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About the length of active life of some xerophytic cryptogams in the dry season

By

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Abstract: A whole night-long experiment was carried out with the aim of clearing up whether xerophytic mosses and lichens were able to live active life daily or only after rainfalls in the dry season. The dynamism of water content of the plants was studied in the field with the aid of gravimetric determinations. In this case a 6-7 hours' long (within it about 2 hours' photosynthetic) active life was proved in a Hungarian sandy steppe.

A great number of authors have dealt with the water relations of mosses and lichens. It turned out already in the earliest experiments that these plants are able to take up water from the atmosphere, too (MÜLLER 1909, MÄGDEFRAU 1931 and others). The water uptaking capacity proved to be independent from the xerophytic character of the examined bryophytes in some experiments (PATTERSON 1943). Anyhow, PATTERSON did not examine the dynamism of this uptake. Indeed, xerophytic mosses take up water from the atmosphere 2-3 times quicker (MÄGDEFRAU 1931). Seasonal changes have a great effect, too. Plants collected in winter take up more atmospheric water and their resistence to desiccation is far greater (HOSOKAWA & KUBOTA 1957, VERSEGHY 1971).

The importance of air humidity as water supply proved to be little in mesophytic bryophytes. According to KLEEPER (1963) Dicranum scoparium gametophytes depend only on rainwater. The leaves of Atrichum undulatum and Polytrichum commune remain crisped in the atmosphere saturated with water as to ANDERSON & BOURDEAU (1955). Another paper is inconsistent with these results. In the experiments of RAJCZY (1978) Atrichum undulatum under cave condition could live more than two years at 95-100% relative humidity (no leaves were crisped during this long period).

The aim of my investigation was how long the active period in the life of real xerophytic mosses and lichens was. If they depend primarily on rain as water supply they will be active only on rainy days (KLEEPER 1963) i.e. 5-6 days monthly in the investigated territory in summer (Fig. 1). If they depend either on air humidity or on rainwater, they will be active every day at night and in the morning utilizing the high moisture content of the air and the dew.

Materials and methods

One moss and two lichen species being common on the investigated territory were used: Tortula ruralis (Hedw.) Gaertn., Meyer et Scherb.; Cladonia furcata (Hds.) Schrad.; Cladonia convoluta Lam. The measurements were carried out on a sandhill near Fülöpháza (Comit. Bács-Kiskun, Hungaria centralis) on the territory of Kiskunság National Park. This territory is a sandy steppe on the Great Hungarian Plain. The soil is calcareous sand with pure vegetation (Brometum tectorum and Festucetum vaginatae danubiale), and in two places with sand-drift. In summer the climate is rather dry. Fig. 1 shows the daily precipitation and daily maximal and minimal temperature values of the nearest meteorological station (Izsák, cca. 10 km from it) in July 1977.

The following measurements were performed from 8 p.m. 20.07.1977 till 7 a.m. 21.07. 1977.

1. Gravimetric determinations were carried out on an analytical balance in the field to four places of decimals. Two samples were taken from each species (whole little thalli from the lichens and a piece of a great tuft from the moss). All samples were put into a little box folded from aluminium foil and laid onto a small grating on the ground. Air-dry samples were weighed in the laboratory at room temperature. There was no need for oven-drying the samples because only the amount of relative changes was studied.
2. Microclimatic measurements: a recording thermometer indicated the temperature of the air at ground level. Mercuries were placed into a moss tuft; under a moss tuft (both were Tortula ruralis); into the soil at -1 cm. Air humidity was determined by an Assman psychrometer at ground level.

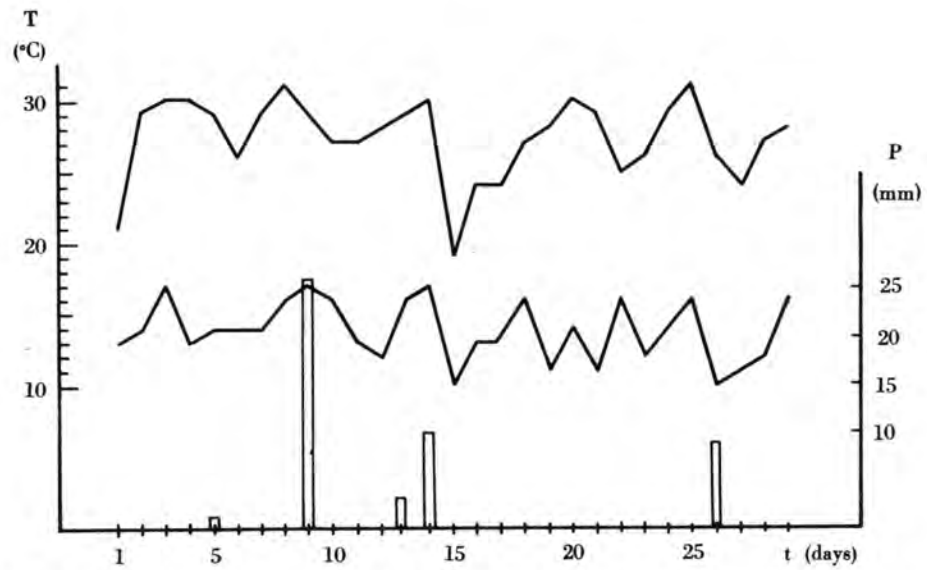


Fig. 1. Daily precipitation and daily maximal and minimal temperature in July, 1977. Meteorological station at the village Izsák (T - temperature; t - time)

Results

On the 19th and 20th of July the cloud was over but there was no rain. The relative humidity of the air varied between 80-90% in day-time. At the beginning of the experiment it was 91% at ground level (microclimatic data are given on Fig. 2 - the temperature of the soil at -1 cm was practically identical with that measured under the moss tuft every time). The leaves of the moss samples were crisped, the lichen thalli were dry to the touch. In the course of the time the plants took up water from the air fast (Fig. 3). Between 22.00 and 23.00 hours the moss leaves became squarrose and the lichen thalli became wet to the touch. At the same time the velocity of water uptake dropped quickly (Fig. 4). Between 1 and 3 o'clock a.m. the plants took up no water, moreover they lost weight. It was dawning from about 3.15 (D on Figs. 2-4) and the weight of the plants increased again. The lowest temperature and the highest air humidity (100%) were measured at sunrise (4.15 - S on Figs. 2-4). This was the time of the morning dew. After sunrise the plants were running become dry at an increasing speed (Fig. 4). From sunrise on samples F2, C2 and T2 were in sunlight, that is why their velocity of drying out was higher and it decreased earlier than that of those being in the shade (F1, C1 and T1). The moisture content of the plants reached the critical level (see above) between 6 and 7 o'clock a.m. From that time on the moss leaves were crisped and the lichen thalli were dry to the touch again.

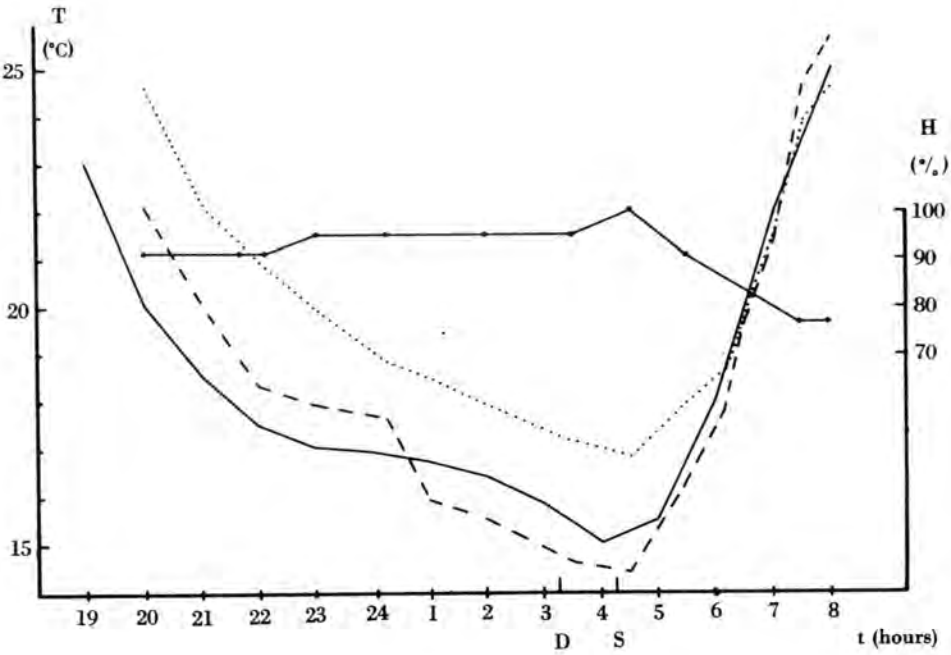


Fig. 2. Microclimatological measurements: relative air humidity (————) at ground level; air temperature at ground level (————); the temperature in the moss-tuft (- - - - -); the temperature under the moss-tuft (.....) (T - temperature; t - time; H - relative air humidity; D - beginning of dawning; S - sunrise)

Discussion

Unfortunately, there was no possibility to measure either the respiration or the photosynthesis of the examined plants this time. Anyhow, during that time when the moss leaves were not crisped (i.e. the turgor was nearly normal) the plant lived a normal active life to all probability. That means these plants have 6-7 hours a day to live under such conditions and during the last 1-2 hours there is enough light for photosynthesis! There is no doubt that this very quick water uptake is partly due to the prolongated previous period of high air humidity. Nevertheless, it is sure that a more arid day-time would not have lengthened the water uptake till the critical moisture-content level for over 2 hours.

An unsolved problem for me is the weight-decreasing period before dawning. Probably it was an evaporating period (see Fig. 2 - the temperature of the moss-tuft dropped under the air temperature!), but this is not sure. Unfortunately, the precision of the Assman psychrometer is very low above 90-95% relative humidity that is why the fine changes remained unchecked.

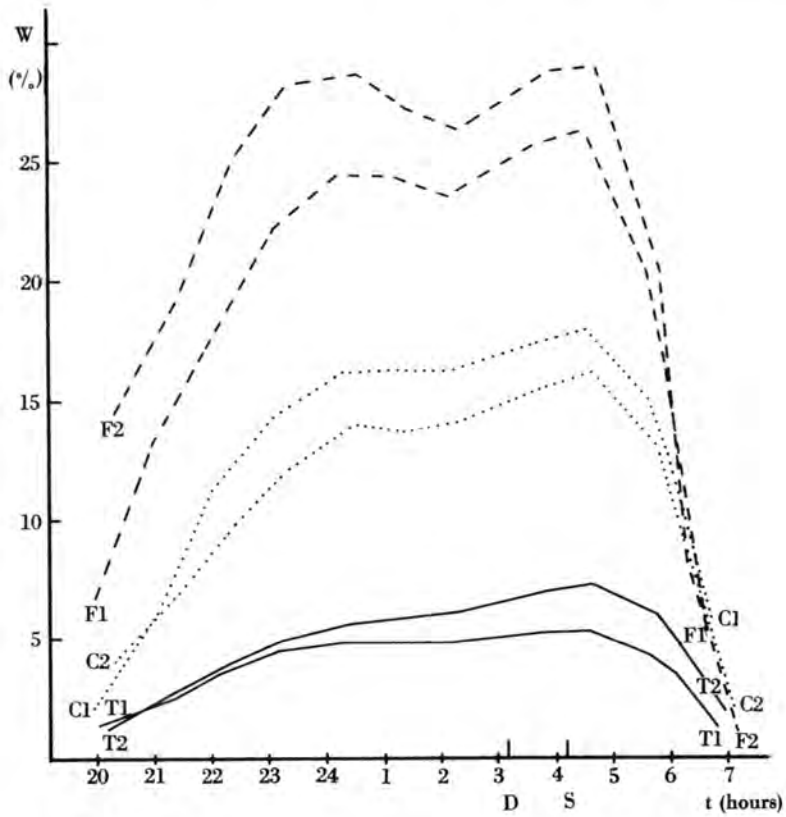


Fig. 3. The process of changing of the water content of the examined plants (W - water content/ dry-weight; F1, F2 - Cladonia furcata samples: - - - - - ; C1, C2 - Cladonia convoluta samples: ····· ; T1, T2 - Tortula ruralis samples: ——— ; other signes see in Fig. 2)

A short rainfall may have a smaller effect than a night because the water is swallowed up very quickly by the sandy soil. Longer rainy periods are relatively rare and the day-time high relative humidity (which is under 90%) is not enough - as we have seen it. As a conclusion, it can be stated that on the examined territory xerophytic cryptogams are dependent mainly on the air humidity as a water supply in summer.

Anyhow, the final word could be spoken only with the knowledge of the results of detailed measurements of respiration and photosynthesis in the field.

Thanks are due to Mr. Gy. Boros, Mr. G. Friedrich and Mr. L. Ponty, the students who helped me in the field measurements.

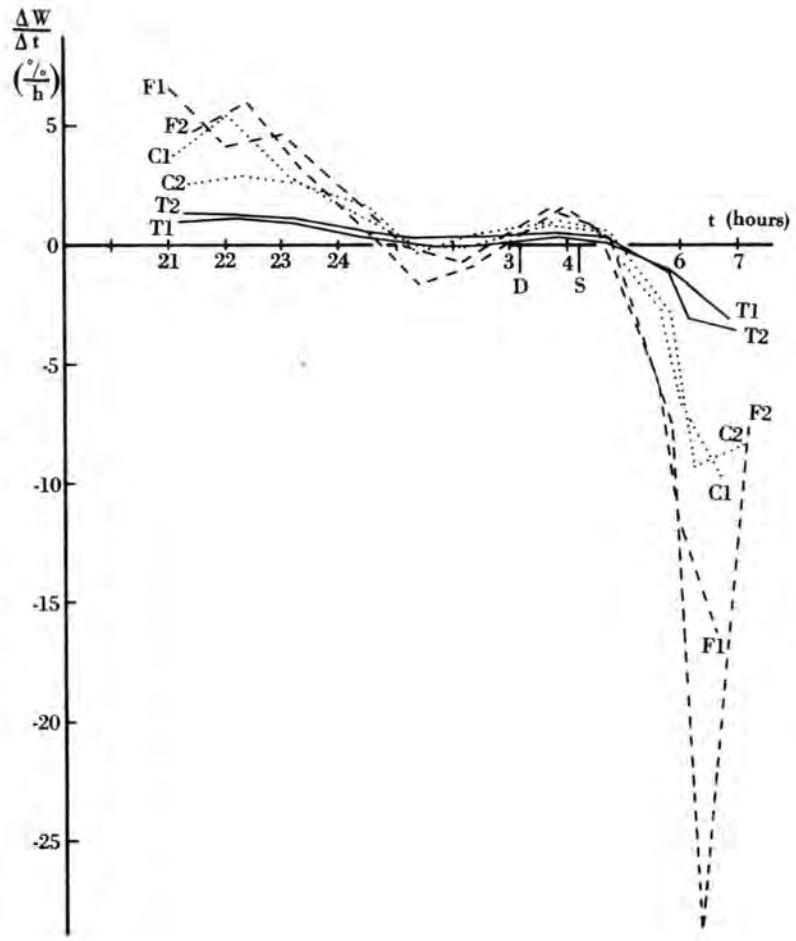


Fig. 4. The velocity of changing of the water content of the examined plants (signs see in Fig. 3)

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