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COMPARATIVE RESPIRATION IN TWO SPECIES OF FRESHWATER UNIONID MUSSELS (BIVALVIA). – The purpose of the following investigation is to determine and compare the respiratory rates of two species of unionid mussels, *Elliptio complanata* (Solander) and *Anodonta grandis* Say, from the same lake. Both species are commonly found in lakes and rivers of the Canadian St. Lawrence drainage system. They frequently occur together and have been reported on all types of bottom, varying from soft mud or clay to coarse gravel (Clarke, 1973). However, in the lake where the study was undertaken, intensive surveys over two seasons indicated that *E. complanata* was restricted to sandy bottom, whereas *A. grandis* occurred on substrata composed of mud or clay mixed with vegetative debris.

Animals were collected from depths of 0.5 to 2 m in Lac Yvan, a small, eutrophic lake in the Laurentians, 50 km to the north of Montreal, Canada. They were transferred to aquaria within 12 h and were subsequently held at appropriate water temperatures (5, 10, 15, 20 and 25°C) for 48 h prior to the commencement of determination of rates of oxygen consumption. Oxygen consumption rates were measured with a Beckman Field Lab Oxygen Analyser. Rates were determined on individual animals in chambers of known volume immersed in a constant temperature bath at the appropriate temperature. Control chambers contained no animals.

Two types of chambers were used. In experiments designed to determine rate of oxygen consumption with decreasing oxygen tension, water was circulated by means of a small rotary pump through a plastic incubation vessel (2.5 l). An oxygen probe was inserted in the system and continuous records of oxygen consumption were maintained over periods of 6-12 h. Four specimens (1-4 g dry tissue weight) of each species were placed, in turn, in the respirometer and allowed to exhaust the available oxygen. Temperatures were maintained at 20-22°C in each experiment.

In experiments designed to measure oxygen consumption at different temperatures, 700 ml glass jars with snap caps were used. Because the experimental animals were actively pumping water in their vessels throughout the experiments, no additional stirring device was required. Incubation times were 1 h in all cases, and oxygen concentrations were measured at the beginning and end of the experiment. Between 15 and 20 individuals were tested at each temperature. After removal from the respirometers, the animals were removed from their shells, dried to a constant weight and reweighed on a Mettler H 10 W balance.

Fig. 1 shows the rates of oxygen consumption with decreasing oxygen concentration of four individuals each of *Anodonta grandis* and *Elliptio complanata* in the flow-through respirometer. In both species, rates of oxygen uptake were relatively constant between concentrations of 9 to about 1 mg O_2/l. Below concentrations of 1 mg/l the rates in all individuals dropped sharply.

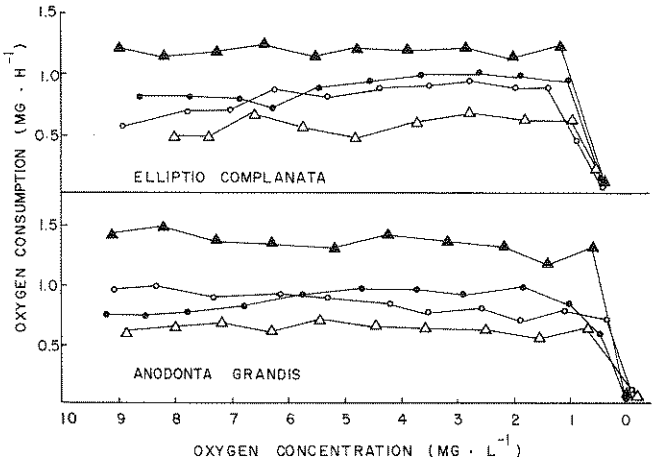

FIG. 1. Oxygen consumption of *Elliptio complanata* and *Anodonta grandis* with declining oxygen tension.

In Fig. 2, the regressions of oxygen consumption on dry body weight are plotted for *Elliptio complanata* and *Anodonta grandis*, respectively, between 5 and 25°C. Although rates of oxygen consumption commonly are expressed as weight-specific rates and regressions on size show an inverse relationship, Kenney (1982) has demonstrated that spurious self-correlations arise when two parameters that are used in a linear regression analysis have a common term. For this reason, comparisons of respiration rates at different temperatures are based simply on the relationship between oxygen consumption and size of the animals. There were no significant intraspecific differences between slopes of the lines ($P = 0.05$).

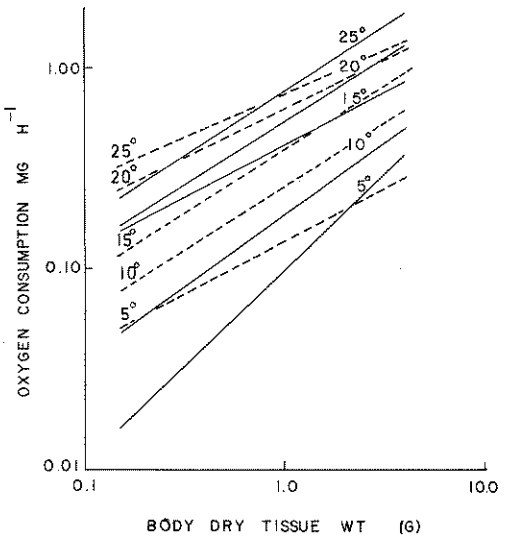

FIG. 2. Oxygen consumption of *Elliptio complanata* (solid lines) and *Anodonta grandis* (dashed lines) at different temperatures.

Analyses of covariance showed that there were significant differences (P = 0.01) in ordinal values of the regression lines and thus respiration rates increased with increasing temperatures between 5 and 25°C in both species. Analysis of covariance tests also showed that there were statistically significant differences (P = 0.01) in ordinal values between the two species (F values, 16.91 and 18.32) at 5 and 10°C, but no interspecific differences at temperatures higher than 10°C.

From the records of the decrease in oxygen concentration of the water in the flow-through incubator, it is evident that both species of mussels are regulators and oxygen uptake remained constant over a wide range of oxygen tensions. This is typical of most aquatic poikilotherms (Prosser & Brown, 1961). Only when oxygen concentration fell below 1 mg/l was there any significant decrease in the rate of uptake. If, as Evermann & Clark (1918) suggested, mussels burrow deeply in the substratum in winter, then toleration of very low oxygen tensions must be required for several months. However, Fuller (1975), who has reviewed the literature on responses of freshwater clams and mussels to low levels of oxygen, concluded that there is a great deal of variability in their capacity to respire.

Both species showed increasing rates of oxygen uptake between 5 and 25°C. Again, this is typical of poikilotherms (Prosser & Brown, 1961) and has been demonstrated in Unionidae (Lukacsovias & Salanki, 1964). Only at 5 and 10°C were there any interspecific differences in respiration rates. *Elliptio complanata* had significantly lower rates of oxygen uptake at 5 and 10°C than had *Anodonta grandis*. This suggests that *A. grandis* is more active at lower temperatures than is *E. complanata*. It is arguable that a higher metabolic rate at low temperature would enhance its burrowing ability in the spring, when temperatures are still low and when flooding due to snow runoff might cause increased sediment deposition. Furthermore, *A. grandis* might remain more active and feed for a longer period than *E. complanata* in the spring and autumn, when water temperatures are low.

Voucher specimens have been retained in the Redpath Museum, McGill University.

LITERATURE CITED. – CLARKE, A.H. 1973. The freshwater molluscs of the Canadian Interior Basin. *Malacologia*, 13: 1-509. – EVERMANN, B.W. & CLARK, H.W. 1918. The Unionidae of Lake Maxinkuckee. *Proc. Indiana Acad. Sci.*, 1917, pp. 251-285. – FULLER, S.L.H. 1975. Clams and mussels (Mollusca: Bivalvia). *In:* Hart, C.E. & Fuller, S.L.H. (Eds.), *Pollution ecology of freshwater invertebrates*. Academic Press, New York. 398 pp [pp. 215-273]. – KENNEY, B.C. 1982. Beware of spurious self-correlations. *Water Resource Res.*, 18: 1041-1048. – LUKACSOVIAS, F. & SALANKI, J. 1964. Effect of substances influencing tissue respiration and of the temperature on the O_2 consumption of the fill tissue *Unio tumidus*. *Ann. Inst. Biol. (Yihany) Hung. Acad. Sci.*, 31: 55-63. – PROSSER, C.L. & BROWN, F.A. 1961. *Comparative animal physiology*. 2nd ed. W.B. Saunders, Philadelphia. 688 pp.

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