Zooplankton fauna from fish ponds in Kumba, Meme Division, Southwest Cameroon

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ABSTRACT

This paper examines the zooplankton fauna (Rotifera & Cladocera) of five fishponds: 3 production ponds (Pp1, Pp2, Pp3), a brood (Bp), and a fingerling pond (Fp). Pp1 and Pp2 are located in Kosala and Pp3, Bp and Fp at the SOWEDA experimentation site in Fiango. A total of 20 species: 8 Cladocera with 4 families dominated by the Chydoridae and 12 Rotifera with 6 families dominated by the Brachionidae are registered and figured (Plates 1 & 2). Cladocera densities are highest in the fingerling pond (Fp=16 x 10^{-2} indiv./l) and lowest in production pond (Pp1=25 x 10^{-3} individuals/l) while Rotifera densities are highest (3.5indiv/l) in brood pond (Bp) and lowest (0.53 indiv./l) in the fingerling pond (Fp). Large size cladocerans (*Moinodaphnia maclaeayi*) dominate the fingerling pond (Fp) and the spine bearing genus *Brachionus* are generally well represented in most ponds. The role of fish and invertebrate predation in regulating this diversity and abundance is herein also briefly discussed.

Key words: Rotifera, Cladocera, Diversity, Fish pond, Predation.

RÉSUMÉ

Une étude a été menée sur du zooplancton (Rotifères et Cladocères) dans cinq étangs piscicoles: 3 étangs de production (P1,P2, P3), un étang des géniteurs (Bp) et un étang d'alevins (Fp). Pp1 et Pp2 sont localisés à Kosala et Pp3, Bp et Fp à dans la site expérimentale SOWEDA à Fiango. Total 20 espèces: soient 8 Cladocères, 4 familles, 12 Rotifères et 8 familles ont été enregistrés et figurés (Planches 1 & 2). La densité des Cladocères varie entre 16 x 10^{-2} indiv./l et 25 x 10^{-3} dans Fp et Pp1 respectivement tandis que la densité des Rotifères varie entre 3.5indiv./l et 0.53indiv./l dans Bp et Fp respectivement. Les Cladocères de grande taille (*Moinodaphnia maclaeayi*) ont dominée Fp tandis que les Rotifères du genre *Brachionus* étaient biens représentés dans tous les étangs. Cette variation des diversités et des densités des espèces peuvent être liées au phénomène de prédation par les poissons et les invertébrés.

Mots clé: Rotifères, Cladocères, Diversité, Etang piscicoles, Prédation.

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1. INTRODUCTION

Rotifers and cladocerans are an important link in the well documented pelagic and littoral food webs of fish ponds and lakes. They are preyed upon by most fish, especially the young, and account for the majority of food items identified in their guts (Hammer, 1985; Telesh, 1993). In Cameroon the diversity of zooplankton in fishponds and their contribution in fish diet is poorly documented. The only available works are those of Corbet et al. (1973) in Lake Mboandong recording organic debris, *Choaborus* larvae, plant tissue and invertebrates: Rotifera and Cladocera (*Alona verrucosa* and *Karualona iberica*), from the stomach contents of small cichlids and *Aphyosemion spp.* Also, Froese and Pauly (2003) have showed that the Clupeid *Serrathrissa leonensis* from the Sanaga river feeds predominantly on zooplankton. The present work has been undertaken with aim to study the species diversity and densities of zooplankton (Rotifera and Cladocera) in some fish ponds in the Kumba area and also to discuss the possible influence of fish and aquatic invertebrates on this zooplankton community.

2. MATERIALS AND METHODS

2.1. Sampling Site

This work was carried out in Kumba, a town within the Bakundu rainforest reserve in Meme Division, Southwest Cameroon. The ponds consisted exclusively of two private production ponds (Pp1 and Pp2) at Kosala quarters and a single brood pond (Bp), fingerling pond (Fp) and a production pond (Pp3) located at the South West Development Authority (SOWEDA) fish farm in Fiango. In both cases the ponds are displayed in parallel then supplied by spring water in Kosala and by a branch of the Kumba river at the SOWEDA site.

2.2. Pond Dimension and Cultured Species

The production ponds at Kosala (Pp1 & Pp2) measured about 400m^2 each with a depth of about 0.8m. Pp1 enclosed a mixed culture of the african catfish *Clarias gariepinus* and the Nile tilapia *Tilapia nilotica* while Pp2, a monoculture of the african catfish exclusively.

At the SOWEDA experimentation site the brood (Bp) and fingerling ponds (Fp) measured 64m^2 in area and 0.4m in depth each. The production pond (Pp3) here measured about 300m^2 in area and 0.6m in depth. The brood pond (Bp) enclosed spawners of the african catfish (*Clarias gariepinus*), the fingerling pond (Fp), african catfish fingerlings and the production pond (Pp3) a mixed culture of the african catfish (*Clarias gariepinus* and the Nile tilapia (*Tilapia nilotica*).

2.3. Sampling Techniques

Five samples each of zooplankton (Rotifera/Cladocera) were collected from each of the ponds between 0-0.5m using a plankton tow-net with a circular orifice. The tow-net consisted of an iron ring with diameter of 20cm attached to a nylon rope of 6m length. A plankton net with mesh size 50μm and length 25cm, was mounted on this ring and provided with a 60ml plastic recipient at the end. All sample were fixed with formaldehyde solution up to 4-5% and transported to the laboratory for analysis.

Alongside plankton samples, 250ml of surface water samples were taken for physical and chemical analysis.

2.4. Analysis of Samples

The sorting and identification of plankton species was done using a stereo-zoom dissection microscope (WILD). The specimens were mounted on slide, without cover slip and a few drops of glycerine added, enough to hold the specimen. This method was particularly good in avoiding distortion of the specimen; also glycerine gave more clarity and prevented the specimen from drying out. Cover slips were then mounted and the slides permanently sealed with glyceal. Physical and chemical parameters of water samples were measured using a TetraTest AnalySet water analysis kit.

2.5. Identifications and Drawings

Identifications were done under oil immersion using an Olympus compound microscope (C011) and with available literature: Koste (1978), Pontin (1978) and Nogrady (1993) for the Rotifera then Smirnov (1996), Alonso (1996) and Negrea (1983) for the Cladocera. Drawings were made using a Camera Lucida.

2.6. Calculation of Zooplankton densities and Volume of filtered water

The number of individuals per sample was estimated by counting of individual species using a counting chamber under a stereo-zoom binocular microscope. The theoritical volume of water filtered was calculated using the formula for non-metered tow nets as given in Wetzel & Likens (1979)

$V = (A)\ (D)$ where A= area of ring orifice and D= the towing distance.

TABLE 1: Physical and Chemical Characteristics

SITE	PHYSICAL AND CHEMICAL VARIABLES						
	PH	0_2mg/1	NH3mg/1	NO2mg/1	NO3mg/1	KH	CO2mg/1
Pp1& Pp2	7	5	0	<0.3	12.5	3°	10
Bp	7	5	0	<0.3	12.5	3°	10
Fp	6.5	5	0.25	<0.3	12.5	2°	21
Pp3	7.5	5	0.25	<0.3	12.5	3°	3

3. RESULTS

Table 1 lists the physical and chemical parameters registered during this study. pH values for all ponds ranged from 6.5-7.5; Dissolved Oxygen (DO), was constant at 5mg/l; Ammonia (NH3) values were <0.25mg/l; Nitrite (NO2), <0.3mg/l; Nitrate(NO3), 12.5mg/l; Carbonate hardness (KH) between 2°-3° and Dissolved Carbon dioxide (CO2) ranged from 3-21mg/l. Except for carbon dioxide (CO2), these values are within the appropriate range for optimum fish growth as given in Huet (1972) and Boyd (1979) (i.e. KH values of 3°-10°, Nitrite values <0.8mg/l, NH3 values < 0.25mg/l, Nitrate concentrations <25mg/l and Carbon dioxide concentrations of 5-15mg/l).

Species Abundance

The zooplankton densities in each of the ponds is given in Table 2. Production ponds (Pp1-Pp3) and brood pond (Bp) register highest values of rotifer densities (1.1-3.5 individuals/ liter) while the fingerling pond (Fp) registers lowest density of 0.53 individuals/ liter. On the other hand, the fingerling pond (Fp) registers highest density of Cladocera (16 $x10^{-2}$ individuals/l), largely dominated by large size species (*Moinodaphnia maclaeayi*) while all the others register lowest densities of between 25-$67x10^{-3}$ individuals/l.

Table 3 and Plates 1 & 2, list and illustrate zooplankton species recorded, and their distribution within the ponds. A total of 20 species, 10 families are recorded in all studied ponds. Rotifera is richest with 12 species, 6 families and dominated by the Brachionidae.
Cladocera record 8 species, 4 families, dominated by the Chydoridae. These species are consistent with zooplankton (Cladocera and Rotifera) shown to dominate Cameroon water bodies (Chiambeng et al, 1994, 1991; Akum et al. 2001; Chiambeng & Dumont, 1999; Chiambeng, 2004; Corbet et al., 1973; Green et al., 1974; Rey & Saint-Jean, 1968, 1980 & Gras & Saint-Jean, 1971). They are also well known in other african and world water bodies (Nogrady, 1993, Segers et al. 1991, Koste, 1978, Smirnov, 1996).

When we consider individual ponds, we find that Pp1 registers highest numbers of zooplankton (10 species) followed by Pp2 and Fp (9 species each) then Pp3 and Bp, 8 and 7 species respectively. Also, the Cladocera/ Rotifera ratio for each of the studied ponds is varied. It is 3:7 in Pp1, 1:8 in Pp2, 3:5 in Pp3, 2:5 in Bp and 6:3 in Fp. The fingerling pond thus has an exceedingly high Cladocera/Rotifer ratio when compared to all the others. This difference in zooplankton diversity and species richness maybe linked to differences in predation by the different fish species.

TABLE 2: Density of Zooplankton Organisms in each Pond

ZOOPLANKTON	SITES				
	Pp1	Pp2	Pp3	Bp	Fp
	(Individuals/liter)				
Rotifera	1.3	1.5	1.1	3.5	0.53
Cladocera	$67x10^{-3}$	25×10^{-3}	$41x10^{-3}$	$33x10^{-3}$	$16x10^{-2}$

TABLE 3: List of Cladocera and Rotifera recorded per pond

TAXON	SITES				
	KOSALA		SOWEDA		
	Pp1	Pp2	Pp3	Bp	Fp
CLADOCERA					
Family Moinidae					
Moinodaphnia maclaeayi	-	-	+	+	++
Family Sididae					
Diaphanosoma excisum	-	-	+	-	+
Family Chydoridae					
Alona guttata	++	-	-	-	+
Chydorus eurynotus	+	-	++	-	+
Disparalona hamata	-	-	-	-	+
Pleuroxus denticulatus	-	-	-	-	+
Nicsmirnovius greeni	-	+	-	+	-
Family Macrothricidae					
Macrothrix triserialis	+	-	-	-	-
ROTIFERA					
Family Brachionidae					
Brachionus calyciflоris	++	++	+	-	+
Brachionus rotundiformis	-	+	-	-	-
Brachionus angularis	++	++	++	++	-
Brachionus falcatus	++	+	++	-	+
Brachionus rubens	-	-	-	+	-
Family Lecanidae					
Lecane bulla	++	++	-	-	+
Lecane closterocerca	+	-	+	-	-
Family Trichocercidae					
Trichocerca dixonnutalli	-	++	-	++	-
Family Notomatidae					
Cephalodella sp.	-	+	-	-	-
Family Testudinellidae					
Testudinella patina	+	-	-	-	-
Filinia longiseta	-	++	-	++	-
Family Synchaetidae					
Polyarthra vulgaris	+	-	++	+	-
TOTAL: 20	10	9	8	7	9

Legend:
+: present; ++: abundantly present ; -: absent
Pp1:Production pond Kosala: african Catfish (*Clarias gariepinus/Tilapia nilotica*)
Pp2: Production pond Kosala (african catfish: *Clarias gariepinus*)
Pp3: SOWEDA Production pond (african catfish: *Clarias gariepinus / Tilapia nilotica*)
Bp: SOWEDA Brood pond (african catfish: *Clarias gariepinus*)
Fp: SOWEDA Fingerling pond (african catfish: *Clarias gariepinus*)

Some Invertebrate Fauna

Fourth larva stages of the phantom midge belonging to the family Chaoboridae: *Chaoborus ceratopogenes*, the water boatman of the family Notonectidae: *Notonecta sp.* and old instars and adults of the order Cyclopoida were present in all pond samples.

4. DISCUSSION

There has been an increasing awareness of the important role played by vertebrate predators (especially fishes), and invertebrate predators in the determination of zooplankton community structure in aquatic ecosystems (Hrbacek, 1962, Kerfoot & Sih, 1987). Stenson (1972) showed that intense predation reduces

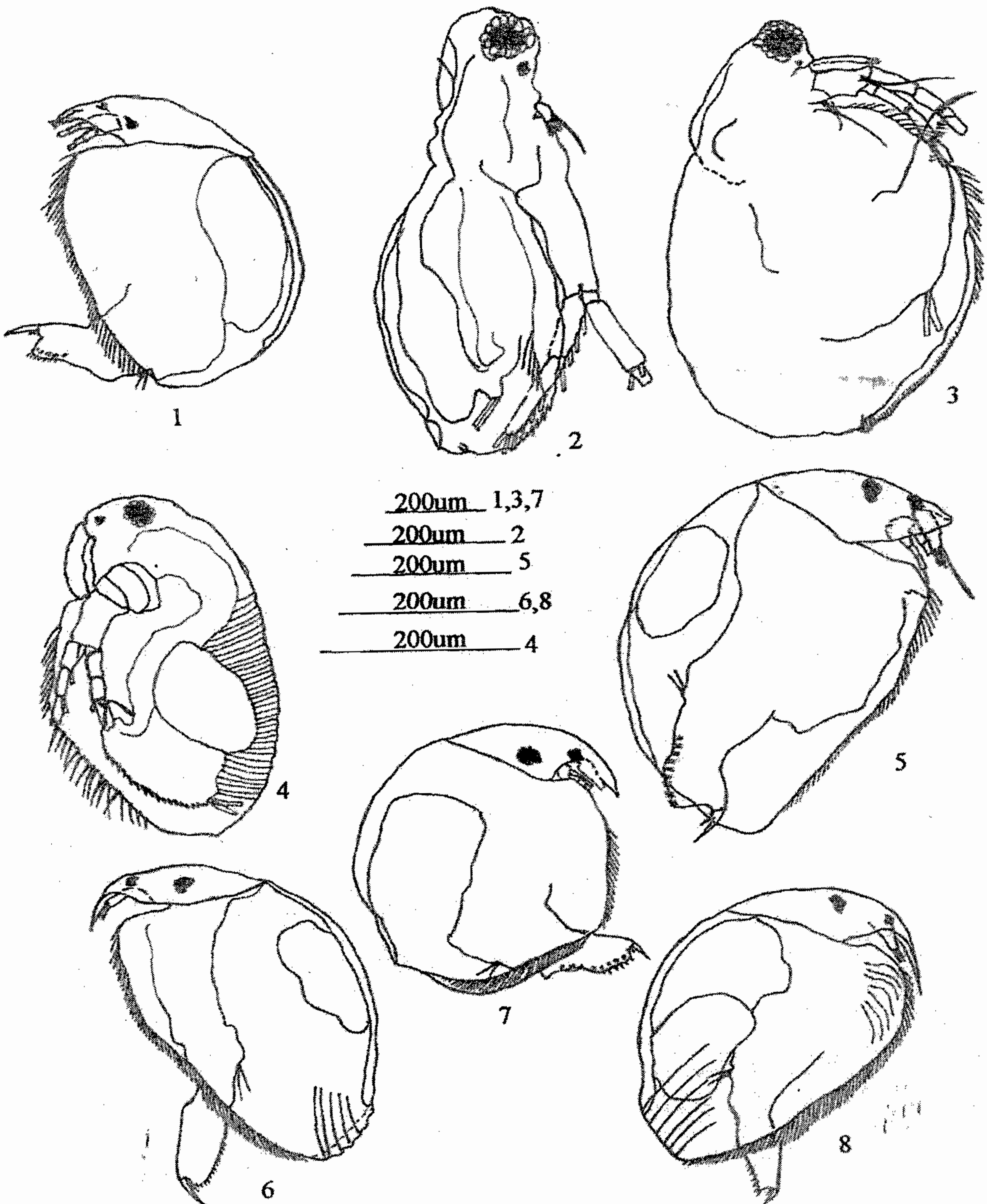

Plate 1:
1. Alona guttata, 2. Diaphanosoma excisum, 3. Moinodaphnia maclaeayi, 4. Macrothrix triserialis, 5. Nicsmirnovis eximius, 6. Disparalona hamata, 7. Chydorus eurynotus, 8. Pleuroxus denticulatus.

mean body size and changes in species composition towards dominance of small species in the community.

Generally these results show low species diversity and densities (tables 2 & 3) of Cladocera compared with Rotifera in the ponds. This may be due to the fact that Cladocera constitute a preferential prey for young and especially adult fish as a result of their larger sizes and slow escape mechanism compared with rotifers. If we accept the "visibility hypothesis" (Hrbacek , 1962). which states that " the prey item is selected by the predator according to visibility" this differences can then only be expected.

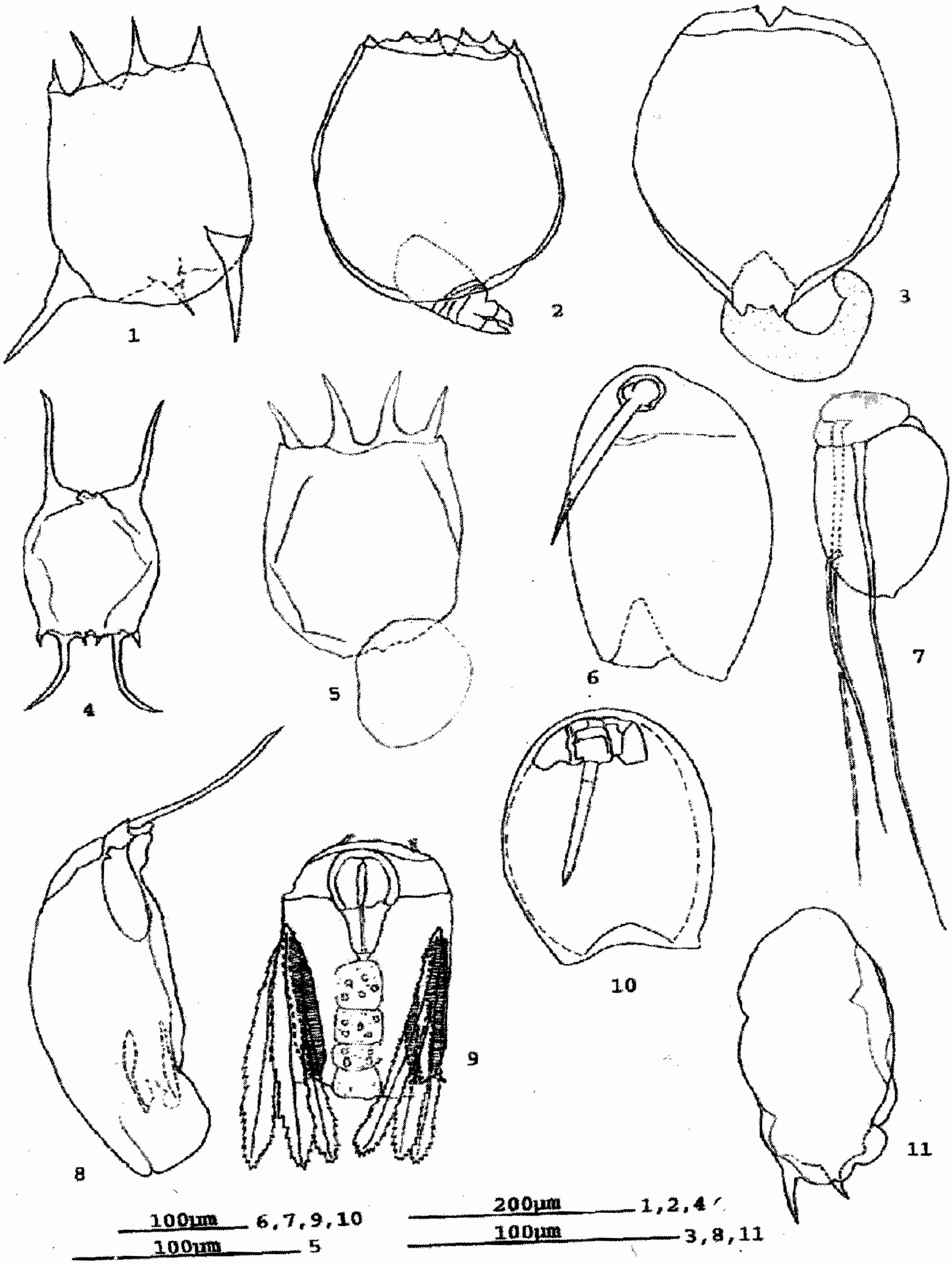

Plate 2:

1. Brachionus calyciflorus, 2. Brachionus rotundiformis, 3. Brachionus angularis, 4. Brachionus falcatus, 5. Brachionus rubens, 6. Lecane bulla, 7. Filinia longiseta, 8. Trichocerca dixonnutalli, 9. Polyarthra vulgaris, 10. Lecane closterocerca, 11. Cephalodella sp.

According to this author, generally all aspects of zooplankton morphology may be expected to contribute to its visibility, including eye pigmentation, body pigmentation, egg pigmentation and body size. Since cladocerans are by far much larger than rotifers and have pigmented eyes we therefore expect them to be more selected comparatively.

There is dominance of large sized species *Moinodaphnia maclaeayi* in catfish fingerling ponds (Fp) (table 3 & plate 1). According to Zaret (1980) in freshwater environments, the size of the prey ingested by fish and other invertebrates depends on their gape sizes. Rotifers and small size cladocerans are the principal food for fish fry and fingerlings (Lair et al., 1996). Fingerling size catfish have small gape sizes and thus will actively eliminate small size zooplankton (rotifers,) thus their low densities in this pond. Incompatibility between their small gape sizes and adult size *Moinodaphnia maclaeyi* makes it difficult for them to feed on these cladocerans and this might have contributed to the dominance of this species in the Fp. This also, goes a long way to explain the high density of cladocerans ($16x10^{-2}$ indiv./l), high Cladocera/Rotifer ratio and low density of rotifers (0.53 indiv/l) registered in the fingerling pond (Fp) compared with the other ponds.

High records of rotifers and low records of Cladocera in production ponds (Pp1-Pp3) and brood pond (Bp) (table 3) may have been as result of the fact that adult catfish though omnivores are not known to actively feed on rotifers (Fagbenro et al. 1991) but may easily consume the larger sized cladocerans. Also, invertebrate predators of the families Chaoboridae: *Chaoborus ceratopogenes*; Notonectidae: *Notonecta sp.*, and order Cyclopoida etc. have been shown in Lake Léré, northern Cameroon and some temperate water bodies to feed on cladocerans and rotifers (Gras & Saint-Jean, 1971; Zaret, 1980). According to these authors, they mostly do not swallow their prey whole but ingest it in bites or actually employ sucking mouth parts to "sip" their prey, the prey size is critical not so much for ingestion but for prey capture.

Dominance of species of the genus *Brachionus* in most ponds may be associated with their morphology. The development of spines (Plate 2) in this species is a mechanism of combating predation by fish and other invertebrates (Dumont and Negrea, 2002). This makes them comparatively less susceptible for selection for consumption by fish and invertebrate predators.

However, the role of abiotic factors (temperature, dissolved oxygen, pH etc) and other physical and chemical factors on the distribution and densities of these species cannot be excluded (Gannon & Stemberger, 1978; Sladecek, 1983). Competition too also contributes significantly in regulating population size and the presence or absence of species (Zaret, 1980) but lacks direct evidence.

5. CONCLUSION

Generally, low species richness and densities (cladocerans/rotifers) in these fish ponds when compared to fishless waters is probably linked in a greater part to fish, and to a lesser part to invertebrate predation and abiotic factors. Small sized fish species with small gape sizes actively eliminate small sized zooplankton while large sized species with large gape sizes actively eliminate large sized zooplankton. Plankton species having mechanisms to combat predation (genus *Brachionus*) probably stand better survival chances in such complex environments. It is very likely that, at the time of stocking there were many more zooplankton species and higher densities in these ponds but with time they progressively got eliminated.

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