RESULTS

RESULTS

Physico - Chemical Parameters:

During the present investigation, the variations in physico-chemical parameters like temperature, pH, free carbon dioxide, dissolved oxygen, salinity, phosphate and nitrates from the three different stations, such as Kotawali, Songaon, Dhamandevi from Dabhol Creek were studied in order to assess the impact of industrial effluents from Lote Maharashtra Industrial Development Corporation (M.I.D.C.) during the period from December, 2007 to November, 2008 and are presented in Tables 1 to 7.

Temperature:

The temperature of water samples showed variations in the range of 26 ^{0}C to 30 ^{0}C from these stations during study period. The range of water temperature for Kotawali (Station A) was 26 ^{0}C to 30 ^{0}C and average temperature was 27.6 ^{0}C. Temperature of water at Songaon (Station B) was 26 ^{0}C to 29 ^{0}C and average temperature was 27.2 ^{0}C. The range of water temperature at Dhamandevi (Station C) was 26 ^{0}C to 28.5 ^{0}C and average temperature was 26.7 ^{0}C. The seasonal variations in temperature were recorded as low in winter at Songaon (Station B) (26 ^{0}C) and high in summer at Kotawali (Station A) (30 ^{0}C). (Table -1; Fig. - 1).

pH:

The pH values indicate acidic nature of water and ranged from 5.15 to 7.90. The range of pH at Kotawali (Station A) was 5.15 to 7.90 and average pH was 6.64. The range of pH at Songaon (Station B) was 5.64 to 7.55 and average pH was 6.66. The range of pH at Dhamandevi (Station C) was 6.40 to 7.33 and average pH was 6.99. Maximum pH (7.90) was recorded in the month of November, 2008 at Station A and Station B and minimum (5.15) in the month of April, 2008 at Station A. (Table - 2; Fig. - 2).

Free carbon dioxide:

The free carbon dioxide showed fluctuations ranging from 3.00 to 76.15 mg / l. at all the stations. At Kotawali (Station A) it ranged from 12.30 to 76.15 mg / l, at Songaon (Station B) 9.80 to 54.00 mg / l and at Dhamandevi (Station C)3.00 to16.10 mg/ l. (Table -3)

The minimum concentration of free carbon dioxide (3.00 mg / l) was recorded at Dhamandevi (Station C) in the month of March 2008 and maximum (76.15 mg / l) at Kotawali (Station A) in the month of July 2008. The free carbon dioxide values were extremely high at Station A (76.15 mg / l) and Station B (54.00 mg / l). (Fig. - 3).

Dissolved Oxygen:

The dissolved oxygen content at Kotawali (Station A) were ranged between 4.48 to 10.23 mg / l, at Songaon (Station B) it ranged from 5.84 to 9.42 mg / l, and at Dhamandevi (Station C) from 6.70 to 10.72 mg / l.

The dissolved oxygen was recorded at minimum levels in the month of February 2008 at all three stations. (Table - 4; Fig. - 4).

Salinity:

Fluctuations in salinity ranged from 0.04 to 6.00 ‰ at all the three stations. At Kotawali (Station A) fluctuation range was between 0.15 to 6.00 ‰, at Songaon (Station B) between 0.07 and 0.45 ‰, and at Dhamandevi (Station C) it was 0.04 and 0.11 ‰. (Table – 5).

The maximum concentration of salinity (6.00 ‰) was noted in the month of May at Kotawali (Station A). At Damandevi (Station C), it was minimum (0.04‰) in the month of December 2007 and November2008. At station Kotawali (Station A) there was increasing trend of salinity (1.10 to 6.00 ‰) from December, 2007 to May, 2008, but drastic decline was observed from May 2008 to June 2008 i.e. from 6.00 ‰ to 0.32 ‰ and then the decline was slow upto November, 2008 i.e. from 0.32 ‰ to 0.15 ‰. The salinity was very low through out the study period at Songaon (Station B) and Dhamandevi (Station C). (Fig. - 5).

Phosphate - P:

Inorganic phosphate in water samples collected from all the stations ranged from 2.21 to12.50 mg / l. At Kotawali (Station A) it was from 2.21 to 12.50 mg / l. It ranged from 2.25 to 9.00 mg / l at Songaon (Station B) and form 2.25 to 5.00 mg / l at Dhamandevi (Station C). (Table – 6)

The phosphate content was maximum (12.50 mg / l) in the month of December, 2007 and September, 2008 at Kotawali (Station A) and Songaon (Station B) (9.00 mg / l)

Table No: 1

Monthly variation in Temperature (^{o}C) of three different stations (A, B and C) from Dabhol creek.

Month / Spot	A	B	C
Dec-07	26.5	26.0	26.5
Jan-08	27.0	26.5	26.0
Feb-08	29.0	27.5	27.0
Mar-08	29.5	28.0	27.0
Apr-08	29.5	28.5	28.0
May-08	30.0	29.0	28.5
Jun-08	27.0	27.0	26.5
July-08	26.5	27.5	26.5
Aug-08	26.5	27.0	26.0
Sep-08	26.0	27.0	27.0
Oct-08	26.5	27.5	26.0
Nov-08	27.5	26.0	26.5
Average	**27.6**	**27.2**	**26.7**

A = Kotawali

B = Songaon

C = Dhamandevi

Table No: 2

Monthly variation in pH of three different stations (A, B and C) from Dabhol creek

Month / Spot	A	B	C
Dec-07	6.35	6.37	6.80
Jan-08	6.68	7.41	7.17
Feb-08	6.70	7.05	7.13
Mar-08	5.83	5.64	6.50
Apr-08	5.15	6.21	7.10
May-08	5.64	5.26	6.60
Jun-08	6.75	6.30	7.20
Jul-08	7.20	7.43	7.13
Aug-08	6.81	6.51	6.40
Sep-08	6.92	6.83	7.20
Oct-08	7.71	7.41	7.33
Nov-08	7.90	7.55	7.27
Average	**6.64**	**6.66**	**6.99**

A = Kotawali

B = Songaon

C = Dhamandevi

Figure No: 1

Monthly variation in Temperature of three different stations (A, B and C) from Dabhol creek.

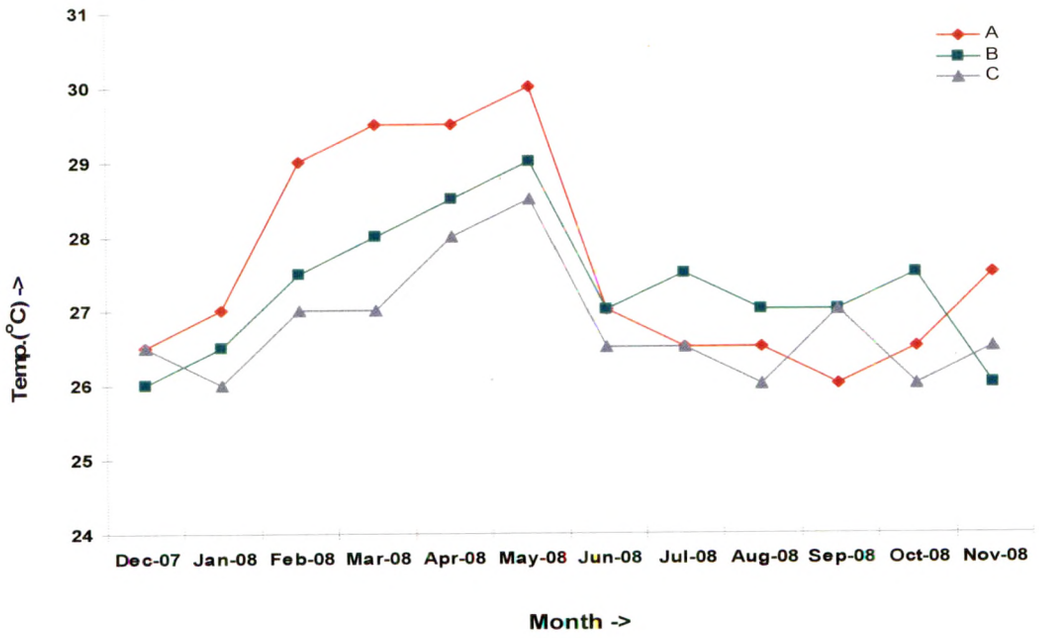


Figure No: 2

Monthly variation in pH of three different stations (A, B and C) from Dabhol creek.

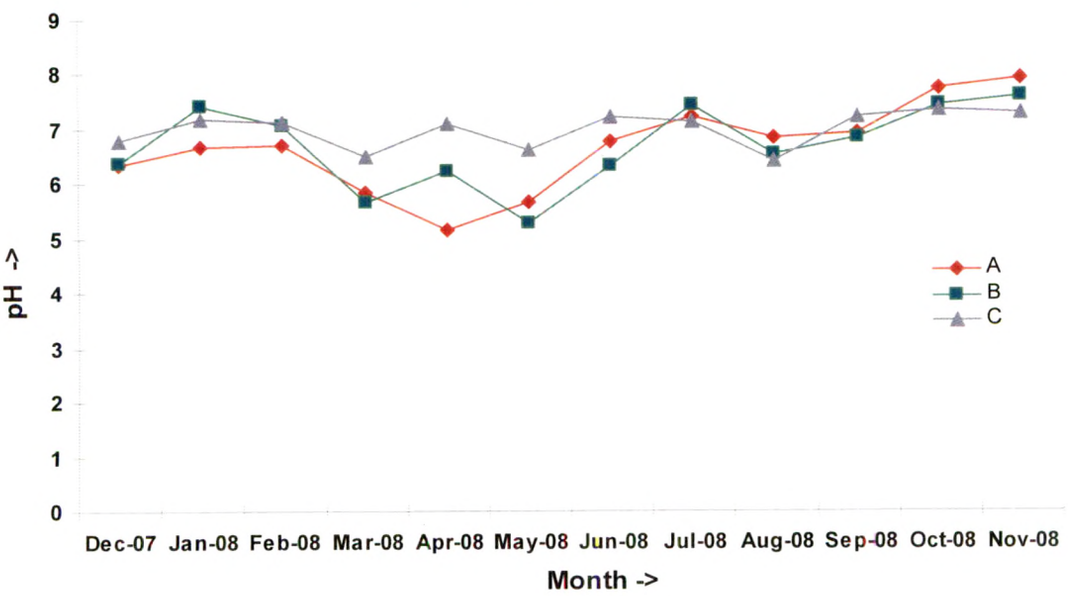


Table No: 3

Monthly variation in Free Carbon dioxide (mg/lit) of three different stations (A, B and C) from Dabhol creek.

Month / Spot	A	B	C
Dec-07	73.12	24.12	16.10
Jan-08	12.30	54.00	10.20
Feb-08	20.80	13.10	4.40
Mar-08	18.60	19.20	3.00
Apr-08	15.54	13.00	3.50
May-08	16.40	15.60	4.50
Jun-08	21.70	9.80	6.70
Jul-08	76.15	34.30	7.50
Aug-08	41.81	21.24	14.71
Sep-08	49.56	25.40	12.19
Oct-08	30.30	24.15	14.18
Nov-08	34.50	21.18	15.40
Average	**34.23**	**22.92**	**9.37**

A = Kotawali

B = Songaon

C = Dhamandevi

Table No: 4

Monthly variation in Dissolved Oxygen (mg/lit) of three different stations (A, B and C) from Dabhol creek.

Month / Spot	A	B	C
Dec-07	5.80	9.33	9.50
Jan-08	6.00	8.10	10.20
Feb-08	4.48	5.84	6.70
Mar-08	5.76	7.36	8.00
Apr-08	7.27	8.17	8.33
May-08	6.72	7.75	8.17
Jun-08	10.23	9.09	10.39
Jul-08	9.30	7.20	9.95
Aug-08	10.02	9.42	10.72
Sep-08	6.40	7.11	6.83
Oct-08	8.00	8.84	10.12
Nov-08	6.14	7.84	7.90
Average	**7.18**	**8.00**	**8.90**

A = Kotawali

B = Songaon

C = Dhamandevi

Figure No: 3

Monthly variation in Free Carbon dioxide of three different stations (A, B and C) from Dabhol creek.

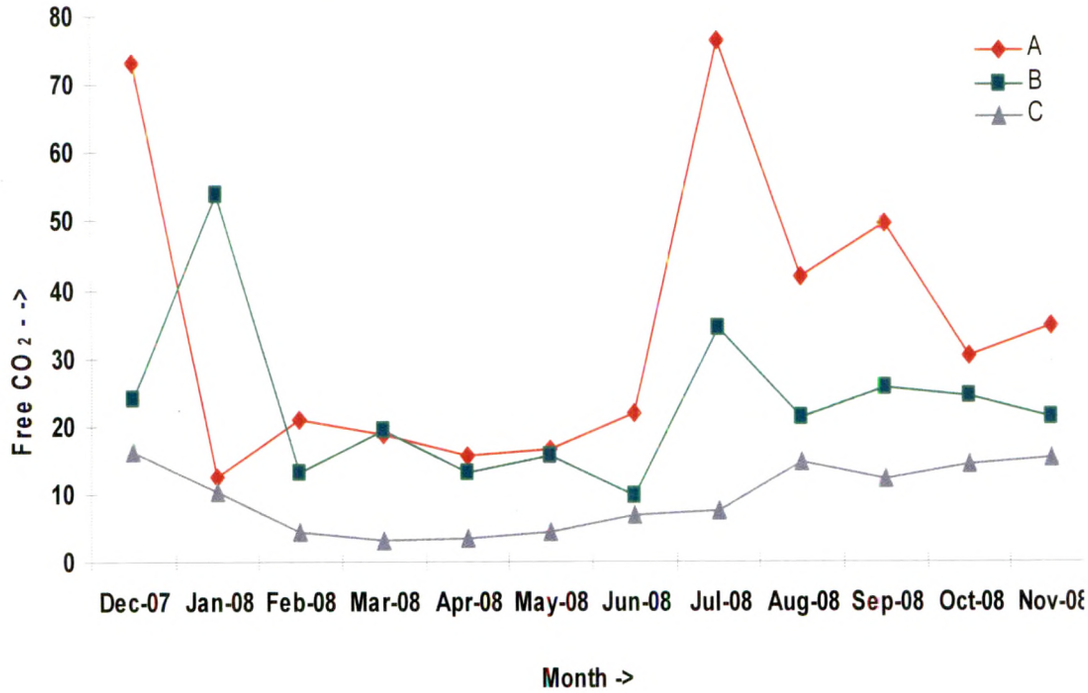


Figure No: 4

Monthly variation in Dissolved Oxygen of three different stations (A, B and C) from Dabhol creek.

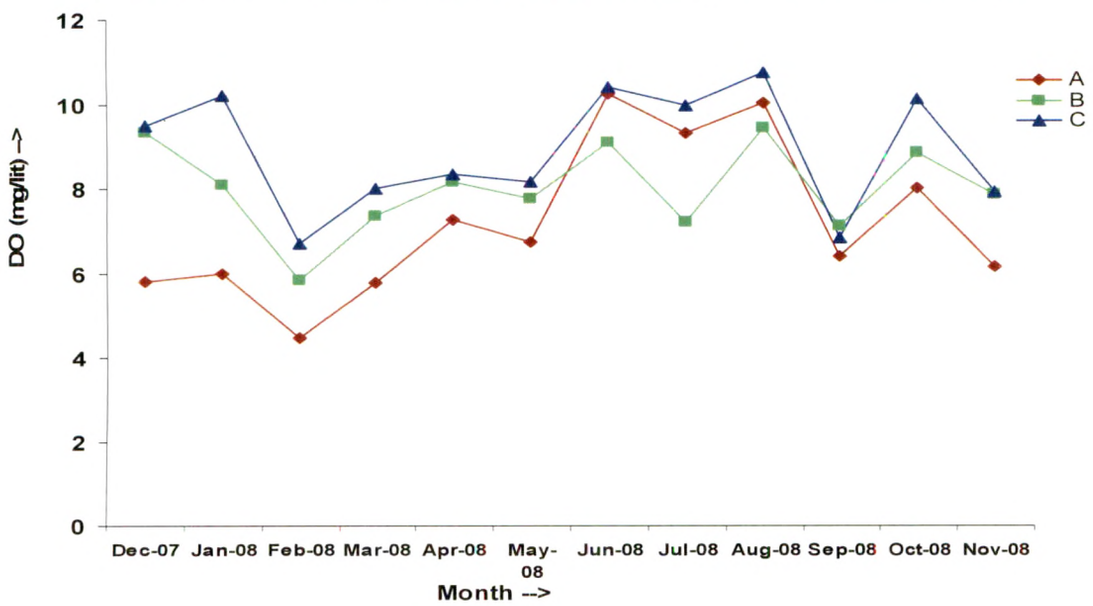


Table No. : 5

Monthly variation in ‰ Salinity of three different stations (A, B and C) from Dabhol creek.

Month / Spot	A	B	C
Dec-07	1.10	0.27	0.04
Jan-08	1.44	0.36	0.05
Feb-08	2.65	0.45	0.07
Mar-08	4.50	0.42	0.11
Apr-08	5.00	0.15	0.10
May-08	6.00	0.17	0.11
Jun-08	0.32	0.10	0.09
Jul-08	0.30	0.10	0.08
Aug-08	0.26	0.09	0.07
Sep-08	0.17	0.09	0.07
Oct-08	0.18	0.08	0.05
Nov-08	0.15	0.07	0.04
Average	**1.84**	**0.20**	**0.07**

A = Kotawali

B = Songaon

C = Dhamandevi

Figure No: 5

Monthly variation in Salinity of three different stations (A, B and C) from Dabhol creek.

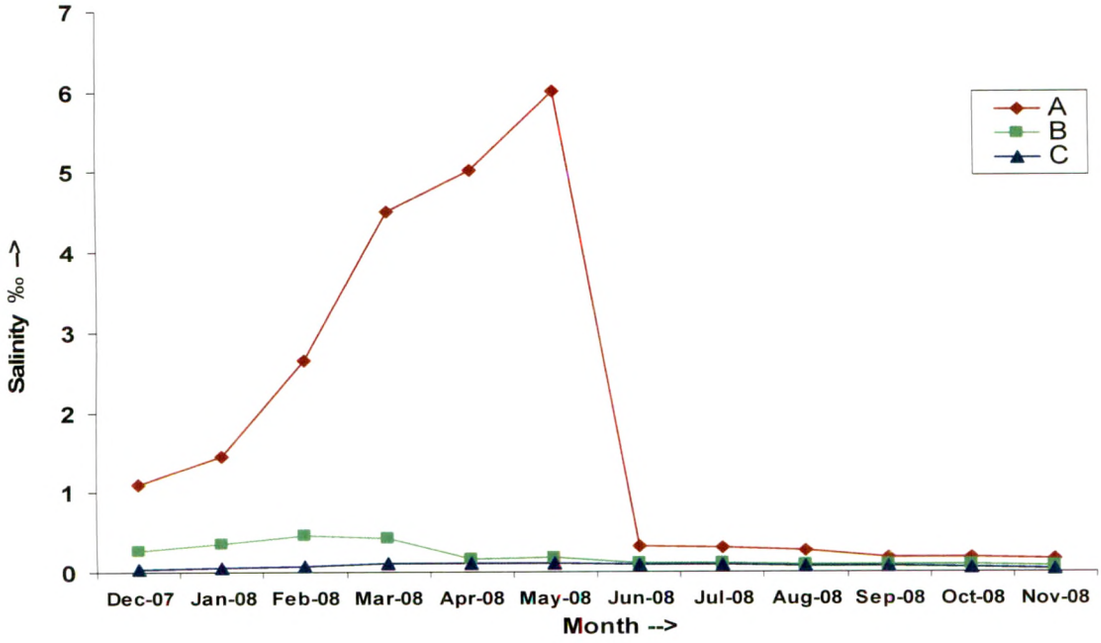


Table No: 6

Monthly variation in Phosphate content (mg/lit) of three different stations (A, B and C) from Dabhol creek.

Month / Spot	A	B	C
Dec-07	12.50	4.50	2.25
Jan-08	8.25	2.25	3.50
Feb-08	4.50	3.50	4.50
Mar-08	2.21	5.00	5.00
Apr-08	2.50	3.00	2.50
May-08	2.75	3.00	2.50
Jun-08	7.50	2.50	3.00
Jul-08	8.25	2.75	3.50
Aug-08	8.75	2.50	2.75
Sep-08	12.50	9.00	4.50
Oct-08	10.50	3.50	2.25
Nov-08	9.50	2.50	3.50
Average	**7.47**	**3.67**	**3.31**

A = Kotawali

B = Songaon

C = Dhamandevi

Table No. : 7

Monthly variation in Nitrate content (mg/lit) of three different stations (A, B and C) from Dabhol creek.

Month / Spot	A	B	C
Dec-07	3.27	1.30	1.24
Jan-08	5.40	1.65	1.58
Feb-08	7.75	8.75	2.00
Mar-08	3.27	48.75	1.50
Apr-08	4.55	1.48	1.56
May-08	5.00	2.00	1.72
Jun-08	47.50	17.50	2.00
Jul-08	32.50	20.00	15.00
Aug-08	45.00	22.50	17.50
Sep-08	12.50	15.00	12.50
Oct-08	39.45	21.66	15.80
Nov-08	47.08	32.10	14.15
Average	**21.11**	**16.05**	**7.21**

A = Kotawali

B = Songaon

C = Dhamandevi

BDL – Below Detectable Level

Figure No: 6

Monthly variation in Phosphate content of three different Stations (A, B and C) from Dabhol creek.

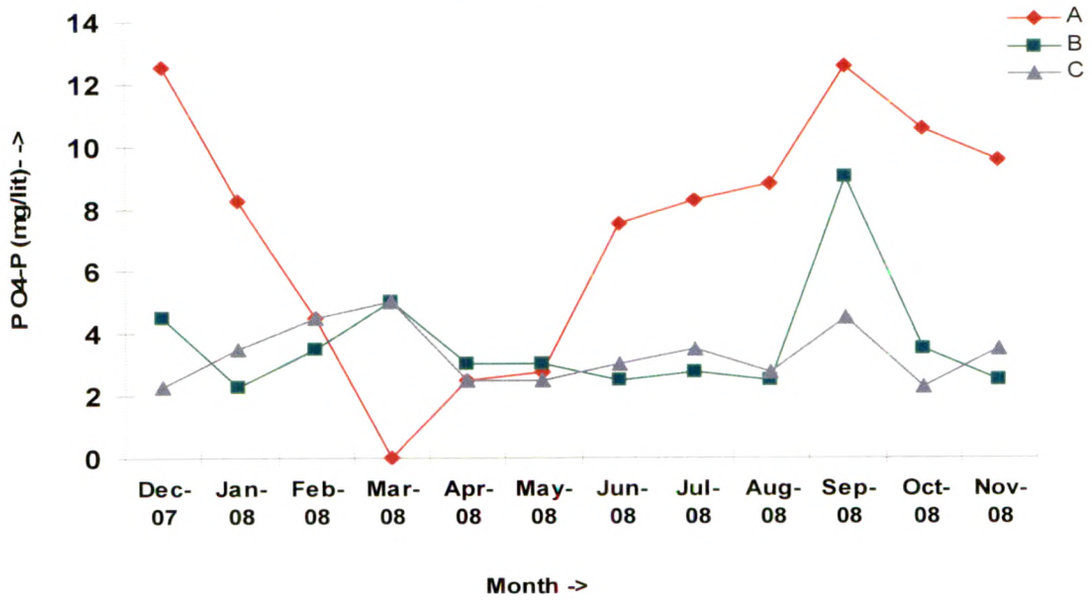
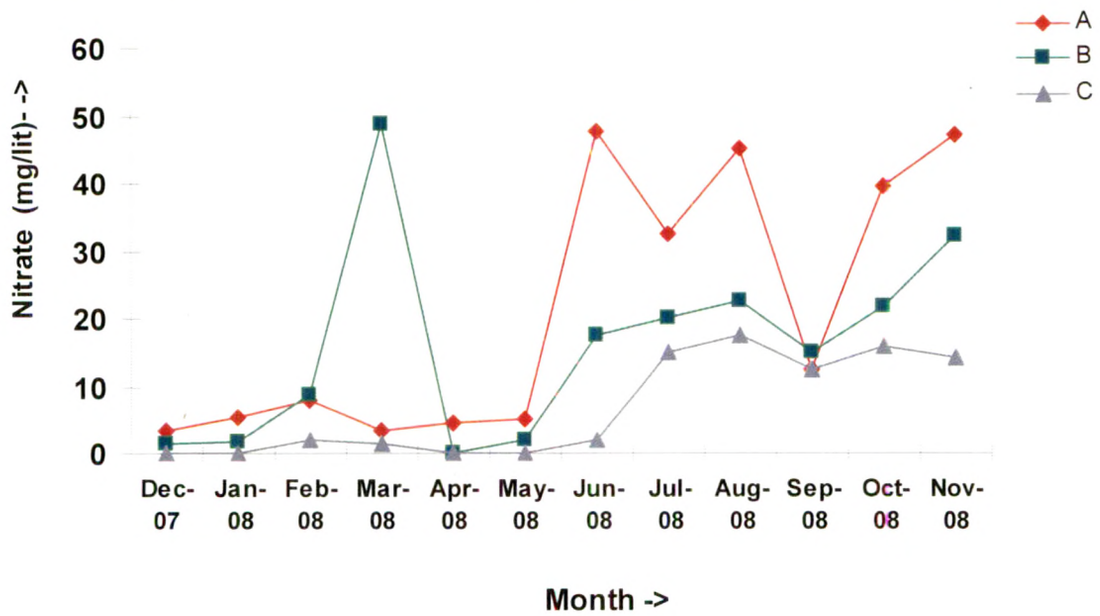


Figure No: 7

Monthly variation in Nitrate content of three different stations (A, B and C) from Dabhol creek.



in the month of September, 2008 and minimum of 2.21 mg / l in the month of March, 2008 at Kotawali (Station A). (Fig. - 6).

Nitrate - N:

Inorganic Nitrate content of three stations was observed from 1.24 to 48.75 mg / l. It ranged from 3.27 to 47.50 mg / l at Kotawali (Station A), from 1.48 to 48.75 mg / l at Songaon (Station B) and from 1.24 to 17.50 mg / l at Dhamandevi (Station C). (Table – 7).

Maximum (48.75 mg / l) concentration of nitrate was observed in the month of March, 2008 at Songaon (Station B), while minimum of 1.24 mg / l was recorded in the month of December, 2007, at Dhamandevi (Station C). (Fig. - 7).

Detection of metals in water and sediment samples:

a) Metal contents in water:

Water samples of Dabhol creek from three sampling stations were analyzed for quantitative estimation of heavy metals concentration during the period December, 2007 to November, 2008. The results are presented in Table No.'s - 8 to 10; Fig. No.'s - 8 to 14.

Concentration of heavy metals viz. Cu, Fe, Zn, Cd, Ni, Co and Mn in water samples from three different stations showed that Zn, Ni and Co were absent at the Dhamandevi (Station C) during study period.

Maximum concentration of Cu at Kotawali (Station A); Songaon (Station B) and Dhamandevi (Station C) were 0.046 ppm, 0.013 and 0.004 ppm during July, 2008; Dec, 2007 and May, 2008 and July, 2008 respectively. During March and April, 2008 Cu content at all the stations were below detectable level. (Table No.'s – 8; 9; 10). (Fig. - 8).

Iron content of water sample was maximum (0.83 ppm) at Kotawali (Station A) in the month of July, 2008 and minimum (BDL) in the month of May, 2008. Fe content of water samples at Songaon (Station B) was high (0.60 ppm) in the month of March, 2008 and low (0.008 ppm) in the month of August, 2008. The maximum (1.95 ppm) concentration of Fe was recorded at Dhamandevi (Station C) in the month of June, 2008, where as it was low (0.002 ppm) in the month of August, 2008. (Table No.'s – 8; 9; 10). (Fig. - 9).

Zinc content of water sample was maximum (0.37 ppm) at Kotawali (Station A) in July, 2008, while at Songaon (Station B) it was (0.33 ppm) in April, 2008. It was below detectable level at Kotawali (Station A) in March and April, 2008. At Songaon (Station B) it was below detectable level (BDL) in the months of March, 2008; May, 2008 and July, 2008. The Zn was below detectable level in the water samples at Dhamandevi (Station C) during study period. (Table – 8; 9; 10). (Fig.-10).

Cadmium (Cd) content of water samples from Kotawali (Station A) were below detectable level, during entire study period except May, 2008 (0.007 ppm). At Songaon (Station B); Cd content was detected during December, 2007 and May, July, August, October and November, 2008 with concentrations of 0.001, 0.005, 0.003, 0.002, 0.006 and 0.008 ppm, respectively. At Dhamandevi (Station C) concentrations of Cd during June and July, 2008 were 0.003 and 0.001 ppm respectively, while it was below detectable level during rest of the study period. (Table – 8; 9; 10). (Fig.-11).

Concentration of Nickel (Ni) was maximum (0.40 ppm) in the water samples at Kotawali (Station A) in the month of March, 2008. In the month of April, 2008 it was 0.017 ppm at Kotawali (Station A). At Songaon (Station B) and Dhamandevi (Station C) Ni was below detectable level in the water samples collected during the study period. (Table No.'s – 8; 9; 10). (Fig.-12).

Concentration of Co in the water samples was maximum (0.14 ppm) at Kotawali (Station A) in the month of April, 2008. At Songaon (Station B), the maximum concentration (0.007 ppm) was detected in the month of August, 2008. At Dhamandevi (Station C) it was below detectable level in the water samples collected during the study period. (Table No.'s – 8; 9; 10). (Fig.-13).

Concentration of Mn was maximum (40.00 ppm) in the water samples from Kotawali (Station A) in the month of May, 2008 and minimum (7.34 ppm) in the month of September, 2008. At Songaon (Station B) the maximum concentration (0.032 ppm) was detected in the month of September, 2008.At Dhamandevi (Station C) it was detected only in the months of March, 2008 (0.008 ppm) and April, 2008 (0.006 ppm) during the study period. (Table No.'s – 8; 9; 10). (Fig.-14).

Table No. : 8

Monthly variation in Heavy metals (ppm) content of Station A (Kotawali) in water from Dabhol creek.

Month/Metal	Cu	Fe	Zn	Cd	Ni	Co	Mn
Dec-07	0.06	0.39	0.08	BDL	BDL	BDL	12.36
Jan-08	0.043	0.28	0.054	BDL	BDL	BDL	32.73
Feb-08	0.032	0.12	0.36	BDL	BDL	BDL	34.95
Mar-08	BDL	0.016	BDL	BDL	0.40	0.015	36.35
Apr-08	BDL	0.014	BDL	BDL	0.017	0.14	38.45
May-08	0.028	BDL	0.034	0.007	BDL	0.001	40.00
Jun-08	0.011	0.32	0.056	BDL	BDL	BDL	12.48
Jul-08	0.046	0.83	0.37	BDL	BDL	BDL	10.90
Aug-08	0.009	0.021	0.042	BDL	BDL	BDL	9.87
Sep-08	0.012	0.18	0.02	BDL	BDL	BDL	7.34
Oct-08	0.034	0.086	0.003	BDL	BDL	BDL	9.39
Nov-08	0.04	0.12	0.045	BDL	BDL	BDL	11.42
Average	**0.032**	**0.216**	**0.106**	**0.007**	**0.209**	**0.052**	**21.353**

BDL – Below Detectable Level

Table No. : 9

Monthly variation in Heavy metals (ppm) content of Station B (Songaon) in water from Dabhol Creek.

Month/Metal	Cu	Fe	Zn	Cd	Ni	Co	Mn
Dec-07	0.013	0.210	0.045	0.001	BDL	BDL	BDL
Jan-08	0.009	0.014	0.021	BDL	BDL	BDL	0.006
Feb-08	0.003	0.090	0.015	BDL	BDL	BDL	0.010
Mar-08	BDL	0.600	BDL	BDL	BDL	BDL	BDL
Apr-08	BDL	0.300	0.330	BDL	BDL	BDL	BDL
May-08	0.013	0.450	BDL	0.005	BDL	BDL	BDL
Jun-08	0.002	0.413	0.035	BDL	BDL	BDL	0.006
Jul-08	0.006	0.510	BDL	0.003	BDL	0.001	0.013
Aug-08	0.004	0.008	0.040	0.002	BDL	0.007	0.020
Sep-08	0.007	0.015	0.017	BDL	BDL	0.001	0.032
Oct-08	0.012	0.010	0.040	0.060	BDL	0.001	0.028
Nov-08	0.010	0.012	0.045	0.080	BDL	0.003	0.012
Average	**0.008**	**0.219**	**0.065**	**0.025**	**BDL**	**0.003**	**0.016**

BDL – Below Detectable Level

Table No. : 10

Monthly variation in Heavy metals (ppm) content of Station C (Dhamandevi) in water from Dabhol Creek.

Month/Metal	Cu	Fe	Zn	Cd	Ni	Co	Mn
Dec-07	0.002	0.014	BDL	BDL	BDL	BDL	BDL
Jan-08	0.000	0.009	BDL	BDL	BDL	BDL	BDL
Feb-08	0.001	0.004	BDL	BDL	BDL	BDL	BDL
Mar-08	0.000	0.008	BDL	BDL	BDL	BDL	0.008
Apr-08	0.000	0.010	BDL	BDL	BDL	BDL	0.006
May-08	0.001	1.140	BDL	BDL	BDL	BDL	BDL
Jun-08	0.002	1.950	BDL	0.003	BDL	BDL	BDL
Jul-08	0.004	0.660	BDL	0.001	BDL	BDL	BDL
Aug-08	BDL	0.002	BDL	BDL	BDL	BDL	BDL
Sep-08	0.003	0.017	BDL	BDL	BDL	BDL	BDL
Oct-08	0.001	0.012	BDL	BDL	BDL	BDL	BDL
Nov-08	0.002	0.009	BDL	BDL	BDL	BDL	BDL
Average	**0.001**	**0.320**	**BDL**	**0.002**	**BDL**	**BDL**	**0.007**

BDL – Below Detectable Level

Figure No: 8

Monthly variation in Cu content of Station (A, B and C) in Water from Dabhol creek.

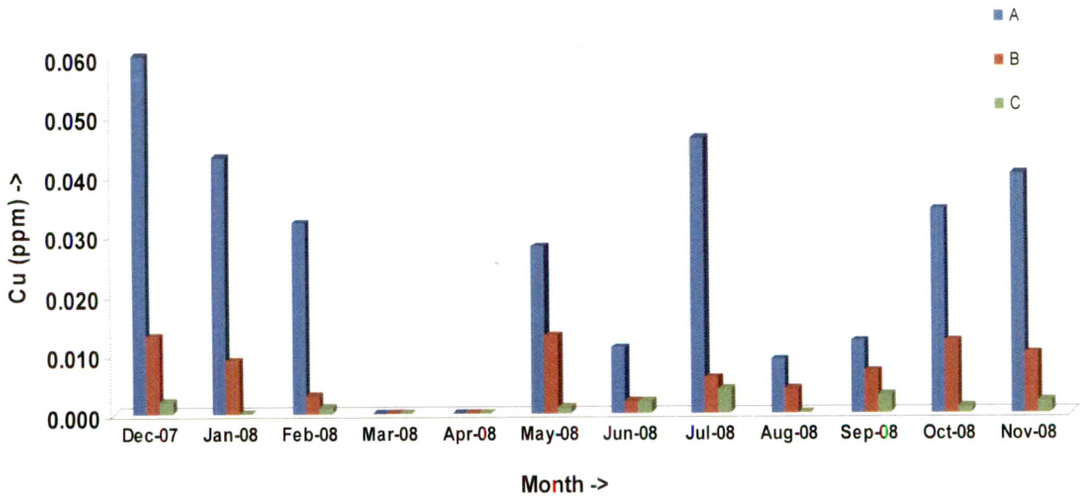


Figure No: 9

Monthly variation in Fe content of Station (A, B and C) in Water from Dabhol creek.

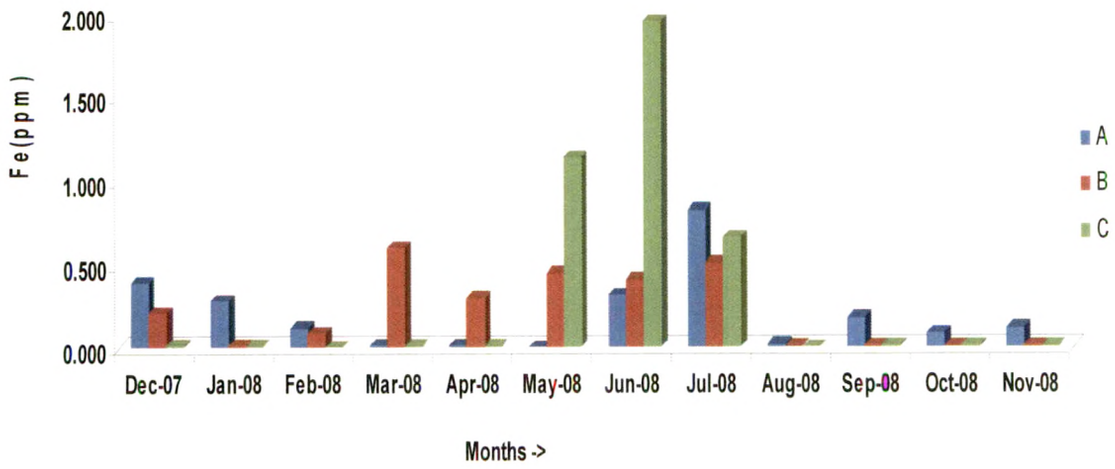


Figure No: 10

Monthly variation in Zn content of Station (A, B and C) in Water from Dabhol creek

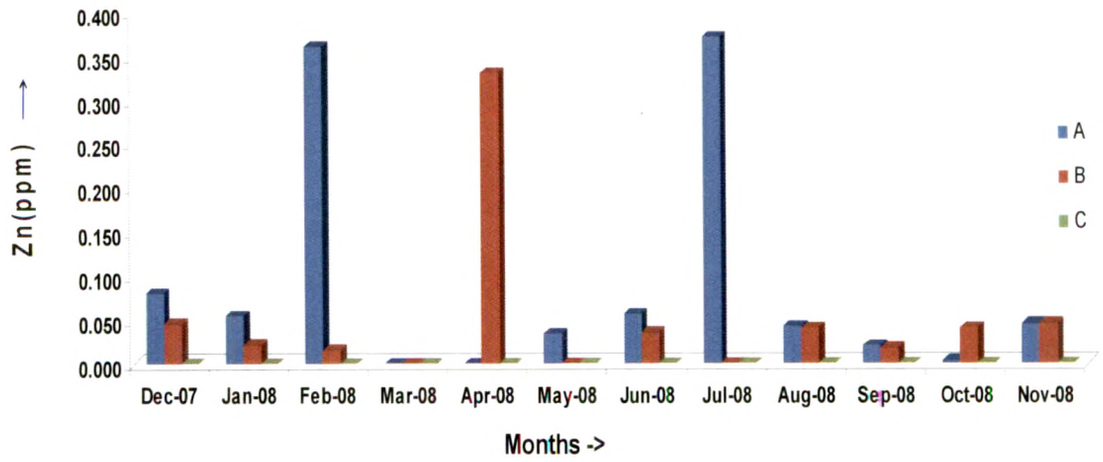


Figure No: 11

Monthly variation in Cd content of Station (A, B and C) in Water from Dabhol creek.

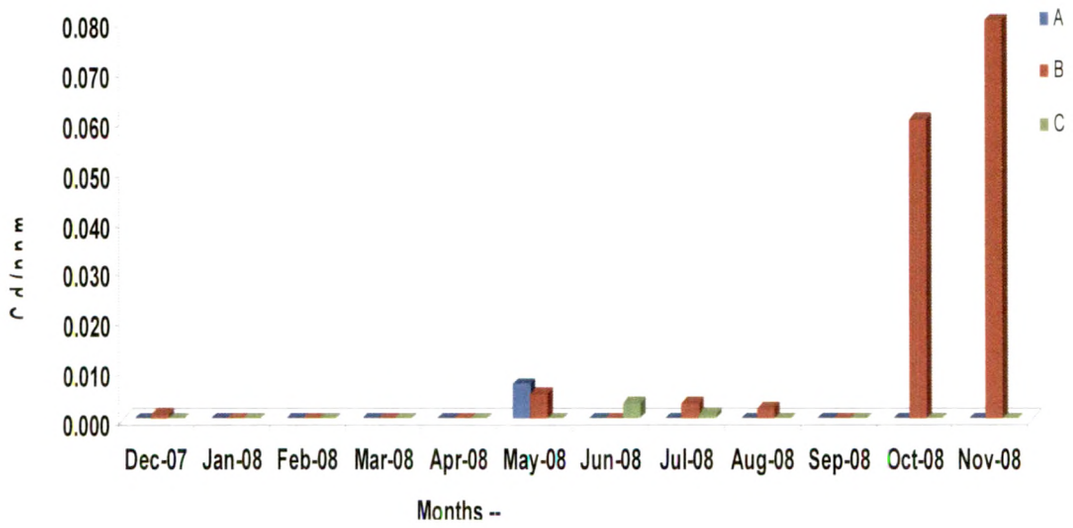


Figure No: 12

Monthly variation in Ni content of Station (A, B and C) in Water from Dabhol creek.

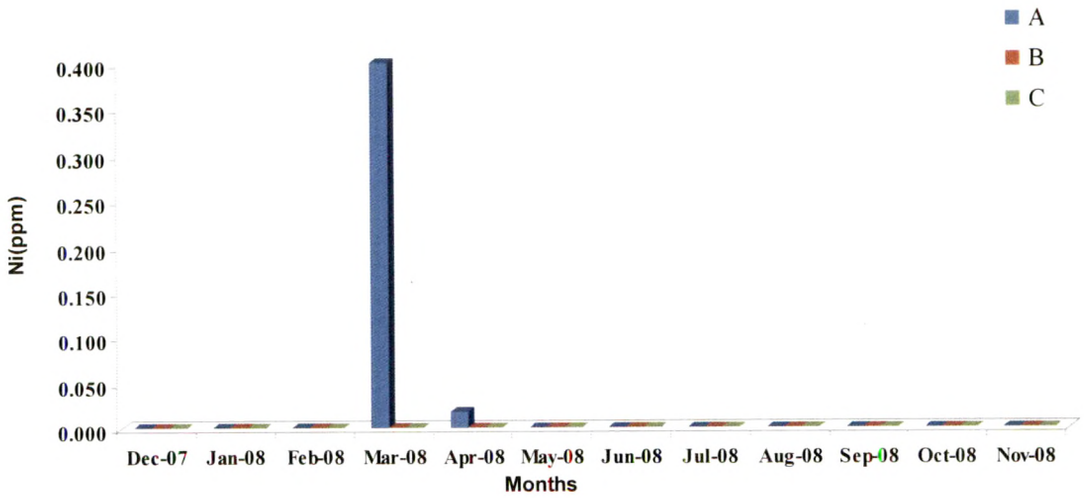


Figure No: 13

Monthly variation in Co content of Station (A, B and C) in Water from Dabhol creek.

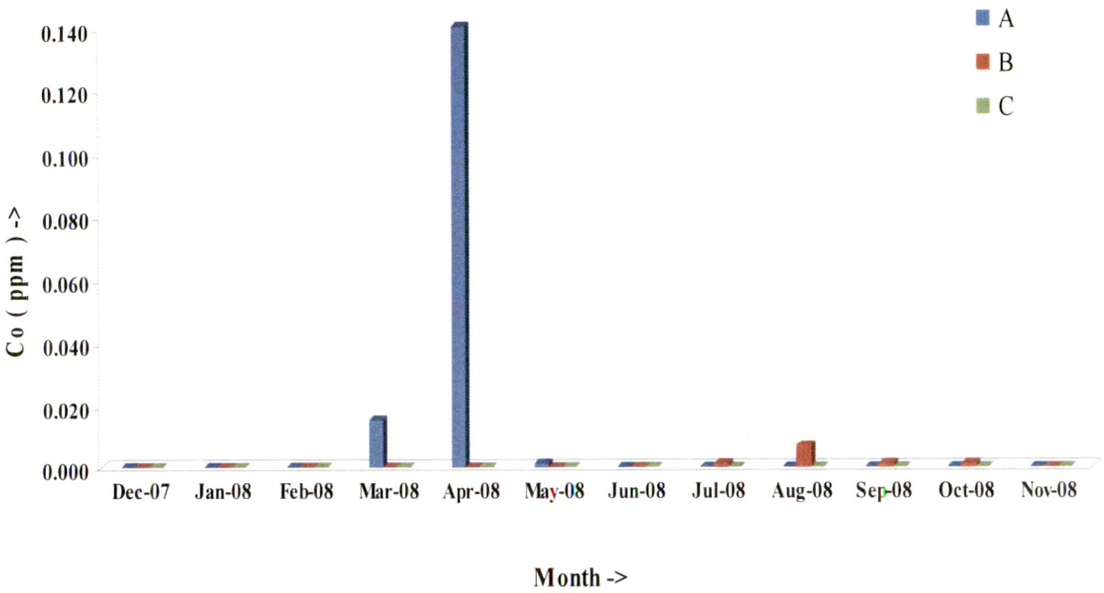


Table No. : 11

Monthly variation in Heavy metals (ppm) content of Station A (Kotawali) in sediment from Dabhol creek.

Month/Metal	Cu	Fe	Zn	Cd	Ni	Co	Mn
Dec-07	15.70	18.50	12.43	0.27	BDL	0.06	90.60
Jan-08	11.07	16.40	18.64	0.09	0.50	0.02	76.45
Feb-08	20.93	13.63	21.10	0.06	0.32	0.40	103.70
Mar-08	19.84	37.21	28.49	0.04	0.52	0.46	112.65
Apr-08	16.06	21.40	16.54	0.03	0.46	0.45	98.30
May-08	8.84	11.63	15.86	0.51	BDL	0.71	90.46
Jun-08	6.13	11.29	16.73	0.07	BDL	0.05	44.38
Jul-08	4.04	11.20	15.50	0.14	BDL	BDL	52.90
Aug-08	3.86	9.86	17.26	0.65	0.24	0.05	33.45
Sep-08	3.65	7.40	16.54	0.53	0.03	0.05	24.70
Oct-08	1.96	6.12	15.70	0.71	BDL	0.07	15.85
Nov-08	2.16	4.15	15.64	0.82	0.02	0.05	12.80
Average	**9.52**	**14.07**	**17.54**	**0.33**	**0.17**	**0.20**	**63.02**

BDL – Below Detectable Level

Table No. : 12

Monthly variation in Heavy metals (ppm) content of Station B (Songaon) in sediment from Dabhol creek.

Month/Metal	Cu	Fe	Zn	Cd	Ni	Co	Mn
Dec-07	3.86	69.84	10.20	0.16	BDL	0.26	80.60
Jan-08	3.54	48.30	8.17	0.09	0.17	0.07	65.85
Feb-08	5.02	28.56	12.60	0.02	0.28	0.31	94.10
Mar-08	4.54	75.71	25.10	0.02	0.46	0.38	113.20
Apr-08	4.26	63.07	0.86	0.02	0.37	0.27	98.38
May-08	3.98	22.24	BDL	0.43	BDL	0.08	91.28
Jun-08	2.10	11.79	0.01	0.37	BDL	0.09	50.29
Jul-08	1.37	8.45	BDL	0.28	BDL	0.04	20.17
Aug-08	1.12	8.30	9.30	0.44	BDL	0.03	16.84
Sep-08	1.10	7.82	5.47	0.36	BDL	0.42	8.64
Oct-08	2.00	7.32	4.56	0.67	BDL	0.09	5.52
Nov-08	1.62	6.82	3.18	0.52	BDL	0.07	4.48
Average	**2.88**	**29.85**	**7.94**	**0.28**	**0.32**	**0.17**	**54.11**

BDL – Below Detectable Level

Table No. : 13

Monthly variation in Heavy metals (ppm) content of Station C (Dhamandevi) in sediment from Dabhol creek.

Month/Metal	Cu	Fe	Zn	Cd	Ni	Co	Mn
Dec-07	3.34	42.56	BDL	BDL	0.04	BDL	15.80
Jan-08	2.30	30.80	0.25	0.36	0.11	0.12	21.36
Feb-08	3.40	62.70	0.30	0.39	0.16	0.56	35.50
Mar-08	5.12	70.46	0.46	BDL	0.18	0.95	53.12
Apr-08	4.83	60.89	0.43	BDL	0.13	0.13	42.20
May-08	4.16	23.94	BDL	0.54	BDL	0.01	37.82
Jun-08	0.95	21.14	BDL	0.65	BDL	0.06	22.25
Jul-08	0.75	10.15	BDL	0.35	BDL	0.05	20.36
Aug-08	0.68	16.84	BDL	BDL	BDL	0.03	18.44
Sep-08	0.64	10.00	BDL	BDL	BDL	BDL	7.56
Oct-08	0.50	8.48	BDL	BDL	BDL	BDL	6.30
Nov-08	0.32	6.52	BDL	BDL	BDL	BDL	4.38
Average	**2.25**	**30.37**	**0.36**	**0.46**	**0.12**	**0.21**	**23.76**

BDL – Below Detectable Level

Figure No: 14

Monthly variation in Mn content of Station (A, B and C) in Water from Dabhol creek.

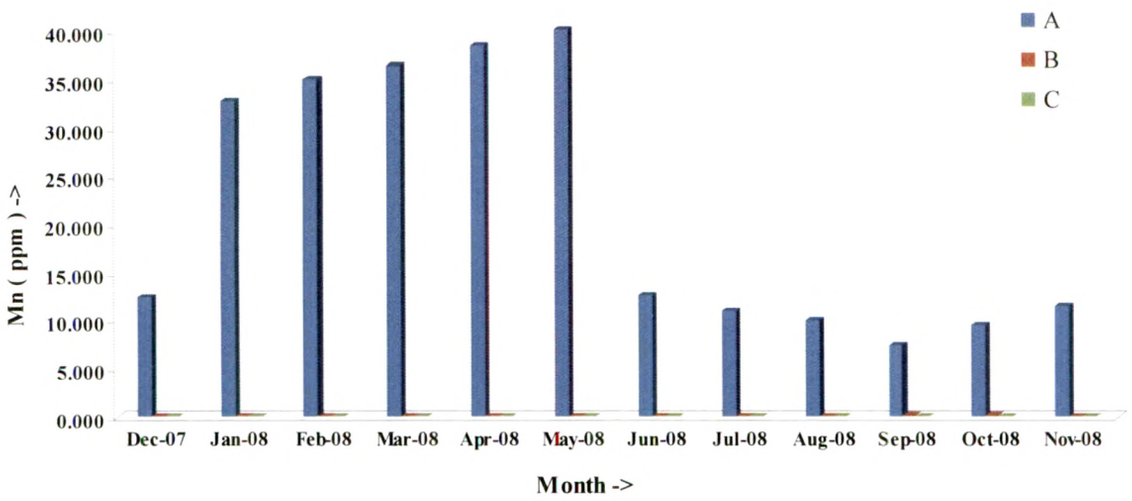


Figure No: 15

Monthly variation in Cu content of Station (A, B and C) in Sediment from Dabhol creek.

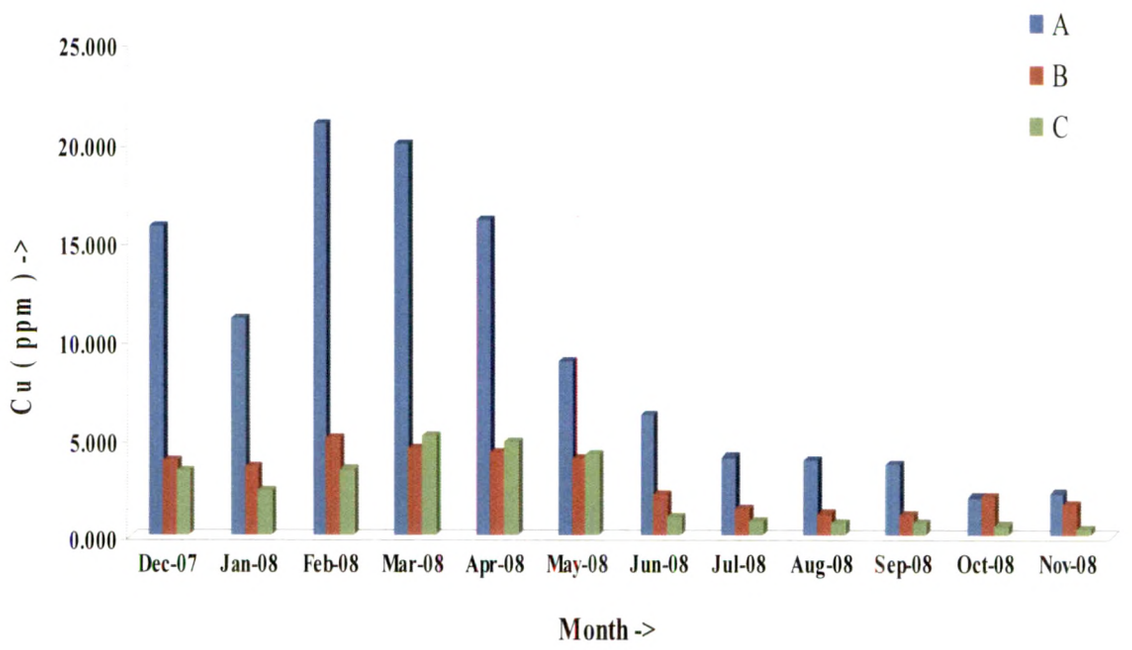


Figure No: 16

Monthly variation in Fe content of Station (A, B and C) in Sediment from Dabhol creek.

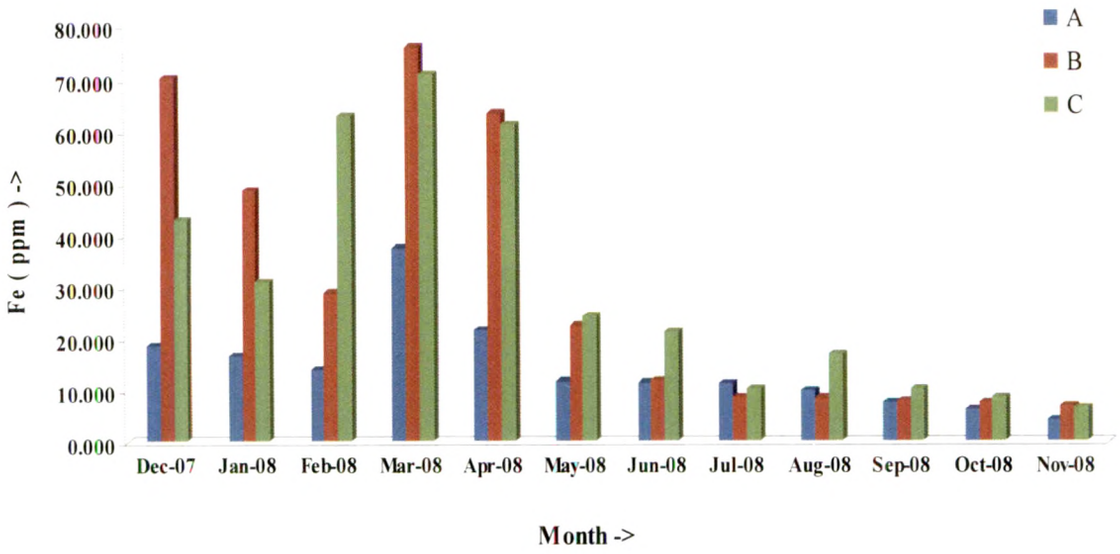


Figure No: 17

Monthly variation in Zn content of Station (A, B and C) in Sediment from Dabhol creek.

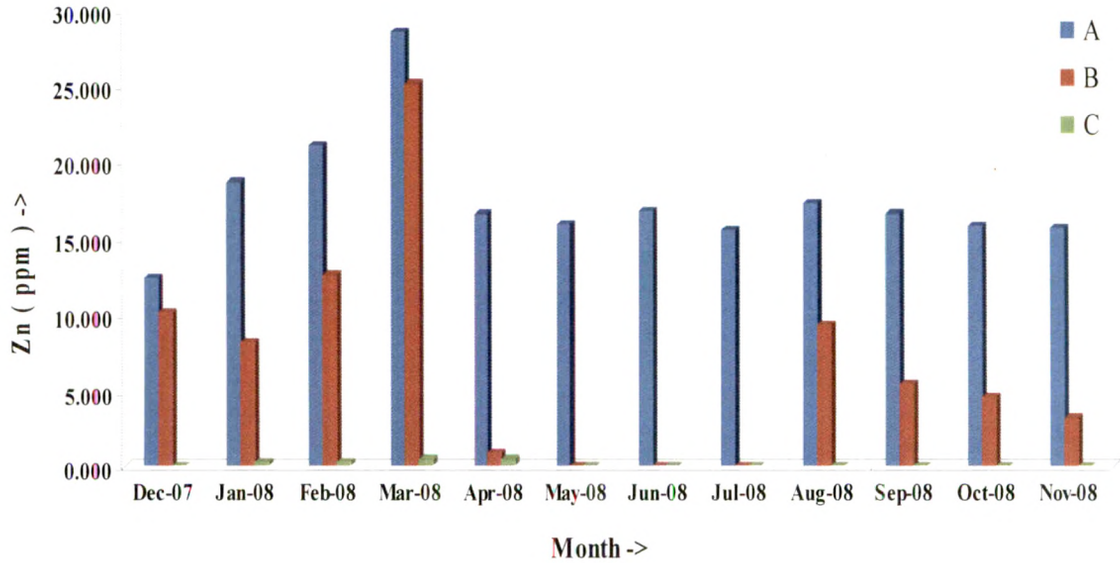


Figure No: 18

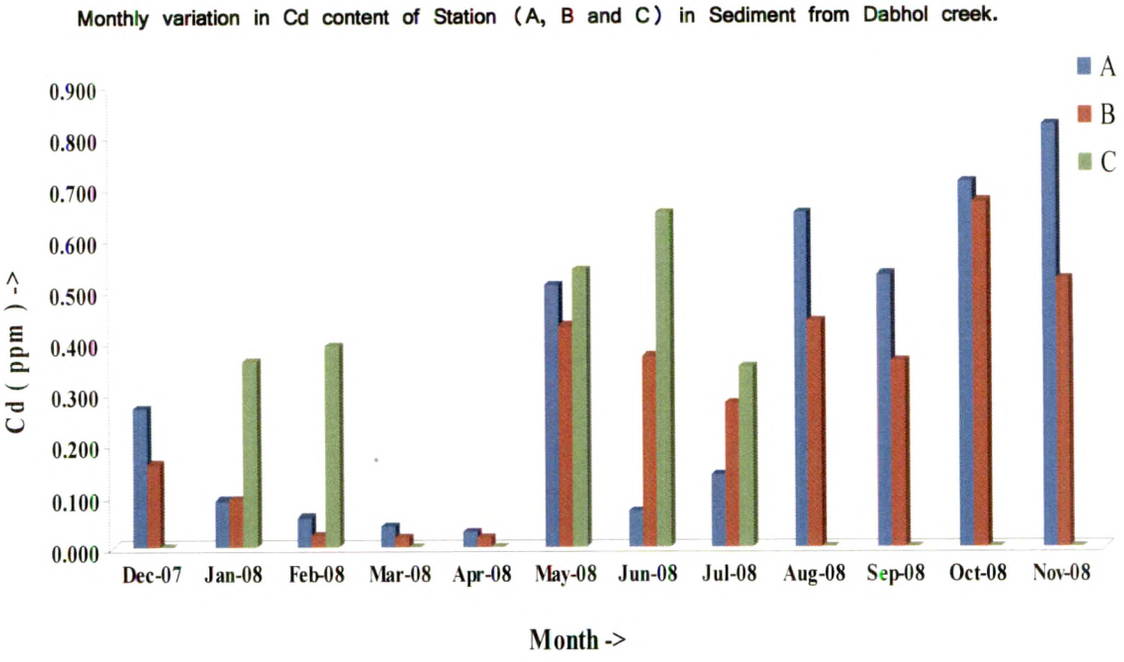


Figure No: 19

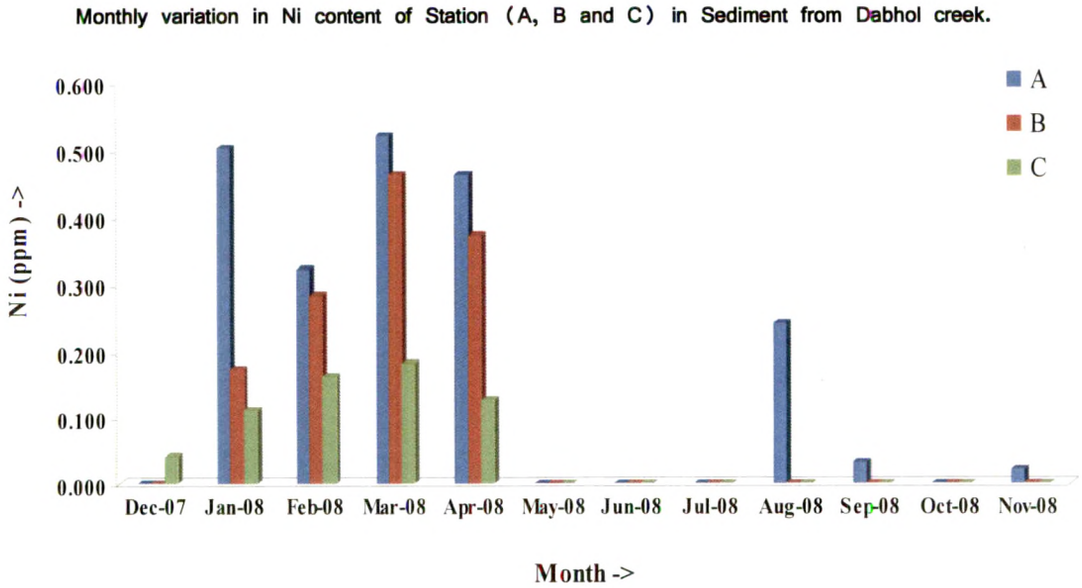


Figure No: 20

Monthly variation in Co content of Station (A, B and C) in Sediment from Dabhol creek.

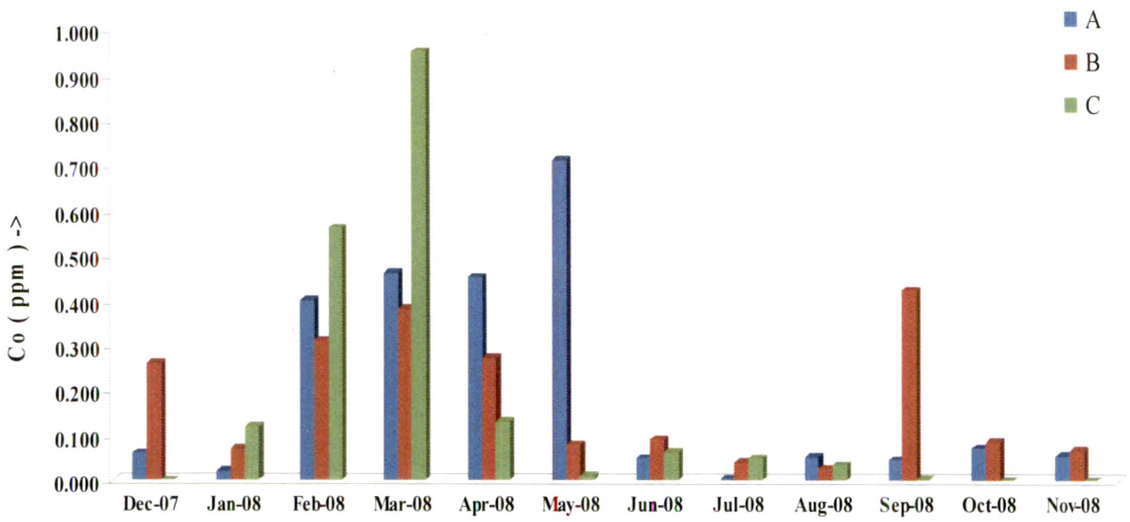
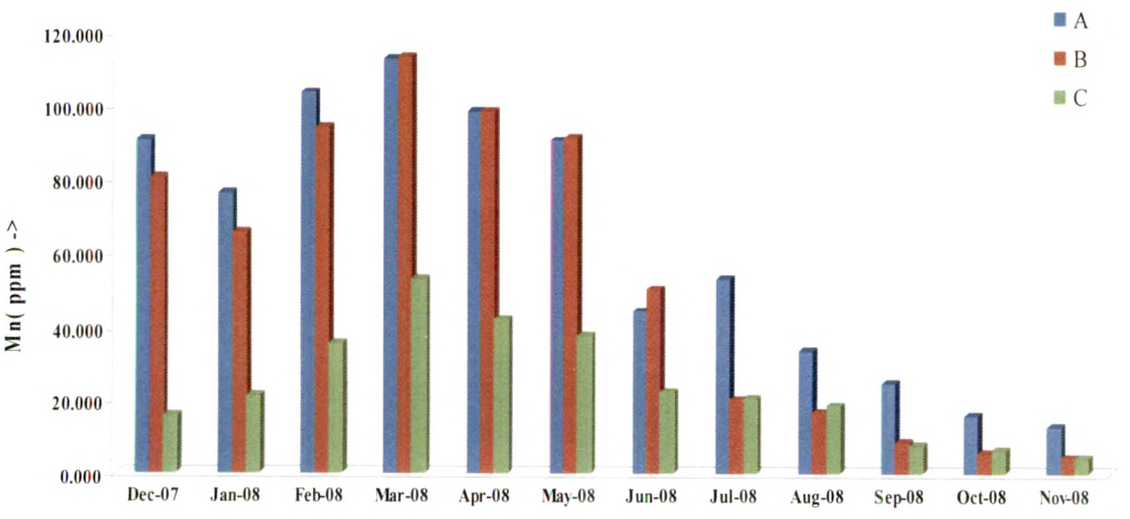


Figure No: 21

Monthly variation in Mn content of Station (A, B and C) in Sediment from Dabhol creek.



b) Metal contents in sediments:

The sediment samples from three sampling stations were analyzed for quantitative estimation of heavy metal concentration during the period from December, 2007 to November, 2008. The results are presented in Table No.'s -11 to 13; Fig. No.'s -15 to 21.

Concentration of heavy metals viz. Cu, Fe, Zn, Cd, Ni, Co and Mn from sediment samples at three different stations showed that Ni was below detectable level at Songaon (Station B) and Dhamandevi (Station C) from May, 2008 to November 2008.

The level of Cu at Kotawali (Station A) was maximum (20.93 ppm) in February, 2008 and it was minimum (1.96 ppm) in October, 2008. At Songaon (Station B) maximum content was recorded (5.02 ppm) in month of February, 2008, while minimum (1.10 ppm) in month of September, 2008. The maximum concentration of Cu at Dhamandevi (Station C) was 5.12 ppm in the month of March, 2008 and minimum of 0.32 ppm in month of November, 2008. (Table No.'s – 11; 12; 13). (Fig.-15).

Iron (Fe) content of the sediment samples from the Dabhol creeck was recorded at all the stations during study period. It was maximum (37.21 ppm) at Kotawali (Station A) in month of March, 2008 and minimum (4.15 ppm) in month of November, 2008. The concentration of Fe recorded at Songaon (Station B) was high (69.84 ppm) in month of December, 2007 and low (6.82 ppm) in month of November, 2008. The maximum concentration of Fe at Dhamandevi (Station C) was 70.46 ppm in month of March, 2008, and low (6.52 ppm) in the month of November, 2008. (Table No.'s – 11; 12; 13). (Fig.-16).

Zinc (Zn) content of sediment samples was maximum (28.49 ppm) at Kotawali (Station A) in month of March, 2008 and was minimum (12.43 ppm) in December, 2007. At Songaon (Station B) it was high (25.10 ppm) in March, 2008 and below detectable level in months of May, 2008 and July, 2008. At Dhamandevi (Station C), level of Zn was high (0.46 ppm) in month of March, 2008 and it was below detectable level in months of December 2007, and through May, 2008 to November, 2008. (Table No.'s – 11; 12; 13). (Fig.-17).

Cadmium (Cd) content of sediment samples was maximum at Kotawali (Station A) in the month of November, 2008 (0.820 ppm), followed by Songaon (Station B) (0.670 ppm) in the month of October, 2008 and Dhamandevi (Station C) 0.650 ppm in

the month of June, 2008. The minimum level of Cd content at Kotawali (Station A) during April, 2008 was 0.0029 ppm ,at Songaon (Station B) during March, 2008 was 0,016 ppm and at Dhamandevi (Station C) below detectable level for most of the months. (Table No.'s – 11; 12; 13). (Fig.-18).

The level of Nickel (Ni) was maximum (0.520 ppm) during the month of March, 2008 in the sediment samples from Kotawali (Station A). It remains below detectable level during the months of December, 2007, May, 2008 to July, 2008 and October, 2008. At Songaon (Station B) the maximum (0.460 ppm) Ni content was recorded in the month of March 2008, and was below detectable level in December, 2007 and May, 2008 through to November, 2008. For Dhamandevi (Station C) maximum level (0.180 ppm) of Ni was in the month of March, 2008, and was below detectable level in the months of May through November, 2008. (Table No.'s – 11; 12; 13). (Fig.-19).

The maximum level (0.710 ppm) of Cobalt (Co) in the sediment samples was from Kotawali (Station A) in the month of May, 2008 and minimum (0.004 ppm) in the month of July, 2008. At Songaon (Station B) the maximum (0.420 ppm) concentration was recorded in the month of September 2008 and minimum (0.027 ppm) in the month of August 2008. At Dhamandevi (Station C) Co content was high in the month of March (0.950 ppm), and was below detectable level in the months of December, 2007, October, 2008 and November, 2008. (Table No.'s – 11; 12; 13). (Fig.-20).

Manganese (Mn) content of sediment samples was maximum (112.650 ppm) at Kotawali (Station A) while minimum (12.800 ppm) during October, 2008. At Songaon (Station B) the maximum (113.200 ppm) level of Mn was detected in March 2008 and minimum of 4.480 ppm in November 2008. At Dhamandevi (Station C) Mn content was maximum (53.120 ppm) during February, 2008 and minimum (4.380 ppm) during October, 2008. At all the stations minimum concentration of Mn was in the month of November, 2008 during the study period. (Table No.'s – 11; 12; 13). (Fig.-21).

Bioaccumulation of heavy metals in fish organs:

Quantitative estimation of heavy metals from gill, muscle, liver and kidney of the experimental estuarine catfish *Mystus gulio* (Ham.) was done after chronic exposure of 30 days to $1/10^{th}$ of LC_{50} value (18 ppm) to industrial effluent. Heavy metals such as Cu,

Table No. : 14

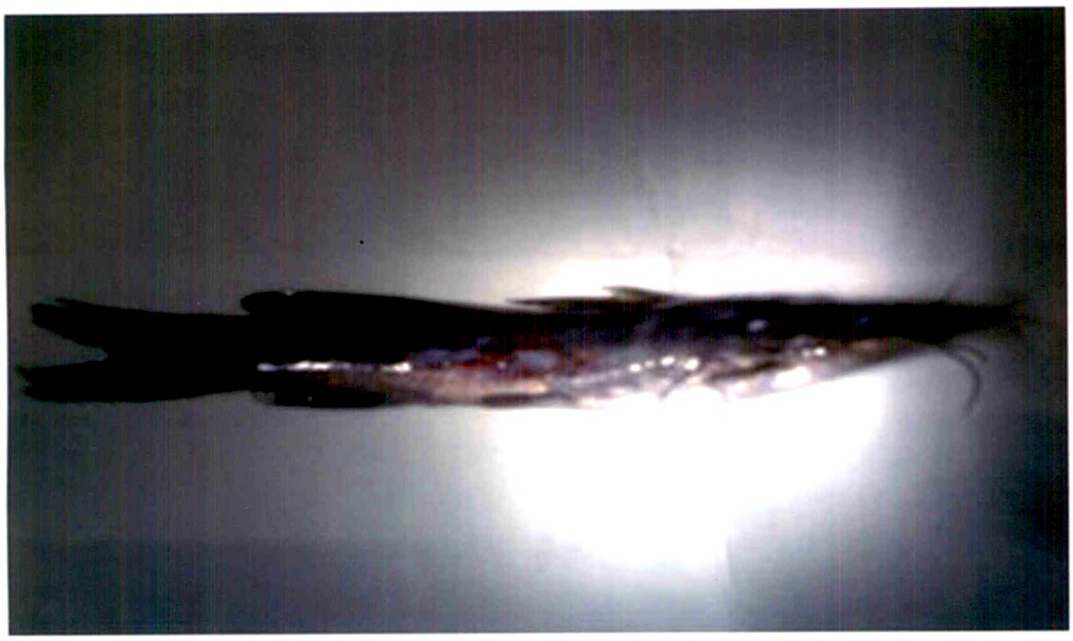
Bioaccumulation of heavy metals (ppm) in various organs of fish *Mystus gulio* (Ham.) after chronic exposure to industrial effluent.
(Chronic concentration 18 ppm)

Organ	Heavy metal concentration in ppm(dry weight)						
	Cu	Fe	Zn	Cd	Ni	Co	Mn
Gill	0.027	0.091	0.14	BDL	BDL	0.001	BDL
Muscle	0.011	0.055	0.060	BDL	BDL	0.002	BDL
Liver	0.053	0.35	0.25	0.002	BDL	0.001	BDL
Kidney	0.22	1.12	1.47	BDL	BDL	0.001	BDL

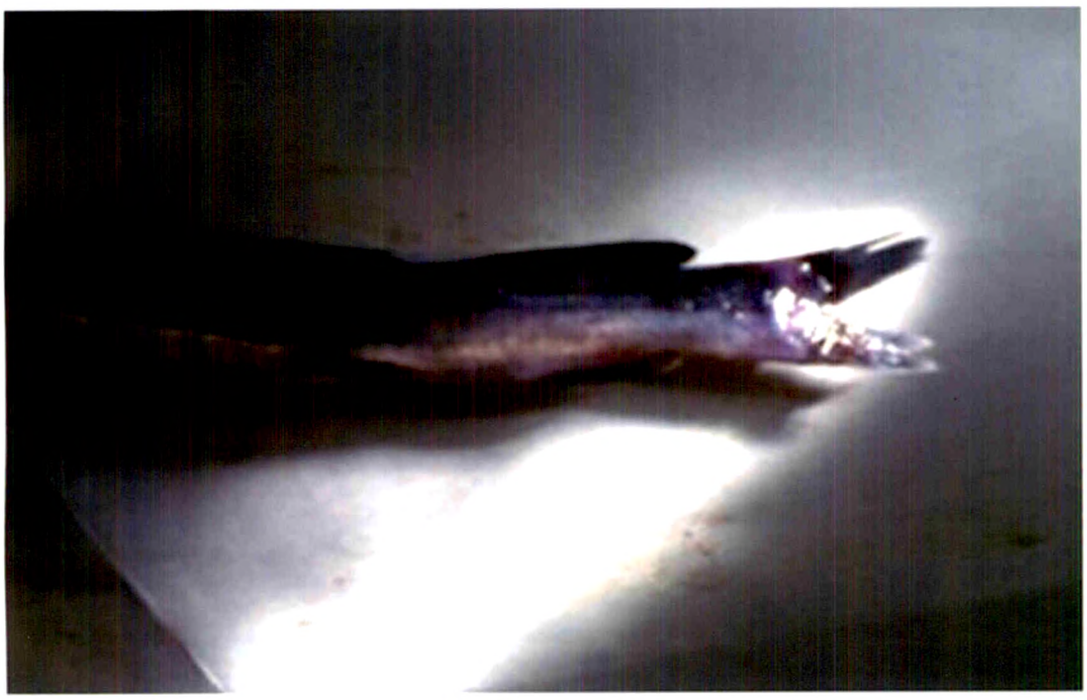
BDL – Below Detectable Level

Plate No. IV.

Mystus gulio after chronic exposure to effluent.



Damage to trunk region.

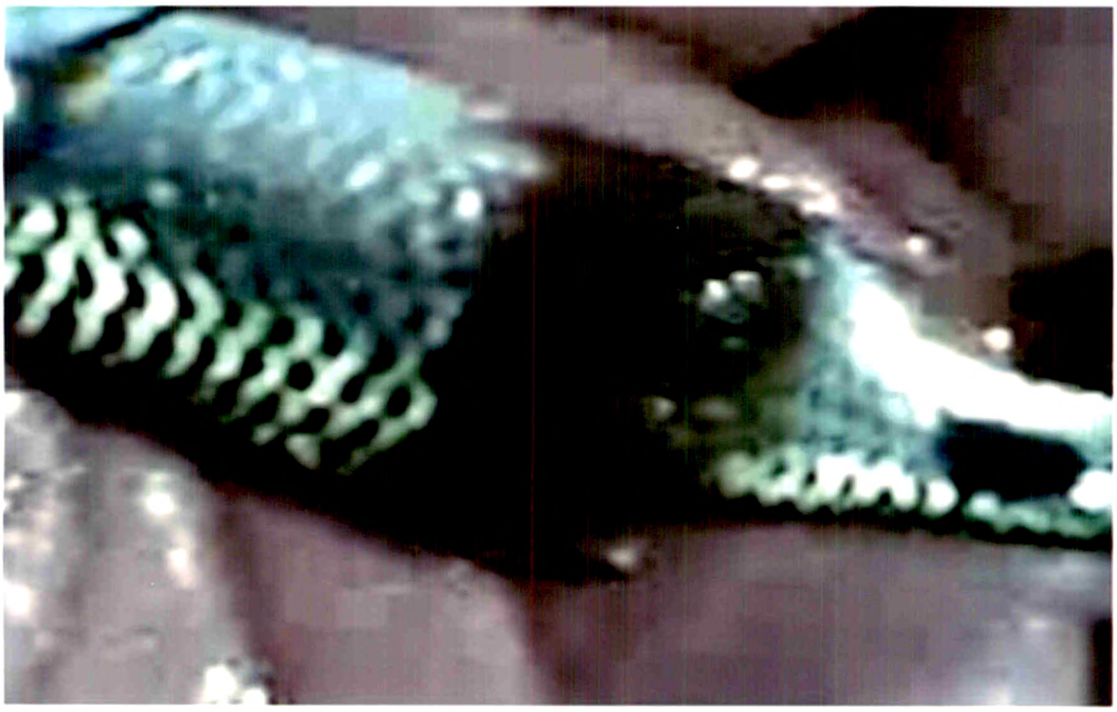


Damage to pelvic and caudal region.

N FUN.J.. Slide1.JPG 815 HD
115 042 -1 N+1-2--- 2099.9/ 100.0

Plate No. V.

Mortality of fishes due to effluents.



Fungal growth in pelvic region.

Fe, Zn, Cd, Ni, Co and Mn were detected from the test organs of cat fish during December, 2007 to November, 2008. The results are presented in Table (14).

Copper (Cu) content of different organs of *Mystus gulio* (Ham.) was from 0.011 to 0.22 ppm. The maximum concentration of Cu was detected in the kidney (0.22 ppm) which was followed by the liver (0.35 ppm), gill (0.027 ppm), and minimum was detected in the muscle (0.011 ppm).

Iron (Fe) content was in the range from 0.055 to 1.12 ppm. The maximum concentration of Fe was detected in the kidney (1.12 ppm) followed by the liver (0.053ppm), gill (0.091 ppm) and muscle (0.055 ppm).

Zinc (Zn) content was in the range of 0.006 to 1.47 ppm. The maximum concentration of Zn was detected in kidney (1.47 ppm) followed by liver (0.25 ppm), gill (0.14 ppm) and muscle (0.060 ppm).

Cadmium (Cd) content was below detectable level in all the organs except liver (0.002 ppm).

Nickel (Ni) content of all the organs was below detectable level.

Cobalt (Co) content of different body organs was from 0.001 to 0.002 ppm. It was high in the muscle (0.002 ppm) and low (0.001 ppm) in gill, liver and kidney.

Manganese (Mn) content of all the organs as gill, muscle, liver and kidney of fish was below detectable level.

Biochemical studies:

The present work encompasses the effect of industrial effluents on the biochemical compositions in an estuarine catfish *Mystus gulio* (Ham.) from Dabhol creek. The healthy specimens were collected from Dabhol creek. These fishes were exposed to the industrial effluents collected from the Lote M.I.D.C area. After chronic exposure of 30 days, experimental as well as control fish were sacrificed and were used for the biochemical study. The study period extended from December, 2007 to November, 2008.

Glycogen:

Industrial effluents caused alterations in glycogen content of gill, muscle, liver and kidney as shown in (Table – 15).

Control group:

The glycogen content in different body parts of *Mystus gulio* (Ham.) were in the order of liver > muscle > gill > kidney. In the liver maximum (7.69 ± 0.30 mg / 100 mg) glycogen content was recorded. The glycogen level in the kidney was minimum (4.54 ± 0.41 mg / 100 mg).

The glycogen content of target tissues gets mobilized under toxic influence of industrial effluent ($1/10^{th}$ of LC_{50}). Compared to control, glycogen was significantly decreased in all the organs like liver, muscle, kidney and gill, in the order of liver > muscle > kidney > gill. In the liver maximum glycogen content was recorded (3.41 ± 0.25 mg / 100 mg, $P < 0.01$), in the muscle it was (3.34 ± 0.48 mg / 100 mg, $P < 0.01$) in the kidney it was (2.76 ± 0.27 mg / 100 mg, $P < 0.01$), and minimum glycogen was recorded in the gill (1.41 ± 0.18 mg / 100 mg, $P < 0.01$) for the$1/10^{th}$ of LC_{50} of industrial effluent.

Compared to the control group the glycogen content in the experimental group was significantly decreased in the liver, muscle, kidney and gill, in order of liver > muscle > kidney > gill. The maximum glycogen content was recorded in the liver it was (5.05 ± 0.49 mg / 100 mg, $P < 0.001$), which is followed by muscle (4.04 ± 0.91 mg / 100 mg, $P < 0.01$), kidney (3.04 ± 0.07 mg / 100 mg, $P < 0.01$), gill (2.13 ± 0.11 mg / 100 mg, $P < 0.01$) for the$1/20^{th}$ of LC_{50} of the industrial effluent.

In general, there was significant decrease in the glycogen level of experimental group of fishes exposed to the chronic concentrations of industrial effluent ($1/10^{th}$ of LC_{50} and $1/20^{th}$ of LC_{50}). (Fig. 23).

Protein:

Changes in the protein content caused by industrial effluent in gill, muscle, liver and kidney of *Mystus gulio* (Ham.) shown in (Table – 16).

Control group:

The protein content in different body parts of *Mystus gulio* (Ham.) were in order of muscle > liver > kidney > gill. The maximum protein content was recorded in the

Table No. : 15

Effect of industrial effluent on total Glycogen content in various organs of the fish *Mystus gulio* (Ham.) (mg/100mg wet tissue)

Organ	Control	Experimental	
		1/10th of LC_{50}	1/20th of LC_{50}
Gill	4.58 ± 0.39	1.41 ** ± 0.18	2.13 *** ± 0.11
Muscle	6.98 ± 0.30	3.34 ** ± 0.25	4.04 ** ± 0.49
Liver	7.69 ± 0.41	3.41 ** ± 0.27	5.05 ** ± 0.07
Kidney	4.54 ± 0.86	2.76 * ± 0.48	3.04 ** ± 0.91

Each value is the mean of three observations.
± SE, Values are significant at * $P < 0.05$,* * $P < 0.01$,* * * $P < 0.001$,
NS - Non Significant.

Table No. : 16

Effect of industrial effluent on total Protein content in various organs of the fish *Mystus gulio* (Ham.) (mg/100mg wet tissue)

Organ	Control	Experimental	
		$1/10^{th}$ of LC_{50}	$1/20^{th}$ of LC_{50}
Gill	10.50 ± 0.51	8.87 ** ± 0.26	9.50 * ± 0.11
Muscle	26.98 ± 0.47	13.42 *** ± 0.54	16.17 *** ± 0.32
Liver	15.06 ± 0.13	3.40 *** ± 0.29	5.46 *** ± 0.59
Kidney	12.35 ± 0.32	5.10 *** ± 0.36	7.58 *** ± 0.13

Each value is the mean of three observations.
± SE, Values are significant at * $P < 0.05$,* * $P < 0.01$,* * * $P < 0.001$,
NS - Non Significant.

Table No. : 17

Effect of industrial effluent on total Lipid content in various organs of the fish *Mystus gulio* (Ham.) (mg/100mg wet tissue)

Organ	Control	Experimental	
		$1/10^{th}$ of LC_{50}	$1/20^{th}$ of LC_{50}
Gill	11.19 ± 0.33	2.67 *** ± 0.30	4.25 *** ± 0.25
Muscle	3.54 ± 0.30	1.09 NS ± 0.41	1.93 ** ± 0.21
Liver	16.69 ± 0.53	4.17 NS ± 0.97	6.36 ** ± 1.17
Kidney	10.69 ± 0.67	2.79 * ± 0.80	5.16 ** ± 0.74

Each value is the mean of three observations.

± SE, Values are significant at * $P < 0.05$,* * $P < 0.01$,* * * $P < 0.001$,

NS - Non Significant.

Figure No: 22

Bioaccumulation of heavy metals (ppm) of various organs in the fish *Mystus gulio* (Ham.) after chronic exposure to industrial effluent.

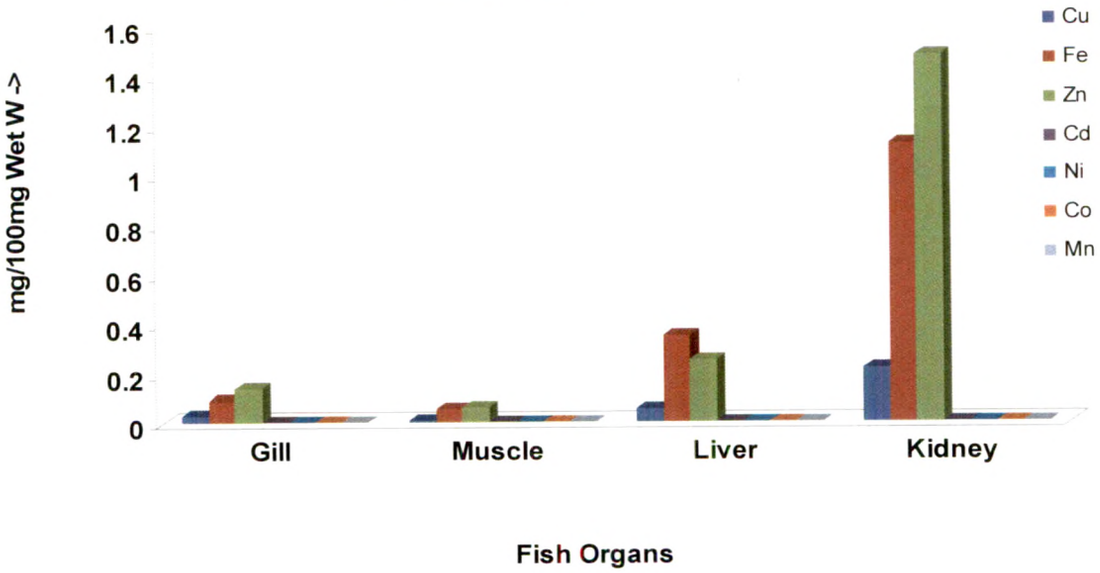


Figure No: 23

Effect of industrial effluent on total Glycogen content of various organs in the fish *Mystus gulio* (Ham.) (mg/100mg wet tissue)

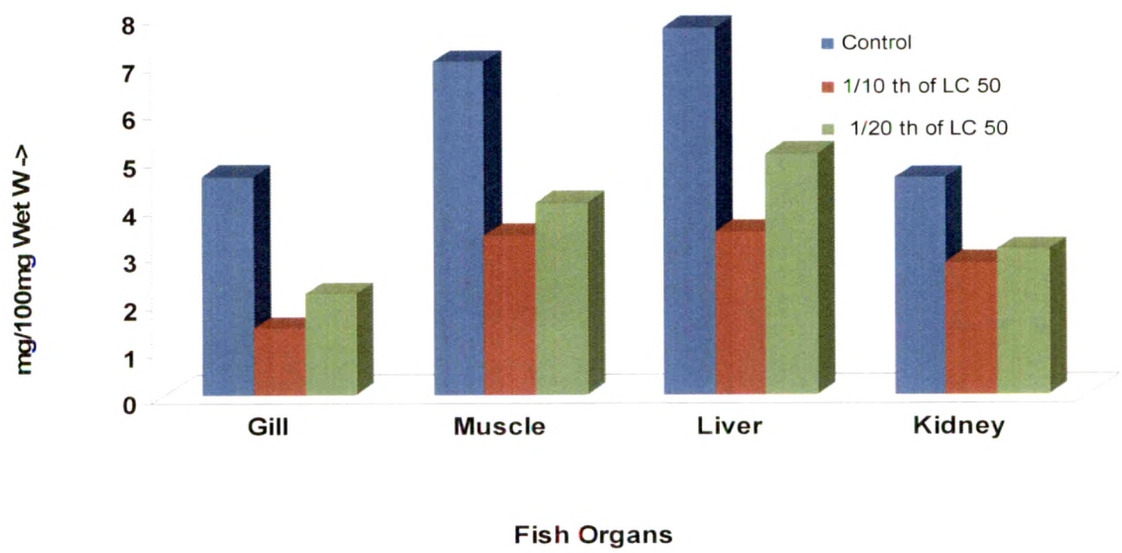


Figure No: 24

Effect of industrial effluent on total Protein content of various organs in the fish *Mystus gulio* (Ham.) (mg/100mg wet tissue)

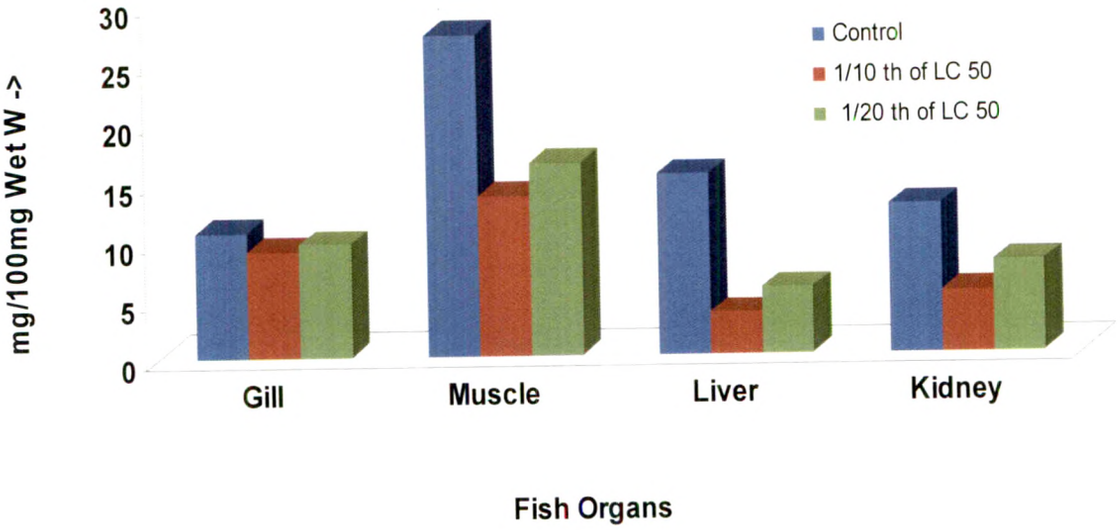
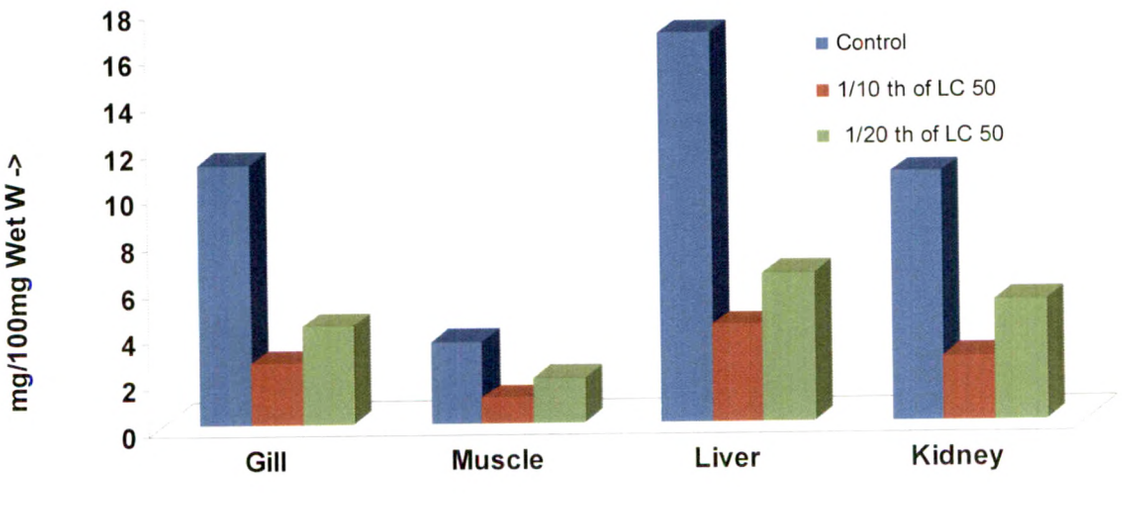


Figure No: 25

Effect of industrial effluent on total Lipid content of various organs in the fish *Mystus gulio* (Ham.) (mg/100mg wet tissue)



muscle (26.98 ± 0.47 mg / 100 mg), followed by liver (15.06 ± 0.13 mg / 100 mg), kidney (12.35 ± 0.32 mg / 100 mg), while it was minimum in the gill (10.50 ± 0.51 mg / 100 mg).

Compared to control, protein content was significantly decreased in almost all the body tissues. This decrease was in order of muscle > gill > kidney > liver. In the muscle maximum protein content was recorded (13.42 ± 0.54 mg / 100mg, $P < 0.001$), followed by gill (8.87 ± 0.26 mg / 100 mg, $P < 0.01$), kidney (5.10 ± 0.36 mg / 100 mg, $P < 0.001$), and liver (3.40 ± 0.29 mg / 100 mg, $P < 0.001$) for the1/10th of LC_{50} of the industrial effluents.

Protein content was also decreased in the experimental (Chronic) group of fishes when exposed to 1/20th of LC_{50} of industrial effluents collected from the industrial zone. There was significant decrease in the protein content of all body tissues. The decrease was in the order of muscle > gill > kidney > liver. In the muscle maximum protein content was recorded (16.17 ± 0.32 mg / 100 mg, $P < 0.001$), and followed by gill (9.50 ± 0.11 mg / 100 mg, $P < 0.05$), kidney (7.58 ± 0.13 mg / 100 mg, $P < 0.001$), liver (5.46 ± 0.59 mg / 100 mg, $P < 0.001$) for the1/20th of LC_{50} of the industrial effluent. (Fig. 24).

Lipid:

Changes in total lipid content caused by industrial effluent in the gill, muscle, liver and kidney are shown in (Table – 17).

Control group:

The lipid content in the control group of different body parts in the *Mystus gulio* (Ham.) was in the order of liver > gill > kidney > muscle. The maximum lipid content was recorded in the liver (16.59 ± 0.53 mg / 100 mg) and in the gill it was (11.19 ± 0.33 mg / 100 mg), followed by the kidney (10.69 ± 0.67 mg / 100 mg), and while minimum was recorded in the muscle (3.54 ± 0.30 mg / 100 mg).

Compared to control, the lipid content was considerably depleted in kidney and gill. There were non significant depletion in the lipid content of liver and muscle. They were in order of liver > kidney > gill > muscle. In the liver maximum lipid content was recorded (4.17 ± 0.97 mg / 100 mg, NS), followed by kidney (2.79 ± 0.80 mg / 100 mg, $P < 0.05$), gill (2.67 ± 0.30 mg / 100 mg, $P < 0.001$), and minimum lipid was recorded in the muscle (1.09 ± 0.41 mg / 100 mg, NS), for the1/10th of LC_{50} of the industrial effluent.

The lipid content of target tissues gets influenced by toxic nature of industrial effluent ($1/20^{th}$ of LC_{50}). Compared to control, glycogen was significantly decreased in all the organs like liver, muscle, kidney and gill. They were in order of liver, kidney, gill and muscle. In liver maximum glycogen content was recorded (6.36 ± 1.17 mg / 100 mg, $P < 0.01$), followed by kidney (5.16 ± 0.74 mg / 100 mg, $P < 0.01$), gill (4.25 ± 0.25 mg / 100 mg, $P < 0.001$) and muscle (1.93 ± 0.21 mg / 100 mg, $P < 0.01$).(Fig. 25).