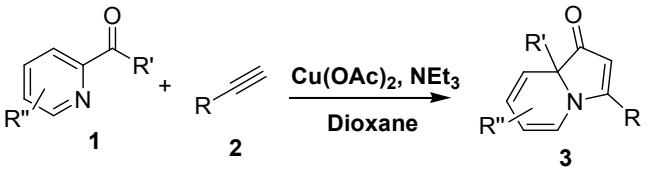
General Methods. Unless otherwise noted, materials obtained from commercial suppliers were used without further purification. ^{1}H spectra were recorded on 300 MHz or 400 MHz NMR spectrometers. Chemical shifts (in ppm) were referenced to tetramethylsilane (δ = 0 ppm) in $CDCl_3$ as an internal standard. ^{13}C-NMR spectra were obtained by using the same NMR spectrometers and were calibrated with $CDCl_3$(δ = 77.00 ppm). Single crystal X-ray diffraction data was collected on Bruker SMART diffractometer at 273(2) K with graphite-monochromated Mo-Kα radiation (λ = 0.71073 Å).

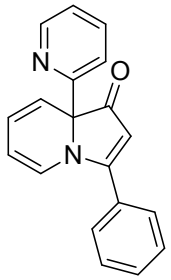
Experimental procedures and characterization datas of compounds

Typical procedure for the synthesis of indolizinone 3aa-3da.



To a screw-cap vial containing a stir bar, **1** (0.3 mmol), **2** (0.6 mmol), $Cu(OAc)_2$ (0.03 mmol) and NEt_3 (0.6 mmol) were added in 1,4-dioxane (2 mL). The reaction vial was fitted with a cap. The reaction vial was heated with stirring at 110 ^{o}C or 130 ^{o}C for several hours. After cooling down to room temperature and concentrated in vacuum, the residue was purified by flash chromatography on a short silica gel to provide the terminal product **3**.

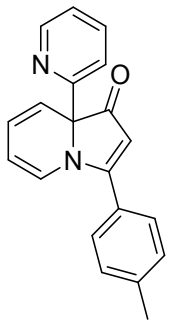
3aa



3-phenyl-8a-(pyridin-2-yl)-indolizinone (3aa). 1a (55.2 mg, 0.3 mmol), **2a** (61.2 mg, 0.6 mmol), $Cu(OAc)_2$ (5.5 mg, 0.03 mmol) and NEt_3 (60.6 mg, 0.6 mmol) were added in 1,4-dioxane (2 mL). The reaction vial was heated with stirring at 110 ^{o}C for 4h. **3aa** (82 mg, 95%, n-hexane/ethyl acetate = 3:1): yellow solid; mp 173-174 ^{o}C; IR (KBr) *v* 3036, 1566,1487, 1389, 1302 cm^{-1}; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.60 (d, *J* = 4.3 Hz,

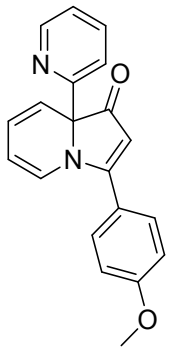
1H), 7.68 (t, *J* = 4.8 Hz, 3H), 7.58 – 7.46 (m, 4H), 7.19 (dd, *J* = 7.0, 5.1 Hz, 1H), 6.73 (d, *J* = 7.2 Hz, 1H), 6.45 (d, *J* = 9.2 Hz, 1H), 6.12 (dd, *J* = 9.2, 5.5 Hz, 1H), 5.39 – 5.29 (m, 1H), 5.21 (s, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.2, 175.2, 158.7, 149.5, 136.8, 131.2, 129.5, 129.1, 128.2, 124.6, 123.5, 122.7, 122.0, 120.2, 108.8, 99.5, 73.8; HRMS (ESI): Exact mass calcd for $C_{19}H_{14}N_2O^+$ $[M+Na]^+$ 309.0996, found 309.0998.

3ab



3-(*p*-tolyl)-8a-(pyridin-2-yl)-indolizinone (3ab). The reaction of $Cu(OAc)_2$ (5.5 mg, 0.03 mmol), NEt_3 (60.6 mg, 0.6 mmol), **1a** (55.2 mg, 0.3 mmol), **2b** (69.6 mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 4 h. **3ab** (90 mg, 100%, n-hexane/ethyl acetate = 3:1): yellow solid; mp 185-186 °C; IR (KBr) *v* 3041, 1675, 1428, 1385, 1300 cm^{-1}; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.59 (d, *J* = 4.7 Hz, 1H), 7.66 (td, *J* = 7.9, 1.7 Hz, 1H), 7.55 (d, *J* = 8.1 Hz, 2H), 7.49 (d, *J* = 8.0 Hz, 1H), 7.34 (d, *J* = 8.0 Hz, 2H), 7.20 – 7.13 (m, 1H), 6.74 (d, *J* = 7.3 Hz, 1H), 6.44 (d, *J* = 9.2 Hz, 1H), 6.10 (dd, *J* = 9.2, 5.5 Hz, 1H), 5.37 – 5.29 (m, 1H), 5.18 (s, 1H), 2.44 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.1, 175.4, 158.8, 149.5, 141.7, 136.7, 129.7, 128.1, 126.6, 124.7, 123.4, 122.7, 122.1, 120.1, 108.7, 99.2, 73.8, 21.7; HRMS (ESI): Exact mass calcd for $C_{20}H_{16}N_2O^+$ $[M+Na]^+$ 323.1152, found 323.1155.

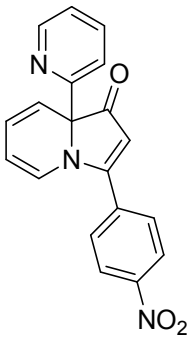
3ac



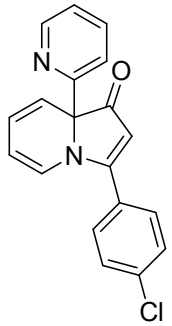
3-(4-methoxyphenyl)-8a-(pyridin-2-yl)-indolizinone (3ac). The reaction of $Cu(OAc)_2$ (5.4 mg, 0.03 mmol), NEt_3 (60.6 mg, 0.6 mmol), **1a** (55.2 mg, 0.3 mmol),

2c (79.2 mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 24 h. **3ac** (81 mg, 85%, n-hexane/ethyl acetate = 3:1): yellow solid; mp 175-176 °C; IR (KBr) *v* 3023, 1675, 1496, 1388, 1256 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 8.58 (d, *J* = 4.1 Hz, 1H), 7.70 – 7.54 (m, 3H), 7.48 (d, *J* = 8.0 Hz, 1H), 7.17 (dd, *J* = 6.7, 5.0 Hz, 1H), 7.04 (d, *J* = 8.8 Hz, 2H), 6.77 (d, *J* = 7.2 Hz, 1H), 6.44 (d, *J* = 9.2 Hz, 1H), 6.10 (dd, *J* = 9.2, 5.4 Hz, 1H), 5.39 – 5.27 (m, 1H), 5.16 (s, 1H), 3.88 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.0, 175.1, 161.93, 158.9, 149.5, 136.7, 129.9, 124.8, 123.4, 122.6, 122.2, 121.7, 120.2, 114.5, 108.7, 98.9, 73.8, 55.5.; HRMS (ESI): Exact mass calcd for $C_{20}H_{16}N_2O^+$ $[M+Na]^+$ 339.1101, found 339.1104.

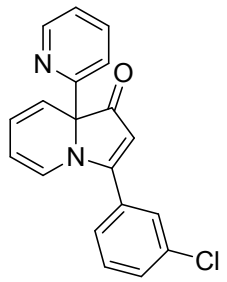
3ad



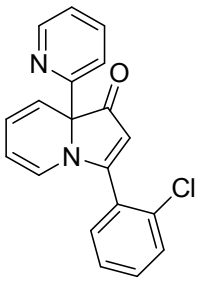
3-(4-nitrophenyl)-8a-(pyridin-2-yl)-indolizinone (3ad). The reaction of $Cu(OAc)_2$ (5.5 mg, 0.03 mmol), NEt_3 (60.6 mg, 0.6 mmol), **1a** (55.2 mg, 0.3 mmol), **2d** (88.2 mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 24 h. **3ad** (77.5 mg, 78%, n-hexane/ethyl acetate = 3:1): red solid; mp 206-207 °C; IR (KBr) *v* 3104, 1683, 1521, 1349, 1289 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 8.57 (d, *J* = 4.3 Hz, 1H), 8.47 – 8.35 (m, 2H), 7.89 (d, *J* = 8.7 Hz, 2H), 7.69 (dd, *J* = 7.7, 1.4 Hz, 1H), 7.53 (d, *J* = 8.0 Hz, 1H), 7.26 (s, 1H), 7.22 (dd, *J* = 7.0, 5.3 Hz, 1H), 6.59 (d, *J* = 7.2 Hz, 1H), 6.42 (d, *J* = 9.2 Hz, 1H), 6.15 (dd, *J* = 9.2, 5.5 Hz, 1H), 5.44 – 5.33 (m, 1H), 5.27 (s, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.1, 172.3, 158.3, 149.3, 137.0, 135.7, 129.4, 124.3, 123.9, 123.8, 123.0, 121.7, 120. 9, 109.4, 100.6, 73.9.; HRMS (ESI): Exact mass calcd for $C_{19}H_{13}N_3O_3^+$ $[M+Na]^+$ 354.0842, found 354.0849.

3ae 

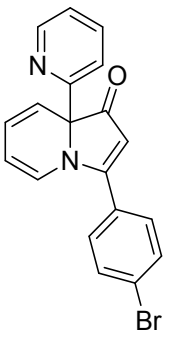
3-(4-chlorophenyl)-8a-(pyridin-2-yl)-indolizinone (3ae). The reaction of $Cu(OAc)_2$ (5.5 mg, 0.03 mmol), NEt_3 (60.6 mg, 0.6 mmol), **1a** (55.2 mg, 0.3 mmol), **2e** (81.9 mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 24 h. **3ae** (89 mg, 93%, n-hexane/ethyl acetate = 3:1): yellow solid; mp 179-180 °C; IR (KBr) *v* 3051, 1682, 1483, 1380, 1297 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 8.58 (d, *J* = 4.1 Hz, 1H), 7.74 – 7.56 (m, 3H), 7.56 – 7.44 (m, 3H), 7.19 (dd, *J* = 6.6, 5.0 Hz, 1H), 6.66 (d, *J* = 7.2 Hz, 1H), 6.42 (d, *J* = 9.2 Hz, 1H), 6.12 (dd, *J* = 9.2, 5.5 Hz, 1H), 5.41 – 5.30 (m, 1H), 5.19 (s, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.1, 173.9, 158.5, 149.4, 137.4, 136.9, 129.6, 129.4, 127.9, 124.3, 123.6, 122.8, 121.9, 120.5, 109.0, 99.6, 73.8.; HRMS (ESI): Exact mass calcd for $C_{19}H_{13}ClN_2O^+$ $[M+Na]^+$ 343.0605, found 343.0609.

3af 

3-(3-chlorophenyl)-8a-(pyridin-2-yl)-indolizinone (3af). The reaction of $Cu(OAc)_2$ (5.5 mg, 0.03 mmol), NEt_3 (60.6 mg, 0.6 mmol), **1a** (55.2 mg, 0.3 mmol), **2f** (81.9 mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 4 h. **3af** (89 mg, 93%, n-hexane/ethyl acetate = 3:1): yellow solid; mp 152-153 °C; IR (KBr) *v* 3049, 1691, 1539, 1430, 1375 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 8.59 (d, *J* = 4.2 Hz, 1H), 7.74 – 7.62 (m, 2H), 7.61 – 7.42 (m, 4H), 7.20 (dd, *J* = 6.8, 5.1 Hz, 1H), 6.67 (d, *J* = 7.2 Hz, 1H), 6.43 (d, *J* = 9.2 Hz, 1H), 6.13 (dd, *J* = 9.2, 5.4 Hz, 1H), 5.43 – 5.31 (m, 1H), 5.21 (s, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 190.2, 173.5, 158.5,149.5, 136.9, 135.2, 131.2, 130.4, 128.2, 126.4, 124.3, 123.6, 122.8, 121.9, 120.5, 109.1, 88.8, 73.8.; HRMS (ESI): Exact mass calcd for $C_{19}H_{13}ClN_2O^+$ $[M+Na]^+$ 343.0605, found 343.0609.

3ag 

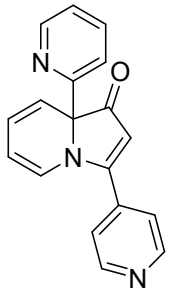
3-(2-chlorophenyl)-8a-(pyridin-2-yl)-indolizinone (3ag). The reaction of $Cu(OAc)_2$ (5.5 mg, 0.03 mmol), NEt_3 (60.6 mg, 0.6 mmol), **1a** (55.2 mg, 0.3 mmol), **2g** (81.9 mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 4 h. **3ag** (92 mg, 96%, n-hexane/ethyl acetate = 3:1): yellow solid; mp 163-164 °C; IR (KBr) *v* 3053, 1683，1,566, 1391, 1301 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 8.63 (d, *J* = 4.4 Hz, 1H), 7.67 (td, *J* = 7.7, 1.7 Hz, 1H), 7.60 – 7.51 (m, 3H), 7.45 (dtd, *J* = 14.4, 7.3, 1.7 Hz, 2H), 7.19 (ddd, *J* = 7.2, 4.8, 1.0 Hz, 1H), 6.48 (d, *J* = 9.2 Hz, 1H), 6.30 (d, *J* = 7.2 Hz, 1H), 6.11 (dd, *J* = 9.2, 5.5 Hz, 1H), 5.35 (t, *J* = 6.1 Hz, 1H), 5.19 (s, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.3, 171.9, 158.3, 149.7, 136.7, 132.5, 131.9, 130.7, 130.4, 128.8, 127.3, 124.2, 123.4, 122.7, 122.5, 119.9, 109.4, 100.5, 73.4.; HRMS (ESI): Exact mass calcd for $C_{19}H_{13}ClN_2O^+$ $[M+Na]^+$ 343.0604, found 343.0609.

3ah 

3-(4-bromophenyl)-8a-(pyridin-2-yl)-indolizinone (3ah). The reaction of $Cu(OAc)_2$ (5.5 mg, 0.03 mmol), NEt_3 (60.6 mg, 0.6 mmol), **1a** (55.2 mg, 0.3 mmol), **2h** (108.6 mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 24 h. **3ah** (100 mg, 91%, n-hexane/ethyl acetate = 3:1): yellow solid; mp 205-206 °C; IR (KBr) *v* 3086, 1680, 1480, 1430, 1291 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 8.57 (d, *J* = 4.2 Hz, 1H), 7.67 (dd, *J* = 10.9, 5.0 Hz, 3H), 7.52 (dd, *J* = 15.4, 8.2 Hz, 3H), 7.19 (dd, *J* = 6.9, 5.4 Hz, 1H), 6.65 (d, *J* = 7.2 Hz, 1H), 6.42 (d, *J* = 9.2 Hz, 1H), 6.12 (dd, *J* = 9.2, 5.5 Hz, 1H), 5.40 – 5.29 (m, 1H), 5.19 (s, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.1, 173.9,

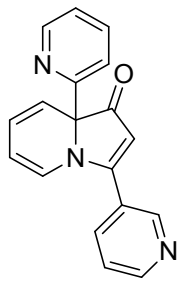
158.5, 149.4, 136.9, 132.4, 129.7, 128.4, 125.7, 124.3, 123.6, 122.8, 121.9, 120.5, 109.0, 99.6, 73.8.; HRMS (ESI): Exact mass calcd for $C_{19}H_{13}BrN_2O^+$ $[M+Na]^+$ 387.0097, found 387.0104.

3ai



3-(pyridin-4-yl)-8a-(pyridin-2-yl)-indolizinone (3ai). The reaction of $Cu(OAc)_2$ (5.5 mg, 0.03 mmol), NEt_3 (60.6 mg, 0.6 mmol), **1a** (55.2 mg, 0.3 mmol), **2i** (61.8 mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 130 °C for 24 h. **3ai** (56 mg, 64%, n-hexane/ethyl acetate = 1:2): yellow solid; mp 230-231 °C; IR (KBr) *v* 3050, 1686, 1487, 1390, 1303 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 8.83 (d, *J* = 5.7 Hz, 2H), 8.57 (d, *J* = 4.1 Hz, 1H), 7.69 (td, *J* = 7.9, 1.6 Hz, 1H), 7.60 – 7.54 (m, 2H), 7.51 (d, *J* = 8.0 Hz, 1H), 7.21 (dd, *J* = 6.9, 5.3 Hz, 1H), 6.61 (d, *J* = 7.2 Hz, 1H), 6.42 (d, *J* = 9.2 Hz, 1H), 6.13 (dd, *J* = 9.2, 5.5 Hz, 1H), 5.39 (t, *J* = 6.3 Hz, 1H), 5.26 (s, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.2, 172.0, 158.2, 150.8, 149.4, 137.2, 137.0, 123.9, 123.7, 122.9, 122.26, 121.8, 120.7, 109.4, 100.2, 73.8.; HRMS (ESI): Exact mass calcd for $C_{18}H_{13}N_3O^+$ $[M+Na]^+$ 310.0949, found 310.0951.

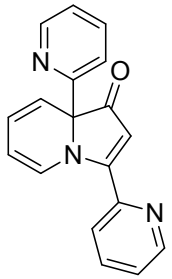
3aj



3-(pyridin-3-yl)-8a-(pyridin-2-yl)-indolizinone (3aj). The reaction of $Cu(OAc)_2$ (5.5 mg, 0.03 mmol), NEt_3 (60.6 mg, 0.6 mmol), **1a** (55.2 mg, 0.3 mmol), **2j** (61.8 mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 72 h. **3aj** (68 mg, 79%, n-hexane/ethyl acetate = 1:2): yellow solid; mp 160-161 °C; IR (KBr) *v* 3047, 1681, 1570, 1426, 1301 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 8.93 (s, 1H), 8.78 (d, *J* = 3.7 Hz, 1H), 8.56 (d, *J* = 4.7 Hz, 1H), 8.06 – 7.93 (m, 1H), 7.67 (td, *J* = 7.8, 1.7 Hz, 1H),

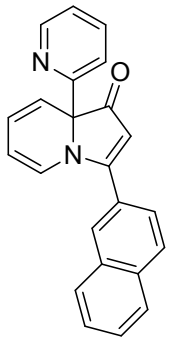
7.48 (dd, *J* = 7.9, 4.1 Hz, 2H), 7.23 – 7.14 (m, 1H), 6.63 (t, *J* = 5.7 Hz, 1H), 6.42 (d, *J* = 9.2 Hz, 1H), 6.13 (dd, *J* = 9.2, 5.3 Hz, 1H), 5.45 – 5.32 (m, 1H), 5.25 (d, *J* = 4.5 Hz, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.1, 171.6, 158.3, 152.1, 149.4, 148.8, 136.9, 135.7, 125.8, 124.0, 123.7, 122.9, 121.9, 120.7, 109.4, 100.2, 73.8.; HRMS (ESI): Exact mass calcd for $C_{18}H_{13}N_3O^+$ $[M+Na]^+$ 310.0948, found 310.0951.

3ak



3-(pyridin-2-yl)-8a-(pyridin-2-yl)-indolizinone (3ak). The reaction of $Cu(OAc)_2$ (5.5 mg, 0.03 mmol), NEt_3 (60.6 mg, 0.6 mmol), **1a** (55.2 mg, 0.3 mmol), **2k** (61.8 mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 130 °C for 18 h. **3ak** (53 mg, 61%, n-hexane/ethyl acetate = 1:2): yellow solid; mp 155-156 °C; IR (KBr) *v* 3095, 1682, 1537, 1392, 1285 cm^{-1}; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.83 (d, *J* = 4.6 Hz, 1H), 8.62 (d, *J* = 4.2 Hz, 1H), 7.88 (td, *J* = 7.8, 1.6 Hz, 1H), 7.77 (d, *J* = 7.8 Hz, 1H), 7.65 (td, *J* = 7.8, 1.7 Hz, 1H), 7.55 (t, *J* = 8.3 Hz, 2H), 7.45 (dd, *J* = 6.5, 5.0 Hz, 1H), 7.17 (dd, *J* = 6.5, 5.0 Hz, 1H), 6.51 (d, *J* = 9.2 Hz, 1H), 6.11 (dd, *J* = 9.2, 5.4 Hz, 1H), 5.44 (s, 1H), 5.42 – 5.34 (m, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.4, 171.5, 158.5, 149.8, 149.7, 149.1, 137.3, 136.8, 126.1, 125.4, 125.2, 123.5, 122.7, 122.5, 119.9, 109.2, 99.5, 74.2.; HRMS (ESI): Exact mass calcd for $C_{18}H_{13}N_3O^+$ $[M+Na]^+$ 310.0947, found 310.0951.

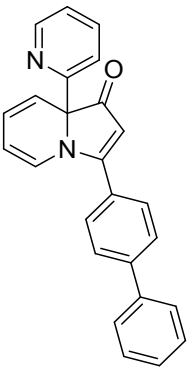
3al



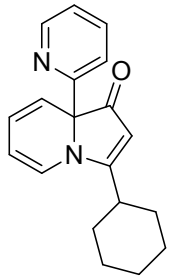
3-(naphthalen-2-yl)-8a-(pyridin-2-yl)-indolizinone (3al). The reaction of $Cu(OAc)_2$ (5.5 mg, 0.03 mmol), NEt_3 (60.6 mg, 0.6 mmol), **1a** (55.2 mg, 0.3 mmol), **2l** (91.2 mg,

0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 130 °C for 5 h. **3al** (100 mg, 100%, n-hexane/ethyl acetate = 3:1): yellow solid; mp 186-187 °C; IR (KBr) *v* 3050, 1675, 1531, 1391, 1296 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 8.64 (d, *J* = 4.0 Hz, 1H), 8.19 (s, 1H), 8.00 (d, *J* = 8.5 Hz, 1H), 7.98 – 7.89 (m, 2H), 7.76 – 7.65 (m, 2H), 7.65 – 7.53 (m, 3H), 7.21 (dd, *J* = 6.7, 5.3 Hz, 1H), 6.81 (d, *J* = 7.2 Hz, 1H), 6.47 (d, *J* = 9.2 Hz, 1H), 6.14 (dd, *J* = 9.2, 5.5 Hz, 1H), 5.36 (t, *J* = 6.3 Hz, 1H), 5.32 (s, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.3, 175.4, 158.8, 149.5, 136.8, 134.4, 132.9, 128.9, 128.66, 128.5, 127.9, 127.9, 127.2, 126.8, 124.8, 124.7, 123.5, 122.7, 122.1, 120.3, 108.8, 99.8, 73.9.; HRMS (ESI): Exact mass calcd for $C_{23}H_{16}N_2O^+$ $[M+Na]^+$ 359.1150, found 359.1155.

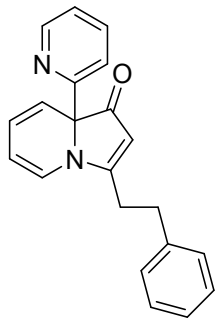
3am



3-([1,1'-biphenyl]-4-yl)-8a-(pyridin-2-yl)-indolizinone (3am). The reaction of $Cu(OAc)_2$ (5.5 mg, 0.03 mmol), NEt_3 (60.6 mg, 0.6 mmol), **1a** (55.2mg, 0.3 mmol), **2m** (106.8 mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 130 °C for 1 h. **3am** (100 mg, 92%, n-hexane/ethyl acetate = 3:1): yellow solid; mp 177-178 °C; IR (KBr) *v* 3049, 1677, 1568, 1427, 1298 cm^{-1}; ^1H NMR (300 MHz, CDCl3) δ 8.61 (d, J = 4.0 Hz, 1H), 7.76 (d, J = 2.8 Hz, 4H), 7.72 – 7.61 (m, 3H), 7.55 – 7.38 (m, 4H), 7.23 – 7.15 (m, 1H), 6.81 (d, J = 7.3 Hz, 1H), 6.47 (d, J = 9.2 Hz, 1H), 6.13 (dd, J = 9.2, 5.4 Hz, 1H), 5.38 (dd, J = 9.3, 3.4 Hz, 1H), 5.26 (s, 1H)；13C NMR (75 MHz, CDCl3) δ 199.16, 174.94, 158.72, 149.49, 144.16, 139.86, 136.83, 129.05, 128.73, 128.26, 128.21, 127.71, 127.20, 124.70, 123.50, 122.73, 122.08, 120.29, 108.84, 99.48, 73.87.；HRMS (ESI): Exact mass calcd for $C_{25}H_{18}N_2O^+$ $[M+Na]^+$ 385.1306, found 385.1311.

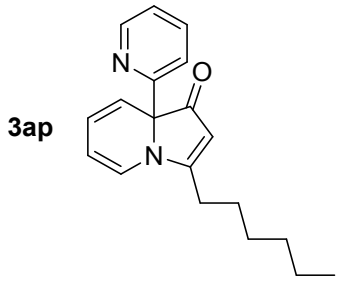
3an 

3-cyclohexyl-8a-(pyridin-2-yl)-indolizinone (3an). The reaction of $Cu(OAc)_2$ (5.5 mg, 0.03 mmol), NEt_3 (60.6 mg, 0.6 mmol), **1a** (55.2 mg, 0.3 mmol), **2n** (64.8 mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 1 h. **3an** (79 mg, 90%, n-hexane/ethyl acetate = 2:1): yellow solid; mp 134-135 °C; IR (KBr) *v* 3045, 1671, 1521, 1442, 1317 cm^{-1}; ^1H NMR (300 MHz, CDCl3) δ 8.54 (d, J = 4.6 Hz, 1H), 7.61 (t, J = 7.7 Hz, 1H), 7.34 (d, J = 7.9 Hz, 1H), 7.21 – 7.09 (m, 1H), 6.67 (d, J = 7.1 Hz, 1H), 6.41 (d, J = 9.1 Hz, 1H), 6.07 (dd, J = 9.2, 5.2 Hz, 1H), 5.50 – 5.31 (m, 1H), 4.93 (s, 1H), 2.67-2.63 (m, 1H), 2.31 – 1.15 (m, 10H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.3, 182.6, 158.5, 149.3, 136.6, 123.4, 123.0, 122.5, 119.9, 109.3, 95.4, 72.9, 36.4, 31.5, 30.7, 26.1, 25.9, 25.8.; HRMS (ESI): Exact mass calcd for $C_{19}H_{20}N_2O^+$ $[M+Na]^+$ 315.1464, found 315.1468.

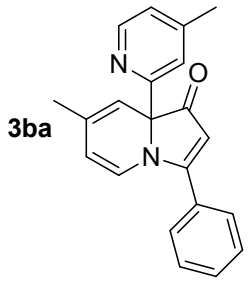
3ao 

3-phenethyl-8a-(pyridin-2-yl)-indolizinone (3ao). The reaction of $Cu(OAc)_2$ (5.5mg, 0.03 mmol), NEt_3 (60.6mg, 0.6 mmol), **1a** (55.2mg, 0.3 mmol), **2o** (78mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 1 h. **3ao** (88 mg, 94%, n-hexane/ethyl acetate = 2:1): yellow solid; mp 157-158 °C; IR (KBr) *v* 3043, 1683, 1565, 1443, 1312 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 8.55 (d, *J* = 4.1 Hz, 1H), 7.62 (t, *J* = 7.1 Hz, 1H), 7.31 (dd, *J* = 9.0, 5.6 Hz, 3H), 7.23 (dd, *J* = 8.3, 4.2 Hz, 2H), 7.19 – 7.12 (m, 1H), 6.60 (d, *J* = 7.1 Hz, 1H), 6.39 (d, *J* = 9.2 Hz, 1H), 6.09 (dd, *J* = 9.2, 5.4 Hz, 1H), 5.43 – 5.36 (m, 1H), 4.98 (s, 1H), 3.13 – 2.83 (m, 4H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.3, 177.0, 158.4, 149.3, 139.7, 136.7, 128.7, 128.4, 126.7, 123.6, 123.0, 122.8,

122.6, 120.4, 109.6, 97.6, 73.1, 32.8, 29.2.; HRMS (ESI): Exact mass calcd for $C_{21}H_{18}N_2O^+$ $[M+Na]^+$ 337.1307, found 337.1311.

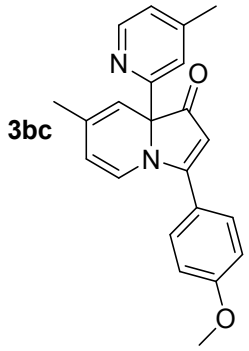


3-hexyl-8a-(pyridin-2-yl)-indolizinone (3ap). The reaction of $Cu(OAc)_2$ (5.5mg, 0.03 mmol), NEt_3 (60.6mg, 0.6 mmol), **1a** (55.2mg, 0.3 mmol), **2p** (66.0mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 1 h. **3ap** (70 mg, 80%, n-hexane/ethyl acetate = 2:1): yellow solid; mp 93-94 °C; IR (KBr) *v* 3045, 1676, 1562, 1445, 1292 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 8.58 (s, 1H), 7.70 (s, 1H), 7.45 (s, 1H), 7.22 (s, 1H), 6.71 (s, 1H), 6.38 (d, *J* = 9.1 Hz, 1H), 6.11 (dd, *J* = 9.0, 5.5 Hz, 1H), 5.44 (t, *J* = 6.1 Hz, 1H), 4.97 (s, 1H), 2.81 – 2.53 (m, 2H), 1.89 – 0.75 (m, 13H).; ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.3, 178.2, 158.5, 149.3, 136.6, 123.5, 123.1, 122.8, 122.6, 120.3, 109.3, 97.5, 73.1, 31.45, 29.0, 27.4, 26.7, 22.5, 14.0.; HRMS (ESI): Exact mass calcd for $C_{19}H_{22}N_2O^+$ $[M+Na]^+$ 317.1621, found 317.1624.

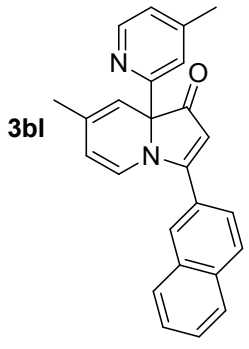


3-methyl-8a-(4-methylpyridin-2-yl)-2-phenyl-indolizinone (3ba). The reaction of $Cu(OAc)_2$ (3.7mg, 0.02 mmol), NEt_3 (40.4mg, 0.4 mmol), **1b**[1] (42.4mg, 0.2 mmol), **2a** (40.8mg, 0.4 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 1 h. **3ba** (48 mg, 77%, n-hexane/ethyl acetate = 3:1): yellow solid; mp 181-182 °C; IR (KBr) *v* 3054, 1680, 1540, 1376, 1287 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 8.43 (d, *J* = 4.9 Hz, 1H), 7.73 – 7.62 (m, 2H), 7.59 – 7.49 (m, 3H), 7.31 (s, 1H), 6.99 (d, *J* = 4.6 Hz, 1H), 6.70 (d, *J* = 7.2 Hz, 1H), 6.12 (d, *J* = 1.1 Hz, 1H), 5.21 (s, 1H), 5.20 (s, 1H), 2.35 (s, 3H), 1.84 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.9, 175.0, 158.9, 149.0, 147.9,

132.1, 131.1, 129.7, 129.0, 128.2, 124.1, 123.7, 121.3, 117.1, 112.4, 99.9, 74.1, 21.3, 20.7.; HRMS (ESI): Exact mass calcd for $C_{21}H_{19}N_2O^+$ $[M+H]^+$ 315.1489, found 315.1492.

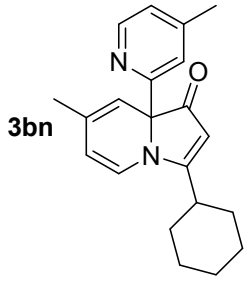


3-(4-methoxyphenyl)-8a-methyl-5-(4-methylpyridin-2-yl)-indolizinone (3bc). The reaction of $Cu(OAc)_2$ (2.7mg, 0.015 mmol), NEt_3 (30.3mg, 0.3 mmol), **1b**[1] (31.8mg, 0.15 mmol), **2c** (39.6mg, 0.3 mmol), in 1,4-dioxane (1.5 mL) were stirred at 110 ^oC for 24 h. **3bc** (35 mg, 68%, n-hexane/ethyl acetate = 2:1): yellow solid; mp 215-216 ^oC; IR (KBr) *v* 3050, 1679, 1608, 1380, 1256 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 8.42 (d, *J* = 4.8 Hz, 1H), 7.63 (d, *J* = 8.4 Hz, 2H), 7.30 (s, 1H), 7.03 (d, *J* = 8.7 Hz, 2H), 6.98 (d, *J* = 4.4 Hz, 1H), 6.74 (d, *J* = 7.2 Hz, 1H), 6.11 (s, 1H), 5.21 (d, *J* = 7.3 Hz, 1H), 5.17 (s, 1H), 3.88 (s, 3H), 2.34 (s, 3H), 1.83 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 199.8, 175.0, 161.9, 159.2, 149.1, 131.9, 129.9, 124.3, 123.6, 121.8, 121.3, 117.3, 114.4, 112.3, 99.2, 74.2, 55.5, 21.3, 20.7.; HRMS (ESI): Exact mass calcd for $C_{22}H_{21}N_2O_2^+$ $[M+H]^+$ 345.1593, found 345.1598.

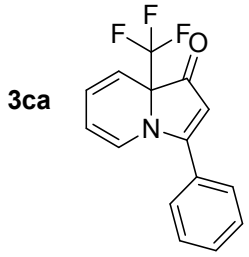


6-methyl-8a-(4-methylpyridin-2-yl)-3-(naphthalen-2-yl)-indolizinone (3bl). The reaction of $Cu(OAc)_2$ (2.7mg, 0.015 mmol), NEt_3 (30.3mg, 0.3 mmol), **1b**[1] (31.8mg, 0.15 mmol), **2l** (45.6mg, 0.3 mmol), in 1,4-dioxane (1.5 mL) were stirred at 110 ^oC for 24 h. **3bl** (45 mg, 82%, n-hexane/ethyl acetate = 3:1): yellow solid; mp 217-218

°C; IR (KBr) *v* 3054, 1679, 1536, 1392, 1340 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 8.64 (d, *J* = 4.0 Hz, 1H), 8.19 (s, 1H), 8.00 (d, *J* = 8.5 Hz, 1H), 7.98 – 7.89 (m, 2H), 7.76 – 7.65 (m, 2H), 7.65 – 7.53 (m, 3H), 7.21 (dd, *J* = 6.7, 5.3 Hz, 1H), 6.81 (d, *J* = 7.2 Hz, 1H), 6.47 (d, *J* = 9.2 Hz, 1H), 6.14 (dd, *J* = 9.2, 5.5 Hz, 1H), 5.36 (t, *J* = 6.3 Hz, 1H), 5.32 (s, 1H).; ^{13}C NMR (75 MHz, $CDCl_3$) δ 200.0, 175.2, 159.1, 149.1, 148.3, 134.3, 132.9, 132.1, 128.9, 128.7, 128.5, 127.9, 127.8, 127.1, 127.0, 124.8, 124.2, 123.7, 121.4, 117.2, 112.4, 100.2, 74.3, 21.3, 20.7.; HRMS (ESI): Exact mass calcd for $C_{25}H_{21}N_2O^+$ $[M+H]^+$ 365.1645, found 365.1648.



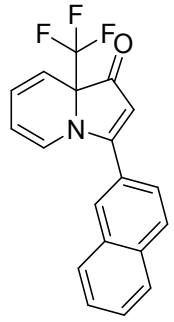
3-cyclohexyl-6-methyl-8a-(4-methylpyridin-2-yl)-indolizinone (3bn). The reaction of $Cu(OAc)_2$ (2.7mg, 0.015 mmol), NEt_3 (30.3mg, 0.3 mmol), **1b**[1] (31.8mg, 0.15 mmol), **2n** (32.4mg, 0.3 mmol), in 1,4-dioxane (1.5 mL) were stirred at 110 °C for 1 h. **3bn** (51 mg, 80%, n-hexane/ethyl acetate = 2:1): yellow solid; mp 207-208 °C; IR (KBr) *v* 3043, 1676, 1525, 1442, 1358 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 8.36 (d, *J* = 4.9 Hz, 1H), 7.17 (s, 1H), 6.94 (d, *J* = 4.0 Hz, 1H), 6.64 (d, *J* = 7.0 Hz, 1H), 6.09 (s, 1H), 5.28 (d, *J* = 7.2 Hz, 1H), 4.93 (s, 1H), 2.65 – 2.61 (m, 1H), 2.31 (s, 3H), 2.20 – 1.27 (m, 10H), 1.81 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 200.1, 182.3, 158.8, 148.9, 147.6, 131. 9, 123.4, 122.5, 121.0, 118.2, 112.9, 95.7, 73.4, 36.4, 31.5, 30.8, 26.1, 25.9, 25.8, 21.3, 20.6.; HRMS (ESI): Exact mass calcd for $C_{21}H_{25}N_2O^+$ $[M+H]^+$ 321.1958, found 321.1961.



3-phenyl-8a-(trifluoromethyl)-indolizinone (3ca). The reaction of $Cu(OAc)_2$ (5.5mg,

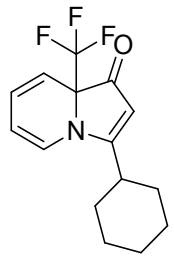
0.03 mmol), NEt_3 (60.6mg, 0.6 mmol), **1c** (52.5mg, 0.3 mmol), **2a** (61.2mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 20 h. **3ca** (58 mg, 70%, n-hexane/ethyl acetate = 12:1): yellow solid; mp 131-132 °C; IR (KBr) *v* 3120, 1708, 1555, 1374, 1240 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 7.58 – 7.53(m, 5H), 6.57 (dd, *J* = 7.4, 0.7 Hz, 1H), 6.22 (dd, *J* = 9.4, 5.7 Hz, 1H), 5.80 (d, *J* = 9.4 Hz, 1H), 5.37 (dd, *J* = 7.2, 1.0 Hz, 1H), 5.35 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 194.6, 178.5, 131.8, 129.3, 128.6, 127.9, 127.4, 126.1, 122.7 (q, J_{C-F} = 288.0 Hz, 1C), 113.3, 108.3, 101.8, 101.8, 69.6.; HRMS (ESI): Exact mass calcd for $C_{15}H_{11}F_3NO^+$ $[M+H]^+$ 278.0786, found 278.0787.

3cl



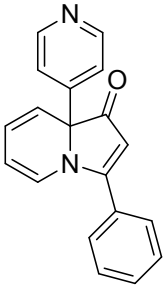
3-(naphthalen-2-yl)-8a-(trifluoromethyl)-indolizinone (3cl). The reaction of $Cu(OAc)_2$ (5.5mg, 0.03 mmol), NEt_3 (60.6mg, 0.6 mmol), **1c** (52.5mg, 0.3 mmol), **2l** (91.2mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 36 h. **3cl** (56 mg, 57%, n-hexane/ethyl acetate = 12:1): yellow solid; mp 144-145 °C; IR (KBr) *v* 3083, 1704, 1550, 1380, 1243 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 8.09 (s, 1H), 8.04 – 7.86 (m, 3H), 7.66 – 7.58 (m, 3H), 6.65 (d, *J* = 7.5 Hz, 1H), 6.24 (dd, *J* = 9.4, 5.7 Hz, 1H), 5.83 (d, *J* = 9.4 Hz, 1H), 5.47 (s, 1H), 5.38 (t, *J* = 6.6 Hz, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 194.6, 178.6, 134.6, 132.8, 129.3, 128.7, 128.5, 128.3, 128.0, 127.44, 127.40, 126.3, 125.9, 124.0, 122.8 (q, J_{C-F} = 288.0 Hz, 1C), 113.4, 108.3, 102.0, 69.6 (q, J_{C-F} = 28.5 Hz, 1C).; HRMS (ESI): Exact mass calcd for $C_{19}H_{13}F_3NO^+$ $[M+H]^+$ 328.0942, found 328.0944.

3cn



3-cyclohexyl-8a-(trifluoromethyl)-indolizinone (3cn). The reaction of $Cu(OAc)_2$ (5.5mg, 0.03 mmol), NEt_3 (60.6mg, 0.6 mmol), **1c** (52.5mg, 0.3 mmol), **2n** (64.8mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 96 h. **3cn** (45 mg, 53%, n-hexane/ethyl acetate = 20:1): yellow solid; mp 98-99 °C; IR (KBr) *v* 3054, 1693, 1539, 1308, 1127 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 6.54 (d, *J* = 7.3 Hz, 1H), 6.22 (dd, *J* = 9.3, 5.6 Hz, 1H), 5.75 (d, *J* = 9.3 Hz, 1H), 5.55 – 5.43 (m, 1H), 5.05 (s, 1H), 2.57 – 2.39 (m, 1H), 2.14 – 1.16 (m, 10H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 195.0, 185.5, 127.5, 124.2, 122.7 (q, J_{C-F} = 288.0 Hz, 1C), 117.0, 114.1, 109.1, 97.6, 68.3 (q, J_{C-F} = 28.5 Hz, 1C), 36.3, 31.4, 30.3, 26.0, 25.70, 25.67.; HRMS (ESI): Exact mass calcd for $C_{15}H_{17}F_3NO^+$ $[M+H]^+$ 284.1257, found 284.1257.

3da

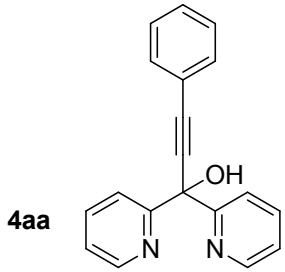


3-phenyl-8a-(pyridin-4-yl)-indolizinone (3da). The reaction of $Cu(OAc)_2$ (5.5mg, 0.03 mmol), NEt_3 (60.6mg, 0.6 mmol), **1d** (55.2mg, 0.3 mmol), **2a** (61.2mg, 0.6 mmol), in 1,4-dioxane (2 mL) were stirred at 110 °C for 63 h. **3da** (28 mg, 33%, n-hexane/ethyl acetate = 3:1): yellow solid; mp 234-235 °C; IR (KBr) *v* 3093, 1676, 1536, 1484, 1390 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 8.63 (s, 2H), 7.68 – 7.52 (m, 5H), 7.46 (s, 2H), 6.74 (d, *J* = 7.3 Hz, 1H), 6.31 (d, *J* = 9.2 Hz, 1H), 6.08 (dd, *J* = 9.2, 5.5 Hz, 1H), 5.46 – 5.33 (m, 1H), 5.22 (s, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 198.8, 175.1, 149.8, 149.2, 131.6, 129.3, 129.0, 128.1, 124.4, 123.8, 121.6, 109.6, 99.7, 71.3；HRMS (ESI): Exact mass calcd for $C_{19}H_{15}N_2O^+$ $[M+H]^+$ 287.1181, found 287.1179.

Preparation of tertiary propargylic alcohols 4aa and 4ea.

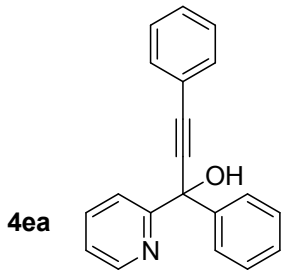
To a stirred solution of terminal alkyne (1.2 equiv) in THF was added n-BuLi (1.1 equiv, 1.6 M solution in hexanes) at -78℃. After 5 min, a solution of pyridyl ketone (1.0 equiv) in THF was slowly added to this mixture at -78℃. After 15 min at -78℃,

the reaction mixture was quenched with saturated NH_4Cl. The reaction mixture was diluted with ethyl acetate and washed with aqueous NH_4Cl. The organic layer was dried over $MgSO_4$ and concentrated in vacuo to give a crude mixture, which was purified by silica gel column chromatography (hexane/ethyl acetate/dichloromethane) to afford the propargylic alcohol.[2]



4aa

3-phenyl-1,1-di(pyridin-2-yl)prop-2-yn-1-ol (4aa).[2] 132 mg (46%). White solid. mp 90-91℃; IR (KBr) *v* 3082, 1652, 1538, 1454, 1296 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 8.55 (d, *J* = 4.2 Hz, 2H), 7.95 (d, *J* = 8.0 Hz, 2H), 7.73 (td, *J* = 7.8, 1.7 Hz, 2H), 7.56 – 7.43 (m, 2H), 7.32 – 7.26 (m, 3H), 7.22 (dd, *J* = 6.7, 5.0 Hz, 2H), 6.79 (s, 1H).; ^{13}C NMR (75 MHz, $CDCl_3$) δ 161.0, 148.0, 137.2, 132.0, 128.5, 128.2, 122. 9, 122.5, 121.4, 91.1, 85.5, 74.2.



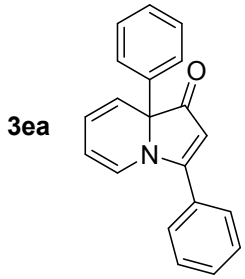
4ea

1,3-diphenyl-1-(pyridin-2-yl)prop-2-yn-1-ol (4ea).[3] 180 mg (63%). White solid. mp 69-70 ℃; IR (KBr) *v* 3067, 1679, 1592, 1434, 1268 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 8.55 (d, *J* = 4.7 Hz, 1H), 7.77 – 7.60 (m, 3H), 7.51 (dd, *J* = 12.6, 4.9 Hz, 3H), 7.40 – 7.19 (m, 7H), 6.62 (s, 1H).; ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.2, 146.9, 144.2, 137.6, 131.9, 128.6, 128.3, 128.3, 127.9, 126.5, 122.9, 122.5, 121.8, 91.0, 86.6, 73.6.

$Cu(OAc)_2$-Catalyzed Transformation from 4 to 3.

The mixture of $Cu(OAc)_2$ (5.5 mg, 0.03 mmol), NEt_3 (60.6 mg, 0.6 mmol), **4aa** (85.8 mg, 0.3 mmol), in 1,4-dioxane (2 mL) were stirred at 110 ^oC for 5 h. Column chromatography on silica gel (n-hexane/ethyl acetate = 3:1) to afford 86 mg (100%)

of **3aa**.



3,8a-dipheny-lindolizinone (3ea). The reaction of $Cu(OAc)_2$ (2.5 mg, 0.0138 mmol), NEt_3 (27.8 mg, 0.276 mmol), **4ea** (39.3 mg, 0.138 mmol), in 1,4-dioxane (1 mL) were stirred at 110 ^oC for 4 h. **3ea** (34 mg, 88%, n-hexane/ethyl acetate = 3:1): yellow solid. mp 125-126 ^oC; IR (KBr) *v* 3056, 1683, 1554, 1434, 1291 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 7.63 (dd, *J* = 6.8, 3.0 Hz, 2H), 7.58 – 7.49 (m, 5H), 7.39 – 7.28 (m, 3H), 6.69 (dd, *J* = 7.2, 0.7 Hz, 1H), 6.41 – 6.31 (m, 1H), 6.05 (dd, *J* = 9.3, 5.4 Hz, 1H), 5.42 – 5.32 (m, 1H), 5.20 (s, 1H).; ^{13}C NMR (75 MHz, CDCl3) δ 200.8, 174.6, 140.4, 131.2, 129.5, 129.2, 128.7, 128.1, 127.9, 124.5, 124.2, 122.9, 109.5, 99.5, 72.1.

Reference:

1) Collman, J. P.; Zhong, M.; Wang, Z.; Rapta, M. *Org. Lett.* **1999**, *13*, 2122.
2) Cho, H.; Kim, I. *Tetrahedron.* **2012**, *68,* 5464.
3) Yan. B.; Zhou Y. B.; Liu Y. H. *J. Org. Chem*. **2007**, *72*, 7783.

Fig.S1. GC-MS analysis of the mixture after the completion of the reaction between **1a** and **2a**.

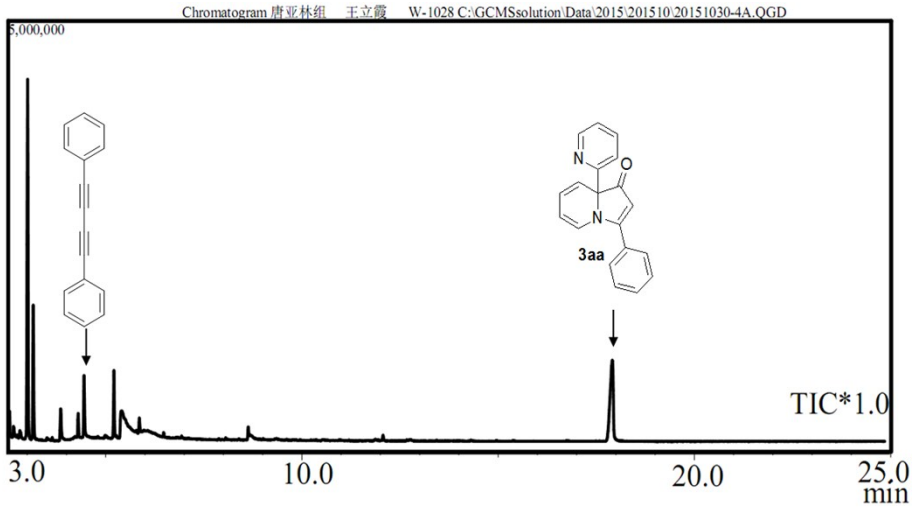


Fig.S2. X-ray crystal structure of **3af**

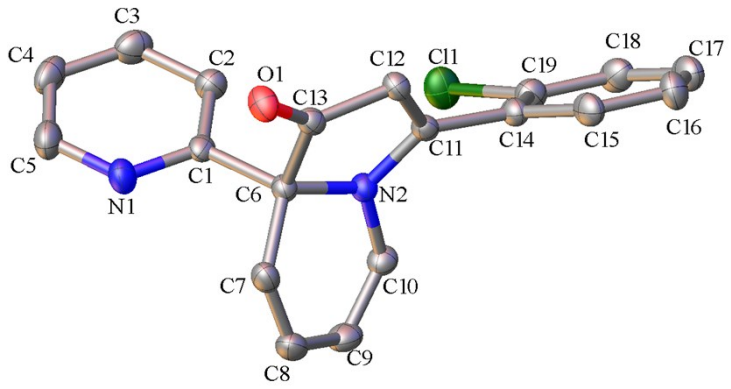
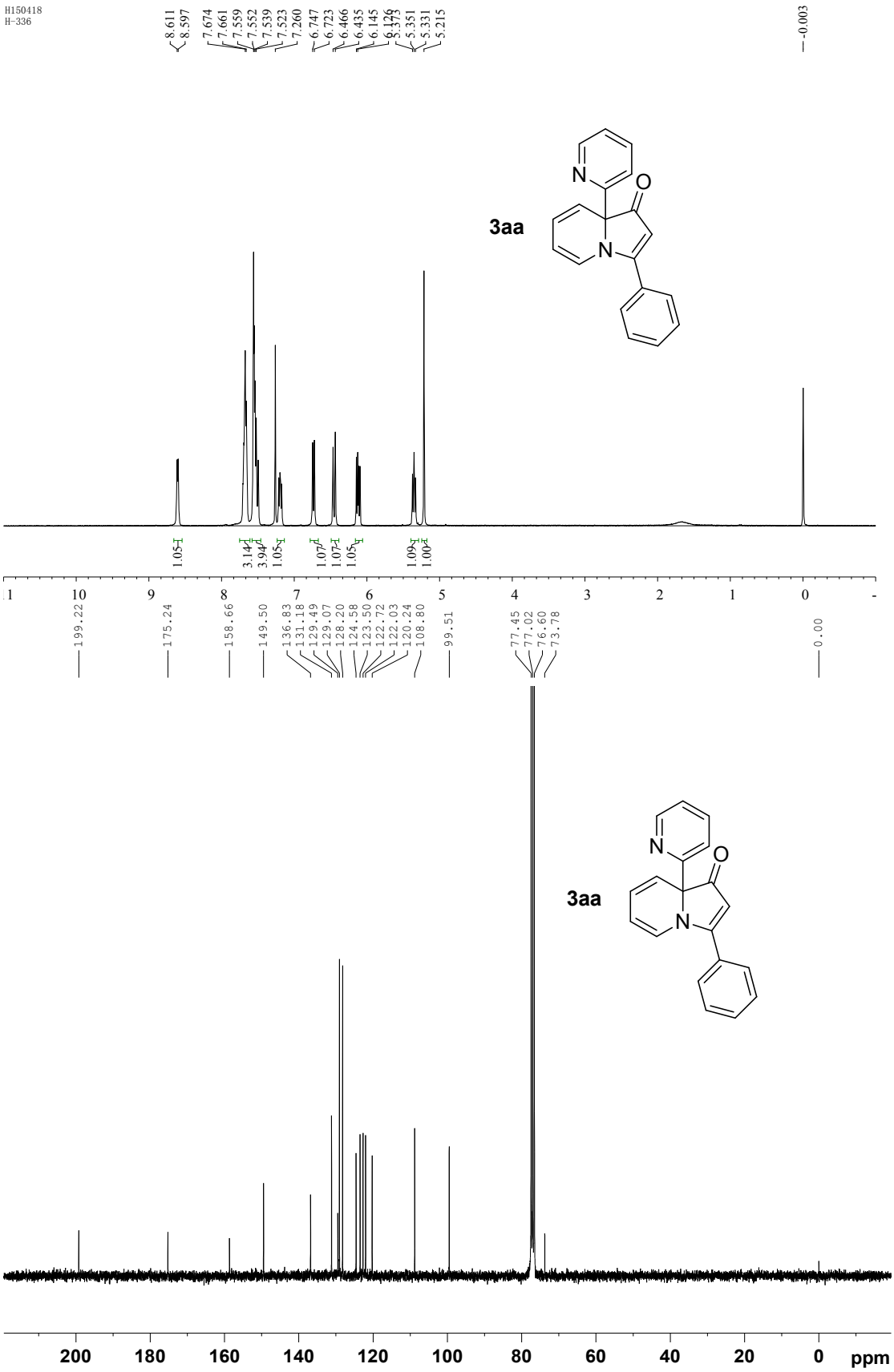
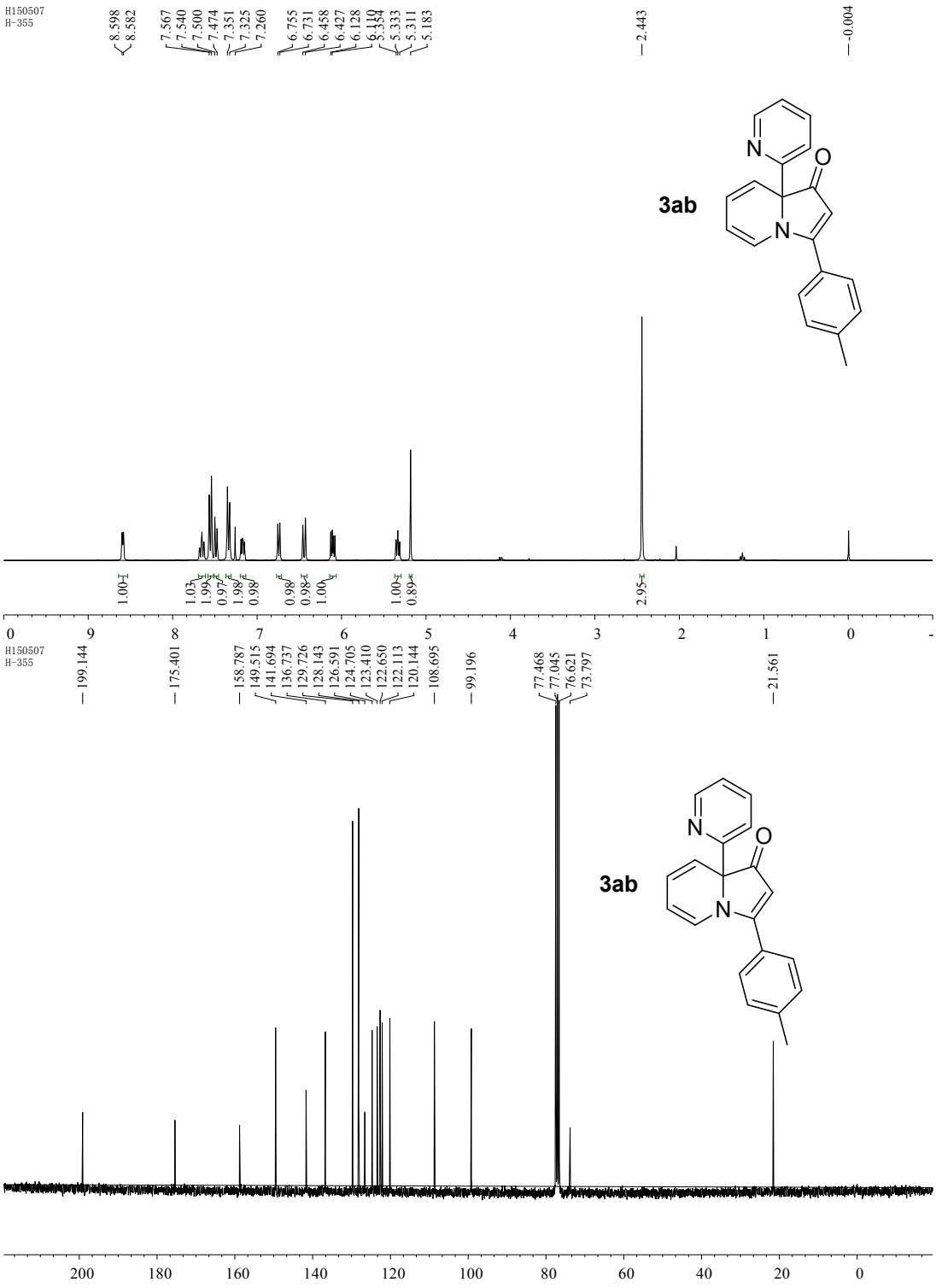


Table.S1. Crystal data and structural refinement for 3af and gem-diol complex.

compound	**3af**	**gem-diol complex**
empirical formula	$C_{19}H_{13}ClN_2O$	$C_{34}H_{46}CuN_4O_{14}$
M_r	320.76	798.29
crystal size [mm^3]	0.31 x 0.29 x 0.28	0.20 x 0.14 x 0.10
crystal system	triclinic	monoclinic
space group	P-1	C12/c1
a [Å]	7.400(3)	21.170(8)
b [Å]	10.351(3)	7.831(3)
c [Å]	11.137(4)	24.511(9)
α [deg]	63.632(9)	90
β [deg]	84.599(15)	114.363(4)
γ [deg]	80.315(16)	90
V [Å^3]	753.3(4)	3702(2)
ρ [g/cm^3]	1.414	1.432
Z	2	4
T [K]	173(2)	173(2)
R1,wR2 [I>2σ(I)]	0.0613, 0.2141	0.0795, 0.1832
R1,wR2 (all data)	0.0633, 0.2158	0.0873, 0.1876
quality of fit	1.788	1.213

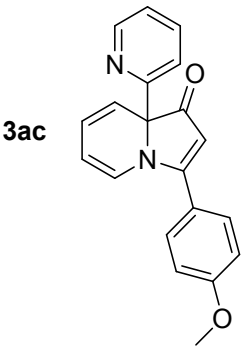
H150418
H-336




H150507
H-355
8.598
8.582
7.567
7.540
7.500
7.474
7.351
7.325
7.260
6.755
6.731
6.458
6.427
6.128
6.110
5.354
5.333
5.311
5.183
2.443
-0.004
3ab
1.00
1.03
1.99
0.97
1.98
0.98
0.98
0.98
1.00
1.00
0.89
2.95
H150507
H-355
199.144
175.401
158.787
149.515
141.694
136.737
129.726
128.143
126.591
124.705
123.410
122.650
122.113
120.144
108.695
99.196
77.468
77.045
76.621
73.797
21.561
3ab

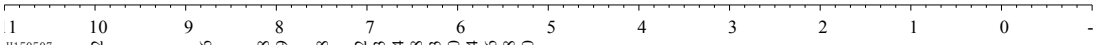
H150507
H-368

8.590
8.576
7.649
7.630
7.624
7.601
7.498
7.472
7.260
7.052
7.023
6.780
6.756
6.452
6.421
5.360
5.340
5.320
5.164
3.881
-0.005



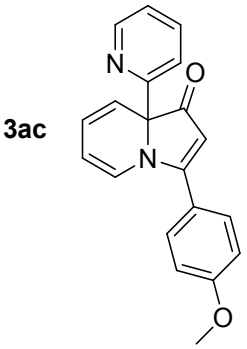
3ac

1.00
3.09
0.99
1.08
2.05
1.05
1.03
1.05
1.05
0.93
3.12

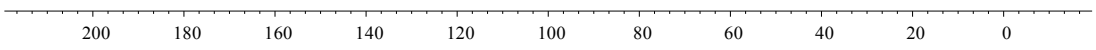


H150507
H-368

198.982
175.106
161.928
158.859
149.478
136.742
129.903
124.794
123.388
122.643
122.160
121.654
120.206
114.488
108.710
98.847
77.471
77.048
76.624
73.814
55.506

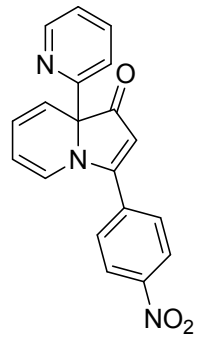


3ac



h150523
h-388

8.582
8.567
8.422
8.415
8.399
8.392
8.385
7.900
7.871
7.709
7.540
7.513
7.260
6.574
6.440
6.409
6.170
5.391
5.369
5.275
-0.003

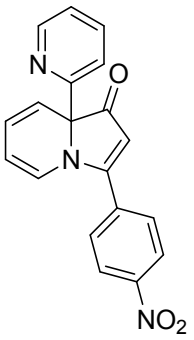


3ad

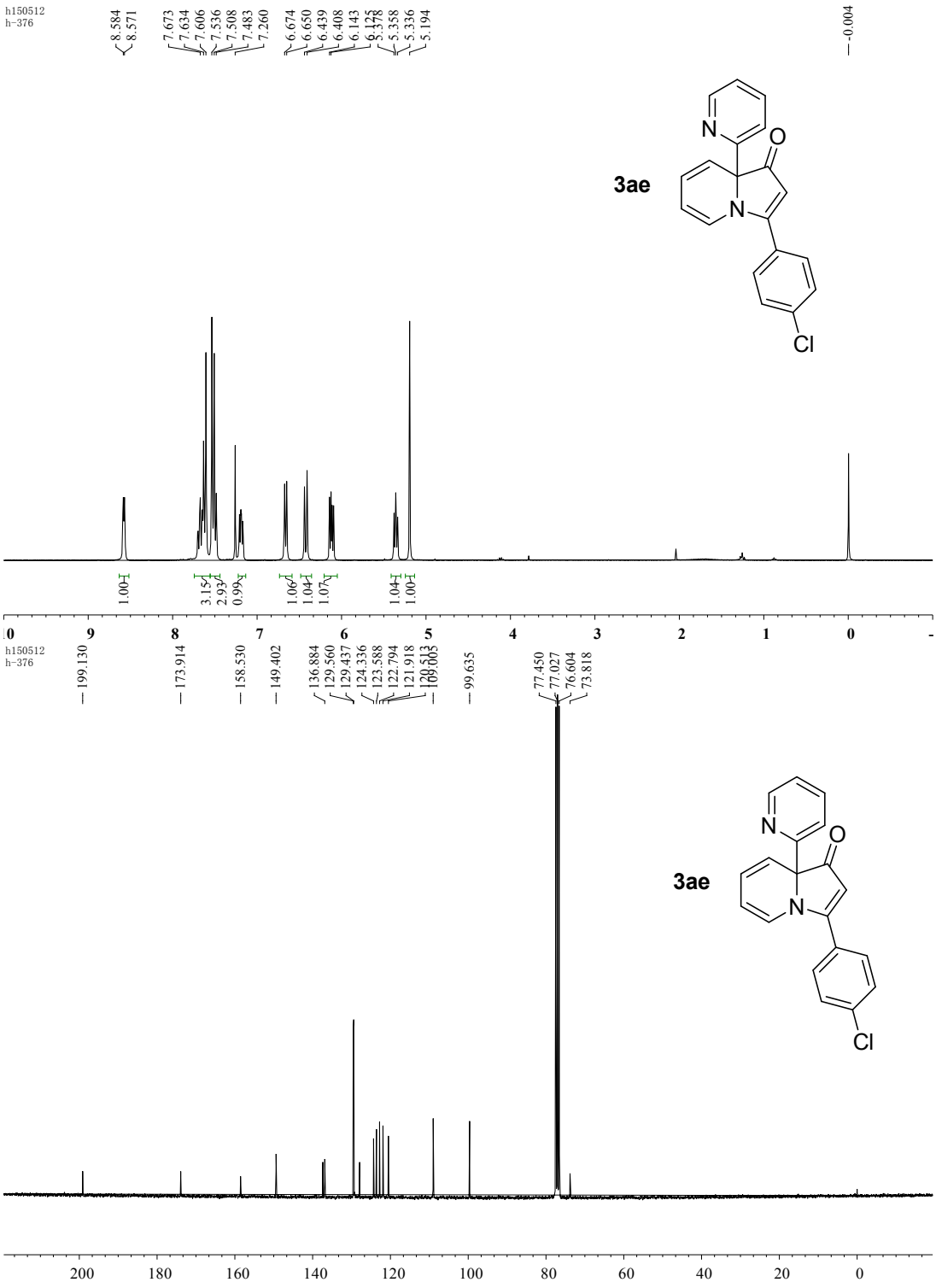
1.09
2.10
2.08
1.12
1.04
0.84
0.98
1.07
1.09
1.11
1.13
1.00

h150530
h-388

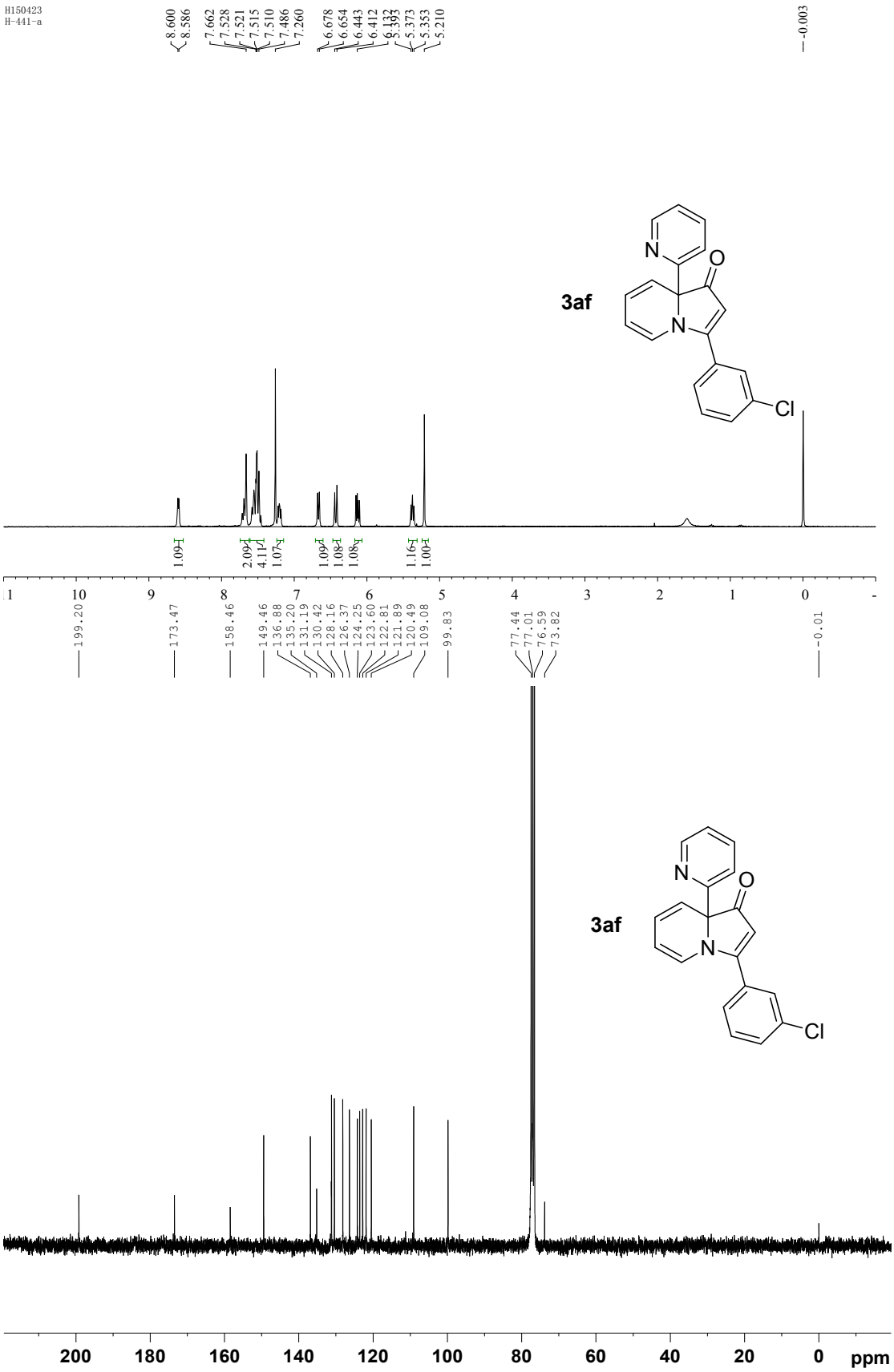
199.128
172.301
158.247
149.338
137.041
129.421
124.282
123.916
123.789
122.972
121.715
109.430
100.556
77.446
77.022
76.599
73.922

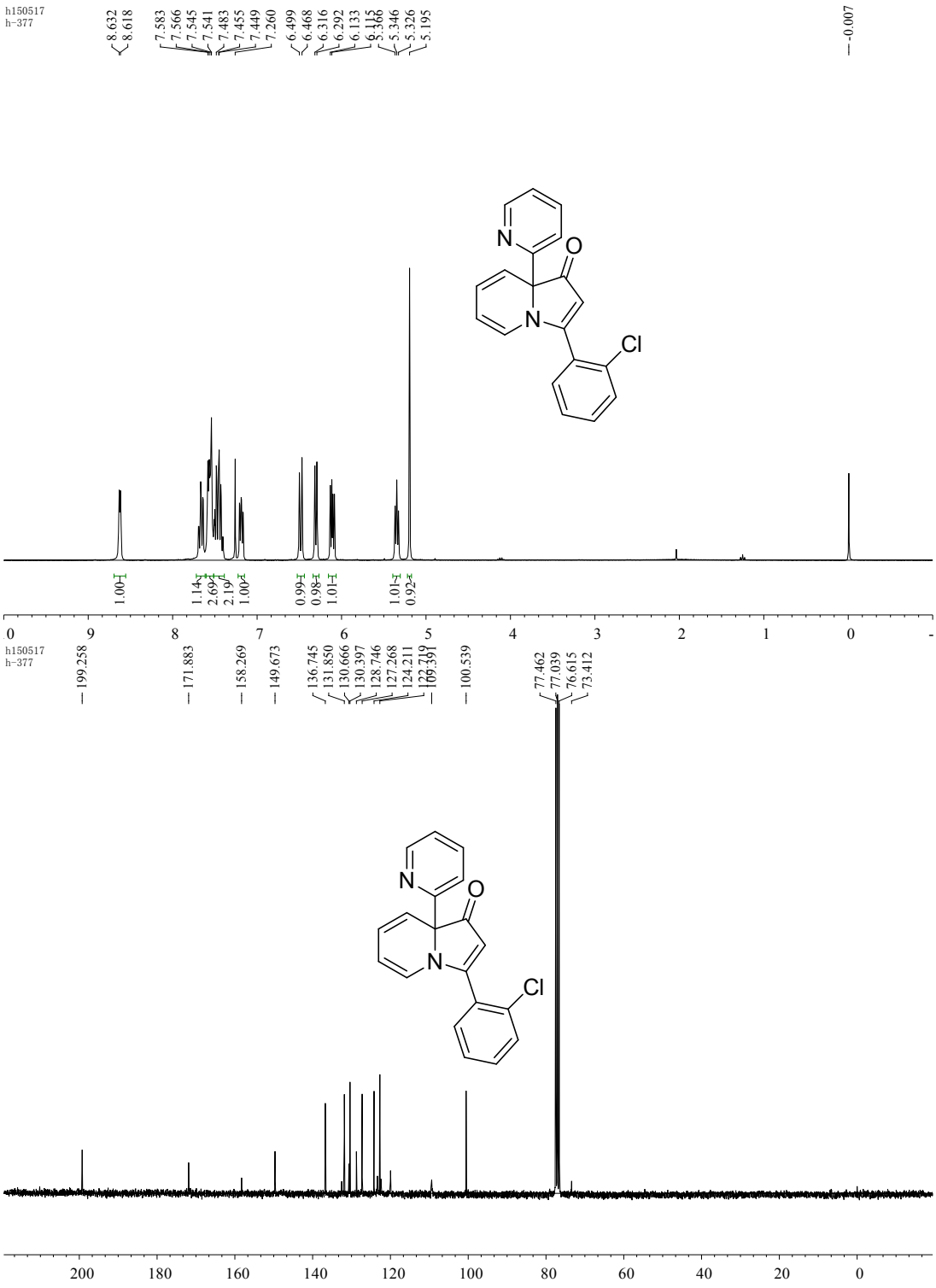


3ad


h150512
h-376
8.584
8.571
7.673
7.634
7.606
7.536
7.508
7.483
7.260
6.674
6.650
6.439
6.408
6.143
6.125
5.378
5.358
5.336
5.194
-0.004
3ae
N
O
N
Cl
1.00
3.15
2.93
0.99
1.06
1.04
1.07
1.04
1.00
0
9
8
7
6
5
4
3
2
1
0
h150512
h-376
199.130
173.914
158.530
149.402
136.884
129.560
129.437
124.336
123.588
122.794
121.918
120.513
109.005
99.635
77.450
77.027
76.604
73.818
3ae
N
O
N
Cl
200
180
160
140
120
100
80
60
40
20
0

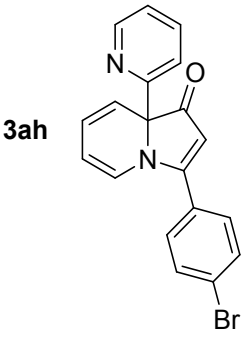
H150423
H-441-a



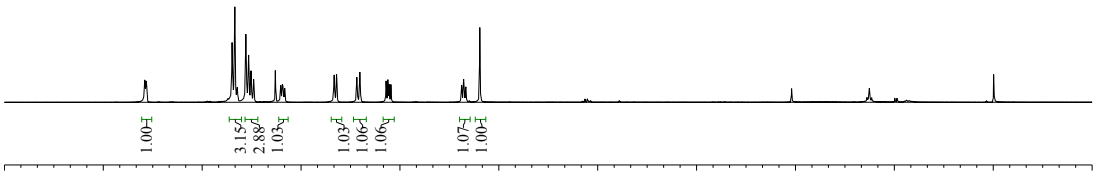

h150517
h-377
8.632
8.618
7.583
7.566
7.545
7.541
7.483
7.455
7.449
7.260
6.499
6.468
6.316
6.292
6.133
5.366
5.346
5.326
5.195
-0.007
N
O
N
Cl
1.00
1.14
2.69
2.19
1.00
0.99
0.98
1.01
1.01
0.92
0
9
8
7
6
5
4
3
2
1
0
h150517
h-377
199.258
171.883
158.269
149.673
136.745
131.850
130.666
130.397
128.746
127.268
124.211
100.539
77.462
77.039
76.615
73.412
N
O
N
Cl
200
180
160
140
120
100
80
60
40
20
0

H150507
H-365

8.580
8.566
7.697
7.670
7.558
7.530
7.506
7.480
7.260
6.665
6.641
6.436
6.405
6.140
6.122
5.375
5.355
5.333
5.192
-0.004

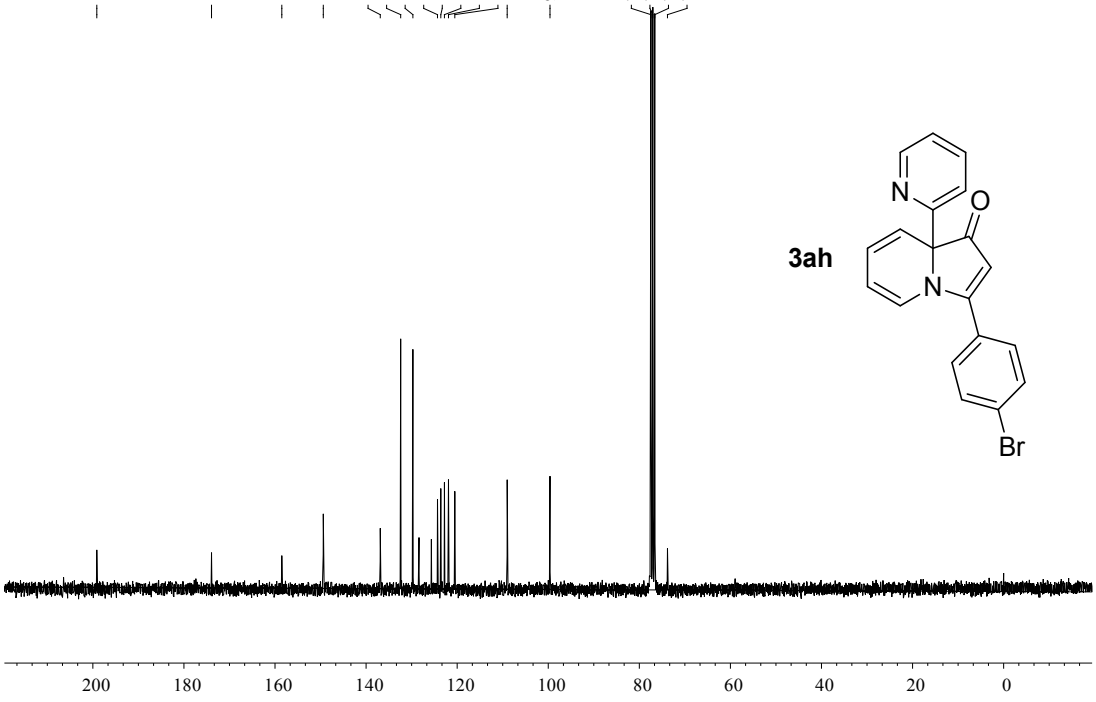


3ah



H150507
H-365

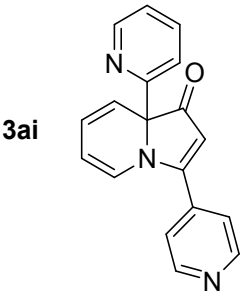
199.132
173.943
158.507
149.397
136.887
132.403
129.724
124.320
123.592
122.797
121.905
120.617
109.617
99.616
77.456
77.032
76.609
73.820



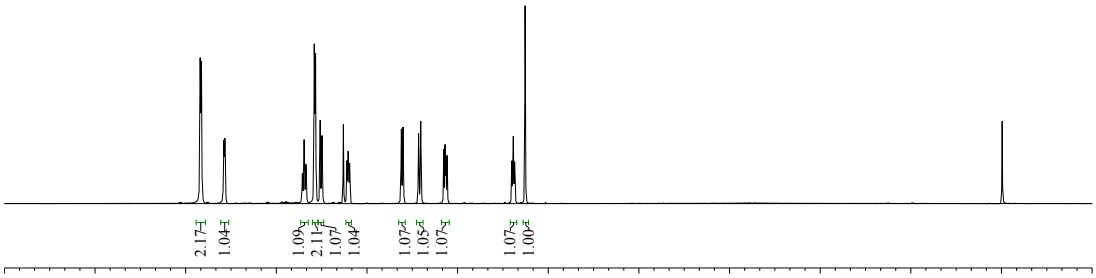
3ah

h150529
h-391

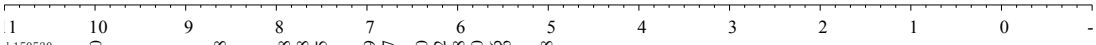
8.840
8.826
8.578
8.568
7.582
7.570
7.567
7.516
7.496
7.260
6.621
6.603
6.430
6.407
5.402
5.386
5.371
5.256
-0.008



3ai

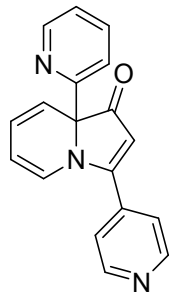


2.17
1.04
1.09
2.11
1.07
1.04
1.07
1.05
1.07
1.07
1.00



h150530
h-391

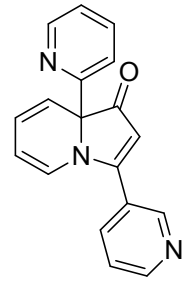
199.230
171.988
158.198
150.768
149.395
137.219
136.977
123.720
122.922
122.258
121.790
109.586
100.228
77.455
77.032
76.608
73.838



3ai

h150512
h-370

8.833
8.818
8.627
8.613
7.880
7.875
7.785
7.579
7.552
7.523
7.260
6.524
6.493
6.136
6.118
6.088
5.405
5.384
5.363
-0.006



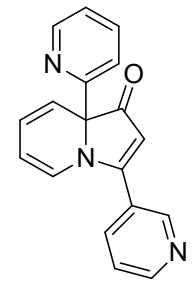
3aj

1.00
0.98
1.10
1.03
1.08
2.02
1.04
1.02
1.01
1.03
0.93
1.03

1 10 9 8 7 6 5 4 3 2 1 0 -

h150512
h-370

199.378
171.457
158.465
149.810
149.686
149.096
137.259
136.806
126.114
125.352
125.146
122.664
109.204
99.460
77.454
77.031
76.607
74.186

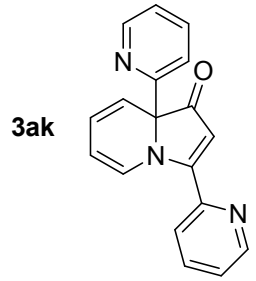


3aj

200 180 160 140 120 100 80 60 40 20 0

h150512
h-371

8.927
8.787
8.775
8.564
8.549
7.993
7.671
7.504
7.491
7.478
7.260
6.637
6.614
6.440
6.409
6.133
5.398
5.378
5.358
5.255
5.240
-0.006



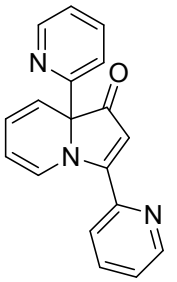
3ak

1.00
1.02
0.98
0.99
1.03
1.96
0.95
0.90
0.97
1.01
1.00
0.96

2 11 10 9 8 7 6 5 4 3 2 1 0 -

h150512
h-371

199.066
171.616
158.278
152.060
149.396
148.760
136.936
135.675
123.961
123.707
122.873
121.885
109.410
100.183
77.482
77.059
76.635
73.805

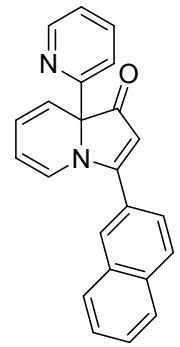


3ak

200 180 160 140 120 100 80 60 40 20 0

h150529
h-389-2

8.642
8.632
8.187
8.015
7.993
7.722
7.622
7.618
7.614
7.607
7.599
7.595
7.575
7.260
6.460
6.455
5.358
5.343
5.323
0.001



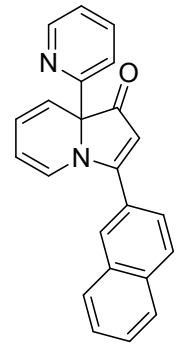
3al

1.05
1.08
1.21
2.33
2.28
3.39
1.09
1.09
1.08
1.11
1.08
1.00

1 10 9 8 7 6 5 4 3 2 1 0

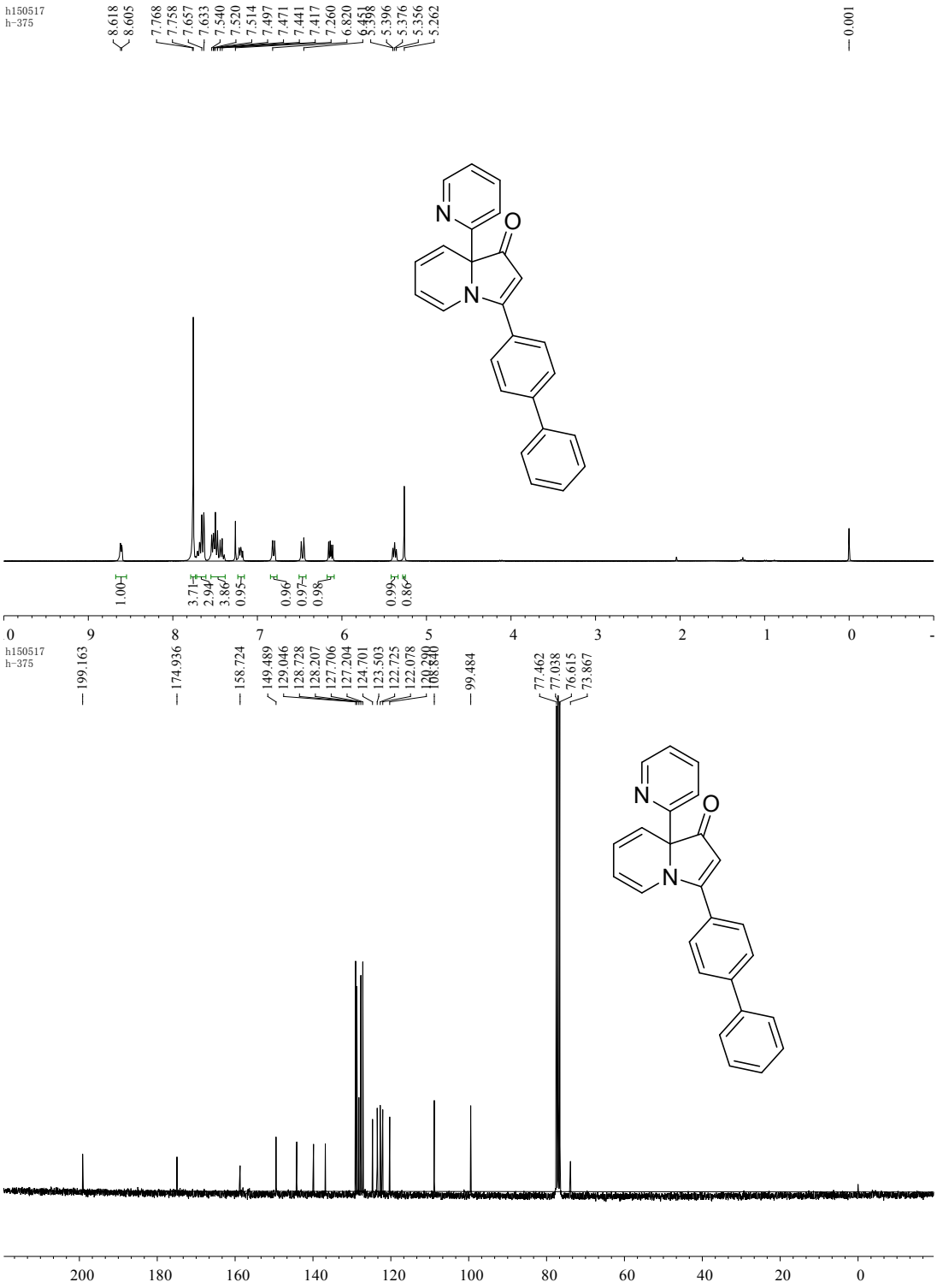
h150530
h-389

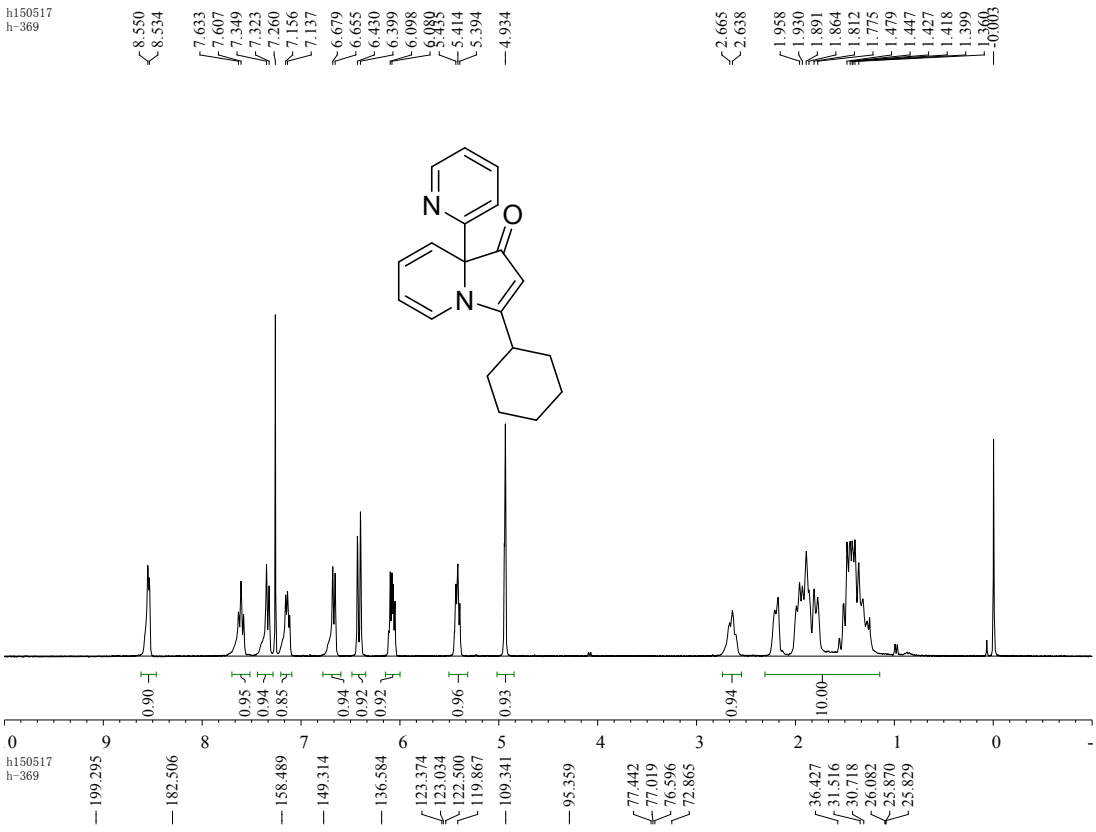
199.261
175.361
158.781
149.543
128.981
128.661
128.477
127.961
127.913
127.208
124.689
122.743
108.831
99.795
77.470
77.047
76.624
73.908

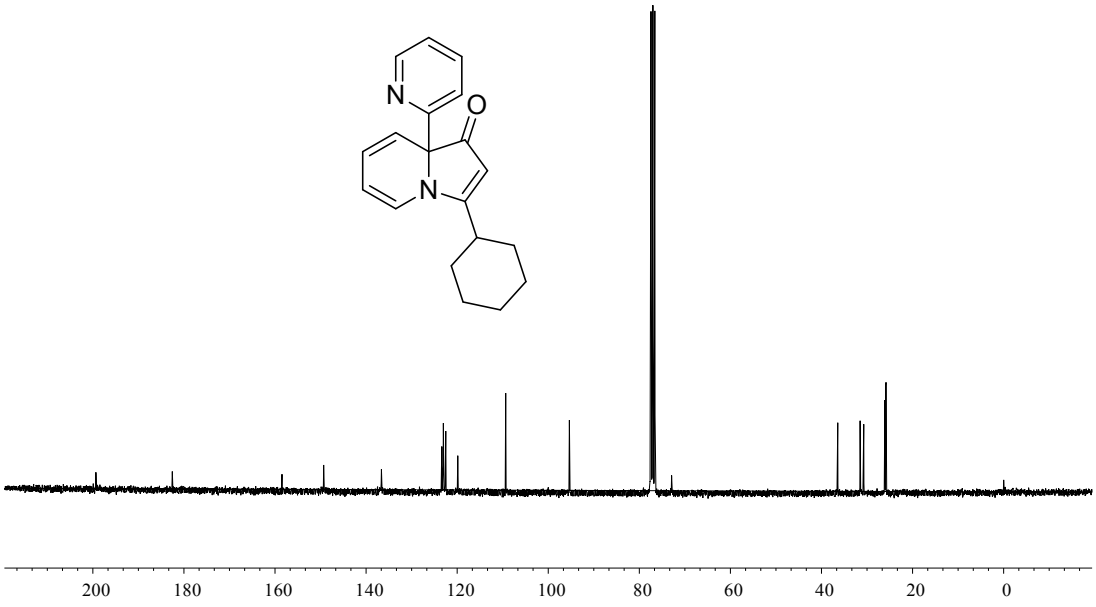


3al

200 180 160 140 120 100 80 60 40 20 0

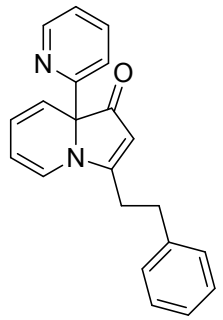

h150517
h-375
8.618
8.605
7.768
7.758
7.657
7.633
7.540
7.520
7.514
7.497
7.471
7.441
7.417
7.260
6.820
5.396
5.376
5.356
5.262
0.001
N
O
N
1.00
3.71
2.94
3.86
0.95
0.96
0.97
0.98
0.99
0.86
0
9
8
7
6
5
4
3
2
1
0
h150517
h-375
199.163
174.936
158.724
149.489
129.046
128.728
128.207
127.706
127.204
124.701
123.503
122.725
122.078
99.484
77.462
77.038
76.615
73.867
N
O
N
200
180
160
140
120
100
80
60
40
20
0


h150517
h-369
8.550
8.534
7.633
7.607
7.349
7.323
7.260
7.156
7.137
6.679
6.655
6.430
6.399
6.098
6.080
5.435
5.414
5.394
4.934
2.665
2.638
1.958
1.930
1.891
1.864
1.812
1.775
1.479
1.447
1.427
1.418
1.399
1.360
0.003
N
O
N
0.90
0.95
0.94
0.85
0.94
0.92
0.92
0.96
0.93
0.94
10.00
0
9
8
7
6
5
4
3
2
1
0


h150517
h-369
199.295
182.506
158.489
149.314
136.584
123.374
123.034
122.500
119.867
109.341
95.359
77.442
77.019
76.596
72.865
36.427
31.516
30.718
26.082
25.870
25.829
N
O
N
200
180
160
140
120
100
80
60
40
20
0

h150502
h-356

8.562
8.548
7.337
7.311
7.300
7.289
7.260
7.254
7.236
6.616
6.593
6.401
6.371
6.114
5.401
5.381
4.983
3.100
3.079
3.053
3.044
3.006
2.982
2.959
2.941
2.924
2.910
-0.008



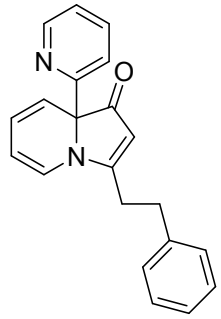
3an

1.00
1.13
3.02
1.70
1.04
0.92
0.94
0.99
0.98
0.89
4.10

1 10 9 8 7 6 5 4 3 2 1 0 -

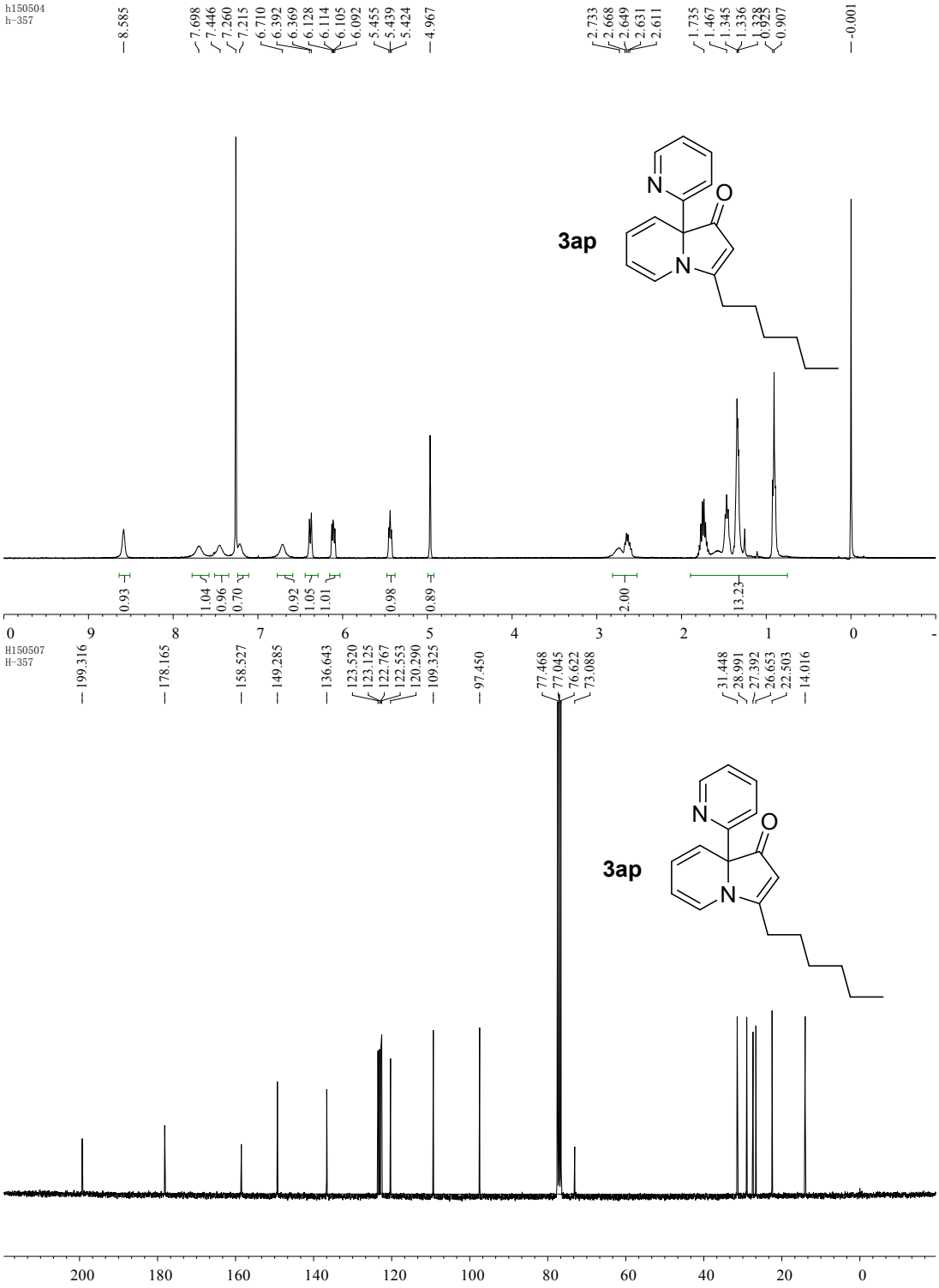
H150507
H-356

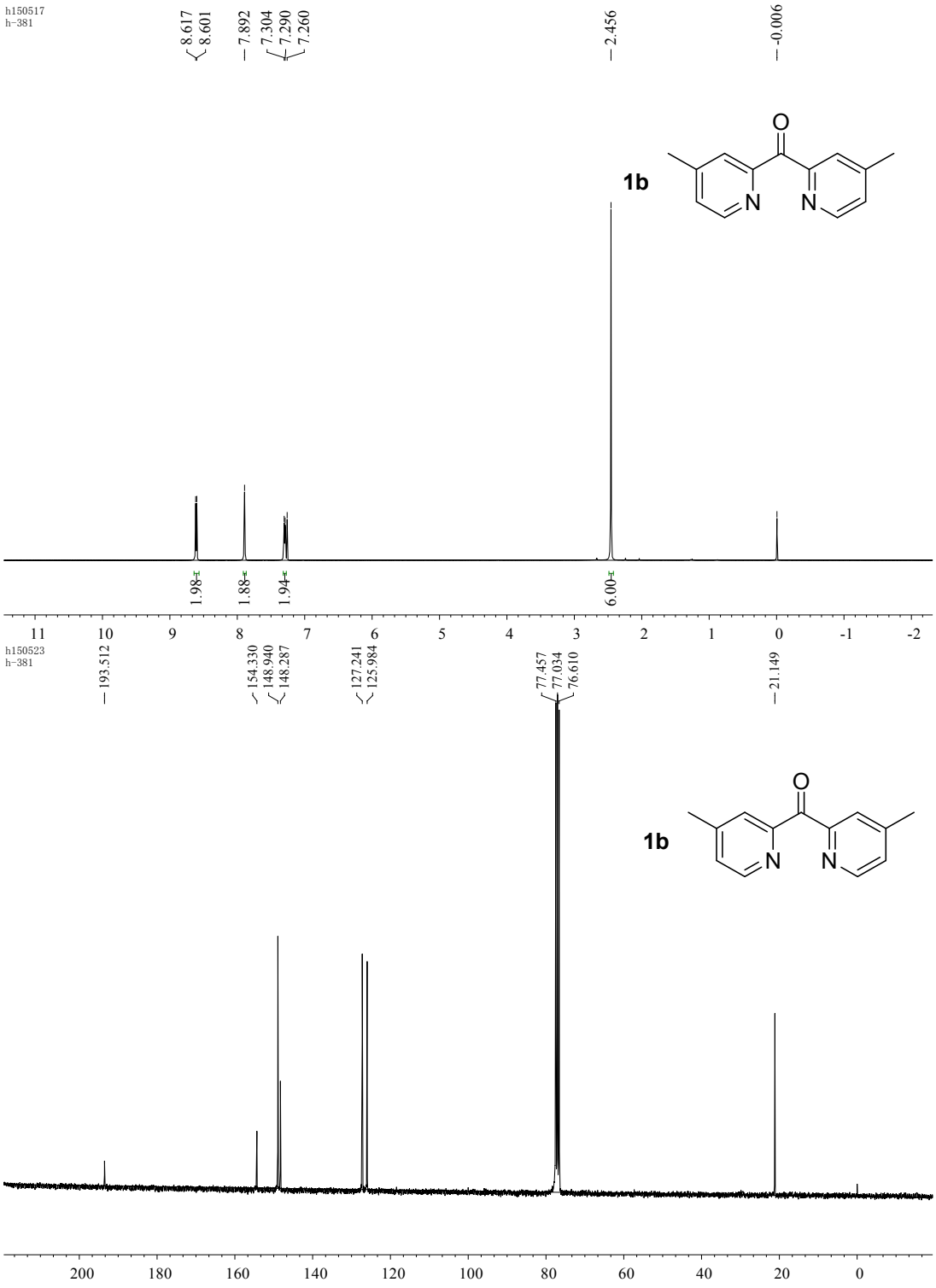
199.318
176.953
158.392
149.305
136.675
128.741
128.357
126.721
123.587
122.770
122.620
97.638
77.526
77.103
76.679
73.119
32.824
29.206

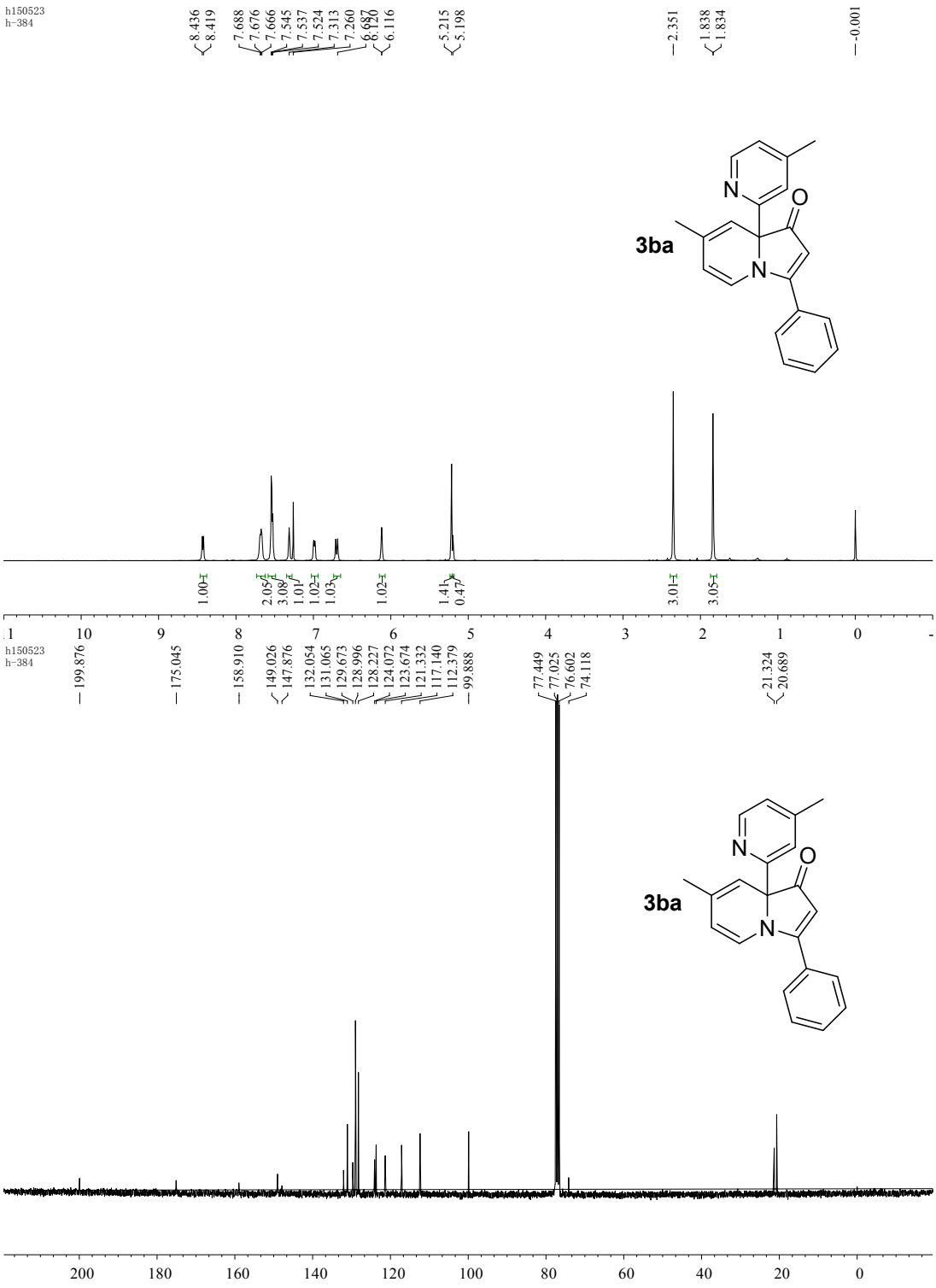


3an

200 180 160 140 120 100 80 60 40 20 0

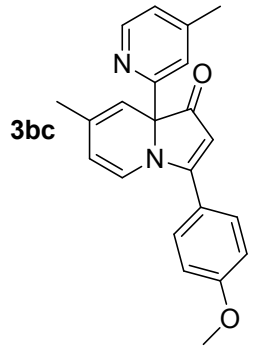

h150504
h-357
8.585
7.698
7.446
7.260
7.215
6.710
6.392
6.369
6.128
6.114
6.105
6.092
5.455
5.439
5.424
4.967
2.733
2.668
2.649
2.631
2.611
1.735
1.467
1.345
1.336
1.328
0.925
0.907
-0.001
3ap
0.93
1.04
0.96
0.70
0.92
1.05
1.01
0.98
0.89
2.00
13.23
H150507
H-357
199.316
178.165
158.527
149.285
136.643
123.520
123.125
122.767
122.553
120.290
109.325
97.450
77.468
77.045
76.622
73.088
31.448
28.991
27.392
26.653
22.503
14.016
3ap

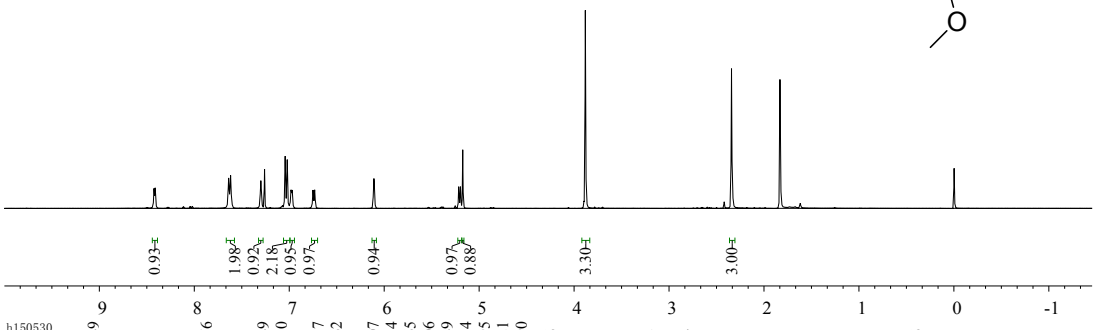

h150517
h-381
8.617
8.601
7.892
7.304
7.290
7.260
2.456
-0.006
1b
O
N
N
1.98
1.88
1.94
6.00
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
h150523
h-381
193.512
154.330
148.940
148.287
127.241
125.984
77.457
77.034
76.610
21.149
1b
O
N
N
200
180
160
140
120
100
80
60
40
20
0


h150523
h-384
8.436
8.419
7.688
7.676
7.666
7.545
7.537
7.524
7.313
7.260
6.687
6.120
6.116
5.215
5.198
2.351
1.838
1.834
-0.001
3ba
1.00
2.05
3.08
1.01
1.02
1.03
1.02
1.41
0.47
3.01
3.05
h150523
h-384
199.876
175.045
158.910
149.026
147.876
132.054
131.065
129.673
128.996
128.227
124.072
123.674
121.332
117.140
112.379
99.888
77.449
77.025
76.602
74.118
21.324
20.689
3ba

h150529
h-386

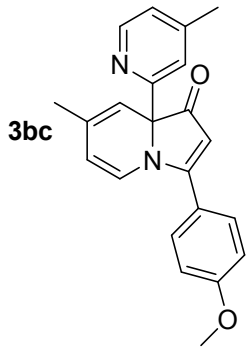
8.424
8.412
7.638
7.617
7.299
7.260
7.043
7.021
6.981
6.970
6.750
6.732
6.108
5.215
5.197
5.173
3.882
2.342
1.832
-0.003

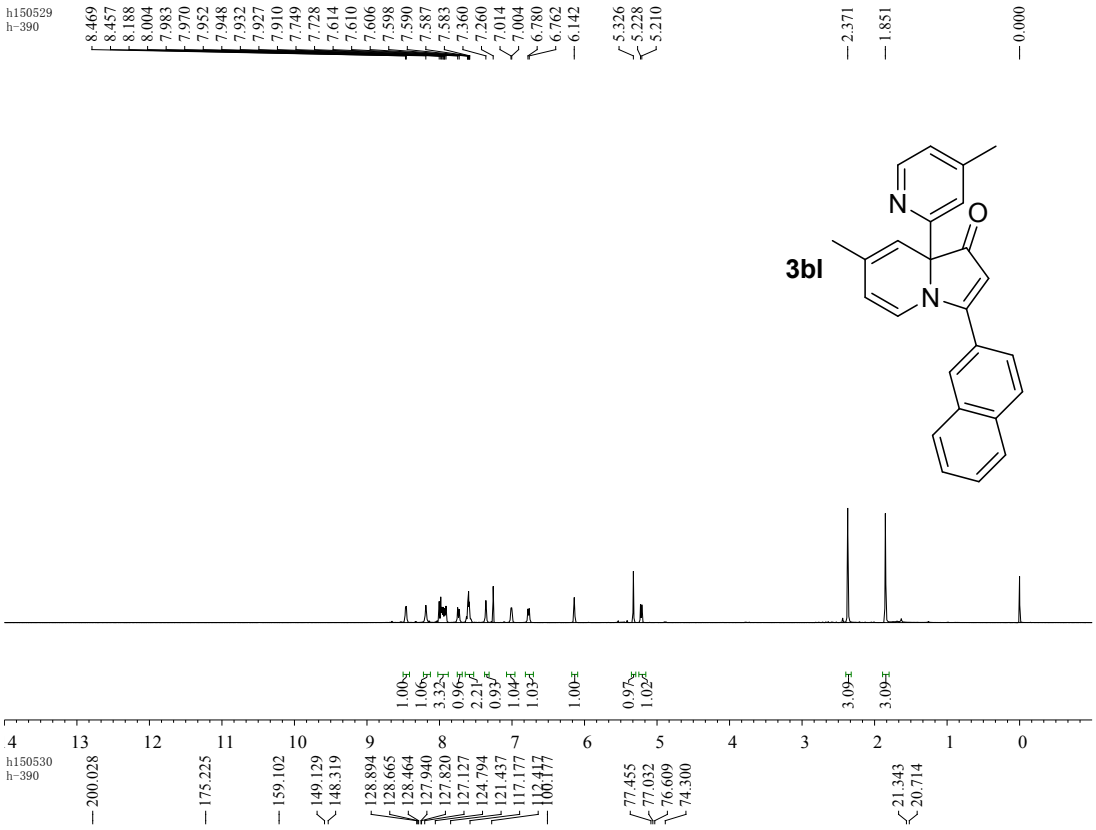


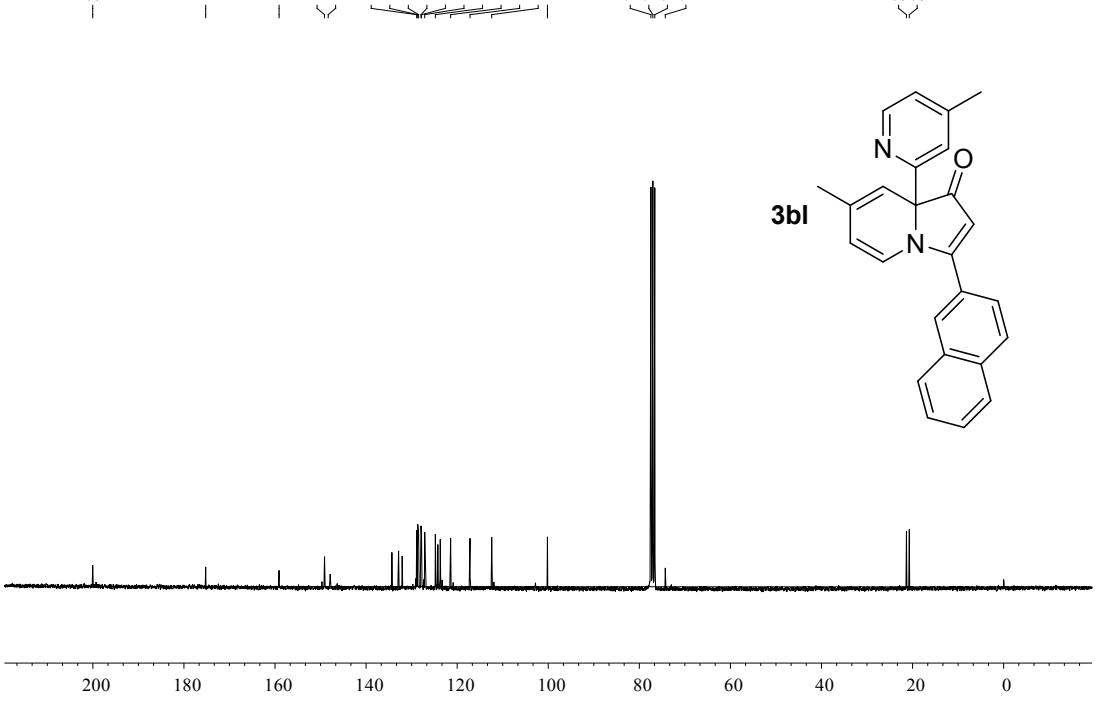


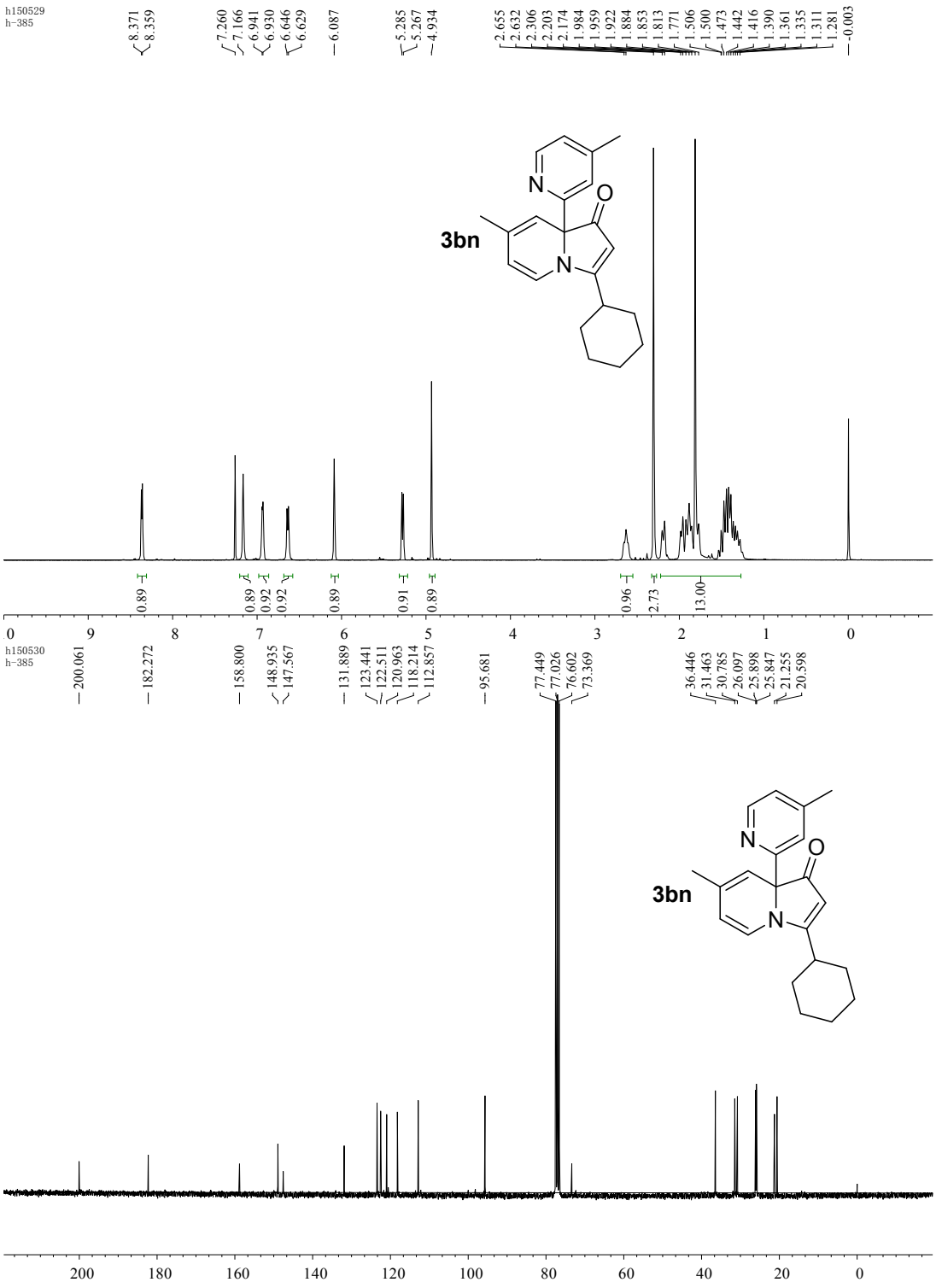
h150530
h-386

199.749
174.976
161.849
159.180
149.087
147.762
131.907
129.914
124.265
123.606
121.849
121.284
117.295
114.421
112.290
99.226
77.455
77.032
76.608
74.214
55.483
21.308
20.676



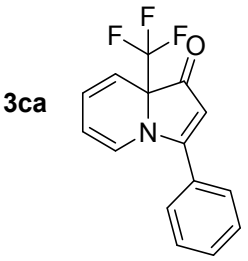

h150529
h-390
8.469
8.457
8.188
8.004
7.983
7.970
7.952
7.948
7.932
7.927
7.910
7.749
7.728
7.614
7.610
7.606
7.598
7.590
7.587
7.583
7.360
7.260
7.014
7.004
6.780
6.762
6.142
5.326
5.228
5.210
2.371
1.851
0.000
3bl
N
O
N
1.00
1.06
3.32
0.96
2.21
0.93
1.04
1.03
1.00
0.97
1.02
3.09
3.09
4
13
12
11
10
9
8
7
6
5
4
3
2
1
0


h150530
h-390
200.028
175.225
159.102
149.129
148.319
128.894
128.665
128.464
127.940
127.820
127.127
124.794
121.437
117.177
100.177
77.455
77.032
76.609
74.300
21.343
20.714
3bl
N
O
N
200
180
160
140
120
100
80
60
40
20
0

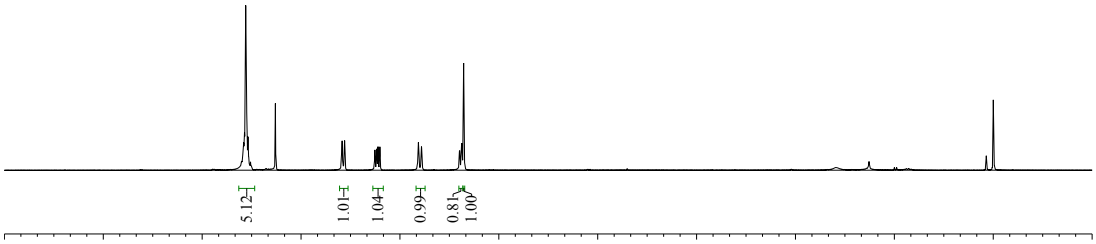

h150529
h-385
8.371
8.359
7.260
7.166
6.941
6.930
6.646
6.629
6.087
5.285
5.267
4.934
2.655
2.632
2.306
2.203
2.174
1.984
1.959
1.922
1.884
1.853
1.813
1.771
1.506
1.500
1.473
1.442
1.416
1.390
1.361
1.335
1.311
1.281
-0.003
3bn
0.89
0.89
0.92
0.92
0.89
0.91
0.89
0.96
2.73
13.00
h150530
h-385
200.061
182.272
158.800
148.935
147.567
131.889
123.441
122.511
120.963
118.214
112.857
95.681
77.449
77.026
76.602
73.369
36.446
31.463
30.785
26.097
25.898
25.847
21.255
20.598
3bn

H150528
H-399

7.602
7.585
7.580
7.572
7.560
7.553
7.537
7.521
7.511
7.260
6.587
6.584
6.562
6.560
5.813
5.782
5.399
5.396
5.375
5.371
5.356
-0.001

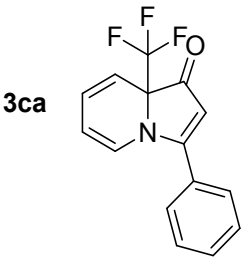


3ca

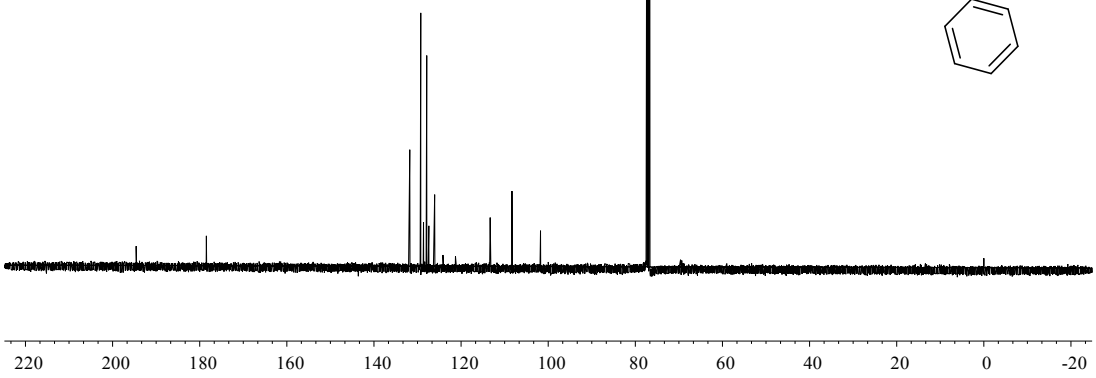


40

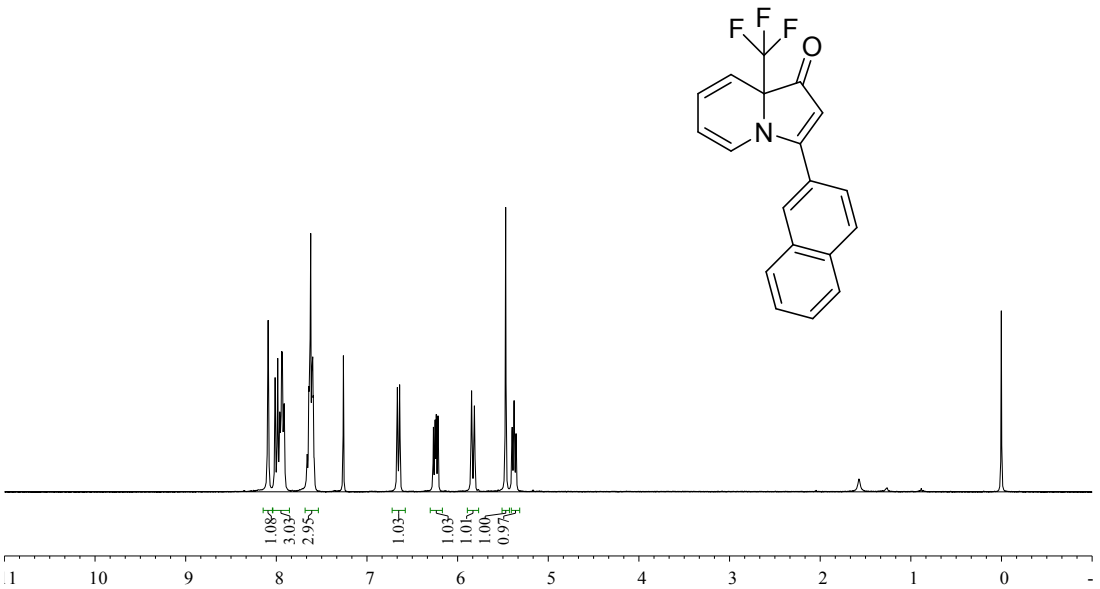
194.592
178.471
131.777
129.254
128.621
127.882
127.401
126.066
124.164
121.286
113.320
108.318
101.764
101.749
77.323
77.006
76.688
69.619

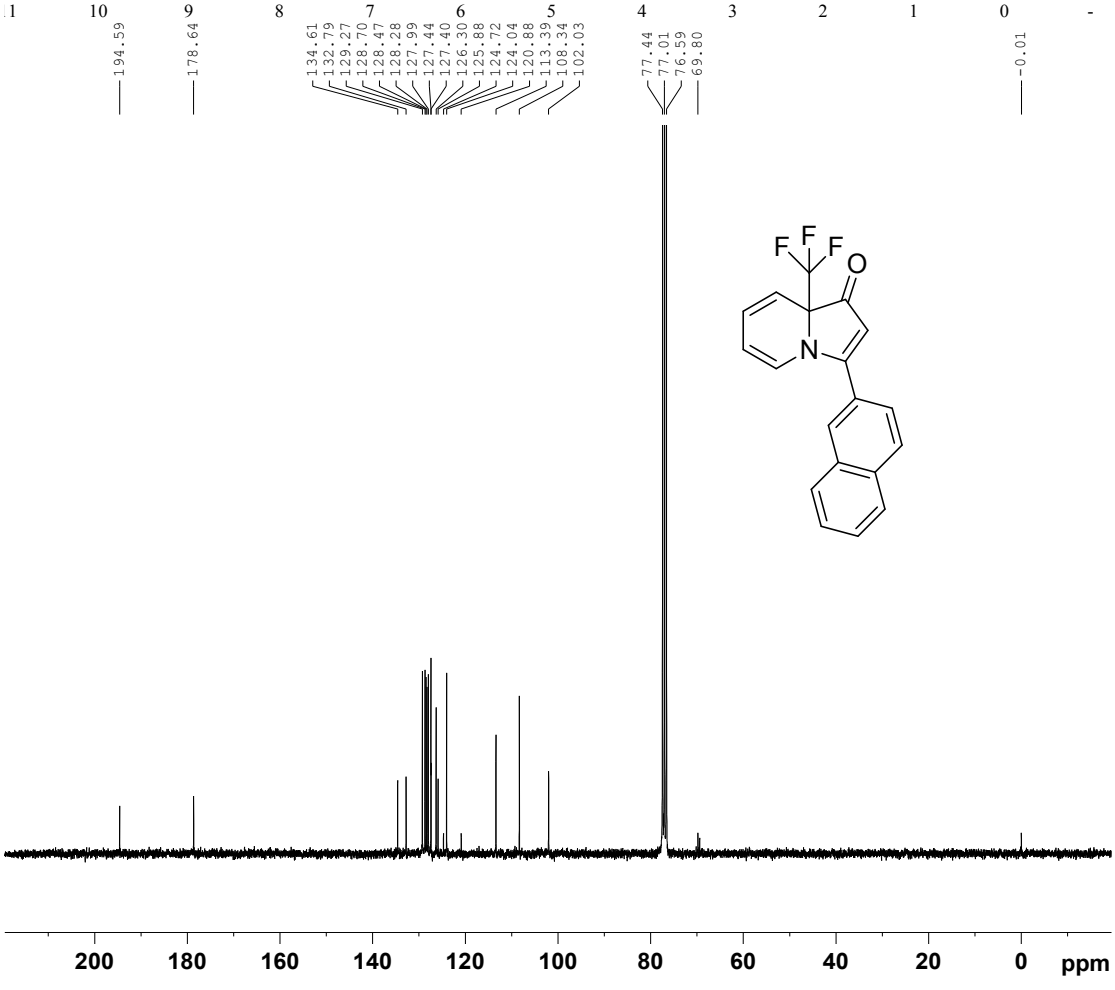


3ca

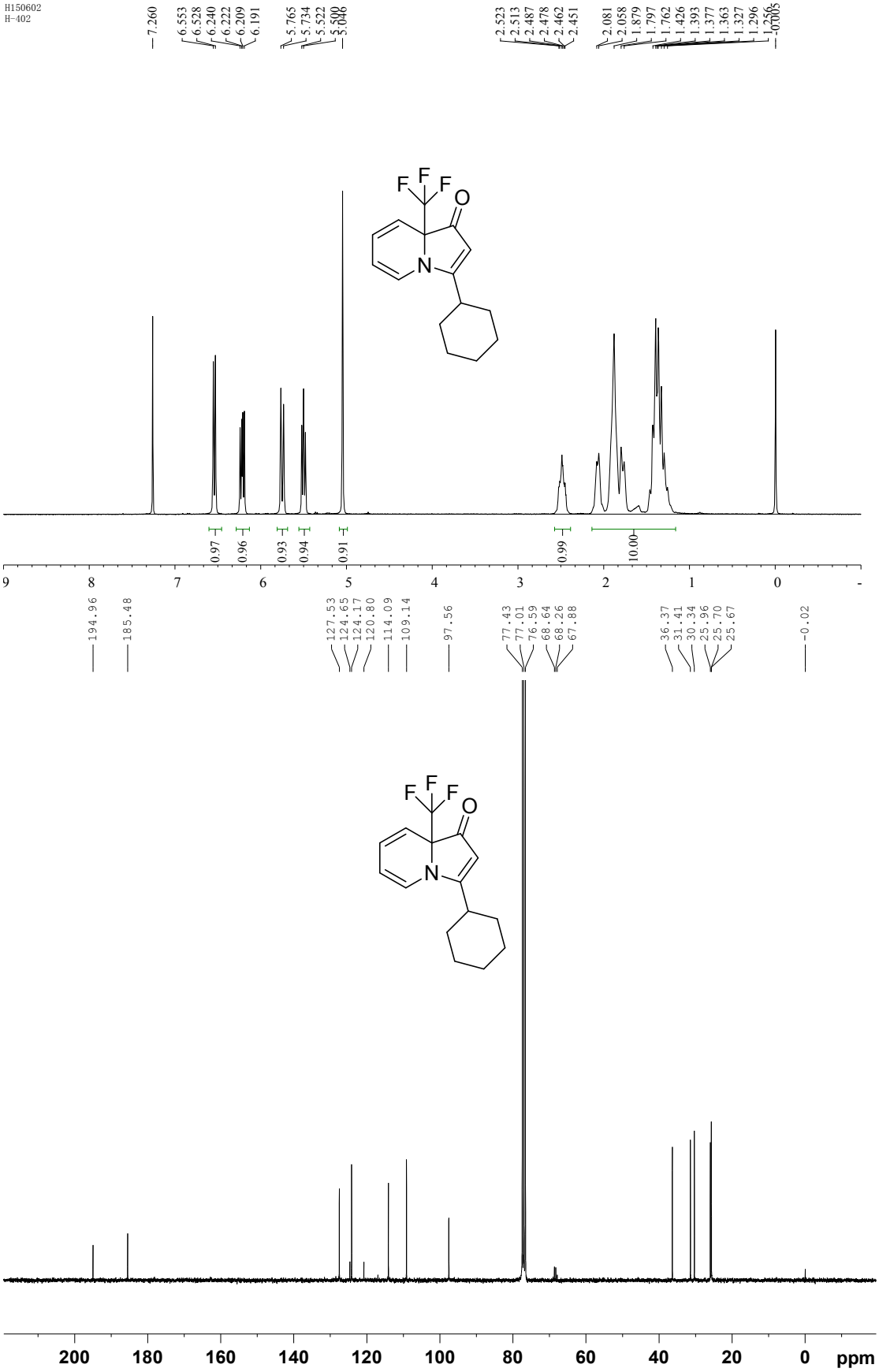


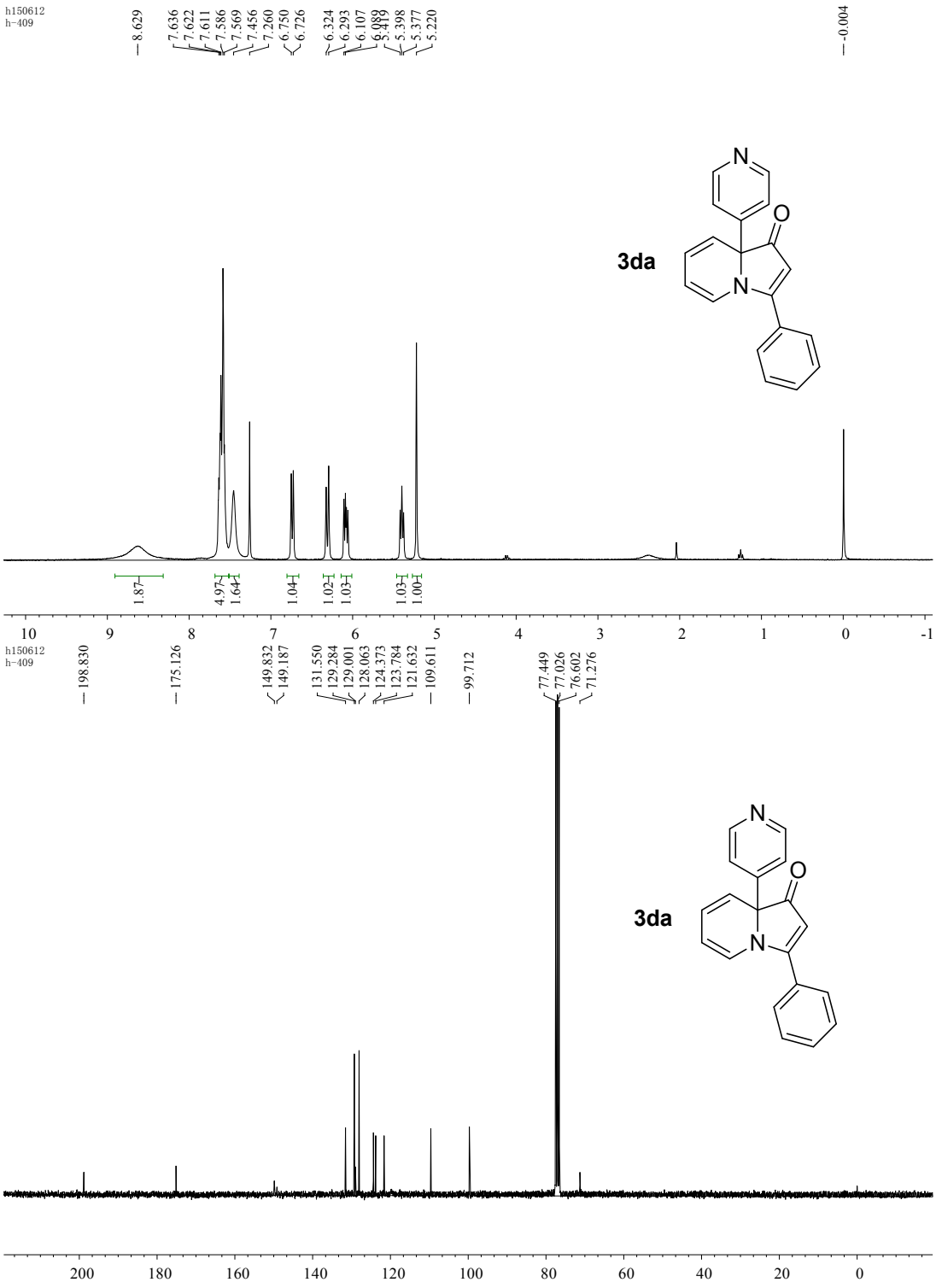
H150602
H-401





H150602
H-402

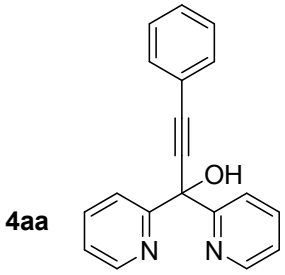



h150612
h-409
8.629
7.636
7.622
7.611
7.586
7.569
7.456
7.260
6.750
6.726
6.324
6.293
6.107
5.398
5.377
5.220
-0.004
3da
1.87
4.97
1.64
1.04
1.02
1.03
1.03
1.00
198.830
175.126
149.832
149.187
131.550
129.284
129.001
128.063
124.373
123.784
121.632
109.611
99.712
77.449
77.026
76.602
71.276
3da

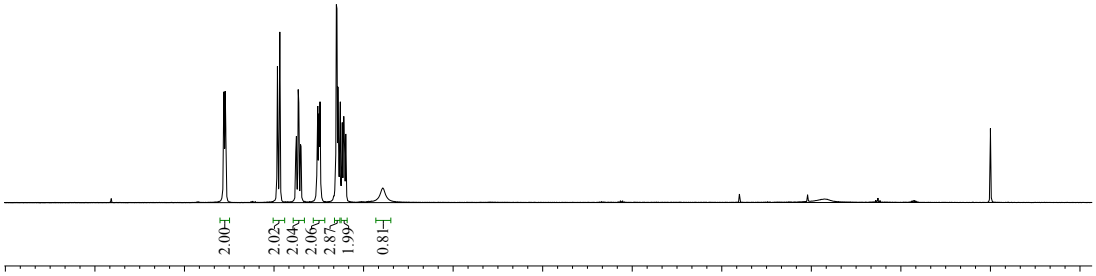
h150624
h-434

8.559
8.545
7.962
7.935
7.755
7.750
7.730
7.725
7.704
7.698
7.519
7.512
7.500
7.497
7.486
7.304
7.298
7.287
7.281
7.267
7.260
7.238
7.221
7.216
7.199
6.785

-0.000



4aa

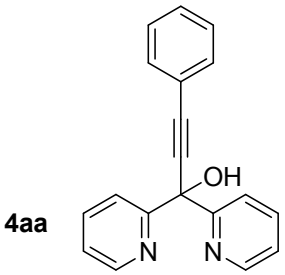


2.00
2.02
2.04
2.06
2.87
1.99
0.81

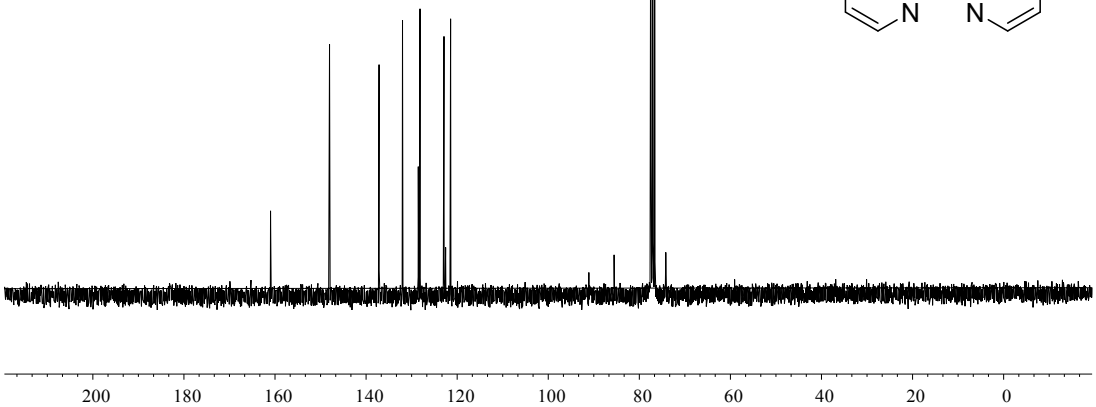
11 10 9 8 7 6 5 4 3 2 1 0 -1

h150624
h-434

160.980
148.028
137.152
132.004
128.542
128.157
122.893
122.535
121.440
91.079
85.541
77.462
77.039
76.616
74.188



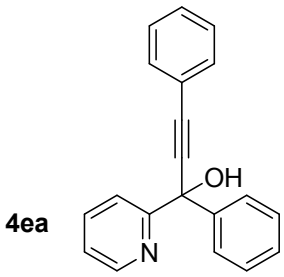
4aa



200 180 160 140 120 100 80 60 40 20 0

h150620
h-427

8.555
8.544
7.718
7.701
7.687
7.667
7.664
7.525
7.520
7.501
7.481
7.370
7.352
7.327
7.322
7.313
7.310
7.302
7.284
7.255
7.246
7.233
6.619
0.000



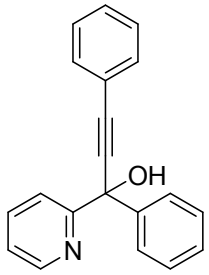
4ea

1.00
2.97
3.00
7.46
0.76

16 14 12 10 8 6 4 2 0 -2

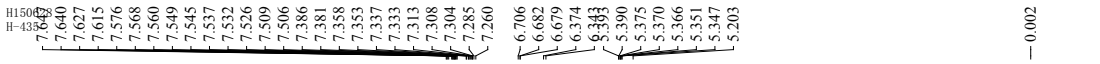
h150620
h-427

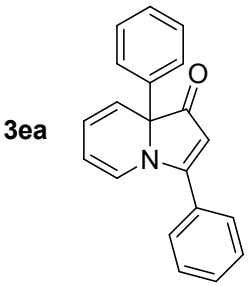
161.189
146.901
144.172
137.578
131.871
128.599
128.336
128.252
127.937
126.454
122.874
122.532
121.796
90.996
86.602
77.327
77.010
76.692
73.618

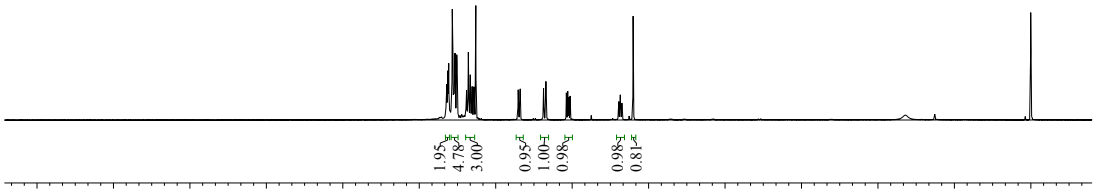


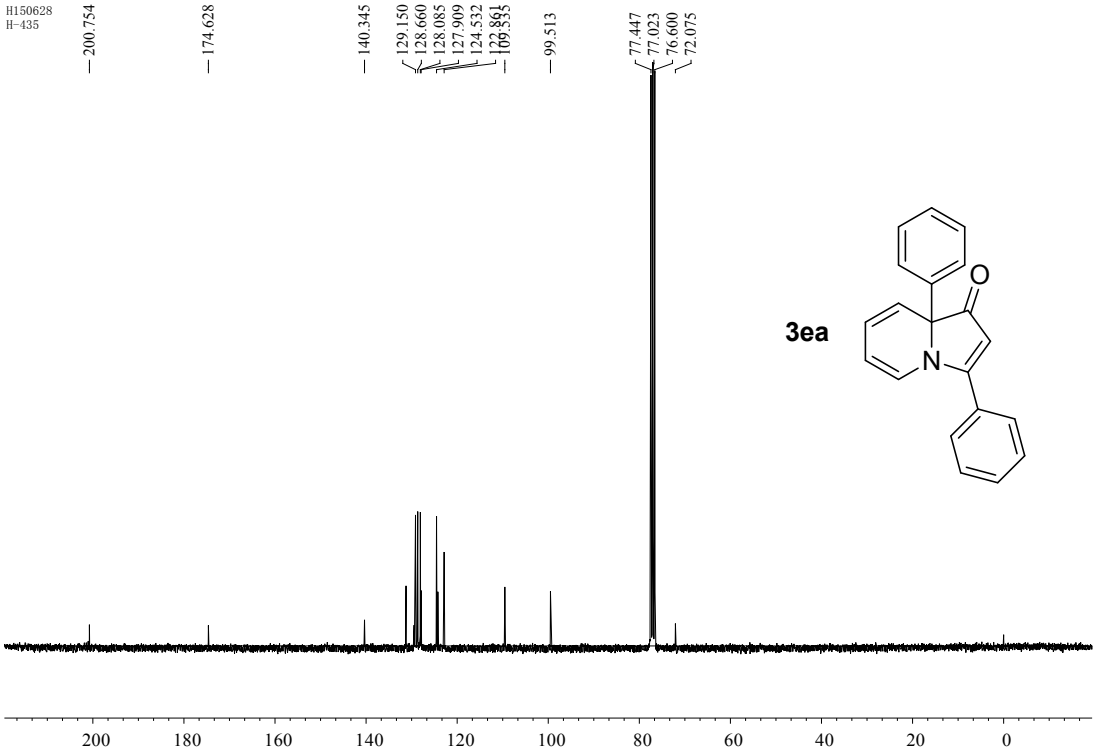
4ea

200 180 160 140 120 100 80 60 40 20 0


H150628
H-435
7.644
7.640
7.627
7.615
7.576
7.568
7.560
7.549
7.545
7.537
7.532
7.526
7.509
7.506
7.386
7.381
7.358
7.353
7.337
7.333
7.313
7.308
7.304
7.285
7.260
6.706
6.682
6.679
6.374
5.390
5.375
5.370
5.366
5.351
5.347
5.203
0.002


3ea
O
N


1.95
4.78
3.00
0.95
1.00
0.98
0.98
0.81
13
12
11
10
9
8
7
6
5
4
3
2
1
0


H150628
H-435
200.754
174.628
140.345
129.150
128.660
128.085
127.909
124.532
99.513
77.447
77.023
76.600
72.075
200
180
160
140
120
100
80
60
40
20
0

3ea
O
N