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LARVAL FISH AND CRUSTACEAN COMMUNITIES IN TIRANG BEACH, SEMARANG, INDONESIA

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ABSTRACT

Coastal ecosystems play a crucial role as nursery habitats for early life stages of aquatic organisms, particularly fish and crustacean larvae. This study aims to analyze the composition, abundance, and spatial distribution of larval communities in Tirang Beach, Semarang, as well as their relationship with environmental parameters. Sampling was conducted at three stations using purposive sampling with three types of nets (push net, seine net, and fish net), and water quality parameters including temperature, salinity, dissolved oxygen, and pH were measured in situ. A total of 120 larval individuals belonging to seven families were identified, consisting of five fish families (Ambassidae, Engraulidae, Gerreidae, Gobiidae, and Mugilidae) and two crustacean families (Penaeidae and Palinuridae). Penaeidae was the dominant family, contributing 51.7% of the total abundance. Spatial variation in larval assemblages was observed, with higher diversity of fish larvae associated with mangrove habitats. Environmental parameters were within suitable ranges for larval survival, indicating favorable ecological conditions. The results highlight the ecological importance of Tirang Beach as a nursery ground and provide baseline information for coastal ecosystem management and conservation.

KEYWORD: Larval fish; coastal ecosystem; mangrove; nursery habitat; water quality; Tirang Beach

INTRODUCTION

Coastal ecosystems are among the most productive environments on Earth and play a critical role in supporting marine biodiversity and fisheries resources. These ecosystems function as essential nurseries, spawning, and feeding grounds for many aquatic organisms, particularly during their early life stages, such as eggs and larvae. The larval stage is highly sensitive to environmental variability, making larval fish communities reliable biological indicators for assessing ecosystem condition and water quality. Variations in environmental parameters, including temperature, salinity, dissolved oxygen, and hydrodynamic conditions, have been shown to influence larval abundance, distribution, and community structure significantly (Wang et al., 2025; Fang et al., 2023; Chen et al., 2022). Larval fish represent a vulnerable phase in the life cycle, with survival strongly influenced by environmental conditions and ecological interactions. Despite high reproductive output in adult fish, larval mortality remains high due to predation, limited mobility, and environmental stressors, resulting in low recruitment success. Previous studies indicate that larval fish assemblages are closely associated with environmental gradients, including nutrient availability, salinity fluctuations, and water circulation patterns, which shape species composition and spatial distribution (Lima et al., 2024; Pepin, 2023; McMahon et al., 2023).

Coastal habitats such as estuaries, mangroves, and shallow nearshore waters serve as important nursery areas by providing shelter, food availability, and suitable environmental conditions for larval development. In tropical ecosystems, larval fish abundance and diversity are influenced by habitat complexity and seasonal environmental variability (Tarimo et al., 2022; Gallego-Zerrato et al., 2025). However, increasing anthropogenic pressures, including coastal development, nutrient enrichment, and land-based pollution, may alter habitat quality and disrupt ecological processes that support larval survival and recruitment (Tarimo et al., 2022; Swalethorp et al., 2023). Changes in coastal environmental conditions may further affect larval growth, feeding success, and recruitment dynamics, potentially influencing the sustainability of fish populations (Pepin et al., 2024; McMahon et al., 2023). Tirang Beach, located in Semarang, Indonesia, is characterized by shallow waters, soft-bottom substrates, and strong estuarine influence. The area receives nutrient inputs from surrounding land-based activities, including aquaculture and urban runoff, which may affect water quality and biological communities. Previous studies have reported increasing nutrient concentrations and primary productivity in Tirang coastal waters, indicating potential ecological changes in the system (Astuti et al., 2024; Sabdaningsih et al., 2024).

Despite the ecological importance of larval fish as indicators of coastal ecosystem dynamics, information regarding larval fish community structure in Tirang Beach remains limited. Existing studies in the area have primarily focused on water quality and environmental parameters, with limited attention to larval assemblages and their relationship with environmental factors. This gap highlights the need for a comprehensive assessment of larval fish communities to improve understanding of ecological conditions and support sustainable coastal management (Alfirdaus et al., 2024). Therefore, this study aims to analyze the abundance and composition of larval fish communities in Tirang Beach, evaluate their spatial distribution patterns under varying environmental conditions, and examine the relationships between environmental parameters, including temperature, salinity, dissolved oxygen, and pH, and larval fish occurrence. The findings are expected to provide baseline ecological information to support coastal ecosystem management and conservation strategies.

MATERIALS AND METHODS

Study Area

This study was conducted in the coastal waters of Tirang Beach, Semarang, Indonesia, in November 2025. The study area (Fig.1) is characterized by shallow coastal waters, soft-bottom substrates, and estuarine influence, with additional inputs from mangrove ecosystems and aquaculture activities. These environmental conditions indicate the ecological potential of the area as a habitat for larval fish assemblages. Three sampling stations were established using a purposive sampling approach to represent distinct habitat conditions within the study area. Station selection was based on ecological characteristics, accessibility, and the presence of coastal features such as mangroves and aquaculture ponds.

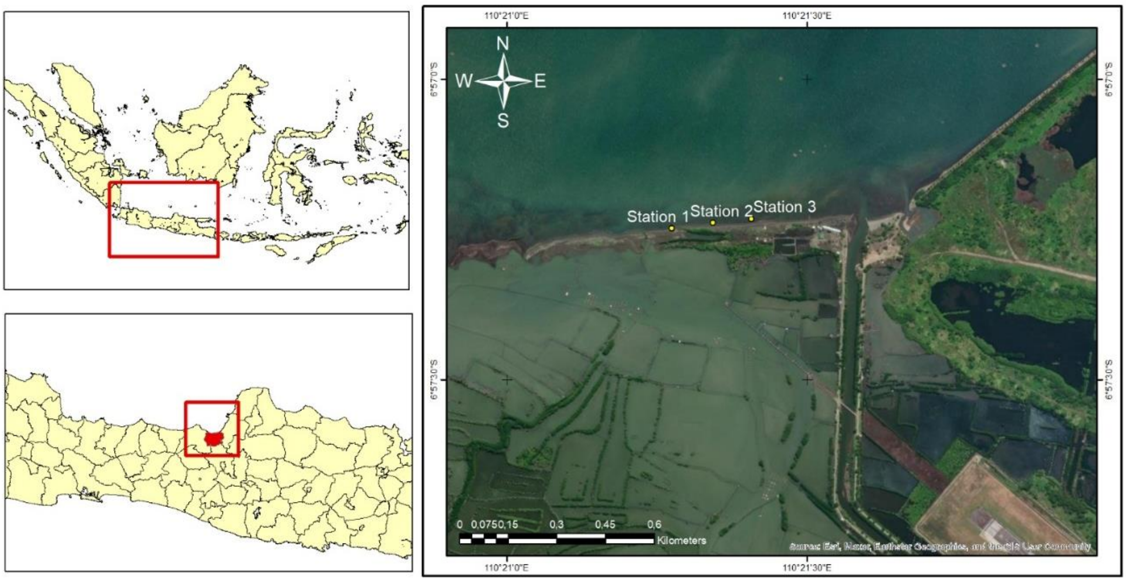

Figure 1. Study Area of Tirang Beach, Semarang, Indonesia.

Sampling and Data Collection

Sampling was conducted using a transect-based design. At each station, a 30 m transect line was established parallel to the shoreline. Three sampling points were defined at 10 m intervals (10 m, 20 m, and 30 m), resulting in three replicates per station (n = 3) and a total of nine sampling units. Larval fish were collected using three types of sampling gears, namely push net, seine net, and fish net, each with a mesh size of 1 mm. The application of multiple gear types was intended to improve sampling efficiency and to capture a broader representation of larval fish assemblages across different microhabitats.

Water quality parameters were measured *in situ* at each sampling point to characterize environmental conditions. The parameters included temperature (°C), salinity (‰), dissolved oxygen (DO, mg/L), and pH, measured using a thermometer, a hand refractometer, a digital DO meter, and a pH meter, respectively. All samples were preserved in 500 mL bottles containing 4% formalin solution and labeled according to station, sampling point, and sampling date. The preserved samples were subsequently transported to the laboratory for further analysis.

Larval fish samples were sorted and examined using a stereo microscope. Identification was performed to the lowest possible taxonomic level based on morphological characteristics, following standard identification references, including *An Atlas of the Early-Stage Fishes in Japan* (Okiyama, 2014) and the *Larval Fish Identification Guide for the South China Sea and Gulf of Thailand* (SEAFDEC, 2013). Supporting equipment such as petri dishes and dissection tools was used during the identification process.

Larval fish abundance was expressed as the number of individuals per sampling unit. Community structure was evaluated based on species composition and relative abundance. Spatial distribution patterns were assessed by comparing larval abundance among stations and sampling points. The relationships between environmental parameters and larval fish abundance were analyzed using descriptive and correlation approaches to identify potential environmental drivers influencing larval distribution.

RESULTS AND DISCUSSION

RESULT

A total of 120 larval individuals belonging to 7 families were collected from three sampling stations at Tirang Beach (Table 1; Fig. 2). The identified larvae consisted of five fish families (Ambassidae, Engraulidae, Gerreidae, Gobiidae, and Mugilidae) and two crustacean families (Palinuridae and Penaeidae). Among these, Penaeidae was the most dominant family, contributing 51.7% of the total abundance. This was followed by Ambassidae (12.5%), Gobiidae (10.8%), Mugilidae (9.2%), Gerreidae (7.5%), and Engraulidae (6.7%), while Palinuridae showed the lowest contribution (1.7%). The composition of larval assemblages varied among stations, indicating spatial heterogeneity in community structure.

Table 1. Identification Results of Larval Families at Tirang Beach, Semarang.

Family	Station 1	Station 2	Station 3	Total Length (mm)
Ambasiidae	2	4	9	22-39
Engraulidae		2	6	5.06 - 10.08
Gerreidae	6	3	-	4.67-6.88
Gobiidae	6	2	5	22-30
Mugilidae	7	4		3.40 – 6.21
Palinuridae	-	-	2	33-83
Penaeidae	17	20	25	3.07-19.68

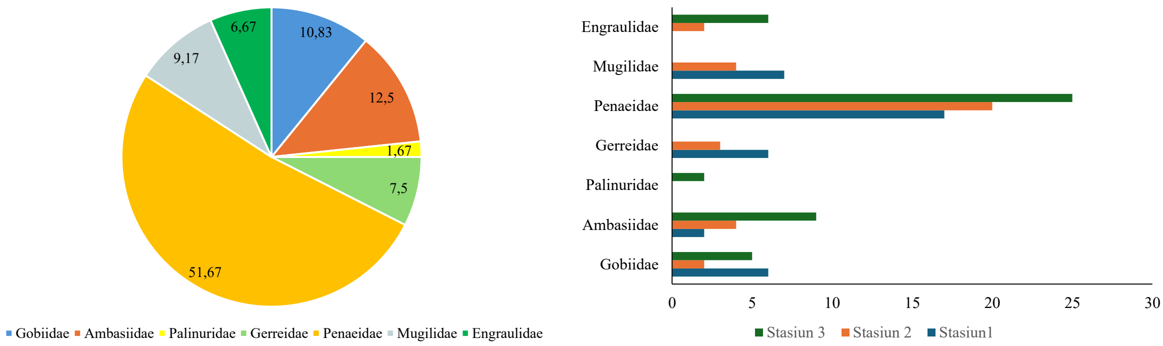

Figure 2a) Percentage of the total Larvae fish and crustacean family richness at Tirang Beach, Indonesia. b) The number of specimens (N) of the larvae of fish and crustacean assemblages at Tirang Beach, Indonesia.

The composition and abundance of larval organisms at each station are presented in Table 1. Penaeidae consistently showed the highest abundance across all stations, with 17 individuals at Station 1, 20 at Station 2, and 25 at Station 3. Fish larvae were more variably distributed, with Gerreidae (6 individuals) and Mugilidae (7 individuals) showing relatively higher abundance at Station 1, while Ambassidae increased in abundance at Station 3 (9 individuals). Engraulidae were absent at Station 1 but present at Stations 2 and 3.

The size distribution of larvae varied among families, reflecting differences in developmental stages. Fish larvae generally exhibited smaller size ranges, such as Gerreidae (4.67–6.88 mm) and Mugilidae (3.40–6.21 mm), indicating early larval stages. Engraulidae larvae ranged from 5.06 to 10.08 mm, while Ambassidae (22–39 mm) and Gobiidae (22–30 mm) showed relatively larger sizes. In contrast, crustacean larvae displayed wider and generally larger size ranges, particularly Palinuridae (33–83 mm) and Penaeidae (3.07–19.68 mm).

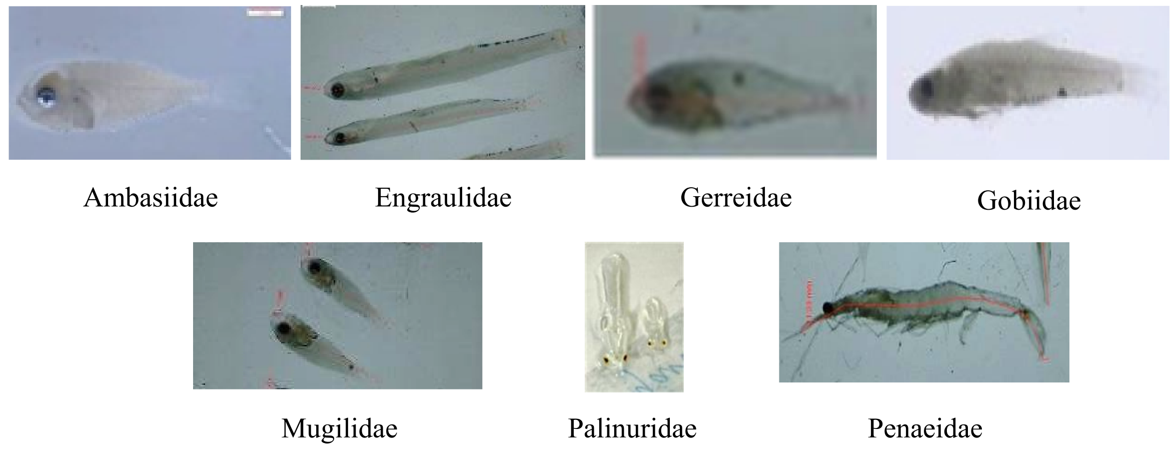

Figure 3. Morphological Identification of Larval Families.

The morphological characteristics of the identified larval families are shown in Fig. 3. Each family exhibited distinct morphological traits that facilitated identification. Ambassidae larvae were characterized by a relatively deep body shape and a well-developed head. Engraulidae larvae exhibited elongated and slender bodies with a transparent appearance, typical of pelagic larvae. Gerreidae larvae showed moderately elongated bodies with distinguishable head morphology. Gobiidae larvae were identified by their compact body shape and relatively large head proportion, while Mugilidae larvae displayed a slender body with uniform pigmentation. Crustacean larvae, particularly Penaeidae, showed elongated segmented bodies with visible appendages, whereas Palinuridae larvae exhibited larger body size and more complex morphological structures, indicating more advanced developmental stages.

Table 2. Water Quality Characteristics of Tirang Beach, Semarang.

Variable	Station 1	Station 2	Station 3
pH	7.6	7.9	7.5
Temperature (°C)	29.2	28.5	28.9
Salinity (‰)	29	31	25
DO (mg/l)	5.4	6,7	5.5
DO (‰) (saturation)	14.2	17.9	15.4

Water quality parameters measured at the study sites are presented in Table 2. The pH values ranged from 7.5 to 7.9, indicating neutral to slightly alkaline conditions. Water temperature varied between 28.5 and 29.2°C, reflecting relatively stable thermal conditions. Salinity ranged from 25‰ to 31‰, with the lowest value recorded at Station 3. Dissolved oxygen (DO) concentrations ranged from 5.4 to 6.7 mg/L, indicating well-oxygenated conditions across all stations. DO saturation values ranged from 14.2% to 17.9%. Overall, the measured environmental parameters indicate relatively stable water quality conditions across sampling stations.

DISCUSSION

Tirang Beach represents a dynamic coastal ecosystem characterized by sandy intertidal geomorphology, mangrove stands, and adjacent shallow-water habitats. This area is subject to continuous environmental change, including coastal abrasion, shoreline shifts, and increasing anthropogenic pressure. Such conditions influence habitat structure and ecological processes, ultimately shaping larval community dynamics. Coastal ecosystems supported by mangroves and seagrass beds are widely recognized as highly productive systems that provide essential nursery habitats for early life stages of aquatic organisms (Tarimo et al., 2022; Swalethorp et al., 2023). Mangrove vegetation, with its complex root systems adapted to tidal and muddy substrates, enhances habitat heterogeneity and provides shelter and feeding grounds for larvae. Similarly, seagrass ecosystems, which require clear water and sufficient light penetration for photosynthesis, contribute to ecological stability and support larval development. However, these ecosystems are vulnerable to environmental disturbances such as sedimentation, coastal development, and land-based inputs, which may reduce habitat quality and ecological function (Azuga et al., 2025; Muhammad et al., 2025).

The dominance of Penaeidae larvae observed in this study highlights the ecological importance of mangrove-associated habitats in supporting crustacean recruitment. Penaeid larvae are known to preferentially inhabit estuarine and mangrove environments due to the availability of organic matter and detritus as food resources, as well as protection from predators (Tjahjo et al., 2019; Lima et al., 2024). The muddy substrate typical of mangrove ecosystems provides favorable conditions for feeding and development, which explains the high abundance recorded across all sampling stations. In contrast, fish larvae such as Gerreidae, Mugilidae, and Gobiidae were more abundant in areas with higher habitat complexity, particularly near mangrove zones, indicating their reliance on structurally complex habitats for survival and recruitment (Fang et al., 2023; Chen et al., 2022). This pattern is consistent with the ecological role of mangroves as critical nursery habitats that enhance larval survival through increased food availability and reduced predation risk.

Environmental parameters measured in this study were generally within optimal ranges for larval development, although spatial variability was observed. Salinity values ranged between 25–31‰, indicating estuarine influence, which is particularly important for species with broad salinity tolerance such as penaeid shrimp (Wang et al., 2025). Temperature ranged from 28.5–29.2°C, which falls within the optimal thermal range for tropical larval fish metabolism and growth (McMahon et al., 2023). Dissolved oxygen concentrations were above 5 mg/L, suggesting that oxygen availability was sufficient to support larval respiration and metabolic processes (Pepin, 2023). However, fluctuations in these parameters may significantly affect larval survival due to their high sensitivity to environmental changes. Variability in salinity, temperature, and oxygen levels can influence physiological processes such as osmoregulation, feeding efficiency, and growth rates (Pepin et al., 2024; Chen et al., 2022).

In addition to physicochemical factors, turbidity and hydrodynamic processes play a critical role in larval distribution. High turbidity levels can reduce light penetration, limit primary productivity and decrease dissolved oxygen concentrations, while also impairing larval visual capacity for feeding (Siswanto et al., 2021). Larvae rely heavily on visual cues for prey detection, and reduced water clarity can negatively affect feeding success and survival. Furthermore, water currents influence larval dispersal, transport, and retention within coastal systems. Larval stages, particularly in early development, often depend on passive transport mechanisms, where currents facilitate movement and distribution across habitats (Fang et al., 2023; Gallego-Zerrato et al., 2025). This may explain the spatial variation observed in larval assemblages across the sampling stations.

The presence of multiple larval size classes in this study indicates that Tirang Beach supports different developmental stages simultaneously, reflecting continuous recruitment and favorable growth conditions. Smaller larvae, particularly within Gerreidae and Mugilidae, suggest recent spawning activity, while larger larvae such as Palinuridae indicate advanced developmental stages. This pattern is characteristic of productive coastal ecosystems, where environmental conditions support both larval settlement and growth processes (Lima et al., 2024; Wang et al., 2025).

Overall, the findings suggest that larval community structure in Tirang Beach is influenced by the interaction between habitat characteristics, environmental parameters, and hydrodynamic processes. The strong dominance of crustacean larvae, particularly Penaeidae, alongside the presence of diverse fish larvae in mangrove-associated areas, underscores the ecological significance of this coastal system as a nursery habitat. However, ongoing environmental pressures, including coastal abrasion and anthropogenic activities, may pose risks to habitat quality and larval survival. Therefore, the conservation and sustainable management of mangroves and associated coastal ecosystems are essential to maintain their ecological functions in supporting early life stages of marine organisms (Swalethorp et al., 2023; Tarimo et al., 2022; Alfirdaus et al., 2024).

A limitation of this study is that the analysis was based on a relatively limited temporal sampling period and a descriptive statistical approach, which may not fully capture seasonal variability and complex ecological interactions influencing larval community dynamics.

CONCLUSION

This study identified larval assemblages at Tirang Beach comprising seven families, including five fish families and two crustacean families, with Penaeidae as the most dominant group contributing more than half of the total abundance. The variation in larval composition and size distribution across stations indicates that the area supports multiple developmental stages and functions as an active nursery habitat. Spatial differences in larval assemblages highlight the influence of habitat characteristics, particularly the ecological role of mangrove-associated areas in supporting larval diversity, while water quality parameters were within suitable ranges for larval survival. Overall, these findings emphasize the ecological importance of Tirang Beach as a coastal nursery ground and provide baseline information to support sustainable management and conservation of coastal ecosystems.

REFERENCES

1. Alfirdaus, R., Pribadi, R. and Suryono, C.A., 2024. Coastal ecosystem management and conservation strategies in Tirang Beach, Semarang. Jurnal Kelautan Tropis, 27(1), pp.45–56.
2. Astuti, R.D., Muslim, M. and Ismanto, A., 2024. Horizontal distribution of silicate and its relationship with chlorophyll-a in Tirang coastal waters, Semarang. Indonesian Journal of Oceanography, 6(4), pp.357–367. https://doi.org/10.14710/ijoce.v6i4.24334
3. Azuga, C., Popescu, I. and Marinescu, D., 2025. Impacts of sedimentation and coastal development on seagrass ecosystems. Marine Environmental Research, 198, 106123. https://doi.org/10.1016/j.marenvres.2024.106123
4. Chen, C.W., Hsieh, H.Y., Lee, M.A. and Chang, Y.J., 2022. Environmental drivers influencing larval fish assemblages in coastal ecosystems. Frontiers in Marine Science, 9, 832817. https://doi.org/10.3389/fmars.2022.832817

5. Fang, C., Wang, X., Sun, D., Zhai, H., Zhang, D., Liao, G. and Wang, C., 2023. Spatial distribution and seasonal variation of fish larvae in the upper 200 m of the Philippine Sea. Frontiers in Marine Science, 10, 1110980. https://doi.org/10.3389/fmars.2023.1110980
6. Gallego-Zerrato, J.J., Morales-Nin, B., Torres, M.A. and González, J.A., 2025. Seasonal variability of larval fish assemblages in tropical coastal waters. Diversity, 17(1), 23. https://doi.org/10.3390/d17010023
7. Lima, L.G., Araújo, F.G., Macário, B.S. and Pessanha, A.L.M., 2024. Larval fish assemblages in selected estuaries under different anthropogenic influences. Marine Pollution Bulletin, 198, 115858. https://doi.org/10.1016/j.marpolbul.2023.115858
8. McMahon, S.J., Donelson, J.M. and Munday, P.L., 2023. Temperature-mediated effects on growth and survival of larval reef fishes. Coral Reefs, 42(1), pp.31–42. https://doi.org/10.1007/s00338-022-02315-4
9. Muhammad, F., Rahman, A. and Putra, D., 2025. Seagrass coverage and nutrient dynamics in tropical coastal ecosystems. Ocean Science Journal, 60(2), pp.215–227. https://doi.org/10.1007/s12601-024-00345-7
10. Okiyama, M., 2014. An atlas of the early stage fishes in Japan. 2nd ed. Tokai: Tokai University Press.
11. Pepin, P., 2023. Feeding by larval fish: The role of taxonomy, size, and behavior in determining feeding variability. ICES Journal of Marine Science, 80(1), pp.91–106. https://doi.org/10.1093/icesjms/fsac215
12. Pepin, P., Dower, J.F. and Davidson, F.J.M., 2024. Seasonal succession and environmental variability in larval fish communities. Journal of Northwest Atlantic Fishery Science, 55, pp.31–58. https://doi.org/10.2960/J.v55.m745
13. Sabdaningsih, A., Widyorini, N. and Muskananfola, M.R., 2024. Environmental quality assessment of Tirang coastal waters, Semarang. AACL Bioflux, 17(2), pp.871–882.
14. SEAFDEC, 2013. Larval fish identification guide for the South China Sea and Gulf of Thailand. Southeast Asian Fisheries Development Center.
15. Siswanto, E., Setiawan, R. and Nugroho, D., 2021. The effect of turbidity on aquatic ecosystems and fish larvae survival. Jurnal Ilmu Perairan, 16(2), pp.89–97.
16. Swalethorp, R., Landry, M.R., Semmens, B.X., Ohman, M.D., Aluwihare, L., Chargualaf, D. and Thompson, A.R., 2023. Anchovy population dynamics linked to trophic shifts in larval diet. Nature Communications, 14, 7412. https://doi.org/10.1038/s41467-023-42966-0

17. Tarimo, B., Winder, M., Mtolera, M.S.P., Muhando, C.A. and Gullström, M., 2022. Seasonal distribution of fish larvae in mangrove–seagrass ecosystems of Zanzibar. Scientific Reports, 12, 4196. https://doi.org/10.1038/s41598-022-07931-9
18. Tjahjo, D.W.H., Kartamihardja, E.S. and Purnomo, K., 2019. Habitat characteristics and distribution of penaeid shrimp larvae in coastal ecosystems. Indonesian Fisheries Research Journal, 25(1), pp.1–10.
19. Wang, X., Zhang, Y., Li, G., Chen, Z., Liu, J. and Sun, M., 2025. Community dynamics of fish larvae in coastal ecosystems: Spatiotemporal variation and environmental drivers. Fishes, 10(1), 24. https://doi.org/10.3390/fishes10010024