International Journal of Research and Reviews in Pharmacy and Applied science

www.ijrrpas.com

STATUS OF SOME HEAVY METALS IN TISSUES OF WEDGE CLAM, DONAX SCORTUM (BIVALVIA: DONACIDAE) COLLECTED FROM PADUKERE BEACH, KARNATAKA

Yambem Tenjing Singh*[1], Machina Krishnamoorthy[1] Hemachandra[2] Seetharamaiah Thippeswamy[1]

1Department of Post-graduate Studies and Research in Biosciences, Mangalore University, Mangalagangothri, Karnataka, India

[2]St. Aloysius College, Departments of Zoology, Mangalore, PIN - 575 006, Karnataka, India

*Email: yambemtenjing@gmail.com

ABSTRACT

The wedge-clam, *Donax scortum* is a filter-feeding bivalve and is one of the few clams collected for food by the coastal population, especially the fishermen community, around Padukere (Karnataka) on the south-west coast of India. The samples of *D. scortum* were collected from Padukere beach from February 2009 to January 2010 at monthly intervals. The concentrations of five heavy metals (Cu, Pb, Fe, Cr and Ni) were detected in tissues of wedge clam, *D. scortum*. The concentrations of heavy metals were determined by Atomic Absorption Spectrophotometer (AAS, GBC 932 $_{plus}$). The concentrations of those metals were in the order of Fe>Cu>Ni>Pb>Cr in the study area. The mean concentrations of the heavy metals, viz., Cu (19.38 µg/g dry weight), Pb (7.56 µg/g dry weight) and Cr (5.38 µg/g dry weight) in the wedge clam were below the permissible limits except for Ni (14.26 µg/g dry weight). Results indicated that higher concentrations of Cu, Pb and Ni were found in larger *D. scortum.* The present study showed seasonal variations of accumulation of metals in the donacids. The hierarchical cluster analysis using complete linkage showed two major groups of seasonal variation of heavy metals in wedge clams.

Keywords: Wedge clam, heavy metal, pollution, Karnataka.

INTRODUCTION

In India estuarine and coastal areas sustain vast resources of molluscs. Large-sized Donax scortum have been exploited by the people of the coastal areas from time immemorial for food. Simultaneously, several authors carried out investigations concentrating on different species of bivalves to prepare a framework for an environmental monitoring programme. An understanding of its heavy metal content can lead to better utilisation of the resources. From human point of view, some important aspects of the metal-based contamination studies are to identify the potentially hazardous levels Several workers have estimated the metal contents in the whole tissue of many donacids like D. incarnatus (Thairit et al., 2011), D. faba (Edward et al., 2009; Asha et al., 2010; Singh et al., 2012a; 2012b), D. trunculus (Mauri and Orlando, 1979; El-Sikaily et al., 2004; Beldi et al., 2006; Abdallah and Abdallah, 2008; Fahima and Abdennour, 2010; Idardare et al., 2011), D. deltoides (Haynes et al., 1995; Haynes et al., 1997), D. serra (Van As et al., 1973; Walting and Walting, 1981, 1983) and D. rugosus (Roméo et al., 2000). There are certain factors that influence the bioconcentration of heavy metal in molluscs' tissues. It was reported that the concentrations of heavy metal accumulated by marine organisms are not only depending on the quality of water but also temperature, salinity, seasonal factor, diet or food intake, individual variation and spawning variation (Hamed and Emara, 2006; Moukrim et al., 2000; Singh et al., 2012a, b). Some metals, such as zinc, copper, iron and manganese are essential micronutrients, while some others like, cadmium, chromium, lead and mercury are toxic elements. Virtually all metals including essential micronutrients become toxic beyond certain level. In coastal waters of Karnataka, total suspended solids (TSS) increased through rivers indicating addition of TSS is either from external sources or due to turbulence (Shirodkar et al., 2009). The present study evaluates the concentration of Cu, Pb, Fe, Cr and Ni in the dry tissues of the large-sized wedge clam, D. scortum from Padukere beach, Karnataka. The values of heavy metals' concentrations of D. scortum were compared with those donacides of the same species obtained from different countries.

MATERIALS AND METHODS

Bivalves, Donax scortum (Linnaeus) were collected at monthly intervals for a period of one year from February 2009 to January 2010 from the intertidal muddy beach from Padukere (Fig. 1; 13º 20'N; 74º 41'E), near the mouth of the Udayawara river, located in Udupi district, along the south west coast of Karnataka. This tropical region is characterized by distinct seasonality, e.g. pre-monsoon (February-May), south-west monsoon (June-September) and post-monsoon (October-January).

The wedge clams were individually measured for shell length (maximum antero-posterior distance accurately to 0.01 mm using vernier callipers (Fig. 2). 10 clams (Donax scortum) ranging in size between 50 mm to 60 mm were pooled monthly for heavy metal analysis. The wet tissues of the wedge clams were washed with distilled water and removed with the help of a stainless steel knife and dried at a constant temperature of 60°C for 2 days and homogenized. 0.5 g of homogenized dry tissue was digested in triplicate. Afterwards, digestion of the sample was carried out by adding 8 ml of nitric acid and 1 ml of perchloric acid. The sample was diluted with double glass-distilled deionised water; the distillate was filtered, the volume was made upto 25.0 ml and kept in precleaned plastic vials. The metals were detected on an Atomic Absorption Spectrophotometer (GBC 932 $_{plus}$) working with air acetylene flame (Singh et al., 2012a, b).

In our present study, the concentrations of the heavy metals were expressed in µg/g dry weight. Statistical analyses were carried out using SPSS 16.0 statistical package and MS Excel 2007. Data were expressed as mean. The data on concentrations of heavy metals were subjected to cluster analysis (CA) which can identify relatively similar, that is homogeneous groups of seasonal patterns associated with metal concentrations.

RESULTS AND DISCUSSION

In the tissue samples of Donax scortum from Padukere beach, the concentration of Cu ranged from 13.95 to 34.25, Pb from 3.10 to 22.90, Fe from 577.00 to 1701.50, Cr from 2.60 to 8.05 and Ni from 7.60 to 21.75 µg/g dry weight (Fig. 3). The mean values of heavy metal concentration in the tissue samples of wedge clam at the study area are given in Table 1.

Singh et al. (2012a) reported the high contents of some heavy metals at the same site where Udayawara river large heavy amount of waste from industrial areas, fishing harbour and other anthropogenic activities. Working on heavy metals in wedge clams Donax faba at Panambur sandy and Padukere beaches, Singh et al. (2012a, 2012b) observed that variation levels of metal were higher during different seasons. High amount of iron in other bivalve like green mussel, Perna viridis was attributed to heavy shipping traffic (Fatima, 1996). In a case, Singh et al. (2012a) suggested that high level of Fe may be due to water runoff and wind flow associated with Fe metals from Tebma Shipyards Ltd. (Shipbuilding Company) in which design and construction of vessels catering to the offshore segment were under taken near to the mouth of Udayawara river. This agrees with the present findings of Fe content in D. scortum collected from Padukere beach. The high contents of heavy metals in wedge clam reflect the high amount of metals in the environment. The levels of different heavy metals in tissues of large-sized wedge clam D. scortum from Padukere beach are comparable with the findings of several authors who worked on donacids (Table 1). In their findings, iron concentration was the highest compared to other heavy metals. These values are comparable with the level of iron concentration in the present study. Highest Ni concentration in D. scortum in Table 1 shows that this species has a capability to store high concentration of Ni in the body compared to other donacids. Temporal cluster analysis generated a dendrogram as shown in Fig. 4 grouping the 12 months into three clusters. Cluster 1 comprised February and January representing the early pre monsoon and late post monsoon periods. Only June formed the second cluster indicating the monsoon period. The rest of the months August, December, September, November, April, March, October, July and May clustered together representing association of all the three seasons in the same group. The temporal pattern of heavy metal was to some extent consistent with the three seasons with only exception of few months which are transition months appeared between different clusters. Temporal variation in heavy metals present in the tissues of large-sized wedge clam, Donax scortum is not absolutely determined by seasonal effects but also by the nature and frequency of discharge. In a case, the seasonal variation in heavy metal concentrations in D. trunculus in the gulf of Annaba could be related to the ocean currents and the reproductive cycle of that species. The high accumulation of metals coincides with the low currents and the reproduction in the gulf of Annaba (Beldi et al., 2006). A drop in metals levels coincide with the spawning period while during gametogenesis more elevated rates of metal integration was observed (Idardare et al., 2011). Well developed gonads are found to coincide with metal retention in a number of the studies (Cheggour et al., 1990; Marina and Enzo, 1983). It has been reported that the metal accumulation in mussels (Mytilus edulis) and clams (D. trunculus) might be affected by reproductive cycle (Combra and Carraca, 1990; Idardare et al., 2011) or it varied significantly between males and females (Lima, 1997; Marina and Enzo, 1983). The spawning season of the bivalve, biotic and abiotic environmental factors may contribute to the wide variability observed in heavy metal concentrations in the tissues.

The relationships between metal concentration and shell length in Donax scortum are illustrated in Fig. 5. The results indicate that higher concentrations of Cu and Pb were found in larger D. scortum, whereas higher concentrations of Fe and Cr were found in smaller clams. Higher and lower concentrations of Ni present in D. scortum appeared in both smaller and larger wedge clams. The concentration was in the order of Fe>Cu>Ni>Pb>Cr at Padukere beach in our present study. Hornung and Oren (1980-81) and Rajakumar et al. (2010) reported the relationships between the levels of heavy metals in the tissues and the lengths of donacid, D. trunculus and brown mussel, Perna indica from Kudankulam coast and Haifa Bay respectively. Results of our present study support the contention that a relationship exists between the concentration of metal in the tissue and the length of bivalve.

Our present study shows that the mean tissue concentrations of heavy metals (Cu, Pb and Cr) in clam collected from the study area along the Karnataka coast were found to be below the MAFF, BOE, NHMRC, Great Britian-Parliament and EEC permissible concentrations for seafood (MAFF, 1956; EEC, 1979; Great Britain-Parliament, 1979; NHMRC, 1987; BOE, 1991). But the Ni level in the clam is beyond the WHO permissible level (WHO, 1987) (Table 2). These observations are entirely consistent with our earlier findings (Singh et al., 2012a, b). Although the present level of heavy metals is beyond or below the international permitted values, it is necessary to launch monitoring programmes to control the metal levels.

ACKNOWLEDGMENT

The first author thanks Rajamanikya, Teacher, Government Composite High School, Alpadi, Kundapur taluk, Udupi district, Karnataka, India for participating in the collection of the samples and his kind encouragement during the course of his work and expresses his gratitude to UGC New Delhi for financial assistance. The authors are thankful to the Head of University Science Instrumentation Centre, Mangalore University for providing necessary facilities.

REFERENCES

1. Abdallah MAM, Abdallah AMA. Biomonitoring study of heavy metals in biota and sediments in the South Eastern coast of Mediterranean sea, Egypt. Environ Monit Assess 2008; 146: 139–45.

2. Asha PS, Krishnakumar PK, Kaladharan P, Prema D, Diwakar K, Valsala KK, Bhat GS. Heavy metal concentration in sea water, sediment and bivalves off Tuticorin. J Mar Biol Ass India 2010; 52:48–54.

3. Beldi H, Gimbert F, Maas S, Scheifler R, Soltani N. Seasonal variations of Cd, Cu, Pb and Zn in the edible mollusc Donax trunculus (Mollusca, Bivalvia) from the Gulf of Annaba, Algeria. A J Agri Res 2006; 1:085–090.

4. BOE (Boletin Oficial dcl Estado or Official Gazette of the State). 1991. Normas microbiôlogicas, limites de contenido en metales pesados y métodos analiticos para la determinacién de metals pesados para los productos de la pesca y de la agricultura (Microbio-logical standards, limits of heavy metal concentration, and analytical methods for the determination of heavy metals in fish and agricultural produce) August 2 Order. Madrid, Spain: Ed. BOE; 1991; 5937-5941.

5. Cheggour M, Texier H, Moguedet G, Elkaïm B. Metal exchange in the fauna-sediment system. The case of Nereis diversicolor and Scrobicularia plana in the Bou Regreg estuary (Morocco). Hydrobiologia1990; 207:209–219.

6. Combra J. Carraca, S. Accumulation of Fe, Zn, Cu and Cd during different stages of the reproductive cycle in Mytilus edulis. Comp Biochem Physiol 1990; 95:265–270.

7. Edward FB, Yap CK, Ismail A, Tan SG. Interspecific variation of heavy metal concentrations in the different parts of tropical intertidal bivalves. Water Air Soil Pollut 2009: 196:297–309.

8. EEC (European Economic Community). Council Directive 79/923/EEC of 30 Oct. 1979 on the quality required of shellfish waters. Luxembourg: Official Publications of the European Communities; 1979.

9. El-Sikaly A, Khaled A, El Nemr A. Heavy metals monitoring using bivalves from Mediterranean Sea and Red sea. Environ Monit Assess 2004; 98:41–58.

10. Fahima D, Abdennour C. Trace metals in the mussel Donax trunculus Linnaeus 1758 from urban and industrial contaminated locations. J Appl Sci Res 2010; 6:2063–2067.

11. Great Britain-Parliament. Food and Drugs Composition. The Lead in Food Regulation 1979, Statutory Instrument N° 1254: 1–7. London: Her Majesty's Stationery Office 1979.

12. Hamed MA, Emara AM. Marine molluscs as biomonitors for heavy metal levels in the Gulf of Suez, Red Sea. J Mar Syst 2006; 60:220–234.

13. Haynes D, Leeder J, Rayment P. Temporal and spatial variation in heavy metal concentrations in the bivalve Donax deltoides from the Ninety Mile beach, Victoria, Australia. Mar Pollut Bull 1995; 30:419–424.

14. Haynes D, Leeder J, Rayment P. A comparison of the bivalve species Donax deltoides and Mytilus edulis as monitors of metal exposure from effluent discharges along the ninety mile beach, Victoria, Australia. Mar Pollut Bull 1997; 34:326–331.

15. Hornung H, Oren OH. Heavy metals in Donax trunculus (Bivalvia) in Haifa Bay, Mediterranean (Isreal). Mar Environ Res 1980-81; 4:195–201.

16. Idardare Z, Moukrim A, Chiffoleau JF, Alla AA. Trace metals in the clam Donax trunculus L. from the Bouadisse sandy beach, discharge zone of a plant sewage outfall in Agadir Bay (Morocco). Proceedings of the Fifth International Symposium on Sandy Beaches, Rabat, Morocco 2011

17. Lima EFA. Deteerminação de cadmio, cromo, cabre e zinco em mexilhões Perna perna (LINNE, 1758) do litoral do estado do Rio de Janeiro. Dissertação de Mestrado. Depto de quimica, PUC/RJ. 1997.

18. MAFF (Ministry of Agriculture, Fisheries and Food). Report on Copper. Revised Recommendations for Limits for Copper Content of Foods, Food Standards Committee, London: Her Majesty's Stationery Office; 1956.

19. Marina M, Enzo O. Variability of zinc and manganese concentrations in relation to sex and season in the bivalve Donax trunculus. Mar Pollut Bull 1983; 14:342–346.

20. Mauri M, Orlando E. Occurrence of trace metals Fe, Mn, Zn, Cu in the wedge shell Donax trunculus L. (Bivalvia). Bull Zool 1979; 46:113–116.

21. Moukrim A, Kaaya A, Najimi S, Roméo M, Gnassia-Barelli M, Narbonne JF. Assessment of the trace metal levels in two species of mussels from the Agadir Marine Bay, South of Morocco. Bull Environ Contam Toxicol 2000; 65:478–485.

22. NHMRC (National Health and Medical Research Council). National Food Standard A l2: Metals and Contaminants in Food, Canberra, Australia: Australian Government Publishing Service; 1987.

23. Özden O, Erkan N, Deval MC. Trace mineral profiles of the bivalve species Chamelea gallina and Donax trunculus. Food Chem. 2009; 113:222–226.

24. Rajakumar PB, Raj YL, Wesley SG. Status of heavy metals in the edible brown mussel Perna indica collected near Kudankulam nuclear power project site, east coast of India. J Theo Exp Biol 2010; 7:43–53.

25. Rómeo M, Gnassia-Barrlli M. Donax tunculus and Venus verrucosa as bioindicators of trace metals in Mauritanian coastal waters. Mar Biol 1988. 99:223–227.

26. Roméo M, Sidoumou Z, Gnassia-Barelli M. Heavy Metals in Various Molluscs from the Mauritanian Coast. Bull Environ Contam Toxicol 2010; 65:269–279.

27. Shirodkar PV, Mesquita A, Pradhan UK, Verlekar XN, Babu MT, Vethamony P. Factors controlling physico-chemical characteristics in the coastal waters off Mangalore – A multivariate approach. Environ Res 2009; 109:245–257.

28. Sidoumou Z, Gnassia-Barelli M, Siau Y, Morton V, Roméo M. Heavy metal concentrations in molluscs from the Senegal coast. Environ Internat 2006; 32:384–387.

29. Singh YT, Krishnamoorthy M, Thippeswamy S. Seasonal variations of Cu, Pb, Fe, Ni and Cr in the edible wedge clam, Donax faba (mollusca, bivalvia) from the Padukere beach, Karnataka. J Theo Exp Biol 2012a; 8:95–100.

30. Singh YT, Krishnamoorthy M, Thippeswamy S. Status of heavy metals in tissues of wedge clam, Donax faba (Bivalvia: Donacidae) collected from the Panambur beach near industrial areas. J Theo Exp Biol 2012b; 4:30–35.

31. Thairit T, Roachanakanan R, Naiyanetr P, Songchitsomboon S. Accumulation of heavy metals in bivalve mollusc: Hoi Seab Donax incarnatus Gmelin, 1789 at Mae Rumphung, Suanson and Mae Pim beaches, Rayong Province, Thailand. 37th Congress on Science and Technology of Thailand, Thailand, 2011.

32. Usero J, Morillo J, Gracia I. Heavy metal concentrations in molluscs from the Atlantic coast of southern Spain. Chemosphere 2005; 59:1175-1181.

33. Van As D, Fourie HO, Vleggaar, CM. Accumulation of certain trace elements in marine organisms from the sea around the Cape of Good Hope. In: Radioactive contamination of the marine environment IAEA-SM-158/9 1973.

34. Walting RJ, Walting, HR. Environmental studies in Saldanha Bay and Langebaan Lagoon. CSIR Report FIS 70, 1974.

35. Walting HR. Selected molluscs as monitors of metals of metal pollution in coastal marine environments. Ph.D. Thesis, Department of Zoology, University of Cape Town, South Africa, 1978.

36. Walting RJ, Walting HR. Trace metal surveys of the South African coast II. Mossel Bay. Port Elizabeth, UPE Zoology Report No 7, 1981.

37. Walting RJ, Walting HR. Trace metal surveys in Mossel Bay, St Francis Bay and Algoa Bay, South Africa. Water SA 1983; 9:57–65.

38. WHO (World Health Organisation). Evaluation of certain food additives and contaminants. Thirty-third report of the joint FAO/WHO expert committee on food additives. WHO Technical Report Series 776, 1987.

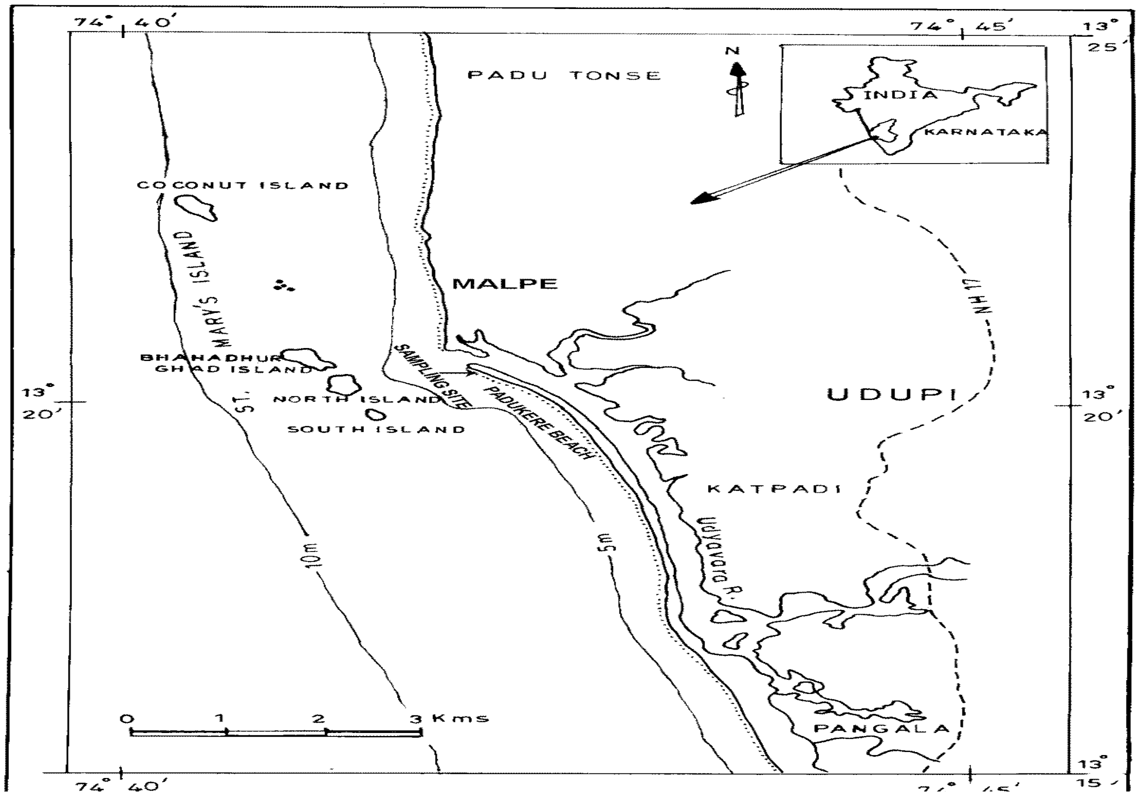

Fig. 1 Location of sampling site along Padukere beach

Fig. 2 Donax scortum collected from Padukere beach, Karnataka

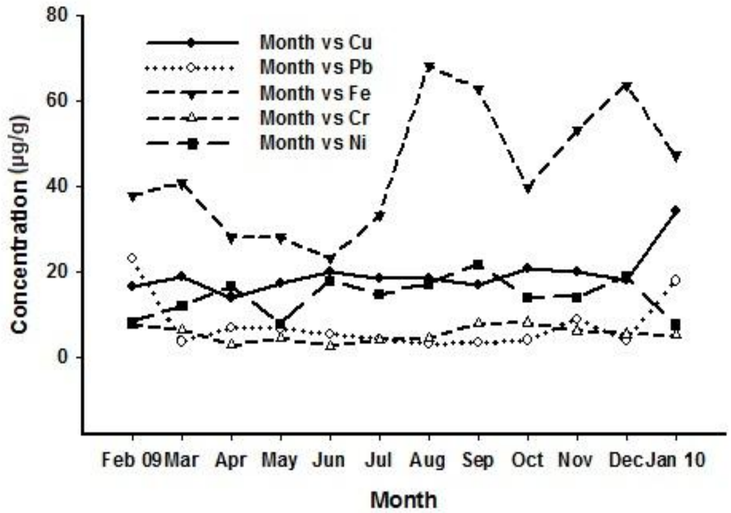

Fig. 3 Seasonal variations of heavy metal (Cu, Pb, Fe x 25, Cr and Ni) concentrations (µg/g dry weight)

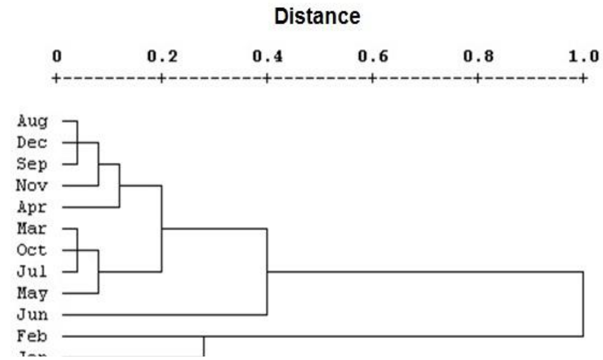

Fig. 4 Dendrogram of temporal clustering of monitoring periods

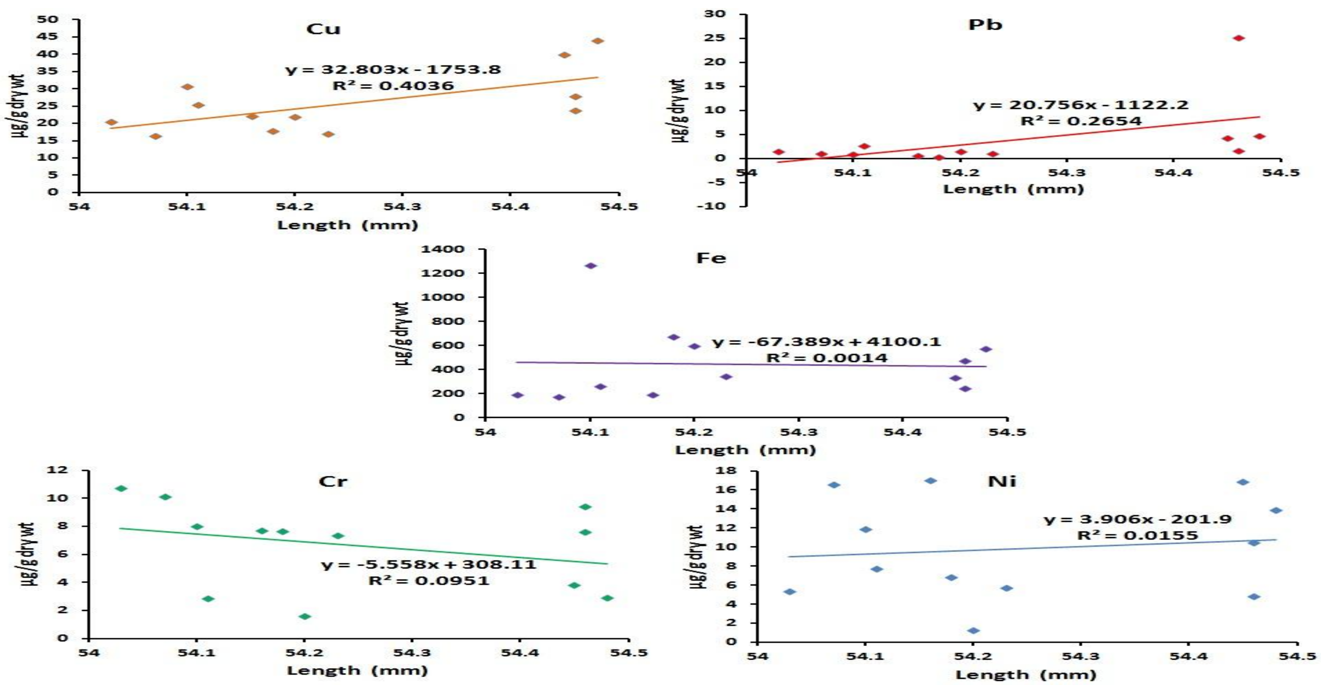

Fig. 5 Relationship between metal concentrations and shell length in Donax scortum

Species	Location	Cu	Pb	Fe	Cr	Ni	Reference
Donax scortum (D)	India	19.38	7.56	1094.96	5.38	14.26	Present study
D. faba (D)	India	25.55	3.75	444.68	6.64	9.85	Singh et al., 2012a
D. faba (D)	India	21.84	4.22	501.11	6.23	5.76	Singh et al., 2012b
D. faba (D)	Malaysia	7.23	12.60	654.00	-	3.65	Edward et al., 2009
D. trunculus (D)	Mauritania	11.80	-	663.00	-	-	Roméo and Gnassia-Barelli, 1988
D. trunculus (D)	Israel	17.40	6.22	-	-	-	Hornung and Oren, 1980/1981
D. trunculus (D)	Egypt	12.57	-	570.07	-	-	Abdallah and Abdallah, 2008
D. trunculus (D)	Morocco	10.52	0.90	-	1.42	1.60	Idardare et al., 2011
D. trunculus (D)	Mauritania	8.88	-	-	-	-	Sidoumou et al. 2006
D. trunculus (D)	Spain	175.00	3.60	-	1.20	1.20	Usero et al., 2005
D. trunculus (W)	Italy	2.80	-	21.40	-	-	Mauri and Orlando, 1979
D. rugosus (D)	Mauritani	20.60	-	-	-	-	Roméo et al., 2000

	a						
D. trunculus (W)	Turkey	1.93	0.57	324.29	-	2.01	Özden et al., 2009
D. deltoides (D)	Australia	6.80	-	-	-	1.16	Haynes et al., 1995
D. serra (D)	South Africa	-	-	181.00	0.70	3.00	Van As et al., 1973
D. serra (D)	South Africa	-	-	59.00	0.24	-	Van As et al., 1973
D. serra (W)	South Africa	1.18	0.03	84.00	0.26	0.43	Watling and Watling, 1981
D. serra (W)	South Africa	1.20	0.06	79.00	0.82	0.23	Watling and Watling, 1981
D. serra (W)	South Africa	1.10	0.14	81.00	0.60	0.38	Watling and Watling, 1983
D. serra (W)	South Africa	1.00	0.06	231.00	0.80	0.33	Watling and Watling, 1983
D. serra (W)	South Africa	0.90	0.03	81.00	0.60	0.28	Watling and Watling, 1983

D. serra (D)	South Africa	3.50	1.90	236.00	0.90	1.20	Watling and Watling, 1974
D. serra (W)	South Africa	1.60	0.03	72.00	-	-	Watling, 1978
D. serra (W)	South Africa	0.82	0.34	81.00	0.65	0.47	Watling, 1978
D. serra (W)	South Africa	0.64	0.34	42.00	0.17	0.21	Watling, 1978
D. serra (W)	South Africa	1.29	0.76	79.00	-	-	Watling, 1978
D. serra (W)	South Africa	1.18	0.03	84.0	0.16	0.43	Watling, 1978

Table 1 Comparison of heavy metal levels found in wedge clam tissues in several field studies. All concentrations are shown as μg/g dry wt (D) and μg/g wet weight (W)

Metal	μg/g	Reference
Cu	100	MAFF, 1956; BOE, 1991
	350	NHMRC, 1987
Pb	25	BOE, 1991
	50	Great Britian-Parliament, 1979
Fe	-	-
Cr	8	EEC, 1979
Ni	2	WHO, 1987

Table 2 Maximum acceptable limits (μg/g) of some heavy metals