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An investigation into the factors affecting the natural reproduction of *Opsaridium peringueyi*

N.A.G. Moyo

University of Limpopo, School of Agricultural and Environmental Sciences, Faculty of Science and Agriculture, Aquaculture Research Unit, Private Bag X1106, Sovenga 0727, South Africa

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ABSTRACT

An endangered freshwater fish, *Opsaridium peringueyi*, was studied from January, 2009 to December, 2009. The analysis of the environmental conditions indicated that the fish is found in streams with moderate to fast flow, high oxygen levels, a depth greater than 0.6 m and temperatures between 10 and 24 °C. *O. peringueyi* is sexually dimorphic with males growing at a faster rate and attaining a larger size than females. The breeding biology of this species was investigated in glass aquarium tanks. The spawning behaviour is described for the first time. The breeding colour of the male is deep red on the operculum, ventral part, caudal and ventral fins. The breeding colour in the female is the same as the male except the red colour is lighter. The breeding of *O. peringueyi* is a four stage process which begins with the appearance of breeding colour culminating in the laying of eggs after courtship. Temperature, flow-rate, conductivity and substrate were identified as the environmental cues important in the reproduction of this species. All these factors had a significant effect on the breeding activity of *O. peringueyi*. The possible effect of climate change on *O. peringueyi* is discussed.

1. Introduction

Opsaridium peringueyi (Cyprinidae) is an endemic fish found in South Africa and Zimbabwe in areas below 1200 m of altitude (Kleyhans and Hoffman, 1992). In Zimbabwe this species may well be extinct or close to extinction (Marshall and Gratwicke, 1999). In South Africa, *O. peringueyi* inhabits clear shallow perennial pools of rivers on a sandy or gravel substratum (Crass, 1964; Gaigher, 1973 and Pienaar, 1978). It favours a temperature of 15–25 °C (Skelton, 1996). *O. peringueyi* is now an endangered fish species (Skelton, 1993). The reasons for this are not clear but habitat alteration and deterioration are probably the major threats affecting *O. peringueyi*. Many formerly perennial rivers of the Transvaal Lowveld now stop flowing during the dry season due to impoundment of water and extraction of water for agricultural purposes. Turbidity and siltation through soil erosion from overgrazing and crop cultivation occurs at the beginning of the rainy season. Both turbidity and siltation probably affect the sight, feeding and breeding of the species (Skelton, 1987).

Few studies have been undertaken on *O. peringueyi* yet it is on the IUCN red data list. There is evidence that the geographical range of this species has shrunk (Skelton, 1993) therefore detailed studies on *O. peringueyi* are needed to conserve this species. This study investigated flow rate, conductivity and substrate to determine if they have any influence on the natural reproduction of *O. peringueyi*. The main objective of this study was to identify and quantify the environmental cues important in the reproduction of *O. peringueyi*.

2. Materials and methods

Ten sites along the Sabie River (Fig. 1) and its tributaries were sampled for *O. peringueyi*. The sampling sites were chosen at random. The Mac-Mac site (9), along the Mac-Mac River was selected for macrohabitat and microhabitat analysis as this was the only site where *O. peringueyi* was caught. No *O. peringueyi* were caught from the other nine sites. Environmental conditions at the Mac-Mac site were recorded during each monthly survey (January–December, 2009). Temperature (°C), dissolved oxygen mg l^{-1}, turbidity (NTU), conductivity (μS cm^{-1}) were determined on site using a Horiba U23 multiprobe meter (Horiba, Ltd., Osaka, Japan). Fish were caught using a Smith-Root VI-A electrofisher (Smith-Root Inc. Vancouver, Canada) powered by a Honda E2500 generator. Depth was averaged from the measurements along a transect of 1/3, 1/2 and 3/4 distance from the bank. Flow velocity was determined using a digital flow meter (PS 2000 Pascal flow meter, Apollo, Ltd., Wasall, UK).

The breeding season was determined by seasonal appearance of juveniles and their abundance was reported as an indirect assessment of the reproductive season. The traditional analysis of

E-mail address: moyon@ul.ac.za

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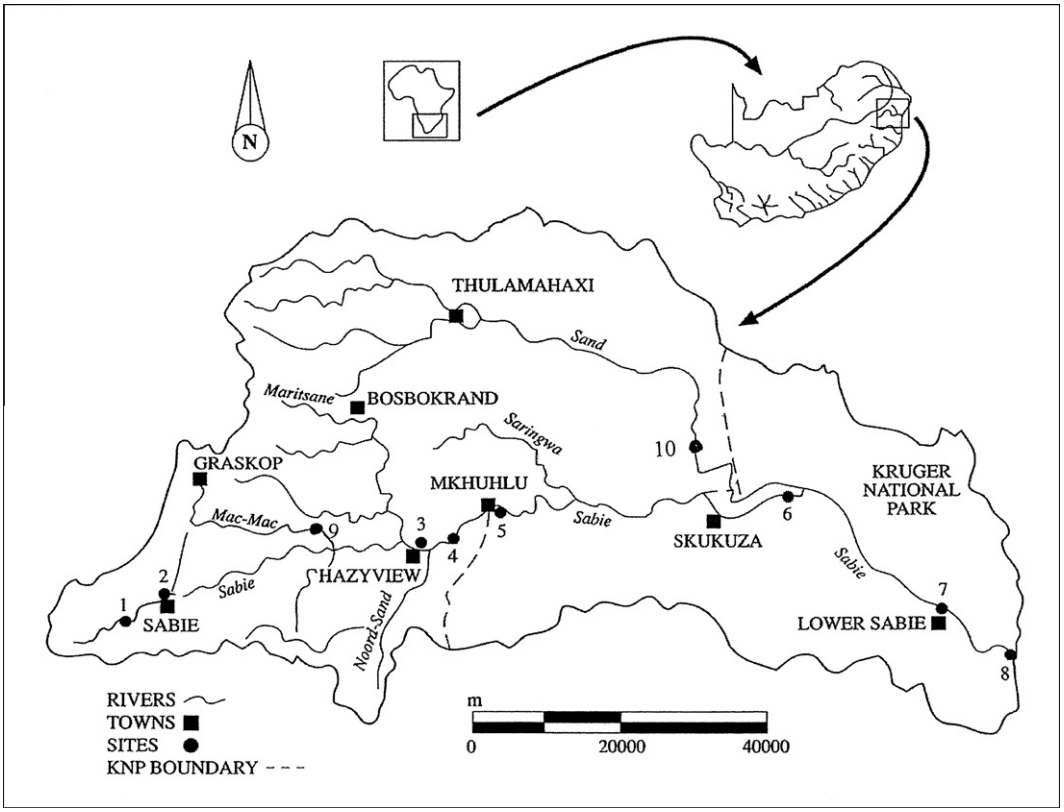

Fig. 1. Map of Sabie River and its tributaries.

gonadosomatic index was not used because *O. peringueyi* is an endangered fish species. However, some fish were sacrificed to determine the length at first maturity. The degree of maturity of all gonads was estimated by visual inspection. Percentage maturation was plotted against length and the length at first maturity was read off at the 50% point. Six scales were removed from the first row of scales above the lateral line. The scales were cleaned by soaking them in water and were then mounted on microscope slides. The number of annuli were counted and recorded. Marginal scale analysis as described by Moyo and Fernando (1999) was used for age validation. The Von Bertalanffy model was used to describe growth:

$$L_t = L[1 - \exp[-K(t - t_0)]] \quad (1)$$

where L_t is the length at time t; K is the growth coefficient; L_∞ is the asymptotic length and t_0 is the hypothetical age at zero length.

Three 100 L rectangular tanks were set aside to investigate the effect of flow rate on natural reproduction of *O. peringueyi*. There was no flow in the first tank. The second tank had a low flow rate of 0.08 m/s while the third tank had a strong flow rate of 0.28 m/s. All the three tanks had a temperature of 21 °C, standard conductivity of 0.783 μS/cm and a substrate of 2/3 sand and 1/3 gravel.

Three tanks were also set aside to investigate the effect of temperature on natural reproduction of *O. peringueyi*. Temperatures of 18, 22 and 25 °C were maintained in the three tanks. All the tanks had flow rate of 0.23 m/s, standard conductivity of 0.783 μS/cm and a substrate of 2/3 sand and 1/3 gravel.

Conductivity was the third factor investigated to determine its influence on natural reproduction of *O. peringueyi*. Two tanks were used for this experiment. The first tank had a standard of conductivity 0.783 μS/cm while the second tank had altered conductivity of 0.291 μS/cm. Both tanks had flow rate of 0.23 m/s, a temperature of 21 °C and a substrate of 2/3 sand and 1/3 gravel.

Substrate was the last factor investigated to determine if it had an influence in the natural reproduction of *O.* peringueyi. Three tanks were set aside for this experiment. The first tank had a substrate of 2/3 sand and 1/3 gravel, the second tank had a gravel substrate while the third tank had no substrate. All the three tanks had a flow rate of 0.23 m/s, a temperature of 21 °C and a standard conductivity of 0.783 μS/cm.

In each experimental tank, the *O. peringueyi* were stocked at a ratio of one male to one female. The males had a mean length of 96 mm and mean weight of 11.00 g while the females had a mean length of 74 mm and mean weight of 5.25 g. The breeding pair were fed with a mixture of natural food to condition them. The mixture of the natural food included Chironomidae, Simuliidae, Culicidae, and Dytiscidae. Each of the experiments was repeated twice.

O. peringueyi's breeding behaviour was recorded with a video camera during this study. The breeding of *O. peringueyi* was a four stage process:

(a) Occurrence of breeding colour (BC) in both male and female fish characterised by red flushes in the operculum, ventral part and anal and caudal fins.
(b) The male continuously chases the female (C) as the female attempts to escape.
(c) The female eventually pairs with the male and swim in parallel, this was designated as 'spawning behaviour' (SB).
(d) The last stage was the actual laying of eggs and this was designated as the 'spawning ritual' (SR).

BC, C, SB and SR were allocated breeding stage scores of 10, 20, 30 and 45 respectively.