

# The correlation between environmental factors and the reproduction of *Oreochromis mossambicus*

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## Abstract

Syferkuil Dam is situated 8 km NW of the University of the North and comprises a series of eight interconnected rectangular dams, having cement sides and mud bottoms. Aspects of the reproductive physiology of *O. mossambicus* that were investigated included the role of environmental factors such as rainfall, photoperiod, dam-water temperature and dam water pH. The environment plays an important role in at least initiating the commencement of the reproductive cycle in *O. mossambicus*. An increase in photoperiod, rainfall and water temperature together with a decrease in water pH are the cues for gonadal maturity to occur. These changes seem to have a greater impact on female gonad development than male development. Male development seems to be dependent on female development in that it "lags" behind the female by two months. The results imply a close interaction between environmental cues and endocrine control of reproduction. Endocrine control cannot continue without the appropriate environmental cues required to stimulate reproduction.

## Introduction

The environment has long been considered to play an important role in the reproductive cycles of freshwater fish. The influence of environmental factors has been reviewed within several fish species (Crim, 1982; Wootton, 1984; Zohar and Billard, 1984; Munro et al., 1990). Amongst those factors considered to be of importance are photoperiod, temperature, salinity, rainfall and lunar cycle. It is thought that the external factors act on exteroceptors of the fish and through them on the hypothalamus - pituitary - gonad axis. Photoperiodic effects on reproduction have been reported for numerous cyprinids (Bromage, 1987; Hontela and Stacey, 1990). A decreasing photoperiod generally inhibits spawning of both male and female fish. Lam (1983) in Hoar et al. (1983) states that photoperiod does not affect the timing of first sexual maturity in *Samtherodon* (now *Oreochromis mossambicus*). Puberty may occur in either continual darkness or continual light, thereby implying an endogenous rhythm.

In subtropical or subtemperate regions (as is this study area - close to the Tropic of Capricorn), seasonal variations in photoperiod are relatively small. In those species that spawn in spring or early summer, gonadal recrudescence may often be stimulated as a result of increasing photoperiod (Lam, 1983). Fish are, however, usually exposed to a gradual rather than an abrupt increase in photoperiod.

In tropical and subtropical species, peak spawning activity is often associated with rainfall, floods or the lunar cycle (Schwassmann, 1971, 1978, 1980; De Vlaming, 1974; Lowe-McConnell, 1975; Billard and Breton, 1978; Gibson, 1978; Liley, 1980).

It is not clear which of the terminal reproductive events (oocyte maturation or ovulation) is triggered or enhanced by rainfall, or whether spermiation and/or sperm release is involved. Further, it is not clear what specific factor or factors associated with rainfall may be involved in spawning stimulation. Bruton (1979) has suggested numerous related factors, like lowering of water temperature, dilution of electrolytes (e.g. decrease in conductivity), increase in

oxygen content and a change in pH. It is most likely that a variety of factors is involved.

It is thought that temperature may exert its effects on fish reproduction by a direct action on gametogenesis (Lofts et al., 1968); an action on pituitary gonadotropin secretion (Breton and Billard, 1977; Peter, 1981); an action on metabolic clearance of hormones (Peter, 1981); an action on the responsiveness of the liver to estrogen in the production of vitellogenins (Yaron et al., 1980) or an action on the responsiveness of the gonad to hormonal stimulation (Jalabert et al., 1977; Bieniarz et al., 1978).

Rana (1990) has shown that low temperatures adversely affect the development of larvae whereas higher temperatures accelerate development in the tilapia, *O. niloticus* (L.). According to Okuzawa et al. (1989), an increase in water temperature induces vitellogenesis and spawning in cyprinid fishes. Their results for the cyprinid, *Gnathopogon caeruleus* indicate that the response to changes in photoperiod is most pronounced at higher water temperatures.

Water pH is an important environmental factor to be considered due to the role it plays in terms of water pollution. Acidification of surface waters is one of the most serious problems of environmental pollution in North America (Fromm, 1980). Acid stress may impair vitellogenesis and even lead to spawning failure. These effects may be related to an upset in calcium metabolism and to a faulty deposition of yolk proteins in developing oocytes. High pH may also pose a problem to the reproductive activity of the fish living in such an environment. Due to the nature of the sampling site, similar problems could be encountered at Syferkuil Dam.

With the foregoing in mind, the role played by the environmental factors of rainfall, photoperiod, dam-water temperature and dam-water pH was examined and related to a possible effect on the reproductive cycle of *O. mossambicus*, using the gonadosomatic index (GSI) as an indicator of reproductive maturity.

## Materials and methods

Each Monday morning, over a 12-month period, 10 adult male and 10 adult female *O. mossambicus* specimens were collected at Syferkuil Dam, 8 km NW of the University of the North using a seine net. Before the experimental animals were transported back

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