# GROWTH AND SURVIVAL OF MOLOBICUS TILAPIA AT DIFFERENT STOCKING DENSITIES WITH WHITE SHRIMP (*PENAEUS VANNAMEI* ) AND *GRACILARIA SP*. IN AN INTEGRATED MULTI-TROPHIC AQUACULTURE SYSTEM

**Casing, L.A.J., E.C. Capinpin, S.C. Parreño, L.V. Damaso, J.J. Ormilla and K. P. Panuncio**

College of Fisheries and Aquatic Sciences, Pangasinan State University – Binmaley Campus, Binmaley, Pangasinan, 2417 Philippines

## ABSTRACT

The study was conducted to determine the growth and survival of the Molobicus tilapia (main cultured species) at different stocking densities (Treatments 1-3 at 20, 30, and 50 fish/0.3m2) co-cultured with *Penaeus vannamei* (deposit feeder); and *Gracilaria sp.* (biofilter) at 20pcs and 200g/0.3m2, respectively in an integrated aquaculture system. Results revealed no significant differences on the growth of tilapia in in terms of length, weight, and specific growth rate (SGR). Of all the growth parameters of *P. vannamei,* only specific growth rate (weight) of Treatment II and III shows significant difference (P>0.05) with Treatment I. Molobicus tilapia and white shrimp (*P. vannamei*) were in good condition throughout the entire culture period as evidenced by their SGR and condition factor. The extractive and biofiltering functions of *P. vannamei* and *Gracilaria sp.*, respectively were evident in the first 60 days of culture in all treatments as evidenced by the zero reading of ammonia nitrite and nitrate. The increasing wastes excreted by tilapia in Treatment III, in the last days of culture period, brought changes in the water quality particularly on the presence of nitrogenous compounds. The change however, was not significant to affect the survival of tilapia and shrimp in this treatment compared with the other two treatments.

It can be deduced that culturing three (3) species in a single environment is possible and can help increase the production of fish per unit area per unit time without sacrificing environmental health. The results however need to be verified in larger area like tanks or pond to determine the yield and net income.

Keywords: integrated multi-trophic aquaculture system, molobicus tilapia, *Penaeus vannamei*

## INTRODUCTION

Fish production from all sources (commercial, municipal and inland fisheries) in the Philippines is declining from 4.65M metric tons in C.Y. 2015 to 4.3M metric tons in 2017 (FSP 2015-2017). Many of our marine fishing grounds are overfished due to increasing number of fishers and illegal fishing activities such dynamite and cyanide fishing and use of fine meshed nets and other destructive fishing gears. Municipal and inland fisheries on the other hand are beseted by pollution problems due to overstocking leading to excess organic loads and consequently algal bloom and fish kills. Fish production should be increased sustainably to support the needs of protein of the growing population without sacrificing the health of the environment. An Integrated Multi-Trophic Aquaculture (IMTA) farming system uses species that commercially valuable and environmentally sustainable. It co-cultures organisms from different level of the food chain in one environment where wastes from one species becomes a source of food for another and unconsumed feeds and other organic matter served as fertilizer for the growth of plants like seaweeds (Largo et al. 2016). The idea of co-culturing two or more species from different food chain in the same environment maximizes production per unit area per unit time, thus increasing production and creating a healthier environment. This could not be a panacea for the declining fish production and the deteriorating condition of the aquatic environment but could help sustain or increase fish production and mitigate water pollution, particularly in the marine waters.

## MATERIALS AND METHODS

The study was conducted at Pangasinan State University – Binmaley Campus. A total of three hundred (300) pieces of saline molobicus tilapia (Fig.1) fingerlings with an initial weight of 0.4-0.6g were stocked in nine (9) plastic drums at a density of 20, 30, and 50fish/0.3m$^2$ representing Treatments 1-3, respectively. The tilapias in each treatment were co-cultured with 20 pieces of *P. vannamei* (Fig. 2) post larvae (PL15), and 200g of *Gracilaria sp.* (Fig.3). The culture units were provided with aeration to ensure sufficient amount of dissolved oxygen.

The tilapias were fed twice a day with floating pellets at 5% of their body weight throughout the culture period. Feeding rations were adjusted every after sampling. The *P. vannamei,* being detrital feeders feed on wastes and some uneaten feeds of tilapia, whereas *Gracilaria sp.* filters organic matter produced/unconsumed by the two species.

Dissolved oxygen, pH and temperature of the water were monitored daily, while ammonia, nitrate and nitrite were monitored weekly. Water salinity was also monitored daily and maintained at 25ppt.

Monitoring of the growth performance of the stocks were undertaken biweekly by measuring the individual length and weight of twenty percent of the stocks using a digital weighing balance and Vernier caliper, respectively (Fig.4). Survival of the stocks were also monitored daily and used in bi-weekly feeding ration adjustments.

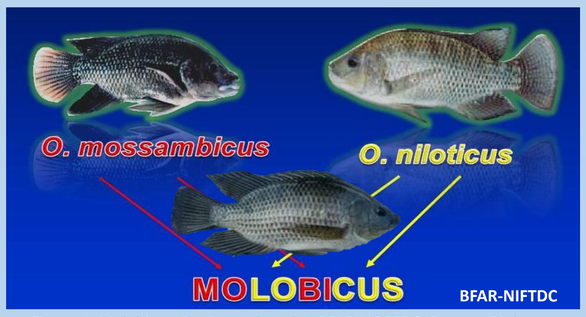


Figure 1. Molobicus tilapia produced at BFAR-NOFTDC, Bonuan Binloc, Dagupan City

Figure 2. White shrimp *(Penaeus vannamei*)

Figure 4. . *Sampling of stocks*

Figure 3. *Gracilaria sp*. locally found in the fishponds in Binmaley, Pangasinan

## RESULTS AND DISCUSSION

Molobicus tilapia in Treatment III (50pcs tilapia, 20pcs *P. vannamei* and 200g *Gracilaria sp.*) obtained the highest gain in weight and length and specific growth rate (SGR) with mean values of 8.73g, 5.37cm and 4.49%/day, respectively. Treatment I (20pcs tilapia, 20pcs *P. vannamei* and 200g *Gracilaria sp.*) followed with mean values of 8.58g, 4.82cm and 3.96%/day, respectively. Treatment II (30pcs tilapia, 20pcs *P. vannamei* and 200g *Gracilaria sp.*) obtained the least values of 8.07g, 4.36cm and 3.45%/day, respectively (Table 1, Fig.5). Analysis of variance (ANOVA) showed no significant differences among treatment means (P>0.5).

**Table 1. Weight (g), length (cm) and SGR of molobicus tilapia in an IMTA system**

| Treatments | Weight (g) | | | Length (cm) | | | SGR (%w/d) | SGR (%l/d) |
|---|---|---|---|---|---|---|---|---|
| | Initial | Day 75 | Gain | Initial | Day 75 | Gain | | |
| I (20pcs Tilapia, 20pcs *P. vannamei* and 200g Gracilaria sp.) | | | | | | | | |
| $R_1$ | 0.53 | 7.57 | 7.04 | 3.17 | 7.22 | 4.05 | 3.45 | 1.10 |
| $R_2$ | 0.34 | 10.32 | 10.00 | 2.80 | 8.21 | 5.41 | 4.51 | 1.43 |
| $R_3$ | 0.45 | 9.16 | 8.71 | 3.05 | 8.04 | 4.99 | 3.94 | 1.29 |
| Mean | 0.4 | 9.02 | 8.58$^{ns}$ | 3.01 | 7.54 | 4.82$^{ns}$ | 3.96$^{ns}$ | 1.27$^{ns}$ |
| II (30pcs Tilapia, 20pcs *P. vannamei* and 200g Gracilaria sp.) | | | | | | | | |
| $R_1$ | 0.54 | 7.93 | 7.39 | 3.47 | 7.43 | 3.96 | 3.48 | 1.02 |
| $R_2$ | 0.37 | 10.36 | 9.99 | 2.84 | 8.28 | 5.44 | 4.40 | 1.43 |
| $R_3$ | 0.76 | 7.57 | 6.81 | 3.63 | 7.32 | 3.69 | 2.93 | 0.94 |
| Mean | 0.6 | 8.62 | 8.07$^{ns}$ | 3.31 | 8.32 | 4.36$^{ns}$ | 3.45$^{ns}$ | 1.13$^{ns}$ |
| III (50pcs Tilapia, 20pcs *P. vannamei* and 200g Gracilaria sp.) | | | | | | | | |
| $R_1$ | 0.46 | 9.41 | 8.95 | 3.05 | 7.96 | 4.91 | 3.95 | 1.28 |
| $R_2$ | 0.44 | 8.66 | 8.22 | 2.81 | 8.47 | 5.66 | 3.89 | 1.47 |
| $R_3$ | 0.31 | 9.32 | 9.01 | 2.93 | 8.47 | 5.54 | 4.48 | 1.42 |
| Mean | 0.40 | 9.31 | 8.73$^{ns}$ | 2.93 | 7.94 | 5.37$^{ns}$ | 4.49$^{ns}$ | 1.39$^{ns}$ |

Weight gain of molobicus tilapia in this study was higher compared to the values obtained by Visperas et al. (2018) using the same species. They recorded a weight gain of 4.40g for the stocks fed with formulated feed and 3.40g for those fed with commercial feed.

*Penaeus vannamei* depends on the unconsumed feeds and feces of molobicus tilapia for food. After 75 days of culture, this species of shrimp grew to a mean range of 1.79g (T-II) to 3.5g (T-III). Highest mean weight gain was recorded in Treatment III with a mean of 3.29g (Figure 6). Analysis of variance showed no significant differences between the highest mean value and the values obtained in other two treatments at 0.05% level of significance. In terms of SGR (%w/day), Treatment II and III have the highest mean SGR of 4.13%. Analysis of variance showed that SGR of Treatments II and III differ significantly (P<0.05) with SGR in Treatment I. Generally, results of this study for *P. vannamei* suggests that with higher stocking density of molobicus tilapia, more food becomes available to sustain the growth of the *P. vannamei*. The mean SGR obtained in this study was higher compared to that obtained by Fourooghifard et al. (2017). They reported an SGR of 1.97%/day for white shrimp stocked at 25pcs/m2 and 400g seaweed/m2 and 1.69%/day for shrimp stocked at 50 pcs/m2 without seaweed. Towers (2013) also obtained mediocre SGR of 1.37%/day for monoculture of *P. vannamei* and 1.29%/day and1.88%/day for co-culture with *Gracilaria birdiae* and with *Ulva fasciata*, respectively.

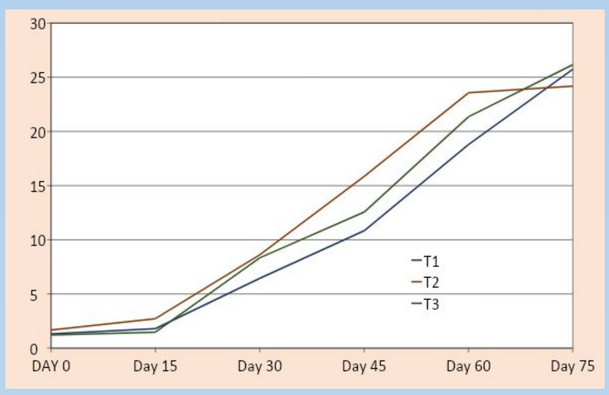


Figure 5. Periodic gain in weight of molobicus tilapia in an IMTA system

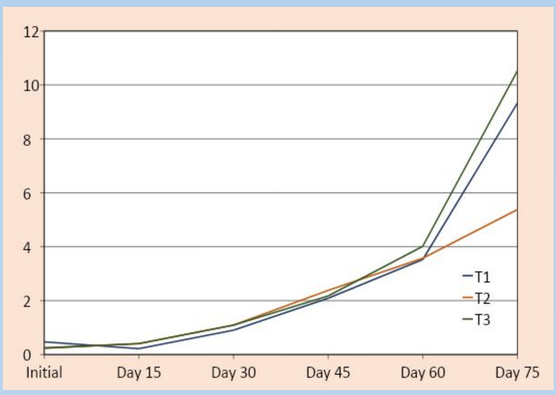


Figure6. Periodic gain in weight of *P. vannamei* in an IMTA system

The growth of *Gracilaria sp* steadily increased as evidenced by the recorded periodic weight, mean weight gain and SGR after 75-days of culture. Highest weight increment was observed in Treatment II with 2,572.38g (Fig. 7). Specific growth rate was high at 3.41%/day (T-II) and this mean value did not differ significantly with the values obtained in T-I and T-III. This indicates that *Gracilaria sp.* could grow steadily even when co-cultured with 20-50pcs of molobicus tilapia and 20pcs of shrimp. Survival rate of Molobicus tilapia and *Penaeus vannamei* were found highest (98.33%) in Treatment I. Results revealed that there is no significant difference (P<0.05) among treatment means. Highest survival rate (Fig. 8.) in this study was a bit higher than the survival rate of *P. vannamei* co-cultured with seaweed as reported by Fourooghifard et al. (2017). They further stated that the co-culture of seaweed with *P. vannamei* could boost the survival of the latter in a zero-water exchange system.

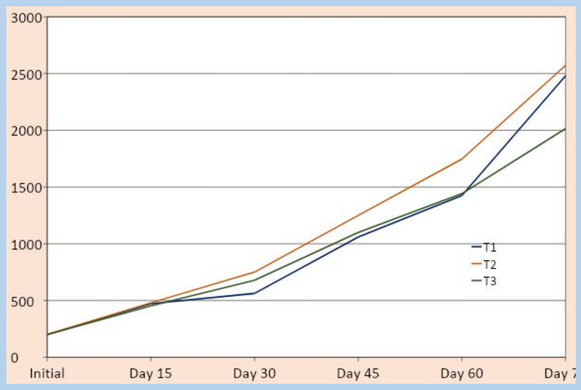


Figure 7. Periodic gain in weight of *Gracilaria sp* in an IMTA system

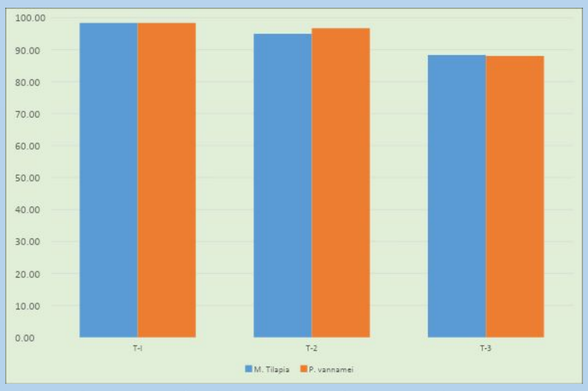


Figure 8. Survival rate of Molobicus tilapia and P. vannamei in an IMTA system

Water parameters (dissolved oxygen, pH, and temperature) recorded throughout the culture period were within the standard for fish culture. Dissolved oxygen (DO) concentrations ranged from 5.34 mg/L to 5.7 mg/L; pH values ranged from 7.20 to 7.37; and the water temperature ranged 25.2$^o$C to 28.3$^o$C. For ammonia, nitrite and nitrate, a zero reading was obtained in the first 60-days of culture. The nitrogenous wastes became evident as the end of the culture period approaches. This shows that the shrimp and *Gracilaria sp.* could remove the nitrite ($NO^2$) and nitrate ($NO^3$) from the water for considerable period of time or their densities should be increased to maintain the good quality of the water for longer culture period.

## CONCLUSION AND RECOMMENDATIONS

Molobicus tilapia, *P. vannamei and Gracilaria sp.* are compatible species to be co-cultured under the integrated multi-trophic aquaculture system as evidenced by their good growth and survival in this study. The lack of significant changes in water quality shows the potential of integrated multi-trophic aquaculture of these high-valued species at high densities.

Another experiment can be conducted, increasing the density of *P. vannamei* and gracilaria sp. to utilize the wastes of the main/fed species. Other high valued species could also be tried for higher income.

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