signal based on the vinylic proton which exists in the cobalt chelate of I is not observed in the bromination product. The bromination on the chelates of other kinds of metals were unsuccessful. Full details of this communication will appear in the forth-coming issue of this Bulletin.

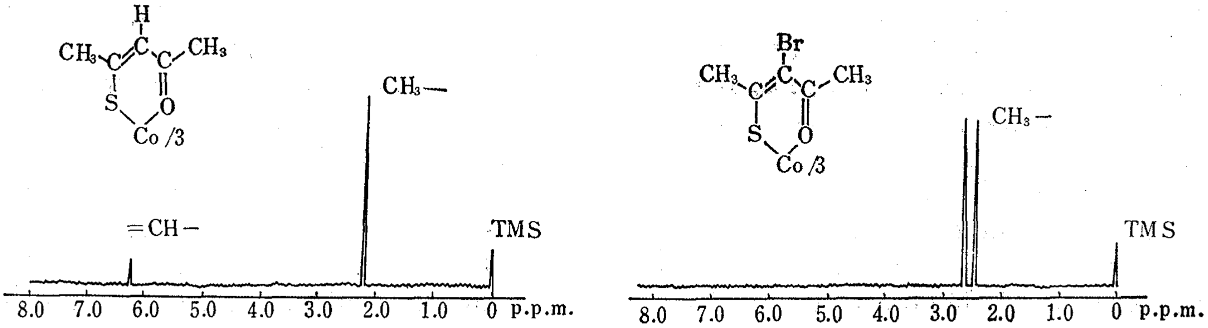

Fig. 1. Nuclear Magnetic Resonance Spectra of Co-Chelate of I and It's Bromination Product

The authors are indebted to the members of the microanalytical center of Kyoto University for the analytical data. The IR spectra were taken by Mr. M. Yamamoto of Kyoto University, and the NMR spectra were measured by Dr. T. Shingu of Kyoto University, to whom the authors are also grateful.

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Synthesis of 2′-Deoxy-2′-thio-3′-deoxy-3′-aminouridine

The synthesis of ribonucleoside analogues, in which 2′-hydroxyl groups in ribofuranosyl residue is substituted with other groups, such as thiol group, should be of worthwhile from the view point that they may reveal some information about the biochemical significance of the hydroxyl group which is substituted with hydrogen in deoxyribonucleosides.

This paper communicates the synthesis of 2′-deoxy-2′-thio-3′-deoxy-3′-aminouridine which was obtained by an intramolecular nucleophilic attack, "complex neighboring approach,[1]" at the activated 2′-carbon atom by a thiocarbonyl group previously

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[*1] Rf_1, Rf_2 and Rf_3 indicate the Rf values of the compound run in respective solvents of: solvent 1, *n*-BuOH-H_2O (84:16); solvent 2, iso-PrOH-conc. NH_4OH-H_2O (7:1:2); and solvent 3, methylethylketone satulated with H_2O; using ascending technique.

[*2] $M_{urid.}$ represents the relative mobility towards cathode of the compound to that of uridine in paper electrophoresis run at pH 4.0 (acetate buffer) and 22.5 V/cm. for 1 hr.

[*3] On paper chromatogram, this reagent which was reported by Grote (I. W. Grote: J. Biol. Chem., **93**, 25 (1931)) for detection of organic sulfur compounds, colored green with those containing C=S and -SH, but it did not color when the thiol group was oxidized to C-S-S-C.

1) L. Goodman, J. E. Christensen: J. Org. Chem., **28**, 2610 (1963).

introduced to the 3′-position. The starting compound, 1-(3′-deoxy-3′-amino-β-D-arabinofuranosyl)uracil (I) was synthesized according to Codington, *et al.*2) and I was reacted with carbondisulfide in pyridine in the presence of triethylamine. The followed methylation of the product with methyl iodide and separation of the product by cellulose column chromatography gave 1-[3′-deoxy-3′-(dithiocarbomethoxy)amino-β-D-arabinofuranosyl]uracil (II), $C_{11}H_{15}N_3O_5S_2$, m.p. 176.5~177° (decomp.), Rf_1*1 =0.69, Rf_2 = 0.72, Rf_3 =0.77, UV $\lambda_{\max}^{\text{pH 1 and 7}}$ mμ (ε) : 265 (22200), $\lambda_{\min}^{\text{pH 1 and 7}}$ 232 (4600), $\lambda_{\max}^{\text{pH 13.4}}$ 260 (13700), $M_{\text{urid.}}$*2 0.88, $[\alpha]_D^{22}$ +78° (C =0.44, MeOH), in 73% yield. II colored green with Grote's reagent.*3 The 5′-hydroxyl group of II was protected by its reaction with methyl chloroformate in pyridine and the amorphous product (III), $C_{13}H_{17}N_3O_7S_2$, Rf_1 =0.81, UV $\lambda_{\max}^{\text{pH 1 and 7}}$ mμ : 265, $\lambda_{\min}^{\text{pH 1 and 7}}$ 232, $\lambda_{\text{shoulder}}^{\text{pH 13.4}}$ 260, IR $\nu_{\max}^{\text{KBr}}$ cm^{-1} : 1765 (ester C=O), was obtained in 86.5% yield. III was subsequently mesylated as usual with methanesulfonyl chloride in pyridine and the 2′-mesylester of III, (IV), Rf_1 0.83, UV $\lambda_{\max}^{\text{pH 1 and 7}}$ mμ : 265, $\lambda_{\min}^{\text{pH 1 and 7}}$ 232, $\lambda_{\text{shoulder}}^{\text{pH 13.4}}$ 260, IR $\nu_{\max}^{\text{KBr}}$ cm^{-1} : 1180 (sulfonate ester), 1760 (ester C=O), was isolated as amorphous yellow powder in *ca.* 65% yield. On refluxing a pyridine solution of IV in nitrogen atmosphere, the intramolecular nucleophilic attack of 2′-carbon by the thiocarbonyl group, which was substituted at 3′-amino group, caused a formation of a thiazoline ring and the product (V), 1-[5′-O-methoxycarbonyl-2′,3′-dideoxy-{2″-methylthio-(3′,2′:4″,5″)-2″-thiazoline}-β-D-ribofuranosyl]-uracil, Rf_1 =0.75, UV $\lambda_{\max}^{\text{pH 1}}$ mμ : 259, $\lambda_{\max}^{\text{pH 7}}$ 258, $\lambda_{\text{shoulder}}^{\text{pH 13.4}}$ 260, IR $\nu_{\max}^{\text{KBr}}$ cm^{-1} : 1762 (ester C=O), 1565 (C=N), was obtained as a glass in *ca.* 53% yield. The methoxycarbonyl group at 5′-position of V was removed by treatment of V with sodium methoxide and the product (VI), 1-[2′,3′-dideoxy-{2″-methylthio-(3′,2′:4″,5″)-2″-thiazoline}-β-D-ribofuranosyl]uracil, needles, m.p. 206.5~207° (dec.), $C_{11}H_{13}N_3O_4S_2$, Rf_1 =0.65, Rf_3 =0.66, $M_{\text{urid.}}$ =0.82, $[\alpha]_D^{23}$ −42° (C =0.42, MeOH), UV $\lambda_{\max}^{\text{pH 1}}$ mμ (ε) : 260 (22600), $\lambda_{\min}^{\text{pH 1}}$ 227 (5200), $\lambda_{\max}^{\text{pH 7}}$ 257.5 (12500), $\lambda_{\min}^{\text{pH 7}}$ 230 (9400), $\lambda_{\text{shoulder}}^{\text{pH 13.4}}$ 260 (9500), IR$\nu_{\max}^{\text{KBr}}$ cm^{-1} : 1558 (C=N), was obtained in 18% yield calculated from II. VI was also produced by direct treatment of IV with methanolic sodium methoxide. Next, VI was reduced with aluminum-amalgam in tetrahydrofuran and the product (VII), 1-[2′,3′-dideoxy-(3′,2′:4″,5″)thiazolidine-β-D-ribofuranosyl]uracil, Rf_1 =0.26, Rf_3 =0.27, UV $\lambda_{\max}^{\text{pH 1}}$ mμ : 261.5, $\lambda_{\max}^{\text{pH 7}}$ 263.5, $\lambda_{\min}^{\text{pH 1 and 7}}$ 233, $\lambda_{\max}^{\text{pH 13.4}}$ 262, $\lambda_{\text{shoulder}}^{\text{pH 13.4}}$ 246, was isolated as a white glass in 68% yield. On treatment of VII with aqueous mercuric chloride, the thiazolidine ring was decomposed to give mercuric chloride complex of 2′-deoxy-2′-thio-3′-deoxy-3′-aminouridine hydrochloride (VIII), powder, $C_9H_{12}N_3O_4S\cdot HCl\cdot HgCl\cdot HgCl_2$, m.p. 195.5° (decomp.) in 44% yield from VI. Upon bubbling of hydrogen sulfide through a suspension of the mercuric complex (VIII) in methanol, the product was obtained as amorphous white powder, yield 98%, which on paper chromatography in solvent 1 showed, by scanning over UV-light, a distinct spot (Rf_1 =0.07) of the main product and two additional faint spots at Rf_1 0.01 (A) and 0.11 (B). The spot of the main product revealed positive reactions to Grote's reagent and periodate benzidine test. It colored yellow with ninhydrine similarly to cysteine and cysteine hydrochloride and migrated to cathode in electrophoresis at pH 4.0, indicating its mono-positive net-charge ($M_{\text{urid.}}$ 2.55). The main product, 1-(2′-deoxy-2′-thio-3′-deoxy-3′-amino-β-D-ribofuranosyl)uracil hydrochloride (IX) was extracted with water and characteristics in UV-absorption of IX were determined, UV $\lambda_{\max}^{\text{pH 1}}$ mμ : 262, $\lambda_{\min}^{\text{pH 1 and 7}}$ 232, $\lambda_{\max}^{\text{pH 7}}$ 262.5, $\lambda_{\text{shoulder}}^{\text{pH 13.4}}$ 263. The aqueous extract was oxidized with iodine and the paper chromatography run in solvent 1 of the product gave a single spot which had the same Rf_1 value of 0.01 to one of the above two faint spost (A). The both spots of the oxidation product and A gave no coloration with Grote's reagent indicating that the side product which gave spot A must be a disulfide

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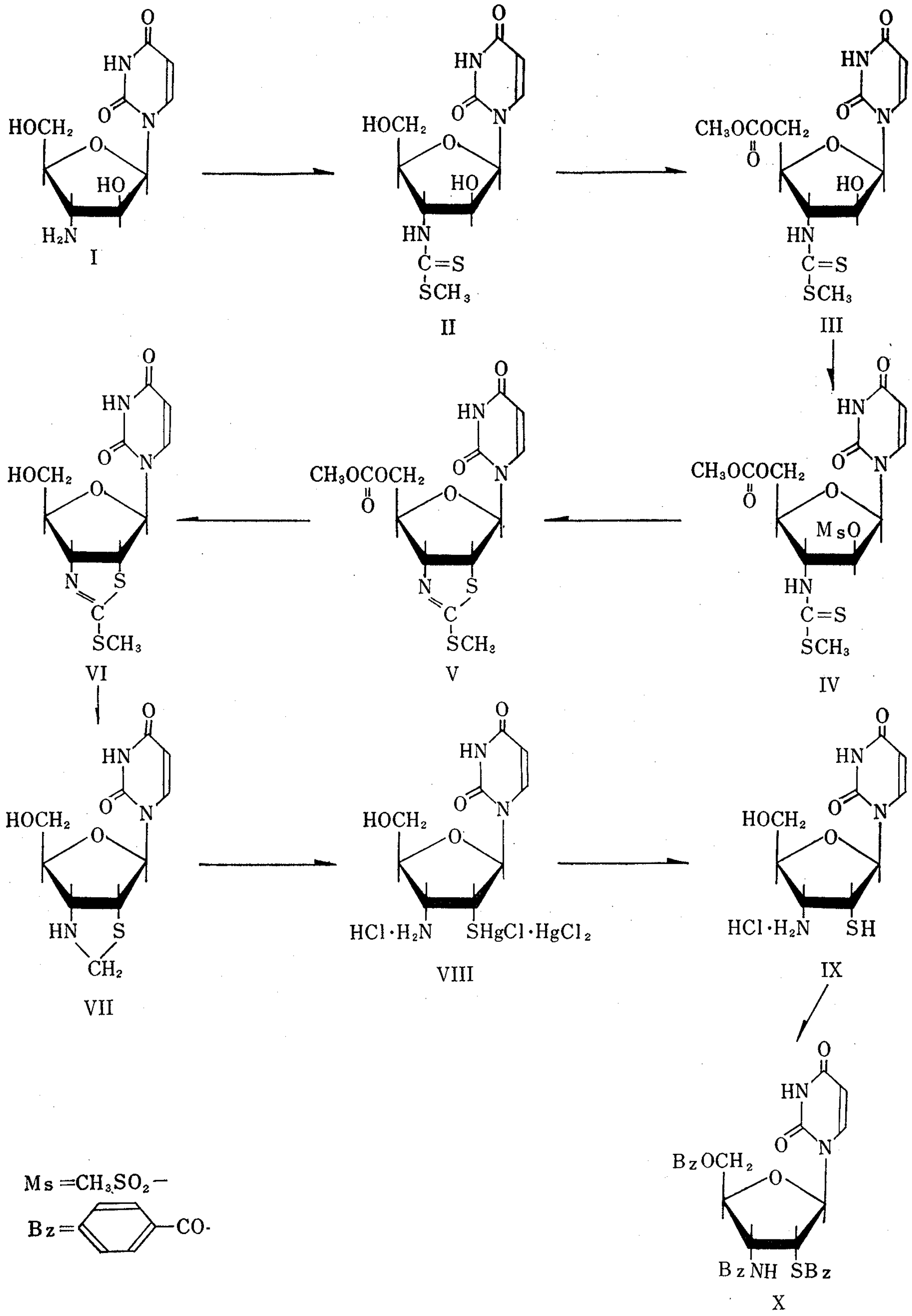
2) J. F. Codington, R. Fecher, J. J. Fox : J. Org. Chem., **27**, 163 (1962).



derivative of IX. As for the compound which gave the faint spot B, no further study was performed.

The compound (IX) was benzoylated in pyridine as usual and the benzoate, 1-(5′-O-benzoyl-2′,3′-dideoxy-2′-benzoylthio-3′-benzoylamino-β-D-ribofuranosyl)uracil (X), $C_{30}H_{25}N_3O_7S\cdot 1/2H_2O$, Rf $=0.53$ (thin-layer chromatography in AcOEt), $[\alpha]_D^{24}$ $-39°$ (C $=0.59$, $CHCl_3$), UV λ_{max}^{EtOH} mμ (ε) : 232 (30300), $\lambda_{shoulder}^{EtOH}$ 260 (17200), was obtained in 51% yield from VIII. The study on the biological activities of the new analogues of uridine thus obtained is now under progress.

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Tricyclic Amines from Azabicyclic Compounds through Carbenes

We have reported1) our studies on the reactions of carbonium ions generated at 9-position of azabicyclo[3.3.1]nonane and 8-position of azabicyclo[3.2.1]octane. We now report on the extension of these studies to include reactions with carbenes at the same positions because these reactions would contribute to the conformations of these azabicyclic compounds.2)

Sodium salt obtained from 3-methyl-3-azabicyclo[3.3.1]nonan-9-one3) tosylhydrazone (I) of m.p. 186° (decomp.) was decomposed at 170° in Diglyme4) to give a tricyclic amine (II), $C_9H_{15}N$, b.p.$_{77}$ 109~110°, in 67% yield (*Anal.* Calcd. for $C_9H_{15}N$: C, 78.77; H, 11.02; N, 10.21. Found: C, 78.90; H, 10.96; N, 10.09). II was characterized as a crystalline methiodide (III), $C_{10}H_{18}NI \cdot 1/2H_2O$, m.p. 230°, and a picrate, $C_{15}H_{18}O_7N_4$, m.p. 180~195°. II showed no absorption in the ultraviolet region and the NMR (nuclear magnetic resonance) spectrum showed no absorption corresponding to any olefinic proton; but infrared absorption of II at 3030 cm^{-1} suggested the presence of a cyclopropane ring in II. Hofmann degradation of III afforded an unsaturated amine (IV), which formed crystalline hydrochloride of m.p. 181~183° (decomp.) (*Anal.* Calcd. for $C_{10}H_{18}NCl$: C, 63.98; H, 9.67; N, 7.46. Found: C, 63.64; H, 9.61; N, 7.37). The presence of an exocyclic methylene in IV was shown by infrared absorptions at 3080, 1651, and 867 cm^{-1}, and NMR absorptions at 4.96 and 4.83 p.p.m. The notable end absorption of IV in ultraviolet region indicated a conjugation of the cyclopropane ring and the exocyclic methylene. Furthermore, NMR spectrum of the methiodide (V) of IV indicated the presence of a dimethylaminomethylene group like $(CH_3)_2N-CH_AH_B-\overset{|}{C}H_X-$: H_A 3.53 p.p.m. (quartet), H_B 3.10 p.p.m. (quartet), $J_{AB}=13.5$, $J_{AX}=5.5$, $J_{BX}=8.5$ (c.p.s.). Hofmann degradation of V gave *m*-xylene which was identified by means of infrared, ultraviolet, and NMR spectrometry, and gas-liquid chromatography.

Different from II, the unsaturated amine (IV) easily took up hydrogen chloride or acetic acid to give VI (hydrochloride, m.p. 179°, and methiodide, m.p. 166° (decomp.)) or VII (picrate, m.p. 155~164°). Osmium tetroxide oxidation of IV afforded a diol (VIII) of

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1) S. Oida, M. Kurabayashi, E. Ohki: This Bulletin, **14**, 1418 (1966).
2) R. Lygo, J. McKenna, I.O. Sutherland: Chemical Communications, **15**, 356 (1965). N.W.J. Pumphrey, M.J.T. Robinson: Chem. & Ind. (London), 1903 (1963).
3) H.O. House, P.P. Wickham, H.C. Müller: J. Am. Chem. Soc., **84**, 3139 (1962).
4) S.J. Cristol, J.K. Harrington: J. Org. Chem., 28, 1413 (1963).