Bull. Environ. Contam. Toxicol. (1987) 39:63–68

Environmental Contamination and Toxicology

Lead Uptake and Lead Loss in the Fresh Water Field Crab, *Barytelphusa guerini*, on Exposure to Organic and Inorganic Lead

S. J. Tulasi, Rafath Yasmeen, C. Padmaja Reddy, and J. V. Ramana Rao

Department of Zoology, Osmania University, Hyderabad-500 007, India

Lead is a heavy metal which is widely used in paint industy, pigments, dyes, electrical components and electronics, plastic chemicals and in various other things (Hodson et al 1984). Since some of the lead salts are soluble in water, lead presents a potential threat to aquatic organisms. However enrichment of lead within aquatic organisms and its transfer through the food chain constitutes a danger to man. Many such investigations has been directed towards studying the toxic effects of lead in fishes (Holcombe et al 1976; Reichert et al 1979; Hodson 1979). Studies dealing with invertebrates include those on mortality, growth and lead uptake in Lymnaea palustris and bioaccumulation of heavy metals in oysters and mussels (Borgmann et al 1978; Martincic et al 1984).

Litle information exists regarding the effect of lead on the fresh water crustaceans (Anderson 1978, Gilles and Pequeux 1983). Hence the present investigation has been undertaken to study the uptake and loss of lead on exposure to subtoxic levels of organic and inorganic lead.

MATERIALS AND METHODS

Fresh water crabs were collected from the local paddy fields and were acclimated to the laboratory conditions. Uninjured Males of uniform size (30-40 gms), in the intermoult stages were selected for the experiment. 10 crabs were placed in each tub containing 8 litres of water. They were fed with fish meat every day and feed was withdrawn one day prior to the experiment. After two weeks of acclimation they were exposed to different concentrations of lead acetate and lead nitrate and the LC_{50} values were determined for 96 hours according to Finney (1964). LC_{50} values for 96 hours for lead acetate was found to be 20 ppm and for lead nitrate 26 ppm, (Tulasi et al 1985). Crabs were exposed to a sublethal concentration (0.5 ppm) of lead acetate and lead nitrate for a period of 30 days. Lead content was analysed according to Kendall and Scanlon (1982) on an Atomic Absorption Spectrophotometer. (Perkin Elmer Model 373). Lead content was analysed in the hepatopancreas, muscle, gill, exoskeleton (shell) and in

Reprint requests to S J Tulasi at the above address

haemolymph of crab on different days of exposure (1,4,15 and 30 days). After 30 days of exposure they were transferred to normal tap water and the lead content was determined for a period of 15 days.

All glassware were thoroughly washed in 20 percent nitric acid before use and rinsed in distilled water several times. Chemicals were of analytical grade and the water used was double distilled water.

RESULTS AND DISCUSSION

Results of the present investigation are given in Figure I.Lead was absorbed through the gills and distributed by the haemolymph to hepatopancreas, muscle and exoskeleton. Haemplymph was found to contain the highest amount of lead followed by gill, hepatopancreas, muscle and exoskeleton.

Lead bioaccumulated over the course of study shows typical differences with a high degree of organ specificity. Such a difference in the organ specific distribution has been reported for various animals including fishes and molluscs. In the case of fishes the tissue residues of lead are highest in skeleton, gill, kidney and liver with lesser amounts in muscle and other tissues (Holcombe et al 1976; Hodson et al 1978). In molluscs the highest amount is found in kidney, gill, digestive gland, foot and mantle (Pringle et al 1968; Schulz Baldes 1974). Thus a general pattern emerges in which the kidneys, gill and digestive gland shows the highest rate of uptake while gonads, mantle and muscle takeup heavy metal more slowly. On exposure to lead the fresh water crab, Barytelphusa guerini was shown to accumulate lead in the following order. Haemolymph, gills, hepatopancreas, muscle, exoskeleton (shell).

In the present investigation the uptake of organic lead was found to be more in the gill and haemolymph when compared to other tissues. The studies of Olson et al (1973) on the kinetics of the uptake of organic and inorganic mercury, indicated to depend on the number of sulfhydryl groups available, polarity and also on solubility of the metal. Since the kinetics of the various froms of lead are poorly understood it might be speculated that the inorganic from of lead (Lead nitrate) is poorly soluble in cell membrane with reduced motility, accumulates in lesser amounts when compared to the organic from (lead acetate). The investigations of Hodson (1979) revealed that organic lead is more toxic than inorganic lead to the fish. The experiments of Bondy (1984) also indicate that organic lead is more toxic than inorganic lead. He suggested that the most toxic froms of lead appear to combine water solubility with hyrophobic properties. This dual nature may allow maximal penetrance into the tissues and also enable a most intimate contact with membranes which also have hydrophilic and hydrophobic regions. Consequently organic lead is more toxic than inorganic lead.

When the fresh water crabs were transferred to normal tap water after 30 days of exposure the lead content was found to decrease in all the tissues and in the haemolymph. (Figure I). Experiments

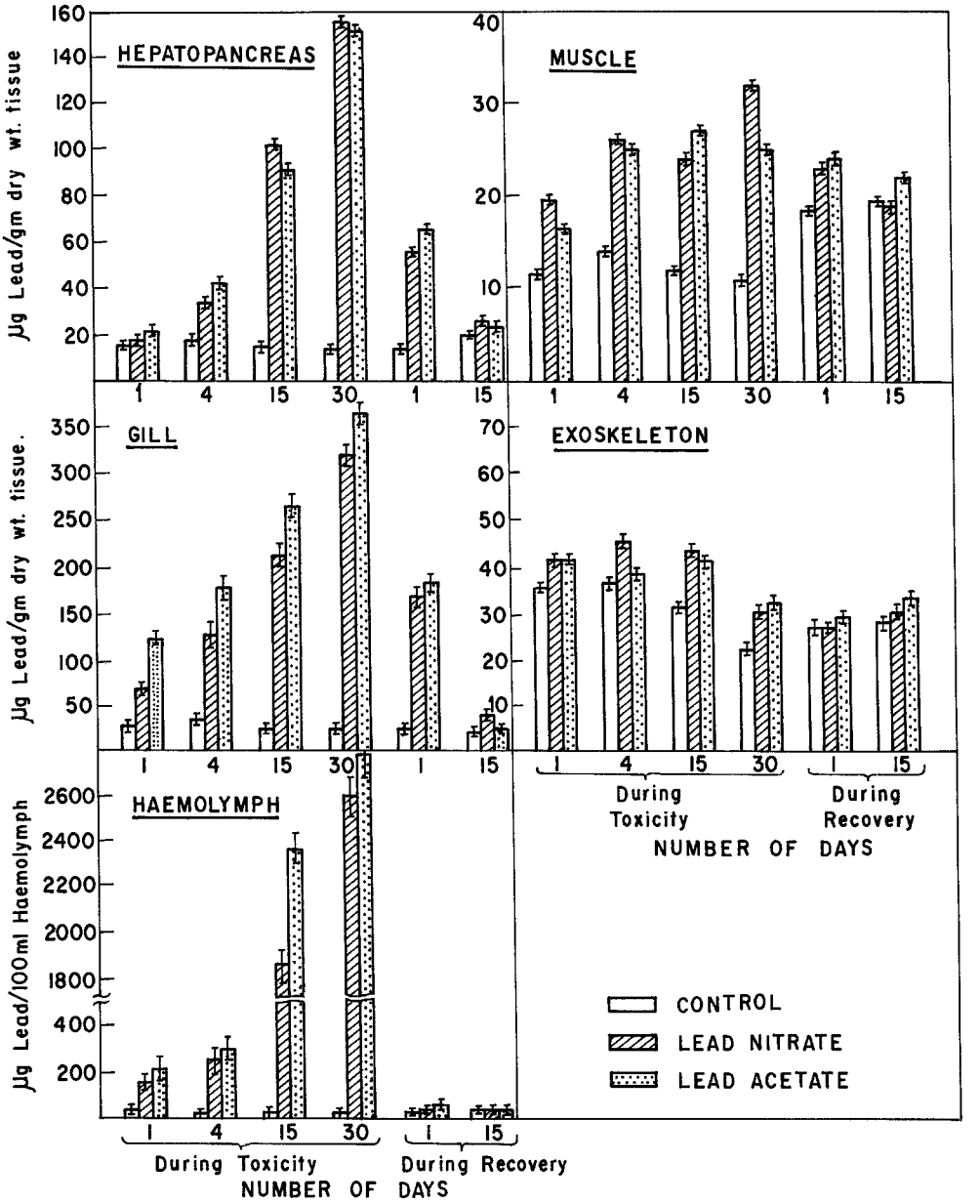

Fig. 1: Lead levels in the fresh water crab, Barytelphusa guerini on exposure to organic and inorganic lead. Each point is the mean of five samples.

of Holcombe et al (1976) have shown that the brook trout on transferring to normal water after 105 weeks of exposure were found to redistribute lead upto 12 weeks. Gill and kidney tissues were loosing lead while liver tissue was further accumulating lead. After 12 weeks in control water gill, kidney and liver contained significantly lower lead residues than initially. Studies of Reichert et al (1979) have shown that after 37 days of depuration lead content was found to decrease in all the tissues except kidney tissue. Therefore salmonids exhibit a strong tendency to retain lead in the kidney for at least one month after termination of the experiment. But in our studies we did not observe any redistribution of lead from one tissue to another but were loosing lead continuously on transfer to uncontaminated water.

The investigations of Cox and Anderson (1973), Tatem and Anderson (1973) have shown that the petroleum hydrocarbons which are rich in lead compounds are taken up very rapidly by crustacean tissues but retained them only for a brief period of time releasing them very rapidly reaching to undetectable levels within 1 to 7 days following exposure. On the other hand molluscs took up hydrocarbons some what more slowly but accumulated in their tissues to a considerable amount of time and released them more slowly than did crustaceans (Neff and Anderson 1974). Complete depuration by oysters may require as long as two months. Thus we have considerable evidences to show that crustaceans not only takeup pollutants rapidly but also release them rapidly as is evident from the present investigation.

In the present study an attempt has been made to find out whether shell (exoskeleton) has any advantages over soft tissues as indicators for monitoring heavy metal content. But the analysis of heavy metal content in the exoskeleton of the fresh water crab did not show any significant accumulation. By comparing our findings with the data published so far on the metal content in the exoskeleton (Bryan 1964; Wright 1977) we conclude that no similarity exists in the metal content of the shell. The multiplicity and complexity of the factors which influence the metal accumulation in shells of crustaceans lead us to conclude that a great deal of information is needed before such tissues can be employed as indicators of heavy metals in the aquatic environment. On the other hand since the haemolymph lead levels directly reflect lead exposure and increases with exposure period the measurement of blood lead levels may be used as a sensitive method of determining lead toxicity in the fresh water crab.

Acknowledgments. We thank the Council of Scientific and Industrial Research (CSIR) New Delhi, India for providing the fellowship and Prof. S.Sitaramayya, geophysics Department, Osmania University for analysing the samples on an Atomic Absorption Spectrophotometer.

REFERENCES

Anderson RV (1978) The effects of lead on oxygen uptake in the cray fish, Oronectes virilis. Bull Environ Contam Toxicol 20:394-400.

Bondy C Stephan (1984) ITRC-IBRO Symposium Neurotoxic substances and their impact on human health. ITRC-IBRO Lucknow India.

Borgmann U, Kramer O, Loveridge C (1978) Rates of mortality growth and biomass production of Lymnaea palustris during chronic exposure to lead. J Fish Res Board Can 35: 1109-1115.

Bryan GW (1976) Heavy metal contamination in the sea. In : Johnstan R (ed) Marine pollution, Academic Press, New York.

COX BA, Anderson JW (1973) Some effects of 2 fuel oil on the brown shrimp, Penacus aztecus. Amer Zool 13:262.

Finney DJ (1964) Probit Analysis. Cambridge University Press, London.

Gilles R, Pequeux A (1983) Interactions of chemical and osmotic regulation with the environment. In: The Biology of Crustacea, Vol 8. Environmental adapations (ed) F John Vernberg, Winona B Vernberg, Academic Press, 109-177.

Hodson PV, Blunt BR, Spry DJ (1978) Chronic toxicity of water borne and dietary lead to rainbow trout, Salmo gairdneri in lake Ontario water. Wat Res 12:869-878.

Hodson PV (1979) Factors affecting the sublethal toxicity of lead to fish. In: Proceedings of heavy metal conference London UK 135-138.

Hodson PV, Whittle DM, Wong PTS, Borgmann U, Thomas RL, Chau YK, Nriagu JO, Hallett DJ (1984) Lead contamination of the great lakes and its potential effects on aquatic biota. Offprints from toxic contaminants in the great lakes (ed) Nriagu JO, Simons MS, John Wiley and Sons Inc.

Holcombe GW, Benoit DA, Leonard EN, Mckim JM (1976) Long term effects of lead exposure on three generations of brook trout, Salvelinus fontinalis. J Fish Res Board Can 33:1731-1741.

Kendall RJ, Scanlon PF (1982) A rapid method for analysis of tissues for heavy metals using Atomic Absorption Spectrophotometer. North West Science 56:(4) 265-267.

Martincic CD, Nurnberg HW,Stoeppler M, Branica M (1984) Bioaccumulation of heavy metals by bivalves from Limfjord (North Adriatic Sea). Mar Biol 81:177-188.

Neff JM, Anderson JW (1974) Uptake and depuration of petroleum hydrocarbons by the estaurine clam, Rangia cuneata. Proceedings Natl Shell Fish Association.

Olson KR,Bergman HL, Fromm PO (1973) Uptake of methyl mercuric chloride and mercuric chloride by trout. A study of uptake pathways into the whole animal and uptake by erythrocytes in Vitro. J Fish Res Board Can 30:1293-1299.

Pringle BH, Hissong DE, Katz EL, Mulawka ST (1968) Trace metal accumulation by estaurine molluscs. J Sanit Engng Div Am Soc Civ Engrs 94:455-475.

Reichert WL, Fderighi DA, Malins DC (1979) Uptake and metabolism of lead and cadmium in coho salmon, Oncorhyncus kisutch. Comp Biochem Physiol C Comp Pharmacol 63(2):229-234.

Schulz - Baldes M (1974) Lead uptake from sea water and food and lead loss in the common mussel, Mytilus edulis. Mar Biol 25:177-193.

Tatem HE, Anderson JW (1973) Toxicity of four oils to Palaemonetes pugio in relation to uptake and retention of specific petroleum hydrocarbons. Amer Zool 13:261.

Tulasi SJ, Rafath Yasmeen, Ramana Rao JV (1985) Toxicity of organic and inorganic lead to the fresh water crab, Barytelphusa guerini. J Aqu Biol 3 (1 & 2) : 38-40.

Wright DA (1977) The effect of salinity on Cadmium uptake by the tissues of the shore crab, Carcinus maenas. J Exp Biol 67:137-146.

Received December 3, 1986; accepted April 13, 1987.