Analysis of fluctuating asymmetry of black strain tilapia *Oreochromis niloticus* and red strain tilapia *Oreochromis niloticus* in Kabat Fish Hatchery Center Banyuwangi, East Java

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**Abstract.** Fluctuating asymmetry of bilateral meristic traits is one of the simple methods to calculate phenotype variation and discover the stability of fish development. The aims of this research are analyzing quantitative information about the level of asymmetry of Black Nile Tilapia and Red Nile Tilapia in Kabat Banyuwangi Fish Hatchery Center (BBI) as reference breeding program at Kabat Banyuwangi Fish Hatchery Center. The length of Black Nile Tilapia and Red Nile Tilapia was 50 – 150 gram with 100 samples of fish for each strain so the total is 200 samples of fish. Bilateral meristic traits that have been observed was the number of soft pectoral fins, the number of soft ventral fins, the number of scales on the lateral line, and the first-gill filter of Nile Tilapia. The results show that the highest value of the fluctuating asymmetry of number (FAn) and the fluctuating asymmetry of magnitude (FAm) are 0.65 and 1.38 for Black Nile Tilapia and 0.6 and 1.04 for Red Nile Tilapia. However, the lowest value of FAn and FAm are in soft ventral fins which are 0.22 and 0.22 for Black Nile Tilapia and 0.37 and 0.37 for Red Nile Tilapia.

1. **Introduction**

One of the commodities that are superior to aquaculture is Nile Tilapia [1]. Nile tilapia (*Oreochromis niloticus*) is one of various fish that have high economical values and include the important part of trading for freshwater fish in Indonesia or abroad. One of the factors that support the success and continuity of Nile Tilapia aquaculture production is the quality of seed. Kabat Fish Hatchery Center (BBI) is one of the producers Nile Tilapia seeds in Banyuwangi district that provide it to the culture of Nile Tilapia. At first, Nile Tilapia has advantages in the rate of growth speed, degree of survival (survival rate), number of eggs and maximum size that can be achieved. With the result of that, Nile Tilapia has experienced and increased as one of the most consumption fish by society.

The developments of Nile Tilapia aquaculture followed with the decrease of Nile Tilapia quality seed, such as the low growth and degree of survival and also the abnormalities in fish. The quality of Nile Tilapia is decided by many factors such as genetic, environment and nutrition from the fish. In genetic factors, the decline of genetic is caused by inbreeding. Inbreeding cause decreased stability, low genetic variation, and increased homozygosity. The phenomenon of seed abnormalities occurs due to the high inbreeding that can be caused by the lack of several parents and companion marriage, resulting in low genetic variation [2]. Inbreeding depression is more often observed in the history of fish marriage.
compared to its morphology [3]. Several studies have shown that inbreeding depression can be demonstrated in the stability of morphological development [4].

The phenomenon of degree growth and survival occur because of the decrease of stability that also characterized by increasing asymmetry and abnormal individuals [5]. The phenomenon of low genetic quality occurs due to a decrease in the stability of individual development which is also characterized by an increase in asymmetric and abnormal individuals [6]. The stability of the development of paired organs in animals is closely related to the level of genetic diversity [7]. The fluctuation of asymmetry is a relatively simple method, but it shows the differences in developmental stability as well as electrophoresis techniques [8]. Presence of phenotypic differences in individuals for meristic and bilateral traits can indicate asymmetric fluctuations, namely the difference between the right and the left side characters that spread normally with an average near zero as a result of the individual’s inability to develop normally and proper [9].

Technic of fluctuating asymmetry methods is divided into two parts, FAn (Fluctuating Asymmetry number) and FAm (Fluctuating Asymmetry magnitude). The data analysis has been done after the writer gets the results of calculated data from symmetry bilateral characters. FAn (Fluctuating Asymmetry number) is the number of asymmetry individual is divided by several observed individuals. On the other hand, FAm (Fluctuating Asymmetry magnitude) is several character differences observed on the right and left side is divided by the total number of individuals observed [10].

The information of genetic variation for each population would be the root for a breeding program. The measurement of genetic variation is more easy and cheap by calculating couples of asymmetry organs. Even though it is simple, fluctuating asymmetry can show the difference in development stability. The asymmetry fluctuations in Nile Tilapia have been conducted to determine their genetic quality as a basis for information for Nile Tilapia breeding programs [11]. The purpose of this study is to analyse quantitative information about the level of asymmetry of Black Nile Tilapia and Red Nile Tilapia at Banyuwangi district Fish Hatchery Center (BBI).

2. Materials and methods
This research has been done at the technology of freshwater aquaculture laboratory (BBI) and PSDKU laboratory Airlangga University in Banyuwangi in February until April 2018. The results of the observation data are then analyzed descriptively and displayed in the form of pictures.

Use 200 samples which are 100 samples of black Nile tilapia and 100 samples of red Nile tilapia with length 50-150 gram. Those samples are randomly chosen. This study uses descriptive methods which were observed the development of an individual by percentages and fluctuating asymmetry, compared some bilateral meristic characters on the right and left side. Bilateral meristic that being observed are number of soft pectoral fins, number of soft ventral fins, number of scales on lateral line, and the first-gill filter of Nile Tilapia. Meristic characteristic was the first shape, easier and precisely calculated [12].

The results of the data are used to calculate the value of fluctuating asymmetry which is number or magnitude. Fluctuating Asymmetry number is the number of asymmetry individual is divided by some observed individual [10]. For example, FAn is 0.17 means if 100 samples were being observed so there are 17 asymmetry samples. On the other hand, Fluctuating Asymmetry magnitude is the differences between meristic characteristic right and the left side is divided by the total individuals that being observed. For example, FAm is 0.21 means if there were 100 samples than the differences between right and left side are 21. Here are the formulae A and B. to calculate Fluctuating Asymmetry [12]:

\[ F_{An} = \frac{\sum Z}{n} \]  \hspace{1cm} (A)

\[ F_{Am} = \frac{\sum (L-R)}{n} \]  \hspace{1cm} (B)

Keterangan:
- Fan : Fluctuating Asymmetry Number
- Fam : Fluctuating Asymmetry Magnitude
FAgb : Fluctuating Asymmetry overall
Z : The total individuals that being observed Asymmetry
L : The number of fish with the characteristic left side
R : The number of fish with the characteristic right side
N : The total individuals of the sample

There is Fluctuating Asymmetry overall is the result of calculated all bilateral symmetric characters of Fluctuating Asymmetry that has been observed. Value of Fluctuating Asymmetry overall is a value of the whole asymmetry from the whole bilateral meristic characters [13], the formula: FAgb = total Fan or FAgb = total FAm was used to calculate Fluctuating Asymmetry in tilapia fish.

3. Result and discussion
The results of analysis FAn and FAm for Black Nile Tilapia and Red Nile Tilapia are in figure 1 and 2. Based on both of pictures above, the highest value of Fluctuating Asymmetry is from gill filter. The value of FAn and FAm of Black Nile Tilapia are FAn is 0.65 and FAm is 1.38. Then, the value of FAn from scales on *linea lateralis* is 0.53 and 0.62 is FAm. For soft pectoral fins, FAn is 0.42 and FAm is 0.5. On the other hand, the lowest value of FAn and FAm are from soft ventral fins which is FAn is 0.22 and FAm is 0.22.

**Figure 1.** Fluctuating asymmetry number (FAn) value of Tilapia in BBI Kabat
Figure 2. Fluctuating asymmetry magnitude (FAm) value of Tilapia in BBI Kabat

Compared to Black Nile Tilapia, the value of FAn and FAm of Red Nile Tilapia are FAn = 0.60 and FAm = 1.04. The value of FAn from scales on *Linea lateralis* is 0.56 and FAm = 0.68. Then, soft pectoral fins FAn is 0.53 and FAm = 0.61. The soft ventral fins have the lowest parameters with FAn 0.37 and FAm 0.37. Based on this research, the highest results from FAn and FAm are gill filter. It might because from the diversity of gill filter’s functions. The functions of gill filter are osmoregulation, metabolism, respiration and excretion of useless material. Conversely, the function of a fin is to swim. So, it makes gill filter more aware of any changes in its process.

Fluctuating asymmetry of Humpback grouper also had the same results. Gill filter is the highest FAn = 0.48 and FAm = 0.63. The soft pectoral fins FAn = 0.33 and FAm = 0.42 and soft ventral fins FAn = 0.22 and FAm = 0.23 [14]. Same results also have on Nile Tilapia which is scales on *Linea lateralis* FAn = 0.78 and FAm = 0.24 is the highest compared to soft pectoral fins FAn = 0.74 and FAm = 1.98 and soft ventral fins FAn = 0.73 and FAm = 1.69 [15].

Based on this research the highest value of FAn and FAm is gill filter fins. It is the highest because some gill filter fins are a lot compared to the others. So, it makes the energy that used to be organogenesis for gill filter is not covered [16]. The highest value of gill filter can be influenced by genetic factors [14]. It is because the gill filter gets a little amount of priority energy for organogenesis processing compared to other bilateral meristic characters. When the organogenesis processing, there are parts inside fish that received enough energy portion, less energy portion and not received energy at all in the asymmetry part and it can be abnormal.

The value of FAn and FAm for Fluctuating Asymmetry overall of Black Nile Tilapia are 1.82 and 2.72. On the other hand, the value of FAn and FAm for Fluctuating Asymmetry overall of Rad Nile Tilapia are 2.06 and 2.7. The comparison shows that Black Nile Tilapia has a better score from every 100 samples; some asymmetry individual (FAn) is less than Red Nile Tilapia. However, if we are looking from fluctuating from each strain, Red Nile Tilapia has a better score because out of 100 samples, the difference from FAm is small.

The standard value of FAn is divided into three categories. First, low values is between 0 – 0.51. Second, the average value is between 0.51 – 1. Third, high value is > 1. The standard value of FAm also divided into three categories. First, low value is between 0 – 1. Second, average value is between range 1.1 – 2. Third, high value is > 2. Based on this result, value of FAn of Black Nile Tilapia includes as low average values. It is because FAn for soft pectoral fins and soft ventral fins are 0.42 and 0.22 (include as lowest categories). Then, FAn for gill filter and scales on LL are 0.65 and 0.53 include as an average value.

There is a linkage between FAn and FAm that if the value of FAn is high then the value of FAm can reach the highest value. This makes sense because if the higher number of asymmetry individual in the total sample, it can be assumed that the fluctuating also become higher. Nile Tilapia in P2MKP Dunia Air has FAn = 2.99 and FAm 7.83 [16]. Nile Tilapia GIFT Jatiluhur received FAn = 4.43 and FAm = 16.66 [11]. Based on that support, it can be said that there is linkages between the increased value of FAn and the high value that FAm received.

In general, the breeding process at Kabat Banyuwangi Hatchery Fish Canter (BBI) lack of intention in breeding Nile Tilapia. Besides, the manager did not have data on the genealogy of elders, origin, the number of pairs spawned and the frequency of spawning of each parent. Fish spawning from parents, the chance of retracement of inbreeding is huge [17]. The use of a limited number of a parent in each spawning can cause inbreeding [18]. To avoid inbreeding it would be better if minimum spawning with 50 pairs [11]. The deep cross pressure that is thought to be the main cause of an increase in the percentage of homozygous individuals is very likely. This can be seen from the way of spawning Black and Red Nile Tilapia in Hatchery Fish Center which is a spawning pond that was put together for generations. The decreasing number of parents allows spawning between relatives of individuals which can lead to homozygous tillers [19]. Hatchery activities must be carried out by good management which includes the provision of parent ponds and water quality must be adequate, feeding in both quantity and quality.
must be sufficient and strive to maintain and maintain its genetic diversity through appropriate selection [19].

4. Conclusion
Based on the research result: Back Nile Tilapia (Oreochromis niloticus) and Red Nile Tilapia (Oreochromis niloticus) at Kabat Banyuwangi Hatchery Fish Center the value of FAn is between 0.22 – 0.65 and FAm is 0.22 – 1.38 show fluctuating asymmetry in average categories. The bilateral symmetry characters that the highest value is gill filter, second is scales on LL, third is soft pectoral fins. Conversely, soft ventral fins was the lowest bilateral symmetry characters.

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