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STUDIES ON THE IMPACT OF THE PARAVANAR RIVER POLLUTANTS ON GLUCOSE AND GLYCOGEN LEVEL OF FRESHWATER PRAWN, *MACROBRACHIUM MALCOLMSONII* (H. MILNE EDWARDS)

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ABSTRACT
In the present study, to find out the impact of Paravanar river pollutants on freshwater prawn, *Macrobrachium malcolmsonii* collected from three Stations viz., Station-I, Station-II and Station-III such as, Unpolluted (Station-I), Less polluted (Station-II) and More polluted (Station-III) regions. Biochemical changes such as glucose and glycogen contents were analyzed in various organs like, gills, testis, vasdeferens, hepatopancreas, and androgenic gland. A decline in glycogen content and an increase in glucose content in all the tissues of freshwater prawn, *Macrobrachium malcolmsonii* collected from three stations were secured. There was a significant difference ($p < 0.01$) in the quantitative biochemical parameters such as glucose and glycogen content. The results obtained are discussed in details.

INTRODUCTION

The river Paravanar contains effluents from different sources affect the aquatic system by depleting and enhancing different physico-chemical parameters thereby affecting the inhabitants. *Macrobrachium malcolmsonii* (Milne Edwards) is the most common freshwater prawn in India. This species is currently much demand in freshwater aquaculture practices. These prawns are widely distributed in tropical, subtropical and temperature zones and are gaining more and more importance as cultivable species.

Industrial effluents contain different toxic substances, affect the aquatic systems, deplete the oxygen content and cause mortality in animals by interfering with their respiratory metabolism (Davis, 1973; Haniffa and Porchelvi, 1985; Jeyachandren and Chockalingam, 1987). Industrial agricultural and domestic wastes pollute the water bodies with heavy metals which reach human tissues through food chain (Kureishy *et al.,* 1979; Saad *et al.,* 1981; Paul and Pillai, 1983 and Ajmal *et al.,* 1985). James *et al.,* (1992) have reported that the indiscriminate discharge of raw and partially treated industrial effluents into aquatic system leads to deterioration of the environment.

Various organic and inorganic wastes in industrial and domestic effluents are responsible for pollution. Non-degradable heavy metals are regarded as hazardous to aquatic ecosystems of their environmental persistence and their tendency for bioaccumulation (Das *et al.,* 2001). As heavy metals are immutable, their biomagnifications has been reported in aquatic ecosystems. Heavy metals may affect aquatic organisms if the organisms are sub-lethally exposed to them for a long time. It has been reported that heavy metals affect various biochemical parameters of the fish liver (Jana and Bandyopadhyaya, 1987; Lomte and Sontkke, 1992 and Tamilmalar, 2002). The pesticides are non-biodegradable and accumulate in the food chain. Mostly they are prone to affect the nervous system causing tumors in living organisms. They are not only neurotoxin but also affect other systems and have shown a high degree of impact on metabolism by altering the proteins, carbohydrate and lipids (Mckee and Knowles, 1986 and Nagabhushanam *et al.,* 1972). The trace metal concentration in queens land estuarine crabs, *Australoplax tridentate* and *Scylla serrata* has been observed (Mortimer, 2000).

A quantitative study on the occurrence of major biochemical constituents including protein, carbohydrate, lipid and cholesterol in the muscle of different growth stages of *Macrobrachium malcolmsonii* and *Penaeus monodon* (Jayanthi, 2000 and Janakiram *et al.,* 2003). Very little information as yet is available on the quantitative occurrence of major biochemical constituents in the shrimps and information available in this direction has been restricted to shrimps of wild origin (Shaikmahmud and Magar, 1957; 1961; Sriraman and Reddy, 1977; Achuthankutty and Parulekar, 1984; Ramraj and Kalaimani, 1993). Therefore, it has been programmed in the present investigation to find out the

quantitative changes in glycogen and glucose level of *Macrobrachium malcolmsonii* collected form three Stations viz., Station-I, Station-II, and Station-III inhabited in the river Paravanar.

MATERIALS AND METHODS

Description of study area

The Paravanar River originating from Virudhachalam Taluk in Cuddalore District. Gadilum River which originates from the foot of the hills of North eastern part of the Shervarayan hills and runs along for a distance of 250 km, joins with adjoining Paravanar estuarine otherwise called Uppanar estuary and finally discharging into the Bay of Bengal. The untreated drainage of municipal and domestic sewage from the cuddalore old and new towns and the wastes from the coconut husk retting grounds are discharged regularly. Agricultural wastes also enter into this area through small drainage channels from the nearby agricultural lands. In addition, effluents from SIPCOT (State Industrial Promotion Corporation of Tamilnadu) industrial complex are discharged into this river which is major pollutant agents of this river.

In this river, Station-I is the unpolluted region at the village Alappakkam. Station-II is the less polluted region at the village Poondiankuppam. This is less polluted when compared to Station-III, due to the absence of direct discharge of effluents. The Station-III is the more polluted region at the village Sonaganchavadi. Fig. 1 shows the three stations of the Paravanar River. The distance between Station-I to Station-II is 2 km and Station-II to Station-III is 4 km. The depth of the river is more than 5m.

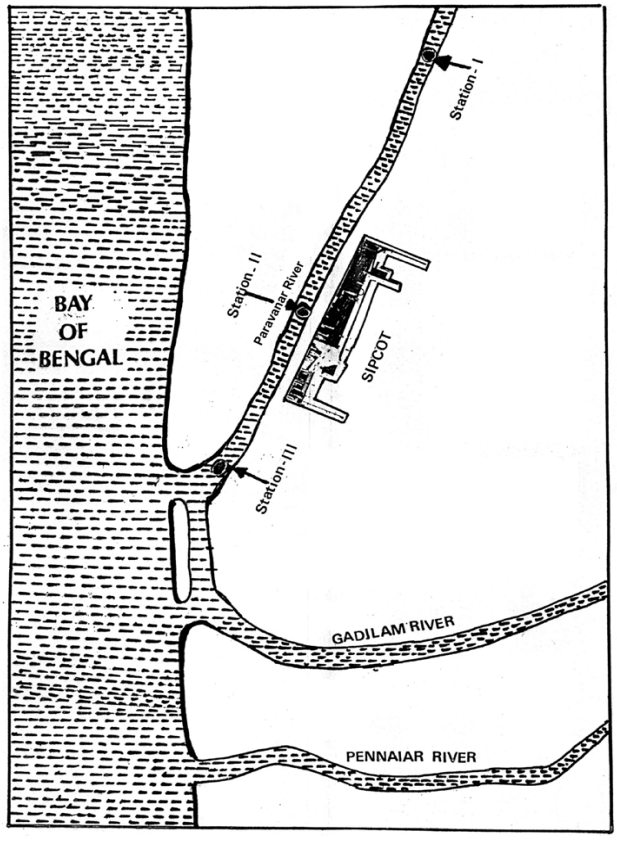

Figure 1: Map showing the study area of the Paravanar river

The domestic and sewage waste waters enter into the Station-II. In Station-III, these pollutants with addition industrial pollutants also enter into this region. In around the Station-III there are above 150 chemical industries are located and the effluents from these industries are discharged into this region. All the physic-chemical parameters of the three Stations, like, temperature, pH, dissolved oxygen, salinity, total dissolved solids, calcium, phosphorus, nitrite and ammonia all the parameters are significant differences between three Stations were found (Table 1)

The adult male freshwater prawn *Macrobrachium malcolmsonii* were collected from three Stations. And the control prawn were transferred to the water filled plastic pools in the laboratory provided with continuous aeration and transferred to the rectangular fiber glass tanks (100 × 175 cm) of 500 liters capacity in the laboratory containing chlorine free aerated well water. Continuous aeration was maintained using aerators to acclimatize the prawn for a maximum period of 10 days in the laboratory conditions at room temperature (28 ±1°C). The prawn was dissected in the field itself to collect the gills, testis, vasdeferens, hepatopancreas and androgenic gland for the biochemical studies like, glucose and glycogen.

Biochemical analysis

Colorimetric micro method by Kemp and Kits Van Heijninger (1954) was adopted for the quantitative estimation of glycogen and glucose.

Statistical analysis

The data collected were analyzed to determine the impact of Paravanar river pollutants on the quantitative distribution of major biochemical constituents such as glucose and glycogen in the freshwater prawn. ANOVA and Student's t-tests were employed to determine the significance of differences noted in the occurrence of biochemical constituents in the freshwater prawn, *Macrobrachium malcolmsonii*.

RESULTS AND DISCUSSION

The gills of control prawn glycogen content was 6.30 µg/mg and increased at Station-I of about 6.36 µg/mg and decreased at Station-II, III was found to be 5.54 µg/mg, 3.65 µg/mg. The glycogen content of testis in the control prawn was 7.41 µg/mg. increased at Station-I and II (8.17 µg/mg, 7.23 µg/mg) and decreased at Station-III of about 5.64 µg/mg and the glycogen content of vasdeferens in the control prawn was 6.49 µg/mg, increased at Station-I 7.42 µg/mg and decreased at Station-II and III (6.13 µg/mg 4.69 µg/mg) and the hepatopancreas of control prawn was 10.45 µg/mg and the values was increased at Station-I 10.66 µg/mg and decreased at Station-II, III was found to be 8.27 µg/mg, 5.63 µg/mg. And androgenic gland of control prawn was 15.53 µg/mg and increased glycogen content at Station-I inhabited prawn of about 16.57 µg/mg and decreased at Station-II, III was 14.40 µg/mg, 11.43 µg/mg respectively. The significant differences were found in gills, testis, vasdeferens, hepatopancreas and androgenic gland of the prawn collected from Station-I, II and III are presented in Table 2 and 3; Fig. 2.

Table1: Physico-chemical parameters of the Paravanar river at Station-I, Station-II and Station-III during January to December 2006

Parameters /Months	January			February			March			April			May			June		
Stations	S-I	S-II	S-III	S-I	S-II	S-III	S-I	S-II	S-III	S-I	S-II	S-III	S-I	S-II	S-III	S-I	S-II	S-III
Temperature ºC	32.2	35.9	35.9	33.0	36.8	36.0	33.6	35.6	35.6	35.2	37.9	37.2	35.0	38.1	38.2	35.3	39.0	38.1
pH	7.2	5.1	5.8	7.5	4.6	4.7	7.4	7.3	7.4	7.9	5.9	5.7	7.6	7.8	7.9	7.8	8.0	8.2
Dissolved oxygen mg/L	5.6	4.5	3.0	5.7	5.0	3.2	6.6	5.7	3.0	6.1	5.5	2.8	5.2	4.1	2.5	5.0	4.2	2.2
Salinity ppt	0.8	1.5	1.7	1.0	1.2	1.6	0.9	1.3	1.7	1.2	1.4	1.8	1.3	1.5	1.7	1.5	1.6	1.7
Alkalinity mg/L	180.2	190.7	230.6	176.3	188.5	232.4	168.2	180.2	332.7	185.7	197.3	361.2	180.5	195.6	312.8	196.3	232.4	431.5
Bio-chemical Oxygen Demand (BOD) mg/L	167.3	173.8	315.6	160.2	175.2	316.3	161.3	182.8	306.7	194.2	196.8	296.8	190.3	201.3	350.6	185.7	213.2	348.6
Chemical Oxygen Demand (COD) mg/L	115.2	263.8	445.7	119.8	248.3	427.6	112.8	196.8	453.8	130.6	182.5	475.6	142.7	206.8	430.2	156.3	212.9	416.3
Total dissolved solids mg/L	450	800	850	350	800	900	500	850	900	500	850	900	450	900	900	400	850	850
Calcium mg/L	41.1	95.0	95.4	42.2	96.4	97.4	40.3	97.2	98.2	41.4	96.8	96.8	42.4	96.3	96.4	43.5	97.4	98.2
Total phosphorus ppm	1.01	1.82	1.86	0.96	2.0	2.02	1.08	1.96	1.96	0.98	1.86	1.92	0.86	1.92	1.96	0.92	1.82	1.96
Nitrite ppm	0.96	2.12	2.16	0.82	2.01	2.12	0.91	1.98	2.01	0.63	1.62	1.86	0.72	1.72	1.96	0.80	1.86	1.98
Ammonia ppm	0.16	0.28	0.26	0.23	0.32	0.32	0.13	0.12	0.14	0.12	0.12	0.14	0.10	0.11	0.12	0.08	0.12	0.14
Stations	S-I	S-II	S-III	S-I	S-II	S-III												
Temperature ºC	33.5	35.9	37.6	34.2	37.8	39.3	S-I	S-II	S-III	S-I	S-II	S-III	S-I	S-II	S-III	S-I	S-II	S-III
pH	7.4	7.2	7.9	7.5	7.4	8.6	34.9	37.6	39.0	35.0	39.6	42.1	35.6	39.0	41.8	35.8	39.2	39.6
Dissolved oxygen mg/L	6.8	6.6	6.2	7.8	6.4	5.6	7.2	6.8	8.3	7.4	6.9	7.9	7.8	8.0	8.2	7.8	8.3	8.8
Salinity ppt	0.6	1.2	2.2	1.2	1.6	2.6	7.2	7.0	6.3	6.9	5.8	5.2	6.1	5.8	4.8	7.2	7.0	5.6
Alkalinity mg/L	265.7	285.6	475.3	270.2	290.4	490.7	1.0	1.8	1.9	0.8	1.9	2.0	1.2	2.0	2.8	1.2	1.8	2.6
Bio-chemical Oxygen Demand (BOD) mg/L	176.3	224.3	330.5	170.5	196.8	337.6	272.8	276.4	461.2	264.7	264.4	475.3	276.6	282.4	497.3	267.2	277.4	492.6
Chemical Oxygen Demand (COD) mg/L	143.8	210.2	450.4	156.4	217.9	463.2	163.7	186.2	350.8	162.2	225.2	363.3	158.8	220.3	374.8	173.2	216.4	360.7
Total dissolved solids mg/L	500	800	900	500	900	950	135.8	208.4	426.8	141.7	222.6	429.3	176.8	240.3	416.2	182.3	216.4	422.3
Calcium mg/L	47.3	78.2	96.3	51.6	82.4	98.4	500	850	950	450	850	900	500	950	950	500	950	950
Total phosphorus ppm	1.86	1.96	2.08	0.98	2.02	2.16	52.3	86.3	96.8	50.8	79.8	96.4	52.8	82.2	96.0	53.0	94.3	99.3
Nitrite ppm	1.02	2.21	2.96	1.96	2.86	3.16	1.02	2.36	1.98	0.96	2.82	2.86	1.32	2.07	2.03	1.08	1.96	2.62
Ammonia ppm	0.14	0.86	1.06	0.16	1.02	1.08	1.91	2.76	2.86	1.76	2.73	3.22	1.58	2.92	3.16	1.56	2.98	3.82

S-I = Station-I S-II = Station-II S-III = Station-III

The glucose level of the gills of control prawn 15.61 µg/mg, Station-I 16.34 µg/mg, While at station-II 17.79 µg/mg and station-III was 25.66 µg/mg. The glucose content of the testis, vasdeferens, hepatopancreas, androgenic gland and gills of the prawn collected from Station-I, II and III are presented in Table 4,5 and Fig.3. The glucose level of testis in the control prawn was 19.25 µg/mg and which decreased at Station-I as 18.19 µg/mg , slightly increased at Station-II 20.34 µg/mg and highly increased at Station-III 30.14 µg/mg and the glucose content of vasdeferens in the control prawn was 27.39 µg/mg decreased at station-I and II (26.40 µg/mg, 27.36 µg/mg) and increased at Station-III (32.60 µg/mg) and the glucose content in hepatopancreas of control prawn was 17.60 µg/mg and Station-I 17.59 µg/mg, Station-II 18.07 µg/mg, Station-III was 22.39 µg/mg. And the glucose level in androgenic gland of the control prawn was 37.38 µg/mg, Station-I 38.32 µg/mg, Station-II 40.38 µg/mg and Station-III was 50.46 µg/mg.

Biochemical studies are very important from the nutritional point of view. The biochemical constituents in animals are known to vary with season, size of the animal, stage of maturity, temperature and availability of food (Vernberg and Vernberg, 1974; Soundarapandian, 1996 and Murugesan *et al.,* 2008).

One of the most fundamental requirements of any organism is the energy which is needed for various metabolic activities (Boell, 1965). Glucose is as immediate source of energy and it can quickly be mobilized from glycogen stores, when sudden demands for energy are made (Lehninger, 1984). When there is a demand for energy, glucose is oxidized to carbon-di-oxide, water and energy in the form of ATP molecules. Achuthankutty and Parulekar (1984) have recorded low glycogen concentration in the muscle of penaeid prawns.

It may be concluded from the present investigation, that the increase in glucose levels in the

Table 2: ANOVA one way analysis of quantitative changes of glycogen the gills, testis, vasdeferens, hepatopancreas and androgenicgland of the control prawn and the prawn collected from Station-I, II and III

Tissues	Test prawns	Glycogen content (μg/mg) Mean ± S.D	ANOVA (one way) Source of variation	Degree of freedom	Sum of square	Mean square	F-value
Gills	C	6.30 ± 0.49	4	3	28.83	9.61	24.96
	S-I	6.36± 0.66					
	S-II	5.54 ± 0.43	6	20	7.69	0.385	
	S-III	3.65 ± 0.81	Total	23	36.53		
Testis	C	7.41 ± 0.73	4	3	20.28	6.76	16.568
	S-I	8.17 ± 0.58					
	S-II	7.23 ± 0.63	6	20	8.16	0.408	
	S-III	5.64 ± 0.58	Total	23	28.45		
Vasdeferens	C	6.49 ± 0.79	4	3	23.03	7.67	13.157
	S-I	7.42 ± 0.88					
	S-II	6.13 ± 0.82	6	20	11.67	0.584	
	S-III	4.69 ± 0.49	Total	23	34.71		
Hepatopa-	C	10.45 ± 0.75	4	3	145998.75	48666.24	1.029
ncreas	S-I	10.66 ± 0.58					
	S-II	8.27 ± 0.59	6	20	945835.09	47291.75	
	S-III	5.63 ±0.66	Total	23	1091833.8		
Androgenic	C	15.53± 0.77	4	3	88.86	29.62	55.145
gland	S-I	16.57 ±0.73					
	S-II	14.40 ± 0.73	6	20	10.74	0.537	
	S-III	11.43 ±0.69	Total	23	99.61		

*indicates that significant difference at 1% level; C = Control Prawn; S-II = Prawn collected from Station –II; S-I = Prawn collected from Station- I; S-III = Prawn collected from Station-III

Table 3: Quantitative changes of glycogen in the gills, testis, vasdeferens, hepatopancreas and androgenic gland of the control Prawn and the prawn collected from Station-I, II and III

Tissues	Glycogen content in test prawns (mg/mg) Mean ± S.D Control prawn	Station-I (Unpolluted)	Station-II (Lesspolluted)	Station-III (Morepolluted)	t- value t_1	t_2	t_3	t_4	t_5	t_6
Gills	6.30 ± 0.49	6.36 ± 0.66	5.54 ± 0.43	3.65 ± 0.81	0.178	2.855*	6.856*	2.549*	6.353*	5.048*
Testis	7.41 ± 0.73	8.17 0.58	7.23 ± 0.63	5.64 ± 0.58	1.996*	0.457	6.226*	2.688*	9.347*	6.264*
Vasdeferens	6.49 ± 0.79	7.42 0.88	6.13 ± 0.82	4.69 ± 0.49	1.926	0.774	4.742*	2.627*	6.639*	3.692*
Hepatopancreas	10.45 ± 0.75	10.66 0.58	8.27 ± 0.59	5.63 ± 0.66	0.542	5.595*	11.81*	7.075*	14.02*	7.304*
Androgenic gland	15.53 ± 0.77	16.57 0.73	14.40 ± 0.73	11.43 ± 0.69	2.400*	2.608*	9.713*	5.148*	12.53*	7.242*

*indicates that significant difference at 5% level; t_4 = t-value of Station-I and Station-II; t_1 = t-value of control prawn and Station-I; t_5 = t-value of Station-I and Station-III; t_2 = t-value of control prawn and Station-II; t_6 = t-value of Station-II and Station-III; t_3 = t-value of control prawn and Station-III

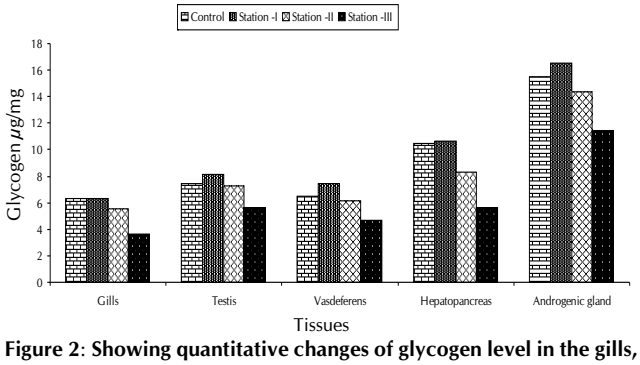

Figure 2: Showing quantitative changes of glycogen level in the gills, testis, vasdeferens, hepatopancreas and androgenic gland of control and the prawns collected from station-I, II, and III

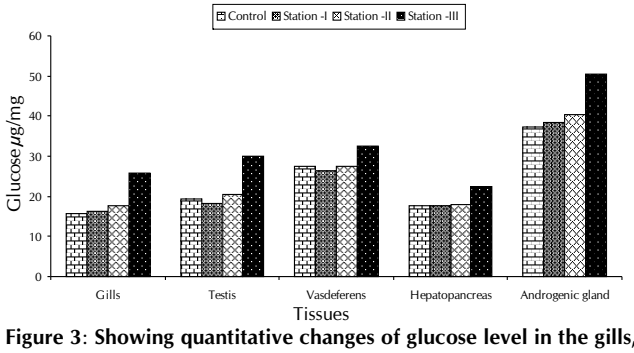

Figure 3: Showing quantitative changes of glucose level in the gills, testis, vasdeferens, hepatopancreas and androgenic gland of control and the prawns collected from station-I, II, and III

tissues of the freshwater prawn collected at Station-III and Station-II than at Station-I and control prawn, and the decreased level of glycogen level at Station-III and Station-II than at Station-I and control prawn suggested that this changes may be due to conversion of glycogen into glucose in all the tissues when animal under stressful conditions at less and more polluted regions of Paravanar river.

These may be attributed due to the occurrence of more pollutants in the river Paravanar. It is further inferred from the present study that the industrial from in and around the aquatic environment could be compulsorily treated and then only it may be let into the nearby aquatic environment, otherwise the pollutants of the river may be caused several impacts on aquatic organism and ultimately enter into the human tissues probably

Table 4: ANOVA one way analysis of quantitative changes of glucose in the gills, testis, vasdeferens, hepatopancreas and androgenic gland of the control prawn and the prawn collected from Station-I, II and III

Tissues	Test prawns	Glucose content (μg/mg) Mean ± S.D	ANOVA (one way) Source of variation	Degree of freedom	Sum of square	Mean square	F-value
Gills	C	15.61 ± 0.60	4	3	385.33	128.44	160.129*
	S-I	16.34 ± 0.80					
	S-II	17.79 ± 1.03	6	20	16.04	0.802	
	S-III	25.66 ± 1.04	Total	23	401.37		
Testis	C	19.25 ± 0.57	4	3	546.69	182.23	
	S-I	18.19 ± 0.57					430.525*
	S-II	20.34 ± 0.75	6	20	8.46	0.423	
	S-III	30.14 ± 0.68	Total	23	555.16		
Vasdeferens	C	27.39 ± 0.66	4	3	142.2	47.40	79.909*
	S-I	26.40 ± 0.72					
	S-II	27.36 ± 0.78	6	20	11.864	0.593	
	S-III	32.60 ± 0.88	Total	23	154.06		
Hepatopa-	C	17.60 ± 0.51	4	3	99.24	33.08	62.541*
ncreas	S-I	17.59 ± 0.73					
	S-II	18.07 ± 0.82	6	20	10.57	0.529	
	S-III	22.39 ± 0.77	Total	23	109.82		
Androgenic	C	37.38 ± 0.78	4	3	651.04	217.01	321.111*
gland	S-I	38.32 ± 0.78					
	S-II	40.38 ± 0.79	6	20	13.51	0.676	
	S-III	50.46 ± 0.92	Total	23	664.56		

*indicates that significant difference at 1% level; C = Control Prawn; S-II = Prawn collected from Station –II; S-I = Prawn collected from Station- I; S-III = Prawn collected from Station-III

Table 5: Quantitative changes of glucose in the gills, testis, vasdeferens, hepatopancreas and androgenic gland of the control prawn and the prawn collected from Station-I, II and III

Tissues	Glucose content in test prawns (mg/mg) Mean ± S.D Control prawn	Station-I (Unpolluted)	Station-II (Lesspolluted)	Station-III (Morepolluted)	t- value t_1	t_2	t_3	t_4	t_5	t_6
Gills	15.61 ± 0.60	16.34 ± 0.80	17.79 ± 1.03	25.66 ± 1.04	1.788	4.479*	20.50*	2.723*	17.39*	13.17*
Testis	19.25 ± 0.57	18.19 ± 0.57	20.34 ± 0.75	30.14 ± 0.68	3.221*	2.834*	30.03*	5.590*	32.98*	23.71*
Vasdeferens	27.39 ± 0.66	26.40 ± 0.72	27.36 ± 0.78	32.60 ± 0.88	2.482*	0.071	11.60*	2.215*	13.35*	10.91*
Hepatopancreas	17.60 ± 0.51	17.59 ± 0.73	18.07 ± 0.82	22.39 ± 0.77	0.027	1.192	12.70*	1.070	11.08*	9.407*
Androgenic gland	37.38 ± 0.78	38.32 ± 0.78	40.38 ± 0.79	50.46 ± 0.92	2.087*	6.619*	26.56*	4.545*	24.65*	20.36*

*indicates that significant difference at 5% level; t_4 = t-value of Station-I and Station-II; t_1 = t-value of control prawn and Station-I; t_5 = t-value of Station-I and Station-III; t_2 = t-value of control prawn and Station-II; t_6 = t-value of Station-II and Station-III; t_3 = t-value of control prawn and Station-III

affect the health of human beings. So that, steps could be taken by the government and public not to allow the pollutants into any aquatic environment and these may be led to deterioration of the aquatic environment.

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