JIP
Jurnal Ilmiah PLATAX
Universitas Sam Ratulangi
Terakreditasi Ristekdikti No: 28/E/KPT/2019
ISSN : 2302-3589 (Online)
E_mail : jm_platax@unsrat.ac.id

Health Condition of *Tridacna* sp. In The Waters of Obi Island, Indonesia

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Abstract

Tridacna sp. is one of the protected heritage in Indonesia, because its population has declined dramatically. Tridacna sp. is the largest type of shellfish in water. Like a clam, Tridacna sp. can be used as a bioindicator of the aquatic environment because it can accumulate more heavy metals than other aquatic organisms due to its nature as a filter feeder. This study aims to determine the health condition of Tridacna sp. in the waters of Obi Island with a histopathological analysis approach. The histopathological analysis aims to see the level of tissue damage due to the accumulation of heavy metals. Observation of water quality was also observed in this study. Water quality parameters observed in-situ are temperature, brightness, salinity, pH, and dissolved oxygen. While the water quality parameters observed ex-situ are nitrate, orthophosphate, ammonia, iron (Fe), and nickel (Ni). Observations show that the water temperature is at 27.99 ℃. Water brightness is at 13 m. Salinity is at 32.13 mg / l. The acidity of the waters is 8.64. Ammonia is at 0.4 mg / L. Nitrate is at 0.009 mg / L. Orthopedics are at 0.016 mg / L. Dissolved oxygen waters are at 3.77 mg / L. The iron (Fe) level of water is at 0.6 mg / L. The level of nickel (Ni) waters is at 0.06 mg / L. This study shows the health condition of Tridacna sp. the histological approach shows that the condition of the network has changed. Symptoms of this change indicate the condition of the Tridacna sp. degeneration and cell necrosis. This change is thought to be influenced by heavy metals. Heavy metal content in liquids exceeds the quality standard threshold.

Keywords: Tridacna sp.; Heavy metal; Water quality; histopathological.

INTRODUCTION

Tridacna sp. is one of the protected aquatic organisms in Indonesia, because its population has declined dramatically (PERMENLHK, 2018). Tridacna sp. is the largest type of shellfish in water. Like a clam, Tridacna sp. can be used as a bioindicator of aquatic environments (Azizi et al. 2018; Jia et al. 2018; Saidov and Kosevich, 2019; Nour 2020).

Shells can accumulate more heavy metals than other aquatic organisms due to their nature as filter feeders (Kodama et al. 2012; Murphy et al. 2019; Feng et al. 2020). Heavy metals can be toxic to aquatic organisms because heavy metals are difficult to degrade, so they are easily accumulated in aquatic environments and their presence is naturally difficult to remove (Baramaki et al. 2012; Mansouri et al. 2012; Hao et al. 2019).

Industrial activities around the waters can contribute to heavy metals entering the waters around the river flow (Karbassi et al. 2008; Kim et al. 2009; Abdolvand et al. 2014; Khan et al. 2019; Paschoalinia et al. 2019). One of the industrial activities on Obi Island is the mining industry. This study aims to determine the health condition of Tridacna sp. in the waters of Obi Island with a histopathological analysis approach. The histopathological analysis aims to see the level of tissue damage due to the accumulation of heavy metals (Poleksic et al. 2010; Dane and Şïşman, 2020).

MATERIALS AND METHODS

Study Area

This research was conducted in the waters of Obi Island, South Halmahera Regency, North Maluku, Indonesia (01022,517'S, and 127033,934'E).

Water Quality Data Collection

Observation of water quality data is done in-situ and ex-situ. Water quality parameters observed in-situ are temperature, brightness, salinity, pH, and dissolved oxygen. While the water quality parameters observed ex-situ are nitrate, orthophosphate, ammonia, iron (Fe) and nickel (Ni). For ex-situ observations, water samples are taken based on the Indonesian National Standard (SNI).

Histopathological examination

The aquatic organisms that were the target of sampling were (*Tridacna* sp.). The sample handling and histopathological analysis followed the Korun and Timur procedure (2008). Samples of fish organs were fixed with NBF 10%, dehydrated using ethanol solution in stages, then clearing using xylene and embedded using paraffin. Next, the sample was cut to a thickness of 5 μm with a microtome and stained using hematoxylin and eosin (H&E).

RESULTS AND DISCUSSION

Water quality parameters

Temperature is one of the most important factors in regulating life processes and the spread of organisms in waters. Water temperature controls the condition of aquatic ecosystems (Burt et al. 2011). Observations show that the water temperature is at 27.99 ℃. These results indicate that the water temperature is below the optimal range of quality standards or low temperatures (KepMenLH, 2004). Seawater brightness is very influential in the growth of marine organisms. Brightness is very high (Boyd and Pine, 2010). The observations showed the brightness of the waters was at 13 m. The results of this observation are following the quality standards for seawater organisms (KepMenLH, 2004).

Physiologically, salinity is closely related to osmotic pressure adjustment (Varsamos et al. 2005). Observations show salinity at 32.13 mg / l. This result shows salinity below the quality standard range (KepMenLH, 2004). The degree of acidity or pH is one of the important chemical parameters in monitoring water stability. The observations showed that the pH of the waters was at 8.64. These results indicate that the pH is in high or alkaline conditions (KepMenLH, 2004). The condition of waters that are acidic or basic will endanger the survival of the organism because it will cause metabolic and respiratory disorders. Besides that, a very low pH will cause the mobility of various toxic heavy metal compounds to be higher, while a high pH will increase the concentration of ammonia (Kale. 2016).

Table 1. Water Quality Observation Results

Parameters	Observation result	Quality standards	Unit
Temperature	27.99	28-30*	℃
Brightness	13	> 5*	Meters
Salinity	32.13	33 – 34*	Mg/L
pH	8.64	7-8.5*	
Dissolved oxygen	3,.7	> 5*	mg/L
Nitrate	0.009	0.008*	mg/L
Ortophospat	0.016	0.015*	mg/L
Ammonia	0.400	.,3*	mg/L
Iron (Fe)	0.600	0.5**	mg/L
Nickel (Ni)	0.060	0.05*	mg/L

Information = (*): Kep-51 / MenKLH / 2004; (**): USEPA.

The analysis showed that ammonia was at 0.4 mg / L. These results indicate that ammonia exceeds the range of quality standards (KepMenLH, 2004). Ammonia can be toxic to organisms if the levels exceed the maximum threshold. High ammonia levels can be indicated by the presence of organic material pollution from domestic waste, industrial waste, and agricultural fertilizer runoff (Franklin and Edward, 2019). Also, ammonia compounds in waters can also be derived from the results of animal metabolism and the results of the process of decomposition of organic matter by bacteria (Kuypers, 2015).

Besides ammonia, the decomposition process by decomposing organisms also produces nitrates. The process is a nitrification process, namely the oxidation process of ammonia to nitrite and nitrate. This process is important in the nitrogen cycle and takes place in aerobic conditions. The oxidation of ammonia to nitrite is carried out by Nitrosomonas bacteria while the oxidation of nitrite to nitrate is carried out by Nitrobacter (Cáceres et al. 2017).

The analysis showed that nitrate was at 0.009 mg / L. These results indicate that nitrate exceeds the threshold range in the range of quality standards (KepMenLH, 2004). The high concentration of nitrate is thought to be influenced by temperature because high temperatures will cause a higher metabolic rate (He et al. 2019). The higher metabolic rate of phytoplankton can cause nitrates to be absorbed by phytoplankton more and so the nitrate measured is getting smaller (Akomeah et al. 2019). Observations (Table 1) show that the temperature is below the optimal range of quality standards or low temperatures (KepMenLH, 2004).

Besides temperature, nitrate concentration is also influenced by pH. If the pH in water is getting closer to base it will affect the concentration of nitrate, because the nitrate will tend to be higher when in an alkaline state (Jaramillo et al. 2018). The observations (Table 1) show that the pH is in a high or base condition. Besides, pH also affects the concentration of orthophosphate in water, if the pH approaches base, orthophosphate will tend to be higher in concentration (Guo et al. 2011). The analysis showed that orthophosphate was at 0.016 mg / L. This result shows that orthophosphate exceeds the range of quality standard threshold (KepMenLH, 2004).

Dissolved oxygen (DO) is needed by all living bodies for breathing, metabolic processes, or exchange of substances which then produce energy for growth and culture (Keene et al. 2017). Besides, oxygen is needed for the oxidation of organic and inorganic materials in the aerobic process (Roots et al. 2019). Observations show DO waters are at 3.77 mg / L. This result shows DO is lower than the range of quality standards (KepMenLH, 2004).

The analysis shows that iron (Fe) waters are at 0.6 mg / L. These results indicate that Fe exceeds the threshold range of quality standards (USEPA, 1986). The analysis shows that nickel (Ni) waters are at 0.06 mg / L. These results indicate that nickel also exceeds the threshold of the quality standard range (KepMenLH, 2004).

High concentrations of heavy metals (Fe and Ni) that exceed the threshold are thought to originate from the activity of the mining industry. Also, the concentration of heavy metals is also influenced by temperature and dissolved oxygen. Low water temperature will make it easier for heavy metals to soak into the sediment. While temperatures are high, heavy metal compounds will dissolve in water (Huang et al. 2018). Low oxygen content causes lower solubility of heavy metals (Jitar et al. 2014). Observations show that temperature and dissolved oxygen are lower than the optimal range of quality standards (KepMenLH, 2004).

Histopathological analysis

Heavy metal pollution in waters is a very serious problem because it disrupts the health of aquatic organisms. The presence of heavy metals in waters can lead to the process of accumulation in the body of aquatic organisms naturally. Heavy metals that enter the body cannot be removed from the body anymore, because heavy metals tend to accumulate in the body. Besides, accumulation can also occur through direct absorption of heavy metals contained in water. Exposure to heavy metals results in physiological disorders that make the body of aquatic organisms have to adapt and can even cause tissue damage (Maleki et al. 2015; Benjamin et al. 2019; Thabet et al. 2019).

The results showed the Kima tissue (Figure 1) experienced an infiltration of lymphocytes, degeneration, and cell necrosis. Heavy metals can endanger the health of aquatic organisms. Heavy metal accumulation influences the immune response resulting in the infiltration of lymphocytes. Excessive accumulation leads to degeneration and necrosis or death of tissue making cells. Necrosis can threaten the sustainability of populations of aquatic organisms because of its low survival rate due to death (Athikesavan et al. 2006; Dohaish et al. 2018; Haredi et al. 2020).

Heavy metal pollution can also threaten human health through the food chain. Materials containing heavy metals that are wasted in the waters are eaten by microorganisms. Microorganisms are eaten by fish, shrimp, and shellfish so that the heavy metals accumulate in the body tissues of fish, shrimp, and shellfish and are finally consumed by humans (Turkmen et al. 2005; Triebskorn et al. 2008).

Heavy metal Fe is an essential metal whose existence in a certain amount is needed by living organisms, but in excessive amounts can affect living organisms, such as ferrous metals (Fe) and nickel (Ni) (Ibrahim and Tayel, 2005). The high content of Fe metal will have an impact on human health including poisoning (vomiting), intestinal damage, premature aging to sudden death, arthritis, birth defects, bleeding gums, cancer, kidney cirrhosis, constipation, diabetes, diarrhea, dizziness, fatigue, hepatitis, hypertension, insomnia (Youdim, 2001; Abbaspour et al. 2014; Wessling-Resnick, 2017). Nickel absorption can be through inhalation, oral, and dermal. Health problems that arise can be in the form of systemic disorders, immunological disorders, neurological disorders, reproductive disorders, developmental disorders, carcinogenic effects, and death (Das et al. 2019; Buxton et al. 2019).

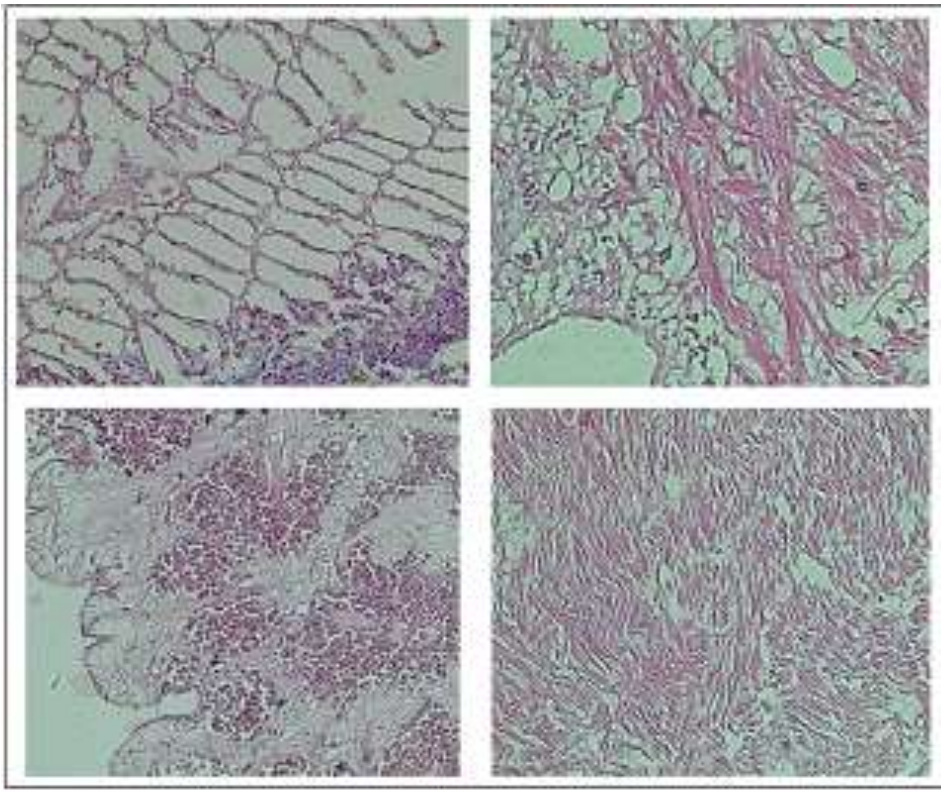

Fig. 1. Histopathological description of the Kima shell

CONCLUSION

The histological approach shows that the condition of the network has changed. Symptoms of this change indicate the condition of the *Tridacna* sp. degeneration and cell necrosis. This change is thought to be influenced by heavy metals. Heavy metal content in liquids exceeds the quality standard threshold.

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