713. *Pyrimidines. Part III.* The Ultra-violet Absorption Spectra of Some Polysubstituted Pyrimidines.*

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Measurements of the ultra-violet absorption spectra of polysubstituted pyrimidines containing not more than one potentially tautomeric group are reported and discussed. The results indicate that the position of the absorption maxima for these compounds can be predicted approximately by adding the bathochromic shifts of the individual substituents to the appropriate wave-length maximum in the spectrum of pyrimidine itself. The same appears to be true for the molecular extinction coefficients. Both relations hold for ethanolic as well as aqueous solutions.

The so-called "dithiourimido-acetylacetone" has been shown to be a simple 1 : 1 molecular complex of thiourea with 2-mercapto-4 : 6-dimethylpyrimidine. Two similar complexes are described.

The ultra-violet light absorption of pyrimidines containing two or more potentially tautomeric groups has been fairly widely studied. Until recently, however, there has been little work reported on pyrimidines containing a single functional group. In order to gain further information about the structure of potentially tautomeric pyrimidines in aqueous solution, Marshall and Walker (*J.*, 1951, 1004) investigated the absorption spectra of a considerable number of these compounds and a representative list of references to the earlier literature is published in their paper. In Part II * the absorption spectra of monosubstituted pyrimidines were reported. The present paper describes our results with polysubstituted pyrimidines which contain not more than one potentially tautomeric group (*e.g.*, OH, SH, NH_2). The measurements were carried out in buffer solutions following the procedure of Part II; non-tautomeric pyrimidines were also examined in ethanol solution. In general, the light-absorption curves for the types of compounds we have measured resemble those for the related monosubstituted compounds and are not illustrated graphically.

Consideration of the results obtained in Part II in conjunction with published data on polysubstituted pyrimidines indicated that, in compounds containing not more than one potentially tautomeric group, the effect of the individual substituents on both the wave-length of maximum absorption and the extinction coefficient was approximately additive for the middle band of the spectrum (see below). This has been confirmed and extended by a study of all suitable pyrimidines available and the results are set out in Tables 1 and 2. In both Tables, the compounds are arranged in the order of increasing $\lambda_{max.}$. The bands whose maxima are italicised are considered to be the displaced middle band of the pyrimidine spectrum (243 mμ in aqueous solution and 244 mμ in ethanolic solution) (cf. Part II). The column headed $\Delta\lambda$ in the Tables gives the difference between the observed and the calculated wave-length of maximum extinction for the compound under consideration. The calculated wave-length is obtained by adding the sum of the shifts

* Part II, preceding paper.

TABLE 1. *Measurements in aqueous solution. (Values for the middle wave-band are in italics.)*

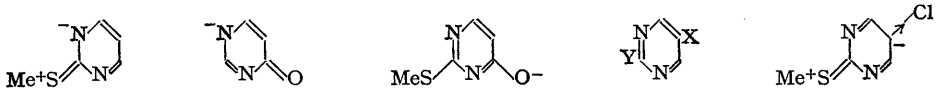
No.	Position of substituent 2	4	6	5	pH	$\lambda_{max.}$ (mμ)	Δλ	$10^{-3}\varepsilon$ (obs.)	$10^{-3}\varepsilon$ (calc.)
1	—	Me	Me	—	0·0	208·5, 247	—	1·9, 4·4	—
					6·98	*246* [1]	10	*4·3*	4·4
2	MeS	Me	—	—	7·0	210, *250* [2]	−10	4·0, *13·8*	14·2
3	MeS	Me	Me	—	5·6	*250* [3]	−20	*12·9*	15·2
4	Me	Me	Me	—	10·2	*251*, 292 [3]	10	*4·2*, 1·4	4·9
5	Ph	Me	Me	—	5·6	*251* [3]	−20	*16·6*	17·0
6	Ph	Me	—	—	—	*252* [6]	0	*22·9*	16·0
7	—	Cl	Cl	—	6·98	*254*	10	*4·6*	4·1
8	Cl	Me	Me	—	5·6	*254·5* [3]	0	*4·7*	4·7
9	Me	Cl	Cl	—	6·98	*257·5*	−5	*6·6*	4·6
10	Cl	Cl	—	—	H_2O	*258* [4]	5	*4·7*	3·5
11	Cl	Cl	Me	—	H_2O	*258* [4]	−5	*5·4*	4·5
12	MeS	—	—	Br	H_2O	218·5, *260·5*	−75	3·3, *21·9*	13·7
13	—	O⁻	Me	—	13	230, *261* [5]	−45	10·7, *3·8*	4·6
14	Cl	Cl	Cl	—	—	*263* [10]	5	*4·8*	4·4
15	MeO	O⁻	Me	—	13	222, *263* [2]	−235	6·8, *7·4*	7·0
16	MeO	Me	—	—	7·0	*264* [2]	−10	*5·4*	5·8
17	MeO	Me	Me	—	10·2	*264* [3]	−20	*6·6*	6·8
18	—	NH_2	Me	—	13	234, *264* [2]	−50	8·9, *2·8*	4·5
19	Me	NH_2	Me	—	—	235, *265* [7]	−90	10·8, *4·4*	5·0
20	Me	—	—	Br	6·98	219, *267*	10	12·3, *3·0*	5·0
21	S⁻	Me	—	—	11	*269* [2]	−20	*17·4*	18·0
22	S⁻	Me	Me	—	0·0	223·5, 284	—	13·2, 36·3	—
						356	—	2·6	—
					6·98	217·5, 276	—	12·6, 24·0	—
						332	—	4·7	—
					13	*269* [8]	−30	*19·1*	19·0
23	Cl	—	—	Cl	6·98	219, *272*	45	17·0, *3·2*	2·7
24	Me	NH_2	—	—	—	231, *272* [7]	−10	10·0, *4·0*	4·0
25	Cl	NH_2	—	—	7·0	232, *272* [9]	−55	8·5, *5·0*	3·8
26	MeS	O⁻	Me	—	13	247, *274*	15	8·5, *6·8*	15·4
27	Ph	O⁻	Me	—	13	231, *277*	35	19·9, *7·4*	17·3
28	Cl	Cl	Cl	Cl	—	232, *278* [11]	5	8·2, *5·2*	4·3
29	S⁻	—	—	Cl	13	227, *279*	−60	8·7, *23·4*	17·0
30	Ph	O⁻	Cl	—	13	233, *280*	25	21·9, *8·7*	17·1
31	MeS	NH_2	CH_3	—	0·0	241	—	28·2	—
					6·98	225, 248	—	21·9, 12·0	—
						280	40	*7·4*	15·3
32	MeS	NH_2	—	—	0·0	241	—	33·1	—
					6·98	224, *285*	100	19·5, *5·8*	14·3
33	MeS	O⁻	Me	Br	13	254, *286*	−45	8·7, *7·4*	15·9
34	NH_2	Me	Me	—	5·6	226, *287* [3]	−70	10·7, *4·6*	5·2
35	NH_2	Me		—	13	225, *289* [2]	−40	12·3, *4·0*	4·3
36	O⁻	Me	Me	—	12·9	223, *289* [3]	−30	7·2, *5·0*	6·6
37	O⁻	Me	—	—	13	220, *290* [2]	−10	11·5, *5·8*	5·6
38	NH_2	Cl	Me	—	0·0	211·5, 302·5	—	18·6, 6·5	—
					6·98	230, *292*	−60	12·9, *5·1*	5·1
39	—	S⁻	Me	—	11·0	*292* [2]	0	*15·9*	12·0
40	—	Me	—	NH_2	13	234, *293* [2]	−60	8·1, *3·5*	4·1
41	NH_2	Cl	—	—	7	229, *296* [9]	−10	13·9, *4·2*	4·1
42	NH_2	Cl	Cl	—	—	233, *298·5* [12]	−35	15·4, *5·9*	5·0
43	NH_2	Me	Me	Br	H_2O	235·5, *301*	−110	19·1, *5·4*	5·7
44	NH_2	—	—	Cl	0·0	233, 325	—	19·5, 3·6	—
					H_2O	235, *311*	40	23·4, *3·7*	3·3
45	O⁻	—	—	Cl	13	230, *311*	60	18·2, *4·9*	4·6
46	NH_2	—	—	Br	0·0	235, 326	—	21·9, 3·9	—
					6·98	237, *311·5*	15	19·5, *2·9*	3·7
47	O⁻	—	—	Br	13	229, *312*	40	18·6, *4·3*	5·0
48	Cl	Cl	—	NH_2	H_2O	250, *316* [13]	35	15·1, *4·1*	4·2

[1] Basic $pK_a = 2·7$. Andrisano and Modena (*Gazzetta*, 1951, **81**, 405) report 246, 5·6; 246, 3·5, at pH 1·03 and 5·6 respectively. [2] Marshall and Walker, *J.*, 1951, 1004. [3] Andrisano and Modena (*loc. cit.*). [4] Heyroth and Loofbourow, *J. Amer. Chem. Soc.*, 1934, **56**, 1728. [5] Williams, Ruehle, and Finkelstein, *ibid.*, 1937, **59**, 526. [6] Measured in 5% ethanol. [7] Williams, Ruehle, and Finkelstein (*loc. cit.*); measured in 0·005M-NaOH. [8] Basic $pK_a = 2·8$, acidic $pK_a = 8·5$. Andrisano and Modena (*loc. cit.*) report 269, 16·6 for the anion. [9] Stimson, *ibid.*, 1949, **71**, 1470. [10] Uber and Winters, *ibid.*, 1941, **63**, 137; measured in 4% methanol. [11] Uber and Winters (*loc. cit.*); measured in 33% methanol and 67% water. [12] Measured in 5% ethanol. [13] Whittaker, *J.*, 1951, 1565.

of the individual substituents (given in Table 2, Part II) present in the compound to the wave-length of maximum extinction in the middle band of the pyrimidine spectrum. The extinction coefficients were calculated in the same way and are recorded in the column headed ε(calc.).

It may be seen that, for the majority of compounds, the agreement between the observed and calculated values, both for the wave-length of maximum extinction and for the extinction coefficient, is reasonably good. (This is true for ethanolic as well as aqueous solutions.) There are, however, certain exceptions which merit further discussion. Methyl or chloro-groups in the 4- or 6-position appear to prevent another different substituent in the 2- or 4-position from exerting its full bathochromic effect, with the result that $\Delta\lambda$ has a fairly large negative value. This phenomenon is well shown by compounds 3, 5, 13, 17, 18, 19, 21, 22, 34, 35, 36, 38, and 42 in Table 1 and compounds 34, 38, and 42 in Table 2. In these compounds, however, there is fair agreement between the calculated and the observed extinction coefficients.

In compounds where the 2-position is occupied by a phenyl or a methylthio-group, and the 4-substituent is an amino- or hydroxy-group, the observed extinction coefficient is very much less than the calculated value (compounds 26, 27, 30, 31, 32, and 33). In these compounds, $\Delta\lambda$ is usually large and positive. Both 2-methylthio- and 2-phenyl-pyrimidine show very high extinction coefficients (10,800 and 12,600 respectively) and presumably therefore there is a high degree of electronic transition as shown in (I) (one canonical form only is shown). Similar conjugation could also occur with 4-aminopyrimidines or anions of 4-hydroxypyrimidines (II) (although probably to a smaller extent, as judged from their lower extinction coefficients—1130 and 1230 respectively). When groups of this type occupy the 2- and the 4-position in one compound (*e.g.*, as in III), they form a " crossed " conjugated system (cf. Braude, *Ann. Reports*, 1945, **42**, 125) which may account for the low observed extinction coefficient. It is interesting that the same effect is not observed when the 2-substituent is methoxyl [*e.g.*, compound 15], which shows a low individual extinction coefficient (2390). Similar effects have been observed by Russell and Whittaker (forthcoming publication) in 5-phenylpyrimidines where substitution by an amino-group in the 2-position leads to increased conjugation between the rings, but an additional 4-amino-group lessens the intensity of absorption. These authors also found that substitution of an amino-group or similar substituent into the 2- or the 4-position of a 6-phenylpyrimidine apparently completely destroyed the conjugation between the rings.



(I) (II) (III) (IV) (V)

In compounds of the type (IV; X = Cl or Br), when Y = $-S^-$ or SMe, it is found that the observed value of the extinction coefficient is considerably higher than the calculated value (compounds 12 and 29 in Table 1). When Y = Me, Cl, NH_2, or O^-, the observed and the calculated values of the extinction coefficient are in good agreement (compounds 20, 23, 44, 45, 46, and 47 in Table 1). Here again, the individual groups S^- and SMe show high extinction coefficients and hence presumably conjugate fairly extensively with the pyrimidine ring. The presence of a strongly electronegative 5-substituent probably enhances this conjugation, as in (V), leading to the high observed extinction coefficient. The individual groups Me, Cl, NH_2, and O^- show little conjugation with the pyrimidine ring and this is apparently not appreciably increased by the presence of an electronegative 5-substituent. The latter compounds show positive $\Delta\lambda$ values of varying magnitude, whereas when Y = S^- or SMe, the values of $\Delta\lambda$ are fairly large and negative.

Both 5-bromo-4-hydroxy-6-methyl-2-methylthiopyrimidine (33 in Table 1) and 2-amino-5-bromo-4 : 6-dimethylpyrimidine (43 in Table 1) have negative values of $\Delta\lambda$ of considerably greater magnitude than those of the corresponding compounds without the bromine in the 5-position (26 and 34 in Table 1). This may be due to a certain amount of

steric interaction between the neighbouring groups in the 4- and the 6-positions and the 5-bromine atom, which would prevent the bromine from exerting its full bathochromic effect. A similar effect has been observed by Maggiolo and Russell (*J.*, 1951, 3297) with 4- and 6-substituted 5-phenylpyrimidines (compounds 50 and 51, Table 2).

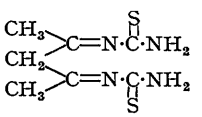
TABLE 2. *Measurements in ethanol.* (*Values for the middle wave-band are in italics.*)

No.	Position of substituent 2	4	6	5	$\lambda_{max.}$ (mμ)	Δλ	$10^{-3}\varepsilon$ (obs.)	$10^{-3}\varepsilon$ (calc.)
1	—	Me	Me	—	*245·5*	−5	*2·0*	2·74
50	—	Cl	—	Ph	*252* [1]	−80	*9·0*	12·9
7	—	Cl	Cl	—	*253*	10	*1·87*	4·08
51	Me	Cl	Cl	Ph	*253* [1]	−160	*6·4*	14·2
8	Cl	Me	Me	—	*254*	0	*3·85*	1·89
9	Me	Cl	Cl	—	*256*	−10	*5·9*	4·5
6	Ph	Me	—	—	*257*	−10	*23·4*	19·17
52	Ph	Me	Me	—	*258* [1]	−10	*20·2*	19·3
12	MeS	—	—	Br	218, *262*	−60	3·85 *37·4*	15·5
20	Me	—	—	Br	218, *266*	0	9·7, *2·1*	2·56
23	Cl	—	—	Cl	219, *268*	20	15·8, *3·1*	1·33
49	Cl	Cl	—	Cl	225, *274*	40	11·7, *4·17*	2·17
31	MeS	NH_2	Me	—	225, *248* *282*	15	23·4, 11·7 *7·08*	18·7
32	MeS	NH_2	—	—	223·5, *286·5*	70	24·0, *7·24*	18·5
34	NH_2	Me	Me	—	229, *290*	−90	18·6, *7·24*	4·23
38	NH_2	Cl	Me	—	232, *294*	−80	14·4, *4·9*	4·9
42	NH_2	Cl	Cl	—	236, *298·5*	−65	15·5, *4·57*	5·57
43	NH_2	Me	Me	Br	237, *302*	−140	19·5, *4·79*	3·97
47	NH_2	—	—	Br	238, *315·5*	15	19·3, *2·89*	3·63
44	NH_2	—	—	Cl	237, *316*	50	23·2, *3·60*	3·67

[1] Maggiolo and Russell, *J.*, 1951, 3297.

Although no additive relation has been found for pyrimidines containing more than one potentially tautomeric group, the results obtained so far may prove to be useful in determining the structure of compounds containing not more than one prototropic group. A similar type of additive relation has been reported by Doub and Vandenbelt (*J. Amer. Chem. Soc.*, 1947, **69**, 2714; 1949, **71**, 2414) in disubstituted benzenes where the two substituents are of complementary electronic character (*i.e.*, one *ortho-para*-directing and one *meta*-directing substituent). The relation was found to hold for the secondary, first primary, and second primary bands of the benzene spectrum. Vittum and Brown (*ibid.*, 1947, **69**, 152) studied the effect on the absorption spectrum of substitution in the oxygen-containing ring of the indoaniline dye, phenol-blue. They found that in general the shifts in the wave-length of maximum extinction and the extinction coefficient brought about by two or more substituents agreed closely with the values calculated by adding the shifts for the separate substituent groups.

During the preparation of 2-mercapto-4 : 6-dimethylpyrimidine by Evans's method (*J. pr. Chem.*, 1893, **48**, 489) difficulty was found in separating it from the compound formed from two molecules of thiourea and one of acetylacetone. Evans called this compound " dithiourimido-acetylacetone " and suggested it had structure (VI) by analogy with a similar compound formed from urea and acetylacetone which had been described in the previous year by Combes and Combes (*Bull. Soc. chim.*, 1892, **7**, 788). Some years later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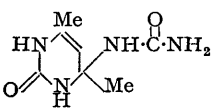
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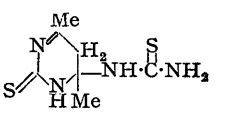
(VIII)

de Haan (*Rec. Trav. chim.*, 1908, **27**, 162) repeated the reaction between urea and acetylacetone and suggested the structure (VII) for " diurimido-acetylacetone." Hale (*J. Amer.*

Chem. Soc., 1915, **37**, 1544) showed that the compound could be formed simply on mixing together concentrated aqueous solutions of thiourea and 2-mercapto-4 : 6-dimethylpyrimidine and put forward (VIII) as the structure of this compound. Since it appeared unlikely that thiourea would add across a double bond in a pyrimidine ring under such mild conditions, we decided to investigate the compound further.

Recently Bray, Lake, and Thorpe (*Biochem. J.*, 1951, **48**, 400) have reported the formation of a 1 : 1 complex between urea and 2-amino-4 : 6-dimethylpyrimidine. We have examined the behaviour of this complex, a similar complex made from thiourea and 2-amino-4 : 6-dimethylpyrimidine, and the "dithiourimido-acetylacetone" in paper-partition chromatography. All three compounds gave two spots whose R_F corresponded exactly to those of the pure components from which the complex was formed. Further, the ultra-violet absorption spectrum of the "dithiourimido-acetylacetone" was the same as that which would be obtained by superimposing the individual spectra of thiourea and 2-mercapto-4 : 6-dimethylpyrimidine. If the "dithiourimido-acetylacetone" had the structure assigned to it by Hale (*loc. cit.*) its ultra-violet spectrum would be expected to be very different from that of a highly conjugated system such as 2-mercapto-4 : 6-dimethylpyrimidine. In the light of these results it is suggested that "dithiourimido-acetylacetone" is simply a 1 : 1 molecular complex of thiourea with 2-mercapto-4 : 6-dimethylpyrimidine. A similar conclusion applies to the other two complexes.

As a continuation of the work on the reaction of thiourea with chloropyrimidines (Part I) two further reactions may be described. Thiourea reacts with 4 : 6-dichloropyrimidine in boiling ethanol, giving *S*-4-mercapto-6-pyrimidylthiuronium chloride. This can be hydrolysed by alkaline solution to 4 : 6-dimercaptopyrimidine in good yield. Under similar conditions, 2 : 5-dichloropyrimidine reacts with thiourea to give the corresponding monothiuronium salt, hydrolysed by sodium hydroxide to 5-chloro-2-mercaptopyrimidine.

Experimental

M. p.s are uncorrected. Microanalyses are by Mr. W. M. Eno, Bristol, and Drs. Weiler and Strauss, Oxford.

Source of Pyrimidines.—Compounds 26 and 31 were kindly supplied by Drs. W. F. Short and D. A. Peak (Boots Pure Drug Co., Ltd., Nottingham). Their purity was checked by m. p. determinations.

Compounds 27, 30, 32, 33, 38, and 42 were gifts from Drs. F. L. Rose and R. Hull (Imperial Chemical Industries Limited). The purity of 30 and 33 was checked by chromatography (acetic acid–water–ethyl acetate : 1 : 2 : 3); 27 32, 38, and 42 were purified by vacuum-sublimation.

Compound 6 was kindly sent to us by Drs. J. C. Roberts and T. D. Heyes (Nottingham University); it was purified by vacuum-sublimation.

4 : 6-Dimethylpyrimidine (I) was prepared by catalytic reduction of 2-chloro-4 : 6-dimethylpyrimidine by Mr. R. N. Timms (unpublished).

Compounds 12 and 20 were prepared by Mr. I. M. White (forthcoming publication).

Compounds 7 (Hull, *J.*, 1951, 2214), 23 and 45 (English *et al.*, *J. Amer. Chem. Soc.*, 1946, **68**, 1043), 44 (Roblin, Winnek, and English, *ibid.*, 1942, **64**, 567), 46 (English *et al.*, *ibid.*, 1946, **68**, 453), and 47 and 49 (unpublished) were prepared by Mr. E. R. Sayer.

2-Amino-4 : 6-dimethylpyrimidine (34) was prepared by the method of Combes and Combes (*Bull. Soc. chim.*, 1892, **7**, 788). It was brominated according to the procedure of Bray, Lake, and Thorpe (*Biochem. J.*, 1951, **48**, 400).

4 : 6-Dihydroxy-2-methylpyrimidine was prepared in 77% yield by using a procedure similar to that described by Huber and Hölscher (*Ber.*, 1938, **71**, 87) for the 2-ethyl derivative.

4 : 6-*Dichloro*-2-*methylpyrimidine* (9).—The above dihydroxy-compound (10 g.) was heated under reflux for 2½ hours in a mixture of phosphorus oxychloride (100 c.c.) and dimethylaniline (7 c.c.). Excess of phosphorus oxychloride was removed under reduced pressure and the residue poured on crushed ice. Extraction with ether in the usual way gave the crude product as a pale yellow solid (10·8 g., 84%). Sublimation at 65°/18 mm. gave the pure compound as highly refracting needles, m. p. 49°. Baddiley, Lythgoe, McNeil, and Todd (*J.*, 1943, 383) obtained this compound, m. p. 48—49°, in 75% yield using phosphorus oxychloride alone.

S-4-*Mercapto*-6-*pyrimidylthiuronium Chloride*.—4 : 6-Dichloropyrimidine (2·0 g.) and thiourea (2·0 g.) were heated under reflux in ethanol (80 c.c.) for 1 hour. The colour of the solution rapidly became bright yellow and much solid separated. After removal of the solid and concentration of the filtrate a total yield of 2·9 g. (99%) of crude crystalline material was obtained. Recrystallisation from aqueous ethanol–ether gave pure S-4-*mercapto*-6-*pyrimidylthiuronium chloride* as a pale yellow powder which darkened above 180° and melted at 214° (decomp.) (Found : C, 27·1; H, 3·2; N, 24·9. $C_5H_7N_4S_2Cl$ requires C, 27·0; H, 3·15; N, 25·2%).

4 : 6-*Dimercaptopyrimidine*.—*S*-4-Mercapto-6-pyrimidylthiuronium chloride (1·5 g.) was heated under reflux for 1¼ hours in N-sodium hydroxide (40 c.c.). After cooling, addition of dilute hydrochloric acid precipitated yellow plates (0·65 g., 68%). Recrystallisation from water gave 4 : 6-*dimercaptopyrimidine* as shining yellow prismatic needles which darkened above 230° and melted at 245—246° (decomp.) (Found : C, 33·6; H, 3·1; N, 19·4. $C_4H_4N_2S_2$ requires C, 33·4; H, 2·8; N, 19·4%). Ultra-violet absorption max. in aqueous solution at pH 6·98 : 214 ($\log_{10}\varepsilon = 3·92$), 260 (4·08), 283 (4·25), 248·5 mμ (4·53); at pH 13 : 268·5 (4·52), 316·5 mμ (4·44).

5-*Chloro*-2-*mercaptopyrimidime* (29).—2 : 5-Dichloropyrimidine (1·8 g.) and thiourea (1·0 g.) were heated under reflux in ethanol (40 c.c.) for 4½ hours, the colour of the solution slowly becoming yellow after the first hour. Evaporation nearly to dryness gave a mixture of the colourless thiuronium salt and the yellow mercapto-compound (2·7 g.). This was heated under reflux with N-sodium hydroxide (30 c.c.) for 1 hour. Cooling and acidification with dilute hydrochloric acid gave the product as a bright yellow powder (1·1 g., 61%). Sublimation at 140°/18 mm. gave pure 5-chloro-2-mercaptopyrimidine, m. p. 218° (decomp.) (Found : N, 19·2. Calc. for $C_4H_3N_2ClS$: N, 19·1%). English and Leffler (*J. Amer. Chem. Soc.*, 1950, **72**, 4324) report m. p. 222° (decomp.) for the compound prepared from 2 : 5-dichloropyrimidine and sodium hydrogen sulphide.

2-*Mercapto*-4 : 6-*dimethylpyrimidine*.—The pure compound was obtained by Hale and Williams's method (*ibid.*, 1915, **37**, 594). Sublimation at 130°/0·5 mm. gave a pale yellow powder, m. p. 209—210° (Hale and Williams report m. p. 210°).

2-*Mercapto*-4 : 6-*dimethylpyrimidine–Thiourea Complex*.—A solution of the mercaptopyrimidine (4·4 g.) in hot water (50 c.c.) was added to a solution of thiourea (2·4 g.) in hot water (30 c.c.), and the yellow solution rapidly filtered. As the solution cooled, highly refracting, bright yellow prisms separated (4·4 g., 65%), m. p. 196° (decomp.). Hale (*ibid.*, 1915, **37**, 1544) reports m. p. 192°.

Chromatography : (*a*) Ethyl acetate–water–acetic acid (3 : 2 : 1) as the solvent mixture, and 2½-inch wide Whatman filter paper strips. After drying, the strips were sprayed with ammoniacal silver nitrate, the position of the pyrimidine and thiourea being revealed by dark spots. The R_F values were : 2-mercapto-4 : 6-dimethylpyrimidine, 0·64; thiourea, 0·52; 2-mercapto-4 : 6-dimethylpyrimidine–thiourea complex, 0·63 and 0·53.

(*b*) Butanol (1 vol.) and water (1 vol.) as the solvent mixture. The R_F values were : 2-mercapto-4 : 6-dimethylpyrimidine, 0·61; thiourea, 0·32; 2-mercapto-4 : 6-dimethylpyrimidine–thiourea complex, 0·61 and 0·34.

Ultra-violet absorption max. in aqueous solution at pH 6·98 : 2-Mercapto-4 : 6-dimethylpyrimidine : 217·5 ($\log_{10}\varepsilon = 4·1$), 276 (4·38), 332 mμ (3·68). Thiourea : 235 mμ (4·04). 2-Mercapto-4 : 6-dimethylpyrimidine–thiourea complex : 217·5 (4·01), 235 (3·96), 276 (4·08); 332 mμ (3·41).

2-*Amino*-4 : 6-*dimethylpyrimidine–Urea Complex*.—This was prepared by the method of Bray, Lake, and Thorpe (*Biochem. J.*, 1951, **48**, 400).

Chromatography : The butanol–water mixture was used as the solvent. 2-Amino-4 : 6-dimethylpyrimidine could be detected as a dark spot on a fluorescent background when the paper strip was viewed by the light of a mercury-discharge lamp. Urea could be detected as a light spot on a dark background after the strip had been treated with ammoniacal silver nitrate, dried, and gently warmed. The R_F values were : 2-amino-4 : 6-dimethylpyrimidine, 0·80; urea, 0·27; 2-amino-4 : 6-dimethylpyrimidine–urea complex, 0·81 and 0·25.

2-*Amino*-4 : 6-*dimethylpyrimidine–Thiourea Complex*.—This was prepared as described for the urea complex. Recrystallisation from ethanol gave the *complex* as large colourless prisms, m. p. 159—160° (Found : C, 42·2; H, 6·45; N, 35·7; S, 16·3. $C_6H_9N_3,CH_4N_2S$ requires C, 42·3; H, 6·55; N, 35·2; 16·1%).

Chromatography : The butanol–water mixture was used as the solvent. The R_F values were : 2-amino-4 : 6-dimethylpyrimidine, 0·80; thiourea, 0·39; 2-amino-4 : 6-dimethylpyrimidine–thiourea complex, 0·38 and 0·79.

Physical Measurements.—The methods employed were described in Part II (preceding paper).

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