

Comparison of the Length-Size Structure of the Glass Eels *Anguilla Bicolor Bicolor* in the Cikaso Estuary and River Areas, Sukabumi, Indonesia

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ABSTRACT

Cikaso is one of several areas in Sukabumi Regency has the highest glass eel catch production. Glass eel catch in the Cikaso area occurs in two areas, around the estuary and river. One of the most dominant glass eel catch species is *Anguilla bicolor bicolor*. This study compared the length structure of glass eels *A. bicolor bicolor* caught in the Cikaso Estuary and River areas. Glass eels were caught using a push net with a mesh size of 0.48 mm every month from December 2020 to April 2021. The study revealed that the average length of glass eels *A. bicolor bicolor*, caught in the river area, was longer (98.0 mm) than those caught in the estuary area (91.2 mm). This is thought to be due to growth factors and the natural selection of glass eels *A. bicolor bicolor* during their movement in the recruitment process to the Cikaso River area.

INTRODUCTION

Glasseels are the early life phase of the genus *Anguilla*, which has high economic value, especially in the capture fisheries and aquaculture industry (Sukardi et al., 2022). One of the species widely found in Indonesia is *Anguilla bicolor bicolor*, which has excellent potential to be developed as an export commodity (Taqwa et al., 2018). As part of their life cycle, glass eels migrate from the ocean to freshwater through estuaries to continue the growth phase (Cresci et al., 2019). During the migration process, glass eels can experience natural selection as a result of changes in aquatic environmental conditions, failure of physiological adaptation, predation, limited food supplies in river areas, running out of energy while moving against river currents, to capture by humans (Harrison et al., 2014; Jellyman & Lambert, 2003; Zumbrägel, 2024).

The Cikaso River and its estuary area in Sukabumi, West Java, is one of the essential habitats for the glass eel *A. bicolor bicolor* (Putri & Syamsudin, 2021). Several researchers have stated that this area has unique ecological characteristics, with variations in environmental factors such as salinity, temperature, and substrate structure that affect the distribution and abundance of glass eels (Baihaqi, 2022; Putri & Syamsudin, 2021; Sugianti et al., 2020). However, studies on the size structure of glass eel catches in this area are still very limited.

This study compared the length structure of glass eels *A. bicolor bicolor* caught from the estuary and Cikaso River area, Sukabumi, Indonesia. Information from this study is essential to support sustainable management of eel resources. The results of this study can also help the theoretical basis related to growth and natural selection that occurs in glass eels during the migration process to river waters.

LITERATURE REVIEW

Anguilla bicolor bicolor is a species of eel known as a catadromous fish where the parent fish migrate from freshwater areas to deep sea waters to spawn (Hakim et al., 2020). Eel larvae in the leptocephalus stage generally live 200 meters below sea level (Miller, 2015). Leptocephalus larvae will then develop into a semi-transparent juvenile stage better known as glass eels (McCleave, 2001). Glass eels will migrate back from the sea to their original habitat in freshwater (Kroes et al., 2020). The success of the glass eel migration process is influenced by environmental factors such as salinity, temperature, river current, high tide, and food availability (Ciccotti et al., 1995; Edeline et al., 2005; Elie & Rochard, 1994; Gascuel, 1986; Jellyman & Lambert, 2003; Laffaille et al., 2007; White & Knights, 1997). Estuarine habitats function as transition zones, where glass eels adapt before entering river habitats (Boardman et al., 2024).

During the transition from a hyperosmotic environment to a more hypoosmotic region, glass eels undergo active osmoregulatory system adjustments (Birrel et al., 2000). This adjustment requires considerable energy (Taqwa et al., 2018). In addition, energy expenditure also occurs for the movement of glass eels that move against the river current. The harsh conditions experienced by glass eels during the recruitment process to freshwater areas are

the reason for their populations' high natural selection process (Guo et al., 2024; Josset et al., 2016).

Cikaso is one of several areas in West Java Province that has high glass eel capture fisheries production, with the most dominant species *A. bicolor bicolor* (Annida et al., 2021). Glass eel fishing in this area is generally carried out from around the estuary to + 8 km into the river area (Annida et al., 2022; Baihaqi & Annida, 2024). According to Baihaqi & Annida (2024), glass eel fishing carried out by fishermen in the Cikaso area is generally carried out using two types of traditional fishing gear, namely traps and push nets. However, push nets are the most widely used fishing gear for catching glass eels along the estuary of the Cikaso River.

Various studies on the composition of glass eel catches, the selectivity of glass eel fishing gear, the survival of glass eels after capture, and the relationship between the abundance of glass eels and the condition of the aquatic environment have been conducted in the Cikaso River (Annida et al., 2021, 2022; Baihaqi & Annida, 2024; Sugianti et al., 2020). However, until now, information on the length and size structure of glass eel catches in the Cikaso River and Estuary is not widely known. Information on the length and structure of glass eels caught in the estuary area of the Cikaso River can provide basic details on managing sustainable eel fisheries resources. This information can also describe the growth conditions of glass eels due to the natural selection that occurs during their migration to the Cikaso River area.

METHODOLOGY

Glass eels were sampled using a push net fishing gear with a mesh size of 0.48 mm. Local fishermen around southern Sukabumi widely use this tool to catch fish larvae and juveniles (Baihaqi et al., 2022; Prabowo et al., 2022; Simanjuntak et al., 2021). This fishing gear was operated in two research areas, around the estuary and river (Figure 1). The glass eel fishing area in the river area is ± 8 km from the estuary area. Glass eel sampling was carried out every month for 5 months from December 2020 to April 2021.

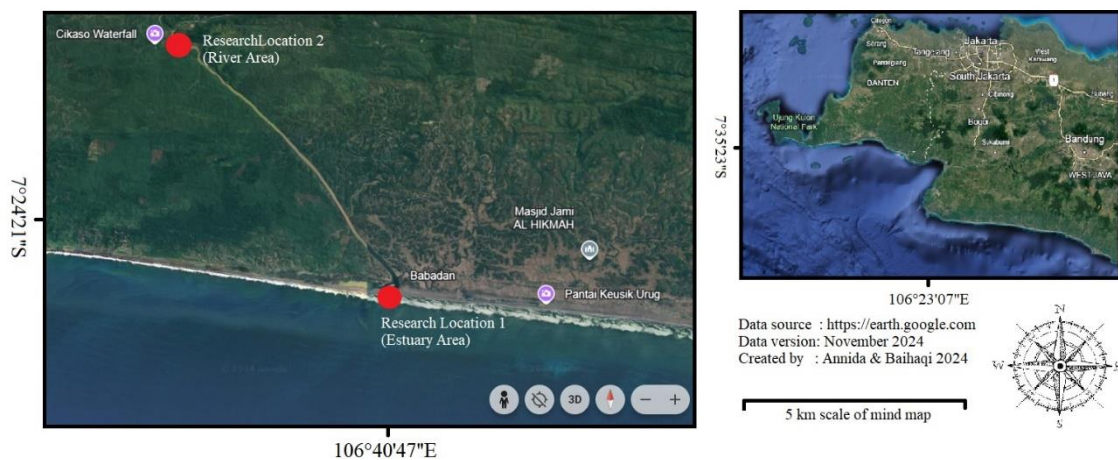


Figure 1. Research map

Glass eels are caught at night during the 3-4 hours high tide. In catching glass eels, fishermen generally use headlamps as a light source, which can also

attract glass eels to gather in the catchable area (Baihaqi & Annida, 2024). Each glass eel successfully caught was then preserved by immersion in a 10% formalin solution, rinsed with running water, and fixed in an 80% ethanol solution (Amaliah et al., 2023; Simanjuntak et al., 2021). All glass eel samples were then identified by species based on the ratio of the ano-dorsal length to the total length. This identification refers to (Hakim et al., 2015).

Afterward, each glass eel sample identified as the *A. bicolor bicolor* species was separated as the object of this study. The total length data of the *A. bicolor bicolor* glass eels were recorded and differentiated based on the location of their capture, namely in the estuary and Cikaso River areas. The total length data of the *A. bicolor bicolor* glass eels were then presented in a length size distribution graph. The length size distribution of glass eels caught in the Cikaso River and estuary areas were combined in one graph for later comparison.

RESEARCH RESULT

Catch composition of the glass eels

Three species of glass eels were successfully caught from the estuary and Cikaso River. The three species are *Anguilla bicolor bicolor*, *A. nebulosa*, and *A. marmorata*. In both areas, glass eels of the *A. bicolor bicolor* species dominate, with a composition above 97% (Figure 2).

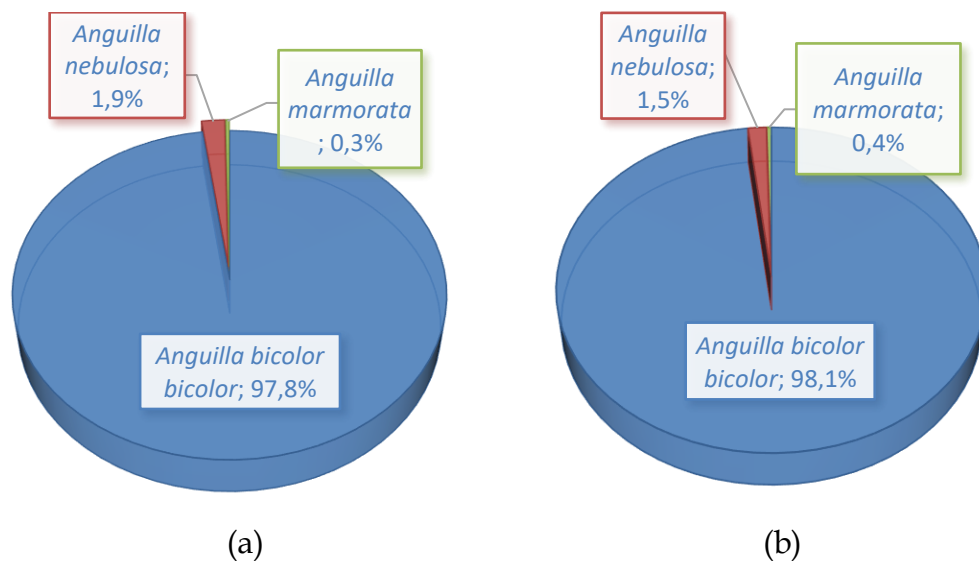


Figure 2. Composition of glass eels caught from the estuary (a) and river (b) Cikaso, Sukabumi, Indonesia

Length-size comparison of glass eels

The length of glass eels caught in the estuary and Cikaso River areas was compared for the *A. bicolor bicolor* species. The analysis results showed that there was a difference in the average length of the catch of glass eels *A. bicolor bicolor* from the estuary and river areas. Glass eels *A. bicolor bicolor* caught in the river area were longer than those caught in the estuary area. The average length of glass eels caught in the river area was 98.0 mm, while those caught in the estuary area were 91.2 mm (Figure 3).

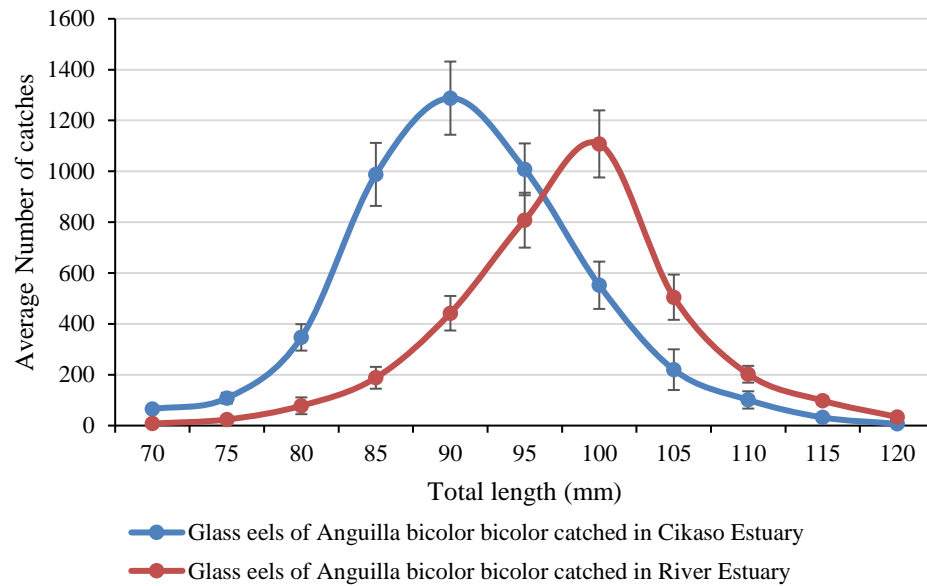


Figure 3. Distribution of total length size of glass eel *A. bicolor bicolor* caught in the estuary and Cikaso River, Sukabumi, Indonesia

DISCUSSION

A. bicolor bicolor is an eel species with a reasonably wide distribution around the Indo-Pacific region (Norarfan et al., 2021). In Indonesia, this species is widely known and is found along the west coast of Sumatra, the south coast of Java, Bali, NTB, NTT, and the east coast of Kalimantan, Sulawesi waters, Maluku to Papua (IFRDMD, 2020).

Glass eels of *A. bicolor bicolor* had the highest composition in this study, both from fishing operations in the estuary and the Cikaso River areas. In previous studies, it has also been widely revealed that Glass eels from *A. bicolor bicolor* are indeed the most commonly found species in the southern waters of Sukabumi, including Cikaso (Annida et al., 2021, 2022; Wahju et al., 2021).

As one of the catadromous fish, *A. bicolor bicolor* at the glass eels stage homed or migrated back from sea waters to freshwater areas through estuaries and river flows (Zydlewski & Wilkie, 2012). During this process, glass eels certainly encountered various obstacles such as predation, adjustment of body osmoregulation, starvation due to not finding food, and running out of energy to move against the river current (Ciccotti et al., 1995; Edeline et al., 2005; Elie & Rochard, 1994; Gascuel, 1986; Jellyman & Lambert, 2003; Laffaille et al., 2007; White & Knights, 1997). These conditions cause a high natural selection factor. In addition, the intensity of glass eel fishing carried out by fishermen is another factor that also increases its mortality value (Triyanto et al., 2020).

Glass eels that have successfully entered river waters will begin to adapt well to their new environment (Nzau Matondo et al., 2021). Some researchers even stated that the growth of glass eels would be rapid when entering freshwater areas (Aquino et al., 2021; Colombier et al., 2007; Edeline et al., 2005). Their growth becomes even faster when they find a freshwater environment with sufficient food availability. When in sea waters until passing through the transition area in the estuary, glass eels have lost enough energy to move against

the current and adjust their osmoregulation system. This is what causes their growth conditions to be very slow. However, their growth rate will increase after successfully recruiting to freshwater areas and home to a suitable river ecosystem (Alvarez-Mora et al., 2024; Colombier et al., 2007; Liu, 2021).

The conditions mentioned above strengthen the results of our research. Glass eels caught in the estuary area have a lower average length than glass eels caught in the river area. Natural selection and growth factors are two things that are very likely to happen to them during the recruitment process.

CONCLUSIONS AND RECOMMENDATIONS

There is a difference in the average length of glass eels, *A. bicolor bicolor*, caught in the estuary and Cikaso River areas, Sukabumi, Indonesia. The study results suggest that glass eels *A. bicolor bicolor* caught in the river area are longer than those caught from the estuary area. This condition indicates that growth factors and natural selection occur in glass eels *A. bicolor bicolor* during recruitment to the Cikaso River area.

The growth factor of glass eels is favorable; however, the natural selection factor needs to be considered. Selection may occur naturally; however, it is indisputable that it can occur due to the decline in aquatic habitat conditions in the Cikaso River, also caused by anthropogenic activities. For this reason, eel fisheries management needs to be carried out based on an integrated river ecosystem management approach.

ADVANCED RESEARCH

Research supporting this finding can be done by approaching the age of glass eels that have just entered the estuary area and those that have passed through the river area with an otolith approach. Through this research, the time needed by glass eels in the recruitment process to find a suitable habitat for them in the river waters can be more wholly known.

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