Arch. Pol. Fish. (2012) 20: 55-59
DOI 10.2478/v10086-012-0007-1

SHORT COMMUNICATION

Effects of three different photoperiods on the growth and body coloration of juvenile African catfish, *Clarias gariepinus* (Burchell)

Moshood K. Mustapha, Benedict U. Okafor, Khalid S. Olaoti, Opeyemi K. Oyelakin

Received – 20 September 2011/Accepted – 04 February 2012. Published online: 31 March 2012; ©Inland Fisheries Institute in Olsztyn, Poland
Citation: Mustapha M.K., Okafor B.U., Olaoti K.S., Oyelakin O.K. 2012 – Effects of three different photoperiods on the growth and body coloration of juvenile African catfish, *Clarias gariepinus* (Burchell) – Arch. Pol. Fish. 20: 55-59.

Abstract. Sixty juveniles of the African catfish, *Clarias gariepinus* (Burchell), were reared in triplicate under three different photoperiods: 24 h total darkness (24D:0L); 24 h total light (24L:0D); 12 h darkness and 12 h light (12D:12L). The latter served as the control in order to investigate the effects of light duration on the growth, body coloration, and feed conversion efficiency of the juveniles. Water quality in the tanks was also measured. Significant ($P < 0.05$) increases in body weight, specific growth rate, and food conversion efficiency were recorded among the fish cultured under 24D:0L, followed by 24L:0D, while those under 12D:12L showed the least growth increase. The high growth increase recorded in the 24D:0L was attributed to better food conversion efficiency and the suppression of swimming activity, aggression, and stress in the dark. All these enabled more energy to be converted to body weight. The body coloration of these fishes was also darker than in the other photoperiods. This was due to the physiological response of the fish in the dark to increase the stimulation and production of melatonin. The simple, low-cost technique of a 24D:0L photoperiod should be applied to ponds in order to achieve faster growth of this fish in less time.

Keywords: body color, Claridae, feed conversion efficiency, growth, nocturnal, photoperiod

M.K. Mustapha [✉], B.U. Okafor, K.S. Olaoti, O.K. Oyelakin
Department of Zoology
University of Ilorin, Ilorin, Nigeria
Tel: +2348035797590; e-mail: moonstapha@yahoo.com.

Hunger and poverty are among the challenges facing African society today. These arise from the ever increasing cost of food, especially dietary fish protein. The declining production of fish from rivers and lakes as well as the subsistence level of aquacultural development are some of the reasons for these problems. Intense aquaculture of local species using simple, low-cost technology could provide a ready solution to overcome these challenges. *Clarias gariepinus* (Burchell) is one of the commonly cultured, indigenous species of fish in Africa. This species is chosen thanks to its hardy nature, omnivorous feeding habits, ability to eat a variety of natural and supplemental feeds, resistance to diseases, as well as its ability to tolerate low oxygen and pH levels (Fagbenro and Syndenham 1988).

One of the simple, low-cost techniques that can be used to obtain faster growth during the intense production of *C. gariepinus* juveniles is photoperiod manipulation. According to Bouef and Le Bail (1999), photoperiodism is one of the physical factors that are known to increase the growth and survival of fish larvae. It is also known to influence body coloration and gonadal activity in several fish species (Brummet 1995). Very dark body coloration of fish species such as *C. gariepinus* coupled with high body mass results in better market value and higher prices. Simensen et al. (2000) also reported that photoperiod is a directive factor which controls growth as a zeitgeber (cue or synchronizer) through its influence on endogenous rhythm and circulating levels of growth hormones, while Hisar et al. (2005) linked the production of melatonin to periods of illumination.

Appelbaum and Kamler (2000) reported that *C. gariepinus* reared in the dark were larger than those reared in the light, while Almanzan-Rueda et al. (2005) showed that no light resulted in an increase growth of this species. Britz and Pienaar (1992) also reported high rates of growth of *C. gariepinus* juveniles when reared under continuous darkness. The aim of the present study was to evaluate the effects of photoperiod on the growth and body coloration of juvenile *C. gariepinus*. This is with a view to simulating the best photoperiod for increasing production of the species from juvenile to table size in less time and with a simple, low-cost technique as well as achieving the most acceptable body coloration for the marketability and high price of the species.

The juvenile *C. gariepinus* were obtained from the fisheries hatchery unit of Kwara State Ministry of Agriculture, Ilorin, Nigeria. The initial mean length and weight of the juveniles were 14.90 ± 0.1 cm and 32.10 ± 0.5 g, respectively. The fish were acclimatized in three 60 l experimental plastic tanks (1 × 1 × 0.2 m) under laboratory conditions for seven days prior to the start of the experiment. The research was carried out for 12 weeks (84 days) between January 24 and April 17, 2011. After acclimatization, each of the three tanks was stocked with twenty fish with three replicates per treatment. The fish were exposed to three photoperiod regimes (light:dark, L:D) cycles: 0L:24D – continuous darkness group (A); 24L:0D – continuous light group (B); and 12L:12D – control group (C) with natural light and darkness. Group A was placed in a ventilated dark room, while group B was illuminated with light intensity measured to 400 lx at the water surface (fluorescent lamp, 40 W). The fish were fed with commercial feed (Coppens and Durante) twice daily (8:00 am and 6:00 pm). The daily ration was 2% of the stock biomass. According to the manufacturers, the feed composition was as follows: protein – 45%; fat – 12%; crude fiber 1.5%, ash 9.55%, total phosphorus 1-2%.

Table 1
Range of water quality parameters during rearing of juvenile *C. gariepinus* in the three photoperiod treatments

Photoperiod	Temperature (°C)	pH	DO (mg l^{-1})	CO_2 (mg l^{-1})
0L:24D	26-27	7.5-8.5	6.0-6.6	0.01-0.03
24L:0D	26-28	7.5-8.0	5.0-7.0	0.01-0.03
12L:12LD	26-28	7.5-8.5	5.0-7.5	0.01-0.03

Table 2
Mean growth data of juvenile *C. gariepinus* in the three photoperiodic treatments SGR – specific growth rate, FCR – feed conversion ratio, FCE – feed conversion efficiency

Specification	12L:12D	0L:24D	24L:0D
Initial total length (cm)	14.90 ± 0.1	14.80 ± 0.1	14.80 ± 0.1
Initial body weight (g)	32.30 ± 0.1	32.30 ± 0.1	32.30 ± 0.1
Final total length (cm)	20.80 ± 0.2	24.80 ± 0.2	22.60 ± 0.2
Final body weight (g)	86.80 ± 1.0	148.40 ± 2.0	102.60 ± 2.0
Weight gain (g)	54.50 ± 0.5	116.20 ± 1.5	70.30 ± 1.5
Weight gain (%)	168.73	260.55	230.03
SGR (% d^{-1})	1.17	1.80	1.38
FCR	8.68	3.4	5.8
FCE (%)	11.53	29.46	17.10

Dissolved oxygen, carbon dioxide, temperature, and pH in each tank were measured twice weekly since the water was changed every third day of the experiment. Throughout the experiment, water temperature and pH in the treatment tanks ranged between 26-28°C and 7.5-8.5, while dissolved oxygen and carbon dioxide concentrations ranged between 5.0-7.5 mg l^{-1} and 0.01-0.03 mg l^{-1} (Table 1).

All of the fish were weighed individually at the beginning and the end of the experiment. Total length (TL; ± 1 mm) and body weight (BW; ± 0.1 g) monitoring were performed once per week to determine fish growth. The weight gain, weight gain percentage, specific growth rate, feed conversion ratio, and feed conversion efficiency were calculated for each treatment according to Liu et al. (1998). Direct visual observation of individual fish in each treatment tank was used to analyze body coloration.

Significant differences were recorded in the growth and feed conversion efficiency of *C. gariepinus* reared under the three photoperiods ($P < 0.05$). The growth performance and feed efficiency values are presented in Table 2. The highest mean growth performance (weight and length increase) was observed in group A, followed by group B, while group C had the least growth (weight) increase (Fig. 1). The final mean BW of *C. gariepinus* reared in the three photoperiods was 148.40 ± 2.0, 102.60 ± 2.0, and 86.80 ± 1.0 g for groups A, B, and C, respectively. As expected from the above measurements, SGR, FCR, and FCE over the course of the study were also affected by the photoperiods. Color variations were observed by direct visual observations among the fish in the three treatment tanks. *C. gariepinus* in group A (0L:24D) were darker and black in appearance. Fish from group B (24L:0D) had a lighter appearance, while fish in group C (12L:12D) had the normal dark coloration on the dorsal part with light gray scattered along the sides.

The significant increase in the length and weight of *C. gariepinus* cultured under total darkness (0L:24D) as compared to total light (24L:0D) and the control (12L:12D) was probably due to better feed conversion efficiency (Almazan-Rueda et al. 2005), the absence or reduction of stress and

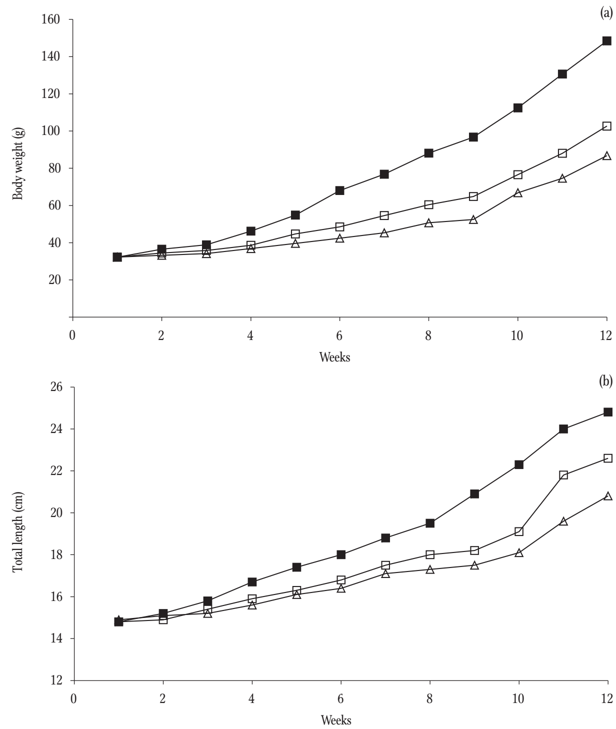

Figure 1. Mean body weight (a), and mean total length (b) of juvenile *C. gariepinus* during rearing period exposed to continuous darkness (■), continuous light (□), and natural light (△).

aggressiveness, as well as the suppression of locomotory activities in the dark. All these enabled more energy, which normally would have been expended on these metabolic activities, to be converted to body growth. Britz and Piennar (1992), Appelbaum and Kamler (2000), and Adewolu et al. (2008) reported growth increase in *C. gariepinus* under total darkness (0L:24D) and suggested reasons like high feeding activity in the dark for the high growth rate. The high specific growth rate under total darkness was a result of the complete feeding and utilization of the feed in the dark, more so because these fishes are nocturnal feeders. The absence of light was responsible for the very dark coloration observed in the fish reared under total darkness 0L:24D. This could be due to the physiological response of the fish in the dark in increasing the stimulation and production of melatonin (Hisar et al. 2005). Melatonin is produced from the pineal gland, an endogenous time-keeping system in teleosts. The very dark coloration of the species is an added value to its marketability and price, especially in Africa. Adewolu et al. (2008) have also noted that fish cultured in total darkness 0L:24D had darker skin coloration than those in 12D:12L. The ranges of water quality parameters measured in the experiment were normal for the culture of the fish species (Boyd 1979) and thus could not be implicated in the significant growth responses recorded in the three photoperiods.

The fishes reared under total light, which produced the next growth increase, was the result of illumination exerting increase locomotory activities on the fish. This made them expend energy which could have otherwise been used for growth. The increased locomotory activities brought about stress, aggression, and cannibalistic behavior among the fish population in the tank, all of which consume energy. Adaptation to the 24L:0D photoperiod throughout the research might be responsible for the increased growth recorded over the 12L:12D. Better food conversion efficiency in this photoperiod regime also contributed to the increase growth recorded over the control. Sawhney and Gandotra (2010) and Rad et al. (2006) recorded increased somatic growth of Nile tilapia, *Oreochromis niloticus* (L.), and *Tor putitora* (Hamilton) fingerlings over 18 hours of light. The light appearance of fishes under 24L:0D was due to their continuous exposure to light.

The constant change in the photoperiods between day and night was the reason for the least growth increase recorded in the 12L:12D photoperiod. Fish reared under continuous darkness or light have become adapted to these photoperiods, thus, they live with them. The constant change between day and night affected the physiology, feeding efficiency, and metabolism of the fish. Since *C. gariepinus* is a nocturnal feeder, and the fish is fed both day and night, most of the feed fed during the day is not consumed thereby reducing the overall feed conversion efficiency and bringing about a higher feed conversion ratio in the fish. This change made the fish more aggressive with the attendant increase in swimming activity thus stressing the fish. All these metabolic activities consumed energy which would have been converted to body weight had it been that the fish were not engaging in higher energy-demanding activities. Another reason could be higher lactate, free fatty acid, and cortisol production in the fishes cultured under the 12D:12L photoperiod as reported by Almazan-Rueda et al. (2005).

Author contributions. M.K.M. conceived of and designed the research; B.U.O., K.S.O., and O.K.O. performed the research and analyzed data; MKM wrote the paper.

References

Adewolu M.A., Adeniji C.A., Ademola B.A. 2008 – Feed utilization, growth and survival of *Clarias gariepinus* (Burchell 1822) cultured under different photoperiods – Aquaculture 283: 64-67.

Almazan-Rueda P., Van Helmond A.T.M., Verreth J.A.J., Schrama J.W. 2005 – Photoperiod affects growth, behavior and stress variables in *Clarias gariepinus* – J. Fish Biol. 67: 1029-1039.

Appelbaum S., Kamler E. 2000 – Survival, growth, metabolism and behavior of *Clarias gariepinus* (Burchell) early stages under different light conditions – Aquacult. Eng. 22: 269-287.

Bouef G., Le Bai P.Y. 1999 – Does light have influence on fish growth? – Aquaculture 177: 129-152.

Boyd C.E. 1979 – Water quality in warm water fish ponds – Craftmaster Printers Inc. Auburn, Alabama, USA, 353 p.

Britz P.J., Pienaar A.G. 1992 – Laboratory experiments on the effect of light and cover on the behavior and growth of African catfish *Clarias gariepinus* (Pisces: Clariidae) – J. Zool. 227: 43-62.

Brummet R.E. 1995 – Environmental regulation of sexual maturation and reproduction in Tilapia – Res. Fish. Sci. 3: 231-248.

Fagbenro O.A., Sydenham D.H.J. 1988 – Evaluation of *Clarias isheriensis* under semi-intensive management in ponds – Aquaculture 74: 287-291.

Hisar S.A., Kirim B., Bektas S., Altinkaynak K., Hisar O., Yanik T. 2005 – Effect of photoperiod on plasma thyroxine hormone level of mirror carp (*Cyprino carpio*) raised at low water temperature in a controlled environment – Isr. J. Aquacult.-Bamidgeh 57: 19-24.

Liu F.G., Yang S.D., Chen H.C. 1998 – Effect of temperature on feed response, growth performance and muscle proximate composition in juvenile hybrid striped bass (*Morone saxatililis* x *M. chrysops*) – Isr. J. Aquacult.-Bamidgeh 50: 184-194.

Rad F., Bozaoglu S., Gozukara S.E., Kurt G. 2006 – Effects of different long-day photoperiods on somatic growth and gonadal development in Nile tilapia (*Oreochromis niloticus* L.) – Aquaculture 255: 292-300.

Sawhney S., Gandotra R. 2010 – Effects of photoperiods on growth, feed conversion efficiency, and survival of fry and fingerlings of Mahseer, *Tor putitora* (Hamilton) – Isr. J. Aquacult.-Bamidgeh 62: 266-271.

Simensen L.M., Jonassen T.M., Imsland A.K., Stefansson S.O. 2000 – Photoperiod regulation of growth of juvenile Atlantic halibut (*Hippoglossus hippoglossus* L.) – Aquaculture 90: 119-128.