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Aza Wittig-type Reaction between the Iminophosphorane Derived from 3-Amino-4-phenylthiazole-2(3*H*)-thione and Iso(thio)cyanates: Preparation of Mesoionic Thiazolo[2,3-*b*]-1,3,4-thiadiazoles and *N,N*-Bisheteroarylamines

Pedro Molina*, Antonio Arques, Asunción Alías

Departamento de Química Orgánica, Facultad de Química, Universidad de Murcia, Campus de Espinardo,
E-30071 Murcia, Spain.

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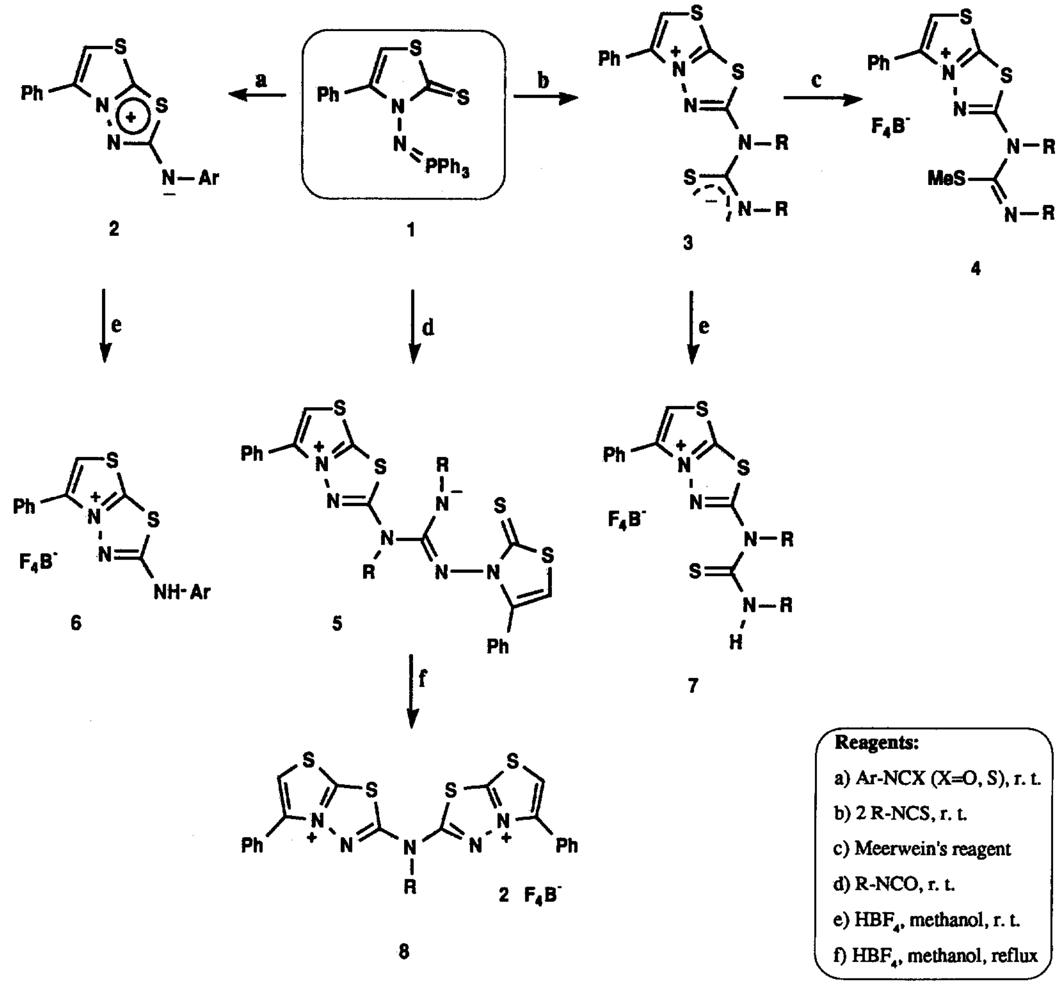
Abstract: Aza Wittig-type reaction of iminophosphorane 1 derived from 3-amino-4-phenylthiazole-2(3H)-thione with several types of iso(thio)cyanates has been studied. The reaction of 1 with aromatic iso(thio)cyanates leads to thiazolo[2,3-b]-1,3,4-thiadiazoles 2 which display mesoionic character, whereas that with aliphatic isothiocyanates affords the betaines 3. N,N'-Bisheteroarylguanidines 5 are obtained from the reaction of 1 with aliphatic isocyanates; further treatment of compounds 5 with tetrafluoroboric acid leads to N,N-bisheteroarylamines 8. The reaction of 1 with acyl chlorides affords thiazolo[2,3-b]-1,3,4-thiadiazolium salts 12.

Iminophosphoranes derived from N-aminoheterocycles are valuable precursors for the preparation of fused heterocycles which may be neutral, cationic or mesoionic[1]. Recently, we have reported[2] a regioselective iminophosphorane-mediated annelation of 1,3,4-thiadiazole ring onto a 1,2,4-triazine starting from iminophosphoranes derived from 4-amino-1,2,4-triazines, and we found that the reaction products are dependent on the substituent adjacent to the N-amino group as well as on the nature of the heterocumulene used.

We now describe the reactions of iminophosphorane **1** with various isocyanates and isothiocyanates, undertaken in order to study how the nature of these heterocumulenes affects the products of the reaction. The starting material **1** is readily available from 3-amino-4-phenylthiazole-2(3*H*)-thione and triphenylphosphine dibromide. When a dichloromethane solution of **1** was treated with aromatic isocyanates or isothiocyanates at room temperature the corresponding mesoionic anhydro-2-arylamino-5-phenylthiazolo[2,3-*b*]-1,3,4-thiadiazolium hydroxides **2** were isolated as yellow crystalline solids in fair yields (48-56%). The iminophosphorane **1** also reacted with alkyl isothiocyanates at room temperature to give the zwitterionic derivatives **3**. However the reaction with



Reagents:
a) Ar-NCX (X=O, S), r. t.
b) 2 R-NCS, r. t.
c) Meerwein's reagent
d) R-NCO, r. t.
e) HBF_4, methanol, r. t.
f) HBF_4, methanol, reflux

Comp	Ar
2a	C_6H_5
2b	$4\text{-}CH_3\text{-}C_6H_4$
2c	$4\text{-}CH_3O\text{-}C_6H_4$
2d	$4\text{-}F\text{-}C_6H_4$

Comp	R
3a	CH_3
3b	C_2H_5
3c	$C_6H_5\text{-}CH_2$
3d	$4\text{-}CH_3\text{-}C_6H_4CH_2$

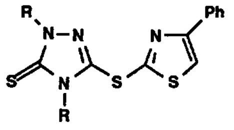
Comp	R
5a	CH_3
5b	C_2H_5
5c	$n\text{-}C_3H_7$
5d	$i\text{-}C_3H_7$
5e	$c\text{-}C_6H_{11}$
5f	$t\text{-}C_4H_9$

Comp	R
8a	CH_3
8b	C_2H_5
8c	$n\text{-}C_3H_7$
8d	$i\text{-}C_3H_7$
8e	$c\text{-}C_6H_{11}$
8f	H

methyl isocyanate led to the thiazolo[2,3-*b*]-1,3,4-thiadiazole derivative **5a**. Reaction of other alkyl isocyanates also resulted in the formation of the derivatives **5b**-**5f** in *ca.* 45% yields, confirming the generality of the reaction.

The ^{13}C n.m.r. spectroscopic data distinguish between neutral or cationic thiazole rings, specially the chemical shift of the C-5 carbon atom. In the iminophosphorane **1** this carbon atom absorbs at δ 105.21 ppm, whereas in compound **2** the C-6 of the thiazolo-thiadiazole ring system appears at δ 113.51-114.68 ppm.

The first indication of a structure of type **3** was provided by ^{1}H and ^{13}C n.m.r. spectra which clearly showed that there are two sets of signals for the alkyl groups and one set for the thiazole ring. The ^{1}H n.m.r. spectra in $CDCl_3$+TFA of compounds **3a**, **3c** and **3d** show a singlet at around δ 7.80 ppm attributed to the H-6, and the ^{1}H n.m.r. spectrum in $CDCl_3$ of **3b** shows a singlet at δ 7.74 ppm. In the ^{13}C n.m.r. spectra of compounds **3a**, **3c** and **3d** the C-6 carbon atom appears at δ 118.75-119.29 ppm, and for **3b** this carbon atom appears at 117.19 ppm, which seems to indicate that the thiazole ring displays cationic character. The thiocarbonyl carbon atom of compounds **3a**, **3c** and **3d** appears at around δ 178.85-180.05 ppm whereas for compound **3b** occurs at 162.00 ppm. In addition, the ^{1}H n.m.r. spectrum of **3a** ($R=CH_3$) shows one methyl group as a singlet at δ 3.92 ppm and the other as a doublet at δ 3.19 ($J=4.4$ Hz) which clearly rules out the structures 2,4-dialkyl-5-(4-phenyl-2-thiazolylthio)-1,2,4-triazoline-3-thione **9** and 4-alkyl-3-(4-phenyl-2-thiazolylthio)-[1,2,4]-thiadiazolin-5-alkylimine **10**. Compounds **3** undergo S-methylation by the action of Meerwein's reagent to give the salts **4** in excellent yields. In the ^{13}C n.m.r. spectra of compounds **4** the methylthio group and the C-6 carbon atom appear at 16.75-16.85 ppm and 122 ppm respectively. The ^{1}H and ^{13}C n.m.r. spectra of compounds **5** show that there are two sets of signals for the alkyl groups and for the thiazole rings. In the ^{13}C n.m.r. spectra appear two signals at δ 106.68-108.93 and 118.96-121.78 ppm due to the C-5 of the thiazole ring and to the C-6 of the fused thiazole portion respectively. The ^{13}C n.m.r. also show that the chemical shifts of the C-2, C-5 and C-7a carbon atoms of the thiazolo[2,3-*b*]thiadiazole moiety in compounds **2**, **3**, **4** and **5** are very similar (± 3 ppm) and the small differences found in compounds **2** could be due to their mesoionic nature.



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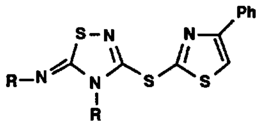

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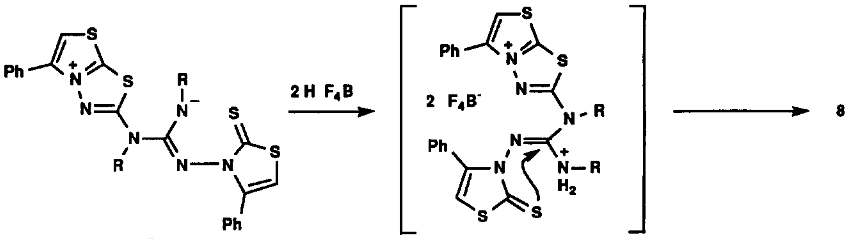
The formation of compounds **2**, **3** and **5** can be understood bearing in mind that the stability of mesionic aminides strongly depends on the nature of the substituent on the exocyclic nitrogen atom. Thus, it is known that mesoionic aminides bearing aryl or electron-withdrawing groups at the exocyclic nitrogen atom are stable[3], whereas mesoionic aminides in which the exocyclic nitrogen atom is attached to an alkyl group are rare[4]. This fact could be due to the instability of those compounds which is associated with a high negative charge density on the exocyclic nitrogen atom. In all cases is assumed that the reaction of iminophosphorane **1** with isocyanates or isothiocyanates leads to a carbodiimide as a reactive intermediate which cleanly undergoes cyclization to give a mesoionic aminide; further evolution of this fused mesoionic compound depends on the nature of the R group. Thus, the formation of

2 is a representative example of stabilized aminides where the exocyclic negative charge is delocalized on the adjacent aryl ring. The conversion **1**→**3** can be understood as nucleophilic attack of the intermediate aminide on a second molecule of alkyl isothiocyanate. A similar reaction pathway for the conversion **1**→**5** could be followed. In this case the highly reactive mesoionic aminide dimerizes by nucleophilic attack of the exocyclic negatively charged nitrogen atom on the C-2 carbon atom of the 1,3,4-thiadiazolium ring of the second molecule with concomitant ring-opening of the five-membered ring to give **5**.

These results show that the order of reactivity of the mesoionic alkyl aminides (carbodiimide valence tautomers[5]) towards heterocumulenes is the following: isothiocyanates > isocyanates, being the reverse of that previously reported[6] in reactions of nucleophiles on these heterocumulenes.

Compounds **2**, **3** and **5** show informative differences in their reactions towards tetrafluoroboric acid. When methanolic solutions of compounds **2** or **3** are treated with tetrafluoroboric acid at room temperature the salts **6** and **7** were obtained as crystalline solids. The n.m.r. data of compounds **6** and **7** are very similar those of compounds **2** and **3**, respectively. However, compounds **5** underwent cyclization followed by elimination of the corresponding amine by the action of tetrafluoroboric acid in methanol at reflux temperature to give **8** in good yields (81-93%). This conversion was found to be general when R was a primary or secondary alkyl group; however for **5f** (R=*t*-Bu) a concomitant dealkylation ocurred and the unsubstituted derivative **8f** was obtained in 86% yield. Presumably, the conversion **5**→**8** involves protonation of the exocyclic anionic guanidino moiety followed by intramolecular nucleophilic attack of the thiocarbonyl group of the neutral thiazole ring on the central carbon atom of the guanidino portion and elimination of the amine.



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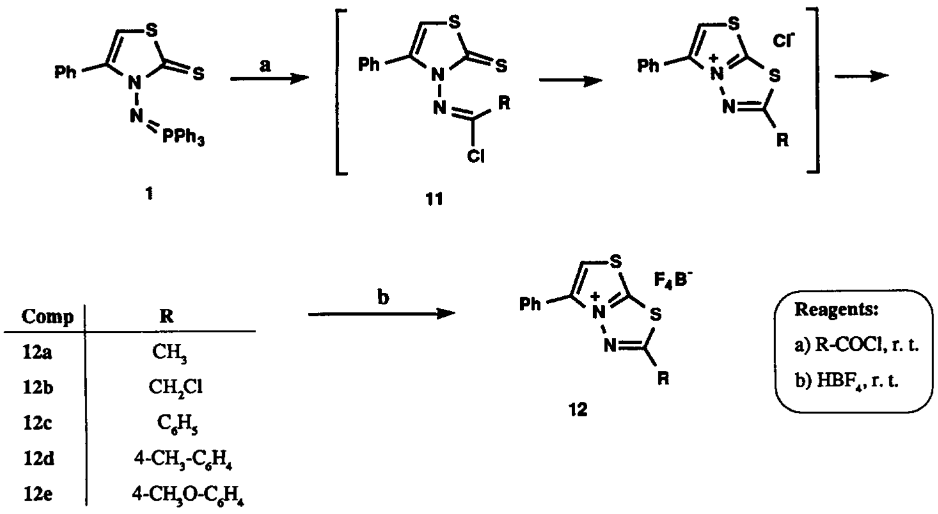
There is current interest in the chemistry of *N,N*-bisheteroarylamines because of the behaviour of this type of compound as ligands[7]; also some boron chelates synthesized from 2-dipyridylamine show antiviral activity[8], and recently studies on the metabolites of the sponge *Clathrina clathrus* revealed the presence of *N,N*-bisheteroarylamines with two imidazole rings[9]. However, there have been no general procedures dealing with the preparation of *N,N*-bisheteroarylamines in which the N-linked rings are fused heterocyclic ring, to the best of our knowledge.

Finally, iminophosphorane **1** also reacts with acyl chlorides at room temperature to give thiazolo[2,3-*b*]-1,3,4-thiadiazolium chlorides which, by the action of tetrafluoroboric acid at room temperature, were converted into the corresponding tetrafluoroborates **12**, the yield of the isolated product being higher than 50%. Presumably, the **1**→**12** transformation involves initial aza Wittig reaction between the iminophosphorane and the acyl chloride to give an imidoyl chloride[10] **11** as intermediate and subsequent cyclization by intramolecular nucleophilic attack of the exocyclic thiocarbonyl group would give the corresponding thiazolo[2,3-*b*]-1,3,4-thiadiazolium salts.

In the ^{13}C n.m.r. spectra in DMSO-d_6 of compounds **12** the C-6 carbon atoms appear at 123.61-124.27 ppm and the chemical shifts of the quaternary carbon atoms C-2 and C-5 are similar to those found in the related compounds **2** and **4**.



1

11

12

Comp	R
12a	CH_3
12b	CH_2Cl
12c	C_6H_5
12d	4-CH_3-C_6H_4
12e	4-CH_3O-C_6H_4

Reagents:
a) R-COCl, r. t.
b) HBF_4, r. t.

In conclusion, the results presented here show a detailed and clear picture of the aza Wittig-type reaction between the iminophosphorane derived from 3-amino-4-phenylthiazole-2(3*H*)-thione and iso(thio)cyanates. Simply by changing the nature of the reagent, the reaction may be driven towards the production of mesoionic compounds **2** or betaines **3** and **5**. These latter show dramatic different reactivity towards tetrafluoroboric acid; betaines **3** are transformed into the corresponding salts, whereas compounds **5** undergo cyclization and elimination to give *N,N*-bisheteroarylamine derivatives. Because of their simplicity, easy access of the starting material, the good yields in the iminophosphorane preparation as well as in the cyclization step, the investigated reactions provide an efficient method for the preparation of different thiazolo[2,3-*b*]-1,3,4-thiadiazoles bearing an amino group or a guanidino function in the 2 position.

EXPERIMENTAL:

All melting points were determined on a Kofler hot-plate melting point apparatus and are uncorrected. IR spectra were obtained as Nujol emulsions on a Nicolet FT-5DX spectrophotometer. ^1H and ^{13}C spectra were recorded on a Bruker AC-200, and chemical shifts are expressed in parts per million (δ) relative to internal Me_4Si. Electron-impact mass spectra were carried out on a Hewlett-Packard 5993C spectrometer at an ionization potential of 70 eV. Microanalyses were performed using a Perkin-Elmer 240C instrument.

Materials. 3-Amino-4-phenylthiazole-2(3H)-thione[11] was prepared as described in literature.

4-Phenyl-3-triphenylphosphoranylidenaminothiazole-2(3*H*)-thione 1.

Bromine (3.20 g, 20 mmol) in dry benzene (40 ml) was added dropwise to a stirred solution of triphenylphosphine (5.25 g, 20 mmol) in the same solvent (40 ml) at 0-5°C under nitrogen. The mixture was stirred for 1 h and then allowed to warm to room temperature. A solution of 3-amino-4-phenylthiazole-2(3*H*)-thione (2.08 g, 10 mmol) and triethylamine (4.05 g, 40 mmol) in dry benzene (20 ml) was added, after heating under reflux for 16 h, triethylammonium bromide was deposited. The salt was separated by filtration and the filtrate was concentrated to dryness to afford a crude product which was recrystallized from dichloromethane/diethyl ether (1:1) to give the iminophosphorane **1** (40%) m.p. 217-218°C as colourless prisms. (Found: C, 69.0; H, 4.6; N, 5.8. $C_{27}H_{21}N_2PS_2$ requires C, 69.2; H, 4.5; N, 6.0); i.r. (Nujol) 3098, 1589, 1437, 1291, 1220, 1111, 838, 727 and 695 cm^{-1}; ^{1}H n.m.r. δ ($CDCl_3$): 6.17 (s, 1H), 7.14 (dd, 2H, ^3J=7.7 Hz, ^4J=1.2 Hz), 7.28-7.47 (m, 18H); ^{13}C n.m.r. δ ($CDCl_3$): 105.21 (C-5), 127.83, 128.09 ($^3J_{P\text{-}C}$=12.0 Hz; C*m*), 128.60 ($^1J_{P\text{-}C}$=96.4 Hz; C*i*), 128.67, 130.14, 131.81 ($^4J_{P\text{-}C}$=2.9 Hz; C*p*), 131.98 (q), 133.23 ($^2J_{P\text{-}C}$=9.5 Hz; C*o*), 146.89 ($^3J_{P\text{-}C}$= 3.4 Hz; C-4), 181.97 ($^3J_{P\text{-}C}$=4.5 Hz; C=S); m/z (%) 468 (M$^+$, 100), 276 (61), 217 (17), 183 (74), 122 (43), 108 (48), 77 (32).

Anhydro 2-arylamino-5-phenylthiazolo[2,3-*b*]-1,3,4-thiadiazol-4-ium Hydroxides (5-Phenylthiazolo[2,3-*b*]-1,3,4-thiadiazol-4-ium-2-arylaminides) (2).

To a solution of iminophosphorane **1** (0.47 g, 1 mmol) in dry dichloromethane (15 ml) under nitrogen the appropriate aromatic isocyanate or isothiocyanate (1 mmol) was added dropwise. The reaction mixture was stirred at room temperature for 7 h, then the solution was concentrated to dryness and the residual material was treated with diethyl ether. The solid formed was separated by filtration and washed with toluene (3x10 ml). The remaining crude product was recrystallized from ethanol to give **2**.

(2a) (Ar=C_6H_5) (55%), m.p. 163-164°C (yellow prisms) (Found: C, 62.3; H, 3.5; N, 13.4. $C_{16}H_{11}N_3S_2$ requires C, 62.1; H, 3.6; N, 13.6); i.r. (Nujol) 1601, 1577, 1560, 1488, 1355, 1189, 1157, 1104, 1041, 1020, 841, 815, 761, 747, 694, 670 and 658 cm^{-1}; ^{1}H n.m.r. δ ($CDCl_3$): 7.01 (t, 1H, ^3J=7.4 Hz), 7.15 (d, 2H, ^3J=7.5 Hz), 7.31 (t, 2H, ^3J=7.8 Hz), 7.39 (s, 1H; H-6), 7.42-7.47 (m, 3H), 7.95-8.00 (m, 2H); ^{13}C n.m.r. δ ($CDCl_3$): 113.51 (C-6), 121.45, 122.65, 127.43 (q), 128.21, 128.65, 129.56, 130.38, 139.68 (C-5), 151.61 (q), 164.10 (C-2), (C-7a not observed); m/z (%) 309 (M$^+$, 2), 218 (2), 193 (66), 192 (16), 135 (35), 134 (100), 118 (10), 102 (13), 91 (15), 90 (16), 89 (22), 77 (31).

(2b) (Ar=4-CH_3-C_6H_4) (56%), m.p. 144-145°C (yellow prisms) (Found: C, 63.4; H, 4.0; N, 13.1. $C_{17}H_{13}N_3S_2$ requires C, 63.1; H, 4.0; N, 13.0); i.r. (Nujol) 1611, 1569, 1554, 1503, 1356, 1158, 1108, 1046, 1030, 848, 821, 767, 751, 724, 693 and 666 cm^{-1}; ^{1}H n.m.r. δ ($CDCl_3$): 2.29 (s, 3H), 7.06 (d, 2H, ^3J=7.8 Hz), 7.11 (d, 2H, ^3J=7.8 Hz), 7.40 (s, 1H; H-6), 7.41-7.44 (m, 3H), 7.94-7.99 (m, 2H); ^{13}C n.m.r. δ ($CDCl_3$): 20.85 (CH_3), 114.01 (C-6), 121.03, 127.41 (q), 128.19, 128.63, 130.11, 130.34, 132.17 (q), 139.60 (C-5), 148.17 (q), 164.02 (C-2), (C-7a not observed); m/z (%) 323 (M$^+$, 5), 218 (3), 195 (50), 192 (11), 149 (33), 134 (100), 132 (28), 131 (20), 105 (6), 104 (20), 102 (11), 91 (48), 90 (15), 89 (23), 77 (24).

(2c) (Ar=4-CH_3O-C_6H_4) (48%), m.p. 148-150°C (yellow prisms) (Found: C, 60.3; H, 3.8; N, 12.5. $C_{17}H_{13}N_3OS_2$ requires C, 60.1; H, 3.9; N, 12.4); i.r. (Nujol) 1608, 1566, 1551, 1503, 1350, 1329, 1300, 1246, 1179, 1107, 1032, 832, 758, 728, 695 and 665 cm^{-1}; ^{1}H n.m.r. δ ($CDCl_3$): 3.77 (s, 3H), 6.85 (d, 2H, ^{3}J=8.6 Hz), 7.16 (d, 2H, ^{3}J=8.6 Hz), 7.45-7.41 (m, 3H), 7.50 (s, 1H; H-6), 7.94-7.99 (m, 2H); ^{13}C n.m.r. δ ($CDCl_3$): 55.40 (CH_3O), 114.68 (C-6+CH), 121.96, 127.35 (q), 128.14, 128.61, 130.29, 139.43 (C-5), 155.39 (q), 164.33 (C-2), (C-7a not observed); m/z (%) 339 (M$^+$, 5), 307 (7), 218 (3), 193 (55), 192 (11), 166 (7), 165 (41), 148 (35), 147 (13), 135 (22), 134 (100), 133 (58), 122 (28), 121 (10), 107 (4), 102 (13), 90 (16), 89 (19), 77 (21).

(2d) (Ar=4-F-C_6H_4) (51%), m.p. 158-159°C (yellow prisms) (Found: C, 58.6; H, 3.1; N, 12.6. $C_{16}H_{10}N_3FS_2$ requires C, 58.7; H, 3.1; N, 12.8); i.r. (Nujol) 1604, 1582, 1571, 1549, 1501, 1356, 1221, 1186, 1159, 1102, 1041, 840, 776, 743, 721, 692, 673 and 658 cm^{-1}; ^{1}H n.m.r. δ ($CDCl_3$): 6.94-7.15 (m, 4H), 7.42 (s, 1H; H-6), 7.43-7.47 (m, 3H), 7.95-7.99 (m, 2H); ^{13}C-RMN δ ($CDCl_3$): 113.64 (C-6), 116.03 (^2J_F=22.1 Hz, C*m*), 122.74 (^3J_F=6.5 Hz, C*o*), 127.37 (q), 128.17, 128.65, 130.42, 139.71 (C-5), 147.74 (^4J_F=2.5 Hz, C*i*), 158.61 (^1J_F=240.6 Hz, C*p*), 164.77 (C-2), (C-7a not observed); m/z (%) 327 (M$^+$, 9), 218 (2), 193 (6), 192 (5), 153 (7), 135 (17), 134 (100), 109 (61), 108 (10), 102 (4), 95 (31), 90 (5), 89 (13), 77 (4).

Preparation of Betaines 3 and 5.

To a solution of iminophosphorane **1** (0.47 g, 1 mmol) in dry dichloromethane (15 ml) the appropriate alkylisothiocyanate or isocyanate (1 mmol) was added dropwise. The resultant solution was stirred at room temperature for 16 h. The solid which separated was collected by filtration and recrystallized from dichloromethane/diethyl ether to give **3** or **5** respectively.

(3a) (R=CH_3) (30%), m.p. 141-143°C (white prisms) (Found: C, 48.9; H, 3.7; N, 17.6. $C_{13}H_{12}N_4S_3$ requires C, 48.7; H, 3.8; N, 17.5); i.r. (Nujol) 1565, 1558, 1516, 1397, 1331, 1228, 1141, 1121, 1067, 994, 829, 749, 720, 693, 673 and 666 cm^{-1}; ^{1}H n.m.r. δ ($CDCl_3$+TFA): 3.19 (d, 3H, ^{3}J=4.4 Hz), 3.92 (s, 3H), 7.54-7.64 (m, 3H), 7.80-7.85 (m, 3H; aromatics+NH), 7.87 (s, 1H; H-6); ^{13}C n.m.r. δ ($CDCl_3$+TFA): 33.17 (NCH_3), 37.31 (C2-NCH_3), 118.75 (C-6), 125.18 (q), 128.32, 129.42, 131.89, 141.12 (C-5), 156.11 (C-7a), 167.60 (C-2), 180.05 (C=S); m/z (%) 218 (3), 193 (14), 192 (5), 135 (13), 134 (100), 103 (6), 102 (14), 90 (11), 89 (17), 77 (13), 73 (12).

(3b) (R=C_2H_5) (38%), m.p. 148-150°C (white prisms) (Found: C, 51.5; H, 4.7; N, 16.2. $C_{15}H_{16}N_4S_3$ requires C, 51.7; H, 4.6; N, 16.1); i.r. (Nujol) 1548, 1541, 1504, 1426, 1354, 1207, 1141, 1059, 1015, 835, 800, 736, 693, 676 and 633 cm^{-1}; ^{1}H n.m.r. δ ($CDCl_3$): 1.36 (t, 3H, ^{3}J=7.3 Hz), 1.40 (t, 3H, ^{3}J=7.0 Hz), 3.72 (q, 2H, ^{3}J=7.3 Hz), 4.75 (q, 2H, ^{3}J=7.0 Hz), 7.46-7.60 (m, 3H), 7.74 (s, 1H; H-6), 7.92-7.97 (m, 2H); ^{13}C n.m.r. δ ($CDCl_3$): 12.49 (CH_3), 14.87 (CH_3), 43.76 (NCH_2), 44.13 (C2-NCH_2), 117.19 (C-6), 126.51 (q), 128.12, 128.94, 130.77, 139.90 (C-5), 159.89 (C-7a), 162.00 (C=S), 168.02 (C-2); m/z (%) 244 (7), 229 (15), 218 (3), 193 (27), 192 (5), 135 (15), 134 (100), 104 (13), 103 (15), 102 (25), 90 (17), 89 (36), 88 (6), 87 (32), 77 (25).

(3c) (R=C_6H_5-CH_2) (43%), m.p. 172-173°C (white prisms) (Found: C, 63.7; H, 4.2; N, 12.0. $C_{25}H_{20}N_4S_3$ requires C, 63.5; H, 4.3; N, 11.8); i.r. (Nujol) 1548, 1506, 1455, 1424, 1354, 1318, 1127, 1071, 1043, 1029, 950, 830, 790, 757, 731, 695, 675 and 644 cm^{-1}; ^{1}H n.m.r. δ ($CDCl_3$+TFA): 4.74 (d, 2H, ^3J=4.9 Hz), 5.63 (s, 2H), 7.04-7.08 (m, 2H), 7.13-7.18 (m, 2H), 7.26-7.30 (m, 3H), 7.35-7.61 (m, 9H; aromatics+NH), 7.86 (s, 1H; H-6); ^{13}C n.m.r. δ ($CDCl_3$+TFA): 50.75 (NCH_2), 54.64 (C2-NCH_2), 119.29 (C-6), 125.04 (q), 125.83, 127.82, 128.14, 128.42, 128.93, 129.13, 129.26, 129.72, 131.69, 132.13 (q), 134.56(q), 140.78 (C-5), 156.48 (C-7a), 167.51 (C-2), 179.09 (C=S); m/z (%) 218 (3), 193 (33), 192 (6), 149 (7), 135 (7), 134 (42), 103 (6), 102 (6), 91 (100), 90 (5), 89 (9), 77 (7).

(3d) (R=4-CH_3-C_6H_4-CH_2) (40%), m.p. 159-161°C (white prisms) (Found: C, 64.6; H, 4.8; N, 11.3. $C_{27}H_{24}N_4S_3$ requires C, 64.8; H, 4.8; N, 11.2); i.r. (Nujol) 1543, 1506, 1352, 1315, 1141, 1128, 1108, 1042, 954, 823, 801, 795, 761, 698, 676 and 638 cm^{-1}; ^{1}H n.m.r. δ ($CDCl_3$+TFA): 2.33 (s, 3H), 2.36 (s, 3H), 4.66 (d, 2H, ^3J=4.8 Hz), 5.57 (s, 2H), 6.94 (d, 2H, ^3J=7.9 Hz), 7.04 (d, 2H, ^3J=8.0 Hz), 7.10 (d, 2H, ^3J=7.9 Hz), 7.18 (d, 2H, ^3J=8.0 Hz), 7.41 (t, 1H, ^3J=4.8 Hz; NH), 7.46-7.56 (m, 3H), 7.60-7.65 (m, 2H), 7.87 (s, 1H; H-6); ^{13}C n.m.r. δ ($CDCl_3$+TFA): 20.79 (CH_3), 20.81 (CH_3), 50.67 (NCH_2), 54.68 (C2-NCH_2), 119.09 (C-6), 124.93 (q), 125.78, 127.77, 128.09, 128.82 (q), 129.26, 129.59, 130.44, 131.36 (q), 131.73, 138.58 (q), 139.56 (q), 140.88 (C-5), 156.44 (C-7a), 167.66 (C-2), 178.85 (C=S); m/z (%): 258 (4), 218 (2), 193 (11), 192 (5), 163 (6), 135 (9), 134 (24), 106 (9), 105 (100), 103 (9), 102 (5), 91 (6), 89 (6), 77 (12).

(5a) (R=CH_3) (38%). m.p. 170-172°C (white prisms) (Found: C, 53.6; H, 3.8; N, 17.1. $C_{22}H_{18}N_6S_4$ requires C, 53.4; H, 3.7; N, 17.0); i.r. (Nujol) 1620, 1539, 1489, 1404, 1323, 1294, 1261, 1161, 1051, 908, 753, 730, 697 and 663 cm^{-1}; ^{1}H n.m.r. δ ($CDCl_3$+TFA): 2.57 (s broad, 3H), 3.64 (s, 3H), 6.59 (s, 1H; H-5 thiazole), 6.78 (s broad, 1H; NH), 7.40-7.58 (m, 8H), 7.79-7.84 (m, 2H), 7.85 (s, 1H; H-6); ^{13}C n.m.r. δ ($CDCl_3$+TFA): 29.40 (CH_3), 36.59 (C2-NCH_3), 107.44 (C-5 thiazole), 119.27 (C-6), 125.49 (q), 128.16, 128.78 (2xCH), 129.09 (q), 129.20, 130.06, 131.43, 140.75 (C-5), 143.81 (C-4 thiazole), 155.79 (C=N), 158.65 (C-7a), 166.77 (C-2), 179.37 (C=S); m/z (%) 247 (3), 207 (19), 206 (3), 193 (6), 160 (3), 159 (6), 135 (16), 134 (100), 133 (14), 104 (5), 103 (12), 102 (21), 90 (18), 89 (54), 77 (21), 70 (7), 69 (8), 55 (5).

(5b) (R=C_2H_5) (50%), m.p. 174-175°C (white prisms) (Found: C, 55.3; H, 4.3; N, 16.2. $C_{24}H_{22}N_6S_4$ requires C, 55.1; H, 4.2; N, 16.1); i.r. (Nujol) 1593, 1558, 1520, 1492, 1447, 1359, 1311, 1295, 1273, 1158, 1050, 918, 874, 759, 735, 693 and 669 cm^{-1}; ^{1}H n.m.r. δ ($CDCl_3$+TFA): 1.04 (t, 3H, ^3J=7.1 Hz), 1.26 (t, 3H, ^3J=6.8 Hz), 2.83 (m, 2H), 4.26 (q, 2H, ^3J=7.1 Hz), 6.60 (s, 1H; H-5 thiazole), 6.65 (s broad, 1H; NH), 7.33-7.51 (m, 8H), 7.68 (s, 1H; H-6), 7.73-7.82 (m, 2H); ^{13}C n.m.r. δ ($CDCl_3$+TFA): 12.15 (CH_3), 14.58 (CH_3), 38.44 (NCH_2), 45.23 (C2-NCH_2), 107.72 (C-5 thiazole), 121.41 (C-6), 125.98 (q), 127.96, 128.52, 128.83, 129.00, 129.36 (q), 129.70, 130.89, 139.62 (C-5), 143.45 (C-4 thiazole), 154.28 (C=N), 159.26 (C-7a), 166.40 (C-2), 178.95 (C=S); m/z (%) 261 (3), 229 (9), 194 (8), 193 (47), 192 (12), 160 (9), 159 (13), 135 (29), 134 (100), 133 (23), 104 (13), 103 (17), 102 (20), 99 (7), 98 (11), 97 (13), 89 (27), 77 (27), 70 (10), 69 (24), 55 (36).

(5c) (R=*n*-C_3H_7) (41%), m.p. 171-172°C (white prisms) (Found: C, 56.8; H, 4.8; N, 15.1. $C_{26}H_{26}N_6S_4$ requires C, 56.7; H, 4.8; N, 15.3); i.r. (Nujol) 1606, 1536, 1490, 1427, 1323, 1306, 1286, 1260, 1163, 1054, 928, 921, 753, 724, 695 and 674 cm^{-1}; ^{1}H n.m.r. δ ($CDCl_3$+TFA): 0.73 (t, 3H, ^3J=7.4 Hz), 0.77 (t, 3H, ^3J=7.3 Hz), 1.40-1.50 (m, 2H), 1.60-1.78 (m, 2H), 2.60-2.90 (m, 2H), 4.20 (t, 2H, ^3J=7.2 Hz), 6.65 (s, 1H; H-5 thiazole), 7.35-7.54 (m, 8H), 7.65

(s, 1H; H-6), 7.69-7.78 (m, 2H), 7.91 (s broad, 1H; NH); ^{13}C n.m.r. δ (CDCl$_3$+TFA): 10.58 (CH$_3$), 11.24 (CH$_3$), 20.23 (CH$_2$), 22.34 (CH$_2$), 45.01 (NCH$_2$), 51.50 (C2-NCH$_2$), 107.60 (C-5 thiazole), 121.78 (C-6), 125.88 (q), 127.79, 128.49, 128.85, 128.95, 129.34 (q), 129.75, 130.84, 139.39 (C-5), 143.53 (C-4 thiazole), 154.44 (C=N), 158.80 (C-7a), 166.63 (C-2), 178.88 (C=S); m/z (%) 275 (4), 247 (10), 246 (74), 229 (10), 193 (24), 192 (5), 135 (12), 134 (100), 133 (5), 103 (11), 102 (14), 89 (13), 77 (7), 69 (5).

(5d) **(R=*i*-C$_3$H$_7$)** (45%), m.p. 161-163°C (white prisms) (Found: C, 56.6; H, 4.6; N, 15.4. C$_{26}$H$_{26}$N$_6$S$_4$ requires C, 56.7; H, 4.8; N, 15.3); i.r. (Nujol) 1637, 1490, 1450, 1349, 1298, 1221, 1161, 1049, 1009, 909, 827, 777, 747, 702 and 638 cm^{-1}; ^{1}H n.m.r. δ (CDCl$_3$+TFA): 1.20 (d, 6H, ^{3}J=6.4 Hz), 1.33 (d, 6H, ^{3}J=6.8 Hz), 3.58 (hept, 1H, ^{3}J=6.4 Hz), 4.21 (hept, 1H, ^{3}J=6.8 Hz), 6.76 (s, 1H; H-5 thiazole), 7.44 (s, 5H), 7.56-7.63 (m, 4H; aromatics+NH), 7.72-7.80 (m, 2H), 7.86 (s, 1H; H-6); ^{13}C n.m.r. δ (CDCl$_3$+TFA): 19.22 (CH$_3$), 20.16 (CH$_3$), 47.89 (N-CH), 59.27 (C2-NCH), 108.93 (C-5 thiazole), 119.07 (C-6), 125.30 (q), 128.22, 128.34, 128.72, 128.85, 129.46 (q), 130.35, 131.77, 141.20 (C-5), 143.46 (C-4 thiazole), 155.20 (C=N), 157.16 (C-7a), 167.20 (C-2), 179.58 (C=S); m/z (%) 275 (7), 261 (11), 260 (64), 243 (10), 193 (16), 192 (4), 135 (10), 134 (100), 102 (16), 101 (62), 90 (9), 89 (19), 77 (10), 70 (6), 69 (14).

(5e) **(R=*c*-C$_6$H$_{11}$)** (42%), m.p. 168-170°C (white prisms) (Found: C, 61.1; H, 5.5; N, 13.2. C$_{32}$H$_{34}$N$_6$S$_4$ requires C, 60.9; H, 5.4; N, 13.3); i.r. (Nujol) 1597, 1530, 1492, 1454, 1318, 1289, 1262, 1215, 1050, 925, 916, 767, 700 and 674 cm^{-1}; ^{1}H n.m.r. δ (CDCl$_3$+TFA): 2.00-1.26 (m, 20H), 3.13-3.21 (m, 1H), 3.68-3.76 (m, 1H), 6.70 (s, 1H; H-5 thiazole), 7.44 (s, 5H), 7.54-7.59 (m, 3H), 7.75 (s broad, 1H; NH), 7.81-7.86 (m, 2H), 7.99 (s, 1H; H-6); ^{13}C n.m.r. δ (CDCl$_3$+TFA): 24.58 (CH$_2$), 24.90 (CH$_2$), 25.78 (CH$_2$), 26.04 (CH$_2$), 29.12 (CH$_2$), 34.18 (CH$_2$), 54.86 (N-CH), 67.50 (C2-NCH), 108.58 (C-5 thiazole), 119.94 (C-6), 125.70 (q), 128.28, 128.56, 128.93, 129.07, 129.29 (q), 130.04, 131.49, 140.54 (C-5), 143.25 (C-4 thiazole), 156.97 (C=N), 157.82 (C-7a), 167.58 (C-2), 179.18 (C=S); m/z (%) 315 (4), 193 (16), 192 (4), 135 (11), 134 (100), 124 (9), 193 (17), 103 (5), 102 (13), 89 (16), 83 (58), 82 (22), 81 (29), 77 (12).

(5f) **(R=*t*-C$_4$H$_9$)** (38%), m.p. 169-170°C (white prisms) (Found: C, 58.2; H, 5.2; N, 14.6. C$_{28}$H$_{30}$N$_6$S$_4$ requires C, 58.1; H, 5.2; N, 14.5); i.r. (Nujol) 1611, 1493, 1446, 1367, 1359, 1296, 1223, 1184, 1056, 930, 872, 773, 736, 699 and 626 cm^{-1}; ^{1}H n.m.r. δ (CDCl$_3$+TFA): 1.57 (s, 9H), 1.39 (s, 9H), 6.71 (s, 1H; H-5 thiazole), 7.39-7.71 (m, 11H; aromatics+NH), 7.82 (s, 1H; H-6); ^{13}C n.m.r. δ (CDCl$_3$+TFA): 27.44 [C2-NC(*C*H$_3$)$_3$], 29.13 [N-C(*C*H$_3$)$_3$], 54.15 (N-C), 87.30 (C2-N-*C*), 106.68 (C-5 thiazole), 118.96 (C-6), 125.90 (q), 128.35 (2xCH), 128.93, 129.37 (CH+q), 130.51, 131.67, 141.17 (C-5), 143.85 (C-4 thiazole), 153.01 (C=N), 155.93 (C-7a), 173.00 (C-2), 187.39 (C=S); m/z (%) 289 (4), 275 (7), 274 (42), 193 (13), 192 (7), 135 (9), 134 (100), 102 (7), 89 (8), 83 (4), 77 (4), 57 (14).

Preparation of Salts 4.

To a solution of the appropiate betaine **3** (0.2 mmol) in dry dichloromethane (5 ml), trimethyloxonium tetrafluoroborate (0.03 g, 0.2 mmol) was added. The resultant mixture was stirred at reflux temperature for 6h. The solid which separated was collected by filtration and recrystallized from methanol to give **4** as crystalline solids.

(4a) (R=C_6H_5-CH_2) (94%), m.p.100-102°C (white prisms) (Found: C, 54.23; H, 4.10; N, 9.63. $C_{26}H_{23}BF_4N_4S_3$ requires C, 54.36; H, 4.03; N, 9.75); i.r. (Nujol) 1614, 1504, 1456, 1347, 1302, 1262, 1177, 1117, 1059, 1022, 804, 755, 697 and 683 cm^{-1}; ^{1}H n.m.r. δ ($CDCl_3$+DMSO-d_6): 2.39 (s, 3H), 5.10 (s, 2H), 5.67 (s, 2H), 7.22-7.45 (m, 13H), 7.55-7.60 (m, 2H), 8.18 (s, 1H; H-6); ^{13}C n.m.r. δ ($CDCl_3$+DMSO-d_6):16.75 (CH_3), 53.20 (CH_2), 55.49 (CH_2), 122.02 (C-6), 125.72 (q), 126.15, 126.91, 127.15, 127.40, 127.74, 128.23, 128.25, 128.35, 130.27, 135.07 (q), 137.55 (q), 138.84 (C-5), 153.39 (*C*-SCH_3), 159.16 (C-7a), 163.95 (C-2); m/z (%) 218 (5), 193 (23), 192 (4), 165 (8), 149 (6), 135 (5), 134 (41), 102 (5), 91 (100), 90 (6), 89 (12), 77 (37).

(4b) (R=4-CH_3-C_6H_5-CH_2) (85%), m.p.89-90°C (white prisms) (Found: C, 55.93; H, 4.40; N, 9.43. $C_{28}H_{27}BF_4N_4S_3$ requires C, 55.81; H, 4.52; N, 9.30); i.r. (Nujol) 1614, 1505, 1309. 1177. 1108. 1061, 1025, 803, 760, 723 and 694 cm^{-1}; ^{1}H n.m.r. δ (DMSO-d_6): 2.34 (s, 3H), 2.39 (s, 3H), 2.53 (s, 3H), 5.13 (s, 2H), 5.69 (s, 2H), 7.25 (s, 4H), 7.29 (d, 2H, ^{3}J=8.0 Hz), 7.41 (d, 2H, ^{3}J=8.0 Hz), 7.57-7.70 (m, 3H), 7.83-7.88 (m, 2H), 8.43 (s, 1H, H-6); ^{13}C n.m.r. δ (DMSO-d_6):16.85 (CH_3), 20.60 (CH_3), 20.67 (CH_3), 53.14 (CH_2), 55.31 (CH_2), 122.68 (C-6), 126.48 (q), 126.72, 127.63, 128.10, 128.73, 129.08, 129.12, 130.49, 132.99 (q), 135.35 (q), 136.25 (q), 136.83 (q), 138.43 (C-5), 153.61 (*C*-SCH_3), 159.62 (C-7a), 164.19 (C-2); m/z (%) 193 (6), 178 (2), 134 (27), 117 (6), 106 (13), 105 (100), 103 (9), 102 (5), 91 (8), 89 (6), 77 (28).

Treatment of Compounds 2 and 3 with Tetrafluoroboric Acid.

To a solution of the appropriate compound **2** or **3** (1 mmol) in methanol (15 ml) was added tetrafluoroboric acid (0.44 g, 5 mmol). The mixture was stirred at room temperature for 7 h. Then the solid was separated by filtration and recrystallized from the adequate solvent to give **6** or **7**.

(6a) (Ar=4-CH_3-C_6H_4) (55%), m.p. 208-210°C (white prisms from methanol) (Found: C, 49.7; H, 3.4; N, 10.3. $C_{17}H_{14}BF_4N_3S_2$ requires C, 49.6; H, 3.4; N, 10.2); i.r. (Nujol) 3313, 1617, 1556, 1516, 1491, 1304, 1117, 1070, 1036, 1002, 817, 757, 727, 696 and 666 cm^{-1}; ^{1}H n.m.r. δ (DMSO-d_6): 2.28 (s, 3H), 7.23 (d, 2H, ^{3}J=8.2 Hz), 7.41 (d, 2H, ^{3}J=8.2 Hz), 7.59-7.64 (m, 3H), 7.95-7.99 (m, 2H), 8.31 (s, 1H; H-6), 10.10 (s, 0.2H; NH), 11.08 (s, 0.8H; NH); ^{13}C n.m.r. δ (DMSO-d_6): 20.35 (CH_3), 118.58, 121.83 (C-6), 126.90 (q), 128.28, 128.84, 129.89, 130.60, 133.45 (q), 135.94 (q), 139.26 (C-5), 156.83 (C-7a), 165.35 (C-2); m/z (%) 324 (M$^+$, 3), 323 (19), 218 (11), 193 (61), 192 (17), 150 (4), 149 (30), 148 (11), 135 (14), 134 (100), 133 (8), 132 (22), 131 (15), 105 (4), 102 (5), 91 (28), 77 (10).

(6b) (Ar=4-F-C_6H_4) (65%), m.p. 253-255°C (white prisms from methanol) (Found: C, 64.2; H, 2.7; N, 10.3. $C_{16}H_{11}BF_5N_3S_2$ requires C, 46.3; H, 2.7; N, 10.1); i.r. (Nujol) 3341, 1620, 1574, 1549, 1510, 1226, 1211, 1127, 1062, 1047, 841, 770, 755, 690 and 673 cm^{-1}; ^{1}H n.m.r. δ (DMSO-d_6): 7.27 (t, 2H, ^3J_H=^3J_F=8.6 Hz), 7.43-7.65 (m, 5H), 7.90-8.00 (m, 2H), 8.30 (s, 1H; H-6), 11.17 (s, 1H; NH); ^{13}C n.m.r. δ (DMSO-d_6): 116.22 (^2J_F=22.8 Hz; C*m*), 120.31 (^3J_F=8.2 Hz; C*o*), 121.92 (C-6), 126.85 (q), 128.25, 128.91, 130.64 , 134.82 (^4J_F=2.3 Hz; C*i*), 139.31 (C-5), 157.11 (C-7a), 158.47 (^1J_F=241.4 Hz; C*p*), 165.47 (C-2); m/z (%) 328 (M$^+$, 2), 327 (5), 218 (23), 193 (32), 192 (12), 153 (17), 136 (21), 135 (14), 134 (100), 133 (8), 109 (11), 102 (6), 95 (11), 90 (10), 77 (5).

(7a) (R=C_2H_5) (85%), m.p. 195-196°C (white prisms from methanol) (Found: C, 41.4; H, 4.0; N, 12.7.

$C_{15}H_{17}BF_4N_4S_3$ requires C, 41.3; H, 3.9; N, 12.8); i.r. (Nujol) 3364, 1540, 1504, 1489, 1411, 1364, 1278, 1094, 1075, 1052, 1033, 801, 763, 699, 689, 670 and 646 cm^{-1}; ^{1}H n.m.r. δ (DMSO-d_6): 1.20 (t, 3H, ^3J=7.0 Hz), 1.31 (t, 3H, ^3J=6.9 Hz), 3.62 (m, 2H), 4.37 (q, 2H, ^3J=6.9 Hz), 7.58-7.63 (m, 3H), 7.95-7.99 (m, 2H), 8.37 (s, 1H; H-6), 9.43 (t, 1H, ^3J=3.9 Hz; NH); ^{13}C n.m.r. δ (DMSO-d_6): 11.73 (C2-NCH$_2$-*C*H$_3$), 12.95 (NH-CH$_2$-*C*H$_3$), 41.19 (NH-CH$_2$), 45.73 (C2-N*C*H$_2$), 122.27 (C-6), 126.61 (q), 128.24, 128.90, 130.56, 138.49 (C-5), 158.04 (C-7a), 166.65 (C-2), 177.09 (C=S); m/z (%) 246 (4), 229 (7), 218 (2), 193 (81), 192 (16), 160 (4), 135 (20), 134 (100), 104 (16), 103 (8), 102 (10), 90 (15), 89 (21), 87 (29), 77 (8).

(7b) (R=C_6H_5-CH_2) (70%), m.p. 134-136°C (white prisms from methanol) (Found: C, 53.7; H, 3.8; N, 10.2. $C_{25}H_{21}BF_4N_4S_3$ requires C, 53.6; H, 3.8; N, 10.0); i.r. (Nujol) 3358, 1542, 1496, 1415, 1357, 1284, 1236, 1175, 1055, 758, 739, 708, 700, 677 and 654 cm^{-1}; ^{1}H n.m.r. δ (DMSO-d_6): 4.84 (d, 2H, ^3J=4.0 Hz), 5.70 (s, 2H), 7.17-7.54 (m, 13H), 7.65-7.70 (m, 2H), 8.35 (s, 1H; H-6), 10.21 (t, 1H, ^3J=4.0 Hz; NH); ^{13}C n.m.r. δ (DMSO-d_6): 49.25 (NH-CH$_2$), 53.35 (C2-N*C*H$_2$), 122.30 (C-6), 126.18, 126.28 (q), 127.16, 127.31, 127.57, 127.99, 128.24, 128.64, 128.74, 130.44, 134.49 (q), 136.64 (q), 138.31 (C-5), 158.50 (C-7a), 167.03 (C-2), 178.99 (C=S); m/z (%) 218 (4), 193 (30), 192 (6), 149 (6), 135 (7), 134 (40), 105 (4), 104 (7), 103 (7), 102 (6), 92 (9), 91 (100), 90 (6), 89 (11), 77 (11).

(7c) (R=4-CH_3-C_6H_4-CH_2) (84%), m.p. 157-159°C (white prisms from methanol) (Found: C, 55.3; H, 4.3; N, 9.4. $C_{27}H_{25}BF_4N_4S_3$ requires C, 55.1; H, 4.3; N, 9.5); i.r. (Nujol) 3370, 1542, 1505, 1480, 1441, 1410, 1362, 1345, 1270, 1175, 1100, 1052, 930, 812, 805, 766, 753, 712, 691, 672 and 656 cm^{-1}; ^{1}H n.m.r. δ (DMSO-d_6): 2.26 (s, 3H), 2.29 (s, 3H), 4.77 (d, 2H, ^3J=4.3 Hz), 5.64 (s, 2H), 7.08 (s, 4H), 7.13 (d, 2H, ^3J=8.1 Hz), 7.21 (d, 2H, ^3J=8.1 Hz), 7.49-7.60 (m, 3H), 7.70-7.76 (m, 2H), 8.35 (s, 1H; H-6), 10.15 (t, 1H, ^3J=4.3 Hz; NH); ^{13}C n.m.r. δ (DMSO-d_6): 20.63 (2xCH$_3$), 49.00 (NH-CH$_2$), 53.07 (C2-N*C*H$_2$), 122.31 (C-6), 126.30, 126.33 (q), 127.34, 128.06, 128.76 (2xCH), 129.12, 130.48, 131.40 (q), 133.55 (q), 136.34 (q), 136.93 (q), 138.32 (C-5), 158.43 (C-7a), 167.06 (C-2), 178.83 (C=S); m/z (%) 218 (5), 193 (29), 192 (5), 163 (3), 135 (9), 134 (39), 119 (5), 118 (7), 106 (10), 105 (100), 103 (10), 102 (5), 91 (11), 90 (7), 89 (11), 77 (15).

Preparation of *N,N*-bisheteroarylamines 8.

To a suspension of the appropriate compound **5** (0.2 mmol) in methanol (5 ml), was added an excess of tetrafluoroboric acid (3 ml). The mixture was heated at reflux temperature for 3 h. After cooling the precipitated solid was separated by filtration and recrystallized from methanol to give **8**.

(8a) (R=CH_3) (85%), m.p. 281-283°C (white prisms) (Found: C, 39.4; H, 2.4; N, 11.1. $C_{21}H_{15}B_2F_8N_5S_4$ requires C, 39.5; H, 2.4; N, 10.9); i.r. (Nujol) 1620, 1556, 1522, 1490, 1406, 1353, 1132, 1066, 1023, 759, 720, 697, 679 and 606 cm^{-1}; ^{1}H n.m.r. δ (DMSO-d_6): 4.01 (s, 3H; CH$_3$), 7.64-7.73 (m, 6H), 7.96-8.05 (m, 4H), 8.50 (s, 2H; H-6); ^{13}C n.m.r. δ (DMSO-d_6): 40.59 (CH$_3$), 123.70 (C-6), 126.32 (q), 128.32, 129.26, 130.92, 139.62 (C-5), 160.92 (C-7a), 165.95 (C-2); m/z (%) 247 (3), 218 (5), 193 (20), 192 (7), 161 (8), 159 (8), 135 (18), 134 (100), 133 (18), 103 (20), 102 (27), 91 (22), 90 (19), 89 (29), 77 (27).

(8b) (R=C_2H_5) (91%), m.p. 239-241°C (white prisms) (Found: C, 40.6; H, 2.7; N, 10.6. $C_{22}H_{17}B_2F_8N_5S_4$ requires C, 40.4; H, 2.6; N, 10.7); i.r. (Nujol) 1548, 1516, 1491, 1359, 1280, 1193, 1131, 1076, 876, 755, 713, 698 and 679 cm^{-1}; ^{1}H n.m.r. δ (DMSO-d_6): 1.48 (t, 3H, ^{3}J=6.9 Hz; CH_3), 4.47 (q, 2H, ^{3}J=6.9 Hz; CH_2), 7.62-7.71 (m, 6H), 7.93-8.03 (m, 4H), 8.48 (s, 2H; H-6); ^{13}C n.m.r. δ (DMSO-d_6): 11.40 (CH_3), 50.37 (CH_2), 123.59 (C-6), 126.35 (q), 128.31, 129.26, 130.93, 139.65 (C-5), 160.99 (C-7a), 165.07 (C-2); m/z (%) 261 (8), 246 (48), 218 (24), 193 (18), 192 (7), 160 (5), 159 (5), 134 (100), 103 (8), 102 (14), 90 (9), 89 (15), 77 (8).

(8c) (R=*n*-C_3H_7) (93%), m.p. 274-276°C (white prisms) (Found: C, 41.2; H, 2.9; N, 10.6. $C_{23}H_{19}B_2F_8N_5S_4$ requires C, 41.4; H, 2.9; N, 10.5); i.r. (Nujol) 1552, 1523, 1492, 1416, 1364, 1302, 1277, 1244, 1135, 1063, 761, 720 and 697 cm^{-1}; ^{1}H r m.n. δ (DMSO-d_6): 1.03 (t, 3H, ^{3}J=7.3 Hz; CH_3), 1.90-2.01 (m, 2H; N-CH_2-CH_2), 4.40 (t, 2H, ^{3}J=6.8 Hz; N-CH_2), 7.64-7.71(m, 6H), 7.94-8.03 (m, 4H), 8.47 (s, 2H; H-6); ^{13}C n.m.r. δ (DMSO-d_6): 11.01 (CH_3), 19.60 (N-CH_2-CH_2), 56.26 (N-CH_2), 123.57 (C-6), 126.40 (q), 128.38, 129.27, 131.00, 139.69 (C-5), 161.01 (C-7a), 165.45 (C-2); m/z (%) 275 (3), 246 (46), 218 (10), 193 (16), 192 (8), 160 (4), 159 (5), 135 (12), 134 (100), 103 (9), 102 (12), 90 (7), 89 (13), 77 (7).

(8d) (R=*i*-C_3H_7) (87%), m.p. 224-226°C (white prisms) (Found: C, 41.3; H, 2.9; N, 10.6. $C_{23}H_{19}B_2F_8N_5S_4$ requires C, 41.4; H, 2.9; N, 10.5); i.r. (Nujol) 1635, 1535, 1516, 1493, 1332, 1290, 1269, 1136, 1080, 1022, 866, 759, 705, 696, 675 and 640 cm^{-1}; ^{1}H n.m.r. δ (DMSO-d_6):1.66 (d, 6H, ^{3}J=6.5 Hz; CH_3), 4.82 (hept, 1H, ^{3}J=6.5 Hz; N-CH), 7.59-7.70 (m, 6H), 7.91-8.00 (m, 4H), 8.46 (s, 2H; H-6); ^{13}C n.m.r. δ (DMSO-d_6): 19.22 (CH_3), 62.08 (N-CH), 123.37 (C-6), 126.35 (q), 128.43, 129.16, 130.93, 139.69 (C-5), 160.86 (C-7a), 165.45 (C-2); m/z (%) 276 (10), 260 (5), 218 (9), 193 (43), 192 (14), 161 (5), 159 (9), 135 (6), 134 (100), 103 (11), 102 (24), 90 (9), 89 (17), 77 (13).

(8e) (R=*c*-C_6H_{11}) (81%), m.p. 204-206°C (white prisms) (Found: C, 44.6; H, 3.4; N, 10.0. $C_{26}H_{23}B_2F_8N_5S_4$ requires C, 44.1; H, 3.3; N, 9.9); i.r. (Nujol) 1627, 1519, 1493, 1459, 1350, 1270, 1138, 1063, 763, 714, 696 and 640 cm^{-1}; ^{1}H n.m.r. δ (DMSO-d_6): 1.07-2.50 (m, 10H), 4.34-4.36 (m, 1H; N-CH), 7.64-7.71 (m, 6H), 7.92-8.03 (m, 4H), 8.49 (s, 2H; H-6); ^{13}C n.m.r. δ (DMSO-d_6): 24.70 (CH_2), 25.18 (CH_2), 28.51 (CH_2), 69.23, 123.35 (C-6), 126.34 (q), 128.46, 129.11, 130.98, 139.68 (C-5), 160.94 (C-7a), 165.74 (C-2); m/z (%) 315 (4), 272 (24), 218 (5), 193 (49), 192 (11), 160 (4), 159 (4), 135 (14), 134 (100), 103 (6), 102 (10), 90 (9), 89 (15), 83 (10), 77 (8).

(8f) (R=H) (86%), m.p. 280-282°C (white prisms) (Found: C, 38.5; H, 2.1; N, 11.3. $C_{20}H_{13}B_2F_8N_5S_4$ requires C, 38.4; H, 2.1; N, 11.2); i.r. (Nujol) 3234, 1629, 1556, 1483, 1341, 1130, 1069, 854, 757, 720 and 696 cm^{-1}; ^{1}H n.m.r. δ (DMSO-d_6): 3.15 (s, 1H; NH), 7.58-7.65 (m, 6H), 7.98-8.06 (m, 4H), 8.28 (s, 2H; H-6); ^{13}C n.m.r. δ (DMSO-d_6): 121.07 (C-6), 127.16 (q), 128.23, 129.03, 130.45, 138.99 (C-5), 156.75 (C-7a), 169.65 (C-2); m/z (%) 258 (15), 218 (5), 216 (17), 193 (24), 192 (9), 160 (3), 159 (5), 135 (10), 134 (100), 103 (6), 102 (10), 90 (7), 89 (12), 77 (6).

2-Substituted-5-phenylthiazolo[2,3-b]-1,3,4-thiadiazolium Tetrafluoroborates 12.

To a solution of iminophosphorane **1** (0.47 g, 1 mmol) in dry dichloromethane (15 ml) the appropriate acyl chloride (1 mmol) was added dropwise. The reaction mixture was stirred at room temperature for 5h. The solid formed was separated by filtration and washed with diethyl ether. The crude product was dissolved in methanol (10 ml) and tetrafluoroboric acid (0.09 g, 0.5 mmol) was added. The resultant solution was stirred at room temperature for 16h. The solid formed was collected by filtration and recrystallized from methanol to give **12** as white crystalline solids.

(12a) (R=CH_3) (70%), m.p. 239-240°C (white prisms) (Found: C, 41.15; H, 2.91; N, 8.90. $C_{11}H_9BF_4N_2S_2$ requires C, 41.27; H, 2.83; N, 8.75); i.r. (Nujol) 3120, 1533, 1489, 1448, 1338, 1287, 1213, 1123, 1071, 1019, 793, 764, 698, 687 and 667 cm^{-1}; ^{1}H n.m.r. δ (DMSO-d_6): 2.90 (s, 3H), 7.57-7.60 (m, 3H), 7.89-7.93 (m, 2H), 8.39 (s, 1H; H-6); ^{13}C r.m.n. δ (DMSO-d_6): 16.97 (CH_3), 123.61 (C-6), 126.56 (q), 128.50, 128.91, 130.72, 139.19 (C-5), 164.92 (C-7a), 173.05 (C-2); m/z (%) 233 (M^+, 11), 193 (83), 192 (19), 160 (8), 135 (22), 134 (100), 102 (12), 91 (11), 90 (14), 89 (20), 77 (13).

(12b) (R=CH_2Cl) (50%), m.p. 177-179°C (white prisms) (Found: C, 37.14; H, 2.35; N, 8.07. $C_{11}H_8BClF_4N_2S_2$ requires C, 37.26; H, 2.27; N, 7.90); i.r. (Nujol) 1521, 1493, 1449, 1293, 1235, 1209, 1193, 1161, 1070, 1035, 920, 793, 756, 724, 700 and 689 cm^{-1}; ^{1}H r.m.n. δ (DMSO-d_6): 5.40 (s, 2H), 7.55-7.65 (m, 3H), 7.88-7.95 (m, 2H), 8.46 (s, 1H; H-6); ^{13}C r.m.n. δ (DMSO-d_6): 38.15 (CH_2), 124.27 (C-6), 126.34 (q), 128.52, 128.94, 130.83, 139.42 (C-5), 165.80 (C-7a), 172.41 (C-2); m/z (%) 269 (M^++2, 1), 267 (M^+, 3), 193 (91), 192 (16), 160 (4), 135 (19), 134 (100), 102 (10), 91 (13), 90 (17), 89 (26), 77 (10), 51 (14), 49 (42).

(12c) (R=C_6H_5) (95%), m.p. 222-223°C (white prisms) (Found: C, 50.36; H, 2.99; N, 7.46. $C_{16}H_{11}BF_4N_2S_2$ requires C, 50.28; H, 2.90; N, 7.33); i.r. (Nujol) 1596, 1509, 1482, 1448, 1339, 1267, 1133, 1071, 1032, 973, 874, 802, 767, 718, 688 and 619 cm^{-1}; ^{1}H r.m.n. δ (DMSO-d_6): 7.62-7.75 (m, 6H), 8.01-8.05 (m, 2H), 8.11 (dd, 2H, ^{3}J=8.1 Hz, ^{4}J=1.4 Hz), 8.49 (s, 1H; H-6); ^{13}C r.m.n. δ (DMSO-d_6): 124.20 (C-6), 126.51 (q), 127.29 (q), 127.89, 128.51, 129.03, 129.92, 130.61, 133.77, 139.60 (C-5), 164.56 (C-7a), 172.28 (C-2); m/z (%) 295 (M^+, 2), 294 (2), 193 (6), 192 (2), 135 (7), 134 (7), 121 (3), 104 (10), 103 (100), 77 (9).

(12d) (R=4-CH_3-C_6H_4) (76%), m.p. 250-251°C (white prisms) (Found: C. 51, 43; H, 3.40; N, 7.19. $C_{17}H_{13}BF_4N_2S_2$ requires C, 51.53; H, 3.31; N, 7.07); i.r. (Nujol) 1603, 1531, 1487, 1447, 1314, 1285, 1267, 1186, 1138, 1069, 1046, 1036, 880, 845, 809, 770, 716, 691 and 608 cm^{-1}; ^{1}H r.m.n. δ (DMSO-d_6): 3.36 (s, 3H), 7.46 (d, 2H, ^{3}J=8.1 Hz), 7.62-7.66 (m, 3H), 7.96-8.05 (m, 4H), 8.47 (s, 1H; H-6); ^{13}C r.m.n. δ (DMSO-d_6): 21.21 (CH_3), 124.11 (C-6), 124.58 (q), 126.53 (q), 127.77, 128.49, 129.02, 130.43, 130.78, 139.56 (C-5), 144.48 (q), 164.24 (C-7a), 172.26 (C-2); m/z (%) 309 (M^+, 2), 193 (13), 192 (4), 176 (2), 149 (5), 135 (6), 134 (23), 117 (100), 116 (59), 102 (4), 91 (11), 90 (31), 89 (24), 77 (5).

(12e) (R=4-CH_3O-C_6H_4) (95%), m.p. 225-226°C (white prisms) (Found: C, 49.45; H, 3.09; N, 6.90. $C_{17}H_{13}BF_4N_2OS_2$ requires C, 49.53; H, 3.18; N, 6.79); i.r. (Nujol) 3182, 1604, 1575, 1482, 1449, 1310, 1267, 1177, 1134, 1084, 1029, 879, 843, 798, 762, 712, 690, 626 and 609 cm^{-1}; ^{1}H r.m.n. δ (DMSO-d_6): 3.86 (s, 3H), 7.16 (d, 2H, ^{3}J=8.5 Hz), 7.58-7.70 (m, 3H), 7.90-8.06 (m, 4H), 8.45 (s, 1H; H-6); ^{13}C r.m.n. δ (DMSO-d_6): 55.79 (CH_3O), 115.29, 119.56 (q), 123.95 (C-6), 126.55 (q), 128.45, 129.01, 129.82, 130.76, 139.50 (C-5), 163.53 (q), 163.89 (C-7a), 171.87 (C-2); m/z (%) 325 (M^+, 2), 193 (5), 192 (1), 165 (5), 151 (2), 150 (4), 134 (13), 133 (100), 103 (29), 102 (7), 91 (4), 90 (29), 77 (3).

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