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The effect of regular collection of *Drosera rotundifolia* in natural peatlands in Finland: plant density, yield and regeneration

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Yield potential and the effect of strict collection on the regeneration of natural populations of *Drosera rotundifolia* were studied in Finland during 1993–1999. Flowering plants were collected in July from 37 sample plots 1 m^2 in size. Plant number; height of flowering plants; fresh weight as well, as 7-methyljuglone, quercetin and kaempferol contents were determined. The average plant density was 45–56 plants m^{-2}, and the average fresh weight was 6.3–6.7 g m^{-2} in the first and second years of collection. Regular and strict collection significantly decreased the population density. The average plant number in the third and seventh years ranged between 21 and 29 plants m^{-2}. The collected fresh weight decreased respectively from 6.7 g m^{-2} to 2.7 g m^{-2}. At the end of the vegetation periods the number of new seedlings averaged 188 m^{-2} on the observation plots, implying that the population may easily regenerate from the seed bank stock of the peat. According to the results of these experiments, the 4H organization elaborated a new, environmentally friendly collection programme for young collectors. The collectors were obliged to leave 5–10 flowering plants to spread seed and to assure natural regeneration of sundew populations.

Key words: *Drosera rotundifolia*, collection, yield, environmentally sustainable collection method, regeneration.

INTRODUCTION

Extracts from some *Drosera* species are used in a number of medicinal products for the treatment of asthma and bronchitis. About 230 preparations are produced worldwide from *Drosera* species (McAlpine 1996). Quantities of the different *Drosera* species on the European market are estimated to range from some hundred kilograms (*Drosera intermedia, D. peltata*) to 7–10 tonnes per year (*Drosera madagascarensis*) (Kirsch 1995).

There are three indigenous *Drosera* species native to Finland, *D. rotundifolia, D. anglica* and

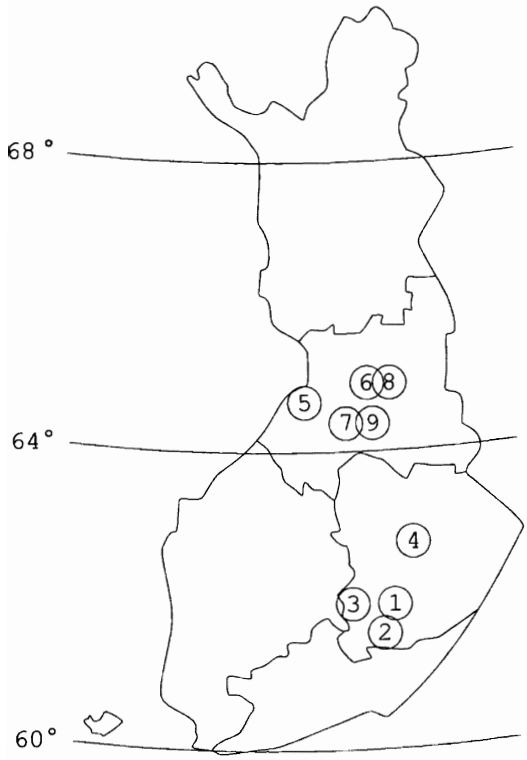

Fig. 1. Location of observation plots.

Kuva 1. Havaintoruutujen sijainti.

D. intermedia (Hämet-Ahti et al.1998). During 1981–1994, the quantity of *Drosera rotundifolia* collected from natural peatlands increased from 100 kg to 2100 kg in Finland and, apart from the small domestic use, most of the yield was exported to Switzerland (Galambosi et al. 1998).

Drosera species are facultative peatland plants. Although the areas of geological peatlands in Finland are very large, 5.1 million hectares (Lappalainen 1996), in other parts of the world they are decreasing for various reasons (drainage, climatic changes, etc.). As a consequence, the natural living conditions of sundew are decreasing as well. In many European countries, e.g. Germany and Hungary, *Drosera* species are considered endangered medicinal plants (Dagmar 1998).

As it takes for each collected kilogram of fresh sundew approximately 5 000–10 000 flowering individuals, environmental specialists raised the following questions: Does regular collection endanger the natural populations of *Drosera rotundifolia* in Finland and to what extent? Is it possible to collect *Drosera* raw material from the nature without damaging the natural populations? Is it possible to cultivate sundew to replace its collection from the nature?

In order to get answers to these questions, a large number of experiments were carried out in Finland during 1992–1997. In this paper we report experiences and results concerning the question whether sundew can be cultivated to replace collection from the nature.

The aims of the study were (1) to monitor the collectable quantities and yields of natural populations of *Drosera rotundifolia*, (2) to determine the differences in plant growth, plant size and yields between natural populations, and (3) to study the quality of the plant material collected and the possibilities for sundew to regenerate under continuous collection.

MATERIAL AND METHODS

Location and description of observation plots

The experiment was carried out at nine peatlands in Finland during 1993–1999. Altogether, 37 observation plots 1-m^2 in size were monitored. Twelve plots were located in southern Finland (61 °N), four plots in South-East Finland (62° N) and 22 plots in northern Finland (64–65 °N) (Fig. 1). In 1994 and 1995, ten plots at two locations (8-Ylikiiminki and 9-Utajärvi) were destroyed by forest machines. Twenty-seven plots at locations 1–7 were observed for four years and 19 plots at locations 1–5 were observed for seven years.

The ecological conditions of the plots can be divided into two groups: open and very dry peatlands (locations 1, 3a, 5, 6 and 7), and wet and grassy peatlands near the water (locations 2, 3b and 4). Details of the peatlands and the main plant species are presented in Table 1.

Plant collection and measurements

All flowering sundew individuals were collected very carefully between 2 July and 24 August, generally three times during the summer, sometimes

twice or four times. The plants collected at locations 1, 2 and 3 were identified at the Botanical Museum, Helsinki. Measurements included plant number per plot (all flowering individual plants collected from the plots were counted), total fresh weight (g m^{-2}), average individual fresh weight (g $plant^{-1}$ calculated from the total fresh weight and total plant number per plot) and plant size (cm, height of flowering stems). At locations 1, 2 and 3, all plants were measured; for the rest, 10 average flower stems were measured per location.

At the end of the growing periods of 1993, 1996, 1997 and 1999, the total plant number was counted at locations 1, 2 and 3. Leaf rosettes of any sizes found in 20×100 cm^2 areas were counted and the results are given as plants m^{-2}.

Table 1. The locations and the number of observation plots of *Drosera rotundifolia* with the main species of the vegetation.

Taulukko 1. Pyöreälehtikihokin havaintoruutujen sijainti, määrä ja runsaimmat kasvilajit.

Location	Number of plots	Main plant species
1. Puumala, Sorjola; on the shore of 0.5 ha lake, (61°34´N, 28°05´E)	3	*Pinus sylvestris, Betula* sp., *Ledum palustre, Calluna vulgaris, Empetrum nigrum, Vaccinium oxycoccos, Rubus chamaemorus, Andromeda polifolia, Carex* sp., *Eriophorum* sp., *Sphagnum* sp., *Drosera rotundifolia.*
2. Puumala, Saarijärvi; 1 ha lakeshore, (61°34´N, 28°05´E)	3	*Pinus sylvestris, Betula pubescens, Ledum palustre, Chamaedaphne calyculata, Empetrum nigrum, Drosera rotundifolia, Andromeda polifolia, Vaccinium oxycoccos, Nuphar luteum, Carex* sp., *Eriophorum* sp., *Sphagnum* sp.
3. Otava, Luhdansuo; 10 ha bog, 1 ha lake, (61°34´N. 28°05´E)	3a (dry)	*Pinus sylvestris, Betula pubescens, Andromeda polifolia, Vaccinium oxycoccos, Ledum palustre, Drosera rotundifolia, Eriophorum* sp., *Carex* sp., *Carex limosa, Scheuchzeria palustris, Cladonia* sp.
	3b (wet)	*Myrica gale, Betula nana,Calluna vulgaris, Carex* sp. *Molinia caerulea, Peucedanum palustre, Andromeda polifolia, Drosera rotundifolia, D. anglica.*
4. Leppävirta, Möhkökoski; 0.2 ha lake-swamp, (62°18´N, 27°51´E)	3	*Pinus sylvestris, Betula* sp., *Salix* sp., *Vaccinium oxycoccos, Carex* sp., *Menyanthes trifolia, Sphagnum* sp., *Drosera rotundifolia.*
5. Kempele, Ristisuo; 1.5 ha inlet (64°56' N, 25°22' E)	4	*Pinus syvestris, Betula* sp., *Salix* sp., *Ledum palustre, Vaccinium oxycoccos, Carex* sp., *Sphagnum* sp., *Drosera rotundifolia.*
6. Ylikiiminki, Niemikylä; (no. observ. in 1997) (65°00´N, 26°05´E)	4	*Pinus sylvestris, Betula pubescens, Rubus chamaemorus, Vaccinium oxycoccos, Vaccinium uliginosum, Sphagnum* sp., *Drosera rotundifolia, Carex* sp.
7. Utajärvi, Naamansuo; (no. observ. in 1997), (64°42´N, 26°35´E)	4	*Pinus sylvestris, Betula pubescens, Vaccinium oxycoccos, Calluna vulgaris, Rubus chamaemorus, Carex* sp., *Drosera rotundifolia, Andromeda polifolia.*
8. Ylikiiminki, Hiltukylä; Vengaslammi (observ. only 1993), (65°00´N, 26°05´E)	4	*Pinus sylvestris, Betula nana, Betula pubescens, Andromeda polifolia, Rubus chamaemorus, Carex* sp., *Equisetum palustre, Drosera rotundifolia, Menyanthes trifoliata*
9. Utajärvi, Utanen; soramonttu (observ. only 1993–1994), (64°42´N, 26°36´E)	6	*Pinus sylvestris, Betula* sp., *Salix* sp., *Vaccinium oxycoccus, Vaccinium uliginosum, Carex* sp., *Drosera rotundifolia.*

Chemical analyses

The 7-methyljuglone contents of *Drosera rotundifolia* and *D. anglica* in the fresh leaf, stem and flower were determined by HPLC. The plant samples were collected from locations 1–2 (Puumala: Sorjola and Saarijärvi) and 3 (Otava) in Finland during 1992–1994. Flavonoid aglycones, quercetin, and kaempferol were analysed by HPLC after acid hydrolysis of glycosides. The dry mass was determined after drying to a constant weight at 105 °C. Extraction and HPLC analysis have been described in our other paper (Galambosi et al. 2000).

Meteorological data

The meteorological data presented in Table 2 was collected from the nearest meteorological stations of the Finnish Meteorological Institute.

RESULTS

Number of plants

The number of collectable flowering sundew plants varied greatly at different locations. In the first two collection years, 1993 and 1994, the average plant number on all plots was 41.4 and 43.7 plants m^{-2}, respectively (Table 3). The highest plant density was recorded in location 1 (Puumala; Sorjola): 100.7 plants m^{-2}; and the lowest in location 9 (Utajärvi): 12.5 plants m^{-2}. In 1995 and 1996, the number of collectable sundew plants on all plots averaged 30.2 and 19.3 plants m^{-2}, and that of locations 1–5, 29.5 and 20.7 plants m^{-2}, respectively. In 1997, a slight increase could be observed in the number of plants collected (32.1 plants m^{-2}), but in 1998 and 1999 there was a drop to 25.1 and 21.0 plants m^{-2}. The decrease of the average plant number of 19 regularly collected plots at locations 1–5 are shown in Fig. 2. Two-

Table 2. The average monthly temperature (°C) and monthly precipitation (mm) of the summer months at three locations during 1993-1997.

Taulukko 2. Kesäkuukausien keskilämpötilat (C°) ja sademäärät (mm) kolmella havaintoalueella vuosina 1993-1997.

Location	Year	Monthly temperature, °C			Monthly precipitation, mm		
		June	July	August	June	July	August
Puumala, Sorjola [1]	1993	11.2	15.4	13.0	74	64	127
	1994	13.4	19.1	15.2	45	48	67
	1995	17.2	15.1	15.3	47	51	54
	1996	13.6	14.2	17.5	39	107	32
	1997	16.4	19.0	17.8	30	20	54
	mean	14.4	16.6	15.8	47	58	67
Leppävirta [2]	1993	11.2	15.7	13.2	82	78	66
	1994	13.5	18.7	14.6	43	23	113
	1995	16.8	14.9	14.7	36	67	81
	1996	14.0	14.5	16.9	49	126	18
	1997	16.0	18.3	16.8	64	76	19
	mean	14.3	16.4	15.2	55	74	59
Kempele [3]	1993	10.4	16.2	13.0	36	44	66
	1994	13.0	17.2	14.8	56	17	36
	1995	15.9	14.5	14.2	58	59	39
	1996	12.8	14.8	16.3	22	48	19
	1997	14.7	18.6	15.9	33	55	43
	mean	13.4	16.3	14.8	41	45	41

[1] Observatory: Puumala, Sorjola, 61°34´ N, 28°05´ E
[2] Observatory: Varkaus, Käpykangas, 62°18´ N, 27°51´ E
[3] Observatory: Oulunsalo, 64°56´ N, 25°22´ E

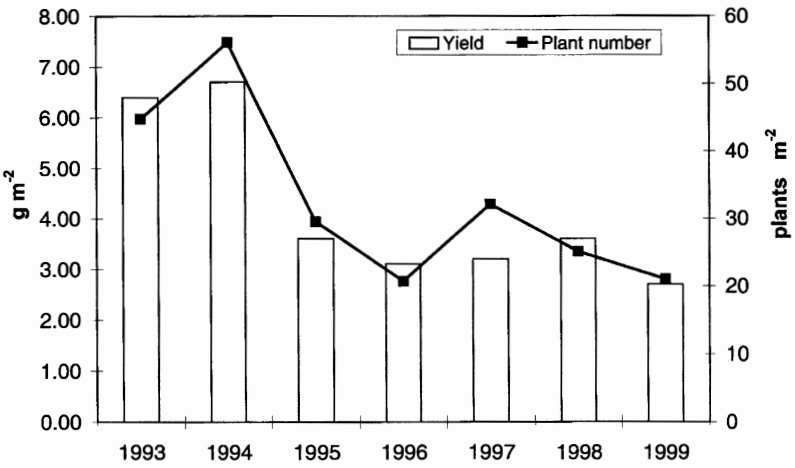

Fig. 2. Effect of regular collection on the plant number and fresh yield of *Drosera rotundifolia* during 1993–1999. Figures are means of 19 plots at locations 1–5.

Kuva 2. Säännöllisen keruun vaikutus pyöreälehtikihokin määrään ja tuoresatoon 1993–1999 . Luvut ovat 19 ruudun keskiarvoja alueilta 1–5.

thirds of the total number of plants collected were picked on the first collection. About 30% of the yields were collected on the second collection and an average of 5% of all the flowering plants were picked on the last collection (Table 4).

Fresh yield

In accordance with the number of plants collected, the yields of fresh sundew showed similar variations. The fresh yield of all observation plots averaged in 1993 and 1994 5.2 and 5.8 g m^{-2}, respectively, which then decreased to 2.7 g m^{-2} in 1996 and to 3.2 g m^{-2} in 1997 (Table 5). The yield of the regularly collected 19 plots at locations 1–5 in 1993 and 1994 averaged 6.4 and 6.7 g m^{-2}, respectively. After two years, the yield decreased to 3.6, 3.1 and 3.2 g m^{-2} in 1995, 1996 and 1997, respectively. In 1998 and 1999, the fresh yield was 3.6 and 2.7 g m^{-2}, respectively (Fig. 2).

Plant size

The average height of the flowering stems ranged between 4.1 and 14.7 cm (Table 6). Clear differences were observed between the observation plots: the highest flower stems were collected at plots where the peatland was covered with grass. The highest flowering stems, 13.4 cm, an average of seven years, were measured in Leppävirta (location 4), followed by Puumala (Saarijärvi, location 2) with an average of 11.7 cm. Under dry, open and non-grassy conditions the flower stems were short, ranging from 4.3– 9.4 cm (locations

Table 3. Average plant number m^{-2} of *Drosera rotundifolia* in the observation plots during 1993-1999.

Taulukko 3. Kihokkien lukumäärä (keskiarvo) havaintoruuduilla vuosina 1993-1999.

Location	1993	1994	1995	1996	1997	1998	1999
1. Puumala, Sorjola	100.7	97.6	26.6	36.6	66.4	47.0	37.3
2. Puumala, Saarijärvi	37.0	41.3	39.4	14.6	22.4	22.0	19.0
3. Otava, Luhdansuo	17.8	10.8	6.9	6.8	16.0	3.8	6.0
4. Leppävirta, Möhkökoski	41.4	64.7	42.4	26.6	30.7	41.0	32.4
5. Kempele, Ristisuo	27.3	36.0	32.2	18.9	25.0	11.7	10.5
6. Ylikiiminki, Niemikylä	55.2	43.8	48.0	16.3	–	–	–
7. Utajärvi, Naamansuo	12.5	9.7	15.7	15.7	–	–	–
8. Ylikiiminki, Hiltukylä	44.0	x	x	x	x	x	x
9. Utajärvi, Utanen	37.3	45.7	x	x	x	x	x
Total mean	41.4	43.7	30.2	19.3	32.1	–	–
Mean of locations of 1-5	44.8	56.1	29.5	20.7	32.1	25.1	21.0

1, 3, 5, 6 and 7) (Fig. 3). The calculated average fresh weight of individual sundew plants was very low. It varied between 0.02 and 0.30 g plant^{-1}. Generally, the plant weights were higher on the first collections, since the tallest individuals were collected first.

Contents of secondary metabolites

The contents of secondary metabolites (7-methyljuglone, quercetin and kaempferol) were measured in the overground plant parts in Puumala (1–2) and Otava (3). The 7-methyljuglone con-

Table 4. Number of *Drosera rotundifolia* flowering individuals growing in plots.

Taulukko 4. Kasvien määrä ja niiden jakauma kolmessa keruussa.

Year	Number of plots	Total number of plants m^{-2}	Percentage of plants by collections		
			First	Second	Third
1993	37	41.4	62	28	10
1994	32	43.7	62	31	4
1995	27	30.6	62	30	7
1996	27	19.3	64	31	5
1997	19	32.1	73	27	0
	Mean	33.4	65	30	5

Table 5. The total fresh yield (g m^{-2}) of *Drosera rotundifolia* picked from the observation plots during 1993-1999.

Taulukko 5. Pyöreälehtisen kihokin tuoresato (g m^{-2}) havaintoruuduilla vuosina 1993-1999

Location	1993	1994	1995	1996	1997	1998	1999
1. Puumala, Sorjola	10.64	11.55	2.36	3.72	4.67	6.1	3.8
2. Puumala, Saarijärvi	5.06	6.72	4.17	1.81	2.05	2.8	1.65
3. Otava, Luhdansuo	1.16	0.37	0.39	0.59	1.23	0.37	0.49
4. Leppävirta, Möhkökoski	11.06	10.63	7.21	5.32	4.71	7.3	6.74
5. Kempele, Ristisuo	3.92	4.14	3.73	2.21	3.12	1.44	1.01
6. Ylikiiminki, Niemikylä	4.95	10.10	11.87	6.87	–	–	–
7. Utajärvi, Naamansuo	1.07	0.25	0.94	1.08	–	–	–
8. Ylikiiminki, Hiltukylä	5.83	–	–	–	–	–	–
9. Utajärvi, Utanen	2.60	2.47	–	–	–	–	–
Total mean	5.20	5.80	4.00	2.70	3.20	–	–
Mean of locations of 1-5	6.40	6.70	3.60	3.10	3.20	3.60	2.7

Table 6. The average height of the flower stems picked of *Drosera rotundifolia* in 1993-1999.

Taulukko 6. Pyöreälehtisen kihokin kukkavarsien keskimääräinen pituus vuosina 1993-1999.

Location	1993	1994	1995	1996	1997	1998	1999	Mean
1. Puumala, Sorjola	8.1	7.8	7.8	8.7	9.7	10.6	13.1	9.4
2. Puumala, Saarijärvi	9.8	11.6	8.3	12.2	12.2	13.2	14.3	11.7
3. Otava Luhdansuo	7.0	7.2	7.6	7.9	8.5	7.7	9.0	7.8
4. Leppävirta, Möhkökoski	14.7	14.3	10.8	12.3	13.6	13.9	14.6	13.5
5. Kempele, Ristisuo	9.4	7.4	7.2	9.1	9.2	10.0	10.3	8.9
6. Ylikiiminki, Niemikylä	4.4	4.4	4.1	4.4	–	–	–	4.3
7. Utajärvi Naamansuo	5.7	6.9	7.4	7.6	–	–	–	6.9

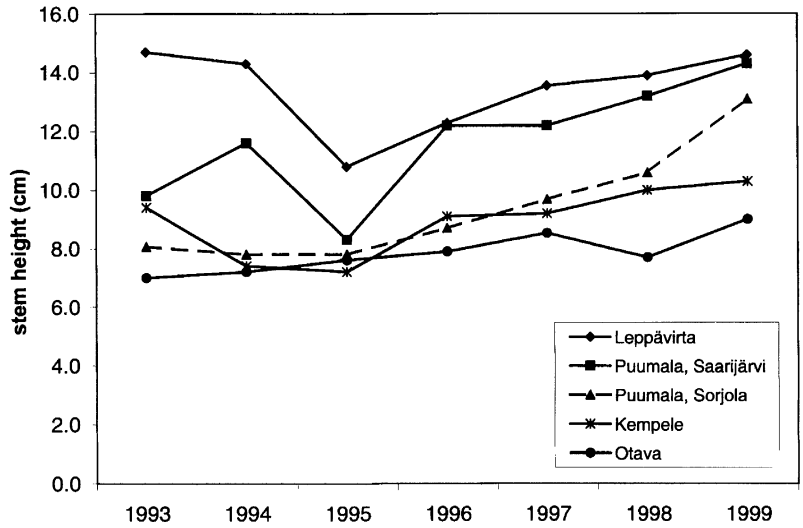

Fig. 3. Average height of flowering stems of *Drosera rotundifolia* at locations 1–5 during 1993–1999.

Kuva 3. Pyöreälehtikihokin kukkavarren pituus alueilla 1–5 vuosina 1993–1999.

tent was highest in the flowers (1.73–2.46%) followed by the leaves (0.52–0.95%) and stems (0.24–0.35%) (Table 7). The quercetin content varied from 4.37 to 5.78% in the leaves and stems, and was highest in the flowers (> 6% in dry mass). The percentage of kaempferol was lower and more variable in the plant parts. It was highest in the flowers (0.448–0.463%), followed by the leaves (0.123–0.155%) and the stems (0.061–0.069%). There were no significant differences in the contents of secondary metabolites of the plants growing in different locations.

Seed production

The seed of sundew ripens in the capsules in August and September. Concerning seed-production potential of sundew, the number of capsules in a single flowering stem ranged from 1–8, with an average of 4.75. In one capsule there was an average of 90 seeds. The average seed production of one *Drosera rotundifolia* plant was 424 seeds (range 63–816 seeds) (Table 8). The weight of seed obtained from 432 capsules of 110 *Drosera rotundifolia* plants was 0.43 grams. As a result of the light weight, the seeds may be distributed in the peatlands by the wind or water flow. They may germinate immediately or the following years after storage in the peat.

Regeneration of the *Drosera* population

All living plants of *Drosera rotundifolia* were recounted at the end of the summer in the twelve plots of locations 1, 2 and 3. The plants counted in autumn were partly medium- and small-sized leaf rosettes without flowering stems, mostly small seedlings with two cotyledons germinated on the humificated peat surface. The number of plants after the fourth, fifth and seventh collection years was nearly the same (182, 200 and 190 plants m^{-2}) as after the first collection year, 1993 (Table 9). The number of small seedlings varied greatly depending on the surface of the plots. A great number of seedlings occurred on the surface of the humificated peat, but there were much fewer seedlings on the surface of live *Sphagnum* plants or on plots covered with water.

DISCUSSION

Although *Drosera rotundifolia* has been collected for commercial purposes for about 10 years, this is the first study in which the yield potential and the effect of regular collection were monitored. The experiment carried out differed from commercial practice in some respects. Collecting was done very carefully and strictly. As expected, this decreased the population density significantly after the second year. The decrease in the third and

seventh years ranged between 28% and 54%. In addition to plant number, the collected fresh yields decreased in parallel from 6.7g m^{-2} to 2.7 g m^{-2}. The collectable fresh herb yields varied in the different areas. The yields strongly depend on the plant density and growth vigour of the harvested population. In dry, sunny peatlands the average height of the flowering stems was short and the available yield was very low, 0.4–3.0 g m^{-2}. The plant size and the yields in semi-shaded, dry conditions were higher, and the yields were highest in wet, sunny and grassy places, ranging from 5–

Table 7. Content of 7-methyljuglone, quercetin and kaempferol in *Drosera rotundifolia* growing in Puumala and Otava in Finland in 1992-1994. n - number of repeating, x - average % of compound in dry mass, Sx - standard deviation.

Taulukko 7. Pyöreälehtisen kihokin 7- metyylijuglonin, kversetiinin ja ja kamferolin pitoisuudet vuosina 1992-1994 Puumalassa ja Otavassa. n – toistojen määrä, x – keskiarvopitoisuus kuivamassasta, Sx – keskihajonta.

Location		n	x	S_x
		7-methyljuglone		
1. Puumala, Sorjola	leaf	13	0.95	2.183
	stem	3	0.30	0.146
	flower	6	2.12	0.591
2. Puumala, Saarijärvi	leaf	14	0.58	0.329
	stem	3	0.24	0.045
	flower	5	2.46	0.459
3. Otava, Luhdansuo	leaf	14	0.52	0.174
	stem	9	0.35	0.265
	flower	8	1.73	0.695
		quercetin		
2. Puumala, Saarijärvi	leaf	9	4.61	0.769
	stem	9	4.37	0.923
	flower	8	6.27	1.520
3. Otava, Luhdansuo	leaf	15	5.78	0.781
	stem	15	4.45	0.645
	flower	15	6.39	0.684
		kaempferol		
2. Puumala, Saarijärvi	leaf	9	0.123	0.002
	stem	9	0.069	0.014
	flower	9	0.463	0.227
3. Otava, Luhdansuo	leaf	15	0.155	0.058
	stem	15	0.061	0.010
	flower	15	0.448	0.119

Table 8. Seed production of *Drosera rotundifolia* 1993, Mikkeli.

Taulukko 8. Pyöreälehtisen kihokin siementuotanto v. 1993, Mikkeli.

Seedcase per stem	Plants counted	Seed per seedcase, mean	Seed total of plant
1	1	63	63
2	8	69	138
3	6	105	315
4	7	104	416
5	8	119	595
6	6	82	492
7	3	80	560
8	4	102	816
	total: 43	mean: 90	mean: 424

11 g m^{-2}.

During the five years of observation there were great differences in the monthly temperatures and precipitation. The differences were the greatest in the temperature of July (3–5°) both in Puumala (Sorjola) and Kempele (Table 2). It seems that these differences did not affect the plant growth much. The average plant heights in the same populations were quite equal in all years (Fig. 3).

One aim of this study was to determine the differences in the quality of the raw material collected from large geographical amplitudes. We observed great variations in the 7-methyljuglone contents in the different plant parts and a great decrease in their content in leaves during ontogenesis. This makes it difficult to compare raw material from different localities. The contents of both flavonoids (quercetin and kaempferol) studied were stable.

At the end of the growing periods it was observed that there were small new plants in large quantities on the observation plots. The average number of the small, new plants on the 12 plots at the end of August each year was 188 m^{-2}. This means that the seed reservoir in the peat is quite high, or that the light seeds can be easily transferred on the surface of the peatland by water or the wind.

Contrary to the great number of germinated plants, the flowering and collectable plants in the experimental plots numbered only 20–55. Since the growth of the leaf rosettes depends on the accidental preys in the swamp, natural populations always comprise plants of different sizes, as was found in experimental conditions (Thum 1988, Schulze and Schulze 1990, Kraft and Handel 1991).

Although the propagation of sundew by leaf cuttings is a common method in horticulture, we had no observations of vegetative propagation, e.g. rooting of sundew leaves, as reported by Phillips (1986).

New environmentally sustainable collection method

As shown by the results of this experiment, sundew populations seem to regenerate by seed. Therefore, the Finnish 4H organisation immediately initiated a new, environmentally sustainable collection programme for young collectors to minimise the harmful effects of the collection and ensure safe regeneration of natural populations. According to the new guidelines - a concrete result of this experiment - the collector must leave 5–10 flowering plants per square metre on the

Table 9. The total number of *Drosera rotundifolia* plants during the end of the growing seasons at three locations.

Taulukko 9. Pyöreälehtisen kihokin kokonaislukumäärä kasvukauden lopussa kolmella alueella.

Location	Plot	Mean number of any size of sundew plants per m^2				Mean
		1993 15.8.	1996 13.8.	1997 15.8.	1999 14.8.	
1. Puumala, Sorjola	1	133	210	220	230	198
	2	199	100	125	115	135
	3	279	185	365	260	272
2. Puumala, Saarijärvi	4	35	100	105	85	81
	5	59	90	130	180	115
	6	85	130	195	160	142
3. Otava, Luhdansuo	7	337	245	275	164	255
	8	441	430	535	465	468
	9	474	310	195	235	303
	10	47*	15	10*	40	28
	11	87	175	145	205	153
	12	0*	195	105	140	110
	Mean	181	182	200	190	188

* = under water

peatlands.

This leaves in theory about 400–900 seeds per square metre peatland. Additionally, sundew may be collected only once in the summer from one place. According to our results, 35% of the whole population flowered after the first collection. According to the new guidelines, later flowering plants can also produce seed safely, spread them and assure the natural regeneration of sundew populations. These instructions are emphasised in collectors' training programmes.

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TIIVISTELMÄ

Säännöllisen keruun vaikutusta pyöreälehtikihokin satoon ja kasvuston uusiutumiseen luonnossa tutkittiin Suomessa vuosina 1993–1999. Kukkivaa kihokkia poimittiin heinäkuun aikana luonnonvaraisilta soilta eri puolilta Suomea. Neliömetrin suuruisia havaintoruutuja oli 37. Tutkimuksessa tarkasteltiin kasvien lukumäärää, kukkavanojen korkeutta, tuoreen sadon määrää ja sadon 7-metyylijugloni-, kversetiini- ja kamferolipitoisuuksia. Syksyisin laskettiin erikokoisten kasvien määrät koeruuduilta.

Ensimmäisen ja toisen keruuvuoden aikana keruukelpoisia kukkivia kasveja oli 45–56 kpl m^{-2} ja tuorepaino oli 5.2–6.7 g m^{-2}. Kasvien säännöllinen ja tarkka keruu vähensi kasvien tiheyttä ja satoa. Kolmantena ja seitsemäntenä keruuvuotena kasveja oli 19–32 kpl m^{-2} ja tuoresato oli 2.7–4.0 g m^{-2}. Syksyisin pieniä taimia oli koeruuduissa keskimäärin 188 kpl m^{-2}. Tämä viittaa siihen, että luonnon populaatiot pystyvät uusiutumaan turpeessa olevien siemenvarastojen avulla.

Tutkimustulosten perusteella Oulun 4H-piiri laati poimijoille ympäristöystävällisen pomintaohjeen, jonka mukaan poimijoita velvoitettiin jättämään 5–10 kukkivaa kasvia neliömetrille. Lisäksi samalta alueelta sai kesän aikana kerätä kasveja vain kerran kihokki-populaation uusiutumisen varmistamiseksi varisevista siemenistä.

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