Oxidative Deoximation

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A number of ketoximes have been deoximated by treatment with Jones reagent, chromium trioxide–pyridine complex, and periodic acid, reagents which have not previously been employed for this purpose. The oximes of camphor and of 1-tetralone also gave 2-nitroiminobornane and 1,1-dinitrotetralin, respectively.

DIFFICULTIES experienced in the deoximation of some oximino-lactams [1] on employing the usual hydrolytic and exchange procedures led us to examine alternative methods, *e.g.*, oxidative and reductive deoximations.[2] Oxidative procedures have yielded a variety of products which depend on the nature of the oxime and the oxidizing reagent used. Thus, nitrosating agents,[2a] thallium trinitrate,[2b] ceric ammonium nitrate–nitric acid,[2c] chromous acetate,[2d] titanium trichloride,[2e] lead tetra-acetate,[3] ozone,[4] and (dioxygen)bistriphenylphosphinepalladium [5] bring about deoximation with varying degrees of success. Manganese dioxide in acetic acid [6] and hydrogen peroxide in trifluoroacetic acid [7] oxidize oximes to the nitro-compounds, while alkaline solutions of chlorine and bromine and alkyl hypochlorites convert them into α-chloronitroso- and α-bromonitroso-compounds.[2a] Surprisingly, there is apparently no mention of the use of either chromic acid † or periodic acid for the oxidation of oximes. We now report that both reagents can be used for the deoximation of saturated ketoximes and describe our results (Table).

Treatment with periodic acid in ether and acetic acid usually gave good results, but the process was marred by the liberation of iodine and the occasional formation of iodinated products. Aqueous chromic acid (50%)–acetic acid successfully oxidized cyclohexanone oxime to the parent ketone, but the reaction was slow and incomplete in other cases. Jones reagent was the most efficient and reacted more rapidly and completely in acetic acid than in acetone, owing to better solubility. Similarly, chromium trioxide–pyridine complex in dichloromethane [8] was also successful in the few cases tried.

Some side-reactions were observed and the by-products identified. The reaction with camphor oxime was comparatively slow with all the reagents tried (Table) and the camphor obtained from these oxidations was contaminated with a nitro-compound (i.r.). Moreover, camphor itself was appreciably attacked by Jones reagent in acetic acid. However, oxidation with periodic acid and chromium trioxide–pyridine complex (CH_2Cl_2) proceeded smoothly and the by-product was isolated and identified as 2-nitroiminobornane by comparison of its i.r. spectrum with the published data [9] and with that of an authentic sample prepared from camphor oxime by reaction with sodium nitrite in acetic acid.

Oxidation of 1-tetralone oxime (Table) gave a good yield of 1-tetralone, contaminated with small quantities of a nitro-compound. Pure tetralone could be easily obtained either by column chromatography or careful

Deoximation of ketoximes; yields (%) [a] by various methods

	Reagent (solvent)				
	Jones reagent		CrO_3–Pyridine	Periodic acid	
Parent ketone	(AcOH)	(Acetone)	(CH_2Cl_2)	(Ether)	(AcOH)
4-t-Butylcyclohexanone	90pp	82pp	85pp	95pp	92c, 71p
Camphor	90m [b]	68m [b]	95c,[b] 70p	95c [b]	82c [b]
1-Tetralone	95c,[b] 50p	87c,[b] 70p	92c,[b] 68p	85c [b]	94c,[b] 81p
(8; $n = 4$) [c]	92p				52m
(8; $n = 5$) [c]	84pp			95p	
(8; $n = 6$) [c]	93p			65p	
(8; $n = 10$) [c]	82p				61p
Cholestan-3-one				61p	
Acetophenone	62p	80c			
Benzophenone	75p				
Isophorone	87m	83m	71m	64m	

[a] c: Yield of the crude product. p: Yield of the purified product. pp: Isolated product practically pure (i.r., t.l.c.). m: Isolated product a complex mixture (i.r., t.l.c.). [b] Product contains nitro-compound (i.r.). [c] $CO[CH_2]_nCO{\cdot}O[CH_2]_2CH_2$ (8); J. R. Mahajan, G. A. L. Ferreira, and H. C. Araújo, *J.C.S. Chem. Comm.*, 1972 1078.

† Some cycloalkanone oximes have been oxidized in the presence of the following catalysts; V_2O_5, $(NH_4)_2MoO_4$, $K_2Cr_2O_7$, and $KMnO_4$ to yield ketones; G.P. 1,078,570 (*Chem. Abs.*, 1961, **55**, 25,808e).

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[2] For leading references see the following and references cited therein: (*a*) J. P. Freeman, *Chem. Rev.*, 1973, **73**, 283; (*b*) A. McKillop, J. D. Hunt, R. D. Naylor, and E. C. Taylor, *J. Amer. Chem. Soc.*, 1971, **93**, 4918; (*c*) J. W. Bird and D. G. M. Diaper, *Canad. J. Chem.*, 1969, **47**, 145; (*d*) E. J. Corey and J. E. Richman, *J. Amer. Chem. Soc.*, 1970, **92**, 5276; (*e*) H. H. Timms and E. Wildsmith, *Tetrahedron Letters*, 1971, 195.

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[5] K. Maeda, I. Moritani, T. Hosokawa, and S. I. Murahashi, *Tetrahedron Letters*, 1974, 797; we thank the referees for bringing this report to our notice.

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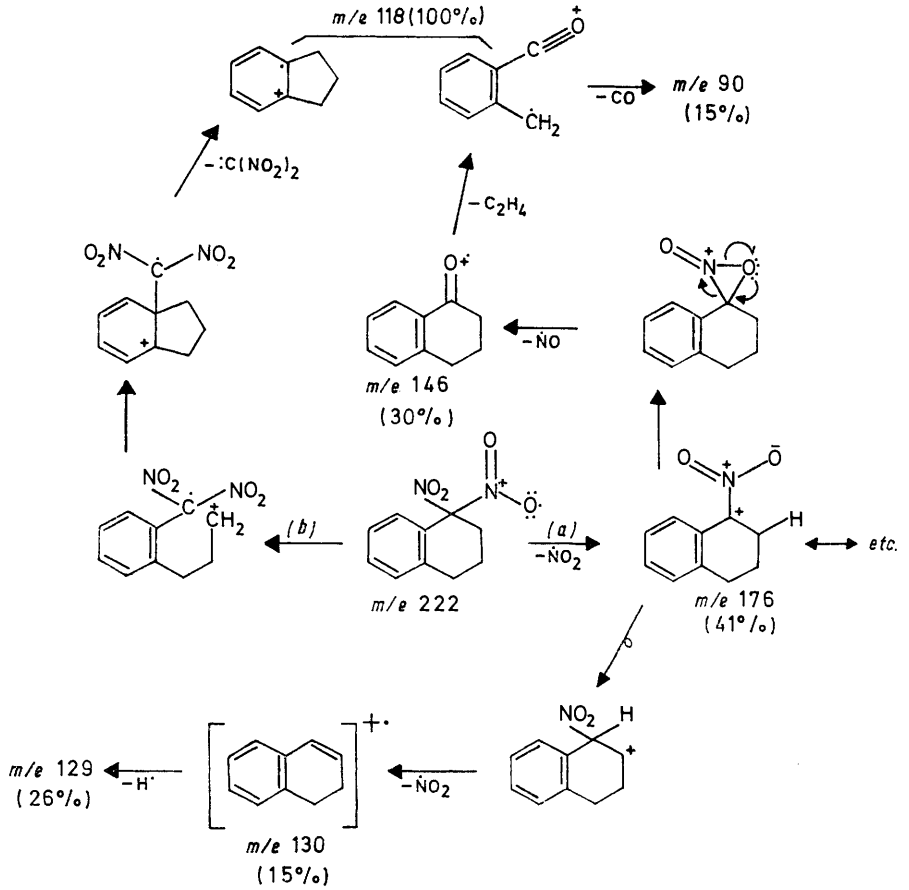
[9] J. P. Freeman, *Chem. and Ind.*, 1960, 1624.

vacuum distillation. In oxidation with Jones reagent in acetic acid, the by-product was identified as 1,1-dinitrotetralin by its elemental analysis and i.r., n.m.r., and mass spectra. Although the molecular ion peak (*m/e* 222) was negligible, peaks at *m/e* 176 (41%), 146 (30), 131 (26), 130 (15), 129 (26), 118 (100), and 90 (15), *etc.*, support the assigned structure (Scheme 1). Although 1-tetralone gives a base peak at *m/e* 118, due to the loss of ethylene,[10] this ion may also arise by an alternative path (*b*), by the loss of dinitrocarbene.

lead directly to intermediate (2), as already postulated by some authors.[2b] In hindered oximes, or where the formation of cation (1) is favoured by electronic effects, this latter could become a predominant pathway. Subsequent hydrolysis of (1), through (2), (3), and the dimer (4),[2c] would lead to ketones, while an alternative fragmentation of the dimer (4) would afford the nitrosonitrone (5). The rearrangement of the nitrosonitrone structure (5) to a ketone and to a nitroimine (6) ($R_2C{=}NNO_2$) has already been discussed by Freeman.[2a,11] We suggest that under



SCHEME 1
Salient fragmentation peaks of 1,1-dinitrotetralin

The formation of 2-nitroiminobornane and 1,1-dinitrotetralin in the present oxidations merits comment, because such compounds have so far been obtained from oximes only in the presence of nitrosating reagents.[2a] 2-Nitroiminobornane is formed by the action of perchloryl fluoride on the sodium salt of camphor oxime, but the suggestion was made that nitrosating agents were produced during the reaction.[11] We have not sought to establish the mechanism of the present oxidations, the formation of the observed products may be rationalized as in Scheme 2. The first step is analogous to reaction with alcohols, and with the participation of water could favorable circumstances, an alternative rearrangement of the nitrosonitrone structure (5) can lead to a *gem*-dinitroso-intermediate, which is eventually oxidized to the *gem*-dinitro-compound (7) under the experimental conditions.

[10] H. Budzikiewicz, C. Djerassi, and D. H. Williams, 'Mass Spectrometry of Organic Compounds,' Holden-Day, San Francisco, 1967, pp. 153 and 512.
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EXPERIMENTAL

Oxidation products were purified by crystallization, distillation, or chromatography (silica gel–benzene). The isolated products were identified by comparison with authentic samples. I.r. spectra were taken with a Perkin-Elmer 137 instrument. ^{1}H N.m.r. spectra were taken with a Varian A60-D instrument. Mass spectra were run on a Finningan 1015 S/L instrument at 20 eV. Some typical oxidation procedures are given below.

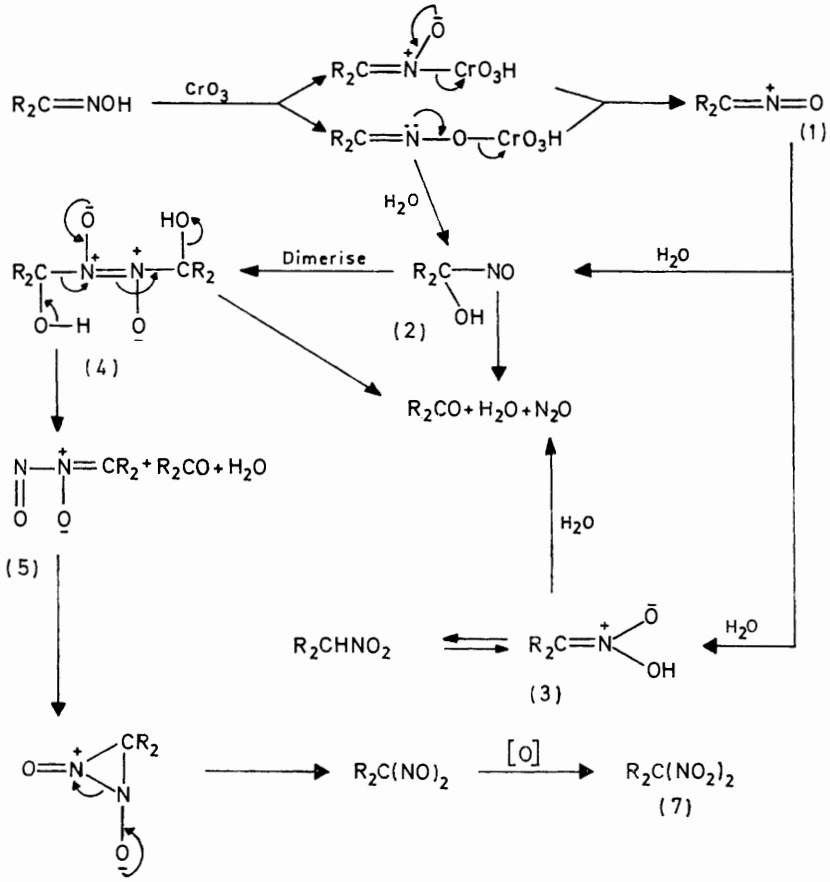
Oxidation of 8-Hydroxyiminoundecanolide to give 8-Oxoundecanolide (8; $n = 6$).—A saturated solution of periodic

acid in ether (80 ml; *ca.* 16 mg ml^{-1}; *ca.* 5·6 mmol) [12] was slowly added to a solution of 8-hydroxyiminoundecanolide (1·065 g, 5 mmol) in ether (20 ml). After stirring at room temperature for 3 h, the mixture was decomposed with a saturated solution of sodium hydrogen carbonate. The ethereal layer was washed with a solution of sodium thiosulphate and water, dried (Na_2SO_4), and evaporated. Chromatography of the crude product gave 8-oxoundecanolide (640 mg, 64·6%), m.p. 58—59°, i.r. spectrum identical with that of an authentic sample.[13]

Oxidation of 12-*Hydroxyiminopentadecanolide to give* 12-*Oxopentadecanolide* (8; $n = 10$).—A solution of periodic acid (798 mg, 3·5 mmol) in acetic acid (5 ml) was added dropwise to a solution of the oxime (858 mg, 3·2 mmol) in acetic acid (5 ml), with stirring and cooling. After stirring at room temperature for 1·5 h, the mixture was taken up in ether and washed successively with a solution of sodium hydrogen sulphite, sodium hydrogen carbonate, and water. Work-up afforded the crude product (770 mg, 87%), which on chromatography gave 12-*oxopentadecanolide* (498 mg, 61·2%), m.p. 31—32°, i.r. spectrum identical with that of an authentic sample.[13]

Oxidation of Camphor Oxime to give 2-*Nitroiminobornane and Camphor.*—Camphor oxime (167 mg, 1 mmol) dissolved in dichloromethane (5 ml) was slowly added to chromium trioxide–pyridine complex [from chromium trioxide (400 mg) and pyridine (0·8 ml)] in dichloromethane (10 ml). After stirring at room temperature for 4 h, work-up furnished a product (145 mg, 95%), which on chromatography yielded 2-nitroiminobornane (30 mg, 15%), $\nu_{max.}$ (film) 1647, 1567, and 1309 cm^{-1} (lit.,[9] 1645, 1563, and 1312 cm^{-1}), followed by camphor (105 mg, 70%).

An authentic sample of the nitroimine was prepared by treating (under N_2) a solution of camphor oxime (167 mg, 1 mmol) in acetic acid (1 ml) with sodium nitrite (69 mg, 1 mmol). After 2 h at 5—10°, the mixture was kept at room temperature for 12 h. Work-up afforded the desired product (166 mg, 84%), which had an i.r. spectrum identical with that of the nitroimine obtained above.



SCHEME 2

Oxidation of 1-*Tetralone Oxime to give* 1,1-*Dinitrotetralin and* 1-*Tetralone.*—Jones reagent (0·4 ml) was added dropwise to a solution of 1-tetralone oxime (161 mg, 1 mmol) in acetic acid (1·5 ml). After stirring at room temperature for 30 min, work-up gave a product (138 mg, 95%), which on chromatography yielded 1,1-dinitrotetralin (48 mg, 22%), as light yellow needles from petroleum (b.p. 40—60°), m.p. 48—49·5° (Found: C, 53·9; H, 4·5; N, 12·7. $C_{10}H_{10}N_2O_4$ requires C, 54·1; H, 4·5; N, 12·6%), $\nu_{max.}$ (KBr) 1582, 1563, 1362, and 1314 cm^{-1}, δ 1·97 (2H, m), 2·92 (4H, two superimposed t, J 6·5 Hz), and 7·33 (4H, m), and 1-tetralone (73 mg, 50%).

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[13] J. R. Mahajan, G. A. L. Ferreira, and H. C. Araújo, *J.C.S. Chem. Comm.*, 1972, 1078.