THE RELATION OF TEMPERATURE ON OXYGEN CONSUMPTION IN *CATLA CATLA* (HAMILTON)

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ABSTRACT

Major carp *Catla catla* subjected to thermal variations in ambient temperature cold and hot showed a gradual increase in the oxygen consumption during heat adaptation and a gradual decrease in the oxygen consumption during cold adaptation. Oxygen consumption in the case of cold adaptation reached the control values within 35 days. Whereas *Catla catla* exposed to sudden temperature change exhibited neither increase in the oxygen consumption nor decrease in the oxygen consumption and they could not reach the control values within 35 days. There is a physiological load achieving upon the fish during stress, whereas adaptation is a slow process of compensation without physiological load.

Keywords: Catla catla, oxygen consumption, Thermal-Stress and Thermal- adaptation.

No: of Figures: 6 **No: of References: 14**

INTRODUCTION

In general studies on the relation of the rate of oxygen consumption to the temperature variation have been limited to the consideration of metabolism. Whereas voluminous work has been done in poikilotherms in relation to Thermal compensation (Kinne, 1964 a: Fry, 1964: Pampapathi Rao, 1965: Hazel and Prosser, 1974: Bashamohideen, 1984, 2005). In recent times it is found necessary and possible to differentiate temperature-stress from temperature-adaptation, otherwise the adaptation processes could be easily mistaken from the other phenomenon like "Stress effects" or Stress-adaptation (Kunnemann and Precht, 1975; Grigo, 1975; Bashamohideen, 1984, 2005). Routine metabolism is the mean of rate of oxygen consumption measured. Little is known about the effect of acclimitation temperature on thermal tolerance and oxygen consumption. The measurement of oxygen uptake has been employed more than any other experimental parameter to monitor changes is metabolism associated with temperature-adaptation. The oxygen consumption rate is considered as a good index for overall physiological activity and an indicator of environmental-stress of the animal, and such a physiological index is easy to obtain both in the field and in the laboratory with a variety of environmental stresses, including the temperature-stress of the present investigation. Further the variation in oxygen consumption can be accounted for the excellent modulation in the metabolic status of the animal (Natarajan, 1980; Basha Mohideen, 1984). According to this new concept on thermal studies, a sudden thermal change within the normal range of temperature acts as a "Stressor" and temporarily inhibits the Compensation or metabolism to a new temperature, and "Stress" is a physiological load acting upon an animal or man and the factors causing the stress are termed as "Stressors", whereas a very slow Thermal change within the normal range, generally results in the process of adaptation, without physiological load. With this background, an attempt is made in this paper on the time course of oxygen consumption in *Catla catla* subjected to thermal-stress and thermal-adaptation.

MATERIAL AND METHODS

The major carp *Catla catla* weighing 10±1 gm were collected from the Local government Fisheries department, Bangalore and stored in large glass aquaria in the laboratory at room temperature (27°C±0.5°C) and exposed to natural photo period. An only male member of the fish Catla catla is used throughout the experimentation in order to avoid the effect of sex. The oxygen consumption (ml/g/hr) of the whole fish was measured by the improved Winkler's method as developed by Basha mohideen and Kunnemann (1978) in the following way.The Oxygen content in the initial and final water samples present in the Winkler's bottles with a duration of half an hour were estimated by adding 0.25 ml of 40% mangnous chloride, 0.25 ml of 10% KOH and 0.25 ml of 3% Dye (Leukoborbeline Blue I) with the help of microsyranje. The bottles were then closed and shaken well for a minute. The precipitate was allowed to settle. After 3 minutes 1 ml of 40% citric acid was added and the bottles were again shaken for a minute in order to dissolve the precipitate. After 5 minutes, a deep blue color was developed. 5 ml of this solution was pipette out into a 50 ml standard flask and was made up to the mark with distilled water. The optical density of the blue color was read in spectronic 20 colorimeter at a wave length of 575 nm. The intensity of the blue color is directly proportional to the amount of oxygen present in the sample. The rate of oxygen consumption is calculated by using the formula.

Initial OD—Final OD x 6.607 (Calibration factor) x 2

-- = O_2 ml/gm/hr

Weight of the fish

The rate of oxygen consumption of the fish adapted to 20°C was measured separately and it was continued till the attainment of constant level in oxygen consumption (Fig.1 & 4). These 20°C and 32°c adapted fishes were readapted separately in the following pattern:

(1) The 20°C adapted fishes were re-adapted to a slow temperature change at the rate of 1°C/60hrs from a temperature range of 20°C to 32°C for a period of 35 days (heat-adaptation).

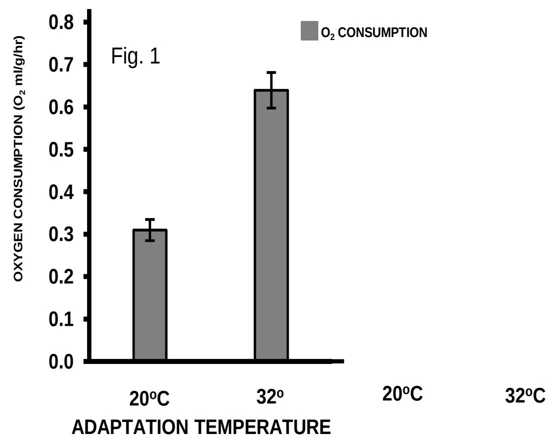
(2) The 20°C adapted fishes were re-adapted to an abrupt temperature change at the rate of 1°C/hrs from a temperature range of 20°C to 32°C for a period of 35 days (heat-stress).

(3) The 32°C adapted fishes were re-adapted to a slow temperature change at the rate of 1°C/60hrs from a temperature range of 32°C to 20°C for a period of 35 days (cold-adaptation)

(4) The 32°C adapted fishes were re-adapted to an abrupt temperature change at the rate of 1°C/hrs from a temperature range of 32°C to 20°C for a period of 35 days (cold-stress).

RESULTS AND DISCUSSION

The oxygen consumption of the fish subjected to slow-temperature change as in the case of heat – adaptation (Fig.3) and cold – adaptation (Fig.6) at the rate of 1°C/60 hrs shows gradual change in oxygen consumption reached the original levels of the control fish within the period of 35 days. On the other hand, the oxygen consumption in the case of stressed fishes heat- stressed (Fig.2) and cold- stressed. (Fig.5) do not reached the control levels when they are subjected to sudden temperature change at the rate of 1°C/hr even within the period of 35 days. These thermal stressed fishes established new levels of oxygen consumption continuous stress operative on these fishes resulted in stress adaptation (heat and cold). The percent change and per cent recovery are much higher in the case of adapted fishes than in the stressed ones.The basic rates of oxygen consumption in the 32°C temperature adapted fishes are much higher than the 20°C temperature adapted fishes. Fish at an elevated temperature is confronted with much



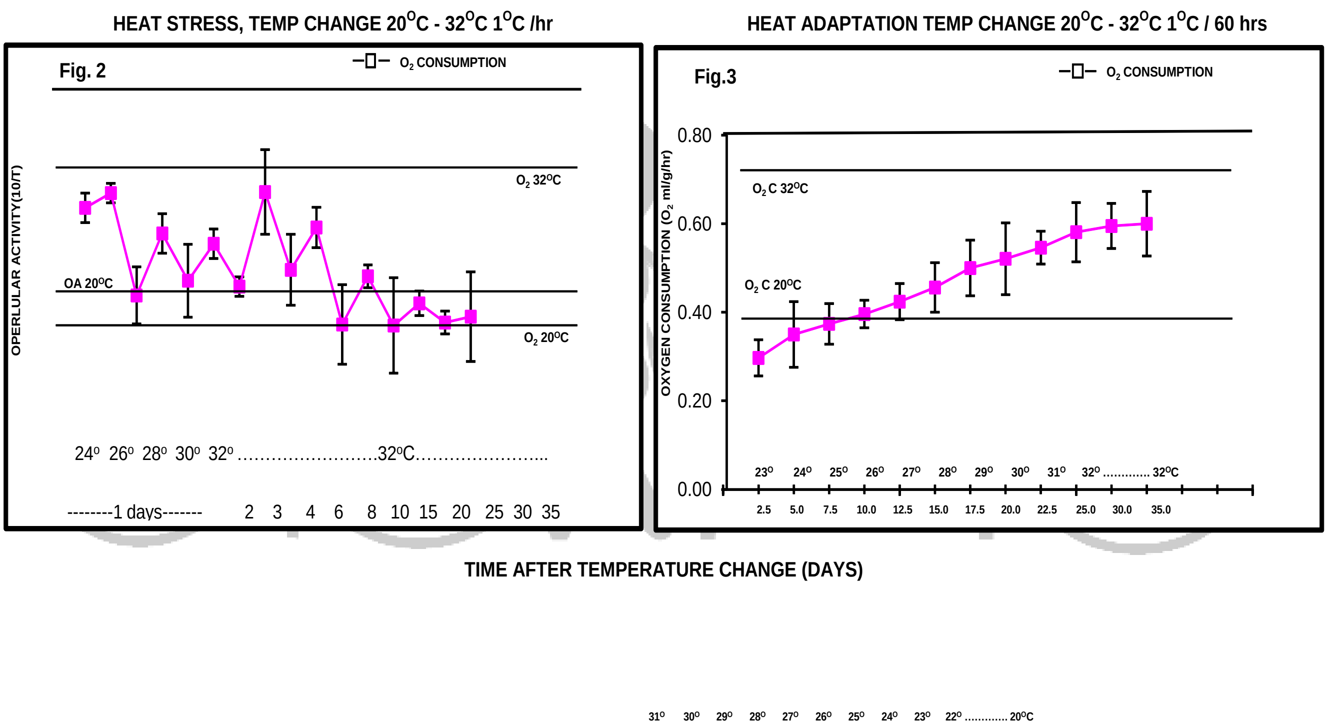


FIGURE – 1

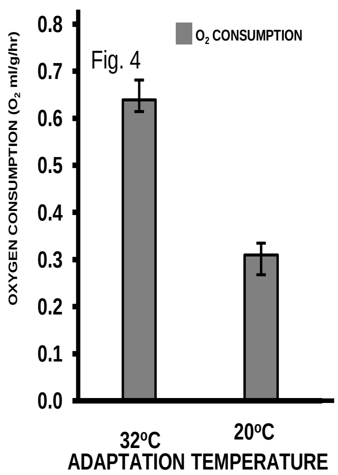
Histogram showing the levels of oxygen consumption (O_2 ml/g/hr.) in ***Catla catla*** adapted to 20°C and 32°C temperatures. Each histogram is a mean of six individual measurements.

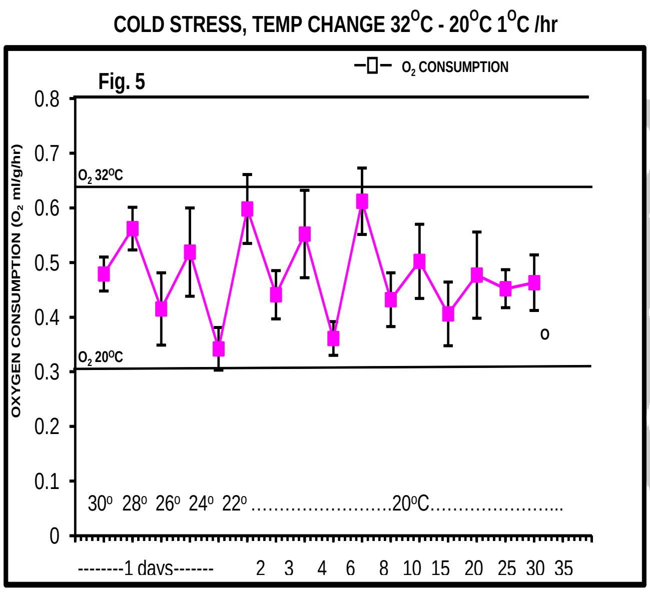
FIGURE – 2

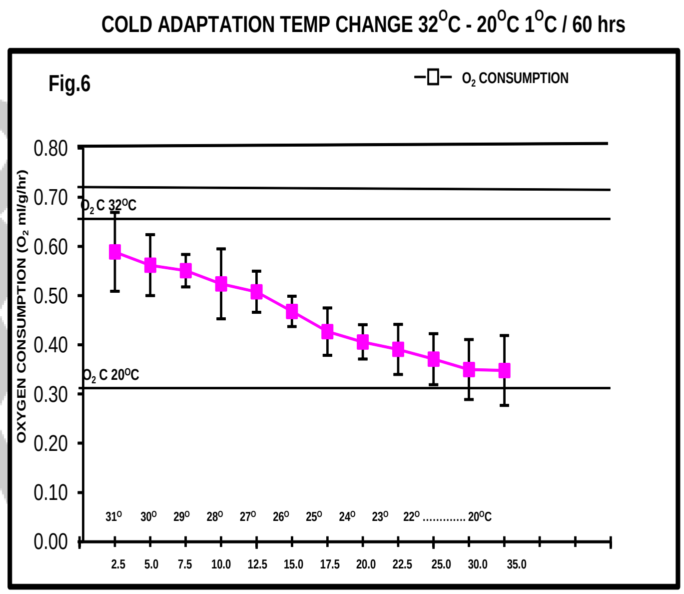
Rate of oxygen consumption (O_2 ml/g/hr.) in ***Catla catla*** subjected to an abrupt temperature change from 20°C and 32°C (heat – stress), at the rate of 1°C/hr. each value is a mean of six individual measurements. Vertical bars represent standard deviation.

FIGURE – 3

Rate of oxygen consumption (O_2 ml/g/hr.) in ***Catla catla*** subjected to a slow temperature change from 20°C and 32°C (heat – adaptation), at the rate of 1°C/60hr. Each value is a mean of six individual measurements. Vertical bars represent standard deviation.







TIME AFTER TEMPERATURE CHANGE (DAYS)

23° 24° 25° 26° 27° 28° 29° 30° 31° 32° …………. 32°C

FIGURE – 4

Histogram showing the levels of oxygen consumption (O_2 ml/g/hr.), in ***Catla catla*** adapted to 32°C and 20°C temperatures. Each histogram is a mean of six individual measurements.

FIGURE – 5

Rate of oxygen consumption (O_2 ml/g/hr.)) in ***Catla catla*** subjected to an abrupt temperature change from 32°C and 20°C (cold – stress), at the rate of 1°C/hr. Each value is a mean of six individual measurements. Vertical bars represent standard deviation.

FIGURE – 6

Rate of oxygen consumption (O_2 ml/g/hr.) in ***Catla catla*** subjected to a slow temperature change from 32°C and 20°C (cold – adaptation), at the rate of 1°C/60hr. Each value is a mean of six individual measurements. Vertical bars represent standard deviation.

increased oxygen demand in an environment that is relatively hypoxic (Mohammad Kasim, 1982; Iyyer et al., 1983 ; zuimfrontes and Macari, 1995). And so, the activity of the organism increases, as it is reflected in its higher rate of oxygen consumption, where at lower temperature oxygen availability in the medium increases. Hence, activity of the organism decreases, as reflected in its depressed rate of oxygen consumption of the fish. Cold temperature is more stressful than warm temperature, and different physiological mechanisms may operate during adaptation to cold and warm temperatures (ParvathewaraRao Rao, 1968; Bashamohideen, 1984, 2005.Basha mohideen & Sujatha, 2001). In heat as well as cold adaptations *Catla catla* was subjected to a slow temperature change at the rate of 1°C/60 hrs (2 ½ days). Therefore, the heat-adapted fishes exhibited a fairly good amount of per cent recovery in oxygen consumption(95%) when compared to heat-stressed fishes which were recorded only (53%) in the rate of oxygen consumption, and also the cold-adapted fishes showed a fairly good amount of per cent recovery of oxygen consumption (88%) when compared to cold-stressed fishes which showed only (51%) in oxygen consumption which is relatively higher in the case of heat-adaptation than that of cold-adaptation in this fish. *Catla catla*. This high degree of recovery is reflected in the corresponding high per cent recovery in the stress condition. Thus, the study on the rate of oxygen consumption, clearly reveals the distinction between gradual and abrupt transitory changes taking place in the range of ambient temperature from 22°C to 32°C and vice-versa. In case of Catla for the reason stated above, there seems to be effects on increase on oxygen demand with increase in the temperature and decrease in the oxygen demand with falls in the temperature . Further, from these findings on temperature-adaptation (heat-adaptation and cold - adaptation) and temperature-stress (heat-stress and cold-stress), it appears as though in this Indian major carp ***Catla catla*** that when the fishes are in the situation of stress, the normal mechanisms of adaptation are switched-off and the mechanisms concerned with stress phenomenon are switched-off and the mechanisms concerned with stress phenomenon are switched-on and vice-versa. A high degree of fluctuations in the physiological and biochemical parameters observed in the early phase of stress situation represents as good indicators of temperature-stress in this fish.Therefore, when poikilothermic animals subjected to environmental change, such as thermal, as it was seen in the present study and when the acclimation is complete, it was found out from the present investigation that it is necessary and possible and one has to differentiate the adaptation process form other phenomenon like 'stress effects' which could be easily mistaken for the adaptation process, coming across in the thermal regime of the animal. Thus, studies of this nature are highly useful in the evaluation of rates of temperature which act as stressors and induce stress situation, and on the other, in the evaluation of safe and ideal rates of temperature which do not act as stressors but result in the slow and easy compensation of adaptation without physiological load on the part of the animal.

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