



EFFECT OF HATCHERY LIGHT CONDITION ON SPAWNING AND EARLY DEVELOPMENT OF *Tilapia guineensis*

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ABSTRACT

To determine the extent light stimuli could influence the spawning and larval performance of *Tilapia guineensis*, sexually matured *T. guineensis* were simultaneously paired to spawn and their larvae nursed in two hatcheries under different light (restricted – closed- and unrestricted-open-) conditions. Hatching of egg in the two hatcheries was compared. Growth of day five larvae in the two hatcheries at equal density of 10 larvae/l and uniform food and feeding regime were monitored for twenty days. Survival of larvae in the two hatcheries was analysed at the end of the study. Duration to spawning in the open hatchery (120 hours) was shorter than in the closed hatchery (132 hours), however the difference was not significant ($P > 0.05$). Also egg hatching in the hatcheries was not significant ($P > 0.05$). Larvae reared in the open hatchery grew significantly ($P < 0.01$) faster than larvae reared in the closed hatchery but the difference only appeared after day-8 post hatch. Larval survival 85% in the open hatchery which was significantly higher than 75% survival observed in larvae reared in the closed hatchery. The findings suggest involvement of visual sense in growth hormone surge, survival and chemosensory activity of spawning but not in egg hatching in *Tilapia guineensis*.

Keywords: cichlid species, illumination, larval growth, ovulation and survival

INTRODUCTION

Reproduction in vertebrate is controlled along brain-pituitary gonadal axis (Maruska *et al.*, 2011). Biological process along this axis is strongly influenced by gonadotropin hormone surge (Weltzien *et al.*, 2004). Delince *et al.* (1987) further reported that even when hormone required for oogenesis and spermatogenesis are produced in sufficient quantities at age of sexual maturity, final oocyte maturation, ovulation, spermiation and spawning behaviour will not occur without gonadotropin surge.

Environmental factors such as light intensity and duration (photoperiod) are among the cues that could induce gonadotropin surge in fish (Taylor and Migaud, 2008). Randall *et al.*, (2001) and Taylor *et al.* (2002) reported that photoperiod manipulation can be used to alter stock spawning time to produce out of season eggs. Taylor and Migaud (2008) added that light can be used to inhibit maturation prior to harvest. They also reported that seasonal changes in day length are primarily responsible for synchronizing the timing of reproduction in *Salmonids*. Modified photoperiod regime can therefore be used to alter the spawning period to ensure all year round supply of salmonid eggs (Taylor and Migaud 2008). Ridha and Cruz (2001) observed that seed production and spawning synchrony was significantly improved ($P < 0.05$) by

subjecting breeders of *Oreochromis niloticus* to higher light intensity and longer photoperiod (2500Lux/18h) against their exposure to medium or short photoperiod and lower light intensity (15h/day, 12h/day and 500 Lux respectively).

Light stimuli could also influence the way fish grows in a particular area. Taylor and Migaud (2008) observed that in tank and cage culture of trout under constant illumination using two light units (400W submersible metal halogen) increased growth above that achieved using one light. It was observed, that in the two-light treatment, there was a slightly higher and more uniform light distribution. This led to a more consistent response from the population and less variation in size between individuals.

The present study was initiated to ascertain the effect of illumination and to search for optimal light condition for propagation of *Tilapia guineensis*, the species was reproduced and nursed under different hatchery light conditions. The findings suggest possibility of reducing duration to spawning and stimulating growth by light manipulation in *T. guineensis*.

MATERIALS AND METHODS

Adult male and female *Tilapia guineensis* of relatively uniform mean sizes of 208 g and 205 g respectively were paired to spawn in a hatchery partitioned into two. The side-wall of one half of the

hatchery was $\frac{3}{4}$ completed with light proof tarpaulin ('closed hatchery' for restricted light penetration). The side-wall of the second half of the hatchery was left open ('open hatchery' for unrestricted light penetration). Ready to spawn *T. guineensis* were simultaneously paired to spawn in both partitions. The spawning trials were replicated in four places in both hatcheries. Spawning in each replicate was examined at intervals of 24 hours. Percentage hatching in each replicate was investigated. Fifty fertilized eggs attached to strands of local jute bag were placed to hatch separately in each replicate. Hatching was recognised on observation of faint but steady tail wagging of the hatching larvae. Larvae were nursed in their spawned tanks until complete yolk absorption before commencement of exogenous feeding by day five post-hatch (5 dph). Forty Samples of unfed 'day five post hatch' fry were collected from each replicate and reared separately in both hatcheries. Light period was defined in this study as period during which the spawners or the hatchlings kept in water depth of 40 cm and 15 cm respectively could be clearly seen without the aid of artificial light. The period lasted for 13 hours in the open hatchery from 6 am to 6.59pm and 10 hours in the closed hatchery from 8 am to 5.59 pm during the study.

Dark period was also defined this study as period during which the spawners or the hatchlings kept in water depth of 40 cm and 15 cm respectively could not be clearly seen without the aid of artificial light. This period lasted for 11 hours in open hatchery from 7 pm to 5.59 am and 14 hours in the closed hatchery from 5 pm to 6.59 am during the study. The fry were nursed for 20 days under uniform food and feeding regime. Three fry were randomly sampled from each replicate for growth monitoring every other day. Fry was weighed to the nearest 0.1 mg with top load precision weighing balance (Ohaus AR2140, Japan). Weighed fry were kept to recover in separate container where they were subsequently reared without returning them to the experimental tanks. On termination of the study on day 20, the remaining fry in each replicate was counted and individual total length and weight of the fry were taken. Total length was measured with

meter rule graduated in millimetre from the tip of the snout to the end of the caudal fin. The water quality parameters such as dissolved oxygen, pH, ammonia; nitrite and temperature were monitored every other day with Hanna equipment meters and LaMotte Salt water Aquaculture test kit (Model AQ-4/AQ-5).

Statistical Analysis

Mean percentage ($\frac{Xi+Xii+Xiii+Xiv}{4}$ %) values of time spent before spawning in different replicates (duration to spawning), number of fertilized eggs (total eggs incubated – total eggs fertilized), number of hatched eggs (total eggs fertilized – number of unhatched eggs), weight at different ages (5 dph to 20 dph), Specific growth rate ($\frac{\ln \text{final body weight} - \ln \text{initial body weight}}{\text{Time in days}}$) and Survival (total number of fry at 5 dph – number of dead fry at 20 dph) for the replicates were computed and compared among the treatments in 2 x 4 Completely Randomized Analysis of Variance Design (Gomez and Gomez, 1984).

RESULTS

Spawning of *T. guineensis* was successful in both light restricted and unrestricted hatcheries. The duration to spawning in light-unrestricted (open) hatchery (120 hours) was shorter than the duration to spawning in light restricted (closed) hatchery (132 hours). However, the difference was not significant ($P > 0.05$). Also there was no difference in egg fertilization and hatching percentage among the hatcheries (Table 1).

Weight of fry was highly significant ($P < 0.01$) after 9 days post hatch in different hatcheries. See Table 2. The specific growth rate of the fry in the open hatchery (11.46) was significantly ($P < 0.01$) higher than the specific growth rate of the fry in the closed hatchery (10.19). Fry survival in open hatchery (85%) was significantly higher ($P < 0.05$) than fry survival in close hatchery (75%).

Water quality parameters namely temperature, dissolved oxygen, pH, Ammonia and Nitrite did not differ significantly ($P > 0.05$) among the treatments (Table 3).

Table 1: Duration to spawning, egg fertilization and hatching in the hatcheries

Hatcheries	Duration to spawning	Mean number of egg fertilized	Hatching (%)
Open	120 ^{ns}	49.5 ^{ns}	99 ^{ns}
Closed	132 ^{ns}	49.5 ^{ns}	99 ^{ns}

ns= Not significant

Table 2: Weight at different ages (days) and specific growth rate in different hatcheries.

Age (days)	Weight (mg) in Open	Weight (mg) in closed	Test of significance
0 (5 dph)	3.05	3.03	F=1.86 ^{ns}
2	3.88	3.78	F=2.00 ^{ns}
4	4.74	4.72	F=25.79**
6	6.68	5.61	F=760**
8	8.09	7.49	F=44.63**
10	12.23	9.66	F=2155**
12	16.33	13.74	F=172**
14	19.92	15.79	F=1709**
16	23.28	18.48	F=1997**
18	26.38	21.18	F=433**
20	30.12	23.22	F=1253**
%SGR	11.46	10.19	F=73.46**
%Survival	85	75	F=20.55*

ns= Not significant, *= significant at 5% probability level, **= significant at 1% probability level., SGR= Specific Growth Rate dph = days post hatch

Table 3: Water quality condition in the hatcheries during the study (Average values)

Hatcheries	Temperature (°C)	Dissolved Oxygen (mg/l)	pH	Ammonia (mg/l)	Nitrite (Mg/l)
Open	29	4.25	6.25	0.001	0.001
Closed	29	4.25	6.25	0.001	0.001
Statistic test	ns	ns	ns	ns	ns

ns= Not significant

DISCUSSION

Spawning of *T. guineensis* was successful in light restricted and un-restricted hatcheries. However, duration to spawning in light-unrestricted (open) hatchery (120 hours) was shorter than the duration to spawning in light restricted (closed) hatchery (132 hours), but the difference was not significant ($P > 0.05$). The above findings suggest the inability of partial darkness to suppress spawning. It also inferred the likely involvement of visual sense in spawning behaviour that could be ascertained under condition of total darkness for a definite time. Taylor and Migaud (2008) reported involvement of visual sense in the spawning of Salmon and trout species and further suggested that changing photoperiod in hatchery can accelerate or delay maturation and ovulation in the species. They also noted that exposing bluegill sunfishes to longer photoperiod 16 light/8 dark hours induced a better gonadosomatic index.

Egg hatching percentage (99%) in both hatcheries was not significant ($P > 0.05$). This observation excluded light stimuli and involvement of visual sense in *T. guineensis* egg hatching. Light

has been shown to be an important ecological factor for fish development from egg to sexually mature adult (Saunders *et al.*, 1989, Battaglione and Talbox 1990). Mino *et al.* (2008) reported the importance of light stimuli in the hatching of *Clarias gariepinus* and *Clarias macrocephalus* eggs and stated that short periods of light exposure increased egg hatching rate, but continuous light exposure shortened egg hatching time in the species.

Fry raised under un-restricted light condition were larger after day 8-posthatch and grew significantly ($P < 0.01$) faster than fry raised under light restricted hatchery condition. Also unrestricted light hatchery condition predisposes the fry to higher survival than the restricted light condition. Light seems to influence the release of hormones that affect larval activities in *T. guineensis*. Hart *et al.* (1996) reported that photoperiod can influence the release of several hormones that affect fish larvae development and performance. Disparity in light intensity and duration could result to disparity in the release of the hormones which dictate the apparent diurnal feeding tendency of larvae for extended feeding time in favour of larvae in the open hatchery. Extended

feeding time will translate to better growth and survival of fry in the open hatchery. Fundamental biological rhythms in nature are frequently related to the periodicity of light and many animals including fish, exhibit a 24-hour cycle in their activities (Boeuf and Le Bail 1999). This cycle dictate the feeding rhythm and is specific for each species, hence species are classified as diurnal, nocturnal or diurnal-nocturnal (Zavalacamin, 1996).

Manipulation of light intensity has been shown to influence growth, survival or feeding success of many larval teleosts (Boehlert, 1981, Dey and Dankaer 1990, Britz and Pienaar, 1992). Light: Dark (0:24) photoperiod was associated with better development in many *Siluriformes* fish (Nwosu and Holzlohmer 2000, Giri *et al.*, 2002). Campagnolo and Nuner (2008) reported that photoperiod affects survival and growth of *Pseudoplatysoma carruscans*. Vinoth *et al.* (2010) also showed that growth of *Amphiprion percula* was significantly faster under a photoperiod of 16 hours light / 8 hours dark compared to the photoperiod of 24 hours light / 0 hour dark and 12 hours light/ 12 hours dark.

CONCLUSION

The influences of light stimuli on spawning and larval performance of *Tilapia guineensis* were investigated. Results obtained suggest involvement of visual sense in growth hormone surge and in larval survival in *Tilapia guineensis*. Faster growth and higher survival percentage were achieved in light unrestricted hatchery than in light restricted hatchery. Light seems to influence the release of hormones that affect larval activities in the species. Hatchery light could be manipulated to achieve faster growth and better survival in *Tilapia guineensis*. The report recommends further investigation to express the involvement of light in inducing spawning behaviour and spawning in *T. guineensis*. Appropriate information on involvement of light in spawning could be employed in economic synchronous spawning of *Tilapia guineensis*.

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REFERENCES

- Battaglione, S.C. and R.B. Talbox (1990). Initial swim bladder inflation in intensively reared Australian bass larvae. (*Steindachner*) (*Perciformes percichthyidae*). *Aquaculture*, 85: 431 – 442
- Boehlert, G.W. (1981). The effects of photoperiod and temperature on laboratory growth of juveniles *Sebastes diplopron* and comparison with growth in the field fish. *Bull.*, 76(4):789 – 794.
- Boeuf, G. and Le Bail, P. Y. (1999). Does light have an influence on fish growth? *Aquaculture* 177: 129 - 15.
- Britz, P. J. and Pienaar, A. G. (1992). Laboratory experiments on the effect of light and cover on the behaviour and growth of African catfish, *Clarias gariepinus* (Pisces *Clariidae*) *J. Zoology* (London), 22: 43-62
- Campagnolo, R. and Nuner, A.P.O. (2008). Survival and growth of *Pseudoplatysoma corruscans* (Pisces: *Pimelodidae*) larvae.: effect of photoperiod. *Arq. Bras. Med. Vet. Zootec.* 60(6):1511 – 1516.
- Dey, D. B. and D. M. Dankaer (1990). Effects of spectral irradiative on the early development of Chinook Salmon. *The progressive fish culturist* 52:141-154.
- Giri, S.S., Sahoo, S.K., Sahu, B.B. (2002). Larval survival and growth in Wallago att. (Bloch and Schneider): Effect of light, photoperiod and feeding regimes. *Aquaculture*, 215:151 – 161.
- Gomez, K. A. and Gomez, A. A. (1984). Statistical Procedure for Agricultural Research. 2nd Edition. John Wiley and Sons Inc. New York. 680pp.
- Hart, P. R., Hutchinson, W. G. and Purser, G J. (1996). Effect of photoperiod, temperature and salinity on hatchery reared Larvae of the green back Flounder *Rhombosolea tuperina* (Gunther 1862.). *Aquaculture* 144:303 - 311.
- Maruska, K. P., Levavi-Sivan, B., Biran, J. and Fernald, R. D. (2011). Plasticity of the Reproductive Axis caused by Social Status Change in an African Cichlid Fish: I. Pituitary Gonadotropins. *Endocrinology* 152; 281 – 290.
- Mino, A.S., Metillo, D. E. and Tobias E. G. (2008). Effects of photo period on Egg Hatching and growth and survival of larvae fed with different diets in the

Asian catfish, *Clarias macrocephallus* (Gunther) and the African Catfish, *C. gariiepinus*. *The Philippine Agricultural Scientist* 91 (4): 431-438.

Nwosu, F.M., Holzlohmer, S. (2000). Effect of light periodicity and intensity on the growth and survival of *Heterobranchus longifilis* Val. 1840 (*Teleostei: Clariidae*) larvae after 14 days of rearing. *J. Appl. Ichthyol.* 16:24 – 26.

Randall, C. F., North, B. Further, W., Porher, M., Bromage, N.R. (2001). Photoperiod effects on reproduction and growth in rainbow trout. *Trout News*, 32: 12 – 16.

Ridha, M.T. and Cruz, E.M. (2001). Effect of light intensity and photoperiod on Nile tilapia seed production. *Aquaculture Research* 31(7): 609 - 617.

Saunders, R. L., Specker, J. L. and Komourdjian, M. P. (1989). Effects of photo period on growth and smolting in juvenile Atlantic salmon (*Salmo Salar*). *Aquaculture* 82:103-117.

Taylor, J. and Migaud, H. (2008). Shinning the light on Trout: Where are we now? *Institute of Aquaculture University of Sterling, Finfish News*, Number 5, Winter/Spring 2008. 9pp.

Taylor, J.F., North, B., Porter, M.J.R. and Bromage, N.R. (2002). Photoperiod Manipulation can be used to improve growth rate and feeding efficiency in rainbow trout. *Trout News*, 33: 20 – 23.

Vinoth, R., Ajithkumar, T. T. and Gopi, M. (2010). Photoperiod induced Larval Growth of *Anemonetirh, Amphipron Percula*. *World Applied Sciences Journal* 10 (3): 283-286.

Weltzien, F., Anderson, E., Anderson, O., Shalchian-Tabrizik, K. and Norberg, B. (2004). The brain-Pituitary gonad axis in male teleosts, with special emphasis on flatfish (*Pleuronectiformes*). *Comparative Biochemistry and Physiology Part A*. 137: 447 – 477.

Zavalacamin, L.A. (1996). In: Taylor, J and Migaud H (2008): Shinning the light on Trout: where are we now? *Institute of Aquaculture University of Sterling, Finfish News*, Number 5, Winter/Spring 2008. 9pp.