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Life History of the Quillback and Highfin Carpsuckers in the Des Moines River

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Abstract. An age and growth study was made of 705 quillback, *Carpiodes cyprinus*, and 399 highfin carpsuckers, *C. velifer*, taken from the Des Moines River, Boone County, Iowa, from June 1 to August 24, 1960. The length-weight relationship, body-scale relationship and coefficient of condition of these two species are very similar, but the quillback is a larger and faster growing fish. Difficulty was encountered in distinguishing young quillbacks and highfins from the young of the other two species of carpsuckers found in the river.

Four species of carpsuckers have been reported from the Des Moines River in Boone County, Iowa (Harlan and Speaker, 1956). The age and growth of the most abundant species, the river carpsucker, *Carpiodes carpio*, was studied by Buchholz (1957). The quillback and highfin carpsuckers, *Carpiodes cyprinus*, and *C. velifer*, are also quite abundant in the river. The fourth species, the plains carpsucker, *C. forbesi*, is fairly rare. Starrett (1948) does not mention it. During the present study, from June 1 to August 24, 1960, 3,611 river carpsuckers, 705 quillbacks, 399 highfins, and 142 plains carpsuckers were collected.

The specimens were taken from a seven-mile stretch of the river between the Boone Waterworks Dam and the dam at Fraser in Boone County. The townships concerned are: R27W, T84N and R26W, T84N and 85N. Most of the fish were taken near the YMCA Camp.

In late spring when the study was started, the river was quite deep, but by mid-August it was shallow enough that we could go across most places in chest-high waders. The river also became less turbid as the summer progressed. The Secchi disk readings in June were as low as 4¾ inches and as high as 14 inches in late July.

METHODS AND MATERIALS

Collection of Specimens

Nearly all of the fish were collected with a 150 volt A.C.

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electric shocker, with woven wire electrodes mounted at the end of wooden closet rods, about 7 feet ahead of a flat-bottomed boat. Several yearling and young-of-the-year carpsuckers were taken in shallow water near shore with a 15 foot, ¼-inch mesh common sense seine.

Carpsuckers of less than 3 inches length are not included in the age and growth data, because these small carpsuckers could not be distinguished as to species.

The majority of the carpsuckers were captured in shallow areas along the shore and in flooded weedy places. In June, when the water level was high, no habitat preference could be detected for the quillback or highfin. However, in July, with lower water levels, the highfin was generally found in riffle areas, while the quillback was found in deeper waters. In August, when the river was at its lowest level, most quillbacks were found in riffle areas also.

Measurements and Scale Preparation

All measurements were made to the nearest tenth of an inch. Only the total length of the fish, which is that distance from the tip of the snout to the tip of the caudal fin when compressed, was used in this study. Weights for fish under 500 grams were recorded in grams, and in ounces for those fish over 500 grams.

Scale samples were taken from 141 quillbacks and 97 highfins. Five to 10 scales from an area about midway between the lateral line and anterior base of the dorsal fin were taken from each fish. Species, length, weight, date, and location were recorded. Later, impressions of three to five scales were made on clear plastic strips, using a roller press. The impressions were then interpreted, using a scale projector at a magnification of 43x.

Scale Analysis

Van Oosten (1928) fully discusses the validity of the scale method. He lists three propositions upon which the soundness of the scale method of determining the length of a fish at successive years and its annual growth increments depends: (1) that the scales remain constant in number and retain their identity throughout life, (2) that the annual increment of the scale maintains, throughout the life of the fish, a constant ratio with the annual increment in body length, and (3) that the annuli are formed yearly and at the same time each year.

Generally speaking, the first annulus on the carpsucker scale was easiest to determine. Then the annuli became harder to determine as the fish increased in age. The characteristics used to identify annuli were (1) incomplete circuli, or "cutting over", as described by Lagler (1956), (2) discontinuous circuli be-

tween complete circuli, (3) relative distance between annuli, and (4) the relative distance between circuli. Annuli were easiest to distinguish at the antero-lateral portion of the scale.

Time of Annulus Formation

The time of annulus formation appears to be quite variable within both species. A 4.2-inch highfin captured on June 25 had not formed its first annulus, while a 4.8-inch highfin captured on June 7 had formed its first annulus. The time of the quillback's annulus formation appears to be even more variable than the highfin's. A 3.9-inch quillback captured on June 18 had formed its first annulus, but a 4.4-inch quillback captured on July 19 had not formed its first annulus. The time of annulus formation appears to be the month of June for age group I highfins and the first half of July for the quillback. Buchholz (1957) suggests May as the month of annulus formation for the river carpsucker.

The determination of a fish's age was based solely on the number of annuli on the scale at the time of capture. Thus, if a fish had not formed its annulus for the year at the time of capture, its true age would be a year older than the age revealed by the number of annuli.

Body-Scale Relationship

Five scale samples were selected at random from each scale length inch group. The mean scale length and body length were calculated, and a linear regression was calculated for each species to determine the relationships (Figure 1).

Quillback:

$$L = 2.67 + 1.075\ (S)$$

Highfin:

$$L = 2.49 + 1.03\ (S)$$

Where: L = total length in inches

S = anterior scale radius x43

It should be understood that 2.67 and 2.49 are not necessarily the lengths of the fish at the time of scale formation, but are correction factors that take into account the fact that the scale forms after the fish has started growth and that the platelet, or early scale, may have grown faster than the fish. Proportional growth between the scale and the body occurs only after the scale has formed.

Since the body-scale relationship is linear, a nomograph (described by Carlander and Smith, 1944) was used to determine the length of the fish at each annulus.

Age and Growth

Young Fish

A length-frequency analysis at two-week time intervals was made on small carpsuckers ranging from 1.5 to 3.5 inches in length (Figure 2). These fish were not identified as to species. Fishing effort for these small carpsuckers was not constant during the period of collection. In June, very little effort was directed toward catching this size. Most of these fish are believed to be age group I, with the young-of-the-year being represented by the smaller fish in the July and August samples.

Scales from fish of lengths 3.2 and 3.5 inches taken on August 4 had one annulus. Scales from fish of lengths 2.1 and smaller taken the same day had no annulus. A 1.5-inch carpsucker taken on July 7 had no annulus. Thus, it appears that fish under 2 inches taken in July and August were young-of-the-year.

Buchholz (1957) reported that young-of-the-year carpsuckers

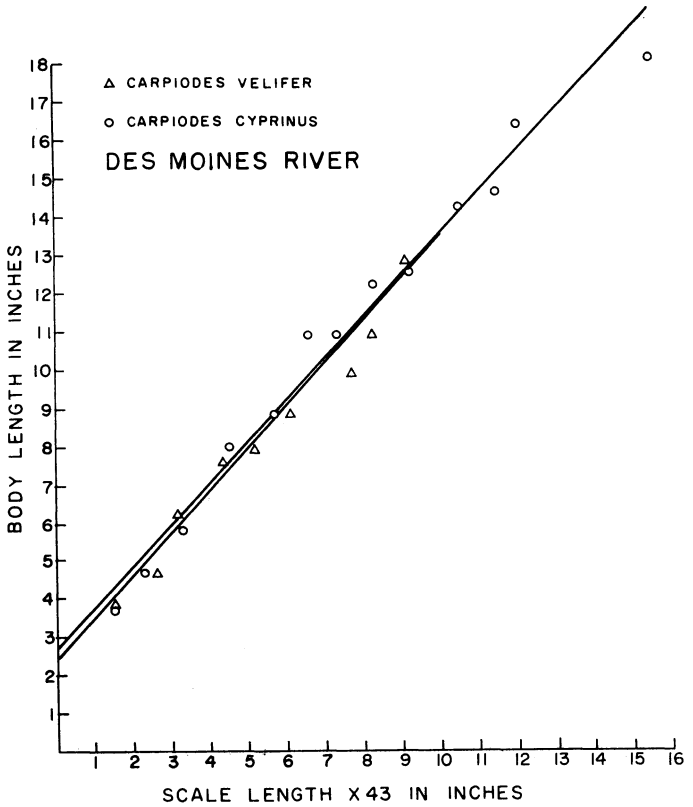

Figure 1. Body-scale relationships of quillback and highfin carpsuckers.

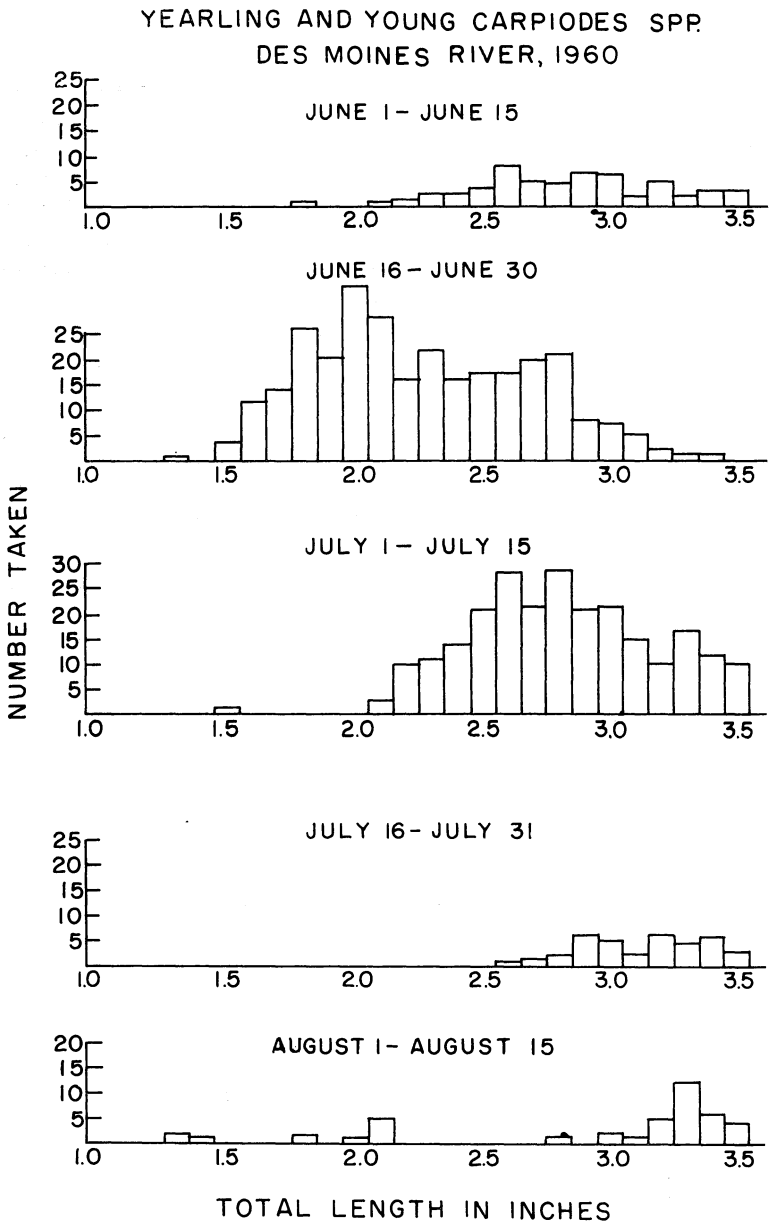

Figure 2. Length frequencies of *Carpiodes* spp. by two-week intervals, 1960.

of the range 1.0-1.4 inches appeared in the catch from June through August, suggesting a spawning period of May through July. He found the peak age class 0 in November to be from 2.5-2.9 inches.

Table 1. Average calculated lengths and increments of growth of highfin carpsuckers, Des Moines River, Iowa, 1960

Year class	Age class	No. of fish	Aver. length	Range	Average calculated total length at annulus 1	2	3	4	5	6	7	8	9
1959	I	4	3.6	3.2- 4.2	3.5								
1958	II	25	5.5	4.9- 7.7	3.5	4.9							
1957	III	23	7.6	5.8- 8.9	3.8	5.2	6.8						
1956	IV	27	8.6	6.9-10.2	3.5	5.5	6.5	7.8					
1955	V	11	9.0	7.8-10.9	3.6	4.7	6.0	7.1	8.3				
1954	VI	4	10.5	9.2-12.1	3.5	5.5	6.5	7.6	8.9	9.9			
1953	VII	2	11.7	11.6-11.9	3.6	5.9	6.8	8.9	10.0	10.9	11.1		
1952	VIII	1	12.3	12.3	3.6	5.9	6.8	7.8	8.9	10.0	10.9	12.0	
Grand average length					3.5	5.2	6.5	7.7	8.7	10.2	11.0	12.0	
Number of fish					97	93	68	45	18	7	3	1	
Average increment					3.5	1.5	1.2	1.2	1.0	1.0	.4	1.1	
Average calculated weight					.018	.06	.12	.20	.28	.46	.56	.72	

Table 2. Average calculated lengths and increments of growth of quillback carpsuckers, Des Moines River, Iowa, 1960

Year class	Age class	No. of fish	Average length	Range	Average calculated total length at annulus 1	2	3	4	5	6	7	8	9	10
1959	I	27	4.8	3.3- 6.1	4.7									
1958	II	6	8.0	5.2-10.7	4.9	6.9								
1957	III	43	9.2	7.4-13.2	5.2	6.8	8.4							
1956	IV	53	9.9	7.0-14.2	4.8	6.2	7.6	9.1						
1955	V	9	10.1	8.7-13.6	4.4	5.8	6.7	8.3	9.7					
1954	VI	4	14.9	14.7-15.1	5.1	7.2	8.8	10.5	12.5	14.1				
1953	VII	4	15.2	13.3-17.3	4.3	6.3	8.1	9.5	10.6	12.8	14.2			
1952	VIII	2	17.3	16.4-18.1	5.6	7.7	9.1	11.4	12.4	14.0	15.2	16.6		
1951	IX													
1950	X	1	16.8	16.8	5.1	5.9	7.7	8.8	10.4	11.7	12.4	14.1	15.2	16.5
Grand average length					4.9	6.5	7.9	9.2	10.6	13.4	14.2	15.7	15.2	16.5
No. of fish					149	122	116	73	20	11	7	3	1	1
Average increment					4.9	1.5	1.4	1.5	1.4	1.8	1.1	1.5	1.1	1.3
Average calculated weight					.047	.114	.21	.34	.52	1.10	1.33	1.68	1.63	2.12

Calculated Lengths

Average lengths and increments, calculated from the scale measurements (Tables 1 and 2) indicate that both the quillback and the highfin make their greatest growth during the first year of life. The increments show a gradual decrease with each year of life. The highfin's growth decreases at a faster and more uniform rate than the quillback's. The quillback is definitely a larger and faster growing fish than the highfin.

Length-Weight Relationship

The length-weight relationship of a fish may be expressed by the formula:

$$W = cL^n$$

where W = weight in pounds
L = total length in inches
c and n are constants

When the lengths and weights are expressed as logarithms for computational purposes, the relationship is linear:

$$\text{Log } W = \log c + n \log L$$

The value of the constant, *n*, will usually be near three since the weight of an object will vary with the cube of the length if shape and specific gravity remain the same (Carlander, 1953, p. 7).

Weights and lengths were averaged from five fish picked at random from each inch group (Table 3).

Table 3. Comparison of observed and calculated weights for the highfin and quillback carpsuckers, Des Moines River, Iowa, 1960

No. of fish		Mean length		Mean observed weight		Calculated weight*	
Quillback	Highfin	Quillback	Highfin	Quillback	Highfin	Quillback	Highfin
2	5	3.6	3.5	.016	.017	.018	.018
5	5	4.6	4.7	.043	.047	.038	.046
5	5	5.3	5.5	.066	.072	.061	.069
5	5	6.3	6.6	.105	.127	.100	.122
5	5	7.6	7.4	.162	.166	.186	.173
5	5	8.5	8.5	.255	.262	.259	.259
5	5	9.4	9.3	.303	.366	.362	.344
5	5	10.4	10.6	.465	.516	.497	.505
5	5	11.4	11.4	.664	.637	.665	.640
5	3	12.4	12.3	.867	.848	.859	.793
5	1	13.4	13.4	1.092	.926	1.107	1.03
5		14.6		1.418		1.435	
5		15.5		1.615		1.734	
5		16.4		2.140		2.045	
2		17.2		2.087		2.399	
1		18.1		2.438		2.831	

* Weights calculated from regressions given in text.

Quillback:

$$\text{Log } W = -1.4912 + 3.134 \text{ (log L)}$$

Highfin:

$$\text{Log } W = -1.3655 + 2.997 \text{ (log L)}$$

Thus, the weight of the quillback appears to increase slightly

faster than the cube of the length, while the weight of the highfin appears to increase about as rapidly as the cube of the length. The length-weight relationships of these two species are quite similar. At first, the weight of the highfin is slightly greater than that of the quillback, but as the length increases, the quillback becomes heavier.

Condition

The condition factor, C, is a measure of the well-being or plumpness of a fish:

$$C = \frac{W \times 10^5}{L^3}$$

where W = weight in pounds
L = total length in inches

Lagler (1956) lists three factors that may affect a fish's coefficient of condition: age, sex, and season. Taking these factors into consideration, suitability of different environments for a particular species of fish may be compared.

Both the quillback and the highfin become more robust as the summer progresses (Tables 4 and 5). Neither species shows a definite trend in condition with age or length. The grand average condition factor was 43 for the highfin and 42 for the quillback. Carlander and Moorman (1949) report an average C of 44 for quillbacks in an Iowa pond. Jenkins, Leonard, and Hall (1952) report an average C of 42 for highfin carpsuckers in the Illinois River, Oklahoma.

Growth Comparisons

The river carpsucker in the Des Moines River (Buchholz, 1957) grows faster than the quillback or the highfin up until the sixth year of growth, when the quillback appears to grow faster. The mean condition factor of the river carpsucker in the Des Moines River was 48, while it was 43 and 42 for the highfin and quillback. Thus, the condition factors of these three species can be correlated with their relative abundance, though this probably is coincidence.

The only other growth data we could find on the quillback was from a TVA reservoir (Eschmeyer, Stroud, and Jones, 1944) where the fish averaged 7.7 inches at the second annulus. Highfin carpsuckers in the Illinois River, Oklahoma (Jenkins, Leonard, and Hall, 1952) grew much more rapidly than those in the Des Moines River and averaged 4, 8, 10.3, 12.4, and 13.5 inches at the first through fifth annuli. The faster growth in both Tennessee and Oklahoma may be associated with the longer growing season.

Table 4. Condition factors of highfin carpsuckers, Des Moines River, Iowa, 1960

Inch	June			July			August			
group	No.	Mean	Range	No.	Mean	Range	No.	Mean	Range	Aver.
3	3	37	33-41	...	...	...	3	38	33-41	38
4	8	43	34-49	5	43	39-50	1	44	44	43
5	17	40	30-48	12	44	39-60	5	47	40-50	42
6	15	40	34-47	19	45	36-52	4	47	39-55	43
7	36	41	33-50	25	45	40-58	24	45	39-49	43
8	54	42	35-50	40	45	36-55	37	45	39-57	44
9	15	40	33-49	19	45	40-55	18	44	40-48	41
10	...	...	...	9	44	38-49	9	42	39-46	43
11	4	40	37-41	6	43	41-46	7	46	41-52	44
12	1	40	40	1	49	49	1	48	48	46
13	...	...	...	...	...	...	1	39	39	39
Total	153	41	30-50	136	45	36-60	110	45	33-57	43

Table 5. Condition factors of quillback carpsuckers, Des Moines River, Iowa, 1960

Inch	June			July			August			
group	No.	Mean	Range	No.	Mean	Range	No.	Mean	Range	Aver.
3	2	33	28-38	...	...	...	...	...	-	33
4	4	45	39-47	14	44	34-53	2	42	38-45	44
5	8	37	33-45	26	45	33-55	11	46	39-52	44
6	2	39	34-43	3	40	40	4	44	41-47	42
7	17	40	31-47	30	43	36-52	4	44	43-47	42
8	61	38	31-49	101	42	35-48	42	42	37-46	43
9	23	37	32-43	66	41	34-49	64	42	38-48	41
10	5	41	36-46	29	42	38-45	32	42	38-53	42
11	2	41	40-42	13	43	33-49	22	42	37-48	42
12	...	...	...	9	41	38-48	16	43	41-47	42
13	1	41	41	3	45	42-47	4	46	41-54	45
14	1	49	49	5	40	39-47	5	43	39-55	42
15	1	46	46	1	37	37	11	45	41-50	44
16	...	...	...	...	...	...	5	46	40-56	46
17	...	...	...	1	42	42	1	41	41	42
18	...	...	...	...	...	...	1	41	41	42
Total	127	39	28-49	301	42	33-55	224	43	38-56	42

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Literature Cited

Buchholz, M. M. 1957. Life history of the river carpsucker (*Carpiodes c. carpio*) in the Des Moines River, Iowa. Proc. Iowa Acad. Sci. 54:589-600.

Carlander, K. D. 1953. Handbook of freshwater fishery biology with first supplement. Dubuque, Iowa. Wm. C. Brown Co. 428 pp.

————and R. B. Moorman. 1949. Project No. 37, Management of small ponds for fish production. Iowa Coop. Wildl. Res. Unit Quarterly Rept. July-Sept. 1949. pp. 54-83.

————and L. L. Smith, Jr. 1944. Some uses of nomographs in fish growth studies. Copeia 1944: 157-162.

Eschmeyer, R. W., R. H. Stroud, and A. M. Jones. 1944. Studies of the fish population on the shoal area of a TVA mainstream reservoir J. Tenn. Acad. Sci. 19:70-122

Harlan, J. R., and E. B. Speaker. 1956. Iowa fish and fishing. Iowa St. Cons. Comm. Des Moines, Iowa. 377 pp.

Jenkins, R. M., E. M. Leonard, and G. E. Hall. 1952. An investigation of the fishery resources of the Illinois river and pre-impoundment study of Tenkiller Reservoir, Okla. Okla. Fish. Res. Lab. Report No. 26.

Lagler, K. F. 1956. Freshwater fishery biology. Dubuque, Iowa. Wm. C. Brown Co. 421 pp.

Van Oosten, J. 1928. Life history of the lake herring (*Leicichthys artedi* Le Sueur) of Lake Huron as revealed by its scales, with a critique of the scale method. Bul. U.S. Bur. Fish. 44:265-428.