New Routes for the Synthesis of Pyrrolo-[3,2-*d*]- and -[2,3-*d*]-pyrimidine Systems starting from a Common Pyrrole Derivative

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New routes for the synthesis of pyrrolo-[3,2-*d*]- and -[2,3-*d*]-pyrimidines from a common 2,3-dicarboxypyrrole derivative are described. The common starting material, 3-ethoxycarbonyl-2-carboxy-4-methylpyrrole (1) is conveniently functionalized to give 2- or 3-azidocarbonylpyrroles (4), (17), and (22) which on Curtius rearrangement followed by treatment with ammonia or amines give the pyrrolylurea (6a) or its derivatives (6b—d), or (23). These, in basic medium cyclise to 7-methylpyrrolo[3,2-*d*]pyrimidine-2,4-diones (7a), its 3-substituted derivatives (7b—d), or to 5-methylpyrrolo[2,3-*d*]pyrimidine-2,4-diones (19).

THE synthetic methods for the preparation of pyrrolopyrimidines have been recently reviewed.[1] Since that report an increasing number of papers have dealt with the chemistry of these heterocyclic systems,[2-4] because of their structural resemblance to purines, natural occurrence, and biological significance. Good examples of this are the pyrrolo[2,3-*d*]pyrimidine nucleosides Q[5] and Q*[6]

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[5] H. Kasai, Z. Ohashi, F. Harada, S. Nishimura, N. J. Oppenheimer, P. F. Crain, J. G. Lierr, D. L. von Minden, and J. A. McCloskey, *Biochemistry*, 1975, **14**, 4198.
[6] H. Kasai, K. Nakanishi, R. D. Macfarlane, D. F. Torgerson, S. Ohashi, J. A. McCloskey, H. J. Gross, and S. Nishimura, *J. Amer. Chem. Soc.*, 1976, **98**, 5044.

and the antibiotic nucleosides [7] tubercidin, toyocamycin, and sangivamycin.

In this paper, we report methods for the synthesis of both pyrrolo-[3,2-*d*]- and -[2,3-*d*]-pyrimidine ring systems that start from a common pyrrole derivative, namely 3-ethoxycarbonyl-2-carboxy-4-methylpyrrole [8] (1). These methods take advantage of the different reactivity of the carboxy-groups at C-2 and -3 which allows their selective functionalisation. The introduction of a nitrogen atom directly bonded to C-2 or -3 of the pyrrole is accomplished in both cases by a Curtius rearrangement [9] of suitable azidocarbonylpyrroles.

Pyrrolo[3,2-d]*pyrimidine*.—Several methods for the synthesis of pyrrolo[3,2-*d*]pyrimidines from pyrimidine derivatives are known.[1] However, recently, the first and only method starting from pyrrole derivatives has been reported.[3] The main difficulty is the synthesis of pyrrolo[3,2-*d*]pyrimidines from pyrroles in the absence of good methods for the preparation of 3-aminopyrrole derivatives. We have applied the Curtius rearrangement [9] to transform the easily available 2,3-dicarboxypyrroles [8,10] to 3-aminopyrrole derivatives, which can be readily cyclised to pyrrolo[3,2-*d*]pyrimidines. Thus, reaction of (1) with hydrazine hydrate gave the known hydrazine [8b] (2) in quantitative yield. Treatment of (2) with nitrous acid afforded the azide (3), which without purification reacted with diazomethane to give the methyl ester (4). In order to obtain a reasonably fast esterification, the reaction with diazomethane was performed in a 1,2-dimethoxyethane–ether (3 : 2) mixture. Azides (3) and (4) were not fully characterised, however their i.r. spectra, $\nu_{max.}$ 2 180 cm^{-1}, as well as the subsequent chemical transformations showed that the structures of (3) and (4) were as indicated. Curtius rearrangement of the azide (4) in benzene or toluene, followed by '*in situ*' reaction of the resulting isocyanate (5) with ammonia, methylamine, benzylamine, or aniline afforded the pyrrolylureas (6a—d) (Table 1). Methoxide treatment of the above ureas followed by neutralisation yielded the pyrrolo[3,2-*d*]pyrimidine-2,4-diones (7a—d). That the ring closure had occurred was demonstrated by the analytical and spectroscopic data of these pyrrolopyrimidines (Table 2). Thus, the n.m.r. spectra clearly showed the absence of methoxy-groups, the u.v. spectra of (7a—d) were very similar to that of analogous pyrrolo[3.2-*d*]pyrimidine-2,3-diones [3,11,12] and the molecular ions of (7a—d), in the mass spectra, were usually

TABLE 1

N.m.r. data of pyrrole derivatives in $(CD_3)_2SO$

Compound	Chemical shift (τ) H-5	CH_3	H-1	Other
(1)	3.06	7.80	−2.50	−4.05 (CO_2H), 5.60 (OCH_2CH_3), 8.64 (OCH_2CH_3)
(2)	3.09	7.85	−2.20	
(3)	3.25	8.00	−1.55	0.30 (CO_2H,$CONHNH_2$)
(6a)	3.25	8.10	−1.50	2.40 (NHCO), 4.10 ($CONH_2$), 6.25 (CO_2CH_3)
(6b)	3.25	8.07	−1.35	2.45 (NHCO), 3.55 ($CONHCH_3$), 6.22 (CO_2CH_3), 7.35 (NCH_3)
(6c)	3.28	8.10	−1.45	2.35 (NHCO), 3.02 ($CONHCH_2$), 6.27 (CO_2CH_3), 5.72 (NCH_2)
(6d)	3.20	8.03	−1.60	0.85 (NHCO), 2.08 (CONH), 6.20 (CO_2CH_3)
(8)	3.25	8.05	−1.35	2.00 (NHCONH), 6.25 (CO_2CH_3)
(11)	3.20	7.80	−2.10	0.65, 2.40 ($CONH_2$), 5.70 (OCH_2CH_3), 8.70 (OCH_2CH_3)
(12)	2.90	7.69		4.85 ($CONHNH_2$)
(14)	3.45	7.75	3.1br (4 H, s pyrrole NH,$CONH_2$,CO_2H)	
(15)	3.15	7.88	−2.05	1.85, 2.85 ($CONH_2$), 6.20 (CO_2CH_3)
(16)	3.25	7.80		
(22)	3.66	7.82	−1.05	5.75 (OCH_2CH_3), 8.70 (OCH_2CH_3)
(23)	3.83	7.90	−1.08	0.8 (NHCO), 3.25 ($CONH_2$), 5.75 (OCH_2CH_3), 8.73 (OCH_2CH_3)

TABLE 2

Spectroscopic data of pyrrolopyrimidines (7) and (13) and pyrrolopyridazine (19)

Compound	Chemical shift (τ) [a] H-6	CH_3	NH	Other	$\nu_{max.}$(Nujol)/cm^{-1} NH	C=O	$\lambda_{max.}$(MeOH)/nm (ε)
(7a)	3.15	8.00	5.8		3 400, 3.200	1 705, 1 655	269 (13 500)
(7b)	3.00	7.95		6.78 (3 H, s, $N\text{-}CH_3$)	3 190	1 710, 1 630	270 (12 500)
(7c)	3.10	8.00	5.05	4.86 (2 H, s, $NCH_2C_6H_5$)	3 160	1 715, 1 635	271 (14 000)
(7d)	2.94	7.92		2.30—2.85 (5 H, m, C_6H_5)	3 185	1 725, 1 640	271 (17 200)
(13)	2.85	7.68	−2.20, 5.07		3 200, 3 100	1 675	281 (6 660), 300 (3 800) [b]
(19)	3.62	7.82	−1.50, −0.95, −0.50		3 140	1 720, 1 670	271 (4 450) [b]

[a] Taken in $(CD_3)_2SO$ solution. [b] Taken in $(CH_3)SO$ solution.

[7] R. J. Suhadolnik, 'Nucleoside Antibiotics,' Wiley–Interscience, New York, 1970.

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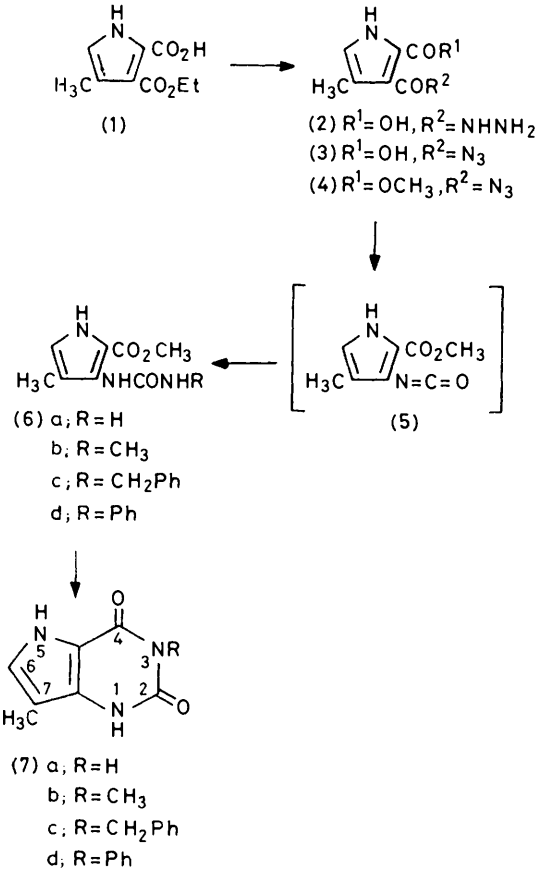
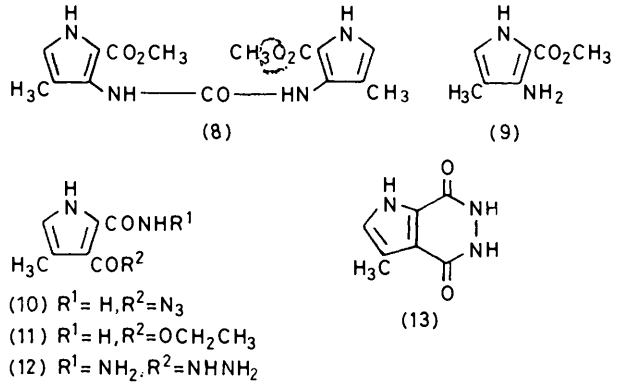
the base peak as it corresponds to heteroaromatic compounds.

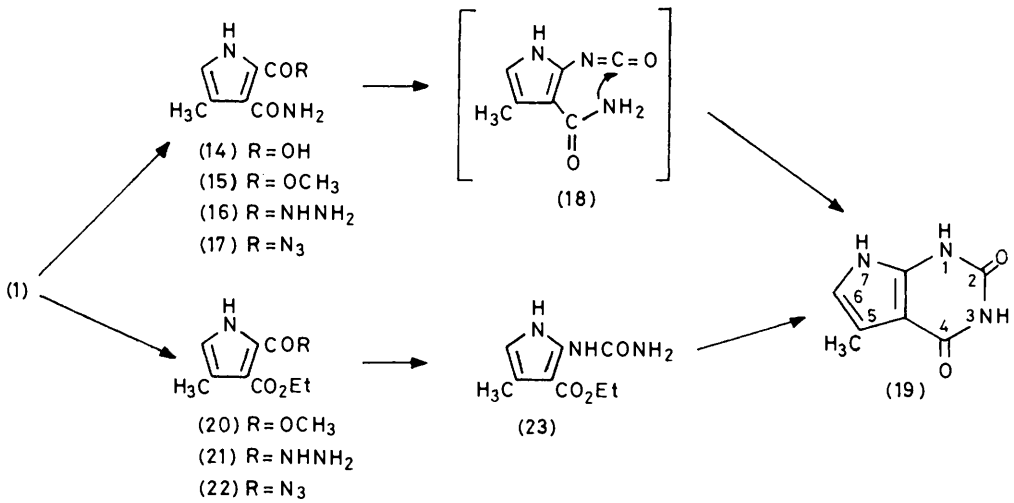


The synthesis of (7a) was also attempted by heating (6a) in the absence of catalyst. However, the main reaction was the formation of the very insoluble compound (8).* Attempts to obtain 3-amino-2-methoxycarbonyl-4-methylpyrrole (9) by heating the azide (4) in water also give (8), presumably formed by *in situ* reaction of the resulting amine (9) with the intermediate isocyanate (5). The 3-aminopyrrole derivative (9) would be useful, since it would be a versatile intermediate for the synthesis of pyrrolo[3,2-*d*]pyrimidines.



Attempts to obtain 3-azidocarbonyl-2-carbamoyl-4-methylpyrrole (10), which by Curtius rearrangement would directly give (7a) were unsuccessful. Thus, treatment of (11), obtained by ammonolysis of the diester (20) with hydrazine hydrate in the absence of solvent at 80 °C gave the dihydrazide (12). No reaction occurred when milder conditions were used. Attempts to transform one of the hydrazide groups to azide by treatment of (12) with $NaNO_2$ in acid (HCl or HOAc) resulted in the formation of the known pyrrolo[3,2-*d*]-pyridazine (13).[8b]

Pyrrolo[2,3-d]*pyrimidine*.—The synthesis of this heterocyclic system has been accomplished by two related procedures, parallel to the route previously described for the preparation of the pyrrolo[3,2-*d*]pyrimidine systems. In the first procedure (1) ⟶ (14) ⟶ (19), the starting compound (1) was treated with methanolic ammonia to give the amide (14). This, on treatment with diazomethane in ether or dimethoxyethane



* Although the elemental analysis of (8) showed small differences between found and required, the structure was assigned by mass, i.r., and n.m.r. spectroscopic data.

yielded the amide ester (15), which on hydrazinolysis gave (16). Reaction of (16) with nitrous acid gave the azide (17), $\nu_{max.}$ 2 180 cm^{-1}. On heating (17) in refluxing dry benzene or toluene, intramolecular attack of the 3-carbamoyl group to the 2-isocyanato-group of (18) gave the very insoluble pyrrolo[2,3-*d*]pyrimidine-2,4-dione (19).

The second procedure (1) ⟶ (20) ⟶ (19) involves a Curtius rearrangement of the azidocarbonylpyrrole (22) [8b] [obtained through (20) and (21)] followed by '*in situ*' reaction of the resulting isocyanate with ammonia to give the ureido derivative (23). This, on treatment with sodium ethoxide followed by neutralization resulted in the precipitation of (19), identical in all respects to the final compound obtained from (17). Attempts to link both procedures by converting (21) into (16) by treatment with methanolic ammonia were not successful. The product of this reaction was the pyrrolo[2,3-*d*]pyridazine (13). The structures of (19) and all the intermediates of these procedures were determined as before by mass, i.r., n.m.r., and u.v. spectroscopy (Tables 1 and 2).

EXPERIMENTAL

M.p.s are uncorrected. U.v. absorption spectra were taken with a Perkin-Elmer 402 spectrophotometer. N.m.r. spectra were recorded at 60 MHz with a Perkin-Elmer R-12 spectrophotometer, in 10—15% w/v solutions at standard probe temperature, tetramethylsilane being used as internal reference. Infrared spectra were taken on a Perkin-Elmer 257 spectrophotometer. Mass spectra were obtained with a Hitachi-Perkin-Elmer RMV-GMG instrument. T.l.c. was performed in GF_{254} (Merck) silica gel. Spots were visualised with u.v. light (254 nm) or iodine.

2-Methoxycarbonyl-4-methyl-3-ureidopyrrole Derivatives (6a—d).—*General procedure*. A mixture of (1) [8c] (1.97 g, 0.01 mol), ethanol (25 ml), and hydrazine hydrate (5 ml, 98%) was refluxed for 8 h. Then, the solution was evaporated *in vacuo* and co-evaporated three times with ethanol (20 ml) leaving 2-carboxy-3-hydrazinocarbonyl-4-methylpyrrole (2) [8b] (1.80 g) which crystallised from acetic acid, m.p. 234 °C (lit.,[8b] 235 °C). To a cooled stirred mixture (ice-bath) of the crude (2), obtained before (1.80 g), water (20 ml), and HCl (2 ml, 6N), a solution of $NaNO_2$ (0.66 g) in water (4 ml) was added dropwise, while the reaction temperature was kept under 10 °C. Then, the mixture was stirred for 5—10 min and solid 3-azidocarbonyl-2-carboxy-4-methylpyrrole (3) was filtered and dried at room temperature, yield 1.3 g; $\nu_{max.}$ (Nujol) 2 180 cm^{-1} (N_3). To a cooled mixture (ice-bath) of crude (3) (1.3 g) in 1,2-dimethoxyethane (10 ml), an ethereal solution of diazomethane (*ca.* 0.015 mol) was added. The resulting mixture was stirred overnight at room temperature and evaporated *in vacuo* (bath temperature <35 °C). The residue containing 3-azidocarbonyl-2-methoxycarbonyl-4-methylpyrrole (4) as a solid was dried at room temperature, yield 1.1 g, $\nu_{max.}$ (Nujol) 2 180 cm^{-1} (N_3). This solid in anhydrous benzene (30 ml) was heated to reflux for 3 h. After cooling, a solution of ammonia, methylamine, benzylamine, or aniline (1 equiv.) in 1,2-dimethoxyethane or methanol (15 ml) caused the precipitation of the corresponding 3-ureidopyrrole derivatives (6a—d).

2-Methoxycarbonyl-4-methyl-3-ureidopyrrole (6a) [0.49 g, 25% from (1)] was crystallised from MeOH–EtOAc, m.p. 280—290 °C (decomp.); $\nu_{max.}$ (Nujol) 3 450, 3 310 (NH), 1 700 (CO_2CH_3), and 1 600 cm^{-1} (N–CO–N) (Found: C, 48.9; H, 5.35; N, 21.4. $C_8H_{11}N_3O_3$ requires C, 48.7; H, 5.6; N, 21.3%). *2-Methoxycarbonyl-4-methyl-3-(3-methylureido)pyrrole* (6b) [0.63 g, 30% from (1)] was crystallised from EtOH–EtOAc, m.p. >330 °C; $\nu_{max.}$ (Nujol) 3 410 (NH), 1 690 (CO_2CH_3), 1 640, and 1 600 cm^{-1} (N–CO–N) (Found: C, 51.3; H, 6.05; N, 19.7. $C_9H_{13}N_3O_3$ requires C, 51.3; H, 6.2; N, 19.9%). *3-(3-Benzylureido)-2-methoxycarbonyl-4-methylpyrrole* (6c) [0.33 g, 20% from (1)] was crystallised from MeOH, m.p. 230—238 °C; $\nu_{max.}$ (Nujol) 3 310 (NH), 1 690 (CO_2CH_3), 1 640, and 1 610 cm^{-1} (N–CO–N) (Found: C, 63.0; H, 5.85; N, 14.5. $C_{15}H_{17}N_3O_3$ requires C, 62.7; H, 5.95; N, 14.6%). *2-Methoxycarbonyl-4-methyl-3-(3-phenylureido)pyrrole* (6d) [0.31 g, 17% from (1)] was crystallised from MeOH, m.p. 270—280 °C (decomp); $\nu_{max.}$ (Nujol) 3 300 (NH), 1 690 (CO_2CH_3), 1 640, and 1 595 cm^{-1} (N–CO–N) (Found: C, 61.2; H, 5.5; N, 15.1. $C_{14}H_{15}N_3O_3$ requires C, 61.5; H, 5.5; N, 15.4%).

7-Methylpyrrolo[3,2-d]*pyrimidine-2,4-dione* (7a).—A mixture of (6a) (0.197 g, 0.001 mol), methanol (30 ml), and sodium methoxide (0.002 mol) was refluxed for 6 h and then evaporated *in vacuo*. The residue was washed with water (5 ml) and the insoluble material was filtered and crystallised from acetonitrile–water yielding (7a) (0.078 g, 47%), m.p. >300 °C; *m/e* 165 (M^+, 100%), 166(10), 122(55), 94(80), 93(25), and 67(65) (Found: C, 51.0; H, 4.2; N, 25.3. $C_7H_7N_3O_2$ requires C, 50.9; H, 4.25; N, 25.4%).

3,7-Dimethylpyrrolo[3,2-d]*pyrimidine-2,4-dione* (7b).—A mixture of (6b) (0.633 g, 0.003 mol), methanol (40 ml), and sodium methoxide (0.006 mol) was refluxed for 5 min and then evaporated *in vacuo*. The residue was dissolved in water and the solution neutralized with acetic acid. On concentration (7b) precipitated as a solid which was recrystallised from acetic acid (0.28 g, 52%), m.p. 330 °C; *m/e* 179 (M^+, 100%), 180(8), 150(8), 149(13), 123(15), 122(70), 94(90), 93(15), 77(15), and 67(30) (Found: C, 53.4; H, 5.05; N, 23.2. $C_8H_9N_3O_2$ requires C, 53.6; H, 5.05; N, 23.5%).

3-Benzyl-7-methylpyrrolo[3,2-d]*pyrimidine-2,4-dione* (7c).—A solution of (6c) (0.15 g, 0.000 6 mol) in methanol (50 ml) and sodium methoxide (0.001 mol) was refluxed for 2 h and then treated as before giving (7c) (0.085 g, 64%) which was crystallised from acetic acid, m.p. >330 °C; *m/e* 255 (M^+, 90%), 256(17), 238(10), 150(40), 132(13), 123(23), 122(30), 121(15), 106(16), 94(15), 91(100), 67(10), and 65(18). (Found: C, 65.5; H, 5.05; N, 16.2. $C_{14}H_{13}N_3O_2$ requires C, 65.9; H, 5.15; N, 16.5%).

7-Methyl-3-phenylpyrrolo[3,2-d]*pyrimidine-2,4-dione* (7d).—Treatment of (6d) (0.15 g, 0.000 6 mol) as before and crystallisation from acetic acid yielded (7d) (0.079 g, 60%), m.p. >330 °C; *m/e* 241 (M^+, 100%), 242(15), 149(20), 122(85), 94(80), 93(80), and 67(30) (Found: C, 64.4; H, 4.65; N, 17.2. $C_{13}H_{11}N_3O_2$ requires C, 64.7; H, 4.6; N, 17.4%).

NN'-Bis-(2-methoxycarbonyl-4-methylpyrrol-3-yl)urea (8).—*From* (6a). A solution of (6a) (0.1 g, 0.000 5 mol) in ethanol (10 ml) was heated to reflux for 3 h. On cooling, a solid precipitated, which was washed repeatedly with ethanol to give (8) (0.052 g, 62%), m.p. 290—295 °C (decomp.); $\nu_{max.}$ (Nujol) 3 300(NH), 1 680, and 1 650 cm^{-1} (C=O); *m/e* 334(M^+,1%), 302(1), 226(3), 181(10), 180(90), 155(6), 154(70), 149(45), 148(95), 147(12), 123(20), 122(100),

121(25), 94(30), 93(30), 92(50), 77(10), 76(30), and 75(25) (Found: C, 53.2; H, 5.55; N, 16.1. $C_{15}H_{18}N_4O_5$ requires C, 53.8; H, 5.4; N, 16.7%).

From (4). A mixture of (4) (0.94 g, 0.003 3 mol) and water (20 ml) was heated to reflux for 0.5 h. On cooling, a solid precipitated, which was washed as above to give (8) (0.495 g, 90%).

2-*Carbamoyl*-3-*ethoxycarbonyl*-4-*methylpyrrole* (11).—A solution of 3-ethoxycarbonyl-2-methoxycarbonyl-4-methylpyrrole (20) (2.11 g, 0.01 mol) in saturated (0 °C) methanolic ammonia was allowed to stand at room temperature for 24 h. The precipitate formed was crystallised from methanol to give (11) (2.80 g, 87%), m.p. 230 °C; $\nu_{max.}$ (Nujol) 3 280, 3 120(NH), 1 680, 1 640, and 1 610 cm^{-1} (C=O) (Found: C, 55.3; H, 6.15; N, 14.5. $C_9H_{12}N_2O_3$ requires C, 55.1; H, 6.15; N, 14.3%).

2,3-*Bishydrazinocarbonyl*-4-*methylpyrrole* (12).—A mixture of (11) (2.00 g, 0.01 mol) and hydrazine hydrate (25 ml, 98%) was heated at 80 °C for 30 min. The excess of hydrazine was repeatedly coevaporated with ethanol to give a solid which was washed with ethanol to yield (12) (1.90 g, 96%), m.p. *ca.* 320 °C (decomp.); $\nu_{max.}$ (Nujol) 3 300—3 100 (NH), 1 670, and 1 640 cm^{-1} (C=O) (Found: C, 42.5; H, 5.6; N, 35.4. $C_7H_{11}N_5O_2$ requires C, 42.6; H, 5.6; N, 35.5%).

7-*Methylpyrrolo*[3,2-d]*pyridazine*-1,4-*dione* (13).— *From* 3-*ethoxycarbonyl*-2-*hydrazinocarbonyl*-4-*methylpyrrole* (21). A mixture of (21) (2.11 g, 0.01 mol) in saturated (0 °C) methanolic ammonia was heated at 90 °C for 6 h. On cooling, a solid precipitated which was filtered and washed repeatedly with methanol to give (13) (1.44 g, 87%), m.p. >330 °C; $\nu_{max.}$ (Nujol) 3 150, 3 100(NH), and 1 675 cm^{-1} (C=O).

From (12). A mechanically stirred suspension of (12) (0.35 g, 0.0017 mol) in water (10 ml) was treated at 0 °C with HCl (2 ml; 6N) for 15 min. The solid was separated by filtration and washed with water to give (13) (0.28 g, 100%).

3-*Carbamoyl*-2-*carboxy*-4-*methylpyrrole* (14).—A mixture of (1) (10 g, 0.05 mol), methanol (100 ml), and liquid ammonia (20 ml) was heated to 90 °C for 6 h. In cooling, the solid which precipitated was filtered and crystallised from methanol giving (14) (7.08 g, 82%), m.p. 221—222 °C, $\nu_{max.}$ (Nujol) 3 350, 3 150 ($CONH_2$,NH), 1 640 (COOH), and 1 610 cm^{-1} ($CONH_2$) (Found: C, 50.3, H, 5.0; N, 16.5. $C_7H_8N_2O_3$ requires C, 50.0; H, 4.8; N, 16.7%).

3-*Carbamoyl*-2-*methoxycarbonyl*-4-*methylpyrrole* (15).—To a mixture of (14) (5.04 g, 0.03 mol) in ether (500 ml) was added an ethereal solution of CH_2N_2 (*ca.* 0.05 mol) and the resulting suspension was stirred for 24 h. Unchanged starting material (2.9 g) was filtered off and the filtrate was evaporated to dryness leaving a solid which was crystallised from ethanol to give (15) (2.0 g, 36%), m.p. 218 °C; $\nu_{max.}$ (Nujol) 3 400, 3 200 ($CONH_2$), 1 680, and 1 650 cm^{-1} (C=O) (Found: C, 52.6; H, 5.65; N, 15.6. $C_8H_{10}N_2O_3$ requires C, 52.7; H, 5.55; N, 15.4%).

3-*Carbamoyl*-2-*hydrazinocarbonyl*-4-*methylpyrrole* (16).—A mixture of (15) (0.785 g, 0.004 3 mol), hydrazine hydrate (5 ml, 98%), and ethanol (30 ml) was refluxed for 8 h. On evaporation of the solvent and coevaporation of the residue with ethanol (3 × 20 ml) a solid was obtained which crystallised from ethanol–water to give (16) (0.55 g, 70%), m.p. >320 °C; $\nu_{max.}$ (Nujol) 3 400, 3 300, 3 200 (NH), 1 630, and 1 600 cm^{-1} (C=O) (Found: C, 46.4; H, 5.35; N, 31.0. $C_7H_{10}N_4O_2$ requires C, 46.1; H, 5.5; N, 30.8%).

5-*Methylpyrrolo*[2,3-d]*pyrimidine*-2,4-*dione* (19).—*From* (16). To a cooled (ice) stirred mixture of (16) (0.40 g, 0.002 2 mol) in water (5 ml) and HCl (1.5 ml, 6N); a solution of $NaNO_2$ (0.207 g, 0.003 mol) in water (1 ml) was added dropwise. Then, the mixture was left until room temperature was reached. On filtration a chromatographically homogeneous solid was obtained (0.40 g, 94%) to which the structure 2-azidocarbonyl-3-carbamoyl-4-methylpyrrole (17) was assigned, $\nu_{max.}$ (Nujol) 2 180(N_3), 1 640, and 1 610 cm^{-1} (C=O). A mixture of crude (17) (0.386 g, 0.002 mol) in anhydrous toluene (30 ml) was refluxed for 2.5 h. The solid which precipitated was filtered and washed repeatedly with ethanol to give (19) (0.280 g, 84%), m.p. >330 °C, *m/e* 165 (M^+, 100%), 166(10), 149(14), 134(20), 122(46), 107(53), 94(20), and 67(25) (Found: C, 50.7; H, 4.55; N, 25.5. $C_7H_7N_3O_2$ requires C, 50.7; H, 4.3; N, 25.5%).

From 3-*ethoxycarbonyl*-4-*methyl*-2-*ureidopyrrole* (23). A solution of (23) (0.353 g, 0.001 67 mol) and sodium ethoxide (0.006 68 mol) in ethanol (25 ml) was refluxed for 2 h, while a solid precipitated. On cooling, the solid was filtered, washed with ethanol, dissolved in water (10 ml), and the aqueous solution neutralized with acetic acid. From the neutral solution, a solid precipitated (0.138 g, 50%) which was identical to (19) obtained before.

3-*Ethoxycarbonyl*-4-*methyl*-2-*ureidopyrrole* (23).—A solution of 2-azidocarbonyl-3-ethoxycarbonyl-4-methylpyrrole (22) [8b] (1.05 g, 0.004 7 mol) in anhydrous benzene (40 ml) was refluxed for 3 h. On cooling the solution was saturated with gaseous ammonia and a solid precipitated which was filtered and crystallised from ethanol to give (23) (0.75 g, 76%), m.p. 229 °C; $\nu_{max.}$ (Nujol) 3 350(NH), 1 675, and 1 640 cm^{-1} (C=O) (Found: C, 51.4; H, 6.45; N, 20.1. $C_9H_{13}N_3O_3$ requires C, 51.2; H, 6.2; N, 19.9%).

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