[CONTRIBUTION FROM THE DEPARTMENTS OF CHEMISTRY, UNIVERSITIES OF NOTRE DAME AND PENNSYLVANIA]

Preparation and Properties of Ethyl Tetronate

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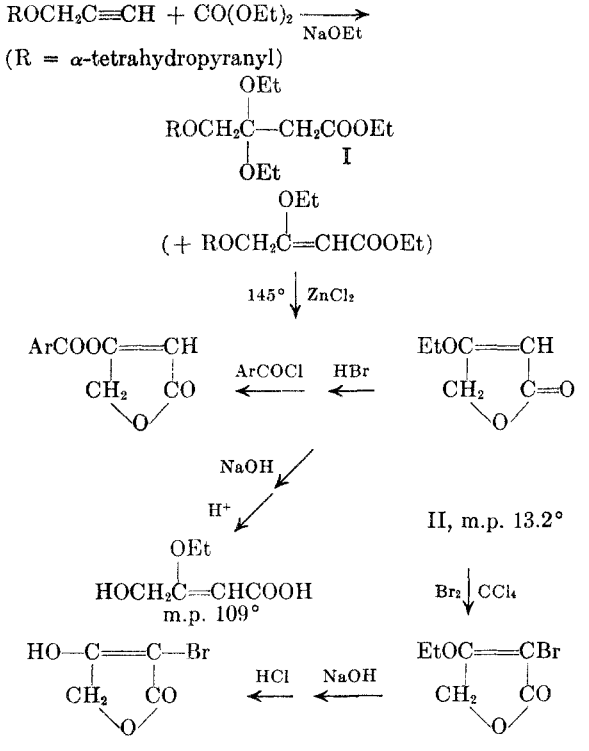
A three-step synthesis of ethyl tetronate (II) from propargyl alcohol has been developed. Its structure was proven by conversion to α-bromotetronic acid. II was found to be remarkably unreactive to a number of reagents.
Ethyl methoxytetrolate was also prepared and characterized.

It was hoped that alkyl or acyl derivatives of tetronic acid might prove useful starting materials for some projected syntheses. We therefore have developed a convenient preparation of these compounds, starting from propargyl alcohol. The latter is first converted to the 2-tetrahydropyranyl

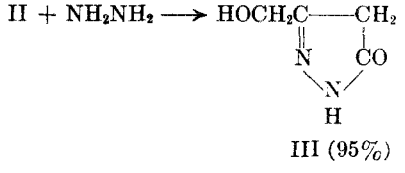


ether by reaction with dihydropyran.[2] Addition of diethyl carbonate to the triple bond[3] was successful but was accompanied by addition of ethanol as well, so that the product was principally ethyl β,β-diethoxy-γ-(2-tetrahydropyranyloxy)butyrate (I). Infrared data on the crude product indicated the presence of appreciable quantities of the β-ethoxycrotonate, but the only product which we were able to isolate in analytical purity by fractional distillation was I.

Treating the crude I with zinc chloride at 140–145° led to a smooth conversion to ethyl tetronate (II) in 55% overall yield from propargyl α-tetrahydropyranyl ether.

II proved to be resistant to reactions normally readily accomplished with vinyl ethers or α,β-unsaturated lactones. For example, attempted Michael addition of nitromethane and addition of aniline to the double bond failed. Cleavage of the vinyl ether group failed with hydrochloric acid but was accomplished by 48% hydrobromic acid.

On the other hand, reaction of the lactone ring appeared to be normal. Saponification led to the hydroxy acid and hydrazinolysis proceeded vigorously to produce a pyrazolone (III).



III (95%)

The double bond of II was also found to be unreactive in the Diels-Alder reaction and in free radical polymerization. In the latter regard, the unreactivity of the double bond resembles that of ethyl β-ethoxyacrylate.[4]

EXPERIMENTAL[5]

The reaction of 2-propargyloxytetrahydropyran with ethyl carbonate in the presence of sodium ethoxide. Powdered sodium ethoxide, prepared from 4.6 g. (0.2 g. atom) of clean sodium, and 295 g. (2.5 moles) of ethyl carbonate were stirred and heated to 80° and 140 g. (1 mole) of 2-propargyloxytetrahydropyran[2] was added over a 1-hr. period, the temperature being maintained at 75–80° by periodic cooling. After being heated for 7 hr. at 70–75°, the reaction mixture was cooled to room temperature and neutralized with 52 g. of 23% aqueous acetic acid. Extraction with ether, washing with water, drying over 20 g. of anhydrous potassium carbonate and distilling from 1 g. of anhydrous magnesium carbonate through a 6-inch column packed with 0.25 inch helices gave 190 g. of ethyl carbonate, 11 g. of 2-propargyloxytetrahydropyran, and 170.2 g. of product (A), b.p. 126–132° (1.2 mm.); n_D^{25} 1.4546.

By careful refractionation of a portion of this product (A) from anhydrous magnesium carbonate, a fairly pure sample of ethyl γ-(2-tetrahydropyranyloxy)-β,β-diethoxybutyrate was obtained, b.p. 110–110.5° (0.3 mm.), n_D^{25} 1.4504, d_{25}^{25} 1.056.

(1) Eli Lilly and Company Fellow, 1953–55.

(2) R. G. Jones and M. J. Mann, *J. Am. Chem. Soc.*, **75**, 4048 (1953).

(3) See W. J. Croxall and H. J. Schneider, *J. Am. Chem. Soc.*, **71**, 1257 (1949).

(4) C. C. Price and T. C. Schwan, *J. Polymer Sci.*, **16**, 577 (1955).

(5) Melting and boiling points are uncorrected. Analyses by Micro Tech. Laboratories, Skokie, Ill.

Anal. Calcd. for $C_{15}H_{28}O_6$: C, 59.19; H, 9.27; M_D 77.70. Found: C, 58.73; H, 8.97; M_D 77.54. Another sample, b.p. 118–119° (1.1 mm.), n_D^{25} 1.4530, was also analyzed. Found: C, 59.25; H, 9.11.

Preparation of ethyl tetronate. A 50 g. portion of the product (A) obtained from the reaction of 2-propargyloxytetrahydropyran with ethyl carbonate in the presence of sodium ethoxide was heated at 140–145° with 0.25 g. of anhydrous zinc chloride. Nitrogen was bubbled through the mixture until no further distillate was formed (about 1 hr.). The dark colored residue was submitted to vacuum distillation and 18.6 g. of ethyl tetronate was collected, b.p. 65–66° (0.08 mm.), m.p. 13–13.2°, n_D^{25} 1.4777, d_{25}^{25} 1.1609.

Anal. Calcd. for $C_6H_8O_3$: C, 56.24; H, 6.29; M_D 30.71; Sapon. Equiv. 128.1. Found: C, 56.33; H, 6.42; M_D 31.23; Sapon. Equiv. 129.1.

The overall yield of ethyl tetronate was 53.7% based on 2-propargyloxytetrahydropyran and 55.5% on the ethyl carbonate consumed. The ultraviolet spectrum of ethyl tetronate in 95% ethanol showed maxima at 219 and 270 mμ, log ε 4.02 and 3.64, respectively.

Preparation of γ-hydroxy-β-ethoxycrotonic acid. A 2 g. sample of ethyl tetronate was heated on a steam bath for 0.5 hr. with 15 ml. of 2*N* sodium hydroxide solution. The yellow-colored solution was cooled to 0° and acidified with 6*N* sulfuric acid. The white solid which separated was extracted with four 15-ml. portions of ether. After drying the combined ether extracts over 3 g. of anhydrous magnesium sulfate, the drying agent was separated and the ether evaporated. The crystals were filtered by suction and washed with 5 ml. of cold anhydrous ether. The resulting colorless crystals were dried in a vacuum desiccator; weight 1.94 g. (85.1%); m.p. 109–109.3°.

Anal. Calcd. for $C_6H_{10}O_4$: C, 49.31; H, 6.90; Neut. Equiv., 146.1. Found: C, 49.30; H, 6.91; Neut. Equiv., 146.6.

Acid hydrolysis of ethyl tetronate. A. *With hydrochloric acid.* Two drops of concentrated hydrochloric acid and 1.28 g. of ethyl tetronate in 2 ml. of water were warmed in a water bath until a homogeneous solution resulted. The solution was heated on a steam bath for 2 hr. and cooled in an ice bath, whereupon two phases separated. The organic layer was separated by extraction with four 10-ml. portions of ether and the combined ether extract dried over magnesium sulfate. Evaporation of the ether gave a residue, weight 0.85 g., having the same refractive index as ethyl tetronate. The aqueous layer when treated with *p*-nitrobenzoyl chloride under Schotten-Baumann conditions failed to give a precipitate.

In a second experiment, ethyl tetronate (1 g.) was refluxed with concentrated hydrochloric acid (5 drops) in 95% ethanol (3 ml.) for 1 hr. On evaporation and cooling, a small amount of white crystals separated, which were shown by mixed melting point to be γ-hydroxy-β-ethoxycrotonic acid. Ethyl tetronate was recovered in 80% yield.

B. *With hydrobromic acid.* A mixture of 3.6 g. (0.028 mole) of ethyl tetronate and 4.75 g. (0.03 mole) of 48% hydrobromic acid was allowed to stand overnight. The solution was then treated with 20 ml. of water and neutralized with 6*N* sodium hydroxide solution. After adding 6.0 g. (0.032 mole) of *p*-nitrobenzoyl chloride, the mixture was stirred at 40° with the occasional addition of sodium carbonate to keep the solution slightly basic to litmus. The solid which separated was filtered by suction, washed with two 10-ml. portions of water and dried in a vacuum desiccator, 4.65 g., m.p. 147.5–165°. The solid was dissolved in 125 ml. of boiling benzene, filtered, and allowed to crystallize. The *p*-nitrobenzoyltetronic acid crystallized as colorless rosettes. At the first sign of yellow needles, the mother liquor was decanted and the crystals washed, by decantation, with two 5-ml. portions of benzene and dried, weight 1.36 g., m.p. 167–170°.

A second crop of crude *p*-nitrobenzoyltetronic acid may be obtained by heating the mother liquor to boiling and adding 50 ml. of petroleum ether (b.p. 65–100°). Total yield 2.1 g. (30.1%). An analytical sample was prepared by recrystallization from benzene, m.p. 172.5–174°.

Anal. Calcd. for $C_{11}H_7O_6N$: C, 53.02; H, 2.83; N, 5.62. Found: C, 52.78; H, 3.07; N, 5.40.

A small sample of the yellow needles was separated manually and shown to be *p*-nitrobenzoic anhydride by mixed melting point with an authentic sample of *p*-nitrobenzoic anhydride and by comparison of infrared spectra of the known and unknown samples.

Attempted reaction of ethyl tetronate with nitromethane. A solution of 0.4 g. (0.0174 mole) of metallic sodium in 100 ml. of absolute ethanol was cooled to room temperature and 5.5 g. (0.09 mole) of nitromethane in 125 ml. of absolute ethanol added over 15 min. A fine, white suspension was formed to which 7.7 g. (0.06 mole) of ethyl tetronate in 50 ml. of absolute ethanol was added and the mixture was stirred at room temperature for 60 hr. After neutralization with acetic acid (1.0 g.), the ethanol and unreacted nitromethane were removed to 40–45° under reduced pressure. The residue was filtered by suction and the filtrate distilled under reduced pressure to give 5.8 g. (75% recovery) of ethyl tetronate. The residue, weight 0.3 g., was a black, polymeric material.

Attempts to prepare Diels-Alder adducts of ethyl tetronate. A. *Anthracene.* To 2 g. (0.0156 mole) of ethyl tetronate in 5 g. of anhydrous xylene was added 2.78 g. (0.0156 mole) of anthracene. The anthracene dissolved when the mixture was heated to 120° and the resulting solution was refluxed for 1 hr. After the solution had cooled to room temperature, the crystals were filtered by suction, washed with 5 ml. of xylene and dried. The crystals were shown by mixed melting point to be pure anthracene, weight 2.65 g. (95.3% recovery).

B. *Cyclopentadiene.* A mixture of 2.5 g. (0.0195 mole) of ethyl tetronate, 5 g. of anhydrous benzene, 5 g. (0.076 mole) of freshly distilled cyclopentadiene, and a pinch of hydroquinone was refluxed overnight. The solvent and unreacted cyclopentadiene were removed under reduced pressure. The residue separated into two layers and, on cooling to room temperature, the upper layer solidified. The solid was shown by refractive index and melting point to be dicyclopentadiene. The lower layer was unchanged ethyl tetronate, quantitatively recovered.

C. *Butadiene.* A mixture of 1 g. of ethyl tetronate, 2.8 g. of butadiene, and a few crystals of hydroquinone was heated in a sealed tube at 100–102° for 2 days. The tube was cooled, opened, and the unreacted butadiene allowed to evaporate. Some jelly-like material adhered to the side of the tube; in the bottom of the tube was 0.8 g. of ethyl tetronate. The jelly-like material was heated for 1 hr. with 10 ml. of 2*N* sodium hydroxide solution, filtered, and the filtrate cooled. Acidification with 6*N* hydrochloric acid gave no precipitate.

The experiment was repeated, the tube being heated at 148–151° for 2 days; 90% of the ethyl tetronate was recovered.

D. *Furan.* A mixture of 1.5 g. (0.012 mole) of ethyl tetronate, 1.6 g. (0.024 mole) of furan, and a few crystals of hydroquinone was heated at 98–102° for 2 days in a sealed tube. The tube was cooled, opened, and weighed. The furan was evaporated on a water bath; loss in weight, 1.5 g. The residue had a refractive index at 25° of 1.4770; the refractive index of ethyl tetronate is 1.4777.

Reaction of ethyl tetronate with bromine. With stirring, 10.4 g. (0.065 mole) of bromine in 100 g. of carbon tetrachloride was added dropwise over a 1-hr. period to 7.7 g. (0.06 mole) of ethyl tetronate in 20 ml. of carbon tetrachloride at room temperature. Some hydrogen bromide was evolved during the addition. The mixture was slowly warmed to reflux temperature and maintained for 0.5 hr. The reflux condenser was turned downward and the carbon tetrachloride distilled off. The residue crystallized on cooling and was filtered by suction and washed with two 5-ml. portions of cold carbon tetrachloride; yield, 11.7 g. (94.2%), m.p. 93–97°. An ana-

TABLE I

INFRARED SPECTRA

Ethyl Methoxy-tetrolate[a]		Ethyl Tetronate[a]		γ-Hydroxy-β-ethoxy-crotonic Acid[b]		p-Nitro-benzoyl-tetronic Acid[c]		Ethyl α-Bromo-tetronate[c]		α-Bromo-tetronic Acid[c]	
λ	% Abs.	λ	% Abs.	λ	% Abs.	λ	% Abs.	λ	% Abs.	λ	% Abs.
3.4	29	3.2	15	2.9–	20–	3.4	80	3.45	72	3.2–	
4.45	22	3.35	18	3.6	30	5.65	81	5.68	95	4.2	—
5.85	80	5.65	68	5.96	71	5.72	84	6.15	95	3.45	68
6.8	30	5.72	72	6.25	88	6.16	79	6.88	59	5.65	43
7.28	37	6.15	83	6.78	weak	6.25	40	7.00	83	5.82	77
7.95	89	6.78	13	7.0	weak	6.56	80	7.16	74	6.1–	
8.38	35	6.90	18	7.16	weak	6.90	56	7.3	94	6.3	85
9.00	67	7.23	42	7.35	weak	7.28	weak	7.65	96	6.9–	
9.40	54	7.36	18	7.50	weak	7.40	74	8.20	88	7.2	75
9.9	27	7.57	68	7.68	weak	7.56	70	9.02	72	7.35	66
11.00	29	8.08	34	8.55	88	8.08	90	9.6	93	7.60	59
11.6	13	8.70	49	9.00	53	8.47	73	10.2	95	8.20	66
13.25	34	9.02	17	9.4–		8.62	70	11.75	88	9.47	76
		9.53	56	9.7	55	9.48	87	13.50	83	9.92	73
		9.8	40	10.35	38	9.65	75	13.95	83	10.05	60
		10.56	17			9.90	72			11.7	50
		11.3–				11.24	48			13.28	68
		11.5	28			11.62	66			13.65	75
		12.5	28								

[a] Pure liquid. [b] In chloroform. [c] Nujol mull.

lytical sample of ethyl α-bromotetronate was prepared by recrystallization from benzene, m.p. 96–98°.

Anal. Calcd. for $C_6H_7O_3Br$: C, 34.80; H, 3.41; Br, 38.60. Found: C, 34.93; H, 3.51; Br, 38.86.

Preparation of α-bromotetronic acid. A 3.0 g. sample of ethyl α-bromotetronate and 15 ml. of 2*N* sodium hydroxide were heated on a steam bath until solution was complete. After heating for a further 5 min., the solution was cooled in an ice-water bath, saturated with salt, and made strongly acid with concentrated hydrochloric acid. The precipitate was filtered by suction and the air-dried material recrystallized by dissolving it in a minimum of boiling ethyl acetate, treating with Norit, filtering, and allowing to crystallize in the refrigerator. The fine, white crystals of α-bromotetronic acid were collected on a filter and washed with a few drops of cold ethyl acetate. Yield of dried material, 0.53 g. (20.4%), m.p. 179° (dec.), corrected m.p. 182.8° (dec.), neut. equiv. 179.4, 179.6 (calcd. 179), pK_a 2.26. (Lit.[6] m.p. 183° (dec.), pK_a 2.23, Br, 44.2.)

Anal. Calcd. for $C_4H_3O_3Br$: C, 26.84; H, 1.69; Br, 44.65. Found: C, 27.24; H, 1.85; Br, 44.81.

Preparation of 3-hydroxymethyl-5-pyrazolone. A solution of 3.2 g. of ethyl tetronate in 5 ml. of methanol was cooled to 0° and was added, with stirring, to a solution of 5.0 g. of 85% hydrazine hydrate in 5 ml. of methanol, also at 0°. There was an exothermic reaction and the temperature rose to 40°. When the initial reaction had subsided, the solution was refluxed on a steam bath for 0.5 hr. The methanol and unreacted hydrazine were removed by heating to 120° at 20 mm. The residue crystallized to an orange-colored mass on cooling. When stirred with 15 ml. of cold acetone, the crystals crumbled and were then filtered by suction and washed with 5 ml. of cold acetone; yield 2.7 g. (95%), m.p. 144–152°.

Attempts to recrystallize the 3-hydroxymethyl-5-pyrazolone were unsuccessful. A portion was extracted by stirring with a small amount of phenylhydrazine, filtered, and the pale yellow crystals washed with ethyl acetate. The dried material melted at 152–156°.

(6) W. D. Kumler, *J. Am. Chem. Soc.*, **60**, 859 (1938).

Anal. Calcd. for $C_4H_6O_2N_2$: C, 42.1; H, 5.3; N, 24.6. Found: C, 41.6; H, 5.3; N, 25.6.

The *3,5-dinitrobenzoate* of 3-hydroxymethyl-5-pyrazolone was prepared and recrystallized from glacial acetic acid, m.p. 209° (dec.).

Anal. Calcd. for $C_{11}H_8O_7N_4$: C, 42.85; H, 2.61; N, 18.18. Found: C, 42.93; H, 2.82; N, 18.07.

Attempted reaction of ethyl tetronate with phenylhydrazine. A solution of 3.84 g. (0.03 mole) of ethyl tetronate in 5 ml. of methanol was cooled to 0° and added to a solution of 13.0 g. (0.12 mole) of phenylhydrazine in 10 ml. of methanol at 0°. No heat was evolved on mixing. The solution was refluxed for 0.5 hr. The methanol was distilled and the unreacted phenylhydrazine removed under reduced pressure. Vacuum distillation recovered 3.65 g. of ethyl tetronate. The residue, weight 0.3 g., failed to crystallize on cooling.

In a second experiment, a mixture of 2.56 g. (0.02 mole) of ethyl tetronate and 4.32 g. (0.04 mole) of phenylhydrazine was heated at 150° for 1 hr. Distillation gave 4.05 g. of phenylhydrazine and 2.2 g. of ethyl tetronate. The residue, a dark viscous oil, failed to crystallize on cooling to 0°.

Attempted reaction of ethyl tetronate with aniline. A solution of 3.84 g. (0.03 mole) of ethyl tetronate in 5 ml. of methanol was cooled to 0° and added to a solution of 11.16 g. (0.12 mole) of freshly distilled aniline in 10 ml. of methanol at 0°. There was no exothermic reaction on mixing. The solution was refluxed for 1 hr. and distilled to give 10.7 g. of aniline and 3.6 g. of ethyl tetronate.

In a second experiment, a mixture of 2.56 g. (0.02 mole) of ethyl tetronate and 7.47 g. (0.08 mole) of freshly distilled aniline was refluxed for 0.5 hr. Distillation under reduced pressure gave an almost quantitative recovery of aniline.

Attempted reaction of ethyl tetronate with 2-mercaptoethanol. A solution of 2.56 g. (0.02 mole) of ethyl tetronate and 1.56 g. (0.02 mole) of freshly distilled 2-mercaptoethanol [b.p. 55° (13 mm.), n_D^{25} 1.4980] was stirred by a magnetic stirrer for 24 hr. in the presence of ultraviolet light. The solution was distilled to give 1.50 g. of 2-mercaptoethanol, b.p. 53° (11 mm.), n_D^{25} 1.4977. The residue had a refractive index at

25° of 1.4780; pure ethyl tetronate has a refractive index of 1.4777.

Attempted copolymerization of ethyl tetronate with acrylonitrile. A mixture of 5.25 g. (0.041 mole) of ethyl tetronate, 2.19 g. (0.042 mole) of freshly distilled acrylonitrile, and 0.046 g. (0.0002 mole) of benzoyl peroxide was sealed under nitrogen, and placed in a constant temperature bath at 60 ± 0.1° for 1.5 hr. Some polymer separated from the monomer solution. The tube was cooled, opened, and the contents poured, with stirring, into 250 ml. of filtered methanol. After standing overnight in the refrigerator, the white, powdery precipitate was filtered on a sintered glass funnel, pressed, and dried to constant weight (1.25 g.) at room temperature and 0.06 mm. pressure. An infrared spectrum of this material failed to show any absorption in the carbonyl area, which would be expected had copolymerization taken place.

Ethyl methoxytetrolate. Methyl propargyl ether was prepared by reaction of the alcohol with methyl sulfate and alkali at 0–5°. The ether, obtained in 85% yield, b.p. 61–62°, n_D^{25} 1.3945, was treated with one equivalent of ethylmagnesium bromide in ether and then with an excess of diethyl carbonate. Extraction and distillation gave a 38% yield of ethyl methoxytetrolate, b.p. 63–64° (3 mm.), n_D^{25} 1.4397.

Anal. Calcd. for $C_7H_{10}O_3$: C, 59.14; H, 7.09. Found: C, 59.11; H, 7.00.

Infrared spectra of some of the compounds are summarized in Table I.

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[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY, UNIVERSITY OF PENNSYLVANIA]

Nitrogen Mustards Related to Chloroquine, Pamaquine, and Quinacrine[1]

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Procedures for the preparation of the nitrogen mustard analogs of the antimalarial drugs chloroquine, pamaquine, and quinacrine have been described.

Extensive investigations of the pharmacology of the quinoline antimalarial drugs[3] has indicated that they are selectively absorbed in certain tissues. For this reason we have undertaken a program involving the preparation and testing of a variety of derivatives of the antimalarial drugs in which the diethylamino group would be replaced by the bis(β-chloroethyl)amino group, the characteristic functional group of the nitrogen mustard gases. The quinoline nucleus and side chain might serve to carry the antimitotic activity of the nitrogen mustard function more selectively to certain areas of the organism, thus enhancing the chemotherapeutic value of the nitrogen mustards in the treatment of various types of cancer.

We here wish to report on the conversion of 4,7-dichloroquinoline to 7-chloro-4-[4-bis(β-chloroethyl) amino-1-methylbutylamino]quinoline (chloroquine mustard) and to 7-chloro-4-[6-bis(β-chloroethyl) aminohexylamino]quinoline (hexyl chloroquine mustard), of 2-methyl-4,7-dichloroquinoline to 2-methylchloroquine mustard, of 6-methoxy-8-(4-amino-1-methylbutylamino)quinoline (primaquine) to the 4-bis(β-chloroethyl) derivative (pamaquine mustard), and of 2-methoxy-6,9-dichloroacridine to 2 - methoxy 6 - chloro - 9 - [4 - bis(β - chloroethyl)-amino-1-methylbutylamino]acridine (quinacrine mustard).

These mustards have been screened against several tumors in mice here and elsewhere[4] and chloroquine and quinacrine mustards have been given initial clinical testing.[2] The activity of these compounds against several ascites tumors in mice[4] is approximately equal to HN_2 [methyl bis(β-chloroethyl)amine] and the toxicity of some to mice is several-fold less. Details of the animal and clinical testing will be reported elsewhere.[4(b)]

EXPERIMENTAL[5]

5-Chloro-2-pentanone. This compound was prepared from α-acetyl-γ-butyrolactone,[6] essentially according to the procedure given in *Organic Syntheses.*[7]

5-bis(β-Hydroxyethyl)amino-2-pentanone. A mixture of 52.5 g. (0.5 mole) of diethanolamine and 30 g. (0.25 mole) of 5-chloro-2-pentanone in 125 ml. of absolute ethanol was gently refluxed for 48 hr. The volatile material was then removed by warming on a water bath under water pump suction. The residual mass was then cooled, treated with 40 ml. of water, and the solution was extracted repeatedly with chloroform. The combined chloroform extracts were dried

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(3) L. H. Schmidt, *Survey of Antimalarial Drugs*, F. Y. Wiselogle, Ed., Edwards Bros., Ann Arbor, Mich., 1946, pp. 94, 106.

(4) (a) Hugh J. Creech, Lankenau Institute for Cancer Research, Fox Chase, Philadelphia 11, Pa.; (b) R. Jones, Jr., H. J. Creech, C. C. Price, A. K. Sen, R. M. Peck, R. F. Hankwitz, Jr., Ruth Rhines, Doris McKenzie, and W. F. Dunning, *Proc. Amer. Assoc. Cancer Research*, **2**, 132 (1956).

(5) All melting and boiling points are uncorrected. Microanalyses were carried out by Micro Tech Laboratories, Skokie, Ill. and Dr. Weiler and Dr. Strauss, Oxford, England.

(6) Obtained from Merck and Co., through the courtesy of Dr. Max Tishler.

(7) G. W. Cannon, R. C. Ellis, and J. R. Leal, *Org. Syntheses*, **31**, 74 (1951).