Effect of burrows of *Boleophthalmus pectinirostris* (Linnaeus, 1758) (Class Actinopterygii Family Gobiidae) on total organic matter in the mangrove ecosystem of Pandansari Brebes, Central Java

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**Abstract.** *B. pectinirostris* constructs different shapes of burrows on the surface of the sediment because of different functions. This study was to determine the effect of burrows on total organic matter (TOM) on the sediment surface in the mangrove ecosystem in Pandansari Brebes, Central Java. Sampling was divided into mangrove areas and muddy beach areas. The shape of the burrows was visually observed in a year. TOM was taken from inside and outside the burrow in June and September using a syringe and analyzed by the LOI method. *B. pectinirostris* had circular burrow openings at the same height as the ground surface. At the mouth of the burrow, there were traces of fish coming in and out. The diameter of the burrows was around 3-4cm in the muddy beach area and 2-9cm in the mangrove area. TOM in the mangrove area inside the burrow was 9,034±0,851% and outside was 8,470%±0,967% and in the muddy beach area inside the burrow was 8,754%±0,476% and outside was 8,558%±0,924%. There was no difference in TOM inside and outside the burrow in the two areas (P>0.05). It is likely caused by the locomotion of fish and tidal stirring, so the burrows do not function as a TOM trap.

**Keywords:** *Boleophthalmus pectinirostris*; burrow; TOM

1. Introduction

Mudskippers (*Boleophthalmus pectinirostris*) belong to the Gobiidae family and subfamily Oxudercinae. This fish distribution throughout Peninsular and eastern Malaysia, Sumatra (Indonesia), China, Taiwan, Korea, and Japan [1]. This fish is amphibious, euryhaline that lives in warm tropical and sub-tropical estuaries [2] and likes muddy habitats close to river mouths and around mangroves [2, 3].

Muddy areas are the habitat preference for *B. pectinirostris* because mud makes it easier for fish to dig burrows [2-4]. Several species of Gobiidae build burrows and are sometimes surrounded by ponds and mud walls [4-6]. As a thermoregulator, the burrow function protects itself from predators and as a storage for eggs [7].

Some fish can change environmental conditions such as *B. boddarti* in Kuwait to build hexagonal mud walls to protect its territory, prevent aggression, maintain microphytobenthos and prevent sediment from being carried away by tides [5, 8]. The *B. pectinirostris* found in the Funing Bay of China also creates a mud wall around the burrows but only occurs in winter to maintain temperature, maintain diatom abundance, and prevent other fish [4]. To maintain the burrow, the fish will carry sediment out...
by using its mouth. Digging activity of B. pectinirostris also increases the surface area of the sediment and oxygenates the bottom sediment [2]. These activities will change the sediment conditions in the area where B. pectinirostris is present.

In Kaliwlingi Pandansari Brebes B. pectinirostris was found in mangrove and muddy beach areas. Fish make burrows on the surface of the sediment. This study aims to determine the function of fish burrows as sediment traps that can affect the presence of other organisms. We focus on total organic matter (TOM) because it was closely related to the presence of benthos, usually as its food [9, 10]. This research is part of the research to determine the function of the B. pectinirostris as an ecosystem engineer through its behavior and their burrows. Ecosystem engineers are organisms capable of influencing the existence of other organisms by changing, shaping or maintaining the environment [11, 12].

2. Method
The research was conducted at Pandansari, Kaliwlingi Village, Brebes Central Java as in figure 1. Visual observations of burrows were carried out in April, July, September, and November 2019 in mangrove areas and muddy beach areas. A sampling of the size of the burrows opening and the total organic matter was carried out on three transects with each 2x2 m in the mangrove and muddy beach areas at low tide during the day in July and September 2019.

Map of the observation site at Brebes

![Sampling Area](image1)

Figure 1. Sampling area.

Total organic matter sampling used a modified core from a 50 ml volumed syringe with a 2.9 cm diameter and a 3.5 cm height. Samples were taken on each transect with six repetitions inside and outside the burrows on each transect. Inside burrow sampling was taken from the inside of the burrow mouth opening. Outside the burrow, sample was taken on the sediment surface around the burrow mouth opening as illustrated in figure 2. TOM samples were immediately put into a cool-box. Analysis of TOM using lost in ignition (LOI).
2.1. Data analysis
The mean value of total organic matter samples inside the burrow was compared with the outside of the burrow in both the mangrove and muddy beach areas using Student’s unpaired t-test.

3. Result and discussion

3.1. The shape and size of the burrows
During the observation, there was no change in the shape of the burrow openings throughout the year, both in the mangrove area as in figure 3 and the muddy beach area as in figure 4. Based on the observation, the burrow B. pectinirostris had a circular burrow opening, which was the same height as the ground surface. There were traces of fish in and out at the mouth of the burrow caused by fish pulling their bodies using their pelvic and pectoral fins. Around the burrow, there was no mud wall. It is difficult to distinguish small B. pectinirostris burrows from those made by megabenthos such as crabs in the mangrove area. We usually look for the existence of a pectoral fin of fish or the presence of crabs in the burrow to differentiate it.

The burrow’s diameter in the mangrove area was 2-9 cm and in the muddy beach area was 3-4 cm as in figure 5. The number of burrows in the mangrove area was less than in the muddy beach area, but the diameter found was larger than in the muddy beach area. The total area of burrows in the muddy beach area was greater than in the mangrove area as in figure 6. Based on the unpaired t-test, there was no significant difference between the total area of burrows in the mangrove area and the muddy beach area [13].
Figure 4. Burrows of *B. pectinirostris* in muddy beach area.

Figure 5. Distribution of burrows’ diameter.

Figure 6. Area of burrows.
3.2. Total organic matter

The average total organic matter in the inside sediment was 9.034% ± 0.851%, and outside was 8.470% ± 0.967% in the mangrove area as in figure 7. However, based on the test, it did not show any difference in TOM content (P value > 0.05) inside and outside the mangrove area.

The total organic matter in the sediment inside the burrow is 8.756% ± 0.476% outside the burrow is 8.558% ± 0.924% in the muddy beach area as in figure 8. However, based on the test, the difference of TOM content inside and outside the burrow in the muddy beach area was insignificant (P-value >0.05).

Figure 7. Distribution of TOM content in mangrove area.

Figure 8. Distribution of TOM content in muddy beach area.

Based on the research, TOM content inside and outside the burrows was no different. It is probably due to the tidal type of Brebes which is mixed tide prevailing semi-diurnal [14]. This tidal caused the observation area to experience two high tides and two low tides in one day, resulting in the stirring of organic matter on the burrows' surface. Another factor is the activity of fish that are actively grazing microphytobenthos on the surface of the sediment [13] and the activity of fish walking in and out of the hole at low tide. These activities may stir the surface sediment so that organic matter does not accumulate in a particular area.
Based on observations for a year, the shape of *B. pectinirostris* burrows on the surface sediment did not change or add to its physical structure. This case is the same as the burrows of *B. pectinirostris* in Mai Po Hongkong [2], while *B. pectinirostris* in the Funian Bay of China changes the morphology of the burrow shape on the surface in winter (November-January). In winter the fish create shallow ponds protected by mud walls around the burrows [4, 15]. The mud walls serve as a territorial barrier from other fish and help maintain temperature and abundance of microphytobenthos. The hexagonal mud walls that surround the burrows can be found in the habitat of *B. boddarti* in Kuwait’s Sulaibikat Bay. This wall’s main function is to reduce aggression from other fish and prevent tides carrying sediment and microphytobenthos [5, 8].

In this study, the burrows did not function as sediment trap. This was indicated by the morphology of the burrow that did not have a wall around it and the contents of the TOM inside and outside the burrow were not different. We also did a prior study about the effect of the burrow on microphytobenthos which states that there was no difference in the abundance of microphytobenthos inside and outside the burrow of *B. pectinirostris* throughout the year [13]. *B. pectinirostris* in Indonesia does not need to maintain an abundance of microphytobenthos and TOM through burrows as *B. pectinirostris* do in subtropical areas. The difference in the morphological shape of the burrow surface is probably the effort of each fish to adapt to environmental conditions.

4. Conclusion
The shape of *B. pectinirostris* burrows on the sediment surface was circular with traces of the fish pelvic and pectoral fins. The burrow’s shape did not change throughout the year both in the mangrove area and in the muddy beach area. The burrow did not function as a trap for total organic material because there was no significant difference in the organic matter content inside and outside the burrow.

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