Sci. J. Fac. Sci. Menoufia Univ. Vol. X (1996). 13 - 19

TOXICITY OF COPPER AND ZINC SULPHATES TO THE HERMIT CRAB *EUPAGURUS CUANENSIS* (CRUSTACEA, DECAPODA PAGURIDAE)

El-Damhougy, K.A.
Department of Zoology, Faculty of Science, Al-Azhar University, Nasr City, Cairo, Egypt.

ABSTRACT

This work was performed to examine the toxicity of copper sulphate and zinc sulphate to the hermit crab Eupagurus cuanensis Thompson, 1843 (Crustacea, Paguridae).

Healthy adullt specimens of this species were exposed separately to different concentrations of copper sulphate and zinc sulphate. The exposed crabs generally showed increased activity immediately after their transfer to test solutions. However their activity was remarkably halted later in copper sulphate whereas in zinc sulphate they remain active for about three hours. Secretion of mucus has been observed on the whole body surface but most pronounced in the gill region. This species has been found to be more sensitive to copper than zinc.

INTRODUCTION

It has been well documented that various invisible toxic chemicals produced by the industrialized countries find their way into the marine ecosystem. Such chemicals become often transferred through the food chains in the sea and exert their effects in animals and places that may be remote in time and in space from the original source. These chemicals are slightly metabolized in some, but not in all organism, and therefore a substantial amount accumulated in the tissues remains there. When several such individuals are consumed by a carnivore of the next trophic level, the carnivore, in turn, gains the chemical from intoxicated individuals, which in turn, increase the total concentration in its body (James 1993).

Toxic metals tend to change biological structures and systems into irreversible and inflexible conformations leading to deformity or death (Luckey & Venugopal, 1977). Occurrence of Cu and Zn in industrial discharges and their toxic effect on ichthyofauna has been well documented (Mount, 1968; Shaw & Brown, 1974; Solbe & Cooper, 1977; Pickering *et al.*, 1977; Horning & Neiheisel, 1979). Toxicity of Cu and Zn to crustaceans has been studied by few workers (Ahsanullah, 1976; Eisler & Hennekey, 1977; Ahsanullah & Arnott, 1978; Ghate & Mulherker, 1979). However, no work seems to have been done on the toxicity of these metals to the hermit crab *Eupagarus cuanensis* Thompson 1843. Accordingly the present investigation deals with the toxicity of Cu and Zn to this species.

MATERIAL AND METHODS

Adult specimens of *E. Cuanensis* were obtained from Abu-Qir Site (Alexandria water). Plastic containers were used for experiments. Stock solutions of zinc sulphate and copper sulphate were prepared by dissolving 1 g. of each salt in 1 litre of distilled water separately. To prevent precipitation, 1 ml. acetic acid was added to the stock solution of copper sulphate. Six concentrations were prepered by adding calculated volumes of these stocks to each conainer having filtered non-polluted sea water. Ten healthy adult individuals were exposed to each test container. After every 24h., the test solutions were replaced by fresh solutions of respective concentrations. With each set of experiments one container was kept for control. Dead individuals were counted and removed daily.

RESULTS

Individuals showed increased activity immediately after their exposure to test solutions. Their activity was noticed to be decreased very soon in response to copper sulphate, whereas in zinc sulphate

solutions they remain active for about three hours and frequently come to the surface of the test solution. Secretion of mucus has been observed on the whole body surface but most pronounced in the gill region in both cases of exposure.

The LC_{25}, LC_{50} and LC_{75} values for 24, 48, 72 and 96h. for both chemicals have been given in Table (1). The 96h. LC_{50} values of zinc sulphte (3.228 mg/L) and copper sulphate (0.235 mg/L) showed that copper is fourteen times more toxic to the studied species than zinc. The minimum concentration of copper sulphate to initiate slight mortality was 0.03 mg./L 0.02 mg/L while for zinc sulphate was 1.2 mg/L. The first mortality in copper sulphate solution of 0.5 mg/L was observed after 6 hr. in contrast to zinc sulphate solution where it took 8 hr. in 15 mg/L solution.

Table (1) : Verious levels of lethal concentration of copper sulphate and Zinc sulphate to *E. cuanensis* after verious exposure periods.

Exposure period (h.)	Copper sulphate			Exposure period (h.)	Zinc sulphate		
	* LC_{25} (mg/L)	* LC_{50} (mg/L)	* LC_{75} (mg/L)		* LC_{25} (mg/L)	* LC_{50} (mg/L)	* LC_{75} (mg/L)
24	0.319	0.398	0.600	24	60882	13.010	19.010
48	0.230	0.328	0.551	48	6.350	11.280	16.020
72	0.177	0.295	0.508	72	4.810	7.760	10.230
96	0.103	0.235	0.490	96	1.232	3.228	7.218

* LC25 = Lethal cocentration for 25% of individuals
** LC50 = Lethal cocentration for 50% of individuals
*** LC75 = Lethal cocentration for 75% of individuals

DISCUSSION

In early hours of exposure to the toxic solutions the hyperactivity of the studied species was a behavioural response shown by the individuals to escape from the toxic solution and later, owing to the intoxication effect of the solution they become lethargic and lie on the bottom.

The present results showed that copper is fourteen times more toxic to *E. Cuanensis* than zinc. Many authors have reported a wide range of variation in the toxicity of copper and zinc to some crab species (Connor, 1972; Ahsanullah & Arnott, 1978; Thompson *et al.*, 1980; Pant *et al.*, 1980 and Murti & Shukla, 1984). These species have been found to be more sensitive to copper than zinc with the exception of *Carcinus maenas* where adults are less sensitive to copper than zinc.

Also the present data are in agreement with the results of Ghate & Mulhertker (1979) and Murti & Shukla (1984) which showed that copper is highly toxic (48 H LC_{50} 300μg) to prawns like *Macrobrachium*.

Lioyd (1960) and Skidmore & Torell (1972) have shown that copper and Zinc poisoning resulted in a separation of gill epithelium from the basement membrane.

Ghate & Mulherker (1979) observed distension of gill plates, vaculation in the gill tissue of two species of prawn, *Caridina* and *Macrobrachium* after chronic exposure to copper sulphate. They concluded that the gill is one of the target organs affected by exposure to copper salts. They further stated that crustacean gills are important in respiration as well as osmoregulation, hence cellular damage resulting in disorganisation of gill tissue would have serious consequences.

REFERENCES

Ahsanullah, M. (1976) : Acute toxicity of cadmium and zinc to seven invertebrate species from Western Prot, Victoria. Australian Journ. Mar. Freshwater Res., 27 : 187 - 196.

Ahsanullah, M. & G.H. Arnott (1978) : Acute toxicity of copper, cadmium and zinc to larvae of the crab *Paragrapraprapsus equadridentatus* (H. Milne Edwards), and implications for water quality criteria. Aust. J. Mar. Freshwater Res., 29 : 1-8.

Connor, P.M. (1972) : Acute toxicity of heavy metals to some marine larvae. Mar.. Poll. Bull., 3 : 190 - 192.

Eisler, R. & J. Hennnekey (1977) : Acute toxicities of Cd^{2+}, Cr^{+6}, Hg^{2+}, Ni^{2+} and Zn^{2+} to estuarine macrofauna Arch. Environ. Contam. Toxicol., 6 : 315 - 323.

Ghate, H.V. & L. Mulherker (1979) : Histological changes in the gills of two freshwater prawn species exposed to copper sulphate. Indian Journ. Exp. Biol., 17 (8) : 838 - 840.

Horning, W.B. & T.W. Neiheisel (1979) : Chronic effect on the bluntnose minnow *Pimephales notatus* (Rafinesque). Arch. Environ. Contam. Toxicol., 8 : 545 - 552.

James, W.N. (1993) : Marine Biology : An Ecological Approach 3rd edition.

Lioyd, R. (1960) : The toxicity of zinc sulphate to rainbow trout. Ann. Appl. Biol., 48 : 84 - 94.

Luckey, T.D. & B. Venugopal (1977) : Physiological and chemical basis for metal toxicity. Metal toxicity in mammals, 1 : 1 - 238. (Plenum Press, New York).

Mount, D. I. (1968) : Chronic toxicity of copper to fathead minnow, *Pimephales pimephales promelas* Rafinesque). Water Res., 2 : 215 - 223.

Murti, R. and Shukla, G.S. (1984) : Toxicity of copper sulphate and zinc sulphate to *Macrobrachium Lamarrei* (H. Milne Edwards) (Decapoda, Palaemonidae). Crustaceana, 47 (2) : 168 - 173.

Pant, S.C., S. Kumar & S.S. Khanna (1980) : Toxicity of copper sulphate and zinc sulphate to freshwater teleost *Puntius conchonius* (Ham.) in hard water. Comp. Physiol. Ecol., 5 : 146 - 149.

Pickering, Q., W. Brungs & M. Gast (1977) : Effect of exposure time

and copper concentration on reproduction of fathead minnow, *Pimephales promelas*. Water Res., 11 : 1079 - 1083.

Shaw, T.L. & V.M. Brown (1974) : Toxicity of some forms of copper to rainbow trout. Water Res., 8 : 377 - 382.

Skidmore, J.F. & P.W.A. Torell (1972) : Toxic effects of zinc sulphate on the gills of rainbow trout. Water Res., 6 : 217 - 230.

Solbe, J.F. de L. G. & V.A. Cooper (1977) : Studies on the toxicity of copper sulphate to stoneloach *Noemacheilus barbatulus* (L.). Water Res., 10 : 523 - 528.

Thompson, K. W., A. C. Hendricks & J. Cairns Jr. (1980): Acute toxicity of zinc and copper singly and in combination to the bluegill *Lepomis macrchirus*. Bull. Environ. Contam. Toxicol., 1 : 122 - 129.

سمية كبريتات النحاس وكبريتات الزنك على السرطان الناسك ايوباجرس كواننسز (قشريات - عشرية الارجل - باجاريدا)

خالد عبد اللطيف الدمهوجى

قسم علم الحيوان ، كلية العلوم ، جامعة الازهر ، مدينة نصر ، القاهرة

تحتوى المخلفات الصناعية على كثير من الكيماويات الضارة منها النحاس والزنك وعندما تجد هذه الكيماويات طريقها إلى النظام البيئى فى البحار والمحيطات فإنها تؤثر على الكائنات الموجودة ، حيث أنها تتجمع وتختزن فى الأنسجة ولا تدخل فى عملية التمثيل الغذائى لتلك الكائنات.

ولقد أجرى هذا البحث لمعرفة تأثير كلاً من كبريتات النحاس وكبريتات الزنك على السرطان الناسك إيوباجرس كواننسز (قشريات - عشرية الارجل - باجاريدا) ، حيث تم تعرض الحيوانات التى تنتمى إلى النوع المذكور إلى محاليل ذات تركيزات مختلفة من كبريتات النحاس وكبريتات الزنك كلاً على حده ، وقد أظهرت الدراسة أن هذه الحيوانات يزداد نشاطها فى البداية ثم سرعان ما ينقص هذا النشاط فى الحيوانات المعرضه لكبريتات النحاس ، بينما الحيوانات التى عرضت لكبريتات الزنك إستمر نشاطها إلى مايقرب من ثلاث ساعات وقد لوحظت مادة لزجة تغطى سائر الجسم مع أن منطقة الخياشيم كانت أغزرها .

وبينت الدراسة أن هذا النوع يبدى حساسية عاليه للنحاس اكثر من الزنك ، حيث بلغ تأثير النحاس ١٤ مرة قدر تأثير الزنك ، وقد تبين أن تركيز ٠٫٤٩ ملجم/لتر من كبريتات النحاس وكذلك تركيز ٧٫٢١٨ ملجم/لتر من كبريتات الزنك كلاً على حدة أدى إلى موت ٧٥٪ من هذه الحيوانات خلال ٩٦ ساعة . وهذا إن دل على شئ فإنما يدل على مدى خطورة هذه الكيماويات وسميتها لهذه الحيوانات ذات الاهمية الخاصة فى النظام البيئى ، مما يشير إلى ضرورة تحويل التصرفات الصناعية بعيداً عن البحار للمحافظة على البيئة من التلوث .