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Effect of Toxicity of Cadmium on Scale Morphology in *Cyprinus carpio* (Cyprinidae)

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Heavy metals, as pollutants of the aquatic environment, form a major hazard because of their toxicity, persistence and bioaccumulation in the food chains. In this respect cadmium pollution is of global concern (Samiullah 1990). Cadmium finds its way via atmospheric transport into the environment from a number of industries, is a byproduct of fossil fuel combustion and base metal smelting. This biologically non-essential element is highly toxic to aquatic organisms. Adverse effects of cadmium on the liver and kidney of aquatic animals are well documented (Mueller 1993; Singhal and Jain 1997). However, very few studies have been made to understand its effect on scale morphology of fish. Presently, such a study has been made in *Cyprinus carpio.* For a study of cadmium toxicity, this fish provides some unique advantages such as its tolerance to temperature variations, toughness and biennial breeding (Singhal 1995).

As the scales are most external to the body of fish, they continuously come in contact with water and the pollutants therein. Therefore, these can be very good bioindicators of the state of pollution in water bodies.

MATERIALS AND METHODS

Cyprinus carpio communis was regularly procured from the National Fish Seed Farm (NFSF), Joytisar. Healthy specimens, 12-15 cm in length and 100 g in weight, were selected. These animals were maintained in the laboratory in dechlorinated tap water at 22-25°C for 2 weeks. *Cyprinus carpio* were released in 100 l plastic containers containing cadmium chloride ($CdCl_2$. 2.5 H_2O) solution of different concentrations, i.e., 14.5, 29, 43.5 and 58 µg/l test solution. Each container was filled upto 90 l of the test solution of each concentration. Fish for treatment were taken into lots of four each. Control specimens were kept in plain water which didn't

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contain any cadmium (as determined by atomic absorption spectrophotometery). Test concentrations were renewed twice a week. Acclimated *C.carpio* were released in aerated containers at 22-25°C (pH 8-9) in semistatic bioassay (fed ad *libitum* fish feed manufactured by Lipton India Ltd. Vijayawada).

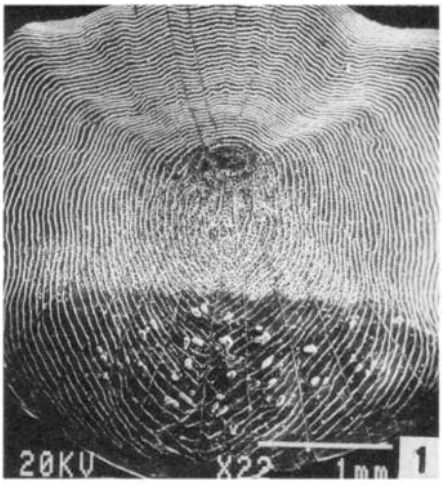
After for weeks exposure to the different concentrations, the scales were removed with the help of tweezers. They were cleaned in a sonicator and dried. Scales were mounted on aluminium stubs keeping the dorsal surface upward and gold-plated 100 A° in a gold plating unit thick under vacuum. Electron microphotographs were obtained using the JEOLJSM-6100 scanning electron microscope. At least three scales were examined in the case of each treatment.

RESULTS AND DISCUSSION

The scales of *Cyprinus carpio* are of cycloid type. The ventral surface is smooth but the dorsal surface is rough due the presence of circuli, radii, lepidonts and chromatophores. Fig. 1,2,3 and 4 show the circuli, radii, lepidonts and chromatophores in the unexposed scales of *C.* carpio.

On exposure to different concentration of cadmium, damage to these structure have been observed. It has been seen that lepidonts are the first affected parts of the scale. The lepidonts disappear before the circuli are damaged. Exposure to 14.5 µg/l cadmium concentration caused the breakage of lepidonts and circuli in the anterior and posterior region (Fig. 5 and 6). With 29 pg/l concentration of cadmium, there occurred breaking of circuli and lepidonts (Fig. 7 and 8). With increasing concentration, more pathological changes were observed. At 43.5 µg/l cadmium, more changes such as broken circuli and lepidonts (Fig. 9 and 10) were observed. At the maximum concentration (58 µg/l) extreme disruption of circuli and chromatophores in posterior region were noticed (Fig. 11). Only a few circuli and radii are visible at the corner of the anterior margins (Fig. 12). All the calcareous material was seen to be disorganised.

Scales have been used for classification and identification of growth in studies of different fishes. But the fine structure of fish scales, including their structural demarcations and shape, has been used inconsistently in fish taxonomy. Although the scales come in immediate contact with the environment and the pollutants therein, they have only rarely been used as bioindicators of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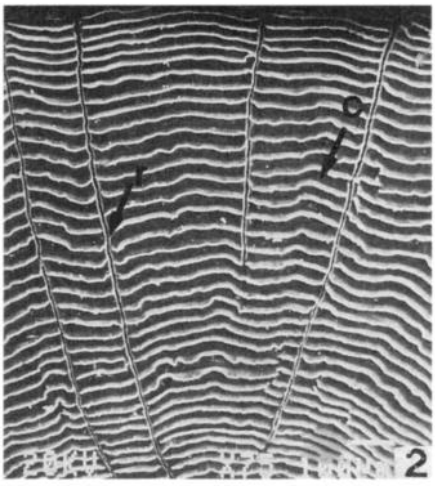
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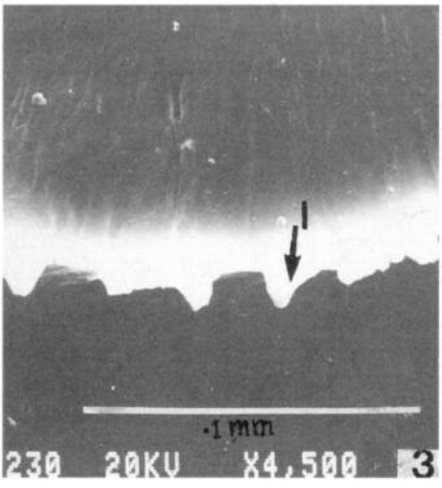
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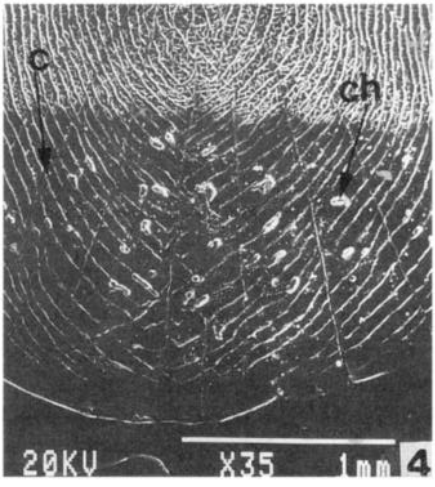
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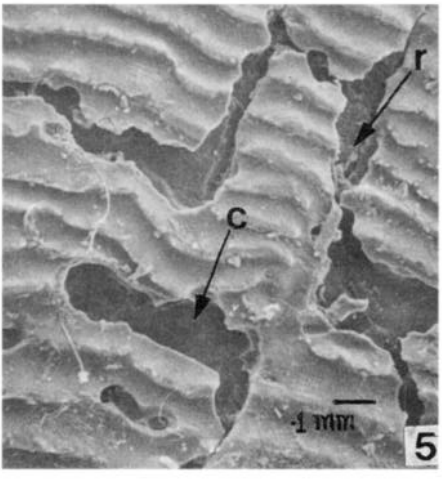
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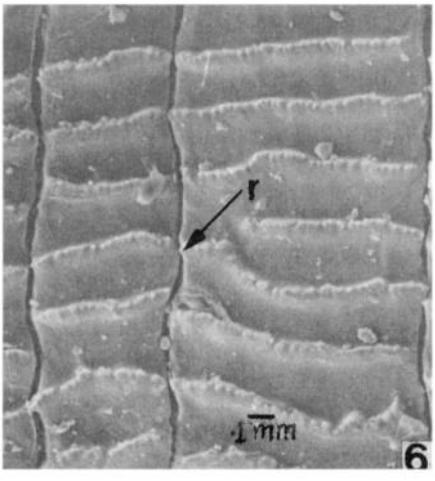
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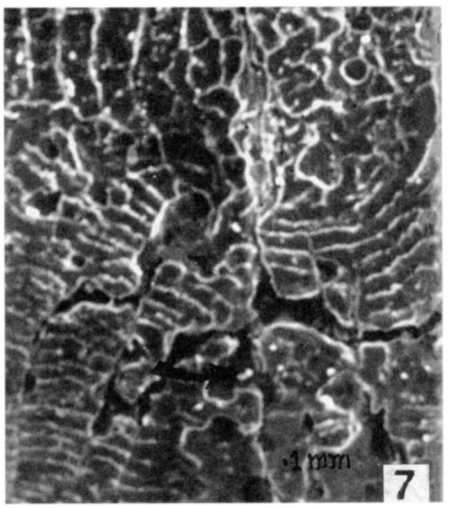
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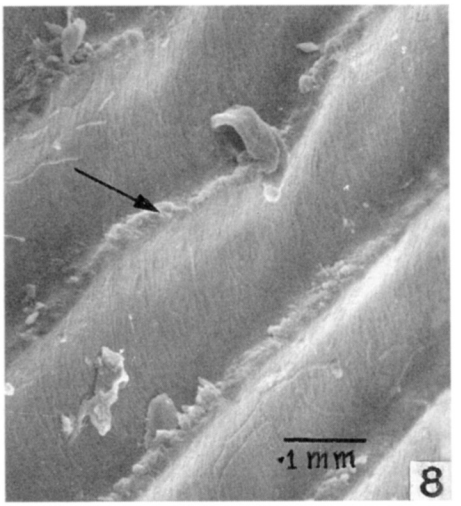
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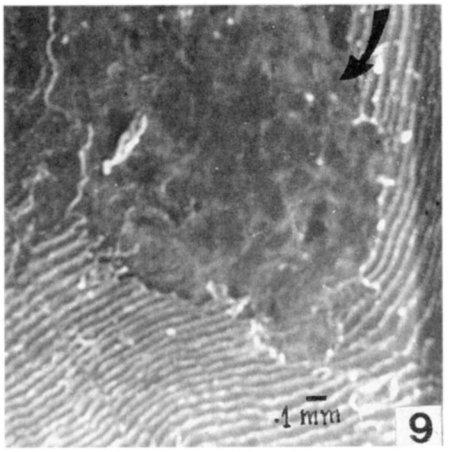
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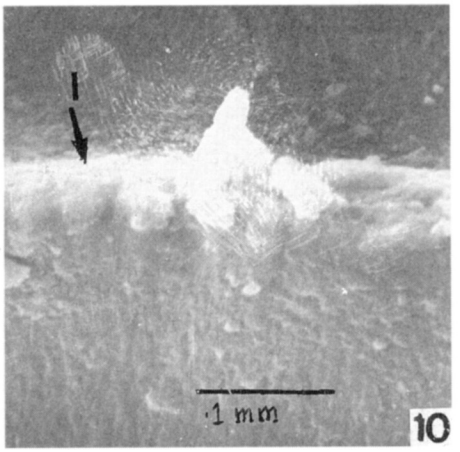
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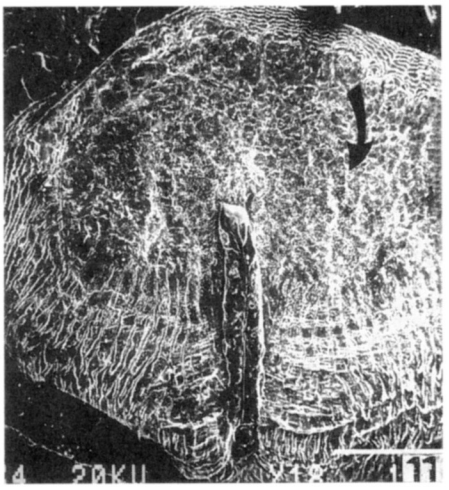
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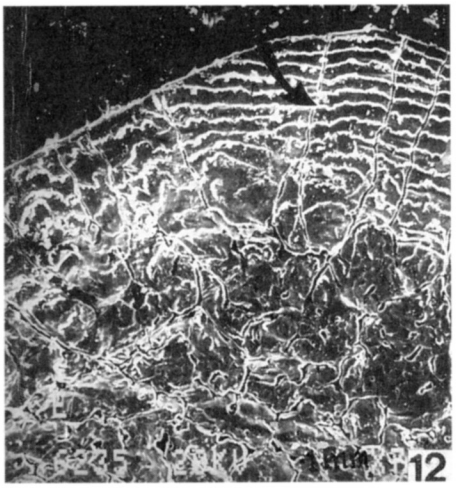
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Figure. 1. SEM picture of scale of control *Cyprinus carpio.*

Figure. 2. SEM picture of scale of control *Cyprinus carpio* showing radii (r) and circuli (c) in the anterior part.

Figure. 3. SEM picture of scale of control *C. carpio* showing conical lepidonts (l).

Figure. 4. SEM picture of scale of control *C. carpio* show chromatophores (ch) and circuli (c) in the posterior part.

Figure. 5. SEM picture of scale of *C. carpio* exposed to 14.5 µg/l) cadmium for 4 weeks showing broken circuli (c) and radii (r).

Figure. 6. SEM picture of scale of *C. carpio* exposed to 14.5 µg/l cadmium for 4 weeks showing radii (r).

Figure. 7. SEM picture of scale of *C. carpio* exposed to 29 µg/l cadmium for 4 weeks showing damaged circuli (arrow).

Figure. 8. SEM picture of scale of *C. carpio* exposed to 29 µg/l cadmium for 4 weeks showing broken lepidonts (arrow).

Figure. 9. SEM picture of scale of *C. carpio* exposed to 43.5 µg/l cadmium for 4 weeks showing broken circuli (arrow).

Figure. 10. SEM picture of scale of *C. carpio* exposed to 43.5 µg/l cadmium for 4 weeks showing broken lepidonts (l).

Figure. 11. SEM picture of scale of *C. carpio* exposed to 58 µg/l cadmium for 4 weeks showing damaged circuli and radii in the central and focal part,

Figure. 12. SEM picture of scale of *C. carpio* exposed to 58 µg/l cadmium for 4 weeks showing a few circuli (arrow) at the anterior part.

pollution (Johal *et al.* 1994; Tandon *et al.* 1993; Johal and Tandon 1989; Tandon and Johal 1983; Johal and Tandon 1983). However, any sudden change in fish environment causes alteration in circuli shape and pattern in elemental deposition of scales (Johal and Dua 1994).

On the basis of the present investigation made on the effect of cadmium on scales, it has been concluded that this heavy metal has adverse effect on the structural aspect of the scales. These observations agree well with the findings of Johal and Dua (1994) who reported disorganisation of circuli in the marginal part of scale on exposure to endosulfan. The scale thus can be used as a biomarker of pollution. An added advantage is that these can be used without sacrificing the animal.

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