Biodiversity And Spatial Distribution of Rotifera in a Shallow Hypereutrophic Tropical Lake (Cameroon)

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ABSTRACT

A qualitative study of the Rotifera fauna was carried out in the Municipal Lake of Yaoundé, a hypereutrophic shallow reservoir of urban zone of Cameroon (Central Africa) from November 1996 to December 1997. One hundred and thirty two (132) morphologically distinct species of Rotifera were recorded, indicating a higher specific diversity of this ecosystem comparatively to other African water bodies. Seventy-four (74) of these species were recorded for the first time in Cameroon. The most representative families were the Lecanidae (24 species and subspecies), the Brachionidae (15 species and subspecies), the Notommatidae (13 species), the Trichocercidae and the Colurellidae (respectively 11 and 10 species). The spectrum of recorded species typically characterizes eutrophic to hypereutrophic ecosystems. The analysis of variance (ANOVA) showed that there was a homogeneous distribution of Rotifera in the Municipal Lake of Yaounde.

Key words : Rotifera, biodiversity, hypereutrophic lake, spatial distribution, tropical zone.

RÉSUMÉ

Une étude qualitative de la faune rotiférienne d'un lac hypereutrophe peu profond en milieu urbain au Cameroun, le Lac Municipal de Yaoundé (Afrique Centrale) a été menée de novembre 1996 à décembre 1997. Cent trente-deux (132) morpho-espèces de rotifères ont été identifiées dans ce plan d'eau, ce qui indique une riche biodiversité spécifique de l'écosystème comparée aux autres plans d'eaux Africains. Soixante-quatorze (74) de ces espèces sont nouvelles pour la faune du Cameroun. Les familles les plus représentatives sont celles des Lecanidae (24 espèces et sous-espèces), des Brachionidae (15 espèces et sous-espèces), des Notommatidae (13 espèces), des Trichocercidae et des Colurellidae (respectivement 11 et 10 espèces). Les espèces récoltées sont caractéristiques des milieux eutrophes à hypereutrophes. L'analyse des variances (ANOVA) montre que la répartition des Rotifères dans le Lac Municipal de Yaoundé est homogène.

Mots clés : Rotifera, biodiversité, lac hypereutrophe, distribution spatial, zone tropicale.

INTRODUCTION

Rotifera are important organisms of freshwater bodies (De Beauchamp, 1965). They play a crucial role in the food web and can be considered as good indicators of water pollution and water quality (Sládecek, 1983; Nogrady *et al.*, 1993). Nogrady *et al.* (1993) showed that Rotifera could be used as a tool for lake management. As Cameroon is endowed with many natural fresh water bodies, it needs a comprehensive knowledge of its fresh water zooplankton communities, especially as concerns the Rotifera. Dussart (1980) and De Ridder (1986) indicated that in Africa, literature dealing with zooplankton is scanty. De Ridder (1986) added that many areas in Africa, particularly the western and the central parts, are *terra incognita* as far as Rotifera are concerned.

Concerning the Rotifera of Cameroon, notable contributions include the works of Green (1972, 1977), Green *et al.* (1973, 1974), Corbet *et al.* (1973), Chiambeng *et al.* (1991, 1994), Segers & Mertens (1997), Zébazé Togouet (2000) and Akum *et al.* (2001). Except Zébazé Togouet (2000) who reported a long-term

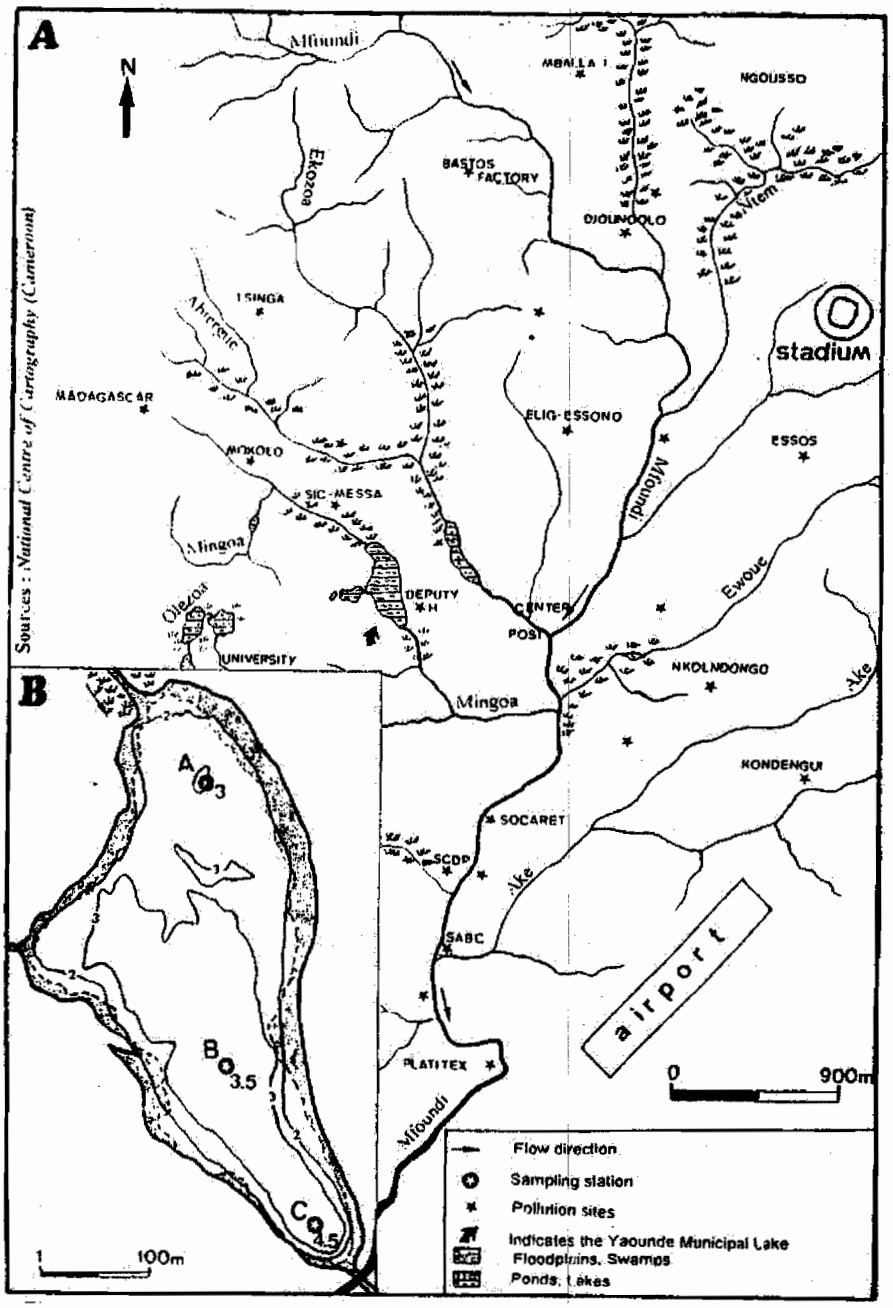

Fig. 1: Presentation of the study site, A– Hydrography of Yaounde showing Yaounde Municipal Lake, B – Yaounde Municipal Lake showing sampling sites and littoral zone

Table 1: Morphometric and hydrologic characteristics of the Yaounde Municipal Lake

Characteristics	*Values*
Altitude (m)	710,8
Total area (m^2)	$7,95 \times 10^4$
Area of open water. (m^2)	$6,5 \times 10^4$
Total volume (m^3)	$1,9 \times 10^5$
Maximal length (m)	576,5
Maximal length of open water (m)	538,5
Maximal width (m)	267,5
Maximal width of open water (m)	237
Maximal depth Zm (m)	4,3
Mean depth Z (m)	2,38
Relative depth Zr (m)	1,35
Ratio Z/Zm	0,55

study realized during fourteen months, most of these contributions are from colonial expeditions and short duration sampling.

The present study carried out in the Yaounde Municipal Lake was aimed at investigating in detail the species composition of the Rotifera fauna over 13 months.

MATERIAL AND METHODS

Site of study

The Yaounde Municipal Lake is a hypereutrophic reservoir (Kemka, 2000; Zébazé Togouet, 2000) elongated in the NW-SE direction. It is a result of a dam constructed in 1951 across a small river named Mingoa, which is one of the tributaries of the Mfoundi basin and situated in the heart of the town (Figure 1 A). Table 1 gives the morphometric and the hydrologic characteristics of this water body.

Sampling

Sampling was carried out weekly from November 1996 to December 1997 at 3 stations (A, B, C) in the pelagic area and one station in the littoral zone (considered as station D). These stations are presented in the Figure 1 B.

At each station of the pelagic zone, sampling was done throughout the water column at five depths (0 m, 0.5 m, 1 m, 1.5 m, 2.5 m, 3.5 m) using a dark 6 liters Van Dorn pvc bottle mounted horizontally (Kahl Scientific instrument Corporation, San Diego, USA). The water samples was sieved through a 40 µm mesh size sieve. At the littoral zone (station D), organisms were collected by hand shaking, scooping and squeezing vegetation in a bucket and sieved through a 64 µm mesh size plankton net. Each water sample was divided into two aliquots of about 200 ml each. The first part was preserved in a solution of 4% formalin by addition of 8.3 ml 100% formalin. The second part was immediatly brought to the laboratory unpreserved for living organisms observation.

In the laboratory, animals were sorted out under a Wild M5 stereomicroscope and identified using a Leitz orthoplan microscope. For some identifications, the examination of mastax was necessary. For this reason, mastax was isolated using NaOCl, following the procedures described by Sanoamuang (1993) and Segers (1995a). Identification was done on living organisms and confirmed using specimens mounted on slide in glycerin and covered with a cover slide using Canada balsam for microscopy. The references used for identification were those of Ruttner-Kolisko (1974), Koste (1978), Pourriot (1980), Koste & Shiel (1986, 1987, 1989a, 1989b, 1990a, 1990b, 1991), Shiel & Koste (1992, 1993), Nogrady *et al.* (1993), Segers (1994, 1995b), Nogrady *et al.* (1995) and Shiel (1995).

Drawing was done using a camera Lucida mounted on a Wild M20 microscope.

The Shannon & Weaver diversity index was calculated using the following formula $H = -\sum_{i=1}^{n} \frac{ni}{N} \log_2 \frac{ni}{N}$ while the similarity index of Sorensen between the stations was estimated using the following formula $S = \frac{2c}{a+b} \times 100$ were, ni = number of specimen of i species, a = number of species in one station, b = number of species in the other station, N = total number of specimen, and c = number of common species in the two stations.

Table 2 : List and frequencies of Rotifera species recorded in different stations

Sub classes	Orders	Families	Species	Frequency in % Stations A	B	C	Littoral zone (D)
Digononta Plate, 1889	Bdelloïdea Plates, 1889	Habrotrochidae Bryce, 1910	**1. *Habrotrocha angusticollis* Murray, 1907	0	0	0	1.72
			**2. *Habrotrocha tridens* Milne, 1886	1.72	0	0	1.72
		Philodinidae Bryce, 1910	**3. *Dissotrocha aculeata* Ehrenberg, 1832	0	0	0	3.50
			**4. *Macrotrachela sp*	0	0	0	5.17
			**5. *Philodina megalotrocha* Ehrenberg, 1832	1.72	0	0	8.77
			**6. *Philodina sp*	1.72	0	0	5.17
			**7. *Rotaria citrina* (Ehrenberg, 1832)	19.26	5.17	0	43.86
			**8. *Rotaria macrura* (Ehrenberg, 1832)	10.52	5.17	3.5	49.12
			9. *Rotaria neptuna* (Ehrenberg, 1832)	28.07	10.52	1.75	40.35
			***10. *Rotaria rotaria* (Pallas, 1766)	75.43	15.75	15.75	89.47
			**11. *Rotaria socialis* Kellicott	10.52	7.17	1.75	3.5
Monogononta Plate, 1889	Ploima Hudson et Gosse, 1886	Asplanchnidae Harring et Myers, 1926	12. *Asplanchna brightwelli* Gosse, 1853	1.72	0	0	1.75
			***13. *Asplanchna priodonta* Gosse, 1850	1.72	3.5	1.71	1.72
			**14. *Asplanchna sieboldi* Leydig, 1854	1.72	0	0	1.72
		Brachionidae Wesenberg – lund, 1899	* 15. *Anuraeopsis fissa* (Gosse, 1851)				
			**16. *Anureopsis navicula* Rousselet, 1910	100	100	100	100
			* 17. *Brachionus angularis* Gosse, 1851	0	0	0	3.50
			18. *Brachionus calyciflorus* Pallas, 1851	100	100	100	92.98
			***19. *Brachionus calyciflorus anuraeiformis* (Brehm, 1909)	32.75	27.58	29.31	37.93
			* 20. *Brachionus falcatus* Zacharias, 1898	1.72	0	0	5.17
			*** 21. *Brachionus leydigi* Cohn, 1862	87.93	89.65	89.65	72.41
			**22. *Brachionus leydigi rotundus* Rousselet, 1907	13.79	10.34	8.62	25.86
			23. *Brachionus quadridentatus* Hermann, 1783	4.17	0	0	6.89
			**24. *Brachionus sp.*	6.89	3.5	5.17	37.93
			* 25. *Keratella tropica* (Apstein, 1907)	0	0	1.72	3.5
			**26. *Notholca labis* (Gosse, 1887)	94.82	98.27	94.82	65.51
			27. *Plationus patulus* (.OF. Müller, 1786), Bryce, 1931	3.5	0	0	0
			**28. *Platyias leloupi* Gillard, 1957	1.72	1.72	1.72	22.41
			29. *Platyias quadricornis* (Ehrenberg, 1832), Bryce, 1931	1.72	0	0	25.86
		Colurellidae Bartos, 1959	30. *Colurella obtusa* (Gosse, 1886)	1.72	0	0	67.24
			31. *Colurella uncinata uncinata* (O.F. Müller, 1773)	0	0	0	3.5
			**32. *Colurellla uncinata bicuspida* Ehrenberg, 1832	0	0	0	25.86
			**33. *Lepadella ehrenbergi* Perty, 1850	0	0	0	3.5
			**34. *Lepadella heterostyla* Murray, 1913	0	0	1.75	10.35
			**35. *Lepadella latusinus* (Hilgendorf, 1899)	0	0	0	3..5
			**36. *Lepadella ovalis* (O.F. Müller, 1786), Bryce 1931	0	0	0	3.5
			37. *Lepadella patella* (O.F. Müller, 1786))	0	1.75	0	17.24
			**38. *Lepadella patella circleformis* Koste, 1978	0	5.17	3.5	62.00
			39. *Lepadella rhomboïdes* Gosse, 1886	0	0	0	8.62
			**40. *Squatinella mutica* Ehrenberg, 1832	0	0	3,44	8.62
		Dicranophoridae Remane, 1933	***41. *Dicranophorus caudatus* Ehrenberg, 1834	0	0	0	1.72
			**42. *Dicranophorus claviger* Hauer, 1965	25.86	1.72	0	12.06
			**43. *Dicranophorus grandis* (Ehrenberg, 1832)	0	0	0	3.50
			44. *Dicranophorus epicharis* Harring et Myers, 1928	3.5	0	0	15.51
			**45. *Dicranophorus robustus* Harring et Myers, 1928	1.72	0	0	6.89
			**46. *Dicranophorus sp.*	0	1.72	0	1.72
		Epiphanidae Bartos, 1959	**47. *Epiphanes clavulata* (Ehrenberg, 1832)	1.72	0	0	3.5
			*48. *Epiphanes macrourus* Barrois et Daday, 1894	0	0	0	3.5
			***49. *Cyrtonia sp.*	98.27	98.27	98.27	98.27
			**50. *Liliferotrocha subtilis* Rodewald, 1940	0	1.72	0	3.5
			**51. *Microcodides sp.*	1.72	0	0	1.72
		Euchlanidae Bartos, 1959	52. *Dipleuchlanis propatula* Gosse, 1886	0	0	0	1.72
			53. *Euchlanis dilatata* Ehrenberg, 1832	0	0	0	17.24
		Gastropodidae Remane, 1933	***54. *Ascomorpha saltans* Bartsh, 1870	0	0	1.72	1.72
		Ituridae Markevich, 1990	55. *Itura myersi Wulfert, 1935*	68.96	79.31	79.31	96.55
				0	0	0	1.72

Lecanidae Bartos, 1959	* 56. *Lecane bulla bulla* Gosse, 1886	86.20	75.86	86.20	79.31
	**57. *Lecane bulla diabolica* Hauer, 1936	17.24	17.24	17.24	22.41
	58. *Lecane closterocerca* Schmarda, 1859	12.06	6.89	3.5	56.89
	59. *Lecane curvicornis* Murray, 1930	22.41	6.89	3.5	3.5
	**60. *Lecane doryssa* Harring, 1914	1.72	0	0	3.5
	61. *Lecane elsa* Hauer, 1931	0	0	0	3.5
	62. *Lecane furcata* Murray, 1913	1.72	0	0	5.17
	63. *Lecane haliclysta* Harring et Myers, 1926	0	0	0	3.5
	64. *Lecane hamata* Stokes, 1896	22.41	13.79	20.68	32.75
	65. *Lecane inopinata* Harring et Myers, 1926	1.72	0	0	15.51
	66. *Lecane leontina* (Turner, 1892)	1.72	0	0	1.72
	67. *Lecane luna* (O.F. Müller, 1776)	0	0	0	3.5
	68. *Lecane lunaris* Ehrenberg, 1832	18.96	15.51	6.89	8.62
	69. *Lecane monostyla* (Daday, 1897)	0	0	0	3.5
	**70. *Lecane nana* Murray, 1913	0	0	0	1.72
	**71. *Lecane obtusa* Murray, 1913	0	0	0	3.5
	72. *Lecane papuana* Murray, 1913	0	0	0	12.06
	**73. *Lecane scutata* Harring et Myers, 1926	0	0	0	3..5
	**74. *Lecane sp.*	10.34	0	0	6.89
	75. *Lecane stichaea* (Harring, 1913)	0	0	0	1.72
	**76. *Lecane subtilis* (Harring, 1913)	0	0	0	1.72
	**77. *Lecane sympoda* Hauer, 1929	0	0	0	3.5
	**78. *Lecane thelera* (Harring et Myers, 1926)	0	0	0	3.5
	79. *Lecane undulata* Hauer, 1939	0	0	0	3.5
Mytilinidae Bartos, 1959	**80. *Mytilina bisulcata* (Luckcs, 1912)	36.20	5.17	0	5.17
	**81. *Mytilina mutica* Perty	12.06	0	0	5.17
	**82. *Mytilina sp.*	0	0	0	3.5
	**83. *Mytilina trigona* (Gosse, 1851)	48.4	13.79	5.17	8.62
	84. *Mytilina ventralis* (Ehrenberg, 1832)	1.72	3.5	0	22.41
Notommatidae Remane, 1933	**85. *Cephalodella böttgeri* Koste, 1988	0	0	0	3.60
	86. *Cephalodella gibba* (Ehrenberg, 1838)	1.72	0	0	1.72
	**87. *Cephalodella gigantica* Remane, 1933	0	0	0	3.5
	**88. *Cephalodella megalocephala* Glasscott, 1893	36.20	15.51	6.89	1.72
	**89. *Cephalodella physalis* Kuyers, 1924	0	0	0	3.5
	90. *Cephalodella sp.*	5.17	3.5	0	5.17
	**91. *Eothina elongata* (Ehrenberg, 1895)	0	0	0	3.5
	**92. *Metadiaschiza trigona* Rousselet, 1895	0	0	0	1.72
	**93. *Monommata grandis* Tessin, 1890	0	0	0	1.72
	**94. *Notommata cerberus* (Gosse, 1886)	0	0	0	8.62
	**95. *Notommata codonella* Harring et Myers, 1924	0	0	0	17.24
	**96. *Notommata cyrtopus* Gosse, 1886	0	0	0	6.89
	**97. *Notommata voigti* Donner, 1949	0	0	0	6.89
Praolidae Bartos, 1953	**98. *Proales decipiens* Ehrenberg, 1831	0	0	0	15.51
	**99. *Proales similis* De Beauchamp, 1908	0	0	0	10.34
Scaridiidae Manfredi, 1927	100. *Scaridium bostjani* Duems et Dumont, 1974	0	0	0	5.17
	101. *Scaridium longicaudum* (O.F. Müller, 1786)	0	0	0	5.17
Synchaetidae Remane, 1933	*102. *Polyarthra dolichoptera* Idelson, 1925	20.68	31.03	24.13	32.75
	*103. *Polyarthra vulgaris* Carlin, 1943	100	100	100	87.93
	104. *Synchaeta pectinata* Ehrenberg, 1832	0	1.72	1.72	3.5
Trichocercidae Remane, 1933	105. *Trichocerca bicristata* (Gosse, 1887)	36.2	50.00	34.48	15.51
	106. *Trichocerca dixonnutalli* Jennings, 1903	0	5.17	1.72	0
	*107. *Trichocerca elongata* (Gosse, 1886)	48.27	62.06	50.00	36.20
	**108. *Trichocerca insignis* (Herrick, 1885)	0	0	1.72	0
	109. *Trichocerca pusilla* (Lauterborn, 1895),Bryce, 1931	0	0	0	12.06
	**110. *Trichocerca rousseletti* (Voigt, 1901)	13.79	13.79	10.34	6.89
	***111. *Trichocerca stylata* (Gosse, 1851)	37.93	43.10	36.20	18.96
	112. *Trichocerca sp.*	1.72	0	1.72	6.89
	113. *Trichocerca tchadiensis* (Pourriot, 1968)	5.77	0	0	0
	114. *Trichocerca tenuior* (Gosse, 1886)	0	0	0	1.72
	115. *Trichocerca tigris* (O.F. Müller, 1786)	0	0	0	1.72
Trichotriidae Bartos, 1959	116. *Trichotria tetractis* (Ehrenberg, 1830)	1.72	0	0	1.72
Filiniidae Bory de St Vincent, 1824	117. *Filinia longiseta* (Ehrenberg, 1834)	0	0	0	3.5
	*118. *Filinia opoliensis* (Zacharias, 1898)	100	100	100	70.68
Flosculariidae Harring, 1913	**119. *Lacinularia flosculosa* (O.F. Müller, 1758)	5.17	0	0	3.5
	**120. *Ptygura* cf *melicerta* (Ehrenberg, 1832)	0	0	0	3.5
	**121. *Sinantherina sp.*	0	0	0	3.5
Hexarthridae Bartos, 1959	*122. *Hexarthra intermedia* Wisznienwski, 1929	84.48	89.65	86.20	50
	123. *Hexarthra mira* (Hudson, 1871)	17.24	0	0	13.79
Testudinellidae Bory de St Vincent, 1824	124. *Testudinella patina patina* Hermann, 1783	12.06	12.00	20.68	56.89
	**125. *Testudinella patina intermedia* Anderson, 1889	8.62	0	0	13.79
Collothecidae Bartos, 1959	**126. *Collotheca campanulata* (Dobie, 1849)	3.5	0	0	1.72
	**127. *Collotheca coroneta* (Cubitt, 1869)	13.79	1.72	0	12.07
	128. *Collotheca sp.*	29.31		1.72	5.17
	**129. *Collotheca trilobata* (Collins, 1872)	1.72	0	0	0
	**130. *Collotheca tenuilobata* (Anderson, 1889)	0	0	0	3.5
	**131. *Stephanoceros milšii* Kellicott, 1885	27.58	0	6.89	5.17
	**132. *Stephanoceros sp.*	5.77	0	0	1.72

N.B. : * represent pelagic species . **Species recorded for the first time in Cameroon. ***Pelagic species recorded for the first time in Cameroon

RESULTS

Species identified

The species of Rotifera identified are listed in Table 2. One hundred and thirty two (132) species and subspecies belonging to forty-five (45) genera and twenty-three families were recorded. The most representative of these organisms were:

(a) - Lecanidae accounted for 24 species and subspecies, all observed at the littoral zone. They represented 18% of the species and subspecies of the Municipal Lake of Yaounde. Three species: *Lecane bulla*, *L. hamata* and *L. inopinata* were tychoplanktonic.

(b) - Brachionidae were accounted for 15 species and subspecies (11.4%) and colonized all the biotopes from the littoral to pelagic zones. The species belonging to this family were the most abundant in terms of density. *Anuraeopsis fissa* and *Brachionus angularis,* for example, appeared at a frequency of 100 % in all the stations prospected (Table 2). Species such as *Brachionus falcatus* and *Keratella tropica* appeared at the 3 pelagic stations (A, B, C) at a frequency of more than 80%. In the littoral zone, they were observed at a frequency of 72.4% and 65.5% respectively.

(c) - Notommatidae were represented by 13 species belonging to 5 genera (about 10% of species recorded). Most of these species were littoral and periphytic.

(d) - Trichocercidae and Colurellidae were represented respectively by 11 and 10 species (8.3% and 7.5% of species recorded). Where as some species of Trichocercidae, as *T. elongata* and *T. bicristata,* were found in the pelagic zone, all the species of Colurellidae recorded were observed in the littoral and periphytic

Philodinidae

Rotaria neptuna was, in size, the biggest Bdelloïdea and was recognised by its long telescopic segmented foot. Its length varied from 700 to 1000 µm. The form observed was similar to the specimen reported in Lake Chad (Pourriot, 1968) and the other African lakes (Green, 1979) (Figure 2).

Rotaria rotaria was the commonest Bdelloïdea encountered. Its length varied from 500 to 800 µm. The species was long with a red eye on a short rostrum. The specimens resemble those described by Koste & Shiel (1986) in Australia. This species was recorded for the first time in Cameroon since previous authors did not mention it's presence in the samples assessed (Figure 3).

Two specimens of Bdelloïdea could not be identified at the species level. These were:

-*Macrotrachela sp.* Its size ranged from 350 to 450 µm. Only few specimens of this species were observed in the littoral zone (Table 2). It presented a 3-segmented foot not formed into pellets, with 3 toes and short and lateral spurs.

-*Philodina sp.* was rare and found in the littoral zone and in station A. The specimens of about 300 µm length presented a short rostrum and cerebral eye spots. The trunk was relatively wide. It's foot was 4-segmented with 4 toes. The specimen ressembled *Philodina citrina* described by Koste & Shiel (1986) in Australia but the spurs were not wide and coniform and the trunk was not yellow-greenish.

Asplanchnidae

Asplanchna sieboldi, which occurred concurrently with *A. brightwelli*, was distinguished by the absence of internal lamellae of the rami of trophi (Figure 4a) as well as by the number of the vittelogen nuclei around sixty (Figure 4b) (Gilbert *et al.*, 1979; Shiel, 1995)

Brachionidae

Anuraeopsis navicula, described for the first time in Cameroon, was thin and extended from 85 to 120 µm (35 to 50 µm wide) with some granulations localized at the anterior and posterior ends (Figure 5).

Brachionus leydigi, also recorded for the first time in Cameroon, was round in shape at the postero-lateral part. The stiff lorica was without ornamentation but had 6 sub-equal anterior minute spines (Figure 6). This species co-occured with the subspecies *B. leydigi rotundus* which measured 200 to 350 µm long and 148 to 290 µm wide.

Keratella tropica was present during the whole study period and has one posterior spine. The specimens were slightly similar to the ones observed by De Smet (1990) in the bas Zaïre (Congo Brazaville) and measured 105 to 150 µm long and 50 to 70 µm wide with a posterior spine of 50 µm (Figure 7).

Platyias leloupi (Figure 8) was big in size with a strong lorica that was generally without ornamentation. When

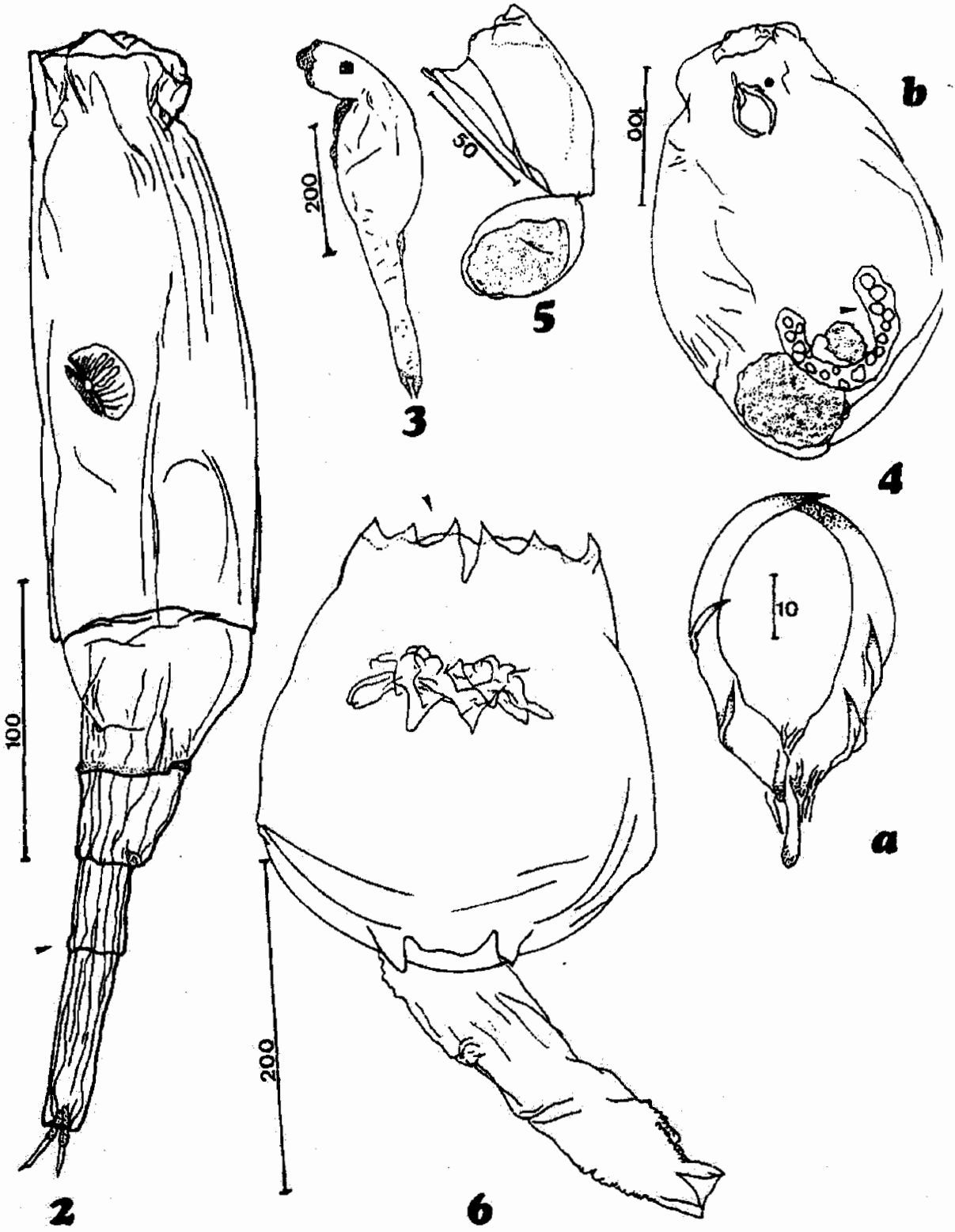

Fig.: 2 – Habitus of *Rotaria neptuna.*
Fig.: 3 – Habitus of *Rotaria rotaria.*
Fig.: 4 – *Asplanchna sieboldi*: **A** – Mastax, **B** – Habitus of specimen.
Fig.: 5 – Habitus of *Anuraeopsis navicula* with egg.
Fig.: 5 – Habitus of *Anuraeopsis navicula* with egg.

ornamentation was present, it did not show a special disposition.

Brachionus sp was very rare and elongated. It was similar to those described in Kenya by Segers *et al.* (1994).

Colurellidae

Lepadella erhenbergi had a rhombic with a triangular posterolateral margin lorica. Dorsally ridged spurs reflexed upward and smaller pointed triangular spurs were observed on each side of foot groove (Figure 9). It measured 75 µm long and 50 µm wide.

Lepadella heterostyla had a rhombic lorica distinguished from *L. erhenbergi* lorica by the lateral round-like wings (Figure 10). The tips were not deflected and the ventral lorica was wider than dorsal in the 1/2 anterior part of the specimen. Specimens observed were similar to those described by Koste & Shiel (1989b). It measured 60 to 70 µm long by 60 to 72 µm wide.

Dicranophoridae

Dicranophorus caudatus (Figure 11a) was the commonest species of this family. The specimens were subcylindric and showed a great polymorphism. Some individuals were elongated with long feet and toes, sometime as long as 1/2 of the total length. Other individuals were stout with small toes (Figure 11b).

Dicranophorus sp. (figure 12) was one of the biggest Rotifera encountered. It was elongated, subcylindric and robust with two wide and stout toes. It did not resemble any known *Dicranophorus* and was very scarce assessed samples. It measured 150 to 350 µm long and 90 to 120 µm wide.

Epiphanidae

Cyrtopus sp was thin, with a conical body arched in lateral view. The cilia of corona were long and the buccal area very large. It appeared in a small number of the littoral samples and just once in station B. The number of specimens did not allow for any reliable measurements to be made.

Microcodides sp. was conical with dorsal symetrical 2 or 3 oblic plications. It had a short foot ending with very short toes and a discret spur. Just like for *Cyrtopus sp*, the number of specimen did not allow reliable measurements to be made.

Lecanidae

Lecane inopinata (Figure 13a) was characterized by its stout lorica with irregular ornamentation. It resembled *L. sympoda* (Figure 13b) and its toes were distally fused from 40 to 45% of its length and ended with distinct claws. The specimens were similar to the ones recorded by Segers (1995b) and Akum *et al.* (2001), and were bigger than those reported by Pourriot (1996) in French Guyana. They measured 82 x 67 µm for the dorsal plate, 78 x 65 µm for the ventral plate and 35 µm for toes + claws.

Lecane closterocerca (Figure 14a, 14b and 14c) showed a great polymorphism throughout the study period and its description corresponds to that of Segers (1995b). The majority of polymorphs described by this author were observed. It measured 75 x 50 µm for the dorsal plate, 77 x 42 µm for the ventral plate and 45 µm for the toe.

Lecane sp. (Figure 15) was big and characterized by the semi-circular lorica shape. The dorsal plate (360 x 385 µm) was longer and wider than the ventral plate (350 x 320 µm). The toes were stiff, without claws and longer (355 µm) than the body length. This species was very rare in the sample examined.

Notommatidae

Cephalodella megalocephala had a medium body length and dorsally gibbous with a large head (Figure 16). The ciliary field was extremely oblique to vertical. The toes were long up to 1/3 of the total body length. This species was generally tychoplanktonic.

Monommata grandis although only present in the littoral zone, was stout with a less elongated spherical body. The specimen observed presented two unequal very long toes. The length of the toes was 2 to 2.5 times greater than the total body length (Figure 17).

Trichocercidae

Trichocerca stylata and particularly *T. elongata* were frequently encountered in the Yaounde Municipal Lake. They were present throughout the study period at all the stations surveyed. Their descriptions were similar to those of Shiel and Koste (1992). *T. elongata* (Figure 18a) measured 500 µm long, 40 to 50 µm wide while *T. stylata* (Figure 18c) measured 200 µm long and 60 µm wide.

Trichocerca sp. was very small (length 60 to 75 µm; width

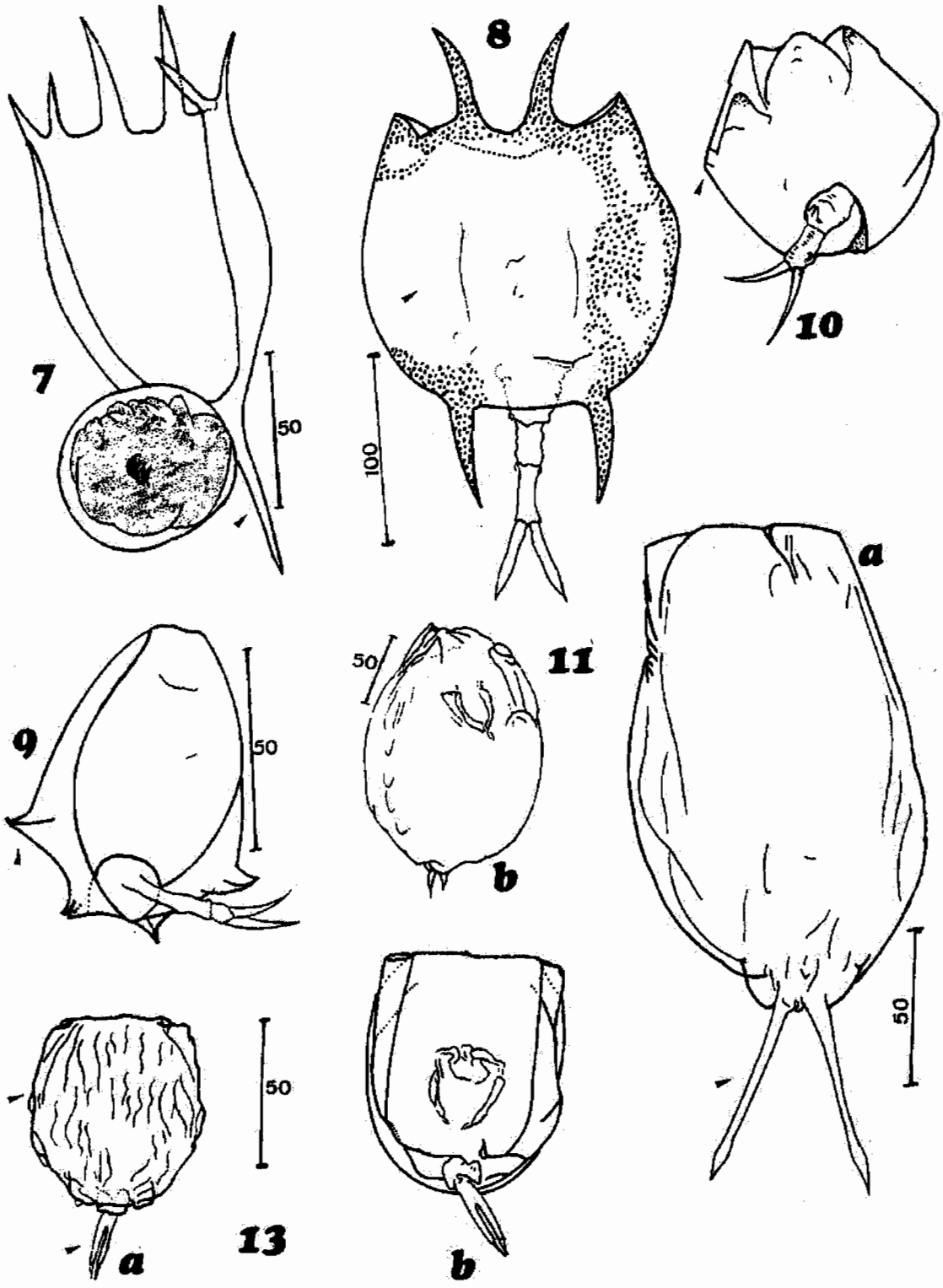

Fig.: 7 – Habitus of *Keratella tropica* with egg.
Fig.: 8 – Habitus of *Platyias leloupi* with the foot
Fig.: 9 – Habitus of *Lepadella erhenbergi* with the foot.
Fig.: 10 – Habitus of *Lepadella heterostyla* with the foot.
Fig.: 11 – Two polymorphs of fixed *Dicranophorus caudatus.*
Fig.: 13 – Genus *Lecane* : **A** – *Lecane inopinata*, **B** – *L. Sympoda.*

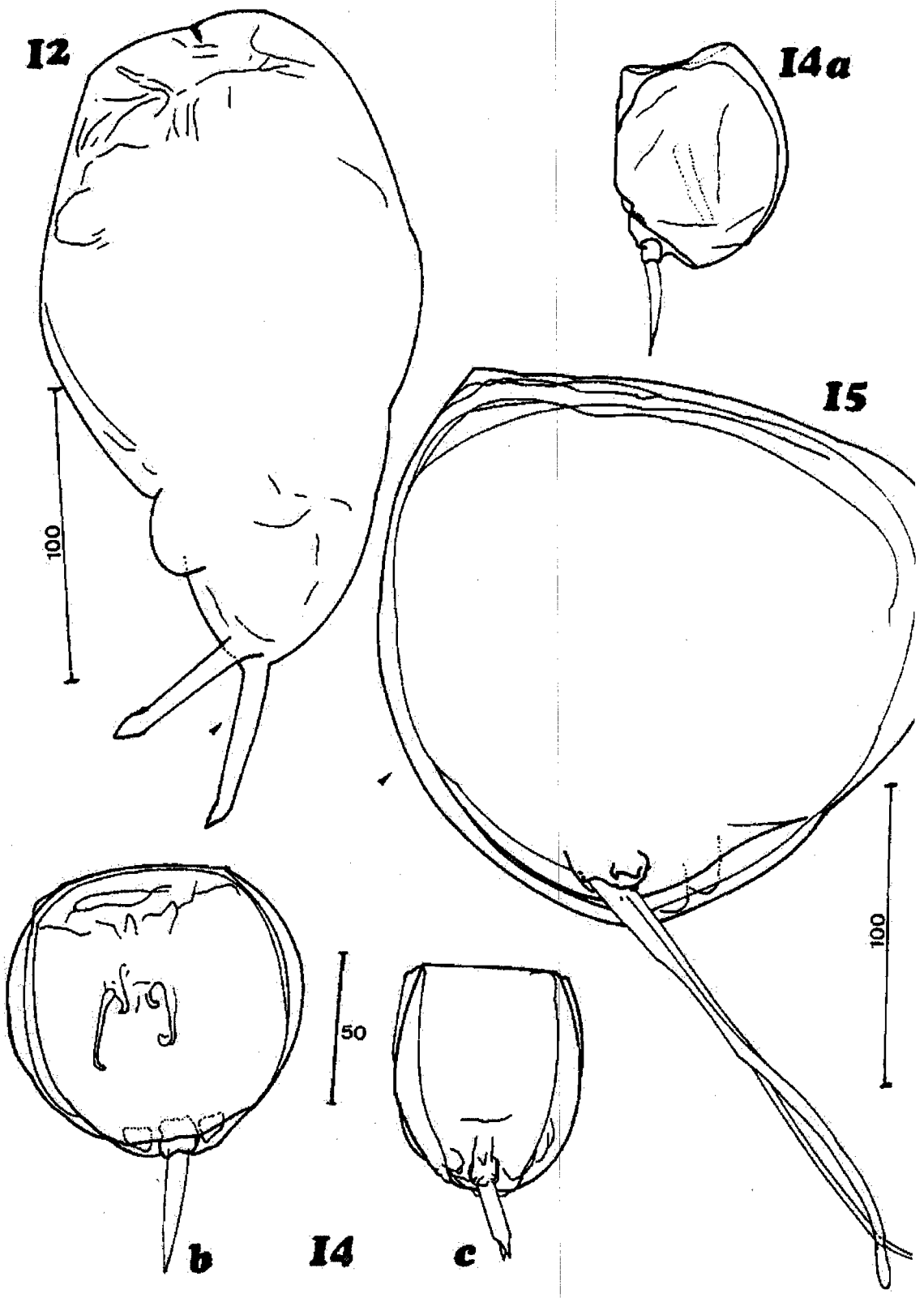

Fig.: 12 – Habitus of *Dicranophorus sp.*
Fig.: 14 – Some polymorphs of *Lecane closterocerca.*
Fig.: 15 – *Habitus of Lecane sp.*

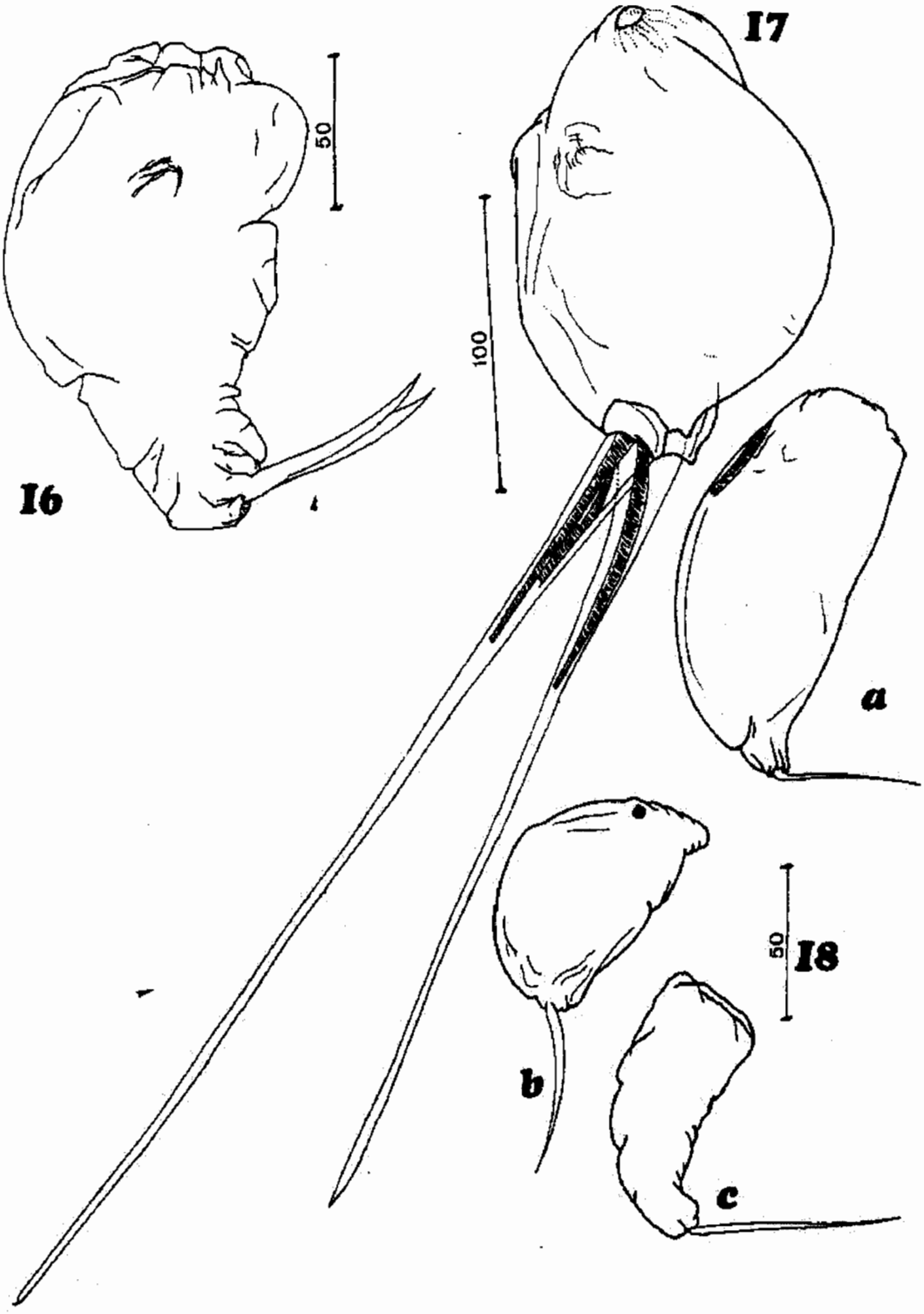

Fig.: 16 – Habitus of *Cephalodella megalocephala.*
Fig.: 17 – Habitus of *Monommata grandis.*
Fig. 18 – Habitus of *Trichocerca elongata* (**a**), *T. stylata* (**c**) and *T. pusilla* (**b**).

Table 3: Similarity indices of Sorensen between the stations (A, B, C, LITTORAL ZONE)

	A	B	C	LITTORAL Z.(D)
A		67.3	63	69
B			82	51.1
C				47

20 to 40) µm) with a long toe, mostly longer than the body length. The body, soft and subcylindric, has numerous folds on the contracted animal. A dorsal keel was not observed.

Collothecidae

Collotheca trilobata (Figure 19) was very long with total length ranging from 2000 to 3000 µm. The head was very large and the ciliary field trilobate in equal part and wide.

Concerning *Collotheca sp.* and *Stephanoceros sp.*, the specimens were soft and always contracted. Thus, it was difficult to specifically observed different characteristics.

Diversity and similarity indices

The variation of the diversity index of Shannon & Weaver is described in Figure 20 and the similarity index of Sorensen between the stations is shown in Table 3.

The values of the Shannon & Weaver index were generally high, varying from 1.5 to 2.5 bits /individual (Figure 20). The highest similarity index was observed between station B and station C while the lowest value was obtained between station C and the littoral zone (Table 3). The similarity index of Sorensen was generally higher than 60%.

DISCUSSION

A total of one hundred and thirty two (132) morphologically distinct species and subspecies of Rotifera belonging to twenty-three families was recorded in the sample analysed in the Yaounde Municipal Lake. The most representative family was the Lecanidae with 18% of species and subspecies recorded. Segers (1996) had previously reported this predominance of Lecanidae and their predilection for the littoral zone of a lentic ecosystem. The same observation has been made in many other African lakes (Green & Mengestou, 1991; Segers *et al.* 1993; Omondi, 2000). Akum *et al.* (2001) had recently made a similar observation on samples from the Korup national park of Cameroon. All the orders of Rotifera were represented in this water body, except that of Seisona.

The result obtained, indicate a rich biodiversity of Rotifera in the Municipal Lake of Yaounde. It confirms the suggestion of Segers & Mertens (1997) that, it is important to take in account small water bodies while doing routine plankton studies. The same observation was done concerning the number of families observed. The Municipal Lake of Yaounde which is situated in the heart of the town is hightly anthropic and hypereutrophic. This could explain the observed rich biodiversity recorded in this hydrosystem. De Ridder (1986) had argued that the number of Rotifera known from African countries is dependent on the number of papers or studies devoted to that country. In fact, she reported from a bibliographical work of 5 articles, that they were 13 species of Rotifera recorded in Cameroon in 1986. Chiambeng *et al.* (1991,1994) increased the recorded number of Rotifera in Cameroon respectively to 33 and 66 species. Segers & Mertens (1997) from a study of a pond in Korup National Park recorded 84 species, Zébazé Togouet (2000), in is work, recorded 132 species. At this level, the work of Akum *et al.* (2001) is difficult to analyze because these authors did not take into account the work of Sergers & Mertens (1997) in Korup National Park and the studies of Zébazé Togouet (2000) has done. For example, Akum *et al.* (2001) considered that 20 species were newly recorded for Cameroon but Zébazé Togouet (2000) realized that the previous authors already cited 14 of these 20 species. Contrary to De Ridder (1986), the result obtained in this study, is close to those of Segers & Mertens (1997) which clearly shows that, the number of papers is not the most important criterium to consider, but rather the number of continuous work with a short sampling frequency. In fact, 74 species have been recorded in the present study for the first time in Cameroon (Table 2). Most of the species reported and the most abundant were cosmopolitan, widely reported in tropical,

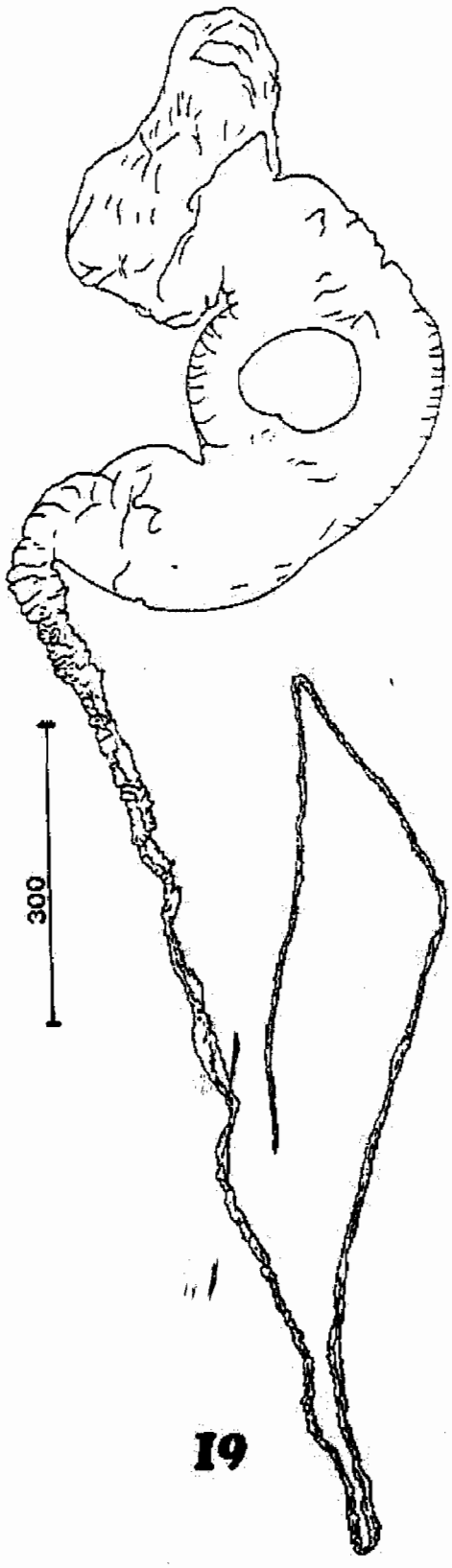

Fig. 19: Habitus of *Collotheca trilobata.*

pantropical and neotropical zones (Jose de Paggi & Koste, 1995). These species were encountered in the American tropical zone (Koste & Robertson, 1990; Rico Martinez & Briano, 1993; Jose de Paggi, 1996; Kuczynski, 1996; Pourriot, 1996; Segers *et al.*, 1998), in the Asian tropical zone (Fernando & Zankai, 1981; Segers & Pholpunthim, 1997), in Australian tropical zone (Shiel *et al.*, 1998), in African tropical zone (Akinbuwa & Adeniyi, 1991; Segers, 1992; Segers *et al.*, 1994) and specifically in Cameroon (Corbet *et al.*, 1973; Chiambeng *et al.*, 1991, 1994; Segers & Mertens, 1997; Akum *et al.*, 2001). This remark confirms the cosmopolitanism of the majority of species recorded.

The species recorded were characteristic of ponds, small man-made water bodies, reservoirs, swamps and wetlands. Koste (1986), Koste & Tobias (1987, 1988) and Akinbuwa & Adeniyi (1991) reporded many of these species in reservoirs of different continental waters. The results of the present study, are similar to the observations of Jose De Paggi (1993), Segers *et al.* (1993), Koste *et al.* (1995), Koste & Tobias (1998) and Shiel *et al.* (1998) who recorded the same species in wetlands, ponds and flood plains. Shiel *et al.* (1998) ascribed the biodiversity richness of these ecosystems to i) the small depth, ii) the continuous mixing of water, iii) the presence of a certain number of macrophytes, iv) the physico-chemical characteristics of water and v) the high number of habitats.

Following the list of species indicators of pollution compiled by Sladecek (1983), the spectrum of recorded species in the Yaounde Municipal Lake is typically eutrophic to hypereutrophic. This confirms the conclusion of Shiel *et al.* (1998) concerning floodplain biodiversity. Among these species, the most abundant were *Anuraeopsis fissa*, *Rotaria rotaria*, *Brachionus angularis*, *Keratella tropica*, *Epiphanes macrourus*, *Ascomorpha saltans*, *Lecane bulla bulla*, *L. hamata*, *Mytilina trigona*, *Polyarthra vulgaris*, *P. dolichoptera*, *Trichocerca elongata*, *T. stylata*, *Filinia opoliensis*, *Hexarthra mira* (Table 2). Pourriot (1980) and Nogrady *et al.* (1993), argued that these species are characteristic of polluted ecosystems i.e. they are eurytrophic species. Futhermore, the dominance of Brachionidae is a characteristic of a high eutrophication level as Zébazé Togouet *et al.* (2005) suggested. The consequence and the confirmation are given by the high values of the diversity indices of Shannon and Weaver (Figure 20).

Concerning the spatial distribution of Rotifera, the analysis of variance (ANOVA) showed that there was a homogeneous distribution of the Rotifera in the Municipal Lake of Yaounde. In fact, there was no significant difference between Rotifera population of the 4 stations prospected. Thus, the acute influence of the Mingoa river on the littoral zone may explain the very low value of the similarity indices of Sorensen observed between stations B, C and the littoral zone (Table 3). The consequence is that the littoral zone, which is closest to the Mingoa river has a high influence on station A. This influence is diluted in the whole lake ecosystem. The ecological action of the Mingoa River which is observable in the littoral zone and in station A

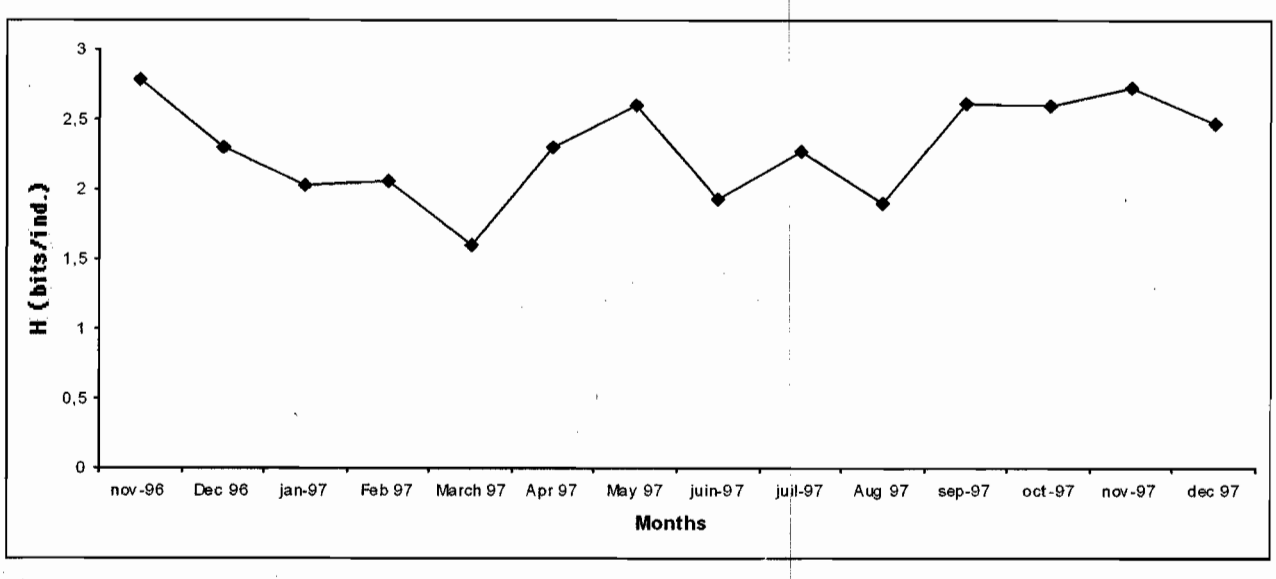

Fig. 20 : Variation of Shannon and Weaver indices of diversity of the Rotifera in Yaounde Municipal Lake

will appear in station C after a four months period. This is the time lapse required for the replacement of the population of Rotifera from stations A to station C. The fact that the river Mingoa is the major source of pollution of the Yaounde Municipal Lake, suggest that the result obtained could serve to built a sustainable strategy for the restoration and the effective management of this lake which has been a major recreation site in the city from 1953 to 1975.

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