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# Growth Characteristics of the Monogonont Rotifer *Asplanchna priodonta* Gosse 1850 on Three Algae Species

**Paul O. Ajah[1,*]**
[1] University of Calabar, Institute of Oceanography, Calabar, Nigeria.

* Corresponding Author: Tel.: +234.803 3707901; Fax: -;
E-mail: ajapaulo@yahoo.com

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**Abstract**

The monogonont rotifer *Asplanchna priodonta*, used in aquaculture as food for fish fry, was mass-produced in three 10 $m^3$ outdoor concrete tanks over an average of 37 days each per batch using the algae *Chlorella vulgaris, Eudorina elegans*, and *Scenedesmus quadricauda* as food. In all three batches, the growth performance of *A. priodonta* fed on *E. elegans* was superior to that fed with either *C. vulgaris* or *S. quadricauda.* The intrinsic rates of natural increase and population doublings were better when fed on *E. elegans* and *C. vulgaris*. Highly significant ($P<0.001$) interactions were observed between *A. priodonta* and the three algae.

*Key words*: Zooplankton, rotifers, culture, phytoplankton, hatcheries.

## Introduction

Mass production of catfish under controlled conditions depends on the provision of live plankton food for the early fry and larval stages. The importance of live food in fry and larval rearing has been reported by Ovie *et al*. (1993), Ajah and Holzlöhner (1996) and Ajah (1997; 1998). Hagiwara *et al.,* (1997) gave a comprehensive review of live food in aquaculture and Ovie *et al.* (1993), Adeyemo *et al.* (1994) and Ajah (1997; 1998) have established the advantages of using freshwater plankton over *Artemia salina* nauplii, a salt-water anostracan.

The culture of *Brachionus*, in particular *B. plicatilis*, has been well documented (Gatesoupe and Luquet, 1981; Lubzens, 1987; Lubzens *et al.*, 1989; 1990). Gatesoupe and Luquet (1981) also noted that there could be nutritional differences in the value of rotifers as food for larvae based on the feeding conditions of the rotifers themselves. Watanabe *et al.* (1979) found that *Chlorella*-fed and yeast-fed rotifers differed in their proximate compositions. Ajah (1998) found increased growth and survivorship of *Heterobranchus longifilis* larvae when fed on enriched zooplankton. Earlier, Fujita (1979) indicated the importance of long chain ω-3 polyunsaturated fatty acids in rotifers used as food for Red Sea bream larvae, and found a further improvement in the dietary value of yeast cultured rotifers by secondary culture with marine *Chlorella* for 6 h.

*Asplanchna priodonta* is from a rotifer genus, which includes some of the largest species (1600-2000 µm as in Australia) of rotifers recorded (Koste and Shiel, 1980). Nandini and Rao (1996), Hampton and Starkweather (1998) and Nandini *et al.* (2003) studied the numerical and functional responses of campanulate morphs of *Asplanchna intermedia* fed five species of rotifer (*Brachionus rubens, B. patulus, B. calyciflorus, Hexarthra mira* and *Filinia longiseta*). Joanidopoulos and Marwan (1999) investigated how chemosensory and mechanosensory stimuli trigger the male mating response in the giant rotifer *Asplanchna sieboldi.* In search for suitable freshwater prey to sustain optimal growth in fish larvae for up to 30 days from yolk sac resorption, contrasted to 13 days with *Artemia* nauplii, *A. priodonta* was identified. Three species of algae, *Chlorella vulgaris, Eudorina elegans* and *Scenedesmus quadricauda* are capable of supporting large-scale production of this rotifer.

This manuscript reports on the use of three mono-cultured algal species, *Chlorella vulgaris, Eudorina elegans* and *Scenedesmus quadricauda,* used as food for mass-production of *Asplanchna priodonta* of about 685 µm x 356 µm in size. This is the first record of the outdoor monoculture of *E. elegans* and *S. quadricauda* as well as *A. priodonta.*

## Materials and Methods

### Indoor Culture of *Asplanchna priodonta*

The Gelose method adopted for *Asplanchna priodonta* culture involved the collection of mixed species from the Institute of Oceanography, University of Calabar, Nigeria fish pond and inoculated into a culture medium in a plankton laboratory within the Hatchery complex of the Institute containing the growth medium and incubated for about two weeks. Repeated isolations using a Pasteur pipette and re-culturing to achieve the desired mono species culture were done. Isolations and transfers were achieved after species identification under a light microscope at 10x magnification.

Two 36-watt daylight fluorescent tubes were

suspended-60 cm above three 60 L aquaria to illuminate continuously a space of 0.6 $m^3$ measuring 120x60x80 cm in a wooden cabinet. The inner walls of the cabinet were lined with reflecting aluminum foil. There were two mosquito-net-screened-vents in the cabinet walls that assisted in reducing heat.

Cabinet temperature was kept at 28±1°C with the aid of a small electric fan placed in the cabinet. Aquaria aeration was continuous by connecting Teflon tubes and air-stones to 3 inch PVC pipes that ran across the entire hatchery building arising from two 1.5 hp air pumps.

Fifty mg of baker's yeast (*Saccharomyces cerevisiae*) or 1.75 mg $L^{-1}$ of inorganic fertilizer (N: P: K) per litre was added to each 60 L culture tank under laboratory conditions for the first two days of culture and thereafter same quantity were added every other day (Ajah, 1995).

**Indoor Algal Culture**

The "Gelose" and "Dilution" isolation techniques of Harder (1917) and McVey and Moore (1983) were adopted. The Gelose method uses different nutrient media to enhance diatomous or non-diatomous, filamentous or non-filamentous algal growth, but requires repeated isolation and re-inoculation to finally achieve mono-species cultures. The Dilution method involves a series of combined dilution and transfer steps of the mixed species collected from the wild using sterile Pasteur pipettes in petri dishes to arrive at the desired mono-species. In the Gelose method, the mixed species collected from the wild were first cultured in a growth medium before repeated isolations and re-culturing to achieve the desired strain. In the Dilution method, isolations and transfers were achieved after identification under a light microscope. Axenic algal cultures of *Chlorella vulgaris* Beij. *Var. vulgaris* Fott, (2–12 µm), *Scenedesmus quadricauda* (Turp.) Bréb (12-15 µm) and *Eudorina elegans* Ehr. (95-105 µm) were produced under highly hygienic laboratory condition using inhibitory bacterial growth precursors such as 0.005 - 0.01 % hypochlorite solution, UV radiation and antibiotics (Ajah, 1995).

**Outdoor Plankton Cultures**

Three outdoor circular concrete tanks were used; each of approximately 10 $m^3$ by volume having five laterally attached airlift pumps to provide continuous mixture of culture and exposure to sunshine. The tanks were sterilized by first washing with detergent and then disinfected with 3 $gl^{-1}$ of 0.005 - 0.01% sodium hypochlorite solution for two to four hours. Thereafter tanks were thoroughly rinsed using borehole water and air-dried prior to inoculation of pure algae and *A. priodonta* from the laboratory three days post algal inoculation.

Physical and chemical factors such as temperature (°C), pH, dissolved oxygen (D.O) (mg $L^{-1}$), turbidity (F.T.U), conductivity (µS $cm^{-1}$), nitrite (mg $L^{-1}$), nitrate (mg $L^{-1}$), chloride (mg $L^{-1}$), phosphate (mg $L^{-1}$), and ammonia (mg $L^{-1}$) were monitored throughout the experimental period. Water temperature was measured using HACH conductivity meter. Concentration of hydrogen ions (pH) was measured with the help of Lectron pH 201 meter. Dissolved oxygen in the pond was determined using Lectron 5509 DO meter. Conductivity and turbidity (formazin turbidity unit) were read using HACH 3000 spectrophotometer. Nitrite ($NO_2^-$-N) was analyzed using the diazotization (spectrophotometric) method and Nitrate ($NO_3^-$-N) by the cadmium reduction method (Parsons *et al.,* 1984) while Chlorine was assessed by the chlorosity method of Rump and Krist (1988). Phosphate ($PO_4^{3-}$-P) was determined by molybdenum blue method (Parsons *et al*., 1984). Ammonium ($NH_4^+$-N) content of the water was analyzed by Neslerization method (Parsons *et al*., 1984). Aeration was provided by two 1.5 h.p air-pumps.

Prior to the use of swine manure, its chemical compositions were as follows: $NH_4$ = 178.3 mg $L^{-1}$, $SO_4$ = 85.44 mg $L^{-1}$, $SiO_2$ = 85. mg $L^{-1}$, $NO_2$ (Below detectable level), $NO_3$ = 25.3 mg $L^{-1}$, $PO_4$ = 0.64 mg $L^{-1}$, N = 28.7 ppm/22.7%, P = 0.20ppm/0.66%, K = 12.5 ppm/31.96% and moisture content was 62.6% (Ajah, 1995). The percentages represented total available nitrogen, phosphorus, and potassium content in the sample. The swine manure contained the main nutrients (N and P) which the algal species were dependent upon. Manure application rates were achieved following a series of trials with accompanying physicochemical monitoring for three years (Ajah, 1995). During the dry season, each outdoor tank received 1 kg swine manure, and during the wet season 2 kg for the first two days. Thereafter 1 kg per tank was administered at exponential log phase every third day in the dry season and every other day in the wet season. Fifty millilitres each of axenic algal monoculture, *Chlorella vulgaris* Beij. *Var. vulgaris* Fott, *Scenedesmus quadricauda* (Turp.) Bréb and *Eudorina elegans* Ehr. were introduced into the respective 10 $m^3$ tank at cell densities of 2.26 x $10^6$, 5.0 x $10^6$ and 0.1 x $10^6$ cells/ml, respectively.

Five litres inoculants containing 34 *Asplanchna priodonta* (Gosse, 1850) per ml were introduced into each 10 $m^3$ tank from the pure laboratory cultures. The zooplankton populations were sustained by the algal population renewed regularly with nutrient from swine manure. The duration of each of the experiments averaged 37 days and they were repeated thrice during each season, following the same procedures of cleaning of the tanks and inoculation**.**

**Determination of Growth Characteristics Cell Counts**

Samples were collected from the plankton

cultures using a 10 L plastic bucket and filtered through a 106-µm-plankton sieve into 25 ml sample bottles. Four replications of cell/zooplankton counts of one ml each from the homogenized sample bottles were carried out every day using a haemocytometer. The zooplankton counts were performed with a 1 ml counting chamber (model: AJAH001) (Ajah, 1995) with average values recorded after multiplying by the concentrate volume.

The intrinsic rate of natural increase, doubling time in days, and population growth were calculated as follows:

$r = Ln (N_t)-Ln (N_o) /t$ (James and Dias, 1984)
$t_D = 0.6931/r$ (James and Dias, 1984)
$N_t = N_o.e^{rt}$ (James and Dias, 1984)

Where,
r = the intrinsic rate of natural increase,
$N_t$ and $N_o$. = final and initial populations,
$t_D$ = Doubling time of the population in days.

Filtration and ingestion were calculated as follows:

Filtration rate $F = (Ln\ C_o - Ln\ C_t) /V.t.$ (Yúfera and Pascual, 1985).

Ingestion rate $IR = F.\sqrt{C_o.C_t}$. (Yúfera and Pascual, 1985).

Where,
$C_o$ and $C_t$ are initial and final cell densities,
V = Zooplankton density, and
t = time.

**Statistical Methods**

The zooplankton replicate samples were first analysed separately for each alga before lumping them together. The coefficients of determination between *Asplanchna* and the algae were calculated (Sokal and Rohlf, 1994). All the zooplankton replicates were pooled together for each algal species before carrying out single classification ANOVA, least significant difference-L.S.D, and fixed range test-L.S.R as well as the multiple range test-S.S.R following Duncan, (1955) and Sokal and Rohlf, (1994) to compare sample means.

## Results

The intrinsic rate of natural increase (r) and doubling time in days ($t_D$) (see Figure 1) revealed that the overall best food for *Asplanchna priodonta* was *Eudorina elegans* with average r =0.120±0.20, $t_D$ = 6.501±2.4; followed by *Chlorella vulgaris* with average r of 0.086±0.03, $t_D$ = 7.445±1.2, and lastly mean r of 0.092±0.02 and $t_D$ = 13.747±3.2, when *A. priodonta* was fed on *Scenedesmus quadricauda*. *Asplanchna* required only 7.445-days to double its population while feeding on *C. vulgaris,* 6.501 days for *E. elegans* and 13.747 days for *S. quadricauda.* Other daily growth data are compared in Table 1.

Daily mean biomasses by standing stock produced outdoors were 242.28 x $10^6$±805, 233.33 x $10^6$±312 and 208.421 x $10^6$±187 individuals/10 $m^3$, respectively, for *S. quadricauda, E. elegans*, and *C. vulgaris* (Table 1). *Asplanchna priodonta* showed a more stable and continuous growth in the *S. quadricauda*-fed tanks. Under the microscope, *A. priodonta* was seen to be feeding more on *E. elegans*, followed by *S. quadricauda* and had the least preference for *C. vulgaris*. The filtration and ingestion rates of *Asplanchna priodonta* using three algal foods are shown on Figure 2. The coefficient of determination ($r^2$) between filtration and ingestion was 0.697, 0.744 and 0.491, respectively, for *S. quadricauda, E. elegans,* and *C. vulgaris,* significant at $\alpha$=0.001. The behavioural tendencies of *Asplanchna* are clearly illustrated using the daily filtration and ingestion rates. The coefficient of determination was only significant between *A. priodonta* and *S. quadricauda*.

Model 11 analysis of variance which was to show the treatment random effects showed high negative significant ($^2_{109}$ F= -10.924, P>0.001) interactions between *Asplanchna* and the algae. Thus, *A. priodonta*'s population continued to increase upon decrease in algal population until a certain threshold level is reached and nutrient renewal becomes inevitable; otherwise, total collapse of the system will result. The tests with the least significant difference (L.S.D), fixed range (L.S.R) and multiple ranges (S.S.R) did show statistical differences among the various treatments.

The physico-chemical parameters measured were as follows: Temperature ranged from 28.7°C to 29.2°C, pH from 5.1 to 7.1 and dissolved oxygen 2.6 to 5.2 mg $L^{-1}$, while mean $PO_4^-$.P was 0.544±0.09 mg $L^{-1}$; $NO_2^-$-N, 0.135±0.04 mg $L^{-1}$; $NO_3^-$-N, 1.361±1.20 mg $L^{-1}$; $NH_4^+$-N, 5.90±0.039 mg $L^{-1}$; Turbidity (FTU), 82.5±8.1; conductivity, 667.6±40.66 µS$cm^{-1}$, and Chloride ($Cl^-$) was 0.241± 0.015 mg $L^{-1}$ (Table 2).

## Discussion

The value of live food for fish larvae and fry cannot be overemphasized. Hagiwara *et al*. (1997) gave a comprehensive review of the importance of live food in aquaculture. Cultivation of live foods, such as, *Moina dubia*, *M. micrura*, *Bosmina* sp., *Ceriodaphnia* sp., *Chydorus* sp., *Brachionus plicatilis* and Copepods has been carried out by Huisman (1976), Marciak and Bogdan (1979), Styczynska-Jrewicz *et al*. (1979), Hogendoorn (1980), Ocvirk and Vovk (1986) and Ajah (1997; 1998). However, the rotifer (*Asplanchna priodonta*) has been neglected as a possible food source. As fish juveniles develop from larval stages to fry, the need for larger prey such as *A. priodonta* becomes paramount.

The physicochemical factors and nutrient load

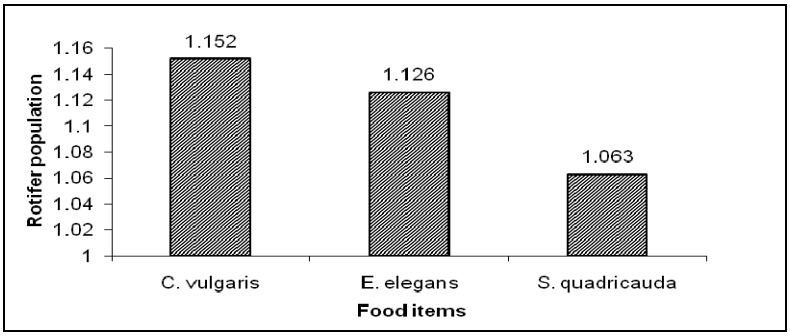


**Figure 1.** Mean daily population growth of *Asplanchna priodonta* fed on three algal species.

**Table 1.** Overall mean growth data relating to *Asplanchna priodonta* fed on three different algal Species

| Parameters | *Chlorella vulgaris* | *Eudorina elegans* | *Scenedesmus quadricauda* |
|---|---|---|---|
| Biomass (no.ind.x$10^6$/10 $m^3$/day) | 208.42±187 | 233.33±412 | 242.28± 805 |
| Peak densities/l | 38,000 | 38,000 | 38,000 |
| Av. Daily pop. Growth($N_t$)(ind/day) | 1.152 | 1.126 | 1.063 |
| Av. rate of natural increase(r)(ind/day) | 0.086 | 0.120 | 0.092 |
| Mean doubling time of pop. ($t_D$) in days. | 7.445 | 6.501 | 13.747 |
| Coefficient of determination($r^2$) b/w F and IR | 0.491, P<0.001 | 0.744, P<0.001 | 0.697, P<0.001 |
| $r^2$ b/w *Asplanchna* and algal density | 0.340, P<0.05 | 0.529, P>0.05 | 0.649, P>0.05 |

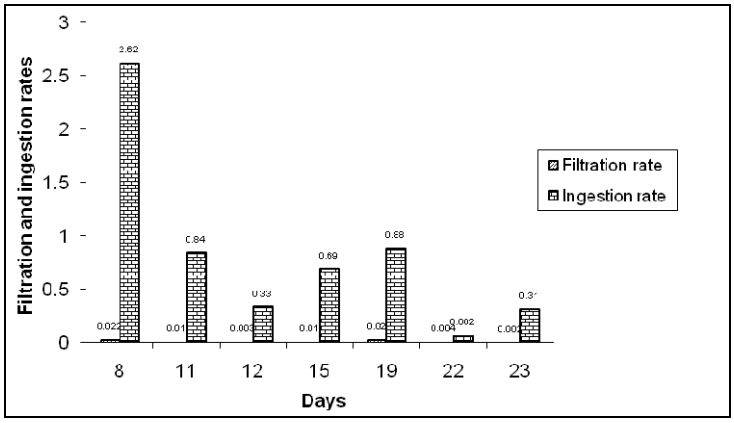


**Figure 2.** Filtration and ingestion rates of *Asplanchna priodonta* fed on three algal foods.

**Table 2.** Physical parameters of *A. Priodonta* culture tanks

| Parameters | *Chlorella vulgaris* | *Eudorina elegans* | *Scenedesmus quadricauda* |
|---|---|---|---|
| Temperature (°C) | 26.6±0.10 | 26.7±0.01 | 26.5±0.25 |
| pH | 6.4±1.50 | 6.7±1.02 | 5.9±0.64 |
| DO (mg $L^{-1}$) | 4.8±0.02 | 4.4±0.50 | 4.6±1.0 |
| $PO_4^-$-P (mg $L^{-1}$) | 0.18±0.11 | 0.18±0.01 | 0.22±0.02 |
| $NO_2^-$-N (mg $L^{-1}$) | 0.77±0.02 | 0.99±0.03 | 0.76±0.15 |
| $NO_3^-$-N (mg $L^{-1}$) | 3.15±1.45 | 3.05±0.01 | 2.85±1.22 |
| $NH_4^-$-N (mg $L^{-1}$) | 3.65±0.50 | 3.15±1.11 | 3.41±1.50 |
| Turbidity (FTU) | 98± 8.0 | 115±12 | 92±4.40 |
| Conductivity(µScm$^{-1}$) | 775±46 | 740±88 | 660±112 |
| Chloride ($Cl^-$) | 0.18±0.12 | 0.18±0.02 | 0.22±0.01 |

were within the acceptable limits required for the proper management of earth ponds (Wedemeyer *et al*., 1976; Post, 1987; Swift, 1988; Agarwal, 1994; Biswas, 1996). Each of the physicochemical factors fell within the recommended optimum required for plankton growth as reported earlier for temperature (IFAS Circular, 1951), DO (Banerjea, 1967; Ajah, 1995), the electrolyte conductivity, pH, and turbidity (Ajah, 1995), nitrate (Sachidanandamurthy and Yajurvedi, 2004) and phosphate (Sawyer, 1947; Screenivasan, 1965).

*Asplanchna priodonta* showed similar growth performances with all three algae, despite algal size differentiation such as *Eudorina elegans* being over 40 times the size of *Chlorella vulgaris* and about 20 times as big as *Scenedesmus quadricauda.* Almost equal selection of the three algae led to near uniform productivity, irrespective of alga types. The two smaller morphotypes of *A. silvestrii*, the saccate and the cruciform responded similarly to prey, except that the smallest morphotype (saccate) was unable to ingest the most mobile prey (nauplii) and less able to ingest relatively large prey (*Brachionus plicatilis*) (Hampton and Starkweather, 1998).

Almost uniform preference for the various food items administered, implied that none of the food items had an objectionable odour or taste or an awkward shape unacceptable to *Asplanchna priodonta*. Prey size, shape, spines, colonies, filaments, hard cell walls and gelatinous sheaths, densities, and movement are implicated as probable causes of the slight differences in feeding behaviour (Nandini *et al.*, 2003; Fileto *et al*., 2004). During microscopic observation, *A. priodonta* tended to be more attracted to *E. elegans* than to *S. quadricauda* or *C. vulgaris*, indicating that it preferred the bigger and faster moving prey (*E. elegans*), or medium sized prey with small spines such as *Scenedesmus.* In the prey selection experiments, *B. calyciflorus* positively selected for the algivorous *Coleps* sp. and the autotrophic *C. ovata* (Mohr and Adrian, 2002). In contrast, Hampton and Starkweather (1998) reported that highly mobile prey (*Hexarthra jenkinae* and copepod nauplii) was much less susceptible to predation by *Asplanchna silvestrii* than the less mobile *Brachionus* species. Earlier, Nandini and Rao (1996) studied the numerical and functional responses of the campanulate morphs of *Asplanchna intermedia* fed five species of rotifer and found that the vulnerability of the prey varied with their morphology and mode of swimming. Both predator morphotype and prey type affected the outcome of predation events significantly.

While evasiveness reduced attacks by saccates and cruciforms, campanulates did not have a significantly lower attack rate on *H. jenkinae* and copepod nauplii than on less evasive prey. Their large body size protected *Brachionus plicatilis* against ingestion by saccates only. The short-spined *B. satanicus* was the only prey that was rejected after capture, resulting in lower ingestion probabilities for *B. satanicus* than other brachionid prey (Hampton and Starkweather, 1998). *Asplanchna priodonta* is well known for its effective hunting abilities, capable of swallowing whole rotifers and crustaceans as well as colonial algae (Ward and Whipple, 1959; Fileto *et al.,* 2004; Mayeli *et al.*, 2004). Personal observation under the microscope proved that *Asplanchna priodonta* swims towards its prey organism using a ciliary's corona which also creates a feeding current by sweeping prey/food items into its oral groove. Fileto *et al*. (2004) observed that nannoplankton was more suitable for the smallest species *Ceriodaphnia cornuta* Sars, *Moina micrura* Kurz and microplankton for the largest one (*Simocephalus mixtus* Sars). *Chlorella vulgaris* is small, round and slow moving, and although population density was higher, it was possibly not as physically appealing to *A. priodonta* as the other algal species. *Chlorella* may be selectively too small for the energy expenditure of this voracious and very active creature (*Asplanchna priodonta*).

The higher r and $t_D$ of *Asplanchna priodonta* observed when fed on spineless *C. vulgaris* and *E. elegans*, rather than the spiny *Scenedesmus quadricauda* agree with the findings of Mayeli *et al.* (2004) and Fileto *et al*. (2004) that spines could obstruct feeding and reproduction of rotifers, although the large size of *A. priodonta* partly countered this effect. Mayeli *et al.* (2004) observed that the larger colony size and the formation of spines in *Scenedesmus quadricauda* were effective defences against grazing by both rotifers *Brachionus calyciflorus* and *B. patulus* and the smaller sized cladoceran *Ceriodaphnia dubia*; whereas larger bodied *Daphnia pulex* could exploit both algal populations equally. This is in agreement with the present findings.

Ingestion (IR) and filtration rates (F) could be considered among the measurements most closely related to feeding behaviour. These rates are influenced by several intrinsic cell factors, such as size, shape, chemical composition, physiological state and concentration (Starkweather, 1980; Bogdan and Gilbert, 1982) which could be summarized as acceptability and catch efficiency of the cell suspension. Positive significant ($P<0.001$) $r^2$ occurred between F and IR in all three algae compared. Higher F and IR occurred at decreasing food densities up to a certain concentration and always zero in all three algae examined whenever cell concentration was lower than the initial concentration. General decreases in F and IR followed increases in cell concentrations. Yúfera and Pascual (1985) observed decreases in F and IR with rotifer *Brachionus plicatilis* fed on *Nannochloropsis gaditana* at cell concentrations above $15 \times 10^6$ cells.ml$^{-1}$, whereas with *Nannochloris oculata*, *N. maculata* and *Nannochloropsis oculata* F decreased with increasing cell concentration at low and moderate food levels, remained constant at moderate densities and increased again at higher food levels. Pourriot (1977) and Starkweather (1980)

showed increased IR with food density at lower concentration and constant at higher algal densities.

*A. priodonta*-fed *Heterobranchus longifilis* larvae have been reported to have grown far better than those fed on nine other live organisms including *Tubifex tubifex*, yielding exceptionally high survival rates (86%) upon enrichment as against 4% by *Artemia* (Ajah, 1998). Specific growth rate of 17.4% per day was also realized with *Asplanchna* compared to 15.9% with *Artemia* (Ajah, 1998).

However, though the overall *A. priodonta* population biomass was the highest when fed on *S. quadricauda* followed by *E. elegans* and lastly *C. vulgaris,* the time it took for *A. priodonta* to double its population was the lowest with *E. elegans* followed by *C. vulgaris* and the highest with *S. quadricauda*. This big rotifer compares favourably in size with the most frequently cultured Cladocerans, *Moina dubia, M. micrura, M. irrasa* and *M. macrocopa*. The high fecundity of *Asplanchna* is shown by very high intrinsic rate of natural increase with the corresponding faster doubling of the population**.** 170,000 individuals per litre introduced into each 10 $m^3$ tank on the first day, representing 17 indiv/L, multiplied to daily averages of 20,421 indiv/L, 23,333 indiv/L, and 24,230 indiv/L, respectively, using *Chlorella*, *Eudorina and Scenedesmus,* at the end of a 37-day period. These far exceeded the 550 *Moina*/L outdoor cultures (ARAC-NIOMR 1990) and 2,475 to 3,745 *Moina*/L indoor cultures (Ovie *et al.*, 1993). Comparatively, *A. priodonta* fed on *E. elegans* yielded the best intrinsic rate of natural increase (r) and population doubling time in days ($t_D$), followed by *C. vulgaris var. vulgaris* and lastly *S. quadricauda*. Fileto *et al.* (2004) observed that the smallest cladoceran species, *Ceriodaphnia cornuta* Sars and *Moina micrura* Kurz, produced larger clutch sizes and exhibited higher intrinsic rates of population growth (r) in nannoplankton, despite contamination of their food by inedible algae. The r and $t_D$ values obtained using *Asplanchna,* though lower than the r = 0.84, $t_D$ = 1.212 obtained by Ahmad *et al.* (1991) using *Nannochloropsis* sp. to feed *B. plicatilis* are compensated for by almost double size in biomass of *Brachionus* by *Asplanchna*.

## Conclusion

There has been much success in the culture of a large number of zooplankton, in particular, *B. plicatilis* (Hogendoorn, 1980; Lubzens *et al.*, 1990; Sorgeloos, 1991; Verreth *et al.*, 1993). This is the first report of the mono and mass culture of *Asplanchna priodonta,* which offers a more reliable alternative to evasive copepods which are more difficult to culture and (Ajah, 1997; 1998), often used for advanced fish fry rearing. Quite often, the freshwater fry and larvae suffer large mortalities (63%) when fed on brine shrimp (*Artemia* nauplii) (Ajah, 1997) and cannot sustain larval growth beyond day-13 post hatch (Gatesoupe and Robin, 1982) due to smallness in size (444.6 µm x 163.8 µm; Ajah, 1995). With *A. priodonta*, larval survival is not only very high but optimal growth could be sustained for up to 30 days (Ajah, 1998) due to its large size, high fecundity and ability to meet larval dietary requirement. Gatesoupe and Robin (1982) earlier recommended feeding of fish larvae for days 9-13 days post-hatch using *Artemia* nauplii and 15-20 days with *B. plicatilis* leaving a gap, that is, 20-30 days, for which *A. priodonta* is an ideal candidate.

It is recommended that finfish (catfish, snakehead, etc.), and shellfish (shrimp, e.g. *Macrobrachium vollenhovenii*) hatcheries should embark on the mass culture of *Asplanchna priodonta,* not just to save the cost of importing *Artemia,* but also for increased freshwater larval survival and, consequently, higher population biomass.

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