ACTA ZOOL. CRACOV.	33	19	459—484	KRAKÓW, 31.XII.1990

Tadeusz NAMIOTKO

Freshwater *Ostracoda (Crustacea)* of Żuławy Wiślane (Vistula Fen Country, Northern Poland)

[With 5 text-figs]

Słodkowodne małżoraczki *(Ostracoda, Crustacea)* Żuław Wiślanych (Północna Polska)

Abstract. The paper presents data on the faunistic analyses of ostracodes found in various types of freshwater reservoirs in the Vistula Fens. 40 species were noted, among them several rare and little-known as well as one new to Polish fauna — *Eucypris moravica* JANCAŘIK, 1947. Opinions are presented concerning the types of habitats inhabited by the species collected, and the effect of certain environmental factors (type of substratum, movement of water) on their occurrence. The species found have been analyzed as regards their phenology, method of reproduction, mode of life, coexistence, and distribution in Poland and the world. A zoocoenological analysis revealed two ostracode communities.

I. INTRODUCTION

The area of the Vistula delta is a fragment of Poland which has been very scantily studied in respect to *Ostracoda*. Only two papers — ZADDACH 1844, SELIGO 1899, may also concern the region in question. Their authors give 20 species of ostracodes found in West Prussia in geographically and ecologically undefined localities (mainly lakes). One of the species mentioned: *Candona pubescens* (KOCH), cannot, unfortunately, be identified today.

Acknowledgements. I am much obliged to Doc. dr hab. Tadeusz SYWULA (University of Gdańsk) my initiator and supervisor for scientific advises and criticism as well as for corrections in the English text. I am also grateful to Mrs Betty PRZYBYLSKA (University of Gdańsk) for the English translation of the text.

II. LOCATION AND CHARACTERISTICS OF SAMPLING SITES

Studies embraced the regional geomorphological area of the Żuławy Wiślane (the Vistula Fen Country) in the Vistula delta. This area was described in the monograph edited by AUGUSTOWSKI (1976).

19 sites located in the central part of the Vistula delta, in the so-called Wielkie Żuławy Malborskie (the Great Malbork Fens), were studied. Sites 1—10 were located in the southern, geologically older part of the Fens and 11—19 in the northern, younger. All sampling sites were located within the physiographic area called the "Pomorze Lake District", denoted under No.03 in the "Katalog fauny Polski" (Catalogus faunae Poloniae). Fig. 1 gives the location positions in the UTM system, and Fig. 2 — the exact geographical site.

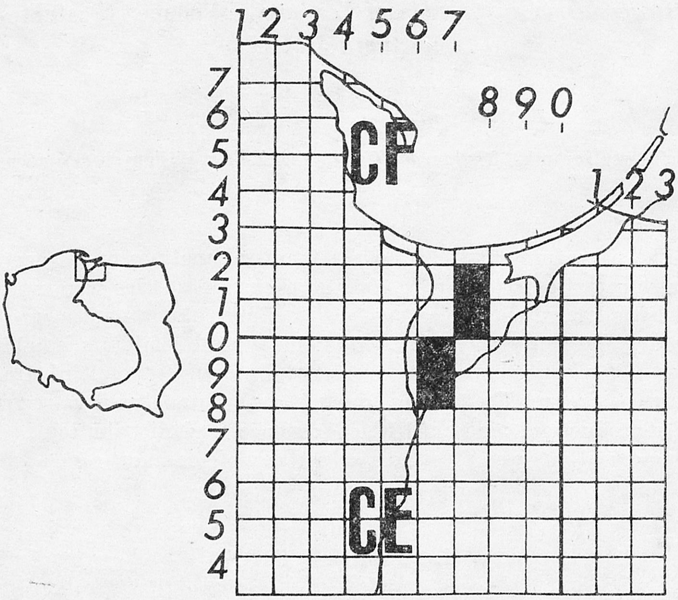

Fig. 1. Area studied on UTM system grid. CE **68:** localities 5, 6, 7, 8; CE **69:** localities 1, 2, 3, 4, 9, 10; CF **70:** localities 11, 12, 17, 18, 19; CF **71:** localities 13, 14, 15, 16

Eight of the locations studied were on muddy substrata in irrigation ditches.

Location 1. Ditch periodically drying up, in a field. Width about 0.5 m, maximum depth 0.3 m. Movement of water denoted (especially in spring), but minimal. Numerous colonies of filiform algae and microalgae: *Conjugatophyceae*, *Bacillariophyceae-Pennatae*, *Cyanophyta*; the bottom rich in organic residues, overgrown with herbaceous plants, including *Phragmites communis* Trin. in places.

Location 4. Roadside ditch which dries up in summer. Width 0.6—0.7 m, depth about 0.25 m. Numerous *Alsima plantago-aquatica* L., *Lemna* sp., fairly numerous *Hottonia palustris* L., and occasionally *Cardamine amara* L., *Myosotis* sp. and *Equisetum* sp.

Location 9. Ditch in a field which becomes fairly dry in summer. Width up to 0.8 m, maximum depth 0.3 m. The influx is probably from subsoil water. Fairly numerous *Lemna* sp., *Cardamine amara*, *Alisma plantago-aquatica*, and

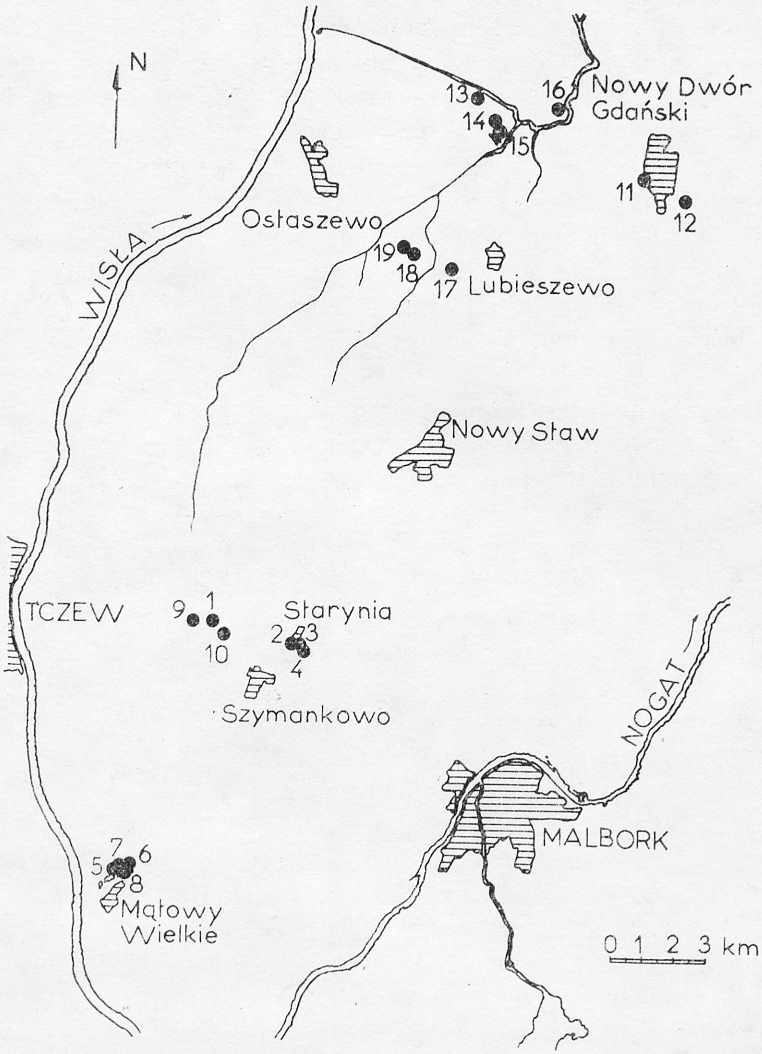

Fig. 2. Location of sampling sites

on the fairly steep sides *Phragmites communis* and herbaceous plants, including those from the *Asteraceae*, *Apiaceae*, *Poaceae* and *Salix* sp.

Location 13. Probably permanent water-body in a field ditch, drying up in places only, width 0.4—0.5 m, depth up to 0.3 m (in spring). Numerous *Alisma plantago-aquatica*, in places *Typha* sp. and a few *Phragmites communis*.

Location 14. Meadow ditch drying up somewhat, width up to 1 m, depth up to 0.4 m. Fairly numerous *Lemna minor* L., and *L. trisulca* L., besides *Hottonia palustris*, *Myosotis* sp., *Alisma plantago-aquatica*, *Typha* sp.

Location 16. Probably permanent water-body in a field ditch, width 0.5 m, depth up to 0.2. m. Bed well lined with allochthonous blades of grass, mainly overgrown with *Hottonia palustris*. Sides very low.

Location 17. Permanent overflow of an irrigation ditch in a meadow; maximum diameter 1.5 m and depth up to 0.3 m (in spring). A film of *Lemna minor* and *L. trisulca*, numerous colonies of filamentous algae, fairly numerous *Hottonia palustris* and some (reaching up the sides) *Cardamine amara, Bidens* sp., *Alisma plantago-aquatica, Juncus* sp., *Glyceria* sp.

Location 19. Irrigation roadside ditch, 0.5—1.0 m wide, which dries up in summer. Bed sandy-loam with a small quantity of detritus, mossy in places. A slight movement of the water has been noted and it is possible that this is due to spring water. One of the least eutrophicated of the waters studied. At certain places in the water and along the sides *Urtica dioica* L., *Callitriche polymorpha* LÖNHR., *Rubus* sp., *Veronica beccabunga* L., and *Phragmites communis*.

The following three locations are irrigation canals.

Location 2. Permanent roadside reservoir, 2.0—2.5 m wide and 0.5—0.6 m deep. The bed muddy in places and in others sandy — mud with fairly numerous fragments of plants together with rotting leaves and fruits of *Tilia* sp.; *Lemna* sp. on the surface, there also being *Phragmites communis, Herophylum* sp., *Hydrocotyle* sp., *Urtica dioica, Arthemisia* sp., *Arctium* sp., *Lamium album* L., *Achillea* sp. and *Lycopus* sp. among others near and on the fairly steep sides.

Location 10. A periodically dried up reservoir in a field with a width of 1.5—2.0 m and depth up to 0.5 m (in spring and autumn). The bed muddy, fertile, with a large quantity of organic matter and small quantity of rotting *Salix* sp. leaves. *Lemna minor* and *L. trisulca* on the whole surface of the water, *Phragmites communis* in places, single specimens of *Acorus calamus* L.

Location 12. Permanent reservoir in a meadow, 1.5 m to 8.0 m wide (on the bend), depth probably over 0.6 m. Bed — slimy mud with a large quantity of organic matter. *Lemna minor* and *Nuphar luteum* (L.) densely on the surface, *Elodea canadensis* RICH. in the water, *Acorus calamus* on the sides.

The next three locations studied were small, isolated reservoirs in natural or artificial depressions, defined as "eyes".

Location 7. This is probably a permanent reservoir with a clayey bed in a cultivated field. Diameter up to 4 m, depth up to about 0.4 m. The sides and bottom overgrown with small numbers of *Juncus* sp., *Polygonum* sp., *Carex* sp., *Alopecurus* sp., *Phleum* sp., *Agropyron* sp., *Alisma plantago-aquatica.*

Location 11. A somewhat drying up meadow reservoir with a diameter of 4—5 m, and depth of from 0.1 m in spring to 0.2—0.3 m in summer. Bed muddy. The whole surface of the water covered with *Lemna* sp., *Typha* sp., *Bidens* sp., *Polygonum* sp., *Equisetum* sp., *Alisma plantago-aquatica, Poaceae.*

Location 18. A permanent, meadow oval-shaped "eye" measuring 10×7 m, with a depth probably exceeding 1 m. Water dark in colour. Bed slimy, muddy with large quantities of organic fragments, branches and leaves of *Salix* sp. and *Ulmus* sp., as well as small blades of *Phragmites communis.* On the surface, dense *Lemna trisulca* and *L. minor*, in the water filamentous algae besides *Cardamine amara, Hottonia palustris, Typha latifolia* L. and *Hepaticopsida* reaching up the side, all around reeds (mainly *Phragmites communis*), obliterating the direct action of the sun rays; the shade intensified due to the depression in the terrain.

The next four locations were old river-bed reservoirs.

Location 5. An oxbow lake on a Vistula bank terrace, about 350 m long and 50 m wide. Sampling site depth 0.3 m. Muddy bed with high detritus content. *Lemna minor* found in places on the surface. The reservoir surrounded and overgrown with patches of reeds, borne down in places by rushes.

Location 6. Small marsh in an old river-bed complex, measuring 14×8 m, almost drying up in summer. The depth of the water in spring about 0.4 m. Muddy bed with numerous fragments of vegetation. Densely overgrown with reeds. A dense cover of *Lemna trisulca* on the surface.

Location 8. A permanent marsh measuring 30×15 m, in an old river-bed complex. Depth of water to about 0.8 m. Muddy bed, with fragments of *Phragmites communis* stems, densely overgrown with elodeids. Patches of *Lemna trisulca* on the surface, with an exuberance of *Phragmites communis, Alisma plantago-aquatica, Equisetum* sp., *Sagittaria sagittifolia* L., *Typha* sp., on the sides.

Location 15. An oxbow lake of the River Linawa, measuring about 300 m in lenght and 30—40 m in width. Sampling site depth about 0.3—0.4 m. Gently sloping sides to the water surface. Surrounded by a narrow belt of reeds, overgrown with nympheids and elodeids. Muddy, very slimy bed with a large content of detritus.

The last to be studied — location 3 — was a periodically dried up pond measuring 20—10 m, on a farm. Depth up to about 1 m. The bed — sandy-mud to sandy, with rotting leaves and fruits of *Quercus robur* L. *Lemna* sp. found over the whole surface of the water, there being grass and a small number of other herbaceous plants along the edge.

Table I presents the composition of the fauna found on the locations studied.

III. MATERIAL AND METHODS

The material was collected in the years 1984 and 1985. Samples were taken from each location in three different seasons: autumn (from 20 November 1984 to 18 December 1984), spring (from 4 May 1985 to 2 June 1985) and summer (from 6 to 28 August 1985), these constituting a closed annual cycle.

The sampling was done by a qualitative method, using a hand net. Bottom matter was taken from various points in the reservoir, then washed in a column with two nets, the upper having a mesh of 1.5—2.0 mm, the lower made of dense botling cloth. Further procedures differed in the autumn and spring-summer seasons. The autumn samples were conserved in 96% ethyl alcohol, whereas the spring (apart from five: locations 3, 11, 12, 14, 16, which were

Table I

The composition of the fauna found on the locations studied

Taxa ascertained		Location: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Turbellaria										+						+				
Mollusca	*Gastropoda*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
	Bivalvia				+	+			+	+	+		+		+					
Oligochaeta		+	+	+	+	+	+	+		+		+	+	+	+	+	+	+	+	+
Hirudinea		+									+		+		+	+		+	+	
Crustacea	*Cladocera*	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+		+	
	Copepoda	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Ostracoda	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Asellus aquaticus (L.)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+
	Amphipoda	+			+				+	+										+
Hydracarina		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Insecta	*Collembola*							+				+								
	Odonata — larvae						+		+											
	Ephemeroptera — larvae								+										+	
	Heteroptera (*Cryptocerata*)			+															+	
	Trichoptera — larvae					+	+													
	Culicidae — larvae and/or pupae	+										+								
	Chironomidae — larvae and/or pupae	+	+	+	+	+	+	+		+		+	+	+	+	+	+			+
	Diptera indet. — larvae and/or pupae		+		+	+	+	+		+		+	+	+	+		+	+		
	Coleoptera — imagines	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+
Rana sp. — tadpoles and/or adults							+		+	+								+	+	
Tritus sp. — tadpoles and/or adults							+											+	+	

conserved immediately after washing) and summer samples were subjected to a dynamic method of separating the animals. Scattering by means of BAERMANN funnels was adopted. A description of the method is given by KACZMAREK 1981. Depending upon the character and size of samples, the scattering lasted from 5.5 to 13.5 h. The fraction obtained after scattering was also conserved in 96% ethyl alcohol. The ostracodes were selected under stereomicroscope. All the specimens caught were identified, basing on the work of ABSOLON (1978), KLIE (1940) and SYWULA (1974 and 1981 a).

All the species of ostracodes coexisting in a given location were accepted as an assemblage (HUTCHINSON 1967). An „ostracode community" was taken to be a comprehensive ecological unit defined by way of zoocoenological analysis of assemblages.

The following figures or indices were adopted in the general assessment of the material:

1. Numbers (n) — the absolute number of individuals in the sample, assemblage, material as a whole.
2. Domination (D) — the ratio of the number of individuals of a given species (n_a) to the number of individuals of all species (n):

$$D = \frac{n_a}{n} \times 100\%$$

A three-grade scale of values of the domination index was adopted in the characterizing of assemblages:

— dominants,

— influents,

— recedents.

Taxa were attributed to the groups mentioned by estimation, considering the percentage participation of a given taxon in samples from the particular seasons.

3. Frequency (F_r). This describes the distribution of a given taxon. It constitutes the ratio of the number of localities (assemblages) in a given type of environment or the whole material in which the taxon was represented, to the total number of localities studied.
4. SHANNON-WIENER index of species diversity of assemblages (H'):

$$H' = -\sum_{i=1}^{s} \frac{x_i}{x} \ln \frac{x_i}{x}$$

where: x — number of individuals of species „i",

x — total number of ostracodes,

s — number of species in a given assemblage.

The distance between each pair of assemblages was defined using the modified index of absolute distance. The distance between the assemblages constituted the arithmetic mean of the absolute distance as to the presence and absolute distance as to the share of particular taxa in both assemblages. This was calculated after the formula:

$$d_{AB} = \frac{\frac{1}{m}\sum_{i=1}^{m} |P_{iA} - P_{iB}| + \frac{1}{m}\sum^{m} |S_{iA} - S_{iB}|}{2}$$

where:

d_{AB} — absolute distance between assemblages A and B;

$m = a+b+c$ (where a — the number of taxa occurring in assemblage A but not in assemblage B, b — the number of taxa found in assemblage B but not in A; c — the number of taxa occurring in both A and B);

$P_{iA}(P_{iB})$ — value of the *i*-th taxon related to its presence in assemblage A (B). P assumes the value of 1 in the presence of the *i* - th taxon in the given assemblage and 0 when this taxon is missing in the assemblage;

$S_{iA}(S_{iB})$ — value of the *i*-th taxon related to its share in assemblage A (B). S_i assumes the following values:

1 for dominants,

0.55 for influents,

0.1 for recedents,

0 for taxa not present in the assemblage.

The method of aggregation chosen was that of UPGMA (Sneath and Sokal 1973).

IV. RESULTS

The material studied embraces 29223 specimens, 29206 of which were determined. Of this number about 70% of the specimens were determined to the species-group, the remainder (the majority of the larvae) to subgenus (about 24%), or genus (about 6%). The collection includes representatives of 4 families *(Ilyocypridae, Candonidae, Cyprididae* and *Cypridopsidae)*, 13 genera, 41 taxa on the species-group and infrasubspecific level. *Cypridopsis parva* cannot be entered without reservation into the list of ostracode species known in Poland, due to damage and paucity of material. The list of taxa collected (after Hartmann and Puri 1974 scheme), number of individuals representing these in the material, as well as general zoocoenological characteristics of the material are presented in Table II. Both males and females were found in 21 species (52.5% of species collected).

The spring samples proved to be richest qualitatively and quantitatively. Namely, both mean number of individuals per sample, number of species given in round figures and total number of species in spring samples were high-

The list of taxa collected and general zoocoenological analysis of the material studied

TAXON	Number of individuals	LOCATION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	F	D (%)	The appearance of taxa in particular seasons of the year: Larvae Sp	Larvae S	Larvae A	Adult specimens Sp	Adult specimens S	Adult specimens A
1. *Ilyocypris decipiens* Masi, 1906	1															R					1/19						X	
*2. *I. gibba* (Ramdohr, 1808) *f. biplicata* Koch, 1838	2										R										1/19					X		
I. sp.	1	O				O	O						R								1/19					X		
3. *Candona (Candona) candida* (O.F. Müller, 1776)	243		I			R	R		R				I	I	I	I			R		9/19		X	X	X	X	X	X
4. *C. (C.) improvisa* Ostermeyer, 1937	325									O	D		O								1/19	1.11	X	X	X			
*5. *C. (C.) lindneri* Petkovski, 1969	229	I								I			R							+	4/19		X	X	X	X	X	X
*6. *C. (C.) neglecta* Sars, 1887	120				R								R					I			3/19		X		X	X		X
*7. *C. (C.) weltneri* Hartwig, 1899	236					I	I						R		I	I		R			6/19			X	X	X	X	X
C. (C.) sp.	2060					N	N	N					N		N	N	N	N					X	X	X			
8. *C. (Eucandona) alexandri* Sywula, 1981	8					R															1/19							X
9. *C. (E.) balatonica* Daday, 1894	1									R											1/19					X		
*10. *C. (E.) fabaeformis* (Fischer, 1851)	522	D				R	R		R	I	R		R		I	I	+	R	I		12/19	1.79	X	X	X	X	X	X
*11. *C. (E.) fragilis* Hartwig, 1898	128				R	O	R		O	I	R										4/19				X	X		X
*12. *C. (E.) holzkampfi*, Hartwig, 1900	79						R								R	I					3/19			X	X	X	X	X
*13. *C. (E.) hyalina* Brady et Robertson, 1870	144					I															1/19		X	X	X		X	X
*14. *C. (E.) protzi* Hartwig, 1898	11					O			R				R			I					3/19				X			X
C. (E.) sp.	1229					N	N		N	N	N				N	N							X	X	X			
*15. *C. (Typhlocypris) compressa* (Koch, 1838)	714				I	I	I		I	I	D				I	I			R		9/19	2.44	X	X	X	X	X	X
*16. *C. (T.) eremita* Vejdovsky, 1880	18				R					R											2/19			X	X		X	X
*17. *C. (T.) hartwigi* G. W. Müller, 1900	33					I							I		I	R					4/19					X	X	
*18. *C. (T.) insculpta* G. W. Müller, 1900	37					I			I				I		O	R					4/19		X			X	X	X
*19. *C. (T.) marchica* Hartwig, 1899	126												I		I	I					3/19					X	X	X
20. *C. (T.) prespica* Petkovski, 1959 *ssp. pomeranica* Sywula, 1981	3									R								R			2/19					X		
C. (T.) sarsi Hartwig, 1899	—												O								—							
C. (T.) sp.	3632					N			N	N			N	N	N	N							X	X	X	X		
*21. *Candonopsis kingsleii* (Brady et Robertson, 1870)	300					I			R	I	R		O		R	I		R	R		8/19	1.03	X	X	X	X	X	X
*22. *C. parva* Sywula, 1967	14					R			R							R					3/19					X		
C. sp.	24															N							X					
*23. *Cyclocypris laevis* (O. F. Müller, 1785)	920					I	R	+	I		R		R	I	I	I	+	R			11/19	3.15	X	X	X	X	X	X
*24. *C. ovum* (Jurine, 1820)	7401	R	R	I	D	R	D	+	R	D	I		D	D	R	I	+	D	D	+	18/19	25.33	X	X	X	X	X	X
C. sp.	1695						N	N	N				O	N	N	N			O				X	X				
*25. *Cypria ophthalmica* (Jurine, 1820)	4122	R	D	D	I	D	D	+	R		I		I	I	I	I	+	D	D	+	17/19	14.11	X	X	X	X	X	X
*26. *Physocypria fadeewi* Dubovskij, 1926	3358					D			R					R	R	D					5/19	11.49	X	X		X	X	X
*27. *Notodromas monacha* (O. F. Müller, 1776)	11					R	R							R	R						4/19			X		X	X	
28. *Cyprinotus (Heterocypris) barbarus* (Gauthier et Brehm, 1928)	1											R									1/19					X		
29. *C. (H.) incongruens* (Ramdohr, 1808)	14	I																			1/19			X			X	X
C. (H.) sp.	—						O														—							
30. *Bradleystrandesia affinis* (Fischer, 1851)	782	D		R	R			+	R	R	R	D	O		R	O		R	D		11/19	2.68	X			X		
31. *B. fuscata* (Jurine, 1820)	2				R																1/19				X			X
32. *Eucypris crassa* (O. F. Müller, 1785)	1																		R		1/19					X		
33. *E. lutaria* (Koch, 1838)	12	R			R					O									R		3/19		X			X		
34. *E. moravica* Jančařik, 1947)	24																		I		1/19					X		
35. *E. virens* (Jurine, 1820)	12	R																			1/19					X		
E. sp.	—	O																			—							
36. *Stenocypria fischeri* (Lilljeborg, 1883)	1	R																			1/19							X
37. *Cypris pubera* O. F. Müller, 1776	51	I		R				+			R					R		R			6/19		X	X		X		
38a. *Cypridopsis elongata f. typica* (Kaufmann, 1900)	8			R			R			R				R							4/19		X	X		X	X	
38b. *C. elongata f. orientalis* Bronštejn, 1927	4						R	+						R							3/19			X		X		
39. *C. cf. parva* G. W. Müller, 1900	2													R							1/19							X
40. *C. vidua* (O. F. Müller, 1776)	455					R	R		D		R					R					5/19	1.86	X	X		X	X	X
Ostracoda indet.	17	N				N																	X				X	
Number of individuals	29223	260	165	107	961	2594	4445	39	1781	3186	944	155	637	794	1347	6718	87	3541	1452	10								
Number of species	40	10	3	5	9	16	12	6	13	11	12	2	13	8	14	18	4	10	10	3								
Shannon - Wiener index of species diversity of assemblages (H')		1.623	0.440	0.809	0.601	2.029	1.428	1.935	1.282	1.449	1.665	0.039	1.696	1.477	1.486	1.776	0.862	0.964	1.374	0.802								
LOCATION		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19								

Explanations:

Numbers denote the taxa of species-group and infrasubspecific rank, which were represented by living specimens only.
* — males of a given taxon were found; D — dominant; I — influent; R — recedent; N — category of domination not estimated; O — only valves were collected; + — taxon was represented, but it is impossible to estimate its domination at the location; F — frequency of a given taxon in the material studied; D (%) — domination of most numerous taxa in the material studied; Sp — spring; S — summer; A — autumn.

Table III

General data on ostracode fauna in particular sampling seasons

Season	Number of samples	Percentage of samples with ostracodes	Mean number of individuals per sample	Approximate number of species in a sample	Number of species	Percentage of all species collected
Spring	19	100.0	798	7	32	82.1
Summer	18	93.4	421	5	25	64.1
Autumn	19	89.5	341	5	25	64.1

est as compared with the other seasons, which were all similar in this respect (Table III).

Mature individuals predominated in all sampling periods, but the percentage was lowest in spring (53% of the total for that season). The age structure and relative abundance of ostracodes fauna in different seasons, can be found in Fig. 3.

Cyclocypris ovum, Cypria ophthalmica, Physocypria fadeewi, Cyclocypris laevis, Bradleystrandesia affinis, Candona compressa, Cypridopsis vidua, Candona fabaeformis, C. improvisa and *Candonopsis kingsleii* predominate in the material under examination (D not less than 1.0%) — Table II.

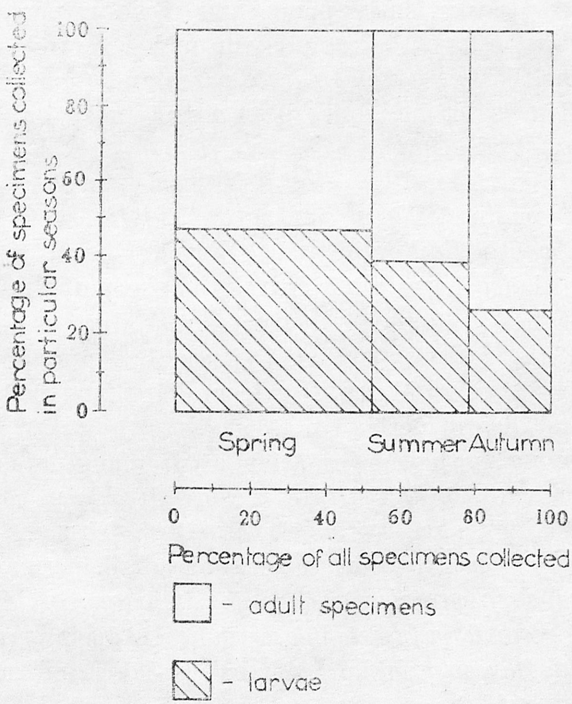

Fig. 3. Age structure and relative number of specimens in particular seasons of the year

Cyclocypris ovum ($F_r = 18/19$) and *Cypria ophthalmica* ($F_r = 17/19$) are ubiquitous in the area studied. Others frequently noted also include *Candona fabaeformis* ($F_r = 12/19$), *Cyclocypris laevis* and *Bradleystrandesia affinis* ($F_r = 11/19$). The remaining taxa occur in a smaller number of localities (35% of the species were found in only one locality) — Table II.

Fig. 4 gives the results of grouping of the assemblages according to absolute distance (d) between them.

V. DISCUSSION

1. Review of the localities populated by the species collected

The occurrence of the majority of species in the localities studied is in accordance with existing information concerning their environmental requirements.

Data concerning species little known in this respect, are worth noting. The finding of *Candona improvisa* in a periodically dried up irrigation canal, *C. lindneri* in permanent irrigation canal and periodically dried up irrigation ditches, *C. balatonica* in a permanent irrigation ditch, as well as *Candonopsis parva* and the rare species *Candona alexandri* in an oxbow-lake, increases the information known as to localities inhabited by these taxa. The first has previously been noted only in small ponds and meadow pools (Sywula 1974), the two consecutive had not been noted in such reservoirs as irrigation ditches and canals, neither were *Candonopsis parva* and *Candona alexandri* noted in oxbow-lakes. The latter had only been found in shallow water lacustrine localities (Sywula et al. 1982).

Worthy of note is the finding of several species in localities atypical for them: *Eucypris crassa* and *E. lutaria* in permanent reservoirs, and *Candonopsis kingsleii* and *Stenocypria fischeri* in periodically drying up reservoirs. The first two species had hitherto been found only in waters periodically drying up (*E. lutaria* only sporadically found in permanent waters — i.a. Sywula 1983, Sywula et al. 1982). The two remaining species had previously been noted in permanent reservoirs. Only Hartwig (from Hiller 1972) gives *C. kingsleii* as being found also in periodic waters.

Worth mentioning is the confirmation of previous data concerning localities inhabited by rare, or fairly rare species (*Ilyocypris decipiens* and *Candona hyalina* in oxbow-lakes — Bronštejn 1947, Hiller 1972; *Cyprinotus barbarus* and *Eucypris moravica* in autonomic, small, permanent reservoirs — Sywula 1974; *Candona prespica pomeranica* in irrigation ditches — Sywula et al. 1982; *Bradleystrandesia fuscata* in a periodically drying up irrigation ditch— Sywula et al. 1982; *Physocypria fadeewi* in oxbow-lakes and irrigation ditches — Hiller 1972, Klie 1938).

Mention should also be made of *Candona eremita*, known as a species specific to subterranean water (ABSOLON 1978, KLIE 1940, SYWULA 1981b). The finding of this species in two localities with surface water should be explained be an influx of subsurface water to these reservoirs, which is highly probable in the Fens (ground water lying immediately below the surface). It can, however, be assumed that this ostracode species may also penetrate the surface waters occasionally, at points of contact with ground water. Dispersal, however, most probably takes place within the permanent environment of subsurface water.

2. Requirements related to the type of substratum and mode of life

The beds of the majority of reservoirs studied are muddy, more or less overgrown with aquatic vegetation. The exceptions were sites 2, 3 and 19, where the bed was sandy-mud or sandy with a thin layer of detritus, and locality 7 — clayey.

As regards the demands concerning type of substratum, these are not known in respect of 8 species: *Candona improvisa*, *C. balatonica*, *C. holzkampfi*, *Eucypris crassa*, *E. moravica*, *Stenocypria fischeri*, *Cypridopsis* cf. *parva* and subterranean *Candona eremita*, which now were collected from reservoirs with a muddy substratum.

Of the remaining species collected 7 (17.5% of the total) are euryplastic, as regards the type of substrata. All other can be considered to be forms more or less pelophylic; from among them, 9 species (22.5% of the total) were previously found also on sandy-muddy substratum, 16 (40%) — sandy with a layer of detritus, 2 (5%) — sandy — stone, coarse — grain sand or stoney, 5 (12.5%) — clayey, 5 on a peaty substratum and 5 on a grassy one (Table IV).

It is worth noting that *Candona lindneri* and *Cypridopsis elongata* in the area studied were found in reservoirs with sandy beds covered with a layer of detritus, and that *Cyclocypris laevis*, *Cypris pubera* and *Cyprifopsis elongata* were found in a reservoir with a clayey substratum. These were previously noted only from reservoirs with muddy beds, and *C. laevis* and *C. pubera* also from those with detritus — covered sandy beds (HILLER 1972, NÜCHTERLEIN 1969, SYWULA 1983, SYWULA et al. 1982).

Apart from the above-mentioned cases, the present investigations confirmed previous information concerning types of substrata required by the species collected.

Most of the species studied are typically bottom, non-floating species (23 species — 57.5% of the total number), the remainder being able to float but being strictly connected with the bottom (15 species — 37.5%), one species related to the surface water membrane and one stygobiont — Table IV.

3. Susceptibility to hydromechanical factors

The water in almost all the reservoirs studied was stagnant, a slight movement only being noted in localities 1, 9, 12, 14, 19 and may be 2, 10 and 13.

Data concerning the influence of the hydromechanical factor is available

Table IV

General characteristics of species collected (based on data from the literature)

No.	Taxon	Type of substratum									Mode of life	Susceptibility to hydromechanical factor	Occurrence in Poland	Geographic range
		E	M	S/M	S/D	S/S	C	P	G	?				
1.	*Ilyocypris decipiens*		+	+	+	+					B	E	4	EM
2.	*I. gibba f. biplicata*		+		+		+				B	E/O	F+	H
3.	*Candona candida*	+									B	E	C	H
4.	*C. improvisa*									+	B	?	1+	E
5.	*C. lindneri*		+								B	?	4	EM
6.	*C. neglecta*		+	+	+						B	M	C	EMA
7.	*C. weltneri*		+					+			B	O	4	EM
8.	*C. alexandri*		+		+						B	?	1	—
9.	*C. balatonica*									+	B	?	1	H
10.	*C. fabaeformis*		+		+		+				B	O	C	H
11.	*C. fragilis*		+		+			+	+		B	F	F	E
12.	*C. holzkampfi*									+	B	?	4	EA
13.	*C. hyalina*		+								B	O	4	H
14.	*C. protzi*	+									B	O	4	E
15.	*C. compressa*		+	+	+	+					B	O	F	H
16.	*C. eremita*									+	St	?	3+	E
17.	*C. hartwigi*		+		+						B	O	3	H
18.	*C. insculpta*		+	+	+						B	O	F	E
19.	*C. marchica*		+		+			+			B	O	F	EMA
20.	*C. prespica pomeranica*		+					+			B	?	2	—
21.	*Candonopsis kingsleii*		+	+	+		+				B	F	F	HNe
22.	*C. parva*		+	+	+			+			B	?	2	—
23.	*Cyclocypris laevis*		+		+						S	E/M	C	H
24.	*C. ovum*	+									S	E	C	H
25.	*Cypria ophthalmica*	+									S	E	C	C
26.	*Physocypria fadeewi*		+	+	+						S	O/F	4	H

27.	*Notodromas monacha*	+									N	O	C	H
28.	*Cyprinotus barbarus*		+	+							S	?	2+	EM
29.	*C. incongruens*		+		+		+				S	E/M	C	C
30.	*Bradleystrandesia affinis*	+									S	O	F	NHt
31.	*B. fuscata*		+				+		+		S	O/F	F	H
32.	*Eurypris crassa*									+	S	?	3+	H
33.	*E. lutaria*		+	+					+		B	O	C	P
34.	*E. moravica*									+	S	?	NP+	—
35.	*E. virens*		+						+		S	O	F	C
36.	*Stenocypria fischeri*									+	B	?	2	P
37.	*Cypris pubera*		+		+				+		S	O/F	C	H
38.	*Cypridopsis elongata*		+								S	?	4	EM
39.	*C. cf. parva*									+	S	?	NP?	—
40.	*C. vidua*	+									S	M/O	C	HNe

Explanations:

Type of substratum: E — euryplastic species, as regards type of substratum; M — species found in reservoirs with muddy bottom; S/M — species found in reservoirs with sandy-muddy bottom; S/D — species found in reservoirs with sandy bottom covered with a thin layer of detritus; S/S — species found in reservoirs with sandy-stony, coarse-sandy or stony bottom; C — species found in reservoirs with clayey bottom; P — species found in reservoirs with peaty bottom; G — species found in reservoirs with grassy bottom; ? — no data. Mode of life: B — species burrowing into substratum, unable to swim; S — species which swim and move over the surface of the bottom; N — species associated with the surface membrane of the water; St — stygobiont. Susceptibility to hydromechanical factor: E — rheoeuryplastic species; M — mesorheophyllous species; O — oligorheophyllous species; F — rheophobes; E/O, E/M, O/F, M/O — opinion divided: ? — no data. Occurrence in Poland: C — common species (numerous localities within numerous physiographic units); F — fairly common species (found in at least 5 physiographic units); 1—4 — species found at localities within 1—4 physiographic units; NP — species new to the fauna of Poland; + — species new to the Pomerania Lake District. Geographic range: — — species little known; C — cosmopolitan; species restricted to the: HNt — Holarctic and Notogaea; HNe — Holarctic and Neogaea; H — Holarctic; P — Palearctic; EMA — European, Mediterranean and Central Asian subareas; EM — European and Mediterranean subareas; EA — European and Central Asia subareas; E — European subarea.

only in respect of 26 species and of these there are contradictory opinions in respect of as many as 7 (see Table IV).

An interesting feature was the finding of *Candona fragilis* and *Candonopsis kingsleii* (species known to be rheophobes) in localities with a slight movement of the water, with the same frequency as in stagnant reservoirs. It may be that these species should be accepted as oligorheophyllous. *Physocypria fadeewi* and *Cypris pubera* were found less frequently in slowly-moving water than in stagnant. Opinions on the effect of this environmental factor on the occurrence of these species are divided (Table IV). Basing on the present material, the author is inclined to include the species in question among the oligorheophyllous forms.

Conclusions can also be drawn from the material studied, concerning several species unknown as regards susceptibility to the movement of water. As there was a slight movement of the water in all the localities of *Candona lindneri*, it is highly probable that species is a oligorheophile. *Candona balatonica, C. holzkampfi, C. prespica pomeranica, Stenocypria fischeri* and *Cypridopsis elongata* were also noted in reservoirs with slow flowing water. It is difficult, however, to give a precise opinion regarding these species due to the paucity of the material, although they may be oligorheophyllous forms.

Basing on data both from the literature (Hiller 1972, Nüchterlein 1969, Sywula et all. 1982 — Table IV) and from present studies, the following groups of species can be distinguished in the localities studied:
— euryplastic forms: 4 species (10% of all found),
— mesorheophyllous forms: 1 species (2.5%),
— oligorheophyllous forms: 17 species (42.5%),
— forms unknown in this respect, or those as regards which opinions differ: 18 species (45%).

4. Phenology

In the majority of cases the data collected on the individual species confirm previous information concerning periods of occurrence and number of generations per annum. Table II gives the periods in which the particular species were collected.

Worth noting are several deviations and informations supplementary to the existing knowledge about certain taxa.

Candona candida. Mature females were found on 6 August (at location 2) and on 23 August (at location 14). It is not clear whether these individuals represented the past or the coming generation. Adult specimens were noted so far from September to (in exceptional cases) June (Alm 1915, Hiller 1972, Sywula 1974).

Candona improvisa. Larvae were found in spring, summer and autumn (maximum summer and autumn). Lack of adults in spring sample (the main period of occurrence — SYWULA 1974) should be explained by the late sampling. Only the valves of adults were found.

Candona lindneri. It is difficult to explain the lack of adults at location 19 in spring. Another strange fact was also the lack of larvae in the main period of occurrence at location 1 (they were only found in summer — 6 August); the 3 mature females and 3 mature males found there on 6 August were most probably from the second generation (autumn). Only one generation of the species — the spring, was noted in location 9 and 12.

Candona neglecta. At location 17, mature individuals were more numerous in the autumn (despite the fact that earlier data indicates a more numerous spring generation — SYWULA et al. 1982). It may have been that the spring generation attained its maximal development prior to the spring sampling. At location 12, this species was represented only by larvae collected in the autumn. These probably constituted the future spring generation. An interesting fact was the occurrence at location 4 (periodically dried up reservoir) of two generations of this species, the autumn one appearing to be most numerous. BRONŠTEJN (1947), SYWULA (1974) and other authors, state that two generations of this species are only to be found in permanent reservoirs. It is also unlikely that the 7 mature individuals taken from this locality in 23 November constituted the beginning of the spring generation, as mature individuals of this generation appear at the beginning of spring (i.a. ALM 1915, SYWULA et al. 1982).

Candona weltneri. One mature male was already collected from location 15 on 23 August. Mature individuals of this species occur from autumn (only in exceptional cases in September) until the end of the following spring, although BRONŠTEJN (1947), states that he found mature *C. weltneri* in summer (from July).

Candona alexandri. Mature individuals were collected in the autumn. In the two previous sites on which this species was found, it occurred only in the spring (SYWULA et al. 1982). It may be that we have to deal here with two generations, or one long (beginning as from autumn) with a spring optimum.

Candona fabaeformis. There was only one generation — spring, in four localities studied (6, 8, 15 — until late summer, 18), there was also one generation in locality 16, but in the autumn, whereas there were two generations in three localities (12, 14, 17). It was difficult to reach concrete conclusions at localities 1 and 10, in view of the paucity of samples.

Candona fragilis. This species probably developed two generations in localities 4, 9 and 10. It cannot be ruled out that the mature individuals collected in the autumn (at locality 4, both older and younger larvae were also noted on 23 November) constituted the beginning of the future spring generation, or that this species is an autumn-winter stenochron there (offspring of the winter generation have been found in spring).

Candona holzkampfi. Apart from the main period of occurrence (spring) mature individuals and larvae of the species have also been collected (although few in number) in the summer and autumn. It may be that on occasions, this species gives a second, less numerous, generation (autumn).

Candona compressa. It is difficult to explain why, despite the fact that there were numerous larvae of the species at locality 10 (almost all the year round), there were no mature individuals. Another singular fact was the noting of two mature individuals at location 9 on 1st December. Previously, mature individuals of this species had been collected in November at the latest (BRONŠTEJN 1947, SYWULA et al. 1982).

Candonopsis kingsleii. One generation develops in locations 5, 8 and 17, whereas two develop in locations 9 and may be 14 and 15. Due to insufficient material, it is difficult to come to any conclusions as to the number of generations in locations 10 and 18.

Candonopsis parva. Only one generation (spring) developed at all the locations in which this was found, although it would appear from the literature that there are always two (SYWULA et al. 1982).

Stenocypria fischeri. One mature female was found at location 1 as late as 6th November, despite the fact that this species is, in principle, a summer form (mature individuals were collected in September at the latest — BRONŠTEJN 1947, SYWULA 1974). This species may also occasionally develop a second generation in the autumn, as suggested by JANČAŘIK (1954), or summer generation individuals may live until late autumn.

Cypris pubera. Younger and older larvae were still noted on 6th August at location 3. Only BRONŠTEJN (1947) and NÜCHTERLEIN (1969) inform us of the occurrence of its larvae still in July.

Cypridopsis vidua. In locations 5 and 6, mature individuals were found in autumn only. Although this species may occur the whole year round (HILLER 1972), the optimum development is at the turn of spring and summer (first generation), or the turn of summer and autumn (second generation) — SYWULA 1974.

Due to infrequency of sampling, problems with accurate determination of larvae and, in the case of many species, paucity of material, it is impossible from the data available to supply precise conclusions as to the number of generations and degree of elimination of individuals belonging to the particular species in the course of ontogenesis. However, basing on data from the literature and present studies (confirming, in the majority of cases, previous information on the subject of phenology), the following groups of species can be distinguished in the material studied:

1. Species with one generation a year, in principle:

1.1. Yearly forms (eurychrons): *Candona candida* (maximum development — autumn, winter), *C. fabaeformis* (maximum development — autumn, winter, spring; sometimes develops 2 generations), *Cyclocypris laevis* (this may develop 2 generations), *C. ovum* (this may develop 2 generations), *Physocypria fadeewi* (maximum development — spring, summer).
5 species (12% of total collected).

1.2. Springs forms: *Candona fragilis* (this may develop 2 generations, or is an autumn-winter form), *C. holzkampfi* (this may develop a second, autumn, generation), *C. compressa* (this may have a long-term development from autumn), *C. hartwigi* (a few also noted in summer), *C. insculpta*, *C. marchica* (this may develop 2 generations), *C. prespica pomeranica*, *Bradleystrandesia affinis*, *B. fuscata* (this may have a long-term development from autumn), *Eurypris crassa*, *E. lutaria*, *E. virens* (sometimes develops an autumn generation also), *Cypris pubera* (sometimes also noted in summer).
13 species (32.5%).

1.3. Summer forms: *Ilyocypris decipiens* (sometimes there is a second generation in autumn), *I. gibba* f. *biplicata* (as *I. decipiens*), *Notodromas monacha*, *Cypridopsis elongata* (there may be 2 generations during the year).
4 species (10%).

1.4. Autumn-winter forms: *Candona weltneri*, *C. hyalina*, *C. protzi*.
3 species (7.5%).

2. Species with two generations: *Candona neglecta* (more numerous in spring, less in autumn).
1 species (2.5%).

3. Species which mainly develop two generations, although sometimes only one: *Candona lindneri* (if 2, the earlier generation is the most numerous), *Candonopsis kingsleii* (occasionally only one generation — the spring-summer, develops), *C. parva* (if 2 generations, both the spring and summer are equally numerous; sometimes there is only a spring generation), *Cypria ophthalmica* (if 2 generations, the summer one is more numerous), *Cypridopsis vidua*.
5 species (12.5%).

4. Species developing more than two generations: *Cyprinotus incongruens*.
1 species (2.5%).

5. Species developing an unknown number of generations: *Candona improvisa* (probably one generation — in spring), *C. alexandri* (may be one generation in spring, with long-term development from autumn, or a second, autumn, generation on sporadic occasions), *C. balatonica* (probably one generation — spring — Jančařik 1954), *C. eremita*, *Cyprinotus barbarus* (most probably one generation: summer-autumn), *Eucypris moravica* (probably one generation — spring), *Stenocypria fischeri* (may be 2 generations: summer and autumn, or only one lasting from late autumn).
7 species (17.5%).

Cyprinotus cf. *parva* has not been taken into account in the list.

5. Mode of reproduction

Basing on previous information on the individual species, it can be concluded that in the case of the species represented by males and females in the material studied, reproduction is by amphigony.

In the material studied, no males were found in 6 species known to be amphigonous: *Ilyocypris decipiens*, *Candona improvisa*, *C. alexandri*, *C. balatonica*, *C. prespica pomeranica* and *Cyprinotus barbarus*. This can only be explained as being due to paucity of material, and in the case of *C. improvisa*, the fact that only larvae were present in the material (although valves of males were found).

Of interest was the finding of male *Ilyocypris gibba* f. *biplicata* in this area of its geographical range. Males of this species are sporadic and mentioned from the southern part of the area in which it occurs (Bronštejn 1947, Martens 1984, Sywula 1967). It can be concluded that at the site on which it was found (location 10), this species is amphigonous.

The remaining species reproduce by parthenogenesis, in the area studied (Table II).

Summing up, 67.5% of the species contained in the material analyzed constituted amphigonous forms, 32,5% reproducing by parthenogenesis.

As regards the quantitative ratio of sexes in the amphigonous forms, it is difficult to give any conclusions, as individuals of one sex often develop and die quicker than the others, and the sex of the younger larvae cannot be determined. Precise conclusions can only be given after having at one's disposal a large quantity of material and analyzing samples with great frequency at specific time intervals, for individual taxa.

6. Coexistence of species

It is worth noting that both *Candona candida* and *C. weltneri*, closely related species and usually appearing separately, were found at five localities (5, 6, 12, 14 and 15). Hitherto, only two localities in which the two occur simultaneously, have been noted in Poland: the oxbow-lake of the river Warta near Poznań (Sywula 1965) and the brackich peat-pond near Włocławek (Sywula 1966). All the sites at which the two species were found together in the area studied (apart from locality 12) either are oxbow-lakes or are connected with them (location 14 — a drainage ditch probably contacts with an oxbow-lake — locality 15). It may be that in this type of habitat, more than in others, these species do not exclude each other.

7. Distribution in Poland

About 25% of all species known to Polish inland waters were found in the material studied. Half the species in the area studied are common or fairly common in Poland, recorded on numerous sites within many physiographic regions, as denoted in the „Catalogus faunae Poloniae" (Table IV).

Among those collected was found one species new to Polish fauna: *Eucypris moravica*. Previously, this species had been known from Moravia (Jančařik 1954) and the eastern part of the Balkan Peninsula (Sywula 1967).

From the faunistic point of view, worthy of note is the finding of species which are rare and little known in Poland: *Candona improvisa, C. alexandri, C. balatonica, C. hyalina, C. eremita, C. prespica pomeranica, Candonopsis parva, Cyprinotus barbarus* and *Stenocypria fischeri*. *C. improvisa, C. balatonica* and *S. fischeri* have hitherto been known only from the Wielkopolska-Kujawy Lowland (SYWULA 1965, 1974), and *S. fischeri* may be also from region of Gdańsk (SELIGO 1899). Although *C. hyalina* was noted in several regions of Poland, it is among the rarer and little known ostracodes. As regards *C. alexandri*, locality 5 is the third recent location of the species, the two previous being in the Cashubian Lake District (SYWULA et al. 1982). *C. prespica pomeranica* is a subspecies previously known only in 10 locations in Poland (the Cashubian Lake District, region of Białowieża and borders of the Sandomierz Lowland and Roztocze — SYWULA 1981a, 1983 and SYWULA et al. 1982). *C. parva* has only, so far, been known outside Poland, in the F.R.G. and Bulgaria (NÜCHTERLEIN 1969, SYWULA 1967). *C. barbarus* is a rare species, the northern range limit of which runs through Poland (SYWULA 1966). The finding of one mature female in locality 11, may indicate that this species is migrating northwards. Localities 4 and 9 are also the most northern of those of *C. eremita*. Hitherto, this has been noted in Poland only in subterranean habitats in the river Bóbr basin, Odra valley (middle section), and Vistula basin in the Małopolska Upland. The most northerly localities so far, have been in the region of Krosno Odrzańskie and Kazimierz Dolny (SYWULA 1981b).

Seven species (including *Eucypris moravica*) new to the Pomorze (Pomerania) Lake District, were noted in the material collected — Table IV. Basing on the results of previous (ZADDACH 1844, SELIGO 1899, SYWULA et al. 1982) and present-day studies, the list of ostracodes find in the eastern part of the Pomerania Lake District embraces 69 taxa of the species-group and infrasubspecific as well, from 64 species and 22 genera.

8. Zoogeographic composition of ostracode species collected

The geographic distribution of the ostracodes from the areas studied is presented in Table IV. This does not include little-known species: *Candona alexandri, C. prespica pomeranica, Candonopsis parva, Eucypris moravica* and *Cypridopsis parva*.

Dominating in the ostracode fauna of the Fens are those with a wide Holarctic range — 13 species (32.5% of the total collected). As regards geographic range, the following groups of species were also found:
— cosmopolitan — 3 species (7.5% of the total),
— those inhabiting the Holarctic Region and Notogaea — 1 species (2.5%),
— those inhabiting the Holarctic Region and Neogaea — 2 species (5%),
— those with a wide Palearctic range — 2 species (5%),
— those restricted to the European, Mediterranean and Central Asian subarea in the Palearctic — 2 species (5%),

— those restricted to the European and Central Asian subarea — 2 species (5%),
— those restricted to the European and Mediterranean subarea — 5 species (12.5%),
— those known only from localities in the European subarea — 5 species (12.5%).

9. Zoocoenological analysis

Due to the small number of specimens collected, localities 7, 16 and 19 have only been treated descriptively in the present analysis.

With the exception of localities 2, 3, 4 and especially 11, characteristic of all the assemblages subjected to numerical analysis was their considerable species diversity — Table II. Notwithstanding the assemblages are rather similar to one another.

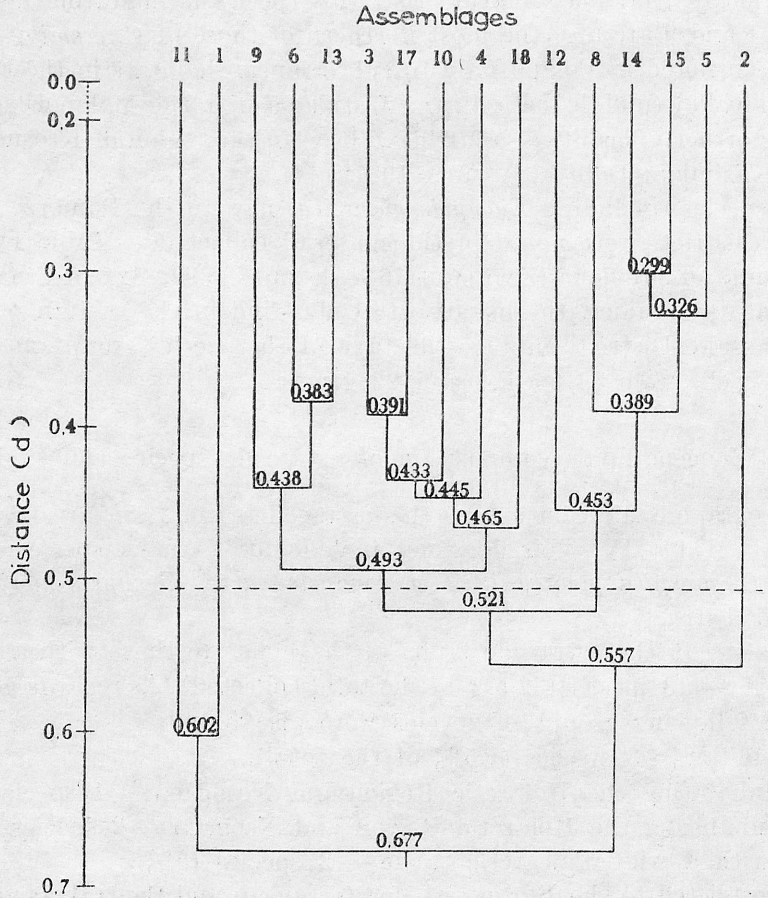

Fig. 4. UPGMA dendrogram of absolute distances (d) of assemblages studied

Applying the UPGMA method the image obtained (Fig. 4), suggested the pertinence of two ostracode communities. The first is a community typical of old river-bed reservoirs, represented by assemblages 5, 8, 12, 14 and 15. The second community occupies drainage ditches and is represented by assemblages 3, 4, 6, 9, 10, 13, 17, 18.

The most typical of the first community would seem to be assemblages 5 and 15, which inhabit permanent, large, shallow oxbow-lakes with muddy bottom, large amount of detritus, surrounded and overgrown by reeds, with nympheids and elodeids, as well as a wealth of accompanying fauna. Fairly strongly related to these is the assemblage 8 from an old river-bed marsh. The fact that one of assemblages from the draining ditches (14) is included in the unit in question, as being very similar to assemblage 15, is due to the proximity of these reservoirs and there most probably being contact between the aquatic environments. What is interesting is the presence of assemblage 12 from the irrigation canal in the first community. This may have resulted from the volume of water in the reservoir (width of canal in meanders attains 8 m), it being undoubtedly less than in oxbow-lakes, but in this case comparative. This canal may also be of river origin. The absence in the first community of assemblage 6, of small old river-bed marsh is hardly explicable. It was noted in the second community, may be in view of the probability of the habitat drying up. The number of taxa of the species-group and infrasubspecific rank for the ostracode community of old river-bed reservoirs in the area studied is 24. The species reproducing parthenogenetically constitute about 17%. Here, the H' index attains very high values: from 1.288 to 2.029 (mean H' 1.654). The figures characterizing the domination D (calculated here as the mean arithmetic value of the relative numerical value of taxa in the assemblage, resulting from its being allocated to a particular dominant category) and the frequency F_r of taxa in the ostracode community discussed, are given in the scatter diagram (Fig. 5A).

The second ostracode community embraces fauna from drainage ditches and canals typical of the Fens landscape. Alongside permanent and periodically drying up, shallow-water ditches and canals with muddy bottoms, marked flow of water, or stagnant water with flourishing vegetation and rich accompanying fauna, assemblages of this collective unit also inhabit various kinds of pools and ponds with similar features. As most typical of this community can be assumed, on the one hand, poorly diversified assemblage 17 inhabiting the permanent, still, shallow-water overflow of a drainage ditch with a muddy bottom, on a relatively wet meadow, to which are related other poorly diversified assemblages from small reservoirs, and on the other hand, assemblage 10 (the highest H' value in this community), inhabiting a periodically drying up canal with muddy bottom, maybe with a visible movement of water, with which are related, in turn, other assemblages of this class with a fairly high species diversity. The number of species in this community is 28. The species reproducing parthenogenetically constitute 32%. The domination (D) and

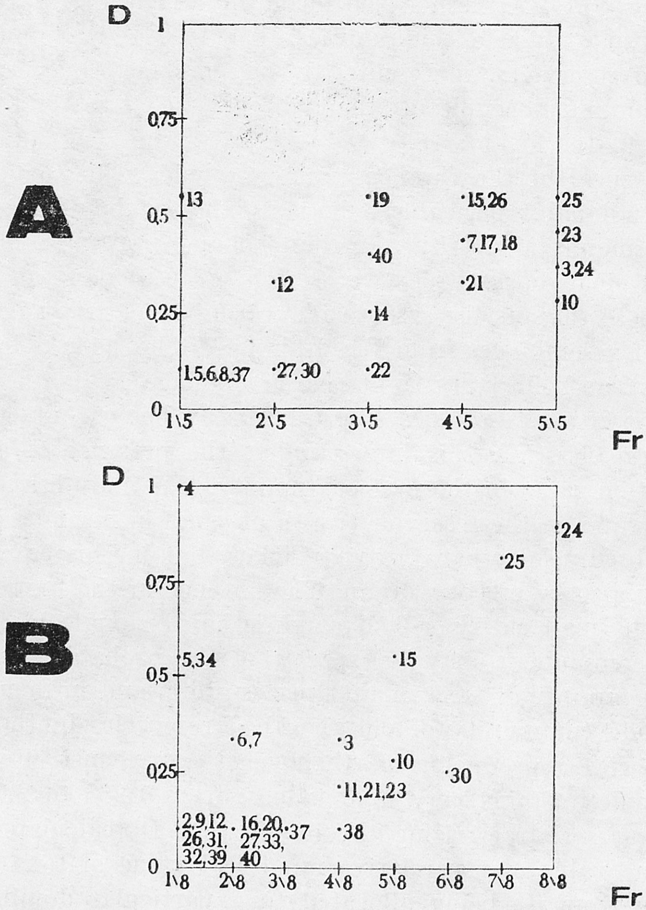

Fig. 5. List of indices of the dominance of species (D) and their frequency (F_r) in an ostracode community typical of old river-bed reservoirs — A, and of drainge ditches and canals — B, in the area studied (the figures are the numbers of taxa in Table II)

frequency (F_r) of taxa in the ostracode community from drainage ditches and canals are illustrated in Fig. 5B. The value of index H' is from 0.601 to 1.665 (mean H' 1.221). This ostracode community would seem to be typical of the Fens.

The remaining assemblages analyzed are so different from the collective ecological units described, that they should be treated separately. The difference of the assemblages at localities 1, 2 and 11 is interesting.

The separate character of the first of these is probably due to the occurrence of specific recedents not found at other localities and the different share of the taxa dominating here, in others assemblages studied. This may be due to the character of the reservoir, which is basically the highly eutrophic run-off from arable fields. No such powerful human intervention was marked at other localities.

This assemblage is most closely related to that at locality 18, which is also quite eutrophicated.

The assemblage at locality 11 is very poor in species (only *Bradleystrandesia affinis* as the dominant and *Cyprinotus barbarus* as the recedent), and therefore hardly diversified. Samples from this locality only contained ostracodes in the spring, despite the fact at the time of sampling, the reservoir always contained water. This assemblage is most similar to assemblage 1, in which *Bradleystrandesia affinis* also dominated.

Assemblage 2 inhabits a slow-flowing drainage canal with a bottom of muddy sand and in places only sand. This habitat is one of the least eutrophicated of those studied, which may have influenced the individual character of the ostracode assemblage.

Localities 7, 16 and 19 are reservoirs eutrophicated in relatively low degree, poor as regards the number of species and individuals. The assemblage at locality 7 (clayey bottom) is related, to a certain degree (as regards species composition), to the assemblages from the drainage ditches and canals. Unfortunately, the modest quantity of material collected from this locality and localities 16 and 19, was insufficient to enable them to be characterized numerically. The two consecutive assemblages from drainage ditches (16 and 19) were among the poorest qualitatively and quantitatively amongst those studied. In the second of these (from a reservoir drying up periodically, with slow-flowing water and sandy bottom with a thin layer of detritus), only three species were found (apart from two eurytopic forms: *Cyclocypris ovum* and *Cypria ophthalmica, Candona lindneri*, a species little known as regards autecology, also occurs). For this reason, it is difficult to compare this assemblage with others and indicate any relationships. If a representative quantity of material were available, assemblage 16, on the other hand, would most probably be included into the ostracode community of drainage ditches and canals typical of the Fens.

It is worth adding that no differentiation was noticed between the geologically separable parts of the Fens. The composition of both ostracode communities mentioned included both assemblages from the northern and southern part. Thus, as regards ostracode fauna, the area studied constitutes a compact physiographic unit.

University of Gdańsk
Department of Genetics
Kładki 24, 80-822 Gdańsk, Poland

REFERENCES

Absolon A. 1978. Die Gattung *Candona (Ostracoda)* im Quartär von Europa. Rozpr. České Akad. Véd., **88** (5): 1—75.

Alm G. 1915. Monographie der Schwedischen Süsswasser-Ostracoden nebst systematischen Besprechungen der Tribus Podocopa. Zool. Bidr. Uppsala, **4**: 1—247.

Augustowski B. (ed.) 1976. Żuławy Wiślane. GTN, Gdańsk, 660 pp.

Bronštejn Z. S. 1947. *Ostracoda* presnych vod. Fauna SSSR. Izd. Akad. Nauk SSSR, Moskva—Leningrad, **2** (1), 339 pp.

Hartman G., Puri H. S. 1974. Summary of neontological and paleontological classification of *Ostracoda*. Mitt. Hamburg Zool. Mus. Inst., **70**: 7—73.

Hiller D. 1972. Untersuchungen zur Biologie und zur ökologie limnischer Ostracoden aus der Umgebung von Hamburg. Arch. Hydrobiol., **40** (4): 400—497.

Hutchinson G. E. 1967. A Treatise on Limnology. Dept. of Biology, Yale Univ., John Wiley and Sons Inc., New York — London — Sydney, vol. II, 1115 pp.

Jačařik A. 1954. *Ostracoda*. (in:) K. Vondraček (ed.): Klič zvireny ČSR, Praha, vol. I, pp. 405—448.

Kaczmarek M. 1981. Aparaty i przyrządy do wydobywania zwierząt z gleby. (in:) M. Górny, L. Grüm (eds): Metody stosowane w zoologii gleby. PWN, Warszawa, pp. 134—162.

Klie W. 1938. *Ostracoda*. Die Tierwelt Deutschlands, **34**, Jena, 230 pp.

Klie W. 1940. Zur Kenntnis der Ostracodenarten *Candona eremita* (Vejdovsky) und *Candona reducta* Alm. Mitt. Höhlen—u. Karstforsch., 1940 (1): 24—29.

Martens K. 1984. On the freshwater ostracods *(Crustacea, Ostracoda)* of the Sudan with special reference to the Red Sea Hills, including a description of a new species. Hydrobiologia, **110**: 137—161.

Nüchterlein H. 1969. Süsswasserostracoden aus Franken. Int. Rev. Hydrobiol., **54**: 223—287.

Seligo A. 1899. Westpreussische Krebsthiere. Schr. Naturf. Ges. Danzing. N. F., **10**: 52—53, 60—63.

Sneath P. H. A., Sokal R. R. 1973. Numerical Taxonomy. W. M. Freeman and Corp., San Francisco, 573 pp.

Sywula T. 1965. Małżoraczki *(Ostracoda)* Wielkopolskiego Parku Narodowego. Pr. Monogr. Przyr. Wielkop. Parku Nar., **5**: 69—94.

Sywula T. 1966. Badania faunistyczne: Małżoraczki *(Ostracoda)* i Widłonogi *(Copepoda)*. (in:) Badania nad solniskami śródlądowymi Polski. Bad. Fizjogr. Pol. Zach., **18**: 7—65.

Sywula T. 1967. Notes on *Ostracoda*. II. On some bulgarian species. Bull. Soc. Amis Sci. Poznań, 8: 11—42.

Sywula T. 1974. Małżoraczki *(Ostracoda)*. Fauna Słodkowodna Polski, PWN, Warszawa—Poznań, 24, 315 pp.

Sywula T. 1981a. New taxa of *Ostracoda (Crustacea)* from Pomerania (North Poland). Bull. Acad. Pol. Sci., **10/11**: 625—636.

Sywula T. 1981 b. Małżoraczki *(Ostracoda)* wód podziemnych Polski. Roczn. Muz. Częstoch., Przyr., **2**: 89—96.

Sywula T. 1983. Materiały do znajomości małżoraczków *(Ostracoda, Crustacea)* wschodniej Polski. Zesz. Nauk. Uniw. Gdańskiego, Wydz. BiNoZ, Biologia, **4**: 133—136.

Sywula T., Sell J., Lorenc R. 1982. Małżoraczki *(Ostracoda)* okolic Otomina na Pojezierzu Kaszubskim. Zesz. Nauk. Uniw. Gdańskiego, Wydz. BiNoZ, Biologia, **3**: 5—17.

Zaddach G. 1844. Synopseos Crustaceorum prussicorum prodromus. Dissertatio Zoologica Regiomonti, Regiomonts, 39 pp.

STRESZCZENIE

Praca stanowi pierwsze opracowanie składu małżoraczków z terenu Żuław Wiślanych. Materiał został zebrany w latach 1984 i 1985. Podano rozmieszczenie i opis 19 stanowisk, na których pobierano próby (ryc. 1, ryc. 2 i tab. I). Z każdego stanowiska pobrano metodą jakościową próby z trzech różnych sezonów, które stanowią cykl roczny. Zbiór obejmuje 29223 osobniki reprezentujące 40 gatunków z 4 rodzin. Lista zebranych taksonów, liczba osobników reprezentujących je w materiale, ich frekwencja na stanowiskach, okresy występowania taksonów w poszczególnych porach roku w rozbiciu na stadia juwenilne i osobniki dojrzałe zestawione są w tabeli II. Dla każdego zgrupowania małżoraczków, występującego na badanych stanowiskach, obliczono wskaźnik różnorodności gatunkowej SHANNONA-WIENERA (H') i określono strukturę dominacyjną (tab. II).

Próby wiosenne okazały się najbogatsze ilościowo i jakościowo (tab. III). We wszystkich okresach poboru prób dominowały osobniki dojrzałe, przy czym wiosną ich udział był najmniejszy (ryc. 3). Najpospolitsze i najliczniejsze na badanym terenie są *Cyclocypris ovum* (F_r = 18/19, D = 25%) i *Cypria ophthalmica* (F_r = 17/19, D = 14%) gatunki mało wybredne środowiskowo — tab. II. Interesujący jest fakt stwierdzenia *Candona eremita* na dwóch stanowiskach z wodą powierzchniową, a także *Eucypris crassa* i *E. lutaria* w zbiorniku trwałym oraz *Candonopsis kingsleii* i *Stenocypria fischeri* w zbiornikach okresowo wysychających.

Zanalizowano zebrane gatunki pod względem ich wymagań dotyczących rodzaju podłoża, sposobu życia, wrażliwości na czynnik hydrodynamiczny, sposobu rozmnażania i fenologii. Okazuje się, że większość gatunków stanowiły formy pelofilne (80% ogółu zebranych, w tym 17,5% euryplastycznych pod tym względem), typowo denne — niepływające (57,5%), oligoreofilne (45%) — tabela IV, amfigoniczne (67,5%), wiosenne z zasadniczo jedną generacją w roku (32,5%).

Zwrócono uwagę na łączne występowanie na pięciu stanowiskach *Candona candida* i *C. weltneri*.

Jeśli chodzi o rozmieszczenie zebranych gatunków w Polsce, to połowę stanowią gatunki pospolite lub dość pospolite. Wśród pozostałych stwierdzono 7 gatunków nowych dla Pojezierza Pomorskiego, w tym *Eucypris moravica* JANČ. nowy dla fauny Polski (tab. IV). Na uwagę zasługuje znalezienie na Żuławach gatunków rzadkich w Polsce i mało znanych: *Candona improvisa, C. alexandri, C. balatonica, C. hyalina, C. eremita, C. prespica pomeranica, Candonopsis parva, Cyprinotus barbarus* i *Stenocypria fischeri*. Dwa nowe stanowiska *C. eremita* i jedno *C. barbarus* są najdalej wysuniętymi na północ ze znanych do tej pory, a nowe stanowisko *C. alexandri* jest trzecim w ogóle holoceńskim stanowiskiem tego gatunku.

Pod względem zoogeograficznym dominują na badanym terenie gatunki o zasięgu holarktycznym (32,5% ogółu) — tab. IV.

W końcowej części pracy przedstawiono analizę zoocenologiczną. Dały się wyróżnić dwie zbiorcze jednostki (ryc. 4, 5): 1) charakterystyczne zgrupowanie małżoraczków zbiorników starorzeczowych; jego strukturę przedstawia ryc. 5A i 2) charakterystyczne zgrupowanie małżoraczków typowych dla krajobrazu Żuław rowów i kanałów melioracyjnych — ryc. 5B.

Redaktor pracy: prof. dr A. Szeptycki