These difficulties were resolved with the synthesis of IV and V by independent methods. Thus, our sample of V was identical in appearance, melting behavior, and ultraviolet spectrum with a sample prepared by reacting 1,1,1,3-tetranitropropane with ammonia and treating the product with potassium chloride as described by Novikov and co-workers.[4] *1,3-Dibromo-1,1,3,3-tetranitropropane*, prepared by brominating suspensions of both samples in ether, melted at 67–69° (lit.[4] m.p. 69–69.5°), and showed no depression on admixture but did show melting point depression with the soluble dibromide, m.p. 70°, prepared by the bromination of II in wet ether.

Anal. Calcd. for $C_3H_2Br_2N_4O_8$: Br, 41.9. Found: Br, 41.5.

N,N-Dimethyl-2,2-dinitroethylamine (III). A solution of 20.0 ml. (0.114 mole) of 25% aqueous dimethylamine and 9.29 g. (0.057 mole) of 1,1,1-trinitroethane was refluxed 5 min. then allowed to stand overnight at room temperature. After filtering and washing with methanol followed by ether, the pale yellow columnar equant crystals which separated weighed 5.13 g. and had m.p. (dec.) 99.2–99.8°.

Anal. Calcd. for $C_4H_9N_3O_4$: C, 29.42; H, 5.51; N, 25.78. Found: C, 29.17; H, 5.42; N, 25.46.

After 3 days further standing in the freezer an additional 0.43 g. of III (total yield 66%), m.p. 94–94.6° dec. precipitated. The compound was soluble in dilute acid or dilute alkali, but even less soluble in water than II.

Two grams of III dissolved readily in a solution of 2.0 g. 85% potassium hydroxide in 5.0 ml. water at 70°. On cooling the solution 2.02 g. (82%) of *potassium N,N-dimethyl-2,2-dinitroethylamine* precipitated as small columnar yellow crystals, m.p. 161–163° dec.

Anal. Calcd. for $KC_4H_8N_3O_4$: C, 23.89; H, 3.98; N, 20.90. Found: C, 24.14, 24.32; H, 3.98, 4.11; N, 20.48, 20.49.

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5-Ethoxy-8-aminoquinoxaline[1]

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A number of carbocyclic substituted quinoxalines having fungistatic and medicinal properties have been reported in the literature. We deemed it of interest to undertake the preparation of 5-ethoxy-8-aminoquinoxaline and some of its derivatives.

In this publication we wish to report the synthesis of 5-ethoxy-8-acetylaminoquinoxaline (IV), 5-ethoxy-8-aminoquinoxaline (V), 5-ethoxy-8-*p*-tolylsulfonamidoquinoxaline (VII), 5-ethoxy-8-*N*-acetylsulfanilamidoquinoxaline (VIII), and 5-ethoxy-8-sulfanilamidoquinoxaline (IX). Also, we wish to report an improved procedure for the preparation of 1-ethoxy-2,3-dinitro-4-acetamidobenzene.[5]

The synthesis of 5-ethoxy-8-aminoquinoxaline was achieved according to the following sequence: *p*-phenacetin (I) was converted to 1-ethoxy-2,3-dinitro-4-acetamidobenzene (II), catalytic reduction of (II) with hydrogen in the presence of 5% palladium-on-charcoal catalyst yielded the intermediate 1-ethoxy-2,3-diamino-4-acetamidobenzene (III), which was not isolated but immediately condensed with sodium glyoxal bisulfite to form 5-ethoxy-8-acetylaminoquinoxaline (IV), and acid hydrolysis of (IV) yielded 5-ethoxy-8-aminoquinoxaline (V).

The reaction of an alcoholic solution of the free amine (V) with an excess of approximately 14% hydrochloric acid yielded 5-ethoxy-8-aminoquinoxaline hydrochloride (VI). The addition of *p*-toluenesulfonyl chloride to pyridine solution of 5-ethoxy-8-aminoquinoxaline (V) yielded 5-ethoxy-8-*p*-tolylsulfonamidoquinoxaline (VII). Similarly, the reaction of *p*-acetamidobenzenesulfonyl chloride with the free amine (V), according to the method of Wolfe *et al.*,[6] afforded 5-ethoxy-8-*N*-acetylsulfanilamidoquinoxaline (VIII). The acetyl derivative (VIII) was hydrolyzed to 5-ethoxy-8-sulfanilamidoquinoxaline (IX) with alcoholic hydrochloric acid.

IV has been found to produce 36% inhibition of *Aspergillus niger* in 250 parts per million concentration. Both (IV) and (V) show some ability to inhibit the growth of *Rhizopus nigricans, Mucar sp.*, and *Penicillium sp.* Further work on the fungistatic properties of these compounds is in progress and will be published elsewhere.

EXPERIMENTAL

The corrected melting points were determined by the use of a microscopic, hot stage melting point block equipped with a calibrated thermometer. The microscope was equipped with a polarized lens which facilitated determination of the precise melting point range. The sample on the hot stage was heated at a uniform rate of 2° per min. The melting point range was taken as the temperature between which the first crystal disappeared and the entire field became dark when observed under polarized light.

1-Ethoxy-2,3-dinitro-4-acetamidobenzene. Twenty-five grams (0.14 mole) of *p*-phenacetin (Charles Pfizer, reagent grade) was placed in a 300-ml. Pyrex mortar which had been positioned in an evaporating dish containing a Dry Ice–acetone mixture. When the dry *p*-phenacetin had cooled to about 15–25° 125 ml. (2.97 moles) of Baker's fuming nitric acid (sp. gr. 1.50) was added dropwise over a period of 1 hr. The reaction mixture was stirred by means of a pestle throughout the entire addition time. Continuous cooling was necessary to maintain the temperature between 15–25°.

The cold reaction mixture was poured into 1.5 l. of cold water, and the yellowish orange product which separated was removed by filtration employing a Buchner funnel. The crude product which weighed 31.9 g. was crystallized a single time from 1.25 l. of an ethanol:acetone mixture (3:1). A second crystallization from the ethanol:acetone mixture (3:1) containing 5 g. of Nuchar afforded a pale, greenish

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(5) P. E. Verkade and P. H. Witjens, *Rec. trav. chim.*, **62**, 201 (1943).

(6) E. J. Wolfe, R. H. Beutel, and J. R. Stevens, *J. Am. Chem. Soc.*, **70**, 2574 (1948).

yellow product which separated as plates; yield 28.1 g. (74.8%), m.p. 211–212°.

Anal. Calcd. for $C_{10}H_{11}N_3O_6$: N, 15.61. Found: N, 15.59.

The average yield from fourteen similar runs was 75%.

5-Ethoxy-8-acetylaminoquinoxaline. A solution of 54 g. (0.2 mole) of 1-ethoxy-2,3-dinitro-4-acetamidobenzene in 350 ml. of dimethyl formamide was reduced in a 1-l., one-neck glass reduction flask in the presence of 40 g. of 5% palladium-on-carbon catalyst. The hydrogenation was conducted at room temperature under a hydrogen pressure of 30 pounds per square inch and was complete in 1.5 hr.

In a dry box, the reduction mixture was filtered, under a nitrogen atmosphere, through Filter-Cel into 68.1 g. (0.256 mole) of reagent grade sodium glyoxal bisulfite (Carbide and Carbon) which was dissolved in 1000 ml. of 70° water. This reaction mixture was heated at total reflux for 6 hr. under a nitrogen blanket. The hot reaction mixture was filtered through Filter-Cel and the low-boiling material removed at the water pump. Approximately 250 ml. of brown oil remained. This oil was poured into 3.0 l. of acetone. The bright yellow solid which separated was collected by filtration on a Buchner funnel and washed with three 250-ml. portions of 5° water. The product was crystallized from ethanol; yield 21.3 g. (46.2%) m.p. 186°.

An estimate of the purity of the product was obtained by eluting a sample which had been placed on a strip of 3MM chromatographic paper (S&S) with a mixture of hexane: acetone (3:2). Examination of the paper strip under ultraviolet light indicated the presence of only one component in the analytically pure sample.

Anal. Calcd. for $C_{12}H_{13}N_3O_2$: C, 62.33; H, 5.63; N, 18.18. Found: C, 62.24; H, 5.72; N, 18.15.

5-Ethoxy-8-aminoquinoxaline. An orange mixture of 2 g. (0.0086 mole) of 5-ethoxy-8-acetylaminoquinoxaline and 20 ml. of 2*N* sulfuric acid was heated at 95–98° for 15 min. in a 50-ml. Erlenmeyer flask. The resulting blood red solution was cooled to room temperature and cautiously neutralized, as indicated by moist Alkacid paper, by the addition of solid sodium bicarbonate. When cooled to 0–5°, the bright orange crystals which separated were removed by filtration on a Buchner funnel and washed with two 100-ml. portions of cold water (2–3°). After drying overnight at 50°, the bright orange product weighed 1.48 g. (90.5%) m.p. 85–86°. The melting point remained unchanged by a single crystallization from an ethanol:acetone mixture (3:1) followed by a single crystallization from an ethanol:isopropyl ether mixture (1:1).

Anal. Calcd. for $C_{10}H_{11}N_3O$: C, 63.49; H, 5.82; N, 22.22. Found: C, 63.74; H, 6.28; N, 21.98.

The product appears to undergo a number of the usual reactions of aromatic amines. It can be coupled in the usual fashion with β-naphthol, 1-phenyl-3-methylpyrazolone-5, *p*-cresol, diphenylamine, dimethylaniline and *N*-ethyl-*N*-β-cyanoethyl-*m*-toluidine to form dyes.

5-Ethoxy-8-aminoquinoxaline hydrochloride. An excess of approximately 14% hydrochloric acid was added to a solution of 0.5 g. (0.0027 mole) of 5-ethoxy-8-aminoquinoxaline in 10 ml. of ethanol. The reaction mixture was stirred for 1 hr. at room temperature whereupon anhydrous ethyl ether was added dropwise until the reaction mixture developed a slight opalescence. The cream colored product which separated on cooling to 5° was collected by filtration on a Buchner funnel and washed with two 25-ml. portions of 5° water. After drying overnight at 50°, the product weighed 0.59 g. (90%) m.p. 180–190°. No change in the decomposition range of the product occurred after one crystallization by the dropwise addition of isopropyl ether to a solution of the salt in boiling ethanol and subsequent cooling of the turbid solution. A sharp decomposition point was not obtained in a sealed capillary tube according to the method of Easley and Bahner.[7]

(7) W. K. Easley and C. T. Bahner, *J. Am. Chem. Soc.*, 72, 3803 (1950).

Anal. Calcd. for $C_{10}H_{12}N_3OCl$: Cl, 15.78. Found: Cl, 15.28.

5-Ethoxy-8-p-tolylsulfonamidoquinoxaline. Thirty-three hundredths of a gram (0.027 mole) of *p*-toluenesulfonyl chloride (Eastman, reagent grade) was added to a stirred solution of 0.5 g. (0.0027 mole) of 5-ethoxy-8-aminoquinoxaline in 5 ml. of pyridine. The mixture was stirred and heated at reflux for 30 min. employing a Mag-Mix hotplate. The hot reaction mixture was treated with 1 g. of Nuchar, filtered through Filter-Cel, and cooled to 0–5°. The cream colored product which separated was collected on a Buchner funnel and dried overnight at 50° prior to purification. The product was crystallized from a boiling ethanol:acetone mixture (3:1); yield 0.48 g. (57%) m.p. 132–133°.

Anal. Calcd. for $C_{17}H_{17}N_3SO_3$: N, 12.24; S, 9.32. Found: N, 12.20; S, 9.24.

5-Ethoxy-8-N-acetylsulfanilamidoquinoxaline. This cream colored compound was prepared from (V) essentially as described by Wolfe *et al.*[6] The yield was 90.5%, m.p. 223–229°.

Anal. Calcd. for $C_{18}H_{18}N_4SO_4$: N, 14.51; S, 8.28. Found: N, 14.47; S, 8.20.

5-Ethoxy-8-sulfanilamidoquinoxaline. Alcoholic hydrochloric acid was employed to hydrolyze (VIII) in a similar procedure to that described by Wolfe *et al.*[6] The crude yield was 71%. The pure bright yellow product had an m.p. of 181–182°.

Anal. Calcd. for $C_{16}H_{16}N_4SO_3$: N, 16.28; S, 9.30. Found: N, 16.19; S, 9.09.

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Vinyl Sulfides. VI. Evidence for a Sulfonium Mercaptide Intermediate

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The preparation of ketene mercaptals by the base-catalyzed reaction of *n*-alkylmercaptoacetaldehyde dialkyl mercaptals with acetylene occurs in high yield[1] (Equation 1a). For a continuing study of the properties of ketene mercaptals, the preparation of 2-methylene-1,3-dithiolane (II) was proposed, to be obtained by a similar reaction sequence (Equation 1b). As in the ketene acetal series,[2] the cyclic ketene mercaptal (II) was expected to have considerably better polymerization characteristics than its open chain counterparts. For convenience in product separation *n*-

$$RSCH_2CH(SR)_2 + HC{\equiv}CH \xrightarrow[ROH]{^-OR} CH_2{=}C(SR)_2 + CH_3{=}CHSR \quad (1a)$$

butylmercapto derivatives were employed. The proposed synthesis therefore required the prepara-

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