

Reproductive biology and spawning periodicities of *Parachanna obscura* (african snakehead, Gunther 1861) in Shagari dam, Sokoto State, Nigeria

Jibrin H¹, Bala G²

¹ Department of Fish Nutrition and Physiology, Nigerian Institute for Oceanography and Marine Research, Lagos, Nigeria

² Department of Agricultural Technology, Niger State College of Agriculture, Mokwa, Nigeria

Abstract

This study investigated the reproductive biology of *Parachanna obscura* (African Snakehead) in Shagari Dam, Sokoto State. Fish samples were collected monthly over a six-month period, spanning from April 2025 to September 2025. Focusing on the Gonadosomatic Index (GSI), maturation stages, and sex ratios from April to September 2025. Analysis of GSI values revealed bimodal spawning activity for females, with peaks occurring in May (2.33 ± 0.40) and August (2.13 ± 0.32), while male GSI remained relatively stable, peaking in May (1.64 ± 0.62). Histological assessment of maturation stages showed that ripe (Stage V) and spent (Stage VI) individuals were most prevalent in July and August, aligning with the peak GSI periods. The overall sex ratio shifted significantly across life stages; males dominated the immature (2.5:1) and developing (1.67:1) stages, whereas females were overwhelmingly more abundant in the mature (0.11:1) and ripe categories. These findings suggest that *P. obscura* in Shagari Dam exhibits a protracted breeding season with intense activity during the peak rainy months. These data are critical for developing sustainable fisheries management strategies for this species in North-Western Nigeria.

Keywords: African snakehead, reproductive biology, spawning periodicities, shagari dam

Introduction

Fish serve as a primary protein source in numerous countries (Daniel Ama-Abasi and Anthony Ogar, 2013) [3]. The family Channidae, commonly known as snakehead fish, encompasses two genera: *Parachanna* found in Africa and *Channa* in Asia (Bonou and Teugels, 1985) [7]. *Parachanna obscura* exhibits year-round reproductive activity, with the exception of February, March, and April (Isangedighi and Umoumoh, 2011) [11]. This species is predominantly carnivorous, functioning as a predator that consumes fish, insects, and crustaceans (Bonou and Teugels, 1985) [7]. *Parachanna obscura* demonstrates resilience to stressful environmental conditions, exhibits rapid growth rates (up to 2 g/day), and possesses significant potential for aquaculture (Olaosebikan *et al.*, 1998) [22]. Optimal growth has been achieved when specimens were fed commercial pellets (Coppens) at feeding rates of 8.25%, 3.6%, and 2.5%, corresponding to initial body weights of 0.9 g, 4.1 g, and 9.4 g, respectively (Kpogue and Fiogbe, 2012). The protein requirements for larvae and fry of this species range from 42.5% to 53.5% of their diet (Kpogue *et al.*, 2013). Wild-caught larvae reared at a density of 20 specimens per liter displayed favorable growth and survival rates (Kpogue and Fiogbe, 2012). Additionally, replacing fish meal with earthworm meal at a 50% ratio has been shown to enhance growth, thereby reducing production costs (Vodounnou *et al.*, 2016) [26]. The high-quality protein and fat content of *P. obscura* fillets make it beneficial for recovery from surgery and growth in children (Abassi, 2012).

However, recent decades have seen a decline in *P. obscura* populations in aquatic ecosystems in Benin, raising significant concerns. Overfishing has threatened this nutritionally valuable species, which contains 21.03% to 22.03% protein in adult specimens (Daniel Ama-Abasi and Anthony Ogar, 2013) [3]. The natural production of *P. obscura* cannot meet local demand due to overexploitation

(Kpogue *et al.*, 2013), and harmful fishing practices such as the use of poisons, fire, and illegal nets have adversely affected both fish populations and their ecosystems (Kpogue *et al.*, 2013).

Sustainable rearing practices for *P. obscura* in semi-intensive and intensive systems could not only conserve and enhance natural stocks but also provide a continuous supply of this important food fish. This would contribute to food security and improve economic conditions for the growing population in Africa, while also safeguarding aquatic biodiversity. Despite the demand, current exploitation methods do not ensure the long-term sustainability of *P. obscura*. Although several studies have explored its domestication, artificial reproduction remains a challenge due to the lack of external sexual dimorphism and insufficient understanding of its reproductive conditions in controlled environments. Consequently, wild populations continue to be the primary source for consumption. This review aims to synthesize the current knowledge of the reproductive biology of *P. obscura*.

Valued for its nutritional qualities it has fleshy meat, high protein content, and relatively few bones, making it popular among consumers (Ayoade, 2011) [4]. Additionally, its hardy nature makes it suitable for aquaculture, and it has been identified as a potential candidate for fish farming in Nigeria (Nwani *et al.*, 2010) [19].

Despite its importance, there is limited information on the reproductive biology of *Parachanna obscura* in many Nigerian water bodies. Studying the reproduction of fish species is crucial because it helps us understand their breeding cycles, fecundity (number of eggs produced), spawning seasons, and maturity stages (King, 1995; Offem *et al.*, 2007) [12, 21]. This knowledge is useful for setting proper fishing regulations, such as minimum landing sizes and closed fishing seasons, which help to prevent overfishing. It also provides valuable data for aquaculture

development, ensuring that fish farmers can breed and rear the species effectively (FAO, 2020) [8].

In the case of *Parachanna obscura*, knowing its reproductive biology will help fisheries managers and local communities around Shagari Dam make informed decisions on how best to harvest and conserve the species. Without this knowledge, overexploitation may occur, leading to the decline of this economically valuable fish and threatening the livelihoods of the people who depend on it. Therefore, research on the reproductive biology of *Parachanna obscura* in Shagari Dam is both timely and necessary for sustainable fisheries management and food security in the region. The main objective of this study is to determine the breeding patterns and reproductive timing of *Parachanna obscura* (the African Snakehead) in Shagari Dam.

Materials and Methods

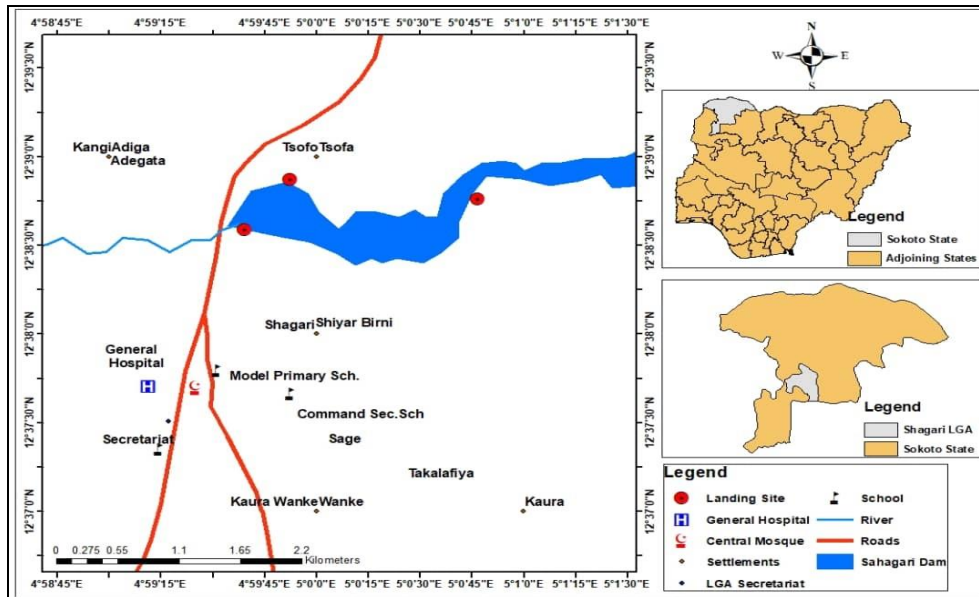
Study Area and Period

Fieldwork for this study was conducted at Shagari Dam, located in the Shagari Local Government Area of Sokoto State, Nigeria. Laboratory analysis was carried out at the Fish Feed Mill Laboratory of the Teaching and Research Farm, Department of Fisheries and Aquaculture, Usmanu

Danfodiyo University Main Campus, Sokoto (N 13° 07' 45.12" E 5° 12' 18"). The region is situated within Nigeria's Sudan Savannah agro-ecological zone, characterized by a long dry season from November to May and a brief rainy season from June to September (Mamman *et al.*, 2000) [17]. Fish samples were collected monthly over a six-month period, spanning from April 2025 to September 2025.

Description of the Study Area

The Shagari Reservoir (formerly the Gawon Gulbi River) is located in the Shagari Local Government Area of Sokoto State, Nigeria. The reservoir typically reaches its full capacity during the rainy season. It is a substantial water body, flowing through Jan-dutsi and Tafkoki villages to the Kamar-sullubawa area in eastern Shagari. In this region, it is fed by various tributaries and streams from nearby villages, which often cause the river to overflow following torrential rainfall. The reservoir reaches a maximum depth of approximately 20 metres and extends 35 kilometres to the east (Magawata and Dankin-Gari, 2010) [16].



Source: GIS Lab. Dept. Of Geography (UDUS)

Fig 1: Map of Shagari LGA showing the study area

Sample Collection and Identification

A total of (60) specimens of *Parachanna obscura* were obtained from local fishers at the landing sites of the dam. The fish were captured using various fishing gears, including gill nets, cast nets, and traps. Upon collection, the samples were transported in ice boxes to the laboratory for further analysis. Species identification was confirmed using standard ichthyological taxonomic keys and guides specifically developed for West African freshwater fishes (Idodo-Umeh, 2003; Olaosebikan & Raji, 2013) [10, 23]. This procedure involved a detailed examination of both external and internal morphological features.

For specimens with ambiguous characteristics, identities were verified by cross-referencing photographic plates, taxonomic monographs, and online ichthyological databases. Additionally, experts from the Department of Fisheries and Aquaculture, Usmanu Danfodiyo University,

Sokoto, were consulted to confirm species identification. All identified specimens were documented using their local names (as provided by Shagari Dam fishers), scientific names, and family classifications.

Materials Used

Scissors, Scalpel, Needles, Petri dishes, Stereo dissecting microscope, and Hand lens magnifier, Tissue paper, Rag, Hand gloves, Face mask, Digital electronic weighing balance 300g x 0.001g capacity (scale), Water, Bowl, Colendar, Formalin(formaldehyde), Pipette, Permanent marker, Pencil, Data table, Labels, Tubes, Plastic bags and Laboratory meter ruler.

Sex Determination

Each fish sample was carefully dissected by making an incision along the ventral side of the body cavity to expose

the internal organs. The gonads (testes or ovaries) were then examined to determine the sex of the fish. In males, the testes usually appear as elongated, whitish or cream-colored structures, while in females the ovaries are larger, lobulated, and often contain developing eggs depending on the maturity stage (King, 2007; Aminu & Babatunde, 2020) [4, 13]. In addition to internal examination, external features such as the genital papilla can also help in distinguishing sexes, as males often have more pointed papilla while females have a rounder one (Nwani *et al.*, 2015).

Determination of Gonad Maturity stages

The gonads were removed through dissection and observed carefully based on their size, color, and texture. For males, the testes were small and thread-like when immature, but became large and whitish as they matured. In females, the ovaries were small with tiny transparent eggs at early stages and later developed into large, yolky eggs that filled most of the body cavity when ripe. These observations made it possible to group the gonads into six stages: immature, developing, maturing, mature, ripe, and spent. Similar methods have been reported in recent studies where researchers stressed the need for clear and consistent classification of gonad stages (Ganga *et al.*, 2023) [9], while others combined both visual and microscopic methods to confirm reproductive phases (Nartey *et al.*, 2024) [18]. Newer techniques like ultrasound have also been tested to distinguish between developing and ripe stages in aquaculture species, showing that both traditional and modern approaches can be useful (Pham *et al.*, 2024) [24].

Immature Stage I

At this stage, the gonads are very small and thread-like. In males, the testes are almost transparent, while in females the ovaries are tiny and eggs cannot be seen with the naked eye.

Developing Stage II

The gonads start growing. Male testes look a bit thicker and whitish, while female ovaries begin to show small, granular eggs though they are still very small.

Maturing Stage III

The gonads become more enlarged. In males, the testes are clearly whitish and lobulated. In females, the eggs can now be seen as distinct tiny spheres, but they are not yet ready for spawning.

Mature Stage IV

The gonads are well developed. Male testes are large and creamy white, while female ovaries are big, often filling part of the body cavity, with eggs that are bigger and yolky.

Ripe Stage V

The fish is ready to spawn. In males, milt (sperm) comes out easily when the abdomen is pressed. In females, the eggs are large, round, and free-flowing, showing they are ready to be released.

Spent Stage VI

This is after spawning. The gonads become shrunken, soft, and reddish or bloodshot. In females, only a few small eggs may remain, and in males the testes look flabby and reduced in size.

Determination of fecundity

Ovaries were weighed and measured in length. The harvested ovaries were then submerged for at least 24 hours

in 10% formaldehyde to separate and harden the eggs to enable accurate estimation of sticky eggs. The eggs were then carefully counted using the gravimetric method after being dried on blotting paper for one to two hours. Three sub-samples of one gram each from the ovary's anterior, middle, and posterior portions were then weighed on a sensitive electric weighing balance.

Gonadosomatic Index (GSI)

The fishes were dissected and the ovaries carefully removed. The weight of gonad was taken with weighing balance, the GSI value was calculated. The weight was expressed as a percentage of the gonad weight (GW) in terms of body weight (BW) of the 100 fish (Afonso-Dias *et al.*, 2005) [2].

The Gonadosomatic Index (GSI) was calculated for each fish as Gonadosomatic index

$$GSI(\%) = \frac{\text{gonad weight}}{\text{total body weight}} \times 100$$

Data Analysis

Reproductive behavior was inferred from sex ratio (tested with a chi-square), maturity staging of dissected gonads, and seasonal patterns in maturity frequencies. and mean GSI values were compared across months/seasons to identify spawning peaks (using t-tests or one-way ANOVA where appropriate). Fecundity was estimated with the gravimetric sub-sampling method: a known weight of preserved ovary subsample was counted under a hand lens, scaled up to total ovary weight to obtain total egg number, and related to fish size (length, weight) and gonad weight using correlation and linear regression. Computer analysis was carried out using the SPSS V: 20.0 package for windows.

Results and Discussion

Gonadosomatic index (GSI) for male and female *P. obscura* between April 2025 and September 2025

The Gonadosomatic Index (GSI) data for *Parachanna obscura* (Snakehead fish) reveals a distinct bimodal spawning pattern during the study period, characterized by two major peaks in reproductive activity.

Peak Spawning Periods (May and August)

The highest GSI values for both males (1.64 ± 0.62) and females (2.33 ± 0.40) occurred in May. This suggests that the fish were in a ripe or gravid stage, preparing for a major spawning event at the onset of the rainy season. A second rise in GSI is evident in August (Females: 2.13 ± 0.32), indicating a second wave of maturation. This is typical for *P. obscura*, which is known to be a fractional or multiple spawner (Odo *et al.*, 2014) [20].

Spawning and Recovery (June)

There is a sharp decline in GSI values for both sexes in June (Males: 0.77 ± 0.19 ; Females: 0.87 ± 0.15). This "dip" represents the post-spawning phase, where gonadal weight decreases significantly after the release of eggs and milt.

Sexual Dimorphism in GSI

In almost every month, the female GSI is higher than the male GSI. This is a standard biological expectation in teleosts, as ovaries (eggs) are significantly denser and heavier than testes (milt) to accommodate the high energy investment required for yolk production (Bolger & Connolly, 1989) [5].

Environmental correlation

The fluctuations from April to September coincide with the rainy season in tropical regions. Increased water levels and changes in temperature are known triggers for gonadal maturation in *P. obscura*, as found by Ude *et al.* (2011) [25], who noted that this species often synchronizes its peak reproduction with periods of high rainfall to ensure food availability for larvae.

The GSI results indicate that *P. obscura* in the study area exhibits an intensive reproductive period between April and May, followed by a second maturation phase in August. The relatively low GSI in June suggests a mass spawning event. These findings are consistent with the reproductive biology of Channidae in West African river systems, where breeding is often protracted to take advantage of seasonal flooding.

Table 1: Gonadosomatic index (GSI) for male and female *P. obscura* between April 2025 and September 2025

Month	Male				Female			
	N	Min.	Max.	Mean ± SD	N	Min.	Max.	Mean ± SD
April	4	0.83	1.71	1.33±0.43	6	0.34	3.66	1.71±1.37
May	4	1.05	2.48	1.64±0.62	6	1.68	2.87	2.33±0.40
June	5	0.50	0.93	0.77±0.19	5	0.67	1.09	0.87±0.15
July	5	0.85	2.00	1.15±0.48	5	1.09	2.27	1.77±0.55
August	4	1.04	1.08	1.06±0.02	6	1.84	2.70	2.13±0.32
September	5	0.95	1.17	1.04±0.11	5	1.80	2.15	1.96±0.13

Reproductive biology

The monthly dynamics in the percentage male and female at each maturation stage (Table 2) showed that immature, mature, ripe and spent gonads were present throughout the year indicating an all year-round gonad recrudescence, breeding period and recruitment. There were significantly more females than males in immature stage

aligns with findings that male gonadal development often peaks in the wet season months of June and July.

Male Development: In April, males are primarily in the Maturing stage (Stage III, 75%). By June and July, there is a notable shift toward higher maturation levels (Stage III and IV), suggesting a peak in readiness for spawning. This

Female Development: Females show a diverse range of stages each month. Ripe females (Stage V) and Spent females (Stage VI) appear in July and August, indicating that active spawning occurs during these months.

Spawning Seasonality: The presence of mature and ripe individuals across most months, with peaks in June-August, suggests that *P. obscura* has a prolonged spawning season, typically intensified during the rainy season.

Table 2: Monthly variation in the percentage female and male *P. obscura* at each maturation stage

Month	No of M	Maturation stage												No of F
		Male						Female						
		I	II	III	IV	V	VI	I	II	III	IV	V	VI	
A	4		25	75	-	-	-	-	33.33	50	16.66	-	-	6
M	4	25	50	-	25	-	-	-	-	83.33	16.66	-	-	6
J	5	20	40	40	40	-	-	20	-	40	40	-	-	5
J	5	-	40	60	60	-	-	-	20	20	20	40	20	5
A	4	25	25	50	50	-	-	16.66	16.66	16.66	33.33	16.66	-	6
S	5	40	40	20	-	-	-	-	40	20	20	20	-	5

Dynamics of female and male *P. obscura* in maturation stages

Table 3 summarizes the distribution of sexes across maturation stages and the corresponding sex ratios.

leave the spawning grounds, or they may have different seasonal peaks than females. Spawning Potential: The high number of females in Stage III and IV indicates a high reproductive potential for the population in this specific area or time of year.

Shift in Sex Ratio

There is a dramatic shift in the "Sex Ratio" as the fish age. Early Stages (I & II): Males outnumber females (2.5 to 1). Late Stages (IV - VI): Females dominate completely. In fact, no males were recorded at the "Ripe" or "Spent" stages.

There were only slight variations in the mean monthly GSI indicating an all year round reproductive pulse, although three peaks in April, August and September were evident (Figures 4).

Maturation Peak

Most of the population sampled is in the Developing (II) and Maturing (III) phases. This suggests the population is actively growing and preparing for reproduction.

Table 3: Dynamics of female and male *P. obscura* in maturation stages

Maturation stage	Male	Female	Sex ratio (M:F)
Immature (I)	5	2	2.5:1
Developing (ii)	10	6	1.67:1
Maturing (iii)	11	13	0.85:1
Mature (IV)	1	9	0.11:1
Ripe (V)	0	2	0:2
Spent (VI)	0	1	0:1

Reproductive Patterns

The "Ripe" Gap: The presence of ripe and spent females (Stages V and VI) without any corresponding males suggests a few possibilities: males might mature faster and

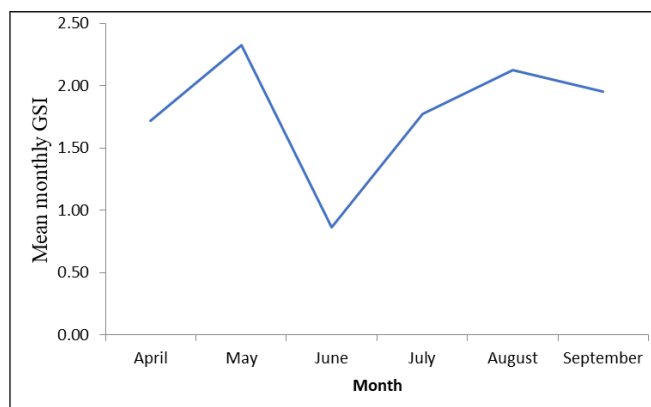


Fig 1: Mean monthly GSI of 6 mature female of *P. obscura*

References

- Abbasi T, Abbasi SA. Water Quality Indices. Elsevier Science, Amsterdam, Netherlands, 2012.
- Afonso-Dias I, Reis C, Andrade JP. Reproductive aspects of *Microchirus azevia* (Risso, 1810) (Pisces: Soleidae) from the south coast of Portugal. *Scientia Marina*,2005;69(2):275–283.
- Ama-Abasi D, Ogar A. Proximate analysis of snakehead fish, *Parachanna obscura*, (Günther 1861) of the Cross River, Nigeria. *Journal of Fisheries and Aquatic Science*,2013;8(1):295–298.
- Aminu A, Babatunde RO. Financial development and agricultural performance in Nigeria: What role do institutions play? *Journal of Developing Areas*, 2020, 54(4). Project MUSE
- Ayoade AA. Population characteristics of *Schilbe mystus* (Linne, 1758) from two different habitats: Asejire and Oyan Lakes southwestern Nigeria. *Journal of Fisheries and Aquatic Science*,2011;6(5):571–577.
- Bolger T, Connolly PL. The selection of suitable indices for the measurement and analysis of fish condition. *Journal of Fish Biology*,1989;34(2):171–182. doi:10.1111/j.1095-8649.
- Bonou CA, Teugels GG. Révision systématique du genre *Parachanna* Teugels et Daget, 1984 (Pisces: Channidae). *Revue d'Hydrobiologie Tropicale*,1985;18(4):267–280.
- FAO. The State of World Fisheries and Aquaculture Sustainability in Action. Rome, Italy, 2020. <https://doi.org/10.4060/ca9229en>.
- Ganga S, Dwivedi AK, Mayank P. Stock status of a few small indigenous fish species exploited in the River Ganga, India. *Fishes*,2023;8(12):572.
- Idodo-Umeh G. Freshwater Fishes of Nigeria: Taxonomy, Ecological Notes, Diet and Utilization. Idodo-Umeh Publishers Ltd., Benin City, Nigeria, 2003, 232.
- Isangedighi IA, Umoumoh OE. Some aspects of the reproductive biology of African Snakehead *Parachanna obscura* in Itu-Cross River system. *Nigerian Journal of Agriculture, Food and Environment*,2011;7(4):19–30.
- King M. Fisheries Biology, Assessment and Management. Fishing News Books, Blackwell Science, Oxford, UK, 1995, 341.
- King M. Fisheries Biology, Assessment and Management. 2nd Edition. Blackwell Scientific Publications, Oxford, UK, 2007, 382.
- Kpogué DNS, Fiogbé ED. Feeding rate requirements for *Parachanna obscura* fry reared under controlled environmental conditions. *Journal of Applied Biosciences*,2012;55:3962–3972.
- Kpogué DNS, Mensah GA, Fiogbé ED. Influence of dietary protein levels on growth, feed utilization and carcass composition of snakehead, *Parachanna obscura* (Günther, 1861) fingerlings. *International Journal of Fisheries and Aquaculture*,2013;5(5):71–77.
- Magawata I, Dankin-Gari AZ. Survey of fish processing and preservation methods in some selected local government areas of Sokoto State, Nigeria. *Biological and Environmental Sciences Journal for the Tropics (BEST)*,2010;7(2):25–29.
- Mamman AB, Oyebanji JO, Peters SW. Nigeria: A People United, A Future Assured (Survey of States). Gabumo Publishing Co. Ltd., Calabar, Nigeria., 2000, 2.
- Nartey LK, *et al.* Population dynamic and characterization of *Parachanna obscura* (Günther, 1861) in Kakum River, Ghana and Lake Nokoué, Benin: A comparative study. *International Journal of Fisheries and Aquatic Studies (or similar institutional repository)*, 2024.
- Nwani CD, Nwachi DA, Okogwu OI, Ude EF, Odoh GE. Heavy metals in fish species from lotic freshwater ecosystem at Afikpo, Nigeria. *Journal of Environmental Biology*,2010;31(5):595–601.
- Odo GE, Didigwu NC, Eyo JE. Role of environmental variables and seasonal changes on the abundance and distribution of fish species in Anambra River basin, Nigeria. *International Journal of Environmental Biology*,2014;4(2):119–134.
- Offem BO, Samsons YA, Omoniyi IT. Reproductive aspects of common freshwater fishes in the Cross River, Nigeria. *Journal of Animal and Plant Sciences*,2007;18(1):1–10.
- Olaosebikan BD, Raji A. Field Guide to Nigerian Freshwater Fishes. New Bussa, Nigeria: Federal College of Freshwater Fisheries Technology., 1998.
- Olaosebikan BD, Raji A. Field Guide to Nigerian Freshwater Fishes. (Revised Edition). Federal College of Freshwater Fisheries Technology (FCFFT), New Bussa, Nigeria, 2013, 144.
- Pham HQ, *et al.* Modeling Sustainable Fish Production and Nutritional Yield: A Comprehensive Review. *Nigerian Journal of Food Science and Nutritional Issues*, 2024.
- Ude EF, Okko LO, Didigwu NC. Evaluation of fish biodiversity integrity of Ebonyi River. *Proceedings of the 26th Annual Conference of the Fisheries Society of Nigeria (FISON)*, Minna, Nigeria, 28th Nov – 2nd Dec, 2011, 103–108.
- Vodounnou DSJV, Kpogué DNS, Mensah GA, Fiogbé ED. Culture of earthworm (*Eisenia fetida*), production, nutritive value and utilization of its meal in diet for *Parachanna obscura* fingerlings reared in captivity. *International Journal of Fisheries and Aquatic Studies*,2016;4(5):01–05.