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Environmental Conditions for the Breeding of Silver Catfish (*Chrysichthys nigrodigitatus*) in Eti-Osa L. G. A., Lagos State

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ABSTRACT

The influence of environmental conditions on the breeding potential of *Chrysichthys nigrodigitatus* collected from the Lagos Lagoon was investigated from November 2020 to January 2021. Female and male broodstock pairs were each put in two replicated aquaculture enclosures; plastic tanks and netted pens-in-ponds within which hollow receptacles had been placed. Water samples were taken fortnightly and analyzed throughout the 10-week duration of the study. The parameters examined were ammonia, nitrite, nitrate, pH, phosphate and iron. Meteorological data (temperature, rainfall and relative humidity) covering the study period was plotted. Four peaks of rainfall in the months of November and December were observed, with no rainfall recorded in January. Pairing of the silver catfish took place in November while a total of four spawning events occurred in the two enclosures in December and January, a period not considered *C. nigrodigitatus*' natural reproductive season. The ability of the breeding adults to spontaneously spawn in captivity showcases the fish's potential as a suitable aquaculture species for culture species diversity in Nigeria.

Keywords:
Environmental conditions, breeding, Chrysichthys nigrodigitatus

Introduction

The silver catfish *Chrysichthys nigrodigitatus* is a bottom dwelling, highly valued food-fish and is among the frequent commercial fish catches from some water bodies in Nigeria, caught mostly with dragnets, hooks and lines, bottom-set gillnets as well as bottom-set traps. Knowledge of the reproductive biology and physiological characteristics of this species is important for management, sustainable utilization, propagation and culture under specific conditions (Offem *et al*., 2008; Francis and Elewuo, 2012; Kouamé *et al*., 2014; Daniel, 2015).

Many catfish species are incapable of spontaneous spawning in captivity thereby requiring hormonal inducement. Such species include; *Clarias gariepinus*, *Heterobranchus bidorsalis* and *Heterobranchus longifilis*, and they represent the only catfish species produced commercially in Nigeria. As a result,

studies have been conducted to assess the reproductive potential of the silver catfish in captivity. The release of eggs and spermatozoa of *C. nigrodigitatus* occurs in natural, simulated and hormone-induced settings which can be impacted by a number of environmental factors (Anwa-Udondiah, 2017; Soboyejo *et al*., 2021; Soboyejo, 2023). These factors include atmospheric conditions and water quality and have been shown to determine the success or failure of the breeding potential of fish (Ji-Lun *et al*., 2019; Serpokrylov *et al*., 2020; Larin *et al*., 2021).

It has been documented that catfish production requires an optimal set of environmental conditions (Waldbieser *et al*., 2010; Qiang *et al*., 2019). The silver catfish is abundant during the rainy season months in Nigeria. It is, therefore, strongly linked to rainfall with regards to its abundance and reproductive activity (Offem *et al*., 2008; Tiogué *et al*., 2020), thereby predisposing the fish to climate change impacts (Ama-Abasi and Sambo, 2013; Anwa-Udondiah *et al*., 2014).

Consequently, it is imperative to ensure that the water quality parameters and atmospheric conditions are adequately monitored for optimal productivity and survival of this fish species. Therefore, the objective of this study was to attempt to propagate *C. nigrodigitatus* outside of its natural reproductive season as has been achieved with the domesticated clariids and report the various environmental conditions at the time of its breeding.

Materials and Methods

Study Area: The study was conducted from November 2020 to January 2021 in Badore Research Center, located in Eti-Osa LGA, an outstation of the Nigerian Institute for Oceanography and Marine Research in Lagos State. It is located at latitude 6.51 and longitude 3.60. Two distinct seasons are represented which are the rainy season (May - November) and dry season (December - April).

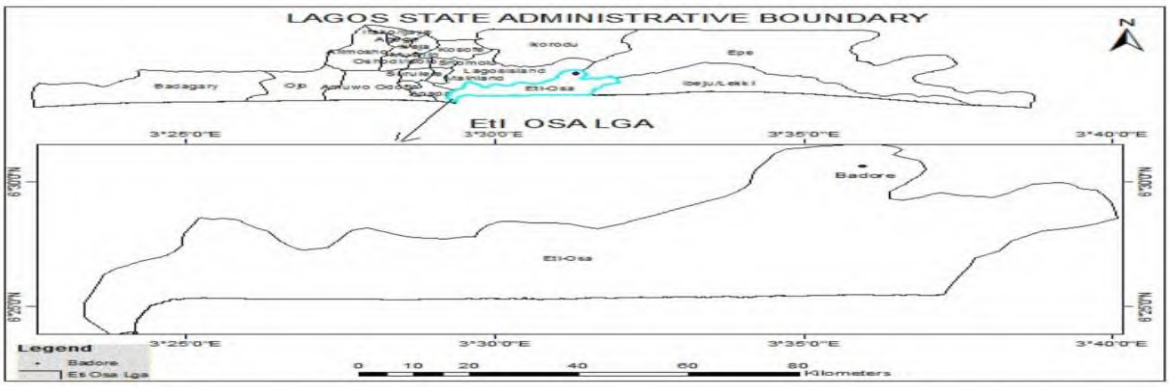

Fig. 1: Geographical location of Eti-Osa LGA showing the study area Badore

Collection of Water and Broodfish Samples: Water sample was obtained from the Lagos Lagoon on the day experimental broodfish were collected in a clean 75 ml plastic bottle. The fish comprised 16 male and female catfish pairs, totaling 32 specimens, which were retrieved from previously deployed bottom-set passive traps used in the artisanal fishery of *Chrysichthys spp.*

Fish samples were conveyed from the lagoon to the Research Centre in water bags infused with oxygen. Also, subsequently, during the course of the study, water samples were collected in 75 ml capacity

plastic bottles fortnightly from November 2020 to January 2021 and obtained from the experimental netted pens-in-pond and plastic tank systems. Each replicated system had a capacity of 2 m^3 within which hollow receptacles; bamboo and pvc pipes had been placed and housed the paired broodstocks that were fed once a day with fish pellets.

Plate I: Installation of a unit of four 2 m^3 pens

Plate II: Silver catfish collection

Plate III: Release of fish samples

Plate IV: Four 2 m^3 plastic tanks

Analysis of Samples: Water samples were tested for pH, phosphate, ammonia, nitrite and nitrate using Sera aqua-test box. The concentration of iron in the water was determined using a LaMotte kit (code 4447-01).

Meteorological Data: The meteorological data for the three months study was obtained from the Nigerian Meteorological Agency (NiMET), Lagos, Nigeria.

Results

Water Parameters **-** Water parameters obtained from the lagoon on the day experimental fish were sourced, and subsequently from the experimental systems are presented in Table 1.

Table 1: Water parameters of lagoon and experimental systems

	Water Parameters					
Water source	pH	Phosphate	Ammonia	Nitrite	Nitrate	Iron
Lagoon	6.5	1.0	0	0	0	---
Pens [earth	6–	0.25 – 5.0	0 – 0.5	0	0	0.5
Tanks [bore-	6.5–	1.0 – 10	0 – 5.0	0 – 0.5	0 – 10	4.0

Data (n = 6) range for experimental systems = week 0, week 2, week 4, week 6, week 8 and week 10

Spawning Indicators of Silver Catfish Breeding Adults in Pen and Tank Systems

The spawning indices shown in Table 2 summarizes spawning performance of *C. nigrodigitatus* broodstock in two aquaculture enclosures; namely, tanks and pens outside its natural environment and breeding cycle.

Table 2: Spawning performance of *C. nigrodigitatus* in replicated tanks and pens

Indices	**Plastic tanks**	**Netted pens-in-pond**
Aquaculture system capacity	2 m^3	2 m^3
Number of system type	4	4
Number of breeding adults/system	2 ♀ and ♂ pairs = 4 adults	2 ♀ and ♂ pairs = 4 adults
Total broodstock per system type	16 breeding adults	16 breeding adults
Mean weight (g)	432.35±141.26	385.63±128.66
Mean standard length (cm)	25.05±3.61	27.02±2.66
Mean fork length (cm)	27.38±4.03	29.37±2.91
Mean total length (cm)	31.91±4.29	34.07±3.48
Pairing of ♀/♂ fish in November	4	2
Spontaneous spawn in November	-	-
Spontaneous spawn in December	2	-
Spontaneous spawn in January	1	1

Data values are Mean±SD of four replicates

Collection and Transfer of C. nigrodigitatus eggs in hollow receptacles to hatching jars

The reproductive products and transfer of eggs to hatching jars are depicted in plates V and VI.

Plate V: Silver catfish eggs

Plate VI: Transfer of eggs to hatching jars

Meteorological Data **-** The rainfall, temperature and relative humidity during the study period was plotted and are depicted from Figures 2 to 6. Four peaks of rainfall in the months of November and December were observed, with no rainfall recorded in January.

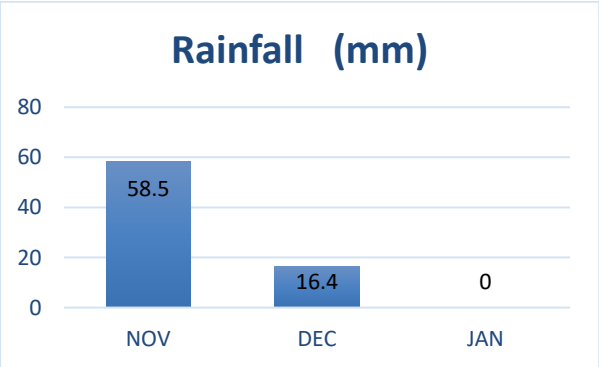

Fig. 2: Mean monthly rainfall during the study

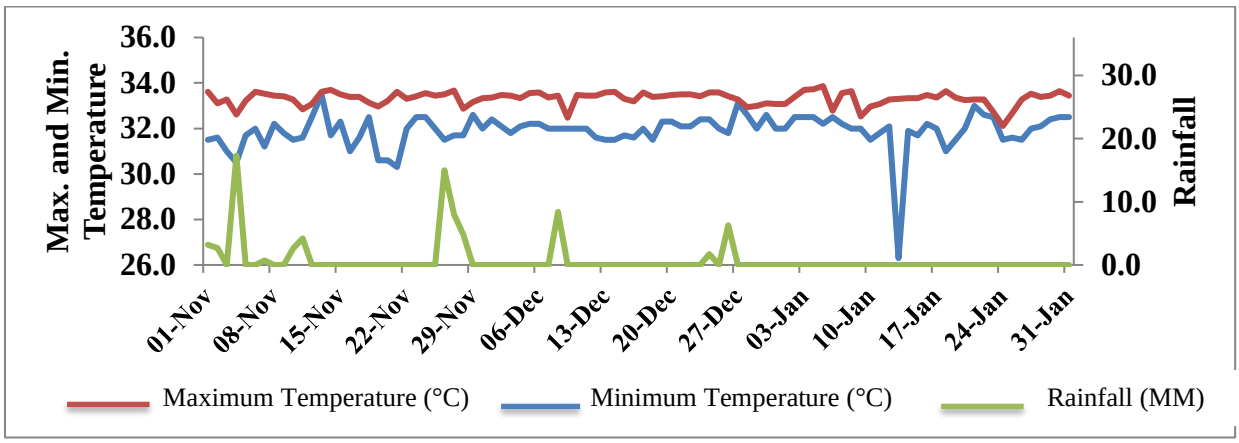

Fig. 3: A chart showing the rainfall against the maximum and the minimum temperatures

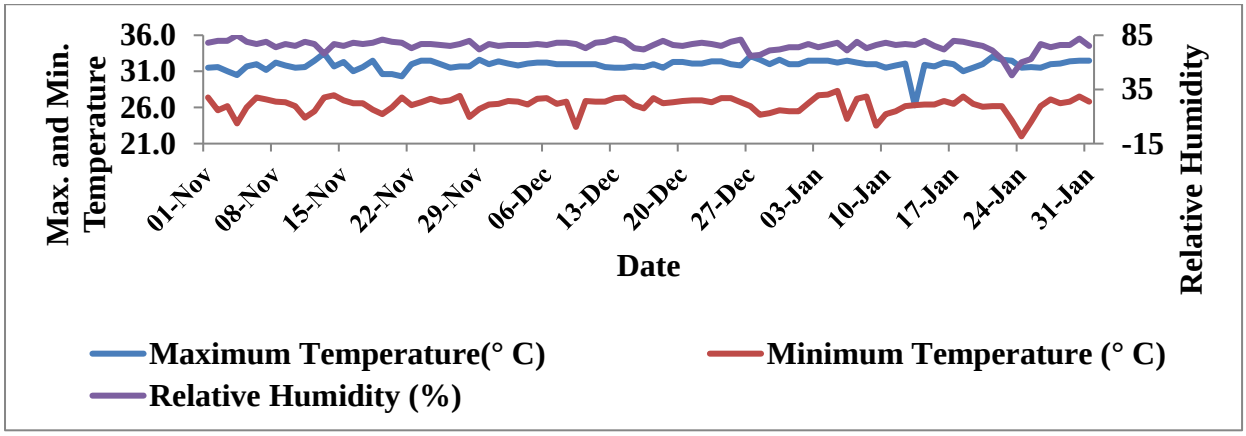

Fig. 4: A plot of the maximum and minimum temperatures against the relative humidity

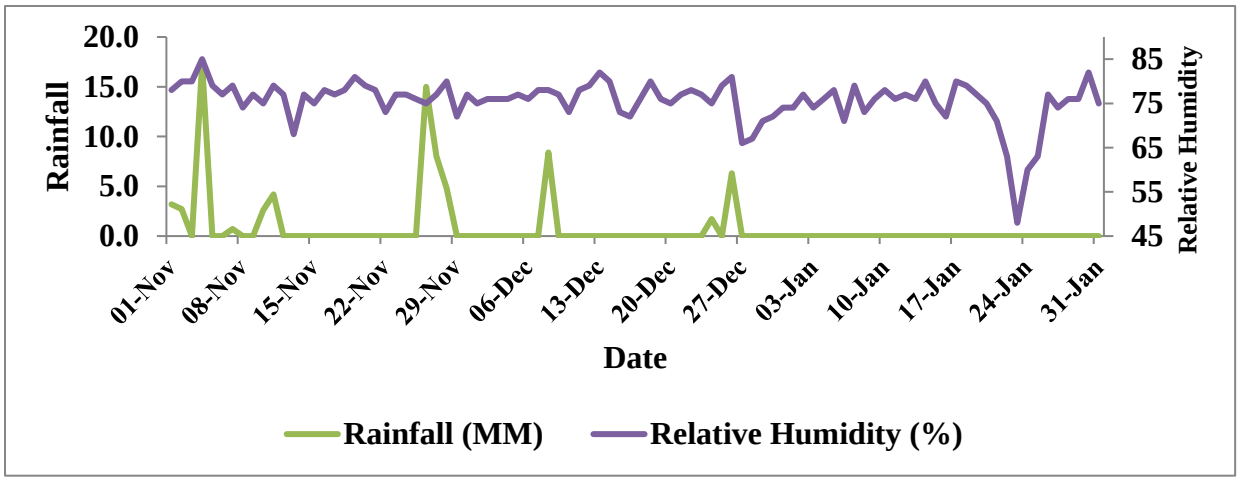

Fig. 5: Plot showing the relative humidity against the rainfall

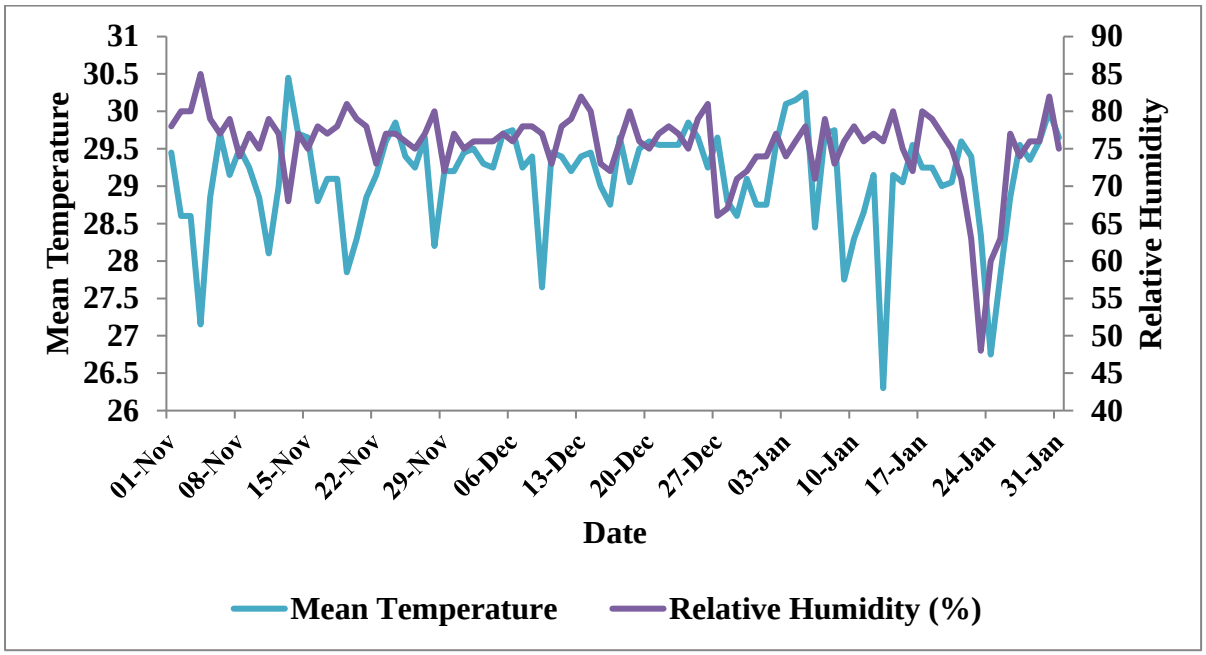

Fig. 6: Plot showing the Mean temperature against the Relative humidity

Discussion

The pH of the water samples obtained from the lagoon and experimental systems were within the desirable range of 6.5 – 9.0 recommended for fish culture management as reported by Bhatnagar and Devi (2013). Also, according to Boyd (2015), the optimum pH range for most aquatic organisms is 6.5 – 8.5 adding that this range is within satisfactory limits for water bodies. The slightly acidic pH range of 6 - 6.5 mg/L recorded for the pens may be attributed to the underlying soil sediment of the earthen pond in which the pens were constructed. A study by Ohimain (2011), reports this to be an outcome of wetland acidification in most tropical coastline areas.

In comparison to the water in the tanks, all other water parameters recorded for the pens such as; phosphate, ammonia, nitrite, nitrate and iron were lower and closer in terms of quality to the water sourced from the natural habitat of the broodfish. According to Boyd (1998), the acceptable range for phosphate concentration in water is within 0.005 to 0.2 mg/L, and this was exceeded in all three water sources.

The data range for ammonia in the tanks was 0 - 5.0 mg/L, which had no negative impact on the spawning process, thereby aligning with previous reports by Hargreaves and Tucker (2004) and Stone *et al*. (2013) that catfish acclimate to high ammonia levels of 2 to 5 mg/L over time. Nitrite and nitrate were undetected in the lagoon and fish pens but was recorded in the fish tanks at 0 – 0.5 mg/L and 0 - 10 mg/L respectively. As reported by Boyd (1998), the typical nitrite-N concentration is between 0.005 - 0.5 mg/L while the desired nitrate concentration in aquaculture systems is in the range of 0.2 - 10 mg/L.

In Table 2, female and male pairing of silver catfish within the hollow receptacles was observed in the first month of study but no spawning was recorded in the month of November in both aquaculture enclosures, while 2 spawning activities were recorded for the plastic tanks in December and none for

the netted pens. In January, both enclosures recorded one spawning activity each. The successful breeding of fish pairs culminating in spawns was indicative of favorable conditions, corroborating the assertion by Pawiroredjo *et al*. (2008) that successful reproduction in fish is dependent on a suitable environment.

Plots of the mean monthly rainfall and mean weekly environmental parameters of temperature, rainfall and relative humidity of the study area revealed some variations from month to month throughout the study period. Figure 2 shows that precipitation occurred in the months of November and December during the course of the study, and the spontaneous spawning by some of the breeding pairs within this season tallies with the report by Rodriguez *et al*. (1995) that the reproductive season of *C. nigrodigitatus* coincides with the short rainy season which is characterized by lower water temperature. In Figure 3, four peak periods of rainfall were recorded with values of 17.3, 15.0, 8.4 and 6.3 mm respectively showing a gradual reduction in millimetres in height as the dry season set in.

Contrarily, no rainfall was recorded in the month of January when the minimum temperature was 0 mm, a season referred to as the harmattan, which is a period of extreme cold and dryness in Nigeria. It appears that the spontaneous spawning of the silver catfish recorded in the month of January when there was zero precipitation disagrees with *C. nigrodigitatus*' reproductive behavior in the wild (Offem *et al*., 2008; Tiogué *et al.,* 2020).

The outcome of this study further reiterates the assertion by Otémé (1993) that the geographical positioning, the duration of the rainy season, and the specific characteristics of the water may vary the extent and period of the fecundity and reproduction in *C. nigrodigitatus* propagated in captivity.

In Figures 4, 5 and 6, the relative humidity was lowest in the month of January when there was zero precipitation and temperatures were at their lowest. The lowest relative humidity throughout the duration of the study (< 50%) was recorded in January, corresponding to a significant decrease in temperature (< 27°C) within the period. Legendre *et al*. (1996) found that when *C. nigrodigitatus* breeders were kept in lagoon enclosures at a low stocking density, spawning began at the end of the major rainy season and at a temperature around 27-29 °C.

Conclusion

Reproduction in *C. nigrodigitatus* outside its natural habitat is achievable under certain favorable environmental conditions comprising both atmospheric and water quality criteria especially with the assistance of hollow receptacles. The result from this study shows that the silver catfish can be successfully bred in captivity and propagated in months not regarded as its natural spawning season, thereby making it a suitable aquaculture species for culture species diversity in Nigeria.

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