Histological Structure of Gill, Kidney and Liver of *Ompok hypopthalmus* Captured in The Upstream and downstream of The Siak River, Riau

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ABSTRACT

Ompok hypopthalmus (Siluridae) is commonly inhabit the Siak River. This river is relatively polluted as there are human activities present in the riverside along the river and the pollutant produced flown to the river. Due to pullutant accumulation, water quality in the downstream of the river may be worse than that of the upstream. As water quality affects the health status of fish, the health condition of fish living in the upstream and downstream of the river might be different and it may be reflected in the histological structure of main organs of the fish. To understand the difference of histological structure of the gill, kidney and liver of O. hypopthalmus, a study has been conducted. Fish samples were captured from the upstream and downstream of the river. Gill, kidney and liver tissue was processed for histological study (formalin fixed, alcohol series processed and HE stained). Results indicate that the histological structure of the fish from both sampling areas showing abnormality symptoms. In the gill tissue of fish from both areas, most of secondary lamella are fused and abnormality symptoms such as hyperplasia, hypertrophy and necrosis are present. In the kidney and liver tissues, there are hemorrhage, mineralization and cell degeneration. The kidney and liver of fish from the downstream shown more mineralization spots than that of the upstream. These data suggested that the fish living in the upstream and downstream of the Siak River have been exposed to relatively polluted water that negatively affects their health in general.

Keywords: *Ompok hypopthalmus*, upstream and downstream, Siak River, tissue structure, Riau

INTRODUCTION

Siak River is one of the biggest rivers in Riau and its presence is strongly affects the daily life of people living in the area along the river. People used to use the river as a place for conducting their domestic activities, transportation and water source for irrigating plantation located around the river. Moreover, many people economically depended to this river as they work as fishermen and used to get fish and other aquatic organisms from this river (Mulyadi 2001 and Mulyadi 2005).

In this recent decade, industries, housing and plantation areas are developing around the Siak River. In the upstream area, people used to get sand from the river. Even though this activity does not produce any chemical pollutant, but it produces soil particles that increase the total suspended solid and reduce the brightness of the water and consequently decrease water quality in general.

In the areas along the river, many industries, especially pulp and paper and palm oil industries are present. The presence of these industries positvely affects the economical aspects of the people living around the river, but the pollutant produced may negatively affect the water and disturb life of aquatic organism living in the river, including fish. Beside the pollutant originated from industries, the quality of the Siak water worsened as organic pollutant originated from plantations and houses around the river are flewn to the river, especially during rainy season. In this season, fertilizer or insectiside agents applied in the plantations may be washed and flown to the river. As well as the plantation waste, domestic waste also enter the river as people used to threw rubbish to the river and also use the river as ”toilet”.

The amount of pollutant entering the Siak River is relatively high, the *self purification* process of the river is not effective to improve the water quality. As the pollutants are carried by water current, more pollutant became accumulated in the downstream atrea and as a consequence the water quality in this area is worse than that of the upstream. Nedi (1999) and Mulyadi (2005) stated that the Water Quality Index Values of the upstream of the Siak River is better than that of the downstream.

Fishermen in the Siak River also stated that the water quality of the water in the upstream and downstream of the Siak River is different. In the upstream (in theTapung Kanan River) the water is n the downstream (in the Perawang/ Tualang k odor and sometimes there is oil layer in the sed on water quality standard value issued by

the Indonesian Government (Keputusan Menteri Lingkungan Hidup Nomor 115 Tahun 2003), the water of the Siak River is categorized as polluted (Mulyadi 2005).

Low water quality in the Siak River significantly affects the fish living in that river. There is decrement in the number of fish species, there was 123 species in 1997 and down into 20 species in 2006 (Menteri Pekerjaan Umum 2005). The condition of the water also affects the general condition of the fish. Putra *et al,*. (2011a and b) and Windarti *et al.*,(2011) stated that *Ompok hypopthalmus* obtained from the Siak River having lower fecundity and smaller egg diameter than fish of the same size obtained from the Kampar River that have good water quality. While Anwar (2008) and Windarti *et al*., (2011) found that growth of *O. hypopthalmus* from the Siak River grow slower that that of the Kampar River, as it is indicated by the presence of more dark growth rings in the otolith of the Siak's fish. Windarti and Putra (2012) also stated that there are abnormalities in the structure of gill of *O. hypopthalmus* from the Siak River. As there is limited information on tissue structure of fish living in the upstream and downstream of the Siak River, a study titled "histological structure of gill, kidney and liver of *Ompok hypopthalmus* captured in the upstream and downstream of the Siak River, Riau" is conducted.

METHODS

In this study, fish samples (*Ompok hypopthalmus*) were captured from the upstream area, in the Tapung Kiri River and in the Siak River that cross the Tualang Siak (downstream of the Siak River). In each sampling site, 20 several sized fishes were taken, males and females. The fish were then identified, sized, and weighed. The identified fishes were fixed in 4% formaldehyde solution. Fish organs such as gill, kidney, liver and heart were then processed for histological study, following Darjono *et al.*, (2001). The tissue were alcohol series processed, paraffin embedded, 6 µ sectioned and Haematoxylin – Eosin stained. The tissues were then studied using a binocular microscope (Olympus CX 21), abnormalities occur in the tissue were described and noted. The level of gill alteration is calculated by using Histopathologic Alteration Index (HAI), following Lopez and Thomas (2011) that modified the index from the work of Poleksik and Mitrovic_Tutundzic (1994). The HAI value was calculated for each fish, using this following formula:

HAI = (1 X SI) + (10 X SII) + (100 X SIII)

I, II and III correspond to the number of stages of alterations
S represents the sum of the number of alterations for each particular stage.

If the value of HAI between 0 and 10 indicate normal, 11 to 20 indicate slight damage to the organ, 21 to 50 indicate moderate changes in the organ; and 50 and 100 indicate severe lesions; and values over 100 indicate irreparable lesions of the organ.

RESULTS AND DISCUSSION

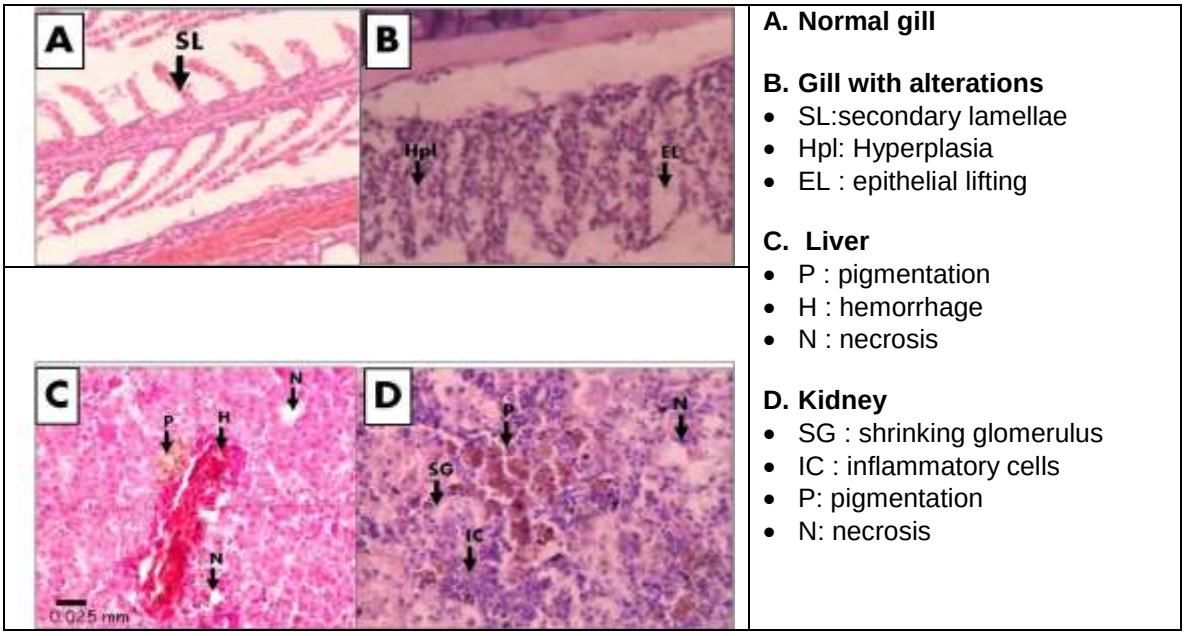
Totally 40 fishes , 20 fishes from each sampling site were captured. The fishes were captured using fish traps that are set in the river at night and were taken in the morning. Only alive fish that were taken, while the dead were excluded. Fish from the downstream is relatively bigger than that of the upstream, they were varied from 51 to169 mm TL and 23 to 29 gram BW (upstream), and 174 to 210 mm SL and 30 to 40 gram BW (downstream).

Histological study shown that the there were abnormalities in the structure of the visceral organs of *Ompok hypopthalmus* captured in both sampling sites (Table 1 and Figure 1). A variety of histopathological changes were found in all organs examined. Being among the first organs to be affected by contaminants present in the water and very sensitive to change, gill, kidney and liver might be important indicators of fish health and environmental condition in general.

Table 1. List of the histopathologic alteration observed in the gill, liver and kidney of *Ompok hypopthalmus* from the upstream and downstream of the Siak River

No	Organs	Histopathologic alterations	Sampling locations	
			Upstream	Downstream
1.	Gill	Hyperplasia and hypertrophy in the gill epithelium	√	√
		Lifting of respiratory epithelium	√	√
		Sanguineous congestion		√
				√
		/ gill	√	√

		Shortening of secondary lamellae		√
		Hemorrhage and rapture of lamellar epithelium	√	√
		Hypertrophy and hyperplasia of mucous cells		√
		Necrosis		√
		Histological Alteration Index (HAI) Value	15.2	37.9
		Necrosis		√
		Pyknotic hepatocyte nuclei	√	√
		Hemorrhage	√	√
2	Liver	Inflammatory cell infiltration		√
		Bile duct fibrosis		√
		Pigmentation	√	√
		Cloudy swelling		√
		Necrosis	√	√
		Hemorrhage	√	√
3.	Kidney	Inflammatory cell infiltration	√	√
		Pigmentation	√	√
		Glomerular alteration	√	√



A. Normal gill

B. Gill with alterations
- SL:secondary lamellae
- Hpl: Hyperplasia
- EL : epithelial lifting

C. Liver
- P : pigmentation
- H : hemorrhage
- N : necrosis

D. Kidney
- SG : shrinking glomerulus
- IC : inflammatory cells
- P: pigmentation
- N: necrosis

Figure 1. Histological structure of *O. hypopthalmus* organs

Among the organs analyzed, gill of the fish in this study showing the most obvious alteration signs. Most of secondary lamellae showing hyperplasia (the number of cell increase as the cell proliferate). As the the lamellae become thickened, distance between lamellae become narrow or the lamellae fused. Besides the hyperplasia, abnormalities occur in the secondary lamellae are hypertrophi (the cell become abnormally bigger), congestion, epithelial lifting and necrosis. Sorour and Harbey (2012) stated that histological condition of fish tissue represent as biomarker that can be used to predict the environmental condition. Research on nile tilapia that inhabit the Wadi Hanifah River, a polluted river in the Saudi Arabia showing hyperplasia, hypertrophi, epithelial lifting and blood congestion. Similar abnormalities symptoms also present in the gill of *Astyanax fasciatus* and *Cyanocharax alburnus* that live in the polluted water (Lopes and Thomaz, 2011), in the *Clarias gariepinus* that is exposed to detergent waste (Ogundiran *et al.,* 2009), in the fish that is exposed to oil waste (Rodrigues *et al.,* 2010) and in the fish living in the pulp and paper industry's waste polluted waters (Belicheva and Sharova, 2011).

The abnormalities in the gill of *O. hypopthalmus* in from the upstream and downstream of the Siak River are similar to those of the fish living in the polluted area (Lopes and Thomaz, 2011; Belicheva and Sharova, 2011). Most of histopathological alterations in the gill of *O. hypopthalmus* might be intepreted as nonspecific respons to stress due to low water quality. Alteration signs such as hyperplasia, hypertrophi and lifting of epithelial cells are present in the gill lamellae of fish that are exposed to a wide spectrum of pollutants (Belicheva and Sharova, 2011) and these lesions indicate that the fish respond to the effects of toxic agents present in the water and sediment [illegible] his study, alterations in the gill structure of *O.*

hypopthalmus indicates that the fish might has been exposed in the polluted water for relatively long time.

Klontz *in* Lopes and Thomaz (2011) stated that fish are intimately associated with their aqueus environment. Any physical and chemical changes in the ecosystem are rapidly reflected as quantifiable physiologic measurement in the fish. In this study, alteration signs occur in the gill of fish captured in the upstream and downstream of the Siak River and this fact indicates that the quality of water in both sampling sites is polluted. The downstream area was considered as low quality due to the finding of more alteration signs in the gill than that of the upstream. Several types of alteration such as hypertrophy and hyperplasia of mucous cells, necrosis and shortening of secondary lamellae were occur in the downstream fish only. The value of the Histological Alteration Index (HAI) also proves that the gill condition of the fish taken from the downstream was worse than that of the upstream. According to Poleksik and Mitrovic-Tutundzik in Lopes and Thomaz (2011) the HAI value of the downstream fish (37.9) can be categorized as "*moderate changes in the organs*". The alterations occur on practically all the surface of the gill and they involve changes that are relatively severe and lead to effects in tissue associated with functioning of the organs. These changes are reparable lesion, but if wide area of the gill are affected or maintained in situation of chronic pollution, they can lead to severe alteration. The HAI value of the upstream fish (15.2), however, can be categorized as "*slight damage to the organs*". The alteration involves changes that do not damage gill tissues and these changes are limited to small part of the gill or some filaments. Restructuration and recovery into normal gill function can occur with improvement of the environmental condition.

According to Belicheva and Sharova (2011) fish that are living in the polluted area directly and indirectly affected by the pollutant. Direct impact of the pollutant on fish might be fatal, but some fish may be able to tolerate the water quality changing. The fish might be survived as they perform the self defense mechanism. Belicheva and Sharova (2011) stated that such pathological changes as epithelial hyperplasia, hypertrophy and lifting are considered as defense mechanism, as they increase the distance between external environment and the blood, and thus serve as barrier to the entrance of xenobiotics. However, development of the alteration may decrease the lamellae surface used for oxygen intake and uptake and this condition may leads to hypoxia.

Liver and kidney structure of *O.hypopthalmus* from the upstream and downstream of the Siak River showing several types of alterations (Figure 2). The liver structure of the fish shown necrosis, pigmentation, hemorrhage, cloudy swelling and the presence of inflammatory cell. Similar liver condition was found in the *Odontesthes argentinensis* that was exposed to oil content waste (Rodrigues *et al.,* 2010) and also in fish living in the polluted area (Belicheva and Sharova, 2012). Rodrigues *et al.*, (2010) stated that liver is the main organ for biotransformation and xenobiotic excretion. The presence of xenobiotic, however, causing the structural, biochemical and molecular alterations. In fish that are exposed to oil content waste, there is dilatation of hepatic sinusoid. This alteration may indicate that the liver receiving more blood that is useful for detoxification process. Histological structures of the liver of Siak fish are similar to the liver structure of *Odontesthes argentinensis* described by Rodrigues *et al*., (2010); Ogundiran *et al.,* (2009), and Belicheva dan Sharova (2012). This fact indicates that the Siak River is polluted.

Kidney structure of *O. hypopthalmus* obtained from both sampling sites showing several alteration types. The most consistently observed alterations are shrunken glomerular tuft with dilation of Bowman's space and pigmentation, while hemorrhage and glomerular necrosis were quite rare observed. Belicheva and Sharova (2012) stated that such kinds of kidney alterations are occur in fish exposed to many types of pollutants and they could be interpreted as a nonspecific response to stress.

Structural changes in gill, liver and kidney of *O. hypopthalmus* obtained in this study proof that the environmental changes stimulate fish to response. There are 2 main types of structural changes, namely direct and indirect changes. Direct toxic effects of pollutant leading to tissue degeneration and necrosis, while the indirect effect trigger the development of compensatory mechanism to deal with the stressor (Belicheva and Sharova, 2012). The finding in this research strongly demonstrate that fish living in the Siak River may have been accidentally exposed to long-term chronic pollution.

CONCLUSION

Histological structure of the organs of *O. hypopthalmus* obtained from the upstream and of alterations. In the gill, the most common of lamellar epithelial cells, while in the liver and oid dilation and cell necrosis. The presence of

these alterations indicate that the fish has long been exposed to chronic pollution and thus confirm that the upstream as well as the downstream areas of the Siak River are polluted.

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