Reduction of 1-Methyl-*s*-triazolo[4,3-*a*]pyridinium Iodide with Sodium Borohydride.—The iodide (2.0 g.) in methanol (75 ml.) was treated with sodium borohydride (4.0 g.) at room temperature and the reaction mixture was left overnight. The solvent was removed and the residue was treated with water (20 ml.) and then extracted with chloroform (150 ml.). The chloroform solution was dried (Na_2SO_4) and concentrated to a light colored oil (0.8 g.) which rapidly darkened. A methanolic solution of the product was treated with picric acid and then diluted with ether, yielding a brown gum that eventually crystallized from methanol–ether (charcoal) as yellow needles, m.p. 186–187° dec.

Anal. Calcd. for $C_{13}H_{11}N_6O_7$: C, 42.8; H, 3.5; N, 22.9. Found: C, 42.9; H, 3.3; N, 23.1.

Reduction of 1-Methyl-3-amino-*s*-triazolo[4,3-*a*]pyridinium Bromide with Sodium Borohydride.—The bromide (0.5 g.) in methanol (30 ml.) was slowly treated with sodium borohydride (1.0 g.) at room temperature and then left for 1 hr. The solvent was removed on the steam bath, the residue was treated with water (10 ml.), and the aqueous solution was saturated with sodium sulfate and then extracted with chloroform (100 ml.). Evaporation of the chloroform solution gave an oil which was chromatographed on alumina (activity II, 25 g.) and eluted with chloroform (100 ml.) and a chloroform–methanol mixture (100 ml., 9:1). Removal of the combined solvents left an oily base which was converted into the hydrobromide. This crystallized from methanol–ether (charcoal) as colorless, irregular prisms: m.p. 191–193°, with previous sintering at 181°; infrared (Nujol), cm.$^{-1}$, 3100–2600, 1660, 1550, 1448, 1380, 1310, 1237, 1180, 1125, 1092, 1063, 1040, 982, 953, 910, 985–975, 692, 673; ultraviolet, strong end absorption only.

Anal. Calcd. for $C_7H_{11}BrN_4$: C, 36.4; H, 4.8; N, 24.2. Found: C, 36.5; H, 5.0; N, 24.5.

Reaction of 3-Methyl-*s*-triazolo[4,3-*a*]pyridine with Iodine and Pyridine.—3-Methyl-*s*-triazolo[4,3-*a*]pyridine (1.3 g.) in dry pyridine (10 ml.) was refluxed with iodine (1.3 g.) for 90 min. After removal of the pyridine under reduced pressure, the dark residue was dissolved in ethanol (charcoal) and treated with ether when a yellow solid (2.1 g.) separated. It crystallized from methanol–ether (charcoal) as colorless needles, m.p. 217–219° dec. The mixture melting point determination and infrared spectral comparison showed it to be identical with a sample of 3-methyl-*s*-triazolo[4,3-*a*]pyridine hydriodide prepared from the base and hydriodic acid by the method described above for the bromide.

Anal. Calcd. for $C_7H_8IN_3$: C, 32.2; H, 3.1; N, 16.1. Found: C, 32.3; H, 3.1; N, 15.7.

Deuteration of *s*-Triazolo[4,3-*a*]pyridine.—The base (0.1 g.) in deuterium oxide (3 ml.) was heated in a sealed tube in an atmosphere of nitrogen at 100° for 12 hr. The solvent was removed under reduced pressure, giving the 3-deuterio product as a low-melting solid: n.m.r. (infinite dilution, $CDCl_3$), τ 1.67 (5-H), 2.22 (8-H), 2.73 (7-H), 3.12 (6-H).

The following experiments illustrate reaction procedures which were unsuccessful when applied to this ring system.

Attempted Reaction of *s*-Triazolo[4,3-*a*]pyridine with Sodamide.—*s*-Triazolo[4,3-*a*]pyridine (1.0 g.) was dissolved in dry benzene (40 ml.), and after distillation of 15 ml. of solvent, sodamide (0.7 g.) was added and the mixture was refluxed for 7 hr. The benzene was decanted and the black tarry residue was washed with hot chloroform (two 15-ml. portions). The combined solution was concentrated and the oily residue (0.6 g.) was converted into the picrate, m.p. 235–237° dec. Mixture melting point determination showed the picrate to be identical with the picrate of *s*-triazolo[4,3-*a*]pyridine.

The dark tarry residue was decomposed with ice water (5 ml.); the solution was saturated with sodium sulfate and then extracted with chloroform (100 ml.). The chloroform solution, after drying (Na_2SO_4), was concentrated to a brown oil (0.34 g.) which was identified as impure starting material by conversion into its picrate.

When the reaction was carried out using dimethylaniline at 120° as solvent, only the starting material again was obtained.

Attempted Reaction of *s*-Triazolo[4,3-*a*]pyridine with Butyllithium.—*s*-Triazolo[4,3-*a*]pyridine (1.2 g.) in ether (300 ml.) was treated slowly with a solution of butyllithium (10 ml.) in dioxane in a nitrogen atmosphere, and the mixture was stirred for 3 hr. at room temperature. Dry carbon dioxide was bubbled through the dark brown reaction mixture for 45 min., and the black residue that was isolated immediately formed a gum. The untractable gummy residue in chloroform was poured through a column of alumina (activity II, 10 g.) and eluted with chloroform when only a very small amount of pungent oil was obtained.

Proton Magnetic Resonance Spectra of Isomeric N-Methyl-3(5)-H-pyrazoles

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The p.m.r. spectra of isomeric N-methyl-3(5)-H-pyrazoles such as 1-methyl-4,5,6,7-tetrahydroindazole (**2**), 2-methyl-4,5,6,7-tetrahydroindazole (**3**), 1′-methylyohimbano[18,17-*d*]pyrazole (**5**), and 1′-methylyohimbano-[17,18-*c*]pyrazole (**6**) have been examined. The numerical differences in the chemical shifts between the N-methyl proton signal and the signal of the proton on the pyrazole nucleus are found to be characteristic for each isomer and can be used to assign structures to isomeric N-methyl-3(5)-H-pyrazoles.

A number of studies on the p.m.r. spectra of pyrazoles have been delineated recently. Williams[1] reported on the utility of p.m.r. for determining structures of isomers formed on acylation of unsymmetrically substituted pyrazoles while Moore and Habraken[2] described the use of p.m.r. for determining the tautomeric structures of 1-alkyl-3(5)-methylpyrazoles and 1-alkyl-3(5)-methyl-4-phenylpyrazoles, utilizing chemical shift differences between signals from the 3(5)-H and the 4-substituent and between signals from the 3(5)-H and the 5(3)-methyl. The chemical shifts of protons in the 3-, 4-, and 5-positions of the pyrazole nucleus and the chemical shifts of 3- and 5-methyl groups have been discussed by Finar and Mooney.[3] The characteristic ranges reported for the 3-, 4-, and 5-protons in various substituted pyrazoles and the characteristic shifts observed on protonation promise to be of use for an unambiguous assignment of structures.[3] We wish to report on some studies with isomeric N-methylpyrazoles such as **2** and **3**, for until now there has been no simple method for differentiating between isomeric pyrazoles of this type. Therefore a convenient method, such as p.m.r., for structural assignment of isomeric N-methylpyrazoles would be of considerable utility.

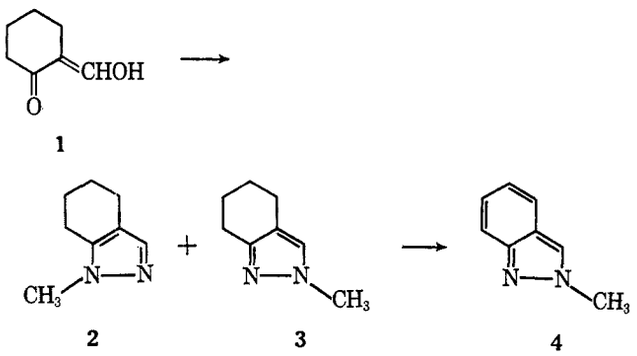
In connection with our alkaloid studies the pyrazoles **5** and **6** were prepared.[4] The p.m.r. spectra showed

(1) J. K. Williams, *J. Org. Chem.*, **29**, 1377 (1964).

(2) J. A. Moore and C. L. Habraken, *J. Am. Chem. Soc.*, **86**, 1456 (1964); C. L. Habraken and J. A. Moore, *J. Org. Chem.*, **30**, 1892 (1965).

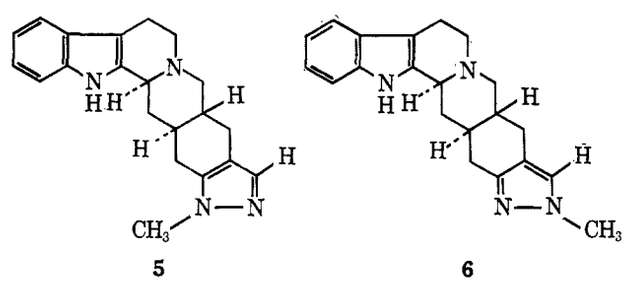
(3) I. L. Finar and E. F. Mooney, *Spectrochim. Acta*, **20**, 1269 (1964).

(4) J. D. Albright and L. Goldman, to be published.



1 2 3 4

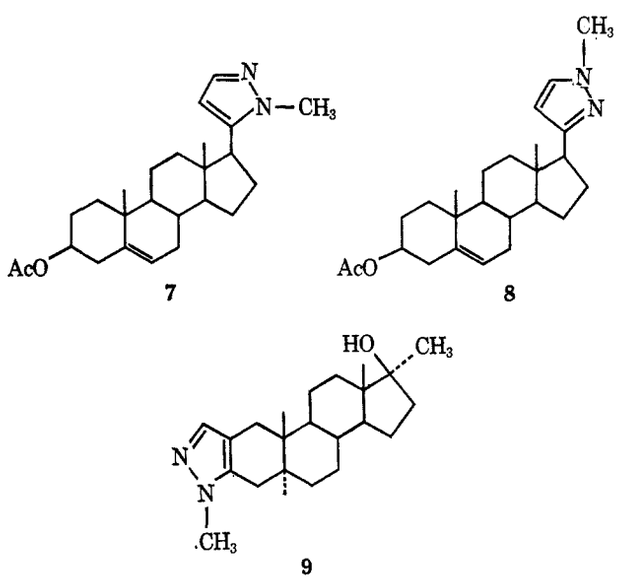
that the N-methyl groups of the two isomers had different chemical shifts. In the isomer, m.p. 245–250° dec., the methyl signal was at δ 3.73 and the pyrazole proton was discernible at δ 7.35, although overlapped with the aromatic proton signals. In the second isomer, m.p. 255–260° dec., the methyl signal was observed at δ 3.83, and the pyrazole proton at δ 7.13. One might expect the pyrazole proton (–N=CH–) in structure **5** to be at lower field than the olefinic pro-



5 6

ton (>C=CHN<) in structure **6**; however, such a conclusion would be only tentative, for it has not been established that in isomeric pyrazoles the proton on carbon with a double bond to nitrogen is consistently at lower field. We therefore prepared the known pyrazoles **2** and **3** for comparison. Reaction of 2-hydroxymethylenecyclohexanone (**1**)[5] with methylhydrazine in methanol at 0° gave a mixture of **2**[6] (14%) and **3**[5] (86%) as shown by p.m.r. spectral measurement, while reaction of **1** with methylhydrazine sulfate gave a mixture of 33% of **2** and 67% of **3**. Reaction of the mixture with picric acid, followed by repeated recrystallization of the picrate mixture, gave pure **3** picrate.[5,6] The picrate was converted to pure **3** base, which was dehydrogenated with 10% palladium on carbon in refluxing decalin[7,8] to give 2-methylindazole (**4**).[9] The characteristic ultraviolet absorption spectrum of **4**, which differs significantly from that of 1-methylindazole,[10,11] allowed the unequivocal assignment of structure **3** to its precursor.

The mixture of **2** and **3** showed signals in the p.m.r. spectrum at δ 3.70, 3.80, 7.03, and 7.25, while in pure **3** the signal of the methyl group was observed at δ 3.80 and the pyrazole proton at δ 7.03. Therefore, the signals at δ 3.70 and 7.25 in the spectrum of the mixture were attributable to **2**. From these spectra it is apparent that when the methyl group is on the pyrazole nitrogen which is bonded to the carbocyclic ring, the methyl signal appears at higher field[12] and the pyrazole proton signal at lower field (structures **2** and **5**) than in the corresponding isomers (structures **3** and **6**). The difference, therefore, between the chemical shift of the methyl proton signal and the signal for the proton on the pyrazole nucleus is characteristic for each isomer and may be used to assign structures to isomeric pyrazoles. (See Table I.) Although additional examples are needed, it should be possible to assign a structure to an N-methylpyrazole of the type **2** or **3** where only one isomer has been obtained by determining the difference between the chemical shifts of the N-methyl protons and the proton on the pyrazole nucleus. Table I summarizes these results and includes the data for the three steroidal pyrazoles **7**,[13] **8**,[13] and **9**.[14]



7 8 9

The difference between the N-methyl signal and the pyrazole proton signal determined from the p.m.r. spectral data reported[14] for pyrazole **9** confirms the structural assignment.

As may be noted with compounds **2**, **3**, **5**, and **6**, those pyrazoles with a methyl on nitrogen which is bonded to the carbocyclic ring (compounds **2** and **5**) exhibit methyl signals at higher field than their isomers (compounds **3** and **6**). This effect alone could be of utility for a structural assignment where two isomeric pyrazoles have been obtained but the pyrazole proton signal is obscured by other signals in the molecule.

Since it would be desirable to have a convenient procedure for the unequivocal synthesis of one pyrazole

(5) K. v. Auwers, W. Buschmann, and R. Heidenreich, *Ann.*, **435**, 277 (1924).

(6) K. v. Auwers, J. Conrad, A. Ernecke, and B. Ottens, *ibid.*, **469**, 57 (1929).

(7) Procedure of C. Ainsworth, *J. Am. Chem. Soc.*, **79**, 5242 (1957).

(8) For the conversion of 2-methyl-4,5,6,7-tetrahydroindazole (**3**) to 2-methylindazole by dehydrogenation with sulfur, see I. Grandberg, A. N. Kost, and L. S. Yaguzhinskii, *Zh. Obshch. Khim.*, **29**, 2537 (1959); *Chem. Abstr.*, **54**, 1100 (1960).

(9) K. v. Auwers and Duesberg, *Ber.*, **53**, 1179 (1920).

(10) V. Rousseau and H. G. Lindwall, *J. Am. Chem. Soc.*, **72**, 3047 (1950).

(11) A. Bellotti and G. Pappalardo, *Boll. sci. fac. chim. ind. Bologna*, **16**, 29 (1958); *Chem. Abstr.*, **53**, 9811 (1959).

(12) Similar variations in the chemical shifts of C-18 and C-19 methyl groups in steroids have been discussed by N. S. Bhacca and D. H. Williams ("Application of NMR Spectroscopy in Organic Chemistry," Holden-Day, Inc., San Francisco, Calif., 1964, p. 16), who point out that "as a given angular methyl group is able to 'see' less of the remaining skeleton, it will appear at lower field."

(13) We wish to thank Drs. S. Bernstein and J. P. Dusza for the results on the pyrazoles **7** and **8**.

(14) The position of the N-methyl group in the steroidal pyrazole **9** was deduced by chemical evidence: D. K. Phillips and A. J. Manson, *J. Org. Chem.*, **28**, 2886 (1963).

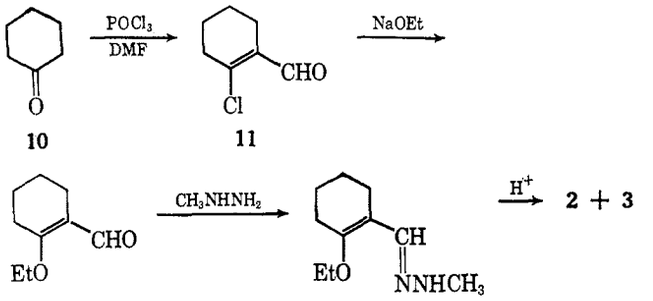
TABLE I

PROTON MAGNETIC RESONANCE SPECTRA OF ISOMERIC N-METHYL-3(5)-H-PYRAZOLES

Compound	Chemical shift (δ) Pyrazole proton	Chemical shift (δ) N-CH_3	Δ ($\delta_H - \delta_{N-CH_3}$)
1-Methyl-4,5,6,7-tetrahydroindazole (2)	7.25	3.70	3.55
2-Methyl-4,5,6,7-tetrahydroindazole (3)	7.03	3.80	3.23
1′-Methylyohimbano[18,17-*d*]pyrazole (5)	7.35	3.73	3.62
1′-Methylyohimbano[17,18-*c*]pyrazole (6)	7.13	3.83	3.30
17-(1-Methyl-5-pyrazolyl)-5-androsten-3β-ol acetate (7)	7.42[a]	3.83	3.59
17-(1-Methyl-3-pyrazolyl)-5-androsten-3β-ol acetate (8)	7.27[a]	3.87	3.40
17β-Hydroxy-17α-methylandrostano[3,2-*c*]-2′-methylpyrazole (9)	7.79	4.25	3.54

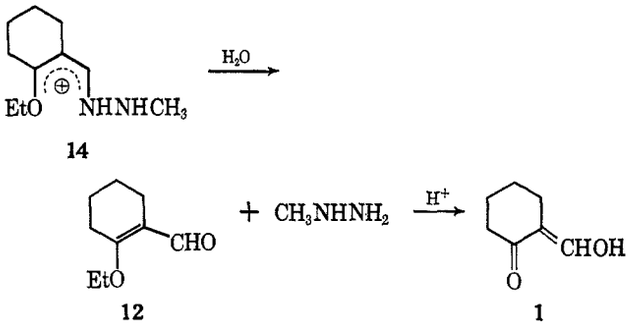
[a] Chemical shift of 3(5)-proton of pyrazole nucleus.

isomer,[15] the following model synthetic sequence was studied. Treatment of cyclohexanone (**10**) with phosphorus oxychloride and N,N-dimethylformamide (DMF) gave 2-chlorocyclohex-1-ene-1-carboxaldehyde[16] (**11**) which was allowed to react with sodium ethoxide in ethanol to give 2-ethoxycyclohex-1-ene-1-carboxaldehyde (**12**)[17] in 43% yield.[18] Reaction of **12** with methylhydrazine gave the hydrazone **13**.



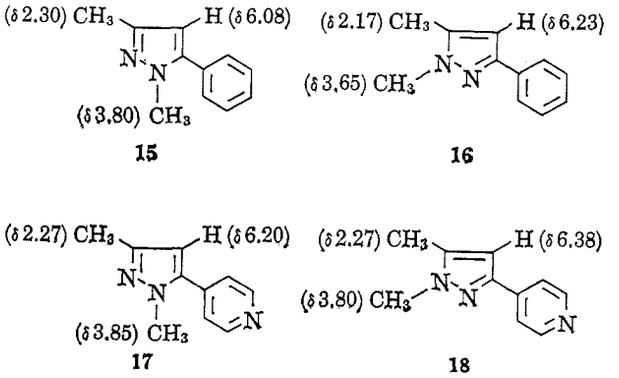
In the p.m.r. spectrum of **12**, a typical pattern for the O-ethyl group (triplet, δ 1.33; quartet, δ 4.07) was observed in addition to the aldehyde proton at δ 10.23 (singlet). Signals at δ 7.93 (–N=CH–, singlet), 5.18 (>NH, broad), and 2.86 ($-CH_3$, singlet) were observed in the spectrum of **13** in addition to a weak signal at δ 7.35 (–N=CH–, singlet). The O-ethyl pattern showed additional lower intensity signals which, along with the weak signal at δ 7.35, indicated the presence of *syn* and *anti* isomers. Compound **13** was only moderately stable, for, on standing, impurities were formed which showed carbonyl absorption in the infrared spectrum. The compound was therefore stored at Dry Ice temperature.

Treatment of **13** with aqueous ethanol–acetic acid gave a mixture of isomers **2** and **3**, as did refluxing in glacial acetic acid. Both isomers were obtained with pyridine–glacial acetic acid in benzene, while refluxing in benzene failed to give pyrazole. That both **2** and **3** were formed was determined by examination of the p.m.r. spectra of the crude products. With aqueous ethanol–acetic acid the mixture consisted of 56% of **2** and 44% of **3**, while with pyridine–acetic acid 53% of **2** and 47% of **3** were formed as determined from p.m.r. spectral measurements. In aqueous medium the formation of both isomers is explicable on the basis that the protonated intermediate **14** reacts with water to give methylhydrazine and 2-hydroxymethylenecyclohexanone (**1**) which recombine to **2** and **3**.



This sequence is essentially a reversal of hydrazone formation followed by acid hydrolysis of the enol ether function of aldehyde **12**. Where supposedly anhydrous conditions were used in the ring closure, either trace amounts of water were present or the formation of both isomers occurs by a different mechanism.

We have also examined the p.m.r. spectra of pyrazoles **15–18**, whose structures are known from their



ultraviolet spectra.[19] The N-methyl proton signals of pyrazoles **15** and **17** are found at lower field than in the corresponding isomers **16** and **18**. This shift to lower field may be attributed to deshielding by the aromatic groups which are in close proximity to the methyl groups in structures **15** and **17**. The ultraviolet spectra of **15** and **17** provide evidence for such interaction, for inhibition of resonance of the aromatic group with the pyrazole nucleus has been noted.[19]

(15) R. O. Clinton, A. J. Manson, F. W. Stoner, H. C. Newmann, R. G. Christiansen, R. L. Clarke, J. H. Ackerman, D. F. Pape, J. W. Dean, W. B. Dickinson, and C. Carabateas [*J. Am. Chem. Soc.*, **83**, 1478 (1961)] claimed the exclusive synthesis of one N-methylpyrazole isomer in the steroid field by pyrolysis of the N-methylsemicarbazone of 2-hydroxymethylene-17α-methylandrostan-17β-ol-3-one. This procedure was shown later to give a mixture of both isomers.[14]

(16) W. Ziegebein and W. Lang, *Ber.*, **93**, 2743 (1960).

(17) For a recent procedure for the preparation of compounds of this type by reactions of ketones with triethyl orthoformate and 72% perchloric acid, see J. P. Dusza, J. P. Joseph, and S. Bernstein, *J. Am. Chem. Soc.*, **86**, 3909 (1964).

(18) Aldehyde **12** had been previously prepared by reaction of DMF, phosphorus oxychloride, and cyclohexanone diethyl acetal, and characterized as the semicarbazone; Z. Arnold and J. Zemlička, *Collection Czech. Chem. Commun.*, **24**, 786 (1959).

(19) W. B. Wright, Jr., H. J. Brabander, R. H. Hardy, Jr., and W. Fulmor, *J. Am. Chem. Soc.*, **81**, 5637 (1959).

In addition the C-4 proton in pyrazoles **16** and **18** is coupled to the protons on the neighboring methyl group[20] (J = 0.3 and 0.9 c.p.s., respectively). This coupling is predictive of the grouping $CH_3>C=C<H$, thus allowing assignment of structures **16** and **18** (ultraviolet data are therefore not required).

In summary, differences in chemical shifts between the N-methyl proton signal and the proton signal of the pyrazole nucleus in structures **2**, **5**, **7**, and **9** fall in the range δ 3.54 to 3.62 while these chemical shift differences in isomers **3**, **6**, and **8** fall in the range δ 3.23 to 3.40. This characteristic of the p.m.r. spectra of N-methylpyrazoles should be of considerable utility in structural assignments.

Experimental Section

All melting points were taken on a Mel-Temp apparatus and are uncorrected. Ultraviolet absorption spectra were measured on a Cary recording spectrophotometer. Infrared spectra were determined on a Perkin-Elmer spectrophotometer (Model 21). P.m.r. spectra were determined with a Varian Model A-60 spectrometer in deuterated chloroform; chemical shifts (δ) are in parts per million relative to internal tetramethylsilane.

1-Methyl-4,5,6,7-tetrahydroindazole (2) and 2-Methyl-4,5,6,7-tetrahydroindazole (3). A.—A solution of 12.6 g. (0.10 mole) of 2-hydroxymethylenecyclohexanone (**1**)[5] in 125 ml. of methanol was chilled to 0°. To the chilled solution was added a chilled solution of 4.6 g. (0.10 mole) of methylhydrazine in 25 ml. of methanol in small portions over a period of 25 min. The ice bath was removed and the solution was stirred for 1 hr. The solvent was removed *in vacuo* to give a pale yellow liquid. From the integration of signals in the p.m.r. spectrum the product was shown to be a mixture of **2** (14%) and **3** (86%).

B.—To 50.46 g. (0.40 mole) of **1**[5] in 600 ml. of cold ethanol was added 60.54 g. (0.42 mole) of methylhydrazine sulfate. The mixture was stirred in an ice bath and 50 ml. of water was added. After stirring for 45 min., the mixture was allowed to warm to room temperature and stand for 4 hr. Water (25 ml.) was added and the mixture was stirred overnight. The mixture was concentrated *in vacuo*, chilled, and made basic with 10 N sodium hydroxide. The mixture was extracted with ether, and the ether extracts were dried over magnesium sulfate and concentrated *in vacuo* to give an amber liquid. Distillation of the liquid at *ca.* 20 mm., b.p. 105–108°, gave 45 g. of pale yellow liquid. From the p.m.r. spectrum the product was shown to be a mixture of **2** (33%) and **3** (67%).

Anal. Calcd. for $C_8H_{12}N_2$: C, 70.6; H, 8.88; N, 20.6. Found: C, 70.8; H, 8.64; N, 20.7.

To 10 g. of the mixture of **2** (33%) and **3** (67%) in ethanol was added a saturated ethanolic solution of picric acid. After standing 15 min. the mixture was filtered to give 7.5 g. of yellow crystals, m.p. 154–163°. Recrystallization from ethanol–acetone (85:15), ethanol–acetone (1:1), and ethanol gave 2.65 g. of **3** picrate, m.p. 166–169° (lit.[5,6] m.p. 166–167°). The yellow picrate was slurried in 20 ml. of water and the mixture was made basic with 10 N sodium hydroxide. The mixture was extracted with four 25-ml. portions of ether, and the ether extracts were dried over solid potassium hydroxide and anhydrous sodium carbonate. The extract was filtered through anhydrous magnesium sulfate and concentrated *in vacuo* to give 0.880 g. of **3** as a colorless oil.

2-Methylindazole (4).—A mixture of 0.200 g. of 2-methyl-4,5,6,7-tetrahydroindazole (**3**) and 0.9 g. of 10% palladium on carbon in 5 ml. of decalin was refluxed for 24 hr. The hot mixture was filtered through diatomaceous earth and washed with petroleum ether (b.p. 30–60°). The filtrate was concentrated and chilled. Filtration gave 0.060 g. of **4** as colorless crystals, m.p. 53–54° (lit.[9] m.p. 56°). The ultraviolet spectrum was identical with the spectrum of 2-methylindazole.[10]

2-Ethoxycyclohex-1-ene-1-carboxaldehyde (12).—To a chilled solution of 150 ml. of ethanol containing 0.11 mole of sodium ethoxide was added 14.1 g. (0.090 mole) of 2-chlorocyclohex-1-ene-1-carboxaldehyde (**11**).[16] The mixture was allowed to warm to room temperature and was stirred for 3 hr. The mixture was chilled at 0° for 88 hr., diluted with 150 ml. of benzene, and filtered. The filtrate was concentrated *in vacuo* at 30° and the residue was dissolved in 100 ml. of benzene. Water (30 ml.) and excess potassium carbonate were added. The organic layer was separated and the aqueous layer was extracted twice with 50-ml. portions of benzene–ethanol (4:1). The organic layer and extracts were combined, dried over potassium carbonate, and concentrated *in vacuo*. The residue was diluted with petroleum ether and filtered. The filtrate was concentrated *in vacuo* and the residue was distilled at 1 mm. to give 6.43 g. (43%) of oil, b.p. 79–83°, which crystallized on cooling to give **12** as white crystals: m.p. 35–37° (lit.[18] m.p. 35°); p.m.r. δ 1.33 (triplet), 4.07 (quartet) ($-OC_2H_5$), 10.23 (singlet) (-CHO); $\nu_{max}^{CHCl_3}$ 1653 (s), 1620 (s) cm.$^{-1}$.

2-Ethoxycyclohex-1-ene-1-carboxaldehyde Methylhydrazone (13).—To a solution of 6.43 g. (0.0417 mole) of 2-ethoxycyclohex-1-ene-1-carboxaldehyde (**12**) in 30 ml. of ethanol, chilled by means of an ice bath, was added portionwise 2.0 g. (0.043 mole) of methylhydrazine in 10 ml. of ethanol. The solution was stirred at 0° for 1.5 hr. and at room temperature 1.5 hr. The solvent was removed *in vacuo* to give a yellow oil. Chilling at Dry Ice temperature overnight gave crystals. The crystalline mass was allowed to warm to room temperature and 15 ml. of petroleum ether was added. Chilling at 0° and filtering gave 3.0 g. of yellow crystals, m.p. 23–25°. Recrystallization from petroleum ether gave 1.3 g. of **13** as pale yellow crystals: m.p. 25–29°; ν_{max}^{film} 3425, 1642, 1590 (w), 1567 (w) cm.$^{-1}$; p.m.r. δ 2.86 ($N-CH_3$), 5.18 (NH broad), 7.93 ($-N=CH-$).

Ring Closure of 2-Ethoxycyclohex-1-ene-1-carboxaldehyde Methylhydrazone (13). A.—To a solution of 2.0 g. of methylhydrazone **13** in 10 ml. of ethanol and 1 ml. of water was added 5 ml. of glacial acetic acid. The solution was stirred at room temperature for 3 hr. and was refluxed on a steam bath for 15 min. The solution was concentrated *in vacuo* and poured into 20 ml. of cold water. The mixture was made basic with 10 N NaOH and extracted with four 20-ml. portions of ether. The ether extracts were dried over magnesium sulfate and the solvent was removed *in vacuo* to give 0.80 g. of light tan oil. From integration of the p.m.r. spectrum the product was shown to be a mixture of 56% of **2** and 44% of **3**. Treatment with picric acid in ethanol gave a yellow picrate, m.p. 125–142° (lit.[5,6] m.p. 141–142° for **2** picrate and m.p. 166–167° for **3** picrate).

B.—A solution of 1.4 g. of methylhydrazone **13** in 10 ml. of glacial acetic acid was refluxed for 15 min. and the solvent was removed *in vacuo*. The residue was dissolved in 15 ml. of ethanol and treated with a saturated ethanolic solution of picric acid. Some gum separated and was removed by filtration. The filtrate, on standing, gave 0.41 g. of yellow crystals, m.p. 120–125°.

C.—To a solution of 2.0 g. of methylhydrazone **13** in 2.0 ml. (0.025 mole) of dry pyridine was added 1.8 g. (0.030 mole) of glacial acetic acid and 20 ml. of dry benzene. The solution was stirred at room temperature for 21 hr. and concentrated at 35°. The residual liquid was diluted with 10 ml. of water and 1 ml. of 10 N sodium hydroxide was added. The mixture was extracted with four 20-ml. portions of ether. The combined extracts were washed twice with 20 ml. of water and dried over magnesium sulfate. The solvent was removed *in vacuo* to give a brown oil. The oil was dissolved in ether and was washed with dilute aqueous sodium hydroxide and water. The ether layer was dried over magnesium sulfate and concentrated *in vacuo* to give a tan oil. From integration of the p.m.r. spectrum the product was shown to be a mixture of **2** (53%) and **3** (47%).

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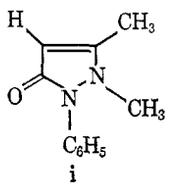
(20) Similar coupling for the pyrazolin-5-one **i** was reported by A. R. Katritzky and F. W. Maine, *Tetrahedron*, **20**, 314 (1964).



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