AN APPARATUS FOR DETERMINING WATER FLUXES IN *FUNDULUS HETEROCLITUS*

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In studies of fish osmoregulation, net water flux is fundamental, and can be measured by repetitive weighing. One must avoid damaging the fish's epidermis while weighing, which precludes supporting the fish in any sieve-like container against which the fish will thrash and loose scales. A second problem is that of continuing frequent weighings for long periods of time. The apparatus here described avoids both problems.

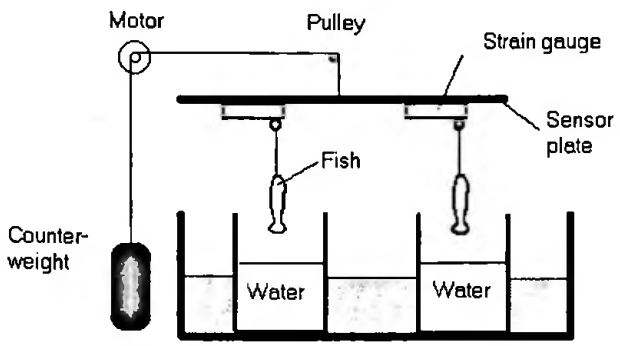

Figure 1. Simplified pictorial drawing of weighing apparatus. Fish (2 of 4 shown) are suspended by threads, and raised from the water by the stepping motor lifting the sensor plate under computer control. The external bath is temperature-controlled. Not shown is the pantograph which constrains the sensor plate to remain level, and the computer and its connections.

As seen in Figure 1, fish are suspended from Physiograph P-50 strain gauges by a sewing thread fastened through the lower jaw, and are raised to weighing position and lowered to a free-swimming position as the sensor plate is moved. The calibrated sensors are connected to the four input channels of a computer system (Sable Systems DAC). The program also commands the drive motor to raise the sensor plate, hold the fish suspended for 1 min to drain, saving data from the last 10 sec as the drained weight. The plate is then lowered to return the fish to the water. The computer initiates a weighing once per hour, storing the resulting data on magnetic disk for subsequent analysis.

Figure 2 shows some results. Five freshwater acclimated *Fundulus* (two runs) were started in fresh water at 16°C, and lost weight over the first 24 hours without feeding. Transfer to 4°C triggered a weight gain, rapidly at first, reducing after 24 hours to a much slower rate which was constant for the subsequent 2 days. After 72 hours at 4°C, the temperature was returned to 16°C, and the weight returned to that predicted at a constant 16°C. The weight changes seem due to water movements, with active water extrusion inhibited at 4°C. The change in slope in the swelling phase suggests a change in effective permeability at constant osmotic driving force. These experiments raise a number of interesting questions.

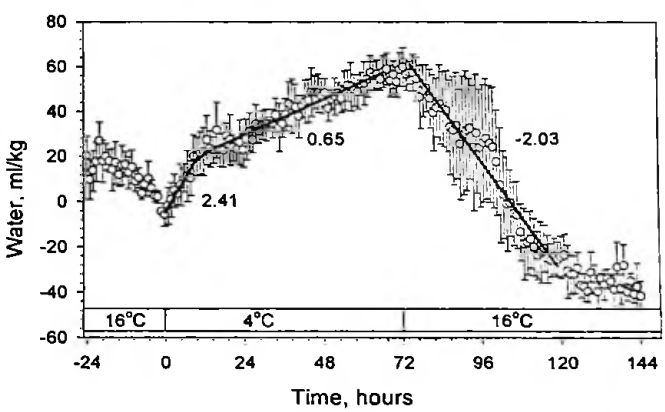

Figure 2. Mean normalized (to time 0) weight (expressed as water) of 5 fish, ± SE. Lines fit by least squares, with slopes ($ml \cdot kg^{-1} \cdot hr^{-1}$) as indicated.

The sensors are somewhat temperature sensitive, which causes an apparent diurnal variation in weight in uncontrolled environments. The apparatus is currently being modified to maintain constant sensor temperature under these conditions.