Corrigendum

Corrigendum: Morphometric distribution of Java eel *Anguilla* sp. caught from different estuaries of Central Java (2020 *IOP Conf. Ser.: Earth Environ. Sci.* 750 012042)

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1. References in the text were written not in the numbered format.
2. Title of Table 1.
Written: Marshes of Buton
Should be: Marshes of Bunton
3. Page 4; last paragraph
Written: Buton Marshes
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4. Title of Table 2.
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Should be: Marshes of Bunton
5. Page 5 after table 2.
Written: Watabe et al (2004)
Should be: Watanabe et al [18]
6. Page 5 after table 2.
Written: Buton (SIBT)
Should be: Bunton (SIBt)
7. Conclusion part
Written:
Bendung Gerak Dam
Should be:
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8. Additional Reference no. [8]
Leander NJ, Shen K-N, Chen R-T, Tzeng W-N. 2012. Species Composition and Seasonal Occurrence of Recruiting Glass Eels (Anguilla spp.) in the Hsiukuluan River, Eastern Taiwan. Zoological Studies 51(1): 59-71.

9. Additional Reference no. [12]
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10. Additional Reference no. [20]
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Morphometric Distribution of Java Eel *Anguilla* sp. Caught from Different Estuaries of Central Java

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**Abstract.** Morphometric analysis is one of the procedures that can be used for identifying organism species. Determination of the long and shortfin eel (*Anguilla* sp.) is usually based on the specific measurements of the dorsal and anal fin. This study aims to evaluate a variety of pre-dorsal (PD/TL %), pre-anal (PA/TL %), and ano-dorsal ratio (AD %) in the different eel size classes and variation of sizes among Central Java estuaries. Samples (148 eels) were taken from riverine, marshes, and impounding seawater of Central Java estuaries in July 2019. The results show that the widest ranges of PD/TL, PA/TL, and AD ratios (%) were 12.98 – 48.18 %, 19.03 – 50.78 %, and -6.56 to 32.88 %, respectively, which were found in Gatel riverine of Nusawungu. Those values overlap with the species of *Anguilla interioris*, *A. megastoma*, *A. nebulosa nebulosa*, *A. labiata*, *A. marmorata*, *A. bicolor bicolor*, and even *A. b. pacifica*. Percentage value in a certain ranges of A-D were dominated by 0 - 3.6 % (96.3 %) and 14.1 – 19.3 % (3.7 %). This can be concluded that during the months of July, the short-fin eel (known as *A. b. bicolor*) had been dominated to be caught from Southern Central Java Estuaries than a long-fin eel.

1. **Introduction**

The Indonesian water was believed as the origin of the eel in the world (Tsukamoto 1999) and was proven by Ao‡yama et al. (2001), wherein a dendrogram phylogeny of *Anguilla borneensis* known as the oldest eel in the world. Furthermore, Tsukamoto (2002) emphasized that a monophyletic origin of the genus *Anguilla* (98 % bootstrap replicates) showed *A. borneensis* to be the most likely as a basal species. Indonesian eel diversity to believe still has at least eight Species i.e. *A. marmorata*, *A. celebesensis*, *A. ancentralis*, *A. borneensis*, *A. bicolor bicolor*, *A. bicolor pacifica*, *A. interioris* and *A. n nebulosa* (Aoyama, 2009, Fahmi and Hirnawati, 2010, Fahmi et al. 2013). However, most of them had been categorized in the red list of IUCN as endangered species (Taufiq-Spj et al. 2017a). This condition needs to be taken into consideration in terms of regular biodiversity monitoring and their spatial distribution. Eel morphometric becomes the first identification of a species before continuing to mitochondrial DNA analysis. Studies on morphometric, especially in the position of the origin of the dorsal fin, body...
proportions, and caudal cutaneous pigmentation have been conducted by some researchers. Leander et al (2012) have identified morphological character the eel in Eastern Taiwan, and they found that *A. marmorata* was the most abundant eel species in the Hsiukuluan River, making up 98.4% of the total catch, *A. bicolor pacifica* (1.6%) and only a few of *A. japonica*. Morphometric studies on Indonesian eel genus *Anguilla* have also started by Sugeha and Arai (2010) which identified one species of *A. marmorata* from different recruitment areas of northern, western, and central Celebes Island. They found that morphologically, length size, and pigmentation development of *A marmorata* glass eels were different between recruitment areas. In the same year, Fahmi and Hirnawati, (2010) found three species, i.e., *A. b. bicolor, A. marmorata, and A. n. nebulosa*, from the Cimandiri river of West Java. In the wide spatial range of Indonesian waters, Fahmi et al. (2013) conducted morphological measurement of the tropical eel from riverine along the Indian Ocean, Pacific Ocean, around Arafura and Celebes seas. They categorized that *A. celebesensis, A. interioris, A. marmorata, A. nebulosa nebulosa, and A. borneensis* as have a long dorsal fin, while *A. bicolor bicolor and A. b. pacifica as have a short dorsal fin.*

The development of the eel population started to decrease since the shortage of eel in Asia, Europe, and America. For this reason, the Indonesian government had been enforced the regulation for some eel species for export purposes (Taufiq-Spj et al. 2017a). This regulation may concern with population conservation and to avoid unmanageable caught of tropical Indonesian eel. Concerning the eel resources in Central Java estuaries, there are some studies, i.e., concerns with feed diet of *A. b. bicolor* (glass eel) in Serayu river (Setijanto et al. 2014), gonadal development of *A. b. bicolor* in Segoro Anakan (Arai et al. 2016). Further study concern with the grey eel physiology (Fatimah et al 2017) and *A. bicolor* gonadal development (Rachmawati et al, 2017) caught from Cilacap estuaries as well as Java eel aquaculture (Taufiq-Spj et al. 2017a, 2017b, 2018, 2019, and 2020). In Central Java estuaries, the study on morphometric of the eel to identify the species variation as well as their recent population was less conducted. Hence, this study aims to evaluate a variety of ano-dorsal ratio (AD), pre-dorsal (PD), and pea-anal (PA) to total length ratios in the different eel size classes among Central Java estuaries.

### 2. Materials and Methods

Eels (148 samples) were caught from four riverine of Central Java – Indonesia during July 2019, i.e., eels from Pasir river at Puring Sidobunder - Kebumen (KB, 15 tails), Gatel river at Nusawungu - Cilacap (KG, 84 tails), marshes at Bunton Adipala – Cilacap (SIBt, 42 tails), and Segoro Anakan – Cilacap (SA, 7 tails) (Figure 1). The eels were bought from local fishermen and collectors. Morphometric measurement was conducted by using a caliper with a minimum scale (of 0.01 mm). Morphometric dispersion of the eel found from each location (i.e., KB, KG, SIBt, and SA), especially in measuring the proportion of pre-dorsal length to total length (PD/TL) and pea-anal length to total length ratio (PA/TL) as conducted by Watanabe et al (2004). While the ano-dorsal ratio (AD), refer to Fahmi and Hirnawati (2010) by measuring the length of dorsal fin (LD) and anal fin (LA) (Figure 2) with the formula used, i.e., A/D=((LD-LA)/LT)*100. In order to predict the species found from each location, we calculated the proportion of each eel's character from different areas compared to the study results conducted by Watanabe et al. (2004).
Figure 1. Sampling locations of the eel caught at riverine of Pasir creek at Kebumen (KB), Kali Gatel at Nusawungu (KG), marshes at Bunton Adipala (SIBt) and Segoro Anakan (SA) Cilacap – Central Java Indonesia.

Figure 2. Morphometric measurement conducted by Watanabe et al (2004), HL head length, PDH pre dorsal head, AD ano-dorsal, PD pre dorsal, TR length of trunk, PA pre anal, TL total length (above), and Fahmi and Hirnawati (2010) (below), where: LD length of dorsal fin, LA length of anal fin, LT total length.
3. Results and Discussion

a. Pre-dorsal and pre-anal distribution

External morphology and body proportion of eel found in riverine and estuaries of Kebumen (KB) and Cilacap (KG, SIBt and SA) during July 2019 varies in size conditions. The averages of total body length of the eels indicated that the certain ecological niche of a certain riverine have been occupied by a certain sizes of eel. As mention by Binder et al. (2011), the timing of migration typically occurs on a seasonal scale, though some species display coordinated daily movements (e.g., vertical or tidal migrations). Since the eel were caught during dry season (July), the riverine were not flooded by fresh water, hereafter not many new recruitment were found during this seasons.

### Table 1. Morphometric conditions of the eel i.e. total (body) length (TL), pre-dorsal (PD), pre dorsal ratio (PD/TL), pre-anal (PA) and pre anal ratio (PA/TL) found from Pasir creek of Puring Sidobunder Kebumen (KB), Kali Gatel Nusawungu (KG), Marshes of Buton, Adipala (SIBt), and Segoro Anakan, Kampung Laut (SA).

| No | Location | No of Sample | Sizes | TL (cm) | PD (cm) | PD/TL % | PA (cm) | PA/TL % |
|----|----------|--------------|-------|---------|---------|---------|---------|---------|
| 1  | KB       | 15           | Max   | 28.10   | 12.20   | 43.57   | 13.31   | 47.54   |
|    |          |              | Min   | 24.20   | 9.59    | 38.10   | 10.00   | 38.61   |
|    |          |              | Average | 26.07 | 10.65 | 40.81 | 11.19 | 42.89 |
| 2  | KG       | 84           | Max   | 29.20   | 12.80   | 48.18   | 12.30   | 50.78   |
|    |          |              | Min   | 11.30   | 1.96    | 12.94   | 2.15    | 19.03   |
|    |          |              | Average | 16.85 | 6.63 | 39.23 | 6.94 | 40.97 |
| 3  | SIBt     | 42           | Max   | 26.00   | 13.51   | 51.96   | 14.11   | 54.27   |
|    |          |              | Min   | 21.50   | 5.52    | 34.55   | 6.01    | 35.05   |
|    |          |              | Average | 19.18 | 7.61 | 39.60 | 8.00 | 41.59 |
| 4  | SA       | 7            | Max   | 76.00   | 39.50   | 51.97   | 41.20   | 54.21   |
|    |          |              | Min   | 40.00   | 16.50   | 41.25   | 17.00   | 42.38   |
|    |          |              | Average | 58.10 | 25.43 | 43.29 | 26.63 | 45.25 |

The average distribution of pre-dorsal to total length ratios (PD/TL) among locations varies between 39.23 to 43.29 %. The widest range of PD/TL belongs to Gatel riverine at Nusawungu (KG), i.e., between 12.94 to 48.18 % with a different range value of 35.24 %. While, the shortest one belongs to the Pasir creek of Kebumen (KB), i.e., 38.1 to 43.57 with the range value of 5.47 % (Table 1). Fortunately, both riverine of Gatel at Nusawungu and Pasir at Kebumen have similar downstream rivers of Bodo River and the river mouth at Logending beach (See Figure 1). This phenomenon of widest morphometrical distribution of the eel at Gatel riverine, riverine has connected to the motion weir of Serayu River (Taufiq-Spj et al. 2020). Hence, flushing the freshwater into this riverine will attract the eel to swim up to Gatel riverine for presumable food. Hereafter, there are much more eels samples in Gatel riverine (84 samples) compare to Pasir creek (15 samples) during July 2019 (Tabel 1). However, the pre-dorsal studies pointed to targeted species were not found unless co-related to pre-anal studies.

The widest range of pre-anal ratio values was also found in Nusawungu riverine (KG), i.e., 19.03 – 50.78 %, follows by Buton Marshes (SIBt, 35.05 – 54.27 %), then Segoro Anakan (SA, 42.38 – 54.21 %), and the shortest range was from Pasir creek at Kebumen (KB, 38.61 – 47.54).
These ranges of PA/TL have overlap to PA/TL of some species done by Watanabe et al. (2004). Where the PA/TL ratio of *A. marmorata* ranges between 32 – 48.4 %, *A. n. labiata* in 36.8 – 42.2 %, *A. megastoma* in between 37.0 – 46.0 %, *A. n. nebulosa* between 37.4 – 42.2 %, *A. interioris* between 38.1 – 45.8 %, *A. mosambica* in 39.4 – 46.9%, while *A. b. bicolor* has PA/TL in 39 – 45 % (Watanabe et al. 2004). Those five species were recognized as tropical and spread along the coastal area of the Indian Ocean. The question has been come up in the value of PA/TL below (<) 36.8 and above (>) 48.4 % have to belong to some other species or are they have morphological evolution of a particular species (Sherratt et al. 2018). Hereafter, continuous studies on the eel's molecular biology from Southern Java estuaries need to be conducted.

### b. Ano-dorsal ratio

**Table 2.** Morphometric conditions of the eel, i.e., dorsal fin length (LD), anal fin length (LA), the difference of dorsal and anal fin (D-A), and ano-dorsal ratio (A/D %) found from Pasir creek of Puring Sidobunder Kebumen (KB), Kali Gatel Nusawungu (KG), Marshes of Buton, Adipala (SIBt), and Segoro Anakan, Kampung Laut (SA).

| No | Location | No of Sample | Sizes | LD (cm) | LA (cm) | D-A (cm) | A/D% |
|----|----------|--------------|-------|---------|---------|----------|------|
| 1  | KB       | 15           | Max   | 16.90   | 16.60   | 1.20     | 4.59 |
|    |          |              | Min   | 14.48   | 13.37   | -0.51    | -1.97|
|    |          |              | Average | 15.42 | 14.89 | 0.53 | 2.08 |
| 2  | KG       | 84           | Max   | 17.60   | 16.90   | 5.59     | 32.88|
|    |          |              | Min   | 6.78    | 7.21    | -1.05    | -6.56|
|    |          |              | Average | 10.21 | 9.91 | 0.30 | 1.74 |
| 3  | SIBt     | 42           | Max   | 14.59   | 13.99   | 1.51     | 7.78 |
|    |          |              | Min   | 4.06    | 3.94    | 0.48     | -2.61|
|    |          |              | Average | 11.57 | 11.18 | 0.39 | 1.99 |
| 4  | SA       | 7            | Max   | 39.80   | 38.50   | 1.70     | 2.91 |
|    |          |              | Min   | 23.50   | 23.00   | 0.30     | 0.71 |
|    |          |              | Average | 32.67 | 31.47 | 1.20 | 1.97 |

Similar to the pre-dorsal and pre-anal ratios, the widest range ano-dorsal ratio found in the Gatel of Nusawungu riverine were -6.56 to 32.88 % (Table 2). The A/D value overlap with the A/D value from Watabe et al (2004), seems to be similar to the PA/TL overlap, which can be matched to the seven species above. However, the eel from Nusawungu (KG) with negative A/D value (-6.56 %) and from Buton (SIBt) with minimum AD value found was -2.61 % (Table 2). This has been curiously predicted as *Angilla bicolor pacifica*. These A/D values have match and overlap with to the data done by Watanabe et al (2004), where *A. b. pacifica* have AD dispersion range value between -5.8 to 3.4 %.

That phenomenon, presumably due to unpredictable Indonesian Through Flow (ITF), brings the *A. b. pacifica* leptocephali to the southern Java estuaries. Eventhough Fahmi (2015) believed that the current system has an important role in Anguillids distribution. However, Fahmi (2015) also stated that there are only four species sympatric in the western of Sumatra and south of Java, i.e., *A marmorata, A. interioris, A. n. nebulosa* and *A. b. bicolor*. For this reason, AD dispersion found in Nusawungu may do not belong to *A. b. pacifica*. In contrast, in other statements, Fahmi (2015) also found four sympatric species: i.e., *A. marmorata, A. interioris, A. celebesensi* and *A. b. pacifica* in Sulawesi waters.
Further calculations, in a certain calculation of A-D percentage ranges value were dominated by 0 - 3.6 % (96.3 %) and 14.1 – 19.3 % (3.7 %). This finding indicated that the short-fin eel (known as A. b. bicolor) had been dominated by the catch from Southern Central Java Estuaries than long-fin eel during July. Due to these complications of morphometric overlapping, hence further molecular analysis is certainly needed.

4. Conclusion
The widest ranges of PD/TL, PA/TL, and AD ratios (%), found in Gatel riverine of Nusawungu are 12.98 – 48.18 %, 19.03 – 50.78 %, and -6.56 to 32.88 %, respectively. Those values overlap with the species of Anguilla interioris, A. megastoma, A. nebulosa nebulosa, A. labiata, A. marmorata, A. bicolor bicolor, and even A. b. pacifica. The formation of anno-dorsal distribution of the eel genus Anguilla which was found in some estuaries of Central Java, tends to spread from a positive value of A/D 32.9 to a negative value of 6.6 %. The AD value ranging between 0 – 5 % is known as the shortfin eel, i.e., Anguilla bicolor bicolor. The longfin eel category has an AD value of more than 5 %, i.e., A. marmorata and A. n. nebulosi, etc. The negative values of AD found in three estuaries remain unknown or lack identifications. The most varied distribution of AD found in Kali Gatel of Nusawungu Cilacap may be correlated to the canal irrigation from the Bendung Gerak Dam of the Serayu River. In a certain calculation of A-D percentage, the range values were dominated by 0 - 3.6 % found in 96.3 %, while in the ranges between 14.1 – 19.3 % were only 3.7 %. This can be concluded that during the months of July, the short-fin eel (known as A. b. bicolor) becomes the dominant catch from Southern Central Java Estuaries than the long-fin eel. The SA samples were found mostly in consumption sizes, and the number was very small (7 tails), hence the species known as A. b. bicolor. These external characteristics of Anguillid species may be used as a base morphometric pattern of the eel found from Central Java estuaries.

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