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A SIMPLE AND EFFICIENT *"ONE-POT"* SYNTHESIS OF 2-AZA-1,3-BUTADIENES FROM *N*-VINYLIC λ^5-PHOSPHAZENES

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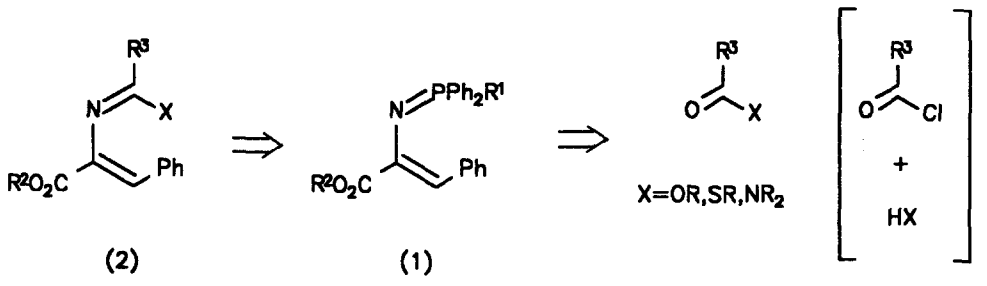
SUMMARY: Reaction of *N*-vinylic λ^5-phosphazenes (1) with acyl halides followed by addition of nucleophiles lead to 1-donor substituted 3-alkoxycarbonyl-2-aza-1,3-butadienes (2) with good to excellent yields.

In the last decade azadienes have become useful key intermediates in organic synthesis for the construction of both heterocyclic systems and open chain polyfunctionalized compounds.[1,2] Particularly significant is the ability of certain types of heterodienes to participate in Diels-Alder reactions. This synthetic strategy comes within what Boger and Weinreb[1b] have called Hetero Diels-Alder Methodology.

The synthesis and some reactions of electronically neutral 2-azadienes,[2] activated 2-aza-1,3-dienes bearing electron-releasing substituents,[3] as well as electron-withdrawing substituted 2-azadienes have been reported.[4,5] However, mixed 2-aza-1,3-dienes with both donor and electron-withdrawing groups have recieved much less attention, probably owing to the lack of general methods for the synthesis of these compounds. Heterodienes of this type were limited to the best of our knowledge, to 4-dialkylamino-1,1-dicyano-2-aza-1,3-butadiene,[4a] 3-electron-withdrawing substituted azadienes with electron-releasing groups - in position 1 and 4 -[4b] and the corresponding 1-methoxy heterodienes recently prepared[4c] by reaction of phosphorus ylides and very reactive functionalized carbonyl compounds.

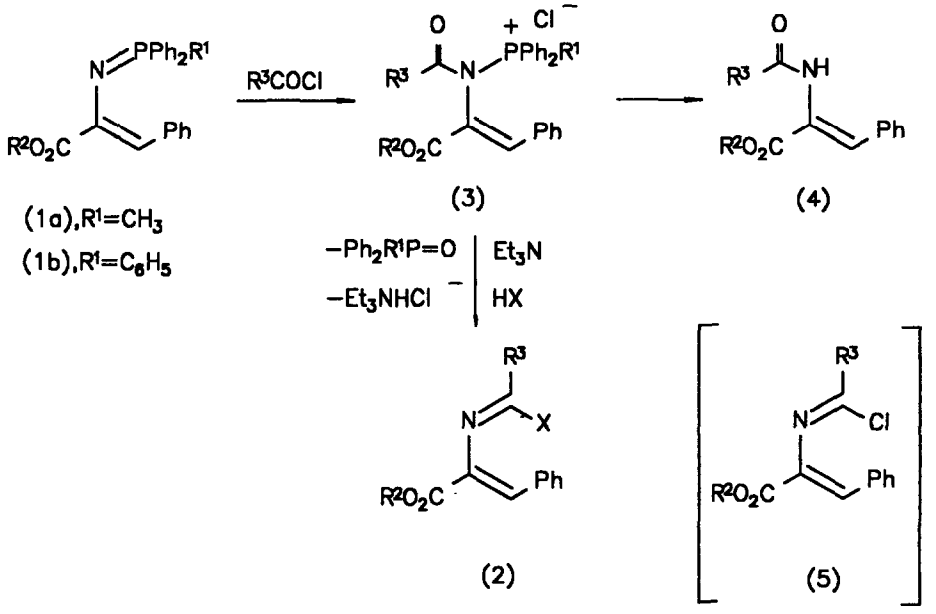
Previously, we have described the utility of phosphazenes in the preparation of acyclic[5,7] and heterocyclic compounds.[8] Our own interest in the chemistry of azadienes and phosphazenes, prompted us to report here a new, simple and *one-pot* synthesis of 2-aza-1,3-butadienes from *N*-functionalized λ^5-phosphazenes (1) derived from dehydroaminoacid esters.

Aza-Wittig reaction of *N*-acrylic phosphazenes (1) with aldehydes provides a good method to create imine double bonds (>C=N-) and lead to azadienes (2).[5] In this paper we report a general *"one-pot"* method of preparing 2-azadienes with a donor group in the 1-position by reaction of *N*-acrylic λ^5-phosphazenes with acyl chlorides followed by addition of nucleophilic reagents HX.



Scheme 1

The treatment of *N*-vinylic λ^5-phosphazenes (**1a**) with acetyl chloride in benzene at room temperature leads to the hygroscopic *N*-acylated aminophosphonium salts (**3a**) (δ_P 32.3 ppm)[9] in excellent yields. The end of the reaction can be easily detected by means of ^{31}P-NMR spectroscopy. Basic hydrolysis (2 N NaOH) of compounds (**3**) gave acyl α,β-dehydro α-aminoacid derivatives (**4**).[10]



Scheme 2

This reaction can be used for the synthesis of 2-azadienes (2) without the isolation of aminophosphonium salts (3). Thus, the reaction of λ^5-phosphazenes (1a) with acetyl chloride followed by addition of phenol in the presence of triethylamine afforded 2-azadiene (2a).[11] The formation of this compound (2a) could be assumed *via* the elimination of phosphine oxide from (3) leading to the haloimine (5) in a similar way to that reported for simple λ^5-phosphazene[12] and subsequent reaction with phenol (scheme 2). Other reagents such as thiophenol, diethylamine, piperidine and *N,N*-diphenylhydrazine can also be used instead of phenol giving the corresponding 2-azadienes (2) (see table).

This communication provides a easy, simple and one-pot synthesis of mixed azadienes (2), making use of readily available starting materials and under mild reaction conditions. It is noteworthy that 2-aza-1,3-butadienes derived from α,β-dehydro α-aminoacids (2) could be valuable intermediates in the synthesis of new aminoacid derivatives,[4b,4c] as well as in the preparation of heterocycles.[1,2] These topics are now under study in our laboratories.

Table of Compounds (3), (4), and (2) obtained

Compound	R^1	R^2	R^3	X	Reaction time(h)	Solvent	Yield(%)
(3a)	CH_3	CH_3	CH_3		6	C_6H_6	97
(3b)	CH_3	Et	CH_3		6	C_6H_6	98
(3c)	Ph	Et	CH_3		24	C_6H_6	96
(4a)		CH_3	CH_3		4	THF	88
(4b)		Et	CH_3		4	THF	86
(2a)		CH_3	CH_3	OPh	48	CH_3CN	78
(2b)		CH_3	CH_3	SPh	48	CH_3CN	76
(2c)		Et	CH_3	NEt_2	48	CH_3CN	80
(2d)		Et	CH_3	$\overline{N(CH_2)_5}$	48	CH_3CN	80
(2e)		Et	CH_3	NPh-NHPh	48	CH_3CN	83
(2f)		CH_3	Ph	NEt_2	48	CH_3CN	82

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9. Compounds (**3**) are very hygroscopic, they were not isolated and were used without purification. Spectral data for (**3a**): δ_H(300MHz, $CDCl_3$) 2.02 (3 H, d, $^2J_{PH}$ 13.2 Hz, Me), 2.60 (3 H, s, COMe), 3.82 (3 H, s, OMe), 7.15 (1 H, s, HC=), and 7.30-7.80 (15 H, m, Ph); δ_P(120MHz, $CDCl_3$) 32.3 ppm.
10. Spectral data for (**4a**): solid, m. p. 110-111°C; $\nu_{max.}$(NaCl) 3212 (NH), 1709 (OC=O), and 1654, 1499 (NC=O) cm^{-1}; δ_H(300MHz, $CDCl_3$) 2.21 (3 H, s, Me), 3.85 (3 H, s, OMe), 7.30 (1 H, s, HC=), and 7.31-7.52 (6 H, m, Ph+NH); δ_C(75MHz, $CDCl_3$) 22.8 (Me), 52.3 (OMe), 124.2-133.3 ($C_{arom.}$+$C_{olef.}$), 165.5 (C=O), and 169.0 (OC=O); MS(70 eV): m/z 219 (M^+, 13%).
11. Triphenyl- and methyldiphenylphosphine oxides were removed by stirring the crude reaction in ether; after removing the bulk of the phosphine oxide by filtration, the solution was passed through a short silica-gel column with ether and evaporated to dryness. Spectral data for (**2a**): solid, m.p. 113-114°C; $\nu_{max.}$(KBr) 1700 (C=O), and 1660 (C=N) cm^{-1}; δ_H(300MHz, $CDCl_3$) 2.23 (3 H, s, Me), 3.52 (3 H, s, OMe), 6.25 (1 H, s, HC=), and 7.10-8.00 (10 H, m, Ph); δ_C(75MHz, $CDCl_3$) 15.2(Me), 51.9 (OMe), 117.9-143.3 ($C_{arom.}$+$C_{olef.}$), 152.2 (C=N), and 167.9 (C=O); MS(70 eV): m/z 295 (M^+, 36%).
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