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ADAPTIVE PHYSIOLOGICAL ACTIVITY OF THE FISH DURING THERMAL-STRESS AND THERMAL ADAPTATION

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ABSTRACT
The Indian major carp *Catla catla* subjected to slow temperature change from 22°C to 32°C (heat-adaptation) and 32°C to 22°C (cold-adaptation) at the rate of 1°C /60hrs showed a gradual elevation of Rate of heart beat in heat-adaptation and gradual decrease of rate of heart beat in the case of cold-adaptation and in both cases reached the control values within 35days. whereas *Catla catla* exposed abruptly to a temperature change from 22°C to 32°C and vice-versa at the rate of 1°C/hr. exhibited neither elevation nor decrease in the Rate of heart beat and they could not reach the control values within 35 days. Stress is a physiological load acting upon the fish, whereas adaptation is a slow process of compensation without physiological load.
Key Words : *Catla catla*, Rate of heart beat, Temperature-Stress, Temperature-adaptation

INTRODUCTION
Both extensive and intensive work has been done in physiological mechanisms during thermal-adaptation in poikilotherms, in relation to temperature compensation (Kinne, 1964a; Fry 1964; Pampapathi Rao, 1965; Hazel and Prosser, 1974; Bashamohideen 1984). In recent times it is found necessary and possible to differentiate thermal-stress from thermal-adaptation. Otherwise the adaptation process could be easily mistaken from the other phenomenon like “Stress effects” or stress adaptation (Kunnemann and Precht, 1975; Grigo 1975; Bashamohideen 1984). According to the new concept on thermal studies an abrupt temperature change within the normal range of temperature acts as a “Stressor” and temporarily inhibits the adjustments of 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 temperature change within the normal range, generally results in the process of adaptation, without physiogical load. Bradycardia (slowing down of heart beat) has been observed in fishes in response to a variety of environmental changes including temperature, salinity, atmospheric pressure and functional significance of many of the heart rate chages was discussed by Randall (1968); and Bashamohideen (1983). With this background an attempt is made in this paper on the rate of heart beat (haematological parameter) in *Catla calta* subjected to thermal-stress and thermal-adaptation.

MATERIALS AND METHODS
The experimental male fish *Catla catla* weighing 20$\pm$2 grams were collected from local Government Fisheries Department, Anantapur and stored in large glass aquaria in the laboratory at room temperature (27°C$\pm$0.5°C) and exposed to natural photoperiod. Only male members of the fish *Catla catla* is used throughout the experimentation in order to avoid the effect of sex.

The rate of heart beat is calculated using the formula 10/t, where “t” is the time (in seconds) taken for 10 heart beats. In each individual fish the study was made for three times and the mean is taken into account.

The rate of heart beat of the fish adapted to 22°C and 32°C was measured separately and it was continued till the attainment of constant level in Rate of heart beat (Figure 1&4). These 22°C and 32°C fishes were re-adapted separately in the following pattern.

(1) The 22°C adapted fishes were re-adapted to a slow temperature change at the rate of 1°C/60hrs from a temperature range of 22°C to 32°C for a period of 35 days (heat-adaptation)
(2) The 22°C adapted fishes were re-adapted to an abrupt temperature change at the rate of 1°C/hr from a temperature range of 22°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 22°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/hr from a temperature range of 32°C to 22°C for a period of 35 days (cold-stress)

RESULTS AND DISCUSSION

The rate of heart beat 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/60hrs shows gradual change in the rate of heart beat and reached the original levels of control (values of 22°C and 32°C temperature adapted control) fishes within the period of 35 days. On the other hand, the rate of heart beat in the case of stressed fishes heat-stressed (Fig-2) and cold-stressed (Fig-5) do not reached the control values when they are subjected to abrupt temperature change at the rate of 1°C / hr even within the period of 35 days. These temperature stressed fishes, established new levels of the rate of heart beat and continuous stress operating on these fishes resulted in stress-adaptation (heat and cold). The per cent change and per cent recovery are much higher in the case of adapted fishes than in the stressed ones.

Rate of heart beat is found to be low in the 22°C temperature adapted fishes than in 32°C temperature adapted ones. It is reported that fish heart increases with rising temperature. (Tsukuda, LiU and Fujii 1985) . These results suggest some metabolic alteration in cardiac tissue with thermal acclimation. Temperature acts as another neural regulator of circulation by direct action on the Pace-makers in the myocadia (Randall,1968)

In both adaptations heat as well as cold, *Catla catla* was subjected to a slow temperature change at the rate of 1°C/60 hrs ($2^{1/2}$ days). Therefore, the heat-adapted fishes exhibited a fairly good amount of per cent recovery in the rate of heart beat (94.17%) when compared to heat-stressed fishes which were recorded only (73.39%) in the rate of heart beat, and so also the cold-adapted fished slowed a fairly good amount of per cent recovery of (86.99%) with reference to rate of heart beat when compared to cold-stressed fishes which slowed only (64.98%) recovery which is relatively higher in the case of heat-adaptation than that of cold-adaptation in the 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 heart beat clearly reveals the distinction between slow and abrupt transitory changes taking place in the range of ambient temperature from 22°C to 32°C and vice-versa. Thus studies of this nature are highly useful in the evaluation of rates of temperature which acts 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 stressor but, result in the slow and easy compensation of adaptation without physiological load on the part of the animal and evaluation techniques concerned with economical rearing and conservation of useful fouma of the aquatic habitat.

FIGURE-1

Histograms showing the leaves of heart beat (10/time in seconds for ten heart beats) in *Catla catla* adapted to 22°C and 32°C temperatures. Each histogram is a mean of six individual measurements.

FIGURE-2

Rate of heart beat (0-0) (10/time in seconds for ten heart beats) in *Catla catla* subjected to an abrupt temperature change from 22°C to 32°C (Heat-stress) at the rate of 1°C/hr. Each point is a mean of size individual measurements. Vertical bars represent standard deviation.

FIGURE-3

Rate of heart beat (0-0) (10/time in seconds for ten heat beats) in *Catla catla* subjected to slow temperature change from 22°C to 32°C (heat-adaptation) at the rate of 1°C/60hrs. Each point is a mean at six individual measurements. Vertical bars represent standard deviation.

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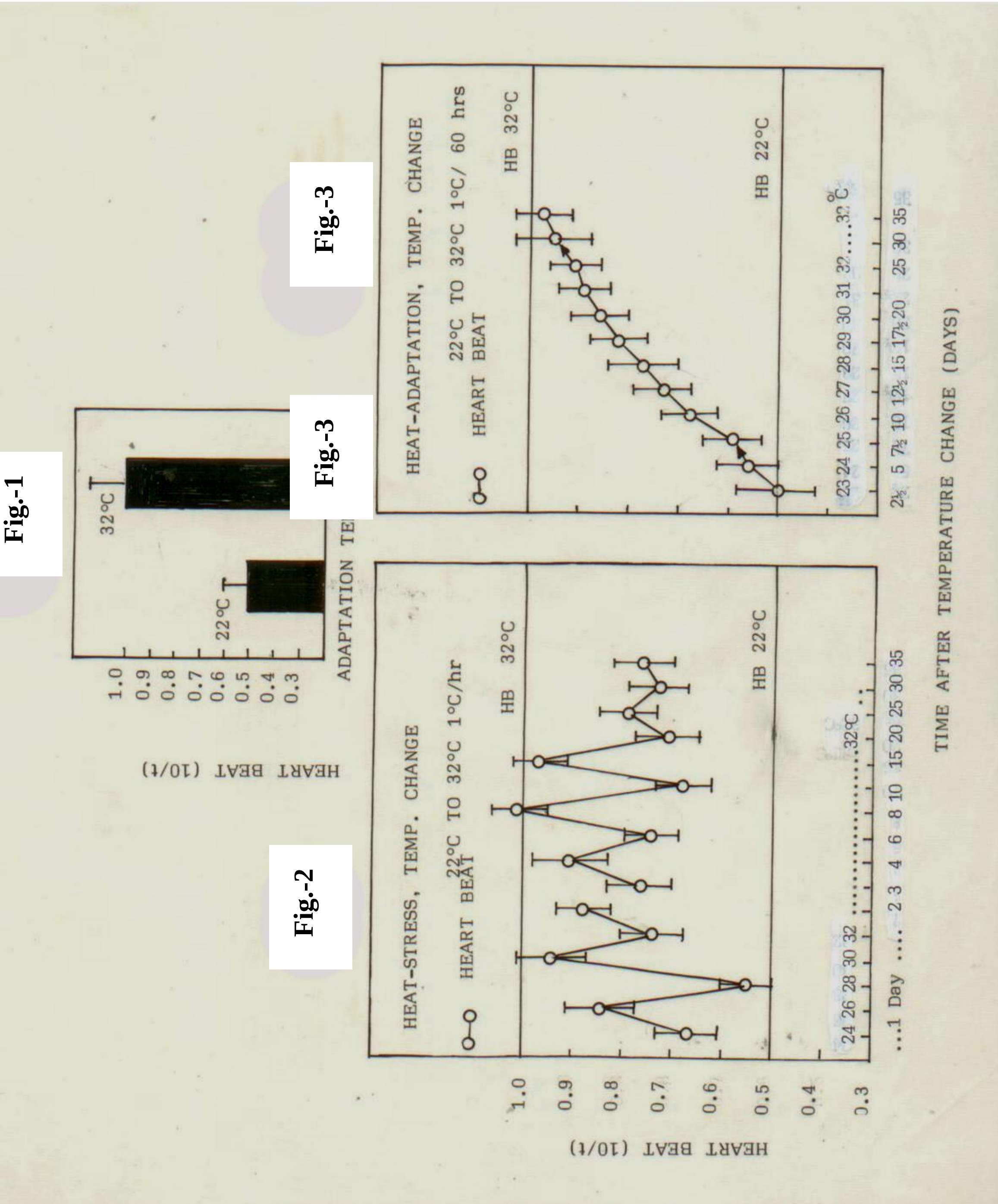

FIGURE-4
Histograms showing the levels of heart beat (10/time in seconds for ten heart beats) in *Catla catla* adapted to 32°C and 22°C temperatures. Each histogram is a mean of six individual measurements.
FIGURE-5
Rate of heart beat (0-0) (10/time in seconds for ten heart beats) in *Catla catla* subjected to an abrupt temperature change from 32°C to 22°C (cold-stress) at he rate of 1°C/hr. Each point is a mean of six individual measurements. Vertical bars represent standard deviation.
FIGURE-6
Rate of heart beat (0-0) (10/ time in seconds for ten heart beats) in Catla catla subjected to slow temperature change from 32°C to 22°C (cold-adaptation) at the rate of 1°C/60 hrs. Each point is a mean of six individual measurements. Vertical bars represent standard deviation.

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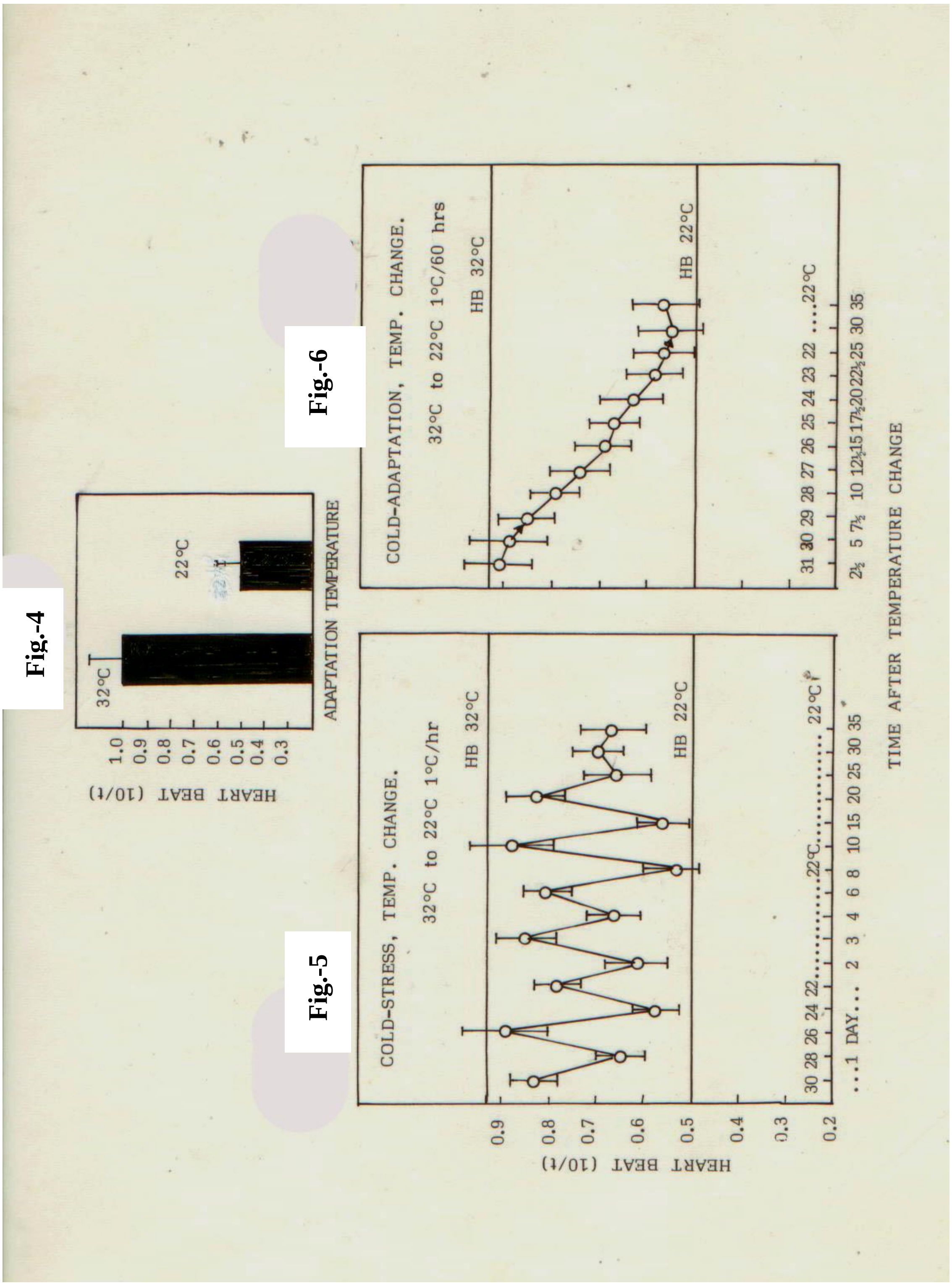

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