SECTION J, BIOCHEMISTRY—BIOPHYSICS

A Note on the Metabolism of Two Diptera Larvae Chaoborus punctipennis and Chironomus plumosus[1]

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In a recent study of community structure of benthic macroinvertebrates in Keystone Reservoir, Oklahoma, significant differences were observed in the distribution of the larvae of *Chaoborus punctipennis* (Say) and *Chironomus plumosus* (Linnaeus) (Ransom, 1969). Larvae of *C. punctipennis* were collected in large numbers from deep anoxic water. Larvae of *C. plumosus* seldom were found in anoxic water, but occurred in shallow water containing dissolved oxygen.

Reviews (Prosser, 1955; Bullock, 1955; Fromm, 1965), relating to the distribution of species have pointed out that physiological limitations can describe the ecological range of an animal. Hence, it seemed possible that differences in the ability of larvae of *C. punctipennis* and *C. plumosus* to carry on anaerobic metabolism could provide the rationale for their distribution in Keystone Reservoir. This note reports experiments which measured oxygen utilization, carbon dioxide production and acid excretion (anaerobic) of *C. punctipennis* and *C. plumosus* larvae.

Materials and Methods

Larvae of *C. punctipennis* were collected as required and transported to the laboratory in reservoir water. Larvae of *C. plumosus* were taken from stocks which were maintained in the laboratory. The final instar of each species was used in all experiments.

Standard Warburg manometric techniques were employed to measure gas exchange and acid production. The experimental medium for the larvae was reservoir water. Volatile fatty acids were measured by titration with 0.01 N NaOH after the acids had been separated by the steam distillation method of Fenner and Elliot (1963). Dry weight determinations for each species were made by drying known numbers of larvae (20-50) at 110 C for 2 hr in tared vessels and reweighing.

Results and Discussion

The results of oxygen uptake, carbon dioxide production and acid production are presented in Table I. The respiratory quotient was approximately the same for both species. In air the metabolic rate of *C. punctipennis* larvae is almost twice the rate observed for larvae of *C. plumosus*. This is probably due to the difference in the size of the larvae of the two species. Fourth instar larvae of *C. plumosus* are more than 5 times as large as larvae (fourth instar) of *C. punctipennis*. Usually metabolic rate is proportional to the size of the animal; with increasing

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TABLE I. GAS EXCHANGE AND ACID PRODUCTION IN THE MIDGE LARVAE *C. punctipennis* AND *C. plumosus*.

Determination	Larvae			
	C. punctipennis		C. plumosus	
Dry wt. (mg/individual)	0.15		1.05	
Q O_2 (μl O_2/mg dry wt/hr)*	7.42	(2)	4.11	(2)
Q CO_2 (μl CO_2/mg dry wt/hr)*	6.08	(2)	3.22	(2)
R.Q.	0.82		0.78	
mμ moles acid excreted/ mg/dry wt/hr**	230.	(2)	70.	(2)

Numbers in ( ) indicate the number of measurements. Each measurement represents 10 or more larvae. Gas phase: * — air; ** 95% N_2—5% CO_2. Temperature: 30 C.

weight there is a decrease in oxygen uptake per unit mass. Edwards (1958) observed this relationship in the midge larvae *Chironomus riparius* (Meigen).

Under anoxic conditions, the larvae of *C. punctipennis* secrete some 230 mμ moles of acid per mg dry weight per hour. This is more than 3 times the amount of acid secreted by *C. plumosus* larvae (Table I) under similar anoxic conditions. At the end of one 2-hr period without oxygen, the larvae of each species and their medium were analyzed separately for volatile fatty acids. A total of 110 μ moles of volatile acid(s) (80 μ moles in the tissues and 30 μ moles in the medium) was produced by the larvae of *C. punctipennis*. Volatile acids accounted for more than 50% of the total acid excreted by the larvae each hour under anoxic conditions. No volatile acids were found in the tissues or medium of *C. plumosus* larvae.

It was pointed out by von Brand (1946), in an excellent review of anaerobiosis, that the production of volatile acids is frequently observed in animals that can live temporarily or permanently in the absence of oxygen. Data presented in this note suggest that differences in the ability of *C. punctipennis* and *C. plumosus* larvae to form and excrete acids can explain the observed difference in distribution of the two species in Keystone Reservoir.

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