Supporting Information

Ruthenium-Catalyzed Aerobic Oxidative Coupling of Alkynes with 2-Aryl-Substituted Indoles and Pyrroles

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General Remarks

The following starting materials were synthesized according to previously described methods: 1b,\(^1\) 1c,\(^1\) 1e,\(^1\) 1i–1l,\(^1\) 2b–2e,\(^2\) 2f,\(^3\) 2i,\(^4\) 1d,\(^5\) 1g,\(^6\) 1m,\(^7\) 8 1h,\(^9\) 4e,\(^10\) and 4a–4d.\(^11,\(^12\) Other chemicals were obtained from commercial sources, and were used without further purification. tAmOH was used as supplied by Merck. Yields refer to isolated compounds, estimated to be >95 % pure as determined by \(^1\)H-NMR and GC. TLC: Macherey-Nagel, TLC plates Alugram\(^2\) Sil G/UV254. Detection under UV light at 254 nm. Chromatography: Separations were carried out on Merck Silica 60 (0.040–0.063 mm, 70–230 mesh ASTM). All IR spectra were taken on a Bruker FT-IR Alpha device. MS: EI-MS: Finnigan MAT 95, 70 eV, DCI-MS: Finnigan MAT 95, 200 eV, reactant gas NH\(_3\); ESI-MS: Finnigan LCQ. High resolution mass spectrometry (HRMS): APEX IV 7T FTICR, Bruker Daltonic. M. p.: Stuart\(^®\) Melting Point Apparatus SMP3, values are uncorrected. NMR (\(^1\)H, \(^13\)C, \(^19\)F) spectra were recorded at 300 (\(^1\)H), 75.5 {\(^13\)C, APT (Attached Proton Test)} and 283 MHz (\(^19\)F), respectively, on Varian Unity-300 and AMX 300 instruments for CDCl\(_3\) solutions if not otherwise specified, chemical shifts (\(\delta\)) are given in ppm.

**Methyl 2-phenyl-1H-indole-3-carboxylate (1f):** A solution of MeMgI in Et\(_2\)O (3M, 3.3 mL, 10.0 mmol) was added dropwise at ambient temperature to a suspension of 2-phenylindole (1a) (0.97 g, 5.0 mmol) in Et\(_2\)O (3.0 mL). After 30 min, ClCO\(_2\)Me (0.95 g, 10.0 mmol) was added dropwise at 0 °C, and the reaction mixture was stirred for 30 min at ambient temperature. Thereafter, H\(_2\)O (10.0 mL) was added to the reaction mixture, and the product was extracted with EtOAc (3 x 20 mL). The combined organic phase was washed with brine (15.0 mL) and dried over Na\(_2\)SO\(_4\). After removal of the solvents in vacuo, the crude product was purified by column chromatography on silica gel (n-hexane/EtOAc: 1/1) to yield 1f (0.63 g, 50%) as a colorless solid. M. p. = 153–154 °C. \(^1\)H-NMR (300 MHz, CDCl\(_3\)): \(\delta\) = 8.71 (br s, 1H), 8.25–8.19 (m, 1H), 7.66–7.61 (m, 2H), 7.44–7.24 (m, 6 H), 3.82 (s, 3H). \(^13\)C-NMR (75.5 MHz, CDCl\(_3\)): \(\delta\) = 165.8 (C\(_q\)), 144.6 (C\(_q\)), 135.1 (C\(_q\)), 131.9 (C\(_q\)), 129.5 (CH), 129.1 (CH), 128.1 (CH), 127.5 (C\(_q\)), 123.2 (CH), 122.1 (CH), 122.1 (CH), 111.0 (CH), 104.4 (C\(_q\)), 50.8 (CH\(_3\)). IR (neat): 3295, 1662, 1550, 1485, 1446, 1336, 1279, 1129, 1025, 695 cm\(^{-1}\). MS (EI) \(m/z\) (relative intensity) 251 (50) [M\(^+\)], 220 (100), 165 (25). HRMS (EI) \(m/z\) calcd for C\(_{16}\)H\(_{13}\)NO\(_2\) [M\(^+\)] 251.0946, found 251.0943.

\[\text{CO}_2\text{Me} \ \text{N} \ \text{Ph} \]

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Electronic Supplementary Material (ESI) for Chemical Science
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Representative Procedure for Ruthenium-Catalyzed Aerobic Coupling of Azoles with Alkynes: The mixture of 2-phenylindole (1a) (96.5 mg, 0.50 mmol), diphenylacetylene (2a) (178 mg, 1.00 mmol), [RuCl2(p-cymene)]2 (15.3 mg, 5.0 mol%) and Cu(OAc)2·H2O (10 mg, 10.0 mol%) in tAmOH (2 mL) was stirred at 100 °C under air for 22 h. At ambient temperature, the reaction mixture was diluted with H2O (75 mL) and extracted with EtOAc (3 x 75 mL). The combined organic phase was washed with brine (50 mL) and dried over anhydrous Na2SO4. After filtration and evaporation of the solvents under reduced pressure, the crude product was purified by column chromatography on silica gel (n-hexane/EtOAc: 20/1) to yield 3aa as a colorless solid (151 mg, 82%).

**5,6-Diphenylindolo[2,1-a]isoquinoline (3aa):** M. p. = 205–206 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 8.31 (d, J = 6.7 Hz, 1H), 7.80 (d, J = 8.0 Hz, 1H), 7.51 (ddd, J = 7.7, 7.2, 1.3 Hz, 1H), 7.42 (s, 1H), 7.38–7.14 (m, 13H), 6.82 (ddd, J = 7.8, 7.0, 1.3 Hz, 1H), 6.01 (d, J = 8.7 Hz, 1H). ¹³C-NMR (75.5 MHz, CDCl₃): δ = 136.7 (C₉), 136.0 (C₉), 135.9 (C₉), 135.3 (C₉), 132.7 (C₉), 131.8 (CH), 130.8 (CH), 130.2 (C₉), 129.7 (C₉), 128.7 (CH), 128.6 (CH), 127.8 (CH), 127.3 (CH), 127.0 (CH), 126.7 (CH), 126.2 (CH), 125.4 (C₉), 123.3 (CH), 121.6 (CH), 121.4 (C₉), 120.2 (CH), 120.1 (CH), 114.6 (CH), 94.2 (CH). IR (neat): 1543, 1484, 1443, 1377, 1338, 1245, 1030, 756, 736, 696 cm⁻¹. MS (EI) m/z (relative intensity) 369 (100) [M⁺], 291 (13). HRMS (EI) m/z calcd for C₂₈H₁₉NO [M⁺] 369.1517, found 369.1518. The spectral data were in accordance with those reported in the literature.¹³

**10-Fluoro-5,6-diphenylindolo[2,1-a]isoquinoline (3ba):** The representative procedure was followed using 5-fluoro-2-phenyl-1H-indole (1b) (106 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/EtOAc: 50/1) yielded 3ba (102 mg, 54%) as a yellow solid. M. p. = 227–228 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 8.26 (d, J = 7.8 Hz, 1H), 7.49 (ddd, J = 7.8, 7.8, 1.2 Hz,
1H), 7.39–7.11 (m, 14H), 6.52 (ddd, J = 9.2, 9.1, 2.6 Hz, 1H), 5.86 (dd, J = 9.4, 4.6 Hz, 1H).

$^{13}$C-NMR (75.5 MHz, CDCl$_3$): $\delta$ = 158.6 (C$_q$, J$_{C-F}$ = 238 Hz), 137.4 (C$_q$), 136.5 (C$_q$), 135.7 (C$_q$), 135.0 (C$_q$), 131.7 (CH), 130.8 (CH), 130.3 (C$_q$, J$_{C-F}$ = 10 Hz), 130.2 (C$_q$), 129.4 (C$_q$), 128.8 (CH), 128.7 (CH), 127.8 (CH), 127.6 (CH), 127.1 (CH), 126.8 (CH), 126.2 (CH), 124.9 (C$_q$), 123.4 (CH), 121.6 (C$_q$), 115.6 (CH, J$_{C-F}$ = 9 Hz), 108.5 (CH, J$_{C-F}$ = 26 Hz), 104.3 (CH, J$_{C-F}$ = 23 Hz), 94.0 (CH, J$_{C-F}$ = 4 Hz). $^{19}$F-NMR (283 MHz, CDCl$_3$): $\delta$ = -(121.7 – 121.8) (m).

IR (neat): 3054, 1610, 1539, 1485, 1441, 1117, 855, 787, 753, 696 cm$^{-1}$. MS (EI) m/z (relative intensity) 387 (100) [M$^+$], 309 (30). HRMS (ESI) m/z calcd for C$_{28}$H$_{18}$FN [M$^+$] 387.1423, found 387.1422.

10-Methoxy-5,6-diphenylindolo[2,1-a]isoquinoline (3ca): The representative procedure was followed using 5-methoxy-2-phenyl-1H-indole (1c) (112 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/EtOAc: 20/1) yielded 3ca as a colorless solid (85 mg, 43%). M. p. = 210–211 °C. $^1$H-NMR (300 MHz, CDCl$_3$): $\delta$ = 8.29 (d, J = 8.1 Hz, 1H), 7.50 (dd, J = 7.5, 7.1 Hz, 1H), 7.39–7.14 (m, 14H), 6.48 (dd, J = 9.4, 2.7 Hz, 1H), 5.87 (d, J = 9.4 Hz, 1H), 3.86 (s, 3H). $^{13}$C-NMR (75.5 MHz, CDCl$_3$): $\delta$ = 155.1 (C$_q$), 136.7 (C$_q$), 136.5 (C$_q$), 135.8 (C$_q$), 135.2 (C$_q$), 131.8 (CH), 130.8 (CH), 130.5 (C$_q$), 130.1 (C$_q$), 128.7 (CH), 128.6 (CH), 127.9 (C$_q$), 127.8 (CH), 127.2 (CH), 126.9 (CH), 126.7 (CH), 126.1 (CH), 125.1 (C$_q$), 123.2 (CH), 121.0 (C$_q$), 115.4 (CH), 110.5 (CH), 100.9 (CH), 93.8 (CH), 55.5 (CH$_3$). IR (neat): 2948, 1613, 1487, 1445, 1336, 1218, 1126, 948, 842, 695 cm$^{-1}$. MS (EI) m/z (relative intensity) 399 (100) [M$^+$], 356 (53), 278 (12). HRMS (ESI) m/z calcd for C$_{29}$H$_{21}$NO [M$^+$] 399.1623, found 399.1612. The spectral data were in accordance with those reported in the literature.$^{13}$
10-Nitro-5,6-diphenylindolo[2,1-a]isoquinoline (3da): The representative procedure was followed using 5-nitro-2-phenyl-1H-indole (1d) (119 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/EtOAc: 25/1) yielded 3da (141 mg, 71%) as a yellow solid. M. p. = 281–282 °C.

$^1$H-NMR (300 MHz, CDCl$_3$): $\delta = 8.66$ (s, 1H), 8.28 (d, $J = 7.8$ Hz, 1H), 7.63 (dd, $J = 9.4$, 2.3 Hz, 1H), 7.58–7.45 (m, 2H), 7.44–7.30 (m, 4H), 7.30–7.08 (m, 8H), 5.96 (d, $J = 9.4$ Hz, 1H).

$^{13}$C-NMR (75.5 MHz, CDCl$_3$): $\delta = 142.5$ (C$_q$), 138.8 (CH), 135.9 (C$_q$), 135.3 (C$_q$), 134.9 (C$_q$), 134.5 (CH), 131.4 (CH), 130.7 (C$_q$), 130.2 (CH), 129.2 (CH), 128.9 (CH), 128.8 (CH), 128.4 (CH), 128.0 (CH), 127.7 (CH), 127.1 (CH), 126.6 (C$_q$), 124.7 (C$_q$), 123.6 (CH), 123.6 (C$_q$), 116.7 (C$_q$), 114.8 (C$_q$), 114.6 (CH), 95.9 (CH). IR (neat): 3060, 1600, 1545, 1505, 1487, 1336, 1073, 759, 731, 696 cm$^{-1}$. MS (EI) $m/z$ (relative intensity) 414 (100) [M$^+$], 384 (27), 368 (30), 291 (13). HRMS (ESI) $m/z$ calcd for C$_{28}$H$_{18}$N$_2$O$_2$ [M$^+$] 414.1368, found 414.1384.

12-Methyl-5,6-diphenylindolo[2,1-a]isoquinoline (3ea): The representative procedure was followed using 3-methyl-2-phenyl-1H-indole (1e) (104 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/EtOAc: 20/1) yielded 3ea as a colorless solid (89 mg, 47%). M. p. = 179–180 °C. $^1$H-NMR (300 MHz, CDCl$_3$): $\delta = 8.55$ (d, $J = 8.3$ Hz, 1H), 7.84 (d, $J = 8.1$ Hz, 1H), 7.55 (ddd, $J = 7.6$, 7.2, 1.2 Hz, 1H), 7.39–7.16 (m, 13H), 6.86 (ddd, $J = 7.8$, 6.8, 1.3 Hz, 1H), 6.01 (d, $J = 8.7$ Hz, 1H), 2.97 (s, 3H). $^{13}$C-NMR (75.5 MHz, CDCl$_3$): $\delta = 137.0$ (C$_q$), 136.1 (C$_q$), 135.7 (C$_q$), 131.9 (CH), 131.3 (C$_q$), 131.2 (C$_q$), 130.9 (C$_q$), 130.8 (CH), 130.3 (C$_q$), 128.6 (CH), 128.5 (CH), 127.8 (CH), 127.3 (C$_q$), 126.6 (CH), 126.4 (CH), 125.9 (CH), 124.4 (CH), 121.0 (CH), 120.9 (C$_q$), 120.4 (CH), 117.9 (CH), 114.5 (CH), 105.2 (C$_q$), 12.0 (CH$_3$). IR (neat): 3052, 3028, 1596, 1474, 1443, 1375, 1336, 1319.
Methyl 5,6-diphenylindolo[2,1-a]isoquinoline-12-carboxylate (3fa): The representative procedure was followed using methyl 2-phenyl-1H-indole-3-carboxylate (1f) (126 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/EtOAc: 10/1) yielded 3fa as a colorless solid (181 mg, 85%). M. p. = 181–182 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 9.33 (d, J = 8.0 Hz, 1H), 8.26 (d, J = 8.3 Hz, 1H), 7.59 (t, J = 7.7 Hz, 1H), 7.47 (t, J = 7.6 Hz, 1H), 7.37–7.14 (m, 12H), 6.84 (t, J = 7.9 Hz, 1H), 6.03 (d, J = 8.8 Hz, 1H), 4.13 (s, 3H). ¹³C-NMR (75.5 MHz, CDCl₃): δ = 167.4 (Cq), 138.3 (Cq), 136.2 (Cq), 135.4 (Cq), 135.0 (Cq), 132.3 (Cq), 131.9 (Cq), 131.5 (CH), 130.8 (CH), 129.1 (Cq), 129.0 (CH), 128.9 (CH), 128.6 (CH), 127.9 (CH), 127.7 (CH), 126.9 (CH), 126.8 (CH), 126.0 (CH), 124.7 (Cq), 124.0 (Cq), 123.3 (CH), 121.3 (CH), 121.1 (CH), 115.0 (CH), 101.5 (Cq), 51.5 (CH₃). IR (neat): 2946, 1693, 1519, 1488, 1447, 1364, 1251, 1153, 1028 cm⁻¹. MS (EI) m/z (relative intensity) 427 (100) [M⁺], 396 (27), 369 (25). HRMS (EI) m/z calcd for C₃₀H₂₁NO₂ [M⁺] 427.1572, found 427.1571.

1-(5,6-Diphenylindolo[2,1-a]isoquinolin-12-yl)ethanone (3ga): The representative procedure was followed using 1-(2-phenyl-1H-indol-3-yl)ethanone (1g) (118 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/EtOAc: 10/1) yielded 3ga as a yellow solid (165 mg, 80%). M. p. = 207–209 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 8.56 (dd, J = 8.3, 1.1 Hz, 1H), 8.09 (d, J = 8.0 Hz, 1H), 7.56 (ddd, J = 8.4, 7.6, 1.4 Hz, 1H), 7.46 (ddd, J = 8.2, 7.2, 1.4 Hz, 1H), 7.41–7.15 (m, 12H), 6.86 (ddd, J = 8.6, 7.0, 1.3 Hz, 1H), 6.04 (d, J = 8.8 Hz, 1H), 2.86
(s, 3H). $^{13}$C-NMR (75.5 MHz, CDCl$_3$): $\delta$ = 198.9 (C$_q$), 136.3 (C$_q$), 136.1 (C$_q$), 135.6 (C$_q$), 134.8 (C$_q$), 132.3 (C$_q$), 131.9 (C$_q$), 131.5 (CH), 130.8 (CH), 129.0 (CH), 128.9 (CH), 128.7 (CH), 128.4 (C$_q$), 127.9 (CH), 127.4 (CH), 127.1 (CH), 126.9 (CH), 126.2 (CH), 124.2 (C$_q$), 124.0 (C$_q$), 123.4 (CH), 121.5 (CH), 119.9 (CH), 115.1 (CH), 112.7 (C$_q$), 32.1 (CH$_3$). IR (neat): 3056, 1634, 1519, 1474, 1368, 1155, 1110, 939, 771, 698 cm$^{-1}$. MS (EI) $m/z$ (relative intensity) 411 (78) [M$^+$], 396 (100), 367 (9), 291 (10). HRMS (EI) $m/z$ calcd for C$_{30}$H$_{21}$NO [M$^+$] 411.1623, found 411.1624.

![5,6-Diphenylindolo[2,1-a]isoquinoline-12-carbaldehyde (3ha)](image)

5,6-Diphenylindolo[2,1-a]isoquinoline-12-carbaldehyde (3ha): The representative procedure was followed using 2-phenyl-1H-indole-3-carbaldehyde (1h) (111 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/EtOAc/CH$_2$Cl$_2$: 10/1/1) yielded 3ha as a colorless solid (122 mg, 62%). M. p. = 283–285 °C. $^1$H-NMR (300 MHz, CDCl$_3$): $\delta$ = 10.98 (s, 1H), 9.15 (d, $J$ = 8.1 Hz, 1H), 8.65 (d, $J$ = 8.1 Hz, 1H), 7.68 (t, $J$ = 7.7 Hz, 1H), 7.57 (t, $J$ = 7.7 Hz, 1H), 7.43–7.15 (m, 12H), 6.91 (t, $J$ = 7.9 Hz, 1H), 6.02 (d, $J$ = 8.8 Hz, 1H). $^{13}$C-NMR (75.5 MHz, CDCl$_3$): $\delta$ = 184.6 (CH), 141.0 (C$_q$), 135.9 (C$_q$), 135.7 (C$_q$), 134.5 (C$_q$), 133.1 (C$_q$), 132.5 (C$_q$), 131.3 (CH), 130.7 (CH), 129.9 (CH), 129.3 (C$_q$), 129.2 (CH), 128.8 (CH), 128.0 (CH), 127.9 (CH), 127.7 (CH), 127.2 (CH), 126.6 (CH), 125.5 (C$_q$), 124.6 (CH), 124.4 (C$_q$), 122.5 (CH), 120.7 (CH), 115.1 (CH), 111.1 (C$_q$). IR (neat): 1621, 1516, 1479, 1446, 1382, 1303, 1209, 1136, 1062, 1032, 732, 698, 579 cm$^{-1}$. MS (EI) $m/z$ (relative intensity) 397 (100) [M$^+$], 367 (9), 291 (10). HRMS (EI) $m/z$ calcd for C$_{29}$H$_{19}$NO [M$^+$] 397.1467, found 397.1480.

![7, 8-Diphenylbenzo[h]indolo[2,1-a]isoquinoline (3ia)](image)

7, 8-Diphenylbenzo[h]indolo[2,1-a]isoquinoline (3ia): The representative procedure was followed using 2-(naphthalen-1-yl)-1H-indole (1i) (122 mg, 0.50 mmol) and
diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/CH₂Cl₂: 5/1) yielded 3ia (97 mg, 46%) as a yellow solid. M. p. = 215−217 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 9.40 (d, J = 8.6 Hz, 1H), 8.06 (s, 1H), 7.96 (dd, J = 9.0, 8.6 Hz, 2H), 7.84 (ddd, J = 7.6, 7.6, 1.2 Hz, 1H), 7.76 (d, J = 8.6 Hz, 1H), 7.66 (dd, J = 7.3, 7.3 Hz, 1H), 7.46−7.18 (m, 12H), 6.92 (ddd, 8.0, 7.8, 1.2 Hz, 1H), 6.17 (d, J = 8.7 Hz, 1H). ¹³C-NMR (75.5 MHz, CDCl₃): δ = 137.2 (Cq), 136.6 (Cq), 135.6 (Cq), 134.9 (Cq), 132.8 (Cq), 132.0 (CH), 131.7 (Cq), 130.7 (CH), 130.2 (Cq), 129.5 (Cq), 129.5 (Cq), 128.9 (CH), 128.6 (CH), 127.9 (CH), 127.9 (CH), 127.2 (CH), 126.8 (CH), 125.9 (CH), 125.7 (CH), 124.2 (CH), 122.1 (Cq), 122.0 (CH), 121.2 (Cq), 120.3 (CH), 120.2 (CH), 114.9 (CH), 99.3 (CH). IR (neat): 3057, 1588, 1543, 1467, 1360, 1210, 1017, 818, 730, 695 cm⁻¹. MS (EI) m/z (relative intensity) 419 (100) [M⁺], 341 (20). HRMS (ESI) m/z calcd for C₃₂H₂₁N [M⁺] 419.1674, found 419.1678. The spectral data were in accordance with those reported in the literature.¹³

3-Fluoro-5,6-diphenylindolo[2,1-a]isoquinoline (3ja): The representative procedure was followed using 2-(4-fluorophenyl)-1H-indole (1j) (106 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/ETOAc: 10/1) yielded 3ja (164 mg, 84%) as a yellow solid. M. p. = 178−179 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 8.26 (dd, J = 8.7, 5.5 Hz, 1H), 7.79 (d, J = 8.0 Hz, 1H), 7.40−7.28 (m, 6H), 7.28−7.11 (m, 7H), 6.87−6.76 (m, 2H), 6.00 (d, J = 8.7 Hz, 1H). ¹³C-NMR (75.5 MHz, CDCl₃): δ = 162.0 (Cq, J_C−F = 246 Hz), 137.1 (Cq), 136.1 (Cq), 135.4 (Cq), 135.0 (Cq), 132.6 (Cq), 132.3 (Cq, J_C−F = 9 Hz), 131.6 (CH), 130.6 (CH), 129.7 (Cq), 128.8 (CH), 128.6 (CH), 128.0 (CH), 127.0 (CH), 125.4 (CH, J_C−F = 9 Hz), 121.9 (Cq), 121.9 (CH), 121.8 (CH), 120.8 (Cq, J_C−F = 3 Hz), 120.1 (CH), 115.2 (CH, J_C−F = 23 Hz), 114.6 (CH), 111.6 (CH, J_C−F = 23 Hz), 93.9 (CH). ¹⁹F-NMR (283 MHz, CDCl₃): δ = −(112.6 − 112.7) (m). IR (neat): 3055, 1609, 1546, 1481, 1442, 1273, 775, 738, 724, 693 cm⁻¹. MS (EI) m/z (relative intensity) 387 (100) [M⁺], 309 (37). HRMS (ESI) m/z calcd for C₂₈H₁₈FN [M⁺] 387.1423, found 387.1412.
**5,6-Diphenyl-3-(trifluoromethyl)indolo[2,1-a]isoquinoline (3ka):** The representative procedure A was followed using 2-{4-(trifluoromethyl)phenyl}-1H-indole (1k) (131 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/CH₂Cl₂: 5/1) yielded 3ka (158 mg, 72%) as a yellow solid. M. p. = 225−226 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 8.38 (d, J = 8.4 Hz, 1H), 7.82 (d, J = 8.0 Hz, 1H), 7.71 (d, J = 8.4 Hz, 1H), 7.51 (s, 1H), 7.41−7.28 (m, 6H), 7.28−7.20 (m, 4H), 7.20−7.12 (m, 2H), 6.86 (ddd, J = 7.8, 7.4, 1.3 Hz, 1H), 6.00 (d, J = 8.8 Hz, 1H). ¹³C-NMR (75.5 MHz, CDCl₃): δ = 137.3 (Cq), 135.7 (Cq), 134.8 (Cq), 134.6 (Cq), 132.9 (Cq), 131.7 (CH), 130.6 (CH), 130.1 (Cq), 129.5 (Cq), 129.3 (Cq, Jₓ-F = 22 Hz), 128.9 (CH), 128.1 (CH), 127.9 (Cq), 127.2 (CH), 123.2 (CH, Jₓ-F = 273 Hz), 123.8 (CH), 123.2 (CH, Jₓ-F = 19 Hz), 123.2 (CH, Jₓ-F = 11 Hz), 123.2 (CH, Jₓ-F = 4 Hz), 122.0 (CH), 121.0 (CH), 120.9 (Cq), 120.6 (CH), 114.7 (CH), 96.0 (CH). ¹⁹F-NMR (283 MHz, CDCl₃): δ = −62.3 (s). IR (neat): 3062, 3018, 1618, 1544, 1485, 1345, 1272, 1017, 977, 744, 695 cm⁻¹. MS (EI) m/z (relative intensity) 437 (100) [M⁺], 359 (11). HRMS (ESI) m/z calcld for C₂₉H₁₈F₃N [M⁺] 437.1391, found 437.1380.

**3-Nitro-5,6-diphenylindolo[2,1-a]isoquinoline (3la):** The representative procedure was followed using 2-(4-nitrophenyl)-1H-indole (1l) (119 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/CH₂Cl₂: 7/1) yielded 3la (92 mg, 44%) as a yellow solid. M. p. = 224−225 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 8.38 (d, J = 8.2 Hz, 1H), 7.83 (d, J = 7.8 Hz, 1H), 7.71 (d, J = 8.2 Hz, 1H), 7.51 (s, 1H), 7.45−7.08 (m, 12H), 6.87 (dd, J = 8.2, 7.4 Hz, 1H), 6.01 (d, J = 8.8 Hz, 1H). ¹³C-NMR (75.5 MHz, CDCl₃): δ = 137.3 (Cq), 135.7 (Cq), 134.9 (Cq), 134.7 (Cq), 132.9 (Cq), 131.7 (CH), 130.6 (CH), 130.1 (Cq), 129.5 (Cq), 129.3 (Cq, Jₓ-F = 22 Hz), 128.9 (CH), 128.1 (CH), 127.9 (Cq), 127.2 (CH), 123.2 (CH, Jₓ-F = 273 Hz), 123.8 (CH), 123.2 (CH, Jₓ-F = 19 Hz), 123.2 (CH, Jₓ-F = 11 Hz), 123.2 (CH, Jₓ-F = 4 Hz), 122.0 (CH), 121.0 (CH), 120.9 (Cq), 120.6 (CH), 114.7 (CH), 96.0 (CH). IR (neat): 3061, 3032,
1618, 1597, 1544, 1485, 1444, 1169, 825, 658 cm$^{-1}$. MS (EI) m/z (relative intensity) 414 (100) [M$^+$], 384 (27), 368 (30). HRMS (ESI) m/z calcd for C$_{28}$H$_{18}$N$_2$O$_2$ [M$^+$] 414.1368, found 414.1368.

Methyl 5,6-diphenylindolo[2,1-a]isooquinoline-3-carboxylate (3ma): The representative procedure was followed using methyl 4-(1H-indol-2-yl)benzoate (1m) (126 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/CH$_2$Cl$_2$: 2/1) yielded 3ma (122 mg, 57%) as a yellow solid. M. p. = 256−257 °C. 1H-NMR (300 MHz, CDCl$_3$): $\delta$ = 8.33 (d, $J$ = 8.3 Hz, 1H), 8.13 (dd, $J$ = 8.3, 1.6 Hz, 1H), 7.86 (s, 1H), 7.82 (d, $J$ = 8.0 Hz, 1H), 7.51 (s, 1H), 7.39−7.28 (m, 5H), 7.27−7.15 (m, 6H), 6.86 (dd, $J$ = 7.8, 7.7 Hz, 1H), 6.00 (d, $J$ = 8.7 Hz, 1H), 3.86 (s, 3H). 13C-NMR (75.5 MHz, CDCl$_3$): $\delta$ = 166.8 (C$_q$), 136.7 (C$_q$), 135.9 (C$_q$), 135.0 (C$_q$), 134.9 (C$_q$), 133.0 (C$_q$), 131.7 (CH), 130.7 (CH), 129.9 (C$_q$), 129.5 (C$_q$), 128.9 (C$_q$), 128.8 (CH), 128.6 (CH), 128.5 (C$_q$), 128.0 (CH), 127.8 (CH), 127.5 (CH), 127.0 (CH), 123.2 (CH), 121.9 (CH), 121.3 (C$_q$), 120.9 (CH), 120.6 (CH), 114.7 (CH), 96.3 (CH), 52.1 (CH$_3$). IR (neat): 3025, 1708, 1604, 1484, 1441, 1422, 762, 738, 701 cm$^{-1}$. MS (EI) m/z (relative intensity) 427 (100) [M$^+$], 367 (9), 291 (10). HRMS (ESI) m/z calcd for C$_{30}$H$_{21}$NO$_2$ [M$^+$] 427.1572, found 427.1578. The spectral data were in accordance with those reported in the literature.13

4-Fluoro-5,6-diphenylindolo[2,1-a]isooquinoline (3oa') and 2-Fluoro-5,6-diphenylindolo[2,1-a]isooquinoline (3oa''): The representative procedure was followed using 2-(3-fluorophenyl)-1H-indole (1o) (106 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/CH$_2$Cl$_2$: 10/1) yielded 3oa' (78 mg, 40%) as yellow solid and 3oa'' (17 mg, 9%) as yellow solid.
4-Fluoro-5,6-diphenylindolo[2,1-a]isoquinoline (3oa\(^{+}\)): M. p. = 211–212 °C. \(^1\)H-NMR (300 MHz, CDCl\(_3\)): \(\delta = 8.12 (d, J = 7.8\) Hz, 1H), 7.83 (d, \(J = 7.8\) Hz, 1H), 7.52–7.10 (m, 13H), 7.05 (dd, \(J = 12.4, 7.8\) Hz, 1H), 6.88 (dd, \(J = 7.8, 7.8\) Hz, 1H), 5.96 (d, \(J = 8.8\) Hz, 1H). \(^13\)C-NMR (75.5 MHz, CDCl\(_3\)): \(\delta = 159.1 (C_q, J_{C-F} = 254\) Hz), 138.7 (C\(_q\), \(J_{C-F} = 3\) Hz), 137.5 (C\(_q\), 134.9 (C\(_q\), \(J_{C-F} = 3\) Hz), 134.8 (C\(_q\), 132.8 (C\(_q\), 131.0 (CH), 130.9 (CH), 129.6 (C\(_q\), 128.7 (CH), 128.5 (CH), 128.0 (CH, \(J_{C-F} = 9\) Hz), 127.7 (C\(_q\), \(J_{C-F} = 4\) Hz), 127.1 (CH), 126.3 (CH), 121.9 (CH), 120.6 (CH), 120.4 (CH), 119.4 (CH, \(J_{C-F} = 4\) Hz), 118.6 (C\(_q\), \(J_{C-F} = 9\) Hz), 117.0 (C\(_q\), \(J_{C-F} = 3\) Hz), 114.7 (CH), 114.4 (CH, \(J_{C-F} = 22\) Hz), 96.1 (CH). \(^{19}\)F-NMR (283 MHz, CDCl\(_3\)): \(\delta = -(107.8 – 108.9)\) (m). IR (neat): 3056, 1608, 1539, 1487, 1461, 1440, 1230, 773, 739, 693 cm\(^{-1}\). MS (EI) \(m/z\) (relative intensity) 387 (100) [M\(^+\)], 309 (13). HRMS (ESI) \(m/z\) calcd for C\(_{28}\)H\(_{18}\)FN [M\(^+\)] 387.1423, found 387.1411.

2-Fluoro-5,6-diphenylindolo[2,1-a]isoquinoline (3oa\(^{+}\)): M. p. = 226–227 °C. \(^1\)H-NMR (300 MHz, CDCl\(_3\)): \(\delta = 7.93 (dd, J = 9.7, 2.6\) Hz, 1H), 7.81 (d, \(J = 8.0\) Hz, 1H), 7.43–7.27 (m, 6H), 7.27–7.09 (m, 7H), 7.05 (ddd, \(J = 8.8, 8.6, 2.6\) Hz, 1H), 6.84 (ddd, \(J = 8.0, 7.7, 1.3\) Hz, 1H), 6.01 (d, \(J = 8.8\) Hz, 1H). \(^13\)C-NMR (75.5 MHz, CDCl\(_3\)): \(\delta = 161.8 (C_q, J_{C-F} = 247\) Hz), 136.7 (C\(_q\), 136.7 (C\(_q\), 135.3 (C\(_q\), 135.3 (C\(_q\), 133.0 (C\(_q\), 131.8 (CH), 131.0 (CH), 129.6 (C\(_q\), 129 (CH), 128.6 (CH), 128.5 (CH, \(J_{C-F} = 9\) Hz), 127.9 (CH), 127.2 (C\(_q\), \(J_{C-F} = 9\) Hz), 126.9 (CH), 126.8 (C\(_q\), \(J_{C-F} = 2\) Hz), 121.9 (CH), 121.0 (C\(_q\), 120.6 (CH), 120.5 (CH), 115.3 (CH, \(J_{C-F} = 23\) Hz), 114.7 (CH), 108.7 (CH, \(J_{C-F} = 23\) Hz), 96.1 (CH). \(^{19}\)F-NMR (283 MHz, CDCl\(_3\)): \(\delta = -(113.7 – 113.8)\) (m). IR (neat): 3061, 1608, 1542, 1487, 1340, 1167, 956, 732, 694, 651 cm\(^{-1}\). MS (EI) \(m/z\) (relative intensity) 387 (100) [M\(^+\)], 309 (9). HRMS (ESI) \(m/z\) calcd for C\(_{28}\)H\(_{18}\)FN [M\(^+\)] 387.1423, found 387.1419.
5,6-Di-\(\mu\)-toly1indolo[2,1-a]isoquinoline (3ab): The representative procedure was followed using 2-phenyl-1\(H\)-indole (1a) (48.3 mg, 0.25 mmol) and 1,2-di-\(\mu\)-toly1ethyne (2b) (103 mg, 0.50 mmol). After 22 h, purification by column chromatography on silica gel (\(n\)-hexane/EtOAc: 30/1) yielded 3ab as a colorless solid (96 mg, 97%). M. p. = 216–218 °C.

\(^1\)H-NMR (300 MHz, CDCl\(_3\)): \(\delta = 8.32 (d, J = 8.0 \text{ Hz}, 1H), 7.83 (d, J = 8.0 \text{ Hz}, 1H), 7.52 (dd, \(J = 7.5, 7.5 \text{ Hz}, 1H), 7.44 (s, 1H), 7.37 (ddd, \(J = 7.6, 7.2, 1.0 \text{ Hz}, 1H), 7.28–7.17 (m, 6H), 7.11 (s, 4H), 6.89 (ddd, \(J = 7.8, 7.1, 1.0 \text{ Hz}, 1H), 6.09 (d, J = 8.7 \text{ Hz}, 1H), 2.43 (s, 3H), 2.36 (s, 3H). 13C-NMR (75.5 MHz, CDCl\(_3\)): \(\delta = 138.3 (C_q), 136.1 (C_q), 136.0 (C_q), 135.9 (C_q), 133.7 (C_q), 132.7 (C_q), 132.4 (C_q), 131.6 (CH), 130.6 (CH), 130.5 (CH), 129.6 (C_q), 129.3 (C_q), 128.5 (CH), 127.2 (CH), 126.8 (CH), 126.1 (CH), 125.3 (C_q), 123.2 (CH), 121.5 (CH), 121.3 (C_q), 120.1 (CH), 119.9 (CH), 114.7 (CH), 94.0 (CH), 21.5 (CH\(_3\)), 21.2 (CH\(_3\)). IR (neat): 3021, 2918, 1506, 1445, 1377, 1338, 1108, 1020, 788, 758 cm\(^{-1}\). MS (EI) \(m/z\) (relative intensity) 397 (100) [\(M^+\)], 381 (9), 305 (7), 291 (6), 182 (7). HRMS (EI) \(m/z\) calcld for C\(_{30}\)H\(_{23}\)N [\(M^+\)] 397.1830, found 397.1831. The spectral data were in accordance with those reported in the literature.\(^{13}\)

5,6-Di-(4-methoxyphenyl)indolo[2,1-a]isoquinoline (3ac): The representative procedure was followed using 2-phenyl-1\(H\)-indole (1a) (48.3 mg, 0.25 mmol) and 1,2-bis(4-methoxyphenyl)ethyne (2c) (119 mg, 0.50 mmol). After 22 h, purification by column chromatography on silica gel (\(n\)-hexane/EtOAc: 20/1) yielded 3ac as a colorless solid (54 mg, 50%). M. p. = 271–273 °C. \(^1\)H-NMR (300 MHz, CDCl\(_3\)): \(\delta = 8.29 (d, J = 8.0 \text{ Hz}, 1H), 7.79 (d, \(J = 8.0 \text{ Hz}, 1H), 7.50 (ddd, \(J = 7.3, 7.2, 1.3 \text{ Hz}, 1H), 7.40 (d, J = 0.8 \text{ Hz}, 1H), 7.34 (ddd, \(J = 7.6, 7.2, 1.3 \text{ Hz}, 1H), 7.25–7.14 (m, 4H), 7.08 (d, \(J = 8.8 \text{ Hz}, 2H), 6.91–6.84 (m, 3H), 6.79 (d, \(J = 8.8 \text{ Hz}, 2H), 6.10 (d, \(J = 8.7 \text{ Hz}, 1H), 3.85 (s, 3H), 3.80 (s, 3H). 13C-NMR (75.5 MHz, CDCl\(_3\)): \(\delta = 159.5 (C_q), 158.1 (C_q), 136.1 (C_q), 136.0 (C_q), 132.8 (C_q), 132.7 (CH), 131.9
(CH), 130.6 (Cq), 129.6 (Cq), 129.1 (Cq), 127.9 (Cq), 127.2 (CH), 126.9 (CH), 126.1 (CH), 125.3 (Cq), 123.2 (CH), 121.5 (CH), 121.3 (Cq), 120.1 (CH), 120.0 (CH), 114.7 (CH), 114.0 (CH), 113.3 (CH), 94.0 (CH), 55.2 (CH3), 55.1 (CH3). IR (neat): 2956, 1606, 1505, 1444, 1376, 1290, 1242, 1108, 827, 758 cm\(^{-1}\). MS (EI) \(m/z\) (relative intensity) 429 (100) [M\(^+\)], 414 (11), 383 (10), 354 (10), 342 (7), 214 (13). HRMS (EI) \(m/z\) calcd for C\(_{30}\)H\(_{23}\)NO\(_2\) [M\(^+\)] 429.1729, found 429.1727. The spectral data were in accordance with those reported in the literature.\(^{13}\)

5,6-Di-(4-fluorophenyl)indolo[2,1-a]isoquinoline (3ad): The representative procedure was followed using 2-phenyl-1\(H\)-indole (1a) (48.3 mg, 0.25 mmol) and 1,2-bis(4-fluorophenyl)ethyne (2d) (107 mg, 0.50 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/EtOAc: 30/1) yielded 3ad as a colorless solid (80 mg, 79%). M. p. = 231–233 °C. \(^1\)H-NMR (300 MHz, CDCl\(_3\)): \(\delta = 8.30\) (d, \(J = 8.1\) Hz, 1H), 7.82 (d, \(J = 7.7\) Hz, 1H), 7.53 (dd, \(J = 7.5,\) 7.5 Hz, 1H), 7.42 (s, 1H), 7.37 (dd, \(J = 7.5,\) 7.5 Hz, 1H), 7.30–7.21 (m, 3H), 7.16–7.03 (m, 5H), 7.01–6.93 (m, 2H), 6.89 (dd, \(J = 7.8,\) 7.2 Hz, 1H), 6.06 (d, \(J = 8.8\) Hz, 1H). \(^13\)C-NMR (75.5 MHz, CDCl\(_3\)): \(\delta = 162.5\) (Cq, \(J_{C-F} = 249\) Hz), 161.7 (Cq, \(J_{C-F} = 247\) Hz), 136.1 (Cq), 135.8 (Cq), 135.2 (Cq), 133.2 (CH, \(J_{C-F} = 8\) Hz), 132.6 (CH, \(J_{C-F} = 8\) Hz), 132.4 (Cq, \(J_{C-F} = 4\) Hz), 131.2 (Cq, \(J_{C-F} = 4\) Hz), 129.9 (Cq), 129.7 (Cq), 127.4 (CH), 127.3 (CH), 126.0 (CH), 125.4 (Cq), 123.3 (CH), 121.8 (CH), 120.8 (Cq), 120.4 (CH), 120.3 (CH, \(J_{C-F} = 4\) Hz), 116.0 (CH, \(J = 22\) Hz), 115.0 (CH, \(J = 22\) Hz), 114.3 (CH), 94.5 (CH). \(^19\)F-NMR (283 MHz, CDCl\(_3\)): \(\delta = -111.5\) (s), –115.0 (s). IR (neat): 1599, 1501, 1445, 1379, 1337, 1218, 1093, 739 cm\(^{-1}\). MS (EI) \(m/z\) (relative intensity) 405 (100) [M\(^+\)], 309 (13), 191 (5). HRMS (EI) \(m/z\) calcd for C\(_{28}\)H\(_{17}\)F\(_2\)N [M\(^+\)] 405.1329, found 405.1332.
5,6-Bis{4-(trifluoromethyl)phenyl}indolo[2,1-a]isoquinoline (3ae): The representative procedure was followed using 2-phenyl-1H-indole (1a) (97.0 mg, 0.50 mmol) and 1,2-bis{4-(trifluoromethyl)phenyl}ethyne (2e) (314 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/CH₂Cl₂: 10/1) yielded 3ae (137 mg, 54%) as a yellow solid. M. p. = 287–288 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 8.32 (d, J = 7.8 Hz, 1H), 7.82 (d, J = 7.8 Hz, 1H), 7.64 (d, J = 7.8 Hz, 2H), 7.59–7.48 (m, 3H), 7.48–7.33 (m, 4H), 7.33–7.18 (m, 3H), 7.05 (d, J = 7.8 Hz, 1H), 6.88 (dd, J = 7.8, 7.8 Hz, 1H), 5.95 (d, J = 8.6 Hz, 1H). ¹³C-NMR (75.5 MHz, CDCl₃): δ = 140.2 (Cq), 138.5 (Cq), 135.7 (Cq), 134.5 (Cq), 132.5 (Cq), 132.1 (CH), 131.2 (Cq, Jₐ–F = 33 Hz), 131.2 (CH), 129.8 (Cq), 129.7 (Cq, Jₐ–F = 33 Hz), 129.2 (Cq), 127.8 (CH, Jₐ–F = 11 Hz), 125.9 (CH), 125.8 (CH, Jₐ–F = 4 Hz), 125.6 (Cq), 125.1 (CH, Jₐ–F = 11 Hz), 125.1 (CH, Jₐ–F = 4 Hz), 124.0 (Cq, Jₐ–F = 272 Hz). 123.7 (Cq, Jₐ–F = 272 Hz), 123.5 (CH), 122.1 (CH), 120.7 (CH), 120.7 (Cq), 120.6 (CH), 114.0 (CH), 94.9 (CH). ¹⁹F-NMR (283 MHz, CDCl₃): δ = −62.6 (s), −62.7 (s). IR (neat): 3065, 1612, 1576, 1545, 1446, 1322, 1171, 1105, 1066, 759 cm⁻¹. MS (EI) m/z (relative intensity) 505 (100) [M⁺], 435 (10), 359 (15), 291 (10). HRMS (ESI) m/z calcd for C₃₀H₁₇F₆N [M⁺] 505.1265, found 505.1269. The spectral data were in accordance with those reported in the literature.¹³

5,6-Bis{3,5-di-tert-butylphenyl}indolo[2,1-a]isoquinoline (3af): The representative procedure was followed using 2-phenyl-1H-indole (1a) (48.3 mg, 0.25 mmol) and 1,2-bis{3,5-di-tert-butylphenyl}ethyne (2f) (201 mg, 0.50 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/EtOAc: 50/1) yielded 3af as a colorless solid (110 mg, 74%). M. p. = 283–284 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 8.30 (d, J = 8.0 Hz, 1H), 7.77 (d, J = 8.0 Hz, 1H), 7.49 (ddd, J = 7.7, 6.4, 2.2 Hz, 1H), 7.42–7.32 (m, 4H), 7.21–7.14 (m, 2H), 7.08 (s, 1H), 7.07 (s, 1H), 6.97 (s, 1H), 6.96 (s, 1H), 6.78 (ddd, J = 7.8, 7.0, 1.3 Hz,
1H), 6.10 (d, J = 8.7 Hz, 1H), 1.18 (s, 18H), 1.16 (s, 18H). $^{13}$C-NMR (75.5 MHz, CDCl$_3$): δ = 150.9 (C$_q$), 149.9 (C$_q$), 136.9 (C$_q$), 136.0 (C$_q$), 135.7 (C$_q$), 134.3 (C$_q$), 132.7 (C$_q$), 130.2 (C$_q$), 129.6 (C$_q$), 126.7 (CH), 126.3 (CH), 126.1 (2 CH), 125.4 (C$_q$), 125.1 (2 CH), 123.3 (CH), 121.9 (C$_q$), 121.7 (CH), 121.4 (CH), 119.9 (CH), 119.6 (CH), 115.3 (CH), 93.9 (CH), 34.7 (C$_q$), 34.6 (C$_q$), 31.5 (CH$_3$), 31.3 (CH$_3$). IR (neat): 2957, 1593, 1542, 1446, 1361, 1247, 901, 859, 790, 739 cm$^{-1}$. MS (EI) $m/z$ (relative intensity) 593 (100) [M$^+$], 521 (9), 289 (7). HRMS (EI) $m/z$ calcd for C$_{44}$H$_{51}$N [M$^+$] 593.4021, found 593.4036.

10-Nitro-5,6-dipropylindolo[2,1-a]isoquinoline (3dg): The representative procedure was followed using 5-nitro-2-phenyl-1H-indole (1d) (119 mg, 0.50 mmol), 4-octyne (2g) (110 mg, 1.00 mmol) and Cu(OAc)$_2$·H$_2$O (30.0 mg, 30.0 mol%). After 22 h, purification by column chromatography on silica gel ($n$-hexane/EtOAc: 20/1) yielded 3dg as an orange solid (78 mg, 45%). M. p. = 172−173 °C. $^1$H-NMR (300 MHz, CDCl$_3$): δ = 8.67 (d, J = 2.4 Hz, 1H), 8.17 (dd, J = 7.7, 1.6 Hz, 1H), 8.08 (dd, J = 9.6, 2.5 Hz, 1H), 7.90 (d, J = 9.4 Hz, 1H), 7.72 (d, J = 7.9 Hz, 1H), 7.54 (ddd, J = 7.5, 7.3, 1.6 Hz, 1H), 7.48 (ddd, J = 7.4, 7.1, 1.3 Hz, 1H), 7.36 (s, 1H), 3.27 (t, J = 8.2 Hz, 2H), 2.87 (t, J = 8.2 Hz, 2H), 1.86 (m, 2H), 1.68 (m, 2H), 1.23 (t, J = 7.5 Hz, 3H), 1.14 (t, J = 7.5 Hz, 3H). $^{13}$C-NMR (75.5 MHz, CDCl$_3$): δ = 142.1 (C$_q$), 138.9 (C$_q$), 135.6 (C$_q$), 134.1 (C$_q$), 128.9 (C$_q$), 128.7 (C$_q$), 128.5 (CH), 126.8 (CH), 124.6 (C$_q$), 123.9 (CH), 123.6 (CH), 118.8 (C$_q$), 116.9 (CH), 115.0 (CH), 114.6 (CH), 95.7 (CH), 31.3 (CH$_2$), 29.8 (CH$_2$), 23.6 (CH$_2$), 21.5 (CH$_2$), 14.5 (CH$_3$), 13.8 (CH$_3$). IR (neat): 2951, 1503, 1455, 1385, 1325, 1199, 1079, 741 cm$^{-1}$. MS (EI) $m/z$ (relative intensity) 346 (100) [M$^+$], 317 (65), 271 (28), 241 (36). HRMS (EI) $m/z$ calcd for C$_{22}$H$_{22}$N$_2$O$_2$ [M$^+$] 346.1681, found 346.1683.

Methyl 5,6-dipropylindolo[2,1-a]isoquinoline-12-carboxylate (3fg): The representative procedure was followed using methyl 2-phenyl-1H-indole-3-carboxylate (1f) (63.0 mg, 0.25 mmol), 4-octyne (2g) (55.0 mg, 0.50 mmol) and Cu(OAc)$_2$·H$_2$O (30.0 mg, 30.0 mol%).
After 22 h, purification by column chromatography on silica gel (n-hexane/EtOAc: 20/1) yielded 3fg as a yellow solid (78 mg, 87%). M. p. = 122−123 °C. 1H-NMR (300 MHz, CDCl₃): δ = 9.01 (d, J = 8.4 Hz, 1H), 8.34 (d, J = 8.2 Hz, 1H), 7.96 (d, J = 8.6 Hz, 1H), 7.80 (d, J = 8.3 Hz, 1H), 7.60 (dd, J = 7.2, 7.2 Hz, 1H), 7.51 (dd, J = 7.6, 7.6 Hz, 1H), 7.44 (dd, J = 7.6, 7.6 Hz, 1H), 7.34 (dd, J = 7.8, 7.8 Hz, 1H), 4.09 (s, 3H), 3.36 (m, 2H), 2.93 (m, 2H), 1.92 (m, 2H), 1.69 (m, 2H), 1.23 (t, J = 7.3 Hz, 3H), 1.13 (t, J = 7.3 Hz, 3H). 13C-NMR (75.5 MHz, CDCl₃): δ = 167.4 (Cₗq), 138.7 (Cₗq), 136.1 (Cₗq), 131.7 (Cₗq), 130.6 (Cₗq), 129.3 (Cₗq), 129.1 (CH), 128.1 (CH), 125.7 (CH), 123.7 (Cₗq), 123.1 (CH), 122.9 (CH), 121.8 (CH), 121.3 (CH), 119.6 (Cₗq), 114.9 (CH), 100.8 (Cₗq), 51.4 (CH₃), 31.6 (CH₂), 29.8 (CH₂), 23.5 (CH₂), 21.9 (CH₂), 14.5 (CH₃), 13.8 (CH₃). IR (neat): 2952, 1684, 1516, 1432, 1242, 1196, 1115, 731 cm⁻¹. MS (EI) m/z (relative intensity) 359 (15) [M⁺], 236 (32), 217 (40), 186 (30), 131 (40), 69 (100). HRMS (EI) m/z calcd for C₂₄H₂₅NO₂ [M⁺] 359.1885, found 359.1873.

5,6-Dipropylindolo[2,1-a]isoquinoline-12-carbaldehyde (3hg): The representative procedure was followed using 2-phenyl-1H-indole-3-carbaldehyde (1h) (111 mg, 0.5 mmol), 4-octyne (2g) (110 mg, 1.00 mmol) and Cu(OAc)₂·H₂O (30.0 mg, 30.0 mol%). After 22 h, purification by column chromatography on silica gel (n-hexane/EtOAc: 10/1) yielded 3hg as a yellow solid (123 mg, 75%). M. p. = 158−159 °C. 1H-NMR (300 MHz, CDCl₃): δ = 10.76 (s, 1H), 8.75 (dd, J = 7.4, 6.8 Hz, 2H), 7.91 (d, J = 8.6 Hz, 1H), 7.84 (d, J = 8.3 Hz, 1H), 7.67 (ddd, J = 7.6, 7.1, 1.3 Hz, 1H), 7.56 (ddd, J = 7.6, 7.1, 1.3 Hz, 1H), 7.48 (ddd, J = 7.5, 6.9, 0.9 Hz, 1H), 7.37 (ddd, J = 7.8, 7.0, 1.4 Hz, 1H), 3.33 (m, 2H), 2.92 (m, 2H), 1.89 (m, 2H), 1.68 (m, 2H), 1.23 (t, J = 7.3 Hz, 3H), 1.14 (t, J = 7.3 Hz, 3H). 13C-NMR (75.5 MHz, CDCl₃): δ = 184.7 (CH), 141.9 (Cₗq), 136.7 (Cₗq), 132.5 (Cₗq), 131.2 (Cₗq), 130.0 (CH), 129.2 (Cₗq), 128.3 (CH), 126.8 (CH), 124.5 (CH), 123.9 (Cₗq), 123.4 (CH), 123.0 (CH), 121.3 (CH), 120.6 (Cₗq), 115.0 (CH), 110.7 (Cₗq), 31.5 (CH₂), 29.8 (CH₂), 23.5 (CH₂), 21.8 (CH₂), 14.5 (CH₃), 13.7 (CH₃). IR (neat): 2868, 1623, 1469, 1383, 1331, 1236, 1173, 1131, 1078, 1045, 736 cm⁻¹. MS (EI) m/z (relative intensity) 329 (100) [M⁺], 300 (75), 272 (30), 256 (30), 241 (25). HRMS (EI) m/z calcd for C₂₃H₂₅NO [M⁺] 329.1780, found 329.1783.
Ethyl 5,6-diphenylpyrrolo[2,1-a]isoquinoline-2-carboxylate (5aa): The representative procedure was followed using ethyl 5-phenyl-1H-pyrrole-3-carboxylate (4a) (108 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/CH2Cl2: 5/1) yielded 5aa (182 mg, 93%) as a yellow solid. M. p. = 200–201°C. 1H-NMR (300 MHz, CDCl3): δ = 8.15 (d, J = 8.0 Hz, 1H), 7.54–7.37 (m, 2H), 7.42 (d, J = 1.6 Hz, 1H), 7.36–7.19 (m, 10H), 7.19–7.11 (m, 2H), 4.33 (q, J = 7.1 Hz, 2H), 1.37 (t, J = 7.1 Hz, 3H). 13C-NMR (75.5 MHz, CDCl3): δ = 165.1 (Cq), 136.2 (Cq), 133.8 (Cq), 133.3 (Cq), 131.3 (CH), 130.8 (Cq), 130.5 (CH), 128.7 (CH), 128.7 (CH), 128.4 (Cq), 127.9 (CH), 127.7 (CH), 127.1 (CH), 126.6 (CH), 126.2 (CH), 125.7 (Cq), 124.6 (Cq), 122.1 (CH), 118.7 (CH), 118.3 (Cq), 101.3 (CH), 60.1 (CH2), 14.5 (CH3). IR (neat): 2979, 1702, 1513, 1454, 1418, 1235, 1207, 1144, 749, 700 cm⁻¹. MS (EI) m/z (relative intensity) 391 (100) [M⁺], 318 (90). HRMS (ESI) m/z calcd for C27H21NO2 [M⁺] 391.1572, found 391.1580.

5,6-Diphenylpyrrolo[2,1-a]isoquinoline-2-carbonitrile (5ba): The representative procedure was followed using 5-phenyl-1H-pyrrole-3-carbonitrile (4b) (84.0 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel (n-hexane/CH2Cl2: 10/1) yielded 5ba (70 mg, 40%) as a white solid. M. p. = 228–229°C. 1H-NMR (300 MHz, CDCl3): δ = 8.11 (d, J = 8.0 Hz, 1H), 7.55 (ddd, J = 7.6, 7.4, 1.3 Hz, 1H), 7.40–7.30 (m, 4H), 7.30–7.21 (m, 8H), 7.21–7.10 (m, 2H). 13C-NMR (75.5 MHz, CDCl3): δ = 135.7 (Cq), 133.2 (Cq), 132.7 (Cq), 131.1 (CH), 130.9 (Cq), 130.3 (CH), 129.1 (CH), 128.9 (CH), 128.5 (Cq), 128.0 (CH), 128.0 (CH), 127.3 (CH), 127.0 (CH), 126.8 (CH), 125.3 (Cq), 124.7 (Cq), 122.2 (CH), 120.7 (CH), 116.5 (Cq), 103.0 (CH), 95.5 (Cq). IR (neat): 3132, 2227, 1598, 1513, 1487, 1389, 1131, 800, 754, 697 cm⁻¹. MS (EI)
$m/z$ (relative intensity) 344 (100) [M$^+$], 266 (10). HRMS (ESI) $m/z$ calcd for C$_{25}$H$_{16}$N$_2$ [M$^+$] 344.1313, found 344.1324.

1-(5,6-Diphenylpyrrolo[2,1-a]isoquinolin-2-yl)ethanone (5ca): The representative procedure was followed using 1-(5-phenyl-1H-pyrrol-3-yl)ethanone (4c) (93.0 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel ($n$-hexane/CH$_2$Cl$_2$: 10/1) yielded 5ca (137 mg, 76%) as a white solid. M. p. = 206 °C (dec.). $^1$H-NMR (300 MHz, CDCl$_3$): $\delta$ = 8.15 (d, $J$ = 8.2 Hz, 1H), 7.56–7.42 (m, 2H), 7.39–7.10 (m, 13H), 2.49 (s, 3H). $^{13}$C-NMR (75.5 MHz, CDCl$_3$): $\delta$ = 194.6 (C$_{q}$), 136.1 (C$_{q}$), 133.8 (C$_{q}$), 133.2 (C$_{q}$), 131.3 (C$_{q}$), 131.2 (CH), 130.4 (CH), 128.8 (CH), 128.8 (CH), 128.5 (C$_{q}$), 128.0 (CH), 127.8 (CH), 127.1 (CH), 127.0 (C$_{q}$), 126.7 (CH), 126.4 (CH), 125.8 (C$_{q}$), 125.0 (C$_{q}$), 122.1 (CH), 118.2 (CH), 100.3 (CH), 27.5 (CH$_3$). IR (neat): 3023, 1651, 1511, 1458, 1241, 1143, 799, 773, 700, 644 cm$^{-1}$. MS (EI) $m/z$ (relative intensity) 361 (100) [M$^+$], 346 (27), 318 (30). HRMS (ESI) $m/z$ calcd for C$_{26}$H$_{19}$NO [M$^+$] 361.1467, found 361.1456.

![Ethyl 1,5,6-triphenylpyrrolo[2,1-a]isoquinoline-2-carboxylate (5da): The representative procedure was followed using ethyl 4,5-diphenyl-1H-pyrrole-3-carboxylate (4d) (146 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol). After 22 h, purification by column chromatography on silica gel ($n$-hexane/CH$_2$Cl$_2$: 10/1) yielded 5da (176 mg, 75%) as a white solid. M. p. = 243–244 °C. $^1$H-NMR (300 MHz, CDCl$_3$): $\delta$ = 7.57–7.42 (m, 7H), 7.41–7.29 (m, 5H), 7.29–7.06 (m, 8H), 4.08 (q, $J$ = 7.0 Hz, 2H), 1.04 (t, $J$ = 7.0 Hz, 3H). $^{13}$C-NMR (75.5 MHz, CDCl$_3$): $\delta$ = 164.8 (C$_{q}$), 136.8 (C$_{q}$), 136.4 (C$_{q}$), 133.6 (C$_{q}$), 133.3 (C$_{q}$), 131.3 (CH), 130.6 (CH), 130.5 (CH), 129.1 (C$_{q}$), 128.8 (CH), 128.8 (CH), 128.4 (CH), 127.9](image-url)
(CH), 127.2 (CH), 127.1 (CH), 127.0 (CH), 126.7 (Cq), 126.6 (CH), 126.4 (Cq), 125.7 (CH),
124.7 (Cq), 122.7 (CH), 119.9 (Cq), 118.9 (CH), 117.6 (Cq), 59.6 (CH$_2$), 13.9 (CH$_3$). IR (neat):
3049, 1713, 1601, 1514, 1456, 1206, 1137, 776, 761, 699 cm$^{-1}$. MS (EI) $m/z$ (relative intensity)
467 (100) [M$^+$], 394 (30). HRMS (ESI) $m/z$ calcd for C$_{33}$H$_{25}$NO$_2$ [M$^+$] 467.1885,
found 467.1872.

Dimethyl 3-methyl-5,6-diphenylpyrrolo[2,1-a]isoquinoline-1,2-dicarboxylate (5ea): The
representative procedure was followed using dimethyl 2-methyl-5-phenyl-1$H$-pyrrole-3,4-
dicarboxylate (4e) (137 mg, 0.50 mmol) and diphenylacetylene (2a) (178 mg, 1.00 mmol).
After 22 h, purification by column chromatography on silica gel (n-hexane/EtOAc: 3/1) yielded
5ea as a yellow solid (157 mg, 70%). M. p. 186–187 °C. $^1$H-NMR (300 MHz, CDCl$_3$): $\delta = 8.56$
(d, $J = 8.0$ Hz, 1H), 7.47 (ddd, $J = 7.7$, 7.1, 1.4 Hz, 1H), 7.29 (ddd, $J = 7.7$, 7.1, 1.2 Hz, 1H),
7.25–7.15 (m, 8H), 7.10–7.03 (m, 3H), 4.05 (s, 3H), 3.85 (s, 3H), 1.93 (s, 3H). $^{13}$C-NMR (75.5 MHz,
CDCl$_3$): $\delta = 168.8$ (Cq), 165.5 (Cq), 136.4 (Cq), 134.9 (Cq), 134.2
(Cq), 131.3 (CH), 131.2 (CH), 130.6 (Cq), 129.0 (Cq), 128.4 (CH), 127.9 (Cq), 127.9 (CH),
127.8 (CH), 127.5 (CH), 127.2 (Cq), 126.9 (CH), 126.9 (CH), 126.7 (CH), 124.8 (Cq), 122.9
(CH), 116.4 (Cq), 109.6 (Cq), 52.7 (CH$_3$), 51.7 (CH$_3$), 14.4 (CH$_3$). IR (neat): 2950, 1722,
1702, 1443, 1365, 1294, 1199, 1151, 1021, 701 cm$^{-1}$. MS (EI) $m/z$ (relative intensity) 449
(83) [M$^+$], 416 (100), 358 (16), 331 (48). HRMS (ESI) $m/z$ calcd for C$_{29}$H$_{23}$NO$_4$ [M$^+$]
449.1627, found 449.1636.

Ethyl 5,6-di(4-fluorophenyl)pyrrolo[2,1-a]isoquinoline-2-carboxylate (5ad): The
representative procedure was followed using ethyl 5-phenyl-1$H$-pyrrole-3-carboxylate (4a)
(108 mg, 0.50 mmol) and 1,2-bis(4-fluorophenyl)ethyne (2d) (206 mg, 1.00 mmol). After 22
h, purification by column chromatography on silica gel (n-hexane/CH₂Cl₂: 10/1) yielded 5ad (116 mg, 54%) as a yellow solid. M. p. = 240–241°C. ¹H-NMR (300 MHz, CDCl₃): δ = 8.14 (d, J = 8.0 Hz, 1H), 7.56–7.41 (m, 2H), 7.41–6.84 (m, 11H); 4.34 (q, J = 7.1 Hz, 2H), 1.37 (t, J = 7.1 Hz, 3H). ¹³C-NMR (75.5 MHz, CDCl₃): δ = 164.9 (Cq), 162.6 (Cq, J_C-F = 250 Hz), 161.9 (Cq, J_C-F = 247 Hz), 133.0 (Cq), 132.9 (CH, J_C-F = 8 Hz), 132.4 (CH, J_C-F = 8 Hz), 132.0 (Cq, J_C-F = 4 Hz), 130.8 (Cq), 129.2 (Cq, J_C-F = 4 Hz), 128.1 (Cq), 128.0 (CH), 126.4 (CH), 126.4 (CH), 125.8 (Cq), 124.0 (Cq), 122.2 (CH), 118.6 (Cq), 118.4 (CH), 116.2 (CH, J_C-F = 22 Hz), 115.2 (CH, J_C-F = 22 Hz), 101.6 (CH), 60.2 (CH₂), 14.4 (CH₃). ¹⁹F-NMR (283 MHz, CDCl₃): δ = −111.2 to −111.4 (m), −114.3 to −114.5 (m). IR (neat): 3144, 2989, 1697, 1598, 1545, 1501, 1218, 789, 756 cm⁻¹. MS (EI) m/z (relative intensity) 427 (100) [M⁺], 354 (60). HRMS (ESI) m/z calcd for C₂₇H₁₉F₂NO₂ [M⁺] 427.1384, found 427.1379.

**Etethyl 6-butyл-5-(4-methoxyphenyl)pyrrolo[2,1-a]isоquinoline-2-carboxylate (5ai):** The representative procedure was followed using ethyl 5-phenyl-1H-pyrrole-3-carboxylate (4a) (108 mg, 0.50 mmol), 1-(hex-1-yn-1-yl)-4-methoxybenzene (2i) (188 mg, 1.00 mmol) and Cu(OAc)₂·H₂O (30.0 mg, 30.0 mol%). After 22 h, purification by column chromatography on silica gel (n-hexane/EtOAc: 30/1) yielded 5ai (160 mg, 80%, 8:1 mixture of regioisomers according to ¹H-NMR) as a yellow oil. Purification by a second column chromatography on silica gel (n-hexane/EtOAc: 30/1) yielded the major regioisomer (95 mg, 47%) as a yellow oil. ¹H-NMR (300 MHz, CDCl₃): δ = 8.10 (d, J = 7.6 Hz, 1H), 7.76 (d, J = 7.8 Hz, 1H), 7.55–7.45 (m, 2H), 7.40 (s, 1H), 7.51 (d, J = 8.4 Hz, 2H), 7.20 (s, 1H), 7.10 (d, J = 8.4 Hz, 2H), 4.52 (q, J = 7.4 Hz, 2H), 3.92 (s, 3H), 2.60 (t, J = 8.4 Hz, 2H), 1.61–1.49 (m, 2H), 1.36 (t, J = 7.0 Hz, 3H), 1.29 (m, 2H), 0.85 (t, J = 7.4 Hz, 3H). ¹³C-NMR (75.5 MHz, CDCl₃): δ = 165.1 (Cq), 160.0 (Cq), 152.8 (Cq), 131.2 (CH), 130.4 (Cq), 127.2 (CH), 127.1 (Cq), 126.2 (Cq), 126.2 (CH), 125.9 (Cq), 124.5 (CH), 122.6 (CH), 121.7 (Cq), 118.4 (CH), 117.6 (Cq), 114.8 (CH), 100.9 (CH), 60.0 (CH₂), 55.3 (CH₃), 32.5 (CH₂), 28.2 (CH₂), 22.9 (CH₂), 14.4 (CH₃), 13.7 (CH₃). IR (neat): 2955, 1705, 1607, 1508, 1454, 1289, 1241, 1173, 1025, 751 cm⁻¹. MS (EI) m/z (relative intensity) 401 (100) [M⁺], 358 (20), 285 (35). HRMS (ESI) m/z calcd for C₂₆H₂₇NO₃ [M⁺] 401.1991, found 401.1989.
Ethyl 6-methyl-5-phenylpyrrolo[2,1-a]isoquinoline-2-carboxylate (5aj): The representative procedure was followed using ethyl 5-phenyl-1H-pyrrole-3-carboxylate (108 mg, 0.50 mmol) (4a), 1-phenyl-1-propyne (2j) (116 mg, 1.00 mmol) and Cu(OAc)$_2$·H$_2$O (30.0 mg, 30.0 mol%). After 22 h, purification by column chromatography on silica gel (n-hexane/ EtOAc: 20/1) yielded 5aj (120 mg, 73%, 5:1 mixture of regioisomers according to $^1$H-NMR) as a yellow solid. Purification by a second column chromatography on silica gel (n-hexane/ EtOAc: 30/1) yielded the major regioisomer (41 mg, 25%) as a yellow oil. M. p. = 114–115 °C. $^1$H-NMR (300 MHz, CDCl$_3$): $\delta$ = 8.10 (d, $J = 7.8$ Hz, 1H), 7.76 (d, $J = 7.8$ Hz, 1H), 7.60–7.38 (m, 8H), 7.25 (d, $J = 1.6$ Hz, 1H), 4.51 (q, $J = 7.1$ Hz, 2H), 2.21 (s, 3H), 1.55 (t, $J = 7.1$ Hz, 3H), 13C-NMR (75.5 MHz, CDCl$_3$): $\delta$ = 165.2 (C$q$), 153.9 (C$q$), 153.0 (C$q$), 150.6 (C$q$), 150.1 (CH), 129.6 (CH), 129.5 (CH), 128.1 (C$q$), 127.6 (CH), 126.5 (CH), 125.9 (C$q$), 124.2 (CH), 122.5 (CH), 118.5 (CH), 117.7 (C$q$), 116.6 (C$q$), 101.1 (CH), 60.0 (CH$_2$), 15.0 (CH$_3$), 14.4 (CH$_3$). IR (neat): 2974, 1695, 1544, 1516, 1454, 1240, 1178, 1019, 747, 703 cm$^{-1}$. MS (EI) $m/z$ (relative intensity) 329 (100) [M$^+$], 256 (55). HRMS (ESI) $m/z$ calcd for C$_{22}$H$_{19}$NO$_2$ [M$^+$] 329.1416, found 329.1417.

Ethyl 5,6-dimethyl-1-phenylpyrrolo[2,1-a]isoquinoline-2-carboxylate (5dg): The representative procedure was followed using ethyl 4,5-diphenyl-1H-pyrrole-3-carboxylate (4d) (72.8 mg, 0.25 mmol), 4-octyne (2g) (55.0 mg, 0.50 mmol) and Cu(OAc)$_2$·H$_2$O (15.0 mg, 30.0 mol%). After 22 h, purification by column chromatography on silica gel (n-hexane/EtOAc: 20/1) yielded 5dg (77 mg, 77%) as a yellow oil. $^1$H-NMR (300 MHz, CDCl$_3$): $\delta$ = 7.97 (s, 1H), 7.69 (d, $J = 8.2$ Hz, 1H), 7.65–7.57 (m, 6H), 7.32 (ddd, $J = 7.7, 7.7, 1.2$ Hz, 1H), 7.09 (ddd, $J = 7.7, 7.7, 1.2$ Hz, 1H), 4.15 (q, $J = 7.1$ Hz, 2H), 3.02 (t, $J = 8.0$ Hz, 2H), 2.87 (t, $J = 8.0$ Hz, 2H), 1.92–1.77 (m, 2H), 1.75–1.61 (m, 2H), 1.22–1.01 (m, 9H). 13C-
NMR (75.5 MHz, CDCl₃): δ = 166.0 (Cq), 157.2 (Cq), 152.5 (Cq), 150.6 (CH), 128.5 (CH), 127.7 (Cq), 127.0 (CH), 126.5 (Cq), 126.5 (Cq), 126.1 (CH), 125.7 (CH), 123.6 (CH), 123.1 (CH), 119.8 (Cq), 119.4 (Cq), 117.4 (Cq), 116.5 (CH), 59.6 (CH₂), 30.7 (CH₂), 30.0 (CH₂), 23.4 (CH₂), 20.3 (CH₂), 14.5 (CH₃), 14.3 (CH₃), 13.9 (CH₃). IR (neat): 2958, 1698, 1604, 1519, 1457, 1202, 1111, 758, 731, 698 cm⁻¹. MS (EI) m/z (relative intensity) 399 (100) [M⁺], 370 (45), 282 (35). HRMS (ESI) m/z calcld for C₂₇H₂₉NO₂ [M⁺] 399.2198, found 399.2198.

**Ethyl 5,6-diethyl-1-phenylpyrrolo[2,1-a]isoquinoline-2-carboxylate (5dh):** The representative procedure was followed using ethyl 2-methyl-4,5-diphenyl-1H-pyrrole-3-carboxylate (4d) (72.8 mg, 0.25 mmol), 3-hexyne (2h) (55.0 mg, 0.50 mmol) and Cu(OAc)₂·H₂O (15.0 mg, 30.0 mol%). After 22 h, purification by column chromatography on silica gel (n-hexane/ EtOAc: 20/1) yielded 5dh (74 mg, 80%) as a white solid. M. p. = 141−142 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 8.01 (s, 1H), 7.73 (d, J = 8.4 Hz, 1H), 7.64−7.38 (m, 6H), 7.32 (ddd, J = 7.7, 7.6, 1.3 Hz, 1H), 7.09 (ddd, J = 7.7, 7.6, 1.2 Hz, 1H), 4.16 (q, J = 7.4 Hz, 2H), 3.09 (q, J = 7.6 Hz, 2H), 2.96 (q, J = 7.6 Hz, 2H), 1.45 (t, J = 7.6 Hz, 3H), 1.31 (t, J = 7.6 Hz, 3H), 1.11 (t, J = 7.4 Hz, 3H). ¹³C-NMR (75.5 MHz, CDCl₃): δ = 166.0 (Cq), 157.3 (Cq), 155.4 (Cq), 150.7 (CH), 128.5 (CH), 127.6 (Cq), 127.0 (CH), 126.5 (Cq), 126.2 (CH), 125.8 (CH), 123.6 (CH), 123.3 (CH), 120.8 (Cq), 119.6 (Cq), 117.7 (Cq), 116.4 (CH), 59.6 (CH₂), 21.8 (CH₂), 20.8 (CH₂), 14.7 (CH₃), 14.0 (CH₃), 11.7 (CH₃). IR (neat): 2966, 1695, 1602, 1521, 1444, 1268, 1221, 1034, 757, 703 cm⁻¹. MS (EI) m/z (relative intensity) 371 (100) [M⁺], 298 (23), 282 (20). HRMS (ESI) m/z calcld for C₂₅H₂₅NO₂ [M⁺] 371.1885, found 371.1887.

**Dimethyl 3-methyl-5,6-di(n-propyl)pyrrolo[2,1-a]isoquinoline-1,2-dicarboxylate (5eg):** The representative procedure was followed using dimethyl 2-methyl-5-phenyl-1H-pyrrole-
3,4-dicarboxylate (4e) (137 mg, 0.50 mmol), 4-octyne (2g) (110 mg, 1.00 mmol) and Cu(OAc)$_2$·H$_2$O (30.0 mg, 30.0 mol%). After 22 h, purification by column chromatography on silica gel (n-hexane/ EtOAc: 10/1) yielded 5eg (141 mg, 74%) as a yellow oil. $^1$H-NMR (300 MHz, CDCl$_3$): $\delta$ = 8.17 (d, $J$ = 7.2 Hz, 1H), 7.67 (d, $J$ = 7.0 Hz, 1H), 7.46–7.36 (m, 2H), 3.99 (s, 3H), 3.87 (s, 3H), 3.12 (t, $J$ = 8.2 Hz, 2H), 2.97 (s, 3H), 2.79 (t, $J$ = 8.2 Hz, 2H), 1.70–1.52 (m, 4H), 1.09 (t, $J$ = 7.3 Hz, 3H), 1.02 (t, $J$ = 7.3 Hz, 3H). $^{13}$C-NMR (75.5 MHz, CDCl$_3$): $\delta$ = 169.0 (C q), 165.7 (C q), 154.7 (C q), 128.8 (C q), 128.4 (C q), 127.9 (C q), 126.9 (CH), 126.8 (CH), 124.7 (C q), 123.6 (CH), 123.1 (CH), 122.2 (C q), 116.4 (C q), 109.2 (C q), 52.5 (CH$_3$), 51.7 (CH$_3$), 50.5 (CH$_2$), 50.2 (CH$_2$), 25.4 (CH$_2$), 25.0 (CH$_2$), 14.8 (CH$_3$), 14.4 (CH$_3$), 13.4 (CH$_3$). IR (neat): 2954, 1708, 1526, 1455, 1438, 1199, 1158, 1091, 755, 730 cm$^{-1}$. MS (EI) $m/z$ (relative intensity) 381 (100) [M$^+$], 350 (30), 334 (42), 263 (28). HRMS (ESI) $m/z$ calcd for C$_{23}$H$_{27}$NO$_4$ [M$^+$] 381.1940, found 381.1933.

**Dimethyl 5,6-diethyl-3-methylpyrrolo[2,1-a]isoquinoline-1,2-dicarboxylate (5eh):** The representative procedure was followed using dimethyl 2-methyl-5-phenyl-1H-pyrrole-3,4-dicarboxylate (4e) (137 mg, 0.50 mmol), 3-hexyne (2h) (82.0 mg, 1.00 mmol) and Cu(OAc)$_2$·H$_2$O (30.0 mg, 30.0 mol%). After 22 h, purification by column chromatography on silica gel (n-hexane/ EtOAc: 10/1) yielded 5eh (152 mg, 86%) as a yellow oil. $^1$H-NMR (300 MHz, CDCl$_3$): $\delta$ = 8.17 (d, $J$ = 6.8 Hz, 1H), 7.71 (d, $J$ = 6.7 Hz, 1H), 7.46–7.34 (m, 2H), 3.99 (s, 3H), 3.88 (s, 3H), 3.21 (q, $J$ = 7.4 Hz, 2H), 3.01 (s, 3H), 2.89 (q, $J$ = 7.5 Hz, 2H), 1.25 (t, $J$ = 7.5 Hz, 3H), 1.24 (t, $J$ = 7.4 Hz, 3H). $^{13}$C-NMR (75.5 MHz, CDCl$_3$): $\delta$ = 168.8 (C q), 165.7 (C q), 155.7 (C q), 128.6 (C q), 128.5 (C q), 128.7 (C q), 126.9 (CH), 126.8 (CH), 125.0 (C q), 125.4 (CH), 125.4 (CH), 125.2 (C q), 116.6 (C q), 109.6 (C q), 52.4 (CH$_3$), 51.6 (CH$_3$), 21.6 (CH$_2$), 20.9 (CH$_2$), 14.9 (CH$_3$), 14.4 (CH$_3$), 14.4 (CH$_3$). IR (neat): 2948, 1706, 1525, 1482, 1439, 1200, 1131, 1083, 784, 755 cm$^{-1}$. MS (EI) $m/z$ (relative intensity) 353 (80) [M$^+$], 322 (42), 306 (100), 235 (74). HRMS (ESI) $m/z$ calcd for C$_{21}$H$_{23}$NO$_4$ [M$^+$] 353.1627, found 353.1636.
Dimethyl 6-(n-butyl)-5-(4-methoxyphenyl)-3-methylpyrrolo[2,1-a]isoquinoline-1,2-dicaboxylate (5ei): The representative procedure was followed using dimethyl 2-methyl-5-phenyl-1H-pyrrole-3,4-dicarboxylate (4e) (137 mg, 0.50 mmol), 1-(hex-1-yn-1-yl)-4-methoxybenzene (2i) (188 mg, 1.00 mmol) and Cu(OAc)$_2$·H$_2$O (30 mg, 0.30 mol%). After 22 h, purification by column chromatography on silica gel (n-hexane/EtOAc: 10/1) yielded 5ei (169 mg, 74%, 6:1 mixture of regioisomers according to $^1$H-NMR) as a yellow oil. Purification by a second column chromatography on silica gel (n-hexane/EtOAc: 20/1) yielded the major regioisomer (146 mg, 64%) as a yellow solid. M. p. = 142–143 °C. $^1$H-NMR (300 MHz, CDCl$_3$): $\delta$ = 8.31–8.24 (d, $J = 7.1$ Hz, 1H), 7.76–7.71 (d, $J = 7.0$ Hz, 1H), 7.50–7.45 (m, 2H), 7.27 (d, $J = 10.8$ Hz, 2H), 6.99 (d, $J = 10.8$ Hz, 2H), 4.00 (s, 3H), 3.90 (s, 3H), 3.82 (s, 3H), 2.49 (t, $J = 8.2$ Hz, 2H), 1.92 (s, 3H), 1.52–1.39 (m, 2H), 1.31–1.18 (m, 2H), 0.80 (t, $J = 7.3$ Hz, 3H). $^{13}$C-NMR (75.5 MHz, CDCl$_3$): $\delta$ = 168.9 (C$_q$), 165.6 (C$_q$), 160.0 (C$_q$), 133.2 (C$_q$), 132.0 (CH), 130.1 (C$_q$), 127.6 (C$_q$), 127.5 (C$_q$), 127.4 (CH), 126.9 (CH), 125.3 (C$_q$), 124.1 (CH), 124.0 (C$_q$), 123.4 (CH), 115.9 (C$_q$), 113.6 (CH), 112.2 (C$_q$), 109.0 (C$_q$), 105.3 (CH$_3$), 52.5 (CH$_3$), 51.6 (CH$_3$), 32.3 (CH$_2$), 28.2 (CH$_2$), 14.1 (CH$_3$), 13.6 (CH$_3$). IR (neat): 2954, 1705, 1604, 1525, 1509, 1438, 1240, 1171, 1021, 798 cm$^{-1}$. MS (EI) $m/z$ (relative intensity) 459 (100) [M$^+$], 426 (70), 341 (60). HRMS (ESI) $m/z$ calcd for C$_{28}$H$_{29}$NO$_5$ [M$^+$] 459.2046, found 459.2041.
Intermolecular Competition Experiment with Indoles 1j and 1n (Scheme 5a):

The mixture of 2-(4-fluorophenyl)-1H-indole (1j) (223 mg, 1.00 mmol), 2-(4-methoxyphenyl)-1H-indole (1n) (211 mg, 1.00 mmol), diphenylacetylene (2a) (89.0 mg, 0.50 mmol), [RuCl_2(p-cymene)]_2 (15.3 mg, 5.0 mol%) and Cu(OAc)_2·H_2O (10.0 mg, 10.0 mol%) in tAmOH (2 mL) was stirred at 100 °C under air for 22 h. At ambient temperature, the mixture was diluted with H_2O (75 mL) and extracted with EtOAc (3 x 75 mL). The combined organic phase was washed with brine (50 mL) and dried over anhydrous Na_2SO_4. After filtration and evaporation of the solvents under reduced pressure, the crude product was purified by column chromatography on silica gel (n-hexane/EtOAc: 50/1) to yield 3ja as a yellow solid (66 mg, 34%).
Intermolecular Competition Experiment with Alkynes 2e and 2b (Scheme 5b):

The mixture of 2-phenylindole (1a) (48.0 mg, 0.25 mmol), 1,2-di-(p-tolyl)ethyne (2e) (103 mg, 0.50 mmol), 1,2-bis{4-(trifluoromethyl)phenyl}ethyne (2b) (157 mg, 0.50 mmol), [RuCl₂(p-cymene)]₂ (7.7 mg, 5.0 mol%) and Cu(OAc)₂·H₂O (5.0 mg, 10.0 mol%) in tAmOH (2 mL) was stirred at 100 °C under air for 22 h. At ambient temperature, the mixture was diluted with H₂O (75 mL) and extracted with EtOAc (3 x 75 mL). The combined organic phase was washed with brine (50 mL) and dried over anhydrous Na₂SO₄. After filtration and evaporation of the solvents under reduced pressure, the crude product was purified by column chromatography on silica gel (n-hexane/EtOAc: 50/1) to yield 3ae as a yellow solid (43 mg, 34%).
References


Methyl 2-phenyl-1H-indole-3-carboxylate (1f)

1f
(CDCl₃, 300 MHz)

1f
(CDCl₃, 75 MHz)
5,6-Diphenylindolo[2,1-a]isoquinoline (3aa)

(CDCl₃, 300 MHz)

(CDCl₃, 75 MHz)

H₂O
10-Fluoro-5,6-diphenyldolo[2,1-a]isoquinoline (3ba)

(CDCl₃, 300 MHz)

H₂O

(CDCl₃, 75 MHz)
10-Methoxy-5,6-diphenylindolo[2,1-a]isoquinoline (3ca)

\[
\begin{align*}
\text{MeO} & \quad \text{N} \\
\text{N} & \quad \text{MeO}
\end{align*}
\]

3ca
(CDC\textsubscript{3}, 300 MHz)

\[
\begin{align*}
f_1 \text{ (ppm)} & : 3.07, 0.98, 0.95, 15.02, 1.05
\end{align*}
\]

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3ca
(CDC\textsubscript{3}, 75 MHz)
12-Methyl-5,6-diphenylindolo[2,1-a]isoquinoline (3ea)
Methyl 5,6-diphenylindolo[2,1-a]isoquinoline-12-carboxylate (3fa)

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1-(5,6-Diphenylindololo[2,1-a]isoquinolin-12-yl)ethanone (3ga)
5,6-Diphenylindolo[2,1-a]isoquinoline-12-carbaldehyde (3ha)

![Chemical Structure](image)

**3ha**
(CDCl$_3$, 300 MHz)

![NMR Spectrum](image)

**3ha**
(CDCl$_3$, 75 MHz)

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7, 8-Diphenylbenzo[h]indolo[2,1-a]isoquinoline (3ia)

3ia
(CDCl₃, 300 MHz)

3ia
(CDCl₃, 75 MHz)
10-Fluoro-5,6-diphenylindolo[2,1-a]isoquinoline (3ja)
5,6-Diphenyl-3-(trifluoromethyl)indolo[2,1-a]isoquinoline (3ka)

(CDCl₃, 300 MHz)

H₂O

(CDCl₃, 75 MHz)
3-Nitro-5,6-diphenylindolo[2,1-a]isoquinoline (3la)

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Methyl 5,6-diphenylindolo[2,1-a]isoquinoline-3-carboxylate (3ma)

3ma
(CDCl₃, 300 MHz)

3ma
(CDCl₃, 75 MHz)
4-Fluoro-5,6-diphenylindolo[2,1-a]isoquinoline (3oa')

(CDCl₃, 300 MHz)

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2-Fluoro-5,6-diphenylindolo[2,1-a]isoquinoline (3oa’’)

\[ \text{(CDCl}_3, 300 \text{ MHz)} \]

\[ \text{H}_2\text{O} \]

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5,6-Di-(p-tolyl)indolo[2,1-a]isoquinoline (3ab)

3ab
(CDCl₃, 300 MHz)

3ab
(CDCl₃, 75 MHz)
5,6-Di-(4-methoxyphenyl)indolo[2,1-a]isoquinoline (3ac)

(CDCl₃, 300 MHz)

H₂O

(CDCl₃, 75 MHz)

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5,6-Bis(4-fluorophenyl)indolo[2,1-a]isoquinoline (3ad)

(CDCl₃, 300 MHz)

H₂O

(CDCl₃, 75 MHz)
5,6-Bis{4-(trifluoromethyl)phenyl}indolo[2,1-a]isoquinoline (3ae)

(CDCl₃, 300 MHz)

H₂O

3ae

(CDCl₃, 75 MHz)
5,6-Bis(3,5-di-tert-butylphenyl)indolo[2,1-a]isoquinoline (3af)

(CDCl₃, 300 MHz)

(CDCl₃, 75 MHz)
10-Nitro-5,6-dipropylindolo[2,1-a]isoquinoline (3dg)

(CDCl₃, 300 MHz)

3dg

(CDCl₃, 75 MHz)
Methyl 5,6-dipropylindolo[2,1-a]isoquinoline-12-carboxylate (3fg)

![Chemical Structure](image)

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5,6-Dipropylindolo[2,1-a]isoquinoline-12-carbaldehyde (3hg)

(CDCl₃, 300 MHz)

(CDCl₃, 75 MHz)
Ethyl 5,6-diphenylpyrrolo[2,1-a]isoquinoline-2-carboxylate (5aa)

5aa
(CDCl₃, 300 MHz)

5aa
(CDCl₃, 75 MHz)
5,6-Diphenylpyrrolo[2,1-a]isoquinoline-2-carbonitrile (5ba)

5ba (CDCl₃, 300 MHz)
1-(5,6-Diphenylpyrrolo[2,1-a]isoquinolin-2-yl)ethanone (5ca)

(CDCl₃, 300 MHz)

(CDCl₃, 75 MHz)
Ethyl 1,5,6-triphenylpyrrolo[2,1-a]isoquinoline-2-carboxylate (5da)

5da
(CDCl₃, 300 MHz)

5da
(CDCl₃, 75 MHz)
Dimethyl 3-methyl-5,6-diphenylpyrrolo[2,1-a]isoquinoline-1,2-dicarboxylate (5ea)

(CDCl₃, 300 MHz)

(CDCl₃, 75 MHz)
Ethyl 5,6-bis(4-fluorophenyl)pyrrolo[2,1-a]isoquinoline-2-carboxylate (5ad)

(CDCl₃, 300 MHz)

(CDCl₃, 75 MHz)

S58
Ethyl 6-butyl-5-(4-methoxyphenyl)pyrrolo[2,1-a]isoquinoline-2-carboxylate (5ai)

$\text{EtO}_2\text{C}$

$\text{MeO}$

$n$-Bu

5ai

$(\text{CDCl}_3, 300 \text{ MHz})$

$\text{EtO}_2\text{C}$

$\text{MeO}$

$n$-Bu

5ai

$(\text{CDCl}_3, 75 \text{ MHz})$
Ethyl 6-methyl-5-phenylpyrrolo[2,1-a]isoquinoline-2-carboxylate (5aj)

5aj
(CDCl₃, 300 MHz)

5aj
(CDCl₃, 75 MHz)

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Ethyl 5,6-dimethyl-1-phenylpyrrolo[2,1-a]isoquinoline-2-carboxylate (5dg)

5dg
(CDCl₃, 300 MHz)

5dg
(CDCl₃, 75 MHz)
Ethyl 5,6-diethyl-1-phenylpyrrolo[2,1-a]isoquinoline-2-carboxylate (5dh)

5dh
(CDCl₃, 300 MHz)

5dh
(CDCl₃, 75 MHz)

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Dimethyl 3-methyl-5,6-di(n-propyl)pyrrolo[2,1-a]isoquinoline-1,2-dicarboxylate (5eg)
Dimethyl 5,6-diethyl-3-methylpyrrolo[2,1-a]isoquinoline-1,2-dicarboxylate (5eh)
Dimethyl 6-(n-butyl)-5-(4-methoxyphenyl)-3-methylpyrrolo[2,1-a]isoquinoline-1,2-dicaboxylate (5ei)

(CDCl₃, 300 MHz)

5ei

(CDCl₃, 75 MHz)
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5ei
(NOESY)