

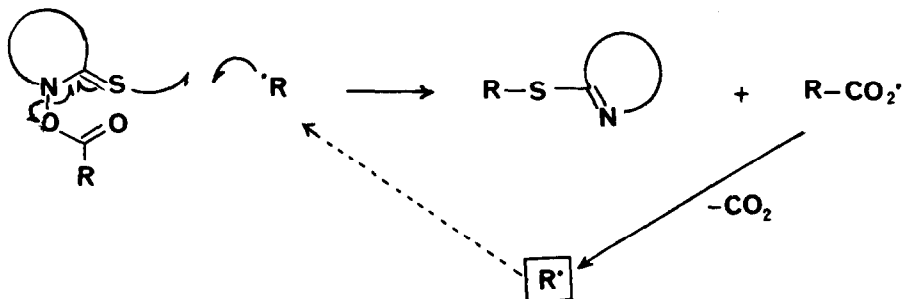
ON THE MECHANISM OF THE DECARBOXYLATIVE REARRANGEMENT  
OF THIOHYDROXAMIC ESTERS<sup>†</sup>

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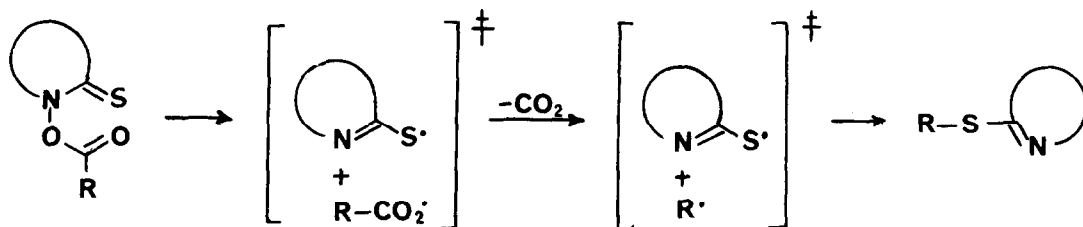
*The thermal and photochemical decomposition of a typical thiohydroxamic ester (mixed anhydride) doubly labelled with deuterium has shown the photochemical reaction to be a radical chain process, whereas about 20% of the thermal reaction involves a cage mechanism. An improved route to 1-hydroxy-5-phenylthiazolin-2-thione is reported.*

Carboxylic esters (mixed anhydrides) of the potentially aromatic thiohydroxamic acids 1, 2 and 3 are a new and useful source of carbon radicals.<sup>1,2</sup> In the absence of efficient radical traps these esters undergo a decarboxylative rearrangement, either thermally or photochemically, giving nor-alkylarylsulphides. Two free radical mechanisms are possible for this rearrangement reaction; a chain mechanism (Scheme 1) or a cage mechanism (Scheme 2). We present here the results of crossover experiments designed to differentiate between these two mechanisms.



Scheme 1

<sup>†</sup> Dedicated with affection to Prof. H.H. Wasserman on the occasion of his 65th birthday.



Scheme 2

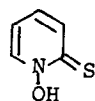
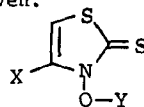
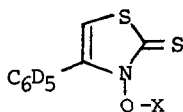
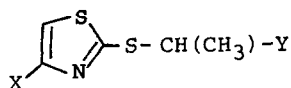
Thus the pentadeuteriothiohydroxamic acid 5 was obtained from pentadeuterioacetophenone,<sup>3</sup> *via* pentadeuteriophenacylbromide analogously to the preparation of 3.<sup>2</sup> The stable white crystalline ester 4 was formed by the reaction of 3 with isobutyryl chloride. ( $\pm$ )-Trideuteroisobutyric acid, obtained by alkylation of diethyl methylmalonate with perdeuteriodomethane, was condensed with 5 *via* the acid chloride to give the octadeuteroester 6. Equimolar mixtures of esters 4 and 6 were then either photolysed in benzene with a 100 W medium pressure mercury lamp, or heated to reflux in benzene. When the esters had been consumed the 70 ev EI mass spectrum of the total reaction mixture was taken and the ratios of the molecular ions of the four possible rearrangement products 7 - 10 determined (Table).

Table

M/Z	N <sup>o</sup> of incorporated D atoms	% of total M <sup>+</sup> . a), b)			
		( $\Delta$ )1	( $\Delta$ )2	(hv)1	(hv)2
243	8	27	28	25	29
240	5	20	20	26	26
238	3	19	19	22	22
235	0	34	33	27	23

a) All values are corrected for incomplete deuteration of the ester 6.

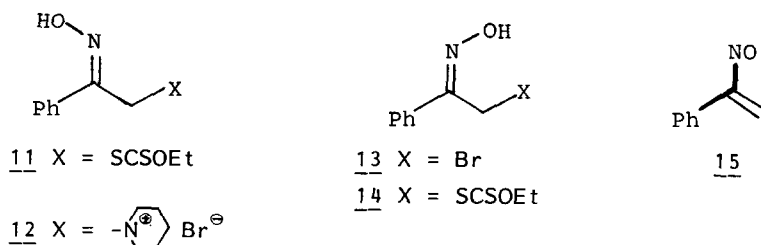
b) Maximum error limits  $\pm$  10% of the numbers given.

12 X = CH<sub>3</sub>, Y = H3 X = Ph, Y = H4 X = Ph, Y = CO-CH(CH<sub>3</sub>)<sub>2</sub>5 X = H6 X = COCH(CH<sub>3</sub>)CD<sub>3</sub>7 X = C<sub>6</sub>D<sub>5</sub>, Y = CD<sub>3</sub>8 X = C<sub>6</sub>D<sub>5</sub>, Y = CH<sub>3</sub>9 X = Ph, Y = CD<sub>3</sub>10 X = Ph, Y = CH<sub>3</sub>

In a preparative scale experiment 10<sup>9</sup> was obtained from 4 in 78% yield. It is immediately obvious that, at least in the case of the photochemically induced reaction, scrambling is complete. This result is best interpreted in terms of a pure radical chain mechanism.

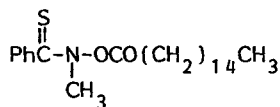
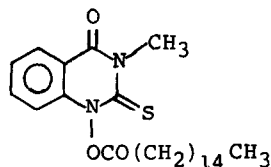
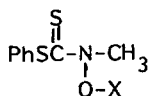
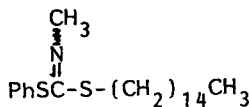
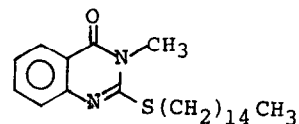
In the case of the thermally induced reaction the situation is not so clear, as although crossover is observed, it is not complete and the ions M/Z 243 and 235 which represent products 7 and 10 predominate. From these observations we conclude that thermally around 20% of the reaction takes place *via* a cage mechanism and the other 80% by a chain process.

In the course of this study we developed a more efficient route to the oxime 11 required for cyclisation to 2. We previously reported<sup>2</sup> that the treatment of phenacyl bromide oxime<sup>4</sup> 13 with potassium-O-ethylxanthate in acetone at room temperature led to a mixture of oximes 11 and 14, presumably *via* the vinylnitroso compound 15.<sup>5</sup> Only one of these oximes underwent cyclisation to 2 on treatment with zinc chloride in ether. We now find that treatment of 13 with potassium ethyl xanthate in acetone at -78°C leads quantitatively to oxime 14.<sup>6</sup> More important was the discovery that the treatment of 13 with pyridine in ether at room temperature leads to the formation of the pyridinium bromide<sup>7,9</sup> 12 in 75% isolated yield. Furthermore, on treatment with potassium ethylxanthate in acetone at room temperature 12 gave the cyclisable oxime 11<sup>6</sup> quantitatively. Thus it is possible to form 11 from 13 *via* 12 in high yield and avoid the formation of the oxime 14 which does not readily cyclise to 2.



We also previously reported<sup>2</sup> that the thiohydroxamic esters 16 and 17 undergo thermally induced rearrangement only on prolonged heating at elevated temperatures. We now find that the stable crystalline ester 18 (stable to reflux in chlorobenzene) of the thiohydroxamic acid 19 is rapidly rearranged in quantitative fashion to the sulphide 20 on irradiation in benzene at room temperature with a 100 W mercury lamp. The crystalline thiohydroxamic acid 19 is readily obtained in excellent yield by treatment of S-phenylchlorodithiocarbonate<sup>8</sup> with N-methylhydroxylamine. Similarly the thermally stable ester 17 was rearranged to 21 in 85% yield on

irradiation with the mercury lamp in benzene at room temperature. These observations suggest that aromatisation is less important as a driving force in the photochemical rearrangements where the light initiates the chain reaction.

161718 X = CO(CH<sub>2</sub>)<sub>14</sub>CH<sub>3</sub>19 X = H2021

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### References

1. D.H.R. Barton, D. Crich and W.B. Motherwell, J. Chem. Soc. Chem. Commun., 939 (1983); *idem*, Tetrahedron, 41, 000 (1985).
2. D.H.R. Barton and G. Kretzschmar, Tetrahedron Lett., 24, 5889 (1983); D.H.R. Barton, D. Crich and G. Kretzschmar, J. Chem. Soc. Perkin Trans I, 000 (1985).
3. J. Baldas and Q.N. Porter, Aust. J. Chem., 32, 2249 (1979).
4. M. Masaki, K. Fukui and M. Ohta, J. Org. Chem., 32, 3564 (1967); P. Blumbergs, C.B. Thanawalla, A.B. Ash, C.N. Lieske and G.M. Steinberg, ibid., 36, 2023 (1971).
5. T.L. Gilchrist, Chem. Soc. Revs, 53 (1983).
6. The configuration of an oxime can be determined by <sup>1</sup>H NMR spectroscopy when both syn and anti forms are available : G.J. Karabatsos and R.A. Taller, Tetrahedron, 24, 3347 (1968). In the case of the oximes of phenacyl bromide the configurations have been confirmed by X-ray analysis. See Ref. 7.
7. A similar result has been observed on treatment of 12 with aqueous morpholine : J.H. Smith, J.H. Heiden, E.T. Kaiser, J.B. Wetherington and J.W. Moncrief, J. Am. Chem. Soc., 94, 9274 (1972).
8. A. Rivier, Bull. Soc. Chim. Fr., 1, 737 (1907); Methoden der Organischen Chemie, Houben and Weyl Eds, Georg Thieme Verlag, Stuttgart, 1955, 9, 808.
9. All new compounds gave satisfactory microanalytical and spectroscopic data.

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