SUMMARY AND RECOMMENDATIONS
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Studies on the effects of lead and chromium on the field crab *Spiralotelphusa hyrodoma* (Herbst) were made to evaluate the toxicity and sublethal effects.

Acute (24, 48, 72 and 96 hrs.) and chronic (30-40 days) toxicity tests were carried out to determine the toxic effects of metals in male and female crabs. All experiments were carried out in 12.8±0.3% salinity, at a temperature of 29 ± 1°C and with a photoperiod of 12 hrs. light and 12 hrs. dark. The crabs were not fed during the period of acute toxicity tests.

The 96 hrs. LC$_{50}$ values were 88 ppm for lead and 117 ppm for chromium for male crab; 120 ppm for lead and 172 ppm for chromium were the 96 hrs. LC$_{50}$ value for the female crab. Female crab was found to be more tolerant than male crab. The order of toxicity of metals to crab was as follows:

Lead > Chromium

Sublethal toxicity tests to study the metal uptake, oxygen consumption rate, acetylcholinesterase activity, ionic regulation, biochemical constituents and energetics were
conducted. One hundredth fraction of 96 hrs. LC$_{50}$ of each metal was among the three sublethal concentrations tested for their toxicity. This fraction is supposed to be the safe concentration of the toxicant. The calculated safe concentrations were 0.88 ppm, 2.2 ppm and 4.4 ppm of lead, 1.17 ppm, 2.93 ppm and 5.85 ppm of chromium for the male crab, 1.2 ppm, 3.0 ppm and 6.0 ppm of lead, 1.72 ppm, 1.3 ppm and 8.6 ppm of chromium for the female crab.

The control crab was seen to possess a background concentration of lead in muscle, chromium in hepatopancreas, gill and muscle. The uptake of lead and chromium by _S. hydrodroma_ was found to be more in male crab than in female crab. An important pattern seen in the uptake studies was that the rate of accumulation was dependent on time and exposure concentrations. The accumulation of metals in tissues was generally found to be in the following order:

Gill > Hepatopancreas > Muscle

The accumulation of chromium was more than lead. When male and female crab of _S. hydrodroma_ was exposed to different concentrations of lead and chromium, an increase in the rate of oxygen consumption at the beginning,
and later on the decrease in the rate of consumption was observed. These decreases were related to the test concentrations and exposure time. The decreases were more in lead treated crab than in chromium. The stress in respiration may be due to the accumulation of metals in vital tissues.

Sublethal concentrations of lead and chromium resulted decrease in AChE activity in male and female crabs. Higher the concentration of contaminants, the greater the decrease in AChE activity. The inhibition in different tissues was generally found to be in the following order:

Brain > Muscle > Gill > Hepatopancreas

These results explain the acute impairment in behaviour and thereby leading to hyperactivity and mortality during acute toxicity tests.

It was evident that the levels of sodium, potassium, calcium, magnesium and phosphorus were found disturbed in the crab exposed to sublethal concentrations. Sodium ions and magnesium ions were found to be increased significantly whereas potassium ions and calcium ions
decreased in the treated crab. Significant increase in phosphorus content was observed in lead treated crab and decrease was observed in crab treated with chromium. The disruption in ionic content may alter the polarity of the membrane constituents. Mg$^{++}$ ions are the inhibitors of neurotransmitters (Hoar, 1984). The changes in calcium and magnesium ions may also possibly be due to decrease in AChE activity.

The biochemical changes such as decrease in protein and lipid content and increase in sugar content of *S. hydrodroma* were seen to correlate with respiratory changes as well as decrease in food intake. The lead treated crab was seem to be the most affected and those in chromium to a lesser extent.

Significant changes in feeding rate, absorption rate, absorption efficiency and conversion rate in the treated crab were observed. Lead treated crab (except in crab treated in 0.88 ppm) incurred loss of weight. Toxicity due to ingestion of sublethal concentration of metals cause extraneous stress on the metabolic processes and extra stress might have resulted in the reduction of biomass.
Metabolic rate showed an almost similar trend as other parameters on exposure to stressors. Metabolic rate was significantly inhibited in metal treated crab. Lead induced decrease in ammonia excretion whereas chromium induced increase in ammonia excretion. These changes were directly related to test concentrations.

To overcome the respiratory stress and less feeding, it was evident that due to prolonged exposure it would have derived energy from biochemical reserves; that may be the reason for the changes in biochemical constituents.

In the laboratory bioassays, the field crab *S. hydrodroma* appear to be at minimum risk as the bioassays were conducted at optimal conditions of salinity, temperature and diet and each of the toxicant was tested individually. But under natural conditions, the crabs might be exposed to hydrographical parameters like salinity, temperature, food, etc., and a variety of contaminants which would most likely synergistically affect the crab.

The present study indicates that sublethal levels of lead and chromium produce dysfunction of several physiological and biochemical processes. At present, it
is difficult to evaluate the ecological significance of these relatively short-term alterations. However, the results encourage further work for longer periods of time.

To know the mechanism of toxic action of pollutants on aquatic organisms, further concurrent studies on whole animal and on specific molecular processes should be encouraged. This approach makes possible direct correlation between specific chemical events and effects upon the complete animal.