SEASONAL VARIATIONS IN HAEMATOLOGI CAL PARAMETERS OF HILL STREAM FISH *Barilius bendelisis (Ham.).*

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Abstract: The present study was designed to investigate seasonal variations in haematological parameters in the blood of *Barilius bendelisis.* Significant seasonal variations in the number of Red blood cells (RBC) and White blood cells (WBC), Haemoglobin concentration(Hb.C), Packed cell volume(PCV), Mean corpuscular volume (MCV), Mean corpuscular Haemoglobin (MCH), and Mean corpuscular Haemoglobin concentration (MCHC). In normal higher values of RBC dependent parameters viz. TEC, HB.C and PCV were noticed during the Rainy Season, Summer Season and Winter Season. White blood cells on the other hand showed gradual decline during the Rainy Season, Summer Season and Winter Season. The proportions of different leucocytes though variable but lymphocytes have been recorded to be the main contributor to TLC fluctuations. Thrombocyte count was significantly higher during the Rainy Season and Summer Seasons. Relation between seasonal changes in environmental factors such as temperature, pH, and dissolved oxygen with various blood parameters has been discussed.

Keywords: Seasonal, haematological parameters, and *Barilius bendelisis.*

Introduction

Fish haematology has become an important tool of research for fish biologists. It has been reported that the blood values remarkably vary in different fishes and, thus, is considered to reflect adaptations to the varied environmental conditions, (Joshi 2000). Comparative and Seasonal variations of haematological studies of lower vertebrates, particularly of fishes, have acquired much significance in recent years. In 1927, Schleicher has published extensive series of observations on the blood corpuscles of several teleosts under a variety of conditions. Moreover, the work of Kisch (1949 a), Jakowska (1956), Stoszesko (1960), Pradhan (1961), Haws and Goodnight (1962), Engel and Davis (1964), Sanders (1966), Khan (1977), Joshi and Tandon (1977), Prasad and Banerjee (1982), Bhaskar and Rao (1987), Joshi & Sharma (1991). Literature on cold water fishes is conspicuously too meagre and incomplete. Existing literature on Indian coldwater fish haematology has mainly come from Uttarakhand. Important contributions have been made by Bhatt and Singh (1981, 1985, and 1986).

Joshi and Tandon (1977), Joshi (1980, 1982, 1986, 1987, 1989, and 2000), Joshi and Sharma (1982, 1991), Sharma and Joshi (1984 1985, 1986), Grover et.al. (1994), Rauthan and Grover (1994), Rauthan and Nautiyal (2018), Rauthan et.al. (2019).

However, the existing literature is too meagre to make its real academic as well as field use especially concerning the highly capricious nature of individual cold water systems of our country (Joshi 2000). Many environmental and Physiological factors are known to influence fish haematology (Hamid et.al. 2013). These include stress due to capturing, transportation sampling, age and sex. Therefore, haematological studies have been widely used as a means of assessing the state health of fish. The establishment of haematology of fishes generally serves as a standard for physiology, pathology and toxicological studies

(Joshi 2000). Blood analysis is crucial in many fields of Ichthyological research and fish farming and the area of toxicology and environmental monitoring as possible indicators of physiological or pathological changes in fishery management and disease investigation (Pradhan 1961).

Haematological indices are very important parameters for the evaluators of fish's physiological status. Their changes depend on fish species, age, the cycle of sexual maturity of spawners and diseases (Joshi 1989).

Materials and methods

This study was conducted at the Fish Laboratory Department of Zoology, DAV (PG) College Dehradun. Thirty samples of the fish *Barilius bendelisis* weighed between 100 - 200 g and their total length 10 -18 cm, were collected from Song River. Blood samples were collected from the caudal vein of the fish in small plastic tubes containing heparin solution (0.2 ml/ml blood) as an anticoagulant. These blood samples were used for determining erythrocyte count using haematocytometers, haemoglobin (Hb) was estimated where it was converted into red cyanomethaemoglobin under the influence of potassium ferricyanide and potassium cyanide. Packed cell volume (PCV), Mean corpuscular volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) were calculated according to Blaxhall and Daisley (1973).The blood samples for haematological parameters PCV, Hb.C, TEC, TLC and ESR were determined by using the method described by Blaxhall and Daisley (1993).

Results and Discussion

The results recorded in table 1 and 2 very clearly indicate rise in Total erythrocyte counts (TEC), Hb.C. and packed cell volume (PCV) from the summer season till the rainy season which is consequently followed by their decline during the winter season. While, concerning calculated values, MCH and MCHC were lowest during the rainy season and highest during the winter season. MCV value was lowest during summer and highest during winter. In depth study the table further details that from January onwards as temperature starts rising, TEC, Hb.C. and PCV undergo gradual increase through summer and rainy season. Further, it is also evident from the results that in spite of the declining temperature a consistent increase in their numerical value was noticed till early summer when they reach maximum in the month of August. From here onwards a sharp drop in these values was recorded with approaching low temperatures in the winter season. In this regard present observations though agreement with those of Preston (1960), Radzinskaya(1966), Khan(1977), Pandey(1977), Joshi and Sharma(1977,1982, 1991), Sharma and Joshi(1985), Bhatt and Singh (1981, 1985), and Rauthan et.al.(2017).

Similar to the present finding these workers reported an increase in blood parameters but only during the summer season and the rainy season and a decline in the winter season.

Joshi and Sharma (1991) held water temperature to affect various blood parameters through its direct influence on the haemoglobin-oxygen building properties and thus on oxygen transport.

Guijarro et.al. (2003) and Gupta et.al. (2013) also explained temperature-related seasonal variability to be the key factor responsible for an increase in RBC-dependent parameters during summer. A consistent rise in TEC, Hb and PCV has been observed till September which happens to be a protracted breeding season for the fish and is exemplified by the rising GSI during these months. Winter decline in TEC, Hb and MCV presently appears to be the result of a hike in dissolved oxygen due to a sharp drop in temperature. MCV, a reflection of TEC, maintains an inverse relationship between TEC and MCV justifies the decline in MCV in the period (March to September) during which TEC showed a gradual increase. Increased erythropoiesis during summer months seemingly may also contribute to lower MCV values.

Both MCHC and MCH have been recorded to behave in similar ways and attain maximum values in the winter (January and February), where Hb.C. otherwise decline exhibiting an inverse relation between them.

Leucocytes by acting as the first line of defence against any infection make an organism immune enough to fight any possible stress. This holds true for fishes also but due to the less developed mechanism of specific immunity Joshi (1989), fishes rather depend on the non-specific resistant system. Fluctuations in TLC observed presently during different seasons.

(Table -2) also indicates that this may be a response to fluctuating weather conditions and some environmental stress encountered frequently in the water bodies. TLC rise during the hot part of the year, pre- summer and summer with a peak in the month of June seems to be a response to elevated water

temperature. TLC declines during the rainy season and reaches ever-low values in winter. Immunodepression reported by early workers (Preston 1960), Khan (1977), Joshi (2000), seemingly appears to be triggered by low temperatures during winter, hence is responsible for the low count of leucocytes.

Durborow and Crouse (1988), and Bly and Clem (1991) revealed that poikilothermic animals including fish suffer from immunodepression due to low temperatures. Starvation-like conditions during these months because of the low availability of food make the fish deficient in important nutrients which ultimately may appear to be another reason for lower TLC.

DLC exhibited an increase in both granulocytes (monocytes and lymphocytes) and agranulocytes (neutrophils, eosinophils and basophils) and hence contributed to the elevated total leucocyte count during summer. There is a decline in lymphocytes to 26% during the winter season. Thrombocytes on the other hand recorded a significant increase during the winter season and lower in the rainy season.

Similar results were also reported by Joshi and Sharma (1991) and Joshi (2000) while studying seasonal fluctuations in hill stream fishes of the Garhwal region. From the overview of present observations, it can be concluded that all the haematological parameters were affected by environmental factors such as temperature, pH, dissolved oxygen and reproduction. This investigation may be helpful as a tool to monitor the health status of this and other related fish species.

Table: 1- Seasonal Variations in haematological values of *Barilius bendelisis* .All values are mean ±SD for 10 fishes (5 males and 5 females) in each month.

Month/Year 2024	TEC (10^6/cmm)	TLC (/cmm)	Hb.C gm%	PCV (%)	MCH (pg)	MCHC (%)	MCV
January	2.40±0.21	16140±170	8.2±1.40	33.9±3.0	35.3±1.80	25.3±0.71	150.40±8.00
February	2.39±0.10	16010±162	8.6±1.30	34.1±3.1	35.8±1.72	23.5±0.62	148.20±11.20
March	2.62±0.10	17055±301	9.2±1.10	38.1±1.2	34.2±1.05	22.4±1.01	147.70±8.00
April	2.89±1.20	17940±205	9.6±1.80	39.6±2.0	32.1±0.80	23.5±0.88	132.62±5.50
May	3.00±0.80	18014±118	9.8±1.90	40.0±2.6	30.2±0.77	24.2±1.20	131.61±4.35
June	3.15±1.52	17640±209	9.7±1.72	41.2±2.1	30.1±0.66	23.8±1.12	128.62±4.00
July	3.33±1.40	18056±400	10.0±2.0	42.4±2.0	29.6±2.20	21.6±0.72	134.52±5.50
August	3.45±0.66	17950±245	10.2±2.2	44.0±2.6	29.8±2.00	22.2±1.16	133.51±3.69
September	3.41±1.50	16930±159	10.0±1.8	44.6±2.1	28.2±1.60	20.4±1.12	131.25±2.60
October	2.78±1.10	17625±301	9.6±1.2	41.2±2.7	33.0±2.60	23.1±0.90	134.10±3.00
November	2.60±0.52	17046±208	8.2±1.2	38.0±2.0	34.2±1.88	24.2±1.80	136.80±4.62
December	2.31±1.0	16870±170	7.9±1.0	35.6±1.8	35.2±1.82	23.2±1.77	142.00±5.69

Table: 2- Seasonal Variations in Differential Leucocyte Counts (%) of *Barilius bendelisis*. All values are mean (± SD) for 10 observations in each month.

Month/Year 2024	Lymphocytes	Monocytes	Neutrophils	Eosinophils	Basophils	Thrombocytes
January	24.2±2.6	1.20±0.6	21.8±2.6	0.6±0.2	0.8±0.1	36.6±2.8
February	30.2±2.1	1.55±0.8	22.0±2.5	0.4±0.1	0.8±0.3	37.6±3.6
March	31.4±3.2	1.81±0.6	22.6±2.9	1.1±0.3	1.6±0.4	34.2±2.8
April	32.2±2.9	2.2±1.8	24.8±2.8	1.4±1.0	1.8±0.5	33.6±4.2
May	33.6±4.2	2.4±0.6	25.0±2.8	1.5±0.6	2.0±1.2	32.4±2.8
June	34.1±5.0	2.2±1.2	26.6±2.1	1.6±0.4	2.6±1.5	30.6±2.0
July	35.6±2.9	2.0±1.0	26.0±1.8	1.4±0.8	1.7±1.0	31.8±2.4
August	33.5±2.6	1.8±1.0	25.6±1.7	1.2±0.7	1.4±0.5	32.5±3.2
September	31.7±3.5	1.4±0.9	24.2±3.0	1.1±0.3	1.0±0.2	35.0±4.0
October	29.6±3.2	1.6±1.2	23.6±1.8	0.9±0.6	0.9±0.1	35.8±3.6
November	27.8±2.9	1.3±0.4	22.1±3.0	0.8±0.2	0.7±0.2	36.2±3.8
December	26.4±2.5	1.0±0.6	21.6±2.6	6.5±0.2	0.6±0.1	37.8±4.0
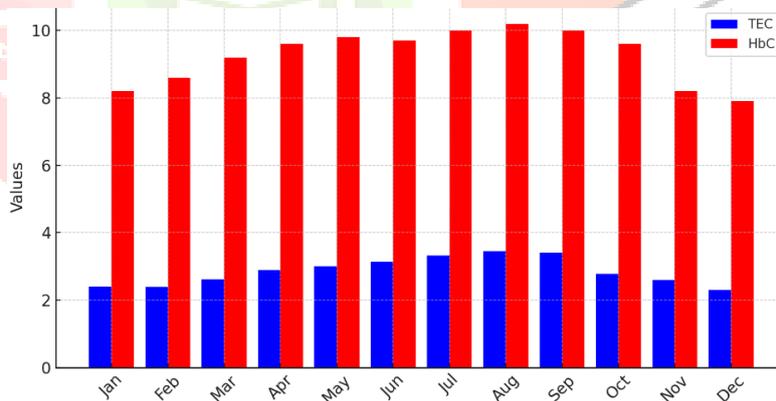
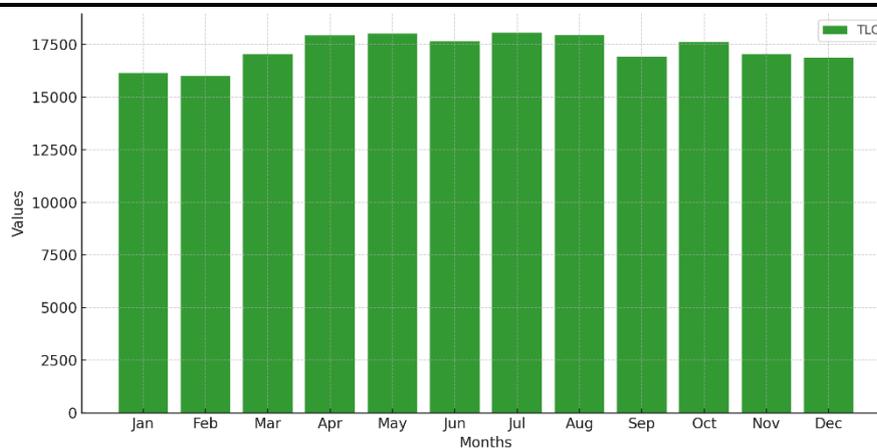Fig 1: TEC and Hb.C. variation across months for *Barilius bendelisis*.

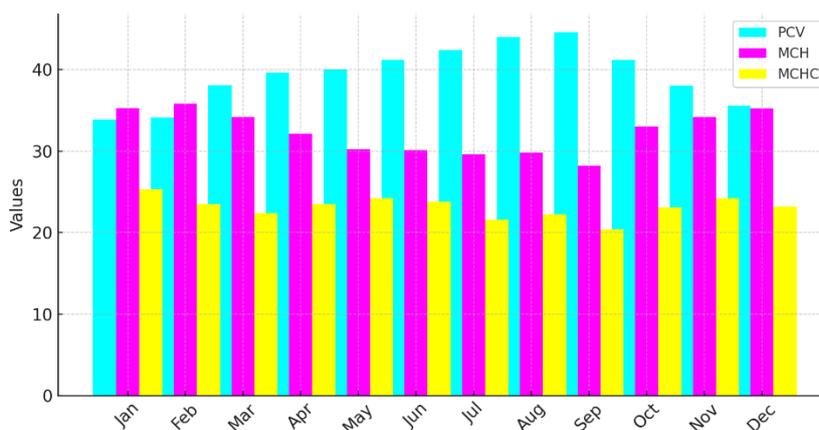Fig 2: TLC variations across months for *Barilius bendelisis.*

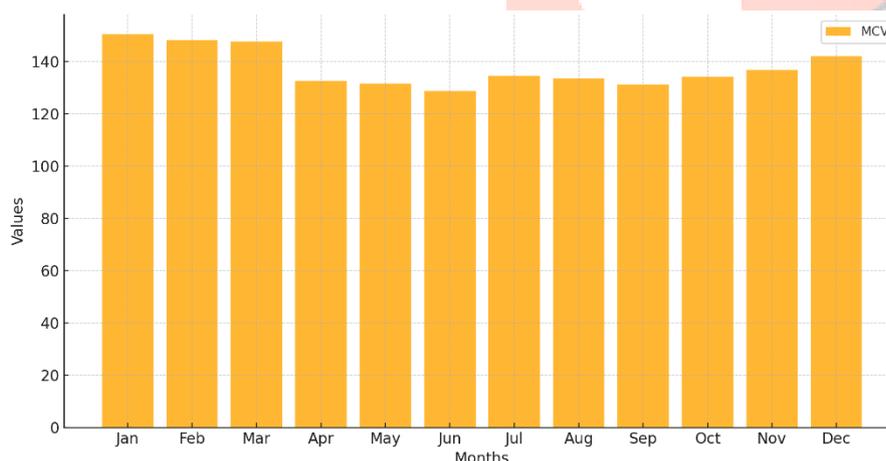Fig 3: PCV, MCH and MCHC variation across months for *Barilius bendelisis.*

Fig 4: MCV variation across months for *Barilius bendelisis.*

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