

Research Paper

**Comparative study of *Artemia* (Brine shrimp) and *Ceriodaphnia* (Zooplankton)
as foods for catfish larvae**

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 highly expensive *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 and stocked in plastic tanks were fed with *Artemia nauplii* and *Ceriodaphnia* for 21 days. Growth and survival records were taken weekly. After 21 days of rearing, % Survival, Specific growth rate (SGR), daily growth rate (DGR) and Percentage weight gain (PWG) were slightly better in *Ceriodaphnia*-fed fry of the three species, even 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.

Keywords: *Artemia*, *Ceriodaphnia*, *C. gariepinus*, *H. bidorsalis*, *Heteroclarias*

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

(Mohammed and Omoregie, 2004). 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 carnivore, their fingerlings are scarce due to inadequate hatchery techniques and insufficient live food of high quality 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*, 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.

According to research findings, the 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 (Huisman 1985, FAO 1987, 2012). Therefore, feeding has been recognized as the major problem in the management of clariids hatchlings to fingerlings (FAO 1987).

Live food in feeding fry and fingerlings is obligatory for successful development of catfish aquaculture (FAO 1987). However, aquaculture research suggested rotifers

(Zooplankton) as the most satisfactory “first food” for fry (Arimoro and Ofojekwu, 2003, 2004, Arimoro 2007). 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 (Madu, *et al.*; 2000, Wang *et al.*, 2005). Reported shows 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 (Huisman 1985, Shiri *et al.*, 2003). *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 (Ludwig and Lochmann, 2000). The research was therefore aimed at comparing the performance of *Ceriodaphnia* (zooplankton) (fig. 1a.) with *Artemia nauplii* (Brine Shrimp) (fig. 1b.) in feeding of *Clarias gariepinus*, *Heterobranchus bidorsalis* and *Heteroclaris* sp. fry, and also to determine if *Ceriodaphnia* can successfully replace highly expensive *Artemia* in the aquaculture production of African catfishes fingerlings.

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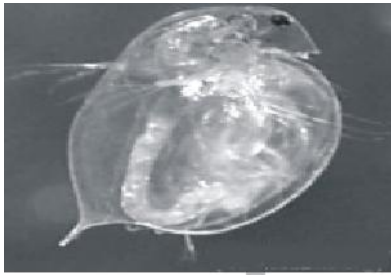


Fig. 1a



Fig. 1b

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80 MATERIALS AND METHOD

81 The experiment carried out to reflect the aim of the study was conducted at the fish
82 hatchery complex of Lagos state University, Ojo.

83 *Experimental Fish*

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

- | | | | | |
|----|------|--------------------------------------|---|--------------------------|
| 88 | i. | <i>Clarias gariepinus</i> (M) | X | <i>C. gariepinus</i> (F) |
| 89 | ii. | <i>Heterobranchus bidorsalis</i> (M) | X | <i>H. bidorsalis</i> (F) |
| 90 | iii. | <i>Heterobranchus bidorsalis</i> (M) | X | <i>C. gariepinus</i> (F) |

91 The larvae produced from the above parental species and hybrid was reared in three
92 separate bowls for five days at the end of which the yolk was completely absorbed and
93 the larvae of *C. gariepinus*, *H. bidorsalis* and *Heteroclaris* measured an average length
94 of $8.75 \pm 0.25\text{mm}$, $8.00 \pm 0.00\text{mm}$ and $8.00 \pm 0.00\text{mm}$ respectively.

95 (M: male. F: female).

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, 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 Lagos State University hatchery as directed by the manufacturer (Ocean Star International, INC. Snowville, UT. 84336 U.S.A.).

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.

The twelve tanks were grouped into three A, B and C (i.e. four tanks per group; Ai, Aii, Aiii and Aiv; Bi, Bii, Biii and Biv; Ci, Cii, Ciii and Civ). Each group of *C. gariepinus*, *H. bidorsalis* and *Heteroclinus* were stocked with 200 fry and fed ad-libitum for 21 days.

Table 1: Showing the different groupings and treatment methods adopted in feeding the different fish fry for 21 days.

Groupings	Treatment
A Tanks i and ii Tanks iii and iv	Fry fed with <i>Ceriodaphnia</i> Fry fed with <i>Artemia nauplii</i>
B Tanks i and ii Tanks iii and iv	Fry fed with <i>Ceriodaphnia</i> Fry fed with <i>Artemia nauplii</i>
C Tanks i and ii Tanks iii and iv	Fry fed with <i>Ceriodaphnia</i> Fry fed with <i>Artemia nauplii</i>

Statistical analysis

Means of parameters were subjected to analysis of variance [ANOVA] (Steel & Torrie, 1960) while levels of significance were determined at 5% confidence limit using Duncan Multiple Range Test (Duncan, 1955).

RESULTS

The growth response of *C. gariepinus*, *H. bidorsalis* and *Heteroclarus* to *Artemia nauplii* and *Ceriodaphnia* over 21 days rearing period is shown on table 2.

Table 2: Mean total length (mm±SD) of *C. gariepinus*, *H. bidorsalis* and *Heteroclarus* fed *Artemia nauplii* and *Ceriodaphnia*

	<i>C. gariepinus</i>		<i>H. bidorsalis</i>		<i>Heteroclarus</i>	
Week	Art	Crd	Art	Crd	Art	Crd
0	9.0±0.4 ^a	8.5±0.4 ^a	8.0±0.0 ^a	8.0±0.0 ^a	8.5±0.0 ^a	8.5±0.0 ^a
1	11.0±0.7 ^a	12.5±0.0 ^b	10.0±0.7 ^a	11.5±0.4 ^a	11.5±0.4 ^a	13.0±1.1 ^b
2	14.5±0.4 ^a	15.5±0.4 ^a	12.5±0.7 ^b	13.5±0.7 ^b	15.5±0.4 ^a	16.0±0.7 ^a
3	18.0±0.7 ^a	18.5±0.1 ^a	18.0±1.4 ^a	19.5±1.8 ^a	19.5±1.1 ^a	21.0±0.0 ^a

Figures in the same horizontal row having the same superscript are not significantly different ($p > 0.05$).

Art= *Artemia nauplii*, Crd= *Ceriodaphnia*

Table 3: Mean body weight (mg±SD) of *C. gariepinus*, *H. bidorsalis* and *Heteroclaras* fed *Artemia nauplii* and *Ceriodaphnia*

	<i>C. gariepinus</i>		<i>H. bidorsalis</i>		<i>Heteroclaras</i>	
Week	Art	Crd	Art	Crd	Art	Crd
0	19.0±0.0 ^a	18.5±0.0 ^a	14.0±0.0 ^b	14.0±0.0 ^b	13.5±0.0 ^b	13.5±0.0 ^b
1	28.0±0.0 ^a	58.0±0.0 ^b	24.0±0.0 ^c	40.0±0.4 ^d	19.0±1.4 ^c	38.0±0.0 ^d
2	49.5±0.7 ^a	80.5±0.7 ^b	46.5±1.4 ^a	64.5±1.4 ^c	42.0±1.4 ^a	71.0±1.4 ^d
3	91.5±0.4 ^a	140.0±0.7 ^b	80.0±0.0 ^c	125.0±0.4 ^d	100.0±0.0 ^e	170.0±1.4 ^f

Figures in the same horizontal row having the same superscript are not significantly different ($p > 0.05$).

ART= *Artemia nauplii*, CRD= *Ceriodaphnia*

Above table 2 indicated the initial mean total length of fry fed *Artemia nauplii* were 9.0 ±0.4mm for *C. gariepinus*, 8.0±0.0mm for *H. bidorsalis* and 8.5±0.0mm for *Heteroclaras* respectively while that of *Ceriodaphnia* was 8.5±0.4mm, 8.0±0.0mm and 8.5±0.0mm for the three species respectively. However, after 21 days of feeding, fry fed *Artemia nauplii* had increased in total length to 18.0±0.7mm for *C. gariepinus*, 18.0±1.4mm for *H. bidorsalis* and 19.5±1.1mm for *Heteroclaras* respectively while those fed *Ceriodaphnia* had increase to 18.5±0.1mm for *C. gariepinus*, 19.5±1.8mm for *H. bidorsalis* and 21.0±0.0mm for *Heteroclaras* spp.

The initial body weight (table 3) of fry fed *Artemia nauplii* were 19.0±0.0mg, 14.0±0.0mg and 13.5±0.0mg while that of *Ceriodaphnia* were 18.5±0.0mg, 14.0±0.0mg, 13.5±0.0mg respectively. At the end of the experiment fry fed *Artemia nauplii* weighed 91.5±0.4mg for *C. gariepinus*, 80.0±0.0mg for *H. bidorsalis* and 100.0±0.0mg for

189 *Heteroclaras* respectively while fry fed *Ceriodaphnia* weighed 140.0 ± 0.7 mg for *C.*
 190 *gariepinus*, 125.0 ± 0.4 mg for *H. bidorsalis* and 170.0 ± 1.4 mg for *Heteroclaras* spp.

191

192 Table 4: Growth performance and Survival rate of *C. gariepinus*, *H. bidorsalis* and

193 *Heteroclaras* fry fed *Artemia nauplii* and *Ceriodaphnia* for three weeks.

194		<i>Artemia nauplii</i>		<i>Ceriodaphnia</i>			
195	Parameters	Clg	Heb	Hcl	Clg	Heb	Hcl
196	Initial total length (mm)	9.0	8.0	8.5	8.5	8.0	8.5
197	Initial body weight (mg)	19.0	14.0	13.5	18.5	14.0	13.5
198	Final total length (mm)	18.0	18.0	19.5	18.5	19.5	21.0
199	Final body weight (mg)	91.5	80.0	100.0	140.0	125.0	170.0
200	Increase in total length (mm)	9.0	10.0	11.0	10.0	11.5	12.5
201	Increase in body weight (mg)	72.5	66.0	86.5	121.5	111.0	156.5
202	SGR (%)	7.49	8.30	9.54	9.64	10.43	12.06
203	Survival (%)	90.5	96.5	85.5	96.0	71.5	94.5
204	K (%)	2.08	2.30	1.66	2.83	2.69	2.34
205	DGR (mg/fish/day)	0.038	0.039	0.041	0.041	0.042	0.044
206	PWG (%)	381.6	471.4	640.7	656.8	792.8	1159.3
207	Clg = <i>Clarias gariepinus</i>	Heb = <i>Heterobranchus bidorsalis</i>			Hcl = <i>Heteroclarias</i>		
208	SGR = Specific growth rate	K = Condition factor		DGR = Daily growth rate			
209	PWG = Percentage weight gain						

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211 The greatest increase in total length (12.5mm), body weight (156.5g), specific growth
 212 rate (12.06%), daily growth rate (0.44mg/day) and percentage weight gain (1159.3%) as
 213 shown on table 3 were achieved by *Heteroclaras* fry fed on *Ceriodaphnia*. The least
 214 increase in total length (9.0mm) and body weight (66mg) were achieved by *Clarias*
 215 *gariepinus* and *Heterobranchus bidorsalis* fry fed on *Artemia nauplii*.

216 *Clarias gariepinus* fry fed on *Artemia nauplii* also had the least specific growth rate
 217 (7.49%), daily growth rate (0.038mg/day) and percentage weight gain (381.58%). The
 218 condition factor (K) was similar but slightly lower (1.66) for *Artemia nauplii* fed
 219 *Heteroclaris* fry. The highest rate (96.5%) was recorded by *Clarias gariepinus* fed on
 220 *Ceriodaphnia* while the lowest (71.5%) was recorded by *Heteroclaris* sp fed on *Artemia*
 221 *nauplii*.

222 Table 5: Proximate composition (%) of the experimental foods.

223	Nutrient	<i>Artemia nauplii</i>	<i>Ceriodaphnia</i>
224			
225	Moisture	84.5	92.0
226	Crude protein*	63.0	58.8
227	Lipid*	18.2	17.9
228	Fibre*	8.5	7.1
229	Ash*	0.9	1.5

230 * On dry matter basis

231
 232 There were slight differences in the proximate composition of *Artemia nauplii* and
 233 *Ceriodaphnia*. The crude protein, lipid and fibre contents of *Artemia* (63.0%, 18.2% and
 234 8.5%) were higher than that of *Ceriodaphnia* whereas, *Ceriodaphnia* on the other hand
 235 had higher moisture content (92.05) and ash (1.5%).

236

237 DISCUSSION

238 The growth performance of *C. gariepinus*, *Heterobranchius bidorsalis* and *Heteroclaris*
 239 larvae at the end of 21 days feeding trial (Table 2, 3 and 4) clearly point to the fact that
 240 total length was slightly higher in *Ceriodaphnia*-fed larvae (18.5mm, 19.5mm and
 241 21.0mm) compared with a length of 18.0mm, 18.0mm and 19.5mm recorded for the

242 *Artemia*-fed larvae. In terms of weight, growth was also slightly better in the
 243 *Ceriodaphnia*-fed larvae as these were heavier (140.0mg, 125mg and 170mg
 244 respectively), compared to a weight of 91.5mg, 80mg and 100.0mg obtained for the
 245 *Artemia*-fed larvae. Analysis of variance (ANOVA) also reveals slight significant
 246 difference in length but wider significant difference in weight ($P<0.05$) between the three
 247 fish larvae fed *Ceriodaphnia* and *Artemia*. Survival rate, specific growth rate (SGR),
 248 condition factor (K), daily growth rate (DGR) and percentage weight gain (PWG) were
 249 all slightly higher in the *Ceriodaphnia*-fed larvae compared to the *Artemia*-fed larvae
 250 (Table 4).

251 The findings above point to the fact that *Ceriodaphnia* performed better than *Artemia*
 252 *nauplii* in the growth of *C. gariepinus*, *Heterobranchus bidorsalis* and *Heteroclinus*
 253 larvae. Growth of fish is generally believed to be a function of the crude protein level in
 254 the diet. In spite of the fact that crude protein level (Table 5) of *Artemia nauplii* (63.0%)
 255 was slightly higher than that of *Ceriodaphnia* (58.8%), the latter still perform well in this
 256 study. This could be attributed to the fact that catfish larvae may not require more than
 257 58.85 C.P. for optimum growth. This assertion is in line with the work of Robinson
 258 (1989) who stated that the proximate composition of fry feed should consist of 55%
 259 protein; and also NRC (2000) recommended dietary requirement of not more than 52%
 260 crude protein for catfish larvae. Dada, *et al*; (2000) added that efficient growth of fish
 261 depend on feeding the best possible diets at levels not exceeding the dietary needs. The
 262 moisture content (Table 5) of *Ceriodaphnia* (92.0%) is higher than that of *Artemia*
 263 (84.5%). This could mean better digestibility for *Ceriodaphnia* by the fish larvae.
 264 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% (Robison, *et al*; 2001).

The relatively longer life span of *Ceriodaphnia* in water as was 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 *Heteroclaris* larvae which also dwell naturally in fresh water) compared with *Artemia nauplii* which is salt water zooplankton.

The better performance of *Heteroclaris* larvae (Table 4) recorded could be attributed to improved hybrid vigour; since similar experimental foods, rearing conditions and techniques were provided. This agree with the findings of Bakos (1986), Jensen, *et al*; (1983), Madu and Ita (1991) and Salami, *et al*; (1993) 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.

CONCLUSION

From the study, it was discovered that *Ceriodaphnia* has a great potential as natural food that can produce fast growth rate of *C. gariepinus*, *Heterobranchus bidorsalis* and *Heteroclaris* sp larvae. The results also show that *Ceriodaphnia* could be efficient as

Artemia in larvae rearing. Therefore, it 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 not easy and very cumbersome; therefore there is need for further research on the aspects of mass production of *Ceriodaphnia* in culture system. Effective culture recipes and techniques that can turn out large quantities of *Ceriodaphnia* throughout the year must be developed.

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