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# DIFFERENCES IN THE GAS-METABOLISM RATES OF TWO FORMS OF TERRESTRIAL MOLLUSKS, Bradybaena fruticum (Müll.) AND Bradybaena schrencki (Midd.)

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In reports dealing with the processes of species-formation a special place is assigned to study of so-called "local" populations, "colonies," and similar phenomena of adaptation by the majority of terrestrial mollusks to a strictly-limited territory. Various characteristics have been taken as the basis of differentiation of such populations from one another, primarily the left-hand or right-hand torsion of the shell of individuals of the same species, or the presence or absence of colored spiral stripes on the shell.

G. F. Gauze and K. P. Smaragdova (1939) were the first to show that the dextral or sinistral shells of Bradybaena lantzi Lindh. did not remain unaffected in mollusks in different experimental conditions and were, beyond question, correlated with the physiological functioning of the organisms. A number of investigations have been aimed at discovery of the interrelationships between environmental conditions and the phenotypic structure of populations (Cain and Sheppard, 1950; Schnetter, 1951; Sedlmair, 1956; Lamotte, 1959; Bondi, 1961; Wolda, 1963; Parkin, 1972), such interrelationships usually being discovered with great difficulty (Owen, 1969). It was observed with regard to some species that differently-colored forms had shells of different chemical composition and differed in fertility (De Ruiter, 1958; Gaudiosi and Sacchi, 1960).

Study of the definite causes that produce changes in the frequency of occurrence of certain forms in populations is impeded, however, by the absence of data regarding the ecologo-physiological differences between different genetic variants. In the present investigation an attempt has been made to discover how substantial such differences in the general level of metabolism, between two forms in closely-related species of terrestrial mollusks, may prove to be.

By means of an OA-5501 optico-acoustical gas-analyzer applied to low $CO_2$ concentrations (range of measurement from 0 to 0.05% by volume) we studied the exhalation of carbon dioxide gas during respiration by the "striped" and "unstriped" forms of Bradybaena fruticum and B. schrencki, as one can estimate the metabolic rate from that feature. Specimens were taken from a population of B. fruticum living in a flood-plain forest on the left bank of the Kama river (near the town of Sarapul, in the Udmurt ASSR), and from a population of B. schrencki living on the Khamar-Daban ridge (near Mamai station, Buryat ASSR). The mollusks were placed in a perspex box of volume about 600 $cm^3$, through which air flowed at a strictly-controlled rate of 0.5 liter/min; the air was then analyzed. The respiration chamber was made in the shape of a pencil-case with double walls, in the space between which water at a specific temperature, coming from an ultrathermostat, circulated. In all the experiments (each of which lasted 1 h) the air temperature in the chamber was 20 ±0.2°C. The period between capture of the mollusks and determination of their gas—metabolism rate was from two to five days.

At first we investigated one sample of the striped form and three samples of the unstriped form of B. fruticum (Table 1). The results showed that $CO_2$ exhalation was 1.5 times as high in the striped form as in the unstriped form. Age-differences, however, did not show up clearly enough, as the average

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TABLE 1. Exhalation of $CO_2$ by Two Forms of the Mollusks B. fruticum and B. schrencki

| Serial No. of expt. | Forms | No. of animals in sample | Wt. of animals in sample, g | Average wt. of one animal, g | $CO_2$ exhaled, $ml^2/g$ of dry wt. per h |
|---|---|---|---|---|---|
| | | B. fruticum | | | |
| 1 | Striped | 27 | 22,2 | 0,8 | 0,17 |
| | Unstriped | 59 | 46,4 | 0,8 | 0,09 |
| | | 49 | 47,7 | 1,0 | 0,11 |
| | | 58 | 58,5 | 1,0 | |
| 2 | Striped | 80 | 9,3 | 0,1 | 0,21 |
| | | 40 | 12,0 | 0,3 | 0,23 |
| | | 17 | 16,3 | 1,0 | 0,18 |
| | Unstriped | 300 | 36,3 | 0,1 | 0,16 |
| | | 130 | 57,0 | 0,4 | 0,14 |
| | | 49 | 49,1 | 1,0 | 0,13 |
| | | 24 | 42,3 | 1,8 | 0,13 |
| 3 | Striped | 44 | 2,9 | 0,1 | 0,22 |
| | | 21 | 14,0 | 0,7 | 0,15 |
| | | 17 | 33,8 | 2,0 | 0,12 |
| | Unstriped | 293 | 21,3 | 0,1 | 0,16 |
| | | 50 | 24,5 | 0,5 | 0,14 |
| | | 36 | 49,5 | 1,4 | 0,09 |
| | | 30 | 59,5 | 2,0 | 0,09 |
| | | B. schrencki | | | |
| — | Striped | 46 | 17,8 | 0,4 | 0,21 |
| | | 41 | 51,7 | 1,3 | 0,15 |
| | | 26 | 46,5 | 1,8 | 0,15 |
| | Unstriped | 51 | 28,0 | 0,6 | 0,17 |
| | | 70 | 99,1 | 1,4 | 0,12 |
| | | 32 | 66,3 | 2,1 | 0,11 |

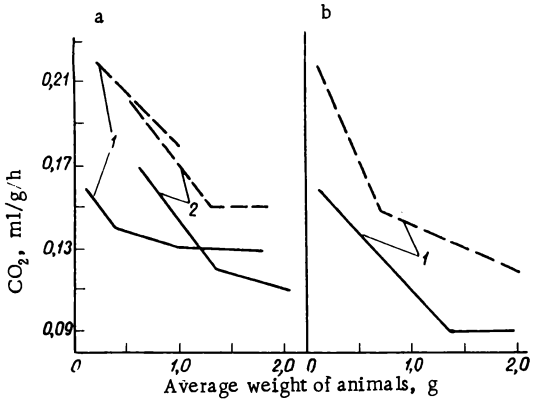


Fig. 1. $CO_2$ exhalation by two forms of B. fruticum (1) and B. schrencki (2). a) Second experiment; b) third experiment; ——) unstriped form; ------) striped form.

weight of the animals was almost the same. It is known, however, that the rate of metabolism in animals is closely related to their age (Methods of Determining the Production of Aquatic Animals, 1968).

We took a new batch of mollusks from the same population of B. fruticum and divided them into approximate age-groups, from small (young) to large (adult). The results of the second experiment showed that in comparable weight-groups the animals of the striped form, in all cases without exception, exhaled much more $CO_2$ (from 1.3 to 1.7 times as much) than those of the unstriped form. Even the largest specimens of the striped form surpassed the smallest unstriped specimens in that respect. A decrease in $CO_2$ exhalation with age was observed within each form (see Fig. 1, a).*

The first two experiments were made with material collected in early summer (June and July) and the third with material collected in September. The results of the third experiment agreed well with those obtained previously, but in both forms $CO_2$ exhalation was lower in the older groups. By the fall, therefore, before hibernation, $CO_2$ exhalation had decreased in both forms of the species (see Table 1 and Fig. 1b).

In all these experiments, when we compared the older groups of the two forms (average weight of individuals from 0.8 to 2.0g) we observed, on an average, a substantial difference in $CO_2$ exhalation between the animals of the striped and unstriped forms of B. fruticum. The amounts of $CO_2$ exhaled were

* As we determined the gas—metabolism rate for a group of animals, and not for individuals, we cannot show on the graphs the limits of the values obtained.

0.16 ±0.020 ml/g per h and 0.11 ± 0.007 ml/g per h respectively. Similar results were obtained by comparing the older groups (from 1.3 to 2.1 g) of B. schrencki: the amounts of $CO_2$ exhaled by the striped and unstriped forms were 0.15 ± 0.002 ml/g per h and 0.12 ± 0.005 ml/g per h respectively. On comparing the two forms of these closely-related species that we investigated, we observed no significant differences between the species in $CO_2$ exhalation.

The results obtained support the suggestion that the metabolic rates in mollusks of the forms compared are different: the level is higher in the striped form. The findings enable us to make a close approach to solution of the question of the ecological significance of different phenotypes in natural populations of mollusks.

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