# FEEDING BEHAVIOUR OF SWORDFISH (*XIPHOPHORUS HELLERII*) AND PLATY FISH (*XIPHOPHORUS MACULATUS*) AS PREDATORS OF MOSQUITO LARVAE (*AEDES* SP.) BASED ON SCIENCE AND ISLAMIC PERSPECTIVES

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**Abstract**

Islam teaches the importance of maintaining the balance of nature and justice in the use of resources. Currently, one of the problems caused by human negligence due to a lack of awareness in protecting the environment is health problems. Therefore, an infectious disease that has become endemic in Indonesia is Dengue Hemorrhagic Fever (DHF). Dengue fever is caused by the dengue virus, which is transmitted through the insect vector *Aedes* sp. One of the controls carried out to control mosquitoes as a vector of dengue disease is to use natural predators with fish as mosquito larvae eaters. The purpose of this study is to observe the feeding behaviour and predation rate of Swordfish (*Xiphophorus hellerii*), and Platyfish (*Xiphophorus maculatus*) against mosquito larvae (*Aedes* sp.) and the study is based on an Islamic perspective. The observation results obtained from the feeding behaviour of *X. hellerii* and *X. maculatus* fish are that they are predators that chase, catch, and directly prey on their prey. *X. hellerii* fish has a higher level of feeding behaviour compared

to X. *maculatus* fish in preying on mosquito larvae (*Aedes* sp.). The average predation ability of *X. hellerii* fish against *Aedes* sp. instar III larvae was 24.8 fish, while X. *maculatus* fish was 18.4 larvae. So that the fish *X. hellerii* is said to have better potential as a biocontrol to control the mosquito population, which is a vector of dengue disease, in accordance with the recommendation to maintain the balance of nature in Islamic teachings.

**Keywords:** *Aedes* sp., Feeding Behaviour, Predation, *Xiphophorus hellerii*, *Xiphophorus maculatus*

**Abstrak**

Islam mengajarkan pentingnya menjaga keseimbangan alam dan keadilan dalam penggunaan sumber daya. Saat ini, salah satu masalah yang diakibatkan oleh kelalaian manusia karena kurangnya kesadaran dalam menjaga lingkungan adalah masalah kesehatan. Oleh karena itu, salah satu penyakit menular yang menjadi endemik di Indonesia adalah Demam Berdarah Dengue (DBD). Penyakit DBD disebabkan oleh virus dengue yang ditularkan melalui vektor serangga Aedes sp. Salah satu pengendalian yang dilakukan untuk mengendalikan nyamuk sebagai vektor penyakit DBD adalah dengan menggunakan predator alami yaitu ikan sebagai pemakan jentik nyamuk. Tujuan dari penelitian ini adalah untuk mengamati perilaku makan dan tingkat pemangsaan ikan Pedang (Xiphophorus hellerii), dan ikan Platyfish (Xiphophorus maculatus) terhadap jentik nyamuk (Aedes sp.) dan kajiannya berdasarkan perspektif Islam. Hasil pengamatan yang diperoleh dari perilaku makan ikan X. hellerii dan X. maculatus adalah ikan tersebut merupakan predator yang mengejar, menangkap, dan langsung memangsa mangsanya. Ikan X. hellerii memiliki tingkat perilaku makan yang lebih tinggi dibandingkan dengan ikan X. maculatus dalam memangsa jentik nyamuk (Aedes sp.). Rata-rata kemampuan memangsa ikan X. hellerii terhadap jentik Aedes sp. instar III sebanyak 24,8 ekor, sedangkan ikan X. maculatus sebanyak 18,4 ekor jentik. Sehingga ikan X. hellerii dikatakan memiliki potensi yang lebih baik sebagai biokontrol untuk mengendalikan populasi nyamuk yang merupakan vektor penyakit DBD, sesuai dengan anjuran untuk menjaga keseimbangan alam dalam ajaran Islam.

**Keywords:** *Aedes* sp., Perlilaku Pemberian Makan, Pemangsaan, *Xiphophorus hellerii*, *Xiphophorus maculatus*

## A. Introduction

Allah SWT., with all His power, has created this earth with all its contents that have been arranged in such a way that the creatures in it can live well; this has been mentioned in QS. Al-A'raf verse 56 [1].

وَلَا تُفْسِدُوْا فِى الْاَرْضِ بَعْدَ اِصْلَاحِهَا وَادْعُوْهُ خَوْفًا وَّطَمَعًاۗ اِنَّ رَحْمَتَ اللّٰهِ قَرِيْبٌ مِّنَ الْمُحْسِنِيْنَ

*" And cause not corruption upon the earth after its reformation. And invoke Him in fear and aspiration. Indeed, the mercy of Allah is near to the doers of good."* [2]

Islam also teaches the importance of maintaining the balance of nature and justice in the use of resources. The Qur'an states that everything is created in the correct size as QS. Al-Hijr verse 19 [3].

وَالْاَرْضَ مَدَدْنٰهَا وَاَلْقَيْنَا فِيْهَا رَوَاسِيَ وَاَنْۢبَتْنَا فِيْهَا مِنْ كُلِّ شَيْءٍ مَّوْزُوْنٍ

*" And the earth - We have spread it and cast therein firmly set mountains and caused to grow therein [something] of every well-balanced thing."* [4]

Currently, one of the problems caused by human negligence is due to a need for more awareness in protecting the environment, namely health problems. Humans, as leaders on earth, have the responsibility to protect and maintain the environment in accordance with the warnings in QS. Al-A'raf verse 56 and QS. Al-Hijr verse 19. Meanwhile, the importance of guarding, managing and maintaining this environment has been written in the religious order of QS. Al-Baqarah verse 205 [5].

وَاِذَا تَوَلّٰى سَعٰى فِى الْاَرْضِ لِيُفْسِدَ فِيْهَا وَيُهْلِكَ الْحَرْثَ وَالنَّسْلَ ۗوَاللّٰهُ لَا يُحِبُّ الْفَسَادَ

*" And when he goes away, he strives throughout the land to cause corruption therein and destroy crops and animals. And Allah does not like corruption "* [6].

One of the infectious diseases that has become endemic in Indonesia due to environmental damage is Dengue Haemorrhagic Fever (DHF). According to data from the Ministry of Health of the Republic of Indonesia, the average number of infection cases each year reaches 121,191. [7]Dengue fever is caused by the dengue virus, which is transmitted

[1] Lailatul Khusnah, "Implementation of QS. Al-A ' Raf 56 in Fostering an Attitude of Loving the Environment," 2023, 289–95.

[2] Ministry of Religion of the Republic of Indonesia, "Lajnah Pentashihan Mushaf Al-Qur'an. 2019" (Indonesia: Agency for Research and Development and Training of the Ministry of Religion of the Republic of Indonesia, 2019).

[3] Dwi Runjani Juwita, "Fiqh of the Environment in an Islamic Perspective," *El-Wasathiya: Journal of Religious Studies* 5, no. 1 (2017): 30–34, http://ejournal.kopertais4.or.id/mataraman/index.php/washatiya/article/view/3025.

[4] Indonesia, "Lajnah Pentashihan Mushaf Al-Qur'an. 2019."

[5] Alia Cahyani, Muhammad Misbakul Munir, and Rima Hafidz Ramadhani, "Islamic Financial Management Perspective of the Qur'an Surah Al-Baqarah," *Holistic Nexus Analytics* 1, no. 6 (2024): 106–12, https://doi.org/10.62504/nexus608.

[6] Indonesia, "Lajnah Pentashihan Mushaf Al-Qur'an. 2019."

[7] Ministry of Health of the Republic of Indonesia, *Indonesia Health Profile 2022*, 2023.

through the *Aedes* sp. mosquito. The mosquito's habitat is widespread throughout Indonesia, so dengue disease quickly causes transmission.[8]. The number of sufferers and the area of its spread will continue to increase along with the increase in disease movement and population density.[9].

Mosquito control methods have been carried out in various ways, both chemical and non-chemical. The limitations in handling this chemical method have the potential to pollute the waters, so it is considered less effective in reducing the number of dengue vectors. One of the alternatives and environmentally friendly efforts in controlling the number of dengue vectors is by using biological methods. Biological larval control is by raising fish that are natural predators of mosquito larvae.[10]Some predators capable of controlling mosquito larvae populations include flatworms, *crustaceans*, arachnids, insects, vertebrates, and carnivorous plants.[11].

The use of fish as natural predators of mosquito larvae (biocontrol) is one of biological control, where certain types of fish can be used as natural enemies or as mosquito predators in the larval stage.[12]. The use of fish as a biological control (biocontrol) has its advantages. Namely, it is considered adequate because it is more effective and does not pose a risk of environmental pollution because it does not contain chemicals that are harmful to health. [13].

Fish as a biological agent has been used and proven to be able to control the presence of mosquito larval populations as dengue vectors[14]. There are types of fish that can eat mosquito larvae, including Betta fish (*Beta splendens*), Guppy fish (*Poecelia reticulatta*), Beunteur (*Puntius binotattus*), Cere (*Gambusia affinis*), Tin Head (*Panchax panchax*), Mas (*Cyprinus carpio*), Melem (*Osteochilus vittatus*), Betok (*Anabas testudineus*) and Sepat (*Trichogaster pectoralis).*[15], [16], [17],, [18] [19] [20],.

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[8] And Hebert Adrianto Dion, Aldy, Michelle Christina Prayogo, Hindri Mufti Yuana, "Study of Catfish Predation on Aedes Aegypti Mosquito Larvae as an Effort to Prevent the Spread of Dengue Hemorrhagic Fever," *Hang Tuah Medical Journal* 19, no. 1 (2021): 41–53, https://doi.org/10.30649/htmj.v19i1.64.

[9] Indonesian *Indonesia Health Profile 2022*.

[10] Dion, Aldy, Michelle Christina Prayogo, Hindri Mufti Yuana, "Study of Catfish Predation on Aedes Aegypti Mosquito Larvae as an Effort to Prevent the Spread of Dengue Hemorrhagic Fever."

[11] Syarif Hidayat Amrullah, "Biocontrol: The Utilization of Predatory Insects as Natural Enemies for Insect Pests (A Review)," *Proceedings of the Indonesian National Seminar on Biodiversity*, 2019, 87–90, https://doi.org/10.5994/jei.13.2.81.

[12] Muhammad Sarwar, "Reducing Dengue Fever Through Biological Control of Disease Carrier Aedes Mosquitoes (Diptera: Culicidae) Natural Enemies Of," *International Journal of Preventive Medicine Research* 1, no. 3 (2015): 161–66.

[13] W. W. Han et al., "Efficacy and Community Effectiveness of Larvivorous Fish for Dengue Vector Control," *Tropical Medicine and International Health* 20, no. 9 (2015): 1239–56, https://doi.org/10.1111/tmi.12538.

[14] D. D. Vinogradov, A. Y. Sinev, and A. V. Tiunov, "Predators as Control Agents of Mosquito Larvae in Micro-Reservoirs (Review)," *Inland Water Biology* 15, no. 1 (2022): 39–53, https://doi.org/10.1134/S1995082922010138.

[15] Siti Mutmainah, Eko Prasetyo, and Lilis Sugiarti, "Predation of Betta Splendens and Guppy Fish (Poecilia reticulate) Against Instar III Larvae of Aedes Aegypti Mosquito as an Effort to Control Dengue Hemorrhagic Fever (DBD) Vectors," *Journal of Natural Sciences* 4, no. 2 (2017): 98, https://doi.org/10.31938/jsn.v4i2.81.

Currently, swordfish (*Xiphophorus hellerii*) and Platy fish (*Xiphophorus maculatus*) are still rarely used in mosquito larval control efforts. Meanwhile, these two types of fish have advantages including in terms of good adaptation in various aspects such as conditions in salty water, temperature changes, rapid reproduction, low maintenance needs, as well as social traits and the ability to live in groups, making them an ideal choice for mosquito biological control and adaptation in various aquatic ecosystems. [21]Based on this background, this study, which is based on an Islamic perspective, aims to observe the feeding behaviour and predation rate of *X. helleri* fish and *X. maculates* fish against mosquito larvae (*Aedes* sp.).

## B. Research Methods

This research is experimental research with an exploratory approach. Data were obtained by observing the feeding potential and behaviour of Swordfish (*X. hellerii*) and Platy fish (*X. maculatus*) against mosquito larvae (*Aedes* sp.). This research was carried out in Takalar Regency, South Sulawesi, Indonesia, in June-July 2023. The sample of this study was 125 *Aedes* sp. instar III mosquito larvae obtained from the surrounding household waste sewer. The mosquito larvae used are healthy, active and agile larvae that are sensitive to the influence of light. The test fish used were 5 *X. hellerii* fish and 5 *X. maculatus* fish aged ±3 months obtained at the Makassar City Hobby Market.

*X. hellerii and X. maculatus fish* are first acclimatized by placing them in a 30 × 50 cm container filled with water and giving them aquatic plants for 24 hours until they begin to adapt to the surrounding environment. The raised fish are fed with fish pellets during the rearing period. After the acclimatization process, the fish are transferred into a 500 ml observation container and fasted for 24 hours so that they become hungry.

The test was carried out by preparing five observation containers with five repetitions so that the results obtained were more accurate. Furthermore, the larvae of *the Aedes* sp. instar III mosquito that had been grouped into 25 were put into an observation container containing fasted *X. hellerii* and *X. maculatus* fish. The number of larvae is 25 per test fish to facilitate the calculation of the number of larvae preyed upon and facilitate the placement of test larvae in containers. Observations were made every 30 minutes for 4

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[16] Muhammad Hifzhi Anshari et al., "Effectiveness of Guppy Fish (Poecilia reticulata) and Manfish (Pterophyllum Scalare) as Larvae Predators of Aedes Aegypti Mosquito," 2023, 0–1.

[17] Jonathan Loody Lukas, Hebert Adrianto, and Arief Gunawan Darmanto, "Predation Ability of Male and Female Aplocheilus Panchax Tinhead Fish Against Aedes Aegypti Mosquito Larvae," *Andalas Health Journal* 9, no. 4 (2021): 387, https://doi.org/10.25077/jka.v9i4.1564.

[18] Aprillysa Muharramnis Putri et al., "The Potential of Tin Head Fish (Aplocheilus panchax Hamilton, 1822) as a Biocontrol Agent for Mosquito Larvae on Bangka Island," *Samakia: Journal of Fisheries Science* 13, no. 2 (2022): 98–104, https://doi.org/10.35316/jsapi.v13i2.1556.

[19] Dion, Aldy, Michelle Christina Prayogo, Hindri Mufti Yuana, "Study of Catfish Predation on Aedes Aegypti Mosquito Larvae as an Effort to Prevent the Spread of Dengue Hemorrhagic Fever."

[20] Asmiani Asmiani, Sarjito Eko Windarso, and Siti Hani Istiqomah, "Predation Ability of Sepat Fish (Trichogaster trichopterus) in Preying on Anopheles Sp Larvae," *Sanitation: Journal of Environmental Health* 4, no. 3 (2013): 136–41, https://doi.org/10.29238/sanitasi.v4i3.682.

[21] N Sundari and K Laila, "Effect of Different Feeding on the Production of Platy Mickey Mouse Fish (Xiphophorus Maculatus) Larvae of Different Ages," *Pioneer Journal* 8, no. 1 (2022), http://jurnal.una.ac.id/index.php/pionir/article/view/2531.

hours by counting the number of larvae eaten by X. *hellerii* and *X. maculatus fish*. The data on the time when the fish start Feeding and the time the larvae are eaten are recorded in this study, graphed and analysed using descriptive statistics.

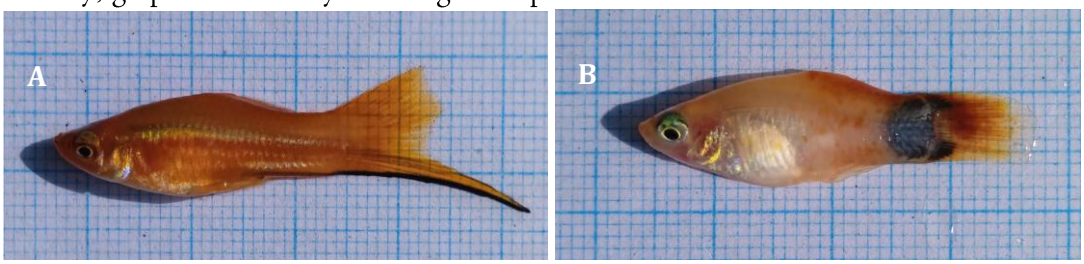


Figure 1. (A) Swordfish (*X. hellerii*), (B) Platy fish (*X. maculatus*).

## C. Results and Discussion

The observation results show that both types of fish, both *X. hellerii* and *X. maculatus,* are predatory fish that have an omnivorous feeding habit because they chase, catch, and prey on mosquito larvae directly, especially when hungry, and eat plant species, both phytoplankton and algae, in their natural habitat. The Feeding behavio*ur of X. helleri* fish can be influenced by several factors such as habitat location, season, population density, environmental quality, life phase, food availability and body size and sex of the fish. The growth pattern and feeding behavio*ur of X. helleri* fish can also change according to the physiological needs of the fish.[22]. *X. helleri* can develop a generalist Feeding strategy. This strategy is related to Feeding habits, which is one of them related to the way the food is obtained. Thus, the abundance and form of food are the main factors that determine the fish determine their food choices[23].

The number of Aedes sp. mosquito larvae eaten by fish *X. hellerii* and *X. maculatus* every 30 minutes for a total of 4 hours (240 minutes) of observation and 5 replications is as follows.

Table 1. Number of *Aedes* sp. mosquito larvae preyed on

| Treatment | Number of larvae | Replication | Preyed larvae | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Test time (minutes) | | | | | | | | Σ |
| | | | 30' | 60' | 90' | 120' | 150' | 180' | 210' | 240' | |
| *X. hellerii* | 25 | I | 7 | 2 | 1 | 4 | 5 | 2 | 4 | 0 | 25 |
| | 25 | II | 7 | 3 | 1 | 4 | 3 | 2 | 2 | 3 | 25 |
| | 25 | III | 5 | 4 | 1 | 5 | 6 | 4 | 0 | 0 | 25 |
| | 25 | IV | 9 | 2 | 0 | 2 | 2 | 4 | 1 | 4 | 24 |
| | 25 | V | 9 | 1 | 1 | 4 | 8 | 1 | 0 | 1 | 25 |
| Total | | | 37 | 12 | 4 | 19 | 24 | 13 | 7 | 8 | 124 |
| Average | | | 7.4 | 2.4 | 0.8 | 3.8 | 4.8 | 2.6 | 1.4 | 1,6 | 24. |

[22] Gil G. Rosenthal and Christopher S. Evans, "Female Preference for Swords in Xiphophorus Helleri Reflects a Bias for Large Apparent Size," *Proceedings of the National Academy of Sciences of the United States of America* 95, no. 8 (1998): 4431–36, https://doi.org/10.1073/pnas.95.8.4431.

[23] Sundari and Laila, "Effect of Different Feeding on Larval Production of Platy Mickey Mouse Fish (Xiphophorus Maculatus) of Different Ages."

| Treatment | Number of larvae | Replication | Preyed larvae | | | | | | | | Σ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Test time (minutes) | | | | | | | | |
| | | | 30' | 60' | 90' | 120' | 150' | 180' | 210' | 240' | |
| | | | | | | | | | | | 8 |
| | % | | 31% | 9.6% | 3.2% | 15.2% | 19.2% | 10.4% | 5.6% | 6.4% | 99.2% |
| *X. maculatus* | 25 | I | 6 | 0 | 0 | 6 | 4 | 1 | 0 | 1 | 18 |
| | 25 | II | 6 | 2 | 0 | 2 | 0 | 4 | 3 | 0 | 17 |
| | 25 | III | 7 | 2 | 1 | 4 | 2 | 2 | 1 | 2 | 21 |
| | 25 | IV | 5 | 1 | 1 | 4 | 2 | 5 | 1 | 0 | 19 |
| | 25 | V | 5 | 1 | 3 | 3 | 2 | 2 | 1 | 2 | 19 |
| Total | | | 29 | 6 | 5 | 19 | 10 | 14 | 6 | 5 | 94 |
| Average | | | 5.8 | 1.2 | 1 | 3.8 | 2 | 2.8 | 0.8 | 1 | 18,4 |
| % | | | 23.2% | 4.8% | 4% | 15.2% | 8% | 11.2% | 4.8% | 4.0% | 75.2% |

The results obtained from 5 replicates for 240 minutes in Table 1, *X. hellerii* fish were able to eat mosquito larvae with an average total of 24.8 out of 25 larvae provided. It can be ascertained that almost all mosquito larvae in each test were eaten within an observation period of 240 minutes; only on the 4th test was there still one *Aedes sp.* instar III mosquito larva out of a total of 125 given. So, the total number of mosquito larvae eaten by *X. hellerii* fish amounted to 124 fish. Based on previous reports [24] It was stated that *X. hellerii* fish had faster feeding behaviour after feeding mosquito larvae. This result is because *X. hellerii* fish is a fish that has food flexibility. In nature, swordfish can eat plankton, algae, small crustaceans, fish larvae, worms, fish eggs, and even aquatic insects, which allows the fish to have a much better predation ability than other fish of the same size. [25].

Meanwhile, based on the same data in Table 1, the average total number of *Aedes* sp. mosquito larvae eaten by fish *X. maculatus* from the total 5 replicates was 18.4 out of 25 mosquito larvae, so the average number of larvae that were not eaten was 6.6. Of the total mosquito larvae given, namely 125 mosquito larvae, Platy fish still left around 31 larvae. The Feeding behaviour of *X. maculatus fish* is considered sufficient because it still leaves a few mosquito larvae. According to Nyoman (2020), in its habitat in several Indonesian lakes, *X. maculatus* tends to eat detritus and several *chironomids'* larvae and *copepods* to a smaller number of *cyclopoids.* The Feeding behaviour of *X. maculatus* fish,

[24] Sundari and Laila.

[25] Hamzah Muhammad Iqbal Aziz, Suprijandani, and Narwati, "Testing the Ability of Maanvis Fish (Pterophyllum Altum), Sword Fish (Xyphophorus Helleri), and Betta Fish (Betta Splendens) as Predators of Aedes Aegypti Mosquito Larvae," *Forikes Vocal Health Research Journal* 12, no. 3 (2021): 393–400, http://forikes-ejournal.com/index.php/SF.

which includes omnivores that eat plant material, aquatic and terrestrial insects, as well as small crustaceans (atyid and caridean shrimp).[26].

Meanwhile, another study showing the effect of different feeding on the production of X. *maculatus* fish larvae showed that mosquito larvae were very good for the growth and spawning of *X. maculatus* fish. [27]

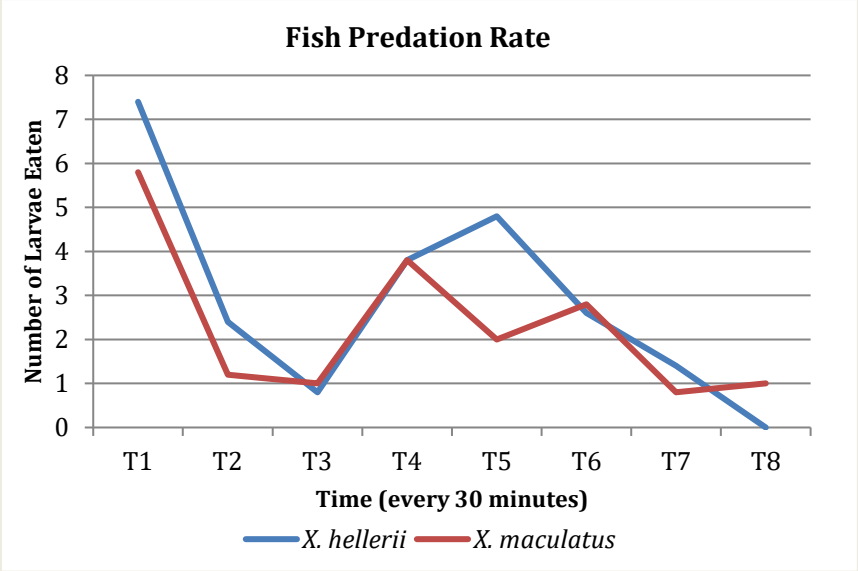


Figure 1. Graph of the average predation of *X. hellerii* and *X. maculatus* against *Aedes* sp. larvae at the time of observation (T).

The graph shows that X. *hellerii* fish's ability to eat mosquito larvae is higher than the time per 30 minutes of X. *maculatus* fish' ability. In addition, the ability of fish to predate larvae was observed at the 30th minute of X. *hellerii* fish and *X. maculatus fish.*

Body size also affects the behaviour of Feeding fish as a predator. Fish, as predators, must be larger than their prey.[28]. This result is what then makes the difference in feeding power between X. *hellerii* fish and *X. maculatus* fish. X. *hellerii* fish have an average size of 4-6 cm, while platy fish are 3-5 cm. Based on the difference in body size, it can also be concluded that the mouth size of swordfish is larger when compared to plates. So, if the food matches its mouth, the fish will immediately grab the existing food. Fish feeding preferences must be adjusted to the size of the fish's mouth opening to make it easier for it to eat[29].

[26] I Nyoman Y. Paramangsa, M. Fadjar Rahardjo, and Charles P.H.Simanjutak, "Reproductive Aspects of the Swordtail Fish, Xiphophorus Hellerii," *Indonesian Journal of Iktiology* 20, no. 1 (2020): 81–92.

[27] Manfred Schartl et al., "The Genome of the Platyfish, Xiphophorus Maculatus, Provides Insights into Evolutionary Adaptation and Several Complex Traits," *Nature Genetics* 45, no. 5 (2013): 567–72, https://doi.org/10.1038/ng.2604.

[28] Mila Sari and Vina Novela, "Biological Control with Predation of Various Types of Fish Against Aedes Aegypti Larvae in the Working Area of the Tigo Baleh Health Center," *Independent Healthy Journal* 15, no. 1 (2020): 79–85, https://doi.org/10.33761/jsm.v15i1.145.

[29] Han et al., "Efficacy and Community Effectiveness of Larvivorous Fish for Dengue Vector Control."

From this study, it can also be seen that the behaviour of fish-Feeding larvae depends on the level of fish activity and the length of the fish's active period. The food and the nature of the fish itself can affect the amount and frequency of fish Feeding. Fish that tend to have aggressive traits with an extended active feeding period tend to need and consume more food. The larvae of *Aedes* sp. instar III have agile and fast movements, so this can be an obstacle for predatory fish to prey on the larvae. However, the X. *helleri* fish is a fish that is agile in controlling its prey and has the same level of proficiency (skill) as the betta fish. Previous observations reported that the predation power of *Beta splendens* fish and *X. hellerii* fish are both effective in preying on mosquito larvae because they have agile swimming abilities in chasing their food, so the two fish have the same proficiency in terms of preying on mosquito larvae.[30].

The importance of overcoming problems regarding the eradication of dengue vectors by utilizing natural predators that have potential, such as X. *hellerii* fish and *X. maculatus fish*, because mosquitoes are also creatures created by Allah SWT that should not be taken for granted like QS. Al-Baqarah verse 26 [31].

اِنَّ اللّٰهَ لَا يَسْتَحْيٖٓ اَنْ يَّضْرِبَ مَثَلًا مَّا بَعُوْضَةً فَمَا فَوْقَهَا ۗ...

*" Indeed, Allah is not timid to present an example - that of a mosquito or what is smaller than it."* [32].

The feeding behaviour of fish as a natural predator of mosquito larvae is an effective and environmentally friendly method in controlling mosquito populations, both from a scientific and Islamic perspective. In science, it is an ecological solution that helps maintain the balance of nature and human health. From an Islamic perspective, this is in line with the principles of maintaining balance, maintaining the mandate as caliph, avoiding damage, and maintaining health and hygiene.

Therefore, it is common for humans to deliberately raise livestock or other animals, such as fish, to be consumed as a delicious side dish because it has been guaranteed to be halal as stated by Allah Swt. in QS. al-Maidah verse 96.

اُحِلَّ لَكُمْ صَيْدُ الْبَحْرِ وَطَعَامُهٗ مَتَاعًا لَّكُمْ وَلِلسَّيَّارَةِ ۚوَحُرِّمَ عَلَيْكُمْ صَيْدُ الْبَرِّ مَا دُمْتُمْ حُرُمًا ۗوَاتَّقُوا اللّٰهَ الَّذِيْٓ اِلَيْهِ تُحْشَرُوْنَ

*". Lawful to you is game from the sea and its food as provision for you and the travellers but forbidden to you is game from the land as long as you are in the state of Ihram. And fear Allah to whom you will be gathered.*[33]

Or based on the hadith of the Prophet Saw which mentions "

هُوَ الطَّهُورُ مَاؤُهُ الْحِلُّ مَيْتَتُهُ

[30] Handoko Santoso et al., "Predation Power of Aedes Sp Mosquito Larvae-Feeding Fish," *Bioeducation* 13, no. 01 (2022): 122–26.

[31] Alia Cahyani, Muhammad Misbakul Munir, and Rima Hafidz Ramadhani, "Islamic Financial Management Perspective of the Qur'an Surah Al-Baqarah."

[32] Indonesia, "Lajnah Pentashihan Mushaf Al-Qur'an. 2019."

[33] Indonesian.

*"The sea is sacred; its water is pure, and its carcasses are permissible" (HR Abu Daud, At-Tirmidhi).*

So, keeping fish, such as swordfish (*X. hellerii*) and Platy Fish (*X. maculatus*) with the aim of being used as a predatory animal to control mosquito larvae is a justified action in religion, especially since mosquitoes are considered the source of various deadly diseases, such as Dengue Haemorrhagic Fever (DHF). Efforts like this are the efforts of human beings in their capacity as caliphs on this earth who have been given the mandate to prosper the earth. This kind of action has been legitimized by religion as it is justified by the actions of a person who deliberately trains wild animals to hunt like dogs, as mentioned in QS. Al-Maidah verse 4.

يَسْـَٔلُوْنَكَ مَاذَآ اُحِلَّ لَهُمْۗ قُلْ اُحِلَّ لَكُمُ الطَّيِّبٰتُۙ وَمَا عَلَّمْتُمْ مِّنَ الْجَوَارِحِ مُكَلِّبِيْنَ تُعَلِّمُوْنَهُنَّ مِمَّا عَلَّمَكُمُ اللّٰهُ فَكُلُوْا مِمَّآ اَمْسَكْنَ عَلَيْكُمْ وَاذْكُرُوا اسْمَ اللّٰهِ عَلَيْهِۖ وَاتَّقُوا اللّٰهَۗ اِنَّ اللّٰهَ سَرِيْعُ الْحِسَابِ

*"They ask you, [O Muhammad], what has been made lawful for them. Say, "Lawful for you are [all] good foods and [game caught by] what you have trained of hunting animals which you train as Allah has taught you. So, eat of what they catch for you, and mention the name of Allah upon it, and fear Allah." Indeed, Allah is swift in account."*[34]

The use of livestock other than as food (QS. an-Nahl/16:5), means of transportation/mounts (QS. Yasin/36: 72 and QS. an-Nahl/16: 8), jewellery (QS. an-Nahl/16: 8), their skins and furs as clothes (QS. al-Nahl/16:5), and milk as a delicious drink (QS. al-Mu'minun/23:21), the livestock/pets still have many other benefits for the benefit of humanity as hinted at in several verses in the Quran, including on QS. Al-Nahl verse 5. says, "*And He has created cattle for you: there is a warming (fur) and various benefits, and you eat as happily as you can",* and in QS. al-Mu'minum/23, 21 which says, "*And indeed, with the cattle, there is indeed an important lesson for you; we give you to drink from the milk that is in their belly, and in the cattle, there are many benefits for you. and some of them you eat.*" The implementation of this strategy requires the cooperation of various parties to ensure its success and sustainability.

This study's limitations included not specifically equalizing the weight, length, and sex of the fish used. Due to the researchers' limited knowledge during the study, it was also impossible to monitor the fish's health accurately during the test. These limitations need to be further researched in future studies to obtain more specific and in-depth results.

## D. Conclusion

The feeding behaviour of *X. hellerii* and *X. maculatus* fish is as predators that chase, catch, and directly prey on their prey. *X. hellerii* fish have a higher level of feeding behaviour compared to X. *maculatus* fish in preying on mosquito larvae (*Aedes* sp.). The average predation ability of *X. hellerii* fish against *Aedes* sp. instar III larvae was 24.8 fish. In contrast, X. *maculatus* fish had 18.4 larvae, so the fish *X. hellerii* has the potential as an excellent biological agent to control the mosquito population, which is a vector of dengue

[34] Indonesian.

disease in accordance with the recommendation to maintain the balance of nature in Islamic teachings.

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