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Determining the Effect of Different Ecological Conditions on the Maturation of Rabbitfish (*Siganus guttatus*)

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ABSTRACT

A study aimed at the rabbitfish *Siganus guttatus* (Bloch, 1787), the reproductive ability of one economically important marine and brackish fish in Giang lagoon systems and marine Asia. The future expectations of mariculture development were decided in Vietnam. The region had enough fingerlings for intensive culture and polyculture to contribute to environmental conservation and sustainability. There were 3 experiments in 3 different ecosystems for fish culture and maturity by feeding a commercial feed and finding suitable areas for the maturing period. The results showed that the growing fish kept in cages on the lagoon had the best growth and rate maturity, much higher than fish in cages of shrimp ponds and plastic bottom ponds, as showed a much bigger size of body, 610 g/head for females and 542 g/head for males, while other culture more 500/head, especially after 3 months of feeding, more than 20% matured for females, they reached more 50% at 6 months feeding. The length at first sexual maturity was 28.87 to 31.20 cm and 27.47 to 29.20 cm for females and males, respectively. The potential ova diameter is from 405 to 483 µm, $P < 0.05$; the benefit for spawning, gonads maturity stages, with GSI (gonadal-somatic index), 3.03 to 4.53 were opportunities for the spawning season, ova diameter and fecundity and the gonadal-somatic index were differed significantly ($P < 0.05$) males and females. This result showed the maximum (peak), and all fish can mature and get to spawning. In conclusion, different ecosystems impacted maturity and spawning during the moon season.

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Introduction

Siganus guttatus is a marine fish species with high economic value and a good market for consumption in Thua Thien Hue and other coastal regions of Central Vietnam. The people of Thua Thien Hue and tourists across the country often know about the commercial value of the species (Nguyen et al 2015; Ton 2009) [1,2]. Depending on the region and each locality, these groups of fish have names such as rabbitfish or cotton fish [2]. Fish has many advantages in exploitation and culture [3]. It can eat aquatic plants, organic humus, and synthetic food distributed in lagoon systems [1,5].

There is a great demand for fingerlings seed and research to perfect the seed production process of rabbitfish. The objective of proactively providing seeds for farmers in the province has practical significance and farmers' income. Inheriting the task of gene fund "Exploiting and developing genetic resources of rabbitfish *S. guttatus*, [6] giant trevally *Caranx ignobilis* (Forsskål, 1775), *Terapon jarbua* (Forsskål, 1775), code number: NVQG -2014/19, conducted from 2014-2017, we studied the effects of support forms on the maturity of broodstock. The study aimed to find a suitable reverse format with a high success rate for artificial reproduction. In the farms, studies on the diet of the fish at different stages have been carried out. Experiments on reproduction and larval rearing of *Siganus guttatus* were conducted over 14 months in 1984–1985 [7]. The broodstock was fed a diet rich in cod liver oil or a mixture of cod liver oil/soybean oil/soy lecithin continuously reproduced for at least 4 consecutive months. Reproduction took place monthly and without using hormones, with high fertilization and hatching rates of 84.2% and 89.6%, respectively. Larvae reared at salinity 20 - 32‰ had no significant difference in survival on day 21 days of age. Larvae fed on days 2-4 with rotifers had a higher survival rate than those fed freely. Artemia larvae and artificial diets were readily accepted when they were introduced between day 15 to 21 days of age. Larval survival in large tanks (5 m^3) was higher than in small tanks (500 L). After 45 days of culture, the survival rate is 3.5 – 16.6%, and the fingerlings are ready for stocking in grow-out farms. At the fingerling stage, the rabbitfish grow well in diets with 35% protein content and 3832 kcal/kg after 8 weeks [8]. Meanwhile, at 21 days

of age, a diet consisting of 40% protein and an estimated energy content of 3,971 kcal/ kg can be used with satisfactory results. The production process of scad fish in hatcheries with specific growth rate, metamorphosis rate and survial rate were was 7.80 - 8.35, 95.2 - 97.9% and 59.9 - 70.3%, respectively experimented with feeding and concluded that the diet of the fishes containing 31% protein, 8% fat and 38% carbohydrates resulted in growth rate and efficiency of forage utilization for rabbitfish, prioritize [9,3]. For brood stock *S. guttatus*, recommended a diet with low energy (2800 kcal kg-1) and lower protein (17%) [10]. Nursery of rabbitfish from fry to fingerlings, we can use commercial feed with a crude protein of 40% for the best result of growth and survival rate [11].

[2] shows that our country has 15 species of fish from the Siganidae family. Many research projects on artificial reproduction, such as the production of fingerling fish seed, were carried out by the Fisheries Extension Center of Thua Thien Hue province (2003-2005) with the technical support of experts from the Research Station, Southeast Asian fisheries. The project of "Exploiting and developing genetic resources of this species. Finally, built a 9-step process for taming fish: Choosing a location, broodstock selection, environmental conditions, live food and additional feed; selection of developing fish as mature, stocking density and fed by different diets and regimes, selection of cultured fish; stocking density and reproductive exploration. The maturity rate is > 50%; the laying rate: is 85%; the hatching rate: is 90%; the survival rate from fry to flavor: is 3.7 - 5.1%; the survival rate from incense - varieties: is 50 - 70%. The study aims to increase the maturity of growing rabbitfish and alternative conditions to improve artificial reproduction in Central Vietnam.

Materials and Method. Broodstock was selected from the wild by fishing captured by fishermen in April to August 2020, 2021, and 2022. Starting stocking density into 3 eco-regions. Males and females were selected from the stock (Table 1).

Research Sites. Location 1: Vinh Xuan, Phu Vang, Thua Thien Hue; Location 2: Phu Hai, Phu Vang, Thua Thien Hue; Location 3: Phu Thuan, Phu Vang, Thua Thien Hue as shown in the map below.

Figure 1: Mapping places of matural feeding on Tam Giang Lagoon

Experimental design. To assess the impact of different forms of pat farming on the maturity ability of broodstock, we arranged flapping farming in 3 different locations corresponding to 3 forms of farming.

Experiments 1, 2, 3: Culture in nets placed in earthen ponds (Vinh Xuan); farming in nets placed in lagoons (Phu Hai); culture in nets placed in canvas ponds (Phu Thuan). Cages and ponds. Site 1 (Expt. 1): Fish are raised in a mesh cage of 2a = 2.5 cm, cage area of 32 m^2 (4 x 5 x 1.6m), placed in an earthen shrimp pond with an area of 2,500 m^2 (Figure 2).

Site 2: (Expt. 2) Fish in a mesh cage of 2a = 2.5 cm with an area of 32 m2 (4 x 5 x 1.6m) placed in the lagoon (Figure 3).

Figure 2: Cages in shrimp pond

Figure 3: Cages in Lagoon

Figure 4: Cages in a plastic bottom pond (Canvas)

Site 3: (Expt. 3) Fish raised in a mesh cage of 2a = 2.5 cm with an area of 8.0 m^2 (2 x 2.5 x 1.6 m) (Figure 4). All cages are located 0.5m from the bottom of the pond, the bottom of the lagoon. Fish cages are allocated in ponds and keep the water level stable. Breeding density stocking as 1.5 animals/m^3 with rate male/female: 1:1 (120 females and 120 males) and already 4 months of age.

Table 1: Initial indicators of females and males (n = 240)

Variables	Males	Females
Body weight (g)	407.5 ± 57.1	394.5 ± 35.7
Length (cm)	24.6 ± 2.5	26.4 ± 1.6
Color	Bright and fresh	
Fins, tail and wags	No signals	

Variables: Evaluating the influence of culture forms on the maturity of broodstock: Growth (g/day, initial and final weight), length of fish, the diameter of egg and GSI (gonadosomatic index), a mass of sexually developed fish (female & male).

Ova Diameter: Eggs were measured using a microscope fitted with an eyepiece

GSI (matured index): Computed as the ratio between gonad and gutted weights in each individual sampled as follows: GSI% = (Gonad Weight/(Body Weight - Gonad Weight))*100.

Feed Management: After 2-3 days of farming, the fish feel healthy, then start feeding. The feed used is Nuri industrial feed for card shrimp of De-Heus company (Table 2, Figure 5a, 5b) combined with feeding fresh chopped squid 1 week/month, from the 1st to 7th day of the lunar month (Figure 6), in addition to adding fishing algae for fish to eat. Daily feeding dosage: 3-5% body weight. Fed 2 times daily: 8 and 15 hours.

Table 2: Dietary and chemical composition

No	Chemical composition	(%)
1	Protein (CP)	43
2	Fat (CF)	7
4	Ash	13
5	Fibre (CF)	3
6	Energy (DE)	3200 Kcal

Figure 5a: Commercial feed

Figure 5b: Commercial feed

Every 2 weeks, check for environmental factors (pH, temperature, oxygen, ammonia gas, salinity), instruments and time is shown in Table 3. Monthly on the 4th or 8th day of the lunar calendar, conduct blood tests to determine the maturity of fish before pairing for calving.

Check and Examination of the Male and Female Fish: Use your hand to stroke lightly above the genital opening about 3 cm. See that there is milky white semen flowing, so the male fish has matured well, showing solid white semen, abundant, quickly dissolving in water. Poorly mature males exhibit dilute and scanty semen. Choosing appearance, using a needle to remove eggs and look under a microscope. Method of choosing appearance for the fish has a large, oblong belly, a soft belly evenly from top to bottom, about between the chest and belly slightly concave, the abdominal wall of the fish is thin, the area around the genital orifice is bright pink, erect, the anal opening expands, scales around the anal opening expand and identify mature fish.

Method of Using an Egg Visiting Needle: Use a needle containing a little Ringer's solution to inject about 5mm into the ovarian sinuses. Then, remove the egg and put it into Ringer's solution for cryopreservation. Observing the egg grain is unclear. The ovary is in stage II; if the egg grains are unevenly sized, not round, and sticking together, the ovaries are in stage III, 4x magnification. the egg grains are yellowish-green and round, leaving the ovary at stage IV and concluding that the fish has matured. The egg grains are separate, mushy, milky color is a degenerate egg. At the same time, combining scan and determination of egg size under a microscope can be combined with a microscope.

Data Analysis: The maturation rate is determined to begin when the ovules and poles reach stage IV: males check when scars begin to drain, and females check when they see eggs from the genital orifice. Monthly inspection of all fish in each recipe to determine the maturity rate of fish. The variance analysis (ANOVA) was used to analyze the data in this study. The normality, homogeneity, and additivity were determined in the first step, and significant differences were observed ($P < 0.05$).

Results

Water conditions

Table 3. Water quality in three eco-regions

No.	Variables	Time (h)	Expt. I (M ± m)	Expt. II (M ± m)	Expt. III (M ± m)
1	Temperature (°C)	800	29 ± 2.0	26 ± 2.0	31 ± 2.0
2	pH	8:00&14:00	7.5 ± 1.25	7.2 ± 1.25	8.2 ± 1.25
3	DO (mg/l)	8:00	4.8 ± 1.15	5.2 ± 1.11	4.5 ± 1.15
4	NH_4+/NH_3(mg/L)	8:00	0	0	0
5	Sanility (‰)	8:00	16.2 ± 1.5	25.2 ± 1.5	27.0 ± 1.5

Environmental factors in cages from April 2020 to September 2020, during the 06 month of monitoring environmental factors at specific culture sites, are as follows: pH fluctuates between 7.0 - 8.0; The dissolved oxygen (DO) content in the morning and afternoon ranges from 4.5 – 5.5mgL^{1} normally a highest in the lagoon, salinity from 16 - 27‰, there was a higher value in research station (experiment III) pumping from sea to pond, but a lowest in the sandy pond with shrimp culture and DO was the lowest value in this site. NH_4^+/NH_3: 0 mgL^{1}, and the morning and afternoon temperature ranges from 26 – 31°C. In general, fluctuations of environmental factors have not changed, and toxic gases have not been detected at the time and during the experimental periods.

Growth of Broodfish In the Maturity Culture Period:

Table 4: The changes in body weight of the broodfish during the experiment (n = 45)

Month	Females (W, g)			Males (W, g)		
	Expt. I	Expt. II	Expt. III	Expt. I	Expt. II	Expt. III
1	407.6±18.7	**404.0± 17.6**	406.6± 18.8	394.5± 22.7	**396.6 ±23.5**	395.9± 19.9
2	424.3±168	**440.7± 32.2**	422 ± 12.1	405.3 ± 4.2	**417.7±16.6**	406.7± 24.6
3	451.3^{a}±22.0	**484.7^{b}±21.7**	458.7^{c}±22.6	423.3^{a}±13.5	**433.7^{b}±18.4**	419.3^{c}±25.8
4	493.2^{a}±35.6	**520.7^{b}±31.0**	492^{c} ± 29.3	442^{a} ± 27.3	**462.7^{b}±27.1**	448.5^{c}±24.6
5	512.7^{a}±28.4	**546.7^{b}±45.9**	487.3^{c}±44.6	500^{a} ± 22.7	**552.0^{b}±42.3**	480^{c} ± 47.2
6	562.7^{a}±42.2	**610.0^{b}±36.5**	559.5^{c}±30.1	531.3^{a}±25.6	**542^{b} ± 20.8**	519.3^{c}±21,2

Values are given as mean ± standard deviation (SD, m); Expt. I: Earthen pond; Expt. II: Lagoon culture; Expt. III: Canvas pond. Letters a,b, and c in the same row, with significant differences, $P < 0.05$

Table 5: The length of fish during the experiment (n = 45)

Month	Females (L, cm)			Males (L, cm)		
	Expt. I	Expt. II	Expt. III	Expt. I	Expt. II	Expt. III
1	26.47±1.25	**25.47±1.36**	24.67±1.29	24.67±2.64	**24.60±1.40**	24.80±1.47
2	26.80±0.86	**26.60±1.50**	25.53±1.36	25.00±1.60	**25.07±1.16**	25.53±1.06
3	27.20±0.77	**27.07±1.44**	26.53±1.63	25.67±1.54	**25.87±0.99**	26.67±1.11
4	27.87^{a}±0.92	**28.87^{b}±1.13**	27.40^{c}±1.06	26.73^{a}±1.22	**27.47^{b}±1.41**	27.47^{c}±0.83
5	31.13^{a}±2.53	**31.13^{b}±2.53**	27.67^{c}±1.63	29.80^{a}±3.30	**28.20^{b}±1.47**	27.67^{c}±1.63
6	30.10^{a}±3.12	**31.20^{b}±1.08**	28.00^{c}±1.31	30.93^{a}±2.56	**29.20^{b}±1.42**	28.40^{c}±1.40

After 4 months of age, fish were captured and harvested from fishermen and farming. We selected for stocking into the cages and ponds for experiments, with healthy ones and good observation by experiences, all the fish fed by the dietary composition of commercial feed. The weight of broodfish selected for the present study ranged between 404-610g (female) and 394.5 – 542 g (male), respectively, and length ranged from 25.47- 30.10 cm (female); 24.60 – 31.20 cm (male). Values are given as mean ± standard deviation (SD); Expt. I: Earthen pond; Expt. II: Lagoon culture; Expt. III: Canvas pond and Letters a,b,c in the same row, significant differences, $P < 0.05$

Brood Farming Results In 3 Different Eco-Regions: Lunar periodicity where known, spawning rhythm in rabbitfish is lunar (Table 5). All observed spawnings took place between the new moon and the full moon—results of 2 years study on the reproductive cycle of S. guttatus in Tam Giang lagoon sexual expression. After 6 months of raising brood fish, the maturity rate results are present in Table 5. The result showed that in different forms of pat farming, there is a difference in maturity rates, in which in Phu Hai (cage farming outside the lagoon) and Vinh Xuan (cage farming in earthen ponds), the female maturity rate has reached the highest rate in cages on the lagoon, 45 – 52% for females and up to 60% for males. Then plastic bottom ponds in the research station were 28 % and 30% for shrimp ponds in 6 months of feeding. They matured up to 45 – 52% at the best rate for mature and moving to the hatchery.

Table 5: Mature fish and eggs up at different stages

Feeding months		Females			Males		
		Testing number	Mature number	Rate %	Testing number	Mature number	Rate %
1	Expt. I	45	0	0	45	0	0
	Expt. II	45	1	2.20	45	2	4.40
	Expt. III	45	2	4.40	45	2	4.40
2	Expt. I	45	4	8.80	45	2	4.40
	Expt. II	45	3	6.60	45	3	6.60
	Expt. III	45	4	8.80	45	3	6.60
3	Expt. I	45	10	22.22	45	10	22.22
	Expt. II	**45**	**10**	**22.22**	**45**	**10**	**22.22**
	Expt. III	45	10	22.22	45	10	22.22
4	Expt. I	45	12	26.66	45	12	26.66
	Expt. II	**45**	**17**	**37.77**	**45**	**18**	**40.0**
	Expt. III	45	12	26.66	45	12	26.66

5	Expt. I	45	14	31.11	45	15	33.33
	Expt. II	**45**	**19**	**42.22**	**45**	**25**	**55.56**
	Expt. III	45	13	33.33	45	15	33.33
6	Expt. I	45	14	31.11	45	15	33.33
	Expt. II	**45**	**23**	**51.11**	**45**	**25**	**55.56**
	Expt. III	45	13	28.89	45	14	31.11

Table 6 and Fig 6 indicate that the diameter initially in the treatments ranged from 180.16 to 188.05 (µm), but after 5 months of culture, the average egg diameter increased markedly, in which the fish was reared in cages at the lagoon with the largest egg diameter at 6th months was 483.92 µm, while Expt I reached 465.51 µm and 462.88 µm (Expt. II). Some researches worldwide show that when the fish (*S. guttatus*) has a diameter of ≥ 400 µm, it can participate in spawning.

Ova diameter

Table 6: Ova-Diameter of the egg by month (n = 15), µm

Month	Expt. I	Expt. II	Expt. III
1	188.05 ± 2.52	180.16 ± 8.88	186.73 ± 5.54
2	273.52 ± 22.18	276.15 ± 13.86	284.04 ± 20.75
3	339.27 ± 14.93	347.16 ± 16.63	331.38 ± 13.58
4	387.39 ± 13.83	405.02 ± 13.58	389.76 ± 11.09
5	429.21 ± 12.70	452.36 ± 11.09	423.95 ± 13.86
6	455.51 ± 12.70	483.92 ± 13.58	442. 88 ± 13.58

Values are given as mean ± standard deviation (SD); Expt. I: Earthen pond; Expt. II: Lagoon culture; Expt. III: Canvas and Letters a,b,c in the same row, significant differences, $P < 0.05$

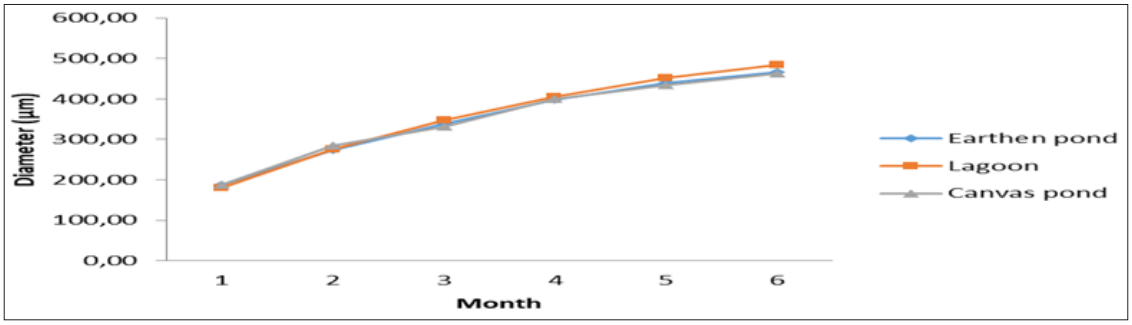

Figure 6: Ova diameter

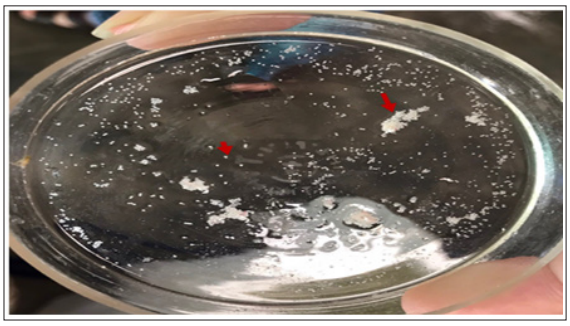

Figure 7: Egg of fish

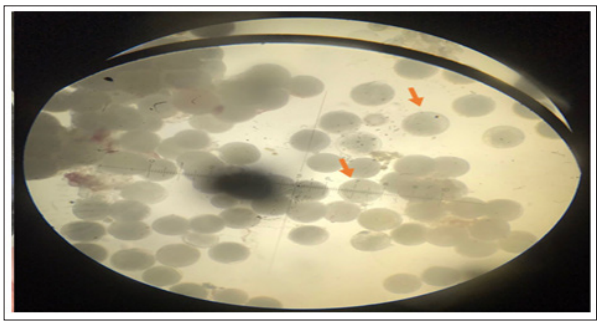

Figure 8: Eggs observed with a microscope (4X)

GSI (matured index).

Table 7: GSI of brood fish, n = 15

Month	Female (%)			Male (%)		
	Expt. I	Expt. II	Expt. III	Expt. I	Expt. II	Expt. III
1	1.29 ± 0.3	1.26±0.2	1.27±0.4	0.70 ± 0.1	0.71 ± 0.1	0.73 ±0.2
2	1.73 ± 0.2	1.93±0.2	1.61±0.3	1.00 ± 0.2	1.17 ± 0.2	1.02 ±0.2
3	1.77 ± 0.2	2.00±0.2	1.73±0.0	1.43 ± 0.2	1.51 ± 0.3	1.49 ±0.1
4	2.69a ± 0.3	3.03b±0.3	2.59±0.3	2.10a± 0.1	2.20b± 0.1	1.73c±0.2
5	3.68a ± 0.3	4.33b±0.3	3.53c±0.4	2.37a± 0.2	2.59b ± 0.1	2.33c ±0.9
6	3.97a± 0.2	4.53c±0.7	3.80c±0.6	2.51a± 0.3	2.78b± 0.3	2.49c±0.1

Values are given as Mean ± standard deviation (SD); Expt. I: Earthen pond; Expt. II: Lagoon culture; Expt. III: Canvas pond and Letters a,b,c in the same row, significant differences, $P < 0.05$.

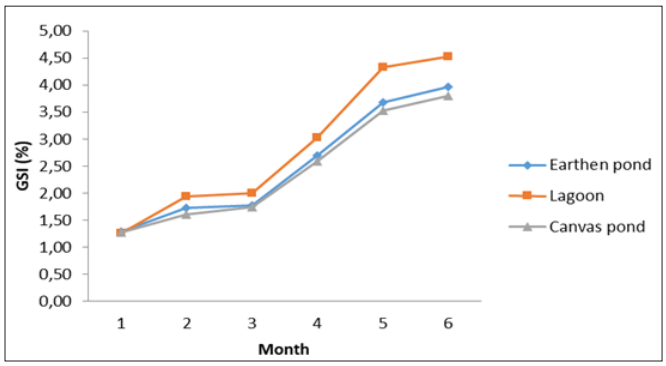

Figure 9: GSI of the females by month

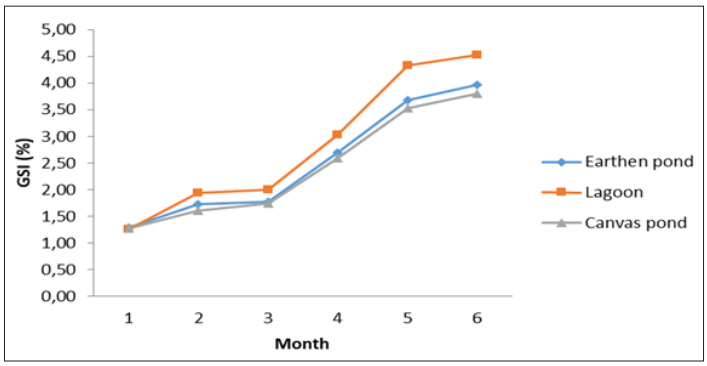

Figure 10: GSI of the male by month

Table 4 shows the weight and Maturity coefficient, important parameters to assess sexual maturity and its gonadal mass. So, when it comes to developing the gland's sexual maturity, one cannot fail to mention the maturation factor (GSI). Through GSI, we can predict and monitor the growth and maturation of genital cells GSI is widely used in biological research. However, GSI sometimes does not fully reflect the actual state of the product's genitalia, especially for fish that spawn several times a year. The study showed that the GSI in female barnacles fluctuated according to the calving cycle. Instrument For example, GSI is lowest in December (first month of feeding) (1.26%) and highest value in June (6 months of feeding), reaching 3.58%. While feeding in season, from November to March of the following year, there are no significant differences between the matured fish ($P > 0.05$), ranging from 1.25% to 1.49%. Winter is coming this season and lowering water temperature and sanility. With no moon and higher tides, rabbitfish go to coral reefs or stoking in shrimp ponds.

Discussions. More water placement on the lagoon is in good condition for fish growth and maturity. While in ponds (experiments: I and II were less condition), rabbitfish cope with sanility and temperature changes, and besides commercial feeding, as a part of live food in the lagoon or shrimp pond can support fish and natural feed ingested. The important factors for mature rabbitfish were the moonlight regime, dark sky, and water temperature [7,12,13].

Males were smaller than females, and broodfish increased in weight and length during the culture period. In which the fish reared in experiment II had the highest growth. This study is suitable for [14,15]. During the study period, the broodstock size did not change much. For the scorpion, at the same time and growing conditions, the female usually has a maximum length and weight greater than males in lagoon cages with more spacemen and an open environmental condition, especially the tide changes by the day. The ratio of the mass to the length of the fish. Females are usually larger than males. This can be said that at the reproductive stage, the female body is in the period of accumulation and storage of energy, so it tends to increase in terms of volume face, with the earlier observation that the fish in captivity spawns during the moon's first quarter [7]. Broodstock is not much information available for species other than *S. guttatus*. suggested a feed formula for *S. canaliculatus* and *S. spinus*, but this is yet to be tested for efficiency. *S. guttatus* fed commercial pellets (42% protein) at 2% of body weight have been maintained in tanks [16]. The fish spawns monthly at a high protein diet, but there is a decline in fertilization, hatching rates, and larval quality with the spawning age [10,16]. Suggests that broodstock be maintained on a diet low in energy and protein content but high in ash. For spawning purposes, the fish should be fed a diet high in energy and protein content but low in ash. A single female spawned for four successive months when fed a diet of 10% pollack or cod liver oil [7]. Diets rich in cod liver oil alone or combined with soybean or lecithin induced repeated spawning for 13 consecutive months. Broodstock of *S. guttatus* fed with formulated diet containing 18% fat from these sources also spawned more eggs and gave better larval survival than those fed diets with only 12-15% fat [4] Larvae from this broodstock were larger at hatching. There were no remarkable effects on fertilization, yolk volume and hatching rates at these three dietary levels [13]. Reported that larvae from spawners injected with 10 and 100 µg thyroxine (T4)/g BW were relatively longer and survived better than those from the control and those injected only with 1 µg T4/g BW 7 days after hatching. They hypothesized that T4 is converted into T3 (triiodothyronine), and these hormones in maternal circulation were transferred into the oocytes and consequently into the larvae.

Larval length at hatching was significantly improved by injecting T3 into the mother fish two days before spawning [13]. Oocyte sizes at the immature stage ranged from 53 to 148 µm, and at the mature stage, ranged from 364 to 371 µm [14]. At the same time, Siganus rivulatus has a mature egg size of 440 µm [17].

With good environmental conditions and more space to absorb the moonlight, mature females in all experiments started mature after feeding for 3 months. The results also showed that in the same farming conditions, male fish have a higher success rate than females under similar conditions. There were fed commercial feed to rabbitfish to maintain their protein diets and energy supply for fish during the developing stages after 4 months of age. Fish ingest enough nutrients, and moonlight conditions on the lagoon as a mature pat breeding place ideal for rabbitfish discussed by [6,19,20]. Who tried to get a condition on the lagoon with suitable sanility and dietary composition.

Table 4 shows the weight and maturity coefficient, important parameters to assess sexual maturity and its gonadal mass. So, when it comes to developing the gland's sexual maturity, one cannot fail to mention the maturation factor (GSI). Through GSI, we can predict and monitor the growth and maturation of genital cells GSI is widely used in biological research. However, GSI sometimes does not fully reflect the actual state of the product's genitalia, especially for fish that spawn several times a year. The study showed that the GSI in female barnacles fluctuated according to the calving cycle. Instrument For example, GSI is lowest in December (1.26%) and highest value in June (3.58%). From November to March of the following year, there is no statistically significant difference ($P > 0.05$), ranging from 1.25% to 1.49%. However, from April to September, GSI increased significantly by sixty-one. After all, the highest value recorded was 3.58%. There is no statistically significant difference ($P > 0.05$) in GSI values between April, May and June (Fig 9 & 10) for females and males. GSI in female fish at 4, 5, and 6 months was higher and showed a significant difference ($P < 0.05$) compared to the remaining months in the sampling period because this is the experiment I and III main spawning during the year of the scorpion, while species *Siganus canaliculatus*, the egg diameter distribution varies significantly during ovarian maturation, with the largest egg diameters ranging from 300-400 µm, accounting for about 88% of the total eggs [18] 350- 450 µm.[21]. Which is consistent with previous studies [22]. Compared with the scorpion in Thua Thien Hue lagoon, the variation in GSI in the reproductive cycle is similar to the results of this study. However, this study determined GSI only through the main breeding season, not the full accumulation of fluctuations throughout the year [23-25].

Conclusions: The ability to mature broodstock in different rearing conditions (ponds, cages and plastic bottom ponds) and different mature methods. During 6 months of feeding by commercial feed, the rabbitfish start mature at 8-9 months of age as 2-3 months of feeding. Water conditions, moon season, and Lunar periodicity are known. Spawning rhythm in rabbitfish is lunar impacted on mature age and weight.

Conflict of interests: The authors declare no conflict of interest.

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