Suo 34 (3): 73—77. 1983

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VARIATION IN SPHAGNUM SHOOT NUMBERS AND SHOOT BULK DENSITY IN HUMMOCKS OF A RAISED BOG

RAHKAMÄTTÄIDEN SAMMALIKON RAKENTEESTA JA TIHEYDESTÄ LAAVIOSUON KEIDASRÄMEELLÄ

Lindholm, T. 1983: Variation in Sphagnum shoot numbers and shoot bulk density in hummocks of a raised bog. (Rahkamättäiden sammalikon rakenteesta ja tiheydestä Laaviosuon keidasrämeellä.) — Suo 34: 73—77 Helsinki.

The shoot number of *Sphagnum fuscum* plants in hummocks was 42160 ± 12800 per m^2 and the bulk density of the 10 mm shoot layer immediately below the capitulum level was 10.6 ± 3.3 g/dm^3. The shoot number explained 36 % of the variation of bulk densities in different samples. There is a large variation in the size of individual shoots, shoot densities and shoot numbers in different parts of a *Sphagnum fuscum* hummock.

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Several mire ecosystems studies have been devoted to primary production (e.g. Vasander 1982, Bradbury & Grace 1983 and references therein) and rates of peat accumulation (e.g. Tolonen 1979, Clymo 1978 and 1983). *Sphagnum* species form an important factor in peats and on raised bogs *Sphagnum fuscum* (Schimp.) Klinggr. is an important peat former (Tolonen 1982).

In most primary production and peat accumulation studies the role of *Sphagnum* is studied at the scale of *Sphagnum* carpets (e.g. Ilomets 1981) rather than at the individual plant scale. The aim of this study is to describe the variation in *Sphagnum* shoot density and volume weight within a single *Sphagnum* hummock carpet, and to analyse the variation in *Sphagnum* shoot populations on hummock moss carpets.

The study is part of an extensive study concerned with the ecology of mire plants on a raised bog, Laaviosuo (e.g. Ruuhijärvi & Reinikainen 1981, Reinikainen et al. 1983).

STUDY AREA

The material was collected from the bog Laaviosuo (61°02'N, 24°58'E), which is located in the vicinity of Lammi Biological Station in southern Finland.

Laaviosuo is an ombrotrophic raised bog characterized by a complex mosaic surface of hollows, lawns and hummocks. A detailed description of the vegetation is given by Lindholm & Vasander (1980) and Vasander (1982).

The sampling sites were located in the centre of the raised bog and samples taken from the intermediate level of hummock, where *Sphagnum fuscum* was dominant and growth vigorous. The exact sites were chosen so that the proportion of vascular plants, mainly the dwarf shrubs *Calluna vulgaris* (L.) Hull, *Empetrum nigrum* L. and *Andromeda polifolia* L., was small and their shoot density sparse.

MATERIALS AND METHODS

Seventeen samples were collected in late autumn 1977 — before the peatland was drained (Reinikainen & Lindholm 1980) — when the surface of *Sphagnum* carpet was already frozen. The samples were extracted by means of a metal cylinder with a diameter of 12.5 cm and area of 39.3 cm^2. Each sample was placed into a plastic bag and stored in a freezing room so that they maintained their original size.

Using a sharp knife two or three 3—4 cm long subsamples were cut off from the surface of each frozen cylinder sample. The subsamples were cut to form squares with an area of 25 cm^2. Their total number was 25.

After melting the subsamples the shoots of

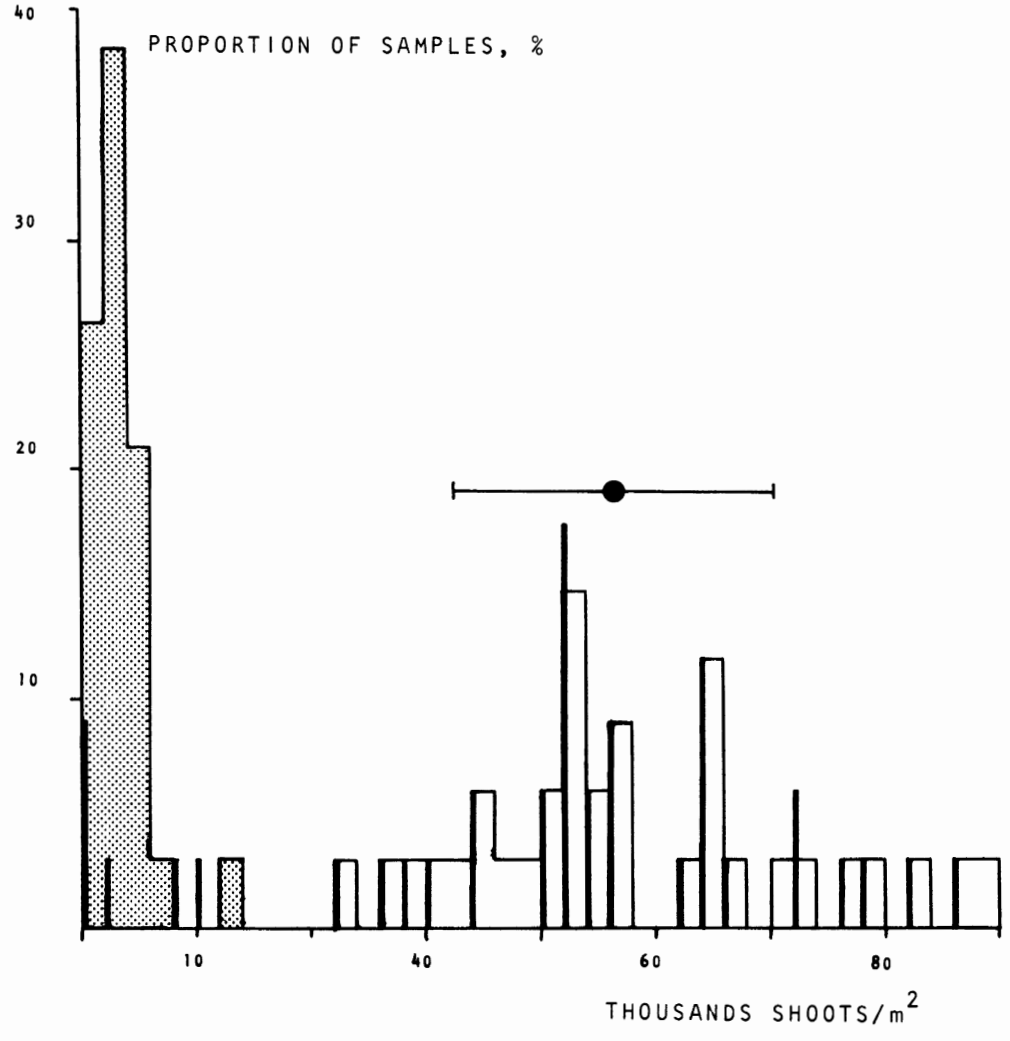

Fig. 1. The % frecuency distribution of *Sphagnum* shoot densities. Open column is the proportion of all shoots in the samples. Black column, cases of 20000 shoots/m^2 or more, the distribution of *Sphagnum rubellum*. The hatched column present the distribution of *Sphagnum angustifolium*. The mean shoot number ($\bar{x}$) with standard deviation (S.D.) is marked by dot and horizontal bar.

Kuva 1. Erilaisten rahkasammaltiheyksien prosenttijakauma. Avoin pylväs ilmaisee kokonaisversotiheyden. Musta pylväs ilmaisee ruskorahkasammalen määrien jakauman (kun versoja on enemmän kuin 20 000 kpl/m^2) ja rusorahkasammalen määrien jakauman (versoja vähemmän kuin 20 000 kpl/m^2). Rasteroitu pylväs ilmaisee jokasuonrahkasammalen määrien jakauman. Keskimääräinen versotiheys keskihajontoineen on ilmaistu mustalla pisteellä ja vaakajanalla.

each subsample were separated out and counted. Thereafter the topmost capitulum part of each shoot was cut off and the first 10 mm length of each shoot was cut off. This 10 mm fraction below capitulum of each subsample was used to determine shoot volume weight by drying the subsample shoot fractions for 24 h at 65°C and then weighing them with an accuracy of 0.01 g.

RESULTS

The shoot composition of the hummocks was dominated by *Sphagnum fuscum* (Table 1), although in most cases there was a minor proportion of *Sphagnum angustifolium* (Russow) C. Jens. A third *Sphagnum* species, *Sphagnum rubellum* Wils., occurred only in a few samples. The amount of *Sphagnum angustifolium* and *Sphagnum rubellum* was small, 4000 shoots/m², compared to *Sphagnum fuscum*, 42160 shoots/m². However, variation in the shoot density between different samples was large.

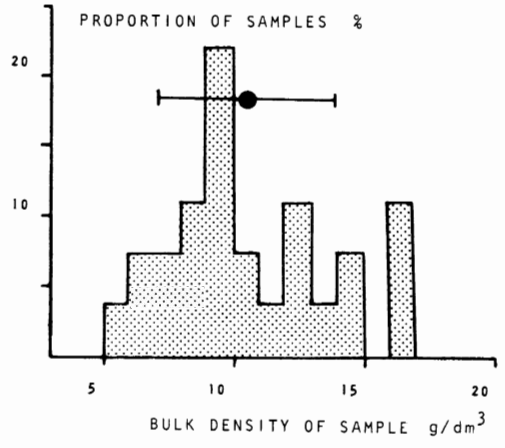

Fig. 2. The % frequency distribution of *Sphagnum* shoot bulk densities as measured for the first 10 mm shoot length below the capitulum level.

Kuva 2. Rahkasammalnäytteiden tiheyspainojakauma mitattuna latvuksen alta ensimmäisestä sentistä.

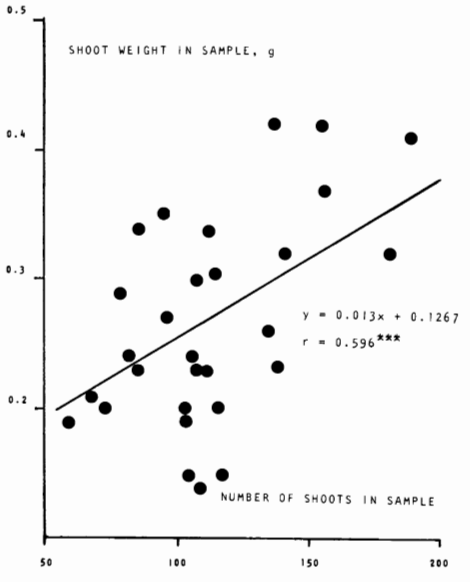

Fig. 3. The relationship between shoot density (number of shoots/25 cm²) and bulk density of *Sphagnum* carpet below the capitulum level.

Kuva 3. Versomäärien ja tiheyspainon välinen riippuvuus.

Table 1. The shoot composition of *Sphagnum* hummocks at Laaviosuo.

Taulukko 1. Mättään rahkasammalversorakenne Laaviosuon keidasrämeellä.

Sphagnum species *lajit*	*Shoot density Versotiheys*			Frequency of species in samples *Esiintymisfrekvenssi*
	Number of shoots per m² *Versojen määrä m²:llä*		Proportion in percentages *Osuus prosentteina*	
	$\bar{x}$	*S.D.*		
S. fuscum	42160	12800	91.3	100
S. angustifolium	3280	2480	7.1	91
S. rubellum	720	2440	1.6	18
Total *Yhteensä*	46200	12800	100	

The shoot numbers were normally distributed (Fig. 1). This was also the case with the *Sphagnum fuscum* shoots alone. The shoot numbers of *Sphagnum angustifolium* and *Sphagnum rubellum* populations were very scewed, the most sparse densities being the most frequent.

The mean dry weight and standard deviation of the shoot carpet, measured as the first 10 mm below capitulum level, was 106 ± 32.5 g/m^2 and the bulk density was 10.6 ± 3.3 g/dm^3, ranging from 5 to 17 (Fig. 2).

The relationshop between *Sphagnum* shoot density and the bulk density of *Sphagnum* carpet was linear (Fig. 3). The shoot number explained 36 % (r^2) of the variation in bulk densities.

DISCUSSION

The main species in the hummocks was *Sphagnum fuscum* as in generally the case for ombrotrophic bogs, especially on *Calluna — Sphagnum fuscum — Cladonia* and *Empetrum — Sphagnum fuscum* site types (Eurola 1962). The proportion of *Sphagnum rubellum* was low. In the study area *Sphagnum rubellum* favoured more the wet level (Lumiala 1944). The location of *Sphagnum angustifolium* in somewhat different. Its optimal location is the oligotrophic lawn level, where it may form a pure carpet (e.g. Eurola 1962). It can also survive on the high hummock level as was the case in Laaviosuo. On hummocks it is normally found as single shoots scattered among *Sphagnum fuscum* and were it typically has a well developed capitulum.

The *Sphagnum* shoots at the surface of hummocks stand vertically upward and do not bend near surface, as is the case in hollows (e.g. Overbeck & Happach 1957, Grosse-Brauckmann 1963 and Fenton 1980). As they are buried deeper in the peat, however, hummock *Sphagnum* shoots become compressed (Pakarinen & Tolonen 1977).

The amount of *Sphagnum* varied greatly between different subsamples. Large differences in the amount of *Sphagnum fuscum* shoots between different hummocks in a Russian bog was also noticed by Grabovik & Antipin (1982). In three cases the number of shoots was reported to be 36000 shoots/m^2, 25000 shoots/m^2 and 60000 shoots/m^2. Therefore the mean shoot density found in this study 42160 is comparable and may represent a mean value for *Sphagnum fuscum* hummocks in general.

The amount of capitulae in surface of *Sphagnum* carpet increases with the bulk density of the surface fraction (Clymo 1970, Sonesson 1973, Tolonen 1977). The results presented here relate to the bulk density of shoots just below the capitulum level. The bulk density seems to be at its lowest just below the capitulum level (Tolonen 1977), which may explain the rather small bulk density values here. Tolonen (1977) has presented bulk density values for the nearby bog Kaurastensuo of approximately 15 g/dm^3 when measured 10—20 mm from the surface.

The number of *Sphagnum* shoots seems to be an important factor in explainging the variation in bulk densities between different samples. Other factores, not studied here, may cause part of the variation.

ACKNOWLEDGEMENTS

I am indebted to personal of the Lammi Biological Station for providing working facilities. Sirkka-Liisa Kiehl assisted in laboratory. Comments on the manuscript were made by Mike Starr, Harri Vasander and Juha Tiainen. Mike Starr also revised the English. I am grateful to all these persons. This study was partly financed by the Finnish Forest Research Institute and the Academy of Finland.

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SELOSTE:

RAHKAMÄTTÄIDEN SAMMALIKON RAKENTEESTA JA TIHEYDESTÄ LAAVIOSUON KEIDASRÄMEELLÄ.

Rahkasammalkon tuotanto-ominaisuudet eri kannoilta tarkasteltuna ovat tärkeitä silloin kun tarvitaan tietoa soiden perustuotannosta tai turpeen muodostumisesta. Tässä työssä on pyritty tarkastelemaan rahkamätästä erillisistä sammalversoista koostuvana yhteisönä. Rahkamättäällähän on perustuotantoyksikkönä erillinen sammaverso, vaikka tavallisesti tällaisena on käytännön syistä pidetty rahkasammalten muodostamaa pintaa.

Työssä mitattiin rahkamättäistä versomäärät pinta-alaa kohden ja pyrittiin tulkitsemaan saatua suurta määrävaihtelua tiheyspainojen avulla. Ruskorahkasammalvaltaisen *(Sphagnum fuscum)* mättään, jossa seassa oli jokasuonrahkasammalta *(Sphagnum angustifolium)* ja rusosammalta *(Sphagnum rubellum),* rahkasammalmääräksi saatiin keskimäärin 42160 versoa (S.D. 12800) neliömerillä. Vastaavasti tiheysarvoiksi saatiin juuri latvuksen alta mitattuna keskimäärin 10.6 g/dm^3 (S.D. 3.3). Versomäärä selitti 36 % tiheysarvoissa havaitusta vaihtelusta. Täten versomäärillä on varsin keskeinen merkitys tiheyspainon määräytymiseen, mutta silti siihen näyttävät vaikuttavan ratkaisevasti jotkin muutkin tekijät.