A longitudinal study of zooplankton along the Lower Orinoco River and its Delta (Venezuela)

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Keywords : Orinoco River, Orinoco Delta, zooplankton abundance, zooplankton composition.

Zooplankton samples collected at low and high water in 14 and 21 stations respectively along some 900 km of the Orinoco and its Delta, revealed the presence of 100 rotifer and 48 cladoceran taxa. Of these, only 13 rotifer and 8 cladoceran species were frequent and numerically important, mainly *Keratella americana*, *Lecane prolecta*, *Ploesoma lenticulare*, *Polyarthra vulgaris*, *Bosmina tubicen*, *Bosminopsis deitersi*, *Diaphanosoma birgei* and *Moina minuta*. Nauplii were dominant among the copepods. At low water, rotifers were by far the most abundant group (mean 49 org./l) followed by cladocerans (mean 2.8 org./l) and copepods (1.5 org./l). At high water, rotifer densities declined to a mean of 3.5 org./l, followed by copepods (mean 3.4 org./l) and cladocerans (1.2 org./l). Mean zooplankton densities at low water were eight times higher than at high water. At low water, longitudinal zooplankton densities seemed to be influenced by tributary river waters. At high water, densities were generally low up to the Delta where a longitudinal increase was observed. A high proportion of egg carrying cladocerans, particularly *B. tubicen*, *B. deitersi* and *M. minuta*, were observed at low water along the sampling sites, suggesting an ability of the species for growth and reproduction in the river.

Étude longitudinale du zooplancton du Bas Orénoque et de son Delta (Vénézuéla)

Mots clés : Fleuve Orénoque, Delta Orénoque, zooplancton, abondance, composition.

L'étude longitudinale de l'abondance et de la composition du zooplancton, en période de basses et de hautes eaux dans 14 et 21 stations respectivement de l'Orénoque et de son Delta, a révélé la présence de 100 taxa de rotifères et de 48 taxa de cladocères. Seuls 13 rotifères et 8 cladocères sont fréquents et numériquement importants : principalement *Keratella americana*, *Lecane prolecta*, *Ploesoma lenticulare*, *Polyarthra vulgaris*, *Bosmina tubicen*, *Bosminopsis deitersi*, *Diaphanosoma birgei* et *Moina minuta*. Les copépodes sont essentiellement représentés par des nauplii. A basses eaux, les rotifères constituent le groupe le plus abondant (49 org/l en moyenne), suivi par les cladocères (2.8 org/l en moyenne) et les copépodes (1.5 org/l). A hautes eaux, les rotifères chutent à 3.5 org/l en moyenne, suivis par les copépodes (moyenne : 3.4 org/l) et les cladocères (1.2 org/l). La densité moyenne du zooplancton est diminuée d'un facteur 8 à hautes eaux. Longitudinalement, à basses eaux, l'abondance du zooplancton semble être influencée par les eaux des tributaires. A hautes eaux, les densités sont généralement faibles jusqu'au Delta où l'on observe un accroissement longitudinal. Une forte proportion de cladocères ovigères, principalement *B. tubicen*, *B. deitersi* et *M. minuta*, observés à basses eaux tout au long des sites échantillonnés, semble indiquer que ces populations peuvent se reproduire et se développer dans le fleuve.

Introduction

Hynes (1970) and Welcomme (1985) have pointed out the scarcity of zooplankton studies from tropical rivers. The study of these communities from Venezuelan rivers of the Orinoco Basin has recently received much attention. This interest stems from

the fact that these rivers are, in most cases, tropical watercourses with no or scarce human intervention. Similarly, the study of zooplankton from these rivers offers the opportunity to study the interactions established between the watercourses and their floodplains.

The first study which included analysis of zooplankton collected in the Orinoco floodplain was that of Hauer (1956). More recent studies include those of Vásquez & Sánchez (1984) who studied plankton from the Lower Orinoco and an adjacent floodplain

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lake and Saunders & Lewis (1989) who carried out an extensive study of zooplankton from the Lower Orinoco and some tributaries. Vázquez (1984 a) and Rey & Vázquez (1986 a) carried out taxonomic studies of rotifers and cladocerans from the Lower Orinoco and some of its tributaries and floodplain lakes. Dussart (1984) studied copepods from different lotic and lentic habitats of the basin.

Zooplankton from the major tributaries of the Orinoco has been studied by Vázquez (1984 b) (Caroni River), and Saunders & Lewis (1988 a, b), (Caura and Apure rivers). Other minor tributaries were studied by Sánchez & al. (1985). Information generated so far has been valuable to establish seasonal patterns of abundance, composition and biomass. This information may also be of value to establish comparisons with other neotropical floodplain rivers such as the Amazon and the Paraná where river zooplankton is well documented (José de Paggi 1978, 1983, Robertson & Hardy 1984).

The present study was carried out to survey the longitudinal abundance and composition of zooplankton along the mainstream of the Orinoco River, margins of the river channel and some of the Orinoco distributaries in the Delta region.

1. Study Area

The Orinoco Basin drains a surface of $1.1 \times 10^6 \text{ km}^2$ shared by Venezuela (70 %) and Colombia (30 %) (Fig. 1). From the north and west, the Orinoco receives the waters of rivers draining the Venezuelan and Colombian Andes as well as the alluvial plains of the Llanos located between the Andes and the Guayana Shield. Rivers draining from this portion of the watershed contribute the greatest quantity of sediments transported by the Orinoco for which they are usually referred to as whitewater rivers. They also present high amounts of electrolytes (Meade et al 1983). From the south, the Orinoco receives primarily blackwaters of rivers draining the Guayana Shield which consists of lithologically complex Precambrian rocks (Gibbs & Barron 1983). Blackwaters are characterized by a very low content of nutrients and dark color caused by a high content of dissolved organic matter. Electrolyte content may also be low (Vegas-Vilarrubia et al 1988). This group of blackwater rivers includes the most important watercourses of the basin with regard to length and average annual discharge. Within this group the Caroni constitutes the only major river regulated in the watershed.

Worldwide the Orinoco ranks third in terms of average water discharge ($36\,000 \text{ m}^3/\text{s}$) and its suspended load has been estimated at $200 \times 10^6 \text{ tons/year}$ (Meade et al. 1983). 73 % of the Orinoco flow reaching its mouth originates from the basin above the Apure River. This river

contributes 7 % of the Orinoco flow while the Caura and Caroni rivers contribute 9 % and 11 % respectively (Lewis 1988). Over most of its 2 060 km length the Orinoco flows through lowlands forming a braided course with banks and islands. In the lower Orinoco slope is weak, water velocity is slow (1-2 m/s) and flow is high (M.A.R.N.R. 1979).

The hydrological regime of the basin belongs to the contrasted type with a high water phase extending from May to November. Minimum water level generally occurs in late April or early May (Fig. 2). The narrow fringing floodplain of the Orinoco presents numerous temporary and permanent floodplain lakes of various sizes and shapes (Vázquez 1988).

The Orinoco Delta is situated between the northern coastal range of Venezuela and the Guayana Shield margin to the south, with an expanse of some $22\,500 \text{ km}^2$. The deltaic plain is formed by very low lands (slope < 1 % and elevation a.s.l. < 10 m). This region is drained by 9 major distributaries and many interconnecting smaller canals, all of which are locally known as « caños », resulting in numerous islands and temporary and permanent lakes (van Andel 1967, M.A.R.N.R. 1979). Measured from the apex of the Delta the major caños are: Río Grande (270 km), Macareo (211 km), and Mánamo (236 km). As a distributary the Río Grande discharges 84 % of the Orinoco flow. Van Andel (1967) considers that tidal range in the Delta is relatively small compared to differences between high and low waters of the river. At high water the Delta is almost completely flooded. Wilbert (1986) divided the Orinoco Delta into a prelittoral zone, covering the region near the apex with a mean elevation of 3-4 m.a.s.l.; a littoral zone (10-30 km wide) which comprises a coastal strip of mangrove forest, palm forest, and savannas permanently flooded by tidal waters; and an intermediate zone, wedged between the previous two and under the influence of the tides.

2. Methods

Zooplankton samples were collected at high water (18-26 September 1985) and low water (3-10 April 1986).

— At high water, collections were made at 21 sampling sites (Fig. 1), within an approximate stretch of 900 km.

— At low water, samples were collected in 14 sampling sites within a stretch of some 750 km.

In 9 of these sites located between Samariapo and the apex of the Delta, collections were made in the middle of the river and in its two shores. In the Delta, collections were taken only in the middle (Table I). At each site, 80 liters of subsurface water was collected and filtered through a $45 \mu\text{m}$ mesh net. For rotifers and copepods 5 ml subsamples were examined; they generally allowed the identification of at least 100 of the most abundant taxa. In cases of low density the entire sample was examined. However, for cladocerans, the entire sample was always counted. Rotifers and crustaceans demanding detailed taxonomic studies were mounted in polyvinyl alcohol and glycerine alcohol, respectively.

Fig. 1. The Orinoco River Basin and location of sampling sites.

Table 1. Number and name of sampling sites and number of samples collected.

LOCATION	SITE NUMBER	Shore a	Middle	Shore c
ORINOCO RIVER				
Samariapo	1	*	*	*
Puerto Ayacucho	2	*	*	*
El Burro	3	*	*	*
Caicara	4	*	*	*
Las Bonitas	5	*	*	*
Las Majadas	6	*	*	*
Ciudad Bolívar	7	*	*	*
San Félix	8	*	*	*
Barrancas	9	*	*	*
ORINOCO DELTA				
Caño Macareo	10-14		*	
Rio Grande	15-18		*	
Caño Nabasanuca	19		*	
Caño Orejana	20-21		*

Fig. 2. Stage height in the Orinoco River (Angostura), (1985-1987).

3. Results and Discussion

3.1. Zooplankton composition

In this paper, copepods are considered as a whole. The inventory of rotifers and cladocerans are reported in Table II.

100 rotifer taxa were identified out of which 25 % belong to the genus *Brachionus*, 22 % to *Lecane*, and 15 % to *Trichocerca*. Over 50 % of the identified organisms were planktonic or semiplanktonic species. 13 rotifer species are new records for Venezuela. The record and description of *B. variabilis* was published elsewhere (Vásquez & Koste 1988). Other new brachionids for the country include *B. bidentata bidentata*, *B. caudatus vulgaris*, and *B. diversicornis diversicornis*. *Lecane lunaris perplexa* was firstly recorded in South America by José de Paggi & Koste (1988) in the Saladillo River Basin. The presence of this species in the Orinoco supports the observations of these authors who consider that the Paraná River carries southwards fauna of tropical or subtropical origin therefore extending the Guyana-Brazilian subregion further to the south. *Lecane amazoniana* had previously been recorded

from Brazil, Paraguay, and Argentina (José de Paggi & Koste 1988). *Ploesoma lenticulare*, an abundant species in our samples, was previously found in South America in Brazil and Argentina (Hauer 1965, Paggi & José de Paggi 1973).

Concerning cladocerans 48 taxa were identified : 45.8 % were Chydoridae, 16.7 % Sididae, 12.5 % Daphniidae, 10.4 % Bosminidae, 8.3 % Macrothricidae, and 6.3 % Moinidae. The number of cladocerans found in the Orinoco was higher than that reported for the Paraná (José de Paggi 1980) as well as for African rivers such as the Sokoto (Green 1962), the Oshun (Egborge 1972) and the Warri (Egborge 1987).

Among cladocerans, *Bosminopsis brandorffi* (a new species described by Rey et Vásquez 1989) collected from the Nhamundá River in the Amazon (Brandorff et al. 1982), was present in many sampling sites of the Orinoco. *Diaphanosoma volzi*, a rare form, only reported from Thailand, China, Australia (Korovchinsky 1981) was observed at site 1, at low water. *Diaphanosoma polyspina* (from Amazon Basin) was again recorded in the Orinoco. *Bosminopsis negrensis* was observed at high water from samples collected at site 3 (El Burro). Described by

ROTIFERA

<i>Anuraeopsis fissa fissa</i>	<i>Lecane amazoniana</i>
<i>Anuraeopsis navicula navicula</i>	<i>Lecane bulla bulla</i>
<i>Asplanchna brightwelli</i>	<i>Lecane bulla styrax</i>
<i>Asplanchna sieboldi</i>	<i>Lecane cornuta cornuta</i>
<i>Bdelloidea ind.</i>	<i>Lecane curvicornis curvicornis</i>
<i>Brachionus angularis pseudolabratus</i>	<i>Lecane hastata</i>
<i>Brachionus bidentata</i>	<i>Lecane hornemanni</i>
<i>Brachionus budapestinensis</i>	<i>Lecane leontina leontina</i>
<i>Brachionus calyciflorus f. amphiceros</i>	<i>Lecane levistyla levistyla</i>
<i>Brachionus calyciflorus calyciflorus</i>	<i>Lecane ludwigi ludwigi</i>
<i>Brachionus caudatus austrogerinitus</i>	<i>Lecane luna luna</i>
<i>Brachionus caudatus caudatus</i>	<i>Lecane lunaris lunaris</i>
<i>Brachionus caudatus f. insuetus</i>	<i>Lecane lunaris perplexa</i>
<i>Brachionus caudatus f. personatus</i>	<i>Lecane melini</i>
<i>Brachionus caudatus vulgatus</i>	<i>Lecane papuana</i>
<i>Brachionus diversicornis diversicornis</i>	<i>Lecane proietta</i>
<i>Brachionus dolabratus</i>	<i>Lecane rhenana</i>
<i>Brachionus falcatus falcatus</i>	<i>Lecane signifera ploenensis</i>
<i>Brachionus forficula</i>	<i>Lecane stichaea stichaea</i>
<i>Brachionus gessneri</i>	<i>Lecane unguolata unguolata</i>
<i>Brachionus gillardi</i>	<i>Lepadella patella f. oblonga</i>
<i>Brachionus havanensis</i>	<i>Lepadella patella patella</i>
<i>Brachionus mirus f. angustus</i>	<i>Macrochaetus collinsi collinsi</i>
<i>Brachionus patulus macracanthus</i>	<i>Monommata sp.</i>
<i>Brachionus patulus patulus</i>	<i>Mytilina ventralis macracantha</i>
<i>Brachionus quadridentatus quadridentatus</i>	<i>Platylas quadricornis quadricornis</i>
<i>Brachionus rubens</i>	<i>Ploesoma lenticulare</i>
<i>Brachionus urceolaris urceolaris</i>	<i>Polyarthra remata</i>
<i>Brachionus variabilis</i>	<i>Polyarthra vulgaris vulgaris</i>
<i>Brachionus voighti</i>	<i>Ptygura sp.</i>
<i>Cephalodella mucronata</i>	<i>Synchaeta sp.</i>
<i>Collotheca sp.</i>	<i>Testudinella mucronata hauerensis</i>
<i>Collotheca campanulata campanulata</i>	<i>Testudinella ohlei ohlei</i>
<i>Colurella sp.</i>	<i>Testudinella patina dendradena</i>
<i>Conochilus dossuarius dossuarius</i>	<i>Testudinella patina patina</i>
<i>Epiphanes macrourus</i>	<i>Testudinella tridentata amazonica</i>
<i>Euchlanis dilatata dilatata</i>	<i>Trichocerca sp.</i>
<i>Euchlanis meneta</i>	<i>Trichocerca bicristata bicristata</i>
<i>Filinia longiseta limnetica</i>	<i>Trichocerca capucina capucina</i>
<i>Filinia longiseta longiseta</i>	<i>Trichocerca chattoni</i>
<i>Filinia opoliensis</i>	<i>Trichocerca elongata elongata</i>
<i>Filinia pejeri pejeri</i>	<i>Trichocerca flagellata</i>
<i>Hexarthra intermedia brasiliensis</i>	<i>Trichocerca gracilis</i>
<i>Hexarthra intermedia intermedia</i>	<i>Trichocerca inermis</i>
<i>Keratella americana</i>	<i>Trichocerca pusilla</i>
<i>Keratella cochlearis cochlearis</i>	<i>Trichocerca ruttneri</i>
<i>Keratella lenzi lenzi</i>	<i>Trichocerca similis grandis</i>
<i>Keratella tropica tropica</i>	<i>Trichocerca similis similis</i>
<i>Lecane sp.</i>	<i>Trichocerca stylata</i>
<i>Lecane aegana</i>	<i>Trichotria tetractis tetractis</i>

Table II. (suite)

CLADOCERA

<i>Alona</i> sp.	<i>Diaphanosoma birgei</i>
<i>Alona eximia</i>	<i>Diaphanosoma brevireme</i>
<i>Alona guttata</i>	<i>Diaphanosoma polyspina</i>
<i>Alona monacantha</i>	<i>Diaphanosoma spinulosum</i>
<i>Alona poppei</i>	<i>Diaphanosoma volzi</i>
<i>Alona quadrangularis</i>	<i>Disparalona dadayi</i>
<i>Alona rustica</i>	<i>Echinisca</i> sp.
<i>Biapertura</i> sp.	<i>Echinisca triserialis</i>
<i>Biapertura intermedia</i>	<i>Ephemeroporus hybridus</i>
<i>Biapertura verrucosa</i>	<i>Ephemeroporus tridentatus</i>
<i>Bosmina hagmanni</i>	<i>Euryalona occidentalis</i>
<i>Bosmina t. bicen</i>	<i>Graptoleberis testudinaria</i>
<i>Bosminopsis brandorffii</i> n.sp.	<i>Ilyocryptus spinifer</i>
<i>Bosminopsis deitersi</i>	<i>Latonopsis australis</i>
<i>Bosminopsis negrensis</i>	<i>Macrothrix spinosa</i>
<i>Camplocercus</i> sp.	<i>Moina micrura</i>
<i>Ceriodaphnia cornuta</i>	<i>Moina minuta</i>
<i>Chydorus</i> sp.	<i>Moina reticulata</i>
<i>Chydorus eurynotus</i>	<i>Notoalona globulosa</i>
<i>Chydorus nitidulus</i>	<i>Oxyurella</i> sp.
<i>Daphnia gessneri</i>	<i>Pseudosida bidentata</i>
<i>Dadaya macrops</i>	<i>Scapholeberis</i> sp.
<i>Diaphanosoma</i> sp.1	<i>Scapholeberis kingi</i>
<i>Diaphanosoma</i> sp.2	<i>Simoccephalus serrulatus</i>

Brandorff (1976) from material collected in the Amazon, *B. negrensis* was firstly recorded for Venezuela by F. Weibezahn (pers. comm.). E. Zoppi de Roa (pers. comm.) has collected but not reported *B. negrensis* from the mouth of the Atabapo River, a blackwater tributary of the Orinoco. Based upon the previous findings, the distribution range of the species is enlarged to include the Orinoco Basin to the Amazon (Weibezahn et al, in press).

Interesting to note in the samples was the presence of *Daphnia gessneri* observed at site 2 (Puerto Ayacucho) at low water (density 0.01 org./l). This species had been reported for reservoirs in the Caroni River (Infante 1984, Rey & Vásquez 1986 a) and this was the first time that it was observed in the Orinoco waters. In contrast with the Amazon where this species is frequent and sometimes abundant in reservoirs and floodplain lakes (Arcifa 1984,

Robertson & Hardy 1984), in the Orinoco system *D. gessneri* is rare and scarce.

Mean rotifer species richness (Fig. 3) was 7.2 at high water and increased to 22.9 at low water. Mean number of cladoceran species was 4.2 and 5.4 at high and low water respectively (Fig. 4).

Longitudinally, rotifer species richness at high water was higher in the Delta than in the Orinoco. At low water, the number of species was relatively similar along the sites. Number of species of cladocerans at both high and low water, was highest in the river.

3.2. Overall zooplankton density

— At high water, mean zooplankton density (Fig. 5 a) was 5.6 org./l along shore a, 2.1 org./l along shore c. Mean density in the middle of the river and in Caño Macareo was 12.6 org./l.

Fig. 3. Rotifer species richness at high water (a) and low water (b).

Fig. 4. Cladoceran species richness at high water (a) and low water (b).

Fig. 5. Zooplankton density at high water (a) and low water (b).

— At low water, zooplankton density showed a marked increase with a mean of 59.1 org./l along shore a, 56.9 along shore c and 47.5 along the middle sites (Fig. 5 b): a mean density eight time higher than at high water.

An inverse relationship between discharge and plankton density in the Orinoco had previously been reported (Vásquez & Sánchez 1984, Saunders & Lewis 1989). The results also indicate that, particularly at low water, densities along the shores were not markedly different from middle sites in spite of the fact that these riverine sites may present more favorable conditions for zooplankton growth. A similar observation was reported by José de Paggi (1980,

1981) who pointed out a fairly homogeneous horizontal distribution of zooplankton in the Paraná River and in some of its tributaries.

Considering each zooplankton group separately, at high water, rotifer abundance showed a mean of 3.5 org./l (43.1 %) followed by copepods (mean 3.4 org./l; 41.8 %) and cladocerans (1.2 org./l; 15.1 %) (Fig. 6 a). At low water rotifers were by far the most abundant zooplankton group with a mean density of 49 org./l (92 %) followed by cladocerans (2.8 org./l; 5.2 %), and copepods (1.5 org./l; 2.8 %) (Fig. 6 b). At both high and low water, copepod abundance was primarily due to nauplii stages.

Fig. 6. Relative density of copepods, cladocerans and rotifers at high water (a) and low water (b).

3.3. Longitudinal patterns of density

a) Overall zooplankton

— At high water (Fig. 5 a), at all river sites, the longitudinal distribution of zooplankton did not show a defined pattern of abundance. The density of organisms was low except in site 5 (shore a) where a high density was observed (mainly cladocerans such as *Bosminopsis deitersi*, *Bosmina hagdmani*,

Ceriodaphnia cornuta, many Chydoridae, and insect larvae). On the contrary in the Delta region, the zooplankton density was higher than that observed in the Orinoco, with a marked tendency to increase along the distributaries, probably due to organisms flushed from the vast flooded areas to the caños. In this period, zooplankton groups showed oscillations in their relative densities along the water-courses. Rotifers, however, were more abundant in most of

the sites except in site 5 where, as mentioned, cladocerans prevailed the other groups, and in sites 11, 19, 20, 21 in the Delta, where copepods (nauplii) represent 70 % to 90 % of the zooplankton (Fig. 6 a).

In this period appeared also drifting organisms such as insect larvae, nematodes, and others, very scarce at low water, and which were present in the samples as the result of being flushed into the mainstream flow from the river bottom and other floodplain areas.

— At low water (Fig. 5 b), zooplankton abundance along shore a and in the middle of the river increased longitudinally in the stretch between sites 1-5 and then decreased up to the apex of the Delta (site 9). In Cano Macareo (sites 10-14) there was a slight oscillating increase in abundance without a clear pattern. Decrease in abundance observed at sites 6 and 8 was probably due to the dilution effect produced by the blackwaters of the Caura and Caroni Rivers. In both these rivers, zooplankton abundances are comparatively much lower than in the Orinoco (Vásquez 1984 b, Saunders & Lewis 1988 a). Along shore c, abundance decreased between sites 1-3 and then increased probably because of the relatively higher suspended load transported by the Meta River. The lowest transparency (25 cm) of all studied sites was observed at the mouth of this river.

During this period, rotifers made up the most important group of zooplankton along the watercourses, exhibiting relative abundances between 81.8 % and 97 % (Fig. 6 b). Copepods, scarce between sites 1-6, then showed a slight increase.

b) Dominant species of zooplankton

In spite of the high number of identified species of rotifers and cladocerans, only 9 taxa of rotifers and 7 species of cladocerans showed at high water densities equal or higher than 10 % (Tables III, IV). Similar observations have been reported for Amazon waterbodies where, despite a large number of rotifer species, few are numerically dominant (Robertson & Hardy 1984). At low water the number of dominant rotifer taxa increased to 14 and that of cladocerans to 8. In all cases, however, both groups showed a predominance of planktonic or semiplanktonic species among the dominants.

At high water the most frequent dominant rotifer species was *Conochilus dossuarius* followed by *Keratella americana* and *Polyarthra vulgaris*. In this

period, dominant bdelloid rotifers showed a certain frequency along the first sites. With regard to cladocerans, the following succession of frequent dominant species was observed : *Moina reticulata* (sites 1-2), *Bosminopsis deitersi* (sites 3-9), and *Bosmina tubicen* (sites 15-21). The rest of dominant cladocerans were present primarily in the Delta.

At low water, dominant rotifer species frequent along the studied section were *K. americana* and *Lecane prolecta*. Dominant *Brachionus falcatus*, *C. dossuarius* and *P. vulgaris* were frequent between sites 1-3, while *Ploesoma lenticulare* was frequent between sites 3-6. At this period, *B. deitersi* and *Moina minuta* were dominant and frequent among the cladocerans up to site 6 from where they were replaced by *B. tubicen*.

Rey & Vásquez (1986 a) characterized whitewater bodies by the species association *M. minuta*, *C. cornuta*, *B. tubicen* and *B. deitersi*. Dominant cladoceran assemblage in the Orinoco was similar to the previous characterization. Some of these species or related ones are also dominant in the potamoplankton of others tropical rivers : South America (José de Paggi 1980 and 1981, Robertson & Hardy 1984), Sri Lanka (Fernando 1980).

The presence of a typical freshwater zooplankton assemblage in sites of the Delta under the influence of tides can be explained by the fact that our samples were collected superficially. At high water, relatively little mixture of fresh and marine waters occurs superficially up to a distance of some 70 km off the Delta coast. At low water, this limit recedes to some 50 km off the coast. For instance, in May 1987, during the rising-water phase, superficial salinity at 50 km offshore was 0.2 ‰ (J. Monente, pers. comm.). Egborge (1987) found in the Warri River a limit of salinity for cladocerans below 0.25 ‰, which is a limit that may be found superficially along the coast of the Orinoco Delta.

Among the dominant cladocerans in the Orinoco, a high proportion of egg carrying females was observed at low water along the sampling sites (Table V a) which suggests that these species may be able to grow and reproduce along the river. This was particularly the case for *B. tubicen*, *B. deitersi*, and *M. minuta*. At high water a large set of egg carrying females was observed mainly restricted to site 5 where cladocerans were abundant (Table V b). In the

Table V. Percentage of egg carrying cladocerans ; a : at low water ; b : at high water (dominant species).

	1	2	3	4	5	6	7	12	14	15	16	17	19
<u>B. hagdmani</u>					25.0								
<u>B. tubicen</u>					27.0				19.0	24.0	31.0	12.5	
<u>B. deitersi</u>			27.3		35.0	25.5	22.0						
<u>C. cornuta</u>					14.0								
<u>D. birgei</u>									100	19.0	19.0	21.0	
<u>D. polyspina</u>				98.0	6.7			100					
<u>M. minuta</u>					14.3		100						25.0
<u>M. reticulata</u>	17.3	7.1											

(b)

	1	2	3	4	5	6	7	8	9	10	12	13
<u>B. hagdmani</u>					9.1		16.7					
<u>B. tubicen</u>	66.7	50.0	58.3	25.0	33.3	18.8	20.0	21.9	13.6	12.8	18.5	11.0
<u>B. deitersi</u>	48.3	9.2	27.8	26.5	27.7	55.3	19.2					
<u>C. cornuta</u>	14.3			23.7	8.8	12.2						
<u>D. birgei</u>	9.9		20.0		11.3	9.1		14.5	9.3			
<u>D. spinulosum</u>		52.0										
<u>M. minuta</u>	39.7	17.2	10.5	24.7	28.0	23.8	20.0					
<u>M. reticulata</u>	9.1	56.0			7.9			8.5			40.0	

(a)

Table VI. Mean number of eggs in ovigerous females (dominant species).

<u>B. hagdmani</u>	3.6
<u>B. tubicen</u>	3.3
<u>B. deitersi</u>	2.8
<u>C. cornuta</u>	2.6
<u>D. birgei</u>	2.5
<u>D. polyspina</u>	2.7
<u>D. spinulosum</u>	2.0
<u>M. minuta</u>	2.5
<u>M. reticulata</u>	2.0

Delta a certain percentage of *B. tubicen* and *D. birgei* egg carrying females was also observed during the high water period.

Mean number of eggs carried by ovigerous females is included in Table VI. In general, number of eggs was low (mean : 2.6) with highest values for *B. hagdmani* and *B. tubicen*. This low fertility supports the observations previously noticed for populations of Bosminidae from the mouth of Amazone (Stingelin (1904) and from a floodplain lake of the Orinoco (Rey & Vásquez 1986 b).

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