Benthic macroinvertebrate communities in the littoral zone of Greek lakes

Patsia A., Kemitzoglou D., Mavromati E., and Tsiaoussi V.

The Goulandris Natural History Museum, Greek Biotope/Wetland Centre (EKBY), 14th km Thessaloniki-Mihaniona, Greece

athina.patsia@ekby.gr, dimitra@ekby.gr, emavromati@ekby.gr, vasso@ekby.gr

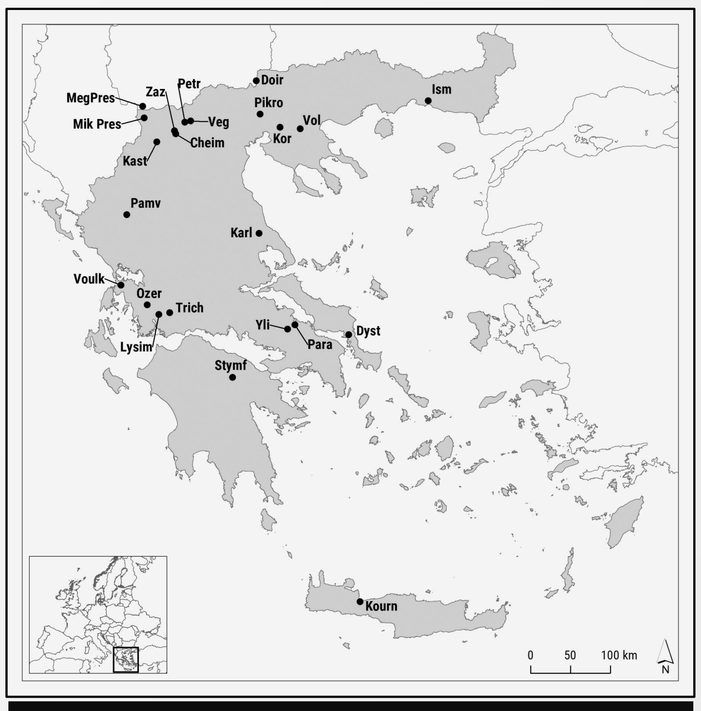


Figure 1. The 23 examined lakes.

Introduction

Greek natural lakes are discerned into three categories according to depth: very shallow lakes (GR-VSNL, mean depth< 3m), shallow lakes (GR-SNL, mean depth: 3-9 m) and deep lakes (GR-DNL, mean depth >9 m) (Kagalou et al., 2021). Lake zoobenthos is regularly examined for the classification of ecological status according to Water Framework Directive (WFD) (EU, 2000).

Objectives

Research objectives are to present the benthic macroinvertebrate communities in the Greek natural lakes, classify their ecological status & to investigate potential differences in benthic macroinvertebrate communities according to lake depth.

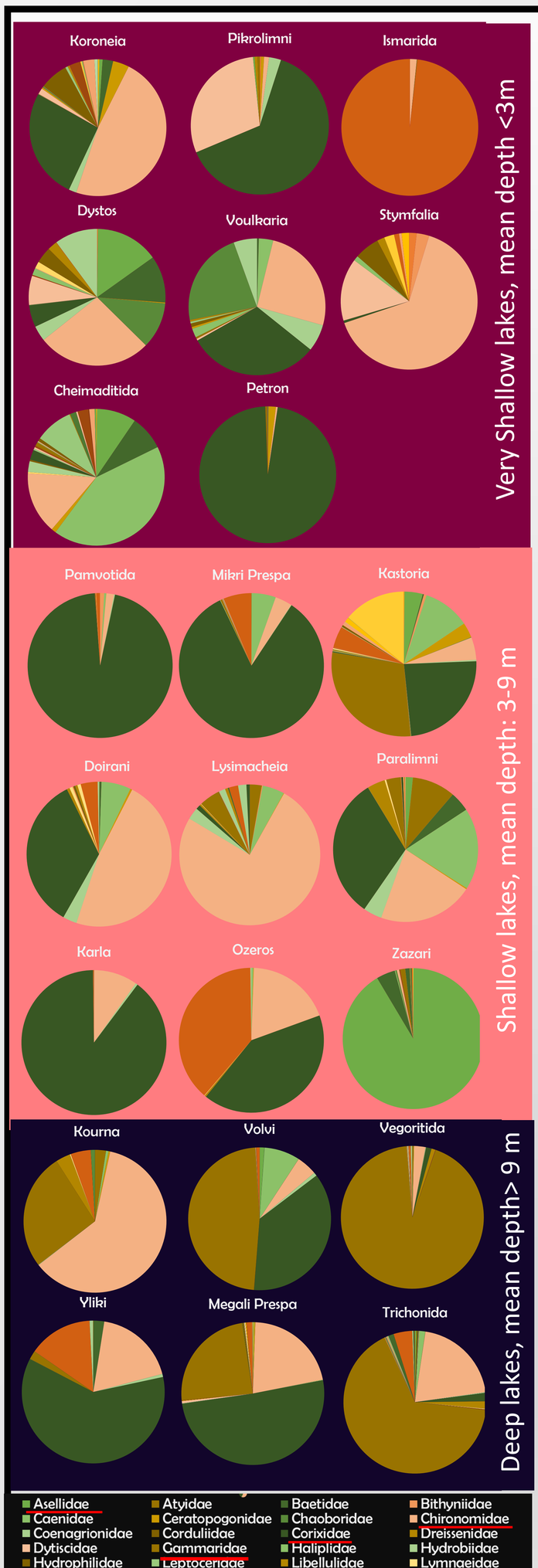
Study area

- ✓ In the present study, we examined 23 lakes (Figure 1);
- ✓ 6 lakes belonged to category GR-DNL, 9 to GR-SNL and 8 to GR-VSNL.

Methods

- ✓ Number of sampling sites in each lake was selected according to lake size, available habitats and accessibility
- ✓ 105 sampling sites were surveyed during spring season from 2018 to 2022
- ✓ Three-minute kick/sweep method with standard hand net (500 μm mesh size) was applied at the littoral zone
- ✓ Macroinvertebrates were identified to family level except for oligochaetes, which were identified as class
- ✓ A data set of average benthic macroinvertebrates taxa abundance of the sampling sites per lake was constructed for all calculations
- ✓ he Hellenic Lake Littoral Benthic Invertebrate fauna (HeLLBI) assessment method was applied for the classification of lakes' ecological status (Mavromati et al., 2021)
- ✓ Non-metric multidimensional scaling (NMDS) and one-way analysis of similarity percentages (SIMPER) were applied to visualize similarities and to identify the taxa responsible for the dissimilarities of benthic macroinvertebrate communities among different lake categories according to depth

Results



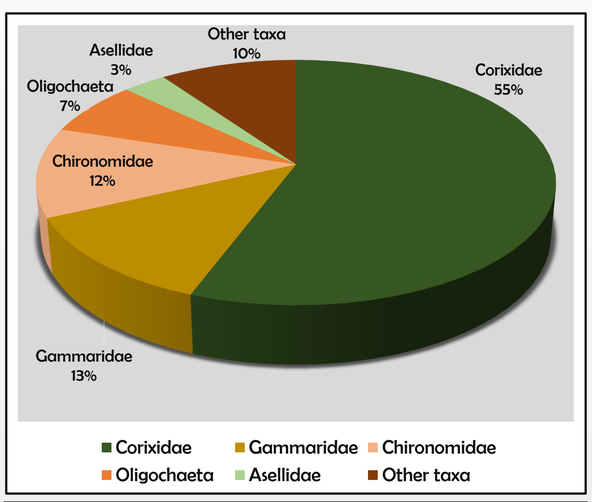


Figure 2. Relative abundance (%) of benthic macroinvertebrate taxa of 105 sampling sites of 23 lakes.

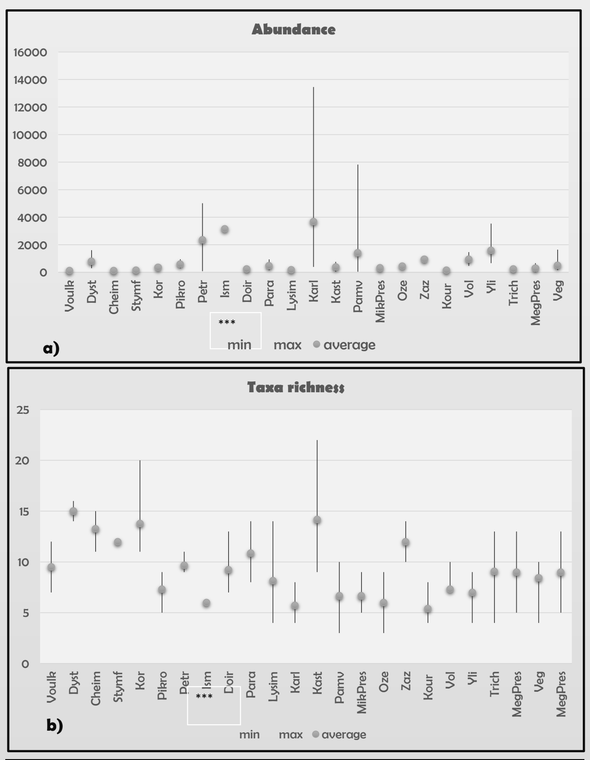


Figure 3. (a) Abundance and (b) Taxa richness of benthic macroinvertebrates per lake.

***One sampling site in Lake Ismarida

Table 1. HeLLBI index, ecological status and lake categories of 23 lakes.

Lake	Abbreviation	Lake category	HeLLBI	Ecological status
Voulkaria	Voulk	GR-VSNL	0.88	High
Dystos	Dyst	GR-VSNL	0.85	High
Cheimaditida	Cheim	GR-VSNL	0.76	Good
Stymfalia	Stymf	GR-VSNL	0.69	Good
Koroneia	Kor	GR-VSNL	0.68	Good
Pikrolimni	Pikro	GR-VSNL	0.67	Good
Petron	Petr	GR-VSNL	0.55	Moderate
Ismarida	Ism	GR-VSNL	0.21	Poor
Doirani*	Doir	GR-SNL	0.80	Good
Paralimni	Para	GR-SNL	0.78	Good
Lysimachia	Lysim	GR-SNL	0.75	Good
Karla**	Karl	GR-SNL	0.56	Moderate
Kastoria	Kast	GR-SNL	0.57	Moderate
Pamvotida	Pamv	GR-SNL	0.51	Moderate
Mikri Prespa*	Mik Pers	GR-SNL	0.42	Moderate
Ozeros	Ozer	GR-SNL	0.40	Poor
Zazari	Zaz	GR-SNL	0.34	Poor
Kourna	Kourn	GR-DNL	0.62	Good
Volvi	Vol	GR-DNL	0.60	Moderate
Yliki	Yli	GR-DNL	0.60	Moderate
Trichonida	Trich	GR-DNL	0.55	Moderate
Megali Prespa *	Meg Pres	GR-DNL	0.49	Moderate
Vegoritida	Veg	GR-DNL	0.43	Moderate

*transboundary lake
**shallow artificial lake (restored)

Table 2. SIMPER results for average dissimilarity among different lake categories (Primer 7 software)

Groups GR-DNL D & GR-VSNL			
Average dissimilarity = 63.93%			
Group GR-DNL	Group GR-VSNL		
Taxa	Average Abundance		Contribution %
Gammaridae	4.8	0.63	13.15
Corixidae	3.58	3.57	9.19
Oligochaeta	2.45	1.34	8.21
Dytiscidae	0.17	1.9	5.53
Groups GR-DNL & GR-SNL			
Average dissimilarity = 51.30%			
Group GR-DNL	Group GR-SNL		
Taxa	Average Abundance		Contribution %
Gammaridae	4.8	1.56	14.23
Corixidae	3.58	4.57	12.5
Caenidae	1.23	2.24	7.33
Asellidae	0.51	1.44	5.74
Groups GR-VSNL & GR-SNL			
Average dissimilarity = 61.89%			
Group GR-VSNL	Group GR-SNL		
Taxa	Average Abundance		Contribution %
Corixidae	3.57	4.57	9.77
Oligochaeta	1.34	2.29	8.29
Caenidae	0.71	2.24	6.4
Dytiscidae	1.9	0	5.65

- ✓ In total, 76,374 individuals were collected and 72 taxa were identified. 5 taxa comprised 90% of the collected individuals: Corixidae, Gammaridae, Chironomidae, Oligochaeta and Asellidae (Figure 1 & 2)
- ✓ The highest average number of individuals was recorded in Lake Karla (3,704) and the lowest in Lake Voulkaria (117.5). The highest average number of taxa was observed in Lake Dystos (15) and the lowest in Lake Kourna (5.42) (Figure 3)
- ✓ According to HeLLBI, 2 lakes were classified as high (Lakes Dystos and Voulkaria), 8 lakes as good, 10 lakes as moderate, and 3 lakes as poor (Table 1)
- ✓ The NMDS plot provided a useful display of the actual multivariate distance among lakes (stress value: 0.16) showing separation according to lake depth. The benthic invertebrate communities of deep and shallow lakes were more similar to each other than the communities of the very shallow lakes (Figure 4)
- ✓ According to SIMPER analysis, the average dissimilarities between deep and very shallow lakes and between deep and shallow lakes were 63.93% and 51.30%, respectively, mainly due to high percentage dissimilarity contribution of Gammaridae and Corixidae. The average dissimilarities between shallow and very shallow natural lakes were 61.89%, as a result of the high percentage contribution of the taxa Corixidae and Oligochaeta. (Figure 1 & Table 2)

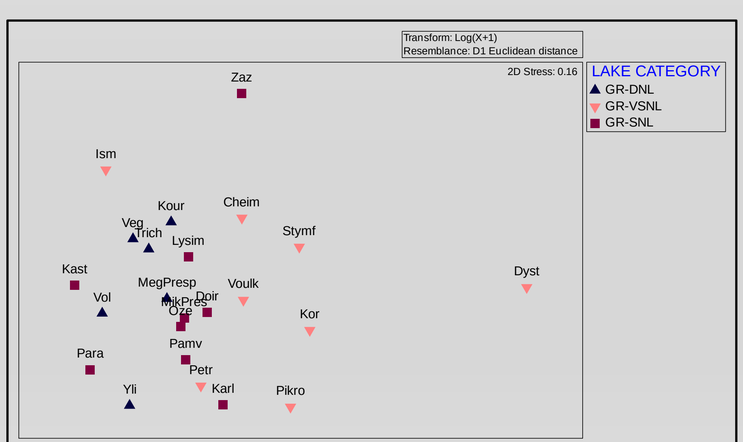


Figure 4. Non-metric multidimensional scaling (NMDS) plot of the benthic macroinvertebrate communities among different lake categories.

In conclusion…

- ✓ Benthic invertebrate communities of the 23 lakes were dominated by a limited number of taxa. Only 5 taxa comprised 90% of the benthic invertebrate fauna, whereas 67 taxa the remaining 10%.
- ✓ The majority of the examined lakes, 78% of them, were classified as moderate and good .
- ✓ Both statistical analyses (NMDS and SIMPER analysis) showed that the benthic invertebrate communities of the very shallow natural lakes were differentiated comparing to those of shallow and deep lakes.

References:

EC, 2000. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. Official Journal of the European Communities L327, 1-72.

Kagalou, I., Ntislidou, C., Latinopoulos, D., Kemitzoglou, D., Tsiaoussi, V., Bobori, D.C. Setting the Phosphorus Boundaries for Greek Natural Shallow and Deep Lakes for Water Framework Directive Compliance. Water 2021, 13, 739. https://doi.org/10.3390/w13050739

Mavromati, E., Kemitzoglou, D., Tsiaoussi, V. et al. A new WFD—compliant littoral macroinvertebrate index for monitoring and assessment of Mediterranean lakes (HeLLBI). Environ Monit Assess 193, 745 (2021). https://doi.org/10.1007/s10661-021-09493-1

Contact:

Greek Biotope-Wetland Centre (EKBY)

E-Mail: athina.patsia@ekby.gr

Tel. +30 2310 473320

URL: www.ekby.gr

European Union
Cohesion Fund
ΕΣΠΑ 2014-2020
ανάπτυξη - εργασία - αλληλεγγύη

This study has been prepared in the framework of the National Water Monitoring Network for lakes, according to the Joint Ministerial Decision 140384/2011. It is financed from the European Union Cohesion Fund under grant agreement No MIS 5001204 and national funds.

THE GOULANDRIS NATURAL HISTORY MUSEUM
GREEK BIOTOPE/WETLAND CENTRE

2023 BALATON WORLD LAKE CONFERENCE

November 7-9, 2023, 19th World Lake Conference, Balatonfüred, Hungary