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The Effect of Derris Root (Rotenone) Upon Plankton and Bottom Fauna Organisms of a Small Minnesota Lake

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A COMPARATIVE STUDY OF THE FOOD HABITS OF *Cottus bairdii* AND ASSOCIATED SPECIES OF *Salmonidae*

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ABSTRACT

The stomach contents of 328 trout and 1074 *Cottus bairdii bairdii* Girard (sculpin) were examined. 292 of the trout were *Salmo trutta fario Linnaeus* (brown trout) and 36 were *Salvelinus fontinalis fontinalis* Mitchill (common brook trout). The fish were collected from the Caribou River in Lake County and from the Main South Branch of the Root River in Fillmore County. Sixteen quadrates (each 18 inches square) of bottom fauna from these rivers were examined.

Salmonid eggs were eaten by the *Cottus* but the number of eggs was small and did not constitute a major food item of the *Cottus* examined in this study. A number of large trout were found to eat their own eggs in considerable numbers.

In general, the bottom fauna was consumed by both trout and *Cottus* in proportion to its availability. The feeding of *Cottus bairdii* was restricted to the bottom while the trout fed at all levels in the water. Both *Cottus* and trout were entirely carnivorous in food habits. The five major food items of *Cottus* were Gammarus, and the aquatic stages of *Trichoptera, Ephemerida, Plecoptera* and *Diptera.* These were major food items also of the trout. Forage fishes largely *Cottus* were an additional major food item for the trout.

Cottus bairdii and trout were considered to be competitors for major food items, however, this competition was lessened by the fact that the food habits of trout were more varied, and *Cottus* were of value to the trout as a forage fish.

THE EFFECT OF DERRIS ROOT (ROTENONE) UPON PLANKTON AND BOTTOM FAUNA ORGANISMS OF A SMALL MINNESOTA LAKE *

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During the summer of 1946, a quantitative investigation was

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made of the summer standing crop of plants and animals in Demming Lake, a small soft-water lake located near the University of Minnesota Biological Station in Itasca State Park. As a part of this investigation, the lake was poisoned with derris root (rotenone) on August 15, 1946, to obtain data on the fish population. Poisoning of the lake afforded an excellent opportunity to study at the same time the effects of the poison upon plankton and bottom fauna.

Demming Lake has an area of 5.09 hectares (12.57 acres). The maximum depth is 16.5 meters; however the mean depth is only 3.5 meters, and 69 per cent of the lake is 4 meters or less in depth. On the date the lake was poisoned, the temperature of the surface water was 29° C. Temperature decreased rapidly with depth in the upper water so that there was little evidence of an epilimnion stratum. At 4 meters, the temperature was 12° C. Dissolved oxygen was present at the surface in a concentration of 6 parts per million. In the lower part of the thermocline and in the hypolimnion (at 6 meters and below) oxygen could not be detected by the unmodified Winkler technique. The surface water had a total alkalinity of only 12 parts per million, and a *p*H of 7.2.

Derris root was applied to the lake by a method similar to that employed by Eschmeyer (1937) and by Greenbank (1941). Approximately 190 pounds of derris root were used, sufficient, it was estimated, to provide a poison concentration of approximately 0.5 part per million in the stratum of water between the surface and 6 meters. This concentration of poison apparently was effective in killing the entire fish population since no live fish were seen in the lake after poisoning and no fish were obtained from a gill net set in the lake 3 days after poisoning. The high temperature of the surface water in Demming Lake on August 15 was believed to be extremely favorable for poisoning (cf. Brown and Ball, 1943). Low temperatures undoubtedly tended to reduce toxicity of the poison in the deeper waters. However, the concentration of dissolved oxygen at depths greater than 5 meters was presumed to be too low to support fish life, and only a limited number of benthic and planktonic organisms occurred below this depth.

Net plankton samples were taken with a Kemmerer water bottle 13 days before poisoning (August 2) and again 4 days after poisoning (August 19). Samples were collected at the surface, and at depths of 2, 4, 6, 8, and 12 meters. Each sample was 100 liters in volume. Counts were made of all plankton samples using a Sedgewick-Rafter cell.

Fresh plankton samples collected 4 days after poisoning were examined immediately after collection. Surface, 2, and 4 meter samples all contained living Protozoa, rotifers, and green and blue-green algae. Free-swimming protozoans such as *Ceratium, Peridinium,* and *Vorticella,* and a variety of rotifers such as *Keratella,*

Polyarthra, and *Oecistes* were all active in these collections. No living Cladocera or Copepoda were present, although the quantitative samples taken before poisoning contained *Daphnia, Scapholeberis, Bosmina, Diaphanosoma, Holopedium, Diaptomus,* and *Cyclops.* All of these species were also present in qualitative samples collected 5 days before poisoning (August 10). The 8 meter sample taken after poisoning contained living specimens of *Chaoborus punctipennis* (Say). Brown and Ball (1943) and Meehean (1942) found that *Chaoborus (Corethra)* larvae were killed by derris root in lake poisoning experiments. Specimens from the 8 meter depth in Demming Lake may have been unaffected by the poison because of the low water temperature and the small amount of poison penetrating to this depth.

Table I gives counts of the plankton samples taken on August 2 (before poisoning) and August 19 (after poisoning). Although the Protozoa decreased markedly between August 2 and August 19, this decrease was due chiefly to a decline in numbers of *Dinobryon* which was at a seasonal maximum on August 2. Similarly, the smaller rotifer population at 1 and 2 meters on August 19 was believed to be due to normal population fluctuations rather than to the toxic effect of the poison. At most depths, green and blue-green algae were more abundant on August 19 than on August 2.

On August 6 (9 days before poisoning) a total of 67 bottom fauna samples were taken in the lake. Forty-eight of the samples were taken with an Ekman dredge, and 19 samples were taken with a Petersen dredge. This series of samples included 57 samples of the littoral and sublittoral fauna (0–5 meters) and 10 samples of the profundal bottom fauna (5–16.5 meters). On August 26 (11 days after poisoning) 26 samples were taken with an Ekman dredge in the littoral and sublittoral zone, and 2 were taken in the profundal zone.

Bottom samples collected on August 26 (after poisoning) were examined immediately after collection. They contained living specimens of nearly all species collected on August 6 (before poisoning). Odonata naiads were not present in the August 26 samples. However, the number of naiads recorded on August 6 (table I) was so small that their absence in the August 26 collections could have been due to an error in sampling. An increase in the number of annelids between August 6 and August 26 suggests that this group was unaffected by the poison. Experiments conducted by Brown and Ball (1943) indicated that leeches were killed by rotenone. Apparently the concentration of rotenone used in Demming Lake was not toxic to *Erpobdella punctata* (Leidy) since large and active specimens of this species were recovered from the 2 meter bottom samples. Ephemerida naiads of the genus *Caenis* recovered after poisoning, were living and apparently in good condition. Nematodes, molluscs (*Pisidium* and *Helisoma antrosa* (Con.)), and

amphipods (*Hyalella azteca* (Sauss.)) were alive in the August 26 samples, although present in smaller numbers than on August 6. All species of dipterous larvae recovered after poisoning, were alive. At the 4 meter depth, the total number of larvae was greater on August 26 than on August 6. At the 1 and 2 meter depths, populations were somewhat smaller on August 26. Living tricopterous larvae were also present in samples taken after poisoning.

The concentration of derris root used in this experiment apparently was toxic only to the Cladocera and Copepoda. A comparison of plankton and bottom fauna samples taken before and after poisoning gave no indications that the poison was toxic to other groups of organisms. Apparent changes in the populations of other organisms occurring during the period of study were believed to be due to either sampling errors or normal population fluctuations resulting from emergence, migration, depredation, and other natural causes.

TABLE I. PLANKTON AND BOTTOM FAUNA POPULATIONS OF DEMMING LAKE, BEFORE AND AFTER POISONING WITH DERRIS ROOT

	BEFORE POISONING			AFTER POISONING		
	August 6, 1946 Individuals per square meter			August 26, 1946 Individuals per square meter		
	1 meter	2 meters	4 meters	1 meter	2 meters	4 meters
BOTTOM FAUNA						
Nematoda	18	3	—	13	—	15
Mollusca	192	35	6	44	9	—
Annelida	87	46	—	114	1	281
Crustacea	123	3	3	48	1	—
Diptera (larvae)	1804	247	1413	706	146	2757
Trichoptera (larvae)	40	17	—	13	1	—
Ephemerida (naiads)	—	—	—	4	—	—
Odonata (naiads)	1	3	—	—	—	—
TOTAL	2265	354	1422	942	158	3053
	August 2, 1946 Individuals or colonies per liter			August 19, 1946 Individuals or colonies per liter		
PLANKTON						
Myxophyceae	262	157	281	6589	213	160
Chlorophyceae	9	22	65	128	592	108
Desmidiaceae	11	24	389	4	5	21
Bacillariaceae	+	2	3	+	+	+
TOTAL PHYTOPLANKTON	282	205	738	6721	810	289
Protozoa	14,164	24,601	27,675	7752	8381	200
Rotifera	629	330	81	105	156	105
Cladocera	10	91	8	—	—	—
Copepoda	6	81	21	—	—	—
TOTAL ZOOPLANKTON	14,809	25,103	27,785	7857	8537	305

+ indicates populations of less than 1 per liter.

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NESTING OF THE BROOK STICKLEBACK

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ABSTRACT

In the southern half of Minnesota nesting begins in late March or early April and continues until June. A male may build two successful nests in one season. The temperature of the water has usually attained a minimum of 8° C. before spawning begins. Nests are placed in shallow water (usually from 1 to 3 decimeters deep) concealed under overhanging banks, dead leaves, or other cover, and are attached to branched twigs or aquatic plant stems just above the bottom.

The chief building materials are the fibro-vascular bundles of plants especially those of monocotyledons but some membranous plant tissues are also incorporated. They are pulled from decomposing vegetation by the male and plaited about the support into a compact hollow sphere by means of his grasping jaws. The entire structure is then bound together by fine filaments of an elastic material produced in the testes. Nests average about 30 millimeters in diameter. Two circular openings about 8 mm. in diameter enter the central chamber from the sides.

The male chases interlopers from the nest site until construction is complete and then escorts one of the ripe females that hover near to the nest with an excited courting dance, circling and butting her. She enters, deposits her entire supply of mature spawn, and is then chased away by the male who promptly enters and fertilizes the eggs. When spawning is complete the male stands guard blowing water through the nest until the young are ready to leave. Two or more females may spawn in the same nest laying up to 250 or slightly more eggs each. The eggs are large (1.3 mm. in diameter) and colorless. The egg primordia present in a female at her first spawning form a continuous series of sizes and are probably ample to last the rest of her life.

The male becomes nearly black, often with a suffused coppery