ISO-SGDC

Relationship between taxonomic and genetic diversity of aquatic plants in lakes of the Atlantic coast

Métaprogramme BIOSEFAIR

Project report: 2021 - 2025

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Biological diversity is the basis for all ecosystem services and thus represents an essential support service. The lakes and ponds of the Aquitaine coastline are unique ecosystems on a national and European scale. They are home to significant biological diversity, particularly in terms of plant life, but this diversity is now under serious threat. While the taxonomic diversity of these communities is well known, knowledge of their genetic diversity is currently non-existent. However, improving this knowledge seems essential for better management of these ecosystems, particularly for threatened species, for which management practices can benefit from knowledge about the distribution of genetic diversity. Furthermore, analyzing the relationships between species genetic diversity within a community and taxonomic diversity of communities (species–genetic diversity correlations) in conjunction with each other provides a better understanding of ecosystem functioning and species assemblages. Studying these two levels of diversity also also allow to assess whether the taxonomic diversity commonly used in conservation practices adequately takes into account the evolutionary processes revealed by genetic diversity.

This is the objective of this exploratory project, developed jointly by two research units, each with strong expertise in one of the dimensions of this diversity.

To this end, nine species belonging to the “isoetid” communities of five water bodies of Aquitaine were sampled: *Lobelia dortmanna, Littorella uniflora, Baldellia ranunculoides, Myriophyllum alterniflorum, Juncus bulbosus, Schoenoplectus pungens, Eleocharis multicaulis, Phragmites australis* and *Chara fragifera*. In total, more than 3,000 individuals were collected from all the water bodies during the spring of 2022 and 2023. Around a hundred genetic markers (microsatellites) were identified and developed for each species. An initial study of population diversity validated around ten markers and identified ways to optimise genotyping protocols. DNA extraction, marker amplification and sequencing have been ongoing since autumn 2023 on all other samples. The collection of data on the taxonomic diversity of the sampled communities was carried out in spring–summer 2024, and their analysis is currently underway.

Results

First, one of the main results of the project concern the methodological aspect and the definition of the routine/procedure for microsatellite sequencing. While there were no nuclear genetic markers available to study the populations of the nine target species, the first result of the project is the development of genetic markers and a protocol for highly accurate genotyping using high-throughput sequencing. One of the challenges was to find experimental conditions that could be adapted to the diversity of the plant species studied (difficulty of grinding depending on the structure of the tissues sampled, minimal amount of plant material sampled for protected species, more or less complex genome structures, etc.). The optimization of these protocols and their routine application allowed to characterize all of the samples collected.

The first analyses of the genetic structure of the different species revealed varying levels of genetic diversity depending on the species. Overall, the most common species exhibit greater genetic diversity, whereas rare and endangered species show lower diversity. A regional structuring of diversity was highlighted for certain species, with strong genetic differentiation despite geographic proximity. The watershed area and habitat quality appear to have a significant influence on genetic diversity, particularly on the clonality of certain species.

This project is eagerly awaited by managers, particularly the South Atlantic National Botanical Conservatory (CBNSA), as part of the coordination and implementation of the national action plan for these species.

Scientific perspectives.

The community-level genetic analysis approach (which is already quite rare in the literature) could be extended spatially along a European latitudinal gradient. In the context of global warming, such a study should provide a better understanding of how different communities function and test the synergy of ecological processes at work along such a gradient.

On a more regional scale, larger-scale sampling, incorporating a greater number of aquatic ecosystems and focusing on common species, could be considered. This would probably enable a genetic-scale approach to meta-communities and thus a better understanding of how aquatic plant communities function. In this context, particular attention could also be paid to invasive alien species in order to better understand their dynamics at the regional level. Finally, this work also contribute to the continuity of the multi-partner Vigie-Lacs project (https://www.biodiversite-nouvelle-aquitaine.fr/connaitre/enjeux-de-territoire/le-projet-vigie-lacs/).

Valorization

Estelle-Marie Blanquart, Aurélien Jamoneau, Olivier Lepais. Diversité génétique des communautés à isoétides des lacs et des étangs du littoral Aquitain. Journée des doctorants de l'école doctorale Sciences et Environnement. Ecole doctorale Sciences et Environnement n°304. Feb. 2025. Bordeaux, France. https://hal.inrae.fr/hal-05226978v1

Bertrin, V., Boutry, S., Debailleul, E.-M., Dutartre, A., Fortin, C., Jan, G., Lepage, M., Lepais, O., Mayen, J., Pierre, M., Pryet, A., Ribaudo, C., Sellier, M., Wunderlich, R. F., & Jamoneau, A. (2025). Rapport intermédiaire du projet Vigie-Lacs (p. 24) [Report, INRAE - EABX]. https://hal.inrae.fr/hal-05228361

Estelle-Marie Blanquart, Aurélien Jamoneau, Olivier Lepais. Biodiversity of the isoetid communities in Aquitaine shallow lakes : a conservation genetic perspective. 6èmes Journées Internationales de Limnologie et Océanographie, Oct 2024, Pessac, France. https://hal.inrae.fr/hal-05226989v1

Estelle-Marie Blanquart, Aurélien Jamoneau, Olivier Lepais. Genetic and taxonomic diversity of Aquitaine coast lakes isoetid communities. 13th Symposium for European Freshwater Sciences, Jun 2023, Newcastle, United Kingdom. 2023. https://hal.inrae.fr/hal-04207311.

Estelle-Marie Blanquart, Aurélien Jamoneau, Olivier Lepais. Diversité taxonomique et génétique des communautés à isoétides des lacs du littoral aquitain. Doctoriales de la biodiversité 2023, Feb 2023, Biarritz, France https://hal.inrae.fr/hal-04382428

Estelle-Marie Blanquart, Aurélien Jamoneau, Olivier Lepais. Genetic and taxonomic diversity of isoetid communities in Aquitaine shallow lakes. 16. International Symposium on Aquatic Plants, International Aquatic Plants Group, Nov 2023, Antwerp, Belgium. https://hal.science/hal-04382438v1

Tauzin, A., 2022. Simple sequence repeat marker developpement and genetic caracterization of 9 species of macrophytes of Aquitaine littoral lakes. Université de Bordeaux, Bordeaux, France: 21.

Support for public policies

Participation in the Steering Committee for the National Action Plan for the vegetation of the hinterland ponds of Landes and Gironde (2021-2030), coordinated by DREAL Nouvelle-Aquitaine and led by the Conservatoire Botanique National Sud-Atlantique, 12/05/2022, videoconference.

Participation in the working group on the management of riparian plots along backwater ponds as part of the National Action Plan for vegetation along backwater ponds in Landes and Gironde (2021-2030), led by the Conservatoire Botanique National Sud-Atlantique, 13/12/2022, Biscarrosse.

Participation in the Steering Committee for the National Action Plan for the vegetation of backwater ponds in the Landes and Gironde regions (2021-2030), coordinated by DREAL Nouvelle-Aquitaine and led by the South Atlantic National Botanical Conservatory, 28/11/2023, Audenge.

Participation in the working group on waterlevel management, coordinated by the South Atlantic National Botanical Conservatory,28/01/2025, Carcans.

Participation in the Steering Committee for the National Action Plan for the vegetation of backwater ponds in the Landes and Gironde regions (2021-2030), coordinated by DREAL Nouvelle-Aquitaine and led by the South Atlantic National Botanical Conservatory, 02/12/2025, Audenge.