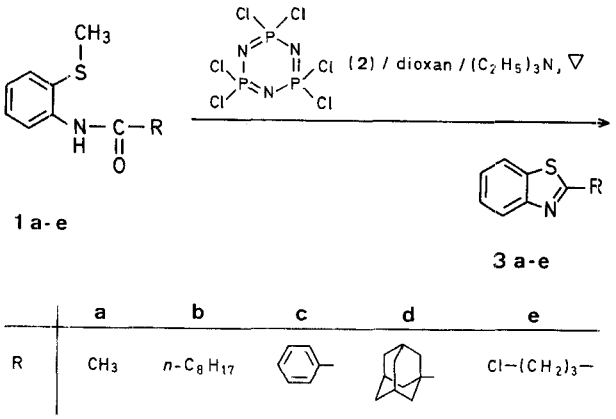

Scheme A

Cyclization of *o*-(Methylthio)-anilides with Phosphonitrile Dichloride; Synthesis of 2-Substituted Benzothiazoles

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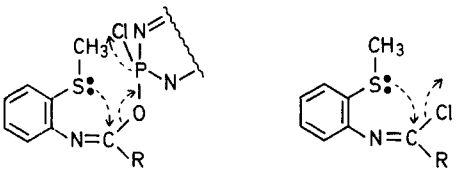
In the last few years several efficient and convenient utilizations of phosphonitrile dichloride (**2**) in organic synthesis have been reported[1-7].

Recently we have found that phosphonitrile dichloride induced cyclization of *o*-(methylthio)-anilides **1a–e** (Scheme A) to form 2-substituted benzothiazoles **3a–e** in good yields. Reactions between **2** and compounds **1a–e** were performed in refluxing dioxan with an excess of triethylamine; our results are summarized in Table 2.

The reaction is assumed to proceed via the intermediate **4** that underwent intramolecular attack with elimination of chloromethane. However, the formation of imidochloride **5** and successive cyclization to **3** cannot be excluded at present.



4 5

Preparation of *o*-(Methylthio)-anilides 1a–e; General Procedure: Carboxylic acid chloride (20 mmol) in tetrahydrofuran (20 ml) is slowly added to a stirred solution of *o*-(methylthio)-aniline (20 mmol) and triethylamine (22 mmol) in tetrahydrofuran (50 ml). After 1 h at room temperature, triethylamine hydrochloride is collected by filtration and the solution is evaporated under reduced pressure. The crude residue is crystallized from ethanol (**1a,b**), or dichloromethane/*n*-hexane (**1d,e**); see Table 1.

Table 1. *o*-(Methylthio)-anilides **1** from *o*-(Methylthio)-aniline and Acyl Chlorides

Compound	Yield [%]	m.p.	I.R. (KBr) [cm^{-1}] ν_{NH}	ν_{CO}	Molecular formula[a]	Reference
1a	90	111–113°	3200	1650	$C_9H_{11}NOS$ (181.2)	8
1b	81	34–36°	3315	1675	$C_{16}H_{25}NOS$ (276.4)	
1c	84	97–99°	3210	1650	$C_{14}H_{13}NOS$ (243.3)	8
1d	87	105–108°	3280	1645	$C_{18}H_{23}NOS$ (301.4)	
1e	85	52–54°	3250	1655	$C_{11}H_{14}ClNOS$ (243.8)	

[a] All products gave satisfactory microanalyses (C ±0.14%, H ±0.06%, N ±0.08%).

Table 2. 2-Substituted Benzothiazoles **3** from *o*-(Methylthio)-anilides **1** and Phosphonitrile Dichloride **2**.

Compound	Yield [%]	m.p.	^{1}H-N.M.R. (CCl_4) δ [ppm]	Molecular formula[a]	Reference
3a	87	oil	8.1–7.1 (m, 4H); 2.8 (s, 3H)	C_8H_7NS (141.2)	9
3b	85	oil	8.1–7.2 (m, 4H); 3.07 (t, 2H, J = 8 Hz); 2.2–0.65 (m, 15H)	$C_{15}H_{21}NS$ (247.4)	
3c	92	112–115°	—	$C_{13}H_9NS$ (211.3)	10
3d	80	74–76°	8.3–7.2 (m, 4H); 2.2 (m, 8H); 1.85 (m, 7H)	$C_{17}H_{19}NS$ (269.4)	
3e	97	oil	8.15–7.1 (m, 4H); 3.65 (t, 2H, J = 7 Hz); 3.28 (t, 2H, J = 7 Hz); 2.35 (m, 2H)	$C_{10}H_{10}ClNS$ (211.7)	

[a] All products gave satisfactory microanalyses (C ±0.25%, H ±0.08%, N ±0.13%).

Synthesis of 2-Substituted Benzothiazoles 3a–e; General Procedure: To a refluxing solution of *o*-(methylthio)-anilide (5 mmol) in dioxan (50 ml) is added drop-wise a solution of phosphonitrile dichloride (**2**; 5 mmol) and triethylamine (20 mmol) in dioxan (50 ml). The resulting yellow solution is allowed to reflux. After a heating period of 8–10 h, thin layer chromatography indicates the disappearance of the starting materials. The cold reaction mixture is washed with saturated aqueous sodium carbonate solution, extracted with ether, dried (Na_2SO_4), and evaporated under reduced pressure. The crude products are chromatographed on silica gel column eluting with cyclohexane/benzene (7:3); see Table 2.

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[1] L. Caglioti, M. Poloni, G. Rosini, *J. Org. Chem.* **33**, 2979 (1968).
M. Fieser, L. Fieser, *Reagents for Organic Synthesis*, Vol. 2, Wiley Interscience, New York, N. Y. 1969, p. 206.
[2] K. C. Das, Yu-Yin Lin, B. Weinstein, *Experientia* **25**, 1238 (1969).
[3] J. Martinez, F. Winternitz, *Bull. Soc. Chim. Fr.* **1972**, 4707.
[4] G. Rosini, G. Baccolini, S. Cacchi, *J. Org. Chem.* **38**, 1060 (1973).
M. Fieser, L. F. Fieser, *Reagents for Organic Synthesis*, Vol. 4, Wiley Interscience, New York, N. Y., 1974, p. 387.
[5] J. C. Graham, D. H. Marr, *Can. J. Chem.* **50**, 3857 (1972).
[6] J. C. Graham, *Tetrahedron Lett.* **1973**, 3825.
[7] G. Rosini, A. Medici, S. Cacchi, *Synthesis* **1975**, 665.
[8] F. Cialdi, A. Bauiffini, *Farmaco Ed. Sci.* **12**, 206 (1957).
[9] L. M. Clark, *J. Chem. Soc.* **1928**, 2313.
[10] H. Gilman, J. A. Beel, *J. Am. Chem. Soc.* **71**, 2328 (1949).