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Histopathological Alteration in Tissues of *Channa punctatus* (Bloch*)* Induced by Lambda-Cyhalothrin

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Abstract: Large-scale application of pesticides to crops and forests may contribute to the presence of toxic substances in the environment. These chemicals can find their way into the water reservoirs, streams and rivers, thus producing an adverse impact on the aquatic biota including fishes. Histological changes in animal tissues provide a rapid method to detect effects of irritants, especially chronic ones, in various tissues and organs. There is a lack of experimental results about the histopathological impact of lambda-cyhalothrin on fish tissues. Hence, the present study investigated the potential changes in histology of fish *Channa punctatus* when exposed to lambda cyalothrin at two different concentrations. Histopathologic changes in liver, gill, gonad, and kidney showed increasing degrees of damage in the tissues in correlation with the accumulation pattern of pesticides.

Keywords: Biochemical changes, Environment, Fish, Histopathological changes, Pesticides

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Introduction

Pesticides are occasionally used in large amounts causing environmental pollution and therefore, are a cause of concern. Synthetic pyrethroids now account for more than 30% of insecticide used worldwide in agricultural, domestic and veterinary applications. Aquatic life is at risk because aquatic species are more vulnerable to a more extensive range of pollutants. Pesticides are one of the significant sources of aquatic contamination, which poses a threat to the world's fisheries (John and Prakash, 2003). Both pyrethroids and pyrethrins are extremely toxic to aquatic organisms, including Fish such as the blue gill and lake trout, with LC_{50} values less than 1.0 g L^{-1}. The widespread use of pesticides on crops and forests may add to the toxicity of the environment. These substances may end up in water reservoirs, streams, or rivers, where they may have a negative effect on aquatic life, especially fish (Gunasekaran *et al*., 2014). Several insect pests in a range of crops are managed with the use of the broad-spectrum pyrethroid pesticide lambda-cyhalothrin. The development of vegetables and cotton both heavily use lambda-cyhalothrin. Additionally, it is applied directly to water bodies to control vectors like mosquitoes. These particular agricultural runoff types are most likely contaminating the environment with lambda-cyhalothrin (Amweg *et al*., 2005). Fish and aquatic invertebrates are very sensitive to synthetic pyrethroids. Pyrethroids have a high rate of gill absorption because they are lipophilic, which may contribute to fish's susceptibility to aqueous pyrethroid exposures (Oros *et al*., 2005) . Based on information on the toxicity of pesticide applications to non-target creatures like fish, the ecotoxicological hazards that pesticides pose to ecosystems are assessed.

Animal tissues' histological alterations provide a quick way to spot the impacts of irritants, particularly chronic ones, on diverse tissues and organs. There are few experimental findings about lambda-histopathological cyhalothrin's effects on fish tissues (Gu *et al*., 2007). The environment is immediately in touch with fish's gills. In fish, the kidney plays a crucial role in maintaining a stable internal environment, maintaining electrolyte and water balance (Shafer and Mayer, 2004). Pesticides are thought to be stored, biotransformed, and excreted mostly in fish liver. The gut is the first organ to come into touch with food particles tainted with pesticides. It has been shown that these organs are a sign of contamination. It was thus chosen to examine the histological consequences of the kidney, gill, intestine, and liver in *Channa punctatus* exposed to lambda-cyhalothrin over an extended period of time (Vander *et al*., 2003; Burr and Rar, 2004).

In India, the national anti-malaria program has recommended using lambda-cyhalothrin's CS formulation as an insecticide and its WP formulation for interior spraying (Fanta *et al*., 2003; Fernandes, 2007). It is heavily used in the cotton plantation and in the production of vegetables, in addition to its usage in the control of vectors like mosquitoes (Dobreva *et al*., 2008). The aquatic ecology is very important to human existence. Fish play a significant role in the aquatic ecosystem. Humans eat them in vast quantities. Additionally, people sometimes utilize this water for a variety of additional purposes. Fish is the best bioindicator for evaluating the risk that various pollutants provide to the aquatic ecosystem (Jayachandran *et al*., 2009; Desai, 2013).

Freshwater fish, *Channa punctatus,* was chosen to evaluate the toxicity of lambda cyhalothrin as the test animal due to its widespread distribution, year-round availability, and simplicity of care in the lab.

Materials and Methods

Experimental fish:

The fish *Channa punctatus* was purchased from Meerut's local market. They were continuously aerated with dechlorinated tap water. For the first two weeks, the fish were acclimatized under laboratory conditions. A commercial fish pellet was fed to the fish once a day during acclimatization. The fish were divided into four groups after the acclimation period and placed in aquaria with a capacity of 25 l.

Experimental groups:

Experimental groups were exposed to sublethal concentrations (0.05 mg/l and 0.1 mg/l) of lambda-cyhalothrin fFor intervals of 24, 48, 72, and 96 h. For microscopic examinations, five fish were obtained at intervals for the control and each experimental group. In the current investigation, fish subjected to Lambda-cyhalothrin for 24, 48, 72, and 96 h were sacrificed and gills, liver, kidney and gonads (testis and ovary) were fixed in Bouin’s solution for histological study.

Histological preparations:

The tissues were dehydrated in graded series of alcohols, cleared in xylene and embedded in paraffin. The sections were cut at 6 μm and stained with hematoxylin-eosin (HE).

Results and Discussion

Histopathological changes:

Gills:

In control fish, a row of secondary gill lamellae is formed by a row of primary gill lamellae around a central rod-shaped axis. Located laterally on either side of the interbranchial septum, they form a pair. There are two blood vessels on either side of the central rod-like support axis of the primary gill lamellae. Secondary gill lamellae are also known as respiratory lamellae. Simple squamous epithelial cells cover the surface, separated by mucous cells. There are numerous blood vessels extending into the secondary gill filaments. Secondary gill lamellae have a single flat nucleus. A region between two adjacent secondary gill lamellae is called an interlamellar region.

No histopathological changes were observed in the gill of the control fish. The damage was more in the group treated with 0.1 mg/l of lambda-cyhalothrin (Fig. 1). 0.1 mg/l of lambda-cyhalothrin provoked alterations-- primary filaments are bulging at the tip, secondary filaments have distorted shapes. In the secondary gill epithelium, the nucleus of the pillar cell was necrotic and showed vacuoles (Fig. 1).

Liver:

Hepatocytes in the control group of *C. punctatus* showed a normal structure with a clear hepatic cord. There was no change in liver structure in fish treated with insecticides up to 0.05 mg/l. A number of changes were observed in 0.1 mg/l lambda cyhalothrin exposed fish when compared to the controls, such as dilation of sinusoids, hypertrophied hepatocytes, and congestion of erythrocytes along the central vein (Fig. 2). Furthermore, vacuolization of the cytoplasmic content of hepatocytes, pyknotic nuclei, rupturing of the hepatocyte's cell membrane, and efflux of their cytoplasmic content were also observed in experimental groups of *C. punctatus* compared to unexposed controls. The sinusoids and bile duct of the liver were ruptured (Fig. 2).

Kidney:

In the control group, the kidney showed normal tubules and a compact renal mass, as well as haemopoietic cells. Atrophied collecting tubules, Bowman's capsule degeneration, and disintegrated, vacuolated tubules were observed in kidneys of the experimental group (0.05 mg/l of lambda cyhalothrin). After exposure to 0.1 mg/l lambda cyhalothrin renal tubule degeneration, Bowman's capsule with atrophied glomeruli, and severe hemorrhage were observed (Fig. 3).

Gonads:

After 96 h of exposure of 0.05 mg/l lambda cyhalothrin, the presence of many inflammatory cells, the condensing of spermatogonic cells, and the swelling of spermatids were noticed. After 72 h of exposure of 0.1 mg/l lambda cyhalothrin, the number of spermatogonic cells had reduced, starry skies appeared, tubules contracted, and seminiferous tubules necrosed (Fig. 4).

Oocytes of fish exposed to sub-lethal concentrations of 0.1 mg/l lambda cyhalothrin after 24 h and 48 h showed deformed, disrupted follicular epithelial cells. A vacuolization of the cytoplasm begins at the periphery of the oocyte and gradually moves towards the center. There are deformed yolk vesicles, stromal hemorrhage, and some degree of damage to tunica albuginea and inner germinal epithelium after 96 h of exposure (Fig. 4).

In fish, gills are critical organs for the respiratory and osmoregulatory functions. Respiratory distress is one of the early symptoms of pesticide poisoning. Vijaya Lakshmi and Tilak (1996) reported histopathological changes in the gills of *Labeo rohita.* Among the changes reported in the gills are epithelial proliferation, congestion of blood vessels, and hyperplasia (Butchiram *et al.*, 2009). In the present study, histological damage to gill surfaces could be caused by high accumulation of pesticides, irritation due to mucus secretion, an increase in ventilation volume, and a decreased ability of the gills to take in oxygen. These changes may be indicated by cell expansion

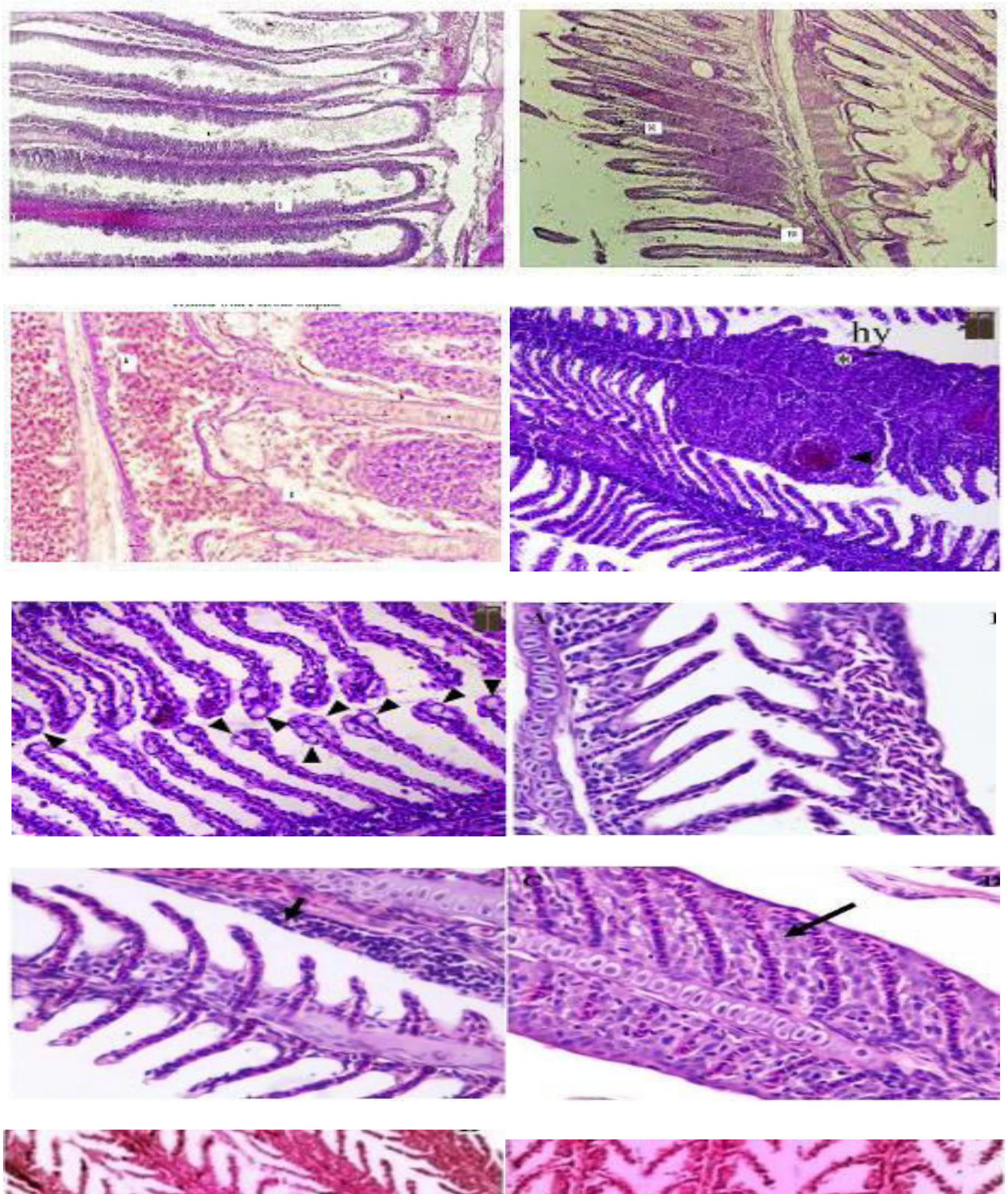

Fig. 1: Alterations in gills of *Channa punctatus* after lambda cyhalothrin (0.1 mg/l) exposure.

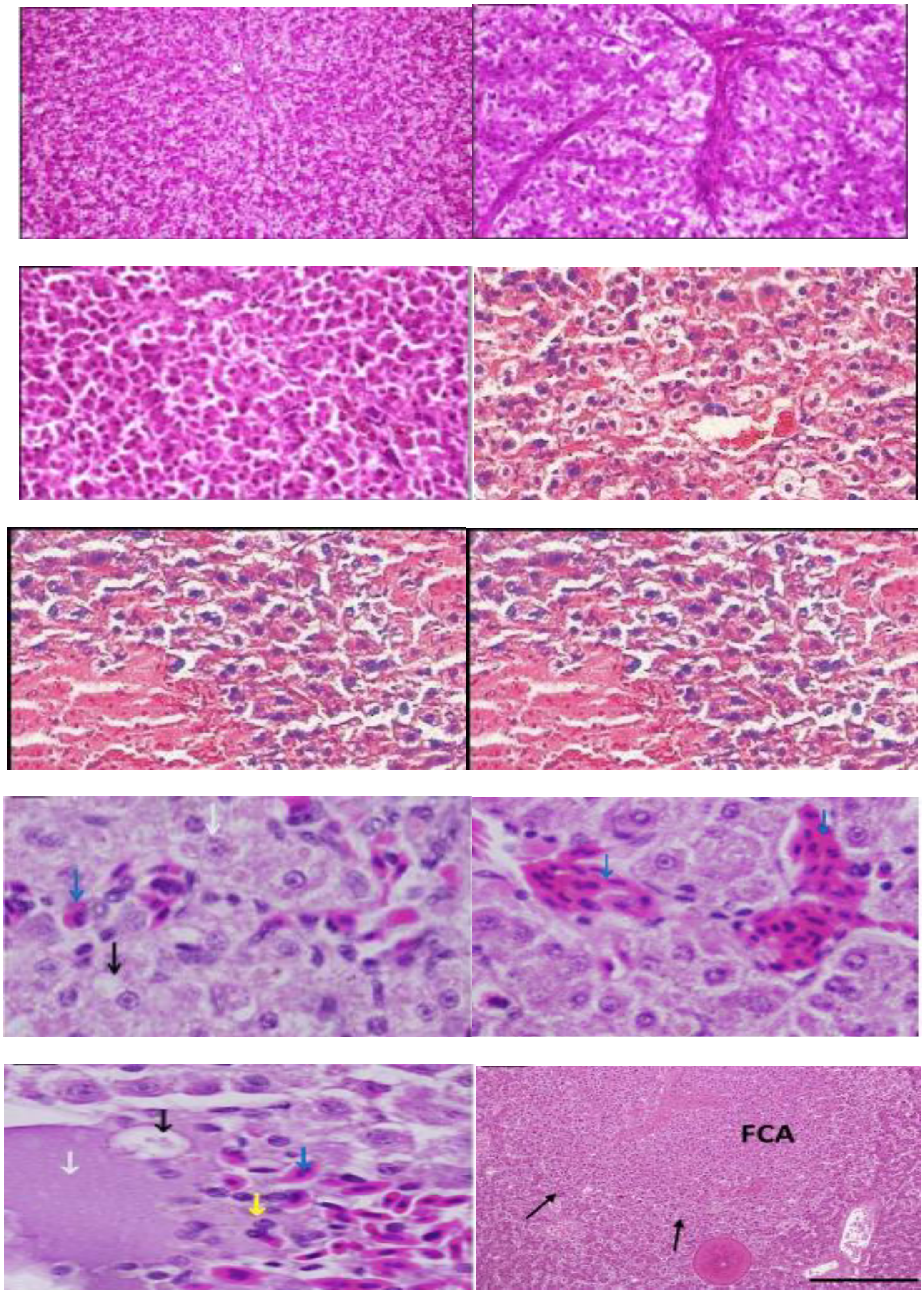

Fig. 2: Alterations in liver of *Channa punctatus* after lambda cyhalothrin (0.1 mg/l) exposure.

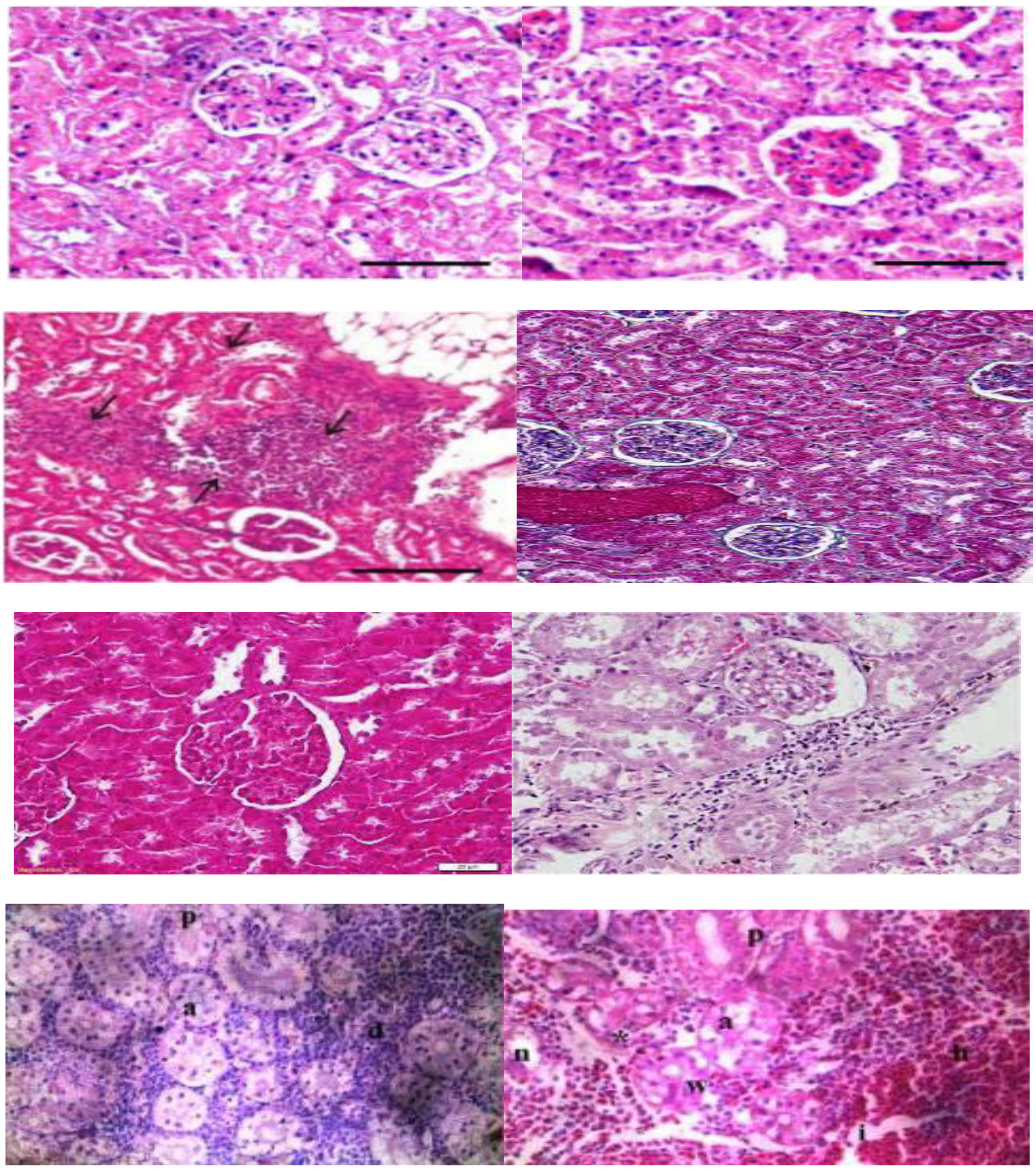

Fig. 3: Alterations in kidney of *Channa punctatus* after lambda cyhalothrin (0.1 mg/l) exposure.

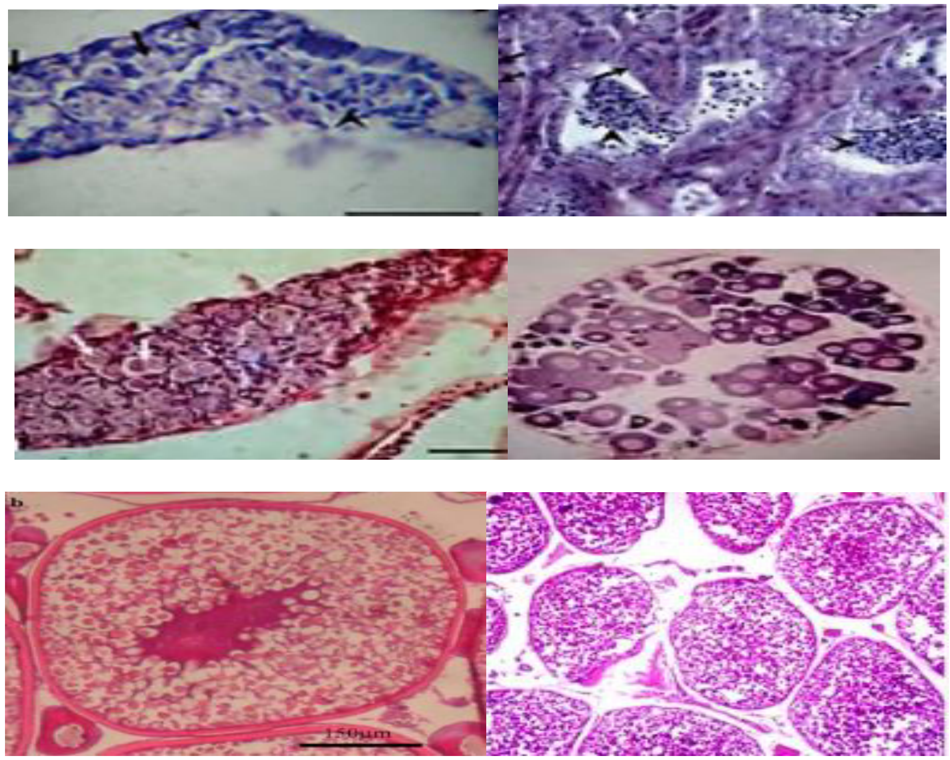

Fig. 4: Alterations in gonads (testis and ovary) of *Channa punctatus* after lambda cyhalothrin (0.1 mg/l) exposure.

and big eosinophilic granules, which simulate hyaline degeneration. Since fish gills are their respiratory and osmoregulatory organs, histopathologic alterations may reduce respiratory surface area, causing hypoxia and respiratory failure.

According to Welling and McCain (1976), bottom dwelling fish have a high incidence of liver hypertrophy, tumors, and other liver diseases. It has been reported that these changes occur frequently in sediments containing relatively high concentrations of polynuclear hydrocarbons (Erkmen *et al*., 2000).

In the present study, pesticide exposure provoked changes in the kidney tissue of *Channa punctatus*, including necrosis of the glomerulus, deterioration of the hematopoietic tissues, and shrinking of the renal tubules. The kidney of fish receives much the largest proportion of post-branchial blood, and therefore renal lesions might be expected to be good indicators of environmental pollution (Velmurugan *et al*., 2007). Present investigation noticed that toxic pesticides caused damage to the gills, liver, kidney and gonads at greater levels, disrupting biological functions. Gill, kidney, liver and gonads histopathological alterations after exposure to toxicant observed in this study may result in severe physiological problems, and in long time exposure may ultimately lead to the death of fish.

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