Acute Toxicity of Metasystox to Wedge Clam, *Donax cuneatus* from West Coast

D. V. MULEY, S. R. AKARTE, D. A. KULKARNI and K. R. RAO
Department of Zoology, Marathwada University, Aurangabad - 431 004

96 h acute toxicity tests were performed using commercial grade metasystox on the marine wedge clam, *Donax cuneatus* during summer 1985. The behaviour and mortality rates were recorded periodically. Most of the clams responded in opening the shell valves and extending the siphons quicker in low test concentrations (0.004-0.0052 p.p.m) but this was slow and late in high concentrations (0.0056–0.008 p.p.m). Mortality began to occur in 0.008 p.p.m. from 12 h, whereas, in 0.0052 p.p.m. from 60 h onwards. The observed LC_0 value was 0.004 p.p.m. and LC_{50} 0.0064 p.p.m. The regression equation established was $Y = 79.0891 + 33.4523 X$. The rate of oxygen concentration increased at LC_0 and LC_{50} values compared to control indicating the disturbed physiological adjustment. The results are correlated with physico-chemical parameters of seawater and discussed in the light of pesticide toxicity to the clam.

The wedge clam, *Donax cuneatus,* is widely distributed in the flat intertidal sand of Mirya Bay at Ratnagiri and eaten by poor people. Biology of this clam has been studied by Talikhedkar (1975). Our earlier studies have shown that the lamellibranch molluscs are sensitive to pesticide toxicity in summer than in monsoon and winter (Mane & Hiwale, 1984; Mane & Muley, 1984; Akarte, 1985). Considering the commerical importance of this wedge clam, we report here the acute toxicity of metasystox in summer.

Materials and Methods

D. cuneatus, were collected from the high tide at Mirya Bay, Ratnagiri during May 1985. They were batched into eight groups of 10 adults of 18–20 mm shell length in aquarium containing 10 litres charcoal filtered seawater. The water was changed after 11–12 h. After 24 h, the water of such aquarium was taken out along with the adults and appropriate test concentrations of metasystox (commercial grade – a product of Bayer India Ltd., Bombay) were prepared in seven test aquaria ranging from 0.004 to 0.008 p.p.m. A control was also run simultaneously. The water of these test concentrations and of control was renewed twice a day at an interval of 11–12 h for a period of 96 h, and before changing the water, behaviour and mortality of clams were noted. The physico-chemical parameters of the seawater was also determined. The glass aquaria were painted black from outside (since these clams burrow in the sand as the tide runs). The experiments were repeated twice. The results were statistically analysed and regression equation between log concentrations (in p.p.m.) (X) and probit mortality (Y) using the formula $Y = a + bx$ was established according to Finney (1971). The rate of oxygen consumption from control, LC_0 and LC_{50} groups was determined using Winkler's technique and statistically analysed for confirmation.

Results and Discussion

The physico-chemical parameters of the seawater used in the experiments were – temperature 25–28.5°C, salinity 28.8–30.5‰, oxygen tension 4.2–5.2 ml/1. and pH 7.0–7.1.

Totally seven different test concentrations were required to obtain LC_0 and LC_{50} values during 96 h. The behaviour pattern showed that in control group the clams after immersion opened the shell valves and extended the foot as well as siphons within 2–3 min to circulate the water through the body for respiration. The faecal matter was present in the aquarium throughout the period.

There was protrusion of mantle margin along the shell valves in the clams at the time when the clams extended the siphons to the maximum extent. Compared to control, within 30 min after immersion, in low test concentrations, 0.004 to 0.0052 p. p. m. most of the clams showed extension of siphons and foot as they did in controls but there was no protrusion of mantle margin whereas in 0.0064 to 0.008 p.p.m. there was no extension of siphons excepting foot protrusion by a few clams. No extension of mantle margin was seen. In 0.004 p.p.m. almost all clams with the lapse of time extended foot and siphons with little extension of mantle margin till 84 h but at 96 h half of the population extended only siphons and the rest only foot. In 0.0052 p.p.m. the clams extended siphons were more than those extended foot. Few clams tightly closed shell valves and frequently opened for water circulation. In 0.0056 p.p.m. 3–4 clams simultaneously showed extension of siphons and foot but remaining were with valves tightly closed. In 0.006 p.p.m. there was similar condition in 2–3 clams and others were with valves closed. In 0.0064 p.p.m. upto 48 h all the clams either extended the siphons or foot but from 60 h onwards most of the survivors were with valves closed. In 0.0068 p.p.m. upto 24 h 1–2 clams could extend the foot and siphons but from 36 h onwards almost all the survivors extended foot and siphons. In 0.008 p.p.m. survivors upto 24 h could extend foot and siphons and rest of them were with shell valves closed. From 36 h onwards all the survivors either extended foot or siphons. In 0.0052 to 0.008 p.p.m. from 12 h onwards the mantle protrusion outside the valves and the faecal matter accumulation were less. Death occurred from 60 h in 0.0052 and 0.0056 p.p.m. but in 0.006 and 0.0064 p.p.m. it occurred from 48 h. In 0.0068 p.p.m. clams died from 36 h and in 0.008 p.p.m. from 12 h. Total mortality at the end of 96 h was 20, 30, 40, 50, 70 and 100% in 0.0052, 0.0056, 0.006, 0.0064, 0.0068 and 0.008 p.p.m. respectively. Thus the observed LC_0 value was 0.004 p.p.m. and the LC_{50} value was 0.0064 p.p.m. The calculated LC_{50} was 0.0061 p.p.m. whereas the 95% fiducial limits (F.L.) were from 0.006 to 0.0063 p.p.m. The regression equation established is, $Y = 79.0891 + 33.4523$ X (Fig. 1).

The pollutant induced mortality pattern, particularly the pesticides, in many marine invertebrates were shown to be measurably related to various physico-chemical parameters of water used in the tests (Eisler, 1968). These include temperature, salinity, pH, type and concentration of pesticide as well as duration of exposure. Since then many investigators have shown that some organophosphorus insecticides are more toxic under conditions of high temperature, high salinities and low oxygen content (Mane & Hiwale, 1984; Akarte, 1985; Muley, 1985; Mane, 1973). While studying the acute toxicity of nuvan to two estuarine edible bivalves, Mane & Hiwale (1984) showed that both the species were sensitive to pesticide during the high temperature and salinity of summer than in monsoon.

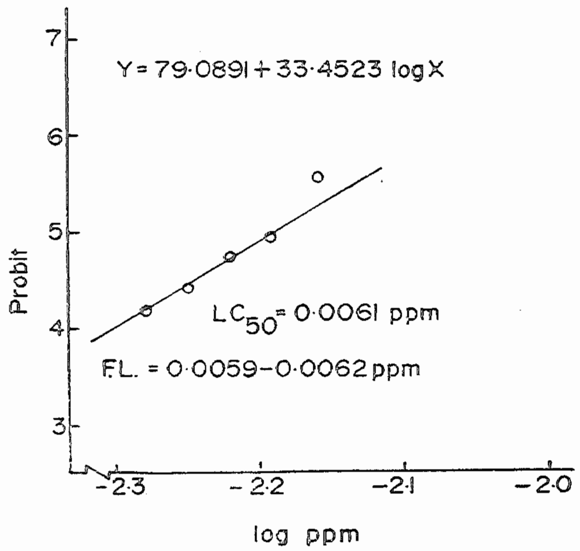

Fig. 1. Acute toxicity of metasystox to *Donax cuneatus* showing regression line

With freshwater bivalves also few investigators have shown that the bivalves are sensitive to pesticides in summer (Mane & Muley, 1984; Akarte, 1985). Variations in the opening of the shell valves, extension of siphons, protrusion of mantle edge and accumulation of excreta in the aquaria were also shown to be related to the pesticide type, duration of exposure and type of concentrations by the above workers. In the present study also similar findings were recorded. Since *D. cuneatus,* occurs along the tidal zone of sandy flats, they are washed with the tide and with ingoing tide they burrow quickly in the sand. Because of this, it is found in the experiments that none remained with shell valves open and siphons extended for a longer period. In higher test concentration at the initial period mostly these clams closed the shell valves but in the latter period opened the valves. Very low concentrations were tolerable but as the pesticide medium penetrated in the body, mortality occurred. This was earlier in high test media than low. Same pesticide when tested for acute toxicity to an estuarine clam, *Paphia laterisulca,* it was observed that LC_0 value was 0.002 p.p.m. and LC_{50} value 0.0045 p.p.m. indicating that the estuarine clam is more sensitive to metasystox toxicity than marine molluscs.

The rate of oxygen consumption of controls, LC_0 and LC_{50} groups showed a fluctuation of 0.139 ± 0.002 to 0.188 ± 0.002 ml 0_2/g/1 during 96 h of experimental period. In LC_0 group it fluctuated from 0.111 ± 0.005 to 0.322 ± 0.016 ml O_2/g/1 during 90 h study. In LC_{50} group, on the other hand, it fluctuated from 0.167 ± 0.004 to 0.461 ± 0.008 ml 0_2/g/1 during the study. The rate of oxygen consumption in LC_0 group increased at 12 h and declined upto 24 h, but at 48 and 96 h increased significantly than in controls ($p < 0.01$). Similarly in LC_{50} group the rate increased at 12 h ($p < 0.01$) but decreased till 48 h and increased considerably ($p < 0.01$) at 96 h. The pesticide at both the concentrations elevated the respiration in the begining but depleted afterwards and once again rose at 96 h (Fig. 2).

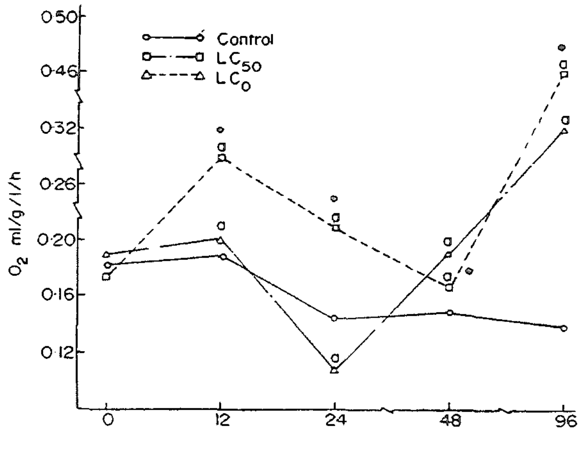

Fig. 2. Effect of metasystox on the rate of respiration of *D. cuneatus.*

Similar elevated rate of oxygen consumption was recorded in *Katelysia opima* by Mane *et al.* (1983) and in *Paphia laterisulca* (Akarte, *et al.*, 1985a). Rice *et al.* (1977) stated that a part of increased oxygen consumption is required to support enhanced physiological activities in metabolising and eliminatingpollutants by the exposed animals. Akarte *et al.* (1985b) showed that *L. marginalis* stored large amounts of metabolites in different parts of the body and were utilized in energy crisis after exposure to folithion. Such parameters are necessary to evaluate on *D. cuneatus,* an 'active' intertidal clam, in order to ascertain the mode of metabolic diversions.

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References

Akarte, S. R. (1985) *Effect of Organophosphorus Insecticides on Bivalve Molluscs.* Ph.D. Thesis, Marathwada University, Aurangabad

Akarte, S. R., Kulkarni, D. A. & Mane, U. H. (1985a) *Proc. Symp. Assess. Environ. Pollut. Aurangabad,* 173

Akarte, S. R., Rao, K. R. & Kulkarni, D.A. (1985b) *Int. J. Ecol. Environ. Sci.* (in press)

Eisler, R. (1968) *Bull. Am. Litt. Soc.* 11

Finney, D. J. (1971) *Probit Analysis,* Cambridge University Press, p. 26

Mane, U. M. (1973) *Some Aspects of the Biology of Marine Clam,Katelysia opima.* Ph.D. Thesis, Marathwada University, Aurangabad

Mane, U. H. & Hiwale, V. V. (1984) *Proc. Sem. Eff. Pest. Aq. Fau. Mhow India,* 169

Mane, U. H. & Muley, D. V. (1984) *Toxicol. Lett.* **23**, 147

Mane, U. H., Muley, D. V. & Akarte, S.R. (1983) *Indian J. Comp. Anim. Physiol.* **1**, 1

Muley, D. V. (1985) *Effect of Pollutants on Freshwater Molluscs from Godavari River at Paithan.* Ph.D. Thesis, Marathwada University, Aurangabad

Rice, S. D., Thomas, L. E. & Short, J. W. (1977) In *Physiological Responses of Marine Biota to Pollutants* (Vernberg, F. J., Calabrase A., Thurberg, F. P. and Vernberg, W. B., eds.) p. 259. Academic Press, New York

Talikhedkar, P. M. (1975) *Studies on the Biology of the Marine Bivalve, Donax cuneatus.* Ph. D. Thesis, Marathwada University, Aurangabad