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Reprinted from TRANSACTIONS OF THE AMERICAN FISHERIES SOCIETY
Vol. 90, No. 3, July, 1961
pp. 269–276

Biology of the Utah Chub in Hebgen Lake, Montana[1]

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ABSTRACT

The Utah chub, *Gila atraria*, was probably introduced into Hebgen Lake, Montana, in 1935 by bait fishermen. Randomly set gill nets indicate that chubs are concentrated in shallow areas in the spring, widely distributed in the summer and fall, and concentrated in deeper waters in winter. Stomach analyses of 165 chubs collected during the summer of 1948 show that by volume the food was 48.2 percent algae, 21.1 percent higher aquatic plants, and 24.3 percent microcrustaceans. The 209 stomachs taken in 1953–54 contained 36 percent insects, 36 percent microcrustaceans, 19 percent higher aquatic plants, and 9 percent debris. The peak of the spawning season in 1953 and 1954 occurred during late June and early July. Most spawning occurred when water temperatures were above 54° F. Eggs were found on different kinds of bottom, but most were recovered from sand and gravel. The average number of eggs per female was 40,750. Fry occurred along most of the shallow protected shorelines. Fry captured on July 7, 1954, averaged 0.3 inch in total length. Young taken October 1, 1943, averaged 1.3 inches. No mature males less than 3 years old or mature females less than 4 were found. Total lengths for the first 8 years of life were calculated on 475 specimens.

INTRODUCTION

The Utah chub, *Gila atraria* (Girard), is native to the Bonneville Basin of Utah and the upper Snake River drainage of Wyoming and Idaho (Simon, 1946). It is presumed that this species was accidentally introduced into Hebgen Lake, Montana, by live-bait fishermen. Local residents report that schools of minnows, believed to be Utah chub, were first observed during the midthirties (1935–37). Chubs rapidly became more abundant and probably reached maximum abundance about 1948. They have remained at a high level since that time. Chubs have been collected in tributaries several miles above Hebgen Lake. Their known range below the lake includes all of the Madison River, and they may also be present in its tributaries. The chub is a poor food fish and is a nuisance to the fisherman because it readily takes most trout baits. Davis (1940) and Sigler (1935) report that a decline of the trout fishery in Fish Lake, Utah, appeared to be associated with an increase in the abundance of the Utah chub, but limited data from Hebgen Lake do not indicate a similar relationship.

Information on the biology of the Utah chub was necessary in order to develop a fisheries management program for Hebgen Lake. Preliminary investigations on abundance and food habits made in 1948 by R. A. Hayes and C. G. Bishop of the Montana Fish and Game Department and more intensive work on the biology conducted during 1953–54 by the writer are presented herein.

Hebgen Lake is an artificial impoundment (Figure 1) created in 1914 and located on the Madison River in Gallatin County, approximately 1 mile west of Yellowstone National Park. Its principal tributaries are Madison River, South Fork of Madison River, Grayling Creek, and Duck Creek—all of which arise in Yellowstone National Park. Most of the land around the lake is in the Gallatin National Forest and is used principally for recreation. The dam which impounds Hebgen Lake has a spillway elevation of 6,544 feet (mean sea level). The reservoir has a capacity of 344,730 acre feet, a surface area of 13,700 acres, and a maximum depth of 61.5 feet. Maximum recorded water temperature at the surface is 76° F. Ice usually forms during the latter part of October or early November and disappears in late April or early May. Methyl orange alkalinity was 77 p.p.m. and pH was 7.2 (November 11, 1954).

Prior to 1953 water was stored in Hebgen Lake during the spring and summer and released during fall and winter. Since 1953 water has been released rapidly in the fall so that the minimum level is usually reached in November. In a normal year the lake level is lowered about 17 feet and the volume reduced to 160,000 acre feet.

The Utah chub is the most abundant fish in Hebgen Lake. Brown trout (*Salmo trutta*) and mountain whitefish (*Prosopium williamsoni*) rank next and are followed by rain-

[1] Joint contribution from Montana State College, Agricultural Experiment Station, Project No. MS844, Paper No. 380 Journal Series, and the Fish Restoration Division, Project F-9-R, Montana Fish and Game Department.

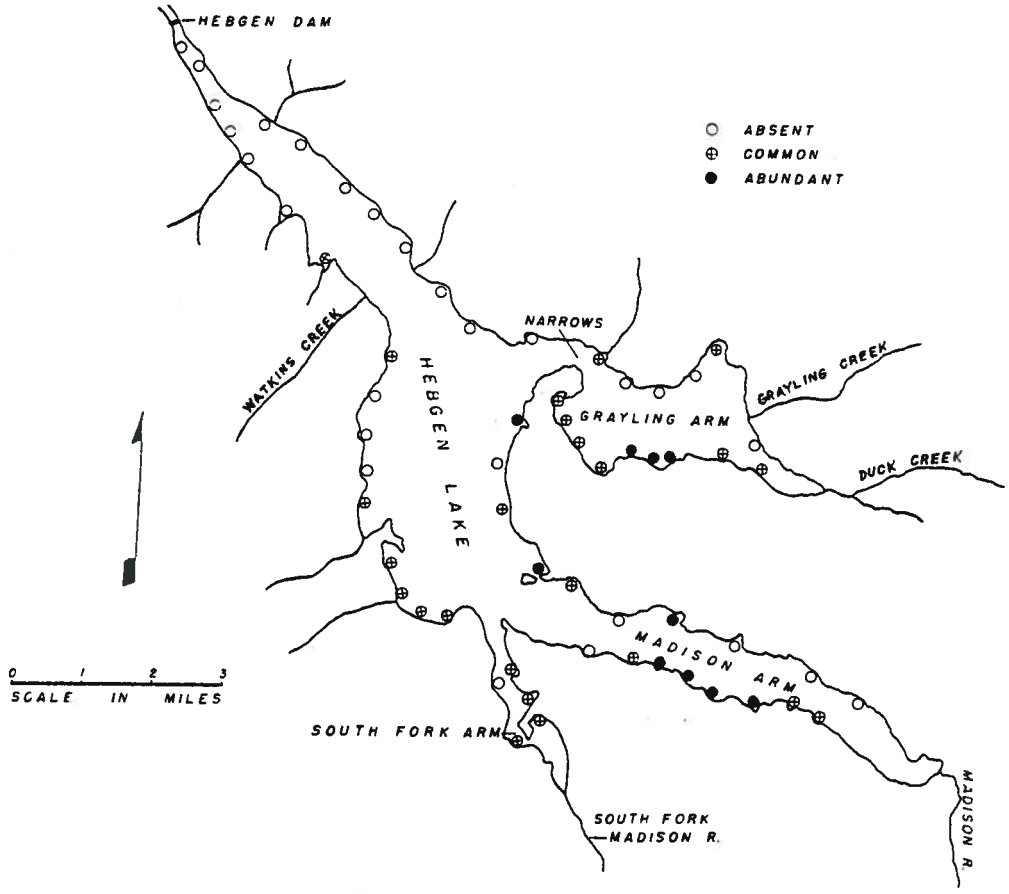

FIGURE 1.—Map of Hebgen Lake showing the distribution and general abundance of Utah chub fry in 1953–54.

bow trout (*Salmo gairdneri*). Cutthroat trout (*Salmo clarki*), brook trout (*Salvelinus fontinalis*), Arctic grayling (*Thymallus arcticus*), longnose sucker (*Catostomus catostomus*), longnose dace (*Rhinichthys cataractae*), and mottled sculpin (*Cottus bairdi*) occur in limited numbers.

Most observations and collections were made in the shallow areas of the lake, particularly the Grayling and Madison arms. Grayling arm is connected to the main lake by a short channel called "The Narrows" (Figure 1). Most of the arm has a depth of less than 15 feet, and during the winter it is almost completely drained. The principal bottom material is muck, although sand and gravel are present along the southern shoreline. The entire arm supported an extensive growth of aquatic vegetation in 1948. Pondweeds (*Potamogeton gramineus*, *P. pectinatus*, *P. richardsonii*), water ladysthumb (*Polygonum amphibium*), water crowfoot (*Ranunculus trichophyllus*), American milfoil (*Myriophyllum exalbescens*), and several algae were common. Local residents report that aquatic vegetation became much reduced during the following 2 years. By 1953 only scattered patches were found, mainly along the southern shoreline. The Madison arm is about 5 miles long and 1 mile wide. More than half of the arm has a depth of less than 15 feet. The bottom is primarily of sand and gravel. All plant species listed above were present, but pondweeds were most abundant.

ABUNDANCE AND DISTRIBUTION

Fish collections, except for fry and fingerlings, were made with 125-foot graded gill

TABLE 1.—*Fish capt gill nets set at ra in 1953–54*

Year	Species
1948[1]	Utah chu
	Whitefish
	Brown tr
	Rainbow
	Cutthroa
	Grayling
	Sucker
1953[2]	Utah chu
	Whitefish
	Brown tr
	Rainbow
1954[3]	Utah chu
	Whitefish
	Brown tr
	Rainbow
	Grayling

[1] 49 sets, average ti ing the morning.
[2] 48 sets, average ti ing the morning.
[3] 90 sets, average ti night.

nets (¾–2 inches were set at rando July 13 to Sept abundance of th mated from these netting operation fined to areas wh abundant. Over sets were made i arms during Jun less than 10 feet parable between catch per hour o

The Utah chu species in the 19 1954 the percenta greater, but this i to selection of si catch per hour fo in 1953, and 6.4 catch per hour w of gill-netting site in 1954 was thre in 1948 or 195 accounts for the nets set overnigh of fish their effi

Netting in 194 concentration of arm. In 1954, Madison arm ar The catch per ho respectively.

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TABLE 1.—*Fish captured in Hebgen Lake by 125-foot gill nets set at random in 1948 and set selectively in 1953–54*

Year	Species	Total number	Percentage of total	Catch per hour
1948[1]	Utah chub	708	72.5	7.3
	Whitefish	147	15.1	1.5
	Brown trout	79	8.1	0.8
	Rainbow	31	3.2	0.3
	Cutthroat	6	0.6	–
	Grayling	3	0.3	–
	Sucker	2	0.2	–
1953[2]	Utah chub	1,030	91.9	8.3
	Whitefish	26	2.4	0.2
	Brown trout	54	4.8	0.4
	Rainbow	10	0.9	0.1
1954[3]	Utah chub	4,595	90.2	6.4
	Whitefish	210	4.1	0.3
	Brown trout	265	5.2	0.4
	Rainbow	25	0.5	–
	Grayling	1	–	–

[1] 49 sets, average time per set 2.0 hours, set mostly during the morning.
[2] 48 sets, average time per set 2.9 hours, set mostly during the morning.
[3] 90 sets, average time per set 8.0 hours, set mostly overnight.

nets (¾–2 inches bar mesh). In 1948 gill nets were set at random throughout the lake from July 13 to September 21. The comparative abundance of the various species was estimated from these collections (Table 1). The netting operations of 1953 and 1954 were confined to areas where chubs were known to be abundant. Over 75 percent of the 1953–54 sets were made in the Madison and Grayling arms during June and July and at depths of less than 10 feet. Collections were not comparable between any 2 years with respect to catch per hour or species composition.

The Utah chub was the most abundant species in the 1948 collections. In 1953 and 1954 the percentage of chubs was considerably greater, but this increase was undoubtedly due to selection of sites for setting of nets. The catch per hour for chubs was 7.3 in 1948, 8.3 in 1953, and 6.4 in 1954. In 1953 the larger catch per hour was probably due to selection of gill-netting sites. The average time for sets in 1954 was three to four times greater than in 1948 or 1953. This difference probably accounts for the smaller catch per hour since nets set overnight frequently became so full of fish their efficiency was reduced.

Netting in 1948 indicated that the greatest concentration of chubs was in the Grayling arm. In 1954, 44 sets were made in the Madison arm and 39 in the Grayling arm. The catch per hour for chubs was 6.0 and 7.3 respectively.

Although no careful study of the seasonal distribution of the Utah chub in Hebgen Lake was made, some general trends were discernible. The adult chubs apparently move from the deeper parts of the lake into shallower areas when the ice disappears and the water level rises. On May 5, 1954, a shallow set at the Narrows in Grayling arm caught only trout and whitefish. At this time most of the lake was covered with ice. On May 23, after ice had disappeared, nets placed in the same area took many chubs. Chubs were abundant in shallow areas throughout the summer, but the catch showed a decline in early July, 1954. At this time most of the chubs had completed spawning, and many small schools of adults were observed moving along the shoreline. Resort owners near the deeper areas of the lake report that chubs are seldom observed until early July. During midsummer large schools were observed by the writer and reported by local residents in widely scattered parts of the lake. Chubs were present in shallow areas through September and October. On November 11, 1954 (ice was beginning to form), a net placed in the shallows of Grayling arm took whitefish but no chubs. These observations indicate that chubs are largely concentrated in deeper sections of the lake during the winter. A similar seasonal distribution was reported for the Tui chub (*Siphateles bicolor*) in Eagle Lake, California (Kimsey, 1954).

FOOD HABITS

During 1948 the stomach contents of 165 chubs, ranging from 5.3 to 14.5 inches in length, were examined. Specimens were collected by angling and gill-netting at irregular intervals during June, July, August, and September. Stomachs were immediately preserved in formalin, the contents from each stomach sorted into taxonomic groups, and the volume of each group was measured by displacement (Table 2). Food of all size groups was very similar. Algae (48.2 percent) and higher aquatic plants (21.1 percent) constituted 69.3 percent of the total food volume of all chubs. Cladocera ranked next with 24.3 percent. The combined volume of insects amounted to 0.7 percent of the total, and unidentified material and debris made up 3.6 percent of the food volume. Sigler (1953) reported that the principal food items of 90 Utah chubs from Fish Lake, Utah, were *Daphnia* and *Gammarus* with algae ranking next.

Stomachs of 209 chubs collected during the summers of 1953 and 1954 were examined.

TABLE 2.—*Percentage frequency of occurrence and percentage of total volume of food items in stomachs of 165 Utah chubs taken in 1948, and 209 in 1953–54, Hebgen Lake*

Item	1948		1953–54	
	Occurrence	Volume	Occurrence	Volume
Algae	31	48	7	tr.[1]
Higher aquatic plants	29	21	44	19
Nematoda	1	tr.	1	tr.
Mollusca	10	1	3	tr.
Hirudinea	1	1	–	–
Cladocera	58	24	55	36
Copepoda	8	tr.	–	–
Amphipoda	4	tr.	tr.	tr.
Odonata	–	–	tr.	tr.
Ephemeroptera	2	tr.	18	8
Homoptera	–	–	2	1
Trichoptera	–	–	5	tr.
Diptera	60	1	64	27
Coleoptera	1	tr.	tr.	tr.
Arachnoidea	16	tr.	1	tr.
Unidentified and debris	41	4	59	9

[1] tr.=trace.

Over 90 percent of the specimens were secured from gill nets set for 2 hours or less. The kinds, percentage of occurrence, and estimated percentage of volume of food of chubs are given in Table 2.

Microcrustacea and insects each constituted 36 percent of the total volume. *Daphnia* was the most important crustacean. Larvae and pupae of Diptera made up about 75 percent of the volume of insects and Ephemeroptera nymphs about 20 percent. Other orders of insects represented were Odonata, Homoptera, Trichoptera, and Coleoptera. Higher aquatic plants comprised about 19 percent and unidentified material and debris 9 percent of the total volume.

A comparison between the foods of chub taken in 1948 and those taken in 1953–54 indicated a change in diet. Approximately 65 percent of the stomachs examined in 1948 were collected in Grayling arm and in the vicinity of the Narrows. During 1953–54 approximately 70 percent of the stomachs were collected in these areas. In 1948 algae occurred in 31 percent of the stomachs and constituted about one-half of the volume, while in 1953–54 algae were found in 7 percent of the stomachs and amounted to only a trace of the volume. Insects (principally Diptera larvae and pupae) replaced algae in volume as they increased from 0.7 percent in 1948 to 36 percent in 1953–54. The change in diet probably resulted from a reduction of aquatic vegetation which occurred in these areas between the two study periods. Contrary to Jordan and Evermann (1896) who characterized the Utah chub as "extremely destructive of other fishes, especially to young trout," no fishes of any kind were found in the stomachs of the 374 chubs studied.

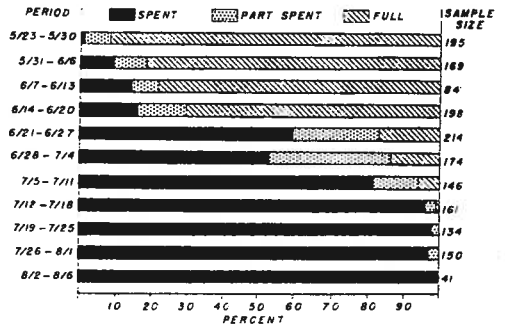


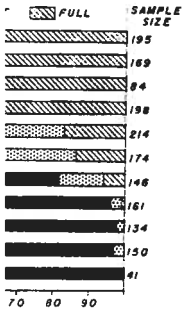
FIGURE 2.—Ovary condition of 1,666 chubs captured during the summer of 1954 in Hebgen Lake, Montana.

SPAWNING

The gonads of all Utah chubs collected in 1953–54 were examined to determine maturity and sex. Depending upon the condition of the ovaries, the mature females were classified as follows: (1) spent—ovaries with very few or no eggs; (2) partially spent—ovaries containing about one-half their egg capacity; (3) full—ovaries full of eggs. Some very ripe females may have lost eggs while struggling in gill nets, but this probably was of little significance to the findings since these females would have spawned within a few days.

The 304 mature female chubs collected May 30–July 12, 1953, were classified as to the condition of their ovaries and grouped by collection periods. All females collected on May 30 were full. The proportion of spent females increased from about 33 percent (June 15–28) to about 76 percent (June 29–July 12), while the full females decreased from about 50 percent to 6 percent during this period. Approximately 20 percent of the females taken were partially spent.

In 1954, 1,666 female chubs were collected, and all except 27 were taken by gill nets. They were classified and grouped by collection periods between the dates of May 23 and August 6 (Figure 2). During the first collecting period (May 23–30) only 1 percent of the captured females were spent. The number of spent females taken May 31–June 20 remained at a low level (13.5 percent) but increased to about 63 percent for periods extending from June 21 to July 11. Over 95 percent of the females collected between July 12 and August



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1 were spent, and during the last period (August 2–6) all were spent.

The rapid rate of increase in proportion of spent females with a corresponding decrease in full females as the netting progressed indicates that the peaks of spawning for 1953 and 1954 were during late June and early July. The fact that in 1954 the largest percentages of partially spent females were noted between June 21 and July 11 further suggests that the peak of spawning occurs in this period. Beginning and ending dates of the 1953 spawning season were not determined. In 1954 the spawning apparently began in May and extended into August. Many ripe males were observed throughout the 1953 collecting period (May 30–July12). In 1954 ripe males were abundant from the earliest collections (May 23–30) until mid-July, and there was some indication that males ripened sooner than females.

Two water temperature stations were established in Hebgen Lake, one in the Madison arm and the other at the Narrows. Maximum–minimum thermometers were placed about 2.5 feet below the surface, and readings were taken at irregular intervals during collecting periods. Water temperature in 1953 during the peak of spawning (June 17–July 9) averaged 60.2° F. with a maximum of 68° and a minimum of 54°. In 1954 the average water temperature was determined for periods corresponding to chub-collecting periods and then compared with the incidence of spent females (Figure 3). Average water temperatures between May 30 and June 21 were below 55° F., and the occurrence of spent females during this time remained below 20 percent. The increase in the percentage of spent females for the period June 21–27 was associated with an increase in the water temperature. Most spawning apparently occurs in water temperatures above 54° F.

Two methods were used to locate chub spawning areas: (1) observation of the fry distribution which would indicate the location of spawning areas with respect to the lake shoreline; and (2) selection of specific areas for bottom sampling to recover eggs.

Information on the presence and distribution of fry was obtained by seining and observation of the shoreline during 1953–54 (Figure 1). The length of shoreline surveyed at each sampling point varied from 75 to 3,500 yards.

The western part of the main lake, from the dam to Watkins Creek, is characterized by

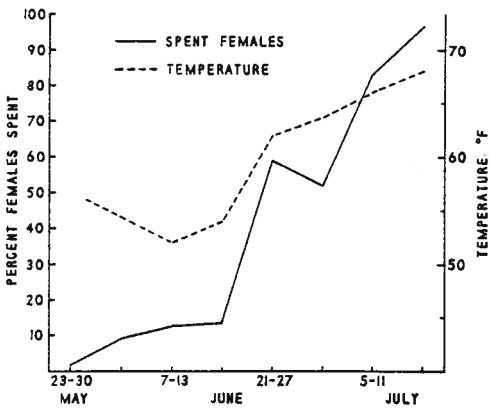

FIGURE 3.—Relationship between temperature and the percentage of spent females occurring in periodic 1954 collections in Hebgen Lake, Montana.

steeply sloping bottoms, and no fry were found there. From Watkins Creek to the South Fork arm the shore has steeply sloping bottoms interspersed with shallow areas. Here fry were locally distributed in protected areas but were never abundant. A few fry were present in several shallow bays of the South Fork arm. Fry were distributed in the numerous shallow areas along the southern shoreline of the Madison arm, and many were observed in certain of these areas. One heavy concentration of fry was found along the northern shore of the Madison arm in a protected shallow area, but fry were abundant in several protected shallow areas along the shoreline from the Madison arm to the Narrows. In the Grayling arm, fry were found along most of the southern shoreline, but heavy concentrations were confined to areas with sand and gravel bottoms. Fry were seldom found along the northern shores of this arm. In 1948, when aquatic vegetation was abundant in Grayling arm, numerous fry were observed in certain areas which had bottoms of silt and muck, but these areas had few or no fry in 1953–54 when vegetation was nearly absent. Few protected shallow areas occur between Grayling arm and the dam, and no fry were found along this shoreline.

Because southwesterly winds prevail during the summer, the northern shores of the lake are subjected to severe wave action. Fry were seldom found in such exposed areas even though other factors seemed favorable for spawning. Fry occurred along most shallow protected shorelines, and the heaviest con-

centrations were found in the Madison and Grayling arms.

In 1954 specific areas were selected for bottom sampling in an attempt to recover eggs. Chub eggs were collected by removing a thin surface layer of the bottom with a scoop or by dragging a fine-mesh insect net through bottom material stirred with the feet. Eggs were separated from bottom materials by successive washings through graded screens. No quantitative samples were taken.

Eggs were recovered from 25 of 47 bottom samples taken June 25–July 9. They were found on gravel, sand, silt, muck, and detritus bottoms, but most were recovered from sand and gravel. Eggs were found at depths of 1 to 4 feet and at distances 2 to 150 feet from shore. They were undoubtedly present at greater depths, but no samples were taken because there were limitations to the collecting methods.

Submerged plants were not abundant during the sampling period, and those present had made very little growth. No eggs were found adhering to plants. Numerous examinations of submerged snags, stumps, and brush in shallow water revealed no attached eggs. Two mats (3 by 4 feet) of woven willow branches, a piece of driftwood, and an iron pipe were placed at depths of 8 to 10 feet in areas where spawning was believed to occur. They were checked periodically during the spawning period, but no eggs were found on them. None were taken in surface plankton hauls over known spawning areas. Deposition and fertilization of eggs were not observed. No evidence was found of nest construction, and the distribution of eggs indicates that they are broadcast over the bottom.

The Montana Fish and Game Department maintained rainbow trout spawning stations on several tributaries to Hebgen Lake for many years. Traps were operated during May and June, and trap tenders reported that very few chubs were taken. No movement of chubs into tributary streams was observed during the present study.

The approximate number of eggs in seven females ranging in size from 8.8 to 13.8 inches and collected during June 1953 was determined. Numbers were calculated from the volumes of the egg sacs. The average number of eggs per female was 40,750 with a minimum of 15,900 (8.8-inch fish) and a maximum of 62,400 (13.8-inch fish).

TABLE 3.—*Size of Utah chub fry and fingerlings in collections from Hebgen Lake, Montana*

Period		Number	Total length (inches)[1]	
			Range	Average
1953				
August	3–6	275	0.4 – 1.3	0.8
August	27–28	345	0.6 – 2.1	1.0
September	15–16	265	0.6 – 2.0	1.2
October	10	62	0.8 – 2.0	1.3
1954				
July	7–9	224	0.25 – 0.5	0.3
July	21–28	226	0.25 – 0.7	0.5
September	7–8	157	0.8 – 1.5	1.1

[1] Measurements from specimens preserved in 10-percent formalin.

AGE AND GROWTH

The first fry were observed in 1953 on August 3 (Table 3) when they ranged in total length from 0.4 to 1.3 inches with an average of 0.8. In 1954 fry were first observed on July 7, and these ranged in total length from 0.25 to 0.5 inch with an average of 0.3. Fry and fingerlings were collected from depths that could be waded at irregular intervals from August to October in 1953 and in July and September in 1954. Fingerlings which averaged 1.3 inches in total length were collected on October 31, 1953. During late September and October fingerlings became scarce. The average total length of young of the year during these months is probably greater than indicated in the samples since larger fish apparently move into deeper water.

A collection of fry (0.8 inch total length) on October 31, 1953, suggests that at least a few chubs may not form scales during their first growing season. Scales with one to three circuli were found on fish 1.0 inch in total length. Scales were not detected on fish 0.8 inch long, but bony plates without circuli were found on several specimens with a total length of 0.9 inch. Kimsey (1954) found scales forming on *Siphateles bicolor* when standard length was 0.78–0.97 inch.

A length-frequency polygon of 189 fry and fingerlings collected from one area on August 6, 1953, indicates that two age groups were present (Figure 4). The average total lengths of fish in the first and second groups were 0.9 and 2.8 inches, respectively, and scales of fish in the second group showed them to be yearlings.

Total lengths of mature male, mature female, and immature chubs collected by gillnetting in 1954 were determined (Figure 5). Fish with undeveloped gonads were classified as immature and were not sexed. The 524

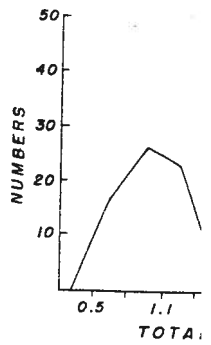

FIGURE 4.—Length
collected on August
Hebgen Lake, Monta

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TABLE 4.—*Average ca*
Montana—1953–54 c

Age group	Sex	Num
I	I[1]	3
II	I	
III	I	3
	M	1
IV	I	2
	M	2
	F	
V	I	
	M	5
	F	4
VI	M	8
	F	10
VII	M	
	F	2
VIII	F	
Grand total	I	104
	M	18
	F	18
	All	475

[1] Immature.

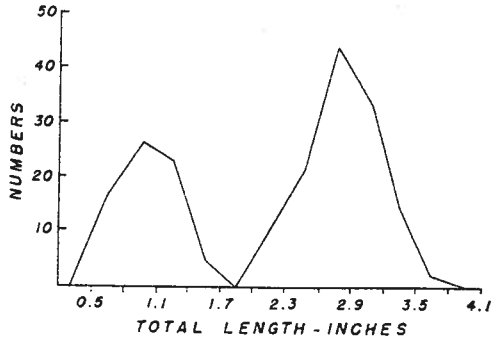

FIGURE 4.—Length frequency for 189 Utah chubs collected on August 6, 1953, from one location in Hebgen Lake, Montana.

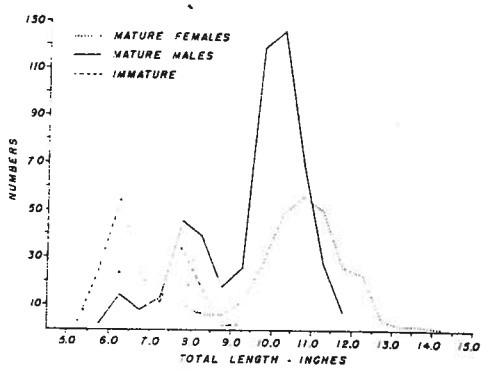

FIGURE 5.—Length frequencies for 524 mature male, 284 mature female, and 175 immature Utah chubs collected by gill nets during 1954 in Hebgen Lake, Montana.

mature males ranged in length from 5.8 to 11.8 inches with an average of 9.4. The 284 mature females varied in length from 7.4 to 14.2 inches with an average of 10.6, or more than 1 inch greater than the average males.

The length-frequency distribution of the fish suggests one age group between 5.0 and 7.5 inches and another between 7.5 and 9.0 inches. Study of the scales shows that fish in the first size group were nearly all 3 years old and those in the second were 4 years old. Of the 160 fish in the first group 74.4 percent were immature, 25.0 percent were mature males, and 0.6 percent were mature females. In the second group of 182 fish, 29.1 percent were immatures; 57.1 percent mature males, and 13.8 percent mature females. No mature males less than 3 years were found, and no mature females were younger than 4 years. Most of the measurements were made on fish caught in nets set in spawning areas just prior to the peak of the spawning activity (June 21–27). These nets took mostly males (age-groups V and VI) which accounts for the large mode at about 10.5 inches. A few chubs with undeveloped gonads were 5 years old. There is considerable overlap in age and size between immature and mature chubs, but males apparently mature a year sooner than females.

Scales of 475 Utah chubs (188 mature males, 183 mature females, 104 immatures) collected during 1953–54 were studied. These fish ranged in total length from 2.2 to 14.5

TABLE 4.—*Average calculated total length (inches) of Utah chubs at succeeding annuli in Hebgen Lake, Montana—1953–54 collections*

Age group	Sex	Number	Average total length at capture (inches)	Calculated length at each annulus							
				1	2	3	4	5	6	7	8
I	I[1]	38	2.8	1.7	–	–	–	–	–	–	–
II	I	2	4.5	1.4	3.1	–	–	–	–	–	–
III	I	38	6.2	1.6	3.4	6.2	–	–	–	–	–
	M	15	6.2	1.6	3.7	6.2	–	–	–	–	–
IV	I	24	7.6	1.4	3.0	5.4	7.6	–	–	–	–
	M	22	7.7	1.6	3.4	5.7	7.7	–	–	–	–
	F	7	7.6	1.4	3.2	5.4	7.6	–	–	–	–
V	I	2	8.2	1.3	2.4	4.1	6.4	8.2	–	–	–
	M	56	9.3	1.6	3.7	6.0	7.9	9.2	–	–	–
	F	44	9.7	1.6	3.9	6.1	8.0	9.6	–	–	–
VI	M	88	10.5	1.5	3.3	6.1	8.2	9.5	10.5	–	–
	F	101	11.0	1.6	3.7	6.3	8.4	9.9	10.9	–	–
VII	M	7	11.8	1.5	3.1	6.0	8.4	9.8	10.9	11.8	–
	F	27	12.5	1.6	3.4	6.5	8.9	10.4	11.5	12.4	–
VIII	F	4	13.6	1.4	3.0	5.7	8.4	10.7	11.8	12.8	13.6
Grand total	I	104	–	1.6	3.4	5.9	7.5	8.2	–	–	–
	M	188	–	1.5	3.5	6.0	8.0	9.4	10.5	11.8	–
	F	183	–	1.6	3.7	6.3	8.4	9.9	11.1	12.5	13.6
	All	475	–	1.6	3.5	6.1	8.2	9.7	10.9	12.4	13.6

[1] Immature.

inches and represented age-groups I to VIII. Scales were taken from the left side of the body between the lateral line and dorsal fin. Annuli beyond the fifth year were crowded and usually difficult to detect. Scale measurements were made along the anterio-lateral radius. Calculated total lengths at each annulus were determined with a nomograph (Table 4), assuming a linear relationship between scale and body growth, since Neuhold (1955) found almost complete linearity in the body-scale relationship of the Utah chub.

The average calculated total length at each annulus was greater for females than for males and increased from 0.1 inch at annulus I to 0.7 inch at annulus VII. Because 27 females and 7 males in the sample were 7 years old, and 4 females and no males were 8 years old, it appears that females live longer than males.

The average calculated total length in inches of all chubs at the time of annulus formation at succeeding ages was I, 1.6; II, 3.5; III, 6.1; IV, 8.2; V, 9.7; VI, 10.9; VII, 12.4; VIII, 13.6. Hazzard (1935), who studied the growth of 26 Utah chubs from Fish Lake, Utah, calculated that total lengths in inches at the end of each year of life for the first 5 years were 1.3, 3.5, 5.5, 6.6, and 7.4 inches, respectively. The Fish Lake chubs were comparable in length at the second annulus with the Hebgen Lake specimens, but thereafter those from Hebgen Lake grew more rapidly. Neuhold (1955) reported that the weighted mean standard lengths of Utah chubs at the end of succeeding years of life from I to XI in Panguitch Lake were 1.3. 2.3, 3.6, 4.9, 5.7, 6.3, 6.8, 7.3, 7.9, 8.6, and 8.8 inches, respectively, and in Navajo Lake were 1.6, 2.6, 4.2, 5.4, 6.1, 6.7, 7.1, and 8.0 inches, respectively.

ACKNOWLEDGMENTS

The author wishes to thank Dr. C. J. D. Brown, who directed the study and helped in preparing the manuscript, and Mr. R. Knight, who assisted with the field work. F. Jans, D. Ridley, and F. Miller, resort operators on Hebgen Lake, provided boats and dock facilities. The Montana Fish and Game Department provided financial support through its Dingell–Johnson Program, and the Montana State College Agricultural Experiment Station furnished certain equipment.

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