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RING CONTRACTIONS IN THE 1,3-DITHIAN SERIES

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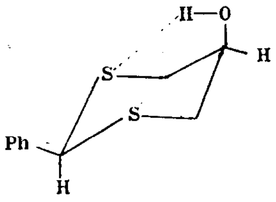
The mixture of isomeric 2-phenyl-1,3-dithian-5-ols, obtained[1] by condensation of benzaldehyde and 1,3-dimercapto-propanol, has been separated by fractional crystallisation,[1] or better, by chromatography on alumina,[2] the pure compounds having m.p. 103° and m.p. 144°. The two alcohols are also formed,[2] in approximately equal amounts, by reduction of 2-phenyl-1,3-dithian-5-one[3,4] with sodium borohydride in pyridine,[5] but with lithium aluminium hydride the isomer, m.p. 103°, is produced in 80% yield.[2] Studies of the infra red spectra of the dithianols and detailed analysis[6] of the nuclear magnetic resonance spectra of the dithianols and their acetates have shown that the isomer, m.p. 103°, has the cis configuration (I). The trans isomer, m.p. 144°, appears to be an equilibrium mixture of conformations (III) and (IV), the former (in which both phenyl and hydroxyl groups are equatorial) being preferred.

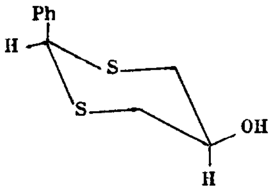
Attempts to dehydrate the 2-phenyl-1,3-dithian-5-ols have been unsuccessful, although 5-aryl-5-hydroxy-1,3-dithians are readily dehydrated to 5-aryl-1,3-dithienes.[2,3] Treatment of cis-2-phenyl-1,3-dithian-5-ol with phosphorus oxychloride and pyridine gave a chloride, $C_{10}H_{11}ClS_2$, m.p. 75°, converted by the action of active (i.e. alkaline) alumina to an alcohol,

$C_{10}H_{12}OS_2$, m.p. 88-9°, identical with one of the two isomeric 4-hydroxymethyl-2-phenyl-1,3-dithiolans[7,8] (V; R=OH). Similar treatment of *trans*-2-phenyl-1,3-dithian-5-ol yielded a chloride, $C_{10}H_{11}ClS_2$, m.p. 62-3°, hydrolysis of which, on alumina, gave the other 4-hydroxymethyl-2-phenyl-1,3-dithiolan, m.p. 87-8° (mixed m.p. with the isomeric dithiolan, 65-7°). In both cases, good overall yields were obtained.

Evidence that ring contraction occurs in the preparation of the chlorides, and not in their hydrolysis, was obtained as follows. Both chlorides, on oxidation with monoperphthalic acid, gave the same disulphone (VI; R=Cl), m.p. 199-200°, as expected from the observations of Roberts and Cheng[8] on the oxidation of 1,3-dithiolans having one hydrogen atom at the 2-position. Reduction of the disulphone chloride in dioxan with Raney nickel afforded an impure sample of 4-methyl-2-phenyl-1,3-dithiolan-1,1,3,3-tetroxide (VI; R=H), m.p. 185-7°, but a more satisfactory proof of structure of the disulphone was obtained by dehydrochlorination (with basic alumina suspended in dioxan), which gave the disulphone (VII; R=Ph, R'=H), m.p. 140-1°, in high yield (the formation of this product involves an isomerisation of a type which has been previously observed[9]). The structure of the unsaturated disulphone was clearly indicated by its nuclear magnetic resonance spectrum; the methyl group appeared as a symmetrical doublet, corresponding to three protons (τ 7.62, 7.66), due to coupling with the olefinic proton at C-5, which itself appeared as a multiple signal (τ 2.8-2.9). The unsaturated disulphone (VII; R=Ph, R'=H) was also obtained from 2,3-dimercaptopropanol, by condensation with benzaldehyde to give a mixture of isomeric



(I)



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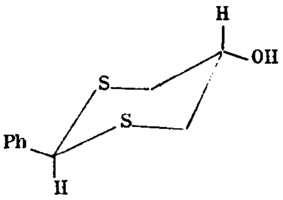

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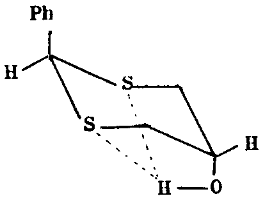

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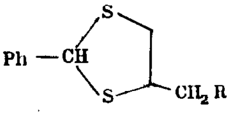

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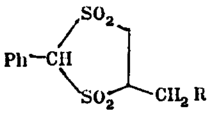

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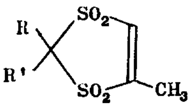

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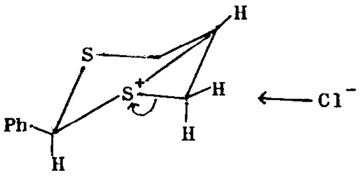
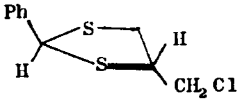


(VIII)



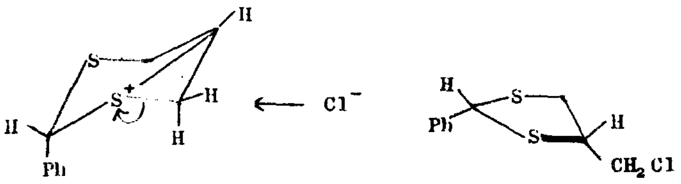
(IX)

4-hydroxymethyl-2-phenyl-1,3-dithiolans,[7] conversion to the mixed bromides,[7] oxidation to the disulphone (VI; R=Br), m.p. 214-5°, and dehydrobromination with alumina. Hydrogenolysis of the bromide with Raney nickel in dioxan gave a satisfactory yield of 4-methyl-2-phenyl-1,3-dithiolan-1,1,3,3-tetroxide (VI; R=H), identical with a sample prepared by oxidation of authentic 2-phenyl-4-methyl-1,3-dithiolan.

A further example of ring contraction was observed in the simpler case of 2,2-dimethyl-1,3-dithian-5-ol (3,5-dinitrobenzoate, m.p. 181-2°), prepared[1] from 1,3-dimercaptopropanol. Reaction with phosphorus oxychloride - pyridine gave a chloride formulated as 4-chloromethyl-2,2-dimethyl-1,3-dithiolan since (a) hydrolysis yielded 4-hydroxymethyl-2,2-dimethyl-1,3-dithiolan, m.p. 55° (3,5-dinitrobenzoate, m.p. 125°), identical with a sample prepared[1] from 2,3-dimercaptopropanol and acetone, and (b) the related disulphone chloride, m.p. 100°, on treatment with alumina, gave an unsaturated sulphone (VII; R=R'=Me), m.p. 142-4°, the nuclear magnetic resonance spectrum of which showed a symmetrical doublet (corresponding to three protons) at τ 7.66, 7.70, a single peak (six protons) at τ 8.27, and multiple peaks (one proton) at τ 3.05-3.15.

The ring contractions of dithian alcohols described above are analogous to the conversion of 6-hydroxy-1,4-dithiacycloheptane to 2-chloromethyl-1,4-dithian with thionyl chloride.[9] Ring contractions of other cyclic sulphides have been observed[10] but the present case is of particular interest in that the reactions show a considerable degree of stereospecificity; the isomeric 2-phenyl-1,3-dithian-5-ols give <u>different</u> 4-chloromethyldithiolans* (V; R=Cl) and hence different hydroxymethyldithiolans. Presumably, the reaction with phosphorus oxychloride involves the formation of bridged sulphonium ions, (VIII) and (X), which are sufficiently rigid to give, in each case, mainly one 4-chloromethyldithiolan in the subsequent reaction with chloride ion. On this basis, the product, m.p. 62-3°, from the *trans*-dithianol (III) will be *trans*-4-chloromethyl-2-phenyl-1,3-dithiolan (IX); the *cis*-dithianol, reacting in conformation (II), in order to allow participation by one (or both?) of the ring sulphur atoms, will yield the *cis*-chloromethyldithiolan (XI).

The tosylates of the 2-phenyl-1,3-dithianols have been prepared and a preliminary study of their reactions indicates that these compounds also undergo stereospecific rearrangements.



(X) (XI)

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[*] The N.M.R. spectra of the crude chlorides indicate that they each contain varying but small amounts of the isomeric dithiolan and, probably, some chlorodithian.

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