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Jyoti Sharma
Govt. Degree College, Kathua, Jammu and Kashmir, India

Shabir Ahmad Dar
Govt. Degree College Baramulla, Jammu and Kashmir, India

Seema Langer
Department of Zoology, University of Jammu, Jammu and Kashmir, India

AN Sayani
College of Fisheries Junagadh Agricultural University, Veraval, Gujarat, India

Correspondence
Jyoti Sharma
Govt. Degree College, Kathua, Jammu and Kashmir, India

Seasonal variations in the spleen somatic index (SSI) of *Garra gotyla gotyla*

Jyoti Sharma, Shabir Ahmad Dar, Seema Langer and AN Sayani

Abstract
In the present research, an attempt was made to study the seasonal variations in spleen somatic index (SSI) of Garra gotyla gotyla. Fish *Garra gotyla gotyla* selected for the present studies, were collected from the Jhajjar stream at Jhajjar Kotli one of the tributaries of river Tawi situated at an elevation of 400 meters above the mean sea level (msl) and is 34Km from Jammu on NH1A to Kashmir, the study was carried out from November,2009 to October, 2010. The lowest value of SSI was recorded during the summer season (0.150) and highest was observed during winter season (0.330). SSI exhibits an inverse relation with gonado somatic index (GSI) and total leucocyte count (TLC). The peak value of GSI was recorded during the summer season (9.31) whereas lowest value of 0.40 was noted during winter season. In similar manner TLC was highest during summer season (17.21×103/cmm) and lowest during winter season (14.29×103 /cmm).

Keywords: Spleen somatic index, gonado somatic index, total leucocyte count, *Garra gotyla gotyla*.

1. Introduction
The teleost spleen is a discrete organ containing in addition to erythrocyte sequestered from circulation, erythropoietic tissue involved in the synthesis of new erythrocytes [12]. Spleen is a major storage organ for blood cells and is known to contract in teleost fish during acute stress. Contraction of spleen results in release of red blood cells in blood and may account for increase in erythrocytes and lymphocytes [8]. So spleen appears to play an important role in haemopoiesis. Besides [2, 10] stated that production of antibodies showing immune reactivity in response to pathogens and foreign particles in blood stream is yet another important function of spleen. Spleen as a secondary lymphatic organ therefore is widely used as a simple measurable immunological variable with a potential role in immune responses against the entry of any foreign pathogen in fish [4, 3, 7].
Review of literature, however reveals that organ size is condition dependent including spleen [9, 3, 10]. A link between spleen size and fish condition has also been reported by workers like [9, 3].
From the state of art about spleen size it becomes apparently clear that though studies on spleen size and its role in haemopoiesis and immune reactivity is recognized but not much is available on its seasonal variations which can have many condition dependent influence on during life history in fishes [4].Presently therefore an endeavor has been made to generate data on spleen size in percentage of body weight which is recognized as spleen somatic index (SSI) in fish *Garra gotyla gotyla*.

2. Material and Methods
Adult specimens of *Garra gotyla gotyla* were collected with the help of cast net from Jhajjar stream a tributary of Chenab (J&K), India and were brought live to the laboratory and the study period was November, 2009 to October, 2010. Blood sample was collected with the help of disposable insulin syringes by making an incision through the heart of fish. Total leucocyte count (TLC) was counted with the help of improved Neubauer haemocytometer [5]. After taking blood, the fishes were dissected out and their gonads and spleen were taken out to study gonado somatic index (GSI) and spleen somatic index (SSI). Gonado somatic index which is the percentage of gonads in body weight was calculated using following formula [3].

GSI =weight of gonads (gm)/ weight of fish (gm) ×100

Spleen somatic index was determined by using the formula (SSI)

= weight of spleen (gm)/weight of fish (gm) ×100

2.1 Statistical Analysis
The data obtained was statistically analyzed by means of one way analysis of variance (ANOVA) and paired sample t-test. Standard deviation and Pearson correlation coefficient were also calculated. All analyses were performed using SPSS software (17 version).

Table 1: Showing seasonal variations in the spleen somatic index (SSI), gonado somatic index (GSI) and total leucocyte count (TLC) of *Garra gotyla gotyla*.

Season	Month	SSI	GSI	TLC ($\times 10^3$/cmm)
Winter Season	November	0.310±0.15	0.40±0.20	16.95±0.24
	December	0.330±0.37	5.56±0.34	14.62±0.52
	January	0.312±0.64	5.76±0.14	14.29`±0.72
Spring Season	February	0.295±0.42	7.0±0.65	14.92±0.07
	March	0.271±0.67	7.53±0.47	15.46±0.51
Summer Season	April	0.215±0.05	8.05±0.54	16.05±0.38
	May	0.150±0.19	9.31±0.05	16.74±0.95
	June	0.197±0.33	8.68±0.39	17.21±0.34
Monsoon Season	July	0.228±0.52	5.53±0.16	16.63±0.19
	August	0.250±0.69	3.03±0.84	16.02±0.46
Autumn Season	September	0.273±0.16	2.80±0.16	15.85±0.83
	October	0.290±0.27	0.82±0.24	15.29±0.55

3. Results and Discussion
In the presently study significant variations were observed in the spleen somatic index of fish *Garra gotyla gotyla* throughout the year (Table 1). Data on spleen somatic index clearly depicted a significant decrement ($P<0.05$) in the values of SSI during the spring and summer season and lowest values were recorded during the month of May (summer season). Similar to present findings workers like [6, 1, 13] also reported significantly lower values of SSI during the spring and summer season.

On the basis of observed decline in SSI during spring and summer season, the present study proposes an inverse relation with gonado somatic index (GSI) which during this very periods record the highest value (Table 1). During spring and summer when GSI of fish witness a rapid increase during developing and developed phases of reproductive cycle, the decline in SSI seemingly reflect that the fishes are immunologically low because of stress of ensuing spawning period [6].Decline in spleen somatic index is also known to occur during the breeding season in wild Arctic Charr, *Salvelinus alpines* [11] and in some captive fishes [14].

Breeding period is high energy demanding period in the reproductive cycle of fish and during this period fishes may go for various physiological adjustments in different systems including immune system to provide required energy for the development of gonads (according to life history theory) [7].Hence expectedly down regulation is apparently noticed in the immune function which is clearly evident from the decline observed in the values of spleen somatic index during this period (Table 1).

Spleen is known to contract during the period of acute stress [8]. During spring and summer, a significant increase in water temperature (Table 1) noticed which results in degradation of water quality and give rise to pathogenic condition in water body which inturn creates a stressful condition for fish. To overcome this stress present fish in agreement with op.cit workers contract its spleen (reduction in spleen somatic index) and release more and more leucocytes in general blood circulation. So this also explains the increase in total leucocyte count during this period (Table 1).

Moreover in the present study after attaining lowest value of SSI during summer, a significant increase ($P<0.05$) in their values have been observed during the monsoon, autumn and winter season (Table 1). Increase in spleen somatic index of fish *Garra gotyla gotyla* from monsoon till winter now appears to find a plausible relation with decrease in GSI values (GSI and SSI as stated elsewhere, exhibit an inverse relation). Present view point gets a direct support from the findings of [14, 4] who also observed increased values of SSI during the non-breeding season of the year. During this period which is not a physically demanding period as fishes are passing through spent and recovery phases, GSI tend to fall and hence an increase in the values of SSI has been noticed. Moreover during this period, water temperature exhibits a decline that limits the prevalence of pathogenic condition in waterbody. In the absence of any foreign pathogen therefore fish *Garra gotyla gotyla* being immunologically strong enough, very rightly depicts an increase in spleen somatic index. This is further authenticated by the observed decline in total leucocyte count during this period.

From the above results and discussion on spleen somatic index (SSI) it can be concluded that spleen somatic index is an important variable used to measure the relative immunity of fish *Garra gotyla gotyla* against any kind of stressor (presently causative of stress is the breeding period).

4. Conclusion
Significant variations have been observed in the spleen somatic index (SSI) of fish *Garra gotyla gotyla* throughout the year. A gradual decrement in the values of SSI has been observed during the spring and summer season and afterwards a significant increment in the values of SSI has been noticed during monsoon till winter. Decline in SSI during spring and summer finds a direct relation with increase in GSI of fish during this period which is the breeding period of fish. During breeding period physiological adjustments were made in different systems including immune system in order to provide maximum energy for the development of gonads and hence decrement in SSI was observed. Moreover to overcome temperature related stress fish contracts its spleen and release more and more leucocytes in general blood circulation.

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