

SHORT COMMUNICATION
SESQUITERPENE LACTONES: A SURVEY OF
21 UNITED STATES TAXA FROM THE GENUS
VERNONIA (COMPOSITAE)

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Abstract—The distribution of four new sesquiterpene lactones in 21 North American taxa of the genus *Vernonia* and the preliminary chemical characterization of three of the new compounds are reported.

THE NORTH American taxa of the genus *Vernonia* (Compositae) are under intensive biochemical systematic investigation, in part, because the synthetic F_1 and F_2 hybrids as well as backcrosses are available for detailed chemical analysis. We plan to analyse the parent plants in combination with the hybrids and backcrosses to determine the mode of inheritance of several classes of secondary compounds in this genus. In this connection, we report here the distribution of four new sesquiterpene lactones in 21 North American *Vernonia* taxa (Table 1) and preliminary chemical data for three of the new compounds, namely, *glaucolide-A*¹, *-B* and *marginatin*. The fourth substance has been named *baldvernin*.

The data available at this time for *glaucolide-A* and *-B* and *marginatin* indicate that they are all germacranolides containing a C_7 — C_{11} double bond and a C_{13} -*O*-acetyl group. Although the latter functional group represents an unusual structural feature, it has been previously ascribed to the germacranolide *confertolide* (1) from *Vernonia conferta* Benth.;² the preliminary data for *glaucolide-A* and *-B* and *marginatin* indicate that they are closely related to 1.

EXPERIMENTAL*

Extraction and Isolation of Glaucolide-A from Vernonia glauca (L.) Willd.

Dried and ground leaves (200 g) of *Vernonia glauca* (collected in Clarke Co., Georgia, 3 July, 1969, Jones 17062) were extracted with $CHCl_3$ and worked up in the usual way;³ yield of crude syrup: 1.0 g. The

* Melting points are uncorrected. Analyses were determined by Dr. Alfred Bernhardt, Mikroanalytisches Laboratorium, Elbach über Engelskirchen, West Germany. NMR spectra were recorded on a Varian A-60 Spectrometer in $CDCl_3$, and δ -values are given in ppm relative to internal tetramethylsilane as reference. Signals are described as follows: s, singlet; c, complex.

¹ The preliminary characterization of a substance which appears to be identical with *glaucolide-A* was previously reported: GLORY C. LLEANDER, Preliminary chemical investigation of *Vernonia glauca* (L.) Willd. Ph.D. Thesis, University of Maryland (1968).

² R. TOUBIANA, MARIE-JOSÉPHE TOUBIANA and B. C. DAS, *C. R. Acad. Sci., Paris* **270**, 1033 (1970).

TABLE 1. SURVEY OF SESQUITERPENE LACTONES IN *Vernonia* SPECIES*

Species	Collection No.†	Collection Site	Yield of Crude Syrup (Yield of major constituent in parenthesis)	Other Minor Constituents
A. THE TAXA CONTAINING GLAUCOLIDE-A AS THE MAJOR CONSTITUENT				
<i>V. acaulis</i> (Walt.) Gleason	Jones 17063	Elbert Co., Ga.—Antioch Church 7.0 miles W of Elberton (8 July 1969)	0.5%	glaucolide-B†
<i>V. altissima</i> Nutt.	Urbatsch 111	Dallas Co., Ala.—Hwy 80 ca. 6 miles W of Selma (8 August 1969)	0.4%	baldvernin† glaucolide-B†
<i>V. angustifolia</i> Michx.	Jones 17110	George Co., Miss.—10 miles S of Lucedale (21 July 1969)	1.0%	glaucolide-B†
var. <i>Mohrrii</i> S. B. Jones	Parker 1031	Bullock Co., Ga.—0.6 miles E of Statesboro High School and 0.5 miles N of U.S. Hwy. 80 (29 July 1969)	0.2%	glaucolide-B†
<i>V. angustifolia</i> Michx.	Jones 15818	Baxter Co., Ark.—2.2 miles WSW of Mountain Home, Hwy. 62 (8 August 1968)	3.0%	baldvernin†
var. <i>Scaberrima</i>	Jones 17062	Clarke Co., Ga.—Oconee Hill Cemetery, Athens (3 July 1969)	0.5 (0.15)%	baldvernin†
<i>V. arkaniana</i> DC.	Jones 15838	Hot Spring Co., Ark.—3 miles NNW of Malvern, Hwy 84, Ouachita River (9 August 1968)	0.4%	baldvernin†
<i>V. glauca</i> (L.) Willd.	Jones 17662	Travis Co., Texas—NW of Austin (5 August 1969)	0.2%	glaucolide-B†
<i>V. lettermanni</i> Engelm.	Jones 17675	Greene Co., Ga.—ca. 2.5 miles SSE of Oconee River, Hwy 15 (18 August 1969)	2(0.4)%	marginatin
<i>V. lindheimeri</i> Gray and Engelm.	Urbatsch 122	Alachua Co., Fla.—Hwy. 20, 1.1 miles E of road jct. 5-225 (28 August 1969)	0.8%	glaucolide-B†
var. <i>lindheimeri</i>	Jones 17659	Jasper Co., Texas—6 miles NE of Burkeville, Hwy 63 (4 August 1969)	0.6%	glaucolide-B
<i>V. noboracensis</i> (L.) Michx.	King 4	Pecos Co., Texas—Hwy. 285, 25 miles N of Sanderson (26 August 1970)	1.7%	glaucolide-B†
<i>V. ovalifolia</i> T. & G.	Jones 15764	Charlotte Co., Fla.—S of Punta Gorda across the road from the Pine Terrace Motel	1.1%	baldvernin†
<i>V. texana</i> (A. Gray) Small	Jones 15831	Faulkner Co., Arkansas—1.3 miles SSW of Damascus on Ark. 124 (8 August 1968)	3.0%	glaucolide-B†
<i>V. lindheimeri</i> Gray and Engelm.				
var. <i>leucophylla</i> Larsen				
<i>V. blodgettii</i> Small				
<i>V. missurica</i> Raf.				

B. THE TAXA CONTAINING GLAUCOLIDE-B AS THE MAJOR CONSTITUENT				
<i>V. baldwini</i> Torr. var. <i>baldwini</i>	Faust 147	Wright Co., Mo.—3.8 miles E of r. jct. 60 + 5 near Mans- field (11 August 1969)	5.0%	baldvernin†
<i>V. baldwini</i> Torr. var. <i>interior</i> (Small) Schubert	Faust 131	Williamson Co., Texas—6 miles NW of Austin at r. jct. 183 and 620 (5 August 1969)	2.4(0.5)%	baldvernin†
C. THE TAXON CONTAINING BALDVERNIN AS THE MAJOR CONSTITUENT				
<i>V. baldwini</i> Torr. var. <i>interior</i> (Small) Schubert	Hammam 2	Travis Co., Texas 1 mile W of Bull Creek Lodge on 2222 (18 July 1969)	2.0%	glaucolide-B
D. THE TAXA CONTAINING MARGINATIN AS THE MAJOR CONSTITUENT				
<i>V. fasciculata</i> Michx. var. <i>fasciculata</i>	Jones 17671	Woodson Co., Kan. Pasture W of Yates Center (10 August 1969)	2.0%	baldvernin† glaucolide-A† glaucolide-B† glaucolide-A† glaucolide-B† glaucolide-A† glaucolide-B†
<i>V. marginata</i> (Torr.) Raf. marginata	Jones 17667	Crosby Co., Texas ca. 3 miles N of Ralls (9 August 1969)	1.7(0.7)%	
<i>V. marginata</i> (Torr.) Raf. var. <i>tenifolia</i> (Small) Shinners	Jones 17665	Brewster Co., Texas. 4 miles SW of Marathon (8 August 1969)	0.8%	
E. THE TAXON WHICH DID NOT CONTAIN SIGNIFICANT AMOUNTS OF SESQUITERPENE LACTONES				
<i>V. flaccidifolia</i> Small	Urbatsch 115	Franklin Co., Tenn.—US Hwy. 64 just E of Sewanee	0.1%	glaucolide-A† glaucolide-B† marginatin

* The compounds were determined by NMR analysis of the crude syrups and co-chromatography on thin-layer plates with authentic specimens unless the yield of pure compound is given. The R_f values on silica gel TLC plates (benzene-ether; 1:3) were: glaucolide-A: 0.35; -B 0.30; marginatin: 0.60 and baldvernin: 0.42. The taxa investigated are placed for convenience in four groups according to their major sesquiterpene lactone constituent; no systematic conclusions are implied by these groupings.

† Vouchers for all the collections are deposited in The University of Georgia Herbarium.

‡ These constituents were detected in these taxa by TLC alone.

crude syrup yielded after trituration with EtOAc-cyclohexane crude crystals of glaucolide-A. A pure specimen of *glaucolide-A* (0.3 g) was obtained by recrystallization from MeOH: m.p. 153–154.5°, $[\alpha]_D^{25} -29^\circ$ (CHCl₃, c 0.5%), UV (EtOH): $\lambda_{\max}$ 211 nm (ϵ 21,300) and 290 nm (ϵ 135); IR (CHCl₃): 1770 and 1730 (carbonyls), 1240 (acetate) and 830 cm⁻¹; NMR: 6.22 (c, 1H), 5.76 (m, 1H), 5.2–4.75 (c, 2H), 4.88 (brd.s, 2H), 2.07 (s, 6H), 1.95 (c, 3H), 1.67 (s, 3H) and 1.61 (s, 3H). (Found: C, 59.82; H, 5.96; O, 34.04. C₂₃H₂₈O₁₀ requires: C, 59.60; H, 6.03; O, 34.45%.)

Extraction and Isolation of Glaucolide-B from Vernonia baldwini Torr. var. interior (Small) Schubert

Dried and ground leaves (302 g) of *Vernonia baldwini* var. *interior* (collected in Williamson Co., Texas, 5 August 1969, *Faust 131*) were extracted and worked up in the usual way; yield of crude syrup: 7.2 g. The crude syrup was chromatographed over a column of silica gel (70 g packed in CHCl₃) and eluted with 300 ml of CHCl₃, then with 420 ml of CHCl₃-acetone (6:1). 20 ml fractions were collected and each fraction was monitored by TLC and NMR. Fractions 5–9 yielded 0.23 g of solid material which appeared to be a mixture of hydrocarbons. Fractions 10–15 yielded 2.72 g of impure *glaucolide-B*. Fractions 16–24 yielded 1.86 g of crude crystals of *glaucolide-B* which were purified by trituration with light petroleum: m.p. 75–77°, $[\alpha]_D^{25} -50^\circ$ (CHCl₃, c 0.5%), UV (MeOH): $\lambda_{\max}$ 213 nm (ϵ 10,000) and 270 nm (650) IR (CHCl₃): 1745 (carbonyls) and 1235 (acetates) cm⁻¹; NMR: 5.1–4.7 (c, 2H), 4.92 (brd.s 2H), 2.13 (s, 3H), 2.10 (s, 3H) 2.06 (s, 3H), 1.63 (s, 3H) and 1.58 (s, 3H) (Found: C, 57.53; H, 6.10 C₂₁H₂₆O₁₀ requires: C, 57.53; H, 5.98%.)

Extraction and Isolation of Marginatin from Vernonia marginata (Torr.) Raf. var. marginata

Dried and ground leaves (200 g) of *Vernonia marginata* var. *marginata* (collected in Crosby Co., Texas, 9 August, 1969; *Jones 17667*) were extracted with CHCl₃, and worked up in the usual way; yield of crude syrup: 3.4 g. Pure marginatin was obtained by either chromatography over a column of silica gel (benzene ethyl acetate; 3:1) or trituration with benzene-ether. Marginatin (**3**), m.p. 104–105°, $[\alpha]_D^{25} -6^\circ$ (CHCl₃, c 1.5%), UV (EtOH): $\lambda_{\max}$ 215 nm (ϵ 25,600), IR (CHCl₃): 1760 and 1710 (carbonyls), 1615 (C—C double bond), 1236 (acetate) and 834 cm⁻¹; NMR: 6.95 (c, 1H), 5.65–4.75 (c, 3H), 4.97 (brd.s, 2H), 2.07 (s, 3H), 1.95–1.70 (c, 9H) and 1.43 (s, 3H). (Found: C, 65.56; H, 6.73; O, 27.40. C₂₂H₂₈O₇ requires: C, 65.35; H, 6.94; O, 27.72%.)

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³ See, for example, T. J. MABRY, H. E. MILLER, H. B. KAGAN and W. RENOLD, *Tetrahedron*, **22** 1139 (1966).