

The acutely measured  $Q_{10}$  is an index of the nature and magnitude of response to a sudden temperature change. In the cold-acclimated group of Fig. 1, the metabolic rate increased from 0.10 (ml.  $O_2$ /gm./hr.) at 10° C. to 0.15 at 20° C. Thus the acutely measured  $Q_{10}$  is equal to 1.5. The rate of the warm-acclimated animals drops from 0.10 at 20° C. to 0.05 at 10° C., giving an acutely measured  $Q_{10}$  of 2.0. A semi-logarithmic rate-temperature plot (Fig. 1) has the advantage in that the slopes of the curves are readily interpreted in terms of  $Q_{10}$ . Bullock (1955) concluded that, as a general rule for poikilotherms, the relative positions and slopes of the rate-temperature curves of cold- and warm-acclimated animals are of the form shown in Fig. 1. Thus, the curves of cold-acclimated animals are higher and flatter than are those of warm-acclimated animals. I have found such acclimation-induced changes in several species of fishes.

Suhrmann (1955), however, found a different acclimation response in the crucian carp, *Carassius vulgaris*. In this species she found that the rate-temperature curve of oxygen consumption was higher for cold-acclimated than for warm-acclimated fish, but that the  $Q_{10}$  was increased as a result of cold history. Considering only the upper portion of the range of temperature tolerance, we can diagrammatically illustrate the positions of the rate-temperature curves of *Carassius* as in Fig. 2.

The two types of acclimation response (Figs. 1 and 2) differ fundamentally. In the first general type, it is the cold-acclimated system that shows the lower sensitivity to temperature change, whereas in the second type the warm-acclimated system is less responsive to temperature change. Implications of these differences will be treated further in the Discussion.

Suhrmann's (1955) findings indicated that in the crucian carp there was quite a different physiological response to thermal history than had been found in other poikilothermic vertebrates. In recent studies of other fishes, I have found the acclimation responses of a catfish, *Ictalurus natalis*, to be similar to those of the crucian carp. Measured acutely over the upper range of tolerance, cold-acclimation results in a high flat curve, acclimation to a high temperature results in a low flat curve, and acclimation to an intermediate temperature results in a curve of intermediate level but having a much steeper slope than the curves representing the two extremes of acclimation temperature.

The present study represents a portion of a continuing survey conducted in order to see whether or not it will be possible to formulate generally applicable rules relating acclimation type to either phylogeny or ecology. Collateral investigations of a more analytical nature are currently in progress.

#### MATERIALS AND METHODS

An initial survey of the Fortobello vicinity indicated a large number of species that would be of considerable interest. In consideration of the probable availability of sufficient numbers of specimens of suitable sizes, the study was limited to four species.

Collecting was done either with a small dredge or by angling. The specimens were kept in running seawater in the laboratory for from one to five days prior to use in an experiment. Since the laboratory seawater was pumped every day and there was a high rate of flow through the system, holding temperatures did not differ significantly from the natural temperatures. Density of the seawater used in the experiments was sampled periodically. These samples showed no indication