

PALAEOCLIMATIC POTENTIAL OF THE MULTI-CENTENNIAL OAK RING WIDTH CHRONOLOGY FROM WESTERN UKRAINE

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Introduction

Oak, due to its widespread distribution in Europe and its properties such as longevity, durability, distinct boundaries of tree-rings and extensive use in history, is one of the most used species in dendrochronology. Therefore, in recent decades, multicentennial and multimillennial oak tree-ring width (TRW) standard chronologies have been compiled on the territory of Europe, which are used especially in dendroarchaeology and dendroclimatology. Because the region of Ukraine is one of the few European countries without a well-replicated oak TRW chronology, there was an effort to compile one. In the last years, a 165-year-long recent oak TRW chronology has been compiled, which has now been improved and also expanded with tree-ring series from historic constructions. In addition, the recent part of the chronology was used to find the climate influence on the radial increment of oak in this region. For more accurate dating, an analysis of the number of sapwood rings was also performed.

Material and methods

Totally 247 oak samples (from 10 to 28 samples from each site) from 14 forests of different altitude and 86 oak samples from different wooden construction elements of 18 oak historical constructions (belfries and churches) have been taken using Pressler increment borer on region of Transcarpathian Ukraine. Also 75 TRW series from historical constructions located in Zemplin region (east Slovakia), are part of regional oak TRW chronology (Fig. 1). The sampling, processing and dendrochronological dating have been performed according to standard dendrochronological methodology.

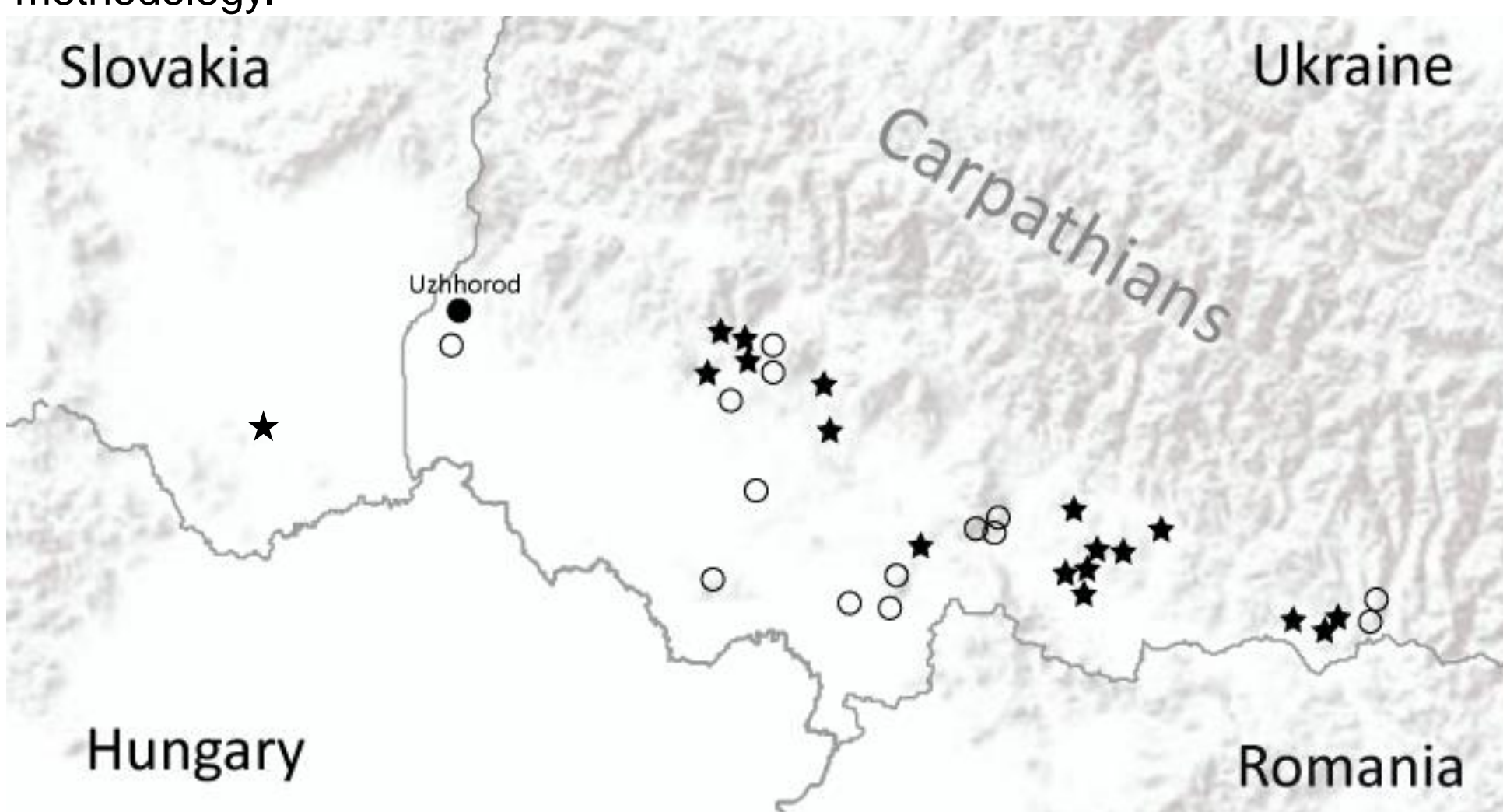


Fig1. Map of eastern Slovakia and western Ukraine with marked sampling points from historical structures (black stars) and forest sites (black circle)

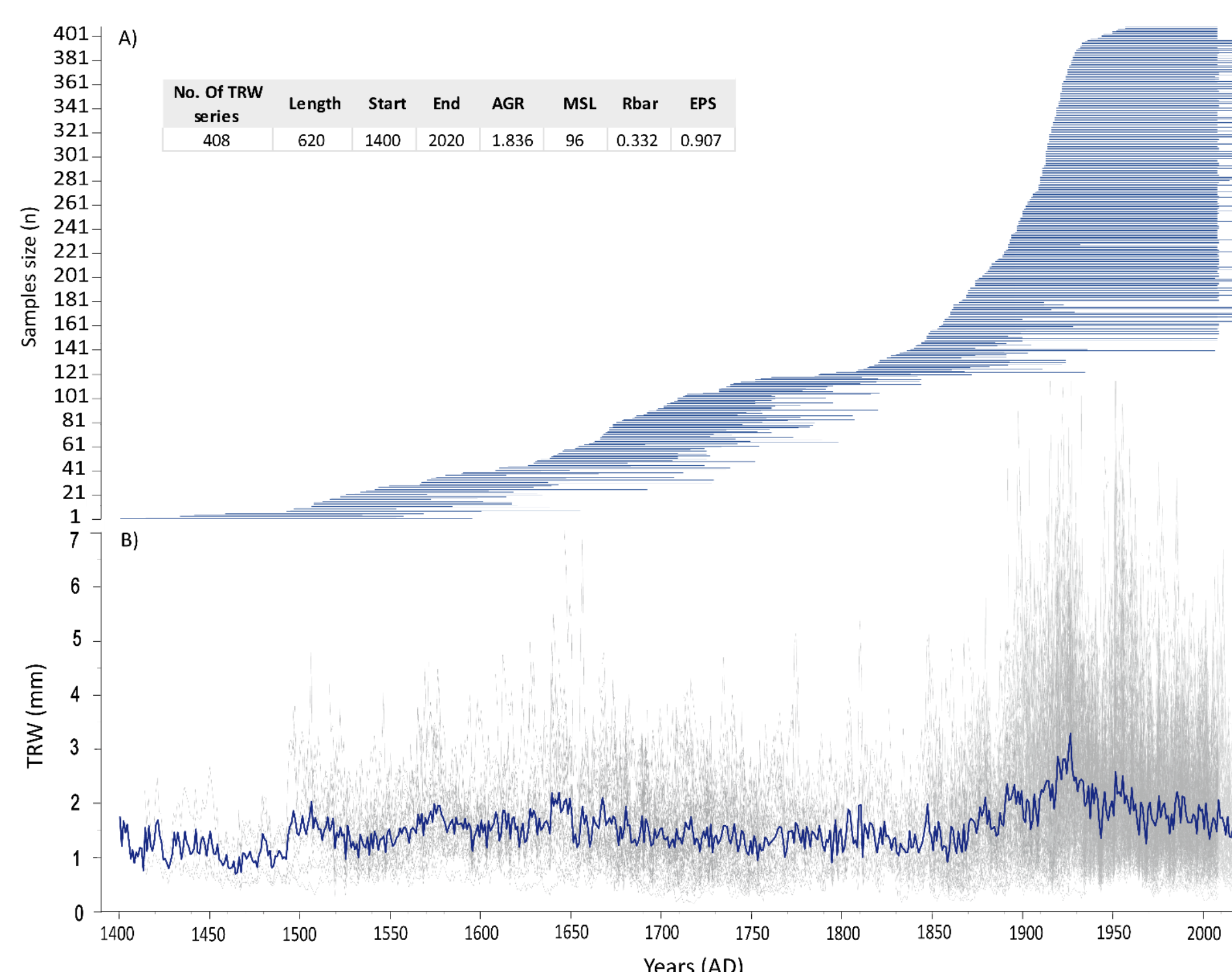


Figure 2. (A) The temporal distribution of the 408 individual oak ring width samples with table of their characteristics, (B) individual oak TRW series (light grey) and mean chronology (blue).

Results and conclusion

The standard oak TRW chronology for Western Ukraine so far consists of 408 TRW series from Transcarpathian (UA) and Zemplin region (SK) and covers the period from 1400 to 2020, from 1506 it consists of at least 10 TRW series (Fig. 2).

After dendroclimatic analysis a significant negative correlation of TRW with the temperature in June, and positive with the temperature in January was found. An even stronger positive correlation with the precipitation in March-August and also with drought indices (SPEI and PDSI) from May till August were found (Fig. 3). This suggests that lack of moisture is most significant limitation for oaks in this area. Thus this chronology can be used to find significant droughts in TRW in the past.

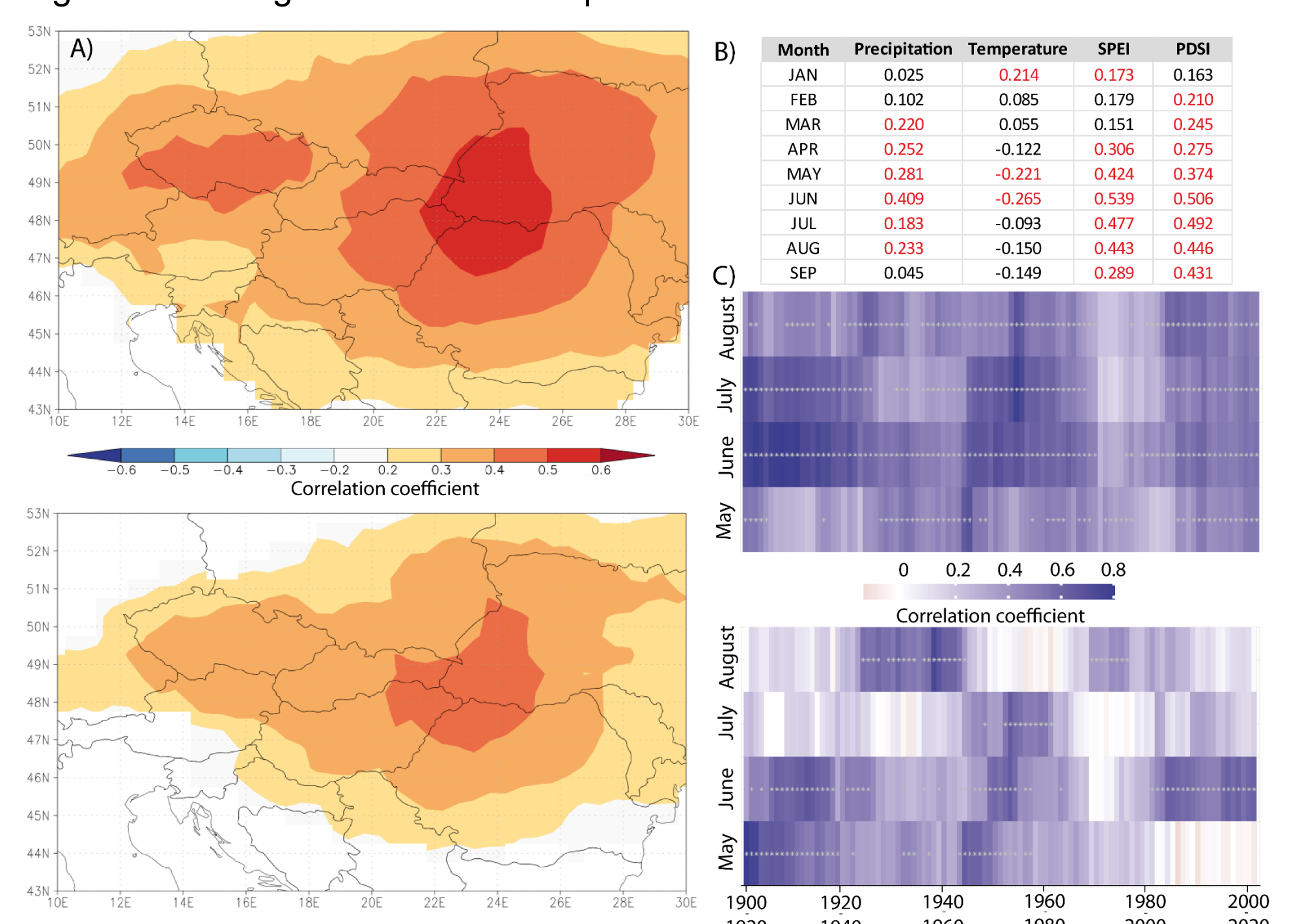


Fig 3. (A) Spatial correlations between TRW and SPEI3 (top) and Precipitation (bottom) in May–August from CRU TS4.06 for the period 1901–2020, (B) table of correlation coefficients between TRW and climate with highlighted significant correlation (red), (C) moving correlation between tree ring width and SPEI3 (top) and precipitation (bottom) in May–August, calculated over the previous 20 years.

For all samples, average value of TRW (AVG, mm / year) ranges from 0.642 to 4.411, and average length of series (MLS) ranges from 24 to 195 years. To assess the quality of regional chronologies, population signal values (EPS) and interseries correlations (Rbar) were calculated. TRW series have mean EPS value 0.907, which is greater than 0.85, which is taken as the threshold (Fig. 3). The number of sapwood rings of samples for the Transcarpathian Ukraine with average values and the 95% confidence limit is 5.55–22.34. Therefore, we recommend using an estimate of 5–23 sapwood rings for a more precise dating for this area (Fig. 4).

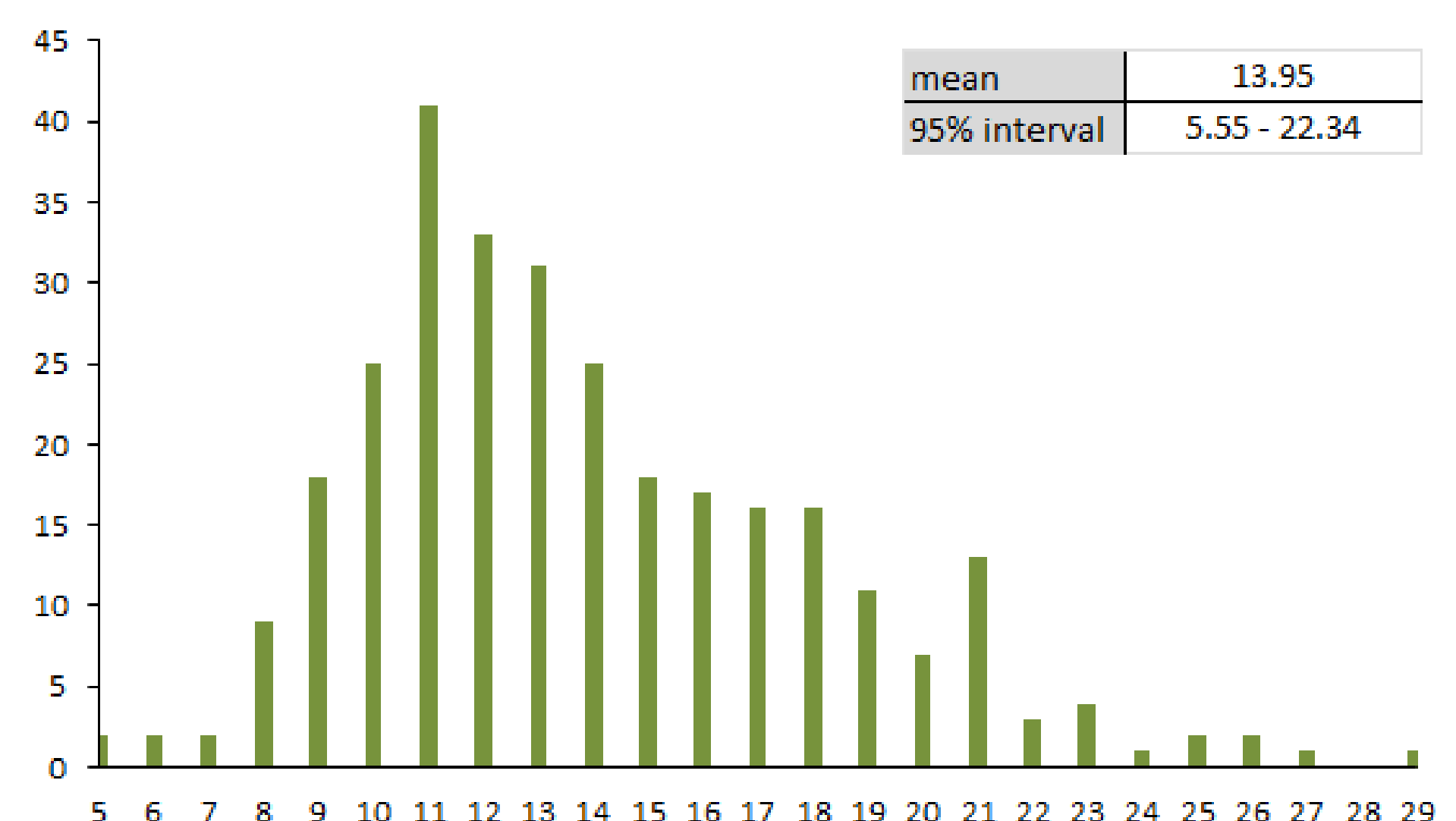


Fig 4. The number of sapwood rings of recent samples for the Transcarpathian Ukraine, the average value and the interval of values of the 95% confidence limit.

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