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A NEW METHOD FOR DIRECT OXIDATION OF THE METHYLENE GROUP ADJACENT TO A CYCLOPROPANE RING TO THE KETO GROUP

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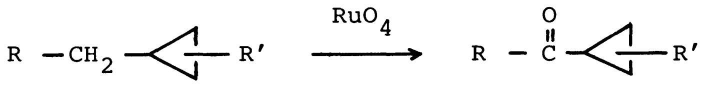
A new finding that the methylene group adjacent to a cyclopropane ring can be oxidized to the keto group directly with ruthenium tetroxide is described.

Cyclopropylcarbonyl compounds are versatile intermediates in synthetic organic chemistry. Nevertheless, "dry ozonation"[1)] has been known as the only method for direct oxidation of the methylene group adjacent to a cyclopropane ring to yield the corresponding cyclopropylcarbonyl compound.[2)]

In this communication, we wish to disclose our new findings that ruthenium tetroxide,[3)] generated in situ from ruthenium trichloride and sodium metaperiodate,[4)] similarly oxidizes the methylene group adjacent to a cyclopropane ring to give the corresponding cyclopropyl ketone (Scheme 1).



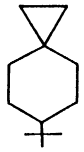
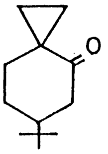
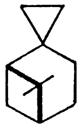
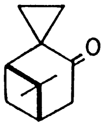
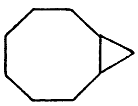
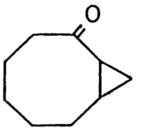
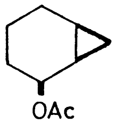
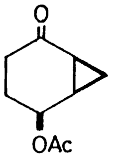
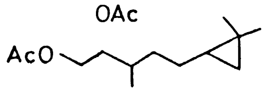
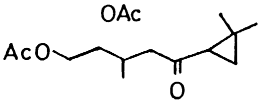
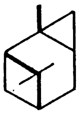
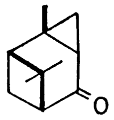
Scheme 1.

Table 1 shows several examples of oxidation of the methylene group connected to the cyclopropane ring. Following procedure is illustrative. To a mixture of 6-t-butylspiro[2.5]octane (3)[5,6)] (118 mg, 0.71 mmol) in CCl_4 (1.4 ml), CH_3CN (1.4 ml), and phosphate buffer (pH 7, 2.0 ml) were added sodium metaperiodate (460 mg, 2.15 mmol) and ruthenium trichloride hydrate (33 mg, 0.14 mmol). The mixture was stirred at room temperature for 27 h, diluted with H_2O (3 ml), and extracted with $CHCl_3$ (5 x 15 ml). The combined organic layers were washed with a mixture (6 ml) of saturated $Na_2S_2O_3$, $NaHCO_3$, and NaCl (1:1:1), dried over anhydrous Na_2SO_4, and concentrated. Chromatographic purification of the crude product afforded the pure ketone 11[6)] (colorless oil, 79 mg, 62%).

The present study clearly indicates that the methylene group located at the α-position to the cyclopropane ring is selectively oxidized with ruthenium tetroxide to give the cyclopropyl ketone, even in the presence of the methyl group connected also to the cyclopropane ring.

While the actual course of this oxidation is not clear as yet, we believe that the electronic effect of the cyclopropane ring may facilitate the abstraction of the hydrogen radical with the high valent oxometal from the methylene group adjacent to the cyclopropane ring.

Table 1. Oxidation of the Methylene Group Adjacent to the Cyclopropane Ring[a]

Substrate[b]		Product[c]		Reaction time/h	Yield/%[d]
	1		9	28	41
	2		10	18	53
	3		11[i]	27	62
	4[e]		12[j]	21	57
	5[f]		13[f]	18	50
	6[g]		14	27	71
	7[h]		15[h]	18	57
	8[e]		16[j]	5.5	53

a) Oxidation was performed with RuCl$_3$ (0.2 equiv.) and NaIO$_4$ (3 equiv.) at room temperature. b) All substrates employed in oxidation were prepared by the procedure in the Ref. 5 and exhibited satisfactory IR, ^{1}H NMR, and mass spectra. c) See Ref. 6. d) All yields refer to the isolated materials. e) See Ref. 7. f) See Ref. 2. g) See Ref. 8. h) This compound was an inseparable mixture (1:1) of the diastereomers. i) See Ref. 9. j) See Ref. 10.

References

1) Z. Cohen, E. Keinan, Y. Mazur, and T. H. Varkony, J. Org. Chem., 40, 2141 (1975).
2) E. Proksch and A. de Meijere, Angew. Chem., Int. Ed. Engl., 15, 761 (1976).
3) Non-selective oxidation of cycloalkanes with RuO$_4$ to the mixture of the cycloalkanones and the dicarboxylic acids in various ratios is known. See, U. A. Spitzer and D. G. Lee, J. Org. Chem., 40, 2539 (1975).
4) P. H. J. Carlsen, T. Katsuki, V. S. Martin, and K. B. Sharpless, J. Org. Chem., 46, 3936 (1981).
5) This compound was prepared from the corresponding olefin by the modified procedure of Simmons-Smith cyclopropanation. See, R. J. Rawson and I. T. Harrison, J. Org. Chem., 35, 2057 (1970).
6) Satisfactory IR, ^{1}H NMR, and high resolution mass spectra were obtained for the purified, chromatographically homogeneous material.
7) C. Filliatre and C. Guéraud, C. R. Acad. Sci., Ser. C, 273, 1186 (1971).
8) A. Itoh, S. Ozawa, K. Oshima, S. Sasaki, H. Yamamoto, T. Hiyama, and H. Nozaki, Bull. Chem. Soc. Jpn., 53, 2357 (1980).
9) L. Joris, P. von R. Schleyer, and R. Gleiter, J. Am. Chem. Soc., 90, 327 (1968).
10) Y. Bessière-Chrétien and M. M. El Gaïed, Bull. Soc. Chim. Fr., 1971, 2189.

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