DECOMPOSITION OF SALIX AND POPULUS LEAVES IN STANDARD CLASS "A" EVAPORATION PANS

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Összefoglalás

A lebontás és a párolgás a vízi ökoszisztémák alapvető mutatója, ennek ellenére ritkán vizsgálják őket egymással összehasonlítva. Egy kísérletet állítottunk be négy párolgásmérő A-káddal. Az egyiket vízzel töltöttük meg (kontroll kád), míg a többi hármat balatoni üledékkel, amire avarzsákokat helyeztünk. A kádakban mértük a lebontás ütemét és a napi párolgást. Az avar lebontása az exponenciális lebontási görbét követte, a lebontási ráták a gyors kategóriába estek. A kádakban a víz hőmérséklete a léghőmérséklettől függött. A meteorológiai elemek közül a levegő napi középhőmérséklete jelentősen befolyásolja a kádak vizének hőmérsékletét, a párolgás mértéke a hőmérséklettel növekszik.

Kulcsszavak: avar lebontás, fűz, nyár, A-kád

Abstract

Decomposition and evaporation are both basic measures of aquatic ecosystems, nevertheless they are rarely studied compared to each other. A research was carried out with four class “A” evaporation pans. One of them was filled with water (control pan), while the other three with sediment from Lake Balaton, on which leaf litter bags were placed. Decomposition rate and daily evaporation were measured in the pans. Leaf mass losses followed the exponential decay curve, decomposition rates were in the fast category. Water temperature in the pans was driven by air temperature. Among the meteorological elements, the daily average air temperature greatly influences the evaporation values, the rate of evaporation increases with warming.

Keywords: leaf litter decomposition, *Salix*, *Willow*, class “A” pan

Introduction

In aquatic environments leaf litter input from the coastal vegetation represents a major nutrient and plays a basic structural and functional role in several ecosystems (Fisher et al., 1973). Pan evaporation (E_p) is a basic physical measure of atmospheric evaporative demand widely measured using standard containers filled with water. Due to its simplicity and low cost, E_p measurement networks have been established worldwide under an institutional framework of meteorological services over half a century (Lim et al., 2013). Ep measurements have many functions, for example the estimation of a water budget (Kisi, 2015).

Decomposition studies are usually carried out under natural circumstances (*in situ*) or in the laboratory (*in vitro*), but not in class “A” evaporation pans. This new, pioneer method was chosen to investigate decomposition and evaporation together.

Materials and methods

The research was carried out at the Agrometeorological Research Station of Keszthely (latitude: 46° 44′ N, longitude: 17° 14′ E, elevation: 124 m above sea level), which belongs to the observation network of the Hungarian Meteorological Service (Fig 1.).

Figure 1: The locations of the study site (https://www.google.hu/maps)

Four Class A pans (Fig. 2.) were laid out in the meteorological garden from 25 May 2017 till 31 August 2017 (in the summer season). One of them was filled with water (control pan), while the other three with sediment from Lake Balaton, on which leaf litter bags were placed.

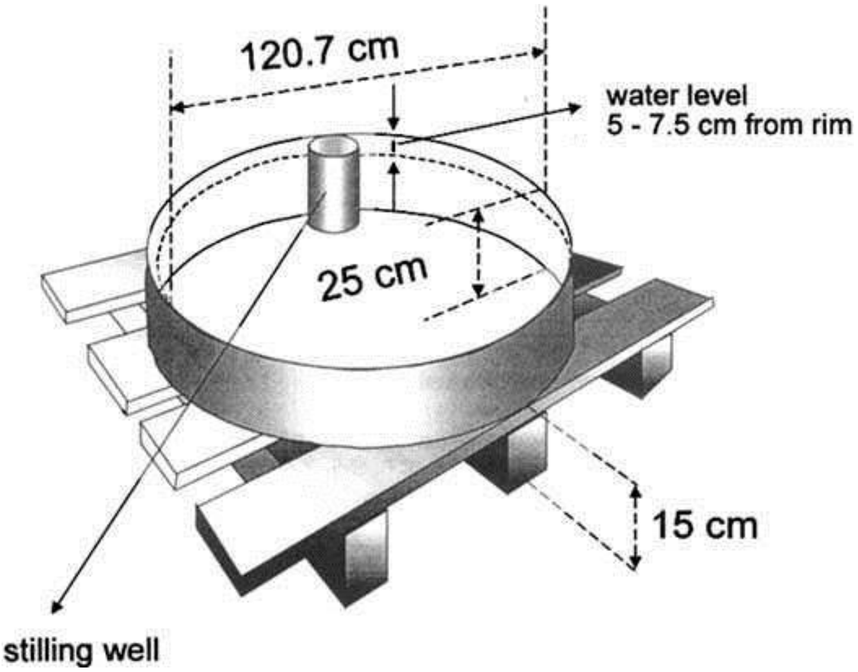

Figure 2: Class A evaporation pan (http://www.fao.org/docrep/X0490E/x0490e08.htm)

The Class A Evaporation pan is circular, 120.7 cm in diameter and 25 cm deep. The pan is mounted on a wooden open frame platform which is 15 cm above ground level. The soil is built up to within 5 cm of the bottom of the pan. It is filled with water to 5 cm below the rim, and the water level should not be allowed to drop to more than 7.5 cm below the rim. The water should be regularly renewed, at least weekly, to eliminate extreme turbidity. Pans should be protected by fences to keep animals from drinking. Pan readings were taken daily in the early morning at the same time that precipitation is measured. Measurements are made in a stilling well that is situated in the pan near one edge. The stilling well is a metal cylinder of about 10 cm in diameter and some 20 cm deep with a small hole at the bottom.

Populus tremula and *Salix alba* leaves were collected shortly after the fall (2016 September). The leaves were dried at 70 °C to constant mass and 10 g were put into two kinds of litter bags (following the method of Gessner, 2005). The size of the bags was the same (10 cm×10 cm), but the mesh size differed: 3 mm (leaf litter bag) and 900 μm (plankton net bag) mesh sizes were used to deprive and let the macroinvertebrates in. The bags contained only one kind of leaf, the leaves were not mixed. Leaf litter bags were fixed to plastic racks and incubated in the pans (Fig. 3.).

Figure 3: Class A evaporation pan with the litter bags fixed to plastic racks

At once one of each type of litterbags was collected from each pan. In the laboratory macroinvertebrates were separated from the samples and stored in 70% alcohol till classification. Sediment was thoroughly washed from the leaves under tap water. The oven dry mass of the cleaned leaves were measured, to determine leaf mass loss. Exponential decay coefficients (*k*) for leaves were calculated by using the exponential decay curve below. Regression analysis assuming negative exponential decay was used (Boulton & Boon, 1991): $M_t = M_0 e^{-kt}$, where M_t is mass at time t, M_0 is mass at time 0, k is exponential decay coefficient and t is time in days. Based on their daily decay coefficients, leaves have been classified as “fast” ($k > 0.01$), “medium” ($k = 0.005$-0.01) and “slow” ($k < 0.005$) (Bärlocher et al., 2005; Petersen & Cummins, 1974). The halving times of the detritus were calculated using the formula proposed: $T_H = \ln 2 \cdot k^{-1}$.

Results and discussion

Leaf mass loss of the two species and the two kinds of bags followed the exponential decay curve (Fig. 4.). The curves of leaf litter bags and plankton net bags almost covered each other.

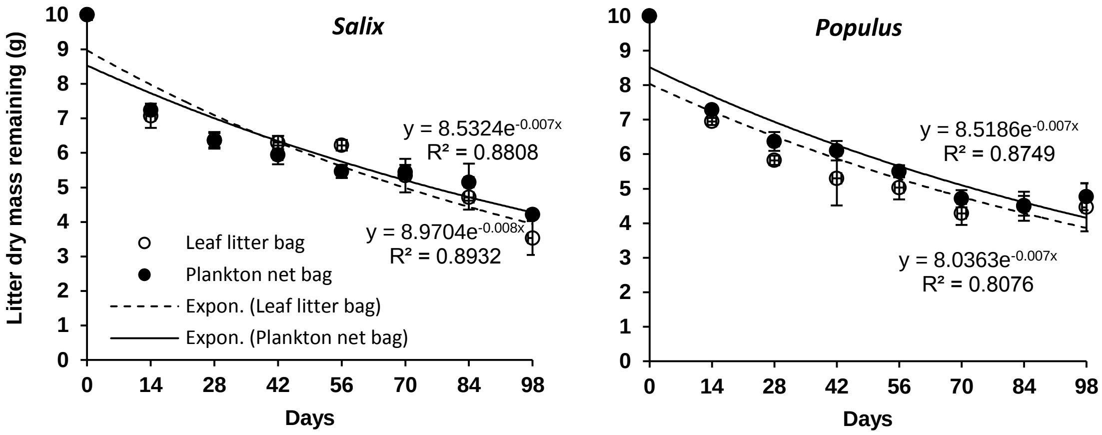

Figure 4: The litter dry mass of Salix and Poplar leaves remaining in the two kinds of bags

Both leaves in both types of bags fell into the fast category. Despite of the lack of drifting, high temperature in the pans caused fast decomposition rates, which matches the findings of Boulton & Boon (1991) under warm circumstances. Decomposition of deciduous leaves are less influenced by temperature, than conifer leaves (Whiles & Wallace, 1997). So the effect of temperature is regionally variable (Tam et al., 1998).

Table 1: Exponential decay coefficients (k) and halving times of Salix and Populus leaves in the pans

Leaf litter	Type of bag	Exponential decay coefficient±SD	Decomposition category	Halving time (day)
Salix	leaf litter bag	0.0127 ± 0.0055	fast	54.6
	plakton net bag	0.0125 ± 0.0050	fast	55.2
Pupulus	leaf litter bag	0.0146 ± 0.0057	fast	47.3
	plakton net bag	0.0127 ± 0.0047	fast	54.5

Water temperate varied from 19.5 to 32.9, while air temperature from 15.5 to 29.2 °C (Fig. 5.). Water temperature in the decomposition pans was continuously about 20% higher, than air temperature. The fluctuation of water temperature in the pans was driven by air temperature.

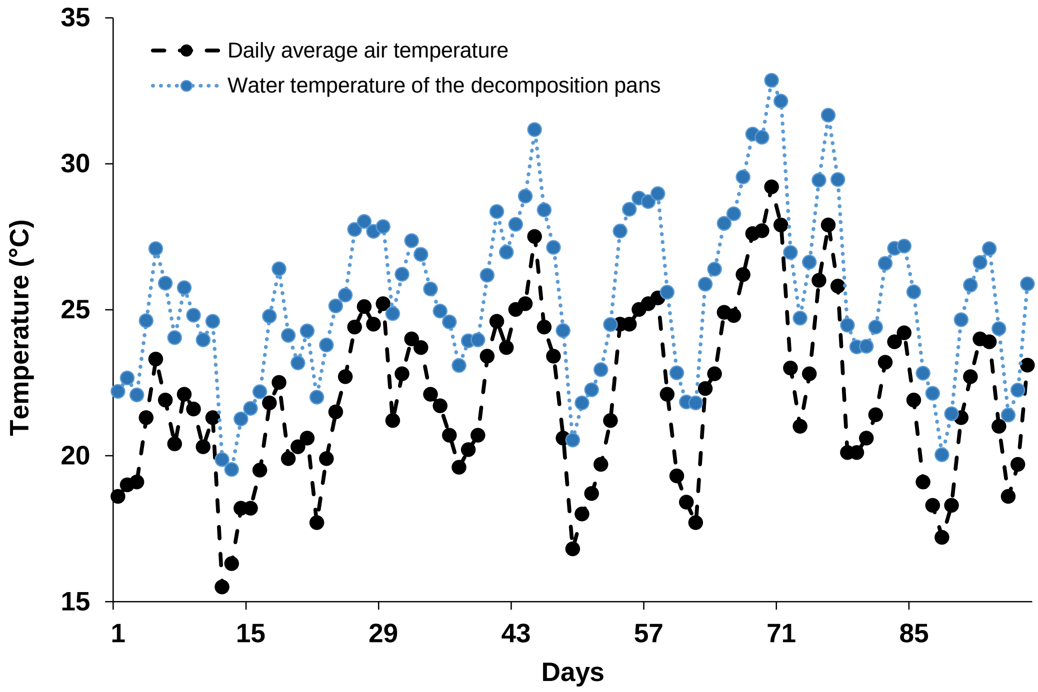

Figure 5: The daily average air temperature and water temperature of the decomposition pans

Among the meteorological elements, the daily average air temperature greatly influences the evaporation values, the rate of evaporation increases with warming (Fig. 6.) Evaporation of the control pan (R^2=0.2222) correlates better with air temperature, than the decomposition pans (R^2=0.2152). The measured evaporation values varied from 3.7 to 7.6 in the control pan, and from 3.3 to 7.5 mm day^{-1} in the decomposition pans.

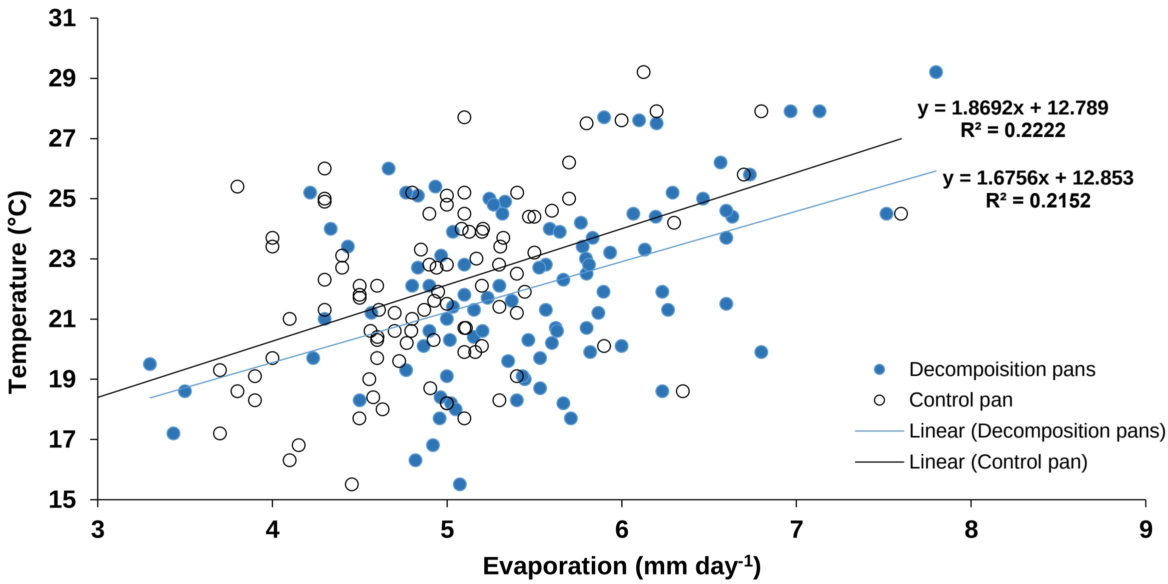

Figure 6: The daily average air temperature and evaporation of the decomposition and control pans

McMahon et al. (2013) proved, that the evaporation of water covered by macrovegetation is higher, than the evaporation of the open water surface. The evaporation of the decomposition pans were higher, than control pans. It can be explained by the dark color of the sludge and leaves, which – additionally with the biological processes of the plants - increased the water temperature and the radiation properties changed.

Conclusion

Leaf mass losses followed the exponential decay curve, decomposition rates were in the fast category. Evaporation has changed due to different circumstances (dark sediment and presence of biomass), which means a better correlation in case of the control pan with air temperature, than the decomposition pans. The experiment should be repeated as far as possible, further expanding of the examined environmental variables is needed.

Acknowledgement

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