Supporting Information

Synthesis of Fused Indoline Heterocycles via Dearomatization of Indoles with α-Bromohydrazones: A Systematic Study on the Substrates

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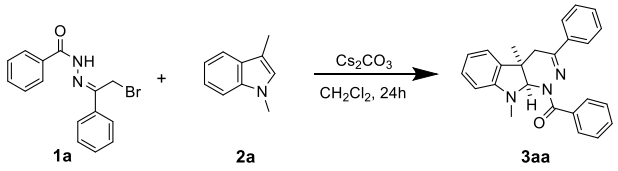
Experimental Section:

General

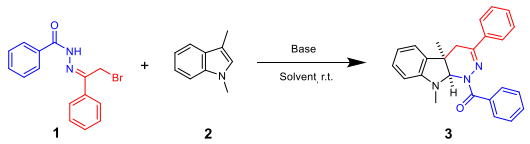
Unless otherwise stated, all reagents were purchased from commercial suppliers and used without further purification. All reactions were carried out in air and using undistilled solvent, without need of precautions to exclude air and moisture unless otherwise noted. Melting points were recorded on an Electrothermal digital melting point apparatus. IR spectra were recorded on a FT-IR spectrophotometer using KBr optics. ^{1}H, ^{13}C NMR spectra were recorded in $CDCl_3$ on 400 MHz spectometers. Tetramethylsilane (TMS) served as internal standard for ^{1}H NMR and ^{13}C NMR. High resolution mass spectra were obtained using a commercial apparatus (ESI or EI Source).

General procedure for assembly of indoline derivatives



α-bromohydrazone **1a** (0.5 mmol), 1,3-dimethly indole **2a** (0.7 mmol), Cs_2CO_3 (0.5 mmol) was stirred at room temperature under air atmosphere in 3 mL of dichloromethane. Upon completion of the reaction (indicated by TLC), solvent was removed in vacuum and the residue was purified by flash silica gel column chromatography using petroleum ether/ethyl acetate as eluent, affording pure product **3aa**.

Table S1 Optimization of the reaction conditions[a]

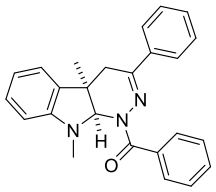


1 2 3

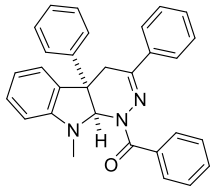
Entry	Base (equiv)	Solvent	Time (h)	Yield [b] (%)
1	Na_2CO_3 (1.3)	CH_2Cl_2	12	82
2	Na_2CO_3 (1.3)	CH_2Cl_2	18	85
3	Na_2CO_3 (1.3)	CH_2Cl_2	24	88(72c)
4	Na_2CO_3 (1.3)	CH_3CN	24	82
5	Na_2CO_3 (1.3)	THF	24	59
6	Na_2CO_3 (1.3)	toluene	24	61
7	Na_2CO_3 (1.3)	DMF	24	70
8	Na_2CO_3 (1.3)	1,4-dioxane	24	74
9	Na_2CO_3 (1.3)	DMSO	24	67
10	$KOBu^t$ (1.3)	CH_2Cl_2	24	30
11	$NaOBu^t$ (1.3)	CH_2Cl_2	24	26
12	$LiOBu^t$ (1.3)	CH_2Cl_2	24	12
13	$^iPr_2NH$ (1.3)	CH_2Cl_2	24	25
14	NaOH (1.3)	CH_2Cl_2	24	78
15	$NaHCO_3$ (1.3)	CH_2Cl_2	24	25
16	K_2CO_3 (1.3)	CH_2Cl_2	24	83
17	KOH (1.3)	CH_2Cl_2	24	76
18	$Na_3PO_4·12H_2O$ (1.3)	CH_2Cl_2	24	94
19	$K_3PO_4·3H_2O$ (1.3)	CH_2Cl_2	24	79
20	Cs_2CO_3 (1.3)	CH_2Cl_2	24	95
21	Cs_2CO_3 (0.5)	CH_2Cl_2	24	78
22	Cs_2CO_3 (1.0)	CH_2Cl_2	24	95(81c)
23	Cs_2CO_3 (1.7)	CH_2Cl_2	24	93

[a]Reaction conditions: **1a** (0.3mmol), **2a** (0.5mmol), Cs_2CO_3 (1.0equiv) and CH_2Cl_2 (3mL). [b]LC yields. The yields were determined by LC analysis using biphenyl as the internal standard. [c]Isolated yields.

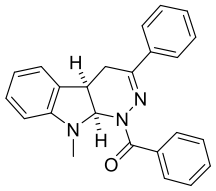
Analytical and spectral data of products:



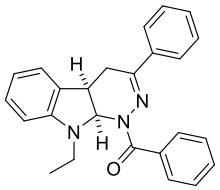
((4aR,9aR)-4a,9-dimethyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)methanone (3aa): Yield = 81% (154mg). White solid. M.p. 105.7-107.2 °C. IR (KBr) ν = 2984, 2928, 1667, 1322, 1112, 923, 743, 722, 684 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.88–7.71 (m, 2H), 7.58–7.41 (m, 5H), 7.31–7.23 (m, 3H), 7.22–7.09 (m, 2H), 6.86–6.74 (m, 1H), 6.58 (d, *J* = 7.8 Hz, 1H), 5.73 (s, 1H), 2.88 (s, 3H), 2.62 (d, *J* = 2.7 Hz, 2H), 1.41 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 172.1, 150.1, 149.0, 136.1, 135.2, 134.9, 130.1, 129.4, 129.1, 128.1, 128.0, 127.0, 125.2, 120.5, 118.5, 108.0, 76.7, 38.1, 33.3, 33.3, 21.2 ppm. HRMS m/z: calcd for $C_{25}H_{24}N_3O$ $[M+H]^+$ 382.1919, found: 382.1920.



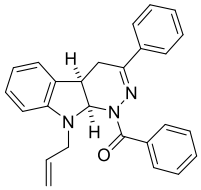
((4aS,9aR)-9-methyl-3,4a-diphenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)methanone (3ab): Yield = 44% (97mg). White solid. M.p. 145.7-146.8 °C. IR (KBr) ν = 2921, 1656, 1395, 1342, 1020, 939, 751, 702, 689, 650 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.62–7.52 (m, 4H), 7.40–7.26 (m, 4H), 7.25–7.21 (m, 6H), 7.14 (dd, *J* = 16.5, 8.7 Hz, 2H), 6.91 (d, *J* = 7.2 Hz, 1H), 6.73 (t, *J* = 7.4 Hz, 1H), 6.59 (d, *J* = 7.8 Hz, 1H), 5.96 (s, 1H), 3.25 (d, *J* = 17.7 Hz, 1H), 2.85 (s, 3H), 2.79 (d, *J* = 17.7 Hz, 1H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 171.8, 149.9, 149.1, 140.8, 135.7, 135.0, 134.7, 130.1, 129.3, 129.2, 128.3, 128.3, 128.1, 127.1, 127.0, 126.9, 125.3, 122.4, 119.0, 108.6, 78.0, 46.4, 33.4, 31.7 ppm. HRMS m/z: calcd for $C_{30}H_{26}N_3O$ $[M+H]^+$ 444.2076, found: 444.2081.



((4aR,9aR)-9-methyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl) methanone (3ac): Yield = 71% (130mg). White solid. M.p. 124.7-125.1 ºC. IR (KBr) ν = 3051, 2956, 1642, 1389, 1338, 737, 712, 688, 644 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.83–7.72 (m, 2H), 7.54–7.41 (m, 5H), 7.33–7.25 (m, 3H), 7.16 (dd, *J* = 17.7, 7.5 Hz, 2H), 6.75 (t, *J* = 7.4 Hz, 1H), 6.51 (d, *J* = 7.8 Hz, 1H), 6.23 (d, *J* = 7.6 Hz, 1H), 3.59–3.48 (m, 1H), 3.01–2.80 (m, 4H), 2.62 (dd, *J* = 16.9, 7.6 Hz, 1H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 171.6, 152.5, 149.8, 135.9, 134.9, 130.5, 130.1, 129.3, 129.2, 128.3, 128.0, 127.0, 125.3, 122.6, 118.2, 107.4, 70.6, 35.0, 33.0, 26.2 ppm. HRMS m/z: calcd for $C_{24}H_{22}N_3O$ $[M+H]^+$ 368.1763, found: 368.1760.

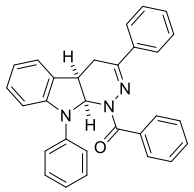


((4aR,9aR)-9-ethyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)m ethanone (3ad): Yield = 58% (110mg). White solid. M.p. 114.5-115.4 ºC. IR (KBr) ν = 2966, 1638, 1488, 1389, 1348, 1064, 909, 786, 747, 694 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.85–7.67 (m, 2H), 7.51 (dd, *J* = 8.0, 1.5 Hz, 2H), 7.49–7.39 (m, 3H), 7.34–7.25 (m, 3H), 7.16 (d, *J* = 7.2 Hz, 1H), 7.10 (t, *J* = 7.7 Hz, 1H), 6.69 (t, *J* = 7.4 Hz, 1H), 6.47 (dd, *J* = 14.3, 8.0 Hz, 2H), 3.66 (dd, *J* = 14.7, 7.3 Hz, 1H), 3.56–3.43 (m, 1H), 3.36–3.20 (m, 1H), 2.84 (dd, *J* = 16.6, 7.3 Hz, 1H), 2.69 (dd, *J* = 16.6, 6.6 Hz, 1H), 1.21 (t, *J* = 7.0 Hz, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 171.5, 154.2, 148.4, 135.8, 135.0, 130.4, 130.1, 129.2, 129.2, 128.2, 128.0, 127.0, 125.4, 122.7, 117.4, 107.0, 68.0, 38.8, 36.1, 26.6, 9.8 ppm. HRMS m/z: calcd for $C_{25}H_{24}N_3O$ $[M+H]^+$ 382.1919, found: 382.1927.

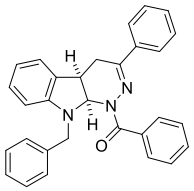


((4aR,9aR)-9-allyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)me thanone (3ae): Yield = 64% (114mg). White solid. M.p. 95.5-97.2 ºC. IR (KBr) ν = 2922, 1642, 1386, 1343, 928, 737, 718, 690, 643 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.76–7.66 (m, 2H), 7.53 (dd, *J* = 8.1, 1.5 Hz, 2H), 7.46 (d, *J* = 7.2 Hz, 1H), 7.41 (t, *J* = 7.2 Hz, 2H), 7.34–7.26 (m,

3H), 7.15 (s, 1H), 7.07 (t, *J* = 7.7 Hz, 1H), 6.69 (t, *J* = 7.4 Hz, 1H), 6.55 (d, *J* = 8.5 Hz, 1H), 6.43 (d, *J* = 7.8 Hz, 1H), 5.98–5.85 (m, 1H), 5.25 (dd, *J* = 17.2, 1.7 Hz, 1H), 5.12 (dd, *J* = 10.3, 1.6 Hz, 1H), 4.15 (dd, *J* = 16.9, 5.3 Hz, 1H), 3.98–3.76 (m, 2H), 2.84 (d, *J* = 6.6 Hz, 2H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 171.8, 155.9, 149.8, 136.2, 135.4, 133.6, 130.5, 130.2, 129.8, 129.7, 128.6, 128.5, 127.4, 125.9, 123.1, 118.1, 116.4, 107.6, 70.2, 48.8, 37.6, 27.1 ppm. HRMS m/z: calcd for $C_{26}H_{24}N_3O$ $[M+H]^+$ 394.1919, found: 394.1926.

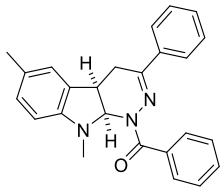


((4aR,9aR)-3,9-diphenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)metha none (3af): Yield = 53% (114mg). White solid. M.p. 155.9-157.6 ^{o}C. IR (KBr) ν = 3061, 1651, 1499, 1383, 1336, 1264, 1053, 743, 695, 650 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.57–7.49 (m, 2H), 7.47–7.26 (m, 12H), 7.24 (d, *J* = 8.1 Hz, 2H), 7.11–6.95 (m, 2H), 6.74 (t, *J* = 7.1 Hz, 1H), 6.45 (d, *J* = 7.9 Hz, 1H), 4.03 (dd, *J* = 12.9, 7.9 Hz, 1H), 2.96 (dd, *J* = 16.1, 5.0 Hz, 1H), 2.84 (dd, *J* = 16.1, 7.5 Hz, 1H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 170.1, 148.5, 140.7, 135.8, 134.7, 130.0, 129.7, 129.4, 128.9, 128.7, 128.0, 128.0, 126.8, 126.4, 125.8, 125.5, 123.1, 118.4, 107.8, 70.4, 38.2, 27.4 ppm. HRMS m/z: calcd for $C_{29}H_{24}N_3O$ $[M+H]^+$ 430.1919, found: 430.1926.

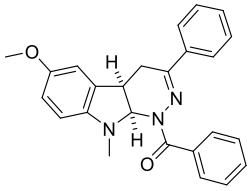


((4aR,9aR)-9-benzyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl) methanone (3ag): Yield = 58% (128mg). White solid. M.p. 144.9-145.6 ^{o}C. IR (KBr) ν = 3057, 2928, 1628, 1395, 905, 745, 708, 689, 647 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.54 (dd, *J* = 8.0, 1.5 Hz, 2H), 7.42–7.37 (m, 3H), 7.36–7.28 (m, 6H), 7.26–7.12 (m, 5H), 7.01 (t, *J* = 7.7 Hz, 1H), 6.69 (t, *J* = 7.4 Hz, 1H), 6.63 (d, *J* = 8.5 Hz, 1H), 6.32 (d, *J* = 7.8 Hz, 1H), 4.78 (d, *J* = 16.5 Hz, 1H), 4.45 (d, *J* = 16.5 Hz, 1H), 3.85 (dd, *J* = 14.5, 6.9 Hz, 1H), 2.94–2.81 (m, 2H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 171.4, 149.8, 138.7, 135.8, 134.8, 129.8, 129.7, 129.4, 128.9, 128.2, 128.0,

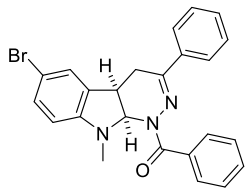
128.0, 126.8, 126.4, 126.2, 125.4, 122.7, 117.9, 106.8, 70.5, 50.5, 37.2, 30.5, 26.5 ppm. HRMS m/z: calcd for $C_{30}H_{26}N_3O$ $[M+H]^+$ 444.2076, found: 444.2079.



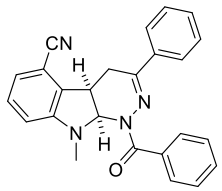
((4aR,9aR)-6,9-dimethyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)methanone (3ah): Yield = 69% (131mg). White solid. M.p. 131.8-133.2 °C. IR (KBr) ν = 2930, 1650, 1385, 1339, 1272, 924, 815, 761, 708, 693, 643 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.84–7.72 (m, 2H), 7.54 (dd, *J* = 7.8, 1.7 Hz, 2H), 7.49–7.41 (m, 3H), 7.35–7.26 (m, 3H), 7.06–6.93 (m, 2H), 6.46 (d, *J* = 7.9 Hz, 1H), 6.11 (d, *J* = 7.2 Hz, 1H), 3.44–3.30 (m, 1H), 3.01–2.76 (m, 4H), 2.52 (dd, *J* = 17.2, 8.3 Hz, 1H), 2.29 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 171.7, 150.9, 147.4, 136.0, 134.9, 131.1, 130.0, 129.3, 129.0, 128.4, 127.9, 127.8, 127.0, 125.2, 123.4, 107.8, 70.6, 34.1, 33.7, 26.0, 20.4 ppm. HRMS m/z: calcd for $C_{25}H_{24}N_3O$ $[M+H]^+$ 382.1919, found: 382.1930.



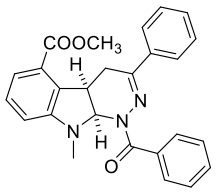
((4aR,9aR)-6-methoxy-9-methyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)methanone (3ai): Yield = 76% (151mg). White solid. M.p. 140.1-141.7 °C. IR (KBr) ν = 3264, 1638, 1515, 1493, 1226, 778, 727, 695 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.86–7.78 (m, 2H), 7.56 (dd, *J* = 7.8, 1.8 Hz, 2H), 7.53–7.41 (m, 4H), 7.34–7.26 (m, 3H), 7.24 (dd, *J* = 7.5, 5.1 Hz, 1H), 6.72 (d, *J* = 7.7 Hz, 1H), 6.10 (d, *J* = 6.8 Hz, 1H), 3.99–3.86 (m, 4H), 3.23 (dd, *J* = 17.8, 7.6 Hz, 1H), 2.87 (s, 3H), 2.34 (dd, *J* = 17.8, 9.1 Hz, 1H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 171.7, 150.9, 147.4, 136.0, 134.9, 131.1, 130.0, 129.3, 129.0, 128.4, 127.9, 127.8, 127.0, 125.2, 123.4, 107.8, 70.6, 34.1, 33.7, 26.0, 20.4 ppm. HRMS m/z: calcd for $C_{25}H_{24}N_3O_2$ $[M+H]^+$ 398.1869, found: 398.1878.



((4aR,9aR)-6-bromo-9-methyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)methanone (3aj): Yield = 76% (169mg). White solid. M.p. 136.5-137.6 ºC. IR (KBr) ν = 2930, 1652, 1386, 1334, 1261, 796, 761, 712, 695, 649 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.77 (dd, *J* = 8.2, 1.4 Hz, 2H), 7.56–7.41 (m, 5H), 7.37–7.26 (m, 4H), 7.23 (dd, *J* = 8.3, 2.0 Hz, 1H), 6.37 (d, *J* = 8.3 Hz, 1H), 6.24 (d, *J* = 7.6 Hz, 1H), 3.57–3.49 (m, 1H), 2.95–2.78 (m, 4H), 2.60 (dd, *J* = 16.9, 7.5 Hz, 1H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 171.5, 152.2, 148.8, 135.7, 134.6, 132.6, 130.9, 130.2, 129.3, 129.3, 128.0, 127.0, 125.6, 125.2, 109.6, 108.7, 70.4, 34.8, 32.8, 26.0 ppm. HRMS m/z: calcd for $C_{24}H_{21}BrN_3O$ $[M+H]^+$ 446.0868, found: 446.0862.

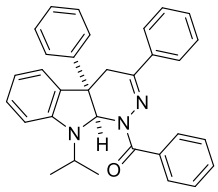


(4aR,9aR)-1-benzoyl-9-methyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indole-5-carbonitrile (3ak): Yield = 61% (120mg). White solid. M.p. 154.9-156.4 ºC. IR (KBr) ν = 2965, 1649, 1398, 1265, 922, 786, 767, 722, 694, 639 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.81–7.70 (m, 2H), 7.60–7.41 (m, 5H), 7.37–7.27 (m, 3H), 7.18 (t, *J* = 7.9 Hz, 1H), 6.93 (d, *J* = 7.6 Hz, 1H), 6.60 (d, *J* = 8.0 Hz, 1H), 6.45 (d, *J* = 8.2 Hz, 1H), 3.98 (dd, *J* = 14.9, 7.0 Hz, 1H), 2.97 (dd, *J* = 6.9, 3.8 Hz, 2H), 2.93 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 171.3, 154.5, 150.6, 135.2, 134.4, 133.6, 130.4, 129.7, 129.3, 129.2, 128.1, 127.1, 125.4, 120.4, 116.9, 110.3, 107.0, 70.3, 36.3, 32.2, 24.6 ppm. HRMS m/z: calcd for $C_{25}H_{21}N_4O$ $[M+H]^+$ 393.1715, found: 393.1720.

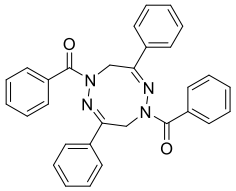


Methyl(4aR,9aR)-1-benzoyl-9-methyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indole-5-carboxylate (3al): Yield = 52% (111mg). White solid. M.p. 150.3-151.1 ºC. IR (KBr) ν = 2963, 1711, 1656, 1408, 1269, 1114, 920, 746, 695, 631 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ =

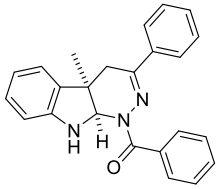
7.86–7.78 (m, 2H), 7.56 (dd, *J* = 7.8, 1.8 Hz, 2H), 7.53–7.41 (m, 4H), 7.34–7.26 (m, 3H), 7.24 (dd, *J* = 7.5, 5.1 Hz, 1H), 6.72 (d, *J* = 7.7 Hz, 1H), 6.10 (d, *J* = 6.8 Hz, 1H), 3.99–3.86 (m, 4H), 3.23 (dd, *J* = 17.8, 7.6 Hz, 1H), 2.87 (s, 3H), 2.34 (dd, *J* = 17.8, 9.1 Hz, 1H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 172.0, 166.3, 150.1, 150.0, 136.1, 134.8, 133.8, 130.1, 129.4, 129.0, 128.2, 127.9, 127.0, 125.2, 124.7, 119.7, 111.8, 70.0, 51.5, 33.5, 33.3, 24.2 ppm. HRMS m/z: calcd for $C_{26}H_{24}N_3O_3$ $[M+H]^+$ 426.1818, found: 426.1810.



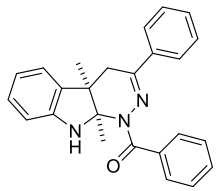
((4aS,9aR)-9-isopropyl-3,4a-diphenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)methanone (3am): Yield = 21% (49mg). White solid. M.p. 119.6-121.1 ^{o}C. IR (KBr) ν = 2924, 1661, 1474, 1387, 1330, 1232, 1021, 791, 755, 692 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.55 (t, *J* = 8.5 Hz, 4H), 7.41–7.28 (m, 4H), 7.27 (s, 2H), 7.25–7.13 (m, 5H), 7.06 (t, *J* = 7.3 Hz, 1H), 6.90 (d, *J* = 7.2 Hz, 1H), 6.74–6.62 (m, 2H), 6.21 (s, 1H), 3.82–3.71 (m, 1H), 3.18 (d, *J* = 17.3 Hz, 1H), 2.92 (d, *J* = 17.3 Hz, 1H), 1.34 (dd, *J* = 12.1, 6.9 Hz, 6H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 171.1, 152.7, 147.0, 141.3, 135.6, 135.1, 135.0, 130.0, 129.3, 129.1, 128.3, 128.1, 127.8, 127.0, 126.8, 125.4, 122.7, 117.9, 109.8, 75.3, 47.6, 46.5, 32.2, 29.2, 19.1, 16.8 ppm. HRMS m/z: calcd for $C_{32}H_{30}N_3O$ $[M+H]^+$ 472.2389, found: 472.2395.



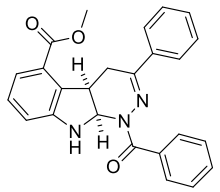
((2Z,6Z)-3,7-diphenyl-1,2,5,6-tetrazocine-1,5(4H,8H)-diyl)bis(phenylmethanone) (3an'): Yield = 16% (23mg). Yellow solid. M.p. 94.7-96.5 ^{o}C. IR (KBr) ν = 2962, 2925, 1725, 1491, 1260, 1018, 794, 688 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.17–8.08 (m, 4H), 7.90 (dd, *J* = 6.5, 3.1 Hz, 4H), 7.55–7.44 (m, 12H), 5.00 (s, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ = 154.2, 153.2, 132.6, 131.6, 130.7, 129.2, 128.5, 128.0, 127.6, 125.9, 58.9. HRMS m/z: calcd for $C_{30}H_{25}N_4O_2$ $[M+Na]^+$ 495.1797, found:495.1803.



((4aR,9aR)-4a-methyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)methanone (3ao): Yield = 45% (83mg). White solid. M.p. 119.7-121.1 ºC. IR (KBr) ν = 2925, 1661, 1386, 1325, 1231, 737, 713, 691 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.81 (d, *J* = 7.5 Hz, 2H), 7.62–7.57 (m, 2H), 7.51–7.41 (m, 3H), 7.33 (d, *J* = 6.3 Hz, 3H), 7.12 (dd, *J* = 13.7, 7.3 Hz, 2H), 6.82 (t, *J* = 7.4 Hz, 1H), 6.72 (d, *J* = 7.7 Hz, 1H), 5.67 (s, 1H), 5.34 (s, 1H), 2.72 (s, 2H), 1.44 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 171.8, 148.6, 146.8, 136.2, 134.2, 134.0, 130.2, 129.7, 129.0, 128.0, 128.0, 127.0, 125.2, 121.2, 119.2, 109.9, 74.4, 39.9, 31.8, 22.8 ppm. HRMS m/z: calcd for $C_{24}H_{22}N_3O$ $[M+H]^+$ 368.1763, found: 368.1757.

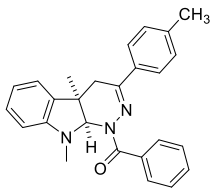


((4aR,9aR)-4a,9a-dimethyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)methanone (3ap): Yield = 46% (88mg). White solid. M.p. 146.2-147.7 ºC. IR (KBr) ν = 3363, 1635, 1610, 1344, 1099, 749, 713, 690 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.48 (dd, *J* = 7.6, 1.9 Hz, 2H), 7.44–7.34 (m, 3H), 7.33–7.25 (m, 5H), 7.08–6.99 (m, 1H), 6.95 (d, *J* = 7.2 Hz, 1H), 6.71 (dd, *J* = 15.7, 7.7 Hz, 2H), 6.61 (s, 1H), 3.32 (d, *J* = 17.7 Hz, 1H), 2.64 (d, *J* = 17.7 Hz, 1H), 1.94 (s, 3H), 1.39 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 172.2, 146.9, 144.0, 136.5, 136.2, 133.8, 129.4, 128.8, 128.8, 128.0, 127.7, 126.7, 124.8, 120.6, 119.2, 109.7, 84.8, 45.4, 28.3, 24.4, 17.3 ppm. HRMS m/z: calcd for $C_{25}H_{24}N_3O$ $[M+H]^+$ 382.1919, found: 382.1923.

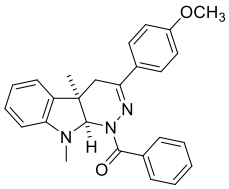


methyl(4aR,9aR)-1-benzoyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indole-5-carboxylate (3aq): Yield = 25% (51mg). White solid. M.p. 115.6-116.9 ºC. IR (KBr) ν = 3334, 1713, 1658, 1408, 1267, 1016, 914, 752, 687, 664, 625 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.84 (d, *J*

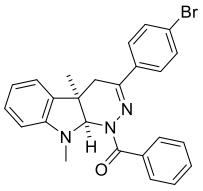
= 7.4 Hz, 2H), 7.64 (d, *J* = 3.8 Hz, 2H), 7.54–7.41 (m, 4H), 7.33 (d, *J* = 4.5 Hz, 3H), 7.19 (t, *J* = 7.8 Hz, 1H), 6.90 (d, *J* = 7.7 Hz, 1H), 6.03 (d, *J* = 3.9 Hz, 1H), 5.48 (s, 1H), 4.02–3.79 (m, 4H), 3.44 (dd, *J* = 16.5, 6.0 Hz, 1H), 2.22 (dd, *J* = 16.4, 11.2 Hz, 1H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 171.9, 166.2, 149.1, 148.3, 136.1, 134.1, 132.5, 130.3, 129.7, 129.0, 128.2, 128.0, 127.0, 125.7, 125.4, 120.7, 114.0, 68.1, 51.6, 35.0, 23.3 ppm. HRMS m/z: calcd for $C_{25}H_{22}N_3O_3$ $[M+H]^+$ 412.1661, found: 412.1660.



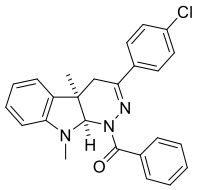
((4aR,9aR)-4a,9-dimethyl-3-(p-tolyl)-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)methanone (3ba): Yield = 89% (176mg). White solid. M.p. 121.3-122.6 ºC. IR (KBr) ν = 2954, 2873, 1667, 1331, 936, 810, 746, 718, 657 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.87–7.72 (m, 2H), 7.56–7.35 (m, 5H), 7.23–7.03 (m, 4H), 6.80 (t, *J* = 7.3 Hz, 1H), 6.57 (d, *J* = 7.8 Hz, 1H), 5.73 (s, 1H), 2.88 (s, 3H), 2.67–2.54 (m, 2H), 2.31 (s, 3H), 1.41 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 172.4, 151.0, 149.5, 139.7, 135.6, 135.4, 133.8, 130.5, 129.8, 129.1, 128.5, 127.4, 125.6, 120.9, 118.9, 108.4, 77.2, 38.8, 33.7, 33.7, 21.9, 21.3 ppm. HRMS m/z: calcd for $C_{26}H_{26}N_3O$ $[M+H]^+$ 396.2076, found: 396.2088.



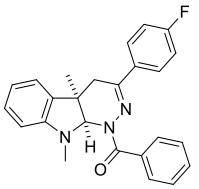
((4aR,9aR)-3-(4-methoxyphenyl)-4a,9-dimethyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)methanone (3ca): Yield = 76% (152mg). Brown solid. M.p. 128.8-130.2 ºC. IR (KBr) ν = 2964, 1664, 1396, 1330, 1254, 1175, 1113, 1028, 928, 831, 720, 658 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.84–7.74 (m, 2H), 7.51–.41 (m, 5H), 7.20–7.09 (m, 2H), 6.79 (dd, *J* = 8.0, 4.1 Hz, 3H), 6.55 (d, *J* = 7.8 Hz, 1H), 5.75 (s, 1H), 3.77 (s, 3H), 2.89 (s, 3H), 2.68–2.52 (m, 2H), 1.42 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 171.8, 160.3, 150.6, 149.1, 135.1, 135.0, 130.0, 129.3, 128.7, 128.0, 127.0, 126.7, 120.5, 118.4, 113.3, 107.8, 76.8, 54.8, 38.7, 33.3, 33.2, 21.6 ppm. HRMS m/z: calcd for $C_{26}H_{26}N_3O_2$ $[M+H]^+$ 412.2025, found: 412.2027.



((4aR,9aR)-3-(4-bromophenyl)-4a,9-dimethyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)methanone (3da): Yield = 46% (106mg). White solid. M.p. 158.8-159.6 °C. IR (KBr) ν = 2964, 2878, 1671, 1393, 1334, 930, 763, 712, 693, 692 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.84–7.72 (m, 2H), 7.57–7.33 (m, 7H), 7.23–7.10 (m, 2H), 6.83 (t, *J* = 7.2 Hz, 1H), 6.60 (d, *J* = 7.8 Hz, 1H), 5.70 (s, 1H), 2.87 (s, 3H), 2.57 (s, 2H), 1.40 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 172.6, 149.3, 149.1, 135.5, 135.5, 135.2, 131.6, 130.7, 129.7, 128.6, 127.5, 127.2, 123.9, 120.9, 119.1, 108.7, 77.2, 38.2, 33.8, 33.5, 21.5 ppm. HRMS m/z: calcd for $C_{25}H_{23}BrN_3O$ $[M+H]^+$ 460.1024, found: 460.1019.

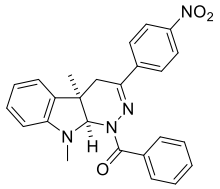


((4aR,9aR)-3-(4-chlorophenyl)-4a,9-dimethyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)methanone (3ea): Yield = 54% (112mg). White solid. M.p. 145.5-146.1 °C. IR (KBr) ν = 2923, 2883, 1658, 1331, 932, 823, 744, 719, 707, 654 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.83–7.74 (m, 2H), 7.53–7.42 (m, 5H), 7.26 (s, 1H), 7.24 (d, *J* = 4.0 Hz, 1H), 7.21–7.11 (m, 2H), 6.82 (t, *J* = 7.2 Hz, 1H), 6.59 (d, *J* = 7.8 Hz, 1H), 5.70 (s, 1H), 2.87 (s, 3H), 2.57 (s, 2H), 1.40 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 172.1, 148.9, 148.7, 135.1, 135.1, 134.8, 134.6, 130.2, 129.3, 128.2, 128.1, 127.1, 126.4, 120.4, 118.7, 108.2, 76.8, 37.8, 33.4, 33.1, 21.1 ppm. HRMS m/z: calcd for $C_{25}H_{23}ClN_3O$ $[M+H]^+$ 416.1530, found: 416.4541.

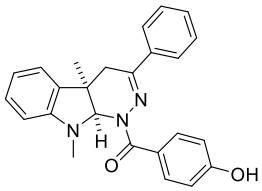


((4aR,9aR)-3-(4-fluorophenyl)-4a,9-dimethyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)methanone (3fa): Yield = 76% (152mg). White solid. M.p. 98.2-99.3 °C. IR (KBr) ν = 2966, 1667, 1332, 1230, 1113, 934, 824, 745, 720 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ =

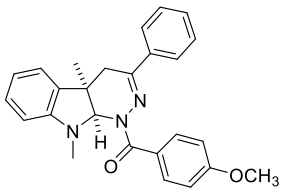
7.82–7.74 (m, 2H), 7.53–7.42 (m, 5H), 7.21–7.11 (m, 2H), 6.96 (t, *J* = 8.7 Hz, 2H), 6.82 (t, *J* = 7.4 Hz, 1H), 6.58 (d, *J* = 7.8 Hz, 1H), 5.72 (s, 1H), 2.88 (s, 3H), 2.64–2.53 (m, 2H), 1.41 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 172.0, 163.1 (d, *J* = 252 Hz), 148.9, 135.0 (d, *J* = 22 Hz), 132.3, 132.3, 130.2, 129.2, 128.1, 127.2, 127.1, 120.4, 118.6, 115.0 (d, J = 22 Hz), 108.1, 38.1, 33.3, 21.2 ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ = -111.34 ppm. HRMS m/z: calcd for $C_{25}H_{23}FN_3O$ $[M+H]^+$ 400.1825, found: 400.1834.



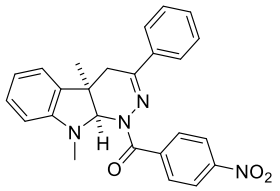
((4aR,9aR)-4a,9-dimethyl-3-(4-nitrophenyl)-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(phenyl)methanone (3ga): Yield = 92% (196mg). Yellow solid. M.p. 142.6-143.2 °C. IR (KBr) ν = 2864, 1672, 1518, 1346, 1326, 1113, 762, 722, 688, 653 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.13 (d, *J* = 8.4 Hz, 2H), 7.78 (d, *J* = 7.8 Hz, 2H), 7.67 (d, *J* = 8.4 Hz, 2H), 7.57–7.45 (m, 3H), 7.24–7.14 (m, 2H), 6.86 (t, *J* = 7.4 Hz, 1H), 6.63 (d, *J* = 7.8 Hz, 1H), 5.68 (s, 1H), 2.87 (s, 3H), 2.69–2.54 (m, 2H), 1.41 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 172.3, 148.6, 147.6, 146.5, 142.0, 135.0, 134.4, 130.5, 129.2, 128.3, 127.2, 125.8, 123.2, 120.4, 119.0, 108.6, 76.4, 37.1, 33.6, 33.0, 20.6 ppm. HRMS m/z: calcd for $C_{25}H_{23}N_4O_3$ $[M+H]^+$ 427.1770, found: 427.1764.



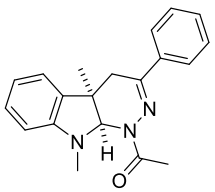
((4aR,9aR)-4a,9-dimethyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(4-hydroxyphenyl)methanone (3ha): Yield = 84% (167mg). White solid. M.p. 93.5-94.1 °C. IR (KBr) ν = 2956, 1607, 1399, 1344, 1240, 1169, 800, 761, 651 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.75 (d, *J* = 8.0 Hz, 2H), 7.58 (d, *J* = 5.1 Hz, 2H), 7.31 (s, 3H), 7.15 (dd, *J* = 12.5, 6.8 Hz, 2H), 6.90–6.76 (m, 3H), 6.55 (d, *J* = 7.5 Hz, 1H), 5.76 (s, 1H), 2.87 (s, 3H), 2.64 (dd, *J* = 35.4, 16.8 Hz, 2H), 1.42 (s, 4H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 171.9, 158.3, 151.3, 149.0, 136.0, 135.0, 132.0, 129.2, 128.1, 128.0, 126.0, 125.3, 120.5, 118.4, 114.1, 107.9, 77.0, 38.8, 33.5, 33.2, 21.6 ppm. HRMS m/z: calcd for $C_{25}H_{24}N_3O_2$ $[M+H]^+$ 398.1869, found: 398.1871.



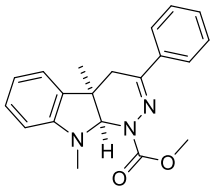
((4aR,9aR)-4a,9-dimethyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(4-methoxyphenyl)methanone (3ia): Yield = 84% (173mg). White solid. M.p. 139.6-140.3 ^{o}C. IR (KBr) ν = 2862, 1655, 1322, 1250, 1170, 1112, 1030, 745, 686 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.87 (d, *J* = 8.9 Hz, 2H), 7.66–7.53 (m, 2H), 7.31 (dd, *J* = 5.2, 1.9 Hz, 3H), 7.16 (dd, *J* = 14.6, 7.1 Hz, 2H), 6.96 (d, *J* = 8.9 Hz, 2H), 6.81 (t, *J* = 7.4 Hz, 1H), 6.57 (d, *J* = 7.8 Hz, 1H), 5.73 (s, 1H), 3.89 (s, 3H), 2.86 (s, 3H), 2.69–2.57 (m, 2H), 1.40 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 171.7, 161.6, 150.3, 149.5, 136.8, 135.7, 132.4, 129.4, 128.5, 128.4, 127.2, 125.7, 120.9, 118.9, 112.8, 108.5, 77.2, 55.4, 38.6, 33.8, 33.8, 21.7 ppm. HRMS m/z: calcd for $C_{26}H_{26}N_3O_2$ $[M+H]^+$ 412.2025, found: 412.2034.



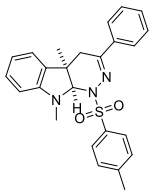
((4aR,9aR)-4a,9-dimethyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)(4-nitrophenyl)methanone (3ja): Yield = 94% (200mg). Yellow solid. M.p. 198.2-199.4 ^{o}C. IR (KBr) ν = 2958, 1667, 1522, 1338, 1110, 860, 760, 746, 729, 688 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.29 (d, *J* = 8.7 Hz, 2H), 7.92 (d, *J* = 8.6 Hz, 2H), 7.47 (d, *J* = 6.9 Hz, 2H), 7.35–7.26 (m, 3H), 7.18 (dd, *J* = 14.9, 7.4 Hz, 2H), 6.83 (t, *J* = 7.4 Hz, 1H), 6.60 (d, *J* = 7.8 Hz, 1H), 5.69 (s, 1H), 2.90 (s, 3H), 2.66 (s, 2H), 1.43 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 170.2, 151.6, 148.8, 148.2, 141.3, 135.6, 134.8, 130.0, 129.5, 128.2, 128.1, 125.2, 122.3, 120.6, 118.9, 108.2, 76.8, 38.1, 33.5, 33.3, 21.3 ppm. HRMS m/z: calcd for $C_{25}H_{23}N_4O_3$ $[M+H]^+$ 427.1770, found: 427.1776.



1-((4aR,9aR)-4a,9-dimethyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indol-1-yl)ethan-1-one (3ka): Yield = 87% (139mg). Colorless oil. IR (KBr) ν = 2958, 2871, 1683, 1393, 1315, 927, 742, 692 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.75–7.66 (m, 2H), 7.35 (d, *J* = 3.7 Hz, 3H), 7.18–7.07 (m, 2H), 6.79 (t, *J* = 7.3 Hz, 1H), 6.55 (d, *J* = 7.7 Hz, 1H), 5.46 (s, 1H), 2.75 (d, *J* = 2.8 Hz, 3H), 2.57 (d, *J* = 3.1 Hz, 3H), 2.50 (t, *J* = 12.3 Hz, 2H), 1.28 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 174.2, 149.0, 148.8, 136.5, 135.4, 129.1, 128.0, 125.2, 120.4, 118.6, 108.3, 75.6, 36.9, 33.4, 33.0, 22.1, 20.5 ppm. HRMS m/z: calcd for $C_{20}H_{22}N_3O$ $[M+H]^+$ 320.1763, found: 320.1751.

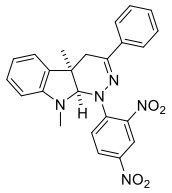


Methyl(4aR,9aR)-4a,9-dimethyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indole-1-carboxylate (3la): Yield = 85% (142mg). White solid. M.p. 45.2-46.7 ºC. IR (KBr) ν = 2955, 1704, 1440, 1321, 1193, 1131, 991, 759, 692 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.69 (dd, *J* = 6.4, 2.9 Hz, 2H), 7.40–7.30 (m, 3H), 7.19–7.03 (m, 2H), 6.76 (t, *J* = 7.4 Hz, 1H), 6.52 (d, *J* = 7.8 Hz, 1H), 5.33 (s, 1H), 3.96 (s, 3H), 2.81 (s, 3H), 2.57 (dd, *J* = 38.7, 16.8 Hz, 2H), 1.38 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 148.9, 136.5, 134.8, 129.1, 128.0, 128.0, 125.4, 120.5, 118.3, 107.6, 79.0, 53.4, 38.9, 33.7, 32.6, 26.4, 21.6 ppm. HRMS m/z: calcd for $C_{20}H_{22}N_3O_2$ $[M+H]^+$ 336.1712, found:336.1724.

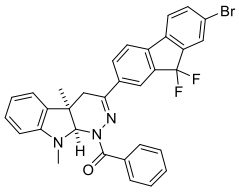


(4aR,9aR)-4a,9-dimethyl-3-phenyl-1-tosyl-4,4a,9,9a-tetrahydro-1H-pyridazino[3,4-b]indole (3ma): Yield = 88% (190mg). White solid. M.p. 154.4-155.2 ºC. IR (KBr) ν = 2857, 1647, 1482, 1357, 1169, 1089, 816, 755, 670, 607 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.91 (d, *J* = 8.3 Hz, 2H), 7.66 (dd, *J* = 6.7, 3.0 Hz, 2H), 7.39–7.32 (m, 3H), 7.29 (d, *J* = 8.1 Hz, 2H), 7.21–7.13 (m, 1H), 7.08–6.99 (m, 1H), 6.84–6.75 (m, 1H), 6.61 (d, *J* = 7.8 Hz, 1H), 4.97 (s, 1H), 2.96 (s, 3H), 2.50–2.30 (m, 5H), 0.77 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 149.9, 148.9, 144.2, 136.7,

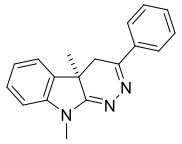
135.5, 135.1, 129.5, 129.4, 128.5, 128.4, 128.3, 125.6, 120.9, 119.1, 108.8, 81.2, 36.3, 32.8, 32.4, 21.6, 19.5 ppm. HRMS m/z: calcd for $C_{25}H_{26}N_3O_2S$ $[M+H]^+$ 432.1746, found: 432.1755.



(4aR,9aR)-1-(2,4-dinitrophenyl)-4a,9-dimethyl-3-phenyl-4,4a,9,9a-tetrahydro-1H-pyridazino [3,4-b]indole (3na): Yield = 90% (199mg). Red solid. M.p. 177.7-178.6 ºC. IR (KBr) ν = 2955, 1704, 1441, 1321, 1131, 991, 759, 692 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 8.60 (d, *J* = 2.3 Hz, 1H), 8.31 (dd, *J* = 9.3, 2.3 Hz, 1H), 7.58 (dd, *J* = 24.3, 6.2 Hz, 3H), 7.34 (d, *J* = 2.9 Hz, 3H), 7.16 (d, *J* = 5.5 Hz, 2H), 6.83 (t, *J* = 7.4 Hz, 1H), 6.52 (d, *J* = 8.0 Hz, 1H), 5.14 (s, 1H), 2.74 (s, 3H), 2.73–2.50 (m, 2H), 1.51 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 154.5, 148.1, 145.6, 139.9, 139.6, 135.4, 134.6, 129.5, 128.3, 128.1, 126.5, 125.2, 122.2, 120.7, 119.0, 117.8, 107.8, 83.0, 40.9, 34.0, 33.1, 21.7 ppm. HRMS m/z: calcd for $C_{24}H_{22}N_5O_4$ $[M+H]^+$ 444.1672, found:444.1683.

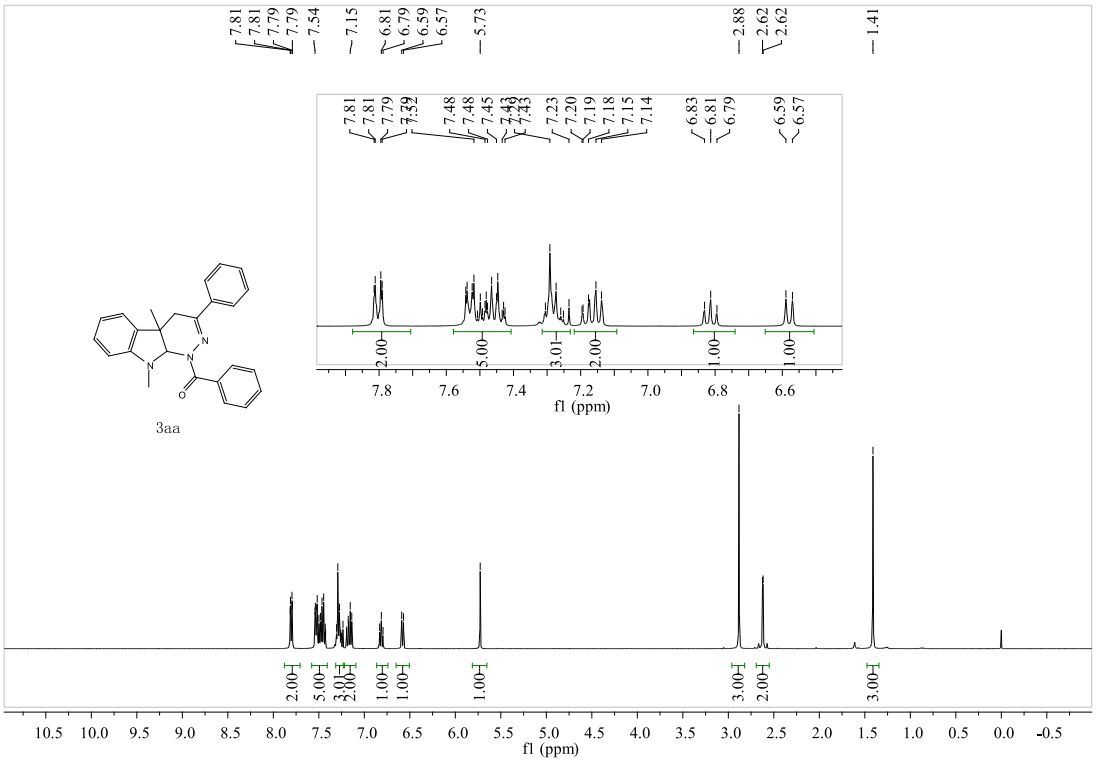


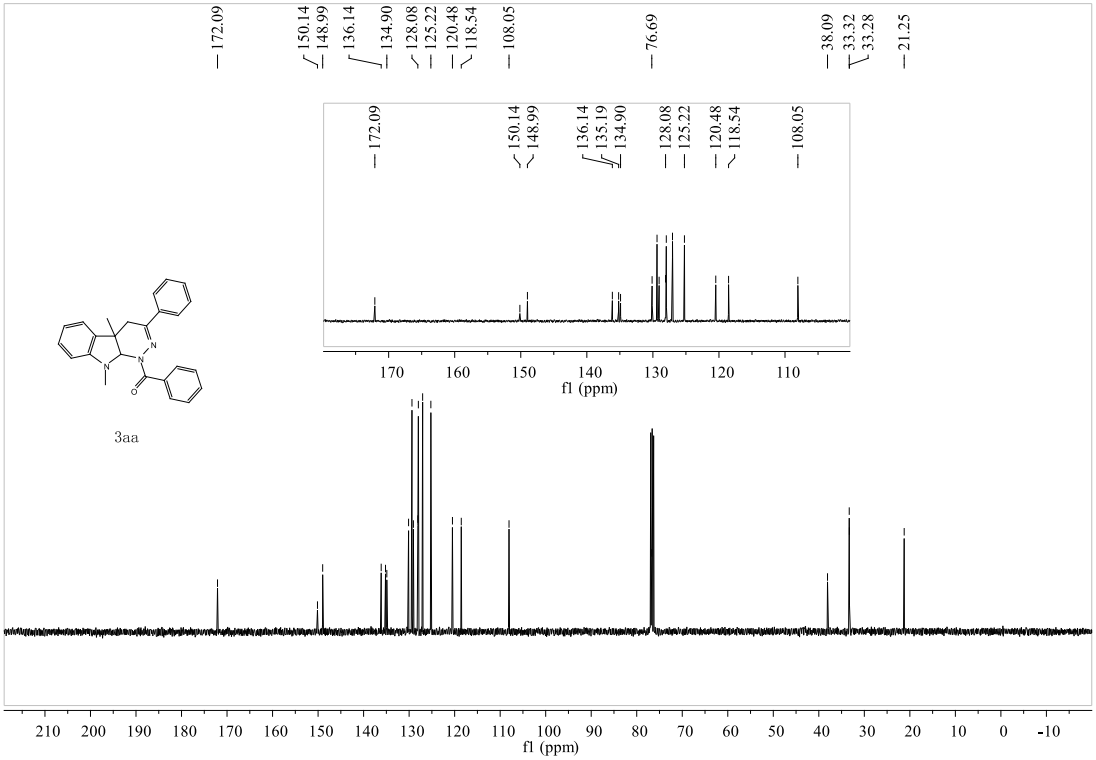
((4aR,9aR)-3-(7-bromo-9,9-difluoro-9H-fluoren-2-yl)-4a,9-dimethyl-4,4a,9,9a-tetrahydro-1H -pyridazino[3,4-b]indol-1-yl)(phenyl)methanone (3pa): Yield = 84% (245mg). White solid. M.p. 196.4-197.3 ºC. IR (KBr) ν = 2959, 1679, 1391, 1330, 1202, 1048, 817, 762, 726, 701, 654 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ = 7.88–7.75 (m, 3H), 7.70 (s, 1H), 7.63 (d, *J* = 7.4 Hz, 1H), 7.51 (dd, *J* = 22.3, 6.9 Hz, 4H), 7.42 (d, *J* = 7.6 Hz, 1H), 7.35 (d, *J* = 7.6 Hz, 1H), 7.25–7.14 (m, 2H), 6.84 (t, *J* = 6.9 Hz, 1H), 6.61 (d, *J* = 7.4 Hz, 1H), 5.70 (s, 1H), 2.88 (s, 3H), 2.62 (s, 2H), 1.41 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 172.1, 148.8, 148.0, 139.4 (d, *J* = 25 Hz), 138.8, 137.3 (d, *J* = 15 Hz), 137.2 (d, J = 5 Hz) 135.1, 134.7, 134.6, 130.3, 129.4, 129.1, 128.2, 127.1, 126.9, 124.0, 122.4, 121.5, 120.7, 120.5, 120,0, 118.8, 108.4, 76.5, 37.5, 33.4, 33.1, 20.8 ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ = -111.25. HRMS m/z: calcd for $C_{32}H_{25}BrF_2N_3O$ $[M+H]^+$ 584.1149, found:584.1142.

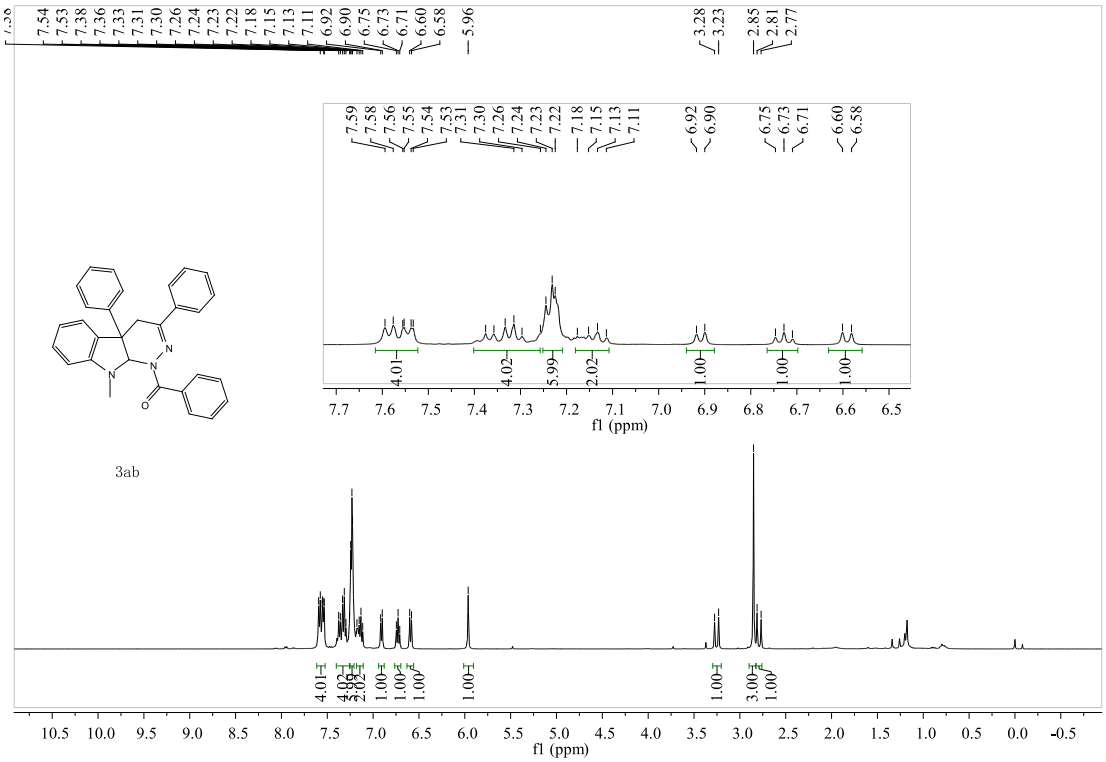


(R)-4a,9-dimethyl-3-phenyl-4a,9-dihydro-4H-pyridazino[3,4-b]indole (4aa): Yield = 66%. White solid. M.p. 96.4-97.3 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.95 (d, *J* = 7.8 Hz, 2H), 7.44 (d, *J* = 7.4 Hz, 3H), 7.29 (d, *J* = 7.6 Hz, 1H), 7.22 (d, *J* = 7.2 Hz, 1H), 6.98 (t, *J* = 7.4 Hz, 1H), 6.83 (d, *J* = 7.8 Hz, 1H), 3.36 (s, 3H), 3.29 (d, *J* = 16.6 Hz, 1H), 2.64 (d, *J* = 16.6 Hz, 1H), 1.26 (s, 4H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ = 166.6, 151.5, 145.5, 137.1, 133.9, 129.2, 128.2, 128.1, 126.0, 121.9, 121.0, 107.5, 37.3, 30.6, 27.6, 21.3ppm. HRMS m/z: calcd for $C_{18}H_{17}N_3$ $[M+H]^+$ 276.1501, found:276.1509.

The ^{1}H , ^{13}C spectra of compounds:



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2.02
1.00
1.00
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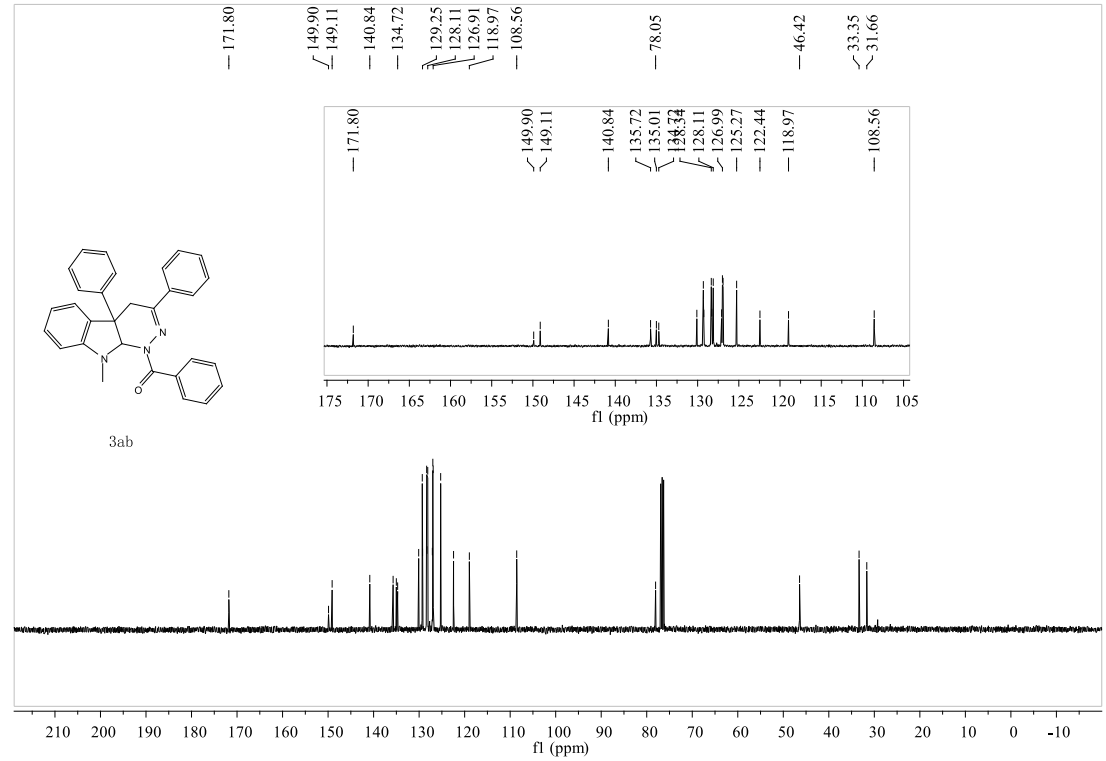
fl (ppm)
3ab
fl (ppm)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135.01
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125.27
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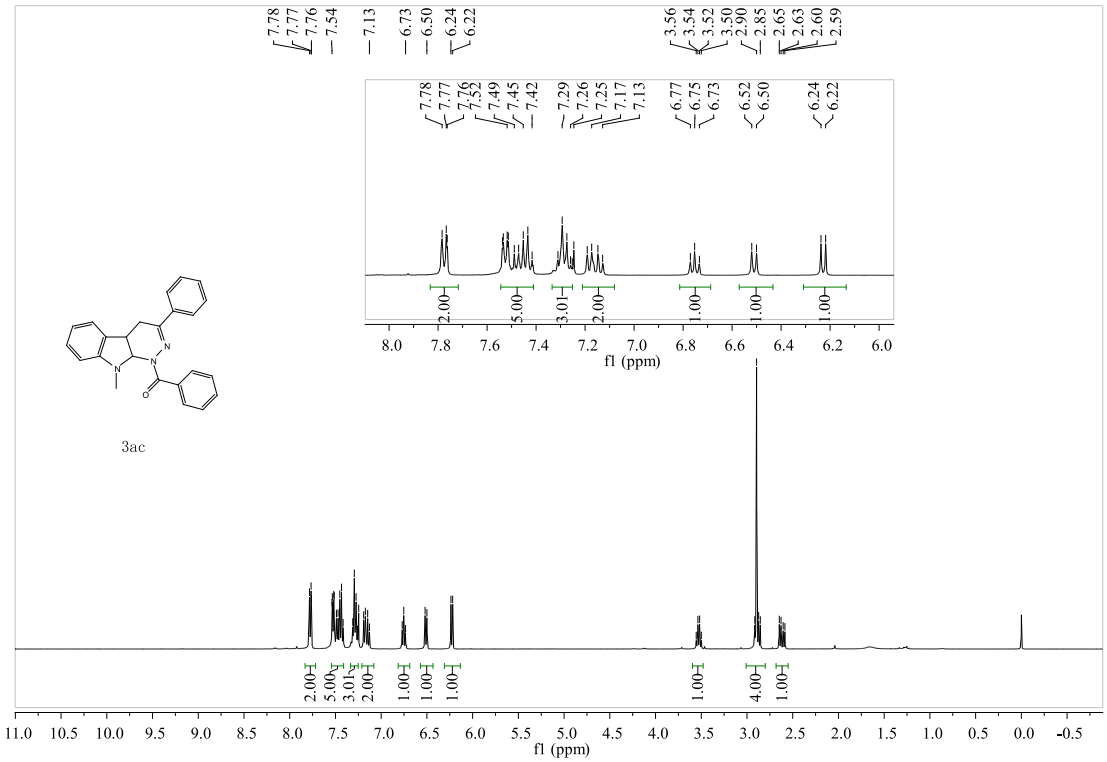
fl (ppm)
3ab
fl (ppm)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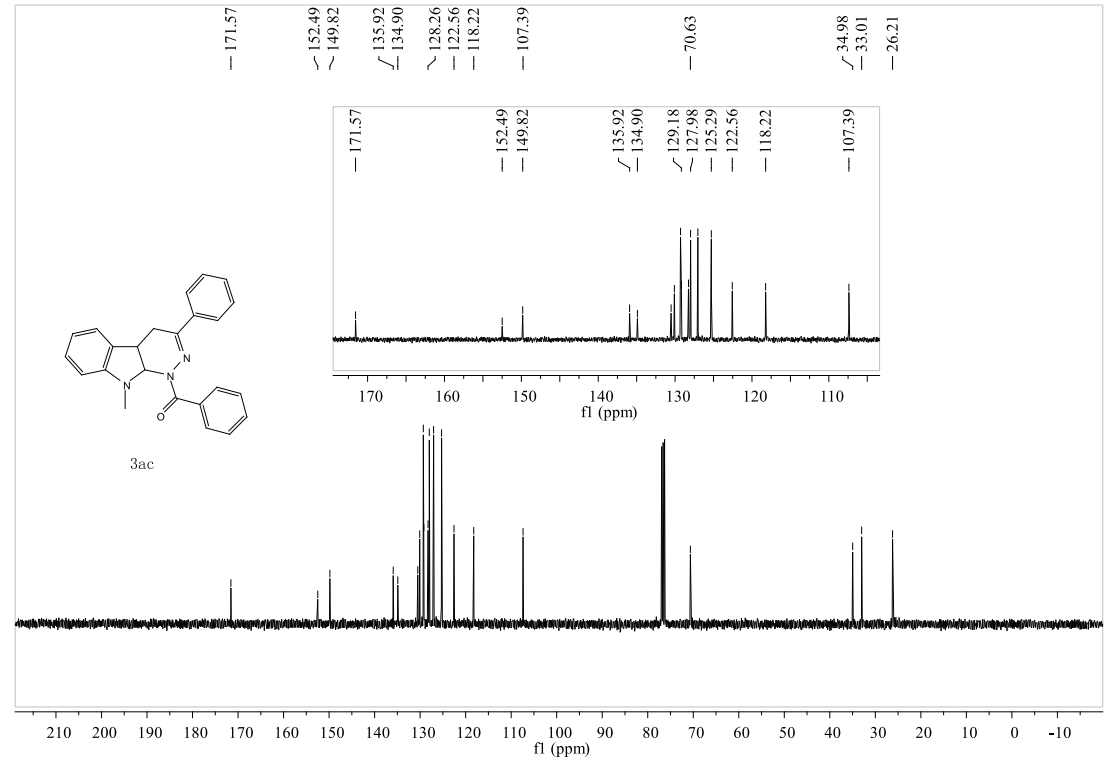
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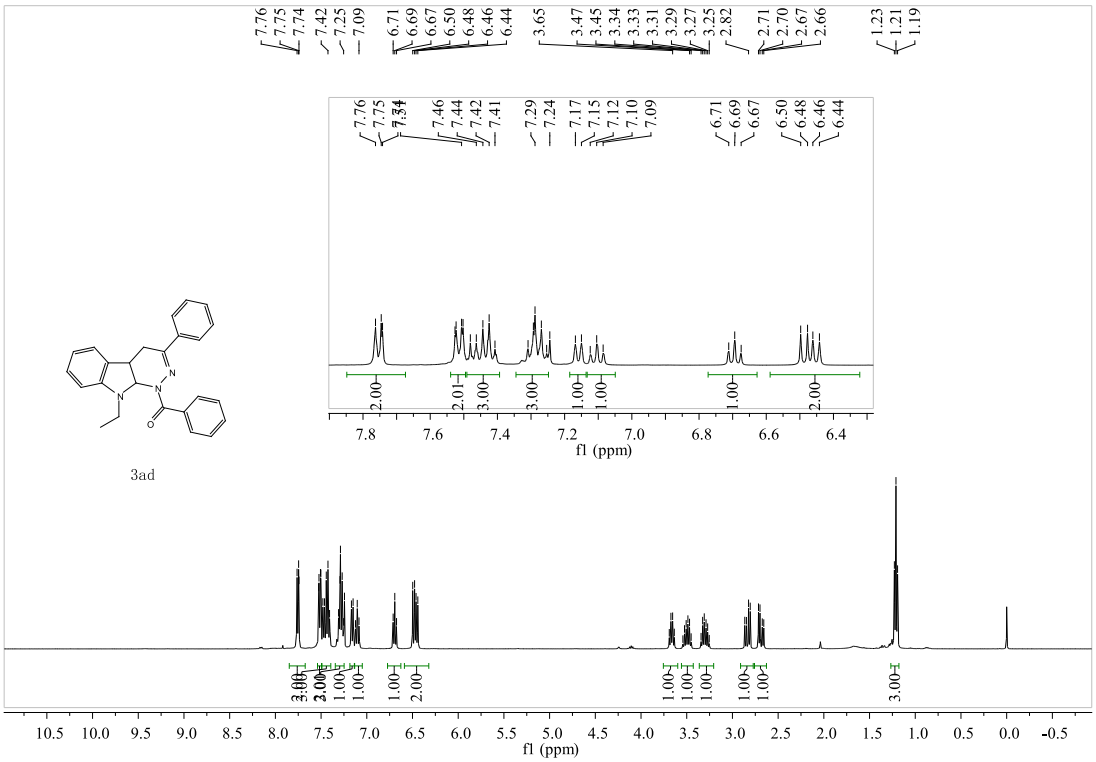
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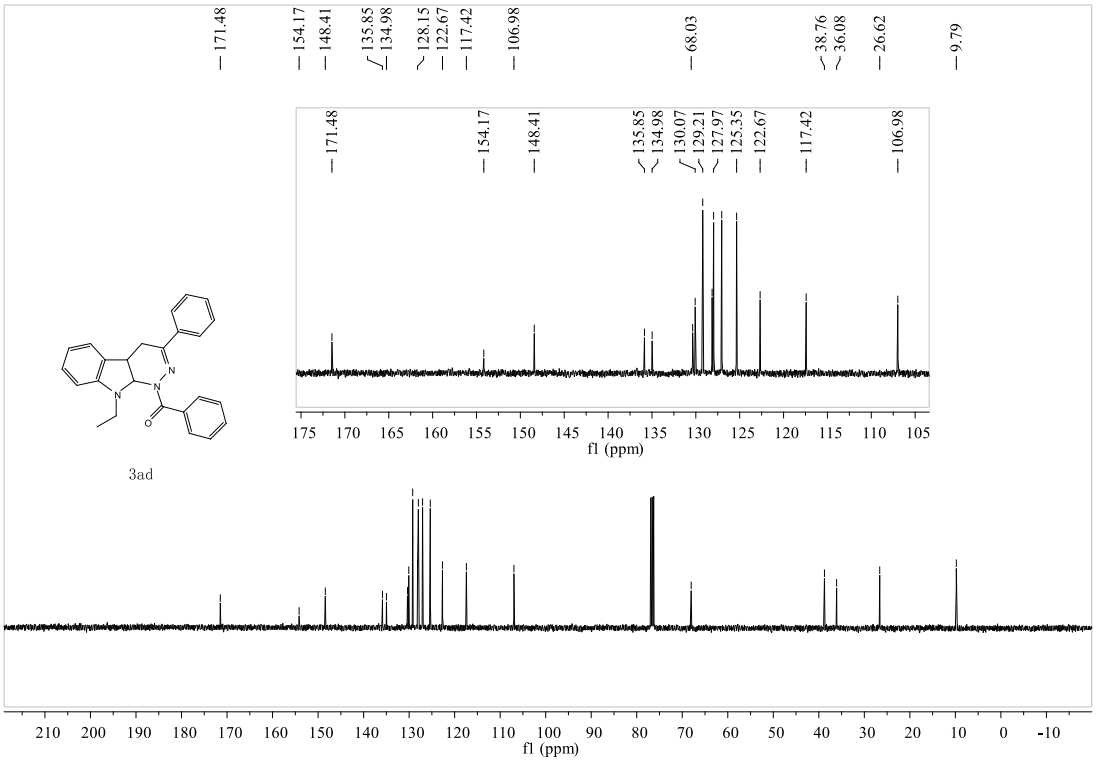
fl (ppm)
3ad
fl (ppm)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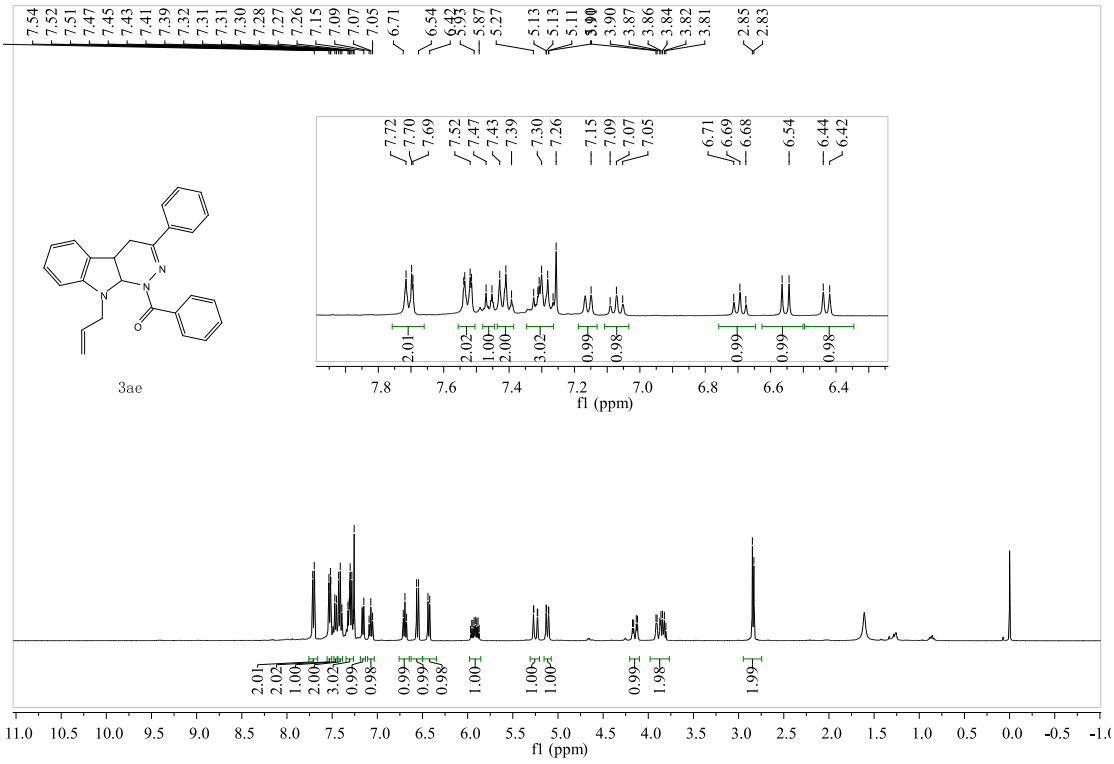
fl (ppm)
fl (ppm)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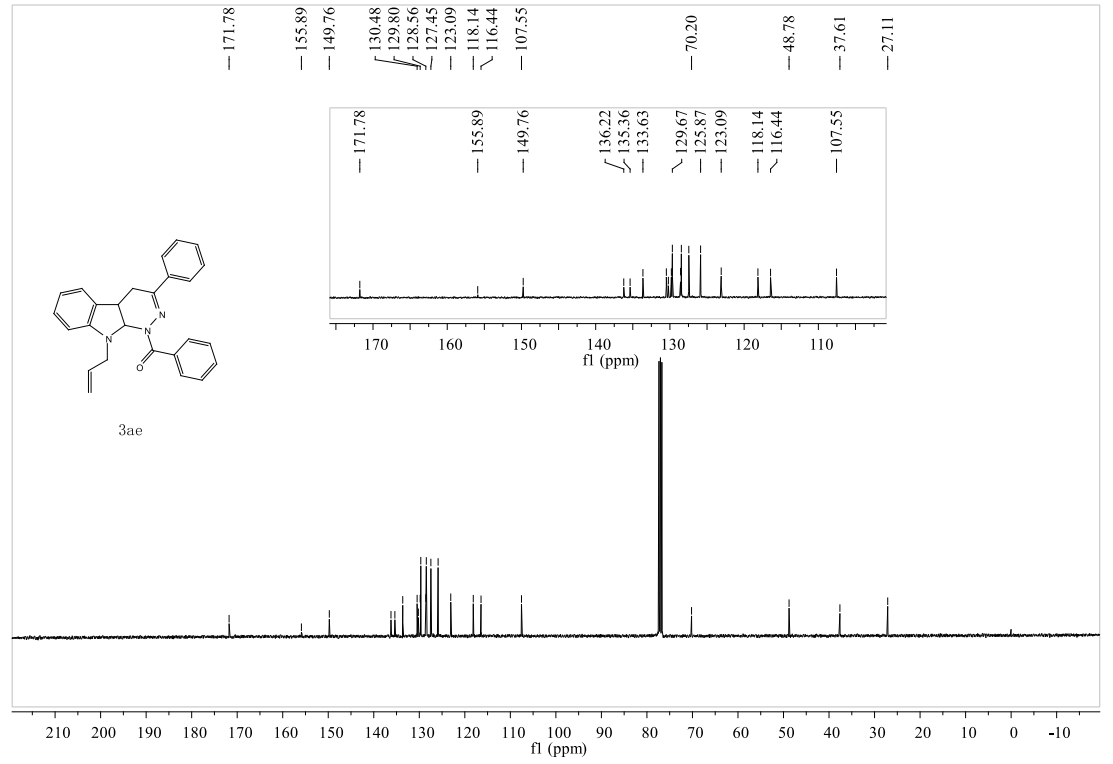
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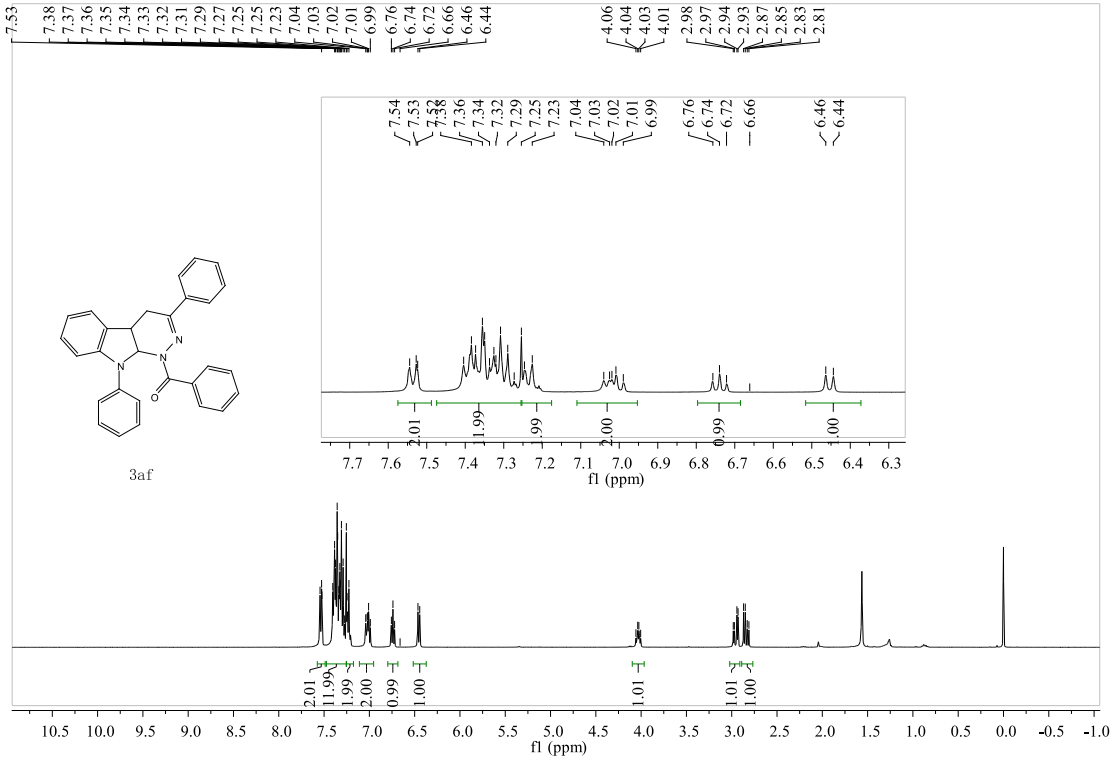
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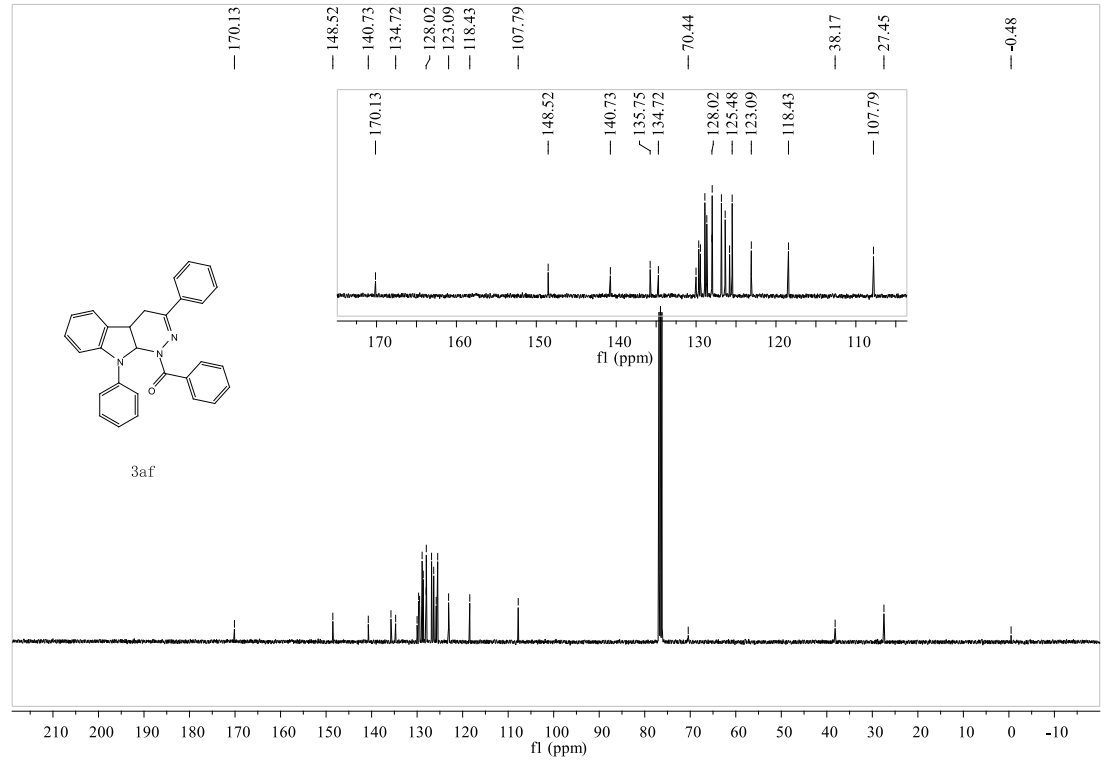
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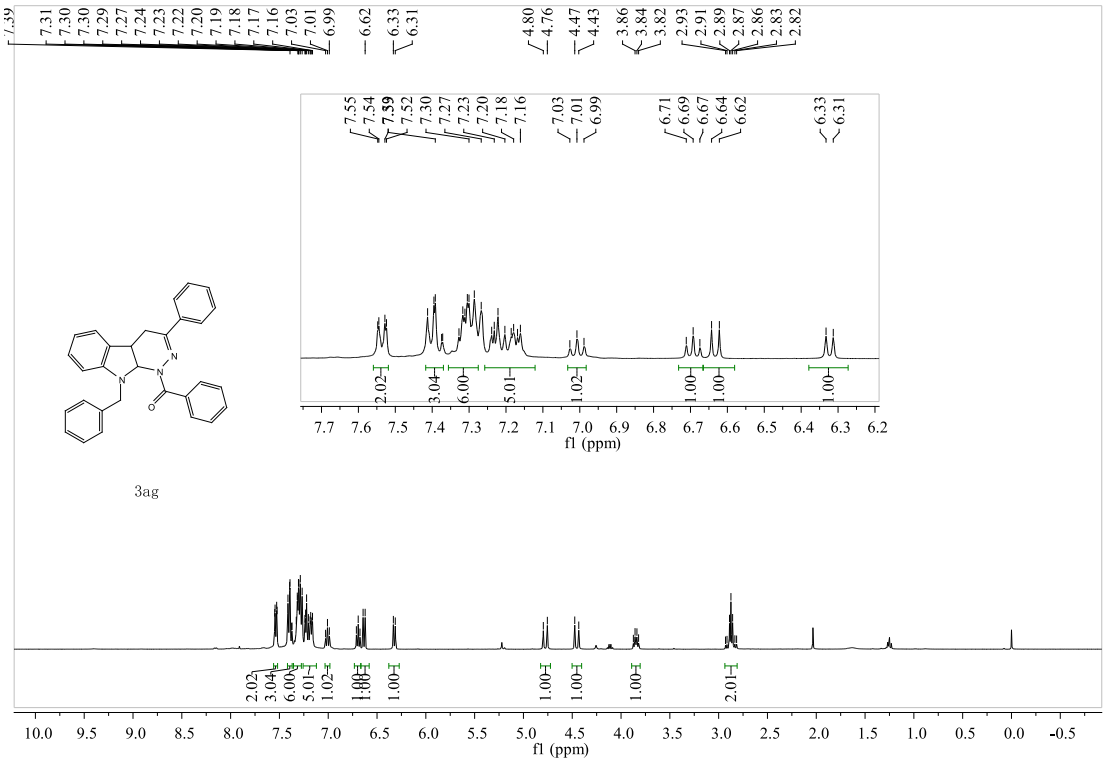
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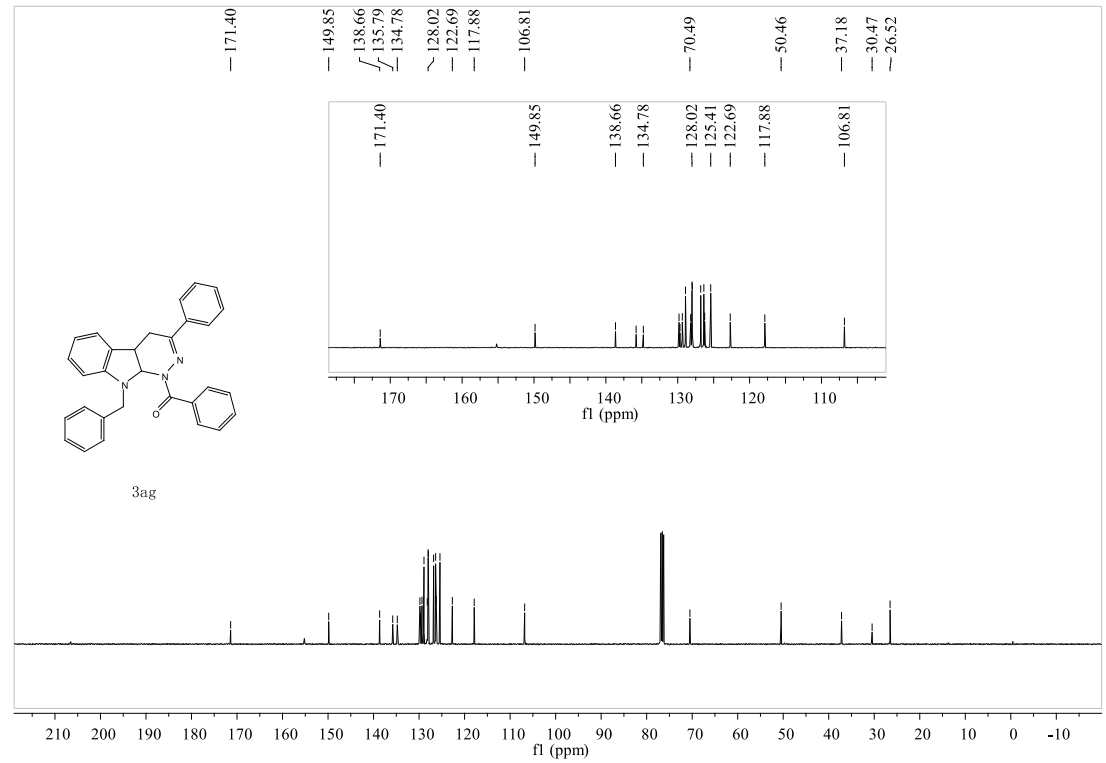
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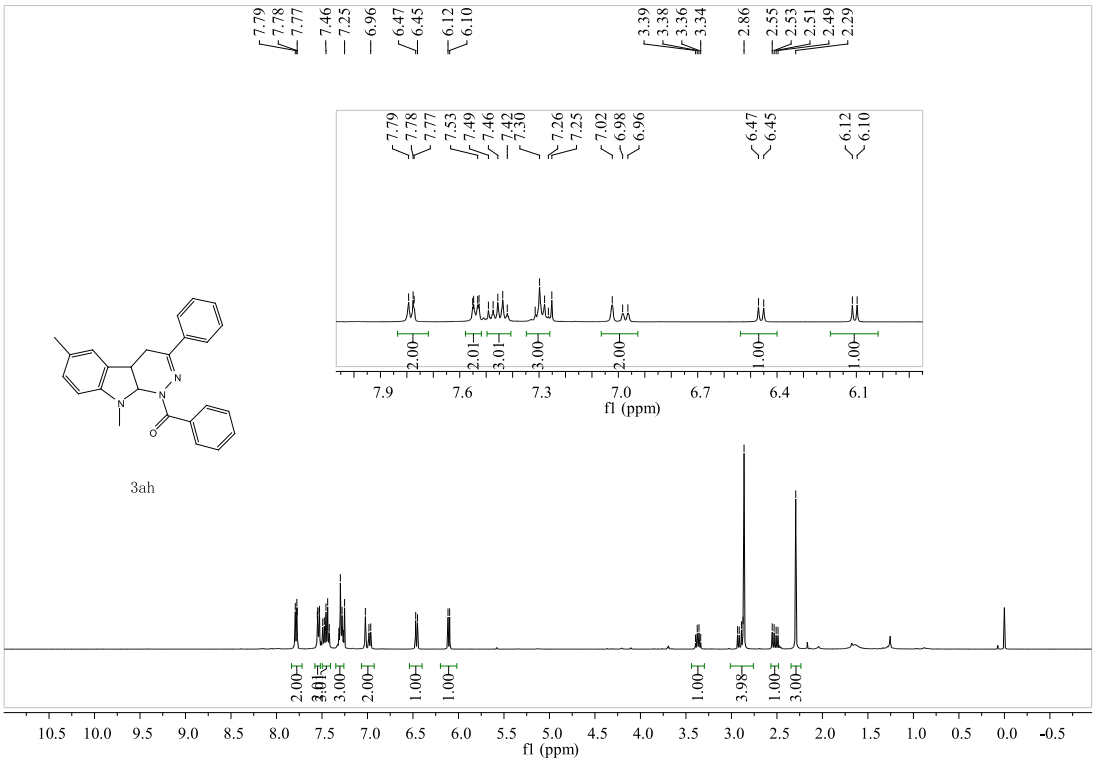
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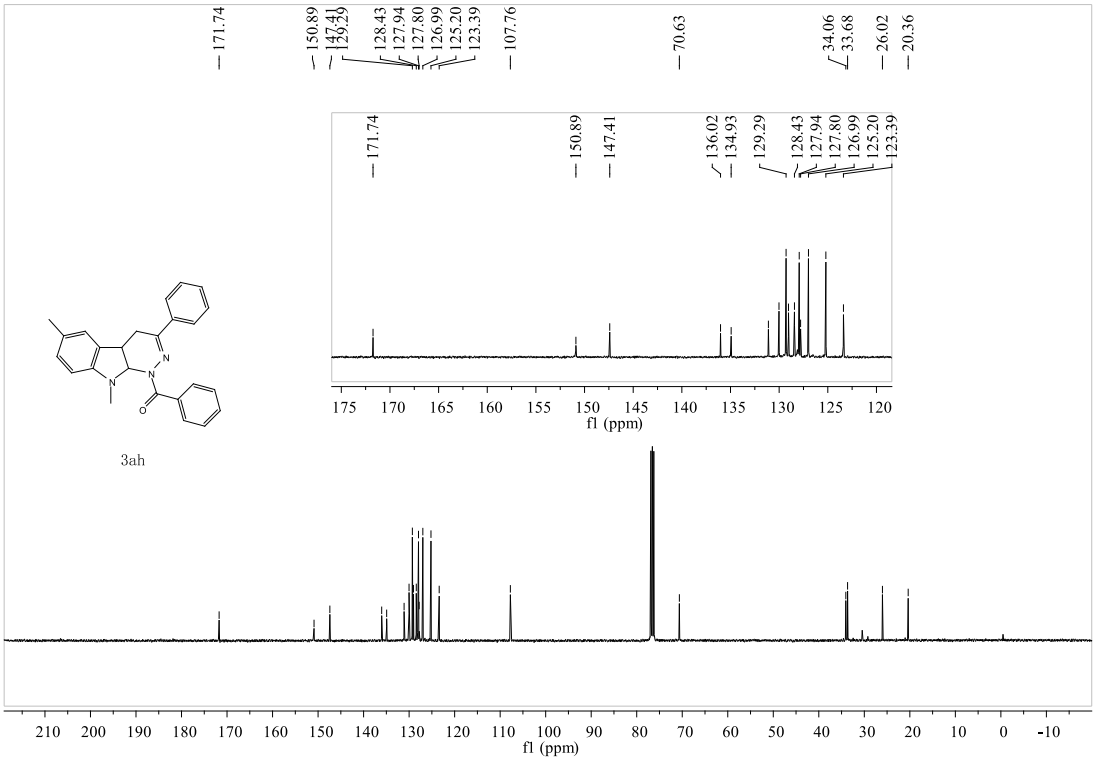
fl (ppm)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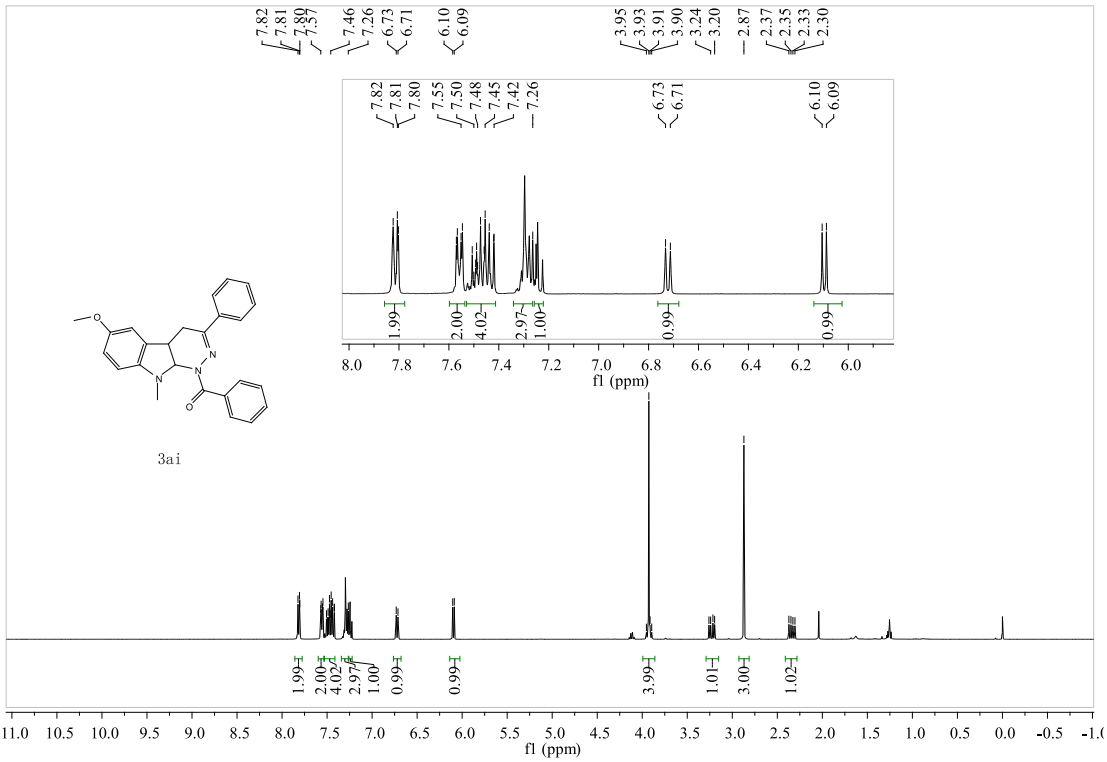
150.89
147.41
136.02
134.93
129.29
128.43
127.94
127.80
126.99
125.20
123.39
107.76
70.63
34.06
33.68
26.02
20.36
fl (ppm)
3ah
fl (ppm)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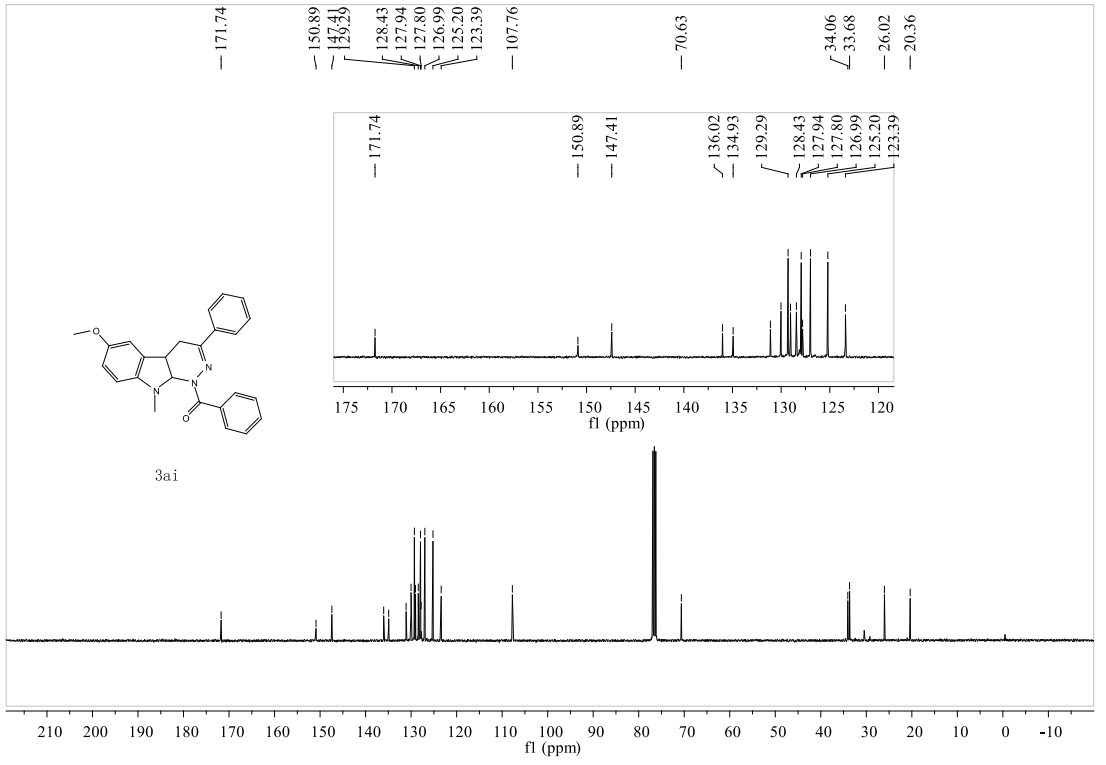
f1 (ppm)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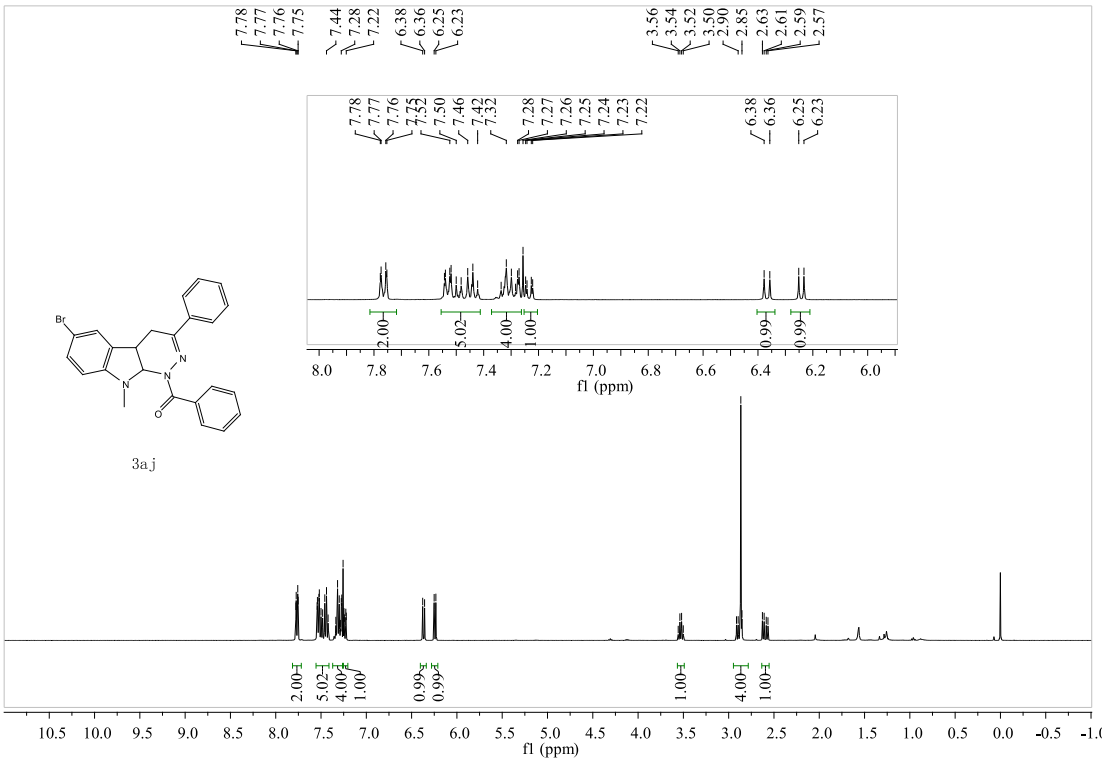
f1 (ppm)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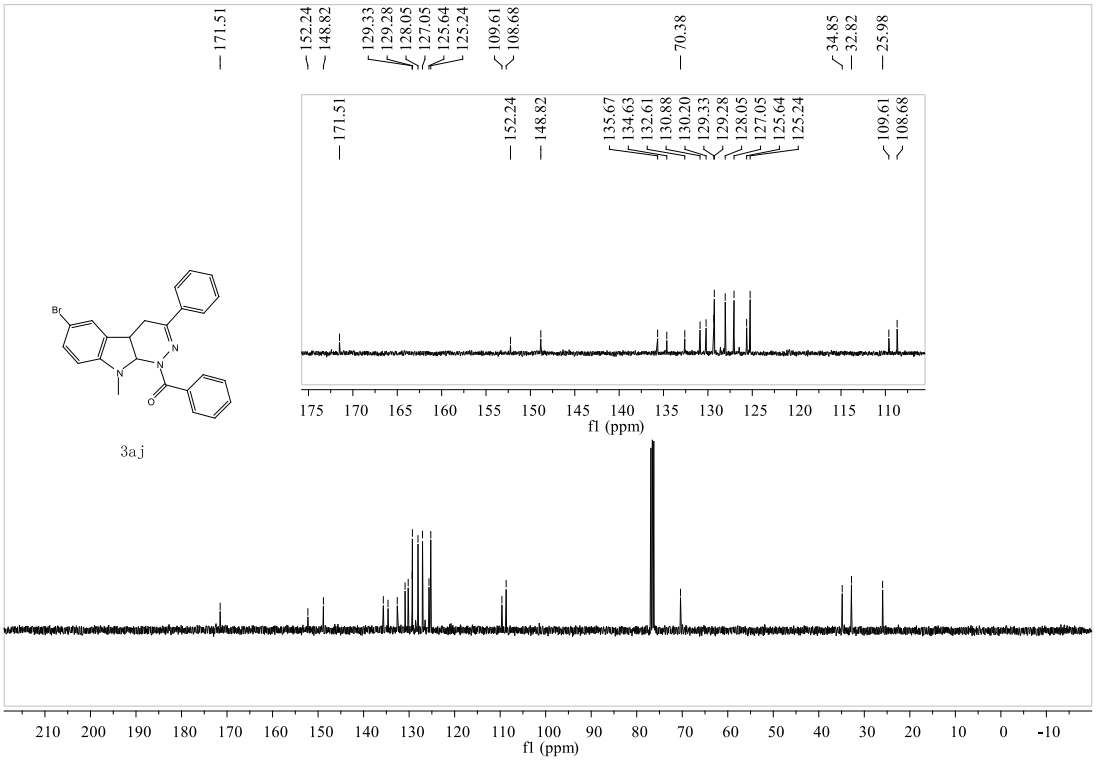
fl (ppm)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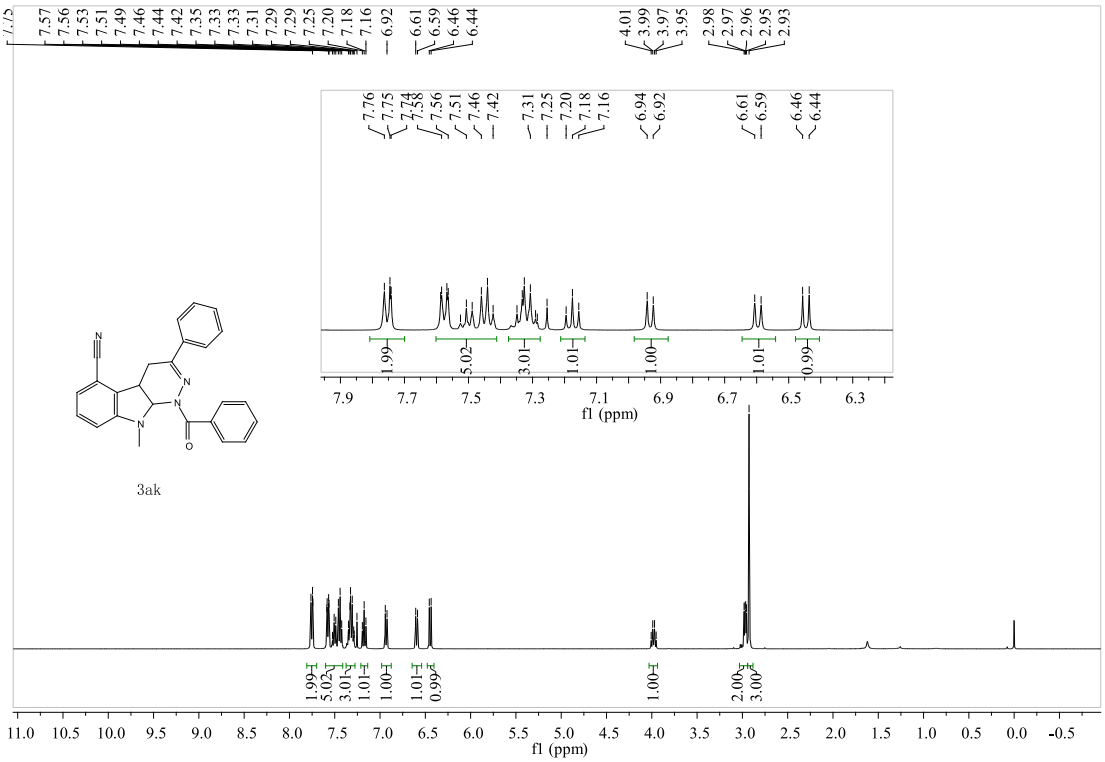
fl (ppm)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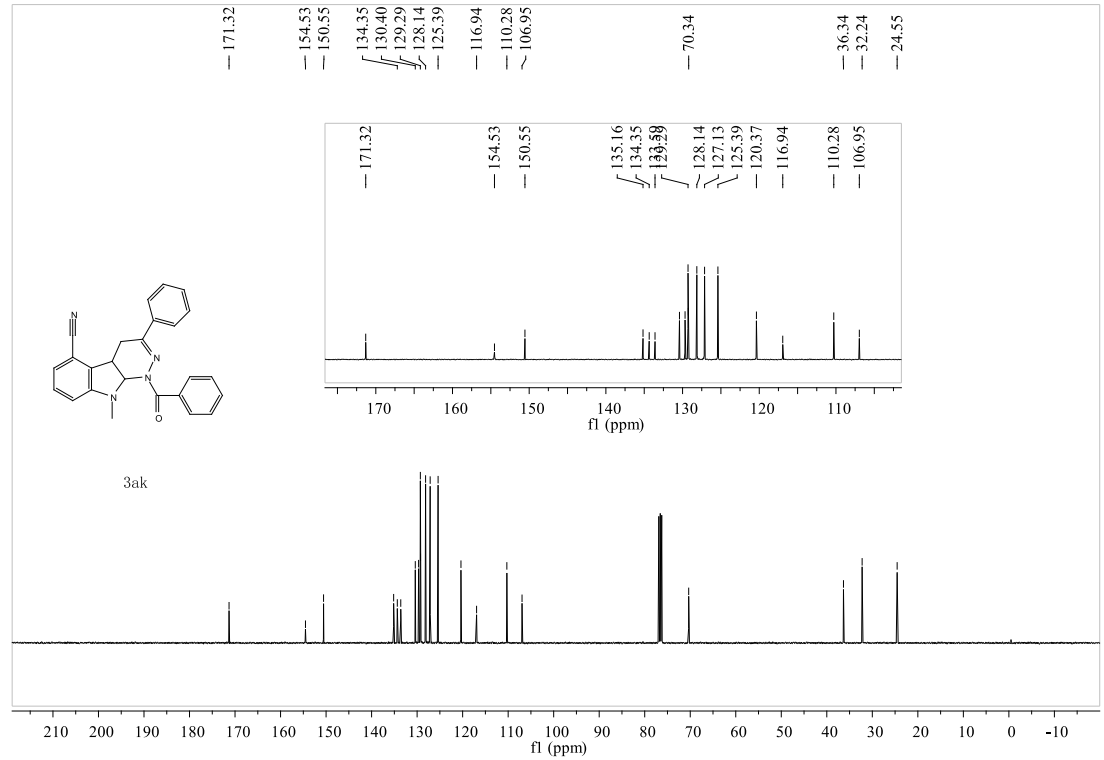
7.44
7.42
7.35
7.33
7.33
7.31
7.29
7.29
7.25
7.20
7.18
7.16
6.92
6.61
6.59
6.46
6.44
4.01
3.99
3.97
3.95
2.98
2.97
2.96
2.95
2.93
1.99
5.02
3.01
1.01
1.00
1.01
0.99
1.00
2.00
3.00
fl (ppm)
3ak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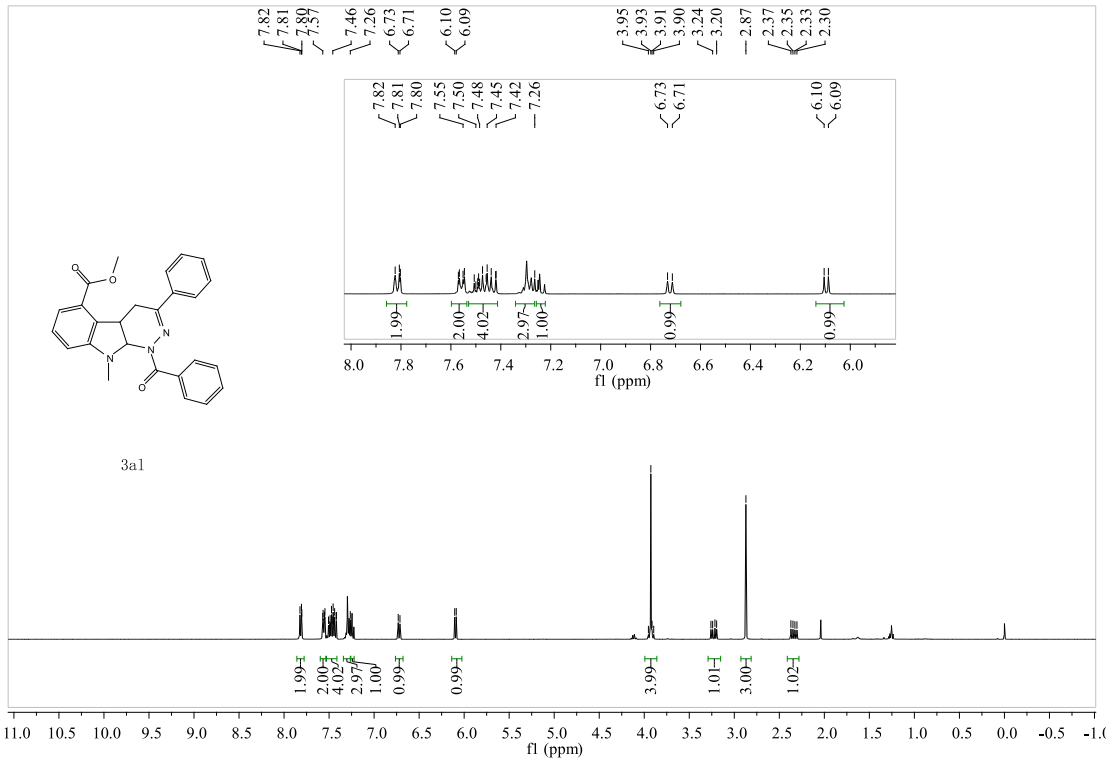
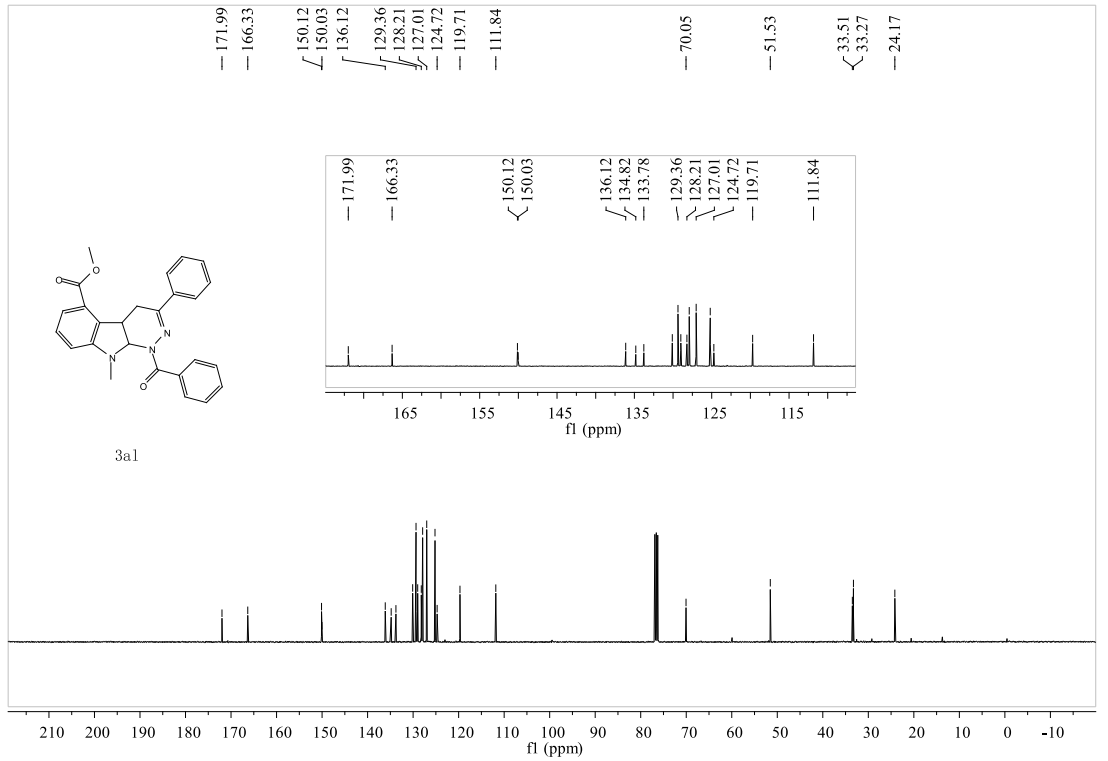
154.53
150.55
134.35
130.40
129.29
128.14
125.39
116.94
110.28
106.95
70.34
36.34
32.24
24.55
fl (ppm)
3ak


3a1
f1 (ppm)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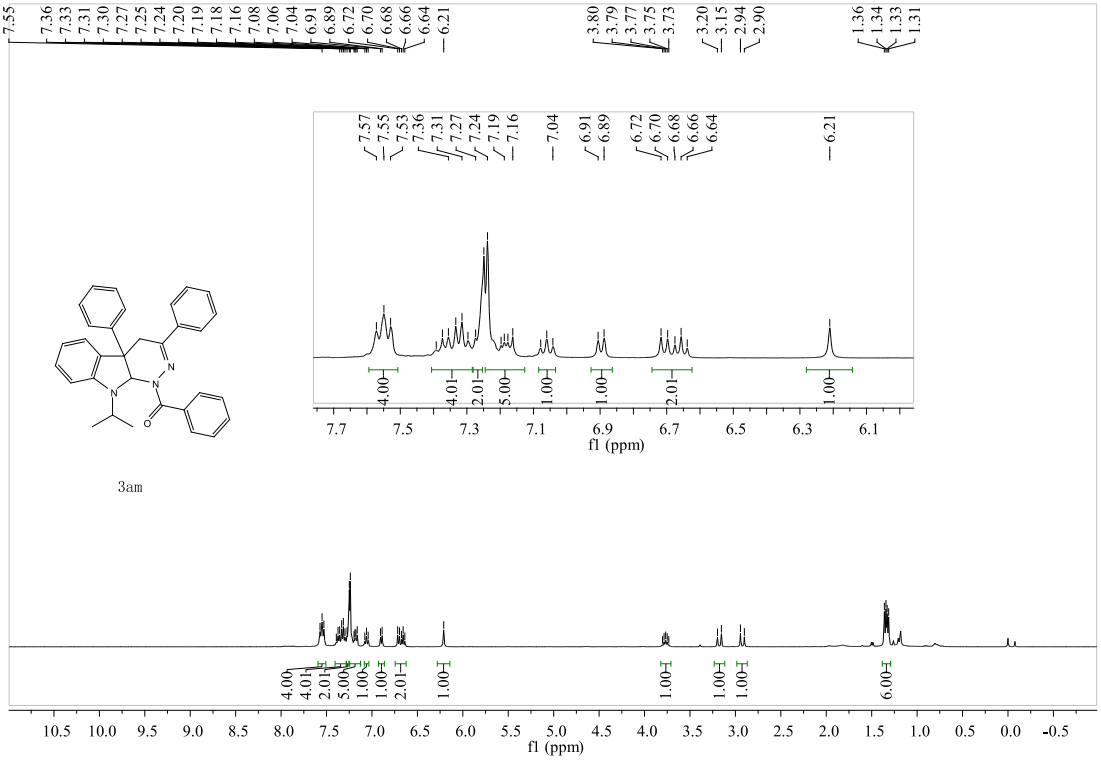
f1 (ppm)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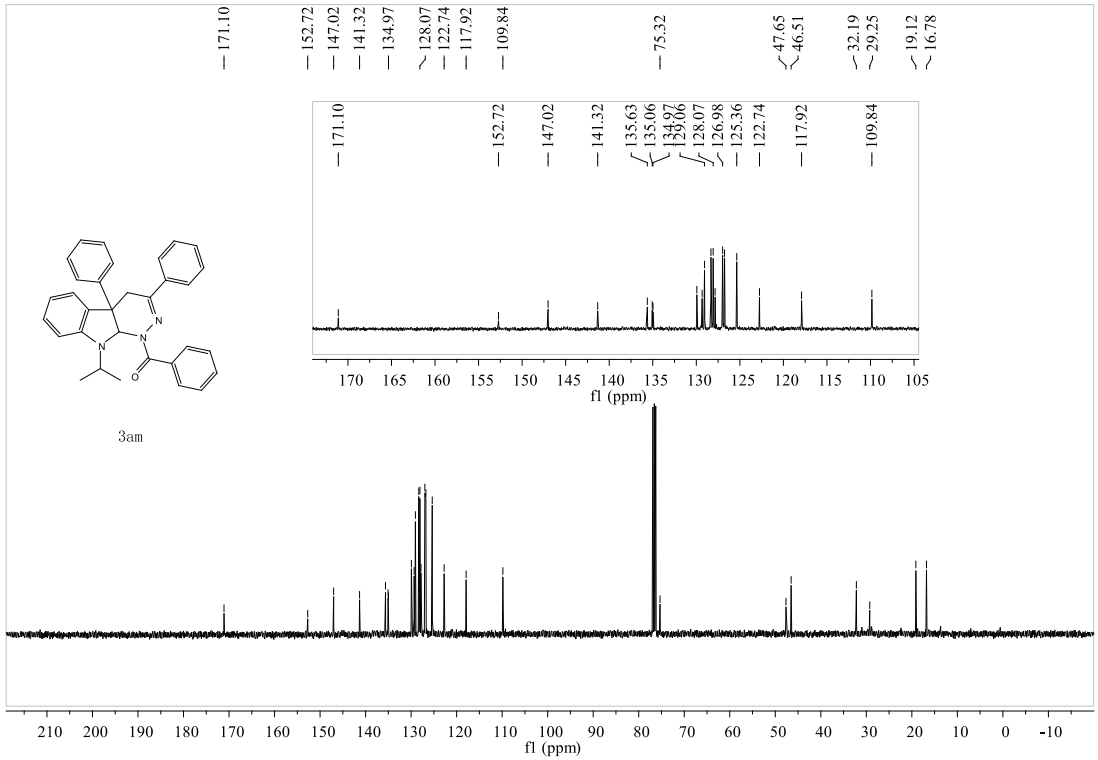
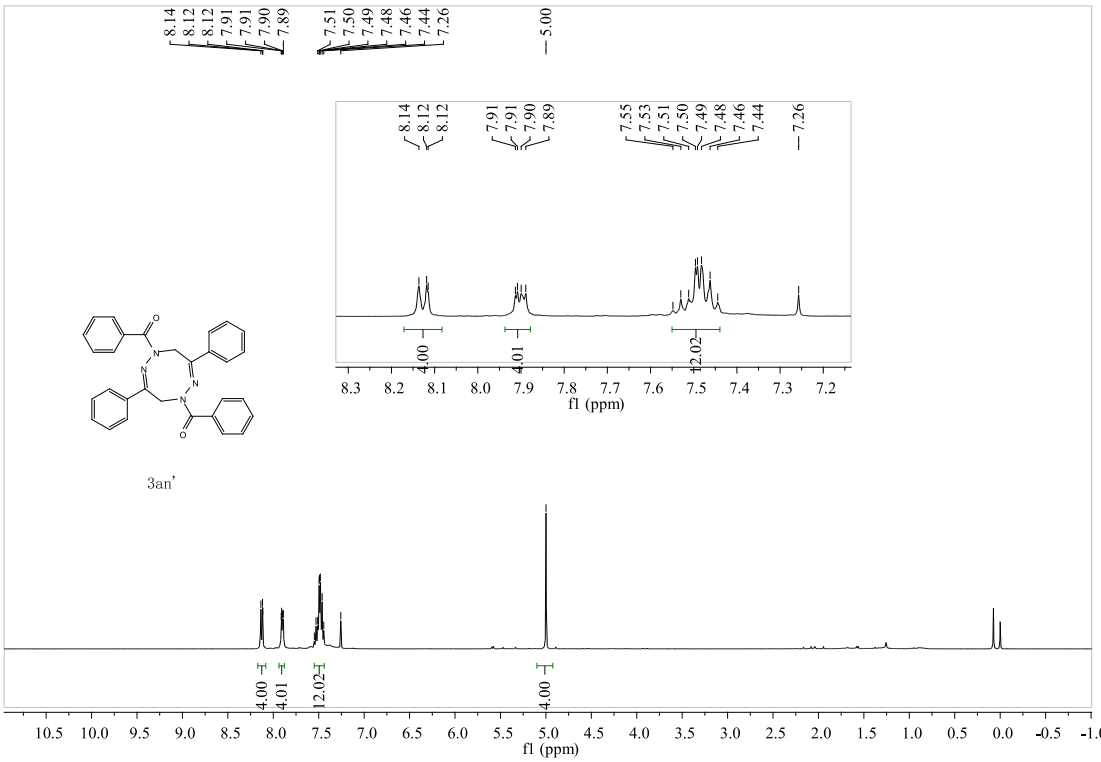
f1 (ppm)


3am
f1 (ppm)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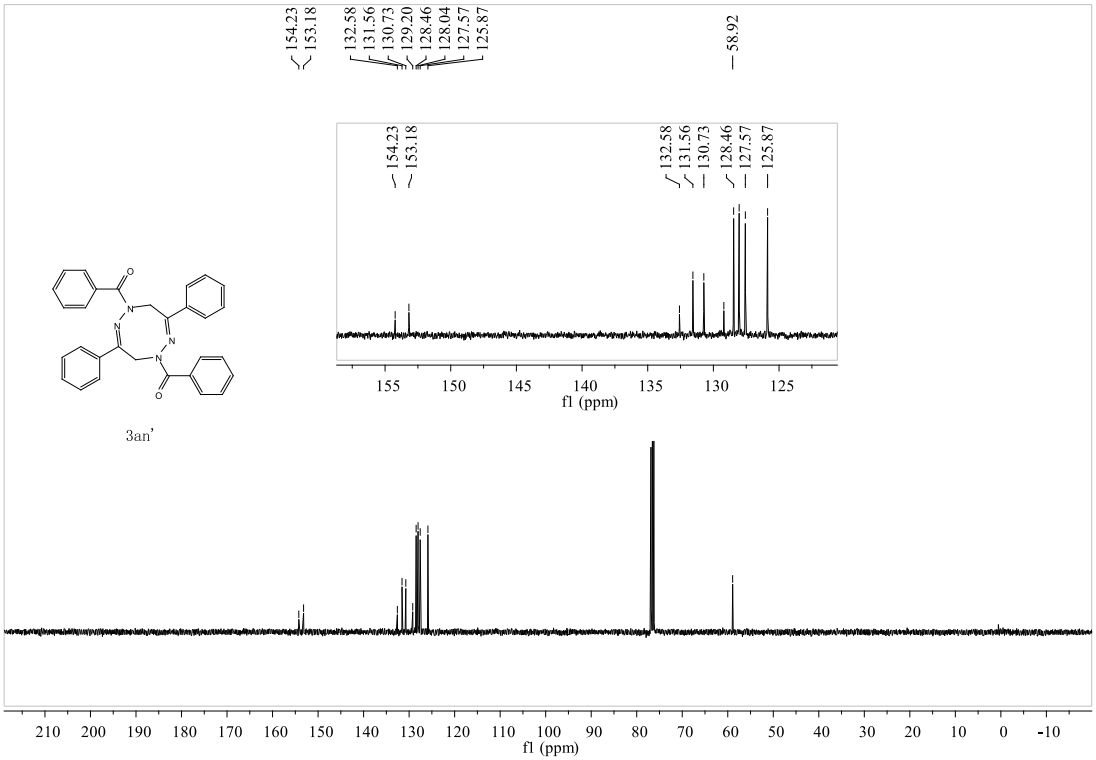
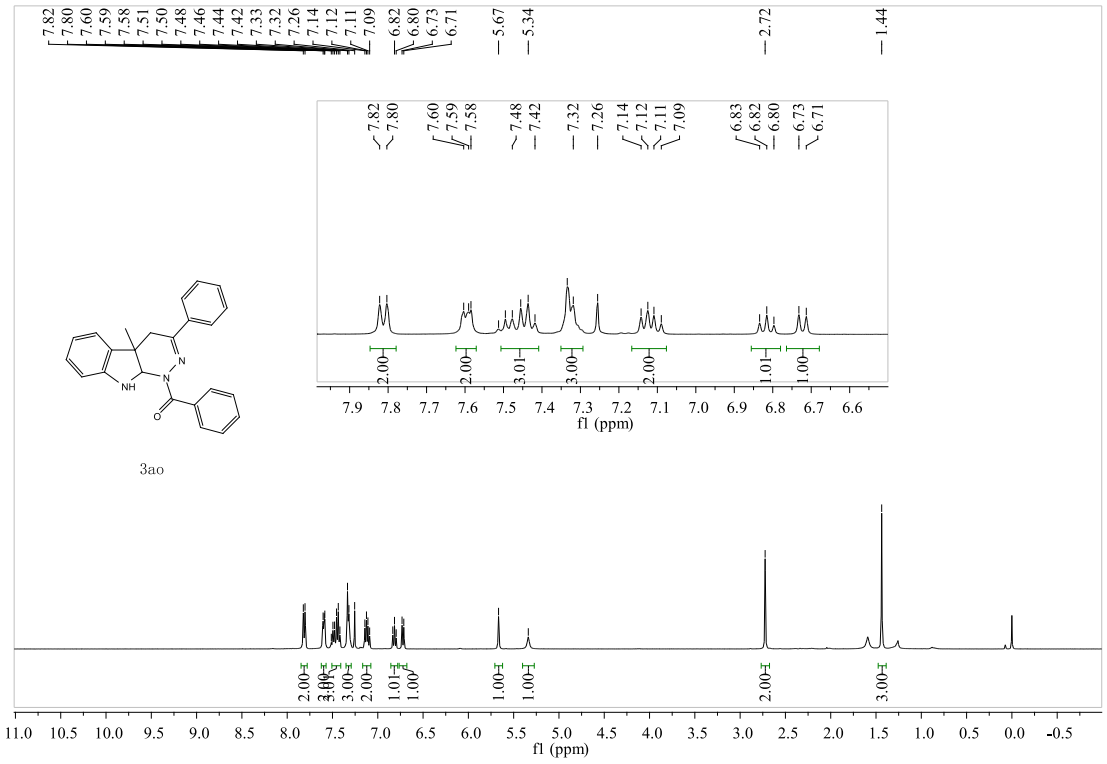
8.12
8.12
7.91
7.91
7.90
7.89
7.51
7.50
7.49
7.48
7.46
7.44
7.26
5.00
4.00
4.01
12.02
4.00
fl (ppm)
3an'


154.23
153.18
132.58
131.56
130.73
129.20
128.46
128.04
127.57
125.87
58.92
fl (ppm)
3an'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7.80
7.60
7.59
7.58
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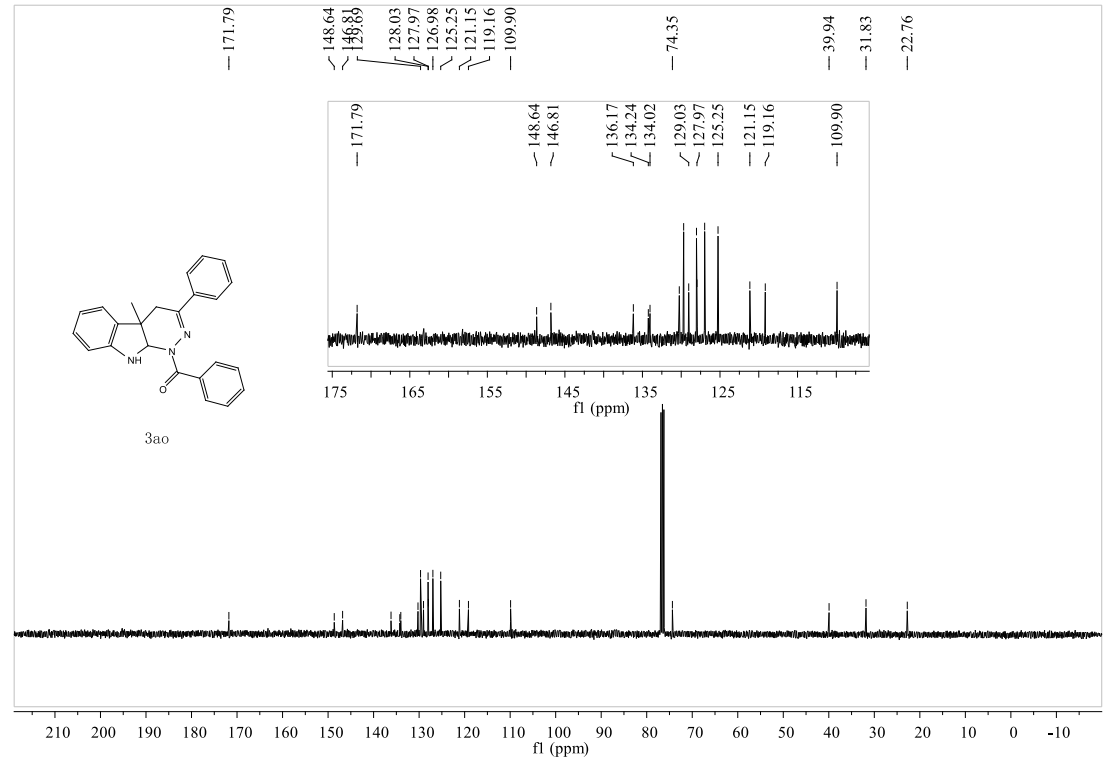
7.50
7.48
7.46
7.44
7.42
7.33
7.32
7.26
7.14
7.12
7.11
7.09
6.82
6.80
6.73
6.71
5.67
5.34
2.72
1.44
2.00
2.00
3.01
3.00
2.00
1.01
1.00
7.9 7.8 7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9 6.8 6.7 6.6
f1 (ppm)
3ao
2.00
3.00
3.00
2.00
1.01
1.00
1.00
1.00
2.00
3.00
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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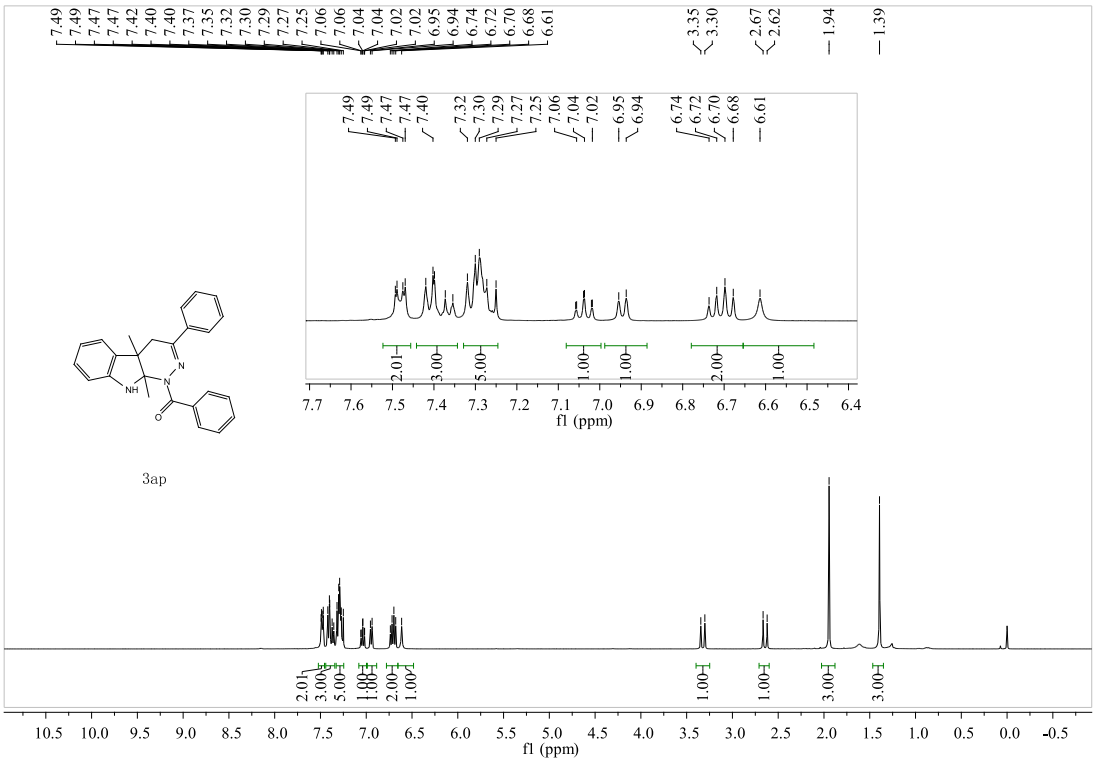
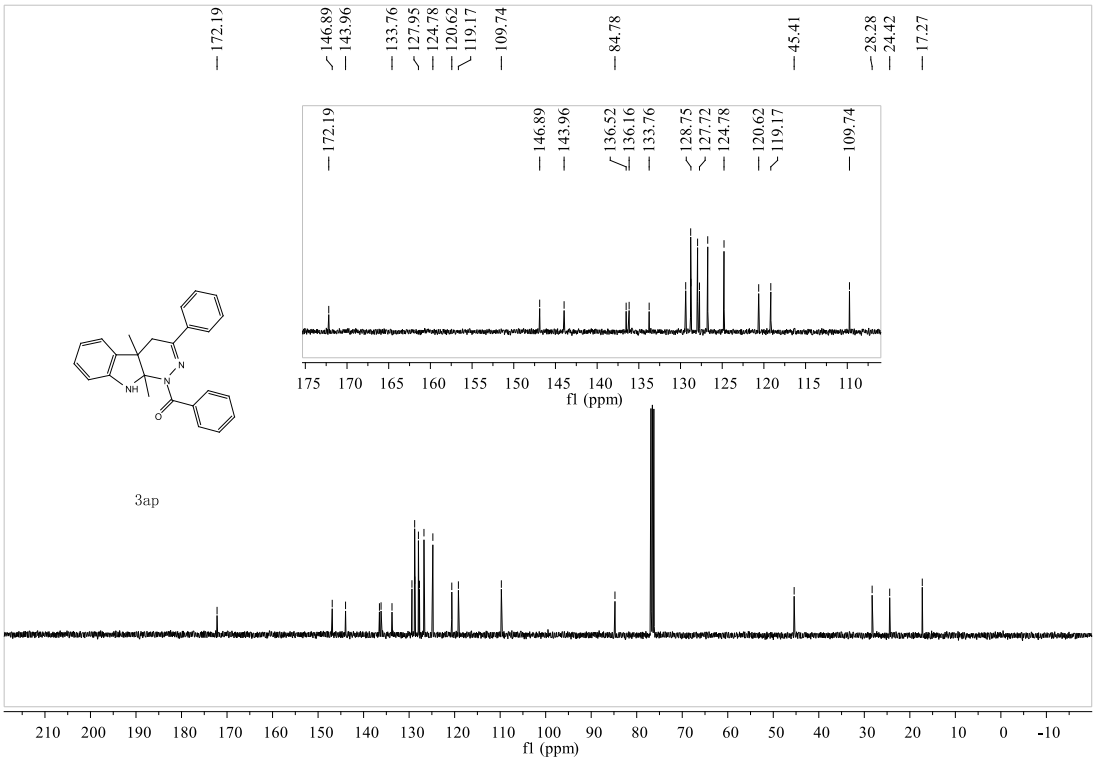
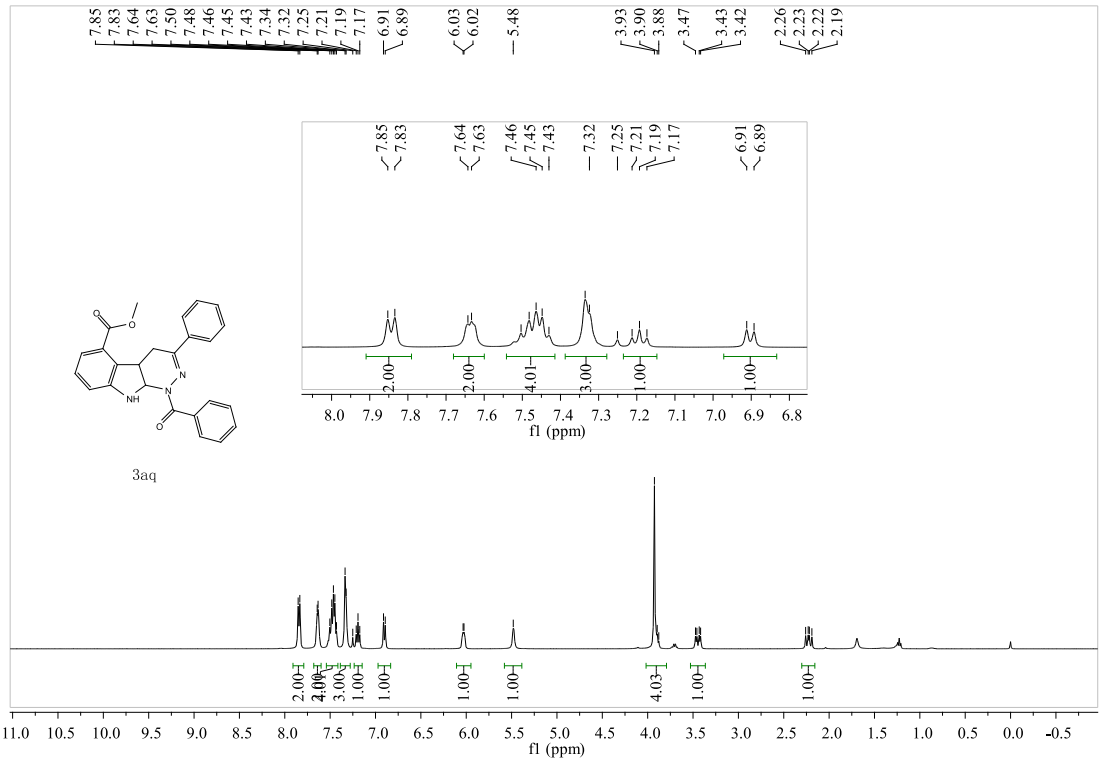
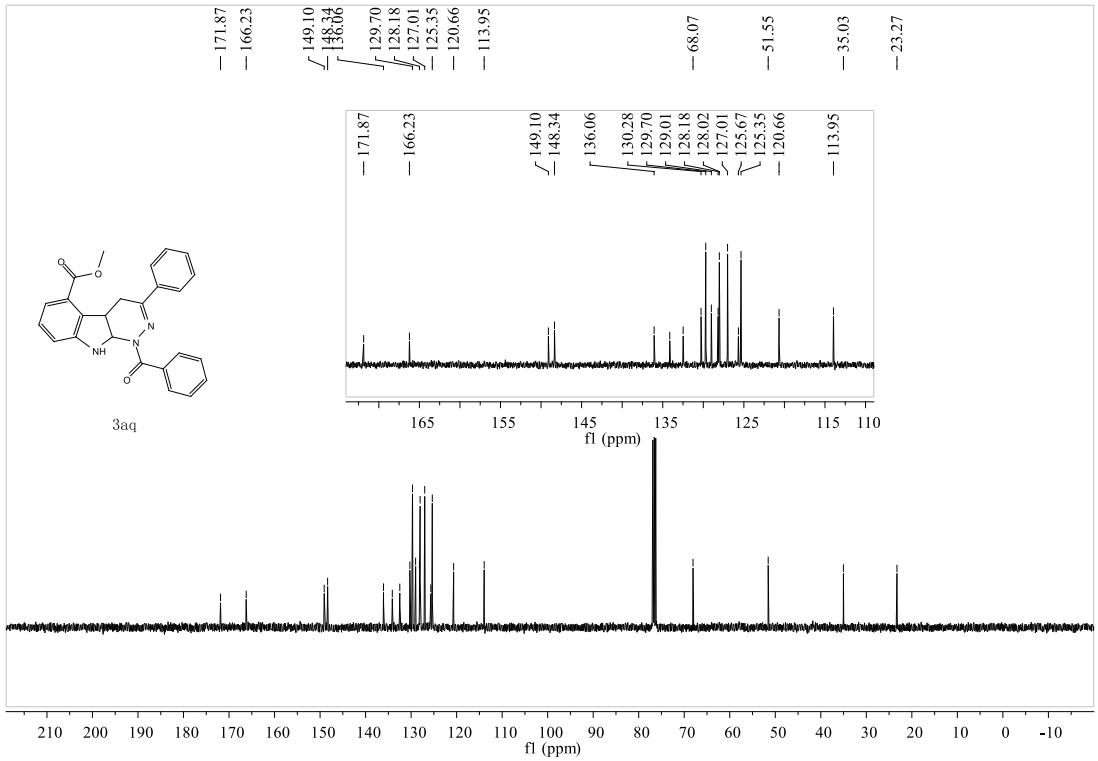
148.64
146.81
129.03
128.03
127.97
126.98
125.25
121.15
119.16
109.90
74.35
39.94
31.83
22.76
175 165 155 145 135 125 115
f1 (ppm)
3ao
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.49 7.49 7.47 7.47 7.42 7.40 7.40 7.37 7.35 7.32 7.30 7.29 7.27 7.25 7.06 7.06 7.04 7.04 7.02 7.02 6.95 6.94 6.74 6.72 6.70 6.68 6.61
3.35 3.30 2.67 2.62 1.94 1.39
7.49 7.49 7.47 7.47 7.40 7.32 7.30 7.29 7.27 7.25 7.06 7.04 7.02 6.95 6.94 6.74 6.72 6.70 6.68 6.61
2.01 3.00 5.00 1.00 1.00 2.00 1.00
7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9 6.8 6.7 6.6 6.5 6.4
f1 (ppm)
3ap
2.01 3.00 5.00 1.00 1.00 2.00 1.00 1.00 1.00 3.00 3.00
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


172.19 146.89 143.96 133.76 127.95 124.78 120.62 119.17 109.74 84.78 45.41 28.28 24.42 17.27
172.19 146.89 143.96 136.52 136.16 133.76 128.75 127.72 124.78 120.62 119.17 109.74
175 170 165 160 155 150 145 140 135 130 125 120 115 110
f1 (ppm)
3ap
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.85
7.83
7.64
7.63
7.50
7.48
7.46
7.45
7.43
7.34
7.32
7.25
7.21
7.19
7.17
6.91
6.89
6.03
6.02
5.48
3.93
3.90
3.88
3.47
3.43
3.42
2.26
2.23
2.22
2.19
2.00
2.00
4.01
3.00
1.00
1.00
fl (ppm)
3aq
2.00
2.00
3.00
1.00
1.00
1.00
1.00
4.03
1.00
1.00
fl (ppm)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166.23
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136.06
129.70
128.18
127.01
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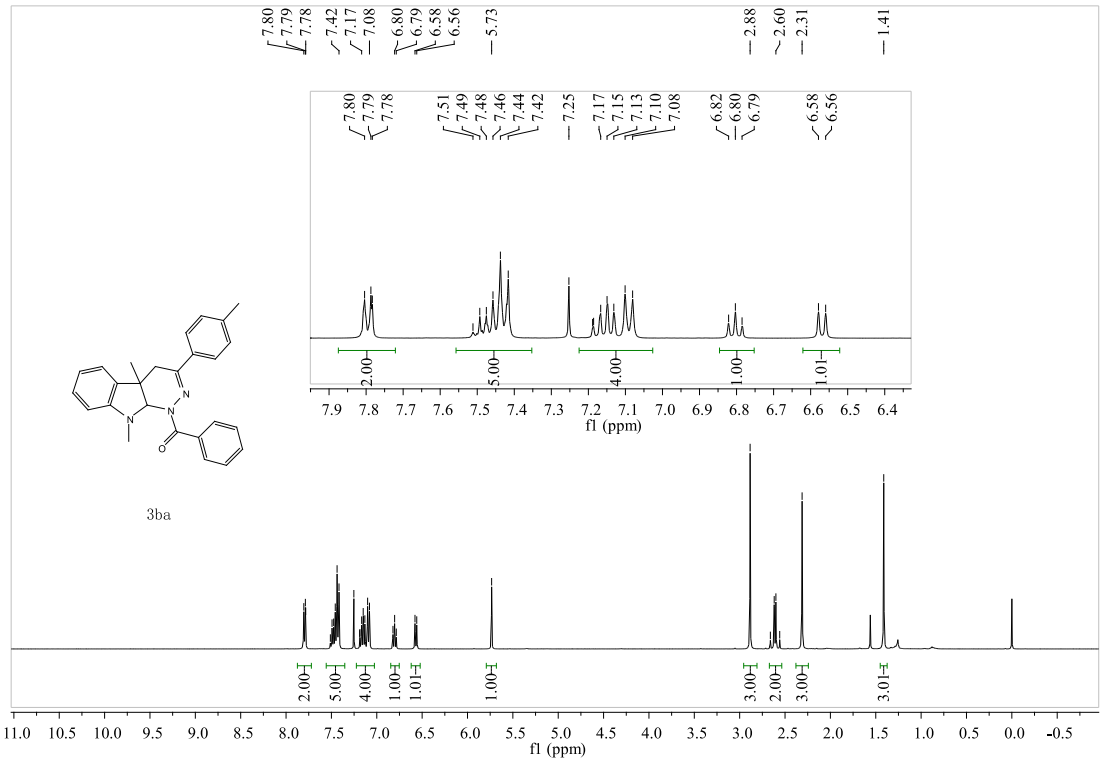
113.95
68.07
51.55
35.03
23.27
fl (ppm)
3aq
fl (ppm)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7.79
7.78
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7.17
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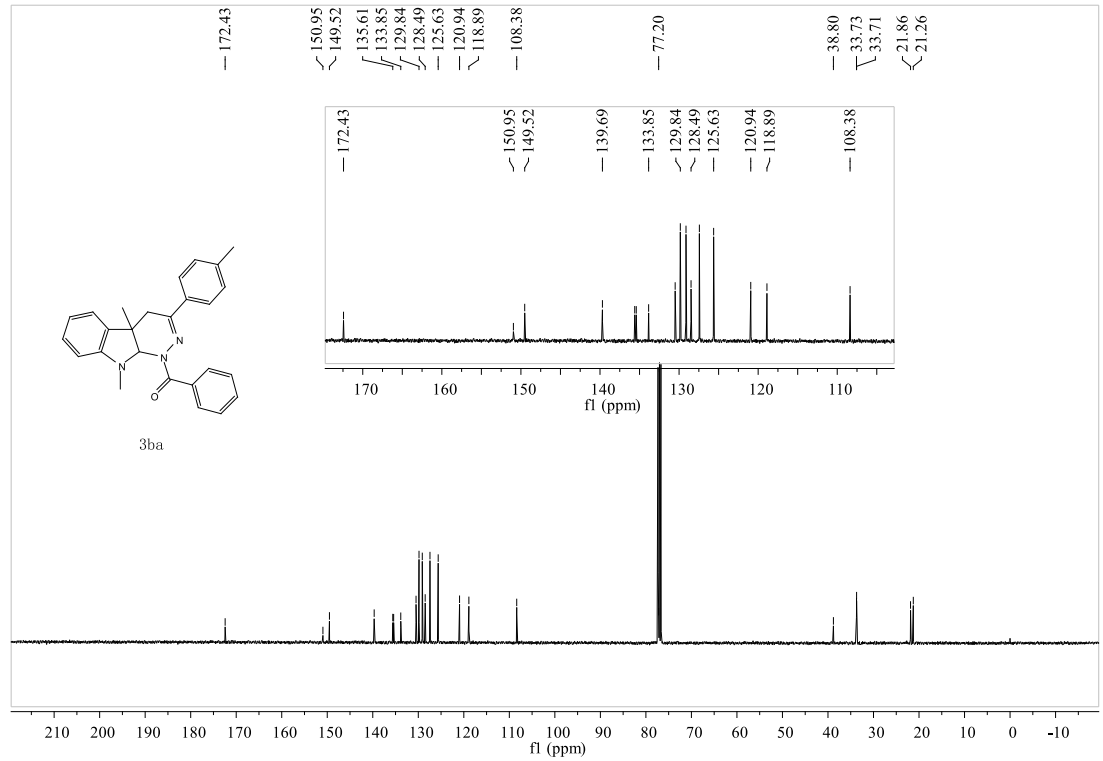
6.79
6.58
6.56
5.73
2.88
2.60
2.31
1.41
3ba
fl (ppm)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128.49
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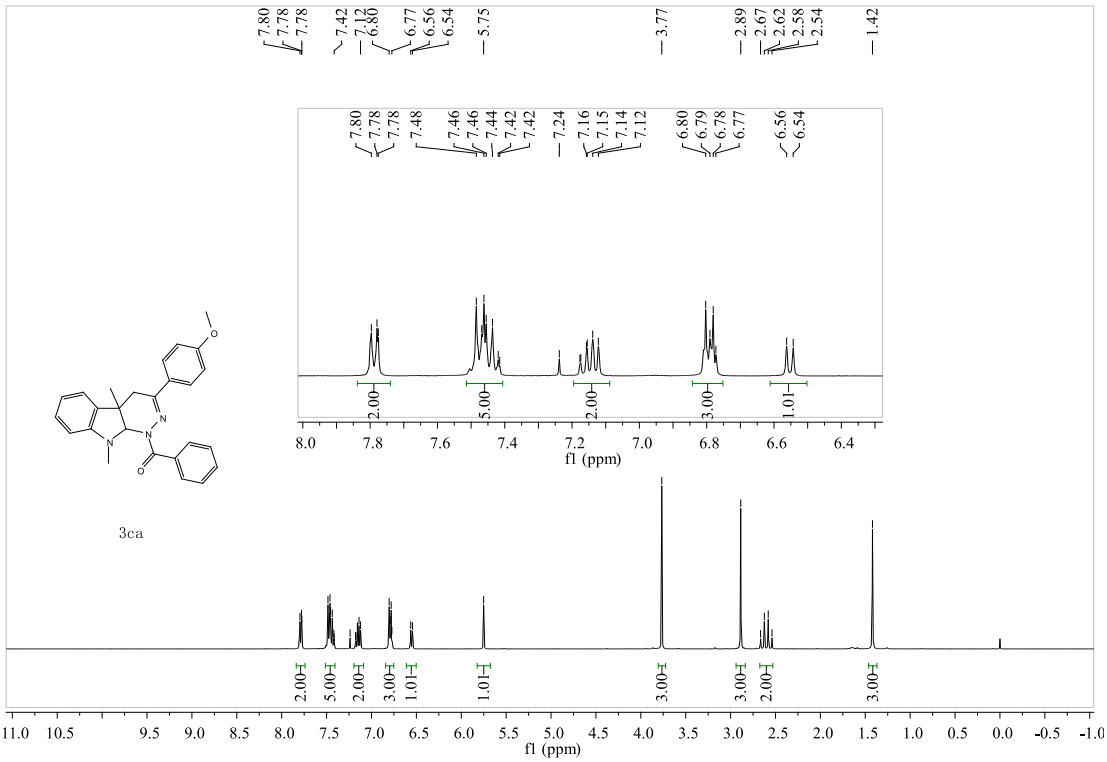
108.38
77.20
38.80
33.73
33.71
21.86
21.26
3ba
fl (ppm)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6.56
6.54
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3.77
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2.67
2.62
2.58
2.54
1.42
7.48
7.46
7.46
7.44
7.42
7.42
7.24
7.16
7.15
7.14
7.12
6.80
6.79
6.78
6.77
6.56
6.54
2.00
5.00
2.00
3.00
1.01
fl (ppm)
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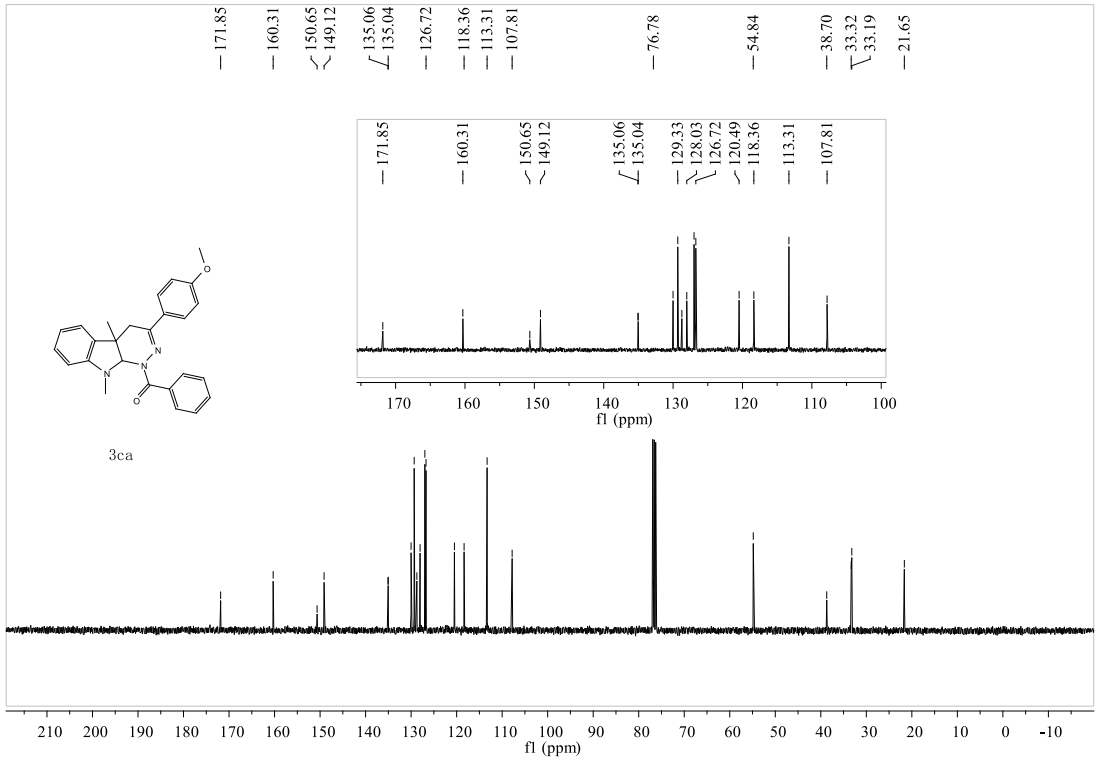
5.00
2.00
3.00
1.01
1.01
3.00
3.00
2.00
3.00
fl (ppm)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135.04
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113.31
107.81
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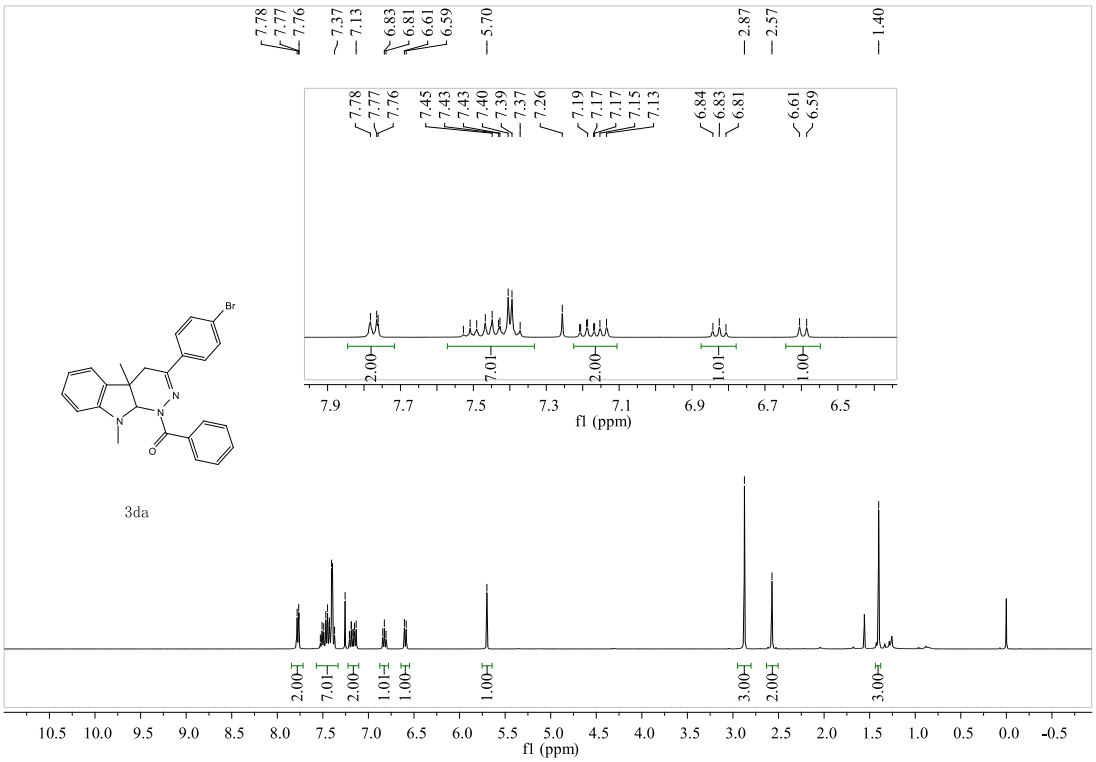
33.32
33.19
21.65
129.33
128.03
120.49
fl (ppm)
3ca
fl (ppm)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7.13
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6.81
6.61
6.59
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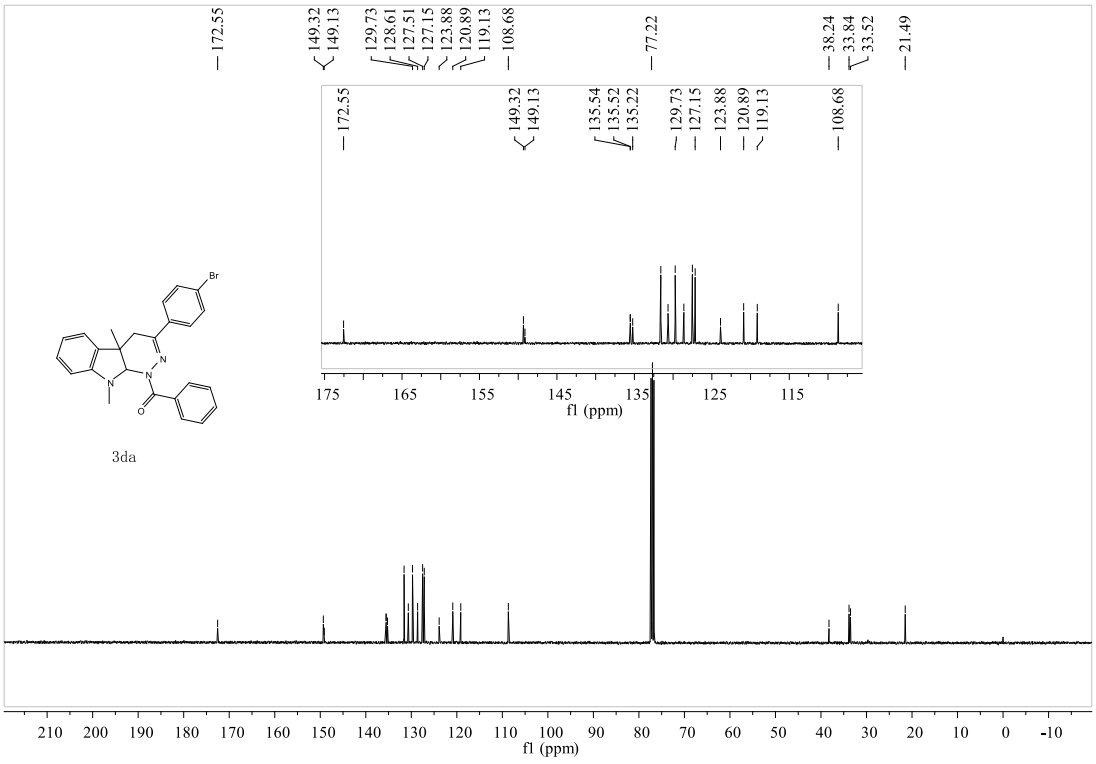
2.87
2.57
1.40
7.45
7.43
7.43
7.40
7.39
7.37
7.26
7.19
7.17
7.17
7.15
7.13
6.84
6.83
6.81
6.61
6.59
2.00
7.01
2.00
1.01
1.00
7.9
7.7
7.5
7.3
7.1
6.9
6.7
6.5
f1 (ppm)
Br
3da
2.00
7.01
2.00
1.01
1.00
1.00
3.00
2.00
3.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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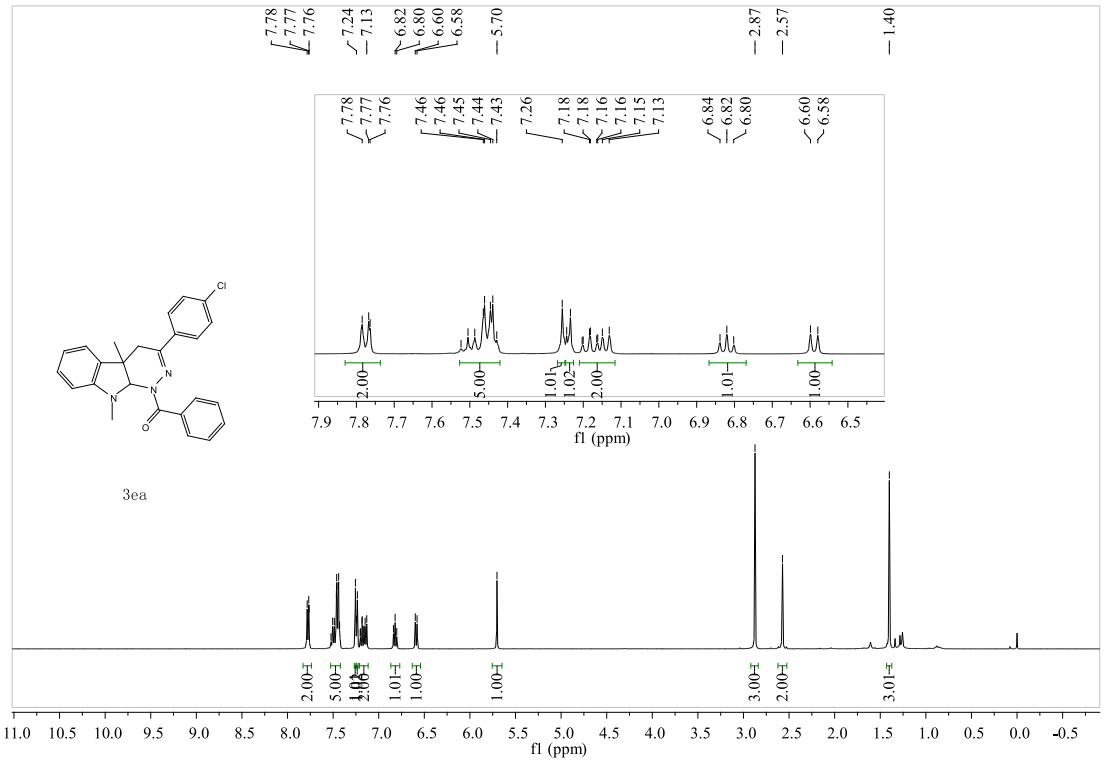
127.51
127.15
123.88
120.89
119.13
108.68
77.22
38.24
33.84
33.52
21.49
172.55
149.32
149.13
135.54
135.52
135.22
129.73
127.15
123.88
120.89
119.13
108.68
175
165
155
145
135
125
115
f1 (ppm)
Br
3da
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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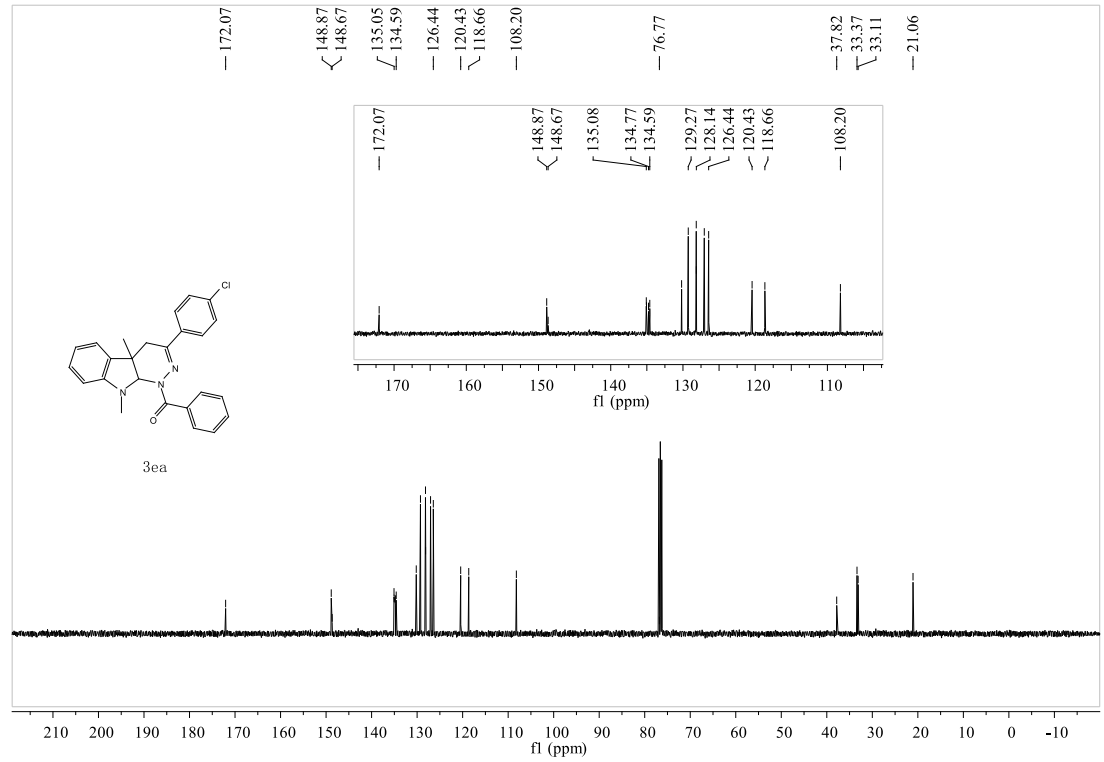
6.80
6.60
6.58
5.70
2.87
2.57
1.40
7.46
7.45
7.44
7.43
7.26
7.18
7.16
7.15
7.13
6.84
6.82
6.80
6.60
6.58
2.00
5.00
1.01
1.02
2.00
1.01
1.00
7.9 7.8 7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9 6.8 6.7 6.6 6.5
f1 (ppm)
Cl
N
N
O
3ea
2.00
5.00
1.01
1.00
1.00
3.00
2.00
3.01
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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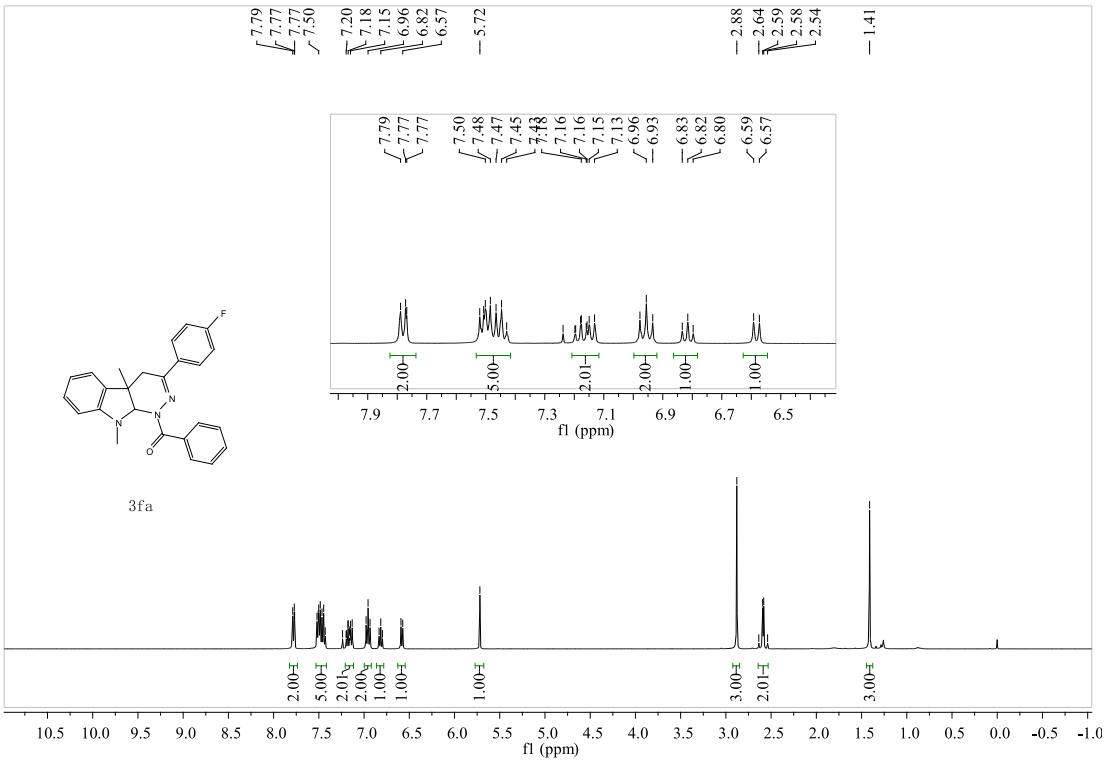
118.66
108.20
76.77
37.82
33.37
33.11
21.06
172.07
148.87
148.67
135.08
134.77
134.59
129.27
128.14
126.44
120.43
118.66
108.20
170 160 150 140 130 120 110
f1 (ppm)
Cl
N
N
O
3ea
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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5.72
2.88
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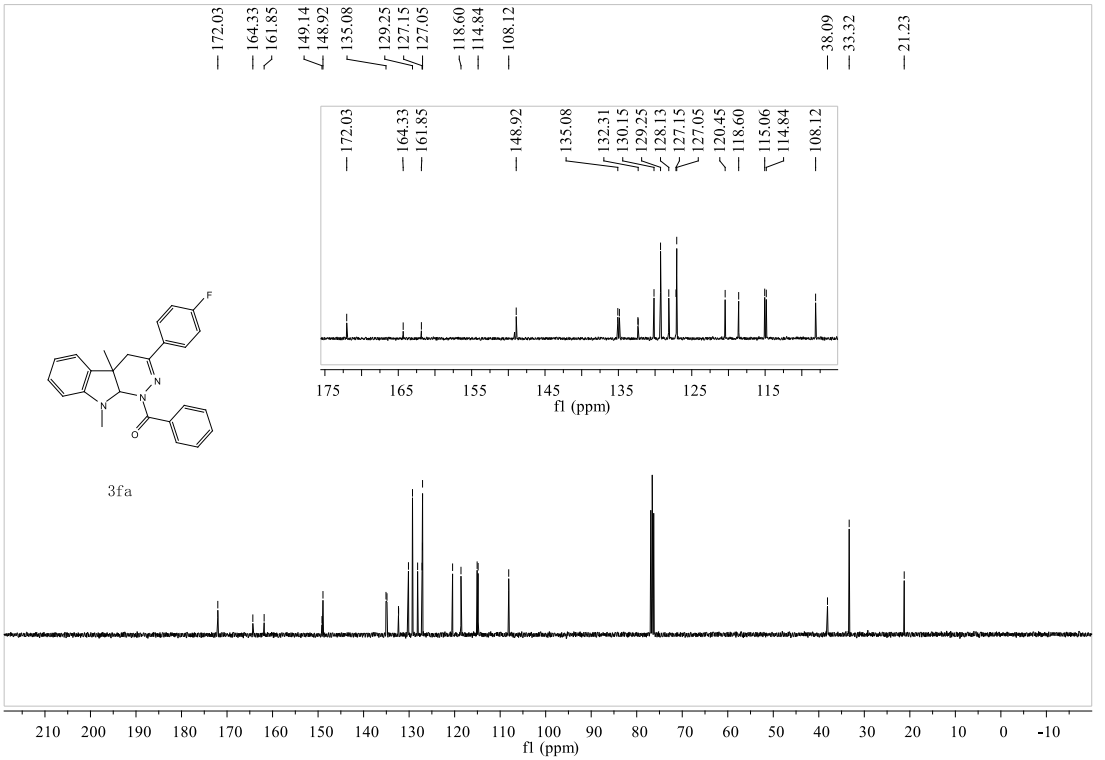
2.59
2.58
2.54
1.41
7.79
7.77
7.77
7.50
7.48
7.47
7.45
7.43
7.18
7.16
7.16
7.15
7.13
6.96
6.93
6.83
6.82
6.80
6.59
6.57
2.00
5.00
2.01
2.00
1.00
1.00
7.9
7.7
7.5
7.3
7.1
6.9
6.7
6.5
f1 (ppm)
F
N
N
O
3fa
2.00
5.00
2.01
2.00
1.00
1.00
1.00
3.00
2.01
3.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)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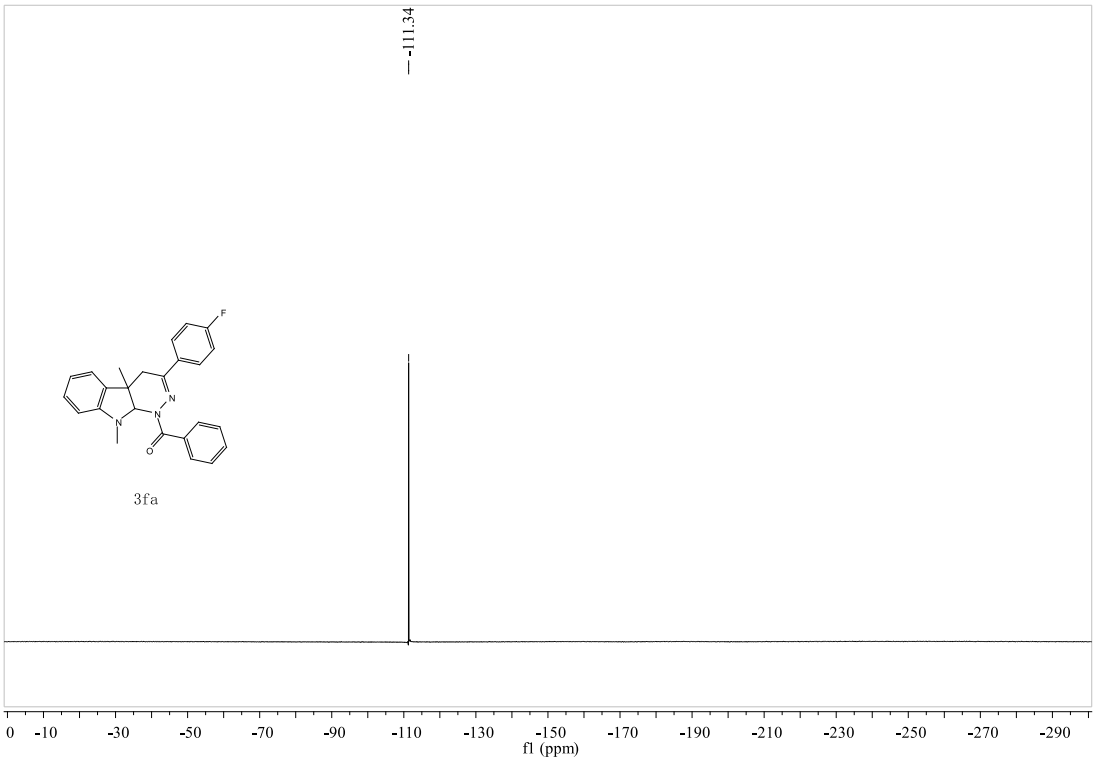
149.14
148.92
135.08
129.25
127.15
127.05
118.60
114.84
108.12
38.09
33.32
21.23
172.03
164.33
161.85
148.92
135.08
132.31
130.15
129.25
128.13
127.15
127.05
120.45
118.60
115.06
114.84
108.12
175
165
155
145
135
125
115
f1 (ppm)
F
N
N
O
3fa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


-111.34
F
N
N
O
3fa
0
-10
-30
-50
-70
-90
-110
-130
-150
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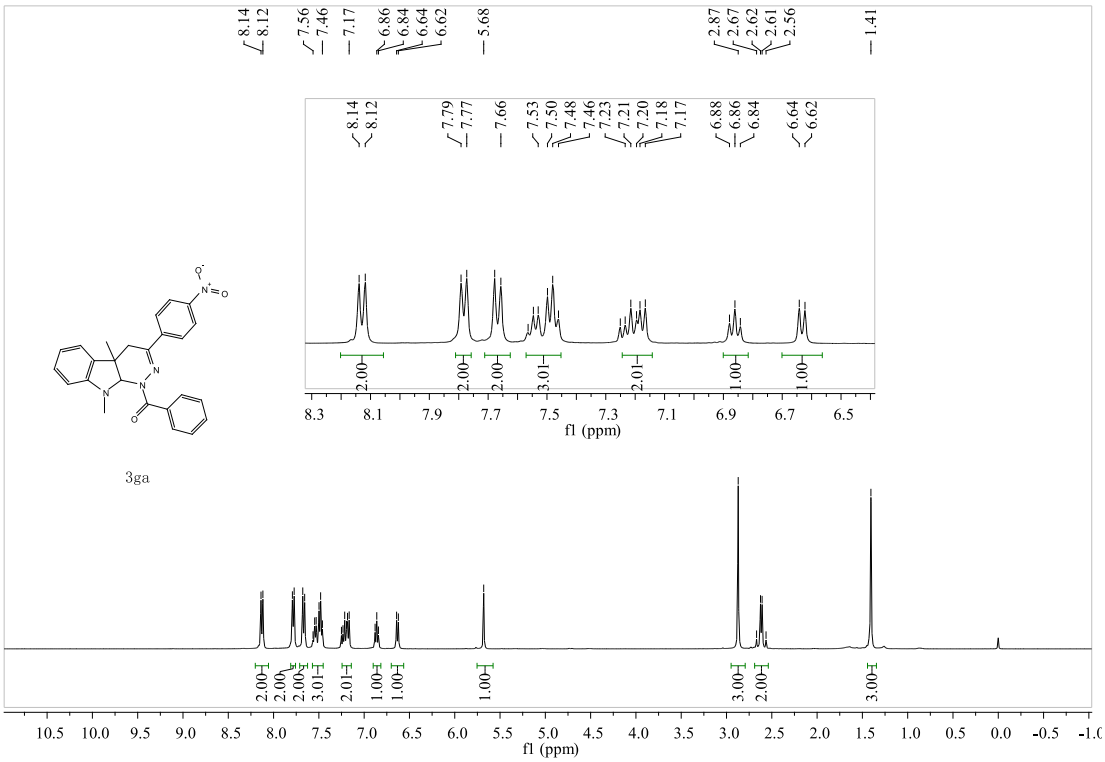
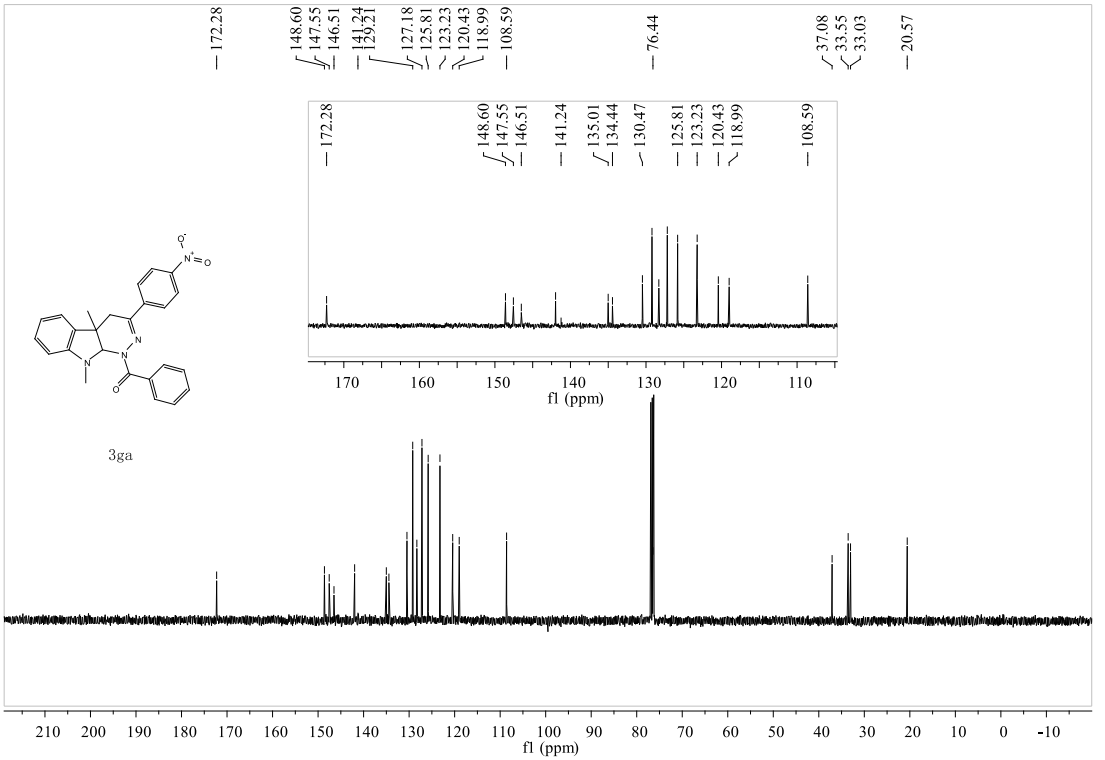
-190
-210
-230
-250
-270
-290
f1 (ppm)


8.14
8.12
7.56
7.46
7.17
6.86
6.84
6.64
6.62
5.68
2.87
2.67
2.62
2.61
2.56
1.41
7.79
7.77
7.66
7.53
7.50
7.48
7.46
7.23
7.21
7.20
7.18
7.17
6.88
6.86
6.84
6.64
6.62
2.00
2.00
2.00
3.01
2.01
1.00
1.00
8.3
8.1
7.9
7.7
7.5
7.3
7.1
6.9
6.7
6.5
f1 (ppm)
3ga
2.00
2.00
2.00
3.01
2.01
1.00
1.00
1.00
3.00
2.00
3.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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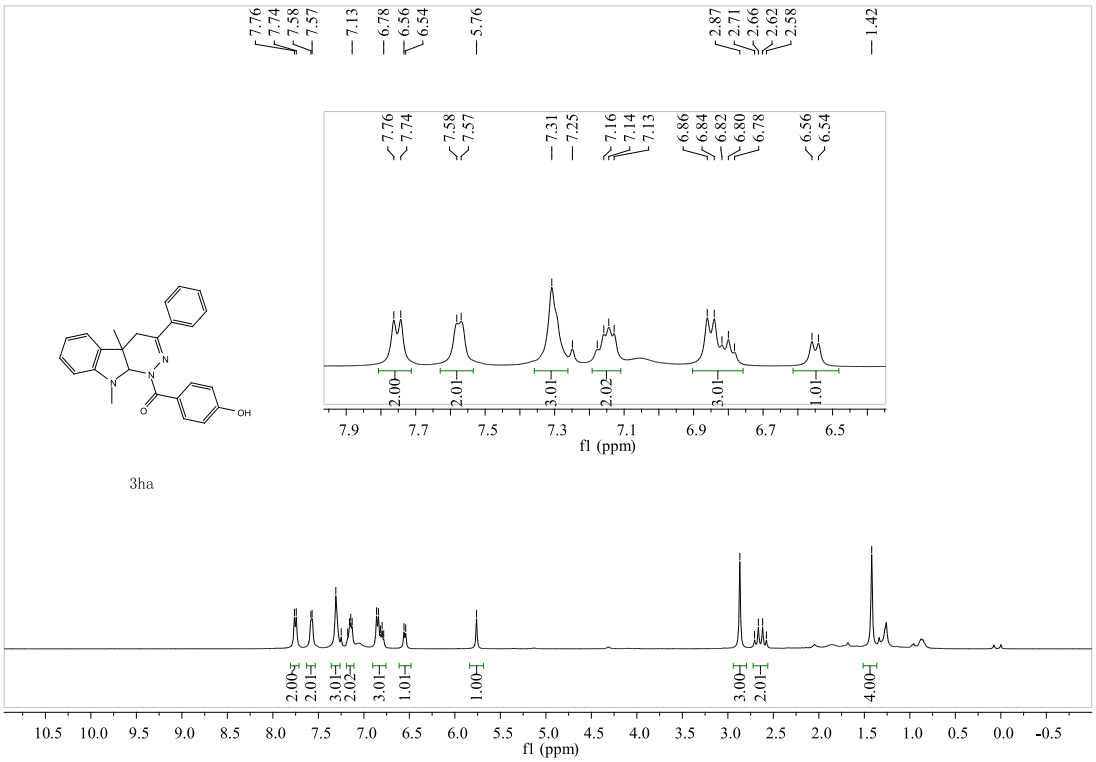
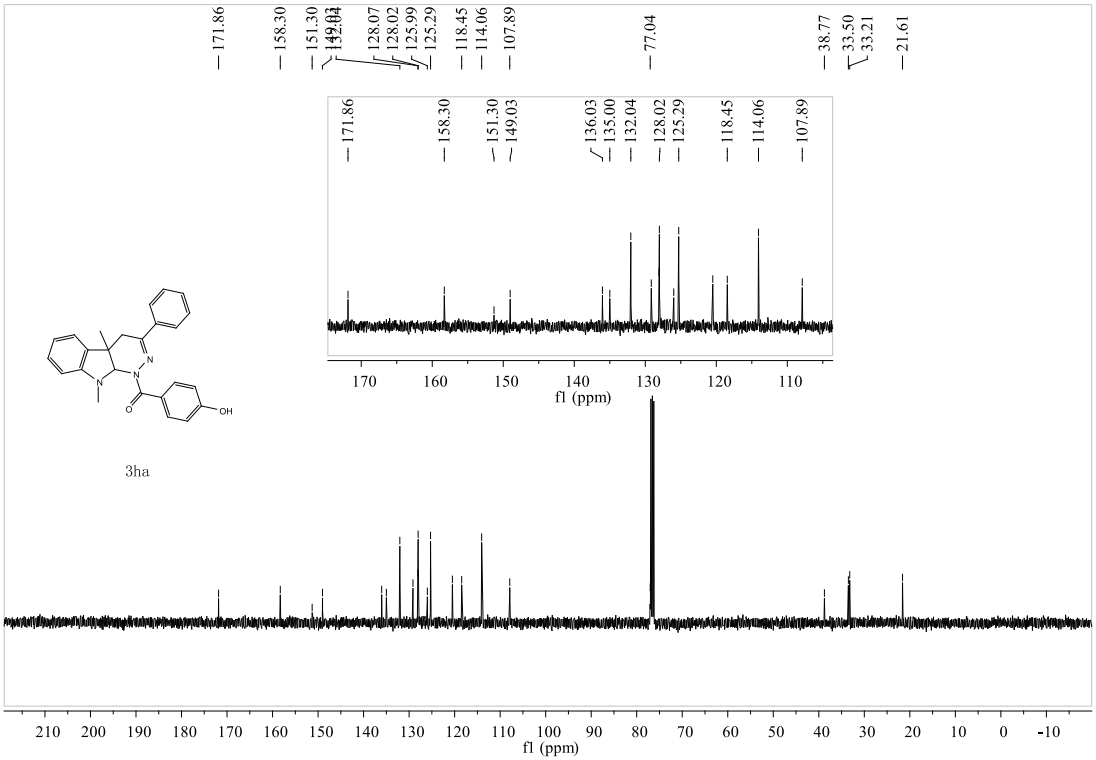
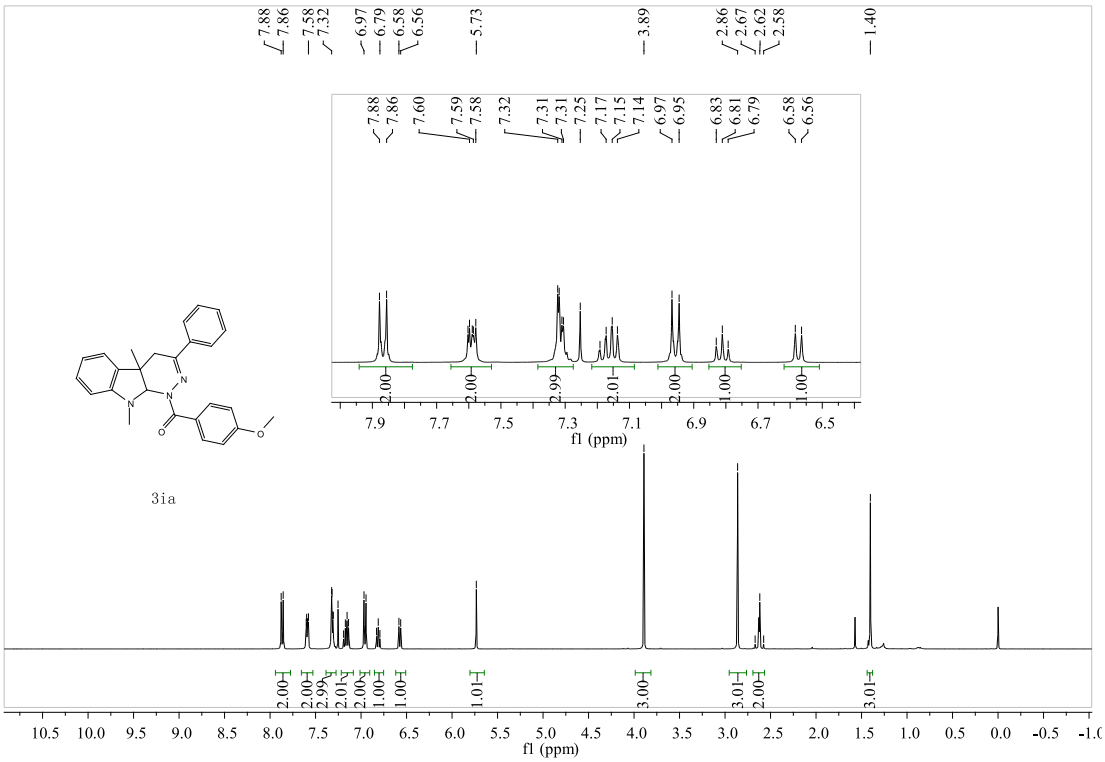
148.60
147.55
146.51
141.24
129.21
127.18
125.81
123.23
120.43
118.99
108.59
76.44
37.08
33.55
33.03
20.57
172.28
148.60
147.55
146.51
141.24
135.01
134.44
130.47
125.81
123.23
120.43
118.99
108.59
170
160
150
140
130
120
110
f1 (ppm)
3ga
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.76
7.74
7.58
7.57
7.13
6.78
6.56
6.54
5.76
2.87
2.71
2.66
2.62
2.58
1.42
7.31
7.25
7.16
7.14
7.13
6.86
6.84
6.82
6.80
6.78
7.58
7.57
6.56
6.54
2.00
2.01
3.01
2.02
3.01
1.01
7.9
7.7
7.5
7.3
7.1
6.9
6.7
6.5
f1 (ppm)
OH
3ha
2.00
2.01
3.01
2.02
3.01
1.01
1.00
3.00
2.01
4.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


171.86
158.30
151.30
149.03
128.07
128.02
125.99
125.29
118.45
114.06
107.89
77.04
38.77
33.50
33.21
21.61
136.03
135.00
132.04
OH
3ha
170
160
150
140
130
120
110
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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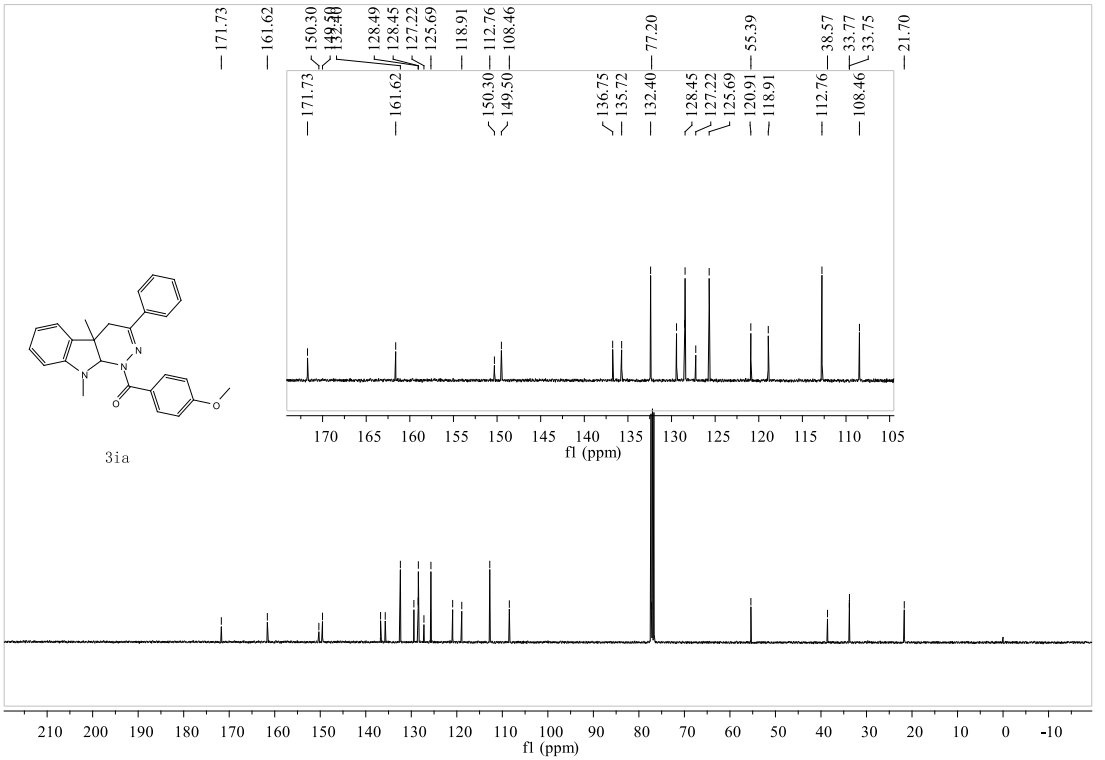
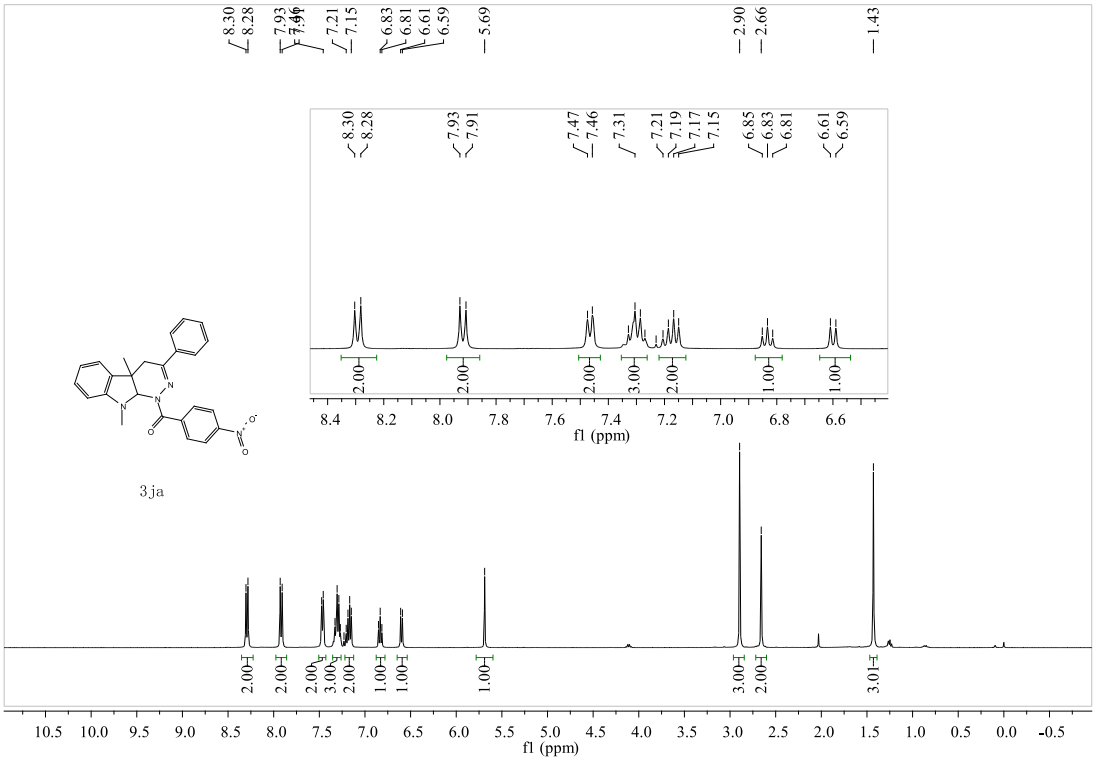
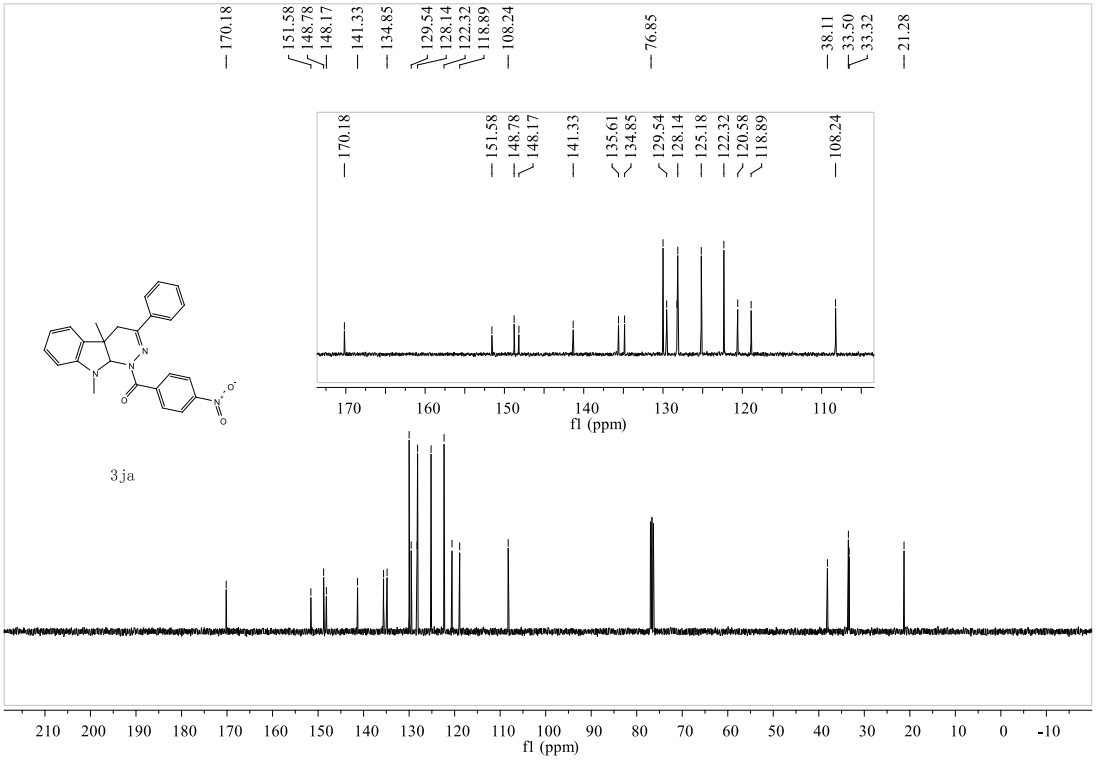
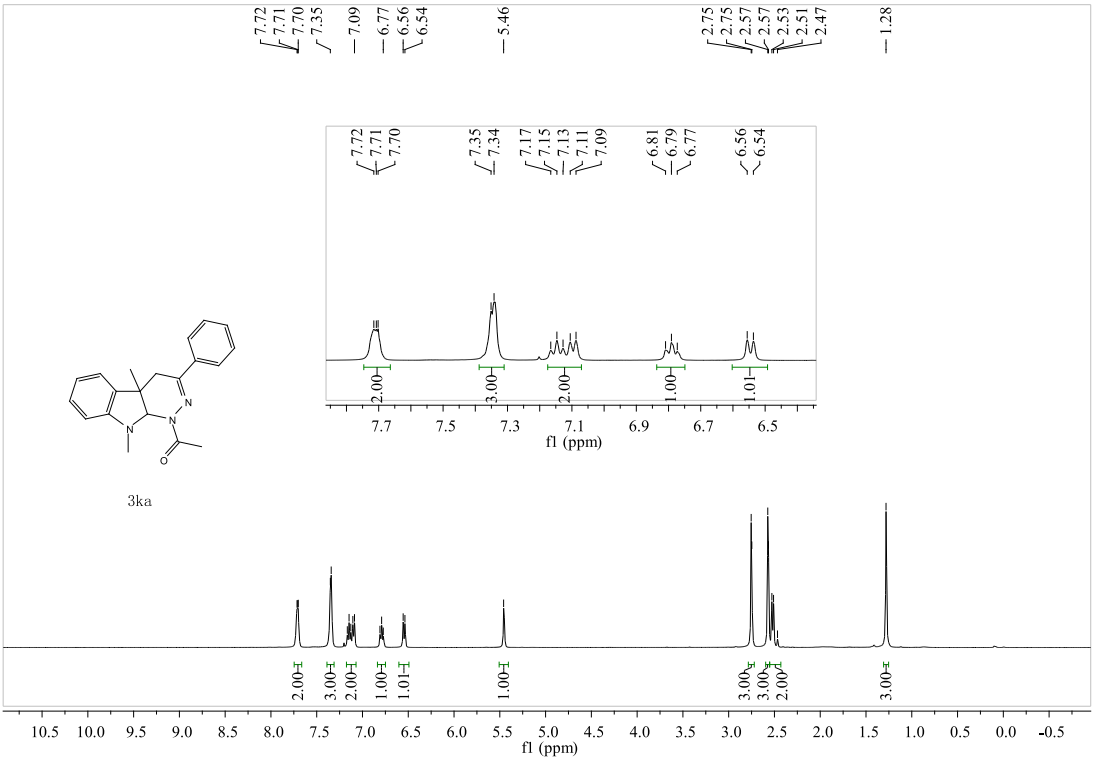
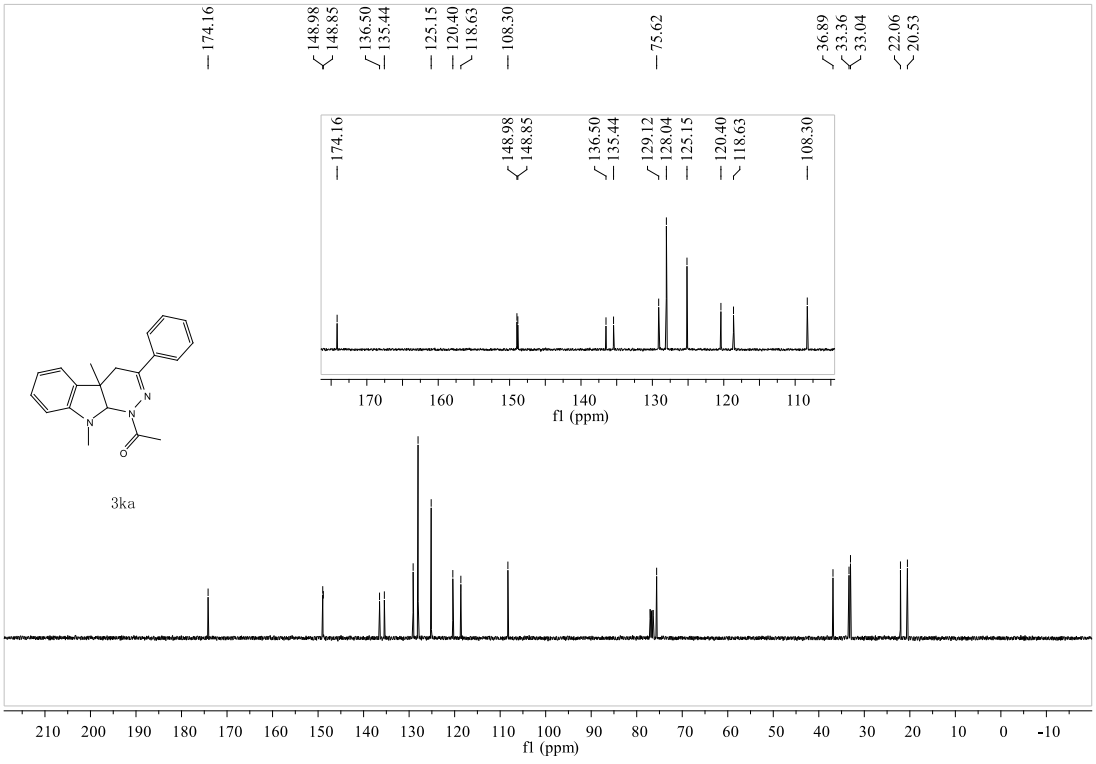
7.86
7.58
7.32
6.97
6.79
6.58
6.56
5.73
3.89
2.86
2.67
2.62
2.58
1.40
7.60
7.59
7.31
7.25
7.17
7.15
7.14
6.95
6.83
6.81
6.79
6.58
6.56
2.00
2.00
2.99
2.01
2.00
1.00
1.00
fl (ppm)
3ia
1.01
3.00
3.01
2.00
3.01
fl (ppm)

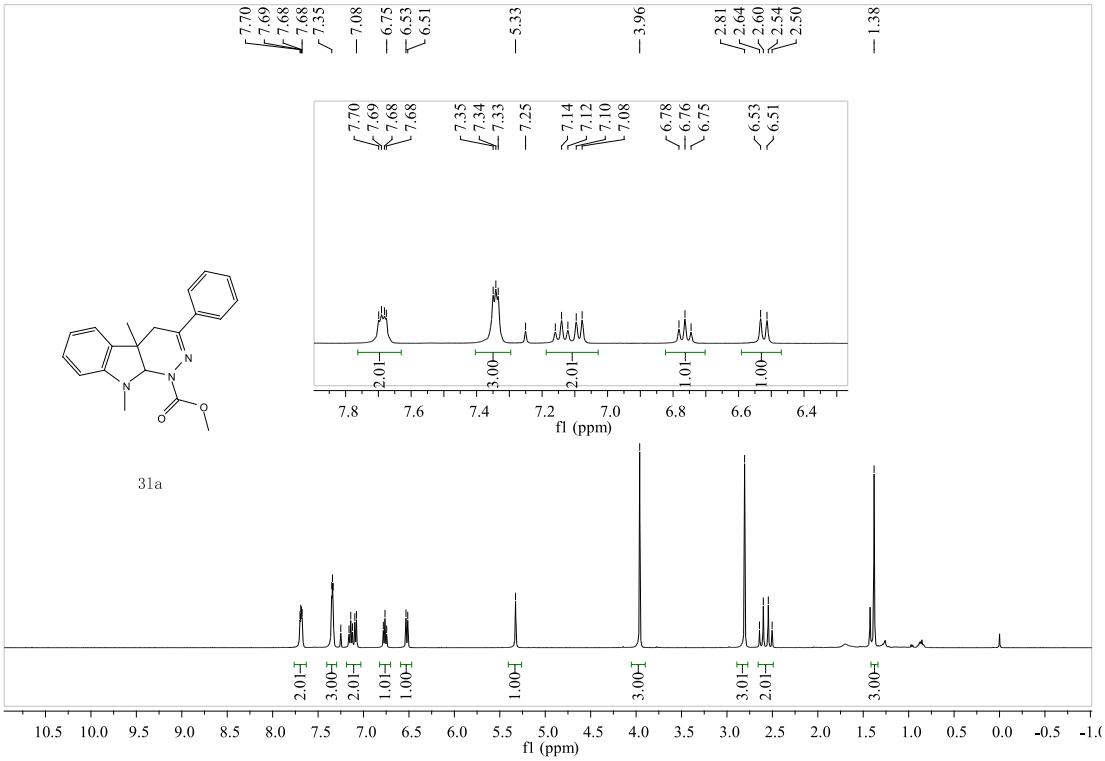

171.73
161.62
150.30
149.50
136.75
135.72
132.40
128.49
128.45
127.22
125.69
120.91
118.91
112.76
108.46
77.20
55.39
38.57
33.77
33.75
21.70
fl (ppm)
3ia
fl (ppm)

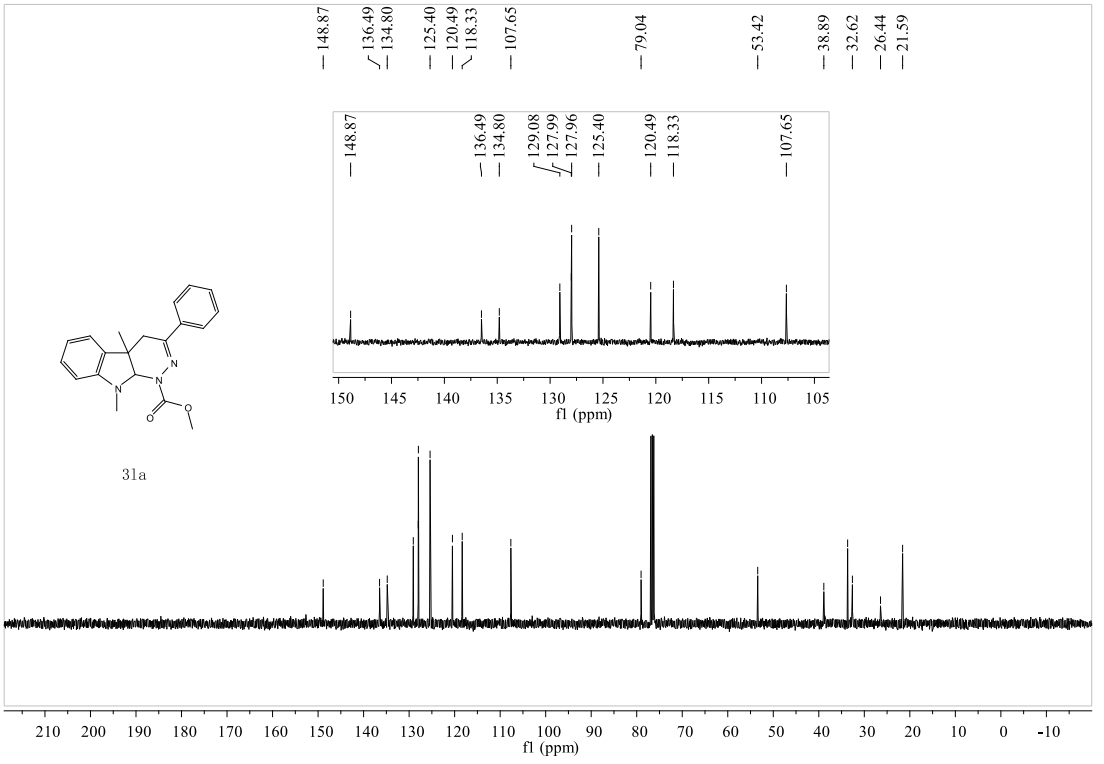

8.30
8.28
7.93
7.91
7.46
7.21
7.15
6.83
6.81
6.61
6.59
5.69
2.90
2.66
1.43
3.ja
fl (ppm)

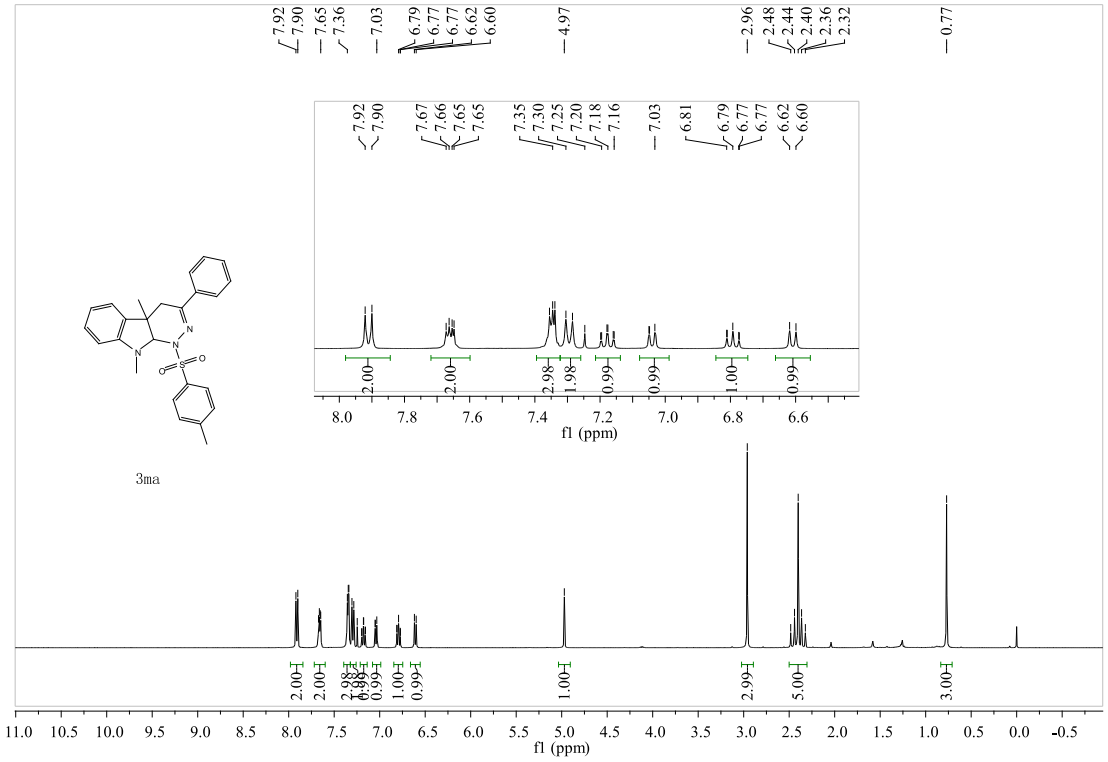

170.18
151.58
148.78
148.17
141.33
134.85
129.54
128.14
122.32
118.89
108.24
76.85
38.11
33.50
33.32
21.28
3.ja
fl (ppm)

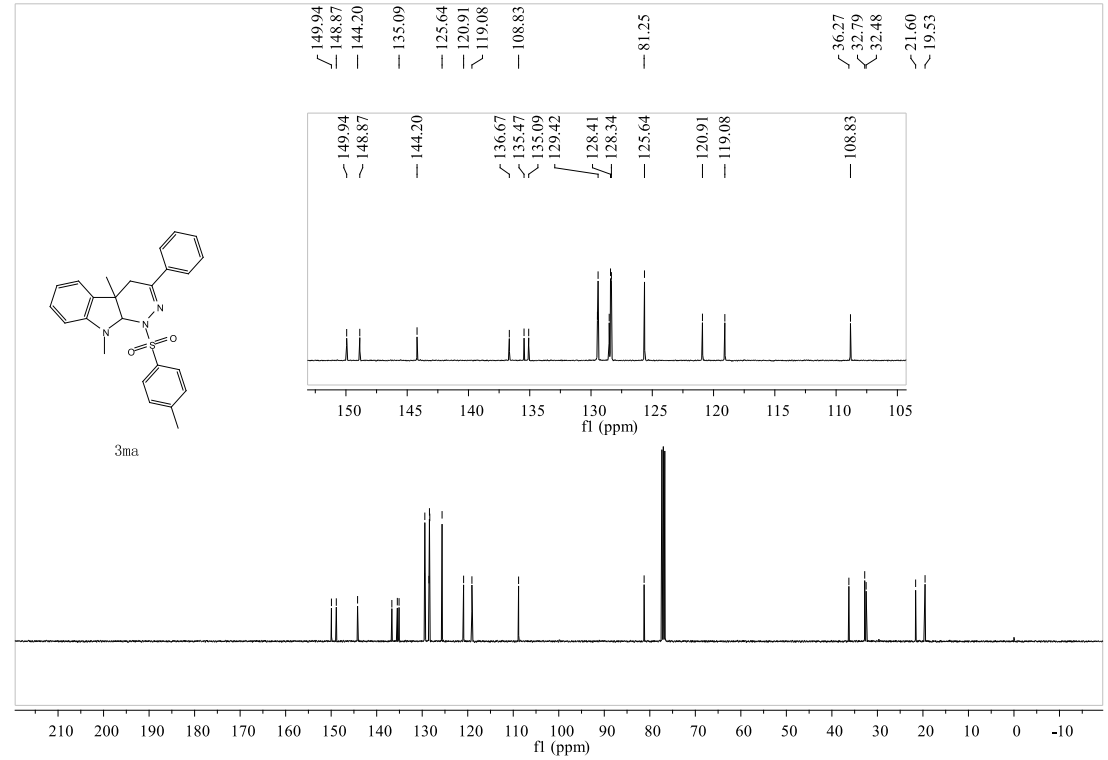

7.72
7.71
7.70
7.35
7.09
6.77
6.56
6.54
5.46
2.75
2.75
2.57
2.57
2.53
2.51
2.47
1.28
7.72
7.71
7.70
7.35
7.34
7.17
7.15
7.13
7.11
7.09
6.81
6.79
6.77
6.56
6.54
2.00
3.00
2.00
1.00
1.01
7.7
7.5
7.3
7.1
6.9
6.7
6.5
f1 (ppm)
3ka
2.00
3.00
2.00
1.00
1.01
1.00
3.00
3.00
2.00
3.00
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

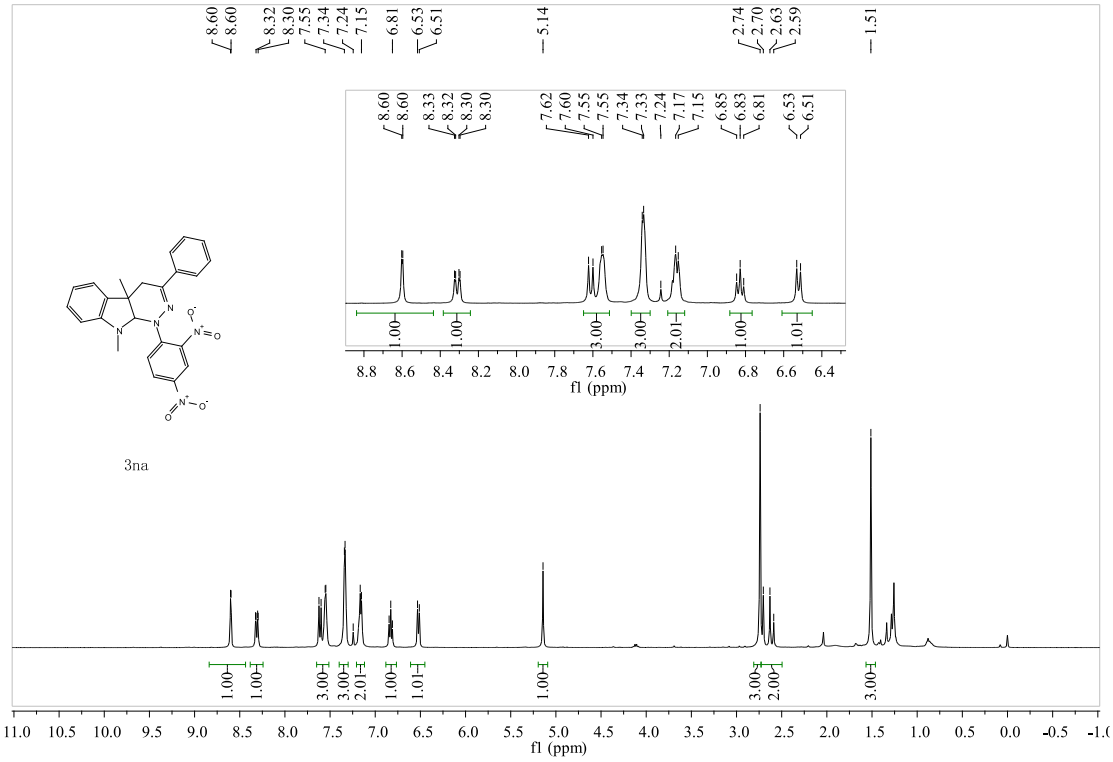

174.16
148.98
148.85
136.50
135.44
125.15
120.40
118.63
108.30
75.62
36.89
33.36
33.04
22.06
20.53
174.16
148.98
148.85
136.50
135.44
129.12
128.04
125.15
120.40
118.63
108.30
170
160
150
140
130
120
110
f1 (ppm)
3ka
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

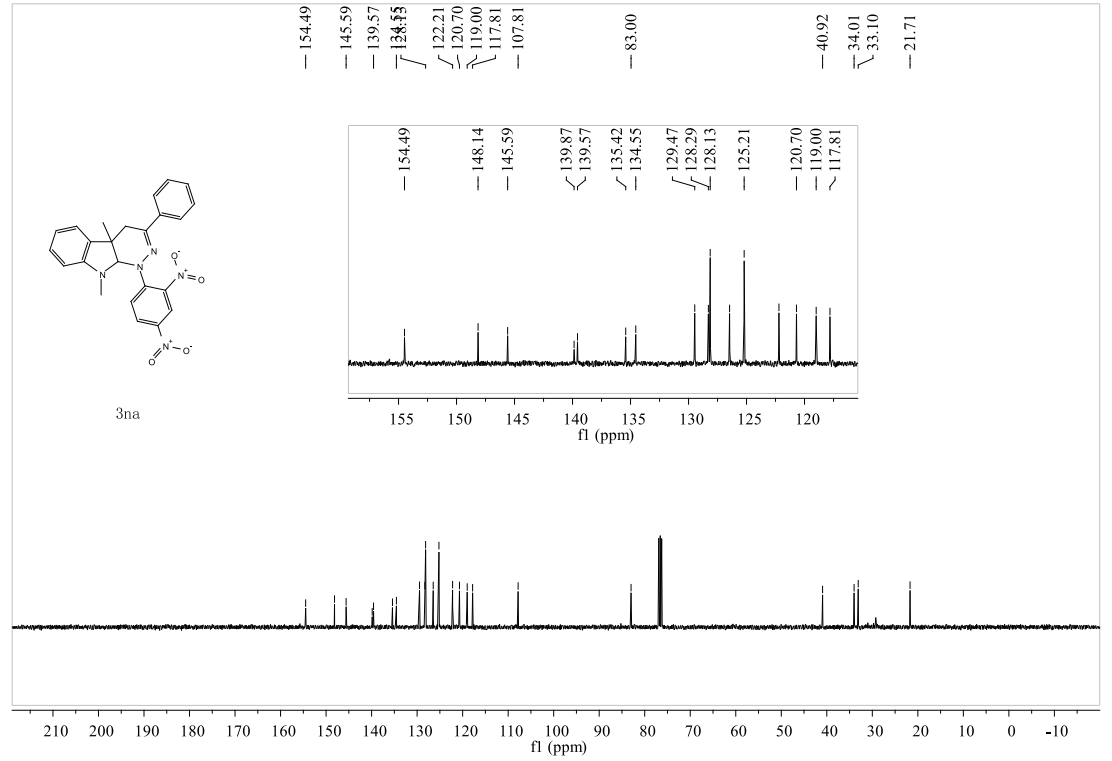

7.70
7.69
7.68
7.68
7.35
7.08
6.75
6.53
6.51
5.33
3.96
2.81
2.64
2.60
2.54
2.50
1.38
7.35
7.34
7.33
7.25
7.14
7.12
7.10
7.08
6.78
6.76
6.75
6.53
6.51
2.01
3.00
2.01
1.01
1.00
fl (ppm)
31a
2.01
3.00
2.01
1.01
1.00
1.00
3.00
3.01
2.01
3.00
fl (ppm)

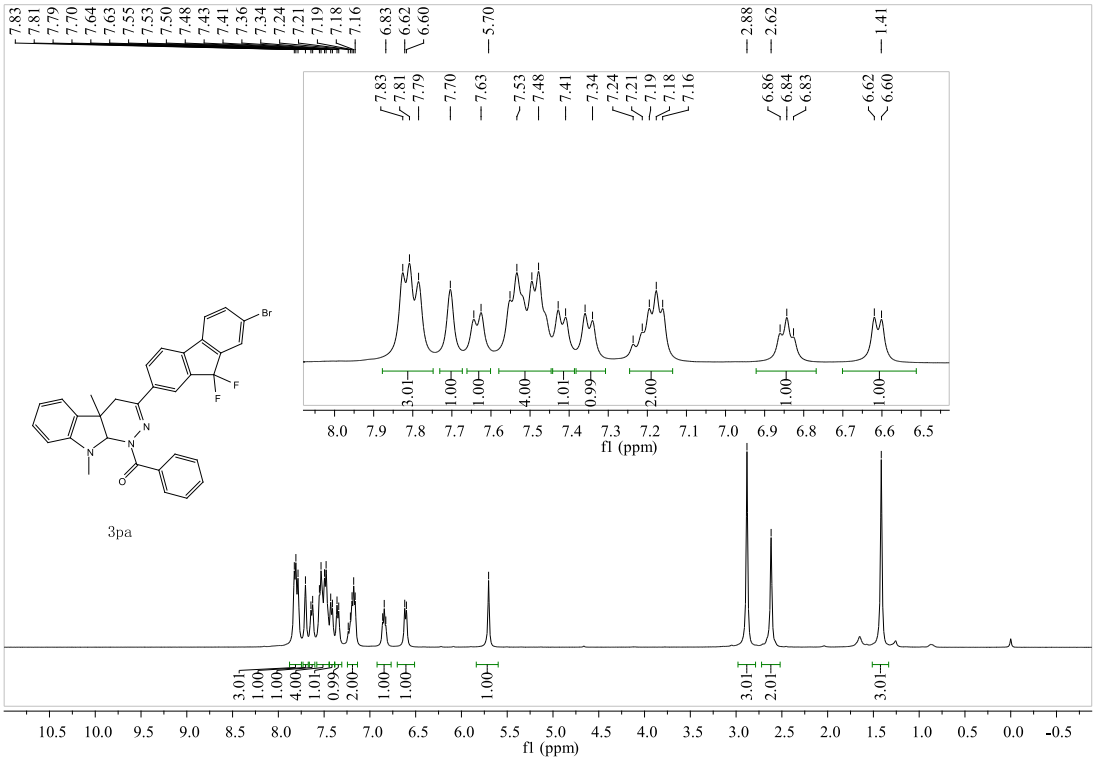

148.87
136.49
134.80
125.40
120.49
118.33
107.65
79.04
53.42
38.89
32.62
26.44
21.59
148.87
136.49
134.80
129.08
127.99
127.96
125.40
120.49
118.33
107.65
fl (ppm)
31a
fl (ppm)

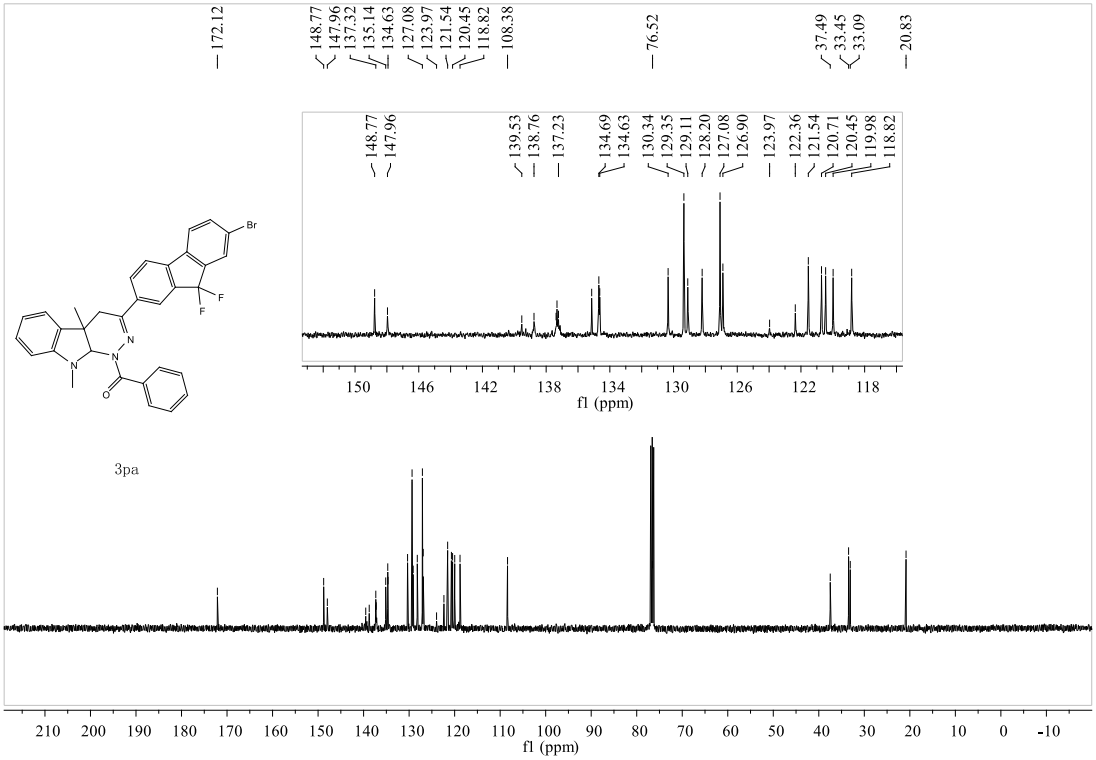

7.92
7.90
7.65
7.36
7.03
6.79
6.77
6.77
6.62
6.60
4.97
2.96
2.48
2.44
2.40
2.36
2.32
0.77
7.67
7.66
7.65
7.65
7.35
7.30
7.25
7.20
7.18
7.16
6.81
6.62
6.60
2.00
2.00
2.98
1.98
0.99
0.99
1.00
0.99
f1 (ppm)
3ma
2.00
2.00
1.00
0.99
1.00
2.99
5.00
3.00
f1 (ppm)

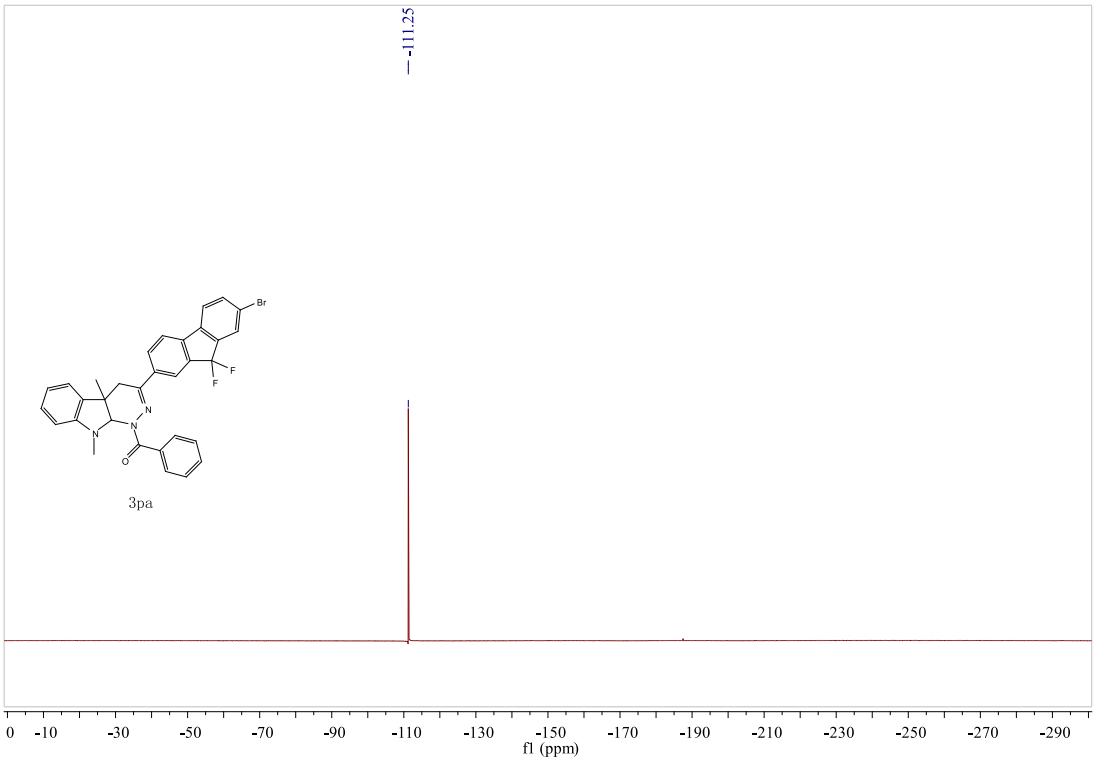

149.94
148.87
144.20
135.09
125.64
120.91
119.08
108.83
81.25
36.27
32.79
32.48
21.60
19.53
136.67
135.47
135.09
129.42
128.41
128.34
f1 (ppm)
3ma
f1 (ppm)

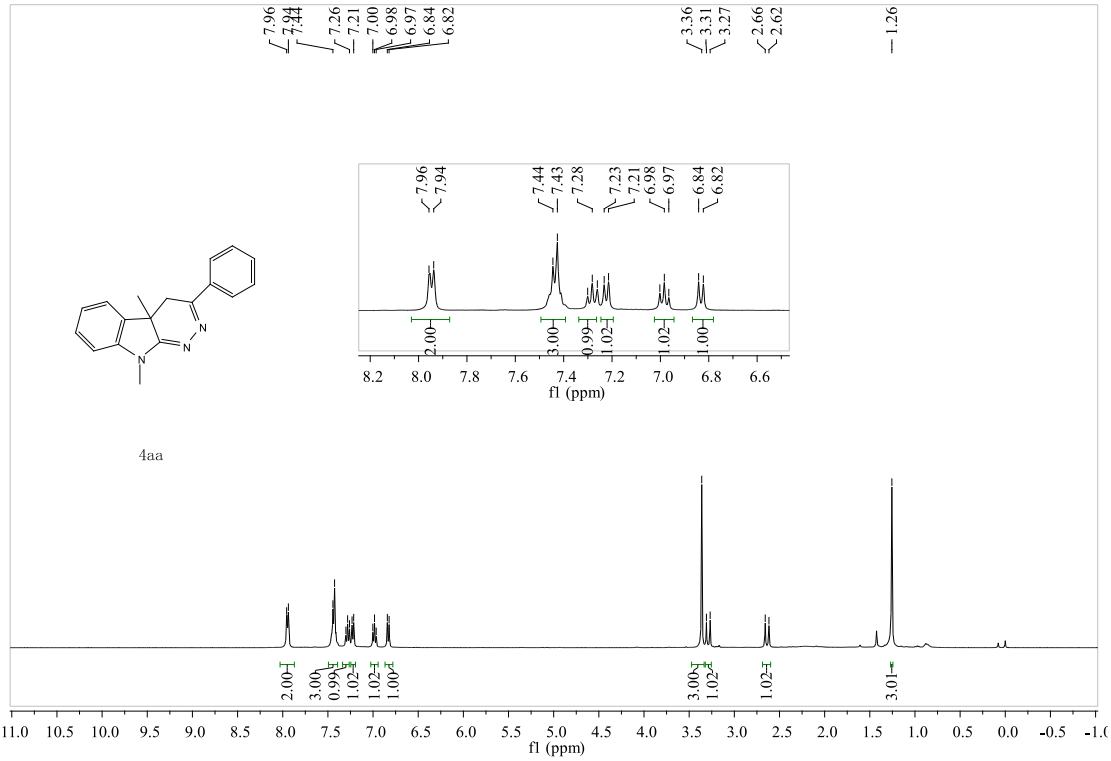

8.60
8.60
8.32
8.30
7.55
7.34
7.24
7.15
6.81
6.53
6.51
5.14
2.74
2.70
2.63
2.59
1.51
3na
f1 (ppm)

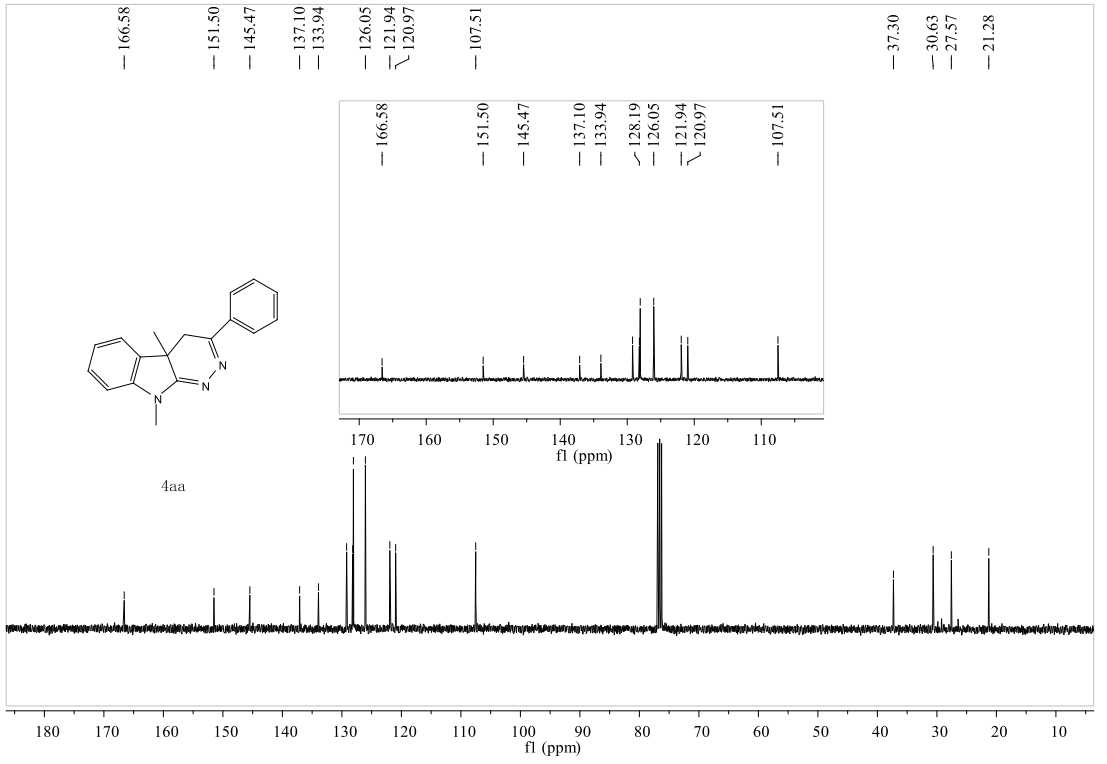

154.49
145.59
139.57
122.21
120.70
119.00
117.81
107.81
83.00
40.92
34.01
33.10
21.71
3na
f1 (ppm)


7.83
7.81
7.79
7.70
7.64
7.63
7.55
7.53
7.50
7.48
7.43
7.41
7.36
7.34
7.24
7.21
7.19
7.18
7.16
6.83
6.62
6.60
5.70
2.88
2.62
1.41
6.86
6.84
6.83
6.62
6.60
3.01
1.00
1.00
4.00
1.01
0.99
2.00
1.00
1.00
fl (ppm)
Br
F
F
N
N
O
3pa
3.01
1.00
1.00
4.00
1.01
0.99
2.00
1.00
1.00
1.00
3.01
2.01
3.01
fl (ppm)


172.12
148.77
147.96
137.32
135.14
134.63
127.08
123.97
121.54
120.45
118.82
108.38
76.52
37.49
33.45
33.09
20.83
148.77
147.96
139.53
138.76
137.23
134.69
134.63
130.34
129.35
129.11
128.20
127.08
126.90
123.97
122.36
121.54
120.71
120.45
119.98
118.82
fl (ppm)
Br
F
F
N
N
O
3pa
fl (ppm)


-111.25
Br
F
F
N
N
N
O
3pa
0
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
-230
-250
-270
-290
f1 (ppm)


7.96
7.94
7.44
7.26
7.21
7.00
6.98
6.97
6.84
6.82
3.36
3.31
3.27
2.66
2.62
1.26
7.96
7.94
7.44
7.43
7.28
7.23
7.21
6.98
6.97
6.84
6.82
2.00
3.00
0.99
1.02
1.02
1.00
8.2 8.0 7.8 7.6 7.4 7.2 7.0 6.8 6.6
f1 (ppm)
4aa
2.00
3.00
0.99
1.02
1.02
1.00
3.00
1.02
1.02
3.01
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


166.58
151.50
145.47
137.10
133.94
126.05
121.94
120.97
107.51
37.30
30.63
27.57
21.28
166.58
151.50
145.47
137.10
133.94
128.19
126.05
121.94
120.97
107.51
170 160 150 140 130 120 110
f1 (ppm)
4aa
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)