Int. J. Mendel, Vol. 31 (3-4), 159-160, 2014 **STRESS PHYSIOLOGY**

COMPENSATORY METABOLIC REGULATION TO THERMAL STRESS IN SOME FRESH WATER FISHES

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Key words : Poikilotherms, metabolic regulation, acclimatization, compensatory regulation.

Thermal equilibration of most fish with their environment and thermal compensation of metabolic and contractile properties is essential for the maintenance of metabolic regulation over a wide range of temperatures. Metabolic modifications during natural acclimatization indicate both hermal compensation and direct thermal effects. Thus, there is compensatory regulation in the oxygen consumption of *P. sophore* and *M. armatus* to the seasonal thermal variation. Compensation in the oxygen consumption of brain, liver and muscle of a tropical freshwater teleost, *Puntius sophore* acclimated to cold (20°C) and warm (35°C) temeratures, was found varying significantly. Temperature acclimation also leads to compensatory responses which, while quite species-specific, consistently increase the capacity for sustained swimming at low temperatures.

INTRODUCTION

Many poikilotherms exhibit in their metabolism or activity some degree of independence of temperature. In general this is regarded as compensation rather than insensitivity of metabolism or the rate of functions measured. Only few of them are aimed at establishing the inner relation between the intact fish and its constituent tissues (Percht, 1958; Evans *et al.*, 1962). Metabolic compensation to thermal stress has been demonstrated in several poikilotherms under natural as well as laboratory conditions. Metabolic regulations and studies were directed at different organizational levels of the animals, such as the organismal, cellular and even the sub-cellular level. This type of approach, besides establishing the fact of metabolic compensation to the thermal stress, elucidates its *modus operandi* (Bullock, 1955; Prosser, 1958; Kanungo and Prosser, 1959). In majority of fishes there is general increase in metabolic rate with increasing water temperature. Influence of metabolic rate, as expressed in terms of oxygen consumption has been studied in a number of fish species (Kumari Rashmi, 2002; Dixit and Kaur, 2003).

MATERIALS AND METHODS

Living specimens of different sizes of Mastocembles armatus (Lac) and Puntius sophore (Ham) were transferred to laboratory in glass aquarium. The fishes were acclimatized to the laboratory conditions for a fortnight and fed on earthworm.

1. Respiratory surface area determinations :

(a) Gill area : Measurements of the gill dimensions of 9 weight groups of fishes were made according to the weight method described by Muir and Hughes (1969) :

Total gill area A=(2.L)/d′bl .... (i) Where L=total length of gill filaments. 2/d′ = secondary lamellae per mm on both sides of the gill lamellae (weighted).

The weighted value for secondary lamellae per mm 2/d' was determined by dividing the total number of secondary lamellae by the total length of the filament. bl = average bilateral surface area of the secondary lamellae (weighted).

(b) Skin area : Skin area determinations of different weight groups of fishes were made by removing the entire skin of fishes fixed in 5% neutral formalin and tracing their outlines on graph paper ruled in mm^2.

2. O_2 Consumption rates : The rate of O_2 consumption through gills and skin was measured in *M. armatus* of different body weights during winter (21±1°C) and summer (30±1°C) seasons.

Calculation of Q_{10} Values : Q_{10} (Change per 10°C rise in temperature) values were calculated by the following formula :

$$\log Q_{10} = (\log M_2 - \log M_1)/(T2-T1) \times 10$$

Where M_1 and M_2 are mean value of parameters at ambient water temperature T_1 and T_2.

RESULTS AND DISCUSSION

Compensatory metabolic regulation to thermal stress in two species of fresh water teleosts namely *Mastocembeles armatus* (Lac.) and *Puntius sophore* (Ham.) has been studied.

The experimental approach to the assessment of the compensatory regulation in their metabolism and activity to their ambient thermal variation by fishes has been critically evaluated.

M. armatus have biomodal gas exchange mechanism as the fish used both the gills and skin to obtain O_2 from water. O_2 consumption (through gills + skin) in this mud-eel has been determined by Winkler's volumetric method. The relationships between O_2 consumption (VO_2) and body weight during winter (21±1°C) and summer (30±1°C) seasons are represented by the equations : $VO_2(ml/hr)=0.1397.W^{.7086}$ and $VO_2(ml/hr)=0.2195.W^{0.7110}$ respectively. The respiratory area (gills+skin) has almost identical relationship to body weight as that of VO_2 against the body weight. Total repiratory area $A=921.35\ W^{0.7119}$ during winter and summer seasons VO_2 increases by a power of 0.9946 and 1.0022 respectively with unit increase in total respiratoty area.

Warm acclimation in *P.sophore* was complete and proceeded fast, while cold acclimation was only partial and proceeded relatively slow, Conversely, warm acclimation in *Mastocembeles armatus* although fast, was but partial.

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Compensatory regulation in the oxygen consumption related to the seasonal thermal changes was studied in the tropical eurythermal freshwater teleost *P. sophore*. At the acute temperatures the winter fish consumed more oxygen than the summer ones and at the respective habitat temperatures the winter and summer fish consumed oxygen almost at the same level dsepite the difference in the habitat temperatures. Thus, there is compensatory regulation in the oxygen consumption of *P. sophore* to the seasonal thermal variation. The temperature consumption in the oxygen consumption of this fish followed Type-2 of Precht and Patetern IV-A of Proser. The different Q_{10} values in winter and summer samples of the fish indicate operation of different enzymatic pathways in the winter (cold acclimated) and summer (warm acclimated) fish. The ecophysiological significane of this temperature compensation has been discussed in detail.

Compensation in the oxygen consumption of brain, liver and muscle of a tropical freshwater teleost, *Puntius sophore* acclimated to cold (20^{O}c) and warm (35^{O}c) temperatures, is studied. Under Precht's classification perfect compensation (Type-2) in the brain, overcompensation (Type-1) in the liver and poor or no compensation (Type-3 or 4) in the muscles were noticed. Under Prosser's classification, the pattern of compensation is found to be size dependent in the three tissues and the tissues from the smaller fish are found to compensate to a greater degree than those from the larger ones.

The interrelation between the intact fish and its constituent tissues with reference to metabolic temperature compensation was studied. The coincidence between the type of compensation in the intact fish and its brain suggest an important role for the central nervous system in the regulation of the compensatory processes in the fish.

The possible physiological significance behind the varying degrees of compensation in the different tissues and the adaptive and evolutionary interest of metabolic temperature compensation in poikilotherms has been discussed.

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