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ABSTRACT

Respiration values for **Chironomus** n. sp. ranged from 0.11 mm^3 O_2 /mg/hr at 5C to 0.44 mm^3 O_2 /gm/hr at 25C. The range for **Chaoborus punctipennis** was from 0.15 mm^3 O_2 /mg/hr at 5C to 0.56 mm^3 O_2 /mg/hr at 25C. These low respiratory rates allow the two species to withstand low oxygen tensions for extended periods of time. Reflecting this ability, both species attained their greatest numerical and biomass values in the profundal regionsof three strip-mine lakes whose lower waters become oxygen depleted during thermal stratification.

INTRODUCTION

Respiration accounts for most of the energy losses between trophic levels (Odum, 1959). Smalley (1960) determined that 63.3% of the energy assimilated by grasshoppers in a salt marsh was released through respiration. Teal (1957) reported the fraction of assimilated energy which various macroinvertebrates transform to heat ranges from 12 to 84%, with a mean value of 71% for the entire community.

Respiration values define the influence of oxygen content of the water on distribution of macroinvertebrates. Kasatkina (1960) reported respiratory values of 1.54 and 1.24 mm^3 O_2/mg live wt/hr for stream inhabitants *Cricotopus bicinctus* (Meigen) and *C. sylvestris* (Fabr.), respectively, at 20 C. *Tanytarsus* characterizes the oxygen-rich oligotrophic lake and has a respiratory rate of 0.52 mm^3 O_2/mg/hr at 17 C (Walshe, 1947). *Tendipes plumosus* (L.), which characterizes the oxygen-poor eutrophic type lake, may have a respiratory rate as low as 0.12-0.19 mm^3 O_2/mg/hr (Harnisch, 1930). Between these extremes, other midge larvae characterize additional lake types, as *Stictochironomus* lakes and *Sergentia* lakes (Ruttner, 1966). Hence, investigation of the rates of respiration of benthic macroinvertebrates can provide important information concerning the oxygen economy and production of a lake.

The purpose of this study was to measure rates of respiration at different temperatures in *Chaoborus punctipennis* (Say) and *Chironomus* n. sp.

METHODS

Organisms were acclimated at the experimental temperature for 24 hr prior to determinations. Seventeen measurements for each species were distributed as follows: for *Chironomus* n. sp., four replicates at 5.9 C, four at 12.5 C, five at 13.5 C, and four at 24 C; for *Chaoborus punctipennis*, four replicates at 6.7 C, three at 10 C, five at 14.8 C, three at 19 C, and two at 24 C. Each replicate of 100-150 individuals was placed in a 100-cc syringe filled with lake water (Ewer, 1941). The chironomids were first removed from their tubes. The oxygen content of the water before and after incubation was measured by the azide modification of the Winkler method (APHA, 1960). After the initial oxygen determination, the syringes were placed in lighted incubators at various temperatures from 6 to 24 C for 2-3 hours, a period of time long enough for a measurable change in oxygen to occur but not sufficiently long to lower oxygen tension detrimentally. During the experimental runs, temperature fluctuation did not exceed ±1 C of the stated value. The syringes were rotated periodically to insure equal distribution of oxygen. After the final oxygen determination, the organisms were removed and weighed. Oxygen consumption was converted to calories by the average oxycaloric coefficient of Ivlev (1934), 3.38 cal/mgO_2.

RESULTS

The rates of respiration for both *C.* n. sp. and *C. punctipennis* were shown to increase exponentially with increased temperature (Fig. 1). The respiratory rate of *Chaoborus* was greater than that of *Chironomus* at all temperatures and differed by a factor of 1.3 at 24 C.

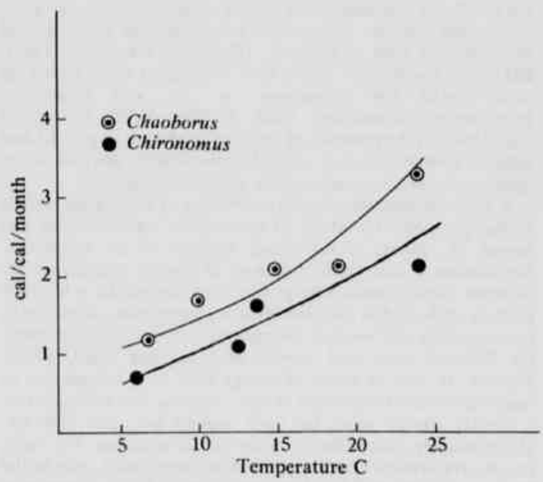

Figure 1. Rates of respiration for *Chironomus* n. sp. and *Chaoborus punctipennis* at various temperatures, expressed as cal/cal/month. The curves were drawn by inspection.

DISCUSSION

The rates of respiration determined for *Chironomus* n. sp. and *C. punctipennis* fall at the lower end of the range reported in the literature for other benthic fauna (Berg et al., 1962; Kasatkina, 1960; Teal, 1957). Walshe-Maetz (1953) reported that respiratory values for *T. plumosus* could be erroneously high if the larvae were out of their tubes and the level of dissolved oxygen fell below 25% saturation. As the dissolved oxygen values in this study were never so low this potential source of error can be ignored.

At a given temperature the higher respiratory rates are characteristic of species which require well oxygenated water (Walshe, 1947). Those species with lower respiratory rates can withstand lower oxygen tensions for protracted periods of time (Harnisch, 1930; Walshe, 1950). *Chironomus* n. sp. and *C. punctipennis* are of the latter group.

The two midge species were collected from three coal strip-mine lakes in central Missouri. *Chironomus* n. sp. was the only midge present in Lake A_1, pH 3.2-4.1. It formed 93.6, 98.1, and 99.7% by number and 46.4, 68.8, and 99.1% by weight of the total benthos at 0.25, 1.5, and 4.0 m (deepest), respectively. The major factor determining the dominance of this species is its tolerance to mineral acidity (Harp and Campbell, 1967). However, within the lake its relative abundance at various depths coincided more nearly with the degree of oxygen depletion during thermal stratification (Campbell and Lind, 1969).

Chaoborus punctipennis was the major benthic species in the two alkaline lakes. In Lake B (pH 6.3-7.8) it formed 0.7, 17.1, and 90.7% by number and 0, 0.3, and 54.2% by weight of the total benthos at 0.25, 2, and 5 m, respectively. In Lake D (pH 6.6-7.4) it formed 0.1, 2.3, and 78.8% by number and 0, 0.1, and 37.2% by weight of the total benthos at 0.25, 2, and 4 m, respectively. Dissolved oxygen concentrations and patterns of the two alkaline lakes were those of similar dimictic temperate lakes.

The large numerical and biomass standing crops established by the two midge species in the three coal strip-mine lakes are the result of a combination of factors. *Chironomus* n. sp. is one of the few benthic forms that can withstand mineral acid environments such as Lake A_1 (Harp and Campbell, 1967). Relatively few benthic forms have respiratory rates as low as those found for *Chironomus* n. sp. and *Chaoborus punctipennis* (Kasatkina, 1960; Walshe, 1950). Given the conditions, in the presence of reduced predation (e.g. fish) and reduced competition (e.g. other benthic fauna), the two midge species are able to increase their populations greatly.

A final consideration is the expression of respiration values in energy units. The study of community metabolism is one means of making a functional analysis of an ecosystem. Respiration is the major pathway of energy transformation between trophic levels. Energy units are preferable to biomass units in such studies because there is recirculation of matter in the ecosystem and because the rates of turnover are so different for different sizes and species of organisms (Teal, 1957). Further, at least in terms of energy flow, in a comparison of respiration values expressed as mm^3 O_2/mg, one must assume a similar energy value for each species per unit biomass. Unfortunately, this is far from the actual situation. For these reasons respiration values expressed in energy units, rare in the literature to date, will be of greatest value in future community metabolism studies.

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