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Histopathological studies on *Mugil cephalus* exposed to treated effluent

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Abstract

Industrial effluents are mostly discharged into the nearby water resources. Thus, fish living in rivers/lagoons receives most of the rich discharges of effluents and causes several physiological abnormalities. These effects have been attributed to various estrogenic chemicals known to be present within treated or/and untreated industrial effluents. Extensive laboratory-based studies conducted to confirm that chemicals in industrial effluent can induce several adverse effects on fish once exposed. It was also determined that such exposure to effluents can inhibit the reproduction of fish. The histopathological studies are useful in evaluating the pollution potential of toxicants since trace levels of chemicals do not bring about animal mortality over a given period and are capable of inducing considerable damage to organ. An investigation was carried out in the vital tissue gill of *Mugil cephalus*.

Keywords: *Mugil cephalus*, Effluent, Gill, Histopathology.

Introduction

Rapid industrialization in India has resulted in the substantial increase in the liquid waste (spent wash or effluent), which is traditionally discharged into open land or into nearby natural water they cause a number of environmental problems including threat to plant and animal lives and also creating problems such as surface water logging, ground water contamination and salinizing good quality land due to presence of high quality salt contents (Ramona *et al*., 2001). The adverse input of diverse industrial wastes has aggravated the problem of contamination and sewage and industrial disposal has greatly impact the aquatic ecosystem. Histological examination has been increasingly recognized as a valuable tool for the assessment of the impact of environmental pollutants on fishes (Heath, 1995). Specific lesion occurring in organs of fish exposed to toxic substances under laboratory conditions help to identify biomarkers of exposure. Gills are the first target of waterborne pollutants due to the constant contact with the external environment. Histopathological changes of gills such as hyperplasia, epithelial lifting, aneurism and increase in mucus secretion have been reported after the exposure of fish to a variety of noxious agent in the water, such as pesticides, phenol and heavy metal (Nowak, 1992).

Any change in water quality is rapidly reflected in fish gill structure and function, since gills are continuously exposed to ambient water. The gills are the primary sites of gas exchange, acid-base regulation and ion transfer (Randall, 1990). The gill epithelium consists mainly of three types of cells: pavement or respiratory cells, mucus cells and chloride cells as pointed out by

Laurent and Perry (1995). Pawert *et al*. (1998) stated that gills represent major sites for respiration; they are always in contact with water, which makes them important targets for water pollutants. The authors further stated that fish gills comprise more than half of the body surface, with an epithelial layer of only a few microns separating the interior of the fish from the external environment. So, the present study was carried out to give the clear details on histopathological changes in gills of *Mugil cephalus* in effluent.

Materials and Methods

Specimens of *Mugil cephalus* were collected from vellar estuary, India and acclimatized to laboratory conditions at Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai for fifteen days. Water was changed daily and fish were fed with bivalves flesh and ground dried shrimp twice a day. For experimental studies, fish ranging from 9-10 cm in length and weighing 10-12 g were selected. The common mixed effluent from SIPCOT Industrial state, Cuddalore, was collected in a polythene container and stored in a refrigerator until use. Temperature and pH were noted at the point of collection itself. The physico-chemical parameters of the common mixed effluent was estimated according to APHA (1998) and are as follows: Colour- white; Odour- Pungent; Dissolved Oxygen- 1.2 ± 0.02 mg, BOD- 2500 ± 2.0 mg; pH- 4.68 ± 0.2; Temperature- 28.2 ± 2.0ºC; Salinity- 3 ± 0.30 ppm.

Preparation of sample

The gills were dissected out from both the control and experimental fishes. They were cut into bits of 0.5 to 1 cm length and immediately put in Bouin's fixative. This procedure is followed to prevent post- mortem changes and shrinkage during dehydration, embedding and sectioning. The tissues were kept in the fixative for 24 hours. Then dehydraded in graded ethanol concentrations and embedded in paraffin wax. Sagittal sections (5µm of thickness) were cut and mounted on glass slides. Sections were deparaffinized in xylene, hydrated in ethanol and stained with Hematoxylin-Eosin. The changes induced by effluent treatment in the gill tissue were photographed and analysed by light microscopy.

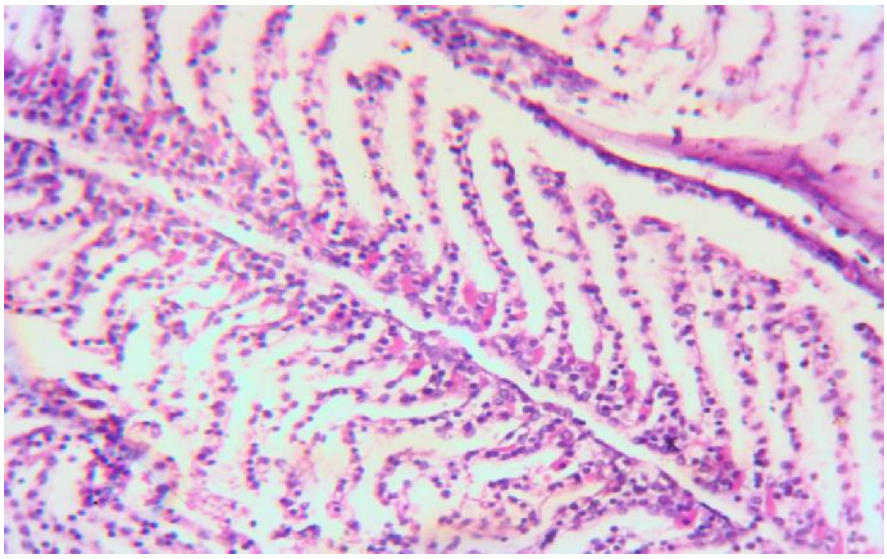
There were no changes in the gills of controlled fish, filaments and lamellae were noticed with flat epithelial cells and pillar cells lining the blood sinusoids. After 96 hours, in *Mugil cephaeus* the curling of secondary lamellae and lamellar fusion was noticed.

Results and Discussion

Histopathology is one of the widely accepted and used methods for the determination of injury in fish to the short term and chronic impacts of industrial effluents. The present study predicts that histopathological changes like difference in gills in *Mugil cephalus* when exposed in 96 hours to industrial effluent. Gill lesions as indicators of exposure to contaminants have previously been used in numerous laboratory and field studies around the world (Thophon *et al.*, 2003). Gills therefore, are potentially useful to monitor the health of fish. According to Domingos *et al*. (2009) and Brito *et al*. (2012) the occurrence of secondary lamellar fusion is frequently found in fishes exposed to urban sewage. Similar to this result, the present investigation also showed the curling of secondary lamellae and lamellar fusion in *Mugil cephalus* on exposure to effluent during the period of 96 hours (Figure 1). Adeyemo (2005) studied the gills of *Clarias gariepinus* and recorded histopathological and lamella deformations. All the above studies are resulted to concurrent to the present result as gill hyperplasia and lamella fusion were reported in *Mugil cephalus* to the exposed effluent at 96 hours

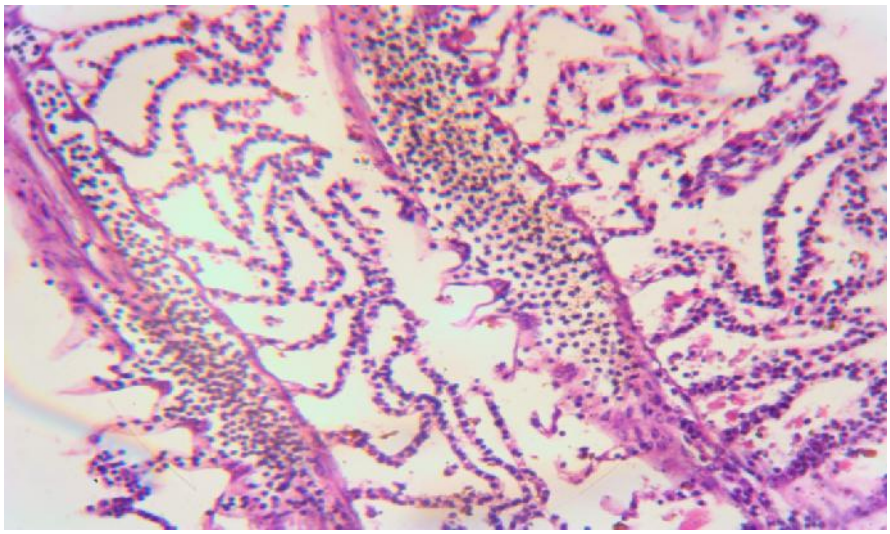
Lamellar fusion could be protective as it diminishes the amount of vulnerable gill surface area in fish. Mallatt. (1985). Fusion of secondary lamellae and swelling of primary and secondary lamellae increases the diffusion distance and reduced the surface area (Smith and Haines. 1995). The results of histopathological lesions on gill of the selected fish reveals the acute exposure of fish to pollutants which in turn shows the impact of effluent on aquatic organisms. Hence, the application of histopathological changes, acts as an important biomarker of environmental monitoring programmes. In addition to all the above symptoms, mucous secretion in the gills and body surface was observed in both fishes during the study period (Figure 2). Several researchers were conducted the same and also support this change in the present study Kumta & Kumar (1998) and Pugazhendy *et al*. (2008) analyzed this mucous formation as a result of reaction of solids in mucous producing cells and the secondary destruction of respiratory system. This reaction affects the CO_2 exchange which ends up the reason for the death of organism. This helps to understand that the effluent exposed fishes are presumptive evidences of dysfunction of the ionic regulations and respiratory mechanism impairment.

Figure 1. Gill structure of *Mugil cephalus* in controlled condition



PL - Primary lamellae **SL –** Secondary lamellae

Figure 2. Gill structure of *Mugil cephalus* under effluent exposed condition



EL – Epithelial lifting, **FSL** – Fusion of secondary lamellae **H** – Hyperplasia

Conclusion

From the above studies it can be concluded that the SIPCOT effluent was found to be highly toxic to the fish *Mugil cephalus* due to uncontrolled or untreated or partially treated industrial waste from SIPCOT industrial complex.

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