Joint ESENIAS and DIAS Scientific Conference and 11th ESENIAS Workshop

Invasive aliens species under conditions of global crisis

Current status of populations development of the invasive and potentially toxic species *Raphidiopsis raciborskii* (Cyanoprokaryota, Nostocales) in stagnant water bodies in Bulgaria

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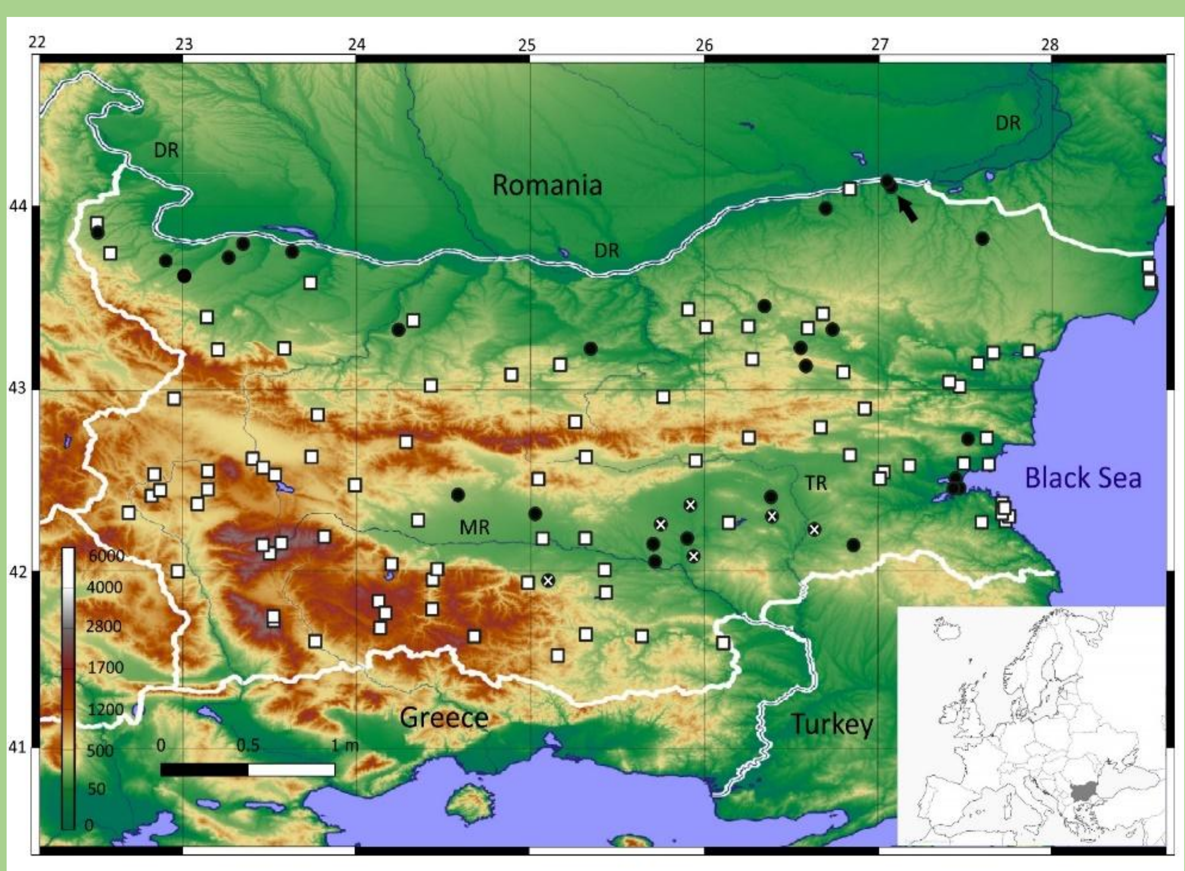


Fig.1. ***Raphidiopsis raciborskii*** occurrence in Bulgaria; ● presence □ absence **x** Localities after Dochin (2022)◄ first locality (Srebarna lake);DR-Danube River; MR-Maritsa River; TR-Toundzha River

From 122 lakes studied between 2009 and 2022 we found the species in 33 lowland lakes (up to 324 m a.s.l.) and colonization of new 14 localities.

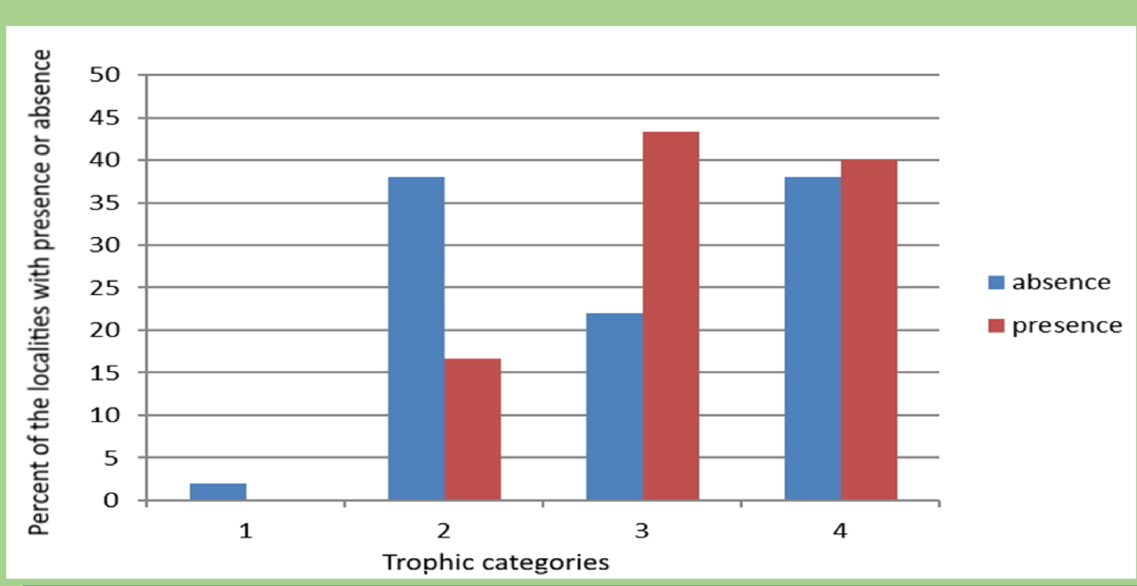


Fig. 3. Percent of localities of lakes with and without ***R. raciborskii*** at different trophic categories. 1: oligotrophic; 2: mesotrophic; 3: eutrophic, 4: hypertrophic (after Vollenweider & Kerekes, 1982)

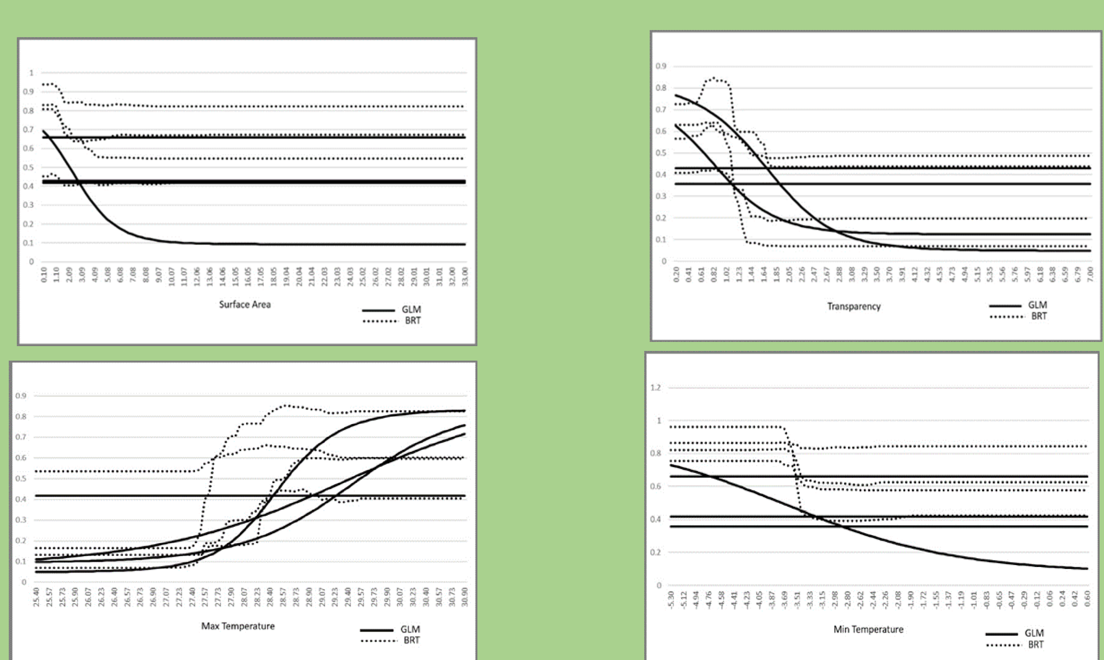


Fig.5.The response curves of ***R. raciborskii*** occurrence in relation to environmental variables, with variable importance above 0.1, according to the GLM and GBM models. On the vertical axes are the values of the predicted probability of occurrence

We found that the most important predictors for the occurrence of ***R. raciborskii*** were the maximum temperature of the warmest month and the water transparency. The other variables: pH, TP, TN, max depth, and conductivity had the lower predictive power.

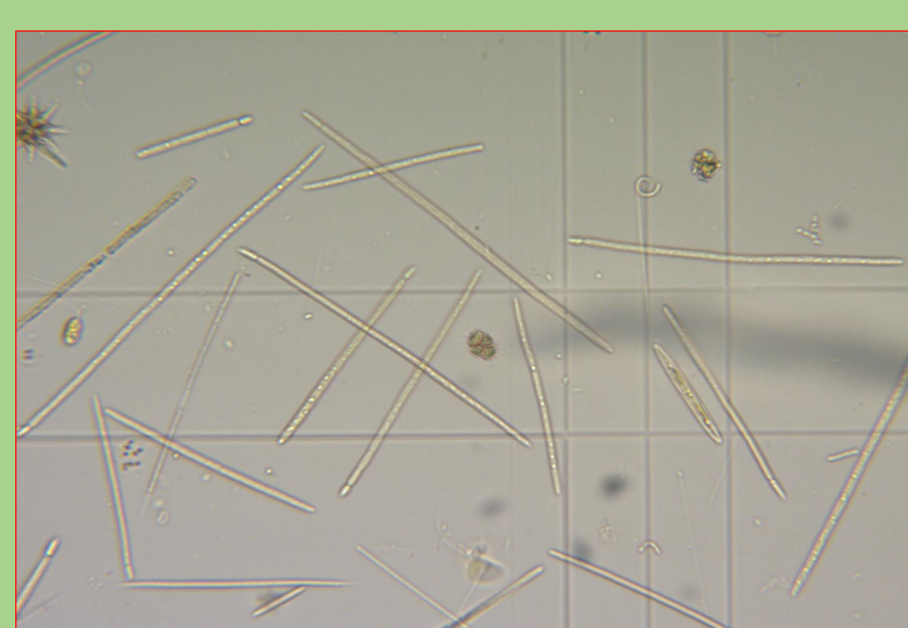
The SDM model predicted high probability of occurrence for four lakes, where the species was not found, but they are at risk of future invasion. Future colonization of lakes above 500 m a.s.l. is also likely

Aim of the study:

1) to expand the study about distribution of ***R. raciborskii*** in Bulgaria during the last 13 years;
2) to identify the most important factors for its spread
3) to predict the risk of colonization in the future

Methodical remarks

- Phytoplankton samples were counted by Utermöhl’s method (CEN EN 15204, 2006) and the biovolume was estimated by stereometrical method.
- Seven local environmental variables (surface area, maximum depth, water transparency, pH, conductivity, TP, TN) and two climatic variables (maximum air temperature of warmest month and minimum air temperature of coldest month) were used to explain and predict the occurrence of ***R. raciborskii***.
- Two different algorithms: Generalized Linear Model (GLM) and Generalized Boosted Models (GBM) were used for data analysis.
- Species distribution models (SDMs) predictions for the distribution of the species in freshwater lakes in Bulgaria was built using the Biomod2 package (Thuiller et al., 2022; R Core Team, 2022).
- The Mann-Whitney U Test was used to determine differences between lakes with presence and absence of R. raciborskii based on each of the environmental variables for 80 freshwater lakes at altitudes bellow 500 m.



R. raciborskii was found in 33 lakes between 1 and 324 m a.s.l. From them 16 localities were in Northern Bulgaria (along the Danube river and tributaries and in the Danube plain); 13 localities in southern Bulgaria (in the Tundzha and Maritsa river basins) and 4 localities in the Black Sea coast. The species has successfully adapted and dominated in 9 lakes, causing a bloom in 7 of them.

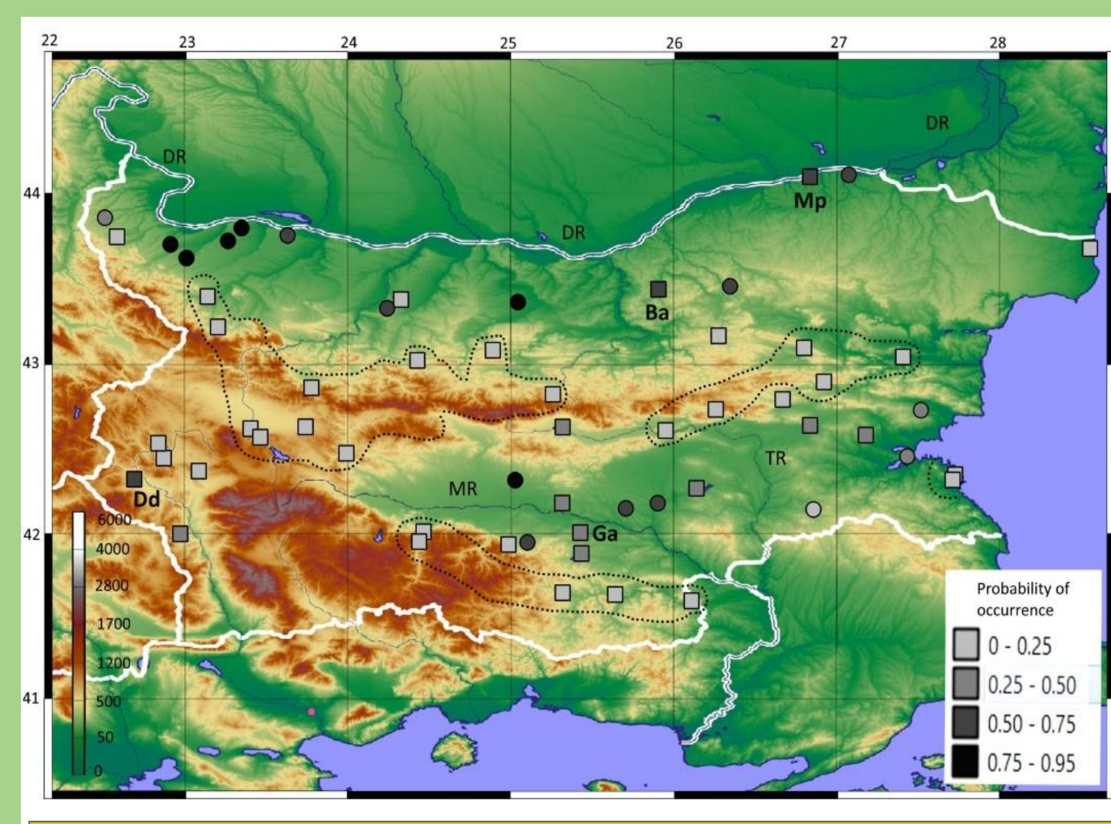


Fig.2. ***Raphidiopsis raciborskii*** SDMs ensemble probability of occurrence. ● presence □ absence; Locations with a low probability of occurrence are outlined with a dotted line; Mp-Malak Preslavets lake; Ba-Baniska Reservoir, Ga-Garvanovo lake; Dd-Drenov dol reservoir

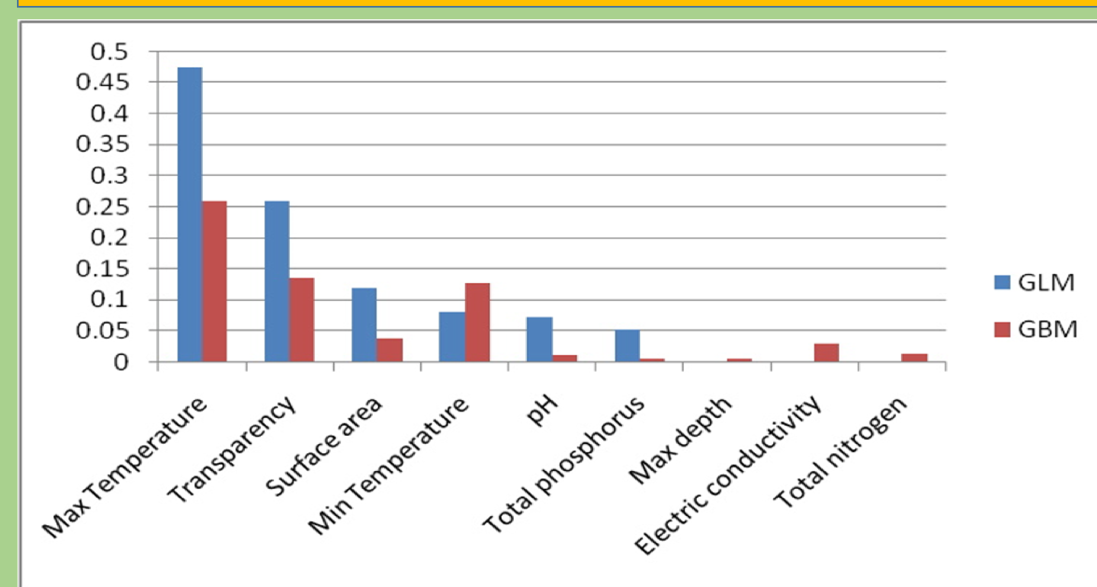


Fig. 4. Variables importance, for each algorithm, influencing the probability of occurrence of the ***R. raciborskii***, based on presence/absence data for lakes located in Bulgaria

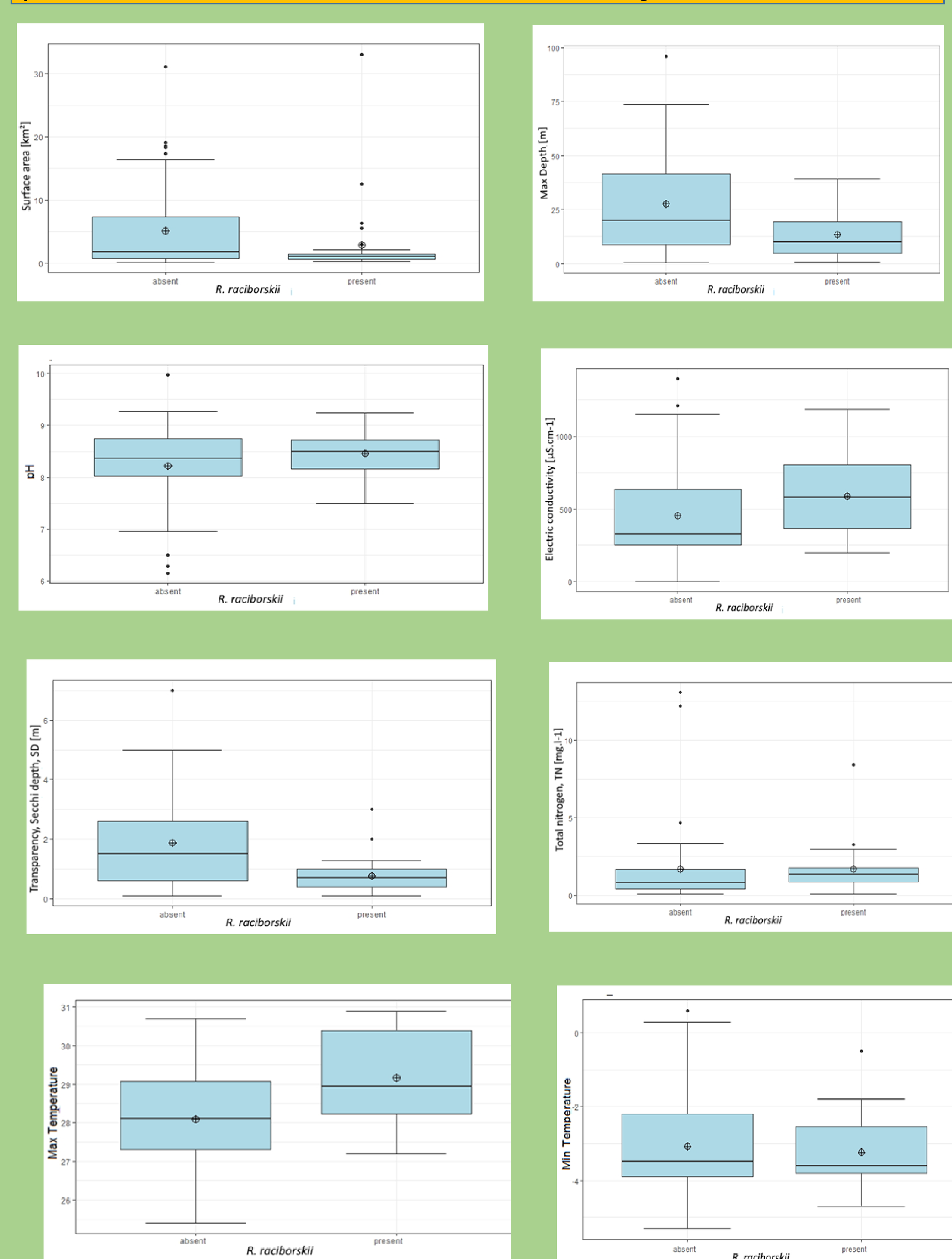


Fig. 6. Box and whisker plot of the environmental variables data for two groups of lakes: absent - where ***R. raciborskii*** was not found; present - where R. raciborskii was found. Boxes indicate the lower and upper quartile. Horizontal line in each box represents the median. The mean value is indicated by a + in a circle

The most suitable habitats for R. raciborskii development were small-area, shallow polymictic or medium-deep lakes, with low transparency in areas with high summer temperatures.

In areas with a suitable climate, with low probability of occurrence of R. raciborskii are large and deep dams, with high water transparency and macrophyte-dominated lakes.