OXYGEN CONSUMPTION OF THE KILLIFISH, *FUNDULUS HETEROCLITUS*

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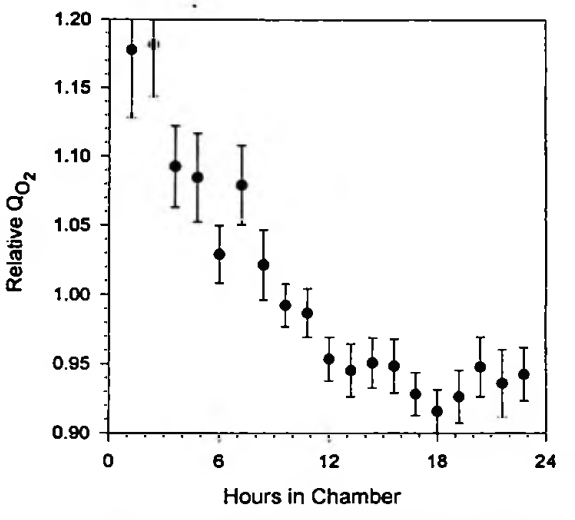

Figure 1. 24 h runs in various conditions normalized to their own 24 h average rate (defined as 1.00). Means ± SE for 36 experiments.

To determine the importance of osmoregulatory work, one must know the total energy available to the organism. We report measurements of oxygen consumption (Q_{O_2}) of *Fundulus heteroclitus* which test the importance of several variables. Q_{O_2} was measured by flow-through respirometry, with fish in 500 ml of water in a jacketed, thermostated vessel. Air was bubbled through the water containing the fish at a rate (10 - 30 ml/min) sufficient to keep the oxygen concentration above 20%. The depletion of O_2 by the fish, the fish weight, and the flow rate allow Q_{O_2} to be determined by standard methods. For all except the single-fish experiments, groups of fish of various sizes were used. As we shall see, this reduced the accuracy of some of these data.

Fundulus Q_{O_2} was examined for changes related to time in the respirometer chamber, as seen in Figure 1. The initial rate was high, decaying to a steady state after 12 hours and remaining constant thereafter. It appears that the novel surroundings induced additional oxygen uptake, probably consequent to behavioral excitation. For this reason, we took the last 12 hours of each 24 hour experimental period as the steady-state value.

These data were also examined for circadian rhythm, by normalizing the Q_{O_2} from runs started at various times between 0700 and 2200 h to the Q_{O_2} found at midnight, and plotting the result against time of day. The data, shown in Figure 2, have been fit with a 10th degree polynomial to indicate any trend. The regression coefficient of this line is very low, and becomes even lower if the first 12

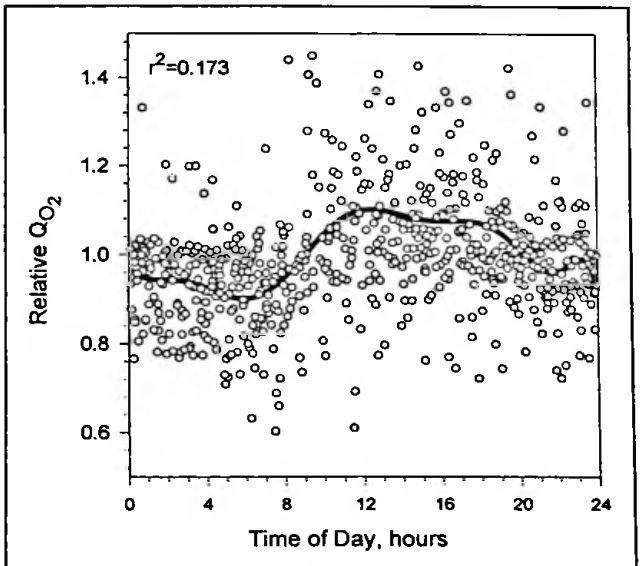

Figure 2. Data from 36 experiments normalized to experiment Q_{O_2} at 2400 h, plotted *vs.* time of day. The line is a 10th degree polynomial to guide the eye; it has no theoretical or statistical significance.

hours in the chamber are excluded. We therefore conclude that if a circadian rhythm in *Fundulus* QO_2 exists, these experiments are not capable of detecting it.

Fundulus QO_2 varies with temperature, as shown in Figure 3. Over the range from 3 to 28° C, QO_2 is a log function of temperature, as expected, with the respiratory rate increasing by 2.65-fold for each 10° C increase in temperature. We do not have data on higher temperatures, although *Fundulus* has been observed in water above 30° C. Much lower temperatures are clearly impossible. The ambient temperature has a large effect on the energy available to the fish for all purposes.

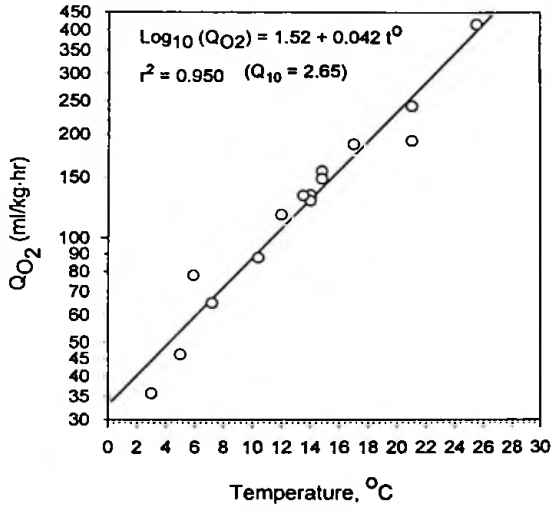

Figure 3. QO_2 of 16 batches of fish acclimatized to 10‰ water and tested in the same water at various temperatures. The last 12 hours of the 24 hour run was averaged to produce each point.

Fundulus QO_2 is an inverse function of body mass, as seen in Figure 4. Nineteen single fish (0.8 to 13.5 g) acclimated to SW were measured in SW. The data form a straight line on the log-log plot usual for this sort of data, with some scatter around the best fit line. We conclude that fish weight has a significant effect on QO_2. Even for fish in the more "usual" weight ranges (3 - 7 g), this variation in QO_2 with body size means that direct comparison between batches of fish is not particularly meaningful unless the sizes of the individual fish (not just their total weight) is known.

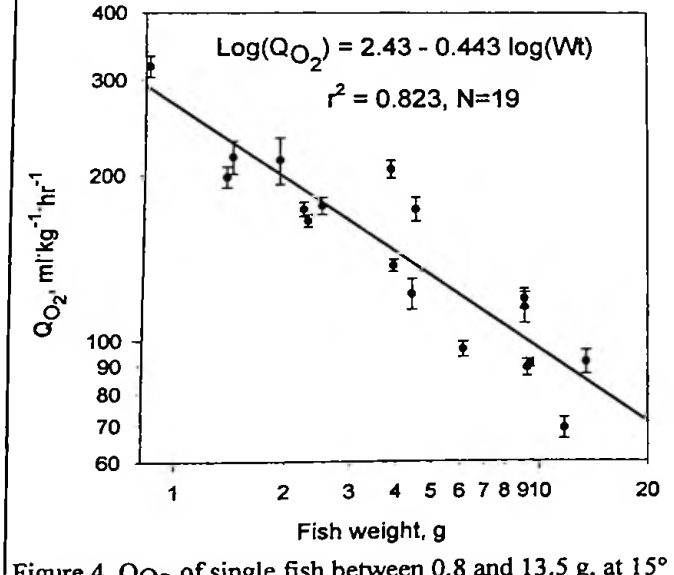

Figure 4. QO_2 of single fish between 0.8 and 13.5 g, at 15° C in sea water. Plotted is the mean of the last 12 hours and the standard error of this mean.

Our failure to control individual fish weight in previous experiments suggests a reason for our failure to obtain consistent differences between the QO_2 of fish in water of various osmolarities. With the information here presented, we should now be able to confirm or refute the expectation that *Fundulus* should have a higher energy production rate (higher QO_2) in conditions requiring higher osmoregulatory work loads.

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