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Thermoacclimatory variation in the red blood cell indices of freshwater fish, *Channa punctatus* Godavari river, Nanded.

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ABSTRACT

Temperature of aquatic environment is important for ensuring the normal metabolism of aquatic animals affects blood vascular system of aquatic organisms. The present investigation deals with influence of temperature on the total count of erythrocytes in freshwater fish, *Channa punctatus*. The fishes were exposed to different temperatures viz. 15° C, 20° C, 30° C and 35° C. The total counts of erythrocytes were observed at different temperature stress. The results were compared with the fish's acclimated to ambient temperature at 26° C. The total RBC count was found to be increased as temperature increases. The total RBC count was found to be decreased as temperature decreases.

KEYWORDS

Temperature Stress, Total Erythrocyte Count, *Channa punctatus*

INTRODUCTION

Numerous biochemical indices are used to assess the health of aquatic organisms exposed under various environmental stress conditions. Blood is a valuable diagnostic tool for the investigation of diseases and physiological or metabolic alterations (Bansal et al, 1979). The physical properties of blood are very sensitive to environmental changes (Hughes and Nemcsok, 1988) and commonly used (Wedemeyer and Yasutake, 1977). The blood is fluid connective tissue which acts as the main transporting system of the body in all animals. In poikilotherms like fish it plays vital role during every movement for maintaining the physiological nature of the body with respect to the fluctuating environmental parameters (Yeragi et al, 2004).

The properties of fish blood have been shown well adapted to the environment and needs of the particular species (Prosser & Brown, 1961). However, these properties are temperature dependent, for an increase in temperature generally causes a large decrease in the oxygen affinity of the blood (Roughton, 1936; Antonini, 1965) and yet this has received little attention in respect to acclimation or acclimatization. The fish living in the temperature fluctuations faces the problem of oxygen affinity; so as to compensate for the effect of temperature. This seems even more likely when the ability of many fishes to undergo thermal metabolic acclimation is considered.

Maintenance of sufficient oxygen supply to the tissue is essential for continued cellular function at changed temperatures; therefore to elucidate this biological problem the effect of cold and warm temperature acclimation on the oxygen-carrying capacity of *Channa punctatus* were investigated. The present work was undertaken to point out the inter-relationship of various hematological parameters due to acclimation at cold and warm temperatures in *Channa punctatus* (Bloch). The parameter including total count of red blood corpuscles (RBC) was studied in details and showed highly sensitive response to temperature fluctuations.

MATERIALS AND METHODS

The freshwater fish, *Channa punctatus* were collected from Godavari River, Nanded (Maharashtra). They were kept in glass aquarium for 8-10 before experimentation. The fishes were exposed to different temperatures up to 96 hrs. Blood sample in fishes were obtained directly by puncturing the caudal vessel (Houston and Mearow, 1979). The blood collected using 2 ml sterile disposable syringe with No. 21 needle. The use of

glass syringes avoided because it may quicken coagulation (Egginton et al., 1991). The syringe rinsed with anticoagulant (potassium salt of ethylene diamine tetra acetic acid, EDTA). The needle inserted in the caudal vessel and very slightly aspirated during penetration. Blood was taken under gentle aspiration and then the needle withdrawn. After detaching the needle from the syringe, the blood mixed well in a vial containing anticoagulant (EDTA) at the concentration of 5 mg EDTA per ml of blood (Blaxhall and Daisley, 1973). Each analysis repeated six times and results subjected to statistical analysis. The collected blood of fish was used for the estimation of total count of RBC. Total erythrocyte count was done by using improved Standard Neubauer's Haemocytometer (Dacie and Lewis, 1991). The total erythrocyte count expressed in lakhs/mm^3.

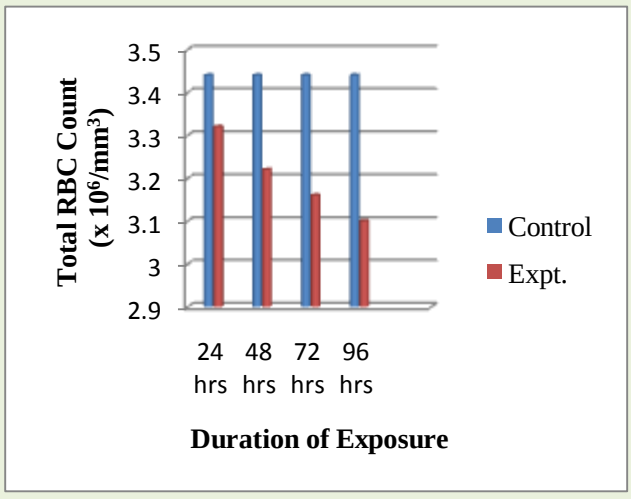
RESULTS

Murrels, commonly called snakeheads belonging to the family *Channidae (Ophiocephalidae)*, constitute the most common and dominant group of air breathing freshwater fishes and are highly regarded as food fish in the India. The snake headed fish *Channa punctatus* were acclimatized at temperatures of 15, 20, 30, 35° C in order to study physiological responses of blood to temperature fluctuations in the laboratory condition. The temperature of control set was 26° C. The study conducted to assess the changes in the total count of RBC's of freshwater fish, *Channa punctatus* (Bloch), an air breathing Indian Teleost, exposed to different temperature conditions. The results are expressed by graphs 1, 2, 3 and 4.

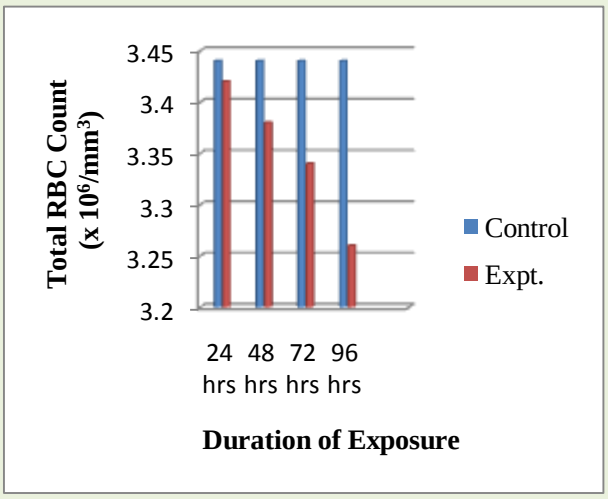
Table 1: Effect of Temperature on Total Erythrocyte Count in *Channa punctatus* at cold and warm temperature stress.

Sr. No.	Period of Exposure in hrs	Total Erythrocyte Count (X 10^6 /mm^3)			
		At 15° C	At 20° C	At 30° C	At 35° C
1	**Control 26° C ± 1° C**	**3.44 ± 0.34**	**3.44 ± 0.34**	**3.44 ± 0.56**	**3.44 ± 0.38**
2	24 Hrs	3.32 ± 0.15	3.42 ± 0.19	3.46 ± 0.44	4.16 ± 0.15
3	48 Hrs	3.22 ± 0.50	3.38 ± 0.33	3.62 ± 0.25	4.26 ± 0.23
4	72 Hrs	3.16 ± 0.51	3.34 ±0.32	3.80 ± 0.29	4.42 ± 0.14
5	96 Hrs	3.10 ± 0.21	3.26 ± 0.45	4.02 ± 0.21	4.72 ± 0.04

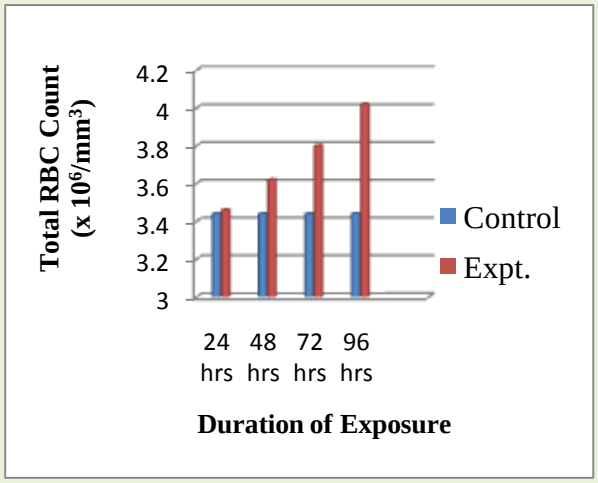
(Each Value is Mean of Six Observations ± S. D.)



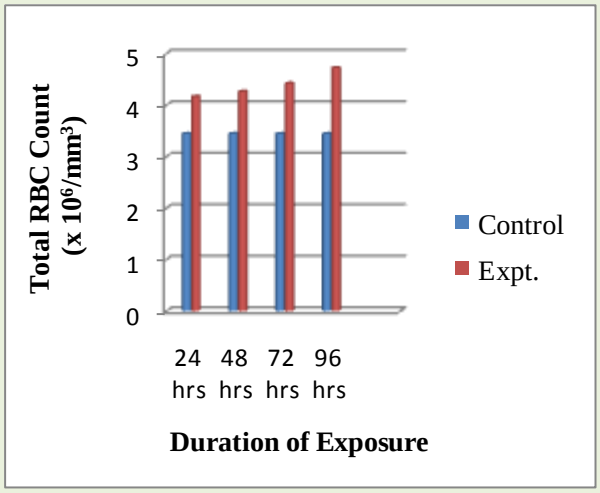
Graph 1- Effect of Temperature on Total RBC Count of *Channa punctatus* at 15 °C



Graph 2- Effect of Temperature on Total RBC Count of *Channa punctatus* at 20 °C



Graph 3- Effect of Temperature on Total RBC Count of *Channa punctatus* at 30 °C



Graph 4- Effect of Temperature on Total RBC Count of *Channa punctatus* at 35 °C

DISCUSSION

Fish may encounter large and rapid variations in the environmental temperature and in the availability of oxygen. Oxygen transport by blood is promoted by an increased oxygen capacity or by an increase of oxygen affinity, achieved by modulation of the internal environment of the red blood cells (Tetens et al., 1985). The fish blood is an important liquefied connective tissue of the body which performs most of the vital activities of life. It has also been undertaken in fish living captivity so that abnormalities occurring in temperature and dissolved oxygen variations, diseases and other factors can be detected (Ranzani-paiva et al., 2000). The environmental disturbance can be considered as a potential source of stress in animals. This results the number of physiological changes triggered by exterior changes. These changes in fish can be detected by the change in the erythrocyte parameters (Donaldson, 1981).

The present results of total erythrocyte count showed the variations in the blood of *Channa punctatus* acclimated to cold and warm temperature stress. In cold condition the erythrocyte count decreases while increase in total count for erythrocyte observed under warm temperature stress. Increasing the aquatic environmental temperature of the fishes increases the demand of oxidative metabolism. This augmented respiratory demand forces various physiological adjustments, including the alterations in the oxygen carrying capacity of blood. When temperature increased, activity of oxygen absorbing by RBC reducing, thus body of the animal compensates with this reduced oxygen while the less concentration of oxygen stimulate the erythropoiesis process and hence it resulted into high production RBC. These results are correlated with the results of Alimohammi et.al, (2011). The similar results were obtained by Houston et al, (1974) who studied hematologic characteristics *Cyprinus carpio*.

Brett, (1964) speculated that at low environmental temperature oxygen could become a limiting factor. Subsequently, Jones, (1971) reported a decline in oxygen content in juvenile trout leads to anaemic condition. The reduction in red cell volume shows the reduction in environmental oxygen concentration, indicating that the availability of oxygen at the gill surface may be a more significant limiting factor on aerobic exercise than carrying capacity of the circulation.

Catecholamines stimulate a rapid release of red blood cells from the spleen into the bloodstream. It is also reported that they increase the oxygen affinity of hemoglobin. Catecholamines may also enhance the oxygen carrying capacity via their homodynamic effects, stimulation of hyperventilation and by increasing branchial gaseous exchange (Kita and Itazawa, 1989; Perry and Kinkead, 1989).

Gordon, 1969 exposed freshwater brown bullhead, *Ictalurus nebulosus* and it showed positive relationship between temperature and metabolic

rate. The Bohr Effect and affinity of oxygen under exposure to low oxygen and high carbon dioxide observed. This problem persists in the summer season where oxygen content decreased. The increased metabolic activities of fish cause great demand for oxygen. The less availability of oxygen results in low demand for oxygen in blood. It can be seen that at warm temperature blood have low oxygen capacity as compared to cold water which results in increase in RBC content. The elevation of erythrocyte number may be due to the hyper secretion of pituitary (Hoar, 1957, 1959).

Spoor, (1951) reported a positive correlation between erythrocyte numbers and acclimation temperature. Bannon exposed the rainbow trout fish under different temperature acclimation period. He was found that at higher temperature hemoglobin content increases. At high temperatures increase in oxygen carrying capacity was appeared to be the splenic release of stored erythrocytes, and increased red cell numbers. The improved performance of warm acclimated fish may involve more than a compensatory increase in oxygen carrying capacity (Bannon & Ling, 2004). Soldatov, 1996 exposed *Pleuronectes flesus luscus* under low oxygen content and the hypoxic fish showed increase in the number of RBC's.

The overall data regarding the variation in total erythrocyte count in freshwater fish, *Channa punctatus* exposed under varying thermal stress reveals that the RBC count tend to vary directly with temperature.

REFERENCES

Houston H. and Mearow K. M. (1979). Temperature related changes in the Erythrocytic Carbonic Anhydrase (Acetazolamide-Sensitive Esterase) activity of Goldfish, *Carassius auratus*, Journal of Experimental Biology, 78: 255-264.

Alimohammi R., M. Hosseinifard, A. Bozorgnia and A. Ghazi (2011). Chronic effects of different temperature in the blood parameters of common carp, *Cyprinus carpio,* Published in 2nd International conference on "Environmental Science and Technology, Singapore, IPCBEE", 6: 48-51.

Antonini E. (1965). Interrelationship between structure and function in hemoglobin an myoglobin. Journal of Physiol. Rev., 45:123-170.

Bannon, H. J., Ling N. (2004). Running the unseen, lowland gauntlet: compounding effects of temperature, hypoxia and exercise for diadromous fishes. In: Rupp, G. L.; White, M. D. ed. Published in Proceedings of the 7th International Symposium on "Fish Physiology, Toxicology, and Water Quality, Tallinn, Estonia", May 12-15, 2003. Athens, Georgia, USA. U. S. Environmental Protection Agency, Ecosystems Research Division. EPA 600/R-04/049: 207-218.

Bansal S. K., Verma S. R., Gupta A. K. and Dalela R. C. (1979). Chronic chlordane exposure. Part I. alterations in certain hematological parameters, Bull. Physiological dysfunction of haemopoietic system in a fresh water teleost, *Labeo rohita*. Journal of Environmental Contamination Toxicology, 22: 666-673.

Blaxhall P. C. and Daisley K. W. (1973). Routine hematological methods for use with fish blood. Journal of Fish Biology. 5:771-781.

Brett J. R. (1964). The respiratory metabolism and swimming performance of young sockeye salmon. Journal of Fish. Res. Bd. Can, 21:1183-1226.

Dacie J. V., Lewis S. M. (1991). Practical Haematology. 7th edition.
London, Churchill. pp. 557

Donaldson E. M. (1981). The pituitary–inter renal axis as an indicator of stress in fish. In *Stress and Fish* (ed. A. D. Pickering), New York, London: Academic Press, pp. 11-41.

Egginton S., E. W. Taylor, R. W. Wilson, I. A. Johnston and T. W. Moon (1991). Stress response in the Antarctic teleosts (*Notothenia neglecta* Nybelin and *N. rossii* Richardson), Journal of Fish Biology, 38:225-235.

Gordon C. G. (1969). Temperature-Induced changes in the oxygen equilibrium curve of the blood of the brown bullhead, *Ictalurus nebulosus*. Comp. Biochem. Physiology, 28:1203-1223.

Bannon H. J. Effects of Water Quality Parameters on Prolonged Swimming Ability of Freshwater Fishes, Ph.D. Thesis, University of Waikato., 48-63.

Hoar W. S. and Gorbman M. E. (ed.) (1957). The physiology of fishes, Academic Press, New York., 1:245-286.

Hoar W. S. and Gorbman M. E. (ed.) (1959). Comparative Endocrinology, Wiley, New York, 11-23.

Houston A. H. and Cyr D. (1974). Thermoacclimatory variation in the hemoglobin systems of goldfish (*Carassius auratus*) and rainbow trout (*Salmo gairdneri*), Journal of Experimental Biology, 61:455-461.

Hughes G.M. and J. Nemcsok (1988). Effects of low pH alone and combined with copper sulphate on blood parameters of rainbow trout. Environ. Pollutant, 55:89-95.

Jones D. R. (1971): The effect of hypoxia and anaemia on the swimming performance of rainbow trout (*Salmo gairdneri*). Journal of Experimental Bioogy, 55:541-551.

Kita J. and Itazawa Y. (1989). Release of erythrocytes from the spleen during exercise and splenic constriction

by adrenaline infusion in the rainbow trout. Japenese Journal Ichthyology, 36:48-52.

Perry S.F. and Kinkead R. (1989). The role of catecholamines in regulating arterial oxygen content during acute hypercapnic acidosis in rainbow trout, *Salmo gairdneri.* Journal of Respiratory Physiology, 77: 365-378.

Prosser C. L. and Brown F. A. (1961). Comparative Animal Physiology. W. B. Saunders, Philadelphia

Ranzani-Paiva M. J. T., Silva_Souza A. T., Pavanelli G. C., Takemoto R. M., Eiras A. C. (2000). Hematological evaluation in commercial fish species from the floodplain of the upper Parna River, Brazil, Acta Scientiarum, 22:507-513.

Roughton F. J. W. (1936). The thermo-chemistry of the oxygen-haemoglobin reaction II. Comparison of the heat as measured directly on purified hemoglobin with that calculated directly by the Vant Hoff isochore. Biochem. J, 30:2117-2133.

Soldatov A. A. (1996). The effect of hypoxia on red blood cells of flounder: a morphologic and autoradiographic study, Journal of Fish Biology, 48 (3): 321–328.

Spoor W. A. (1951). Temperature and the erythrocyte count of Goldfish, Published in Proceeding of Fen, 10:131.

Tetens V. and Lykkeboe G. (1985). Acute exposure of rainbow trout to mild and deep hypoxia: O_2 affinity and O_2 capacitance of arterial blood, Journal of Respiratory Physiology, 61:221-235.

Wedemeyer G. A. and Yasutake W. T. (1977). Clinical methods for the assessment of the effect of environmental stress of fish health. Technical papers of the U.S. Fish and Wildlife Service, No. 289, (88):18

Yeragi S. G., Lendhe R. S. (2004). Seasonal variations in the hematological parameters of *Catla catla* and *Tilapia mossambica* of Phirange Kharbav Lake. Dist. - Thane, Journal of Comp. Toxicol. Physiology, 1 (3 & 4):265-266.