Integrating bivalves in IMTA system using earthen ponds

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Introduction

The demand for aquatic resources increases with increasing population. However, production from capture fisheries plateaued as early as the mid-90s (FAO, 2019a). With limited production from natural sources, aquaculture has become an important source of fisheries products and production has been steadily increasing (FAO, 2019b) (**Figure 1**). Despite the sustainability of aquaculture, studies have shown of its negative impacts to the natural environment. Because of these negative impacts of aquaculture, scientists are finding ways to eliminate or at least minimize these impacts to improve environmental quality and productivity while keeping production sustainable.

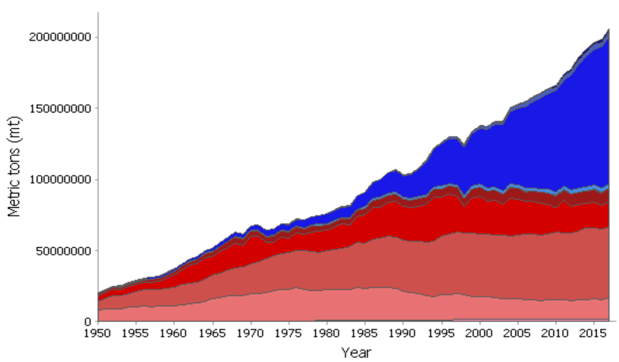

Figure 1. Total world capture (shades of red) and aquaculture (shades of blue) production (FAO, 2019a; FAO, 2019b).

Integrated multi-trophic aquaculture, popularly known as IMTA, is a system where one species finds a feeding niche in the waste generated by another species. The concept of integrating species into one culture system originated from Asia and the Middle East and the development of integrated aquaculture involving marine bivalves is relatively new, around the 1980s in China and 1990s in Western countries (Strand *et al.*, 2019).

This study aimed to integrate the mangrove clam *Anodontia philippiana* (**Figure 2**), which has the capacity to assimilate sulfide (Lebata, 2001; Lebata, 2000), in a pond culture system with milkfish *Chanos chanos* and seaweeds *Gracilariopsis heteroclada*. Specifically, it aimed to know the effects of integrating other commodities on the growth and survival of milkfish, the primary culture species in IMTA in ponds.

Figure 2. The mangrove clams, *Anodontia philippiana*, used in integrated culture with milkfish in earthen ponds in Concepcion, Iloilo, Philippines.

Materials and Methods

The study was conducted in Concepcion, Iloilo, Philippines. An earthen pond with 4 compartments, each measuring 320 m^2 was utilized for the experiment. The experiment had 4 treatments, as follows, and distribution of cultured species is shown in **Table 1**:

Treatment 1 = milkfish only
Treatment 2 = milkfish + seaweeds
Treatment 3 = milkfish + mangrove clams
Treatment 4 = milkfish + seaweeds + mangrove clams

Table 1. Density of milkfish, seaweeds and mangrove clams in 4 compartments of the earthen pond. Each compartment represents one treatment.

Pond	Milkfish	Seaweeds	Mangrove clams
1	320 pcs	None	None
2	320 pcs	32 kg	None
3	320 pcs	None	160 pcs
4	320 pcs	32 kg	160 pcs

The experiment commenced on 24 May 2013 and was terminated when the milkfish attained harvestable size of 300 g average body weight (ABW) at 82 days of culture (DOC). During the experiment, milkfish were fed commercial diet starting at 8 % of the total biomass tapering gradually to 3 % towards harvest, equally rationed three times a day. Sampling of stocks was done every 3 weeks by weighing individually 10 % of the total stocks per compartment/treatment. Mortality was recorded daily and during sampling.

Water temperature and salinity were monitored daily while pH, dissolved oxygen (D.O.), sulfide, phosphate, nitrate, nitrite and ammonia every 3 weeks.

Results and Discussion

Milkfish growth did not significantly differ during the first two months of culture but apparently during harvest, milkfish reared with mangrove clams had significantly higher ABW than those reared with mangrove clams and seaweeds (ANOVA, $p<0.05$) (**Figure 3**).

Upon harvest, survival was higher when milkfish was reared with seaweeds and mangrove clams (98.1 %) while lowest when monocultured (92.5 %) (**Figure 4**). The lowest ABW upon harvest of milkfish reared with other commodities may be attributed to the higher stocking density because of the highest survival in this compartment. Average survival from four compartments was 95.1 %

Feed conversion ratios were 1.9, 1.9, 1.7 and 2.0 in ponds 1 (milkfish only), 2 (milkfish + seaweeds), 3 (milkfish + mangrove clams) and 4 (milkfish + seaweeds + mangrove clams), respectively.

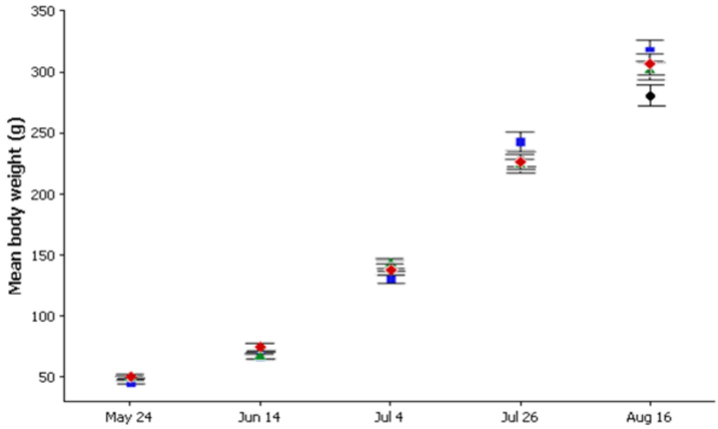

Figure 3. Monthly average body weight (ABW) of milkfish reared with or without other aquaculture commodities in earthen ponds in Concepcion, Iloilo, Philippines; red-filled diamonds = milkfish only, green-filled triangles = milkfish+seaweeds, blue-filled squares = milkfish+mangrove clam, black-filled circles = milkfish+seaweeds+mangrove clams.

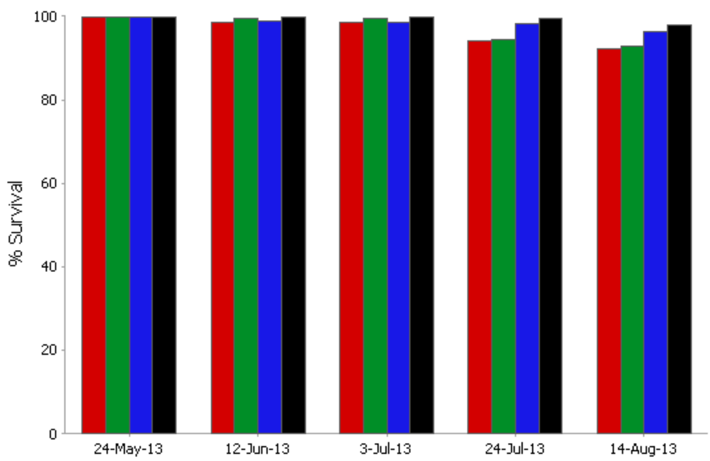

Figure 4. Milkfish survival (%) every 3 weeks when reared with or without other aquaculture commodities in earthen ponds in Concepcion, Iloilo, Philippines; red-filled bars = milkfish only, green-filled bars = milkfish+seaweeds, blue-filled bars = milkfish+ mangrove clam, black-filled bars = milkfish+ seaweeds+mangrove clams.

There was not much difference in temperature, salinity and D.O. between pond compartments. pH was higher in ponds with milkfish and mangrove clams and lower in milkfish and seaweeds. The elevated pH in compartments with mangrove clams may be due to the sulfide assimilating property of the clams. Towards harvest, ammonia and phosphate were higher in compartment with milkfish only.

Conclusions and Recommendations

Although this one run may not be conclusive, the results showed that milkfish may be cultured with extractive species in an IMTA system without significantly affecting its growth and survival. Integrating mangrove clams and seaweeds in the system may help improve water quality. However, studies on species combinations and ratio of the different species to be incorporated in the system should be done to establish a sustainable and effective IMTA technology.

References

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