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FOOD HABITS OF THE YELLOWSTONE WHITEFISH *PROSOPIUM WILLIAMSONI CISMONTANUS* (JORDAN)[1]

MARTIN LAAKSO
Biology Department, Westminster College
Fulton, Missouri

ABSTRACT

A quantitative analysis of the food habits of 385 whitefish *(Prosopium williamsoni cismontanus* (Jordan)) and 52 trout from the Yellowstone and Gallatin Rivers was made. Collections were taken over a period of 1 year beginning in September, 1947, on the Yellowstone and on the Gallatin Rivers. Fingerling whitefish used the same food organisms as did adults but consumed smaller numbers and sizes. There was no important difference in the kinds of foods eaten by whitefish of different lengths. Caddis larvae and stonefly nymphs made up about equal parts of the whitefish diet. Midges were next in importance and mayflies comprised the smallest volume. Caddisflies and Diptera larvae together constituted 87 percent of the total number of organisms consumed. Whitefish in the Yellowstone ate mostly immature caddis- and stoneflies, while the Gallatin fish utilized caddis, fish eggs, Diptera, stoneflies, and mayflies in more nearly equal amounts. Seasonal variations found in the diet of whitefish show that caddis was important in the fall and winter, stoneflies were abundant except in the fall, mayflies were most numerous in the spring, and midges were numerous in the food throughout the year.

INTRODUCTION

The Yellowstone whitefish, *Prosopium williamsoni cismontanus* (Jordan), a protected game species in Montana, has received scant attention from fishery workers. Because this species is potentially an important element of game-fish fauna in the state, a series of studies on the basic ecological and fishery relationships was initiated at Montana State College. The present study has attempted to determine some of the food relationships of the whitefish and competing species. Data are derived from the analysis of stomach contents of 385 whitefish, 33 rainbow trout, and 19 brown trout collected on the Yellowstone and Gallatin Rivers during a 1-year period beginning in September, 1947. The 65-mile portion of the Yellowstone River sampled, extends from Corwin, 6 miles north of the Yellowstone National Park boundary, to a point 15 miles northeast of Livingston. This section of the river flows north through a narrow valley between the Absaroka and Gallatin ranges to Livingston and then flows in a northeast direction. The water level is more constant than in the Gallatin River, and the peak of the spring flood usually occurs in June. During severe winter weather, shore ice extends some distance over the water, but the main channel always

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remains open. In the Gallatin River sampling was done in a 25-mile section extending from Williams Bridge near the mouth of the Gallatin Canyon to the bridge east of Manhattan. This portion of the river flows north along the western edge of Gallatin Valley. The volume of water in summer is greatly reduced in the lower two-thirds of this section because much is removed for irrigation. Winter conditions in the Gallatin River are comparable to those in the Yellowstone. A limited number of whitefish were obtained from the Missouri River one-half mile below the confluence of the Madison and Jefferson rivers. The area sampled is near Trident, about one-half mile upstream from the mouth of the Gallatin River. A few specimens were also taken directly in the mouth of the Gallatin.

The whitefish is distributed throughout the cold headwaters of the Missouri River drainage. In this area it is associated with cutthroat trout *(Salmo clarkii)*, rainbow trout *(Salmo gairdnerii)*, brown trout *(Salmo trutta)*, eastern brook trout *(Salvelinus fontinalis)*, white sucker *(Catostomus commersonnii)*, carp *(Cyprinus carpio)*, longnose dace *(Rhinichthys cataractae)*, burbot *(Lota lota)*, and freshwater sculpin *(Cottus* sp). Additional species which may occur in the Yellowstone and Gallatin rivers and which are known to occur in the Missouri River include flathead chub *(Platygobio gracilis)*, yellow perch *(Perca flavescens)*, and stonecat *(Noturus flavus)*.

No previous food-habits work on the subspecies of whitefish discussed here has been done, but McHugh (1940) has studied the food habits of another form of whitefish in a different area. Various studies have been made on trout in the inter-mountain region (Hazzard and Madsen, 1933; Muttkowski, 1925). However, no observations on competition between the whitefish and these species have been recorded by these authors.

Methods of Collecting and Stomach Analysis

Angling was found to be the only practical method of obtaining specimens of mature fish for stomach analysis since the size and rugged nature of the streams made the use of seines or other nets impractical. Angling was selective to a certain degree since no fish smaller than 7 inches was taken by this means. It is also possible that non-feeding individuals or those utilizing foods dissimilar to baits offered, were omitted from the collections. Immature aquatic insects, particularly stonefly nymphs, were the most commonly used bait but fly maggots were also an effective bait in winter. At certain seasons, earthworms, grasshoppers, and small dry-flies yielded good catches. During June and July, fingerling whitefish were seined from shallow water near shore in the Yellowstone River but none was found in the same areas later in the summer.

Collections of aquatic food organisms from most of the fish sampling stations were made to assist in the identification of partially digested material found in the stomachs of whitefish and trout.

In order to prevent post-mortem decomposition of food items, viscera were removed and preserved in 10 percent formalin within a few minutes after the fish were caught. When temperatures were low, removal of viscera was sometimes delayed a few hours without danger of decomposition. All material in the stomach and oesophagus of each fish was later emptied into a vial and stored in 80 percent alcohol. The contents of each stomach were classified and all recognizable items were identified and counted. Items which could be clearly identified as bait were discarded. Each group of organisms was placed on blotting paper for 2 minutes to remove excess moisture and then its volume was determined by displacement in alcohol. Volumes smaller than 0.1 milliliters were reported as "traces." Unidentifiable material was separated from the rest and measured in the same way.

The Food of Fingerling Whitefish

Two collections of fingerling whitefish were seined at Carters Bridge on the Yellowstone River. The fish in the first sample collected on June 22 averaged 1¼ inches in total length, while the second group taken a month later averaged 2 inches. Stomach analyses showed the dependence of young whitefish on aquatic insects. The principal item of food was midge larvae, but relatively large numbers of adult chironomids were also taken (Table 1). *Baetis* nymphs, immature stoneflies, and caddis larvae were also important items in the diet. There was no apparent difference in number or kinds of food organisms utilized by the fingerlings of the two size classes.

Food of the Adult Whitefish in the Yellowstone River

The food of adult whitefish, although composed almost entirely of immature insects, was quite different from that taken by fingerlings. In the Yellowstone River 81.1 percent by weight of all food taken

Table 1.—*Stomach contents of 35 fingerling whitefish taken from the Yellowstone River in June and July.*

Food organism[1]	June 22		July 21	
	Average number per stomach	Percentage of fish with organism	Average number per stomach	Percentage of fish with organism
Plecoptera	.....	.....	1.0	15.4
Ephemeroptera	2.0	52.0	1.0	77.0
Psychomyiidae	1.5	8.0	.....	.....
Hydropsychidae	1.0	8.0	1.0	7.7
Simuliidae	.....	.....	1.0	7.7
Chironomidae				
Larvae	32.2	100.0	25.8	100.0
Pupae	3.0	32.0	8.3	77.0
Adults	2.7	72.0	1.0	23.0

[1]Plecoptera, Psychomyiidae, Hydropsychidae, and Simuliidae were taken in the immature state. Ephemeroptera occurred as nymphs, subimagoes, and adults.

TABLE 2.—*Food of adult whitefish at different seasons*[1] *in the Yellowstone River.*
(Percentages of fish containing each group are enclosed in parentheses)

Food Organisms[2]	September—November		December—February		March—May		June—August	
	Average number per fish	Percentage of total volume	Average number per fish	Percentage of total volume	Average number per fish	Percentage of total volume	Average number per fish	Percentage of total volume
Annelida (Worms)								
Mollusca (Snails)	2.0	Trace (4.3)						
Diplopoda (Millipedes)								
Plecoptera (Stoneflies)					1.0	16.7 (33.3)	6.0	36.5 (11.1)
Pteronarcys californica					4.0	16.7 (33.3)	1.0	1.1 (5.6)
Pteronarcella badia	3.0	2.5 (43.5)	1.5	1.2 (16.0)			1.0	1.1 (5.6)
Acroneuria pacifica								
Perlodidae	5.1	11.2 (65.2)	2.6	3.4 (27.0)				
Isoperla	9.5	0.2 (56.5)	13.4	4.0 (56.0)	4.0	5.5 (33.3)	1.0	Trace (5.6)
Ephemeroptera (Mayflies)								
Heptageniidae	3.5	0.8 (43.5)	3.6	1.2 (40.0)			13.2	3.4 (55.6)
Baetidae	5.7	3.7 (78.3)	7.3	3.4 (80.0)	4.0	16.7 (67.7)	52.8	50.0 (100.0)
Coleoptera (Beetles)								
Aquatic larvae								
Trichoptera (Caddisflies)			1.0	Trace (4.0)	3.0	5.6 (33.3)		
Rhyacophila			29.4	10.9 (60.0)	78.5	38.8 (67.7)	2.5	Trace (11.1)
Glossosoma	3.6	0.5 (21.8)						
Psychomyiidae								
Hydropsychidae	6.6	4.5 (78.3)	6.1	7.5 (60.0)	1.0	Trace (67.7)		
Hydroptilidae	4.0	Trace (4.3)	8.0	Trace (28.0)				
Leptoceridae	4.0	0.2 (13.1)			1.0	Trace (33.3)	8.0	Trace (11.1)
Brachycentridae	11.4	10.4 (87.0)	2.4	0.6 (28.0)	1.0	Trace (33.3)	8.3	4.6 (83.4)
Neothremma, Lepidostoma	154.8	18.2 (95.7)	24.1	2.9 (60.0)			2.0	Trace (5.6)
Lepidoptera (Moths)								
Elophila								
Diptera (True Flies)			1.0	1.2 (4.0)				
Tipulidae	1.8	2.0 (26.5)	1.7	0.6 (12.0)				
Bibiocephala			67.0	3.4 (32.0)			5.3	1.1 (44.4)
Simuliidae L and P	17.2	0.5 (60.8)	195.0	55.6 (100.0)	3.0	Trace (33.3)	13.9	1.1 (55.6)
Chironomidae L and P	36.5	1.5 (47.8)	1.3	Trace (28.0)			3.0	Trace (5.6)
Chironomidae Adults								
Atherix	1.0	Trace (4.3)						
Hymenoptera							4.0	1.1 (5.6)
Formicidae (Ants)							10.9	Trace (38.8)
Hydracarina (Water mites)								
Vertebrata								
Fish								
Fish eggs	31.3	43.8 (95.7)	4.0	4.0 (20.0)				
Average identifiable stomach volume (Milliliters)		1.75		.70		.60		.49

[1]The data for each season are based on the following number of stomachs: Fall—85; Winter—85; Spring—60; Summer—31.
[2]All food insects not having the stage of development indicated, were taken in the immature stage except for the following: mayflies—nymphs, subimagoes, adults; Glossosoma—larvae, pupae; Brachycentridae—larvae, pupae, adults; Bibiocephala—larvae, pupae, adults; Formicidae—adults.
Unidentifiable material constituted the following percentages of the total volume of stomach contents: fall—74.2 percent; winter—22.6 percent; spring—48.5 percent; summer—57.5 percent.

throughout the year was composed of approximately equal amounts of the immature stages of caddisflies and stoneflies (Table 2). True flies including midges made up almost 10 percent of the volume. Caddis larvae were the most numerous and frequent item in the stomachs. Hydropsychidae were the commonest representative of the group and made up about one-fourth of the average diet. Midges predominated in the fall collections (32.2 percent by volume) and *Brachycentrus* were second with a volume of 24.2 percent (Table 2). Cases of *Brachycentrus* were included in the volume measurement of the first 40 whitefish studied. In later collections, the cases were removed in order to measure digestible material more accurately. To correct these early measurements, a factor was established by comparing volumes of cased and uncased larvae from 17 stomachs containing approximately 680 larvae. The volume of the uncased larvae was found to be 48 percent of the cased larvae. The presence of gravel in some of the stomachs was evidence that *Glossosoma* larvae or pupae, which construct cases of this material, had been eaten and digested.

Lepidostoma and *Neothremma* which appeared in large numbers in the stomachs of Yellowstone fish, were not considered separately because they were difficult to identify. The microcaddis, Hydroptilidae,

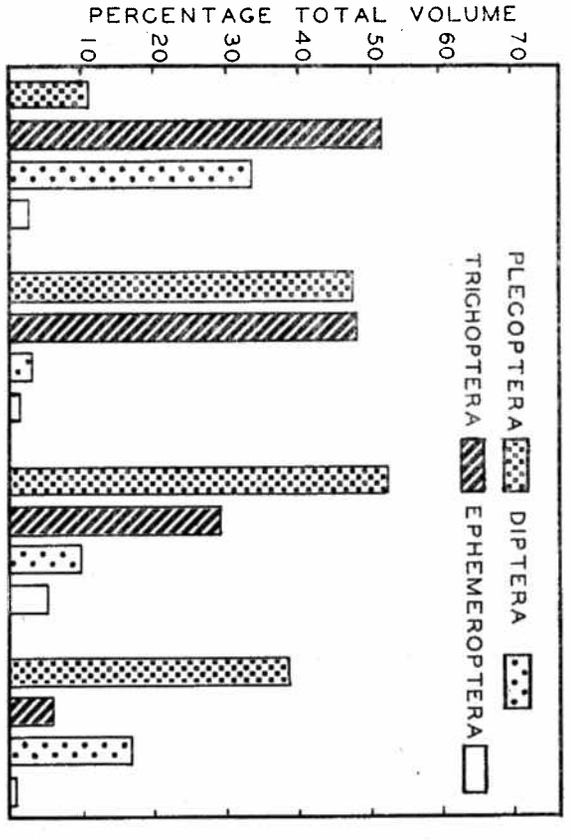

FIGURE 1.—Abundance of important insect food items in the diets of Rocky Mountain whitefish from the Yellowstone River at various seasons—expressed as percentage of total volume.

were also numerous in a few instances. During colder weather, cases with larvae intact were observed in the intestines of several whitefish. Psychomyiidae were most numerous in the diet of spring-caught fish with a few occurring in the fall. A few *Rhyacophila* were found in the spring samples.

Plecoptera nymphs were less common than caddis larvae in whitefish stomachs although their total volume was a little greater. *Isogenus (Isogenoides) elongatus* and *Areynopteryx parallela* of the family Perlodidae, and *Pteronarcella badia* were abundant in the diet during the winter and spring months. These species contribute little volume in the early summer when they are mostly small in size. The nymphs of these three species were most abundant at the stations below Livingston.

Stream bottom samples and the stomachs of whitefish from the vicinity of Emigrant Creek (elevation 5,000 feet) on the Yellowstone River lacked *Acroneuria* and *Pteronarcys*. They occurred more frequently in the stomachs of whitefish during the summer months at a time when other stoneflies and caddis had emerged. *Acroneuria* and *Pteronarcys* spend at least 2 years as nymphs and are more obvious as food items at the time when other aquatic insects are in the early stages of development.

The small stonefly, *Isoperla,* was fairly common but contributed little to the total volume. The Diptera, which were largely Chironomidae and *Bibiocephala,* made up 7 percent of the total volume of whitefish food. Chironomids were more numerous than any other organism. Approximately 96 percent of the fall collection contained midge larvae and pupae (Figure 1). A smaller number of midges occurred in stomachs collected at other seasons. Adults were seen frequently on shore ice in January and February. The stomach of one whitefish collected at this season contained 35 adult midges. *Bibiocephala* was most common in the winter and occurred in one-third of the stomachs. A specimen taken on March 4 at Carters Bridge, 5 miles above Livingston, contained 153 of these larvae. Simuliidae were eaten by whitefish in small numbers throughout the year. About 90 percent of the total recorded for the year were in the stomach of one fish caught at Carters Bridge in July.

Ephemeroptera observed in the diet of whitefish included *Heptagenia, Ephemerella, Baetis, Ameletus,* and *Rhithrogena.* These nymphs occurred rather frequently in the stomachs during the year but made up less than 2 percent of the total volume and less than 4 percent of the total number.

Whitefish eggs were found in the stomachs of 16 fish taken during the fall and winter. The largest number occurred in specimens taken below Livingston on January 2. Fewer eggs were found in the stomachs of Yellowstone whitefish than in the Gallatin River specimens, possibly because the collections did not coincide with actual spawning. A few ants, leaf hoppers, earthworms, and a millipede constituted the

TABLE 3.—*Food of adult whitefish at different seasons*[1] *in the Gallatin River.*
(Percentages of fish containing each group are enclosed in parentheses)

Food Organisms[2]	September—November		December—February		March—May		June—August	
	Average number per fish	Percentage of total volume	Average number per fish	Percentage of total volume	Average number per fish	Percentage of total volume	Average number per fish	Percentage of total volume
Annelida (Worms)			1.0	Trace (1.2)			2.8	27.9 (12.9)
Mollusca (Snails)								
Diplopoda (Millipedes)					1.0	Trace (1.7)		
Plecoptera (Stoneflies)								
Pteronarcys californica			1.0	0.4 (1.2)	4.0	7.1 (5.0)	2.0	33.9 (45.1)
Pteronarcella badia	1.0	Trace (3.6)	13.7	25.5 (64.8)	6.0	21.4 (48.4)	1.5	0.9 (6.5)
Acroneuria pacifica			4.3	0.9 (3.5)	1.8	2.2 (8.3)	1.0	4.2 (19.4)
Perlodidae	2.1	11.0 (49.4)	9.9	21.1 (60.0)	5.7	21.9 (48.4)		
Isoperla	2.1	Trace (17.6)	2.7	Trace (23.5)	2.0	Trace (23.3)	1.0	Trace (6.5)
Ephemeroptera (Mayflies)								
Heptageniidae	2.5	Trace (15.3)	4.7	0.4 (38.8)	2.7	Trace (35.0)	1.0	Trace (12.9)
Baetidae	10.5	2.1 (28.3)	3.0	0.4 (28.2)	11.6	5.1 (66.7)	3.5	0.9 (32.2)
Coleoptera (Beetles)								
Aquatic larvae	1.0	Trace (1.2)	1.0	Trace (2.4)	1.0	Trace (1.7)	2.6	9.3 (16.1)
Trichoptera (Caddisflies)								
Rhyacophila					1.0	Trace (3.3)		
Glossosoma					4.7	0.5 (25.0)		
Psychomyiidae	8.1	3.8 (65.8)	4.4	0.4 (28.2)	26.0	Trace (10.0)	1.0	Trace (3.2)
Hydropsychidae	2.8	Trace (4.7)			7.7	7.9 (96.7)		
Hydroptilidae	8.9	11.5 (78.8)	57.0	31.6 (86.0)	64.1	2.8 (31.6)	4.3	4.2 (71.0)
Leptoceridae	4.6	0.4 (42.4)	3.6	Trace (11.8)	2.2	Trace (8.3)		
Brachycentridae	3.6	0.4 (9.4)	1.4	Trace (5.9)	12.9	9.6 (60.0)	7.0	1.7 (16.1)
Neothremma, Lepidostoma	9.4	24.2 (55.4)	27.5	14.7 (64.8)	46.1	8.5 (71.7)	3.0	Trace (3.2)
Lepidoptera (Moths)	40.5	13.2 (76.5)	27.3	1.3 (65.9)				
Elophila			1.0	Trace (3.5)				
Diptera (True Flies)								
Tipulidae	1.0	0.4 (2.4)	1.3	Trace (3.5)	1.0	0.5 (10.0)		
Bibiocephala	2.2	0.8 (10.6)	1.5	0.9 (32.9)	23.1	4.8 (11.7)		
Simuliidae L and P	2.3	Trace (9.4)	6.1	Trace (14.1)	3.5	Trace (3.3)	130.1	14.4 (22.6)
Chironomidae L and P	53.1	32.2 (96.5)	50.1	1.8 (61.2)	53.2	4.4 (65.0)	16.8	1.7 (77.4)
Chironomidae Adults	1.2	Trace (5.9)	35.0	Trace (1.2)	3.1	Trace (1.7)	4.0	Trace (3.2)
Atheriz	1.0	Trace (3.6)	1.3	0.3 (4.7)	1.0	Trace (5.0)	2.5	0.9 (6.5)
Hymenoptera								
Formicidae (Ants)					3.5	Trace (3.3)	1.3	Trace (12.9)
Hydracarina (Water mites)								
Vertebrata								
Fish	1.0	Trace (2.4)	2.2	0.3 (16.5)	2.0	3.3 (1.7)		
Fish eggs					1.0	Trace (1.7)		
Average identifiable stomach volume (Milliliters)		.81		.76		1.24		.51

[1]The data for each season are based on the following number of stomachs: Fall—23; Winter—25; Spring—3; Summer—18.
[2]All food insects not having the stage of development indicated, were taken in the immature stage except for the following: mayflies—nymphs, subimagoes, adults; *Glossosoma*—larvae, pupae; Brachycentridae—larvae, pupae, adults; *Bibiocephala*—larvae, pupae, adults; Formicidae—adults.
Unidentifiable material constituted the following percentages of the total volume of stomach contents: fall—24.5 percent; winter—55.1 percent; spring—83.0 percent; summer—40.5 percent.

terrestrial food taken by whitefish from the Yellowstone River. These were found in all except the winter season.

Food of Whitefish from the Gallatin River

Caddisflies and stoneflies were conspicuous in the diet of Gallatin River whitefish but did not predominate to the same extent as in the Yellowstone River. Trichoptera larvae comprised approximately 27 percent of the volume of all food taken by whitefish from the Gallatin River through the year (Table 3). *Lepidostoma* and *Neothremma* were the most abundant representatives of this group. Their numbers were greatest in the fall collection. *Brachycentrus* larvae and pupae were likewise most frequent at this season. Adults belonging to this genus were present in 8 out of 13 whitefish collected at Cameron Bridge on July 29. Caddis of the family Hydropsychidae were less conspicuous and formed only one-sixth of the total volume of caddis found in the diet.

The volume of whitefish eggs was the largest single item in the autumn food. All but one of the stomachs from the collections of fish made November 16 and 23 contained fish eggs. Two brown-trout eggs were

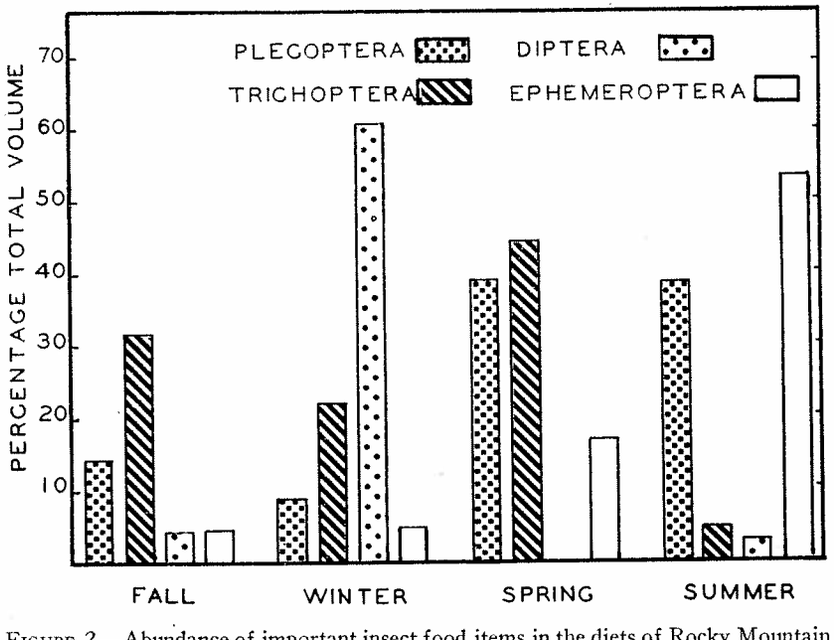

Figure 2.—Abundance of important insect food items in the diets of Rocky Mountain whitefish from the Gallatin River at various seasons—expressed as percentage of total volume.

present in the stomach of one whitefish. Midges occurred in every fish taken during the winter. At this season they were the most important item in the diet (55.6 percent) and made a much greater contribution than in the Yellowstone River. Adults were observed in stomachs of fish which were taken in January, February, and July.

The Perlodidae and *Pteronarcella* contributed most to the volume of stonefly nymphs taken during the fall season, while *Isoperla* was most prevalent in the diet of specimens collected in January and February. As in the Yellowstone River, a large volume of *Pteronarcys* was present in the stomach contents of fish taken in June and July. Mayflies made up about 11 percent of the total volume of food taken by whitefish in the Gallatin River collections as compared to 2 percent for the Yellowstone. They were most numerous in the stomachs of fish caught at Cameron Bridge in July. A collection of 14 fish from this locality contained an average of 62 nymphs. The contents of one stomach was composed of 130 subimagoes and adults almost to the exclusion of other items.

A greater use of surface food during the spring season and the consumption of more fish eggs in the fall months was characteristic of Gallatin River whitefish (Figure 2). Stomach examinations revealed more nearly representative volumes of available aquatic insects in the fish from the Gallatin than those from the Yellowstone River where stonefly nymphs and caddis larvae represented more than 80 percent of the total food volume.

A collection of 60 whitefish taken in January on the Yellowstone River was divided into three groups on the basis of size. The stomach content of each group was compared with the others. No important differences in the kinds of food organisms utilized by the different sizes could be observed. The percentage of stonefly nymphs was a little greater in the stomachs of the largest fish while the volume of caddis was larger in the group of smallest individuals. The average volume of food per stomach was more than twice as great in the biggest group (over 16 inches total length) than in the smallest group (under 14 inches total length).

Comparison of Whitefish and Trout Food

An effort was made to collect trout from the same localities and at the same time that whitefish were taken in order to make a comparison of their food habits. Only a small number of trout were secured, and while no specific conclusions can be drawn from the limited information obtained, a few observations are of interest.

The proportion of caddis larvae, stonefly nymphs, and whitefish eggs was approximately the same in the stomachs of brown trout and whitefish collected at Manhattan Bridge, on the Gallatin River, November 23. Whitefish eggs were the most abundant item in the diet of both

species. On November 29, stoneflies made up 39 percent of the stomach content of five brown trout (9 to 15 inches total length) from Carters Bridge as compared with 15.5 percent for whitefish collected at the same time and place.

No algae were found in the stomachs of whitefish but this material comprised 22.6 percent of the stomach contents of rainbow trout and was taken by 36 percent of the specimens collected. Two rainbow trout (7½ and 10 inches total length) taken near Carters Bridge in October contained a variety of surface food including the adults of mayflies and midges, as well as leaf hoppers, beetles, and ants. Whitefish taken at the same time lacked all of these items. An 18-inch rainbow trout from Carters Bridge in May contained eight *Pteronarcys* nymphs. This species of stonefly was not found in the food of whitefish from the same area at any time during the year.

Only small amounts of food were in the stomachs of whitefish and rainbow trout taken on June 22 at Carters Bridge. This light feeding may have been the result of the high water condition which occurred at that time. Four rainbow trout (8 to 15 inches total length) from this collection contained a small amount of surface food consisting of adult mayflies, *Isoperla*, midges, and ants. One trout of this collection had the remains of a fish in its stomach. Whitefish taken at the same time and place contained earthworm, beetle larvae, caddis larvae, and stonefly nymphs.

Needham (1930) observed that trout fed less actively during the winter when temperatures were low. Whitefish, on the other hand, usually had full stomachs even during the coldest part of the year. A comparison of stomach contents of 124 whitefish and 13 trout taken December to February shows that whitefish contained over five times as much food per stomach as the trout.

Whitefish and Trout Relationships

There is considerable competition for aquatic food organisms by whitefish and trout in the streams which were studied. In the winter, the diets of the two are strikingly similar. However, according to Leonard (1941), the food supply may not be a limiting factor in the success of trout during cold weather since digestion is slow and the amount of nourishment obtained from food is questionable. The condition of foods in the intestine of whitefish also indicates that digestive processes are slower during winter. In the summer, competition is probably keener because food supply is reduced by scouring during the spring "runoff" (Muttkowski, 1929), and because many species of aquatic insects emerge during the season. Trout and whitefish utilize surface organisms as a supplement to aquatic organisms during the summer.

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Literature Cited

Hazzard, A. S. and M. J. Madsen
1933. Studies of the food of the cutthroat trout. Trans. Am. Fish. Soc., Vol. 63 (1933), pp. 198-203.

Leonard, J. W.
1941. Some observations on the winter feeding habits of brook trout fingerlings in relation to natural food organisms present. Trans. Am. Fish. Soc., Vol. 71 (1941), pp. 219-227.

McHugh, J. L.
1940. Food of the Rocky Mountain whitefish, *Prosopium williamsoni* (Girard). Jour. Fish. Res. Bd. Canada, Vol. 5, pp. 131-137.

Muttkowski, R. A.
1925. The food of trout in Yellowstone National Park. Roosevelt Wild Life Bulletin, Vol. 2, No. 4, pp. 471-497.
1929. The ecology of trout streams in Yellowstone National Park. Roosevelt Wild Life Annals, Vol. 2, No. 2, pp. 155-240.

Needham, P. R.
1930. Studies on the seasonal food of brook trout. Trans. Am. Fish. Soc., Vol. 60 (1930), pp. 73-88.