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Assessment of growth dominance of females over males in earthen ponds of *Litopenaeus vannamei* (Boone, 1931)

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Abstract
Sexual growth dimorphism is an evident in white leg shrimp, *Litopenaeus vannamei*, Boone, 1931 with females grows faster than the males. A study was carried out at private shrimp farm, Navsari, Gujarat to ascertain the growth superiority of females over the male populations in earthen pond of *L. vannamei.* Five earthen pond of 0.75 ha stocked with PL-20 (post larvae) at 32 m^{-2} were selected for study. Date *viz.*, age of sex identification, average body weight (ABW), feed conversion ratio (FCR), sex ratio (M:F) and water quality parameters were recorded. First external sex differentiation was possible at sizes of above 7 g at 45-50 days of rearing. In earthen pond, female shrimps attained higher growth rate around 11% compared to male populations at same rearing period. Result of the present study revealed that all female culture of *L. vannamei* can makes better enterprise.

Keywords: *Litopenaeus vannamei*, sex differentiation, growth rate, all female culture

Introduction
Many crustacean species shows sexual growth dimorphism in which females grows faster and attain larger size than males at same age [1-6]. Females of *P. monodon* grew 16% faster when grown in isolation compared to those in mixed-sex culture [7]. Some commercially important penaeid shrimp species shows same growth dimorphism under culture conditions [8-12]. All female of *P. monodon* attained significantly higher growth of 40% and 43% compared to all male and mixed-sex treatments, respectively, with greater specific growth rate and protein efficiency ratio, and lower feed conversion ratio [13]. *Litopenaeus vannamei*, Boone, 1931 is the most important cultured penaeid shrimp worldwide. For the development of shrimp industry production needs to be improved. *L. vannamei* also exhibit sexual growth dimorphism in which females achieves a larger size than males. But the mechanism by which females grows larger than males is not known. Sexual dimorphism for growth of *L. vannamei* would be useful for determining when the females should be separated from males during culture in order to ensure consistent size of shrimp in ponds and to determine if the differences are large enough to warrant mono-sex (all-female) culture. Therefore, size of the sex differentiation is also important. From the day 50, the external sex differentiation is possible in pacific white shrimp [14]. Moss and Hennig [15] reported that the growth of *L. vannamei* females diverges from males at approximately 20 g and monosex females grew 16% faster than those in mix-sex culture. While most of the trials on all female culture of *L. vannamei* were carried out in temperate or subtropical regions, such reports from the tropics are rare. The goal of the present study was to determine size of first external sex differentiation and assess the growth dominance of females over males in earthen ponds of *L. vannamei.*

Materials and Methods
The present study was performed at the private shrimp farm, Navsari, Gujarat. Five earthen ponds of 0.75 ha stocked with 32 m^{-2} were selected for study. Ponds were harvested 130 days after stocking. At harvest, fifty male and female shrimps were randomly sampled from each pond and average body weight was measured. For sex ratio (M: F), 50 shrimps from each pond was randomly sampled and male and female percentage in pond was calculated. Data *viz.*, feed conversion ratio (FCR), percentage survival and pond yield (kg ha^{-1}) were taken. Water samples were taken from each pond for analysis. Physico-chemical parameters of water *viz.*,

temperature-by using mercury thermometer; pH-by using universal indicator solution; dissolved oxygen-by Winkler's method; salinity-by using salinity refractometer (Atago, Japan); alkalinity, and ammonia (NH3-N) (by test kits – Merck, Darmstadt, Germany) were monitored.

Results and Discussion

In present study, water quality parameters were recorded (Table 1) and they were in desired range except hardness which was higher than desire range. In *L. vannamei* external sex determination was started after a period of 45-50 days of rearing at size of above 7 g which was same as the reported by workers [14].

Average body weight (g), sex ratio (M: F), FCR, percentage survival and pond yield (kg ha^{-1}) is shown in (Table 2). Moss and Moss [16] reported that in *L. vannamei* females in monosex culture grows 16% faster than those in mixed-sex culture. In present study, ponds were harvested 130 days after the stocking and average weight of females (29.59±0.87 g) was significantly larger than average weight of males (25.72±1.36 g) in respective pond. Females were approximately 4 g heavier than males in all earthen ponds after 130 days of culture. Female attained higher growth rate of 11.4% compared to male populations in earthen pond.

Therefore, we conclude that weight is more important than age in determining onset of sexual dimorphism for growth in *L. vannamei*. So, results of present study have two implications for the *L. vannamei* culture. Firstly, large variation in harvest weight from a pond due to difference in growth rates between male and female shrimp which may be undesirable if farmers want to produce same size product. This could be solved by segregating slow growing males from females and they will be cultured in separate ponds. Secondly, the 4g difference between females and males in the commercial pond environment represents an important (11%) female-superior sexual dimorphic advantage (Figure 1). So, more production can be increased by culturing all female shrimp. However, efficient technique for production of all female populations needs to be development and more research is needed to find out the mechanisms behind the growth superiority of females.

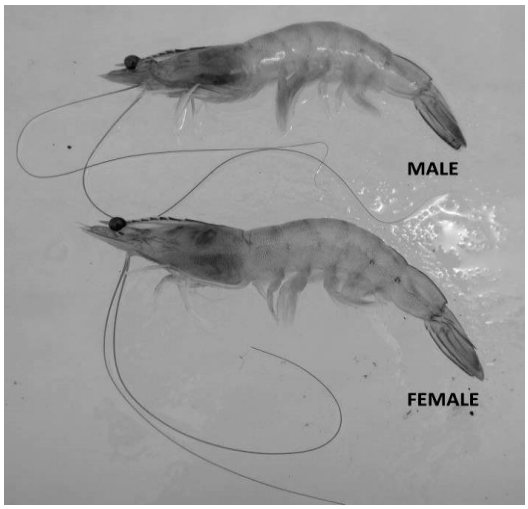

Fig 1: Male and female of *L. vannamei* same age and same pond

Table 1: Harvest weight of male and female, sex ratio (M:F), feed conversion ratio (FCR), percentage survival and pond yield of *L. vannamei*

Pond No.	Average body weight (g)		Sex Ratio (M:F)		FCR	Survival (%)	Pond Yield (kg/ha)
	Male	Female					
1	27.40	30.58	46	54	1.50	94.00	6615
2	24.56	28.78	58	42	1.62	94.00	6236
3	26.98	30.48	36	64	1.54	86.00	6872
4	24.68	28.92	62	38	1.54	87.00	6177
5	24.98	29.18	54	46	1.56	92.00	6316
(Mean±SD)	25.72±1.36	29.59±0.87	51±10.35	49±10.35	1.55±0.04	90.60±3.85	6443±292.98

Table 2: Water quality parameters of *L. vannamei* culture pond

Water parameter	Range
Salinity (ppt)	33-40
Temperature (C°)	26-31
Dissolved oxygen (ppm)	4.4-5.9
pH	7.7-8.4
Total Ammonia (ppm)	0.00-0.03
Total hardness (ppm)	7800-8500
Water colour	Light brown to greenish brown
Alkalinity (ppm)	180-220
$HC0_3$ (ppm)	190-210

Conclusiona

Results of the present study support for all female culture of *L. vannamei*. The results also indicate that females might have some physiological advantages in terms of growth, which would confer positive benefits during grow-out period in pond. The results further indicates that farming of monosex females of *L. vannamei* could be more economical than the present practice of mixed sex culture. However, more studies, especially on the economic aspects are required before all female culture could be adopted as a standard practice in commercial shrimp farming practices.

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