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A Survey on Physico-Chemical Parameters in relation to Abundance/ Distribution of fresh water Crab (Paratelphusa Masoniana) in GHO Manhasan Stream of Jammu Region, India

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Abstract

Present survey was conducted to investigate physico chemical parameters in relation to Crab abundance in Gho-Manhasan Stream located in Western Region of Jammu. JandK (India). For this purpose, monthly sampling was done from two stations identified on the basis of the extent of anthropogenic activities. Physico-chemical parameters viz temp Air/Water, pH, DO, FCO_2, Cl^-, Ca^{++}, Mg^{++}, HCO_3 were assessed from Jan 2012 to Dec 2012. This water body harbours only one species of crab i.e. Paratelphusa masoniana. Population survey over a period of one year (Jan 2012-Dec 2012) revealed abundance of Crabs, to be more at station II as compared to station I as indicated by catch per unit. Presently, an attempt has been made to co-relate the observed variations with habitat disturbance. It was observed that total crab population exhibited a positive correlation to water temperature .009885, pH 0.338326, Dissolved Oxygen 0.174293, Calcium 0.056325 Magnesium 0.602844, while negative correlation was exhibited with chloride --0.00447, HCO_3^- --0.245292 and FCO_2 --0.396196

Keywords: Physico-chemical parameters, crab distribution, Gho-Manhasan Stream, Jammu, J&K India.

Introduction

Fresh Water Systems in tropics host a diverse endemic fauna including fresh water Crabs, with 1280 species representing one fifth of all the world's Brachyurans. Cumberlidge[1]. The family *'Pseudothelphisidae'* in general include typical fresh water species of Crabs that complete their life cycles in fresh water itself Chace and Hobbs[2]. Crustaceans are highly sensitive to pollution and govern the disturbances in the physico-chemical parameters that in turn induce changes in immune system of crustaceans, by stressing them and resulting in a reduction of immune vigour. The environmental parameters of any wetland are very important, because the variations in the physico-chemical properties such as temperature, salinity; pH, dissolved oxygen, FCO_2, Ca^{++}, Mg^{++}, influence the crustacean abundance and life cycles.

Present studies on fresh water crabs from Gho-Manhasan stream, Jammu experiencing tropical and sub tropical climate, have been conducted Jan 2012 to Dec 2012 with an aim to assess the population structure of Paratelphusa masoniana in relation to prevailing physico-chemical parameters.

Gho-Manhasan stream (lotic) is located at a distance of about 12 Kms from University of Jammu, ($30^0 67^/$ Lat N; $74^0 79^/$ Long E). This stream being fed by river Chenab is a sole source of water for the people inhabiting its adjoining areas, regarding irrigation as well as domestic purpose thereby indicating anthropogenic activities at some sites. It was observed that this water body harbours only one species of crab i.e. *Paratelphusa masoniana.* Monthly sampling of this wetland was done and based on the data collected; an attempt has been made to correlate the seasonal occurrence and abundance of Crabs with the ambient ecological parameters of this wetland.

Methodology

Two stations I and II were identified for collection purpose, depending upon the extent of anthropogenic activities and transferred to laboratory, Department of Zoology, University of Jammu for recording various observations. To record Crab's abundance, catch per unit effort is taken into consideration, as C.P.U.E is an indirect measure of abundance of a target species Maunder[3]

$$\text{C.P.U.E} = \frac{\text{Total catch}}{\text{Sum of efforts}}$$

Air and water temp were measured using mercury thermometer and pH was recorded with the help of pH meter. Physico-chemical parameters such as DO, FCO_2, Cl^-, Mg^{++}, Ca^{++} etc were analyzed by using standard methods propsed by (APHA, 1998) and expressed in mg/l .

Results and Discussion

A look at table 1 reveals that values of C.P.U.E never remained constant but fluctuated seasonally as well as at two different stations. It is also clearly evident that value of C.P.U.E is comparatively higher at station II as compared to station I. Maunder[3] while studying the relationship between C.P.U.E and abundance of individual stocks held that C.P.U.E varies with (a) efficiency of a fleet (b) Species being targeted by a fleet and (c) environmental factors. Since there is only one type of species of crab in stream (target species), therefore, both factors (a) and (b) are constant but environmental factors i.e. physico-chemical parameters and anthropogenic disturbances (bathing by human and cattle in and around stream) varied to great extent at two stations seasonally.

Table 2 and 3 represent the status of various physico-chemical parameters prevailing throughout the year Jan 2012-Dec 2012 at station I and II.

The crustaceans are highly sensitive to pollution and their distributions are strongly influenced by physico chemical parameters. The variations in physico chemical parameters influence crustacean's abundance and life cycle.

Temperature: Temperature is a limiting factor in aquatic environment and considerably affects various metabolic activities, growth, oxygen consumption, reproduction molting, survival, distribution and migratory behavior of crustaceans. The air and water temperature were found to go more or less hand in hand.

During the study period Jan 2012 –Dec 2012 the air temperature at two stations fluctuated between 16^0C to 40^0C with maxima in June viz 40^0C at both stations and minima in the month of December. Like air temperature, water temperature varied between 12.5^0C to 34^0C at station I and 12^0C to 33.5^0C at station II table 2 and 3. In the present investigation, total crab population showed a direct positive correlation with water temperature at both stations viz station I 003147 and station II 009885 table 4. That the existing temperature range falls within the tolerable limits of crab is indicated by their respective CPUE values table-1 and such observations get authenticated by those made by Diwan and Nagabhushanab[4] who on the basis of their investigations on the heat tolerance in crab *Barytelphusa cunicularis,* concluded 34.5 ± 0.5^0C to be the critical limiting temperature for the said species.

Apart from survival, temperature also plays an important role in breeding. During study period, it was observed that juveniles started appearing in the collection during March-June there by indicating a rise in temp to be a stimulant for hatching. That the hatching bears a positive co-relation with increasing temperature further gets supported by the observation already made by Anger who while studying the effect of temperature on larval development of Chinese mitten Crab, *Enocheir Sinesis*, reported that development from hatching to metamorphosis occurred at a temperature more than 12^0C. In this context the observations made by workers like Manohar and Qureshi[6] became quite relevent who recorded a direct correlation between water temp and prawn ecological parameters 0.1111. Though very little variations in temperature are evident at the two study stations, yet the variations in population structure as indicated by C.P.U.E is remarkable. This can definitely be attributed to more anthropogenic activities at Station I as compared to Station II (table 2 and 3).

pH: In decopods, pH influences the metabolism, physiology and maturation process. In the present investigation, pH value range between 6.7 to 7.1 at Station I and 7.0 to 7.4 at Station II which simply implies that water at Station II is slightly alkaline and more basic as compared to Station I (table 2 and 3). Very interestingly Crabs also followed the same trend of their population abundance viz station II > station I as indicated by C.P.U.E. Thus the relationship of pH to the crab abundance registered significant positive correlation viz +0.449495 at station-I and +0.338326 at station-II (table 4). Such findings are authenticated by work of Das and Sahoo[7] who held alkaline pH to be associated with more number of crab species up to a particular extent after which further increase in pH leads to a decrease in the number of species.

Less crab pop at station –I can be attributed to slight acidic pH, which appears to be the main cause for decline of crabs at station I than at station II. This is in accordance to EPA[8] that accepted that the water quality criteria indicating pH range less than 6.5 is not suitable for aquatic species. Moreover, in this context a strong support can be drawn from the findings of Sarah[9], that pH have great effect on immunity of crabs, higher the pH more immune are crabs and a decrease in pH makes them vulnerable to infection. At lower pH 6.7 the activity of phenol oxidase enzymes which helps to provide protection against infection in arthropod gets suppressed. This very clearly indicates that pH, like other parameters have marked influence on distribution /abundance of crabs.

Depth: Crab abundance at station I shows negative co-relation viz -0.024061 with depth ranging from 14 to 42 cm whereas at staion II being less deep, a positive co-relation viz 0.0i5695 is observed with depth ranging from 18 to 30 cm (table 4). A similar relationship of depth with crab population has been highlighted by Marijnisson[10] who stated that crab density decrease with increase in depth of water body. Therefore, station I being deeper was characterized by less crab abundance as compared to station II which is less deep comparatively.

Dissloved oxygen: During present course of study, the values of DO at two Stations are highly variable, on the basis of which station I can be categorized as polluted one. At station I, (table 2) dissolved oxygen fluctuate between 3.2 to 5.6 mg/ltr and for most of time i.e 10 months remained below 5.5 whereas at station II DO values fluctuate between 5.2 to 9.2 mg/ltr and for most of the period 11 months remained above 5.5. A very strong positive correlation of pH and crab abundance could be recorded viz + 0.095074 station I and +0.174293 station II. (table 4). Similar correlation have been established by Manohar and Qureshi[6] in prawn as well i .e +0.0778 Where as, Cheng[11] while studying *Haliotis diverscolor* reported that haemolymph, osmolality and sodium balance at very low concentration at DO

3.08 mg/land even lower than this value might result in acid base imbalance leading ultimately to acidosis for short term period and hence may then limit distribution of crabs.

Station I with range of less DO than 6 mg/l shows polluted because of anthropogenic activities as compared to station II. This is supported by findings of Egemen and Sunlu[12] according to which the minimum. DO may not be < 5.0mg/l for aquatic life in fresh water ecosystem.

This is also supported by CPCB[13] that water bodies with DO at 6 mg/l or high is categorized as class I and less than 6mg/l is categorized as low class or polluted.

FCO_2: FCO_2 usually maintains an inverse relationship with pH, but a direct one with that of temp. In the present study the tables at two stations reflect that FCO_2 has been observed to fluctuate between 4.0-12mg/l at Station I and 4.2-7.4 mg/l at Station II (table 2 and 3). FCO_2 is negatively correlated viz -0.396196 at station I and positively correlated at station II viz +0.13258 (table 4) therefore have strong influence on the crab population.

At station I FCO_2 value was high during summers at high temperature (May-June) hovering between 10.0-12.0 mg/l but was inversely related to pH value range (6.8-6.9). Since $FC0_2$ has great bearing on pH, therefore it can have strong influence on the Crab population. CO2 related increase in pH at station I may be responsible for resultant decline in Crab population as a consequence of disturbance in the acid base balance of ecosystem. This can be authenticated by findings of spicer *etal*[14] who also stated that CO_2 related acidification leads to disturbance of acid base balance in velvet swimming Crab *Neuora puber*.

Further, at station I anthropogenic activities add to the rate of decomposition and respiration thereby increasing CO_2 concentration in water body which further led to decline in crab population at this station. At station II positive correlation of FCO_2 with crab abundance can be attributed to low values of FCO_2 during summers (6.2-7.4 mg/l) and more basic values of pH (7.1 and 7.2) as compared to station I showing negative correlation (table 2 and 3)

Further no-anthropogenic activities were witnessed at station II. This comparison strongly indicates role of FCO_2 in crab distributions which is much pronounced at station II as compared to station I.

Chloride: At Station I the levels of Cl^- ranged from 23.6 to 51.9 mg/l showing negative correlation with crab distribution and at station II, levels of Cl^- (20-40mg/l) (table 2 and 3) though less than Station I but still indicate negative co-relation, with respect to crab distribution. It therefore indicated that increase in salinity at station I resulted in a decrease in crab population as compared to station-II where the levels of chloride are less than station I. Since chlorides helps in maintenance of body fluid and acid base balance, therefore an increase in salinity of water influenced the acid base balance and hence checked distribution of crabs in study area. Whitely *etal*[15] too held that increase in salinity disturbs acid base balance and rather cause acidosis in crab and thus support the view that conc of Cl^- does influence the distribution of crabs. Thus crab population of present investigation exhibited negative correlation with chloride viz -0.02784 at station I and -0.00447 at station II (table 4). Manohar and Qureshi[6] also reported similar relationship with prawn population and chloride -0.0598.

It was also noticed during present study that high values of chloride content at station I is also related with anthropogenic activities which in turn can be attributed to less crab population at this station I. This is authenticated by findings of Khare *etal*[16] according to which Cl^- is important indicator of pollution. On the other hand absence of anthropogenic activities along with low level of Cl^- at Station II indicated more congenial habitat for fresh water crabs.

Calcium and Magnesium: Calcium and Magnesium are very vital components as far as crabs are concerned because they have their special requirement for these ions during the formation of exoskeleton.

Though in comparison to Ca^{++}, Mg^{++} is required in very small concentrations. Mg^{++} fluctuated between (40.2 -64.7 mg/l) at station –I and between 34.5 -54.9 mg/l at Station –II showing a positive correlation with crab abundance at two stations viz +0.495669 at station I and + 0.602844 at station –II. Table 2, 3 and 4.

Comparative high levels of Ca^{2+} at station II (20.0 to 54.5 mg/l) as compared to station I (22.8 - 42.2 mg/l) show positive correlation viz 0.056325 with respect to crab abundance at this station but station I indicated negative correlation -0.326441 (table 4). Present observation get strengthened by the findings of Neufeldt *etal*[17] who while studying effect of Ca^{2+} concentration in water on post moult uptake in blue crab. *Callinectes* sapidus, inferred that rate of Ca^{2+} uptake in these crabs have direct relation with availability of Ca^{2+} in water body as they require high concentration of calcium of surrounding water during ecdysis. At station I negative correlation appears to be an indicator of the fact that extremely low calcium possibly must have led to incomplete calcification of developing crabs.

It was also observed that crabs having poor exoskeleton, being highly vulnerable to predation and cannibalism must have resulted in limiting their distribution at station–I. In this context, finding of Rayhanen[18] that in crustaceans, incomplete calcification lead to prolonged period of soft exoskeleton, making them more valunerable to predation, very strongly justifies the less crab abundance at station –I.

In comparison to station I, station II with high value of Ca^{2+} and positive correlation with more abundance of crab population of Juveniles and adults strongly indicates that calcium may limit the distribution and success of crustaceans in soft water localities.

Carbonates and Bicarbonates: In water CO_2 exist in 3 different forms viz FCO_2, bound CO_3^{2-} and half bound form (HCO^{3-}). During present studies bicarbonates have been observed to be present at two stations but (CO_3^{2}) could not be ever recorded at any station as FCO_2 was present.

Role of bicarbonates as buffer in a water body is of utmost significance particularly when it appears that bicarbonates by regulating pH in turn control the crab population abundance and same may be true for presently studied stream as well.

At station I value of HCO_3 ranged between 430.3-886.3 mg/l with positive correlation +0.183321 whereas station –II 400.2-752. 0 mg/l showed negative correlation with bicarbonates -0.24529 thereby indicating soft water at station II to be more productive than hard water at station I (table 2, 3 and 4). It was observed that at both the stations the level of HCO_3 was on higher side during summer and monsoon period. Present observations are in line with those made by Zuber[19] regarding increase in the value of bicarbonates in summer seasons.

Verma[20] too emphasized maximum value of bicarbonates during monsoon because of entry of rain water, rich in $CaCO_3$ which increased the bicarbonates concentration in study area.

Conclusion

Based on the results of crab population vis-à-vis physico-chemical parameters at two stations of Gho-Manhasan stream of Jammu Region, J&K it is concluded that water temp, depth, pH, FCO_2, DO, Ca^{2+} and Mg^{2+} exhibit positive impact on crab abundance and therefore high C.P.U.E at station II can be attributed to the combined effect of (a) favorable water quality parameters (b) physical anthropogenic disturbances that are apparently very less at station II.

Physical disturbances seemingly appear to have resulted in large scale changes in water parameters which ultimately influence crab abundance as is witnessed by a comparative low C.P.U.E at Station I.

Table-1
Catch per unit effort of Crab *Paratelphusa masoniana* during the study period (Jan 2012-Dec 2012)

S.No	Months	Catch per unit effort	
		Station - I	Station – II
1	Jan 2012	2.0	3.0
2	Feb	2.6	3.3
3	March	2.6	4.0
4	April	3.0	4.3
5	May	2.3	4.0
6	June	3.3	5.0
7	July	3.6	4.0
8	August	3.3	5.3
9	September	4.0	5.0
10	Oct	3.3	6.0
11	Nov	4.0	6.0
12	Dec 2012	4.6	6.6

Table-2
Physico –chemical parameters at Station – I (Jan 2012-Dec2012)

Month	Temp ^{0}C		Depth (Cm)	pH	FCo_2 (mg/l)	DO (mg/l)	Cl^- (mg/l)	Ca^{2+} (mg/l)	$HC0_3^-$ (mg/l)	Mg^{2+} (mg/l)
	Air	Water								
Jan -12	18	15.5	16	7.0	6.0	5.6	39.8	24.2	682.2	58.6
Feb	20	19.5	30	6.8	8.0	5.6	36.3	28.4	860.2	40.2
March	24	20	28	7.1	10.0	5.2	30.5	42.2	816.3	44.1
April	28	24	32	7.2	8.0	4.8	30	26.3	512.3	53.4
May	35	25	31	6.8	10.0	3.2	33.7	31.2	430.3	48.6
June	40	34	35	6.9	12.0	3.2	45.9	41.6	722.2	50.5
July	33	32	22	6.9	10.0	5.2	50.3	25.6	680.4	51.3
August	37	28	26	7.0	8.0	4.8	51.9	26.2	650.2	40.8
Sept	31	25	27	7.0	7.0	5.2	48.6	22.8	886.3	52.6
Oct	29	23	25	7.0	6.0	4.8	40.7	24.0	683.3	55.4
Nov	23	19.5	42	7.1	6.0	4.8	29.9	27.6	570.2	64.2
Dec-12	16	12.5	14	7.2	4.0	5.2	23.6	23.2	726.2	64.7

Table-3
Physico-chemical parameters at Station – II along Gho-Manhasan Stream (Jan 2012 –Dec 2012)

Month	Temp ^{0}C		Depth (Cm)	pH	FCo_2 (mg/l)	DO (mg/l)	Cl^- (mg/l)	Ca^{2+} (mg/l)	$HC0_3^-$ (mg/l)	Mg^{2+} (mg/l)
	Air	Water								
Jan -12	16.5	13	27	7.0	4.4	8.2	36.7	43.5	400.2	37.5
Feb-12	20.5	18.5	19	7.1	5.6	7.2	18.9	14.0	764.4	39.6
March-12	23.5	20	20	7.2	5.8	6.2	19.9	19.5	752	35.0
April -12	27	23	22	7.4	4.4	5.4	17	24.5	496.2	49.6
May	34.5	24	21	7.2	6.2	5.2	36	32.2	500.2	38.9
June	40	33.5	23	7.1	7.4	5.4	36	27.7	685.4	46.7
July	33	30	25	7.3	5.2	5.6	38	42.2	680.0	34.5
August	37	28	28	7.2	5.8	5.6	40	54.5	535.1	47.2
Sept	31.5	26	30	7.1	5.2	5.4	35	20.0	600.5	44.5
Oct	30	24	27	7.2	7.2	6.2	33	12.8	484.2	42.5
Nov	24	18	22	7.1	5.2	7.2	29	14.2	508.4	38.9
Dec	16	12	18	7.4	4.2	9.2	20	52.9	530.0	54.9

Table-4
Co-relation values between crab Abundance and Physico-chemical parameters at two stations I and II during study period (Jan 2012-Dec 2012)

S.No	Crab Abundance (CA) / Physico-chemical parameters	Station - I	Station-II
1	CA/Temp	0.003147	0.009885
2	CA/Depth	-0.024061	0.015695
3	CA/pH	0.449495	0.338326
4	CA/FCo_2	-0.396196	0.13258
5	CA/DO	0.095074	0.174293
6	CA/Cl^-	-0.02784	-0.00447
7	CA/Ca^{++}	-0.326441	0.056325
8	CA/HCO_3^-	0.183321	-0.245292
9	CA/Mg^{++}	0.495669	0.602844

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