Phenylsulphenyl-lactonization: an Easy and Synthetically Useful Lactonization Procedure

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Summary Certain unsaturated carboxylic acids react with benzene sulphenyl chloride in the presence of triethylamine to afford phenylsulphenyl-lactones, a new class of synthetically useful intermediates.

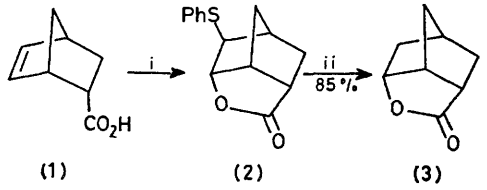
THE addition of arenesulphenyl halides to olefins has been extensively studied both mechanistically and synthetically.[1,2] However, intramolecular reactions involving trapping of the intermediate episulphonium ion[2] by internal nucleophiles, although of great potential value in the synthesis of heterocycles, have not been investigated systematically.[3] We report a novel lactonization procedure of unsaturated carboxylic acids, based on the above principle, which furnishes phenylsulphenyl-lactones, a new class of synthetically useful compounds.

The reaction is illustrated in Scheme 1. Treatment of *endo*-norborn-5-ene-2-carboxylic acid (**1**)† with triethylamine followed by addition of PhSCl‡ furnishes, after

† Prepared from an *endo–exo* mixture by iodolactonization followed by regeneration of the *endo*-acid from the pure iodolactone with zinc in acetic acid.

‡ PhSeCl reacts in a similar fashion with unsaturated carboxylic acids. These results will be reported elsewhere.

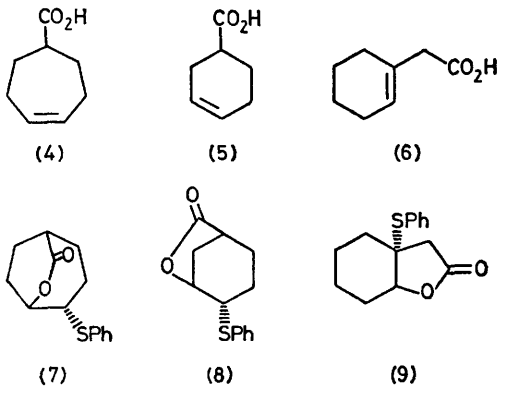
column chromatography, the phenylsulphenyl-lactone (**2**) in 95% yield, m.p. 112·5—113 °C (hexane), ν_{max} (KBr), 1770 cm^{-1} (γ-lactone). Removal of the PhS group from (**2**)



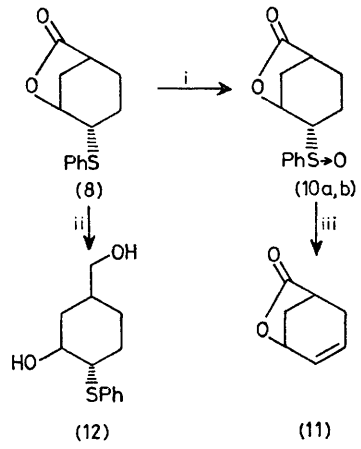
SCHEME 1. i, CH_2Cl_2, (1) Et_3N, 25 °C, (2) PhSCl, −78 °C; ii, Raney Ni, tetrahydrofuran, 25 °C.

by Raney Ni[4] proceeded smoothly to afford the known γ-lactone (**3**), m.p. 154—155 °C.[5] The stereochemistry of the sulphur group in (**2**) is tentatively assigned as shown and is based on mechanistic considerations.[2,6]

Acids (**4**),[7a] (**5**),[7b] and (**6**)[7c] similarly gave the phenylsulphenyl-lactones, (**7**) (82%), m.p. 82—82·5 °C, (**8**) (70%), m.p. 94—95 °C, and (**9**) (86%), m.p. 84—85 °C.§ Preliminary observations indicate that the initial product in the reaction of (**6**) is the corresponding spiro β-lactone [ν_{max} (neat) 1820 cm^{-1}], which rearranges on SiO_2 during chromatography to the thermodynamically more stable γ-lactone (**9**) [ν_{max} (KBr) 1770 cm^{-1}].



This mild procedure is an alternative to halogenolactonization, which has ample applications in the synthesis of natural products.[8] Furthermore, recent developments in the chemistry of the phenyl sulphenyl species and the ease of preparation of the phenylsulphenyl-lactones make these intermediates versatile synthons. For example, controlled oxidation of the thio group to sulphoxide, followed by thermal, *syn*-elimination away from the lactone oxygen was expected to lead to unsaturated lactones.[9] Thus, (**8**) was converted with *m*-chloroperoxybenzoic acid into the sulphoxide (**10a,b**) (94%), m.p. 128—130 °C (ether), [mixture of diastereoisomers; (**10a**):(**10b**), *ca.* 55:45 by ^1H n.m.r. spectroscopy] which, upon heating at reflux in toluene for 36 h, furnished (**11**)[10] in 80% yield (Scheme 2).§



SCHEME 2. i, *m*-Chloroperoxybenzoic acid (1·1 equiv.), CH_2Cl_2, −78 °C; ii, $LiAlH_4$, Et_2O, 0 °C; iii, PhMe, heat.

Interruption of the pyrolysis after 10 h led to the isolation of pure (**10a**), m.p. 154—155 °C (ether), (35%) as well as (**11**) (50%).§ Finally, $LiAlH_4$ reduction of (**8**) afforded the diol (**12**), m.p. 108·5—109 °C (ether) (98%), demonstrating further the utility of this method in the regio- and stereoselective synthesis of polyfunctional intermediates from readily available unsaturated carboxylic acids.

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§ All new compounds were characterized by full spectroscopic and analytical data.

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