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Comparative analysis of rotifer community in two Rayahs of River Nile, Egypt

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ABSTRACT

The rotifer communities were determined in El-rayah El-Nasery and El-rayah El-Tawfeky (Egypt) as small branches of River Nile by tracking seasonally variations in diversity and population density. It was found that the annual density of rotifers in El-Rayah El-Nasery (5442000 Ind. /m³) was higher than that in El-Rayah El-Tawfeky (3680000 Ind./m³).The highest density of rotifer occurring in spring season but the lowest density occurring in winter season in the two rayahs. A total of 40 rotifer species were identified in the present study. The highest number of species and richness was observed in summer and the lowest number and richness was recorded in winter season. Of these species, *Prolides sp, Keratella cochlearis ,k. tropica, Brachionus calyciflorus, B. caudatus, Polyarthra vulgaris, Philodina roseola* and *Tricocerca pusilla* were abundant.

Key words: Rotifer community**,** El-rayah El-Nasery and El-rayah El-Tawfeky, Nile river.

INTRODUCTION

Rotifers are a particularly significant group of the littoral and limnetic micro-invertebrates (Wallace and Snell, 2010). Rotifers are jelly plankton (gelata) with no export endoskeleton and a water content of 92%–98% that are usually more or less transparent (Dumont, 2007). Rotifers contain about 2030 species worldwide (Segers, 2007).

The apparent dominance of rotifers in rivers may be due to their relatively short generation time compared to the larger crustacean zooplankton (Van Dijk and Van Zanten, 1995 & Mola, 2011). In addition also its simple parthenogentic reproduction (Herzig, 1983) which in favorable conditions results in high production rates often manifested as very high population densities (Andrew and Fizsimons, 1992) and they are less vulnerable to fish predation (Brook and Dodson, 1965, Allan, 1976). Rotifers are also able to reproduce over a wide temperature range (Galkovskaja, 1987). The eutrophication affects the composition of zooplankton, shifting the dominance from large species (Copepoda) to smaller species (Rotifer) (El- Shabrawy, 2000; Emam, 2006; Mola, 2011).

Rotifers are highly nutritious food for the larvae of aquatic crustaceans and fish and have complex diversity and distributions in fresh water because many samples species are cosmopolitan (Segres, 2008). They are very good indicators of alterations in water quality because they respond quickly to environmental changes (Gannon and Stumberger, 1978).

Most of the studies conducted on the plankton of the River Nile were concerned with certain areas of the River (Aboul Ezz *et al*, 1996; Abd El-Mageed, 2001; Galal and Gaber, 2002; Bedair, 2006; Emam, 2006; Abo- Taleb, 2009; Elfeky and Khalifa, 2014). These studies have shown that Rotifer group contributed about 54% to the total number of zooplankton community.

No recent studies of the rotifer community in rayahs of River Nile have been conducted; therefore, this study was conducted to investigate the density of the rotifer community in two rayahs of River Nile (El-Rayah El-Tawfwky and El-Rayah El-Nasery) and the relationship between water parameters and rotifers community.

MATERIALS AND METHODS

Sites study:

Rayahs are the main channels of fresh water from Damietta and Rosetta branches, which are vital for irrigation, navigation, fishing and other domestic uses in Egypt. Two rayahs were investigated in this study;

1- El-Rayah El-Towfiky which starts from the Damietta branch at el-Kanater station and extends into the middle and the east of Delta heading north parallel to the Damietta branch until Mansoura city at station (T5) and then heading East ward within Dakahlia governorate even Manzalah city. This rayah extends with average length of 180-200 Km from El-Kanater and with average width 40-50 m and its average depth 2-3 m. this rayah characterized by existence of many water plants and electricity stations on its beaches which include large water stations such as: Banha station and small water stations which heavily scattered on both sides of Rayah. This Rayah branched at the Mansoura city into sub-main branches: the first one: extending north to Damietta city, it is characterized by a lack of water and lack of breadth (little width); almost water disappears in Faraskour city. So the water samples are not collected from this branch. The second: run east to Dekerness, El-Gamalia and El-Manzalah. This branch ends into Manzalah Lake previously but now it doesn't reach it. Also this branch is characterized with abundantly water as compared with the first branch. Seven samples were collected from this branch.

2- El-Rayah El-Nassery starts from the Rosetta branch at El-Kanater and runs in the West of Delta where it is heading northwest in the direction of Nubaria canal, and meet it at Kanater Pauline (Kom Hamada), then heading to the northwest even Mediterranean Sea breaking Mariot Lake. The length of This Rayah could be up to 200 Km from El-Kanater and with average width 40-50 m and its average depth 2-3 m. This rayah characterized by existence of many water plants and electricity stations on its beaches especially on El Nubaria canal. Eight samples were taken from this rayah.

Fig (1): Map of El-Rayah El-Tawfeky and El-Rayah El-Nasery demonstrating the collected Stations.

Sampling:

Water samples were conducted seasonally throughout 2014. All samples took place from surface water from each station. Prior to sampling, the pH, dissolved oxygen, water temperatures and electrical conductivity were measured in situ using portable meters. Thirty liters of each water sample were filtered through a zooplankton net of 55µm mesh diameter. Samples were subsequently taken back to the laboratory and preserved in 4 % formaldehyde. Rose Bengal was added to facilitate separation of organisms from the suspended matter. Sub samples of 1 ml were drawn from each sample (after careful mixing) using a wide-pipette (McCallum, 1979). 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 rotifer taxa were based on the works of Edmondson (1959) and Foissner and Berger (1996).

Data analysis:

The diversity indices of rotifer species were seasonally calculated as Species Richness, Shannon-Weaver Diversity Index and Index of Evenness by using Primer 5 (2001); the indices were calculated at individual species level. Principal component analysis (PCA) between different rotifer main species and environmental variables at the study area was performed using XLSTAT, 2014.

RESULTS AND DISCUSSION

Physico- chemical analysis:

The physico-chemicals parameter of El-Rayah El- Tawfeky and El- Nasery were determined seasonally and nearly similar in variation as shown in Table (1). The values of pH at the studied area were in the alkaline side and recorded the maximum value in summer and the minimum reading in winter in El-Rayah El-Tawfeky and El-Nasery with annual average 8.27 and 8.34, respectively. Alkaline pH helps flourishment and growth of rotifer **(Sharma *et al.,* 2015).** This tendency to the alkaline side may be due to the increased photosynthetic activity of planktonic algae, or to the chemicals nature of water **(Fathi and Kobbia, 2000)**. It showed positive correlation with temperature in El-Rayah El-Tawfeky and El-Nasery (r= 0.663; 0.607, respectively), and showed negative correlation with dissolved oxygen in El-Rayah El-Nasery (r=-0.415).

Temperature is considered the main factor affecting directly or indirectly not only on population density, species composition and richness of rotifers in freshwaters, but also on their growth activity, activation of reproduction processes and susceptibility to diseases (**Shayestehfar *et al*., 2008 ; Kaya *et al*., 2010 ; Moustafa *et al*., 2010**). Water temperature has the same pattern of pH, where it recorded the maximum value in summer and decreased to minimum reading in winter in El-Rayah El-Tawfeky and El-Nasery with annual average 23.89^{o}C and 24.75^{o}C, respectively. It showed negative correlation with Dissolved Oxygen (DO) in El-Rayah El-Tawfeky (r=-0.388) and Ec in El-Rayah El-Nasery (r=-0.619).

The annual average of electrical conductivity (EC) was 431.46µS/cm in El-Rayah El-Tawfeky and 417.41µS/cm in El-Rayah El-Nasery. The maximum value of EC was recorded in autumn in El-Tawfeky and in winter in El-Nasery and decreased to minimum value in summer season in two rayahs. EC values are negatively correlated with DO in El-rayah El-Tawfeky. The highest value of electrical conductivity could be due to the high pollution levels in water, resulted from the high nutrient loads of wastewater (**Kobbia *et al.*, 1995; Fathi and Al-Kahtani, 2009).** The lowest reading of EC during summer in Rosetta branch of River Nile may be attributed to the increase of water level during flood period and uptake of dissolved salts by phytoplankton (**Saad *et al*., 2011)**

The presence of oxygen in water is an important factor for most aquatic plants and animals to survive (**Stahl and Ramadan, 2008**), and plays an important role in the occurrence and abundance of rotifer species, (**Hoffman, 1977).** The mean dissolved oxygen value recorded was 7.15 mg/l in El-rayah El-Tawfeky and 7.63 mg/l in El-rayah El-Nasery. It increased to the maximum value in winter and recorded the minimum one in autumn. The highest of DO in winter may be due to the activities of wind action that permits high solubility of oxygen in atmosphere and the transfer of more oxygen across the air-water interface (**Ibrahim *et al*., 2008 ; Mahmoud *et al.*, 2008)**.

Table (1): Range of variations in main physical and chemical parameters in main River Nile rayahs measured during the investigated period.

	El-Rayah El-Tawfeky					El-Rayah El-Nasery				
	Spring	Summer	Autumn	Winter	Annual Average	Spring	Summer	Autumn	Winter	Annual Average
pH	(7.07 - 8.47) 8.21	(8.39 - 8.50) 8.49	(8.29 - 8.41) 8.35	(7.96 - 8.12) 8.06	8.27	(8.15 - 8.46) 8.31	(8.44 - 8.62) 8.50	(8.11 - 8.81) 8.30	(8.02 - 8.26) 8.15	8.34
Temp 0C	(26.3 - 28.2) 27.1	(28.5 - 31.5) 30.63	(21.6 - 23.7) 22.56	(14.2 - 23.7) 15.24	23.89	(25.8 - 28.3) 27.03	(29.1 - 33) 31.03	(22.3 - 25.1) 23.20	(15 - 19.8) 17.76	24.75
EC µS/cm	(353 729) 416.29	(345 785) 413.14	(401 810) 475.29	(398 481) 421.14	431.46	(345 519) 392.38	(357 385) 359.88	(409 602) 442.25	(410 740) 475.13	417.41
DO mg/l	(4.39 - 7.85) 6.86	(4.83 - 7.62) 6.74	(5.39 - 7.57) 6.58	(5.02 - 10.19) 8.40	7.16	(7.42 - 8.4) 7.93	(6.4 - 10.85) 7.34	(5.69 - 8.12) 6.98	(6.63 - 9.12) 8.25	7.63

Rotifer species Composition and Distribution:

A total of 40 species of rotifers were recorded, these species were listed in Table (2). 37 species were appeared in both rayahs. The highest number of species was observed in summer. 25 species at station 2 in El-Rayah El-Tawfeky and 27 species at station 3 in El-Rayah El-Nasery, consequently the highest species richness of 1.85 and 1.99, respectively was recorded. The lowest number of species and richness was recorded in winter season, 6 species and 0.48 at station 5 in El-Rayah El-Tawfeky and 10 species and 0.83 at station 2 in El-Rayah El-Nasery, (Fig. 2A&C and Fig. 3A&C). Higher diversity of rotifers in summer might be attributed to enhanced rate of population growth at higher temperatures (Galkovskaya, 1987), and the production of new species in summer and inflow of large amount of river water into the flood plain water during summer, which brought different types of riverine species into the floodplain (Segers, 2008). This result agrees with the work of Saler and Sen (2002); Malik and Sulehria (2003, 2004) and Schöll and Kiss (2008).

The annual density of rotifers in El-Rayah El-Nasery (5442000 Ind. /m³) during the study was higher than that in El-Rayah El-Tawfeky (3680000 Ind. /m³). Rotifer density was more abundant in spring season and recorded the minimum value in winter season in both rayahs. Stations 2 and 1 attained the greatest value of rotifer density (2352000 Ind. /m³ and 2256000 Ind. /m³) in El-Rayah El-Tawfeky and El-Rayah El-Nasery. Sharply decreased to the minimum reading of rotifer density at station 5 and 3 (36000 Ind. /m³ and 42000 Ind. /m³) in El-Rayah El-Tawfeky and El-Rayah El-Nasery, respectively (Figs. 2B & 3B). The dominance of rotifers in spring may be attributed to the favorable conditions as suitable temperature, stable water condition and abundance of food. Abdel Aziz, (2005) and Cooke *et al*. (2005) found that the highest rotifer's crop during spring may be due to the presence of dissolved organic matter. This result agrees with (Amer, 2007 ; Zakaria, 2007; Khalifa, 2014; Khalifa and Bendary, 2016).

Diversity index was abundant in summer season and showed remarkable decreased in autumn in both rayahs. On the contrary, evenness was higher in summer in El-Rayah El-

Tawfeky. While in El-Rayah El-Nasery, it was slightly increased in winter except station 4 & 6 (Fig. 2D & E and Fig. 3 D&E).

In this work, *Prolides sp* was the most dominant rotifer species. It contributed about 28.4% and 28.9% of the total rotifer density in El-Rayah El-Tawfeky and El-Rayah El-Nasery, respectively. It attained its highest population density in spring in El-Rayah El-Tawfeky and in autumn in El-Rayah El-Nasery. In winter season, *Prolides sp* showed the minimum value in two rayahs. El-Shabrawy and Dumont (2003), Saad *et al.* (2013) and El-Shabrawy and Germoush (2014) found that *Prolides sp* was one of the dominant rotifer species in many freshwater bodies in Egypt.

Genus *keratella* was the second dominant rotiferan genus which represented by *K. cochlearis* and *k. tropica*. *Keratella cochlearis* contributed about 16.9% in El-Rayah El-Tawfeky and 21.6% in El-Rayah El-Nasery of total rotifer density. It recorded the highest density in spring and the least density count in autumn season. *Keratella tropica* formed 13% and 12% of total rotifer density in El-Rayah El-Tawfeky and El-Rayah El-Nasery. The maximum density of *Keratella tropica* showed in spring in El-Rayah El-Tawfeky and in autumn in El-Rayah El-Nasery. It sharply decreased to the lowest reading in winter season in two rayahs. Pejler and Bērziņš (1989) and Koste (1978) believed that, *Keratella cochlearis* is one of the most common representatives of the family Brachionidae and is known to inhabit a diverse range of waters. The dominant result of *Keratella cochlearis* agreed with (Pace *et al*., 1992; Van Dijk and Van Zanten, 1995; May and Bass, 1998; Burger *et al*., 2002; Khalifa,2014 and Khalifa and Bendary, 2016).

Trichocerca represented by four species *T.Pusilla*, *T.olngata*, *T.cylindrica* and *T.porcellus*. Among which *T. pusilla* dominated and detected about 10.4% of total rotifer in El-Rayah El-Tawfeky and 7.3% in El-Rayah El-Nasery. It flourished in autumn and decreased to the lowest density in winter season.

Brachionus was the most taxon-rich genus being represented by eight species; however their densities were very low throughout the study period, the high richness of Brachionidae indicates eutrophic conditions according to Mageed, 2008; Claps *et al*, 2011 and Perbiche-Neves, 2013. Kumari *et al.* (2008) described *Keratella* sp. and *Brachionus* sp. as pollution indicator species. *B. caudatus, and B. calyciflorus* dominated and detected in all seasons. *B. calyciflorus* contributed about 4.5% and 5.2% in El-Rayah El-Tawfeky and El-Rayah El-Nasery respectively. It peaked in autumn and decreased in winter.

The population density of *B. caudatus* increased in spring and decreased in winter and recorded about 4.7% and 2.5% El-Rayah El-Tawfeky and El-Rayah El-Nasery respectively. El-Bassat (1995) referred that high existence of these genus at Delta Barrage was attributed to there ability to tolerate pollution.

The population density of *Polyarthra vulgaris* increased in spring in El-Rayah El-Tawfeky and its crop decreased in winter but it constituted 6.1% of total rotifers. The species flourish in autumn season and gradually decreased to the lowest density in winter and attained to form about 6.5% in El-Rayah El-Nasery. This result agreed with Khalifa (2000 & 2014), El-Bassat (2002) and George (2012) whereas they recorded the dominance of this species in late spring and autumn. And attributed the high abundance to high eutrophication level and reported this species as good indicators of eutrophication. On the contrary, *Polyarthra* spp. has been recorded as indicator of clean water with low temperature (Bahura *et al.* 1993).

Philodina roseola flourished in spring to the maximum value of density and sharply decreased in winter season. It contributed about 3.4% of total rotifer density in El-Rayah El-Tawfeky and 2.9% in El-Rayah El-Nasery. Khalifa (2000) believed that, *Philodina roseola* appeared more tolerant to the industrial waste in River Nile and might be used as indicators of industrial waste pollution.

Principal Component Analysis:

Principal Component Analysis (PCA) considering physical and chemical data beside the densities of main Rotifer species for El-Rayah El-Tawfeky is shown in Figure (4). The first ax of the PCA explained 41.81% of the variance and was positively correlated with *K. cochlearis, K. tropica, B. caudatus, B. calyciflorus, Proalides sp, T. pusilla* and *P. vulgaris.* Axes 2 explained 17. 01% of the variance; it was positively correlated with physico-chemical variables conductivity and dissolved oxygen.

An ax 1 of the PCA for El-Rayah El-Nasery explained 42.14% of the variance and was positively correlated with *Proalides sp, K. tropica, T. pusilla, B. calyciflorus* and *P. vulgaris.* Axes 2 explained 19. 17% of the variance; it was positively correlated with *K. cochlearis* and *B. caudatus*, (Fig: 5).

Recomindation:

The present study recommended

1- Using rotifer species as a bioindicators for water quality to provide early warning mechanisms of possible environmental damage.

2- The impacts of effluents can also be tested before their discharge into River Nile water.

3- Drainage wastewater should be treated using more advanced methods prior to discharge into River Nile and its branches.

Table (2): Rotifer species collected from main River Nile rayahs (Tawfeky and Nasery) during the investigated period.

Rotifer species	El-rayah El-Tawfeky	El-rayah El-Nassery	Rotifer species	El-rayah El-Tawfeky	El-rayah El-Nassery
Anuraeopsis fissa	+	+	*L. luna*	+	+
Asplanchna priodonta	+	+	*L. sp*	-	+
Brachionus angularis	+	+	*L.ungulata*	+	-
B. budapestinensis	+	+	*Lepadella patella*	+	+
B. calyciflorus	+	+	*Polyarthra vulgaris*	+	+
B. caudatus	+	+	*Proalides sp*	+	+
B. falcatus	+	+	*Philodina roseola*	+	+
B. plicatilis	+	+	*Rotaria sp*	+	+
B. quadridentatus	+	+	*Scaridium*	+	+
B. patulus	+	+	*longicaudum*	+	-
Cephalodella gibba	+	+	*Synchaeta pectinata*		
Collotheca pelagica	+	+	*Testudinella patina*	+	+
Colurella adriatica	+	+	*Trichocerca*	+	+
Conochilus unicornis	+	+	*elongata*	+	+
Epiphanes macrourus	+	+	*T. cylindrical*	+	+
Euchlanis dilatata	+	+	*T. pusilla*		
Filinia longisetea	+	+	*T. porcellus*	+	+
Hexarthra mira	+	+	*Trichotria tetractis*	+	+
Keratella cochlearis	+	+			
K. tropica	+	+			
Lecane aculeata	+	+			
L. bulla	+	+			
L. leontina	+	+			
L. closterocerca	+	+			

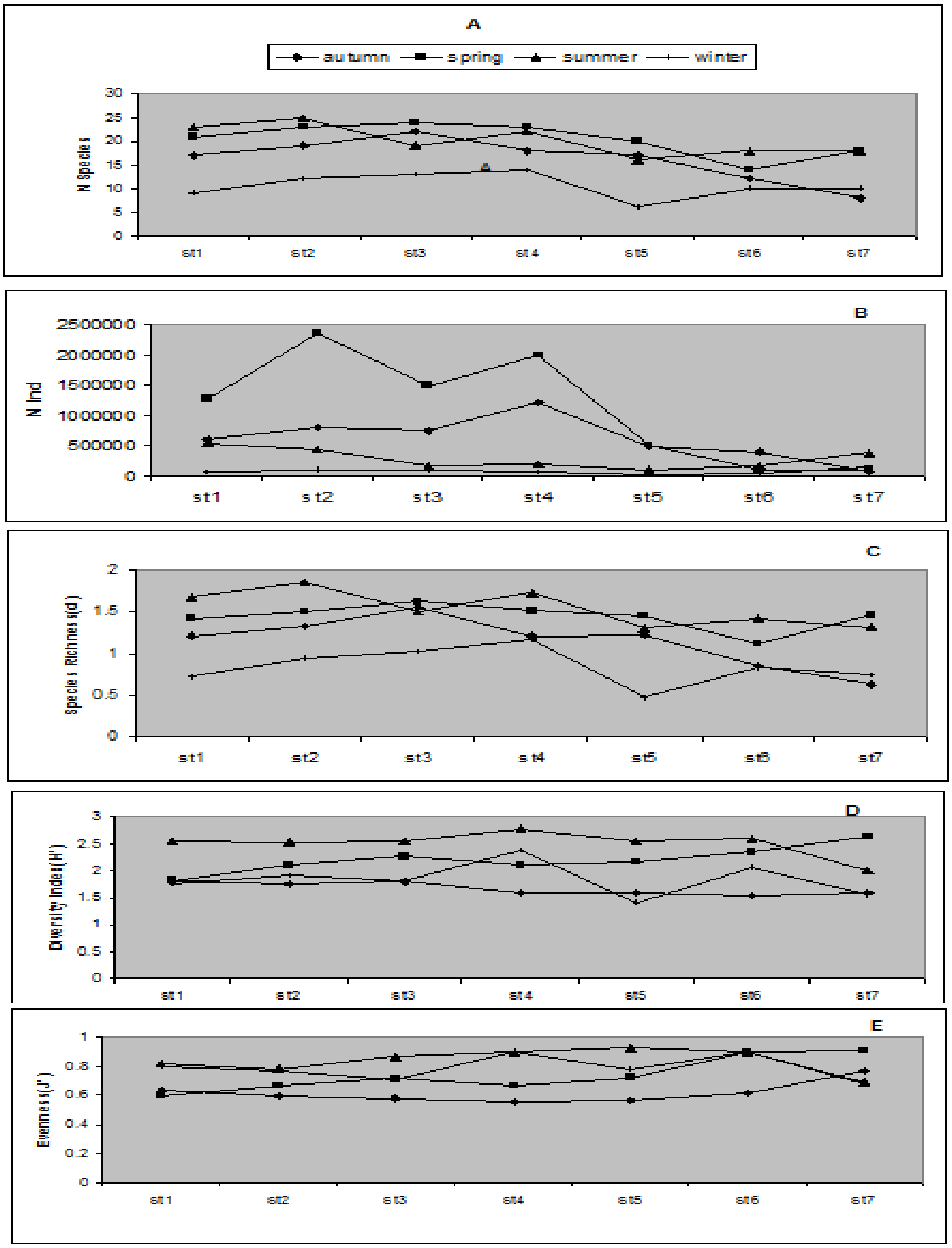

Fig. 2: A. Species number, B: Population density, C: Species richness, D: diversity index and E: Evenness of rotifers at El-Rayah El-Taweky during 2014.

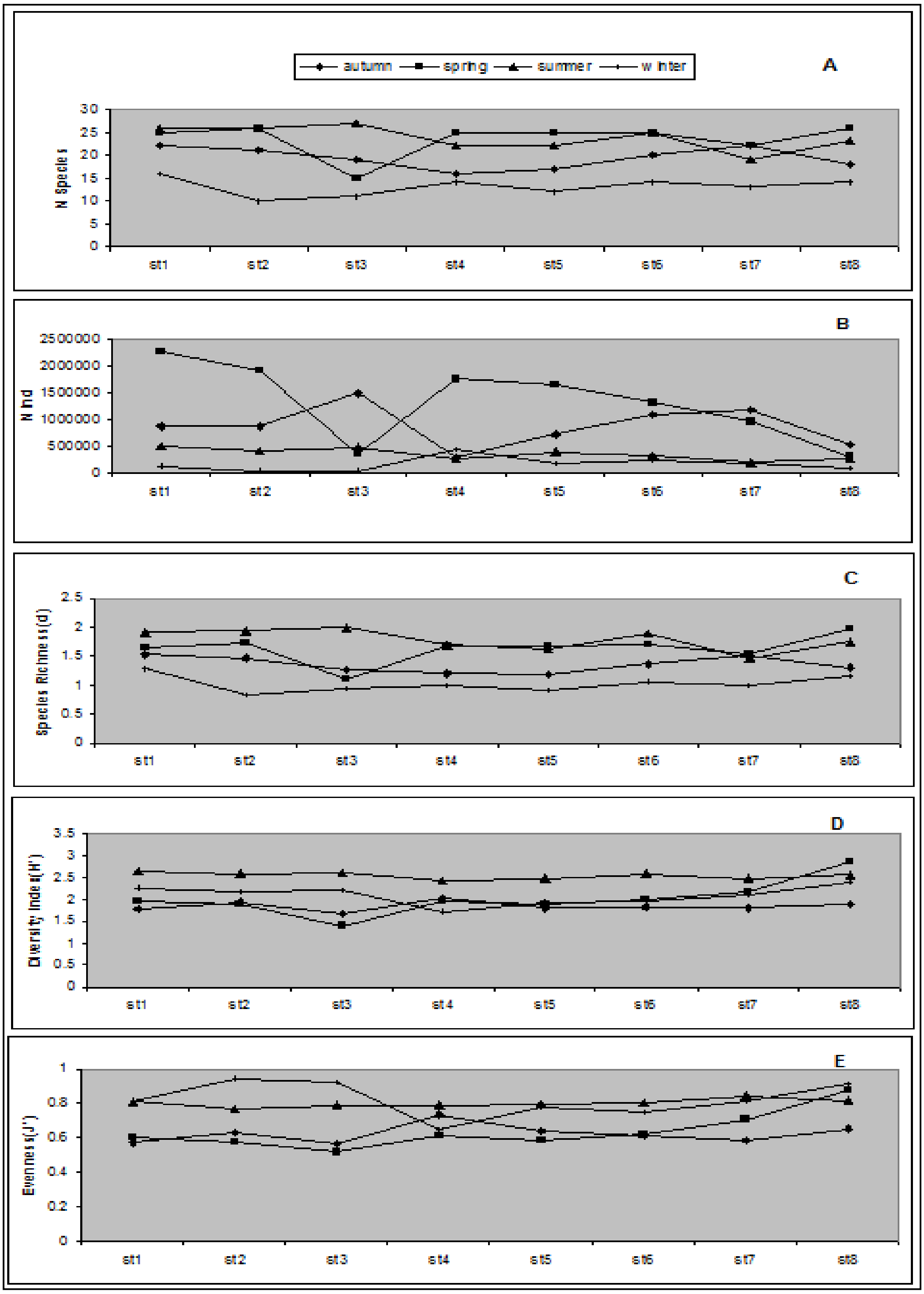

Fig. 3: A. Species number, B: Population density, C: Species richness, D: diversity index and E: Evenness of rotifers at El-Rayah El-Nasery during 2014.

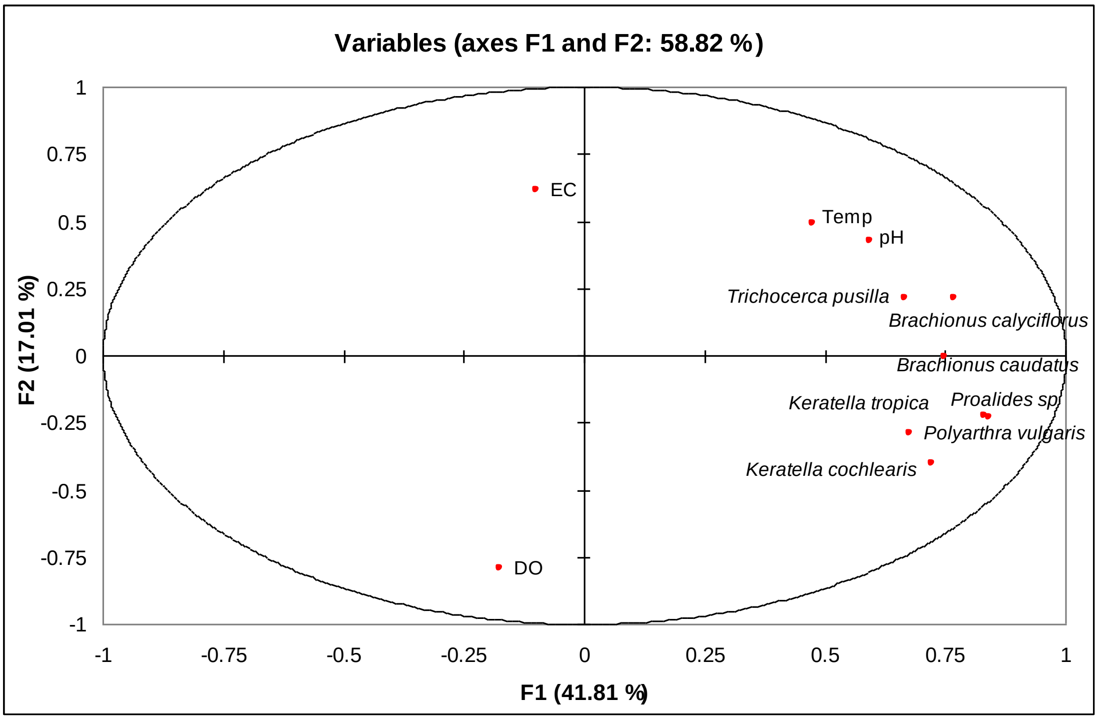

Fig. 4: Principal Component Analysis (PCA) of Physico-chemical Variables and the Main Rotifer Species in El-Rayah El-Tawfeky. Temp. : Temperature, EC: Electrical Conductivity and DO: Dissolved Oxygen.

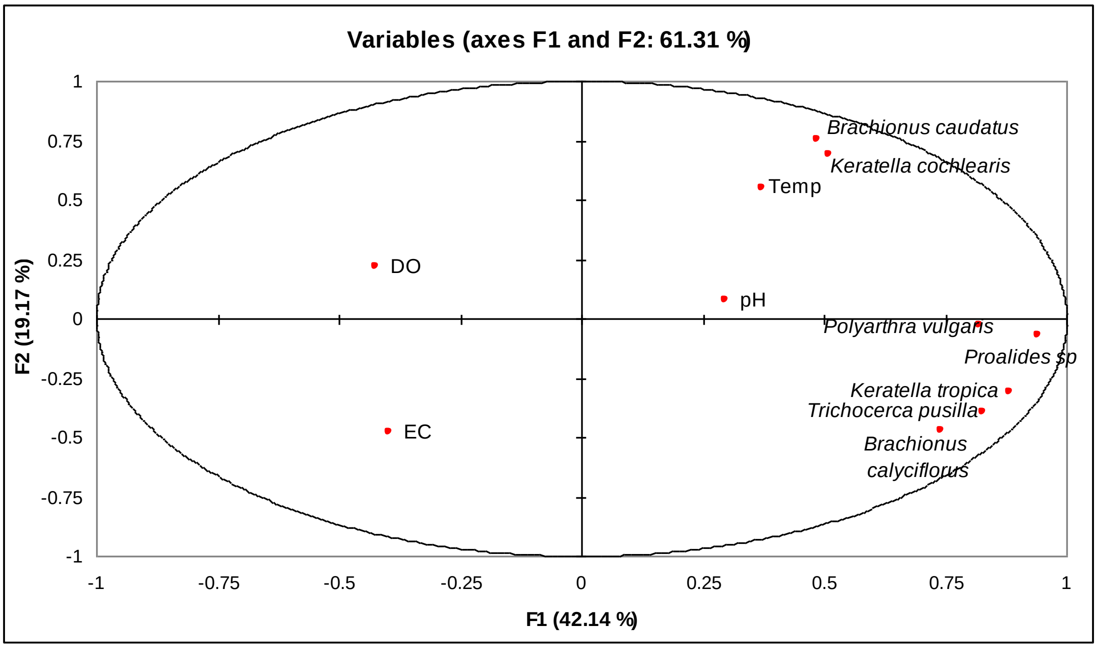

Fig. 5: Principal Component Analysis (PCA) of Physico-chemical Variables and the Main Rotifer Species in El-Rayah El-Nasery. Temp. : Temperature, EC: Electrical Conductivity and DO: Dissolved Oxygen.

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تحليل مقارن لمجتمع الهائمات الحيوانية فى اثنين من رياحات نهر النيل.مصر.

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المستخلص

تقوم الدراسة الحالية على تحديد مجتمعات الهائمات الحيوانية في الرياح الناصري والرياح التوفيقى كفروع صغيرة لنهر النيل من خلال تتبع التغيرات الموسمية في التنوع والكثافة . أتضح من النتائج أن الكثافة السنوية للهائمات الحيوانية في الرياح الناصري (5442000 كائن / م 3) كانت أعلى من تلك الموجودة في الرياح التوفيقي (3680000 كائن / م^3) .كما أن أعلى كثافة للهائمات الحيوانية قد سجلت في فصل الربيع بينما أقل كثافةحدثت في فصل الشتاء .وقد تم تحديد 40 نوعا من الهائمات الحيوانية خلال الدراسة الحالية ول وحظ أن أعلى عدد من الأنواع تم تسجيله خلال فصل الصيف بينما أقل عدد كان فى فصل الشتاء.