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Website: http://ija.biopublisher.ca

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11388 Stevenston Hwy,
PO Box 96016,
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**Gut Associated Lactic Acid Bacteria Isolated from the Estuarine Fish *Mugil cephalus*: Molecular Diversity and Antibacterial Activities against Pathogens**  
Mohamed Hatha Abdulla, Shubhankar Ghosh, Deborah Gnanaselvam, Mujeeb Rahiman Karuppanveetil, Naveen Sathyan, Nifty John, Einar Ringo

1-11

**The Performance of Rotifer *Brachionus plicatilis* (Müller 1786) and Chicken Egg Yolk on the Larval Rearing of African Catfish, *Clarias gariepinus* (Burchell 1822) in Hatchery**  
Godfrey Ngupula, Magreth Musiba

12-19

**Diversity and Seasonal Fluctuation of Zooplankton in Ghagardara Pond, Taluka Kandhar Dist. Nanded**  
N.V. Shrirame, G. Gyananath, M.T. Mulgir, N.N. Phartale, O.S. Kanse

20-23

**Disease Occurrence in *Litopenaeus vannamei* Shrimp Culture Systems in Different Geographical Regions of India**  
B. Gunalan, P. Soundarapandian, T. Anand, Anil S. Kotiya, Nina Tabitha Simon

24-28

**Effect of Seasonal Changes in Fatty Acids Profile of Orange Fin Pony Fish (*Leiognathus bindus*) and Sulphur Goatfishes (*Upeneus sulphureus*)**  
Khadijeh Nabi Ghahfarrokhi, Mansoreh Ghaeni, Ladan Zaheri

29-35

**Heavy Metals Concentration in Water, Muscles and Gills of *Oreochromis niloticus* Collected from the Sewage-Treated Water and the White Nile**  
Elagba Haj Ali Mohamed, Abdel-Rahman Osman

36-42

**Identification of the Most Potential Indigenous Ornamental Fishes of South Tripura District in India for Commercial Production**  
Sagar C. Mandal, Debtaun Barman

43-47

**Growth Performance of Nile Tilapia (*Oreochromis niloticus*) Fed Processed Soybean Meal Based Diets Supplemented With Phytase**  
S. E. Olusola, L.C. Nwanna

48-54

**Assessment of Genetic Variability of Prawn (*Macrobrachium rosenbergii*) Post Larvae (PL) from the Broods Stocked under Different Sex Ratios**  
Sk. Shahinur Islam, Md. Saifuddin Shah, Md. Lifat Rahi

55-63

**Preliminary Studies on Larval Rearing of an Endangered Fish of Northeast India, *Ompok Bimaculatus* (Bloch) for Future Conservation**  
P.K. Pradhan, Debtaun Barman

64-66
<table>
<thead>
<tr>
<th>Title</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larvicidal Activity of <em>Phyllanthus fraternus</em> Powder in Suppressing <em>Dermestes maculatus</em> Degeer (Coleoptera: Dermestidae) Infestation on Smoked African Catfish (<em>Clarias gariepinus</em>)</td>
<td>67-72</td>
</tr>
<tr>
<td>J. M. Adesina, A. R. Jose, O. O. Adetuyi, D. A. Olorunfemi</td>
<td></td>
</tr>
<tr>
<td>The Potential of Mopani Worm (<em>Gonimbrasia belina</em>) as an Alternative Protein Source in Fish Feed</td>
<td>73-78</td>
</tr>
<tr>
<td>Lumbo Mwimanzi, Confred G. Musuka</td>
<td></td>
</tr>
<tr>
<td>Accessory Kidney of Threadfin Bream <em>Nemipterus japonicus</em> and Their Relation to Gonad Maturation</td>
<td>79-84</td>
</tr>
<tr>
<td>Magdy M. EL-Halfawy, Amal M. Ramadan</td>
<td></td>
</tr>
<tr>
<td>Endocrine Disruption by the Consumption of Fish (<em>Tilapia oreochromis</em>) from Heavy Metals Polluted River Sites and its Reversal Using Zinc</td>
<td>85-88</td>
</tr>
<tr>
<td>Bolawa O.E., Gbenle G.O., Ebuehi O.A.T.</td>
<td></td>
</tr>
<tr>
<td>Effect of Supplemental Phytase on Phosphorus Digestibility and Mineral Composition in Nile Tilapia (<em>Oreochromis niloticus</em>)</td>
<td>89-95</td>
</tr>
<tr>
<td>Nwanna L. C., Olusola S. E.</td>
<td></td>
</tr>
<tr>
<td>Effect of Commercial Feed on Sexual Maturity of Two Tilapia Species (<em>Oreochromis niloticus</em> and <em>Oreochromis tanganicae</em>)</td>
<td>96-101</td>
</tr>
<tr>
<td>Jonathan Nkhoma, Confred G Musuka</td>
<td></td>
</tr>
</tbody>
</table>
Effect of Commercial Feed on Sexual Maturity of Two Tilapia Species (Oreochromis niloticus and Oreochromis tanganicae)

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Abstract

An experiment was conducted for twelve weeks (90 days) in hapas inserted in the semi-concrete ponds to evaluate the effect of commercial feed on the sexual maturity of two tilapia species, Oreochromis niloticus and Oreochromis tanganicae. Results indicated that the final mean body weight was 73.65g for O. niloticus and 66.30g for O. tanganicae respectively. First maturity in both species was observed in the sixth week and the smallest fish matured at 34g and 73mm for O. niloticus, while for O. tanganicae, it was 42g and 111mm. Length at first maturity was 136mm for O. niloticus and 129mm for O. tanganicae. Maturity stages were macroscopically identified into three stages (immature, maturing and mature) and at the end of the trial, 73% of O. niloticus and 58% of O. tanganicae were in the reproductive process (mature). The gonadosomatic index (GSI) mean value for O. niloticus was higher than that of O. tanganicae. However, there was no significant difference (p>0.05) between GSI values.

Keywords

Commercial feed; Sexual maturity; Effects; Tilapia species; Oreochromis niloticus; Oreochromis tanganicae

Introduction

Tilapia is the common name applied to three genera of family Cichlidae: (Sarotherodon; Oreochromis and Tilapia) including about 70 species (Meyer, 2002). Tilapias are the second most important farmed fish after carp (El-Sayed, 2002) that is one of the most important food fish in the world, especially in Europe and Asia (Currie, 1991). Carp production is growing rapidly in Asia, increasing from 5,537 million t in 1990 to 16,313 million t in 2001, an annual growth rate of 11 per cent (Dey et al., 2005).

In Zambia, as in many parts of the world wild Oreochromis species are the major cultured tilapia species because they are readily acceptable by consumers throughout the country (Mudenda, 2004). They are good candidate species for pond culture due to their high adaptability to a wide range of environments, tolerance to harsh conditions (low water quality and high stocking densities), handling, ease reproduction and fast growth (El-Sayed, 2002).

One of the major problems in tilapia culture, is the tendency of females to mature and reproduce at small sizes (Popma and Lovshin 1995). In that study authors observed that, in tilapia sexual maturity is a function of age, size, and environmental conditions. Furthermore, they reported that tilapia populations in large lakes mature at a later age and larger size than the same species raised in culture ponds (Popma and Lovshin, 1995). For instance, O. niloticus matures at about 10 to 12 months and 350 to 500g in several East African lakes but the same population culture in ponds will reach sexual maturity at an age of 5 to 6 months and 150 to 200g (Popma and Lovshin, 1995). A study conducted by Hopher and Pruginin (1982) observed that some tilapias species can also reach sexual maturity in 3 to 6 months, and spawn before they reach a marketable size when grown in ponds and controlled cultured conditions. When growth is slow in culture ponds, sexual maturity will be delayed by a month or two but fish may spawn at weights as low as 20g (Mair and Little, 1991). According to Hopher and Pruginin (1982), their early maturation and prolific “wild” spawning produce such large number of small fry as to cause stunting of the entire tilapia population and often of other species in the pond. Similarly, Baroiller and Toguyeni (1996) reported that the early sexual maturity of Oreochromis species leads to overcrowding and stunting resulting in limited economic yields for fish farms since energy is directed towards reproduction instead of somatic growth.
Manissery et al., (2001) and Muchlisin et al., (2006) showed that nutrition plays a major role in the reproductive performance of fish. Early sexual maturity in tilapias can be achieved by feeding them commercial feed with all the required nutrients to support growth. In Tilapia species sexual maturity advances in stages and gonad maturation has been categorised into 6 stages where stage (I) consists of immature or virgin fish, stage (II) are fish beginning maturation, (III) is a developing phase, (IV) pre-spawning stage (V) spawning stage and (VI) post spawning stage (Duponchelle and Legendre,1996; Nyakuni, 2009). The present study, focused on the role played by commercial feed on sexual maturity of *Oreochromis niloticus* and *Oreochromis tanganicae*.

1 Materials and Methods

The experiment to determine the effect of commercial feed (Namfeed) on sexual maturity of *Oreochromis niloticus* and *Oreochromis tanganicae* (mean wt. 30g), was conducted in six hapas placed in semi-concrete outdoor ponds for 12 weeks (90 days) at the National Aquaculture Research and Development Centre (NARDC) in Mwekera on the Copperbelt Province, Zambia.

The study was a two by two factorial run in a Completely Randomized Design (CRD) with three replicates. Fish were sampled by using a scooping net at fortnight intervals. Weight and length were measured using an analytical balance and measuring board, while maturity was checked by stripping or massaging the fish on the belly.

Water quality parameters were taken and the figures recorded using a Horiba U-10 water quality checker that measures six parameters: pH, Temperature, Dissolved Oxygen, Electrolytic Conductivity, Turbidity and Salinity. The water quality checker sensor measures by being directly submersed in the water as opposed to collecting samples. pH, water temperature and dissolved oxygen were measured twice per day, in the morning (at 08:00 hours) and afternoon (at 14:00 hours) by dipping a probe of the oxygen meter about 20 cm into the water.

One-hundred and eighty (180) juvenile *Oreochromis niloticus* and *Oreochromis tanganicae*, with an individual average weight of 30g were used in the experiment. 30 fingerlings, locally provided by the NARDC, were randomly distributed among the hapas measuring 4m×2m×1m. Fish were acclimatized to the rearing environment for a period of two weeks before the beginning of the trial.

Throughout the experimental period, fish were fed with a commercial feed (Namfeed) at the rate of 5% of their total biomass, twice per day (at 09:00 and at 15:00hrs) for 5 days in a week. Clove (herbal spice) was used to anesthetise the fish to minimize stress during sampling. At the beginning and at the end of the experiment 10% of the fish were individually weighed and dissected to remove the gonads. The gonads were weighed using the analytical balance and results recorded for the calculation of GSI. The relative gonad weight or gonadosomatic index, an index of reproductive maturity was calculated by using the formula: GSI = (Gonad weight (g)/Body weight of fish (g) × 100 according to Singh and Dhawan (1996). Gonadosomatic index has been considered as reliable estimate for gonadal maturity and spawning of any species. The gonadosomatic index increased with the maturation of fish and reaches to its maximum at the peak period of maturity (Mishra and Saksena, 2012).

Fish were anesthetised using Clove (herbal spice) to minimize physical injury and stress. Stripping of sperms and eggs method was used to determine the stages of sexual development in fish. The fish were stripped by applying gentle pressure to the abdomen between the pelvic fin. When the eggs or milt came out with pressure on the abdomen, the fish was considered to have reached maturity.

Fish belonging to maturity stage onwards were considered as mature and used for the purpose of calculating the size at first maturity.

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Fish belonging to maturity stage onwards were considered as mature and used for the purpose of calculating the size at first maturity.

The water quality parameters included were: water temperature, dissolved oxygen and pH.

The statistical model used in the experiment was as follows:

$$Y_{ij} = \mu + \tau_i + \beta_j + (\tau\beta)_{ij} + e_{ij}$$

Where: $Y_{ij}$ = observed response variables

$\mu$= overall mean

$\tau_i$= the effect of feed on *O. niloticus* (i=1,2)
\[ \beta_j = \text{the effect of feed on } O. \text{tanganicae (} j=1,2 \) \\
(\tau \beta)_j = \text{interaction between two species} \\
\varepsilon = \text{experimental error} \\
\]

Statistical Package for Social Scientists (SPSS) version 16.0 was used to analyze the data on body weight, length, first maturity and Gonadosomatic index. A two-way analysis of variance (ANOVA) was used to determine whether there was any significant difference in the variables measured among the experimental groups.

### 2 Results and Discussion

Figure 1 shows the changes in mean weight of fish over 12 weeks experimental period. The initial mean weights of fish were 30g for both species while final body weights were 73.65g for \( O. \text{niloticus} \) and 66.30g for \( O. \text{tanganicae} \).

Slow growth was observed in both species in the first four weeks of trial. However, the species showed faster growth in the sixth week. Based on the results of growth it was clear that \( O. \text{niloticus} \) performed better than \( O. \text{tanganicae} \). Higher growth could partly be influenced by effective feed utilization and gonadal development (Figure 1). However, final weight showed no significant difference (p>0.05) between the two species.

The smallest \( O. \text{niloticus} \) matured at the weight and standard length of 34g and 73mm while that of \( O. \text{tanganicae} \), it was at the weight and standard length of 42g and 111mm respectively, an indication that some fish matured earlier than others. The present study showed that \( O. \text{niloticus} \) reaches sexual maturity at a smaller size and younger age than \( O. \text{tanganicae} \). This present study was in agreement with that conducted by Al Hafedh et al (1999), which revealed that fish that grew fast matured earlier. According to the Popma and Lovshin (2005), \( O. \text{mossambicus} \) reached sexual maturity at a smaller size and younger age than \( O. \text{niloticus} \) and \( O. \text{aureus} \). Morales (1991) also reported that the tilapias attained their sexual maturity at three months old with a total length of 8 to 16 cm. The results of the present study were also in agreement with de Graff et al. (1999) who reported that the first maturation size for reared Nile tilapia was between 30 and 50 g.

However, at the end of the experimental period, the length at first maturity at which 50% of the fish population reaches sexual maturity (\( L_{50} \)) was observed to be 136mm for \( O. \text{niloticus} \) and 129mm for \( O. \text{tanganicae} \) (Figure 2).

The results of the present study therefore disagree with the results obtained by Popma and Lovshin (2005). The differences in length at first sexual maturity could be attributed to the differences in genetical and environmental conditions such as food supply and changes in water quality parameters such as temperature, pH and dissolved oxygen.

The gonadal development for \( O. \text{niloticus} \) showed that 12 % were in immature (I) stage, 15 % were in maturing (II) stage and 73 % were in mature (III) stage (Figure 3). In a similar manner, the gonadal development for \( O. \text{tanganicae} \) showed that, 17 % of the fish were in immature (I) stage, 25 % were in maturing (II) stage and 58 % were in mature (III) stage (Figure 4).

The maturity stages of these tilapia species were classified macroscopically and three stages were observed,
Figure 3 Percentages of maturity stages of *O. niloticus*

Figure 4 Percentages of maturity stages of *O. tanganicae*

which was in agreement with the results reported by Pena-Mendoza *et al.* (2005), but disagree with Shalloof and Salama (2008) for *O. niloticus* and Olele (2010) for *S. galilaeus*. These differences arose probably because the sexual maturity was a function of the size and could have been influenced by the abundance and seasonal availability of food, temperature, photoperiod and other environmental factors at different localities (Pena-Mendoza *et al.*, 2005). Seventy-three (73 %) percent of *O. niloticus* had matured and were in the reproductive process compared to fifty-eight (58 %) percent for *O. tanganicae*. Maturity peak of both species was observed in October, which was associated with warm temperature and onset of the rain season culminating into a rise in water levels.

The gonadal weight and gonadosomatic index was calculated by using gonad and body weight (Gonad/body weight * 100) and the average values for *O. niloticus* was found to be 1.07 and 1.53, while that for *O. tanganicae* was 0.86 and 1.41 respectively. Gonadosomatic index is a very important parameter for understanding gonad development of fish (Begum *et al.*, 2008). There was no significant differences (p>0.05) between gonadosomatic index values of *O. niloticus* and *tanganicae*. Both growth performance in terms of somatic and maturation were higher in *O. niloticus* than in *O. tanganicae*. That could be due to differences in uptake and utilization of feed between these species.

The mean water quality parameters during the entire experimental period are presented in Table 1.

Table 1 Mean value (±SD) of water quality parameters for different months

<table>
<thead>
<tr>
<th>Months</th>
<th>Water temperature (°C)</th>
<th>Dissolved oxygen (mg/L)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>23.34±0.76</td>
<td>4.92±0.94</td>
<td>7.39±0.06</td>
</tr>
<tr>
<td>September</td>
<td>24.56±0.51</td>
<td>5.01±1.03</td>
<td>7.42±0.02</td>
</tr>
<tr>
<td>October</td>
<td>25.46±0.82</td>
<td>6.19±1.17</td>
<td>7.50±0.03</td>
</tr>
</tbody>
</table>

Note: Values represent means of three replicates

Tilapias are more tolerant to a wide variety of environmental conditions and to the extreme growth and development is affected (Popma and Lovshin 1995). Water temperature influences the physico-chemical and biological factors of water body. Water temperature also has a major influence on the amount of food consumed by a fish (Jobling, 1998). When fish are fed to satiation, growth at the preferred temperature is typically three times greater than at 22°C. Maximum feed consumption at 22°C is only 50 to 60% as great as at 26°C (Popma and Lovshin 1995). Reproduction is also inhibited at water temperatures below 20°C, slowed at waters temperature of 21 to 24°C and most frequent growth is recorded in waters above 25°C. The ranges of mean values for water temperature in different months in the present study were: 23.34±0.76 to 25.46±0. These values were more or less similar to those reported by Paul (1998), Rahman (1999), Kohinoor (2000) and Kohinoor *et al.*, (2004).
The ranges of mean value of dissolved oxygen concentrations were found to be from 4.92±0.94 to 6.19±1.17mg/L, which was similar to findings reported by several researchers (Rahman, 2000; Kohinoor, 2000; Kohinoor et al., 2004). Low dissolved oxygen is usually the first water quality constraint to growth in intensively managed ponds as a result, maturation was affected indirectly. Most tilapia species are tolerant to dissolved oxygen levels as low as 0.5mg/L, which was not tolerable for most other cultured fish (Popma and Lovshin, 2005). In the case of the present study, the values for dissolved oxygen concentration were within the optimum level (4.92±0.94 to 6.19±1.17mg/L).

The pH in all the hapas was alkaline throughout the experimental period and the values ranged from 7.39±0.06 to 7.50±0.03. Tilapia seems to grow best in water that was near neutral or slightly alkaline (Popma and Lovshin, 2005). The ranges and mean values of pH in the present study were alkaline indicating the productive nature of water.

3 Conclusion
The aim of the study was to determine the effect of commercial feed on sexual maturity of tilapia species (O. niloticus and tanganicae) reared in hapas. The present study showed that O. niloticus matured at a smaller size than O. tanganicae and the mean values of growth weight and gonadosomatic index. However, there was a difference in terms of gonadosomatic index and gonad mean weight. Maturity stages were macroscopically identified into three stages (immature, maturing and mature) and at the end of the experimental period, 73% of O. niloticus and 58% of O. tanganicae were in the reproductive process (mature).

Acknowledgement
The authors wish to extend their heartfelt thanks to staff and management of NARDC and the Copperbelt University for their invaluable moral, material and financial support to the research team.

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