Worldwide body size distributions of freshwater crustacean communities - are global mechanisms overriding local ones?

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Framework of the study

Body size is a key functional trait that affects many physiological and ecological processes. Among ectotherms, body size patterns are strongly influenced by temperature variation (temperature-size rule). Consequently, climate change is likely to alter body size patterns affecting ecosystem function, particularly in size-structured aquatic communities. However, predicting the impacts of climate change on aquatic communities is challenging due to the multiple interacting factors involved (e.g., exploitation, nutrient enrichment). Hence, there is a need to collect detailed global data on body size of keystone organisms (i.e., zooplankton) and environmental characteristics of their habitats.

The **thermal regions scheme**, introduced by Maberly et al. (2020, Nat. Comm.) to classify the thermal behavior lakes according to their annual surface temperature, provides an opportunity to investigate the size structuring of zooplankton along gradients in temperature and climate.

The **ZooSize** project was launched in 2021 to create a global database of **individual crustacean zooplankton body size measurements** along with environmental factors from an array of freshwater lakes to address the following questions:

1. How do **zooplankton community size metrics** (e.g., size diversity, mean size, and metrics describing size distributions) change across lake thermal regions?
2. How do other **local environmental factors** affect the body size-temperature relationship within and across thermal regions?

Methodology

We launched a data call for community composition and individual body size measurements. We required data for only one sampling date per lake, at the time of peak seasonal biomass. We also asked for some characteristics of the lake (coordinates, altitude, depth…) and some limnological variables (temperature, chlorophyll-a concentration, etc.). Scan the provided **QR code** for more information on the project.

We received data for 315 lakes over 4 continents. Data harmonization shows that about 25% of the data do not fit our initial requirements (60+ individual measurements and full community data), so the overall final number of lakes will be lower. The availability of potential explanatory variables varies among datasets and may constitute another filter for sites inclusion in subsequent analysis (Fig. 1).

For this poster, we used the method presented in Quintana et al. (2008) to calculate crustaceans commuity size diversity and geometric mean size indices across thermal regions (Fig. 2).

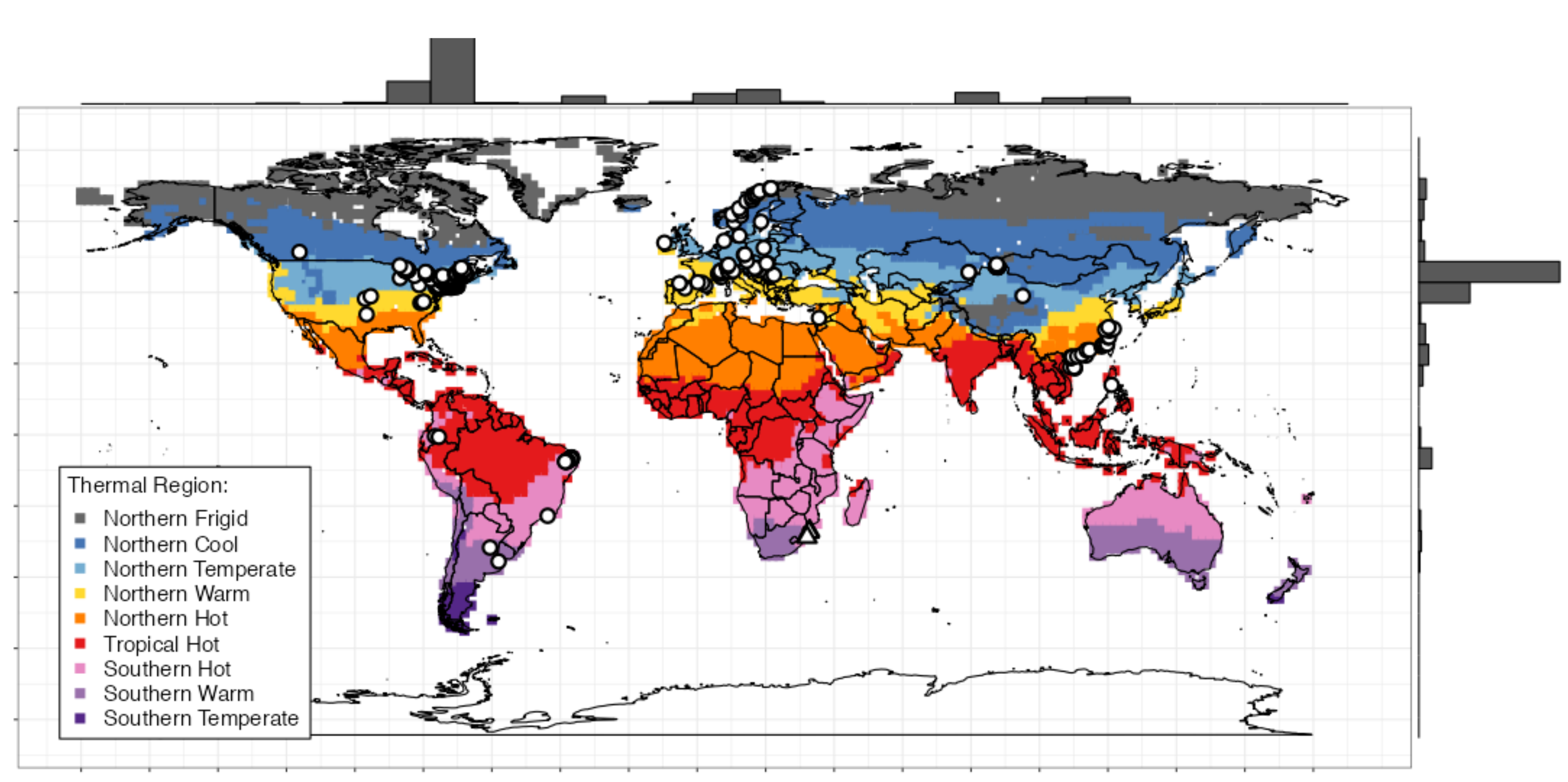

Figure 1. *Global map of submitted (points) and expected (triangles) data across lake thermal regions. Histograms on the top and right margins indicate the number of lakes per longitude and latitude, respectively. Map modified from Maberly et al. (2020)*

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global lake ecological observatory network

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Preliminary Results

Caution: Those are preliminary results and data harmonization and qualification is not complete.

The preliminary results show differences in size distribution across thermal regions, and notably, smaller individuals at latitudes characterized with warmer climate, which is consistent with existing hypotheses (Daufresne et al, 2009, 10.1073/pnas.0902080106).

Maximum size diversity indices are found for community with smaller mean community sizes.

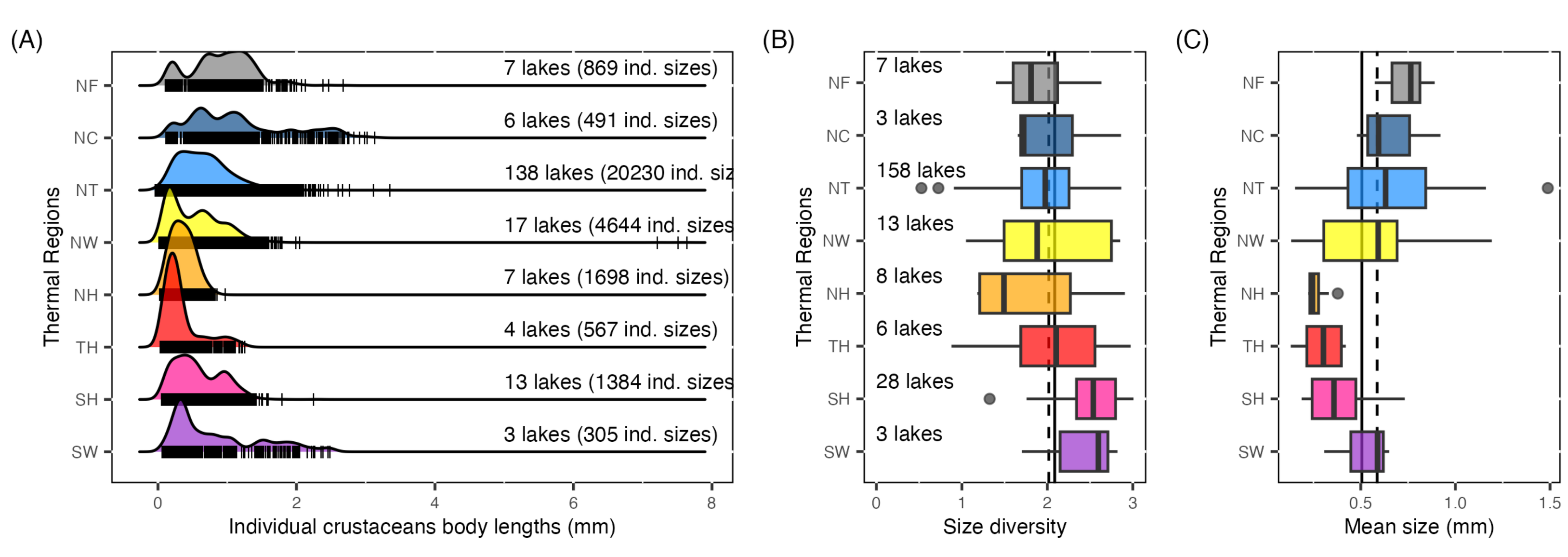

Figure 2. A) Size distributions, B) size diversity and C) community mean size for crustacean zooplankton per thermal region (colors). Number of lakes (and number of individual size measurements for A) are shown for each thermal region. The discrepancies in number come from some different levels of QC progress; the final result will look slightly different.

Perspectives

Size is an interesting indicator to compare ecosystem functioning across wide scales, because it does not rely on taxonomy and its potential inherent weaknesses (hybridization, differences in operator, etc.).

If thermal regions alone are good predictors of zooplankton size structure, it may indicate that ecosystem functioning might shift with future trends of climate change, not least because up to two-thirds of lakes may dissociate from their current thermal regions under the most pessimistic climate scenario at RCP8.5.

Future work will tackle the issues of differences in number of lakes per thermal regions (leads: resampling, explicit models accounting for differences in sample size). Furthermore, we plan to take in account the contribution of over variables, such as Chl-a, a proxy for primary production (Fig. 3).

Our unique and comprehensive dataset will provide critical insights into the impacts of climate change on global patterns of zooplankton community size structure and how body size can be used as an indicator of ecological status in lake conservation and restoration.

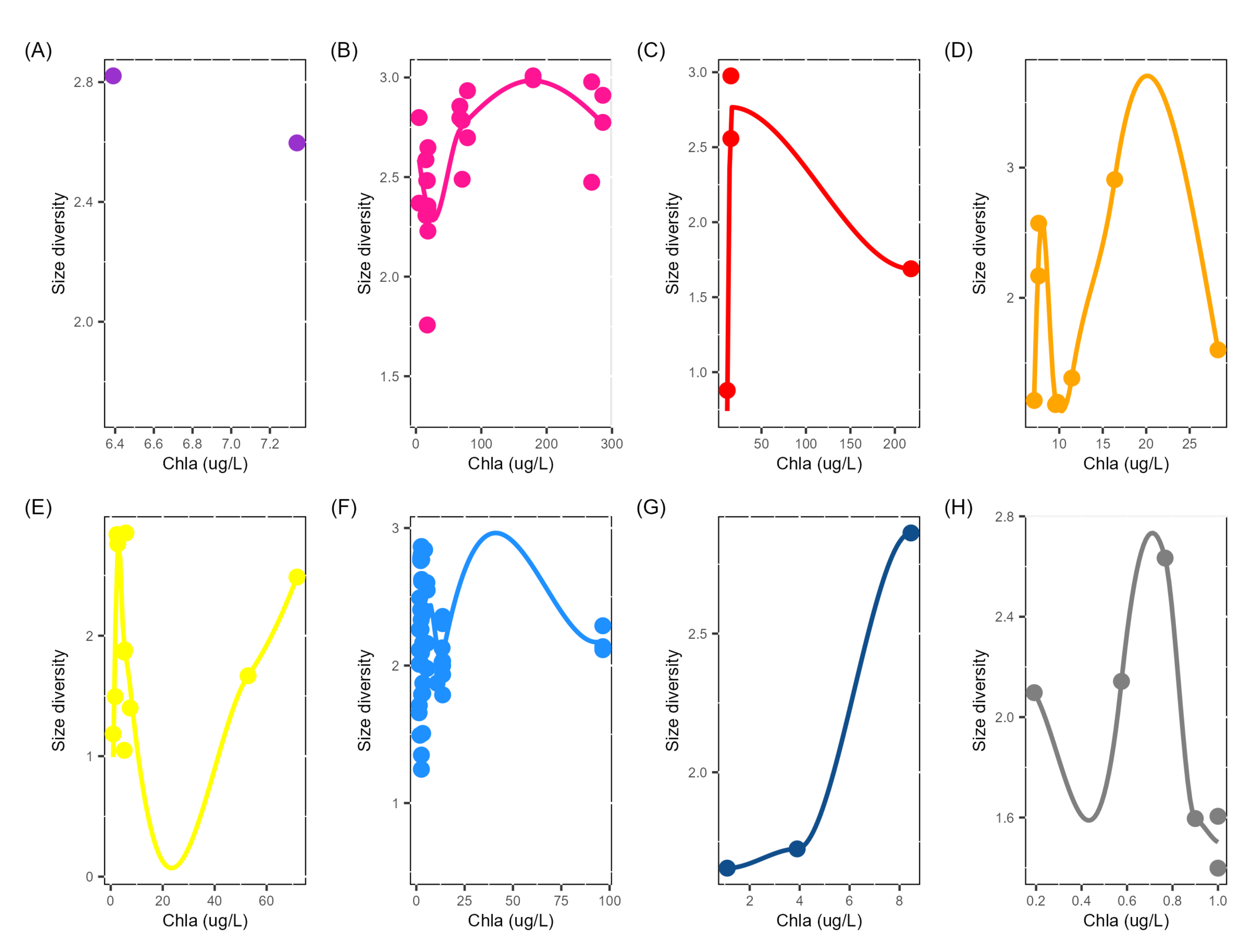

Figure 3. Relation (line geom_smooth, method = "loess") between chlorophyll-a (Chla, as a proxy for bottom-up forcing) and thermal regions (A. SW; B. SH; C. TH; D. NH; E. NW; F. NT; G. NC; H. NF) to explain the differences in size diversity.