Sundew cultivation (*Drosera rotundifolia*) on *Sphagnum* in paludiculture – the great potential of a tiny medicinal plant

Dr Balázs Baranyai

Institute of Botany and Landscape Ecology, University of Greifswald, Germany, Partner in the Greifswald Mire Centre,

Email: balazs.baranyai@uni-greifswald.de

Fig. 1 Drosera rotundifolia

Introduction

The round-leaved sundew (*Drosera rotundifolia* L.) is a perennial insectivorous herb which occupies open, wet, oligotrophic habitats such as acidic bogs and poor fens, and specifically grows in *Sphagnum*-dominated communities (Fig. 1). The plant plays a special role in the ecosystem. In many European countries, this plant species is considered endangered or highly endangered. This can be attributed to three causes:

1) For decades the management and therewith drainage and fertilization of European peatlands have led to a significant decline of wet, oligotrophic and acidic habitats, which are favoured by *Drosera* species. 2) Already in the Middle Ages, *Drosera* species were used as medicinal plants mainly for the treatment of respiratory diseases (asthma, bronchitis, whooping cough etc.). 3) Cultivation experiments with *Drosera* species have been conducted since 1920. Nevertheless, no method for the large-scale cultivation of sundew has yet been realized to produce the quantities of the *Drosera* raw material required by the pharmaceutical industry. Therefore, large quantities of European and non-European *Drosera* species are still being collected in natural peatlands.

The increasing destruction of the natural bogs and the collection for medicinal purposes together pose a serious threat to the conservation of *D. rotundifolia*. *Sphagnum* farming areas in Germany are in many respects comparable to intact raised bogs, and the nutrient-poor environment of the cultivated *Sphagnum* serves as a habitat for native *Drosera* species, such as *Drosera rotundifolia* L. and *Drosera intermedia* Hayne. Therefore, these cultivated areas offer a new alternative for the cultivation of *Drosera* species.

The suitability for *Drosera* cultivation was investigated in four studies with a focus on the cultivation of *D. rotundifolia* in *Sphagnum* farming areas:

- Comprehensive literature review: ecology, cultivation and use [1]
- Concentrations of 7-methyljuglone, plumbagin and quercetin in wild and cultivated *D. rotundifolia* plants[2]
- Seed germination and seedling survival of *D. rotundifolia* on different cultivations conditions and methods[3]
- Biomass productivity and yield on different cultivation conditions [4]

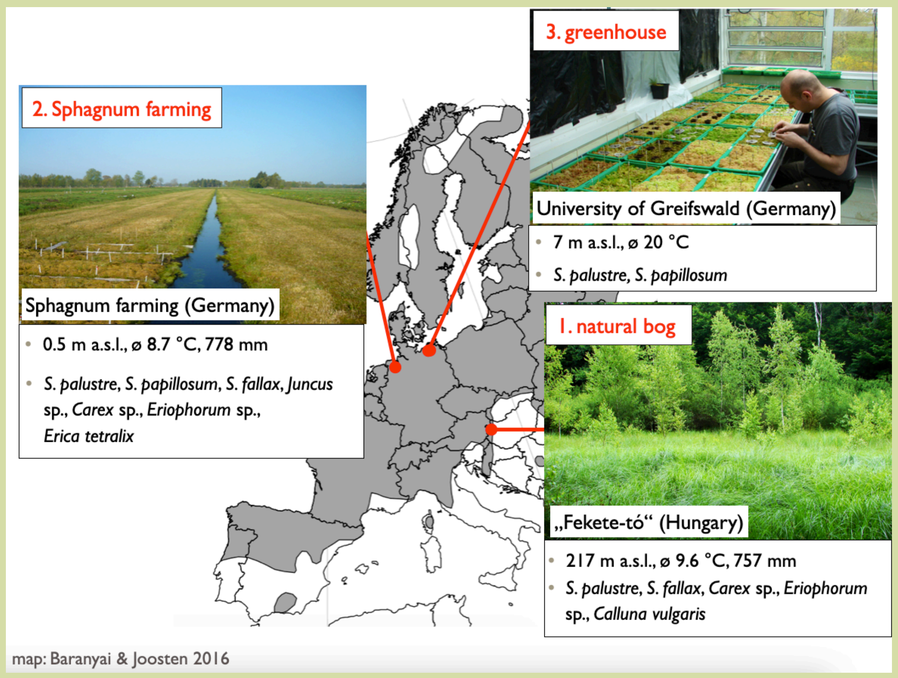

Fig. 2 Study sites for the germination experiment[3]

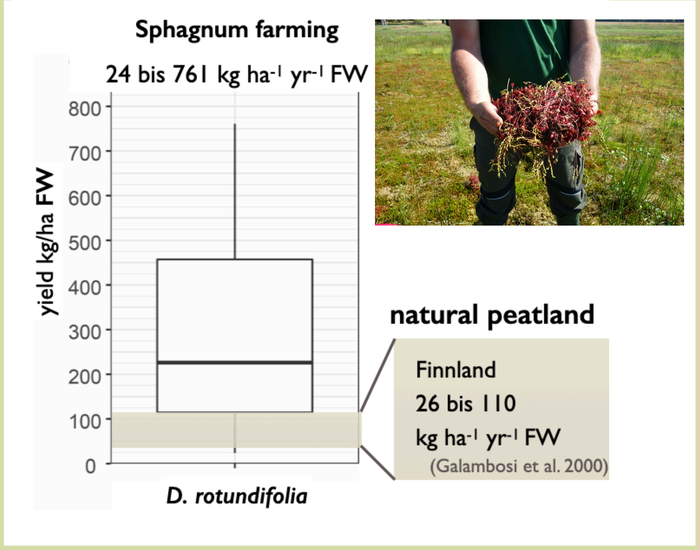

Fig. 3 Fresh yield (kg/ha) of D. rotundifolia on Sphagnum farming in comparison to natural peatlands in Finland

Seed germination and survival rates of *D. rotundifolia* was studied for biodegradable cellulose pots, paper mesh bags or directly sowing (cultivation methods) under a natural, semi-natural Sphagnum farming and greenhouse environment (cultivation conditions); along with varied seed density, cultivation happened on *Sphagnum palustre* or *S. papillosum* lawn and with or without co-occurring vascular plants

Results

The main results of these studies are as follows[5]:

1. *Drosera rotundifolia* is strongly associated with *Sphagnum*-dominated plant communities, which have declined or disappeared throughout Europe due to drainage. As a result *D. rotundifolia* has become a rare and protected plant species in most European countries.

2. Several *Drosera* species, including *D. rotundifolia*, *D. intermedia*, *D. anglica* and *D. madagascariensis*, are still used by pharmaceutical companies. The plants are collected in natural peatlands, because their cultivation is time- consuming and not (yet) efficient. Therefore, the development of cultivation methods is necessary.

3. The self-developed „peat pot method“ turned out to be the most suitable *Drosera* cultivation method because of the special microclimate of the *Sphagnum* lawn, the low-competitive environment and the permanently wet *Sphagnum* peat in the plant pots (Fig. 2).

4. In the field very low germination rates <1 % were recorded by directly seed sowing. Therefore large quantities of seeds are required for cultivation with seed sowing.

5. The removal of vascular plants showed a positive correlation with the number of *Drosera* seedlings in the first year and led to a higher number of surviving *Drosera* plants in the second year.

6. *D. rotundifolia* plants growing in the Sphagnum farming area showed a 7 to 8 times higher concentration of 7-methyljuglon than *D. madagascariensis*, which is mainly used for ‚Droserae herba‘.

7. The highest concentrations of bioactive ingredients of *D. rotundifolia* and *D. intermedia* were found in 13 to 24 month old flowering plants.

8. Biomass productivity of *D. rotundifolia* on Sphagnum farming areas was 320 kg ha^{-1} yr^{-1} FW (total biomass). Harvestable yield (only flowering plants) were 6 times higher (230 ha^{-1} yr^{-1} kg FW) than in natural bogs of Central and Northern Europe (Fig. 3).

9. The highest yield of *D. rotundifolia* and *D. intermedia* was documented in July and August. In these months, the plants reach their highest weight.

10. On *Sphagnum* farming areas *D. rotundifolia* yields were 4 times higher than for *D. intermedia*. *D. rotundifolia* should therefore be preferred for cultivation.

11. For a long-term sustainable production of *Drosera*, harvesting of plants older than 12 months old is recommended.

Conclusions[3,4]

Results of this studies implicate that further research is necessary to increase germination and survival rates of *D. rotundifolia*, as well as optimal plant growth, on *Sphagnum* lawn.

Cultivation of *D. rotundifolia* in biodegradable cellulose pots and direct seed sowing on *Sphagnum* lawns meets the cultivation requirements of the pharmaceutical industry and has many ecological benefits compared to collection in the wild.

Drosera rotundifolia occurs in high abundances spontaneously in *Sphagnum* farming areas. To allow a long-term sustainable production of *Drosera*, constantly high biomass yields of flowering plants are required every year. This study shows that these conditions are ensured when plants are harvested in July/August that are more than 12 months old.

Cultivation on Sphagnum farming fields (*Sphagnum* paludiculture) provides new opportunities for the industrial production of sundew raw material and offers synergies with climate, peatland and biodiversity protection initiatives.

Sources:

(1) Baranyai, B. & Joosten, H. (2016) Biology, ecology, use, conservation and cultivation of round-leaved sundew (*Drosera rotundifolia* L.): a review. *Mires and Peat*, 18(18), 1–28. (2) Baranyai, B., Bäcker C., Reich C. & Lindequist U. (2016). The production of 7-methyljuglone, plumbagin and quercetin in wild and cultivated *Drosera rotundifolia* and *Drosera intermedia*. *Mires and Peat*. 18(19), 1–8. (3) Baranyai, B., Krebs, M., Oehmke, C. & Joosten, H. (previewed 2021). Seed germination and seedling survival of *Drosera rotundifolia* (L.) cultivated on *Sphagnum*: Influence of cultivation method and condition, seed density, *Sphagnum* species and vascular plant cover. *Mires and Peat*. (4) Baranyai, B., Krebs, M., Oehmke, C. & Joosten, H. (submitted 2020). Biomass productivity and yield of *Drosera* on cultivated *Sphagnum* in NW Germany. *Mires and Peat*. (5) Baranyai, B. (2020) Untersuchungen zur Machbarkeit der Kultivierung von Drosera rotundifolia für medizinale Zwecke auf wiedervernässten Hochmoorflächen in Deutschland mit besonderer Berücksichtigung der Co-Nutzung bei der Torfmooskultivierung. Dissertation, University of Greifswald, 129 pp. (in German). (6) Galambosi, B., Takkunen, N. & Repčák, M. (2000) The effect of regular collection of *Drosera rotundifolia* in natural peatlands in Finland: plant density, yield and regeneration. Suo, 51, 37–46.