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Sexual Dimorphism Characteristics of the White Spot Fish, *Aplocheilus panchax* (Hamilton, 1822)

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Abstract: Sexual dimorphism characteristics of the white-spot fish, *Aplocheilus panchax* (Hamilton, 1822) was determined by using the analysis of morphometric and meristic characters, color pattern and gonad observation. Digimizer Analyzer Software was used to measure six morphometric and 21 meristic characters. The characters and Standard Length (SL) were subjected to Independent Sample T-test and Mann-Whitney Test to identify the significant differences between sexes of *A. panchax*. The findings indicate that SL and Truss 7 (anal fin length) of males*A. panchax* are significantly longer than females. The mean SL of males are 34.98±2.98 mm and8.61 mm±0.83 in Truss 7, while females have mean of 33.23 mm±2.55 in SL and 7.47 mm±0.86 in Truss 7. The male gonad (testes) is whitish and female gonad (ovary) is pale color with clearly seen ova in each sac ovary. Meanwhile, the males' body scales, dorsal, caudal and anal fins reflect a metallic bluish sheen under light which only subtle or absent in females. Black and yellow band border on dorsal fin are more obvious in males than females.

Key words: *Aplocheilus panchax* · Ornamental fish · Sex determination · Fish breeding · Morphometric, meristic

INTRODUCTION

Aplocheilus panchax(Hamilton, 1822) is a small fish from diverse group of killifish. It is easily identified by the white spot on top of its head make it well known as 'White-Spot' fish and locally as '*Ikan Kepala Timah'*. *A. panchax* is a native species in Malaysia and present abundantly in our local freshwater habitat. This species has a huge potential as ornamental fish due to its small size and striking color pattern [1]. Besides of its potential as an ornamental fish, *A. panchax* had also documented as an agent for biological control of mosquito larvae by Sen [2], Hora and Nair [3] and Chandra *et al*. [4]. Inspite of its enormous potential as an ornamnetal fish, the sexes of *A. panchax* is quite difficult to be distinguished. Parenti [5] stated that the males of *A. panchax* have fairly uniform body color of silver-blue with rows of red spots, unpaired fins with either red, yellow or bluish-white sub-borders within black edging. Meanwhile the females are plain with more rounded and almost colourless fins. The male shows brilliant metallic colors on the side of their body and head [6].

Sexual dimorphism is the differences in body size, shape, coloration or morphology that exhibits by male and female of the same species [7]. Most of the fish exhibit sexual dimorphism or secondary sexual characters by which sexes can be distinguished from each other. In some species, sexual characters are discernible throughout the life span whereas in some others they are discernible during breeding season. The secondary sexual characters serve several functions such as for recognition of opposite sex by members of a given area, external morphological differences between males and females pertain to the following features such as size of fish, length, shape or texture of fins, coloration, genital papillae, ovipositor and shape of head [8].

To fully utilize the potential of *A. panchax* as ornamental and model fish, it is very important to understand how to breed this species in captivity. And the first step towards a sustainable breeding program is to know how to differentiate the sex of the fishes. As for now, for Malaysian variation of *A. panchax*, limited information of sexual dimorphism is available. Thus, this present study is aiming to gather the information of sexual

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dimorphism of *A. panchax* from Terengganu, Malaysia by observing the morphometric and meristic characters, color patterns and gonad morphology.

MATERIALS AND METHODS

Fish Sampling: Fish samples were captured from paddy plots of University Sultan Zainal Abidin, Gong Badak (5°23'44.7"N 103°04'58.0"E). Sampling were done by using scoop net and the sample size were keep within an uniformity size range from 2.5 to 3.5 inch.

Morphometric and Meristic Measurement: Digital photograph of each fish sample (N=30) were taken using Olympus Stylus/μ 1040. Six morphometric variables of Total Length, TL; Standard Length, SL; Head Length, HL; Snout Length, SnL; Eye Diameter, ED; Body Depth, BD and 21 Truss Variables (meristic variables) as described by Strauss and Bookstein in 1982 were measured using Digimizer Analyzer Software to the nearest 0.01 millimeters, mm in two decimal points.

Body Coloration Observation: The fish samples were observed under Stereomicroscope LEICA/EZ4ID Model for coloration differentiation between sexes.

Gonad Examination: Each fish sample was dissected and the gonads were examined and observed under Stereomicroscope LEICA/EZ4ID Mode for sex determination.

Data Analysis: The mean (millimeter, mm) ± Standard Deviation (SD) of each morphometric and meristic data were computed to the nearest 0.01 mm in two decimal points. The morphometric and meristic data were transformed into common logarithms in order to increase linearity and multivariate normality [9]. Outliers were detected by regression analyses of these data against standard length [10]. This size dependent variation was removed using an allometric approach developed by Reist [11]. Data were transformed using the formulae

$$M_{trans} = \log M - \beta(\log SL - \log SL_{mean})$$

where

M_{trans} = Transformed measurement
M = Original measurement
β = Within–group slope regression of logM versus logSL
SL = Standard length of Fish
Sl_{mean} = Overall mean of the standard length

Transformed data were analyzed using Simple Linear Regression at significant-value of 0.05. Non-significant data were further analyzed using Independents Sample T-test as reported used by Matsumoto [12] at significant level, α of 0.05 to determine the significant different between sexes of *A. panchax* in term of meristic and morphometric data, while the significant data were excluded form the analysis. The Mann-Whitney Test of Non-Parametric Test at significant level, α of 0.05 was used to analyzed the significantcy of Standard Length [13] for sexual dimorphism of *A. panchax* as it was considered as outliers in the regression analysis.

RESULTS AND DISCUSSIONS

Morphometric and Meristic Characters: The transformed data of all morphometric and meristic characters except Truss 5, Truss 6, Truss 19 and Truss 21 shows no significant correlation in standard length (significant value > significant α-value of 0.05) which indicates the size dependent variations is removed. Only Standard Length, SL which significant-value < significant α-value of 0.05 (Mann-Whitney Test) and Truss 7 which significant *t* -value < significant α-value of 0.05 (Independent Sample T-test) are significantly different in sexual dimorphism of *A. panchax*. Male have longer length than female in both characters as represent in Figure 3.1 below.

Significant different in sexual dimorphism occur in standard length suggested that the different is mainly contributed by the sizes that males are longer than females. The different growth rate of males and females with differ annual growth characteristics from one age to another provides large extent of variation exist between genders of a same species. Male exhibits permanent increase in relative growth once they are matured and showing secondary sex characters especially that associated with mate selection, sexual selection and dominance of plays [14].

Male killifish poses elongate fin that indicates high degree of sexual selection and male secondary characters are speculates to be used by males in competition for mates during mating season[15]. Larger size of males than females *A. panchax* might related with females' preference for larger mates attributed to superior genes inherited by offspring [16] or due to increase sperm quality and/or quantity [17]. A study by Basolo [18] shows female response better to larger males as size difference between paired males is more significant.

Morphometric and meristic variation among sexes of *A. panchax* also exist due to male courtship behavior and female choice during mating season. This might happens

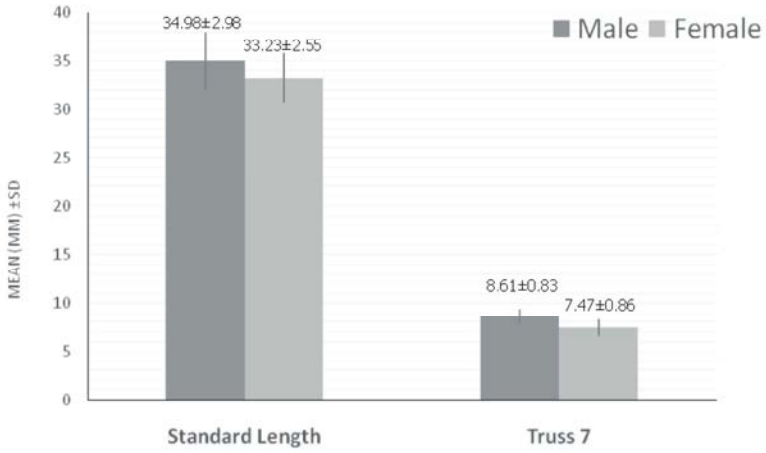

Fig. 1: Means of Standard Length and Truss 7 of males and females *Aplocheilus panchax*

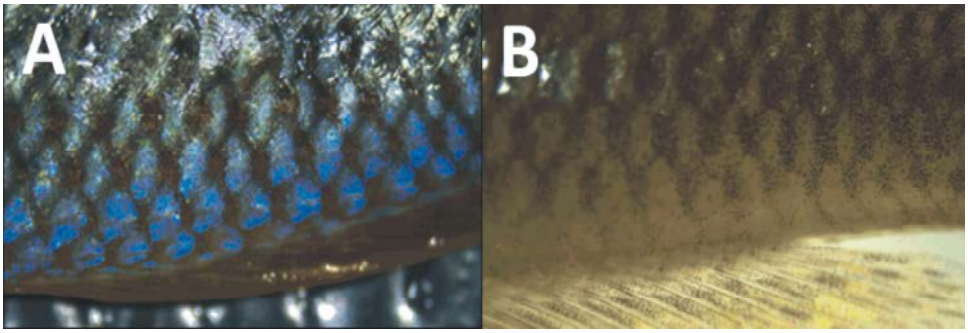

Fig. 2: The colour pattern comparison of the abdomen of male and female *Aplocheilus panchax* (A) Bluish sheen of male abdomen (B) Subtle bluish sheen of female abdomen.

as samples of *A. panchax* were randomly collected in a reared tank mix with males and females. The male-male interference competition explained by Natsumeda *et al*. [19] and Katano [20] as well as natural selection for females can influence the body size evolution in each sexes leading to sexual dimorphism. These reproductive roles in gaining individuals reproductive success differ between sexes. Males are towards maximization of mate acquisition in mating system whereas females are towards maximization of offspring production [21]. Though, mate acquisition and offspring production and growth shows dissimilar expenditure of time and energy. As a result, sexual differences found to be in various life story traits as wells as in ecological traits. Life story traits as such time and size of maturation, time and rate of growth, mortality rates and longevity, while ecological traits for examples are reproductive behavior and foraging. Additionally, females are more concern regarding female's size advantages for fecundity [22] promiscuity with random mating [23] and scramble competition among males.

Furthermore, significant different in sexual dimorphism occur in Truss 7 (anal fin length) is suggested that the different is due to the male secondary characteristics of *A. panchax*. Oordt [24] described that the anal fin of adult male in all viviparous Cyrinodontiformes has been transformed into an intromittent organ that called as gonopod which occur in the late stage of tubule formation in testes. Ogino *et al*. [25] also noted that the anal fin shows to be longer in males as they grow up to its sexual maturity stage.

Color Pattern: The scales of male's *A. panchax* reflect of bluish sheen which found to be subtle in female (Figure 2). The caudal fins of male also seen bluish in color with black and yellow band border at edges that is absent in female, while the dorsal fin of female shows lighter hint of black and yellow markings which is more obvious on male's dorsal fin. In the anal fin, the spots are faint orange color in both male and female but it somewhat more obvious in male which also reflect bluish sheen color under light.

Large differences in color pattern between sexes of *A. panchax* implied good indicator of sexual dimorphism of *A. panchax*. *Aplocheilus* species are considered as a unique species by Parenti [5] because males are more gorgeously pigmented than females and the males are in fact having more elaborate color pattern compare to females. Male's *A. panchax* has deep blue to black edge tail and have bluish abdomen [26] while females of *A. panchax* are similarly in color with males but they are lack blue border to the tail with tiny black dot at the extreme upper end of the caudal peduncle [27].

The scales of male *A. panchax* as describes by Scheel [28] show brilliant metallic colors on the side of its body. These metallic colors seen as bluish sheen and are very often the casts are concentrated into very small gleams on the body sides. Less obvious crossbars present in females which continuously fade away in the maturing males but remaining in females. A black dorsal spot is present in both sexes of *A. panchax* [28] but it is more obvious in males compare to females. Orange yellow pigmentation is present in the anal and caudal fins, while the ground color of anal fins are yellow in both sexes.

Gonad Examination: Male gonad of *A. panchax* composed of a pair of whitish color testes while female gonad comprised of a pale grey color ovary with clearly seen of ova (eggs) approximately about one millimeter in size. Male gonad of mature *Aplocheilus* species is look wholly white as noted by Aoyama [13] and composed by many lobules [29]. Nelson [30], Parenti& Grier [31] further classified the testis of *Aplocheilus*species as restricted lobular. The restricted lobular testis is which spermatogonia are restricted to the distal termini of lobules other than distributed along the lobule. The germinal cells are situated close to each other which similar population of cells found in each lobule [29]. The further research done by Grier&Parenti [32] indicates lobules of testes in *Aplocheilidae*branch that extent from efferent ducts to the periphery of the testes.

On the other hand, the female gonads in mature *Aplocheilidae* are pale in color. The female gonad composed of two sac-shape ovaries. These ovaries found to be extended along the female's body cavity of *A. panchax* in a dorsal position just above its [29]. In each single ovary, there were clearly seen ova (eggs) in unknown developmental stage [13].

CONCLUSION

Sexes of *A.panchax* can be differentiated using Standard Length, Truss 7 (anal fin length), color pattern and gonad examination. The males are longer in both standard length and Truss 7.The male gonad of *A. panchax* composed of a pair of whitish color testes while female gonad comprised of a pale grey color ovary with clearly seen of ova (eggs). The color pattern described how the males are differ compare to females in terms of their coloration of abdomen scales, caudal, dorsal and anal fin. Their scales, caudal fin and dorsal fins reflect bluish sheen which is more subtle in females. The yellow and black band border at the edges of the dorsal fin is more obvious seen in males than females.

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