Analysis of Dominance and Shannon Diversity Indices in Relation to Reconstructed Temperature

Introduction

This report presents an analysis of the relationship between dominance indices and Shannon diversity indices of various proxies with reconstructed temperature over defined climate periods. The proxies analyzed include Cladocera, Diatoms, Ostracods, and Pediastrum. The aim is to explore how these ecological indices correlate with historical temperature changes, which are crucial for understanding past ecological dynamics and predicting future trends.

Methods

Data Preparation

The datasets used in this analysis include the dominance indices and Shannon diversity indices for Cladocera, Diatoms, Ostracods, and Pediastrum, as well as reconstructed temperature data. The climate periods analyzed were the Roman Warming Period (RWP; 0-200 CE), Dark Age Cold Period (DACP; 200-550 CE), Sui and Tang Dynasties Warm Period (S&TWP; 550-700 CE), Medieval Climate Anomaly (MCA; 900-1400 CE), Little Ice Age (LIA; 1400-1850 CE), and Current Warming Period (CWP; 1850 CE-present).

Calculation of Mean Indices

For each proxy and each climate period, the mean dominance index and Shannon diversity index were calculated. This involved averaging the values of these indices for the respective periods. The dominance index used was Simpson's Dominance Index (D), and the diversity index was Shannon Diversity Index (H').

Correlation Analysis

Spearman's rank correlation coefficient was used to assess the correlation between the mean indices and the reconstructed temperature for each climate period. This non-parametric measure was chosen due to its robustness in handling non-linear relationships and its ability to work with ordinal data.

Visualization

Heatmaps were generated to visualize the mean dominance indices and Shannon diversity indices across the climate periods. These heatmaps provide a clear representation of how the indices varied over time. Additionally, a separate heatmap for reconstructed temperature was created to visually correlate temperature changes with the ecological indices.

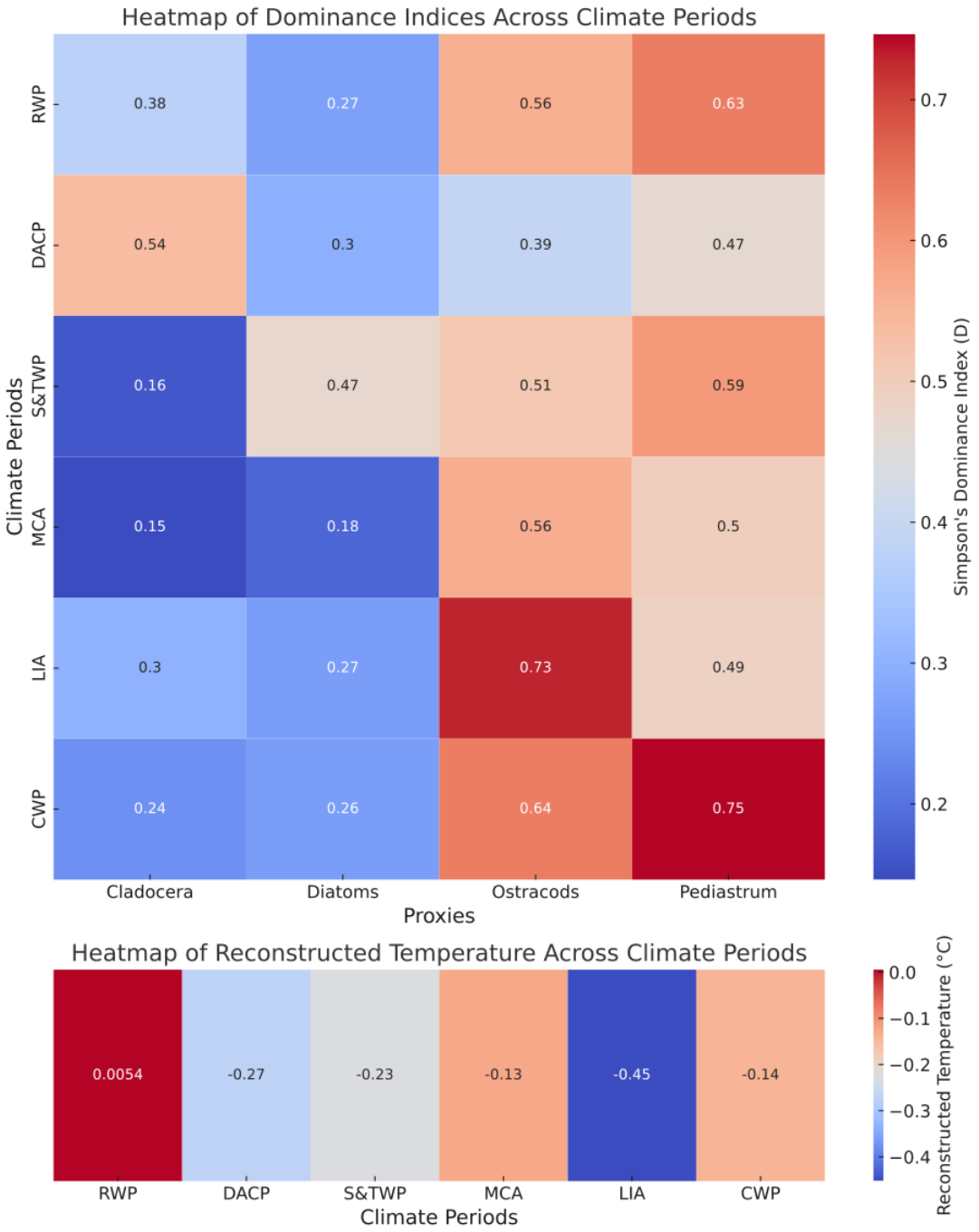
Results

Dominance Indices

The mean dominance indices for each proxy across the climate periods are presented in the heatmap below. Spearman's correlation analysis revealed the following relationships between dominance indices and reconstructed temperature:

Proxy	Correlation (r)	p-value
Cladocera	-0.26	0.62
Diatoms	-0.31	0.54
Ostracods	-0.09	0.87
Pediastrum	0.66	0.16

The heatmap of dominance indices across climate periods can be visualized in the attached figure.



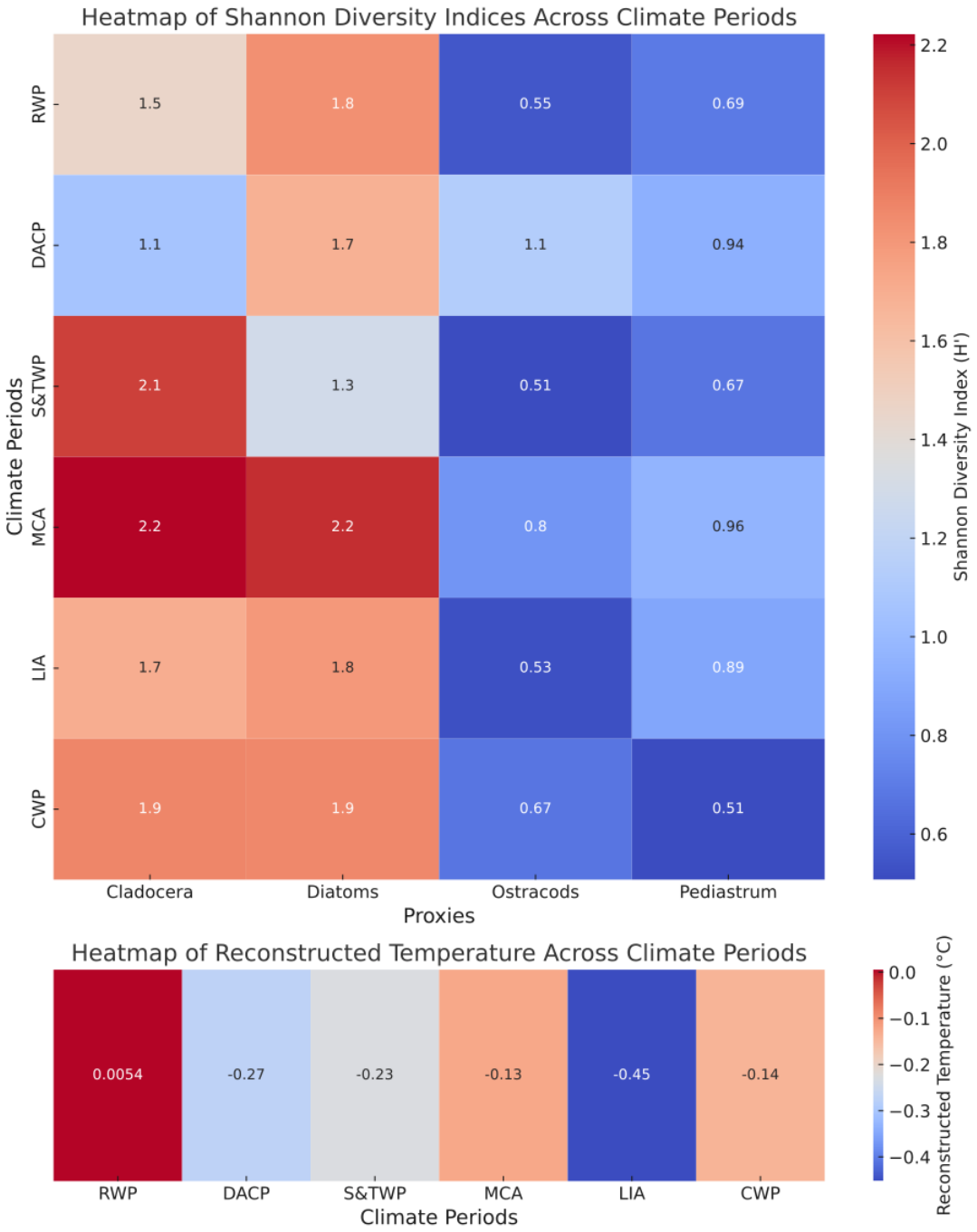
Shannon Diversity Indices

The mean Shannon diversity indices for each proxy across the climate periods are presented in the heatmap below. Spearman's correlation analysis revealed the following relationships between Shannon diversity indices and reconstructed temperature:

Proxy	Correlation (r)	p-value

Cladocera	-0.43	0.39
Diatoms	-0.5	0.3
Ostracods	-0.26	0.62
Pediastrum	0.54	0.26

The heatmap of Shannon diversity indices across climate periods can be visualized in the attached figure.



Conclusion

The analysis reveals varying degrees of correlation between the ecological indices and reconstructed temperature. While none of the correlations were statistically significant, the trends observed provide insights into the ecological dynamics over historical climate periods. Further research with more data points and advanced analytical techniques may yield more definitive conclusions.