BIOASSAYS ON MARINE ORGANISMS Ⅲ. ACUTE TOXICITY TEST OF MERCURY, COPPER CADMIUM AND TO YELLOWTAIL, *SERIOLA QUINQUERADIATA* AND ROCK BREAM, *OPLEGNATHUS FASCIATUS*

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海洋生物에 對한 生体實驗 Ⅲ. 빙어 및 돌돔에 대한 水銀, 구리 및 카드뮴의 毒性

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南海岸産 방어와 돌돔에 대한 水銀, 구리 및 카드뮴의 重金屬毒性 實驗을 1978年 7月 18日~27日間 靜水式으로 實驗室에서 實施하였다.

實驗結果 24時間 半數致死濃度(24*hr-LC* 50)는 방어에 있어서는 水銀 0.10*mg/l*, 카드뮴 0.82*mg/l*, 구리1.03 *mg/l*였고, 돌돔에 있어서는 水銀 1.61*mg/l*, 구리 1.73*mg/l*를 나타냄으로서 重金屬別 毒性 順位는 방어는 水銀, 카드뮴 구리이고 돌돔은 水銀—구리—카드뮴 順이며 두종류 共히 水銀 毒性이 가장 強함을 究明하였다.

INTRODUCTION

The cute toxicity bioassays of heavy metals on important commercial shellfish such as arkshell, oyster and clam in the south coast of Korea have been conducted by Park and Kim(1978; 1979).

The Present toxicity tests by heavy metals were given to the yellowtail and rock bream fish because of their economic importance in the aquaculture of the south Korean coast.

MATERIAL AND METHODS

Collection and Acclimation of Test Animals

Eight hundred yellowtail, *Seriola quinqueradiata*, from the fish-pen near Chung-Mu and seven hundred rock-bream, *Oplegnathus fasciatus* sampled from Han-San Is were transported in plastic containers to the laboratory by ship with continuous aeration and water replacement with new seawater, and they were immediately acclimated for a week in a holding tank. During the acclimation, they were fed with fish and shellfish-slices purchased from the market. The mean total length of the yellowtail was 4.65*cm* and that of rock bream was 8.53*cm*. The salinity, temperature, dissolved oxygen and pH in the the yellowtail holding tan kwere 33.8‰, 23.4°C, 5.34*cc/l* and 7.5 and those in the rock bream tank were 34.35‰, 19.2°C, 4.97*cc/l* and 8.02 respectively.

Testing Procedures

The volume of test sea water, ten liters for each container (22*W*×37*L*×28*cm H*), accommodated five to seven test animals. A group in a similar healthy test animals was distributed to test container for a preliminary test, and then five series of heavy metal concentrated test solutions for each test metal were employed for the final test.

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In the random selection of the test animals for five test containers, the first five fish to be caught from each holding tank were distributed one to each of the test containers and the next five catchs were done by the same process until the containers were filled (Gaddum, 1953).

The test solutions and their control for the constant metal concentration during the test used the same toxicity test methods as for the clam *Meretrix lusoria* by Park and Kim (1979 in press *Ibid*).

For comparison, the control test was simultaneously made in the same regular test containers as in the metal test containers.

Observations and recordings on the fish mortality during the exposure had been checked. Test animals were not fed in the test.

The lethal concentration for half of the animals (*LC* 50) was calculated from the data, customarily used in the U.S. as recommended by Doudroff *et al* (1951).

The toxicity curve was drawn with the mortality in ordinate and the concentration in abscissa for 24 hours for yellowtail and 48 hours for rock bream in the figure 1—2.

RESULTS

Mortality of Test Animals

The mortality of yellowtail at each concentration in the test containers is shown in Table

Table 1. Mortality(%) of the test animals for every concentration in the toxicity tests of heavy metals after 24 hours for yellowtail and 48 hours for rockbream

Animal	Metal	Item				
		Concentration	Mortality	Water quality		*LC* 50
		mg/l		pH	Temp.	*mg/l*
Yellowtail	Mercury	0.04	20	7.79		
		0.06	30	7.96		
		0.08	40	7.97	26±2°C	0.11
		0.1	70	7.88		
		0.2	80	7.87		
		0.4	100	7.87		
	Copper	0.2	30	7.79		
		0.4	10	7.68		
		0.6	30	7.77	26±2°C	1.03
		0.8	50	7.78		
		2	100	7.98		
	Cadmium	0.4	0	7.77		
		0.6	35	7.89		
		0.8	60	8.01	26±2°C	0.82
		1	50	8.00		
		2	100	8.02		
Rockbream	Mercury	0.6	10	8.02		
		0.8	27.1	7.95		
		1	52.4	7.79	18.5±1°C	1.40
		2	95.2	8.00		
		3	100	7.79		
	Copper	0.8	0	7.69		
		1	38.5	7.78		
		2	55.3	7.79	18.5±1°C	1.73
		4	88.6	7.90		
		6	100	7.88		

1. A hundred percent death rate appeared in the 0.4*mg/l* test container for mercury and the 2*mg/l* for cadmium and copper after 24 hours. At the 0.4*mg/l* of the test solution, the fish showed a ten percent mortality in copper and zero percent in cadmium for the same period. Consequently it was concluded that mercury was the most toxic substance to yellowtail among the three heavy metals.

In the rock bream acute toxicity test, there were no dead animals in the test containers for a copper solution of 0.8*mg/l* in concentration after 48 hours. On the other hand, no survival was found at 3*mg/l* for mercury and at 6*mg/l* for cop per after 48 hours. Rock bream were most sensitive to mercury and had the keenest sensitivity to mercury of all the metals.

Response and Concentration Relation

The relation of the response to the concentration of acute toxicity in heavy metals in the two species of test animals appeared to be a linear equation when plotted in logarithmic scale (Fig. 1—2).

The 24*hr-LC* 50 value of the yellowtail was 0.11*mg/l* for mercury, 1.03*mg/l* for copper and 0.82*mg/l* for cadmium, while the 48*hr-LC* 50 value of rock bream was 1.40*mg/l* for mercury and 1.73*mg/l* for copper respectively under the temperature conditions of 26±2°C for the former and 18.5± 1°C for the later in the test solutions.

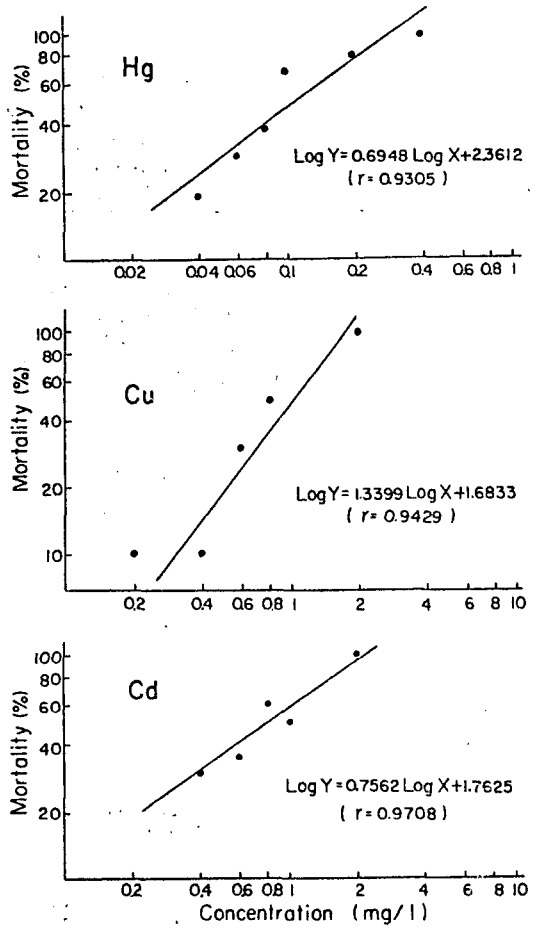

Fig. 1. Toxicity curve of mercury, copper and cadmium on yellowtail, *Seriola quinqueradiata* for 24 hours.

DISCUSSION

In the present toxicity test, yellowtail were much more sensitive to heavy metals than rock-bream. From the response of the two species of test animals, the most toxic substance of the metals tested proved to be mercury. The next most toxic metals were cadmium for yellowtail and copper for rock bream. It seems that different *LC* 50 values of the metals between yellowtail and rock bream might be caused by diffent conditions of water quality between two test species solutions especially in high water temperature(26±2°C) for the former and low one (18.5±1°C) for the later comparatively.

As shown in Table 2, the 24*hr-LC* 50 value of mercury for the yellowtail was higher than the 96*hr-LC* 50 value for minnow and slightly lower than the 96*hr-LC* 50 value for carp by Malacea (1966) according to National Academy of Sciences/National Academy of Engineering(1972). The 48*hr-LC* 50 value of copper for the rock bream was slightly bigger than that of rainbow trout (Brown 1968). In the cadmium solution, the 24*hr-LC* 50 value for yellowtail occurred at 0.82*mg/l* which was much less than the 58*hr-LC* 50 value

Table 2. Literature *LC* 50 values of mercury, copper and cadmium for marine organisms

Metal	Species	Time(*h*)	*LC* 50(*mg/l*)	Reference
Mercury	Carp (*Cyprinus carpio*)	96	0.30	* Malacea 1966
	Minnow (*Phoxinus phoxinus*)	96	0.02	〃
	Mummichog (*Fundulus heteroclitus*)	96	0.23	Jackim *et al* 1970
	Daphnia (*Daphnia magna*)	48	0.005	Biesinger & Christensen 1972
	Copepod (*Nitocra spinipes*)	96	0.23	Bengtsson 1978
Copper	Rainbow trout (*Salmo gairdneri*)	48	0.4—0.5	Brown 1968
	Feathead minnow (*Pimephales promelas*)	96	1.4	* Tarzwell & Henderson 1960
	Mummicog (*Fundulus heteroclitus*)	96	3.2	Jackim *et al* 1970
	Daphnia (*Daphnia magna*)	48	0.01	Biesinger & Christensen 1972
	Copepod (*Nitocra spinipes*)	96	1.8	Bengtsson 1978
Cadmium	Feathead minnow (*Pimephales promelas*)	96	5	* Tarzwell & Henderson 1960
	Mummichog (*Fundulus heteroclitus*)	96	27	JaKim *et al* 1970
	Daphnia (*Daphnia magna*)	48	0.065	Biesinger & Christensen 1972
	Yellow-eye mullet (*Aldrichetta forsteri*)	58	15.5	Negilski 1976

* According to National Academy of Sciences/National Academy of Engineering(1972).

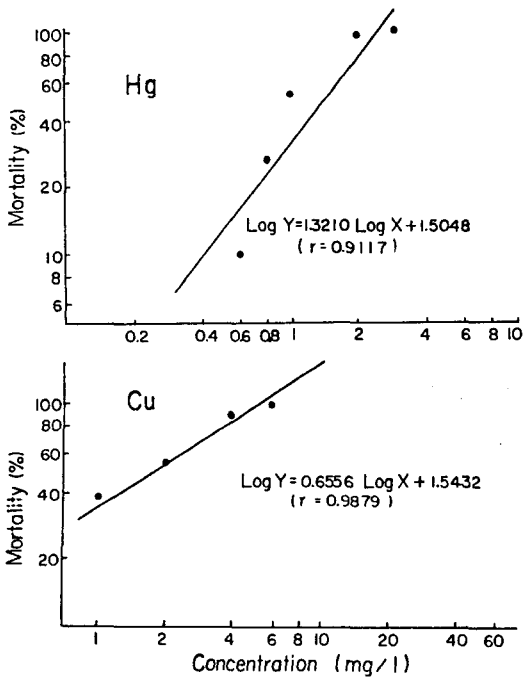

Fig. 2. Toxicity curve of mercury and copper on rock bream, *Oplegnathus fasciatus* for 48 hours.

of 15.5*mg/l* for yelloweye-mullet (Negilski 1976).

For environmental consideration, by using small number of small test fish and a large volume of solution with replacement at 24 hours intervals, five or seven test animals in each tank could be enough to minimize the degradation of respiration. So the production of ammonia by fish is unlikely to be a limiting factor(Alabaster and Abram 1965).

Aeration during the test might have an effect on the loss of volatile material which causes a change in pH value and would not be known tho effect to balance the respiratory needs of the test fish.

SUMMERY

The cute toxicity test of mercury, cadmium and copper to yellowtail, *Seriola quinqueradia*, and to rock-bream, *Oplegnathus fasciatus*, were conducted by static bioassays from 18 July to 27 October, 1978. In the tests, the least sensitive heavy metals were cadmium to rock bream and copper to yellowtail. The test species were most sensitive to mercury among all the chemicals used.

The 24*hr-LC* 50 value for the yellowtail was 0.11*mg/l* for mercury, 0.82*mg/l* for cadmium and 1.03*mg/l* for copper. While the 48*hr-LC* 50 value for the rock bream was 1.40*mg/l* for mercury and 1.73*mg/l* for copper,

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