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ASPECTS OF THE BIOLOGY OF THE FLATHEAD CHUB (*HYBOPSIS GRACILIS*) IN MONTANA

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ABSTRACT.— Mature flathead chubs (*Hybopsis gracilis*) were present in mid-July and mid-August collections from the Musselshell River, Montana. The estimated numbers of mature eggs present in eight females were 360–753 per female. The smallest mature female and male collected were 113 and 123 mm in total length, respectively. The male to female sex ratio in collections was about 1:1. Only small differences were detected among the length-weight relationships of males and females and samples taken from various seasons and localities in Montana. Observations on size groups, fish associates, and habitat characteristics of flathead chubs are presented.

The life histories of several species of *Hybopsis* are poorly known (Lee et al. 1980). One of these is the flathead chub, *Hybopsis gracilis* (Cross 1967, McPhail and Lindsey 1970, Brown 1971, Scott and Crossman 1973, Pflieger 1975 and Lee et al. 1980). Most of the published information on the natural history of this species in the United States is contained in a systematic study by Olund and Cross (1961) and a bionomics study by Martyn and Schmulbach (1978). This report presents additional biological information on the flathead chub.

Description of the Study Site

The collection site was on the Musselshell River (T8N R25E S22) in central Montana. At this location the river is a plains stream having an elevation of about 971 m and a substrate of sand- and silt-covered pebbles.

Records taken at the collection site over a four-year period (USGS 1979, 1980, 1981, 1982), showed the pH range was 7.7–8.5, with 90% of the measurements being 8.0 or greater. Average monthly values were 100–1700 mg/l for suspended solids, 240–830 mg/l (as $CaCO_3$) for alkalinities, and 4–31 m^3/s for flows. Flows were usually highest in May or June and lowest in August or September. Water temperatures ranged from 0.0 to 23.0 C, with lows occurring from December through February and annual highs from June through August. Flathead chub typically inhabit fluctuating streams with alkaline, turbid waters (Olund and Cross 1961, Brown 1971).

Methods and Materials

Specimens were collected with an 11.0 × 3.7 m seine having an 8-mm-square mesh and preserved in 10% formalin. In addition, collections in the Vertebrate Museum of Montana State University (MSU) were examined. The total length (TL) of each specimen was measured to the nearest 1 mm; standard length (SL) was derived from TL in the linear regression SL = 0.2665 + 0.7863 TL, which was obtained from measurements of 65 specimens 70–134 mm TL. The weight of each blot-dried specimen was determined to the nearest 0.01 g on a Mettler Model H16 balance. The sex of each fish was determined by examination of the gonads under a dissecting microscope. Egg size was measured with an ocular scale calibrated with a stage micrometer. The total number of mature eggs in a fish was estimated by using:

$$M_T = \frac{W_T M_S}{W_S}$$

where M_T = the total number of mature eggs in the fish's ovaries, W_T = the total weight of the fish's ovaries, M_S = the number of mature eggs in the sample of the ovary, and W_S = the weight of the sample of

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TABLE 1. The average diameter (mm) of 10 of the largest eggs in 58 specimens of *Hybopsis gracilis* collected from the Musselshell River, Montana.

Collection date	Total length of fish (mm)	Average egg diameter in mm (numbers of specimens)
31 Mar 81	71–123	0.2(12), 0.3(2) 0.5(1), 0.7(7) 0.8(2)
19 Jul 83	113–155	0.2(4), 0.3(1) 0.4(2), 0.5(3) 0.6(2), 0.8(1) 1.0(1), 1.1(3) 1.2(1), 1.3(1) 1.4(1)
15 Aug 83	117–160	0.2(1), 0.3(1) 0.4(3), 0.5(1) 0.6(3), 1.3(1)
11 Nov 82	114–134	0.2(1), 0.6(2) 0.7(1)

the ovary. Two estimates were made of the M_T in each fish. The length-weight relationships in specimens were determined by using $\log_{10} w = \log a + b (\log_{10} L)$, where w = blot-dried weight in grams, L = total length in millimeters, and a and b were constants derived from the data.

RESULTS

Reproductive Condition of Females

Fifty-eight females were collected prior to, during, and after the presumptive spawning season for an evaluation of their reproductive condition (Table 1). Females with the largest eggs (1.0–1.4 mm in diameter) were found in July and August 1983 collections. These specimens were considered mature because of the large size and orange color of the eggs. Examination of 23 females from eight collections at MSU showed that females with eggs of a comparable size were present only in July samples; none were present in August and September collections. The average daily maximum and minimum water temperatures associated with the collection of mature females in this study were 23 and 18 C in July and 25 and 21 C during the first 15 days in August (unpublished data, Montana Department of Fish, Wildlife, and Parks).

The estimated average number of mature eggs (1.0 mm or greater in diameter) in the eight mature specimens collected during this study was about 491 (Table 2). There was no trend for larger females to have more eggs than smaller ones within the size range treated ($r = 0.15$). The smallest mature female collected (Table 2) was 113 mm TL (89 mm SL). The smallest mature female found in nine museum collections of MSU was 112 mm TL (88 mm SL).

The ovaries of the eight mature fish in Table 2 weighed 0.59–0.99 g and were 2.3–5.9% of total body weights. In the 22 immature females collected concurrently with the mature fish in this study, ovary weights were 0.10–0.71 g and 0.5–1.8% of total body weights.

Reproductive Condition of Males

Milt was stripped from 13 males taken in July and August 1983 (Table 3). The smallest ripe male was 123 mm TL (97 mm SL). However, some males larger than this were not ripe in August.

TABLE 2. Estimated numbers of mature eggs in eight *Hybopsis gracilis* collected from the Musselshell River, Montana.

Collection date	Total length of fish (mm)	Total weight of fish (g)	Estimated total numbers of mature eggs from two samples	Average diameter of 10 mature eggs (mm)
19 Jul 83	113	12.99	442/293	1.0
	120	16.72	453/521	1.1
	122	17.55	508/524	1.1
	124	18.50	539/446	1.3
	130	20.04	483/441	1.2
	136	22.95	638/633	1.1
	155	36.02	753/360	1.4
15 Aug 83	160	37.72	453/372	1.3

TABLE 3. The reproductive condition of 18 male *Hybopsis gracilis* collected from the Musselshell River, Montana. Numbers of specimens in parentheses.

Collection date	Total length of males in mm	
	Ripe	Not ripe
19 Jul 83	123, 128, 129 132, 133, 143	—
15 Aug 83	127, 132, 135 (2), 136 (2), 146	122, 124, 127 132, 140

Sex Ratio

The male to female sex ratios of specimens examined were not significantly different from 1:1 (Table 4). This ratio did not change significantly with increases in the size of specimens examined.

Length-Weight Relationships

The length-weight relationships of a sample of males and females taken 31 March 1981 were calculated separately (Table 5). An F test of the slope and intercept showed the two regressions were not statistically different ($P=0.66$), so length-weight data from all fish were combined.

The length-weight relationships of flathead chubs collected during different seasons and from different localities in Montana were similar (Table 5). The relationship was also similar among different size groups.

Fish Associates

Fish captured with *H. gracilis* in the Musselshell River were *Couesius plumbeus*, *Cyprinus carpio*, *Hybognathus argyritis*, *H. placitus*, *Carpiodes carpio*, *Catostomus commersoni*, *C. platyrhynchus*, *Moxostoma macrolepidotum*, *Micropterus dolomieui*, and *Noturus flavus*. *Hybognathus placitus* and *C. commersoni* were reported previously by Olund and Cross (1961) as associates of flathead chubs.

Age and Growth

The length-frequency analysis of 305 specimens 29–127 mm TL collected from the Musselshell River 31 March 1981 indicated three size groups were present. The approximate average total length of specimens in each size group was 43 ($N=116$), 81 ($N=149$), and 116 ($N=40$) mm. Attempts to verify these size groups as age groups by examination of scales, opercula, and vertebrae proved unsuccessful.

DISCUSSION

Most of the characteristics studied in flathead chubs from Montana were similar to those reported for the species in the midwestern U.S. The July and August spawning season for flathead chubs in Montana was the same as has been reported for this species in Kansas (Cross 1967) and Iowa (Martyn and Schmulbach 1978), but it is more extended than the July season suggested by Brown (1971) and reported by Bishop (1975) for Montana and Peace River, Canada specimens. The water temperatures recorded during the spawning season of the flathead chub in Montana were virtually the same as those

TABLE 4. The numbers of males and females in samples of *Hybopsis gracilis* from Montana.

Sources of specimens	Total length (mm)	Sample size	Number of males	Number of females	Calculate X^2
Musselshell River, this study	71–171	75	38	37	0.007
Collections in MSU museum	79–154	53	25	28	0.085
Composite of above sources	71–171	128	63	65	0.016

Tabular $X^2 = 3.84$ at $P = 0.05$ with one degree of freedom.

TABLE 5. The length-weight relationships in collections of *Hybopsis gracilis* from Montana.

Collection locations and dates	Sample size	Total length (mm)	Intercept	Slope	Correlation coefficient (r)
Musselshell River,					
3 Mar 81	27 (males)	77–127	-5.299	3.082	0.98
3 Mar 81	23 (females)	71–123	-5.472	3.203	0.99
3 Mar 81	80*	30–127	-5.275	3.105	0.99
11 Mar 82	33	54–159	-4.991	2.936	0.99
19 Jul 83	24	62–155	-4.924	2.958	0.99
Five other locations,					
25 Jul 48					
6 Jul 57					
15 Jul 57					
22 Jul 65					
23 Jul 66	36	56–187	-5.395	3.151	0.99

*Includes the 50 specimens listed above

taken periodically during their breeding season in Iowa (Martyn and Schmulbach 1978). Other chubs also spawn when water temperatures reach about 25 C (Lee et al. 1980).

The minimum lengths of sexually mature flathead chubs found during this study were similar to those reported from Montana (Brown 1971), Kansas (Olund and Cross 1961), and Iowa (Martyn and Schmulbach 1978). The length-weight relationships of flathead chubs in Montana and Iowa (Martyn and Schmulbach 1978) also were alike.

The length groups of Montana flathead chub found during this study approximated the length at ages reported by Brown (1971) for an undetermined number of Montana conspecifics. If the length groups in this study represent age groups, it means Montana flathead chub grew more slowly than Iowa specimens (Martyn and Schmulbach 1978) during the first 3 years of life, respectively. This would also signify that Montana fish generally become sexually mature at age 3, but those in Iowa (Martyn and Schmulbach 1978) and Canada (Bishop 1975) mature at ages 2 and 4, respectively.

Olund and Cross (1961) and Cross (1976) reported the presence of minute tubercles on male flathead chubs and associated this with spawning activity. However, small tubercles were found on males and females as small as 78 (62 mm SL) and 85 mm TL (67 mm SL) during this study and were visible on representatives of both sexes as early as March and as late as November. Therefore, tubercles were also present on immature fish, and their existance was not limited to the known spawning season.

The maximum ovary weights as percents of total body weights of mature Montana flathead chubs were only about 60% of those found in Iowa flathead chubs (Martyn and Schmulbach 1978). This may mean Montana fish have fewer or smaller eggs.

The basic information available on the food habits, age and growth, and fecundity of the flathead chubs is fragmentary and inadequate. Information on the seasonal movements and habitat usage, spawning behavior, embryology, and interactions with other fish species appears to be nonexistent. Virtually all the limited biological information available on this species has been obtained from work on populations near the center of its range. Studies undertaken from near the extremes of the range of this species, the mouth of the Mississippi River (Douglas 1974) and the delta of the Mackenzie River (Scott and Crossman 1973), should show the maximum variations in the life history parameters of the flathead chub.

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