



Preliminary study on abundance, Distribution and size of anchovies eggs and larvae in Langkawi Island, Kedah: Northwest coast of peninsular Malaysia

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Abstract

This study was conducted to determine the baseline information on abundance, distribution and size of anchovy eggs and larvae in Langkawi Island, Kedah: Northwest Coast of Peninsular Malaysia. Sampling was conducted from 18 to 21 September 2022 at 32 stations with the larval distribution estimated from the spawning distribution in the previous month. Larvae were sampled using a larva net with a 500 μm mesh size and sub-surface horizontal towing was carried out around Langkawi Island. Fish eggs and larvae samples were observed under stereomicroscopy, identified to the family level and preserved in 4% formalin. Abundance was calculated using the number of anchovy eggs and larvae with volume water filtered, standardized to 1000 m^3 and distribution was mapped using QGIS 3.2. The results showed that the average size of anchovy eggs was 1.43 ± 0.01 mm ($n=947$) and larvae was 3.94 ± 0.14 mm ($n=43$). The highest abundance of anchovy eggs occurred in PL12 with 51.8 eggs/1000 m^3 , distributed in the area near the shore while highest abundance of larvae in LI 04 with 3.2 larvae/1000 m^3 in the coastal area. Thus, the finding of this study provides the baseline information on the abundance, distribution and size of anchovies eggs and larvae in Langkawi Island, Kedah. This biological information can be used as primary data for fishery resources management to ensure the sustainability of fisheries resources in Malaysia.

Keywords: anchovy, density, composition and spawning area

Introduction

Studying fish eggs and larvae is important in identifying the spawning grounds and providing information to conserve resources as well as contributed to the stock assessment of certain fish species. Engraulidae also known as anchovies or 'bilis' in Malay, is an economically important fish species in Malaysia. The Engraulidae family which includes genus of *Coilia*, *Encrasicholina*, *Lycorhissa*, *Setipinna*, *Stolephorus* and *Thryssa* which are found in Malaysian waters (Wongratana *et al.*, 1998) [30]. Several families like Clupeidae, Pristigasteridae, Chirocentridae, Chanidae, Gonorychidae, Ammodytidae and Schindleriidae have similar characteristics to Engraulidae (Okuyama, 2013 & Leis and Carson-Ewart, 2000) [27, 18]. According to Froese and Pauly (2018), *Encrasicholina heteroloba* and *Encrasicholina punctifer* are the main commercial species of anchovies in most tropical waters.

Langkawi Island in Kedah is the primary location for anchovy landings, contributing approximately 72% of the total landings in the West Coast of Peninsular Malaysia waters. The Annual Fisheries Statistics (DOFM, 2023) show fluctuations in the numbers from 2012 to 2022. In 2015, the total landings suddenly dropped to 2,397.4 TM before significantly increasing in 2019 to 6,840.4 TM. However, from 2020 to 2021, there was a decrease in anchovy landings from 3,962.01 TM to 204.81 TM due to the COVID-19 pandemic and the Movement Control Order (MCO) announced by the Malaysian government. During this time, most fishing activities could not be done and all of the foreign crew of Anchovy Purse Seine in Langkawi Island returned to their home countries. In 2022, there was a recovery in the landings with 824.93 TM recorded. The drastic decrease in anchovy landing led to an investigation of resources associated with the early life stages.

Anchovies have a short lifespan (Ganias, 2014) [11] of about 2-3 years, depending on the species, and lay eggs throughout the year (FAO, 1993), with peak egg production occurring during certain months depending on the species. They are small in size, schooling fish and most anchovy species are found in shallow coastal areas (Young *et al.*, 1995) [32] at depths of 5-35 meters, with the highest densities around islands (Fricke *et al.*, 2011) [8]. Most anchovy species are marine fish, although some can be found in brackish and freshwater in tropical waters (Morgado-Dueñas and Castillo-Rivera, 2022) [20]. Moreover, they play a crucial role in the marine food web as both predator and prey. Overall, anchovies are an important and fascinating group of fish, with a wide range of ecological adaptations and roles in marine ecosystems.

According to Janekarn & Boonruang (1986) [16] and Leis & Carson-Ewart (2000) [18], fertilized eggs of anchovies are elliptical in shape and not adhesive, while newly hatched larvae are transparent and devoid of pigment. There are two shape of anchovy eggs which are oval-shaped, with or without a knob at the end (Chayakul, 2000) [5]. Larvae typically have different physical characteristics, habitats, diets, predators and behaviors compared to adults. During the larval phase, anchovies develop from eggs into fully functioning larvae with all organs. Anchovy larvae lack pigmentation, making them difficult to spot in their natural habitat. They rely on their feeding behavior and ocean currents to survive and grow into adults. Understanding the different life stages of a fish species is necessary to ensure sustainable fishing practices, making it an important consideration when studying fish populations and fisheries management.

Engraulidae, also known as anchovy, are among the top ten family compositions in Pangkor Island waters (Nur Hidayah

et al., 2021)^[23], while in Labuan waters, they are in the top three with 15.09% (Nur Hidayah *et al.*, 2023)^[24]. Additionally, Engraulidae are among the top five dominant families of fish larvae in Peninsular Malaysia (Abd. Haris & Muhammad Faisal, 2006)^[1]. According to Lee and Go (2006), the size of anchovy larvae ranges from 10 to 26 mm, while the size of eggs ranges from 1.00 to 1.37 mm (Gordina *et al.*, 1997)^[13]. In Pangkor Island, anchovy eggs are from 0.8 to 0.9 mm in size, while larvae range from 1.3 to 5.3 mm (Nur Hidayah *et al.*, 2021)^[23]. The average size of anchovy larvae in Labuan is 3.04±0.94 mm with a minimum total length (TL) of 1.90 mm and maximum TL of 4.55 mm (Nur Hidayah *et al.*, 2023)^[24].

Moreover, the distribution of fish larvae and its abundance are very important for recruitment pattern of fish that lead to an efficient management of fish stock (Huwur *et al.*, 2016; Hedberg *et al.*, 2018)^[15, 14]. Commonly, anchovy larvae are found in shallow mangrove ecosystems, which are classified as nursery areas. According to Ara *et al.* (2013)^[3], anchovy larvae are found in the mangrove ecosystems of the Johor Strait in Malaysia. Additionally, according to Ooi and Chong (2011)^[28], anchovy larvae are also found in the Matang mangrove estuary in Perak, Malaysia. Thus, this study was carried to determine the abundance, distribution and size of anchovy eggs and larvae in Langkawi Island waters. Biological information in this study can be used for fishery resources management to ensure the sustainability of fisheries resources.

Material And Methods

Sampling was conducted from 18 to 21 September 2022 at 32 stations as these two months were considered as

spawning season (Abd. Haris Hilmi *et. al.*, 2018)^[2]. The locations of the sampling area were shown in Figure 1. Larvae were sampled using a 500 µm in mesh size larva net. Subsurface horizontal towing of the larva net was carried out with the research vessel at a speed of 2 knots in the study location along the waters of Langkawi Island. A flowmeter was attached to the mouth of net to determine the volume of seawater that passing through the larva net. The samples were preserved with formalin at a concentration of 10% (Nur Hidayah *et al.*, 2020)^[22].

After that, fish larvae samples were observed under stereomicroscopy and identified to family level at laboratory. Larvae were identified follow keys of Russell (1976)^[29], Okiyama (1988) Leis and Carson-Ewart (2000)^[18] and Ghaffar *et al.* (2010)^[12]. Eggs and larvae of Engraulidae family were measured and then preserved in 4% of formalin. Abundance of eggs and larvae were calculated by using the number of Engraulidae larvae and volume of water filtered. Density was standardized to 1000m³ and the distribution was mapped using QGIS 3.2. Formula for calculation of larvae density are as follows:

Density per 1000 m³ =

$$\text{Density per } 1000 \text{ m}^3 = \left(\frac{1000}{\text{volume of water filtered}} \right) \times \text{total number of larvae}$$

Where,

volume of water filtered is R X 0.3 m/rpm X area of larvae net’s mouth,

R is the differences between the flowmeter reading.

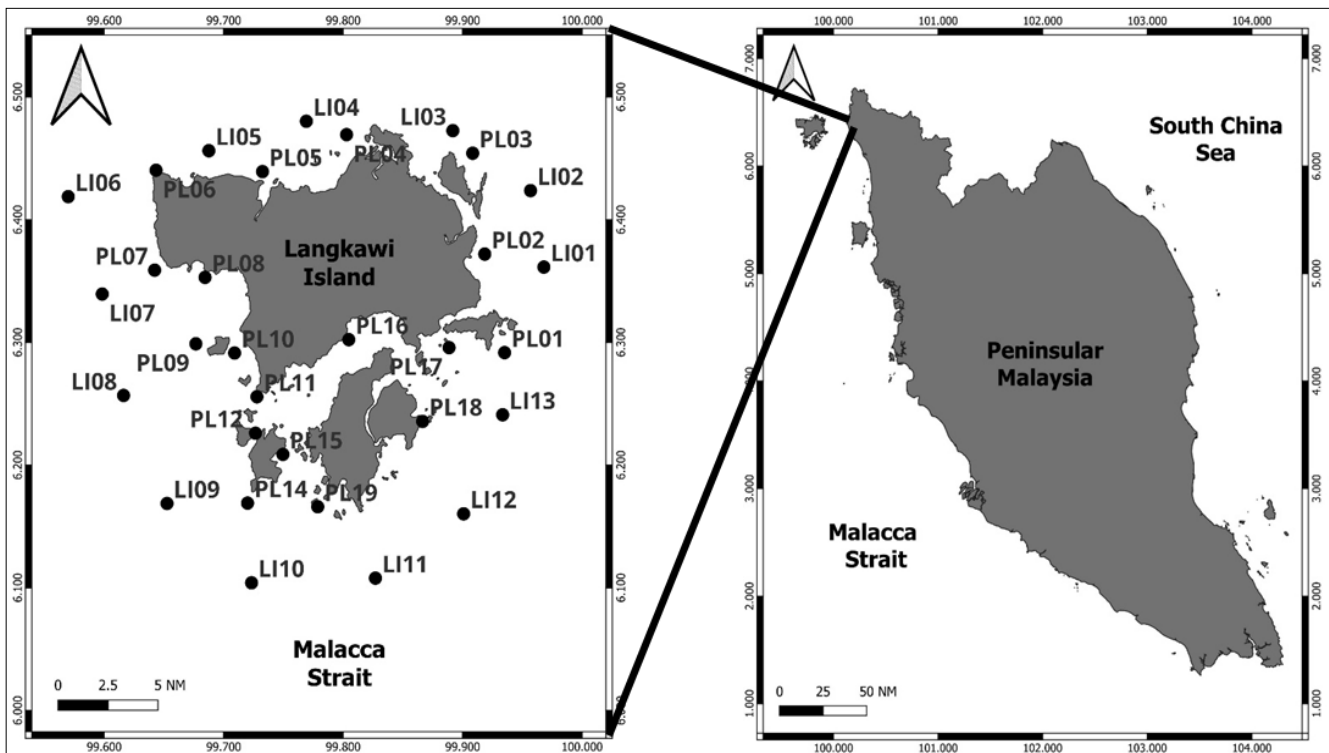


Fig 1: Location of sampling area in Langkawi Island, Kedah.

Results

A total of 947 of anchovy eggs and 43 of anchovy larvae were recorded during the sampling. Apart from that, for the other family showed that 22,100 of eggs and 2,926 of larvae

were identified from 35 families of larvae. Anchovy or also known as family Engraulidae demonstrated top eight highest family composition during the sampling.

Percentages of Fish Larvae Species Composition

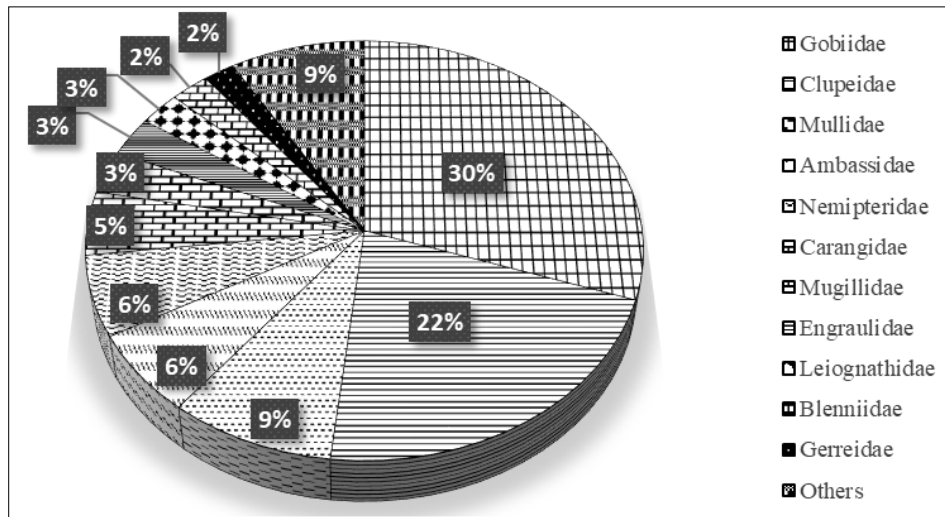


Figure 2: Percentages of top ten fish larvae family composition in Langkawi Island, Kedah.

Figure 2 above showed the top ten fish larvae family composition percentages in Langkawi Island, Kedah. The highest family recorded was Gobiidae (30%) followed by Clupeidae (22%), Mullidae (9%), Ambassidae and Nemipteridae (6%), Carangidae (5%). Engraulidae (3%) which also known as anchovy illustrated among top eight fish larva family composition in the study location. Mugilidae and Leiognathidae showed 3 % family composition and Blenniidae and Gerreidae recorded about 2 %.

Size and morphology of Anchovy eggs and larvae

Table 1: Measurement size of Anchovy Eggs and Larvae (Total length, mm)

Details	Anchovy Eggs	Anchovy Larvae
Total number (n)	947	43
Average±SE Total Length (mm)	1.43±0.01	3.94±0.14
Minimum Total Length (mm)	0.76	2.67
Maximum Total Length (mm)	2.29	8.24

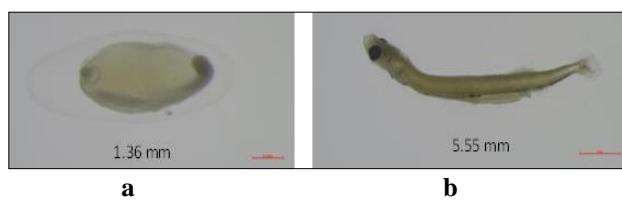


Fig 3: Morphology of anchovy eggs (a) and larvae (b).

Table 1 shows the size measurements of anchovy eggs and larvae with a total of 947 eggs and 43 larvae were measured. The mean total length of eggs is 1.43±0.01 mm and larvae is 3.94±0.14 mm. Figure 3 shows morphology of anchovy eggs (a) and larvae (b) observed in this study. The characteristics of anchovy eggs depict two shapes: oval and with a knob (Figure 3 a) or without a knob (Figure 3 b) at the end. The larvae are slightly pigmented but have consistent pattern of pigmentation in the gut which is long and straight initially reaches three-quarters of the body length. The larvae have an elongated and moderately

compressed body shape with a depressed head, and their eyes are typically small to moderate in size. The size of the mouth can vary, ranging from small to large.

Abundance and Distribution of Anchovies Eggs and Larvae

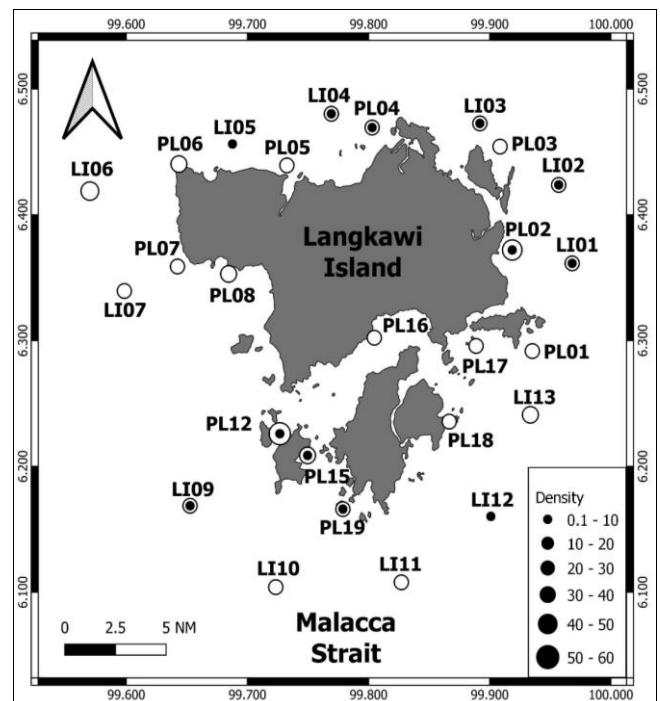


Fig 4: Abundance and Distribution of Anchovies Eggs (O) and Larvae (●).

Figure 4 shows the distribution and density of anchovy eggs and larvae. The highest abundance of anchovy eggs recorded in Station PL12 with 51.8 eggs/1000 m³ and the highest abundance of anchovy larvae were in Station LI 04 with 3.2 larvae/1000 m³. From the maps above it showed that anchovy eggs occurred more compared to larvae. Besides, the anchovy eggs were distributed in the area near the shore while anchovy larvae occurred more in coastal area.

Discussion

Anchovy larvae are important to the marine food chain and are a significant commercial fishery resource in Southeast Asia. Their early life history provides valuable information on the health and sustainability of marine ecosystems. However, identifying anchovy species at different life stages is challenging due to morphological changes (Ko *et al.*, 2013) ^[19]. To address this, the present study classified anchovy larvae based on a single life stage. Accurately identifying the eggs and larvae of fish species to the right species level allows researchers to understand biological information about a fish species such as what species lays eggs, the spawning area and the nursery that the fish may have migrated to in its early life history. This information is critical for ecological monitoring, resource management and the establishment of marine protected areas (Moura *et al.*, 2008 and Valdez-Moreno *et al.*, 2010) ^[31].

Abd. Haris and Muhammad Faisal (2006) ^[1] discovered that Engraulidae was the most dominant family during the Northwest Coast survey, which included Langkawi Island waters. This finding was similar to an earlier study in Pangkor Island waters, which found that Engraulidae were among the top ten family compositions (Nur Hidayah *et al.*, 2021) ^[23] and to a study in Labuan waters, which found that Engraulidae were in the top three with a composition of 15.09% (Nur Hidayah *et al.*, 2023) ^[24]. Furthermore, the results of the current study demonstrate similar findings to the previous study in the same area mentioned above, where Engraulidae was recorded as the eighth most dominant fish larvae family composition. It can be the top family composition of fish larvae in Malaysian waters and their dominance in certain areas may be related to the abundance of their prey (Abd. Haris and Muhammad Faisal, 2006) ^[1]. This is due to several factors, such as the availability and quality of food sources, as well as their spawning behavior and duration.

The size of eggs in this study was larger (1.43 ± 0.01 mm) compared to a study conducted by Gordina *et al.* (1997) ^[13], which recorded sizes ranging from 1.00 to 1.37 mm, and in Pangkor Island, where anchovy eggs ranged from 0.8 to 0.9 mm (Nur Hidayah *et al.*, 2021) ^[23]. Additionally, the Total Length (TL) of anchovy larvae in this study (3.94 ± 0.14 mm) was quite similar to the average size of anchovy larvae in Labuan, which was 3.04 ± 0.94 mm (Nur Hidayah *et al.*, 2023) ^[20], but larger in size compared to the study conducted by Lee and Go (2006), which recorded sizes ranging from 10 to 26 mm, and Nur Hidayah *et al.* (2021) ^[23], which found larvae ranging from 1.3 to 5.3 mm. Factors like female anchovy's age and size, spawning duration and food availability during early life stages can influence the size of anchovy larvae and eggs. For instance, Oh *et al.* (2013) found that the size of anchovy eggs was positively related to the size and age of the female anchovy.

Anchovy eggs and larvae have unique characteristics that distinguish them from other species. Anchovy eggs are generally small, transparent, and oval-shaped with or without a knob at the end. *Encrasicholina* eggs are also oval-shaped but without a knob at the end, while *Stolephorus* eggs are oval-shaped with or without a knob (Chayakul, 2000) ^[5]. In contrast, anchovy larvae are very elongated and have their gas bladder located near the midbody (Wongratana *et al.*, 1998) ^[30]. The long and straight gut initially reaches up to 74-81% of the body

length, and larvae are slightly pigmented with a consistent pattern of pigmentation on the gut. Most species also develop pigment dorsolateral on the gas bladder. Therefore, understanding the unique characteristics of anchovy eggs and larvae is important for their biology and ecology, as well as for identifying and distinguishing them from other species in the marine environment.

The presence of fish larvae in an area is a good indicator of the aquatic environment's health as it shows that the area is a spawning ground for fish aimed at producing new fish stocks (Freitas & Muelbert, 2004) ^[9]. Most fish larvae choose habitats with abundant food sources and stable ocean conditions to grow. Mangrove areas with shallow water depths share similar characteristics with these habitats. For anchovy species, spawning activity is more focused in the mangrove areas (Blaber *et al.*, 1997) ^[4]. The assemblage of anchovy larvae constantly changes in terms of species composition and distribution patterns. Consequently, anchovy larvae are classified as migratory species that enter estuarine and mangrove areas at the postflexion and post-larvae stages (Ooi & Chong, 2011) ^[28]. This situation is similar to the present study area located near the crucial nursery area of mangrove around Langkawi Island, particularly in Kilim Karst Geoforest Park (Mohd Khairul *et al.*, 2019) ^[25].

Apart from that, the distribution of eggs and larvae was high in the coastal areas and around the islands due to the topography condition in the study area. The north, east, and south of Langkawi Island are protected by terrain or islands, resulting in calmer waters compared to the more open western part. This area has a muddy plain that is sheltered from strong waves and tidal currents. Consequently, there are more anchovy larvae in the north, east, and south of Langkawi Island. Thus, the finding of this study provides the baseline information on the abundance, distribution and size of anchovies eggs and larvae in Langkawi Island, Kedah. The biological information in this study can be used as primary data for fishery resources management to ensure the sustainability of fisheries resources. However, further detailed studies, conducted at least once a year continuously, are necessary to ensure data accuracy to achieve a more conclusive conclusion.

Conclusion

This study found that protected areas with topographic patterns had a high density of anchovy larvae, particularly around the island and near the mangrove area. The high distribution of eggs in the study location also indicated the spawning time during the study period. This information can be used to manage fishery resources and ensure their sustainability in Malaysia.

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