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The Absolute Configuration of P-1894B, A Potent Prolyl Hydroxylase Inhibitor[1]

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The previous X-ray-crystallographic determination of the relative configuration of P-1894B, a potent prolyl hydroxylase inhibitor isolated from the culture broth of *Streptomyces albogriseolus*, was extended by means of chemical and spectral studies. The absolute configuration of P-1894B (**1**) was established from the absolute configuration of two constituent monosaccharides, L-aculose (**3**) and L-rhodinose (**4**), produced by chemical degradation of **1**. The absolute configuration of the aglycone part (aquayamycin) was also established as **2**. The stereostructure of the reduction product (**11**) obtained by the catalytic hydrogenation of **1** was also elucidated.

Keywords——P-1894B; prolyl hydroxylase inhibitor; absolute configuration; ^{1}H-NMR; ^{13}C-NMR; L-aculose; L-rhodinose; aquayamycin

P-1894B (**1**) is a potent prolyl hydroxylase inhibitor produced by *Streptomyces albogriseolus* subsp. No. 1894. Its production, isolation, identification, X-ray crystallographic analysis and biological properties have been reported.[2-4] In a preliminary communication,[1] we briefly reported the absolute configuration of **1** based on the absolute configuration of the sugars obtained from P-1894B hydrolysate and the result of an earlier X-ray analysis[4] which established the relative configuration of P-1894B. In the present paper, we wish to present a full account of the work described in the preliminary communication.[1]

In order to establish the structure and absolute configuration of **1**, we carried out the isolation and identification of the sugar and aglycone parts of **1** by chemical degradation studies (Charts 1 and 2) and spectral analysis.

On acid hydrolysis with 0.3 N H_2SO_4, **1** liberated an aglycone (**2**), together with two sugar moieties. The field desorption mass spectrum (FD-MS), elementary analysis and proton nuclear magnetic resonance (^{1}H-NMR) spectrum indicated **2** to have the formula $C_{25}H_{26}O_{10}$. The aglycone **2** was identified as aquayamycin by comparison of the physico-chemical data with those reported.[5b,6] Chromatographic separation of the sugar moieties yielded 2,3,6-trideoxy-L-hex-2-enopyran-4-ulose (L-aculose, **3**),[7,8] and 2,3,6-trideoxy-L-*threo*-hexopyranose (L-rhodinose, **4**).[8,9] Although compound **3** has been reported in the total synthesis of monosaccharides[10] and the structural determination of aclacinomycin Y_1 was reported by Oki *et al.*,[8] no other detailed study has been reported on the isolation from the natural product, probably owing to low stability. In order to establish the anomeric configuration of **3**, methyl glycosidation with 0.1 N HCl–MeOH to give **6** and **7** was undertaken. Unfortunately, this attempt was unsuccessful and a considerable amount of by-product was formed as a result of the addition of MeOH to the conjugated double bond. Since the OMe group introduced at C_2 is in a "*trans*" position with respect to the anomeric glycosidic group and the anomeric proton is observed at δ4.78 (1H, d, $J=2$ Hz), the structure of this by-product was assumed to be methyl 3,6-dideoxy-2-*O*-methyl-α-L-*threo*-hexopyranosid-4-ulose (**5**), $C_8H_{14}O_4$, $[\alpha]_D^{23}$ $-56.1°$ (MeOH), electron impact mass spectrum (EI-MS) *m/z*: 174 (M^+).

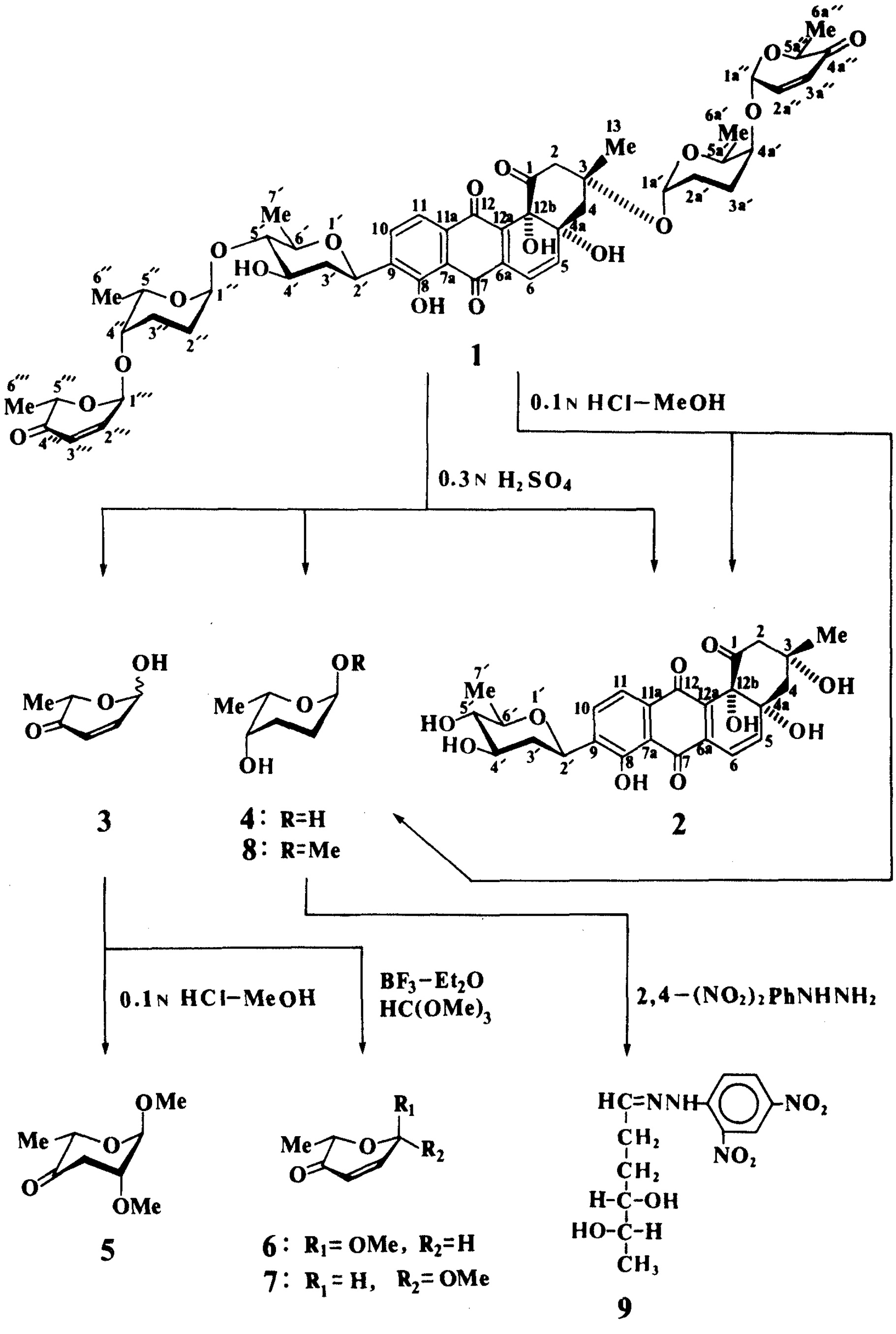

Chart 1

A satisfactory result was obtained by the reaction of **3** with trimethyl orthoformate in the presence of BF_3-etherate at room temperature for 2 h. The resulting products, which on thin layer chromatography (TLC) showed essentially two spots, were carefully separated by silica gel chromatography to give two methyl glycoside isomers: methyl 2,3,6-trideoxy-α-L-hex-2-enopyranosid-4-ulose (**6**)[10b,c,e,f] and its β-anomer (**7**).[10b,d] Their structures were assigned as depicted in Chart 1 on the basis of ^{1}H-NMR spectral data, among which the most informative were the spin–spin coupling constants for the anomeric protons: **6**, δ 5.06 (d, $J_{1,2}=3.4$ Hz); **7**, δ 5.23 (m, $J_{1,2}=2.0$ Hz). This identification was finally confirmed by comparing the results with known data.[10] Therefore, the structure of the sugar, a component of **1**, has been established as L-aculose (**3**).[7,8]

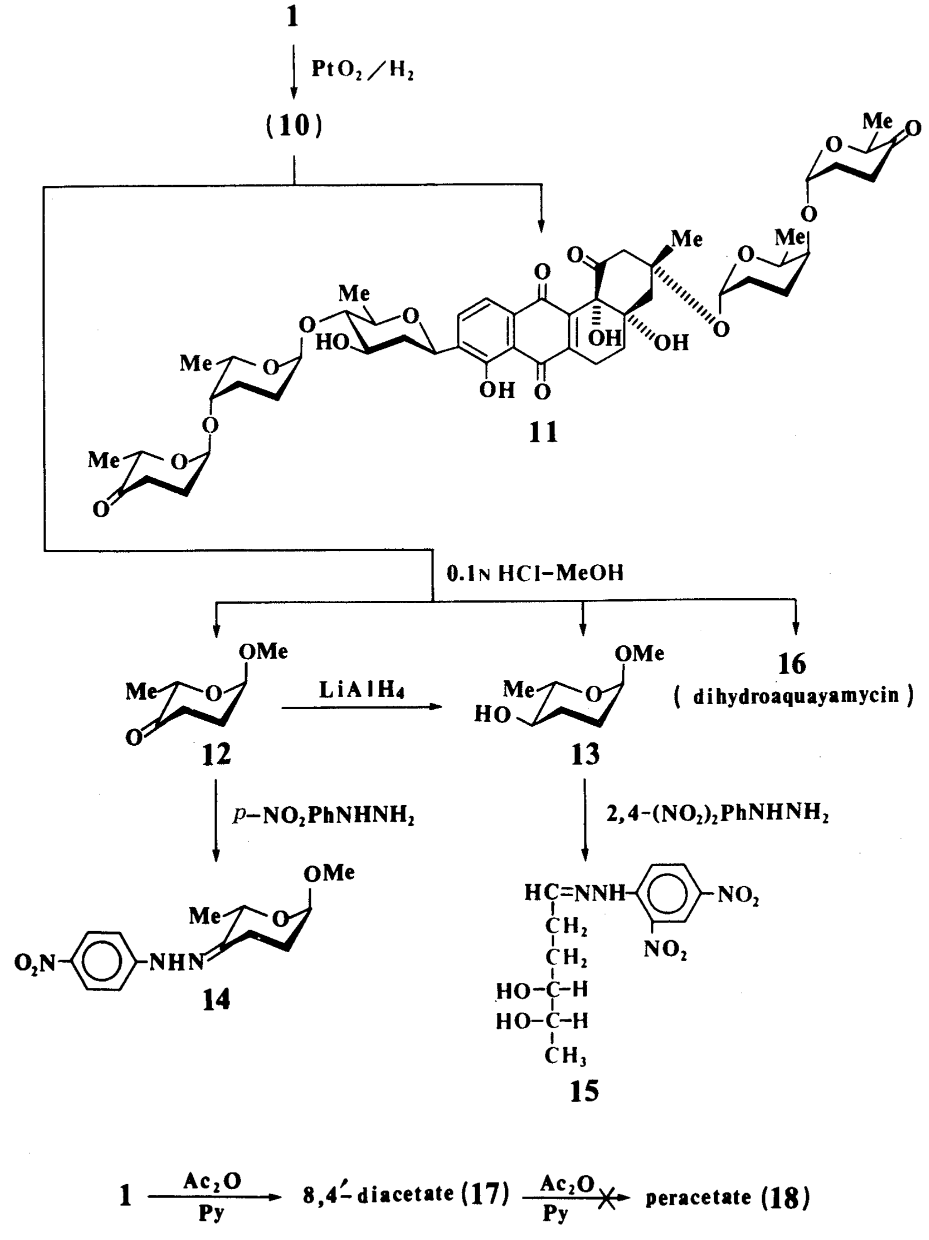

Chart 2

Compound **4**, a component of **1**, was determined to be L-rhodinose[8,9] by direct comparison of $[\alpha]_D^{20}$ and the TLC behavior of the acid hydrolysates with those of natural rhodinose from aclacinomycin N_1,[8] kindly provided by Dr. T. Oki, Pfizer Taito Co., Ltd. On treatment with 0.1 N HCl–MeOH, **1** afforded **2** and a mixture of methylated sugars. Chromatographic purification of the methylated sugars gave methyl α-L-rhodinoside (**8**), which was identified as its 2,4-dinitrophenylhydrazone (**9**).[9c–e]

The anomeric configuration of **8** was assigned as α based on the coupling constants ($J = 1$ and 3 Hz) of an anomeric proton at δ 4.70 (1H, dd). Hence, the sugar, a component of **1**, was established as L-rhodinose (**4**).[8,9]

On the other hand, the ^{1}H-NMR spectral data of **1** obtained at 400 MHz gave much information on the structure. Signal assignments were accomplished by consideration of the chemical shifts and multiplicities as well as by means of spin decoupling experiments and the overall results are shown in Table I. The modes of linkage of L-aculose and L-rhodinose units were regarded as all α. These results were consistent with the chemical shifts and coupling constants of anomeric protons in the ^{1}H-NMR spectral data of **1**.

Moreover, the carbon-13 nuclear magnetic resonance (^{13}C-NMR) spectrum of **1** showed 49 carbon signals (Table II); among them, 25 signals were assigned to the aglycone **2** by comparison with the ^{13}C-NMR spectrum of aquayamycin[5b)] and the signals at δ 92.38 (d), 95.24 ($\times$ 2, each d) and 99.45 (d) were assigned to the anomeric carbons in four sugar units. In the FD-MS of **1**, there were weak molecular-related ions at m/z: 957 $(M+Na)^+$, 935 $(M+1)^+$, 916 $(M-H_2O)^+$, 898 $(M-2H_2O)^+$ and 784, together with prominent fragment peaks at m/z: 674 $[(M+1-2H_2O-225)^+$ (base peak)], 450 $(M-2H_2O-2\times224)^+$, 225, 115 (rhodinose) and 111 (aculose) corresponding to the ions formed by stepwise elimination of aculosyl and rhodinosyl units from the molecular ion.

From the above results, it is clear that **1** consists of two mol each of **3** and **4** together with one mol of **2** as structural constituents, and **3** is located at the terminal of the oligosaccharides of **1**. The validity of the proposed structure of **1** was supported by the chemical conversion and degradation studies described below.

On catalytic hydrogenation over PtO_2 in EtOAc, **1** absorbed about seven mol of hydrogen to give a reduction product mixture (**10**), which contained a yellow crystalline compound (**11**), as a main product. The stereostructure of this reduction product was elucidated as **11** on the basis of infrared (IR), ultraviolet (UV), ^{1}H-NMR and ^{13}C-NMR spectra (see Experimental section). In the ^{1}H-NMR spectrum of **11**, the protons at C-1‴ and C-1a″ each appeared as a clear triplet ($J=5.5$ Hz) corresponding to those of the disaccharide from cinerubin A (triplet, $J=5$ Hz).[11a)] This finding suggested that the terminal sugar moieties of **11** probably took a flat conformation as shown in Chart 2.

Methanolysis of **10** with 0.1 N HCl–MeOH gave a mixture of methylated sugars and aglycone. Chromatographic separation of the methylated sugars furnished a quite unstable ketosugar, methyl 2,3,6-trideoxy-α-L-*glycero*-hexopyranosid-4-ulose (methyl α-L-cineruloside A, **12**)[10f,11,12)] which was identified as its crystalline *p*-nitrophenylhydrazone (**14**), and methyl 2,3,6-trideoxy-α-L-*erythro*-hexopyranoside (methyl α-L-amicetoside, **13**)[8,9e,10b,11,13)] which was identified as its crystalline 2,4-dinitrophenylhydrazone (**15**).[9e,11a,13)] Reduction of **12** with $LiAlH_4$ in ether afforded **13** exclusively.[10b)] The stereoselectivity may be caused by the coordination of the aluminum atom to the ring-oxygen atom of the ketone **12**, leading to attack by hydride from the "top" side of the molecule.[14)] From these results, it was demonstrated that **12** and **13** were derived from the terminal sugar moiety of **1** by catalytic hydrogenation. Subsequent chromatographic purification of the methanolysate of **10** afforded an artifact aglycone, named dihydroaquayamycin (**16**).[6b)]

In order to determine the site of linkage of the sugar to the pyran ring of the aglycone, **1** was acetylated with Ac_2O–pyridine in the usual manner to yield a 8,4′-diacetate (**17**), and the ^{1}H-NMR spectrum of **1** was compared with that of **17**. In the ^{1}H-NMR spectrum of **17**, two acetoxyl groups were apparent. Since the multiplet signal at δ 5.04 (1H, $J=5.0$, 9.0 and 11.0 Hz) of **17** corresponds to that of δ 3.81 (1H, m, $J_{3'\beta,4'\beta}=5.0$, $J_{4'\beta,5'\alpha}=9.0$, $J_{3'\alpha,4'\beta}=$ 11.0 Hz) ascribable to $C_{4'\beta}$–H in the spectrum of **1**, it is evident that $C_{4'}$–OH is acetylated, that is, the sugar chain is linked to $C_{5'}$–OH of **2**. Upon acetylation of **17** with Ac_2O–pyridine to yield a peracetate (**18**), starting material was recovered. This fact indicated that the remaining two OH groups were all tertiary groups.

Finally, since the relative stereochemistry has been determined by means of X-ray crystallographic analysis,[4)] the absolute configurations of P-1894B and aquayamycin were established as **1** and **2**, respectively, from the absolute configuration of two constituent monosaccharides, L-aculose (**3**) and L-rhodinose (**4**), obtained by chemical degradation of **1** as shown in Chart 1. Based on the above evidence, we concluded that the absolute configuration of P-1894B is **1**, and this compound is the first example of a potent prolyl hydroxylase inhibitor containing a benz[*a*]anthraquinone glycoside.

Recently, Imamura *et al.*[5b] reported the identity of the antitumor antibiotic vineomycin A_1 and **1** by comparing their spectral properties.

Experimental

Melting points were determined on a Yanagimoto micro-melting point apparatus and are uncorrected. Optical rotations were measured with a JASCO DIP-181 polarimeter. IR spectra were recorded with a Hitachi 260-30 spectrometer. UV spectra were taken on a Hitachi 124 spectrometer. ^{1}H- and ^{13}C-NMR spectra were recorded with Varian EM-390, XL-100-12, JEOL FX-200 and JEOL JNM GX-400 spectrometers at 90, 100, 200 or 400 MHz (^{1}H) and 25.2 or 100.40 MHz (^{13}C), respectively. Chemical shifts are given in δ values (ppm) downfield from tetramethylsilane (TMS) as an internal standard and coupling constants are recorded in Hz (J). The following abbreviations are used: s = singlet, d = doublet, t = triplet, q = quartet, dd = doublet of doublets, ddd = doublet of doublets of doublets, br = broad and m = multiplet. MS were measured on a JEOL JMS-01S G apparatus (EI-MS) or on a JEOL JMS-D 300 apparatus (FD-MS) or on a Hitachi M-80A apparatus (secondary ion mass spectrometry: SIMS). TLC was carried out on Merck DC-Fertigplatten (Kieselgel 60 F_{254}), and column chromatography was performed on Kieselgel 60 (70—230 mesh ASTM; Merck).

Extraction and Isolation of P-1894B (1)——The details of the extraction and isolation procedures were given in the preceding paper.[2]

Properties of 1——Orange to orange-yellow needles from toluene–EtOAc, mp 164—166 °C, $[\alpha]_D^{23}$ +95° (c = 1.0, $CHCl_3$), (lit.,[5a] mp 162—163 °C, $[\alpha]_D^{26}$ +92° (c = 0.5, $CHCl_3$)), *Anal.* Calcd for $C_{49}H_{58}O_{18}$: C, 62.93; H, 6.26; O, 30.81. Found: C, 62.62; H, 6.28; O, 30.64. IR ν_{max}^{KBr} cm^{-1}: 3450 (OH), 1720 (C=O), 1700 (α,β-unsaturated C=O), 1660 sh (non chelated C=O), 1640 (chelated C=O). UV $\lambda_{max}^{90\%\,MeOH}$ nm (ε): 218 (40349), 318 (5511), 438 (6631); $\lambda_{max}^{0.1\,N\,HCl-90\%\,MeOH}$ nm (ε): 218 (39882), 318 (5791), 435 (6538); $\lambda_{max}^{0.1\,N\,NaOH-90\%\,MeOH}$ nm (ε): 228 (27740), 282 (13450), 530 (7192). FD-MS (emitter current, 17—20 mA; accelerating voltage, 3 kV; cathode voltage, −6 kV; solvent, $CHCl_3$), m/z (%): 957 $(M+Na)^+$ (0.3), 935 [$(M+1)^+$ (0.5), $C_{49}H_{58}O_{18}$ = 934], 916 $(M-H_2O)^+$ (1), 898 $(M-2H_2O)^+$ (2), 784 [(898-114) (2)], 674 $(M+1-2H_2O-225)^+$ (100, base peak), 450 $(M-2H_2O-2\times224)^+$ (98), 225 (29), 115 (13), 111 (98). ^{1}H-NMR: see Table I. ^{13}C-NMR: see Table II. $FeCl_3$ reagent: positive (dark reddish-brown), magnesium acetate reagent: positive (bluish-purple), *p*-anisaldehyde–H_2SO_4 reagent: positive (dark green), sodium dithionite reagent: positive (decoloration). The physico-chemical properties of **1** were essentially identical with those of the antitumor antibiotic vineomycin A_1[5b] (formerly OS-4742 A_1[5a]).

Acid Hydrolysis of 1 with 0.3 N H_2SO_4——A solution of **1** (30 g) in 0.3 N H_2SO_4 (3 l) was heated on a water bath at 80 °C for 1 h. After cooling, the reaction mixture was filtered and the filtrate was extracted with EtOAc (1 l × 3). The EtOAc solution was washed with H_2O, dried over Na_2SO_4 and concentrated *in vacuo* to afford an orange powder (12 g), which was recrystallized from EtOAc to provide an orange aglycone (**2**, 9 g). A part of the acid hydrolysate was examined by TLC. TLC (solvent, EtOAc; detection, *p*-anisaldehyde–H_2SO_4): *Rf* values (color), 0.76 (greenish-blue), 0.31 (bluish-purple). These products were determined by direct comparison of the acid hydrolysate with authentic hexoses from aclacinomycin Y_1[7,8] and N_1[8] to be aculose (**3**, *Rf* 0.76) and rhodinose (**4**, *Rf* 0.31), respectively.

Identity of Aglycone with Aquayamycin (2)——Orange to reddish-orange fine needles from EtOAc–MeOH, mp 200—203 °C (dec.), $[\alpha]_D^{24}$ +149° (c = 1.0, dioxane), (lit.,[5b] mp 175—180 °C (dec.) (benzene–hexane), $[\alpha]_D^{20}$ +130° (c = 1, dioxane); lit.,[6] mp 189—190 °C (dec.) (butyl acetate), $[\alpha]_D^{20}$ +160° (c = 1, dioxane)), *Anal.* Calcd for $C_{25}H_{26}O_{10}$: C, 61.72; H, 5.39; O, 32.89. Found: C, 60.30; H, 5.66; O, 32.55. IR ν_{max}^{KBr} cm^{-1}: 3450, 1720, 1660, 1640. UV λ_{max}^{MeOH} nm (ε): 220 (26195), 320 (5735), 430 (5249); $\lambda_{max}^{0.02\,N\,NaOH-90\%\,MeOH}$ nm (ε): 230 (26098), 280 (14920), 320 (9477), 395 (3548), 540 (6415). FD-MS m/z: 486 (M^+), 468 $(M-H_2O)^+$, 450 $(M-2H_2O)^+$. ^{1}H-NMR (CD_3OD) δ: 1.24 (3H, s, 3-Me), 1.37 (3H, d, J = 6 Hz, 7′-Me), 2.03 (2H, q, J = 15 Hz, 4-C$\underline{H}_2$–), 2.74 (2H, q, J = 13 Hz, 2-C$\underline{H}_2$–), 6.38, 6.83 (2H, ABq, J = 10 Hz, 5-$\underline{H}$ and 6-$\underline{H}$), 7.52, 7.83 (2H, ABq, J = 8 Hz, 10-$\underline{H}$ and 11-$\underline{H}$). ^{1}H-NMR (d_8-dioxane) δ: 3.78, 3.90 (1H each, d, J = 5 Hz, disappeared in D_2O, 4′ or 5′-O$\underline{H}$), 4.23, 5.00, 5.17 (1H each, s, disappeared in D_2O, 3 × *tert*-O$\underline{H}$), 6.30, 6.76 (2H, ABq, J = 10 Hz, 5-$\underline{H}$ and 6-$\underline{H}$), 7.52, 7.84 (2H, ABq, J = 8 Hz, 10-$\underline{H}$ and 11-$\underline{H}$), 12.30 (1H, s, disappeared in D_2O, chelated O$\underline{H}$). All spectral data were identical with those of aquayamycin.[5b,6]

Isolation and Identification of 2,3,6-Trideoxy-L-hex-2-enopyran-4-ulose (L-Aculose, 3)[7,8]——The mother liquor of the crystallization of **2** obtained by the above acid hydrolysis was evaporated to dryness. The residue was chromatographed on silica gel with $CHCl_3$ to give **3** (2 g) as a yellow oil, which solidified on standing. Recrystallization from Et_2O afforded pure **3** (1.6 g) as colorless needles. mp 59—60 °C, (lit.,[10a] mp 62—65 °C (Et_2O)), $[\alpha]_D^{23}$ +62° (c = 1.05, $CHCl_3$), *Anal.* Calcd for $C_6H_8O_3$: C, 56.25; H, 6.25. Found: C, 56.00; H, 6.30. IR ν_{max}^{KBr} cm^{-1}: 3450 (OH), 1690 (C=O), 1630 (C=C). UV λ_{max}^{EtOH} nm (ε): 215 (6995), 294 (24), 345 (35). EI-MS m/z: 128 (M^+), 111, 84 $(M-CO_2)^+$, 56, 55. ^{1}H-NMR ($CDCl_3$) δ: 1.38 (3H, d, J = 6 Hz, 6-Me), 4.71 (1H, q, J = 6 Hz, 5-$\underline{H}$), 5.62 (1H, d, J = 3.5 Hz, 1-$\underline{H}$), 6.10 (1H, d, J = 10 Hz, 3-$\underline{H}$), 6.92 (1H, dd, J = 3.5 and 10 Hz, 2-$\underline{H}$), 3.80 (1H, br s, disappeared in D_2O, 1-O$\underline{H}$). The physico-chemical (mp, IR, UV and ^{1}H-NMR) properties of this sample were almost identical with those

TABLE I. ^{1}H-NMR Spectral Data for P-1894B (**1**)

Protons		Chem.$^{a)}$ shift (δ)	Multiplicity	Coupling constants (J in Hz)
2-CH$_2$	ax	2.52	d	$J_{gem}=13.2$
	eq	3.17	dd	$J_{2,4}=2.8$ (W-letter)
4-CH$_2$	ax	1.85	d	$J_{gem}=15.1$
	eq	2.28	dd	
5-H		6.44	d	$J_{5,6}=9.8$
6-H		6.91	d	
8-OH		12.29	s	
10-H		7.61	d	$J_{10,11}=7.8$
11-H		7.88	d	
2′β-H		4.87	dd	$J_{2'\beta,3'\beta}=1.5$, $J_{2'\beta,3'\alpha}=11.5$
3′α-H		1.36	m	
3′β-H		2.51	ddd	$J_{3'\beta,4'\beta}=5.0$, $J_{3'\alpha,3'\beta}=13.0$
4′β-H		3.81	m	$J_{4'\beta,5'\alpha}=9.0$, $J_{3'\alpha,4'\beta}=11.0$
5′α-H		3.06	t	$J_{5'\alpha,6'\beta}=9.0$
6′β-H		3.55	dq	$J_{6'\beta,7'\text{-Me}}=6.6$
7′-Me		1.38	d	
13-Me		1.41	s	
1″-H		4.99$^{b)}$	br s	
1a′-H		5.25$^{b)}$	br s	
2″-CH$_2$		1.40—2.20$^{c)}$	m	
2a′-CH$_2$		1.40—2.20$^{c)}$	m	
3″-CH$_2$		1.40—2.20$^{c)}$	m	
3a′-CH$_2$		1.40—2.20$^{c)}$	m	
4″-H		3.69$^{b)}$	br s	
4a′-H		3.72$^{b)}$	br s	
5″-H		4.24	dq	$J_{4'',5''}=1.0$
5a′-H		4.24	dq	$J_{4a',5a'}=1.0$
6″-Me		1.27	d	$J_{5'',6''}=6.6$
6a′-Me		1.29	d	$J_{5a',6a'}=6.6$
1‴-H		5.26	d	$J_{1''',2'''}=3.4$
1a″-H		5.26	d	$J_{1a'',2a''}=3.4$
2‴-H		6.88$^{b)}$	dd	$J_{2''',3'''}=10.3$
2a″-H		6.89$^{b)}$	dd	$J_{2a'',3a''}=10.3$
3‴-H		6.09$^{b)}$	d	
3a″-H		6.11$^{b)}$	d	
5‴-H		4.54	q	$J_{5''',6'''}=6.8$
5a″-H		4.57	q	$J_{5a'',6a''}=6.8$
6‴-Me		1.37	d	
6a″-Me		1.39	d	
–OH		4.33		
		4.59		
		4.93		

a) Measured in CDCl$_3$ at 400 MHz with TMS as an internal standard. Chemical shift assignments were made on the basis of decoupling experiments.
b) Assignments may be interchangeable.
c) The exact chemical shifts and coupling constants could not be determined because of overlapping of the signals.

reported for (±)-3.[10a)]

Methylation of 3 with 0.1 N HCl–MeOH Giving 5——A solution of **3** (27 mg) in 0.1 N HCl–MeOH (2 ml) was kept at room temperature for 20 h. The reaction mixture was neutralized with Ag$_2$CO$_3$ and filtered. The filtrate was concentrated *in vacuo* and the residue was subjected to column chromatography on silica gel using CHCl$_3$ to give methyl 3,6-dideoxy-2-*O*-methyl-α-L-*threo*-hexopyranosid-4-ulose (**5**, 6.3 mg) as a colorless oil. ^{1}H-NMR (CDCl$_3$) δ: 1.30 (3H, d, $J=6$ Hz, 6-Me), 2.70 (2H, m, 3-C$\underline{\text{H}}_2$–), 3.38 (3H, s, 1-OMe), 3.50 (3H, s, 2-OMe), 3.63 (1H, m, 2-C$\underline{\text{H}}$<),

Table II. ^{13}C-NMR Spectral Data for P-1894B (**1**)

Carbon No.	Chem.[a] shift (δ)	Multiplicity	Carbon No.	Chem.[a] shift (δ)	Multiplicity
1	204.70	s	1″	92.38	d
2	50.19	t	1a′	99.45	d
3	77.39[b]	s	2″	24.31	t
4	44.35	t	2a′	24.51	t
4a	82.38	s	3″	24.72	t
5	145.53	d	3a′	25.12	t
6	117.35	d	4″	66.89	d
6a	138.52	s	4a′	67.77	d
7	188.23	s	5″	70.57	d
7a	113.92	s	5a′	70.59	d
8	158.00	s	6″	16.92	q
9	138.70	s	6a′	17.11	q
10	133.57	d	1‴	95.24	d
11	119.60	d	1a″	95.24	d
11a	130.42	s	2‴	142.76	d
12	182.16	s	2a″	143.06	d
12a	138.88	s	3‴	127.19	d
12b	79.87[b]	s	3a″	127.35	d
13	25.50	q	4‴	196.38	s
2′	74.47	d	4a″	196.61	s
3′	38.75	t	5‴	71.01	d
4′	76.14[c]	d	5a″	71.37	d
5′	88.91	d	6‴	15.12	q
6′	76.17[c]	d	6a″	15.12	q
7′	18.43	q			

a) Measured in $CDCl_3$ at 100.40 MHz with TMS as an internal standard. Chemical shift assignments were made on the basis of off-resonance and selective proton decoupling experiments.

b, c) Assignments may be interchangeable among the signals with the same superscripts.

4.13 (1H, q, $J=6$ Hz, 5-$\underline{H}$), 4.78 (1H, d, $J=2$ Hz, 1-$\underline{H}$).

Methylation of 3 with Trimethyl orthoformate in the Presence of BF_3-Etherate Giving 6 and 7[10)]——A solution of **3** (1.37 g) and trimethyl orthoformate (1.21 g) in abs. Et_2O (30 ml) was chilled to 0 °C, BF_3-etherate (0.02 ml) was added, and the reaction mixture was allowed to stand at room temperature for 2 h. The Et_2O layer was washed with H_2O, dried over $MgSO_4$ and concentrated *in vacuo*. The residue was subjected to column chromatography on silica gel using hexane–EtOAc (95 : 5) to afford methyl 2,3,6-trideoxy-α-L-hex-2-enopyranosid-4-ulose (**6**, 33 mg) and methyl 2,3,6-trideoxy-β-L-hex-2-enopyranosid-4-ulose (**7**, 34 mg). **6**: Colorless needles from hexane, mp 50—51 °C, $[\alpha]_D^{23}$ −12° ($c=1.0$, $CHCl_3$), (lit.,[10b)] mp 50—52 °C (hexane), $[\alpha]_D^{24}$ −16.6° ($CHCl_3$); lit.,[10c)] mp 40—45 °C, $[\alpha]_D^{20}$ −18° ($c=2.3$, MeOH); lit.,[10e)] mp 49—50 °C (hexane), $[\alpha]_D^{20}$ −14° ($c=0.6$, $CHCl_3$); lit.,[10f)] mp 51—52 °C, $[\alpha]_D$ −12° ($c=1$, $CHCl_3$)), *Anal.* Calcd for $C_7H_{10}O_3$: C, 59.14; H, 7.04. Found: C, 58.53; H, 6.97. IR ν_{max}^{KBr} cm^{-1}: 1700, 1630, 1050. UV λ_{max}^{EtOH} nm (ε): 211 (8000), 278 (20), 343 (50). EI-MS *m/z*: 142 (M^+), 111 $(M-OMe)^+$, 98 $(M-CO_2)^+$, 83. ^{1}H-NMR ($CDCl_3$) δ: 1.39 (3H, d, $J_{5,6}=7$ Hz, 6-Me), 3.52 (3H, s, 1-OMe), 4.52 (1H, q, $J_{5,6}=7$ Hz, 5-$\underline{H}$), 5.06 (1H, d, $J_{1,2}=3.4$ Hz, 1-$\underline{H}$), 6.06 (1H, d, $J_{2,3}=10$ Hz, 3-$\underline{H}$), 6.81 (1H, dd, $J_{1,2}=3.4$ Hz, $J_{2,3}=10$ Hz, 2-$\underline{H}$). **7**: Colorless oil, $[\alpha]_D^{23}$ +40.0° ($c=1.0$, $CHCl_3$), (lit.,[10d)] bp 78—80 °C (17 Torr), $[\alpha]_D^{20}$ +49.5° ($c=1.7$, $CHCl_3$)), ^{1}H-NMR ($CDCl_3$) δ: 1.48 (3H, d, $J_{5,6}=7$ Hz, 6-Me), 3.56 (3H, s, 1-OMe), 4.21 (1H, q, $J_{5,6}=7$ Hz, 5-$\underline{H}$), 5.23 (1H, m, $J_{1,2}=2.0$ Hz, 1-$\underline{H}$), 6.12 (1H, d, $J_{2,3}=10$ Hz, 3-$\underline{H}$), 6.87 (1H, dd, $J_{1,2}=2.0$ Hz, $J_{2,3}=10$ Hz, 2-$\underline{H}$). All spectral data for **6** and **7** coincided with those reported.[10)]

Isolation and Identification of 2,3,6-Trideoxy-L-*threo*-hexopyranose (L-Rhodinose, 4)[8,9a,e)]——The aqueous layer recovered from the acid hydrolysate (0.3 N H_2SO_4) of **1** by the above procedure was passed through a column of Amberlite IR-45 (OH) (300 ml). The eluate with H_2O was concentrated and treated with a small amount of activated carbon. The decolorized solution was concentrated to dryness and the residue was purified by silica gel column chromatography (eluent: $CHCl_3$–MeOH (500 : 1 to 30 : 1)) to give **4** (580 mg) as a colorless oil. $[\alpha]_D^{20}$ −10° ($c=1.0$, $CHCl_3$), (lit.,[8)] $[\alpha]_D^{24}$ −10° ($c=0.5$, $CHCl_3$); lit.,[9a)] $[\alpha]_D^{20}$ −11° (acetone); lit.,[9e)] bp 90—105 °C (0.5 mmHg), $[\alpha]_D^{27}$ −6.7°

(c = 1.1, acetone)), *Anal.* Calcd for $C_6H_{12}O_3$: C, 54.54; H, 9.09. Found: C, 53.26; H, 9.28. EI-MS *m/z*: 132 (M^+), 114 $(M-H_2O)^+$.

Methanolysis of 1 with 0.1 N HCl–MeOH Giving 2 and Methyl α-L-Rhodinoside (8)——A solution of **1** (3 g) in 0.1 N HCl–MeOH (300 ml) was allowed to stand at room temperature overnight and the reaction mixture was neutralized with Ag_2CO_3 and filtered. The filtrate was concentrated *in vacuo* and the residue was crystallized from EtOAc to give orange needles (600 mg), mp 200—203 °C (dec.); this product was identified as aquayamycin (**2**)[5b,6] by comparison of the physico-chemical data with those obtained above. The mother liquor of crystallization of **2** was concentrated and the residue was chromatographed on a column of silica gel with $CHCl_3$–MeOH (100 : 1 to 4 : 1) to give methyl α-L-rhodinoside (**8**, 20 mg). Compound **8** was a colorless oil, $[\alpha]_D^{20}$ $-85.2°$ (c = 0.44, acetone), IR ν_{max}^{KBr} cm^{-1}: 3400—3500, 1440, 1370, 1000—1200. EI-MS *m/z*: 146 ($C_7H_{14}O_3$, M^+), 115 $(M-OMe)^+$. ^{1}H-NMR ($CDCl_3$) δ: 1.20 (3H, d, J = 6 Hz, 6-Me), 1.50—2.10 (4H, m, 2 and 3-CH_2–), 3.38 (3H, s, 1-OMe), 3.58 (1H, m, 4-H), 3.96 (1H, dq, J = 2 and 6 Hz, 5-H), 4.70 (1H, dd, J = 1 and 3 Hz, 1-H), 1.60 (1H, s, disappeared in D_2O, 4-OH). A solution of the glycoside (**8**, 15 mg) in 2 N HCl (0.7 ml) was added to a warm solution of 2,4-dinitrophenylhydrazine (27 mg) in 2 N HCl (4 ml). The mixture was heated for 5 min on a steam bath and then kept for 1 h at room temperature. The yellow crystalline product that separated was filtered off, washed with a small amount of H_2O and dried to give the 2,4-dinitrophenylhydrazone (**9**, 10 mg). Recrystallization from benzene–MeOH gave **9** (5 mg)[9c–e] as yellow crystals, mp 116 °C, $[\alpha]_D^{20}$ $-18.1°$ (c = 0.83, pyridine), (lit.,[9c] mp 121—122 °C, $[\alpha]_D^{25}$ $-14.9°$ (c = 0.5, pyridine); lit.,[9d] mp 117—119 °C (MeOH), $[\alpha]_D$ $-17°$ (c = 0.83, pyridine); lit.,[9e] mp 118—121 °C (benzene–MeOH), $[\alpha]_D^{20}$ $-17.7°$ (c = 0.6, pyridine)), IR ν_{max}^{KBr} cm^{-1}: 3400, 3300, 1620. EI-MS *m/z*: 312 (M^+).

Catalytic Hydrogenation of 1 with PtO_2 Catalyst——A solution of **1** (8 g) in EtOAc (700 ml) was hydrogenated over PtO_2 (400 mg) at room temperature. Within 4 h, the theoretical uptake of about seven equivalents of hydrogen was completed and the reaction stopped. The catalyst was filtered off and the filtrate was concentrated *in vacuo*; precipitation with hexane to give a yellow-brown product mixture (**10**, 8 g), which was purified by silica gel column chromatography (eluent: $CHCl_3$–EtOAc (100 : 1 to 1 : 1)) to yield **11** (600 mg). Compound **11**: A yellow crystalline powder from EtOAc–Et_2O, mp 216—218 °C, *Anal.* Calcd for $C_{49}H_{64}O_{18}$: C, 62.55; H, 6.81; O, 30.64. Found: C, 62.16; H, 6.72; O, 30.42. IR ν_{max}^{KBr} cm^{-1}: 3400—3500, 1720, 1660, 1640, 1610, 1050, 1010. UV λ_{max}^{MeOH} nm (ε): 219 (39292), 250 (10152), 275 (8742), 430 (4888). SIMS *m/z*: 985 $(M+2Na-H)^+$, 963 $(M+Na)^+$, 737 $(963-C_{12}H_{19}O_4+H)^+$, 129 ($C_6H_9O_3$). FD-MS *m/z*: 660 $(M+1-3H_2O-C_{12}H_{19}O_4)^+$, 546 $(660-C_6H_{10}O_2)^+$, 227 ($C_{12}H_{19}O_4$), 115, 114 ($C_6H_{10}O_2$). ^{1}H-NMR ($CDCl_3$) δ: 3.05 (1H, t, J = 9 Hz, 5′α-H), 3.54 (1H, dq, J = 6.6 and 9.0 Hz, 6′β-H), 3.66 (1H, br s, 4″-H), 3.68 (1H, br s, 4a′-H), 3.81 (1H, m, J = 5.0, 9.0 and 11.0 Hz, 4′β-H), 4.23 (1H each, dq, J = 1.0 and 6.6 Hz, 5″ and 5a′-H), 4.29 (1H, q, J = 6.6 Hz, 5‴-H), 4.32 (1H, q, J = 6.6 Hz, 5a″-H), 4.86 (1H, dd, J = 1.5 and 10.3 Hz, 2′β-H), 4.99 (1H, br s, 1″-H), 5.08 (1H each, t, J = 5.5 Hz, 1‴ and 1a″-H), 5.25 (1H, br s, 1a′-H), 7.59 (1H, d, J = 7.8 Hz, 10-H), 7.85 (1H, d, J = 7.8 Hz, 11-H), 12.30 (1H, s, disappeared in D_2O, 8-OH), 4.36, 4.66, 4.96 (disappeared in D_2O, 3 × OH). ^{13}C-NMR ($CDCl_3$) δ: 14.9 (2C, q, 6‴ and 6a″-C), 16.9, 17.1 (each q, 6″ and 6a′-C), 18.4 (q, 7′-C), 22.3 (t, 6-C), 24.5, 24.6 (each t, 2″ and 2a′-C), 24.9, 25.2 (each t, 3″ and 3a′-C), 25.6 (q, 13-C), 28.4 (2C, t, 3‴ and 3a″-C), 28.6 (t, 5-C), 33.5 (2C, t, 2‴ and 2a″-C), 38.7 (t, 3′-C), 43.0 (t, 4-C), 49.6 (t, 2-C), 67.1, 68.0 (each d, 4″ and 4a′-C), 71.0 (d, 5″-C), 71.1 (each d, 5‴ and 5a′-C), 71.3 (d, 5a″-C), 74.4 (d, 6′-C), 74.6 (d, 2′-C), 76.3 (d, 4′-C), 77.3 (s, 3-C), 78.1 (s, 12b-C), 81.5 (s, 4a-C), 88.8 (d, 5′-C), 92.3 (d, 1″-C), 98.9 (2C, d, 1‴ and 1a″-C), 99.4 (d, 1a′-C), 114 (s, 7a-C), 119.6 (d, 11-C), 130.1 (s, 11a-C), 133.2 (d, 10-C), 138.2 (s, 9-C), 143.2 or 146.5 (each s, 6a or 12a-C), 157.6 (s, 8-C), 182.3 (s, 12-C), 189.7 (s, 7-C), 204.5 (s, 1-C), 210.3 or 210.6 (each s, 4‴ or 4a″-C).

Methanolysis of 10 Giving 12, 13 and 16——The reduction product mixture (**10**, 8 g) was dissolved in 0.1 N HCl–MeOH (500 ml), kept at room temperature overnight and then evaporated *in vacuo* to remove excess HCl. The residue was poured into ice-water (300 ml). The resulting mixture was extracted with EtOAc (200 ml × 3), washed with H_2O and dried over Na_2SO_4. The extract was concentrated to give a yellowish-brown residue, which was chromatographed on a column of silica gel (3 × 77 cm) successively with a mixture of hexane–EtOAc (9 : 1 to 1 : 1), EtOAc and then EtOAc–MeOH (1 : 2). Effluent fractions (200 ml) were monitored by TLC, which was developed with a solvent system composed of $CHCl_3$–EtOAc (1 : 1), and divided into three main fractions: F-A (Nos. 10—11, *Rf* 0.76); F-B (Nos. 19—23, *Rf* 0.42); F-C (Nos. 41—45, *Rf* 0.05). The oily materials (200 mg) from F-A were rechromatographed on a silica gel column (1.7 × 38 cm) with $CHCl_3$ and then mixtures of $CHCl_3$–MeOH (400 : 1), yielding **12** (70 mg), and the materials (400 mg) from F-B were rechromatographed on a silica gel column (2 × 37 cm) with $CHCl_3$ to provide **13** (132 mg). Finally, the materials (500 mg) from F-C were rechromatographed on a column of silica gel (2.5 × 60 cm) with hexane–EtOAc (3 : 7) saturated with H_2O to give **16** (385 mg) as a yellow crystalline powder.

Identity of Compound 12 with Methyl 2,3,6-Trideoxy-α-L-*glycero*-hexopyranosid-4-ulose (Methyl α-L-Cineruloside A)[10f,11,12]——A colorless unstable liquid, $[\alpha]_D^{23}$ $-149.9°$ (c = 1.3, $CHCl_3$), (lit.,[10f] bp 80 °C (16 mmHg), $[\alpha]_D$ $-254°$ (c = 1.1, $CHCl_3$); lit.,[11c] $[\alpha]_D$ $-305.4°$ ($CHCl_3$); lit.,[12b] $[\alpha]_D^{20}$ $-232°$ (c = 0.72, $CHCl_3$)), *Anal.* Calcd for $C_7H_{12}O_3$: C, 58.33; H, 8.33. Found: C, 58.30; H, 8.36. IR ν_{max}^{KBr} cm^{-1}: 1725, 1450, 1130, 1060. EI-MS *m/z*: 144 (M^+), 113 $(M-OMe)^+$. A solution of *p*-nitrophenylhydrazine hydrochloride (56 mg) in H_2O (0.4 ml) and pyridine (0.4 ml) was mixed with a solution of **12** (35 mg) in MeOH (2 ml). The resulting mixture was kept at room temperature overnight and then evaporated. The residue was recrystallized from EtOH–H_2O to give **14** (30 mg) as yellow needles. mp 158—159 °C, $[\alpha]_D^{20}$ $-198.7°$ (c = 0.60, $CHCl_3$), (lit.,[14] for the enantiomer, mp 158—159 °C (EtOH–H_2O), $[\alpha]_D^{20}$ $+347°$ (c = 0.6,

$CHCl_3$)), high resolution MS (HRMS) m/z: 279.1235 (M^+) (Calcd for $C_{13}H_{17}N_3O_4$, 279.1219). ^1H-NMR ($CDCl_3$) δ: 1.47 (3H, d, $J=6$ Hz, 6-Me), 1.72—2.20 (2H, m, 2-CH_2–), 2.47 (2H, m, 3-CH_2–), 3.46 (3H, s, 1-OMe), 4.54 (1H, q, $J=6$ Hz, 5-H), 4.82 (1H, t, $J=4.5$ Hz, 1-H), 7.05 (2H, d, $J=9$ Hz, Ar-2 and 6-H), 7.56 (1H, br s, disappeared in D_2O, –NH), 8.14 (2H, d, $J=9$ Hz, Ar-3 and 5-H). The physico-chemical data given here were identical with those of the synthetic product[14] except for $[\alpha]_D$.

Identity of Compound 13 with Methyl 2,3,6-Trideoxy-α-L-*erythro*-hexopyranoside (Methyl α-L-Amicetoside)[8,9e,10b,11,13]——A colorless liquid, $[\alpha]_D^{23}$ $-115°$ ($c=0.13$, $CHCl_3$), (lit.,[8] $[\alpha]_D^{24}$ $-113°$ ($c=0.13$, $CHCl_3$); lit.,[9e] bp 97—99 °C (12 mmHg), $[\alpha]_D^{20}$ $-144°$ ($c=0.23$, $CHCl_3$); lit.,[10b] bp 110 °C (10 Torr), $[\alpha]_D^{20}$ $-147°$ (H_2O); lit.,[11a] $[\alpha]_D$ $-129°$ ($c=0.44$, $CHCl_3$); lit.,[11b] $[\alpha]_D^{22}$ $-144.2°$ ($CHCl_3$); lit.,[11c] $[\alpha]_D$ $-140.7°$ (H_2O); lit.,[13] bp 94—96 °C (15 mmHg), $[\alpha]_D$ $-139°$ ($c=1.3$, $CHCl_3$)), IR ν_{max}^{KBr} cm^{-1}: 3450, 1450, 1370, 1000—1200. HRMS m/z: 146.0956 (M^+) (Calcd for $C_7H_{14}O_3$, 146.0943). EI-MS m/z: 146 (M^+), 115 $(M-OMe)^+$. ^1H-NMR ($CDCl_3$) δ: 1.27 (3H, d, $J=6$ Hz, 6-Me), 1.54 (1H, br s, disappeared in D_2O, 4-OH), 1.60—2.00 (4H, m, 2 and 3-CH_2–), 3.2—3.4 (1H, m, 4-H), 3.36 (3H, s, 1-OMe), 3.58 (1H, dq, $J=6$ and 9 Hz, 5-H), 4.62 (1H, br s, $J=2$ Hz, 1-H). A solution of **13** (63 mg) in 2 N HCl (5 ml) was added to a warm solution of 2,4-dinitrophenylhydrazine (105 mg) in 2 N HCl (15 ml). The mixture was heated for 5 min on a steam bath and then kept for 30 min. The yellow crystalline precipitate that separated was filtered off, washed with H_2O and dried to give **15** (50 mg) as yellow needles, mp 159—160 °C, $[\alpha]_D^{23}$ $+7.9°$ ($c=0.65$, pyridine), (lit.,[9e] mp 154—156 °C (benzene–MeOH), $[\alpha]_D^{20}$ $+11.3°$ ($c=0.23$, pyridine); lit.,[11a] mp 152—155 °C, $[\alpha]_D$ $+7.8°$ ($c=0.65$, pyridine); lit.,[13] mp 154—156 °C (benzene–MeOH), $[\alpha]_D$ $+12°$ ($c=0.4$, pyridine)), *Anal.* Calcd for $C_{12}H_{16}N_4O_6$: C, 46.15; H, 5.16; N, 17.94. Found: C, 45.75; H, 5.33; N, 18.49. IR ν_{max}^{KBr} cm^{-1}: 3400, 3300, 1605. EI-MS m/z: 312 (M^+). ^1H-NMR (C_5D_5N) δ: 1.55 (3H, d, $J_{5,6}=6$ Hz, 6-Me), 1.80—2.45 (2H, m, 3-CH_2–), 2.60—3.08 (2H, m, 2-CH_2–), 3.80—4.27 (2H, br m, 4 and 5-H), 4.50—6.40 (3H, br hump, disappeared in D_2O, –OH, –NH), 7.91 (1H, d, $J=10$ Hz, Ar-6-H), 7.94 (1H, t, $J_{1,2}=4.5$ Hz, 1-H), 8.28 (1H, q, $J_{ortho}=10$ Hz, Ar-5-H), 9.15 (1H, d, $J_{meta}=2$ Hz, Ar-3-H).

Reduction of 12 with $LiAlH_4$ Giving 13[10b,14]——$LiAlH_4$ (7.6 mg) was added under stirring at room temperature to a solution of **12** (8 mg) in Et_2O (3 ml). The mixture was stirred for 3 h, then EtOAc was added to decompose excess reagent. The solution was washed successively with 0.01 N HCl and saturated aq. $NaHCO_3$. The aqueous layer was extracted with CH_2Cl_2 and the combined organic layers were dried over Na_2SO_4, and evaporated to leave an oily residue. Column chromatography of the residue on silica gel with hexane–EtOAc (2 : 1) afforded pure **13** (2 mg) as a colorless liquid. The $[\alpha]_D$, and IR and ^1H-NMR spectra were the same as those for **13** obtained above.

Identity of Compound 16 with Dihydroaquayamycin[6b]——Yellow needles from EtOAc, mp 209—211 °C (dec.), $[\alpha]_D^{23}$ $+263.8°$ ($c=1.0$, dioxane), *Anal.* Calcd for $C_{25}H_{28}O_{10}$: C, 61.45; H, 5.78; O, 32.77. Found: C, 61.69; H, 6.32; O, 31.72. IR ν_{max}^{KBr} cm^{-1}: 3400, 1720, 1690, 1660 sh, 1640 (lit.,[6b] mp 183—184 °C (benzene–MeOH), *Anal.* Calcd for $C_{25}H_{28}O_{10}\cdot MeOH$; C, 59.99; H, 6.20; O, 33.81. Found: C,60.06; H, 6.26; O, 32.09. IR ν_{max}^{KBr} cm^{-1}: 3450, 1725, 1660 sh, 1645). UV λ_{max}^{MeOH} nm (ε): 217.5 (39467), 248 (10046), 276 (8515), 430 (5358). FD-MS m/z: 488 (M^+), 452 $(M-2H_2O)^+$. ^1H-NMR (d_8-dioxane) δ: 1.15 (3H, s, 3-Me), *ca.* 1.3 (1H, m, $J=12$ and 13 Hz, 3′α-H), 1.33 (3H, d, $J=6$ Hz, 7′-Me), 1.7—2.8 (6H, m, –CH_2–), 2.45 (2H, q, $J=13$ Hz, 2-CH_2–), 2.92 (1H, t, $J=9$ Hz, 5′α-H), 3.42 (1H, dq, $J=6$ and 9 Hz, 6′β-H), 4.85 (1H, dd, $J=2$ and 12 Hz, 2′β-H), 3.83, 3.96 (1H each, d, $J=5$ Hz, disappeared in D_2O, 2 × OH), 4.34, 4.56, 5.24, 12.34 (1H each, s, disappeared in D_2O, 4 × OH), 7.54, 7.85 (1H each, d, ABq, $J=8$ Hz, Ar-H). ^{13}C-NMR ($CDCl_3$) δ: 19.4 (q, 7′-C), 23.9 (t, 6-C), 31.3 (t, 5-C), 31.3 (q, 3-Me), 41.7 (t, 3′-C), 43.3 (t, 4-C), 53.1 (t, 2-C), 73.2 (d, 2′-C), 74.4 (d, 4′-C), 77.6 (s, 3-C), 78.4 (d, 6′-C), 78.7 (s, 4a-C), 79.6 (d, 5′-C), 79.6 (s, 12b-C), 116.2 (s, 7a-C), 120.4 (d, 11-C), 132.1 (s, 11a-C), 134.4 (d, 10-C), 139.7 (s, 9-C), 144.8 (s, 12a-C), 147.6 (s, 6a-C), 158.6 (s, 8-C), 183.6 (s, 12-C), 192.1 (s, 7-C), 205.4 (s, 1-C).

Acetylation of 1 Giving 17——A solution of **1** (1 g) in Ac_2O–pyridine (2 : 1, 15 ml) was allowed to stand overnight at room temperature. After the reaction mixture had been treated in the usual manner, the product was purified by column chromatography on Lobar Li Chroprep RP-8 (Merck) with CH_3CN–AcOH–H_2O (70 : 1 : 29) and divided into 50 fractions (5 ml per fraction). Repeated chromatography of the main fraction (Fr. Nos. 16—30) afforded only a single band, which was collected, diluted with H_2O, and extracted with EtOAc. The EtOAc extract was concentrated *in vacuo* to afford the 8,4′-diacetate (**17**, 230 mg) as a yellow powder. mp 158—159 °C, $[\alpha]_D^{23}$ $+74.6°$ ($c=0.5$, $CHCl_3$), *Anal.* Calcd for $C_{53}H_{62}O_{20}$: C, 62.48; H, 6.09; O, 31.43. Found: C, 61.71; H, 6.15; O, 32.09. IR ν_{max}^{KBr} cm^{-1}: 3400, 1780, 1730, 1700, 1665, 1600, 1085, 1040, 1010. UV λ_{max}^{MeOH} nm (ε): 213 (44385), 255 (23719), 310 (5395), 352 (5294). FD-MS m/z: 759 $(M-2H_2O-223)^+$, 716 $(759-COCH_3)^+$, 552 $(M-H_2O-2\times 224)^+$, 534 $(M-2H_2O-2\times 224)^+$, 225 (aculose + rhodinose), 111 (aculose). The ^1H-NMR spectral data of **17** determined in $CDCl_3$ at 400 MHz with TMS as the internal standard were essentially identical with those of **1** except for the following signals; δ: 2.05 (3H, s, 4′-OAc), 2.51 (3H, s, 8-OAc), 3.44 (1H, t, $J=9.2$ and 9.2 Hz, 5′α-H), 4.30, 4.56 (1H each, s, disappeared in D_2O, 2 × OH), 5.04 (1H, m, $J=5.0$, 9.0 and 11.0 Hz, 4′β-H).

Attempted Acetylation of 17 to Peracetate (18)——**17** (100 mg) was acetylated with Ac_2O–pyridine (1 : 1, 4 ml) for 16 h at room temperature, but no product corresponding to **18** was detected on TLC.

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