

Supporting Information

Rh(I)-Catalyzed Direct *ortho*-Alkenylation of Aromatic Ketimines with Alkynes and Its Application to the Synthesis of Isoquinoline Derivatives

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1. General Methods

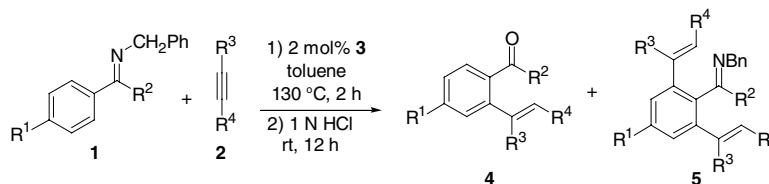
Flash column chromatography was performed using E. Merck 230-400 mesh silica gel. Reaction progress and column chromatography were monitored by analytical thin-layer chromatography (TLC) carried out on 0.25 mm E. Merk silica gel plates (60 F-254) using UV light as a visualizing agent and *p*-anisaldehyde solution, and heat as developing agent. Infrared spectra were obtained on a Nicolet Impact 400 spectrometer. Gas chromatographic analyses were performed on a Donam DS 6200 instrument with FID detector and a Hewlett Packard HP-5 capillary column. Low-resolution mass spectra were measured on a Hewlett-Packard HP G1800A GCD system equipped with a Hewlett Packard HP-5 capillary column. ¹H NMR and ¹³C NMR were recorded on a Bruker Advance/DPX 250 (250 MHz ¹H, 62.9 MHz ¹³C NMR) and a Bruker AMX 500 NMR (500 MHz ¹H, 125.7 MHz ¹³C NMR) spectrometers with chemical shifts reported relative to residual deuterated solvent peaks. ¹H NMR spectra were referenced to tetramethylsilane (δ 0.00 ppm) as an internal standard and are reported as follows: chemical shift, multiplicity (br = broad, s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet). ¹³C NMR spectra were referenced to the residual CDCl₃ (δ 77.0 ppm). High Resolution Mass spectra were provided by the National Center for Inter-University Facilities, Seoul National University (Seoul 151-742, Korea) and by the Regional Mass Spectrometry Center of the Korea Basic Science Institute (Seoul 136-701, Korea).

2. Materials

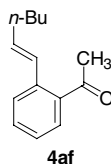
All commercially available reagent grade chemicals were purchased from Aldrich Chemical Company and used as received without further purification unless otherwise stated. All aromatic ketimines (**1**) were prepared by the condensation of the corresponding ketones with benzylamine using a Dean-Stark apparatus according to the known procedures and purified by bulb-to-bulb distillation followed by recrystallization from appropriate solvents if necessary. Diphenylacetylene (**2i**) was recrystallized from ethanol, dried under reduced pressure, and stored in a refrigerator. Tetrahydrofuran and toluene were distilled from sodium/benzophenone ketyl under nitrogen atmosphere prior to use. Carbon tetrachloride was distilled from calcium hydride under nitrogen atmosphere prior to use. Chlorotris(triphenylphosphine)rhodium (**3**, RhCl(PPh₃)₃, Wilkinson catalyst) was prepared according to

the literature procedure and stored in a refrigerator under N₂ atmosphere.¹

3. General Procedure for the Rh(I)-catalyzed *ortho*-alkenylation of aromatic ketimines (**1**) with alkynes (**2**).



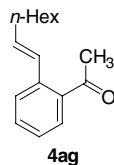
A screw-capped pressure vial (1 ml) equipped with a magnetic stirring bar was charged with aromatic ketimine (**1**, 0.324 mmol), alkyne (**2**, 0.389 mmol), RhCl(PPh₃)₃ (**3**, 6.48 μmol), and toluene (400 mg). The vial was closed and heated at 130. with a vigorous stirring for 2 h. After cooling to room temperature, the reaction mixture was hydrolyzed with 1 N HCl (10 mL) in EtOH(10 mL). The organic layer was separated and the aqueous layer was extracted with EtOAc. The combined organic layers were washed successively with water, saturated aqueous solution of NaHCO₃, water, and then brine. The organic layer was dried over anhydrous MgSO₄, filtered, and concentrated using a rotatory evaporator. The crude mixture was purified by column chromatography (*n*-hexane/EtOAc) on silica gel. For a GC analysis, the crude mixture was filtered on a small plug of silica gel to remove the catalyst. The ratio of **4**:**5** was determined by a GC analysis.



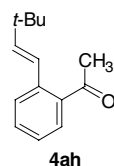
(*E*)-1-[2-(1-Hexenyl)phenyl]ethanone (**4af**):² ¹H NMR (500 MHz, CDCl₃) δ 7.57 (d, *J* = 7.7 Hz, 1H, Ar), 7.50 (d, *J* = 7.8 Hz, 1H, Ar), 7.42-7.39 (m, 1H, Ar), 7.31-7.26 (m, 1H, Ar), 6.84 (d, *J* = 15.7 Hz, 1H, ArCH=C), 6.11 (dt, *J* = 15.7, 6.9 Hz, 1H, C=CHCH₂CH₂CH₂CH₃), 2.56 (s, 3H, C(O)CH₃), 2.27-2.21 (m, 2H, C=CHCH₂), 1.50-1.45 (m, 2H), 1.40-1.36 (m, 2H), 0.93 (t, *J* = 7.2 Hz, 3H, CH₂CH₂CH₂CH₃). ¹³C NMR (125.7 MHz, CDCl₃) δ 203.0 (CO), 137.9, 137.7, 134.8, 131.5, 128.7, 128.5, 127.7, 126.8, 33.12, 31.61, 30.36, 22.55, 14.19. MS (EI, 70 eV) *m/z* (relative intensity) 202 (M⁺, 3), 159 (3), 145 (100), 131 (4), 115 (11), 77 (4), 43 (40). IR (neat): 3062, 2965, 2923, 2863, 1690 (CO), 1599, 1569, 1467, 1358, 1243, 1056, 965, 766 cm⁻¹.

1. Osborn, J. A.; Wilkinson, G. In *Reagents for Transition Metal Complex and Organometallic Syntheses*; Angelici, R., Ed.; Wiley: New York, 1989; Vol. 28, pp. 77-79.

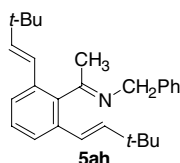
2. Darses, S.; Jeffery, T.; Brayer, J.-L.; Demoute, J.-P.; Genet, J.-P. *Bull. Soc. Chim. Fr.* **1996**, 133, 1095.



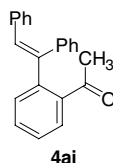
(*E*)-1-[2-(1-Octenyl)phenyl]ethanone (**4ag**): ^1H NMR (250 MHz, CDCl_3) δ 7.58-7.49 (m, 2H, Ar), 7.43-7.37 (m, 1H, Ar), 7.30-7.24 (m, 1H, Ar), 6.84 (d, J = 15.7 Hz, 1H, $\text{ArCH}=\text{C}$), 6.12 (dt, J = 15.7, 6.9 Hz, 1H, $\text{ArCH}=\text{CH}$), 2.56 (s, 3H, $\text{C}(\text{O})\text{CH}_3$), 2.27-2.19 (m, 2H, $\text{C}=\text{CHCH}_2$), 1.48-1.26 (br m, 8H), 0.89 (t, J = 6.8 Hz, 3H, CH_3). ^{13}C NMR (62.9 MHz, CDCl_3) δ 198 (CO), 137.6, 137.4, 134.6, 131.3, 128.4, 128.2, 127.5, 126.5, 33.20, 31.71, 30.11, 29.16, 28.92, 22.61, 14.08. MS (EI, 70 eV) m/z (relative intensity) 230 (M^+ , 2), 159 (3), 145 (100), 132 (4), 115 (8), 103 (2), 91 (3), 77 (3), 43 (34). IR (neat) 3068, 2959, 2929, 2857, 1684 (CO), 1606, 1569, 1473, 1364, 1243, 965, 911, 7421 cm^{-1} . HRMS (CI) calcd for $\text{C}_{16}\text{H}_{23}\text{O}$ ($\text{M}-\text{H}^+$) 231.1749, found 231.1752.



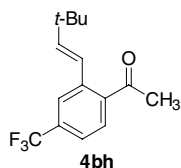
(*E*)-1-[2-(3,3-Dimethyl-1-butenyl)phenyl]ethanone (**4ah**): ^1H NMR (500 MHz, CDCl_3) δ 7.57 (d, J = 7.6 Hz, 1H, Ar), 7.49 (d, J = 7.8 Hz, 1H, Ar), 7.41 (m, 1H, Ar), 7.27 (m, 1H, Ar), 6.79 (d, J = 16.0 Hz, 1H, $\text{ArCH}=\text{C}$), 6.10 (d, J = 16.0 Hz, 1H, $\text{ArCH}=\text{CH}$), 2.56 (s, 3H, $\text{C}(\text{O})\text{CH}_3$), 1.13 (s, 9H, $\text{C}(\text{CH}_3)_3$). ^{13}C NMR (125.7 MHz, CDCl_3) δ 203.1 (CO), 145.3, 138.2, 137.9, 131.5, 128.8, 127.8, 126.8, 123.9, 33.95, 30.41, 29.72. MS (EI, 70 eV) m/z (relative intensity) 202 (M^+ , 1), 169 (4), 159 (3), 145 (100), 128 (5), 115 (5), 91 (2), 77 (3), 43 (33). IR (neat): 3072, 2967, 2875, 1683 (CO), 1644, 1598, 1473, 1361, 1249, 973, 913, 729 cm^{-1} . HRMS (CI) calcd for $\text{C}_{14}\text{H}_{19}\text{O}$ ($\text{M}-\text{H}^+$) 203.1436, found 203.1436.



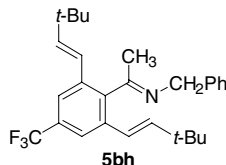
(*E,E*)-*N*-Benzyl-*N*-{1-[2,6-bis-(3,3-dimethyl-1-butenyl)phenyl]ethylidene}amine (**5ah**): ^1H NMR (500 MHz, CDCl_3) δ 7.41 (d, J = 7.8 Hz, 2H, Ar), 7.32-7.17 (m, 6H, Ar), 6.21 (d, J = 16.0 Hz, 2H, $\text{C}=\text{CH}$), 6.13 (d, J = 16.0 Hz, 2H, $\text{C}=\text{CH}$), 4.16 (s, 2H, CH_2Ph), 2.26 (s, 3H, CH_3), 1.05 (s, 18H, $\text{C}(\text{CH}_3)_3$). ^{13}C NMR (125.7 MHz, CDCl_3) δ 169.7, 144.7, 144.0, 140.3, 137.0, 134.3, 128.5, 128.3, 126.7, 124.5, 123.9, 122.7, 122.0, 57.82, 33.80, 29.75, 28.73. MS (EI, 70 eV) m/z (relative intensity) 373 (M^+ , 3), 358 (15), 316 (98), 282 (80), 167 (4), 91 (100), 57 (6), 41 (4). IR (neat) 3058, 2987, 2920, 1424, 1266, 914, 756, 706 cm^{-1} . HRMS (CI) calcd for $\text{C}_{27}\text{H}_{36}\text{N}$ ($\text{M}-\text{H}^+$) 374.2848, found 374.2850.



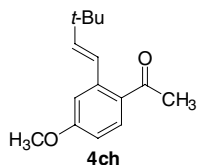
(*E*)-1-[2-(1,2-Diphenylvinyl)phenyl]ethanone (**4ai**): ^1H NMR (250 MHz, CDCl_3) δ 7.67 (d, J = 8.9 Hz, 1H, Ar), 7.44-7.41 (m, 2H, Ar), 7.28-7.21 (m, 6H, Ar), 7.13-7.10 (m, 3H, Ar), 7.02 (s, 1 H, $\text{PhCH}=\text{C}$), 6.97-6.94 (m, 2H, Ar), 2.20 (s, 3H, $\text{C}(\text{O})\text{CH}_3$). ^{13}C NMR (62.9 MHz, CDCl_3) δ 201.2 (CO), 142.5-126.9 (Cs in phenyl group and vinyl group), 28.70. MS (EI, 70 eV) m/z (relative intensity) 298 (M^+ , 35), 283 (8), 265 (8), 252 (17), 239 (11), 221 (100), 202 (7), 193 (22), 178 (19), 141 (10), 126 (12), 105 (16). IR (neat) 3065, 3026, 1696 (CO), 1598, 1499, 1446, 13610, 1282, 1256, 913, 736 cm^{-1} . HRMS (CI) calcd for $\text{C}_{22}\text{H}_{19}\text{O}$ ($\text{M}-\text{H}^+$) 299.1436, found 299.1434.



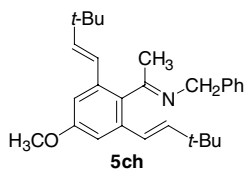
(*E*)-1-[2-(3,3-Dimethyl-1-butenyl)-4-trifluoromethylphenyl]ethanone (**4bh**): ^1H NMR (250 MHz, CDCl_3) δ 7.72 (s, 1H, Ar), 7.62 (d, J = 8.2 Hz, 1H, Ar), 7.51 (d, J = 8.2 Hz, 1H, Ar), 6.72 (d, J = 16.1 Hz, 1H, $\text{C}=\text{CH}$), 6.19 (d, J = 16.1 Hz, 1H, $\text{C}=\text{CH}$), 2.57 (s, 3H, $\text{C}(\text{O})\text{CH}_3$), 1.14 (s, 9H, $\text{C}(\text{CH}_3)_3$). ^{13}C NMR (62.9 MHz, CDCl_3) δ 202.4 (CO), 147.1-122.4 (Cs of aromatic ring, vinyl group and CF_3), 34.06, 30.48, 29.44. MS (EI, 70 eV) m/z (relative intensity) 255 (M^+ , 0.8), 227 (6), 213 (100), 200 (8), 172 (2), 128 (2), 43 (13). IR (neat) 3058, 2961, 2865, 1698 (CO), 1418, 1337, 1271, 1179, 1133, 1093, 970, 899, 741 cm^{-1} . HRMS (CI) calcd for $\text{C}_{15}\text{H}_{18}\text{F}_3\text{O}$ ($\text{M}-\text{H}^+$) 271.1310, found 271.1320.



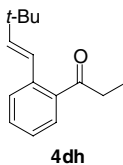
(*E,E*)-*N*-Benzyl-*N*-{1-[2,6-bis-(3,3-dimethyl-1-butenyl)-4-trifluoromethylphenyl]ethyldene}amine (**5bh**): ^1H NMR (250 MHz, CDCl_3) δ 7.63 (s, 2H, Ar), 7.31-7.20 (m, 5H, Ar), 6.31 (d, J = 16.0 Hz, 2H, $\text{C}=\text{CH}$), 6.12 (d, J = 16.0 Hz, 2H, $\text{C}=\text{CH}$), 4.15 (s, 2H, PhCH_2), 2.26 (s, 3H, CH_3), 1.07 (s, 18H, $\text{C}(\text{CH}_3)_3$). ^{13}C NMR (62.9 MHz, CDCl_3) δ 168.3, 146.5-120.3 (Cs of aromatic rings, vinyl group and CF_3), 57.91, 34.00, 29.60, 28.34. MS (EI, 70 eV) m/z (relative intensity) 422 (0.2), 384 (40), 350 (5), 236 (1), 91 (100), 57 (5), 29 (1). IR (neat) 3058, 2966, 1652, 1429, 1352, 1271, 1169, 1128, 981, 909, 746 cm^{-1} . HRMS (CI) calcd for $\text{C}_{28}\text{H}_{35}\text{F}_3\text{N}$ ($\text{M}-\text{H}^+$) 442.2722, found 442.2704.



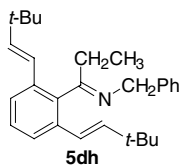
(*E*)-1-[2-(3,3-Dimethyl-1-butenyl)-4-methoxyphenyl]ethanone (**4ch**): ^1H NMR (250 MHz, CDCl_3) δ 7.67 (d, J = 8.6 Hz, 1H, Ar), 6.97 (d, J = 16.0 Hz, 1H, $\text{C}=\text{CH}$), 6.96 (d, J = 2.4 Hz, 1H, Ar), 6.78 (dd, J = 8.6, 2.4 Hz, 1H, Ar), 6.07 (d, J = 16.0 Hz, 1H, $\text{C}=\text{CH}$), 3.86 (s, 3H, OCH_3), 2.54 (s, 3H, $\text{C}(\text{O})\text{CH}_3$), 1.14 (s, 9H, $\text{C}(\text{CH}_3)_3$). ^{13}C NMR (62.9 MHz, CDCl_3) δ 200.4 (CO), 162.2, 144.8, 141.7, 132.0, 129.9, 124.8, 113.1, 111.8, 55.56, 33.86, 29.78, 29.72. MS (EI, 70 eV) m/z (relative intensity) 217 (M^+ , 0.5), 189 (1), 175 (100), 162 (2), 115 (3), 91 (2), 43 (7); IR (neat) 3058, 2987, 2966, 1673 (CO), 1602, 1561, 1424, 1266, 1037, 899, 741, 706 cm^{-1} ; HRMS calcd for $\text{C}_{15}\text{H}_{21}\text{O}_2$ (M^+) 233.1542, found 233.1537.



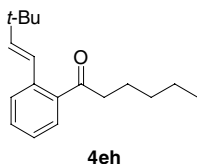
(*E,E*)-*N*-Benzyl-*N*-{1-[2,6-bis-(3,3-dimethyl-1-butenyl)-4-methoxyphenyl]ethyldene}amine (**5ch**): ^1H NMR (250 MHz, CDCl_3) δ 7.27-7.18 (m, 5H, C_6H_5), 6.96 (s, 2H, Ar), 6.22 (d, J = 16.0 Hz, 2H, $\text{C}=\text{CH}$), 6.09 (d, J = 16.0 Hz, 2H, $\text{C}=\text{CH}$), 4.16 (s, 2H, PhCH_2), 3.88 (s, 3H, OCH_3), 2.25 (s, 3H, CH_3), 1.05 (s, 18H, $\text{C}(\text{CH}_3)_3$). ^{13}C NMR (62.9 MHz, CDCl_3) δ 169.8, 159.6, 144.7, 140.3, 135.7, 130.1, 128.5, 126.7, 121.9, 109.3, 57.81, 55.57, 33.80, 29.71, 29.14. MS (EI, 70 eV) m/z (relative intensity) 403 (M^+ , 6), 388 (25), 346 (100), 312 (8), 198 (2), 130 (3), 91 (53), 57 (4). IR (neat) 3062, 2990, 1417, 1266, 1112, 912, 746 cm^{-1} . HRMS (EI) calcd for $\text{C}_{28}\text{H}_{37}\text{NO}$ (M^+) 403.2875, found 403.2879.



(*E*)-1-[2-(3,3-Dimethyl-1-butenyl)phenyl]-1-propanone (**4dh**): ^1H NMR (500 MHz, CDCl_3) δ 7.48-7.47 (m, 2H, Ar), 7.38 (t, J = 7.5 Hz, 1H, Ar), 7.25 (t, J = 7.2 Hz, 1H, Ar), 6.67 (d, J = 16.0 Hz, 1H, $\text{C}=\text{CH}$), 6.09 (d, J = 16.0 Hz, 1H, $\text{C}=\text{CH}$), 2.87 (q, J = 7.2 Hz, 2H, $\text{C}(\text{O})\text{CH}_2$), 1.18 (t, J = 7.2 Hz, 3H, CH_3), 1.12 (s, 9H, $\text{C}(\text{CH}_3)_3$). ^{13}C NMR (125.7 MHz, CDCl_3) δ 206.8 (CO), 145.2, 133.1, 131.0, 129.2, 127.5, 126.7, 126.3, 123.3, 42.78, 31.70, 30.27, 29.69, 24.46, 22.75, 14.24. MS (EI, 70 eV) m/z (relative intensity) 216 (M^+ , 0.1), 160 (14), 159 (100), 144 (2), 131 (11), 128 (6), 57 (10), 29 (4). IR (neat) 3056, 2962, 2910, 2859, 1687 (CO), 1463, 1265, 1222, 1153, 1045, 955, 8932, 739 cm^{-1} . HRMS (CI) calcd for $\text{C}_{15}\text{H}_{21}\text{O}$ ($\text{M}-\text{H}^+$) 217.1592, found 217.1598.

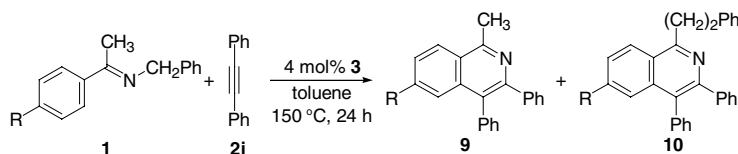


(*E,E*)-*N*-Benzyl-*N*-{1-[2,6-bis(3,3-dimethyl-1-butenyl)phenyl]propylidene}amine (**5dh**): ^1H NMR (250 MHz, CDCl_3) δ 7.59 (d, J = 8.1 Hz, 2H, Ar), 7.50-7.15 (m, 6H, Ar), 6.20 (d, J = 16.0 Hz, 2H, C=CH), 6.09 (d, J = 16.0 Hz, 2H, C=CH), 4.22 (s, 2H, CH_2Ph), 2.53 (q, J = 7.5 Hz, 2H, CH_2CH_3), 1.17 (t, J = 7.5 Hz, 3H, CH_2CH_3), 1.04 (s, 18H, $\text{C}(\text{CH}_3)_3$). ^{13}C NMR (62.9 MHz, CDCl_3) δ 173.6, 144.2, 140.6, 136.8, 134.6, 128.4, 128.2, 128.1, 126.6, 123.7, 122.3, 57.31, 35.06, 33.79, 29.72, 10.70. MS (EI, 70 eV) m/z (relative intensity) 387 (M^+ , 4), 331 (27), 330 (100), 316 (2), 131 (6), 91 (82). IR (neat) 3053, 2961, 2905, 2864, 1642, 1469, 1423, 1362, 1271, 914, 741, 660 cm^{-1} . HRMS (EI) calcd for $\text{C}_{28}\text{H}_{37}\text{N}$ (M^+) 387.2926, found 387.2917.



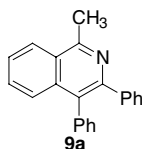
(*E*)-1-[2-(3,3-Dimethyl-1-butenyl)phenyl]-1-hexanone (**4eh**): ^1H NMR (500 MHz, CDCl_3) δ 7.51-7.47 (m, 1H, Ar), 7.43-7.38 (m, 1H, Ar), 7.27-7.22 (m, 2H, Ar), 6.65 (d, J = 16.0 Hz, 1H, C=CH), 6.12 (d, J = 16.0 Hz, 1H, C=CH), 2.85 (t, J = 7.4 Hz, 2H, $\text{C}(\text{O})\text{CH}_2$), 1.68-1.65 (m, 2H), 1.33 (br s, 2H), 1.25 (br s, 2H), 1.12 (s, 9H, $\text{C}(\text{CH}_3)_3$), 0.88 (t, J = 7.40 Hz, 3H). ^{13}C NMR (125.7 MHz, CDCl_3) δ 206.8 (CO), 145.2, 133.1, 131.0, 127.9, 127.5, 126.7, 123.3, 42.78, 31.70, 29.95, 29.69, 24.46, 22.74, 14.24. MS (EI, 70 eV) m/z (relative intensity) 258 (M^+ , 0.1), 243 (0.6), 201 (100), 157 (1), 131 (11), 103 (2), 57 (3). IR (neat) 2960, 2927, 2855, 1683 (CO), 1466, 1374, 1098, 913, 736, 650 cm^{-1} . HRMS (EI) calcd for $\text{C}_{18}\text{H}_{26}\text{O}$ (M^+) 258.1984, found 258.2002.

4. General Procedure for the Tandem *ortho*-Alkenylation-Cyclization Reaction of **1**.

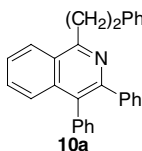


A screw-capped pressure vial (5 mL) equipped with a magnetic stirring bar was charged with aromatic ketimine (**1**, 0.324 mmol), diphenylacetylene (**2i**, 0.389 mmol), $\text{RhCl}(\text{PPh}_3)_3$ (**3**, 6.48 μmol), and toluene (400 mg). The vial was closed and heated at 150. with a vigorous stirring for 24 h. After cooling to room temperature, the reaction mixture was purified by column chromatography (*n*-hexane/EtOAc) on

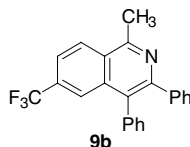
silica gel. For a GC analysis, the crude mixture was filtered on a small plug of silica gel to remove the catalyst. The ratio of **9**:**10** was determined by a GC analysis.



1-Methyl-3,4-diphenylisoquinoline (**9a**):³ ¹H NMR (250 MHz, CDCl₃) δ 8.22-8.18 (m, 1H, Ar), 7.66-7.56 (m, 3H, Ar), 7.38-6.70 (m, 10H, C₆H₅), 3.08 (s, 3H, CH₃). ¹³C NMR (62.9 MHz, CDCl₃) δ 157.9, 149.6, 141.2, 137.8, 136.2, 131.6, 130.4, 130.1, 129.8, 129.6, 129.3, 128.7, 128.4, 127.9, 127.8, 127.3, 127.1, 126.7, 126.4, 125.7. MS (EI, 70 eV) m/z (relative intensity) 295 (M⁺, 53), 294 (M-1, 100), 252 (16), 146 (12). IR (KBr) 3058, 2987, 1434, 1266, 909, 741 cm⁻¹. HRMS (CI) calcd for C₂₂H₁₈N (M-H⁺) 296.1439, found 296.1445.



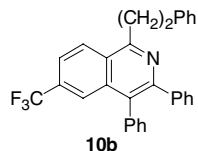
1-Phenethyl-3,4-diphenylisoquinoline (**10a**): ¹H NMR (500 MHz, CDCl₃) δ 8.25-8.23 (m, 1H, Ar), 7.68-7.656 (m, 1H, Ar), 7.58-7.56 (m, 2H, Ar), 7.37-7.16 (m, 15H, C₆H₅), 3.74-3.71 (m, 2H, CH₂CH₂Ph), 3.34-3.31 (m, 2H, CH₂Ph). ¹³C NMR (125.9 MHz, CDCl₃) δ 159.9, 149.2, 142.2, 141.0, 137.7, 136.4, 131.4, 130.4, 129.7, 129.1, 128.5, 128.4, 128.2, 127.5, 127.1, 126.9, 126.5, 126.4, 126.0, 125.5, 124.9, 121.8, 120.6, 39.92, 37.19. MS (EI, 70 eV) m/z (relative intensity) 385 (M⁺, 100), 370 (9), 369 (9), 308 (38), 280 (34), 252 (11), 216 (9), 204 (11), 189 (13), 154 (10), 91 (16), 77 (6). IR (KBr) 3055, 2985, 1600, 1495, 1446, 1415, 1385, 1265, 1030, 900, 739, 704 cm⁻¹. HRMS (EI) calcd for C₂₉H₂₃N (M⁺) 385.1830, found 385.1828.



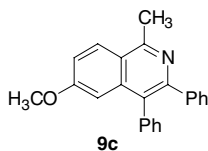
1-Methyl-3,4-diphenyl-6-trifluoromethylisoquinoline (**9b**): ¹H NMR (500 MHz, CDCl₃) δ 8.29 (d, *J* = 8.6 Hz, 1H, Ar), 7.98 (s, 1H, Ar), 7.73 (d, *J* = 8.7 Hz, 1H, Ar), 7.38-7.11 (m, 10H, C₆H₅), 3.09 (s, 3H, CH₃). ¹³C NMR (125.7 MHz, CDCl₃) δ 158.1, 151.1, 150.7, 140.7, 136.7, 135.7, 131.5, 130.5, 129.9, 129.5, 129.3, 127.9, 127.5, 127.1, 125.8, 124.1, 122.4, 23.00. MS (EI, 70 eV) m/z (relative intensity) 362 (M⁺, 100), 252 (16), 146 (26). IR (KBr) 3054, 2987, 1423, 1265, 897, 739, 706 cm⁻¹. HRMS (CI) calcd

3. (a) Rocha Gonsalves, A. M.; Pinho e Melo, M. V. D.; Gilchrist, T. L. *Tetrahedron* **1992**, 48, 6821. (b) Kitamura, T.; Kobayashi, S.; Taniguchi, H. *Chem. Lett.* **1984**, 1351.

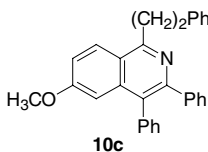
for $C_{23}H_{16}F_3N$ ($M-H^+$) 363.1235, found 363.1318.



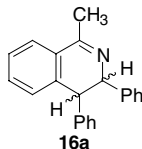
1-Phenethyl-3,4-diphenyl-6-(trifluoromethyl)isoquinoline (**10b**): 1H NMR (500 MHz, $CDCl_3$) δ 8.33 (d, J = 8.7 Hz, 1H, Ar), 7.98 (s, 1H, Ar), 7.72 (dd, J = 8.7, 1.7 Hz, 1H, Ar), 7.40-7.11 (m, 15H, C_6H_5), 3.78-3.71 (m, 2H, CH_2CH_2Ph), 3.36-3.29 (m, 2H, CH_2Ph). ^{13}C NMR (125.7 MHz, $CDCl_3$) δ 160.3, 142.0, 140.7, 136.8, 136.0, 131.5-122.4 (Cs of aromatic rings), 37.40, 35.39. MS (EI, 70 eV) m/z (relative intensity) 377 (27), 376 (100), 348 (36), 280 (39), 252 (12), 189 (21), 152 (10), 91 (62), 77(14). IR (KBr) 3055, 2985, 1602, 1423, 1315, 1265, 1130, 897, 739, 706 cm^{-1} . HRMS (CI) calcd for $C_{30}H_{23}F_3N$ ($M-H^+$) 454.1783, found 454.1776.



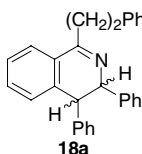
6-Methoxy-1-methyl-3,4-diphenylisoquinoline (**9c**): 1H NMR (500 MHz, $CDCl_3$) δ 8.08 (d, J = 9.1 Hz, 1H, Ar), 7.35-7.13 (m, 11H, Ar), 6.91 (s, 1H, Ar), 3.69 (s, 3H, OCH_3), 3.00 (s, 3H, CH_3). ^{13}C NMR (125.7 MHz, $CDCl_3$) δ 160.7, 157.2, 150.3, 141.4, 138.3, 138.1, 131.5, 130.4, 128.5, 127.7, 127.3, 127.0, 126.7, 126.5, 122.1, 118.9, 104.7. MS (EI, 70 eV) m/z (relative intensity) 325 (M^+ , 57), 324 ($M-1$, 100), 281 (21), 239 (4), 139 (9). IR (KBr) 3053, 2987, 1418, 1271, 894, 741 cm^{-1} . HRMS (EI) calcd for $C_{22}H_{18}N$ (M^+) 325.1467, found 325.1445.



6-Methoxy-1-phenethyl-3,4-diphenylisoquinoline (**10c**): 1H NMR (500 MHz, $CDCl_3$) δ 8.13 (d, J = 9.1 Hz, 1H, Ar), 7.33-7.09 (m, 17H, Ar), 3.71 (s, 3H, OCH_3), 3.67-3.64 (m, 2H, CH_2CH_2Ph), 3.31-3.27 (m, 2H, CH_2Ph). ^{13}C NMR (125.9 MHz, $CDCl_3$) δ 160.63, 159.6, 150.2, 142.4, 141.5, 138.7, 138.2, 132.4, 131.5, 128.8, 128.7, 128.6, 127.8, 128.6, 128.5, 127.8, 127.4, 127.1, 126.8, 126.2, 121.5, 119.0, 104.9, 55.42, 37.46, 35.76. MS (EI, 70 eV) m/z (relative intensity) 415 (M^+ , 100), 414 ($M-1$, 67), 400 (89), 338 (33), 311 (12), 267 (13), 169 (16), 91 (15). IR (KBr) 3054, 2979, 1496, 1452, 1415, 1265, 739, 704 cm^{-1} . HRMS (EI) calcd for $C_{30}H_{25}NO$ (M^+) 415.1936, found 415.1926.

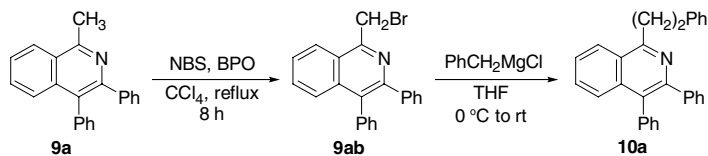


1-Methyl-3,4-diphenyl-3,4-dihydroisoquinoline (**16a**): ^1H NMR (250 MHz, CDCl_3) δ 7.69 (d, $J = 6.0$ Hz, 1H, Ar), 7.40 (m, 2H, Ar), 7.19-6.97 (m, 9H, Ar), 6.46 (d, $J = 7.4$ Hz, 2H, Ar), 5.01 (br, 1H, $\text{PhCHN}=\text{C}$), 4.22 (d, $J = 6.2$ Hz, 1H, $\text{PhCHC}=\text{C}$), 2.60 (s, 3H, CH_3). ^{13}C NMR (125.9 MHz, CDCl_3) δ 165.5, 141.7, 138.1, 131.6, 129.7, 128.7, 128.4, 128.0, 127.8, 126.8, 126.6, 125.8, 65.61, 49.00, 23.62. MS (EI, 70 eV) m/z (relative intensity) 297 (M^+ , 100), 294 (14), 220 (18), 206 (22), 191 (159), 179 (23), 178 (24), 167 (16). IR (KBr) 3052, 29817, 1419, 1265, 891, 738, 701 cm^{-1} . HRMS (CI) calcd for $\text{C}_{22}\text{H}_{20}\text{N}$ ($\text{M}+1$) 298.1596, found 298.1593.



1-Phenethyl-3,4-diphenyl-3,4-dihydroisoquinoline (**18a**): ^1H NMR (250 MHz, CDCl_3) δ 7.67-7.63 (m, 1H, Ar), 7.35-6.85 (m, 18H, Ar), 4.89 (d, $J = 11.0$ Hz, 1H, $\text{PhCHN}=\text{C}$), 3.97 (d, $J = 11.0$ Hz, 1H, $\text{PhCHC}=\text{C}$), 3.29-3.26 (m, 2H, PhCH_2CH_2), 3.25-3.04 (m, 2H, PhCH_2). ^{13}C NMR (62.9 MHz, CDCl_3) δ 166.1, 143.2, 141.9, 141.7, 131.2, 129.6, 129.4, 128.9, 128.7, 128.6, 128.1, 128.0, 127.5, 126.9, 126.8, 126.2, 125.0, 67.68, 50.86, 37.86, 33.57. MS (EI, 70 eV) m/z (relative intensity) 387 (M^+ , 36), 297 (25), 296 (100), 218 (9), 191 (19), 178 (16), 115 (16), 91 (37). IR (KBr) 3058, 2987, 2961, 2926, 1423, 1266, 904, 741, 711 cm^{-1} . HRMS (EI) calcd for $\text{C}_{29}\text{H}_{25}\text{N}$ (M^+) 387.1987, found 387.1992.

5. Structural Confirmation of 1-Phenethyl-3,4-diphenylisoquinoline (10a)



Preparation of 1-Bromomethyl-3,4-diphenylisoquinoline (9ab): A mixture of 1-methyl-3,4-diphenylisoquinoline **9a** (37.0 mg, 0.125 mmol), benzoyl peroxide (1.51 mg, 6.25 μmol), and *N*-bromosuccinimide (23.4 mg, 0.132 mmol) in dry CCl_4 (1.2 mL) was refluxed with a vigorous stirring for 8 h. After cooling to room temperature, the mixture was filtered on a Celite pad to remove succinimide. The filtrate was concentrated under reduced pressure and the resulting crude product was used in the next step

without further purification: ^1H NMR (250 MHz, CDCl_3) δ 8.34 (d, $J = 7.3$ Hz, 1H, Ar), 7.73-7.59 (m, 3H, Ar), 7.37-7.35 (m, 4H, Ar), 7.25-7.19 (m, 6H, Ar), 5.16 (s, 2H, CH_2Br). ^{13}C NMR (125.7 MHz, CDCl_3) δ 155.2-125.4 (Cs of aromatic rings), 32.28. MS (EI, 70 eV) m/z (relative intensity) 375 ($\text{M}+2$, 11), 373 (M^+ , 11), 294 (M-Br, 100), 265 (9), 252 (17), 216 (13), 189 (16), 146 (47). HRMS (CI) calcd for $\text{C}_{22}\text{H}_{17}\text{BrO}$ ($\text{M}-\text{H}^+$) 374.0544, found 374.0551.

Preparation of 1-Phenethyl-3,4-diphenylisoquinoline (10a): To a stirred solution of **9ab** (39.2 mg, 0.105 mmol) in dry THF (1.0 mL) was added a solution of benzylmagnesium chloride in THF (2.0 M solution in THF, 0.105 mL, 0.210 mmol) at 0 °C. The reaction mixture was allowed to warm slowly to ambient temperature and stirred for 30 min at that temperature. The reaction was quenched with a saturated solution of NH_4Cl at 0 °C. The organic layer was separated and the aqueous layer was extracted with EtOAc. The combined organic layers were washed with brine, dried over anhydrous MgSO_4 , filtered, and concentrated using a rotatory evaporator. The crude mixture was purified by column chromatography (*n*-hexane/EtOAc) on silica gel to afford **10a** (17 mg, 42%), which is identical in all respects (^1H NMR, TLC behavior, and HRMS) to that obtained by the tandem *ortho*-alkenylation-cyclization reaction of **1a** with **2i**.

6. General Procedure for the One-Pot Reaction of 11.

A screw-capped pressure vial (1 mL) equipped with a magnetic stirring bar was charged with aromatic ketone (**11**, 0.324 mmol), benzylamine (**12**, 0.972 mmol), diphenylacetylene (**2i**, 0.972 mmol), $\text{RhCl}(\text{PPh}_3)_3$ (**3**, 32.4 μmol), and toluene (200 mg). The vial was closed and heated at 170 °C with a vigorous stirring for 12 h. After cooling to room temperature, the reaction mixture was purified by column chromatography (*n*-hexane/EtOAc) on silica gel. For a GC analysis, the crude mixture was filtered on a small plug of silica gel to remove the catalyst. The ratio of **9:10** was determined by a GC analysis.