

The Importance of Temperature, Individual Size and Habitat Arrangement on the Bubble Nest Construction of Siamese Fighting Fish (*Betta splendens* Regan, 1910)

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Abstract: In the present study, the importance of temperature, individual size and habitat arrangement on the bubble nest construction of Siamese fighting fish (*Betta splendens* Regan, 1910) was investigated. 75 males and 15 females of *B. splendens* were used for the study. Ten aquariums (33 × 100 × 60 cm) were used and were divided into two sides by a glass layer. Aquariums were aerated and heated by aquarium heaters. Cartons were placed in the wall of aquariums in order to prevent excess lighting. To observe the importance of habitat arrangement on the bubble net construction, adult of male *B. splendens* were maintained in aquariums having different color raffia (white, black, gray, green, blue) or in aquariums having a natural water plant (*Lemna* sp.), artificial plants (made from plastic material) and raffia (white, black, gray, green and blue). Males of *B. splendens* were exposed to 25, 26, 27, 28 and 29 °C in order to observe the effect of temperature range in the construction of bubble nest. Fish samples in different length were set up in aquariums to find the relations between fish length and area of constructed bubble nests. In the present study, it is found that *B. splendens* is able to construct bubble nest in a wide range of temperature (25-29 °C), and the best result is observed from the fish maintained at 28 °C (mean bubble nests area: 43.15 ± 6.74 cm²), habitat arrangement gives a better result to encourage males in the construction of bubble nests, and there is a positive, but a weak relation between constructed bubble nests and individual size (r= 0.45).

Keywords: *Betta splendens*, Bubble Nest, Water Temperature, Habitat Arrangement

Kavgacı Siyam Balığı (*Betta Splendens* Regan, 1910)'nın Köpük Yuva Oluşturmasında Su Sıcaklığı, Birey Büyüklüğü Ve Ortam Düzenlemesinin Önemi

Özet: Bu çalışmada, Kavgacı Siyam Balığı (*Betta splendens* Regan, 1910)'nın köpük yuva oluşturmasında su sıcaklığı, birey büyüklüğü ve ortam düzenlemesinin önemi araştırıldı. Çalışmada 75 erkek ve 15 dişi *Betta splendens* kullanıldı. Çalışmalar 33 × 100 × 60 cm ebatlarında, cam bir tabaka ile iki kısma ayrılmış, havalandırma uygulanmış ve ısıtıcı bağlanmış 10 adet akvaryumda yapıldı. Akvaryumların çok fazla ışık almasını engellemek için akvaryumların etrafları karton ile kapatıldı. Köpük yuva oluşumunda ortam düzenlemesinin önemini incelemek için ergin erkek *B. splendens*'ler, farklı renkteki rafyalarla (beyaz, siyah, gri, yeşil, mavi) düzenlenmiş akvaryumlar ile doğal su bitkisi (*Lemna* sp.), plastik materyalden oluşturulmuş yapay bitki ve rafyayla (beyaz, siyah, gri, yeşil ve mavi) düzenlenmiş akvaryumlara bırakıldı. Erkek *B. splendens*'lerin köpük yuva oluşturmalarında su sıcaklığının önemini belirlemek için, bireyler sıcaklığı 25, 26, 27, 28 ve 29 °C olan akvaryumlarda tutuldu. Balık büyüklüğü ile oluşturulan köpük yuva alanı arasındaki ilişkiyi araştırmak için farklı uzunluktaki balıklar akvaryum ortamına yerleştirilerek oluşturdukları köpük yuvaların alanları ölçüldü. Sonuç olarak, yapılan bu çalışmada *B. splendens*'lerin geniş bir sıcaklık aralığında (25-29 °C) köpük yuva oluşturabildikleri, bu yuvaları oluşturabilmek için ortam düzenlemesinin daha iyi sonuç verdiği ve oluşturulan köpük yuvalar ile birey büyüklüğü arasında pozitif, fakat zayıf bir ilişkinin (r=0,45) bulunduğu görüldü. Ayrıca, bu çalışmada 3 cm uzunluğa sahip *B. splendens*'lerin köpük yuva oluşturabildikleri belirlendi.

Anahtar Kelimeler: *Betta splendens*, Köpük Yuva, Su Sıcaklığı, Ortam Düzenlemesi.

1. Introduction

Siamese fighting fish, *Betta splendens* is among the most beautiful and fascinating of all aquarium fish. It attracts many novice aquarium fish holders with their long flowing fins and various unique colors. Males of *B. splendens* have the most brilliant colors and longest fins [1,2]. They are very territorial and the people of their native country of Thailand traditionally place males together and wager bets as to who will be the winner after the ensuing no holds-barred battle [3]. The extraordinary behavior and beautiful shape of *B. splendens* hasn't only attracted the novice aquarium fish holders and scientists who want to learn more about the behavior of *Betta* species.

Indeed, published studies on *Betta* up to date are mainly concentrated on their fighting behavior [4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21] rather than their reproduction and rearing [22, 23, 24, 25, 26, 27, 28, 29, 30].

In recent years, there has been an increase in the interest of *B. splendens* in aquariums in Turkey. The majority of *B. splendens* is imported from its natural habitats thus avoiding the development of local reproduction procedures. The present study is aimed to investigate the importance of temperature range, individual size and habitat arrangement on the bubble nest construction of *B. splendens* under laboratory conditions.

2. Materials and Methods

Studies were carried out in the aquarium laboratories of Fisheries Faculty, Firat University, and Elazığ, Turkey between June 2005-May 2006. Total of 75 males and 15 females of *B. splendens* were used for the study. Fish were fed with JBL Novel Bel Tropical Fish Food twice in a day. Standard length of fish was taken at the beginning of the experiment. Ten aquariums (33 × 100 × 60 cm) were partitioned into two compartments by a glass, heated and

aerated. Only one male was set up in each compartment and one female was placed in the other to encourage males to build bubble nests. Cartons were placed in the wall of aquariums in order to reduce excess lighting. Water level of aquariums was 20cm. Experiments were carried out with three replicates. To test the preferences of the males in nest building, different substrates were introduced in each aquarium namely:

- Different color raffia (white, black, gray, green and blue) or
- A natural water plant (*Lemma* sp.) artificial plants (made from plastic material) + raffia (white, black, gray, green and blue).

To observe the effect of temperature range in the construction of bubble nests adults of male *B. splendens* (size range: 3.5-4.6 cm) were placed in aquariums.

The bubble nest length (b), width (a) and depth were measured to the nearest 0.01 mm by vernier callipers, and its area (A) estimated using the ellipsoid equation $A = \pi ab$ [23]. Kruskal-Wallis test was employed for the statistical analysis of the data (significant difference, $p = 0.05$).

3. Results

In aquariums having different color raffia; the preference of *B. splendens* to construct bubble nests was gray raffia (9 fish, 25 %), black raffia (8 fish, 21 %), blue raffia (6 fish, 15 %), green raffia (5 fish, 13 %) and white raffia (2 fish, 5 %), respectively. On the other hand, eight *B. splendens* (21 %) didn't use any of raffia to construct bubble nests and they produced their bubble nests far away from the raffia (Figure 1).

In aquariums having different color raffia, artificial water plant and natural water plant, the preference of *B. splendens* to construct bubble nests was white raffia (6 fish, 17 %), gray raffia, natural and green raffia (4 fish, 11 % for each case), but no fish preferred blue raffia, and 7 fish (19 %) constructed their bubble nests not under the raffia, natural plant or artificial plant. They preferred open areas (Figure 2).

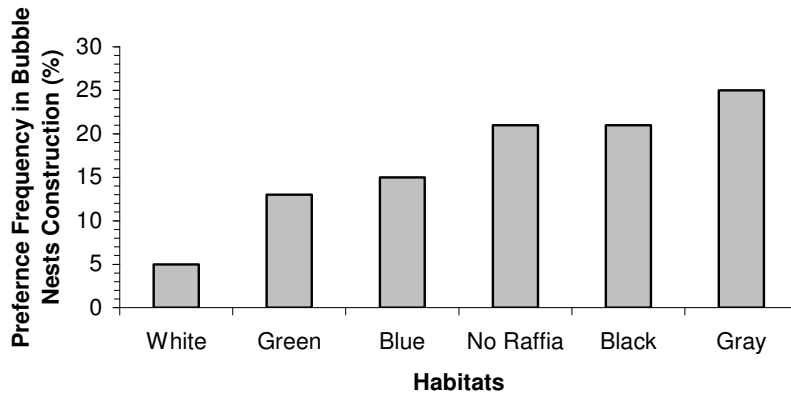


Figure 1. Preference frequency of different color raffia in bubble nest construction.

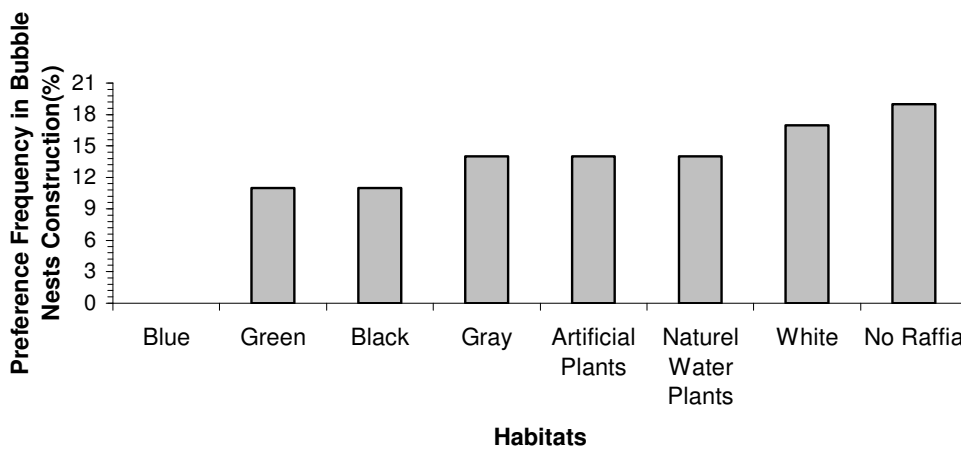


Figure 2. Preference frequency of different color raffia, natural and artificial plants in bubble nest construction.

There was not a significant difference ($P > 0.05$) in bubble nest construction between the temperatures. However, the best result was taken from the fish maintained at 28 °C (mean bubble nests area: $43.15 \pm 6.74 \text{ cm}^2$). That of the males exposed to 27 °C was $39.79 \pm 5.01 \text{ cm}^2$. Table 1 shows mean bubble nests area, standard error

and minimum-maximum values of *B. splendens* maintained in different temperatures.

In the determination of the relation between fish size and constructed bubble nests area it was observed that there is a positive, but a weak relation between constructed bubble nests and fish size ($r = 0.45$) (Figure 3).

Table1. The mean bubble nest area, standard errors, minimum-maximum values at different temperatures. Note: values within brackets are standard error of means

Water Temperature (°C)	n	Mean Bubble Nests Area (cm ²) and range	P
25	12	35.11 (±6.79) range: 10.07 – 90.98	p> 0.05
26	12	35.83 (±5.47) range: 11.40 – 80.42	
27	12	39.79 (±5.01) range: 15.87 – 71.22	
28	9	43.15 (±6.74) range: 17.08 – 77.13	
29	13	39.01 (±7.14) range: 10.46 – 80.78	

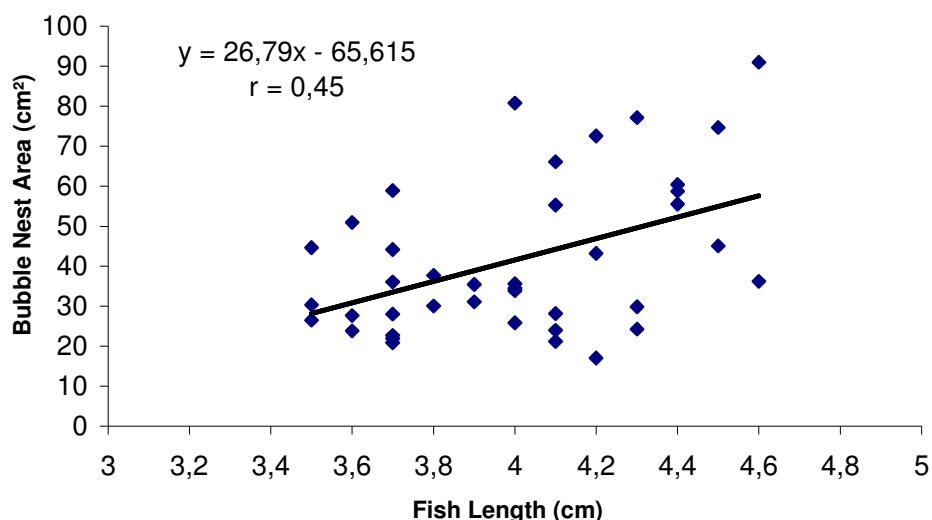


Figure 3. Relation between constructed bubble nest area and fish length.

4. Discussion and Conclusion

In aquarium habitats, *B. splendens* prefers lower intensity colors [31]. Ritter [32] found that blue and black color habitats were the least preferred habitats to build bubble nests. Moreover, Gude [31] observed that *B. splendens* preferred yellow and light-green habitats (rather than red, gray, white, blue and black habitats) in the presence of plant material to build bubble nests.

Gude [31] stated that color of habitat is not always a determining factor in the construction of bubble nests. Blue and black were least preferred because they transmitted the least light,

and some light is required although beta's don't prefer that much light so white was third to last [31].

This study showed that *B. splendens* prefers low light intensity in the construction of bubble nests. Significantly more bubble nest area were constructed by males of *B. splendens* under white color raffia in the presence of natural and artificial plant material, but no male of *B. splendens* preferred blue raffia in the construction of bubble nests. In addition, in the present study, it was also observed that gray raffia was commonly used by the males in the

absence of plant material in the bubble nests construction. The stated results from the literature are opposed to your results. How do you explain these discrepancies? This should be discussed and not just stated.

According to Axelrod [33] and Scheurmann [22] normal temperature range of *B. splendens* is between 20 and 30 °C. Reyes-Bustamante and Ortega-Salas [26] also stated that temperature should be 25-28 °C for the maturation and reproduction of *B. splendens* in aquarium habitats.

In a study, Jaroensutasinee and Jaroensutasinee [23] observed that optimal water temperature is 30 °C in the ovarian egg development and production of *B. splendens*. The present study revealed that although *B. splendens* is able to construct bubble nest in a wide range of temperature (25-29), the best temperature is 28 °C.

In the present study, it was found that there is a positive, but a weak relation between constructed bubble nests and fish size ($r=0.45$). For example, 80 cm² bubble nest area was produced by 4 cm of *B. splendens*, but 30 cm² bubble nest area was produced by 4.6 cm of *B. splendens*. Similarly, approximately 50 cm² bubble nest area was produced by 3.6 cm, but 20 cm² bubble nest area was produced by 4.3 cm of *B. splendens*. In addition, another reason causing low r value ($r=0.45$) is that *B. splendens* at same length produced very different size of bubble nests. For example, 3.7 cm of 4 males of *B. splendens* produced approximately 20, 30, 35 and 65 cm² bubble nests. Similarly, 50 males of *B. splendens* in 4.1 cm length produced approximately 20, 25, 30, 60 and 70 cm² bubble nests.

In a study, on the bubble nest habitat characteristics of *B. splendens*, Jaroensutasinee and Jaroensutasinee [23] found that there is a positive relation between fish length and bubble nest area. However, in the present study, besides there is an increase in fish size, this relation is a positive, but a weak relation. Similar to this study, Goulet and Green [34] also found that bubble nest area of *B. splendens* is not always dependent on the size of fish.

In light of the findings of present study we conclude that *B. splendens* is able to construct

bubble nest in a wide range of temperature range (25-29 °C) and optimum temperature is 28 °C. Habitat arrangement gives a better result in the construction of bubble nests in aquariums, and there is a positive, but a weak relation between fish size and constructed bubble nests.

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