Comparative Analysis of Spawn mass and Egg Regeneration in *Clarias gariepinus* and *Heterobranchus bidorsalis* for some size categories

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Abstracts
Understanding reproductive performance in aquaculture species is essential for optimizing hatchery success and improving yield. This study investigates the spawn mass and egg regeneration in *Clarias gariepinus* and *Heterobranchus bidorsalis* across four distinct size classes: < 1 kg, 1 kg, 1.5 kg, and 2 kg. Twenty-four healthy female fish (12 *C. gariepinus* and 12 *H. longifilis*) broodstocks were used. The fish were fed *ad-libitum* for initial 7 days before the first data collection and subsequent 90 days using commercial feed. Data obtained were compared between species using t-tests to determine statistical significance. The results shows that fish < 1 kg had no significant differences (p >0.05) in any measured parameters between the two species, suggesting similar reproductive output at smaller sizes. However, in the 1 kg and 1.5 kg categories, *C. gariepinus* consistently exhibited significantly higher egg weights than *H. bidorsalis* (p < 0.05), indicating superior spawn mass. This trend was most visible in the 1.5 kg group, where *Clarias* produced an average egg weight of 206.00 ± 11.53 g compared to 123.00 ± 20.22 g in *Heterobranchus*. Post-stripping weights also revealed notable differences, with *Heterobranchus* retaining more body mass after spawning in larger size classes. In fish > 2 kg, *C. gariepinus* maintained its advantage in egg production, with significantly higher egg weights (p < 0.05), while *H. bidorsalis* showed greater post-stripping body weight, suggesting a trade-off between reproductive investment and somatic maintenance. In conclusion, *C. gariepinus* demonstrates greater spawn mass and egg regeneration than *H. bidorsalis*, particularly in larger size categories, making it a more favourable and effective species for intensive aquaculture breeding programs.

Keywords; hatchery optimization, Species comparison, Egg yield variability, Aquaculture performance, Reproductive metrics**.**

Introduction
The global demand for fish has been increasing geometrically, driven by population growth, urbanization, and rising income levels, reaching a market value of USD 416 billion in 2020 (FAO, 2022). In many developing countries, this growing demand is further compounded by rapid population growth, ongoing depletion of natural resources due to overexploitation, and the escalating cost of living all of which have contributed to rising levels of hunger and poverty (Akinrotimi *et al*., 2015; Ajah *et al*., 2023).
Since 2013, aquaculture has surpassed capture fisheries as the primary source of aquatic food production, accounting for 57% of total global production by 2020 (FAO, 2022). This rapid growth in the aquaculture sector has significantly increased the demand for fish fingerlings, thereby intensifying the need for effective artificial propagation of cultured warm-water fish species (FAO, 2007). To meet this demand sustainably, year-round research and development efforts must be strengthened, particularly in the area of artificial seed production (Oguntuase & Adebayo, 2014).
In sub-Saharan Africa, the cultivation of freshwater species such as *Clarias gariepinus* and *Heterobranchus bidorsalis* has gained significant traction due to their fast growth rates, high fecundity, and adaptability to a range of aquaculture systems (Adewumi & Olaleye, 2011). However, the success and sustainability of aquaculture in the region largely depend on consistent and reliable seed production, which in turn is closely linked to effective broodstock management and advanced artificial propagation techniques.
Achieving sustainable aquaculture development requires not only the intensification and integration of breeding technologies for established species but also the domestication and promotion of other underutilized species with high aquaculture potential. A deeper understanding of such species is becoming increasingly urgent to support adaptation strategies and future food security (Barange *et al*., 2018; Dagoudo *et al*., 2021).
One of the major challenges facing large-scale juvenile production is the variability and unpredictability in the reproductive performance of some species (Segura *et al*., 2021). To ensure the consistent availability of high-quality juveniles for stocking, it is essential to thoroughly understand and apply knowledge of the species' biological—particularly reproductive—characteristics. This includes considerations of nutrition, health status, genetic quality, and appropriate husbandry practices, all of which play a critical role in producing offspring with the desired genetic and reproductive traits (Okure *et al*., 2024).
Although, *Clarias* and *Heterobranchus* species are widely cultivated in aquaculture, there is a notable lack of comparative data on their reproductive performance across different broodstock size classes. Most hatchery protocols employ standardized breeding strategies that

often overlook size-dependent variations in spawn mass and egg regeneration. This can result in sub-optimal larval yields and inconsistent broodstock performance. The present study addresses this gap by providing a comparative analysis of spawn mass and egg regeneration in *Clarias gariepinus* and *Heterobranchus bidorsalis* across four distinct weight categories.

Materials and Methods

Experimental site

The experiment was carried out at the Hatchery Unit of Motherhood Freshwater Fish Farms, off Abeokuta-Ibadan Expressway, Obantoko, Odeda Local Government Area, Abeokuta, Ogun State, Nigeria. The farm lies between Latitudes 7°10'34.4"Nand 7°10'35.4"N and Longitudes 3°23'48.4"E and 3°23'49.3"E.

Experimental procedure

The broodstocks were selected based on their external morphological features as described by Viveen *et al.* (1985). *C. gariepinus* and *H. bidorsalis* share similar external features but can be distinguished by specific traits. *H. bidorsalis* possesses a well-developed adipose fin located behind the dorsal fin, which is absent in *C. gariepinus*. *C. gariepinus* and *H. bidorsalis* share similar external features but can be distinguished by specific traits. *H. bidorsalis* possesses a well-developed adipose fin located behind the dorsal fin, which is absent in *C. gariepinus*. A total of twenty-four healthy female broodstocks comprising 12 *Clarias gariepinus* and 12 *Heterobranchus bidorsalis* were randomly selected from a pool of fish sourced from reputable commercial fish farm and acclimatized for seven days under optimal hatchery conditions. All the fish were 18 months old. Approximate weights of < 1kg (614.17±22.69 g), 1 kg (1,036.84±45.17 g), 1.5 kg (1,528.67±40.59 g) and 2 kg (2,106.00±52.06 g) were selected from the population in three replicates per selected weight using digital electronic weighing scale (KERN EOE 10K-3). Each treatment group (weight sizes) was stocked in a separate 500-liter fiber glass tank, ensuring no mix between species or treatments. The selected broodstocks were fed *ad-libitum* for initial 7 days before the first data collection and subsequent 90 days using commercial feed containing 35% crude protein.

Each fish was weighed individually using a digital scale (KERN EOE 10K-3) before hormonal induction. A standard hormonal dosage of 0.5 ml/kg Ovaprim was administered intramuscularly. After 10–12 hours latency, fish were carefully stripped, and the eggs were collected in plastic bowls and weighed immediately. Post-stripping body weight was recorded to compute the spawn mass. After initial stripping, each group was returned to its respective tank and managed for three months under the same feeding and environmental conditions. At the end of the three-month period, the fish were again weighed, induced, stripped, and the eggs were measured for comparison.

Statistical Analysis

The data collected for both species were subjected to statistical analysis using computer Statistical Package for Social Sciences (IBM SPSS version 20). Independent t-test was used to determine the differences (at 95% confidence interval) in the parameters between the two fish species. Microsoft Excel 2016 was used to plot the graph.

Results

The results of comparative reproductive performance between *Clarias gariepinus* and *Heterobranchus bidorsalis* across four size categories: < 1 kg, 1 kg, 1.5 kg, and 2 kg are presented in Tables 1 to 4. In 1 kg fish (Table 1), no statistically significant differences ($p > 0.05$) were observed in any measured parameters, indicating similar Spawn mass and egg regeneration between the two species at smaller sizes. *Clarias gariepinus* exhibited significantly higher egg weights (187.67 ± 11.59 g and 174.33 ± 16.50 g) compared to *Heterobranchus bidorsalis* (111.33 ± 12.90 g and 99.00 ± 21.79 g), with p-values of 0.00 and 0.01 respectively. Although *Heterobranchus* had higher post-stripping weights, the differences were not statistically significant.

At 1.5 kg body weight (Table 3), *Clarias* outperformed *Heterobranchus* in egg weight (206.00 ± 11.53 g vs. 123.00 ± 20.22 g; $p = 0.00$), and similar trends were observed in the second egg weight measurement (203.67 ± 7.37 g vs. 115.33 ± 19.86 g; $p = 0.00$). The results obtained in this study affirm the superior reproductive output of *Clarias* in mid-size broodstock.

In fish with approximately 2 kg body weight (Table 4), *Clarias* maintained its advantage in egg production, recording the highest egg weight of 233.00 ± 46.87 g, while *Heterobranchus* had the lowest at 129.67 ± 12.58 g ($p = 0.00$). Additionally, *Heterobranchus* showed significantly higher post-stripping weight (2176.00 ± 124.59 g) compared to *Clarias* (1923.00 ± 56.67 g), with a p-value of 0.03, indicating a trade-off between somatic maintenance and reproductive investment.

Discussion

The initial egg weight for *Clarias gariepinus* (<1 kg body weight) reported in this study aligns with the findings of Maradun *et al*. (2018), who observed egg weights ranging from 85.33 to 86.67 g in 600 g *C. gariepinus* injected with 0.3 ml/kg Ovulin hormone. Similarly, the initial egg weight recorded for *C. gariepinus* at a body weight of 1 kg in this study is comparable to the ovarian weight of 192 g reported by Esa *et al*. (2023) for the same species in a comparative study involving *C. gariepinus* and *C. macromystax*.

A positive correlation between broodstock size and egg weight was observed, with larger broodfish yielding a greater quantity of stripped eggs in both species. This observation is consistent with Ataguba *et al*. (2009), who reported that larger fish tend to have higher fecundity than

Table 1: Spawn mass and egg regeneration in *C. gariepinus and H. bidorsalis* of sizes below 1kg

Parameters	*C. gariepinus*	*H. bidorsalis*	t-value	p-value
Initial weight of fish (g)	626.67±25.17	601.67±20.21	1.34	0.25
weight of egg (g)	87.00±7.55	95.00±14.93	-0.83	0.45
weight of fish after stripping (g)	539.67±24.09	507.67±11.50	2.08	0.11
Weight of fish after three months (g)	661.00±19.97	642.67±37.75	0.74	0.50
Weight of egg after three months (g)	148.67±38.07	91.67±10.02	2.51	0.07
Weight of fish after stripping after three months (g)	535.67±4.93	551.00±27.87	-0.94	0.40

NS – no significant difference

Table 2: Spawn mass and egg regeneration in *C. gariepinus and H. bidorsalis* of sizes 1kg range

Parameters	*C. gariepinus*	*H. bidorsalis*	t-value	p-value
Initial weight of fish (g)	1031.67±27.54	1042.67±62.80	-0.28	0.80
weight of egg (g)	187.67±11.59 ^{a}	111.33±12.90 ^{b}	7.63	0.00
weight of fish after stripping (g)	844.00±23.90	931.33±53.59	-2.58	0.06
Weight of fish after three month (g)	1098.33±53.46	1112.00±87.43	-0.23	0.83
Weight of egg after three months (g)	174.33±16.50 ^{a}	99.00±21.79 ^{b}	4.77	0.01
Weight of fish after stripping after three months (g)	924.00±44.71	1013.00±71.97	-1.82	0.14

Means with different superscripts along same row are significantly different (P<0.05)

Table 3: Spawn mass and egg regeneration in *C. gariepinus and H. bidorsalis* of 1.5kg size range

Parameters	*C. gariepinus*	*H. bidorsalis*	t-value	p-value
Initial weight of fish (g)	1523.00±16.70	1534.33±64.47	-0.30	0.78
weight of egg (g)	206.00±11.53 ^{a}	123.00±20.22 ^{b}	6.18	0.00
weight of fish after stripping (g)	1317.00±8.19	1411.33±77.26	-2.10	0.10
Weight of fish after three month (g)	1634.67±31.34	1602.67±91.00	0.58	0.60
Weight of egg after three months (g)	203.67±7.37 ^{a}	115.33±19.86 ^{b}	7.22	0.00
Weight of fish after stripping after three months (g)	1425.00±23.58	1487.33±107.16	-0.98	0.38

Means with different superscripts along same row were significantly different (P<0.05)

Table 4: Spawn mass and egg regeneration in *C. gariepinus and H. bidorsalis* of 2kg sizes

Parameters	*C. gariepinus*	*H. bidorsalis*	t-value	p-value
Initial weight of fish (g)	2041.33±59.50	2170.67±124.62	-1.62	0.18
weight of eggs (g)	233.00±46.87	162.67±20.60	2.38	0.08
weight of fish after stripping (g)	1807.67±42.34	2008.00±142.92	-2.33	0.08
Weight of fish after three month (g)	2126.00±46.81	2305.67±112.01	-2.56	0.06
Weight of eggs after three months (g)	203.67±7.37 ^{a}	129.67±12.58 ^{b}	8.79	0.00
Weight of fish after stripping after three months (g)	1923.00±56.67 ^{b}	2176.00±124.59 ^{a}	-3.20	0.03

Means with different superscripts along same row were significantly different (P<0.05)

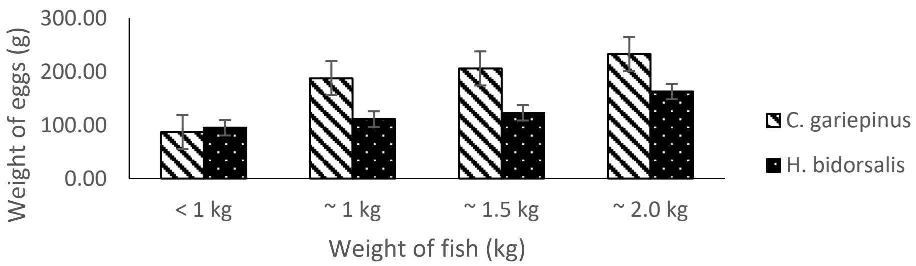

Figure 1: Weight of eggs stripped (initially)

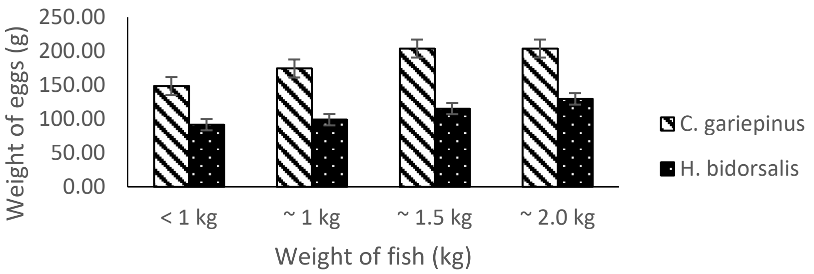

Figure 2: Weight of eggs stripped at the end of three months regeneration period

smaller individuals. Esa *et al*. (2023) also confirmed that fecundity increases with fish size, likely due to greater visceral capacity to accommodate developing eggs.

However, as Oyelese (2006) noted, the total weight of eggs stripped from a female broodstock depends on the number of ovulated eggs at the time of stripping, which may not represent the total egg production capacity of the fish. In this study, care was taken to ensure that only ripe, fertilization-ready eggs were stripped, thus the reported egg weights accurately reflect the actual spawn mass.

In comparison, Otoh *et al*. (2024) reported higher egg weights (267.30–363.40 g) for *C. gariepinus*, which exceeded all values obtained in this study across different spawner sizes cut opened using a pair of scissors. This discrepancy may be attributed to the use of larger broodstock (2.5 kg) in their study. Supporting this, Ataguba *et al*. (2013) established a strong positive correlation between the body weight of female *C. gariepinus* broodstock and the weight of eggs produced.

In this study, *C. gariepinus* consistently produced a higher number of eggs compared to *H. bidorsalis* across various body sizes and after a three-month period. This finding aligns with the report by Esa *et al*. (2023), who observed superior reproductive performance in *C. gariepinus* compared to *C. macromystax* across all measured reproductive parameters. These results reinforce the status of *C. gariepinus* as a more favorable species for aquaculture.

For *H. bidorsalis*, the egg weights recorded at 2 kg body size in this study were higher than the 128.13 g reported by Abubakar and Ipinjolu (2019) when 0.1 mL/kg of ovatide hormone was used. However, they were lower than the 242.30 g egg weight obtained using 0.1 mL/kg of ovaprim for similarly sized broodstock (2.25 kg) in the same study.

Comparatively, Onyia *et al*. (2017) reported a higher egg yield of 400 g and a similar yield of 160 g from *H. bidorsalis* weighing 7.8 kg and 2.5 kg, respectively, sourced from different locations. These variations highlight the influence of broodstock weight and maturity on egg yield, as emphasized by Onyia *et al*. (2017). This may be attributed to large in ovaries in larger fish compared to smaller ones.

Conclusion

Overall, *C. gariepinus* demonstrated consistently higher spawning potentials across all size categrories, especially in egg weight, while *H. bidorsalis* retained more body mass post-stripping, suggesting differing reproductive strategies between the species. Utilizing larger female broodfish can significantly enhance egg size, quantity, and quality, while also improving hatching success, survival rates, and the overall quality of the resulting fish seed.

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