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LUPANE TRITERPENOIDS OF *SALACIA CORDATA*

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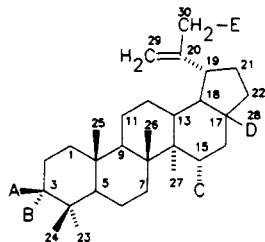
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ABSTRACT.—The stem bark of *Salacia cordata* has afforded 28-hydroxylup-20(29)-en-3-one, 30-hydroxylup-20(29)-en-3-one, betulin, pyracrenic acid, and a new compound, 15,28-dihydroxylup-20(29)-en-3-one [3]. Two-dimensional nmr methods have been used to assign structures and nmr spectra.

Salacia cordata Miers (Celastraceae) is a vine endemic to Guyana. An MeOH extract of the bark afforded five triterpenoids that were separated by chromatography. Routine spectroscopic data (ir, ^1H and ^{13}C nmr, eims, and hreims) were collected and used to determine the molecular formula and salient functional and structural features of each compound. Three were obtained in amounts sufficient for detailed examination by 2D nmr spectroscopy. A standard HETCOR experiment established one-bond ^{13}C - ^1H connectivities, and our FLOCK pulse sequence was used to establish 2- and 3-bond connectivities (1). We have previously described in detail how these methods can be used to assign complex structures, and we have shown specifically their value in the investigation of pentacyclic triterpenes (2,3). In general, these compounds have methyl groups strategically placed to allow a complete connectivity map to be assembled quickly. For example, the 3-bond ^{13}C - ^1H connectivities (^{13}C -detected) seen in both directions for a pair of methyl groups requires them to be a geminal pair, probably at C-4; 3-bond connectivities to these methyl protons are detected at C-3 and C-5, confirming the assignment. The C-5 cross section also shows cross peaks to a methyl group (C-25); the 3-bond connectivities between the C-25 protons and C-9 and between the C-26 protons and C-9 are established in the same way. The number of connec-

tivities detected is usually more than sufficient to assign structures unambiguously. The ^{13}C and ^1H chemical shifts assigned in this way are shown in Tables 1 and 2, respectively.

The most abundant triterpenes isolated were identified as 28-hydroxylup-20(29)-en-3-one [1], which has been reported previously as an oxidation product of betulin (4), and 30-hydroxylup-20(29)-en-3-one [2] (5). The third compound, 15,28-dihydroxylup-20(29)-en-3-one [3], has not been described previously. Its molecular formula, $\text{C}_{30}\text{H}_{48}\text{O}_3$, was determined (hreims), and structural and functional features were recognized from ir and nmr spectra. The structure was then established unequivocally from the connectivity data, and the stereochemistry at C-15 with an equatorial OH



	A	B	C	D	E
1		-O-	H	CH_2OH	H
2		-O-	H	Me	OH
3		-O-	OH	CH_2OH	H
4	HO	H	H	CH_2OH	H
5	CaFO	H	H	COOH	H

CaF = 3,4-dihydroxycinnamoyl

TABLE 1. ^{13}C Chemical Shifts for Compounds 1-5.

Carbon	Compound				
	1 ^a	2 ^a	3 ^a	4 ^b	5 ^c
C-1	39.58	39.59	39.88	38.76	38.32
C-2	34.11	34.13	34.14	27.19	23.75
C-3	218.24	218.27	218.27	78.92	80.45
C-4	47.32	47.32	47.24	38.86	37.94
C-5	54.87	54.87	54.52	55.34	55.96
C-6	19.65	19.68	19.81	18.33	18.10
C-7	33.50	33.58	36.89	34.26	34.17
C-8	40.84	40.79	42.39	40.94	40.66
C-9	49.72	49.73	50.28	50.43	50.35
C-10	36.85	36.87	37.08	37.17	36.98
C-11	21.36	21.57	21.51	20.87	20.82
C-12	25.20	26.68	25.24	25.25	25.39
C-13	37.40	38.12	37.04	37.34	38.07
C-14	42.75	42.85	47.79	42.73	42.34
C-15	27.03	27.40	69.04	27.04	29.61
C-16	29.12	35.40	40.26	29.20	32.22
C-17	47.77	43.01	47.92	47.76	55.37
C-18	48.68	48.81	48.34	48.81	49.07
C-19	47.76	43.75	47.19	47.83	46.83
C-20	150.39	154.67	149.87	150.60	150.72
C-21	29.73	31.75	29.99	29.78	30.55
C-22	33.97	39.83	33.91	34.00	37.03
C-23	26.63	26.68	26.63	27.98	27.94
C-24	21.02	21.04	20.99	15.40	15.97
C-25	15.95	15.99	16.06	16.12	16.14
C-26	15.78	15.80	16.26	15.97	16.61
C-27	14.67	14.47	8.07	14.77	14.58
C-28	60.36	17.72	61.52	60.21	178.32
C-29	109.72	106.83	110.04	109.64	109.37
C-30	19.08	64.95	19.12	19.11	19.28

^aChemical shifts measured at 100.6 MHz for CDCl_3 solution; assignments based on HETCOR and FLOCK experiments (1). Listings of connectivity data are available from authors at the Toronto address.

^bChemical shifts measured at 100.6 MHz for CDCl_3 solution containing a few drops of CD_3OD ; assignments based on HETCOR experiment and comparison with other compounds in this Table.

^cChemical shifts measured at 100.6 MHz for $\text{DMSO}-d_6$ solution; assignments based on HETCOR experiment and comparison with other compounds in this table.

followed from the vicinal ^1H - ^1H couplings of 11.2 and 5.1 Hz observed at H-15. Two triterpenoids were isolated in amounts too small for complete investigation by 2D nmr methods. In these cases the one-bond ^{13}C - ^1H connectivities were established by HETCOR, and the site assignments were made by comparison with the other compounds. A small amount (5 mg) of $3\beta,28$ -dihydroxylup-20(29)-ene [**4**] was isolated, and it was also obtained by NaBH_4 reduction of **1** in order to have enough material for the nmr investigation; its iden-

tity as betulin was confirmed from data in the literature (6). The final compound, the 3,4-dihydroxycinnamate ester **5** of betulinic acid, has been reported previously as a constituent of *Pyracantha crenulata* (Rosaceae) and named pyracrenic acid (7).

EXPERIMENTAL

GENERAL EXPERIMENTAL PROCEDURES.—Mp's were determined on a micro hot stage. A Nicolet 5DX FTIR, a Varian XL 400 NMR, and a VG70-250S mass spectrometer and a Perkin-Elmer polarimeter were used.

PLANT MATERIAL.—*S. cordata* was collected

TABLE 2. ¹H Chemical Shifts for Compounds 1–5.^a

Proton	Compound				
	1	2	3	4	5
H-1	1.91, 1.39	1.91, 1.42	1.91, 1.40	1.65, 0.89	<1.69>
H-2	<2.46>	<2.47>	<2.43>	<1.58>	<1.65>
H-3	—	—	—	3.18	4.55
H-5	1.34	1.35	1.34	0.67	0.81
H-6	<1.49>	<1.50>	<1.48>	1.52, 1.38	1.52, 1.38
H-7	<1.46>	<1.46>	1.88, 1.64	<1.39>	<1.37>
H-9	1.39	1.39	1.31	1.27	1.31
H-11	1.44, 1.28	1.46, 1.27	1.43, 1.25	1.41, 1.19	1.39, 1.25
H-12	1.67, 1.07	1.47, 1.18	1.68, 1.11	1.63, 1.03	1.68, 0.99
H-13	1.69	1.70	1.65	1.64	2.26
H-15	1.74, 1.09	1.73, 1.07	4.23	1.70, 1.04	1.47, 1.16
H-16	1.98, 1.22	1.56, 1.39	2.20, 1.18	1.93, 1.20	2.25, 1.33
H-18	1.61	1.50	1.59	1.57	1.55
H-19	2.41	2.32	2.36	2.38	3.03
H-21	1.98, 1.42	2.10, 1.37	1.99, 1.44	1.95, 1.40	1.94, 1.34
H-22	1.91, 1.05	1.43, 1.28	1.87, 1.05	1.86, 1.02	1.90, 1.40
H-23	1.08	1.09	1.06	0.96	0.86
H-24	1.04	1.05	1.02	0.76	0.94
H-25	0.94	0.95	0.93	0.82	0.86
H-26	1.07	1.09	1.14	1.02	0.89
H-27	1.00	0.98	1.00	0.98	0.96
H-28	3.80, 3.37	0.81	3.66, 3.40	3.77, 3.31	—
H-29	4.71, 4.61	4.99, 4.93	4.70, 4.62	4.68, 4.58	4.71, 4.57
H-30	1.69	<4.16>	1.68	1.68	1.67

^aChemical shifts measured at 400 MHz. Solvents and other conditions are described in the footnote to Table 1. The δ_{H} for each identifiable proton (or methyl) is listed; the <mean δ_{H} > is reported for incompletely resolved CH₂ multiplets.

in the Mabura Hills, Guyana, in March 1990. Voucher specimens have been deposited at the Herbarium of the University of Guyana. Dried stems and adhering bark (1.8 kg) were ground and extracted with cold MeOH. The residue (10 g) from the extract was separated into major fractions by cc (Si gel with hexanes/Me₂CO), and individual terpenes were then isolated by plc [Si gel with hexanes-Me₂CO (5:1)].

28-Hydroxylup-20(29)-en-3-one [**1**].—Compound **1** (195 mg): C₃₀H₄₈O₂; mp 175–176°; [α]_D +16.4° (c = 0.2, CHCl₃). Treatment of **1** (90 mg) with NaBH₄ (100 mg) in 10 ml of EtOH for 45 min converted it to **4** (41 mg).

30-Hydroxylup-20(29)-en-3-one [**2**].—Compound **2** (263 mg): C₃₀H₄₈O₂; mp 184–185°; [α]_D +20° (c = 0.26, CHCl₃).

15,28-Dihydroxylup-20(29)-en-3-one [**3**].—Compound **3** (35 mg) was isolated as colorless crystals: mp 140–142°, [α]_D -5° (c = 1.1, CHCl₃); ir 3400, 1704 cm⁻¹; eims 456 (32), 438 (57), 425 (63), 407 (72), 339 (16), 249 (45), 219 (54), 205 (88), 187 (86), 93 (100); hreims 456.3603, calcd for C₃₀H₄₈O₃, 456.3603.

3 β ,28-Dihydroxylup-20(29)ene (betulin) [**4**].—Compound **4** (5 mg): C₃₀H₅₀O₂, mp 236–238°, [α]_D +24° (c = 0.075, pyridine).

3-O-(3',4'-Dihydroxycinnamoyl)betulinic acid [**5**].—Compound **5** (16 mg): C₃₉H₅₄O₆; mp 284–285° (phase change), >300° (dec); [α]_D -5° (c = 0.06, pyridine).

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