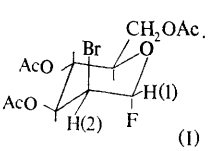
Structural Studies on Bromoglycosyl Fluorides

By J. C. CAMPBELL, R. A. DWEK, P. W. KENT, and C. K. PROUT*

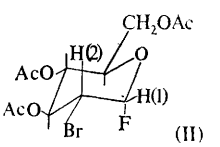
(*Departments of Biochemistry, Physical Chemistry, and *Crystallography, University of Oxford*)

IN a survey of bromofluorination reactions involving acetylated glycals, it has been reported[1] that 3,4,6-tri-*O*-acetyl-D-glucal with *N*-bromosuccinimide and anhydrous hydrogen fluoride in ether at −70° give two crystalline isomeric bromofluorides, 3,4,6-tri-*O*-acetyl-2-bromo-2-deoxy-β-D-mannopyranosyl fluoride (I) (major product) and 3,4,6-tri-*O*-acetyl-2-bromo-2-deoxy-α-D-glucopyranosyl fluoride (II). The *X*-ray crystal structure analysis of the *manno*-isomer (I) gives the crystal data: $C_{12}H_{16}O_7BrF$, $M = 371{\cdot}2$, orthorhombic disphenoidal, optically biaxial; $a = 6{\cdot}97 \pm 0{\cdot}02$, $b = 15{\cdot}47 \pm 0{\cdot}03$, $c = 14{\cdot}72 \pm 0{\cdot}03$ Å; $U = 1586$ Å^3; $D_m = 1{\cdot}544$ g.cm.$^{-3}$ by flotation; $Z = 4$; $D_c = 1{\cdot}555$ g.cm.$^{-3}$; $F(000) = 752$; Space group, $P2_12_12_1$; Cu-K_α radiation, $\mu = 42{\cdot}81$ cm.$^{-1}$; 910 independent reflections were measured visually from equi-inclination Weissenberg photographs.

The position of the bromine atom was determined from a three-dimensional Patterson function "sharpened to point atoms at rest" and the light atoms were located from a three-dimensional



(I)



(II)

minimum function. The trial structure, with individual isotropic temperature factors, was refined by full-matrix least-squares. Hydrogen atoms were placed by difference syntheses. The reliability factor, *R*, stands at 10·1%, the bond length e.s.d.'s being $\gtrsim 0{\cdot}04$ Å.

The projection of the molecule perpendicular

to the plane of the 4-acetoxy-side-chain clearly shows that the bromine atom on C-2 and the fluorine atom on C-1 are *trans*-diaxial. Thus (I) is in fact the α-D-mannopyranosyl fluoride, and thus it accords with results of other glycal additions.[2]

The ^{19}F and proton magnetic resonance spectra of (I) were interpreted on the basis of the above structure and the values $J_{H-1,F}$ (*gem*) = 51·0 ± 1·0 c./sec. and $J_{H-2,F}$ (gauche) = 2·7 ± 0·3 c/sec. were assigned. Similar values for $J_{H-1,F}$ (*gem*) have been observed in the other glycosyl fluorides examined by ourselves and Hall and Manville.[3] The coupling constants for $J_{H-2,F}$ (gauche) were of the same order as above, whereas the values for $J_{H-2,F}$ (*trans*) were of the order of 27 c./sec. Their use as a simple diagnostic test for establishing the stereochemistry of the C(1)–C(2) positions already suggested by Hall and Maville,[3] is validated by comparisons with an independently determined structure in our systems. Thus ^{19}F resonance measurements confirmed the structures proposed for 2-bromo-2-deoxy-α-D-galactopyranosyl fluoride,[4] 2-bromo-2-deoxy-β-D-arabinopyranosyl fluoride[5] and compound (II). However, the sugar previously described[6] as the β-anomer was found to be 2,4,5-tri-*O*-acetyl-2-deoxy-2-iodo-α-D-mannopyranosyl fluoride.

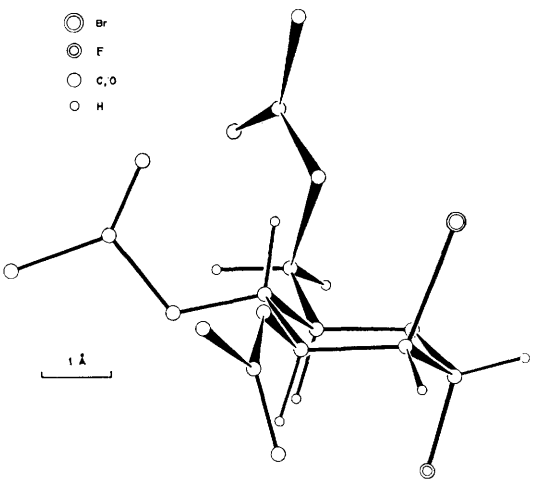


FIGURE. *The projection of the molecule perpendicular to the plane of the 4-acetoxy-side-chain.*

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