Global Journal of Fisheries Science
Volume 6(4), pages 107-111, October 2024
Article Number: F443BCE33
ISSN: 2782-750X
https://doi.org/10.31248/GJFS2024.051
https://integrityresjournals.org/journal/GJFS
Full Length Research

Effects of weather on reproductive performance of African catfish (*Clarias gariepinus,* Burchell 1882) in Maiduguri, Borno State, Nigeria

Umar, A.[1], Mohammed, Z. B.[1]*, Umate, U.[1], Shettima, H. M.[1], Saidu M.[2], Pinak, K. B.[3] and Adam, A. A.[4]

[1]Department of Fisheries, University of Maiduguri, Borno State, Nigeria.
[2]Department of Fisheries Technology, Federal College of Freshwater Fisheries Technology Baga, Nigeria.
[3]College of Fisheries Science, Kamdhenu University, Veraval, India.
[4]Department of Fisheries Technology, Binyaminu Usman Polytechnic Hadejia, Jigawa State, Nigeria.

*Corresponding author. Email: zbmohammed@unimaid.edu.ng; Tel: +234 7013031635.

Received 5th April 2024; Accepted 8th August 2024

ABSTRACT: Studies on the effects of changes in weather conditions on the gonadosomatic index and some reproductive performance of African catfish were carried out with the aims of determining the fecundity, gonadosomatic index, fertilisation, hatchability and survival of the fish bred during (hot, rainy and cold periods). Eighteen broodstocks- comprising nine males and nine females were procured and conveyed to the Teaching and Research Fish Farm of the Department of Fisheries, University of Maiduguri and tested for their reproductive performance in each of the periods of the season; hot, rainy and cold time in April, August and January respectively. Data was analyzed using analysis of variance at a 95% confidence level. The results showed the highest fecundity, gonadosomatic index and number of fertilized eggs in the hot period while the number of hatched eggs and percentage survival were higher in the rainy period. Therefore, the most suitable periods that *Clarias gariepinus* can be bred are both hot and rainy periods as they give better results in terms of the reproductive performance of the fish.

Keywords: *Clarias gariepinus,* effects, reproductive performance, weather.

INTRODUCTION

Clarias gariepinus is widely distributed in Africa and parts of Asia, its main habitats are calm lakes, rivers and swamps that could be flooded on a seasonal basis (De-Graaf and Janssen, 1996). However, *Clarias gariepinus* has pseudo-lungs, long bodies and a high capacity to produce mucous as adaptations in stagnant environments or out of water. It is an omnivore feeding on plankton, arthropods, mollusks, fish, reptiles and amphibians (Yalçin *et al.*, 2001). Reproduction is seasonal with gonadal maturation associated with periods of flooding. The maturation process is influenced by changes in water temperature and photoperiod but the increase in water level is the principal factor for their reproduction (Yalçin *et al*., 2001). *Clarias gariepinus* has all the qualities of an aggressive and successful invasive species. It has high fecundity, flexible phenotype, rapid growth, wide habitat that is tolerant to extreme water conditions and the ability to subsist on a wide variety of prey and can devastate indigenous fish and aquatic invertebrate populations (Bruton, 1986). *Clarias garipinus* are readily recognized by their cylindrical body with scales skin, flattened bony head, small eyes, elongated spineless dorsal fin and four pairs of barbells around a broad mouth. The upper surface of the heads is coarsely granulated in adult fishes but smooth in young fish (Van-Oijen 1995). The anal, caudal and dorsal fins are not united. The male can be easily recognized by a distinct sexual papilla which is not present in female fish. The body is grey-black with the underside of the head and

body creamy-white colour (Van Oijen 1995). The fish has a distinct black longitudinal band on each side of the ventral surface of the head spaces (which is absent in young fish less than 9 cm long). Larger fish more than 9 cm are mottled with an overall grey and light intensity in the culture system.

Reproductive activity of captive fish is feasible (or potentially feasible) but with few exceptions is currently impracticable for most species therefore chemical method of manipulating reproductive activity continuously to be widely used in fish production operations worldwide. However, the control of fish reproduction in captivity cannot be exercised without regard to adequate environmental conditions which can differ for different species. Most research on the control of reproduction in fish has focused on female physiology because ovarian development and maturation are easily disturbed by environmental stressors, control of sex ratio by steroid treatment has become a well-established technique for several fish species but the technique continues to be problematic (Patino, 1997). In some cases, final gonadal growth and spawning usually can be achieved by important treatment with gonadotropin releasing hormone analogs (GnRHa) which in some species have to be applied in combination with dopamine antagonists to enhance responsiveness to GnRHa. However, efforts to accelerate gonal maturational competence by chemical means have yielded mixed results reflective of a relative lack of understanding or the basic physiological and biochemical mechanisms controlling these processes (Patino, 1997).

In the wild, breeding or spawning in *Clarias gariepinus* takes place during the rainy season. The fish make a lateral migration towards the inundated plains to breed and return to the river or lake soon afterwards while the juveniles remain in the inundated area. Juveniles return to the lake or river when they are between 1.5 and 2.5 cm long (Froese and Pauly 2013). First sexual maturity occurs when females are between 40-45 cm and males between 35-40 cm. Eggs are greenish while incubations last for a little time (about 33 hours at 25°C) (Froese and Pauly, 2013).

Due to the increase in human population, there is a need to increase the protein food (fish) to cope with the population demand. Captured fisheries alone cannot solve the problem and there is a need to produce fish seed through artificial propagation in the hatcheries. Many fish breeders produce a lower percentage of fingerlings in the hatcheries due to improper use of breeding time or changes in weather conditions. Therefore, this study aims to determine the effects of three-season periods (hot, rainy and cold) on the fecundity and gonadosomatic indices of African catfish *(Clarias gariepinus*) and as well investigate the effects of these periods on the fertilization and hatching rates of African catfish (*Clarias gariepinus*).

MATERIALS AND METHODS

Study area

The experiment was conducted at the teaching and research farm of the Department of Fisheries, University of Maiduguri situated between latitude 11° 051^{l} N and longitude 13° 051^{l} E. Maiduguri has two seasons; dry and rainy seasons. On average, the temperature is always high. June, July, August and September have a high chance of rainfall while January, February, March, April, October, November and December are regarded as the dry season. The warmest month in Maiduguri is April with an average maximum temperature of 40°C (104°F). The coldest month is January with a maximum temperature of 31°C (87°F). August is the wettest month while November is the driest (Field View, 2020).

Experimental fish

Eighteen (18) *Clarias gariepinus* brooders consisting of nine (9) males and nine (9) females were used for the experiment. The brooders were purchased from Garbati Fish Farm in Damboa Road, Maiduguri and conveyed to the Department of Fisheries, University of Maiduguri in a 50-litre jerrican containing 50% water and acclimatised in 2 x 2 x 1.5 m^2 concrete tanks for the period of 5 days before the commencement of the experiment.

Experimental procedure

The eighteen *Clarias gariepinus* brood fish (350 – 790g in weight and 25 – 32.0 cm in total length) were used to ascertain their reproductive performance. Three (3) of the males and females each were bred during hot (April), rainy (August) and cold (January) and this served as treatment 1, 2 and 3. The females were induced with ovatide at 0.2 ml/kg of their body weight and allowed for the latency period. The latency period depends on the weather condition and thus it was 9, 10 and 12 hours for the hot, rainy and cold seasons, respectively. The males were sacrificed and milts removed washed with a physiological solution and weighed for further experimentation.

Gonadosomatic Index

After the latency period, eggs from the females and milt from males of each of the treatments were collected and weighed using sensitive top loading electric balance (Model: BSSRB2 100g/0.0g capacity). The gonadosomatic index (GSI) was estimated using the formulae below:

GSI = GW/ TW x 100

Where: GSI = gonadosomatic index, GW = gonad weight and TW = fish weight.

Fecundity

The fecundity rate was determined according to Oscar *et al*. (2015) as the product of the number of eggs in 1 g of the egg mass and the total weight of the ovary.

Fertilization and Hatching rates

The collected eggs from the females and milt from the males were mixed for fertilization. One (1) gram of the fertilized eggs was used for the estimation of the fertilization rate in each treatment, the fertilization and hatching rates were estimated using the formulae below;

$$\text{Fertilization rate } (\%) = \frac{\text{No of fertilized eggs}}{\text{No estimated eggs}} x100$$

All eggs that turned whitish after 5-10 minutes of fertilization are regarded as unfertilized or dead eggs while those that maintained the normal colour of the egg were considered as fertilized eggs.

$$\text{Hatching rate } (\%) = \frac{\text{Total No of hatched eggs}}{\text{Total No.of fertilized eggs}} x100$$

$$\text{Survival } (\%) = \frac{N_2 - N_1}{\text{t}} x100$$

Where: N_2 and N_1 are the final and initial numbers of fish respectively, t = the culture period.

Water quality parameters

The water quality parameters monitored during the experiment includes Temperature and pH (hydrogen ions).

Data analysis

Data obtained from the experiment were subjected to One–way Analysis of Variance (ANOVA). The differences between the means were determined using Fisher's Least Significant Differences (LSD) at 95% confidence level ($p \leq 0.05$) with the aid of Statistix version 8.0.

RESULTS

Table 1 presented the results on the effect of change in weather conditions on fecundity and gonadosomatic index of *Clarias gariepinus.* The fecundity rate of 49467 was recorded in the hot period followed by 37100 in the rainy period and least value of 30100 was recorded in the cold season. No significant variation ($p>0.05$) was recorded in the fecundity rate of the fish in three of the season periods. A higher female gonadosomatic index of 2.86 was observed in the hot period while the values of 2.66 and 2.33 were recorded in the cold and rainy seasons, respectively. No significant differences ($p>0.05$) were seen throughout the period (hot, rainy and cold). A higher male gonadosomatic index of 0.33 was recorded in the hot period of the season while a value of 0.28 was recorded in the rainy season and 0.22 in the cold season. No significant differences ($p>0.05$) were seen throughout the period (hot, rainy and cold). A female gonad weight of 32.00 g was recorded in the rainy period followed by 30.66 g in the hot period and the least was recorded in the cold period as 17.66 g. No significant variation ($p>0.05$) was recorded in the female gonad weight in the three of the periods used for the breeding. A higher male gonad weight of 3.33 g was obtained in the hot period of the season while the values of 2.66 and 2.00 g were recorded in the rainy and cold seasons, respectively. No significant differences ($p>0.05$) were seen throughout the periods tested. The number of fertilized eggs of 681.33 was recorded in the hot period of the season while the value of 679.00 and 671.33 was obtained in the rainy and cold periods, respectively. There were no statistical differences observed throughout the treatments (hot, rainy and cold periods).

Table 2 presented the result on the effect of the period of weather conditions on the reproductive performance of *Clarias geriepinus.* Number of eggs used in each period of the season is one gram (1g) without significant difference ($p>0.05$) throughout the periods (hot, rainy and cold). A higher number of dead eggs 28.66 was recorded in the cold period of the season while the values of 21.00 and 18.66 were recorded in the rainy and hot seasons, respectively. No significant differences ($p>0.05$) were seen during the different periods used in testing the breeding performance. A higher percentage of fertilization 97.30% was recorded in the hot period while the value of 97.26% was seen in the rainy season and the lowest value was recorded in the cold season as 95.86%. No significant variation ($p>0.05$) was recorded in the percentage fertilization of the fish in three periods of the period used for the breeding. The number of hatched eggs of 184.67 was recorded as the highest value followed by 110.00 in cold seasons and the least is recorded in hot season period as 103.6. No significant differences ($p>0.05$) were seen throughout the breeding period (hot, rainy and cold). The highest percentage hatchability of 27.13% was recorded in the rainy season while the value of 16.33 and 15.20% were recorded in cold and hot respectively. No significant differences ($p>0.05$) were seen throughout the breeding period (hot, rainy and cold). A percentage survival of 32.33% was recorded in the rainy period

Table 1. Effect of periods of the season on Gonadosomatic Index and hatchability of *Clarias gariepinus.*

Season	Parameters								
	FW (g)	FTL (cm)	MW(g)	MTL (cm)	FR	FGSI	MGSI	FGW (g)	MGW (g)
Hot	812.00^{a}	41.06^{a}	1001.1^{a}	38.66^{a}	49467^{a}	2.86^{a}	0.33^{a}	30.66^{a}	3.33^{a}
Rainy	973.17^{a}	41.76^{a}	900.80^{a}	32.93^{a}	37100^{a}	2.33^{a}	0.28^{a}	32.00^{a}	2.66^{a}
Cold	860.87^{a}	31.13^{a}	900.97^{a}	34.20^{a}	30100^{a}	2.66^{a}	0.22^{a}	17.66^{a}	2.00^{a}
SEM	298.36^{ns}	5.60^{ns}	50.91^{ns}	2.79^{ns}	7739.1^{ns}	0.42^{ns}	0.07^{ns}	4.53^{ns}	0.76^{ns}

Means within the same column having the same superscript are not significantly different (P>0.05). **Key**: $FW_{(g)}$ = Female weight, FTL = female total length MW = male weight, MTL = male total length, FR = fecundity rate, FGSI = female Gonadosomatic index, MGSI = Male Gonadosomatic index, FGW = Female gonad weight, MGW = Male gonad weight.

Table 2. Effect of periods of the season on reproductive performance of *Clarias gariepinus.*

Season	Parameters						
	NEU	NDE	NFE	% FERT	NHEG	% HATB.	% SUV
Hot	700^{a}	18.66^{a}	681.33^{a}	97.30^{a}	103.60^{b}	15.20^{b}	19.00^{b}
Rainy	700^{a}	21.00^{a}	679.00^{a}	97.26^{a}	184.67^{a}	27.13^{a}	32.33^{a}
Cold	700^{a}	28.66^{a}	671.33^{a}	95.86^{a}	110.00^{b}	16.33^{b}	14.66^{b}
SEM	0.00^{ns}	9.47^{ns}	9.47^{ns}	1.21^{ns}	11.14*	1.56*	2.19*

Means within the same column having the same superscript are not significantly different (p>0.05). **Key**: NEU = number of eggs used, NDE= number of death eggs, NFE= number of fertilized eggs, % FERT. = percentage fertilization, NHEG = number of hatched eggs, % HATB. = Percentage hatchability, SR = survival rate.

followed by 19.00% in the hot season and least value of 14.66% was recorded in the cold season. No significant variation (p>0.05) was recorded in the percentage survival of the fish in three of the season periods.

DISCUSSION

Based on the results, the higher fecundity of 49467 recorded in this research was divergent from the findings of Ekanem *et al*. (2013) who reported the fecundity of 15,575 eggs upon working with *Clarias gariepinus* in their research on the effect of uncial feed on the fecundity and gonad development. The reason for the differences in fecundity could be due to the size of the broodstock used in the two experiments. A higher female gonadosomatic index of 2.86 recorded in this research was different from the finding of Akpaniteaku (2012) who reported that gonadosomatic index varied monthly with peaks in May and September on the relationship between the size of African catfish (*Clarias gariepinus*) spawners and their ovaries. The reason for the deviation in the gonadosomatic index could be due to the season of the research conducted for the two studies. The male gonadosomatic index of 0.33 recorded in this research was variant from the findings of Ekanem *et al.* (2013) who documented the mean gonadosomatic index of 1.85 for male *Clarias gariepinus* on the effect of uncial feed on the fecundity and gonad development. The reason for the divergence in the male gonadosomatic index could be due to the differences in the period of the research (season). The male and female gonad weights of 3.33 and 4.53 g reported from this study were lower than the values documented by Mohammed *et al*. (2019) as 5.04 and 22.91 g, respectively. The lower values of the gonad reported from this study might be due to the age and size of the broodfish used in the study.

Based on the result, the higher percentage fertilization of 97.30% recorded in this research was close to the one reported by Ukwuani *et al.* (2016) who reported the fertilization of 80.00 % in their work on induced breeding of *Clarias gariepinus* as influence by milt dilution through deferent level of normal saline inclusion. The reason for the closeness in the fertilization could be due to the inclusion of saline in the study by increasing the surface area of milt. The value of 184.67 was recorded as the number of hatched eggs which was found to be higher than the value documented by Mohammed *et al* (2019) as 144.00. The higher hatchability reported in this research might be due to good water quality and good management during the breeding. The value reported on the percentage hatchability for this study was 27.13% lower than the value reported by Abdulrahman *et al.* (2017) who reported the hatchability of 60.99% in the comparative studies on *Clarias gariepinus* pituitary extracts and synthetic hormones on induced spawning and growth performance of the African catfish. The difference in the hatchability could be due to the quality of the eggs used and also water

quality. Percentage survival of 32.33% recorded in this research varied from the finding of Chellewani *et al.* (2016) who reported a survival of 36.0% for *Clarias gariepinus* fingerlings feed soya bean-based diet. The reason for the variation in the survival rate could be due to variations in the environment and also water quality parameters.

Conclusion

Clarias gariepinus can be best bred during both hot and rainy periods of the season as they present better reproductive performance of the fish in terms of fecundity, gonadosomatic index, fertilization rate, hatchability and survival.

Recommendation

It is recommended to fish farmers to always embark on breeding exercises during hot and rainy periods of the season because gonadal development mostly takes place within these periods especially broodstocks that were kept in captivity. Further studies should be conducted on the reproductive performance of the fish especially in other parts of the country to test for the reproductive performance of the fish during the three periods of the season.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

Abdulrahman, B. H., Edward, K., & Sogbesan, O. A. (2017). Comparative studies on C*larias gariepinus* pituitary extracts and synthetic hormone on induced spawning and growth performance of the African catfish *Clarias gariepinus* fry. *Journal of Dairy and Veterinary Sciences,* 4(3), 1-8.

Akpaniteaku, R. C. (2012). The relationship between sizes of African catfish (*Clarias gariepinus*) spawners and their ovaries. *International Journal of Water and Soil Resources Research*, *3*(1), 9-14.

Bruton, M. N. (1979). The breeding biology and early development of *Clarias gariepinus* (Pisces: Clariidae) in Lake Sibaya, South Africa, with a review of breeding in species of the subgenus Clarias (Clarias). *The Transactions of the Zoological Society of London*, *35*(1), 1-45.

Chellewani, A. P., Kassam, D., & Chiwanda, V. J. M. (2016). Assesment of growth and survival rates of African catfish *Clariasgareipionus* fry fed on soybean milk based diet. *International Journal of Aquaculture* 6(7): 10-53.

De-Graaf, G., & Janssen, H. (1996). *Artificial reproduction and pond rearing of the African catfish Clariasgariepinusin Sub-sahara Africa*. FAO fisheries technical paper 362.

Ekanem, A., Eyo, V. O., James P. U., & Udo, N. E. (2013). Effects of unical feed on fecundity and gonad development of *Clarias gariepinus*; A comparative study with coppens commercial feed in earthen pond. *International Journal of Science and Research*, *2*(10), 8-14.

Field View (2020). Weather and Climate of Maiduguri Nigeria. Retrieved from https://climate.com/.

Froese, R., & Pauly, D. (2013). Fishbase. World Wide Web electronic publication. Retrieved from https://www.fishbase.se/search.php.

Mohammed, Z. B., Nasir, A., Umar, H. M., Ibrahim, Y., & Aliyu, M. (2019) Effects of thermal treatment on growth performance and survival rate of African catfish (*Clarias Gariepinus*) in Maiduguri, Nigeria. *International Journal of Fisheries and Aquatic Studies*, *7*(6), 176-180.

Oscar, E. V., Mfon, A. M., & Solomon, U. I. (2015). Some aspects of the biology of the female blue crab Callinectes amnicola (De Rocheburne) from the Cross River estuary, Nigeria. *Journal of Coastal Life Medicine*, *3*(4), 259-264.

Patino R. (1997) Manipulations of the reproductive system of fishes by means of exogenous chemicals. *United State Geographical Survey*, *59*(2), 118-128.

Ukwuani, C. M., Adinde, J. O., Anieke, U. J., Nwankwo, O. G., Ugwuanyi, P. O., Ugwu, M. K., Ajibo, F.E., Aniakor, A. C., & Isani, L. C. (2016). Induced Breeding of African Catfish (Clarias gariepinus) as influenced by milt dilution through different levels of normal saline inclusion. *Global Journal of Bio-Science and Biotechnology*, *5*(3), 340-344.

Van Oijen, M. J. P (1995). Key to Lake Victoria fishes other than haplochromine cichlids. In: Witte, F. and Van Densen, W. L. T. (eds.). *Fish stocks and fisheries of Lake Victoria*. A Handbook for Field Observations. UK: Samara Publishing Limited. Pp. 209-300.

Yalçin, Ş. Ö., Akyurt, I., & Solak, K. (2001). Stomach contents of the catfish (Clarias gariepinus Burchell, 1822) in the River Asi (Turkey). *Turkish Journal of Zoology*, *25*(4), 461-468.