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 C^7,N^6-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 chloro[2] and *p*-tolylsulfonyl groups[2] 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 ($KMnO_4$) in acetic acid (AcOH).

It was reported[3] 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 reported[2] 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 reported[2] 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 C^7, N^6-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 reported[4] that Grignard reagents added to the C^7, N^6-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

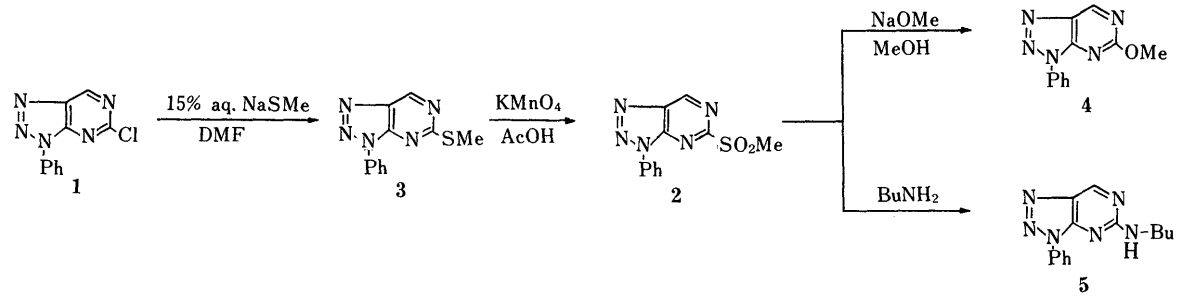

Chart 1

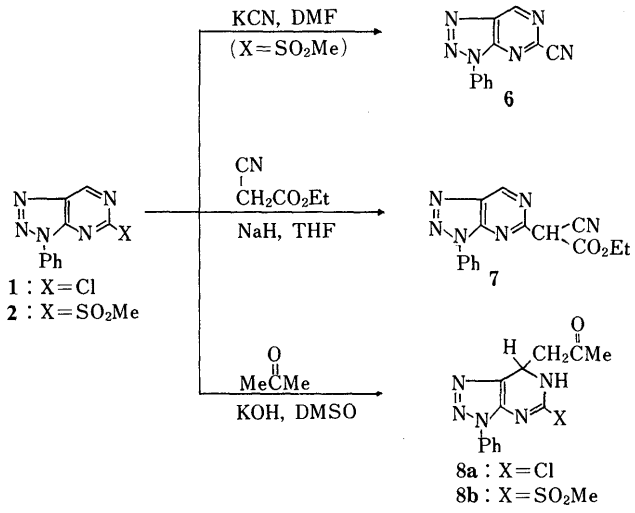

Chart 2

phosphine complex[5] 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 C^7, N^6-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 C^7, N^6-double bond rather than nucleophilic substitution of the chlorine atom at the 5-position.

It is well known that sulfonyl groups of pyridine[6] and quinoline[7] rings are replaced by Grignard reagents. Thus, we investigated the reaction of **2** with Grignard reagents.

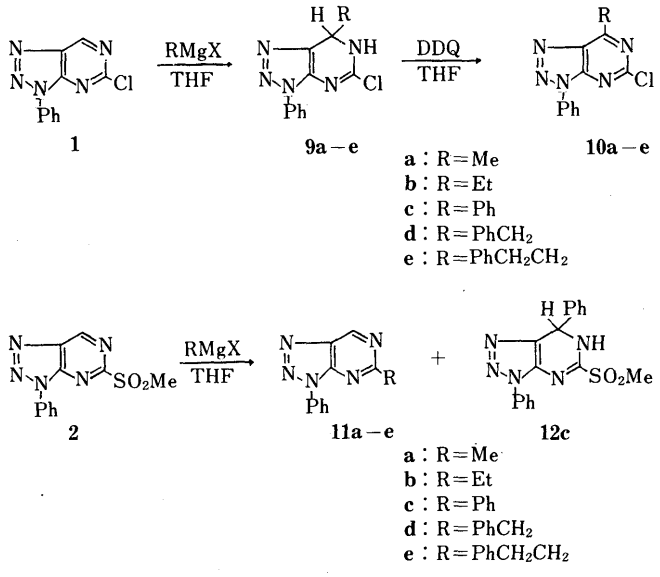

Chart 3

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]	$C_{11}H_8ClN_5$	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 benzin–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]	$C_{11}H_9N_5$	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]	$C_{17}H_{15}N_5O_2S$	57.78 (57.48)	4.28 (4.32)	19.82 (19.51)

a) Recrystallized from petroleum benzin–benzene. *b*) Recrystallized from petroleum benzin. *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 C^7, N^6-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**), respectvely.

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 (^{1}H-NMR) spectra were taken at 60 MHz and 23 °C with a Hitachi R-24B high-resolution ^{1}H-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 NaSMe (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 SiO_2 column chromatography using petroleum benzin–benzene to give **3** as colorless needles, mp 119—120 °C. Yield 2 g (70%). *Anal.* Calcd for $C_{11}H_9N_5S$: C, 54.30; H, 3.73; N, 28.79. Found: C, 54.63; H, 3.72; N, 28.53. ^{1}H-NMR ($CDCl_3$): 2.66 (3H, s, SCH_3), 7.37—7.75 (3H, m, N^3-Ph), 8.24—8.31 (2H, m, N^3-Ph), 9.28 (1H, s, C^7-H).

5-(Methylsulfonyl)-3-phenyl-3*H*-1,2,3-triazolo[4,5-*d*]pyrimidine (2) A solution of $KMnO_4$ (2.6 g, 16.4 mmol) in H_2O (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 H_2O, made alkaline with Na_2CO_3, and extracted with benzene. The crude product obtained from the benzene extract was purified by SiO_2 column chromatography using benzene–$CHCl_3$ (1 : 1) as an eluant and recrystallized from benzene–$CHCl_3$ to give **2** as colorless needles, mp 149—150 °C. Yield 1.46 g (65%). *Anal.* Calcd for $C_{11}H_9N_5O_2S$: C, 48.00; H, 3.30; N, 25.44. Found: C, 48.47; H, 3.33; N, 25.27. IR ν_{max}^{KBr} cm^{-1}: 1120, 1305 (SO_2). ^{1}H-NMR ($CDCl_3$): 3.45 (3H, s, SO_2CH_3), 7.41—7.67 (3H, m, N^3-Ph), 8.08—8.24 (2H, m, N^3-Ph), 9.64 (1H, s, C^7-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 H_2O and extracted with $CHCl_3$. The crude product obtained from the $CHCl_3$ extract was recrystallized from petroleum benzin–benzene to give **4** as colorless needles, mp 94—95 °C (lit.[3] mp 98—99 °C). Yield 120 mg (97%). ^{1}H-NMR ($CDCl_3$): 4.14 (3H, s, OCH_3), 7.38—7.65 (3H, m, N^3-Ph), 8.10—8.28 (2H, m, N^3-Ph), 9.41 (1H, s, C^7-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 $CHCl_3$ (5 ml) was refluxed for 30 min. The mixture was diluted with H_2O and extracted with $CHCl_3$. The $CHCl_3$ extract was washed with 2 N HCl. The crude product obtained from the $CHCl_3$ extract was recrystallized from $CHCl_3$ to give **5** as colorless needles, mp 149—150 °C. Yield 125 mg (86%). *Anal.* Calcd for $C_{14}H_{16}N_6$: C, 62.66; H, 6.02; N, 31.32. Found: C, 62.47; H, 6.03; N, 31.22. IR ν_{max}^{KBr} cm^{-1}: 3250 (NH). ^{1}H-NMR ($CDCl_3$): 0.84—1.17 (3H, m, $NH(CH_2)_3C\underline{H}_3$), 1.28—1.78 (4H, m, $NHCH_2(C\underline{H}_2)_2CH_3$), 3.35—3.66 (2H, m, $NHC\underline{H}_2(CH_2)_2CH_3$), 5.62—6.18 (1H, br, NH), 7.25—7.61 (3H, m, N^3-Ph), 8.05—8.21 (2H, m, N^3-Ph), 8.95 (1H, s, C^7-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 H_2O 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 $C_{11}H_6N_6$: C, 59.45; H, 2.72; N, 37.82. Found: C, 59.65; H, 2.79; N, 38.00. ^{1}H-NMR ($CDCl_3$): 7.36—7.79 (3H, m, N^3-Ph), 7.94—8.33 (2H, m, N^3-Ph), 9.63 (1H, s, C^7-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 H_2O, neutralized with AcOH, and extracted with $CHCl_3$. The crude product obtained from the $CHCl_3$ extract was purified by SiO_2 column chromatography using $CHCl_3$–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 $C_{15}H_{12}N_6O_2 \cdot H_2O$: C, 55.21; H, 4.32; N, 25.76. Found: C, 55.41; H, 3.95; N, 26.10. IR ν_{max}^{KBr} cm^{-1}: 1695 (C=O), 2140 (CN). ^{1}H-NMR (DMSO-d_6): 1.31 (3H, t, J = 7.0 Hz, $OCH_2C\underline{H}_3$), 4.23 (2H, q, J = 7.0 Hz, $OC\underline{H}_2CH_3$), 7.38—7.89 (6H, m, N^3-Ph and $C\underline{H}(CN)CO_2Et$), 8.82 (1H, s, C^7-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 3h. The same work-up of the reaction mixture as described for **7** under item 1) gave **7** in 93% yield (210 mg).

7-Acetonyl-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 H_2O, neutralized with AcOH, 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 **1**. Recovery, 35 mg (15%). The fraction eluted from $CHCl_3$ gave **8a** as pale yellow needles, mp 192—193 °C. Yield 26 mg (9%). *Anal.* Calcd for $C_{13}H_{13}ClN_5O$: C, 53.70; H, 4.51; N, 24.09. Found: C, 53.98; H, 4.18; N, 24.19. IR ν_{max}^{KBr} cm^{-1}: 1690 (C=O), 3200 (NH). ^{1}H-NMR ($CDCl_3$): 2.22 (3H, s, $CH_2COC\underline{H}_3$), 3.09 (1H, d, d, J = 19.0, 2.4 Hz, $C\underline{H}_2COCH_3$), 3.48 (1H, d, d, J = 19.0, 10.0 Hz, $C\underline{H}_2COCH_3$), 5.59 (1H, d, d, J = 2.4, 10.0 Hz, C^7-H), 6.34—6.66 (1H, br, NH), 7.24—7.50 (3H, m, N^3-Ph), 7.62—7.88 (2H, m, N^3-Ph).

7-Acetonyl-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 H_2O, neutralized with AcOH, and extracted with $CHCl_3$. The crude product

Table III. IR and ^{1}H-NMR Spectral Data for **9a**—**e**

Compd.	IR ν_{max}^{KBr} (cm^{-1})	^{1}H-NMR ($CDCl_3$) δ
9a	3320 (NH)	1.68 (3H, d, J = 7.0 Hz, CH_3), 5.30 (1H, dq, J = 7.0 Hz, J = 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, J = 7.0 Hz, $CH_2C\underline{H}_3$), 1.73—2.21 (2H, m, $C\underline{H}_2CH_3$), 5.10 (1H, t, J = 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, J = 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-Ph), 7.71—7.93 (2H, m, N^3-Ph)
9d	3150 (NH)	3.90 (1H, dd, J = 14.0, 3.2 Hz, $C\underline{H}_2$Ph), 3.47 (1H, dd, J = 14.0 8.8 Hz, $C\underline{H}_2$Ph), 5.42 (1H, dd, J = 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 $CH_2\underline{Ph}$), 7.67—7.89 (2H, m, N^3-Ph)
9e	3200 (NH)	2.06—2.97 (4H, m, $C\underline{H}_2C\underline{H}_2$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 $C_2H_4\underline{Ph}$), 7.67—7.89 (2H, m, N^3-Ph)

Table IV. ^{1}H-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, J = 7.0 Hz, $CH_2C\underline{H}_3$), 3.38 (2H, q, J = 7.0 Hz, $C\underline{H}_2CH_3$), 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, $C\underline{H}_2$Ph), 7.07—7.65 (8H, m, N^3-Ph and $CH_2\underline{Ph}$), 7.88—8.15 (2H, m, N^3-Ph)
10e	3.12—3.82 (4H, m, $C\underline{H}_2C\underline{H}_2$Ph), 7.24 (5H, s, $CH_2CH_2\underline{Ph}$), 7.38—7.80 (3H, m, N^3-Ph), 7.97—8.28 (2H, m, N^3-Ph)

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

Compd.	IR ν_{max}^{KBr} (cm^{-1})	^{1}H-NMR ($CDCl_3$) δ
11a		2.88 (3H, s, CH_3), 7.30—7.78 (3H, m, N^3-Ph), 8.01—8.25 (2H, m, N^3-Ph), 9.38 (1H, s, C^7-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, N^3-Ph), 8.03—8.31 (2H, m, N^3-Ph), 9.39 (1H, s, C^7-H)
11c		7.08—7.60 (6H, m, N^3-Ph and C^5-Ph), 8.02—8.42 (4H, m, N^3-Ph and C^5-Ph), 9.34 (1H, s, C^7-H)
11d		4.45 (2H, s, CH_2Ph), 7.05—7.78 (8H, m, N^3-Ph and CH_2Ph), 8.00—8.43 (2H, m, N^3-Ph), 9.45 (1H, s, C^7-H)
11e		2.71—3.80 (4H, m, CH_2CH_2Ph), 7.17 (5H, s, CH_2CH_2Ph), 7.34—7.67 (3H, m, N^3-Ph), 8.05—8.23 (2H, m, N^3-Ph), 9.42 (1H, s, C^7-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, C^7-H), 7.22—7.50 (9H, m, N^3-Ph, C^7-Ph, and NH), 7.72—7.95 (2H, m, N^3-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 $C_{14}H_{15}N_5O_3S$: C, 50.44; H, 4.54; N, 21.01. Found: C, 50.26; H, 4.46; N, 20.87. IR ν_{max}^{KBr} cm^{-1}: 1130, 1310 (SO_2), 1700 (C=O). ^{1}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, C^7-H), 7.25—7.66 (4H, m, N^3-Ph and NH), 7.70—8.01 (2H, m, N^3-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% NH_4OH–NH_4Cl–H_2O (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% NH_4OH–NH_4Cl–H_2O (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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