Climate Trends Changing Threads in the Prehistoric Pannonian Plain
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Introduction
We present the results of an interdisciplinary case study, incorporating archaeological analysis and climate modelling results for the evaluation of the effects of past climate change on textile production of the Pannonian Plain. Period of interest, beginning with the middle Eneolithic and ending with the early Bronze Age falls roughly between the late 7th and the end of the 5th millennium BP.

Materials and Methods

836 spindle-whorls recorded by Grabundzija & Russo 2016 in a textile tools database were used in this study. The chronological division used placed spindle-whorl samples from the first half of the 6th millennium BP into the middle Eneolithic and the samples from the second half of the 6th, and the very beginning of the 5th millennium, into the late Eneolithic assemblage. Samples from the advanced 5th millennium contexts thus entered the early Bronze Age assemblage.

The raw sample of spindle-whorls was divided into four weight and three height categories, according to the distribution of the spindle-whorl’s weight and height-diameter ratio values (Fig. 2). Both whorl’s size and weight account for the rotational properties of the spindle-whorl, determining the tool’s moment of inertia. This plays the central role for the determination of the tool functionality, being connected with both the raw material (Verhacken 2010) and the spun thread properties (Bohnack 1981, Crewe 1998).

Indeed, knowing the height/diameter ratio and weight of the tool we can make inferences on the final product entered the early Bronze Age assemblage. In the following centuries of the 6th millennium BP, a continuous worsening of climatic conditions led to the employment of alternative resources.

Climate Modeling
The results of the archaeological investigations were used together with the outcomes of a continuous transient climate simulation with the coupled model ECHO-G. The horizontal resolution of the simulation is 3.75 longitude degrees. The region considered in the analysis extends from 14°W to 21°W in longitudes and from 42°N to 48°N in latitudes. Analysis focused on seasonal values of near surface temperature, moisture balance (i.e. precipitation minus evaporation) and growing degree days above 5 degrees. Additionally, Sea Level Pressure (SLP) anomalies were considered.

Results
Figure 3: The distribution of weight classes according to the height type, shown for each respective period, separately. Results of spindle analysis shows how the analyzed tools distribution is considerably different from one period to the other. The late Eneolithic seems to have been a transitional period between the middle Eneolithic and the early Bronze age, for which the textile production seems instead to have been more specialized. In particular, the middle Eneolithic tools fall mainly into the flat/light category, indicating processing of plant fibers; relatively high value of the high/height categories in this case, would suggest the use of early-type wool. Conversely, the early Bronze age samples mainly fall into the steep-height category, suggesting a higher use of, together, longer fibers and wool.

Conclusions
According to the evinced results we can conclude that:
- During the middle Eneolithic period, a shorter-fiber flax variety was likely the most exploited material for textile production in the area. Simultaneously, along with the deteriorating climate conditions, the use of animal products, presumably including fibres, started to be more important.
- In the following centuries of the 6th millennium BP, a continuous worsening of climatic conditions led to the employment of alternative resources.
- More organized fibre material resources had to be acquired and established by the end of the 6th millennium BP during the early Bronze age. Both altered environmental and cultural conditions resorted further in the new demands for the specific types of textile products, possibly corresponding to the intensified use of transport and traction.

References