

Inter-relationship Between Condition Coefficient (K) of *Penaeus monodon* and Heavy Metals from a Brackish Water Pond

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The condition coefficient (K) of *Penaeus monodon*, collected from a traditional brackish water system at Kanmari, about 50 km away from the city of Calcutta, during the period from March 1992 to February 1994, was estimated. During the investigation period, concentrations of heavy metals (Zn, Cu, Mn, Fe, Cr, Ni, Pb and Cd) in the ambient media (sediment and water) were determined to study the suitability of the environment for the growth and survival of the species. There was a negative correlation between the condition coefficient and the concentration of heavy metals in water.

Key words: Condition coefficient, heavy metals, *Penaeus monodon*, environment

There are many impounded water bodies around the Kulti outfall region near Calcutta city, where prawn culture by traditional methods is an important activity. These water bodies are contaminated with the metropolitan wastes of the city and therefore the ambient environment often becomes stressful for the growth and survival of the aquatic organisms. The condition coefficient (K) demonstrates the well being of aquatic organism (Maceina & Murphy, 1988) and provides information regarding the suitability of environment (Alkalem *et al.*, 1997).

In the present study, an attempt has been made to analyse the inter-relationship between the condition co-efficient (K) of prawn, *Penaeus monodon* with dissolved heavy metals and biologically available (leachable by weak acids) heavy metals of pond sediment.

Materials and Methods

One hundred and fifty specimens of *P. monodon* were collected each month from

traditional brackish water farm at Kanmari in the North 24 Parganas district of the state of West Bengal using cast net. The collected specimens were immediately cotton-dried and measured for total length to the nearest millimeter and weighed on an analytical balance to the nearest 0.1 g. These values were used to determine the condition coefficient or Ponderal index (K) using the conventional equation (Alkalem *et al.*, 1997).

$$K = \frac{W}{L^3} \times 100$$

Where W = body weight in gm, L = total body length in cm.

Monthly analyses of dissolved heavy metals in the aquatic phase and biologically available fraction of the total metal content in the pond bed sediment were carried out.

Water samples were collected in clean TARSON bottles and filtered through a 0.45 μ Millipore membrane. The filtered samples were treated with diethyl-dithio-

carbamate and extracted with carbon tetrachloride. The extract was evaporated to dryness and the residue was mineralized with 0.1 ml of conc. HNO_3 as outlined by Chakraborty *et al.* (1987). Analytical blanks were prepared and treated with the same reagents. All analyses were done in duplicate by direct aspiration into flame atomic absorption spectrophotometer (AAS) (Perkin-Elmer Model 3030) equipped with a HGA-500 graphite-furnace atomizer and a deuterium background corrector.

Sediment samples were collected from the surface of the pond bed randomly from ten different spots and pooled together to minimize the error as much as possible. The pooled sediment sample was then dried overnight at 105°C , freed from visible shell and shell fragments and crushed in a porcelain mortar to pass through a 0.45 mm nylon sieve. 1 gm of the sample was digested with 0.5 N HCl as outlined by Malo (1977). Analytical blanks were prepared and treated with the same reagents. All analyses

were done in duplicate by aspirating the digested sample in the same AAS as used for analysing dissolved heavy metals.

Inter-relationship between trace metals of the ambient media and condition coefficient of the prawn was evaluated using the SYSTAT computer programme. The analysis consists of the computation of the single correlation coefficient between K and heavy metals of the ambient media and few multiple regressions using 'K' as the dependent variable. Two regression equations of the following general forms were obtained for analysing the effect of dissolved trace metals and biologically available trace metals from sediments on 'K'.

$$Y = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7 + b_8 X_8 \quad (2)$$

$$Y = b_0 + b_9 X_9 + b_{10} X_{10} + b_{11} X_{11} + b_{12} X_{12} + b_{13} X_{13} + b_{14} X_{14} + b_{15} X_{15} + b_{16} X_{16} \quad (3)$$

where x_1 to x_8 are concentrations of dissolved Zn, Cu, Mn, Fe, Cr, Ni, Pb and Cd

Table 1. Monthly variations of dissolved trace metals (in $\mu\text{g l}^{-1}$) in brackish water pond of Kanmari station, West Bengal.

Month	Zn	Cu	Mn	Fe	Cr	Ni	Pb	Cd
March 1992	107.30	97.30	209.70	2157.10	5.70	15.90	36.50	4.10
April	109.40	100.60	217.40	2183.40	6.20	16.40	38.70	4.60
May	120.90	95.40	214.20	2219.60	7.50	8.70	39.40	4.70
June	127.60	109.70	235.50	2271.90	8.30	21.40	40.70	5.20
July	163.10	143.20	260.80	3625.70	13.20	25.20	44.20	6.30
August	172.30	169.10	271.90	3721.50	14.50	28.70	49.50	7.10
September	181.70	173.30	292.70	3897.80	16.40	29.30	52.10	8.50
October	205.20	191.60	296.40	3920.70	17.90	32.40	59.70	9.70
November	184.40	169.40	262.60	2465.50	12.20	27.60	44.20	8.10
December	176.50	153.20	256.10	2532.40	11.40	24.30	40.60	7.40
January 1993	165.70	140.50	247.60	2719.30	10.90	22.70	38.50	6.30
February	160.50	128.80	240.70	2864.70	9.50	20.40	37.20	6.30
March	100.30	94.50	205.90	2263.90	5.60	14.30	37.70	4.50
April	107.10	98.30	210.40	2237.40	6.10	16.90	40.5	4.90
May	119.40	90.20	216.30	2256.10	6.80	17.30	41.20	5.00
June	107.10	98.30	210.40	2237.40	6.10	16.90	40.10	4.90
July	152.70	148.70	256.30	3703.60	12.70	24.20	45.70	6.70
August	167.90	153.20	278.20	3765.40	14.90	28.90	50.60	7.70
September	173.40	167.10	297.40	3907.60	15.50	30.70	53.40	8.90
October	188.60	178.30	299.60	3986.40	18.20	31.50	43.80	8.80
November	179.20	172.60	160.30	2519.30	11.40	28.30	43.80	8.80
December	162.40	155.80	259.20	2607.40	10.50	25.10	41.70	7.50
January 1994	168.10	146.30	252.40	2634.50	11.40	23.20	37.20	7.90
February	163.40	133.50	243.60	2876.30	10.30	21.50	38.50	6.80

Table 2. Monthly variations of biologically available trace metal (in mg Kg⁻¹ dry wt.) in the pond bottom sediment of Kanmari, West Bengal.

Month	Zn	Cu	Mn	Fe	Cr	Ni	Pb	Cd
March 1992	165.7	66.70	87.90	8647.40	23.50	7.10	13.40	2.10
April	157.10	58.60	102.10	8147.70	22.90	8.20	10.50	2.20
May	159.70	50.90	145.50	9164.50	22.10	9.40	11.30	2.40
June	167.30	70.70	74.70	8549.20	21.30	11.20	7.50	2.50
July	109.40	42.60	49.40	6200.30	11.80	2.30	6.70	—
August	114.40	22.50	62.90	6216.30	10.90	2.50	5.80	—
September	107.60	30.20	78.20	5197.10	11.30	2.30	5.30	—
October	122.80	42.10	70.60	5434.80	9.50	1.90	8.40	—
November	135.30	42.70	78.40	8148.40	11.80	3.50	8.30	—
December	132.40	35.40	79.40	8429.10	13.50	4.10	12.30	—
January 1993	136.2	35.90	68.70	6611.20	15.60	5.10	13.10	—
February	139.50	34.30	83.40	5572.10	17.70	5.20	11.30	—
March	107.30	57.60	72.50	10119.80	22.20	6.70	13.40	2.20
April	156.10	54.90	61.20	71120.80	23.10	0.30	7.80	2.00
May	164.30	52.20	59.10	5654.70	24.30	11.70	8.10	2.30
June	165.90	65.30	69.40	8780.20	23.60	8.50	9.40	2.20
July	106.60	40.10	64.10	7293.10	12.110	3.30	6.20	—
August	109.30	33.40	76.30	6221.70	10.40	2.90	5.50	—
September	104.20	42.70	77.80	7196.60	9.60	2.30	4.20	—
October	119.30	43.90	70.20	6404.90	8.60	3.40	3.80	—
November	133.70	49.30	77.90	9196.40	13.80	3.90	4.70	—
December	134.30	37.80	72.90	9830.60	13.20	4.30	8.20	—
January 1994	132.60	42.60	70.60	6538.10	15.30	5.30	11.50	—
February	140.60	37.20	81.80	5894.80	17.40	5.90	13.20	2.00

= below detectable level

respectively and x_0 to x_{16} , the concentrations of biologically available Zn, Cu, Mn, Fe, Cr, Ni, Pb and Cd respectively in the sediment.

Results and Discussion

The two year study revealed a unique seasonal variation of heavy metals in the ambient media of the sampling station. In general, high values of dissolved heavy metals were recorded during the monsoon period (Table 1) which might be attributed to the runoff from the highly urbanized and industrialized city of Calcutta (Mitra & Choudhury, 1993a). The biologically available heavy metals decreased in the pond bed sediment during the monsoon season (Table 2) which may be due to dissolution of the metallic compounds from the sediment as a result of low salinity and pH (Mitra & Choudhury, 1993b; Lakshmanan & Nambisan, 1983).

The condition coefficient (K), which is a measure of the suitability of the

Table 3. Monthly variations of condition coefficient (K) of *Penaeus monodon* sampled from Kanmari, West Bengal.

Month	Total length (in mm)	Weight (gm)	K
March 1992	158.99	35.12	0.873
April	159.21	36.46	0.903
May	161.12	37.09	0.878
June	163.84	39.93	0.907
July	152.89	27.99	0.783
August	152.24	27.17	0.770
September	151.47	27.02	0.777
October	150.21	26.57	0.783
November	156.28	30.92	0.810
December	156.93	31.13	0.805
January 1993	157.18	32.94	0.848
February	158.34	33.88	0.853
March	158.88	35.01	0.872
April	159.11	36.35	0.902
May	161.51	37.20	0.882
June	163.72	39.82	0.907
July	152.78	27.85	0.780
August	152.13	27.06	0.768
September	151.36	26.95	0.777
October	150.12	26.75	0.781
November	156.17	30.31	0.808
December	156.82	31.02	0.804
January 1994	157.08	33.90	0.874
February	158.22	34.71	0.876

Table 4. Inter-relationship between the selected environmental variables and 'K' value of *Penaeus monodon* of Kanmari, West Bengal.

Combination	'r' - value	'p' - value
K x dissolved Zn	-0.7943	≤ 0.01
K x dissolved Cu	-0.8631	≤ 0.01
K x dissolved Mn	-0.6862	≤ 0.01
K x dissolved Fe	-0.8471	≤ 0.01
K x dissolved Cr	-0.8777	≤ 0.01
K x dissolved Ni	-0.8725	≤ 0.01
K x dissolved Pb	-0.7595	≤ 0.01
K x dissolved Cd	-0.7610	≤ 0.01
K x biologically available Zn of sediment	-0.8325	≤ 0.01
K x biologically available Cu of sediment	-0.7243	≤ 0.01
K x biologically available Mn of sediment	0.2018	IS
K x biologically available Fe of sediment	0.3228	IS
K x biologically available Cr of sediment	0.9324	≤ 0.01
K x biologically available Ni of sediment	0.1904	IS
K x biologically available Pb of sediment	0.6177	≤ 0.05
K x biologically available Cd of sediment	0.8632	≤ 0.01

I.S. - Insignificant

environment for the normal growth and survival of the species (Table 3), was found to be negatively correlated with the concentration of dissolved heavy metals ($p < 0.01$) indicating that the presence of dissolved heavy metals is highly stressful for the normal well being of the species (Table 4). The dissolved heavy metals mainly enter the body tissues of the prawn through gills (Mitra *et al.*, 1999) which may reduce the enzyme activities of the organism by blocking the active sites of the enzymes and consequently hamper the normal growth of the animal.

The significant positive relationships of condition coefficient (K) with biologically available Zn, Cu, Cr, Pb and Cd from the sediment of pond bed illustrated that the precipitation of these metals from the aquatic

phase to sediment bed reduces the environmental stress on these organisms.

Multiple regression equations computed by treating the condition coefficient (K) of *P. monodon* as dependent variable separately with dissolved heavy metals and biologically available heavy metals from sediment (Table 5) indicated significant negative impact of dissolved Cu and Ni on the healthy growth of the prawn species.

The considerable positive magnitude of multiple regression coefficients of biologically available Cr, Ni, Pb, Cd from pond sediment (Table 5) indicate that healthy growth of prawn can take place in this environment contaminated with waste water, if the concentrations of biologically available Cr, Ni, Pb and Cd increased in the sediment

Table 5. Multiple linear regression constant b_0 and coefficients $b_1 - b_{16}$ (multiplied by 10^{-4})

	b_0	b_1	b_2	b_3	b_3	b_4	b_5	b_6	b_7	R^2	F	'p'
Water	10320	2.35	-15.58	0.91	-0.35	1.77	-36.06	0.52	0.16	0.87	13.14	<0.01
	b_0	b_9	b_{10}	b_{11}	b_{12}	b_{13}	b_{14}	b_{15}	b_{16}	R^2	F	'p'
Sediment	6800	2.67	5.90	-0.28	-0.02	20.70	67.96	42	23	0.93	23.47	<0.01

through the process of precipitation from the water. Since the process of precipitation is favoured by high pH of the aquatic phase the conditions favouring a high pH would be helpful for the healthy growth of this species of prawn in these water bodies.

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