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# CLIMATIC AND MICROCLIMATIC PECULIARITIES OF THE TISZA AND ITS INUNDATION AREA

M. ANDÓ

Institute for Physico-Geography of the A. J. University, Szeged, Hungary

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Within the framework of the complex works of Tisza investigations carried out continuously for more than a decade, I have been studying the climatic peculiarities of the Tisza and its inundation area, their macro- and microclimatic conditions. In my present work there are made known the climatic data that depart from the adjacent plain climate. For this study I have used the data on the subject obtained from the station net of the Hungarian Meteorological Institute (HMI 1960) as well as my microclimatic observations performed in vorious sectors of the Tisza-valley.

## Evaluation of the macroclimatic conditions

The Tisza and its inundation area are an independent geomorphological terrain of the Hungarian Plain where — particularly in respect of the microclimatic peculiarites — evein the climate is differring from that of the environment, as a result of the considerable water mass of the river and of the variedly extended inundation area. On the basis of the macroclimatic conditions, the Hungarian sector of the inundation area of the Tisza can be divided into three parts:

1) The Upper Tisza (between Tiszabecs and Tokaj),
2) The Middle Tisza (between Tokaj and Csongrád),
3) The South Tisza (between Csongrád and the frontier of the country).

Except the Upper Tisza, the most typical characteristic of the climatic conditions of the areas enumerated is a warm-arid and even hot summer that is the most characteristic of the regon of the Middle Tisza.

In the regional development of the single meteorological factors we can find also some individual peculiarities of the three districts. The annual amount of clouds is growing from South to North, the difference being, however, not more than 5—10 percent. The lowest annual value is in the area of the South Tisza, as well as in that of the Middle Tisza (50—55 p.c.). In the winter season, a greater lot of clouds can be observed everywhere than in the summer half-year. In the winter half-year, namely, the sunshine supply is considerably decreased by the often occurring fog. On the other hand, in summer there are the most cloudless conditions in the area of the Middle and South Tisza, even in national relation. In August, the mean degree of the cloud cover falls short even of 35 percent. Thus, a result of the small cloud cover is plenty of sunshine. In the region of the South Tisza that means 2.100 hours, in that of the Middle Tisza 2.000 hours, at the North Tisza, however, only 1.900 hours in annual average. The favourable sunshine manifests itself mainly in the summer half-year. We may observe plenty of sunshine particularly in the region of the Tisza-valley between Szolnok and Csongrád. In winter, however, there is but a lesser difference between the single region types concerning the amount of sunshine.

There is a great difference between the Tisza regions also on the basis of air temperature. According to the annual mean temperatures, the area of the South Tisza is our warmest region. Here is the annual average temperature higher than 10,5°C. In the middle sector, between Csongrád and Tokaj, it is already only 10°C, and at the Upper Tisza it is between 8,5—10,5°C, on the average.

In winter, the South Tisza region is but temperately cold. The average temperature of the month January is about —1,5°C, there are as many as 25—30 winter days. In the area of the Middle Tisza, the conditions are somewhat colder, the January value being —2, —3°C. The coldest region is that of the Upper Tisza, the average temperature of the month January being between —3 and —4°C there.

The maor differences in temperature observed in the winter half-year are in summer less characteristic of the geographical regions. The warmest region is that of the South Tisza where the daily average temperature exceeds 10°C already between April 5—10, and the July mean temperature surpasses 22°C. Here occur the most summer days in this country (85—90 on the average), and here are also the most hot days (25—30).

O n e o f t h e m o s t i m p o r t a n t c h a r a c t e r i s t i c s o f t h e r e g i o n i s a h o t s u m m e r, e x p r e s s e d n o t o n l y i n t h e m e a n t e m p e r a t u r e s b u t a l s o i n a g r e a t f r e q u e n c y o f a s t r o n g r i s e i n t e m p e r a t u r e. A prolonged warm autumn is characteristic of this area, the daily average temperature sinking under 10°C only after Cctober 25th. Similar conditions can be observed in the Middle Tisza-valley, as well, where the value of the average temperature in July is lower only 0,5°C. The annual precipitation is here, however, less, being in the middle sector, in this regard, comparatively drier conditions.

On the other hand, the 19—20,5°C July mean temperatures of the North Tisza region are referring to somewhat cooler summers. Here is the regional distribution of temperature of zonal structure, decreasing more and more from South towards North.

Inside the single parts of the regions, the regional distribution of precipitation is producing highly various conditions. It is generally characterizing that the Middle Tisza region is the driest part, here is the annual value of precipitation between 500—550 mm, and in the area of the Zagyva-mouth it remains even under 500 mm. In the annual formation of the relatively little annual precipitation, an aridity of a particularly higher degree is observed in the summer and autumn months.

In the area of the South Tisza there are, however, more favourable conditions. Here is the precipitation growing from N towards S. While the annual average precipitation in the region of the Körös-mouth is not higher than 500 mm, at the Maros-mouth it is already 580 mm. The month the most abundant in rainfall is July, with a monthly amount of 60—70 mm. The most arid month is January with a precipitation of 30—35 mm. In this area, also the second maximum in autumn can be demostrated well (Table 1).

Table 1. Average precipitations of pentades between 1890-1960 /Szeged/

| Pentades: | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| January | 4,7 | 6,1 | 5,9 | 7,6 | 4,1 | 5,1 |
| February | 7,2 | 7,0 | 7,2 | 5,1 | 4,4 | 3,5 |
| March | 6,9 | 7,5 | 5,1 | 3,2 | 5,0 | 9,6 |
| April | 6,3 | 7,9 | 8,6 | 9,9 | 8,3 | 8,0 |
| May | 11,9 | 11,8 | 9,1 | 8,8 | 10,5 | 13,8 |
| June | 12,7 | 10,4 | 13,2 | 11,3 | 9,5 | 9,0 |
| July | 10,0 | 9,3 | 9,5 | 8,0 | 9,1 | 8,0 |
| August | 8,5 | 8,6 | 8,9 | 6,0 | 6,9 | 7,5 |
| September | 8,4 | 5,2 | 9,7 | 6,3 | 6,1 | 7,7 |
| October | 7,2 | 8,6 | 6,8 | 6,3 | 7,5 | 13,4 |
| November | 8,5 | 8,3 | 7,1 | 9,5 | 6,8 | 5,5 |
| December | 6,8 | 6,6 | 7,2 | 5,0 | 5,0 | 8,1 |

Here is the Sub-Mediterranean formation of precipitation characteristic of the 25 percent of the 25 percent of the years. In the second half of the summer, however, as compared with other areas of this country, here is the probability of prolongated rainless periods much higher, i.e., the tendency of the inundation area of the South Tisza to aridity is at the end of summer of a very high degree (Table 2).

Table 2. The percentage of a probability of rainless periods longer than five days /1/ and longer than ten days /2/ in Szeged, between 1936 and 1960

| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 17 | 21 | 28 | 17 | 14 | 17 | 32 | 30 | 39 | 30 | 19 | 20 |
| 2 | 4 | 7 | 12 | 5 | 4 | 2 | 11 | 12 | 15 | 11 | 6 | 6 |

As compared with the enumerated ones, the greatest difference concerning the regional distribution of precipitation has been observed at the Upper Tisza. In the region of the Upper Tisza between Tiszabecs and Záhony, in an area of the Plain which is one of its richest parts, the annual value is 650—700 mm. In other parts, however, the annual precipitation is between 550 and 650 mm. At relatively low temperatures, owing to a less evapotranspiration, the conditions of humidity are here more favourable than in the more southern parts. Here is the highly productive rainfall characteristic in both parts of the summer period. Only September may be considered as a particuarly arid month. In winter, the number of snowy and snow-covered days is in this area the highest one. At the same time, the average thickness of snow-cover is smaller than in the Middle and South Tisza-valleys. In the South Tisza region, e.g., the number of snow-covered days changes only between 33 and 36, and even there are winters without any lasting snow-cover.

In the macroclimate of the Tisza and its environment, as a consequence of the conditions of percipitation, temperature and evaporation, there is generally a strong scarcity in the annual water balance. There isn't to be observed any annual water-balance in state of equilibrium, in any part of the area. Scarcity of water is meaning in this case the scarcity of water supply in the covering stratum of soil that takes place if the average annual precipitation has for months been lower than the potential evapotranspiration and does not surpass the capacity of preserving the subsoil water. The Upper Tisza may be considered to have the most favourable situation, the second one being the area of the South Tisza and the last one that of the Middle Tisza (Table 3).

Table 3

| | | | |
|---|---|---|---|
| Upper Tisza region | | | |
| Between Tiszabecs-Dombrád | scarcity of | water | 50- 75 mm |
| Between Dombrád-Tiszabercel | scarcity of | water | 75-100 mm |
| Between Tiszabercel-Tokaj | scarcity of | water | 100-125 mm |
| Middle Tisza region | | | |
| Between Tokaj-Tiszapalkonya | scarcity of | water | 125-150 mm |
| Between Tiszapalkonya-Szolnok | scarcity of | water | 150-175 mm |
| Between Szolnok-Tiszaföldvár | | above | 175 mm |
| Between Tiszaföldvár-Tiszaug | scarcity of | water | 150-175 mm |
| Between Tiszaug-Szentes | | above | 175 mm |
| South Tisza region | | | |
| Between Szentes-Algyő | scarcity of | water | 150-175 mm |
| Between Algyő-Frontier of the country | scarcity of | water | 125-150 mm |

The annual amount of the scarcity of water demostrated in the Table above can, of course, be taken into account only in its general aspects. That value can be modified considerably by local factors and the data of microclimate.

Between the scarcity of water of the area and the humidity of air

Table 4. Percentage of air humidity-its value for 14 hours, on the average of many years

| | | | Percent |
|---|---|---|---|
| | **In winter period** | | |
| **Upper Tisza-valley** | | | |
| Between | Tiszabecs-Vásárosnamény | | 78-80 |
| " | Vásárosnamény-Tuzsér | | 76-78 |
| " | Tuzsér-Tiszalök | | 74-76 |
| **Middle Tisza-valley** | | | |
| Between | Tiszalök-Kisköre | below | 74 |
| " | Kisköre-Szolnok | | 74-76 |
| " | Szolnok-Martfü | | 76-78 |
| " | Martfü-Tiszaug | above | 78 |
| **South Tisza-valley** | | | |
| Between | Tiszaug-Frontier of the country | | 76-78 |
| | **In spring period** | | |
| **Upper Tisza-valley** | | | |
| Between | Tiszabecs-Kisar | | 52-54 |
| " | Kisar-Mezőladány | | 50-52 |
| " | Mezőladány-Tokaj | below | 50 |
| **Middle Tisza-valley** | | | |
| Between | Tokaj-Csongrád | below | 50 |
| **South Tisza-valley** | | | |
| Between | Csongrád-Szeged | | 50-52 |
| " | Szeged Southern frontier of the country | | 52-54 |
| | **In summer period** | | |
| **Upper Tisza-valley** | | | |
| Between | Tiszabecs-Mezőladány | | 50-52 |
| " | Mezőladány-Tokaj | | 48-50 |
| **Middle Tisza-valley** | | | |
| Between | Tokaj-Tiszapalkonya | | 46-48 |
| " | Tiszapalkonya-Kisköre | | 44-46 |
| " | Kisköre-Csongrád | below | 44 |
| **South Tisza-valley** | | | |
| Between | Csongrád-Szeged | about | 44 |
| " | Szeged-Southern frontier of the country | | 44-46 |
| | **In autumn period** | | |
| **Upper Tisza-valley** | | | |
| Between | Tiszabecs-Záhony | | 60-62 |
| " | Záhony-Tuzsér | | 62-64 |
| " | Tuzsér-Tokaj | | 60-62 |
| **Middle Tisza-valley** | | | |
| Between | Tokaj-Tiszafüred | | 58-60 |
| " | Tiszafüred-Csongrád | below | 58 |
| **South Tisza-valley** | | | |
| Between | Csongrád-Southern frontier of the country | | 58-60 |

a close correlation has been observed. In the parts where the annual balance is closed with a major amount missing, the absolute value of air humidity is relatively smaller.

From the point of view of the investigation of the ecological connections and habitat endowments, we are reviewing in this study the conditions observed in the macroclimate of the Tisza-valley, on the basis of the lowest daily average values of the relative air humidity measured for several years (Table 4).

The values published so far may mostly serve as comparative data at revelation of the microclimatic conditions. The microclimaic values developed as a result of the mass of water, the natural endowments of the habitats in stagnant water and inundation area, are differring from the above mentioned ones. The particular climate of the river and of its inundation strip, made known below, develops in the course of the interaction of the latter factors.

## Evaluation of the microclimatic conditions

In various sectors of the inundation area of the Tisza the microclimatic investigations were mostly carried out in the summer period. During these investigations our aim was to collect data concerning the interaction of water mass and environs (inundation area), the microclimatic peculiarities of the various plant associations in the inundation area, the data of the river valley (bed and inundation area) that climatically differ from the conditions of the adjacent plain.

Table 5. Temperature in °C in the area of the South Tisza region Algyő

| June 1955 | Szeged | | Algyő | |
|---|---|---|---|---|
| | Meteor. Observ. of the Univ. | Airport | Right bank | Left bank |
| 16th: daily average | 19,4 | 18,6 | 18,6 | 19,1 |
| maximum | 24,4 | 24,3 | 21,5 | 22,3 |
| minimum | 12,6 | 10,5 | 12,5 | 12,4 |
| 17th: daily average | 21,8 | 21,1 | 20,2 | 21,1 |
| maximum | 26,3 | 26,6 | 24,1 | 25,8 |
| minimum | 16,6 | 15,2 | 15,0 | 15,0 |
| 18th: daily average | 18,6 | 17,5 | 17,8 | 18,2 |
| maximum | 22,2 | 22,3 | 20,0 | 21,0 |
| minimum | 15,4 | 14,4 | 15,0 | 15,1 |
| 19th: daily average | 22,8 | 21,8 | 21,5 | - |
| maximum | 27,0 | 26,9 | 24,6 | - |
| minimum | 14,6 | 11,5 | 11,5 | - |

For the investigations (macro- and microclimatic determinations) we have used instruments accepted internationally and applied in researches; apart from climatic observations, also other investigations (soil, hydrographic, morphological researches) have been carried out.

The mciroclimatic temperature of the various substratum surfaces of the inundation area has a considerable influence on the macroclimatic values, as well. In the inundation area of the Tisza, the daily average temperature of air in Summer is generally 1—2°C cooler than that of the plain surroundings (Table 5).

If investigated for a longer time, there can be observed even in the gloomy, rainy periods some difference of temperature between the inundation area and the free surface of its environment (Meteorologycal Station, Szeged) (Fig. 1).

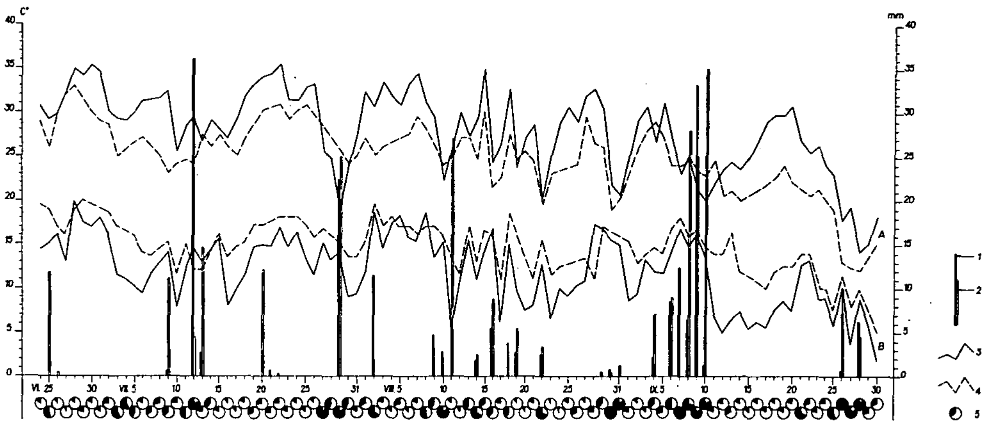

Fig. 1. Maximums of air temperature (A) and maximums of radiation (B) in the inundation area of the Tisza and in the Meteorological Station (Airport) of Szeged.

1. Precipitation in the airport in mm
2. Precipitation of the station in the inundation area in mm
3. Temperature graph of the station in the airport
4. Temperature graph of the station in the inundation area
5. Duration of sunshine in 100 percent of the possible sunshine

Its character is cooler partly owing to the orographic situation (valley-effect), partly to the composition to the peculiar microclimates of the habitats of various ecology. There belong to the substrata that develop the particular climate of the Tisza-valley: the shrubberies covered densely with undergrowth, the grassy and clear surfaces, the surface of water ,as well as the orographic peculiarity.

## The role of surface form in influencing the microclimate

The Tisza-valley is in time of cooling down (at radiating, clear nights) a reservoir of cold air. In the Tisza-valley of Hungary, this peculiarity is expressed the most sharply in the mountainous region at Tokaj. Here causes the amount of cold air that slides down on the S-S.E. slope of the 515 m high mountain in the neighbourhood of the river bed and inundation area cooler microclimatic conditions as compared with other Tisza regions in the Plain. The consequences of this climatic fact appears also in the augmentation of the biotops preferring cold climates (Fig. 2).

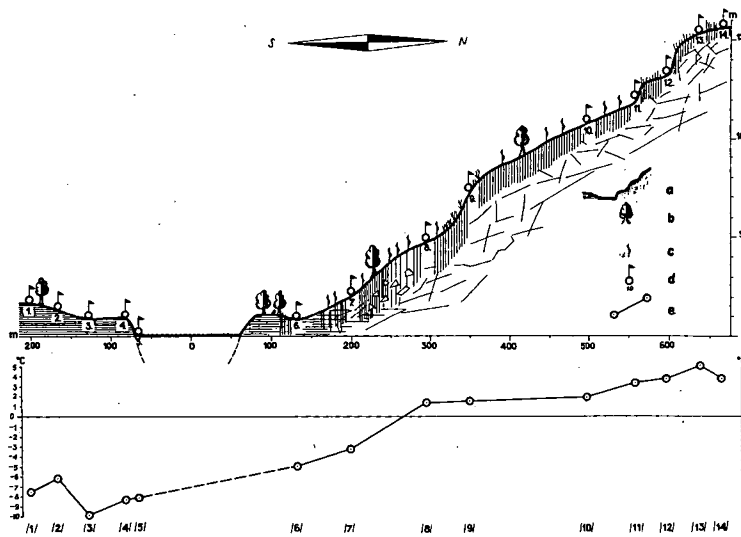

Fig. 2. Minimum values of radiation in the cross-section of the Tisza-valley, in the region of the Tokaj mountains (October 27th 1961).
a) surface form of the valley
b) tree groups
c) surfaces with grapes and grass
d) sites of the microclimatic investigations
e) values of radiation minimums in °C

The radiation values of the figure are demostrating a major inversion as well as the warmer situation of the slope of southern exposition of the Tokay mountains, contrasting sharply with its environs. The cooler air that fills in the valley is getting Warm but slowly in a calm, radiating weather as compared with the environment, and the difference of temperature disappears only in the late morning hours (Table 6).

The air layer neor to the surface of the mountainside of southern exposition is warmer even at the time of temperature maximum than the flat surface of the Tisza-valley and adjacent plain. Here in the low air layer get on well the size of the angle of scope, the degree of being exposed, as well as the stone material of surface. In our figure, also the temperature modifying effect of the mass of water can be found, but it is perceptible only in the strip of river bed.

Similarly to the Tisza-valley in the environs of Tokaj, cooler conditions can be observed in other Tisza regions, as well. In these places the accumulation of the cold air amesses coming from the fall in temperature at nght isn't first of all a result of orographic factors but that of the reciprocal effects of the woods with closed foliage in the

Table 6. Air temperature on 5 cm, in the stations placed on the cross-section of Fig. 1 (Tokaj, October 28th 1961)

| Station: | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| $8^h$ | 4,5 | 2,5 | -1,5 | 2,0 | 4,0 | -0,1 | 2,0 |
| Station: | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| $8^h$ | 4,0 | 6,1 | 6,0 | 6,4 | 10,0 | 6,1 | 6,7 |

inundation area and of the clearings among these woods. In orographic sense — at cooling down in the Tisza regions of the Plain — the dams in the inundation area have got a remarkable role, too; the deep clearings of the outer and inner sides of dams are, namely, generally the places of acumulation of the cold air (Fig. 3).

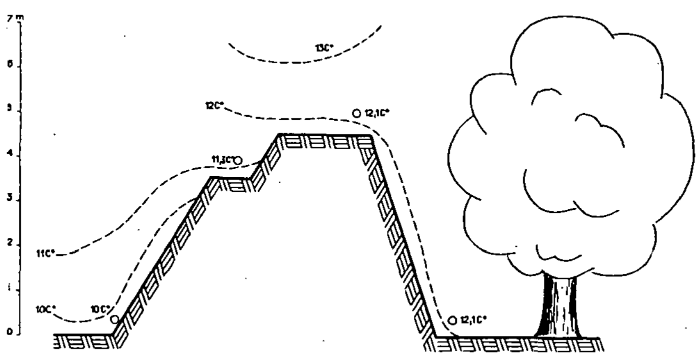


Fig. 3. The effect of the dam configuration upon the territorial distribution of air temperature, at cooling down.

This practically means that the irrigated cultures and orchards in the neighbourhood of the dam system of the Tisza-valley often suffer frost damages at the late falls in the spring temperature.

## Microclimatic effects of water mass, water surface

As known, the climate of the inundation area is influenced by the temperature of the river water, as well.

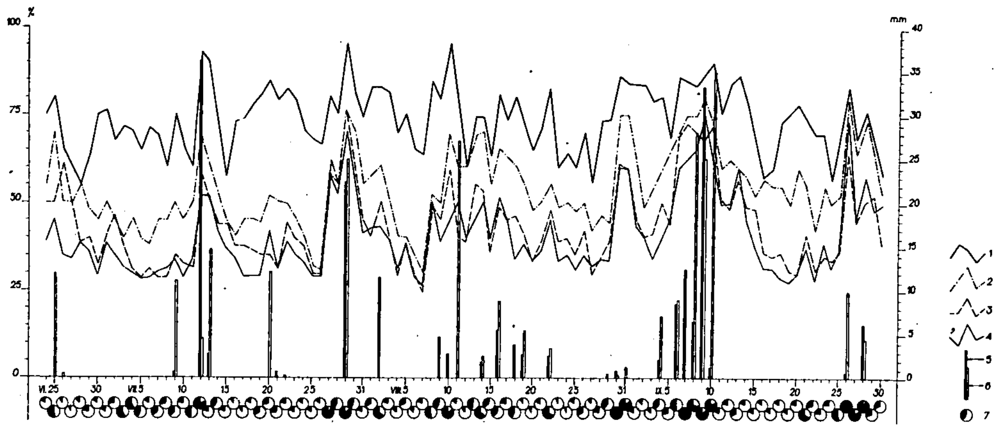

Fig. 4. The 24 hrs lowest relative air humidity on the surfaces of various substrata.
1. values of air humidity in wood
2. values of air humidity in a willowy thinned out
3. values of air humidity in the airport
4. values of air humidity in a clearing of an inundation area
5. precipitation in mm in the airport
6. precipitation in mm in the inundation area
7. duration of sunshine in 100 percent of the possible sunshine

The water course of the river, the territorial and temporal distribution of precipitation, the close interconnection between the conditions of humidity are expressed in the development of the temperature of river water, as well. Opposite to an arid ground form, at the heat economy of a river water the situation is, however, inverse; therefore, in respect of the heat economy, the water remains rather under the heat traffic of a dry surface.

In case of the river Tisza, we may render account of a well formed course of annual temperature; the fluctuation of the water temperature is not at all as extreme as that of a surface of another type. In case of this river, a daily fluctuation of 24 hours can be observed mostly only in case of small water. The curves of the monthly water temperature are indicating, anyway, a tendency to a uniform warming up or cooling down (Table 7).

At low water it frequently occurs, anyhow, that the daily water temperature differs from the monthly course and follows the alteration of the air temperature. In a case like that, if weather is extreme, the daily fluctuation of the water temperature can reach 3—4°C, and exceptionally even 6°C.

A warmer temperature value can be observed in the Tisza regions between Szolnok and Csongrád. The decrease in temperature of the South Tisza-valley is caused by the cooling effect of the water mass of the Köröses and of the Maros.

It is generally known that the influence of the mass of water on the microclimate is considerable in the microregions near the river bed.

The water surface as a substratum surface generally means one of the extremes opposite to the soil. The water, besides its considerable capacity of reflecting the light, is absorbing nearly fully the rays arrived

Table 7. Monthly mean values of water temperature of the Tisza on the basis of many years (1954/63) of values

| | I. | II. | III. | IV. | V. | VI. | |
|---|---|---|---|---|---|---|---|
| Tiszabecs | 0,9 | 0,9 | 3,8 | 8,6 | 13,7 | 18,2 | |
| Vásárosnamény | 0,9 | 0,8 | 3,3 | 9,5 | 15,0 | 20,5 | |
| Záhony | 0,8 | 0,7 | 3,4 | 9,4 | 15,1 | 19,9 | |
| Tokay | 0,6 | 0,7 | 4,0 | 10,5 | 16,0 | 20,2 | |
| Polgár | 0,7 | 0,3 | 3,0 | 11,2 | 16,0 | 20,2 | |
| Tiszafüred | 0,7 | 0,7 | 3,6 | 9,9 | 15,7 | 20,3 | |
| Szolnok | 1,0 | 1,0 | 4,1 | 10,6 | 16,3 | 20,9 | |
| Csongrád | 0,8 | 0,8 | 3,8 | 10,3 | 15,8 | 20,8 | |
| Szeged | 1,5 | 0,9 | 3,9 | 10,3 | 16,1 | 20,7 | |
| | VII. | VIII. | IX. | X. | XI. | XII. | Year |
| Tiszabecs | 20,0 | 19,6 | 16,2 | 10,6 | 6,2 | 2,4 | 10,0 |
| Vásárosnamény | 21,4 | 20,6 | 17,1 | 10,6 | 6,8 | 2,3 | 10,7 |
| Záhony | 21,6 | 21,2 | 17,4 | 11,1 | 6,7 | 2,2 | 10,8 |
| Tokay | 22,2 | 21,8 | 17,9 | 11,9 | 7,5 | 2,3 | 11,3 |
| Polgár | 21,9 | 22,4 | 19,7 | 13,9 | 8,7 | 2,4 | 11,2 |
| Tiszafüred | 22,2 | 21,8 | 18,6 | 12,2 | 7,2 | 2,4 | 11,3 |
| Szolnok | 22,7 | 22,5 | 19,2 | 13,0 | 7,9 | 2,8 | 11,9 |
| Csongrád | 22,6 | 22,4 | 18,9 | 13,0 | 11,0 | 2,4 | 11,9 |
| Szeged | 22,6 | 22,3 | 19,1 | 12,8 | 7,7 | 2,6 | 11,7 |

at its surface, preserving the heat and giving, therefore, but minimal amount of heat to the air layer over the water. In case of a river water, this property causes practically only an insignificant stratification of water temperature. Inside the water space, namely, owing to being intermingled, the temperature gradient is mostly equalized (Table 8).

Table 8. Water temperatures in $^{o}C$ in case of a two metres water column (Tokaj, August 10th 1959)

| h | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 2 | 4 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|
| Water surface | 20,0 | 20,5 | 20,9 | 20,0 | 20,0 | 20,0 | 19,9 | 19,8 | 19,9 | 20,0 |
| Water bottom | 19,1 | 19,2 | 19,3 | 19,0 | 18,9 | 18,9 | 18,8 | 18,4 | 18,4 | 19,3 |

As a result of the peculiar heat economy of the river water, in summer we observed a considerable decrease of temperature is the 40—50 cm cross-section of the air layer over the water. In case of a clear, raditing weather, e.g., the daily (24 hours) temperature amplitude of the water surface is not more than 0,8—1,2°C, that of the air layer over the water 6—8°. In higher regions, the value of the daily amplitude is fast increasing. In a height of 100 cm over the water surface already values higher than 10°C are characteristic. Here get a role the advections of the air mass of various temperatures of the environment, as well. *The mass of water has, therefore, an influence modifying the temperature considerably only on the lowest layers of air.*

A similar situation has been observed also in horizontal sense; i.e., with the distance from the mass of water, the role of that mass — that influences the microclimate — fast decreases (Table 9).

Table 9. Air temperature in $^{o}$C, 10 cm over the surface, in the Tisza-valley at Tokaj (between 13-14 h), in the time of temperature maximum

| August 11th 1959. | C$^{o}$ |
|---|---|
| 1. At the left bank, 10 m far from water | 27,4 |
| 2. 10 m from the left bank, over water | 25,0 |
| 3. At the centre line of the river, over water | 24,4 |
| 4. 10 m from the right bank, over water | 25,2 |
| 5. At the right bank, 10 m from water | 27,0 |
| 6. At the right bank, 20 m from water | 28,6 |
| 7. At the right bank, 50 m from water | 30,5 |
| **August 13th 1959.** | |
| 1. At the right bank, 2 m from water | 25,6 |
| 2. 10 m from the right bank, over water | 25,4 |
| 3. At the centre line of the river | 25,0 |
| 4. 10 m far from the left bank, over water | 25,8 |
| 5. At the left bank, 10 m from water | 27,4 |
| 6. At the left bank, 20 m from water | 28,4 |
| 7. At the left bank, 100 m from water | 30,1 |

It is proved by the above data that in summer, in a clear, calm weather, *in the bed inundation area the cooling effect of the mass of water is less expressed.*

A particulary quick change in temperature, resp. cooling effect can be observed if the river flows in a deepened bed as compared with the inundation area. During our investigations, e.g., in case of a bed side of 30° angle of gradient (4 m level difference), in a distance of 8 m from water, 10°C difference could already be measured in the air temperature (A n d ó, 1959).

## Air-temperature conditions of habitats of a different ecology

In the daytime, in summer ,the radiation balance on the surface of a plain environment of the Tisza has a strongly positive direction and, therefore, the gradient of the surface air layer is positive, as well. In the wood substance of the inundation area, however, similarly to the

Table 10. Temperature maximums of various substrata in the South Tisza-valley, in the summer of 1963

| Date | July | | | | August | | | |
|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | A | B | C | D |
| 1. | 38,0 | 35,5 | 29,0 | 43,5 | 34,5 | 33,5 | 23,0 | 32,1 |
| 2. | 33,0 | 34,0 | 25,0 | 30,0 | 31,5 | 30,0 | 26,0 | 30,4 |
| 3. | 32,5 | 32,5 | 24,0 | 29,2 | 35,5 | 35,0 | 25,0 | 33,3 |
| 4. | 34,5 | 34,0 | 24,5 | 29,0 | 33,0 | 33,0 | 25,5 | 32,8 |
| 5. | 35,0 | 35,0 | 25,0 | 30,0 | 35,5 | 34,0 | 25,0 | 31,7 |
| 6. | 35,5 | 37,0 | 25,0 | 31,2 | 36,5 | 34,5 | 26,0 | 33,2 |
| 7. | 37,0 | 36,0 | 26,0 | 31,5 | 37,0 | 35,0 | 27,0 | 34,3 |
| 8. | 36,0 | 35,0 | 27,0 | 32,2 | 32,5 | 30,0 | 24,5 | 31,0 |
| 9. | 27,0 | 29,0 | 20,5 | 24,6 | 33,0 | 30,0 | 23,5 | 29,3 |
| 10. | 32,5 | 33,0 | 22,0 | 27,4 | 25,6 | 23,0 | 22,0 | 22,0 |
| 11. | 34,0 | 33,0 | 23,0 | 29,4 | 27,0 | 25,0 | 24,0 | 26,2 |
| 12. | 30,0 | 30,0 | 22,0 | 25,6 | 31,0 | 27,5 | 27,0 | 29,9 |
| 13. | 30,0 | 30,5 | 22,0 | 28,1 | 28,0 | 25,0 | 22,0 | 27,1 |
| 14. | 30,5 | 28,5 | 24,0 | 28,7 | 31,0 | 26,5 | 23,5 | 29,3 |
| 15. | 30,0 | 31,0 | 25,0 | 28,0 | 35,5 | 30,0 | 24,0 | 34,7 |
| 16. | 29,0 | 30,0 | 22,5 | 27,0 | 23,0 | 22,5 | 20,5 | 24,2 |
| 17. | 33,0 | 33,0 | 23,5 | 29,2 | 28,0 | 25,5 | 22,5 | 26,6 |
| 18. | 37,0 | 36,0 | 24,5 | 31,7 | 34,0 | 29,5 | 23,5 | 32,6 |
| 19. | 37,0 | 36,5 | 25,0 | 33,0 | 25,0 | 21,0 | 18,0 | 23,7 |
| 20. | 36,5 | 37,0 | 24,5 | 33,9 | 29,5 | 25,0 | 20,0 | 27,1 |
| 21. | 37,0 | 37,5 | 25,0 | 34,1 | 30,5 | 27,0 | 24,5 | 28,6 |
| 22. | 35,0 | 35,5 | 25,0 | 32,4 | 20,0 | 17,5 | 16,5 | 20,1 |
| 23. | 37,0 | 39,5 | 24,5 | 31,2 | 28,0 | 24,0 | 20,0 | 25,0 |
| 24. | 35,5 | 36,0 | 25,0 | 31,3 | 31,5 | 26,0 | 21,0 | 28,6 |
| 25. | 36,5 | 37,5 | 24,0 | 32,7 | 34,0 | 29,0 | 23,0 | 30,4 |
| 26. | 37,5 | 38,0 | 24,5 | 33,0 | 32,0 | 27,0 | 21,5 | 28,7 |
| 27. | 25,0 | 27,0 | 18,5 | 25,3 | 34,0 | 29,5 | 23,5 | 31,9 |
| 28. | 26,5 | 29,0 | 18,0 | 24,7 | 34,0 | 30,0 | 24,5 | 32,6 |
| 29. | 20,5 | 20,5 | 16,0 | 19,4 | 30,0 | 28,0 | 24,0 | 30,2 |
| 30. | 23,5 | 25,5 | 18,0 | 23,8 | 19,5 | 18,5 | 16,0 | 21,7 |
| 31. | 30,5 | 29,0 | 20,0 | 27,1 | | | | |

water surface, a negative temperature gradient develops. As a result of that, the lower air layer is colder all day than it is in the foliage zone, resp. in the parts above the foliage zone. The reason of that is that in wood the direct radiation getting to the soil surface is highly decreased. According to data measured with Campbell-Stokes's instrument measuring the duration of sunshine, in wood the radiation time was not more than half an hour opposite to the 14 hours value of a plantless surface (A n d ó, 1956, 1958, 1959).

Here is the vertical distribution of temperature of radiative type. At rise in temperature, we every day find the highest temperature in the level orf foliage. An explanation for that is partly that even the little solar radiation that penetrates is hindered by the dense undergrowth from getting to the soil and causing a greater rise of temperature, partly that owing to the wood foliage being strongly closed the warmest so-called "active" level develops in the upper foliage level of wood instead of the soil surface. It can be noticed that in the daytime, the warm convections rise from the foliage level, as well as from the adjacent clearings. The warmer air is stratified in the foliage zone while in the lower wood levels there are cool and comparatively damp microclimatic conditions.

Comparing with one another the plantless clearing in the inundation area *(A)*, the grassland *(B)*, the wood in the inundation area *(C)*, as well as the daily maximums in temperature of the meteorological station in Szeged, outside the inundation area 10—12 km from it *(D)*, we see that in summer the wood in the inundation area is 5—10°C cooler than its environment (Table 10).

It is worth while being mentioned that in the daytime the temperature of the clearings in the inundation area is often higher than of the adjacent plain area. That may be explained by being highly sheltered from the wind owing partly to the dam system and partly to the wood vegetation. Particularly in case of a wind blowing at right angles to the line of the river-valley there can be observed some calmness in the inundation area, while in case of a wind blowing in the same direction as the river-valley is lying, only the wood substance is in a situation sheltered strongly from the wind.

To sum up, it can be established that in summer in the daytime the woods with closed foliage in the inundation area have a cooler substratum as compared with their environment that, like the surface of the river water, is considerably differring from the extreme temperature data so characteristic of the Hungarian Plain.

At night, as it is cooling down, the wood substance with closed foliage is a warm substratum as compared with its environs. In the course of the investigations in the summer of 1955, in an area of a size of 100 sq.m, there were found 3—4°C differences of radiation minimums between the clearing and the associations with closed foliage. These data are supported, in an increased degree, also by the investigations of a longer period in the summer of 1963. In this case, as well, the radiation minimum of the plantless surface of an area of the size of 100 sq.m or so *(A)*, of a surface covered by weed and undergrowth *(B)*, by a wood substance in the inundation area with closed foliage *(C)*, as well as of a substance with pruned and weeded willow-bushes *(D)* (Table 11). From the substrata enumerated, the wood with a rich underwood and closed foliage in the inundation area is as a rule warmer at night than the other ones, preserving this property in dull weather, as well. At clear nights, of course, the difference of temperature increases in a high degree. The cause of that is partly that the closed foliage of dense leaves behaves like a hothouse and partly that the infiltration of the cold air from the foliage level is strongly impeded by the leaves. At the same time, on a plantless surface the eradiation is undisturbed, and even the cold air accumulates there from the leafage of the adjacent wood. A consequence of that process is a difference of 8—10°C in the surface temperature.

Table 11. Radiation minimum values in °C, in the South Tisza-valley, in the summer of 1963 (holm Atka)

| Date | July | | | | August | | | | September | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | A | B | C | D | A | B | C | D |
| 1. | 17,5 | 17,0 | 19,0 | 17,5 | 14,0 | 15,0 | 15,0 | 13,0 | - | - | - | - |
| 2. | 16,5 | 17,0 | 18,5 | 16,0 | 17.0 | 21,0 | 17,5 | 18,5 | 10,0 | 14,0 | 13,0 | 11,5 |
| 3. | 16,0 | 15,0 | 17,0 | 15,0 | 14,0 | 16,0 | 17,0 | 16,0 | 12,0 | 12,0 | 14,0 | 12,0 |
| 4. | 11,0 | - | - | - | - | - | - | - | - | - | - | - |
| 5. | 10,0 | 11,0 | 16,0 | 13,0 | 12,5 | 17,0 | 17,0 | 14,5 | 12,0 | 12,0 | 14,0 | 12,0 |
| 6. | 10,5 | 10,5 | 14,0 | 12,0 | 14,0 | 16,0 | 17,0 | 14,5 | 15,0 | 15,5 | 17,0 | 15,0 |
| 7. | 10,0 | 11,0 | - | - | 11,5 | 15,0 | 16,0 | 14,0 | - | - | - | - |
| 8. | 11,5 | 11,5 | - | - | 10,5 | 17,0 | 17,0 | 15,0 | 15,0 | 15,0 | 16,0 | 15,0 |
| 9. | 7,0 | 12,0 | 15,0 | 17,5 | 15,0 | 16,5 | 17,0 | 15,5 | - | - | - | - |
| 10. | 6,0 | 8,0 | 11,5 | 10,0 | 11,5 | 14,5 | - | - | 12,0 | 14,0 | 14,5 | 13,5 |
| 11. | 12,0 | 13,0 | 15,0 | 13,0 | 9,0 | - | - | - | 13,0 | 14,0 | 14,0 | 14,0 |
| 12. | 14,0 | 10,5 | 12,0 | 10,5 | 8,0 | 10,5 | 11,5 | 9,5 | 9,5 | 7,0 | 14,0 | 13,0 |
| 13. | 12,5 | 10,8 | 12,0 | 10,5 | 10,0 | 17,0 | 17,0 | 10,5 | 9,5 | 8,5 | 16,5 | 10,0 |
| 14. | 12,0 | - | - | - | 12,0 | 12,5 | 13,0 | 15,5 | 9,5 | 9,0 | 12,0 | 10,0 |
| 15. | 10,5 | 14,0 | 16,0 | 14,0 | 14,0 | 16,0 | 16,5 | 15,0 | - | - | - | - |
| 16. | 10,0 | 12,0 | 13,5 | 11,5 | 14,0 | 14,0 | 16,0 | 14,5 | 12,0 | 11,0 | 11,0 | 8,5 |
| 17. | 9,0 | 11,0 | 14,5 | 12,0 | 10,0 | 10,5 | 11,0 | 15,0 | 8,0 | 9,5 | 10,0 | 8,0 |
| 18. | 10,0 | 11,5 | 15,0 | 13,0 | 11,0 | 12,0 | 18,5 | 18,5 | 9,0 | 11,0 | 12,0 | 10,0 |
| 19. | 14,0 | 14,2 | 17,0 | 15,5 | 9,5 | 9,5 | - | - | 10,0 | 11,0 | 12,5 | 11,0 |
| 20. | 15,0 | 15,0 | 17,0 | 15,5 | 8,0 | 8,0 | - | - | 10,5 | 12,0 | 12,5 | 11,0 |
| 21. | 16,5 | - | - | - | 9,0 | 10,0 | 11,0 | 9,0 | - | - | - | - |
| 22. | 16,0 | 16,0 | 18,0 | 16,0 | 10,0 | 12,0 | 15,5 | 12,5 | - | - | - | - |
| 23. | 17,5 | 17,6 | 18,0 | 16,0 | 9,5 | 10,0 | 11,5 | 9,5 | 7,0 | 8,5 | 10,0 | 8,0 |
| 24. | 17,0 | 17,0 | 18,0 | 16,0 | 11,0 | 11,5 | 12,5 | 10,0 | 7,0 | 8,5 | 10,0 | 8,0 |
| 25. | 15,5 | 16,0 | 17,0 | 15,0 | 8,5 | 9,0 | - | - | 5,0 | 7,0 | 7,5 | 5,0 |
| 26. | 14,5 | - | - | - | 11,0 | 11,5 | 13,0 | 10,5 | 11,0 | 10,0 | 11,5 | 10,0 |
| 27. | 16,0 | - | - | - | 12,0 | 12,5 | 13,5 | 11,5 | 6,0 | 7,0 | 8,0 | 8,0 |
| 28. | 13,0 | - | - | - | 15,0 | 15,5 | 16,0 | 13,0 | 6,0 | 9,5 | 10,0 | 8,0 |
| 29. | 13,0 | 15,0 | 15,5 | 14,0 | 15,0 | 16,0 | 17,0 | 14,5 | - | - | - | - |
| 30. | 8,5 | 11,5 | 13,5 | 11,0 | 16,5 | 18,0 | 16,5 | 15,5 | 2,0 | 3,5 | 5,0 | 3,0 |
| 31. | 9,0 | 12,0 | 13,5 | 11,5 | 16,5 | 18,0 | 16,0 | 16,0 | - | - | - | - |

## Air humidity in the inundation area

Apart from temperature, also other factors of microclimate of the wood in the inundation area (humidity, surface temperature, air current, etc.) develop peculiarely. There excels from them first of all the air humidity, getting — like that on the water surface — very high values here (Table 12).

Table 12. The daily average values of air humidity, in a clear weather, on 50 cm, in the South Tisza-valley (Algyő, June 16th 1955)

| | relative air humidity | vapour pressure | air temperature in °C |
|---|---|---|---|
| 1. water surface | 78,8 | 14,4 | 20,0 |
| 2. edge of bed | 62,2 | 14,4 | 24,1 |
| 3. wood in the inundation area | 58,8 | 13,7 | 24,1 |
| 4. substance of willow-bushes | 54,1 | 12,9 | 25,3 |

In the Tisza inundation area where the relative air humidity is about 15—20 p.c. greater than in the adjacent plain, in a clear, calm weather it can be observed, too, that the nearby mass of water increases the air humidity. This effect is, of course, less present in a gloomy, rainy weather because, after it ceased raining, the humidity content of air above the wood and willow-bush surfaced is higher than even over the surface of water (Table 13).

Table 13. The daily average values of air humidity, in a gloomy, rainy weather, on 50 cm, in the South Tisza-valley (Algyő June 18th 1955)

| | relative air humidity | vapour pressure | air temperature in °C |
|---|---|---|---|
| 1. water surface | 79,0 | 14,1 | 19,5 |
| 2. edge of bed | 72,3 | 14,4 | 21,0 |
| 3. wood in the inundation area | 79,5 | 15,6 | 21,0 |
| 4. substance of willow-bushes | 84,2 | 15,4 | 21,1 |

The air humidity of higher degree is caused by the precipitation evaporated from the surface of vegetation, as well as the fast and intensive vaporization of the damp soil.

The soil of the wood substance with closed foliage in the inundation area is moist and damp in the great part of summer what, in addition to the dense underwood, increases the humidity content of air, as a result of an increased evaporation. Consequently, it can often be observed that in a wood the relative and absolute vapour content is higher than even the humidity of air over the water surface (Table 14).

Table 14. Relative air humidity in the inundation area of the South Tisza (June 18th 1955)

| h | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|
| wood | 67 | 72 | 77 | 85 | 97 | 95 | 91 | 84 |
| water surface | 66 | 70 | 74 | 84 | 83 | 86 | 84 | 85 |
| edge of bed | 64 | 65 | 63 | 77 | 82 | 76 | 78 | 81 |

Relative humidity in the inundation area of the Middle Tisza (Tiszalök) (October 28th 1961)

| h | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|
| water surface: | | | | | | |
| 50 cm | 65 | 54 | 42 | 52 | 46 | 89 |
| 100 cm | 46 | 48 | 42 | 43 | 46 | 65 |
| willow-bushes | | | | | | |
| 50 cm | 51 | 45 | 45 | 48 | 68 | 92 |
| 100 cm | 53 | 43 | 43 | 44 | 79 | 90 |
| wood | | | | | | |
| 50 cm | 67 | 56 | 49 | 58 | 89 | 97 |
| 100 cm | 69 | 56 | 56 | 58 | 90 | 90 |

Relative air humidity in the inundation area of the Upper Tisza (Tokaj) (October 29th 1961)

| Between | 5-6 | 10-12 | 18-20 o'clock |
|---|---|---|---|
| 1. water surface | 92 | 83 | 92 |
| 2. willow-bushes | 97 | 86 | 89 |
| 3. orchard in the inundation area | 99 | 87 | 88 |
| 4. clearing in the inundation area | 97 | 69 | 81 |

The territorial distribution of air humidity in the inundation area, in a calm weather, develops according to the substrata (Fig. 4). From the substrata the substance of wood has the peculiarity differring for the most part from that of the others. Here, in the summer period, doesn't sink even the lowest value of air humidity below 55 percent. On the other hand, on the surface of a clearing in the inundation area, as well as in the adjacent plain area, even a value about 25 percent could be observed. Comparing the values enumerated with the mean air-humidity values of the summer period of Table 4, it is obvious that in the Tisza-valley the water surface and the wood region are the substrata that develop the peculiarity of air humidity of the inundation area.

As a result of being wind-screened and of low temperature, the temporal change of air humidity in the wood substance of the inundation area is of slow course. It could be observed that here are two (night and day) periods of the development of air humidity well separated from each other. While the values of the day period changed in an extreme way, in the night period there were everywhere less unstable air-humidity conditions of a uniform course. At night the relative air humidity is between 85—100 p.c., in the daytime this value changes between 30—80 p.c., depending upon the substrata.

As the water mass of the marsh and river affords a continous vapour supply for the air-space of the wood in the inundation area, the daily course of vapour pressure in the inundation area is identical with that of temperature, i.e., the daily course of vapour pressure is uniwave. It isn't, however, characteristic on the higher lying loess and quicksand surfaces, outside the inundation area of the Tisza, any more. Here is the double wave characteristic in the course of vapour pressure; minimum situations can be noticed in the morning and evening. In the latter case, opposite to the more humid climate of the inundation area, the characteristic of vapour pressure can be told to be a typical continental one (Andó, 1955, 1956). As a summary of the microclimatic investigations carried out in the Hungarian Plain we may establish that already above the areas lying 5—10 km from the inundation area, the daily course of vapour pressure has a double wave. This characteristic appears even in the course of the rainy period in June (European monsoon); the daily course of vapour pressure has a single wave in the inundation area, even in the most arid weather.

From the very humid atmosphere of the inundation area, if a stronger fall in temperature comes, there can arise vapour, dew, and even local fog, as well. It cannot be said that the formation of dew were of identical development and strength. The areas of the most intensive dew formation are the substrata of low temperature and high vapour content, like e.g. a wood and the narrow strip along the bank line; the clearings in the inundation area and the agricultural regions are less important. The air commotion, too, contributes considerably to the dewless characteristic of the atter ones. In cases of a stronger cooling down, the formation of fog can also be noticed at the edge of bank where the absolute vapour content is very high.

## Conditions of soil temperature and soil moisture in the inundation area

The general physical state of the air stratum near the soil is highly influenced by temperature and moisture of the soil. The various soil can take up heat of different amount into their strata near the surface, and they become accordingly warm. It is generally known that a moist soil can absorb usually more heat than the same soil in a dry state; and that in case of a moist soil, a larger part of heat is used for evaporation and for warming up the deeper lying strata, and only a smaller part of it is used for warming up the air.

The distribution of soil moisture in the inundation area, in addition to its covered character, is an important factor of the territorial development of soil temperature (Table 15).

In the comparatively homogenous alluvium of the inundation area

Table 15. Soil temperature, in a depth of 2 cm, in a clear day in the inundation area of the South Tisza (Algyő, June 16th 1955)

| | Dam top | Wood of closed foliage | Half--moist mud | Dry mud | Thinned--out willows |
|---|---|---|---|---|---|
| minimum °C | 14,0 | 12,2 | 15,0 | 16,5 | 13,8 |
| maximum °C | 30,0 | 19,1 | 26,0 | 30,5 | 28,2 |
| Δ | 16,0 | 6,9 | 11,3 | 14,0 | 14,4 |

| | Upper part of the bed side | Central part of the bed side | Lower part of the bed slope | Water bottom (1,5 m) |
|---|---|---|---|---|
| minimum °C | 13,6 | 12,8 | 13,0 | 18,9 |
| maximum °C | 28,2 | 27,6 | 23,1 | 19,6 |
| Δ | 14,6 | 12,8 | 10,1 | 0,7 |

the temperatures of the surfaces investigated are differring from one another considerably. The differences can be explained with being covered variously by plants and with the different soil moisture. From the substrata enumerated we have, of course, to evaulate separately the soil temperature of the surface covered with river water, produced by water mixing and the temperature accompanying it. Here is the daily oscillation of 0,7°C nothing else than an alteration regulated by the water temperature developing independently from the daily course of air temperature. E.g., we demonstrate the hourly temperature of a clear day, in connection with that, from the muddy clay surface below the river water (Table 16).

Table 16. Soil temperature of a surface covered with 0,5 m deep river water, on a clear, radiating day (Algyő, June 16th 1955)

| at | 1 | 2 | 3 | 4 | 5 | 6 | 7 o'clock | |
|---|---|---|---|---|---|---|---|---|
| | 19,3 | 19,0 | 19,2 | 19,9 | 19,4 | 19,5 | 20,0 | |
| at | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 c'clock |
| | 19,4 | 19,4 | 19,7 | 19,6 | 19,4 | 20,0 | 19,9 | 19,8 |
| at | 16 | 17 | 18 | 19 | 20 | 21 | 22 c'clock | |
| | 20,0 | 19,8 | 19,4 | 19,3 | 19,9 | 19,5 | 19,6 | |

The temperature difference caused by the various soil mosture can be illustrated in the most characteristic way with the data concerning soil temperature on the bed side (Table 17).

Table 17. The moisture content of the bed side in percentage, referred to dry weight, and the soil temperature values of the hourly 2 cm stratum (Algyő, June 16th 1955)

| between (cm) | I lower | | II central | | III upper |
|---|---|---|---|---|---|
| | parts of the bed slope (p.c.) | | | | |
| 2 - 5 | 33,77 | | 16,87 | | 14,97 |
| 10 - 15 | 33,99 | | 17,25 | | 12,05 |
| 15 - 20 | 36,13 | | 17,73 | | 9,89 |

| c'clock 6 | | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|
| I | 13,0 | 14,7 | 16,4 | 18,5 | 20,0 | 21,3 |
| II | 14,1 | 16,4 | 18,8 | 21,8 | 24,4 | 26,4 |
| III | 14,6 | 16,8 | 20,2 | 23,2 | 25,3 | 27,6 |

| c'clock 12 | | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|
| I | 21,5 | 22,3 | 23,1 | 22,2 | 22,4 | 22,3 |
| II | 27,5 | 26,0 | 26,4 | 25,2 | 23,8 | 23,3 |
| III | 27,8 | 28,2 | 27,9 | 27,8 | 26,7 | 25,8 |

On the bed side of 30° slope angle and 70° exposition, the difference of soil temperature, observed inside a distance of 8—10 m, shows correlation with the territorial distribution of soil moisture. In case of the deeper soil stratum in upper and central parts of bed, the daily amplitude of temperature is 10—15°C, and in the lower levels only 5—10°C. This distribution of temperature is explaining the increase of moisture content and the more intensive rise in temperature of the deeper strata.

In a like way, the teritorial distribution in connection with moisture and plant coverage is expressed in other regions of the inundation area, as well. In the inundation area there can be distinguished two characteristic surface types in this respect: the shaded one and the clearing. While the shaded soil surface of woods in the inundation area is damp even in the most arid period of summer, the surface of clearings in the inundation area dries up strongly. For comparing the two areas in respect of soil temperature, we demostrate the temperature differences in 10 cm depth in the soil stratum (Table 18).

**Table 18. Differences of soil temperatures in °C, between a wood and a clearing in the inundation area, in the summer of 1963 (Holm Atka)**

A/ In a clear, arid, warm weather

| h | | 8 | 10 | 12 | 14 | 16 | 18 |
|---|---|---|---|---|---|---|---|
| July | 1st | 4,4 | 4,7 | 4,5 | 6,0 | 5,4 | 6,4 |
| July | 2nd | 5,1 | 5,0 | 5,4 | 5,6 | 6,3 | 7,5 |
| July | 3rd | 5,4 | 5,1 | 5,2 | 5,4 | 5,8 | 6,1 |
| July | 5th | 5,1 | 5,4 | 6,1 | 6,8 | 6,5 | 7,8 |
| July | 6th | 5,7 | 5,8 | 6,0 | 7,2 | 6,9 | 8,2 |
| July | 16th | 3,2 | 3,2 | 3,6 | 5,1 | 5,0 | 5,7 |
| July | 17th | 3,5 | 3,4 | 4,5 | 5,8 | 6,4 | 6,7 |
| July | 18th | 4,5 | 4,5 | 5,6 | 6,8 | 7,8 | 8,0 |
| July | 19th | 4,9 | 5,4 | 6,2 | 7,4 | 7,6 | 5,2 |
| July | 20th | 4,1 | 4,4 | 5,2 | 5,4 | 8,7 | 7,8 |

B/ In a gloomy, rainy, cool weather

| h | | 8 | 10 | 12 | 14 | 16 | 18 |
|---|---|---|---|---|---|---|---|
| July | 29th | 4,0 | 4,1 | 4,4 | 4,7 | 4,7 | 4,8 |
| July | 30th | 3,2 | 3,0 | 3,2 | 3,9 | 4,0 | 4,0 |
| July | 31sh | 2,8 | 3,1 | 3,5 | 4,2 | 4,3 | 5,2 |
| August | 1st | 2,8 | 3,2 | 3,1 | 6,2 | 4,0 | 4,2 |
| August | 2nd | 2,8 | 3,0 | 2,9 | 3,1 | 3,8 | 3,9 |
| August | 12th | 1,9 | 2,0 | 2,8 | 3,2 | 3,4 | 3,9 |
| August | 13th | 2,2 | 2,3 | 2,5 | 3,3 | 3,2 | 3,8 |
| August | 14th | 2,1 | 2,2 | 2,5 | 2,8 | 3,3 | 3,4 |
| August | 15th | 2,0 | 2,0 | 2,4 | 3,5 | 3,4 | 3,9 |
| September | 5th | 2,0 | 2,0 | 3,0 | 3,5 | 3,5 | 4,4 |
| September | 6th | 2,4 | 2,7 | 3,0 | 3,7 | 3,7 | 4,0 |
| September | 11th | 0,8 | 0,5 | 1,5 | 2,3 | 2,7 | 3,1 |

In a clear, arid, warm weather, in the daytime there develop 4—6°C temperature differences. In a gloomy, rainy weather the soil of wood is 2—3°C cooler than the surface of clearing. With the data above we have demostrated in general outlines the most important characteristics of the soil temperature in the inundation area. The soil temperature alterations connected with the soil-moisture differences and shade-effects are contributing with further data to the knowledge of the microclimatic characteristics of the single substrata.

## Aerodynamic conditions of the inundation area

Evaluating shortly the aerodynamic conditons of the inundation area, we can establish that the territorial distribution of temperature and air humidity depends considerably upon the wind conditions. The orographical data and plant coverage of the inundation area modify considerably the strength of air motion in case of the various wind directions. On the basis of our measurements, in case of the Tisza-valley of N-S direction, we can observe a 60—75 p.c. decrease in wind strength at NW, W, SW, E wind directions while only 10—20 p.c. at N, S wind directions. In forming a lee in the inundation area, there plays first of all the flora (wood) an important role. In the single regions the Tisza inundation area, the inundation wood strips that border the river valley exert a considerable effect in case of winds which blow at right angles to the river valley. They change the structure of air current, divide the large eddies of the stream into smaller ones, that conducts in the parts protected, in the surface air layer, to a decrease of intensity of the vertical turbulence. On the other hand, in the higher layers over the wood (till a height of 500 m or so), the turbulent exchange increases. The increase of air masses towards the wood strips causes some decrease of temperature and increase of relative humidity in the inundation area because the evaporation will be less in the protected areas, owing to a diminution of wind velocity and a weakening of the turbulent exchange.

The cooler situation of the inundation area as compared with its surroundings has an influence on the stoppage of the formation of up currents that are otherwise frequent above the adjacent plain surfaces. Particularly in calm or only weakly windy summer days we may notice a full absence of up currents above the inundation area (P a p, 1957). In case of weaker air motions, at the valley line, also a confluence of air is frequent, i.e., the Tisza-valley can be characterized like a wind reservoir, as well.

In this work we did not endeavour to afford a regional summary of taxonomic character. From the results of the microclimatic investigations performed in the single Tisza regions, there were investigated mostly only the typical values and basic connections that are characteristic of the peculiarities of the inundation area. We expect to have promoted with this work the successful solution of the tasks of the complex investigations.

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