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Food Habits of Rocky Mountain Whitefish (Prosopium williamsoni) from the Teton River in Relation to Their Age and Growth

Abstract

Food habits of Rocky Mountain whitefish (*Prosopium williamsoni*) were related to age classes. Three dominant families of food items in the diet of whitefish were Chironomidae, Hydroptilidae, and Dytiscidae. Chironomids occurred in all fish. The percent of chironomids in the diet decreased as the ages increased. Statistical analysis of diversity of food habits between age classes revealed significant differences, except between age class one and two, and age three and combined ages four and five, which may mean that within these subgroups fish could compete for food.

Introduction

The Rocky Mountain whitefish *Prosopium williamsoni* (Girard) is the most abundant species in many streams in western North America (Sigler and Miller, 1963; Brown, 1971; McPhail and Lindsey, 1970; Goodnight and Bjornn, 1971). Whitefish have been reported as competing with trout for food (Sigler, 1951). Current ecological thought is that direct competitors do not exist in the same environment (Royce, 1972). The subtle differences in space utilization and food utilization often prevent even members of the same genera from being in direct competition (Johnson and Minckley, 1972). Biological theory, therefore, indicates that whitefish and trout should not be in direct competition, yet examination of food habits of the species reveals similarities in diet (Carl *et al.,* 1959; Carlander, 1969). The interaction of whitefish and trout populations has not been clearly established (Baxter and Simon, 1970). Research into the biology of various trout and salmon species has been more extensive than the research into the biology of whitefish even though the whitefish may be the most abundant fish in many streams. Frequently, diets are not related to age classes, but merely to size categories of fish. This situation makes an accurate assessment of competition between whitefish, as well as between whitefish and trout, impractical. This study of whitefish in the Teton River relates food items to age class.

Description of Study Area

The study area was located in Teton County, Idaho, at an elevation of 1550 m. The fish collecting area was the entrance of Teton Creek into the Teton River. The area is a sparsely populated mountainous region characterized by hillsides with dry farms, aspen, and pine. The area is moderately grazed, and bank erosion was present. This erosion has caused silting in both Teton Creek and Teton River, with heavier silting in the slower flowing Teton Creek.

Methods

Seventy-five whitefish were collected during October 1973 by electrofishing. Standard length, body depth, weight, and sex were recorded. Scale samples were taken from below the dorsal fin and above the lateral line. Back-calculated growth was determined by using a clear plastic nomograph (Lowry, 1951). Stomachs were removed, tied in cheese cloth, cross indexed with scales, and preserved in 10 percent formalin. Volumes of the stomachs were subsequently determined by displacement. Stomach contents were analyzed by separating and counting each individual organism under a variable power dissecting microscope. Classifications were based on taxonomic keys by Barnes (1963), Borror and Delong (1964), Ross (1956), Ward and Whipple (1918), and Needham and Needham (1966). The frequence of occurrence (FO%) was established for each food item (Lagler, 1956). The numerical method (N%) was also employed to establish percent of various food items in the diet (Lagler, 1956). The data obtained were then related to whitefish age classes. Shannon's index of diversity (Zar, 1974) was utilized to calculate diversity indices of food items for each whitefish age class. Indices of diversity were then compared by t-test to test the hypothesis that age classes have similar diets.

Two quantitative and two qualitative samples of aquatic organisms in the Teton River were taken by use of Hess net ($1/16m^2$) and kick net, respectively. The quantitative samples were taken at two locations representative of the study site. The total area sampled encompassed $1/8m^2$. The substrate consisted primarily of fine sand and silt, with water depth ranging from .6 to 1.5 m.

Forage ratio for each food item was calculated by dividing the percentage in stomach by the percentage in the quantitative environmental samples. Values higher than one indicate preferential selection, a value equal to one is interpreted as chance, and values less than one indicate avoidance.

Results

Age and growth are determined for 75 Rocky Mountain whitefish from the Teton River (Table 1). Figure 1 shows the percent of each food item present in the entire fish sample. The three dominant families of food items in the diet of whitefish were Chironomidae, Hydroptilidae, and Dytiscidae (Fig. 1). These families were compared by chi-square analysis to determine if there were differences in food items selected between age groups (Table 2). Quantitative aquatic invertebrate sampling indicated chironomid larvae as the most abundant, followed by tubificids (Table 3). Percent of individual food items (N%) and frequency of occurrence (FO%) of food items for the various age classes are listed in Table 4. Analysis of forage ratios by age classes revealed that chironomid larvae had a positive selection ratio in all age groups. Brachycentridae had a ratio less than one, indicating negative selection. Age class four and five had the highest occurrence of Brachycentridae. A positive selection for Hydrachinellidae was seen in age class three whitefish. Haliplidae had positive selection by age class three and a negative selection in all other age classes. Basommataphora's forage ratio for classes four and five revealed positive preference; forage ratio for this organism in all other age classes indicated negative selection. Sphaeridae had chance selection in age class three and combined age classes four and five, and negative selection in age classes one and two.

Simuliidae did not show up in any aquatic samples (Table 3), but age class three indicated selection of Simuliidae as a food item. Dytiscidae was not collected in aquatic samples; however, it occurred in all age class stomachs, and was increasingly selected

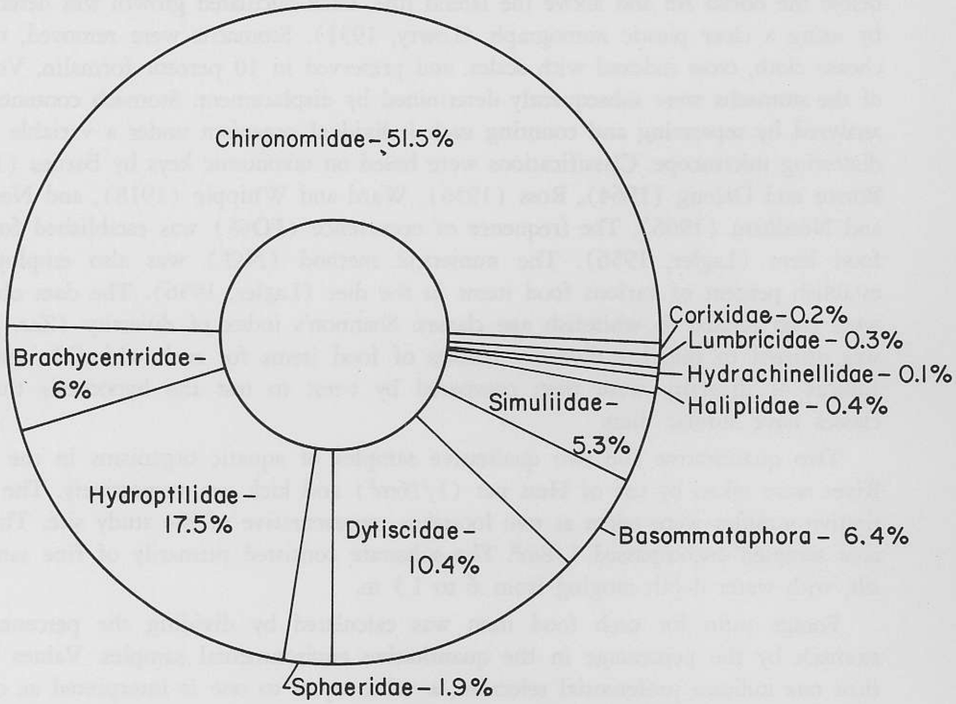

Figure 1. Percent of food items present in seventy-five Teton River mountain whitefish.

TABLE 1. Growth measurements of whitefish in Teton River for various age classes at time of capture.

Age Class	Sex	Sample Size	Average Standard Length (cm)	Average Weight (g)	Average Back-calculated Standard Length (cm at each annulus) 1	2	3	4	5	Average Depth (cm)	Average Condition Factor
1	—	16	10.50	14.65	6.50					2.20	0.0124
2	Males	15	17.00	86.50	6.96	13.20				3.74	0.0170
2	Females	7	14.78	84.78	6.74	13.00				3.85	0.0168
3	Males	18	18.10	92.69	5.86	9.82	14.99			4.14	0.0149
3	Females	4	21.25	143.12	8.87	13.12	18.50			4.40	0.0148
4	Males	9	23.60	193.20	6.22	11.61	16.90	21.00		5.08	0.0147
4	Females	1	25.00	233.00	7.00	10.50	17.00	23.00		5.10	0.0149
5	Males	2	26.25	251.50	6.50	9.50	14.00	19.00	24.00	5.45	0.0138
5	Females	3	28.60	370.00	6.83	11.40	17.06	21.50	25.83	6.53	0.0169
Average for Males					6.33	11.35	15.53	20.63	24.00		
Average for Females					7.34	12.55	17.77	21.92	25.83		
Average all Groups					6.57	11.66	16.01	20.98	25.10		
			Males			5.02	4.18	5.10	3.37		
			Females			5.21	5.22	4.15	3.97		
			All Groups			5.09	4.35	4.97	4.12		

for as age increased. Hydroptilidae larvae were not collected in the quantitative samples, but did appear as a major food item in the diet of the whitefish. These three families were probably picked up in the drift or missed by the sampling device. Additional environmental sampling is required to determine the distribution of these organisms.

Comparison of food habits between age classes revealed significant differences in diet between age classes (Table 2). No differences in food habits existed between age classes one and two. It appears that these age classes are dependent upon the same

TABLE 2. Chi-square test results for differences of selection between age groups of mountain whitefish on three dominant food item families and t-test results of comparisons of indices of diversity between age classes.

Food Item	Age Class Comparison	X^2 Value	X^2.05(2) with 1 d.f.	Conclusion
Chironomidae	1 vs 2	2.28	3.841	similar selection
	2 vs 3	5.32	3.841	dissimilar selection
	3 vs 4-5	5.07	3.841	dissimilar selection
Hydroptilidae	1 vs 2	2.30	3.841	similar selection
	2 vs 3	1.19	3.841	similar selection
	3 vs 4-5	10.74	3.841	dissimilar selection
Dytiscidae	1 vs 2	6.44	3.841	dissimilar selection
	2 vs 3	6.33	3.841	dissimilar selection
	3 vs 4-5	1.86	3.841	similar selection

Comparison of Ages	Differences (J_1-J_2)	sH1-H2	t-value	t.05(2)1	Conclusion	
1 vs 2	-0.1028	0.0600	-1.7133	1.973	Ho: $J_1=J_2$	Accept
1 vs 3	-0.4106	0.0574	-7.1533	1.973	Ho: $J_1=J_3$	Reject
1 vs 4-5	-0.4052	0.0539	-7.5176	1.972	Ho: $J_1=J_{4-5}$	Reject
2 vs 3	-0.3078	0.0640	-4.8094	1.972	Ho: $J_2=J_3$	Reject
2 vs 4-5	-0.3024	0.0608	-4.9737	1.973	Ho: $J_2=J_{4-5}$	Reject
3 vs 4-5	-0.0054	0.0583	0.0926	1.973	Ho: $J_3=J_{4-5}$	Accept

sH=Shannon's Index of Diversity.

TABLE 3. Quantitative and qualitative samples of aquatic organisms in the Teton River.

Taxon Present	Taxa present in two kick net samples of study area.	Percent of individual Taxa present in 1/8 m^2 of study area.
Arthropoda		
Trichoptera		
Hydroptilidae	+	0.0
Brachycentridae (larvae)	+	16.0
Diptera		
Chironomidae (larvae)	+	35.8
Plecoptera		
Acroneuriinae		2.0
Acarina		
Hydrachinellidae	+	2.0
Coleoptera		
Haliplidae **Haliplus** sp. (larvae)	+	0.5
Mollusca		
Pelecypoda		
Sphaeridae **Pisidium** sp.	+	12.8
Gastropoda		
Basommataphora **Physa** sp.	+	6.1
Annelida		
Oligochaeta		
Tubificidae	+	24.5

food resources. There was a significant difference in the indices of food diversity between age classes one and two and age class three indicating reduced competition for food. There was also a highly significant difference in food categories between age class one and combined age classes four and five. Age class three and combined age class four and five showed an insignificant difference between food categories and may be in competition for food.

TABLE 4. Percent of individual food items (N%) and frequency of occurrence (FO%) of food items for various age classes of Teton River whitefish.

Food Items	N% Age Class 1	FO% Age Class 1	N% Age Class 2	FO% Age Class 2	N% Age Class 3	FO% Age Class 3	N% Age Class 4&5	FO% Age Class 4&5
Chironomidae	85.8	100.0	78.5	78.3	50.4	77.0	45.3	53.3
Simuliidae	1.0	12.5	0.1	8.7	13.1	31.8	0.6	6.7
Brachycentridae	0.1	6.3	1.9	21.7	4.2	22.7	9.8	60.0
Hydroptilidae	12.6	81.3	9.9	34.8	10.9	31.8	21.5	26.6
Hydrachinellidae	0.0	0.0	0.0	0.0	0.2	9.0	0.0	0.0
Haliplidae	0.0	0.0	0.0	0.0	1.0	9.0	0.2	6.7
Dytiscidae	0.4	18.8	8.5	56.5	12.4	72.7	8.4	66.6
Basommataphora	0.1	18.8	0.7	8.7	4.8	27.2	11.2	33.3
Sphaeridae	0.0	0.0	0.1	4.3	2.7	22.7	2.3	20.0
Corixidae	0.0	0.0	0.2	8.7	0.0	0.0	0.2	6.7
Lumbricidae	0.0	0.0	0.0	0.0	0.1	13.6	0.6	13.3

Discussion and Conclusion

Food Habits

Whitefish food habits in the Teton River indicated variation in families of aquatic insects utilized between different age classes. Similar results were obtained from food habit studies of whitefish of Wyoming, British Columbia, and in the Snake River of Idaho (Baxter and Simon, 1970; Carl *et al.*, 1969; Carlander, 1969). This study is most nearly comparable to that of Snake River whitefish in Grand Teton National Park (Pontius and Parker, 1973).

The October 30, 1970 collection of Pontius and Parker (1973) of size class one whitefish from the Snake River is equivalent to age classes one-three in this study. They indicated chironomids in all stomachs of class one fish, and as the size classes increased, the percent of chironomids in the diet decreased. This study confirms these results. They found Plecoptera and ephemeropterans in Snake River whitefish, as did Sigler (1951) in Logan River whitefish, and as Laakso (1951) found in whitefish of Yellowstone River. However, the two orders appeared in small numbers in Laakso's (1951) fall samples. Plecoptera and ephemeropterans were not present in Teton River whitefish stomachs. Ephemeropterans were not collected in the aquatic samples of the Teton River, and a small percent of plecopterans were sampled. This finding may be a function of the siltation of Teton River. Tubificidae and chironomids were the most abundant organisms in the environmental samples and are characteristic of silt bottoms, but the numbers of Plecoptera and Ephemeroptera decrease in silt substrate (Eustis and Hillen, 1954). Teton River whitefish food habits may be adapted to the environmental disturbance resulting from overgrazed stream banks.

Food Diversity in Age Classes

Intraspecific competition for food items may exist between age class one and age class two when food resources are limited. However, age class two had a highly significant selection for Dytiscidae compared to age class one. This difference probably results from the ability of the larger fish to feed on the large Dytiscidae larvae. Age class two had a reduced weight gain compared to the other age groups (Table 1). This disparity could result from competition for food. Age class two fish are less capable of competing with larger age classes and partially share their feeding niche with age class one.

Age class three whitefish were captured in all sampling areas and contained the same types of food items as age class four and five. However, age class four and five had a higher occurrence of larger food items in the stomach than did age class three. Age class three also showed less linear growth than age class four and five. This disparity again may result from intraspecific competition (Emlen, 1966). Age class three has to expend more energy collecting smaller food items than age class four and five, which feed on larger items.

Further study is needed in the biology of the whitefish. Studies in population dynamics, food habits, and growth need to be undertaken in conjunction with other salmonids during seasonal changes, low waterflows, and different habitat types. The interaction of whitefish and trout needs to be further understood so that management plans may be adequately constructed for the game fish species. The decrease in the more preferred trout species is probably the result of stream siltation and not intraspecific competition with whitefish. The abundance and believed increase in whitefish may be correlated with decreased trout densities which result from increased silt deposition. The whitefish may adapt more readily than trout to a silted environment.

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ANNOUNCEMENT

This number of Northwest Science consists of two parts. The November number will return to the usual format, as will future issues of Northwest Science.