



Studies on the behavior and life history of the mountain whitefish (*Prosopium williamsoni* Girard)
by James Edward Liebelt

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
DOCTOR OF PHILOSOPHY in Zoology
Montana State University
© Copyright by James Edward Liebelt (1970)

Abstract:

In-season homing of displaced adult mountain whitefish from Mission Creek was demonstrated by the return of 31 fish (10.2%) in 1968, and 367 fish (31.4%) in 1969, from release sites. In 1969, there was a significant difference in homing time between sexes.

More fish homed from release sites in the Yellowstone River down-stream than upstream from the mouth of Mission Creek and a greater percentage of males homed than females from all release sites in 1969. Repeat homing in 1969 was evidenced by the return of eight fish marked in 1968. Mountain whitefish fry ranging in age from newly hatched to seven weeks exhibited strong positive phototaxis to illumination ranging from 40-200 ft-c and also responded strongly to a decrease in light intensity. Fry were more attracted to red, yellow and white rectangles and showed greater avoidance to black and blue rectangles in a trough than in a tank under approximately equal light intensities. They showed a greater preference for red than any other of the colors used. Adult mountain whitefish spawned under artificial conditions in the laboratory and in an outdoor raceway.

Fry of this species were reared on commercial trout food for approximately seven weeks subsequent to hatching. Analyses of digestive tract contents of mountain whitefish ranging in total length from 12.5-31.0 mm collected from the Yellowstone River showed Tenedepididae larvae to be the most important food organism both in numbers and frequency occurrence.

STUDIES ON THE BEHAVIOR AND LIFE HISTORY OF THE MOUNTAIN
WHITEFISH (*PROSOPIUM WILLIAMSONI* GIRARD)

by

JAMES EDWARD LIEBELT

A thesis submitted to the Graduate Faculty in partial
fulfillment of the requirements for the degree

of

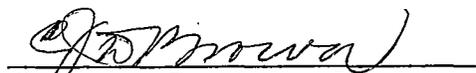
DOCTOR OF PHILOSOPHY

in

Zoology

Approved:


Head, Major Department


Chairman, Examining Committee


Graduate Dean

MONTANA STATE UNIVERSITY
Bozeman, Montana

December, 1970

ACKNOWLEDGMENT

I wish to express sincere thanks to Dr. C. J. D. Brown who directed this study and aided in preparation of the manuscript; to Mr. Edward Twiss who allowed access to Mission Creek; to Mr. Jack Larmoyeux, Director of the Fish Cultural Development Center, Bozeman Montana for use of facilities and to Richard Heckmann, James Hodgson, Merle Gunsch, Robert Stevenson, and Lelyn Stadnyk for field assistance. Cooperation by the Montana State Fish and Game Department for use of equipment is appreciated. Thanks are due Dr. R. E. Lund and my brother, Paul, for help in statistical analyses, and special thanks to my wife, Jeanne, for encouragement. Financial support was provided by training grants 5T1-WP-180-01 and 1T1-WP-228-01 Federal Water Pollution Control Administration.

TABLE OF CONTENTS

	Page
VITA	ii
ACKNOWLEDGMENT	iii
LIST OF TABLES	v
LIST OF FIGURES	vi
ABSTRACT	vii
INTRODUCTION	1
DESCRIPTION OF STUDY AREA	3
MATERIALS AND METHODS	4
RESULTS	13
Homing Behavior	13
Fry Behavior	26
Propagation of Mountain Whitefish	34
Food Analysis of Digestive Tract of Fry	37
DISCUSSION	40
LITERATURE CITED	43

LIST OF TABLES

Table	Page
I. Number of mountain whitefish displaced and number homing in 1969	18
II. Combined number of mountain whitefish displaced and number homing in 1969	18
III. Mean homing time (days) of mountain whitefish displaced in 1969 (M = Mission Creek; Y = Yellowstone River, B = below mouth of Mission Creek, A = above mouth of Mission Creek; S = Shields River)	19
IV. Analysis of variance of homing time of mountain whitefish displaced in 1969	20
V. Number, sex, and homing time of mountain whitefish displaced in 1968 (percent homing per release date in parentheses)	23
VI. Number of mountain whitefish displaced and number homing in 1968 (Y = Yellowstone River, M = Mission Creek)	24
VII. Mean homing time (days) of mountain whitefish displaced in 1968	24
VIII. Mountain whitefish fry response to color	33
IX. Digestive tract contents of mountain whitefish (12.5-31.0 mm). FO = Frequency occurrence	38

LIST OF FIGURES

Figure	Page
1. Fyke net used to capture mountain whitefish in Mission Creek during 1968 viewed from upstream	5
2. Traps used to capture mountain whitefish in Mission Creek during 1969 viewed from downstream	5
3. Fiberglass laboratory tank used in propagation and fry behavior experiments of mountain whitefish	9
4. Test plate used to determine mountain whitefish fry response to colors. Two colors were used on each plate with two diagonal rectangles, A-A or B-B, painted the same color	9
5. Section of outdoor raceway used in propagation experiments of mountain whitefish in 1969	10
6. Study area of Yellowstone River and Mission Creek showing locations of release sites, fyke net, traps, tributaries, side channel, and direction of stream flow	16
7. Analysis of return probability of displaced mountain whitefish versus increasing distances from traps in 1969	21
8a-f. Fish count versus time (minutes) in tank and trough color experiments	31
8g-k. Fish count versus time (minutes) in tank and trough color experiments	32

ABSTRACT

In-season homing of displaced adult mountain whitefish from Mission Creek was demonstrated by the return of 31 fish (10.2%) in 1968, and 367 fish (31.4%) in 1969, from release sites. In 1969, there was a significant difference in homing time between sexes. More fish homed from release sites in the Yellowstone River downstream than upstream from the mouth of Mission Creek and a greater percentage of males homed than females from all release sites in 1969. Repeat homing in 1969 was evidenced by the return of eight fish marked in 1968. Mountain whitefish fry ranging in age from newly hatched to seven weeks exhibited strong positive phototaxis to illumination ranging from 40-200 ft-c and also responded strongly to a decrease in light intensity. Fry were more attracted to red, yellow and white rectangles and showed greater avoidance to black and blue rectangles in a trough than in a tank under approximately equal light intensities. They showed a greater preference for red than any other of the colors used. Adult mountain whitefish spawned under artificial conditions in the laboratory and in an outdoor raceway. Fry of this species were reared on commercial trout food for approximately seven weeks subsequent to hatching. Analyses of digestive tract contents of mountain whitefish ranging in total length from 12.5-31.0 mm collected from the Yellowstone River showed Tendipedidae larvae to be the most important food organism both in numbers and frequency occurrence.

INTRODUCTION

Mountain whitefish (*Prosopium williamsoni* Girard) are often abundant and provide an extensive and increasingly important sport fishery. They have rarely been artificially propagated or planted. The natural range of this species extends from northern British Columbia eastward to the Peace River, Alberta (Lindsey, 1955) and southward throughout much of the northern intermountain region of the United States. In Montana, it is native in all larger streams on both sides of the Continental Divide and extends from the western boundary to the central part of the state (Brown, 1970).

The objectives of my study were to investigate: the in-season homing behavior of adult mountain whitefish in a river (fluvial) system; the early fry behavior; the spawning of adults and rearing of fry under artificial conditions; the food from fry which were collected in a river. Studies began in October, 1968, and continued through June, 1970.

Previous studies on mountain whitefish cover a broad spectrum of subjects including food habits, (McHugh, 1940, Laakso, 1951); life history, (Sigler, 1951); spawning habits and early development, (Brown, 1952); and hematology, (McKnight, 1966).

While the Coregoninae have received little attention with respect to homing behavior, many of the Salmoninae and other fishes have been

rather intensively investigated. The majority of homing investigations of freshwater fishes have dealt with those living in lake (adfluvial) environments which either spawn there or migrate to tributaries to spawn. Some important studies include: brook trout (*Salvelinus fontinalis*) Vladykov, 1942; lake trout (*S. namaycush*) Loftus, 1957; cutthroat trout (*Salmo clarki*) Platts, 1959; sockeye salmon (*Oncorhynchus nerka*) Hartman and Raleigh, 1964; white bass (*Roccus chrysops*) Horrall, 1961, and others, but these have all been studied in adfluvial situations. Investigations where a tributary choice was involved in a fluvial system include: brown trout (*S. trutta*) Stuart, 1957; charr (*Salvelinus willughbi*) Frost, 1963; cutthroat trout (*Salmo clarki*) LaBar, 1970, and others, but again, these fish were all from adfluvial systems.

Propagation of Coregonines in North America has been more or less restricted to the commercially important lake whitefish (*Coregonus clupeaformis*), but at least two instances of mountain whitefish propagation are known (Simon, 1951; Montana Fish and Game Communication). No previous studies of the behavior of whitefish fry or of mountain whitefish food habits (fry less than 31.0 mm) have been found.

DESCRIPTION OF STUDY AREA

The homing behavior investigation of adult mountain whitefish was restricted to the following areas (Fig. 1): Mission Creek (lower 2.1 km); Yellowstone River (8.5 km upstream and 16.1 km downstream from the mouth of Mission Creek); Shields River (lower 0.6 km); side-channel extending from the Yellowstone River and tributary to Mission Creek (0.7 km). Mission Creek, the side-channel, and Shields River are the only tributaries to the Yellowstone River in the study area.

Mission Creek has an annual spawning run of several thousand mountain whitefish which enter it from the Yellowstone River. This creek is small, accessible, on private property, and little influenced by fishermen. It is approximately 20.9 km long and has an average gradient of about 65.1 m/km and enters the Yellowstone River from the south. The maximum flow occurs during spring run-off; and the minimum flow, which would normally be in winter, takes place during mid-summer and early fall due to irrigation diversion. The stream bed in the study area is mainly composed of rubble, gravel, sand, and silt, with boulders predominating in the upper reaches. Bank cover is primarily composed of willows, with some red dogwood and cottonwood.

MATERIALS AND METHODS

In 1968, most mature mountain whitefish were captured in a fyke net (1.0 m dia.) set about 1.8 km from the mouth in Mission Creek (Fig. 1). Common sense netting (6.4 mm mesh) was used to block the creek and divert fish into the fyke net. Some fish were taken by electrofishing during the day or with a dip net at night. In 1969, adult fish were captured exclusively with two traps made of hardware cloth (1.27 cm mesh) attached to wooden frames (1.54 x 1.54 x 0.63 m). These were set about 200 m up the creek from the mouth (Fig. 2) and another trap was placed in the side channel about 27 m from its confluence with Mission Creek, but this failed to take any fish. These traps were secured to the stream bed by metal posts. Either wooden or metal grates, with bars spaced about 1.5 cm apart, were used to block the streams and divert fish into the traps. In both years, fish were dipnetted from the traps into live cars. The majority of fish were held less than one hour but a few were kept as long as 18 hours before being used in experiments.

Mountain whitefish fry were taken from the Yellowstone River during low water periods by means of either a drift net or an aquatic dip net (both 20 cm mesh) for the food study. The drift net was anchored to the river bottom so it would catch suspended organisms and other materials. The aquatic dip net was rapidly swept over the river bottom near shore. When water levels were high, a seine

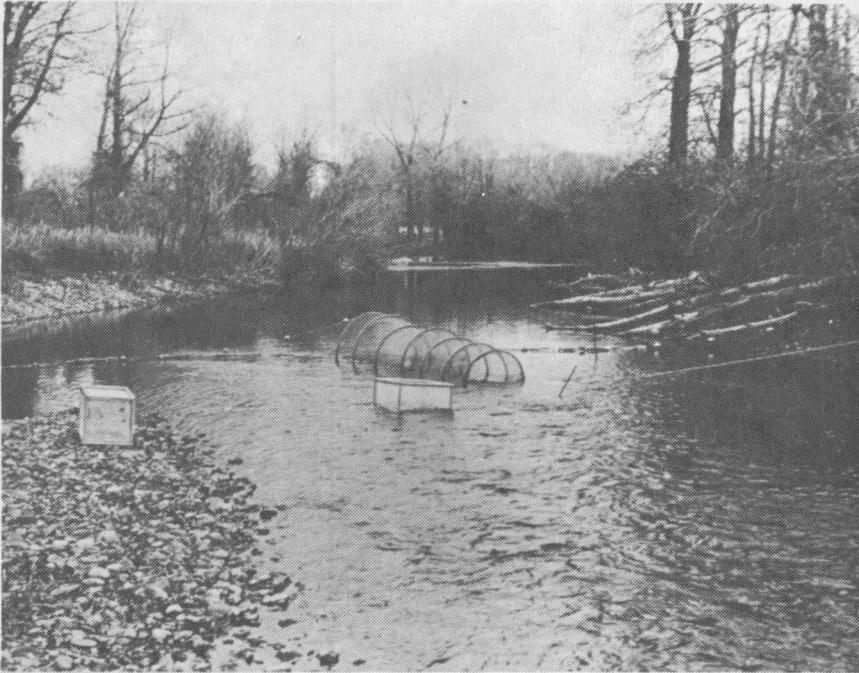


Fig. 1. Fyke net used to capture mountain whitefish in Mission Creek during 1968 viewed from upstream.



Fig. 2. Traps used to capture mountain whitefish in Mission Creek during 1969 viewed from downstream.

