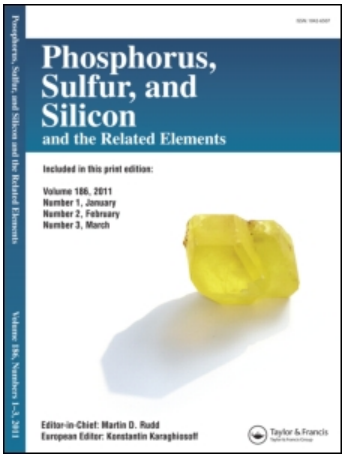


Phosphorus, Sulfur, and Silicon and the Related Elements

Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713618290

Synthesis and Reactivity of Bicyclic Phosphoric (and Thiophosphoric) Amides

Zhengjie He[a]; Susan Laurens[a]; Xavier M. Mbianda[a]; Agnes M. Modro[a]; Tom A. Modro[a]
[a] Center for Heteroatom Chemistry, Department of Chemistry, University of Pretoria, Pretoria, South Africa

Online publication date: 27 October 2010

To cite this Article He, Zhengjie , Laurens, Susan , Mbianda, Xavier M. , Modro, Agnes M. and Modro, Tom A.(2002) 'Synthesis and Reactivity of Bicyclic Phosphoric (and Thiophosphoric) Amides', Phosphorus, Sulfur, and Silicon and the Related Elements, 177: 6, 1689 — 1692
To link to this Article: DOI: 10.1080/10426500212303
URL: http://dx.doi.org/10.1080/10426500212303

Phosphorus, Sulfur and Silicon, 2002, Vol. 177:1689–1692

1042-6507/02 $12.00 + .00
DOI: 10.1080/10426500290093081

SYNTHESIS AND REACTIVITY OF BICYCLIC PHOSPHORIC (AND THIOPHOSPHORIC) AMIDES

Zhengjie He, Susan Laurens, Xavier M. Mbianda, Agnes M. Modro, and Tom A. Modro
Center for Heteroatom Chemistry, Department of Chemistry, University of Pretoria, Pretoria, South Africa

(Received July 29, 2001; accepted December 25, 2001)

This work summarizes studies on the preparation, structure, and reactivity of a new heterocyclic system containing phosphorus and nitrogen: 2,8-disubstituted-2,5,8-triaza-1λ^5-phosphabicyclo[3.3.0]octane 1-oxide (and 1-sulfide).

Keywords: Bicyclic structures; lithiation-induced N ⇒ C phosphorus migration; *N*-phosphorylated nitrogen mustards; P—N bond cleavage

The title system **1** was prepared from the *N*-phosphorylated nitrogen mustard and primary amines via the disubstitution at phosphorus, followed by two 1,5-cyclizations[1] (Figure 1). Since molecular structure determined for some triamides **1** demonstrated low values of the N—P—N bond angles, and the ^{31}P-NMR spectroscopy revealed unusual deshielding of phosphorus,[2] system **1** was expected to exhibit interesting and diverse reactivity.

The first reaction of choice was the nucleophilic (solvolytic) cleavage of the P—N bond(s). If limited to single P—N bond, the cleavage of **1** can lead to a 1,3,2-diazaphospholidine derivative **2**, or to a novel, eight-membered heterocyclic system **3**. As expected on the basis of the mechanism of the acid-catalyzed solvolysis of phosphoric amides,[3] alcoholysis of **1a** (**1**, R = Ph) in an alcohol containing 1 equivalent of HCl led to the exclusive cleavage of the P—N(5) bond, yielding 1-oxo-1alkoxy-2,8-diphenyl-2,5,8-triaza-1λ^5-phosphacyclooctane **3a**[4] (Figure 2).

We thank the University of Pretoria and the National Research Foundation for support.

Address correspondence to Tom A. Modro, Center for Heteroatom Chemistry, Department of Chemistry, University of Pretoria, Pretoria 0002, South Africa.

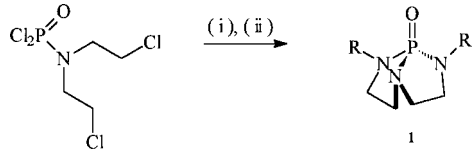


FIGURE 1 (i) 2 RNH_2, 2 Et_3N; (ii) base.

The solvolysis has been extended to other substrates **1**, and in all cases the acidic cleavage led to the corresponding **3** as the exclusive product. Products **3** are rather unstable, but they could be isolated and purified as stable hydrochloride salts or N(5)-acyl derivatives. As free amines, **3** rearrange slowly to the isomeric phospholidines **2** in a new type of the $8 \Rightarrow 5$ ring contraction (Figure 3).

The change of the solvolysis medium to a solution of sodium alkoxide in alcohol gave results depending on the nature of the groups at the N(2) and N(8) atoms in **1**. For the N-Ar substituted **1**, the selectivity was rigorously opposite to that under the acidic conditions, and **2** were the exclusive and direct products. All N-alkyl substrates **1** yielded in the base-catalyzed alcoholysis exclusively the products **3**.

Next, reaction of **1** allowed us to prepare other new types of heterocyclic products. Lithiation (BuLi in tetrahydrofuran, THF) of **1a** results in the *ortho*-deprotonation of the phenyl substituent, followed by the migration of phosphorus from nitrogen to the aromatic carbon. Quenching of the migration product with methanol affords a seven-membered cyclic phosphonic diamidate **4a**; quenching with an alkylating agent yields an N-alkyl analog. The lithiation induced migration can occur twice; the final; product is then the bicyclic phosphinic amidate **5a**[5] (or its bis-N-alkyl derivative).[6] Acidic alcoholysis of the latter leads to a monocyclic, twelve-membered phosphinic ester **6**.[7] The full reaction scheme is given in Figure 4.

As an extension of our studies of **1**, we decided to prepare its thio analogue, **7**. The route analogous to that used for the preparation of

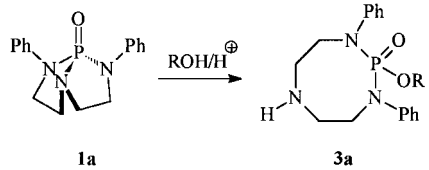
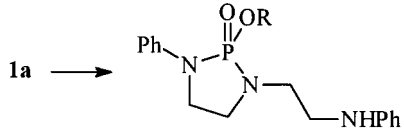


FIGURE 2



2a

FIGURE 3

1 gave unsatisfactory results. Preparation of **7** was achieved starting with **1**. When **1a** was subjected to exhaustive hydrolysis, the β,β'-diphenyl "diethylenetriamine" **8** was obtained in high yield,[8] which was then transformed to product **7** (Figure 5). Whose structure was proven by x-ray diffraction.[9] The chemistry of products **7** is currently under investigation.

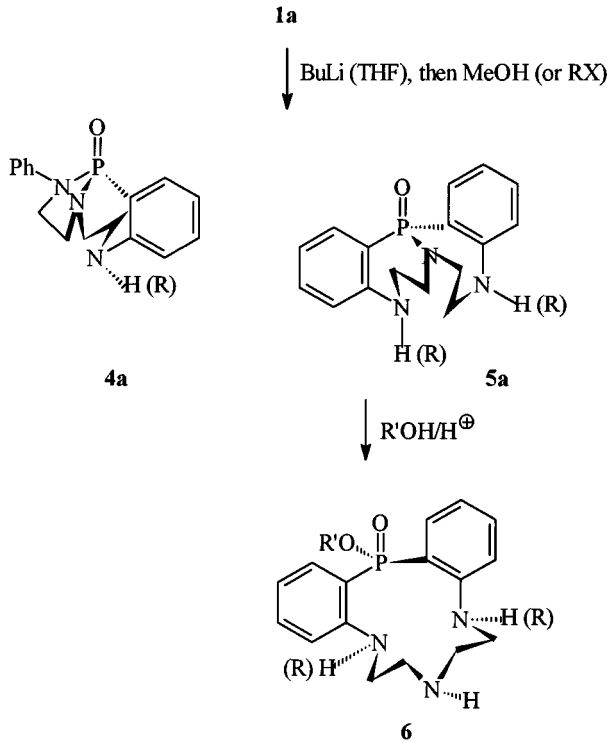


FIGURE 4

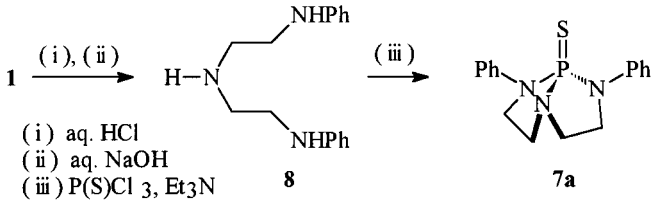


FIGURE 5 (i) aq. HCl; (ii) aq. NaOH; (iii) $P(S)Cl_3$, Et_3N.

REFERENCES

[1] H. Wan and T. A. Modro, *Synthesis*, 1227 (1996).
[2] S. A. Bourne, X. Y. Mbianda, T. A. Modro, L. R. Nassimbeni, and H. Wan, *J. Chem. Soc. Perkin Trans. 2*, 83 (1998).
[3] J. Rahil and P. Haake, *J. Am. Chem. Soc*., **103,** 1723 (1981).
[4] X. Y. Mbianda, T. A. Modro, and P. H. van Rooyen, *Chem. Commun*., 741 (1998).
[5] S. A. Bourne, Z. He, T. A. Modro, and P. H. van Rooyen, *Chem. Commun*., 853 (1999).
[6] Z. He and T. A. Modro, *Synthesis*, 565 (2000).
[7] S. A. Bourne, Z. He, and T. A. Modro, *J. Mol. Str*., **522,** 249 (2000).
[8] D. P. Pienaar, T. A. Modro, and A. M. Modro, *Synthesis*, 1315 (2000).
[9] S. Laurens, V. V. H. Ichharam, and T. A. Modro, *Heteroatom Chem*., in press.