ZOOPLANKTON AND BENTHIC MACROINVERTEBRATES IN LAKE CARL BLACKWELL

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Zooplankton and benthic macroinvertebrates were collected from Lake Carl Blackwell between October 1980 and September 1981. Six genera of zooplankton common to area lakes were found. The density of zooplankton has declined with time. Nineteen genera of benthic macroinvertebrates were found; *Chaoborus* made up 91.5% of the assemblage. The diversity of benthic macroinvertebrates was much lower than in other Oklahoma lakes.

INTRODUCTION

Zooplankton and benthic macroinvertebrates support the economically important fish populations. Zooplankton are the major mode of energy transfer between the phytoplankton and the fish, while benthic macroinvertebrates facilitate the recycling of detritus and are also a significant source of food. We determined the composition and abundance of the zooplankton and benthic macroinvertebrates in Lake Carl Blackwell. Although the lake is one of the most frequently studied lakes in Oklahoma, little data has been published on the plankton and benthic macroinvertebrates.

STUDY SITE

Lake Carl Blackwell is located 13 km west of Stillwater. At spillway elevation it has a surface area of 1250 ha, a volume of 6.09×10^7 m^3, and average and maximum depths of 4.9 and 15 m, respectively. Since the watershed is only 194 km^2, rainfall in the area is sporadic, and no major sources of groundwater exist, the lake is usually below spillway elevation. The water in Lake Carl Blackwell is usually highly turbid owing primarily to resuspension of bottom sediments by wind-driven currents and wave action and occasionally by silt-laden runoff.

METHODS

Zooplankton and benthic macroinvertebrates were sampled 20 Oct 1980 and 7 Jan, 13 Apr, and 13 Jul 1981 at stations 1, 3, 7 and 9 (See Randolph and Wilhm, this volume, p. 57). Three vertical zooplankton tows from top to bottom were taken from each station using an 11.5-cm-diameter, 80 μm-mesh Wisconsin plankton net. Samples were preserved with sugar formalin (1). The contents of one 1-m*l* subsample were counted from each sample. Rotifers and copepod nauplii were not counted. Benthic macroinvertebrates were collected with an Ekman dredge and separated in a No. 30 bucket. The contents of three dredges made up one sample and three samples were taken at each station. Animals were preserved in 10% formalin and all the organisms in a sample were identified to genus and counted. Diversity was calculated using the formula of Shannon and Weaver (2).

RESULTS AND DISCUSSION

Zooplankton

Two genera of copepods and six genera of cladocerans were identified in Lake Carl Blackwell (Table 1). Total zooplankton density ranged from 32.8 animals/*l* in winter to 76.6 animals/*l* in spring. In 1980-81, *Diaptomus* was the most common genus except on 13 Apr 1981, when *Bosmina* was the most numerous. Two trends existed in seasonal abundance. *Diaptomus* and *Ceriodaphnia* numbers were relatively low in spring and winter and higher in summer and fall. *Mesocyclops*, *Daphnia,* and *Bosmina* peaked in density in spring.

The genera of crustacean zooplankton in Lake Carl Blackwell are typical of midwestern reservoirs (3). However, the number of genera in Lake Carl Blackwell was generally lower than that reported for other Oklahoma reservoirs. McClintock and Wilhm (4) found the same genera in Ham's Lake as in Lake Carl Blackwell plus two genera of chydorids. Arbuckle Lake contained three more genera of copepods (4), Eufaula Lake one more cyclopoid genus (5), and Keystone Reservoir four more genera of cladocerans and four more genera of copepods (6). Variability of sampling methods may possibly have influenced differences among reservoirs.

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The mean density of crustacean zooplankton in Lake Carl Blackwell was within the range reported for other Oklahoma reservoirs (4, 5, 6). Leonard (7) reported a decline in zooplankton density in Lake Carl Blackwell from 168 to 98 animals/*l* in 1940-41 and 1950-51, respectively. This trend has continued to the present and is possibly related to decreasing water clarity over time (7,8). Turbidity interferes with filter feeding by zooplankton (9). Because zooplankton are a major food source for fish, the standing crop of planktivorous fish is related to the standing crop of zooplankton. Further, high turbidity reduces the ability of visually feeding planktivores to locate food (10, 11) and reduces feeding rate (12). This may affect many of the planktivorous fish in Lake Carl Blackwell.

Benthic macroinvertebrates

Nineteen genera of benthic macroinvertebrates were found (Table 2), but nine genera were the maximum found at one time and station. Total density ranged from 2310 animals/m^2 in fall 1980 to 1625 animals/m^2 in spring 1981 and the greatest density was at Station 1 (Table 3). In summer 1981, densities were much lower because of emergence of adults. The dipteran *Chaoborus* averaged 91.5% of the benthic macroinvertebrate assemblage resulting in an average diversity of < 1.

Densities of benthic macroinvertebrates in 1967 in Lake Carl Blackwell (13) were similar to those found in the present study, but *Chaoborus* was only 7.7 and 61.5% of the assemblage in June and October, respectively. However, Norton sampled many different locations in the lake, while only open water areas were sampled in the present study.

The average density of benthic macroinvertebrates in Lake Carl Blackwell (1651 animals/m^2) was higher than in other Oklahoma reservoirs but the number of genera and diversity were relatively low. Densities ranged from 879 animals/m^2 in Keystone Reservoir (14) to 3039 animals/m^2 in Arbuckle Lake (15). The number of genera found in other studies range from 23 in Keystone Reservoir (14) to 74 in Ham's Lake (16). Diversity ranged from 1.6 in Keystone Reservoir (14) to 3.0 in Boomer Lake (17).

Benthic macroinvertebrates are a primary source of food for several species of fish in Lake Carl Blackwell such as carp river carpsucker, drum and channel catfish (18). The

TABLE 1. *Density of zooplankton (animals/l) in Lake Carl Blackwell (excluding rotifers and nauplii). Values are means of three replicates.*

Station	*Diaptomus*	*Meso-cyclops*	*Daphnia*	*Diaph-anosoma*	*Cerio-daphnia*	*Bosmina*	Total
20 Oct 1980							
1	19.7	1.9	4.9	4.7	7.6	1.2	40.0
3	38.7	2.6	6.8	6.2	8.6	1.2	64.1
7	11.4	0.9	4.0	6.2	6.6	3.1	35.2
9	40.9	2.8	5.8	6.5	8.3	1.1	65.5
Mean	27.7	2.0	5.3	5.9	7.8	1.6	51.2
7 Jan 1981							
1	24.9	0.7	6.0	0.1	0	4.5	36.2
3	17.3	1.0	4.7	0.1	0	1.1	24.2
7	20.3	1.4	4.5	0	0	6.4	32.6
9	26.8	0.7	5.7	0.1	0.5	4.0	38.0
Mean	22.3	1.0	5.2	0.1	0.2	4.0	32.8
13 Apr 1981							
1	26.8	10.6	28.4	1.7	0.1	38.4	106.0
3	17.1	5.2	28.6	0.4	0	11.7	63.0
7	24.6	10.5	14.0	0.5	0	61.3	111.2
9	9.7	3.3	11.5	0	0	1.8	26.3
Mean	19.5	7.5	20.6	0.6	0.0	28.3	76.6
13 Jul 1981							
1	20.1	3.4	0.6	5.7	15.2	0.6	47.0
3	16.0	3.5	1.4	7.9	18.9	3.5	51.5
7	37.7	4.8	0.4	5.7	17.3	3.8	71.8
9	18.3	3.0	0	3.4	29.1	4.9	58.8
Mean	23.6	3.7	0.6	5.7	20.2	3.5	57.3

relatively high density of benthic macroinvertebrates suggests that adequate food resources exist for these fish.

TABLE 2. *Benthic macroinvertebrate genera found in Lake Carl Blackwell, October 1980 - July 1981.*

Annelida
- *Tubifex*
- *Aulodrilas*
- *Limnodrilus*
- *Branchiura*

Mollusca
- *Sphaerium*

Arthropoda
- Insecta
  - Ephemeroptera
    - *Hexagenia*
  - Coleoptera
    - *Gyraulus*
  - Megaloptera
    - *Sialas*
  - Diptera
    - Chaoboridae
      - *Chaoborus*
    - Chironomidae
      - *Chironomus*
      - *Tanypus*
      - *Larsia*
      - *Cryptochironomus*
      - *Coelotanypus*
      - *Procladius*
      - *Ablabesmyia*
      - *Polypedilum*
      - *Anatopynia*
      - *Clinotanypus*

TABLE 3. *Genera diversity ($\bar{d}$), number of genera, and density of benthic macroinvertebrates in Lake Carl Blackwell.*

Station	$\bar{d}$	Number of genera	Animals/m²
20 Oct 80			
1	0.04	3	6090
3	0.46	7	1860
7	0.96	7	545
9	0.05	3	732
Mean	0.38	5	2310
7 Jan 81			
1	0.49	6	3230
3	0.84	6	2270
7	0.86	9	2180
9	0.62	7	1560
Mean	0.70	7	2310
13 Apr 81			
1	0.31	4	2620
3	0.84	8	1290
7	0.88	7	1280
9	0.71	5	1310
Mean	0.69	6	1625
13 Jul 81			
1	0.00	1	201
3	1.72	7	445
7	0.10	5	589
9	1.13	3	197
Mean	0.74	4	358

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