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Short Communication: Behavioral study on *Anguilla bicolor* using a modified trap design at laboratory scale

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Abstract. *Fitri ADP, Boesono H, Kurohman F, Jayanto BB, Dewi DE, Sabdono A. 2019. Short Communication: Behavioral study on Anguilla bicolor using a modified trap design at laboratory scale. Biodiversitas 20: 2159-2165.* The information on the behavioral juvenile eels *Anguilla bicolor* is urgently needed as basic design of selective and sustainable traps. The objectives of this study were to find out and analyze the behavioral pattern and characteristics of *A. bicolor* elvers in the modified and non-modified eel traps. The test organism, *A. bicolor* juvenile eels with 150-170 mm in length, were obtained from Segara Anakan waters, Cilacap. The 2 trap designs, which were modifications of the 450 mm long PVC eel trap, with and without the addition of bait hole, were used in this study. All experiments were carried out in the laboratory of Fish Behavior, Diponegoro University, Semarang, Indonesia. The eel characters and response time were recorded using a handy camera that placed on top of the aquariums. The results indicated six types of *A. bicolor* behavior in response to the modification of eel traps. Moreover, the trap design with an additional hole on the wall, with or without bait, was proven to have no significant effect on the response time. While trap without column and bait possessed the fastest response time at which elver penetrated to the trap (p-value ≤ 0.05). Furthermore, these results indicated that *A. bicolor* elver gained entrance into the trap, in an attempt to take shelter.

Keywords: *Anguilla bicolor*, behavior, eel trap, shelter

INTRODUCTION

Anguilla sp. belongs to *catadromous* biota, which lives in estuarine ecosystems (Righton and Metcalfe 2011; Shrimpton 2013; Zydlewski and Wilkie 2013; Bultel et al. 2014; Miller and McCleave 2018). However, the types commonly found in Indonesia, include *A. celebesensis* (endemic eels in the islands of Borneo and Sulawesi), *A. interioris*, *A. obscura* (in the waters of Papua), *A. marmorata*, *A. bicolor bicolor*, and *A. bicolor pacifica* (in the waters of Java) (Putra 2015). Furthermore, *A. bicolor* is easily spotted in the waters of Pelabuhan Ratu, West Java and that of Segara Anakan in Cilacap district, Central Java (Nijman 2015; Haryono and Wahyudewantoro 2016). The development of this organism consists of six phases, including egg, larvae (*leptocephalus*), glass eel, elver, fingerling (yellow eel), and adult (silver eel) (Miller and McCleave 2018; Verhelst et al. 2018). Their living habitat includes in the continental and ocean waters. The newly hatched larvae drift with the ocean currents, grow into glass eels and elver in the continental waters. The growth of fingerling phase may happen in freshwaters, brackish (transitional), or marine, then in adult phase migrates to the sea to breed, spawn and dies after spawning (Righton and Metcalfe 2011; Bultel et al. 2014; Miller and McCleave 2018). *Anguilla* sp. is a nocturnal creature, which feeds by utilizing its olfactory organ, just like any other nocturnal biota (Weltersbach et al. 2019; Fitri 2012).

The device trap that constructed from a 4-inch thick PVC with 450 mm in length is used to capture *Anguilla* sp. in the Segara Anakan waters, Central Java. The capture took place late in the afternoon, with a 12-hour immersion. This timing is selected to match the organism's hours of activity as nocturnal biota. The fish and shrimp baits are used to attract even more *Anguilla* sp. Furthermore, the holes are made at the top of the trap construction, in order to allow chemical attractants to spread faster outside of the trap. Hence, it is assumed that eels become more willing to enter the entrapment.

According to the past studies, tropical eel species *A. bicolor* has been found in the south coast of Java island (Setiawan et al. 2001; Honda et al. 2016; Taqwa et al. 2017). However, these studies have mainly focused on the population dynamics, nutritional feeds, habitat ecology of the anguillid eels (Sugeha and Genisa 2015; Lukas et al. 2017; Handajani et al. 2018). Little effort has been made to examine the fish behavior of the anguillid eels. Shiao et al. (2003) and Chen et al. (2018) reported migratory behaviors and habitat use in Taiwan. However, information concerning the behavior of *A. bicolor* elver, using modified traps has not been explored-hence the need for this investigation. This study was aimed at identifying and analyzing patterns and characteristics of *A. bicolor* for both modified and non-modified eel trap in the laboratory scale.

MATERIALS AND METHODS

This research was carried out in the laboratory of Fish Behavior, Department of Fishing Capture, Faculty of Fisheries and Marine Science, Diponegoro University, Indonesia. Furthermore, the objects were *A. bicolor* elvers, obtained from the waters of Segara Anakan in Cilacap, Central Java, Indonesia using eel traps.

The organism was of medium size, with a total length (TL) of 150-170 mm. The eel traps were made into two designs, each with a length of 450 mm, a hole was put into one (modified), while the other had no holes (control). Furthermore, the opening at the top of the device allowed a faster dispersion of chemicals than the bait, in order to accelerate detection through its olfactory organ, to enhance the efficiency of the immersion time. The PVC pipe contained 64 holes on each, with a diameter of 0.50 cm. The specification for each part of the set up is shown in Figures 1, 2, 3, and 4, while that of the modified apparatus was illustrated in Figures 5 and 6.

The baits used as attractants were bits of *Penaea* sp., which were hanged in the body of the trap. Furthermore, they are one of the biota, *A. bicolor* feeds on in nature (Engman et al. 2017; Miller and McCleave 2018).

Observation for treatment was performed with the simulation of *A. bicolor* capture, using traps in the designated aquarium, including the application of the 450 mm long modified trap, which consists of two designs (with and without lattice). Furthermore, other procedures applied during the study involved the use and absence (control) of bait on each constructed device, intending to determine the response and behavior of *A. bicolor* from different dealings. During the capture operation, both traps were put in separate aquariums and observed for 60 minutes, in line with the rate of chemical dispersion from attractants or baits (*Penaea* sp.) to lure optimal catch (Fitri 2012; Fitri et al. 2017b). Moreover, these processes were carried out in the evening, in an attempt to match the nature of *A. bicolor* as nocturnal biota (Fitri et al. 2017a). Prior to the observation, the organism had to undergo pre-treatment, where it was left without food for 24 hours, enabling them to respond better during the process. The surveillances were carried out to collect data of response time and behavior of *A. bicolor* as they approach and enter the traps. Furthermore, a timer, indicating how long it takes for *A. bicolor* to gain entrance into the device (in seconds) was used as an indicator. Data were collected during capture simulation by utilizing handy cameras, placed across the on top of the aquariums (Figures 7 and 8).

RESULTS AND DISCUSSION

Fish behavioral habits in response to their surrounding are either positive (taxis) and negative (phobias) (Fitri 2012; Gutowsky et al. 2017; Pouca and Brown 2017; Benitez et al. 2018; Suriyampola et al. 2018). This research revealed six patterns of behavior of *A. bicolor* elver against different trap designs, which include: (i). reaching straight into the trap, (ii). holding still and hiding beside the device, (iii). staying calm at the trap entrance facing outward, (iv). reaching for the inside of the trap and holding still within, (v). swimming toward the top of the trap near the hole of the bait, (vi). moving around the device. Hence, an illustration during treatment is shown in Figure 9.

The primary response of the organism during the immersion of a trap into the aquarium was an approach into the PVC eel trap. This behavioral response was due to the natural curiosity of biota (thigmotaxis nature) against any new object in their surroundings (Bolliet et al. 2007; Fitri et al. 2017a). In addition, this reaction was also due to the perception that the trap could function as a shelter. Hence, it is perceived as protection from another biota of the same or different species (von Brandt 2005). Furthermore, solitary biota tends to find their own space and attempt to hide in any shelter they discover. The response of approaching the trap and swimming to the hole indicated a process of chemical dispersion from the bait. This dispersion stimulated the nocturnal biota with olfactory organ (Hara 2011; Atta 2013; Fitri et al. 2017b). Atta (2013) and Engman et al. (2017) reported that the olfactory organ of *A. bicolor* is more dominant than that of visual counterpart.

The response of the organism to stay motionless under the trap was an attempt to hide. This behavior is a natural response regards that treatment may sign indication of threat. One of the natural traits of *A. bicolor* as a group of demersal fish is its tendency to hold still and hide in any spot regarded safe from certain predators. Eel's body shape permits the performance of undulation moves when they swim which enables them to stay calm and hide (Bergstad 2009; Miller and McCleave 2018).

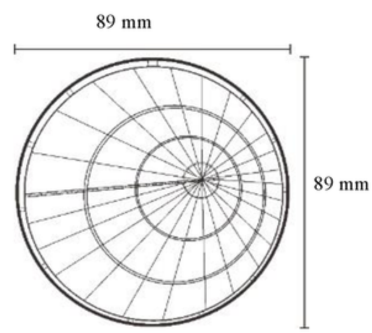


Figure 1. Design of eel trap opening (front view)

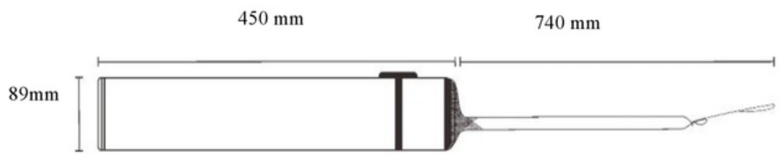


Figure 2. Eel trap design (side view)

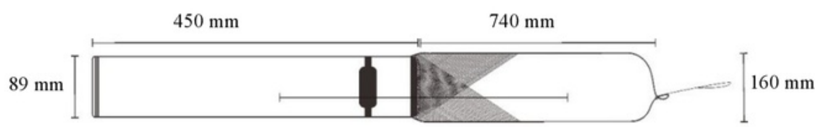
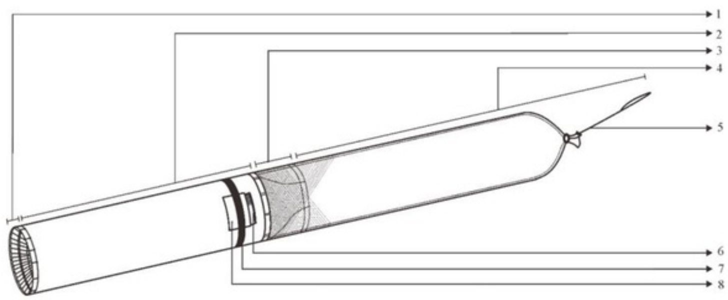


Figure 3. Eel trap design (top view)



Note:

1. The main door of PVC traps
2. Body of PVC trap
3. Doors of PVC trap
4. The casing of PVC traps
5. Anchor rope of PVC trap
6. Bait box of trap
7. Rubber band for the bait of PVC trap
8. Baitholder of PVC trap

Figure 4. Eel trap specification

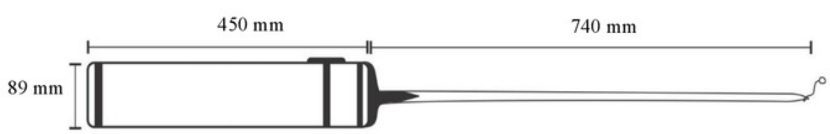


Figure 5. Eel trap construction without additional holes (control)

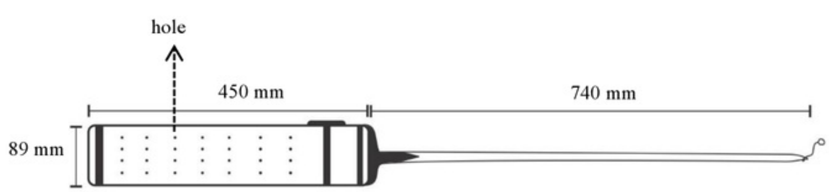


Figure 6. Eel trap construction with additional holes (modified)

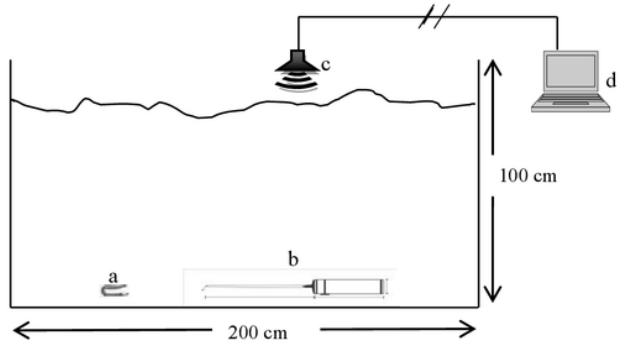


Figure 7. Observation design for response and behavior of *Anguilla bicolor*. Note: A. *A. bicolor*, B. Trap, C. Handy camera, D. Observation monitor

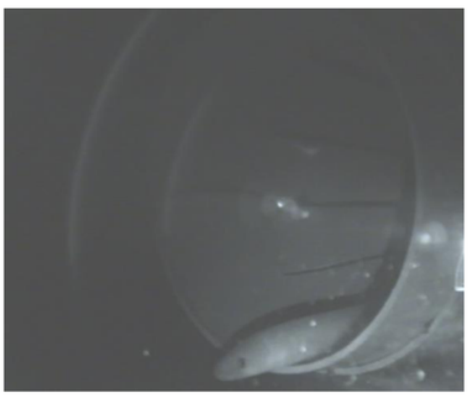


Figure 8. *Anguilla bicolor* behavior elver stage with trap eel designs from PVC

The other typical response of *A. bicolor* within the presence of a trap was to approach and gain entrance into the trap (Figure 10). This figure illustrated the time response occurred for elver entering in both control and treatment modifications. The quickest response time for the organism towards an eel trap with bait and without a hole is 143 seconds. It indicated that the chemical attractant nature triggers the reaction. Further analyses of all responses showed that *A. bicolor* elver regards any trap constructions only as protection. It has been known that the predatory and nocturnal fish groups possess the habit of taking shelter and explore prey hunting only when hungry (Fitri et al. 2017a; Fitri et al. 2017b). Furthermore, the organism tends to take cover for longer when compared to the older species (yellow eel and silver eel) with tendency to seek shelters for safety (Baker et al. 2019). The shelter in this context is the trap, which only suits them better, allows hiding from the surroundings (Broadhurst and Millarc 2018; Martasuganda 2003).

The chemical present in the attractant was detected via dispersion that related to the amino acid content of the bait (Weltersbach et al. 2019; Ingólfssona 2017; Ward and Myers 2007; Løkkeborg and Johannessen 1992). Furthermore, nocturnal fish such as *Anguilla* sp. detects chemical substances through their olfactory organs that are more dominant than others, e.g. eyes (Capoccioni et al. 2018; Fitri et al. 2018, Claveau et al. 2015; Bardonnet et al. 2005). While another organ is lateral line, which detects vibrations in their surroundings for compensating the lack of vision (Aman and Piotrowski 2011).

Eel trap design with an additional hole on the wall, with or without bait, was proven to have not significantly affected the response time of the organism as a juvenile stadium. It means that the perception organ has not adequately developed in comparison with their adult counterparts. Hence, chemical attractants did not affect *A. bicolor* elver (Miller and McCleave 2018; Fitri 2012; Hara 2011; Bergstad 2009). Therefore, it could be stated that the elver organism possesses the behavior of investigating its surroundings (thigmotaxis nature), especially with the presence of foreign objects. However, baits do not affect their response as they only take the eel trap as a space to take shelter from other predators. Furthermore, the ophthalmic organ of *A. bicolor* does not develop as advanced as its olfactory organ, which is natural for nocturnal biota.

In conclusion, six types of *A. bicolor* elver stage behavior, manifested with different PVC trap designs were recorded in this study. However, the fastest response time was an eel trap without column and bait. The ANOVA test (p-value $\leq$ 0.05) showed a significant difference in response time from the four treatments. Hence, the bait makes the organism interested in entering the device, which also functions as a shelter.

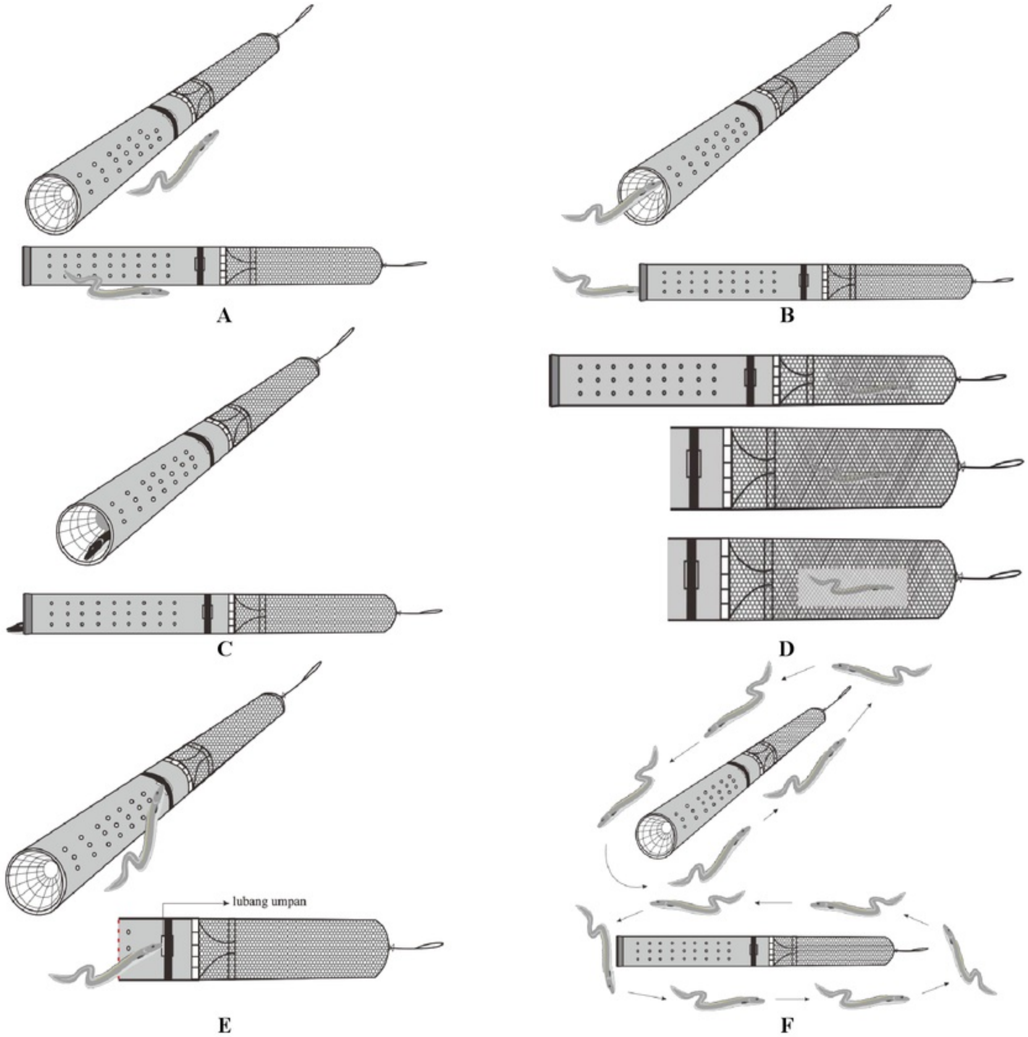


Figure 9. An illustration of *A. bicolor* behavior during capture simulation: (A) Getting into the PVC eel trap; (B) Holding still beside the PVC eel trap; (C) Holding still at the entrance of the device while preventing other fish from coming in; (D) Getting into the bag in the trap; (E) Approaching the bait from outside the device; (F) Moving around the tool

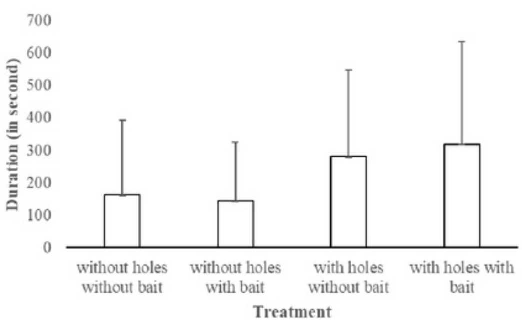


Figure 10. Elver response time upon entering the eel trap

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