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REPRODUCTIVE CHARACTERS OF YELLOWCATFISH *HORABAGRUS BRACHYSOMA* (HORABAGRIDAE) FROM PERIYAR RIVER, WESTERN GHATS

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Abstract: The reproductive biology of *Horabagrus brachysoma*, a threatened riverine catfish endemic to the Western Ghats was studied to inform management plans. Although, the Gonado-Somatic Index (GSI) values of male and female *H. brachysoma* co-varied among months, the mean monthly value was always highest among females. Annual profile of GSI pointed to a prolonged spawning season extending from March until July. *H. brachysoma* are 'single spawners' with a prolonged breeding season. Overall sex ratio of *H. brachysoma* did not show any significant deviation from the expected 1:1. The size at first maturity was observed to be 188mm T_L for males and 168mm T_L for females.The smallest of males and females belonged to the 180-200mm length class. The highest absolute fecundity observed was 62015 in a fish with a T_L of 340mm and T_W of 388.3g. Based on the information generated, fishery management plans including closed season and catch size have been suggested.

Key words: Reproduction, golden catfish, *Horabagrus brachysoma*,gonadosomatic index, size at first maturity, spawning season

INTRODUCTION

Riverine fishes across the world are threatened by a multitude of stressors including habitat loss, over harvest, invasive alien species and pollution (Dudgeon, 2000; 2003, 2011; Allan *et al.,* 2005), making them one of the most threatened taxa among vertebrates (CBD, 2011). The freshwater ecosystems are reported to have a higher portion of species threatened with extinction than their marine or terrestrial counterparts (Dudgeon *et al.,* 2006, Strayer and Dudgeon, 2010; Dudgeon, 2011).Efforts to conserve riverine fishes are however hindered by the very fact that natural histories including population status of the vast majority of rare or economically important species are still poorly known (Dudgeon, 2003). Majority of the assessments of freshwater fish species in the IUCN Red List, were mainly based on their distribution or range size, as there is an extreme paucity of information on biology, ecology or population status of most species. Generation of critical information on the natural history and demography of freshwater fish, especially endemic and threatened species are thus an urgent priority.

The yellow catfish, *Horabagrus brachysoma* (Horabagridae) (Fig. 1a, b) is endemic to the Western Ghats Freshwater Ecoregion (WGFWE) of peninsular India where it has a restricted distribution in lowland rivers and associated backwaters (Ali *et al.,* 2007). *H. brachysoma* is one of the most important inland food fish in the region, highly appreciated for its taste and having high consumer demand (Sreeraj *et al.,* 2007). In addition, fingerlings of this species are collected and exported to the international aquarium trade. Continuous exploitation for both the food and ornamental trade has led to a high

pressure on wild stocks in many rivers of the WGFWE. Recent research has revealed that *H. brachysoma* is overfished in River Periyar (Prasad *et al.,* 2012) and has reached the brink of overfishing in at least two other rivers (Prasad, 2008). The recently completed IUCN Freshwater Biodiversity Assessments in the Western Ghats region has categorized *H. brachysoma* as a 'vulnerable' species due to its global population decline (35% in the last 10 years) and continuing habitat loss (Molur *et al.,*2011). There is hence an urgent need to develop and implement fishery management plans in the native range of *H. brachysoma* to protect the wild stocks from further decline. However, currently very little is known on the life history of this species from freshwater ecosystems like many other endemic and threatened species of the Western Ghats.

Knowledge of the reproductive biology is fundamental in the study of fish population dynamics (Murua *et al.,* 2003), as they are basal to quantifying the reproductive capacity at both individual and population levels. Determining the spawning patterns is of great importance in estimating fecundity as well as its ability to recover from fishery impact. Spawning strategy, fecundity and egg production are also factors of considerable importance as they influence reproductive potential of the stock, and thus have a direct implication on a population's ability to sustain harvesting (Ling *et al.,* 2009). Manipulation of reproductive system under artificial conditions also requires an understanding of natural spawning patterns and other influential factors based on information on size-at-sexual maturity as well as the duration and periodicity of spawning (Ling *et al.,* 2009). Padmakumar *et al.* (2011) have been successful in captive breeding of this fish and Bindu *et al.* (2012) reported the reproductive biology of this fish from a lake ecosystem in Kerala. Even then information on the reproductive biology of *H. brachysoma* from the riverine conditions is missing or still incomplete. The aim of this paper is to determine the reproductive biology of *H. brachysoma* from River Periyar, where the species is known to be under severe threat of overfishing (Prasad *et al.,* 2012). The results of this study will help to provide baseline information for developing fishery management plans in the River Periyar.

MATERIALS AND METHODS

River Periyar with a length of about 300 km and a catchment area of 5243km^2 (Smakhtin *et al.,* 2007) is one of the most important rivers flowing through the WGFWE. Monthly samples of *H. brachysoma* were purchased from fish markets located in the lower reaches of the Periyar drainage (Kalady, Angadikkadavu and Manjaly).

Our study was based on the analysis of an annual sample of 436 individual fish. Although the fish has been listed as threatened in the IUCN Red List, there is an active fishery and marketing of this species in the Periyar River (Prasad *et al.,* 2012). The study also strictly adhered to the IUCN Policy Statement on Research Involving Species at Risk of Extinction' with special reference to scientific collecting of threatened species (IUCN, 2008).

Fresh fish were procured from the markets and were preserved in 4% formaldehyde and transferred to the laboratory, where each individual was tagged, measured (Total Length T_L), weighed (Total Weight T_W) and sexed (by external sexual characteristics or by examining gonads under a dissecting microscope). Gonads were subsequently removed, weighed (G_W) and preserved in 4% formaldehyde, while matured ovaries with visible eggs were preserved in Gilson fluid to break down ovarian tissues. Gonado Somatic Index (GSI) was calculated as $100 \times G_W (T_W - G_W)^{-1}$ and used to delineate the spawning season. The length at which 50% of male and female fish were in maturing stages III and IV was taken as the minimum length at first maturity (Bagenal, 1978). For estimation of the mean lengths at 50% maturity size class verses % maturity curve was fitted using non-linearregression. Absolute fecundity (A_F) was estimated by weighing all the eggs in the ovary and also by counting three sub samples of eggs from different parts of the ovary. Relative fecundity (R_F) was calculated as T_F / T_W. Regression

analyses of A_F with T_L and T_W was carried out by the least square method with linear or non-linear regression using Pearson's correlation analysis (Bagenal, 1978). Sex ratio was determined for each population by using pooled fish from monthly collections. Any deviation from the expected 1:1 sex ratio was analyzed using chi-square test(Corder and Foreman, 2009).

RESULTS

Spawning season

The GSI values of male and female *H. brachysoma* co-varied among months, but the mean monthly value was always highest among females. The monthly GSI variations of both sexes were significant during all months (P< 0.05) except August. The variation in GSI followed a uni model pattern, with highest values from March to June with a peak in May indicating the spawning season. GSI values declined slowly from June-August, and then rapidly in September as a result of spawning (Fig. 3). There was a quiescent period in gonad development during September-November (Fig. 3).

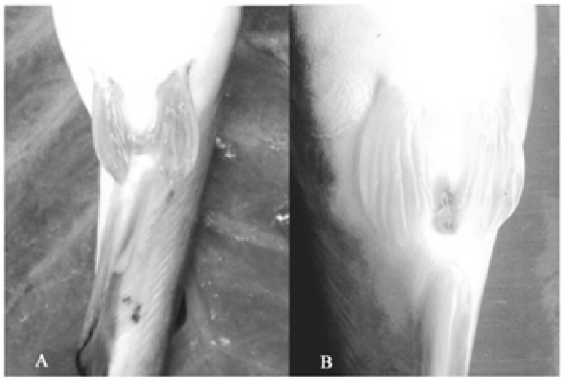

Figure 1. Sexual dimorphism in *H. brachysoma* - A. Male, B. Female

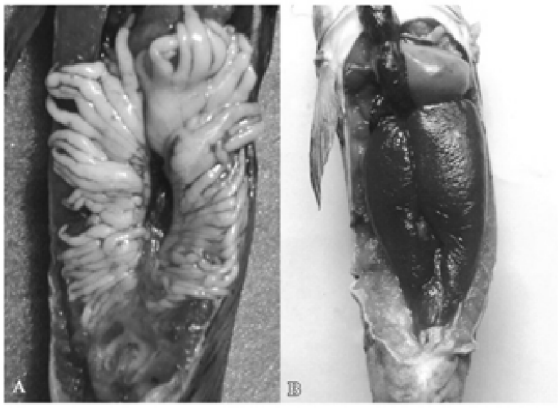

Figure 2. Gonads in ripe specimens A. Testis, B. Ovary

Spawning pattern

Annual profile of GSI pointed to a prolonged spawning season extending from March until July. A spurt in GSI during March (Fig. 3) pointed to the development of gonadal maturation. The climax in GSI values during the months of April and May indicated the intense breeding season, while the decline in GSI starting from the month of June until August pointed to a prolonged spawning activity. *H. brachysoma* belongs to the group of fish which are 'single spawners',spawning only once a year with a prolonged breeding season.

Sex ratio

Overall sex ratio of *H. brachysoma* did not show any significant deviation from the expected 1:1 (÷2 = 0.091; df = 1; P> 0.05(0.7629).

Size at first maturity

The maturity ogives for *H. brachysoma* showed that 50% of males were sexually mature at 188 mm T_L (Fig. 4a) and females at 168 mm T_L (Fig. 4b). The smallest of males and females belongs to the 180-200 mm length class.

Fecundity

The highest absolute fecundity (A_F) observed was 62015 in a fish with a T_L of 340 mm and T_W of 388.3 gm. The relationship between T_L and A_F was best explained by the linear equation: y = 2.449.x +0.962 (R^2 =0.60) (n=130)(Fig. 5a) while the relationship between T_W and A_F was best explained by the power function: y = 0.914x+2.322(R^2 = 0.61) (n=130) (Fig. 5b).

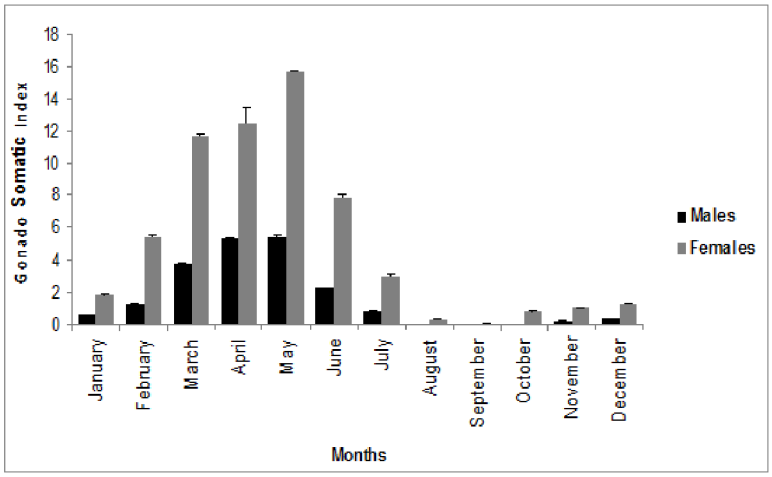

Fig. 3. Gonado Somatic Index of male and female *H.brachysoma* from River Periyar

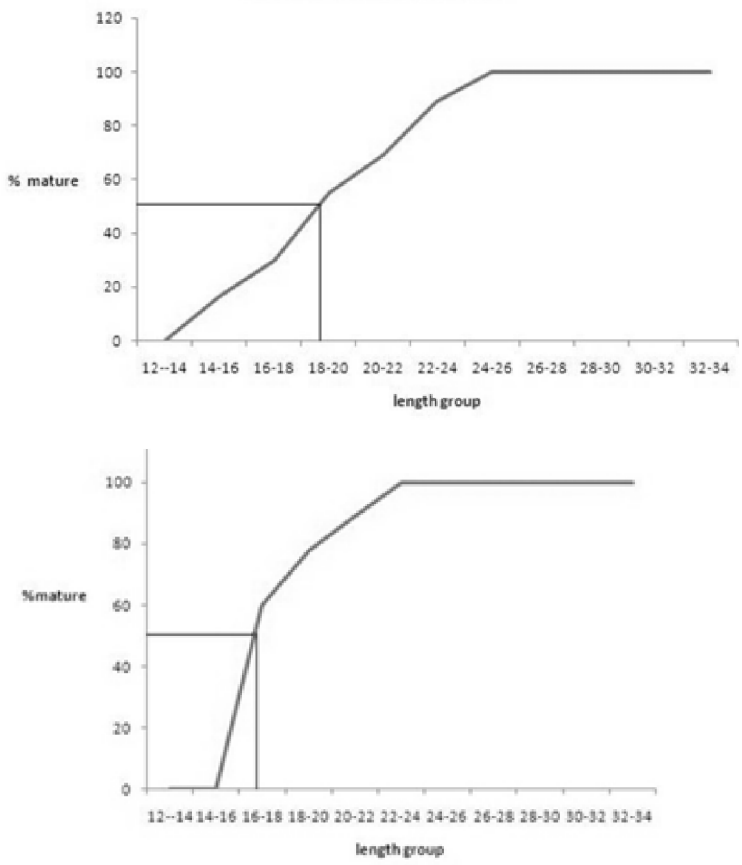

Fig. 4. Size at first maturity for (a) male and (b) female *H. brachysoma* from River Periyar.

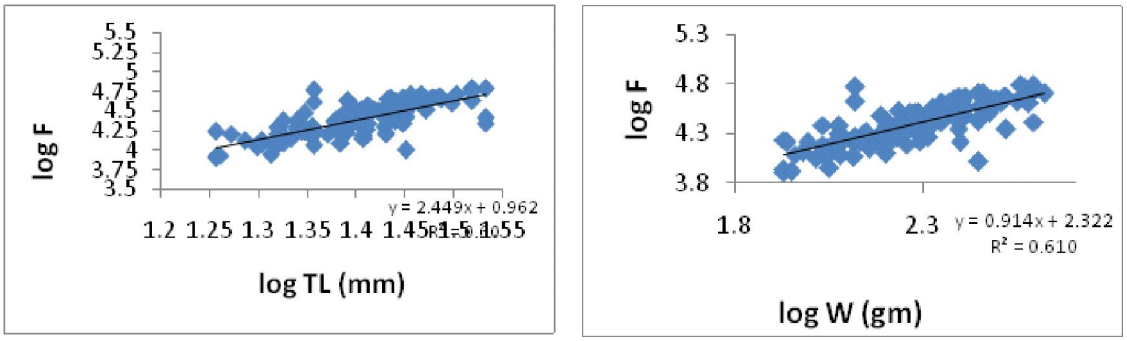

Fig. 5. Relationship between (a) total length and fecundity and (b) total weight and fecundity of *H. brachysoma*

DISCUSSION

Sexual dimorphism is one of the most important indices in fish biology and also the preliminary step for artificial breeding. Three types of sexual dimorphism are known in fish, (1) body size of females > males; (2) body size of females < males; (3) similar size of both sexes with partial differences on morphology (Lin and Lei, 2004). *H. brachysoma* belongs to type 1, since females were always much bigger than males at the same age. Larger size and higher abdominal capability of females, with marked differences in total weight and net body weight (T_w –G_w) could be due to more reserve energy in females for reproduction.

The overall sex ratio of *H. brachysoma* was close to the expected 1:1. In general, sex ratio of reproductive-aged fish is known to vary with both the age and size at which the fish begin to participate in breeding, as well as resistance to physical environmental stress, water temperature and/or pH during sex determination period and population density among other factors (Liu, 1997). The sex ratio reported for this fish in a lake ecosystem in Kerala is 1:1.97 with dominance of females (Bindu *et al.* 2012) and suggested that this dominance of females could be due to the migratory behaviour of the fish during breeding season but in the present study such a schooling behaviour is not observed in the studied ecosystem. Unbiased sex ratios are found in wild populations of catfishes in the absence of hermaphroditism, sex reversal and environmental constraints (Mazzoni and Carmaschi, 1995).

The maturation of reproductive organs and spawning activities of *H. brachysoma* seems to synchronize with the regional monsoon (May to August) and this observation is well corroborated with the findings of Bindu *et al.* (2012) for this fish from the lake ecosystem. Synchronization of sexual maturation with elevation in temperature in summer, and subsequent spawning during the onset of the monsoonal rains is a reproductive character of several riverine fish species. Fishes that are single annual spawners are known to have a low tempo of reproduction, and for such species GSI is typically a reliable guide to reproduction (McAdam *et al.* 1999). A single peak in GSI pointed to single spawning season in *H. brachysoma*. The primary cause for the initiation of spawning has been well studied in catfishes most of which have been related to rainfall patterns or flooding (Van der Waal, 1974; Marriott *et al.,* 1997). Many species of tropical clariids exhibit communal spawning in the flood plains of Africa (Yalcin *et al.,* 2001; Ezenwaji, 2002), while neotropical catfishes breed in the flood plains of Brazil (Peixer *et al.,* 2006; Mazzoni and Caramaschi, 1995). As like these catfishes, the floodplains formed in the Priyar river during South west monsoon probably offer *H. brachysoma* with the optimal conditions necessary for spawning as observed by Prasad (2008).

Knowledge of the size at first maturity of any fish stock is essential in order to determine the minimum size of capture by regulating the mesh size of the nets (Dadebo *et al.* 2003). For the same species, the length at first maturity can differ between regions due to the difference in environmental conditions (Abdel-Bakiel, 2005). The higher GSI and lower size at maturity in males can often be related to high reproductive effort as an adaptation for environmental constraints, indicating that the population is under high environmental pressure (Mazzoni *et al.*,2002). Here, the first maturity of male is at 188mm and female at 168mm T_L. As per the reports of Bindu *et al.* (2012)the size at first maturity of this fish from the lake ecosystem is 130 mm and 135mm for males and females respectively. This earlier maturity in the lake system may be due to the variations exists in populations and in turn the growth rate as observed by Lehtonen(1987). Another reason for this difference in maturity could be the better environmental conditions and food availability in the lake ecosystem than that of the riverine habitat but detailed studies are needed to prove this unequivocally.

The determination of actual numbers of eggs produced by fish species is also useful for the analysis of stock dynamics (Mason, 1985). Absolute fecundity (A_F) of *H. brachysoma* in river Periyar was observed to be between 8200 and 62015 and this value is higher than the observed values of Kurian and Inasu (2003) and lower than the values observed by Bindu *et al*. (2012). Fecundity in fish is known to vary among populations, and at times, between strains of the same species (Bromage *et al.,* 1990, Jonsson and Jonsson, 1999) and the changes in the individual physiology and their surroundings (Bindu*et al.,*2012). All the mathematical correlations described in this study were highly correlated and the predictive equations were all significant ($P < 0.05$) as with several species of catfish (Khan *et al.*, 2002; Marraro *et al,.* 2005).

Based on the results of the present study, we suggest three management plans for managing the wild populations of *H. brachysoma* in River Periyar. First the implementation of a closed season during March to August to prevent the exploitation of egg carrying females and reproductive males. Secondly, the catch size should be regulated and a minimum size of 150mm should be imposed for the fishery to save the new recruits. Third, the flood plains of the rivers should be protected since a flood plain spawning behaviour is seen in this catfish which will help for the healthy recruitment of the stocks naturally.

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