Preface: Georeferenced Freshwater Biodiversity Data

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The special issue on "**Georeferenced Freshwater Biodiversity Data**", sponsored by the Global Biodiversity Information Facility (GBIF; Heberling *et al*., 2021), has the aim of mobilising georeferenced data on freshwater organisms to become openly accessible. Biodiversity is one of the main hot topics of the current socio-economic and environmental global issues because biodiversity loss triggering ecosystem collapse is considered one of the major threats for humanity in the next decades (MacDougall *et al*., 2013; Valiente-Banuet *et al*., 2015).

In principle, we witness increasing attention and finer granularity of biodiversity evidence in the global discourse. Top international agreements exist that demand biodiversity data, with conventions, *e.g.* the Convention on Biological Diversity, CBD, supporting National Biodiversity Strategies and Action Plans, NBSAPS (Virnig, 2016), directives and other forms of international legislation, *e.g.* the Knowledge Centre for Biodiversity of the European Union aiming to provide data, information and analyses to help protect nature and restore ecosystems in support of the EU Biodiversity Strategy for 2030 (McLennan, 2021). National legislations also exist to gather information and knowledge, according to the guidelines of the International Union for Conservation of Nature (IUCN) and of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Additional expert knowledge is available from books and reviews, to biodiversity indicators and data intensive analyses, to data infrastructures, such as the International Nucleotide Sequence Database Collaboration (INSDC) and the GBIF products and services, fueling fundamental and applied research as well as the science-policy interface. As seen from this gradient, reliable biodiversity data is considered of primary importance to allow consistent inference to support sound actions. Unfortunately, easy access to biodiversity data is often missing, even in scientific studies dealing with biodiversity, considering 'biodiversity' mostly as a concept and not as a measurable and quantifiable ecological metric (Mammola *et al*., 2023). Availability of and access to the primary biodiversity data is of utmost importance to provide foundation for understanding patterns and processes of life on Earth, including less considered realms, such as freshwaters. Freshwater ecosystems indeed host a disproportionately high biodiversity, besides providing fundamental ecosystem services (Dudgeon *et al*., 2006).

The joint action of **GBIF** and the **Journal of Limnology** focus on species occurrence data to increase coverage, representation, and community uptake for freshwater biodiversity: this special issue started as a call to gather as much freshwater biodiversity data as possible, making the datasets publicly available through GBIF, to enhance availability of reliable georeferenced biodiversity data in freshwater habitats. A total of 11 papers answered the call for the special issue providing 44 new datasets for above 200,000 georeferenced occurrence records, mostly from Europe but also from Africa and New Zealand. The call achieved its goals: on the one hand, directly, it increased the amount of available data; on the other hand, indirectly, it allowed limnology to move some steps from its rather isolated ivory tower of the past (Fontaneto *et al*., 2021) of 'data in one's own drawer' towards the current field of

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Findability, Accessibility, Interoperability, and Reusability (FAIR) of data (Wilkinson *et al*., 2016). The call for data papers has also served an important role in introducing data standards, data quality, and data publishing solutions to the community of biodiversity researchers who had to apply, or sometimes to discover, the data solutions and to integrate them into their routine while working on the data papers.

The data papers cover a wide range of organisms: diatoms, phytoplankton, zooplankton, macrophytes, benthic macroinvertebrates, mayflies, ostracods, rotifers, and fish. The datasets span from entire continents (*e.g.*, Africa) to countries (*e.g.*, Italy, Spain, Uganda, New Zealand, South Africa), and to parks, single waterbodies or watersheds, especially in Northern Italy, also covering sites included in the Long Term Ecological Research (LTER) network (Vanderbilt and Gaiser, 2017) (Fig. 1). The temporal span of the occurrence data covers a broad range of years, from the XIX century to the end of 2022 (Fig. 2). In detail, Musazzi *et al*. (2023) report 4,124 records of sedimentary diatoms in Lake Maggiore, a wide

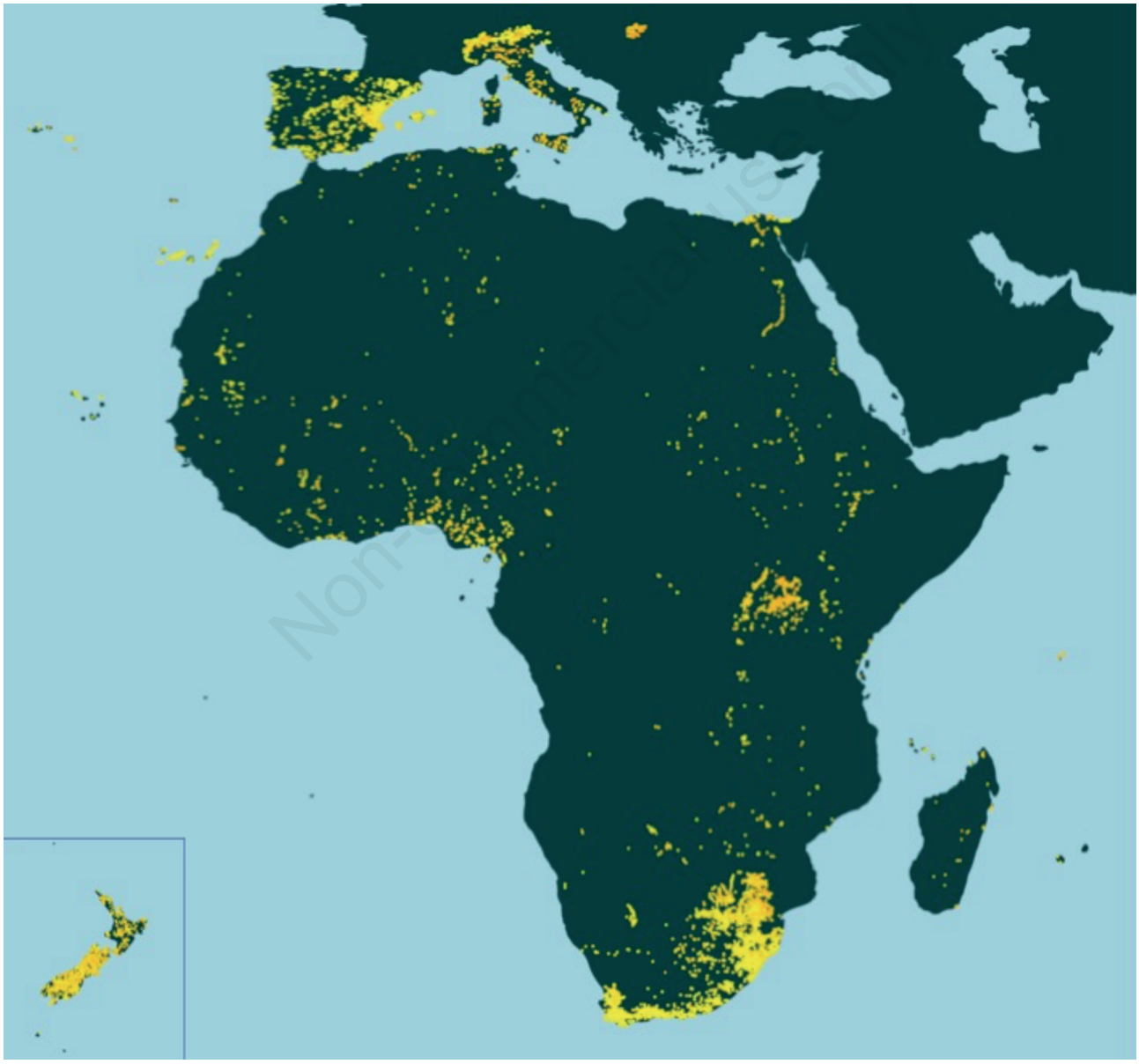

Fig. 1. Maps of the distribution of occurrence records gathered for this special issue. Africa and Europe in the main part, with New Zealand in the small inset at the bottom left. No new records were generated for other parts of the world. Data downloaded from GBIF.

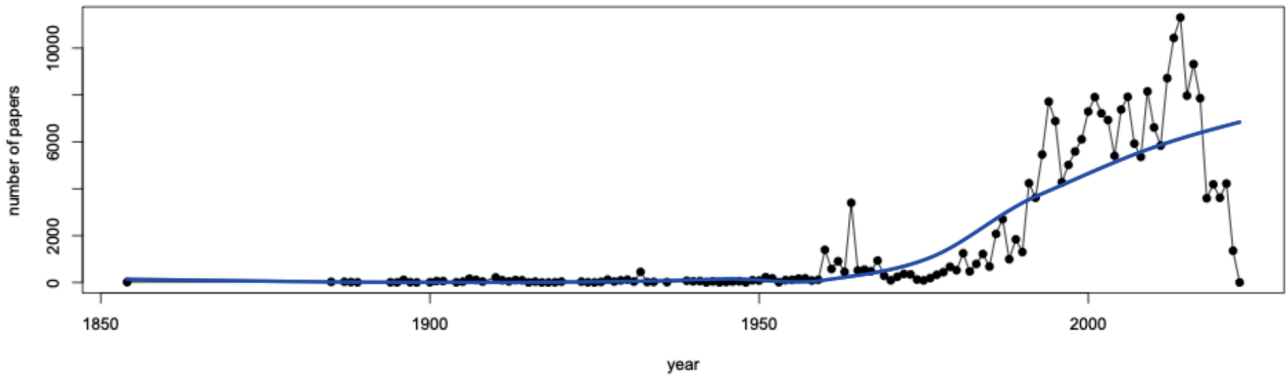

Fig. 2. Number of occurrence records through time gathered for this special issue, with a loess trendline approximation as a blue line. Data downloaded from GBIF.

and deep subalpine lake belonging to the LTER network. Oggioni *et al*. (2023) report a dataset of 10,120 records of phytoplankton from Lake Candia, another LTER site in Northern Italy. Austoni *et al*. (2023) report a dataset of 3,549 records of phytoplankton, macrophytes, macroinvertebrates and fish from a selection of lakes and reservoirs of two Italian regions, Piedmont and Sardinia. Musinguzi *et al*. (2023) report 34 datasets for a total of 56,104 records of zooplankton, macroinvertebrates, and fish from Uganda. Kajee *et al*. (2023) report a dataset of 35,955 records of fish in South Africa. Boda *et al*. (2023) report a dataset of 25,935 records of macroinvertebrates from a protected area in SE Hungary. Boggero *et al*. (2023) report 2,641 records of benthic macroinvertebrates from high altitude alpine lakes in North-Western Italy, within the LTER network. Ridden *et al*. (2023) report 48,992 records of the Canterbury Museum Mayfly Collection for 55 of the 58 species known for New Zealand. Castillo-Escrivà *et al*. (2023) report a dataset of 7,548 records of non-marine ostracods in the Iberian Peninsula, the Balearic Islands and Macaronesia. Two datapapers on rotifers made 39,497 records available through GBIF and increased local knowledge: 956 species are reported for Africa by Fresno-Lopez et al. (2023) in comparison to 765 that were reported in the most recent review on African rotifers (Smolak *et al*., 2023); 584 species are reported for Italy by Ferrari *et al*. (2023) in comparison to 483 reported in the most recent review on Italian rotifers (Fontaneto *et al*., 2022).

Our hope is that the impressive achievement of this special issue, providing more than 200,000 new records, will prompt other researchers to share further occurrence data on freshwater biodiversity through GBIF, in order to provide invaluable primary information in support of political decisions and actions to help protect nature and restore ecosystems.

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