7-Alkylation and 7-Sulphonylation of 5,6-Dihydroimidazolo[2,1-*b*]-thiazoles

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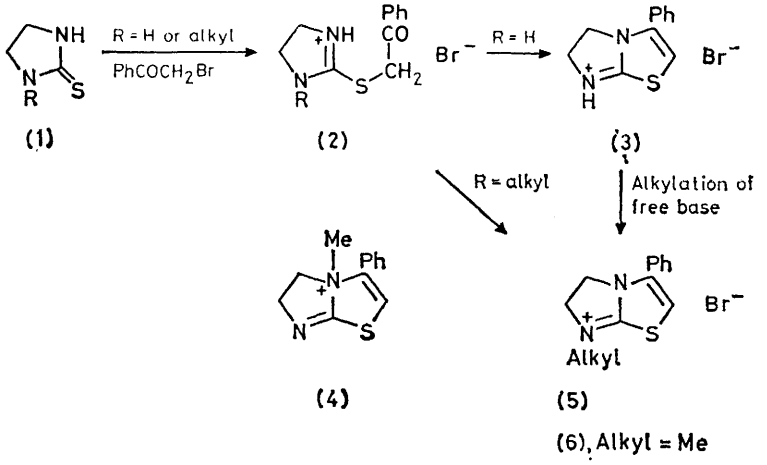
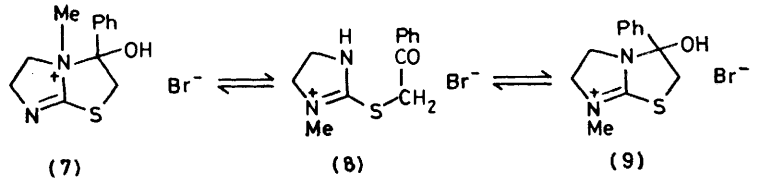
Reinvestigation of the alkylation of 3-phenyl-5,6-dihydroimidazolo[2,1-*b*]thiazole has shown that methylation occurs exclusively at the 7-position, and that the free base is readily solvolysed to a mixture of 1-methylimidazolidin-2-one, 1-methylimidazolidine-2-thione, and diphenacyl sulphide and disulphide. 3-Methyl-5,6-dihydroimidazolo[2,1-*b*]thiazole with methane- and arene-sulphonyl chlorides gave the corresponding 7-sulphonylthiazolium chlorides. On heating, these rearranged to 3-(2-chloroethyl)-4-methyl-3-aryl (or alkyl)sulphonylimido-2,3-dihydrothiazoles. The 7-(4-chlorophenylsulphonyl) derivative lost this substituent with aqueous base while concentrated aqueous ammonia attacked the 7a-position leading to a 3-[2-(*p*-chlorobenzenesulphonamido) ethyl]-2-imino-4-methyl-2,3-dihydrothiazole.

THE discovery of hypoglycaemic and growth promotant activity,[1] and later of acaricidal activity,[2] in a series of substituted 5,6-dihydroimidazolo[2,1-*b*]thiazolium salts (5), and related structures, led us to prepare many compounds of this general type. The imidazo[2,1-*b*]thiazolium hydrobromides (3) or the thiazolium salts (5) can be made from the appropriate substituted thiourea (1) and a suitable halogenoketone, followed by cyclisation. The cyclisation of (2; R = alkyl), and the alkylation of (3) leading to structures of type (5), where the positive charge is stabilised by resonance over both nitrogen atoms, rather than to structures of type (4) where this cannot occur, was assumed and was in agreement with the spectral properties of our products. However because Shadbolt's studies of the tautomerism [3] and of some reactions [4] of 1-methyl-2-phenacylthioimidazoline hydrobromide (8) appeared to cast doubt on this the tautomerism and cyclisation of this bromide were re-examined.[5]



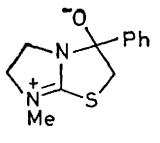
SCHEME 1

The dihydroimidazole (8) hydrobromide was obtained as described [3] and had the reported [3] spectral characteristics (C=O, strong 1 680 cm^{-1} and no OH absorption) which confirm that the predominant tautomer in Nujol has the non-cyclic structure shown. However, in deuteriated methanol there was no singlet in the ^1H n.m.r. spectrum corresponding to the SCH_2 group but a series of broad peaks between τ 5.5 and 6.6 integrating for six protons. There was no absorption around τ 2, expected of protons *ortho* to an aromatic carbonyl group. In this solvent, therefore, only a small amount of (8)



can be present. Conversion of the ketone group by the solvent into an acetal or hemiacetal would almost certainly leave the SCH_2 as a singlet, and so one can conclude that cyclisation to (7) or more likely (9), where these methylene protons would be in different environments, had occurred. In deuteriated dimethyl sulphoxide a singlet was observed at τ 4.60 (SCH_2), and as the ratio of the integral for the phenyl protons to this resonance was 5 : 0.4 it appeared that *ca.* 20% of the solute was present as (8). Fefer and King [6] have suggested that for the hydrobromide of (2; R = H) enolisation of the carbonyl function can occur, but this is excluded for (8) as no deuterium exchange took place in either solvent employed. It is clear that (8) tautomerises, but there is no spectral data from which one can conclude whether (7) and/or (9) is involved.

The free base (10) was obtained from the bromide (8) under non-solvolytic conditions in quantitative yield, and showed singlets in its ^1H n.m.r. spectrum for the methyl and methylene groups. No tautomers could be detected. The compound had m.p. 54—56 °C and decomposed in a few days at room temperature. Shadbolt obtained [4] his 'free base' of m.p. 134—135 °C, which he considered to have structure (17), by treating



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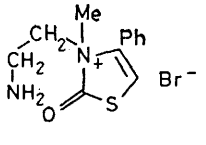
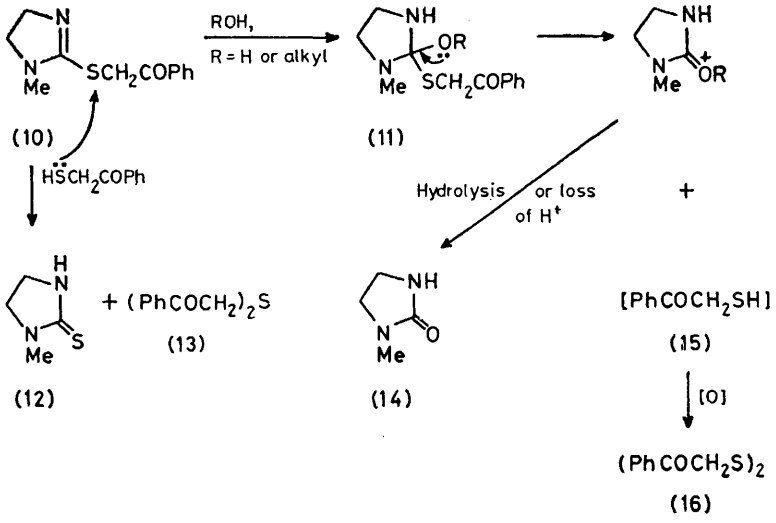


(18)

(7)—(9) with aqueous ammonia and recrystallising the resulting precipitate from ethanol. The initial precipitate prepared in this way did show a simple n.m.r. spectrum corresponding to our free base, but treatment with cold ethanol decomposed this substance to give a mixture of solvolysis products, some involving addition of the ethanol and thereby accounting for the complex n.m.r. spectrum he reported.

On standing in cold anhydrous ethanol for one hour the free base (10) was completely converted into a mixture containing the known (13) and (14) in a 1 : 4 ratio, and other materials giving rise to a multiplet at *ca.* τ 8.8. In some experiments this multiplet took the form of a quartet as observed [4] but in others it was more complex and must be due to incorporation of ethanol.

After refluxing (10) in ethanol the n.m.r. spectrum of the crude product indicated the presence of (14), which was isolable, and the corresponding thione (12), which was not, in a 3.5 : 1 ratio. In a similar way, refluxing (10) with water gave (12), (13), (14), and (16) in a 2.0 : 1.4 : 7.0 : 1.0 ratio and Scheme 2 shows a possible genesis of these compounds through the initial solvolysis product (11).



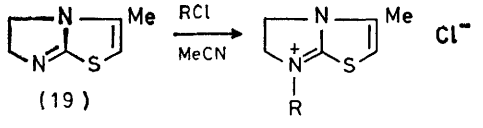
Scheme 2

In earlier work [6,7] on (2; R = H) no attempt was made to recrystallise the free base, but we have now shown that solvolysis occurs in refluxing water and methanol in a similar way to that for (10) but that insignificant quantities of (16) are formed.

Shadbolt reports that his free base, which he formulated as (17) but which must be a mixture, with aqueous hydrogen bromide cyclised to the anhydrous salt (6) which analysed correctly but possessed two NCH_3 resonances tentatively attributed to nitrogen inversion. The pure free base in our hands gave (6) as a hemihydrate possessing the expected n.m.r. spectrum including a single NCH_3 resonance. However there was an additional singlet at τ 5.35 which varied in intensity depending on how the sample had been dried, and even after heating at 90 °C for 8 h at 1 mmHg over phosphorus pentaoxide it corresponded to *ca.* one proton. Addition of deuteriated methanol caused a shift to τ 6.15 and peaks in the i.r. spectrum at 3 400 and 3 330 cm^{-1} coupled with the absence of both a carbonyl

absorption in the infra-red and a third methylene resonance in the n.m.r. spectra confirm our interpretation.

Shadbolt also states that treating (8) with acetic acid or (3) with methyl toluene-4-sulphonate gave (18), formed through the intermediacy of (4) and hydrolytic ring-opening. A product of exactly the same properties as described for (18) was obtained using the acetic acid method, and these properties (m.p., mixed m.p., and all spectra) were identical with those for our hemihydrate (6). Shadbolt assigned the extra peaks in the i.r. and n.m.r. spectra to the presence of an NH_2 group, and not to water of crystallisation, and reported that his compound evolved nitrogen when treated with nitrous acid; in our hands at 0—5 °C no nitrogen was evolved. The n.m.r. spectrum (in CD_3OD) of the product from (3) and methyl toluene-4-sulphonate showed the presence only of the cation corresponding to (6) accompanied by a small amount of that derived from (3); melting (8) also gave (6).



(19)

(20) R = 4-Cl·C_6H_4·SO_2

(21) R = 4-NO_2·C_6H_4·SO_2

(22) R = 4-Me·C_6H_4·SO_2

(23) R = 4-AcNH·C_6H_4·SO_2

(24) R = $MeSO_2$

(25) R = 4-Cl·C_6H_4·CO

Although arylsulphonylammonium salts are considered to be intermediates when amines and alcohols are tosylated with tosyl chloride in the presence of, for example, pyridine, there are only two examples of the isolation of such salts.[8,9] We have now found [10] that 3-methyl-5,6-dihydroimidazolo[2,1-*b*]thiazole (19) reacts with arene- and methane-sulphonyl chlorides, as well as with 4-chlorobenzoyl chloride, in acetonitrile to give a series of crystalline salts (20)—(25).

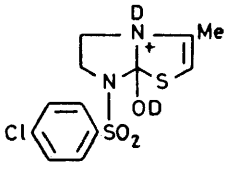
The ^1H n.m.r. spectra for these salts (Table 1) in deuterium oxide were normal, except that for (22) showed two sets of peaks, as did that for (20) when the solution had stood at 37 °C for 5 h. The new set of peaks for (20) showed a general upfield shift compatible with partial conversion into the covalent hydrate (26); (20) was recovered after removal of solvent. The u.v. spectrum for (20) in methanol showed absorption at 233 nm due to the 4-chlorophenylsulphonyl group, but no absorption around 265 nm expected of the chromophore in (19), showing that addition of methanol had taken place to give a species like (26).

TABLE 1

^1H N.m.r. data for the sulphonyl derivatives, measured at 60 MHz for deuterium oxide solutions and recorded in τ (*J* in Hz) using internal sodium trimethylsilylpropanesulphonate as internal standard

Compound	Proton 2-H [a]	Resonances 3-Me [b]	Resonances 5,6-H_4 [c]	Other
(20)	3.20	7.80	5.61	1.80—2.25 [d]
(20) [e]	3.18, 3.80	7.80, 7.92	5.60, 5.70	1.89—2.42
(21)	2.95	7.67	5.35	1.40—1.79 [d]
(22)	3.18, 3.68	7.78, 7.81	5.51, 5.69	2.07—2.82; 7.57; [g] 7.67 [g]
(23)	2.87	7.72	5.30	2.07; [f] 7.62 [g]
(24)	3.50	7.63	5.40	6.48 [g]
(25)	2.76	7.52	5.05	2.09—2.48 [d]

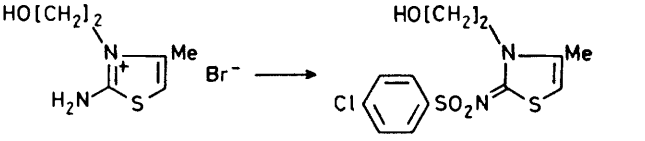
[a] q, *J* 2 Hz. [b] d, *J* 2 Hz. [c] Apparent s. [d] AA'BB' m. [e] After standing at 37 °C for 5 h. [f] br, H_4. [g] s, CH_3.



(26)

Refluxing (20) in acetonitrile, chloroform, or ethanol gave an isomer (29) which was extracted into chloroform from water and which contained no easily ionised chlorine; (24) in chloroform similarly gave (30) but (25) was unchanged even in refluxing diglyme.

The n.m.r. spectrum of (29) was compatible with covalent structures which could be derived from addition of the chlorine anion at position 7a of the ring system or attack at positions 5 or 6 accompanied by ring open-



(27) (28)

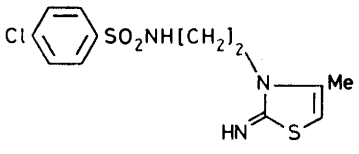
(29) R = 4-Cl·C_6H_4

(30) R = Me

ing. Addition of tris-[3-(2,2,2-trifluoro-1-hydroxyethylidene)-(+)-camphorato]europium(III),[11] a chiral shift reagent, changed the spectrum indicating that complexation had taken place, but no peak-doubling was observed which might have been the case had the chlorine anion added at position 7a. The rearrangement product (29) was now synthesised from 2-amino-4-methylthiazole showing that nucleophilic attack had in fact taken place at position 6. Treatment with 2-bromoethanol gave presumably (27); 2-aminothiazole alkylates at the ring nitrogen and only in the presence of lithium amide can exocyclic alkylation be effected.[12] Treatment with 4-chlorobenzenesulphonyl chloride in triethylamine now gave the thiazoline (28), which with thionyl chloride in pyridine yielded the rearrangement product (29).

In the i.r. spectra of the tertiary sulphonamides (29) and (30) absorption maxima at 1 150—1 160 and 1 340—1 345 cm^{-1} may be attributed to the $-SO_2N=$ system. In the quaternary salts (20) and (24) the corresponding bands have moved *ca.* 15 cm^{-1} to higher frequencies which may be associated with the presence of the positive charge.

Although the salt (20) rearranged to (29) on refluxing in dry ethanol, it was rather stable to hydrolysis being



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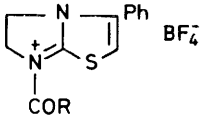
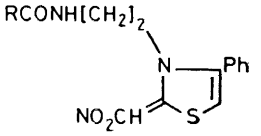


(32) R = Me

(33) R = OMe



(34)

recovered unchanged after standing in ethanol or water for 12 h. However treatment with 0.1M-aqueous sodium carbonate at 20 °C gave 88% of (19) and 12% of (28) showing that anionic attack takes place mainly at the sulphonyl group under these conditions. No trace of 4-chlorobenzenesulphonamide could however be detected after (20) had been mixed with concentrated aqueous ammonia. The product was identified as (31), nucleophilic attack having taken place at position 7a as in the case of hydration to (26), followed by ring opening. The i.r. and ^1H n.m.r. spectra for (31) did not differentiate between the possible isomers, but the u.v. spectrum showed bands at 233 and 265 nm which are very similar to those of the isolated 4-chlorobenzenesulphonyl (233 nm) and 2-amino- or 2-imino-4-methylthiazoline (262 nm) chromophores and are different from the spectra of (28) and (29). The mass spectra of (31) however showed in part a strong similarity to the fragmentation of (28) and (29), as the different substituents at position 3 are split off in all cases.

Nucleophilic attack has therefore been observed for (20) at the sulphonyl group, at positions 6 and 7a, but not at position 5. These results are similar to those of Kohn and Davis[13] for the acyl derivatives (32) and (33) which are deacylated by methoxide ion to 3-phenyl-5,6-dihydroimidazolo[2,1-*b*]thiazole and are attacked at position 7a by the anion derived from nitromethane to give (34).

EXPERIMENTAL

Instruments and general procedures have been described.[14] U.v. spectra are for solutions in methanol, n.m.r. spectra were recorded at 60 MHz for solutions in chloroform using tetramethylsilane as internal standard unless otherwise stated; sodium trimethylsilylpropanesulphonate was used as standard for the deuterium oxide solutions. Light petroleum was b.p. 40—60 °C unless otherwise stated.

1-*Methyl*-2-*phenacylthioimidazoline* (10).—(i) The bromide (8) (1.0 g), m.p. 168—169 °C (from MeOH–Et_2O) [$\tau(CD_3)_2SO$ 1.80—2.20 (m, ArH_2), 2.25—2.65 (m, ArH_3), 4.60 (s, SCH_2, 0.4 H), 5.50—6.70 (m, SCH_2 + NCH_2, 5.6 H), and 6.85 and 6.90 (s, CH_3), $\tau(CD_3OD)$ 2.10—2.65 (m, ArH_5), 5.40—6.40 (m, SCH_2 + NCH_2, 6 H) and 6.80 (s, CH_3)] [lit.,[4] m.p. for unpurified (8) 158—159 °C] suspended in chloroform (50 ml) was stirred with anhydrous sodium carbonate (2.0 g) and anhydrous magnesium sulphate (2.0 g) for 1 h at 18 °C. After filtration the solvent was removed *in vacuo* at 18 °C to give the free *base* (10) (0.74 g) which decomposed rapidly on standing. After rapid crystallisation from light petroleum it (0.2 g) had m.p. 54—56 °C (Found: C, 61.4; H, 6.0; N, 11.8. $C_{12}H_{14}N_2OS$ requires C, 61.6; H, 6.0; N, 12.0%) and was relatively stable but turned brown after a few days; τ 1.95—2.15 (m, 2′- and 6′-H), 2.40—2.80 (m, ArH_3), 5.35 (s, CH_2), 6.10—6.90 (m, $[CH_2]_2$), and 7.20 (s, CH_3).

(ii) The bromide (1.0 g) in water (20 ml) was basified with aqueous ammonia. The precipitate was collected, washed well with water, and dissolved in chloroform, and the product (10) (0.3 g, m.p. 50—52 °C) isolated as in (i).

Solvolysis of 2-*Phenacylthioimidazoline*.—(i) The hydrobromide (2; R = H) (2.0 g) [m.p. 248—249 °C (lit.,[6] 248—249 °C)] was converted into the free base [m.p. 140—143 °C (lit.[6] 143—144 °C)] as for (8) and refluxed with water (50 ml) for 1 h. Work-up gave (13) (0.08 g), m.p. 77—78 °C, and the ^1H n.m.r. spectrum of the residual material showed the presence of (12) and (14) only.

(ii) Solvolysis in refluxing methanol (1 h) followed by distillation gave imidazolin-2-one, b.p. 80—100 °C at 0.05 mmHg, m.p. 128—130 °C (from acetone) (lit.,[15] 131—132°).

Experiments with the Free Base (10).—Freshly prepared (10) of m.p. *ca.* 54 °C was employed.

(i) The base (1.0 g) was refluxed with water (25 ml) for 1 h and the solvent removed *in vacuo*. Light petroleum extracted a trace of 1-methylimidazolin-2-one, and recrystallisation of the insoluble material from ethanol gave diphenacyl sulphide (13), m.p. 76—78 °C (lit.,[16] 76—77 °C) [τ 2.0—2.2 and 2.4—2.9 (m, ArH_{10}) and 6.10 (s, 2 × CH_2); $\nu_{max.}$ (film) 1 685 cm^{-1}; *m/e* 270 (M^+, 2%), 237 (12), 165 (19), 116 (83), 105 (100), *m** 208.0 (270 → 237)] as the less soluble fraction, and diphenacyl disulphide m.p. 67—69° [τ 2.20—2.25 and 2.45—2.85 (m, ArH_{10}), and 5.90 (s,

2 × CH_2); $\nu_{max.}$ 1 670 and 1 660 cm^{-1}; *m/e* 302 (M^+, 6%, 152 (20), 106 (10), and 105 (100), *m** 76.5 (302 ⟶ 152)], as the more soluble material. This compound, prepared as described,[16] had m.p. (and mixed m.p. with the previous specimen) 69—70 °C (from ethanol), and 79—80 °C (lit.,[16] 79—81 °C) (from CH_2Cl_2–Et_2O). The filtrate from this was evaporated and the residue sublimed at 100 °C and 14 mmHg to give more 1-methylimidazolin-2-one, m.p. 110—112 °C (lit.,[17] 116—116.5°), identical to an authentic specimen [τ 4.25br (s, NH), 6.65 (s, 2 × CH_2), and 7.25 (s, CH_3); $\nu_{max.}$ 3 250, 1 690, and 1 510 cm^{-1}]. The ^1H n.m.r. spectrum of the residue showed peaks corresponding to authentic 1-methylimidazoline-2-thione, τ 3.40 (s, N*H*), 6.20—6.60 (apparent quintet, 2 × C*H*$_2$), and 6.95, (s, CH_3), prepared as and with the properties reported in ref. 18.

(ii) The base (10) was left in cold ethanol, or refluxing ethanol (or methanol which behaved similarly) for 1 h, the solvent removed, and the residue worked up as in (i).

7-Methyl-3-phenyl-5,6-dihydroimidazo[2,1-b][1,3]*thiazolium Salts*.—(i) The base (10) (1.0 g) was treated successively with 48% aqueous hydrogen bromide (0.8 ml) and dry ether (100 ml). The precipitated oil recrystallised from methanol–ether to give, after drying at 90 °C (P_2O_5 at 1 mmHg), the bromide (6) as the hemihydrate (0.8 g), m.p. 182—184 °C (lit.,[4] 186—189 °C), τ(CD_3OD) 2.30—2.65 (m, ArH_5), 3.10 (s, 2-H), 5.40, (s, 1/2 H_2O), 5.40—5.70 (m, 2 × C*H*$_2$), and 6.80 (s, CH_3); $\nu_{max.}$ 3 400, 3 330, 1 615, 1 585, 1 550, 1 490, and 1 425 cm^{-1}; $\lambda_{max.}$ 278 nm (ε 13 200).

(ii) The bromide (8) (1.0 g) was refluxed with glacial acetic acid (10 ml) for 8 h, the solvent removed *in vacuo*, and the residue worked up as in (i) to give a product (0.6 g) identical to (6).

(iii) The bromide (8) was warmed slowly until completely molten, cooled, and worked up as in (1) to give (6) (0.9 g).

(iv) The bromide (3) (0.5 g), was converted into the free base, τ 2.65 (s, ArH_5), 4.40 (s, 2-H), and 5.80 and 6.20 (both apparent t, each CH_2, *J* 7 Hz), m.p. 110—112 °C (lit.[7] 112—113 °C), which was refluxed with methyl toluene-*p*-sulphonate (0.5 g) in methanol (25 ml) for 3 h. Ether now precipitated a mixture of the toluene-*p*-sulphonates derived from the cations of (6) and (3) in a 1 : 2 ratio, identified from their n.m.r. spectra (CD_3OD), no additional resonances being observed.

The 7-{4-Substituted phenylsulphonyl and (4-chlorobenzoyl)]}-3-methyl-5,6-dihydroimidazolo[2,1-b]*thiazolium Chlorides* (20)—(25).—3-Methyl-5,6-dihydroimidazolo[2,1-*b*]thiazole hydrochloride was prepared in 85% yield as described [19] and the free base obtained by stirring with aqueous sodium carbonate (1 equiv.), extracting with chloroform, and drying and evaporating the extract. The base (19) (1.0 g) was stirred with the appropriate sulphonyl or benzoyl chloride (1 equiv.) in acetonitrile (50 ml) for 3 h at room temperature when the precipitate of the *chloride* was washed with ether, and dried (Table 2).

Rearrangement of 7-(4-Chlorophenylsulphonyl)-3-methyl-5,6-dihydroimidazolo[2,1-b]*thiazolium Chloride* (20).—The chloride (20) (2.0 g), $\lambda_{max.}$ 233 nm (ε 13 400), was refluxed in acetonitrile (50 ml) for 12 h, the solvent evaporated off, and the residue recrystallised from acetonitrile–ether to give 2-(*4-chlorobenzenesulphonimido*)-3-(*2-chloroethyl*)-4-*methylthiazoline* (29) (1.8 g) as plates, m.p. 141—142 °C (Found: C, 40.8; H, 3.4; N, 8.0. $C_{12}H_{12}Cl_2N_2O_2S_2$ requires C, 41.0; H, 3.4; N, 8.0%), $\lambda_{max.}$ 227.5 (ε 15 000) and 292 nm (13 400); *m/e* (^{35}Cl only) 350 (M^+, 14%), 288 (11), 224 (23), 175 (12), 139 (23), 116 (60), and 111 (24), *m** 174.2 (228 ⟶ 224); τ 2.06—2.60 (AA'BB', ArH_4) 3.82 (q, *J* 2 Hz, 5-H), 5.64—6.44 (A_2B_2, 3-[CH_2]$_2$), and 7.72 (d, *J* 2 Hz, 4-CH_3).

TABLE 2

Analytical data

Compound	Yield (%)	M.p. /°C	Found (%) C	H	N	Formula	Required (%) C	H	N
(20)	77	140—142	41.0	3.6	8.3	$C_{12}H_{12}Cl_2N_2O_2S_2$	41.0	3.4	8.0
(21)	76	191—192	40.1	3.4	11.5	$C_{12}H_{12}ClN_3O_4S_2$	39.9	3.3	11.6
(22)	80	148—150	47.4	4.8	8.5	$C_{13}H_{15}ClN_2O_2S_2$	47.2	4.5	8.5
(23) [a]	80	151—152	46.3	4.6	13.5	$C_{14}H_{15}ClN_3O_3S_2$	46.1	4.6	13.1
(24) [b]		160—161	31.6	5.0	10.3	$C_7H_{11}ClN_2O_2S_2 \cdot \frac{1}{2}H_2O$	31.9	4.6	10.6
(25) [c]	69	235—237	49.5	3.9	8.8	$C_{13}H_{12}Cl_2N_2OS$	49.7	3.8	8.9

[a] CH_3CN of crystallisation. [b] Recrystallised from MeCN, hemihydrate. [c] Reaction left for 18 h; recrystallised from MeCN.

Synthesis of the Chloroethylthiazoline (29).—2-Amino-4-methylthiazole [20] (18.2 g) [τ (hydrochloride in D_2O) 3.59 (q, *J* 2 Hz, 5-H) and 7.75 (d, *J* 2 Hz, 4-CH_3)] in acetonitrile (100 ml) was refluxed with 2-bromoethanol (20 g) for 12 h. Cooling and addition of ether precipitated the *2-amino-3-(2-hydroxyethyl)-4-methyl-1,3-thiazol-3-ylium bromide* (27), crystals (30.5 g) (from EtOH), m.p. 150—151 °C (Found: C, 29.9; H, 4.7; N, 11.7. $C_6H_{11}BrN_2OS$ requires C, 30.1; H, 4.6; N, 11.7%), $\lambda_{max.}$ 264 nm (ε 6 300) and (after addition of MeONa) 267 nm (ε 7 000); τ(D_2O) 3.37 (q, *J* 2 Hz, 5-H), 5.64—6.22 (A_2B_2, 3-[CH_2]$_2$), and 7.68 (d, *J* 2 Hz, 4-CH_3).

The above bromide (27) (20.4 g) in ethanol (250 ml) was stirred with triethylamine (15 g) and 4-chlorobenzenesulphonyl chloride (19.2 g) at room temperature for 30 min. The solvent was evaporated off, aqueous sodium carbonate added, and the chloroform-soluble part of the mixture chromatographed on alumina. Elution with chloroform yielded the *thiazoline* (28) as crystals (14.3 g), m.p. 124—126 °C [from $CHCl_3$–light petroleum (b.p. 60—80 °C)] (Found: C, 43.8; H, 4.0; N, 8.3. $C_{12}H_{13}ClN_2O_3S_2$ requires C, 43.8; H, 4.0; N, 8.3%), $\lambda_{max.}$ 228 (ε 14 900) and 292 nm (10 800); *m/e* (^{35}Cl only) 332 (M^+, 15%), 288 (61), 224 (26), 175 (9), 139 (7), 113 (100), 111 (32), and 100 (12); τ 2.03—2.65 (AA'BB', ArH_4), 3.85 (q, *J* 2 Hz, 5-H), 5.77—6.33 (m, 3-[CH_2]$_2$), 6.9 (t, OH), and 7.77 (d, *J* 2 Hz, 4-CH_3).

The alcohol (28) (3.3 g) in dry pyridine (10 ml) was stirred with redistilled thionyl chloride (1.5 g) at 0 °C for 2 h and poured into 2M-aqueous hydrochloric acid. Extraction with chloroform followed by chromatography on alumina and elution with chloroform yielded first the chloride (29) as crystals (0.5 g) m.p. and mixed m.p. 140—142 °C [from $CHCl_3$–light petroleum (b.p. 60—80 °C)],

then a material (0.75 g) which could not be characterised (a chlorosulphite?) but on refluxing with chloroform gave more (29), and finally unchanged (28) (1.0 g).

3-(2-*Chloroethyl*)-2-*methanesulphonimido*-4-*methylthiazoline* (30).—The chloride (24) (2.0 g) was refluxed in acetone (50 ml) for 12 h. Evaporation yielded the *thiazoline* (30) as micro-plates m.p. 141—142 °C (from CH_3Cl–EtOH) (Found: C, 33.2; H, 4.4; N, 11.0. $C_7H_{11}ClN_2O_2S_2$ requires C, 33.0; H, 4.3; N, 11.0%); $\lambda_{max.}$ 278 nm (ε 9 400); *m/e* (^{35}Cl only) 254 (M^+, 29%), 219 (9), 192 (81), 139 (43), and 113 (100), *m** 145.2 (254 ⟶ 192); τ 3.84 (q, *J* 2 Hz, 5-H) 5.65—6.30 (A_2B_2, 3-$[CH_2]_2$), 7.04 (s, SO_2CH_3), and 7.68 (d, *J* 2 Hz, 4-CH_3).

3-[2-(4-*Chlorobenzenesulphonamido*)*ethyl*]-2-*imino*-4-*methyl*-2,3-*dihydrothiazole* (31).—The chloride (20) (3.2 g) in water (10 ml) was treated with aqueous ammonia (*d* 0.88; 20 ml). Extraction with chloroform gave the *thiazole* (31) as crystals m.p. 112—113 °C (from $CHCl_3$) (Found: C, 42.4; H, 4.4; N, 12.3. $C_{12}H_{14}ClN_3O_2S_2.1/2H_2O$ requires C, 42.8; H, 3.8; N, 12.1%) $\lambda_{max.}$ 233 (ε 14 200) and 265 nm (5 600); *m/e* (^{35}Cl only) 331 (M^+, 13%), 259 (8), 175 (13), 156 (100), 139 (48), 128 (66), 114 (66), 111 (55), and 100 (27); τ 2.12—2.64 (AA'BB', ArH_4), 3.74br (2H), 4.62 (q, *J* 2 Hz, 5-H), 6.12—6.96 (A_2B_2, 3-$[CH_2]_2$), and 7.99 (d, *J* 2 Hz, 4-CH_3).

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