Triazolo[4,5-*d*]pyrimidines. IX.¹⁾ Reactions of 5-Chloro- and 5-(Methylsulfonyl)-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidines with *C*-Nucleophiles

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The nucleophilic substitution of 5-(methylsulfonyl)-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine (2) with potassium cyanide proceeded smoothly to give 3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine-5-carbonitrile (6), but the same reaction did not take place in the case of 5-chloro-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine (1).

Compounds 1 and 2 reacted with ethyl cyanoacetate in the presence of sodium hydride in tetrahydrofuran, giving ethyl α -cyano-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine-5-acetate (7). When acetone was used as a ketone, it added across the C⁷,N⁶-double bond, giving 7-acetonyl-5-chloro-6,7-dihydro- (8a) and 7-acetonyl-6,7-dihydro-5-(methylsulfonyl)-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidines (8b), respectively, although the yields were low.

The reaction of 1 with Grignard reagents resulted in the formation of addition products such as 7-alkylated 5-chloro-6,7-dihydro-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidines (9a—e). The substitution of the methylsulfonyl group of 2 with Grignard reagents proceeded to give the corresponding 5-alkylated 3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidines (11a—e).

Keywords 5-chloro-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine; 5-(methylsulfonyl)-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine; nucleophilic substitution; Grignard reagent; addition reaction; *C*-nucleophile

We reported that chloro²⁾ and *p*-tolylsulfonyl groups²⁾ at the 7-position of the 3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine ring could be replaced by *C*-nucleophiles, resulting in the introduction of functionalized carbons at the 7-position. However, little work has been reported on introducing a functionalized carbon at the 5-position of the 3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine ring. In the present paper, we describe the reactions of 5-chloro-(1) and 5-(methylsulfonyl)-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidines (2) with *C*-nucleophiles.

Compound 2 was easily prepared by the substitution of 1 with sodium methyl sulfide in dimethylformamide (DMF), followed by oxidation with potassium permanganate (KMnO₄) in acetic acid (AcOH).

It was reported³⁾ that the reaction of 1 with *O*-, *N*-, and *S*-nucleophiles gave 5-substituted 3*H*-1,2,3-triazolo[4,5-*d*]pyrimidines. Similarly, compound 2 reacted with sodium methoxide and butylamine to afford 5-methoxy- (4) and 5-butylamino-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine (5), respectively.

Then we investigated the reactions of 1 and 2 with *C*-nucleophiles. We reported²⁾ that the chlorine atom at the 7-position of the 3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine ring was replaced by potassium cyanide (KCN) in DMF, giving 3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine-7-carbonitrile. However, similar substitution did not take place at the 5-position. On the other hand, nucleophilic substitution of the methylsulfonyl group at the 5-position with KCN in DMF

proceeded smoothly at room temperature, yielding 3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine-5-carbonitrile (6).

It was reported²⁾ that the reactions of 7-chloro- and 7-(*p*-tolylsulfonyl)-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine with active methylene compounds and ketones in the presence of sodium hydride (NaH) in DMF gave the corresponding 7-substituted 3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine. Similarly, in the reaction with ethyl cyanoacetate as an active methylene compound in the presence of NaH in tetrahydrofuran (THF), compounds 1 and 2 underwent substitution, giving ethyl α -cyano-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine-5-acetate (7). On the other hand, application of this nucleophilic substitution to 1 and 2 with acetone as a ketone under the same conditions did not give the anticipated acetonyl compound. However, use of potassium hydroxide (KOH) as a base and dimethyl sulfoxide (DMSO) as a solvent instead of NaH and THF gave the addition products across the C⁷, N⁶-double bond, 7-acetonyl-5-chloro-6,7-dihydro- (8a) and 7-acetonyl-6,7-dihydro-5-(methylsulfonyl)-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidines (8b), respectively, although the yields were low.

We reported⁴⁾ that Grignard reagents added to the C⁷, N⁶-double bond of 3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine, giving corresponding 7-alkylated 6,7-dihydro-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidines. Some work has been reported on the reaction of halogenated *N*-heteroarenes with Grignard reagents in the absence of metal

Chart 1

phosphine complex⁵⁾ catalysts. Thus, we examined the reaction of **1** with Grignard reagents.

When a solution of **1** and methylmagnesium iodide in THF was refluxed for 2 h, the addition of methylmagnesium iodide across the C⁷, N⁶-double bond of **1** was found to occur, giving 5-chloro-6,7-dihydro-7-methyl-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine (**9a**). A similar addition proceeded in the case of the reaction of **1** with ethyl-, phenyl-, benzyl-, and phenethylmagnesium bromide under the same conditions, giving the corresponding 7-alkylated 5-chloro-6,7-dihydro-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidines (**9b–e**). Compounds **9a–e** were easily aromatized to 7-alkylated 5-chloro-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidines (**10a–e**) by oxidation with 2,3-dichloro-4,5-dicyano-*p*-benzoquinone (DDQ) in THF. It appeared from the above results that **1** undergoes addition of Grignard reagents to the C⁷, N⁶-double bond rather than nucleophilic substitution of the chlorine atom at the 5-position.

It is well known that sulfonyl groups of pyridine⁶⁾ and quinoline⁷⁾ rings are replaced by Grignard reagents. Thus, we investigated the reaction of **2** with Grignard reagents.

TABLE I. Yields, Melting Points, and Elemental Analysis for **9** and **10**

Compd.	Yield (%)	mp (°C)	Formula	Analysis (%)		
				Calcd	Found	
				C	H	N
9a	87	190–191 ^{a)}	C ₁₁ H ₁₀ ClN ₅	53.34 (53.27)	4.07 (4.03)	28.27 (28.20)
9b	80	148–150 ^{b)}	C ₁₂ H ₁₂ ClN ₅	55.07 (55.29)	4.62 (4.62)	26.76 (26.80)
9c	76	158–161 ^{b)}	C ₁₆ H ₁₂ ClN ₅	62.04 (62.03)	3.90 (3.90)	22.61 (22.39)
9d	73	172–173 ^{a)}	C ₁₇ H ₁₄ ClN ₅	63.06 (62.78)	4.36 (4.35)	21.62 (21.38)
9e	76	100–102 ^{b)}	C ₁₈ H ₁₆ ClN ₅	64.00 (64.25)	4.77 (4.78)	20.73 (20.61)
10a	88	124 ^{b)}	C ₁₁ H ₈ ClN ₅	53.78 (54.08)	3.28 (3.33)	28.51 (28.68)
10b	90	114–115 ^{b)}	C ₁₂ H ₁₀ ClN ₅	55.50 (55.44)	3.88 (3.89)	26.97 (26.94)
10c	68	183–187 ^{b)}	C ₁₆ H ₁₀ ClN ₅	62.44 (62.48)	3.28 (3.30)	22.89 (22.63)
10d	50	110–111 ^{b)}	C ₁₇ H ₁₂ ClN ₅	63.46 (63.63)	3.76 (3.83)	21.76 (21.76)
10e	86	99–100 ^{b)}	C ₁₈ H ₁₄ ClN ₅	64.38 (64.60)	4.20 (4.26)	20.86 (20.49)

a) Recrystallized from benzene. b) Recrystallized from petroleum benzene.

TABLE II. Yields, Melting Points, and Elemental Analysis for **11** and **12**

Compd.	Yield (%)	mp (°C)	Formula	Analysis (%)		
				Calcd	Found	
				C	H	N
11a	76	155–157 ^{a)}	C ₁₁ H ₉ N ₅	62.55 (62.69)	4.30 (4.36)	33.16 (33.11)
11b	69	75–77 ^{b)}	C ₁₂ H ₁₁ N ₅	63.98 (63.99)	4.92 (4.95)	31.09 (30.88)
11c	35	131–134 ^{b)}	C ₁₆ H ₁₁ N ₅	70.31 (70.55)	4.06 (4.05)	25.63 (25.54)
11d	24	106–107 ^{a)}	C ₁₇ H ₁₃ N ₅	71.06 (71.20)	4.56 (4.54)	24.38 (24.42)
11e	55	105–107 ^{a)}	C ₁₈ H ₁₅ N ₅	71.74 (71.82)	5.02 (5.09)	23.24 (22.88)
12c	12	176–177 ^{c)}	C ₁₇ H ₁₅ N ₅ O ₂ S	57.78 (57.48)	4.28 (4.32)	19.82 (19.51)

a) Recrystallized from petroleum benzene–benzene. b) Recrystallized from petroleum benzene. c) Recrystallized from chloroform.

When a solution of **2** and methylmagnesium iodide in THF was stirred at room temperature for 2 h, the substitution proceeded to give 5-methyl-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine (**11a**). Similarly, **2** reacted with ethyl-, benzyl-, and phenethylmagnesium bromide to give **11b**, **d**, **e**, respectively. On the other hand, in the case of the reaction with phenylmagnesium bromide under the same conditions, both addition across the C⁷, N⁶-double bond and substitution of the methylsulfonyl group at the 5-position occurred, giving 6,7-dihydro-3,7-diphenyl-5-(methylsulfonyl)-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine (**12c**) and 3,5-diphenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine (**11c**), respectively.

We concluded that the methylsulfonyl group at the 5-position of the 3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine ring was easily substituted with C-nucleophiles, that is, potassium

cyanide, the carbanion of ethyl cyanoacetate, and Grignard reagents, giving the corresponding 5-substituted 3*H*-1,2,3-triazolo[4,5-*d*]pyrimidines. The substitution of the methylsulfonyl group in **2** with *C*-nucleophiles provides a useful method for the introduction of functionalized carbons at the 5-position of the 3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine ring.

Experimental

All melting points are uncorrected. Infrared (IR) spectra were measured with a Jasco A-102 diffraction grating IR spectrometer. Proton nuclear magnetic resonance (¹H-NMR) spectra were taken at 60 MHz and 23 °C with a Hitachi R-24B high-resolution ¹H-NMR spectrometer. Chemical shifts are expressed in parts per million (ppm) downfield from tetramethylsilane as an internal standard. The following abbreviations are used: s=singlet, d=doublet, t=triplet, br=broad, q=quartet, m=multiplet.

5-(Methylthio)-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine (3) A solution of **1**³ (2.5 g, 12 mmol) and 15% aqueous NaSMc (10 ml, 22 ml) in DMF (5 ml) was stirred at 60 °C for 1 h. The reaction mixture was poured into water and extracted with benzene. The crude product obtained from the benzene extract was purified by SiO₂ column chromatography using petroleum benzin-benzene to give **3** as colorless needles, mp 119–120 °C. Yield 2 g (70%). *Anal.* Calcd for C₁₁H₉N₃S: C, 54.30; H, 3.73; N, 28.79. Found: C, 54.63; H, 3.72; N, 28.53. ¹H-NMR (CDCl₃): 2.66 (3H, s, SCH₃), 7.37–7.75 (3H, m, N³-Ph), 8.24–8.31 (2H, m, N³-Ph), 9.28 (1H, s, C⁷-H).

5-(Methylsulfonyl)-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine (2) A solution of KMnO₄ (2.6 g, 16.4 mmol) in H₂O (50 ml) was added to a solution of **3** (2.0 g, 8.2 mmol) in AcOH (100 ml). The mixture was stirred at room temperature for 2 h. The reaction mixture was diluted with H₂O, made alkaline with Na₂CO₃, and extracted with benzene. The crude product obtained from the benzene extract was purified by SiO₂ column chromatography using benzene-CHCl₃ (1:1) as an eluant and recrystallized from benzene-CHCl₃ to give **2** as colorless needles, mp 149–150 °C. Yield 1.46 g (65%). *Anal.* Calcd for C₁₁H₉N₃O₂S: C, 48.00; H, 3.30; N, 25.44. Found: C, 48.47; H, 3.33; N, 25.27. IR $\nu_{\text{max}}^{\text{KBr}}$ cm⁻¹: 1120, 1305 (SO₂). ¹H-NMR (CDCl₃): 3.45 (3H, s, SO₂CH₃), 7.41–7.67 (3H, m, N³-Ph), 8.08–8.24 (2H, m, N³-Ph), 9.64 (1H, s, C⁷-H).

5-Methoxy-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine (4) A solution of **2** (150 mg, 0.55 mmol) and NaOMe (30 mg, 0.55 mmol) in MeOH (15 ml) was stirred at room temperature for 1 h. The solvent was removed under reduced pressure. The residue was diluted with H₂O and extracted with CHCl₃. The crude product obtained from the CHCl₃ extract was recrystallized from petroleum benzin-benzene to give **4** as colorless needles, mp 94–95 °C (lit.³¹ mp 98–99 °C). Yield 120 mg (97%). ¹H-NMR (CDCl₃): 4.14 (3H, s, OCH₃), 7.38–7.65 (3H, m, N³-Ph), 8.10–8.28 (2H, m, N³-Ph), 9.41 (1H, s, C⁷-H).

5-Butylamino-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine (5) A solution of **2** (150 mg, 0.55 mmol) and butylamine (41 mg, 0.55 mmol) in CHCl₃ (5 ml) was refluxed for 30 min. The mixture was diluted with H₂O and extracted with CHCl₃. The CHCl₃ extract was washed with 2*N* HCl. The crude product obtained from the CHCl₃ extract was recrystallized from CHCl₃ to give **5** as colorless needles, mp 149–150 °C. Yield 125 mg (86%). *Anal.* Calcd for C₁₄H₁₆N₆: C, 62.66; H, 6.02; N, 31.32. Found: C, 62.47; H, 6.03; N, 31.22. IR $\nu_{\text{max}}^{\text{KBr}}$ cm⁻¹: 3250 (NH). ¹H-NMR (CDCl₃): 0.84–1.17 (3H, m, NH(CH₂)₃CH₃), 1.28–1.78 (4H, m, NHCH₂(CH₂)₂CH₃), 3.35–3.66 (2H, m, NHCH₂(CH₂)₂CH₃), 5.62–6.18 (1H, br, NH), 7.25–7.61 (3H, m, N³-Ph), 8.05–8.21 (2H, m, N³-Ph), 8.95 (1H, s, C⁷-H).

3-Phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine-5-carbonitrile (6) A solution of **2** (200 mg, 0.72 mmol) and KCN (95 mg, 1.44 mmol) in DMF (5 ml) was stirred at room temperature for 1.5 h. The mixture was diluted with H₂O and extracted with benzene. The crude product obtained from the benzene extract was recrystallized from benzene to give **6** as a yellow solid, mp 172–173 °C. Yield 156 mg (96%). *Anal.* Calcd for C₁₁H₆N₆: C, 59.45; H, 2.72; N, 37.82. Found: C, 59.65; H, 2.79; N, 38.00. ¹H-NMR (CDCl₃): 7.36–7.79 (3H, m, N³-Ph), 7.94–8.33 (2H, m, N³-Ph), 9.63 (1H, s, C⁷-H).

Ethyl α-Cyano-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine-5-acetate (7) 1) A solution of **1** (116 mg, 0.5 mmol), ethyl cyanoacetate (113 mg, 1 mmol), and 60% (in oil) NaH (40 mg, 1 mmol) in DMF (3 ml) was stirred at room temperature for 3 h. The mixture was diluted with H₂O, neutralized with AcOH, and extracted with CHCl₃. The crude product obtained from the CHCl₃ extract was purified by SiO₂ column

chromatography using CHCl₃-MeOH (100:1) and recrystallized from benzene-MeOH to give **7** as pale yellow needles, mp 280–282 °C. Yield 105 mg (62%). *Anal.* Calcd for C₁₅H₁₂N₆O₂·H₂O: C, 55.21; H, 4.32; N, 25.76. Found: C, 55.41; H, 3.95; N, 26.10. IR $\nu_{\text{max}}^{\text{KBr}}$ cm⁻¹: 1695 (C=O), 2140 (CN). ¹H-NMR (DMSO-*d*₆): 1.31 (3H, t, *J* = 7.0 Hz, OCH₂CH₃), 4.23 (2H, q, *J* = 7.0 Hz, OCH₂CH₃), 7.38–7.89 (6H, m, N³-Ph and CH₂CN), 8.82 (1H, s, C⁷-H).

2) A mixture of **2** (200 mg, 0.73 mmol), ethyl cyanoacetate (165 mg, 1.46 mmol), 60% (in oil) NaH (58 mg, 1.46 mmol), and DMF (5 ml) was stirred at room temperature for 3 h. The same work-up of the reaction mixture as described for **7** under item 1) gave **7** in 93% yield (210 mg).

7-Acetyl-5-chloro-6,7-dihydro-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine (8a) A solution of **1** (232 mg, 1 mmol), acetone (87 mg, 1.5 mmol), and KOH (86 mg, 1.5 mmol) in DMSO (5 ml) was stirred at 40 °C for 5 h. The reaction mixture was diluted with H₂O, neutralized with AcOH, and extracted with CHCl₃. The crude product obtained from the CHCl₃ extract was purified by SiO₂ column chromatography. The fraction eluted from benzene gave **1**. Recovery, 35 mg (15%). The fraction eluted from CHCl₃ gave **8a** as pale yellow needles, mp 192–193 °C. Yield 26 mg (9%). *Anal.* Calcd for C₁₃H₁₃ClN₅O: C, 53.70; H, 4.51; N, 24.09. Found: C, 53.98; H, 4.18; N, 24.19. IR $\nu_{\text{max}}^{\text{KBr}}$ cm⁻¹: 1690 (C=O), 3200 (NH). ¹H-NMR (CDCl₃): 2.22 (3H, s, CH₃COCH₃), 3.09 (1H, d, d, *J* = 19.0, 2.4 Hz, CH₂COCH₃), 3.48 (1H, d, d, *J* = 19.0, 10.0 Hz, CH₂COCH₃), 5.59 (1H, d, d, *J* = 2.4, 10.0 Hz, C⁷-H), 6.34–6.66 (1H, br, NH), 7.24–7.50 (3H, m, N³-Ph), 7.62–7.88 (2H, m, N³-Ph).

7-Acetyl-6,7-dihydro-5-(methylsulfonyl)-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine (8b) A solution of **2** (150 mg, 0.55 mmol), acetone (47 mg, 0.83 mmol), and KOH (46 mg, 0.83 mmol) in DMSO (5 ml) was stirred at room temperature for 3 h. The mixture was diluted with H₂O, neutralized with AcOH, and extracted with CHCl₃. The crude product

TABLE III. IR and ¹H-NMR Spectral Data for **9a–e**

Compd.	IR $\nu_{\text{max}}^{\text{KBr}}$ (cm ⁻¹)	¹ H-NMR (CDCl ₃) δ
9a	3320 (NH)	1.68 (3H, d, <i>J</i> = 7.0 Hz, CH ₃), 5.30 (1H, dq, <i>J</i> = 7.0 Hz, <i>J</i> = 3.8 Hz, C ⁷ -H), 6.51–6.79 (1H, br, NH), 7.29–7.65 (3H, m, N ³ -Ph), 7.80–7.97 (2H, m, N ³ -Ph)
9b	3160 (NH)	1.02 (3H, t, <i>J</i> = 7.0 Hz, CH ₂ CH ₃), 1.73–2.21 (2H, m, CH ₂ CH ₃), 5.10 (1H, t, <i>J</i> = 4.0 Hz, C ⁷ -H), 6.45–6.90 (1H, br, NH), 7.23–7.56 (3H, m, N ³ -Ph), 7.70–7.79 (2H, m, N ³ -Ph)
9c	3150 (NH)	5.99 (1H, d, <i>J</i> = 2.0 Hz, C ⁷ -H), 6.18–6.91 (1H, br, NH), 7.21–7.55 (8H, m, N ³ -Ph and C ⁷ -H), 7.71–7.93 (2H, m, N ³ -Ph)
9d	3150 (NH)	3.90 (1H, dd, <i>J</i> = 14.0, 3.2 Hz, CH ₂ Ph), 3.47 (1H, dd, <i>J</i> = 14.0, 8.8 Hz, CH ₂ Ph), 5.42 (1H, dd, <i>J</i> = 3.2, 8.8 Hz, C ⁷ -H), 6.09–6.35 (1H, br, NH), 6.96–7.60 (8H, m, N ³ -Ph and CH ₂ Ph), 7.67–7.89 (2H, m, N ³ -Ph)
9e	3200 (NH)	2.06–2.97 (4H, m, CH ₂ CH ₂ Ph), 5.00–5.28 (1H, m, C ⁷ -H), 6.25–6.50 (1H, br, NH), 6.96–7.55 (8H, m, N ³ -Ph and C ₂ H ₄ Ph), 7.67–7.89 (2H, m, N ³ -Ph)

TABLE IV. ¹H-NMR Spectral Data for **10a–e**

Compd.	¹ H-NMR (CDCl ₃) δ
10a	2.88 (3H, s, CH ₃), 7.20–7.65 (3H, m, N ³ -Ph), 7.83–8.13 (2H, m, N ³ -Ph)
10b	1.54 (3H, t, <i>J</i> = 7.0 Hz, CH ₂ CH ₃), 3.38 (2H, q, <i>J</i> = 7.0 Hz, CH ₂ CH ₃), 7.35–7.79 (3H, m, N ³ -Ph), 7.96–8.34 (2H, m, N ³ -Ph)
10c	7.30–7.69 (5H, m, C ⁷ -Ph), 7.97–8.30 (3H, m, N ³ -Ph), 8.74–8.99 (2H, m, N ³ -Ph)
10d	4.56 (2H, s, CH ₂ Ph), 7.07–7.65 (8H, m, N ³ -Ph and CH ₂ Ph), 7.88–8.15 (2H, m, N ³ -Ph)
10e	3.12–3.82 (4H, m, CH ₂ CH ₂ Ph), 7.24 (5H, s, CH ₂ CH ₂ Ph), 7.38–7.80 (3H, m, N ³ -Ph), 7.97–8.28 (2H, m, N ³ -Ph)

TABLE V. IR and $^1\text{H-NMR}$ Spectral Data for **11** and **12**

Compd.	IR $\nu_{\text{max}}^{\text{KBr}}$ (cm^{-1})	$^1\text{H-NMR}$ (CDCl_3) δ
11a		2.88 (3H, s, CH_3), 7.30—7.78 (3H, m, $\text{N}^3\text{-Ph}$), 8.01—8.25 (2H, m, $\text{N}^3\text{-Ph}$), 9.38 (1H, s, $\text{C}^7\text{-H}$)
11b		1.46 (3H, t, $J=7.0$ Hz, CH_2CH_3), 3.17 (2H, q, $J=7.0$ Hz, CH_2CH_3), 7.27—7.65 (3H, m, $\text{N}^3\text{-Ph}$), 8.03—8.31 (2H, m, $\text{N}^3\text{-Ph}$), 9.39 (1H, s, $\text{C}^7\text{-H}$)
11c		7.08—7.60 (6H, m, $\text{N}^3\text{-Ph}$ and $\text{C}^5\text{-Ph}$), 8.02—8.42 (4H, m, $\text{N}^3\text{-Ph}$ and $\text{C}^5\text{-Ph}$), 9.34 (1H, s, $\text{C}^7\text{-H}$)
11d		4.45 (2H, s, CH_2Ph), 7.05—7.78 (8H, m, $\text{N}^3\text{-Ph}$ and CH_2Ph), 8.00—8.43 (2H, m, $\text{N}^3\text{-Ph}$), 9.45 (1H, s, $\text{C}^7\text{-H}$)
11e		2.71—3.80 (4H, m, $\text{CH}_2\text{CH}_2\text{Ph}$), 7.17 (5H, s, $\text{CH}_2\text{CH}_2\text{Ph}$), 7.34—7.67 (3H, m, $\text{N}^3\text{-Ph}$), 8.05—8.23 (2H, m, $\text{N}^3\text{-Ph}$), 9.42 (1H, s, $\text{C}^7\text{-H}$)
12c	1130 (SO_2) 1300 (SO_2) 3270 (NH)	3.12 (3H, s, SO_2CH_3), 6.22 (1H, d, $J=2.0$ Hz, $\text{C}^7\text{-H}$), 7.22—7.50 (9H, m, $\text{N}^3\text{-Ph}$, $\text{C}^7\text{-Ph}$, and NH), 7.72—7.95 (2H, m, $\text{N}^3\text{-Ph}$)

obtained from the CHCl_3 extract was purified by SiO_2 column chromatography using CHCl_3 as an eluant and recrystallized from benzene to give **8b** as a colorless solid, mp 163—165°C. Yield 25 mg (14%). *Anal.* Calcd for $\text{C}_{14}\text{H}_{15}\text{N}_5\text{O}_3\text{S}$: C, 50.44; H, 4.54; N, 21.01. Found: C, 50.26; H, 4.46; N, 20.87. IR $\nu_{\text{max}}^{\text{KBr}}$ cm^{-1} : 1130, 1310 (SO_2), 1700 ($\text{C}=\text{O}$). $^1\text{H-NMR}$ (CDCl_3): 2.22 (3H, s, CH_2COCH_3), 2.61—3.80 (2H, m, CH_2COCH_3), 3.16 (3H, s, SO_2CH_3), 5.51—5.80 (1H, br, $\text{C}^7\text{-H}$), 7.25—7.66 (4H, m, $\text{N}^3\text{-Ph}$ and NH), 7.70—8.01 (2H, m, $\text{N}^3\text{-Ph}$).

General Procedure for the Reaction of 1 with Grignard Reagents A solution of **1** (232 mg, 1 mmol) and Grignard reagent (2 mmol) in THF

(10 ml) was refluxed for 3 h. The solvent was removed under reduced pressure. The residue was diluted with a mixture of 28% $\text{NH}_4\text{OH-NH}_4\text{Cl-H}_2\text{O}$ (1:1:5) and extracted with CHCl_3 . The crude product obtained from the CHCl_3 extract was purified by SiO_2 column chromatography using CHCl_3 as an eluant and recrystallized from the appropriate solvent shown in Table I to give **9a—e**.

General Procedure for the Oxidation of 9 with DDQ A solution of **9** (0.47 mmol) and DDQ (0.55 mmol) in THF (4 ml) was stirred at room temperature for 2 h. The solvent was removed under reduced pressure. The residue was diluted with H_2O and extracted with CHCl_3 . The crude product obtained from the CHCl_3 extract was purified by SiO_2 column chromatography using benzene- CHCl_3 (1:1) as an eluant and recrystallized from petroleum benzin-benzene to give **10a—e**.

General Procedure for the Reaction of 2 with Grignard Reagents A solution of **2** (275 mg, 1 mmol) and Grignard reagent (1.5 mmol) in THF (10 ml) was stirred at room temperature for 3 h. The solvent was removed under reduced pressure. The residue was diluted with a mixture of 28% $\text{NH}_4\text{OH-NH}_4\text{Cl-H}_2\text{O}$ (1:1:5) and extracted with CHCl_3 . The crude product obtained from the CHCl_3 extract was purified by SiO_2 column chromatography. The fraction eluted from benzene gave **11a—e**. The fraction from CHCl_3 gave **12c**.

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