THE IMPACT OF VARYING NUTRIENT REGIMES IN EARTHEN FRESHWATER PONDS ON THE COMPARATIVE ECOLOGY OF DIURNALLY OCCURRING CANDIDATE LIVE FEEDS

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ABSTRACT

The daytime composition and relative abundance of zooplankton species were studied in three treatments of two replicate earthen ponds each with varying nutrient sources and water replenishment regimes. Treatment-A (200m^2 surface area supplied 900kgha^{-1}month^{-1}pig manure only). Treatment-B (200m^2 surface area supplied 70kgha^{-1}month^{-1} pig manure, 50kgha^{-1}month^{-1} N.P.K [15:15:15] and 30kgha^{-1}month^{-1} Urea) and Treatment-C (1500m2 surface area supplied 1150kgha^{-1}month^{-1}commercial grade 40% crude protein compounded feed). Water replenishment for Treatment A was daily tidal deluge from the New Calabar River while that for treatment B and C was from column –well and occasional rains. No zooplankton species were recovered from the pig-manure only treatment (A) while only Difflugia constricta and Difflugia urceolata were the two protozoans that occurred together in treatments B (combined fertilization) and C (compounded feed only). In contrast, Difflugia acuminata and three rotifers, Collurella uncinata, Diurella stylata and Keratella quadrata occurred only treatment B. Similarly, Arcella arenaria, Arcella costata, Centropyxis aculeata, Difflugia pyriformis, Branchionus calyciflorus, Lepadella patella, Polyarthra trigla and Onchocamptus mohammedi were recovered from treatment C. Arcella costata was the most abundant zooplankton in the entire experiment, while Arcella arenaria was very abundant in treatment C, Collurella uncinata was very abundant in treatment B. The inference is that combined fertilization of earthen freshwater ponds tend to be more suitable for the culture of rotifers such as Brachionus calyciflorus, popular in fish larva nursery, while those supplied compounded feed could be used to produce protozoans where desirable.

INTRODUCTION

The availability of suitable live feed is cardinal to the success of commercial fin and shellfish seed multiplication activities. However, for extensive level and rural centered aquaculture development the nursery of fish larvae in earthen freshwater ponds remain indispensable to their being raised to full-fledge fingerlings or juveniles.

While the debate on the suitability and proportion of organic, inorganic and compounded nutrients to be used for these purposes remain alive, the expediency in using readily available nutrients to generate zooplanktons and live feeds to raise fish larvae far outweigh the cost of using commercially acceptable live feed such as *Artemia* for fish seed multiplication endeavors. It is widely accepted that the principal essence of fertilizing ponds is to initially increase pond fertility for algal growth (Shrestha and Lin, 1996) but the consequent microfauna resulting from each fertility regime have been more conjectured than listed in literature.

Not only would some of these zooplanktons favorably compare with commercial live feed in contemporary use as regards their size, regeneration rate and nutritional value (Kerfoot *et al.*, 1980; Geiger, 1983), information on their diurnal occurrence in earthen freshwater ponds coincident to when most fish larvae introduction into nurseries occur, remain scanty. This is notwithstanding the fact that the photophilic tendency (Hall et al., 1979) of some of these zooplanktons in relation to their forage for phytoplankton fodder is well documented (Maskey and Boyd, 1986; Coleman and Edwards, 1987; Mc Nabb *et al.*, 1990 and Raven and Johnson, 1996).

Since the initial stocking of fish fry traditionally occurs in the daytime there is the need to examine the most immediately available zooplanktons in the pelagic and peripheral zones of the pond water where fin and shellfish larvae traditionally forage for live feed. These live feeds could therefore be introduced during incubation for weaning the fry in tanks to encourage spontaneous feeding upon stocking the fish larvae in nursery ponds.

In the current study, nutrient regimes were varied to test the suitability of each and understand the ecology of pelagic and peripheral zooplanktons existing diurnally in these fertilized earthen freshwater ponds. In one treatment piggery manure was used alone, in another it was used in combination with inorganic fertilizers while in the third treatment forty percent crude protein compounded feed was the major nutrient source.

MATERIALS AND METHOD

STUDY AREA

The eighty seven hectare sized fish farm of the African Regional Aquaculture Center (ARAC) at Aluu, Rivers State of Nigeria was the study area chosen for this experiment. Three types of freshwater earthen ponds in two replicates each were selected with treatments (A) and (B) being of 200m^2 surface area while treatment (C) had a surface area 1500m^2. Treatment A was linked to a tidal channel to the New Calabar River for regular water renewal apart from occasional rain as for the other two treatments (B and C) which separately had column well water replenishment.

NUTRIENT REGIME

Nutrient regime supply for treatment (A) was organic fertilizer: 900kgha^{-1}month^{-1} of fresh piggery manure only; treatment (B) was combined organic and inorganic fertilizers: 750kgha^{-1}month^{-1} piggery manure, 300kgha^{-1}month^{-1} N.P.K (15:15:15) with 50kgha^{-1}month^{-1} Urea while the third treatment (C) was supplied 1150kgha^{-1}month forty percent crude protein commercial compounded feed (ARAC grade catfish fry feed the 'Branblo').

SAMPLE COLLECTION

A one-liter glass beaker was used to collect one liter of water from ten randomly chosen points from the pond periphery and towards the center at a depth of not more than thirty centimeters from the pond surface. All samples collected were added up in a fifteen-liter plastic bucket with care taken not to waddle in the pond to collect samples. The water was then strained through a twenty-five micrometer mesh-sized plankton concentration net with only a 100ml of these samples fixed in four drops of four percent formalin solution.

ZOOPLANKTON IDENTIFICATION AND ENUMERATION

Sample preparation and examination was as described by APHA (1985) and Pennak (1985) while zooplankton identification and enumeration followed the methods of Vollen Weider (1976) and Hans Maosen (1981).

ECOLOGICAL PARAMETERS

The zooplankton species encountered in this study were itemized in a table while indicating their individual frequencies of occurrence and relative abundances as well as the aggregate spatial distribution of the taxa to which they collectively belong. The frequency of occurrence inversely measured the unique encounter of a given zooplankton species across all the treatments, relative abundance measured comparatively the number of cellsml^{-1} of one zooplankton species to the others while spatial distribution comparatively measured the number of species of a given Class of zooplankton encountered across all treatments as an indication of their suitability in generating known live feeds.

The following methods were used to calculate the parameters:

(i) The frequency of occurrence for a given species = number of treatments in which the species occurred / total number of treatments
(ii) Relative abundance for a given species were as ranked below:

x = 1-15 cellsml^{-1}(sparsely abundant)
xx =16-63 cellsml^{-1}(fairly abundant)
xxx = 64-255 cellsml^{-1}(very abundant)
xxxx = 256-1024 cellsml^{-1}(most abundant)
a = species absent not encountered in entire treatment
^{r} = rare species occurrence and only encounter in the entire enumeration.
(iii) The spatial distribution for a taxon (%) = total number of species of a taxon in a treatment / total number of species of a taxon across all treatments x 100

RESULTS

SPECIES OCCURRENCE

PROTOZOA

There was no protozoan species in the pig-manure treatment but those in the combined fertilization treatment were *Difflugia acuminata*, *Difflugia constricta*, and *Difflugia urceolata*. Those found in the compounded feed treatment were *Arcella arenaria*, *Arcella costata*, *Centropyxis acualeata*, *Difflugia constricta*, *Difflugia pyriformmis* and *Difflugia urceolata*.

ROTIFERA

. There was no species composition for the pig-manure treatment. However, the species occurrence for the combined fertilization treatment were *Collurella uncinata*, *Diurella stylata* and *Keratella quadrata*. Those encountered in the compounded feed treatment were *Brachionus calyciflorus*, *Lepadella patella* and *Polyarthra trigla*.

COPEPODA

The only copepode species obtained from the whole experiment was *Onchocamptus mohammedi* and it was obtained from the compounded feed treatment.

Table1: The diurnally occurring zooplankton species, relative abundance and frequency of occurrence in the treatments

Taxa	Treatments			
Species	Pig-Manure Only	Combined Fertilization	Compounded Feed (40% C.P)	Frequency of Occurrence
Protozoa				
Arcella arenaria	a	a	xxx[r]	0.33
Arcella costata	a	a	xxxx[r]	0.33
Centropyxis aculeata	a	a	x[r]	0.33
Difflugia acuminata	a	xx[r]	A	0.33
Difflugia constricta	a	xx	Xx	0.67
Difflugia pyriformis	a	a	xx[r]	0.33
Difflugia urceolata	a	xx	Xx	0.67
Total number of species	0	3	6	
Rotifera				
Collurella uncinata	a	xxx[r]	A	0.33
Diurella stylata	a	xx[r]	A	0.33
Keratella quadrata	a	xx[r]	A	0.33
Branchionus calycflorus	a	a	x[r]	0.33
Lepadella patella	a	a	x[r]	0.33
Polyarthra trigla	a	a	xx[r]	0.33
Total number of species	0	3	3	
Copepoda				
Onchocamptus mohammedi	a	a	xx[r]	0.33
Total number of species	0	0	1	

*Zooplankton enumeration and relative abundance rankings:
x = 1-15 cellsml^{-1}(sparsely abundant)
xx =16-63 cellsml^{-1}(fairly abundant)
xxx = 64-255 cellsml^{-1}(very abundant)
xxxx = 256-1024 cellsml^{-1}(most abundant)
a = species absent not encountered in entire enumeration
= rare species occurrence and only encounter in the entire enumeration

FREQUENCY OF OCCURRENCE

PROTOZOA

The frequency of occurrence which is an inverse measure of the monoculture potential for each zooplankton species showed that while species that occurred in two treatments such as *D. constricta* and *D. urceolata* had 0.67 (Table 1) others like *D. acuminata* which occurred only in the combined fertilization treatment., *A. arenaria*, *A. costata*, *C. aculeata* and *D. pyriformis* which occurred only in the compounded feed treatment each had 0.33 frequency of occurrence. Therefore those with 0.33 frequency of occurrence have better monoculture potential in the existing treatments.

ROTIFERA

All rotifers were obtained in one treatment only with 0.33 frequency of occurrence for each species. While *B. calyciflorus*, *C. Uncinata* and *D. stylata* were obtained from the combined fertilization treatment *L. patella* and *P. trigla* were obtained from the compounded feed treatment.

COPEPODA

O. mohammedi had 0.33 frequency of occurrence for appearing only in the compounded feed treatment.

SPATIAL DISTRIBUTION OF TAXA ACROSS TREATMENTS

The spatial distribution (%), which measured the level of commonness of a given class across the three treatments, varied for the three classes of zooplanktons encountered in the whole experiment. The spatial distribution for protozoa in the combined fertilization and compounded-feed treatments were 33% and 67% (Figure 1), while those for the rotifers in these same treatments were 43% and 57% (Figure 2) respectively. The spatial distribution of copepods showed that only the compounded feed treatment yielded any copepod at a 100% (Figure 3). These generally showed that the compounded feed treatment had gross suitability for culturing all taxa of zooplankton but this does not indicate its suitability for the monoculture of individual live feed readily acceptable to fin and shellfish larvae. The frequency of occurrence would be a better indicator of this.

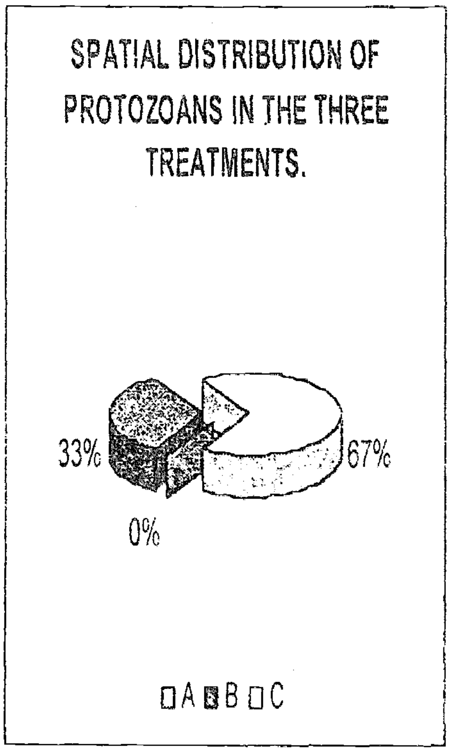

Figure 1

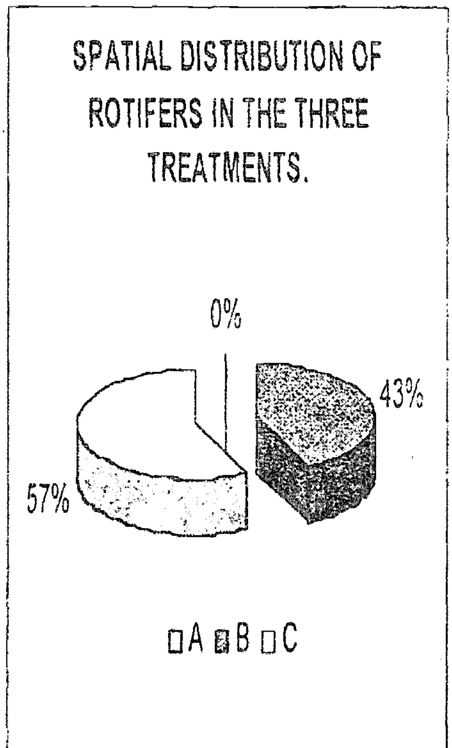

Figure 2

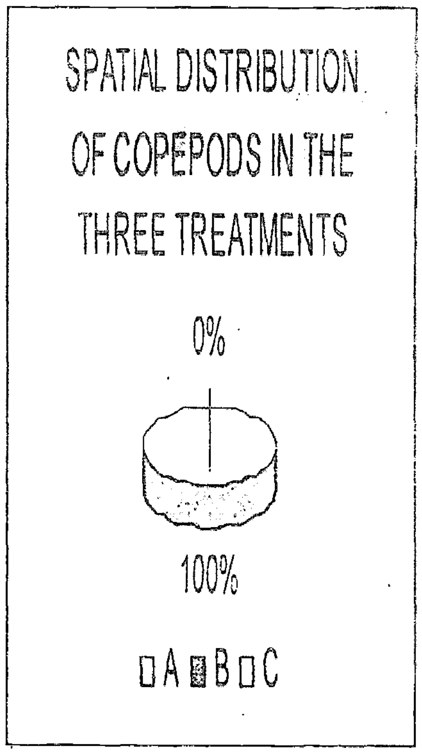

Figure 3

A-Pig-manure treatment; B-combined fertilization treatment and C-compounded feed treatment.

SPECIES RELATIVE ABUNDANCE

PROTOZOA

The most abundant protozoan in the whole experiment was *A. costata* followed by *A. arenaria* which was very abundant. All these were obtained from the compounded feed treatment only. However, *D. acuminata*, *D. constricta* and *D. urceolata* were fairly abundant in the combined fertilization treatment just as *D. constricta*, *D. pyriformis* and *D. urceolata* were also fairly abundant in the compounded feed treatment. *C. aculeata* was only sparsely abundant in the compounded-feed treatment.

ROTIFERA

C. uncinata was very abundant in the combined fertilization treatment while *D. styllata* and *K. quadrata* were fairly abundant in the same treatment. However, *P. trigla* was fairly abundant in the compounded feed treatment while *B. calyciflorus* and *L. patella* were only sparsely abundant in the same treatment.

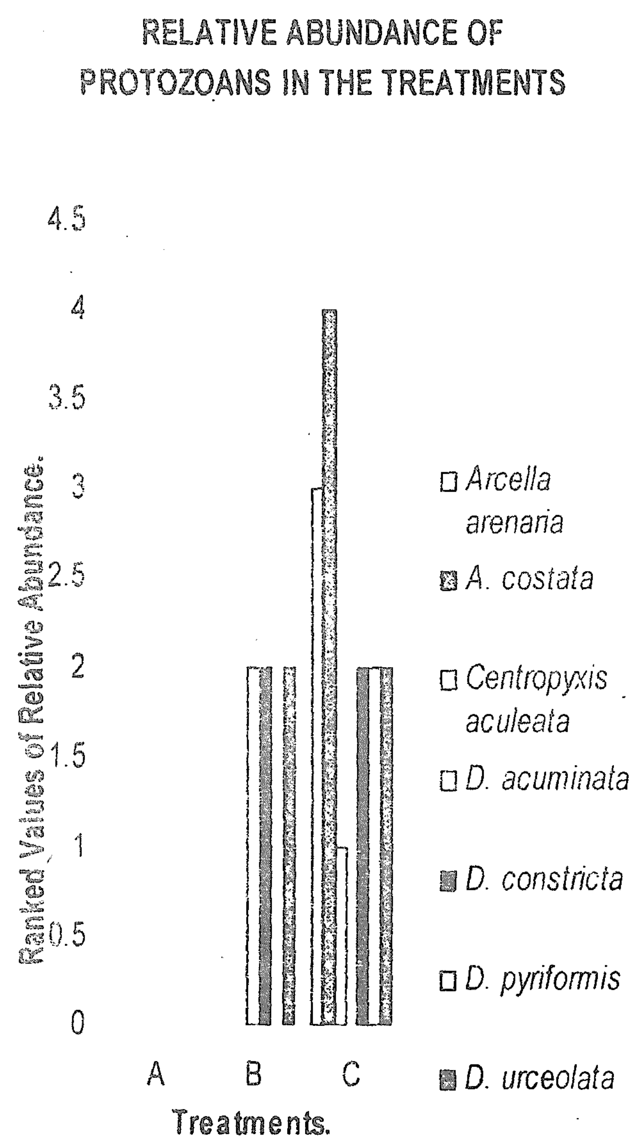

Figure 4

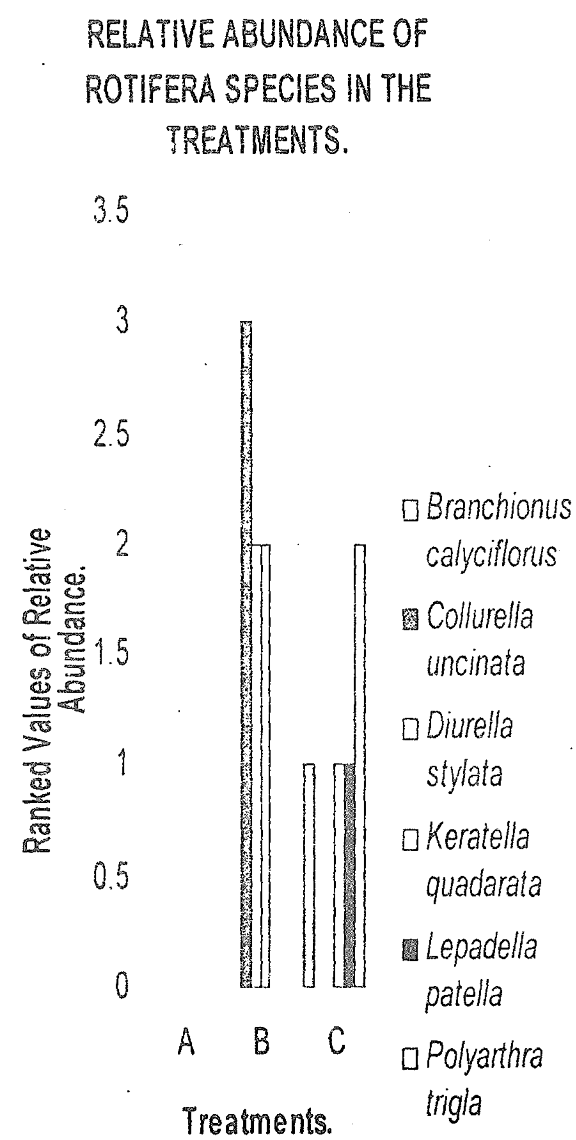

Figure 5

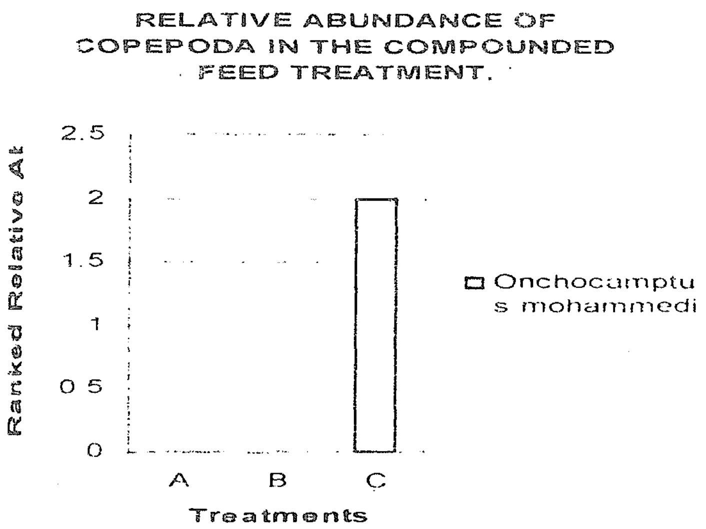

Figure 6
A-Pig-manure treatment; B-combined fertilization treatment and C-compounded feed treatment.

COPEPODA
O. mohammedi was fairly abundant in the compounded feed treatment (Figure 6)

DISCUSSION

The suitability of a given nutrient regime in the potential monoculture of a given taxon of zooplankton can be measured by their species composition, relative abundance and spatial distribution in the earthen freshwater pond. However, this suitability can only be indicated at the species level with the frequency of occurrence showing the best treatment for raising the candidate live feed.

It is important to examine what species could be described as a candidate live feed in fin and shell fish culture. The three classes of zooplanktons encountered in this experiment are known in varying degrees to have been useful as live feed in the culture of aquatic organisms (D'Abramo and Lovell, 1991). Many protozoan species have been directly implicated in shellfish nutrition and as detritivores that potentiate and ferment substrates in that regard (Coleman and Edwards, 1987). The major considerations governing these choices concern the ease of culture, regeneration time, nutritional quality, cell size, ease of capture and digestibility of prey ((Kamler *et al.*, 1986 and Awaiss *et al.*, 1992). Hence, while rotifers such as *Branchionus calyciflorus* would almost compare favorably with the brine shrimp, *Artemia*, with regards to cell size, nutritional quality and digestibility as first feed for catfish hatchlings it gradually becomes unsuitable for feeding advanced fries (Awaiss *et al.*, 1996). In the latter case copepods such as *Onchocamptus mohammedi* qualify to compensate for energy expenditure, cell size and ease of capture during advanced catfish larval feeding (Watanabe and Fujita, 1983).

For this reason, where a species occurred only in one treatment to the exclusion of other treatments (0.33 frequency of occurrence), that single treatment would be the best monoculture regime for that species if suitable as a live feed candidate in commercial fish seed multiplication undertakings.

This is why the use of combined organic and inorganic fertilization would be recommended for the monoculture of a protozoan species such as *D. acuminata* and rotifers like *C. uncinata*, *D. stylata* and *K. quadrata*. However, for the monoculture of protozoans like *A. arenaria*. *A. costata*, *C. aculeata* and *D. pyriformis* as well as the rotifers- *B. calyciflorus*, *L. patella* and *P. trigla* and the only copepod species *O. mohammedi* the best nutrient regime to be supplied in earthen freshwater ponds would be the compounded feed. Though the relative abundance of the well-known live feed *B. calyciflorus* (Gilbert, 1963) was low in the latter treatment, yet it offered the better nutrient regime for its potential monoculture in earthen freshwater ponds.

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