Biology, ecology, use, conservation and cultivation of round-leaved sundew (*Drosera rotundifolia* L.): a review

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SUMMARY

Drosera rotundifolia 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. Since mediaeval times the species has been collected from natural habitats and used as a remedy for coughs and pulmonary diseases. Due to the substantial decline of *Drosera* habitat, the plant has been protected in most European countries since the 1980s, which means that wild *D. rotundifolia* has become unavailable to the pharmaceutical industry. The persistent demand has stimulated research into the cultivation of *Drosera* in several European countries. These studies have shown that *Drosera* cultivation is time-consuming and not (yet) cost-effective, and there is a need for the development of cultivation methods. This article reviews the morphology, distribution, ecology and reproduction of *Drosera rotundifolia*; outlines its commercial use and nature conservation requirements; and describes previous research on its propagation and cultivation.

KEY WORDS: cultivation, distribution, *Drosera rotundifolia*, Droserae herba, *Sphagnum* spp.

INTRODUCTION

Carnivorous plants, and especially the widespread genus *Drosera*, have fascinated and inspired researchers for centuries [264]. Charles Darwin's comprehensive study on *Drosera* [51] was followed by extensive work on the morphology, biology and ecology of the round-leaved sundew (*Drosera rotundifolia* L.) [54, 90, 91, 48].

Drosera has a long history as a remedy ('Droserae herba', 'Herba Droserae') for coughs and pulmonary diseases [201, 14]. Nowadays, the air-dried or fresh plant [58, 84] is used in 200–300 of the medications registered in Europe [142], creating a continuing demand from pharmaceutical companies. For this purpose, the plants are still collected (as they traditionally have been) from natural habitats. Whereas collecting from the wild has contributed to the reduction of local populations, and even to their extinction [245, 258], *D. rotundifolia* and other *Drosera* species of wet, oligotrophic and acidic habitats have declined most as a result of land reclamation and drainage. *Drosera* species are strongly associated with *Sphagnum* mosses (see Appendix) and are characteristic for many *Sphagnum*-dominated communities. *Sphagnum* cultivation ('Sphagnum farming') to provide raw materials for horticultural growing media is a promising technology in paludiculture [76]. *D. rotundifolia* occurs spontaneously on the Sphagnum farming pilot area at Hankhausen (Lower Saxony, Germany), and this has stimulated research into whether it could be cultivated with *Sphagnum*. This article reviews aspects of the biology, ecology, propagation and cultivation of *D. rotundifolia* that are relevant to the prospect of growing it on Sphagnum farms. Its commercial use and nature conservation status are also discussed. What follows is in sections: Morphology, Geographical and altitudinal distribution, Ecology (climatic and hydrological conditions, soil conditions, communities), Reproduction (asexual reproduction, sexual reproduction), Commercial use, Conservation, Propagation and cultivation (*in vitro* propagation, indoor cultivation, outdoor cultivation), and Prospects.

MORPHOLOGY

Drosera rotundifolia is a small, clonal and perennial carnivorous (usually insectivorous) herb [218, 261, 195, 117]. The roots are generally poorly developed and fibrous, consisting of a tap root with (1–) 3–5 (–6) fine, blackish and slightly divided branches with a length of (2–) 13–25 (–44) mm [54, 205, 139, 261]. The 4–12 (–20) leaves are arranged in a basal rosette [218, 195]. The leaves are (10–) 20–50 mm long [255], horizontally spreading (but sometimes semi-erect) and long-petioled [238, 19, 120]. The petioles are green, flat, hairy or sometimes glabrous [157, 48, 85], 10–30 (–50) mm long and 6–10 mm wide [209, 195, 120]. The stipules are usually united up to their centre with the petiole [93], membranously adnate, fimbriate, 4–6 mm in length [157], and each divided into about 7 teeth [255]. The laminae are initially helical involute [101] and later orbicular to vertically oval, 4–10 × 5–18 mm, and abruptly narrowed into the petiole [54, 209, 85]. The abaxial surfaces of the laminas are glabrous, lightish olive green to yellow-green; the adaxial surfaces are often reddish because of anthocyanins [48, 5].

The adaxial surface and the margin of the lamina are covered with digestive glands, glandular trichomes and tentacles [127, 197]. The approximately 200 tentacles on each lamina are long-petioled, reddish, flexible and 1–5 (–6) mm long [101, 24, 261, 258], perpendicular to the surface and longest on the leaf margin [48].

The rosette has 1–5 (–7) terminal, erect, reddish, leafless, glabrous and initially epinastically inrolled flower stalks [255, 217] of (1–) 5–20 (–30) cm length [48, 202, 85, 63]. The inflorescence is one-sided, with a cymose raceme that terminates in a naked, single or double un-ranked raceme [101, 261].

The 1–15 (–25) flowers on each flowering scape are radially symmetric [54, 215, 209], androgynous [122] and short-petioled (5–12 × ≤ 3 mm, [93, 13, 261]). The pedicel is short (2 mm), and erect during anthesis [54, 213]. The 5 sepals are united at the base, obtuse, remaining till ripening and 5 × ≤ 1.5 mm long [54, 122, 5]. Their colour is green or brownish green, and black in the fruit [204, 48]. The 5 free petals are spatulate, obovate, white or pinkish, 4–7 × ≤ 3 mm [54, 157, 5, 201,] wedge-shaped and persistent in cleistogamic flowers [48]. The androecium includes 4–8 free, 4–5 mm long stamens with reddish, filiform filaments [54, 256, 48, 195] and white extrorse anthers [256, 255]. The pollen consists of inaperturate tetrads 51–75 µm in diameter; the nexine is 2–3 (–4) µm thick, the sexine 1.5–3.5 µm high with dimorphic spinules [185, 23]. Each flower produces only a few hundred pollen grains [210], and these remain in permanent tetrahedral tetrads [222, 87]. The ovary of 3 (rarely 4 or 5) united carpels is superior, unilocular, 3 mm long [54, 90, 157], and occasionally bears tentacles [48]. The styles are 2–5 partite [157], free, forked, straight or club-shaped, about 1.5–2 mm long [54, 93, 48]. The 3 stigmas are papillate, whitish, club-shaped and 2-parted [13, 255]. The ovules are 3 – ∞ in number, anatropous, tenuinucellate (embryo sac and epidermis not being separated by nucellar tissue) and bitegmic (having two integuments) [91, 212].

The fruit is a blackish-brown, smooth, loculicidal capsule [1, 13, 127], 1-valved and split into 3 sections [48, 209], 3–5 (–6) mm long and 1.7–2 mm wide [101, 217, 195]. Each capsule contains 69 ± 95 seeds (SD, n = 273, B. Baranyai, unpublished data). For Finland, averages of 90 (80–119) seeds *per* seedcase and 424 (63–816) seeds *per* plant have been reported [75]. The seeds are yellowish-brown to blackish-brown, narrow ellipsoid, smooth, reticulate, shining with a metallic lustre, 1.5–1.7 mm long and 0.2–0.3 mm wide; the inner seeds are 0.3–0.5 mm × 0.2–0.3 mm [80, 13, 27]. The seeds are endospermous, including endosperm and small basal embryos [95, 212]. The average weight of 1,000 seeds is 0.02 g [194].

GEOGRAPHICAL AND ALTITUDINAL DISTRIBUTION

Drosera rotundifolia is probably one of the most widely distributed carnivorous plant species, appearing in most regions of the Holarctic (Figure 1; [105, 206, 99, 18, 227, 199]). In northern Eurasia it is known from Iceland, the British Isles, Norway (up to 70° 65′ N [163]), north-western Russia and Siberia (50–65° N) [94, 83] to the Kamchatka Peninsula and Manchuria [262, 254]. The southern Eurasian distribution includes the Mediterranean mountain ranges of Portugal, Spain [90, 40, 12], Italy and Corsica (as var. *corsica* (Maire) Briq.) [179], the Balkan Peninsula [86, 6, 57], the Caucasus [113], Mongolia [49], South Korea and Japan [42, 103]. In arctic and temperate North America the species is found from Greenland and Newfoundland to the Canadian Northwest Territories (to 67° 97′ N [239]), and from Alaska to California and Alabama, to 33° 97′ N [88, 240, 83]. Outliers in the distribution are known from Lebanon, Israel [233, 49] and New Guinea (as subsp. *bracteata* Kern & Steen) [255].

In the British Isles, *D. rotundifolia* occurs from sea level up to 670 m [33], but has also been reported at about 900 m in Scotland [105]. In continental Europe it reaches altitudes of 1,100 m in Scandinavia [149]; 1,395 m in Germany [167]; 2,000 m in Austria, France and Italy [186, 249, 179]; and 2,100 m in Spain [40]. In Japan *D. rotundifolia* may be found up to 1,920 m [81], and in Colorado (USA) up to about 3,000 m [147].

ECOLOGY

Climatic and hydrological conditions

Globally, *D. rotundifolia* grows in both continental and oceanic climates [111, 44, 161]. In Europe, the species is closely connected to wet and oligotrophic sites [192] in continental, oceanic and suboceanic regions [91, 187]. *D. rotundifolia* is highly adapted to the microclimatic conditions of peatlands [41], including the “higher air humidity compared to mineral soils, greater frequency of mists and dew, notably greater frequency of ground frost, lower air temperatures and

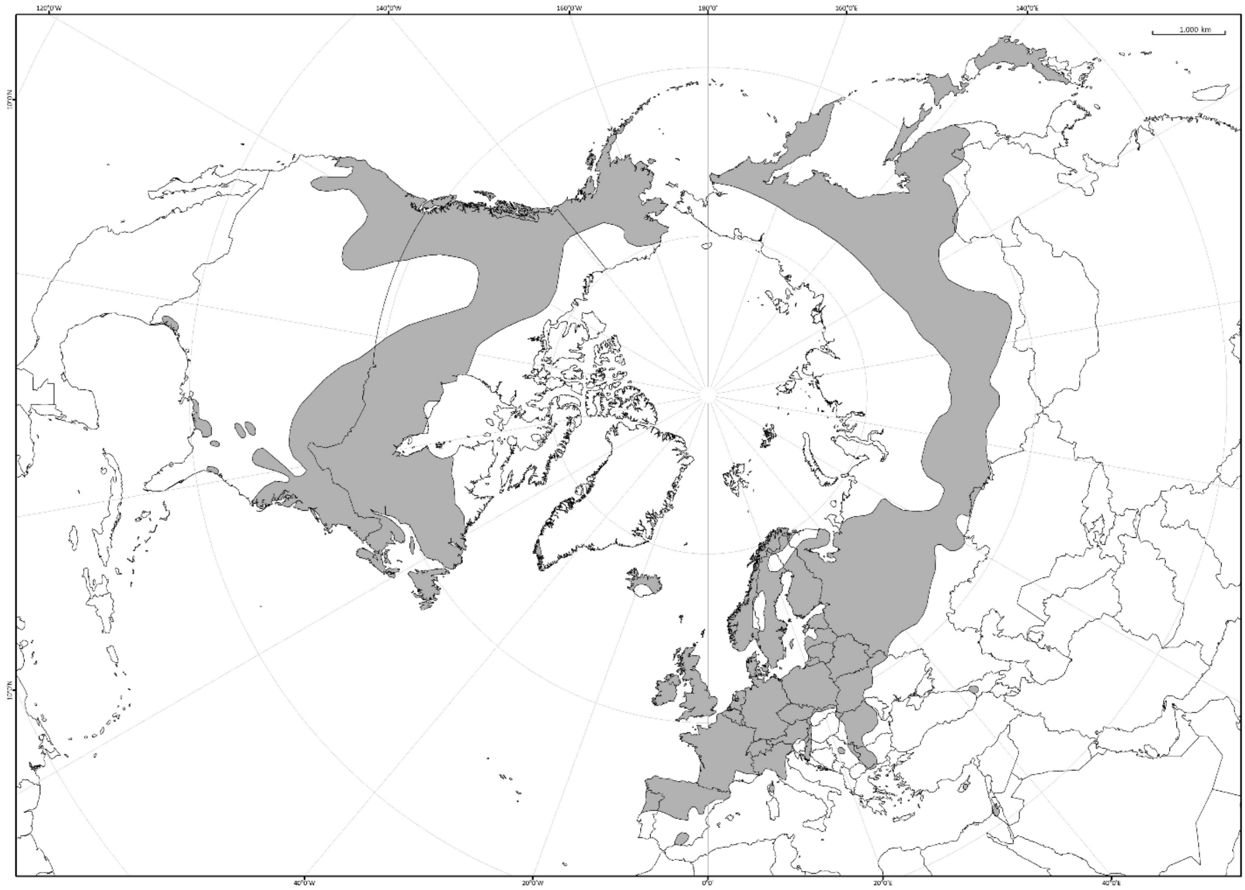

Figure 1. The distribution of *D. rotundifolia* in the Holoarctic (based on [149, 105, 224, 48, 255, 30, 126, 237, 8, 261, 40, 113, 86, 145, 241, 77, 166]).

lower topsoil temperatures in the summer period" [107].

Amongst the European species of sundew, *D. rotundifolia* grows in the highest locations within the bog microrelief [138, 137], i.e. on rather high *Sphagnum* hummocks [199], where it does not form basal rosettes and its long axis and petioles grow fast enough to evade competition with the rapidly growing *Sphagnum* mosses [48, 218]. The species has generally larger leaves in the shade [232]. The length of the slender vertical axis of *D. rotundifolia* was about 3 cm in full sun and up to 5 cm in shade [261].

The species avoids waterlogged places with perennial standing water [228, 261]. As a hemicryptophyte with frost-resistant hibernacula (winterbuds) [164, 230, 197], it can survive ground frosts. It tolerates strong wind on vertical faces and at high altitudes, but is smaller in such places [48].

Soil conditions

Drosera rotundifolia flourishes in continuously moist acid soils which are poor in nutrients (N, P, K, Ca and Mg; [186, 2, 141]) and lime [208], with various granulometric structures [114, 230]. Its main substrates are living *Sphagnum* moss and humus, i.e. peat, raw humus or moder [131, 220, 197]. The species also grows on moist acidic sand, e.g. in dune valleys along the Baltic Sea coast [91, 219, 200], on silicate bedrock deficient in bases and lime (e.g. granite, lime-free sandstone) and on dolomite rocks that are wet from freshwater seepage [13, 209, 134]. Other habitats include sand and clay mining areas [255]; the edges of ponds, springs or streams on mineral soil [219, 255, 66]; freshly cut peat surfaces [139]; and, rather rarely, constantly damp or mouldering logs [48, 255].

The soils where *D. rotundifolia* thrives are uniformly acidic at the surface, with soil pH 3.3–5.0 in central Europe and 3.5–4.5 in North America (Table 1), though it is sometimes found in rich fens (see below). A Canadian study found the species on loamy sand with a pH of 6.1 [219]. Water pH values range from 3.0 to 6.5 with outliers of 7.5 (Table 2). The concentrations of Ca^{2+} and Mg^{2+} ions in the surface water and groundwater of *D. rotundifolia* habitats differ from region to region but are generally low (Table 2).

The growth and growth form of *D. rotundifolia* are influenced by the (hydro)chemical conditions of the habitat. For example, calcium is toxic to

Table 1. pH values for wetland soils with *Drosera rotundifolia* in central Europe and North America.

Location	Soil pH	Source
Europe		
Germany	3.6–4.3	Forst (1997)
Germany	4.6	Oltmanns (1996)
Germany	3.3–3.5	Huntke (2008)
Hungary	4–5	Borhidi (2003)
Italy	4.4–4.9	Miserere *et al*. (2003)
North America		
Maine	3.5–4.5	Davis & Anderson (1991)
Virginia	3.5–3.7	Byers *et al*. (2007)

Table 2. pH, calcium (Ca^{2+}) and magnesium (Mg^{2+}) concentrations (mg L^{-1}) in water of wetlands with *Drosera rotundifolia*. (Some publications list more than one site, e.g. Fernández-Pascual (2016): Los Cándanos pH 3.0 and La Veiga Cimera pH 4.6). NA = not available.

Location	pH	Ca^{2+}	Mg^{2+}	Source
Europe				
Britain	3.5–4.4	2.4–24	1.2–7.0	Crowder *et al*. (1990)
Britain	4.54–5.22	1.2–2.5	0.09–1.05	Shimwell (2005)
Britain	6.5–6.8	5.5–7.1	3.50–3.70	Shimwell (2005)
Britain	4.8	14	8.7	Box *et al.* (2011)
Britain	5	17	6.6	Box *et al.* (2011)
Germany	4.6–5.1	NA	NA	Ellwanger (1996)
Italy	4.4–4.9	NA	NA	Miserere *et al.* (2003)
Italy	5.6	5.55 (± 0.43)	1.40 (± 0.11)	Gerdol *et al.* (2011)
Italy	6.1	8.27 (± 0.38)	1.91 (± 0.09)	Gerdol *et al.* (2011)
Netherlands	4.5 (± 0.07)	0.46	0.46	Adema *et al*. (2006)
Poland	4.0	0.75	0.18	Wojtuń *et al*. (2013)
Spain	3.0	NA	NA	Fernández-Pascual (2016)
Spain	4.6	NA	NA	Fernández-Pascual (2016)
Sweden	3.9–4.4	NA	NA	Vinichuk *et al*. (2010)
North America				
Canada	4.3– 6.9	NA	NA	Pellerin *et al*. (2006)
Minnesota	3.9	0.8	NA	Glaser *et al.* (1990)
Minnesota	7.5	30	NA	Glaser *et al.* (1990)
Ohio	4.0–5.1	2.8 (± 0.8)	1.7 (± 0.3)	Andreas & Bryan (1990)
Ohio	4.1–4.3	2.8 (± 0.8)	1.2 (± 0.4)	Andreas & Bryan (1990)
Ohio	6.3–7.3	6.0 (± 1.3)	2.6 (± 0.7)	Andreas & Bryan (1990)

D. rotundifolia but the toxicity depends on the pH of the soil [198, 4]. The species responds to higher nitrogen and phosphorus supply by growing to a smaller size and producing fewer leaves and flowers *per* plant [216]. *D. rotundifolia* can tolerate low salt concentrations [201], but is salt-intolerant [131] and growth is hampered by raised salt concentrations [216].

Communities

In the following account, the nomenclature of plant communities in Europe follows Mucina *et al*. (in prep.); the taxonomy and nomenclature of Spermatophyta follows Wisskirchen & Haeupler (1998) and Moss (1983); for Bryophyta we follow Frahm & Frey (2004); and for the genus *Sphagnum* we follow Michaelis (2011).

The main habitats of *D. rotundifolia* are acidic bogs and poor fens, but the species has also been recorded from intermediate-rich and extreme-rich fens [221, 261, 18]. It grows primarily in *Sphagnum*-dominated communities [131, 191, 151]. Species in wetlands supporting occurrences of *D. rotundifolia* are listed in the Appendix.

In central Europe, *D. rotundifolia* occurs mainly in two phytosociological classes, the Oxycocco-Sphagnetea Br.-Bl. & R. Tx. ex Westh. *et al*. 46 and the Scheuchzerio-Caricetea fuscae Tx. 37. Furthermore, the species is represented in the Montio-Cardaminetea Br.-Bl. et Tx. ex Klika 48, the Vaccinio-Piceetea Br.-Bl. in Br.-Bl. *et al*. 1939 and the Alnetea glutinosae Br.-Bl. & R. Tx ex Westhoff *et al*. 1946 (Table 3). In the Oxycocco-Sphagnetea, *D. rotundifolia* is mainly associated with *Sphagnum* (e.g. *Sphagnum magellanicum*, *S. fuscum*, *S. rubellum*), *Eriophorum vaginatum* and *Andromeda polifolia* together with *Oxycoccus palustris*, *Narthecium ossifragum*, *Vaccinium uliginosum* and *Erica tetralix*, as well as with *Calluna vulgaris* in dry areas [255, 207]. In Scheuchzerio-Caricetea fuscae Tx. 37 communities, the species is found together with, for example, *Rhynchospora alba*, *R. fusca*, *Eriophorum angustifolium*, *Molinia caerulea*, *Trichophorum cespitosum*, *Menyanthes trifoliata* and *Sphagnum* (e.g. *Sphagnum fallax*, *S. inundatum*, *S. cuspidatum*) [214, 183].

In Japan *D. rotundifolia* has been recorded from communities of lawns, hummocks, hollows and floating mats [111].

In North America *D. rotundifolia* typically flourishes on bogs and occupies the margins of acidic ponds and floating peat mats in fens throughout Canada and in many states of the USA [172, 147]. The species occurs in central Alberta (Canada) in an extreme-rich fen, with *Scorpidium scorpioides*, *Drepanocladus revolvens*, *Campylium stellatum* and *Tomenthypnum nitens* [221].

Table 3: List of central European plant communities that include *Drosera rotundifolia*.

Plant communities	References
Oxycocco-Sphagnetea Br.-Bl. & R. Tx. ex Westh. *et al*. 46	Weber (1995), Schubert *et al.* (2001)
Sphagnion medii Kästner et Flössner 1933	Berg *et al*. (2004), Thébaud (2011)
Ericion tetralicis Schwickerath 1933	Berg *et al*. (2004)
Oxycocco-Ericion tetralicis Nordhagen ex Tx.1937	Pott (1995), Schaminée *et al*. (1995)
Scheuchzerio-Caricetea fuscae Tx. 37	Borhidi (2003), Rodondi *et al.* (2009)
Scheuchzerion palustris Nordhagen ex Tx. 1937	Linder-Effland (2002), Huntke (2008)
Caricion fuscae Koch 1926 em. Klika 1934	Oberdorfer (1992), Borhidi (2003), Berg *et al*. (2004)
Caricion davallianae Klika 1934	Anthes (2002), Conradi & Friedmann (2013)
Montio-Cardaminetea Br.-Bl. et Tx. ex Klika 48	Borhidi (2003)
Vaccinio-Piceetea Br.-Bl. in Br.-Bl. *et al*. 1939	Pietsch (1985), Oberdorfer (1992), Wagner (2000)
Salicion cinereae Th. Müller et Görs ex Passarge 1961	Borhidi (2003)
Alnetea glutinosae Br.-Bl. & R. Tx ex Westhoff *et al*. 1946	Linder-Effland (2002)

REPRODUCTION

D. rotundifolia possesses the ability to reproduce both asexually (vegetatively) and sexually (generatively) [159, 103].

Asexual reproduction

Asexual reproduction can occur by the development of new buds on the adaxial surface of the lamina, on the petiole, in the axils of the leaves and on the flower stalks, as well as by means of root suckers [164, 20, 257, 121, 4].

The production and development rate of buds is affected by humidity, temperature, and - in respect of lamina buds - physiological leaf age [20, 257]. Shoots grow under conditions of constantly high air and soil humidity and indirect sunlight [257]. The exogenous buds on the leaves usually form on the lower part of a tentacle stalk, probably from all tissues except the lower epidermis, but the bud is not connected to the parental vascular system [48]. Buds develop preferentially in the centre of a lamina, where (*per* lamina) 4–5 and rarely 10 buds may originate [208, 257]. Bud development takes 14–30 days [20, 92, 257]. The roots of the buds form endogenously and shoot growth starts from epidermal cells [20]. The appearance of buds on the leaves can be observed from early spring until late autumn [164, 146]. These buds develop on old adult leaves which are partially or completely detached from the axis (of the leaf) [164]. It is only when the petiole of the lamina is detached from the axil that buds can develop on the surface of the petiole [20]. If the mother plant is mechanically damaged, e.g. by rot, fungal decay, or invertebrate attack, the apical dominance is lifted and within 14 days an axillary bud develops on the undamaged lower part of the plant [257]. In the case of the shoot tip being damaged, the top axillary shoot takes over the (regeneration) function of the terminal shoot [257]. If the peduncle is removed, buds can - in humid conditions - also appear on the stem [257]. Another form of vegetative reproduction occurs when roots develop below-ground suckers [129], and when the plants produce new ramets from axillary buds [218, 103]. In a Swedish subarctic bog, 1.57 ± 0.8 (max. 4; SD, n = 93) ramets *per D. rotundifolia* plant were reported [218].

The axillary bud forms a secondary rosette beside or below the main rosette [48], which is genetically identical to the parent plant [261].

Sexual reproduction

D. rotundifolia reproduces sexually [48, 218] by producing seeds from its hermaphroditic flowers [61, 261], and this is the main method of reproduction. Under natural conditions, sexual reproduction is mostly autogamous (self-pollinating) [127, 159, 261]. Initially the plant forms small unopened cleistogamic flowers, whereas later, well-developed reproductive structures in chasmogamous flowers are formed. According to Goebel (1914), the occurrence of cleistogamic *Drosera* flowers is caused by intense light and high temperature, rather than by lack of visiting insects. A high proportion of cleistogamous flowers in a population may lead to significant inbreeding [82, 231]. Chasmogamous flowers bloom in midsummer, i.e. mainly in June, July and August [154, 143, 120, 18] but, depending on the altitude, flowering may also occur in May or October [48, 217]. The flower opens only in direct sunlight, for two or three hours on a single day [116, 54, 193, 19, 18]. If the calyx is not fully open, withering can take at least five hours [54]. *D. rotundifolia* flowers start opening if the temperature reaches 25–30 °C, but complete blooming requires at least 35 °C [180].

During long periods of rainfall and cool sunny days the chasmogamous flowers remain closed [101, 54]. Usually, only one or two flowers bloom *per* flowering scape, so blooming flowers and mature capsules can co-occur on the same flower scale [176]. In contrast, that little to no cross-pollination occurs has been inferred from pollen to ovule ratios and pollinator visitation [159]. After cross-pollination the corolla closes in the evening [216]. Self-pollination occurs in the closed flower, as the anthers empty their pollen onto the stigmas [90].

Pseudo-cleistogamous flowers of *D. rotundifolia*, which are half open at midday but close within a short time, are also found [54]. These normally chasmogamous flowers develop as a consequence of habitat disturbance such as deficient light, high water level and strong water currents [160].

The fruit of *D. rotundifolia* matures 5–7 weeks after flowering [176]. The number of capsules on a single flowering scape and seed production differ among populations. Finnish plants had, on average, 4.75 capsules *per* scape (n = 110) and 90 seeds *per* capsule (n = 432) [75]; and Hungarian plants 9.3 ± 2.2 capsules *per* scape (SD, n = 30) and 76.0 ± 26.0 seeds *per* capsule (SD, n = 279) (B. Baranyai, unpublished data). Depending on the time of pollination, seeds are released from July onwards, but mostly in autumn [48]. Dispersal of the small seeds is anemochorous, zoochorous, and hydrochorous (by wind, animals, and water) [219, 48, 261, 197]. The seed has a sack-shaped husk (testa) which enables it to fly on the wind, even as far as 10 km [102, 35, 197]. The testa has ribs or striae which make the seed waterproof and able to float for several months [13, 48, 146], which promotes dispersal by stream water. The seeds remain viable for 1–5 years [181, 229]. Germination occurs in May/June [71]. In order to germinate, the seeds need cold stratification (by frost [32]), sufficient light, and temperatures of 20–25 °C [39, 197, 17]. If dormancy break happens in summer, *D. rotundifolia* seeds are able to germinate in the same year as they are dispersed [17]. On peat, seeds usually germinate within 20–30 days [176, 39], with exposure to cold causing almost simultaneous germination over a period of two weeks [48].

Campbell & Rochefort (2003) showed experimentally that germination in peat decreases rapidly if burial depth exceeds 5 mm. *D.rotundifolia* seeds germinate very effectively on *Sphagnum* moss [199] but their ability to germinate decreases rapidly if they are washed into the *Sphagnum* carpet, as burial depth increases and light flux declines (B. Baranyai, unpublished data).

COMMERCIAL USE

The above-ground parts of *Drosera* are used in Europe as a medicine for treatment of diseases of the respiratory tract [14]. Traditionally, *D. rotundifolia* L. was used for the drug 'Droserae herba'; but since this species became rare, *D. intermedia* Hayne and *D. anglica* Huds. have been used as substitutes [148, 96]. Asian and African *Drosera* species (*D. indica* L., *D. burmanii* Vahl, *D. peltata* Smith, *D. ramentacea* Burch. ex Herv. et Sond. and *D. madagascariensis* DC.) are also officially permitted for pharmaceutical purposes in European countries [124, 53, 244, 171, 18]. Currently, the commercial source of 'Droserae herba' is mainly *D. madagascariensis* DC. [263], which has notably lower concentrations of naphthoquinones (the active ingredient) than does *D. rotundifolia* [124, 18].

The annual demand for pharmacological use on the European market is currently 6–20 tons of air-dried *Drosera* biomass [70]. This consists mostly of *D. madagascariensis* (from Madagascar, East Africa) at 2–20 t yr^{-1}, followed by *D. rotundifolia* (from Finland) at 1–3 t yr^{-1} and *D. peltata* (from eastern Asia, India, Malaysia and China) at 0.1–0.5 t yr^{-1} [69, 244, 258]. The market shares of other *Drosera* species are insignificant. Thus, Finland (*D. rotundifolia*) and Madagascar (*D. madagascariensis*) have been the countries most engaged in export of Drosera drugs in recent years. In both of these countries, plants are harvested from wild populations [263, 104]. The collection of *D. rotundifolia* has also been reported from Spain, France, Sweden and Norway [247, 132].

Drosera rotundifolia is collected in 13 regions of northern Finland (64–68 °N) [100], and most of the harvest is exported to Switzerland [60]. The pickers are specially trained Finnish youths (4H-Young Organization); or temporary immigrants, mainly Asian berry pickers [75, 9]. One kilogram of freshly collected *Drosera* biomass contains approximately 5,000–10,000 flowering individuals [75] and one picker collects about 40 kg of *Drosera* during the season, which begins in July and ends in August [60]. The pickers are paid 43 EUR kg^{-1} for raw *Drosera* material [104].

The prices for fresh *D. rotundifolia* drug on the European market are 80–120 (–900) EUR kg^{-1} and for air-dried drug 1000–1200 EUR kg^{-1}. The change in weight from fresh *D. rotundifolia* drug to air-dried is 8:1 (12–24 months old *D. rotundifolia* plants with flower stem dried at 40 °C for 72 hours in a Memmert Cleanroom drying oven) (B. Baranyai, unpublished data).

CONSERVATION

The destruction of *Drosera* habitats (especially mires), as well as their eutrophication, leads to the reduction of natural *Drosera* populations [132, 197, 15]. Hence, the European *Drosera* species are listed as endangered, vulnerable or rare in many European countries [132, 117]. For example, *Drosera rotundifolia* is critically endangered in Croatia [162], endangered in Greece and Hungary [119, 177], and vulnerable in Bulgaria and Germany [140, 175]. In Switzerland, collecting is allowed only for scientific purposes and with a special permit issued by the cantonal and federal administrations. The fine for collecting without permission is up to 1,000 CHF (970 EUR) in most cantons (A. Bedolla, personal communication). In France, all native *Drosera* species (*D. anglica*, *D. intermedia* and *D. rotundifolia*) are protected at national level. Harvesting, use, transport or trade of wild *Drosera* specimens requires special permission from the Ministry in charge of nature conservation (F. Muller, personal communication). In Germany, commercial collection of *Drosera* species is prohibited by law [67]. In some states of the USA, *D. rotundifolia* is federally protected and listed as threatened or endangered [242]. In Finland, on the other hand, natural populations of *D. rotundifolia* are protected from over-collection by guidelines developed by the organisation "4H". For example, pickers are requested to leave 5–10 flowering plants *per* square metre on the habitat [75], which maintains a sufficiently high population density and contributes to natural regeneration by seed dispersal.

PROPAGATION AND CULTIVATION

The first cultivation experiments with *D. rotundifolia* [97, 245, 196] arose from over-collection in its natural habitat as the demand for 'Droserae herba' increased in the first part of the 20th century. More recently, in response to the sustained demand from pharmaceutical companies since nature protection measures curtailed the availability of wild material, several European research institutes have tested a variety of *Drosera* propagation and cultivation technologies [74, 132]. These include *in vitro* propagation under sterile laboratory conditions [123], cultivation in glasshouses, and cultivation outdoors under semi-natural conditions on peatlands [72].

In vitro propagation

In vitro micropropagation allows rapid clonal propagation of genetically identical copies of a single plant under sterile conditions [144, 133, 15]. *Drosera* species are well suited for *in vitro* micropropagation because of their high regeneration potential [201]. Seeds, leaf rosettes, isolated leaves, roots, flowers and gemmae are all used as explants for establishing tissue cultures [201]. So far, *in vitro* propagation has been carried out with 21 *Drosera* species [189, 201, 118, 109, 225, 15, 223].

Drosera rotundifolia explants can be cultured on Murashige-Skoog (MS) or Reinert-Mohr (RM) medium [158, 190, 201]. The optimal pH of the medium is between 5.5 and 5.8 [15]. According to Crouch & van Staden (1988) and Perica & Berljak (1996), the best medium for *in vitro* multiplication of *Drosera* is the MS medium, which is a mixture of macronutrients, micronutrients, vitamins and organics [158]. The culture media can be supplemented with casein hydrolysate, various nitrogen sources (in inorganic or organic form), coconut milk or grapevine exudate [201]. Natural or synthetic growth regulators such as auxins (e.g. 1-naphthaleneacetic acid (NAA)) and cytokinins (e.g. 6-benzylaminopurine (BAP)) may significantly increase the rates of regeneration and callus formation [28, 47, 123, 15], although BAP may cause morphological abnormalities in newly formed shoots [251].

In vitro cultures are susceptible to contamination [201], e.g. by fungi and bacteria [47, 11]. Explant sterilisation can be carried out with commercial bleach, CaOCl, $HgCl_2$ or NaOCl [201].

Propagation of *D. rotundifolia* on culture media may be achieved either by using seeds [98] or by caulogenesis from leaves [11, 252, 25], shoot rosettes [250], root and leaf explants [252, 1996, 26], shoot tips [108, 115], axillary shoots and internodes [243].

Kukułczanka & Cząstka (1988) reported germination of sterilised *D. rotundifolia* seeds on RM medium after 16–24 days at 20–25 °C. Clapa *et al*. (2010) achieved high multiplication rates on modified MS medium with coconut water, MS medium with 5 mg L^{-1} kinetin, and hormone-free MS gelled with agar. Bobák *et al*. (1995) reported an average regeneration rate of 18.3 shoots *per* explant from isolated leaves on MS medium without growth regulators, or on media supplemented with 10^{-8} M NAA. Banasiuk *et al*. (2012) reported 3–12 plants *per* leaf explant after 6–8 weeks on MS medium supplemented with growth regulators. Micropropagation is reported [251] of *D. rotundifolia*, using cytokinins (2iP), achieving about 20 shoots *per* leaf explant. In a later study [250] using a two-step culture system with liquid and semi-solid media, averages of 27.4 shoots *per* leaf explant and 53.3 shoots *per* shoot explant were recorded. *Drosera rotundifolia* plantlets produced extensive root systems after 6–8 weeks in subculture [11]. Young shoots with 3–7 leaflets rooted spontaneously on a growth-regulator-free medium within 38 days of culture, and isolated mature plants produced viable seeds [25]. The leaf tissue of *D. rotundifolia* grown *in vitro* is relatively thick, fibrous and mucilaginous [21].

After acclimatisation, *in vitro* cultivated plantlets of *D. rotundifolia* are able to grow under outdoor conditions and in non-sterile substrates (e.g. horticultural soil, black peat, peatmoss), showing significant growth and low mortality [251, 253, 236, 133].

Indoor cultivation

Indoor cultivation of *Drosera* has been described [213, 39, 32, 130, 16, 50] often, mainly for demonstration and decorative purposes [176]. Successful indoor *Drosera* culture requires suitable temperature, humidity, shading and aeration [32]. Conventionally, seeds, leaf cuttings or root cuttings are used [135, 130, 16]. For germination and undisturbed development, *D. rotundifolia* requires acidic to subneutral (pH 3.5–6.5) substrates [32, 130]. The structural stability of the substrate (e.g. *Sphagnum* moss or *Sphagnum* peat) can be improved by mixing it with lime-free sand or very small proportions of vermiculite or perlite [39, 32, 130]. Furthermore, *Drosera* plants need 10,000–15,000 lx of artificial light for 14–16 hr day^{-1} in summer, and 8,500 lx for 8–12 hr day^{-1} in winter after gradually reducing the light flux in autumn [213]. A warm-humid microclimate is ideal; i.e. a summer temperature of 15–25 °C (< 40 °C) and a winter temperature between 3 °C and 8 °C [213, 39, 16] with (40–) 60–70 % relative humidity [130, 36]. The irrigation water should have a pH of 5–6, a total hardness of 0–5 °dH, and an electrical conductivity of 50–100 µS cm^{-1} [39]. Germination of *Drosera* species occurs at 20–25 °C, 2–3 weeks after seeding. After three months the seedlings are pricked out and transplanted into fresh substrate [39].

Cultivation of *D. rotundifolia* by sowing seeds on non-fertilised and fertilised commercial peat (pH 3.5–4.5) in 5 × 5 cm containers has been reported [72, 74]. After overwintering for six months outdoors, the containers were transferred into a glasshouse in spring. The plants were fed at weekly intervals with milk powder and various fish feed preparations, red bloodworms and *Tubifex* worms [72]. The fresh yield of entire *D. rotundifolia* plants was 1,209–1,863 g m^{-2} in the second growing year and 735–1,149 g m^{-2} in the third year [72]. The results confirmed that protein feed had a positive effect on growth, life cycle, fresh plant weight, and yield [74, 72].

Outdoor cultivation

Seeds of *D. rotundifolia* were sown in *Sphagnum*-free peat and natural 'suitable raised bogs' [97]. The first flowering and the first harvest took place in the second year. A futher report [245] suggested that successful culture requires high humidity.

Few outdoor *D. rotundifolia* cultivation studies have been published in detail. One report [110] is of experiments in beds at an abandoned peat-cutting site. The beds were 2 m wide and separated by 1 m wide flooded channels from which the experiments could be accessed by boat. In the middle of each bed, a 0.3 m wide strip was left as a seed source to ensure natural reseeding. The water level was maintained at a constant depth of 0.05 m below the surface in order to provide continuous humidity, and no fertiliser was applied. *D. rotundifolia* produced high yields in pure culture only if weeds (*Juncus*, *Carex*, *Rhynchospora*, *Sphagnum*) were completely removed, but biomass production was not recorded.

Cultivation of *Drosera rotundifolia* and *D. anglica* was studied in southern Finland between 1992 and 2002 [73, 71, 70]. In the first experiments, *Drosera* plants were propagated in raised peat beds (size 3 × 1 × 0.7 m) filled with unfertilised peat (pH 3.5), using a drip irrigation system with tap water (pH 7) [71]. In a larger-scale pilot cultivation (1999–2004) the size of the peat beds was 9 × 1 m. Seeds were collected from natural sites, cold stratified, mixed with sand (ratio 1:10) and sown directly into the beds. The plants were artificially fed with natural proteins (e.g. fish food, milk powder). Flowering started in the second and third growing years [71]. The plants showed more growth with regular artificial feeding [73], reaching an average fresh mass of 259 g m^{-2} with feeding (milk powder) and 89 g m^{-2} without [71]. In the cultivation with 9 m^2 beds, the total fresh yield in years 3–6 was 836 g m^{-2} (Table 4) with the highest yields in the second (489 g m^{-2}) and third (212 g m^{-2}) harvest years. After collecting all sundew plants the top 5 cm layer of peat could be replaced with new peat and the beds used for the next 5–6 year growing cycle [68].

Table 4. Fresh yields of *Drosera rotundifolia* in peat beds (total 54 m^2) between 1999 and 2004 in Mikkeli, Finland. Source: Galambosi & Galambosi (2013).

Year	**Fresh Yield**	
	g m^{-2}	**%**
1999	-	-
2000	-	-
2001	75	9
2002	489	58,5
2003	212	25,3
2004	69	7,2
total	**836**	**100**

A problem identified during these experiments was that weeds (*Polytrichum*, *Epilobium*, *Betula* and *Pinus sylvestris* seedlings) in the beds reduced the productivity of *Drosera* and increased the risk of inadvertently removing young *Drosera* plants whilst weeding [71, 70]. Also, especially if the density of *Drosera* was high, young and non-flowering plants could be damaged during harvesting, reducing the yield in the following year [70].

PROSPECTS

Drosera rotundifolia is one of the most common carnivorous plants in the world. This species is distributed contiguously across the Temperate and Boreal zones, as well as part of the Subarctic zone, from Europe, northern and central Asia to Japan and North America, and is scattered around the Mediterranean (Figure 1). Its distribution is correlated with wet and oligotrophic biotopes dominated by *Sphagnum*. As a result of human intervention (reclamation, nitrogen pollution) in the last 100 years, these habitats have decreased in extent, causing *D. rotundifolia* to be restricted to isolated communities which are sensitive to anthropic impacts.

From the early twentieth century onwards, the phyto-pharmacological properties of *D. rotundifolia* have been increasingly recognised and the plants have been collected in ever larger quantities for medical purposes. With the significant decline of *D. rotundifolia* populations in Europe, pharmaceutical producers have focused increasingly on other native *Drosera* species such as *D. intermedia* and *D. anglica*. Since the 1980s, over-harvesting and habitat losses have led to the protection of these species in many European countries, forcing the pharmacological sector to use non-European *Drosera* species as substitute drugs and as feedstock for medicinal products. Today, *D. madagascariensis* is the most imported and most used *Drosera* species in Europe. It is collected from the native populations of Madagascar in an unsustainable way, which causes a threat to the species. Furthermore, the drug derived from *D. madagascariensis* is of low quality because it contains smaller amounts of active ingredients than *D. rotundifolia* does [124, 18]. Therefore, *D. rotundifolia* is still preferred on the herbal market and is still collected from wild habitats.

Since the second half of the 20th century, research in Europe has addressed the propagation and cultivation of European and non-European *Drosera* species for medicinal purposes. However, despite positive results, *Drosera* species are not yet commercially cultivated. Compared with other plant species, sundews can be propagated very successfully *in vitro* and can achieve high propagation rates (C. Wawrosch, personal communication). Plants propagated *in vitro* are, however, rejected by the pharmaceutical industry because they are genetically identical (cloned), unnatural and artificially fed ([123], L. Krenn, personal communication). The Finnish methods for indoor and outdoor cultivation are practicable and demonstrate that cultivation can replace collection from the wild. However, the cultivated *Drosera* product must again fit the requirements of the pharmaceutical industry. At least one company is not interested in cultivated, artificially fed plants (B. Galambosi, personal communication).

The reasons why *Drosera* has not yet been commercially cultivated include: a) the high cost and time requirements for maintaining *Drosera* cultures; b) the specific ecological and technical requirements of *Drosera* cultivation; and c) the current availability of sufficient material from the wild.

At present, the largest *Drosera* drug exporter in Europe is Finland. To protect natural *D. rotundifolia* populations, the Finnish organisation “4H” has developed guidelines for collectors in order to prevent over-exploitation. These guidelines are, however, merely recommendations and are not legally binding. Moreover, it is not always possible to monitor compliance with the guidelines, and the selective collection of larger individuals can easily lead to genetic drift in small populations. There are no such guidelines in Madagascar, and it is not expected that guidelines will be implemented there in the near future.

In summary, the causes of the decline of natural *D. rotundifolia* populations are often complex and interrelated, but are not necessarily similar in different countries. However, the native habitats of *D. rotundifolia* are steadily diminishing in several countries, and the collection of plants from natural populations poses an additional threat to the species. In order to prevent natural populations from declining in the long term, cultivation methods that are time- and cost-effective must be developed and implemented.

Recently, *Sphagnum* cultivation (‘Sphagnum farming’) was established as a new alternative for commercial production of *Drosera* raw material in a sustainable way for commercial pharmacological purposes.

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REFERENCES

[1] Abrams, L. (1944) *Illustrated Flora of the Pacific States: Washington, Oregon and California*, Volume II. Stanford University Press, Stanford, 635 pp.

[2] Adamec, L. (1997) Mineral nutrition of carnivorous plants: A review. *The Botanical Review*, 63(3), 273–299. Online at: http://dx.doi.org/10.1007/BF02857953.

[3] Adema, E.B., Baaijens, G.J., van Belle, J., Rappoldt, C., Grootjans, A.P. & Smolders, A.J.P. (2006) Field evidence for buoyancy-driven water flow in a *Sphagnum* dominated peat bog. *Journal of Hydrology*, 327(1–2), 226–234. Online at: http://dx.doi.org/10.1016/j.jhydrol. 2005.11.019.

[4] Adlassnig, W., Peroutka, M., Lambers, H. & Lichtscheidl, I.K. (2005) The roots of carnivorous plants. *Plant and Soil*, 274, 127–140.

[5] Aichele, D. & Schwegler, H.-W. (1994) *Die Blütenpflanzen Mitteleuropas* (*The Flowering Plants of Central Europe*). Franckh-Kosmos,

Stuttgart, 2712 pp. (in German).

[6] Anderle, B. & Leban, V. (2011) Novelties in the flora of the Gorenjska region (Northwestern Slovenia). *Hladnikia*, 27, 27–56.

[7] Andreas, B.K. & Bryan, G.R. (1990) The vegetation of three *Sphagnum*-dominated basin-type bogs in Northeastern Ohio. *Ohio Journal of Science*, 90(3), 54–66. Online at: http://hdl.handle.net/1811/23392.

[8] Andreev, A.V. (2001) *Wetlands in Russia, Volume 4: Wetlands in Northeastern Russia*. Wetlands International, Moscow, 296 pp.

[9] Anon. (2008) Poimijat keräävät kihokkia pohjoisessa (Pickers collecting sundew in the north). Online at: http://yle.fi/uutiset/poimijat_keraavat_kihokkia_pohjoisessa/5847557, accessed 04 Jan 2015 (in Finnish).

[10] Anthes, N. (2002) *Lebenszyklus, Habitatbindung und Populationsstruktur des Goldenen Scheckenfalters* Euphydryas aurinia *Rott. im Alpenvorland* (*Habitat Preferences and Population Structure of the Golden Fritillary Butterfly* Euphydryas aurinia *Rott. in the Alpine Foothills*). Dissertation, University of Münster, 59 pp. (in German).

[11] Anthony, J.L. (1992) *In vitro* propagation of *Drosera* spp. *HortScience*, 27(7), 850.

[12] Araújo, P.V., Porto, M., Silva, A., Almeida, J.D., Lourenço, J., Schwarzer, U., Silveira, P. & Peixoto, M. (2014) *Drosera rotundifolia* L. - mapa de distribuição (*Drosera rotundifolia* L. - distribution map). *Flora-On: Flora de Portugal Interactiva*, Sociedade Portuguesa de Botânica. Online at: http://www.flora-on.pt/#wDrosera+rotundifolia, accessed 12 Jan 2015 (in Portuguese).

[13] Auster, F. & Schafer, J. (1957) *Arzneipflanzen:* Drosera rotundifolia *L.* (*Medicinal Plants:* Drosera rotundifolia *L.*). VEB Georg Thieme, Leipzig, 12 pp. (in German).

[14] Babula, P., Adam, V., Havel, L., & Kizek, R. (2009) Noteworthy secondary metabolites naphthoquinones - their occurrence, pharmacological properties and analysis. *Current Pharmaceutical Analysis*, 5(1), 47–68. Online at: http://dx.doi.org/10.2174/157341209787314936.

[15] Banasiuk, R., Kawiak, A. & Królicka, A. (2012) *In vitro* cultures of carnivorous plants from the *Drosera* and *Dionaea* genus for the production of biologically active secondary metabolites. *BioTechnologia*, 93(2), 87–96.

[16] Barthlott, W. (2004) *Karnivoren: Biologie und Kultur fleischfressender Pflanzen* (*Carnivores: Biology and Culture of Carnivorous Plants*). Eugen Ulmer, Stuttgart, 224 pp. (in German).

[17] Baskin, C.C. & Baskin, J.M. (2014) *Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination*. Academic Press, London, 682 pp.

[18] Bäumler, S. (2012) *Heilpflanzenpraxis Heute: Porträts - Rezepturen – Anwendung* (*Medicinal Plants Practice Today: Portraits - Formulations - Application*). Elsevier, Urban & Fischer Verlag, München, 1003 pp. (in German).

[19] Becker, K. & John, S. (2000) *Farbatlas Nutzpflanzen in Mitteleuropa* (*Colour Atlas of Crops in Central Europe*). Eugen Ulmer, Stuttgart, 300 pp. (in German).

[20] Behre, K. (1929) Physiologische und zytologische Untersuchungen über *Drosera* (Physiological and pathological examinations of *Drosera*). *Planta*, 7(2–3), 208–306 (in German). Online at: http://dx.doi.org/10.1007/BF01916031.

[21] Bekesiova, I., Nap, J.-P. & Mlynarova, L. (1999) Isolation of high quality DNA and RNA from leaves of the carnivorous plant *Drosera rotundifolia*. *Plant Molecular Biology Reporter*, 17(3), 269–277. Online at: http://dx.doi.org/10.1023/A:1007627509824.

[22] Berg, C., Dengler, J., Abdank, A. & Isemann, M. (eds.) (2004) *Die Pflanzengesellschaften Mecklenburg-Vorpommerns und ihre Gefährdung: Textband* (*The Plant Communities of Mecklenburg-Vorpommern and Their Vulnerability: Text Volume*). Weissdorn, Jena, 606 pp. (in German).

[23] Beug, H.-J. (2004) *Leitfaden der Pollenbestimmung für Mitteleuropa und angrenzende Gebiete* (*Guide to Pollen Identification for Central Europe and Adjacent Areas*). Dr. Friedrich Pfeil, München, 542 pp. (in German).

[24] Blaschek, W. (1998) *Hagers Handbuch der Pharmazeutischen Praxis. Drogen A–K* (*Hagers Handbook of Pharmaceutical Practice. Drugs A–K*). Springer, Heidelberg, 909 pp. (in German).

[25] Bobák, M., Blehová, A., Krištín, J., Ovečka, M. & Šamaj, J. (1995) Direct plant regeneration from leaf explants of *Drosera rotundifolia* cultured in vitro. *Plant Cell, Tissue and Organ Culture*, 43(1), 43–49. Online at: http://dx.doi.org/10.1007/BF00042670.

[26] Bobák, M., Hlavačka, A., Ovečka, M. & Šamaj, J. (1999) Effect of trifluralin and colchicine on the extracellular matrix surface networks during early stages of direct somatic embryogenesis of *Drosera rotundifolia* L. *Journal of Plant Physiology*, 155(3), 387–392. Online at:

http://dx.doi.org/10.1016/S0176-1617(99)80121-7.

[27] Bojňanský, V. & Fargašová, A. (2007) *Atlas of Seeds and Fruits of Central and East-European flora: The Carpathian Mountains Region*. Springer, Heidelberg, 1046 pp.

[28] Bonnet, M., Coumans, M., Hofinger, M., Ramaut, J.L. & Gaspar, T. (1984) High-performance gas chromatography of 1,4-naphthoquinones from Droseraceae. *Chromatographia*, 18, 621–622.

[29] Borhidi, A. (2003) *Magyarország növénytársulásai* (*Plant Communities of Hungary*). Akadémia, Budapest, 610 pp. (in Hungarian).

[30] Botch, M.S. (ed.) (1999) *Wetlands in Russia, Volume 2: Important Peatlands*. Global Series No. 2, Wetlands International, Russia, 91 pp.

[31] Box, J., Brown, M., Coppin, N., Hawkeswood, N., Webb, M., Hill, A., Palmer, Q., Duc, M.L. & Putwain, P. (2011) Experimental wet heath translocation in Dorset, England. *Ecological Engineering*, 37(2), 158–171. Online at: http://dx.doi.org/10.1016/j.ecoleng.2010.08.006

[32] Braem, G.J. (2002) *Fleischfressende Pflanzen: Arten und Kultur* (*Carnivorous Plants: Species and Culture*). Augustus, München, 136 pp. (in German).

[33] BRC (2012) *Botanical Society of the British Isles and the Biological Records Centre (BRC) Online Atlas of the British and Irish Flora*. Online at: http://www.brc.ac.uk/plantatlas/index.php?q=plant/drosera-rotundifolia, accessed 12 Jan 2014.

[34] Breeuwer, A., Robroek, B.J.M., Limpens, J., Heijmans, M.M.P.D., Schouten, M.G.C. & Berendse, F. (2009) Decreased summer water table depth affects peatland vegetation. *Basic and Applied Ecology*, 10(4), 330–339. Online at: http://dx.doi.org/10.1016/j.baae.2008.05.005.

[35] Brouwer, W. & Stählin, A. (1955) *Handbuch der Samenkunde: für Landwirtschaft, Gartenbau und Forstwirtschaft* (*Handbook of Seed Types: for Agriculture, Horticulture and Forestry*). DLG, Frankfurt a.M., 656 pp (in German).

[36] Bruzzese, B.M., Bowler, R., Massicotte, H.B. & Fredeen, A.L. (2010) Photosynthetic light response in three carnivorous plant species: *Drosera rotundifolia*, *D. capensis* and *Sarracenia leucophylla*. *Photosynthetica*, 48(1), 103–109. Online at: http://dx.doi.org/10.1007/s11099-010-0014-7.

[37] Byers, E.A., Vanderhorst, J.P. & Streets, B.P. (2007) Classification and conservation assessment of high elevation wetland communities in the Allegheny Mountains of West Virginia. West Virginia Natural Heritage Program. Online at: http://www.wvdnr.gov/publications/, accessed Jan 2015.

[38] Campbell, D. & Rochefort, L. (2003) Germination and seedling growth of bog plants in relation to the recolonization of milled peatlands. *Plant Ecology*, 169, 71–84. Online at: http://dx.doi.org/10.1023/A:1026258114901.

[39] Carow, T. & Fürst, R. (1997) *Fleischfressende Pflanzen: Arten Übersicht, Kultur, Vermehrung* (*Carnivorous Plants: Species Overview, Culture, Propagation*). T. Carow, Müncheberg, 72 pp. (in German).

[40] Castroviejo, S., Luceño, M., Galán, A., Jiménez Mejías, P., Cabezas, F. & Medina, L. (eds.) (2008) *Flora Iberica: Plantas Vasculares de la Península Ibérica e Islas Baleares – Cyperaceae – Pontederiaceae* (*Flora Iberica: Vascular Plants of the Iberian Peninsula and Balearic Islands - Cyperaceae - Pontederiaceae*). Real Jardín Botánico, Madrid, 472 pp. (in Spanish).

[41] Chmielewski, T.J. & Urban, D. (2011) Peatlands: Environmental functions. In: Glinski, J., Horabik, J. & Lipiec, J. (eds.) *Encyclopedia of Agrophysics*, Springer, Dordrecht, 548–551.

[42] Chung, M.Y., Lopez-Pujol, J. & Chung, M.G. (2013) Population history of the two carnivorous plants *Drosera peltata* var. *nipponica* and *Drosera rotundifolia* (Droseraceae) in Korea. *American Journal of Botany*, 100(11), 2231–2239. Online at: http://dx.doi.org/10.3732/ajb.1200486.

[43] Clapa, D., Alexandru, F. & Pacurar, I. (2010) *In vitro* multiplication, conservation and *ex vitro* acclimation of *Drosera rotundifolia*. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, *UASVM Horticulture*, 66(1)/2009, 34–39.

[44] Cohen, J.G., Albert, D.A., Kost, M.A. & Slaughter, B.S. (2010) *Natural Community Abstract for Coastal Fen*. Michigan Natural Features Inventory, Lansing, MI, 16 pp.

[45] Conradi, T. & Friedmann, A. (2013) Plant communities and environmental gradients in mires of the Ammergauer Alps (Bavaria, Germany). *Tuexenia*, 33, 133–163.

[46] Crouch, I.J. & van Staden, J. (1988) *In vitro* propagation of *Drosera natalensis*. *South African Journal of Botany*, 54, 94–95.

[47] Crouch, I.J., Finnie, J.F. & van Staden, J. (1990) Studies on the isolation of plumbagin from *in vitro* and *in vivo* grown *Drosera* species. *Plant Cell, Tissue and Organ Culture*, 21, 79–82.

[48] Crowder, A.A., Pearson, M.C., Grubb, P.J. &

Langlois, P.H. (1990) Drosera L. *Journal of Ecology*, 78(1), 233–267. Online at: http://dx.doi.org/10.2307/2261048

[49] Culham, A. & Yesson, C. (2008) Droseraceae species checklist, Species 2000 & ITIS Catalogue of Life: 2010 Annual Checklist. Online at: http://www.catalogueoflife.org/annual-checklist/2010/details/species/id/6300478, accessed 03 Jan 2015.

[50] D'Amato, P. (2013) *The savage Garden: Cultivating Carnivorous Plants*. Ten Speed Press, Berkeley, 384 pp.

[51] Darwin, C.R. (1875) *Insectivorous Plants*. John Murray, London, 462 pp.

[52] Davis, R.B. & Anderson, D.S. (1991) *The Eccentric Bogs of Maine: a Rare Wetland Type in the United States*. Department of Plant Biology and Pathology, and Institute for Quaternary Studies, University of Maine, Orono, 176 pp.

[53] Didry, N., Dubreuil, L., Trotin, F. & Pinkas, M. (1998) Antimicrobial activity of aerial parts of *Drosera peltata* Smith on oral bacteria. *Journal of Ethnopharmacology*, 60(1), 91–96. Online at: http://dx.doi.org/10.1016/S0378-8741(97)00129-3.

[54] Diels, L. (1906) Droseraceae. In: Engler, A. (ed.) *Das Pflanzenreich 26* (*The Plant Kingdom 26*). Wilhelm Englemann, Leipzig, 1–116 (in German).

[55] Dierssen, B. & Dierssen, K. (1984) *Vegetation und Flora der Schwarzwaldmoore* (*Vegetation and Flora of the Black Forest*). Veröffentlichungen für Naturschutz und Landschaftspflege in Baden-Württemberg (Publications for Nature Conservation and Landscape Management in Baden-Württemberg), Landesanstalt für Umweltschutz Baden-Württemberg, Karlsruhe, 520 pp. (in German).

[56] Dijkema, K.S. & Wolff, W.J. (1983) *Flora and Vegetation of the Wadden Sea Islands and Coastal Areas: Final Report of the Section "Flora and Vegetation of the Islands"*. Wadden Sea Working Group Report 9, A.A. Balkema, The Netherlands, 413 pp.

[57] Dimopoulos, P., Raus, T., Bergmeier, E., Constantinidis, T., Iatrou, G., Kokkini, S., Strid, A. & Tzanoudakis, D. (2013) V*ascular Plants of Greece: an Annotated Checklist*. Botanic Garden and Botanical Museum Berlin-Dahlem, 372 pp.

[58] Egan, P.A. & van der Kooy, F. (2013) Phytochemistry of the carnivorous sundew genus *Drosera* (Droseraceae) - Future perspectives and ethnopharmacological relevance. *Chemistry & Biodiversity*, 10(10), 1774–1790. Online at: http://dx.doi.org/10.1002/cbdv.201200359.

[59] Ellwanger, G. (1996) Die Vegetation der Moore des Brockengebietes I. Pflanzengesellschaften soligener Hangmoore (Mire vegetation of the Brocken area I. Plant communities of soligenous swamp bogs). *Hercynia N F Halle*, 30, 69–97 (in German).

[60] Elo, T. (2008) Kihokkia vientiin Pohjois-Suomen soilta (Sundew for Export from Northern Finnish Bogs). Online at: http://www.terveydenhoitouutiset.fi/sitenews/view/-/ngid/7/nid/32, accessed 04 Jan 2015 (in Finnish).

[61] Engelhardt, T.L. (1998) *Pollination Ecology of the Round-leaved Sundew,* Drosera rotundifolia *L. (Droseraceae) in Sequoia National Park, California*. California State University, Fullerton, 124 pp.

[62] Fernández-Pascual, E. (2016) Comparative seed germination traits in bog and fen mire wetlands. *Aquatic Botany*, 130, 21–26. Online at: http://dx.doi.org/10.1016/j.aquabot.2016.01.001

[63] Fischer, M.A., Oswald, K. & Adler, W. (2008) *Exkursionsflora für Österreich, Liechtenstein und Südtirol* (*Excursion Flora for Austria, Lichtenstein and the South Tyrol*). Land Oberösterreich, Landesmuseen, Linz, 1392 pp. (in German).

[64] Forst, M. (1997) *Hoch- und Zwischenmoore in Trockenmaaren der Vulkaneifel: Vegetationsentwicklung in Abhängigkeit von natürlichen und anthropogenen Veränderungen des Wasser- und Nährstoffhaushaltes, Ergebnisse aus dem F+E-Vorhaben 80804024 des Bundesamtes für Naturschutz, Angewandte. Landschaftsökologie* (*Raised and Intermediate Mires in Dry Maars of the Volcanic Eifel: Vegetation Development in Response to Natural and Anthropogenic Changes of Water and Nutrient Balance, Results from the R&D Projects 80,804,024 of the Federal Agency for Nature Conservation, Applied Landscape Ecology*). Bundesamt für Naturschutz, Bonn-Bad Godesberg, 481 pp. (in German).

[65] Frahm, J.P. & Frey, W. (2004) *Moosflora* (*Moss Flora*). Ulmer, Stuttgart, 538 pp. (in German).

[66] Frey, W. & Lösch, R. (2010) *Lehrbuch der Geobotanik: Pflanze und Vegetation in Raum und Zeit* (*Textbook of Geobotany: Flora and Vegetation in Space and Time*). Spektrum, Wiesbaden, 616 pp. (in German).

[67] Frohn, B. (2010) *Lexikon der Heilpflanzen und ihrer Wirkstoffe: das Standardwerk zur*

Pflanzenheilkunde (*Encyclopedia of Medicinal Plants and Their Active Ingredients: the Standard Work on Phytotherapy*). Weltbild, Augsburg, 592 pp. (in German).

[68] Galambosi, B. & Galambosi, Zs. (2013) Kihokin viljely ja sen kriittiset pisteet (Cultivation of sundew and its critical points). In: Peltola, R. & Soppela, K. (eds.) *Luonnontuotealan Valtakunnallinen Tutkimusseminaari* (*National Research Seminar of Natural Products 4.10.2011*), 40–44(in Finnish). Online at: http://www.mtt.fi/mttraportti/pdf/mttraportti87.pdf, accessed 07 Jan 2014.

[69] Galambosi, B. & Jokela, K. (2002) *Uhanalaisten lääkekasvien markkinat ja viljely. Kirjallisuusselvitys* (*Endangered Species of Medicinal Plants and their Increasing Market Share. Literature Survey*). Maa-ja elintarviketalous 17, MTT, Jokioinen, 88 pp. Online at: http://www.mtt.fi/met/pdf/met17.pdf, accessed 04 Jan 2014 (in Finnish).

[70] Galambosi, B. (2002) Elaboration of field growing technics of *Drosera* species. *Drogenreport*, 15(28), 56–58.

[71] Galambosi, B., Galambosi, Zs. & Repčák, M. (2000a) Growth, yield and secondary metabolite production of *Drosera* species cultivated in peat beds in Finland. *Suo*, 51, 47–57.

[72] Galambosi, B., Galambosi, Zs., Repčák, M. & Takkunen, N. (1999) The effect of artificial feeding on growth, yield and quality of *Drosera* species grown indoors. *Drogenreport*, 12(22), 9–18.

[73] Galambosi, B., Takkunen, N. & Repčák, M. (1995) Experiences of cultivating *Drosera* species in Finland. In: *Proceedings of the Workshop "Herba Droserae-Botanik, Inhaltsstoffe, Analytik", 10 Nov 1995*, Universität Wien, 2 pp.

[74] Galambosi, B., Takkunen, N. & Repčák, M. (1998) Can we replace collection of *Drosera* by cultivation? In: *TRAFFIC Europe. Medicinal Plant Trade in Europe: Conservation and Supply*, Proceedings of the First International Symposium on the Conservation of Medicinal Plants in Trade in Europe, 22–23 June 1998, Royal Botanic Gardens, Kew, TRAFFIC Europe in collaboration with WWF, IUCN/SSC Medicinal Plant Specialist Group, Royal Botanic Gardens, Kew, UK, 131–139. Online at: http://www.trafficj.org/publication/99_Medicinal_Plant_Trade_in_Europe.pdf, accessed 15 Jun 2016.

[75] Galambosi, B., Takkunen, N. & Repčák, M. (2000b) The effect of regular collection of *Drosera rotundifolia* in natural peatlands in Finland: plant density, yield and regeneration. *Suo*, 51, 37–46.

[76] Gaudig, G., Fengler, M., Krebs, M., Prager, A., Schulz, J., Wichmann, S. & Joosten, H. (2014) Sphagnum farming in Germany: a review of progress. *Mires and Peat*, 13(8), 1–11.

[77] GBIF Secretariat. (2014) *Drosera rotundifolia* L. species in GBIF backbone taxonomy. Online at: http://www.gbif.org/species/3191030, accessed 05 July 2014.

[78] Gerdol, R., Pontin, A., Tomaselli, M., Bombonato, L., Brancaleoni, L., Gualmini, M., Petraglia, A., Siffi, C. & Gargini, A. (2011) Hydrologic controls on water chemistry, vegetation and ecological patterns in two mires in the south-eastern Alps (Italy). *Catena*, 86(2), 86–97. Online at: http://dx.doi.org/10.1016/j.catena.2011.02.008.

[79] Glaser, P.H., Janssens, J.A. & Siegel, D.I. (1990) The response of vegetation to chemical and hydrological gradients in the Lost River Peatland, Northern Minnesota. *Journal of Ecology*, 78(4), 1021–1048. Online at: http://www.jstor.org/stable/2260950.

[80] Gleason, H.A. (1952) *The new Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada*. New York Botanical Garden, New York, 937 pp.

[81] GMNHJ (2005) Vascular Plant Specimen (*Drosera rotundifolia*), Gunma Museum of Natural History. National Museum of Nature and Science, Japan. Online at: http://www.gbif.org/occurrence/394054616, accessed 01 Dec 2014.

[82] Goebel, K. (1914) Die kleistogamen Blüten und die Anpassungtheorien (Cleistogamic flowers and adaptation theories). *Biologisches Zentalblatt*, 24, 780–781 (in German).

[83] GRIN (2015) Taxon: *Drosera rotundifolia* L. Germplasm Resources Information Network (GRIN), USDA/ARS National Genetic Resources Program, National Germplasm Resources Laboratory, Beltsville, Maryland. Online at: http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?400172, accessed 05 Jan 2015.

[84] HAB (2014) *Homöopathisches Arzneibuch* (*Homeopathic Pharmacopoeia*). Deutscher Apotheker Verlag, Stuttgart, 1882 pp. (in German).

[85] Haeupler, H. & Muer, T. (eds.) (2007) *Bildatlas der Farn- und Blütenpflanzen Deutschlands* (*Illustrated Atlas of Ferns and Flowering Plants of Germany*). Eugen Ulmer, Stuttgart, 789 pp. (in

German).

[86] Hájek, M., Hájková, P. & Apostolova, I. (2008) New plant associations from Bulgarian mires. *Phytologia Balcanica*, 14, 377–399.

[87] Halbritter, H., Hesse, M. & Weber, M. (2012) The unique design of pollen tetrads in *Dionaea* and *Drosera*. *Grana*, 51(2), 48–157. Online at: http://dx.doi.org/10.1080/00173134.2012.677856.

[88] Hansen, C. (1973) Note on *Drosera rotundifolia* L. in Greenland. *Botanisk Tidsskrift*, 67, 342–343.

[89] Hansen, H.P. (1967) Palynology of a bog in eastern Norway. *Review of Palaeobotany and Palynology*, 4(1–4), 129–133. Online at: http://dx.doi.org/10.1016/0034-6667(67)90179-0.

[90] Hegi, G. (1923) *Illustrierte Flora von Mittel-Europa, Dicotyledones* (*Illustrated Flora of Central Europe, Dicotyledons*), Carl Hanser, München, 668 pp. (in German).

[91] Hegi, G. (1961) 56. Familie Droseraceae. In: Huber, H. (ed.) *Illustrierte Flora von Mittel-Europa* (*Illustrated Flora of Central Europe*), Carl Hanser, München, 4–17 (in German).

[92] Heinricher, E. (1902) Zur Kenntnis von *Drosera* (Information about *Drosera*). *Ferdinandeum Zeitschrift Innsbruck*, 46(3), 1–25 (in German).

[93] Hermann, F. (1956) *Flora von Nord- und Mitteleuropa* (*Flora of North and Central Europe*). Gustav Fischer, Stuttgart, 1134 pp. (in German).

[94] Hess, H.E., Landolt, E. & Hirzel, R. (1976) *Flora der Schweiz und angrenzender Gebiete* (*Flora of Switzerland and Adjacent Areas*). Birkhauser, Basel, 657 pp (in German).

[95] Heywood, V. H. (1978) *Flowering Plants of the World*. Oxford University Press, London, 336 pp.

[96] Hiller, K. & Loew, D. (2009) Droserae herba. In: Wichtl, M. (ed.) *Teedrogen Und Phytopharmaka: Ein Handbuch für die Praxis auf wissenschaftlicher Grundlage* (*Tea Drugs and Herbal Products: a Handbook for Scientifically Based Practice*). Wissenschaftliche Verlagsgesellschaft, Stuttgart, 221–223 (in German).

[97] Himmelbaur, W. (1926) Über die Kultur von Sonnentau (About the cultivation of sundew). *Mitteilungen des Komitees zur Staatlichen Förderung der Kultur von Arzneipflanzen in Österreich*, 66, 146–147 (in German).

[98] Hirsikorpi, M., Kämäräinen, T., Teeri, T. & Hohtola, A. (2002) Agrobacterium-mediated transformation of round leaved sundew (*Drosera rotundifolia* L.). *Plant Science*, 162(4), 537–542. Online at: http://dx.doi.org/10.1016/S0168-9452(01)00592-1.

[99] Hogan, C. (2011) *Drosera rotundifolia*. In: *Encyclopedia of Earth*, National Council for Science and the Environment. Online at: www.eoearth.org/view/article/151802/, accessed 12 Jan 2014.

[100] Hohtola, A., Jalonen, J., Tolonen, A., Jaakola, L., Kämäräinen, T., Pakonen, M., Laine, K., Neubauer, P., Myllykoski, L., György, Z., Rautio, A. & Pelkonen, O. (2005) 5.7. Natural product formation by plants; enhancement, analysis, processing and testing. In: *Sustainable Use of Renewable Natural Resources - From Principles to Practices*, Ecology Publications 34, Department of Forestry, University of Helsinki, 1–10.

[101] Holzner, G. & Naegele, F. (1904) Vorarbeiten zu einer Flora Bayerns - Die bayerischen Droseraceen (Preparatory work for a Bavarian Flora - the Bavarian Droseraceae) *Berichte der Bayerischen Botanischen Gesellschaft*, 9, 1–18 (in German).

[102] Holzner, G. (1902) Die äussere Samenhaut der deutschen *Drosera*-Arten (The outer seed coat of the German *Drosera* species). *Flora oder Allgemeine Botanische Zeitung*, 90, 342–343 (in German).

[103] Hoyo, Y. & Tsuyuzaki, S. (2015) Sexual and vegetative reproduction of the sympatric congeners *Drosera anglica* and *Drosera rotundifolia*. *Flora - Morphology, Distribution, Functional Ecology of Plants*, 210, 60–65. Online at: http://dx.doi.org/10.1016/j.flora.2014.10.003.

[104] Huhtala, A. (2014) Kiimingin 4H-yhdistys ry – Kihokki (Kiimingin 4H association - Sundew). Online at: http://kiiminki.4h.fi/muu-toiminta/luonnontuotteet/kihokki/, accessed 07 Jan 2014 (in Finnish).

[105] Hultén, E. (1968) *Flora of Alaska and Neighbouring Territories: a Manual of the Vascular Plants*. Stanford University Press, Stanford, 1032 pp.

[106] Huntke, T. (2008) *Vegetationsökologische Untersuchungen zur Entwicklung des Naturschutzgebiets Lengener Meer (Landkreis Leer) - eine Fallstudie zur Effizienz des Naturschutzes von Hochmooren* (*Vegetation Ecological Studies on the Development of the Lengener Meer Reserve (Leer District) - a Case Study on the Effectiveness of Conservation of Raised Bogs*). Dissertation, University of Oldenburg, 330 pp. (in German).

[107] Ilnicki, P. (2002) *Peatlands and Peat*.

Wydawnictwo AR Poznan, 606 pp.

[108] Jang, G.W. & Park, R.D. (1999) Mass propagation of sundew, *Drosera rotundifolia* L. through shoot culture. *Journal of Plant Biotechnology*, 1, 97–100.

[109] Jayaram, K. & Prasad, M.N.V. (2008) Rapid *in vitro* multiplication of *Drosera burmanii* Vahl.: A vulnerable and medicinally important insectivorous plant. *Indian Journal of Biotechnology*, 7, 260–265.

[110] Jopke, W. (1954) Einige Bemerkungen über den feldmäßigen Anbau von Arctostaphylos uva ursi (L.) Spreng und *Drosera rotundifolia* L. für Heilzwecke (Some remarks on the field cultivation of A*rctostaphylos uva ursi* (L.) Spreng and *Drosera rotundifolia* L. for medicinal purposes). *Acta Phytotherapie*, 1, 1–4 (in German).

[111] Julve, P. (1999) Botanical variance in some mire vegetation between Hokkaido and Europe. *Acta Botanica Gallica*, 146, 207–225.

[112] Kachalkin, A.V., Glushakova, A.M., Yurkov, A.M. & Chernov, I.Y. (2008) Characterization of yeast groupings in the phyllosphere of *Sphagnum* mosses. *Microbiology*, 77(4), 474–481. Online at: http://dx.doi.org/10.1134/S0026261708040140.

[113] Kaffke, A. (2008) Vegetation and site conditions of a *Sphagnum* percolation bog in the Kolkheti Lowlands (Georgia, Transcaucasia). *Phytocoenologia*, 38(3), 161–176.

[114] Kämäräinen, T., Uusitalo, J., Jalonen, J., Laine, K. & Hohtola, A. (2003) Regional and habitat differences in 7-methyljuglone content of Finnish *Drosera rotundifolia*. *Phytochemistry*, 63(3), 309–314. Online at: http://dx.doi.org/10.1016/S0031-9422(03)00115-8.

[115] Kawiak, A., Królicka, A. & Lojkowska, E. (2003) Direct regeneration of *Drosera* from leaf explants and shoot tips. *Plant Cell, Tissue and Organ Culture*, 75, 175–178. Online at: http://dx.doi.org/10.1023/A:1025023800304.

[116] Kerner von Marilaun, A. (1890) *Pflanzenleben* (*Plant Life*). Verlag des Bibliographischen Instituts, Leipzig und Wien, 892 pp (in German).

[117] Khela, S. (2012) *Drosera rotundifolia*. In: The IUCN Red List of Threatened Species, Version 2014.3. Online at: http://www.iucnredlist.org, accessed 04 Jan 2015.

[118] Kim, K.-S. & Jang, G.-W. (2004) Micropropagation of *Drosera peltata*, a tuberous sundew, by shoot tip culture. *Plant Cell, Tissue and Organ Culture*, 77(2), 211–214. Online at: http://dx.doi.org/10.1023/ B:TICU.0000016812. 66762.45.

[119] Király, G. (ed.) (2007) *Vörös Lista. A magyarországi edényes flóra veszélyeztetett fajai* (*Red List of the Vascular Flora of Hungary*). Private edition of the authors, Sopron, 73 pp. (in Hungarian). Online at: http://www.termeszetvedelem.hu/_user/downloads/vedett_fajok/Red%20List_final%20version.pdf, accessed 03 Sep 2016.

[120] Király, G., Virók, V. & Molnár, V.A. (eds.) (2011) *Új Magyar Füvész könyv. Magyarország hajtásos növényei. Ábrák* (*New Hungarian Herbal. The Vascular Plants of Hungary. Figures*). Aggtelek National Park Directorate, Jósvafő, 676 pp (in Hungarian).

[121] Krafft, C.C. & Handel, S.N. (1991) The role of carnivory in the growth and reproduction of *Drosera filiformis* and *D. rotundifolia*. *Bulletin of the Torrey Botanical Club*, 118(1), 12–19. Online at: http://www.jstor.org/stable/2996970.

[122] Kräusel, R. (1960) *Mitteleuropäische Pflanzenwelt. Sträucher und Bäume* (*Central European Plant World. Shrubs and Trees*). Kronen-E. Cramer, München Hamburg, 144 pp. (in German).

[123] Krenn, L. & Kartnig, T. (2005) Sonnentau - Aktuelles über medizinisch genutzte *Drosera*-Arten (Sundew - current medicinal uses of *Drosera* species). *Zeitschrift für Phytotherapie*, 26(4), 197–202. Online at: http://dx.doi.org/10.1055/s-2005-915657 (in German).

[124] Krenn, L., Länger, R. & Kopp, B. (1995) Qualitätsprüfung von Sonnentaukraut. 2. Botanische Identitätsprüfung sowie qualitative und quantitative Naphthochinonbestimmung an Handelsmustern (Quality control of Sundew. 2. Verification of botanical identity and qualitative as well as quantitative determination of naphthoquinone from commercial material samples). *Deutsche Apotheker Zeitung*, 135, 867–870 (in German).

[125] Kritzler, U.H., Artz, R.R.E. & Johnson, D. (2016) Soil CO_2 efflux in a degraded raised bog is regulated by water table depth rather than recent plant assimilate. *Mires and Peat*, 17(1), 1–14.

[126] Krivenko, V.G. (ed.) (2000) *Wetlands in Russia, Volume 3: Wetlands on the Ramsar Shadow List.* Global Series No. 6, Wetlands International, Moscow, 409 pp.

[127] Kubitzki, K. (2003) Droseraceae. In: Kubitzki, K. & Bayer, C. (eds.) *The Families and Genera of Vascular Plants*. Springer, Stuttgart, 198–202.

[128] Kukułczanka, K. & Cząstka, B. (1988) Regeneration abilities of *Drosera* sp. *Acta Horticulturae*, 226, 631–634.

[129] Kutschera, L., Lichtenegger, E. & Sobotik, M. (1992) *Wurzelatlas mitteleuropäischer Grünlandpflanzen. Band 2: Pteridophyta und Dicotyledoneae (Magnoliopsida)* (*Root Atlas of Central European Grassland Plants. Volume 2. Pteridophyta and Dicotyledoneae (Magnoliopsida)*). Gustav Fischer, Stuttgart, 851 pp. (in German).

[130] Labat, J.-J. (2003) *Fleischfressende Pflanzen Auswählen und Pflegen* (*Selection and Maintenance of Carnivorous Plants*). Ulmer, Stuttgart, 96 pp. (in German).

[131] Lahring, H. (2003) *Water and Wetland Plants of the Prairie Provinces, Canadian Plains Studies*. Canadian Plains Research Center, University of Regina Press, Regina, 326 pp.

[132] Lange, D. (1998) *Europe's Medicinal and Aromatic Plants: Their Use, Trade and Conservation*. A Traffic Network report, Traffic International, Cambridge, 77 pp.

[133] Laslo, V., Zăpârţan, M. & Agud, E. (2011) *In vitro* conservation of certain endangered and rare species of Romanian spontaneons flora. *Analele Universităţii din Oradea, Protecţia Mediului*, 16, 247–252.

[134] Lauber, K., Wagner, G. & Gygax, A. (2012) *Flora Helvetica*. Haupt, Bern, 1656 pp.

[135] Lecoufle, M. (1990) *Carnivorous Plants*. Blandford, London, 144 pp.

[136] Linder-Effland, M. (2002) *Vegetation und Stratigraphie von* Sphagnum-*Mooren in der Jungmoräne Schleswig-Holsteins, Mecklenburg-Vorpommerns und Südjütlands* (*Vegetation and Stratigraphy of* Sphagnum *Bogs in the Young Moraine of Schleswig-Holstein, Mecklenburg-Vorpommern and in South Jutland*). Dissertation, University of Kiel, 176 pp. (in German).

[137] Lindsay, R., Rigall, J. & Burd, F. (1985) The use of small-scale surface patterns in the classification of British Peatlands. *Aquilo Serie Botanica*, 21, 67–79.

[138] Lindsay, R.A., Riggall, J. & Bignal, E.M. (1983) Ombrogenous mires in Islay and Mull. *Proceedings of the Royal Society of Edinburgh - Biology*, 83, 341–371.

[139] Lloyd, F.E. (1942) *The Carnivorous Plants*. Chronica Botanica Company, Waltham, 352 pp.

[140] Ludwig, G. & Schnittler, M. (1996) *Rote Liste gefährdeter Pflanzen Deutschlands* (*Red List of Threatened Plants in Germany*). Bundesamt für Naturschutz, Bonn-Bad Godesberg, 744 pp. (in German).

[141] Lüttge, U., Kluge, M. & Thiel, G. (2010) *Botanik die umfassende Biologie der Pflanzen* (*Botany - The Comprehensive Biology of Plants*). Wiley-VCH-Verl., Weinheim, 1236 pp. (in German).

[142] MacKinnon, A. (2009) *Edible and Medicinal Plants of Canada.* Lone Pine Publishing, Edmonton, 448 pp.

[143] Magee, D.W. & Ahles, H.E. (2007) *Flora of the Northeast: a Manual of the Vascular Flora of New England and Adjacent New York*. University of Massachusetts Press, Amherst, 1264 pp.

[144] Marczak, Ł., Kawiak, A., Lojkowska, E. & Stobiecki, M. (2005) Secondary metabolites in *in vitro* cultured plants of the genus *Drosera*. *Phytochemical Analysis*, 16, 143–149.

[145] Masing, V., Botch, M. & Läänelaid, A. (2010) Mires of the former Soviet Union. *Wetlands Ecology and Management*, 18(4), 397–433.

[146] Matthews, R.F. (1994) *Drosera rotundifolia*. Fire Effects Information System, US Department of Agriculture Forest Service, Rocky Mountain Research Station, Fort Collins. Online at: http://www.fs.fed.us/database/feis/plants/forb/drorot/all.html, accessed 05 Jun 2015.

[147] McCormick, B., Sumerlin, D., Larkin-McKim, K. & Popovich, S. (2011) Final biological report - Biological assessment, biological evaluation, management indicator species report, and review of local and state species of concern, United States, Grand County, Colorado. Online at: https://ww2.wapa.gov/sites/western/transmission/infrastruct/Documents/gpp-wgp/Final_Biological_Report_30-Sept-11.pdf, accessed 02 Feb 2015.

[148] Melzig, M.F., Pertz, H.H. & Krenn, L. (2001) Anti-inflammatory and spasmolytic activity of extracts from Droserae Herba. *Phytomedicine*, 8, 225–229. Online at: http://dx.doi.org/10.1078/0944-7113-00031.

[149] Meusel, H., Jager, E. & Weinert, E. (1965) *Vergleichende Chronologie der zentraleuropäischen Flora* (*Comparative Chronology of the Central European Flora*). VEB Gustav Fisher, Jena, 833 pp. (in German).

[150] Michaelis, D. (2011) *Die* Sphagnum-*Arten der Welt* (*The* Sphagnum *Species of the World*). Schweizerbart Science, Stuttgart, 408 pp. (in German).

[151] Millett, J., Leith, I., Sheppard, L. & Newton, J. (2012a) Response of *Sphagnum papillosum* and *Drosera rotundifolia* to reduced and oxidized wet nitrogen deposition. *Folia Geobotanica*, 47(2), 179–191. Online at: http://dx.doi.org/10.1007/s12224-011-9114-9.

[152] Millett, J., Svensson, B.M., Newton, J. &

Rydin, H. (2012b.) Reliance on prey-derived nitrogen by the carnivorous plant *Drosera rotundifolia* decreases with increasing nitrogen deposition. *New Phytologist*, 195(1), 182–188. Online at: http://dx.doi.org/10.1111/j.1469-8137.2012.04139.x

[153] Miserere, L., Montacchini, F. & Buffa, G. (2003) Ecology of some mire and bog plant communities in the Western Italian Alps. *Journal of Limnology*, 62, 88–96.

[154] Mohlenbrock, R.H. (2002) *Vascular Flora of Illinois*. Southern Illinois University Press, Carbondale, 491 pp.

[155] Moss, E.H. (1983) *Flora of Alberta*. University of Toronto Press, Toronto, 691 pp.

[156] Mucina, L., Bültmann, H., Dierßen, K., Theurillat, N.J.-P., Raus, T., Čarni, A., Šumberová, K., Willner, W., Dengler, J., Gavilán Garcia, R., Chytrý, M., Hájek, M., Di Pietro, R., Iakushenko, D., Pallas, J., Daniëls, F.J.A., Bergmeier, E., Santos Guerra, A., Ermakov, N., Valachovič, M., Schaminée, J.H.J., Lysenko, T., Didukh, Y.P., Pignatti, S., Rodwell, J.S., Capelo, J., Weber, H.E., Solomeshch, A., Dimopoulos, P., Aguiar, C., Hennekens, S.M. & Tichý, L. (in press) Vegetation of Europe: Hierarchical floristic classification system of vascular plant, bryophyte, lichen, and algal communities. *Applied Vegetation Science*, 19.

[157] Munz, P.A. & Keck, D.D. (1959) *A California Flora*. University of California Press, Berkeley, 1681 pp.

[158] Murashige, T. & Skoog, F. (1962) A revised medium for rapid growth and bio assays with tobacco tissue cultures. *Physiologia Plantarum*, 15(3), 473–497. Online at: http://dx.doi.org/ 10.1111/j.1399-3054.1962.tb08052.x.

[159] Murza, G.L. & Davis, A.R. (2003) Comparative flower structure of three species of sundew (*Drosera anglica*, *Drosera linearis*, and *Drosera rotundifolia*) in relation to breeding system. *Canadian Journal of Botany*, 81(11), 1129–1142. Online at: http://dx.doi.org/ 10.1139/b03-104.

[160] Murza, G.L. & Davis, A.R. (2005) Flowering phenology and reproductive biology of *Drosera anglica* (Droseraceae). *Botanical Journal of the Linnean Society*, 47(4), 417–426. Online at: http://dx.doi.org/10.1111/j.1095-8339.2005.00395.x.

[161] Nagy, J. (2010) The southernmost *Sphagnum*-dominated mires on the plains of Europe: formation, secondary succession, degradation and protection. In: Tuba, Z., Slack, N.G. & Stark, L.R. (eds.) *Bryophyte Ecology and Climate Change*, Cambridge University Press, 17–332.

[162] Nikolić, T. & Topić, J. (2005) *Crvena knjiga vaskularne flore Hrvatske* (*Red Book of Vascular Flora of Croatia*). Ministarstvo kulture, Državni zavod za zaštitu prirode, Zagreb, 695 pp. (in Croatian).

[163] NINA (2014) Botanical Collection, Norwegian Institute for Nature Research. Online at: http://www.gbif.org/occurrence/177927754, accessed 03 Dec 2014.

[164] Nitschke, T.H. (1860) Wachsthums-verhaltnisse des rundblattrigen Sonnenthaues (Growth conditions of the round-leaved sundew). *Botanische Zeitung*, 18, 57–61 & 65–69 (in German).

[165] Nordbakken, J.-F., Rydgren, K. & Økland, R.H. (2004) Demography and population dynamics of *Drosera anglica* and *D. rotundifolia*. *Journal of Ecology*, 92(1), 110–121. Online at: http://dx.doi.org/10.1046/j.0022-0477.2004.00839.x.

[166] NRM (2014) Rundsileshår - *Drosera rotundifolia* L. (Sundew - *Drosera rotundifolia* L.). *Den Virtuella Floran*, Naturhistorika riksmuseet (NRM). Online at: http://linnaeus.nrm.se/flora/di/drosera/drose/drosrot.html, accessed 05 July 2014 (in Swedish).

[167] Oberdorfer, E. (2001) *Pflanzensoziologische Exkursionsflora für Deutschland und angrenzende Gebiete* (P*lant Sociological Excursion Flora for Germany and Adjacent Areas*). Ulmer, Stuttgart, 1051 pp. (in German).

[168] Oberdorfer, E. (ed.) (1992) *Süddeutsche Pflanzengesellschaften* (*South German Plant Communities*). VEB Gustav Fischer, Jena, 282 pp. (in German).

[169] Oltmanns, A. (1996) *Vegetationskundliche und floristische Beschreibung eines ehemaligen Panzerübungsgeländes (Rote Fläche I) bei Schneverdingen in der Lüneburger Heide im Hinblick auf eine Heidegeneration* (*Vegetation and Floristic Description of a Former Tank Training Area (Red Area I) in Schneverdingen on the Lüneburg Heath in the Context of Heath Generation*). University of Bremen, 166 pp. (in German).

[170] Paal, J., Jürjendal, I., Suija, A. & Kull, A. (2016) Impact of drainage on vegetation of transitional mires in Estonia. *Mires and Peat,* 18(2), 1–19.

[171] Paper, D.H., Karall, E., Kremser, M. & Krenn, L. (2005) Comparison of the antiinflammatory effects of *Drosera rotundifolia* and *Drosera*

madagascariensis in the HET-CAM assay. *Phytotherapy Research*, 19(4), 323–326. Online at: http://dx.doi.org/10.1002/ptr.1666.

[172] Pellerin, S., Huot, J. & Côté, S.D. (2006) Long-term effects of deer browsing and trampling on the vegetation of peatlands. *Biological Conservation*, 128(3), 316–326. Online at: http://dx.doi.org/10.1016/j.biocon.2005.09.039.

[173] Perica, M.C. & Berljak, J. (1996) *In vitro* growth and regeneration of *Drosera spathulata* Labill. on various media. *HortScience*, 31, 1033–1034.

[174] Petronijevic, A.M., Trajković, S. & Randjelović, V. (2009) Anthropogenic effects on environment: Case study: Peat islands of Lake Vlasina. *Facta Universitatis - Series: Architecture and Civil Engineering*, 7(1), 95–105. Online at: http://dx.doi.org/ 10.2298/FUACE0901095M.

[175] Petrova, A. & Vladimirov, V. (2008) Red List of Bulgarian vascular plants. *Phytologia Balcanica*, 15(1), 63–94.

[176] Phillips, H.R. (1985) Sundews (*Drosera* species). In: Phillips, H.R., Gardner, R., Jones-Roe, C.A., Bell, C.R. & Moore, K. (eds.) *Growing and Propagating Wild Flowers*. The University of North Carolina Press, Chapel Hill, NC, 256–258.

[177] Phitos, D., Constantinidis, T. & Kamari, G. (eds.) (2009) *The Red Data Book of Rare and Threatened Plants of Greece*. Hellenic Botanical Society, Patra, 527 pp.

[178] Pietsch, W. (1985) Vegetation und Standortverhältnisse der Heidemoore der Lausitz (Vegetation and site conditions of the moorlands of Lausitz). *Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien*, 123, 75–98 (in German).

[179] Pignatti, S. (2002) *Flora D'Italia* (*Flora of Italy*). Edagricole, Bologna, 2324 pp. (in Italian).

[180] Pissarek, H.P. (1965) Beobachtungen über das Blühen von *Drosera rotundifolia* (Observations on the flowering of *Drosera rotundifolia*). *Schriften des Naturwissenschaftlichen Vereins für Schleswig-Holstein*, 36, 26–29 (in German).

[181] Poschlod, P. (1995) Diaspore rain and diaspore bank in raised bogs and implications for the restoration of peat-mined sites. In: Wheeler, B.D., Shaw, S.C., Fojt, W.J. & Robertson, R.A. (eds.) *Restoration of Temperate Wetlands*, John Wiley & Sons Ltd., Chichester, 471–494.

[182] Poto, L., Gabrieli, J., Crowhurst, S.J., Appleby, P.G., Ferretti, P., Surian, N., Cozzi, G., Zaccone, C., Turetta, C., Pini, R., Kehrwald, N. & Barbante, C. (2013) The first continuous Late Glacial - Holocene peat bog multi-proxy record from the Dolomites (NE Italian Alps). *Quaternary International*, 306, 71–79. Online at: http://dx.doi.org/10.1016/j.quaint.2013.05.001.

[183] Pott, R. (1995) *Die Pflanzengesellschaften Deutschlands* (*The Plant Communities of Germany*). Eugen Ulmer, Stuttgart, 622 pp. (in German).

[184] Prieto, J.A.F., Ordóñez, M.C.F. & Prieto, M.A.C. (1985) Datos sobre la vegetación de las "turberas de esfagnos" galaico-asturianas y orocantábricas (Data on the vegetation of the Galicio-Asturian and oro-Cantabrian "*Sphagnum* bogs"). *Lazaroa*, 7, 443–471 (in Spanish).

[185] Punt, W., Blackmore, S., Hoen, P.P. & Stafford, P.J. (2003) *The Northwest European Pollen Flora*. Elsevier, London, 194 pp.

[186] Rameau, J.C., Mansion, D. & Dumé, G. (1993) *Flore Forestière Française: Guide Écologique Illustré 2. Montagnes* (*French Forest Flora: Illustrated Ecological Guide 2. Mountains*). Institut pour le Développement Forestier (IDF), Paris, 2421 pp. (in French).

[187] Rameau, J.C., Mansion, D., Dumé, G. & Gauberville, C. (2008) *Flore Forestière Française Tome 3: Région Méditerranéenne* (*French Forest Flora Volume 3: Mediterranean Region*). Institut pour le Développement Forestier (IDF), Paris, 2432 pp. (in French).

[188] Redbo-Torstensson, P. (1994) The demographic consequences of nitrogen fertilization of a population of sundew, *Drosera rotundifolia*. *Acta Botanica Neerlandica*, 43(2), 175–188. Online at: http://dx.doi.org/10.1111/ j.1438-8677.1994.tb00743.x.

[189] Reichling, J., Sauerwein, M. & Wink, M. (1995) Naphthoquinone production in *in-vitro*-culture of *Drosera communis* ST.HIL. *Drogenreport*, 8(13), 26–27.

[190] Reinert, R.A. & Mohr, H.C. (1967) Propagation of *Cattleya* by tissue cultures of lateral bud meristems. *Proceedings of the American Society for Horticultural Science*, 91, 664–671.

[191] Rodondi, G., Beretta, M. & Andreis, C. (2009) Ovule and pollen development in the natural hybrid *Drosera* x *obovata* Mert. & Koch (Droseraceae) and its parents. *Flora - Morphology, Distribution, Functional Ecology of Plants*, 204(9), 685–691. Online at: http://dx.doi.org/10.1016/j.flora.2008.10.001.

[192] Rodondi, G., Beretta, M. & Andreis, C. (2010) Life history in *Drosera* L. (Droseraceae) - Emphasizing the natural hybrid *Drosera* x

obovata Mert. and Koch. *Bollettino dei Musei e Degli Istituti Biologici dell'Università di Genova*, 72, 155–158.

[193] Rosenberg, O. (1909) Cytologische und morphologische Studien an *Drosera longifolia* x *rotundifolia* (Cytological and morphological studies on *Drosera longifolia* x *rotundifolia*). *Kunglliga Svenska Vetenskapsakademiens Handlingar*, 43(11), 1–63 (in German).

[194] Royal Botanic Gardens Kew (2008) *Drosera rotundifolia* L. - Seed Information Database. Online at: http://data.kew.org/sid/SidServlet?ID=8250&Num=AYc, accessed 13 Jan 2014.

[195] Royer, F. & Dickinson, R. (2007) *Plants of Alberta: Trees, Shrubs, Wildflowers, Ferns, Aquatic Plants & Grasses*. Lone Pine Publishing, Edmonton, 528 pp.

[196] Rudolf, W. (1938) Arzneipflanzenanbau und –züchtung (Medicinal plant cultivation and breeding). *Forschungsdienst Sonderheft*, 8, 424–428 (in German).

[197] Ruprecht, D. & Kutzelnigg, H. (2011) *Taschenlexikon der Pflanzen Deutschlands und angrenzender Länder: die häufigsten mitteleuropäischen Arten im Porträt* (*Pocket Encyclopedia of the Plants of Germany and Adjacent Countries: the Most Common Central European Species in Portrait*). Quelle & Meyer, Wiebelsheim, 936 pp (in German).

[198] Rychnovska-Soudkova, M. (1953) Studie o minerální výžive rostliny *Drosera rotundifolia* L. 1. Vliv kalcia jako d'ležitý fyziologické a ekologická cinitel (A study of the mineral nutrition of *Drosera rotundifolia*. 1. The physiological and ecological role of calcium). *Preslia*, 25, 51–66 (in Czech).

[199] Rydin, H. & Jeglum, J.K. (2013) *The Biology of Peatlands*. Oxford University Press, 382 pp.

[200] Sagan, K. & Pogorzelec, M. (2011) Attempt to determine the optimal conditions for culture of endangered plants species of the genus *Drosera*, in terms of their *ex situ* conservation. *TEKA Komisji Ochrony i Kształtowania Środowiska*, 8, 145–150.

[201] Šamaj, J., Blehová, A., Repčák, M., Ovečka, M. & Bobák, M. (1999) *Drosera* species (sundew): *In vitro* culture and the production of plumbagin and other secondary metabolites. In: Bajaj, Y.P.S. (ed.) *Medicinal and Aromatic Plants XI, Biotechnology in Agriculture and Forestry*. Springer Berlin Heidelberg, 105–135.

[202] Schaffner, W., Häfelfinger, B. & Ernst, B. (1996) *Heilpflanzenkompendium: Vorkommen, Merkmale, Inhaltsstoffe, Anwendung* (*Herbs Compendium: Occurrence, Characteristics, Ingredients, Application*). Naturbuch-Verlag, München, 336 pp. (in German).

[203] Schaminée, J.H.J., Weeda, E.J., Westhoff, V. (1995) *De Vegetatie van Nederland. Deel 2. Plantengemeenschappen van Wateren, Moerassen en Natte Heide* (*The Vegetation of The Netherlands. Part 2. Plant Communities of Waters, Marshes and Wet Heath*). Opulus Press, Uppsala-Leiden, 358 pp. (in Dutch).

[204] Schlechtendal, D.F.L. & Langethal, L.E. (1883) *Flora von Deutschland* (*Flora of Germany*). Fr. Eugen Köhler, Gera-Untermhaus, 186 pp. (in German).

[205] Schmid, G. (1912) *Beiträge zur Oekologie der insektivoren Pflanzen* (*Contributions to the Ecology of Insectivorous Plants*). Inaugural-Dissertation, G. Fischer, Jena, 52 pp. (in German).

[206] Schnell, D.E. (2002) *Carnivorous Plants of the United States and Canada*. Timber Press, Markham, 468 pp.

[207] Schubert, R., Hilbig, W. & Klotz, S. (2001) *Bestimmungsbuch der Pflanzengesellschaften Mittel- und Nordostdeutschlands* (*Field Guide to the Plant Communities of Central and East Germany*). G. Fischer, Jena - Stuttgart, 472 pp. (in German).

[208] Schulz, B. (1965) *Fleischfressende Pflanzen* (*Carnivorous Plants*). Ziemsen, Wittenberg, 112 pp. (in German).

[209] Sebald, O., Seybold, S., Philippi, G., Voggesberger, M. & Philippi, G. (1992) *Die Farn -und Blütenpflanzen Baden-Württembergs* (*The Ferns and Flowering Plants of Baden-Württemberg*). Eugen Ulmer, Stuttgart, 362 pp. (in German).

[210] Seeholzer, C. (1993) Biosystematische Untersuchungen an schweizerischen *Drosera*-Arten (Biosystematic studies of Swiss *Drosera* species. *Botanica Helvetica*, 103, 39–53 (in German).

[211] Shimwell, D.W. (2005) Health of *Sphagnum* flush vegetation and the conservation of populations of *Drosera rotundifolia* (Round-leaved Sundew). Moors for the Future, Edale, 7 pp. Online at: http://www.moorsforthefuture.org.uk/sites/default/files/documents/2005_Shimwell_Sphagnum%20flush%20vegetation%20and%20Sundew.pdf, accessed 13 Dec 2014.

[212] Simpson, M.G. (2010) *Plant Systematics*. Elsevier-Academic Press, Waltham, 752 pp.

[213] Slack, A. (1986) *Insect-eating Plants and How To Grow Them*. Alphabooks, Sherbourne Dorset, 160 pp.

[214] Steiner, M.G. (1993) Scheuehzerio-Caricetea

fuscae. In: Grabherr, G. & Mazina, L. *Die Pflanzengesellschaften Österreichs, II. Natürliche Waldfreie Vegetation* (*The Plant Communities of Austria, II. Naturally Treeless Vegetation*. Gustav Fischer, Jena, 131–159 (in German).

[215] Stern, K. (1917) Beiträge zur Kenntnis der Nepenthaceen (Contributions to the knowledge of Nepenthaceae). *Flora oder allgemeine botanische Zeitung*, 109, 213–282 (in German).

[216] Stewart, N.C. & Nilsen, E.T. (1992) *Drosera rotundifolia* growth and nutrition in a natural population with special reference to the significance of insectivory. *Canadian Journal of Botany*, 70(7), 1409–1416. Online at: http://dx.doi.org/10.1139/b92-177.

[217] Strid, A. & Tan, K. (2002) *Flora Hellenica*. ARG Gantner, Lichtenstein, 511 pp.

[218] Svensson, B.M. (1995) Competition between *Sphagnum fuscum* and *Drosera rotundifolia*: a case of ecosystem engineering. *Oikos*, 74(2), 205–212.

[219] Swales, D.E. (1975) An unusual habitat for *Drosera rotundifolia* L., its overwintering stage and vegetative reproduction. *Canadian Field Naturalist*, 89, 143–147.

[220] Szakács, S. (2008) *Talajtan* (*Soil Science*). Sapientia Erdélyi Magyar University Press, Kolozsvár, 109 pp. (in Hungarian).

[221] Szumigalski, A.R. & Bayley, S.E. (1997) Net above-ground primary production along a bog-rich fen gradient in Central Alberta, Canada. *Wetlands*, 16(4), 467–476.

[222] Takahashi, H. & Sohma, K., (1982) Pollen morphology of the Droseraceae and its related taxa. *Science Reports of the Tohoku University - Biology*, 38, 81–156.

[223] Taraszkiewicz, A., Jafra, S., Skrzypczak, A., Kaminski, M. & Krolicka, A. (2012) Antibacterial activity of secondary metabolites from *in vitro* culture of *Drosera gigantea* against the plant pathogenic bacteria *Pseudomonas syringae* pv. *syringae* and *P. syringae* pv. *morsprunorum*. *Journal of Plant Pathology*, 91, 63–68. Online at: http://dx.doi.org/10.4454/jpp.v94i1sup.011.

[224] Tatić, B., Gigov, A., Petković, B. & Marin, P. (1985). Novo nalazište rosulje (rosice, rosike) *Drosera rotundifolia* L. (fam. Droseraceae) na Staroj planini u SR Srbiji (A new locality of the sundew (rosice, rosike) *Drosera rotundifolia* L. (fam. Droseraceae) on the Stara planina in SR Serbia). *Glasnik Instituta za Botaniku i Botaničke Baste*, 19, 103–106 (in Serbian).

[225] Thaweesak, J., Seiichi, S., Hiroyuki, T. & Waraporn, P. (2011) Elicitation effect on production of plumbagin in *in vitro* culture of *Drosera indica* L. *Journal of Medicinal Plant Research*, 5, 4949–4953.

[226] Thébaud, G. (2011) Contribution au prodrome des végétations de France: les Oxycocco–Sphagnetea Braun-Blanq. & Tüxen ex V. Westh., Dijk, Paschier & Sissingh 1946 (tourbières acides eurosibériennes) (Contribution to the prodromus of the vegetation of France: the Oxycocco–Sphagnetea Braun-Blanq. & Tüxen ex V. Westh., Dijk, Paschier & Sissingh 1946 (eurosiberian acid bogs). *Journal de Botanique de la Société Botanique de France*, 56, 69–97 (in French).

[227] Theodoropoulos, K. & Eleftheriadou, E. (2012) *Drosera rotundifolia* L. (Droseraceae). A rare and endangered species for the flora of Greece. *Journal of Environmental Protection and Ecology*, 13, 1405–1411.

[228] Thommen, F. (1990) Systematisch-okologische Untersuchungen an schweizerischen *Drosera*-Arten, (Taxonomical-ecological studies on Swiss *Drosera* species). *Berichte des Geobotanischen Instituts der Eidgenössische Technische Hochschule Stiftung Rubel*, 56, 150–174 (in German).

[229] Thompson, K., Bakker, J.P. & Bekker, R.M. (1997) *The Soil Seed Banks of North West Europe: Methodology, Density and Longevity*. Cambridge University Press, 279 pp.

[230] Thorén, L.M., Tuomi, J., Kämäräinen, T. & Laine, K. (2003) Resource availability affects investment in carnivory in *Drosera rotundifolia*. *New Phytologist*, 159(2), 507–511. Online at: http://dx.doi.org/10.1046/j.1469-8137.2003.00816.x.

[231] Thum, M. (1986) Segregation of habitat and prey in two sympatric carnivorous plant species, *Drosera rotundifolia* and *Drosera intermedia*. *Oecologia*, 70(4), 601–605. Online at: http://dx.doi.org/10.1007/BF00379912.

[232] Thum, M. (1989) The significance of carnivory for the fitness of *Drosera* in its natural habitat. *Oecologia*, 81(3), 401–411. Online at: http://dx.doi.org/10.1007/BF00377091.

[233] Tohmé, G. & Tohmé, H.S. (2007) *Illustrated Flora of Lebanon*. National Council for Scientific Research, Beirut, 610 pp.

[234] Topić, J. & Stančić, Z. (2006) Extinction of fen and bog plants and their habitats in Croatia. *Biodiversity and Conservation*, 15(11), 3371–3381. Online at: http://dx.doi.org/10.1007/s10531-005-4874-2.

[235] Triisberg, T., Karofeld, E. & Paal, J. (2011) Re-

vegetation of block-cut and milled peatlands: an Estonian example. *Mires and Peat*, 8(5), 1–14.

[236] Turcuş, V., Constantinovici, D., Cachitá-Cosma, D. & Halmágyi, A. (2008) *In vitro* cultures of *Drosera rotundifolia* L. preserved in Suceava Gene Bank. *Studia Universitatis Vasile Goldis Seria Stiintele Vietii-Life Sciences Series*, 18, 111–117.

[237] Turunen, J., Tahvanainen, T., Tolonen, K. & Pitkänen, A. (2001) Carbon accumulation in West Siberian Mires, Russia *Sphagnum* peatland distribution in North America and Eurasia during the past 21,000 years. *Global Biogeochemical Cycles*, 15(2), 285–296. Online at: http://doi.org/10.1029/2000GB001312.

[238] Tutin, T.G., Heywood, V.H., Burges, N.A., Valentine, D.H., Walters, S.M. & Webb, D.A. (1993) *Flora Europaea, Lycopodiaceae to Platanaceae*. Cambridge University Press, Cambridge, 587 pp.

[239] UBC (2014) University of British Columbia Herbarium Vascular Plant Collection. University of British Columbia (UBC). Online at: http://www.gbif.org/occurrence/466235745, accessed 12 Jan 2014.

[240] UNA (2014) Specimen of *Drosera rotundifolia* L. recorded on Jul 10, 1949. Herbarium (UNA), University of Alabama Biodiversity and Systematics. Online at: http://www.gbif.org/occurrence/56561857, accessed 12 Jan 2014.

[241] USDA & NRCS (2014). *Drosera rotundifolia* - roundleaf sundew. The PLANTS Database, National Plant Data Team, Greensboro, NC 27401-4901 USA. Online at: http://plants.usda.gov/core/profile?symbol=DRRO, accessed 05 July 2014.

[242] USDA. (2015) Threatened & endangered species/protected plants for all scientific names - *Drosera rotundifolia*. Online at: http://plants.usda.gov/java/threat, accessed 04 Jan 2015.

[243] van Waes, J. (1985) Vermenigvuldiging van zonnedauw (*Drosera*) in proefbuizen (Multiplication of sundew (*Drosera*) in test tubes). *Verbondsnieuws voor de Belgishce Sierteelt*, 29, 547–559 (in Dutch).

[244] van Wyk, B.-E., Wink, C. & Wink, M. (2004) *Handbuch der Arzneipflanzen: ein Illustrierter Leitfaden* (*Handbook of Medicinal Plants: an Illustrated Guide*). Wissenschaftliche Verlagsgesellschaft, Stuttgart, 480 pp. (in German).

[245] Velenovskỳ, J. (1928) Die *Drosera*-Kultur im Böhmen (The *Drosera* culture in Bohemia). In: Dorell, E.G. (ed.) *Festschrift Anläßlich des 70. Geburtstages von J. Stoklasa* (*Commemoration of the 70th Birthday of J. Stoklasa*). Parey, Berlin, 391–393 (in German).

[246] Vinichuk, M., Johanson, K.J., Rydin, H. & Rosén, K. (2010) The distribution of (137)Cs, K, Rb and Cs in plants in a *Sphagnum*-dominated peatland in eastern central Sweden. *Journal of Environmental Radioactivity*, 101(2), 170–176. Online at: http://dx.doi.org/10.1016/j.jenvrad.2009.10.003.

[247] Vonarburg, B. (1991) Rundblättriger Sonnentau (*Drosera rotundifolia*) - Insektenschmaus als Nahrungsmittel (Sundew (*Drosera rotundifolia*) - insects as a food feast). *Naturheilpraxis mit Naturmedizin*, 7, 760–765 (in German).

[248] Wagner, A. (2000) *Minerotrophe Bergkiefernmoore im süddeutschen Alpenvorland - Die* Carex lasiocarpa-Pinus rotundata-*Gesellschaft* (*Minerotrophic Bergkiefer Moore in the Southern German Alpine Foothills – the* Carex lasiocarpa-Pinus rotundata *Association*. Dissertation, University München, München, 185 pp. (in German).

[249] Wallnöfer, B. & Vitek, E. (1999) Die Gattung *Drosera* (Droseraceae) in Österreich (The genus *Drosera* (Droseraceae) in Austria. *Annalen des Naturhistorischen Museums in Wien. Serie B für Botanik und Zoologie*, 101(B), 631–660 (in German).

[250] Wawrosch, C., Benda, E. & Kopp, B. (2009) An improved 2-step liquid culture system for efficient *in vitro* shoot proliferation of sundew (*Drosera rotundifolia* L.). *Scientia Pharmaceutica*, 77, 827–835.

[251] Wawrosch, C., Markotai, J., Steinberger, B. & Kopp, B. (1996) *In vitro*-Vermehrung von Sonnentau-Arten (*In-vitro* propagation of sundew species). *Scientia Pharmaceutica*, 64, 709–717 (in German).

[252] Wawrosch, C., Steinberger, B., Markotai, J. & Kopp, B. (1993) *In vitro* propagation of *Drosera* species. *Planta Medica*, 59, A653.

[253] Wawrosch, C., Vackar, E., Grauwald, B. & Krenn, L. (2005) Variations of naphthoquinone levels in micropropagated *Drosera* species *in vitro*, under greenhouse and outdoor growth conditions. *Scientia Pharmaceutica*, 74, 251–262.

[254] WCSP (2014) World Checklist of Selected Plant Families. *Drosera rotundifolia* L., Sp. Pl.: 282 (1753). Royal Botanic Gardens, Kew. Online at: http://apps.kew.org/wcsp/, accessed 02 Jan 2015.

[255] Weber, H.E. (1995) Familie Droseraceae Sonnentaugewächse (Family Droseraceae

sundew family). In: Weber, H.E. (ed.) *Gustav Hegi - Illustrierte Flora von Mitteleuropa* (*Gustav Hegi - Illustrated Flora of Central Europe*). Blackwell Wissenschafts-Verlag, Berlin, 19–33 (in German).

[256] Weeden, N.F. (1975) *A Sierra Nevada Flora*. Wilderness Press, Berkeley, 262 pp.

[257] Weilbrenner, I. (1974) Vegetative Vermehrung und Wuchsstoffhaushalt bei dem Rundblättrigen Sonnentau (*Drosera rotundifolia*) (Vegetative propagation and growth budget in round-leaved sundew (*Drosera rotundifolia*)). *Mitteilungen der Pollichia*, 21, 46–67 (in German).

[258] Wichtl, M. (ed.) (2009) *Teedrogen und Phytopharmaka: ein Handbuch für die Praxis auf wissenschaftlicher Grundlage* (*Tea Drugs and Herbal Products: a Handbook for Scientifically Based Practice*). Wissenschaftliche Verlagsgesellschaft, Stuttgart, 786 pp. (in German).

[259] Wisskirchen, R. & Haeupler, H. (1998) *Standardliste der Farn- und Blütenpflanzen Deutschlands* (*Standard List of Ferns and Flowering Plants of Germany*). Ulmer, Stuttgart, 765 pp. (in German).

[260] Wojtuń, B., Sendyk, A. & Martyniak, A. (2013) *Sphagnum* species along environmental gradients in mires of the Sudety Mountains (SW Poland). *Boreal Environment Research*, 18, 74–88.

[261] Wolf, E., Gage, E. & Cooper, D.J. (2006) *Drosera rotundifolia* L. (roundleaf sundew): A technical conservation assessment. USDA Forst Service, Rocky Montain Region. Online at: http://www.fs.fed.us/r2/projects/scp/assessments/droserarotundifolia.pdf, accessed 05 Feb 2015.

[262] Yakubov, V.V. & Chernyagina, O.A. (2004) *Catalog of Flora of Kamchatka* (vascular plants). Kamchatpress, Petropavlovsk-Kamchatskiy, 165 pp.

[263] Zehl, M., Braunberger, C., Conrad, J., Crnogorac, M., Krasteva, S., Vogler, B., Beifuss, U. & Krenn, L. (2011) Identification and quantification of flavonoids and ellagic acid derivatives in therapeutically important *Drosera* species by LC–DAD, LC–NMR, NMR, and LC–MS. *Analytical and Bioanalytical Chemistry*, 400(8), 2565–2576. Online at: http://dx.doi.org/10.1007/s00216-011-4690-3.

[264] Zhang, M., Lenaghan, S., Xia, L., Dong, L., He, W., Henson, W. & Fan, X. (2010) Nanofibers and nanoparticles from the insect-capturing adhesive of the sundew (*Drosera*) for cell attachment. *Journal of Nanobiotechnology*, 8(1), 20. Online at: http://dx.doi.org/10.1186/1477-3155-8-20.

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Appendix. Common vegetation associates reported from wetlands supporting *Drosera rotundifolia* L.

Location	Source	Associated species
Europe		
Britain	Lindsay *et al*. (1983)	*Calluna vulgaris, Trichophorum cespitosum, Cephalozia connivens, Molinia careulea, Erica tetralix, Narthecium angustifolium, Sphagnum tenellum, S. magellanicum.*
Britain	Box *et al*. (2011)	*Agrostis curtisii, Erica tetralix, Betula* spp., *Potentilla erecta, Molinia caerulea, Aulacomnium palustre, Luzula campestre, Sphagnum cuspidatum, S. palustre, S. papillosum, S. auriculatum.*
Britain	Lindsay *et al*. (1985)	*Empetrum nigrum, Calluna vulgaris, Eriophorum vaginatum, Erica tetralix, Drosera anglica, Sphagnum inbricatum, S. rubellum, S. tenellum, S. papillosum.*
Britain	Shimwell (2005)	*Narthecium ossifragum, Vaccinium oxycoccos, Juncus bulbosus.*
Britain	Shimwell (2005)	*Molinia caerulea, Nardia scalaris, Carex viridula* ssp. *oedocarpa, Sphagnum auriculatum, S. subnitens, S. fallax.*
Britain	Shimwell (2005)	*Eriophorum angustifolium, Narthecium ossifragum, Carex viridula* ssp. *oedocarpa, Carex panicea, Sphagnum fallax.*
Britain	Millett *et al*. (2012a)	*Molinia caerulea, Scirpus cespitosus, Erica tetralix, Calluna vulgaris, Sphagnum papillosum.*
Britain	Kritzler *et al*. (2016)	*Betula pubescens, Carex rostrata, Empetrum nigrum, Erica tetralix, Eriophorum angustifolium, Juncus squarrosus, Narthecium ossifragum, Plagiothecium undulatum, Pleurozium schreberi, Sphagnum cuspidatum, S. fimbriatum, S. palustre, S. recurvum, S. tenellum.*
Croatia	Topić & Stančić (2006)	*Carex echinata, C. flava, C. lepidocarpa, Sphagnum* sp.
Estonia	Paal *et al*. (2016)	*Rubus chamaemorus, Aulacomnium palustre, Equisetum fluviatile, Succisa pratensis, Peucedanum palustre, Carex nigra.*
Estonia	Triisberg *et al.* (2011)	*Betula nana, Calluna vulgaris, Andromeda polifolia, Empetrum nigrum, Eriophorum vaginatum, Ledum palustre, Oxycoccus palustris, Pleurozium schreberi, Sphagnum capillifolium, S. fuscum, S. magellanicum.*

Finland	Galambosi *et al*. (2000b)	*Pinus sylvestris*, *Betula* sp., *Ledum palustre*, *Calluna vulgaris*, *Empetrum nigrum*, *Vaccinium oxycoccos*, *Rubus chamaemorus*, *Andromedia polifolia*, *Carex* sp., *Eriophorum* sp., *Sphagnum* sp.
Germany	Dierssen & Dierssen (1984)	*Scheuchzeria palustris*, *Carex limosa*, *Drosera* x *obovata*, *Sphagnum cuspidatum*, *S. majus.*
Germany	Forst (1997)	*Potentilla palustris*, *Carex rostrata*, *Agrostis canina*, *Viola palustris*, *Aulacomnium palustre*, *Sphagnum squarrosum*, *S. fimbriatum.*
Germany	Oltmanns (1996)	*Rhynchospora alba*, *Andromeda polifolia*, *Vaccinium oxycoccos*, *Erica tetralix*, *Drosera intermedia*, *Sphagnum magellanicum.*
Germany	Huntke (2008)	*Odontoschisma sphagni*, *Molinia caerulea*, *Eriophorum angustifolium*, *Erica tetralix*, *Vaccinium oxycoccos*, *Andromeda polifolia*, *Sphagnum cuspidatum*, *S. papillosum.*
Germany	Huntke (2008)	*Drosera intermedia*, *Rhynchospora alba*, *Cephalozia macrostachya*, *Odontoschisma sphagni*, *Molinia caerulea*, *Eriophorum angustifolium*, *Erica tetralix*, *Vaccinium oxycoccos*, *Sphagnum pulchrum*, *S. cuspidatum*, *S. tenellum.*
Germany	Ellwanger (1996)	*Trientalis europaea*, *Eriophorum angustifolium*, *Oxycoccus palustris*, *Picea abies*, *Potentilla erecta*, *Sphagnum fallax*, *S. papillosum.*
Germany	Ellwanger (1996)	*Nardus stricta*, *Viola palustris*, *Carex nigra*, *Potentilla erecta*, *Calliergon stramineum*, *S. fallax*, *S. russowii.*
Hungary	Borhidi (2003)	*Brachythecium rivulare*, *Bryum pseudotriquetrum*, *Calliergonella cuspidata*, *Myosotis palustris*, *Cirsium palustre*, *Doronicum austriacum*, *Sphagnum contortum*, *S. subsecundum.*
Hungary	Borhidi (2003)	*Pycreus flavescens* f. *monostachys*, *Rhynchospora alba*, *Potentilla erecta*, *Carex echinata*, *Sphagnum contortum*, *S. recurvum.*
Hungary	Borhidi (2003)	*Carex canescens*, *C. nigra*, *Epilobium palustre*, *Sphagnum recurvum*, *S. palustre*, *S. subsecundum.*
Hungary	Borhidi (2003)	*Lysimachia vulgaris*, *Betula pubescens*, *Carex elata*, *Menyanthes trifoliata*, *Peucedanum palustre*, *Sphagnum*

		flexuosum, *S. cuspidatum*, *S. fallax*, *S. magellanicum*, *S. palustre*.
Hungary	Borhidi (2003)	*Eriophorum vaginatum*, *Salix aurita*, *Vaccinium oxycoccos*, *Hammarbya paludosa*, *Carex lasiocarpa*, *Sphagnum palustre*, *S. magellanicum*, *S. fuscum*, *S. recurvum*, *S. fimbriatum.*
Italy	Miserere *et al*. (2003)	*Potentilla erecta*, *Molinia caerulea*, *Scirpus sylvaticus*, *Calluna vulgaris*, *Sphagnum subnitens*, *S. papillosum.*
Italy	Miserere *et al*. (2003)	*Carex echinata*, *C. nigra*, *C. rostrata*, *Scirpus caespitosus*, *Viola palustris*, *Warnstorfia exannulata*, *Eriophorum angustifolium*, *Calliergon stramineum*, *Sphagnum subsecundum.*
Italy	Gerdol *et al*. (2011)	*Calluna vulgaris*, *Pinus mugo*, *Vaccinium microcarpum*, *V. myrtillus*, *V. uliginosum*, *Carex pauciflora*, *Eriophorum vaginatum*, *Melampyrum pratense*, *Sphagnum magellanicum*, *S. capillifolium.*
Italy	Gerdol *et al*. (2011)	*Eriophorum vaginatum*, *Molinia caerulea*, *Trichophorum caespitosum*, *Potentilla erecta*, *Dicranum bonjeanii*, *Sphagnum capillifolium*, *S. compactum*, *S. magellanicum.*
Italy	Poto *et al*. (2013)	*Drosera longifolia*, *Andromeda polifolia*, *Vaccinium microcarpum*, *Sphagnum magellanicum*, *S. majus*, *S. squarrosum*, *S. capillifolium.*
Neatherland	Adema *et al*. (2006)	*Utricularia minor*, *Erica tetralix*, *Calluna vulgaris*, *Rhynchospora alba*, *Vaccinium oxycoccos*, *Sphagnum cuspidatum*, *S. magellanicum*, *S. palustre*, *S. fallax*.
Norway	Nordbakken *et al*. (2004)	*Mylia anomala*, *Kurzia pauciflora*, *Cladopodiella fluitans*, *Cephalozia loitlesbergeri*, *Sphagnum rubellum*, *S. fuscum.*
Norway	Hansen (1967)	*Andromeda polifolia*, *Rubus chamaemorus*, *Calluna vulgaris*, *Vaccinium oxycoccos*, *Myrica gale*, *Eriophorum* sp., *Cladonia rangerifera*, *Betula nana*, *Sphagnum* spp.
Serbia	Petronijević *et al*. (2009)	*Eriophorum angustifolium*, *E. latifolium*, *Comarum palustre*, *Menyanthes trifoliata*, *Pedicularis palustris*, *Ranunculus lingua.*
Spain	Prieto *et al*. (1985)	*Erica makaiana*, *Aulacomnium palustre*, *Carex durieui*, *Nathecium ossifragum*, *Molinia careulea*, *Agrostis canina*, *Sphagnum subnitens*, *S. auriculatum.*

Spain	Prieto *et al*. (1985)	*Eriophorum angustifolium, Eleocharis multicaulis, Molinia caerulea, Drosera intermedia, Sphagnum cuspidatum.*
Spain	Prieto *et al*. (1985)	*Erica tetralix, Calluna vulgaris, Aulaconium palustre, Sphagnum capillifolium, S. recurvum.*
Spain	Prieto *et al*. (1985)	*Scirpus caespitosus, Narthecium ossifragum, Sphagnum tenellum, S. papillosum.*
Sweden	Vinichuk *et al*. (2010)	*Eriophorum vaginatum, Empetrum nigrum, Andromeda polifolia, Carex rostrata, Menyanthes trifoliata, Vaccinium oxycoccos, Sphagnum papillosum, S. angustifolium, S. magellanicum.*
Sweden	Breeuwer *et al*. (2009)	*Andromeda polifolia, Calluna vulgaris, Erica tetralix, Eriophorum vaginatum, Vaccinium oxycoccos, Rynchospora alba, Sphagnum cuspidatum, S. magellanicum, S. tenellum, S. balticum, S. rubellum.*
Sweden	Redbo-Torstensson (1994)	*Eriophorum vaginatum, Andromedia polifolia, Vaccinium oxycoccos, Sphagnum fuscum, S. rubellum.*
Sweden	Svensson (1995)	*Empetrum hermaphroditum, Rubus chamaemorus, Vaccinium microcarpum, Betula nana, Sphagnum fuscum.*
Sweden	Millett *et al*. (2012b)	*Sphagnum fuscum, S. balticum.*
North America		
Canada	Pellerin *et al*. (2006)	*Chamaedaphne calyculata, Kalmia angustifolia, K. polifolia, Ledum groenlandicum, Rubus chamaemorus, Vaccinium oxycoccos, Sarracenia purpurea, Sphagnum fuscum, S. rubellum, S. angustifolium, S. capillifolium, S. magellanicum.*
Canada	Pellerin *et al*. (2006)	*Myrica gale, Dasiphora floribunda, Andromeda polifolia* var. *glaucophylla, Rhamnus alnifolia, Vaccinium oxycoccos, Trichophorum caespitosum, Campylium stellatum, Sphagnum warnstorfii, S. fuscum, S. capillifolium, S. rubellum, S. russowii.*
Canada	Swales (1975)	*Erigeron strigosus, Leucanthemum vulgare, Solidago nemoralis, Betula populifolia, Polygonum cilinode, Chrysanthenum leucanthemum.*
Minnesota	Glaser *et al*. (1990)	*Scirpus hudsonianus, Cladium mariscoides, Parnassia palustris, Muhlenbergia glomerata, Scirpus cespitosus, Carex limosa, C. livida, Cladium mariscoides, Drosera*

		anglica, *Utricularia intermedia*, *U. cornuta*, *Rhynchospora alba*, *Eleocharis compressa*, *Sarracenia purpurea*, *Menyanthes trifoliata*, *Vaccinium oxycoccos*.
Minnesota	Glaser *et al*. (1990)	*Picea mariana*, *Thuja occidentalis*, *Carex gynocrate*, *C. leptalea*, *Ledum groenlandicum*, *Sarracenia purpurea*, *Sphagnum angustifolium*, *S. magellanicum*, *S. capillifolium*, *S. russowi*, *S. warnstorfii*.
Minnesota	Glaser *et al*. (1990)	*Carex lasiocarpa*, *Utricularia intermedia*, *Equisetum fluviatile*, *Potentilla palustris*, *Carex chordorrhiza*, *Menyanthes trifoliata*, *Sarracenia purpurea*, *Sphagnum angustifolium*, *S. magellanicum*, *S. warnstorfii*.
Maine	Davis & Anderson (1991)	*Chamaeaphne calyculata*, *Rynchospora alba*, *Eriophorum spissum*, *Vaccinium oxycoccos*, *Eriophorum virginicum*, *Kalmia angustifolia*, *Sphagnum rubellum*, *S. fuscum*, *S. magellanicum*.
Virginia	Byers *et al*. (2007)	*Vaccinium oxycoccos*, *Rhynchospora alba*, *Photinia melanocarpa*, *P. pyrifolia*, *Vaccinium myrtilloides*, *V. macrocarpon*, *Sphagnum rubellum*, *S. fallax*, *S. papillosum*, *S. flexuosum*, *S. cuspidatum*, *S. recurvum*, *S. magellanicum*.
Virginia	Byers *et al*. (2007)	*Pinus rigida*, *Picea rubens*, *Rubus hispidus*, *Gaultheria procumbens*, *Coptis trifolia*, *Rhynchospora alba*, *Sphagnum rubellum*, *S. magellanicum*, *S. fallax*, *S. papillosum*.
Other		
Iceland	Dijkema & Wolff (1983)	*Potentilla erecta*, *Pedicularis silvatica*, *Gentiana pneumonathe*, *Carex panicea*, *Sphagnum subsecundum*, *S. compactum*.
Japan	Julve (1999)	*Eriophorum vaginatum*, *Sanguisorba tenuifolia* var. *alba*, *Carex pauciflora*, *C. middendorffii*, *Geum pentapetalum*, *Tilingia ajanensis*, *Sasa senanensis*, *Sphagnum magellanicum*, *S. papillosum*.
Japan	Julve (1999)	*Ledum palustre* subsp. *diversipilosum*, *Empetrum nigrum* subsp. *japonicum*, *Vaccinium oxycoccos*, *Chamaedaphne calyculata*, *Scheuchzeria palustris*, *Carex middendorffii*, *Sphagnum fuscum*, *S. magellanicum*, *S. papillosum*.
Japan	Hoyo & Tsuyuzaki (2015)	*Carex middendorffii*, *Drosera anglica*, *Sphagnum papillosum*.