

Alpine butterflies want to fly high: Species and communities shift upwards faster than their host plants (*in: Ecology*)

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Data S1: R Markdown file, data and figures used to analyze butterfly and host plant richness patterns, drivers of butterfly richness and drivers of change in butterfly richness, as well as to calculate butterfly community shifts and individual shifts of butterfly and host plant species in the national park Berchtesgaden, Bavarian Alps, Germany.

File descriptions (Kerner_et_al-2022-DataS1.zip)

The folder is organized in three subfolders:

script:

`Kerner_et_al-2022-Alpine_butterflies_want_to_fly_high.Rmd` – you only need to open this file. The Markdown document loads the data and contains all the code used for data analysis and plotting figures.

`Word_template_ecology.docx` – dependent file for document formatting

figures:

`climate_stations_temperature.jpeg` – example of temperature modelling for each plot (= Figure S1). The figure was created externally and saved here for importation into the script.

`location_study_sites_and_climate_stations.png` – location of study sites and climate stations, including changes in temperatures between years. The figure was created externally after exporting the temperature graph from R and saved here for importation into the script.

`Logo_(...) .png` – all five files beginning with “Logo_” contain the externally created icons used in the figures.

data:

`plotdata.csv` – plot names, elevation and plot attributes averaged for each year (2009, 2019): summer temperature, annual temperature, butterfly species richness, flower cover, butterfly abundance, butterfly ACE (abundance-based coverage estimator), butterfly detection rate, butterfly community score.

`plotdata-long.csv` – same variables as `plotdata.csv` without butterfly detection rate, but instead of separate columns per year, years are merged into one column, one below the other, adding a column for the year.

`plotdata-SEM.csv` – plot names, elevation and plot attributes selected to calculate path models analyzing the drivers of butterfly richness averaged for each year (2009, 2019): management, butterfly species richness, flower cover, host plant richness, host plant cover, summer temperature and annual temperature. Years are merged into one column, one below the other, adding a column for the year.

`plotdata-change-between-years.csv` - plot names, elevation and difference in plot attributes of `plotdata-SEM.csv` between the two sampled years (2019 - 2009) to calculate path models analyzing the drivers of change in butterfly richness.

`butterfly-shifts-10individuals.csv` – mean elevation and number of recorded individuals per butterfly species in each year (2009, 2019), only including species with at least 10 individuals in each year and used to calculate the average elevational shift of all species.

`butterflies-elevation-individual.csv` – each row represents a recorded butterfly individual with its elevation and year of record, used to calculate species-specific elevational shifts.

`butterfly-shifts-Tukey-results-figure.csv` – average elevational shifts and confidence intervals per butterfly species with at least 10 individuals in each year according to post-a hoc Tukey test based on a linear model, used to plot Figure 5.

`hostplant-shifts-10subplots.csv` – mean elevation and number of occupied subplots per host plant species in each year (2009, 2019), only including species with at least 10 occupied subplots in each year and used to calculate the average elevational shift of all species.

`hostplants-elevation-subplot.csv` – each row represents a subplot occupied by a certain species with its elevation and year of record, used to calculate species-specific elevational shifts.

`hostplant-shifts-Tukey-results-figure.csv` – average elevational shifts and confidence intervals per host plant species with at least 10 occupied subplots in each year according to a post-hoc Tukey test based on a linear model, used to plot Figure 5.

`mean-shift-species-number-butterflies.csv` – mean elevational shift for different thresholds of minimum number of individuals per butterfly species, including the corresponding species numbers and number of significantly shifting butterfly species, used to plot Figure S4 and to define the minimum number of 10 individuals in each year for species-specific shifts.

`mean-shift-species-number-host-plants.csv` – mean elevational shift for different thresholds of minimum number of occupied subplots per host plant species, including the corresponding species numbers and number of significantly shifting host plant species, used to plot Figure S5 and to define the minimum number of 10 occupied subplots in each year for species-specific shifts.

`yearly-mean-temperature.csv` – mean annual temperature from 2009 to 2019, used to calculate expected species shifts based on differences in temperature and plot Figure S2.

`summer-mean-temperature.csv` – mean annual summer temperature (May – September) from 2009 to 2019, used to plot Figure S2.

subfolder metadata: dependent metadata files (.csv), one for each file in the data folder, explaining each column per file in detail.

Note: All file paths in the script are given as relative file paths, meaning they always relate to files inside the main folder so that the script still runs when changing the location of the main folder. However, it is important to preserve the folder structure inside the main folder as it is. Otherwise, the Markdown file cannot access all dependencies necessary to run the script.

All final figures of the manuscript are included in the Markdown file when running the code (script folder) and are also exported into a Word file when clicking 'knit' in the RStudio pane showing the code. Therefore, figures are not additionally saved in the figure folder, although some will be cached there for later reimportation into the script when running the code.