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BIOCHEMICAL EFFECT OF CADMIUM TOXICITY ON A HILL STREAM TELEOST *GARRA MULLYA* (SYKES) DURING EGG MATURATION. I. TOTAL PROTEIN, GSI, HSI.

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ABSTRACT

Response of protein content of liver and ovary as well as gonosomatic index (GSI) and hepatosomatic index (HSI) to sublethal cadmium toxicity in a hill stream teleost *Garra mullya* (Sykes) during egg maturation, has been described. Cd-toxicity has been found to cause significant decrease in all the parameters i.e. protein content of liver and ovary as well as GSI and HSI.

INTRODUCTION

Heavy metals from several industrial, mining and other sources have been noted to create enormous pollutional problems. Cadmium is a non-essential heavy metal whose toxicity effects have been studied by different authors on a variety of fish species (Ball, 1967; Banerjee *et al.*, 1978; Wani and Latey, 1982, 1983; Dutta and Sinha, 1987). However, a lot of information is still lacking about the damage to different organs and disturbed physiological and biochemical processes within organisms, specially among hill-stream fishes exposed to Cd-polluted environment. Physiological and biochemical effects of heavy metals on hill-stream fishes and other riverine organisms are the area of special interest because rivers and streams in the Chhotanagpur plateau often get contaminated by heavy metals due to various industrial and mining effluents. In the present communication an attempt has been made to study the effect of cadmium toxicity on the biochemical aspect during gonadal maturation in the female *Garra mullya* which is a highly relished food fish in rural areas of this region.

MATERIALS AND METHODS

These fishes (female *Garra mullya*) were collected from Suvarnarekha river at Getalsud, 30 kms west of Ranchi town with the help of local fishermen. Fishes were brought to laboratory and kept in aquaria for a week in normal tap water for acclimatization. Total length of the test fishes were between 14 cm to 15 cm with a mean weight of 33.2 gm. The 96 hour LC50 value of cadmium for

Garra mullya in the present study was determined by Probit Analysis (Finney, 1971; Fisher and Yates, 1974), and was found to be 8.6 mg/lit. The water in which the fishes were kept for experiment had the following physico-chemical characteristics:

	April	May	June
Temperature (Deg. C)	24.7	26.2	25.5
pH	7.5	7.2	7.2
Total hardness (ppm)	69.0	61.0	72.0
Total alkalinity (ppm)	107.0	116.0	112.0
Dissolved oxyen (ppm)	6.5	7.2	7.5

The test fishes were kept in water containing 4 mg/lit. of $CdCl_2$ for 28 days. One dozen individuals were kept in Cd-containing and control waters. Fishes were lodged in water on second day of each month from April to June and were sacrificed on 30th day of the respective month. Present authors have studied the seasonal cycle of *Garra mullya* from the site mentioned above and it has been found that the ovary enters in maturing phase in April, the maturation is complete by June and by July spawning begins which continues upto early September. As the objective of the present study was to investigate the effect of sub-lethal concentration of $CdCl_2$ on some biochemical composition during gonad maturation, therefore the experiment was conducted from April to June separately. Control groups were maintained in identical condition without $CdCl_2$. During experiment the fishes were fed with *Hydrilla* leaves.

Tissue analysis

At the end of each treatment (28 days) the liver and ovaries of both treated and control fishes were dissected, weighed and gonosomatic index (GSI i.e. ovary wt./100 gm. body wt.) and hepatosomatic index (HSI i.e. liver wt./100 gm. body wt were determined for each fish. After that the ovary as well as liver was placed in fish saline and processed for the estimation of protein.

Extraction of protein from the tissue was done following the method of Munro and Fleck (1966) as modified by Abalain *et al.* (1980). The estimation was done by the method of Lowry *et al.* (1951) using spectrophotometer at 620 nm. Statistical analysis of the data was carried out by student's 't' test (Bruning and Kintz, 1970).

RESULTS

Results of the experiment has been represented graphically in Fig. 1. All the three parameters, HSI, GSI and protein content of liver and ovary showed significant decrease in Cd-treated fish in comparison to control groups in all the three months. Decease of gonosomatic index of Cd-treated fish in comparison to control was more significant in April and May ($p<0.001$) than in June ($p<0.02$). However, the ovary protein revealed highly significant decrease in Cd-treated fishes in all the three months ($p<0.001$). In liver the HSI of Cd-treated specimens recorded more significant decrease in May and June ($p<0.001$) than April ($p<0.05$). Liver protein also exhibited highly significant decrease during all the three months in Cd-treated specimens ($p<0.001$).

DISCUSSION

Mortality was not found either in Cd-treated or control specimens. No visible

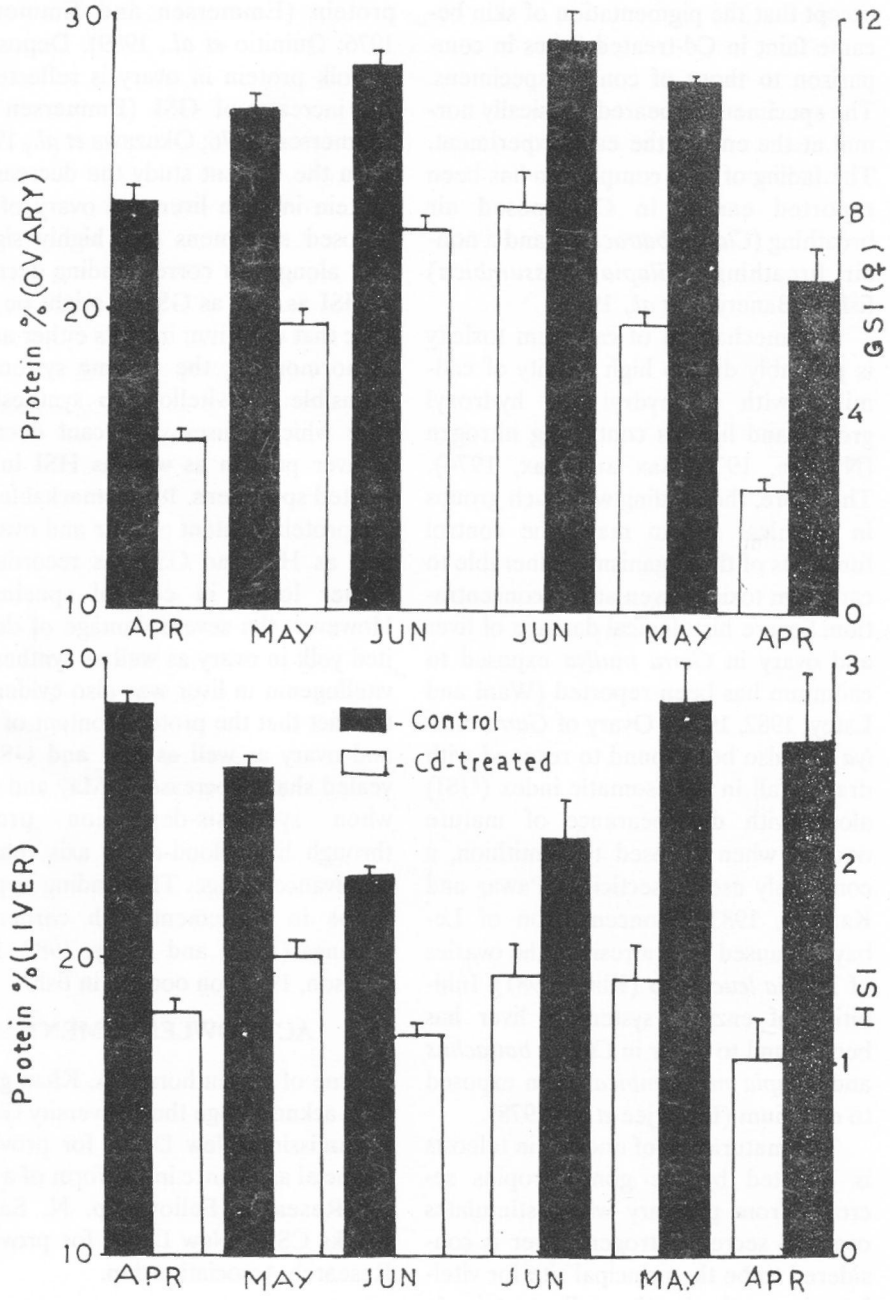

Fig. 1. Graphical representation of variation in total protein, in the liver and ovary and on gonosomatic index (GSI) and hepatosomatic index (HSI) due to Cd-toxicity in *Garra mullya*.

morphological changes were noticed except that the pigmentation of skin became faint in Cd-treated fishes in comparison to those of control specimens. The specimens appeared physically normal at the end of the each experiment. The fading of skin complexion has been reported earlier in Cd-exposed air breathing (*Clarias batrachus*) and a non-air breathing (*Tilapia mossumbica*) fishes (Banerjee, *et al.,* 1978).

The mechanism of cadmium toxicity is probably due to high affinity of cadmium with sulphydryl and hydroxyl groups and ligands containing nitrogen (Nilsson, 1970; Sax and Sax, 1974). Therefore, the binding with such groups in chemical system make the control functions of the organisms vulnerable to cadmium toxicity even at low concentration. Severe histological damage of liver and ovary in *Garra mullya* exposed to cadmium has been reported (Wani and Latey, 1982, 1983). Ovary of *Garra mullya* has also been found to respond with drastic fall in gonosomatic index (GSI) along with disappearance of mature oocytes when exposed to sumithion, a commonly used insecticide (Pawar and Katdare, 1983). Concentration of Lebaycid caused total atresia in the ovaries of *Tilapia leucostica* (Kling, 1981). Inhibition of enzyme system in liver has been found to occur in *Clarias batrachus* and *Tilapia mossumbica* when exposed to cadmium (Banerjee *et al*., 1978).

The maturation of oocytes in teleosts is initiated by the gonadotropins secreted from pituitary which stimulates ovary to secrete estrogen. Liver is considered to be the principal site for vitellogenin synthesis, the yolk protein (a phospho-lipo-protein) under the influence of estrogen. Vitellogenin synthesized in liver is transported by blood to ovary where it is incorporated as yolk protein (Emmersen and Emmersen, 1976; Quinitio *et al*., 1989). Deposition of yolk protein in ovary is reflected in the increase of GSI (Emmersen and Emmersen, 1976; Okuzawa *et al.*, 1986).

In the present study the decrease of protein in both liver and ovary of Cd-exposed specimens was highly significant along with corresponding decrease in HSI as well as GSI. It might be possible that cadmium inhibits either action of hormone or the enzyme system responsible for vitellogenin synthesis in liver which causes significant decrease in liver protein as well as HSI in Cd-treated specimens. It is remarkable that the protein content of liver and ovary as well as HSI and GSI was recorded in higher levels in control specimens. However, the severe damage of deposited yolk in ovary as well as synthesized vitellogenin in liver was also evident by the fact that the protein content of liver and ovary as well as HSI and GSI revealed sharp decrease in May and June when synthesis-deposition process through liver-blood-ovary axis remains in advanced stage. This finding appears to be in agreement with earlier reportings (Wani and Latey, 1982, 1983; Carlson, 1972) on oocytes in fish.

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