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Abstract. Age and growth of 151 creek chubs, *Semotilus atromaculatus*, from the Des Moines River in 1961 were determined by scale and length-frequency methods. The body scale relationship had an intercept of 8.3 millimeters in total length. Chubs reached total lengths of 58, 95, and 128 millimeters at the formation of the first, second and third annuli respectively. Annuli form in May. Weight increased approximately as the cube of the length. The most important food items were plant material, aquatic insects, and, in the case of larger chubs, fish. The chubs were found adaptable in their food habits with the changing conditions of the river.

INTRODUCTION

Data on the age and growth of the creek chub, *Semotilus atromaculatus* (Mitchill), were collected from a seven-mile section of the Des Moines River in Boone County, Iowa, between the Boone and Fraser Dams during the summer of 1961. This area is in townships R22W, T84 and 85N; and R26W, T84 and 85N, and has been the location of several fishery investigations. In this study area the Des Moines River is mainly sand-gravel bottom, but silt-bottomed holes and gravel-rubble bottoms are present in some areas. During the summer the water level fluctuated greatly, with the general trend toward a gradual lowering of the water level until, at the end of the summer, large areas of the river bottom were exposed. Chubs were collected most extensively over gravel and rubble bottoms, especially above riffle areas. Since the creek chub is primarily a fish of small streams, prefering streams less than 40 feet in width (Starrett, 1948), the Des Moines River may be considered somewhat marginal habitat. The creek chub is found throughout eastern United States and as far west as Montana and New Mexico (Dobie, Meehean, Snieszko, and Washburn, 1956).

Although the creek chub is an excellent bait minnow (Harlan and Speaker, 1956), no extensive work has been done with its age and growth in this region. Since this study was initiated in June, after the major spawning period for the creek chub (Dobie,

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Meehean, Snieszko, and Washburn, 1956), no opportunity was present for observations on this topic. However, the creek chub has a rather complex breeding behavior, which is described by Rieghard (1910).

Methods and Materials

Creek chubs were collected in the Des Moines River for this study primarily from June through September, 1961. although data from two isolated collections made in March and May, 1961, are included. Three methods were used to collect chubs. A 20-foot common sense seine wtih ¼-inch mesh, used to collect in shallow areas along sand bars, was especially successful in collecting chubs of the O and I-year age groups. A second method of collecting involved an electric shocker powered with a 220-volt AC-DC generator. Two, 4-foot sections of copper tubing, suspended from wooden booms extending in front of the boat, served as electrodes. The boat was pushed upstream through shallow water and riffle areas while the generator was running. The fish were picked up with dip nets as they floated to the surface after being stunned. This method was especially successful for collecting chubs above 10 cm in total length. The third method of collecting chubs was utilized only for a short time in one small isolated pool which was discovered, on July 28, to have been cut off from the river by the receding water level. This pool contained a number of young-of-the-year chubs which were easily caught with a hand dip net. An attempt was made to study this group of fish as an isolated population, but the pool dried up within the next week.

During the study period, 151 creek chubs were collected from the Des Moines River. When collected, the fish were placed in a 10 per cent formalin solution and returned to the laboratory where their weight in grams and total length in centimeters were recorded. Scale samples also were taken, and gross stomach analyses were made at this time.

Length-Weight Relationship

Using a log transformation, the length-weight relationship (Table 1) can be described by the equation:

$$\text{Log } W = -3.972 + 2.98 \text{ (Log I.)}$$

Where W = weight in grams

and L = total length in millimeters

The standard error of estimate was 0.0916.

A "t" test (Snedecor, 1956, p. 136) indicated that the slope does not differ significantly from 3.00. Thus, the shape of the fish remains fairly constant with increase of length over the range covered.

The coefficient of condition, K(TL) was computed for all the fish using the formula $K = W(10^5/L^3)$ where W = weight in grams and L= total length in millimeters. Nomographs from Carlander (1953) were used to determine the K values. The average condition factors for age groups O-III were 1.07, .90, 1.08, and 1.22 respectively. The mean for the 151 fish was 1.02.

Table 1. Mean lengths and weights by 10-millimeter size groups of creek chubs, Des Moines River, 1961

Total length in mm	Number of fish	Mean length in mm	Weight in grams Mean	Range
20- 29	15	27.2	.25	.15- .30
30- 39	34	34.5	.45	.30- .65
40- 49	12	43.2	.86	.65- 1.15
50- 59	6	56.2	1.00	1 - 1
60- 69	16	65.8	2.41	1 - 3
70- 79	11	74.1	4.00	2 - 6
80- 89	11	83.5	5.73	5 - 7
90- 99	12	92.8	7.71	6 -10
100-109	8	105.5	12.31	10 -14
110-119	7	113.1	14.44	9 -19
120-129	7	126.0	23.71	21 -26
130-139	4	137.5	29.25	27 -33
140-149	2	140.5	33.00	33 -33
150-159	4	153.5	41.00	38 -45
160-169	2	160.5	58.00	56 - .60

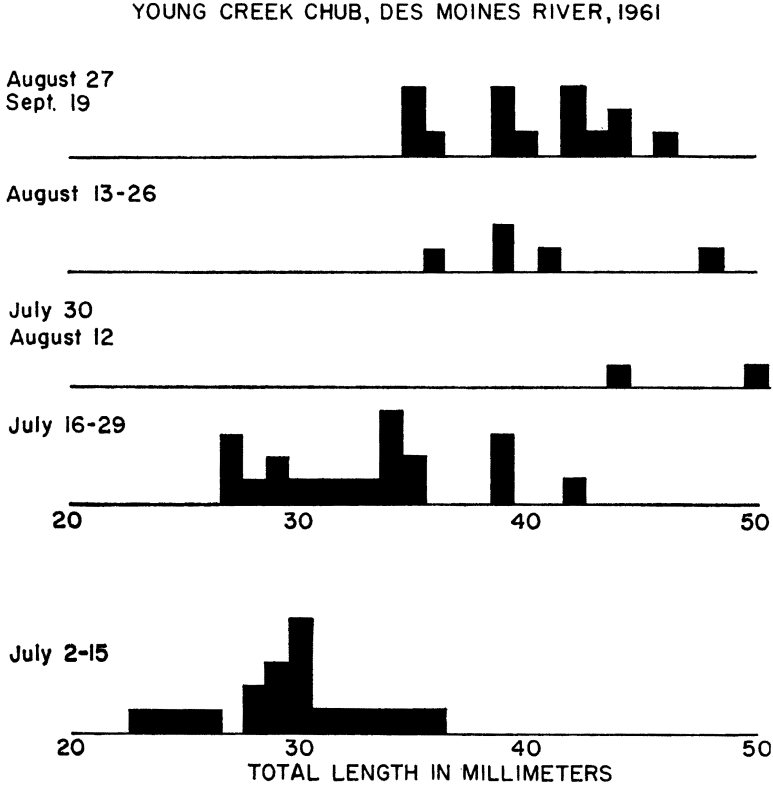

Figure 1. Numbers of young creek chub by 1-millimeter size groups collected in the Des Moines River, 1961, showing growth through the season.

Age and Growth

In determining the age of the creek chubs, both the scale and the length-frequency methods were used. Since the 0 age group was easily followed throughout the summer, only the length-frequency method was used to determine their age (Figure 1). For the other age groups, scale impressions were made on clear plastic strips with a roller press of the type described by Smith (1954). These impressions were then inspected at 32X on a scale reading apparatus similar to that of Van Oosten (1929).

A combination of several characteristics was used to recognize the annuli on the scales. The anastomosis of the circuli in the lateral field, with closely formed circuli immediately before the annulus and widely spaced circuli immediately following it were the most important characteristics.

Once the annuli had been determined, their relative locations to the focus of the scale were recorded on paper strips, to be later used with a nomograph. Lateral field measurements were used since all of the circuli were extremely crowded in the anterior field. The time of annulus formation was determined to be in May. Only one of three fish collected on May 4 had formed a new annulus while all of the fish collected after June 1 had formed new annuli.

The body-scale relationship can be expressed by the formula:

$$\mathbf{L} = 8.29 + 2.75\ \mathbf{R}$$

where **L** = total length of fish in millimeters
and **R** = lateral radius of scale in millimeters (X32)

A nomograph was constructed using 8.29 as the focal intercept and total length at the time of each annulus formation was computed for each age group. Mean total lengths at the first 3 annuli were 58, 95, and 128 mm (Table 2).

Table 2. Average calculated total lengths in millimeters at each annulus of creek chub from the Des Moines River, 1961

Year class	Age group	No. fish	Total length Mean	Total length Range	Mean weight, grams	Average calculated total lengths in millimeters at end of year 1	2	3
1961	0	62	34.7	23-50	.48			
1960	I	56	76.7	55-105	4.63	56.2		
1959	II	24	117.3	92-139	18.06	61.7	95.8	
1958	III	9	150.7	138-162	47.11	60.9	91.7	127.6
Total		151	70.3	23-162	7.29	58.2	94.6	127.6
Average annual increment							33.2	35.9

According to Dobie, Meehean, Snieszko and Washburn (1956), hatchery-raised chubs reach lengths of up to 3.5 inches in September of their first year, considerably more than the maximum of 2 inches which was found in this study. Growth was also faster in a spotted-bass stream in southern Illinois (Lewis and Elder, 1952). In a cold-water stream in southern Illinois (Gunning and

Lewis, 1956), however, the growth rate was about the same as in the Des Moines River.

Food Habits

To determine food habits, the contents of the stomach and intestine were removed and placed in a petri dish with water and then inspected under a dissecting microscope. In this study, the stomachs of 123 chubs were examined, 33 of which were empty. Of the remaining 90, an estimate of the stomach's fullness was made and then the contents were examined and the presence of various food items was noted. From these data, the percentage occurrence of each food item was tabulated (Table 3).

Table 3. Frequency of occurrence of food items found in creek chubs in Des Moines River, 1962

Food item	March	May	June	July	Aug.	Sept.	Total	Per cent
Plant material	2	2	2	11	7	2	26	21.1
Cladophora sp.	0	0	0	9	1	2	12	9.8
Undetermined	2	2	2	3	7	0	16	13.0
Insects								
Ephemeroptera naiads	2	0	3	15	5	1	26	21.1
Ephemeroptera adults	0	0	0	5	0	0	5	4.1
Plecoptera nymphs	1	0	0	2	0	0	3	2.4
Tricoptera larvae	0	0	0	4	0	0	4	3.3
Diptera larvae	0	0	0	3	0	0	3	2.4
Adult Coleoptera	0	0	1	11	4	1	17	13.8
Undetermined adult insects	0	1	0	9	8	3	21	17.1
Undetermined larval insects	0	0	1	5	2	0	8	6.5
Fish	1	0	1	13	5	0	20	16.3
Annelida	1	0	0	0	0	0	1	0.8
Crayfish	0	0	0	3	0	0	3	2.4
Mollusk shells	0	0	0	3	0	0	3	2.4
Empty	0	2	6	13	12	0	33	26.8
Total fish examined	4	4	12	64	35	4	123	

Food items found most important for the creek chub were plant material, especially *Cladophora* sp.; insects, with mayfly naiads and Coleoptera being the most important; and small fish, especially in larger chubs (Table 3). The smallest chub found eating fish was 46 mm long, but this was rather unusual as the next smallest one was 72 mm. In several cases the stomachs were so full as to cause a noticeable, external distention. One chub, 76 mm long, had eaten a 45 mm blacksided darter (*Percina maculata*). The darter was doubled over in the stomach. A 134 mm chub had a 65 mm minnow and a third chub, 123 mm long, had two minnows, 24 and 35 mm long, in its stomach.

Seven chubs were found infested by nematodes, identified as *Rhabdochona* sp. Bangham (1941) found nematodes of this genus in creek chubs in Ontario.

The creek chub was also found quite adaptable to the varying supplies of food found in the river. On July 5, the water level in the river was quite low and several large rubble areas were exposed. On these areas large numbers of carabid beetles were observed eating the aquatic insects and other organisms that were stranded when the water level had gone down. On the

night of July 5, heavy rains raised the water level of the river enough to reflood these areas, and, on July 6, several chubs were collected in the shallows around the flooded rubble areas. These chubs had eaten large numbers of small insects, especially the small carabid beetles which apparently had been caught in the high water. This adaptability, along with the wide variety of food accepted, perhaps partly explains why the chub is such a wide-ranging fish.

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