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Research Article
Preliminary Study on Invasive Fish Species Diffusion in Selected Malaysian Freshwater Ecosystems

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Abstract

Background and Objective: Malaysia reported experiencing serious invasive species intrusion in various rivers and threatening some local species to distinct. A study was undertaken to estimate and compare their composition and species richness in two pristine and two disturbed freshwater ecosystems. **Materials and Methods:** Invasive and local species growth pattern was also estimated using length-weight analysis. Sampling was conducted using cast net and electric shock in each river twice in 12 months. Fish collected were identified, photo captured and measured for their weight and length. The growth pattern was also estimated using length-weight analysis. **Results:** A total of 188 fishes were caught, comprises of 8 families and 15 species (ten local species with 119 individuals and five alien species with 69 individuals). *Sistomus binotatus* was the most dominant local species, whereas *Tilapia nilotica* was the most dominant alien species. There is no significant difference in composition between local and invasive species occur indicates the raise of alien species in those ecosystems even local species still dominated. The growth pattern for *Sistomus binotatus* and *Clarias batrachus* is isometric in the pristine ecosystem but negative isometric in disturbed rivers. Contrary, *Tilapia nilotica* has isometric for both ecosystems. **Conclusion:** This study concluded the capability and potential of colonization of alien species in stress ecosystem especially *Tilapia nilotica*. Thus, there is potential colonization of alien in Malaysia freshwater systems and a threat to local species due to food competition, site preferences and survival ability.

Key words: Intruder species, length-weight analysis, isometric growth, local species, species richness

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Each ecosystem inhabitant by various fish species, which adapted to specific preference[1]. Without any interference, the population would interact to ensure the survivor. Translocation of species across new environments or natural geographical range could impetus conflict between invasive to native species. Invasive species have a built-in competitive advantage over native species. They can increase their population and disrupt ecological processes especially if new habitat lacks natural predators. They may create competition in food obtaining, habitat preference, disease spread and predation, which finally would eliminate the native species[2].

Fish has been deliberated for many reasons such as trading purposes (ornamental)[3,4], disease control[5,6] and biological contamination control and fish meat production[7]. The invasive problems started since the 19th. Centuries North America. Not just fish, other organisms that cause serious invasive problems worldwide[7-10] are such as a plant (kudzu) (South America)[11], the zebra mussel (North America), rat (Norway) and Burmese python (Florida)[12].

Invasive species have become critical issues in Malaysia by many ornamental and fish meat species such as gar species, arapaima, sturgeon, tilapia and many other invasive species. Those species reported growing in local river systems and gradually dominating the ecosystem. Those invasive species have been introduced in Malaysia since 50 years ago especially for cultivation. Malaysia has imported invasive species for aquaculture (64.3%), aquarium (19%), recreational (14.3%) and biological 2.4%)[13]. Invasive species thwart native species in their bid to obtain food, over time they can effectively replace and thus eliminate from the ecosystem. On the other hand, invasive predators, which also could spread diseases, may be so adept at capturing prey that prey populations decline over time and many prey species are eliminated from affected ecosystems. One of the reasons that cause invasive species surveillance at new introduced ecosystems is food. Thus, this study was undertaken to estimate the level of alien species dispersion in selected river systems and determining their growth through.

MATERIALS AND METHODS

Study area: The study was undertaken at four different streams in the Selangor State of Malaysia. All four streams are tributaries that flow through different land use before confluent to nearby main river (Langat River). Each tributary is selected to represent different river conditions. The first stream flows through the golf course, second flows through protected botanical fernarium, third stream flows through center of developed area and the last stream flows through newly open land for building constructions. The first and last streams were represented in disturbed ecosystems and another two streams to represent pristine ecosystems.

Fish sampling and measurements: Pristine streams represent water ecosystems that received minimum adverse effects from human activities and disturbed rivers experience physical alterations such as channelization, riverbed alterations and low water conditions. Fish sampling was undertaken twice between July to December 2019. Since all rivers are shallow and wadeable, fish was sampled using adjustable electric shocker LR-20 (with permissions) and cast net. The equipment's voltage was adjusted regards to water conductivity to ensure appropriate voltage released to create seizure fish prior to collection. The cast net was used at a deeper site where electric shocker is less effective. Collected fish were identified to species level, measured for its length, weight and photo captured. Unidentified fish was brought to the laboratory for further detailed identification. Fish was identified to the species level[14].

Length-weight analysis: Length-weight analysis with conjunction age can give information on growth conditions, reproduction and life span[15]. This information is useful in the rapid estimation of biomass[16] and fish health based on environmental factors[17]. Rickter[18] has introduced length-weight formula as below:

$$W = aL^b$$

where, W is fish weight (g), L is fish length (cm), a is initial growth coefficient and b is growth coefficient

The values of constant 'a' and 'b' were estimated after logarithmic transformation using the least square linear regression as described by Zar [19] as below:

$$LogW = loga + blogL$$

Fish is considered as in isometric growth if 'b' value equal to 3, which means healthy growth and negative isometric if 'b' < 3 and positive isometric if 'b' > 3.

Statistical data analysis: The invasive species compositions were compared to local species using a one-way ANOVA test at 95% confidence level ($\alpha = 0.05$). The probability *p*-value below 0.05 indicating a significant differences.

RESULTS

Native and invasive fish composition: The study has collected 188 fish (native and invasive species) from four studied streams, represented by 8 families and 15 species. As in other tropical river systems, Cyprinidae has dominated the studied area and represents 62.5% of total recorded. Other families that recorded are Channidae, Osphronemidae, Cichlidae, Poeciliidae, Symbranchidae, Loricariidae and Clariidae. Their families and species composition are presented in Fig. 1. From 15 species recorded (Fig. 2), five are invasive species to Malaysia namely *Barbonymus goniotus* (Java barb), *Gambusia affinis* (mosquito fish), *Tilapia nilotica* (perch), *Cichlasoma trimaculatum* (flower horn) dan *Pterygoplichthys pardalis* (Amazon sailfin catfish). Those alien species represent 36.7% of total species recorded. Amongst invasive species recorded, *Tilapia nilotica* was the most dominant species recorded (46 individuals) and recorded in all four streams (Fig. 3).

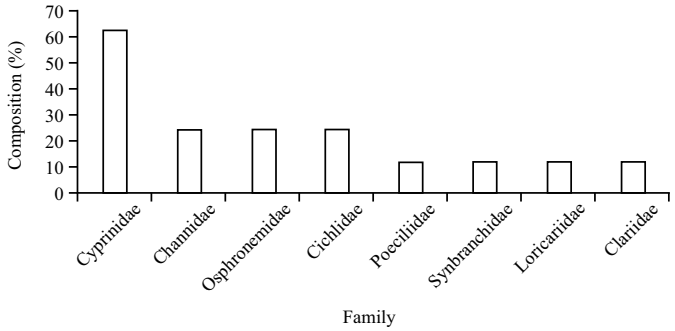

Fig. 1: Fish composition percentage (%) for eight families fish at all study areas

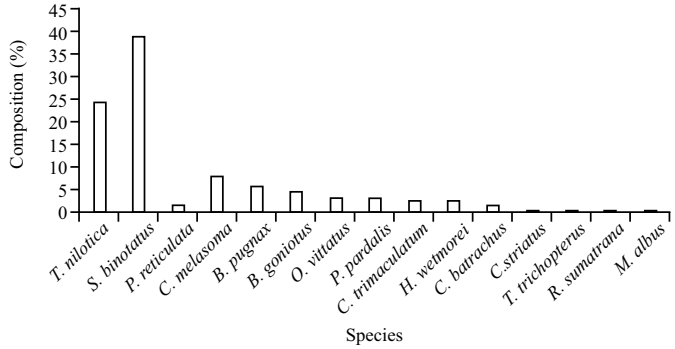

Fig. 2: Fish species percentage composition (%) at all study areas

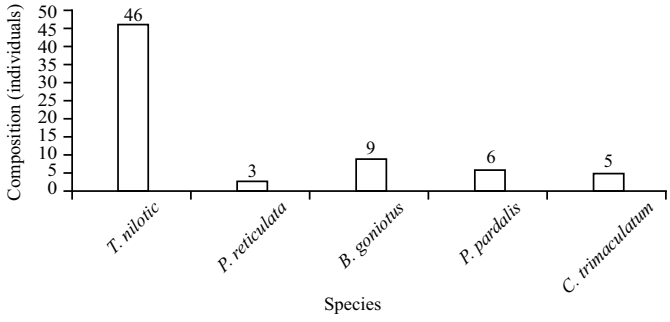

Fig. 3: Number of individuals for five invasive fish species collected at all study areas

Table 1: Computed variables of Length-weight analysis for selected species

Species	A	b	r^2	Growth condition	$W = aL^b$
Tilapia nilotica	1.648	2.902	0.9519	Isometric	$W = 1.648L^{2.902}$
Barbonymus gonionotus	2.2774	3.3116	0.9933	Positive isometric	$W = 2.277L^{3.311}$
Hypostomus plecostomus	2.722	3.3611	0.9791	Positive isometric	$W = 2.722L^{3.361}$

W: Fish weight (g), L: Fish length (cm), A: Initial growth coefficient, b: Growth coefficient, r^2: Coefficient of determination

Growth pattern: *Tilapia nilotica* (perch), *Barbonymus gonionotus* (Java barb) and *Hypostomus plecostomus* (armored catfish are invasive species found dominating in all studied ecosystems and as such, their length-weight analysis were undertaken to estimate their growth pattern (Table 1). Result demonstrates *Tilapia nilotica*, *Barbonymus gonionotus* and *Hypostomus Plecostomus* exhibit an isometric growth pattern. However, *Tilapia nilotica* (perch) exhibit normal growth even in poor river conditions (b = 2.902). Meanwhile, the *Barbonymus gonionotus* and *Hypostomus plecostomus* have positive isometric (b>3), which explains more weight proportion than the length.

DISCUSSION

Recently, *Tilapia nilotica* observed to inhabitant in most streams and rivers in Malaysia. The species initially was brought to Malaysia for aquaculture purposes as it has nice fleshy meat and fast grow[20]. *Tilapia nilotica* aquaculture grows very well in Malaysia and being grown either in large scale aquaculture or small scale by the individual house for own use[21]. The species reported has spread in local ponds or rivers and quickly dominating the ecosystems[21]. As regards to their size, aggressive behavior and high survival rate, this species can rapidly establish them in the new environments and they could effectively eliminate native species for many reasons. To overcome the problem, the Fisheries Department of Malaysia[22] has announced and published list of invasive species that are prohibited to be imported. Most of invasive species recorded in this study are in the Fisheries Department Blacklist except Java barb (*Barbonymus gonionotus*) and mosquitofish (*Gambusia affinis*).

To date, 42 invasive species have been recorded in Malaysia[13,20] and this study recorded 36% from total alien species mentioned above. This study indicates that *Tilapia nilotica* exhibits the most robust dispersion throughout four studied streams. *Barbonymus gonionotus* (Java carb) and *Hypostomus plecostomus* (armored catfish) is another invasive species recorded with high composition in this study. Those species also exhibits high survival rate and very resistant to poor water quality. One-way ANOVA test demonstrates insignificant composition differences between invasive species as compared to native species ($\alpha = 0.05$, $p>0.05$), which demonstrates the increment of invasive species in the local habitat. Besides that, the isometric growth pattern of *Tilapia nilotica*, *Barbonymus gonionotus* and *Hypostomus Plecostomus* explain the capability of invasive species to adapt to various habitat conditions. However, the survival factors of the resulted on *Tilapia nilotica* (perch) are not well studied but the possible factors could be due to aggressive behavior, feeding behavior and larger in size[23]. Whereas, results growth for *Barbonymus gonionotus* and *Hypostomus plecostomus* explain those species have sufficient food sources and gain more weight than their length. Both species are omnivore and they are capable to eat almost everything possible and easy to adapt to any habitat conditions. Asian carp (*Barbonymus gonionotus*) was second dominated invasive recorded followed by *Hypostomus plecostomus*. It usually inhabits bottom to mid-water in slow to moderate flowing water or standing waters like lakes or reservoirs. The *Hypostomus plecostomus* is known as the most robust species even recorded as the third dominant species. The species is seen very dominant even in the most polluted river in Malaysia. Most of urban rivers or canals that normally very turbid found to have very dense *Hypostomus Plecostomus*. Jalal *et al*.[24] also found a similar pattern of domination of family and *Hypostomus plecostomus* was also third species that dominate the area after *Barbonymus* sp. and *Tilapia* sp. Chuan *et al*.[25] reviewed the lack of research on this non-native dispersion effects on natives as most research focused on aquaculture production for market demand. Rahim *et al*.[20] discussed and agreed that the invasive species is easy to tolerate a variety of environmental conditions that can affect the native species populations. Even Batubara *et al*.[26] has reviewed that *T. niloticus* is known as world invasive species while Batubara *et al*.[26] explained the isometric growth based on weight-length analysis indicated the environment is promising for fish to survive. Batubara *et al*.[26] also believed the low competitors and low predators one of the factors that contribute to this isometric growth. Therefore, the isometric growth of those three invasive species in the study areas shows the native species is not their competitors and also not their predators which can increase their species diffusion in the future.

CONCLUSION

Invasive species intrusion in Malaysian riverine systems is threatening local species to a distinct level. This study reveals their composition in selected rivers as high as native species even more abundant in some rivers. The declining of native species could be affected by aggressive colonization by invasive species in many ways. *Tilapia nilotica* (perch), *Barbonymus gonionotus* (Java barb) and *Hypostomus plecostomus* (armored catfish) are three invasive species recorded dominating studied streams and exhibits comfort grow.

SIGNIFICANCE STATEMENT

This study discovers the invasive species growth pattern that can be beneficial for estimation the level of those species dispersion in the selected river system. This study will help the researcher to uncover the critical areas of dominant invasive fish species growth and population that many researchers were unaware this can affect the growth and population of native species.

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