Reconstruction of the Spring Temperatures in the 18th Century from Measured Lengths of Grapevine Sprouts

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ABSTRACT. Lengths of new grapevine sprouts have been measured systematically in Köszeg, Hungary, since 1740 in the 24th April every year. In some years no new sprouts have been seen, in other years they exceed 30 cm. They exhibit a good correlation with the average air temperatures in April and even better for weighted averages (Mar+2×Apr)/3.0, when correlation coefficient reaches 0.6. Data from Budapest, Vienna, and Prague show that the correlation decreases with increasing distance. Using square roots of the lengths one arrives to values higher by about 0.05. Calculating April temperatures till the 24th only the correlation increases by other 0.05. These results confirm relatively colder period in the 19th century and warm decades to the end of the 18th century and suggest that the warm period continued back to the past at least till 1740; it concerns spring temperatures only.

KEY WORDS: spring temperature, climate reconstruction, grapevine sprouts, 18th century.

Introduction

Instrumental air temperature data series at individual stations are relatively short. The observations started at the most central European stations during the second half of the 18th century. From this point of view it is very desirable to look for any independent indirect data further to the past using various different observations or natural archives. Each of these reconstructions, however, is limited in some extent as to the region from where the data were taken, or the season connected with these data.

Methods and material studied

We have used measured lengths of new grapevine sprouts available since 1740 in Köszeg for different grapevine sorts in the same day each year. Köszeg is located in the West Hungary near the boundary with Austria. The inhabitants keep an interesting tradition: every year on St. George's day (24th April) a procession in folk costumes walks through the town bringing new grapevine sprouts from vineyards to the town hall. These sprouts are then drawn on paper as documentation, keeping carefully their size and form. These pictures have been saved in the town museum since 1740 till now, together with comments about the wine production and the weather in the respective year (e.g. unusual meteorological occasions).

The lengths of the mentioned grapevine sprouts are very different: in some years not yet opened blossoms, other years they exceed 30 cm. Till now the only comparisons of the measured lengths with some meteorological data were carried out by Berkes (1942) and Péczely (1982). They found some interesting correlations. Lengths of grapevine sprouts for 1740–1939 are published in Berkes (1942); the first author in the Köszeg museum has measured those for 1900–1998. The lengths in the individual years are shown graphically in Fig. 1. Striking low values after 1900 are apparent; it will be explained later.

There are some inhomegeneities in the data set. There are different wine sorts, some of them grow earlier and the other later, the sprouts were taken from different localities in the vicinity of the town with possibly different microclimate. Fortunately, sprouts of more sorts and from more localities have been documented each year for comparison (at least five or often more) and therefore this diversity brings no problem. The most serious inhomogeneity occurred in 1900. In this year the vineyards were attacked by Phyloxera, therefore it was necessary to cut old plants and to introduce new variants. They grow slowlier than the older ones and this is the explanation of systematically shorter branches in the 20th century.

Results

The measured grapevine sprouts lengths have been compared with the observed air temperatures in Budapest, Vienna, and Prague. The most important correlation coefficients are summarised in Table 1. In the last four columns correlations with mean temperatures in March (III), in April (IV), with the average March+April (A) and with the weighted average defined as (March+2× April)/3.0 (WA) are given. The first column indicates the station in question. The notation PRAGUE G means that mean values for April were calculated only till the 24th (this applies to the averages A and WA too). This calculation is methodically better. However, we were able to provide these means only for data from Prague. The correlation with Budapest temperature separately for period till 1900 (due to the inhomogeneity) is given at the first row of Table 1; it is significantly higher than that for the whole period. Levels for the 95% and 99% significance of correlation coefficients are 0.12 and 0.16, respectively.

Lower lengths after 1900 offer a possibility to introduce some corrections and homogenisation of the data. We tried

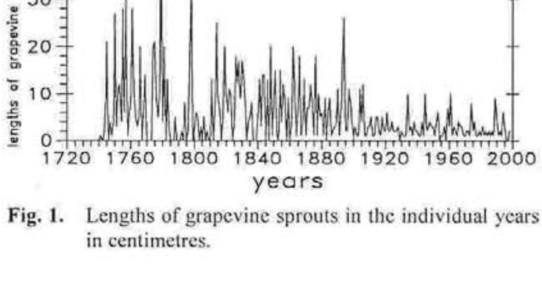

Fig. 1. Lengths of grapevine sprouts in the individual years in centimetres.

station and data		period	III	IV	A	WA
BUDAPEST	orig.	1780-1900	0.395	0.516	0.598	0.613
BUDAPEST	orig.	1780-1998	0.178	0.447	0.405	0.466
VIENNA	orig.	1775-1998	0.186	0.393	0.378	0.422
PRAGUE	orig.	1775-1998	0.221	0.371	0.367	0.394
PRAGUE G	orig.	1775-1998		0.422	0.403	0.437
BUDAPEST	corr.	1780-1998	0.338	0.441	0.528	0.551
VIENNA	corr.	1775-1998	0.333	0.423	0.508	0.525
PRAGUE	corr.	1775-1998	0.350	0.440	0.510	0.494
PRAGUE G	corr.	1775-1998		0.494	0.534	0.554
BUDAPEST	corr. sq.	1780-1998	0.376	0.498	0.592	0.619
VIENNA	corr. sq.	1775-1998	0.375	0.467	0.566	0.584
PRAGUE	corr. sq.	1775-1998	0.411	0.490	0.569	0.577
PRAGUE G	corr. sq.	1775-1998		0.539	0.601	0.617

Tab. 1. Correlation of lengths of grapevine sprouts with mean air temperatures.

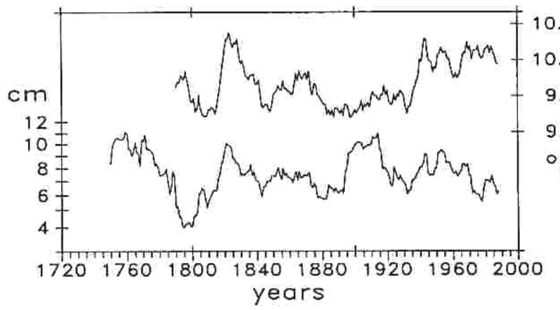

Fig. 2. The course of spring temperatures in Budapest, weighted average (March+ 2×April)/3.0 - upper curve, right-hand scale, and lengths of grapevine sprouts in Köszeg - lower curve, left-hand scale, both smoothed using running averages in the 21-yr interval.

to multiply all values after 1900 by different factors. The multiplication by 3 results in the highest coefficients and it seems therefore to be the most suitable. The correlations with the original data are marked "orig.", with the corrected data "corr." in Table 1. This correction improves the correlation by about 0.1 in columns A and WA. The highest correlations appear for Budapest, lower for Vienna and for Prague (but still significant). Using the averages till the 24th April only the correlation increases by about 0.05.

Using correlation coefficients one silently supposes that the relation between correlated quantities is linear. But the growth at the beginning is very slow and only later the sprouts grow more rapidly. It is therefore better to correlate the temperature with e.g. the logarithm or square root of the sprouts length. Using this transform differences between long sprouts (20, 30, 40 cm) decrease. Correlation coefficients between square roots of grapevine sprouts and temperatures are given in Table 1 in rows marked by "sq.". They increase by about 0.05.

Conclusion

We represented graphically the course of the air temperature in Budapest (weighted averages WA used in Table 1) together with the length of grapevine sprouts in square-root scale (this combination exhibits the best correlation), both smoothed by running averages in 21 year interval (Fig. 2). The picture shows a good agreement between both curves. Both curves display similar periods with higher or lower values lasting several decades, with the exception of the most recent decades (after 1960). This point confirms other observed and indirect data. The sprouts are relatively long even in decades before 1780 (see Figs 1 and 2), where no instrumental observation in the region in question is available. We may claim that spring temperatures between 1740–1780 were approximately on the same level as they were between 1780–1790, and surely higher than those in the middle of the 19th century were.

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Evidence of Climatic Variations in Loess and Cave Palaeolithic Sites of Southern Poland and Western Ukraine

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ABSTRACT. An outline of the Upper Pleistocene environmental changes reconstructed with the use of data gathered in Palaeolithic cave and loess sites from Southern Poland and Western Ukraine is presented. Lithological composition of cave sediments, mainly the weathering degree of limestone rubble as well as fossil fauna composition show a succession in landscape diversity from deciduous and coniferous forest to open vegetation and tundra. This succession is compared with loess sedimentation succession, interrupted several times by soil development under steppe or forest vegetation. Archaeological finds help with stratigraphical correlation.

KEY WORDS: Upper Pleistocene environments, Palaeolithic, loess, cave sediments.

Precisely documented profiles of cave and loess archaeological sites of Southern Poland and western Ukraine cover the time from the decline of the penultimate glaciation (Warthanian), through the Eemian to the end of Vistulian, which means 5–2 oxygen iso-