Population dynamics of rotifers and some factors affecting their populations in Canyon Ferry Reservoir, Montana

by Gerald Lynn Kaiser

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Botany
Montana State University

Abstract:
Zooplankton and phytoplankton collections were taken biweekly and weekly in 1957 and 1958, respectively. A total of 58 samples were taken from one station in Canyon Ferry Reservoir.

In earlier papers, on Canyon Ferry, Dr. J. C. Wright discussed primary production and the population dynamics of Daphnia schodleri. However, the rotifer community was not discussed.

Finite birth rates, birth rates, population change, and death rates were calculated for populations of Polyarthra vulgaris, Keratella cochlearis, K. quadrata and Kellicottia longispina. Finite birth rates were strongly correlated with temperature. Birth rates were often correlated with extinction coefficients, temperature and to a lesser extent chlorophyll concentrations, and phytoplankton standing crops. There werq strong correlations between abundance of Daphnia spp. and Diaptomus leptopus and rate of rotifer mortality due to interspecific competition. The correlations between phytoplankton standing crop and rotifer mortality were attributed to Myxophyceaen "blooms". The latter suggests the Myxophyceae have an inhibitory effect on the rotifer community. Correlations with Cyclops bicuspidatus and Asplanchna priodonta versus mortality rates of totifers indicated the predators preferred the illoricate forms; some predation was observed to affect Keratella cochlearis.

It was concluded that mechanisms controlling a rotifer community are primarily temperature, competition, antibiosis, and to a lesser extent predation.

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by

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Approved:

Head, Major Department

Chairman, Examining Committee

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ABSTRACT

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In earlier papers, on Canyon Ferry, Dr. J. C. Wright discussed primary production and the population dynamics of Daphnia schodleri. However, the rotifer community was not discussed.

Finite birth rates, birth rates, population change, and death rates were calculated for populations of Polyarthra vulgaris, Keratella cochlearis, K. quadrata and Kellicottia longispina. Finite birth rates were strongly correlated with temperature. Birth rates were often correlated with extinction coefficients, temperature and to a lesser extent chlorophyll concentrations, and phytoplankton standing crops. There were strong correlations between abundance of Daphnia spp. and Diaptomus leptopus and rate of rotifer mortality due to interspecific competition. The correlations between phytoplankton standing crop and rotifer mortality were attributed to Myxophyceaen "blooms". The latter suggests the Myxophyceae have an inhibitory effect on the rotifer community. Correlations with Cyclops bicuspidatus and Asplanchna priodonta versus mortality rates of rotifers indicated the predators preferred the illoricate forms; some predation was observed to affect Keratella cochlearis.

It was concluded that mechanisms controlling a rotifer community are primarily temperature, competition, antibiosis, and to a lesser extent predation.

INTRODUCTION

This paper describes a study of rotifer populations and some plausible factors affecting their populations in Canyon Ferry Reservoir, a Missouri River impoundment. Previous limnological studies on Canyon Ferry have been carried out by Wright (1958, 1960, 1961 and 1965). A follow-up study is currently in progress.

Similar studies in Lake Francis Case and Lewis and Clark Lake, two Missouri River impoundments, revealed the occurrence of populations of Asplanchna priodonta, Polyarthra vulgaris, and Keratella cochlearis (Cowell, 1970). Williams (1966) observed that Polyarthra spp. and Keratella spp. are among the dominant rotifers found in major waterways of the United States.

In Lake Ashtabula reservoir, North Dakota, rotifers were observed to have a bimodal cycle, (Knutson, 1970). Beach (1960) also observed bimodal cycles with pulses occurring in early and late summer.

Edmondson (1960, 1965) observed that reproduction of rotifer populations is strongly influenced by food supply and temperature. Predation on rotifers by the predaceous rotifer Asplanchna priodonta has been observed by Edmondson (1946) and Nelson and Edmondson (1955).

Phytoplankton may have inhibitory effects on rotifer populations. Ryther (1954) observed inhibitory effects of phytoplankton on a population of Daphnia magna. Phytoplankton present may or may not represent the food of the zooplankton (Hazelwood and Parker, 1963).

Lund (1969) points out that one of the reasons blue-green algae are so often the dominant algae in the plankton is their relative freedom from grazing, compared to smaller green algae.

Rotifer populations may also be suppressed by competition. In an open water system, Brooks and Dodson (1965) found the following relations to prevail.

> "(1) Planktonic herbivores all compete for the fine particulate matter (1 µ to 15 µ in length) of the open waters.
>
> (2) Larger zooplankters compete more efficiently and can also take larger particles.
>
> (3) When predation is of low intensity, the small planktonic herbivores will be competitively eliminated by large forms (dominance of Cladocera and Calanoid copepods)."

The objectives of this study were to determine the mechanisms that influence population control in rotifer communities.

DESCRIPTION OF THE STUDY AREA

Canyon Ferry Dam is located 24 km east of Helena, Montana (Fig. 1). Canyon Ferry Reservoir was formed by the closure of Canyon Ferry Dam in 1953. It was constructed by the Bureau of Reclamation and is the uppermost impoundment on the Missouri River. Canyon Ferry attained operating levels in 1955. The reservoir is approximately 40 km long with a mean width of 1.3 km. At maximum operating pool level (1155 meters m.s.l.) the reservoir has a capacity of 25.3 x $10^8 m^3$, a surface area of 14.1 x $10^7 m^2$, with a maximum depth of 49.5 m and a mean depth of 18.1 m.

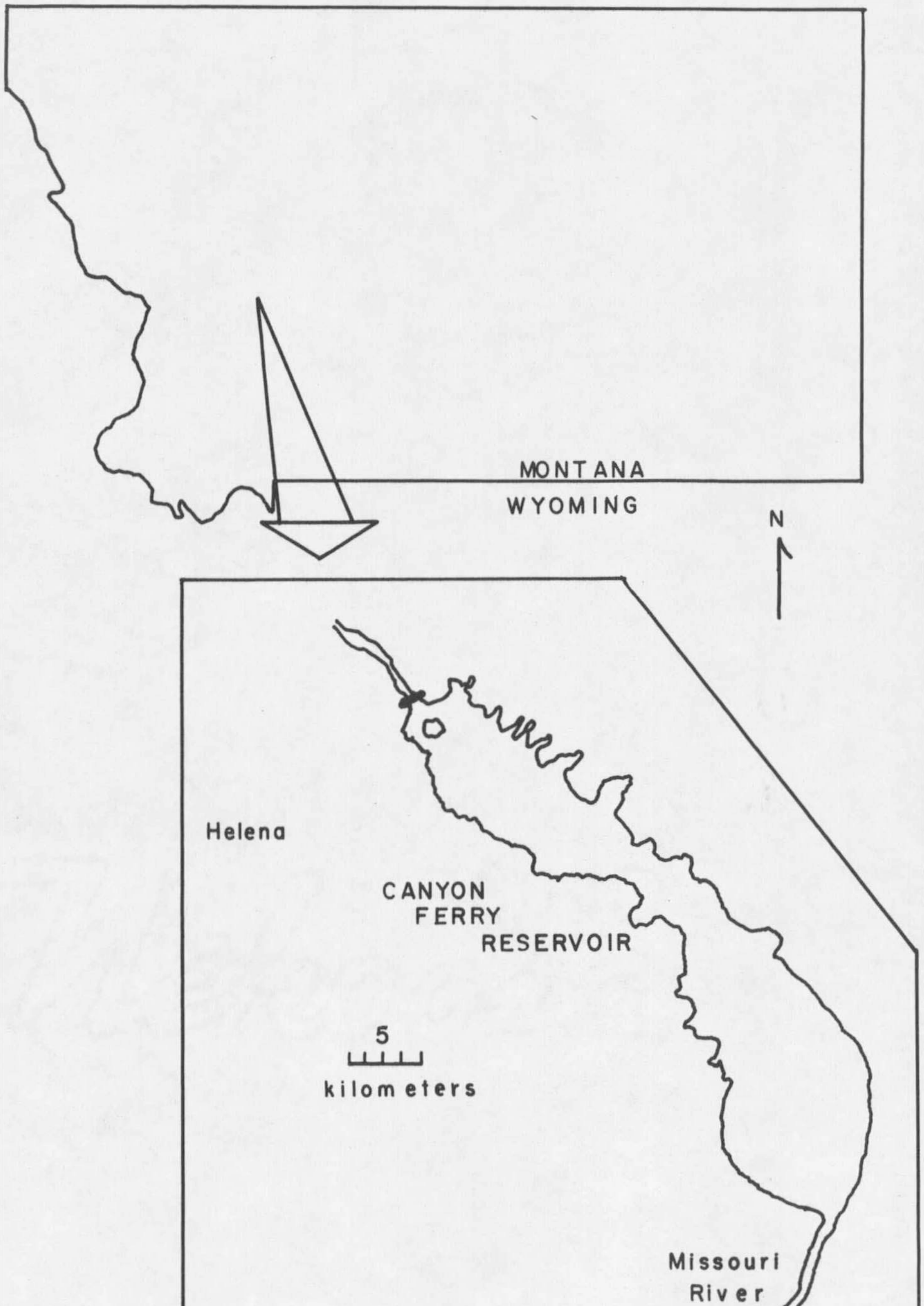

Fig. 1. Map of the study area, Canyon Ferry Reservoir, Montana.

MATERIALS AND METHODS

Zooplankton samples were collected by Dr. J. C. Wright in 1958 and 1959. Oblique tows were made with a Clarke-Bumpus plankton sampler using a No. 10 net. On each sampling date a tow was made through the euphotic zone to the surface and from the bottom (43 m) to the surface. All tows were made in the center of the reservoir at a station near the dam (Wright, 1965).

The samples from the euphotic zone were used for rotifer counts. The rotifers were identified to genus and species using a 60X binocular microscope and according to Edmondson (1959). Aliquots of 3 ml were placed in a modified rotary counting chamber (Ward, 1955). To attain statistical validity a minimum of 15 ml was counted (Lund, personal communication).

Calculations of the population dynamics follow Edmondson (1960). Rotifer egg duration times are from Edmondson (1965). Finite birth rate (B) was then calculated as follows: $B = E/DN$ where E = number of eggs, D = egg duration, and N = population size. Instantaneous birth rate (b) was then calculated from the following equation: $b = \ln (B + 1)$. Instantaneous rate of increase (r) was obtained from the following: $N_t = N_o e^{rt}$ where N_o = initial population and N_t the population after time t. Therefore, knowing b and r the death rate (d) may be calculated from the following relationship: $r = b - d$.

Statistics reported in this thesis follow standard procedures of Snedecor and Cochran (1967). The multiple linear regression analysis program was provided by Dr. R. E. Lund, Mathematics Department, Montana State University.

RESULTS

In decreasing order of abundance the six most common rotifers in 1957, were: Asplanchna priodonta, Polyarthra vulgaris, Keratella cochlearis, Anuraeopsis sp., Keratella quadrata, and Ascomorpha sp. For 1958, the following six genera were the most abundant: Polyarthra vulgaris, Asplanchna priodonta, Keratella cochlearis, K. quadrata, Ascomorpha sp. and Kellicottia longispina (see appendix, Table XXI).

POLYARTHRA VULGARIS

In 1957, the population was bimodal in appearance. The first peak occurred in mid-June, and the following peak in early July (Fig. 2). The decline in numbers of P. vulgaris at the end of June coincides with the decline of phytoplankton standing crop and phosphate concentrations (see appendix, Table XXII). After the second pulse in July the population declined and never recovered (Fig. 2).

Numbers per liter of P. vulgaris were positively correlated with numbers per liter of other rotifers and negatively correlated with phosphate concentrations (Table I).

Death rate was positively correlated with temperature, phytoplankton standing crop, abundance of Daphnia spp. and copepodids (Table I).

Finite birth rates were positively correlated with temperature and negatively correlated with the abundance of predaceous zooplankton (Table I). Finite birth rate demonstrated a lag phase response to the

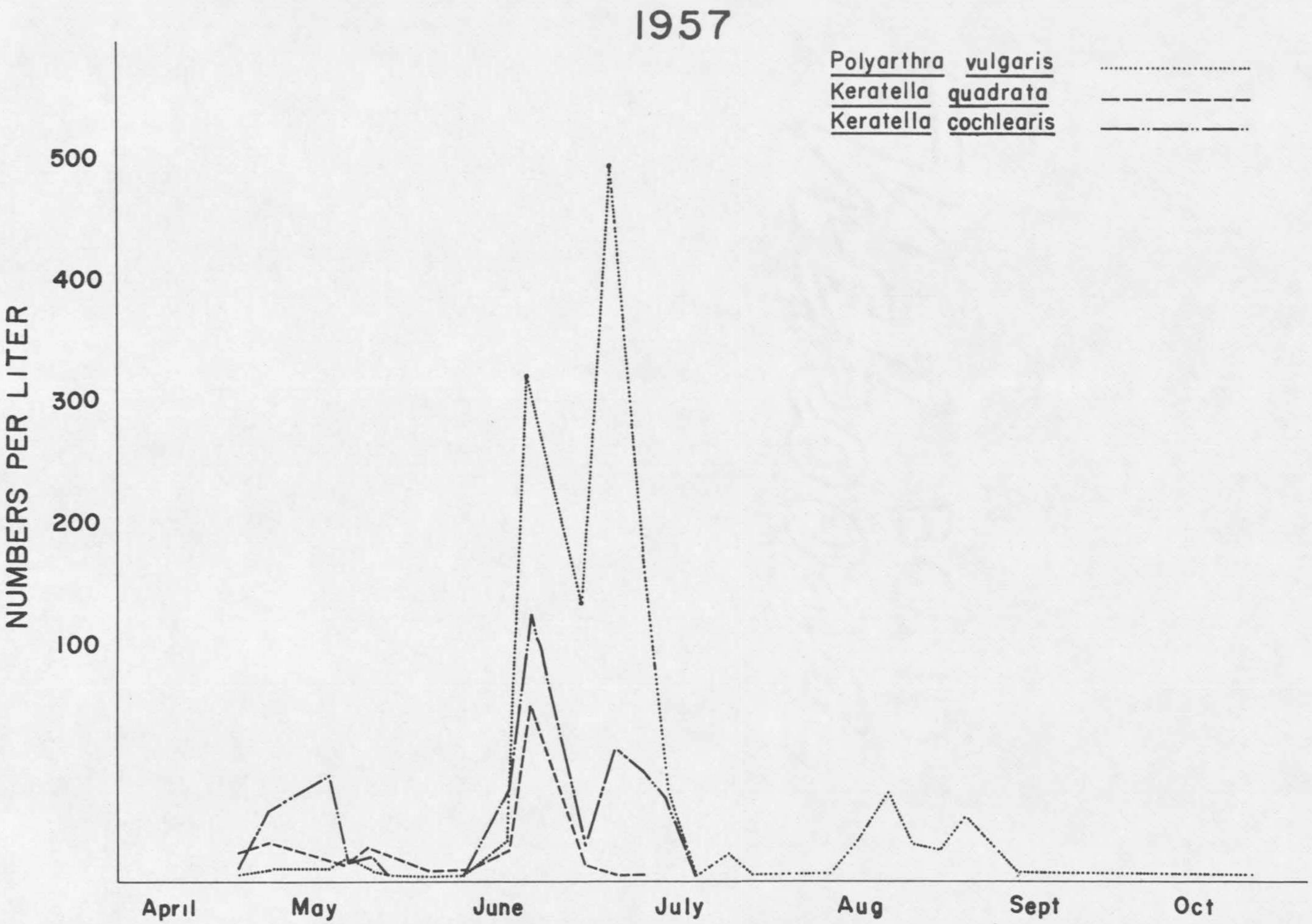

Fig. 2. Fluctuations of rotifer populations for the sampling period of 1957.