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Influence of level of farm management and correlation of water quality in the parasitosis of Nile tilapia (*Oreochromis niloticus* L.) in selected grow-out farms in Central Luzon Philippines

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Abstract
The present study recorded six genera of ectoparasites (*Trichodina* spp., *Coleps* spp., *Euplotes* spp., *Dactylogyrus* spp., *Gyrodactylus* spp. and *Ergasilus* spp.) and three taxa of endoparasites (*Camallanus* spp., and unknown digenean and acanthocephalan) from the gills and skin, and intestine, respectively of the examined Nile tilapia in Central Luzon, Philippines. The study revealed that farms receiving intensive level of management (>7 fish/m^2) had the highest parasites' load as compared to semi-intensive (4 to 6 fish/m^2) and extensive system (1 to 3 fish/m^2). Moderate fish stocking in semi-intensive system is an advantage on the reduction of parasite infestation and transmission. In extensive level of management, even of low stocking density, fish were just stocked and not provided with good husbandry. This kind of practice also resulted to higher infestation and easy spread of ectoparasites. Environmental factors such as the physico-chemical properties of water could influence the level of parasitosis in pond-reared tilapia but show little consistency in the present results.

Keywords: Nile tilapia, ectoparasites, endoparasites, level of farm management, water quality

1. Introduction
Aquaculture has emerged as an important industrial force of environmental, economic and social change in many regions in the world. Farming of species such as tilapias (*Oreochromis* spp.) has contributed immensely to food security. Tilapias have been hailed as the culture species of the 21st century and referred to as the aquatic chicken. World tilapia production has increased steadily by the years; most has been obtained from Asia [1].
Tilapias are farmed under extensive, semi-intensive and intensive systems. Extensive system requires a low stocking density (1 to 3 fish/m^2) without provision of supplemental and formulated feeds. Supplemental feeds are usually given to semi-intensive management in order to support the moderate stocking density (4 to 6 fish/m^2). Under intensive system, fish are more heavily dependent on formulated feeds because of high stocking density (> 7 fish/m^2) [2].
In recent years, tilapia farming is becoming more intensified in order to produce higher yields, and this necessitates the use of fishmeal and fish oil in feeds. Asian countries such as China are increasingly using formulated feeds for tilapia farming [3].
The intensification of fish culture creates parasitic disease problems that originate from overcrowding or deteriorating water quality such as unsuitable water temperature, pH, carbon dioxide and free ammonia concentrations [4, 5, 6]. According to Folke and Kautsky [7], stress related to the environmental conditions greatly favor disease outbreaks and transmission in the facilities. Therefore, aquaculture can also be considered as an important vector in the introduction, transfer and spread of aquatic diseases and parasites [8]. The high risk of disease transmission and parasite infestations among species has increased the level of uncertainty which farm managers have to contend with to develop the industry [9]. This study was conducted in order to determine the influence of level of management and correlation of water quality in the parasitosis of Nile tilapia (*O. niloticus* L.) in selected grow-out farms in Central Luzon Philippines.

2. Materials and Methods

2.1 Sample collection and preparation

Pond-reared Nile tilapia samples were collected from the four leading tilapia-producing provinces in Central Luzon, Philippines namely Pampanga, Bulacan, Nueva Ecija and Tarlac. Sampling was carried out during dry season in a monthly interval from January to April 2011. Ten per cent (10%) of the number of freshwater tilapia pond owners in each province operating ≥ 5 ha fish farm were selected. The level of farm management (i.e., either extensive, semi-intensive or intensive) was noted and the classification was based on the stocking practices of the farm (extensive = 1 to 3 fish/m^2, semi-intensive = 4 to 6 fish/m^2, intensive = >7 fish/m^2). Forty (40) fish samples in every farm were collected using cast net and/or gill net. The samples were placed in aerated plastic bags and/or in a tub with pond water. The sex of the collected samples was determined by examining the genital papilla. Males have pointed genital papilla as opposed to rounded and swollen in females.

Smears of gills, skin, fin, stomach and intestine were made and examined under the microscope for the presence of parasite. The parasite specimens were identified to genus or family level using the keys of Kabata [10]. Recovered parasites were treated with physiological saline to retain morphological definition [11].

2.2 Computation of per cent prevalence and intensity of parasites

Prevalence and intensity were computed following the formulae proposed by Margolis *et al*. [12] as:

Prevalence = (number of host parasitized/number of host examined) x 100

Intensity = number of parasite/number of host parasitized

2.3 Physico-chemical analysis of water samples

The analysis of water was done immediately after fish collection. Temperature, dissolved oxygen and pH readings were determined on-site using the DO meter its thermistor. Unionized ammonia concentration was analyzed following the procedures of Boyd and Tucker [13].

2.4 Statistical analysis

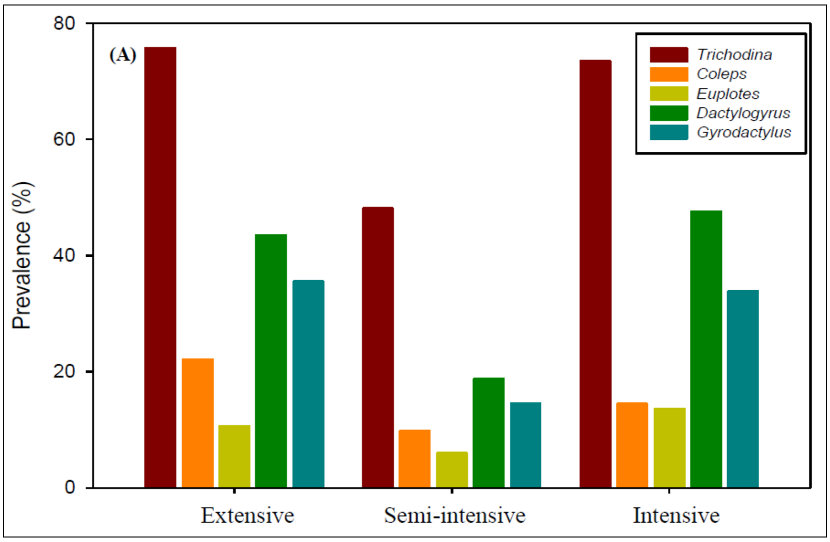
Differences in parasite prevalence and intensity between levels of farm management were analyzed using One-way Analysis of Variance (ANOVA); the possible relationship of the physico-chemical properties of water with the intensity of parasites was carried-out using Pearson's Product Moment Correlation Analysis.

3. Results and Discussion

3.1 Influence of level of farm management on parasite prevalence and intensity

A total of four extensive, five semi-intensive and 16 intensive farms served as the collection sites for tilapia and water samples. Farms practicing semi-intensive management recorded the lowest prevalence in most of the parasites (*Trichodina* = 48.15%, *Dactylogyrus* = 18.76%, *Gyrodactylus* = 14.55%, *Coleps* = 9.76%, *Euplotes* = 5.97%) (Figure 1A). Prevalence of *Camallanus* and digenean in intensive system was significantly higher as compared to semi-intensive system ($p<0.05$) (Figure 1B). The same low pattern was observed in the intensity of ectoparasites (*Trichodina* = 4.88±0.30, *Dactylogyrus* = 1.47±0.60, *Gyrodactylus* = 1.42±0.09, *Coleps* = 1.68±0.12) in semi-intensive system; the observed intensities were significantly lower as compared to extensive and semi-intensive ($p<0.05$) (Figure 2A). *Ergasilus* was only observed in extensive system while endoparasites were only present in semi-intensive and intensive system at a very low prevalence and intensity (Figures 1B and 2B).

Culture system influences the occurrence of parasites. Each culture system has its own characteristics. For instance, intensive tanks or cages are good environments for the transmission of ectoparasites with a direct life cycle such as protozoans and monogeneans. Earthen ponds are usually vegetated where crustacean parasites such as copepods can lay eggs. The bigger the pond, the more difficult it is to control the parasite population as it is more open to fish predators which can seed eggs and other parasite stages.



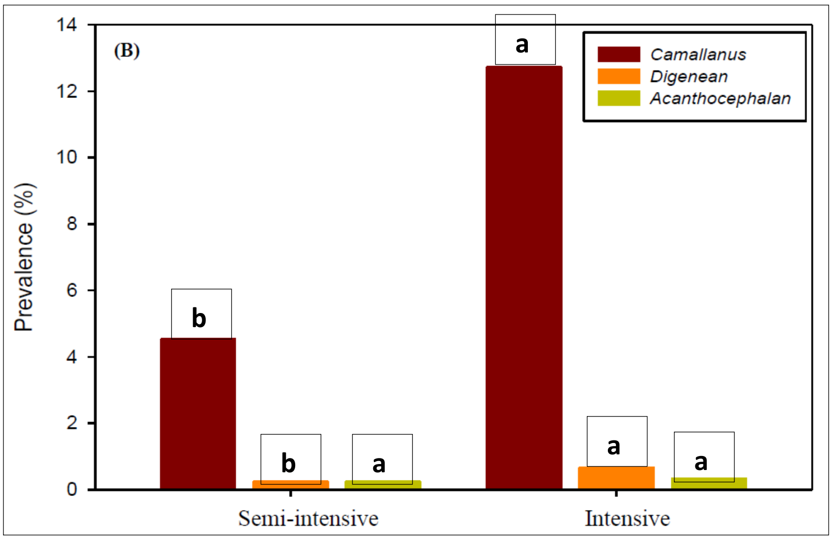


Fig 1: Mean prevalence (%) of ectoparasites (A) and endoparasites (B) of Nile tilapia (*O. niloticus*) reared at different levels of management from selected ponds in Central Luzon, Philippines (different letter was significant at p<0.05).

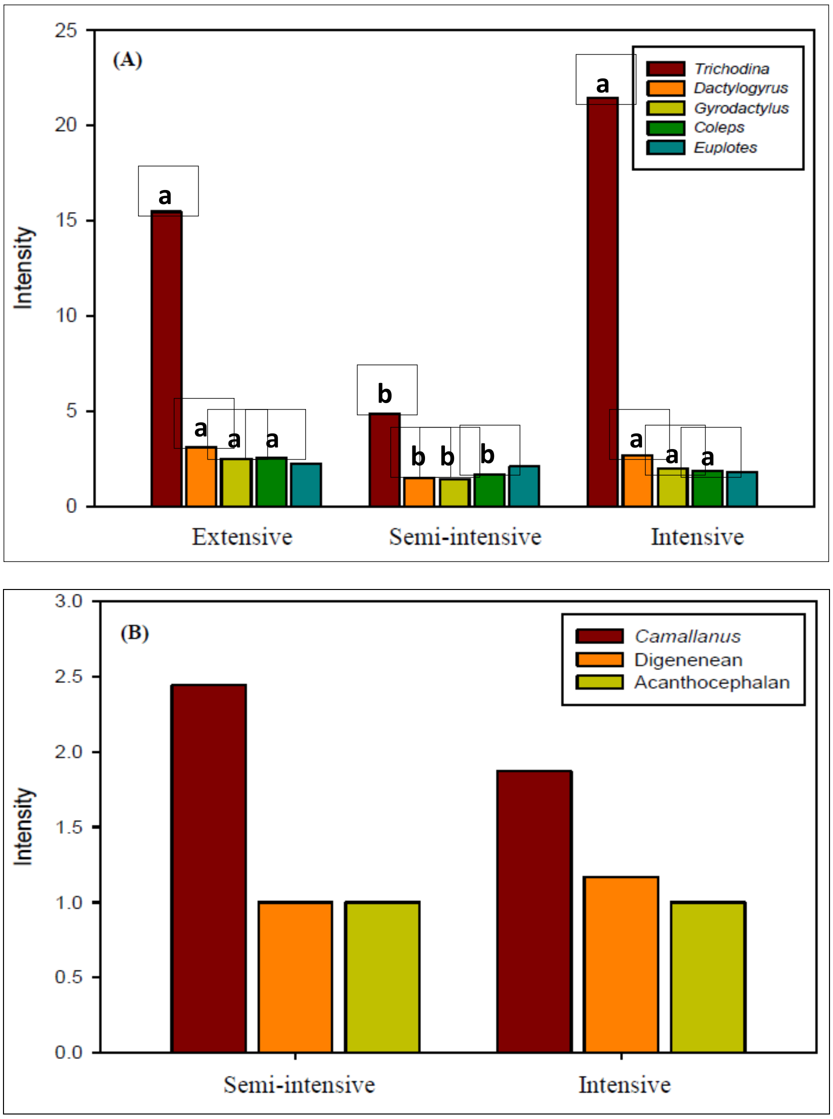


Fig 2: Mean intensity of ectoparasites (A) and endoparasites (B) of Nile tilapia (*O. niloticus*) reared at different levels of management from selected ponds in Central Luzon, Philippines (different letter was significant at p<0.05).

3.2 Relationship of physico-chemical properties of water on parasite intensity

Intensities of protozoan parasites (*Trichodina*, *Coleps*, *Euplotes*) showed a significant and positive weak correlation with pH and temperature (p<0.01). The *Gyrodactylus*, *Ergasilus* and *Camallanus* responded negatively with pH and temperature, whereas positive correlations were found in *Dactylogyrus*. Majority of the ectoparasites (*Dactylogyrus*, *Gyrodactylus*, *Coleps*, *Ergasilus*) exhibited a negative weak correlations with dissolved oxygen and unionized ammonia as compared to the weak positive correlations in *Trichodina* and *Camallanus* (p>0.01). No association was found between all water parameters and acanthocephalan because of very low recorded intensity (Table 1).

Changes in environmental conditions that affect any of the hosts, directly or indirectly, will have a significant effect on the prevalence and intensity of infection and on the diversity of parasites infecting fish [14]. Study of Amoako [15] revealed a positive correlation between water pH, dissolved oxygen, hardness and ammonia, and intensity of *Trichodina* and monogeneans identified in the gill samples and skin mucus of Nile tilapia. The association was also found very weak. Eutrophication of ponds from the addition of fertilizers has an overall positive effect on parasite abundance and diversity [16, 17].

Table 1: Correlation (Correlation coefficient *r*) of parasite intensity with physico-chemical properties of water collected from selected ponds in Central Luzon Philippines.

Parasites	pH	Temperature	Dissolved Oxygen	Ammonia
Trichodina	0.165*	0.046*	0.016	0.117
Coleps	0.051	0.006	-0.022	-0.172*
Euplotes	0.062	0.128*	-0.004	0.015
Dactylogyrus	0.047	0.019	-0.058	-0.036
Gyrodactylus	-0.018	-0.005	-0.087	-0.077*
Ergasilus	-0.150	-0.323	-0.459	-0.524
Camallanus	-0.081	-0.054	0.027	0.049
Digenean	0.261	-0.056	0.443	-0.370

*significant at p<0.01 level

4. Conclusion

The study showed that farms receiving intensive level of management had the highest parasites' load as compared to semi-intensive and extensive system. Environmental factors (Physico-chemical properties of water) could influence the level of parasitosis in pond-reared tilapia but show very little consistency in the present results.

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