Extended abstract No. 365

ARE SPHAGNUM PROPAGULES STILL VITAL WHEN STORED UP TO 12 MONTHS?

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SUMMARY

Storage and transport of *Sphagnum* propagules might be necessary for broad implementation of *Sphagnum* farming. We tested the vitality and growth of *Sphagnum palustre* after refrigerated storage at 6°C for three, six and twelve months in comparison to fresh peat mosses.
Even propagules stored for up to twelve months developed lawns with a similarly vital moss cover as fresh propagules. Fresh propagules, however, produced significantly more biomass when growing on peat. The fresher the propagules the better they are suited for *Sphagnum* farm establishment.

KEYWORDS: *Sphagnum* farming, propagule storage, regrowth, *Sphagnum palustre*

INTRODUCTION

Sphagnum biomass may provide a sustainable alternative to fossil white peat as a raw material for horticultural growing media. In many regions it is not possible to collect *Sphagnum* from natural habitats because of the scarcity of undisturbed bogs. Thus, *Sphagnum* biomass must be cultivated to obtain the required volumes (Gaudig *et al.*, this volume, Wichmann *et al.*, this volume). Establishment of *Sphagnum* farms requires vital *Sphagnum* propagules for seeding. For restoration purposes Quinty and Rochefort, (2003) advise to use *Sphagnum* from natural sites in a ratio of 1:10 (i.e. material from 1 m² collection site for 10 m² restoration site). In our *Sphagnum* farming field trials we used 75 to 100 m³ of *Sphagnum* propagules per hectare (Krebs *et al.*, this volume).

In Germany, collection of *Sphagnum* from natural sources is prohibited by law. Consequently the availability of *Sphagnum* propagules of regional origin is a major bottleneck for large scale *Sphagnum* farming. To provide sufficient seeding material its storage and transport might be necessary. Here we explore the vitality of *Sphagnum* propagules after storage under cool conditions, with the hypothesis that their vitality declines proportional to the duration of storage.

MATERIALS AND METHODS

Sphagnum palustre was collected from a natural peat moss lawn, with other mosses and vascular plants removed and cultivated fresh or after storage in a fridge at 6°C for 3, 6 and 12 months, respectively. Peat moss fragments (5-10 mm and 5-10 cm long) were evenly distributed (cover ca. 80%) over sterilised peat or mats floating on open water (nutrient solution after Rudolph *et al.*, 1988) and grown under controlled conditions in a greenhouse (after Rudolph *et al.*, 1988). The water level was maintained by irrigating with demineralised water. The mosses were fertilized weekly with a nutrient solution after Rudolph *et al.* (1988). Treatments comprised six replicas. We monitored *Sphagnum* growth by recording coverage, lawn thickness, number of capitula in permanent plots (10x10 cm) and harvested the biomass after six months. Newly developed capitula ('innovation') and bigger capitula with branches ('capitula') were assessed separately. Biomass weight was determined separately for peat mosses and brown mosses after drying at 80°C for 24 hours.

Statistical analyses and figures were made with the software R (R Development Core Team 2009). Differences between sites were analysed with the non parametric Kruskal Wallis test and a multiple comparison test after Siegel & Castellan (1988, R package pgirmess, Giraudoux 2010).

RESULTS

Initially fresh peat mosses and those stored for three months started with significantly more vital (green) plants than longer stored mosses (Fig. 1A). However, after three months the growing moss cover was similar (mean cover 73%) independent of length of storage time (Fig. 1A) reaching on average 80% cover after six months.

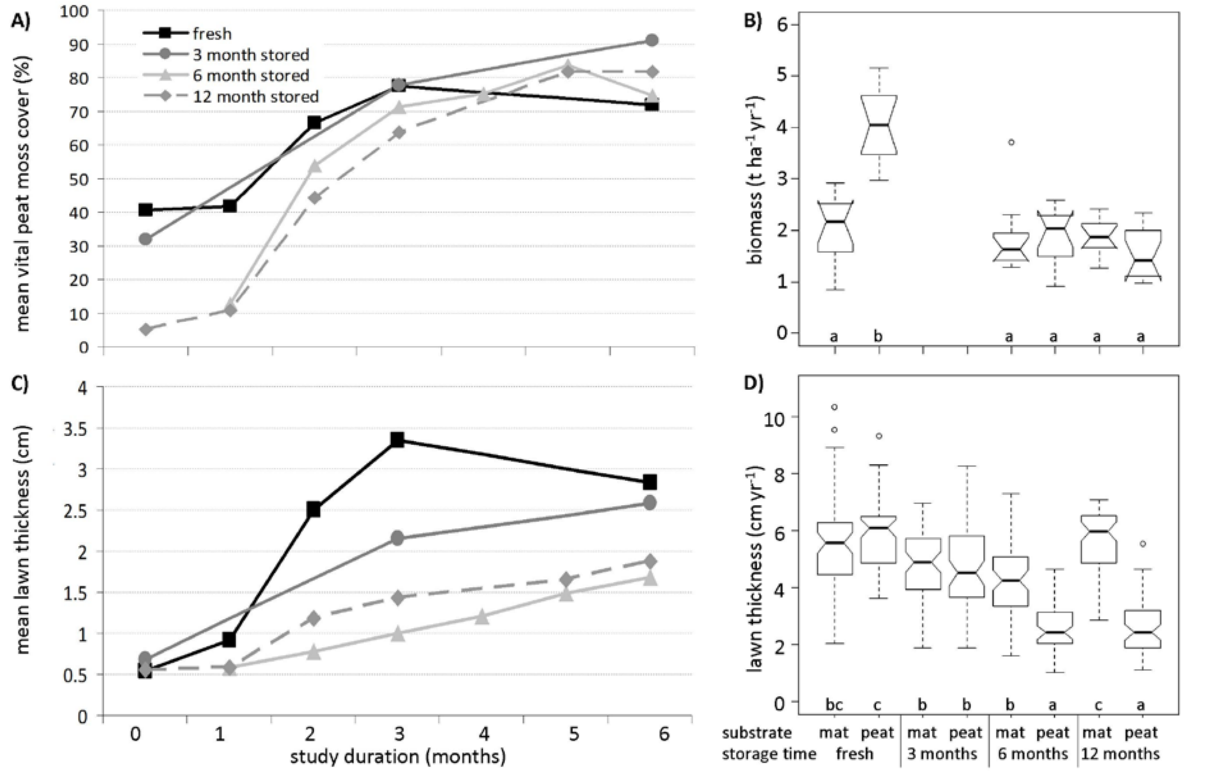

Fig. 1. Development of A) mean vital peat moss cover (in %) of differently long stored propagules from *Sphagnum palustre* and C) mean lawn thickness (in cm) and B) biomass productivity (in t dry mass ha^{-1} yr^{-1}) and D) lawn thickness (in cm yr^{-1}) in relation to substrate and storage time six months after seeding. Differences of treatments were tested separately for B) and D) (Kruskal Wallis and multiple comparison test). Values with different letters differ significantly (P≤0.05).

While the number of (big) capitula increased over the time (on av. from 500 to 8,000 capitula m^{-2}), the number of innovations increased rapidly in the first two month but decreased towards the end of the experiment. The maximum number of capitula was reached after two or three months (Fig. 2A). Storage time had no influence on the number of (big) capitula after six months, but longer stored mosses (6 and 12 months) developed significantly more innovations, especially from small fragments (Fig. 2C). On peat the mosses had more (big) capitula than on floating mats (Fig. 2B). This difference is most clear for fresh mosses.

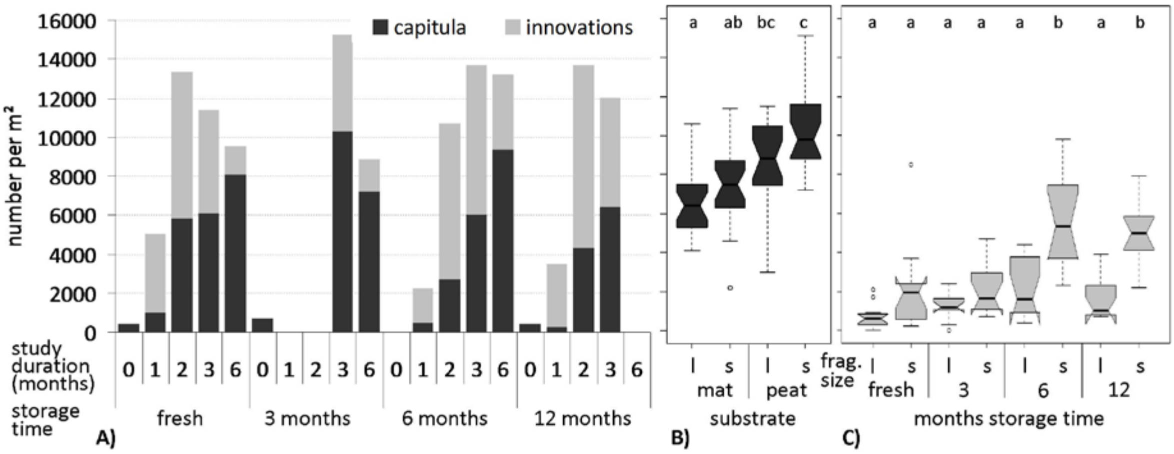

Fig. 2. A) Mean number of (big) capitula and innovations (new capitula) of *Sphagnum palustre* propagules per m² over time in relation to length of storage time (cumulative bars); B) number of (big) capitula six months after seeding in relation to initial fragment size (l = 5-10 cm, s = 5-10 mm) and substrate (all lengths of storage time); C) number of innovations (new capitula) six months after seeding in relation to initial fragment size and length of storage time. Differences of treatments were tested separately for B) and C) (Kruskal Wallis and multiple comparison test). Values with different letters differ significantly ($P \leq 0.05$).

The longer mosses were stored, the lesser was the lawn thickness, with maximum differences compared to the fresher mosses occurring three months after seeding (Fig. 1C).
Mosses stored for 6 and 12 months showed after six months significantly smaller lawn thicknesses on peat than on floating mats (Fig. 1D). Productivity ranged between 1 and 2.5 t dry mass ha^{-1} yr^{-1}, except for fresh mosses growing on peat reaching significantly higher values of 3 to 5 t dry mass ha^{-1} yr^{-1} (Fig. 1B).

DISCUSSION

Already three months after seeding the cover of vital mosses was similar for all storage variants. Propagules stored for up to twelve months are thus able to develop lawns with similar moss cover than fresh propagules. The peat mosses, however, differed significantly with respect to growth in length and biomass. Even with an initially similar number of capitula between the storage variants, the initial cover of green vital moss capitula was higher for fresh mosses (cover 36% vs. 5%; Fig. 1A). The larger number of vital capitula resulted in a better initial growth of fresh mosses, especially on peat, while longer stored mosses still needed time to establish, because regeneration ability from brown parts of *Sphagnum palustre* is slower than from green parts (Poschlod and Pfadenhauer, 1989).

Six months after seeding, mosses stored for 6 and 12 months had developed significantly more innovations than the fresh propagules, in particular after fragmentation. This was probably as a result of reduced vitality, less (light) competition from the big capitula and the loss of apical dominance.

After three months the fresh mosses had developed a lawn of on average 3.3 cm thick, which corresponds to a growth rate of 12 cm per year. Three months later lawn thickness had decreased (mean value: 2.8 cm) and did not differ much from the stored mosses anymore, probably because of fungal infection and subsequent slumping of the lawn. Nevertheless biomass production (measured after six months) was highest for fresh mosses growing on peat with a mean of 4 t dry mass ha^{-1} yr^{-1}, which is more than observed for *Sphagnum palustre* in natural bogs (Lütt, 1992). As fungal infection is a common problem of *Sphagnum* cultures in the greenhouse (Landry *et al.*, 2011), outdoor growth rate may even be higher. Independent of the length of storage, mosses on floating mats produced significantly less biomass. Their mean productivity of 2 t dry mass ha^{-1} yr^{-1} corresponded to values measured for *Sphagnum palustre* growing on similar floating mats in acid water bodies in abandoned opencast lignite mining areas in Germany (Blievernicht *et al.*, 2011). Longer storage of the propagules (6 or 12 months) resulted on peat in similarly low productivity values of around 2 t dry mass ha^{-1} yr^{-1}. Since high *Sphagnum* productivity is crucial to get maximum yields, only fresh mosses seem suitable as Sphagnum farming propagules on peat. The larger number of (big) capitula after six months also indicates better *Sphagnum* growth on peat, most clearly for fresh mosses.

CONCLUSION

Our study shows that *Sphagnum* propagules stored up to twelve month at 6°C still can develop lawns, but with significantly lower productivity than fresh mosses. Rapid establishment and high productivity rates are crucial for *Sphagnum* farming and in this respect the quality of the propagules has to be as good as possible. Under storage, the vitality of the propagules decreases proportional to the duration of storage, probably because photosynthesis does not proceed but respiration and decomposition of the mosses do (Lindholm 1990, Asada *et al.* 2003). Using fresh propagules ensures best results for establishing a *Sphagnum* farming site, in particular on peat. If propagules have to be stored (because an immediate spreading in the field is not possible) freezing might keep the mosses more vital than storing in a fridge, because respiration is halted and decomposition is strongly reduced (Dioumaeva *et al.* 2003). However, as longer stored mosses (6 and 12 months) had developed significantly more innovations (new capitula) after six months, they may prove to be advantageous for propagules production (Gaudig *et al.*, this volume).

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