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Temporal Catch Composition and Length-Weight Relationship of Glass eel (*anguilla sp*.) Caught in Konaweha River Southeast Sulawesi Indonesia

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Abstract: *This study aims to identify the type of glass eel in the Konaweha River estuary, determine the number of glass eel catches in the dark and bright moon phases, determine the growth pattern and condition factors of the glass eel in the Konaweha River estuary, Konawe Regency, Southeast Sulawesi. The research was carried out in July 2020-July 2021. The collection of glass eel data was carried out through catching using a modified bagged net fishing gear to catch glass eel. The results of identification and calculation of morphological characters found 2 types of glass eel, namely Anguilla bicolor pacifica (58.88%) and Anguilla marmorata (41.12%). The catch in the dark month (90.82%) was higher than the light month (9.18%). The growth of glass eel was negative allometric (0.4586-2.6120) and condition factor value (0.580-2.057).*

Keywords: *Glass eel, Long weight relationship, Growth Pattern, Konaweha River, Dark light catch*

INTRODUCTION

The family Anguillidae or eels (eels) has one genus, namely Anguilla, where 19 species have been identified and are valid species in the world (Watanabe *et al*., 2009; Sugeha, 2010; Budiharjo, 2018). The genus Anguilla has a tubular (anguilliform) body shape (Tesch, 2003; Miller and Tsukamoto, 2004).

Eel (*Anguilla spp*) is a fish that inhabits the earth with a very wide distribution, namely in the tropics and sub-tropics, is a type of fish that lives in two habitats, namely inland waters (brackish and fresh) and marine waters and from 19 species that exist. in the world, it is known that 9 of them are spread in the waters of the Pacific Ocean and the Indonesian Ocean

(Tesch, 2003; Watanabe *et al*, 2009; Fahmi, 2013; Hakim et al, 2015). The distribution area of glass eel starts from the west coast of Sumatra, the south coast of Java, the east coast of the island of Kalimantan, the coast of Sulawesi, the Maluku islands, Bali, NTT, NTB to the North Coast of Papua (Fahmi 2013). Southeast Sulawesi is included in one of the eel distribution areas, especially in large rivers such as the Lasolo-Lalindu River and the Konaweha River (Pangerang, 2018).

Eels migrate catadromously (Arai *et al*, 2020; Arai and Taha, 2021; Arai, 2022; Higuci *et al*, 2021; Kasai *et al*, 2021; Marini *et al*, 2021; Noda *et al*, 2020; Vaughan *et al*, 2021; Wichelen, 2021). At the juvenile stage, when they are rounded, they are known as glass eels, which migrate anadromously. The process of migration from the sea into river mouths follows the tides and waves and generally enters the river when the moon is dark.

At the juvenile stage, eels like to live among the roots of aquatic plants, in the root gaps of plants on the banks of rivers, including between the roots of mangroves (in estuaries). At the adult stage, eels live alone (solitary) in rock crevices on the banks of rivers. In river waters, eels occupy areas ranging from river mouths (estuaries) to springs in the upper reaches of the river. Small young eels like shallow waters, while large adult eels like deep river parts (Fekri, 2019).

The Konaweha River, located in Konawe Regency, is one of the centers for adult eel (silver eel) fishing in Southeast Sulawesi. Eel fishing usually uses fishing traps, electric fishing gear and handlines that are operated in rivers, lakes or swamps (Pangerang *et al.*, 2018). The common eels found in the river waters of Southeast Sulawesi are Anguilla marmorata and Anguilla bicolor pacifica (Fahmi 2013; Fahmi, 2015; Pangerang *et al*., 2018).

Fishermen catching eel in the Konaweha River are scattered almost along the watershed, however, their target is yellow eel and silver eel. There have been no reports of catching glass eels. In general, adult eels are caught in the Konaweha River using traps or electric fishing gear.

Data and information about eels and glass eels in rivers in Southeast Sulawesi are still limited, therefore it is necessary to conduct research on eels and glass eels to enrich and provide a lot of information about eels and glass eels in Southeast Sulawesi.

The purpose of this research isidentify the type of glass eel in the Konaweha river estuary, determine the number of glass eel catches in the dark and bright moon phases, determine growth patterns and condition factors of glass eel at the Konaweha River estuary.

MATERIALS AND METHODS

Design of study location and Time

The Konaweha River Estuary (3o51'52.79"S 122o30'11.45"E) is administratively located in the area of Sampara estuary Village and Lalimbue Village, Kapoiala District, Konawe Regency, Southeast Sulawesi Province. The Konaweha River or the Sampara River extends from the upper reaches of the Gunung Bulu Brama area, Uluiwoi District, East Kolaka Regency across 3 (three) regencies, namely East Kolaka Regency, South Konawe Regency and Konawe Regency. The Konaweha River is also one of the longest and largest rivers on Sulawesi Island with a length of 341km, where in the middle of this river flow there is a codeta that connects the Rawa Aopa Watumohai National Park.

The substrate at the Konaweha River estuary is sandy mud, where in some locations there are quite dense mangrove plants and also villages on the left and right sides of the river. The study was conducted for thirteen months (July 2020-July 2021).

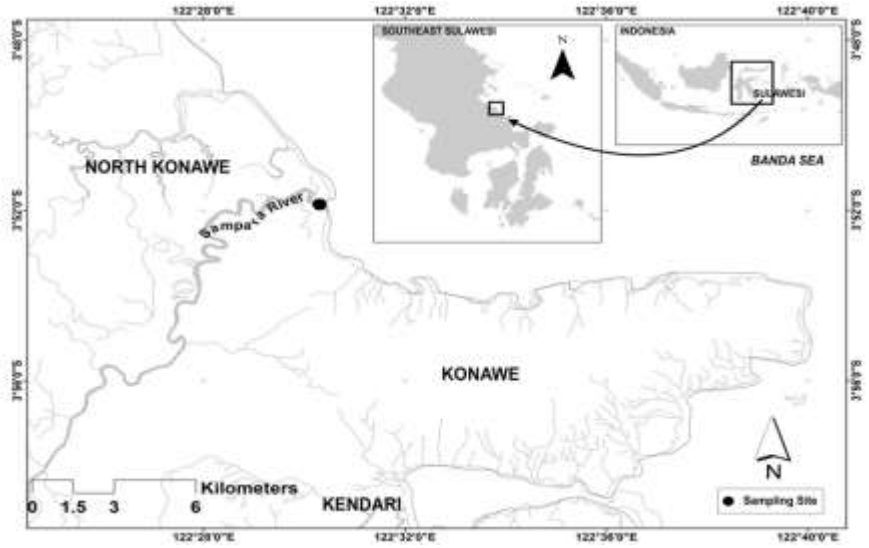

Figure 1. Research Location Map

Data Collection

Catching glass eels at the mouth of the Konaweha River is done by using a net installed on the left side of the river to block the direction of the tide. The net is specially modified to catch glass eels, rectangular in shape at the mouth with wings on either side of the front. The wingspan is 4 meters on each side. The opening of the mouth of the net is 1m2. The net is made of nylon with a diameter of 1mm and is green. On the upper rope of the mouth of the net, several buoys were attached to the wings so that they remained a float when operated, as well as at the bottom, and several weights were attached to the lower wing ropes, so that the wings remained at the bottom of the water. On the front of the bag, there is a 3 meter long base from left to right. In the pocket, there is a green net 3 meters long in the shape of a cylinder and at the

end there is a 1 meter long plastic material. This plastic material can hold water and serves to keep the caught glass eel alive. In order to keep the net position open, several poles are installed as supports. The nets are operated at night with 2 (two) arrests, namely at 22.00-24.00 and at 24.00-03.00 when the moon is dark and the moon is bright.

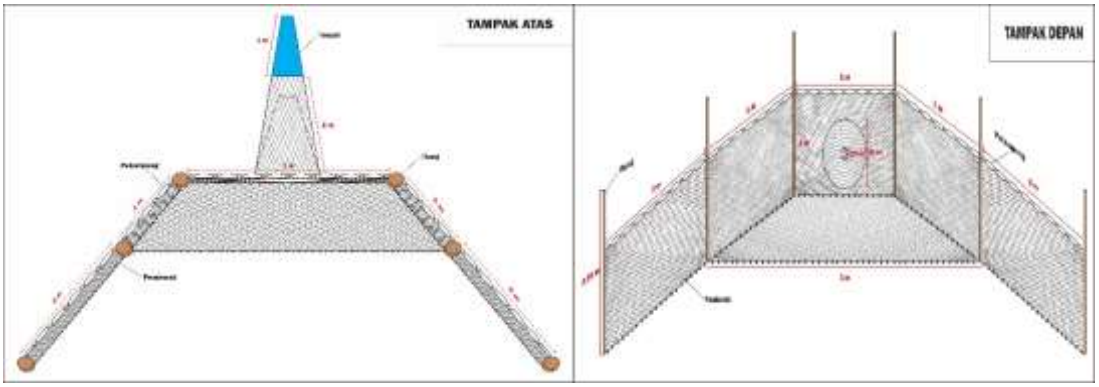

Figure 2. Fishing gear 'marmora' (Modified)

Each type of eel caught was identified based on the morphometric character of the comparison value of ano-dorsal length (ADL) and total length (TL) AD/TL (%) (Tebeta *et al.* 1976; Hakim *et al.* 2015) and based on their morphological characters (Tebeta *et al*. 1976; Hakim *et al.* 2015) and based on their morphological characters (Weber and Beufort 1929; Kottelat *et al.* 1993). Illustration of glass eel morphometric measurement in determining AD/TL (%) is presented in Figure 2.

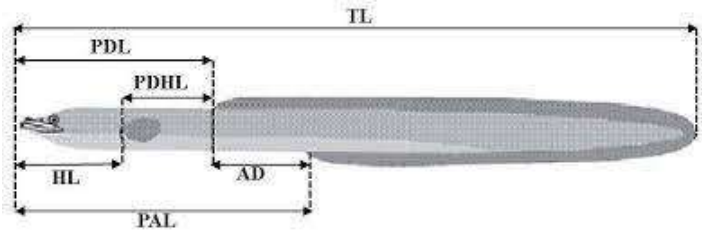

Figure 3. Eel morphometric measurements, information: total length (TL), head length (HL), pre-dorsal head length (PDHL), pre-anal length (PAL), pre-dorsal length (PDL), and ano-dorsal length (AD) (Tabeta et al. 1976; Hakim *et al.* 2015).

Data Analysis

Analysis of the relationship between length and weight and condition factors

The length-weight relationship is described in two forms, namely isometric and allometric (Sparre and Venema 1999), with the equation:

$W = aLb$

Information:

W: individual weight of glass eel in grams;

L : total length*glass eel*in mm;

a : intercept (intersection of the long-term relationship curve weight with y-axis);

b : Long-term growth pattern estimator heavy

The condition factor was analyzed to determine the quality of the glass eel based on the comparison between the actual weight and the estimated weight. The condition factor represents the curvaceous body of the fish. Condition factor analysis was determined based on the formulation of Le Cren (1951) and Zahid and Simanjuntak (2009), which are as follows:

□=/Ŵ

Information:

Kn: condition factor

W: actual glass eel weight (g)

: estimated glass eel weight (W = aLb)

RESULTS

Temporal catch composition

*Glass eel*caught during the study consisted of two species, namely A. bicolor pacifica totaling 295 individuals and A. marmorata 206 individuals. 501 individuals were measured for length and weight and partially preserved for identification and morphometric analysis.

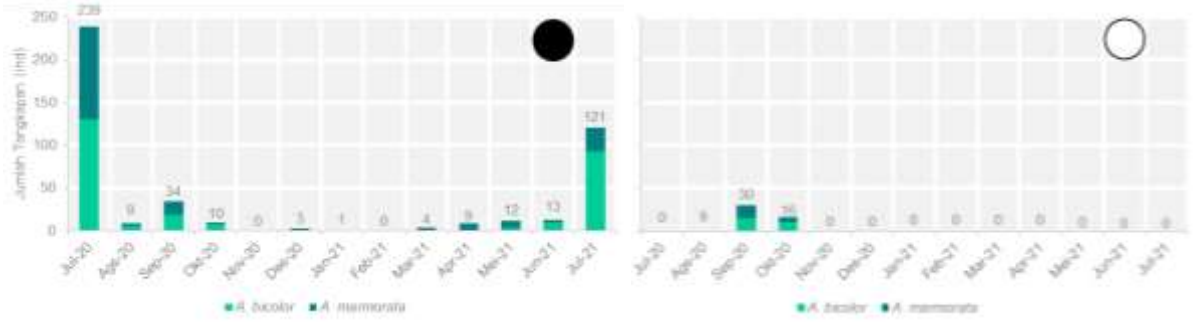

Figure 4. Composition of catch of glass eel: (●) dark moon; (○) bright moon

a

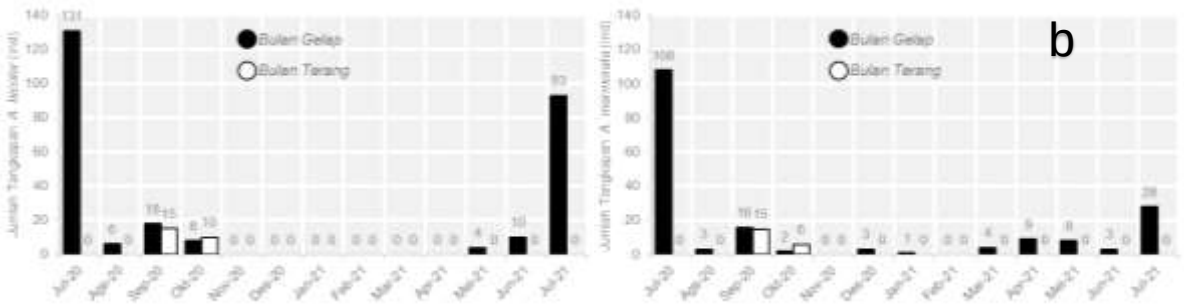

Figure 5. Composition of captured dark moon and light moon phases:
(a)*A. bicolor pacific*; (b)*A. marmorata*

Length-weight relationship

The length-weight relationship of the glass eel during the study is presented in Table 1.

Table 1. Length-weight relationship of glass eel

Type	N	A	b	Information
A bicolor pacific				
- dark moon	270	0.0273	1.2631	Negative allometric
- bright moon	25	0.0043	2.6120	Negative allometric
A marmorata				
- dark moon	185	0.0982	0.4586	Negative allometric
- bright moon	21	0.0445	0.9836	Negative allometric

DISCUSSION

The types of glass eels found during the study were A. bicolor pacifica and A. marmorata. This shows that the Konaweha River estuary is an area for the distribution of the eel species.Fahmi (2013)stated that the type of eel A. mamorata has a wide distributionin Indonesian waters. Furthermore, Pangerang (2018) showed that the species A. mamorata was the dominant eel in the waters of the Lasolo River and Lalindu River, Southeast Sulawesi. The size of the glass eel caught at the study site ranged from 3.50 to 5.6 cm. The variation in the size of the glass eel migrating into the river mouth is influenced by the distance of the spawning ground and the age of the glass eel (Sugeha *et al* 2001; Budiharjo, 2009).

Table 2. Comparison of the total length of glass eels found in several rivers

Region	n	Species	TL range(cm)	Source
hammer river	155	A. marmorata	4.1– 4.9	Ndobe, 2010
Cagayan river	187	A celebesensis	4.54 – 4.69	Shinoda et al, 2015
	1426	A Luzonensis	4.31 – 5.01	
Cimandiri river	23	A marmorata	4.56-5.33	Hakim et al, 2015
	76	A bicolor bicolor	4.58-5.88	
	1301	*Anguilla*spp	5.42*	Triyanto et al, 2020
Viti Levu Island	35	A marmorata	4.13 – 5.63	Hewavitharane et al, 2017
Poigar River	613	A marmorata	4.15 – 5.58	Sugeha et al, 2001
	12	A. bicolor pacific	4.43 – 5.30	
	2844	A celebesensis	4.00 – 5.50	
Konaweha river	295	*A bicoor pacific*	3.50 – 4.50.	This study
	206	*A marmorata*	3.90 – 5.60	

Notes + *) Average

Identification of glass eel species based on AD/TL characters (%) refers to Reveillac et al. (2009), AD/TL characters (%) of A. bicolor pacifica ranged from 0-3%, A. marmorata ranged from 14-17%. Morphologically this reference can provide information quickly in identifying the type of glass eel. Some results of morphometric studies of glass eel species A marmorata and A bicolor pacifica. The type A marmorata is cosmopolitan with a wide distribution and the waters of Sulawesi Island are the distribution areas of A bicolor pacifica (Fahmi, 2013; Sugaha et al, 2001). Comparison of AD/TL values (%) of glass eel at several research sites is presented in Table 3.

Table 3. Comparison of AD/TL values (%) of glass eel in several research sites

Region	n	Species	AD/TL (%)	Source
Cimandiri River	1301	A marmorata	13.73 – 20.75	Triyanto et al, 2020
	23	A marmorata	15.07 ± 1.04	Hakim et al, 2015
Viti Levu Island	35	A marmorata	16.0±0.9	Hewavitharane et al, 2017
Poigar River	613	A marmorata	15.10±1.60	Sugeha et al, 2001
	12	A bicolor pacific	0.0±0.56	

Konaweha River	295	A. bicolor pacific	0.20 ±1.09	This study
	206	A marmorata	15.85±1.66	

Table 4. Comparison of growth patterns of (b) glass eel in several research locations

Region	N	Species	b	Remark	Source
Cimandiri River	1301	*Anguilla*spp.	0.557 - 2.607	Allometric negative	Triyanto et al, 2020
Halmahera	28	A marmorata	1,187	Allometric negative	Ahmad, 2016
Konaweha River	295	A bicolor pacific	1.2631 - 2.612	Allometric negative	This study
	206	A. marmorata	0.4586 - 0.9836	Allometric negative	

Variations in glass eel abundance are related to the recruitment process of glass eels that enter estuary waters after passing through the ocean phase. Tropical eels carry out the downstream migration process to reproduce every month. There is a certain period when downstream migration takes place in large populations of adult eels as indicated by the abundance of glass eels entering estuary waters. In addition to these factors, environmental factors also affect the recruitment process of glass eels entering fresh waters. The results of several studies explain that the recruitment of glass eels into fresh waters is influenced by temperature, salinity, turbidity, river currents, tidal and tidal cycles, moon phases and tends to be phototaxis negatively (Tabeta and Mochioka, 2003; Bru *et al*, 2009).

The catch during the study showed a comparison of catch t in the dark moon (90.82%) and bright moon (9.18%) periods. The peak of glass eel migration at the mouth of the Konaweha River occurs in May-July. This is in accordance with the opinion of Budiharjo (2009) that the peak of annual migration occurs after the previous 3-5 months of high rainfall and low river flow velocity. Daily migration takes place at the end of the lunar month at night when the light intensity is 0 lux.

The relationship between growth patterns and condition factors (fish body fatness) is closely related to the availability of food and environmental conditions. The abundance and types of fish vary each month. The results of the glass eel growth analysis showed a negative allometric growth pattern (0.4586-2.6120). Condition factor (Kn) which represents the plumpness of the glass eel body at a certain time when the glass eel enters the estuary of the Konaweha River. Condition factor values during the study ranged from 0.580 to 2.057. Differences in the value of growth pattern (b) and factor of condition of glass eel between locations and between time are caused by differences in the number and variation of sample size, differences in stock within the same species, growth phase, geographical location, environmental conditions, and food availability (Triyanto *et al*, 2010). 2020; Pangerang *et al*, 2018; Ahmad, 2016; Budiharjo et al, 2009; Sugeha et al, 2001). The relationship between the average value of the growth pattern (b) and the condition of the glass

eel in the Konaweha River Estuary (July 2020 to July 2021) is presented in Figure 6.

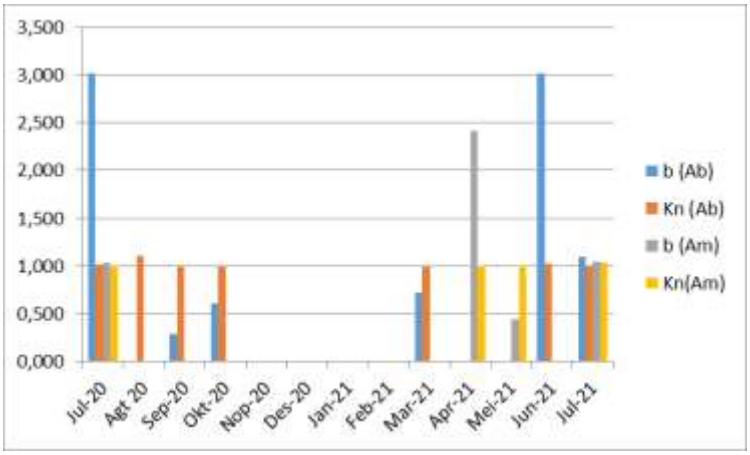

Figure 6. The average value of the growth pattern (b) with condition factor (Kn) glass eel: Ab (A.*bicolor*); Am (A.*marmorata*)

CONCLUSIONS

The catch during the study consisted of 2 (two) species, namely Anguilla Bicolor pacifica (58.88%) and *Anguilla marmorata* (41.12%). The size of the caught glass eel varies between 3.5-56 cm. The monthly catch shows that the catch in the dark moon phase is higher than the light moon phase. The peak of glass eel migration occurs in May-July. The growth pattern of glass eel in the Konaweha River estuary is negative allometric with varying condition factor values.

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