# Studies on Phosphonium Ylides. XVIII. The Reaction of Wittig Reagents with Phthalimidobenzoic Acid Azides

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Abstract : Wittig reagents (1a,c) react with phthalimidobenzoic acid azide (2a) to give the new products 3a, 3b, 3c, and 5, respectively. On the other hand, methylenetriphenylphosphorane (1b) reacts with azides (2a,b) to afford the corresponding 1, 5- disubstituted -1, 2, 3-triazoles (4,6). Structural reasoning for the new products was based on compatible analytical and spectral data.

# INTRODUCTION

The action of Wittig reagents (1) on tosyl azides<sup>1,2</sup>, acyl azides<sup>3</sup>, azidoformates<sup>4</sup>, and aryl azides<sup>3,5</sup>, has been extensively studied. However, to the best of our knowledge, there appears no information in the literature regarding the behaviour of these reagents towards o-, and m-phthalimidobenzoic acid azides 2 (Scheme 1).



(Scheme 1)

## **RESULTS AND DISCUSSION**

We have found that the reaction of o-phthalimidobenzoic acid azide 2a with one mole equivalent of cya-

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nomethylenetriphenylphosphorane 1a in dry benzene proceeds at room temperature to give three pure adducts formulated as 3a, 3b, and 3c respectively [cf. Scheme 2]. Triphenylphosphine (TPP) was also isolated from the reaction medium.



The structure of compound 3a is deduced from its analysis, IR, <sup>1</sup>H-NMR, <sup>31</sup>P-NMR, and mass spectral data. The IR spectrum of 3a reveals the presence of strong -NH absorption band at 3300 cm<sup>-1</sup>. Moreover, the IR spectrum of 3a exhibits strong bands at 1670 and 1500 cm<sup>-1</sup> characteristic for the >C=P group absorption<sup>6</sup>, at 1410 cm<sup>-1</sup> for the >P-C-(phenyl) absorption<sup>7</sup> and at 1720 cm<sup>-1</sup> (C=0 coupling bands of cyclic imides)<sup>8-10</sup>. The <sup>1</sup>H-NMR spectrum of adduct 3a showed the exchangeable (D<sub>2</sub>O) proton (NH) appeared as singlet at 11.8 ppm. The aromatic protons appeared as a multiplet at 6.7 - 7.95 ppm (m, 23H). Adduct 3a possesses phosphorane structure since it exhibits a positive shift in its <sup>31</sup>P-NMR spectrum (d = +18.743, vs. 85% H<sub>3</sub>PO<sub>4</sub>)<sup>11</sup>. Actually, the mass spectrum of adduct 3a by Field Ionization Method yielded a prominent ion peak M<sup>+</sup> at 593 which supports structure 3a.

The identity of compound 3b is attested by compatible analytical and mass spectroscopic results. The IR spectrum of 3b exhibits strong absorption bands at  $1700 \text{ cm}^{-1}$  (acid azide C=O), 1770 and 1710 (C=O, coupling bands of cyclic imides)<sup>8-10</sup>. The mass spectrum of 3b gives a prominent ion peak at m/e 528 (M<sup>+</sup>, 30%).

Elemental and mass spectral analysis for compound 3c [by Field Ionization Method] correspond to an empirical formula of  $C_{33}H_{23}N_4O_3P$ . Its IR spectrum, in KBr, revealed the absence of asymmetric azide absorption near 2100 cm<sup>-1</sup><sup>12</sup>. On the other hand, the IR spectrum of 3c exhibits strong absorption bands at 1350 cm<sup>-1</sup> (N=P), 1700 (acid azide C=O), 1780 and 1720 (C=O, coupling bands of cyclic imides)<sup>8-10</sup>.

Adduct 3c possesses phosphoranimine structure since it exhibits a positive shift in its <sup>31</sup>P-NMR spectrum (d = +22.324, vs. 85%  $H_3PO_4$ ) and absorbs in the region characteristic for this class of compounds<sup>11</sup>. Heating of adduct 3c gives rise to the corresponding iminophosphorane derivative 3d accompanied with loss of nitro-gen<sup>12</sup> [Scheme 3].



#### (Scheme 3)

Further evidence for the formation of compound 3d was obtained by allowing o-phthalimidobenzoic acid azide (2a) to react with triphenylphosphine. The new iminophosphorane derivative, thus formed, proved to be identical with 3d (mp, mixed mp, comparative IR spectra). The structure of compound 3d was deduced from analysis, IR, <sup>1</sup>H-NMR, <sup>31</sup>P-NMR, <sup>13</sup>C-NMR and MS [cf. Experimental].

Acetylmethylenetriphenylphosphorane (1b) reacts with 2a in dry benzene to give the dimeric from 3b together with pure adduct assigned structure 4 [Scheme 4].

The IR Spectrum of 4, in KBr, reveals the presence of the triazole absorption band at 1183 cm<sup>-1</sup>. <sup>1</sup>H-NMR spectrum of compound 4 disclosed the presence of signals at  $\delta = 2.52$  (3H, doublet with  $J_{HH} = 1$  Hz), 7.20 (1H, quartet with  $J_{HH} = 1$ Hz). The aromatic protons together with the triazole ring appeared as multiplet centered at 7.6 ppm (8H, m). The mass spectrum of compound 4 yielded a prominent ion peak at m/e = 332. A possible explanation of the course of the reaction of phthalimidobenzoic acid azide 2a with acetylmethylenetriphenylphosphorane 1b is shown in [Scheme 4]. The reaction can be visualized as 1, 3-dipolar cycloaddition of the azide 2a onto the C=C bond of the ylide 1b (enolate form) occurred in the first step of the reaction followed by loss of OPPh<sub>3</sub> from the cyclic intermediate (A) to give N-1 substituted 5-methyl-1, 2, 3-triazole  $4^{13}$  [Scheme 4].



(Scheme 4)

R—CO—CH= PPh<sub>3</sub> ↔ R—CO—
$$\overline{C}$$
H—PPh<sub>3</sub> ↔ R—C = CH $-PPh_3$   
 $|$   
 $\overline{O}$   
enolate

On the other hand, benzoylmethylenetriphenylphosphorane (1c) reacts with (2a) at room temperature to give the addition product 5 together with the dimeric adduct 3b [Scheme 5].

The identity of compound 5 is inferred from its correct analytical and mass spectroscopic analyses. The IR spectrum of compound 5 exhibits several IR absorptions at 1665, 1500 cm<sup>-1</sup> corresponding to C=P absorption, 1415 cm<sup>-1</sup> (>P-C phenyl) and at 1720 cm<sup>-1</sup> (C=O, coupling bands of cyclic imides). Moreover, the IR spectrum of adduct 5 shows strong band at 3350 cm<sup>-1</sup> attributed to the NH absorption band. <sup>1</sup>H-NMR spectrum of the phosphorane adduct 5 showed the exchangeable (D<sub>2</sub>O) proton (NH) appeared as singlet at 12.2 ppm. The aromatic protons appeared as multiplet at 6.5 - 8.5 ppm (m, 28H). Adduct 5 possesses phosphorane structure since it exhibits a positive shift in its <sup>31</sup>P-NMR spectrum ( $\mathcal{S}$ =+18.534, vs. 85% H<sub>5</sub>PO<sub>4</sub>). Compound 5 has a prominent ion peak M<sup>+</sup> at 672 in its mass spectrum which supports structure 5.

Next, we have investigated the behaviour of m-phthalimidobenzoic acid azide 2b towards phosphorane 1b. We have found that acetylmethylenetriphenylphosphorane 1b reacts with 2b to give N-1 substituted 5methyl-1, 2, 3-triazole 6 in 88% yield [Scheme 6]. Triphenylphosphine oxide was also isolated from the reaction medium.













# The structure of compound 6 was inferred from the following :

i) Correct elemental analysis and molecular weight determination (MS) of this product corresponds to  $C_{18}H_{12}N_4O_3$ . ii) The IR spectrum (in KBr) of 6, showed band at 1185 cm<sup>-1</sup> (Triazole). Its <sup>1</sup>H-NMR disclosed the presence of doublet at  $\xi = 2.61$  ppm (3H with  $J_{HH}=1$  Hz) and quartet at 7.30 ppm (1H with  $J_{HH}=1$  Hz) corresponding to the methyl and methine protons, respectively. The aromatic protons together with the triazole ring appeared as multiplet centered at 7.8 (8H, m).

The results of the present investigation allow certain interesting conclusions to be drawn. While ophthalimidobenzoic acid azide 2a reacts with phosphorus ylides 1a, c to yield the corresponding phosphorane adducts 3a, 5, a different behaviour is noted with ylide 1b. This latter gives with azides 2a, b the respective 1, 5-disubstituted 1, 2, 3-triazoles (4, 6). Moreover, it is safe to conclude that the reaction of phthalimidobenzoic acid azides 2 with ylides 1 leads to different products depending on the nature of the ylide used and also on the stability of the addition products. The significance of these findings is not only the discovery of a new pattern for Wittig reaction but also the establishment of a novel method for the synthesis of the stable azido phosphorane adducts (3a, 5).

#### **EXPERIMENTAL**

All melting points are uncorrected. The benzene used was dried over Na. Cyanomethylene-,<sup>14</sup> acetylmethylene-,<sup>15</sup> and benzoylmethylene triphenylphosphoranes<sup>15</sup> were prepared according to established procedures. The IR spectra were taken in KBr, on Perkin-Elmer Infracord Spectrophotometer Model 157 (Grating). The <sup>1</sup>H-NMR spectra were taken in CDCl<sub>3</sub> on JNM-GX-400 FA Jeol, Tokio, Spectrometer. The <sup>31</sup>P-NMR spectra were recorded in CDCl<sub>3</sub> (vs.  $H_3PO_4$  as external standard) on JNM-PS-200 Fa Jeol and JNM-GX-400 Fa Jeol Spectrometer. The mass spectra were run at 70 eV on Kratos MS equipment and/or Varian MAT 311 A Spectrometer.

# Reaction of Cyanomethylenetriphenylphosphorane (1a) with o-phthalimidobenzoic acid azide (2a) :

To a solution of azide (2a) (0.29 g, 0.001 mol) in benzene (25 ml) was added a solution of ylide 1a (0.31 g, 0.001 mol) in benzene (10 ml) and the mixture left at ambient temperature for 24 hr. Benzene was concentrated and cooled whereas the brown precipitated material was filtered off and recrystallized from chloroform/pet-ether (60-80°) to give 3a as brown crystals in 30% yield, mp. 242°C. Anal. Calcd for  $C_{35}H_{24}N_5O_3P$  (593.597) : C, 70.81; H, 4.07; N, 11.79; P, 5.22. Found C, 70.80; H, 4.05; N, 11.80; P, 5.28%. Mol. wt (MS) = 593. The filtrate was concentrated then cooled, the yellow precipitated material thus formed was filtered off, washed with benzene (5 ml) and recrystallized from chloroform/benzene to give 3b as yellow crystals (15%), mp. 283°C. Anal. Calcd for  $C_{30}H_{16}N_4O_6$  (528.490) : C, 68.18; H, 3.03; N, 10.61. Found C, 68.12; H, 3.09; N, 10.10%. The benzene filtrate was treated with pet-ether (40-60°) to give 3c as red brown crystals (30%), mp. 108°C. Anal. Calcd for  $C_{33}H_{23}N_4O_3P$  (554.559) : C, 71.48; H, 4.15; N, 10.11; P, 5.59. Found : C, 71.45; H, 4.17; N, 10.10; P, 5.57% Mol. wt (MS) = 554.

## Action of Heat on Phosphorus Triazo Adduct 3c :

Adduct 3c (0.2 g) was heated in a cold finger sublimation at 120°C (bath temperature) under reduced pressure (2 mm/Hg) for 10 min. The substance that sublimed was collected, crystallized from benzene-petether (60-80°) to give iminophosphorane derivative 3d in 85% yield, mp. 212°C. Anal. Calcd for  $C_{33}H_{23}N_2O_3P$  (526.543), C, 75.29; H, 4.37; N, 5.32; P, 5.89. Found : C, 75.25; H, 4.35; N, 5.28; P, 5.87. Mol. wt (MS) = 526.

IR spectrum (3d), in KBr, bands at  $1355 \text{ cm}^{-1}$  (N=P), 1700 (acid azide C=0), 1775 and 1720 (C=0, coupling bands of cyclic imides). <sup>31</sup>P-NMR (in CDCl<sub>3</sub>, vs. 85% H<sub>3</sub>PO<sub>4</sub>); +22.6. <sup>13</sup>C-NMR : 177.3 (d, C=0), 169.5 (s, C=0), 142, 136.4, 135.25, 133.9, 133.22, 131.3, 131.16, 130.7, 130.17, 129.17, 125.7.

### Action of Triphenylphosphine on Acid Azide (2a) :

A mixture of azide (2a) (0.001 mol) and triphenylphosphine (0.001 mol) in benzene (30 ml) was allowed to stir at room temperature for 24 hr. The crystals that separated (90%) were recrystallized from benzene-pet-ether (60-80°C) to give colourless crystals proved to be 3d (mp, mixed mp and comparative IR spectra).

# Reaction of o-phthalimidobenzoic acid azide (2a) with ylide 1b :

A solution of compound 1b (0.32 g, 0.001 mol) in benzene (10 ml) was added to a solution of acid azide 2a (0.29 g, 0.001 mol) in the same solvent (25 ml) and the reaction mixture left at room temperature for 24 hr. The precipitated material was filtered off, recrystallized from benzene-pet-ether (40-60°C) to give 1, 5disubstituted-1, 2, 3-triazole derivative 4 as pale yellow crystals, mp. 182° in 75% yield. Anal. Calcd for  $C_{18}H_{12}N_4O_3$  (332.326) C, 65.06; H, 3.61; N, 16.87. Found : C, 65.10; H, 3.70; N, 16.80%. Mol. wt (MS) = 332. Benzene was evaporated from the filtrate and the residual substance was recrystallized from benzenepet-ether (b.r. 60-80°C) to give colourless needles proved to be triphenylphosphine oxide (TPPO) (mp and mixed mp)<sup>16</sup>. The filtrate was evaporated and the residual substance was recrystallized from chloroformbenzene to give 3c as yellow crystals (mp, mixed mp and comparative IR spectra).

### Reaction of benzoylmethylenetriphenylphosphorane (1c) with azide 2a :

A solution of ylide 1c (0.38 g, 0.001 mol) in benzene (10 ml) was added to a solution of azide 2a (0.29 g, 0.001 mol) in the same solvent (25 ml) and the reaction mixture left at room temperature for 24 hr. The precipitated material was filtered off, recrystallized from benzene-pet-ether (40-60°C) to give 5 as yellow crystals, mp. 208° (75% yield). Anal. Calcd for  $C_{41}H_{29}N_4O_4P$  (672.695). C, 73.20; H, 4.34; N, 8.33; P, 4.61. Found : C, 73.23; H, 4.40; N, 8.30; P, 4.63%. Mol. wt (MS) = 672.

Compound 3b was also separated from the filtrate (mp, mixed mp and comparative IR spectra).

#### Reaction of acetylmethylenetriphenylphosphorane (1b) with m-phthalimidobenzoic acid azide (2b) :

To a solution of azide (2b) (0.29 g, 0.001 mol) in 25 ml. benzene was added a solution of ylide 1b (0.32 g, 0.001 mol) and the reaction mixture left at room temperature for 24 hr. The precipitated material thus formed, filtered off, recrystallized from benzene-pet-ether (60-80°C) to give the triazole derivative (6) as col-

ourless crystals (75%), mp. 185°C. Anal. Calcd for  $C_{18}H_{12}N_4O_3$  (332.326) C, 65.06; H, 3.61; N, 16.87. Found : C, 65.08; H, 3.63; N, 16.85% Mol wt (MS) = 332.

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