Epicuticular Wax Hydrocarbons of Ericaceae in Germany

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Alkane distribution patterns were determined in the epicuticular wax of 7 species of Ericaceae, including 5 species from more than one location. Results showed good agreement between samples of any given species from different locations; thus any differences in environmental conditions including altitude were insufficient to affect the alkane patterns. Average chain length was highest in *Calluna vulgaris* and lowest in *Vaccinium uliginosum*.

Introduction

Following our studies of the epicuticular waxes of Ericaceae in the USA [1, 2] and Norway [3], the work has been extended to the Federal Republic of Germany where the waxes of 13 samples (7 species) have been collected and analyzed. The aim of these studies is to obtain sufficient data from various habitats and different parts of the world to determine the relative effects of genetic and environmental factors on the wax composition. If the genetic effects prove to be dominant, then the question arises whether the wax composition – including the alkane distribution pattern – is a useful taxonomic indicator.

Materials and Methods

All plant material was collected by the author. Plants from Niedersachsen, Schwarzwald and Odenwald were collected in August 1985, those from Oberbayern in September 1985. Voucher specimens are kept in the Botanical Institutes at Heidelberg and Innsbruck, respectively. All collection areas were on plains or gently undulating land. The first three were in gymnosperm or mixed forests; the area in Oberbayern was a peat bog near Königsdorf. *Erica tetralix* (Sample 6 in Table I) was found on a section of the peat bog apparently ploughed and sown with hay seed some years ago; none of it was seen on the surrounding, partly drained but otherwise uncultivated moor.

Epicuticular wax was isolated by dipping the fresh leafy cuttings in redistilled light petroleum ($2 \times 2-5$ min) at room temperature. Leaves of *Oxycoccus quadripetalus* were separated from stems and soaked in light petroleum (3×40 min). Flowers of *Andromeda polifolia* and *Erica tetralix,* and ripe berries of *Vaccinium* spp. were removed before wax extraction. When collecting *Calluna vulgaris,* cuttings with few or no flowers were selected.

The wax solutions were worked up, the waxes fractionated and the hydrocarbon fractions analyzed as described previously [4].

Results and Discussion

Results are given in Table I.

Both the highest and the lowest wax yields are from the subfamily Ericoideae, with *Erica tetralix* scoring the highest yield and *Calluna vulgaris* the lowest. The latter showed the highest percentage of hydrocarbons in wax, as if to counterbalance the low wax yield. However, the hydrocarbon content was lowest in *Vaccinium uliginosum*. Normal alkanes formed 98–100% of the hydrocarbon fraction. There was no evidence of the presence of any branched or unsaturated hydrocarbons. Similarly absent was rimuene, a diterpene hydrocarbon found in a number of gymnosperms and recently reported [5] in Ericaceae (two species of *Gaultheria*).

While several patterns emerge for the alkane chain length distribution, the agreement between replicates of given species is mostly good. In two samples of *Calluna vulgaris,* tritriacontane is the major alkane, followed by hentriacontane and nonacosane; and although the order of the major two alkanes is reversed in the third sample, the actual difference is small enough to be considered insignificant. *Erica tetralix* shows the ranking order $C_{31} > C_{33} > C_{29}$. *Andromeda polifolia* and *Vaccinium myrtillus* show the

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Table I. Alkane distribution in epicuticular wax of Ericaceae leaves in Germany[a].

No. Species	Location[b]	Altitude [m]	Wax yield [%]	Hydrocarbons in wax [%]	Alkanes in hydrocarbons [%]	Carbon chain length of alkanes 19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	Average chain length
Subfamily Arbutoideae																									
1 *Andromeda polifolia* L.	Königsdorf (Ob)	900	0.85	10.1	100					tr	tr	1	tr	3	2	29	1	57	1	5					30.2
Subfamily Ericoideae																									
2 *Calluna vulgaris* (L.) Hull	Wisselhorst (N)	65	0.06	37.2	100							tr	tr	2	1	7	1	37	4	44	1	2		tr	31.8
3 *Calluna vulgaris* (L.) Hull	Besenfeld (S)	815	0.17	31.9	99.9							tr		1	1	6	1	38	4	44	1	2		tr	31.8
4 *Calluna vulgaris* (L.) Hull	Buchen (Od)	440	0.11	32.1	99.8							tr		2	1	8	1	41	4	40	1	2			31.7
5 *Erica tetralix* L.	Wisselhorst (N)	65	1.36	7.1	99.5					tr		1	tr	2	1	7	1	61	3	23	tr				31.2
6 *Erica tetralix* L.	Königsdorf (Ob)	900	1.42	3.8	99.6					tr	tr	1	1	3	1	5	1	54	3	31	tr				31.3
Subfamily Vaccinioideae																									
7 *Oxycoccus quadripetalus* Gilib.	Königsdorf (Ob)	900	0.11	6.9	99.9					tr	tr	tr	1	16	3	49	2	27	tr	1					29.2
8 *Vaccinium myrtillus* L.	Wisselhorst (N)	65	0.24	19.0	99.5	tr				tr		1	tr	5	2	21	1	59	1	8	tr	tr	tr	tr	30.4
9 *Vaccinium myrtillus* L.	Besenfeld (S)	815	0.19	20.1	99.3					tr		1	1	6	2	23	2	57	1	7	tr				30.3
10 *Vaccinium uliginosum* L.	Besenfeld (S)	815	0.45	1.2	98.1	tr	tr	tr	2	8	8	24	18	33	1	4		tr							25.7
11 *Vaccinium uliginosum* L.	Königsdorf (Ob)	900	0.33	2.0	99.0	tr	tr	1	1	6	6	21	10	47	2	4		tr							26.0
12 *Vaccinium vitis idaea* L.	Wisselhorst (N)	65	0.14	6.6	99.9					1	1	5	3	13	8	54	3	12		tr					28.6
13 *Vaccinium vitis idaea* L.	Besenfeld (S)	815	0.26	6.8	99.9					1	1	13	3	25	6	42	2	6	tr	tr					27.9

[a] Percentages (by weight) are rounded off to the nearest 1%. Trace (tr) = 0.1–0.5%.

[b] Districts: N = Niedersachen; Ob = Oberbayern; Od = Odenwald; S = Schwarzwald.

usual order $C_{31} > C_{29} > C_{33}$; in *Oxycoccus quadripetalus* and *Vaccinium vitis idaea* nonacosane is the major alkane, but the runners-up are different. *Vaccinium uliginosum* is true to form with $C_{27} > C_{25} > C_{26}$ (cf. [3]) and with the shortest average chain length. Both samples reported here have only trace quantities of hentriacontane and nothing above C_{31}; previous work [2, 3] has found definite amounts of C_{31} alkane in this species, though it still has retained the position of the species with the lowest cut-off. On the opposite end is *Calluna vulgaris:* it contains several per cent pentatriacontane; and the Ericoideae are characteristic in having the average chain length exceed 31 carbons.

The good agreement between samples of any given species from different locations indicates that any external factors which may differ between these locations have no significant effect on the epicuticular wax alkanes. Although differing in altitude, the locations are similar in being sheltered from harsh climatic conditions. Two other groups have reported the effects of altitude on the external and internal lipids of Ericaceae species. Lütz and Gülz [6] noted considerable differences in the alkane patterns of *Loiseleuria procumbens* from different altitudes (1950 m and 2660 m). On the other hand, Kirschbaum [7] found that the lipids in two samples of *Rhododendron setosum,* both collected at 3700 m, differed considerably, depending on whether the plant material was collected from a dense dwarf shrub heath or from shrubs standing alone on adjacent subalpine grassy slopes, the composition of the latter resembling much more closely that of the same species at 4200 m on alpine grassy slopes. It must be concluded for the species studied here that it is not so much the altitude as various aspects of the climate (including the local microclimate) that affect the plant metabolism and the accumulation of metabolic end products in the epicuticular wax.

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