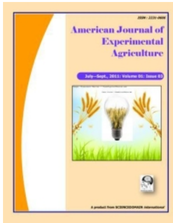

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Comparative Study of *Artemia* (Brine Shrimp) and *Ceriodaphnia* (Zooplankton) as Foods for Catfish Larvae

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Authors' contributions

This work was carried out in collaboration between all authors as team work. Author RGA was responsible for the initial idea and study design. Authors RGA, AMH and AOA collected and compiled all information and performed the experiment. Authors RGA and AMH worked with authors AOA and HAFB in data analysis and interpretation. All authors contributed to the editing, revision and final preparation of the manuscript. All authors have read and approve the final manuscript.

Original Research Article

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ABSTRACT

Artemia and *Ceriodaphnia* were used as "first food" for the larvae of *Clarias gariepinus*, *Heterobranchus bidorsalis* and their hybrid *Heteroclarias* in order to determine if *Ceriodaphnia* could effectively replace *Artemia* in Nigeria in the production of Catfish fingerlings. The 5-day old fry of *C. gariepinus*, *H. bidorsalis* and *Heteroclarias* weighing 18.5mg, 14.0mg and 13.5mg respectively were stocked in plastic tanks and fed with *Artemia nauplii and Ceriodaphnia* for 21 days. Growth indices such as Percentage Survival (PS), Specific Growth Rate (SGR), Daily Growth Rate (DGR) and Percentage Weight Gain (PWG) were determined. At the end of the experiment, PS, SGR, DGR and PWG were determined weekly. At the end of the experiment, PS, SGR, DGR and PWG were slightly better in *Ceriodaphnia*-fed fry of the three species, though the composition of crude protein in *Artemia nauplii* (63.0%) was higher than that of *Ceriodaphnia* (58%). However, analysis of variance (ANOVA) did not reveal any significant difference (P>0.05) in the performance of the two experimental foods. The study reveals the potential of

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Ceriodaphnia as natural food for catfish larvae to produce fast growing species of *C. gariepinus* (Burchell, 1822), *H. bidorsalis* (Geoffroy, 1809) and *Heteroclarias* (reciprocal hybrid).

Keywords: Artemia; Ceriodaphnia; Clarias gariepinus; Heterobranchus bidorsalis; Heteroclarias.

1. INTRODUCTION

The catfish families are among the most valued fresh and marine water fish species in West Africa. African catfishes of the genera *Clarias* and *Heterobranchus* are highly esteemed in Nigeria and command very high commercial value in our markets [1]. They are very hardy and have accessory air breathing organs, which enable them to tolerate low dissolved oxygen levels and other adverse aquatic condition where most cultivable species cannot survive. With these unique characteristics of this omnivore, their fingerlings are scarce due to inadequate hatchery techniques and insufficient live food of high quality which is a major setback to fish farmers.

Clarias and *Heterobranchus* species are very popular among Nigerian fish farmers. Considerable interest had been generated in the growth potential of *Clarias gariepinus* and *Heterobranchus* spp. However, because of the need for fast growing fingerlings that will satisfy the culture requirements and market value of fish farmers, *Heteroclarias* [2], which is the hybrid of *Clarias* and *Heterobranchus*, came into being.

It has been noted that these species are very important to the sustainability of aquaculture industry particularly in tropical countries. However, in spite of the break through recorded in the artificial propagation of these species, demand for the fingerlings still outstrips the supply. The difficulties being encountered in rearing hatchlings to fingerlings is the major cause of demand outstripping supply for catfish fingerlings in Nigeria.

Lack of suitable feed as the main cause of mortality in catfish fry management and points out that the food must be adequate not only in quality but also in quantity [3,4,5]. Therefore, feeding has been recognized as the major problem in the management of clariids hatchlings to fingerlings [4].

Live food in feeding fry and fingerlings is obligatory for successful development of catfish aquaculture [4]. However, aquaculture research suggested rotifers (Zooplankton) as the most satisfactory “first food” for fry [6,7,8]. It has been revealed that within the first two weeks of life, the food of *Clarias* hatchlings should entirely be zooplankton and are healthy for most fish species since it leads to better larvae growth [9,10]. Report show that *C. gariepinus* requires, after yolk sac absorption an initial phase of exogenous feeding with natural, preferably live food organisms such as *Artemia nauplii* meet their nutritional requirements for optimization of growth and survival at this stage [3,11]. *Artemia nauplii* are being used today to feed fish larvae all over the world including Nigeria. However, high cost of *Artemia* cysts, problem of hatching and irregularity in supply had been the bane of many Nigeria catfish farmers that depended entirely on the use of *Artemia*. Therefore there is need for better alternatives.

Live organisms, particularly Rotifers, *Cladocerans* and *Artemia* have been used in the large scale rearing of African catfish larvae. However, the collection of live food from the wild is cumbersome and only available on a seasonal basis, and Artemia is expensive particularly for hatcheries in developing countries in Africa. Additional benefit for commercial fingerling producers may reduce the need and the stress required in harvesting fingerlings from culturing chambers and transporting them to holding tanks prior shipping to growers [12].

The research was therefore aimed at comparing the performance of *Ceriodaphnia* with *Artemia nauplii* in feeding of *Clarias gariepinus* (Burchell, 1822), *Heterobranchus bidorsalis* (Geoffroy, 1809) and *Heteroclarias* spp (reciprocal hybrid). fry and also to determine if *Ceriodaphnia* can successfully replace *Artemia* in the aquaculture production of African catfish fingerlings.

2. MATERIALS AND METHODS

2.1 Experimental Fish

Mature males and females of *C. gariepinus* and *H. bidorsalis* were selected and artificially spawned in the hatchery with ovaprim injected intramuscularly in a single dose of 0.5ml/kg fish weight. The ripe-running eggs were stripped and fertilized with milt as follows:

i. *Clarias gariepinus* (Male) X *C. gariepinus* (Female)
ii. *Heterobranchus bidorsalis* (Male) X *H. bidorsalis* (Female)
iii. *Heterobranchus bidorsalis* (Male) X *C. gariepinus* (Female)

The larvae produced from the above parental species and hybrid was reared in three separate bowls for five days at the end of which the yolk was completely absorbed. After absorption of the yolk sac, the mean length (±SD) of each larvae of *C. gariepinus* (8.75±0.25mm), *H. bidorsalis* (8.00±0.00mm) and *Heteroclarias* (8.50±0.04mm) was measured respectively.

2.2 Collection and Preparation of Experimental Foods

The *Ceriodaphnia* (Fig. 1a.) used for this study were collected daily with zooplankton net from a wetland located close to the University campus. This zooplankton was confirmed to be *Ceriodaphnia* when examined under microscope with the aid of FAO plankton identification sheet in the fisheries laboratory prior to the commencement of the experiment. The proximate analysis of *Ceriodaphnia* was carried out in a laboratory at the Department of biological Sciences, Federal University of Agriculture Abeokuta Ogun State.

A tin of Vacuum-packed *Artemia cysts* (PRO 80) was purchased from a local supplier and hatched in the hatchery unit of department of fisheries, Lagos State University as directed by the manufacturer (Ocean Star International, INC. Snowville, UT. 84336 U.S.A.).

2.3 Feeding of Fish Larvae

Twelve circular plastic tanks each containing 20 litres of water from borehole supplied with aeration devices were used for the feeding experiment. The tanks were covered with mosquitoes net to prevent insect predators from entering.

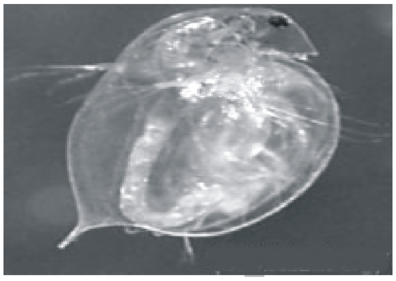

Fig. 1a: ***Ceriodaphnia***

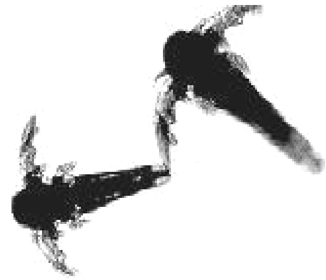

Fig. 1b: ***Artemia nauplii***

Fig. 1 (a) daphnia with body enclosed by an uncalcified shell (carapace)
(b) artemia cysts hatched to provide live nauplii fish larvae

The twelve tanks were grouped into three A, B and C (i.e. four tanks per group; A (i-iv), B (i-iv) and C (i-iv). Each group of *C. gariepinus, H. bidorsalis* and *Heteroclarias* were stocked with 200 fry and fed adlibitum twice daily for 21 days.

Table 1. Different groupings and treatment methods adopted in feeding the fry for 21 days

Groupings		Treatment
A	Tanks i and ii	Fry fed with *Eriodaphnia*
	Tanks iii and iv	Fry fed with *Artemia nauplii*
B	Tanks i and ii	Fry fed with *Ceriodaphnia*
	Tanks iii and iv	Fry fed with *Artemia nauplii*
C	Tanks i and ii	Fry fed with *Ceriodaphnia*
	Tanks iii and iv	Fry fed with *Artemia nauplii*

2.4 Statistical Analysis

Parameters such as analysis of variance (ANOVA) [13] and levels of significance of the experimental data were determined at 5% confidence limit using Bayesian Multiple Comparisons and Multiple Tests (BMCMT) [14].

3. RESULTS

There were slight differences in the proximate composition of *Artemia nauplii* and *Ceriodaphnia*. The crude protein, lipid and fibre contents of Artemia (63.0%, 18.2% and 8.5%) were higher than that of *Ceriodaphnia* whereas, *Ceriodaphnia* on the other hand had higher moisture content (92.05) and ash (1.5%).

The greatest increase in total length (12.5mm), body weight (156.5g), specific growth rate (12.06%), daily growth rate (0.44mg/day) and percentage weight gain (1159.3%) as shown on Table 3 were achieved by *Heteroclarias* fry fed on *Ceriodaphnia*. The least increase in total length (9.0mm) and body weight (66mg) were achieved by *Clarias gariepinus* and *Heterobranchus bidorsalis* fry fed on *Artemia nauplii. Clarias gariepinus* fry fed on *Artemia nauplii* also had the least specific growth rate (7.49); daily growth rate (0.038mg/day) and percentage weight gain (381.58%). The condition factor (K) was similar but slightly lower

(1.66±0.26) for *Artemia nauplii* fed *Heteroclarias* fry. The highest survival rate (96.5%) was recorded by *Clarias gariepinus* fed on *Ceriodaphnia* while the lowest (71.5%) was recorded by Heteroclarias sp fed on *Artemia nauplii*.

Table 2. Proximate composition (%) of the experimental foods

Nutrient	*Artemia nauplii*	*Ceriodaphnia*
Moisture	84.5	92.0
Crude protein*	63.0	58.8
Lipid*	18.2	17.9
Fibre*	8.5	7.1
Ash*	0.9	1.5

**On dry matter basis*

4. DISCUSSION

The growth performance of *C. gariepinus, Heterobranchus bidorsalis* and *Heteroclarias* larvae at the end of 21 days feeding trial reveals total length being slightly higher in *Ceriodaphnia*-fed larvae (18.5mm, 19.5mm and 21.0mm) compared with a length of 18.0mm, 18.0mm and 19.5mm recorded for the *Artemia*-fed larvae. The weight was also slightly better in the *Ceriodaphnia*-fed larvae (140.0mg, 125mg and 170mg respectively), compared to the weight of 91.5mg, 80mg and 100.0mg recorded for the *Artemia*-fed larvae. Analysis of variance (ANOVA) also reveals slight significant difference in length but wider significant difference in weight ($P<0.05$) between the three fish larvae fed *Ceriodaphnia* and *Artemia*. Survival rate, specific growth rate (SGR), condition factor (K), daily growth rate (DGR) and percentage weight gain (PWG) were all slightly higher in the *Ceriodaphnia*-fed larvae compared to the *Artemia*-fed larvae (Table 3).

The growth of fish is generally believed to be a function of the crude protein level in the diet. In spite of the fact that crude protein level (Table 2) of *Artemia nauplii* (63.0%) was slightly higher than that of *Ceriodaphnia* (58.8%), the latter still perform well in this study. This could be attributed to the fact that catfish larvae may not require more than 58.85 C.P. for optimum growth. This assertion is in line with the work of [15] who stated that the proximate composition of fry feed should consist of 55% protein; and also [16] recommended dietary requirement of not more than 52% crude protein for catfish larvae. It was reported that efficient growth of fish depend on feeding the best possible diets at levels not exceeding the dietary needs [17]. The moisture content (Table 2) of *Ceriodaphnia* (92.0%) is higher than that of *Artemia* (84.5%). This could mean better digestibility for *Ceriodaphnia* by the fish larvae. However, the higher lipid content in *Artemia* (18.2%) compared to that of *Ceriodaphnia* might not necessarily be an advantage since lipid requirement for catfish rarely exceed 6% [18].

The relatively longer life span of *Ceriodaphnia* in water as observed during the study, coupled with the fact that *Ceriodaphnia* is a fresh water zooplankton, makes it more available and acceptable to *C. gariepinus, Heterobranchus bidorsalis* and *Heteroclarias* larvae which also dwell naturally in fresh water compared with *Artemia nauplii* which is salt water zooplankton.

Table 3. Growth performance and Survival rate of *C. gariepinus, H. bidorsalis* and *Heteroclarias* Fry fed *Artemia nauplii* and *Ceriodaphnia* for 21 days (Mean±SD)

Parameters	*Artemia nauplii*			*Ceriodaphnia*		
	C. gariepinus	*H. bidorsalis*	Heteroclarias	*C. gariepinus*	*H. bidorsalis*	Heteroclarias
Initial total length (mm)	9.0±0.35	8.0±0.00	8.5±0.00	8.5±0.34	8.0±0.00	8.5±0.00
Initial body weight (mg)	19.0±0.00	14.0±0.00	13.5±0.00	18.5±0.00	14.0±0.00	13.5±0.00
Final total length (mm)	18.0±0.71	18.0±1.41	19.5±1.06	18.5±0.70	19.5±1.77	21.0±0.00
Final body weight (mg)	91.5±0.35	80.0±0.00	100.0±0.00	140.0±0.71	125.0±0.35	170.0±1.41
Increase in length (mm)	9.0±5.20	10.0±5.30	11.0±5.77	10.0±5.39	11.5.905±	12.5±6.38
Increase in weight (mg)	72.5±37.59	66.0±34.78	86.5±46.54	121.5±65.47	111.0±60.45	156.5±86.72
SGR%	7.49±0.24	8.30±0.31	9.54±0.36	9.64±0.43	10.43±0.67	12.06±1.24
% survival	90.5	85.5	71.5	96.5	96.05	94.5
K (Condition factor)	2.08±0.38	2.30±0.41	1.66±0.26	2.83±0.97	2.69±0.58	2.34±0.43
DGR (mg/fish/day)	0.038±0.01	0.039±0.00	0.041±0.00	0.041±0.01	0.042±0.01	0.044±0.02
PWG (%)	381.6±32.31	471.4±29.26	640.7±39.56	656.8±50.76	792.8±47.46	1159.3±68.75

The better performance of *Heteroclarias* larvae (Table 3) recorded could be attributed to improved hybrid vigour; since similar experimental foods, rearing conditions and techniques were provided. This agree with the findings of [19,20,21,22] who observed that hybrid in most cases were superior to the parental strains in growth, food conversion and resistance to diseases.

Survival of larvae (Table 3) ranged from 71.5% to 96.5%. The mortality recorded was due to handling stress during the initial stocking and sampling because sampling was done every week. The general high survival rate however, could be attributed to proper management of larvae and level of acceptability of the two experimental foods by the fish.

5. CONCLUSION

It was discovered that *Ceriodaphnia* has a great potential as natural food that can produce fast growth rate of *C. gariepinus, H. bidorsalis* and *Heteroclarias* spp larvae. The results also show that *Ceriodaphnia* could be efficient in catfish larvae rearing and will enhance the aquaculture development in rural areas of Nigeria with little or no access to Artemia. The study therefore provides a good replacement for *Artemia*, which has inherent problem of high cost, scarcity, hatching difficulties and sometimes the question of viability of cysts. In spite of the great potential discovered in *Ceriodaphnia* however, collection from the wild is a herculean task; therefore there is need for further research on mass production of Ceriodaphnia in culture system with the development of effective culture recipes and techniques that can turn out large quantities of *Ceriodaphnia* throughout the year.

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COMPETING INTERESTS

The authors have declared that no competing interests exist.

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