The effect of environmental parameters on the pairing behaviors of sharknose gobies (*Gobiosoma evelynae)*

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Introduction

Aquaculture is a growing industry that struggles with sustainability. One aspect of aquaculture research focuses on the effects of parasites on raised fish. Chemicals, such as formalin which can be harmful to local environments surrounding aquaculture systems (Deady, *et al.* 1995), are the primary means of removing parasites. However, current research is looking into methods that are both cost-effective and environmentally friendly. The most promising solution entails the use of cleaner fish to remove parasites and clean fish, simulating the process that is done in the wild (Deady, *et al.* 1995).

The sharknose goby is a cleaner fish native to South Eleutheran reefs. Along with its close proximity to the study site, it exhibits easily observed pairing and breeding behaviors. Sharknose gobies form monogamous mating pairs (Olivotto, *et al.* 2005) and are hermaphroditic (Sadovy de Mitcheson, and Liu. 2008) which facilitates breeding and pairing in captivity. This species has been observed to lay sticky eggs on the roofs of PVC piping in captivity (Olivotto, *et al.* 2005).

Several research groups show that goby breeding and production is viable. (Olivotto, *et al.* 2005; Meirelles, *et al.* 2009). However, these few studies do not touch on all the various parameters of breeding this species. Further research is needed to establish the artificial breeding protocol that best suites an individual environment as well as the differing methods that can be practiced. The study is testing several different variables in the goby breeding program with two different tank systems, an indoor and an outdoor setup. The indoor tank system is likely to have a higher breeding success rate compared to the outdoor breeding system, due to the indoor tank having more stable and easily controlled tank parameters.

Figure 1: The outdoor pairing tank is a 464 L raceway tank that is on a flowthrough system. This is where some of the gobies are placed after being taken off reefs and held until they pair and are moved. The PVC provides a place for the gobies to perch and display pairing behavior.

Figure 2: The indoor pairing tank has a filter to recirculate water and reduce waste. When gobies were captured they were placed in this tank until they paired and then transported to a breeding tank.

Methods

From several reefs around South Eleuthera, 20 Sharknose gobies were caught and moved to one of two pairing tanks, either inside (Figure 2) or outside (Figure 1). Once pairs were formed, they were moved to breeding tanks. There were two indoor (Figure 3) and two outdoor breeding tanks (Figure 4). Dissolved oxygen (D.O.), ammonia, temperature, salinity, and pH were monitored for each of the six tanks. Breeding tanks were observed for feeding behavior, proximity to mate, and use of substrate.

Figure 3: The indoor breeding tank is a filtered recirculating tank containing PVC to allow the paired gobies to lay their eggs in.

Figure 4: This tank is the outdoor breeding tank. There is PVC in the tank to provide substrate for them to lay their eggs on. This tank is on a flow through system.

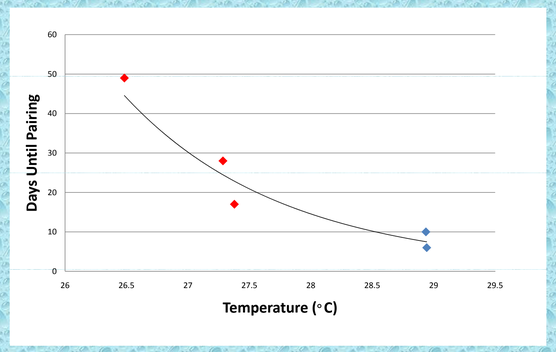

Fig. 5: The relationship between temperature and days until paring. The red diamonds are the three outdoor breeding tanks and the blue diamonds are the indoor breeding tanks. The trendline has an R^2 value of 0.9104.

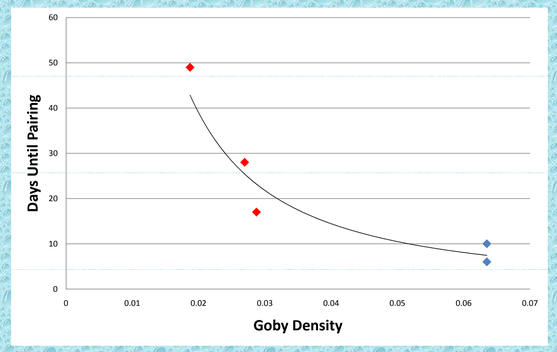

Fig. 7: The relationship between gobies per liter and days until pairing. The red diamonds are the outdoor breeding tanks and the blue diamonds are the indoor breeding tanks. The R^2 value is 0.906 for the trendline.

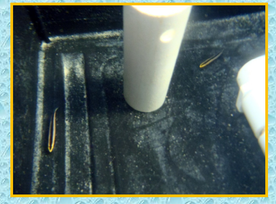

Fig. 8: A pair of sharknose gobies in a breeding tank

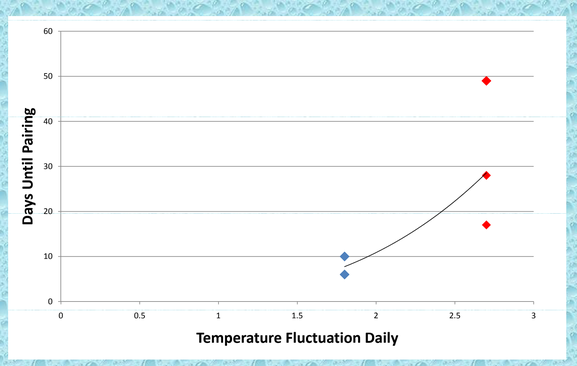

Fig. 6: The relationship between daily temperature fluctuation in the tanks and days until pairing. The blue diamonds are the indoor breeding tanks and the red diamonds are the outdoor breeding tanks. The trendline of this graph has an R^2 value of 0.747.

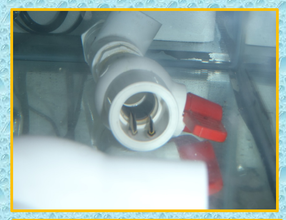

Fig.11: Two gobies exhibiting pairing behaviors

Fig. 12: A sharknose goby cleaning a host fish

Fig. 9: The aquaculture team measuring artemia to feed the gobies

Fig. 10: Two students out on the reefs collecting gobies

Results

Three pairs formed in the outdoor pairing tank (fig. 1). The first outdoor pair formed after 18 days in the pairing tank. The second outdoor pair formed after 28 days in the pairing tank. The third outdoor pair formed after 49 days in the pairing tank. The average temperature in the outdoor pairing tank was 25.9°C (fig. 5). The temperature fluctuation was 2.7°C (fig. 6). The average ammonia level was .05 mg/L. The population density of the outdoor pairing tank was 0.025 gobies per liter, due to the large volume (fig. 7). Two pairs formed in the indoor pairing tank (fig. 3). The first indoor breeding pair formed after 6 days and the second indoor breeding pair formed after 10 days. The average temperature in the tank was 28.9°C, with a temperature variation of 0.2°C. The average ammonia levels were 0 mg/L. The outdoor pairing tank was 7.4 times larger than the indoor pairing tank. The population density of the indoor pairing tank was 0.063 gobies per liter, due to a smaller volume.

Discussion

The data collected supports the hypothesis that gobies have a higher propensity to pairing in the indoor tank conditions, compared to the outdoor tank conditions. The gobies in the indoor pairing tank paired faster (an average of 8 days) than the gobies in the outdoor tanks (an average of 22.5 days). Gobies paired more rapidly at a higher stocking density. In addition, pairing was faster when the water was warmer. Temperature was the most influential variable in goby pairing as shown by the high R^2 value. The R^2 value represents how strong the correlation is between the independent variable and goby pairing. The reason the gobies pair faster in warmer water is likely because it is closer to the warm water temperature of the ocean during their natural breeding season.

From the results an efficient way to begin pairing in a goby-breeding program can be established. Future research should lead to a study on the best settings to optimize goby breeding in order to create a complete breeding protocol. With the protocol established, full-scale production of gobies could be created for use on raised aquaculture fish to combat parasitism. Studies should lead into researching whether gobies are a successful cleaner for aquaculture fish populations. Further research should also focus on preventing gobies from escaping offshore aquaculture cages, goby density for optimal parasite removal, and the ability of gobies to clean cobia. In the future, gobies will hopefully substitute the use of chemical cleaners, such as formalin, in the aquaculture industry.

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