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Attempt at evaluation of the degree and rate of moss decay in a natural habitat

I. REJMENT-GROCHOWSKA and M. MISZTAL-CIELICZKO

Institute of Botany, Warsaw University

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Abstract

Analyses of soil samples from under a *Climacium dendroides* population demonstrated that the total mass of decomposed moss depends on the depth of the profile, the vegetation period and the character of the habitat. Changes in the degree of moss decay at a depth of 0—12 cm were estimated by the weight or washing method during 8 months on two grassland study areas differing in moisture conditions. The degree of moss decomposition increases with depth. The decay rate increases from April to August and then decreases up to November.

INTRODUCTION

This study belongs to a more general scope of investigations on the structure and dynamics of development of bryophyte populations and is an attempt of evaluation of the amount of ogranic matter contained in these populations.

Living biomass in the populations studied was estimated preliminarily to be very high as compared with that of vascular plants of the herb layer occurring in the same plant associations. This is due to the long period of life of these populations which may be considered as permanent, and to the short life of the individuals (2—6 years) forming these populations, definite for each species in the given habitat.

The individuals in the population are different-aged, they exhibit a high viability and ability of producing large length increments and reproducing new individuals.

At the same time, with rapid development of the population, continuous dying back in the ground layer and accumulation of organic matter occur.

The present study was undertaken to check the rate of dying back and the distribution of the organic matter of mosses in the course of one vegetation season. If we assume that there exists a seasonal rhythm of population development in definite conditions, estimation of the accumulated dead plant material may be attempted.

AREA INVESTIGATED AND METHODS

The studies were performed on Łąki Sierakowskie (meadows) situated in the North-eastern part of the Kampinos National Park, on an old accumulation terrace of the Vistula. These meadows exhibit characters of a sodden marshy inter-dune area. The floristic composition and soil-forming processes on this territory depend mainly on the hydrological conditions. The local depressions here are submerged for a great part of the year. On account of these differences in moisture there is a wide variability of the soil layer thickness. The soil consists mainly of shallow peat, highly decomposed boggy soil and silt-marsh soils.

The area from which the samples were taken situated West of the road Dziekanów Leśny — Sieraków at a distance of 2 km North of Sieraków is a transitional zone between marshes and dunes involving the associations *Junceto-Sphagnetum* and *Caricetum lasiocarpae* (K o b e n d z a, 1930). These meadows deprived of shrubs include the following characteristic herbaceous plants: *Carex stricta, Calamagrostis lanceolata, Lythrum salicaria, Peucedanum palustre, Carex riparia, Cardamine pratensis, Caltha palustris, Iris pseudacorus, Juncus conglomeras, Lysimachia vulgaris, Ranunculus flammula, R. repens, Rumex hydrolapathum, Stachys palustris.*

The rich moss layer consists of the species: *Climacium dendroides, Calliergon cuspidatum, C. giganteum, C. cordifolium, Drepanocladus vernicosus, Sphagnum nemoreum, S. palustre.*

On the two permanent experimental plots chosen, for complex studies, soil samples were taken every month on the same date from April to November, 1972, from *Climacium dendroides* populations in pure one-species patches.

The study areas I and II, distant from each other about 200 m differed in ecological conditions: area I situated in a local depression was very moist, whereas area II was dry, exposed to sunshine and covered with *Calamagrostis lanceolata.*

The samples were cut out with a metal cylinder with cross section surface area 25 cm^2 and 12 cm high. From each of the areas each time 8 samples were taken. Samples A and B lay near each other (twin samples) and were treated further in analysis as one mixed A+B thus, instead of eight, four profiles were obtained each month from each plot.

The cut out cylinders were at once, divided in moist state into 6 discs of 2 cm height which were numbered from below 1—6.

The material was analysed by the method of washing that is by weighing. A 100 g sample was divided into two equal parts. One was dried for 48 h. at 80°C and weighed, and the result (m) represented the weight of nondecomposed plant remnants, humus and sand. At the same time the natural moisture of the peat w = 50-m was determined in grams.

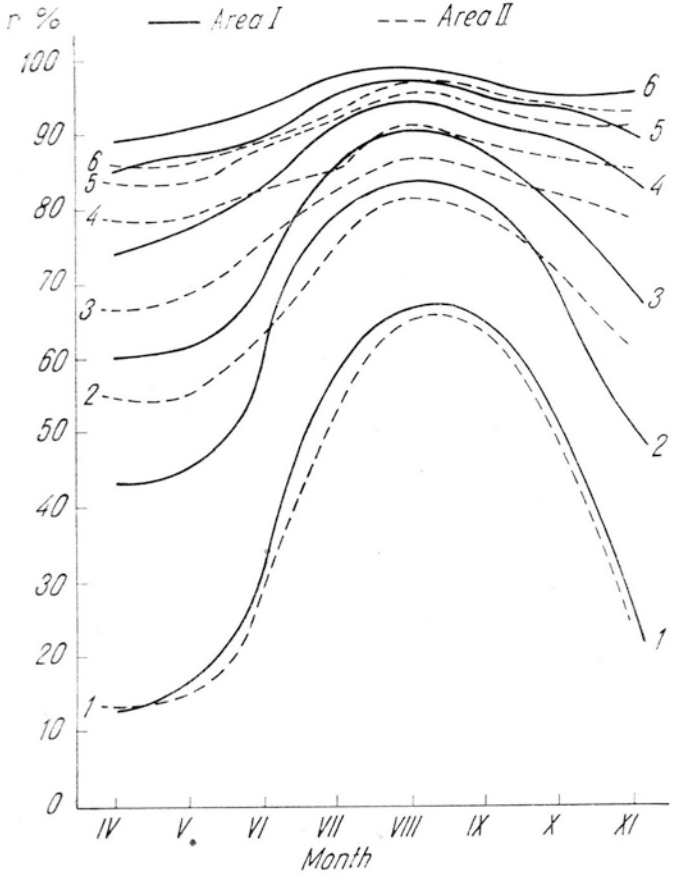

Fig. 1. Degree of moss decomposition during vegetation period at the depths 0-12 cm on sooden surface I and on dry surface II;

r — the degree of decomposition in per cent; 1-6 the subsequent strata: 1 — 0-2 cm, 2 — 2-4 cm, 3 — 4-6 cm, 4 — 6-8 cm, 5 — 8-10 cm, 6 — 10-12 cm

The second part of the sample weighing 50 g was washed on a soil sieve with appropriate mesh size (0.3 mm) with running water. The procedure was continued until the washings were colourless. The plant remnants on the sieve with sand were dried for 48 h at 80°C and weighed giving as result the mass (n).

Further procedure consisted in decanting sand from both samples. The weight of this sand (p') in the first sample allowed to determine the mass of plant remnants (a) together with humus, and mass of the sand (p'') in the second sample allowed the determination of the plant remnants without humus (b) from the formulae $a=m-p'$ and $b=n-p''$. The humus content was $h=a-b$. The degree of decomposition (r) that is the ratio of humus to the initial organic matter (a) in per cents is

$$r=\frac{h}{a}100=\frac{a-b}{a}100.$$

In complex studies on the dynamics of moss population development measurements of the weight of the underground part make it possible to relate this value to the value of the above ground part. Therefore in these investigations the weight method is very useful.

RESULTS

The methods applied served mainly to evaluate the rate and degree of decomposition of *Climacium dendroides* gametophytes. Indirectly, however, they made possible determination of the total organic matter produced by these plants at various depths of the profile from 0 to 12 cm and determination in this matter of the detritus with humus.

The degree of moss decomposition depends, as described in the method, on the humus proportion (h) in the total plant material (a).

The lower layers of the population die back continuously. The process of dying varies in intensity in the course of the 8 months investigated and the rate of decomposition of the dead plants changes. These processes in conditions of greater moisture and higher temperature in the summer months (July—September) occur quickest.

Decay is most rapid in the three upper levels — 0—2, 2—4 and 4—6 cm. This finds its expression in the rapidly rising curve from May to July, reaching its peak between August and September. At the uppermost level (0—2 cm) decomposition r=66 per cent on area I and 64 per cent on area II. (Fig. 1).

At lower levels in the profile, a depth of 6—12 cm decomposition in the course of the vegetation seasons is almost equal as shown by the slightly bent curve. Further transformations of the vegetal material at this depth are slight and the maximal degree of decomposition in August at a depth of 10—12 cm was on area I 98.4 and on area II 96.7 per cent.

At the depth of 10—12 cm the mass of plant detritus varies within the limits of 1—2.5 per cent as compared with the remains at the 0—2 cm level. The dynamics of these changes is similar on both the experimental plots.

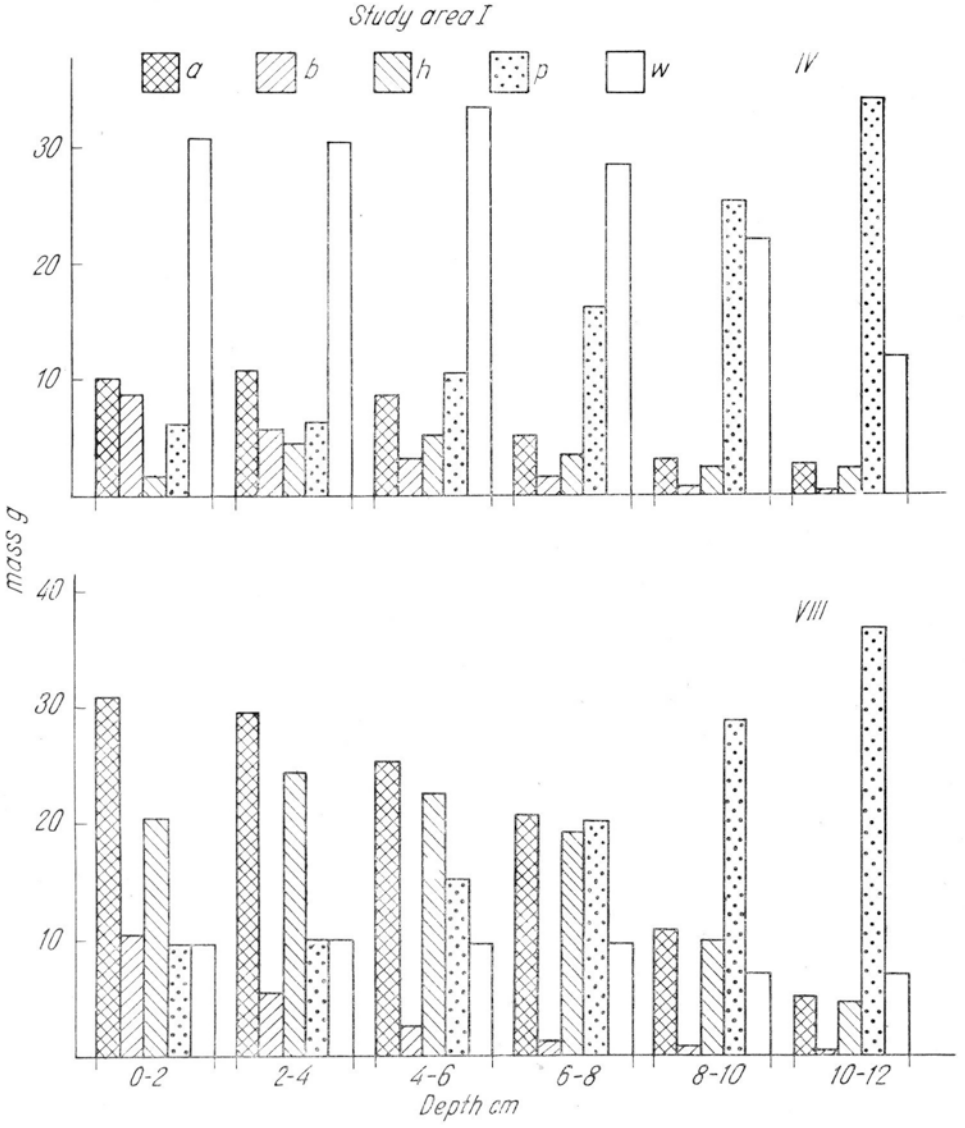

Fig. 2. The content of dry mass of decayed mosses, sand and water in 50 g samples on different depths 0-12 cm on I sodden surface, in April (IV) and September (VIII)

a — the total mass of decayed mosses, *b* — dry mass of washed decayed mosses, *h* — mass of humus with detritus, *p* — mass of sand, *w* — mass of water

Since the investigations were performed on two areas differing by their ecological conditions: area I — sodden peat meadow, area II — dry sandy meadow, the influence of the habitat conditions on the rate of moss decomposition can be evaluated. On the sodden meadow the process occurs more rapidly, particularly in the upper layers (0—2 and 2—4 cm). (Tables 1, 2).

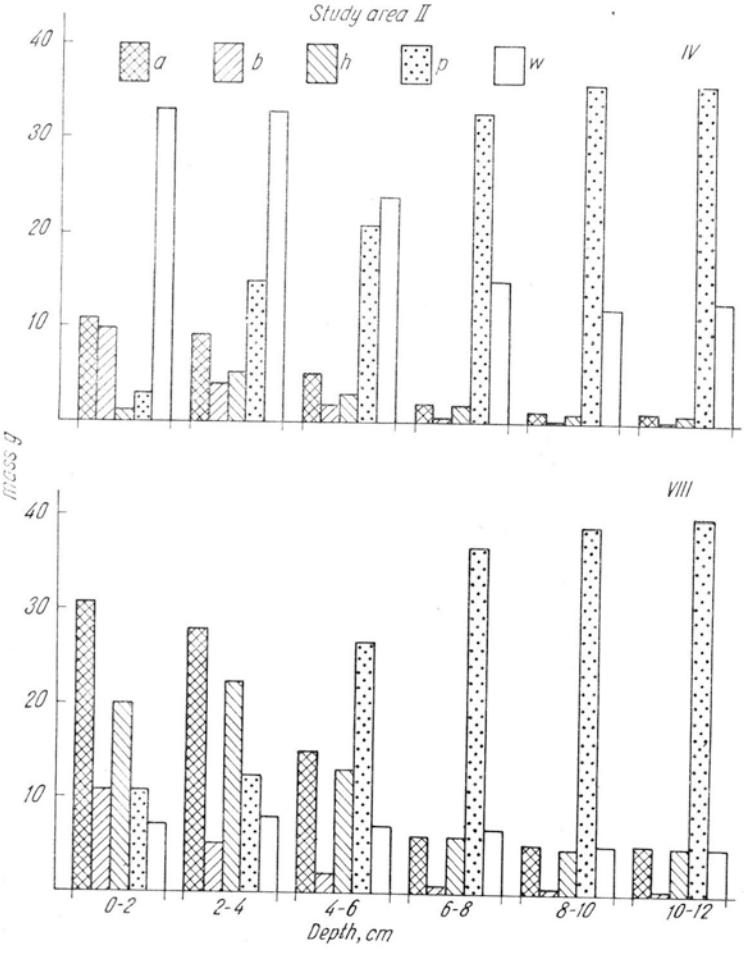

Fig. 3. The content of dry mass of decayed mosses, of sand and water in 50 g samples of soil from different depths 0-12 cm, on dry surface II in April (IV) and September (VIII)

a — the total mass of decayed mosses, *b* — dry mass of washed decayed mosses, *h* — mass of humus and detritus, *p* — mass of sand, *w* — mass of water

Analysis of the results for areas I and II shows a consistent decrease in total organic matter (*a*) with soil depth. This comprises a decrease of the mass of washed moss remnants (*b*) and of humus (*h*). The amount of sand in the soil samples increases with depth.

Table 1

The content of dry mass of decomposed mosses, sand and water in 50 g. sample of soil from different depths (0—12 cm) during on vegetation period from April to November on surface I.

The data for depth are means from, 4 samples; *m*-mass of dryed sample, *p'*-mass of sand, *p''*-total of decayed mosses, *n*-dry mass of washed 50 g sample, *a*-mass of sand from washed sample, *b*-dry mass of washed moss debris, *h*-mass of humus and detritus, *w*-mass of water

Study area I

1	2	3	4	5	6	7	8	9	10	11
Months	Depth profiles cm	Total dry mass with sand g	Mass of sand in 3 g	Total organic dry mass g	Remains with sand after washing g	Mass of sand in 6 g	Remains after washing without sand g	Humus g	Disintegration in %	Mass of water g
		m	p'	$a=m-p'$	n	p''	$b-n-p''$	$h=a-b$	$r=\frac{h}{a}\cdot 100$	w
April	0—2	18.27	5.12	13.15	16.99	5.48	11.51	1.64	12.5	31.55
	2—4	17.45	6.08	11.37	12.99	6.52	6.47	4.90	43.1	32.33
	4—6	18.55	9.96	8.59	13.79	10.34	3.45	5.14	59.8	31.26
	6—8	19.11	14.07	5.04	19.44	18.11	1.33	3.71	73.6	28.87
	8—10	29.60	26.43	3.14	23.65	23.15	0.50	2.67	85.0	22.04
	10—12	36.43	33.72	2.71	35.56	35.21	0.30	2.41	88.9	12.80
May	0—2	19.97	4.82	15.15	18.02	5.34	12.68	2.47	16.3	29.77
	2—4	19.22	6.13	13.09	13.36	6.09	7.27	5.82	44.5	30.80
	4—6	20.21	9.87	10.34	13.63	9.51	4.02	6.32	61.1	29.97
	6—8	22.23	15.72	6.51	16.78	15.27	1.51	5.00	76.9	27.99
	8—10	28.91	24.86	4.05	25.70	25.18	0.51	3.53	87.2	20.93
	10—12	36.54	33.72	2.82	43.70	34.43	0.27	2.55	90.5	13.10
June	0—2	26.79	6.72	20.07	20.31	6.48	13.83	6.24	31.1	23.33
	2—4	25.64	8.47	17.42	15.95	8.51	7.44	9.98	57.3	24.09
	4—6	25.64	11.73	13.91	15.22	11.05	4.17	9.74	70.0	24.75
	6—8	27.68	18.05	9.63	20.43	18.71	0.59	4.93	82.2	22.04
	8—10	32.61	27.09	5.52	27.92	27.33	0.59	4.93	89.4	17.27
	10—12	38.49	35.28	3.21	35.34	35.12	0.22	2.99	93.2	11.59

1	2	3	4	5	6	7	8	9	10	11
July	0—2	34.71	8.13	25.58	19.42	8.21	11.21	15.21	57.9	15.25
	2—4	34.33	9.71	24.62	14.49	9.42	5.07	19.55	79.4	15.80
	4—6	34.43	14.08	20.35	17.18	14.16	3.02	17.33	85.2	15.53
	6—8	33.77	19.50	14.27	20.26	19.04	1.22	13.05	91.5	16.46
	8—10	37.79	29.66	8.13	29.73	29.30	0.43	7.70	94.8	12.39
	10—12	41.06	37.01	4.05	37.21	37.11	0.10	3.95	97.5	8.89
August	0—2	40.55	9.38	31.17	19.96	9.72	10.24	20.93	66.0	9.28
	2—4	40.70	11.27	29.53	17.01	12.03	4.98	24.45	83.0	8.92
	4—6	40.80	15.02	25.78	18.37	15.80	2.57	23.21	90.2	8.81
	6—8	40.60	20.41	20.29	21.93	20.67	1.26	18.93	93.8	9.27
	8—10	43.11	31.56	11.55	31.49	31.12	0.37	11.18	96.8	7.11
	10—12	43.10	38.24	4.86	38.20	38.12	0.08	4.78	98.4	6.96
September	0—2	36.65	8.31	28.34	18.06	8.11	9.95	18.39	64.9	13.39
	2—4	3.38	9.65	26.73	14.81	9.61	5.20	21.53	80.6	13.67
	4—6	35.57	13.42	22.15	16.83	13.88	2.95	19.20	86.7	14.43
	6—8	34.23	18.16	16.07	20.07	18.62	1.45	14.62	90.9	15.75
	8—10	36.64	27.39	9.30	27.64	27.11	0.53	8.77	94.3	13.12
	10—12	40.16	36.05	4.11	36.83	36.71	0.12	3.99	97.0	9.72
October	0—2	29.83	28.02	22.83	18.31	7.22	11.09	11.74	51.4	20.21
	2—4	28.48	8.72	19.76	14.40	8.14	6.26	13.50	68.4	21.42
	4—6	27.46	12.05	14.41	15.57	12.37	3.20	12.31	79.4	22.58
	6—8	28.79	18.51	10.28	19.33	18.13	1.20	9.08	88.4	21.17
	18—10	34.15	27.84	6.31	27.87	27.42	0.45	5.86	92.9	15.95
	0—12	29.21	26.17	3.04	26.17	27.01	0.16	2.88	94.8	20.84
November	0—2	22.67	4.83	17.84	17.13	4.05	13.08	4.76	26.7	27.16
	2—4	21.92	6.21	15.71	14.13	6.32	7.80	7.91	50.3	28.03
	4—6	32.78	10.09	12.69	14.54	10.55	3.99	8.70	68.6	17.24
	6—8	24.73	16.31	8.42	17.55	16.13	1.42	7.00	83.3	25.21
	8—10	30.56	25.46	5.10	25.71	25.18	0.53	4.57	89.6	19.46
	10—12	36.61	34.08	2.53	34.33	34.20	0.13	2.40	94.9	13.52

Table 2

The content at of dry mass of decomposed mosses, sand and water in 50 g soil sample indifferet depths (0—12 cm) during the vegetation period from April to September on surface II

(*m*, *p'*, *a*, *p''*, *b*. *h*, *w*, as in table 1)

Study area II

1	2	3	4	5	6	7	8	9	10	11
Months	Depth profiles cm	Total dry mass with sand	Mass of sand in 3 g	Total organic dry mass g	Remains with sand after washing g	Mass of sand in 6 g	Remains after washing without sand g	Humus g	Disintegration in %	Mass of water g
		m	p'	a=m—p'	n	p''	b=n—p''	h=a—b	$r=\frac{h}{a}\cdot 100$	w
April	0—2	16.39	5.03	11.36	15.11	5.27	9.84	1.52	13.4	33.49
	2—4	16.56	7.52	9.04	11.38	7.29	4.09	4.95	54.8	33.56
	4—6	25.47	20.13	5.34	22.88	21.08	1.80	3.54	66.3	24.06
	6—8	35.98	33.81	2.17	32.61	32.14	0.47	1.70	78.4	14.85
	8—10	37.63	36.05	1.57	36.75	36.49	0.26	1.31	83.5	12.16
	10—12	38.03	36.84	1.19	35.20	35.03	0.17	1.02	85.8	12.87
May	0—2	19.38	5.53	13.85	18.02	6.28	11.74	2.11	15.20	30.25
	2—4	19.78	8.47	11.21	12.98	7.92	5.03	6.18	55.1	30.59
	4—6	26.92	21.14	5.78	22.65	20.81	1.84	3.94	68.2	23.24
	6—8	37.93	34.87	3.06	35.66	35.01	0.65	2.41	78.8	13.00
	8—10	38.68	36.21	2.37	37.86	37.45	0.41	2.06	83.4	10.70
	10—12	39.07	37.05	2.02	36.45	36.17	0.28	1.74	86.2	11.37
June	0—2	26.00	6.37	19.63	20.09	6.13	13.63	5.67	28.9	24.12
	2—4	26.00	10.72	15.28	16.61	10.94	5.67	9.61	62.9	23.89
	4—6	29.35	22.04	7.31	24.10	22.30	1.80	5.51	75.9	20.52
	6—8	39.84	35.11	4.73	36.27	35.43	0.84	2.86	82.2	9.53
	8—10	40.63	37.38	3.25	37.45	37.06	0.39	2.86	88.0	9.53
	10—12	41.41	38.52	2.90	38.43	38.12	0.31	2.59	89.3	8.76

1	2	3	4	5	6	7	8	9	10	11
July	0—2	33.97	8.37	25.36	20.06	8.01	12.05	13.31	52.5	16.45
	2—4	23.25	12.41	19.84	17.27	12.23	5.04	14.80	74.7	17.84
	4—6	34.85	25.12	9.72	26.93	25.14	1.79	7.93	81.5	15.15
	6—8	41.69	36.52	5.17	36.86	36.08	0.78	4.39	85.0	8.53
	8—10	42.20	38.71	3.49	38.72	38.39	0.33	3.16	90.6	7.98
	10—12	42.37	39.02	3.35	39.71	39.46	0.25	3.10	92.6	7.41
August	0—2	41.72	10.27	31.45	22.43	11.33	11.10	20.35	64.7	7.84
	2—4	42.14	13.88	28.26	19.42	14.04	5.38	22.88	81.0	7.92
	4—6	43.21	27.84	15.37	29.00	26.96	2.04	13.33	86.7	6.89
	6—8	43.96	37.35	6.71	37.60	37.01	0.51	6.12	91.2	6.79
	8—10	44.42	39.31	5.11	39.31	39.70	0.25	4.86	95.1	5.64
	10—12	44.89	40.06	4.83	40.36	40.20	0.16	4.67	96.7	5.06
September	0—2	36.31	8.47	27.84	18.75	8.51	10.24	17.64	63.0	13.74
	2—4	34.16	12.23	21.93	17.42	12.79	4.63	17.30	79.0	15.85
	4—6	35.87	25.31	10.56	27.61	25.97	1.64	8.92	84.5	14.28
	6—8	42.60	36.69	5.91	37.43	36.73	0.70	5.21	88.3	7.51
	8—10	42.68	38.16	4.53	38.34	38.01	0.33	4.20	92.8	7.06
	10—12	42.76	38.92	3.84	38.22	38.02	0.20	3.64	94.9	6.97
Ocotber	0—2	29.43	6.48	22.95	17.00	6.32	11.68	11.27	49.1	20.61
	2—4	28.15	10.51	17.64	15.65	10.63	5.02	12.62	71.5	21.93
	4—6	33.10	23.27	9.83	24.91	23.07	1.84	7.99	81.3	16.87
	6—8	40.27	35.17	5.10	35.80	35.11	0.69	4.41	86.5	9.74
	8—10	40.79	27.22	3.57	37.96	37.64	0.32	3.25	91.0	9.15
	10—12	41.50	38.09	3.41	39.49	38.28	0.22	3.19	93.5	8.44
November	0—2	21.44	4.72	16.72	16.76	4.22	12.54	4.28	25.0	28.37
	2—4	21.06	7.69	13.37	12.35	7.15	5.20	8.17	61.1	28.84
	4—6	17.32	10.83	6.49	11.73	10.31	1.42	5.07	78.1	32.15
	6—8	37.31	34.15	3.16	35.18	34.67	0.51	2.65	82.9	12.66
	8—10	39.09	36.28	2.81	36.27	35.98	0.29	2.52	89.7	10.88
	10—12	39.95	36.98	2.97	36.75	36.52	0.23	2.74	92.3	10.05

The main concentration of decomposition products of the population occurs in conditions directly connected with the living population at the depth of 0—2 cm. With the progress of humification the aqueous solutions of organic acids penetrate to deeper layers. As a consequence of these processes only a small amount of moss remnants (0.6 g/m^2) is washed out in August from a depth of 10—12 cm as compared with 82 g/m^2 at the depth of 0—2 cm.

Comparative analysis of organic matter content in mosses between April and August, that is in the period when the intensity of decay increases considerably, indicates that at the same depth there are smaller amounts of decomposed moss in April than in August. The amount of total detritus with humus (*a*) and of washed remnants (*b*) is also smaller. The increase of the amount of decomposed organic matter from April to August is the consequence of the progressing moss decomposition process in this period.

It results from complex investigations on the development dynamics of the *Climacium dendroides* population on the Sierakowskie Meadows that the quantities of the underground and above-ground parts of the population are highest in August. In this period the aerial part reaches the peak of its development manifested by the highest value of dry biomass amounting to about 300 g/m^2. At the same time in the underground layer at a depth of 0—2 cm detritus is accumulated in the amount of about 250 g/m^2 dry mass.

During the first part of the vegetation period from March to July regeneration and growth of the population occur in connection with the gradual increase of the above- and underground biomass as a whole.

The second part of the vegetation period from September to November is characterized by a decrease in the above- and underground mass resulting from inhibition of growth.

There is a certain balance between the values for the initial vegetation period (March) and the end period (November). These amounts are almost two times smaller than the maximal values for August.

CONCLUSIONS

Moss decomposition in all the profiles examined increases with depth. It was lowest percentually in April at a 0—2 cm depth amounting to 12.5 per cent (area I) and 13.4 per cent (area II).

The highest degree of decomposition in the uppermost 0—2 cm layer is noted in August, amounting to 66 per cent. In this period decomposition is highest even at a 10—12 cm depth reaching 98.4 per cent. At this depth mainly large quantities of humus derived from the decaying plant remnants in the upper layers and of flowing down sand are present.

Complex investigations revealed some interesting relations between the dry weight of the above-ground moss part and the underground part on a 1 m^2 surface area at a depth of 0—2 cm: this ratio was in April 250:90, in August 300:250 and in November 220:120. In August the two biomasses show the highest values and their state is close to equilibrium. This is the time of periodic stabilization of the processes of increase in mass and decomposition. The population after reaching the peak of its development at the time when decomposition was highest, prepares for the rest period.

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Authors' addresse
Prof. dr Irena Rejment-Grochowska and
Mgr M. Misztal-Cieliczko
Institute of Botany, Warsaw University
Al. Ujazdowskie 4; 00-478 Warszawa, Poland

Próba oceny stopnia i szybkości rozkładu mchów w naturalnym środowisku

Streszczenie

Badania rozkładu mchów pod populacją *Climacium dendroides* prowadzone były na Łąkach Sierakowskich na dwóch wybranych do tych celów powierzchniach: I — podmokłej, torfiastej łące, II — suchej, piaszczystej łące. Z każdej powierzchni, w każdym miesiącu od kwietnia do listopada 1973 r. wycinano po 8 profilów glebowych głębokości 12 cm. Wycięte profile rozcinano na 6 warstw, po 2 cm grubości. Dwa najbliżej siebie leżące profile, zwane bliźniaczymi, A i B były mieszane warstwami i łącznie analizowane.

Rozkład mchów kontrolowano metodą wagową czyli przemywania, której wyniki wagowe wykazują przydatność w badaniach kompleksowych nad dynamiką rozwoju populacji mchów.

Uzyskane wyniki pochodzące z 6-ciu warstw (0—2 cm, 2—4 cm, 4—6 cm, 6—8 cm, 8—10 cm, 10—12 cm) 8 profilów, każdej z dwóch powierzchni, pozwoliły na ocenę zawartości ogólnej masy organicznej (a), masy przemytych szczątków mchów (b) oraz masy humusu z detrytusem (h). Na podstawie $\frac{h}{a}$ 100 uzyskano procentowy rozkład (r) dla każdej warstwy w każdym miesiącu. W każdym miesiącu stopień rozkładu wzrasta wraz z głębokością. Najsłabszym rozkładem charakteryzują się górne warstwy, szczególnie na głębokości 0—2 cm.

W pierwszym okresie badanego sezonu od kwietnia do sierpnia odbywa się szybki wzrost stopnia rozkładu mchów, zwłaszcza na górnym poziomie (ryc. 1); w drugim okresie sezonu, od sierpnia do listopada zmniejsza się stopień rozkładu, w górnej warstwie obniża się on o prawie 40%. Rozkład mchów w głębszych warstwach, 6—12 cm, jest w ciągu sezonu bardzo wyrównany, co wyraża się słabo wygiętą krzywą.

Porównawcze wyniki (Tab. 1, Tab. 2) ogólnej masy organicznej, masy przemytych szczątków oraz procentowego rozkładu na obu powierzchniach są zbliżone; wykazują one, że proces rozkładu na łąkach podmokłych (pow. I) przebiega nieco szybciej niż na łąkach suchych (pow. II).