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Original Article

The role of mosquito predators in the ecosystem in reducing the incidence of Dengue

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Abstract

The aim of this study was to show that the presence of mosquito predators in the ecosystem decreased the incidence of dengue cases. Data was obtained by daily inspection of 85 *Aedes* mosquito potential breeding point at 15 dengue outbreak hotspot localities with at least one mosquito predator present at the locality and the VEKPRO programme used in the monitoring of dengue cases in Malaysia. The mosquito predators identified were dragonfly, dragonfly nymph, *gambushia* fish, tadpole and frog. The study was done at the district of Petaling from 4th January, 2015 to 4th July 2015. The results show that the presence of mosquito predators hinder the breeding of *Aedes* mosquito in the ecosystem which is related to a decrease in dengue cases

Keywords: *Aedes* mosquito, *Aedes* larvae, Dengue cases, Mosquito predators, Breeding point

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Introduction

In Malaysia, the number of dengue cases is increasing at an alarming rate. The district of Petaling, Selangor contributed more than 50 percent of the total number of dengue cases in Malaysia (Mudin, 2015). Within a period of 20 years (1995-2016) dengue cases increased from 6,543 to a mind blowing of 120,836 cases which is about 20 fold increase (Paul and Tham, 2015). The dengue mortality rose from 28 deaths in 1995 to 336 in the year 2015 (Ministry of Health Malaysia, 2016). Dengue is related to the population of Aedes mosquito, which is a vector for the disease (Walker and Sinkins, 2016). The occurrence of dengue cases is a marker for the abundance of Aedes mosquito (Wilke et al., 2017). Aedes mosquito is found in tropical and sub-tropical climates worldwide, mostly in urban and semi-urban areas. The transmission of dengue illness is associated with the geographic expansion and distribution of mosquito vectors and viruses in an ecosystem (Cheong et al., 2013; Halstead, 2008; Hay et al., 2000).

An ecosystem is defined as an area of land where all the plants, animals, microorganisms and environment lives as parasite and symbiotically to maintain a perfect balance (Biberaj et al., 2014). When the balance of the ecosystem fails due to increase or decrease of certain species, changes will be inevitable and it will lead to unsustainability of the ecosystem until self-consistency is achieved. Ecosystem is inter-connected within each and every insect species (Dreyer et al., 2015; Jankielsohn, 2018).

Insects play a very critical role in an ecosystem structure and function (Zhang et al., 2014). They act as important food resources and play several important

roles which capable to affect the universe (Schowalter, 2013). They affect, and are affected by environmental issues such as land, water and air pollution including the issue of genetically modified crops, disease epidemiology and climate change (Bosc et al., 2018). However relatively limited attention has been given to the important role of them to balance the ecosystem (Schowalter, 2013).

Predators consume another organisms partly or wholly. This includes predator-prey, herbivore-plant, and parasite-host interactions (Zhang et al., 2013). Their presence is very important in balancing the ecology population and for the survival of an ecosystem (Chatterjee and Venturino, 2011). Logically, when the number of prey increase, the number of predators increase which later reduce the number of prey (Cortez and Weitz, 2014).

This study aims to explore how the presence of mosquito predators in the ecosystem deter the breeding of Aedes mosquito population and thus reduce dengue cases. Many study and research has been done on mosquito predators but this study exhibit an insight into the effect of mosquito predators on Aedes mosquito in a naturally existing environment. Two specific objectives were used that is to determine the frequency of Aedes larvae breeding and the number of dengue cases in relation to the type of mosquito predators at 15 hotspot localities.

Material and Methods

This is a descriptive cross-sectional study in which the interested outcome and the exposure status were measured simultaneously. It was used to measure the interested outcome in a defined area at one time point and over a period (Bray and Parkin, 2014). This study was conducted at the District of Petaling in the state of Selangor, Malaysia, it was chosen because it is an area of high dengue incidence which constitute more than 50% of the total dengue cases in Malaysia. According to the Ministry of Health Malaysia, the incidence rates for dengue cases in Selangor for the year 2014 was 361 cases per 100,000 populations which are higher than the national target of less than 50 cases per 100,000 population (Mudin, 2015).

Petaling is a district located in the state of Selangor in Malaysia. This district is located in the middle of the Klang Valley adjacent the capital, and thus has experienced tremendous urbanization (Leh et al., 2014). The population increased from 633,165 in 1991 to 1,782,375 in 2010. It covers some 484.32 km² in area consisted of three urban cities Alam, Petaling Jaya and Subang Jaya (Department of Statistics Malaysia, 2016).

Table-1: VEKPRO program the locality under study, number of hotspot days, cases and check point at each locality December 2014

Locality	Number of hotspot days	Number of dengue cases during the hotspot period	Number of check point
Selangor petaling Seksyen 27	121	133	5
Seksyen 15	117	29	5
PJS 9 /1	116	50	6
SS 15/4	104	42	5
Seksyen 27	103	60	5
Seksyen 13	97	36	5
Seksyen 20	96	60	7
Seksyen 13	93	27	6
Seksyen U13	92	79	5
Seksyen U8	87	111	7
Seksyen 17	77	19	7
Tmn puchong utama	77	29	5
Seksyen 26	76	17	6
Seksyen U5	74	29	6
Seksyen 17 teres b	73	30	5
Total			85

The locality under this study is specified in table 1 together with the number of hotspot day, the number of cases during the period and the number of check point to be inspected. The type of indicators used was numbers and percentage and logical, use of "presence" or "absence" for quantitative analysis (Freeman and Moisen, 2008). A description was given by collaborating both quantitative and descriptive indicators (AECT, 2001; Bray and Parkin, 2014; Sidel et al., 2017).

To achieve the objectives, 15 areas (refer table 1) with the presence of at least one mosquito predator in the naturally existing environment of prolong high dengue cases incidence namely Hotspot (Definition: an area where the outbreak is continuous for more than 30 days from the day the dengue outbreak started) was detected at the district of Petaling. The method used in detecting the predators was direct observation method (Leather, 2005).

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The direct observation was tabulated in a form according to the type of predators and mosquito larvae found. A description was given by collaborating both quantitative and descriptive indicators. Criteria for the check point was a hotspot area. Hotspot area is a locality where dengue outbreak is continuous for more than 30 days. At the district of Petaling there were 145 hotspot areas with dengue cases ranging from 25 to 175 cases. Each hotspot area has many localities. The localities from the hotspot area chosen based on the highest number of dengue cases and with the presence of at least 1mosquito predator. Each locality had 5 to7 potential breeding area called check points (refer to table 1) Daily inspection for larvae breeding and dengue cases was done for 26 weeks at the locality. `

Results and Discussion

Figure 1 shows the breeding of Aedes larvae at the 15 localities in relation to the type of mosquito predators stated in table 2.

The presence of mosquito predators reduces the population of Aedes larvae. Results also shows that Aedes larvae population is inversely proportional to the number and type of mosquito predators. In Seksyen 27, Seksyen 13, Seksyen 20, Seksyen 13 (teres E), Seksyen U13, Seksyen U8, Taman Puchong Utama and Seksyen U5, only dragonfly was found as a predator where the breeding of Aedes larvae is higher. Since dragonfly prey only on adult mosquito thus the breeding of Aedes larvae is not required to be monitored (Goertzen and Suhling, 2013).

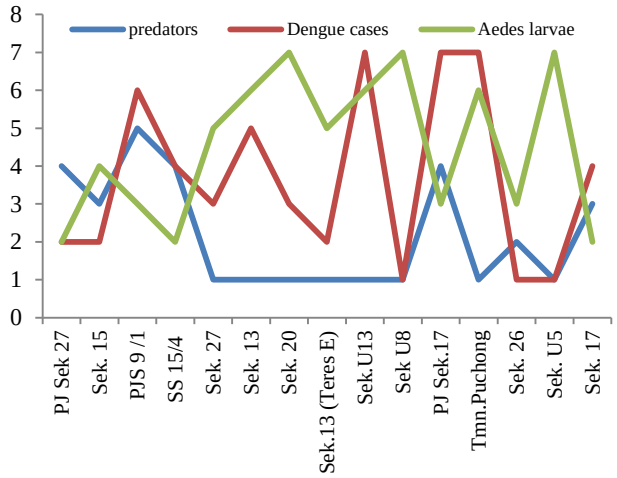

Figure-1: Number of *Aedes* larvae breeding on weekly inspection for 26 weeks at 15 localities in relation to mosquito predator

Table-2: Types of predators in relation to incidence of dengue cases and the frequency of Aedes larvae breeding for 26 weeks (6 months) at the 15 localities.

Locality	Type of Predator	Incidence of Dengue cases	Frequencies of Aedes larvae breeding
PJ Seksyen 27	Dragonfly, Frog, Tadpole, Nymph	2	2
Seksyen 15	Dragonfly, Frog, Tadpoles	2	4
Pjs 9 /1	Dragonfly, Frog, Tadpoles, Gambushia fish, Nymph	6	3
Ss 15/4	Dragonfly, Frog, Tadpole, Gambushia fish	4	2
Seksyen 27	Dragonfly	3	5
Seksyen 13	Dragonfly	5	6
Seksyen 20	Dragonfly	3	7
Seksyen 13	Dragonfly	2	5
Seksyen U13	Dragonfly	7	6
Seksyen U8	Dragonfly	1	8
PJ Seksyen 17	Dragonfly, Frog, Tadpole, Gambushia fish	7	3
Tmn Puchong	Dragonfly	7	6
Seksyen 26	Dragonfly, Frog	1	3
Seksyen U5	Dragonfly	1	7
Seksyen 17	Dragonfly, Frog, Gambushia fish	4	2

Table 3 shows the frequency of all predators for a period of 26 weeks and figure 2 states the frequency of dragonfly and number of dengue cases at 15 localities for 26 weeks. The frequencies of dragonfly ranged from 13 to 26, and the number of dengue cases ranged from 1 to 4 cases. The highest frequency was 26 at Selangor Petaling, Seksyen 27 and Seksyen 17, while the lowest was 13, at Seksyen 17 Teres B. In figure 2 the higher the frequency of dragonfly the lower the dengue cases. Since dengue is transmitted by adult mosquito thus preying of dragonfly on adult mosquito seems to reduce the transmission rate of dengue cases.

Figure 3 showed the frequency of frog found at 15 localities. The frequencies of frog ranged from 11 to 17, the highest frequency was found at SS 15/4, while the lowest was 11 found at Seksyen 15. However, frogs were only present in 7 localities out of 15 localities. The frog frequency as a predator did not pose much impact on dengue cases. Although they mostly prey on larvae and sometimes on adult mosquito, they are important in the breeding of tadpoles as a predator for *Aedes* larvae.

Figure 4 shows the frequency of tadpole at 15 localities which was ranged from 25 to 26. They breed in pond and water ways like monsoon drains. They are good predators of larvae but also they prey on other organisms. *Gambushia* at times preys on tadpoles, even though they are seen to live in the same habitat.

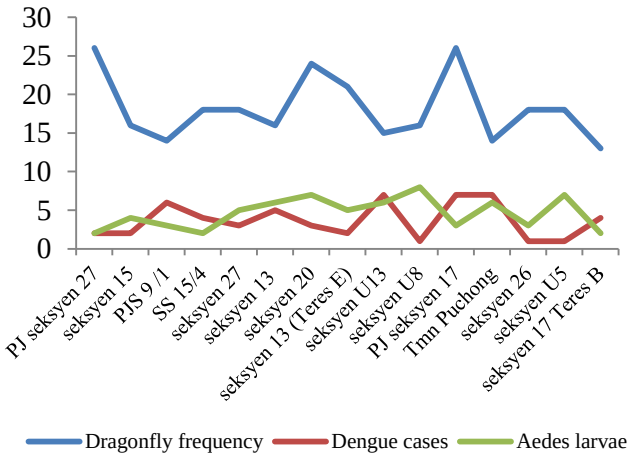

Figure-2: Frequency of dragonfly in relation to dengue cases and *Aedes* larvae for a period of 26 weeks at 15 localities

Table-3: Frequency of predators for 26 weeks at 15 localities

Locality	Dragonfly	Frog	Tadpole	Gambushia fish	Dragonfly nymph
PJ Seksyen 27	26	12	26	0	26
Seksyen 15	16	11	26	0	0
Pjs 9 /1	14	13	26	26	26
Ss 15/4	18	17	25	26	0
Seksyen 27	18	0	0	0	0
Seksyen 13	16	0	0	0	0
Seksyen 20	24	0	0	0	0
Seksyen 13	21	0	0	0	0
Seksyen U13	15	0	0	0	0
Seksyen U8	16	0	0	0	0
PJ Seksyen 17	26	15	26	26	0
Tmn Puchong	14	0	0	0	0
Seksyen 26	18	16	0	0	0
Seksyen U5	18	0	0	0	0
Seksyen 17	13	14	0	26	0

Their impact is more to larvae rather than adult mosquito thus their presence can also prevent dengue cases. Figure 5 shows the frequency of gambushia fish at 15 localities. Their highest frequencies were 26, they were present at each inspection for 26 weeks.

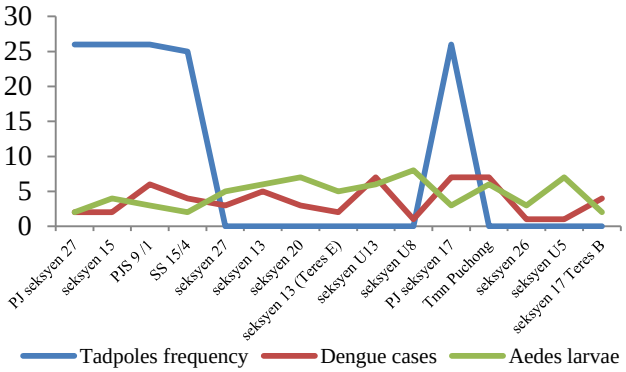

Figure-4: Frequencies of tadpoles, dengue cases incidence and *Aedes* larvae breeding for 26 weeks at 15 localities

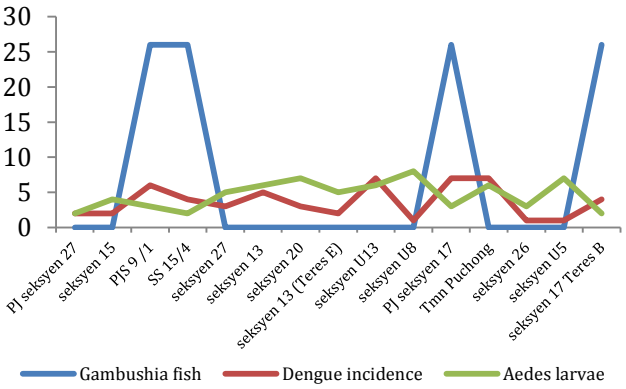

Figure-5: Frequencies of gambushia fish, dengue cases incidence and *Aedes* larvae breeding for 26 weeks at 15 localities

Figure 6 shows the frequency of dragonfly nymph at 15 localities. The dragonfly nymphs were only found in 2 localities. The presence of dragonfly nymph in the habitat acts as one of the best mosquito larvae predator and gave a great impact on the presence of mosquito larvae. As with Gambushia fish their presence in the 2 localities has no breeding of mosquito larvae. Their impact on dengue fever is less since they act on the aquatic period of the mosquito life cycle. [Figure 6]

Findings shows that mosquito predators keep the population of *Aedes* larvae low. When the number of mosquito predators increase the *Aedes* larvae breeding drops. Results also indicated that the breeding of mosquito larvae depends on the type of predators. In locations where *Aedes* larvae breeding were high only dragonfly was found. Since dragonfly prey only on adult mosquito, the *Aedes* larvae breeding was high.

The frequencies of dragonfly were ranging from 13 to 26, and the number of dengue cases range from 1 to 4 cases. The highest being 26, at Selangor Petaling, Seksyen 27 and seksyen 17, while the lowest is 13, at Seksyen 17 Teres B. The compounding factor is related to the abundance of vector in relation to the abundance and type of predators. This is also incorporated with the breeding site where the predators can reproduce. *Aedes* larvae can even breed in an amount of 20mm diameter and 5mm depth of water thus making it a very versatile vector whereas their predator needs a large amount of water to reproduce and stay alive such as rivers, drains and ponds.

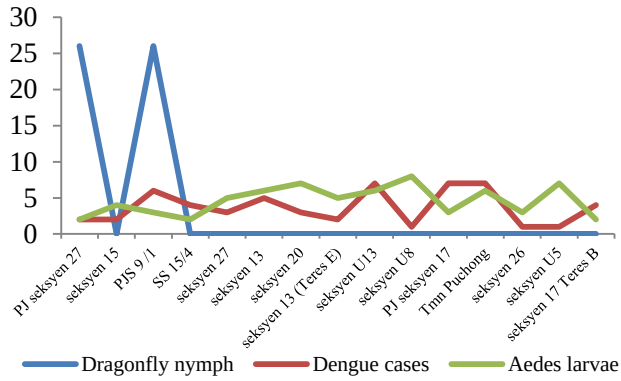

Figure-6: Frequencies of dragonfly nymph, dengue cases incidence and *Aedes* larvae breeding for 26 weeks at 15 localities

The frequency of dragonfly is indirectly proportional to the incidence of dengue cases. Since dengue is transmitted by adult mosquito thus preying of dragonfly on adult mosquito seems to reduce the transmission rate of dengue cases while the breeding of *Aedes* larvae is high where only dragonfly is the prey. Frog as a predator has not much impact on the dengue cases and larvae breeding even though they are present at seven localities. Since frog prey not only on larvae but many other insects and at times on adult mosquito thus they are important in the breeding of tadpoles as a predator for *Aedes* larvae.

The frequencies of tadpole ranged from 25 to 26 and found only at 5 localities. They breed in the pond and water ways like monsoon drains. They are good

predator of larvae but also they prey on other organisms. The presence of gambushia at times preys on tadpoles, even though they are seen to live in the same habitat. Their impact on *Aedes* mosquito are more to the larvae rather than to adult mosquito thus their role in preventing dengue cases is more efficient during the aquatic period of the *Aedes* mosquito. Again, their capacity as predators lies on the breeding of mosquito larvae in their habitat. *Gambushia* fish are very hardy type of fish and feeds on mosquito larvae very lavishly as they are named larvivirous fish (Silberbush and Resetarits, 2017). Their presence is very much limited since most of their breeding areas has been compromised. They were only detected at 4 localities. There was no mosquito larvae breeding at the localities where they were present even though it's a highly potential area for *Aedes* mosquito to breed.

The presence of dragonfly nymph in the habitat acts as one of the best mosquito larvae predator and thus give a great impact on the presence of mosquito larvae. Similar with *gambushia* fish the 2 localities where dragonfly nymph was present recorded no breeding of mosquito larvae. Their impact on dengue fever is less since they act on the aquatic period of the mosquito life cycle so the reproduction of adult mosquito was put to halt. In summary, the findings clearly showed that the presence of mosquito predators combatted the breeding of *Aedes* larvae to nil, even though the sites are highly potential areas for the breeding of the *Aedes* mosquito.

Conclusion

The results show that the presence of mosquito predators hinder the breeding of Aedes mosquito in the ecosystem. With the presence of these mosquito predators there is decrease in frequency of larvae breeding and the incidence of dengue cases.

Contribution of Authors

Rasdi I: Conceived idea, conducted experiment and write up of article
Kamaruzaman K: Helped in experiment, compilation of results and statistical analyses

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