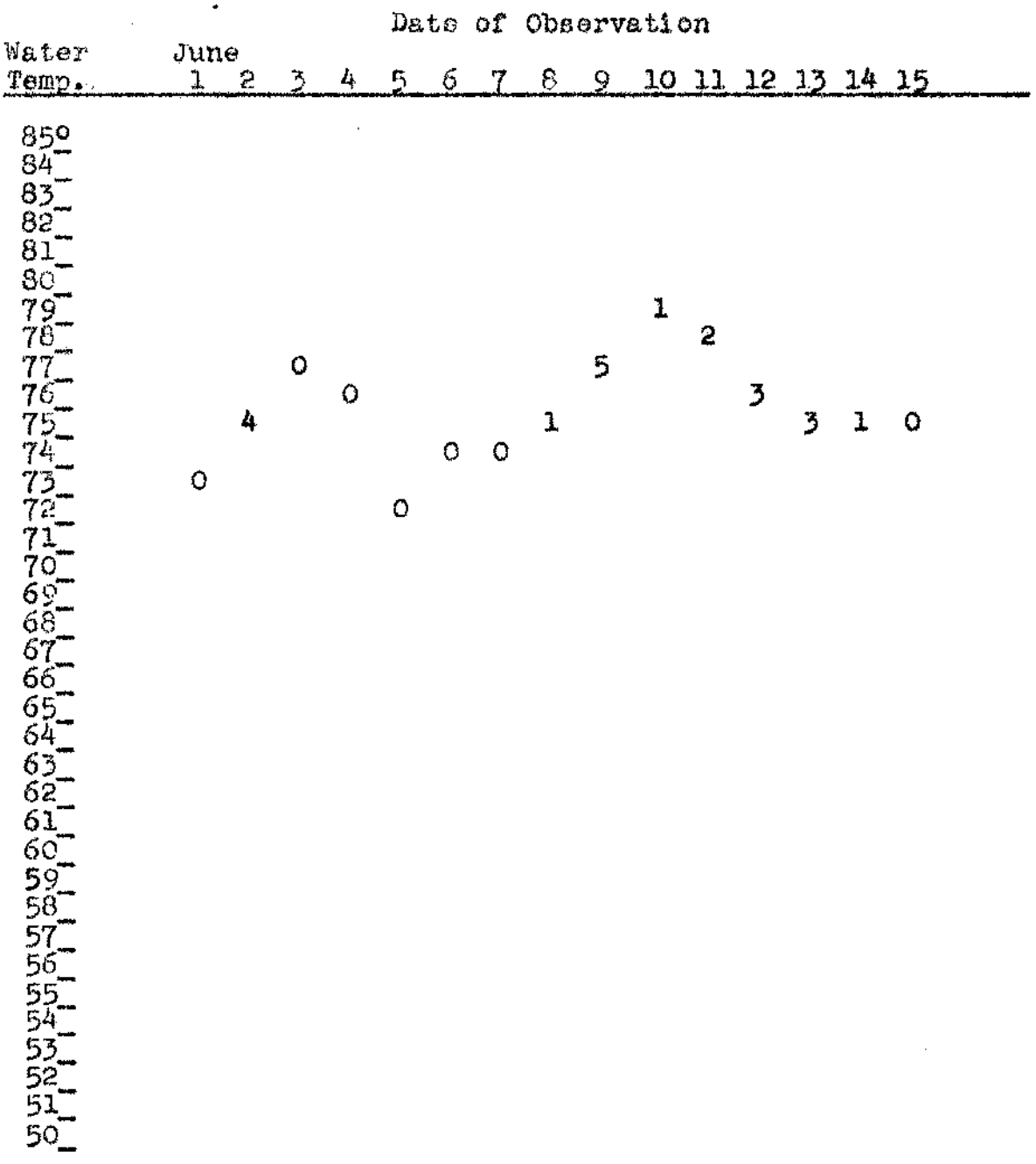

TABLE 2--Continued

Water Temp.	Date of Observation: June 16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
85°															
84															
83															
82															
81															
80														0	
79															0
78			0	0	0							0	2		
77		1													
76						2	0								
75	2														
74								2	2	1	0				
73															
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TABLE 2--Continued

Water Temp.	Date of Observation: July 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
85°															
84															
83															
82															
81															
80					0										
79				0		0								2	
78	3	0	0				0	0				0	0		0
77															
76									0		0				
75										0					
74															
73															
72															
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TABLE 2--Continued

Water Temp.	Date of Observation July 16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
85°															
84															
83															
82															
81															
80															
79															
78			O	O	O	O	O	O	O	O	O	O	O	O	O
77	O														
76		O													
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These data indicate that weather variability may influence time of spawning. However, the data show that no spawns were found after the water temperature had gone above eighty degrees. This was in line with the findings from the observations made in 1951.

In 1953, twenty-five pens of catfish were used in production of catfish. In each instance, the catfish were repaired as soon as possible after the spawn was removed from the pens until late in the season. Stocking of the ponds was not done until May 24 after the water had reached a temperature of seventy degrees. Data on the number of spawns found and the corresponding water temperatures are shown in Table 3.

According to the data in Table 3, the first spawns were found on May 30 at a water temperature of seventy-two degrees. No spawns were found at a lower temperature during the period of observation which lasted from May 24 through July 20, 1953.

Data from these production records indicate a very narrow range of water temperature within which the catfish spawn, extending from seventy to eighty degrees in normal weather conditions. The few spawning activities that occurred at lower temperatures, it is believed, were due to unseasonably warm weather which quickly reverted to cooler weather. During 1951 and 1953 the earliest dates on which spawns were found were May 22, and May 28, respectively. During 1952,

TABLE 3

SPAWNING ACTIVITIES OF CHANNEL CATFISH STOCKED IN PENS AT LAKE DALLAS HATCHERY ON MAY 5, 1953, AND OBSERVED FROM MAY 24 THROUGH JULY 20, 1953

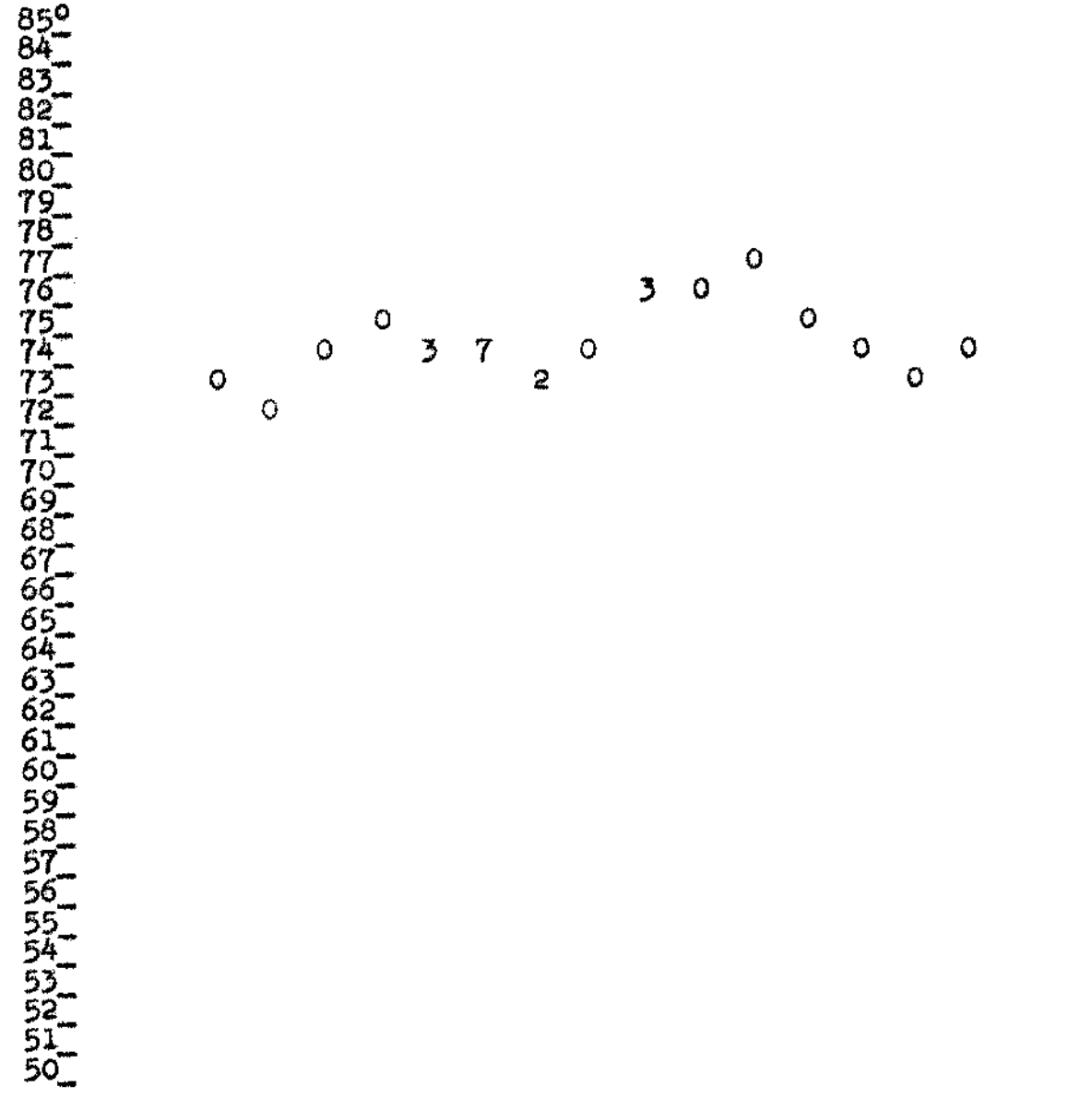

TABLE 3--Continued

Water Temp.	Date of Observation: June 8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
85°															
84															
83															
82															
81															
80					1	0									
79							0				1				
78								3	0	0		1		0	2
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TABLE 3--Continued

Water Temp.	Date of Observation: June 23	24	25	26	27	28	29	30	July 1	2	3	4	5	6
85°														
84														
83														
82														
81														
80				0	1	0								
79	2	0											0	
78			1				1			0	1	0		1
77									0					
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TABLE 3--Continued

Water Temp.	July 7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Date of Observation													
85														
84														
83														
82														
81														
80														
79		0	0	0	0									
78	0													
77												0	0	
76									0	0				1
75						0		1						
74							0				1			
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the earliest date was May 7. These data were secured from observations recorded at the Lake Dallas Fish Hatchery in north-central Texas, and are believed to be representative for this area.

A large number of eggs are produced by one fish. It has been determined that a three-pound catfish will produce approximately four to five thousand eggs in one season, a six-pound catfish will produce approximately twelve to fourteen thousand eggs in one season, and an eight or nine-pound catfish will produce between twenty and twenty-five thousand eggs in one season.[1]

When the female has laid the first layer of eggs, the male passes over these and expels milt, the male germ cells. This procedure is followed until all layers have been stacked on top of one another. During this process, the female catfish may or may not leave the spawning area. In the event that she does, the male will seek her out and escort her back to the spawning area until the spawning is completed. The completed spawn is a hemispherical mass lying at the bottom of the spawning area. Each layer of eggs is firmly attached to the preceding layer because of the gelatinous covering around each egg. The egg mass is firm but resilient to the

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[1]Gerhard Lens, "Propagation of Catfish," Progressive Fish Culturist, Vol. IX (Sept.-Oct.-Nov.-Dec., 1947).

touch. Seemingly, it is very solid, but closer examination reveals that there appear to be small interstices for water circulation throughout the entire mass.

Once the spawning is finished, the male catfish forces the female from the spawning area and at times the battle is terrific. When the battle is decisive, or the female catfish has been removed from the pen, the male will begin his ceaseless vigil of fanning and guarding the eggs.

Very soon after fertilization the eggs show a cephalic development. The incubation period ranges from seven to nine days depending on the water temperature. If the temperature range of the water is between seventy and seventy-two degrees, the period is approximately nine days, and may be eight days where the water temperature is between seventy-two and seventy-four degrees. If the temperature is seventy-five degrees, the eggs will hatch in seven days. At such a temperature, the embryonic development progresses rapidly from the cephalic development and on the fifth day the body of the small catfish can be seen with the unaided eye. On the sixth day the spawn becomes flaccid and the small catfish show definite signs of life by movement in the egg sac. On the seventh day the eggs begin to hatch and within a few minutes from the time the first eggs hatch the last ones have hatched. The process is the same at the lower temperatures, but is slower.

The eggs in the outer layer, the ones last laid and fertilized, are the ones which hatch first, and the eggs in the layer first laid and fertilized are the last ones to hatch. Just exactly how this is accomplished is not known, but it is the opinion of the writer that the layer of eggs on the bottom receives a lesser amount of oxygen than those on the outside and are retarded sufficiently to hatch later than the other layers. Another supposition is that the eggs in the bottom layer remain cooler than the outer layer which is washed with warmer water by the male as he "fans" the eggs.

The catfish fry, the newly-hatched little fish, are one-fourth of an inch long when they are hatched and are transparent except for the cephalic region and the yolk. Within the next four or five days the yolk is absorbed and the catfish fry grow to the length of one inch. At this time their bodies have taken on a blue coloration. They are now ready to place in the rearing ponds for feeding.

The amount of recovery of fingerlings, small catfish ready for stocking purposes, from the rearing ponds depends upon a number of factors. The condition of the water, the extent of insect infestation, and the care and feeding all enter into the final results. Records of the number of fingerlings recovered, the size of the ponds, the amount of feed, and the total pounds of fish produced were kept at the

Lake Dallas Fish Hatchery during 1952 and 1953 and are presented in Table 4 as indicative of expected results in rearing catfish fry to the fingerling stage.

TABLE 4

SIZE OF REARING PONDS, AMOUNT OF FEED, CATFISH FINGERLINGS RECOVERED AND THE TOTAL POUNDS OF FISH PRODUCED AT LAKE DALLAS FISH HATCHERY IN 1952 AND 1953

Number of Pond	Acres of Water	Feed	Number of Recovery	Fish per Pound	Total Pounds
			1952		
17	1.00	1,500	11,200	75	20
18	.91	1,800	42,000	115	149.0
19	1.21	2,300	61,300	125	490.4
20	1.00	2,300	45,000	95	473.7
21	.81	1,900	57,000	130	442.3
41	.88	1,100	28,570	100	285.7
42	.88	1,300	33,000	100	330.0
43	.88	1,300	41,000	90	478.8
44	.88	1,400	21,000	95	210.0
			1953		
41	.88	800	32,300	200	161.5
42	.88	880	41,100	100	410.0

The data in Table 4 show considerable variation in the recovery of fingerlings, the amount of food consumed, the fish per pound and the total number of pounds recovered. These variations were due to a number of factors. The year

of 1952 was an extremely dry one in Texas and the water in Lake Dallas fell to a critically low level. The hatchery water supply failed. Due to this the ponds had to be drained later than normal. The longer feeding time and the contaminated water combined to produce very poor results in some of the pens. In 1953 the water supply was adequate and the catfish fingerlings were harvested at near normal time. The results show a much lower feed consumption and the total pounds of fish produced slightly less. Under normal or average conditions, the recovery of fingerlings should be somewhere near the 1953 returns where 161.5 total pounds of fish were recovered from the use of 800 pounds of feed in .88 of an acre of water.

Necessarily, these tiny fish were kept in a crowded condition from hatching to shipping as the aim of the hatchery is to produce quantities of fish instead of size. This crowded condition retards their growth from the beginning, and after the first rapid growth of the fry into fingerlings, the catfish used to be reduced in numbers if they are to continue to grow at a rapid rate.

The catfish fingerlings are then introduced into the lakes and ponds of the area to be stocked. In a normal pond these fish will grow to be adults within twelve to eighteen months. In a two-acre pond on the farm of Ted Dealy in the Dallas area 1,000 catfish fingerlings were stocked in Odtober, 1940,

and fed. On November 1, 1941, eight catfish were caught whose average weight was 15.6 ounces. By the following spring these fish would be capable of spawning since it has been observed by the writer that one-pound channel catfish are capable of producing spawns.

These data indicate that channel catfish, if they are properly cared for, will develop from fry into fish of desirable weight in little more than one year's time.

CHAPTER III

METHODS OF PROPAGATION AND HANDLING OF THE SOUTHERN SPOTTED CHANNEL CATFISH *ICTALURUS PUNCTATUS*

The purpose of this chapter is to describe methods of propagation and handling of the southern spotted channel catfish. Attention is given to the selection and care of brood stock, propagation techniques, methods of sexing or pairing catfish, and to the care of brood stock before and during spawning.

Selection and Care of Brood Stock

The procurement of adult males and females for propagation purposes frequently poses a difficult problem to the hatchery operator. In order to be assured of a maximum production of young fish, it is important that the brood fish be well-developed and in good physical condition. A channel catfish is in good physical condition when it is well-fleshed and the bony structures of the skeleton not prominent. This flesh is firm to the touch and the fish during the handling necessary for the selection will be vigorous in his actions. In addition the fish should be well-developed sexually. This is determined by the ease with which the male or female characteristics may be distinguished. These characteristics are

described in detail in another section of the study (Figures 1 and 2, pp. 41 and 42). The selected fish must also be capable of maintaining themselves under conditions of captivity. Field experiences have shown that certain native strains do especially well in small impoundments. These catfish are usually found in the small intermittent streams where the conditions of the small impoundments are more nearly duplicated as during part of the year it is a flowing body of water and during the remainder of the year it is a reservoir. As no external characteristic has been described to distinguish those collected from particular streams, the best results have been obtained by constantly culling the least desirable brood fish from the brood stock each year. Those catfish that do not maintain themselves in the hatchery ponds are culled as unfit for production.

Over a period of years, brood stock for propagation has been obtained from such sources as rivers and streams. Generally, there is no preferred method of capturing brood fish used for propagation purposes. Successful captures have been made with fyke nets, trammel nets, and hook and line.

Today, however, enough brood stock exists in the hatchery ponds to permit the shipment of brood stock from one hatchery to another as the need arises. The present brood stock in the hatcheries is composed of adults that are the progeny of several generations of catfish which have been reared in

captivity. Generally, each hatchery of the Texas Game and Fish Commission is capable of producing its own brood fish. Some brood stock is produced in the hatchery each year to replace those catfish which are lost from old age, mishandling, disease, and intra-species competition.

Two methods are employed in the production of brood stock from the crop of fingerlings: (1) those specimens which are larger than the average fingerling are separated and held over for brood stock when they reach maturity; and (2) a group of normal fingerlings are selected and fed for one year and the most desirable specimens of this group are kept for brood stock. Occasionally, hatchery operators find it necessary to procure brood stock directly from streams. This practice is employed only at those times when a sudden, unforeseen depletion of brood stock occurs.

The hatchery operator or those interested in the selection of brood fish should know something about the age span of fish or their natural productive limits in order to know the length of time that a brood fish may be used for reproduction. This information is needed as an indicator when to replenish the brood stock.

In 1947 the writer became interested in finding a method for the determination of the age of the members of the catfish family. The first attempts followed the work of L. A.

Adams, a research worker in Illinois.[1] In an article concerning the age of fish, Adams indicated that the vertebrae could show the age of the catfish. This method called for the sectioning and polishing of the vertebrae. The spine was also indicated as a possible source for age determination.

The main objection to using the vertebrae method of age determination was that it called for the sacrifice of the fish. Study, therefore, was concentrated upon examination of the spines of living catfish. The use of the vertebrae method, however, was not completely abandoned, and upon publication of an article by William M. Lewis[2] in studying vertebrae without sectioning renewed attention was directed to this method. In an experiment with bullheads (Ameiurus melas) in the Lake Dallas area, the accessory marks described by Lewis were found to be too difficult to distinguish from the true annuli to give an accurate indication of the age of the catfish.

In the study of the spines of fish, experiments were conducted with channel catfish taken from experimental ponds at the state fish hatchery at Lake Dallas, Texas. In this

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[1] L. A. Adams, "Determination of the Age of Fishes," reprinted from the Transactions of the Illinois State Academy of Science, Vol. XXIII, No. 3 (March, 1931).

[2] William M. Lewis, "The Use of Vertebrae as Indicators of the Age of the Northern Black Bullhead," reprinted from Iowa State College Journal of Science, Vol. XXIII, No. 2 (January, 1949), pp. 209-218.

way it was possible to select fish that were known to be one, two, or three years old, respectively.

The pectoral spines of the channel catfish were first cut into saggital sections. This was done to determine the region of greatest accuracy for reading the annulus formation. This work indicated that a section near the base of the spine is best for this purpose. The spines were then cross-sectioned from the base to the tip as a further determination of the most ideal region for reading the annulus. Again the base of the spine was indicated as the more accurate region to be employed. This method also presents an opportunity to remove the spine from the catfish and leave the specimen alive for future reference.

The equipment used to section the spines was a small, circular jeweler's saw. This saw had very fine teeth and left a smooth cut that did not require hand polishing. By using a table for the saw, it was possible to cut the section to the desired thickness. The saw used in this experiment was powered by a 1/20 horsepower electric motor with a standard $\frac{1}{4}$ inch hand-tightened chuck for mounting the saw mandrel. The sander mandrel was also used in the same chuck for the grinding. Discs were cut from the regular sheets of emery cloth by a cork borer. Later, it was found that a small grinding wheel gave better results than the sander discs. The grinding was done to bring the sections to the required thickness.

When the sections were first cut they were cemented to a glass slide with clear fingernail polish. This held the sections sufficiently firm so that grinding could be easily accomplished without damage to the section. With occasional checking under a wide-field vision binocular microscope, the thickness of the section could be better prepared than by grinding all of the sections to the same thickness. After the grinding was completed, the section and slide was washed in acetone alcohol. This removed the fingernail polish that had caught the dust from grinding the sections, but did not remove the section from the slide.

Plate 1 is a photograph of the bone section as ground from a catfish that was known to be three years old. This section was taken from the spine in the joint attaching it to the pectoral girdle. The third ring as shown is just being laid down. The clear rings are considered the annual rings laid down during the season of least growth. The wider and more opaque areas are bone formations which are laid down during the time of more rapid growth.[3]

This method of using the cross section of the pectoral spines for age determination of channel catfish age was used in experiments made by Kermit E. Sneed.[4] A correlation factor

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[3]Adams, op. cit.

[4]Kermit E. Sneed, "A Method for Calculating the Growth of the Channel Catfish Ictalurus Lacustris Punctatus," reprinted from Transactions of the American Fisheries Society, Vol. LXXX (1951), p. 36.

Plate 1--Photograph of the bone section as ground from a catfish known to be three years old.

of 0.969 was found in the use of the cross section in determining age of the channel catfish. This is a relatively high degree of correlation and is in line with the experiment conducted by the writer in his study of the age of channel catfish through a study of pectoral spines.

By the use of this method, a study was made of the ages of fish that died in one of the ponds at the Lake Dallas Fish Hatchery during the summer of 1953. The summer period was chosen because it is at this time when the greatest number of fish are found dead. This is possibly due to the fact that in the winter the dead fish seldom float to the top of the water. This statement is made from the observation that the numbers of fish placed in the holding ponds and the dead counted floating do not add up to the numbers taken from the pond upon draining.

The total number of fish placed in the pond under observation was 175. Thirteen dead fish were taken from the pond and study made of their age through the spine method. The possible age groups were divided into nine. No distinction was made between the fish that died of old age and those that died from disease or injury. From the point of view of necessary replacement of brood stock, this distinction was not necessary. Data in Table 5 show the possible age groups and the number of dead fish that were found in each group.

TABLE 5

AGE GROUPS OF THIRTEEN FISH THAT DIED FROM VARIOUS CAUSES AS DETERMINED BY STUDY OF THEIR PECTORAL SPINES AT LAKE DALLAS FISH HATCHERY IN 1953

Age Group	Number of Fish
I	0
II	0
III	3
IV	2
V	4
VI	3
VII	1

The average age of death of the channel catfish from all causes was found to be 4.77. The active productive life of the channel catfish in the Lake Dallas Fish Hatchery, when based on these findings, is believed by the writer to be near three years. By replacing a few each year the brood stock can be maintained at the desired level. The oldest specimen examined by the writer was from the Tyler hatchery; it had attained eleven years of age. Possibly the channel catfish may live for longer periods of time in natural waters.

In the care and feeding of the brood catfish and the rearing of fingerling catfish for brood stock, knowledge is needed of the natural food of these fish. The writer was unable to find any reference to the natural food habits of the Southern spotted channel catfish in the literature in the field. It is believed, however, that information on the food habits of any of the catfish family would be

indicative of similar food habits of the others. A stomach analysis, therefore, was made of one hundred and fifty-two yellow bullhead catfish, Ameiurus natalis (Rafinesque). Data in Table 6 show the type of food found in the stomachs of the fish and the percentages of each type.

TABLE 6

TYPE AND PERCENTAGES OF FOOD IN THE STOMACHS OF ONE HUNDRED AND FIFTY-TWO YELLOW BULLHEAD CATFISH AT THE LAKE DALLAS FISH HATCHERY

Type of Stomach Content	Percentage
Fish	72.97
Debris	12.13
Insects	8.05
Higher plants	3.78
Nematodes	1.84
Algae	.73
Sand	.43

Minute quantities of crustaceans, spiders, crayfish, mollusks, snail, and grape seed were also found. This information would indicate that the normal diet of the catfish is meat. This corresponds with results shown in the feeding of the brood catfish at the Lake Dallas hatchery. The higher protein diet has been found by the writer to result in better fish conditioning. Oatmeal used as a supplementary diet with the higher protein food has also been found to give good results when fed to the brood stock in the spawning pens.

Methods of Sexing or Pairing Broodfish

The female catfish has a more slender head than the male of the same body length, but as the catfish grow older and larger this difference is less noticeable. This characteristic, however, is useful in that experienced hatchery personnel can often pair the brood fish in this manner with 100 per cent accuracy. Fullness in the abdominal region does not necessarily denote the presence of eggs as the male will often have enough stored fat to be confusing.

A more accurate method of pairing brood catfish is the examination of the urogenital openings. While handling the catfish for the close scrutiny necessary, the catfish is grasped firmly around the caudal peduncle. This induces temporary paralysis as long as the grip is maintained and allows the handling to be gentle and non-injurious to the fish.

As shown in Figures 1 and 2, the urogenital opening of the female is round, smooth, and possibly slightly raised above the surrounding area, whereas the urogenital opening of the male is oblong and protrudes. If the protrusion is not definite enough for conclusions, a broomstraw moved back and forth across the opening from anterior to posterior will hang on the male. If further doubt exists, the broomstraw may be inserted gently into the urogenital opening. The opening of the male enters at an

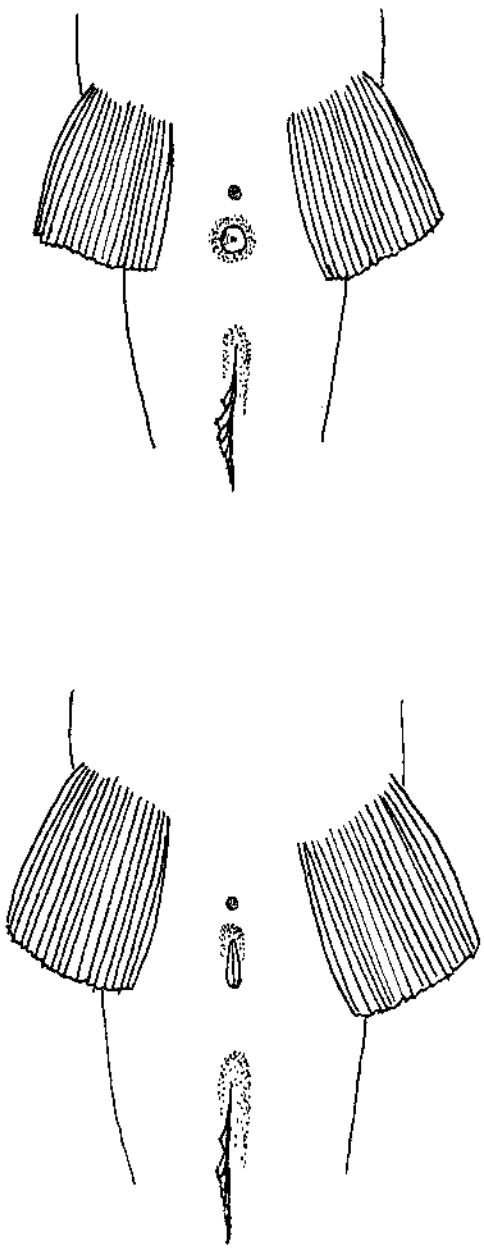

Fig. 1--Ventral view of male and female fish showing urogenital openings.

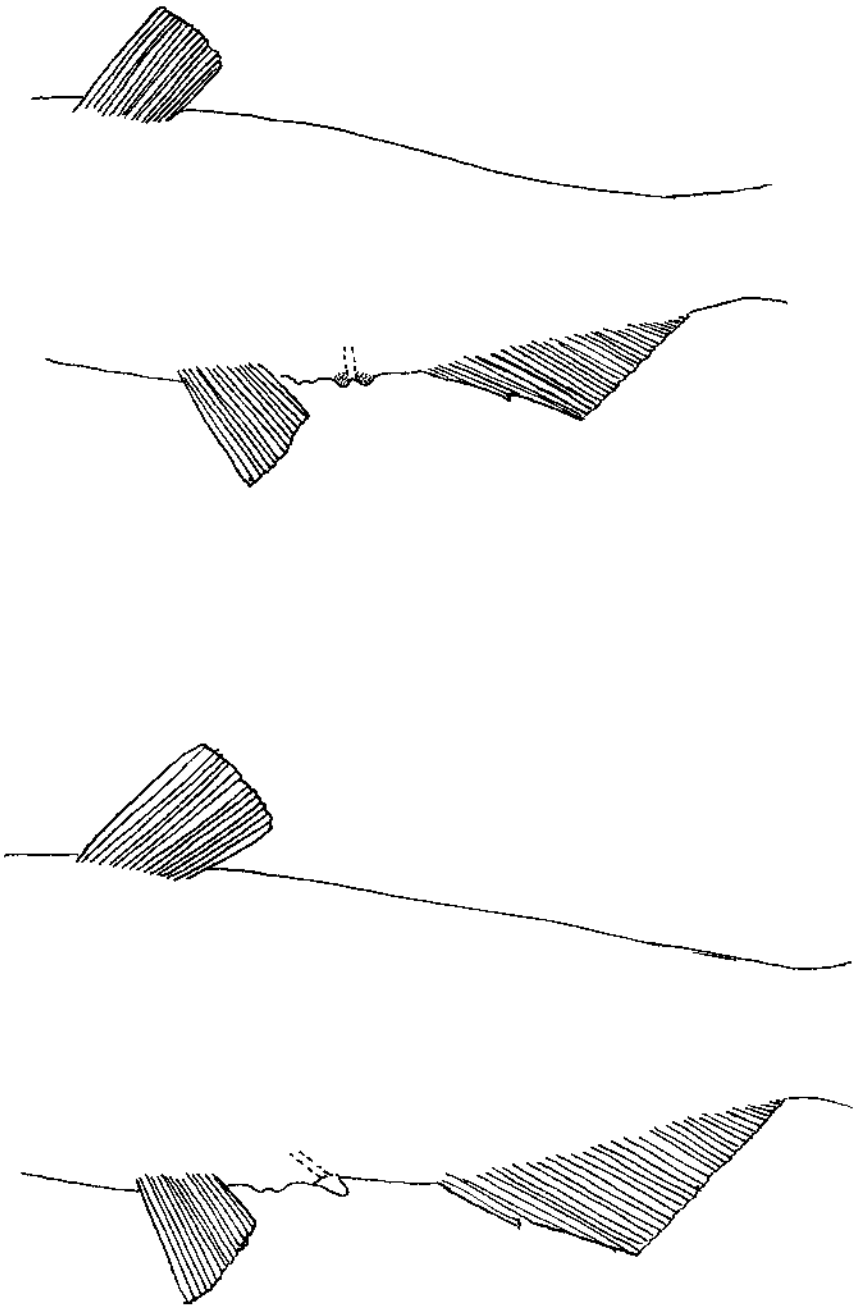

Fig. 2--Side view of male and female catfish showing urogenital openings.

angle from the caudal region while the female enters perpendicular to the ventral side. Naturally this procedure involves a certain amount of danger to the fish and should be employed only when identification by all other means fails.

Since the female will eat the spawn if it is possible for her to do so, it is advisable that the male be the larger of the two fish in the pen. However, a smaller male is often able to control a larger female. Occasionally one or both of the catfish are killed while the male is protecting the spawn from being devoured by the female. This situation can be alleviated by the removal of the female from the pen as soon as the spawn has been observed. Occasionally, the initial battle has occurred before the spawn has been found even though the jars are checked for spawns each day. The removal of the female will stop what would otherwise continue as a running battle.

When the catfish are spawned in an open pond, there is no chance to remove the female. The practice in this instance is to remove the spawn from the receptacle or the receptacle and the spawn are removed from the pond.[5] The spawn thus removed from the care of the male catfish is then placed in running water alone or in combination with some mechanical device to agitate the water in a manner similar

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[5]H. L. Canfield, "Artificial Propagation of Those Channel Catfish," Progressive Fish Culturist, Vol. IX (Jan.-Feb.-March-April, 1947), p. 127.

to the action of the male catfish during the incubation period. It is thought that the female eats the spawn due to the lack of sufficient food of a high protein diet as the female seldom eats the spawn if fed well and regularly.

Care of Brood Stock before and during Spawning

If the brood stock are not maintained in excellent condition through the spring, they frequently reabsorb their eggs or sperm and consequently will not serve in the capacity for which they are intended. The male, in particular, must have ample quantities of stored fat since he does not feed during the incubation nor directly after the hatching of the eggs.

After the brood stock have been paired and placed in the pond or pens, they will not be ready for spawning until they have become acquainted with their new surroundings and recover from the handling. After the third day the receptacles should be checked regularly for evidence of spawning activities.

The first indication that the catfish are preparing to spawn is that the earth in front of the jar is firm. This is caused by the activities of the male catfish in cleaning the silt from the spawning area. The receptacle is also thoroughly cleaned because collections of silt will inhibit incubation or destroy the spawn entirely.

Some hatchery men check the receptacles every other day in order to disturb the fish less. Daily checking, however, reduces the chance of the female devouring the spawn before she can be removed from the pen. The checking procedure consists of removing the male from the receptacle and checking for the spawn. Several methods are employed in removing the male catfish from the receptacles. One method consists of inserting a short length of rubber hose into the mouth of the receptacle. The male catfish will usually grasp the hose in his mouth and can be pulled from the receptacle. If the catfish refuses to grasp the hose or releases it before he can be pulled from the receptacle, the hose can be pushed past the head of the fish and used to touch him on the caudal region. The fish reacts to this stimulus by swimming out of the receptacle. The receptacle can then be checked for a spawn with the bare hand.

Another means of protection for the hatchery personnel is the use of a heavy glove. The glove must be removed before checking for the spawn since the eggs cannot be felt through heavy leather, cotton, or rubber. A third means is to use a heavy woolen sock drawn over the hand and forearm. The toe of the sock is left dangling below the finger tips to act as a decoy for the catfish. As the spawn can be felt through the sock without damaging it, the hand and forearm are protected if the catfish decides to return

before the checking has been finished. An experienced hatchery man may use no device for protection with little danger of being bitten by the catfish. In using the bare hand, the hand is moved into the mouth of the receptacle, fingers extended together, palm up, and in contact with the top side of the receptacle. As long as the hand is kept flat against the receptacle, the catfish cannot take it into his mouth. In this way the hand can be extended far enough into the receptacle to touch the catfish on the caudal region and cause him to leave the receptacle.

If the open pond method is used, the spawn or the spawn and receptacle is removed. If the pen method is used, the female may or may not be removed. If the female is not removed then each pen must be fed regularly to insure that the female does not have the added incentive of hunger to devour the spawn.

After the proper time for hatching has elapsed, the receptacle is again checked to see if the spawn has hatched. When the spawn has hatched it is removed from the pen with its receptacle. After about five days the small catfish fry are ready to be placed in the ponds for rearing to the stage of fingerlings ready for stocking purposes.

Propagation Techniques

Open-pond method.--Methods of handling the brood stock and collecting the spawn vary in different hatcheries. In

certain hatcheries the catfish are introduced into open ponds containing submerged receptacles which receive the spawn or mass of fertilized eggs which are produced by the male and female catfish. This procedure is known as the open-pond method. This method is characterized by the fact that the catfish are permitted to choose their own mates from within the group introduced into the pond. The chief advantages of this method lie in the fact that the pond requires little preparation before receiving the catfish. The receptacles for the spawns are placed in the dry pond in the proper positions and the pond filled until the water level is between twelve and eighteen inches above the top of the receptacle. These receptacles used may be jars, cans, or kegs.[6]

The cans commonly used are the wide-mouthed, ten-gallon milk cans. These cans have a hole punched or drilled at the highest point of the can and that side is placed uppermost to permit the air to escape.when the pond is filled with water. The common nail keg is also used since it may be obtained at less expense and will ordinarily last longer than milk cans.[7] Since the kegs are made of wood, they must be anchored in some appropriate manner. This can be done by

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[6]George A. Morris, "Lives of Gus and Gertie," Missouri Conservationist (March, 1950), p. 32.

[7]Lens Gerhard, "Propagation of Catfish," Progressive Fish Culturist, Vol. IX (Jan.-Feb.-March-April, 1947), pp. 231-233.

attaching them to stakes driven into the earthen bottom of the pond or by pouring a layer of concrete in one side of the nail keg. In the Texas State fish hatcheries a crock jar is commonly used in catfish propagation. The jars are illustrated in Figure 3 on the following page. As shown they have the following specifications: height, twenty-two inches; body diameter, fourteen inches; and mouth diameter, eight inches. Apertures are placed near the top of the jars and these also serve as handles.[8]

The open pond techniques of catfish production may be adapted to any pond which will support fish life. The restrictions which must be observed are: (1) use of proper number of receptacles for the pairs of brood fish used, and (2) correlating the size of the pond with the number of brood catfish placed in it.[9]

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[8]Marion Toole, "Propagation of Channel Catfish," Texas Game and Fish (March, 1951), p. 14.

[9]Canfield, "Artificial Propagation of Those Channel Catfish," Progressive Fish Culturist, Vol. IX (Jan.-Feb.-March-April, 1947), p. 127.

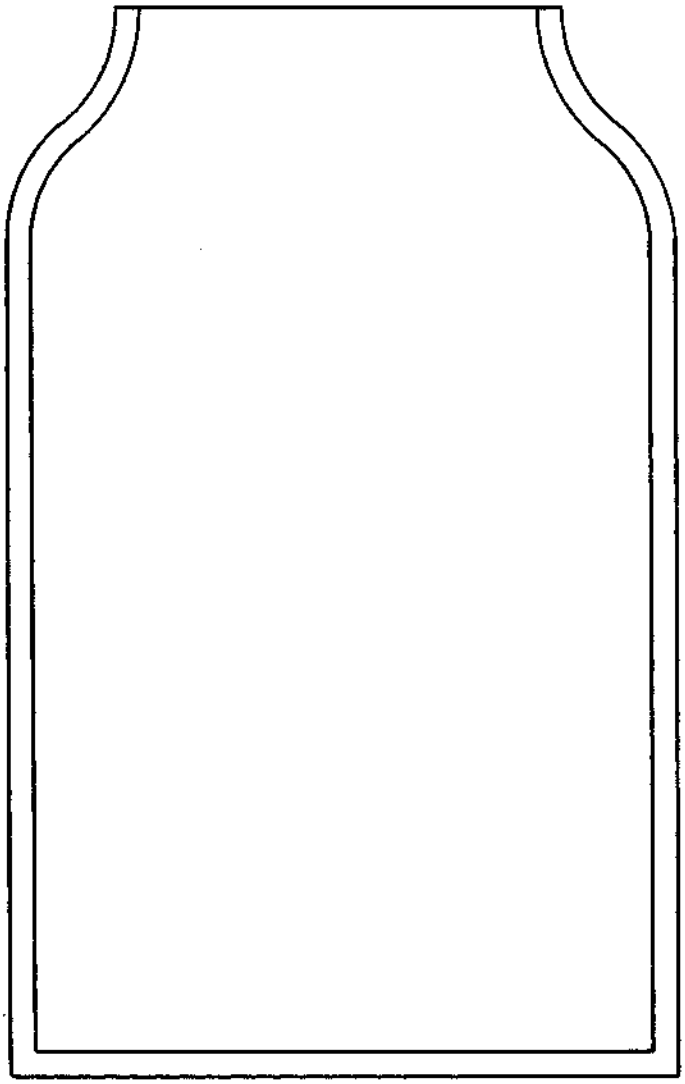

Fig. 3--Crock jar used in spawning

Pen method of propagating catfish.--The second procedure sometimes used in propagating channel catfish is known as the pen method. It is differentiated from the open pond method in that selected pairs of brood fish are placed in enclosures, or small pens, which separate them from the remainder of the pond and other pairs of brood fish. In the pen method of spawning, the pens must extend far enough out into the pond so that the jars will be from twelve to eighteen inches below the surface of the water. The jar should face the open water rather than the bank of the pond, and should be slightly elevated so as to permit the air to escape from the jars through the apertures for that purpose. There should be enough space on either side and in front of the jar to permit hatchery personnel to work. The width of the pen may vary with the working space desired; however, less than six feet is usually inappropriate. Figure 4 on the following page illustrates the end view of such a pen.

The pen construction is composed of wire fencing or wood. In the event wood is used, as illustrated in Figure 4, a picket-type fence should be used with the pickets spaced sufficiently far apart to just retain the catfish in the pens. The wider the space between the pickets, the better access of the wind action to the water in the pens. In either case the construction of the pen should extend into the bottom of the pond to the depth of twelve inches and

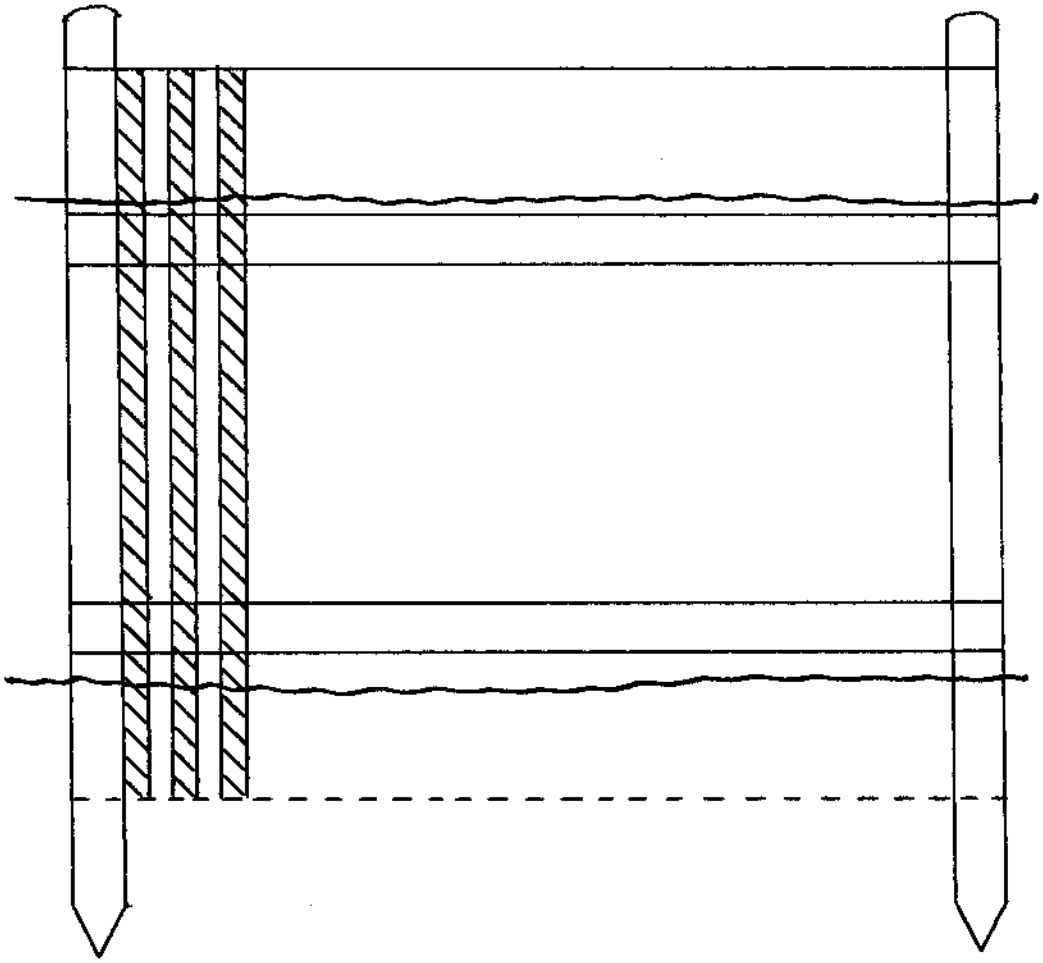

Fig. 4--End view of a pen enclosure for brood channel catfish.

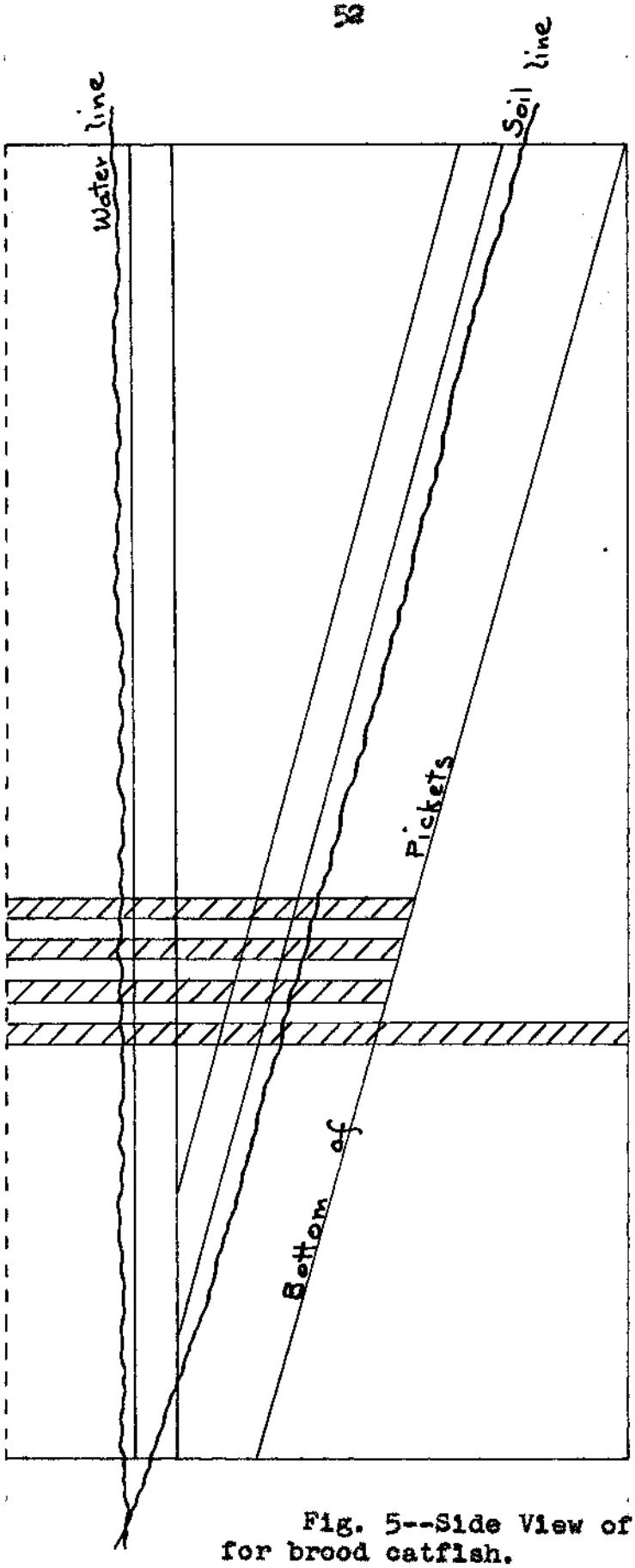

Fig. 5--Side View of a pen enclosure for brood catfish.

above the water to the same extent as is shown in the preceding Figure 5. This will prevent the fish from burrowing under the fence or jumping over as they may be inclined to do. Each pen is numbered so that accurate records may be kept on the spawning activities.

The ponds used in the pen method must be large enough to support the total number of brood stock needed in the pens at any one time. Even though the pens themselves may actually occupy only a small portion of the pond, hatchery men have found that a certain area-volume relationship must be maintained in order to carry on successful propagation. The chief advantage in using the pen method is that (1) better yields of fingerlings are obtained from the same number of brood stock, and (2) the hatchery personnel have control over the spawning process of the catfish.

As each pen is used for more than one pair of catfish, there are more brood fish than can be used at one time. This gives the opportunity of selecting those that are ready for immediate spawning and for the others to remain in the pond for further feeding and later spawning.

Attention in this chapter has mainly been centered on the selection and care of brood fish and propagation techniques. In the next chapter detailed attention is given to the care of the catfish fry after they have been successfully propagated.

CHAPTER IV

CARE OF THE CATFISH FRY

Attention is given in the present chapter to the care of the catfish fry after they have been removed from the brood pens, the recommended number to be stocked per acre of water, and the kind and amount of feed to be given.

Care of the Fry

In the event the receptacle has been left in the pen or pond for the male catfish to care for the spawn, the receptacle and the catfish fry are removed as soon as the spawn has been hatched. From here they may be either stocked directly into the rearing ponds or they may be taken to holding troughs for the length of time necessary for them to absorb the yolk or even longer if such a need arises. Where the spawn is hatched in the troughs, the fry are sometimes held and fed in the troughs for two or three weeks.[1] The growth of these small catfish, however, is very rapid at this period and by the time the yolk has disappeared, they can well fend for themselves.

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[1]Canfield, "Artificial Propagation of Those Channel Catfish," Progressive Fish Culturist, Vol. IX (Jan.-Feb.-March-April, 1947), p. 127.

These fry can be stocked at the rate of 100,000 per acre of water, but at this high rate the waste products of the small catfish will pollute the water enough to endanger the lives of the catfish fry. The larger amounts of feed that will be required will also be another source of contamination. For rapid and relatively trouble-free growth, 75,000 catfish fry or less are stocked to each surface acre of water. The pond should not be filled with water until the day the catfish fry are to be placed in it. This eliminates the immediate danger of dragonfly nymphs which prey upon the catfish fry as some time is required for the dragonfly eggs to be laid, hatched, and developed into nymphs. The catfish fry, since they are the small fish of a spawn or spawns that feed and act as a group showing no tendency of leaving the group to feed and act as individuals, are particularly vulnerable to attack by these dragonfly nymphs. An entire hatch can be destroyed in a short time.

After stocking, the fry are fed on a high protein diet that has been ground into fine enough particles so that they may ingest it with no trouble. For this feed, ground beef heart is excellent although it is expensive. Beef and hog livers that have been rejected as unfit for human consumption have also been used. This food, however, is believed to have been the cause of loss in the catfish fry where it has been used. In one pond the loss was 85 per cent and other ponds showed a loss of 5 per cent and a continuing loss before

alterations were made. When the diet was changed, the loss stopped. In the Texas state fish hatcheries, ground, dehydrated meat scraps with most of the fat removed are used for feeding the catfish fry. This gives excellent results and is much less expensive than beef hearts or beef and hog livers.

When first placed in the rearing ponds, the catfish fry can consume very little food, but they should be fed regularly although lightly. The food is scattered around the edge of the pond in the shallow water. As the catfish fry move and feed around the pond, they encounter this food on the bottom of the pond. In a very short time they have learned to search for the food and later they learn that a truck driving slowly by the pond followed by a splash means that the food is available to them. At this stage of development they will follow the truck and wait for the food. After they have learned to come for their feed, they will begin feeding on the surface of the water. From this time on they can be easily observed. This top feeding occurs within three to four weeks after they have been introduced into the rearing pond. While they feed on the surface of the pond the catfish fry can be seen moving to the feeding area from all regions of the pool.

The feeding starts with about two or three pounds of meat scraps daily and is increased continuously until the catfish are harvested. In a heavily stocked pond, the

feeding will increase to twenty pounds daily at the end of a three-month feeding period at which time the small catfish may attain a length of three inches. If larger fish are desired in the same length feeding period, the rate of stocking should be less. At the end of the three-month feeding period the catfish fry are ready for stocking in the various ponds, lakes, and streams of the area.

Care of the Fingerlings

Fingerlings, at the end of the three-month feeding period, are stocked by the Texas Game and Fish Commission at the rate of seventy-five to each surface acre if stocked alone, or at the rate of fifty to the acre if stocked with other fish. In an average pond in the north-central Texas area, these fingerling catfish can be expected to reach the weight of one pound twelve months after they have been introduced into the pond or lake. If the lake owner is willing, he can produce a much greater growth in the same length of time by supplementary feeding. As an illustration of what is possible, results obtained from the Ted Dealey farm near Roanoke, Texas, are summarized below. A pond of two surface acres on the Dealey farm was stocked with channel catfish at the rate of seventy-five per acre in October, 1940. On November 1, 1941, an incomplete harvest yielded the following fish:

1 Blue-channel catfish weighing one pound eight ounces.

1 Southern spotted channel catfish weighing eight ounces.

3 Southern spotted channel catfish weighing fourteen ounces.

2 Southern spotted channel catfish weighing fifteen ounces.

1 Southern spotted channel catfish weighing thirteen ounces.

1 Southern spotted channel catfish weighing ten ounces.

The combined weight of the nine fish was five pounds eight ounces. This fish harvest is indicative of what may be expected under favorable growth conditions for the spotted channel catfish and other types.

In the selection of feed for the fingerlings, the pond owner should use the food most readily available for him. Cotton seed cake, hog supplement pellets, corn, oats, wheat or stale bread will all give good results, but it has been found that the higher protein content will yield the best results. With the daily feeding of hog supplement, one pond owner was able to catch a three-pound catfish from his tank twelve months after it was stocked at the rate of seventy-five per acre. The channel catfish feeds well in the colder weather and does not seem to be affected as much as the scale fish by the cooler water slowing their metabolism. The channel catfish also feeds very well in the hottest part of the summer. The supplementary feeding provides food in the

winter when the natural food is at the lowest point of the food cycle, and also provides more food than the pond could produce in the summer.

Production records of channel catfish at the Lake Dallas Fish Hatchery illustrate the possibilities of raising fingerling catfish to sizes favorable for use. On December 5, 1943, Hatchery pond No. 21 with a surface area of .81 of an acre was stocked with 800 Southern spotted channel catfish fingerlings from two to six inches in length. This pond was not fed. At the end of one year, fifteen catfish exceeding eight inches in length and with a combined weight of 25.1 pounds were harvested. Six hundred and ten catfish less than eight inches in length with a total weight of 410 pounds were also taken. Of the 800 original stock, 625 catfish with a combined weight of 435.1 pounds were recovered. This pond was very fertile from previous heavy feeding in preceding years.

Pond No. 21 with a surface area of .81 of an acre was stocked with different varieties of fish on October 5, 1940, as follows:

500 Southern spotted channel catfish, Ictalurus punctatus

100 Southern channel catfish, bob-tail variety

175 Black Crappie, Pomoxis nigro maculatus

200 Green Sunfish, Lepomis cyanellus

150 Texas Golden Shiner minnows, Notemigonus crysoleucas

These fish were fed. Data in Table 7 show the type of feed, the amount, and times of feeding for one year.

TABLE 7

TYPE OF FOOD FED FISH IN POND NO. 21 AT LAKE DALLAS FISH HATCHERY, AMOUNT OF FEED FED, AND TIME OF FEEDING FOR ONE YEAR

Time of Feeding	Type of Food and Amount Fed		
	Meat Scraps	Stale Bread	Beef Heart
October	60 lbs.	.....	.....
November	60 "	.....	.....
December	20 "	.....	.....
January	20 "	.....	.....
February	20 "	.....	.....
March	20 "	.....	8 lbs.
April	60 "	.....	8 "
May	110 "	.....	12 "
June	150 "	30 lbs.	15 "
July	140 "	100 "	15 "
August	100 "	100 "	15 "
September	100 "	.....	10 "
October	100 "	.....	15 "
Total	960 lbs.	230 lbs.	98 lbs.

As shown in the data in Table 7, a total of 960 pounds of meat scraps, 230 pounds of bread, and 98 pounds of beef heart were fed the 1,125 fish in the pond, 600 of which were some variety of channel catfish. Records kept by hatchery personnel show that at the end of the year, 373 channel catfish with an average weight of 1.52 pounds, and a total weight of 566.96 pounds were recovered. All other fish had a total weight of 854 pounds.

At the time this experiment was executed, in 1940, the feed prices were lower than at the present time, but the prices that could be expected for the produce were lower. At the present price of $5.00 for 100 pounds of meat scrap,

the total cost of the 960 pounds fed the fish in Pond 21 would be $48.30. The present price for beef hearts is twenty cents per pound, and the ninety-eight pounds used in the experiment would cost $19.60. Stale bread sells at the price of five cents per pound loaf. At this price the total cost of the 230 pounds of bread would be $11.50. The total cost of all the feed would be $79.40. With a total production of 566.96 pounds of channel catfish at the present price of fifty cents per pound, a total of $283.48 can be expected as a return.

Labor costs and the use of a truck for feeding also are factors in the cost of producing the fish. The frequency of feeding was once a week in December, January, and February. During the remainder of the year the feeding was twice each week. For the meat scraps, ten minutes is a sufficient time for the operation. Preparation and feeding of the beef hearts take slightly longer. The beef hearts were fed from once to twice each month. Allowing thirty minutes for feeding and preparing beef hearts, and ten minutes for feeding stale bread and the meat scraps, the total time adds up to 18.5 hours. At a cost for labor of $1.00 per hour, the cost would be $18.50. The expected use of a truck at the cost of seven cents per mile on one-half mile basis gives a cost for the year of $31.85.

Costs and profits of the operation may now be figured. The total cash return as figured was $283.48 while the total expense account including feed, labor, and use of a truck was $129.75. The net profit would be $153.73. Considering the small amount of labor-time required, this return is especially good when one thinks that only .81 acres of water were used in this production.

Other production records kept at the Lake Dallas hatchery give validity to the foregoing experiment. On September 9, 1949, one surface acre, Pond No. 14, was stocked with 2,000 channel catfish fingerlings. These fish were fed a total amount of 4,850 pounds of meat scrap from March, 1950, to December 21, 1950. At this time the pond was drained and 896 channel catfish weighing a total of 378.75 pounds were recovered. The average weight of the catfish was .422 pounds.

On November 1, 1945, 1000 catfish fingerlings were stocked in Hatchery Pond No. 51, which had an area of 1.26 acres. In a period covering a year's time, the fish were fed 3,268 pounds of feed. Five hundred and thirty-three catfish, with an average weight of 5.75 ounces, were recovered. The total weight of the catfish recovered was 191.54 pounds. Other fish came into the pond from the water supply and a total weight slightly over 900 pounds was recovered from rough fish.

Observations by the writer indicate that the Southern spotted channel catfish can be expected to arrive at maturity

within eighteen months after they are hatched. Consequently they should be harvested during the first year so that over-population will not occur. It will also be noted that the channel catfish can be fed a supplement to its normal diet and can be profitable produced as a meat supply. However, this practice is not without hazards as shown by results of feeding and low production of catfish in Pond No. 51.

The presence of the numerous ponds and lakes on the farms of Texas and the availability of catfish fingerlings from the fish hatcheries of Texas present the possibility to the farmer and the stockmen not only for raising their own supply of fish but for developing a new type of farm return from a hitherto unrecognized source.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The following findings may be used as a summary of the study:

1. The propagation and rearing of the channel catfish in Texas fish hatcheries has been largely on a trial-and-error basis; comparatively few data on raising the channel catfish have been available for use.

2. Before the 1930's, little effort had been made to propagate catfish fingerlings for stocking purposes; the chief cause of this was lack of demand for such stock fish and a belief that they could not be successfully raised in quantities sufficient for stocking.

3. The Kerrville Fish Hatchery pioneered the way in Texas in raising channel catfish for stocking purposes, but the operators of the Dallas and Lake Dallas fish hatcheries are due much credit for the development of successful propagation of channel catfish for stocking purposes.

4. The work of the Soil Conservation Commission has been influential in promoting farm lakes and ponds, thereby increasing the demand for the channel catfish fingerlings, fish that can be easily caught on a line and pole.

5. No data on the life history of the channel catfish were found in the research; information obtained by the writer through field data reveal that the catfish spawn in north-central Texas in May, June, and July within a water temperature range of seventy to eighty degrees, Farenheit, in seasonal weather for this area. The spawn are deposited along banks in the streams and in receptacles in pens or ponds at the fish hatcheries. Normal hatching time is seven days, and the small catfish fry absorb the yolk in four to five days afterwards. Within three to four months they reach the fingerling stage at which time they are ready for use in stocking lakes or ponds. Under normal conditions, the channel catfish reach sufficient size in a year's time for use as meat.

6. In propagating the channel catfish in captivity, care should be taken in selection and care of the brood stock, in sexing and pairing the brood fish, and in providing a proper environment for spawning activities. The spawn should be removed from the receptacle directly after hatching, if not before, and placed in a protected area. Two methods are used in propagating: (1) the open pond method and (2) the pen method. Advantages of the pen method are that the operator has control of the brood fish and may offer protection from insects injurious to the catfish fry.

7. Field experiments conducted by the writer indicate that the productive span of the channel catfish averages approximately three years.

8. The major portion of the food consumed by the channel catfish is some type of meat.

9. Field experiments show better results are obtained from brood stock where a high protein feed is provided.

10. Records available of catfish stocked in farm lakes reveal that catfish reach sufficient size to be desirable as meat in the space of one year's time.

11. Production records of channel catfish raised in ponds at the Lake Dallas hatchery reveal that a net profit of value is possible; market price of the fish greatly exceeded the cost of food, labor, and necessary truck expenses.

Conclusions

The following conclusions have been developed from the study of channel catfish production for stocking purposes:

1. Channel catfish for stocking purposes may be propagated and raised to the fingerling stage with reasonable success.

2. Farm lakes or ponds are adequate for raising channel catfish and have possibilities of yielding a money income the same as other crops harvested on the farm.

Recommendations

The following recommendation is offered in the light of information developed in the study:

1. There should be continued study and experimentation in the raising and feeding of the channel catfish in order to improve existing procedures and to furnish data valuable to farmers and others wishing to stock and raise this fish which reaches maturity and usable size in a short time.

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