A Novel Resolution Procedure for the Preparation of P-Stereogenic Phosphine Oxides

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Supporting Information

TBS Azide 3: Alcohol **4** (5.56g, 21.72 mmol) was dissolved in DMF (150 mL) and Et_3N (15 mL) to which was then added TBSCl (10.84 g, 71.92 mmol). The resulting mixture was stirred for 3 h at r.t. and the solvents were removed *in vacuo* (55ºC, 0.05 mmHg). The residue was taken up into ether and filtered through a pad of Celite® 545. The filtrate was then concentrated *in vacuo* to afford a thick orange oily residue which was then dissolved in benzene (150 mL). A catalytic quantity (5 drops) of DMF was added followed by $SOCl_2$ (9.5 mL, 128.8 mmol). The resulting solution was then heated to reflux for 12 h, quenched with saturated brine, and extracted with ether (3 x 200 mL). The combined organic extracts were then dried ($MgSO_4$), filtered, and concentrated *in vacuo* to afford the desired product (7.76 g, 82% from **4**). The crude sulfonyl chloride was then dissolved in DMA (80 mL) and H_2O (40 mL). To the solution was then added NaN_3 (4.54 g, 69.8 mmol) and the resulting mixture was heated to 60ºC for 12 h. The cooled mixture was then extracted with Et_2O (3 x 150 mL), washed with brine, dried ($MgSO_4$), and concentrated to furnish a light yellow oil. The product was purified by column chromatography (15:1 hexanes/EtOAc) to afford the desired product. (6.13 g. 70%). α_D^{20} = -36.2º (c=5.5, $CHCl_3$); (KBr) cm^{-1} 2954, 2131; ^{1}H NMR (200 MHz) δ 4.06 (m, 1H), 3.97 (d, *J* = 14.0, 1H), 3.12 (d, *J* = 14.0 Hz, 1H), 2.10-1.88 (m, 1H), 1.86-1.49 (m, 4H), 1.47-1.06 (m, 3H), 1.05 (s, 3H), 0.90 (s, 9H), 0.89 (s, 3H), 0.11 (s, 3H), 0.08 (s, 3H); ^{13}C NMR (50 MHz) δ 75.8, 54.9, 50.4, 49.3, 44.5, 41.9, 28.6, 27.2, 25.8, 20.6, 20.1, 17.8, -4.1, -5.4; mass spectrum, *m/z* (relative intensity, %) 345 (M^+-N_2, 1), 288 (44), 115 (66), 73 (100). Exact mass calcd for $C_{16}H_{31}N_3O_3SSi$ – C_4H_9: 316.1151. Found: 316.1120.

Phosphinimine 6a: α_D^{20} = -39.7º (c=0.86, $CHCl_3$); Mp 175-177 ºC; IR (KBr) cm^{-1} 2930, 1452, 1110; ^{1}H NMR (200 MHz) δ 7.90-7.72 (m, 2H), 7.66-7.45 (m, 3H), 4.19 (m, 1H), 3.70 (dd, *J* = 13.8, 2.0 Hz, 1H), 2.81 (d, *J* = 13.8 Hz, 1H), 2.24-1.91 (m, 3H), 2.04 (d, *J* = 11.2 Hz, 3H), 1.90-1.07 (m, 16H), 1.00 (s, 3H), 0.91 (s, 9H), 0.82 (s, 3H), 0.16 (s, 3H), 0.06 (s, 3H); ^{13}C NMR (50 MHz) δ 134.2 (d, *J* = 3 Hz) 131.1 (d, *J* = 9 Hz), 128.7 (d, *J* = 12 Hz), 127.7 (d, *J* = 86 Hz), 76.3, 53.8 (d, *J* = 5 Hz), 50.4, 48.5, 44.6, 42.2, 38.7 (d, *J* = 71 Hz), 28.1, 27.4, 26.2, 26.0, 25.6, 25.1 (d, *J* = 3 Hz), 25.0 (d, *J* = 3 Hz), 20.9, 20.3, 17.9, 10.3 (d, *J* = 58 Hz), -4.4, -4.9; ^{31}P NMR (81 MHz) δ 23.3. mass spectrum, *m/z* (relative intensity, %) 551 (M^+, 0.2), 536 (1), 494 (53), 268 (64), 73 (100). Exact mass calcd for $C_{29}H_{50}NO_3PSSi$ – C_4H_9 : 494.2314. Found: 494.2339.

Phosphinimine 7a: α_D^{20} = -10.0º (c=1.06, $CHCl_3$); Mp 147-149 ºC; IR (KBr) cm^{-1} 2930, 1452, 1110; ^{1}H NMR (200 MHz) δ 7.82-7.70 (m, 2H), 7.64-7.41 (m, 3H), 4.10 (m, 1H), 3.67 (dd, *J* = 13.8, 2.4 Hz, 1H), 2.81 (d, *J* = 13.8 Hz, 1H), 2.26-1.98 (m, 3H), 2.03 (d, *J* = 13 Hz, 3H), 1.98-1.02 (m, 16H), 0.99 (s, 3H), 0.87 (s, 9H), 0.85 (s, 3H), 0.14 (s, 3H), 0.06 (s, 3H); ^{13}C NMR (50 MHz) δ 132.3 (d, *J* = 3 Hz) 131.1 (d, *J* = 10 Hz), 128.7 (d, *J* = 12 Hz), 127.7 (d, *J* = 86 Hz), 76.4, 53.9 (d, *J* = 5 Hz), 50.4, 48.5, 44.6, 42.2, 38.7 (d, *J* = 72 Hz), 28.3, 27.4, 26.2, 26.0, 25.6, 25.2 (d, *J* = 3 Hz), 25.0 (d, *J* = 3 Hz), 20.9, 20.3, 17.9, 10.3 (d, *J* = 59 Hz), -4.4, -4.9; ^{31}P NMR (81 MHz) δ 23.2. mass spectrum, *m/z* (relative intensity, %) 551 (M^+, 0.2), 536 (1), 494 (53), 268 (64), 73 (100). Exact mass calcd for $C_{29}H_{50}NO_3PSSi$ – C_4H_9 : 494.2314. Found: 494.2365.

Phosphinimine 6b: α_D^{20} = -13.5° (c=2.46, $CHCl_3$); Mp 151-153 ºC; IR (KBr) cm^{-1} 2932, 1439, 1111; ^1H NMR (400 MHz) δ 7.85-7.78 (m, 2H), 7.60-7.47 (m, 3H), 4.14-4.09 (m, 1H), 3.69 (d, *J* = 13.8, 1H), 2.85 (d, *J* = 13.8 Hz, 1H), 2.52-2.44 (m, 1H), 2.21-2.06 (m, 1H), 2.04 (d, *J* = 12.7 Hz, 3H), 2.01-1.45 (m, 15H), 1.00 (s, 3H), 0.88 (s, 9H), 0.85 (s, 3H), 0.14 (s, 3H), 0.06 (s, 3H); ^{13}C NMR (50 MHz) δ 132.7, 131.5 (d, *J* = 9 Hz), 129.5 (d, *J* = 100 Hz), 129.2 (d, *J* = 12 Hz), 76.8, 54.3, 50.9, 49.0, 45.0, 42.6, 39.1 (d, *J* = 75 Hz), 28.6, 27.8, 27.1 (d, *J* = 11 Hz), 26.8 (d, *J* = 21 Hz), 26.8, 26.4, 21.4, 20.7, 18.3, 12.5 (d, *J* = 60 Hz), -4.0, -4.5; ^{31}P NMR (81 MHz) δ 23.0. mass spectrum, *m/z* (relative intensity, %) 551 (M^+, 0.2), 536 (1), 494 (53), 268 (64), 73 (100). Exact mass calcd for $C_{28}H_{48}NO_3PSSi - CH_3$: 522.2627. Found: 522.2633.

Phosphinimine 7b: α_D^{20} = -52.8° (c=2.47, $CHCl_3$); Mp 152-154 ºC; IR (KBr) cm^{-1} 2956, 1462, 1111; ^1H NMR (400 MHz) δ 7.83-7.77 (m, 2H), 7.62-7.44 (m, 3H), 4.13-4.07 (m, 1H), 3.69 (d, *J* = 13.8, 1H), 2.80 (d, *J* = 13.8 Hz, 1H), 2.55-2.42 (m, 1H), 2.18-2.08 (m, 1H), 2.05 (d, *J* = 13.3 Hz, 3H), 1.98-1.43 (m, 14H), 1.00 (s, 3H), 0.90 (s, 9H), 0.83 (s, 3H), 0.15 (s, 3H), 0.06 (s, 3H); ^{13}C NMR (100 MHz) δ 132.7 (d, *J* = 3 Hz) 131.4 (d, *J* = 10 Hz), 129.2 (d, *J* = 12 Hz), 129.5 (d, *J* = 100 Hz), 76.8, 54.3 (d, *J* = 6 Hz), 50.8, 49.0, 45.0, 42.6, 39.2 (d, *J* = 74 Hz), 28.6, 27.8, 27.1, 27.0, 26.8 (d, *J* = 10 Hz), 26.7 (d, *J* = 10 Hz), 26.4, 21.3, 20.7, 18.3, 12.4 (d, *J* = 60 Hz, -4.0, -4.5; ^{31}P NMR (81 MHz) δ 24.4. mass spectrum, *m/z* (relative intensity, %) 537 (M^+, 0.3), 522 (4), 480 (99), 328 (41), 254 (100). Exact mass calcd for $C_{28}H_{48}NO_3PSSi - CH_3$: 522.2627. Found: 522.2620.

Phosphinimine 6c: α_D^{20} = -10.2° (c=0.84, $CHCl_3$); Mp 149-150 ºC; IR (KBr) cm^{-1} 2928, 1439, 1113; ^1H NMR (200 MHz) δ 7.85-7.64 (m, 2H), 7.61-7.41 (m, 3H), 4.08 (m, 1H), 3.66 (d, *J* = 18.0, 1H), 2.79 (d, *J* = 18.0 Hz, 1H), 2.37 (m, 2H), 2.01 (d, *J* = 17.0 Hz, 3H), 1.80-1.33 (m, 5H), 1.28-1.00 (m, 6H), 0.97 (s, 3H), 0.85 (s, 9H), 0.82 (s, 3H), 0.10 (s, 3H), 0.03 (s, 3H); ^{13}C NMR (50 MHz) δ 132.2 (d, *J* = 3 Hz) 131.0 (d, *J* = 9 Hz), 128.6 (d, *J* = 12 Hz), 127.7 (d, *J* = 104 Hz), 76.2, 53.7 (d, *J* = 5 Hz), 50.3, 48.4, 44.5, 42.1, 29.5, 28.1, 27.2, 25.9, 20.8, 20.1, 17.8, 15.2 (m, 2xCH_3), 10.9, 9.7, -4.9, -5.0; ^{31}P NMR (81 MHz) δ 26.1. mass spectrum, *m/z* (relative intensity, %) 496 (M^+-CH_3, 3), 454 (89), 302 (32), 228 (100). Exact mass calcd for $C_{26}H_{46}NO_3PSSi - CH_3$: 496.2471. Found: 496.2443.

Phosphinimine 6d: α_D^{20} = +18.2° (c=1.80, $CHCl_3$); IR (KBr) cm^{-1} 2927, 1439, 1141; ^1H NMR (200 MHz) δ 8.29-7.99 (m, 3H), 7.90 (d, *J* = 8.2 Hz, 1H), 7.80 (d, *J* = 8.2 Hz, 1H), 7.77 (d, *J* = 6.7 Hz, 1H), 7.67-7.31 (m, 6H), 4.09 (m, 1H), 3.45 (d, *J* = 13.9 Hz, 1H), 2.49 (d, *J* = 13.3 Hz, 3H), 2.40 (d, *J* = 13.9 Hz, 1H), 2.17-1.92 (m, 1H), 1.76-1.41 (m, 6H), 0.84 (s, 9H), 0.81 (s, 3H), 0.48 (s, 3H), 0.10 (s, 3H), 0.02 (s, 3H); ^{13}C NMR (50 MHz) δ 134.3 (d, *J* = 3 Hz), 133.9 (d, *J* = 9 Hz), 133.6 (d, *J* = 10 Hz), 132.4 (d, *J* = 3 Hz), 132.1 (d, *J* = 9 Hz), 131.0 (d, *J* = 11 Hz), 129.3, 129.0 (d, *J* = 13 Hz), 128.2 (d, *J* = 72 Hz), 127.4, 126.5, 126.0 (d, *J* = 7 Hz), 124.7 (d, *J* = 15 Hz), 124.2 (d, *J* = 103 Hz), 76.1, 53.7 (d, *J* = 3 Hz), 50.3, 48.4, 44.5, 42.1, 28.3, 27.3, 26.0, 20.6, 20.1, 17.9, 16.5 (d, *J* = 66 Hz), -4.5, -4.9; ^{31}P NMR (81 MHz) δ 12.6. mass spectrum, *m/z* (relative intensity, %) 595 (M^+, 0.2), 580 (1), 538 (33), 312 (100). Exact mass calcd for $C_{33}H_{46}SO_3SiPN$ - CH_3 :580.2471. Found:580.2462. Anal. Calcd for $C_{33}H_{46}SO_3SiPN$: C, 66.52; H, 7.78. Found C, 66.20; H, 7.70.

Phosphinimine 7d: α_D^{20} = -101.4° (c=1.36, $CHCl_3$); Mp 183-184 ºC; IR (KBr) cm^{-1} 2955, 1440, 1122; ^1H NMR (200 MHz) δ 8.28-8.02 (m, 3H), 7.97-7.68 (m, 3H), 7.66-7.30 (m, 6H), 4.10-3.95 (m, 1H), 3.39 (d, *J* = 14.0 Hz, 1H), 2.46 (d, *J* = 13.3 Hz, 3H), 1.97 (d, *J* = 14.0 Hz, 1H), 1.90-1.16 (m, 7H), 0.91 (s, 9H), 0.60 (s, 3H), 0.30 (s, 3H), 0.19 (s, 3H), 0.03 (s, 3H); ^{13}C NMR (50 MHz) δ 134.3 (d, *J* = 3 Hz), 133.9 (d, *J* = 9 Hz), 133.5 (d, *J* = 10 Hz), 132.4 (d, *J* = 3 Hz), 132.2 (d, *J* = 9 Hz), 131.0 (d, *J* = 11 Hz), 129.2, 129.0 (d, *J* = 13 Hz), 127.6 (d, *J* = 102 Hz), 127.5, 126.6, 126.2 (d, *J* = 7 Hz), 124.8 (d, *J* = 15 Hz), 124.1 (d, *J* = 97 Hz), 76.0, 53.3, 50.2, 48.2, 44.3, 42.0, 28.0, 27.2, 26.1, 20.4, 19.8, 17.9, 16.6 (d, *J*

= 66 Hz), -4.4, -5.0; ^{31}P NMR (81 MHz) δ 12.9. mass spectrum, *m/z* (relative intensity, %) 595 (M^+, 0.3), 580 (2), 538 (39), 264 (100). Exact mass calcd for $C_{33}H_{46}SO_3SiPN$ - CH_3 :580.2471. Found:580.2485. Anal. Calcd for $C_{33}H_{46}SO_3SiPN$: C, 66.52; H, 7.78. Found C, 66.28; H, 7.52.

Phosphinimine 6e: α_D^{20} = +6.6° (c=5.45, $CHCl_3$); Mp 183-184 ºC; IR (KBr) cm^{-1} 2953, 1439, 1114; ^{1}H NMR (400 MHz) δ 8.72-8.68 (m, 2H), 8.58 (d, *J* = 17.0 Hz, 1H), 8.08 (d, *J* = 7.5 Hz, 1H), 8.01 (d, *J* = 7.0 Hz, 1H), 7.89-7.28 (m, 9H), 4.12 (m, 1H), 3.48 (d, *J* = 13.8 Hz, 1H), 2.58 (d, *J* = 13.3 Hz, 3H), 2.45 (d, *J* = 13.8 Hz, 1H), 2.08 (m, 1H), 1.82-1.30 (m, 5H), 0.98 (m, 1H), 0.84 (s, 9H), 0.82 (s, 3H), 0.52 (s, 3H), 0.13 (s, 3H), 0.04 (s, 3H); ^{13}C NMR (100 MHz) δ 137.7 (d, *J* = 9 Hz), 133.0 (d, *J* = 3 Hz), 132.8 (d, *J* = 2 Hz), 132.4 (d, *J* = 9 Hz), 132.0 (d, *J* = 94 Hz), 131.8 (d, *J* = 59 Hz), 131.5 (d, *J* = 11 Hz), 130.7, 130.2, 129.0 (d, *J* = 25 Hz), 129.6 (d, *J* = 13 Hz), 127.9, 127.6, 127.4 (d, *J* = 10 Hz), 129.1, 124.0, 123.1, 123.2 (d, *J* = 103 Hz), 76.6, 54.3 (d, *J* = 3 Hz), 50.8, 48.8, 45.0, 42.6, 28.8, 27.8, 26.4, 21.1, 20.5, 18.3, 16.9 (d, *J* = 65 Hz), -4.0, -4.4; ^{31}P NMR (162 MHz) δ 15.2. mass spectrum, *m/z* (relative intensity, %) 630 (M^+-CH_3, 0.2), 588 (4), 362 (91), 314 (100). Exact mass calcd for $C_{37}H_{48}SO_3SiPN$ – C_4H_9: 588.2158. Found:588.2211.

Phosphinimine 7e: α_D^{20} = -76.0° (c=1.14, $CHCl_3$); Mp 224-225 ºC; IR (KBr) cm^{-1} 2926, 1441, 1111; ^{1}H NMR (200 MHz) δ 8.72 (t, *J* = 6.9 Hz, 2H), 8.56 (d, *J* = 17.1 Hz, 1H), 8.13 (d, *J* = 8.2 Hz, 1H), 8.04 (d, *J* = 7.9 Hz, 1H), 7.94-7.36 (m, 9H), 4.10 (m, 1H), 3.48 (d, *J* = 14.0 Hz, 1H), 2.57 (d, *J* = 13.3 Hz, 3H), 2.13 (d, *J* = 14.0 Hz, 1H), 1.99-1.16 (m, 7H), 0.94 (s, 9H), 0.67 (s, 3H), 0.28 (s, 3H), 0.22 (s, 3H), 0.06 (s, 3H); ^{13}C NMR (50 MHz) δ 137.0 (d, *J* = 9 Hz), 132.5 (d, *J* = 3 Hz), 132.4, 131.0 (d, *J* = 11 Hz), 130.9 (d, *J* = 11 Hz), 130.4, 129.7, 129.6 (d, *J* = 22 Hz), 129.0 (d, *J* = 13 Hz), 129.1 (d, *J* = 50 Hz), 127.5, 127.4, 127.3, 127.1, 123.4, 122.8 (d, *J* = 98 Hz), 121.8, 76.1, 54.5, 50.2, 48.2, 44.4, 42.0, 28.0, 27.2, 26.1, 20.4, 19.9, 18.0, 16.7 (d, *J* = 67 Hz), -4.4, -5.0; ^{31}P NMR (81 MHz) δ 13.2. mass spectrum, *m/z* (relative intensity, %) 630 (M^+-CH_3, 0.2), 588 (4), 362 (83), 314 (100). Exact mass calcd for $C_{37}H_{48}SO_3SiPN$ – C_4H_9: 588.2158. Found: 588.2131.

Phosphinimine 6f: α_D^{20} = -13.7° (c=0.83, $CHCl_3$); IR (KBr) cm^{-1} 2954, 1438, 1116; ^{1}H NMR (400 MHz) δ 8.31 (d, *J* = 8.5 Hz, 1H), 8.10 (d, *J* = 8.1 Hz, 1H), 8.03-7.84 (m, 5H), 7.76-7.63 (m, 3H), 7.63-7.31 (m, 11H), 4.13 (m, 1H), 3.60 (d, *J* = 13.8 Hz, 1H), 2.40 (d, *J* = 13.8 Hz, 1H), 2.11-1.93 (m, 1H), 1.77-1.42 (m, 5H), 1.06-0.92 (m, 1H), 0.91 (s, 9H), 0.87 (s, 3H), 0.49 (s, 3H), 0.20 (s, 3H), 0.08 (s, 3H); ^{13}C NMR (100 MHz) δ 145.6 (d, *J* = 3 Hz), 140.0, 136.7 (d, *J* = 12 Hz), 134.8 (d, *J* = 3 Hz), 134.5 (d, *J* = 9 Hz), 134.1 (d, *J* = 11 Hz), 133.5 (d, *J* = 9 Hz), 133.3 (d, *J* = 11 Hz), 132.9 (d, *J* = 3 Hz), 129.7, 129.44 (d, *J* = 109 Hz), 129.4, 129.3, 128.7, 127.94, 127.88 (d, *J* = 6 Hz), 127.8 (d, *J* = 3 Hz), 127.7, 127.6 (d, *J* = 106 Hz), 127.0, 125.1 (d, *J* = 15 Hz), 124.5 (d, *J* = 98 Hz), 76.7, 54.0 (d, *J* = 4 Hz), 50.8, 48.8, 45.0, 42.6, 28.6, 27.7, 26.5, 21.0, 20.5, 18.4, -4.0, -4.5; ^{31}P NMR (162 MHz) δ 13.7. mass spectrum, *m/z* (relative intensity, %) 602 (M^+-OTBS, 2), 525 (20), 450 (100). Exact mass calcd for $C_{44}H_{52}NO_3PSSi$ – C_4H_9: 676.2471. Found: 676.2468.

Phosphinimine 7f: α_D^{20} = -36.3° (c=1.44, $CHCl_3$); IR (KBr) cm^{-1} 2953, 1439, 1116; ^{1}H NMR (400 MHz) δ 8.32 (d, *J* = 8.5 Hz, 1H), 8.10 (d, *J* = 8.1 Hz, 1H), 8.02-7.84 (m, 5H), 7.76-7.64 (m, 3H), 7.63-7.56 (m, 3H), 7.56-7.34 (m, 8H), 4.12 (m, 1H), 3.59 (d, *J* = 13.8 Hz, 1H), 2.41 (d, *J* = 13.8 Hz, 1H), 2.00-1.94 (m, 1H), 1.73-1.42 (m, 5H), 1.08-0.95 (m, 1H), 0.90 (s, 9H), 0.82 (s, 3H), 0.49 (s, 3H), 0.19 (s, 3H), 0.07 (s, 3H); ^{13}C NMR (100 MHz) δ 145.6 (d, *J* = 3 Hz), 140.0, 136.7 (d, *J* = 12 Hz), 134.7 (d, *J* = 3 Hz), 134.5 (d, *J* = 9 Hz), 133.8 (d, *J* = 11 Hz), 133.6 (d, *J* = 11 Hz), 133.5 (d, *J* = 9 Hz), 132.9 (d, *J* = 3 Hz), 129.8, 129.4, 129.3 (d, *J* = 121 Hz), 129.2 (d. *J* = 13 Hz), 128.7, 128.0, 127.9 (d, *J* = 7 Hz), 127.82 (d, *J* = 109 Hz), 127.77 (d, *J* = 8 Hz), 127.7, 127.0, 125.1 (d, *J* = 15 Hz), 124.5 (d, *J* = 98 Hz), 76.7, 54.0 (d, *J* = 4 Hz), 50.8, 48.8, 45.0, 42.6, 28.6, 27.7, 26.5, 21.0, 20.5, 18.3, -4.1, -4.5; ^{31}P NMR

(162 MHz) δ 13.7. mass spectrum, *m/z* (relative intensity, %) 602 (M^+-OTBS, 1), 580 (1), 524 (27), 450 (75), 402 (81), 41 (100). Exact mass calcd for $C_{44}H_{52}NO_3PSSi - C_4H_9$: 676.2471. Found: 676.2495.

Phosphine Oxide 8b: $\alpha_D^{20} = +33.3^o$ (c=1.62, MeOH); IR (KBr) cm^{-1} 2960, 1438, 1167, 752; ^1H NMR (400 MHz) δ 7.72-7.63 (m, 2H), 7.51-7.41 (m, 3H), 2.27-2.11 (m, 1H), 1.96-1.74 (m, 2H), 1.75-1.44 (m, 6H), 1.66 (d, *J* = 12.4 Hz, 3H); ^{13}C NMR (100 MHz) δ 134.2 (d, *J* = 94 Hz), 131.8 (d, *J* = 3 Hz), 130.7 (d, *J* = 9 Hz), 128.9 (d, *J* = 11 Hz), 40.0 (d, *J* = 74 Hz), 27.1 (d, *J* = 9 Hz), 26.8 (d, *J* = 9 Hz), 26.73 (d, *J* = 1 Hz), 26.70 (d, *J* = 1 Hz), 15.2 (d. *J* = 69 Hz); ^{31}P NMR (162 MHz) δ 40.1. mass spectrum, *m/z* (relative intensity, %) 208 (M^+, 11), 167 (100), 140 (78), 125 (43). Exact mass calcd for $C_{12}H_{17}OP$: 208.1017. Found: 208.1029.