THE VAPOR CONTENT OF THE AIR LAYERS NEAR THE SOIL OF SANDY WOODED STEPPES IN FALL

BY J. JUHÁSZ

Besides the radiation system and the air flow the active surfaces, such as the crown level, the brush level, the surface of the bare soil, etc., play an important role in the development of the local peculiarities of temperature and air humidity (1).

The daily amplitude of temperature is usually greater in the valleys or depressions than in the plains, on the slopes and summits; in the daytime the summits, elevations, hill-tops do not warm up as much as the lowlying parts, they give off more heat to the air masses, and at night they do not cool off as much because the cold air flows down (2).

In summer and spring the daily amplitude of temperature was much smaller on the sandhill tops than on the steppe-meadow, the sedge meadow and in the spaces between sandhills owing to the rise of the temperature minima and the decrease of the maxima. In connection with the fall measurements we found that the nocturnal cooling of the air layers near the soil-depending on the density of vegetation and through heat conduction-developed in a much more complicated way than the warming (3).

We have mentioned the well-known importance of water in connection with soil and atmosphere as well as the variability of the vapor content of the local air layers near the soil depending on the compactness of the plant associations, radiation, and air flow. Generally the areas, depending on the situation of the basic landscape units and the compactness of the plant associations, are subject to variations in the vapor content of the local air layers near the soil. The air layers of the areas near the soil are ofter subject to violent temperature variations, and with the occurence of these phenomena the saturation valves become modified (1).

In the function of the air temperatures we determined on the basis of Aujesky s theory the variations of the saturation values. Also, being in possession of the saturation and relative humidity values, we determined the values of absolute vapor content and saturation deficiency in the various areas (1).

In the course of complex territorial examination of the geographical small landscape there is an opportunity for comparison or *evaluation of the vapor content by basic landscape units.*

According to practice used so far also we employed here the method of *comparative* and *principal factors* (4).

Our aim was to find out on the basis of the results *what are the characteristics of the vapor content in fall* within the different plant associations under known soil and air temperature conditions.

On the basis of the saturation values we have referred, within the —5 to 10° temperature range, to the average rise. We have demonstrated that a more considerable increase in the saturation values can be observed only in the case of more considerable warming, above 20°. At the same time we have referred to the percentage rise per 1° of the saturation values between —0 and 40° within 10° ranges— (1).

For the determination of the absolute vapor content and the saturation deficiency as well as of the corresponding slopes of the extreme values of relative humidity we as a function of time present the daily extreme values of the relative vapor contents developed in two levels over the soil surface (Table 1).

Table 1.

f The daily extreme values of the relative vapor contens (November 1962, Csévharaszt)

	Height over soil cm	max. %	2 nd min. %	max. %	3 rd min. %	4 th max. %
Sandhill top	10	100	73	100	66	100
	150	100	78	100	68	97
Space between sandhills	10	100	70	100	66	96
	150	100	76	100	71	100
Steppe-meadow	10	97	73	100	69	95
	150	97	74	97	68	97
Quercus robur stand	10	97	77	99	71	87
	150	100	74	100	66	97
Juniper brushwood with poplars	10	98	79	100	77	97
	150	99	74	100	69	97
Sedge-meadow	10	100	78	100	73	98
	150	98	72	97	64	99
Oakwood with lilies of the valley	10	97	85	99	73	100
	150	98	73	96	65	97
Poplar grove	10	100	84	100	79	96
	150	99	73	97	67	95

At the time of the development of the relative extreme values presented there was generally cloudy, rainy weather in Central Europe. On the finst the lingering front of the cyclone that developed divided the territory of our country into two parts: the weather was rainy, cold and windy in Transdanubia, while in the eastern half of the country it was mild. On November 2, great storms and rains formed with the collapse of the cyclone. On November 3, the weather in our country was misty, foggy, cloudy. Between the Danube and the Tisza and in the northern counties the clouds broke up in the early morning and for several hours there was sunshine (5).

It appears from the macrosynoptic situation that in the fall of 1962, the period of observation, cool rainy, foggy weather prevailed in the area examined.

It was in the midst of these conditions that the values of the soil temperature and of the temperature near the soil as well as the relative humidity developed. We determined the saturation values as well as the absolute vapor content and the saturation deficiency. In such and similar conditions the temperature (T), the saturation value (A), the relative humidity (R), the absolute vapor content (a), and the saturation deficiency (S) can be examined together complexly on the basis of Table 2 in the different areas and plant associations.

Table 2.

Characteristics of the air humidity
(November, 1962, Csévharaszt)

Height over soil	At time of maximum relative humidity					At time of minimum relative humidity				
	T	A	R	a	S	T	A	R	a	S
cm	°C	gr/m³		gr/m³	gr/m³	°C	gr/m³		gr/m³	gr/m³
Sandhill top										
on 2										
10	5,7	7,14	100	7,14	—	12,2	10,93	73	7,98	2,95
150	3,9	6,37	100	6,37	—	11,8	10,65	78	8,30	2,35
on 3										
10	4,8	6,72	100	6,72	—	14,6	12,59	66	8,30	4,29
150	4,6	6,65	100	6,65	—	14,2	12,31	68	8,37	3,94
on 4										
10	0,8	5,17	100	5,17	—					
150	1,4	5,39	97	5,22	0,17					
Space between sandhills										
on 2										
10	4,1	6,45	100	6,45	—	14,2	12,31	70	8,61	3,70
150	4,2	6,49	100	6,49	—	12,0	10,79	76	8,20	2,59
on 3										
10	5,0	6,80	100	6,80	—	16,4	14,10	66	9,30	4,80
150	4,9	6,76	100	6,76	—	13,4	11,75	71	8,34	3,41
on 4										
10	0,2	4,90	100	4,90	—					
150	0,6	5,09	100	5,09	—					
Steppe-meadow										
on 2										
10	3,0	6,02	97	5,87	0,18	13,2	11,62	73	8,48	3,14
150	4,3	6,53	97	6,33	0,20	12,4	11,07	74	8,19	2,88
on 3										
10	4,0	6,41	100	6,41	—	13,4	11,76	69	8,11	3,65
150	4,8	6,73	97	6,52	0,21	13,7	11,97	68	8,13	3,84

on 4										
10	1,4	5,39	95	5,12	0,27					
150	2,0	5,63	97	5,46	0,17					
Quercus robur stand										
on 2										
10	3,1	6,06	97	5,87	0,19	12,1	10,86	77	8,36	2,50
150	4,2	6,49	100	6,49	—	12,2	10,93	74	8,08	2,85
on 3										
10	6,8	7,73	99	7,65	0,08	14,7	12,66	71	8,99	3,67
150	4,8	6,93	100	6,93	—	13,7	11,97	66	7,90	4,07
on 4										
10	2,3	5,75	87	5,00	0,75					
150	1,8	5,55	97	5,38	0,17					
Juniper brushwood with poplars										
on 2										
10	5,2	6,90	98	6,76	0,14	11,6	10,52	79	8,13	2,21
150	4,5	6,61	99	6,54	0,07	11,5	10,45	74	7,73	2,72
on 3										
10	7,1	7,89	100	7,89	—	13,4	11,76	77	9,05	2,71
150	4,4	6,57	100	6,57	—	13,7	11,97	69	8,26	3,71
on 4										
10	1,5	5,43	97	5,26	0,17					
150	2,1	5,67	97	5,50	0,17					
Sedge-meadow										
on 2										
10	2,2	5,71	100	5,71	—	13,1	11,55	78	9,01	2,54
150	1,9	5,59	98	5,48	0,11	11,3	10,31	72	7,42	2,89
on 3										
10	3,1	6,06	100	6,06	—	15,3	13,22	73	9,58	3,54
150	5,6	7,11	97	6,89	0,22	13,6	11,90	64	7,61	4,29
on 4										
10	2,0	5,63	98	5,51	0,12					
150	2,1	5,67	99	5,61	0,06					
Oakwood with lilies of the valley										
on 2										
10	7,2	7,94	97	7,70	0,24	11,1	10,17	85	8,64	1,53
150	4,4	6,57	98	6,44	0,13	11,2	10,24	73	7,47	2,77
on 3										
10	4,1	6,45	99	6,38	0,07	14,0	12,17	73	8,88	3,29
150	5,3	6,92	96	6,64	0,28	13,7	11,97	65	7,78	4,19
on 4										
10	1,5	5,43	100	5,43	—					
150	2,3	5,75	97	5,58	0,17					
Poplar grove										
on 2										
10	3,8	6,33	100	6,33	—	10,0	9,41	84	7,90	1,51
150	4,8	6,73	99	6,55	0,18	11,2	10,24	73	7,47	2,77
on 3										
10	5,0	6,80	100	6,80	—	13,2	11,62	79	9,18	2,44
150	4,9	6,76	97	6,56	0,20	13,5	11,83	67	7,93	3,90

on 4

10	1,6	5,47	96	5,25	0,22
150	1,3	5,35	95	5,08	0,27

From the values of the air humidity it can be seen that the saturation values, the relative humidity the absolute vapor content and the saturation deficiency are all functions of the temperature.

The saturation values in heat grow rapidly with the temperature. The saturation deficiency is, in case of the same relative humidity, much greater in heat than in cold (1).

The influence of the situational peculiarities on the heat system could not develop to the same extent as in the areas with greater level differences. The situational peculiarities were influenced partly by differences of the soil, partly by differences of the plant associations and the environment. Some peculiarities, however, remained; for inctance the air layer near the soil of the sandhill top did not warm up or cool off so much as that of the space between sandhills. The air between the sandhills was cool and damp at night and in the early morning, while it was warm and dry in the afternoon; inverses of these phenomens were observed on the sandhill top.

On the basis of the results of the investigation period in the fall of 1962 we have established that the nocturnal cooling of the air layers near the soil, depending on the density of the vegetation and the kinds of plant associations (6) by heat conduction, developed in a much more complicated way than the warming up.

The influence of dynamic convection and advection was most noticeable in the open areas, as on the steppemeadow and the sedge-meadow, in the daytime but with significant differences in the various basic landscape units (7).

The temperature of the soils on the steppe-meadow, in the space between sandhills, and on the sedge-meadow influenced the temperature of the air layers near the soil more in the day than at night (Fig. 1).

The turbulent effect of the air flow sometimes produced absurd results in the air temperature. The daily temperature wave varied in the afore-mentioned open areas (3) in the different basic landscape units. The active surfaces in the juniper brushwood with poplars and the oakwood with lilies of the valley became active controllers of the temperature and humidity of the air layers near the soil (Figs. 2 and 3).

Besides the radiation system and the active surfaces the air flow has always an important influence on the temperature of the air layers near the soil, indirectly on air humidity, and so plays an important part in the development of the local peculiarities.

The horizontal air flow over the soil surface is weakened owing to friction and eddying. The weakening of the process is determined by turbulent exchange as a result of the unevenness of the soil surface and the vegetation cover on it. The turbulence is intensified by the height of the plant associations in the half-closed and closed areas in the different basic landscape units (facies) and even in the different landscape mosaics (urochishche), and in the open areas by the unevenness of the soil surface

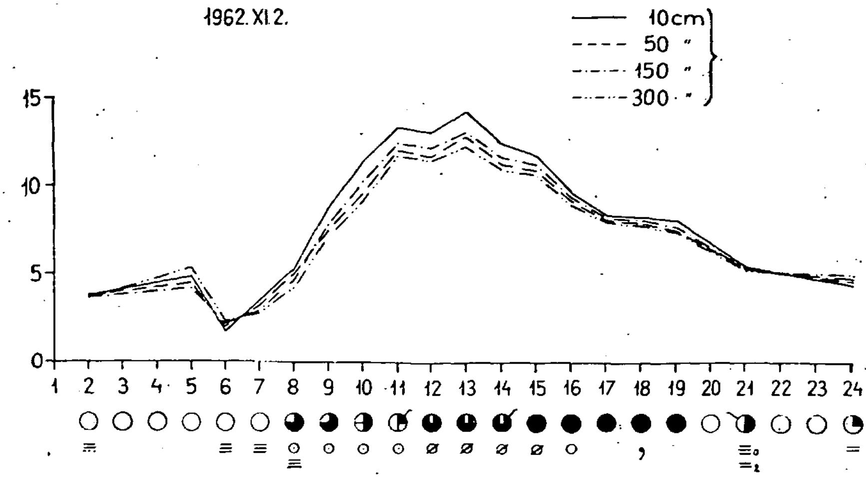

Fig. 1. The diurnal variation of the air temperature on the steppe-meadow.

(3). These factors always played a part in the varied development of the relative humidity, the absolute vapor content, and the saturation deficiency (Table 2).

Owing to weak radiation conditions the temperature of the air layers near the soil cooled off on November 2 and 3, 1962. The mixing effect of the air flow caused temperature variations in the warming of the air layers near the soil in the daytime. The frequent temperature variations influenced the development of the saturation values (7), or more exactly, changed the saturation values the natural consequence of which was the varied development of the „R", „a" and „S" values.

We found that the values of air humidity are always primarily conditioned by the temperature. The daily variations of temperature can be expressed by the values of the slopes. Since we have to reckon with factors or variables connected with the temperature, the diurnal variation of the *relative humidity,* corresponding to the periods of warming and cooling, can also be expressed by *slopes.* The difference is only that to the positive direction tangent „T" in relation to „R" correspods a negative direction tangent, or vice versa. In our measurements and in similar cases where such correlations can be demonstrated *the extreme values can* always *serve as the basis of the calculations.* The changes of temperature or air humidity between the extreme values can be interpeted as *the ranges of the values expressed by the slopes.*

The temperature differences between x the air layers over the soil surface at the same time can be expressed by the function $f(x) = const. a^{x-}$ both in the period of warming and cooling. This method can be employed to demonstrate the temperature differences between the soil layers as well as to compare the changes in air humidity, for instance in relative humidity.

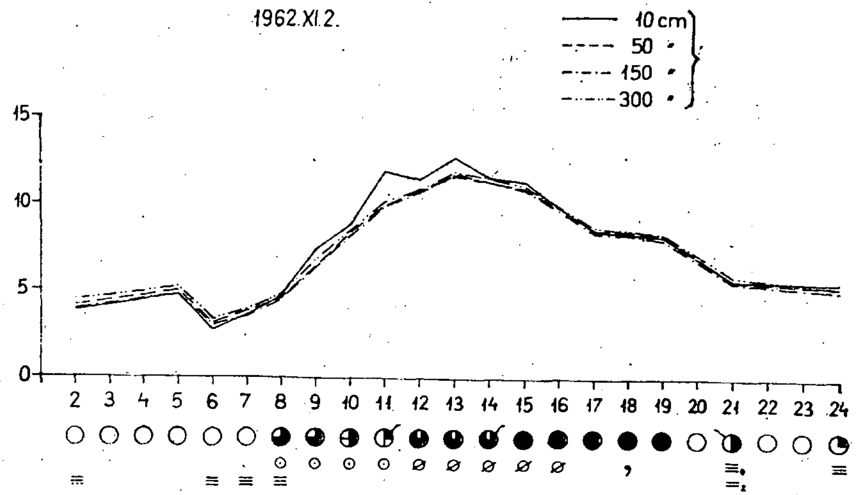

Fig. 2. The diurnal variation of the air temperature in the juniper bruswood with poplars.

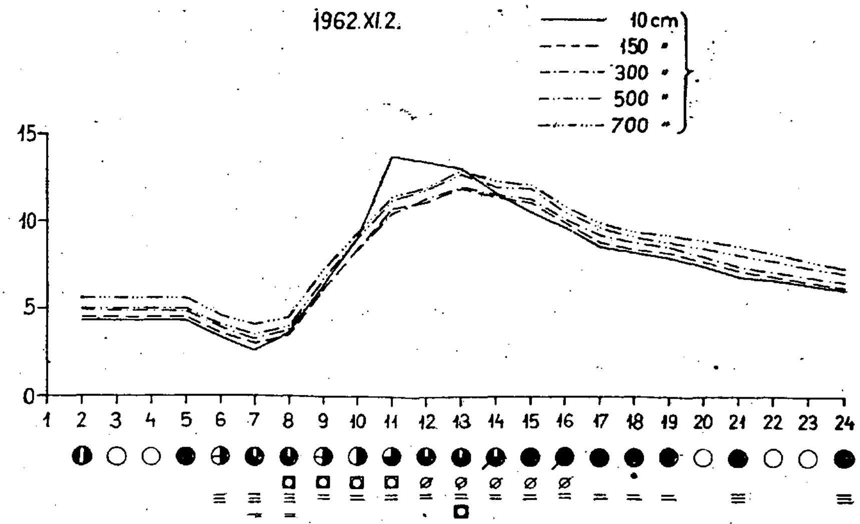

Fig. 3. The diurnal variation of the air temperature in the oakwood with lilies of the valley.

If the temperature of the air layers and soil layers or the relative humidity are examined in daily intervals, the gradient can be determined, besides the methods already known, by the aid of the extreme values of the factor to be examined:

$$m = \frac{y_2 - y_1}{x_2 - x_1}.$$

The slopes can be determined with the coordinates of the extreme values of the factors to be examined. In case of cooling the angle of the gradient is for instance negative as regards air temperature and soil temperature while in case of warming it is positive. In case of such an examination of the relative humidity we must reckon with the inverses of the results found in the temperature values.

The magnitude of the diurnal changes in temperature and relative humidity can be read from the gradients of the slopes. Using the above method we determined for each area and layer the slopes of the air temperature and relative humidity values as of correlated factore (Table 3). Here T denotes the slope of the temperature-difference as curve of a function of tune in degrees provided that 10 °C is represented by the same length as 6 hour.

R denotes the slope of the curve of relative humidity as a function time in degrees provided that 10% relative humidity is represented by the same length as 6 hour.

Table 3.

Slopes of air temperature and relative humidity values

Height over soil		In period of warming		In period of cooling	
		T	R	T	R
	cm	degree, hour	percentys hour	degree hour	percentys hour
Sandhill top					
on 2	10	57,5	−81,6	−31,8	58,0
	150	54,8	−77,1	−30,6	50,2
on 3	10	63,1	−75,7	−50,7	65,6
	150	60,3	−75,9	−41,0	61,0
Space between sandhills					
on 2	10	63,0	−80,6	−34,2	60,4
	150	58,6	−75,0	−32,2	71,6
on 3	10	64,0	−78,3	−55,6	64,9
	150	61,3	−71,0	−58,0	69,0
Steppe-meadow					
on 2	10	60,7	−75,0	−34,2	62,5
	150	57,0	−73,0	−27,1	56,8
on 3	10	61,1	−77,2	−53,1	67,0
	150	48,8	−71,0	−54,5	69,2
Quercus robur stand					
on 2	10	52,6	−63,5	−26,6	67,7
	150	47,0	−83,4	−26,1	55,4
on 3	10	57,5	−77,8	−54,1	74,9
	150	43,3	−73,7	−49,7	79,0
Juniper brushwood with poplars					
on 2	10	46,4	−72,4	−25,2	47,8
	150	51,2	−74,4	−26,1	65,2
on 3	10	52,7	−80,1	−43,5	65,7
	150	53,9	−68,8	−41,1	66,8

Sedge — meadow					
on 2	10	66,0	−82,9	−43,9	72,4
	150	58,0	−79,2	−36,5	72,2
on 3	10	73,2	−75,9	−61,7	83,7
	150	50,0	−79,7	−53,5	84,8
Poplar rove					
on 2	10	53,1	−76,0	−20,9	68,2
	150	56,8	−80,5	−27,1	73,7
on 3	10	49,5	−66,8	−49,8	81,9
	150	56,8	−73,5	−45,1	81,8

The slopes of the temperature corresponding both to 10 cm and 150 cm heights in the period of warming were on average smaller on the 2 nd than in the same period on the 3 rd.

The slopes of the temperature, corresponding to 10 cm and 150 cm height, respectively, were in average the month than in the same period on the 3 rd.

In 10 cm height over the soil surface the *shade effect*, in 150 cm height advection slowed down the rate of warming in spite of the fact that the radiation conditions improved considerably (on the 2 the nd sunshine period was 3,2 hours, on the 3 rd it rose to 5,9 hours). With the exception of the air temperatures measured in 150 cm on the steppe-meadow, in the Quercus robur stand, and on the sedge-meadow where the rate of warming was slow, the warming of the air became faster at both levels in the area of all the basic lanscape units on the 3 rd in spite of the fact that the rain of the previous day had cooled off the surface of the areas examined. The incoming quantities of energy ensured faster warming of the soil and of the contiguous air layers and the evaporation of its water content (3).

On the basis of a complex examination of the air humidity values (Table 2) we established that the absolute vapor content was in the early morning hours on average 1—3 gr/m^3 less than in the midday hours when the temperature varied around the maximum and the relative humidity around the minimum. This determination applied to areas of the sandhill top, the steppe-meadow and the sedge-meadow, to all three landscape mosaics, and to the half-closed and closed areas.

The saturation values (A) increased or decreased in each basic landscape unit parallelly with the temperature (T). A consequence of the above-described development of the two correlated factors is that in case of similar relative humidities (R) the saturation deficiency (S) was alway greater in heat than in cold.

The differences between the values of absolute vapor content (a) were minimal not exceeding 1—2 gr. The relative humidity varied generally between 95—100. A value of 87% was observed in 10 cm over the ground in the Quercus robur stand on the fourt of the month. Thus the basic landscape unit (facies) where the saturation deficiency was greatest (0,75 gr/m^3) was determined. During the period of observation the air was saturated in both heights on the sandhill top and in the space between sandhills.

In the midday hours during the period of observation the air near the soil warmed up on the sandhill, in the space between the sandhills, on the steppe-meadow and on the sedge-meadow, in the open areas more intensively than in the closed areas. Corresponding to the warming rose the saturation value in the different areas, while there was hardly any change in the absolute vapor content (Table 2).

In the open areas — in basic landscape units — the saturation deficiency varied between 2,35 and 4,8 gr/m^3; in the half-closed areas between 2,21 and 3,71 gr/m^3. In the closed areas in places further decrease in the saturation deficiency was observable. Only the saturation deficiencies of the oakwood with lilies of the valley and the juniper brushwood with poplars constitute an exception.

In general in the fall period of observation the heat used for evaporation, the humidity of the soil, the evaporating surface of the vegetation, and not the least the radiation, decreased considerably. On the other hand *these factors* working together invariably *control evaporation.*

For consideration we present here the slopes relating to the near-to-soil temperature and relative humidity of the forest climate (Table 4).

Table 4.

Diurnal Slopes of the air temperature and relative humidity of the forest climate

	Height over soil cm	In period of warming T degree hour	R percents hour	In period of cooling T degree hour	R percents hour
on 2	200	45,0	−48,8	−20,4	50,9
on 3	200	48,8	−75,5	−34,7	57,5

Abbreviations: T = temperature, A = saturation value, a = absolute vapor content, R = relative humidity, S = saturation deficiency.

Evaluating the slopes of the forest climate and the basic landscape units we could see the following facts:

The absolute values of the slopes of the air temperatures are generally greater in the period of warming than in the period of cooling. This is also true of the relative humidity.

Under conditons of weak radiation there are in both periods greater differences between the absolute values of the slopes of the temperature in the different basic landscape units than under condicions of intense radiation. This rule is also valid for the relative humidity.

As for air temperature and relative humidity, differences between the slopes in open basic landscape units are much smaller than in half-closed or closed basic landscape units.

Our rules concerning the temperature, relative humidity and other properties of air humidity contributed to a better differenciation of the basic landscape units.

For the differenciation of the basic landscape units of the landscape mosaics the evaluated air humidity values as chief characteristic factors besides the air temperature and soil temperature values (7) are adequate when we use the method of comparative or principal factors.

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