

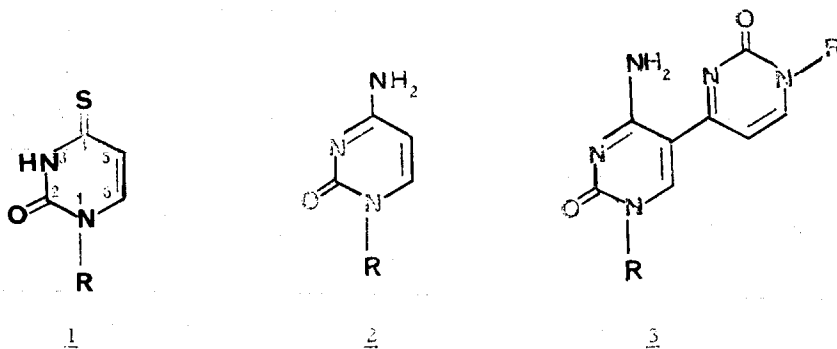
THIOCARBONYL PHOTOCHEMISTRY. II. THE REACTION OF  
4-THIOURACIL DERIVATIVES WITH UNSATURATED NITRILES

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(Received in UK 19 June 1973; accepted for publication 13 July 1973)

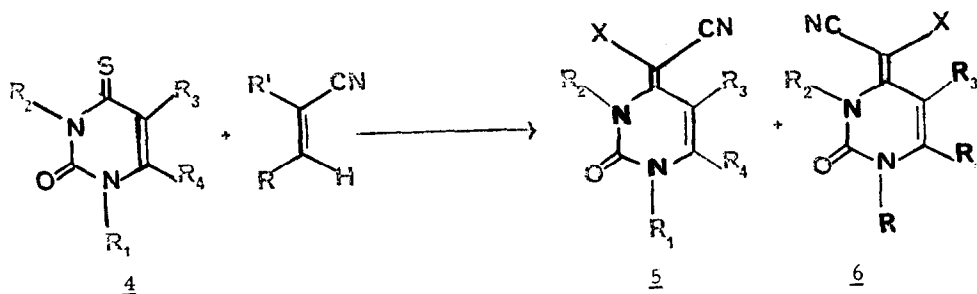
Thio-4-uridine 1, a minor nucleoside of t-RNA (1), has been shown to be involved in a specific and quantitative photoreaction in E. coli t-RNA<sup>Val.</sup><sub>I</sub> (2) resulting in the cross-linking of thio-4-uridine 1 with a cytosine residue 2 to give compound 3 (3,4). It was suggested that the cross-linking arises through the addition of the thiocarbonyl group of thio-4-uridine 1 to the 5,6 double bond of cytosine 2 to produce an unstable thietane intermediate (3). Such a reaction involves thiocarbonyl photochemistry which has so far received little attention and has been practically confined to thiobenzophenone (5, 6).



R = Ribosyl

We report here our preliminary results, related to the above reaction, concerning the photoreaction of thio-4 uracil derivatives with unsaturated nitriles.

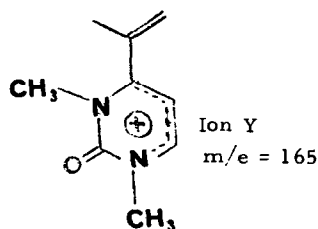
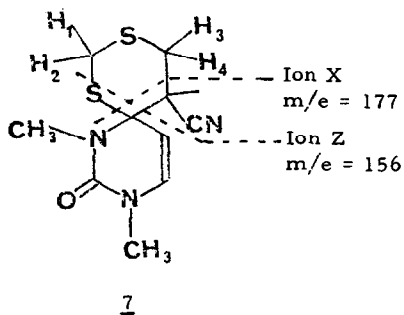
When compounds 4a, 4b and 4c are irradiated (7) in the presence of acrylonitrile, crotonitrile and methacrylonitrile, the photoproducts listed in Table 1 are formed according the following reaction (8) :



- a  $R_1=R_2=CH_3$  ;  $R_3=R_4=H$   
 b  $R_1=R_2=R_3=CH_3$  ;  $R_4=H$   
 c  $R_1=R_2=R_4=CH_3$  ;  $R_3=H$

	Acrylonitrile R=R'=H	Crotonitrile R=CH <sub>3</sub> R'=H	Methacrylonitrile R=H R'=CH <sub>3</sub>	
<u>4a</u>	<u>6</u> X = CH <sub>2</sub> SH 70 % m.p. 114-116	<u>5</u> X = H 60 % m.p. 165-166	<u>6</u> X = CH <sub>3</sub> 60 % m.p. 154-155	<u>7</u> 30 % m.p. 218-219
<u>4b</u>	<u>5</u> + <u>6</u> X = CH <sub>2</sub> SH 80 % of a 1 : 1 mixture	<u>5</u> X = H 60 % m.p. 178-181	(8)	
<u>4c</u>	<u>6</u> X = CH <sub>2</sub> SH 70 % m.p. 122-125	<u>5</u> X = H 60 % m.p. 182-184	<u>6</u> X = CH <sub>3</sub> 45 % m.p. 208-210	

Table 1

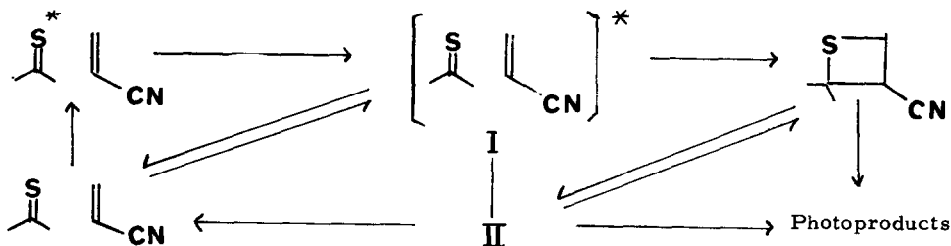


Structural elucidation of the 9 compounds derived from formulas 5 and 6 (Table 1) is based on NMR, mass spectrometry IR and UV data which will be published elsewhere.

Compound 7 ( $C_{11}H_{15}N_3OS_2$ ) is a 1,3-dithiane as shown by NMR, since one group of methylenic protons ( $H_1H_2$ ) appears as a quartet centered at  $\delta_{H_1} = 4.45$  and  $\delta_{H_2} = 3.60$  ppm ( $J = 15$  Hz), while the other methylenic protons appear at  $\delta_{H_3} = 3.35$  and  $\delta_{H_4} = 2.70$  ppm ( $J = 15$  Hz). The splitting ( $J = 3$  Hz) of the signal centered at 3.60 and 2.70 ppm is in agreement with a  $J^4$  coupling constant as shown by a double irradiation experiment. Analysis of the mass spectrum of compound 7 confirms the structural assignment. The three major peaks at  $m/e$  177, 165 and 156 are attributed to ions X, Y, Z respectively.

Interestingly, in contrast to the enone system (uracil) which reacts with olefins to yield cyclobutane derivatives (9, 10, 11)-i.e., enone cycloaddition (12)- the interaction of the corresponding unsaturated thiono compounds with olefins involves the C = S double bond instead of the  $C_5-C_6$  double bond.

At this stage it is hazardous to propose a reasonable mechanism. Tentatively we suggest the following pathway (scheme)



I is an excimer or a charge transfer complex which could collapse directly to a thietane which then yields the photoproducts. Alternatively the thietane could be formed through one (or several) intermediates, (e.g. II). Although thietanes have been characterized as photoproducts of aryl thioketones (5) and adamantane thione (13), it can be envisaged that 4-thiouracil photoproducts could arise directly from II. Elucidation of the above mechanism (nature of II, occurrence of a thietane) and a study of the reactive excited state are in progress (14).

#### Acknowledgement

We are grateful to Dr J. POLONSKY for her encouragement and support throughout this work.

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7. Standard irradiation conditions were the following : a  $5 \cdot 10^{-3}$  M solution of the 4-thiouracil derivative in  $\text{CH}_2\text{Cl}_2$ =unsaturated nitrile (9 : 1) was irradiated under nitrogen in a pyrex apparatus using a Hanau QF 81 lamp.  
All compounds display correct analytical data.
8. In presence of methacrylonitrile, compound 4b reacts according a different pathway to be reported in a forthcoming publication.
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14. This paper is dedicated to Professor E. Lederer on his 65th birthday.