Scale and Body Growth of Young-of-Year Centrarchids in Two Oklahoma Farm Ponds

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INTRODUCTION

This paper reports the scale size and body lengths that centrarchids in Oklahoma ponds may obtain in their first year of growth and the body-scale relationship in small sunfishes. The difficulty biologists have in locating the first annulus on the scales of farm pond species is well documented in the literature (Burress, 1949; Proffitt, 1950; Regier, 1959; and Sprugel, 1950). Therefore, observations on young fishes are of importance for age determinations in fish population studies. The authors wish to thank Dr. Milton Curd, Zoology Department, Oklahoma State University, for advice on staining procedures, Dr. Robert Summerfelt, Oklahoma Cooperative Fishery Unit, for review of the manuscript, Mr. Jesse Jossel for drawing Figs. 3 and 4, and Mr. Irvin W. McKey for the use of his ponds.

DESCRIPTION OF PONDS

Fishes from two farm ponds located south of Stillwater in Payne County, Oklahoma, in R3E, T18N, S15, were sampled for study. Pond I was 1.5 acres with a maximum depth of 12 ft. It was built in 1959 and stocked at that time with bass *(Micropterus salmoides)* and bluegills *(Lepomis macrochirus)*. Fishing pressure was limited to an occasional visit by a fisherman. A few bass and practically no bluegills had been caught in the pond. The pond was muddy during its earlier years, but recently has maintained a bloom and shown reduced turbidity. Waste grain had occasionally been dumped into the pond in recent summers. Samples taken by hook and line, with a 15-ft common-sense seine, and with 50- and 150-ft seines indicated that 6- and 7-inch bluegills in good condition and bass 9 to 11 inches in fair condition were present. No other species were found.

Pond II was located about ¼ mile southwest of Pond I. It was 1.25 acres, and 8 ft deep. Built in 1963, it was originally stocked with bass and bluegills. In the fall of 1966, additional bass fingerlings were added. Green sunfish (*Lepomis cyanellus*) were present and a channel catfish (*Ictalurus punctatus*) had been reported caught.

FISH SAMPLING

Fish were collected by seining around all edges of the ponds with a 15-ft common-sense minnow seine. Pond I was sampled on 9, 15 and 23 September, 1, 15 and 29 October 1966, and on 28 March 1967. Pond II was sampled on the last five of these dates. The number of fishes was recorded for each inch group and random samples preserved in 10% for-

malin for laboratory study. Water temperatures were between 70 and 80F in September and 60 and 70F in October. The water temperature on 28 March 1967 was 69F.

Fall Growth

The mean lengths, with 95% confidence limits, estimated for fishes in the fall samples are presented in Table I.

TABLE I. LENGTH OF FISH IN FALL SAMPLES

Pond	Species	Dates	No. of Fish	Mean Length (mm)
I	Largemouth bass	15 Sept.	14	40.7 ± 4.8
I	Largemouth bass	23 Sept. - 29 Oct.	11	74.2 ± 4.1
I	Bluegills	15 Sept. - 29 Oct.	152	52.2 ± 2.2
II	Bluegills	23 Sept. - 29 Oct.	90	21.3 ± 0.8
II	Green sunfish	23 Sept. - 29 Oct.	63	25.2 ± 1.8

The largemouth bass collected 23 September to 29 October were considerably larger than the 15 September sample and therefore, the mean for that date is presented separately. Growth of that magnitude in the 8-40 days would hardly be sufficient to account for the difference obtained. Perhaps the bimodal data represent two distinct spawnings or sampling peculiarities.

Although the common-sense seine is selective for smaller sunfishes, we do not believe that this biased the collection of young-of-year bluegill as all fish over 90 mm long were aged as I+ by the scale method. The length-frequency curve (Fig. 1) was not multimodal, suggesting continuous rather than distinct spawning periods. Growth of bluegills apparently continued at least until the last sampling date (Fig. 2). However, no large increments were observed after the 15 September collection and thus the fish collected from 15 September to 29 October were pooled to estimate fall growth. The bluegills in Pond II were significantly smaller than those in Pond I, but the reason for this is not evident.

All of the average lengths obtained for first year growth in the fall in this study are extremely low for Oklahoma (Houser and Bross 1963, Jenkins et al. 1955).

Changes in Size Distribution over Winter

The mean lengths with 95% confidence limits for fish in the 28 March sample are presented in Table II.

TABLE II. SIZE OF FISH SAMPLED 29 MARCH 1967

Pond	Species	Number of Fish	Length
I	Bass	4	65.8
I	Bluegill	43	61.0 ± 2.2
II	Bluegill	23	33.9 ± 1.4
II	Green sunfish	4	53.0

The bass came through the winter in very poor condition (very thin, as seen from the dorsal view, and with concave bellies).

The increase in bluegill size (8.8 mm in Pond I and 12.6 mm in Pond II) could be a result of growth or it could be at least partially caused by selective mortality of the smaller individuals. Change in the length-frequency distribution indicates the latter. The size range of 1966 year-class bluegills in Pond I was 46 to 76 mm in the spring sample, while the distribution the previous fall was from 20 to 90 mm, with 15% of the total sample smaller than 46 mm. A 70-mm bass can swallow a 34-mm bluegill (Lawrence, 1958) and thus predation, rather than growth, could account for some of the shifts in size. Fingerling bass were stocked in

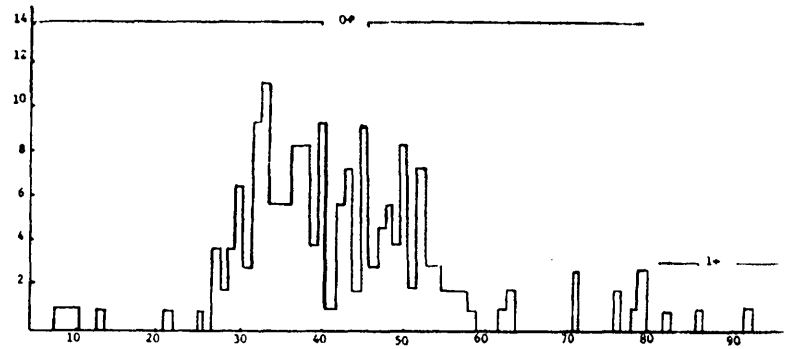

Figure 1. Length Frequency Distribution of Bluegills Collected from 18 September to 29 October 1966, in Farm Pond I.

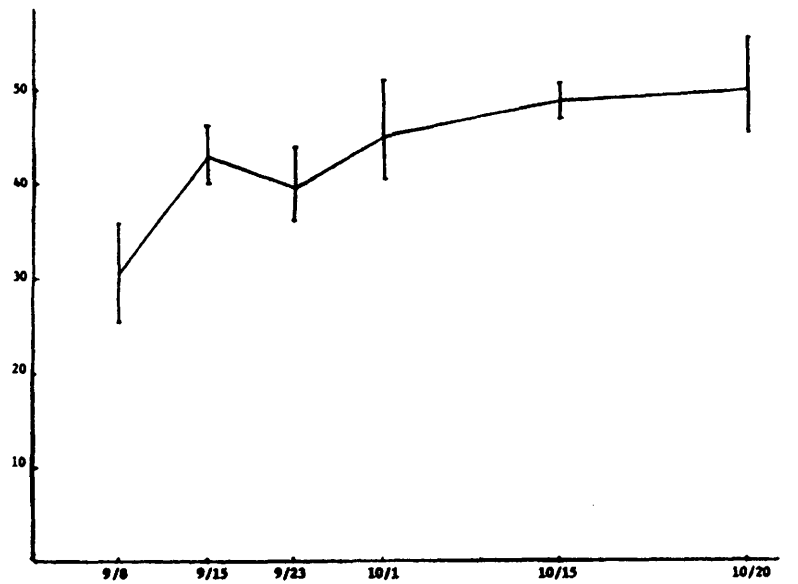

Figure 2. Mean Size with 95% Confidence Limits of Bluegills Captured in Farm Pond I.

Pond II in the fall of 1966 and could have eaten enough bluegills to cause a shift in average size.

There were not enough green sunfish collected to allow any inferences concerning changes in average size over winter.

Early Scale Formation

Study Procedures—Early scale formation was studied by use of alizarin red stain as suggested by Brown and Bailey (1952), and observing scales under both a dissecting microscope and an Eberback microprojector. Pieces of skin, with scales, were removed to examine scale structure in detail.

Bluegills—Scales from a total of 21 bluegills ranging from 16 to 29 mm were studied. No ctenii were present on the scales of 16- to 23-mm fish. Ctenii were also absent on the 29-mm fish. The number of ctenii on the scales of 24- to 25-mm fish were not in a set pattern in these early stages of development, as one to four ctenii were observed in the 24-mm and only two on the 25-mm fish.

Circular scales had 3-9 circuli and were found on fish up to 23-25 mm in size. Rudimentary circuli varied in shape from square to circular. Formed scales (i.e., those with adult shape) began to occur in the 23- to 25- mm fish; some of these had both circular and formed scales. Circuli were broken at various locations and apparently, as was observed in older fish, circuli were added to the anterior field first during growth. Therefore, the posterior field has fewer circuli than the anterior. Scales apparently begin growing in a circular pattern (Fig. 3) and later form the typical scale shape (Fig. 4). The addition of circuli and the flattening of the anterior end gives the scale its adult form. At the magnification (80×) used in this study, the circular scales had roughly one circulus/mm of radius, whereas, the formed scales had this ratio at the posterior end, with approximately two circuli/mm at the anterior end. This agrees in general with the findings of Creaser (1926).

Scales did not cover the entire body of 16-, 17-, and 19-mm fish. Scales apparently first begin to form in the caudal area, as reported by Proffitt (1950), as opposed to Potter (1925) who found that scales first appeared scattered over the body. In the 17-mm fish, scales were found to the mid-point of the dorsal fin area, whereas, in the 19-mm fish, scales were found all the way to the dorsal origin. In the 16-mm fish, scale formation had only reached the posterior end of the dorsal fin. In all of the above cases scales had only reached the pectoral fin area in the lower half of the fish. These observations on size at scale formation are in general concurrence with those of Proffitt (1955) and Potter (1925).

Green sunfish—Scale development in green sunfish was studied using 11 fish 17 to 25 mm in length. Scales had already grown over the entire body of the 17-mm fish. However, on the 22-mm fish, most scales showed circuli beginning to crowd in the posterior field, indicating a transition to adult shape. The 20-mm fish had some fully formed scales and some that were still circular.

Ctenii were formed on the 22-mm and larger fish. The green sunfish had more scales and more fully developed scales at smaller sizes than the bluegills. This agrees with Proffitt's (1950) findings in Michigan.

Body-Length Scale-Radius Analysis

Bass—A total of 33 fish scales was taken from largemouth bass 55 to 76 mm (average 67) in total length. The average scale radius for fish of this size was 44.8 mm with a 95% confidence interval of ± 3 mm.

Bluegills—The body scale relationship was calculated for the 58 blue-

gills from the fall sample. Measurements of radii were made on three scales from each fish (size range 16-116 mm). The equation calculated was: $Y = 16.70 + .7099X$, where Y equals total length of fish in mm and X equals 80× scale radius in mm.

The mean size of bluegills in the fall in Pond I was 52 mm and the calculated scale radius 50.2. The corresponding mean-size fish in Pond II was 21 mm and the calculated scale radius was 6.4.

Forty-eight fish (size range 20-118 mm) were measured in the spring sample. The radius of one scale was measured for each fish.

The equation for estimating length from scale measurements was: $Y = 15.69 + 0.6284X$.

The value of the slope for the above two equations was significantly different from zero; thus, straight-line relationships were valid. The intercept values for scale growth agreed with the observed findings of this study, as well as with those of Proffitt (1950).

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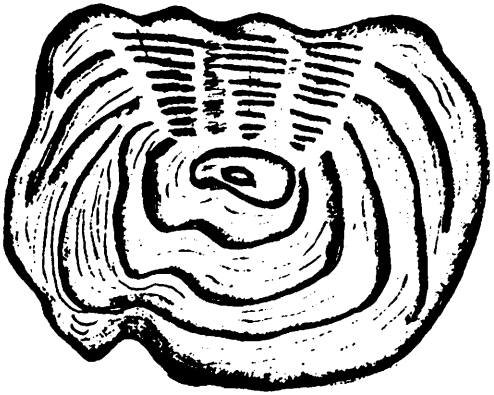

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Figure 3. Platelet Type Scale

Figure 4. Scale with Adult Form but Still without Ctenii

The mean-size bluegill in Pond I in the spring was 61.0 mm in length with an estimated scale radius of 72.2. The bluegills from Pond II had a mean size of 33.9 mm with an estimated radius of 29.4. Annulus formation was observed in the scales from the larger fish in both ponds.

Green sunfish—Body length-scale relationship was computed for 20 green sunfish 17-46 mm in total length. The body-scale regression was $Y = 11.14 + 0.7834X$. Our intercept value agrees with Proffitt (1950) who found green sunfish first had scales at 11 mm in length.

Discussion and Conclusions

Bluegills, green sunfish, and largemouth bass are important components in farm pond fish populations. In order to manage these ponds properly, knowledge is needed about age structure and growth rates. Aging is usually done by examining the scales for annuli. As mentioned previously, difficulty in correctly aging fish may result in miscalculations that could invalidate management conclusions.

In the two farm ponds in this study first-year growth was very slow. In addition, bluegills probably spawned at least into September, as fry were found in all collections. Lack of changes in size of fish collected in periodic seinings indicated that growth was over by the end of October for the bluegill and the bass, when temperatures were still between 60 and 70F. Not enough green sunfish were collected to provide information on cessation of growth. As determined by changes in abundance of the different size groups, spring collections indicated the possibility of higher mortality of the smallest fish spawned in late fall due to predation by largemouth bass. However, this might not be true in ponds where small fingerling bass were not present.

Annulus formation occurs after the month of March. Recognition of the first annulus in sunfishes with less than two inches of growth in their first season may be difficult because of its proximity to the focus. In fact, some fishes collected in March still had scales only in the form of platelets. In these fishes no annulus formed because adult-type circuli were not formed during their first year. Regier (1959) reported lack of first annulus formation in some New York farm ponds.

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