The Reaction of Epibromohydrin with Aromatic Cyclic Hydrazines A One-Step Synthesis of Pyrazolo[1,2-*a*]pyrazolium Salts (1)

T. W. G. Solomons, Richard W. Harold and Kathleen Whitney (2)

Chemistry Department, University of South Florida, Tampa, Florida 33620

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In the course of our work leading to the synthesis of 3a,6a-diazapentalenes (**5**) we investigated the reaction between pyrazoles and epibromohydrin as a possible route to **5**. Although our final goal was not realized by this route (3), we were pleased to find that the first step did furnish an easy synthesis of 2,3-dihydro-1*H*-pyrazolo-[1,2-*a*]pyrazolium bromides (**2**). The results are summarized in Table I.

TABLE I

1 and 2	R_1	R_2	R_3	% Yield
a	H	H	H	64
b	CH_3	H	H	35
c	H	Br	H	11
d	CH_3	H	CH_3	24

Only in the reaction of pyrazole (**1a**) was any attempt made to find conditions which lead to maximum yield. The product **2a** is a colorless crystalline solid which is soluble in water and alcohol. The proton magnetic resonance spectrum (in deuterium oxide) is consistent with the structure assigned. The equivalent pyrazolium protons, R_1 and R_3 appear as a low field doublet (J = 5 cps) at 8.25 δ, and the proton R_2 as a triplet (J = 5 cps) at 6.9 δ. The protons of the reduced ring occur at 5.45 δ (multiplet 1*H*) and between 4.6 δ and 4.8 δ (four peaks: 5H, methylene protons plus superimposed hydroxyl proton).

Compound **2a** was esterified by treating it with the appropriate anhydride, and thus were obtained the acetate, propionate, and butyrate (**3a**, R_4 = CH_3, C_2H_5 or *n*-C_3H_7).

All attempts to prepare **4a** by dehydration of the alcohol **2a** or by ester-pyrolysis of **3a** resulted either in no reaction at all or complete decomposition. Compound **4a** is ap-

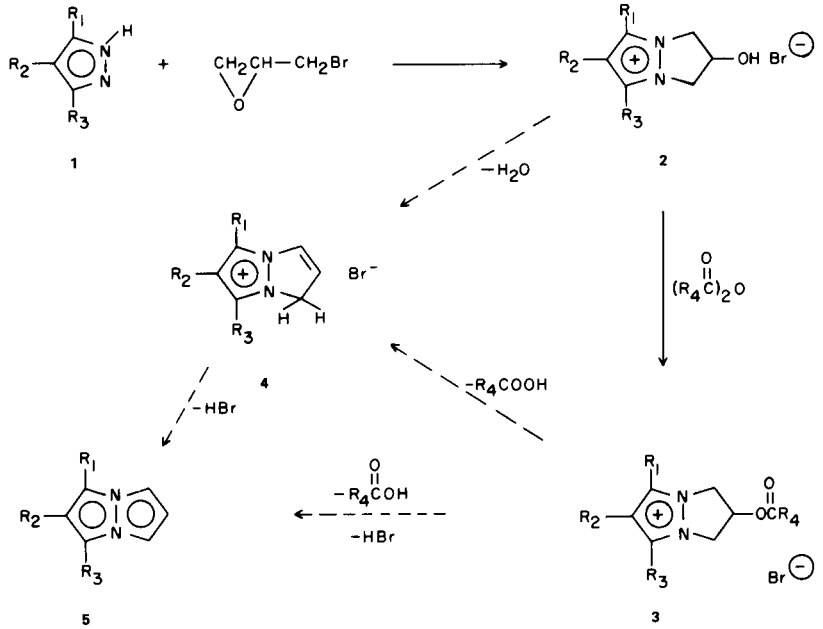
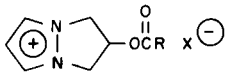


TABLE II

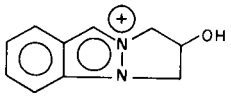
2-Acyloxy-2,3-Dihydro-1*H*-Pyrazolo[1,2-*a*]pyrazolium Salts



R	X	Yield %	M.p. °C	Formula	Calcd. % C	H	N	Found % C	H	N
CH_3	Br	65	117-119°	$C_8H_{11}BrN_2O_2$	38.88	4.48	11.34	38.89	4.71	11.12
CH_3	$C_6H_2N_3O_7$		158-160	$C_{14}H_{13}N_5O_9$	42.54	3.31	17.72	42.71	3.14	17.83
C_2H_5	Br	83	124-127	$C_9H_{13}BrN_2O_2$	41.39	5.02	10.77	41.43	4.88	10.90
n-C_3H_9	Br	44	110-112	$C_{10}H_{15}BrN_2O_2 \cdot 1/3H_2O$	42.72	5.62	9.96	42.90	5.80	9.93

parently unstable at temperatures required for dehydration or ester-pyrolysis. An attempt was made to carry out a double-elimination on the ester **3a** using lithium hydride. The reaction was carried out in deuteriodimethyl sulfoxide at room temperature and the reaction mixture was analyzed by NMR. Peaks characteristic of 3a,6a-diazapentalene (**5a**) appeared at 6.48 δ and 7.05 δ along with a number of other peaks characteristic of neither **5a** nor the starting ester. At the same time we developed a better synthesis of 3a,6a-diazapentalenes (3) and work on the route described here was discontinued.

Finally, indazole also was allowed to react with epibromohydrin to give the cation **6** in 16% yield.



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EXPERIMENTAL

Analyses were carried out by Galbraith Laboratories, Knoxville, Tenn. The melting points were determined in capillaries with a Laboratory Devices Melt-Temp block and are uncorrected. NMR data were obtained with a Varian A-60 Spectrophotometer using tetramethylsiiane as an external standard when deuterium oxide was the solvent and as an internal standard in deuteriodimethyl sulfoxide.

2-Hydroxy-2,3-dihydro-1*H*-pyrazolo[1,2-*a*]pyrazolium Bromide (**2a**).

Pyrazole (25 g., 0.367 mole) was dissolved in 100 ml. of dimethylformamide in a 300 ml. flask equipped with a dropping funnel, condenser, and magnetic stirring device. Both the condenser and dropping funnel were equipped with fresh drierite tubes. Heating on a steam bath and stirring were carried out while epibromohydrin (50.6 g., 0.367 mole) was added over a thirty minute period. Heating was continued for an additional eleven hours, then the solution was allowed to cool to room temperature. Slow addition of ethyl acetate caused the deposition of colorless prisms, yield 47.5 g., m.p. 187-191°. The analytical sample, m.p. 189-191°, was obtained by recrystallization from methanol-ethyl acetate.

Anal. Calcd. for $C_6H_9BrN_2O$: C, 35.14; H, 4.42; N, 13.66. Found: C, 35.27; H, 4.47; N, 13.89.

2-Hydroxy-2,3-dihydro-5-methyl-1*H*-pyrazolo[1,2-*a*]pyrazolium Bromide (**2b**).

A solution of 3-methylpyrazole (8.2 g., 0.10 mole) in 30 ml. of dimethylformamide was added dropwise to a solution of epibromohydrin (13.7 g., 0.10 mole) in 10 ml. of dimethylformamide over the course of one hour at 100°. The reaction mixture was left at room temperature for 16 hours, then ether was added to precipitate the product. The microcrystalline substance was recrystallized from propanol-ethyl acetate to yield 7.76 g. (35%) of a very hygroscopic colorless powder, m.p. 111-113°. The analytical sample, m.p. 112.5-114°, was obtained by recrystallization from acetonitrile-ether.

Anal. Calcd. for $C_7H_{11}BrN_2O$: C, 38.38; H, 5.06; N, 12.79. Found: C, 38.56; H, 5.15; N, 12.73.

The picrate, m.p. 168.5-169.5°, was prepared in ethanol.

Anal. Calcd. for $C_{13}H_{13}N_5O_8$: C, 42.52; H, 3.56; N, 19.07. Found: C, 42.74; H, 3.67; N, 18.85.

The tetraphenylborate, m.p. 181-182°, was prepared from ethanol.

Anal. Calcd. for $C_{31}H_{31}BN_2O$: C, 81.23; H, 6.81; N, 6.11. Found: C, 81.41; H, 6.95; N, 6.07.

6-Bromo-2-hydroxy-2,3-dihydro-1*H*-pyrazolo[1,2-*a*]pyrazolium Bromide (**2c**).

Epibromohydrin (2.74 g., 0.02 mole) in 25 ml. of dimethylformamide was added dropwise to a solution of 4-bromopyrazole (2.94 g., 0.02 mole) in an equal quantity of dimethylformamide. The reaction mixture was stirred at steam-bath temperature for 16 hours. The product, 0.64 g. (11%) was precipitated with ether as a tan powder, m.p. 233-235°. The analytical sample, m.p. 234-235°, was obtained by recrystallization from methanol.

Anal. Calcd. for $C_6H_8Br_2N_2O$: C, 25.38; H, 2.84; N, 9.87. Found: C, 25.20; H, 2.78; N, 9.68.

5,7-Dimethyl-2-hydroxy-2,3-dihydro-1*H*-pyrazolo[1,2-*a*]pyrazolium Tetraphenylborate (**2d**).

The bromide was obtained from 3,5-dimethylpyrazole and epibromohydrin in the same way as **2c**, but it could not be crystallized. When treated with sodium tetraphenylborate it gave a 24% yield of the tetraphenylborate as a colorless microcrystalline solid, m.p. 168-169°.

Anal. Calcd. for $C_{32}H_{33}BN_2O$: C, 81.36; H, 7.03; N, 5.93. Found: C, 81.22; H, 7.06; N, 5.84.

2-Hydroxy-2,3-dihydro-1*H*-pyrazolo[1,2-*a*]indazolium Tetraphenylborate (**6**).

This compound, m.p. 161-161.5°, was obtained in 18% yield in the same way as **2d**.

Anal. Calcd. for $C_{34}H_{31}BN_2O$: C, 82.60; H, 6.31; N, 5.67. Found: C, 82.40; H, 6.42; N, 5.80.

Esters of 2-Hydroxy-2,3-dihydro-1*H*-pyrazolo[1,2-*a*]pyrazolium Bromide.

These were prepared by adding an excess of the appropirate anhydride (10 ml.) to a solution of **2a** (0.015 mole) in pyridine (10 ml.) and stirring the reactants at room temperature for one to four days in a reaction vessel protected from moisture. The very hygroscopic salts were precipitated by the addition of ethyl acetate. The results are summarized in Table II.

REFERENCES

(1) This research was supported by an American Chemical Society, Petroleum Research Fund grant (# 1605-B).

(2) ACS-PRF Undergraduate Scholar, 1967.

(3) For successful syntheses of 3a,6a-diazapentalenes see T. W. G. Solomons and C. F. Voight, *J. Am. Chem. Soc.*, **88**, 1992 (1966) and references cited therein.