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FEEDING IN WHITE SUCKERS *(CATOSTOMUS COMMERSONI)* FROM GAMELIN LAKE, QUÉBEC, OVER A TWELVE MONTH PERIOD

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Résumé

L'auteur a analysé 711 contenus stomacaux de meunier noir *(Catostomus commersoni)* du lac Gamelin, au Québec, qui ont été capturés en 1969-70 sur une période de douze mois. Cette étude a montré que les meuniers noirs sont actifs et se nourrissent toute l'année. De plus, bien qu'ayant une bonne capacité d'adaptation à une diète variée, il a été démontré qu'ils établissent une sélection parmi les différents organismes à leur disposition. La diète de ce poisson change non seulement au cours de l'année, mais aussi avec la taille du spécimen. Chez les jeunes de l'année, on a trouvé surtout du zooplancton comme les Cladocères et les Copépodes. Les spécimens d'un an et plus se nourrissaient surtout de crustacés, d'insectes, de végétation et de différents débris.

Abstract

Data from 711 stomach contents of white suckers *(Catostomus commersoni)* from Gamelin Lake, Québec, captured over a period of twelve months in 1969-70, showed that these fish are active and eat during the entire year. Furthermore, although white suckers have a good ability to adapt to whatever food is available, it was demonstrated that they establish preferences amongst the food organisms, and do not simply eat at random whatever they find. This fish diet varies with time and with the size of the specimen. Young-of-the-year white suckers ate mainly zooplankton such as Cladocera and Copepoda; suckers one year and older consumed maintly of crustaceans, insects, vegetation and miscellaneous.

Introduction

The diet of the white sucker, *Catostomus commersoni* (Lacépède), has been investigated by several workers (Bigelow, 1924; Stewart, 1926; Rawson, 1930; Bassett, 1957; Siefert, 1972), but all factors affecting the determination of their food habits were not taken into account. Often, the number of fish stomachs examined was too low to determine the feeding habits of a species with such a varied diet. In addition, in most cases, the sample of fish did not cover an adequate size range, in any locality, to give a true picture of the biological relationships between the suckers and the organisms they consumed during different periods of their life. The time of the year is not always indicated, yet age, season, and available food all influence the selection of items in the fishes diet.

This study is the first attempt to quantify numerically the organisms eaten by white suckers during an entire year. It is very important to know the food of white sucker because, being principally an insectivore, it is a competitor of the trout (Stewart, 1926).

Material and methods

Gamelin Lake (48°40'N, 71°09'W), a small oligotrophic lake located 40 km north of Chicoutimi, Québec was described by Lalancette (1973). It has an

area of 12,3 hectares, maximum depth of 13 m, mean depth of 5,1 m and it lies at an elevation of 215 m. The water has a total hardness of 44 ppm and a pH of 6,5. The lake is ice-covered from late November to early May. During 1970, surface temperatures reached a mean of 20,7°C in July and 23,5°C in August, with a maximum recorded surface temperature of 27°C in August. A thermocline occurred between 3 and 5 m in June, descending to 6 m in August. Temperatures in the hypolimnion ranged from 10°C to 12°C in July and August. Oxygen concentrations in the surface waters averaged 7,5 ppm (over 16 months) but remained at 6,5 ppm in the hypolimnion throughout the summer. In addition to white suckers the lake contained brook trout, *Salvelinus fontinalis* and northern pearl dace, *Semotilus margarita*. Further limnological details are given in Lalancette (1973).

White suckers were collected between October 1969 and September 1970 using traps for older specimens and a fine seine for underyearlings. Wire mesh traps baited with bread were most effective for the collection of suckers older than 0^+. Fishing was arranged to provide specimens on a weekly basis throughout the year, but because catches were often large, subsamples were taken for study. Out of approximately 6 300 fish captured, 711 were selected for study including 46 from age group O, collected in July and August and 665 older fish. Stomachs were preserved in 8% formalin immediately after capture and examined later in the laboratory.

Plankton samples were obtained using a no 12 plankton net; 125 meshes per 25 mm, 875 mm long, with an aperture of 273 mm. Vertical hauls, from surface to bottom and from bottom to surface, in 10 m of water were taken to coincide with fish samples. Plankton was preserved in 5% formalin.

Two methods were used to analyze the stomach contents: frequency of occurrence and numerical abundance (Hynes, 1950).

Traps were normally emptied three times a week except during winter when they were emptied only once a week. Often several days elapsed between the time the fish entered the trap and the time the trap was emptied. This might explain why, throughout the year, only 33% of the stomachs contained food.

Enumerating the stomach contents was difficult. Organisms were often very small so numerous as to be impossible to count. In some cases, the number of organisms was simply estimated. It was also often impossible to identify some of the partially digested organisms.

Although frequency of occurrence and number of organisms in the stomachs provide a good indication of the diet of the white sucker, they do not take into account the size or volume of individual organisms involved. For example, insects are relatively rare in the stomachs of Gamelin Lake suckers but their size is such that, for example, many hundreds of cladocerans are required to provide the same volume as one dragonfly. The methods used demonstrate seasonal changes in the diet and selection of food items.

Selection was measured by use of the quantitative index of electivity E, described by Ivlev (1961). The electivity index is calculated by the formula:

$$E = \frac{r_i - p_i}{r_i + p_i}$$

where r_i is the relative quantity of any ingredient in the digestive tract expressed as a percentage of the total digestive tract contents, and p_i is the relative quantity of the same ingredient in the

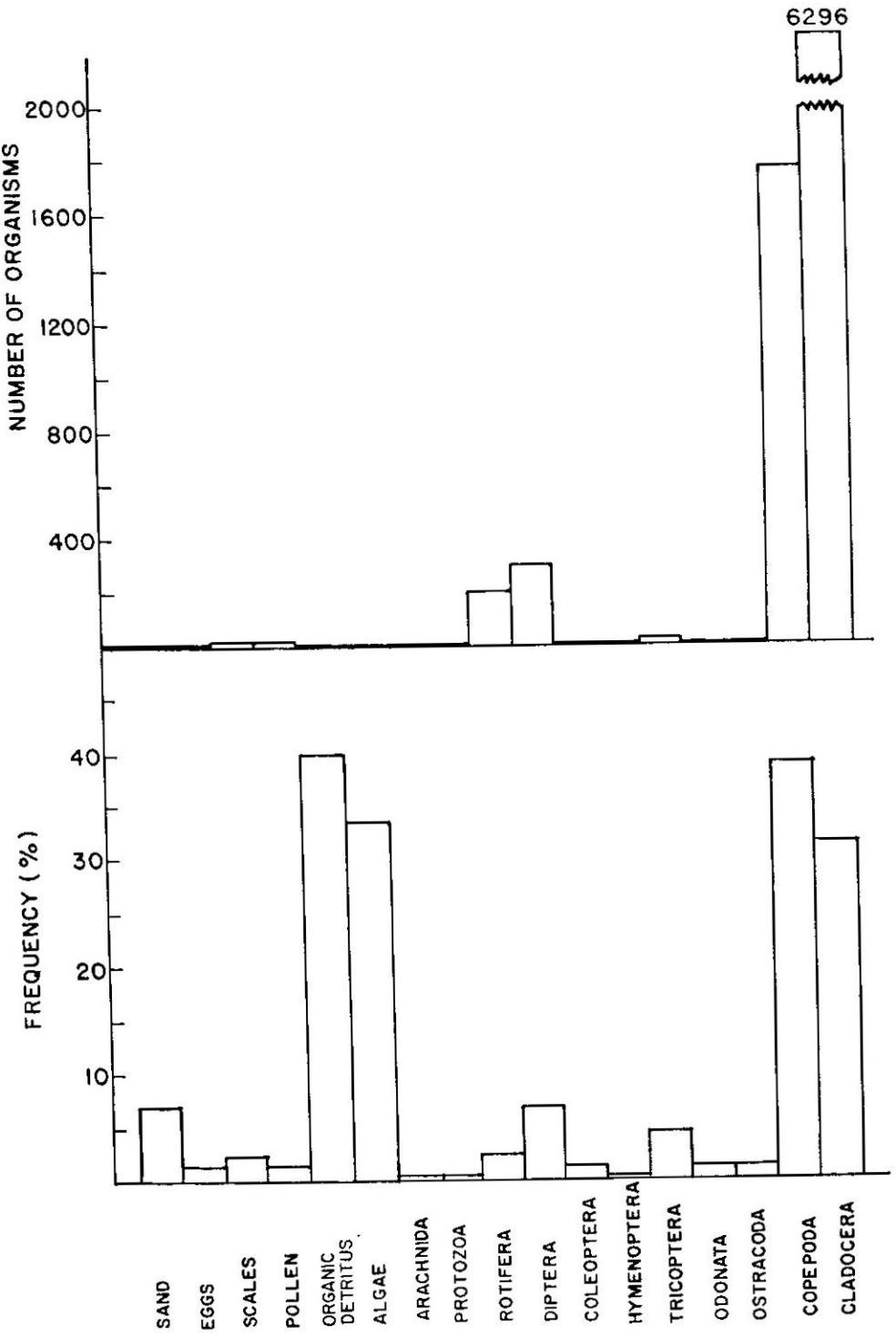

Figure 1. Frequency of occurrence and numbers of different organisms found in the stomachs of *Catostomus commersoni* of one year and older.

plankton of the environment expressed as a percentage. E values for each major food group occur within the limits of + 1 and − 1, the former value indicating complete positive selection and the later, complete rejection of a food item. The electivity index is strictly for a planktivorous fish, since comparisons are made only with the available plankton. It is not entirely appropriate for older suckers which use a much broader spectrum of food.

Results

FREQUENCY OF OCCURENCE OF ORGANISMS IN STOMACH CONTENTS

Because organisms eaten do not all have the same importance in size and to better describe the diet, the number of specimens of each genus was counted and the total recorded for each. The ratio of the number of stomachs containing a particular organisms to the total stomachs examined and containing food, was used to express the relative importance of the different organisms.

For young-of-the-year white suckers, the major organisms consumed were Cladocera (87,8%), Copedoda (80,5%) and nauplii (68,3%). Organic detritus (29,3%) and algae (15,2%) are less important (Table I).

TABLE I

Frequency of occurrence (%) and percentage composition of 2130 organisms in the stomach of 46 young-of-the-year *Catostomus commersoni* from Gamelin Lake (43 stomachs containing food)

Food item	*Occurrence*	*% composition*
Cladocera	87,8	45,8
Copepoda	80,5	32,5
Nauplii	68,3	18,4
Organic detritus	29,3	1,4
Eggs	17,1	0,5
Algae	15,2	0,6
Scales	14,6	0,8

The diet was a little more varied for older white suckers (Fig. 1). Most frequently encountered in the stomach contents were organic detritus (40,3%), copepods (39,4%), algae (33,9%), and cladocerans (31,7%). Insects, predominantly Diptera (7,2%), Trichoptera (5,0%), and Rotifera (2,7%) occupied a secondary place. Sand (7,2%) and fish scales (2,7%) were found fairly frequently in stomach contents.

NUMBERS OF ORGANISMS IN THE STOMACH

The number of organisms has been determined for each major group and expressed as the percentage of the total number consumed by both young-of-the-year and the older suckers.

For young-of-the-year (Table 1), Cladocera (45,8%) were the number one ranking food, followed by Copepoda (32,5%) and nauplii (18,4%). Organic detritus (1,4%), algae (0,6%), fish scales (0,8%) and eggs (0,5%) were of minor importance.

For older while suckers, Cladocera (72,7%) were the most important food with Copepoda (20,6%) ranking second. Although the latter occurred more frequently (Fig. 2), they were 3,5 times less numerous. Crustacea comprised 93% of the food of the white sucker. Insects (3,8%) and rotifera (2,5%) played a very minor role.

VARIATION OF FOOD WITH SIZE OF FISH

Diet changed with increased size of white suckers. This is particularly evident when the food of two major groups (young-of-the-year and older suckers) is compared (Table I and Fig. 1). Fish were divided following Stewart (1926); he mentions that white suckers become adult with respect to feeding when 75 mm long. When of this size, they

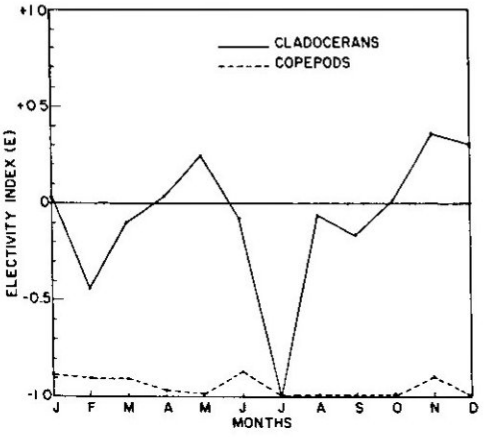

Figure 2. Electivity indices, (E), for cladocerans and copepods by white suckers, one year and older, Gamelin Lake, Quebec.

begin to feed on the bottom. Microorganisms are almost entirely replaced by insect larvae, molluscs, etc..., as a food source. The size of young-of-the-year was under 50 mm and older suckers varied from 85 to 230 mm.

MONTLY VARIATION IN DIET

Table II indicates the percentages of stomachs which contained food and the number of organisms present in each stomach containing food during each collection month. White sucker feed all year round except during the spawning period. Stomachs of the suckers collected during the spawning season were mostly empty; of fifteen specimens of both sexes examined, twelve had completely empty stomachs and three contained only a small quantity of organic detritus.

To show the dietary variations of the white sucker during the year, only the older fish were used. The major kinds of organisms found in the stomach were grouped into five categories and their relative importance was expressed as a percentage of the total contents (Table III). Crustaceans were consumed the whole year, but maximum consumption was in the fall. Organic detritus was most important during the winter whereas algae dominated in summer when water temperature was the warmest.

AVAILABLE FOOD AND SELECTION

Lake benthos was sparse but zooplankton populations were well developed. There were more species of Cladocera than Copepoda, a characteristic shared with subalpine and alpine lakes in western Canada (Anderson, 1971).

Young-of-the-year white suckers exhibited a preference for cladocerans. Electivity index for cladocerans was 0,67 and for copepods -0,39. For older specimens, electivity index was calculated for each month of the year and it is clear (Fig. 2) that cladocerans are prefered to copepods.

Discussion

Young-of-the-year suckers ate mainly plankton (Table I). In general, my results confirm the observations of other workers. The four principal groups of organisms ingested by young suckers in lakes studied by other investigators were: crustacea, small insects, rotifera

TABLE II

Numbers of stomachs collected each month (N), the percentage of stomachs containing food (S) and mean number of organisms consumed ($\bar{X}$) by *Catostomus commersoni* from Gamelin Lake.

Month	*N*	*S (%)*	$\bar{X}$
J	98	20	77
F	55	25	26
M	30	57	44
A	34	29	63
M	90	53	7
J	42	90	19
J	18	89	12
A	20	25	2
S	79	20	4
O	59	14	103
N	59	37	96
D	81	20	76

TABLE III

Monthly changes in the relative percentage composition of the diet of *Catostomus commersoni* of Gamelin Lake

Months	*Crustacea*	*Insects*	*Organic detritus*	*Algae*	*Miscellaneous*
J	41	0	30	20	9
F	31	8	33	21	8
M	18	6	39	20	16
A	32	0	32	18	18
M	25	43	4	14	14
J	23	16	47	5	9
J	0	33	22	33	0
A	27	18	18	27	9
S	14	2	31	33	19
O	48	9	4	26	13
N	68	2	4	21	4
D	67	5	14	10	5

and algae (Hankinson, 1916; Clemens *et al.;* 1924; Bigelow, 1924; Greeley, 1927; Nurnberger, 1930; Dobie, 1966, Olson, 1963, Flemer and Woolcott, 1966; Siefert, 1972).

The diet of older white suckers was compared with the diet from other lakes (Table IV). In Waskesiu Lake, Campbell (1935) found chironomids to be the first ranking food followed by molluscs and amphipods. That author added that chironomids constitute 85% of the benthic fauna, followed by molluscs and amphipods. The high percentage (44%) of amphipods found in the stomachs of white suckers in Lake Nipigon (Clemens *et al.,* 1924) reflects their abundance in the lake fauna. Stewart's data (1926) for Cayuga Lake and Bouchard's (1955) for Lauzon Lake, also show that chironomids are major food items.

The small proportion of benthic insects in the diet of older white suckers may reflect the low productivity of Gamelin Lake. Low productivity of benthic insects would explain why crustaceans were the major food item consumed.

There have been few attempts to establish a correlation between food of white suckers and the available planktonic and benthic food. Rawson (1930), in comparing the food of white suckers of several lakes, showed that the dietary habits of these fish changed with the nature of the benthic community. Other attempts to establish a correlation between stomach contents and potential food organisms were made by Clemens *et al.* (1924) and Campbell (1935) but results were not conclusive. A considerable variation in stomach contents of individual fish was noted in Gamelin Lake. This conformed with observations on white suckers living in other areas (Rawson, 1930).

Food selection for cladocerans was clearly present in the planktonic component of the diet in Gamelin Lake. Zooplankton was quantitatively sampled during the year (Lalancette, 1973). There were nine times more copepods than cladocerans in the lake, but cladocera occurred in the stomachs of both the young and older suckers in greater number than copepods. The choice is probably a question of selection for size as the cladocerans found in the lake are slightly larger than the copepods. The role of prey size in the selection of zooplankters by lake planktivores was observed for *Salmo gairdneri* and *Perca*

flavescens by Galbraith (1967) and for *Alosa pseudoharengus* by Brooks and Dodson (1965) and Brooks (1968). It seems then that the nature of the fauna of the lake does influence the dietary habits of the white suckers and that suckers establish preferences amongst the food organisms available, not simply eating at random whatever they find. The electivity index, Fig. 2, clearly shows the selection of cladocerans over copepods.

During the summer, the majority of stomachs contained food but in smaller quantities than during other seasons. This may be due to higher water temperatures which increase the rate of digestion (Ball, 1948). In the winter and fall, a lower proportion of suckers contain food but the ones which do eat contain more food organisms in their stomachs than they did during the other seasons of the year. But this does not necessarily prove that white suckers eat more during the cold seasons. It is possible that the fall increase can be attributed to a slower digestion rate due to the decrease in water temperature or due to less active gastric enzymes. In any case, the food eaten does not greatly influence the growth nor is there any marked accumulation of fat before the beginning of the winter period (Lalancette, 1973).

Because of the paucity of insects, change in diet with size was less obvious than was observed by Campbell (1935) in Waskesiu Lake, Saskatchewan. There white suckers of 118 to 245 mm length consumed 34% chironomids whereas 61% of the diet of larger specimens, 250 to 445 mm long was chironomids. That author, using the data given by Clemens *et al.* (1924), showed that the white suckers in Lake Nipigon also changed their diet as they grew. Amphipods comprised only 1% of the food of fish which were 50 to 240 mm long whereas those measuring 250 to 450 mm fed heavily on them (28,5%).

TABLE IV

Comparison of the percentage of occurrence of foods in stomachs of *Catostomus commersoni* from different lakes. The authors of these observations are cited in the text. N indicates the number of specimens.

Organisms	*Waskesiu Lake*	*Nipigon Lake*	*Cayuga Lake*	*Lauzon Lake*	*Gamelin*[1] *Lake*
N	29	16	52	100	665
Diptera	—	—	—	60	7
Ephemeroptera	1	—	9	—	—
Trichoptera	4	15	13	—	5
Odonata	—	—	9	6	1
Chironomidae	61	30	30	45	—
Mollusca	12	6	0.2	—	—
Amphipoda	12	44	5.4	3	—
Entomostraceae	4	—	5	—	—
Cladocera	—	—	—	30	32
Copepoda	—	—	—	14	39
Algae	—	—	2.4	18	34
Miscellaneous	1	3	26	9	11

[1] Percentage of occurrence in stomachs of suckers of age group I and older.

Bigelow (1924) who worked with young-of-the-year fish in Lake Nipigon observed the same thing.

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