

## Parental Care of Ornamental Discus Fish, *Symphysodon* sp. (Heckel, 1840)

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### Abstract

The protein content in mucus of discus fish at stages of breeding time and non-breeding time, behavior and relationship between the parents and offsprings during a breeding period were studied in the present work. In discus fish, both parents provided offsprings with mucus secretions to feed after hatching. Mucus protein content was highest at the time of laying eggs. Protein content of premature fish was the lowest. Relationship between parents and fry increased the maximum around the first 15 free-swimming day which exhibited a steady increase in biting rate. Parental care found in discus was unique.

**Key words:** Discus, Breeding, Mucus, Fry

### Introduction

The family behavior of discus has been a thrill and a joy to discus fanciers ever since these fish were first bred in the home aquarium. The new parents, mother and father both are closely followed by their newly free-swimming fry. To see a school of young discus so close to their parents is a sight never to be forgotten. People are fascinated by difficult tasks, since the complicated brood behavior makes the brooding of discus particularly difficult. This is doubtless one reason why discus breeding can be considered the crowning achievement in the freshwater aquarium hobby (Degen, 1995). The large majority of fishes have no parental care. A notable exception to this is the parental care provided by a variety of cichlid species that display behaviours including the post-hatch defence of the young. At least 30 species of cichlid are also known to provide mucus for their developing young to feed on (Noakes & Barlow, 1973; Hildemann, 1959). Although several species of cichlid are present, it may only be obligated for the survival of offsprings in *Symphysodon*, a genus of Amazonian cichlids commonly known as discus fish (Chong et al., 2005).

Discus produce a skin secretion that is necessary for the survival of their fry. The skin secretion serves several main purposes. These include nutrition, protection and regulatory function. The mucus secretion can be likened to breast milk production in mammals. Breast milk contains proteins, fats, carbohydrates, minerals, etc., in the correct amounts and proportions resulting in an optimal food for the newborn baby. This also holds true for the discus (Chan, 1991). The mucus produced by the discus contain antibacterial substances, i.e., antibodies much akin to human breast milk. This would confer upon the young fish the much needed protection in their early lives against the numerous bacteria that are present in the tank. Young discus are immature physiologically and are therefore dependent on the mucus produced by the parents (Chan, 1991).

Like the benefits to maternally nursed human infants, there are many benefits especially for the immune system (Degen, 1995). Unlike in mammals, where nutritional demands are met solely by the mother, in discus both parents are responsible for providing mucosal secretions. Parental care duties are shared between parents (Chan, 1991; Chong et al., 2005). Discus mucus milk is unique and incomparable food for their offsprings. Mucus feeding in discus fish displays advanced behavior of parental care in fish. This natural method is widely used in discus hatcheries of several Southeast Asian countries. The present study was conducted with the objectives: to investigate the protein content of mucus from skin of discus

fish and to find out the relationship between parents and offspring during the parental care period.

## **Materials and Methods**

### **Study site and study period**

The study site was ornamental fish breeding farm in Mayangone Township, Yangon Region from June, 2010 to February, 2012.

### **Selection of breeding pair**

Breed stock used for experiments were fully grown at least one year old fish and selected from stock population maintained at breeding farms. Breeding pairs were easily noted from their aggressive territorial behaviour and spawning behaviour. The sex was distinguished reliably during breeding time by the shape of the spawning papillae. The spawning papilla of male was shorter and tapers to a point, whereas the spawning papilla of the female was longer and blunter (Degen, 1995).

### **Preparation and maintenance of aquaria**

Individual breeding pairs were transferred into 100 L capacity of breeding aquaria measuring 60 cm x 45 cm x 45 cm. Breeding aquaria were maintained at constant water conditions such as pH 6.5 to 6.8, regular aeration, filter system, daily partial water exchange, and weekly clean and renewed water.

### **Feeding method**

All adult fish were fed minced beef-heart and pellets twice per day. Newly hatched fry fed mucus of their parents. Fry from one aquarium were not fed any supplemented foods and depend only on mucus of their parents. Fry from other aquaria were fed supplemented with newly hatched *Artemia nauplii*.

### **Spawning method**

Spawning method was followed after Sweeney (1996). The mature male and female were allowed to pair naturally. When they were over one year old, a couple of fish was spending a lot of time alone together. The coupling mature fish were selected and moved into the spawning aquarium. Spawning aquarium was prepared with a heater, thermometer, sponge filter, regular aeration and a spawning surface. The spawning substrate was clay vase measuring 25 cm high. Before spawning, one third of water was daily exchanged with clean water to remove debris from the spawning aquarium. When spawning occurred, daily water exchange was ceased and minimal amount of water was siphoned out to remove the excrement.

### **Counting the mucus biting rate of fry**

Fry feeding on mucus secretion of their parents were recorded through counting of biting rate. Two methods of counting were carried out as follows:

- (i) The frequency of bites per 30 s by fry feeding only on parental mucus was recorded from ten randomly selected fry.
- (ii) The frequency of bites per 30 s by fry feeding on both mucus and supplementary feeding *Artemia nauplii* was counted from ten fry after feeding at 1h and 3h. Counting method was followed after Chong *et al.* (2005) and Buckley *et al.* (2010).

### **Counting the body flicking of parents**

Throughout the parental care period, the breeding pair regularly changed the mode of parental care that was done by body flicking to transfer the fry from one parent to another and frequency of body flicking within one hour were also counted.

### **Statistical analysis**

Collected data were statistically analysed using statistical package for social science (SPSS 11.3) and Microsoft Excel 2003 (Student's test was used to compare).

### **Collection and analysing of mucus sample**

Mucus samples were collected from premature fish and breeding stages of fish at to seek the variation of protein contents of mucus in different ages of fish. Mucus samples were collected from six phases of fish (i) premature (nearly one year old fish), (ii) mature fish (prepare to lay egg), (iii) breeding fish (spawning time), (iv) parent fish at first week of parental care period, (v) parent fish at second week of parental care period and (vi) parent fish at third week of parental care period. Mucus from fish was gently scrapped with spatula and mucus collection was done by using glass pipette. Collected mucus was immediately transferred to glass test-tubes and kept on ice until arrival to the laboratory. And then centrifuged and the supernatant was frozen for analysis. Mucus protein content was analyzed at the Analytical Laboratory, Fish Inspection and Quality Control Division, Department of Fisheries, Yangon.

## **Results**

### **Parental care of discus fish**

Before spawning, the coupling fish cleaned the spawning cone by sucking dirt vigorously (Plate 1, A). And then female inspected the spawning cone from bottom to top and took up about an hour (Plate 1, B). When she was satisfied with the spawning surface, she began laying the eggs. After the female laid the eggs, both male and female stayed near the eggs and continuously fanned them with their pectoral fins (Plate 2 A). After the eggs hatched, the fry with tiny tails wriggling out and attached on the spawning substrate (Plate 2 B). Both parents also fanned the fry and carefully looked after the fry. Parents moved the fry with their mouths place to place on the spawning substrate. They caught immediately the fry which felled down and spit back to spawning surface (Plate 2 C).

About 60 to 72 hours after hatching, the wriggling fry were free-swimming. They swam to their parents and sucked the mucus from the body of the parents which secreted from the skin of both parents (Plate 3). During the first two weeks after hatching, breeding pair changed the parental care duty by flicking the body for driving fry from female to male or male to female. The numbers of body flicking increased gradually to third week which was obviously increased than other weeks (Fig. 1). Parental care persisted up to 18 to 21 days. The frequency of the biting rate of the fry decreased with the age of fry. About three weeks later, fry separated from the parents, and the parental care period was ended. Most pairs of discus prepared to spawn again within two weeks after separating of the fry. According to the data, the relationship between parents and offsprings was observed from 1<sup>st</sup> week to 4<sup>th</sup> week.

### **Biting rate of fry on parental mucus**

Biting rates of fry on parental mucus were gradually increased from first free swimming day to 15<sup>th</sup> day. After 15<sup>th</sup> day, biting rate decreased gradually to 24<sup>th</sup> day (Table 1). Biting rate of fry fed only on parental mucus was significantly higher than those of fry

feeding supplementary feeds ( $t = 4.844$ ,  $df = 8$ ,  $p < 0.01$  for recording at 1h after feeding, and  $t = 3.788$ ,  $df = 8$ ,  $p < 0.01$  for recording at 3hs after feeding). Highest biting rate was recorded in 15<sup>th</sup> day ( $5.70 \pm 0.47$ ). As for supplementary feeding fry, biting rate recorded at one hour after feeding supplementary feed (*Artemia*) decreased and it is less than that of feeding *Artemia* (Table 1 and Fig. 2). Biting rate increased significantly again in recording at three hours after feeding *Artemia* ( $t = 6.026$ ,  $df = 8$ ,  $p < 0.01$ ).

### Protein content of mucus secreted from fish skin

Mucus secreted from fish skin contained protein, and the protein content varied according to the age and situation of fish (Fig. 3). Mucus of mature and spawning fish contained higher amount of protein than pre-mature fish. During the parental care period, the protein content in mucus of fish decreased gradually on 1<sup>st</sup> week, 2<sup>nd</sup> week to 3<sup>rd</sup> week as 15.4 mg/g, 13.6 mg/g and 12.3 mg/g, respectively (Fig. 3).

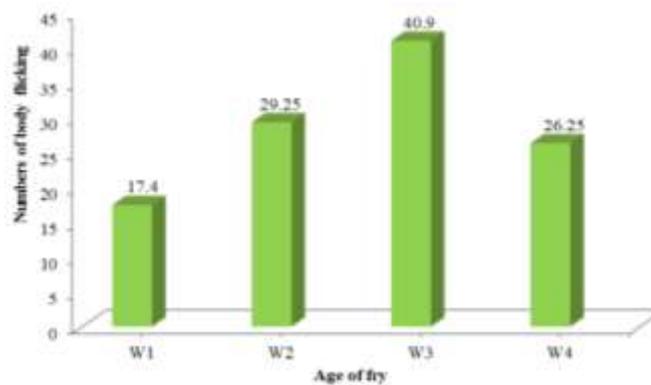


Fig.1 Frequency of body flicking of parents associated with the age of fry

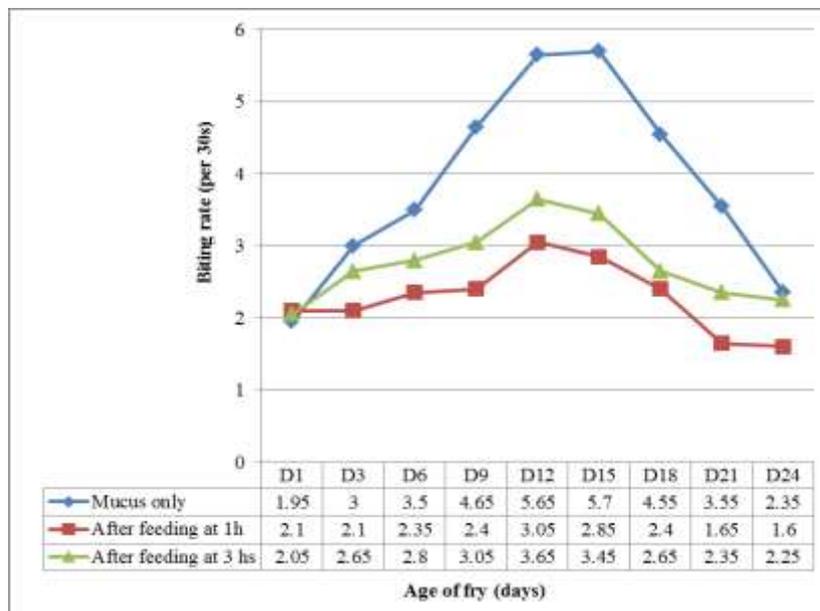


Fig. 2 Comparison of biting rates between fry fed on mucus only and feeding supplemented feed *Artemia*

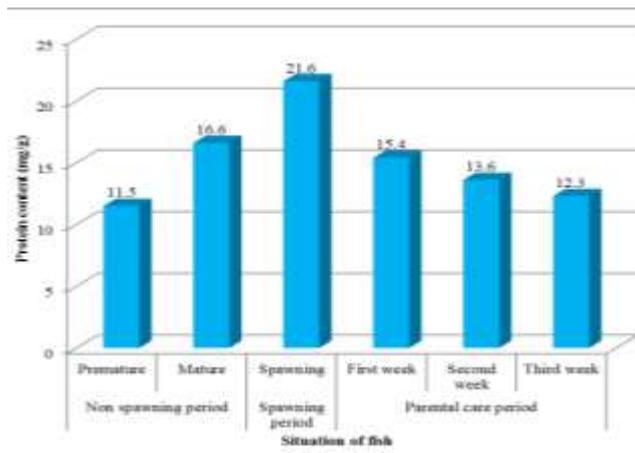


Fig. 3 Protein content in mucus of discus fish

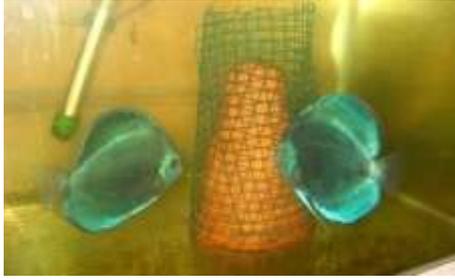


(A) Cleaning the spawning surface before egg laying



(B) Inspecting the spawning surface by female

Plate 1. Behaviour of fish before egg laying



(A) Fanning the eggs with pectoral fins of parents

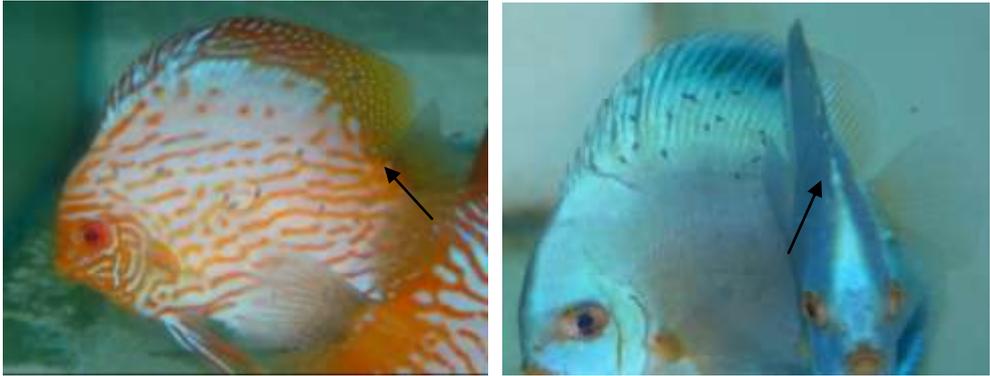


(B) Eggs and wriggling fry on the spawning surface



(C). Eggs and wriggling fry hanging back on the spawning surface by parents

Plate 2. Looking after the eggs and wriggling fry by the parents



(A) One week old fry feeding mucus on parents



(B) Three weeks old fry feeding mucus on parents

Plate 3. Fry feeding mucus on parents

Table 1. Biting rates of fry

Sr. No.	Biting rate (per 30s)	Age of fry (day)	Fry without supplemented food	Fry with supplemented food ( <i>Artemia</i> )	
			Mucus only Mean $\pm$ SD	Recording at 1h after feeding	Recording at 3hs after feeding
1		D <sub>1</sub>	1.95 $\pm$ 0.69	2.10 $\pm$ 0.71	2.05 $\pm$ .51
2		D <sub>3</sub>	3.00 $\pm$ 0.65	2.10 $\pm$ 0.31	2.65 $\pm$ 0.49
3		D <sub>6</sub>	3.50 $\pm$ 0.51	2.35 $\pm$ 0.49	2.80 $\pm$ 0.52
4		D <sub>9</sub>	4.65 $\pm$ 0.49	2.40 $\pm$ 0.50	3.05 $\pm$ 0.22
5		D <sub>12</sub>	5.65 $\pm$ 0.49	3.05 $\pm$ 0.69	3.65 $\pm$ 0.49
6		D <sub>15</sub>	5.70 $\pm$ 0.47	2.85 $\pm$ 0.67	3.45 $\pm$ 0.51
7		D <sub>18</sub>	4.55 $\pm$ 0.51	2.40 $\pm$ 0.50	2.65 $\pm$ 0.81
<b>8</b>		<b>D<sub>21</sub></b>	<b>3.55 <math>\pm</math> 0.51</b>	<b>1.65 <math>\pm</math> 0.49</b>	<b>2.35 <math>\pm</math> 0.49</b>
9		D <sub>24</sub>	2.35 $\pm$ 0.59	1.60 $\pm$ 0.60	2.25 $\pm$ 0.55

### Discussion

Discus fish could spawn the year round if the temperature was controlled at 30°C. The couple of fish prepared the suitable places for their offsprings before spawning and then looked after their eggs and fry very carefully after hatching. Besides, they provided mucus from their skin for nourishing the fry. The parental care of discus fish is remarkable. These

findings coincide with the findings of Degen (1995) and Sweeney (1996). About three weeks after hatching, the fry were separated from the parents slightly sucking up the mucus of their parents and mostly depend on supplementary feeding. It seems to the fact that the protein contents in the mucus decreased through the later weeks of the parental care period. Therefore, the fry have not enough the protein content only depended on mucus, so as they separated from their parents, and substituted with supplemented foods. This finding is similar to the statement of Schulze (1988).

Most pairs of discus prepared to spawn again within two weeks after separating of the fry. The intervals were as short as four days, but sometimes as long as two weeks. The frequency of breeding greatly depended on the conditions of the fish and their environmental factors especially temperature. This finding is in agreement with the finding of Schulze (1988). Throughout the study period, both parents spent the vast majority of time with fry. The inter-relationship between fry and parents increased until the 15<sup>th</sup> free-swimming day and then the relationship decreased slowly. This finding is similar to the findings of Chong *et al.* (2005) and Buckley *et al.* (2010). This behaviour was also seen in other cichlid species, *Cichlasoma citrinellum*, and the cichlid species utilized mucus secretion as feed for fry (Noakes and Barlow 1973 and Shultz and Barlow 1997).

Biting rate of fry reached the maximum at second week and gradually declined to third week. The supplementary food to fry influenced the biting of parental mucus and it is clearly showed that the lower biting rate was observed after feeding on *Artemia*. These finding is in accordance with the finding of Chong *et al.* (2005) and also observed in *C. citrinellum* fry as stated by Schultz and Barlow (1997). Depletion of mucus could be replaced rapidly by secreting from the skin of the parents. It was clearly observed that the skin colour was light in area where mucus sample was taken. However, normal colour had restored within one hour after taken sample. Therefore, parents successively provided mucus for fry. It coincides with the study of Buckley *et al.* (2010).

Protein content of parental mucus at the spawning period was highest due to deposition of concentrated nourishment for newly hatched fry. Protein content was lowest in pre-mature fish since they had no need to feed the fry. Protein contents decreased gradually from first week through the second week to third week in relation to the growing larger size and higher biting rate of fry. The decrease of protein content in third week was due to the fact that the feeding rate of the fry was excess than the mucus production rate. The repeated production of mucus led to decrease the quality of mucus. This finding agrees with the statement of Buckley *et al.* (2010). Behaviour of parents changed at the third week of parental care period. Parents carried out more body flicking movements to avoid biting of fry since size of fry increased gradually day after day and their biting rate also became greater and greater. Therefore, the frequency of body flicking of parents increased with the age of the fry, so as the fry faced the difficulty to regular mucus feeding on their parents. This situation led the fry to finding available food themselves. Consequently, the interrelationship between parents and fry decreased gradually tend to live independently. This finding is in accordance with the finding of Buckley *et al.* (2010).

### Conclusion

Discus performed advanced behavior of the parental care that cannot find in other ornamental fishes. Parental care duty was equally shared between the male and the female parents. Early stage of discus fry required parental mucus but later stages, parental mucus was replaced by exogenous live feed such as *Artemia* can be used. Fry are removed from the

parents for about 12 to 14 day free-swimming. This is to enable the young to derive as much nourishment from their parents as possible. It is usually a good idea to separate the fry from the parents as soon as possible, otherwise the spawning cycle of the parents will be slowed down and also prolonged feeding from the body tends to weaken the parents resulting in a longer recuperation phase.

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