Branched-chain sugars. Part V.[1] Identification and Synthesis of Vinelose[2]

By **John S. Brimacombe, Safia Mahmood,** and **Anthony J. Rollins,** Department of Chemistry, University of Dundee, Dundee DD1 4HN

6-Deoxy-2-*O*,3-*C*-dimethyl-L-talose (24) has been synthesised from 1,2-*O*-isopropylidene-3-*C*-methyl-α-D-allofuranose (3) and shown to be identical with vinelose, a component of two cytidine nucleotides isolated from *Azotobacter vinelandii* strain O.

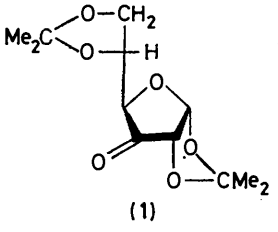
THE branched-chain sugar vinelose occurs [3,4] as a component of two cytidine nucleotides isolated from cultures of *Azotobacter vinelandii* strain O, and these represent the first examples of a new class of sugar nucleotide isolated from living cells. Chemical and spectroscopic evidence indicated [5,6] that vinelose is a 6-deoxy-2-*O*,3-*C*-dimethyl-L-aldohexose possessing the *allo*-, *altro*-, *galacto*-, or *talo*-configuration; however, the first structure was eliminated when vinelose was shown [6] to be chromatographically and spectroscopically distinguishable from synthetic 6-deoxy-2-*O*,3-*C*-dimethyl-D-allose.[7] Since vinelose has not been crystallised and no crystalline derivatives of the free sugar are at present available, thereby precluding determination of its structure by *X*-ray crystallographic analysis, we undertook a synthesis of 6-deoxy-2-*O*,3-*C*-dimethyl-L-talose (24), which seemed to be the most likely structure for vinelose from a consideration of the available data.[5,6]

In Part I [8] it was shown that 1,2:5,6-di-*O*-isopropylidene-α-D-*ribo*-hexofuranos-3-ulose (1) undergoes a highly stereoselective reaction with methylmagnesium iodide to form 1,2:5,6-di-*O*-isopropylidene-3-*C*-methyl-α-D-allofuranose (2), which was subsequently transformed, *via* the triol (3), into 6-deoxy-1,2-*O*-isopropylidene-3-*C*-methyl-α-D-allofuranose (4). It seemed that entry into the L-*talo*-series would be achieved most readily by a nucleophilic displacement reaction on the derived 5-toluene-*p*-sulphonate (5). However, treatment of this sulphonate with benzoate ion in hot *NN*-dimethylformamide gave only *ca.* 5% yield of 5-*O*-benzoyl-6-deoxy-1,2-*O*-isopropylidene-3-*C*-methyl-β-L-talofuranose (6), and the presence of a number of other products, possibly arising from bimolecular elimination of the sulphonyloxy-group, was revealed by t.l.c. Other means of inverting the configuration at C-5 of an appropriate D-allofuranose derivative were therefore sought.

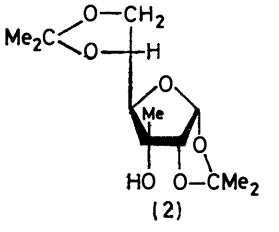
In the first method examined, 1,2-*O*-isopropylidene-3-*C*-methyl-5,6-di-*O*-*p*-tolylsulphonyl-α-D-allofuranose (7) was heated with benzoate ion in *NN*-dimethylformamide

[1] Part IV, J. S. Brimacombe, J. Minshall, and C. W. Smith, *J.C.S. Perkin I*, 1975, 682.
[2] Preliminary communication, J. S. Brimacombe, S. Mahmood, and A. J. Rollins, *Carbohydrate Res.*, 1974, **38**, C7.
[3] S. Okuda, N. Suzuki, and S. Suzuki, *Seikagaku*, 1961, **33**, 657.
[4] S. Okuda, N. Suzuki, and S. Suzuki, *Biochim. Biophys. Acta*, 1964, **82**, 436.
[5] S. Okuda, N. Suzuki, and S. Suzuki, *J. Biol. Chem.*, 1967, **242**, 958.
[6] S. Okuda, N. Suzuki, and S. Suzuki, *J. Biol. Chem.*, 1968, **243**, 6353.
[7] G. B. Howarth, W. A. Szarek, and J. K. N. Jones, *Canad. J. Chem.*, 1968, **46**, 3375.
[8] J. S. Brimacombe, A. J. Rollins, and S. W. Thompson, *Carbohydrate Res.*, 1973, **31**, 108.

to afford a mixture of 5,6-di-*O*-benzoyl-1,2-*O*-isopropylidene-3-*C*-methyl-β-L-talofuranose (10) and the corresponding 6-benzoate (11). Further benzoylation of the monobenzoate (11) gave the dibenzoate (10), thus establishing that they possess the same absolute configuration. The L-*talo*-configuration of the benzoates (10) and (11) followed from the fact that they were readily distinguishable (mixed m.p.s) from the epimeric benzoates (12) and (13), obtained by benzoylation of 1,2-*O*-isopropylidene-3-*C*-methyl-α-D-allofuranose [8] (3). Although the structure of the monobenzoate (11) was not rigorously established, esterification of the primary hydroxy-group seems most probable by analogy with a similar displacement [9] on 1,2-*O*-isopropylidene-3-*O*-methyl-5,6-di-*O*-methylsulphonyl-α-D-allofuranose (14) [*i.e.* an unbranched isomer of (7)]. The latter [9] and related [10] studies have demonstrated that displacements with benzoate and acetate ions in such solvents as *NN*-dimethylformamide are generally effected by S_N2 processes. Thus, the dibenzoate (10) can be assumed to be formed principally by a direct displacement with benzoate ion on 6-*O*-benzoyl-1,2-*O*-isopropylidene-3-*C*-methyl-5-*O*-*p*-tolylsulphonyl-α-D-allofuranose (8), formed



(1)



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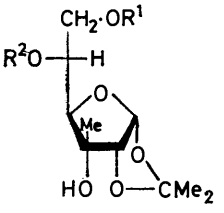
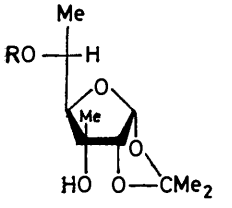
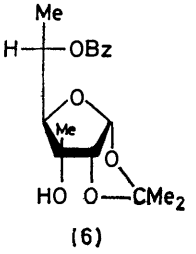


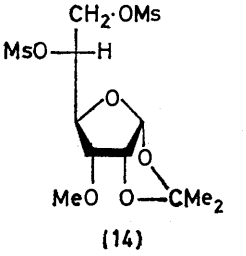
(3) $R^1 = R^2 = H$
(7) $R^1 = R^2 = Ts$
(12) $R^1 = R^2 = Bz$
(13) $R^1 = Bz, R^2 = H$



(4) R = H
(5) R = Ts

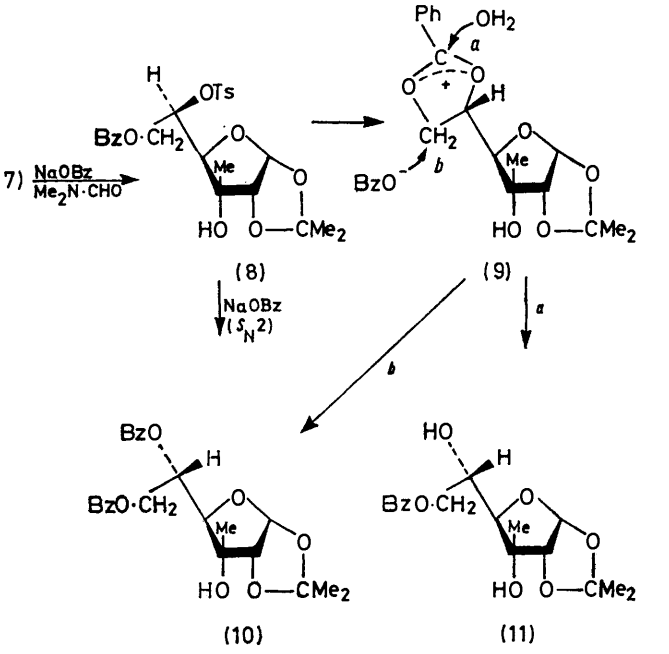


(6)



(14)

by a similar displacement of the more reactive primary sulphonyloxy-group of the disulphonate (7). However, the formation of the monobenzoate (11) indicates that the pathway involving the external nucleophile is



competitive with one involving intramolecular participation by the 6-benzoyloxy-group. The latter pathway would produce more dibenzoate (10) and the monobenzoate (11) by attack of benzoate ion and adventitious water, respectively, on the intermediate dioxolanium ion (9) in the manner indicated. Entry into the L-*talo*-series is achieved in acceptable yield by this procedure, which could be adapted easily to a synthesis of vinelose (see later) following de-esterification of the di- and mono-benzoates (10) and (11).

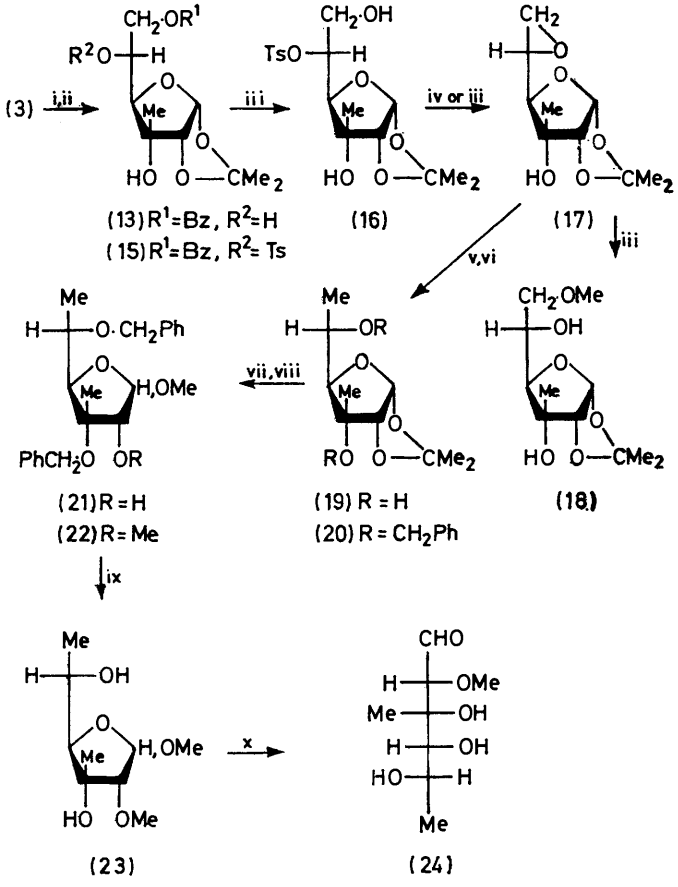
The method finally adopted in the synthesis proceeded through the formation and reductive ring opening of 5,6-anhydro-1,2-*O*-isopropylidene-3-*C*-methyl-β-L-talofuranose (17) (see Scheme). Thus, sulphonylation of the monobenzoate (13), prepared by unimolar benzoylation of the triol (3),[8] furnished 6-*O*-benzoyl-1,2-*O*-isopropylidene-3-*C*-methyl-5-*O*-*p*-tolylsulphonyl-α-D-allofuranose (15). On brief treatment (*ca.* 2 h) of the latter with methanolic sodium methoxide at −25 °C, the oxiran (17) was obtained in *ca.* 15% yield *via* the monosulphonate (16) formed initially. A substantial proportion of the oxiran (17) was further converted into 1,2-*O*-isopropylidene-3-*C*,6-*O*-dimethyl-β-L-talofuranose (18) by regiospecific opening at C-6 with methoxide ion; the methylated derivative (18) was the only product detected and isolated when the reaction was allowed to proceed for *ca.* 10 h. Unacceptable loss of the oxiran (17) by ring opening with methoxide ion was avoided by isolation of the intermediate sulphonate (16) following brief treatment (*ca.* 1 h) of compound (15) with methanolic sodium methoxide at −25 °C. Whereas

[9] J. S. Brimacombe, A. M. Mofti, and L. C. N. Tucker, *J. Chem. Soc.* (*C*), 1971, 2911.

[10] R. C. Chalk, D. H. Ball, M. A. Lintner, and L. Long, jun., *Chem. Comm.*, 1970, 245; M. Miljković, A. Jokić, and E. A. Davidson, *Carbohydrate Res.*, 1971, **17**, 155.

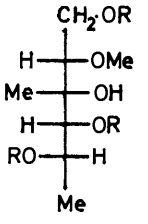
the sulphonate (16) gave only a low yield of the oxiran (17) on treatment with methanolic sodium methoxide at −25 °C, this transformation was accomplished in 87% yield on heating the sulphonate (16) in benzene with the non-nucleophilic base 1,5-diazabicyclo[5.4.0]-undec-5-ene (DBU). Regiospecific opening of the oxiran (17) with lithium aluminium hydride then afforded 6-deoxy-1,2-*O*-isopropylidene-3-*C*-methyl-β-L-talofuranose (19), from which was prepared a benzoate (6) identical with that obtained from the benzoate-exchange reaction on the 6-deoxy-D-allofuranose sulphonate (5).

The 3- and 5-hydroxy-groups of the diol (19) were next protected by benzylation [11] and the product (20), on refluxing with methanolic hydrogen chloride, yielded a mixture of methyl 3,5-di-*O*-benzyl-6-deoxy-3-*C*-methyl-α- and -β-L-talofuranosides (21), from which the corresponding 2-*O*-methyl ethers (22) were obtained.[11]



SCHEME Reagents: i, BzCl–C_5H_5N; ii, TsCl–C_5H_5N; iii, NaOMe–MeOH; iv, DBU; v, $LiAlH_4$; vi, $PhCH_2Br$–Me_2N·CHO–NaH; vii, MeOH–HCl; viii, MeI–Me_2N·CHO–NaH; ix, Pd–C–H_2; x, M-H_2SO_4.

Catalytic debenzylation of the methylated compound (22) furnished methyl 6-deoxy-2-*O*,3-*C*-dimethyl-αβ-L-talofuranoside (23), which liberated 6-deoxy-2-*O*,3-*C*-methyl-L-talose (24) on hydrolysis with dilute sulphuric acid. The i.r. (KBr disc) and mass spectra, optical rotation, and paper chromatographic and electrophoretic properties of the synthetic branched-chain sugar were indistinguishable from those of vinelose. Further, the n.m.r. spectra and physical properties of the alditol (25), prepared by reduction of the free sugar (24) with



(25) R = H
(26) R = Ac

sodium borohydride, and the derived triacetate (26) also proved to be indistinguishable from those of the same derivatives obtained from natural vinelose.

The foregoing synthesis establishes vinelose to be 6-deoxy-2-*O*,3-*C*-dimethyl-L-talose (24). The same conclusion was reached by Funabashi *et al.*,[12] whose results appeared in preliminary form just prior to our own.[2] The Japanese workers used an essentially similar approach and the two syntheses converge in their later stages.

EXPERIMENTAL

T.l.c. was performed on Kieselgel G; spots were located with vanillin–sulphuric acid.[13] Unless otherwise indicated, i.r. spectra were recorded for Nujol mulls on a Perkin-Elmer Infracord spectrometer, and n.m.r. spectra were measured with a Perkin-Elmer R-10 spectrometer for solutions in deuteriochloroform with tetramethylsilane as internal reference. Optical rotations were measured at ambient temperature with a Perkin-Elmer 141 automatic polarimeter. Light petroleum refers to the fraction having b.p. 40—60°.

6-*Deoxy*-1,2-O-*isopropylidene*-3-C-*methyl*-5-O-p-*tolylsulphonyl*-α-D-*allofuranose* (5).—The monoacetal [8] (4) (1·65 g) in dry pyridine (20 ml) was treated overnight at room temperature with toluene-*p*-sulphonyl chloride (3 g) in dry pyridine (20 ml); t.l.c. (light petroleum–ethyl acetate, 4 : 1) then showed that no starting material remained. Work-up in the usual manner gave a syrup that crystallised. Recrystallisation from ether–light petroleum gave the *sulphonate* (5) (2·65 g, 94%), m.p. 76·5—78·5°, $[\alpha]_D$ +27° (*c* 1·5 in $CHCl_3$) (Found: C, 54·8; H, 6·5; S, 9·1. $C_{17}H_{24}O_7S$ requires C, 54·8; H, 6·5; S, 8·6%); τ 2·34 (4H, m, aromatic), 4·31 (1H, d, $J_{1,2}$ 4 Hz, H-1), 5·88 (1H, d, $J_{2,1}$ 4 Hz, H-2), 7·54 (3H, s, Ar*Me*), 8·46, 8·64, and 8·80 (9H, each s, HOC*Me* and CMe_2), and 8·59 (3H, d, $J_{5,6}$ 6 Hz, HC*Me*).

5-O-*Benzoyl*-6-*deoxy*-1,2-O-*isopropylidene*-3-C-*methyl*-β-L-*talofuranose* (6).—A solution of the sulphonate (5) (2·5 g) in *NN*-dimethylformamide (40 ml) containing sodium

[11] J. S. Brimacombe, B. D. Jones, M. Stacey, and J. J. Willard, *Carbohydrate Res.*, 1966, **2**, 167.

[12] M. Funabashi, S. Yamazaki, and J. Yoshimura, *Tetrahedron Letters*, 1974, 4331.

[13] E. Merck A.G., 'Chromatography,' Darmstadt, 2nd edn., p. 30.

benzoate (5 g) was heated at 140 °C for 18 h, whereafter t.l.c. (light petroleum–ethyl acetate, 4 : 1) showed that at least three products had been formed. Water (50 ml) was added and the solution was extracted with methylene chloride (3 × 100 ml). The combined extracts were dried ($MgSO_4$) and concentrated to a syrup (1·8 g), and the residue was chromatographed on silica gel (elution with light petroleum–ethyl acetate, 4 : 1). The third component eluted was the *benzoate* (6) (0·1 g, *ca.* 5%), m.p. 136—137° (from ether–light petroleum), $[\alpha]_D$ *ca.* 0° (*c* 0·6 in $CHCl_3$) (Found: C, 63·6; H, 7·0. $C_{17}H_{22}O_6$ requires C, 63·4; H, 6·8%); τ 4·09 (1H, d, $J_{1,2}$ 4 Hz, H-1), 5·78 (1H, d, $J_{2,1}$ 4 Hz, H-2), 8·37, 8·61, and 8·73 (9H, each s, HOC*Me* and CMe_2), and 8·55 (3H, d, $J_{5,6}$ 6 Hz, HC*Me*).

1,2-O-*Isopropylidene*-3-C-*methyl*-5,6-*di*-O-p-*tolylsulphonyl*-α-D-*allofuranose* (7).—The monoacetal (3) (11 g) in dry pyridine (150 ml) was treated over 2 days at room temperature with toluene-*p*-sulphonyl chloride (22 g) in dry pyridine (150 ml), whereafter t.l.c. (light petroleum–acetone, 2 : 1) showed that the reaction was complete. Work-up in the usual manner gave the *disulphonate* (7) (21 g, 82%), m.p. 132—133° (from chloroform–light petroleum), $[\alpha]_D$ +21° (*c* 1·5 in $CHCl_3$) (Found: C, 52·8; H, 5·4; S, 11·6. $C_{24}H_{30}O_{10}S_2$ requires C, 53·1; H, 5·5; S, 11·8%); τ 4·37 (1H, d, $J_{1,2}$ 4 Hz, H-1), 7·52 (6H, s, 2 × Ar*Me*), and 8·46, 8·65, and 8·77 (9H, each s, HOC*Me* and CMe_2).

Reaction of 1,2-O-*Isopropylidene*-3-C-*methyl*-5,6-*di*-O-p-*tolylsulphonyl*-α-D-*allofuranose* (7) *with Sodium Benzoate in* NN-*Dimethylformamide*.—A solution of the disulphonate (3·5 g) in *NN*-dimethylformamide (85 ml) containing sodium benzoate (10 g) was heated at 150 °C for 20 h; t.l.c. (light petroleum–acetone, 3 : 1) then showed the formation of two products as well as the presence of a little starting material. The solution was diluted with ethyl acetate and filtered to remove inorganic material, and the solvents were removed. The residue was taken up in methylene chloride and the organic extract was washed with water (3 × 250 ml), dried ($MgSO_4$), and concentrated to a syrup. Chromatography on silica gel (elution with light petroleum–acetone, 3 : 1) gave first 5,6-*di*-O-*benzoyl*-1,2-O-*isopropylidene*-3-C-*methyl*-β-L-*talofuranose* (10) (0·94 g, 33%), m.p. 158·5—159·5° (from methylene chloride–light petroleum), $[\alpha]_D$ −28° (*c* 1·1 in $CHCl_3$), $\nu_{max.}$ 1710 cm^{-1} (benzoate) (Found: C, 65·2; H, 6·1. $C_{24}H_{26}O_8$ requires C, 65·2; H, 5·9%); τ *ca.* 2·20 (10H, m, aromatic), 4·11 (1H, d, $J_{1,2}$ 4 Hz, H-1), and 8·38 and 8·62 (9H, each s, intensity ratio 1 : 2, HOC*Me* and CMe_2). Continued elution furnished 6-O-*benzoyl*-1,2-O-*isopropylidene*-3-C-*methyl*-β-L-*talofuranose* (11) (0·53 g, 24%), m.p. 111—112° (from methylene chloride–light petroleum), $[\alpha]_D$ +6° (*c* 0·2 in $CHCl_3$), $\nu_{max.}$ 1710 (benzoate) and 3400 cm^{-1} (OH) (Found: C, 60·5; H, 6·7. $C_{17}H_{22}O_7$ requires C, 60·4; H, 6·5%); τ *ca.* 2·12 (5H, m, aromatic), 4·10 (1H, d, $J_{1,2}$ 4 Hz, H-1), and 8·41, 8·63, and 8·67 (9H, each s, HOC*Me* and CMe_2). Benzoylation of the monobenzoate (11) transformed it into the dibenzoate (10) (identified by m.p. and mixed m.p.).

6-O-*Benzoyl*-1,2-O-*isopropylidene*-3-C-*methyl*-α-D-*allofuranose* (13).—A cooled (*ca.* 0 °C) solution of benzoyl chloride (8·5 g) in dry pyridine (50 ml) was added to a cooled solution of the monoacetal (3) (13·3 g) in dry pyridine (100 ml) and the mixture was stored at room temperature for 3 h; t.l.c. (light petroleum–acetone, 2 : 1) then showed the formation of two products and the presence of a little starting material. The solution was processed in the usual way, and the resulting syrup was chromatographed on silica gel (elution with light petroleum–acetone, 2 : 1) to give first the 5,6-*dibenzoate* (12) (10·9 g, 43%), m.p. 155·5—156° (from methylene chloride–light petroleum), $[\alpha]_D$ +41° (*c* 0·9 in $CHCl_3$), $\nu_{max.}$ 1710 cm^{-1} (benzoate) (Found: C, 65·4; H, 5·85. $C_{24}H_{26}O_8$ requires C, 65·2; H, 5·9%); τ *ca.* 2·20 (10H, m, aromatic), 4·18 (1H, d, $J_{1,2}$ 4 Hz, H-1), and 8·42, 8·65, and 8·69 (9H, each s, HOC*Me* and CMe_2). Continued elution afforded the *monobenzoate* (13) (9 g, 47%), m.p. 112·5—113·5° (from methylene chloride–light petroleum), $[\alpha]_D$ +28° (*c* 3 in $CHCl_3$), $\nu_{max.}$ 1710 (benzoate) and 3420 cm^{-1} (OH) (Found: C, 60·6; H, 6·4. $C_{17}H_{22}O_7$ requires C, 60·4; H, 6·5%); τ *ca.* 2·12 (5H, m, aromatic), 4·24 (1H, d, $J_{1,2}$ 4 Hz, H-1), and 8·46 and 8·68 (9H, each s, intensity ratio 1 : 2, HOC*Me* and CMe_2).

6-O-*Benzoyl*-1,2-O-*isopropylidene*-3-C-*methyl*-5-O-p-*tolylsulphonyl*-α-D-*allofuranose* (15).—A solution of the monobenzoate (13) (5·5 g) in dry pyridine (75 ml) was treated overnight at room temperature with toluene-*p*-sulphonyl chloride (17·5 g) in dry pyridine (75 ml), whereafter t.l.c. (light petroleum–acetone, 3 : 1) showed that the reaction was complete. Work-up gave the *diester* (15) (5·3 g, 66%), m.p. 137—138° (from methylene chloride–light petroleum), $[\alpha]_D$ +45° (*c* 1·1 in $CHCl_3$) (Found: C, 58·7; H, 5·8; S, 7·0. $C_{24}H_{28}O_9S$ requires C, 58·5; H, 5·7; S, 6·5%); τ *ca.* 2·37 (9H, m, aromatic), 4·28 (1H, d, $J_{1,2}$ 4 Hz, H-1), 7·65 (3H, s, Ar*Me*), and 8·47 and 8·64 (9H, each s, intensity ratio 1 : 2, HOC*Me* and CMe_2).

1,2-O-*Isopropylidene*-3-C,6-O-*dimethyl*-β-L-*talofuranose* (18).—The diester (15) (1 g) in dry chloroform (5 ml) was cooled to *ca.* −25 °C and treated with cold methanolic M-sodium methoxide (7·5 ml); afterwards the solution was stored for 10 h at room temperature, and t.l.c. (light petroleum–acetone, 4 : 1) then showed the formation of a product of lower mobility than the starting material. Solid carbon dioxide was added to neutralise the base and the solvent was then removed. The residue was extracted with ether, and the extract was filtered and chromatographed on silica gel (elution with light petroleum–methanol, 7 : 1) to give the *methyl ether* (18) (0·3 g, 59·5%), b.p. 85—90° (bath) at *ca.* 0·2 mmHg, $[\alpha]_D$ +11° (*c* 0·5 in $CHCl_3$) (Found: C, 52·3; H, 8·35. $C_{11}H_{20}O_6$ requires C, 53·2; H, 8·1%); τ 4·13 (1H, d, $J_{1,2}$ 4 Hz, H-1), 5·78 (1H, d, $J_{2,1}$ 4 Hz, H-2), 6·54 (3H, s, OMe), and 8·38, 8·62, and 8·73 (9H, each s, HOC*Me* and CMe_2).

1,2-O-*Isopropylidene*-3-C-*methyl*-5-O-p-*tolylsulphonyl*-α-D-*allofuranose* (16).—A solution of the diester (15) (5·2 g) in dry chloroform (30 ml) was cooled to *ca.* −25 °C and treated with cold methanolic M-sodium methoxide (40 ml); after 30 min, t.l.c. (light petroleum–acetone, 3 : 1) revealed the formation of a single product of slightly lower mobility than the starting material. The solution was worked up (as before) and the resulting syrup was chromatographed on silica gel (elution with light petroleum–acetone, 3 : 1) to give the *tosylate* (16) (3·6 g, 88%), m.p. 78·5—79·5° (from methylene chloride–light petroleum), $[\alpha]_D$ +18° (*c* 0·9 in $CHCl_3$) (Found: S, 8·0. $C_{17}H_{24}O_8S$ requires S, 8·3%); τ 2·28 (4H, m, aromatic), 4·35 (1H, d, $J_{1,2}$ 4 Hz, H-1), 7·54 (3H, s, Ar*Me*), and 8·43, 8·68, and 8·78 (9H, each s, HOC*Me* and CMe_2).

5,6-*Anhydro*-1,2-O-*isopropylidene*-3-C-*methyl*-β-L-*talofuranose* (17).—*Method* (*a*). To a cooled (−25 °C) solution of the sulphonate (16) (0·95 g) in dry chloroform (10 ml) was added methanolic M-sodium methoxide (15 ml) and, after 2 h, the mixture was worked up, as previously

described, to give a syrupy residue (0·35 g). Chromatography on silica gel (elution with light petroleum–acetone, 3 : 1) gave the anhydro-sugar (17) (80 mg, 15%), m.p. 129—130° (from methylene chloride–light petroleum), identical with that described below.

Method (*b*). A solution of the sulphonate (16) (1·94 g) in anhydrous benzene containing 1,5-diazabicyclo[5.4.0]undec-5-ene (0·8 g) was heated under reflux for 2 h, whereafter t.l.c. (light petroleum–acetone, 3 : 1) showed the formation of a product having higher mobility than the diester (15). The solvent was removed and the residue was extracted with methylene chloride (50 ml), which was washed alternately with M-sulphuric acid (2 × 20 ml) and sodium hydrogen carbonate solution (2 × 20 ml); the combined washings were further extracted with methylene chloride (2 × 100 ml). The combined organic extracts were dried (Na_2SO_4), decolourised (charcoal), and concentrated to give the ***anhydro-sugar*** (17) (0·95 g, 87%), m.p. 129—130° (from methylene chloride–light petroleum), $[\alpha]_D$ +30° (*c* 0·7 in $CHCl_3$) (Found: C, 55·9; H, 7·5. $C_{10}H_{16}O_5$ requires C, 55·6; H, 7·4%); τ 4·13 (1H, d, $J_{1,2}$ 4 Hz, H-1), 5·80 (1H, d, $J_{2,1}$ 4 Hz, H-2), and 8·43, 8·63, and 8·68 (9H, each s, HOC*Me* and CMe_2).

6-*Deoxy*-1,2-O-*isopropylidene*-3-C-*methyl*-β-L-*talofuranose* (19).—Lithium aluminium hydride (1·2 g) was added in portions to a stirred solution of the anhydro-sugar (17) (3 g) in dry ether (200 ml) and, after 30 min, more ether (500 ml) was added, followed by ethyl acetate to destroy the excess of hydride. Concentration of the dried ($MgSO_4$) ethereal layer gave the 6-*deoxy-sugar* (19) (2·5 g, 83%), m.p. 112·5—113° (from methylene chloride–light petroleum), $[\alpha]_D$ +14° (*c* 2 in $CHCl_3$) (Found: C, 55·3; H, 8·6. $C_{10}H_{18}O_5$ requires C, 55·0; H, 8·3%); τ 4·18 (1H, d, $J_{1,2}$ 4 Hz, H-1), 5·83 (1H, d, $J_{2,1}$ 4 Hz, H-2), 8·42, 8·64, and 8·83 (9H, each s, HOC*Me* and CMe_2), and 8·76 (3H, d, $J_{5,6}$ 6 Hz, HC*Me*).

Benzoyl chloride (0·07 ml) was added carefully to a cooled (0 °C) solution of the 6-deoxy-sugar (19) (90 mg) in dry pyridine (2 ml), and the mixture was kept for 1 h at room temperature; t.l.c. (light petroleum–acetone, 3 : 1) then showed that all the starting material had reacted. Work-up in the usual manner and chromatography on silica gel (elution with light petroleum–acetone, 5 : 1) furnished the benzoate (6) (0·1 g), m.p. 136—136·5° (from ether–light petroleum), $[\alpha]_D$ *ca.* 0° (*c* 0·2 in $CHCl_3$). The n.m.r. spectrum of this compound was indistinguishable from that prepared previously and no depression of m.p. was observed on mixing the samples.

3,5-*Di*-O-*benzyl*-6-*deoxy*-1,2-O-*isopropylidene*-3-C-*methyl*-β-L-*talofuranose* (20).—Sodium hydride (2 g) was added in small portions to a stirred and cooled (0 °C) solution of the diol (19) (2 g) in *NN*-dimethylformamide (25 ml) and, after the gradual addition of benzyl chloride (4 ml), the mixture was stirred for 4 h at room temperature; t.l.c. (light petroleum–acetone, 3 : 1) then showed that no starting material remained. Methanol was added to destroy the excess of reagent and the solvents were removed. The residue was extracted with methylene chloride (150 ml), and the extract was filtered, washed with water (3 × 100 ml), and dried ($MgSO_4$). Removal of the solvents left a syrup (4·4 g) that was chromatographed on silica gel (elution with light petroleum–acetone, 9 : 2) to give the *dibenzylated compound* (20) (2·4 g, 66%), b.p. 140—145° (bath) at *ca.* 0·05 mmHg, $[\alpha]_D$ +27° (*c* 0·4 in $CHCl_3$) (Found: C, 72·5; H, 7·5. $C_{24}H_{30}O_5$ requires C, 72·4; H, 7·5%); τ 2·59 (10H, s, aromatic), 4·27 (4H, q, 2 × PhCH_2O), 4·47 (1H, d, $J_{1,2}$ 4 Hz, H-1), 5·97 (1H, d, $J_{2,1}$ 4 Hz, H-2), 8·38, 8·63, and 8·76 (9H, each s, $PhCH_2OCMe$ and CMe_2), and 8·74 (3H, d, $J_{5,6}$ 6 Hz, HC*Me*).

Methyl 3,5-*Di*-O-*benzyl*-6-*deoxy*-2-O,3-C-*dimethyl*-α- *and* β-L-*talofuranosides* (22).—The benzylated acetal (20) (0·95 g) was methanolysed in refluxing methanolic 2·5% hydrogen chloride (80 ml) during 1·5 h. The solution was neutralised ($PbCO_3$) and filtered, and the filtrate was concentrated to furnish a syrupy αβ-mixture (0·89 g) of the glycosides (21).

Sodium hydride (0·5 g) was added in portions to a cooled (0 °C) and stirred solution of the glycosides (0·89 g) in *NN*-dimethylformamide (60 ml), whereupon methyl iodide (2·5 ml) was added carefully and the mixture was stirred for 2 h at room temperature. Methanol was then added to destroy the excess of reagents and the solution was concentrated. The residue was extracted with methylene chloride (225 ml), which was washed with water (3 × 75 ml) and dried (Na_2SO_4). Removal of the solvent left a syrupy mixture of the methylated α- and β-glycosides (22) (0·94 g, *ca.* 100%), which was suitable for the next stage of the sequence. However, in one instance, chromatography on silica gel (elution with light petroleum–acetone, 6 : 1) gave the ***methylated glycoside*** of higher mobility in pure form; it had b.p. 125—130° (bath) at *ca.* 0·05 mmHg, $[\alpha]_D$ +14° (*c* 0·5 in $CHCl_3$); τ 2·57 (10H, s, aromatic), 4·93 (1H, d, $J_{1,2}$ 3 Hz, H-1), 5·32 and 5·41 (q and s, intensity ratio 1 : 1, 2 × PhCH_2O), 6·52 (6H, s, 2 × OMe), 8·63 (3H, s, $PhCH_2OCMe$), and 8·71 (3H, d, $J_{5,6}$ 6 Hz, HC*Me*) (Found: C, 70·6; H, 7·7. $C_{23}H_{30}O_5$ requires C, 71·5; H, 7·8%). Funabashi *et al.*[12] record $[\alpha]_D$ −3·4° (*c* 1 in MeOH) for the more mobile α-(22) and $[\alpha]_D$ +66° (*c* 1 in MeOH) for β-(22).

Methyl 6-*Deoxy*-2-O,3-C-*dimethyl*-α- *and* -β-L-*talofuranosides* (23).—A solution of the α- and β-glycosides (22) (0·61 g) in methanol (30 ml) containing 5% palladised charcoal (0·6 g) was shaken with a slight overpressure of hydrogen for 2 h at room temperature; t.l.c. (light petroleum–acetone, 3 : 1) then showed that no starting material remained. The catalyst was filtered off and the filtrate was concentrated to a syrup containing the debenzylated α- and β-glycosides (23) (0·32 g, 98%), which was suitable for the next stage of the sequence. However, in one instance, chromatography on silica gel (elution with light petroleum–acetone, 2 : 1) gave the *component* of higher mobility in pure form; b.p. 55—60° (bath) at *ca.* 0·05 mmHg, $[\alpha]_D$ *ca.* 0° (*c* 0·6 in $CHCl_3$) (Found: C, 52·4; H, 9·0. $C_9H_{18}O_5$ requires C, 52·4; H, 8·7%); τ 5·01 (1H, d, $J_{1,2}$ 3 Hz, H-1), 6·44 (6H, s, 2 × OMe), 8·59 (3H, s, HOC*Me*), and 8·74 (3H, d, $J_{5,6}$ 6 Hz, HC*Me*). Funabashi *et al.*[12] report $[\alpha]_D^{24}$ −15° (*c* 1·3 in MeOH) for the α-anomer.

6-*Deoxy*-2-O,3-C-*dimethyl*-L-*talose* (*Vinelose*) (24).—A solution of the α- and β-glycosides (23) (0·32 g) in ethanol (2 ml) and M-sulphuric acid (6 ml) was heated for 2 h on a boiling water-bath, during which time complete hydrolysis occurred. The hydrolysate was neutralised ($BaCO_3$) and the filtered solution was concentrated. Chromatography of the syrupy residue on silica gel (elution with light petroleum–acetone, 3 : 1) gave *vinelose* (24) (0·2 g, 67%), $[\alpha]_{546}$ +13° (*c* 0·7 in H_2O), as a syrup which could not be induced to crystallise {lit.,[5] $[\alpha]_{546}$ +12° (*c* 1 in H_2O)}. The mass spectrum of the syrupy product was in agreement with that published [5] and accurate measurement of the highest peak ($M^{+\cdot}$ − 18) gave a value of *m/e* 174·0889 ($C_8H_{14}O_4$ requires 174·0892). The i.r. spectrum (KBr disc) of the synthetic material was indistinguishable from that

published [6] for the branched-chain sugar derived from natural sources. Paper chromatography and paper electrophoresis (see Table) confirmed the identity of the synthetic material with vinelose.

Paper chromatographic and paper electrophoretic properties of 6-deoxy-2-*O*,3-*C*-dimethyl-L-talose (24) and natural L-vinelose

	Chromatography [a]					
Vinelose	A	B	C	D	E	Electrophoresis [b]
Synthetic	0·79	0·82	0·77	0·79	0·79	9·5
Natural	0·79	0·82	0·77	0·79	0·79	9·5

[a] R_F Values in A, ethyl acetate–acetic acid–water, 3 : 1 : 3; B, pyridine–ethyl acetate–water, 1 : 3 : 1·15; C, butan-1-ol–ethanol–water, 4 : 1 : 5; D, butan-1-ol–pyridine–water, 6 : 4 : 3; and E, butan-1-ol–pyridine–0·05M-morpholinium tetraborate (pH 8·6), 7 : 5 : 2. Both samples gave a pink colour with vanillin–perchloric acid, which showed a change to greenish blue within 24 h. [b] Movement towards anode (cm) in 0·1M-sodium tetraborate (pH 9·8) at 30 V cm^{-1} for 75 min.

6-*Deoxy*-2-O,3-C-*dimethyl*-L-*talitol* (*Vinelitol*) (25).—Sodium borohydride (0·62 g) was added to a solution of vinelose (24) (0·17 g) in 0·005N-sodium carbonate (100 ml) and the mixture was set aside overnight at room temperature. The solution was then deionised by passage through Amberlite IR-120 (H^+) resin, and the effluent and washings were concentrated to a syrup, with repeated additions of methanol. The residue was chromatographed on silica gel (elution with light petroleum–acetone, 2 : 1) to give *vinelitol* (0·1 g), $[\alpha]_{546}$ −6° (*c* 0·5 in H_2O) {lit.,[5] $[\alpha]_{546}$ −6·4° (*c* 1 in H_2O)}. The n.m.r. spectrum (D_2O) of the material so obtained was indistinguishable from that published [5] for the alditol derived from natural vinelose.

1,4,5-*Tri*-O-*acetyl*-6-*deoxy*-2-O,3-C-*dimethyl*-L-*talitol* (26).—Acetylation of vinelitol (25), according to the literature procedure,[5] afforded the *triacetate* (26), $[\alpha]_{546}$ −41° (*c* 0·9 in $CHCl_3$) {lit.,[5] $[\alpha]_{546}$ −46° (*c* 1 in $CHCl_3$)}, whose n.m.r. spectrum ($CDCl_3$) was identical with that published.

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