The Effects of Mercuric Chloride upon Respiration in *Congeria leucophaeata*

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Endogenous factors such as body, size, food abundance, age, and environmental factors: salinity, photoperiod, temperature, circadium rhythms and pollution have a large effect upon respiration (GALTSOFF, 1964; NEWELL, 1970).

Introduction of mercury into the marine environment is responsible for alteration of normal life functions in aquatic inhabitants. The bivalves come under scrutiny when there is heavy metal pollution, since many are of commercial importance. Evidence produced has shown that bivalves and other marine animals accumulate and store mercury in high concentrations (JOHNELS and WESTERMARK, 1969; MAYER, 1970; PEAKALL and LOVETT, 1972).

It was the purpose of this study to measure respiration rates of the bivalve Congeria leucophaeata in sub-lethal concentrations of mercuric chloride.

METHODS AND MATERIALS

The test animals, Congeria leucophaeata were collected at the NOAA National Fisheries Laboratory in Galveston, Texas. The size of the animals ranged between 1.2-2.4 cm. Test animals were maintained in aquaria containing filtering synthetic sea water (Instant Ocean), at 21°/oo salinity and 20-24°C.

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Respiration was measured using oxygen electrodes in glass jars within a controlled temperature bath, monitored on a Yellow Springs Instrument #54 oxygen meter. Baseline respiration data were accumulated on control animals. The shells were first thoroughly scrubbed to remove fouling organisms. The animals were then acclimated in aquaria for at least one week before respiration was measured. After transfer of active filtering animals from aquaria to the respiration chamber, an hour was allowed for further acclimation. Ten animals were placed in each oxygen electrode setup and suspended on a rubber mesh above a spinning stir bar to provide adequate water circulation within the closed system. All experiments were performed at 20^{o} C in synthetic sea water, 21^{o}/oo salinity and run for two hours. Change in oxygen levels was measured every 30 minutes to insure uniform depletion. At the end of the two-hour run all animals were sacrificed and dry weight was determined.

A stock solution of 1 mg Hg/L (1000 ppm) was prepared for use (21^{o}/oo salinity PH 8.2). From this, test solutions containing 10, 1.0, 0.1, 0.01, 0.001 ppm mercury as mercuric chloride were prepared to determine sub-lethal levels for a 48-hour period. Ten clean, active filtering animals were placed into each offive 3L vessels; each vessel contained a different test solution. The animals were kept in the vessels for 48 hours under constant mixing with stir bars and mild aeration. During this time, the system remained sealed with plastic wrapping. At the end of the exposure period, the animals were placed into clean water and respiration was measured. Measurements were recorded as ml O_2/g/hr.

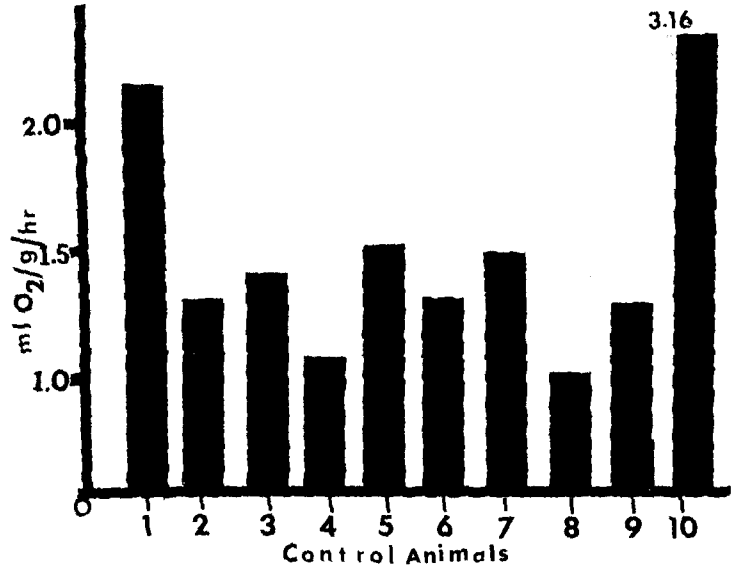

Fig.1- Respiration rates of Congeria leucophaeta in control conditions

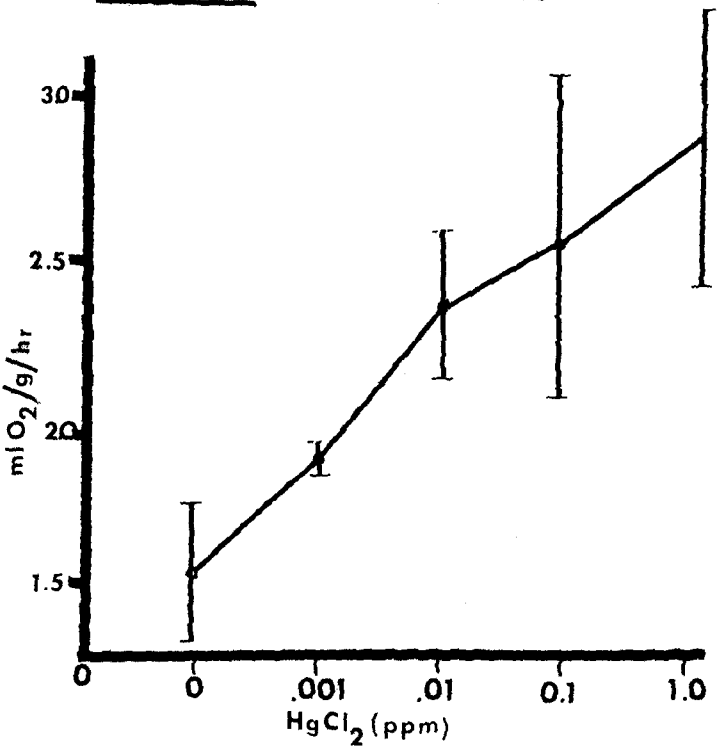

Fig.2-Mean respiration rates of Congeria leucophaeta in stressed and control conditions

RESULTS

A concentration of 10 ppm mercuric chloride was found to be (100%) lethal at 48 hours of exposure. All other concentrations were sub-lethal. The 1.0 ppm group showed 20% mortality; no mortality was seen at any other concentration. The mean respiration rate for 10 control experiments was 1.58 ml O_2/g/hr (Table 1). The variability of respiration among these 10 animals is depicted in Figure 1. The mean respiration increased with increasing concentration of mercury (Table 1, Figure 2).

	CONCENTRATION ($HgCl_2$)				
Statistic	0	0.001	0.01	0.1	0.1
$\bar{x}$	1.58	1.86	2.43	2.68	2.89
Σx^2	28.73	13.88	24.46	30.87	34.91
$(\Sigma x)^2/n$	24.96	13.77	23.68	28.70	33.49

Table 1. Mean respiration rate comparison

Using a Student's t-test for unpaired comparisons, significant ($p > .05$) differences in oxygen consumption were seen between the control and concentrations of 0.01, 0.1, and 1.0 ppm; and between 0.001 ppm and 0.01, 0.1 and 1.0 ppm; between 0.01 and 1.0 ppm (Table 2).

Group Comparison	df	t($p > .05$)
0-0.01	11	3.449*
0.001-0.01	6	5.374*
0.001-0.1	6	3.051*
0.01-1.0	6	1.777

Table 2. Unpaired comparison t-test. df=degrees of freedom, *=significant

DISCUSSION

This investigation has shown that the respiration rate of the bivalve rose with increasing mercury concentration. Departure of respiratory rates from the control became statistically significant above 0.01 ppm.

Mercury, acting as a protein denaturant, binds to membranes, altering ionic distribution and osmoregulatory activity of the animal (PASSOW et al., 1961). This alteration may account for increased respiratory rates in Congeria. However, the biochemical effect of mercury chloride was not severe enough to cause the animals to close their shells and begin anaerobic respiration as found in intertidal molluscs under environmental stress due to temperature, salinity (VERNBERG, 1972).

Other combinations of environmental parameters were found to have more effect on respiration than by using sub-lethal mercury concentrations. Hopkins (1949) found that low salinity coupled with a respiratory inhibitor was more stressful to bivalves than at high salinity. Studies on Mercenaria mercenaria show a greater oxygen consumption with increase in temperature; and increased respiration with decreased salinity (VAN WINKLE, 1968). Studies on Uca pugilator have shown synergistic effects using varying temperature and salinity with mercury (DE COURSEY and VERNBERG, 1972).

This study indicates that further investigation is necessary to determine synergistic effects such as combinations of temperature and salinity on respiration over an extended period of time.

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