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INFLUENCE OF WATER QUALITY PARAMETERS ON PREVALENCE OF NEMATODES IN FRESHWATER FISH *BARBONYMUS SCHWANENFELDII* IN TASIK KENYIR, MALAYSIA

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ABSTRACT

This paper presents a parasitological nematode survey in Tinfoil barb fish *Barbonymus schwanenfeldii*, from six different rivers around Tasik Kenyir, Malaysia, and the relationship between water quality and parasites. A total of 647 fish were collected and examined from six sampling stations at a water depth of 1m, within the period between September 2013 to November 2014. Physical water quality parameters were measured for all stations (pH, conductivity, dissolved oxygen and water temperature) to correlate them with the prevalence and mean intensity of the parasites in fish. The results showed that water pH values ranged from 5.5 to 8.6, while dissolved oxygen varied from 4 mg/L to 8 mg/L which supports increased prevalence of nematode. The conductivity was between 25 µS cm^{-1} and 35 µS cm^{-1}, and water temperature ranged from 25.7 ^{o}C to 31.6 ^{o}C. Results showed a positive significant correlation (P < 0.001) between nematode infections and both the dissolved oxygen, pH, conductivity and water temperature from all locations.

KEYWORDS: Nematode, Tinfoil barb fish, water parameters, Lake Kenyir.

INTRODUCTION

Malaysia can be classified as an advanced country in the management of its precious water resources. Pollutants go into aquatic systems as a result of the normal weathering of rocks, soils; and the development of industries and from human settlements, the main contributing activities being mining industries and agriculture as well as the release of sewage. The relationship between parasitism in aquatic organisms and environmental pollution and the potential role of endoparasites as water-quality indicators have received increasing attention during the past two decades (Le *et al.*, 2014).

Water quality performs significant role in health of human, animals and plants (Heath 1995). Increase in human population has resulted in new human settlements around lakes which served as water resources or tourism area which resulted in the deterioration of water quality (Mathur *et al.*, 2007). Moreover, increasing contamination in the river cause debilitation of water quality and in addition undermines human prosperity and the balance of aquatic ecosystems (Tobiszewski *et al.*, 2010).

Pollution can cause an increase in parasitism if, for example, host defense mechanisms are negatively affected, increasing host susceptibility, or by only increasing the population densities of suitable intermediate or final hosts (Lafferty & Kuris 1999). Fish are relatively sensitive to changes in their surrounding environment, including an increase in pollution factors (Ishadi *et al.*, 2014). Fish health may thus reflect, and give a good indication of the health status of a particular aquatic ecosystem (Crafford & Avenant-Oldewage 2010). The aim of the present work is to study the relation of numbers of nematodes in the fish hosts and water quality parameters. The data set is obtained from 18 sampling stations in six rivers of Lake Kenyir between September 2013 to November 2014.

MATERIALS AND METHODS

The Study Area

Lake Kenyir is the biggest artificial lake in South East Asia and located in Terengganu on the East coast of Malaysia, between longitude 102^{o}30'E to 102^{o}55'E and latitude 4^{o}27'N to 5^{o}15'N (Figure 1). This artificial lake was initially inundated in 1986 to generate hydroelectric power, receiving water inputs from two major rivers – the Terengganu River and the Terengan River (Furtado *et al.*, 1977). In addition, the surface area 36,900 ha and the lake have an average depth of 37 meters with a maximum depth of 145 meters. There are 340 islands in the lake, more than 14 waterfalls and numerous rapids and rivers (Kamaruddin *et al.*, 2011). It is an important irrigation and drinking water source. Boating activity for tourism, for example, could lead to an introduction to the input of pollution into the lake. A study was undertaken in the lake parts for the duration of one year.

Field work was conducted in six rivers, comparing of the parts of the East Petuang and Ketiar Rivers, North, Tekak and Kiang Rivers, South, Cacing River and West, Chomo River. The samples of fish, sediments and water quality were studied from six Rivers at the Lake.

Figure 1: Map of Lake Kenyir showing six sampling locations of fish and water quality.

Sampling

A total of 18 sampling stations were selected at six rivers, three stations on each river. Each place was visited at least twice for seasonal purpose. The location of each sampling station was determined based on the readings of GPS at the sites and given in Table 1.

Table 1: List of sampling sites in Lake Kenyir.

Sampling station	Location	Latitude (N)	Longitude (E)
1	Sungai Tekak	$05^o.12$-$05^o.16$	$102^o.73$-$102^o.73$
2	Sungai Kiang	$05^o.11$-$05^o.11$	$102^o.74$-$102^o.74$
3	Sungai Cacing	$04^o.84$-$04^o.87$	$102^o.69$-$102^o.70$
4	Sungai Chomo	$05^o.03$-$05^o.62$	$102^o.83$-$102^o.84$
5	Sungai Petuang	$05^o.19$-$05^o.25$	$102^o.66$-$102^o.67$
6	Sungai Ketiar	$05^o.05$-$05^o.06$	$102^o.56$-$102^o.56$

Fish and water samples were collected twice of Sungai Ketiar and Sungai Petuang and three times of Sungai Cacing, Sungai Chomo, Sungai Kiang and Sungai Tekak from September 2013 to November 2014. Weight of fish specimens collected ranged from 45 - 223 g and standard length ranged from 14 - 25 cm. All fish were caught using gill netting (2 - 2.5 & 3 cm mesh) from six different locations in the lake during the period of this study. Nets were set in the night at about 8.00 pm and permitted to stay unattended overnight. Nets were then checked early morning and evening to gather fish trapped in the nets. Live fish were placed in aerated aquaria on board and transported to examination camp where they were kept in separate containers for three to four hours. For diagnostic examaination, the fish were killed by pithing on the head before measurement of the aggregate length, standard length and weight.

The viscera were removed and put in a plastic Petri dish into physiological saline solution (0.9%) 9 g/L NaCl. Then the intestine was examined individually under a dissecting microscope for endoparasites. The intestine was split open and was shaken in a tube to dislodge any nematodes attached to the epithelial lining. Sometimes the epithelial layers of the intestine were scraped with a scalpel to remove the nematodes. The nematodes found were carefully removed and preserved in individual vials. All detected parasites were removed by using the same instruments and placed in cleaned bottles with lids for each fish. Recovered parasites were washed with physiological saline and examined all nematodes using a stereomicroscope (magnification factor is set from 8 up to 50). After examination, nematodes were counted to obtain the prevalence and abundance (Yen *et al.*, 2013).

Physical water quality was measured in situ, during high tide, using Multi-Sensor Probe YSI model 556 MPS for temperature, conductivity, dissolved oxygen (DO) and pH. Physical parameters of water samples were measured at the same time of fish sampling. The statistical analysis was performed using the GraphPad Prism version 5.00 (Motulsky 2007). The difference in Nematode prevalence with water parameters were compared using the One-Way Analysis of Variance (ANOVA), Tukey's test was used to identify pairwise relationships. Significance levels were set between $p < 0.001$ and $p < 0.05$.

RESULTS AND DISCUSSION

The pH values in the study area ranged between 5.5 to 8.6 (Mean = 6.9 ±0.7), these values categorise the waters of study sites as class I and III, and falls within the natural range according to Malaysian Interim Water Quality Standards INWQS (Ahmad *et al.*, 2009). Also, the pH value recorded in this study was within the World Health Organization (WHO) limit of 6.5- 8.5 for drinking water (WHO 1996). The lowest pH value was observed at Sungai Chomo, while the highest value was recorded at Sungai Tekak (Figure 2).

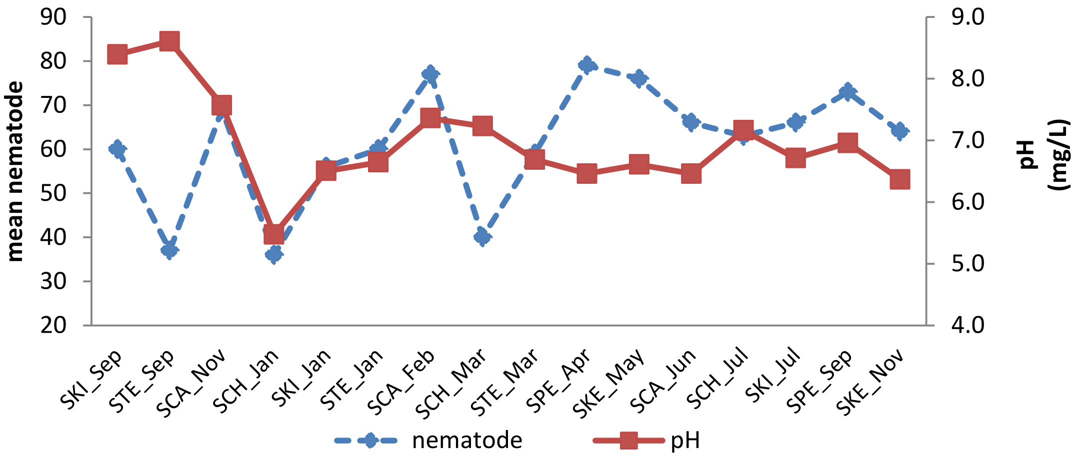

Figure 2: Monthly and seasonal variation of pH against mean nematode prevalence in the intestine of one fish species (*B. schwanenfeldii*) in six different locations at Lake Kenyir (Sep. 2013 - Nov. 2014). Locations**:** SCA = Sungai Cacing; SCH = Sungai Chomo; SKE = Sungai Ketiar; SKI = Sungai Kiang; SPE = SnugaiPetuang; STE = Sungai Tekak.

These values are either comparable to or somewhat lower than the values reported for Lake Kenyir (Modu *et al.*, 2012), but higher than those recorded by Najiah *et al.* (2012) and Yunus *et al.* (2015). However, pH could be altered through several mechanisms such as eutrophication and acidification, resulting in a decrease in dissolved oxygen content and pH (Pietrock & Marcogliese 2003). The prevalence of the nematode infection was found to be higher at a moderate pH (6.6 to 7.6), as nematodes cannot survive in very low pH environments, although other research suggests that parasites can resist large fluctutaions in pH outside their hosts (Ford *et al.*, 1998).

Dissolved oxygen (DO) was measured as the amount of gaseous oxygen (O_2) dissolved in the water. Optimal DO for bottom feeders, such as crustaceans and worms is 1-6 mg/L, while shallow water fish need higher levels between 4-15 mg/L (Boyd, 2015). Results indicate that DO in the study area ranged from 4 ±1.5 mg/L at

Sungai Cacing to 8 ±0.9 mg/L at Sungai Petuang (Figure), which indicate that these rivers are healthy habitats for both fish and invertebrates. The majority of DO values in study rivers fall within the class I and class II of the Interim National River Water Quality Standards (Zainudin, 2010), however the waters of Sungai Cacing were considered in class III of INRWQ, which require extensive treatment before using it for drinking or Agricultural purposes. There was a slight difference between the DO values of this study with that of previous studies (Ahmad *et al.*, 2009, Khalik & Abdullah 2012 & Modu *et al.*, 2012). Our DO value was higher (7.2±0.40 mg/L), (6.67±1.47 mg/L) and (>8.0 mg/L) than that recorded by Modu *et al.*, 2012. With regard to nematode prevalence, lower DO concentration (4.0 - 4.9 mg/L) in the lake water tend to favor moderate prevalence of the nematode in host fish, while higher concentration of DO supports increased prevalence of the nematode (Francis & Kester 2013).

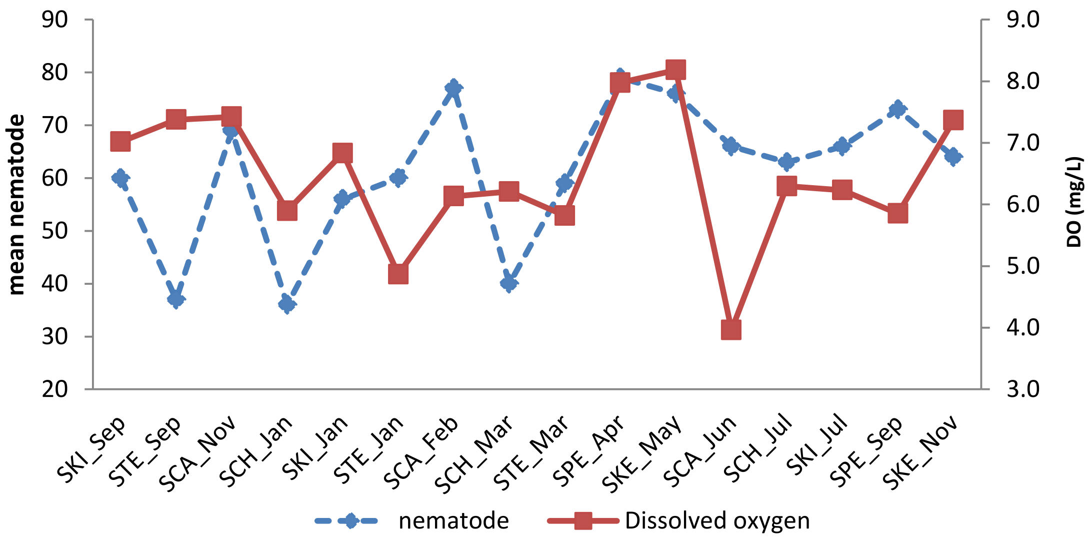

Figure 3: Monthly and seasonal variation of dissolved oxygen against mean nematode prevalence in the intestine of one fish species (*B. schwanenfeldii*) in six different locations at Lake Kenyir (Sep. 2013 - Nov. 2014).

The mean conductivity ranged between 25±0.6 μS cm^{-1} at Sungai Kiang while the highest value was found at Sungai Petuang, 35±3.8 μS cm^{-1} (Figure 4). The conductivity of water samples has been suggested as a good indicator of water quality

(Arimoro *et al.*, 2007). Our results showed that high conductivity levels coincide with the high tide, due to increased flow of soil to lake water. Data also showed that conductivity in the Lake Kenyir area (Study sites) is much lower than those recorded at Lake Chini (Shuhaimi-Othman et al, 2007), where the conductivity ranged from 14.98 to 50.83 µS cm^{-1} (mean 24.52± 3.19). The mean conductivity values obtained in this study had exceeded the Malaysian guideline for drinking water (INWQS).

The prevalence of nematode parasites in fish, followed the same fluctuating pattern of the lake water conductivity (Figure 4). Nematode prevalence in fish was lower during low water conductivity (September, January and March). On the other hand, higher nematode prevalence at high conductivity was attributed to good water conductivity with little or no turbidity. Turbid waters negatively affect fish immune system, making fish susceptable to higher nematode infestation (Paperna 1980).

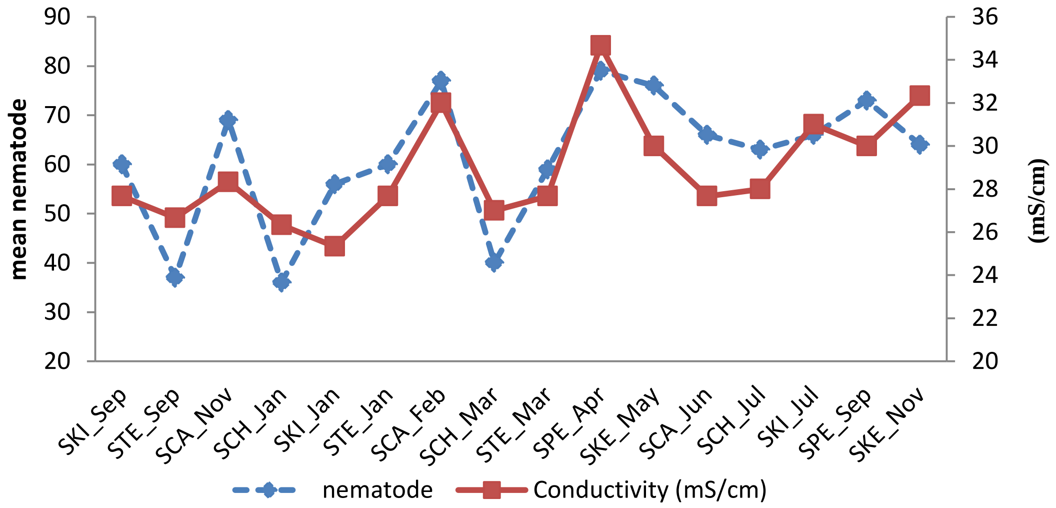

Figure 4: Monthly and seasonal variation of conductivity against mean nematode prevalence in the intestine of one fish species (*B. schwanenfeldii*) in six different locations at Lake Kenyir (Sep. 2013 - Nov. 2014).

Water temperatures in study sites ranged from 24.1°C to 31.6 °C, with an average temperature ranged between 25.7±1°C at Sungai Kiang in January 2014 to 31.6±0.7°C at Sungai Petuang in April 2014 (Figure 5). The mean value of temperature recorded in this study was lower than that previously reported for Lake

Kenyir (Modu *et al.*, 2012) possibly due to differences in sampling frequency, but it was higher than that reported by Siti-Zahrah *et al.* (2005), the water temperature found were within the Interim National River Water Quality Standards (Zainudin, 2010).

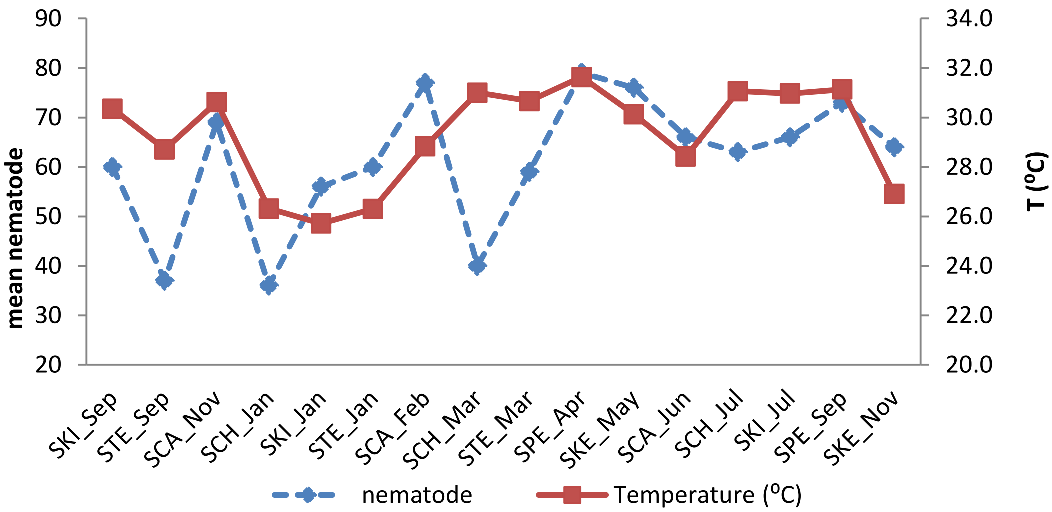

Figure 5: Monthly and seasonal variation of water temperature against mean nematode prevalence in the intestine of one fish species (*B. schwanenfeldii*) in six different locations at Lake Kenyir (Sep. 2013 - Nov. 2014).

The highest parasite infection was found in fish from Sungai Petuang (April 2014), while the lowest infection was at fish from Sungai Chomo in January 2014 (Figure 5). Research showed that when lipid containing organic pollutants were compared between the parasite and its host, Despite lower lipid contents in parasites compared to their hosts, weight-based concentrations of organic compounds have been observed to be higher in parasites than in their hosts for some host–parasite systems (Le *et al.*, 2014), which makes parasites a better choice for organic and heavy metal accumulation estimates in the aquatic ecosystems.

Water parameter changes, habitat alterations, fisheries, and invasive species can result in increased parasitism, because of the various direct and indirect factors that can interrupt parasite life cycle. Consequently, pollutants may increase parasitism due to increaeed host susceptibility or by increased abundance of intermediate hosts and vectors. Also, introduced species may introduce new parasites to susceptible native populations. In addition, pollutants can also decrease parasitism if infected hosts suffer differentially high mortality. Contrary to Le et al, 2014 findings, parasites can become more susceptible to pollution than their hosts when evaluating stressors of aquatic systems (Lafferty & Kuris 1999).

The fish are relatively sensitive to changes in their surrounding environment (Ishadi *et al.*, 2014). Therefore, fish health reflect the health of certain aquatic ecosystem (Crafford & Avenant-Oldewage 2010).

CONCLUSION

The present study showed a positive relationship between nematode infections in freshwater fish *Barbonymus schwanenfeldii* and each of the pH, dissolved oxygen, conductivity and water temperature at rivers of Lake Kenyir. Parasite infection was highest at both Sungai Cacing and Sungai Petuang. Therefore, based on the results of this study, the levels of nematode infection in fish can be used as bioindicators of certain water quality parameters, such as high dissolved oxygen and high water temperatures.

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