IDENTIFICATION AND ENVIRONMENTAL BACKGROUND OF CHARA REMAINS IN THE HOLOCENE SEQUENCE OF LAKE PEŢEA (NW ROMANIA) AND THE POSSIBILITIES OF USING THE RESULTS IN ARCHAEOBOTANY

A SZENT LÁSZLÓ-TÓ (ÉNY-ROMÁNIA) HOLOCÉN KORI SZELVÉNYÉBEN TALÁLHATÓ CHARA MARADVÁNYOK AZONOSÍTÁSA ÉS KÖRNYEZETI HÁTTERE, VALAMINT AZ EREDMÉNYEK ARCHEOBOTANIKAI FELHASZNÁLÁSÁNAK LEHETŐSÉGEI •

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Abstract

The charophyte remains play an important role in the reconstruction of the hydrological characteristics (pH, water depth, stream flow, carbonate content, isotope geochemistry-water chemistry and temperature) of the former lake habitats. This is of particular importance in environmental historical studies, since the possibilities for obtaining aquatic food resources and the techniques and tools used are fundamentally influenced by these hydrological conditions. Our gyrogonite samples were recovered from the Holocene sequence of the thermal-spring fed Lake Peţea NW Romania. The presence of the recovered Chara cf. hispida *Linnaeus, 1753 gyrogonites marks the emergence of an oligotrophic shallow water lake system characterized by high dissolved Ca and Mg content and relatively poor plant cover in the Early Holocene. The results of previous malacological and ostracod studies also indicate the development of a shallow water lake with a muddy substrate and water temperatures above 18°C. As a warm-water lake, the local micro-environment was also home to many exploitable tree species. The charophyte remains that we recovered were from the Mesolithic level of the lake, so we were able to provide information on the hydrology of the lake for this period. Unfortunately, there have been no detailed archaeological investigations in the area to date revealing any potentially Mesolithic remains. Thus, no information is currently available on actual human occupation from the period in question.*

Kivonat

A csillárkamoszat maradványok fontos szerepet játszanak az egykori tavi élőhelyek hidrológiai jellemzőinek (pH, *vízmélység, áramlás, karbonáttartalom, izotópgeokémia-vízkémia és hőmérséklet) rekonstrukciójában. Ez különösen fontos a környezettörténeti vizsgálatokban, mivel a vízi táplálékforrások megszerzésének lehetőségeit, valamint az alkalmazott technikákat és eszközöket alapvetően befolyásolják ezek a hidrológiai viszonyok. Chara girogonit mintáinkat az ÉNy-Romániában található, termálforrás táplálta Szent László-tó holocén rétegsorából nyertük. A megtalált* Chara cf. hispida *Linnaeus, 1753 girogonitok jelenléte egy oligotróf sekélyvízi tórendszer kialakulását jelzi, amelyet magas oldott Ca és Mg tartalom és viszonylag szegényes növénytakaró jellemzett a koraholocénben. A korábbi malakológiai és* Ostracoda *vizsgálatok eredményei szintén egy sekély vizű, iszapos aljzatú, 18°C feletti vízhőmérsékletű tó kialakulására utalnak. Meleg vizű tóként a helyi mikrokörnyezet számos hasznosítható fafajnak is otthont adott. Az általunk vizsgált* Chara *maradványok a tó mezolit szintjéről származnak, így a tó hidrológiai viszonyairól erre az időszakra vonatkozóan tudtunk információt szolgáltatni. Sajnos a területen eddig nem folytak részletes régészeti kutatások, amelyek egyértelműen mezolit maradványokat*

• How to cite this paper: BENYÓ-KORCSMÁROS, R.; GULYÁS, S.; BÓNI, Z.; NAGY, B.; TÖRŐCSIK, T. & SÜMEGI, P. (2023): Identification and environmental background of Chara remains in the Holocene sequence of Lake Peţea (NW Romania) and the possibilities of using the results in archaeobotany, *Archeometriai Műhely* **XX/2** pp. 119–126.
doi: 10.55023/issn.1786-271X.2023-009

tártak volna fel. Így jelenleg nem áll rendelkezésre információ a kérdéses időszak tényleges antropogén hatásaira vonatkozóan.

KEYWORDS: CHAROPHYTES, GYROGONITES, ARCHAEOBOTANY, ENVIRONMENT RECONSTRUCTION, LAKE PEŢEA

KULCSSZAVAK: CSILLÁRKAMOSZATOK, GIROGONITOK, ARCHEOBOTANIKA, KÖRNYEZETI REKONSTRUKCIÓ, SZENT LÁSZLÓ-TÓ

Introduction

Charophytes are macroscopically visible algae, the most common representatives of which live in freshwater (Soulié-Märsche 2004). An important feature is that their fertilized female reproductive organs (oospores), depending on species and environmental conditions, form a resistant structure suitable for fossilization. This structure is formed by the calcification of the spiral cells, and the resulting formula is called a gyrogonite (Soulié-Märsche & García 2015). The first fossil gyrogonites are known from layers formed in the Palaeozoic Silurian and have been found in sediments continuously since then. The structure described above carries essential morphometric, taxonomic, and geochemical data. The extracted data can be used as a proxy for archaeological and environmental reconstruction studies (Horn af Rantzien 1959; O'Brien et al. 2005; Palacios-Fest 2010; Jakab & Sümegi 2011; Frenzel 2019; Marton 2021; Demirci et al. 2023). The depth, temperature, stream flow, chemical composition and amount of light in the water are important for charophytes (Horn af Rantzien 1959; Jakab & Sümegi 2011). The most important water chemistry parameters are pH, lime and phosphorus content. High phosphorus content is not favourable for charophytes and is the limiting factor for them. Although phosphorus and nitrogen compounds can be naturally introduced into standing waters, their presence is mainly due to human activities such as agriculture and wastewater production (Jakab & Sümegi 2011).Exploring the evolutionary history of natural sedimentary systems and their environments is in the focus of complex archaeobotanical studies (Sümegi et al. 2015).The present work is concerned with the study of such a natural sedimentary system, the former environment of the thermal spring fed Lake Peţea (Lake St. Ladislaus) in Băile 1 Mai NW Romania through the analysis of the fossil gyrogonites recovered from a geological profile dug in 2012.

Sampling area

Băile Episcopale (Hungarian: Püspökfürdő, German: Bischofsbad) is a popular bathing resort located 9 km SE from the city of Oradea NW Romania. It is one of the oldest known bathing sites, mentioned as early as the 18th century. Its popularity is based on the thermal waters found in the area, whose therapeutic properties are widely used to treat a wide range of ailments (e.g., rheumatism) (Benyó-Korcsmáros et al. 2020).

It is also famous for its thermal spring fed Lake Peţea (Lake St. Ladislaus) and the Peţea stream. Several outstanding species, unique to the Carpathian Basin and only to this lake, have survived here. These include the thermal rudd *Scardinius rakoviczai*, the melanopsid *Microcolpia parreyssi* and Egyptian white water-lily *Nymphaea lotus* var. *thermalis*. Recognizing its importance, the area was first declared protected in 1932 and then became part of the Natura 2000 network in 2007 (Tóth 1891; Kormos 1903, 1904, 1905a,b; Pauča 1937; Sîrbu & Sárkány-Kiss 2002; Sümegi et al. 2012a,b;Sîrbu et al. 2013; Neubauer et al. 2014; Sümegi et al. 2018; Gulyás et al. in rev; Gulyás & Sümegi 2023). Unfortunately, this thermal pond dried up in 2014, probably due to excessive thermal water extraction, and these three species disappeared from the Peţea Creek Nature Reserve. Our research, carried out in cooperation with the Ţării Crişurilor Museum, aims to reconstruct the former lake environment because this complex ecosystem may have played an important role in human settlement or activity like raw material acquisition. Our further aim is to help restore the dried-up lake and, last but not least, to better understand the environmental needs of the protected species that unfortunately went fully extinct in 2016 (Sîrbu & Sárkány-Kiss 2002; Telcean & Cupşa 2006; Mintaş et al. 2012; Telcean & Cupşa 2012; Sîrbu et al. 2013; Telcean & Cupşa 2013; Müller et al. 2014; Sîrbu & Benedek 2016).

Material and methods

The material derives from stratified samples of the geological profile of the 2012 campaign (Sümegi et al. 2012a,b, 2018, Gulyás & Sümegi 2023) (**Fig. 1.**).

The base of the 8.4 m sequence is given by limestone pebbles overlain by ca. 2 m thick organic-rich sediments (peaty, clayey marl) representing the emergence of a eutrophic lake.

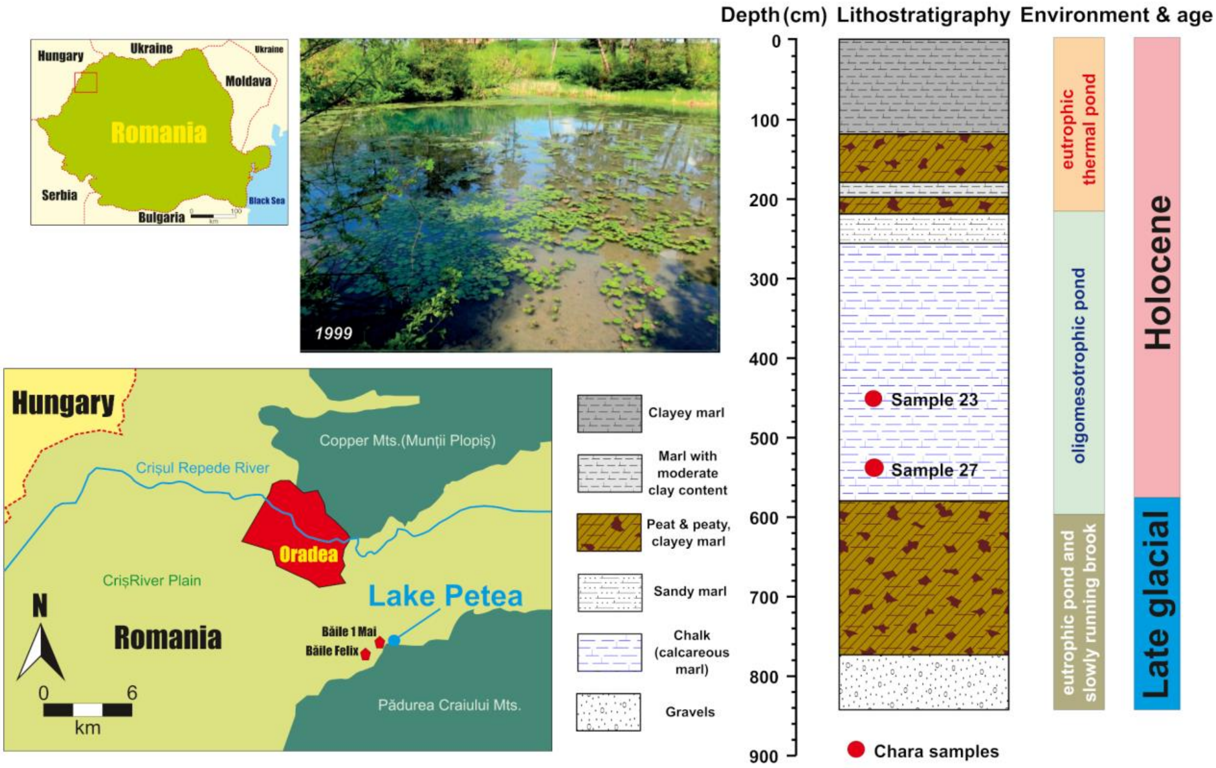

Fig. 1.: Location of the sampling area with stratigraphic data

1. ábra: A mintavételi terület elhelyezkedése és a vizsgált szelvény rétegrajza

This is overlain by ca. 3 m of calcareous marl up to a depth of 2.5 m with thin pebbly, sandy intercalations in its top part representing deposits of an oligomesotrophic lacustrine system. The next unit is a 1.4 m organic-rich lacustrine sediment with thin silty, sandy marl intercalations overlain by 1.2 m of clay-rich silty marls again deposited in a eutrophic thermal lake system. Based on available radiocarbon data for charcoal samples taken from the base of the 2012 profile, the evolution of the lake must have started at 22.5 ky cal BP and most of the sequence are dated to the Holocene. The ages of the two samples are 10 300–10 200 year cal BP and 11 200–10 900 year cal BP so it can be dated to the Early Holocene (Sümegi et al. 2012a,b, 2018, Gulyás et al. in rev, Gulyás & Sümegi 2023).

Three specimens of gyrogonite were recovered from sample 23 (between 440–460 cm) and two specimens from sample 27 (between 520–540 cm) of the section. The gyrogonites were collected under a Leica Wild M3Z stereomicroscope. Photographs were taken and more detailed morphological and morphometric analysis (Soulié-Märsche & García 2015) were performed using a Zeiss Discovery.V12 stereomicroscope. Statistical analysis was not performed due to the small sample size. The results of the residuals determination were compared with sedimentological, malacological data for the horizons (Sümegi et al. 2012a,b, 2018; Gulyás & Sümegi 2023). The ages of the two levels containing the gyrogonites were adopted from Sümegi et al. (2018), Gulyás et al. (in rev) and Gulyás & Sümegi (2023).

Results

The gyrogonites are medium in size, the mean longest polar axis (LPA, length) is 810 µm, the mean largest equatorial diameter (LED, width) is 580 µm. The isopolarity index (ISI) is 139.65 and the shape is usually subovoidal to ellipsoidal, subprolate to prolate. The mean distance of the apex and the equator is 435 µm. The apex is round and there are not any apical modifications. The number of spiral cells is 5. The outer structure of the gyrogonites is white, there are not any ornamentations. The spiral cells are 81–100 µm wide and the spirals are convex. In specimens where the outer casing is damaged, the brown-coloured inner structure becomes visible. In lateral view, the number of visible convolutions is 11–12. Mean basal pore diameter is 79 µm, the simple pentagonal basal plate is visible. Based on the above data, the studied gyrogonites belong to the species *Chara* cf. *hispida*. Linnaeus, 1753 (**Fig. 2.**).

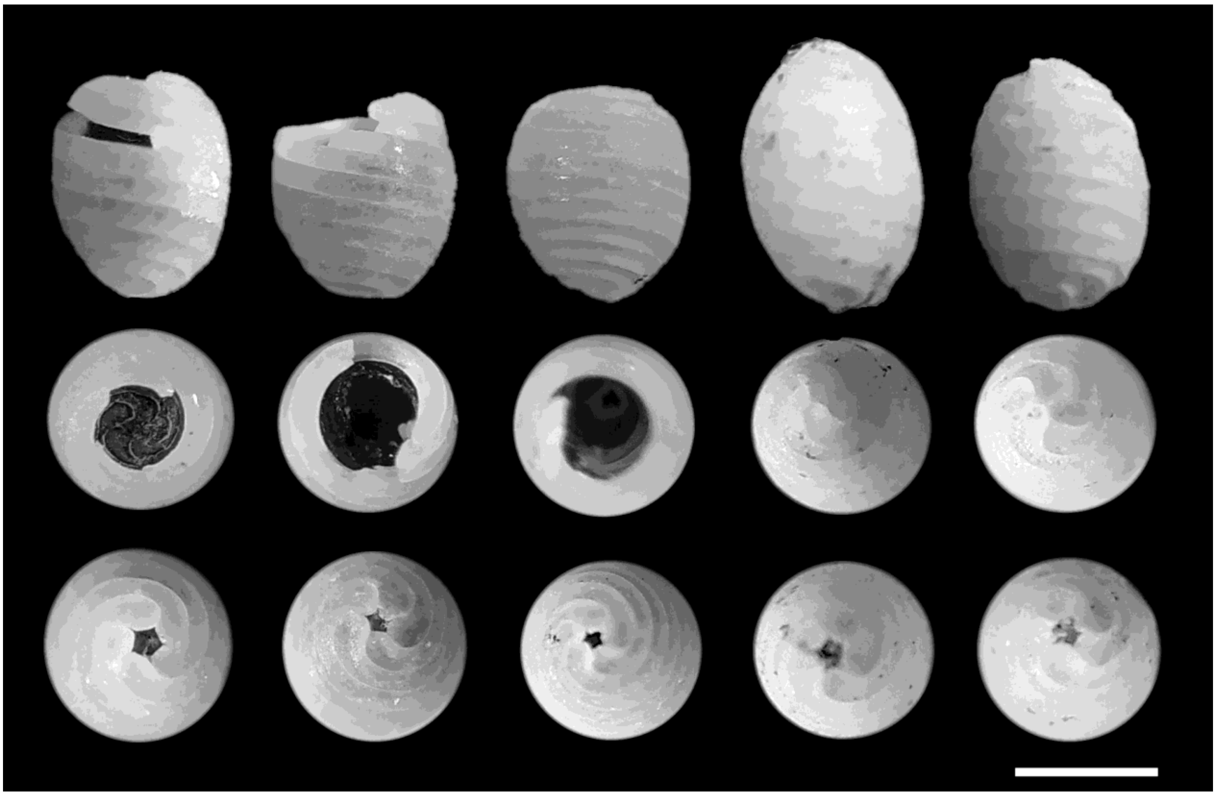

Fig. 2.: *Chara* cf. *hispida* gyrogonites from the section. From left to right 23/1-23/2-23/3-27/1-27/2, top-down lateral-apical-basal view. Scale bar 500 μm

2. ábra: A szelvényből származó *Chara* cf. *hispida* girogonitok. Balról jobbra 23/1-23/2-23/3-27/1-27/2, fentről lefelé oldal-csúcsi-alapi nézetben. Méretskála 500 μm.

Discussion

Chara hispida Linnaeus, 1753 is most often described Chara species from lakes and peatlands exploitation ponds, but it can also grow in shallow areas of pools or calcium-rich ditches. The species is also found in open areas of ponds but, like other charophytes, prefers smaller, sheltered areas. They usually grow at depths of 0.5–2 m, but also occur at depths of 4 m. They have a wide temperature tolerance and are indifferent to light conditions (Haas 1994; Urbaniak & Gąbka 2014).

The mollusc fauna composition of the levels containing gyrogonites was dominated by *Microlpia daudebartii acicularis* A. Férussac, 1823 (level 23: 93.23%, level 27: 100%) and *Theodoxus prevostianus* C. Pfeiffer, 1828 (level 23: 6.77%), which is considered to be a Pannonian endemism (Sümegi et al. 2012a,b, 2018). Among the ostracods, species of the genus Candona, *Candona candida* O.F. Müller, 1776 and *Candona weltneri* Hartwig, 1899 were identified (Bóni 2022).

Based on the results of Gulyás & Sümegi (2023) using sedimentary, environmental magnetic, LOI, and fire intensity data a three-stage sedimentary evolution occurred in Lake Peţea between 17.5 and 0.05 ka cal BP which was mainly controlled by major climate-driven hydrological changes also seen in regional palaeoenvironmental records; i.e. 17.5–14.5 ka shallow eutrophic lake, 14.5–5.5 ky oligotrophic carbonate-rich lake, 5.5–0.5 ka shallow eutrophic lake. A major lowstand at 11.7–10.2 ky because of a drier climate was followed by progressively rising water levels up to 5 ky followed by a drop. The main control on lake level fluctuations and sedimentary phases was varying input of thermal water due to recurring increased/decreased recharge of the underground shallow karst water system. Based on the stratigraphic location of the charophyte samples, the occurrence of these fossils postdates the mentioned lowstand seen from palaeo-environmental data.

Both ostracod species indicate a lacustrine, shallow lake environment with a muddy substrate and water temperatures above 18°C (Bóni 2022), which is consistent with the malacological temperature data previously obtained on the mollusc fauna (Sümegi et al. 2012a,b, 2018).

The results show that, although *Chara* cf. *hispida* Linnaeus, 1753 was present in the Early Holocene oligotrophic lake, the hydrological conditions were not particularly favourable for *Characeae* species in the remaining part of the lake history despite the

HU ISSN 1786-271X; urn: nbn: hu-4106

documented high carbonate content present in the lake system (Gulyás & Sümegi 2023). This assumption is supported by the complete absence of gyrogonites in the other levels of the section.

Conclusion

The results confirm that the former environment of the lake provided suitable conditions for human settlement and activity. The Chara remains that we recovered were from the Mesolithic level of Lake Peţea, so we were able to provide information on the hydrology of the lake for this period. The section and these two levels are not of anthropogenic origin, but are the result of natural processes, and are thus indirectly linked to archaeological research. Unfortunately, there have been no detailed archaeological investigations in the area to date revealing any potentially Mesolithic remains. Thus, no information is currently available on actual human occupation from the period in question. Nevertheless, the methods of analysis detailed above can be reliably applied in archaeology and the results of the environmental reconstruction of the Lake Peţea will help future archaeological research in the area.

Contribution of authors

Benyó-Korcsmáros Réka Writing - Original Draft, Writing - Review & Editing, Research. **Gulyás Sándor** Conceptualization, Writing - Review & Editing, Research. **Bóni Zoltán** Analysis of ostracod remains. **Nagy Balázs** Fieldwork, Sample preparation. **Tőrőcsik Tünde** Writing - Review & Editing. **Sümegi Pál** Source funding, Research.

Acknowledgements

Support of 20391-3/2018/FEKUSTRAT and NKFIH Grant 129265 is acknowledged. We wish to acknowledge the editors and two reviewers for their useful recommendations and advice. The manuscript was improved by their valuable comments.

References

BENYÓ-KORCSMÁROS, R., TORMA, A., GULYÁS, S. & SÜMEGI, P. (2020): Lotus from Nagyvárad: The question of the origin of the thermal water lily from Püspökfürdő. In: SZÓNOKYNÉ ANCSIN, G. (ed.): Magyarok a Kárpát-medencében 4. Régmúlt és Jelen: Tudományos Nemzetközi Konferencia, Szeged, Magyarország: Egyesület Közép-Európa Kutatására 97–103.

BODNÁR, B. (2013): The sedimentological analysis of the thermal Peţea lake, Püspökfürdő. *Közöletlen diplomamunka* (MA/MSc), Department of Geology and Paleontology, University of Szeged, 21–25.

BÓNI, Z. (2022): Kagylósrákok taxonómiai, paleoökológiai vizsgálata a püspökfürdői Szent László-tó üledékeiből. *Közöletlen diplomamunka* (MA/MSc), Department of Geology and Paleontology, University of Szeged, 28–39.

DEMIRCI, E., SANJUAN, J., NAZIK, A., MERIÇ, E., YÜMÜN, Z. Ü. (2023): Subrecent charophyte flora from Çeşmealti (Izmir Gulf, Western Turkey): Palaeoecological implications. Aquatic Botany, 186, 103613, ISSN 0304-3770. https://doi.org/10.1016/j.aquabot.2022.103613

FRENZEL, P. (2019): Fossils of the southern Baltic Sea as palaeoenvironmental indicators in multi-proxy studies. *Quaternary International* **511** 6–21. https://doi.org/10.1016/j.quaint.2018.09.014

GULYÁS, S. & SÜMEGI, P. (2023): Late Pleistocene to Holocene Palaeohydrological History of the Thermal-Spring-Fed Lake Peţea (NW Romania) Revealed by Radiocarbon Dating and Complex Sedimentological Investigations. *Quaternary* **6**, 37. https://doi.org/10.3390/quat6020037

GULYÁS, S.; SÜMEGI, P.; MÜLLER, T.; GEARY, D.H.; MAGYAR, I.; NAGY, B.; BENYÓ-KORCSMÁROS, R. (in rev): Assessing phenotypic variation and plasticity of endemic gastropods from thermal water refugia using complex morphometric techniques: A case study of Lake Peţea melanopsids. *Palaeontology*, submitted.

HAAS, J.N. (1994): First identification key for charophyte oospores from central Europe, *European Journal of Phycology* **29/4** 227–235.

HORN AF RANTZIEN, H. (1959): Recent charophyte fructifications and their relations to fossil charophyte gyrogonites. Arkiv För Botanik, Serie 2, 165–332.

JAKAB, G. & SÜMEGI, P. (2011): *Negyedidőszaki makrobotanika*, Szeged, Magyarország: SZTE TTIK Földrajzi és Földtani Tanszékcsoport, 251 p.

KORMOS, T. (1903): Beitrage zur kenntnis der Melanopsis-arten aus den Thermen von Püspökfürdő bei Nagyvárad. *Földtani Közlöny* **33** 496–503.

KORMOS, T. (1904): Új adatok a Püspökfürdő élő csigáinak ismeretéhez. *Állattani Közlemények* 3 102–111.

KORMOS, T. (1905a): A Melanopsis hungarica, Korm. alkalmazkodásáról. *Állattani. Közlemények* **4** 155–156.

KORMOS, T. (1905b): Über den ursprung der thermenfauna von Püspökfürdő. *Földtani Közlöny* **35** 421–450.

MARTON, T. (2021): Csontszigonyok tőzeglápból - a sárréti leletek újraértékelése. In: LÖFFLER, Zs.

& MOLNÁR, Cs. (szerk.) „Járni csak együtt tudnak" *Régészet és néprajz összefüggései*. Móra Ferenc Múzeum kiadványa, Szeged, 9–19.

MINTAŞ, O., VICAŞ, G. & MINTAŞ, I. (2012): The influence of the natural factors on the evolution of the Peţea thermal hydro-geo-ecosystem in the period 2009–2012. *Analele Universității din Oradea, Fascicula: Protecția Mediului* **19** 733–738.

MÜLLER, T., VÁRKONYI, L., GAGIU, A., KOVÁCS, B., BUZA, E., MAJOROS, G., STASZNY, Á., HORVÁTH, Á., BERNÁTH, G., TÓTH, G., TATÁR, S., URBÁNYI, B., FEHÉR, Z., GRIGORAS, G., SERBAN, C. & MÜLLERNÉ-TRENOVSZKI, M. (2014): Attempts on ex situ conservation of Melanopsis parreyssii and Scardinius racovitzai. In: Zimmermann, Z. Szabó, G. (eds.) "*II. Sustainable development in the Carpathian Basin" international conference* – Book of Abstracts, Gödöllő, 35–38.

NEUBAUER, T.A., HARZHAUSER, M. & KROH, A. (2013a): Phenotypic evolution in a fossil gastropod species lineage: evidence for adaptive radiation? *Palaeogeography, Palaeoclimatology, Palaeoecology* **370** 117–126.

NEUBAUER, T. A, HARZHAUSER, M., GEORGOPOULOU, E. & WROZYNA, C. (2014): Population bottleneck triggering millennial-scale morphospace shifts in endemic thermal-spring melanopsids. *Palaeogeography, Palaeo-climatology, Palaeoecology* **414** 116–128.

O'BRIEN, C., SELBY, K., RUIZ, Z., BROWN, A., DINNIN, M., CASELDINE, C., LANGDON, P. & STUIJTS, I. (2005): A sediment-based multiproxy palaeoecological approach to the environmental archaeology of lake dwellings (crannogs), central Ireland. *The Holocene* **15/5** 707–719. https://doi.org/10.1191/0959683605hl845rp

PALACIOS-FEST, M. R. (2010): Late Holocene Paleoenvironmental History of the Upper West Amarillo Creek Valley at Archaeological Site 41PT185/C, Texas, USA. *Boletín de la Sociedad Geológica Mexicana*, **62/3** 399–436. https://doi.org/10.18268/BSGM2010v62n3a7

PAUCĂ, M. (1937): Les mollusques pléistocènes de Băile Episcopeşti. *Bulletin de la Societe Roumanie de Geologie* **3** 130–142.

PEŁECHATA, A., PUKACZ, A., KACZMAREK, L. & PEŁECHATY, M. (2020): Do charophytes influence biomass and species composition of phytoflagellates? *Aquatic Botany* **165** 103240. https://doi.org/10.1016/j.aquabot.2020.103240

SÎRBU, I. & BENEDEK, A.M. (2005): The genus Theodoxus Montfort 1810 (Mollusca, Gastropoda, Neritidae) in the Romanian Inner Carpathian Basin. *Scientific Annals of the Danube Delta Institute for Research and Development (Tulcea)* **11** 92–98.

SÎRBU, I. & BENEDEK, A.M. (2009): The extinction of Theodoxus prevostianus (C. Pfeiffer,1828) (Mollusca: Gastropoda: Neritidae) in Romania. *Tentacle* **17** 19–21.

SÎRBU, I. & BENEDEK, A.M. (2016): Requiem for Melanopsis parreyssii or the anatomy of a new extinction in Romania. *Tentacle* **24** 26–28.

SÎRBU, I., GAGIU, A. & BENEDEK, A.M. (2013): On the brink of extinction: fate of the Peţea thermal lake (Romania) and its endemic species. *Tentacle* **21** 34–37.

SÎRBU, I. & SÁRKÁNY-KISS, A. (2002): Endangered freshwater mollusc species from the eastern tributaries of the Tisa river (Romanian territory). *Tiscia monograph series* **6** 71–80.

SOULIÉ-MÄRSCHE, I. (2004): Charophyte Gyrogonites, the Result of Enantioselective Influence 250 Million Years Ago. In: PALYI, G., ZUCCHI, C. & CAGLIOTI, C. eds., *Progress in Biological Chirality*. Elsevier, Oxford: 365–375.

SOULIÉ-MÄRSCHE, I. & GARCÍA, A. (2015): Gyrogonites and oospores, complementary viewpoints to improve the study of the charophytes (Charales). *Aquatic Botany* **120** 7–17., https://doi.org/10.1016/j.aquabot.2014.06.003

SÜMEGI, P., MOLNÁR, M., JAKAB, G., PERSAITS, G., MAJKUT, P., PÁLL, D., GULYÁS, S., JULL, A. & TÖRŐCSIK, T. (2011): Radiocarbon-Dated Paleoenvironmental Changes on a Lake and Peat Sediment Sequence from the Central Great Hungarian Plain (Central Europe) During the Last 25,000 Years. *Radiocarbon* **53/1** 85–97. https://doi.org/10.1017/S0033822200034378

SÜMEGI, P., MOLNÁR, D., SÁVAI, S. & GULYÁS, S. (2012a): Malacofauna evolution of the Lake Peţea (Püspökfürdő), Oradea region, Romania. *Nymphaea, Folia naturae Bihariae* **39** 5–29.

SÜMEGI, P., MOLNÁR, D., SÁVAI, S. & TÖVISKES, R.J. (2012b): Preliminary radiocarbon dated paleontological and geological data for the Quaternary malacofauna at Püspökfürdő (Băile 1 Mai, Oradea region, Romania). *Malakológiai. Tájékoztató* **30** 31–37.

SÜMEGI, P., JAKAB, G., NÁFRÁDI, K., TÖRŐCSIK, T., GULYÁS, A. & BEDE, Á. (2015): Antropogén és természetes üledékgyűjtő rendszerek elemzésének jelentősége a komplex archeobotanikában. In: TÖRŐCSIK, T., NÁFRÁDI, K. & SÜMEGI, P. szerk., *Komplex archeobotanika*. Szeged, Magyarország: SZTE TTIK Földrajzi és Földtani Tanszékcsoport, 23–60.

SÜMEGI, P., GULYÁS, S., MOLNÁR, D., NÁFRÁDI, K., TÖRŐCSIK, T., SÜMEGI, B. P., MÜLLER, T., SZILÁGYI, G. & VARGA, Z. (2018): Ice Age Terrestrial and Freshwater Gastropod Refugia in the Carpathian Basin, Central Europe. In: RAY, S. ed., *Biological Resources of Water*. IntechOpen 93–117. https://doi.org/10.5772/intechopen.71910

TELCEAN, I. & CUPSA, D. (2006): Püspökfürdő endemikus hala a Racovitza kele (Scardinius racovitzai). *Halászat* **99/4** 135.

TELCEAN, I. & CUPŞA, D. (2012): Threatened and rare fishes from Upper Tisa valley and its Romanian left shore tributaries (North ‑ Western Romania). *Pisces Hungarici* **6** 87–94.

TELCEAN, I.C. & CUPŞA, D. (2013): The drastic decline of fish fauna in the thermal lake of “Baile 1 Mai” (Băile Episcopale, Bihor County, Romania). *Pisces Hungarici* **7** 141–142.

TÓTH, M. (1891): Data about Diluvial formations of Nagyvárad region. *Magyar Orvosok és Természetvizsgálók 25. Vándorgyűlése Munkálatai* 25, 474–479.

URBANIAK, J. & GĄBKA, M. (2014): *Polish Charophytes: An Illustrated Guide to Identification.* Uniwersytet Przyrodniczy we Wrocławiu: Wroclaw, Poland; 60–61.

WOLF, H. (1863): Berichtüber die geologischen Verhältnisse im Körösthale in Ungarn, nach den Aufnahmen im Jahre 1860. *Jahrbuch der kaiserlich und königlich geologische Keischsanstalt* 1863, 265–292.

HU ISSN 1786-271X; urn: nbn: hu-4106 © by the author (s)