addition of nitromethane and nitroethane to benzalacetone and chalcone gave the normal 1:1 adducts.[2] No evidence of 6-hydroxy-5,6-dihydro-4H-1,2-oxazine 2-oxides was found upon examination of the infrared and nmr spectra of product mixtures or selected fractions thereof from each of these reactions.

Registry No.—**4**, 19639-72-6; **4** (2,4-dinitrophenylhydrazone), 19639-73-7; **6**, 19639-74-8; **7**, 19639-75-9; **9a**, 19640-00-7.

Acknowledgment.—The authors are indebted to Donald W. Moore for helpful discussions.

Some Reactions of 2,4,4-Trimethyl-1-pyrroline 1-Oxide

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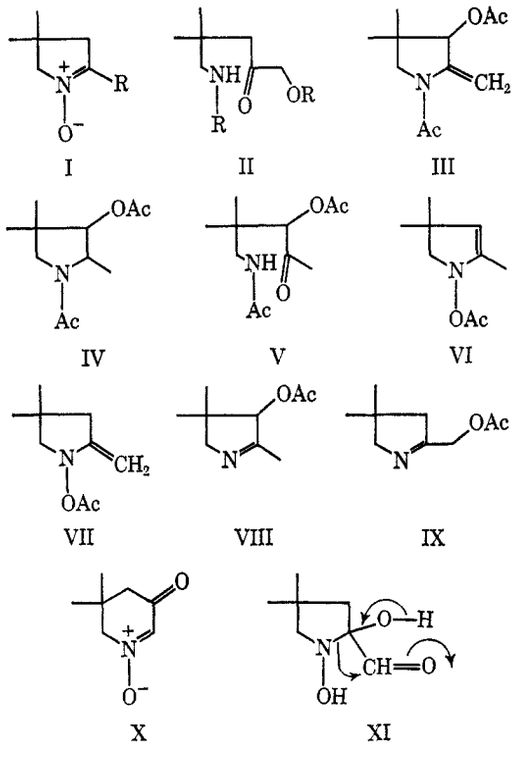
In connection with other work we had need to investigate some reactions of the title compound. Many of the interesting properties of cyclic nitrones have already been delineated.[1,2] For example, treatment of 2,4,4-trimethyl-1-pyrroline 1-oxide (I, R = Me) with benzoyl chloride under Schotten–Baumann conditions gave smoothly a ketobenzoate to which the structure II (R = PhCo) was assigned.[1] We were interested in carrying out the corresponding process of acetylation to give II (R = Ac).[3]

Treatment of the nitrone (I, R = Me) with acetic anhydride in carbon tetrachloride at −20° gave in reasonable yield a crystalline derivative of the composition $C_{11}H_{17}O_3N$ and therefore not the diacetyl compound (II, R = Ac) (Chart I). The new derivative showed in the ^1H nmr spectrum two acetyl groups, two vinyl hydrogens, and one hydrogen on a carbon to which an acetoxyl (or equivalent) function was attached. This, and other spectroscopic evidence, suggested structure III. The following experiments confirmed the correctness of this suggestion. Hydrogenation of derivative III over palladized charcoal (1-mol uptake) gave a compound (IV) which showed an additional secondary methyl group in its nmr spectrum. Treatment of derivative III with aqueous acetic acid containing a little hydrochloric acid at 0° gave smoothly ketoamide V in which the methyl ketone function could be readily recognized in the nmr spectrum. Ketoamide V was characterized as its crystalline 2,4-dinitrophenylhydrazone derivative, a compound which could be prepared directly by treating III with acidic 2,4-dinitrophenylhydrazine solution. The acid-catalyzed hydration of III to give V is a conventional enamide reaction, but the acetylation process itself deserves brief comment. Acetylation of nitrone I should give either enamine VI or its analog VII. The rearrangement of this type of compound to the corresponding imines (VIII and IX,

CHART I



respectively) has much precedent.[4] The N acetylation of VIII and concommitant loss of methyl proton would furnish III directly. A route from IX would require a further allylic rearrangement which would be improbable in the presence of only a small amount of acetic acid at −20 to 0°. The driving force for such an additional rearrangement would also appear to be lacking. We favor, therefore, the direct route I (R = Me) → VI → VIII → III.

Since the methyl group of nitrone I (R = Me) was not functionalized by the acetylation process, we considered also a direct oxidation procedure to give aldehyde I (R = CHO), or other equivalent derivative. It had been shown earlier[5] that oxidation of I (R = Me) with selenium dioxide in methanol[6] under reflux gave a dark oil which with dilute hydrochloric acid afforded crystalline nitrone X. We have found that the selenium dioxide oxidation of I (R = Me) will proceed smoothly at room temperature in ether to give I (R = CHO) in satisfactory (65%) yield. This aldehyde readily afforded a crystalline dimedone derivative and showed the expected aldehyde proton in the nmr spectrum. Oxidation of the aldehyde with silver oxide afforded the corresponding crystalline acid (I, R = CO_2H). A by-product from the selenium dioxide oxidation was the rearranged nitrone X. Indeed if the initial selenium dioxide oxidation solution was left to stand at room temperature substantial amounts of nitrone X were formed. An attempted formation of the 2,4-dinitrophenylhydrazone of aldehyde I (R = CHO) afforded only the known derivative of X. The facile rearrangement of I (R = CHO) to X

(1) R. Bonnett, R. F. C. Brown, V. M. Clark, I. O. Sutherland, and A. Todd, *J. Chem. Soc.*, 2094 (1959), and sequential papers.

(2) J. Hamer and A. Macaluso, *Chem. Rev.*, **64**, 473 (1964); G. R. Delpierre and M. Lamchen, *Quart. Rev.* (London), **19**, 329 (1965).

(3) Compare F. Agolini, R. Bonnett, D. E. McGreer and G. F. Stephenson, *J. Chem. Soc., C*, 1491 (1966).

(4) *Inter alia* T. Cohen and J. H. Fager, *J. Amer. Chem. Soc.*, **87**, 5701 (1965); T. Cohen and G. L. Deets, *ibid.*, **89**, 3939 (1967); R. F. C. Brown, W. D. Crow, L. Subrahmanyan, and C. S. Barnes, *Aust. J. Chem.*, **20**, 2485 (1967); R. Bodalski and A. R. Katritzky, *Tetrahedron Lett.*, 257 (1968).

(5) R. F. C. Brown, V. M. Clark, and A. Todd, *J. Chem. Soc.*, 2105 (1959).

(6) Compare M. Lamchen, *J. Chem. Soc.*, 2300 (1966).

must involve hydration of the nitrone function to give XI followed by a conventional α-hydroxy–carbonyl rearrangement (XI, see arrows) and subsequent dehydration of the intermediate α-carbinolhydroxylamine.

Experimental Section

General.—All melting points were taken on a Kofler block and are uncorrected. Infrared spectra were measured on a Perkin-Elmer 137 Infracord spectrometer and ultraviolet spectra on a Cary Model II spectrometer. Nmr spectra were taken in $CDCl_3$ on a Varian A-60 spectrometer. Microanalyses were done by Dr. A. Bernhardt, Max Planck Institute, Mülheim (Ruhr), Germany.

Acetylation of 2,4,4-Trimethyl-1-pyrroline 1-Oxide (I, R = Me).—The nitrone (I, R = Me,[1] 5.0 g) in carbon tetrachloride (120 ml) was treated with ice-cold acetic anhydride (18.8 ml) added dropwise with stirring at −20° and held at this temperature for 5 hr. The solution was then left at room temperature for 16 hr, poured into ice–water, and extracted with methylene dichloride. After it was washed with aqueous sodium hydrogen carbonate solution and with water the solvent was removed *in vacuo* to furnish a viscous red oil. This was chromatographed in methylene dichloride over Florisil to give a pale yellow oil which crystallized on trituration with ether–hexane. Recrystallization from hexane afforded acetate III (3.0 g): mp 49°; ν_{max}^{Nujol} 1745, 1675, and 1640 cm^{-1}; τ 8.95 (3 H), 8.89 (3 H), 7.89 (3 H), 7.82 (3 H), 6.61 and 6.46 (2 H, J = 10 cps), 5.21 (1 H), 4.80 (1 H), and 4.02 1 (H).

Anal. Calcd for $C_{11}H_{17}NO_3$: C, 62.54; H, 8.11; N, 6.63. Found: C, 62.74; H, 8.32; N, 6.61.

Acetate III (800 mg) in benzene (150 ml) was hydrogenated over 5% palladized charcoal (800 mg) for 5.5 hr (1-mol uptake). The resultant suspension was filtered through "Hyflo Supercel" and the benzene removed *in vacuo*. The resultant oily product was chromatographed in benzene over Florisil to give a trace of starting material and then dihydroacetate IV as an oil: $\nu_{max}^{thin\ film}$ 1745 and 1640 cm^{-1}; τ 8.96 (6 H), 8.83 and 8.71 (3 H, J = 7 cps), 7.95 (3 H), 7.87 (3 H), 6.69 (2 H), 5.69 (1 H), and 4.97 (1 H).

Acid-Catalyzed Hydrolysis of Acetate III.—Acetate III (1.33 g) in glacial acetic acid (20 ml) and water (2 ml) was treated with concentrated hydrochloric acid (3 drops) at 0° for 45 min. The solution was poured into water and extracted with methylene dichloride. The organic phase was washed with aqueous sodium hydrogen carbonate and with water and the solvent removed *in vacuo* to furnish ketoamide V (730 mg). The aqueous phases were combined; excess sodium hydrogen carbonate and sodium borate were added; the mixture was extracted with methylene dichloride to furnish additional ketoamide V (202 mg). Ketoamide V was an oil: $\nu_{max}^{thin\ layer}$ 3400, 1750, 1725, and 1665 cm^{-1}, τ 8.99 (6 H), 8.01 (3 H), 7.80 (6 H), 6.80 (2 H).

Ketoamide V was characterized as the 2,4-dinitrophenylhydrazone. Recrystallized from ethanol, this had mp 113–115°; ν_{max}^{Nujol} 3340, 3150, 1740, 1640, 1625, 1590, and 1515 cm^{-1}.

Anal. Calcd for $C_{17}H_{23}N_5O_7$: C, 49.87; H, 5.66; N, 17.11; mol wt, 409.4. Found: C, 49.88; H, 5.52; N, 17.06; mol wt (Rast), 381.

Treatment of acetate III with acidified 2,4-dinitrophenylhydrazine in the usual way gave the same 2,4-dinitrophenylhydrazone.

Selenium Dioxide Oxidation of 2,4,4-Trimethyl-1-pyrroline 1-Oxide (I, R = Me).—The pyrroline 1-oxide (1.0 g) in ether (30 ml) was treated with selenium dioxide (970 mg) at room temperature for 20 min. The suspended selenium was removed by filtration through a small pad of Florisil and the solvent removed *in vacuo*. Chromatography in methylene dichloride over Florisil gave, as minor product, rearranged nitrone X (identical in all respects with a specimen prepared by the standard method[5]). Further elution afforded as the major product (715 mg) the aldehyde (I, R = CHO, 715 mg), which was an oil: $\nu_{max}^{thin\ film}$ 1665 and 1545 cm^{-1}; τ 8.70 (6 H), 7.30 (2 H), 6.09 (2 H), and −0.07 (1 H). The aldehyde readily afforded a dimedone derivative in aqueous methanol at room temperature. Recrystallized from aqueous methanol this had mp 175–180°.

Anal. Calcd for $C_{23}H_{33}O_5N$: C, 68.46; H, 8.24; N, 3.47. Found: C, 68.39; H, 8.37; N, 3.34.

When aldehyde I (R = CHO) in methanol was treated with acidic 2,4-dinitrophenylhydrazine solution in the usual manner it afforded the 2,4-dinitrophenylhydrazone of keto nitrone X.

Oxidation of Aldehyde I (R = CHO) with Silver Oxide (with Dr. D. R. Brittain).—Aldehyde I (R = CHO) [prepared from nitrone I (R = Me, 1.7 g)], suspended in water (20 ml), was treated with stirring with silver oxide [prepared from silver nitrate (4.64 g) and sodium hydroxide (2.18 g)] at room temperature for 2 hr. The mixture was extracted with chloroform. The pH of the aqueous phase was then adjusted to 1.0 and extraction with chloroform was repeated. This second chloroform extract was evaporated *in vacuo* and the residue crystallized from ether–*n*-hexane to give carboxylic acid I (R = CO_2H, 700 mg): mp 80–92°; λ_{max}^{MeOH} 266 mμ (ε 6700); ν_{max}^{KBr} 1520 cm^{-1}

Anal. Calcd for $C_7H_{11}NO_3$: C, 53.49; H, 7.05; N, 8.91. Found: C, 53.50; H, 7.20; N, 9.64.

Registry No.—I (R = Me), 6931-11-9; I (R = CHO) dimedone derivative, 19689-70-4; I (R = CO_2H), 19713-63-4; III, 19689-71-5; IV, 19689-72-6; V, 19689-73-7; V (2,4-dinitrophenylhydrazone), 19689-74-8.

2,2-Dichlorocyclopropyl Acetates as Intermediates for the Preparation of Pyrazoles and Pyrimidines

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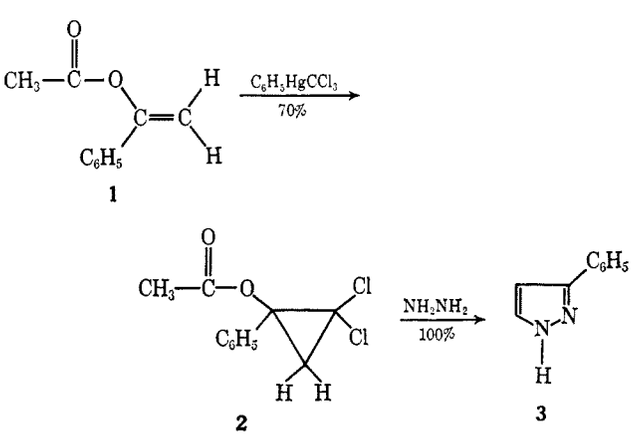
The reaction of *gem*-dihalocyclopropyl acetates with hydrazine and substituted hydrazines provides a new synthetic route to pyrazoles.[3] In order to define further the scope of this synthesis, reactions of compounds of type 2 with a variety of nucleophiles have been examined; the results of this study constitute the subject of this report.

α-Acetoxystyrene (1) was treated with excess phenyl(trichloromethyl)mercury and 2,2-dichloro-1-phenylcyclopropyl acetate (2) was obtained in 70% yield. The cyclopropyl acetate (2) was shown to undergo facile ring opening with 4.5 equiv of 95% hydrazine in hot ethanol, and gave an essentially quantitative yield of 3-phenylpyrazole (3).



(1) Supported by the National Science Foundation Grant GP-6169X.

(2) Taken in part from the Ph.D. Thesis of J. F. Dooley, University of Minnesota, 1967.

(3) (a) W. E. Parham and J. F. Dooley, *J. Amer. Chem. Soc.*, **89**, 985 (1967); (b) W. E. Parham and J. F. Dooley, *J. Org. Chem.*, **33**, 1476 (1968).