## 426. *Carbohydrate Components of Antibiotics. Part IV.*[1] *Configurational Correlation of Desosamine and Chalcose*[2]

By A. B. Foster, M. Stacey, J. M. Webber, and J. H. Westwood

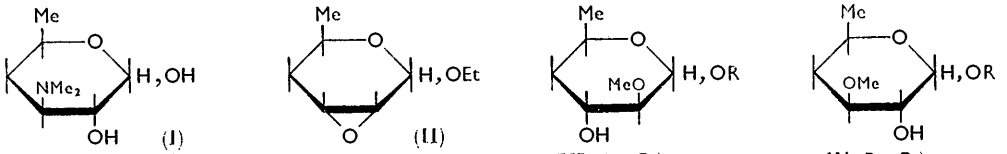
The conversion of desosamine (3,4,6-trideoxy-3-dimethylamino-D-*xylo*-hexose) into chalcose (4,6-dideoxy-3-*O*-methyl-D-*xylo*-hexose) is described by a route which further confirms the configurational assignments for these sugars. Deductions about the configurations of intermediate glycosides and their conformations in aqueous solution and in dilute solution in carbon tetrachloride are made from molecular rotation values and from the patterns of intramolecular hydrogen bonding.

On the basis of chemical [3,4] and nuclear magnetic resonance studies,[5] desosamine (I), the 3,4,6-trideoxy-3-dimethylaminohexose component of erythromycin and a number of other macrolide antibiotics,[6] was assigned the D-*xylo*-configuration, and this assignment has been confirmed by synthesis.[7] Chalcose, the 4,6-dideoxy-3-*O*-methylhexose component of chalcomycin [8] and lankamycin,[9] has similarly been shown [10,11] to have the D-*xylo*-configuration. We now report the conversion of desosamine into chalcose and thereby further substantiate these configurational assignments.

Ethyl αβ-desosaminide readily gave a crystalline, sharp-melting methiodide which, from its strongly positive $[M]_D$ value (+310°), appeared to consist predominantly of the α-anomer; the configurationally related methyl 3,6-dideoxy-3-dimethylamino-α-D-glucopyranoside [12] had $[M]_D$ +252°. With moist silver oxide, the methiodide gave a syrupy

[1] Part III, A. B. Foster, T. D. Inch, J. Lehmann, M. Stacey, and J. M. Webber, *J.*, 1962, 2116.
[2] For a preliminary report see *Proc. Chem. Soc.*, 1963, 279.
[3] C. H. Bolton, A. B. Foster, M. Stacey, and J. M. Webber, (*a*) *J.*, 1961, 4831; (*b*) *Chem. and Ind.*, 1962, 1945.
[4] H. Newman, *Chem. and Ind.*, 1963, 372.
[5] W. Hofheinz and H. Grisebach, *Tetrahedron Letters*, 1962, 377; P. W. K. Woo, H. W. Dion, L. Durham, and H. S. Mosher, *ibid.*, p. 735.
[6] J. D. Dutcher, *Adv. Carbohydrate Chem.*, 1963, **18**, 259.
[7] A. C. Richardson, *Proc. Chem. Soc.*, 1963, 131.
[8] P. W. K. Woo, H. W. Dion, and Q. R. Bartz, *J. Amer. Chem. Soc.*, 1961, **83**, 3352.
[9] W. Keller-Schierlein and G. Roncari, *Helv. Chim. Acta*, 1962, **45**, 138.
[10] P. W. K. Woo, H. W. Dion, and L. F. Johnson, *J. Amer. Chem. Soc.*, 1962, **84**, 1066.
[11] N. K. Kochetkov and A. I. Usov, *Tetrahedron Letters*, 1963, 519.
[12] A. B. Foster, T. D. Inch, J. Lehmann, M. Stacey, and J. M. Webber, *J.*, 1962, 2116.

methohydroxide which on pyrolysis (80—200°/12 mm.) gave ethyl 2,3-anhydro-4,6-dideoxy-αβ-D-*ribo*-hexopyranoside (II) in 59% yield. This behaviour of the methohydroxide would be expected because the *trans*-orientation of the hydroxyl and amino-functions at positions 2 and 3 enables them to assume the diaxial arrangement which permits ready epoxide formation with elimination of trimethylamine. Newman [4] has similarly prepared the epoxide (II), a related reaction sequence having been reported by Paul and Tchelitcheff [13] in their characterisation of mycaminose.




Treatment of the epoxide (II) with boiling, methanolic sodium methoxide for 3·5 days gave a product which, in addition to the expected components (III) and (IV), contained *ca.* 5% of vicinal diol impurity as measured by the consumption of periodate; glycosides (III) and (IV) do not contain a vicinal diol grouping. The diol material presumably consisted of a 4,6-dideoxy-hexoside mixture produced by opening of the epoxide ring with hydroxyl ions formed from traces of water contaminant. Evidence to support this view was obtained when paper-chromatographic analysis of the acid-hydrolysed methanolysis product showed a minor component having an $R_F$ value similar to that of 4,6-dideoxy-D-*xylo*-hexose. Although stringent precautions to minimise ingress of water during the methanolysis did not prevent formation of diol contaminants, these could be conveniently removed by oxidation with periodate followed by absorption [12] of the resulting aldehydes on a strongly basic ion-exchange resin. Fractionation of the remaining glycoside mixture on neutral alumina yielded ethyl 4,6-dideoxy-2-*O*-methyl-α-D-*arabino*-hexopyranoside (29%) and ethyl 4,6-dideoxy-3-*O*-methyl-αβ-D-*xylo*-hexopyranoside (68%), as syrupy products. Vapour-phase chromatography of these glycosides revealed a single component for the *arabino*-isomer, but two components (ratio 5·5 : 1) for the *xylo*-product; the glycoside mixture prior to fractionation showed the same components, in a similar weight ratio. The assignment of anomeric configuration to the glycosides is discussed below.

Acidic hydrolysis of the *arabino*-glycoside gave a chromatographically-homogeneous, syrupy product which, in accord with its assigned structure as 4,6-dideoxy-2-*O*-methyl-D-*arabino*-hexose (V), was not oxidised by periodate, and had zero mobility in paper electrophoresis with alkaline borate buffer. Similar hydrolysis of the *xylo*-glycosides gave a chromatographically-homogeneous syrup which on sublimation and recrystallisation yielded 4,6-dideoxy-3-O-methyl-D-*xylo*-hexose (VI). Comparison of physical properties established the identity of this synthetic product and natural chalcose, and the mode of synthesis confirms that chalcose has the D-*xylo*-configuration. The formation of a mixture of the *arabino*- and *xylo*-derivatives, (III) and (IV), respectively, on cleavage of ethyl 2,3-anhydro-4,6-dideoxy-D-*ribo*-hexopyranoside with sodium methoxide would be expected by analogy with the behaviour of many other sugar epoxides.[14] Scission of an epoxide occurs predominantly in the direction producing two axial groups in the initial conformation of the product, and, for flexible systems, the direction of scission probably depends on the preferred conformation of the epoxide. With epoxide (II), the observed ratio of *xylo* : *arabino* products, 2·3 : 1, indicates a substantial difference in the two routes of epoxide cleavage, there being preferential attack at position 3. Newman [15] has discussed this effect in detail.

[13] R. Paul and S. Tchelitcheff, *Bull. Soc. chim. France*, 1957, 1059.
[14] W. G. Overend and G. Vaughan, *Chem. and Ind.*, 1955, 995.
[15] H. Newman, *J. Org. Chem.*, 1964, **29**, 1461.

Table 1 comprises infrared spectral data recorded for *ca.* 0·005M-solutions of the alcohols in carbon tetrachloride. Under these conditions, intermolecular hydrogen-bonding is negligible, and absorptions in the hydroxyl stretching region may be assigned to free and intramolecularly-bonded hydroxyl groups.[16] An approximate measure of the proportions of these groups is given by the relative extinction coefficients.[17] In the absence of unusual steric effects, the size of the ring formed by an intramolecular hydrogen bond is indicated by the arithmetical difference ($\Delta\nu$) between the absorption frequencies for free and bonded hydroxyl groups. For a five-membered ring (*e.g.*, 2-methoxyethanol [18]) $\Delta\nu$ is *ca.* 30, and for a six-membered ring (*e.g.*, 3-methoxypropanol [18]) *ca.* 80.

TABLE 1

Infrared spectral data for ethyl 4,6-dideoxyhexopyranosides and related compounds (*ca.* 0·005M-solutions in $CCl_4$)

| | $\nu_{max.}$ (cm.$^{-1}$) (ε) | | |
|---|---|---|---|
| Alcohol | Free OH | Bonded OH | |
| Ethyl 4,6-dideoxy-3-*O*-methyl-αβ-D-*xylo*-hexopyranoside ..... | | 3601(38) | 3581(48) |
| Ethyl 4,6-dideoxy-2-*O*-methyl-α-D-*arabino*-hexopyranoside ... | | 3595(8) | 3535(63) |
| Methyl β-chalcoside ..... | | 3605 | |
| 2-Methoxyethanol [18] ..... | 3641(16) | 3610(55) | |
| 3-Methoxypropanol [18] ..... | 3641(34) | | 3554(44) |
| *cis*-2-Methoxycyclohexanol [19] ..... | | 3586 | |
| *trans*-2-Methoxycyclohexanol [19] ..... | | 3594 | |

An absorption value of 3629 cm.$^{-1}$ for free secondary hydroxyl groups [17] is used to calculate $\Delta\nu$ values.

Ethyl 4,6-dideoxy-3-*O*-methyl-αβ-D-*xylo*-hexopyranoside showed strong absorptions for hydroxyl groups bonded in five-membered rings at 3601 (ε 38, $\Delta\nu$ 28) and 3581 cm.$^{-1}$ (ε 48, $\Delta\nu$ 48). This pattern agrees with that to be expected for the preferred C1 conformation (VII) of the α-glycoside in which intramolecular hydrogen-bonding of the equatorial hydroxyl group at position 2 can occur with the vicinal *cis*-ethoxyl group (3581 cm.$^{-1}$) and also with the vicinal *trans*-methoxyl group (3601 cm.$^{-1}$). Similar frequency differences in the absorption maxima associated with five-membered ring systems involving hydrogen-bonding of *cis*- and *trans*-groups have been observed [19] with *cis*- [3586 cm.$^{-1}$ ($\Delta\nu$ 43)] and *trans*-2-methoxycyclohexanol [3594 cm.$^{-1}$ ($\Delta\nu$ 35)]. In the C1 conformation of the β-glycoside, intramolecular hydrogen-bonding (five-membered ring) of the hydroxyl group at position 2 must involve a *trans*-related grouping, and should produce a single absorption in the infrared spectrum. Confirmation of this view was obtained when methyl β-chalcoside showed a single absorption at 3605 cm.$^{-1}$. Single absorptions (bonding in a five-membered ring) would also be expected for the 1C conformations of the α- and β-glycosides, but these conformations are sterically very unfavourable and ought not to be significant contributors. It is therefore concluded that the α-anomer is the principal component of the mixture of *xylo*-glycosides. Further evidence to support this view was obtained by Whiffen's method [20] for calculating the $[M]_D$ values of methyl pyranosides in aqueous solution. Since replacement of the glycosidic methyl group by an ethyl group does not significantly change the $[M]_D$ value,[21] no allowance was necessary for this structural change. The $[M]_D$ values calculated (Table 2) for the preferred C1 conformations of the α- and β-*xylo*-glycosides are +290 and −87°, respectively, and the observed value of +251° for the mixture confirms that the α-anomer is the principal component.

The *arabino*-glycoside showed strong absorption at 3535 cm.$^{-1}$ (ε 63, $\Delta\nu$ 94, six-membered ring) which is attributed to hydrogen-bonding involving the axial hydroxyl

[16] L. P. Kuhn, *J. Amer. Chem. Soc.*, (*a*) 1952, **74**, 2492; (*b*) 1954, **76**, 4323.
[17] A. R. H. Cole and P. R. Jefferies, *J.*, 1956, 4391.
[18] A. B. Foster, A. H. Haines, and M. Stacey, *Tetrahedron*, 1961, **16**, 177.
[19] K. W. Buck, A. B. Foster, A. Labib, and J. M. Webber, *J.*, 1964, 2846.
[20] D. H. Whiffen, *Chem. and Ind.*, 1956, 964.
[21] W. W. Pigman and R. M. Goepp, jun., "Chemistry of the Carbohydrates," Academic Press, New York, 1948, p. 80.

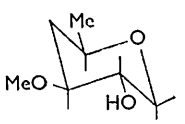
TABLE 2

Optical rotations for ethyl 4,6-dideoxyhexopyranosides in water

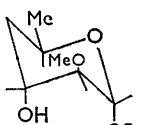
| Ethyl hexopyranoside | Conformation | Calc.[20] $[M]_D$ (parameters) | Obs. $[M]_D$ |
|---|---|---|---|
| 4,6-Dideoxy-3-*O*-methyl-α-D-*xylo*- ..... | C1 | +290° ($F + G + J + 100$) | +251° |
| 4,6-Dideoxy-3-*O*-methyl-β-D-*xylo*- ..... | C1 | −87° ($F - G - 100$) | |
| 4,6-Dideoxy-2-*O*-methyl-α-D-*arabino*-... | C1 | +170° ($J - I + 100$) | +127° |
| | 1C | +58° ($G + K - F + 100$) | |

Parameter values: $F$, +45; $G$, +32; $I$, +43; $J$, +113; $K$, −29. An allowance of +100 is made for the contribution of the α-glycosidic group, and −100 for the β-glycosidic group.

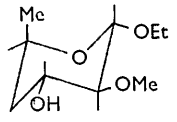
group at position 3 and the axial ethoxyl group in the C1 conformation (VIII) of the α-anomer. A similar situation exists in cyclohexane-*cis*-1,3-diol,[16a] some methyl 4,6-*O*-benzylidene-D-aldohexosides,[22] and some branched-chain sugars.[23] For the 1C conformation of the α-glycoside (IX), only a five-membered ring can be formed by hydrogen-bonding. With the β-glycoside, hydrogen-bonding is possible only in the 1C conformation and would also give a five-membered ring. As with the principal *xylo*-glycoside, the



(VII)



(VIII)



(IX)

α-configuration can therefore be assigned to the apparently homogeneous *arabino*-glycoside. The weak absorption (ε8, Δν 34) for bonding in a five-membered ring is possibly due to the presence of a small amount of the 1C conformation of the α-glycoside.

The presence of three axial substituents in the C1 conformation (VIII) of ethyl 4,6-dideoxy-2-*O*-methyl-α-D-*arabino*-hexopyranoside would be expected to act as destabilising factors. However, in this conformation, the hydroxyl and ethoxyl groups are very favourably placed for intramolecular hydrogen-bonding, and it appears that the resulting stabilisation causes the C1 conformer, or some closely similar shape, to become the preferred form in dilute solution in carbon tetrachloride. Information on the shape of the glycoside in aqueous solution was obtained from a consideration of optical rotation values. The observed $[M]_D$ of +127° is approximately mid-way between the values calculated (Table 2) for the C1 and 1C conformations by Whiffen's rules, and this suggests that neither chair form is preferred in aqueous solution. A possible explanation of this difference in the conformations adopted by the *arabino*-glycoside in water, and in dilute solution in carbon tetrachloride, is that, in water, stabilisation of the C1 conformation by intramolecular hydrogen bonding is reduced because of intermolecular bonding between the alcoholic group and the water (cf. the results obtained[24] for ethyl 2,3-dideoxy- and ethyl 2,3,6-trideoxy-α-D-*threo*-hexopyranosides).

The above configurational assignments indicate that the α-anomer is the principal component of epoxide (II), and this accords with the assignment for the methiodide; the α : β ratio for the epoxide appears to be less than the 3 : 1 ratio obtained by Newman.[4,15] Methanolysis of epoxide (II) would be expected to give αβ-mixtures of the *xylo*- and *arabino*-glycosides, and the reason why β-*arabino*-glycoside was not detected is not known. However, it is possible that it was obscured by one of the *xylo*-glycosides in the vapour-phase analysis of the crude product, and was discarded during the subsequent fractionation.

## EXPERIMENTAL

Thin-layer chromatography was performed on silica-gel with benzene–methanol (9 : 1), or on alumina with benzene–methanol (99 : 1); detection was effected by iodine vapour or sulphuric

[22] H. Spedding, *J.*, 1961, 3617.
[23] R. J. Ferrier, W. G. Overend, Mrs. G. A. Rafferty, H. M. Wall, and N. R. Williams, *Proc. Chem. Soc.*, 1963, 133.
[24] A. B. Foster, R. Harrison, J. Lehmann, and J. M. Webber, *J.*, 1963, 4471.

acid–vanillin.[25] Vapour-phase chromatography was performed with a Gas Chromatography Ltd. instrument and gas-density detection on an ethylene glycol–adipic acid polyester column, at 152° and a gas flow of 2·6 units. Paper electrophoresis was performed on Whatman No. 3 paper by the enclosed strip technique [26] and with a borate buffer pH 10.[27] Paper chromatography was performed on Whatman No. 1 paper by downward irrigation with the organic phase of butanol–ethanol–water (4 : 1 : 5); detection was effected by alkaline silver nitrate [28] or aniline hydrogen phthalate,[29] as appropriate.

*Ethyl αβ-Desosaminide Methiodide.*—A solution of desosamine hydrochloride [3a] (8·8 g.) in dry ethanol (150 ml.) was saturated with dry hydrogen chloride gas and boiled under reflux for 18 hr. The solution was concentrated to dryness and an aqueous solution of the syrupy residue was filtered, adjusted to pH 10 with 10% aqueous sodium hydroxide, and extracted with chloroform. Concentration of the dried ($MgSO_4$) extract and distillation of the residue gave ethyl αβ-desoaminide (5·7 g., 69%) as a colourless syrup, b. p. 66—68°/0·4 mm. Flynn *et al.*[30] record b. p. 65—67°/0·2 mm.

To a solution of the foregoing product (1·01 g.) in acetone (4 ml.) was added methyl iodide (2·27 g., 3 mol.), when the crystalline methiodide was precipitated. After evaporation of the solvent from the mixture, the residue was recrystallised from acetone to give ethyl αβ-desosaminide methiodide (0·76 g., 44%), m. p. 188—190°, $[\alpha]_D^{25}$ +90° (*c* 1·0 in $H_2O$), $[M]_D$ +310° (Found: C, 37·9; H, 7·0; I, 36·2; N, 3·9. $C_{11}H_{24}INO_3$ requires C, 38·3; H, 7·0; I, 36·8; N, 4·1%). Newman [15] records m. p. 186—188°. In a repeat experiment, the methiodide was obtained in 82% yield.

*Ethyl 2,3-Anhydro-4,6-dideoxy-αβ-*D*-ribo-hexopyranoside.*—To a solution of ethyl αβ-desosaminide methiodide (0·353 g.) in water (20 ml.) was added silver oxide (1 g., 10 mol.), and the mixture was stirred magnetically for 30 min. Filtration and concentration of the iodide-free solution at room temperature gave ethyl αβ-desosaminide methohydroxide (0·25 g., 100%) as a colourless syrup.

The methohydroxide (0·838 g.) was pyrolysed at 80—200° (bath)/12 mm. to give *ethyl 2,3-anhydro-4,6-dideoxy-αβ-*D*-ribo-hexopyranoside* (0·33 g., 59%), b. p. 74—84°/12 mm. (Found: C, 60·35; H, 9·05. $C_8H_{14}O_3$ requires C, 60·7; H, 8·9%). Examination of the epoxide by thin-layer chromatography showed one major component with traces of unidentified, slower-moving substances.

*Action of Sodium Methoxide on the Foregoing Epoxide.*—A solution of the epoxide (4·43 g.) in methanolic sodium methoxide [obtained by dissolving sodium metal (3·8 g.) in dry methanol (350 ml.)] was boiled under reflux for 3·5 days when examination by thin-layer chromatography showed a negligible amount of remaining epoxide; in repeated experiments, continuation of the methoxide treatment for from 3 to 5 days was required to effect complete opening of the epoxide. Carbon dioxide was then bubbled through the cooled solution for 1 hr., the precipitated sodium carbonate removed by filtration, and the solution concentrated to dryness. Extraction of the residue with chloroform and distillation [110—150° (bath)/12 mm.] of the concentrated extract gave a colourless liquid (3·9 g., 74%). Thin-layer chromatography of this product showed two major components ($R_F$ 0·28 and 0·65), and, after acidic hydrolysis (N-sulphuric acid at 95° for 3 hr.), paper chromatography showed a mixture of reducing sugars having $R_F$ 0·74, 0·84, and 0·61 (minor component); chalcose had $R_F$ 0·74. Chalcose and the reducing sugar with $R_F$ 0·74 underwent the same characteristic series of colour changes with aniline hydrogen phthalate. A light brown spot was obtained initially but, on storage overnight, the outer edges assumed a grey-green colour; with small amounts of sugar, the entire spot assumed the latter colour.

The consumption of periodate (determined by the standard arsenite procedure [31]) by a portion of the above product indicated the presence of *ca.* 5% of vicinal diol impurity. A solution of the product (1·79 g.) in water (50 ml.) containing sodium metaperiodate (2 g.) was therefore stored in the dark for 4 hr. and then extracted with chloroform (10 × 25 ml.). The dried ($MgSO_4$) extract was concentrated to dryness and an aqueous solution of the residue was

[25] E. Merck AG, Darmstadt, " Chromatography," 2nd edn., p. 30.
[26] A. B. Foster, *Chem. and Ind.*, 1952, 1050.
[27] A. B. Foster, Miss P. A. Newton-Hearn, and M. Stacey, *J.*, 1956, 30.
[28] W. E. Trevelyan, D. P. Procter, and J. S. Harrison, *Nature*, 1950, **166**, 444.
[29] S. M. Partridge, *Nature*, 1949, **164**, 443.
[30] E. H. Flynn, M. V. Sigal, jun., P. F. Wiley, and K. Gerzon, *J. Amer. Chem. Soc.*, 1954, **76**, 3121.
[31] E. L. Jackson, *Org. Reactions*, 1944, **2**, 341.

passed through a column of Amberlite IRA-400 resin ($HO^-$ form, 15 ml.). The eluate was adjusted to pH 7 with dilute hydrochloric acid, concentrated to *ca.* 70 ml., and extracted continuously with chloroform for 2 hr. Concentration of the dried ($MgSO_4$) extract and distillation [120—160° (bath)/12 mm.] of the residue gave a mixture (1·125 g.) of ethyl 4,6-dideoxy-2-*O*-methyl-αβ-D-*arabino*- and ethyl 4,6-dideoxy-3-*O*-methyl-αβ-D-*xylo*-hexopyranosides, $[\alpha]_D$ +132° (*c* 0·56 in $CHCl_3$) (Found: C, 56·5; H, 9·5. $C_9H_{18}O_4$ requires C, 56·8; H, 9·5%). Thin-layer chromatography of the product showed the same two major components described above, but, after acidic hydrolysis, paper chromatography showed only the reducing sugars with $R_F$ 0·74 and 0·84. Examination of the glycoside mixture by vapour-phase chromatography showed three components with retention distances of 10·2, 12·0, and 16·3 cm., and approximate weight ratios of 2·5 : 6 : 1. A *ca.* 0·005M-solution of the product in $CCl_4$ had $\nu_{max.}$ at 3600 (ε 34), 3576 (ε 43), and 3533 (ε 28) $cm.^{-1}$ for intramolecularly-bonded hydroxyl groups.

*Fractionation of the Glycoside Mixture.*—The foregoing mixture of glycosides (500 mg.) was adsorbed on a column of alumina (100 g., neutral, Brockmann III) which was then eluted (25 ml. fractions) with ether (3·35 l.) followed by methanol. Analysis by thin-layer chromatography gave the following results:

| Fractions | Component $R_F$ value | Yield (mg.) |
|---|---|---|
| 50—94 | 0·65 | 157 |
| 95—112 | 0·65 (traces only), 0·46 | *ca.* 15 |
| 113—136 | No component detected | — |
| 137—165 | 0·28 | 368 |

Distillation of the material from fractions 137—165 gave *ethyl* 4,6-*dideoxy*-3-O-*methyl*-αβ-D-xylo-*hexopyranoside* as a pale yellow liquid, b. p. 155—170° (bath)/12 mm., $[\alpha]_D^{24}$ +147° (*c* 0·54 in $CHCl_3$) (Found: C, 56·4; H, 9·5. $C_9H_{18}O_4$ requires C, 56·8; H, 9·5%). Examination by vapour-phase chromatography showed two components (retentions 11·7 and 15·9 cm.), with an approximate weight ratio of 5·5 : 1.

Distillation of the material from fractions 50—94 gave *ethyl* 4,6-*dideoxy*-2-O-*methyl*-α-D-arabino-*hexopyranoside* as a colourless liquid, b. p. 150—160° (bath)/12 mm., $[\alpha]_D^{24}$ +65° (*c* 0·46 in $CHCl_3$) (Found: C, 56·7; H, 9·6. $C_9H_{18}O_4$ requires C, 56·8; H, 9·5%). Vapour-phase chromatography showed a single component with retention distance 10·1 cm. Acidic hydrolysis of the glycoside with N-sulphuric acid at 95—100° for 3 hr., concentration of the neutralised [aqueous $Ba(OH)_2$] hydolysate, and attempted sublimation of the residue at *ca.* 80°/0·1 mm. gave a colourless, viscous liquid, $[\alpha]_{5461}^{21}$ *ca.* +1° (*c* 0·4 in $H_2O$). Paper chromatography showed a homogeneous, reducing product with $R_F$ 0·84. In paper electrophoresis, the product had zero mobility; chalcose had $M_G$ *ca.* 0·1.

4,6-*Dideoxy*-3-O-*methyl*-α-D-xylo-*hexose.*—Hydrolysis of the *xylo*-glycosides as described above for the *arabino*-isomer gave a syrupy product (96% yield) which in paper chromatography showed a single component having the same $R_F$ value (0·74) as natural chalcose. Sublimation of a portion (109 mg.) of this material at 70—80°/0·1 mm. gave a colourless, crystalline solid (60 mg.) which on recrystallisation from ether–light petroleum (b. p. 60—80°) gave 4,6-dideoxy-3-*O*-methyl-α-D-*xylo*-hexose, m. p. 91—94° alone or in admixture with natural chalcose [8] (m. p. 92—96°), $[\alpha]_D^{24}$ +130 (*c* 0·4 in $H_2O$; 3 min.) ⟶ +78° (equilib., 3 hr.). Woo *et al.*[8] record m. p. 96—99°, $[\alpha]_D^{24}$ +120 (2 min.) ⟶ +76° (equilib., 3 hr.) in water for natural chalcose, and Kochetkov and Usov [11] record m. p. 92—93°, $[\alpha]_D$ +96 (15 min.) ⟶ +75° (equilib., 3 hr.) in water for synthetic chalcose. The infrared spectra (KBr disc) of the product and natural chalcose were indistinguishable.

*Infrared Spectra.*—Dilute solution spectra in the hydroxyl stretching region (Table 1) were obtained using 2-cm. fused-quartz cells and a Unicam S.P. 100 spectrometer equipped with a grating (3000 lines/in.). The extinction coefficients (ε) are maximum values and are equal to $(1/cl)\log_{10}(I_0/I)$, with *l* in cm. and *c* in moles/l.

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