337 spectrometer for potassium bromide disks. Rotations were measured at 26° with a Kreis polarimeter 0.01 for solutions in chloroform. Nmr spectra were obtained for solutions in deuteriochloroform with a Varian HA-100 spectrometer, with tetramethylsilane as internal standard. Mass spectra were recorded on a Hitachi Perkin-Elmer RMU 6E at 70 eV using a direct inlet system. Thin layer chromatograms were prepared on silica gel G and developed with chloroform–ethylamine (usually 100:2–5, v/v); the spots were observed either by spraying with Dragendorff's reagent or by exposure to iodine vapor. All extracts were dried over anhydrous sodium sulfate or magnesium sulfate before evaporation. Microanalyses were carried out by A. Bernhardt, Microanalytical Laboratory, 5251 Elbach über Engelskirchen, West Germany.

**Alkaline Hydrolysis of Daphmacropodine (1b).**—The alkaloid (100 mg) was heated under reflux with 1 *N* methanolic sodium hydroxide (10 ml) for 1.5 hr. After addition of water, the product was extracted with chloroform and the chloroform extract was washed with water, dried, and evaporated. The crude product (92 mg) thus obtained was chromatographed over Merck standardized alumina (activity II–III). Elution with 2–5% methanol in chloroform yielded the deacetyl derivative **2** (35 mg). After recrystallization from acetone, it showed mp 130–135°.

*Anal.* Calcd for $C_{30}H_{49}O_3N$: C, 76.38; H, 10.47; N, 2.97. Found: C, 76.15; H, 10.26; N, 3.10.

**Oxidation of the Deacetyl Derivative 2 with Jones Reagent.**[6]—The deacetyl derivative **2** (50 mg) in acetone (3 ml) was oxidized with stirring at 0° with Jones reagent (0.08 ml). After 10 min, methanol was added to destroy the excess reagent. The solution was diluted with water and basified with aqueous ammonia, and the product was extracted with chloroform. Washing of the chloroform extract with water, drying, and evaporation yielded a crude product (49 mg). This was converted into the hydrochloride and purified by chromatography over Mallinckrodt silicic acid (3 g). Elution with 10% methanol in chloroform yielded a keto lactone (**3**) (25 mg) as the hydrochloride, mp 179–180° (from acetone–ether), mass spectrum *m/e* 467 ($M^+$ − HCl), 452, 424, 369, 302, 290, 286, 272, and 230.

*Anal.* Calcd for $C_{30}H_{45}O_3N \cdot HCl$: C, 71.40; H, 9.19; N, 2.77. Found: C, 71.25; H, 8.89; N, 2.51.

**Reduction of Daphmacropodine (1b) with Lithium Aluminum Hydride.**—A solution of the alkaloid (300 mg) in anhydrous dioxane (6 ml) was added dropwise at room temperature to a stirred suspension of lithium aluminum hydride (150 mg) in anhydrous ether (80 ml). After 4 hr, a mixture of ethyl acetate (5 ml) and chloroform (15 ml) was added and the solution was stirred for 40 min. Then ethyl acetate (5 ml) saturated with water (1 ml) was added and stirring was continued for a further 20 min. The solution was filtered and the filtrate was concentrated *in vacuo* and extracted with chloroform. The chloroform extract was washed with water, dried, and evaporated to yield crystals (290 mg) which gave two spots on tlc. Purification by recrystallization from ethanol–acetone yielded a triol (**4**) (139 mg), mp 238–239°, mass spectrum *m/e* 473 ($M^+$), 455 ($M^+ - H_2O$), 440 [$M^+ - (H_2O + CH_3)$], 424 [$M^+ - (H_2O + CH_2OH)$], 412 {$M^+ - [H_2O + (CH_3)_2CH]$}, 372, 300, 286, 272, and 230.

*Anal.* Calcd for $C_{30}H_{51}O_3N$: C, 76.06; H, 10.85; N, 2.96. Found: C, 75.89; H, 10.66; N, 2.79.

The mother liquor of the above triol was chromatographed on neutralized Mallinckrodt silicic acid[7] (10 g). Elution with 1–2% ethanol in chloroform yielded a second alcohol (70 mg) (**5**), mp 204–205° (from acetone), mass spectrum *m/e* 471 ($M^+$), 456 ($M^+ - CH_3$), 453 ($M^+ - H_2O$), 438 [$M^+ - (H_2O + CH_3)$], 428 [$M^+ - (CH_3)_2CH$], 412, 388, 306, 300, 294, 286, 272, and 230.

*Anal.* Calcd for $C_{30}H_{49}O_3N$: C, 76.38; H, 10.47; N, 2.97. Found: C, 76.27; H, 10.28; N, 2.69.

The ir spectrum of this alcohol was found to be different from that of the deacetyl derivative **2**.

**Reduction of Daphmacrine (1a) with Lithium Aluminum Hydride.**—To a stirred suspension of lithium aluminum hydride (100 mg) in anhydrous ether (10 ml) was added dropwise at room temperature a solution of the alkaloid (98 mg) in anhydrous ether (10 ml). After 1 hr, anhydrous ether (30 ml) was added and the mixture was stirred at room temperature overnight. The excess reagent was decomposed by addition of a saturated aqueous solution of sodium sulfate. After basification with aqueous ammonia, the product was extracted with chloroform. The chloroform extract was washed with water, dried, and evaporated to yield a crude product (95 mg) which gave two spots on tlc. After recrystallization from acetone, a triol (**4**) (44 mg), mp 238–239°, was separated. The mother liquor of this triol was chromatographed on neutralized silicic acid[7] and elution with 1% methanol in chloroform afforded a second alcohol (**5**) (12 mg), mp 202–203° (from acetone). These two alcohols were also obtained by the lithium aluminum hydride reduction of daphmacropodine (**1b**) (see above).

**Oxidation of Daphmacropodine (1b) with Jones Reagent.**[6]—The alkaloid (80 mg) in acetone (8 ml) was treated with Jones reagent (0.2 ml) at 0° for 10 min. Methanol was added to decompose the excess reagent. The solution was then basified with aqueous ammonia and the product (80 mg) was isolated in the usual way. The product was converted into the hydrobromide and purified by chromatography on Mallinckrodt silicic acid (1.0 g). Elution with 1% methanol in chloroform furnished a lactone (**1a**) as the hydrobromide (50 mg), mp >300°.

*Anal.* Calcd for $C_{32}H_{49}O_4N \cdot HBr$: C, 64.84; H, 8.50; N, 2.36. Found: C, 64.56; H, 8.32; N, 2.17.

Its ir spectrum was identical with that of daphmacrine hydrobromide.

**Registry No.**—**1a**, 19775-48-5; **1a** HBr, 39729-20-9; **1b**, 39729-21-0; **1b** HBr, 39729-22-1; **2**, 39729-23-2; **3** HCl, 39729-24-3; **4**, 39729-25-4; **5**, 39729-26-5; lithium aluminum hydride, 16853-85-3.

## An Improved Synthesis of Aminoethanethiols

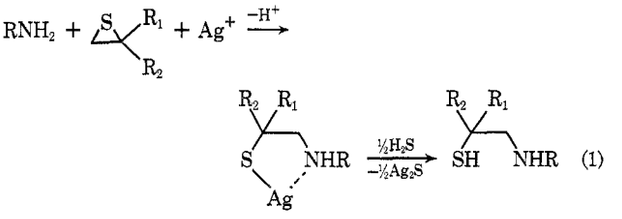
ROBERTA LUHOWY AND FRANK MENEGHINI*

*Polaroid Corporation, Cambridge, Massachusetts 02139*

*Received February 21, 1973*

Of the variety of synthetic routes used to prepare aminoethanethiols, one of the most direct involves the addition of amines to episulfides or episulfide precursors.[1] Although this reaction is general, applying to both aromatic and aliphatic amines, it suffers from the fact that it often requires elevated temperatures in sealed tubes and that the yields are dependent on solvent polarity.[1,2a,d] A further disadvantage of this reaction is that the product aminoethanethiols are further mercaptoethylated on sulfur or nitrogen to give bismercaptoethylated products or polymers resulting from polymercaptoethylation.[2] The addition of excess amine has been successfully used to obviate these side reactions,[1,2a] but has also necessitated separating the excess amine from the product.

We have found that the mercaptoethylation of primary aliphatic amines can be carried out near room temperature with equimolar amounts of episulfide and amine in aqueous media containing amine–silver ion complex. Although only little effort has been spent



(1)

(1) D. D. Reynolds and D. L. Johnson, *Mech. React. Sulfur Compounds*, **5**, 103 (1970).

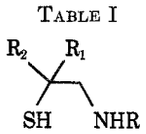
(2) (a) R. J. Wineman, M. H. Gollis, J. C. James, and A. M. Pomponi, *J. Org. Chem.*, **27**, 4222 (1962); (b) H. R. Snyder, J. M. Stewart, and J. B. Ziegler, *J. Amer. Chem. Soc.*, **69**, 2672 (1947); (c) N. S. Isaacs, *Can. J. Chem.*, **44**, 395 (1966); (d) E. Tobler, *Ind. Eng. Chem., Prod. Res. Develop.*, **8**, 415 (1969).

optimizing reaction conditions, aminoethanethiols have been obtained in yields of 40–90%.

The procedure involves the addition of episulfide to an aqueous mixture of silver nitrate and amine. In reactions employing equimolar concentrations of amine, episulfide, and silver ion, excess triethylamine is added to prevent precipitation of $Ag_2O$. The addition of episulfide to silver–amine complex is accompanied by the evolution of heat and in the absence of external cooling the temperature of the reaction mixture can rise to 50°. However, the yields of the reaction do not appear to be a function of temperature within the range of 20–50°, as shown by comparing yields for compounds **1** and **3**, which were prepared without external cooling, with **2**, **4**, and **5**, which were synthesized at 20–35°.

The advantages afforded by this method are the mild reaction conditions involved, its general application to various primary aliphatic amines, and the ease with which the product can be separated from unreacted starting material *via* its silver complex. Moreover, as seen from Table I, the method is equally applicable to mono- and disubstituted episulfides as well as ethylene sulfide.

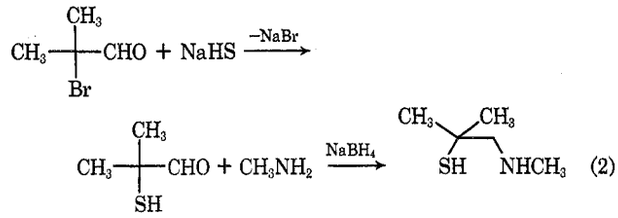
TABLE I



| Compd | R | $R_1$ | $R_2$ | Yield, % |
|---|---|---|---|---|
| **1** | $C_{10}H_{21}$ | H | H | 90 |
| **2** | $(CH_2)_3OCH_3$ | $CH_3$ | H | 40 |
| **3** | $(CH_2)_3N(n\text{-}C_4H_9)_2$ | $CH_3$ | $CH_3$ | 40 |
| **4** | $C_{16}H_{33}$ | $CH_3$ | $CH_3$ | 61 |
| **5** | $CH_3$ | $CH_3$ | $CH_3$ | 79 |

With these unsymmetrically substituted episulfides the question of regiospecificity arises. It is known that unsymmetrically substituted episulfides suffer nucleophilic attack at the least substituted carbon atom,[3] and there are numerous examples of this in the addition of amines to episulfides.[2b-d,4] However, electrophilic reagents lead to appreciable ring opening at both carbon centers of such compounds.[3] Moreover, sulfenyl chloride additions to olefins which are presumed to go through similar episulfonium ion intermediates also lead to products derived from attack of chloride at both carbon centers.[5] It was therefore of interest to see if the incorporation of an electrophile such as silver ion resulted in a reversal of the usual mode of episulfide ring opening by amines.

The direction of ring opening was established by comparing the product obtained from the reaction in eq 1 using isobutylene sulfide and methylamine with 1,1-dimethyl-2-methylaminoethanethiol prepared as shown in eq 2. The hydrochloride salts of both aminoethanethiols had the same ir and nmr spectra, and both disulfide dihydrochloride salts melted with decomposition at 268–270°. The mercaptoamines were converted into thiazolidines by reaction with *p*-dimethylaminobenzaldehyde and the dihydrochloride salts of these two derivatives were shown to be identical by ir, nmr, and melting point. Thus the product from the silver nitrate mediated reaction of isobutylene sulfide and methylamine was assigned structure **5**, *i.e.*, the isomer derived from amine attack at the least substituted carbon atom.[6] By analogy mercaptoethylamines **2**, **3**, and **4** were assigned structures shown in Table I.



Apparently the activation provided by silver ion in the mercaptoethylation of amines resulted in a predominance of the same isomer as obtained without silver present. Possible roles attributed to silver ion in this reaction are that it acts as an electrophile for sulfur resulting in C–S bond weakening, it coordinates to the reagents to form a kinetically active ternary complex, or it provides a more favorable free energy for the reaction by forming a stable complex with the product.[7]

## Experimental Section

Infrared spectra were taken on a Perkin-Elmer Model 421 spectrophotometer. Nuclear magnetic resonance spectra were obtained with a Varian A-60 spectrometer. Melting points are uncorrected and were taken in sealed capillaries on a Mel-Temp. Microanalyses were performed by Galbraith Laboratories, Inc., Knoxville, Tenn. Isobutylene sulfide was prepared from the epoxide,[8] which in turn was purchased from Research Organic/Inorganic Corp. All other episulfides and amines were purchased from Aldrich or Eastman and used as received. *Caution!* Although aminoethanethiols prepared by this method have been distilled without incident several times, a mild explosion occurred on two occasions of continued heating of the pot residue. Incomplete removal of nitrate ion prior to distillation was presumed to be the cause. In this light it is noteworthy to mention that AgOAc has been successfully used in replacement of $AgNO_3$ for the preparation of **5**.

**2-Decylaminoethanethiol (1).**—To a stirring solution of 15.5 g (0.153 mol) of triethylamine in 75 ml of distilled water was slowly added a solution of 12 g (0.071 mol) of $AgNO_3$ in 20 ml of water. A small amount of black $Ag_2O$ formed. The temperature was adjusted to 25° and 14.5 g (0.092 mol) of decylamine was added. Dropwise addition of 5 g (0.084 mol) of ethylene sulfide was accompanied by evolution of heat and formation of an insoluble yellow silver complex. After stirring for 1.5 hr the silver complex was filtered off, washed with distilled water, and suspended in 100 ml of distilled water. Hydrogen sulfide was bubbled through the vigorously stirred mixture to liberate the free mercaptoethylamine. The mixture was filtered and the $Ag_2S$ precipitate was washed with hot ethanol. The washings were combined with the original filtrate and evaporated *in vacuo*. The residue was treated with 100 ml of water and extracted with ether. Solvent evaporation led to 16.5 g (90% yield) of product, $n^{25}D$ 1.4702 (lit.[9] $n^{25}D$ 1.4674). *Anal.* Calcd for $C_{12}H_{27}NS$: C, 66.29; H, 12.52; N, 6.44; S, 14.75. Found: C, 66.09; H, 12.38; N, 6.18; S, 14.66.

(3) N. V. Schwartz, *J. Org. Chem.*, **33**, 2895 (1968).

(4) (a) J. M. Stewart, *J. Org. Chem.*, **28**, 596 (1963); (b) R. Daniels, B. D. Martin, and B. K. Lee, Abstracts of Papers, 142nd National Meeting of the American Chemical Society, Washington, D. C., March 1962, p 33N; (c) J. B. Wright, *J. Amer. Chem. Soc.*, **79**, 1694 (1957); (d) S. D. Turk, R. P. Louthan, R. L. Cobb, and C. R. Bresson, *J. Org. Chem.*, **29**, 974 (1964).

(5) W. H. Mueller, *Angew. Chem., Int. Ed. Engl.*, **8**, 482 (1969).

(6) Private communication from Dr. J. W. Foley confirmed that Raney nickel desulfurization of the mercaptoethylation product gave methyl isobutylamine.

(7) (a) D. Hopgood and D. L. Leussing, *J. Amer. Chem. Soc.*, **91**, 3740 (1969); (b) R. Breslow and M. Schmir, *ibid.*, **93**, 4960 (1971).

(8) H. R. Snyder, J. M. Stewart, and J. B. Ziegler, *J. Amer. Chem. Soc.*, **69**, 2672 (1947).

(9) D. D. Reynolds, D. L. Fields, and D. L. Johnson, *J. Org. Chem.*, **26**, 5126 (1961).

**1-Methyl-2-(3-methoxypropylamino)ethanethiol (2).**—An aqueous (260 ml) mixture of 50 g (0.29 mol) of $AgNO_3$ and 63.5 g (0.71 mol) of methoxypropylamine was made up as described above and 19 g (0.26 mol) of propylene sulfide was slowly added. An oily semisolid separated out. After stirring for 2 hr, 70% $HClO_4$ was slowly added until no further precipitation occurred. The supernatant was decanted off and the residue was washed with water until the washings were at pH 7. The free mercaptoethylamine was liberated from its silver complex as described above. Claisen distillation led to 1 g of forerun, 17 g (40% yield) of clear liquid distilling at 56° (0.95 mm), $n^{25}D$ 1.4705, and 9 g of residue. *Anal.* Calcd for $C_7H_{17}NOS$: C, 51.48; H, 10.49; N, 8.58; S, 19.64. Found: C, 51.65; H, 10.37; N, 8.58; S, 19.67.

**1,1-Dimethyl-2-(3-di-*n*-butylaminopropylamino)ethanethiol (3).**—An aqueous (160 ml) mixture of 34 g (0.20 mol) of $AgNO_3$, 53 g (0.53 mol) of triethylamine, and 35.3 g (0.19 mol) of di-*n*-butylaminopropylamine was made up in the usual way, and 16.5 g (0.18 mol) of isobutylene sulfide was slowly added to it. During the episulfide addition the reaction mixture became more viscous. After stirring overnight, $H_2S$ was bubbled through the reaction mixture and the $Ag_2S$ precipitate was filtered off. Further work-up as described above led to an oil residue. Claisen distillation of the oil residue led to 4 g of forerun distilling at 114–123° (0.45 mm), $n^{27}D$ 1.4644, 10 g distilling at 123–128° (0.5 mm), $n^{27}D$ 1.4666, and 10.5 g distilling at 128° (0.45 mm), $n^{27}D$ 1.4666. The yield based on the last two cuts was 40%. *Anal.* Calcd for $C_{15}H_{34}N_2S$: C, 65.63; H, 12.48; N, 10.20; S, 11.68. Found: C, 65.64; H, 12.22; N, 10.34; S, 11.46.

**1,1-Dimethyl-2-hexadecylammoniumethanethiol Perchlorate (4).**—An aqueous (300 ml) mixture of 65 g (0.38 mol) of $AgNO_3$, 105 g (1.04 mol) of triethylamine, and 77 g (0.32 mol) of hexadecylamine was made up and 31.5 g (0.36 mol) of isobutylene sulfide was slowly added. After stirring for 3.5 hr, 110 g (0.78 mol) of 70% $HClO_4$ was added. Within 10 min the mixture agglomerated. The supernatant was decanted off and 600 ml of 50% aqueous ethanol was added. The mercaptoethylamine was liberated from its silver complex with $H_2S$, and $HClO_4$ (about 30 g) was added until the mixture was below pH 2. After heating on the steam bath to help dissolve the product, the mixture was filtered. The $Ag_2S$ precipitate was treated with ethanol, heated, and again filtered. Upon addition of water to the combined filtrates a white solid came out of solution which was dried over $P_2O_5$. The yield of crude product was 84 g (61% yield). Recrystallization from hexane–methanol and twice from ethanol gave the disulfide salt,[10] mp 224–228° dec. *Anal.* Calcd for $C_{40}H_{86}N_2S_2Cl_2O_8$: C, 55.98; H, 10.10; N, 3.27; S, 7.47; Cl, 8.26. Found: C, 56.38; H, 10.26; N, 3.59; S, 7.61; Cl, 8.02.

**1,1-Dimethyl-2-methylaminoethanethiol Hydrochloride (5).**—An aqueous (120 ml) mixture of 88.5 g (0.52 mol) of $AgNO_3$ and 163 g (2.10 mol) of 40% methylamine was made up and 44.5 g (0.51 mol) of isobutylene sulfide was slowly added. Toward the end of the episulfide addition a yellow solid precipitated out which congealed after 45 min of stirring. The supernatant was decanted off and the residue was washed repeatedly with water to remove excess methylamine. Aqueous HCl was added and the mercaptoethylamine was liberated from its silver complex with $H_2S$. The $Ag_2S$ was filtered off and the filtrate was evaporated to dryness *in vacuo*. The residue was triturated with hot $CHCl_3$, leaving behind $CH_3NH_3Cl$. The dried solvent was removed under reduced pressure. The resulting residue was triturated with ether to yield 62 g (79% yield) of white solid which was crystallized from dioxane–methanol:[10] mp 222–224° dec; ir (KBr) 2950, 1457 (CH), 2645, 2490, 2400, 1585 ($NH_2^+$), 1415 ($CH_2N^+$), 1390, 1365, 1175, 1162 $cm^{-1}$ [$(CH_3)_2C$]; nmr ($D_2O$) δ 1.43 [6, s, $C(CH_3)_2$], 2.77 (3, s, $NCH_3$), 3.16 (2, s, $CH_2$). *Anal.* Calcd for $C_5H_{14}NSCl$: C, 38.57; H, 9.06; N, 9.00; S, 20.60. Found: C, 38.73; H, 9.35; N, 8.84; S, 20.97.

**2-(*p*-Dimethylaminophenyl)-3,5,5-trimethylthiazolidine Dihydrochloride.**—A mixture of 2 g (0.013 mol) of 5, 1.1 g (0.013 mol) of $NaHCO_3$, and 2 g (0.013 mol) of *p*-dimethylaminobenzaldehyde in 100 ml of 95% ethanol was refluxed through a Soxhlet extractor containing $CaC_2$ for an overnight period. The NaCl was filtered off and the filtrate was evaporated to dryness. The resulting oil was dissolved in absolute ethanol and the solution was made acidic with gaseous HCl. Upon cooling a yellow solid came out of solution which was recrystallized from ethanol–ether to give 2.2 g (48% yield) of white product: mp 216–217° dec; ir (KBr) 3000, 2940, 2900, 1460, 1137, 827 (CH), 2670–2300 ($NH^+$), 1610, 1510 $cm^{-1}$ (aromatic); nmr ($D_2O$) δ 1.77, 1.80 [6, $C(CH_3)_2$], 2.93 (3, s, $NCH_3$), 3.40 [6, s, $N(CH_3)_2$], 3.67 (1, A of AB q, $J$ = 12 Hz, $CH_2$), 4.03 (1, B of AB q, $J$ = 12 Hz, $CH_2$), 5.96 (1, s, CH), and an AA′BB′ pattern centered at 7.84 (4, m, $C_6H_4$). *Anal.* Calcd for $C_{14}H_{24}N_2SCl_2$: C, 52.00; H, 7.48; N, 8.66; S, 9.92. Found: C, 51.93; H, 7.51; N, 8.65; S, 9.78.

**1,1-Dimethyl-2-methylaminoethanethiol Hydrochloride (5) by Reduction of Mercaptoisobutyraldehyde Schiff Base.**—A solution of 2.5 g of $NaSH \cdot xH_2O$ in 10 ml of methanol was added to 4 g (0.026 mol) of bromoisobutyraldehyde[11] in 20 ml of methanol. After standing for 1.5 hr, 2.5 g (0.032 mol) of 40% methylamine and 20 ml of acetic acid were added and the mixture was stirred for 5 min. While cooling, 10 ml of acetic acid and 8.5 g (0.22 mol) of $NaBH_4$ were alternately added in small portions.[12] The mixture was stirred for 1.5 hr and water was added to destroy the excess $NaBH_4$. Methanol and HCl were added and the mixture was distilled until the distillate no longer showed a green flame test for boron. The remainder of the solvent was removed under reduced pressure and the residue was extracted with $CHCl_3$. The $CHCl_3$ was removed under vacuum and the residue was triturated with ether to give 1 g (25% yield) of crude product which was recrystallized from dioxane–methanol.

**Registry No.**—**1**, 5891-06-5; **2**, 39981-44-7; **3**, 39981-45-8; **4** disulfide perchlorate salt, 39981-46-9; **5** HCl, 39981-47-0; decylamine, 2016-57-1; ethylene sulfide, 420-12-2; 3-methoxypropylamine, 5332-73-0; propylene sulfide, 1072-43-1; di-*n*-butylaminopropylamine, 102-83-0; isobutylene sulfide, 3772-13-2; hexadecylamine, 143-27-1; methylamine, 74-89-5; 2-(*p*-dimethylaminophenyl)-3,5,5-trimethylthiazolidine dihydrochloride, 39981-49-2; *p*-dimethylaminobenzaldehyde, 100-10-7; bromoisobutyraldehyde, 13206-46-7.

**Acknowledgment.**—The authors wish to thank Mr. J. D. Gondolfe for his help in the synthesis of compound **5**.

(10) A % SH test using 2,2′-dithiodipyridine as described by D. R. Grassetti and J. F. Murray, Jr., *Arch. Biochem. Biophys.*, **119**, 41 (1967), showed that repeated recrystallization of the aminoethanethiol salt led to the disulfide salt, presumably *via* aerial oxidation.

(11) T. A. Favorskaya and D. A. Shkurgina, *J. Gen. Chem. USSR*, **25**, 713 (1955); *Chem. Abstr.*, **50**, 2427 (1956).

(12) V. J. Hruby and V. du Vigneaud, *J. Amer. Chem. Soc.*, **91**, 3624 (1969).

## The Mechanism of the Robinson–Gabriel Synthesis of Oxazoles

HARRY H. WASSERMAN* AND FREDERIC J. VINICK[1]

*Department of Chemistry, Yale University, New Haven, Connecticut 06520*

*Received March 7, 1973*

One of the most commonly used methods for the preparation of oxazoles is the Robinson–Gabriel synthesis, in which an α-acylamino ketone undergoes cyclization and dehydration on treatment with $PCl_5$ or a strong mineral acid.[2,3] This synthesis is especially applicable to the formation of 2,5-diaryloxazoles, compounds of current interest in our studies on the reactions of heterocyclic systems with singlet oxygen.

As pointed out by Cornforth,[4] there are two reason-

(1) NSF Predoctoral Fellow, 1970–1973.

(2) R. Robinson, *J. Chem. Soc.*, **95**, 2167 (1909).

(3) S. Gabriel, *Ber.*, **43**, 1283 (1910).

(4) R. C. Elderfield, Ed., "Heterocyclic Compounds," Vol. V, Wiley, New York, N. Y., 1957, p 302.