

**Paleolimnological study of Cladocera species and geochemical identification through multi-proxy analysis in shallow Lakes of Hungary**

Umar Abba Kawu<sup>1,2,3</sup>, Sheila Mumbi A. Wamugi<sup>1,2,4</sup>, Jázmin Jakab<sup>1,2,5</sup>, Andrea C. Bőjthe<sup>1,2</sup>, Andor G. Soltész<sup>1,2</sup>, János Korponai<sup>6,7</sup> and István Gyulai<sup>2,5</sup>

<sup>1</sup>Pál Juhász-Nagy Doctoral School of Biology and Environmental Sciences, University of Debrecen, Egyetem tér 1, H-4032 Debrecen, Hungary

<sup>2</sup>Department of Hydrobiology, Faculty of Science and Technology, University of Debrecen, Egyetem tér 1, H-4032 Debrecen, Hungary

<sup>3</sup>Nigeria Agricultural Quarantine Service

<sup>4</sup>Mount Kenya University, P.O. Box 342-01000, General Kago Road, Thika, Kenya

<sup>5</sup>National Laboratory for Water Science and Water Security, Department of Hydrobiology, University of Debrecen, Egyetem tér 1, H-4032 Debrecen, Hungary

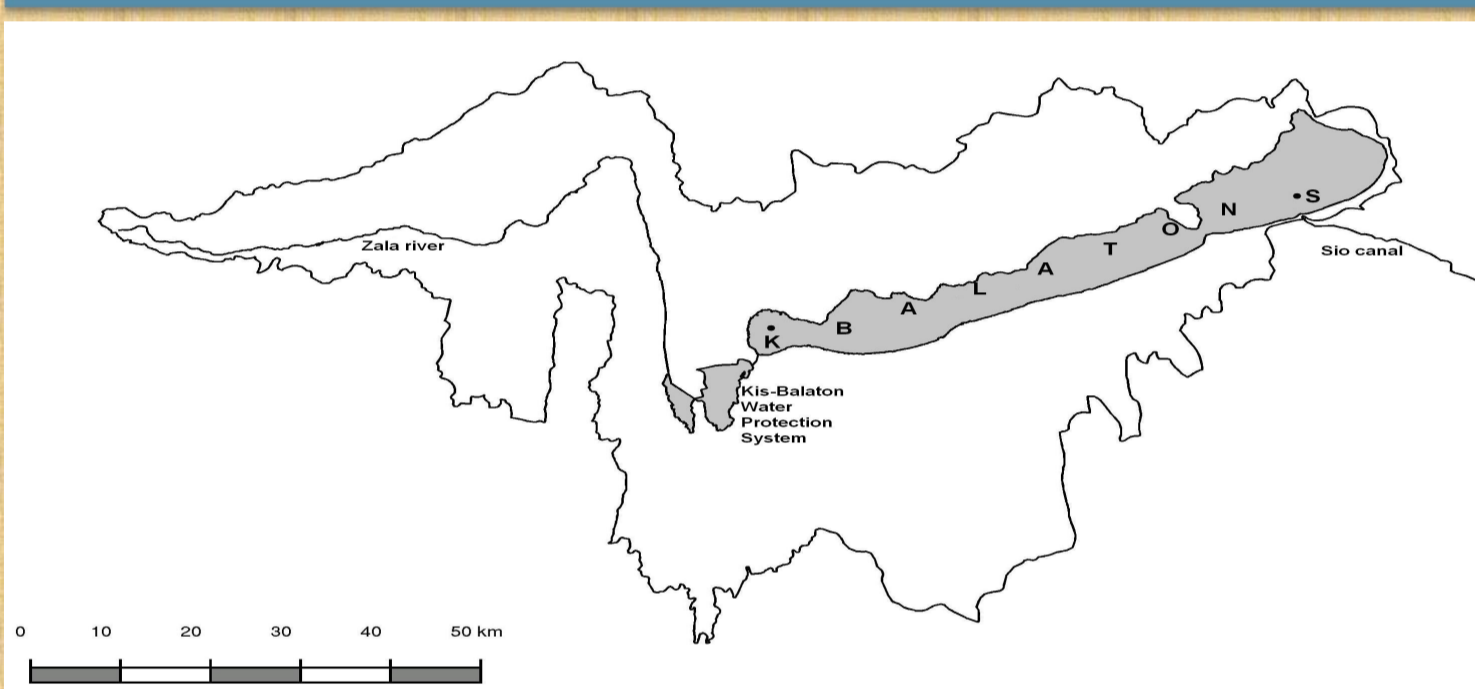
<sup>6</sup>Department of Water Supply and Sewerage, Faculty of Water Sciences, University of Public Services, Bajcsy-Zs. utca 12-14, H-6500 Baja, Hungary

<sup>7</sup>National Laboratory for Water Science and Water Security, Faculty of Water Sciences, University of Public Services, Bajcsy-Zs. utca 12-14, H-6500 Baja, Hungary

**INTRODUCTION & AIM**

Our study aimed to conduct a paleolimnological reconstruction of a shallow lake, based on Cladocera remains and geochemical identification through multi-proxy analysis in a shallow lake (Balaton) in Hungary. Because of the past few years of drought, water level reached a level of minimum which caught specialists' attention because we do not know the history of the lake. The lake's sediment provides good quality and a large quantity of the species of this cladocera, and information about it requires exploration, which is essential to reconstructing the history of the lake

**METHOD**



**Figure 1** Sampling stations (K – Keszthely Bay and S - Siófok Bay)

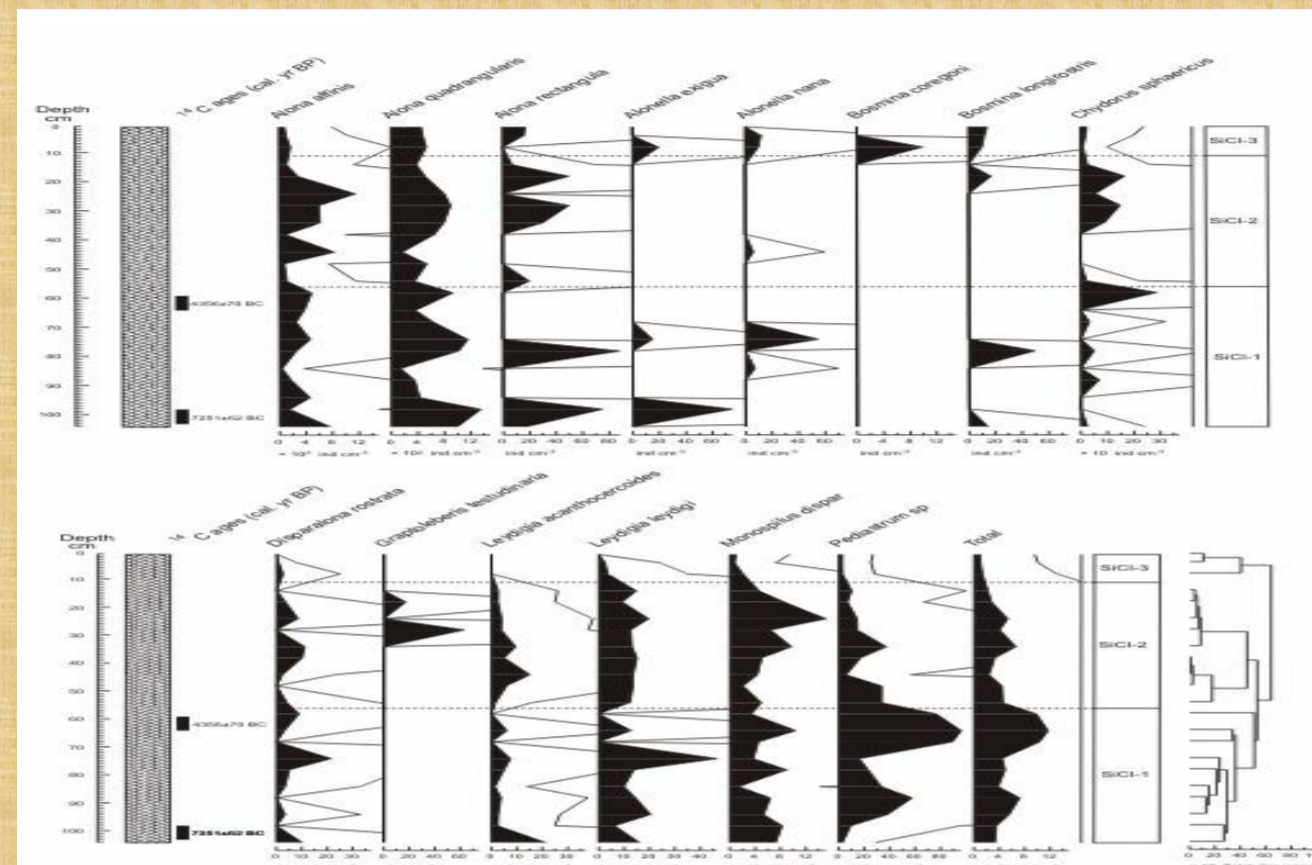
Sediment columns were taken in Keszthely and Siófok Bays and analysed by Frey (1986) methods. For identification and nomenclature, keys from (Szeroczyńska, Sarmaja-Korjonen, (2007). Cladocera results were assessed using R (R Development Core Team, 2008) vegan (Oksanen et al., 2017), and Biodiversity R packages. Concentrations and species data were log-transformed and standardized for the PCA.

**RESULTS & DISCUSSION**

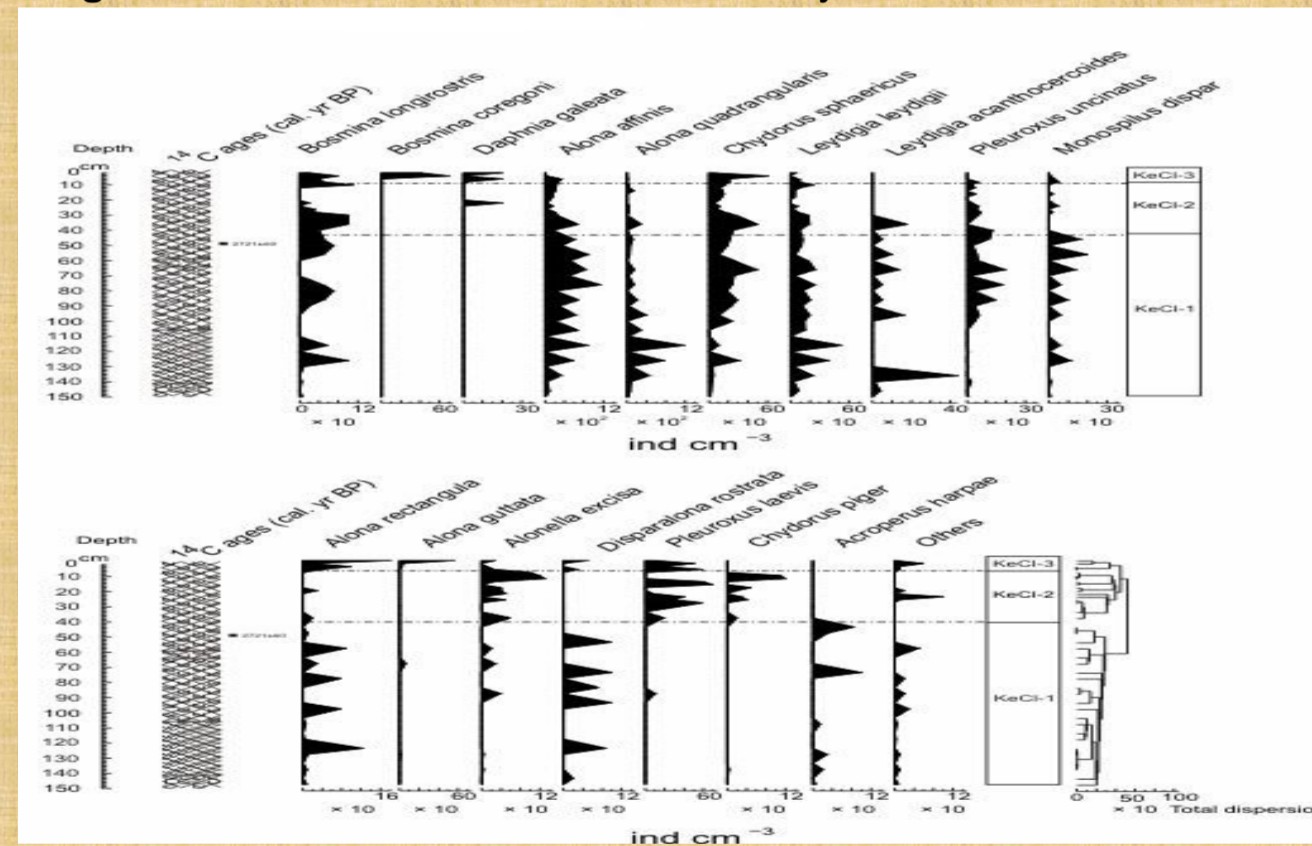
14 Cladocera species were identified in Siófok and 17 in Keszthely with three layers in both Bays and chydorid were common in the sediment of Siófok in Figure 2 and chydorid remains were common along the core with remains of planktonic cladocera, such as daphnids and bosmids underrepresented in Figure 3. In the Siófok Zone, Pelagic species like *Bosmina coregoni* were identified only in the youngest strata, while in the middle section of the sediment column is the poorest in species but richest in remains. *Monospilus dispar* reached its maximum. Three chydorid species were dominant in the samples. In the last layer, Several species *Alona* and remains were identified in the lower part of the sediment in this zone. In Keszthely zone *Daphnia* remains – ehippia - were only found in this sediment layer. *Bosmina coregoni* and *Daphnia galeata* appeared in the youngest layers, and the dominant species *Disparalona rostrata* and *Chydorus ovalis* were found as characteristic species for the uppermost layers of the core. In the middle section, a more diverse cladocera fauna was found in this zone, which was characterised by *Bosmina longirostris*, *Chydorus sphaericus*, *Alona rectangula*, *A. quadrangularis*, *A. affinis*, *Alonella excisa*, *Leydigia leidigii*, *Pleuroxus uncinatus*. *Monospilus dispar*, *Chydorus piger* and *P. leavis* were found in this zone's uppermost part. The lower parts of the sediment were characterised by low proportion of littoral taxa. *Monospilus dispar*, *Leydigia acanthocercoides*, *L. leidigii*, *Acroperus harpae*, *Graptoleberis testudinaria* and *Pleuroxus truncatus* were dominant

**CONCLUSION**

A multi-proxy analytical approach, surrounding geochemical characterization, clarified historical environmental conditions, including nutrient concentrations and water level changes, which have considerable implications for Cladocera assemblages that signify ecological transformations



**Figure 2** Cladocera remains in Siófok Bay



**Figure 3** Cladocera remains in Keszthely Bay

**Acknowledgments**

The research presented in the article was carried out within the framework of the Széchenyi Plan Plus program with the support of the "RRF 2.3.1 21 2022 00008" project. Project no. TKP2021-NKTA-32 was implemented with support from the Ministry of Innovation and Technology of Hungary from the National Research, Development and Innovation Fund, financed under the TKP2021-NKTA funding scheme

**REFERENCES**

1. Frey, D.G. The Taxonomy and Biogeography of the Cladocera. *Hydrobiologia* **1987**, *145*, 5–17. [
2. Szeroczyńska, K.; Sarmaja-Korjonen, K. *Atlas of Subfossil Cladocera from Central and Northern Europe*; Friends of the Lower Vistula Society: Swiecie, Poland, 2007; Volume 84.
3. R Core Team. *R: A Language and Environment for Statistical Computing*; R Foundation for Statistical Computing: Vienna, Austria, 2018.
4. Oksanen, J.; Blanchet, M.; Friendly, R.; Legendre, P.; McGlinn, D.; Minchin, P.R.; O'Hara, R.B.; Simpson, G.L.; Solymos, P.; Stevens, M.H.H.; et al. *Community Ecology Package: "Vegan" Package*; R Development Core Team: Vienna, Austria, 2017