RESEARCH ARTICLE

Effect of Various Light Conditions on Vertebral Column Shape from Pre to Post Spawning Phases in *Clarias batrachus*: an Indian Cat fish

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Abbreviation used: LL- constant light conditions; DD- constant dark conditions

Abstract

Present study was aimed to examine the effect of constant light (LL) and constant dark (DD) on vertebral column in Indian fresh water cat fish, *Clarias batrachus*. Experiments were carried out during different phases of the annual reproductive cycle of the fish i.e., pre spawning, spawning and post spawning phases for three consecutive years. During each experimental protocol, four animals from each group were dissected out at every 15 days to observe changes occurring in the vertebral column. It was found that the animals maintained under DD exhibit bending of vertebral column at abdominal region (scoliosis) during pre spawning and spawning phases, irrespective of year of study. We also found, the bending of skeleton increases with the days of exposure under DD. However, these changes were not seen in other groups. Thus, it could be concluded that the exposure under DD may be a stress condition for the fish, *C. batrachus* specially during its high energy demanding phases like pre spawning and spawning phases.

Introduction:

Fishes have been recently recognized as a suitable model organism to study vertebrate physiological processes in particular skeleton development and tissue mineralization (Marques *et al.*, 2007). Skeletal anomalies have an important role in aquaculture, as they decrease the quality of the fish by affecting their external morphology, growth, and survival (Andrades & Fernandez-Ilebrez, 1996; Koumoundouros *et al.*, 1997; Favaloro & Mazzola, 2000). In general, deformities that involve bending of the spine like scoliosis (lateral curvature), lordosis (ventral curvature) and kyphosis (dorsal curvature) have been reported to be associated with earlier life stages (Messaoudi *et al.*, 2009). Further, malformations of bone consist of fracture and non-fracture related compression of vertebral bodies, distortion and underdevelopment of single vertebrae, alterations of the intervertebral space and fusion of vertebrae (Vagsholm & Djupvik, 1998; Kvellestad *et al.*, 2000 & Gavaia *et al.*, 2002). Various types of deformities in the vertebral column were reported earlier among various piscine species like common carp, *Cyprinus carpi* (Al-Harbi, 2001) red sea bream, *Pagrus major* (Hattori *et al.*, 2003), gilthead seabream, *Sparus aurata* (Afonso *et al.*, 2000), and *Clarius gariepinus* (Eissa, 2009). In general, these deformities in fishes are suggested to be associated with environmental disturbance, (Couch *et*

al., 1979; Backiel *et al.*, 1984; Weis & Weis., 1989; Wiegand *et al.*, 1989), nutritional deficiency in the feeds (Rucker *et al.*, 1970; Lim & Lowell, 1978; Akiyama *et al.*, 1985; Dabrowski *et al.*, 1988; Frischknecht *et al.*, 1994; Quigley, 1995) a genetic mutation (Mair, 1992), or a combination of these factor (Al-Harbi, 2001). Further, seasonal effect of continuous light on the growth of different region of the vertebral column in Atlantic salmon was also reported by Fjelldal *et al.*, (2005) and Wargelius *et al.*, (2008). Light intensity has also been reported to cause aberrations in the development of the vertebral column (Carls & Rice, 1990). Lordosis in fish was reported as an abnormal ventral curvature of the vertebral column, accompanied by abnormal calcification of the afflicted vertebrae and a bulking failure of the vertebral column (Kranenbarg *et al.*, 2005) and one of the most severe deformities develop in reared fish (Fjelldal *et al.*, 2006). Further, skeletal anomalies were used as an indicator of pollution stress in fish (Bengtsson *et al.*, 1985; Karen *et al.*, 2001; Klumpp *et al.*, 2002; Boglione *et al.*, 1989). Reports on the effect of constant light and dark on the growth of vertebral column in fish are scarce. Thus the present study was aimed to examine the effect of continuous light (LL) and continuous dark (DD) on the growth of vertebral column in a freshwater catfish, *Clarias batrachus*.

Methodology:

Live *Clarias batrachus* of mixed sex (body weight $70 \pm \text{gm}$) were procured from the local fish market during different phases (pre-spawning, spawning, and post-spawning) of its annual reproductive cycle. During each phase, prior to starting the experiment animals were kept in stock aquaria for proper acclimation. Following acclimation, animals were divided into three groups ($n=18$, in each group) and maintained under different photoperiods i.e., natural day length (control), continuous light (LL) and continuous dark (DD) for 60 days. Experiments were carried out for three consecutive years. During each experimental protocol, four animals from each group were dissected out successively in every 15 days and visual analysis of the structure of vertebral column was made during experiment water inside the aquaria was renewed every alternate day and animals were fed *ad libitum*.

Results:

(Results were summarized in Figure-1 to 3)

Natural day length (NDL; control): visual observation of the structure of vertebral column has revealed normal standard change in growth of vertebral column in the group kept under NDL and was treated as control during different phases of annual reproductive cycle (Fig.-1a).

Constant light (LL): like control visual analysis of the vertebral column showed no deformities in its structure during different studied phases of annual reproductive cycle.

Constant dark (DD): in contrast, in most of the fish maintained under constant dark, curvature in vertebral column at trunk/abdominal region (lordosis) were observed during pre-spawning (Fig.-2 a,b(i & ii)) and spawning phases (Fig.-3a,b,c), irrespective of years of the study.

Further, it has also been observed that the angle of curvature increases with the days of exposure (Fig.-2 a,b(i & ii) & 3a,b,c). In addition, fusion in some trunk vertebrae with decreased intervertebral and inter-rib space were noticed (Fig.-3b,c).

Discussion:

Skeleton deformities irreversibly affect the production cost, biological performances and marketing image of the fish (Afonso *et al.*, 2000).

A wide range of physico-chemical and biological factors like temperature (Sfakianskis *et al.*, 2004), light (Biswas *et al.*, 2006), stress (Valenzuela *et al.*, 2007), parasite (Lom *et al.*, 1991) and pollution (Bengtsson *et al.*, 1985; Jawad *et al.*, 2017) had already reported to cause spinal deformities in various fish species.

Similarly, present results revealed the occurrence of lordosis and fusion of some vertebrae in the group of *Clarias batrachus* maintained under constant dark. However, no

Figure 1: Vertebral column (Lordotic vertebrae) of *C. batrachus* almost straight in control group

Figure 2: Vertebral column (Lordotic vertebrae) of *C. batrachus* kept under DD conditions during prespawning phase, started to bend gradually (a) After 30 days; (b) (i) After 45 days (ii) After 60 days.

Figure 3: Vertebral column (Lordotic vertebrae) of *C. batrachus* kept under DD during spawning Phase, showing bend (a) After 30 days; (b) After 45 days; (c) After 60 days (ribs collapsed)

structural changes in vertebral column were observed under constant light.

Earlier studies of Bolla & Holmefjord (1988) & Fjellidal *et al.* (2005) suggested light dependent spinal deformities in *Hippoglossus hippoglossus* and *Salmo salar*. They concluded that overgrowth of algal bloom, phytoplankton in the eutrophic pond may check the penetration of light and develop the complete dark condition in natural water bodies which might be responsible for the vertebral column deformities in fish. However, several studies (Tutman *et al.*, 2000; Hårdig & Höglund, 1984; Hamaza Chaffai *et al.*, 1998; Sloff, 1982; Whittle *et al.*, 1992 & Massaudi *et al.*, 2009) reported the occurrence of high frequency of spinal deformities in fish found in polluted water. Economic loss is a major outcome in fish industries due to deformities in shape (Jawad *et al.*, 2017).

On the basis of present results, it could be concluded that constant dark may cause stress in the *Clarias batrachus* resulting lordosis.

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