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Ancient death assemblage of molluscs from the Garda Lake (Lago di Garda, Northern Italy)

With 3 figures

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Abstract. The collection of 56 molluscs species sampled on shores of the Garda Lake about hundred years ago, stored in the Museum of Kremsmünster Abbey, Upper Austria was the subject of the detail study. It is the ancient thanatocoenosis composed of both land and water snails, corresponding to the contemporary environment. Shells of *Valvata piscinalis* were the dominant component of sediments accumulating at that time in the sublittoral zone of the lake.

Kurzfassung. **Eine historische Mollusken-Thanatozönose vom Garda-See (Lago di Garda, Norditalien).** – Eine Aufsammlung von 56 Molluskenarten, welche im Museum der Abtei von Kremsmünster, Oberösterreich aufbewahrt wird, war der Gegenstand der Detailstudie. Es handelt sich um eine historische Thanatozönose von Land- und Süßwasserschnecken, welche die damaligen Umweltverhältnisse widerspiegelt. Gehäuse von *Valvata piscinalis* waren die dominante Komponente der abgelagerten Sedimente aus jener Zeit in der sublitoralen Zone des Sees.

Key words. Land snails, water snails, thanatocoenosis, Garda Lake, Northern Italy.

Introduction

Lago di Garda, situated near Verona, is the biggest lake of Italy (13 km long, 346 m deep). Its northern part is long and narrow, surrounded by considerably wooded mountains exceeding 2000 m and sloping steeply to the foot. The southern segment of the lake extends within the deforested area of the flattened foothills and is limited by belts of end moraines of an ancient mountain glacier. Thanatocoenoses enriched in shells of molluscs accumulate mainly in the southern part of the Garda Lake on flat shores and beaches, after temporary floods and fluctuations of the water level.

The described death assemblage of molluscs, sampled about hundred years ago (October 1895) by Dr I. WIZLSPERGER, has been stored in Museum of the Kremsmünster Abbey (Upper Austria). It is composed of several species selected and preserved in matchboxes, but not identified. The author visited this Museum several times during the last ten years and had the opportunity to determine this very interesting collection. It encloses 570 specimens representing 56 species of molluscs including 41 species of land snails, 14 species of water snails and a single shell of a bivalve. The majority of shells is partly or even entirely

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filled with grey mud with plant detritus. Seeds and other plant remains as well as small shells of molluscs or their fragments can be also found in sediments extracted from shells of large snails. Such preservation of the material as well as the jointly occurrence of land- and water molluscs, are typical features of a thanatocoenosis (allocoenosis), deposited and redeposited by flowing water of streams and rivers or by waves in the littoral zone of a lake (WASMUND 1926; ALEXANDROWICZ 1987, 1999a). It is an ancient thanatocoenosis accumulated at the end of the nineteenth century and related to the contemporary environment, strongly changed since that time. Tubes of Trichoptera larvae, formed of mollusc shells have also been sampled by Dr I. WIZLSPERGER and are a supplementary component of the described collection.

Standard methods of malacological analysis have been adopted and used in the present study (ALEXANDROWICZ 1987, 1999a). The list of taxa with numbers of specimens (in square brackets) is presented in taxonomic order. Ecological groups of species have been distinguished according to patterns described by LOŽEK (1964), EVANS (1972) and the author (ALEXANDROWICZ 1987, 1992). Following symbols are used: F – shadow loving snails (F_1 – woodland species, F_2 – species connected with partly shady habitats, F_3 – snails typical of humid forests), O – open-country snails (O_1 – xerophile species, O_2 – snails tolerating different humidity), M – mesophile species, H – species of swamps and marshes, W – water molluscs. Indices of constancy and dominance (C-D), their normalised values (C_n-D_n) and two indices of species diversity (TDA – the formula defined by the author, SWN – the Shanon-Weaver formula) were calculated additionally. The identification of species is based mainly on publications of: EHRMANN (1956), LOŽEK (1964), GIROD, BIANCHI & MARIANI (1980), GIUSTI & PEZZOLI (1980), KERNEY, CAMERON & JUNGBLUTH (1983), FECHTER & FALKNER (1990), GLÖER & MEIER-BROOK (1994) and T. & V. COSSIGNANI (1995).

List of species (leg. Dr I. WIZLSPERGER, 1895)

Neritidae:
Theodoxus danubialis (C. PFEIFFER, 1828) – **W** – [1]

Cyclophoridae:
Cochlostoma septemspirale (RAZOUMOWSKY, 1789) – **M** – [29]

Viviparidae:
Viviparus contectus (MILLET, 1813) – **W** – [4]

Valvatidae:
Valvata piscinalis (O.F. MÜLLER, 1774) – **W** – [16]

Hydrobiidae:
Emmericia patula (BRUMATI, 1838) – **W** – [1]
Pyrgula annulata (LINNAEUS, 1767) – **W** – [15]

Bythyniidae:
Bithynia tentaculata (LINNAEUS, 1758) – **W** – [121]

Carychiidae:
Carychium tridentatum (RISSO, 1826) – **M** – [1]

Lymnaeidae:
Lymnaea stagnalis (LINNAEUS, 1758) – **W** – [2]
Galba truncatula (O.F. MÜLLER, 1774) – **W** – [8]
Radix auricularia (LINNAEUS, 1758) – **W** – [2]
Radix peregra (O.F. MÜLLER, 1774) – **W** – [6]

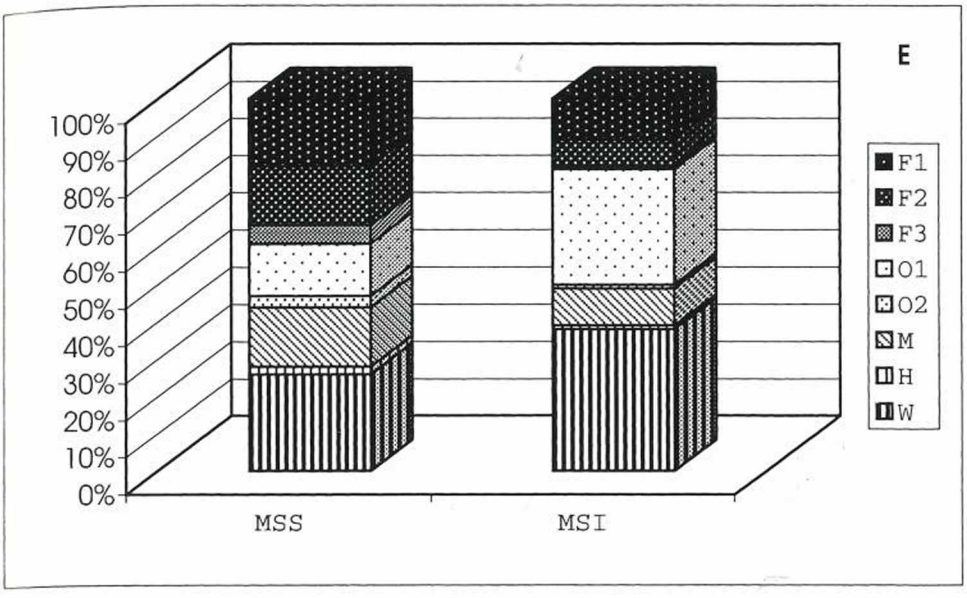

Fig. 1: Malacospectra of the ancient death assemblage of the Garda Lake. MSS – malacospectrum of species, MSI – malacospectrum of specimens; E – ecological groups of molluscs: F1 – woodland snails, F2 – snails of partly shady habitats, F3 – snails of humid forests, O1 – xerophile species, O2 – open-country snails, M – mesophile species, H – hygrophile snails, W – water molluscs.

Planorbidae:

Planorbis planorbis (LINNAEUS, 1758) – **W** – [11]
Planorbis carinatus O.F. MÜLLER, 1774 – **W** – [31]
Gyraulus albus (O.F. MÜLLER, 1774) – **W** – [3]
Hippeutis complanatus (LINNAEUS, 1758) – **W** – [2]

Succineidae:

Catinella arenaria (BOUCHARD-CHANTEREAUX) – **M** – [1]
Succinea putris (LINNAEUS, 1758) – **H** – [4]

Cochlicopidae:

Cochlicopa lubrica (O.F. MÜLLER, 1774) – **M** – [6]

Vertiginidae:

Vertigo pygmaea (DRAPARNAUD) – **M** – [1]

Chondrinidae:

Granaria frumentum (DRAPARNAUD) – $\mathbf{O_1}$ – [16]
Granaria illyrica (ROSSMÄSSLER) – $\mathbf{O_1}$ – [89]
Chondrina avenacea (BRUGUIÈRE) – $\mathbf{O_1}$ – [56]
Chondrina clienta (WESTERLUND, 1883) – $\mathbf{O_1}$ – [3]

Valloniidae:

Vallonia pulchella (O.F. MÜLLER, 1774) – $\mathbf{O_2}$ – [8]

Enidae:
Chondrula tridens (O.F. MÜLLER, 1774) – **O_1** – [1]
Ena montana (DRAPARNAUD, 1801) – **F_1** – [5]
Ena obscura (O.F. MÜLLER, 1774) – **F_1** – [2]
Zebrina detrira (O.F. MÜLLER, 1774) – **O_1** – [15]

Endodontidae:
Discus rotundatus (O.F. MÜLLER, 1774) – **F_2** – [9]

Vitrinidae:
Eucobresia diaphana (DRAPARNAUD, 1805) – **F_2** – [1]

Zonitidae:
Aegopinella minor (STABILE, 1864) – **F_2** – [1]
Aegopinella nitens (MICHAUD, 1831) – **F_1** – [14]

Clausiliidae:
Cochlodina laminata (MONTAGU, 1803) – **F_1** – [6]
Macrogastra ventricosa (DRAPARNAUD, 1801) – **F_3** – [2]
Macrogastra plicatula (DRAPARNAUD, 1801) – **F_1** – [2]
Clausilia parvula FÉRUSSAC, 1807 – **M** – [18]
Clausilia dubia DRAPARNAUD, 1805 – **M** – [1]
Balea biplicata (MONTAGU, 1803) – **F_2** – [11]

Bradybaenidae:
Bradybaena fruticum (O.F. MÜLLER, 1774) – **F_2** – [9]

Helicidae:
Cernuella neglecta (DRAPARNAUD, 1805) – **O_1** – [3]
Helicella itala (LINNAEUS, 1758) – **O_1** – [1]
Perforatella bidentata (GMELIN, 1788) – **F_3** – [2]
Perforatella incarnata (O.F. MÜLLER, 1774) – **F_1** – [1]
Perforatella umbrosa (C. PFEIFFER, 1828) – **F_3** – [2]
Trichia hispida (LINNAEUS, 1758) – **M** – [2]
Trichia striolata (C. PFEIFFER, 1828) – **F_2** – [6]
Trichia unidentata (DRAPARNAUD, 1805) – **F_1** – [12]
Trichia edentula (DRAPARNAUD, 1805) – **F_1** – [3]
Euomphalia strigella (DRAPARNAUD, 1805) – **O_2** – [1]
Helicodonta obvoluta (O.F. MÜLLER, 1774) – **F_1** – [3]
Arianta arbustorum (LINNAEUS, 1758) – **F_2** – [3]
Helicigona lapicida (LINNAEUS, 1758) – **M** – [2]
Chilostoma achates (ROSSMÄSSLER, 1835) – **F_2** – [2]
Isognomostoma isognomostoma (SCHRÖTER, 1784) – **F_1** – [18]
Cepaea hortensis (O.F. MÜLLER, 1774) – **F_2** – [3]

Sphaeriidae:
Pisidium subtruncatum MALM, 1855 – **W** – [1]

Five species are main components of the described death assemblage reaching values of the dominance index D >5 % (*Bithynia tentaculala*, *Granaria illyrica*, *Chondrina avenacea*, *Planorbis carinatus*, *Cochlostoma septemspirale*), while 38 species are accessory elements (D <1 %). Relatively high values of species diversity indices (TDA = 0,83; SWN = 4,46) characterise this assemblage and reflect its low differentiation. The MSS spectrum indicate that the content of species representing particular ecological groups are ordered as follow: shadow loving snails – 39 %, water mollusc – 26 %, open country snails – 17 %, mesophile species – 16 % (fig. 1 – MSS). According to the MSI spectrum specimens of water molluscs and xerophile snails are most numerous, distinctly exceeding the content of specimens of

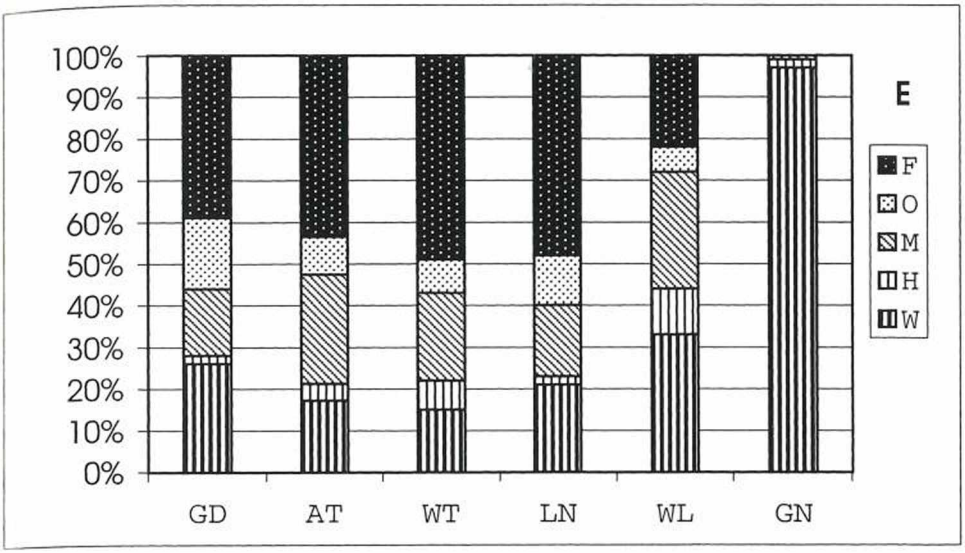

Fig. 2: Malacospectra of species (MSS) of thanatocoenoses from selected lakes: GD – Garda Lake, AT – Attersee Lake (Alps), WT – dam lake in the Wetlina River Valley (Carpathians), LN – Untersee Lake near Lunz am See (Alps), WL – Wallersee Lake (Foothills of Alps), GN – Gardno Lake (Polish Lowland); E – ecological groups of molluscs: W – shadow-loving snails, O – open-country species, M – mesophile snails, H – hygrophile species, W – water molluscs.

other ecological groups (fig. 1 – MSI). The structure of such assemblage is typical for a thanatocoenosis composed of species living in different habitats, particularly of woodland snails, xerophile snails and water molluscs. Their shells are being transported by slopewash, with streams and rivers or along shores of lakes to be finally accumulated.

Similar thanatocoenoses are formed on beaches of other mountain lakes. The MSS spectra of death assemblages collected on shores of Attersee Lake near Gmunden and Untersee Lake near Lunz am See in Austrian Eastern Alps contain 40 – 50 % of woodland species, 20 – 30 % of water- and mesophile species and about 10 % of open-country species (fig. 2 – AT, LN). The same spectrum characterises the thanatocoenosis described by the author (ALEXANDROWICZ 1991) from the dam lake in the Wetlina River Valley in the Polish Eastern Carpathians (fig. 2 – WT). On the other hand the assemblage collected on shores of Wallersee Lake situated within the Foothills of Alps near Salzburg has a nearly equal content of woodland-, mesophile- and water species, reaching 20 – 30 % each one (fig. 2 – WL). Quite another thanatocoenoses are being accumulated on shores of lowland lakes in Northern Poland (fig. 2 – GN). They are clearly dominated by water molluscs reaching more than 90 % of the assemblage (ALEXANDROWICZ & FLOREK 1999). These differences indicate, that the formation of thanatocoenoses is controlled by the type of the relief and the afforestation of the area surrounding the water basin as well as by the course and intensity of the slopewash, erosion, transportation and deposition of mineral and organogenic material.

Zoogeographical structure of the assemblage is differentiated. Widespread components (Holarctic/Palearctic, European and East European taxa) reaches 39 % while West-European, Middle European and South European species are represented by 7 – 8 species

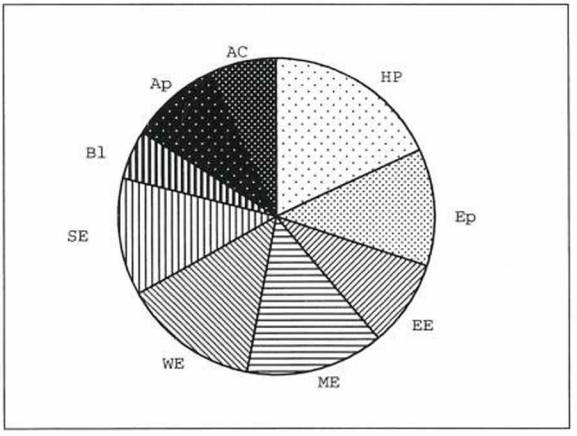

Fig. 3: Zoogeographical structure of the thanatocoenosis from the Garda Lake. HP – Holarctic-Palaearctic species, Ep – European species, EE – East European - West Asiatic species, ME – Middle European species, WE – West European species, SE – South European species, Bl – South-East European species, Ap – Alpine species, AC – Alpino-Carpathian species.

each (12 – 14 %). The remaining 21 % fall to snails connected with mountain regions: Alps, Carpathians and Balkans (fig. 3). Water molluscs migrating during the last century and following the human impact, noted recently from Middle Europe and Northern Alps (*Potamopyrgus antipodarum*, *Physa acuta*, *Dreissena polymorpha*) do not occur in the described thanatocoenosis, therefore they were absent in the Garda Lake at the end of the nineteenth century.

Trichoptera larvae living on the bottom of different water bodies use the accessible material to build their tubes. These are usually grains of minerals and fragments of plants, and rarely also shells of molluscs. Tubs formed nearly exclusively of small shells and opercula of snails are preserved in the collection of Dr I. WIZLSPERGER. Five species of snails represented by 214 specimens have been identified. Indices of their constancy (C) and domination (D) within this set were calculated and arranged in fife classes, as follow: 0 – **C1** – 20 – **C2** – 40 – **C3** – 60 – **C4** – 80 – **C5** – 100 %; 0 – **D1** – 1 – **D2** – 5 – **D3** – 10 – **D4** – 20 – **D5** – 100 % (ALEXANDROWICZ 1987, 1999a):

Valvata piscinalis (O.F. MÜLLER) – C5, D5
Bithynia tentaculata (LINNAEUS) – Opercula – C5, D4
Bithynia tentaculata (LINNAEUS) – Shells – C4, D4
Gyraulus albus (O.F. MÜLLER) – C4, D3
Hippeutis complanatus (LINNAEUS) – C4, D2
Radix peregra (O.F. MÜLLER) – C3, D2

Shells of *Valvata piscinalis* are most numerous reaching 56 % of all specimens. Normalised indices of constancy and domination have relatively low values (C_n = 0,79; D_n = 0,58) and correspond with a high species diversity (TDA = 0,43; SWN = 1,89). The shell material is well sorted and the mean size of particular components is 3 – 4 mm (2 – 5 mm). The list of species reflects the composition of the ancient shell zone of the lake ("Schalenzone" or "Zone der Toten Muscheln" described by WASMUND, 1926) accumulated within the sublittoral of the lake, inhabited by the mentioned larvae. The quantitative relation between shells and opercula of *Bithynia tentaculata* confirms this interpretation. According to data pub-

lished by STEENBERG (1917) and ALEXANDROWICZ (1999b), the number of shells and opercula used by larvae in the mentioned zone of lakes is nearly equal. On the other hand in near-shore zones of water bodies overgrown with reed opercula prevail while on the surface of beaches mainly shells are concentrated.

The described thanatocoenosis reflects the molluscan fauna living in the Garda Lake and around them about hundred years ago. Changes in malacocoenoses following the human impact and the degradation of the environment during the last century can be estimated, if thanatocoenoses accumulated nowadays be collected and studied in a short time.

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