Comparison of Food Habits of Brook Trout and Blacknose Dace in an East Tennessee Stream

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Abstract: Food habits of wild and hatchery-reared brook trout stocked in a stream environment were compared to those of blacknose dace within the same stream. Trout utilized aquatic adult insects (38.9%), terrestrial insects (19.5%), and immature dipterans (14.2%) as their major food sources while dace consumed immature Trichoptera (27.0%) and Diptera (23.0%) as their major food items. A comparison of food habits suggested that some inter-specific competition might have been involved. Brook trout stomachs contained significantly more organisms than dace stomachs; however, no difference was found in mean volume of organisms in either.

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Brook trout, *Salvelinus fontinalis* (Mitchill) of the Great Smoky Mountains National Park (GSMNP), are relatively scarce and are found only in remote, headwater streams (Lennon 1967). During recent years, surveys have been conducted in the Park to determine the status of brook trout populations. Current findings by Park employees reveal a continual decrease of brook trout inhabited waters. If the present trend in the brook trout range continues, the species might disappear from the southern Appalachian Mountains within the next 10 to 20 years (R. Jones and P. Wilkins, pers. commun.).

The original range of the brook trout in the streams of the southern Appalachians extended from about 610 m elevation to the headwaters. Today, brook trout are usually found above 1,066 m in elevation. The reason for the decline in range is uncertain, but it is probably the result of a combination of factors: (1) widespread introduction of the rainbow and brown trout into the area which appears to have created competition detrimental to brook trout, (2) early logging and its attendant clearing and building or railroads which has eliminated brook trout from numerous drainages, and (3) heavy fishing pressure and illegal use of dynamite which has reduced many brook trout populations.

In past years, reclaiming of former brook trout waters has had only limited success in this region (Lennon and Parker 1959). The failures were blamed, in part, to the planting of hatchery fish of the New England strain and subsequent competition of the planted fingerlings with rainbow and brown trout. The purpose of this study was to examine food habits of wild and hatchery-reared brook trout in a stream environment and to gather information concerning competition with blacknose dace.

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Description of Study Area

Spruce Flats Branch (SFB) is located in the northwestern section of GSMNP where it flows through Blount and Sevier counties, Tennessee. The length of the stream is approximately 4.0 km from its headwaters to its confluence with Middle Prong of the Little River. The headwaters arise at an elevation of 975 m while the elevation at the mouth of SFB is 488 m. The gradient of the stream is 122 m/km.

The SFB study area included 2.07 km of stream with a mean width of approximately 228 cm. The volume of flow varies according to the seasonal precipitation levels, but is approximately 0.113 m^3/sec most of the year.

Electrofishing in the stream revealed that the only fish species present in the stream before the planting of brook trout fingerlings was the blacknose dace *Rhinichthys atratulus* (Hermann). Sampling revealed a greater dace abundance in lower elevations of the stream. Although no salmonid species were found with extensive electrofishing, brook were thought to have been native to the drainage. In addition to the blacknose dace, salamanders (*Desmognathus* spp. and *Eurycea bislineata*) and crayfish were abundant in the study area.

SFB was divided into 2 sections of 1,036 m each (designated A and B) which were measured into 17 subsections (61 m per subsection). Surveyor's tape attached to trees along the stream served to define subsection boundaries. No artificial barriers were established to prevent movement of fingerling brook trout between subsections or between Sections A and B; however, fish fauna in Middle Prong were unable to immigrate into SFB due to the height of several waterfalls at the base of the stream. These waterfalls served as natural barriers and help explain the absence of salmonid species above the falls.

There were several differences in the general appearance of Section A and Section B in SFB. In Section A the first 5 subsections were characterized by a steep gradient and pools, while the remaining subsections upstream were in flattened relief with little change in gradient and few pools. The majority of the water in Section A was shallow with scant streamside cover. Except for a period in early spring when moderate scouring of the stream occurred, the pools in Section A were heavily silted.

Section B was generally characterized by a steeper continuous gradient than in Section A and a consistent series of pools and riffles in the majority of its subsections. Observation of pools in Section B revealed a lighter silt load than in Section A. Streamside vegetation was profuse in Section B, particularly the upper subsections.

Methods

Research in the field and the laboratory was conducted from October 1974 to December 1975. On 8 October 1974, wild brook trout were collected in the West Prong, Little Pigeon River, in GSMNP for the purpose of collecting their eggs for future release as fingerlings in SFB. The fish were collected by electrofishing with a 700-V AC back-pack power unit mounted on a packboard with a gasoline motor as the power source. Twelve large brook trout were collected and served as the parent stock for the F_1 wild brook trout fingerlings used in the study. The mean fork length of the 5 males was 28.3 cm with an average weight of 349.0 g. The 7 females had a mean fork length of 25.2 cm with an average weight of 241.1 g.

Collected brook trout were transported to holding facilities at Pheasant Fields in the Tellico Wildlife Management Area. Tricaine methanesulfonate (MS-222) was used to facilitate handling of the trout while stripping eggs and milt from them. The dry method of egg fertilization was followed (Leitritz 1972) and approximately 400 eggs were taken to Buffalo Springs Fish Hatchery and incubated until hatching. The resulting F_1 wild strain fingerlings were fed commercial trout feed until their planting in SFB in early May 1975.

Hatchery trout fingerlings used in the study were obtained from a commercial hatchery in Brevard, North Carolina. The hatchery fingerlings were of the New England (Maryland) strain; they were also fed commercial trout feed until planted in SFB.

Planting tables developed by Embody (1927) and modified by Davis (1938) and Needham (1969) were used for determining brook trout fingerlings needed in the 2 sections of SFB. The stream was classified as a B-2 or average stream according to their rating system. According to planting rates for a stream such as SFB, 460 brook trout fingerlings 77-104 mm total length were needed for planting with an expected mortality rate of 30% (Embody 1927); however, 497 fingerlings were planted in the stream study sections. This was done to help compensate for any fingerlings lost en route to SFB.

Prior to planting, each fingerling was marked by cold branding with liquid nitrogen (Raleigh et al. 1973). Both F_1 wild and hatchery strain fingerlings were sorted for uniformity of size, counted, measured (total length in mm), and weighed to the nearest g. The numbers of fingerlings branded and planted in both sections are summarized in Table 1. Section A was greater in width; therefore, a greater number of fingerlings were to be planted in that section. All of the fingerlings were transported to SFB in sealed water-filled plastic bags and released according to cold brand number or letter group; however, each branded group, whether hatchery or F_1 wild, was distributed randomly within study section boundaries.

The 2 strains of brook trout were sampled once a month by electrofishing from June through November 1975. The following data were recorded for each fingerling sampled: (1) the subsection where recovered, (2) the cold brand number or letter, (3) brand clarity, (4) weight of fish, (5) total length of fish in mm, and (6) any other pertinent information. After data were collected from each fingerling, the fish was released or kept for later analyses of stomach contents.

In order to better understand fingerling growth and feeding habits, a systematic and broad sampling of stream macroinvertebrates was done. Qualitative and quantitative sampling was planned monthly in the 2 sections. Riffles were sampled using a square-foot Surber sampler with 2 or 3 samples collected from each section/month. These samples were collected from subsections chosen at random. Six artificial substrate samplers were used in riffle areas of both sections and were anchored to the stream bottom. These samplers were a modified design similar to those used by McDaniel (1974).

Qualitative sampling of macroinvertebrates was accomplished by picking organisms from overturned rocks and disturbed leaves and sticks. Also, the kicking of disturbed bottom toward a fine-mesh window screen was used. All samples were preserved in 70% ethanol in the field and taken back to the laboratory for sorting and identification. They were later keyed to the lowest taxon possible.

Table 1. Number and brand of brook trout planted in Spruce Flats Branch.

Strain	Total number planted	Brand and number planted in Section A	Brand and number planted in Section B
F_1 wild	237	X – 131	7 – 106
Hatchery	260	J – 140	H – 120

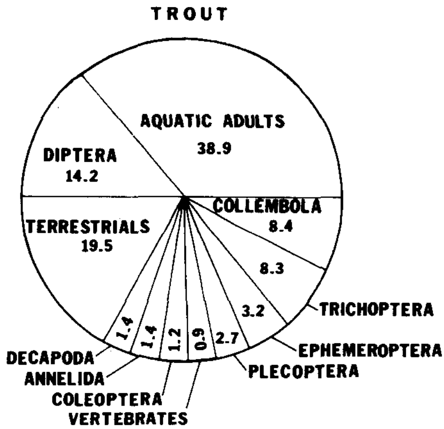

Figure 1. Occurrence of food items from 22 brook trout stomachs. Numbers indicate percent of total organisms counted.

Food habits were determined from the 22 brook trout fingerlings collected during the length of the field study. Fifty-seven blacknose dace stomachs were also collected to determine if interspecific competition between native dace and the planted brook trout fingerlings occurred as a result of similar feeding habits. Numbers of blacknose dace/subsection were also counted as a possible means of determining whether interspecific competition might be different between Section A and Section B.

As mentioned previously, individual organisms were keyed to family and, if possible, to genus. Mean number and volume of organisms in stomachs of brook trout and dace were determined following Tebo and Hassler (1963). Frequency of occurrence of food organisms was determined by dividing the total number of stomachs the food item was found in by the total number of stomachs in that category.

Results

In an effort to determine if bottom fauna might have been a limiting factor to survival and growth of the brook trout fingerlings in either Section A or Section B, quantitative sampling was done. The sampling revealed no significant differences ($P \geq 0.05$) in mean numbers of organisms; however, caution is emphasized. Needham and Usinger (1956) showed that at least 194 samples/unit area would be required to obtain a 95% confidence value for weight, and 73% value for numbers. Furthermore, Hynes (1970) stated that all quantitative estimates of the numbers or biomass of animals on stream beds are, at best, only very rough estimates.

Results of examining 22 brook trout stomachs are illustrated in Fig. 1. Aquatic adult insects (38.9%), terrestrial insects (19.5%), and immature dipterans (14.2%) comprised the greatest percentage by numbers of the brook trout diet during the study period. Immature forms of Trichoptera (8.3%), Ephemeroptera (3.2%), and Plecoptera (2.7%) were not found as often in the diet of the fingerlings as were the surface organisms.

Terrestrial Homoptera and Hemiptera were found to occur most frequently in the 22 stomachs examined. They were obtained from 16 stomachs, while Collembola and adult Diptera were obtained from 14. Chironomidae and *Simulium* were found in 11 stomachs, Heptageniidae nymphs in 7, and crayfish in 6. Several other organisms were collected, but none occurred as frequently as did the above organisms. Four hundred-forty organisms were identified from 21 fingerling stomachs. Only 1 stomach was empty.

Results of examining 57 blacknose dace stomachs are given in Fig. 2. Immature Trichoptera (27.0%) and Diptera (23.0%) comprised the greatest percentage of their diet by number. Ephemeroptera accounted for 16.5% of the dace diet, while terrestrial insects accounted for 12.7%.

Of all stomachs examined, Chironomidae immatures were the most frequent in occurrence (17) followed by Heptageniidae nymphs (15). *Ephemera* nymphs were obtained from 13 stomachs, while *Lepidostoma* and terrestrial Homoptera and Hemiptera were found in 10. Five stomachs were empty. The 52 stomachs contained 253 organisms.

Both hatchery and F_1 wild strains of brook trout were included together in a study of food habits since the recoveries were low. Because blacknose dace appeared to be numerous in the lower section, a study of their food habits was undertaken to determine if interspecific competition was involved. A comparison of mean dace numbers in subsections of Section A and Section B revealed more dace in the lower section. Saunders and Smith (1962) determined that transplanted trout fared better in partially depopulated habitats.

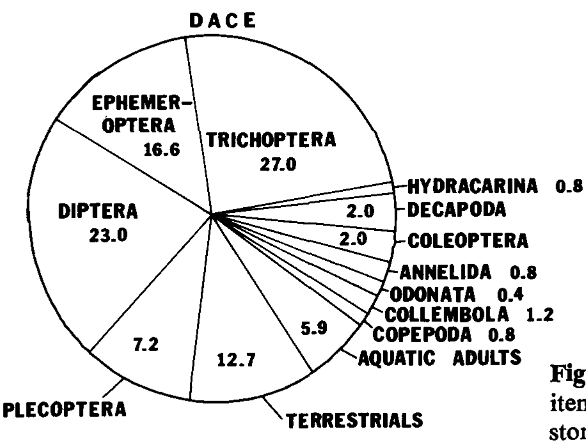

Figure 2. Occurrence of food items from 57 blacknose dace stomachs. Numbers indicate percent of total organisms counted.

A comparison of food habits of the 2 species suggested that interspecific competition might have been involved. The blacknose dace fed on a wide variety of bottom fauna and terrestrial organisms. Five crayfish were found in stomachs of 4 dace, even though Traver (1929) stated that crustaceans were rarely found in their stomachs. As Miller (1958) pointed out, when trout are introduced into a stream containing resident fish, they must compete with the residents for food and a home. Competition was lessened by the fact that the trout fed more on surface organisms such as aquatic adults and terrestrials. Competition may increase during winter months when the feeding habits of the brook trout will be limited to the bottom fauna.

Mean number of organisms and volume in both dace and brook trout stomachs were compared. Brook trout fingerling stomachs contained significantly ($P \leq 0.05$) more organisms than did dace stomachs; however, no difference was found in mean volume or organisms in brook trout and dace stomachs. Therefore, brook trout fingerlings may expend more energy acquiring food than the dace, which eat fewer but larger food items.

Literature Cited

Davis, H. S. 1938. Instructions for conducting stream and lake surveys. U.S. Bur. Fish., Fish Circ. 26:1–55.

Embody, G. C. 1927. An outline of stream study and the development of a stocking policy. Cornell Univ., Ithaca, N.Y. Mimeo 21pp.

Hynes, H. B. N. 1970. The Ecology of Running Waters. Univ. of Toronto Press, Toronto, Can. 555pp.

Leitritz, E. 1972. Trout and salmon culture. Calif. Dep. Fish and Game, Fish Bul. 107:1–169.

Lennon, R. E. 1967. Brook trout of Great Smoky Mountains National Park. Tech. Pap. Bur. Sport Fish and Wildl. 15:1–18.

Lennon, R. E. and P. S. Parker. 1959. The reclamation of Indian and Abrams Creeks Great Smoky Mountains National Park. U.S. Dep. Int. Sci. Rep. 306: 1–22.

McDaniel, M. D. 1974. Design and preliminary evaluation of an improved artificial substrate sampler for aquatic macroinvertebrates. Prog. Fish-Cult. 36(1):23–25.

Miller, R. B. 1958. The role of competition in the mortality of hatchery trout. J. Fish. Res. Board Can. 15:27–45.

Needham, P. R. 1969. Trout Streams. Winchester Press, New York, N.Y. 241pp.

Needham, P. R. and R. L. Usinger. 1956. Variability in the macrofauna of a single riffle in Prosser Creek, California, as indicated by the Surber sampler. Hilgardia 24:383–409.

Raleigh, R. F., J. B. McLaren, and D. R. Graff. 1973. Effects of tropical location branding techniques and changes in hue recognition of cold brands in centrarchid and salmonid fish. Trans. Am. Fish. Soc. 102:637–641.

Saunders, J. W. and M. W. Smith. 1962. Transplantation of brook trout within a small stream system. Trans. Am. Fish. Soc. 91:388–393.
Tebo, L. B. and W. W. Hassler. 1963. Food of brook, brown, and rainbow trout from streams in western North Carolina. J. Elisha Mitchell Soc. 70(1):44–53.
Traver, J. R. 1929. The habits of the blacknosed dace, *Rhinichthys astraonsus* (Mitchill). J. Elisha Mitchell Soc. 45:101–125.