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The title compound (**14**), a representative of a novel ring system, was prepared from 9*H*-carbazole-1-carboxylic acid 1-methylhydrazide (**7**) and triethyl orthoformate. Attempted cyclization of **7** with triethyl orthoacetate led only to 9*H*-carbazole-1-carboxylic acid 2-(1-ethoxyethylidene)-1-methylhydrazide (**16**). Treatment of **16** with trifluoroacetic acid gave 9*H*-carbazole-1-carboxylic acid (**12**). A postulated mechanism for this transformation was supported by studies with model compounds. A new synthesis of 1-benzoyl-2-methylhydrazine (**24**), using 1-acetyl-1-methylhydrazine (**22**) as a synthon, is described.

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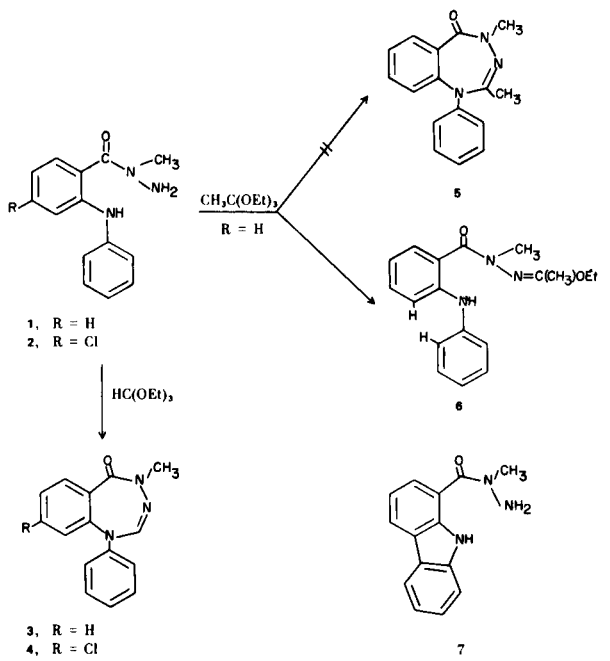
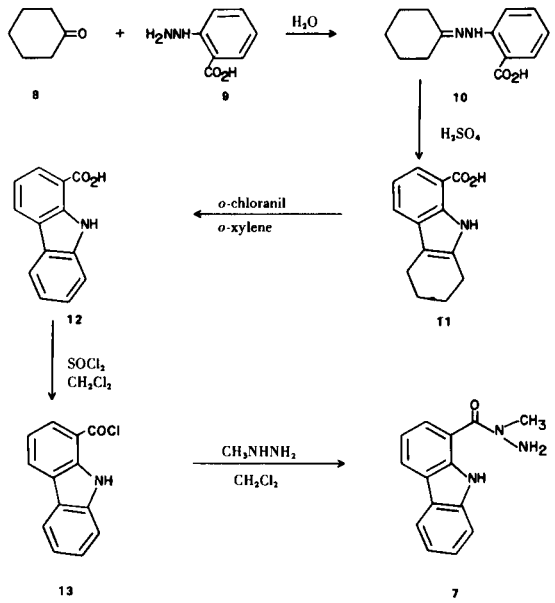
We recently reported (1) the preparation of 1,4-dihydro-4-methyl-1-phenyl-5*H*-1,3,4-benzotriazepin-5-one (**3**) and its 8-chloro analog **4**. The final step in these syntheses involved the treatment of the respective hydrazides **1** and **2** with triethyl orthoformate. However, when **1** was treated with triethyl orthoacetate in an attempt to generate benzotriazepinone **5**, only Schiff base **6** was obtained. Moreover, subsequent attempts to cyclize **6** to **5** were unsuccessful. We felt that steric parameters (2) may be influential in prohibiting the cyclization of **6** to **5**. By eliminating the steric interaction of the ortho aromatic protons in the diphenylamino moiety, which are shown in strucure **6**, we felt that cyclization might be possible with triethyl orthoacetate. Accordingly, we chose to synthesize carbazole derivative **7**. See Scheme I.

Scheme I



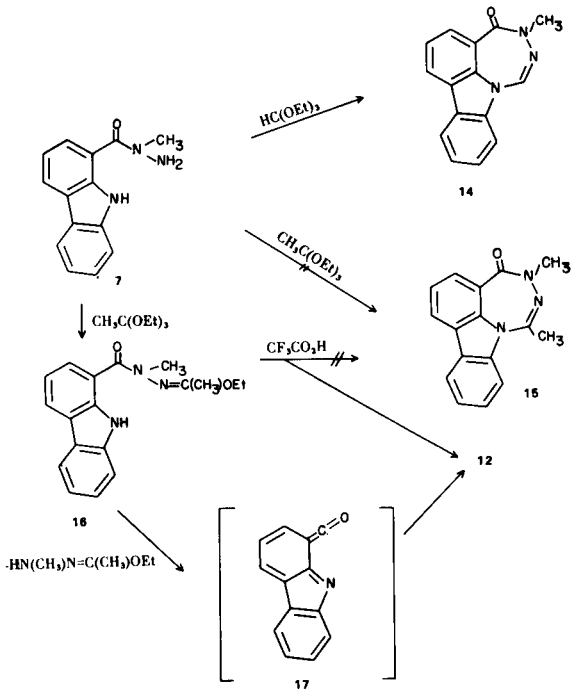
Scheme II



The synthesis of 9*H*-carbazole-1-carboxylic acid 1-methylhydrazide (**7**) is shown in Scheme II. Using the standard conditions of the Fischer indole synthesis, we prepared 5,6,7,8-tetrahydro-9*H*-carbazole-1-carboxylic acid (**11**) from Schiff base **10**, which, in turn, was prepared from cyclohexanone (**8**) and 2-carboxyphenylhydrazine (**9**). Aromatization of **11** with tetrachloro-*o*-benzoquinone (*o*-chloranil) gave 9*H*-carbazole-1-carboxylic acid (**12**), which was treated with thionyl chloride to yield the corresponding acid chloride **13**. Treatment of **13** with methylhydrazine gave hydrazide **7**.

Treatment of **7** with triethyl orthoformate produced 3-methyl-[1,2,4]-triazepino[6,5,4-*jk*]carbazol-4(3*H*)one (**14**), which was a bright yellow crystalline solid after chromatographic purification. However, when cyclization of **7** was attempted with triethyl orthoacetate, the corresponding triazepineone **15** was not formed. Schiff base **16** was the sole reaction product. Since trifluoro-

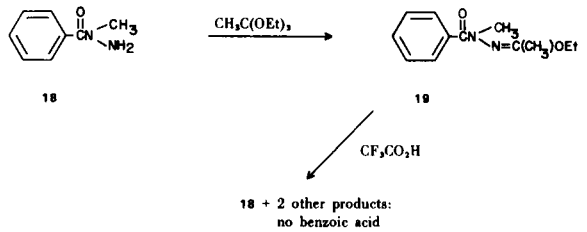
Scheme III



acetic acid is a recommended medium for the cyclization of compounds similar to **16** (4), we chose that solvent for attempted ring closure. The only isolable product from this reaction, however, was 9*H*-carbazole-1-carboxylic acid (**12**). We suspected that ketenimine **17** was an intermediate in this transformation. See Scheme III.

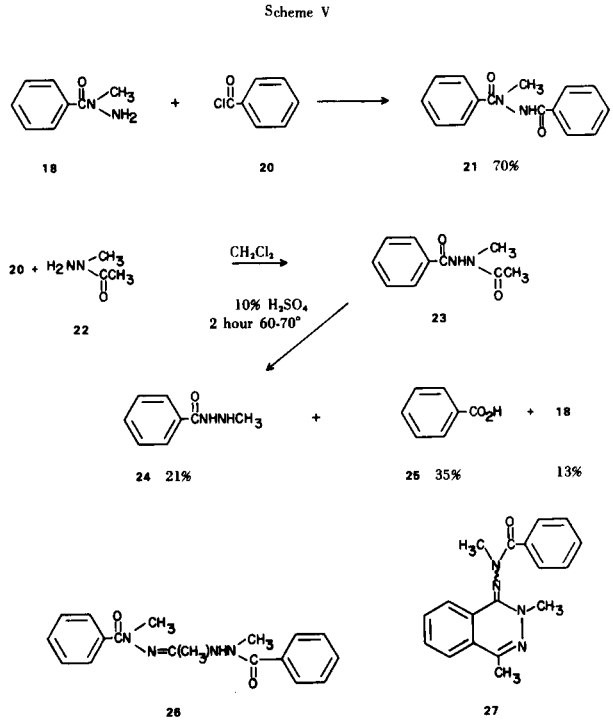
In order to substantiate the intermediacy of ketenimine intermediate **17**, we needed to rule out the possibility of simple hydrolytic cleavage of hydrazide **16**. For this purpose, we chose to prepare a related hydrazide which could be converted to the corresponding acid only by hydrolytic cleavage. Accordingly, we prepared the ethoxyethylidene Schiff base of hydrazide **18** (**19**) and subjected it to trifluoroacetic acid under the same conditions as was **16** (Scheme IV). *No benzoic acid was present in the product mixture.* The product mixture was

Scheme IV



subjected to column chromatography (silica gel) which produced two fractions, each displaying a single spot on thin layer chromatography (silica gel). The first fraction was shown to be pure **18**, while nmr indicated that the second fraction was a mixture.

Scheme V



In an attempt to identify the components of the second fraction, we prepared compounds **21** and **24**, which we felt were potential components of the mixture, as shown in Scheme V. Diacylhydrazine **21** was prepared in good yield by acylating **18** with benzoyl chloride (**20**). Acylation of 1-acetyl-1-methylhydrazine (**22**) with **20** afforded diacylhydrazine **23**, which produced a 21% yield of 1-benzoyl-2-methylhydrazine (**24**) upon treatment with dilute sulfuric acid at 60-70° for two hours. This procedure constitutes a good preparation of **24**, superior to those described by Hinman and Fulton (5) and Gillis and Schimmel (6). The simple process is at least competitive with those described by Ainsworth (7) and Meyer (8) for **24**. Additional utility of 1-acetyl-1-methylhydrazine (**22**) in introducing the methylhydrazine unit in specific fashion has recently been demonstrated (9, 10, 11). From an examination of the nmr spectra of compounds **21** and **24**, it was clear that they were not components of the second fraction. It is interesting to note that coproduced with **24** in the hydrolysis of **23** was 1-benzoyl-1-methylhydrazine (**18**), indicating that acid-catalyzed isomerization of **24** to **18** may have occurred. The absence of **24**, however, in the product mixture obtained from **19** and trifluoroacetic acid indicates that the reverse isomerization (**18** to **24**) does not occur. This is interesting in view of a result obtained by Ainsworth (7), who heated **18**·HCl at 200° for five minutes and obtained a mixture of **24** and **24**·HCl.

We were able to obtain mass spectral data on the individual components of the second fraction obtained from the treatment of **19** with trifluoroacetic acid.

From these spectra and the nmr spectrum of the mixture, we assign structures **26** and **27** to the components of the second fraction. It should be reemphasized that the observation of primary importance was that benzoic acid was not observed in the product mixture obtained from the treatment of **19** with trifluoroacetic acid. This result lends support for postulated intermediate **17** in Scheme III.

Although the design of carbazoylhydrazine **7** did not allow us to prepare triazepinone **15**, we were able to prepare the interesting triazepinocarbazole **14**. Recent literature reports have described syntheses of related diazepinocarbazole systems (12,13,14).

EXPERIMENTAL

All melting points are uncorrected. The ir spectra were recorded with a Perkin-Elmer Model 727 Spectrophotometer, nmr spectra with a Varian T-60 spectrometer, and mass spectra with a Finnigan gc/ms Model 3000D (electron impact and chemical ionization) mass spectrometer at 70 eV. Combustion analyses for C, H, and N were performed by Dow Analytical Laboratories.

Materials.

2-(Cyclohexylidenehydrazino)benzoic acid (**10**), m.p. 168-169° [lit. (15) m.p. 62°], 5,6,7,8-tetrahydro-9*H*-carbazole-1-carboxylic acid (**11**), m.p. 201-203° [lit. (15) m.p. 203°], and 9*H*-carbazole-1-carboxylic acid (**12**), m.p. 270-271° [lit. (16) m.p. 271-273°] were prepared using the procedures of Barclay and Campbell (16). 9*H*-Carbazole-1-carbonyl chloride (**13**), m.p. 173-175° [lit. (17) m.p. 179-180°] was prepared using the procedure of Manske and Kulka (17).

9*H*-Carbazole-1-carboxylic Acid 1-Methylhydrazide (**7**).

To a ten-fold excess of methylhydrazine in 50 ml. of methylene chloride was added 3.00 g. (13.8 mmoles) of **13**. After 4 hours the reaction mixture was concentrated, partitioned between methylene chloride and water and the organic phase was separated, dried (sodium sulfate) and concentrated. The residue was triturated with ether and the resulting glassy solid was collected to yield 2.92 g. (88%) of **7**; ir (Nujol): 3500-3150 (NH), 1605 (C=O) cm^{-1}; nmr (deuteriochloroform): δ 9.77 (broad s, 1H, NH, deuterium oxide-exchangeable), 8.20-7.80 (m, 2H, aromatic), 7.57-6.94 (m, 5H, aromatic), 4.54 (broad s, 2H, NH_2, deuterium oxide-exchangeable), 3.30 (s, 3H, CH_3).

3-Methyl-[1,2,4]-triazepino[6,5,4-*jk*]carbazol-4(3*H*)one (**14**).

A 3.00-g. (9.70 mmoles) quantity of **7** in 25 ml. of triethyl orthoformate was heated at reflux for 14 hours. The solution was concentrated to yield 3.75 g. of brown solid which was applied, in a minimum volume of chloroform, to a 175-g. column of Silica Gel 60 (70-230 mesh, EM Reagents) and eluted with chloroform. The product-containing fractions were combined to yield 2.24 g. (93%) of **14**. An analytically pure sample of **14** was obtained by crystallization from ethanol and harvesting the second crop. Compound **7** appeared to be somewhat unstable to recrystallization from ethanol: the first crop of crystals obtained from the recrystallization of analytically pure **14** contained an impurity by tlc. Triazepinone **14** was obtained as bright yellow needles, m.p. 172-173°; ir (Nujol): 3040 (CH), 1675 (C=O), 1635 (C=O) cm^{-1}; nmr (deuteriochloroform): δ 8.17-7.04 (m, 8H, aromatic and CH), 3.46 (s, 3H, CH_3); ms: (70 eV, chemical ionization, methane): m/e 250 (M^++1), 278 (M^++29), 290 (M^++41).

Anal. Calcd. for $C_{15}H_{11}N_3O$: C, 72.27; H, 4.45; N, 16.86. Found: C, 72.00; H, 4.41; N, 16.54.

9*H*-Carbazole-1-carboxylic Acid 2-(1-Ethoxyethylidene)-1-methylhydrazide (**16**).

A 2.00-g. (8.26 mmoles) quantity of **7** in 25 ml. of triethyl orthoacetate was heated at reflux for 18 hours. The solution was concentrated and the resulting oil was applied, in a minimum volume of chloroform, to a 175-g. column of Silica Gel 60 (70-230 mesh, EM REagents) and eluted with chloroform containing 2% methanol. The fractions containing pure **16** (by tlc) were combined and concentrated to yield 2.25 g. (87%) of **16** as a viscous oil; ir (neat): 3430 (NH) and 3260 (broad NH), 1635 (C=O), 1605 (C=N) cm^{-1}; nmr (deuteriochloroform): δ 9.83 (broad s, 1H, NH), 8.15-6.91 (m, 7H, aromatic), 4.11 (q, J = 7.2 Hz, 2H, CH_2), 3.35 (s, 3H, $N{=}CCH_3$), 1.83 (s, 3H, NCH_3), 1.20 (t, J = 7.2 Hz, 3H, OCH_2CH_3); ms: (70 eV, chemical ionization, methane): m/e 310 (M^++1), 338 (M^++29), 350 (M^++41).

Treatment of **16** with Trifluoroacetic Acid.

A 0.450-g. (1.45 mmoles) quantity of **16** in 10 ml. of trifluoroacetic acid was heated at reflux for 50 minutes. The mixture (solid was present) was thoroughly concentrated. The residue was triturated with chloroform and the solid collected to afford 0.100 g. (33%) of **12**.

Benzoic Acid 1-Methylhydrazide (**18**).

A 28.1-g. (20.0 mmoles) quantity of benzoyl chloride was added dropwise, over a 15-minute period with icebath cooling, to a solution of 40 ml. of methylhydrazine in 200 ml. of methylene chloride. After 1 hour the mixture (white solid was present) was treated with water. The separated organic phase was washed with water, dried (sodium sulfate) and thoroughly concentrated to leave 26.8 g. (89%) of **18** as a clear oil (18); ir (neat): 3315 and 3220 (NH_2), 1615 (C=O) cm^{-1}; nmr (deuteriochloroform): δ 7.54-7.10 (m, 5H, aromatic), 4.60 (broad s, 2H, NH_2, deuterium oxide-exchangeable), 3.12 (s, 3H, CH_3).

Benzoic Acid 2-(1-Ethoxyethylidene)-1-methylhydrazide (**19**).

A 10.0-g. (60.5 mmoles) quantity of **18** in 25 ml. of triethyl orthoacetate was heated at reflux for 2 hours. The clear solution was concentrated and distilled at reduced pressure to yield 13.3 g. (100%) of **19** as a clear oil; b.p. 136° (0.5 mm); ir (neat: 1735 (C=O), 1710 (C=N) cm^{-1}; nmr (deuteriochloroform): δ 7.60-7.15 (m, 5H, aromatic), 4.14 (q, J = 7.2 Hz, 2H, CH_2), 3.20 (s, 3H, $N{=}CCH_3$), 1.87 (s, 3H, NCH_3), 1.23 (t, J = 7.2 Hz, 3H, OCH_2CH_3).

Anal. Calcd. for $C_{12}H_{16}N_2O_2$: C, 65.43; H, 7.32; N, 12.72. Found: C, 65.20; H, 7.30; N, 12.90.

Treatment of **19** with Trifluoroacetic Acid.

A solution of 2.20 g. (10.0 mmoles) of **19** in 10 ml. of trifluoroacetic acid was heated at reflux for 50 minutes. A tlc (silica gel, 9:1::chloroform:methanol) of the reaction mixture indicated the absence of **19** and the lack of benzoic acid. The solution was concentrated and partitioned between methylene chloride and dilute sodium hydroxide solution. The organic phase was dried (sodium sulfate) and concentrated to yield 350 mg. of viscous oil which was applied, in a minmum volume of chloroform, to a 50-g. column of Silica Gel 60 (70-230 mesh, EM Reagents). Elution with 1500 ml. of chloroform followed with 1500 ml. of chloroform containing 2% methanol gave two sets of fractions, each of which displayed a single spot on tlc (silica gel, 9:1::chloroform:methanol). The appropriate fractions were combined into two fractions, the first of which was concentrated to yield

0.140 g. of pure **18**, as shown by ir (neat). Concentration of the second fraction gave 0.140 g. of a glassy material, which was assigned as a mixture of **26** and **27**; ir (Nujol): 3230 (NH), 1630 (broad C=O) cm^{-1}; nmr (deuteriochloroform): δ 8.70 (broad s, 0.5 H, NH), 7.68-7.04 (m, 10H, aroamtic), 3.32-2.84 (3 or 4 singlets, 6H, NCH_3 groups); 1.83-1.52 (2 or 3 singlets, 3H, CCH_3 groups); ms: (70 eV, chemical ionization, methane) showed two ion currents, which were resolved into separate spectra: m/e 325 (M^++1), 353 (M^++29), 365 (M^++41) for **27**, and 307 (M^++1), 335 (M^++29) for **26**.

Benzoic Acid 2-Benzoyl-1-methylhydrazide (**21**).

To a solution of 8.26 g. (50.0 mmoles) of **18** in 50 ml. of methylene chloride was added 3.51 g. (25.0 mmoles) of benzoyl chloride (**20**). The addition was exothermic. The clear solution was washed with water. Concentration of the aqueous phase left 3.16 g. (68%) of **18**·HCl, m.p. 138-141°. The organic phase was dried (sodium sulfate) and concentrated to leave 8.95 g. (70%) of **21** as a viscous oil which solidified upon trituration with ether; m.p. 142-143° (ethanol) [lit. (19) m.p. 145°]; ir (Nujol): 3200 (NH), 1665 (C=O) cm^{-1}; nmr (deuteriochloroform): δ 9.78 (s, 1H, NH, deuterium oxide-exchangeable), 7.57-6.95 (m, 10H, aromatic), 3.19 (s, 3H, CH_3).

Anal. Calcd. for $C_{15}H_{14}N_2O_2$: C, 70.85; H, 5.55; N, 11.02. Found: C, 71.10; H, 5.46; N, 10.87.

Benzoic Acid 2-Acetyl-2-methylhydrazide (**23**).

To a solution of 26.4 g. (30.0 mmoles) of 1-acetyl-1-methylhydrazine (**22**) (9) in 100 ml. of methylene chloride was added, dropwise over a 15-minute period with icebath cooling, 21.1 g. (15.0 mmoles) of benzoyl chloride (**20**). After 15 hours, the white, crystalline material was removed by filtration to yield 16.9 g. (93%) of **22**·HCl, m.p. 131-132°. The filtrate was washed with water, dried (sodium sulfate) and concentrated to yield 2.26 g. (79%) of **23** as a colorless, viscous oil which solidified upon trituration with ether-hexane; m.p. 89-90° (partial), 99-110° (benzene) [lit. (21) m.p. 157°]; ir (Nujol): 3280 (NH), 1695, 1660 and 1625 (C=O) cm^{-1}; nmr (deuteriochloroform): δ 9.50 broad s, 1H, NH, deuterium oxide-exchangeable), 8.02-7.00 (m, 4H, aromatic), 3.21 and 3.15 (2 singlets, *ca.* in a 1:1 ratio, 3H, NCH_3), 2.01 and 1.74 (2 singlets, *ca.* in a 1:1 ratio, $COCH_3$); tlc (silica gel, 9:1::chloroform:methanol) displayed a single spot.

Anal. Calcd. for $C_{10}H_{12}N_2O_2$: C, 62.48; H, 6.29; N, 14.58. Found: C, 62.70; H, 6.30; N, 14.46.

Benzoic Acid 2-Methylhydrazide (**24**).

A 9.61-g. (50.0 mmoles) quantity of **23** was mixed with 90 ml. of 10% sulfuric acid and warmed on the steambath. After 5 minutes, solution had resulted. Reaction progress was monitored by tlc. After 2 hours, the solution was cooled and the resulting white, crystalline solid was collected to yield 2.14 g. (35%) of benzoic acid (**25**), m.p. 120-122°. The filtrate was basified (sodium hydroxide) and extracted with methylene chloride. The extract was dried (sodium sulfate) and concentrated to yield 2.83 g. of clear oil. From nmr integrals, this oil contained 1.06 g. (13%) of **18**, and 1.77 g. (21%) of **24**. Crystallization of this mixture from ether-hexene gave 1.29 g. (16%) of **24** as clear rods, m.p. 83-85°[lit. (5) m.p. 83-85°]; ir (Nujol): 3260 (NH_2), 1630 (C=O) cm^{-1}; nmr (deuteriochloroform): δ *ca.* 8.4 (very broad s, 1H, NH, deuterium oxide-exchangeable), 7.80-7.55 (m, 2H, aromatic), 7.40-7.00 (m, 3H, aromatic), *ca.* 5.1 (very broad s, 1H, NH, deuterium oxide-exchangeable), 2.64 (s, 3H, CH_3).

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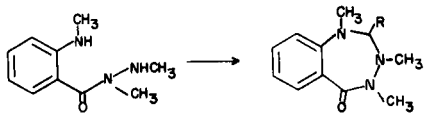
(1) N. P. Peet and S. Sunder, *J. Heterocyclic Chem.*, **13**, 967 (1976).

(2) It is interesting to note the influence of steric parameters in similar cyclization reactions. Hromatka, Knollmüller and Krenmüller (3) report the cyclization of **i** with formaldehyde in ethanol at reflux to give benzotriazepinone **ii**. However, under the same conditions with benzaldehyde, **iii** failed to form; even in diethylene glycol dimethyl ether at reflux, cyclization did not occur. Benzotriazepinone **iii** was ultimately prepared by heating **i** and benzaldehyde diethyl acetal.



ii, R = H
iii, R = C_6H_5

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(18) Compound **18** has been prepared from methylhydrazine and benzoic anhydride (19, 20). Upon attempted distillation, disproportionation to methylhydrazine and **21** occurred (19).

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