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„SHARE" OF TEMPERATURE OF PARTICULAR MONTHS IN THE ANNUAL TEMPERATURE IN POZNAŃ IN THE PERIOD 1848-1997

Abstract: The relationships between annual temperature and temperature of particular months in Poznań in the period 1848-1997 are presented. Significance of this relationship was examined with the calculation of the Pearson's correlation coefficient. Within a year the average percentage "share" of monthly values of temperature changes from 1.6% in April and October to 12.9% in July.

Key words: air temperature, Poznań, Pearson's correlation coefficient.

The annual course of certain meteorological elements, especially the time of occurrence of extreme values within the year, is treated as a crucial component of the characteristic of climatic relationships. The usage of analysis of an annual run of meteorological elements is well illustrated with the example of precipitation. Monthly and seasonal sums of precipitation, particularly their share in the annual sum constitute important information about rain features of the climate of a given place or region. Annual course of air temperature also takes into consideration regional conditions, which is shown in the differentiated annual temperature amplitude. Thermal relationships are most often discussed using annual, seasonal or monthly temperature. Relations between these coefficients are discussed much less frequently. Mean annual air temperature in Poznań calculated for the period of 150 years is 8.2°C. In the period 1848-1997 the annual temperature changed from 6.1°C in 1855 and 1940 to 10.0°C in 1934. Other data concerning thermal conditions in Poznań in the analysed period are given in Table 1.

This paper deals with relations between annual temperature and temperature of particular months in Poznań in the period 1848-1997. It aims at comparing the long-term course of annual temperature and the course of temperature of particular months, together with establishing the quantitative relations between them. Taking into consideration that the annual temperature is determined by temperature of all

Tab. 1. Air temperature (°C) in Poznań over the 1848-1997 period.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Mean	-1,9	-0,9	2,5	7,7	13,2	16,9	18,5	17,6	13,6	8,5	3,2	-0,3	8,2
Lowest monthly	-11,9	-12,9	-4,4	3,5	9,0	12,3	15,0	14,6	9,7	5,4	-1,7	-7,7	6,1
Year	1848	1929	1853	1852	1864	1923	1848	1864	1912	1920	1919	1855	1855 1940
Highest monthly	3,9	5,3	6,8	12,9	18,0	20,8	21,4	20,9	17,2	11,7	7,2	3,8	10,0
Year	1983	1990	1990	1918	1889	1889	1865	1944	1947	1967	1963	1974	1934

months of a particular year, the survey procedures included the issue of "share" of temperature of particular months in the annual temperature. There is, however, an arithmetical obstacle to parameterization of this "share", as the annual temperature (in contrast with, for example, annual precipitation) is an arithmetical mean value of the monthly values. Temperature of some months is negative and thus it cannot be referred to positive values of annual temperature in a direct way as it can be done in the case of months with positive values of temperature. The issue of influence of monthly temperature values is important as the same annual value of temperature can be obtained in years with sometimes very different courses of monthly temperature values. For example, the annual temperature in Poznań in 1963 and 1965 was 7.3°C. Monthly temperature values in 1963 varied from –10.5°C in January to 20.0°C in July (annual amplitude 30.5°C). Remarkably lower range of temperature was observed in 1965 when monthly temperature values changed from –3.7°C in February to 16.3°C (annual amplitude 20.0°C).

The first step of the survey was to analyze relations between annual and particular months' values of temperature for in Poznań in the period 1848-1997. The significance of this relationship was examined with the calculation of the Pearson's correlation coefficient (Tab. 2). It can be observed that in Poznań the changes of the temperature of February are closest to the long-term rhythm of changes of annual temperature. As the correlation coefficient is $r = 0.619$ both series of temperature values show statistically significant similarity. The lowest value of the correlation coefficient is that of June $r = 0.051$. Such low value of the r coefficient means that the course of temperature in June differs from the annual values' course of temperature in the surveyed period. These relations of the months of February and June are presented in a dissolution diagram in Figure 1 and there are significant differences between both months as far as the similarity relations are concerned. The data in Table 2

Tab. 2. Coefficient of correlation between monthly and annual air temperature in Poznań over the 1848-1997 period.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
0,580	0,619	0,540	0,467	0,283	0,051	0,298	0,372	0,307	0,190	0,286	0,374

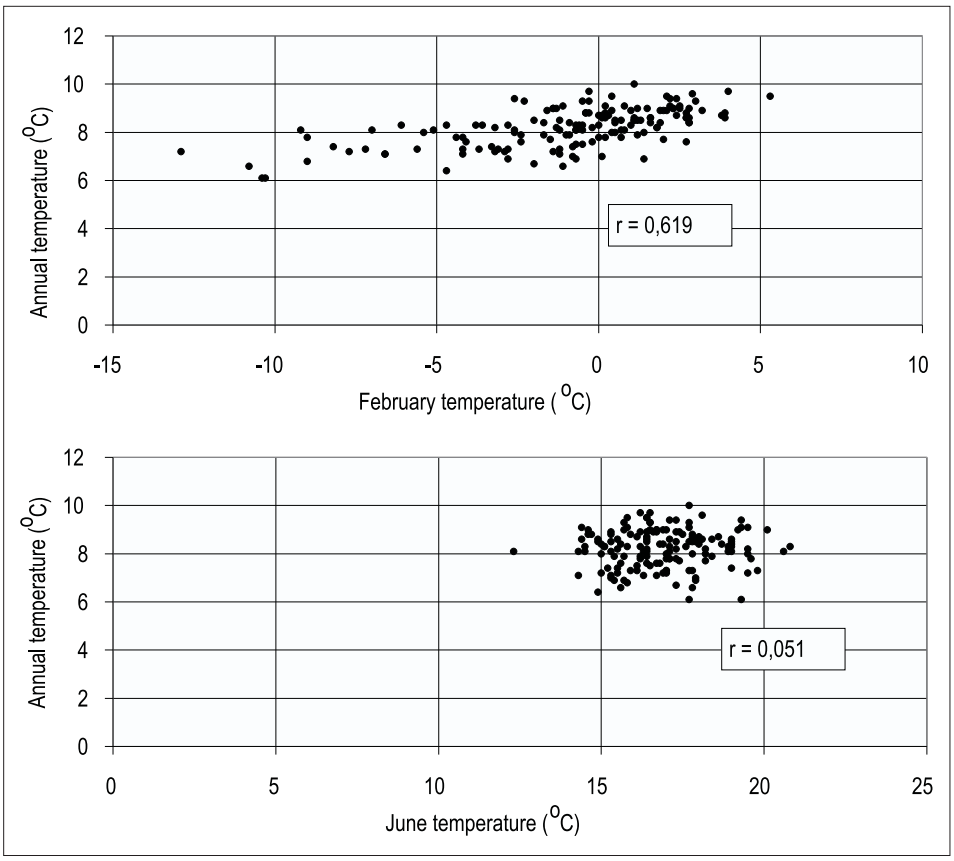

Fig. 1. Relation between the temperature of February and June and the annual temperature in Poznań in 1848-1997.

suggest that the correlation coefficient is higher for winter months than for summer months. The result of the comparison of temperature values of particular seasons with the annual temperature is shown in Figure 2. Annual temperature is correlated mostly with winter temperature ($r = 0.793$) and spring temperature ($r = 0.685$). Summer temperature shows the lowest correlation similarity to the annual temperature ($r = 0.364$).

To supplement the previous discussion Figure 3 shows the annual temperature's course along with the temperature of February and June in the years 1848–1997 (11-element moving average). Evaluating the changes of the annual temperature it can be generally stated that since 1916 it tended to increase and then it decreased till around 1960 (in 1945-1950 a growth of the annual temperature was observed). In the following period the temperature increased again. The rhythm of changes of the temperature of February is very similar. The rhythm of changes of the temperature of June is also similar to the change of annual temperature up to 1935. However later

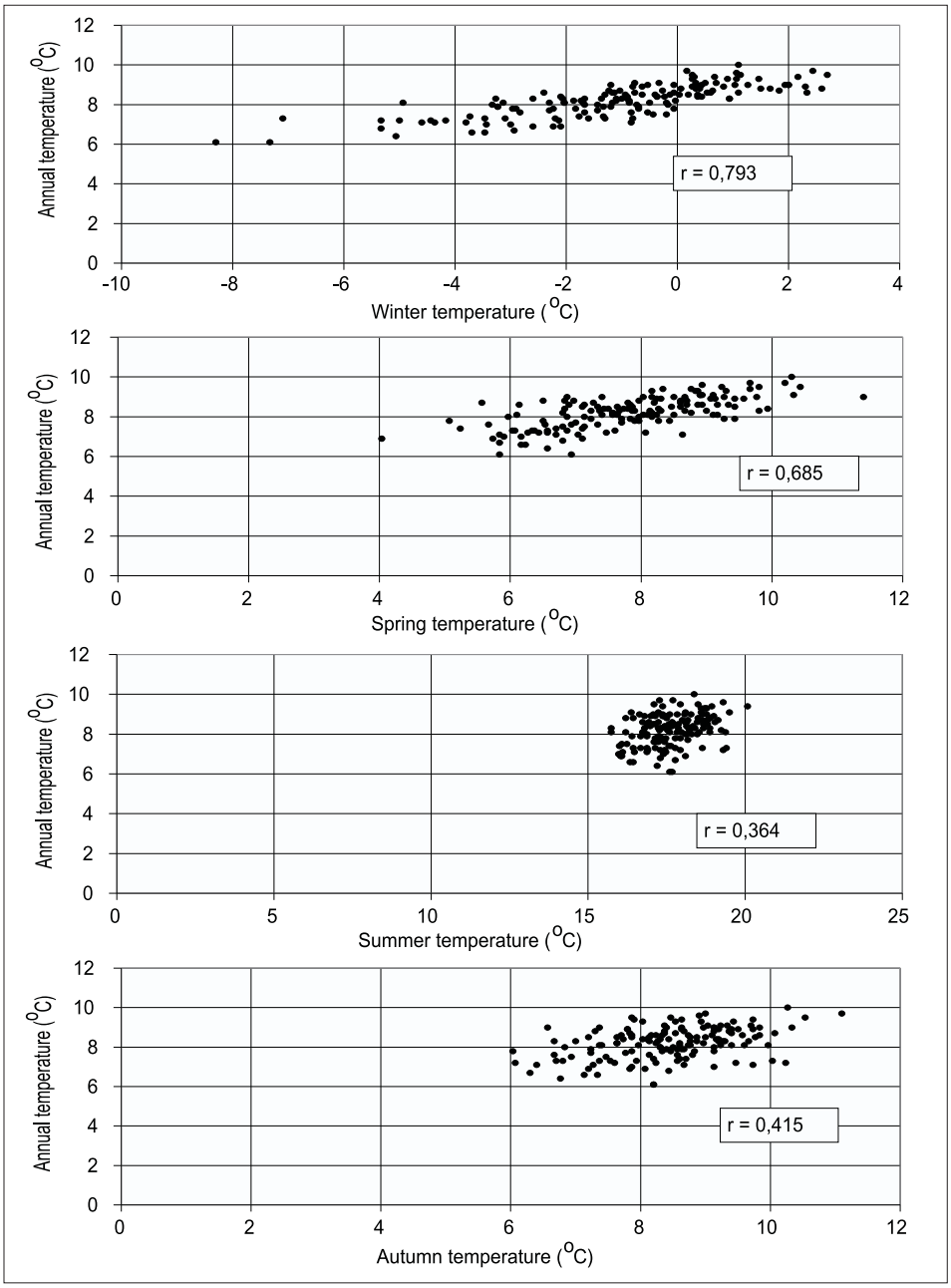

Fig. 2. Relation between the temperature of particular seasons and the annual temperature in Poznań in 1848-1997.

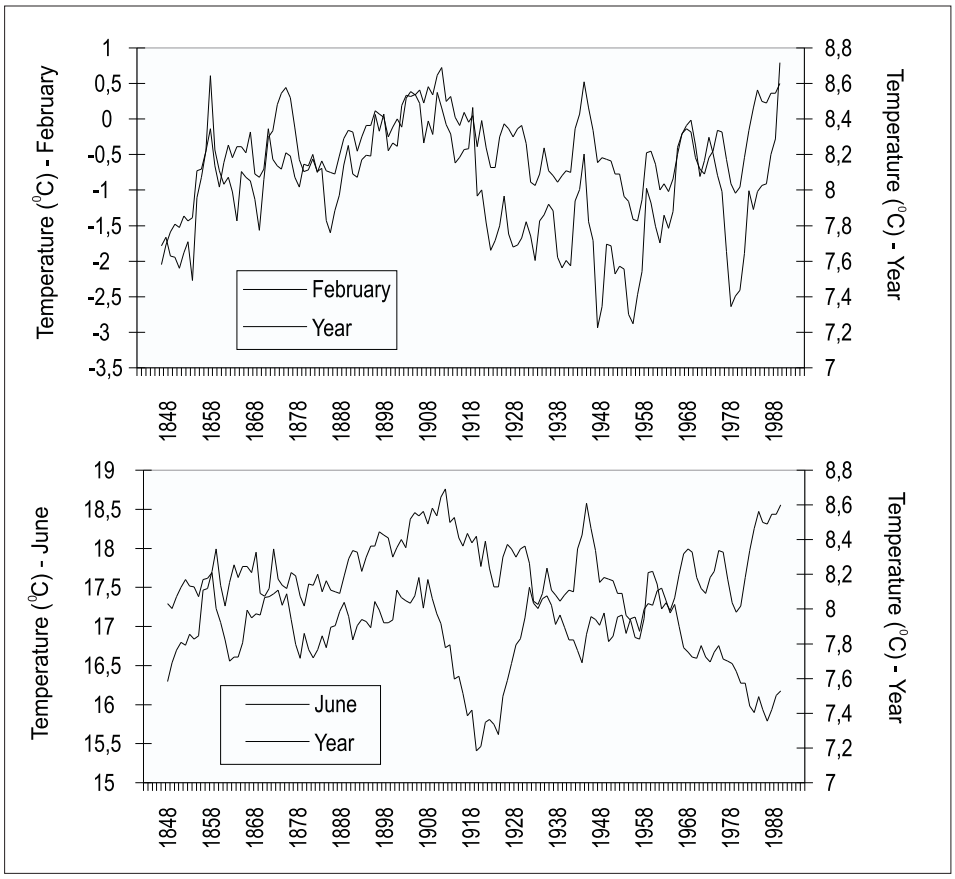

Fig. 3. Long-term changes of the annual temperature and the temperatures of February and June in Poznań (11-element moving average).

both series of temperature did not reveal such similarity (Fig. 3) and therefore the correlation coefficient for the examined period is small in June.

Another issue is connected with the attempt to present the "share" of monthly temperature in the annual temperature in terms of numbers. A particular value of annual temperature is an arithmetical mean of the values of particular months. It can be assumed that annual value separates the total of "positive" and "negative" deviations of values of monthly temperature form the value of annual temperature. "Positive" and "negative" sums of deviations expressed by numbers in °C are equal in a particular year and may be different in other years. This fact evokes a question whether a given monthly temperature (*de facto* values of its deviation from the annual temperature) may not be treated as a digital equivalent of the "share" of monthly temperature in the annual temperature. It can be easily proved that the same value of

monthly temperature gives a deviation, the value of which may be in a different relation to the annual sum of deviations as compared with other years. It depends, among other things, on the range of temperature values in an annual course.

For the Poznań series of air temperature it was attempted to calculate deviations of temperature of particular months from annual temperature for each year. Having ignored whether the value was "positive" or "negative", absolute values of deviations were calculated. In the surveyed period these sums were from 60.6°C in 1974 to 103.2°C in 1858. This procedure allowed excluding negative values of deviations. Then the percentage shares of the following months in the sums of deviations were established. Some chosen results of the calculations are shown in Table 3.

Within a year the average percentage "share" of monthly values of temperature changes from 1.6% in April and October to 12.9% in July. In general it is the biggest in winter months (December through February) and in summer (June through August), when in each month it exceeds 10% (Fig. 4). In the period 1848-1997 this coefficient's

Tab. 3. Percentage share of monthly air temperature in the yearly air temperature in Poznań over the 1848-1997 period.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Mean	12,7	11,4	7,2	1,6	6,2	10,8	12,9	11,8	6,8	1,6	6,4	10,8
Lowest monthly	5,9	6,1	2,2	0,0	1,2	5,7	9,1	8,9	2,7	0,0	0,1	4,5
Year	1902	1995	1927	1897 1916 1983	1874	1923	1979	1940	1912	1990	1963	1929
Highest monthly	24,2	21,3	12,6	6,5	11,5	15,2	17,4	15,7	10,5	4,7	12,7	17,4
Year	1848	1986	1883	1853	1993	1866	1912	1974	1919	1855	1921	1899

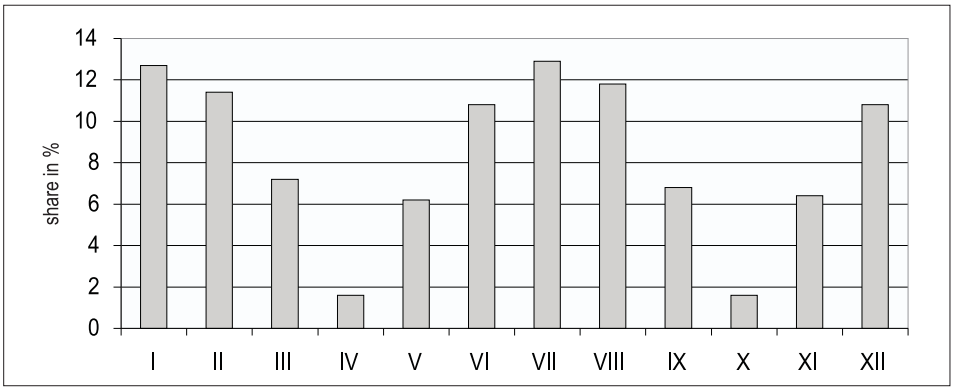

Fig. 4. Annual course of mean values of the percentage "share" of monthly temperature in annual temperature in Poznań (1848-1997).

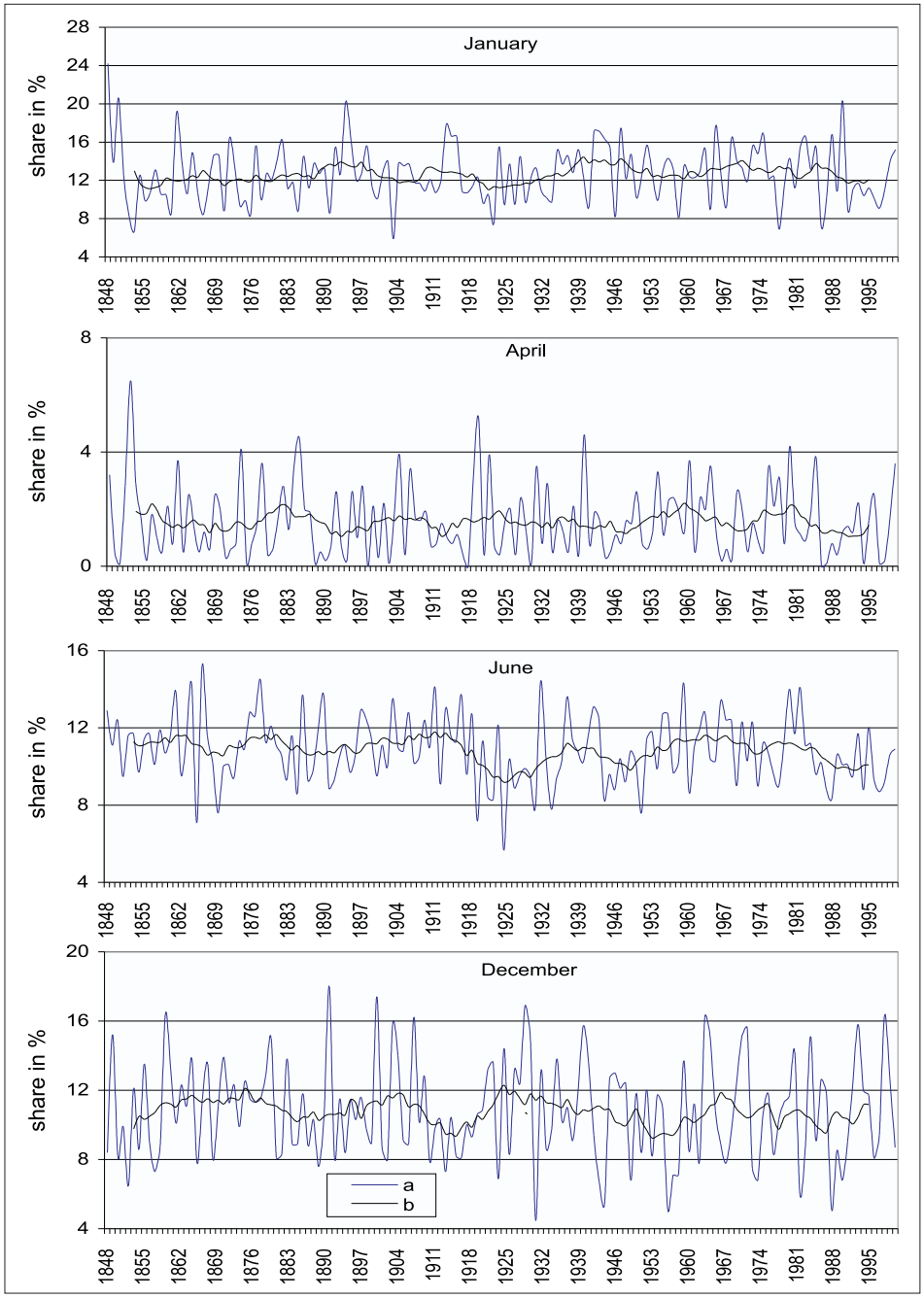

Fig. 5. Long-term course of the percentage "share" of temperature of particular months in annual temperature in Poznań; a – actual values; b – 11-element moving average.

values varied consideablyt. For example, in 1902 the "share" of the temperature of January was 5.9% whereas in 1848 the temperature of January contributed to the annual temperature with a "share" of 24.2% (Tab. 3). The review of the obtained values of the percentage "share" of monthly temperature shows that usually the same value of a "share" is related to different temperatures. In January of 1924 and 1934 the temperature "share" in the annual temperature equaled 13.7%. The temperature of January in 1924 was –4.6°C, whereas in 1934 the temperature of January was much higher (-0.2°C).

In the surveyed period the course of the percentage "share" of temperature of particular months in the annual temperature is characterized with more or less clear oscillations (Fig. 5). In some months the course of the coefficient's moving averages corresponds well with the annual temperature course, in other months they show little similarity. Interpreting the obtained results it must be taken into consideration that in the area of Poland every year the temperature crosses twice (in spring and autumn) the value corresponding with the mean value of a particular year. Therefore spring and autumn months are characterized with the temperature least deviated from the annual value. If in the proposed calculating procedure the "share" of temperature of particular months expressed in numbers refers to the value of the temperature deviation from the annual temperature, then these months should be expected to have small values of percentage "share" in comparison with winter and summer months. It does not change in any respect the usefulness of the obtained results for the evaluation of a long-term tendency of "share" of temperature of particular months in the annual temperature.

In conclusion, it must be stated that the results of the calculations carried out as well as the graphic representation of the examined relations give possibilities for more analytical evaluation of thermal relations occurring within a year and over many years.

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