An Efficient One-Pot Synthesis of Pyrrolo[4,3,2-*ij*]isoquinoline Derivatives by a Consecutive Aza-Wittig/Electrocyclic Ring-Closure/Intramolecular Acylation Process

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Received 4 June 1991

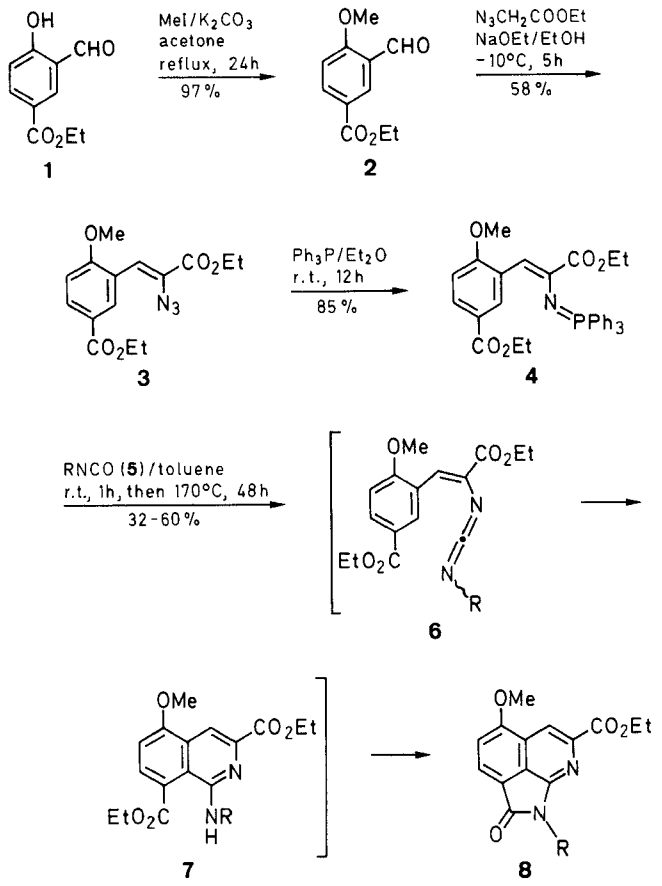
Iminophosphorane, ethyl 5-ethoxycarbonyl-2-methoxy-α-[(triphenylphosphoranylidene)amino]cinnamate (**4**) reacts with aliphatic and aromatic isocyanates in toluene at 170 °C to give directly the corresponding pyrrolo[4,3,2-*ij*]isoquinolines **8** in moderate yields.

We have been interested recently in exploiting the unique reactivities afforded by the iminophosphorane function in developing efficient strategies for the preparation of polyheterocycles[1]. In this context, we have found that the tandem aza-Wittig/electrocyclization strategy has shown to be a useful protocol for the preparation of fused indoles,[2] pyridines[3] and isoquinoline[4] derivatives. In essence our synthetic approach consists of treating iminophosphoranes bearing an unsaturated group with easily accessible heterocumulenes such as isocyanates in an aza-Wittig-type reaction to give a 1,3,5-hexatriene moiety containing cumulated double bonds at one end, which subsequently undergo electrocyclic ring closure.

As a further extension of the above methodology we report herein a new general synthesis of the previously unreported pyrrolo[4,3,2-*ij*]isoquinoline ring system, under neutral conditions, based on the aza-Wittig-type reaction of iminophosphorane **4**. One-pot double-annulation occurs via an unsaturated carbodiimide, available from the iminophosphorane **4** and isocyanates, which then undergoes electrocyclic ring-closure followed by 1,3-hydrogen shift and finally intramolecular acylation of the exocyclic amino group.

The salicylaldehyde **1** is prepared in 35% yield by Duff reaction of ethyl *p*-hydroxybenzoate with hexamethylenetetramine (HMT) in trifluoroacetic acid.[5] Treatment of **1** with methyl iodide in the presence of potassium carbonate leads to **2** in 97% yield. The azide **3** is easily prepared in 58% by condensation of **2** with ethyl azidoacetate in the presence of sodium ethoxide at −10 °C. Staudinger reaction[6] of azide **3** with triphenylphosphine at room temperature affords the iminophosphorane **4** in 85% yield. The reaction of iminophosphorane **4** with several isocyanates in dry toluene at room temperature for 1 hour and then at 170 °C in a sealed tube for 48 hours leads directly to the corresponding pyrrolo[4,3,2-*ij*]isoquinoline derivatives **8** in moderate yields (Table).

The IR spectra of pyrrolo[4,3,2-*ij*]isoquinolines **8** show absortion bands due to the two carbonyl stretch at ν = 1742–1721 cm^{-1} and at ν = 1719–1706 cm^{-1} respectively, except for compound **8a** which only show an absorption band at ν = 1705 cm^{-1}. The ^1H NMR spectra reveal the presence of only one ethoxy group, while the ^{13}C NMR spectra show two signals at δ = 164.59–165.77 and δ = 166.42–167.31 due to the carbon atoms of the two carbonyl groups. Salient features of the ^1H and ^{13}C NMR spectra are given in the Table.



8	R	8	R
a	*i*-Pr	e	3-MeC_6H_4
b	Bn	f	4-$MeOC_6H_4$
c	Ph	g	4-FC_6H_4
d	4-MeC_6H_4	h	4-ClC_6H_4

The EI-mass spectra show the expected molecular ion peaks.

We believe that the conversion **4** to **8** involves an initial aza-Wittig-type reaction between the iminophosphorane and the isocyanate to give a carbodiimide **6** (as evidenced by IR) as intermediate, which undergoes electrocyclic ring-closure and further 1,3-hydrogen shift to give the isoquinoline derivative **7** which, under the reaction conditions, cyclizes to give **8**.

The above method demonstrated that the tandem aza-Wittig/electrophilic ring-closure annulation strategy affords a general entry to a variety of pyrrolo[4,3,2-*ij*]isoquinolines with variable substituents at the pyrrole ring.

Table. Pyrrolo[4,3,2-*ij*]isoquinoline Derivatives **8** Prepared

Product	Yield (%)[a]	mp (°C)[b]	Molecular Formula[c]	IR (Nujol)[d] ν (cm^{-1})	^1H NMR (200 MHz)[e] ($CDCl_3$/TFA/TMS) δ, J (Hz)	^{13}C NMR (50 MHz)[e] ($CDCl_3$/TFA/TMS) δ, J (Hz)	MS (70 eV)[f] m/z (%)
8a	32	225–226	$C_{17}H_{18}N_2O_4$ (314.3)	1705, 1585, 1437, 1297	1.47 (t, 3H, J = 7.1, CH_3), 1.64 [d, 6H, J = 6.9, $CH(CH_3)_2$], 4.09 (s, 3H, CH_3O), 4.47 (q, 2H, J = 7.1, CH_2), 4.86 [sept, 1H, J = 6.9, $CH(CH_3)_2$], 7.08 (d, 1H, J = 7.8, H-4), 8.00 (d, 1H, J = 7.8, H-3), 8.33 (s, 1H, H-6)	14.39 (CH_3), 20.37 [$CH(CH_3)_2$], 44.12 [$CH(CH_3)_2$], 56.4 (CH_3O), 61.63 (CH_2), 110.91 (C_4), 113.26 (C_6), 119.05 (q), 122.57 (q), 122.59 (q), 128.90 (C_3), 143.11 (q), 156.15 (C_{8a}), 160.62 (C_5), 165.77 (CO_2Et), 167.31 (C_2)	314 (M^+, 50), 299 (20), 272 (100), 225 (43), 114 (11), 113 (9), 101 (9)
8b	44	230–231	$C_{21}H_{18}N_2O_4$ (362.4)	1742, 1719, 1495, 1295	1.47 (t, 3H, J = 7.1, CH_3), 4.05 (s, 3H, CH_3O), 4.52 (q, 2H, J = 7.1, CH_2), 5.17 (s, 2H, NCH_2), 7.03 (d, 1H, J = 7.9, H-4), 7.22–7.35 (m, 3H), 7.55–7.59 (m, 2H), 8.00 (d, 1H, J = 7.9, H-3), 8.35 (s, 1H, H-6)	14.43 (CH_3), 42.81 (NCH_2), 56.56 (CH_3O), 61.72 (CH_2), 111.09 (C_4), 113.85 (C_6), 118.68 (q), 122.75 (q), 122.77 (q), 127.61 ($C_{4'}$), 128.56 ($C_{2'}$, $C_{3'}$), 128.92 ($C_{2'}$, $C_{3'}$), 129.41 (C_3), 137.11 ($C_{1'}$), 143.26 (q), 155.75 (C_{8a}), 160.81 (C_5), 165.71 (CO_2Et), 167.17 (C_2)	362 (M^+, 100), 361 (6), 290 (41), 288 (44), 260 (28), 185 (39), 91 (93)
8c	55	264	$C_{20}H_{16}N_2O_4$ (348.3)	1731, 1709, 1436, 1292	1.40 (t, 3H, J = 7.1, CH_3), 4.09 (s, 3H, CH_3O), 4.42 (q, 2H, J = 7.1, CH_2), 7.15 (d, 1H, J = 7.9, H-4), 7.37–7.44 (m, 1H), 7.50–7.55 (m, 2H), 7.60–7.66 (m, 2H), 8.13 (d, 1H, J = 7.9, H-3), 8.41 (s, 1H, H-6)	14.14 (CH_3), 56.78 (CH_3O), 62.26 (CH_2), 111.96 (C_4), 114.78 (C_6), 117.45 (q), 122.90 (q), 122.93 (q), 126.54 ($C_{2'}$), 128.10 ($C_{4'}$), 129.26 ($C_{3'}$), 130.63 (C_3), 133.01 ($C_{1'}$), 141.81 (q), 155.64 (C_{8a}), 161.24 (C_5), 165.36 (CO_2Et), 166.56 (C_2)	348 (M^+, 56), 277 (19), 276 (100), 77 (18), 55 (5)
8d	34	276–277	$C_{21}H_{18}N_2O_4$ (362.4)	1722, 1708, 1493, 1297	1.41 (t, 3H, J = 7.1, CH_3), 2.41 (s, 3H, CH_3–Ar), 4.09 (s, 3H, CH_3O), 4.43 (q, 2H, J = 7.1, CH_2), 7.15 (d, 1H, J = 7.8, H-4), 7.32 (d, 2H, J = 8.1), 7.50 (d, 2H, J = 8.1), 8.12 (d, 1H, J = 7.8, H-3), 8.41 (s, 1H, H-6)	14.19 (CH_3), 21.15 (CH_3–Ar), 56.74 (CH_3O), 62.14 (CH_2), 111.82 (C_4), 114.60 (C_6), 117.70 (q), 122.93 (q), 126.45 ($C_{2'}$), 129.90 ($C_{3'}$), 130.40 (C_3), 130.48 ($C_{1'}$), 138.15 ($C_{4'}$), 142.17 (q), 155.89 (C_{8a}), 161.15 (C_5), 165.38 (CO_2Et), 166.65 (C_2)[g]	362 (M^+, 50), 333 (5), 291 (21), 290 (100), 247 (6), 144 (5), 91 (11)
8e	39	274–275	$C_{21}H_{18}N_2O_4$ (362.4)	1721, 1709, 1438, 1295	1.39 (t, 3H, J = 7.1, CH_3), 2.39 (s, 3H, CH_3–Ar), 4.14 (s, 3H, CH_3O), 4.42 (q, 2H, J = 7.1, CH_2), 7.21–7.42 (m, 5H), 8.21 (d, 1H, J = 7.9, H-3), 8.47 (s, 1H, H-6)	14.03 (CH_3), 21.16 (CH_3–Ar), 56.95 (CH_3O), 62.63 (CH_2), 112.63 (C_4), 115.24 (C_6), 117.15 (q), 123.04 (q), 123.33 (q), 124.26, 127.83, 129.28, 129.78, 131.52 (C_3), 132.19 ($C_{3'}$), 139.71 ($C_{1'}$), 140.55 (q), 155.60 (C_{8a}), 161.56 (C_5), 164.83 (CO_2Et), 166.81 (C_2)	362 (M^+, 63), 333 (5), 291 (22), 290 (100), 144 (6), 91 (31), 65 (18)
8f	45	280–281	$C_{21}H_{18}N_2O_5$ (378.4)	1724, 1706, 1252, 1063	1.39 (t, 3H, J = 7.1, CH_3), 3.81 (s, 3H, CH_3O), 4.16 (s, 3H, CH_3O), 4.42 (q, 2H, J = 7.1, CH_2), 6.96 (d, 2H, J = 8.8), 7.27 (d, 1H, J = 7.9, H-4), 7.38 (d, 2H, J = 8.8), 8.22 (d, 1H, J = 7.9, H-3), 8.47 (s, 1H, H-6)	14.03 (CH_3), 55.41 (CH_3O), 57.01 (CH_3O), 62.74 (CH_2), 112.83 (C_4), 114.78 ($C_{3'}$), 115.31 (C_6), 117.03 (q), 122.99 (q), 123.43 (q), 124.67 ($C_{1'}$), 128.79 ($C_{2'}$), 131.75 (C_3), 140.03 (q), 155.64 (C_{8a}), 159.98 ($C_{4'}$), 161.63 (C_5), 164.59 (CO_2Et), 167.00 (C_2)	378 (M^+, 68), 306 (100), 28 (6), 263 (7), 137 (9), 91 (12), 85 (11)
8g	60	303–304	$C_{20}H_{15}FN_2O_4$ (366.3)	1727, 1710, 1294, 1233	1.40 (t, 3H, J = 7.0, CH_3), 4.18 (s, 3H, CH_3O), 4.44 (q, 2H, J = 7.1, CH_2), 7.19 (t, 2H, J = 8.5), 7.31 (d, 1H, J = 8.1, H-4), 7.49 (dd, 2H, J = 4.7, 8.9), 8.27 (d, 1H, J = 8.1, H-3), 8.53 (s, 1H, H-6)	13.98 (CH_3), 57.14 (CH_3O), 63.15 (CH_2), 113.25 (C_4), 115.80 (C_6), 116.66 (d, $^2J_{F,C}$ = 23.2, $C_{3'}$), 116.67 (q), 123.19 (q), 123.58 (q), 127.91 (d, $^4J_{F,C}$ = 3.2, $C_{1'}$), 129.41 (d, $^3J_{F,C}$ = 6.9, $C_{2'}$), 132.39 (C_3), 139.33 (q), 155.15 (C_{8a}), 161.97 (C_5), 162.82 (d, $^1J_{F,C}$ = 250.1, $C_{4'}$), 164.59 (CO_2Et), 166.76 (C_2)	366 (M^+, 43), 337 (5), 295 (19), 294 (100), 293 (10), 266 (5), 251 (6), 95 (12)

Table. (continued)

Product	Yield (%)[a]	mp (°C)[b]	Molecular Formula[c]	IR (Nujol)[d] ν (cm^{-1})	^1H NMR (200 MHz)[e] ($CDCl_3$/TFA/TMS) δ, J (Hz)	^{13}C NMR (50 MHz)[e] ($CDCl_3$/TFA/TMS) δ, J (Hz)	MS (70 eV)[f] m/z (%)
8h	47	306–307	$C_{20}H_{15}ClN_2O_4$ (382.8)	1723, 1708, 1502, 1265	1.42 (t, 3H, J = 7.1, CH_3), 4.17 (s, 3H, CH_3O), 4.45 (q, 2H, J = 7.1, CH_2), 7.30 (d, 1H, J = 8.0, H-4), 7.40–7.51 (m, 4H), 8.25 (d, 1H, J = 8.0, H-3), 8.51 (s, 1H, H-6)	13.97 (CH_3), 57.11 (CH_3O), 63.11 (CH_2), 113.15 (C_4), 115.76 (C_6), 116.54 (q), 123.13 (q), 123.46 (q), 128.34 ($C_{3'}$), 129.64 ($C_{2'}$), 130.68 ($C_{4'}$), 132.30 (C_3), 134.92 ($C_{1'}$), 139.50 (q), 154.79 (C_{8a}), 161.95 (C_5), 164.77 (CO_2Et), 166.42 (C_2)	384 ($M^+ + 2$, 15), 382 (M^+, 44), 312 (35), 311 (24), 310 (100), 111 (12)

[a] Yield of isolated pure product.
[b] Uncorrected.
[c] Satisfactory microanalyses obtained: C ±0.25, H ±0.29, N ±0.28.
[d] Recorded on a Nicolet FT 5DX spectrophotometer.
[e] Recorded on a Bruker AC-200 spectrometer.
[f] Recorded on a Hewlett-Packard 5993C instrument.
[g] One quaternary carbon not observed.

Ethyl 3-Formyl-4-hydroxybenzoate (1):
To a well-stirred solution of ethyl *p*-hydroxybenzoate (4.98 g, 30 mmol) in TFA (24 mL) was added HMT (8.41 g, 60 mmol). The mixture was heated at 80 °C for 3 h. After cooling at 0 °C, 50% H_2SO_4 (15 mL) and H_2O (90 mL) were added and the resultant mixture was stirred at r.t. for 1 h, then extracted with Et_2O (2 × 50 mL). The combined organic layers were washed with H_2O (2 × 25 mL), and dried ($MgSO_4$). The solvent was evaporated and the crude product **1** was chromatographed on a silica gel column (40 cm × 3.5 cm; 70–230 mesh) using CH_2Cl_2 as eluent; yield: 1.86 g (32%); mp 69–70 °C.

$C_{10}H_{10}O_4$ (194.2) calc. C 61.85 H 5.19 found 61.63 4.95

IR (Nujol): ν = 3347, 1707, 1662 cm^{-1}.

^1H NMR ($CDCl_3$/TMS): δ = 1.41 (t, 3H, J = 7.0 Hz, CH_3CH_2O), 4.38 (q, 2H, J = 7.0 Hz, CH_3CH_2O), 7.02 (d, 1H, J = 8.8 Hz, H-5), 8.18 (dd, 1H, J = 2.1, 8.8 Hz, H-6), 8.31 (d, 1H, J = 2.1 Hz, H-2), 9.95 (s, 1H, CHO), 11.38 (s, 1H, OH).

^{13}C NMR ($CDCl_3$/TMS): δ = 14.31 (CH_3), 61.16 (CH_2), 117.82 (C_5), 120.02 (C_1), 122.58 (C_3), 135.97 (C_2), 137.72 (C_6), 164.91 (C_4), 165.02 (CO_2Et), 196.34 (CHO).

Ethyl 3-Formyl-4-methoxybenzoate (2):
To a solution of ethyl 3-formyl-4-hydroxybenzoate (**1**; 3.88 g, 20 mmol) in acetone (40 mL) were added MeI (5.68 g, 40 mmol) and K_2CO_3 (2.76 g, 20 mmol). The resultant mixture was stirred at reflux temperature for 24 h. After cooling, the solution was poured into H_2O (50 mL) and extracted with EtOAc (3 × 50 mL). The combined organic layers were washed with H_2O (2 × 50 mL) and dried ($MgSO_4$). The solvent was evaporated an the crude product **2** was chromatographed on a silica gel column (40 cm × 3.5 cm; 70–230 mesh) using hexane/Et_2O (2:3) as eluent; yield 4.03 g (97%); mp 76–77 °C (Et_2O/hexane).

$C_{11}H_{12}O_4$ (208.2) calc. C 63.45 H 5.81 found 63.59 5.63

IR (Nujol): ν = 1708, 1682 cm^{-1}.

^1H NMR ($CDCl_3$/TMS): δ = 1.39 (t, 3H, J = 7.2 Hz, CH_3CH_2O), 4.01 (s, 3H, CH_3O), 4.36 (q, 2H, J = 7.2 Hz, CH_3CH_2O), 7.04 (d, 1H, J = 8.8 Hz, H-5), 8.22 (dd, 1H, J = 2.2, 8.8 Hz, H-6), 8.46 (d, 1H, J = 2.2 Hz, H-2), 10.44 (s, 1H, CHO).

^{13}C NMR ($CDCl_3$/TMS): δ = 14.25 (CH_3), 56.00 (CH_3O), 60.97 (CH_2), 111.49 (C_5), 123.13 (C_3), 124.28 (C_1), 130.31 (C_2), 137.02 (C_6), 164.62 (C_4), 165.38 (CO_2Et), 188.78 (CHO).

Ethyl α-Azido-5-ethoxycarbonyl-2-methoxycinnamate (3):
A mixture of ethyl azidoacetate (10.32 g, 80 mmol) and ethyl 3-formyl-4-methoxybenzoate (**2**; 4.16 g, 20 mmol) was added dropwise under N_2 at −10 °C to a well-stirred solution containing Na (1.84 g) in anhydr. EtOH (100 mL). The mixture was stirred for 5 h, poured into aq NH_4Cl (150 mL), and then extracted with Et_2O (3 × 100 mL). The combined organic layers were washed with H_2O (2 × 100 mL) and dried ($MgSO_4$). Concentration to dryness yielded a crude material which was recrystallized from EtOH to give **3**; yield: 3.70 g (58%); mp 92–93 °C.

$C_{15}H_{17}N_3O_5$ (319.3) calc. C 56.42 H 5.37 N 13.16 found 56.28 5.49 13.27

MS (EI, 70 eV): m/z (%) = 319 (M^+, 19), 218 (100).

IR (Nujol): ν = 2112, 1706 cm^{-1}.

^1H NMR ($CDCl_3$/TMS): δ = 1.40 (t, 6H, J = 7.2 Hz, $2CH_3CH_2O$), 3.91 (s, 3H, CH_3O), 4.37 (q, 4H, J = 7.2 Hz, $2CH_3CH_2O$), 6.88 (d, 1H, J = 8.8 Hz, H-3), 7.29 (s, 1H, H-β), 7.98 (dd, 1H, J = 2.0, 8.8 Hz, H-4), 8.82 (d, 1H, J = 2.0 Hz, H-6).

^{13}C NMR ($CDCl_3$/TMS): δ = 14.15 (CH_3), 14.32 (CH_3), 55.85 (CH_3O), 60.79 (CH_2), 62.22 (CH_2), 109.90 (C_3), 118.09 (C_β), 121.94 (C_1*), 122.61 (C_5*), 126.33 (C_α), 132.09 (C_6), 132.27 (C_4), 160.71 (C_2), 163.41 (CO_2Et), 166.08 (CO_2Et).
* Interchangeable.

Ethyl 5-Ethoxycarbonyl-2-methoxy-α-[(triphenylphosphoranylidene)amino]cinnamate (4):
A solution of Ph_3P (2.62 g, 10 mmol) in dry Et_2O (30 mL) was added dropwise under N_2 at r.t. to a solution of **3** (3.19 g, 10 mmol) in the same solvent (15 mL). The mixture was stirred at r.t. for 12 h. The separated solid was collected by filtration, air-dried and recrystallized from benzene/hexane (1:1) to give **4**; yield: 4.70 g (85%); mp 135–136 °C.

$C_{33}H_{32}NO_5P$ (553.6) calc. C 71.60 H 5.83 N 2.53 found 71.48 5.96 2.39

MS (EI, 70 eV): m/z (%) = 553 (M^+, 6), 183 (100).

IR (Nujol): ν = 1718, 1693 cm^{-1}.

^1H NMR ($CDCl_3$/TMS): δ = 0.99 (t, 3H, J = 7.1 Hz), 1.12 (t, 3H, J = 7.1 Hz), 3.85 (q, 2H, J = 7.1 Hz), 3.87 (s, 3H, CH_3O), 4.22 (q, 2H, J = 7.1 Hz), 6.85 (d, 1H, J = 8.6 Hz, H-3), 6.94 (d, 1H, J = 7.2 Hz, H-β), 7.33–7.40 (m, 9H), 7.73–7.88 (m, 7H), 9.73 (d, 1H, J = 2.0 Hz, H-6).

^{13}C NMR ($CDCl_3$/TMS): δ = 14.06 (CH_3), 14.17 (CH_3), 55.59 (CH_3O), 60.21 (CH_2), 60.74 (CH_2), 107.48 ($^3J_{P-C}$ = 19.9 Hz, C_β), 109.13 (C_3), 122.25 (C_1*), 127.10 (C_5*), 128.10 ($^3J_{P-C}$ = 12.2 Hz, C_m), 128.52 (C_4), 130.80 ($^4J_{P-C}$ = 2.6 Hz, C_p), 131.77 (C_6), 132.52 ($^2J_{P-C}$ = 9.8 Hz, C_o), 133.11 ($^1J_{P-C}$ = 103.1 Hz, C_i), 137.65 ($^2J_{P-C}$ = 6.7 Hz, C_α), 159.74 (C_2), 167.02 (5-CO_2Et), 167.93 ($^3J_{P-C}$ = 7.7 Hz, α-CO_2Et).

Ethyl 1-Alkyl(aryl)-1,2-dihydro-5-methoxy-2-oxo-1*H*-pyrrolo[4,3,2-*ij*]isoquinoline-7-carboxylates 8; General Procedure:
To a solution of the iminophosphorane **4** (1.11 g, 2 mmol) in dry toluene (15 mL), the appropriate isocyanate (2 mmol) was added

dropwise. The resultant solution was stirred at r.t. for 1 h and then heated in a sealed tube at 170°C for 48 h. After cooling, the precipitated solid was collected by filtration and recrystallized from toluene to give **8**. Compound **8b** is recrystallized from EtOH.

We gratefully acknowledge the financial support of the Dirección General de Investigación Científica y Técnica (Project Number PB89-0436).

(1) Basset, A.; Luheshi, N.; Salem, S.M.; Smalley, R.K. *Tetrahedron Lett.* **1990**, *31*, 6561.
Burson, W.C.; Jones, D.R.; Turnbull, K.; Preston, P.N. *Synthesis* **1991**, 745.
Suschitzky, H.; Kramer, W.; Neidlein, R.; Rosyk, P.; Bohn, T. *J. Chem. Soc., Perkin Trans. 1* **1991**, 923.
Nitta, M.; Soeda, H.; Koyama, S.; Iino, Y. *Bull. Chem. Soc. Jpn.* **1991**, *64*, 1325.

(2) Molina, P.; Fresneda, P.M. *J. Chem. Soc., Perkin Trans. 1* **1988**, 1819.
Molina, P.; Fresneda, P.M. *Synthesis* **1989**, 878.
Molina, P.; Alajarín, M.; Vidal, A. *Tetrahedron* **1990**, *46*, 1063.

(3) Molina, P.; Fresneda, P.M.; Alarcon, P. *Tetrahedron Lett.* **1988**, 379.
Molina, P.; Arques, A.; Fresneda, P.M.; Vinader, M.V.; Foces-Foces, M.C.; Hernández-Cano, F. *Chem. Ber.* **1989**, *122*, 307.
Molina, P.; Vilaplana, M.J. *Synthesis* **1990**, 474.

(4) Molina, P.; Alajarín, M.; Vidal, A. *J. Chem. Soc., Chem. Commun.* **1990**, 7.
Molina, P.; Tarraga, A.; Lidon, M.J. *J. Chem. Soc., Perkin Trans. 1* **1990**, 1277.
Molina, P.; Alajarín, M.; Vidal, A. *J. Org. Chem.* **1990**, *55*, 6140.

(5) Suzuki, Y.; Takahashi, H. *Chem. Pharm. Bull.* **1983**, *31*, 1751.

(6) Staudinger, H.; Meyer, J. *Helv. Chim. Acta* **1919**, *2*, 635.