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Abstract

Zooplankton is known to form an important component of the biological communities in large rivers due to their high abundance and ability to cycle nutrients through the aquatic environment. Little is known about these communities in the River Nile, so the present study was designed on sampling Zooplankton in the River Nile (main body) and its two branches, Rosetta and Damietta, along four seasons of the year 2009. During the investigation period, Rotifera represented the most dominant species recording 54% followed by Protozoa, Cladocera, Copepoda, and Meroplankton with ratios of 17%, 15%, 9%, and 6% respectively. There were marked seasonal differences between individual species in the main body of the river and its two branches.

Introduction

The River Nile is the main water supply for drinking purposes, irrigation and industry in Egypt**.** The River Nile constitutes over 98% of the fresh water resources available to Egypt, it provide 55.5 Billion m^3 per year coming from the south according to the international agreement for the distribution of water resources of the River Nile between countries of Nile basin **(El-Dib, 2004)**.

Zooplankton may form an important component of the biological communities in large rivers due to their high abundance and ability to cycle nutrients through the aquatic environment **(Kobayashi *et al.*, 1998).** The zooplankton abundance is primarily controlled by fluctuations in physical environment, particularly temperature, which causes high seasonality among samples **(Isinibilir *et al.*, 2008).** Pollution effect of industrial waste water on the structure of zooplankton communities in certain segments along the River Nile had been studied by **Ghazy (1990)**. Recent studies dealing with zooplankton in the River Nile are very rare.

Borhan (1976) surveyed the zooplankton population of the River Nile. The study covered the zooplankton fluctuation, the important groups and the dominant genera and species**.**

Zaghloul (1988) studied the distribution of zooplankton community between Rosetta Nile branch and Nile River and found that the Rotifera are the dominant group.

Mageed (1995) studied zooplankton in Lake Nasser during 1993-1994 and **El-Bassat (1995)** studied seasonal variations and distribution of zooplankton community along the River Nile.

Ali and Heikal (2006) determined factors which regulate zooplankton organisms along Lake Nasser and recorded 23 species of zooplankton.

Nagwa *et al.*, (2011), studied the spatial and temporal distribution of rotifers in Rosetta Estuary in the River Nile.

Potential differences in zooplankton communities between the upstream and downstream of River Nile are rarely examined in the last years. Accordingly, the present study undertook a large spatial (28 sites) and temporal scale (1 year) aiming to determine the distribution and the seasonal dynamics of zooplankton through the main body of Nile River and its branches Rosetta and Damietta.

Materials and Methods

Site description:

The study area extends through 28 stations from Aswan to Cairo. After, Cairo, to the north the River is divided into two branches which flow into the Mediterranean Sea at Rosetta (Rashid) and Damietta (Dumyat) each of the tow branches flows intensively among cultivated land of the Nile delta ,as illustrated in the map. (Fig.1)

Fig. 1A space Map of the River Nile, showing locations of the sampling site

Samples collection :

Samples were taken seasonally from surface water from each station and thirty liters of each water sample were filtered through a zooplankton net of 55µm mesh diameter. Each collected sample was transferred to a labeled clean bottle and fixed into 4 % formaldehyde. Rose Bengal was added to facilitate separation of organisms from the suspended matter.

Sub samples of 1 ml were drawn from the sample (after careful mixing), using a wide-pipette**.** The contents of such pipette were let to flow freely into 1 ml Sedgwick-Rafter cell. Three successive sub samples were examined under a binocular compound microscope at 10x magnification. Identification of various taxa was based on the works Edmondson (1959), Negrea (1983) and Foissner and Berger (1996).

Results

The total percentages of species recorded during the investigation period were showen in figure 2. Rotifera was the most dominant species recording 54% followed by Protozoa, Cladocera, Copepoda, and Meroplankton with ratio of 17%, 15%, 9%, and 6% respectively.

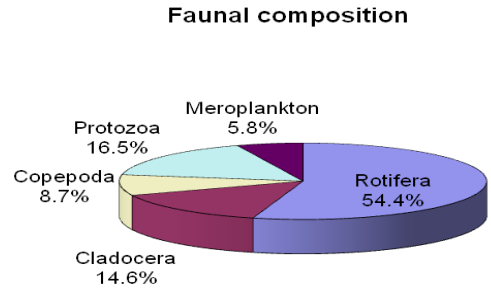

Fig.2. Ratios of different zooplankton groups recorded during the investigation period in River Nile and its branches.

In the main body of the river, during autumn season, Rotifera represented 55% of the total organisms followed by Protozoa (22%), cladocera (9%), copepoda (8%), and the Meroplankton (6%) (Fig. 3, Table1a). During winter, Rotifera decreased to reach 48 %, while, Protozoa and Copepoda showed similler percentage (22%). Cladocera reached the maximum level (17%) and Meroplankton decreased slightly to reach 5%.

In the spring season, Rotifera still showed the highest percentage 57%, while Protozoa formed the minimum value 14% .Meanwhile, Cladocera represented 17 %, and copepoda reached the maximum value 9%, and the Meroplankton decreased to a minimum level (3%). During summer season, Rotifera continued with the maximum level (60%), while Protozoa increased again to reach 17%, with

decreasing in Cladocera and Copepoda 11% and 9% respectively. Meanwhile, the Meroplankton increased slightly to reach 6%.

Table 1 . Seasonal percentages of different zooplankton groups

a)- In the main body of the river

	Rotifera	Protozoa	Cladocera	Copepoda	Meroplankton
Autumn	55	22	9	8	6
Winter	48	22	8	17	5
Spring	57	14	17	9	3
Summer	60	17	11	9	6

b)- In Rosetta branch

	Rotifera	Protozoa	Cladocera	Copepoda	Meroplankton
Autumn	64	13	11	5	7
Winter	55	18	15	8	4
Spring	61	18	9	5	7
Summer	72	14	6	4	4

c)- In Damietta branch

	Rotifera	Protozoa	Cladocera	Copepoda	Meroplankton
Autumn	62	16	12	6	4
Winter	56	15	18	6	5
Spring	57	19	14	6	4
Summer	66	15	9	6	4

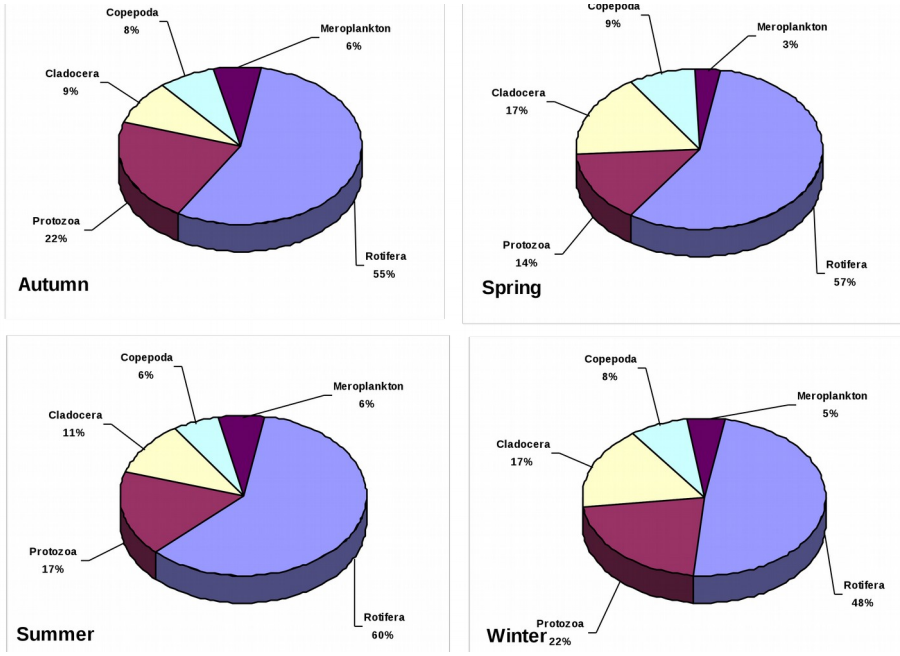

Fig.3. Seasonal percentages of different zooplankton groups inhabiting the main body of River Nile.

In Rosetta branch, during autumn season, Rotifera represented 64% of the total organisms, While Protozoa decreased to reach the minimum level of 13%, followed by Cladocera 11%, Copepoda 5%, and the Meroplankton 7%.

During winter season, Rotifera decreased slightly reaching 55%, while Protozoa and Cladocera continued reaching to the maximum ratios (18% and15%) of the total organisms. In the same pattern, Copepoda reached the maximum value of 8%, while the Meroplankton decreased to minimum value (4%) during this season.

There was a remarkable increase during spring season where the percentage of Rotifera was 61%, while Protozoa had the maximum value (18%).

On the other hand, Cladocera and Copepoda decreased to 9% and 5% respectively,while the Meroplankton increased to reach the maximum level (7%) of the total organisms.

In summer season, Rotifera reached the maximum percentage (72%), while Protozoa showed a remarkable decrease to 14% and Cladocera showed the same trend to reach 6% of the total organisms. Copepoda and the Meroplankton decreased and had the same ratio of 4% during this season (Fig.4, Table1b)

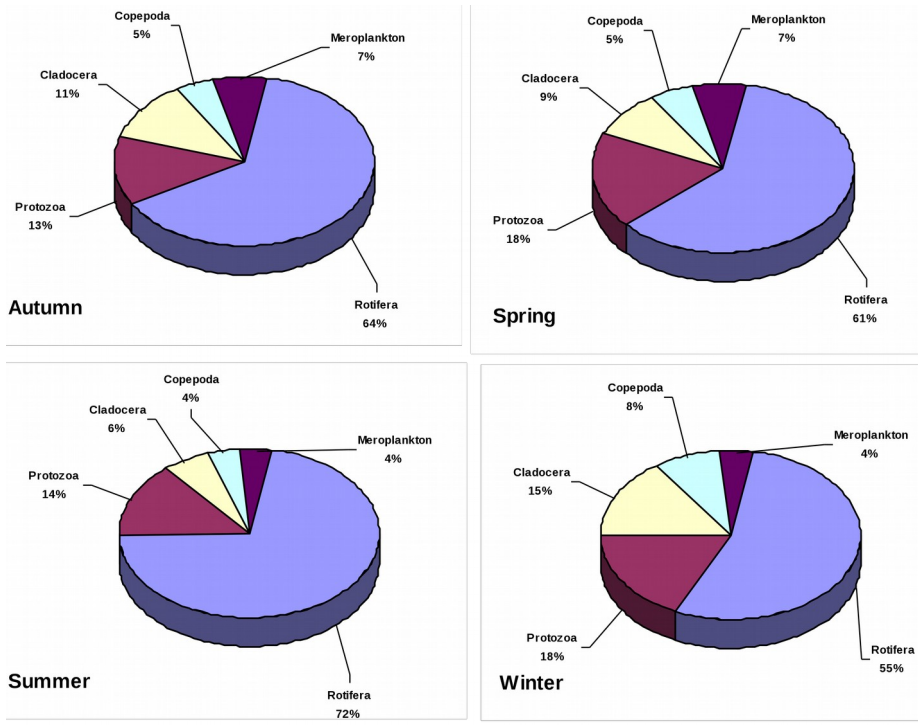

Fig.4. Seasonal percentages of different zooplankton groups inhabiting Rosetta branch

In Damietta branch, there was a remarkable decreasing in the total organisms during autumn season , where Rotifera represented 62% while Protozoa formed about 16%. Cladocera , Copepoda and the Meroplankton were represented by12%, 6%, 4% of the total organisms respectively during this season. During winter season, Rotifera decreased slightly to reach 56%. Protozoa showed the minimum value of 15% only. On the other hand, Cladocera increased to reach the maximum level 18% of the total organisms. Copepoda had the same ratio (6%) of the previous season, while the Meroplankton increased to reach the maximum percentage (5%).

There was a remarkable increasing during spring season, where Rotifera increased slightly to reach 57% .Protozoa reached the maximum value (19%) of the total organisms. This combined with decrease in Cladocera that represented by 14%. Meanwhile, Copepoda and the Meroplankton formed 6% and 4% respectively (Fig.5,Table1c).

In summer season, Rotifera increased to the maximum percentage (66%). Protozoa decreased to reach 15% and Cladocera decreased to the minimum value (9%) of the total organisms. Meanwhile, Copepoda and the Meroplankton still had the same level of 6% and 4% respectively during this season .

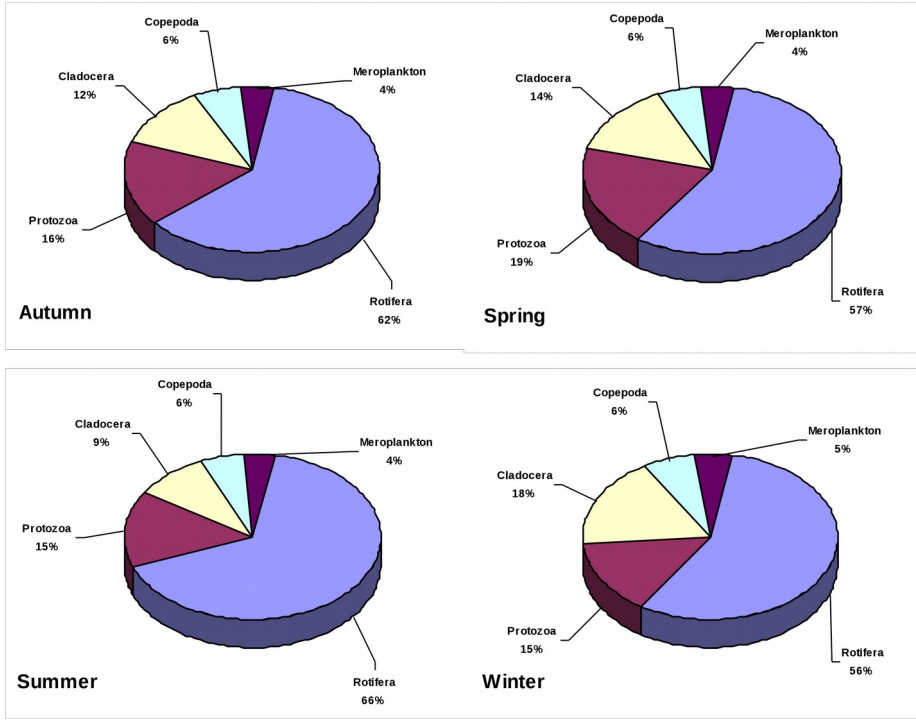

Fig.5. Seasonal percentages of different zooplankton groups inhabiting Damietta branch

Discussion:

Considering all the data of the present study Rotifera was the most dominant group of zooplankton investigated (54%). This was followed by Protozoa (17%), Cladocera (15%), Copepoda (9%), and finally the Meroplankton (6%). The population density of Rotifers in the main body of the river and its two branches in different season showed that it showed the highest percentage over other groups. **Tidame and Shinde (2012), Nagwa *et al.*, (2011) and David *et al.*, (2002),** confirm this result where **James and William (1988)** found that Copepoda was the dominant group in the Caura River Colorado, U.S.A.

Rotifera recorded the highest percentage of density (60%, 72%, and 66%) in the main body of the river and its two branches (Rosetta and Damietta) respectively during summer season. This means that there is a significant relationship between high density and high temperature. The zooplankton abundance is primarily controlled by fluctuations in physical environment, particularly temperature, which causes high seasonality among samples **(Isinibilir *et al.*, 2008).** Water temperature is known to be an important biotic parameter that controls the population growth of Rotifers (**Radwan, 1984; Galkovskaja, 1987; Berzins and Pejler, 1989).** The ecological studies of Rotifers in different world regions indicated that some Rotifers have the ability to exist in polluted waters and are considered as pollution indicators. They are known to be excellent indicators of organic pollution as they increase in species

Richness and abundance in organically rich environment (**Abdel Aziz *et al.*, 2001& Abdel Aziz and Dorgham, 2001**), or serve as indicator of tropic nature of the environment **(Arora, 1966).**

There were marked seasonal differences between individual species in most of groups (Protozoa, Cladocera, Copepoda, and the Meroplankton) in both the main body of the river and its two branches. Numerous investigators have shown relationships between rainfall and growth activity of several aquatic organisms. The relationship between rainfall and total zooplankton abundance is obviously not a direct one but relates to nutrient input after rainfall, thus influencing and promoting growth of the phytoplankton and subsequent grazing, growth and production of the zooplankton **(Mavuti, 1990 & Osore *et al*., 1997).**

Rotifers density increased with increasing distance down-stream , which was explained by the high percentage of Rotifers in both Rosetta and Damietta than that in the main body of the river. Reproduction of zooplankton in the flowing waters can increase plankton abundance .But typically, only at low flow, high current velocities appear to inhibit reproduction (**James and William, 1988).**

The percentage of the other groups was slightly fluctuated downstream.

Protozoa was significantly decreased down-stream in autumn, winter, and summer , but slightly increased in spring. Generally, this reduction may be due to the predation by planktivorous fishes along the downstream. Furthermore, predation may not be the only mechanism resulting in mortality, mechanical damage may result in the loss of zooplankton (**Hynes, 1970).**

Cladocera increased down-stream in Damietta branch only, but significantly decreased in Rosetta branch because of the different nature of this branch .

The Rosetta Estuary is semi-enclosed coastal area having a free connection with the Mediterranean Sea and within which the sea water is always diluted with freshwater coming from the River Nile. The Rosetta Estuary is the classical example of a transitional environment between the river and the sea (**Ibrahim *et al.*, 2007).** The reduction of Cladocera may be due to the increase in the salinity of the water.

Copepoda decreased downstream in all seasons that may be due to predation and mechanical damage (**Hynes 1970).**

The Meroplankton, insignificantly changed in percentage downstream and in all seasons.

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توزيع وتوافر العوالق الحيوانية فى نهر النيل

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تمت دراسة اعداد ونسب العوالق الحيوانية بأنواعها المختلفة الموجودة فى 28 محطة على نهر النيل من اسوان جنوبا الى القاهرة شمالا ثم من خلال فرعى النيل دمياط شرقا ورشيد غربا. وقد تم جمع العينات خلال الأربع فصول (الخريف- الشتاء- الربيع- الصيف) وذلك خلال عام 2009. وقد قسمت النتائج الى ثلاث مجموعات المجموعة الاولى والتى اخذت من المحطات الواقعة على الجزء الرئيسى من نهر النيل والممتد من اسوان الى القاهرة والمجموعة الثانية من المحطات التى تمر خلال فرع دمياط شرقا والمجموعة الثالثة من تلك التى تمر خلال فرع رشيد غربا وقد بينت النتائج ان هذه العوالق الحيوانية تتمثل فى انواع مختلفة الاشكال والتصنيف وهى العجليات التى تمثل النسبة الاعلى (54%) تليها الاوليات الحيوانية (البروتوزوا) 17% ثم متفرعة القرون وتمثل 15% ثم مجدافيات الأرجل ممثلة فى 9% واخيرا الميروبلانكتون التى تمثل 6%. وقد اختلفت هذه النسب لهذه المجموعات صعودا وهبوطا مع اختلاف الفصول والمواقع المختلفة للمحطات فى الجزء الرئيسى للنيل وفرعى دمياط شرقا ورشيد غربا مع احتفاظ الروتيفرا بأعلى النسب خلال كل الفصول والأماكن.