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ORIGINAL ARTICLE

IMPACT OF INDUSTRIAL POLLUTANTS ON THE HISTOPATHOLOGICAL ALTERATIONS IN THE GILL AND LIVER OF *Lates calcarifer* IN UPPANAR ESTUARY, NEAR SIPCOT, CUDDALORE, SOUTH COAST OF INDIA.

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ABSTRACT

Histopathological alterations are used as potent indicators for monitoring the effects of various pollutants on the aquatic organisms, which may induce considerable damage to the organs. An investigation was carried out in the gill and liver tissues of *Lates calcarifer* inhabiting the Uppanar estuary, Cuddalore, at three different stations with respect to summer and monsoon seasons. Substantially noticeable pathological changes were observed at station II when compared to that of station III and station I especially during summer season than that of the monsoon season. The possible reasons for the above regional and seasonal variations were elucidated.

K e y w o r d s : *Lates calcarifer*, histopathology, bioaccumulation, biomonitoring, necrosis.

1.INTRODUCTION

Pollution in the aquatic environment is a serious threat throughout the world. Due to rapid industrialization and extensive agricultural practices, large quantum of toxicants are being discharged into the aquatic environment. These toxicants include heavy metals, pesticides and some other harmful materials. Among these, heavy metal contamination may lead to various deleterious effects on the health of the aquatic organisms (Farombi *et al.*, 2007). The histopathological studies on fish represents the changes in the structural organization that occurs in the organs due to the prevalence of pollutants in the environment. The gills are efficient tools for biomonitoring potential impacts (Oliveira Ribeiro *et al.*, 2005) because of their large surface area in contact with water and high permeability (Arellano *et al.*, 2004 and Evans *et al.*, 2005). The fish gill plays a vital role in ionic regulation and gas exchange (De La Torre *et al.*, 2005). Several reports are available on the histological changes in fish gills exposed to myriad toxicants (Mallat, 1985; Elahee and Bhagwant, 2007; Velmurugan *et al.*, 2009).

Liver is the major organ of accumulation, biotransformation and excretion of toxicants in fish. Hence, the evaluation of histiological changes in fish liver is important for monitoring the toxicity effect of aquatic ecosystem (Kohler *et al.*, 2004; Matos *et al.*, 2007; Liu *et al.*, 2010).

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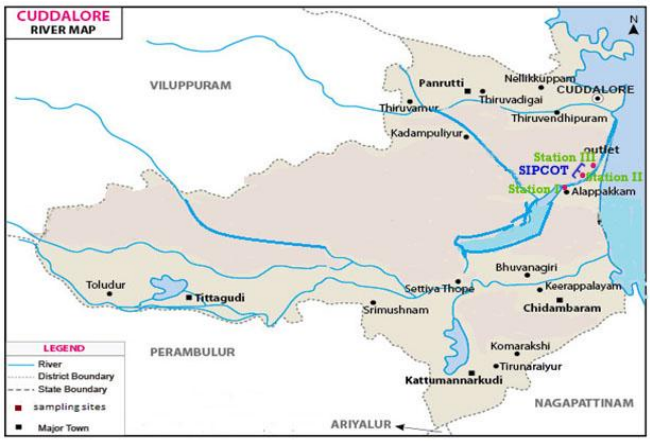
Liver is the major organ of metabolism, comes into close contact with xenobiotics absorbed from the environment and liver lesions are often associated with aquatic pollution. Many reports are available on the histopathology of liver in fishes (Thopan *et al.*, 2004; Tayel *et al.*, 2008; Saad *et al.*, 2011; Abdel-Moneim *et al.*, 2012). An attempt has been made in the present study to investigate the histopathological changes in the gill and liver tissues of *Lates calcarifer* collected from three different stations during summer and monsoon seasons from January 2012 to December 2012.

2.MATERIALS AND METHODS

Fig. 1: Location map of study area



The present study was carried out in the Uppanar estuary, which runs behind the SIPCOT industrial complex, Cuddalore.

Uppanar estuary is a major fishing ground for many kinds of fishes. It receives industrial effluents from SIPCOT industrial complex as well as domestic and municipal sewages from Cuddalore town. Three sampling stations were selected to study the impact of industrial effluents on the histopathology of gill and liver tissues of *Lates calcarifer*. The study was undertaken from January 2012 to December 2012 during summer (April to June) and monsoon (October to December) seasons. The station I is 10 kilometers upstream, station II is purely an industrial zone and station III is 2 kilometers away from station II (Fig.1).

Live *Lates calcarifer* were collected from the Uppanar estuary at station I, station II and station III during summer and monsoon seasons with the help of local fisher folks. In the field itself, the fish was dissected and the gills and liver were quickly removed and fixed in 5% formaldehyde solution (pH 7.0). After fixation, the tissues were dehydrated through a graded alcohol series and embedded in paraffin wax. Tissue sections of 6 to 8 µm thickness were taken and stained with hematoxylin and eosin. Selected areas were photographed by using Carlzeiss photomicroscope III.

3.RESULT AND DISCUSSION

The histoarchitecture of the gills of *Lates calcarifer* collected from station I was not much affected during monsoon season. The primary lamellae were arranged in double rows with a series of alternatively arranged secondary lamellae, while in summer season the gills possessed slightly curled secondary lamellae at few points (Fig. 2 and 3). The gills showed drastic changes during summer season at station II, where in the observed changes were shortening and fusion of secondary lamellae, proliferation of mucous cells, bending of the secondary lamellae and aneurysm, while very mild variations were noticed during monsoon season (Fig. 4 and 5). In station III the gills exhibited fused secondary lamellae, bending of secondary lamellae and aneurysm but the frequency of damage was less than that of station II during summer season, while during monsoon season the noticed histopathological changes were comparatively lesser than that of station II (Fig. 6 and 7).

Any change in water quality is rapidly reflected in fish gill structure and function, since gill is the only organ continuously exposed to the water medium (Fernandes *et al.*, 2008). Gills are the primary organs of gas exchange, acid-base balance and ion transfer. Changes in fish gills that live in altered environments were also reported by Ribeiro *et al.*, (2005) and Torre et al., (2005). The observed alterations in the present study were also been recorded in the gill of *Mugil cephalus* at Uppanar estuary (Pugazhendy *et al.*, 2008) and in *Mugil cephalus* at Ennore estury Vasnthi *et al.*, (2013). The present study also agree with the findings of Krishnari *et al.*, (2003) in the fry of *L.calcarifer* and Nero *et al.*, (2006) in the gill of *Perca flavescens*.

The histoarchitecture of the liver of *L.calcarifer* was not much affected at station I during monsoon season. The liver exhibited a continuous mass of hepatocytes, which are polygonal in shape with centrally placed nuclei, while in summer season the hepatocytes showed shrunken nuclei with irregular hepatic cords (Fig. 8 and 9). In station II, the liver exhibited remarkable changes during summer season and the

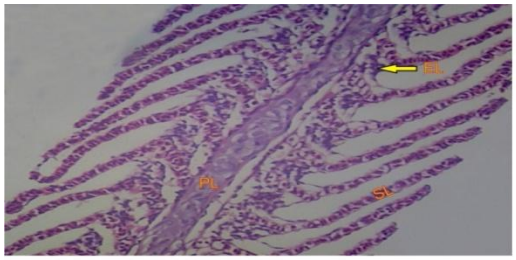


Fig. 2: Gill - Station I - Monsoon season
PL - Primary lamellae
SL - Secondary lamellae
EL - Epithelial layer

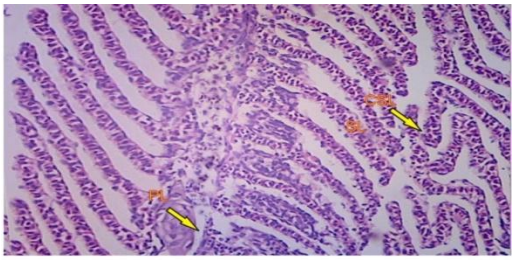


Fig. 3: Gill - Station I - Summer season
PL - Primary lamellae
SL - Secondary lamellae
CSL - Curled secondary lamellae

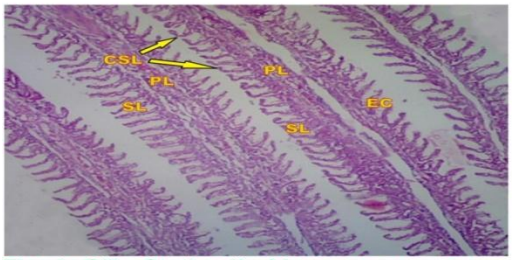


Fig. 4: Gill - Station II - Monsoon season
PL - Primary lamellae SL - Secondary lamellae
EC - Epithelial cell CSL - Curled secondary lamellae

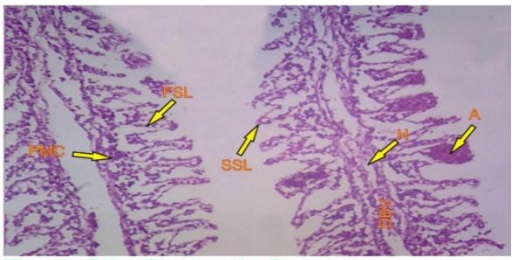


Fig. 5: Gill - Station II - Summer season
FSL - Fused secondary lamellae H - Hyperplasia
SSL - Shortening of secondary lamellae A - Aneurysm
PMC - Proliferation of mucous cells
DBV - Damaged Blood vessel

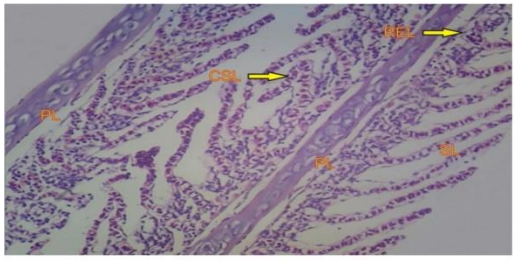


Fig. 6: Gill - Station III - Monsoon season
PL - Primary lamellae SL - Secondary lamellae
CSL - Curled secondary lamellae
REL - Ruptured epithelial layer

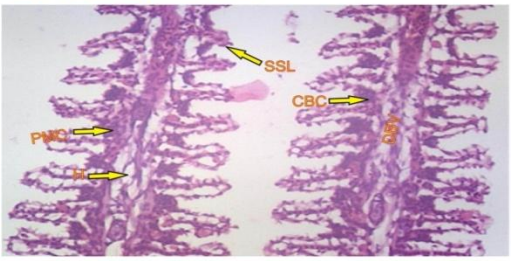


Fig. 7: Gill - Station III - Summer season
SSL - Shortening of secondary lamellae H - Hyperplasia
CBC - Congestion of blood cells
PMC - Proliferation of mucous cells
DBV - Damaged blood vessel

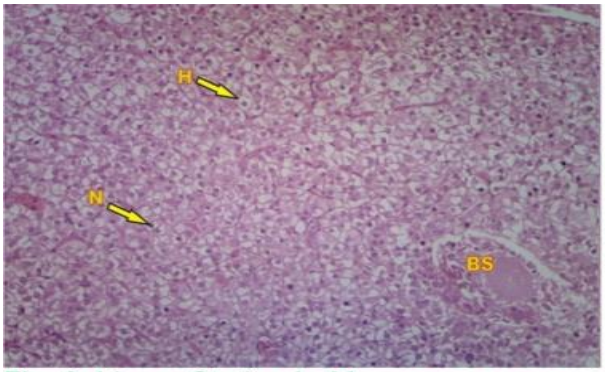


Fig. 8: Liver - Station I - Monsoon season
H - Hepatocyte
N - Nucleus
BS - Blood sinusoid

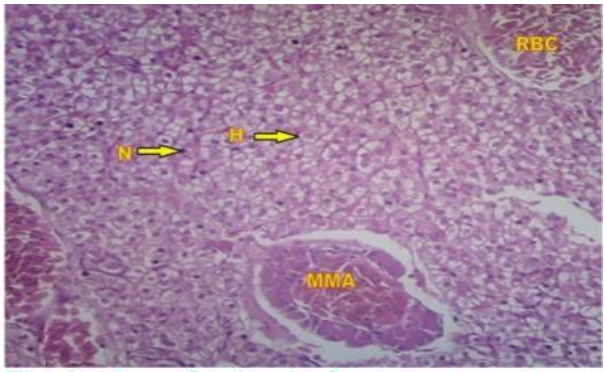


Fig. 9: Liver- Station I - Summer season
H - Hepatocyte
N - Nucleus
RBC - Red blood cell aggregation
MMA - Melanomacrophage aggregation

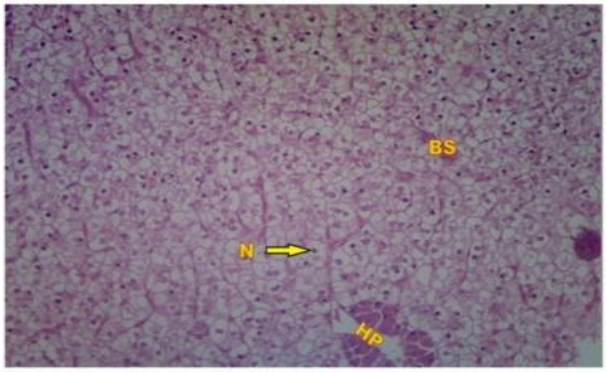


Fig. 10: Liver - Station II - Monsoon season
N - Nucleus
BS - Blood sinusoide
HP - Hepatopancreas

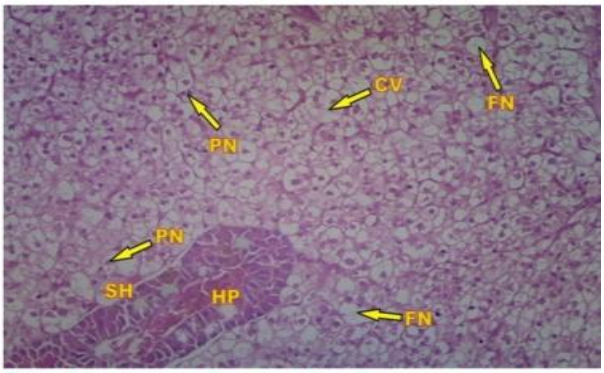


Fig. 11: Liver - Station II - Summer season
PN - Pyknotic nuclei FN - Focal area of necrosis
CV - Cytoplasmic vacuolization
SH - Swollen hepatocyte
HP - Hepatopancreas

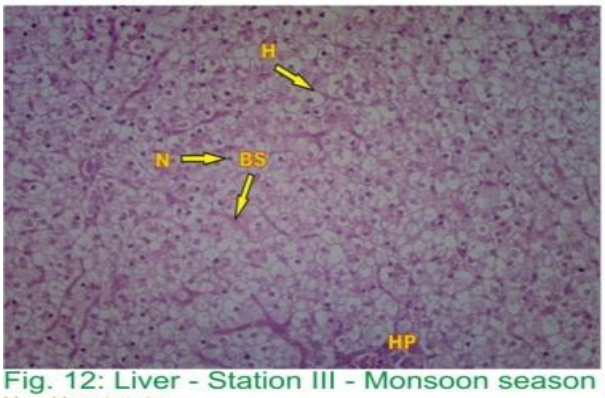


Fig. 12: Liver - Station III - Monsoon season
H - Hepatocyte
N - Nucleus
BS - Blood sinusoid
HP - Hepatopancreas

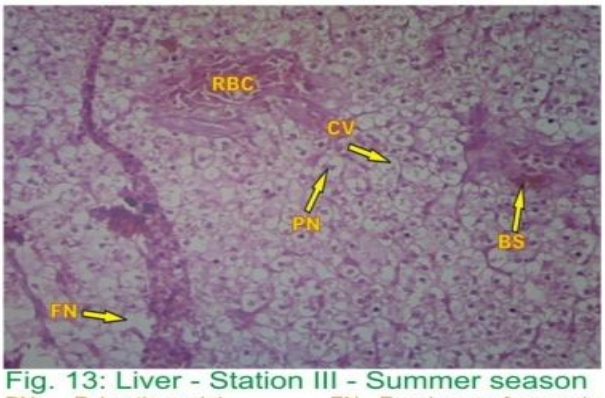


Fig. 13: Liver - Station III - Summer season
PN - Pyknotic nuclei FN - Focal area of necrosis
CV - Cytoplasmic vacuolization
RBC - Red blood cells aggregation
BS - Blood sinusoid

observed changes were focal area of necrosis, vacuolar degeneration, pyknotic nuclei, swelling and disorientation of hepatic cords (Fig. 10 and 11). In station III, the liver showed minor changes when compared to that of station II. During summer season the hepatocytes revealed vacuoles, pyknotic nuclei and swelling of hepatocytes while in monsoon season the observed changes were minimum (Fig. 12 and 13).

Liver is one of the most recommended environmental indicator organs of water pollutants at different levels from their environment (Canli and Atli, 2003). Histopathology of liver is commonly used as a potential biomarker for environmental pollution (El-Serafy *et al.,* 2009). The observations of the present study has also been recorded in the liver of *Hypophthalmichthys molitrix* exposed to nickel by Athikesavan *et al.,* (2006). Van Dyk (2003) observed vacuolar degeneration, focal area of necrosis and pyknotic nuclei in the liver of *Oreochromis mossambicus* exposed to cadmium and zinc. The observations of Sarker et al., (2005) in *Labeo rohita* also agrees with the present investigation. Numerous reports are available on the histological changes of liver of fish exposed to a wide range of heavy metals and organic compounds (Loganathan *et al.,* 2006; Abdel *et al*., 2012).

4.CONCLUSION

A multi range of toxic effects of industrial pollutants have been demonstrated in aquatic animals. To conclude, the present study augments well that histopathological biomarkers of toxicity in fish organs are useful indicators of environmental pollution. The organ and tissue damage in the experimental fish were due to the direct toxicity of industrial pollutants on the gills and liver. Also the results showed that

the degree of damage of the tissues was proportional to the seasonal changes and bioaccumulation of metals.

5.RECOMMENDATIONS

It is recommended to treat the pollutants before discharging into the natural water body.

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