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ECOLOGY OF EIGHT SPECIES OF FRESHWATER OSTRACODS (CRUSTACEA) FROM QENA GOVERNORATE, UPPER EGYPT

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ABSTRACT

The present work deals with the ecology of eight species of freshwater ostracods *(Cypridopsis vidua, Potamocypris variegata, Hemicypris dentatomarginata, Ilyocypris gibba, Ilyocypris biplicata, Fabaeformiscandona holzkampfi, Pseudocandona semicognita and Limnocythere inopinata)* collected from Qena Governorate. Monthly samples were collected for a period of one year (from July, 2000 till June, 2001) from four sites. Some ecological factors were measured during the period of investigation and correlated with the density of the ostracod species studied. Statistical analysis was performed by using SPSS software package (version 9) and the model equations controlling the density and the physical factors measured for the studied species were deduced.

INTRODUCTION

Ostracods are small bivalved crustaceans. Their calcified carapaces have an average length of 1 mm. and completely envelop the reduced body (Martens *et al.*, 1996). Horne (1983); Martens *et al.* (1985); Geiger (1990a and b), and Martens & Tudorancea (1991) indicated that quantitative studies on seasonality, life history and distribution of freshwater ostracods are scarce. Some studies were concerned with the distribution of freshwater ostracods as those of Martens & Toguebaye (1985); Martens & Tudorancea (1991); Rieradevall & Roca (1995) and Martens (1998). Other studies were dealing with the relation between freshwater ostracods and environmental factors. These include Martens (1985, 2000); Latifa

(1987); Santamaria *et al.* (1992); Roca *et al.* (1993); Roca & Wansard (1997) and Yin *et al.* (1999).

In Egypt, to the best of the present author's knowledge, studies of freshwater ostracods did not gain the attention they deserve, although they play an important role in the freshwater ecosystem. Klintz (1907) reported *Cypris sculpta* from the Nile, but the genus can not be identified with certainty from his paper. Also Daday (1910) described a new genus and six new species from Egypt. His monumental work had no details of the described species and the names of some genera had been changed.

The present paper is meant to contribute to the knowledge of taxonomy and ecology of this neglected crustacean group.

MATERIAL AND METHODS

Monthly samples were collected during one year (from July, 2000 till June, 2001) from four sites at Qena Governorate including the following freshwater irrigation canals: I- El-Twarat canal (26° 7′ N/ 32° 41′ E), II- El-Taramsa canal (26° 8′ N/ 32° 40′ E), III- Faw Bahary canal (26° 8′ N/ 32° 24′ E), and IV- Hagaza canal (25° 51′ N / 32° 48′ E). For quantitative samples, an iron cuboidal sampler, with open ends, measuring 30 x 30 x 60 cm. was used. The sampler was applied to enclose a column of known volume of water. Three replicates of samples were applied at each collection. The relative density of each species was calculated as the number of specimens present in the whole volume of the sampler. Ecological factors measured included air and water temperatures, dissolved oxygen, pH and conductivity. Statistical analysis was performed by using SPSS software package (version 9).

RESULTS

1- Dominance levels of the studied species:

In the present study, 2324 specimens were collected from the eight different species studied during the whole period of investigation. The most dominant species was *Cypridopsis vidua* (Sp.1), from which 826 specimens were collected, constituting 35.5 % of the total catch, followed by *Ilyocypris biplicata* (Sp.5) (626 specimens) constituting 26.9 %, followed by *Pseudocandona semicognita* (Sp.7) (339 specimens) constituting 14.6%, then

Hemicypris dentatomarginata (Sp.3) (234 specimens) constituting 10.1%, followed by *Ilyocypris gibba* (Sp. 4) (137 specimens) constituting 5.9 %, then *Limnocythere inopinata* (Sp.8) (93 specimens) constituting 4 %, followed by *Potamocypris variegata* (Sp.2) (65 specimens) constituting 2.8 % and *Fabaeformiscandona holzkampfi* (Sp.6) (4 specimens) constituting 0.17 % of the total catch. (Table 1).

2- Seasonal variations:

Generally, the total catch of the eight species showed its maximal value in Autumn (792 specimens, constituting 34.1 %), followed by Winter (781 specimens constituting 33.6 %), then Spring (440 specimens, representing 18.9 %), whereas the least catch was recorded in Summer (311 specimens, constituting 13.4 %) (Table 1).

3- Statistical analysis of the relative density of recorded species:

Applying the MANOVA test for the relative density of the species collected during the period of investigation, as dependent variables and the sites of collection, as independent variables (Table 2), revealed that the majority of differences were highly significant (P<0.01), but for *Fabaeformiscandona holzkampfi* and *Pseudocandona semicognita* were insignificant.

Applying the above mentioned test using the seasons as independent variables, it was found that the majority of differences were insignificant except for *Ilyocypris biplicata* that was highly significant while *Hemicypris dentatomarginata* and *Limnocythere inopinata* was significant. On using both sites and seasons as independent variables, it was concluded that *Ilyocypris biplicata, Hemicypris dentatomarginata, Potamocypris variegata* and *Limnocythere inopinata* were highly significant different, *Cypridopsis vidua* and *Pseudocandona semicognita* were significantly different and *Ilyocypris gibba* and *Fabaeformiscandona holzkampfi* were insignificantly different.

4- Correlation between the environmental factors and the relative density of the recorded species:

By applying the correlation analysis between the relative densities of ostracod species with the ecological factors during the period of investigation (Table 3), it was concluded that:

1- The relative density of *Cypridopsis vidua* was negatively correlated with water temperature and positively correlated with dissolved oxygen.

2- The relative density of *Potamocypris variegata* was positively correlated with *Ilyocypris gibba.*

3- The relative density of *Hemicypris dentatomarginata* was positively correlated with *Limnocythere inopinata* and negatively correlated with dissolved oxygen.

4- The relative density of *Ilyocypris gibba* was positively correlated with *Potamocypris variegata* and negatively correlated with conductivity.

5- The relative density of *Ilyocypris biplicata* was positively correlated with pH.

6- The relative density of *Fabaeformiscandona holzkampfi* was positively correlated with conductivity.

7- The relative density of *Limnocythere inopinata* was positively correlated with *Hemicypris dentatomarginata* and negatively correlated with dissolved oxygen.

On applying Stepwise multiple regression to select a model where all variables are significant (Table 4), it was concluded that:

1- The relative density of *Cypridopsis vidua* was affected by dissolved oxygen and water temperature. The model equation was : Relative density of animal in 54000 cm^3 = -536.62 + 39.49 dissolved oxygen + 10.81 water temperature

2- The relative density of *Hemicypris dentatomarginata* was affected by dissolved oxygen and air temperature. The model equations was: Relative density of animal in 54000 cm^3 = 56.07 – 4.05 dissolved.oxygen – 0.77 air temperature

3- The relative density of *Ilyocypris gibba* was affected by conductivity. The model equation was: Relative density of animal in 54000 cm^3 = 16.21 – 42.82 conductivity

4- The relative density of *Ilyocypris biplicata* was affected by pH.The model equation was: Relative density of animal in 54000 cm^3 = 452.73 + 62.5 pH

5- The relative density of *Fabaeformiscandona holzkampfi* was affected by conductivity. The model equation was: Relative density of animal in 54000 cm^3 = -1.001 + 3.52 conductivity

6- The relative density of *Limnocythere inopinata* was affected by dissolved oxygen. The model equation was: Relative density of animal in 54000 cm^3 = 9.39 – 0.95 dissolved oxygen

DISCUSSION

From the present results, it is evident that both Autumn and Winter were the most suitable seasons for the recorded ostracod species, whereas Spring and Summer were less favorable for these animals. Species (1) (*Cypridopsis vidua*), Sp.(5) (*Ilyocypris biplicata*) and Sp.(7) (*Pseudocandona semicognita*) exhibited the same general trend, and these species constituted 77 % of the total catch. On the other hand, Sp.(2) (*Potamocypris variegata*), Sp. (3) (*Hemicypris dentatomarginata*), Sp.(4) (*Ilyocypris gibba*) and Sp.(8) (*Limnocythere inopinata*) were most abundant during Spring and Summer. Species (6) (*Fabaeformiscandona holzkampfi*) could be neglected, since four specimens only were recorded during the whole period of investigation. The higher value during Autumn is attributed to the higher value of the species *Cypridopsis vidua* and *Pseudocandona semicognita*. In Winter, the higher value is attributed to *Ilyocypris biplicata* (Table 1). Mezquita *et al.* (1999) studied the ecology and distribution of ostracods associated with flowing waters in the Eastern Iberian Peninsula during Autumn and Spring and concluded that no clear patterns were observed on the seasonality of common species. However, they found *Eucypris virens* and *Trajancypris clavata* only in the Spring months. Baltanás (1994) regarded the first species as a Winter-Spring form, while the second species was regarded by Martens (1989) as a Spring-Summer species. In the present study, it was observed that *Fabaeformiscandona holzkampfi* was represented only in Winter and Spring, while the other seven species were represented during all seasons. Cohen & Morin (1990) recorded that peak numbers usually occur in warm seasons and only occasionally in late fall or Winter. On the contrary, Rieradevall & Roca (1995) observed that *Candona neglecta* and *Darwinula stevensoni* showed a tendency towards maximum densities when temperature were low, while other species such as *Isocypris beauchampi*, *Cypridies torosa* and *Cyclocypris ovum* seem to tolerate warmer water.

Roca and Wansard (1997) indicated that the temperature has a strong impact on the development and survival rates of ostracods. For

Herpetocypris brevicaudata, 15 - 19° C constitutes a threshold, below which calcification of the valves and survival rates significantly decrease. Other species adapted to high latitude or high altitude may tolerate very low temperature (Delorme, 1991). In contrast, a species of *Potamocypris* has been found in hot springs that ranged from 30 to 54° C (Wickstrom & Castenholz, 1973).

Concerning the collected species during the present study, one can conclude that *Cypridopsis vidua* and *Ilyocypris biplicata* constituted the highest percentage of the total ostracods collected (35.5% and 26.9%, respectively) (Table 1). This result is in accordance with many investigators concerning species *Cypridopsis vidua*, where it seems to be a cosmopolitan and highly tolerant species (Meisch & Broodbakker, 1993; Beyer & Meisch, 1996 ; Beyer *et al.*, 1997). The present study indicated that *Cypridopsis vidua* is positively correlated with water temperature. This may help the species to tolerate higher temperatures and may account for its cosmopolitan distribution.

The present results showed a positive correlation between the pH and the relative density of *Ilyocypris biplicata* and that all sites were nearly neutral (Tables 3, 4). This result supports the view of Dole-Olivier *et al.* (2000) who indicated that ostracods generally live in circumneutral water, with a readily available source of Calcium Carbonate, because of their calcareous carapaces. The positive correlation of the above mentioned species with pH may give it an advantage to resist high pH values and may account for its cosmopolitan distribution. On the contrary, Delorme (1991) indicated that some species have a very broad pH range (5.4 – 13 such as *Candona candida*).

The present investigation indicated that *Hemicypris dentatomarginata* and *Limnocythere inopinata* are negatively correlated with dissolved oxygen, while *Cypridopsis vidua* is positively correlated (Tables 3, 4). This result is in accordance with that of Dole-Olivier *et al.* (2000) who stated that most ostracods can survive a wide range of dissolved oxygen concentrations and species that live in shallow muddy ponds may tolerate very low oxygen supply, like some Canadian ostracods which have been found near zero concentrations such as *Candona candida* and *Cypria ophthalmica* (Delorme, 1991). *Heterocypris incongruens* can tolerate anaerobic conditions for at least 2 weeks.

The present study indicated that the two species *Ilyocypris gibba* and *Potamocypris variegata* are positively correlated to each other (Table 3). This result agrees with that of Mezquita *et al.* (1999) who studied the species associations and species environment relationships and concluded that the two mentioned species were clustered together in the same group.

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Abbreviations used in the tables

Sp. 1: *Cypridopsis vidua*

Sp. 2: *Potamocypris variegata*

Sp. 3: *Hemicypris dentantomarginata*

Sp. 4: *Ilyocypris gibba*

Sp. 5: *Ilyocypris biplicata*

Sp. 6: *Fabaeformiscandona holzkampfi*

Sp. 7: *Pseudocandona semicognita*

Sp. 8: *Limnocythere inopinata*

Table (1): The total relative density of all species, relative density (N) and percentage of each species in different seasons at the four sites during the period of investigation.

Season	Sp. 1		Sp.2		Sp.3		Sp.4		Sp.5		Sp.6		Sp.7		Sp.8		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Summer	55	6.66	12	18.46	120	51.28	43	31.38	1	0.16	0	0.00	12	3.54	68	73.12	311	13.4
Autumn	438	53.03	1	1.54	66	28.21	39	28.47	5	0.79	0	0.00	237	69.91	6	6.45	792	34.1
Winter	122	14.77	2	3.08	24	10.26	22	16.06	569	90.89	2	50.00	37	10.91	3	3.23	781	33.6
Spring	211	25.54	50	76.92	24	10.26	33	24.09	51	8.15	2	50.00	53	15.63	16	17.20	440	18.9
Total	826	35.5	65	2.8	234	10.1	137	5.9	626	26.9	4	0.17	339	14.6	93	4	2324	

Table (2): MANOVA for different species and ecological factors for the four sites during the four seasons.

Source	Dependent Variable	Sum of Squares	df	Mean Square	F	Sig.
SITES	Total R.D.	82176.854	3	27392.285	4.124	.008
	Sp.1	92217.806	3	30739.269	11.252	.000
	Sp.2	752.083	3	250.694	5.071	.002
	Sp.3	6796.188	3	2265.396	12.585	.000
	Sp.4	2785.333	3	928.444	30.385	.000
	Sp.5	65347.299	3	21782.433	8.569	.000
	Sp.6	2.250	3	.750	2.298	.081
	Sp.7	7157.076	3	2385.692	2.109	.102
	Sp.8	1304.250	3	434.750	5.587	.001
	Air temp.	787.187	3	262.396	17.696	.000
	Water temp.	202.850	3	67.617	11.545	.000
	pH	.249	3	8.285E-02	1.623	.187
	DO2	39.369	3	13.123	13.946	.000
	Cond.	1.912E-02	3	6.373E-03	13.550	.000
SEASON	Total R.D.	45148.965	3	15049.655	2.266	.084
	Sp.1	20902.472	3	6967.491	2.550	.059
	Sp.2	406.972	3	135.657	2.744	.046
	Sp.3	1570.299	3	523.433	2.908	.037
	Sp.4	60.667	3	20.222	.662	.577
	Sp.5	57078.854	3	19026.285	7.485	.000
	Sp.6	1.361	3	.454	1.390	.249
	Sp.7	8007.910	3	2669.303	2.360	.075
	Sp.8	702.306	3	234.102	3.009	.033
	Air temp.	3850.188	3	1283.396	86.551	.000
	Water temp.	2456.325	3	818.775	139.801	.000
	pH	4.190	3	1.397	27.353	.000
	DO2	291.174	3	97.058	103.147	.000
	Cond.	6.188E-04	3	2.063E-04	.439	.726

Table (2): **Continued**

Source	Dependent Variable	Sum of Squares	df	Mean Square	F	Sig.
SITES* SEASONS	Total R.D.	292620.729	9	32513.414	4.894	.000
	Sp.1	60454.806	9	6717.201	2.459	.013
	Sp.2	1220.917	9	135.657	2.744	.006
	Sp.3	6219.229	9	691.025	3.839	.000
	Sp.4	222.889	9	24.765	.811	.607
	Sp.5	176222.507	9	19580.279	7.703	.000
	Sp.6	3.250	9	.361	1.106	.363
	Sp.7	24803.896	9	2755.988	2.436	.014
	Sp.8	2038.972	9	226.552	2.912	.004
	Air temp.	398.563	9	44.285	2.987	.003
	Water temp.	123.025	9	13.669	2.334	.018
	pH	2.786	9	.310	6.062	.000
	DO2	10.457	9	1.162	1.235	.280
	Cond.	3.601E-02	9	4.001E-03	8.506	.000
Error	Total R.D.	850291.111	128	6642.899		
	Sp.1	349696.222	128	2732.002		
	Sp.2	6327.333	128	49.432		
	Sp.3	23040.222	128	180.002		
	Sp.4	3911.111	128	30.556		
	Sp.5	325384.000	128	2542.062		
	Sp.6	41.778	128	.326		
	Sp.7	144805.556	128	1131.293		
	Sp.8	9959.778	128	77.811		
	Air temp.	1898.000	128	14.828		
	Water temp.	749.660	128	5.857		
	pH	6.536	128	5.106E-02		
	DO2	120.444	128	.941		
	Cond.	6.020E-02	128	4.703E-04		

Table (3): Correlation coefficients for association between different species with each others and ecological factors during the period of investigation.

		Sp.1	Sp.2	Sp.3	Sp.4	Sp.5	Sp.6	Sp.7	Sp.8	Air temp.	Water temp.	pH	DO2
Sp.1	r												
	sig.												
Sp.2	r	-.022											
	sig.	NS											
Sp.3	r	-.075	-.051										
	sig.	NS	NS										
Sp.4	r	-.073	.282	-.122									
	sig.	NS	**	NS									
Sp.5	r	-.037	.016	-.026	-.060								
	sig.	NS	NS	NS	NS								
Sp.6	r	.014	-.028	.003	-.068	-.033							
	sig.	NS	NS	NS	NS	NS							
Sp.7	r	-.021	-.012	-.045	-.048	-.028	-.020						
	sig.	NS	NS	NS	NS	NS	NS						
Sp.8	r	-.046	-.026	.547	-.067	-.039	.015	-.026					
	sig.	NS	NS	**	NS	NS	NS	NS					
Air temp.	r	-.141	.020	.045	.097	-.034	-.142	.050	.064				
	sig.	NS	NS	NS	NS	NS	NS	NS	NS				
Water temp.	r	-.174	.042	.099	.132	-.148	-.155	.071	.123	.913			
	sig.	*	NS	NS	NS	NS	NS	NS	NS	**			
pH	r	-.150	.015	.026	-.154	.293	.008	-.134	.100	-.134	-.239		
	sig.	NS	NS	NS	NS	**	NS	NS	NS	NS	**		
DO2	r	.368	-.077	-.169	-.153	.092	.127	-.043	-.173	-.842	-.906	.115	
	sig.	**	NS	*	NS	NS	NS	NS	*	**	**	NS	
Cond.	r	.046	-.121	.115	-.175	.024	.172	-.017	.068	-.163	-.207	.094	.092
	sig.	NS	NS	NS	*	NS	*	NS	NS	NS	*	NS	NS

** Correlation is significant at the 0.01 level.
* Correlation is significant at the 0.05 level.
NS Correlation is not significant.