and −0.96 (2 H). None of this product was observed in any of the reaction conditions above.

Dimethyl-2-chloroethylamine hydrochloride (II HCl) in ^2H_2O (0.1 *M*, pH 5) showed nmr absorption at δ' −1.71 (6 H), −1.10 [triplet, J = 6.0 cps (2 H)], and −0.66 [triplet, J = 6.0 cps (2 H)]. On adjustment of the pH to 9 with sodium bicarbonate, these shifted to δ' −2.34, −1.85, and −0.91, respectively. The singlet for the aziridinium methylenes in II_{im}, δ' −1.51, developed rapidly but was quickly converted to the cyclic dimer, N,N,N′,N′-tetramethylpiperazinium ion, δ' −1.20 (3 H) and −0.64 (2 H). Data on rate of conversion are summarized in Table I.

For the **Bunte salt from II**, prepared from 0.2 *M* II and 2 *M* sodium thiosulfate in ^2H_2O by heating to 75° for 2.5 hr, nmr absorption was observed as sharp singlets at δ' −1.78 (6 H) and δ' −1.17 (4 H).

For **methylbis(2-chloroethyl)amine (III)** about 1 *M* in water and also 1 *M* in sodium bicarbonate, nmr spectra showed absorption at δ' −2.67 (3 H), −2.18 [triplet, J = 8.4 cps (4 H)], and −1.25 [triplet, J = 8.4 cps (4 H), CH_2Cl], rapidly developing absorption for III_{im} at δ' −1.74 (3 H) and −1.60 [doublet, J = 2.4 cps (4 H)] and for the cyclic dimer, N,N′-dimethyl-N,N′-bis(2-chloroethyl)piperazinium dichloride (III_{cd}), at δ' −1.30 (singlet, 6 H) and −0.52 (singlet, 8 H). These spectra were useful for following the course of reaction, as summarized in Table II. Our values for nmr chemicals shifts and rates of reaction are not in full agreement with those of Levins and Papanastassiou,[5] perhaps owing to some differences in pH. Our reaction mixtures were buffered by 1 *M* bicarbonate, theirs were "neutralized by a predetermined amount of sodium hydroxide."

Registry No.—I, 100-35-6; cyclic dimer of I, 18386-47-5; II, 107-99-3; III, 51-75-2.

Branched-Chain Sugar Nucleosides. Synthesis of a Purine Nucleoside of 4-*O*-Acetyl-L-arcanose

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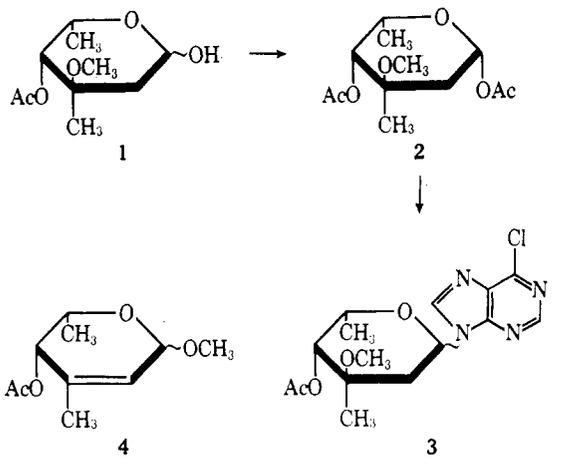
Arcanose is a dideoxy branched-chain sugar which occurs naturally as its 4-*O*-acetyl derivative in lankamycin,[1] a medium-spectrum macrolide antibiotic produced by *Streptomyces violaceoniger*.[2] By a combination of nmr and degradative studies, the 2,6-dideoxy-3-*C*-methyl-3-*O*-methyl-L-*xylo*-hexose structure **1** was proposed for arcanose (Scheme I).[3] This assignment has been corroborated recently by us[4] by the synthesis of the D-enantiomer. We report now the utilization of L-arcanose in the preparation of 6-chloro-9-(4′-*O*-acetyl-2′,6′-dideoxy-3′-*C*-methyl-3′-*O*-methyl-β-L-*xylo*-hexopyranosyl)purine (**3**), the first synthetic nucleoside containing a naturally occurring branched-chain sugar.

SCHEME I



Attempts to obtain a glycosyl chloride derivative of **1** by treatment of its methyl glycoside with methylene chloride saturated with hydrogen chloride were unsuccessful. Although thin layer chromatography (tlc) showed that predominantly one compound had been formed, the nuclear magnetic resonance (nmr) spectrum of the crude product indicated the loss of a methoxyl group and the H-2ax hydrogen, and a downfield shift from τ 8.9 to 8.5 of the signal attributable to the C-3 tertiary methyl group. These data are consistent with the loss of methanol between C-2 and C-3 to give the unsaturated derivative **4**.

Treatment of 4-*O*-acetyl-L-arcanose[4] with acetic anhydride and pyridine gave a syrupy diacetate (**2**), which was assigned the β-L configuration by nmr spectroscopy. Condensation of 1,4-di-*O*-acetyl-2,6-dideoxy-3-*C*-methyl-3-*O*-methyl-β-L-*xylo*-hexopyranose (**2**) with 6-chloropurine was achieved by fusing an intimate mixture of the two compounds in the presence of a trace of *p*-toluenesulfonic acid at 100° for 5 min. Fractionation of the complex mixture of products by preparative tlc on silica gel afforded the pure branched-chain sugar nucleoside **3**. The anomeric configuration has not been established. The ultraviolet absorption, uv max (EtOH) 264 mμ (ε 11,000), is in agreement with a 9-substituted purine.[5]

Experimental Section[6]

1,4-Di-*O*-acetyl-2,6-dideoxy-3-*C*-methyl-3-*O*-methyl-β-L-*xylo*-hexopyranose (2).—A solution of **1** (105 mg) in pyridine (3 ml) and acetic anhydride (2 ml) was kept at ambient temperature overnight. The reaction mixture was poured into water, and the product isolated in the usual manner. Fractionation of the crude product on silica gel (100 × 2 cm column) with 2:3 ethyl acetate–petroleum ether as eluent gave 100 mg (80%) of diacetate **2** as a colorless mobile oil: $[\alpha]_D$ +35° (*c* 1.1, EtOAc); ir (film) 5.75 μ (OAc); nmr ($CDCl_3$) τ 4.1 (one-

(1) (a) W. Keller-Schierlein and G. Roncari, *Helv. Chim. Acta*, **45**, 138 (1962); (b) *ibid.*, **47**, 78 (1964).

(2) E. Gäumann, R. Hütter, W. Keller-Schierlein, L. Neipp, V. Prelog, and H. Zähner, *ibid.*, **43**, 601 (1960).

(3) G. Roncari and W. Keller-Schierlein, *ibid.*, **49**, 705 (1966).

(4) G. B. Howarth, W. A. Szarek, and J. K. N. Jones, *Chem. Commun.*, 62 (1968); *Carbohyd. Res.*, **7**, 284 (1968).

(5) E. E. Leutzinger, W. A. Bowles, R. K. Robins, and L. B. Townsend, *J. Amer. Chem. Soc.*, **90**, 127 (1968).

(6) Optical rotations were measured with a Perkin-Elmer Model 141 polarimeter at 20 ± 2°. Infrared spectra were measured on a Beckman-IR5A spectrophotometer. Ultraviolet spectra were measured with a Unicam SP 800B spectrophotometer. Nmr spectra were determined with a Varian A-60 spectrometer; the freshly prepared compounds were examined in chloroform-*d* with tetramethylsilane as the internal standard. Thin layer chromatography was performed using silica gel G and 2:3 ethyl acetate–petroleum ether (bp 60–80°), with indication by sulfuric acid.

proton quartet, $J_{1ax,2ax}$ = 9 Hz, $J_{1ax,2eq}$ = 3 Hz, H-1), 5.26 (one-proton broad singlet, H-4), 5.78 (one-proton octet, $J_{5,6}$ = 6 Hz, $J_{5,4}$ = 1 Hz, H-5), 6.75 (three-proton singlet, C-3 OMe), 7.9, 7.95 (three-proton singlets, C-1 and C-4 OAc's), 8.9 (three-proton singlet, C-3 Me), 8.9 (three-proton doublet, J = 6 Hz, C-5 Me).

Anal. Calcd for $C_{12}H_{20}O_6$: C, 55.5; H, 7.7. Found: C, 55.8; H, 7.9.

6-Chloro-9-(4′-*O*-acetyl-2′,6′-dideoxy-3′-*C*-methyl-3′-*O*-methyl-β-L-*xylo*-hexopyranosyl)purine (3).—An intimate mixture of compound **2** (24 mg), 6-chloropurine (16 mg, 1.1 equiv), and a trace of *p*-toluenesulfonic acid was heated at 100° (oil bath temperature) for 5 min. The dark brown solid residue was extracted with two 10-ml portions of hot ethyl acetate and the extracts were concentrated to a viscous syrup after treatment with carbon. Tlc showed the presence of eight components, the major one having R_f 0.13. Preparative tlc afforded 3.8 mg (12%) of nucleoside **3** as a homogeneous glass: R_f 0.13 (tlc); $[\alpha]_D$ +10° (*c* 0.4, EtOAc), $[\alpha]_{365}$ +50° (*c* 0.4, EtOAc); uv max (EtOH) 208 mμ (ε 13,000), 264 (11,000); ir (film) 5.75 (OAc), 6.3, 6.4, 6.7 μ (purine ring); nmr ($CDCl_3$) τ 1.23, 1.62 (one-proton singlets, H-8 and H-2), 4.15 (one-proton quartet, $J_{1'ax,2'ax}$ = 8 Hz, $J_{1'ax,2'eq}$ = 4.5 Hz, H-1′), 5.05 (one-proton broad singlet, H-4′), 5.70 (one-proton multiplet, H-5′), 6.60 (three-proton singlet, C-3′ OMe), 7.76 (three-proton singlet, C-4′ OAc), 8.74 (three-proton singlet, C-3′ Me), 8.8 (three-proton doublet, J = 6 Hz, C-5′ Me).

Anal. Calcd for $C_{15}H_{19}O_4N_4Cl$: C, 51.0; H, 5.4; N, 15.8. Found: C, 51.3; H, 6.0; N, 15.4.

Registry No.—2, 7308-86-3; **3**, 18339-01-0.

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The Reactions of 3-Hydroxyflavanone with Carbonyl Reagents

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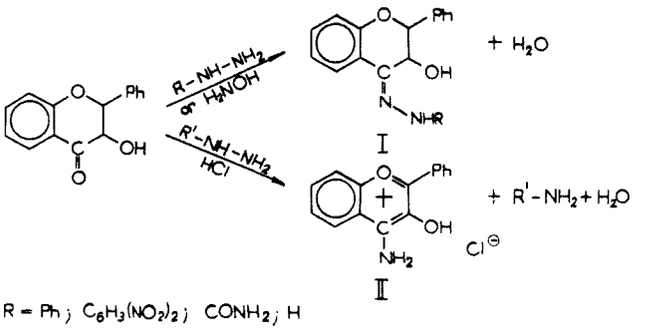
An extension of the study on the carbonyl reactions of flavanone[1] has shown that 3-hydroxyflavanone with *p*-tosylhydrazine gives, by an anomalous reaction, 3-hydroxy-4-aminoflavylium chloride.[2]

The present study is aimed at establishing the conditions leading to the formation of the true carbonyl derivatives I of 3-hydroxyflavanone, or of the flavylium salt II.

Examples from the literature[3] and our additional experiments have revealed that the normal carbonyl derivatives I can be prepared by reacting 3-hydroxyflavanone with hydrazine, a substituted hydrazine, or hydroxylamine.

The use of an acid hydrazide invariably results in the formation of the flavylium salt II (Scheme I).

SCHEME I[a]



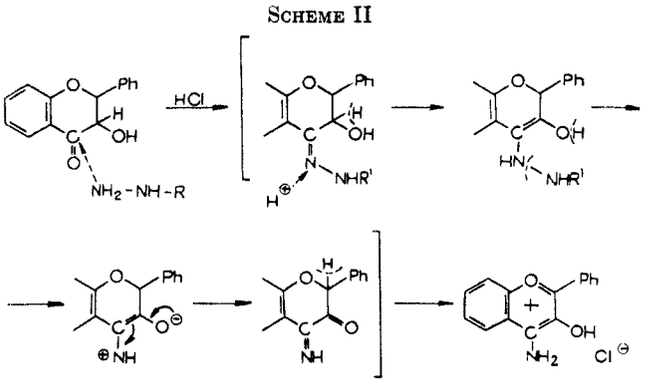
R = Ph; $C_6H_3(NO_2)_2$; $CONH_2$; H

R′ = $SO_2C_6H_4CH_3$; $SO_2C_6H_4Br$; $COC_6H_4NO_2$; COPh; $COCH_3$

[a] In the case of hydroxylamine NHR stands for OH.

Presumably, I is the primary product of the reaction leading to II; it is the electron-withdrawing character of the substituent attached to the N atom of the carbonyl reagent and the pH of the reaction medium which decide whether I is isolable as such, or eliminates $R'NH_2$ to become converted into II. The yields of II are higher as the electrophilic character of R′ is increased. The role of I as an intermediate is confirmed by conversion of the isolated normal carbonyl derivatives (including the oxime) into the aminocyanidin salt by boiling them in alcoholic hydrochloric acid. For further evidence, 3-hydroxyflavanone tosylhydrazone (I, R = $SO_2C_6H_4CH_3$) was prepared by tosylation in alkaline medium. This compound is converted into II in hot alcoholic HCl, in quantitative yield. It is reasonable to suppose the reaction mechanism given in Scheme II.

SCHEME II



The necessity of the presence of an enolizable 3-OH group is shown by the experimental evidence that while 3-acetoxyflavanone N-monoacetylhydrazone gives mainly 3-hydroxyflavanone on treatment with alcoholic HCl, the 3-hydroxy derivative is converted into II in 63% yield.

A continuation of this work is in progress concerning the carbonyl reactions of C_5-substituted 3-hydroxyflavanones.

Experimental Section

All melting points were determined on a Kofler block and are uncorrected. The compounds were checked for purity by tlc;

(1) F. Kállay, G. Janzsó, and I. Koczor, *Tetrahedron*, **23**, 4317 (1967).
(2) G. Janzsó, F. Kállay, and I. Koczor, *ibid.*, **22**, 2909 (1966).
(3) R. Bognár, M. Rákosi, H. Fletcher, E. M. Philbin, and T. S. Wheeler, *ibid.*, **19**, 391 (1963).