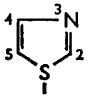
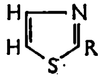
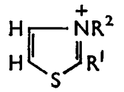
852. *Nuclear Magnetic Resonance Spectra of 2-Substituted Thiazoles and Thiazolium Salts*

By G. M. Clarke and Dudley H. Williams

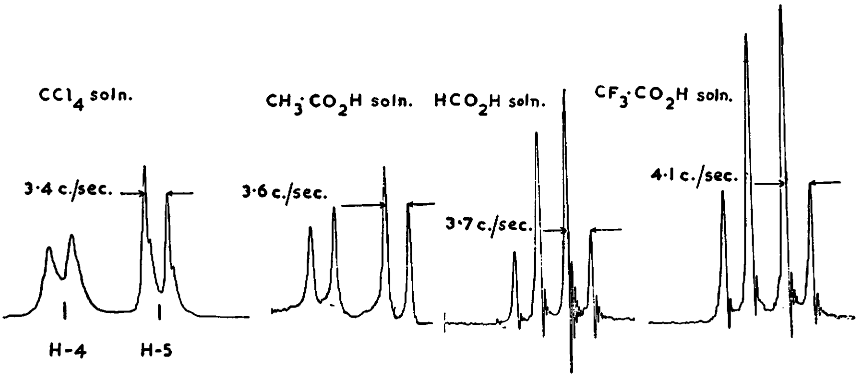
THE only previously reported n.m.r. spectra in the thiazole series are those of thiazole (I), 2-methyl-, 4-methyl-, and 2,4-dimethyl-thiazoles, and related thiazolium ions.[1-3] In the present Note we report results obtained for some 2-substituted thiazoles and thiazolium salts.


(I)


(II: R = Br)
(III: R = NH$_2$)


(IV: R^1 = Br, R^2 = CH$_2$Ph)
(V: R^1 = Br, R^2 = p-NO$_2$·CH$_2$·C$_6$H$_4$)
(VI R^1 = NH$_2$, R^2 = CH$_2$Ph)

In all but one of the cases summarised in the Table it has been possible to assign the A and B doublets of the AB system specifically to H-4 or H-5 since the H-4 resonance is usually broadened more than the H-5 resonance by nitrogen quadrupole relaxation.[1] The broadening of the H-4 resonance decreases as the positive character of the nitrogen atom increases.



Proton resonances in the n.m.r. spectrum of 2-bromothiazole (II)

It will be seen from the Figure that, as the acidity of the solvent is increased, the H-4 resonance becomes sharper; a smaller but significant, sharpening of the H-5 resonance is also evident. In the spectrum of 2-bromothiazole (II) in trifluoroacetic acid and of 2-bromo-3-p-nitrobenzylthiazolium bromide (V) in deuterium oxide, the AB systems are almost symmetrical and so unambiguous assignments in the spectrum of compound (V) are not possible.

The chemical shifts and coupling constants listed in the Table show several interesting trends. As the positive character of the nitrogen atom in 2-bromothiazole is increased, a marked downfield shift of the H-4 resonance is observed (cf. CCl$_4$, CH$_3$·CO$_2$H, H·CO$_2$H, and CF$_3$·CO$_2$H as solvents). Such shifts are expected since it has been shown previously[4]

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[1] A. Taurins and W. G. Schneider, *Canad. J. Chem.*, 1960, **38**, 1237.

[2] B. Bak, J. T. Nielson, J. Rastrup-Andersen, and M. Schottlander, *Spectrochim. Acta*, 1962, **18**, 741.

[3] P. Haake and W. B. Miller, *J. Amer. Chem. Soc.*, 1963, **85**, 4044.

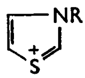
[4] A. R. Katritzky and J. M. Lagowski, *J.*, 1961, 43.

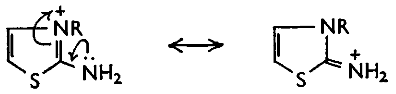
that the α-hydrogens in pyridine are deshielded on protonation of the nitrogen atom. Similar or even larger shifts are observed for the H-5 resonance (see Table). This behaviour is also paralleled by downfield shifts for the β-hydrogen resonances on protonation of the nitrogen in pyridine,[4] although in view of the importance of the resonance structure (VII) in thiazolium salts,[3] electron withdrawal by the positively charged sulphur atom may be directly responsible for the deshielding of H-5. The chemical shifts of H-4 and H-5 in the 2-bromothiazolium salts (IV) and (V) are similar to those in 2-bromothiazole (II) in strong acids (see $CF_3{\cdot}CO_2H$ and H_2SO_4 in the Table).

The downfield shifts for H-4 and H-5 in 2-aminothiazole (III) on passing from neutral to acidic media are much smaller (Table); this is understandable since the positive charge can be partially removed from the immediate vicinity of the 4,5-bond by delocalisation on to the exocyclic nitrogen atom [see (VIII) and (IX)].

Coupling constants and chemical shifts for thiazoles and thiazolium salts

Compound	Solvent	H-4	H-5	$J_{4,5}$ (c./sec.)
(II)	CCl_4	7·59	7·35	3·4
(II)	$CH_3\,CO_2H$	7·73	7·44	3·6
(II)	$H{\cdot}CO_2H$	7·85	7·70	3·7
(II)	$CF_3{\cdot}CO_2H$	8·23	8·16	4·1
(II)	25% Aq. H_2SO_4	8·07	8·07	—
(IV)	D_2O	8·34	8·34	—
(V)	D_2O	8·36 or 8·46	8·46 or 8·36	4·0
(III)	D_2O	7·07	6·68	3·8
(III)	$CH_3{\cdot}CO_2H$	7·28	6·81	4·4
(III)	$H{\cdot}CO_2H$	7·20	6·85	4·5
(III)	$CF_3{\cdot}CO_2H$	7·23	6·87	4·6
(IV)	D_2O	7·24	7·01	4·6


(VII)



(VIII) (IX)

The broadening effect of the nitrogen quadrupole on the H-4 resonance is strong in deuterium oxide but negligible even in acetic acid. This suggests [as do the coupling constants (see below)] that protonation of 2-aminothiazole (III) is almost complete even in acetic acid.

Finally, it should be noted that protonation of the ring nitrogen causes a small increase in $J_{4,5}$ (Table). This is surprising since it has been shown[5,6] that, as the electron-withdrawing power of a group attached to a double bond is increased, the vicinal coupling constant between the olefinic hydrogens decreases.

We thank Dr. P. Sykes for permission to discuss these results, Miss P. Grist and Mr. A. C. Gray for skilful technical assistance in obtaining some of the spectra, and the D.S.I.R. for a maintenance grant (to G. M. C.).

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[*Received, January* 12*th*, 1965.]

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[5] C. N. Banwell and N. Sheppard, *Discuss. Faraday Soc.*, 1962, **34**, 115.
[6] T. Schaefer, *Canad. J. Chem.*, 1962, **40**, 1.