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REPORT

Variation in Meristic Characters of four strains of Malaysian Freshwater Angelfish *Pterophyllum scalare* (L.)

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ABSTRACT The present study conducted between 2002 and 2006 to determine the strains of *Pterophyllum scalare* (freshwater angelfish) available in the ornamental fish trade of Malaysia indicated that there are 46 strains present including the long-fin strains. Four strains of this fish were studied for phenotypic variation based on their meristic counts. Significant variation in counts of pelvic fin rays, anal fin rays, caudal fin rays and dorsal fin rays were observed among the strains.

(*Pterophyllum scalare*, meristic counts, phenotype)

INTRODUCTION

Aquarium fish trade is one of the major cash crops of the world aquaculture economy. Malaysia is the second major ornamental fish exporting country after Singapore that exports about two hundred and fifty species of them with an annual production of tropical ornamental fish worth about 50 million ringgit in the world market [1, 2, 3]. Originating from the soft acid waters of tropical America, Guyana and Venezuela, in Amazon south to Mato Grosso of Brazil and Peru [4], angelfish is an all time favourite, which thrive in captivity at a water temperature ranging from 24 - 28°C and pH 6.4 - 7.2. According to the Malaysian Fisheries Department statistics, there are 22 strains of *Pterophyllum scalare* available in the country [2] but these strains are not described.

Other than the breeding biology as well as some nutritional requirements and genetic variation of a few strains [4, 5, 6] there are no documents that characterize *P. scalare* strains of Malaysia. This paper aims to identify different strains of *P. scalare* available in Malaysia and a meristic comparison of Gold Marble (Figure 1), Silver (normal) (Figure 2), Light Marble and Koi strains. The range of meristic characters of dorsal fin spines, dorsal fin rays, anal fin spines and anal fin rays of this fish is already documented [7]. Meristic counts are still in use to delineate stocks and to detect even small variations between populations [8].

MATERIALS AND METHODS

The list of strains was compiled from personal contact with fish breeders and through breeding experiments conducted in the Ornamental Fish Genetics Laboratory, University of Malaya (Table 1).

Twenty five males each of the sturdiest short-finned normal (Silver) and mutant strains (Light Marble, Gold Marble and Koi) were selected for the study based on availability of healthy fry. Twenty days old fry were collected from fish farms in Rawang, Ipoh and Johor, Malaysia, reared in the laboratory, and fed on a commercial pellet and frozen bloodworms. Randomly selected fish from a common stock were sacrificed for study at eight months of age. The physico-chemical characteristics of water such as pH, temperature and ammonia were monitored

once a week. Half of the water volume was changed weekly.

The meristic counts that were recorded were dorsal fin rays, dorsal fin spines, pectoral fin rays, pectoral fin spines, pelvic fin rays, pelvic fin spines, anal fin rays, anal fin spines, caudal fin rays and caudal fin spines (Figure 3). Two way analysis of variance (ANOVA) was used to estimate differences between the four strains using SPSS software [9]. A difference between the mean values of each meristic count was determined using Tukey's test.

RESULTS

Phenotype and genotype of *P. scalare* strains of Malaysia

It was found that 46 strains of *P. scalare* are present in the aquarium trade of Malaysia including the long-finned strains having a clearly distinguishable very long and drooping tail fin and short-finned strains with much shorter and straight tail fin. The genotypes and phenotypes of short finned *P. scalare* strains of Malaysia are given in Table 1 indicating the genes for traits [10, 11, 12].

Table 1. Genotype and phenotype of *P. scalare* strains in Malaysia

	STRAIN	GENOTYPE	DESCRIPTION
1	Silver	+/+	It has four black stripes, one through the eye and one through the caudal peduncle and a brownish head on a silver body.
2	Silver Diamond	+/+-p/p	This body is normal silver type body covered by pearly scales.
3	Ghost	+/+-S/+	There may be the remnant of a stripe on the caudal peduncle.
4	Albino	a/a-+/+	These are nearly all white with red pupils.
5	Albino Diamond	a/a-+/+-p/p	It has a white body and pearly scales.
6	Gold	g/g	It has pale yellow body and bright gold head.
7	Red Eye Gold	not described	It is a gold angelfish having red pupils.
8	Gold Diamond	g/g-p/p	It has yellow coloured body and pearly scales.
9	Gold Blushing	g/g-S/S	It is similar to a gold angelfish, but has red cheek area.
10	Black	D/g or D/D	This hybrid strain has a nearly carbon black body and fins, with no streaks.
11	Black Lace	D/+	This is a darker strain with very dark bars and lace patterned fins.
12	Marble	M/g	It has black marbled body with streaks of black and silver on the body and fins, and sometimes slight golden colour on the head.
13	Dark Marble	M/M	True breeding Dark Marble has 20% or less white pattern.
14	Marble Diamond	M/M-p/p or M/g-p/p	It has a similar pattern as the marble angelfish but has pearly scales.
15	Gold Marble	Gm/g or Gm/Gm	It has a golden body with bright gold head and light marble pattern on the head and fins.
16	Koi	Gm/Gm-S/S	It is white with black patches and gold colour on the body. There will be orange colour on the crown, body and fins.
17	Koi Blushing	Gm/g-S/S	It is similar to Koi angelfish but has a blushing cheek area.
18	German Blue Blushin	+/+-S/S	It has greyish blue body and black trimmed fins with blue spangles on the fins, body and around the gills.
19	Turquiose Blushing	D/+-S/S	It has a dark gray body with black fins.
20	Leopard	Sm/Sm-Z/Z or Sm/Sm-Z/+	Adult has dots and blue /green iridescence.

Table 1. Genotype and phenotype of *P. scalare* strains in Malaysia (continued)

	STRAIN	GENOTYPE	DESCRIPTION
21	Halfblack	h/h	This strain is silver on the front and its body and tail behind the last body stripe is all black
22	Zebra	Z/+ or Z/Z	It has narrow and zebra stripes on a black body with slight golden tinge on the top of the body.
23	Zebra Lace	D/+-Z/Z -	This hybrid is similar to black lace but has an extra body stripe.

Colour genes: a (albino), D (black), C (chocolate), g (gold), Gm (gold marble), L (German blue), h (half black), M (marble), S (blushing), Sm (smokey), Z (zebra) and + (silver/normal).
Scale gene: p (diamond/pearl scale)
Fin gene: n (long fin), V (veil tail).
Cap genes: Q1 and Q2

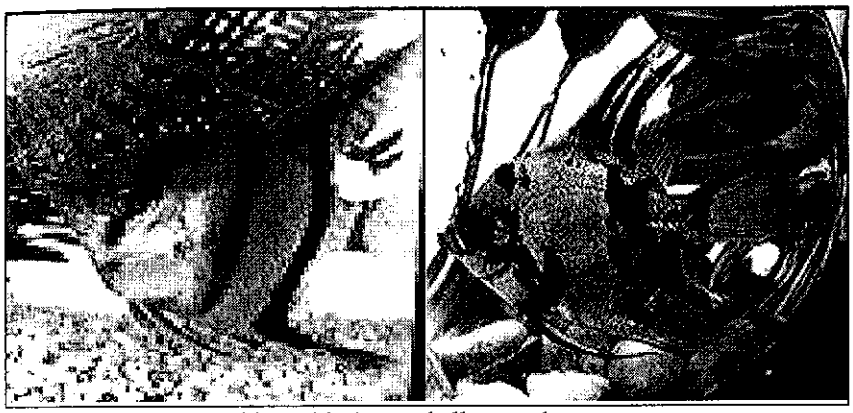

Figure 1 (left). Gold Marble *Pterophyllum scalare*
Figure 2 (right). Silver *Pterophyllum scalare*

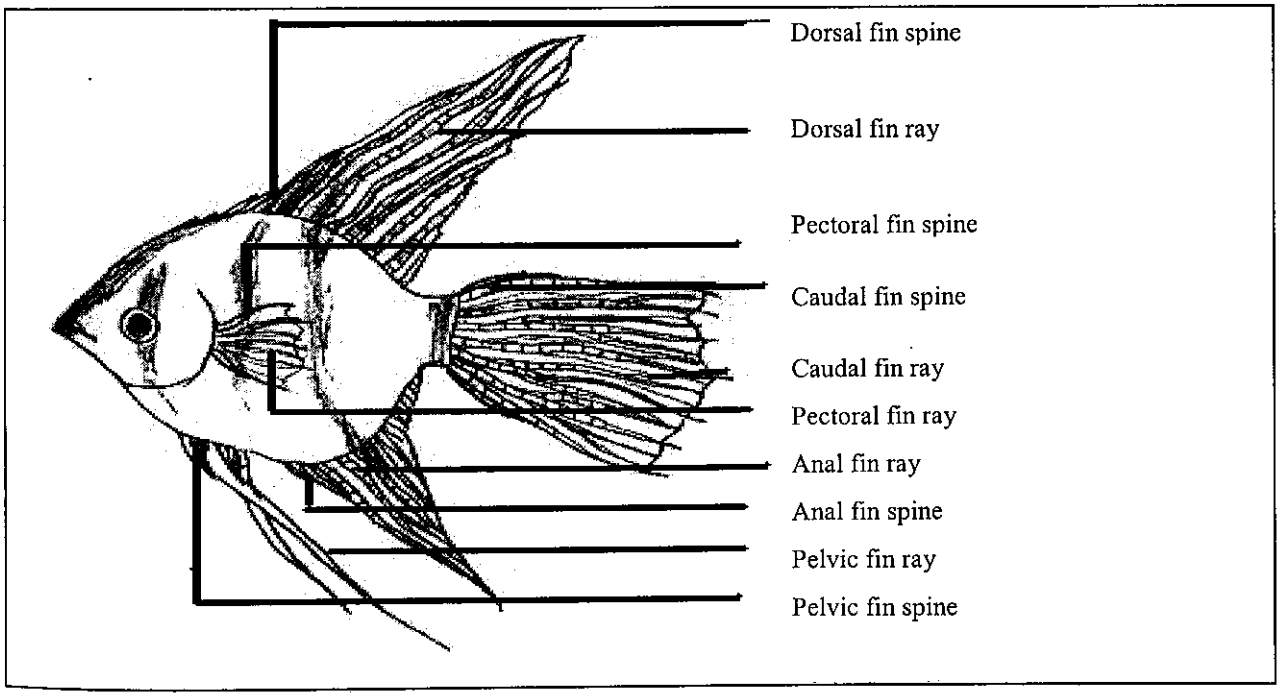

Figure 3. Meristic characters of *Pterophyllum scalare*

Meristic counts of Silver, Light Marble, Gold Marble and Koi strains

The range and mean values of the meristic counts are given in Table 2. There was insignificant ($P > 0.05$) difference in mean value of dorsal fin spines, pectoral fin rays, pectoral fin spines, pelvic fin spines, anal fin spines and caudal fin spines among the four strains. The difference in mean value of dorsal fin rays count between Silver and Koi was significant ($P < 0.05$). There was insignificant difference between Silver and the other three strains ($P > 0.05$) in number of pelvic fin rays. There was significant difference between Gold Marble and Light Marble ($P < 0.05$) in number of anal fin rays. There was a significant difference in mean value ($P<0.05$) of caudal fin rays between Silver and Gold Marble as well as Silver and Koi.

Table 2. Values of meristic counts of Malaysian hatchery strains of Silver, Light Marble, Gold Marble and Koi angelfish, *Pterophyllum scalare*

Meristic counts	S	LM	GM	K
Dorsal fin spines	10 - 13 (11.68 ± 0.74)	10 - 13 (11.56 ± 0.76)	11 - 13 (12.04 ± 0.73)	11 - 14 (12.08 ± 0.99)
*Dorsal fin rays	22 - 24 (22.64 ± 0.63)	21 - 25 (22.56 ± 0.91)	21 - 24 (22.16 ± 0.98)	18 - 23 (21.84 ± 1.43)
Pectoral fin spines	0 - 1 (0.44 ± 0.50)	0 - 2 (0.48 ± 0.65)	0 - 2 (0.56 ± 0.65)	0 - 2 (0.56 ± 0.58)
Pectoral fin rays	10 - 12 (10.72 ± 0.61)	8 - 12 (10.88 ± 1.01)	10 - 12 (10.80 ± 0.64)	9 - 11 (10.52 ± 0.65)
Pelvic fin spines	1 - 2 (1,6 ± 0.50)	1 - 6 (1.68 ± 1.34)	1 - 2 (1.52 ± 0.50)	1 - 2 (1.4 ± 0.50)
*Pelvic fin rays	6 - 8 (6.92 ± 0.64)	3 - 8 (5.64 ± 1.25)	5 - 7 (5.76 ± 0.59)	5 - 7 (5.52 ± 0.58)
Anal fin spines	5 - 6 (5.56 ± 0.50)	3 - 6 (5.56 ± 0.76)	4 - 6 (5.44 ± 0.58)	5 - 6 (5.6 ± 0.50)
*Anal fin rays	23 - 2 (24.04 ± 0.78)	21 - 26 (24.68 ± 1.02)	21 - 25 (23.32 ± 1.81)	23 - 25 (24.12 ± 0.78)
Caudal fin spines	0 - 2 (1.12 ± 0.52)	0 - 2 (1.48 ± 0.71)	0 - 2 (1.44 ± 0.71)	1 - 2 (1.56 ± 0.50)
*Caudal fin rays	16 - 19 (17.28 ± 0.84)	11 - 19 (16.48 ± 1.96)	15 - 17 (15.88 ± 0.66)	13 - 17 (15.88 ± 1.36)

Mean ± standard deviation is given in parentheses
S = Silver; LM = Light Marble; GM = Gold Marble; K = Koi
* Values are significant ($P<0.05$) among some of the strains

DISCUSSION

The study revealed that there was significant difference ($P < 0.05$) among the four strains in the counts of dorsal fin rays, pelvic fin rays, anal fin rays and caudal fin rays. Silver strain varied significantly with some or all of the other strains, which indicates a possible genetic differentiation of the former with the other strains. Morphological differences between populations could be the consequences of environmental modifications coupled with adaptive genetic changes [13, 14] as evident from population studies. They may represent genotypic difference, given common environmental conditions were provided to all the groups [15]. In the present study, individuals from different populations were reared in the same controlled environment until they were adults. The culture environment during their fertilization and embryonic stage is not expected to vary very much since the hatcheries from which they were collected employ the same culture techniques for different strains using river water.

Intraspecific differentiation of fish stocks occurs as a microevolutionary process below the species level mainly through genetic drift and selection coupled with reproductive isolation and the differences in environment [16] to cause genotypic and phenotypic differentiation of fish stocks. The extent of above factors is not determined for ornamental species due to their wide international export.

CONCLUSION

The *P. scalare* strains might have evolved by mixing up of the three species and have undergone intense inbreeding as well as over dominance of selection among them. Hence it is assumed from the present study that the significant differences in some of the meristic features among the Normal Silver, Light Marble, Gold Marble and Koi varieties can be due to genetic variation among them.

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