Chapter 7
Zooplankton

Zooplankton community is an important trophic level both in grazing and nutrient regeneration of phytoplankton and as food for juvenile and adult fishes. The study of zooplankton distribution is also useful for the general monitoring of certain aspects of the environment such as hydrographic events, pollution, eutrophication, warming trends and long-term changes which are signs of environmental disturbance. Aboul-Ezz (1984) studied the monthly variation and community structure of zooplankton and benthos of Lake Burullus during late seventies. She mentioned that Copepoda group dominated the other taxa, forming 68.4% and 36.8% during 1978 and 1979, where it was represented by 44 and 34 species, respectively; 8 species of them were marine in origin. El-Sherif and Aboul-Ezz (1988) studied zooplankton-phytoplankton relationship in Lake Burullus, and stated that both zooplankton and phytoplankton had a linear relationship in the western sector, which harbored the highest standing stock of both. The consumption rate of phytoplankton by zooplankton was less pronounced, reflecting the eutrophic condition of the lake. Aboul-Ezz (1995) mentioned that zooplankton population in the lake showed a remarkable increase during 1987 – 1988 (183,000 ind. m^{-3}), when compared with that recorded during 1978 – 1979 (111,000 and 45,000 ind. m^{-3}, respectively). Copepoda dominated the other groups (36.6 %) and were represented by 26 species, Cladocera and Rotifera came next (21.8 and 15.5 % respectively) and was represented by 7 and 26 species, respectively. Ramdani *et al*. (2001) included the zooplankton of Lake Burullus in their study on the open water zooplankton communities in north African wetland lakes.

El-Shabrawy (2002 & 2004) studied the biodiversity, density and population dynamics of zooplankton in Lake Burullus at 11 stations (Fig. 7.1), before and after the implementation of the management plan of the Lake.

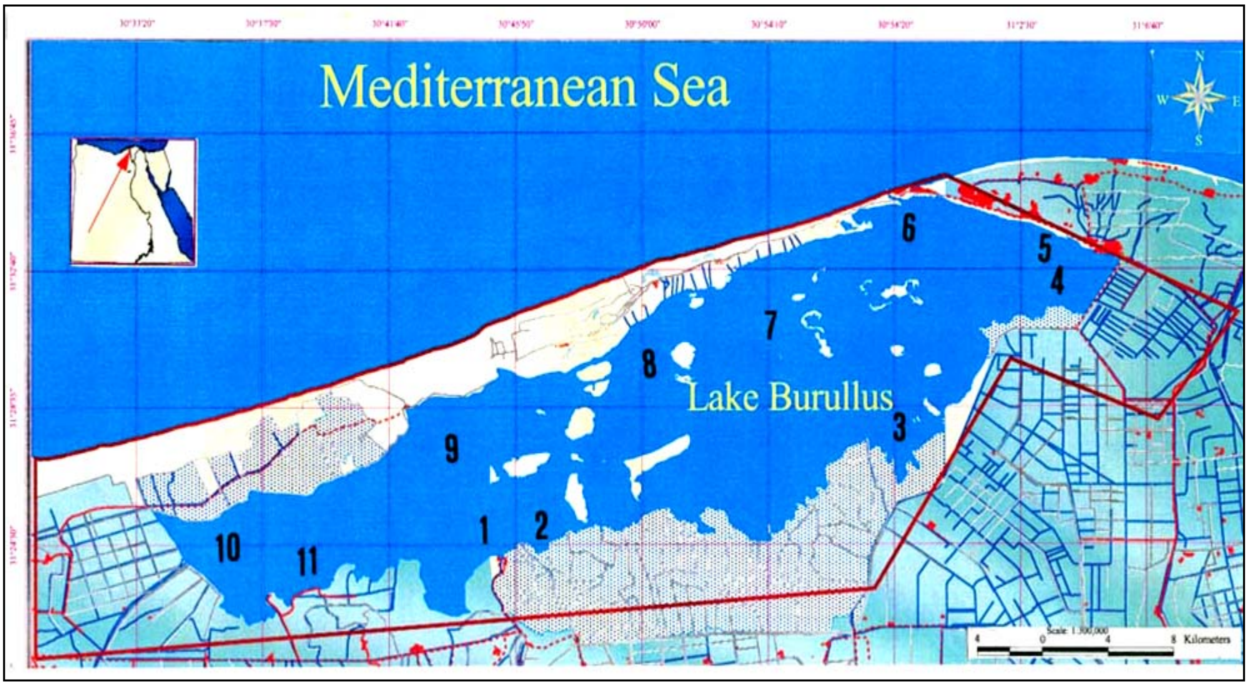

Fig 7.1. **Map of Lake Burullus showing the location of sampling sites (El–Shabrawy 2002 and 2004)**

7.1. PRESENT STATUS OF ZOOPLANKTON

A total of 75 zooplankton species belonging to 3 main groups (Rotifera, Copepoda and Cladocera) in addition to 8 protozoan and 4 meroplankton species were recorded during 2003/04 (El-Shabrawy 2004) (Table 7.1). It is worth mentioning that some marine species were redetected at the northern area of the Lake, near El-Boughaz, after implementation of the management plan in 2002. These species include: two of Protozoa (*Eutintinnus lusus-undae* and *Metacylis mediterrnean*), and five of Copepoda (*Oithona nana*, *Paracalanus parvus, Euterpina acutifrons, Harpacticus* sp. and *Macrosrtella gracillis*).

7.1.1. Newly recorded species for Lake Burullus

Four zooplankton species were recorded for the first time in Lake Burullus in 2003-04 (El-Shabrawy 2004), these are two of Rotifera (*Lecane arcula* and *Trichocerca inermis*), one of Copepoda (*Harpacticus* sp.) and one of Cladocera (*Diaphanosoma mongolanium*).

Table 7.1. **Checklist of the zooplankton species recorded in Lake Burullus during different time periods. F. W.: Freshwater species, M. W.: Marine water species.**

Species	Abou-Ezz (1984)		Abou-Ezz (1995)	El-Shabrawy (2002)	El-Shabrawy (2004)	Habitat
	1978	1979	1987 1988	2001 2002	2003 2004	
Rotifera						
Anuraeopsis fissa (Gosse)	--	--	--	+	+	F.W.
Asplanchna girodi De Guerne	--	--	--	+	+	F.W.
Asplanchna priodonta Gosse	+	+	+	--	--	F.W.
Asplanchna sieboldi Leydig	--	--	--	+	+	F.W.
Brachionus angularis Gosse	+	+	+	+	+	F.W.
Brachionus budapestinensis Daday	--	--	+	+	+	F.W.
Brachionus calyciflorus Pallas	+	+	+	+	+	F.W.
Brachionus caudatus (Barrois &Daday)	+	+	+	+	+	F.W.
Brachionus falcatus Zacharias	--	--	+	--	--	F.W.
Brachionus plicatilis (Müller)	+	+	--	+	+	F.W.
Brachionus quadridentatus Hermann	+	+	+	+	+	F.W.
Brachionus rubens Her.	--	--	--	+	+	F.W.
Brachionus urceolaris (Müller)	+	+	+	+	+	F.W.
Cephalodella gibba Ehr.	--	--	--	+	+	F.W.
Cephalodella megalocephala Glascott	+	+	+	--	--	F.W.
Colurella adriatica Carlin	+	+	--	+	+	F.W.
Colurella obtusa Haver	+	+	--	--	+	F.W.
Filinia longiseta Ehr.	--	--	+	+	+	F.W.
Harringia rouseleti Beauchamp.	+	--	--	+	+	F.W.
Hexarthra oxyuris Hudson	--	--	--	+	+	F.W.
Kellicottia longispina Kellicott	--	+	--	--	--	F.W.
Keratella cochlearis Gosse	+	+	+	+	+	F.W.
Keratella quadrata Müller	+	+	+	+	+	F.W.
Keratella tropica Apstein	+	+	+	+	+	F.W.
Keratella vulga Ehr.	+	+	+	+	+	F.W.
Lecane arcula Harring	--	--	--	--	+	F.W.
Lecane bulla Gosse	--	+	+	+	+	F.W.
Lecane closterocera Schmarda	+	+	--	--	+	F.W.
Lecane depressa Müller	+	+	--	--	--	F.W.
Lecane elasma Harring & Myers	+	+	--	--	--	F.W.
Lecane luna Müller	+	+	+	+	+	F.W.
Lecane lunaris Ehr.	--	+	+	--	+	F.W.
Lecane ohioensis Müller	+	+	--	--	--	F.W.

Table 7.1. Cont.1

Species	Abou-Ezz (1984)		Abou-Ezz (1995)	El-Shabrawy (2002)	El-Shabrawy (2004)	Habitat
	1978	1979	1987 1988	2001 2002	2003 2004	
Lepadella ovalis Müller	+	+	--	--	--	F.W.
Lepadella patella Müller	+	+	+	--	+	F.W.
Macrochaetus nearsubquadratus Petry	+	+	+	--	--	F.W.
Philodina roseola Ehr.	--	--	--	+	+	F.W.
Polyarthra ramata Skorikow	--	--	--	+	+	F.W.
Polyarthra vulgaris Carlin	+	+	+	+	+	F.W.
Proalides sp.	--	--	--	+	+	F.W.
Pseudoharringia similis Fadeau	--	+	--	--	--	F.W.
Pseudoploesoma formosum Myers	--	+	--	--	--	F.W.
Rhinoglena frontalis Ehr.	--	+	--	--	--	F.W.
Rotatoria sp.	--	--	+	+	+	F.W.
Synchaeta oblonga Ehr.	+	+	+	+	+	F.W.
Synchaeta pectinata Ehr.	+	+	+	+	+	F.W.
Testudinella patina Hermann	--	--	--	+	+	F.W.
Trichocerca cylindrica Imhof	+	+	+	+	+	F.W.
Trichocerca elongata Gosse	--	--	--	+	--	F.W.
Trichocerca gracilis Tessin	--	--	--	+	+	F.W.
Trichocerca pusilla Jennings	--	--	--	+	+	F.W.
Trichocerca inermis Linder	--	--	--	--	+	F.W.
Tripleuchlanis plicata Carlin	+	+	+	--	--	F.W.
Copepoda						
Acanthocyclops americanus March	+	+	+	+	+	F.W.
Acanthocyclops exilis Coker	+	+	+	--	--	F.W.
Acanthocyclops vernalis Fischer	+	+	+	--	--	F.W.
Acartia latisetosa Kriczaguin	+	+	+	--	--	M.W.
Apocyclops panamensis March	--	--	--	+	+	F.W.
Bryocamptus hiemalis Pearse	+	--	--	--	--	F.W.
Calanus brevicornis Lubbock	+	--	--	--	--	M.W.
Canthocamptus dentatus Poggenpol	+	+	--	--	--	F.W.
Canthocamptus gracilis Sars	+	--	+	--	--	F.W.
Canthocamptus proegeri Scourfield	+	--	+	--	--	F.W.
Canthocamptus pygmaens Sars	+	--	+	--	--	F.W.
Canuella perplexa Scot	--	--	+	--	--	M.W
Centropages sp.	--	--	+	--	--	M.W.
Cyclops capillatus Sars	+	+	+	--	--	F.W.

Table 7.1. Cont.2

Species	Abou-Ezz (1984)		Abou-Ezz (1995)	El-Shabrawy (2002)	El-Shabrawy (2004)	Habitat
	1978	1979	1987 1988	2001 2002	2003 2004	
Cyclops crassicaudis Sars	+	+	--	--	--	F.W.
Cyclops magnus March	+	+	--	--	--	F.W.
Cyclops scutifer Sars	+	+	--	--	--	F.W.
Cyclops sepratus Lilljeborg	+	+	+	--	--	F.W.
Cyclops strennus Fischer	+	+	+	--	--	F.W.
Cyclops varicans Lilljeborg	+	+	--	--	--	F.W.
Cyclops venustus Norman & Scott	+	+	--	--	--	F.W.
Cyclops vicinus Uljanin	+	+	--	--	--	F.W.
Diacyclops bicuspidatus Claus	+	+	+	--	--	F.W.
Diaptomus gracilis Sars	--	--	+	--	--	F.W.
Diaptomus marshianus M.S. Wilson	+	+	--	--	--	F.W.
Diaptomus minutus Lilljeborg	+	+	+	--	--	F.W.
Diaptomus purpureus Harsh	+	+	--	--	--	F.W.
Diaptomus saltillinus Brewer	+	+	--	--	--	F.W.
Eucyclops agilis Koch	+	+	+	--	--	F.W.
Eucyclops prionophorus Kiefer	+	+	--	--	--	F.W.
Ergasilus sieboldi Norman	+	--	+	--	--	F.W.
Euterpina acutifrons Dona	--	+	+	--	+	M.W
Halicyclops magniceps Sars	+	+	+	--	--	F.W.
Horsiella brevlicornis Van Dauwe	+	+	--	--	--	F.W.
Harpacticus sp.	--	--	--	--	+	M.W.
Isias clavipes Boeck	+	--	--	--	--	M.W.
Macrocyclops albidus Jurine	--	--	--	+	+	F.W.
Macrosetella gracilis Dona	+	--	+	--	+	M.W
Maraenobiotus vejdovskyi Gurney	+	--	--	--	--	F.W.
Mesochra rapiens Schmeil	+	+	--	--	--	F.W.
Mesocyclops leuckarti Claus	+	+	+	--	--	F.W.
Nitocra lacustris Schmankevitch	+	+	+	+	+	F.W.
Oithona helgolandica Claus	+	+	--	--	--	M.W.
Oithona nana Giesb	+	+	+	--	+	M.W.
Oithona robusta Giesb	+	+	--	--	--	M.W.
Oncychocamptus mohamed Blanchard	+	+	+	--	--	F.W.
Paracalanus parvus Claus	+	--	--	--	+	M.W.
Paracyclops fimbriatus Poppei	+	+	--	--	--	F.W.
Schizopera clandestina Kile	+	--	+	--	--	F.W.

Table 7.1. Cont.3

Species	Abou-Ezz (1984)		Abou-Ezz (1995)	El-Shabrawy (2002)	El-Shabrawy (2004)	Habitat
	1978	1979	1987 1988	2001 2002	2003 2004	
Schizopera nilotica	--	--	--	+	+	F.W.
Tachidius descipes Geisb	+	--	--	--	--	F.W.
Thermocyclops crassus Fischer	--	+	+	--	+	F.W.
Thermocyclops decipinis Kieker	--	--	--	+	+	F.W.
Thermocyclops neglectus Sars	--	--	--	+	+	F.W.
Nauplius larvae	+	+	+	+	+	F.W.
Copepodid stages	+	+	+	+	+	F.W.
<u>Cladocera</u>						
Alona intermedia Sars	+	+	+	--	--	F.W.
Alonella nana Baird	+	+	--	--	--	F.W.
Bosmina longirostris Muller	+	+	+	+	+	F.W.
Ceriodaphnia reticulata Jurine	+	+	+	--	+	F.W.
Chydorus ovalis Kurz	--	+	+	--	--	F.W.
Chydorus sphaericus Muller	--	--	--	+	+	F.W.
Daphnia similis Claus	--	--	--	+	+	F.W.
Diaphanosoma brachynrum Lieven	+	+	--	--	--	F.W.
Diaphanosoma mongolianum	--	--	--	--	+	F.W.
Diaphanosoma excisum Sars	+	+	+	+	+	F.W.
Ilyocryptus agilis Kurz	--	--	--	+	+	F.W.
Macrothrix laticornis Jurine	--	--	--	+	+	F.W.
Macrothrix rosea Jurine	+	+	--	--	--	F.W.
Moina micrura Kruz	+	+	+	+	+	F.W.
Oxyurella longicaudis Birge	+	+	+	--	--	F.W.

7.2. DISTRIBUTION OF COMMON SPECIES

7.2.1. Rotifera

7.2.1.1. *Keratella quadrata*

K. quadrata has been found to be the most dominant rotifer species of zooplankton community in Lake Burullus, forming 34.3 % of the total rotifers. The highest standing crop of 1950000 ind. m^{-3} was observed in the west area during winter, while it was completely missing in summer and autumn (Fig. 7.2). Aboul-Ezz (1995) recorded it with a maximum yield in winter in the Lake. El-Shabrawy (1999) considered it the most dominant plankters in Wadi

El-Rayan Lakes. Moreover, it was represented mainly during October in the River Nile (Ahmed 2000), and only seen during spring and autumn in Damietta Nile branch (El-Bassat 2002). *K. quadrata* is a cosmopolitan species in fresh and brackish waters (Shiel *et al.* 1982).

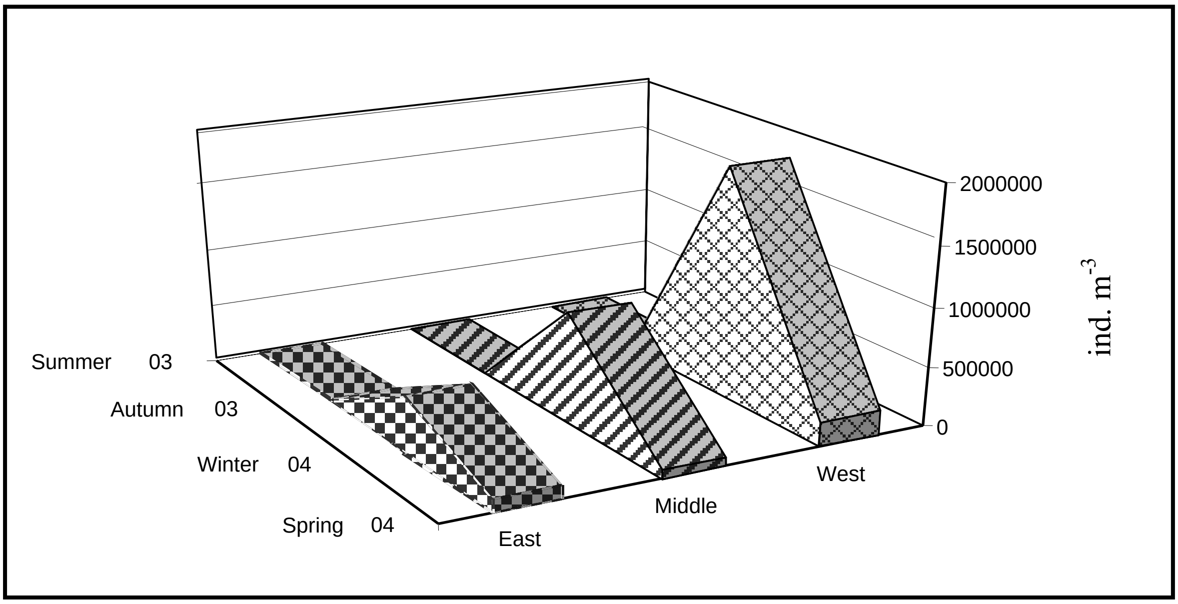

Fig. 7.2. **Standing crop of *Keratella quadrata* in Lake Burullus during 2003-2004.**

7.2.1.2. *Brachionus calyciflorus*

B. calyciflorus is one of the most dominant plankters, occupying the 2nd position and forming 21.5% of the total rotifers count. The west area of the lake maintained the highest density, with peak of 690000 ind. m^{-3} in summer (Fig. 7.3). *B. calyciflorus* was previously recorded from most of the Egyptian fresh waters. It is considered an indicator for eutrophic water (Guisande & Joja 1988), being cosmopolitan, eurythermal, euryhaline in alkaline and also polluted shallow waters (Shiel *et al.* 1982).

7.2.1.3. *Brachionus angularis*

Brachionus angularis occupied the third dominance position among rotifers, forming 15.3 % of the total rotifers community. During this survey, it was perennially reported in the different lake areas. The highest crop was at the west area during summer and autumn (330000 and 270000 ind. m^{-3}) (Fig. 7.4). *B. angularis* was previously recorded in Lake Burullus with a distinct peak in winter (Aboul-Ezz 1984), and with a high density during September and October in River Nile at Helwan (Ahmed 2000), forming 25 % of the total genus at El-Serw area of Damietta Nile branch (El-Bassat 2002). Bartos (1959) reported that *B. angularis* was a perennial species, prefering alkaline water, with littoral vegetation. Moreover, it occurs in most eutrophic waters (Sladecek 1983).

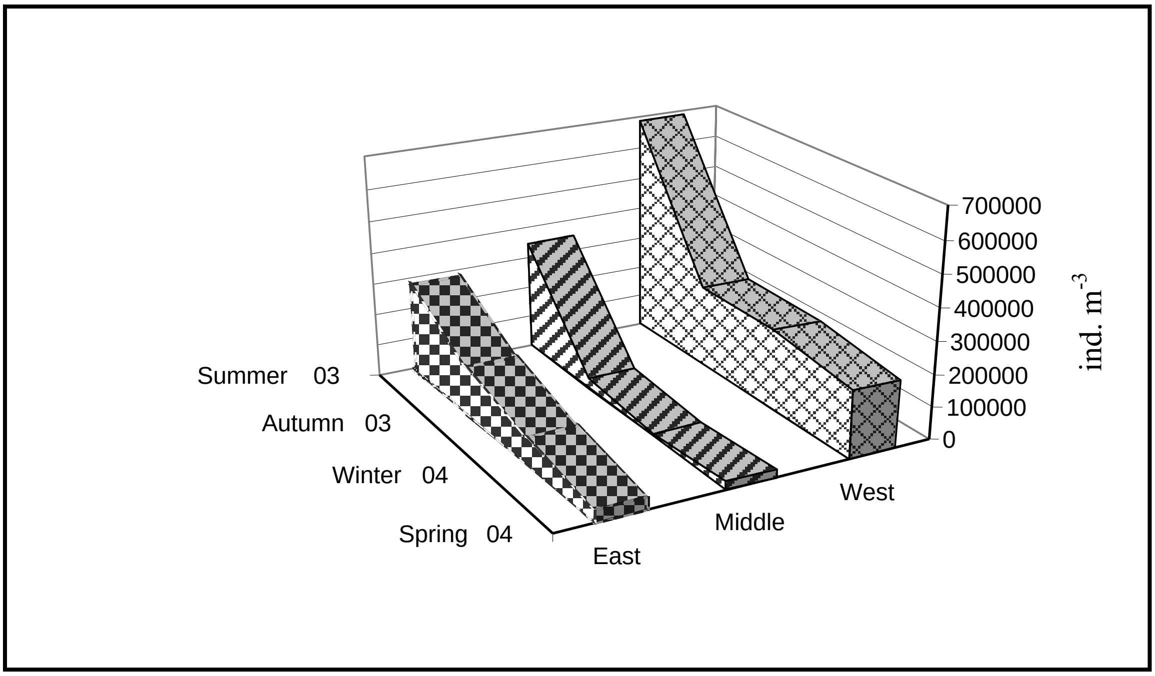

Fig. 7.3. **Standing crop of *Brachionus calyciflorus* in Lake Burullus during 2003-2004.**

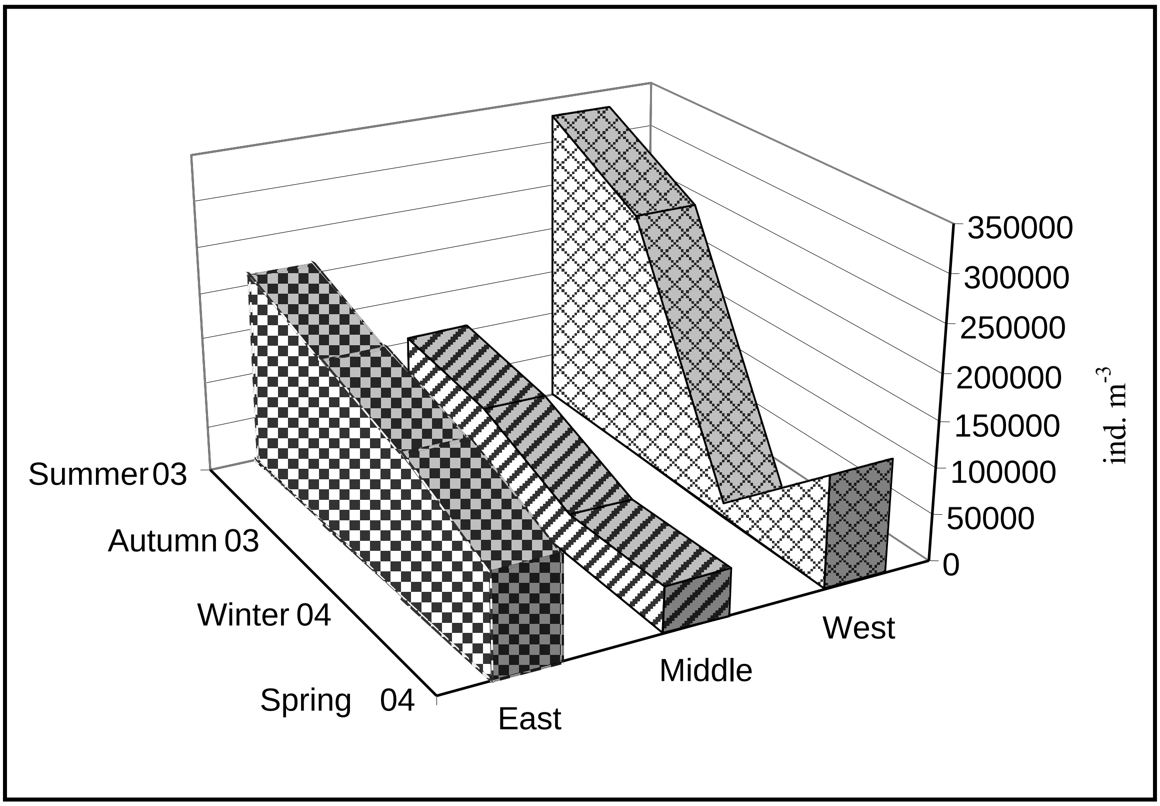

Fig. 7.4. **Standing crop of *Brachionus angularis* in Lake Burullus during 2003-2004 (El-Shabrawy 2004).**

7.2.1.4. *Polyarthra vulgaris*

Polyarthra vulgaris represents the second example for dominant rotifer plankters in the lake. This species was highly represented during summer, with a major peak of 150,000 ind. m^{-3} in the middle area (Fig. 7.5). The maximum density of this species occurred in spring in River Nile and Damietta Nile branch (Ahmed 2000 and El-Basat 2002, respectively). Attayge and Bonzlli (1998) considered it as a good indicator of eutrophication.

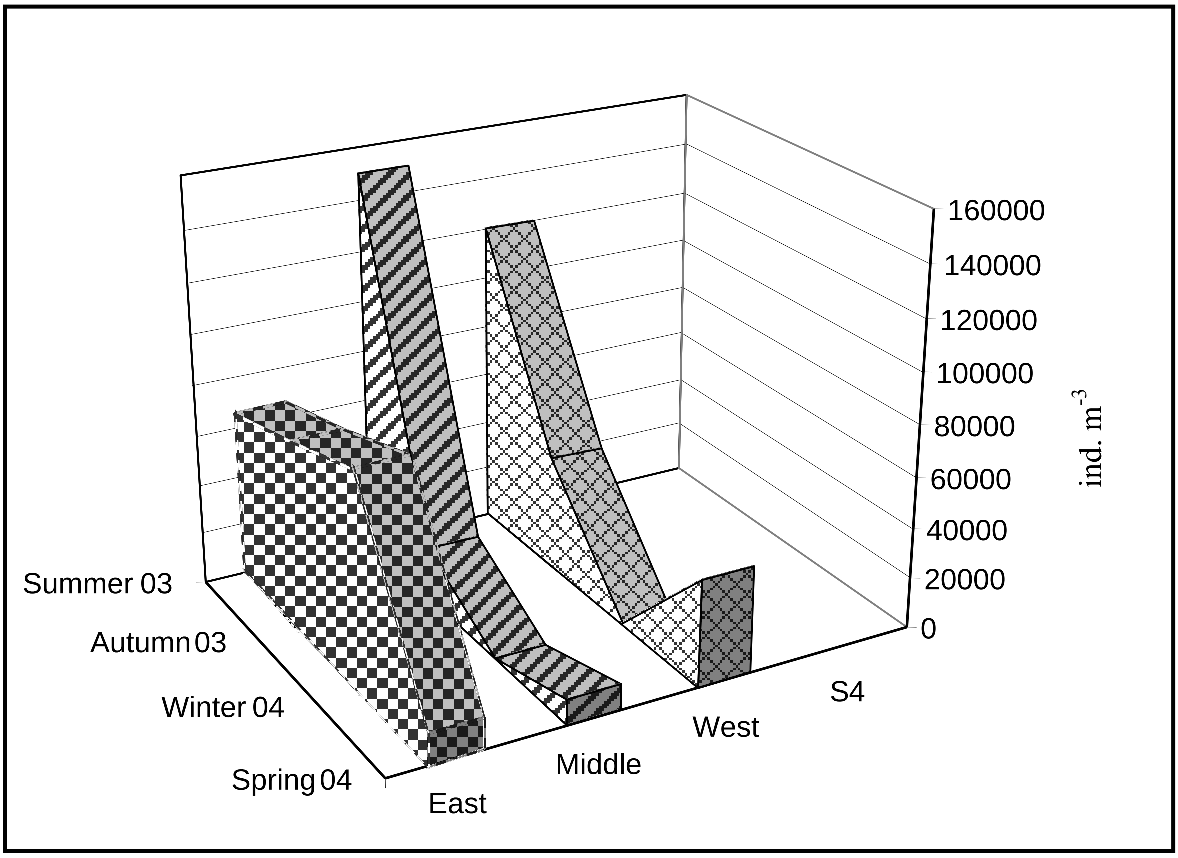

Fig. 7.5. **Standing crop of *Polyarthra vulgaris* in Lake Burullus during 2003-2004.**

7.2.1.5. *Brachionus plicatilis*

This species is one of the dominant species, that can be regarded as a typical summer plankter. The maximum density occurred in summer, with a major peak of 300,000 ind. m^{-3} at the east area. It was rare or even absent from the majority of stations in autumn and winter (Fig. 7.6). El-Shabrawy (2002) stated that *B. plicatilis* reached its maximum density in Lake Qarun during summer, while it was rare or even missing in winter and spring counts. This agrees with the present study. It was previously recorded in River Nile at Helwan with gradual increase from May to August (Ahmed 2000), and it was recorded in Wadi El-Rayan as a predominant among 23 rotiferan species (El-Shabrawy 1999). It contributed 0.6% of the total genus count at El-Serw area (Damietta Nile Branch; El-Bassat 2002). This species also has been recorded in Rosetta

Nile Branch (Aboul-Ezz 1995). The highest density of this species was confined to July in Lake Mariut (Abdel-Aziz 1987). *B. plicatilis* is a cosmopolitan species, though restricted to alkaline waters and is considered as a brackish water species as well as marine inhabitant.

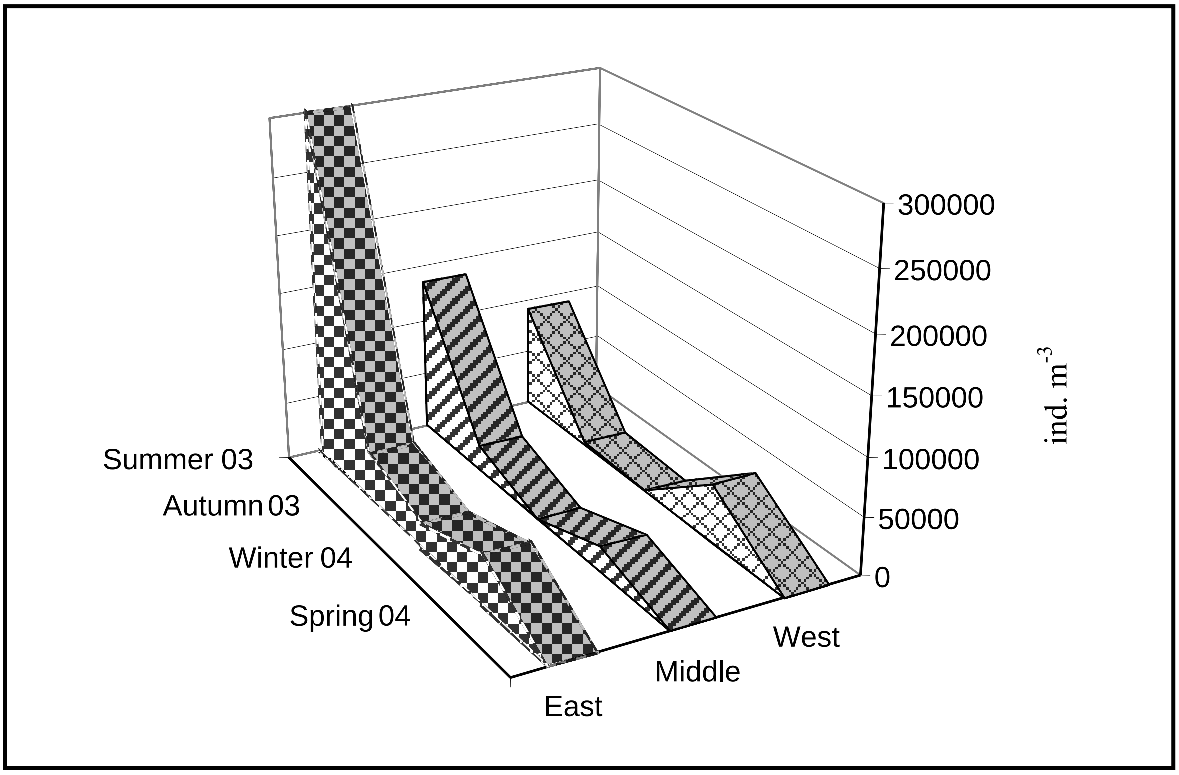

Fig. 7.6. **Standing crop of *Brachionus plicatilis* in Lake Burullus during 2003-2004 (El-Shabrawy 2004).**

7.2.1.6. *Filinia longiseta*

This species was reported to be an aestival plankter, owing to its highest occurrence in summer (Fig. 7.7). It is considered as a truly planktonic organism which indicates mesotrophic or eutrophic conditions (Gannon and Stenberger 1978). It has a wide geographical distribution, being found in large numbers of eutrophic Indian waters and the rivers of Europe. It was recorded in lakes of White Nile, Blue Nile and in Nile water. In Egypt, it has been formerly reported from Lake Nasser (Zaghloul 1985), Edku (Samman 1976), Mariut (Abdel-Aziz 1987), and Rosetta Nile Branch (Aboul-Ezz 1995).

7.2.2. Copepoda

7.2.2.1. *Acanthocyclops americanus*

A. americanus is the most dominant copepod plankter in Lake Burullus The population density of this species reached its maximum in winter, with a major peak of 15,000 ind. m^{-3} at the middle of the lake (Fig. 7.8). Aboul-Ezz

(1995) recorded this species with its maximum frequency in winter and spring in Lake Burullus. This agrees with Samaan (1976); Guerguess (1979); Abdel-Aziz (1987) and El-Shabrawy (2004).

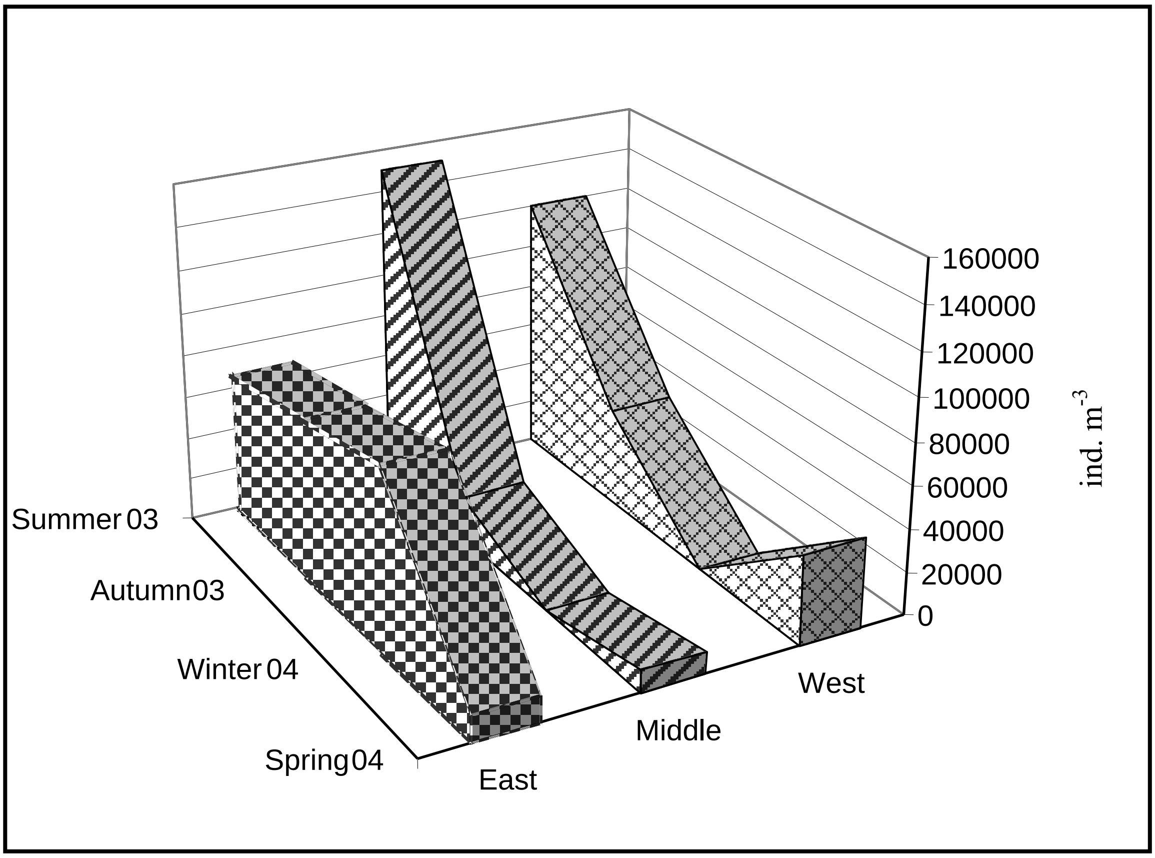

***Fig. 7.7.* Standing crop of *Filinia longiseta* in Lake Burullus during 2003-2004 (El-Shabrawy 2004).**

7.2.2.3. *Apocyclops panamensis*

A. panamensis is a moderately common species in Lake Burullus. It weakly exists during winter, but widely spread in summer, with a peak of 18,000 ind. m^{-3} at the middle of the lake (Fig. 7.9).

7.2.3. Cladocera

7.2.3.1. *Moina micrura*

M. micrura is a perennial species, monopolized other cladocerans and forming 78.7 % of their total count. The population density of this species attained its maximum level in summer with a pinnacle of 540000 ind. m^{-3} at the middle of the lake. It was faintly represented in winter (Fig. 7.10). Aboul-Ezz (1995) mentioned that *M. micrura* dominated the other Cladocera and reached its maximum during autumn and summer in Lake Burullus.

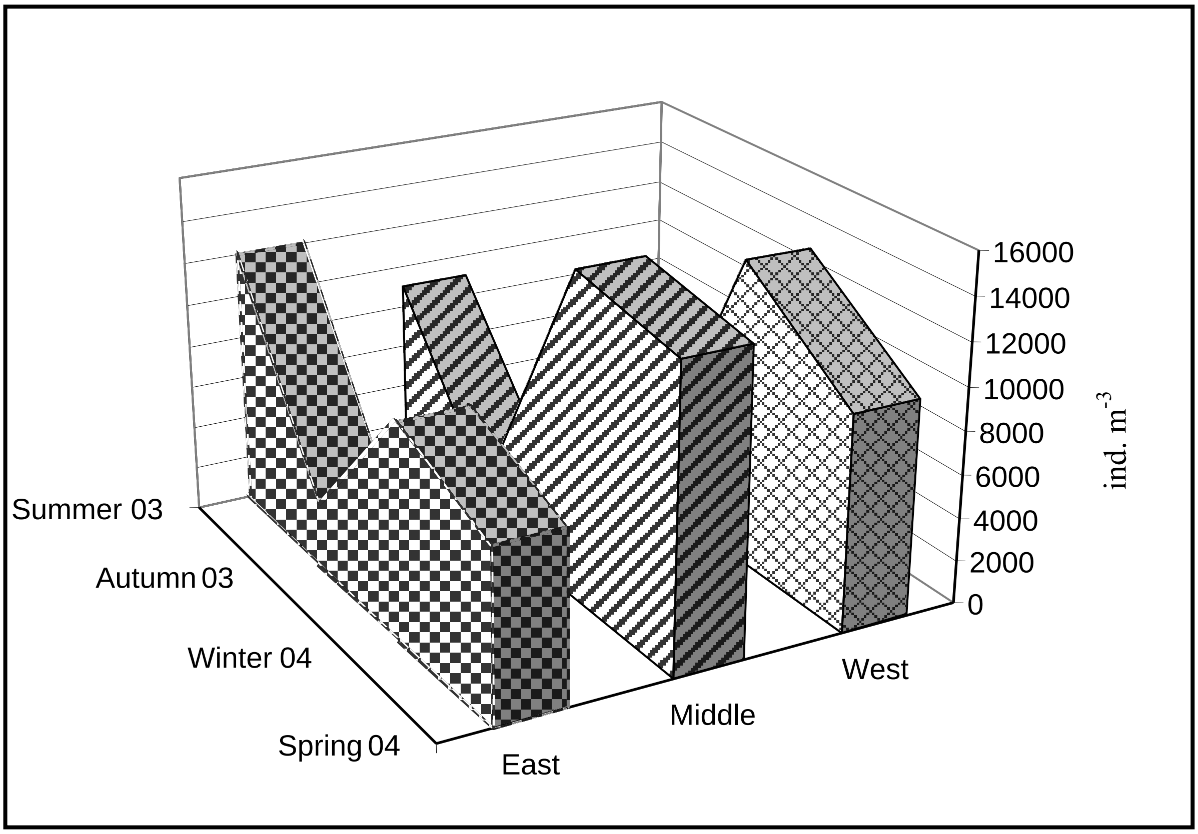

***Fig. 7.8*. Standing crop of *Acanthocyclops americanus* in Lake Burullus during 2003-2004.**

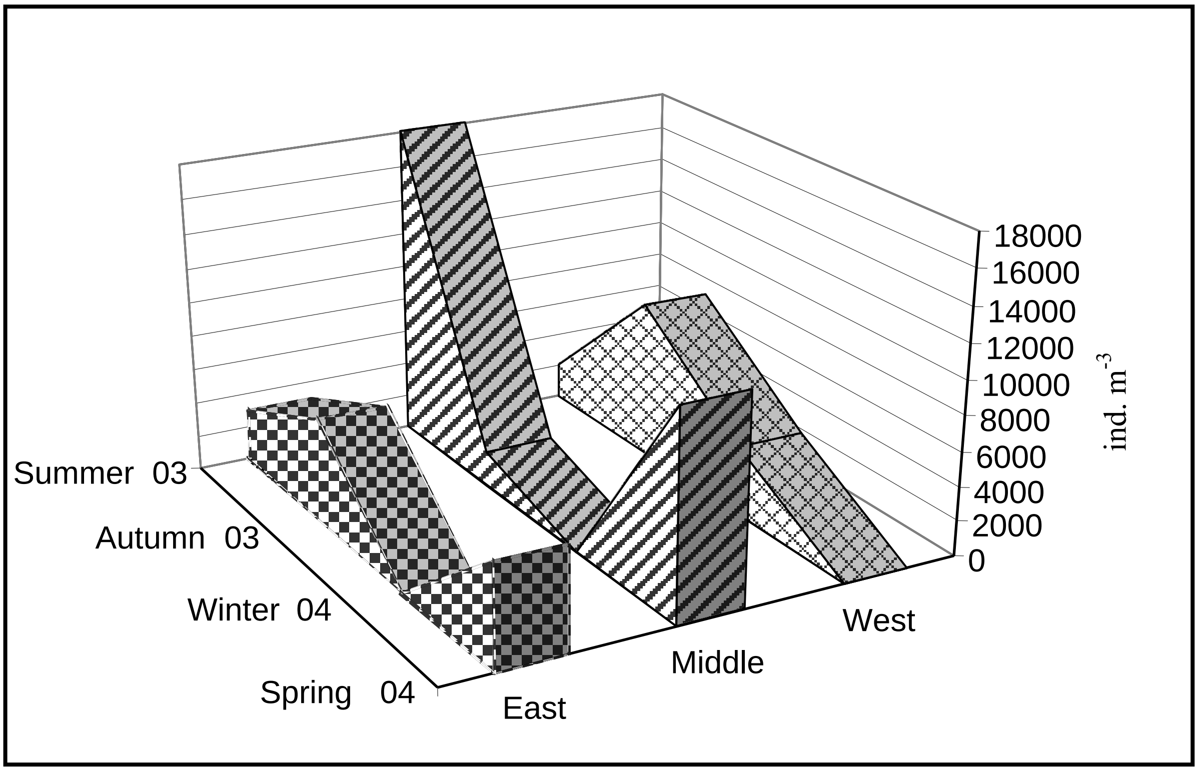

***Fig. 7.9.* Standing crop of *Apocyclops panamensis* in Lake Burullus during 2003-2004 (after El-Shabrawy 2004).**

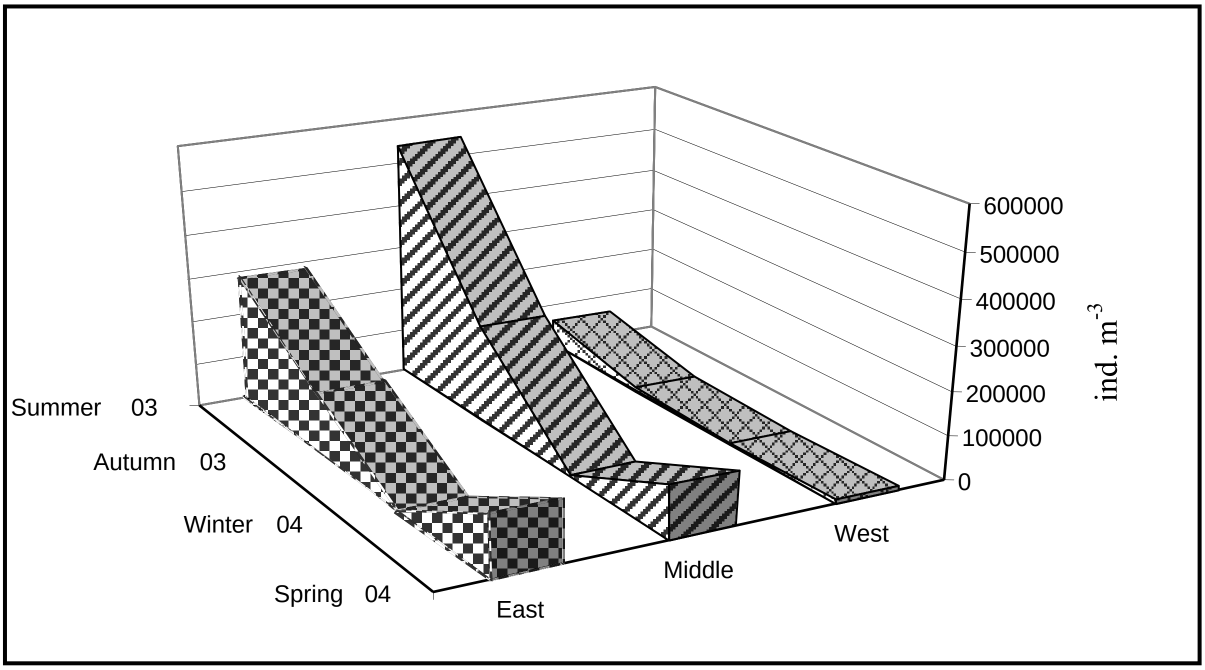

Fig. 7.10. **Standing crop of *Moina micrura* in Lake Burullus during 2003-2004.**

7.2.3.2. *Diaphanosoma mongolanium*

This species was found to be an aestival plankter, owing to its highest occurrence in summer (Fig. 7.11), where it attained a major peak of 45,000 ind.m^{-3} at the eastern sector of the lake. The population density of this species was sharply decreased during the other seasons, Robinson and Robinson (1971) mentioned that *D. mongolanium* was common throughout the hot period but was absent or rare from early December until late June in Lake Chad in Nigeria (El-Shabrawy 2004).

7.2.3.3. *Bosmina longirostris*

B. longirostris was highly represesnted at the western sector compared to other sectors of the lake (Fig. 7.12). It was the most abundant cladoceran species, that peaked in winter (El-Bassat 2002). Moreover, *B. longirostris* filters large algae (> 20 µm) at a faster rate than small cells, as a result of structure of its thoracic limbs.

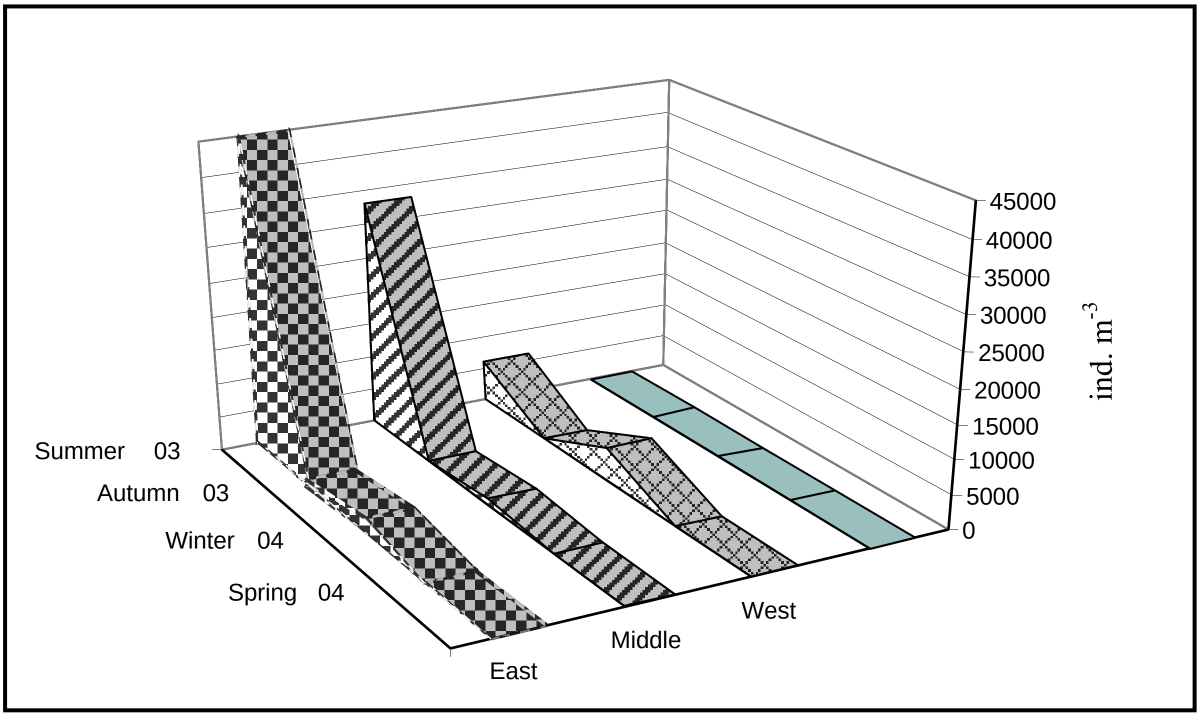

Fig. 7.11. **Standing crop of *Diaphanosoma mongolanium* in Lake Burullus during 2003-2004.**

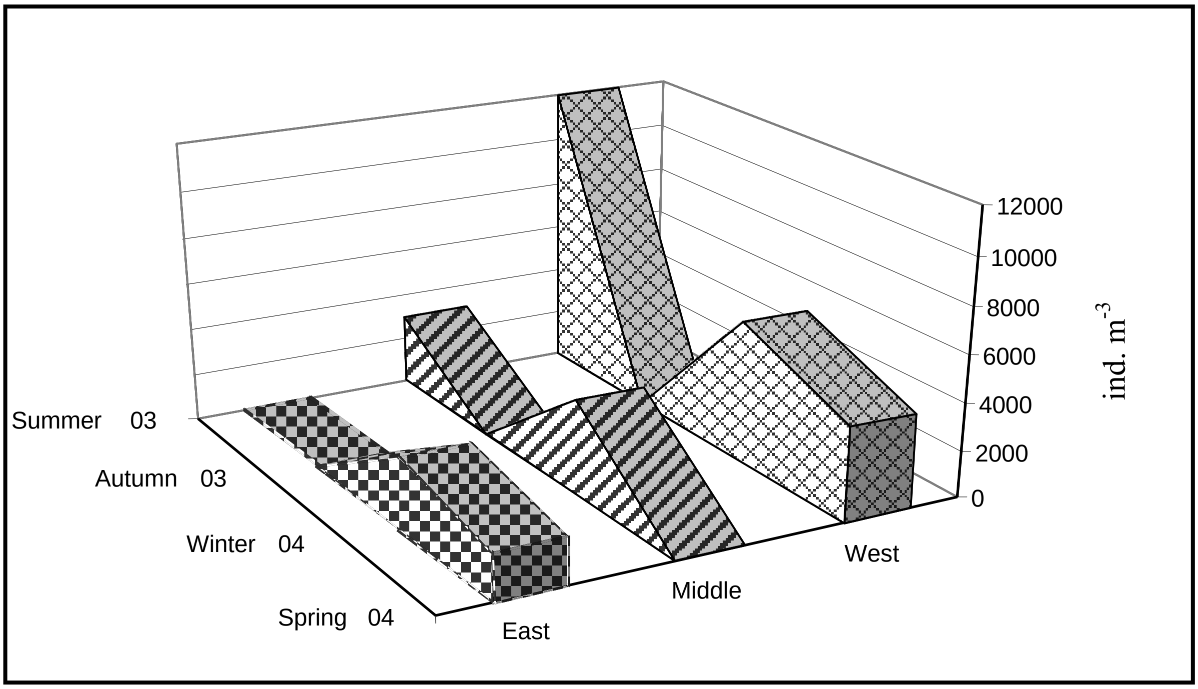

Fig. 7.12**. Standing crop of *Bosmina longirostris* in Lake Burullus during 2003-2004.**

7.3. POPULATION DYNAMICS OF ZOOPLANKTON

Seventy five species of zooplankton community were identified from Lake Burullus during the 2004 survey (El-Shabrawy 2004): 39 Rotifera, 15 Copepoda, 9 Cladocera, 8 Protozoa and 4 meroplankton species (Table 7.1). Generally, the population density of zooplankton is obviously high in the western sector of the lake, compared with the middle and eastern sectors (Fig. 7.13). Regarding seasonal variation, two population density peaks were observed in summer 2003 and winter 2004 (1599900 and 1709500 ind. m^{-3} respectively), while spring 2004 sustained the minimum population of 681300 ind. m^{-3}. As shown in Table (7.2), the standing crop of zooplankton was obviosly higher in 2001/02 and 2003/04 (666575 and 1193509 ind. m^{-3}) as compared with the situation in 1978 and 1987/88; 111000 and 183000 ind. m^{-3}, respectively (Aboul-Ezz 1984 &1995). The species composition of zooplankton community undergoes distinct changes throughout the seasons which can be easily observed in an eutrophic lake (Gliwicz 1977). Species or even genera reaching their maximum abundance in spring are replaced by others in summer.

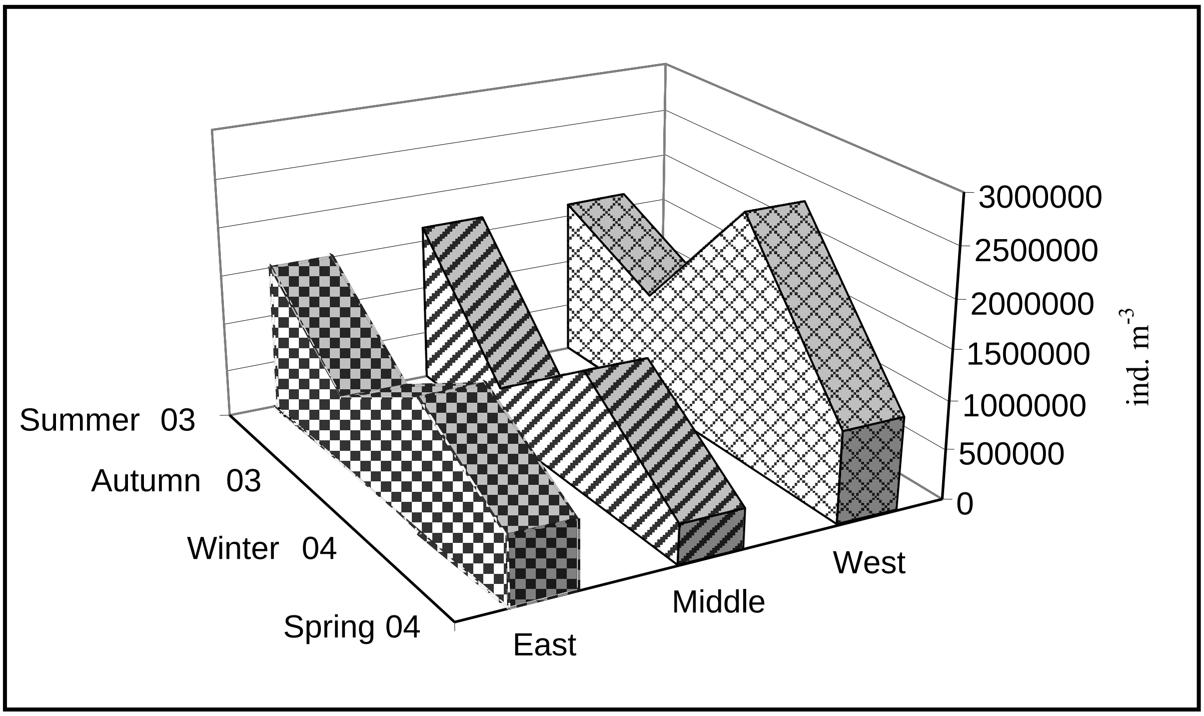

Fig. 7.13. **Standing crop of total zooplankton in Lake Burullus during 2003 – 2004.**

Rotifera is the most abundant group in all seasons and stations, comprising 66.3% and 76.7% of total zooplankton in 2001/02 and 2003/04, respectively (Table 7.2 and Fig. 7.14); while in 1978 and 1987/88 it was only forming 17% and 15.5 % of total zooplankton. They were represented by 34 and 39 species, which relatively higher than that recorded by Aboul-Ezz (1984 & 1995) in 1978 and 1987–1988 (27 and 26 species, respectively) (Table 7.3 and

Fig. 7.15). Rotifera exhibits more or less the same trend as the total zooplankton in its distribution and seasonal variation (Fig. 7.16). *Brachionus angularis, Brachionus calyciflorus, Brachionus urceolaris, Filinia longiseta, Keratella quadrata* and *Polyarthra vulgaris* were reported to be the most common species.

Table 7.2. **Standing crop of different zooplankton groups (ind. m^{-3}) and their percentage frequency to total zooplankton during 1978, 1987 / 1988 and 2003 / 2004.**

Group	Aboul-Ezz (1984)		Aboul-Ezz (1995)		El-Shabrawy (2002)		El-Shabrawy (2004)	
	1978		1987-1988		2001 – 2002		2003 - 2004	
	ind.m^{-3}	%	ind. m^{-3}	%	ind. m^{-3}	%	ind. m^{-3}	%
Rotifera	18902	17.0	28300	15.6	441905	66.3	915625	76.7
Copepoda	76135	68.4	67000	36.6	189905	28.5	110350	9.2
Cladocera	9808	8.8	40300	21.8	20902	3.1	145417	12.2
Others	6509	5.8	47500	26	13864	2.1	22117	1.9
Total	**111354**	**100**	**183100**	**100**	**666575**	**100.0**	**1193509**	**100.0**

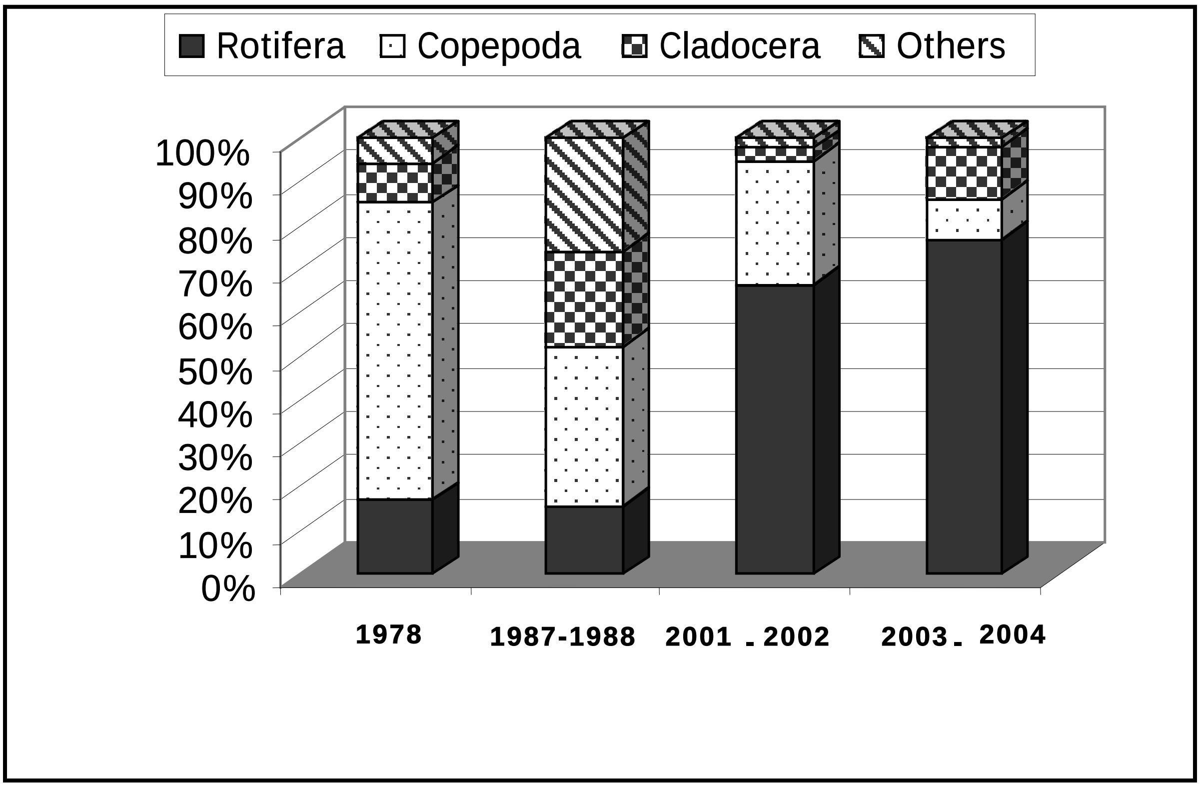

Fig. 7.14. **Percentage composition of zooplankton groups in Lake Burullus during different periods.**

Table 7.3. **Species diversity of zooplankton groups during different periods.**

Groups	**Aboul-Ezz (1984)**	**Aboul-Ezz (1995)**	**El-Shabrawy (2002)**	**El-Shabrawy (2004)**
	1978	**1987 - 1988**	**2001 - 2002**	**2003 - 2004**
Rotifera	27	26	34	39
Cladocera	9	7	7	9
Copepoda	44	26	7	15
Total	**80**	**59**	**48**	**63**

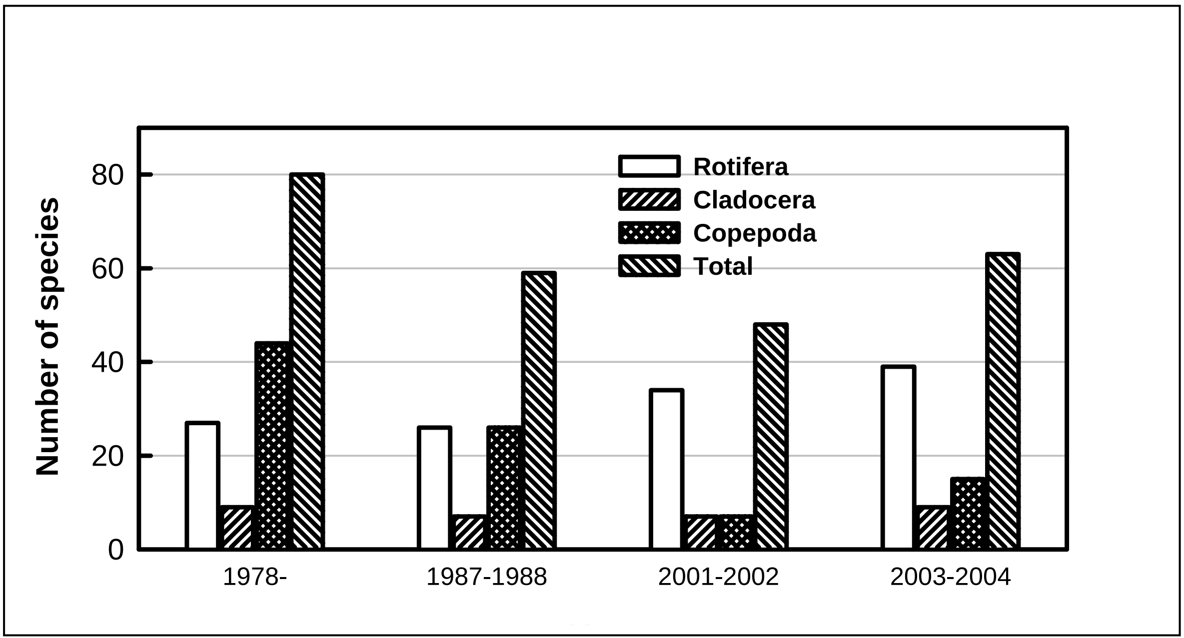

Fig. 7.15. **Species diversity of zooplankton groups in Lake Burullus during different periods.**

Copepoda was the second abundant and common group, forming 28.5 % of the total zooplankton density during 2001/02 and occupied the third position, contributing 9.2% of the total zooplankton crops in 2003/04. Seven and 15 copepod species were identified in Lake Burullus during 2001/02 and 2003-04, which are very low, compared with 44 and 26 species recorded by Aboul-Ezz (1984 & 1995, respectively) (Table 7.3). In fact, there are three reasons, among others, for such reduction: many records of copepods species were misidentified, as 9 species of *Cyclops* and 5 *Diaptomus* were only restricted to temperate region not sub-tropical region, where Lake Burullus lies; the disappearance of all marine copepod species; and the eutrophication process always accompanied with decreasing the diversity of species.

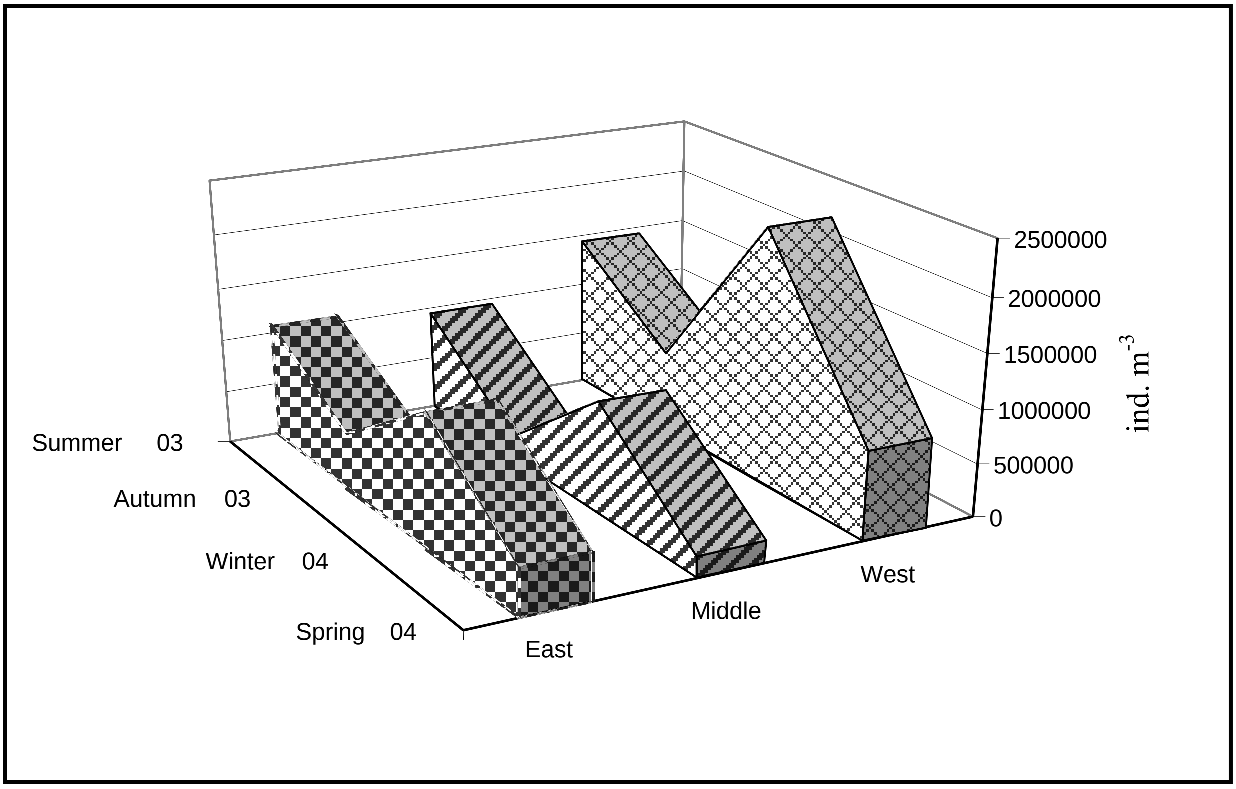

Fig. 7.16. **Standing crop of total Rotifera in Lake Burullus during 2003 – 2004.**

Regarding seasonal variation, the highest density of copepods occurred in western area of the lake in Autumn 2003 (371,000 ind. m^{-3}) (Fig. 7.17). Nauplius larvae dominated the copepodid and adult stages, contributing 62.2 and 51.6% of total copepods density in 2001-02 and 2003-04, respectively. Previous studies showed that Copepoda was the first predominant group, forming 68.4%, in 1978 decreased to 36.6% of total zooplankton in 1987–1988, respectively (Table 7.2).

Cladocera comes next, contributing 3.1% of the total zooplankton count in 2001-02 and increased to 12.2% in 2003-04. It was represented in the lake by 1 dominant, 1 sub-dominant, 2 rare and 5 very rare species. Contrary to the mentioned groups, the standing crop of Cladocera reached its maximum in summer with a major peak of 590,000 ind. m^{-3} at the middle area of the lake. It was faintly represented or even absent from most stations in winter (Fig. 7.18).

The percentage composition of Cladocera was obviously decreased from 8.8% and 21.8 % in 1979 and 1987/1988 to 3.1 % during 2001/02, then increased to 12.2% in 2003/04 (Table 7.2); while the diversity of species shows a slight decrease from 9 in 1978 to 7 during 2001/02. Nine species were recorded in 2003/04 (Table 7.1). *Moina micrura* and *Diaphanosoma mongolanium* were common species, while the rest of species were frequently encountered.

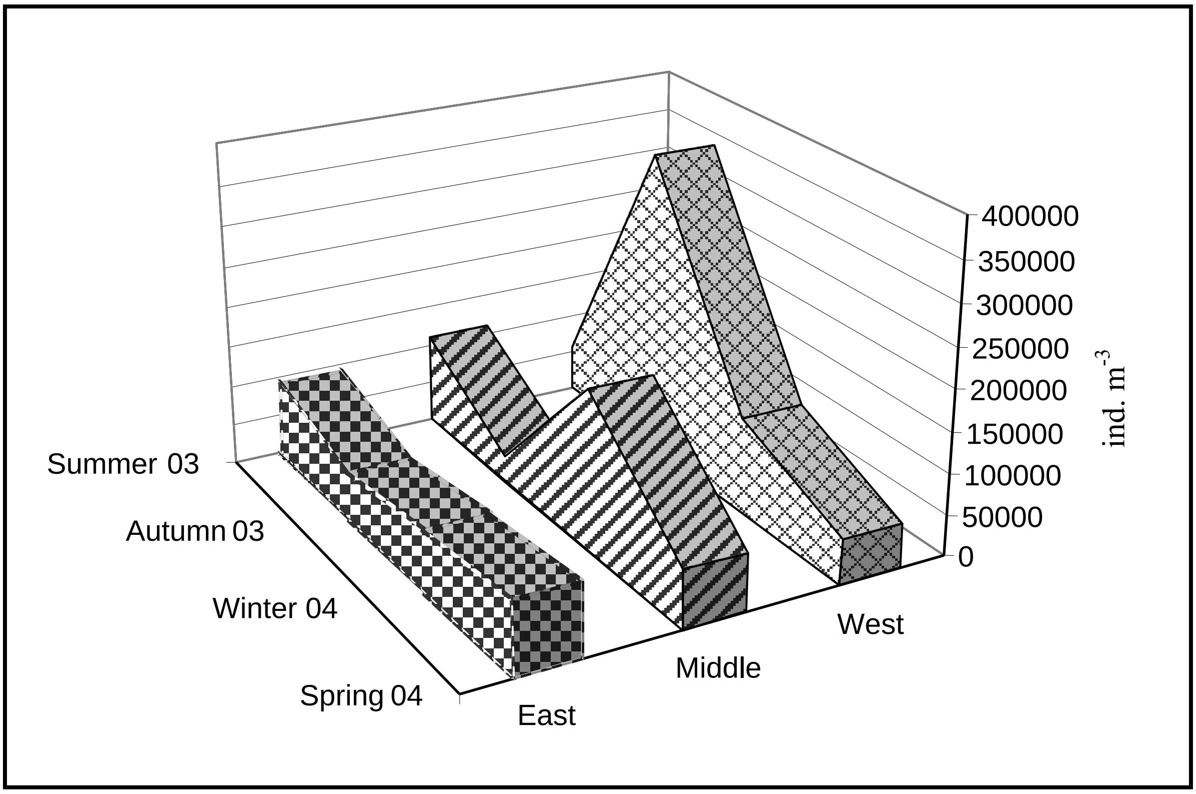

Fig. 7.17. **Standing crop of total Copepoda in Lake Burullus during 2003 – 2004.**

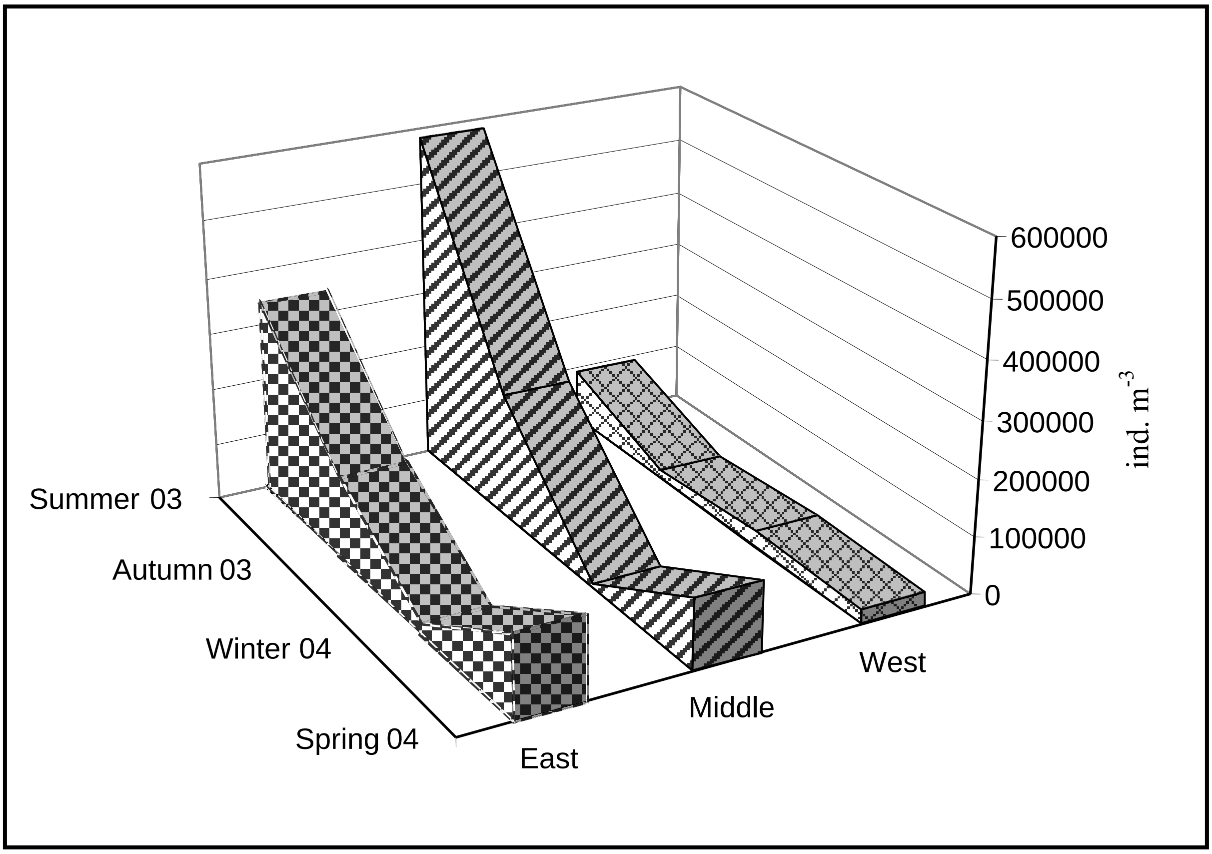

***Fig. 7.18*. Standing crop of total Cladocera in Lake Burullus during 2003 – 2004**

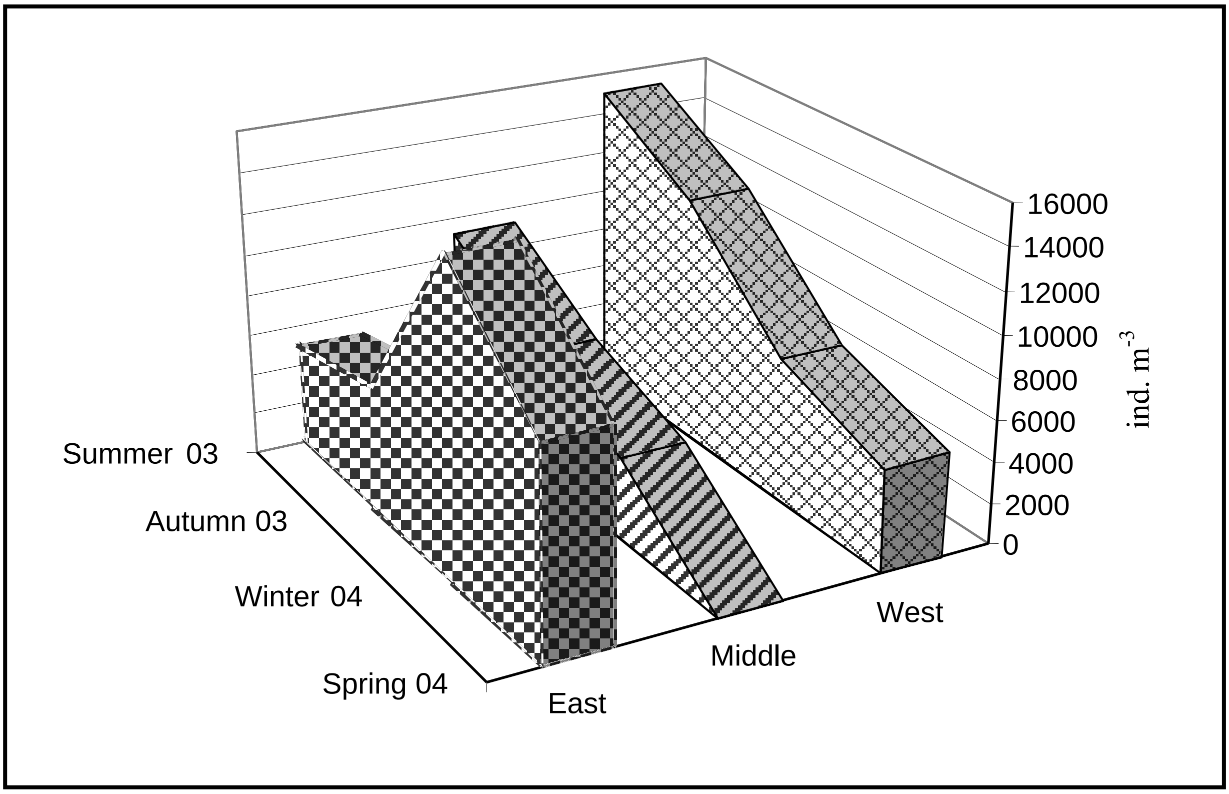

***Fig. 7.19*. Standing crop of total meroplankton in Lake Burullus during 2003 – 2004.**

7.4. INDICATOR SPECIES

7.4.1. Eutrophication-indicator species

Zooplankton is a reliable indicator of changes in water quality, because it is strongly affected by environmental conditions and responds quickly to changes in water quality**.** Among zooplankton, rotifers with their high population turnover rates, are particularly sensitive to water quality changes. They are good indicators of saprobity (i.e. the content of putrescible organic matter), as expressed by BOD_5 (Sladecek 1983). Other studies have shown that eutrophication affects zooplankton composition, shifting the dominance from large species (Copepoda) to smaller ones (Rotifera) (Premazzi & Chiaudani 1992). Xenosaprobic and oligosaprobic rotifers are considered as indicators of oligotrophic conditions, while Beta and Alpha mesosaprobic as indicators of eutrophy.

The dominant rotifer genera and species in Lake Burullus (*Keratella* spp, *Brachionus* spp., *Polyarthra vulgaris, Filina longiseta* and *Synchaeta oblonga*) are eutrophic indicator species, classified by Saldecek (1983) as Alpha and Beta mesosaprobic. Thus, the community composition of the rotifers and their significant dominance over the other zooplankton groups indicate that Lake Burullus is a highly eutrophic ecosystem and shows slight signs of partial organic pollution. Such eutrophication appears to be more related to the increased fertility of water due to the high concentration of nutrients inputs to the lake via agricultural drains.

The genus *Brachionus* is the most predominant and common rotiferan plankter in the lake and is represented by 9 species. Angeli (1976) stated that the simultaneous presence of several species of the genus *Brachionus* was a good indication of the eutrophic nature of an aquatic ecosystem. Sladecek (1983) established a *Brachionus* : *Trichocerca* quotient (QB/T):

QB/T = No. of species of *Brachionus /* No. of species of *Trichocerca*

Values of QB/T less than 1.0 mean oligotrophic condition, values between 1.0 and 2.0 mean mesotrophy and values over 2.0 mean eutrophic condition. When we applied this quotient in Lake Burullus, QB/T = 9/4 = 2.5, so the lake is eutrophic ecosystem. The annual fish yield revealed a gradual increase from 7018 ton in 1979 to 22510 ton in 1987 and reached maximum of 55000 ton in 1999. This is concurrent with the population density of phytoplankton and zooplankton, which gives another indication for the gradual increase of lake eutrophication (Fig. 7.20). Pejler and Berzins (1994) listed many species that indicate organic pollution, of them, many species have been recorded in Lake Burulls such as *Brachionus claciflorus, B. urceolaris, Polyarthra vulgaris, Filinia longiseta* and *Synchaeta oblonga.*

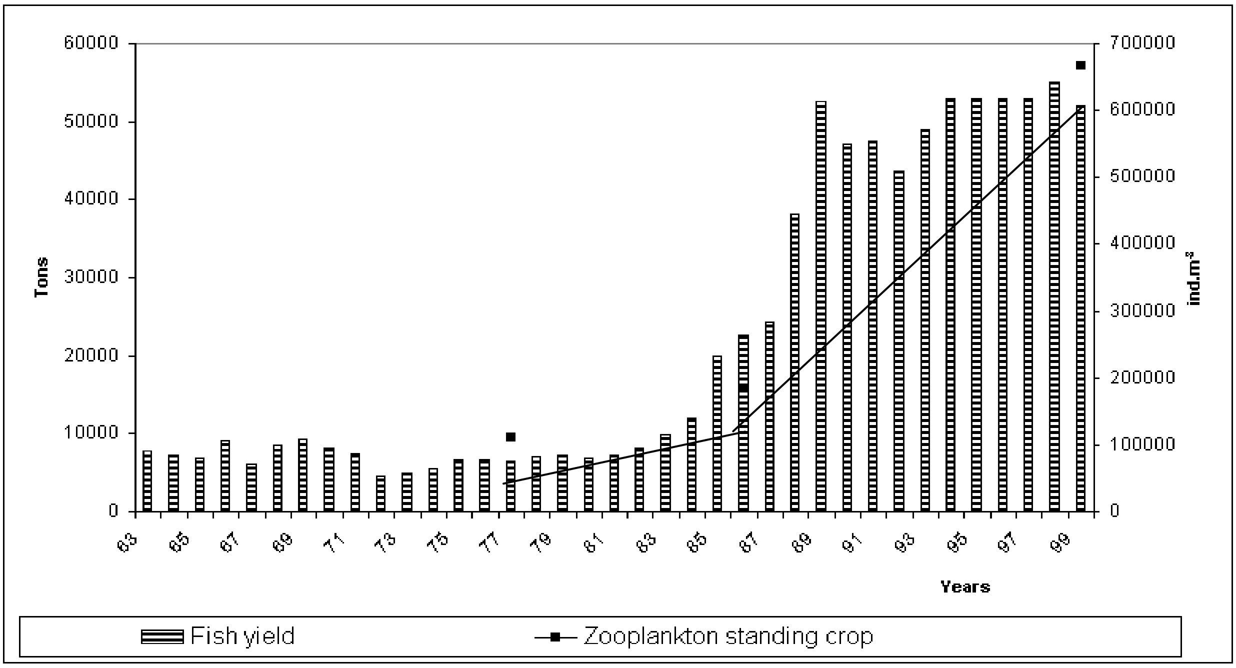

Fig. 7.20. **Fish yield and zooplankton standing crop in Lake Burullus during different time intervals.**

7.4.2. Salinity-indicator species

The hydrographic condition of Lake Burullus has been changed since few years ago, (i.e. the amount of drainage fresh water was increased and led to decrease in salinity of the lake water). The disappearance of marine species, previously recorded by Aboul-Ezz (1984 & 1995), confirmed this phenomenon. These species are: *Oithona nana*, *Oithona helgolandica, Oithona robusta*, *Macrosetella gracilis, Canvella perplexa, Euterpina acutifrons, Isias clavipes, Paracalanus parvus, Calanus brevicornis, Centropages* sp., *Sagitta* sp., *Oikopleura dioica* and *Fritillararia borealis.* Increasing predominance of freshwater components in the fish stock of the lake and decreasing marine fishes (Khalil and El –Dawy 2002) are another sign for decreasing salinity.

7.5. ZOOPLANKTON AND GUT CONTENTS OF FISHES:

El-Shabrawy (2004) studied the gut contents of Nile tilapia and mullets to investigate the importance of zooplankton for different fish species in the Lake .

7.5.1. *Oreochromis niloticus*

Zooplankton was infrequently found, contributing 13-18% of the total food except in winter, when it was highly detected, forming 45% of total food items (Fig 7.21). *Keratella quadrata* monopolized the other species.

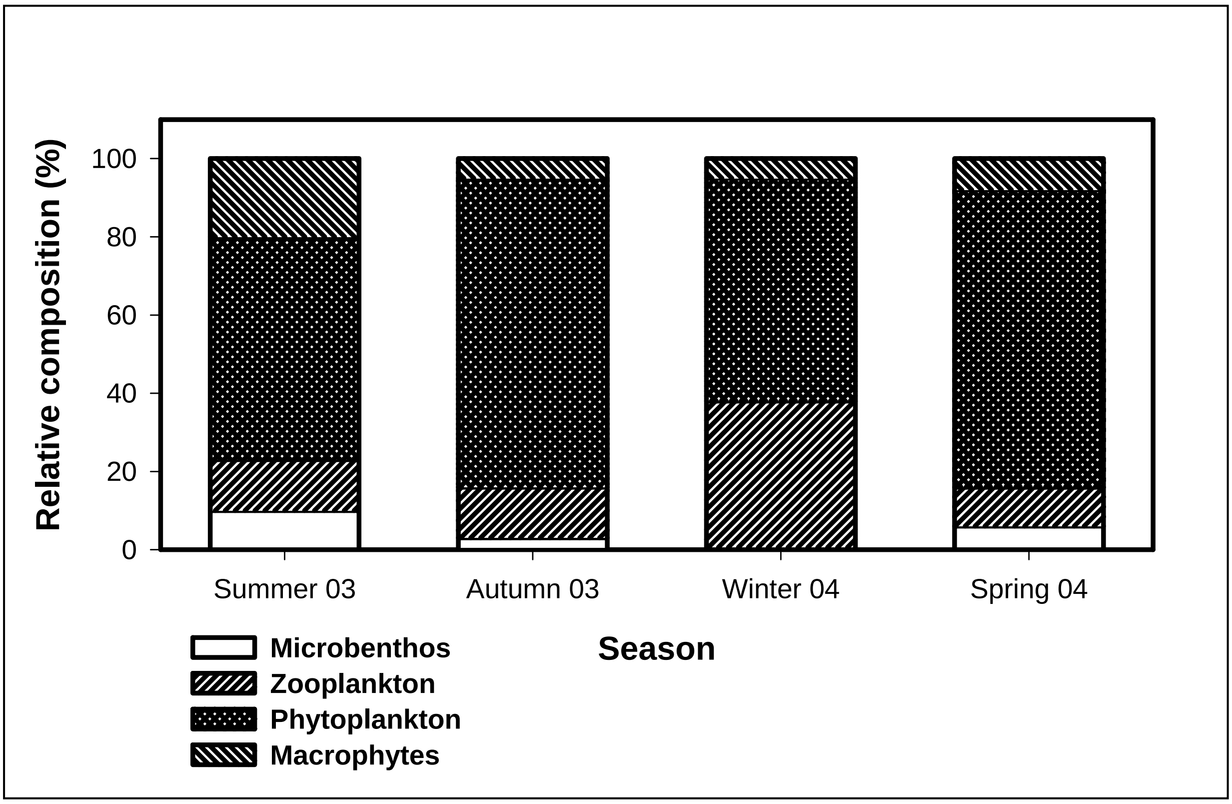

Fig 7.21. **Relative composition of different food items (%) in *Oreochromis niloticus* gut.**

7.5.2. Mullets

Mullets feed mainly on phytoplankton in winter, forming about 64.1% of total food items and was represented in the gut of all the studied fish species (Fig. 7.22). Bacillariophyceae was the most common group, forming 36% of total food and represented in 100% of the studied fish species (Fig 7.22). *Cyclotella* sp. was the most important food item, forming 23.3% of the total gut contents. Chlorophyceae, Cyanophyceae and Dinophyceae were contributing 14.5, 7.0 and 60.5%, respectively. Zooplankton contributed 32.5 % of the food items during winter. *Keratella quadrata* seems to be the most important food item, forming 21.3% of total gut contents. *Brachionus angularis* and *acanthocyclops americanus* were infrequently detected.

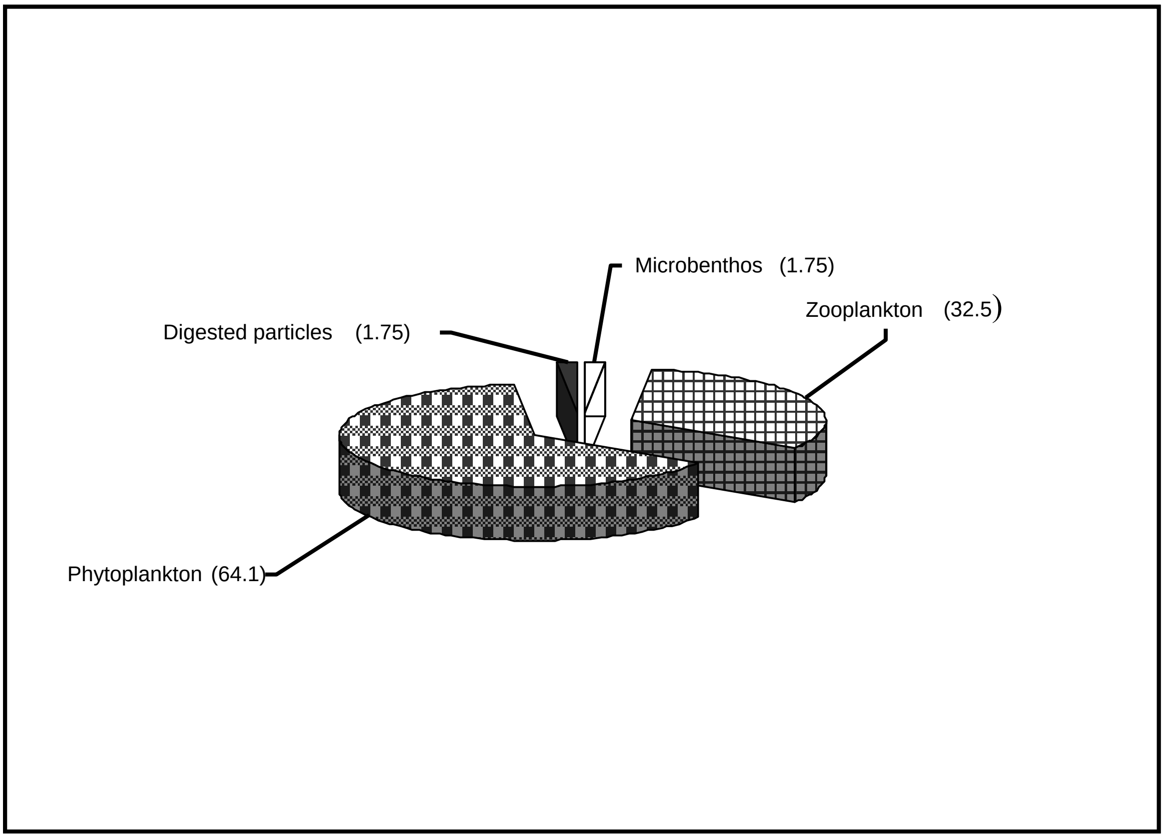

Fig 7.22. **Relative composition (%) of different food items in mullets (El-Shabrawy 2004).**

7.6. SUMMARY

Lake Burullus has become more eutrophic and productive ecosystem during the last decade, due to the increasing amount of discharged drainage water, loaded with nutrients into the lake via the southern drains. At the same time, diversity of zooplankton species was sharply decreased, due to disappearance of marine species as a result of salinity decreasing and increasing of organic pollution.

During 2001/02, 48 zooplankton species belonging to 3 main groups (34 Rotifera, 7 Copepoda and 7 Cladocera) were recorded in Lake Burullus. There was no sign of the occurrence of all marine species (13 species) which have been previously recorded during the seventies of the last century. 18 zooplankton species (freshwater in origin) were recorded for the first time in the Lake during a recent survey in 2003/04. During this survey, 75 species of zooplankton were identified from the Lake; 39 rotiferan species, 15 copepods, 9 cladocerans, 8 protozoans and 4 meroplankton species.

Some marine species [(*Oithona nana. Paracalanus parvus, Euterpina acutifrons, Harpacticus* sp. and *Macrosrtella gracillis* (Copepoda) and *Eutintinnus lusus-undae, Metacylis mediterrnean* (Protozoa)] started to re-occur in the lake at the area near El-Boughaz, particularly during spring 2004. This was mainly due to the construction of two radial canals and clearing of El-Boughaz canal.

In general, the population density of zooplankton was obviously high in the western sector compared with the middle and eastern sectors. Regarding seasonal variation, there was a gradual increase in zooplankton standing crop from a minimum of 437,000 ind. m^{-3} in summer until reaching a maximum of 1,174,000 ind. m^{-3} in spring 2002, with an annual average of 667,000 ind. m^{-3}. The present standing crop of zooplankton is 6 times higher as compared with the situation in the seventies.

Rotifera is the most abundant group in all seasons and areas of the Lake, comprising 66.3% and 76.7% of total zooplankton in 2001/02 and 2003/04; while in 1978 and 1987/88 it was forming only 17% and 15.5 % of the total zooplankton, respectively. Copepoda was the second abundant group, forming 28.5 % of the total zooplankton density during 2001/02 and occupied the third position, contributing 9.2% of the total zooplankton crops in 2003/04.

Gut content analysis of adult fishes inhabiting lake Burullus revealed that Tilapia and mullets mainly feed on *Keratella quadrata* (zooplankton) and *Cyclotella* sp. (phytoplankton), so mass culture of these two species are highly recommended when establishing fish hatchery for the lake.

7.7. REFERENCES

Abdel-Aziz, N. E. 1987. Liminological investigation on zooplankton and benthos in Lake Mariut. M.Sc. Thesis, Fac. Sci., Alexandria Univ. 247 pp.

Aboul-Ezz, S. M. 1984. Limnological investigation on zooplankton and benthos in Lake Burullus. Ph.D. Thesis, Fac. Sci., El-Mansoura Univ. 340 pp.

Aboul-Ezz, S. M. 1995. Zooplankton of Lake Burullus (Egypt). Bull. Nat. Inst. of Oceanogr. & Fish. 21(1): 233 – 261.

Ahmed, N. K. 2000. Study on the impact of industrial wastes at Helwan on River Nile zooplankton. Ph.D. Thesis, Fac. Sci., Cairo Univ. 141pp.

Angeli, N. 1976. Influence de la pollution sur les elements du plancton. In Pesson, P.: La Pollution des Eamx continentals, pp.97 – 133.

Attayge, J. L. and Bonzlli, R. L. 1998. Assessing the indicator properties of zooplankton assemblages to disturbance gradient by canonical correspondence analysis. Canadian J. Fish. Aquat. Sci. 55: 1787 – 1797.

Bartos, E. 1959. Rotatoria fauna CSR. 15 NCSAV, Praha, 969 pp.

El-Bassat, R. A. 2002. Ecological studies on zooplankton communities with particular reference to protozoa at Damietta Nile branch. Ph.D. Thesis, Fac. Girls, Ain Shams Univ. 116pp.

El-Shabrawy, G. M. 1999. Monthly variation and succession of rotifera in Wadi El-Rayan area in relation to some physical and chemical conditions, Egypt. J. Aquat. Biol. & Fish. 3(3): 217 – 243.

El-Shabrawy, G. M. 2002. Ecological Survey of Burullus Nature Protectarate. Zooplankton (Report 1). MedWetCoast, Egyptian Env. Aff. Ag. (EEAA), Final Report, 53 pp.

El-Shabrawy, G. M. 2004. Ecological Survey of Burullus Nature Protectarate. Zooplankton (Report Π). edWetCoast, Egyptian Env. Aff. Ag. (EEAA), Final Report, 50 pp.

El-Sherif, Z. M. and Aboul-Ezz, S. M. 1988. Preliminary study on the phytoplankton-zooplankton relationship in Lake Burullus. Bull. Inst. Oceanogr. & Fish. 14(1): 23 – 30.

Gannon, J. E. and Stemberger, R. S. 1978. Zooplankton especially Rotifers and crustaceans as indicators of water quality. Trans. Am. Micros. Soc. 971: 16–35.

Gliwicz, Z. M. 1977. Food size selection and seasonal succession of filter feeding zooplankton in an eutrophic lake. Ekol. Pol. 25(2): 179 – 225.

Guerguess, Sh. K. 1979. Ecological study of zooplankton and distribution of macrofauna in Lake Manzalah. Ph.D. Thesis, Fac. Sci., Alexandria Univ. 316pp.

Guerguess, S. K. 1986. Check-list and additions to the Rotifera of Egyptian waters. Bull. Fac. Sc., Alex. Univ., 26 (4):123- 129.

Guerguess, S. K. 1993. Cladocera of Egyptian inland waters. Check-list and distribution with new additions. Bull. Fac. Sc. Alex. Univ.,33:166-209.

Guisande, C. and Joja, J. 1988. The dynamics of various species of the genus *Brachionus*. Guadalquiver River. Arch. Hydrobiol. 112: 579 – 595.

Khalil, M.T. and El-Dawy, F. A. 2002. Ecological Survey of Burullus Natural Protectorate: Fishes and Fisheries. MedWetCoast, Egyptian Environmental Affairs Agency (EEAA), 69 pp.

Pejler, B. and Berzins, V. 1994. On the ecology of *Lecane* (Rotifera). Hydrobiol. 273: 77 – 80.

Premazzi, G. and Chiaudani, G. 1992. Current approach to assess water quality in lakes. In River Water Quality. Published by the Commission of the European Community, 249 – 308.

Ramdani, M. ; Flower, R. and Roger, J. 2001. Open water zooplankton communites in North African wetland lakes: the CASSARINA Project. Aquatic Eclogy 35: 319-333.

Robinson, A. H. and Robinson, R. K. 1971. Seasonal distribution of zooplankton in northern basin of Lake Chad. J. Zool. London 163: 25 – 61.

Samaan, A. A. 1976. Distribution of zooplankton in Lake Edku. Bull. Inst. Oceanogr. & Fish. 6: 159 – 196.

Shiel. R. J. ; Walker, K. F. and Williams, W. D. 1982. Plankton of the lower River Murry, South Australia. Aust. J. Mar. Freshwat. Res. 33: 301 – 327.

Shiel, R. J. and Koste, W. 1992. Rotifera from Australian inland water. III: Trichocercidae. Trans. R. Soc. S. Aust., 116 (1): 1 – 37.

Sladecek, V. 1983. Rotifers as indicators of water quality. Hydrobiol. 100:169– 201.

7.8. PLATES OF ZOOPLANKTON OF LAKE BURULLUS (7.1-7.16)

(after Guerguess 1986 and 1993; El-Shabrawy 2004)

Plate 7.1
Brachionus angularis
Brachionus caudatus
Brachionus calyciflorus
Brachionus falcutus
Polyarthra vulgaris
Hexarthra oxuris
Asplachnia sieboldi
Anuraeopsis fissa

Plates 7.2
Keratella cochlearis
Keratella tropica
Keratella quadrata dispersa
Keratella quadrata quadrata
Proalides sp
Lecane luna
Filinia longiseta
Brachionus urceolaris

Plates 7.3
Moina micrura
Diaphanosoma exesium
Bosmina longirostris
Chydorus sphearicus

Plates 7.4
Macrothrix laticorinis
Daphnia similes

Plates 7.5
Thermocyclops neglectus

Plates 7.6
Acanthocyclops americanus

Plates 7.7
Anuraeopsis fissa
Brachionus calyciflorus
Brachionus caudatus
Brachionus falcatus
Brachionus plicatilis
Keratella cochlearis
Keratella tropica

Plates 7.8
Asplanchna sieboldi
Asplanchna priodonta
Proalids sp.
Trichocerca pusilla
Polyarthra vulgaris
Filinia longiseta

Plates 7.9
Lepadella ovalis
Lepadella patella
Colurella Adriatic
Lecane luna
Lecane arcula
Lecane depressa
Synchaeta oblonga
Hexartha oxyuris
Keratella quadrata

Plates 7.10
Diaphanosoma excisum
Moina micrura
Ceriodaphnia reticulata
Alonna intermedia
Chydorud sphaericus
Bosmina longirostris

Plates 7.11
Diaphanosoma mongolanoum
Macrothris laticornis

Plates 7.12
Nitocro lacustris
Onychocamptus mohamed

Plates 7.13
Thermocyclops crassus
Halicyclops magniceps

Plates 7.14
Mesocyclops leuckarti
Diacyclops bicuspidatus

Plates 7.15
Acanthocyclops americanus

Plates 7.16
Ergasilus sieboldi
Acartia latisetosa
Canuella perplexa