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A CONVENIENT NEW ROUTE TO CYCLOPROPANOL DERIVATIVES

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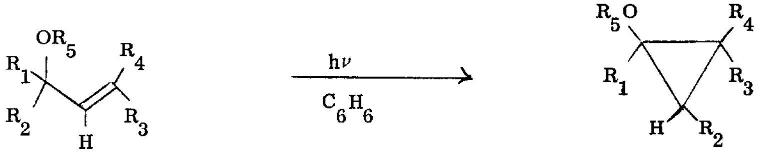
In an extension of our previous studies on the photocyclization of simple arylsubstituted propenes[2] to functionalized propenyl systems, we have investigated the photochemistry of 3-alkoxysubstituted propenes with the intent of obtaining a more convenient route to cyclopropanol ethers.[3] Our continuing interest in the photofragmentation of arylsubstituted cyclopropanes[5] (perhaps in this case to arylalkoxycarbenes) as well as in the direction of photoaddition of protic solvents to such substrates[6] provided additional incentives for developing a more convenient synthetic route to polyarylalkoxycyclopropanes.

When a solution (0.1 M) of the methyl ether[7,8] of 1,3,3-triphenylpropen-3-ol (1b)[7] which is readily prepared in high yield (75%) by the addition of phenyllithium[9] to benzalacetophenone is irradiated in benzene[10] for 36 hours photocyclization occurs to give the cyclopropane 2b (60%). The product (m.p. 151) identical to that obtained by Breslow and Dowd by addition of sodium methoxide to 1,2,3-triphenylcyclopropene,[11] was isolated by dilution of the concentrated irradiation mixture with n-heptane and is presumed to have trans-stereochemistry on the basis of the nmr spectrum[12] which exhibits signals at τ 6.85 (2 H, broad singlet),[11] 7.15 (3 H, singlet) and 2.5-3.0 (15 H, multiplet). Conspicuously absent is any signal in the vinyl proton region of the nmr spectrum of 2b.



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a) $R_1 = R_2 = R_3 = R_4 = C_6H_5$; $R_5 = CH_3$

b) $R_1 = R_2 = R_3 = C_6H_5$; $R_4 = H$; $R_5 = CH_3$

c) $R_1 = R_2 = R_3 = C_6H_5$; $R_4 = H$; $R_5 = CH_2C_6H_5$

d) $R_1 = H$; $R_2 = R_3 = R_4 = C_6H_5$; $R_5 = CH_3$

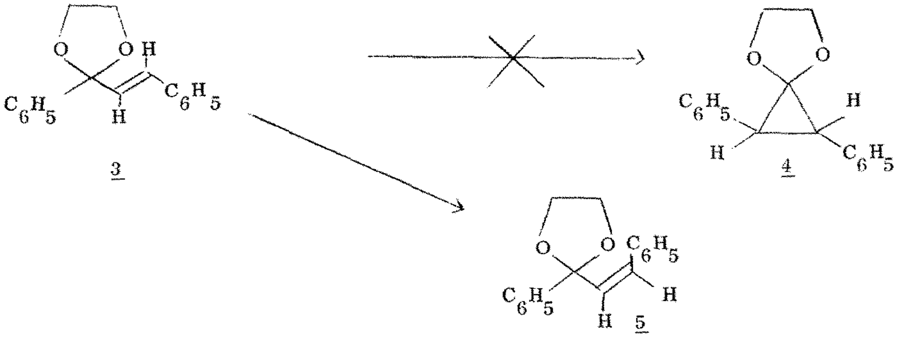
When a (0.1 M) solution of 1c, the benzyl ether related to 1b, is irradiated under similar conditions,[10] a single product (m. p. 128°; 60%) is isolated by recrystallization of the crude reaction residue from heptane and is assigned structure 2c on the basis of the nmr spectrum which has signals at τ 6.7 (2 H, singlet), 6.18 (1 H, doublet; 10 Hz); 5.85 (1 H, doublet; 10 Hz) and a multiplet (15 H) at 2.7-3.2. The appearance of the AB quartet assigned to the two cyclopropyl protons establishes that a trans relationship exists between these hydrogens in 2c and by analogy probably in 2b as is suggested by the broad singlet at τ 6.85 which is observed in the nmr spectrum of the latter.

Irradiation[10] of a benzene solution of 1a (0.1 M) for 36 hours led to the formation of tetraphenylallene (50%) (separated by trituration of the concentrated reaction mixture with heptane) and 2a (30%). The latter was isolated by preparative thin-layer chromatography of the residual heptane solution and purified by distillation (150°/0.1 mm; M/e 376).[10] The nmr spectrum of 2a, which shows signals at τ 7.05 (3 H, singlet); 6.35 (1 H, singlet) and 2.8 (20 H, multiplet), indicates (by comparison of chemical shifts of the other members of the series) that a trans relationship probably exists between the methoxy group and the cyclopropyl hydrogen atom, but this remains to be verified; however, the absence of a vinyl proton signal in the nmr spectrum coupled with the mass spectral data indicates that cyclization has occurred.

Irradiation of 1d[14] under similar conditions provided 2d (30%) which was isolated by preparative thin-layer chromatography and purified by distillation (140°/0.1 mm). The nmr spectrum of 2d exhibits signals at τ 6.59 (3 H, singlet), 6.35 (2 H, broad singlet), 2.8 (15 H, multiplet) and the mass spectral data confirms that 1d and 2d are isomeric (M/e 300).

Independent syntheses of the isomeric pairs of cyclopropanes are in progress to establish the stereochemistry of 2a and 2d. These data in turn would define the stereochemistry of cyclization provided equilibration subsequent to ring closure can be excluded since 2d (and for that matter 2a) appear to be the sole products.

Attempts to prepare cyclopropanone ketals by this procedure utilizing propenes such as 3 have to date proved unsuccessful and only cis-trans isomerization to 5 has been observed. Similarly attempts to induce the photocyclization of 3-alkoxy-1,3-diphenylpropynes have also failed to yield any of the desired alkoxy cyclopropenes which might serve as direct precursors for cyclopropenium derivatives. Our efforts in these areas are continuing with similarly substituted enol ethers and heteroanalogs.



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(1) To whom inquiries regarding this communication should be directed.

(2) G. W. Griffin, A. F. Marcantonio, H. Kristinsson, R. C. Petterson, and C. S. Irving, Tetrahedron Lett., , 2951 (1965).

(3) To date the principal routes which exist for the synthesis of cyclopropanols and their derivatives[4a] include: (a) treatment of epichlorohydrins with magnesium bromide and subsequent reaction with a Grignard reagent and ferric chloride;[4b] (b) hydrolysis of cyclopropyl vinyl ethers under acid conditions;[4c] (c) hydrolysis of cyclopropyl acetates available from Baeyer-Villiger oxidation of methylcyclopropyl ketones or pyrolysis of acetoxypyrazolines;[4d] (d) from derivatives of cyclopropanones;[4e] and (e) from the oxygenation of cyclopropyl lithium reagents.[4f]

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(7) K. Ziegler, K. Richter and B. Schnell, Ann., 443, 161 (1925).

(8) All methyl ethers were prepared in high yield by treatment of the corresponding carbinols with methyl iodide in dimethyl sulfoxide under basic conditions according to the method of R. D. Gillis, Tetrahedron Lett., 1413 (1968). The benzyl ether 1c was prepared in an analogous manner.

(9) Commercial phenyllithium obtained from Alpha Inorganics, Inc., (Beverly, Mass.) was employed in these preparations.

(10) Irradiations were conducted in quartz vessels in a Rayonet Chamber Reactor (The Southern New England Ultraviolet Co., Middletown, Conn.) equipped with sixteen 8w low-pressure mercury lamps. Solutions were degassed prior to irradiation by sparging with argon for 20 minutes.

(11) R. Breslow and P. Dowd, J. Amer. Chem. Soc., 85, 2729 (1963); we are indebted to Professor Breslow for a sample of this adduct for direct comparison with our sample. A doublet is reported by these workers for the cyclopropyl hydrogens of 2b.

(12) All nmr spectra were recorded on a Varian A60 instrument in deuteriochloroform with tetramethylsilane as internal standard. All new compounds gave satisfactory analyses and mass spectral data were obtained on a Perkin-Elmer Hitachi RMU-6 spectrometer.

(13) In cyclopropyl derivatives the ranges of vicinal coupling constants overlap (J cis 6.6-12.5 Hz and J trans 3.9-8.6 Hz) precluding unequivocal structural decisions to be made on this basis of nmr data. S. Sternhill, Quarterly Reviews, 23, 248 (1969); however, the small coupling constant observed for the protons in 2b support a trans structure. In the methoxycyclopropanes made there is an almost coincidence of cyclopropyl protons.

(14) F. Straus and M. Ehrenstein, Ann., 442, 93 (1925).

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