The diffusion of ostracode fauna in Lake Ragogna (Friuli, Italy) [1]

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SUMMARY

The study of 62 sediment samples collected in different seasons from 1981 to 1986 in lake Ragogna, has permitted the recognition of relationships between the biotopes and ostracode species belonging to the biocoenoses. In particular, the species idenfitied are 14, pertaining to 10 genera. The comparison between the Ostracoda found and those of other Italian and foreign lake environments has brought to light the existence of some species common to the central-northern European basin. The finding of *Metacypris cordata* for the first time in Italy results as being its most southern European location. Future research will be turned to the verification as to whether this species in Italy is exclusive to lake Ragogna or if it is present in other fresh-water environments within Friuli-Venezia Giulia, in order to determine if also among Ostracoda there exist microthermal species explainable as Ice Age relicts, as already proved in other vegetal and animal taxonomic groups.

INTRODUCTION

Papers concerned with fresh-water Ostracoda of the Friuli-Venezia Giulia region are still very rare. An exception are a few studies undertaken by Fox (1962) and Stoch (1983) which respectively describe the Ostracoda of the mouth of the river Timavo and those of the ponds and lilly pools of the Triestine Karst. The study of the Ostracoda of lake Ragogna is the first such contribution to knowledge about the systematic and environmental value of Ostracoda in the lake environments of Friuli-Venezia Giulia. This also permits a comparison with the Ostracoda of other fresh-water environments in Italy and abroad, in order to obtain an indication of their geographical diffusion.

MATERIALS AND METHODS

Sixty-two samples were taken by unsing different methodologies (grab, skin-diver, plankton net) over the four seasons in the biotopes recognized in the lake (Fig. 1).

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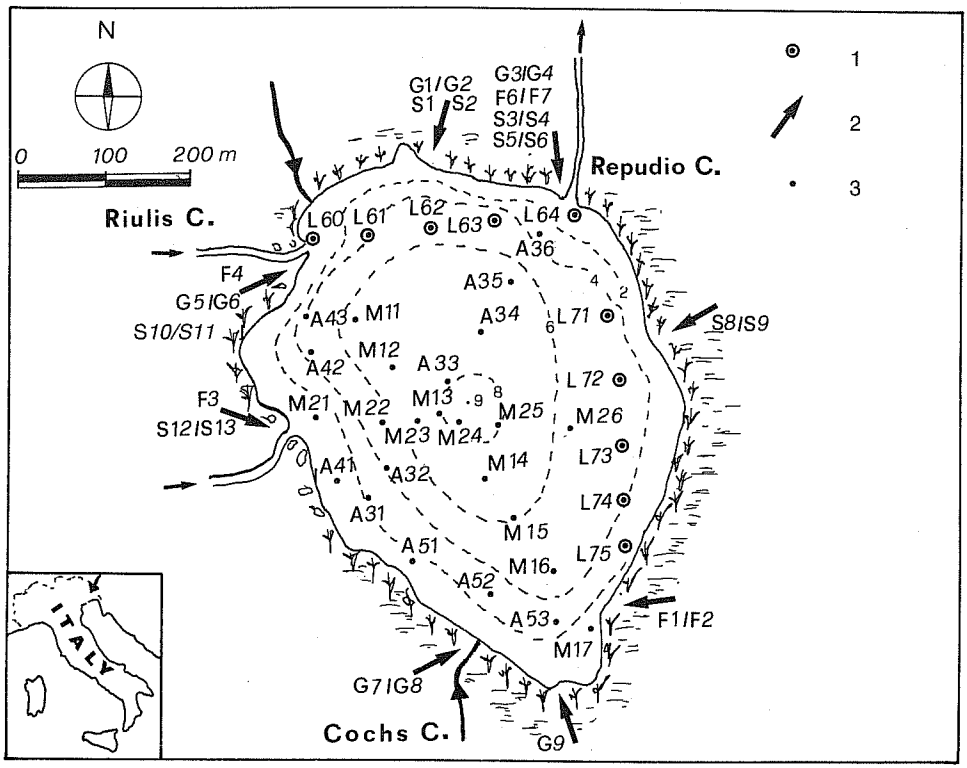

FIG. 1 - Location of the sampling stations of the Lake Ragogna in January (G), April (A), May (M), June (F), July (L), and September (S). Skin-diver sample (1), plankton net sample (2), grab sample (3). Bathymetry expressed in meters.

During each survey, samples were treated with a 2% formalin solution to fix living specimens. Later, samples were washed on a 200 meshes sieve and dried at room temperature. Those specimens recognized as belonging to the biocoenosis were separated from the residue obtained during the washing process.

LAKE RAGOGNA: ENVIRONMENT

Lake Ragogna is an intermorainic temperate lake situated at the southern margin of the Carnic Pre-Alps close to the most external ridge of the Tilaventine morainic amphitheatre. The lake has a subelliptical shape with a maximum axis of 645 meters and minimum of 455 meters. Maximum depth is about 9 meters. Supply is through ephemeral tributaries: the only outlet is the Repudio Creek.

The main physical and chemical characteristichs (Reisenhofer et Al., 1985) are the following:

Temperature: direct summer thermic stratification (T = 27^{0}C at the surface; T= 7.7^{0}C at the bottom); inverse winter stratification (T= 1.5^{0}C at the sur-

face: T= 3.8°C at the bottom); homothermal in spring and autumn (T= 7°C); very superficial thermocline (3-4 meters in the warmer months).
Dissolved oxygen: orthograde distribution in winter; positive heterograde distribution during the rest of the year (in the summer maximum concentration at about 2 meters depth and values near 0 at the bottom).
pH: mean value 7.4 at the bottom; gradual increase towards the surface.

According to Fanzutti and Marocco (1984) the coarser sediments (sands) ark the littoral belt in the western sector. Part of the sandy deposits of the south-western zone has been interpreted as the remains of fans of tributaries which were artificially diverted.

Sands and gravels are found in the delta fans of the principal tributaries.

The grain size of the sediments decreases gradually from the littoral zone towards the central and eastern part of the lake where the pelite fraction is dominant.

LAKE BIOTOPES

A few characteristic biotopes of this lacustrine basin have been recognized (Fig. 2): upper infralittoral (UI), middle infralittoral (MI), lower infralittoral (LI), hypolimnic muds (HM), delta fan (DF).

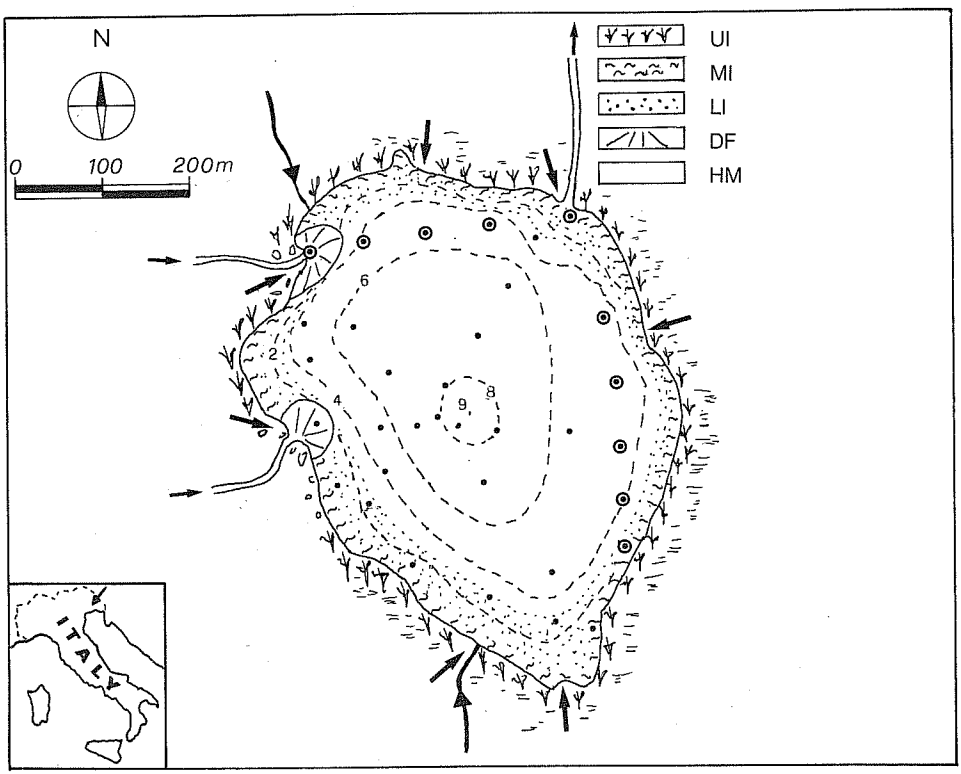

FIG. 2 - Lake biotopes. (Legend: see the text).

Upper infralittoral: belt located in the upper part of the littoral zone characterized from the vegetal point of view mainly by *Phragmites communis* and nearer the shore-line by Bryophyta. Sediments are sand, pelitic sand and very sandy pelite in the western zone and mainly pelite and sandy pelite in the East and North. Peat is present in patches. Samples: G2, G3, G4, G5, G6, G7, G8, G9, F1, F2, F7, S2, S3, S4, S5, S8, S9, S10, S13.

Middle infralittoral: delimited by the *Phragmites communis* band characterized by a second vegetal belt in the littoral zone where *Nuphar luteum* and *Nymphaea alba* and *Trapa natans* predominate. The sediments vary from very sandy pelite to pelite. Samples: G1, F6, S1, S6, S11, S12.

Lower infralittoral: this continues from the medium infralittoral and extends to a depth of 3 meters; it is mainly characterized by the following vegetal species: *Polygonium* sp., *Myriophyllum* sp. and, subordinately, *Potamogeton* sp. with variable sediments, manly, sandy pelite and pelite. Samples: A31, A36, A41, A51, A52, A53, M17, L67, L75.

Hypolimnic muds: delimited by the lower infralittoral, this zone extends to the maximum depth of the lake. Sediments are pelite followed by sandy pelite. For most of year, anoxic conditions are found. Samples: A32, A33, A34, A35, A42, A43, M11, M12, M13, M14, M15, M16, M22, M23, M24, M25, M26, L61, L62, L63, L71, L72, L73, L74.

Delta fans: situated in the western part of the lake and characterized by coarse sediments (sand and gravel). Samples: M21, F3, F4, L60.

OSTRACODE BIOCOENOSIS

The ostracode biocoenoses are made up of 14 species belonging to 10 genera. Some of them are illustrated in Fig. 3. Table I compares recognized species and biotopes.

Cypria lacustris, *Cypria ophthalmica*, *Cypridopsis vidua* and *Limnocythere inopinata* have the widest distribution in the lake as they were encountered between the upper infralittoral zone and hypolimnic muds. Of these species, *Cypria lacustris*, *Cypridopsis vidua* and *Limnocythere inopinata* are also found in the delta fans.

Darwinula stevensoni is instead spread throughout the littoral zone including the delta fans.

Other species (*Candona* aff. *C. fragilis*, *Candona candida*, *Metacypris cordata*, *Pseudocandona sarsi* and *Pseudocandona* aff. *P. sucki*) appear in the belt between the upper infralittoral and middle infralittoral zone.

Candona candida is found also in the scattered areas of the delta fans associated wiht *Candona neglecta*.

Both *Candona neglecta* and *Candonopsis kingsleyi*, on one side, and *Potamocypris similis*, on the other, have been found in the upper infralittoral and middle infralittoral zone.

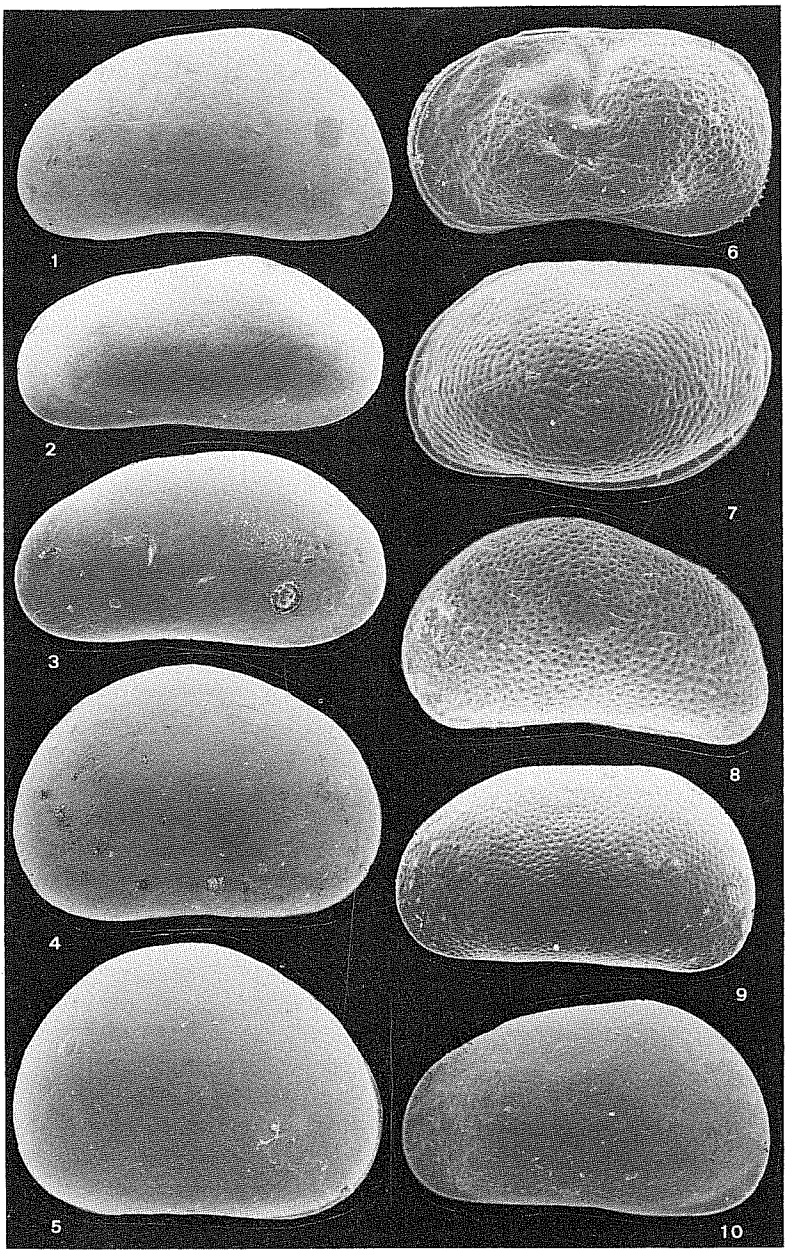

FIG. 3 - SEM photographs of the ostracode species: 1) *Candona candida*, exterior of left valve, 48x; 2) *Candona* aff. *C. fragilis*, exterior of left valve, 50x; 3) *Candonopsis kingsleyi*, exterior of left valve, 52x; 4) *Cypria lacustris*, exterior of right valve, 105x; 5) *Cypria ophthalmica*, exterior of right valve, 85x; 6) *Limnocythere inopitata*, exterior of left valve, 85x; 7) *Metacypris cordata*, exterior of left valve, 105x; 8) *Potamocypris similis*, exterior of left valve, 100x; 9) *Pseudocandona sarsi*, exterior of left valve, 76x; 10) *Pseudocandona* aff. *P. sucki*, exterior of left valve, 95x.

TABLE I - Ostracode fauna and biotopes: DF= delta-fan; UI= upper infralittoral; MI= middle infralittoral; LI= lower infralittoral; HM= hypolimnic muds; R= rare; F= frequent; VF= very frequent; (5)= number corresponding to the month of sampling.

SPECIES	DF	UI	MI	LI	HM
Candona candida (O. F. MUELLER, 1785)	R(6)	R(1) R(6)	R(9)		
Candona aff. C. fragilis HARTWIG, 1898		R(1) R(9)	VF(1) F(9)		
Candona neglecta SARS, 1887	R(6)	R(6)			
Candonopsis kingsleyi (BRADY & ROBERTSON, 1870)		F(6)			
Cypria lacustris SARS, 1890	F(5)	VF(1) VF(6) VF(9)	VF(1) VF(6) VF(9)	R(4) R(5)	R(5)
Cypria ophthalmica (JURINE, 1820)		VF(1) VF(6) VF(9)	R(1) R(9)	R(5)	
Cypridopsis vidua (O. F. MUELLER, 1776)	R(6)	VF(1) VF(6) VF(9)	VF(1) R(6) R(9)	R(4)	R(5)
Darwinula stevensoni (BRADY & ROBERTSON, 1870)	F(6)	VF(1) VF(6) VF(9)	VF(1) VF(6) VF(9)	R(4) R(7)	
Limnocythere inopinata (BAIRD, 1843)	R(5)	R(9)	R(9)	R(4)	R(5)
Metacypris cordata BRADY & ROBERTSON, 1870		R(1) F(9)	R(9)		
Potamocypris similis G. W. MUELLER, 1912				R(4)	
Pseudocandona sarsi (HARTWIG, 1899)		VF(1) R(6)	VF(1) R(9)		
Pseudocandona aff. P. sucki (HARTWIG, 1901)		R(6)	R(6)		

In table I, *Eucypris* sp. has not been considered, as it is a very rare species and at the first stages of development. However this species was found in the upper infralittoral zone.

Table I points out that a higher number of species and specimens is present in the middle-upper infralittoral zone. On the contrary the number of species and specimens decreases in the lower infralittoral zone and reduces quickly in the delta fans and hypolimnic muds. The later were sampled during the spring and summer only. It was noticed that only the samples collected in May present a living ostracode fauna. The lack of living speci-

mens during the summer seems to depend on the decrease of dissolved oxygen with depth.

COMPARISON WITH OTHER FRESH-WATER BASINS

Table II illustrates the geographical distribution of species taxonomically exactly defined. It can be noted that most of these are widespread in both Italian lake environments and others abroad.

Among the living species, only *Metacypris cordata* has never been found in Italian lentic waters, whereas it is widespread in the central-northern areas of Europe.

TABLE II - Geographical distribution of the ostracode species taxonomically exactly defined in Lake Ragogna.

SPECIES	ITALY	ABROAD
Candona candida	L. Maggiore, L. Mergozzo, Pallanza area, Locarno area, rice-fields (Piedmont, Lombardy, Veneto, Tuscany), L. Pausa, R. Timavo, North Apennine Lakes	Europe, Spitsbergen, Greenland, Central and Northwest Asia, Siberia, North America
Candona neglecta	L. Maggiore, Pallanza area, L. Garda, L. Pausa, L. Fusine, rice- fields (Lombardy, Veneto), R. Timavo, Mt. Sibillini (pools), Latium (irregular waters), L. Fusaro	Europe, Central Asia, North America
Candonopsis kingsleyi	L. Maggiore, Piedmont (canals), Pallanza area, North Apennine Lakes	Europe, Siberia, North America
Cypria lacustris	L. Pausa	Central and North Europe
Cypria ophthalmica	L. Maggiore, L. Mergozzo, L. Martignano, Pallanza area, L. Fusine, R. Timavo, Karst (ponds), North Apennine Lakes, Apulia (groundwaters, springs, brackish waters)	cosmopolitan
Cypridopsis vidua	L. Maggiore, L. Mergozzo, Pallanza area, rice-fields (Lombardy, Veneto, Emilia Romagna), R. Timavo, North Apennine Lakes, Marches (Rascino), Latium (pools)	cosmopolitan
Darwinula stevensoni	L. Maggiore, L. Mergozzo, L. Varese, L. Comabbio, Pallanza area, L. Monate, North Apennine Lakes, L. Fusaro, Sardinia (thermal waters)	cosmopolitan
Limnocythere inopinata	L. Maggiore, L. Comabbio, Pallanza area, rice-fields (Lombardy, Emilia, Veneto), Sardinia	Europe, Asia, Asia Minor, North America
Metacypris cordata		Central and North Europe, Ukraine
Potamocypris similis	L. Maggiore, L. Varese, L. Comabbio, Pallanza area	Europe, Iran
Pseudocandona sarsi	generic findings	Central and North Europe, British Isles

The finding of *Metacypris cordata* would appear particularly significant as it results as being the only species of this genus to have outlived the climatic vicissitudes of the Plio-Pleistocene (Colin & Danielopol, 1980). In its fossil form, *Metacypris cordata* is known from the Pleistocene of Croatia, Dinaric Alps and Pannonian Basin (Sokač, 1978).

FINAL CONSIDERATIONS

The study of the living Ostracoda in lake Ragogna has permitted to recognize their precise link with the biotopes.

The comparate geographical distribution of the Ostracoda found here and those of other Italian and foreign lake environments has brought to light the existence of some species common to the central-northern European area.

The finding of *Metacypris cordata* for the first time in Italy provides its most southern European location.

Future research will be addressed to lake Ragogna and fresh-water environments within Friuli-Venezia Giulia, in order to determine if also among Ostracoda, there exist microthermal species explainable as Ice Age relicts, as long since hypothesized in other vegetal and animal taxonomic groups by old Authors (Lorenzi, 1897, 1899, 1901; Pirona, 1877).

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