Bioenergetics of the freshwater prosobranch Idiopoma angularis Muller in Laguna de Bay

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This study was made as an attempt to investigate some of the ecological aspects of the freshwater snail *Idiopoma angularis* Muller in a modern framework of energy flow and mathematical models. It offers the first investigation of respiration (as related to temperature and body size), production (growth), and excretion in the prosobranch *I. angularis* in Laguna Lake.

The snails utilized in the various observations and experiments were collected at biweekly intervals from three sampling sites, each measuring 500 m^2, in Binangonan, Rizal. Station 1 is a cove at Tapao Point; Station 2 is an exposed area at Tapao Point; and Station 3 is an area off Diablo Pass. The experiments were carried out at the Binangonan Freshwater Station of the Southeast Asian Fisheries Development Center (SEAFDEC) Aquaculture Department at Tapao Point, Binangonan, Rizal.

The interrelationships among the different snail attributes (shell length, shell width, fresh weight, meat weight, and dry weight) were determined. Linear relationships were found to exist for shell length and shell width, fresh weight and dry weight in contrast to the non-linear relationships found for fresh weight and shell length, meat weight and shell length, and dry weight and shell length. Nevertheless, the logarithmic values of the attributes which were related non-linearly showed very strong linear properties with correlation coefficients as follows: log fresh weight and log shell length, correlation coefficient 0.90; log dry weight and log shell length, correlation coefficient 0.81; and log meat weight and log shell length, correlation coefficient 0.81; and log meat weight and log shell length, correlation coefficient 0.94. The precise relationships among the various physical attributes had to be determined for use in estimating the energy budget of the snail populations at the three sampling stations.

There is an increase in the caloric content of snail flesh with increasing shell length, above which it decreases with size. A mean caloric value of 5.6 kcal/g dry weight was found for snails ranging in size from 10-30 mm.

Since it was impractical to measure the energy lost by metabolic activities in poikilotherms by direct calorimetry, respiratory rate was measured using a constant volume apparatus and the respiratory rate was converted into heat output by the application of an oxycalorific equivalent to 5 cal/mL of O_2.

The relationships between the rate of oxygen consumption and size of snail and between rate of respiration and temperature were investigated. The rate of oxygen consumption, or dO_2/dt (expressed as microliters/min) was found to vary directly with the negative power of weight; that is, oxygen consumption decreases with increasing size of snail. The rate of respiration was found to vary directly with temperature up to about 26°C, above which it varies inversely with temperature. Hypothetical models were constructed for dO_2/dt for any sized snail at any of three temperatures: 23°C, 26°C, and 29°C. The relation of oxygen consumption to weight is given by the equation $dO_2/dt = aW^b$ where dO_2/dt is the rate of oxygen consumption in mL/min, W is the fresh weight, and a and b are constants. The value of b was found to be –.29 at a temperature 23°C, –.33 for a temperature of 26°C, and –.29 at a temperature 23°C, –.33 for a temperature of 26°C, and –.26 for a temperature of 29°C.

To obtain an index of the influence of temperature and body size on the rate of respiration, a two-way analysis of variance (ANOVA) was run on the oxygen consumption of the different groups of snails at different temperatures. The F values of the ANOVA indicate highly significant effects (at the .01 level) of temperature and body size on oxygen consumption.

Q_{10}, or the rate of change of respiratory rate with change in temperature, was computed for three groups of snails by weight. The computed Q_{10} values tend to indicate that the values decrease with size at temperatures from 23^{o}–26^{o} but increase with size at temperatures above 26^{o}C.

The growth curve drawn for the snails kept under laboratory conditions is a gently-bending sigmoid, similar to those published in the literature for other freshwater gastropods.

From the measured values, a model for energy flow through a single representative individual was constructed. The energy budget of an animal is represented by the equation $1 = G + R + E$, where I is the total energy income (ingestion) G, the energy of growth or secondary production, R, respiratory energy loss, and E, energy egested as feces and metabolic waste.

Such an energy budget is obtained by determining the partitioning of the ingestion within the system under consideration and assigning energy equivalents to the different components (Boyd, 1971). By substituting measured values in the equation, energy flow for an average-sized snail can be estimated. For a snail of 1.5875 g fresh weight, energy values of the different components of the energy budget would equal: R = 46.8 cal/day; G = 12.05 cal/day; and E = 290 cal/day. Consequently, the energy of assimilation (R + G) = 58.85 cal/day. This value represents the proportion of the ingested energy that is assimilated by the snail and is called energy flow (Smalley, 1960). Since it was impractical to measure ingestion directly in the field, the energy of ingestion was estimated by taking the sum of R, G, and E. To determine the efficiencies with which the average individual utilizes its energy resources, the assimilation efficiency (A/I) and the net growth efficiency (G/A) were estimated. The assimilation efficiency was computed to be 16.9% and the net growth efficiency was computed to be 20.5%.

The model of an energy budget for one snail was expanded to the population using the data collected on population density and distribution. The energy values estimated for the snail population at Diablo Pass were much higher than those for the other two sampling sites, Tapao Cove and Tapao Point.

From an ecological point of view, the freshwater prosobranch *Idiopoma angularis* Muller plays an important role in the flow of energy in the lake, as demonstrated by its utilization of energy for growth, respiration and excretion. Since it is an organism of high energy value, its potential as a food resource for other consumers, both aquatic and terrestial, may be greater than otherwise imagined.

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