



**HISTOLOGICAL CHANGES IN FISH OREOCHROMIS
MOSSAMBICUS EXPOSED TO THE WASTEWATER COLLECTED
FROM VATTAKAYAL NEAR INDUSTRIAL AREA CHAVARA,
KOLLAM (DT), KERALA**

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ABSTRACT

Addition of undesirable substances into the water bodies cause changes in the physical, chemical and biological characteristics of the aquatic system which lead to ecological imbalance. Histological studies used as the tool for assessing the toxic effects in the target organs of fish in laboratory experiments and in the field experiments. The present study is to analyse the histological parameters in the fish (*Oreochromis mossambicus*) exposed to different concentrations of effluent contaminated wastewater collected from Vattakayal near industrial area. The lethal concentration LC₅₀ was calculated as 2.4%. It has been observed that the fish after treatment exhibit lethargic. Gills are the first targeted organs to the polluted water. In the present observation fish exposed to the different concentrations exhibited various abnormalities in the gills like epithelial hyperplasia, curling of secondary, aneurism, lamellar fusion, epithelial lifting, dilation and congestion in the blood vessels of primary gill lamellae, desquamation, and atrophy.

Keywords: *Oreochromis mossambicus* (Peters), Histology, Waste water, Gill, industrial area

INTRODUCTION

The industrial effluents contribute a lot to water pollution forming a threat to aquatic plants and animals [1]. The pollution leads to a steady decline in the aquatic flora and fauna, particularly fishes.

The toxic contaminants from the industrial and agricultural areas are let out into the water bodies and most of them are very much persistent, their levels fast reach to life threatening in terms of both space and

time [2]. Wedemeyer [3] reported that the fishes are more susceptible to stress than many other animals because of their intimate dependence upon their surrounding environment. Fish have been often used as appropriate bioindicators of chemical contaminants [4]. Histological studies have been considered as the tool for evaluating the toxic effects in target organs of fish in laboratory experiments and in the field experiments [5-6]. Gills are the primary site for oxygen uptake in fishes and these delicate organs are in contact with chemical toxins that cause stress exacerbated. Another study revealed that the sediments of Vattakayal near to the industrial area were contaminated with heavy metals in significantly higher levels in the sequence of Fe>Cr> Zn> Ni> Cu> Pb [7].

MATERIALS AND METHODS

Contaminated water samples

The effluent contaminated water sample was collected during premonsoon from station 11 (Plate I). The collected samples were stored in the refrigerator. Chlorine free tap water was taken as the control medium [8].

Experimental Animal

The fish selected for the present study was *Oreochromis mossambicus* (Peters) belonging to the family Cichlidae. It can inhabit both in freshwater and saline water [9]. *Oreochromis mossambicus* was

selected for the study because of its easy availability, hardy nature, rapid growth rate and tolerance to varied environmental salinity [10].

The fish was collected from freshwater ponds of Alappuzha District. They were acclimatized by keeping them in glass aquaria (250L) for a period of four weeks. During the period of acclimatization the fishes were fed with standard food pellets and were exposed to the natural day and night cycle. The acclimatization was done at room temperature [8].

EXPERIMENTAL PROTOCOL

Healthy fishes with active movements were considered for the experimentation. The test fishes were starved for 24hrs prior to and during the 96 hrs test period when the fishes were exposed to different concentrations of effluent contaminated wastewater to determine 96 hrs LC₅₀ values. The test was carried out in 90 x 60 x 30cm rectangular tanks with ten healthy fishes in triplicate. Controls were also maintained. The test medium was changed every day in order to remove the metabolic waste (Ammonia). The lethal concentration of effluent contaminated water for 50% fish death (LC₅₀ - 96 hrs exp) was calculated using the computerized programme, SPSS ver. 10 for Finney's probit analysis. The lethal concentration was calculated as 2.4%. Based on the LC₅₀ value, four different sub

lethal concentrations (0.15%, 0.3%, 0.6% and 1.2%) of the contaminated water were prepared.

Healthy fishes irrespective of sex of uniform body weight (30 ± 5 gm) and body length (12 ± 1.4 cm) were selected for the experimental study. The fishes were divided into five groups: F1, F2, F3, F4 and control group (C), with ten fishes in each group and maintained for 12 hours before the exposure to effluent. The fishes in F1, F2, F3, F4 groups were experimentally exposed to sub lethal concentrations 0.15%, 0.3%, 0.6% and 1.2% respectively, under controlled conditions in aquarium water. The fifth group (C) served as control, and these fishes were maintained in chlorine free tap water without effluent. Three sets of experiments for each group were also conducted and the test was performed by the semistatic (renewal) method in which the exposure medium was changed every 24 hrs to maintain toxicant strength and level of dissolved oxygen as well as minimizing the ammonia excretion levels during this experiment [11]. The total period of exposure was 20 days.

For histopathological examinations gills isolated from control and experimental fishes through trans-spinal dissection, gently rinsed with physiological saline solution (0.9% NaCl) to remove blood and adhering debris and immerse in fixative

composed of glacial acetic acid, formaldehyde and ethanol (1:3:7) [8].

RESULTS AND DISCUSSION

Histological changes in Gills

The histological changes due to toxicant are illustrated in Plate II, III, IV and V. It is found that the effect increases with increasing time and concentration and the changes are most prominent by the 20th day. The histological analysis in the control fish showed normal structure but in the treated fishes the gill exhibits the abnormalities like epithelial hyperplasia (EH), curling of secondary lamellae (CSL), aneurism (A), lamellar fusion (LF), epithelial lifting (EL), dilation and congestion in the blood vessels of primary gill lamellae (DC), desquamation (DS), atrophy (AT). Epithelial hyperplasia, curling of secondary lamellae, aneurism, and lamellar fusion were observed in the first day itself in various concentrations of treatment. Lamellar fusion, epithelial lifting and aneurism are the commonly observed alterations.

The gill in fishes are concerned with functions such as respiration and osmoregulation and are in close contact with the external environment. Any change in the water quality therefore adversely affect the functioning of the gill, [12]. The alterations observed in the present study like epithelial hyperplasia, epithelial lifting and curling of secondary lamellae are the

defence mechanisms for increasing the distance between external environment and blood. Another change noted in the study was aneurism, dilation and congestion in the blood vessels of primary gill lamellae, as has been observed by [13]. Similarly, [14] Figueiredo-Fernandes reported the epithelial lifting, dilation and congestion in the blood vessels of primary gill lamellae, lamellar fusion, aneurism in fish exposed to copper [15]. The study on the effect of the mixed effluent of Sipcot Industrial Estate on histopathological and biochemical changes in estuarine fish, *Lates calcarifer*, showed hyperplasia, epithelial lifting, fused lamella and desquamation [16]. Desquamated secondary lamellae, vacuolization, degenerated cells, pycnotic

nuclei and fusion of secondary gill lamellae had also been observed in *Tilapia mossambica* exposed to industrial pollutant [17]. It may be noted that the cell proliferation results in the hyperplasia which leads to lamellar fusion and also decrease the surface area for oxygen binding and increase the oxygen distance between water (oxygen) and the blood which in turn cause hypoxia [18]. According to Yasser *et al.*, since gills function as respiratory and osmoregulatory organ of fish, any histopathological change due to toxicity to the gills may damage respiratory function by reducing total respiratory surface area, resulting in hypoxia and respiratory failure problems [19].



PLATE-I

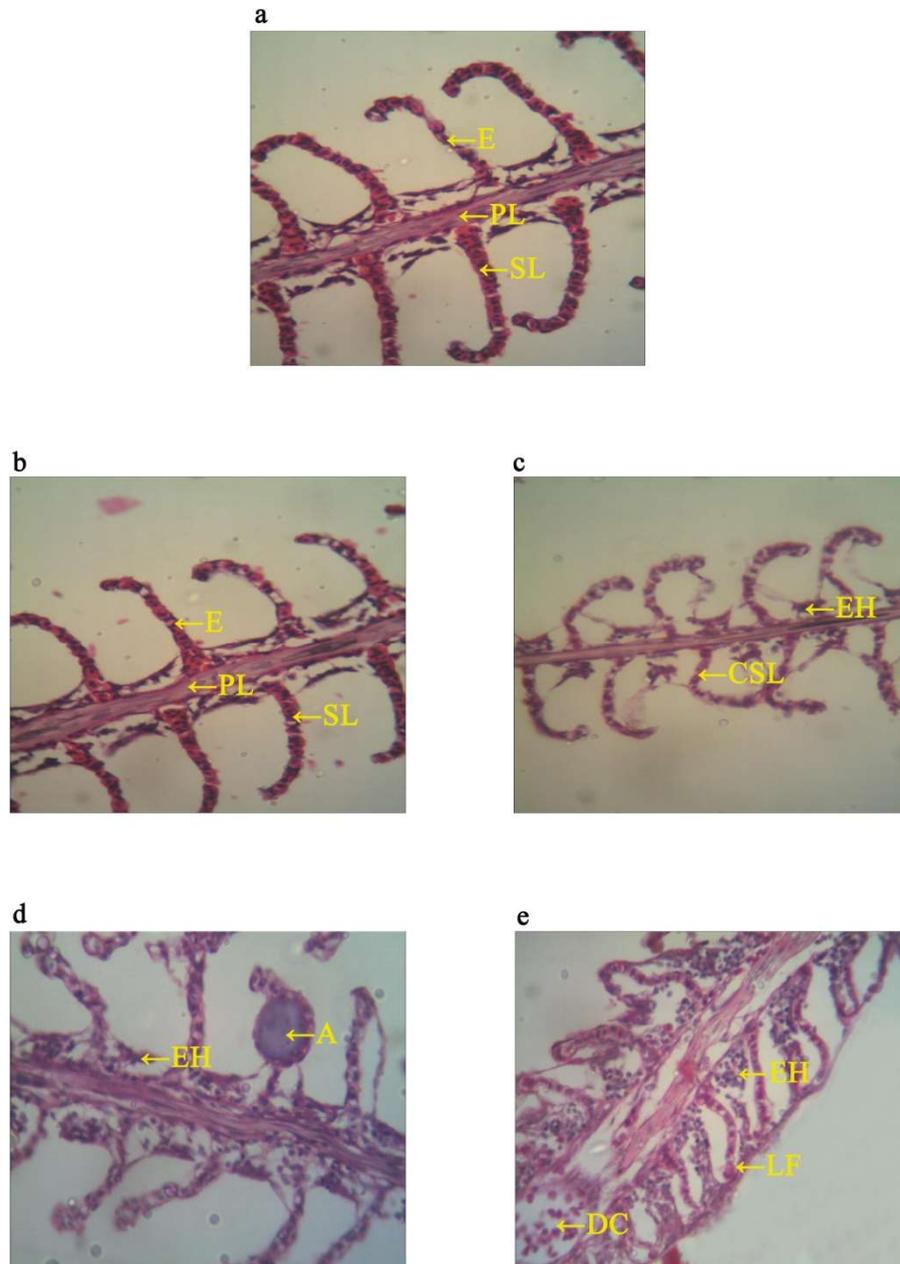


PLATE-II

Histological changes in the Gill of fish exposed to different concentrations of effluent contaminated wastewater for one Day-1 (x100).

- a) Control
- b) 0.15%
- d) 0.6%

c) 0.3%

e) 1.2%

E	-	Epithelial cells	EH	- Epithelial hyperplasia
PL	-	Primary lamellae	CSL	- Curling of secondary lamellae
SL	-	Secondary Lamellae	A	- Aneurism
LF	-	Lamellar fusion		

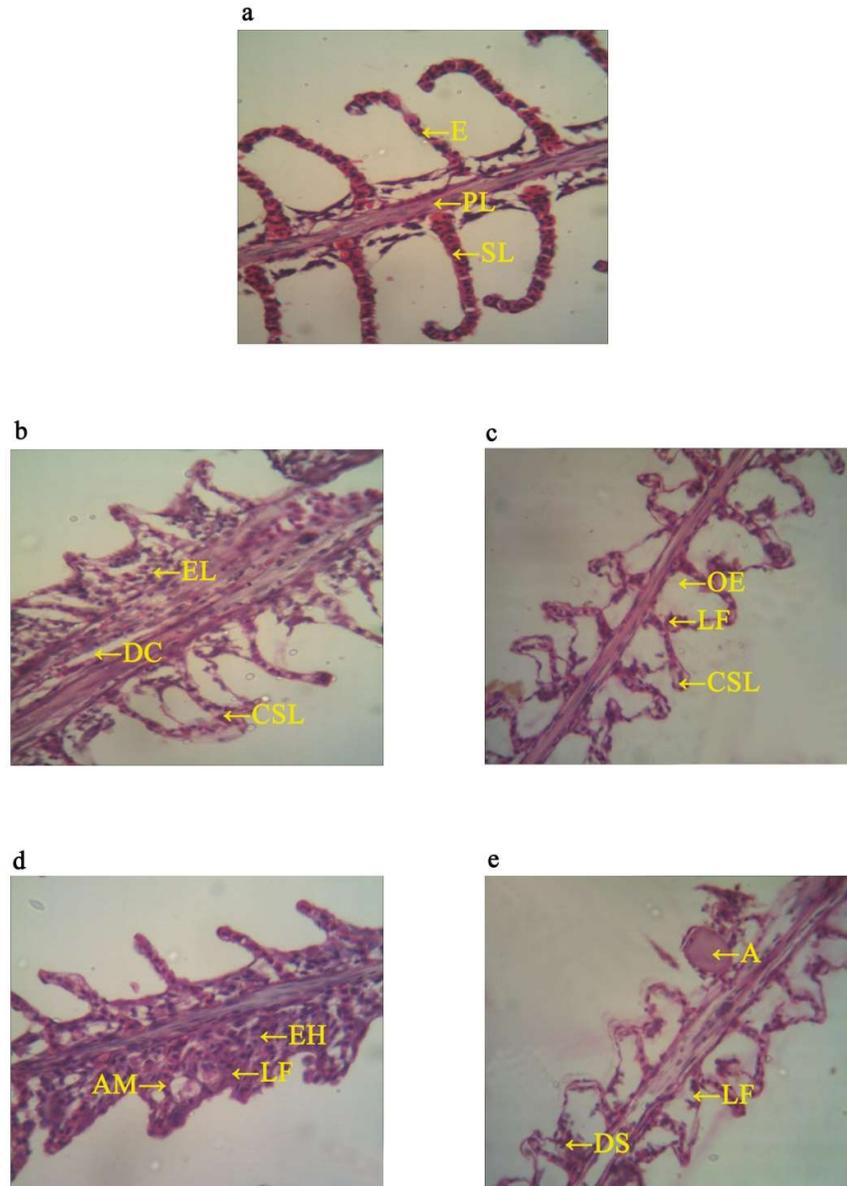


PLATE-III

Histological changes in the Gill of fish exposed to different concentrations of effluent contaminated wastewater for Day-5 (x100).

		a) Control
		c) 0.3%
	b) 0.15%	e) 1.2%
	d) 0.6%	CSL - Curling of secondary lamellae
E	- Epithelial cells	- Aneurism
PL	- Primary lamellae	LF - Lamellar fusion
SL	- Secondary Lamellae	
EL	- Epithelial lifting	
DC	- Dilation and congestion in the blood vessels of primary gill lamellae	
DS	- Desquamation	

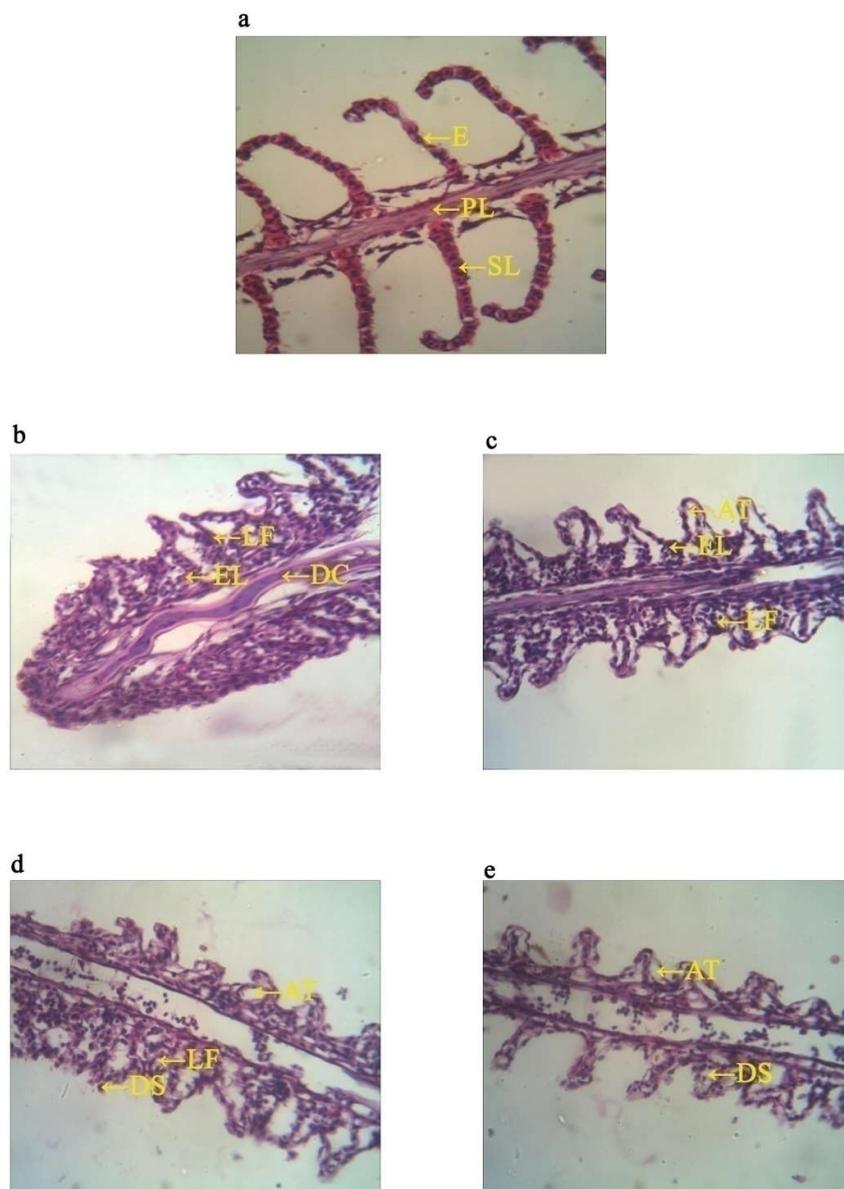


PLATE-IV

Histological changes in the Gill of fish exposed to different concentrations of effluent contaminated wastewater for Day-10 (x100).

		a) Control
		c) 0.3%
	b) 0.15%	e) 1.2%
	d) 0.6%	SL -Secondary Lamellae
E -	Epithelial cells	EL - Epithelial lifting
PL -	Primary lamellae	AT -Atrophy
LF -	Lamellar fusion	
DS -	Desquamation	
DC -	Dilation and congestion in the blood vessels of primary gill lamellae	

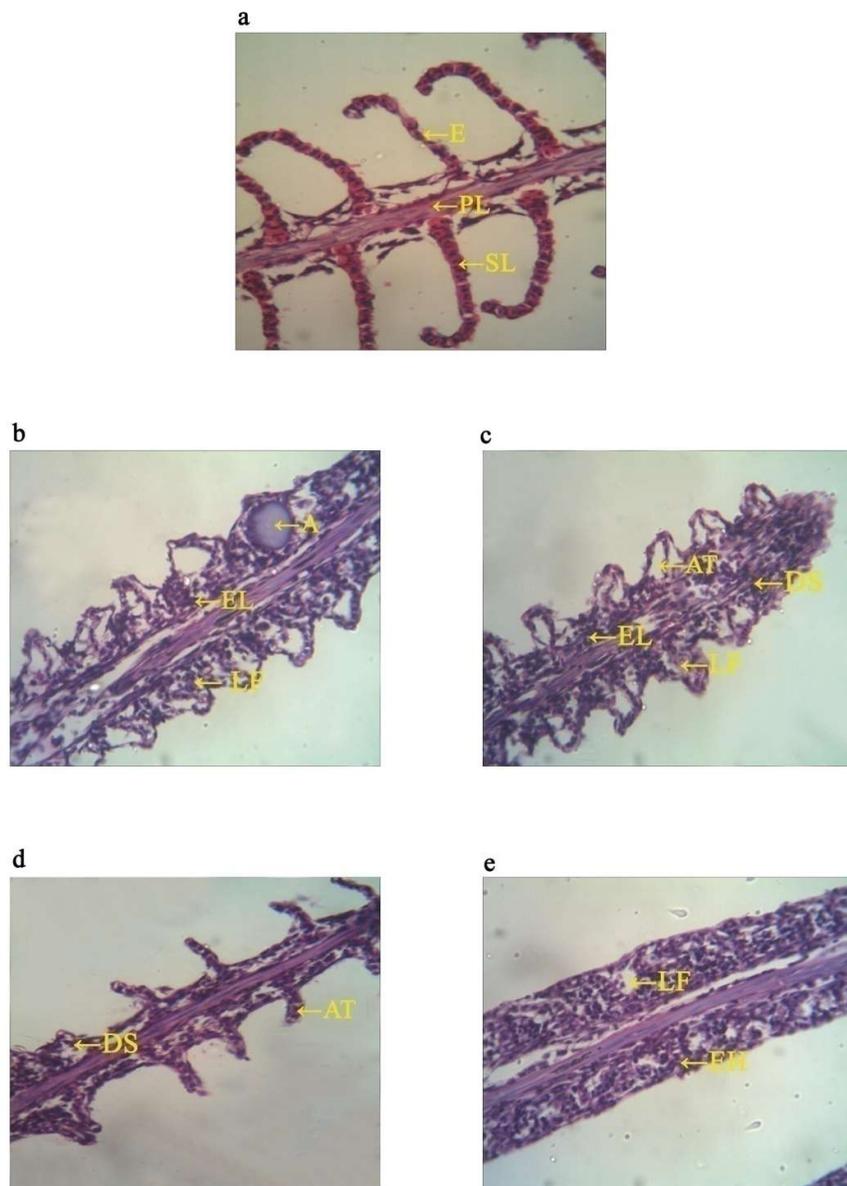


PLATE-V

Histological changes in the Gill of fish exposed to different concentrations of effluent contaminated wastewater for Day-20 (x100).

- a) Control
- b) 0.15%
- c) 0.3%
- d) 0.6%
- e) 1.2%

E- Epithelial cells
 SL- Secondary Lamellae
 EL- Epithelial lifting
 EH- Epithelial hyperplasia
 PL-Primary lamellae
 A- Aneurism
 LF-Lamellar fusion

SUMMARY AND CONCLUSION

The present work has been undertaken to study the environmental stress in the Vattakayal backwaters, Chavara, Kollam, Kerala due to the pollution caused by the industry situated quite near to the estuary. The estuary lies parallel to Trivandrum – Shornur (TS) canal, towards the northern side it is connected to the Kayamkulam lake and towards the southern side to the Ashtamudi lake. The fish exposed to the various concentrations of wastewater exhibited abnormalities in the gills like epithelial hyperplasia (EH), curling of secondary lamellae (CSL), aneurism (A), lamellar fusion (LF), epithelial lifting (EL), dilation and congestion in the blood vessels of primary gill lamellae (DC), desquamation (DS) and atrophy (AT).

REFERENCES

- [1] Ramona, A, Biawas, AK, Kundu, S, Saha, AK. and Yadav, RBR. 2001. Efficacy of distillery effluent on seed germination and seedling growth in mustard, cauliflower and radish. Proc. Nat. Acad. Sci. India., 71: 129-135.
- [2] Brack, W, Schirmer, K, Kind, T, Schrader, S. and Schuurmann, G. 2002. Effect-directed fractionation and identification of cytochrome P450A-inducing halogenated aromatic hydrocarbons in

contaminated sediment. Environ. Toxicol. Chem., 21: 2654-2662.

- [3] Wedemeyer, GA. 1996. "Transportation and Handling." In: Principles of Salmonid Culture. (eds. Pennell, W. & Barton, B.A). Elsevier Science (Pub.) Amsterdam. 727-758.
- [4] Sinaie M, Darvish Bastami K, Ghorbanpour M, Najafzadeh H, Shekari M, Haghparast S. 2010. Metallothionein biosynthesis as a detoxification mechanism in mercury exposure in fish, spotted scat (*Scatophagus argus*). Fish Physiol Biochem. doi: 10.1007/s10695-010-9403-x
- [5] Poleksic, V. 2010. Liver, gills, and skin histopathology and heavy metal content of the Danube sterlet (*Acipenser ruthenus* Linnaeus, 1758). Environ. Toxicol. Chem. 29:515–521. <https://doi.org/10.1002/etc.82>
- [6] Javed, M, Ahmad, I, Usmani, N. & Ahmad, M. 2016. Studies on biomarkers of oxidative stress and associated genotoxicity and histopathology in *Channa punctatus* from heavy metal polluted canal. Chemosphere 151: 210–219. <https://doi.org/10.1016/j.chemosphere>.
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- [7] Koshy PM, Rinoy Varghese, Subin KJ, Mayarani CB and Thomas AP.2012. Assessment of heavy metal pollution and bacterial heavy metal resistance in the sediment of vattakayal lake system, near Chavara industrial area, Kollam, Kerala. Poll res., 31(2):55-61.
- [8] Koshy P M., A.P. Thomas and Neena Suzzan Joshua.2014. Haematological changes in fish *Oreochromis mossambicus* (Peters) exposed to the wastewater collected from Vattakayal near industrial area Chavara, Kollam (Dt). International Research Journal of Natural and Applied Sciences. 1(4): 41-52.
- [9] Uchida, K, Kaneko, T., Miyazaki, H., Hasegawa, S. and Hirano, T. 2000. Excellent Salinity Tolerance of Mozambique Tilapia (*Oreochromis mossambicus*): Elevated Chloride Cell Activity in the Branchial and Opercular Epithelia of the Fish Adapted to Concentrated Seawater. Zoological Science. 17: 149–160.
- [10] Pullin, R.V.1991. Cichlids in aquaculture. In “Cichlid Fishes: Behaviour, Ecology and Evolution” Ed by MA Keenleyside, Chapman and Hall, London, pp 280–299.
- [11] Kori-Siakpere, O. 1995. Some alterations in haematological parameters in *Clarias isheriensis* (Sydenham) exposed to sub lethal concentrations of water-borne lead. BioScience Res. Commun. 8 (2):93-98.
- [12] Fernandes, M N. & AF. Mazon. 2003. Environmental pollution and fish gill morphology. In: Val, A. L. & B. G. Kapoor (Eds.). Fish adaptations. Enfield, Science Publishers. 203-231.
- [13] Winkaler, E. U., Silva, A. G., Galindo, H. C. and Martinez, C. B. R. 2001. Biomarcadores histológicos e fisiológicos para o monitoramento da saúde de peixes de ribeirões de Londrina, Estado do Paraná. Acta Scientiarum. 23 : 507-514.
- [14] Figueiredo-Fernandes, A, Ferreira-Cardoso, JV, Garcia-Santos, S, Monteiro, S.M, Carrola, J, Matos, P. and Fontainhas Fernandes, A. 2007. Histopathological changes in liver and gill epithelium of Nile tilapia, *Oreochromis niloticus*, exposed to waterborne copper. Pesq. Vet. Bras. 27 (3):103-109.
- [15] Peebua, P, Kruatrachue, M, Pokethitiyook, P. and Singhakaew, S. 2008. Histopathological

- alterations of Nile tilapia, *Oreochromis niloticus* in acute and subchronic alachlor exposure. *Journal of Environmental Biology*. 29 (3): 325-331.
- [16] Chezian, A, Kabilan, N, Suresh Kumar, T, Senthamilselvan, D. and Sivakumari, K. 2010. Impact of Common Mixed Effluent of Sipcot Industrial Estate on Histopathological and Biochemical Changes in Estuarine Fish *Lates calcarifer*. *Current Research Journal of Biological Sciences*. 2 (3): 201-209.
- [17] Ravanaiah, G. and Narasimha murthy, C.V. 2010. Impact of aquaculture and industrial pollutants of nellore district on the histopathological changes in the gill of fish, *Tilapia mossambica*. *Ind .jour. Comp.Animal. Phsiol*. 28 (1):108-114.
- [18] Wani, AA, Sikdar-Bar, M, Borana K, Khan, HA, Andrabi, SSM. and Pervaiz, PA. 2011. Histopathological Alterations Induced in Gill Epithelium of African Catfish, Exposed to Copper Sulphate *Clarias gariepinus*. *ASIAN J. EXP. BIOL. SCI.*, 2 (2): 278-282.
- [19] Yasser, AG. & Naser, MD.2011. Impact of pollutants on fish collected from different parts of Shatt Al- Arab river: a histopathological study. *Environ. Monit. Assess*. 181(1):175–182.