THE SEASONAL DIETARY VARIATION OF THE BROOK STICKLEBACK (*CULAEA INCONSTANS*) IN A SOUTHEASTERN WISCONSIN STREAM

INTRODUCTION

The inter-relationship between predator and prey is often influenced by the season of the year. This concept has been noted by Hynes (1950) in two species of sticklebacks in England, *Gasterosteus aculeatus,* and *Pygosteus pungitius,* while Winn (1960) has reviewed the overall biology of the brook stickleback in Michigan streams.

The present study has been undertaken to investigate the seasonal variations in diet exhibited by the brook stickleback.

METHODS AND MATERIALS

A ten foot minnow seine was used to collect the fish. They were preserved in 10% formalin. The stomach contents were removed and examined under a microscope.

The specimens were collected in a stream flowing into the Milwaukee River at Ehler's Park in Ozaukee County, along Highway 57, about 1.5 miles north of Saukville, Wisconsin. The stream varied from 5 to 10 feet in width, and 6 inches to 3 feet in depth.

RESULTS

Perhaps the most conspicuous change occured with regard to the isopod *Asellus.* Its frequency of occurrence in the stickleback's stomach in the fall was 100%, the only organism in either the fall or spring group exhibiting this universality (Table 1.). Its percentage composition varied directly with its frequency (Table 2.). Copepods also showed a drop in numbers from fall to spring, although the frequencies of occurrence were similar (Table 1.).

On the other hand, the amphipod *Gammerus* showed a large increase from fall to spring in both frequency of occurrence and percentage of individuals in stickleback stomachs. The same is also true for dipteran larvae. Damselfly naiads were present in the spring, but not in the fall. The few beetle larvae were also found only in the spring.

Organisms found only in the fall sampling were rather insignificant amounts of *Daphnia* and diatoms, which may have been eaten as they were available.

Table 1. Frequency of Occurence (%) in Stickleback Stomachs

Organism	Fall	Spring
Algae	10	10
Annelids	15	5
Asellus	100	50
Beetle larvae	0	20
Copepods*	80	85
Damselfly larvae	0	35
Daphnia	15	0
Dipteran larvae	40	80
Diatoms	5	0
Gammerus	20	55
Nematodes	5	15

*Such organisms as *Limnocalanus, Canthocamptus,* and *Cyclops* were listed under the general heading of Copepods.

Table 2. Composition by Numerical Percent in Stickleback Stomachs

Organism	Fall	Spring
Algae	.96	1.03
Annelida	1.43	.41
Asellus	35.40	19.40
Beetle larvae	.00	1.03
Copepods*	46.40	19.60
Damselfly larvae	.00	3.93
Daphnia	3.83	.00
Diatoms	.96	.00
Dipteran larvae	7.66	38.00
Gammerus	2.87	15.30
Nematodes	.48	1.24

*Organisms such as *Limnocalanus, Canthocamptus,* and *Cyclops* were listed under the general heading of Copepods.

Items common to both groups, other than those already mentioned, were algae, annelids, and nematodes. They remained at relatively low frequencies and numerical percentages in both groups.

The spring collected fish ate more than the fall collected fish; 484 items in 20 spring fish, as opposed to 209 organisms for 20 fall fish.

DISCUSSION

Concerning the feeding behavior of sticklebacks, Ruiter and Beukema (1963) indicate the importance of the aspect of food being conspicuous, and eating rapidly until the stomach is full. Conspicuousness may account for the reason so many dipteran larvae or wigglers were consumed by the spring fish. That these fish gorge themselves is evident by the fact that most of the fish had stomachs which were quite full. Two fall fish had as many as 10 and 11 *Asellus* in them, while two spring specimens consumed 49 and 58 dipteran larvae.

Many studies have been done on the feeding habits of sticklebacks. Winn (1960) reported, as had others, that aquatic insects (especially larvae) and Crustaceans are the principle food. Other foods are snails, water mites, fish eggs (their own and others), and oligochaetes. Tower (1933) elaborated by pointing out that he found what appeared to be walleye eggs in the stomachs of sticklebacks. Leiner (1930) also reported that infusoria may be a part of the diet. Day (1880) has reported that sticklebacks have been observed to kill and eat larger fish in aquaria. Gunther (1963) found that sticklebacks will greedily devour young fry.

With a general picture of the feeding habits of the stickleback in mind, the seasonal variation will be considered. Hynes (1950) found that the sticklebacks had been feeding on a higher percentage of copepoda in the spring, while this study revealed a higher percentage in the fall. In both studies, the algae was rather low and similar for both periods. *Asellus* was higher in fall for both studies, while dipteran larvae were similarly more prominent in the spring group. Hynes found that most of the higher crustacea eaten were *Asellus,* which is confirmed in this report. In general, the largest specimen occured in the largest fish, but large fish often contained small specimens. One in the spring group had consumed 53 small *Asellus.*

Hartley (1940) found by the frequency of occurence method that insects formed 60% of the food and crustacea 29%. A few molluscs and some plants and diatoms were also eaten. Crustacea were found to be the most important food in winter. This was also true in this study as *Asellus* and copepods comprised 81.8% of the total food of the fall fish. It is interesting to note that *Asellus* was quite prominent and *Gammerus* seemed somewhat significant, but Hartley (1940) found both of these to be unimportant.

In attempting to account for the seasonal variation, Hynes (1950) proposed that fluctuations are probably due partly to actual variation in numbers of the various food organisms in the environment, and partly to variations in relative availability. During the winter, cladocerans and copepods are scarcer than in the summer, which seems to refute present data, and the fish are driven to eat such things as molluscs and oligochaetes, which, although always present, appear to be less attractive, or are possibly not as easy to eat or find as small crustacea. It seems possible, too, that in other bodies of water, where conditions and the specific composition of the food items are different, the time of the seasonal maxima are different.

The fact that spring collected fish eat more may be due to two factors: 1) there is a wider spectrum of food organisms, offering more palatable items. Organisms such as dipteran larvae are proportionately more available in the spring, and the damselfly naiads would be available only at this time. In the spring the metabolic rate of the fish will increase as the water warms, and as the fish require more food for the energy involved in the spawning process.

CONCLUSION

This study indicates that brook sticklebacks feed heavily on isopods and copepods in the fall and insects in the spring.

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