

Supporting Information

Three-dimensional range shifts in biodiversity driven by recent global warming

Peter Haase^{12†}, Fengqing Li^{1†*}, Andrea Sundermann¹, Armin W. Lorenz³, Jonathan D. Tonkin¹, Stefan Stoll¹

¹Department of River Ecology and Conservation, Senckenberg Research Institute and Natural History Museum
Frankfurt, Gelnhausen, Germany

²Department of River and Floodplain Ecology, University of Duisburg-Essen, Essen, Germany

³Department of Aquatic Ecology, Faculty of Biology, University of Duisburg-Essen, Essen, Germany

[†]Equally contributing

^{*}Corresponding author: Fengqing Li

Table S1. Regression coefficients between the environmental variables and metrics of temperature and community temperature index (CTI) based on the linear mixed-effects models. The variables of ‘catchment area’ and ‘sampling method’ only apply to the CTI model and are therefore not considered in the model of temperature. The variable of ‘sampling method’ is treated as random effect in the linear mixed-effects models and their regression coefficients are not given in the model of CTI. ** $P < 0.01$; * $P < 0.05$; SE = Standard error; and VIF = Variance inflation factor.

Variable	Elevation	Latitude	Longitude	Year	Area	Method	R^2	P
Temperature	−5.67E-03**	−4.23E-03**	−1.93E-03**	3.31E-02**	–	–	0.87	< 0.0001
SE	6.22E-05	8.88E-05	7.38E-05	2.02E-03	–	–		
VIF	1.41	1.48	1.05	1.31	–	–		
CTI-Abundance	−4.31E-03**	−8.36E-04**	2.06E-03**	2.09E-02*	6.30E-03**	–	0.94	< 0.0001
SE	1.90E-04	2.67E-04	2.20E-04	9.33E-03	6.39E-04	–		
VIF	1.46	1.53	1.07	4.61	1.04	4.87		
CTI-Presence/absence	−3.92E-03**	−1.32E-03**	1.43E-03**	1.79E-02*	6.98E-03**	–	0.96	< 0.0001
SE	1.61E-04	2.25E-04	1.86E-04	7.82E-03	5.41E-04	–		
VIF	1.46	1.53	1.07	4.61	1.04	4.87		

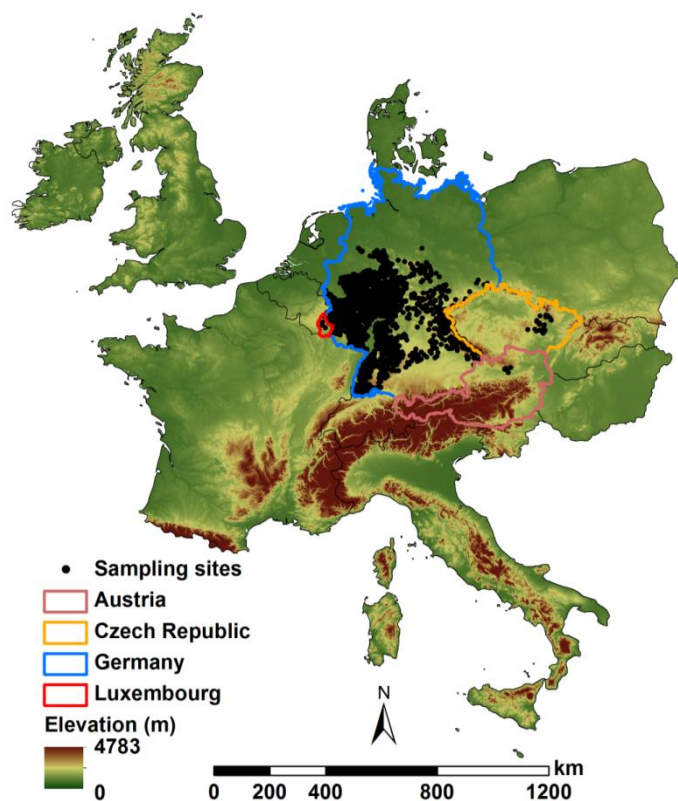
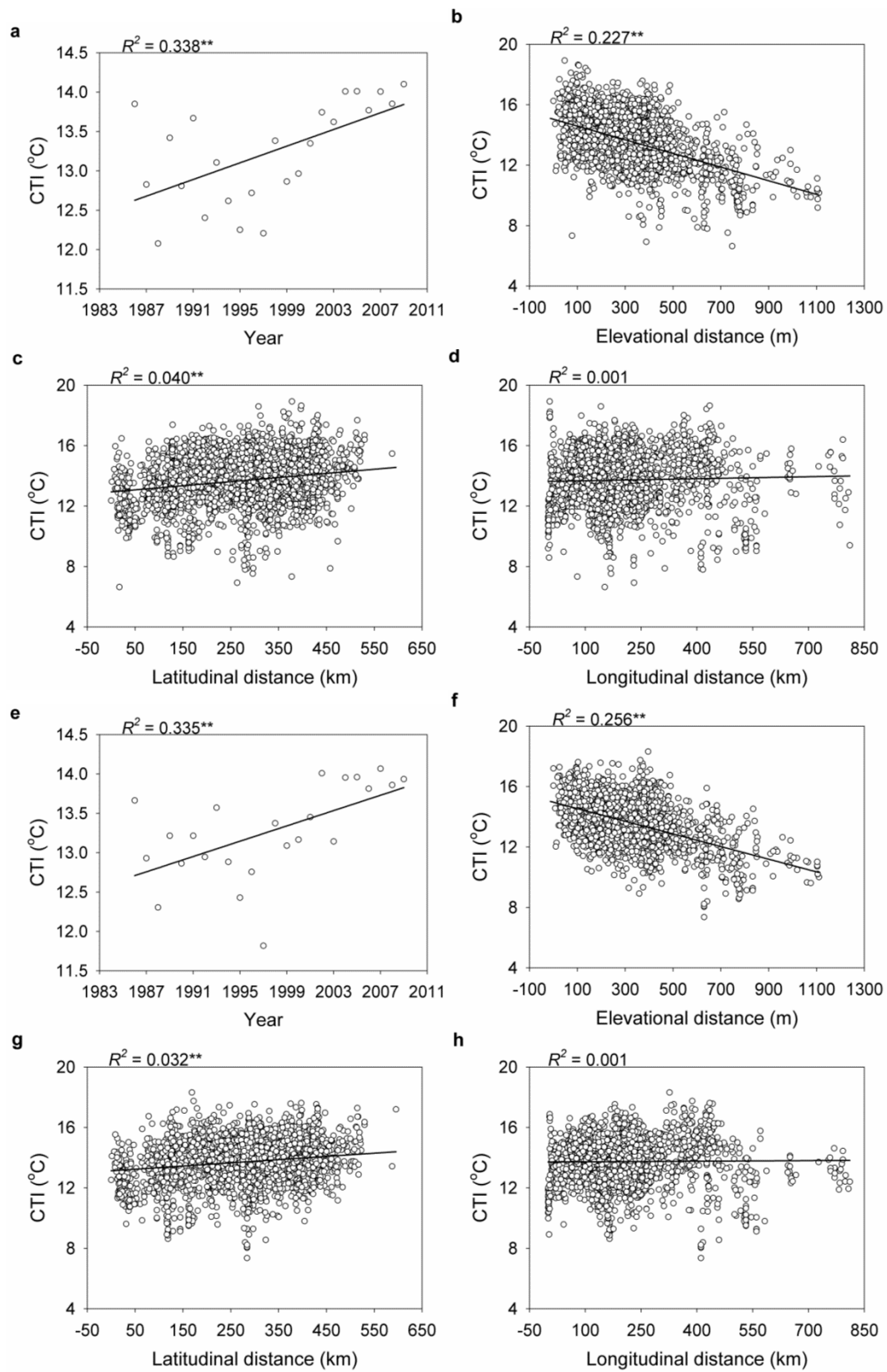


Figure S1. Geographic locations of the sampling sites in the low mountain rivers in Central Europe. Digital elevation map (DEM) was obtained from U.S. National Aeronautics and Space Administration (<https://asterweb.jpl.nasa.gov/gdem.asp>), and access to this data is free of charge. DEM and localities of sampling sites were visualized using ArcGIS 10.2 (<http://www.esri.com>).



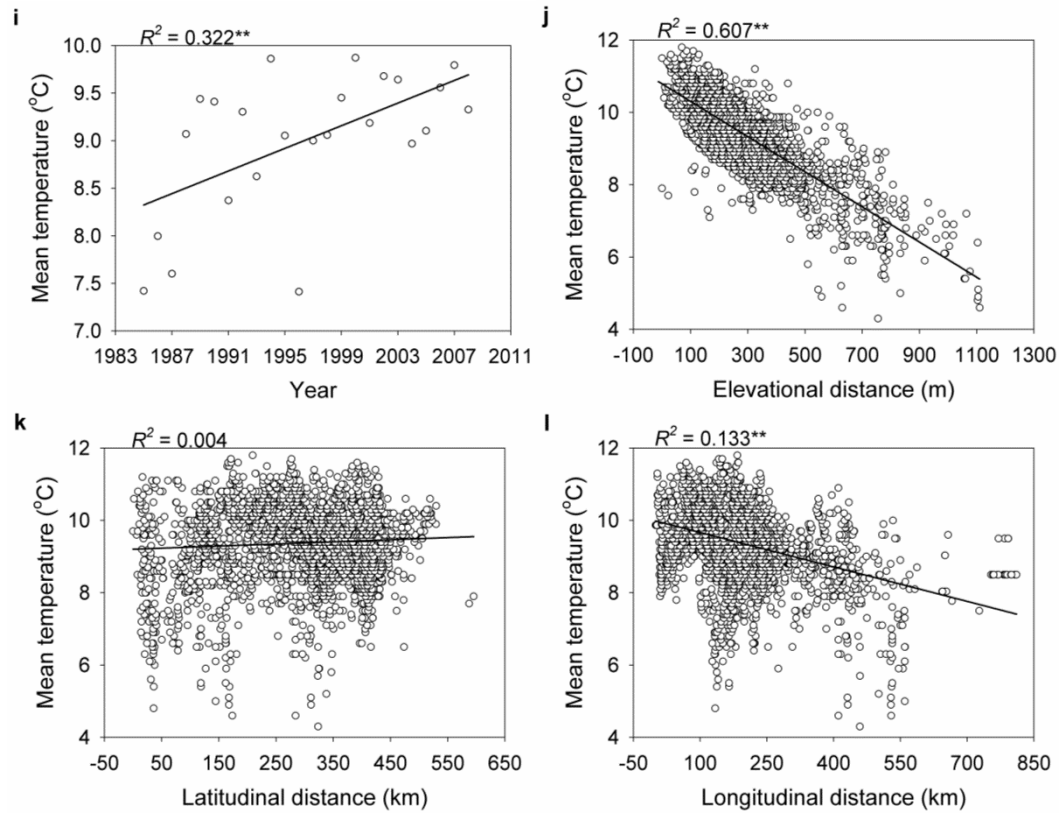


Figure S2. Trends of the CTI (community temperature index) for benthic invertebrates and mean temperatures based on the single linear regression models in the low mountain rivers in Central Europe.

Temporal and spatial trends of the CTI for benthic invertebrates (a–d) with abundance data and (e–h) presence/absence data from 1986 to 2009, and the (i–l) mean temperatures from 1985 to 2008. $** P < 0.01$.

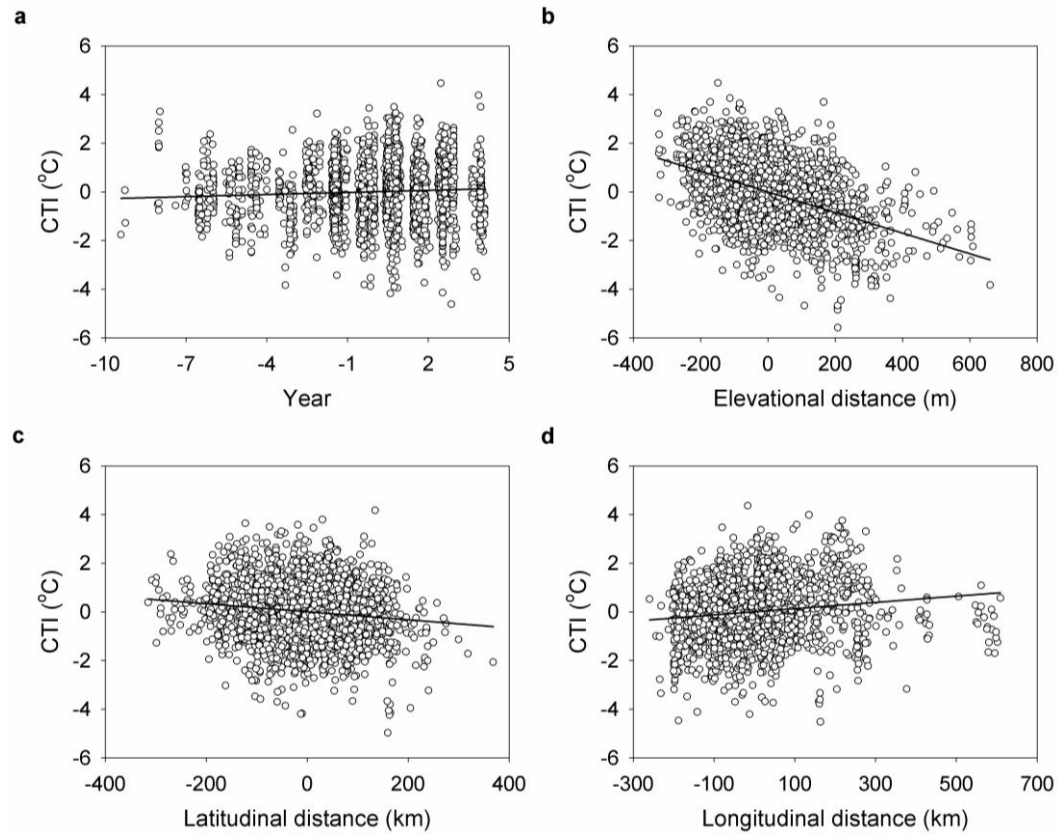


Figure S3. Partial residual plots of the CTI (community temperature index) for benthic invertebrates with presence/absence data based on the linear mixed-effects models in the low mountain rivers in Central Europe.

(a) Temporal trend of the CTI for benthic invertebrates from 1986 to 2009; spatial trends of the CTI (b) from low to high elevation; (c) from south to north; and (d) from west to east. The results of significance tests are in Supplementary Table S1.

Appendix S1. References for Figure 3.

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