UNIVERSITY OF WISCONSIN STEVENS POINT

STEVENS POINT, WISCONSIN

THE MUSEUM OF NATURAL HISTORY

Reports on the Fauna and Flora of Wisconsin

No. 12. Ecology of the Creek Chub

ECOLOGY OF THE CREEK CHUB

BY

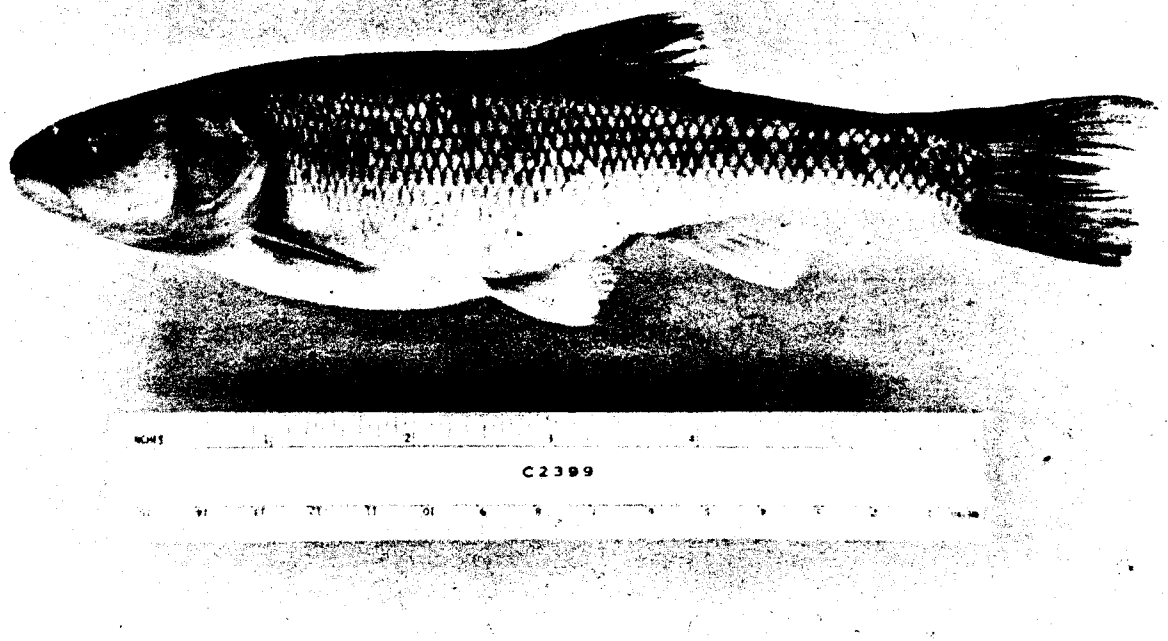
FREDERICK C. COPES
University of Wisconsin - Stevens Point

Principal Editors for this Number:
George C. Becker and Charles A. Long

April 30, 1978

THE MUSEUM OF NATURAL HISTORY
Stevens Point, Wisconsin

Reports on the Fauna and Flora of Wisconsin
No. 12



NORTHERN CREEK CHUB. FEMALE, 195 MM., FROM CEDAR CREEK,
OZAUKEE COUNTY, WISCONSIN, AUGUST 1, 1963.

ECOLOGY OF THE CREEK CHUB
SEMOTILUS ATROMACULATUS (MITCHILL)
IN NORTHERN WATERS (CYPRINIDAE)

The creek chub is found from Newfoundland west to the Rockies, south to northern Florida and the Gulf of Mexico (Trautman, 1957). In Wyoming, the creek chub is native and abundant in the North and South Platte, Big Horn, Niobarara, Tongue, and Belle Fourche river drainages, and has been introduced into other areas by bait fishermen (Baxter and Simon, 1970). It is found in all major drainages in Wisconsin and eastern North Dakota (Copes and Tubb, 1966).

The creek chub was second to the brassy minnow as the most abundant cyprinid collected during this study and was a top carnivore at many study sites. It is of some economic importance in that it is occasionally used as food or as a bait fish by man. Carlander (1969) presented an excellent review of literature on the creek chub. Reighard (1910) described nest building, territorial behavior, and the spawning act of the creek chub. Life history studies of the creek chub were conducted by Dinsmore (1962), Leonard (1927), Dobie et al. (1956), and Greeley (1930).

AREA AND TIME OF STUDY

As part of the field investigations reported here, intensive studies of creek chubs were conducted from December 1967 to August 1970, and in July 1975, in Sand Creek and Laramie River, Albany County, Wyoming. Additional studies in Wisconsin were conducted from March 1971 through 1975 in Mill Creek and Plover River, Portage County; Tomorrow River, Portage and Waupaca Counties; Marengo River, Bayfield and Ashland Counties; and Castle Creek, Bayfield County, Wisconsin. Twenty lakes were surveyed in central and northern Wisconsin from

1971 through 1976. Laboratory aquaria investigations were conducted periodically from 1967 through 1975.

MATERIALS AND METHODS

Dipnets, a bag seine of one-quarter inch mesh size, three-sixteenth inch mesh minnow traps, weighted explosives (cherry bombs), rotenone and electrofishing gear were used to collect fish during this study. Fish were collected under special permits issued by the North Dakota Fish & Game Department, Wyoming Fish and Game Department, and the Wisconsin Department of Natural Resources.

Measurements and meristic counts were made according to Hubbs and Lagler (1958). In this report fish weights are in grams and length refers to total length in millimeters.

Some stomachs and the anterior part of the intestines were removed and the contents emptied on to a microscope slide or shallow glass dish. The contents were examined under various magnifications of a binocular dissecting scope and, if needed, a compound microscope. Food items were counted and an attempt was made to identify the food items to the lowest taxonomic category. Stomach contents were placed in graduated centrifuge tubes and the relative volumes (cubic mm) of the various food items were recorded. Data were recorded as numbers of items, frequency of occurrence, and estimated per cent of total volume.

External examinations for parasites and evidence of disease were conducted in the field and laboratory prior to preservation. Internal examination was aided by the use of a microscope. Parasites were identified and fixed by Edwin Keppner, Department of Zoology and Physiology, University of Wyoming.

The population structure was determined using a combination of length-frequency and the scale method described by Lagler (1956) and Rounsefell and Everhart (1965). Size ranges for each age group were determined.

The average weights and lengths were calculated for each age class. Assuming that the summer growth period was terminated by early September. the difference between the average weight or length of age class i and age class i - 1 was interpreted as the calculated annual increment of growth (length or weight). Fish collected later in October, November, April,and May fell within the same weight and length classes that were determined for the September fish. Therefore, the assumption that most growth ceased by early September appears valid.

The weight-length relationship of the species ($W = aL^b$) was computed by the logarithmic formula:

$$\log W = \log a + b \log L$$

Where:

W = weight in grams

L = length in mm

a and b are constants

The average coefficient of condition, K, was calculated from fish recovered after chemical treatment and electrofishing for each age class of the species using the formula:

$$K = \frac{\frac{10^5 W}{L^3}}{n}$$

Where:

K = coefficient of condition

W = weight in grams

L = length in mm

n = number of fish in sample

Survival of fish species was calculated by Jackson's (1930) formula:

$$S = \frac{N_2 + N_3 + N_4 + \ldots N_r}{N_1 + N_2 + N_3 + \ldots N_{r-1}}$$

Where:

S = survival

N_1 through N_r are the number of fish in the respective age classes.

The mean values reported in this study were arithmetic unless otherwise specified.

It was assumed that sample sites and samples were randomly selected, and the samples were representative of study areas.

HABITAT AND BEHAVIOR

The creek chub was found throughout the study areas in Wisconsin, Wyoming, and North Dakota and was abundant in warm water streams. It made up 60 percent of the estimated total fish population and 52 percent of the total fish biomass in the lower reaches of Sand Creek, Wyoming, and 16 percent of the estimated total fish population and 24 percent of the total fish biomass in the upper reaches of Sand Creek. Stream sections of the Tomorrow River, Wisconsin, were found to have 149 fish per 100 feet of stream in August 1975. Trautman (1957) lists the creek chub as an abundant inhabitant of creeks and small streams, having gradients of 10 to 75 feet per mile, which had scoured bottoms of sand,

gravel, boulders, well defined riffles, and pools with brush, roots, or other cover sufficient for retreat in times of danger. Trautman's description of creek chub habitats is a good description of Sand Creek, Tomorrow River, and Marengo River.

The creek chub was primarily a schooling species and schools were observed in all types of stream habitats. During the spring and summer, schools of larger creek chubs were generally inactive until the water temperature had increased a few degrees from the daily minimum. In August, schools of age-class 0 creek chubs were active throughout the day and were found in shallow runs. Age-class 0 creek chubs were commonly observed with age-class 0 longnose dace and common shiners, and they avoided deeper areas which were occupied by larger fish. Age-class 1 and small age-class 2 creek chubs usually were found in schools which occupied the edges of pools and deeper runs. Immature creek chubs were found to frequent flooded areas in June and July. Creek chubs, larger than 180 mm, generally did not school, and occupied a sheltered spot in a deep pool or run at the edge of the current.

In August when the flow was low, creek chubs were generally found in shaded and sheltered sections of pools and deeper runs. There was vertical and horizontal stratification of fish sizes in the larger pools, with larger suckers, trout, and larger creek chubs occupying the bottom and lower levels of water in the center of the pools, while smaller fish occupied the upper levels of water in the center and the bottom nearer the edges of the pools, and fry occupied the shallowest areas near the edges of the pools.

Creek chubs wintered in deeper pools and runs. They were seen lying on the stream bottom, and many were collected from under stream shelter (rocks,

logs, vegetation, etc.) in November. Trapping results indicated they were generally inactive during the winter.

When alarmed, schools of creek chubs would break up and they would swim rapidly toward vegetation and other shelter. Riffles were not barriers to daily movement as many creek chubs were seen swimming up or down a riffle to a deep run or pool.

Fifty-one creek chubs, 150 to 240 mm, were marked with dart tags in Sand Creek, in August, 1968. Thirty-eight of the marked fish were recaptured in August and September, 1968 (Copes, 1970). No recaptured fish had moved more than 100 feet from where it was tagged. Ten creek chubs were found to have moved from one large pool to another within a 24 hour period. Creek chubs were found in 18 of 20 lakes surveyed in Wisconsin, believed to have been introduced by bait fishermen.

FEEDING HABITS AND FOOD

Creek chubs fed both in schools and individually. School of age-class 0 fish fed actively throughout the day on drift and benthic organisms, and were observed searching in vegetation for food organisms. Age-class 1 and smaller age-class 2 fed extensively in vegetated areas of streams.

Schools of larger creek chubs were not observed feeding before 11 AM in April and early May. Schools of creek chubs usually did not leave the sheltered areas where they spent the night until the water temperatures had increased a few degrees from the daily minima. Schools of larger chubs were seen foraging on the bottom and in vegetation for a one to two-hour period. They then returned to a pool or deep run and appeared to lie and wait for drift items. As a drift organism entered the vicinity of the creek chub aggregation, 2 to 50 chubs would rush to consume it. Any small item dropped

on the surface would bring a rush of chubs to it. Leaves, small sticks, willow buds, insects, etc. were dropped on the surface of pools in July and August and all were consumed by the chubs. Creek chubs were seen to pursue invertebrates and smaller fish on several occasions. Creek chubs, in excess of 175 mm in length, generally did not forage or feed in schools, but fed individually on fish and larger invertebrates. Creek chubs were observed feeding on tadpoles on several occasions.

The contents from the stomachs of 144 creek chubs collected in Wyoming were examined. Insects made up 35.2 percent, fish 30 percent, insect remains 18.3 percent, amphipods 5.2 percent, frogs 4.6 percent, vegetation 1.4 percent, leeches 0.8 percent, and gastropods 0.8 percent of the total volume of food consumed (Table 1). The stomachs of 21 percent of the fish examined were empty. Amphipods and insects made up 100 percent of the stomach contents of age-class 0 creek chubs (Table 2). The composition of the stomach contents was not the same for fish collected in upper and lower Sand Creek (Table 2). The difference in the composition of stomach contents of fish collected in the upper and lower Sand Creek was believed due to difference in abundance of various aquatic organisms. The volume of food from the stomachs of 50 creek chubs collected in North Dakota were 60 percent insect, 28 percent fish, 7 percent vegetation, 2.8 percent gastropods, and 2.2 percent amphipods.

Forage ratios and feeding selectivity was not determined because most drift food items could not be distinguished from benthic food items.

The food items consumed by age-class 0 fish were similar to that of age-class 1 fish (Table 2). The main difference was age-class 0 fish consumed smaller insects and amphipods (earlier instars), while age-class 1 creek chubs consumed larger insects and amphipods. Fish were not found in the stomach of

Table I. Stomach contents of 144 creek chubs collected from Sand Creek, expressed in per cent frequency of occurrence and estimated per cent of total volume (in parentheses).

Food Items	July 1968	Aug. 1968	Oct. 1968	Apr. & May, 69	June & July, 69	Aug. 1969	Sept. 1969	July 68-Sept. 69
Diptera L*	7.6 (1)	0	11.1 (2.5)	13.3 (10.8)	2.5 (.3)	0	3.1 (.8)	4.1 (1)
A	23 (19)	44.4 (21.0)	11.1 (1.3)	0	25 (39.6)	7.6 (1.0)	6.2 (1.7)	13.1 (17.2)
Ephemeroptera N	0	11.1 (5.4)	11.1 (2.5)	0	2.5 (0.3)	15.3 (5.5)	6.2 (3.5)	6.2 (3.0)
A	0	0	0	0	7.5 (1.5)	3.8 (0.5)	0	2.4 (0.8)
Trichoptera L	38.4 (11)	33.3 (18.9)	11.1 (2.5)	53.3 (34.7)	17.5 (6.2)	7.6 (6.5)	6.2 (5.2)	20.1 (8.7)
Odonata N	7.6 (1)	0	11.1 (3.7)	20.0 (10.8)	12.5 (2.3)	3.8 (0.5)	3.1 (1.7)	8.3 (2.1
Coleoptera A	15.3 (10)	22.2 (5.4)	0	0	10.0 (5.0)	11.5 (2.5)	18.7 (8.7)	9.0 (4.0)
Hemiptera A	0	0	0	0	7.5 (1.5)	0	0	2.0 (0.4)
Hymenoptera A	0	0	11.1 (2.5)	0	2.5 (0.3)	11.6 (3.5)	6.2 (4.3)	4.8 (1.6)
Hirudinea	15.3 (2)	0	11.1 (2.5)	0	0	0	6.2 (3.5)	3.4 (0.8)

Table I (continued)

Food Items	July 1968	Aug. 1968	Oct. 1968	Apr. & May, 69	June & July, 69	Aug. 1969	Sept. 1969	July 68-Sept. 69
Amphipoda	7.6 (2)	22.2 (10.8)	22.2 (5.0)	0	7.5 (3.1)	15.3 (7.0)	15.6 (8.7)	11.1 (5.2)
Gastropoda	0	0	0	0	2.5 (0.3)	0	3.1 (5.2)	1.2 (0.8)
Fish	15.3 (30)	11.1 (27.0)	22.2 (50.0)	13.3 (43.4)	10.0 (23.3)	23.0 (35.0)	9.1 (26.0)	11.8 (30.0)
Frogs L	7.6 (20)	0	0	0	2.5 (3.8)	0	0	1.2 (3.5)
A	0	0	11.1 (10.0)	0	0	0	0	0.6 (1.1)
Vegetation	23 (3)	0	0	0	2.5 (0.3)	0	0	2.7 (1.4)
Insect Remains	15.3 (2)	44.4 (27.0)	44.4 (15.0)	0	25.0 (11.6)	46.1 (35.0)	40.6 (31.6)	31.2 (18.3)
Number of empty stomachs	2	3	1	2	8	3	11	30
Number of fish examined	13	9	9	15	40	26	32	144

*L = larvae, A = adult, N = nymph

Table II. Stomach contents of creek chubs collected from upper and lower Sand Creek, Wyoming, August, 1969, and Castle Creek, Wisconsin, 1975, expressed in percent frequency and estimated percent of total volume (in parentheses).

	Sand Creek			Castle Creek
	Adult Fish		Age 0 Fish	Adult Fish
Food Item	Upper	Lower		
Diptera A*	16.6 (3.7)	(10) (1.6)	40 (16.6)	6 (2.1)
L	0	0	20 (10)	4 (1.2)
Ephemeroptera N	8.3 (3.7)	30 (6.1)	20 (6.6)	26 (4.1)
Trichoptera L	20 (21.5)	0	10 (3)	0
Odonata L	0	10 (1.5)	0	4 (2.3)
Coleoptera A	16.6 (3.7)	0	20 (13.3)	10 (4.4)
Hymenoptera A	8.3 (3.8)	10 (1.5)	0	
Amphipoda	0	20 (3.0)	50 (24.0)	30 (6.4)
Hirudinea	0	10 (1.5)	0	
Fish	8.3 (49)	30 (46.1)	0	28.4 (62)
Insect remains and vegetation	41.6 (20.4)	40 (38.4)	60 (27)	48 (17.5)
Number of empty stomachs	3	0	0	4
Number of fish examined	12	10	10	50

*A = adult, L = larvae, N = nymph

any creek chub smaller than 95 mm in length. Fish made up 90 percent of the volume of food consumed by creek chubs which were 175 mm or greater in length.

The contribution each food item made to the diet of the creek chub varied throughout the year. The changes in diet composition, the frequency of occurrence, and percent contributed by each food item can be seen in Table 1. Changes in the composition of the diet were believed to have represented changes in abundance and availability of food items.

The creek chub is best described as an opportunist and a carnivore feeding on whatever organisms are available, from surface drift to the benthos.

Very little difference between food items utilized and the degree to which they were taken was found in comparison with the findings of Dobie, Meehean, and Washburn (1948), Dinsmore (1962), Starrett (1948), and the present study. Simpson (1941) reported a higher occurrence of vegetation than was found in this study. Hubbs and Cooper (1936) reported that the creek chub had an extremely varied diet and would find suitable food in most aquatic habitats.

REPRODUCTION

The spawning season was determined from dates on which creek chubs were observed on spawning nests. The spawning season was believed to have occurred from May 28 to July 15 in central Wisconsin, Wyoming and North Dakota. Spawning occurred in coarse gravel bottom runs in a current velocity of 1 to 2.4 feet per second and other gravel bottom littoral regions of lakes. No spawning activity was observed when water temperatures were less than 15 degrees C. Hubbs and Cooper (1936) listed April to July as the spawning period of the

creek chub and Paloumpis (1958) listed March as the period when spawning took place in Iowa.

Prior to the spawning season, male creek chubs developed breeding tubercles and underwent a slight color change similar to that described by Reighard (1908). Sexually mature males were collected from May 10 to July 15. Male creek chubs were found to have been sexually mature at age 3 compared with age 4 as reported by Hubbs and Cooper (1936). Male and female creek chubs were found to migrate upstream from runs and pools to small eddies and pools near gravel-bottomed runs. Two of eight age-class 1 females, examined in May 1969, showed egg development. Ripe females were collected from May 15 to July 12. The eggs flowed from ripe females while they were being handled.

Periodically from May 28 to July 10 in North Dakota, Wyoming, and Wisconsin streams, male creek chubs were seen building nests in gravel runs. The males did not enter the runs or start nest building until the water temperature reached 13 to 15 degrees C. On days when the water temperature did not reach this minimum, no nest building activity occurred. Several males would enter a gravel area, feed, and then establish territories which included 3 to 8 feet of stream above and below their nest site. The nest building process was described in detail by Reighard (1910) and to some extent by Hubbs and Cooper (1936). The nests were formed by a male pushing and carrying gravel (pebbles) upstream from a small area and depositing them. The male continued to carry and push the pebbles to the upstream end of the nest, resulting in the continual enlargement and downstream progression of the nesting cavity. The nest was defended against intruders (other males and other species of fish). The territorial males were seen to attack smaller intruding males and drive them off. If the intruding male was of equal size

or larger, the two would rapidly swim parallel upstream 5 to 15 feet, then separate and one male would return to the nest. Hubbs and Cooper (1936) and Reighard (1910) described similar behavior and referred to it as "deferred combat." Creek chub spawning nests in Sand Creek were never over 10 inches wide, 3 inches deep, and 14 inches long. Spawning nests in Tomorrow River were never over 14 inches wide, 6 inches deep, and 30 inches long. The abandoned nests remained detectable for only 1 to 4 days in Sand Creek and 2 to 5 days in Marengo and Tomorrow rivers. There was an apparent shortage of suitable spawning habitat in streams which lacked adequate gravel and rubble bottom areas.

Ripe females approached the male and his nest singly or in groups of 2 to 10. They did not enter the nest immediately, but remained 1 to 3 feet away for several minutes and then one to three females would enter the nest on their own accord. The male and female (or females) in the nest would lie side-by-side. The male on several occasions was seen to wrap his caudal region around the female and press her to the bottom and then quickly straighten his body. This entire act lasted less than 2 seconds. On two occasions the female left the nest after the spawning act was completed and on two other occasions the spawning act was repeated. Eggs were found lying on the bottom of the nest immediately after this act. On three occasions males were seen to press the female against the side of the nesting depression and eggs were observed dropping out of the female and this did not involve the act previously described. One large female was observed to enter 2 nests in less than 10 minutes. Reighard (1910) described the spawning act of the creek chub in great detail and his description resembled the act first described above.

The nest was not continually guarded by one male. Males were seen to leave a nest and drift downstream into a pool. In such cases the nest was immediately occupied by another male.

A sudden drop in water temperature interrupted spawning, and the males left the nests. No spawning occurred at water temperatures lower than 15 degrees C.

AGE AND GROWTH

Three creek chub fry, 5 to 6 mm long, were collected on July 19, 1969; and additional collections were made on July 21. The fry were collected in small quiet areas in runs over sand and gravel bottoms in Sand Creek. Creek chub fry (10 to 12 mm) were collected on July 20, 1974, in the Tomorrow River and July 11, 1972, in the Plover River.

Scales were laid down by the time creek chubs had grown to 26 mm in length. Scales of specimens, 30 mm in length, had two to four circuli.

No scales from creek chubs examined for age in September, 1968, 1969, 1972, 1974, and 1975 had more than five annuli, and the fish were ranked in age-classes 0, 1, 2, 3, 4, and 5. Apparently few, if any, creek chubs live longer than through 7 summers. Greeley (1930) found 7 year old creek chubs in his collections. One 292 mm, 8 year old creek chub was collected from the Tomorrow River in August, 1965. The largest creek chub observed by the author was a 330 mm specimen caught by hook and line from the Pembina River, North Dakota, 1964.

There was a large amount of overlap in the ranges of length for each succeeding age-class (Table III). Data obtained from creek chubs collected in October and in April and May indicated that little or no growth occurred after the first September. Therefore, the ranges of the lengths in Table III for age-classes 0, 1, 2, 3, 4, and 5 creek chubs in September also applied to

Table III. Growth and population structure of the creek chub in Sand Creek, based on a sample of 1,618 fish collected by chemically treating 800 feet of Sections 1 and 2, September, 1969.

	0	1	2	3	4	5
Number of fish examined	905	331	315	49	15	3
Per cent of total	55.9	20.4	19.4	3.0	0.9	0.2
Number per 100 feet of stream	113.1	41.4	39.4	6.1	1.9	0.4
Mean weight per fish (g)	.43	4.4	13.0	24.2	56.3	68.0
Annual increment of weight (g)	.43	4.0	8.6	11.2	32.1	11.7
Biomass (g) per 100 feet of stream	48.2	182.1	522.1	147.8	105.6	25.5
Range of lengths (mm)	26-52	50-94	80-135	120-161	147-184	175-203
Mean total length (mm)	38.6	74.2	108.3	141	163	184.5
Annual increment of length	38.6	35.6	34.1	32.7	22.0	21.5

Table IV. Weight-length relationships, $W = aL^b$, of the Creek Chub calculated by the logarithmic formula ($\log W = \log a + b \log L$).

Location	sample size	a	b	S_b*	r**	S_r***
Plover River	75	.17	2.95	.20	.95	.15
Tomorrow River	100	.64	3.05	.05	.89	.20
Marengo River	50	.24	2.80	.10	.99	.05
Sand Creek	250	.57	2.85	.14	.93	.25

* Standard deviation of b

** Correlation coefficient between log W and log L

*** Standard deviation of r

age-classes 1, 2, 3, 4, 5, and 6 respectively in the spring prior to the formation of the new annulus. Thus, the increments of length and weight calculated for the September fish sample represented the annual increments of growth for each age-class (Table III). The annual increment of weight increased each year, while the annual increment of length decreased (Table III). Growth of males appeared to be faster than the growth of females. For creek chubs collected in Iowa, Dinsmore (1962) reported mean lengths of 34.7, 76.7, 117.3, and 150 for age-class 0, 1, 2, and 3, which was very close to the findings of this study. Carlander (1969) summarized the data from several studies and these indicated a wide variation in the size of creek chubs at various ages in different parts of its range, and a great variation growth. None of the scales of creek chubs collected in May showed the new annulus. The new annulus showed on the scales of 10 specimens collected on July 1.

Population Structure: The creek chub sample collected from Sand Creek on September 4 and 5, 1969, was composed of 55.9 percent age-class 0, 20.4 percent age-class 1, 19.4 percent age-class 2, 3 percent age-class 3, 0.9 percent age-class 4, and 0.3 percent age-class 5 fish. Age-class 2 made up 50 percent of the total creek chub biomass (Table III). A 1972 Plover River collection was composed of 15 percent age-class 0, 39 percent age-class 1, 28 percent age-class 2, 11 percent age-class 3, 5 percent age-class 4, and 2 percent age-class 5.

Weight-length Relationship: A general weight-length relationship was calculated for sample fish collected from Sand Creek, Plover River, Tomorrow River, and Marengo River. The creek chubs ranged in size from 26 to 203 mm in length and from 0.24 to 78 grams in weight. The weight-length equation varied from Log W = -1.641 + 2.80 Log L for Marengo River creek chubs to -1.87

+ 3.05 Log L for the Tomorrow River specimens (Table IV). The correlation coefficient between the weight and length varied from 0.89 to 0.99.

Coefficient of Condition: The coefficient of condition (K_{TL}) was computed for each age-class of creek chub in the September, 1969 Wyoming sample. The K values ranged from 0.95 for age 0 to 1.18 for age 5, with an average of 1.03. Dinsmore (1962) reported an average K value of 1.02 for creek chubs collected in Iowa. Seventy-five specimens collected from the Plover River had an average K value of 1.05.

Survival: The rate of survival of creek chubs was estimated from three Wyoming samples, and the results varied from 0.44 to 0.48, using Jackson's (1939) formula. These values appear realistic because there were no age-class 6 fish in the September samples and survival rate of 0.45 would indicate a population turnover every 6 to 7 years.

PREDATION AND DISEASE

Creek chubs were found in the stomachs of brown trout, northern pike, small mouth bass, and five larger creek chubs. Creek chubs were found infected with Proteocephalus sp., Triganodistomus sp., Allocreadium sp., Tetracotyle sp., Saprolegnia sp., and Neascus sp. Saprolegnia was commonly found infecting the worn lower part of the caudal fin of males in July.

MERISTICS

Creek chubs from Sand Creek were found to have an average of 5^{a}(55-62) pored scales in the lateral line, and a mode of 8(7-9) dorsal and 7(7-8) anal fin rays. Fifty creek chubs from Wisconsin were found to have an average of 60(54-68) pored scales in the lateral line and 8(7-8) dorsal and anal fin rays.

Seventy-six percent of the creek chubs examined had a flap-like barbel which was well in advance of the posterior end of the upper jaw. The pharyngeal tooth counts were variable with 1 or 2 teeth in the outer rows and 4 or 5 in the inner rows. The two most common counts encountered were 2, 5-4, 2 and 2, 4-4, 2. Simon (1951) and Beckman (1952) reported 8 dorsal and anal fin rays, and 55 to 70 scales in the lateral line.

LITERATURE CITED

American Fisheries Society. 1960. A list of common and scientific names of the better known fishes of the United States and Canada. Second edition. Amer. Fish. Soc. Spec. Publ. 2, 102 p.

Baxter, G. T. and J. R. Simon. 1970. Wyoming Fishes. Wyoming Game and Fish Dept. Cheyenne, Wyoming. Bull. 4: 1-168.

Beckman, W. C. 1952. Guide to the fishes of Colorado. Univ. Colorado Mus. Boulder, Colorado. Leaflet 11, 110 p.

Carlander, K. D. 1969. Handbook of freshwater fishery biology. Iowa State Univ. Press, Ames. 752 p.

Copes, F. A. 1970. Ecology of the native fishes of Sand Creek, Albany County, Wyoming. Ph.D. thesis. Univ. Wyoming, Laramie, Wyoming. 281 p.

Copes, F. A. and R. A. Tubb. 1966. Fishes of the Red River tributaries in North Dakota. Inst. for Ecological Studies, Univ. N. Dakota. No. 1. 25 p.

Dinsmore, J. J. 1962. Life history of the creek chub, with emphasis on growth. Proc. Iowa Acad. Sci. 69: 296-301.

Dobie, J., O. L. Meehean, and G. N. Washburn. 1948. Propagation of minnows and other bait species. U.S. Fish Wildl. Serv. Circ. 12, 113 p.

Greeley, J. R. 1930. A contribution to the biology of the horned dace, *Semotilus atromaculatus* (Mitchill). Ph.D. thesis. Cornell Univ. 114 p.

Hubbs, C. L. and G. P. Cooper. 1936. Minnows of Michigan. Cranbrook Inst. Sci. Bull. 8, 95 p.

Hubbs, C. L. and K. F. Lagler. 1958. Fishes of the Great Lakes Region. Cranbrook Inst. Sci. Bull. 26, 186 p.

Jackson, A. J. C. 1939. The analysis of an animal population. J. Animal Ecol. 8: 238-246.

Lagler, K. F. 1956. Freshwater fishery biology. Wm. C. Brown Co., Dubuque, Iowa. xii + 921 p.

Leonard, A. K. 1927. The rate of growth and the food of the horned dace *(Semotilus atromaculatus)* in Quebec, with some data on the food of the common shiner *Notropis cornutus)* and of the brook trout*(Salvelinus fontinalis)* from the same region. Publ. Ontario Fish. Res. Lab. 30: 35044.

Paloumpis, A. A. 1958. Responses of some minnows to flood and drought conditions in an intermittent stream. Iowa State J. Sci. 32(4): 547-562.

Reighard, J. E. 1910. Methods of studying the habits of fishes with an account of the breeding habits of the horned dace. Bull. U.S. Bur. Fish. 28: 1111-1136.

Ricker, W. E. 1958. Handbook for biological statistics of fish populations. Fish. Res. Board. Canada, Ottawa. 300 p.

Rounsefell, G. A. and W. H. Everhart. 1965. Fishery science. Its methods and applications. J. Wiley and Sons, Inc. xii + 444 p.

Simon, J. R. 1951. Wyoming fishes. Wyoming Game and Fish Dept. Bull. 4, 129 p.

Simpson, J. C. 1941. Food analysis of some important species of Wyoming forage fishes. Univ. Wyoming. MS thesis, 85 p.

Starrett, W. C. 1948. An ecological study of the minnows of the Des Moines River, Boone County, Iowa. Ph.D. thesis, Iowa State Univ. 148 p.

Trautman, M. B. 1957. The fishes of Ohio. Ohio State Univ. Press. 683 p.