

## Effect of Ring Size in Cyclic Phosphonates Upon Their Reaction with Nitrones

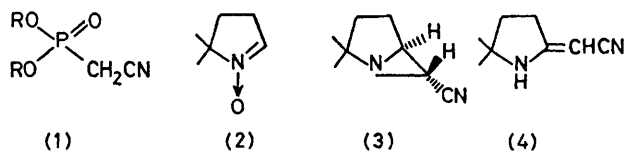
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**Summary** Reaction of 5,5-dimethyl- $\Delta^1$ -pyrroline *N*-oxide (2) with 2-cyanomethyl-4,5-dimethyl-2-oxo-1,3,2-dioxaphospholan (1b) gives *exo*-6-cyano-2,2-dimethyl-1-azabicyclo[3.1.0]hexane (3), but reaction of (2) with 2-cyanomethyl-5,5-dimethyl-2-oxo-1,3,2-dioxaphosphorinan (1c) gives 5,5-dimethyl-2-cyanomethylenepyrrolidine (4).

PREVIOUSLY we reported that reactions of carbanions derived from phosphonates (e.g. 1a) with  $\Delta^1$ -pyrroline *N*-oxide (2) in 1,2-dimethoxyethane (DME) lead predominantly or exclusively to the formation of aziridines (e.g. 3), whereas in protic solvents the same reactions lead to enamines (such as 4), the proportion of which increases with increasing acidity of the solvent.<sup>1</sup> This was interpreted by assuming the formation of a pentaco-ordinated intermediate

(6a), which may decompose to the aziridine (3). Protonation neutralizes the negative charge on the oxygen that serves as driving force to this fragmentation of (6a); consequently enamine formation, *via* (7a), by a 1,2-elimination mechanism prevails.



a; R = Et

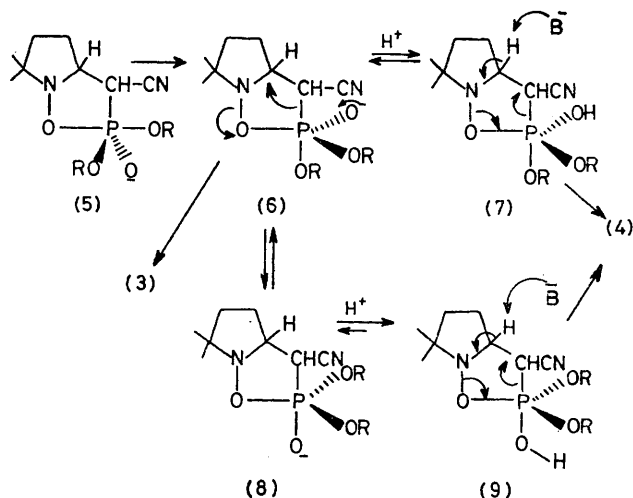
b; R,R = -CHMe-CHMe

c; R,R = -CH<sub>2</sub>Me<sub>2</sub>CH<sub>2</sub>-

We now report that the outcome of the reaction of cyclic phosphonates with the nitrone (2) varies drastically with the ring size of the phosphonate.

Thus, reaction of the five-membered cyclic phosphonate (1b),<sup>2</sup> (mixture of *meso* and *racemic*) with (2) in DME using sodium hydride gave, as with (1a), the aziridine (3) (30%) as the only detectable product. In contrast in the reaction of the six-membered phosphonate (1c)<sup>3</sup> with (2) under the same conditions only (4) (41%) could be detected. We have ascertained that both (3) and (4) are stable and are not interconvertible under the reaction conditions.

It is possible to rationalize these results by assuming the formation of pentaco-ordinated intermediates. The reaction of (2) with a phosphonate carbanion is expected to lead initially to the intermediate (5). Formation of either product (3) or (4) occurring by C-P cleavage requires bringing the carbon atom to an apical position,<sup>4</sup> which can be attained by permutational isomerization (Berry-pseudorotation, or turnstile rotation) of (5). In (6b) thus formed,<sup>†</sup> the apical-equatorial orientation of both five-membered rings and the equatorial orientation of the oxide anion will lead to stabilisation of the intermediate. Six-membered rings, in contrast, prefer occupying diequatorial orientation in a pentaco-ordinated phosphorus trigonal bipyramid.<sup>5</sup> However when the six-membered ring contains heteroatoms attached to the phosphorus, owing to lone-pair orientation effects, the apical-equatorial boat conformer was found to be preferred.<sup>6</sup> Our results can be rationalized by assuming that in the 5,5-dimethyl-1,3,2-dioxaphosphorinane ring of (6c) non-bonded 1,4-interactions between the *gem*-dimethyl groups and the phosphorus substituent will



raise the energy of the apical-equatorial boat conformer. Therefore a diequatorial chair may be preferred or at least be of comparable energy. Such an orientation of the six-membered ring in the intermediate (6c → 8c) will force the oxide anion to become apical [(8c)] and therefore a much stronger base,<sup>4</sup> which will readily undergo protonation to (9c), and β-elimination to (4). Under identical conditions (6b), which is a weaker base than (8c), remains as the anion and undergoes fragmentation to (3).

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† Formulae (5)–(9) do not represent all possible structures for the reaction intermediate. Structures (6)–(9) are less favoured than their respective analogues with apical oxygen (ref. 4) (*e.g.* 5); however, as the latter do not lead to products they are not listed.

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<sup>3</sup> E. Breuer and D. M. Bannet, *Tetrahedron*, in the press.

<sup>4</sup> P. Gillespie, F. Ramirez, I. Ugi, and D. Marquarding, *Angew. Chem. Internat. Edn.*, 1973, **12**, 91.

<sup>5</sup> P. Gillespie, P. Hoffmann, H. Klusacek, D. Marquarding, S. Pfohl, F. Ramirez, E. A. Tsois, and I. Ugi, *Angew. Chem. Internat. Edn.*, 1971, **10**, 687.

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