Phytochemistry, Vol. 26, No. 6, pp. 1723–1724, 1987.
Printed in Great Britain.

0031–9422/87 $3.00 + 0.00

LIPID POLYMERS FROM THE TURF-FORMING MOSS *DICRANUM ELONGATUM*

PIRJO KARUNEN, LAILA HEIKKILÄ and EEVA KÄLVIÄINEN

Department of Biology, University of Turku, SF-20500 Turku 50, Finland

(*Revised received* 10 *August* 1986)

Key Work Index—*Dicranum elongatum*; Bryophyta; cutin; suberin; cell wall.

Abstract—The green part of *Dicranum elongatum* contained polymerized lipids amounting to 1.4 mg/g dry cell-wall preparation. The major monomer classes were hydroxy acids (44.9%) and fatty acids (39.7%), and the minor classes α,ω-dicarboxylic acids and fatty alcohols. The underground shoot parts encrusted with rhizoids contained a smaller amount of polymerized lipids (1.1–0.9 mg), with the important classes fatty acids, α,ω-dicarboxylic acids and hydroxy acids with 16 carbon atoms. The content of long-chain ω-hydroxy acids with 18 carbon atoms or more increased with shoot age, being highest in the oldest, decaying part of the turf. Similar age-dependent increases, although more conspicuous, occur in the turfs of two *Sphagnum* mosses but not in the wefts of two forest mosses.

INTRODUCTION

The age-dependent contents of polymerized lipids exhibit a clearly different pattern in the peat mosses *Sphagnum fuscum* and *S. papillosum* and the forest mosses *Pleurozium schreberi* and *Hylocomium splendens* [1]. Long chain ω-hydroxy acids accumulate in the former mosses, which decay very slowly and form tall turfs, whereas no such accumulation occurs in the rapidly decaying, weft-forming forest mosses. These results suggest that a more general relationship may prevail between the growth forms of mosses [2] and the age-dependent changes in the lipid polymers of their cell walls. Further evidence in favour of such a relationship is reported in this paper.

RESULTS AND DISCUSSION

Dicranum elongatum is a turf-forming mixed endo- and ectohydric moss [3], the oldest parts of the turf attaining an age of about 50 years [4]. In this respect it is intermediate between *Sphagnum* mosses whose tissue structure can be preserved for hundreds, even thousands, of years [5], and the forest mosses *Pleurozium schreberi* and *Hylocomium splendens*, which decay completely within a few years [6, 7].

The total amount of polymerized lipids in the green shoot parts of *D. elongatum* was 1.4 mg/g dry cell-wall preparation (Table 1). This is the same level as in the ectohydric peat and forest mosses [1]. In older parts of *D. elongatum* turf, 1.5–3.5 and 3.5–7.5 cm below the surface, the amounts were only 1.1 and 0.9 mg, respectively. In *D. elongatum*, rhizoids thickly cover the stems of underground shoot parts, and the rhizoidal cell walls may, at least partly, explain the lower level of lipid polymers in the underground parts. Slight decreases are also found in the senescent or newly dead parts of forest mosses, whereas in the peat mosses the level of polymerized lipids increases with shoot age [1, 8, 9]. The oldest shoot parts of *D. elongatum*, 7.5–12.5 cm below the surface, were partially disintegrated and contained more polymerized lipids (1.6 mg) than the other underground shoot parts. The increase may be due to the better decay-resistance of lipid polymers than other cell-wall material. The age-dependent increase of polymerized lipids in *D. elongatum* turf is not as conspicuous as that in the *Sphagnum* turfs, however [8, 9].

The major monomer classes in the green tissue of *D. elongatum* were hydroxy acids and fatty acids, making up 44.9% and 39.7% of the total amount of monomers, respectively. The same classes were dominant in the older shoot parts. The minor classes in both parts were fatty alcohols and α,ω-dicarboxylic acids. Both the major and minor classes were the same as in other mosses [1, 8–10]. The amount of ω-hydroxy acids was greatest in the decaying parts of *D. elongatum* turf. A similar increase occurs in decaying *Sphagnum* turfs but not in the decaying parts of weft mosses [1].

The individual monomers of the polymerized lipids of *D. elongatum* were about the same as those in other mosses [1, 10]. The major individual components were mixtures of 9,16- and 10,16-dihydroxyhexadecanoic acids and hexadecanoic acids, which in the green tissue made up 40 and 20%, respectively, of the total amount of monomers. These same acids were major components in older parts, although the levels were lower. The amount of long-chain (18 carbon atoms or more in the chain) ω-hydroxy acids was low in the green tissue, only 7% of the total hydroxy acids, and increased with the age of the shoot tissue, being 40% in the brown part, 3.5–7.5 cm below the surface, and 62% in the oldest, decaying part. This behaviour is very similar to that found for *Sphagnum* mosses: even the major increases occurred in the contents of the same monomers, 18-hydroxyoctadec-9-enoic and 22-hydroxydocosanoic acids, as in *Sphagnum* mosses [8, 9]. Thus, it can be concluded that the age-dependent increase of long chain ω-hydroxy acids is common to turf-forming *D. elongatum* and turf-forming *Sphagnum* mosses.

Table 1. The contents (μg + s.e./g dry cell-wall preparation) of constituents of polymerized lipids in green and aged parts of *D. elongatum* shoots

Components	Segments			
	1	2	3	4
Hydroxy acids	610 ± 21	550 ± 15	520 ± 17	1090 ± 60
16-Hydroxyhexadecanoic	20 ± 1	20 ± 1	10 ± 2	40 ± 3
18-Hydroxyoctadec-9-enoic	20 ± 4	60 ± 4	140 ± 19	380 ± 16
9,16- and 10,16-dihydroxy-hexadecanoic	540 ± 16	430 ± 11	300 ± 2	370 ± 10
Dihydroxyoctadecenoic	+	10 ± 1	10 ± 3	50 ± 6
20-Hydroxyeicosanoic	+	10 ± 4	20 ± 1	50 ± 2
9,10,18-Trihydroxyocta-decanoic	10 ± 1	10 ± 1	+	50 ± 7
22-Hydroxydocosanoic	10 ± 1	20 ± 1	40 ± 3	130 ± 5
2-Hydroxytetracosanoic	+	+	+	10 ± 2
24-Hydroxytetracosanoic	+	+	+	20 ± 1
Dicarboxylic acids	60 ± 8	30 ± 2	10 ± 3	100 ± 3
Hexadecan-1,16-dioic	30 ± 8	10 ± 7	+	+
Octadec-9-ene-1,18-dioic	+	+	+	30 ± 2
Octadecan-1,18-dioic	20 ± 1	20 ± 1	10 ± 3	40 ± 3
Docosan-1,22-dioic	+	+	+	20 ± 7
Tetracosan-1,24-dioic	+	+	+	+
Fatty acids	540 ± 51	360 ± 25	250 ± 9	320 ± 23
Hexadecanoic	260 ± 26	170 ± 9	130 ± 3	140 ± 7
Unsaturated C18	110 ± 15	40 ± 5	30 ± 1	50 ± 2
Octadecanoic	50 ± 4	40 ± 2	40 ± 4	40 ± 3
Eicosanoic	50 ± 2	40 ± 1	30 ± 2	30 ± 3
Docosanoic	20 ± 10	40 ± 14	20 ± 2	20 ± 8
Tetracosanoic	30 ± 3	20 ± 3	10 ± 1	30 ± 3
Hexacosanoic	20 ± 2	10 ± 1	10 ± 1	20 ± 0
Fatty alcohols	20 ± 1	20 ± 1	20 ± 4	70 ± 6
Octadecanol	+	+	+	+
Eicosanol	20 ± 1	10 ± 1	+	20 + 2
Docosanol	+	10 ± 5	20 ± 4	50 ± 3
Tetracosanol	+	+	+	+
Hexacosanol	+	+	+	+
Unknown	130 ± 17	160 ± 31	120 ± 9	90 ± 8
Total	1360 ± 66	1130 ± 70	930 ± 9	1640 ± 94

+ = < 10 μg. 1, Green top (0–1.5 cm); 2, yellow part (1.5–3.5 cm); 3, brown part (3.5–7.5 cm) and 4, decaying blackish brown part (7.5–12.5 cm). The number of independent replicates is three.

EXPERIMENTAL

Dicranum elongatum Schleich and Schwaegr. turfs were collected in July 1983 from a peaty soil on an abrupt mountain slope near Lake Kevojärvi in N. Finland (69° 45'N). The moss samples were sent immediately after collection to Turku University. Mosses were separated from other plants, and debris and the shoots were cut into four parts: 1, green top (0–1.5 cm); 2, yellow part (1.5–3.5 cm below the surface); 3, brown part (3.5–7.5 cm); and 4, decaying blackish brown part (7.5–12.5 cm). The chemical analyses of the solvent-extracted cell-wall preparations were performed as previously reported [1]. The purity of the solvent-extracted tissue residue was checked by a light microscope. The residue consisted of cell-wall fragments and no whole cells or cytoplasmic or waxy material stained with Sudan Black were observed.

Acknowledgement—Financial support was received from the Academy of Finland.

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