with phenothiazine in the presence of sodamide (or lithium amide), according to known procedures.[11]

The introduction of groups larger than methyl on the terminal amino nitrogen does not increase the effectiveness of these phenothiazine derivatives as antihistamines; more often the activity is lowered as is shown in Table III.

Experimental[12,13]

Procedure A. N-Isopropyl-N-methylethanolamine was prepared by treatment of 2-isopropylaminoethanol[10] with formic acid and formaldehyde according to the method of Biel.[14]

Procedure B. N-(*n*-Butyl)-N-methylethanolamine.—A mixture of 49.8 g. (0.664 mole) of methylethanolamine,[8] 61.1 g. (0.332 mole) of *n*-butyl iodide and 200 ml. of dry benzene was refluxed for three hours. When cool, the mixture was transferred to a separatory funnel, the upper benzene layer separated and the lower layer extracted with benzene. The benzene extracts were combined and the solvent removed through a short Vigreux column. To the residue was added 75 ml. of acetic anhydride, the solution heated on the steam-bath for two hours and, when cool, poured into 500 ml. of a 5% hydrochloric acid solution. The resulting solution was extracted with ether and these ethereal extracts discarded. The acid extract was basified with solid potassium carbonate, a large excess being added to saturate the solution, and the resulting mixture extracted with ether. The ether was removed and the residue refluxed for five hours with 25% sodium hydroxide solution. The resulting mixture was extracted with ether, the extracts dried over anhydrous magnesium sulfate, the solvent removed and the residue distilled *in vacuo;* yield 23.9 g. (55%), b. p. 97° (39 mm.).

Procedure C. β-Diallylaminoethanol.—The general method of Horne and Shriner[6] was employed using 48.6 g. (0.5 mole) of diallylamine[15] and 29.3 g. (0.67 mole) of ethylene oxide; yield, 54.8 g. (78%), b. p. 114–115° (49 mm.).

Procedure D. N-Isopropyl-N-(*n*-propyl)-ethanolamine.—Procedure B was modified in that 30.9 g. (0.30 mole) of 2-isopropylaminoethanol, 63.6 g. (0.60 mole) of anhydrous sodium carbonate, 53.6 g. (0.315 mole) *n*-propyl iodide and 40 ml. of xylene were refluxed together for five hours. When cool, the reaction mixture was filtered. To the filtrate was added 50 ml. of acetic anhydride, the solution heated on the steam-bath for one hour and then worked up as described in Procedure B; yield, 25.5 g. (59%), b. p. 80.5–81° (17 mm.).

β-(Ethylisopropylamino)-ethyl Chloride.—To a stirred solution of 29.8 g. (0.25 mole) of thionyl chloride in 60 ml. of dry benzene cooled in an ice-bath was added, dropwise, 26.2 g. (0.2 mole) of N-ethyl-N-isopropylethanolamine. The mixture was heated under reflux for two hours and the benzene and excess thionyl chloride removed by distillation, the last traces being removed *in vacuo.* The residue was dissolved in a small amount of water, the solution filtered, the filtrate extracted once with ether and the ethereal extract discarded. The aqueous extract was basified with potassium carbonate, a large excess being added to saturate the solution. The mixture was extracted with ether, the ethereal extracts dried over anhydrous magnesium sulfate, the ether removed and the residue distilled *in vacuo* through a Vigreux column; yield, 20.6 g. (69%); b. p. 87–89° (72 mm.). The freshly distilled product very slowly precipitates long thin needles of the cyclic dimer. By the same general procedure all of the compounds reported in Table II were prepared.

N-[β-Isopropylmethylamino)-ethyl]-phenothiazine Hydrochloride.—The general method for the preparation of N-(alkylaminoalkyl)-phenothiazines previously reported[11a] was employed using equivalent amounts of β-(isopropylmethylamino)-ethyl chloride and sodamide.[16]

All of the compounds reported in Table III were prepared by this general procedure. In several instances toluene was used in place of xylene as a solvent with corresponding longer reflux times (eight to twenty-four hours).

Summary

1. Nine new 2-disubstituted aminoalcohols and fifteen new 2-disubstituted aminoalkyl chlorides have been prepared.

2. Sixteen new N-disubstituted aminoalkylphenothiazines have been prepared.

3. The results of preliminary pharmacological tests on these phenothiazine derivatives for antihistaminic activity is reported.

(11) (a) British Patent 608,208; (b) Reid, Wright, Kolloff and Hunter, THIS JOURNAL, **70**, 3100 (1948); (c) Dahlbom, *Acta Chem. Scand.*, **3**, 247 (1949); (d) French Patent 917,595.

(12) All melting points and boiling points are uncorrected.

(13) Appreciation is expressed to Mr. Harold C. Emerson and his staff for analyses reported.

(14) Biel, THIS JOURNAL, **71**, 1308 (1949).

(15) "Organic Syntheses," Coll. Vol. I, 1944, p. 201.

(16) Vaughn, Vogt and Nieuwland, THIS JOURNAL, **56**, 2120 (1934).

KALAMAZOO, MICHIGAN RECEIVED JANUARY 23, 1950

[CONTRIBUTION FROM THE LILLY RESEARCH LABORATORIES]

The Synthesis of Some β-Aminoethyldiazines as Histamine Analogs

BY REUBEN G. JONES, EDMUND C. KORNFELD AND KEITH C. MCLAUGHLIN

The histamine-like activities of a number of β-aminoethyl heterocyclic nitrogen compounds were reported[1] recently. Among this group were 2-β-aminoethylquinoxaline, 2-β-aminoethylpyrazine, 3-β-aminoethylpyridazine and the 2- and 4-β-aminoethylpyrimidines. These compounds, presented in Table I, were synthesized by the same general procedure, and it is the purpose of this paper to describe their preparation.

After considering a number of possible synthetic routes, a method similar to that used by Walter, Hunt and Fosbinder for the preparation of 2-β-aminoethylpyridine[2] appeared to be the most promising. The method is outlined in the accompanying sequence of reactions.

$$RCH_3 + CCl_3CHO \xrightarrow[\Delta]{\text{Pyridine}}$$

$$\underset{\text{I}}{RCH_2CHOHCCl_3} \xrightarrow{NaOH} \underset{\text{II}}{RCH{=}CHCO_2H} \xrightarrow[Ni]{(H)}$$

(1) Lee and Jones, *J. Pharmacol.*, **95**, 71 (1949).

(2) Walter, Hunt and Fosbinder, THIS JOURNAL, **63**, 2771 (1941).

TABLE I

β-AMINOETHYLDIAZINE DIHYDROCHLORIDES, $RCH_2CH_2NH_2 \cdot 2HCl$

R	Yield, %	M. p., °C.	Carbon, % Calcd.	Carbon, % Found	Hydrogen, % Calcd.	Hydrogen, % Found	Nitrogen, % Calcd.	Nitrogen, % Found
2-Quinoxaline[a]	76	184-186 dec.	48.79	49.27	5.32	5.22	17.07	17.28
2-Pyrazine[b]	80	159–161 dec.	36.75	37.26	5.66	5.68		
3-Pyridazine[b]	73	168–169					21.43	22.16
2-Pyrimidine	60	167–168					20.45[c]	20.43
4-Pyrimidine[b]	48	180–182	36.75	36.60	5.66	5.38		

[a] Empirical formula, $C_{10}H_{11}N_3 \cdot 2HCl$. [b] Empirical formula, $C_6H_9N_3 \cdot 2HCl$. [c] $C_6H_9N_3 \cdot 2HCl \cdot 0.5H_2O$. Calcd.: Cl, 34.60. Found: Cl, 34.42.

$$RCH_2CH_2CO_2H \longrightarrow RCH_2CH_2CO_2CH_3 \xrightarrow{NH_3}$$
III IV
$$RCH_2CH_2CONH_2 \xrightarrow{NaOCl} RCH_2CH_2NH_2$$
V VI

In each of the starting compounds, RCH_3, the methyl group was active; *i.e.*, it was attached to the nucleus, R, in a position adjacent to one of the nitrogen atoms.

2-Methylquinoxaline[3] was obtained in 65% yield together with some resinous by-products when aqueous solutions of *o*-phenylenediamine and pyruvic aldehyde[4] were mixed. However, if two molar equivalents of sodium bisulfite were first added to the pyruvic aldehyde solution, the yield of 2-methylquinoxaline was increased to 90–95%.

Methylpyrazine was prepared conveniently from 2-methylquinoxaline. The latter was first oxidized with permanganate to yield 2-methyl-5,6-pyrazinedicarboxylic acid,[5] and this was decarboxylated by heating with glacial acetic acid in an autoclave at 200°. 2-Methylpyrimidine,[6] 4-methylpyrimidine,[7] and 3-methylpyridazine[8] were prepared according to directions in the literature with certain modifications as noted in the Experimental section. .

It has long been known that quinaldine[9] and the 2- and 4-picolines[10] undergo condensation with chloral to yield compounds of the type I. Therefore, it was not surprising to find that the methyl diazines in the present study also underwent condensation with chloral to give satisfactory yields of the adducts, I. This reaction was studied in some detail in order to determine the conditions which would give the highest yields of desired products. The best general procedure appeared to be to heat the methyl compound with 1.25 molar equivalents of chloral in pyridine solution at about 90–100°. The optimum length of the heating period was different for each compound. For example, the reaction with 2-methylquinoxaline appeared to be complete in about one hour or less, whereas the optimum time for the reaction with 3-methylpyridazine was about twenty hours and for 2-methylpyrimidine, about forty hours or longer. Incidentally, by the use of this procedure with a twenty-hour heating period, γ-(3,3,3-trichloro-2-hydroxypropyl)-pyridine[11] was obtained in a yield of 40%. No difficulties were encountered in the hydrolysis of the trichloro compounds, I; reduction of the acids, II; and formation and degradation of the amides V.

Experimental

2-Methylquinoxaline.[3]—To 550 g. of 31% pyruvic aldehyde[4] diluted with one liter of water was added 490 g. of sodium bisulfite. The resulting solution was added all at once with stirring to a solution of 216 g. of *o*-phenylenediamine in 1100 ml. of water. After standing overnight, the mixture was treated with 400 g. of sodium carbonate and extracted with three 300-ml. portions of ether. The ether extract was dried and distilled to yield 365 g. (92%) of 2-methylquinoxaline; b. p. 125–127° (11 mm.).

2-Methyl-5,6-pyrazinedicarboxylic Acid.—This procedure is given in detail because it appears to be much simpler and affords better yields than previously reported.[5]

A solution of 196 g. (1.36 moles) of 2-methylquinoxaline in 4.5 l. of water in a 12-l. three-necked flask provided with reflux condenser, dropping funnel and mechanical stirrer, was heated to 90°. With stirring a hot saturated aqueous solution of 1250 g. of potassium permanganate was added during a period of one and one-half hours. The mixture was cooled somewhat and filtered. The manganese dioxide was washed by suspension in two one-liter portions of water. The combined filtrate and washings were evaporated in vacuum on the steam-bath to about two liters, or until solid began to separate. Carefully, 650 ml. of 12 *N* hydrochloric acid was added, and the resulting solution was immediately evaporated in vacuum with only gentle warming. Excessive heating darkened the product at this stage. The damp crystalline residue was extracted with three one-liter portions of warm acetone, and the acetone solution was evaporated in vacuum. The product was removed from the flask, sucked dry on a Buchner funnel, washed on the funnel with a little ice-cold acetone, and then kept in a vacuum desiccator over potassium hydroxide until thoroughly dry and free of hydrochloric acid. The crude brown product was dissolved in the minimum quantity (about 3 l.) of boiling acetone, and after treating with decolorizing carbon the solution was filtered and evaporated in vacuum leaving the acid as a light tan crystalline powder. It was finally dried in an oven for fifteen hours at 100°. The yield was 175 g. (71%).

(3) (a) Böttcher, *Ber.*, **46**, 3084 (1913); (b) Fischer and Taube, *ibid.*, **57**, 1502 (1924).

(4) Obtained from Carbide and Carbon Chemicals Corporation.

(5) Leonard and Spoerri, THIS JOURNAL, **68**, 526 (1946); see also ref. 3a.

(6) Gabriel, *Ber.*, **37**, 3638 (1904).

(7) Gabriel and Colman, *ibid.*, **32**, 1525 (1899).

(8) Pappenberg, *ibid.*, **34**, 3263 (1901). 3-Methylpyridazine was not stable for long periods of time. When kept in a stoppered glass bottle it gradually darkened, and after several months it had changed to a hard black resin.

(9) Miller and Spady, *ibid.*, **18**, 3402 (1885); Einhorn, *ibid.*, **18**, 3465 (1885); Gerngross, *ibid.*, **42**, 400 (1909).

(10) Einhorn, *Ann.*, **265**, 208 (1891); Düring, *Ber.*, **38**, 167 (1905); Tullock and McElvain, THIS JOURNAL, **61**, 961 (1939).

(11) Alberts and Bachman, *ibid.*, **57**, 1284 (1935); Webb and Corwin, *ibid.*, **66**, 1456 (1944).

TABLE II

CHLORAL ADDUCTS OF METHYLDIAZINES, β-DIAZINEACRYLIC ACIDS

	RCH₂CHOHCCl₃					R—CH=CH—COOH			
R	Yield, %	M. p., °C.	Anal. Calcd.	N, % Found	Reaction time, hours	Yield, %	M. p., °C.	Anal. Calcd.	N, % Found
2-Quinoxaline	93	105.5–106	9.61[a]	9.72	1[d]	70	219–220 dec.	14.00[i]	14.28
2-Pyrazine	48	106–107	11.60[b]	11.81	90[e]	77	183.5–184	18.66[j]	18.49
3-Pyridazine	85	138.5–139	11.60[b]	11.42	20[f]	62	223–224 dec.	18.66[j]	18.47
2-Pyrimidine	43	115–115.5	11.60[b]	11.46	44[g]	92	235–237 dec.	18.66[j]	18.01
4-Pyrimidine	73	164–165	[b]	[h]	66	45	265–267 dec.	18.66[j]	18.52
4-Pyridine	42	160–162[c]			20				

[a] Empirical formula, $C_{11}H_9Cl_3N_2O$. [b] Empirical formula, $C_7H_7Cl_3N_2O$. [c] See ref. 11. [d] Higher temperatures or longer heating gave lower yields. [e] Heating at 120° for six hours gave 21% yield, and 120° for sixteen hours, gave a 35% yield. [f] Heating for sixty hours gave a 50% yield. [g] Heating for twenty hours gave a 33% yield. [h] Calcd.: Cl, 44.04. Found: Cl, 44.23. [i] Empirical formula, $C_{11}H_8N_2O_2$. [j] Empirical formula, $C_7H_6N_2O_2$.

2-Methylpyrazine.[12]—In a one-liter steel autoclave was placed 228 g. (1.25 moles) of 2-methyl-5,6-pyrazinedicarboxylic acid and 300 ml. of glacial acetic acid. The autoclave was heated at 195–205° for two hours. The dark reaction liquid was placed in a large beaker, cooled in an ice–salt-bath, and 500 ml. of 12.5 *N* sodium hydroxide solution was added slowly with stirring, followed by 750 g. of sodium carbonate. The resulting almost solid mass was extracted with four 500-ml. portions of ether. After the ether extract had been dried over magnesium sulfate it was distilled through a packed column to remove the ether. The residual dark liquid was distilled through a small packed column, and there was obtained 72 g. (63% yield) of pure 2-methylpyrazine; b. p. 132–133° (745 mm.).

3-Methylpyridazine.[8]—In a low-pressure hydrogenation bottle was placed 1 g. of 5% palladium–charcoal catalyst, 20 ml. of concentrated ammonium hydroxide solution, 50 ml. of 95% ethanol and 30 g. (0.23 mole) of 3-methyl-6-chloropyridazine.[8] The mixture was shaken under 50 lb. hydrogen pressure and the theoretical 0.23 mole of hydrogen was taken up in fifteen to thirty minutes with evolution of heat. The mixture was filtered, and the catalyst was washed on the funnel with 25 ml. of water.

Six such filtrates were combined and evaporated on the steam-bath under vacuum until solid began to separate. About 100 g. of solid sodium hydroxide was then added in portions with cooling and shaking. The dark non-aqueous layer was separated by extraction into benzene. After the benzene solution had been dried over potassium hydroxide, it was distilled to remove the benzene, and the residual liquid was distilled in vacuum to yield 114 g. (88%) of 3-methylpyridazine; b. p. 88–90° (12 mm.), 219–220° (745 mm.).

Methylpyrimidines.—2-Methylpyrimidine,[6] b. p. 130–131° (750 mm.), was obtained in 84% yield by the catalytic hydrogenation of 2-methyl-4-chloropyrimidine[6] as described above for 3-methylpyridazine. It was necessary to stop the hydrogenation as soon as the theoretical quantity of hydrogen had been absorbed, otherwise hydrogen continued to be taken up rapidly with a consequent lowering of the yield of desired product. In working up the reaction mixture, an excess of hydrochloric acid was first added, and then the filtered solution was evaporated almost to dryness before it was made basic with excess sodium hydroxide. Ether was used to extract the product.

4-Methylpyrimidine, b. p. 139–142°, was prepared in a 38% yield by catalytic hydrogenation of 4-methyl-2,6-dichloropyrimidine[7] in the same manner as described above for 2-methylpyrimidine.

Condensation of Methyldiazines with Chloral.—The products presented in Table II, with the exception of that from 2-methylquinoxaline, were prepared by the same general procedure as follows:

In a round-bottom flask was placed 0.3 mole of the methyldiazine, 120 ml. of dry pyridine and 60 g. (0.4 mole) of chloral. The solution was heated on the steam-bath (90–95°) for varying lengths of time as indicated in Table II, and then the pyridine was removed as completely as possible by evaporation in vacuum. A black tar-like mass remained which was thoroughly mixed with 500 ml. of 2 *N* hydrochloric acid. The solution was treated with a liberal quantity of decolorizing carbon, filtered and the carbon extracted with an additional 250 ml. of 2 *N* hydrochloric acid. The dark brown filtrate was made basic with ammonium hydroxide and evaporated to dryness in vacuum. This residue was extracted with three 500-ml. portions of boiling benzene, the solution was decolorized with carbon and evaporated in vacuum almost to dryness, and 500 ml. of petroleum ether was added. The white crystalline product required no further purification.

In the condensation of 2-methylquinoxaline with chloral only a little pyridine was used. The reaction mixture was washed with water, and the product was recrystallized from petroleum ether.

β-Diazineacrylic Acids.—One example will suffice to illustrate the method by which the acids presented in Table II were prepared.

To a solution of 20 g. (0.083 mole) of the chloral adduct of 2-methylpyrimidine (Table II) in 100 ml. of alcohol was added 33 ml. (0.41 mole) of 12.5 *N* sodium hydroxide solution. The solution was warmed to about 70° whereupon a vigorous exothermic reaction took place. After the brown solution had cooled, the alcohol was removed by warming in vacuum. To the residue was added 50 ml. of water followed by 13 ml. of 12 *N* hydrochloric acid bringing the solution to about *p*H 2 or 3. After chilling, the acid was collected, washed with a little ice water and air dried. It could be purified by recrystallization from water.

β-Diazinepropionic Acids, Esters and Amides, Table III.—The acrylic acids of Table II were hydrogenated to the propionic acids by the following procedure: In a low-pressure hydrogenation bottle was placed 0.80 mole of the acrylic acid, 85 ml. of 1 *N* sodium hydroxide solution and 3 g. of Raney nickel catalyst. The mixture was shaken under hydrogen at 40 pounds pressure, and the hydrogenation was usually complete in about three hours. The solution was filtered, brought to *p*H 3 with hydrochloric acid, and evaporated to dryness in vacuum. The residue was thoroughly extracted with hot ethyl acetate. Evaporation of this left the crude acid, which could be purified by recrystallization from benzene or petroleum ether. The acids were esterified with methanol and hydrogen chloride or with diazomethane. Amides were obtained by allowing the esters in alcoholic ammonia solution to stand for several days. Yields were 90–98%.

β-Aminoethyldiazine Dihydrochlorides.—These compounds listed in Table I were prepared by the procedure which is illustrated in the following typical example:

To a cold solution of 16 g. (0.40 mole) of sodium hydroxide in 16 ml. of water was added 30 g. of ice, and then chlorine was bubbled into the mixture until 6.0 g. (0.085

(12) Previously prepared by another method; see Brandes and Stoehr, *J. prakt. Chem.*, [2] **54**, 486 (1896); Stoehr, *ibid.*, **51**, 464 (1895).

TABLE III

β-DIAZINEPROPIONIC ACIDS, METHYL ESTERS AND AMIDES

R	RCH₂CH₂COOH Yield, %	M. p., °C.	Anal. Calcd.	N, % Found	RCH₂CH₂COOCH₃ M. p., °C.	Anal. Calcd.	N, % Found	RCH₂CH₂CONH₂ M. p., °C.	Anal. Calcd.	N, % Found
2-Quinoxaline	92[a]	115–115.5	13.86	13.95	39–40[d]	12.96	13.14	152–152.5[f]	20.88	20.95
2-Pyrazine	79[b]	91.5–92	18.42	18.71	Liquid			125–126[g]	[h]	
3-Pyridazine	93[b]	168–170 dec.	[c]		42.5–43[e]	16.86	16.76	141–142[g]	27.80	27.50
2-Pyrimidine	84[b]	179–180	18.42	18.60	Liquid			135–136[g]	27.80	27.88
4-Pyrimidine	75[b]	198–199	18.42	18.46	Liquid			117–118[g]	27.80	27.77

[a] Empirical formula, $C_{11}H_{10}N_2O_2$. [b] Empirical formula, $C_7H_8N_2O_2$. [c] Calcd.: C, 55.26; H, 5.30. Found: C, 54.90; H, 5.45. [d] Empirical formula, $C_{12}H_{12}N_2O_2$. [e] Empirical formula, $C_8H_{10}N_2O_2$. [f] Empirical formula, $C_{11}H_{11}N_3O_2$. [g] Empirical formula, $C_7H_9N_3O_2$. [h] Calcd.: C, 55.62; H, 6.01. Found: C, 55.90; H, 6.19.

mole) had been absorbed. Ninety grams of ice was added to the resulting solution followed by 11.8 g. (0.078 mole) of β-(2-pyridazine)-propionamide (Table III). The mixture was stirred until all of the solid had dissolved, and then it was allowed to stand at room temperature for one hour after which it was heated on the steam-bath for one hour. The cooled solution was extracted with three 150-ml. portions of isoamyl alcohol. This extract was washed with a little water after which it in turn was extracted with three 100-ml. portions of 2 *N* hydrochloric acid. Evaporation of the hydrochloric acid solution in vacuum left a sirup which soon crystallized. The product was triturated with hot absolute ethanol, in which it was sparingly soluble, and air dried.

The β-aminoethylquinoxaline, pyrazine and pyrimidines were best extracted from the hypochlorite–reaction mixture with ethyl acetate instead of isoamyl alcohol. The ethyl acetate solutions were dried with magnesium sulfate, and the amine hydrochlorides were precipitated with dry hydrogen chloride. The products were purified by solution in hot methanol, decolorization with carbon and precipitation with dry ether. They were obtained as white crystalline solids; readily soluble in water or warm methanol, insoluble in non-polar solvents.

Acknowledgment.—The authors are grateful to W. L. Brown, H. L. Hunter and W. J. Schenck for the microanalyses reported here.

Summary

The syntheses of 2-β-aminoethylquinoxaline, 2-β-aminoethylpyrazine, 3-β-aminoethylpyridazine, 2-β-aminethylpyrimidine and 4-β-aminoethylpyrimidine are described.

INDIANAPOLIS, INDIANA RECEIVED JANUARY 25, 1950

[CONTRIBUTION FROM THE CHEMICAL LABORATORIES OF THE UNIVERSITY OF NOTRE DAME]

The Reaction of Dimethylethynylcarbinol with Hydrochloric Acid[1]

BY G. F. HENNION, J. J. SHEEHAN AND D. E. MALONEY

Discussion

It is not surprising that treatment of dimethylethynylcarbinol (I) with hydrochloric acid produces a variety of products. There is, however, a good deal of uncertainty about the nature of these materials as well as the yields and properties of those which are isolable. Furthermore, no attempt has been made previously to ascertain the mechanisms by which the various products are formed. Hurd and McPhee[2,3] observed that 2-chloro-3-methyl-1,3-butadiene (II) was in their product and claimed the amount to be "far in excess of 36%" on the basis of ozonolysis (36% yield of formaldehyde) and 42% yield of a maleic anhydride adduct reported to melt at 124–126°. Carothers and Coffman[4] first prepared II and presented an adequate description and proof of structure, both confirmed in the present study. The Hurd–McPhee product admittedly differed from that of Carothers and Coffman and no definite explanation could be offered.

There are two plausible mechanisms for the formation of II from I: (a) that the carbinol dehydrates *in situ* to form isopropenylacetylene (III) which then adds hydrogen chloride across the triple bond; (b) that the reaction initially produces the tertiary chloride (IV), then adding hydrogen chloride to form an unstable dichloride, $(CH_3)_2C(Cl)—C(Cl)=CH_2$, which loses the tertiary chlorine as hydrogen chloride. The addition of hydrogen chloride to III is known to yield II (Carothers–Coffman synthesis[4]) and the reaction is catalyzed by cuprous and ammonium chlorides.

The behavior of the carbinol (I) with hydrochloric acid *in the presence of cuprous and ammonium chlorides* has been studied by Favorskii and Favorskaya.[5] These investigators did not report II among the products which were said to be dimethylethynylcarbinyl chloride (IV), 1-chloro-3-methyl-1,2-butadiene (V), 1-chloro-3-methyl-1,3-butadiene (VI) and a dichloride, $C_5H_8Cl_2$, of unknown structure.

Since we have been engaged for some time in a

(1) Paper LIV on substituted acetylenes; previous paper, THIS JOURNAL, **71**, 2813 (1949).

(2) Hurd, U. S. Patent 2,274,611 (Feb. 24, 1942).

(3) Hurd and McPhee, THIS JOURNAL, **71**, 398 (1949).

(4) Carothers and Coffman, *ibid.*, **54**, 4071 (1932).

(5) Favorskii and Favorskaya, *Compt. rend.*, **200**, 839 (1935); Favorskaya, *J. Gen. Chem.* (*U. S. S. R.*), **9**, 386, 1237 (1939); Favorskaya and Zakharova, *ibid.*, **10**, 446 (1940).