Electronic Supplementary Material (ESI) for Green Chemistry.

Supporting Information

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1. General methods

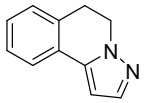
Unless otherwise mentioned, all reagents were purchased from commercial suppliers without further purification. Solvent purification was conducted according to Purification of Laboratory Chemicals (Peerrin, D. D.; Armarego, W. L. and Perrins, D. R., Pergamon Press: Oxford, 1980). Reactions were monitored using Merck Kieselgel $60F_{254}$ aluminium plates. TLC was visualized by UV fluorescence (254 nm) then one of the following: $KMnO_4$, phosphomolybdic acid, ninhydrin, *p*-anisaldehyde, vanillin. The Displacement ellipsoids are scaled to the 30% probability level. If not specially mentioned, flash column chromatography was performed using Yantai xinnuo Chemicals (China) (particle size 0.040–0.063 mm). NMR spectra were recorded on JEOL 400 instruments and calibrated by using residual undeuterated chloroform-d (δ ^{1}H = 7.26 ppm, δ ^{13}C = 77.0 ppm) as internal references. The following abbreviations were used to explain the multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, b = broad, td = triple doublet, dt = double triplet, dq = double quartet, m = multiplet. Infrared (IR) spectra were recorded on an iCAN 9-T FT-IR spectrometer. High-resolution mass spectra (HRMS) were recorded on a Thermo Fisher Q Exactive Orbitrap mass spectrometer using ESI (electrosprayionization) as ionization method. *C,N*-Cyclic azomethine imines **1**[1] and enamides **2**[2] were synthesized according to the literature methods.

2. **Experimental procedures and characterization data**

Synthesis of 5,6-dihydropyrazolo[5,1-*a*]isoquinolines

Typical Procedure: To a stirred solution of *C,N*-cyclic azomethine imines (0.22 mmol, 1.1 equiv) in THF (2.0 mL) was added enamides (0.2 mmol, 1.0 equiv) at room temperature. The reaction was stirred at room temperature for 24 h. The reaction mixture was directly charged to column chromatography on silica gel to give the cycloadduct.

5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3aa)[3]



Yellow oil, isolated yield 92% (31 mg);

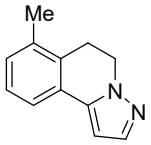
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.56-7.52 (m, 2H), 7.32-7.25 (m, 3H), 6.55 (d, J = 1.8 Hz, 1H), 4.37 (t, J = 6.9 Hz, 2H), 3.21 (t, J = 6.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 139.2, 138.7, 131.7, 128.2, 128.0, 127.3, 127.0, 124.0, 100.5, 46.2, 29.2;

IR (neat): v 3856, 3847, 3638, 3456, 2967, 2332, 1656, 1529, 1469, 1378, 1048, 669 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{11}H_{11}N_2$: 171.0917; found: 171.0914;

7-methyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ba)



Yellow oil, isolated yield 70% (26 mg);

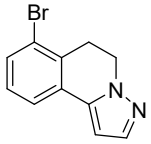
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.52 (d, J = 1.8 Hz, 1H), 7.42 (d, J = 7.5 Hz, 1H), 7.20 (t, J = 7.6 Hz, 1H), 7.13 (d, J = 7.5 Hz, 1H), 6.53 (d, J = 1.9 Hz, 1H), 4.36 (t, J = 7.0 Hz, 2H), 3.15 (t, J = 7.0 Hz, 2H), 2.35 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 139.2, 138.9, 135.8, 130.0, 129.8, 126.9, 126.8, 121.9, 100.6, 45.7, 25.5, 19.6;

IR (neat): v 3905, 3841, 3653, 3427, 2923, 2851, 2370, 1651, 1260, 1096, 1017, 797 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{12}H_{13}N_2$: 185.1073; found: 185.1070;

7-bromo-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ca)



Yellow solid, isolated yield 60% (30 mg);

mp: 42.4-43.2 °C;

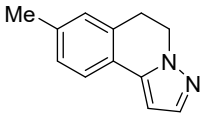
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.54 (d, J = 1.6 Hz, 1H), 7.51 (s, 1H), 7.49 (d, J = 1.1 Hz, 1H), 7.17 (t, J = 7.8 Hz, 1H), 6.56 (d, J = 1.6 Hz, 1H), 4.37 (t, J = 7.0 Hz, 2H), 3.34 (t, J = 7.0 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 139.6, 137.8, 132.0, 131.3, 128.8, 128.6, 124.3, 123.1, 101.2, 45.6, 29.1;

IR (neat): v 3902, 3820, 3748, 3433, 2965, 2361, 1634, 1045, 873, 768, 746, 670 cm^{-1};

HRMS (ESI): m/z $[M +H]^+$ calcd. for $C_{11}H_{10}BrN_2$: 249.0022; found: 249.0017;

8-methyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3da)



Colorless oil, isolated yield 94% (34 mg);

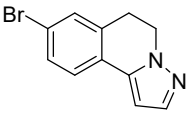
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.51 (d, J = 2.0 Hz, 1H), 7.54 (d, J = 7.8 Hz, 1H), 7.12-7.08 (m, 2H), 6.50 (d, J = 2.0 Hz, 1H), 4.34 (t, J = 6.9 Hz, 2H), 3.16 (t, J = 7.0 Hz, 2H), 2.36 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 139.1, 138.8, 138.0, 131.6, 128.8, 128.0, 124.3, 123.9, 100.0, 46.2, 29.2, 21.3;

IR (neat): v 3838, 3748, 3673, 3651, 3444, 2973, 2361, 1735, 1649, 1256, 1051, 748 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{12}H_{13}N_2$: 185.1073; found: 185.1070;

8-bromo-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ea)



Yellow solid, isolated yield 68% (34 mg);

mp: 64.3-65.1 °C;

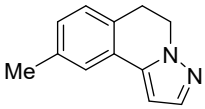
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.53 (s, 1H), 7.42-7.39 (m, 3H), 6.55 (s, 1H), 4.35 (t, J = 6.8 Hz, 2H), 3.18 (t, J = 6.7 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 139.4, 133.6, 131.2, 130.5, 126.0, 125.4, 121.6, 100.92, 100.86, 45.9, 28.9;

IR (neat): v 3904, 3805, 3749, 3425, 2971, 2902, 2362, 1651, 1463, 1245, 1041, 876 cm^{-1};

HRMS (ESI): m/z $[M +H]^+$ calcd. for $C_{11}H_{10}BrN_2$: 249.0022; found: 249.0016;

9-methyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3fa)



Yellow oil, isolated yield 92% (34 mg);

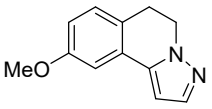
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.51 (d, J = 1.8 Hz, 1H), 7.36 (s, 1H), 7.15 (d, J = 7.7 Hz, 1H), 7.06 (d, J = 7.7 Hz, 1H), 6.52 (d, J = 1.7 Hz, 1H), 4.34 (t, J = 6.9 Hz, 2H), 3.16 (t, J = 6.9 Hz, 2H), 2.37 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 139.1, 138.8, 137.0, 128.8, 128.7, 128.0, 126.8, 124.5, 100.3, 46.3, 28.8, 21.1;

IR (neat): v 3904, 3755, 3653, 3432, 2967, 2921, 2372, 1657, 1493, 1257, 1052, 770 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{12}H_{13}N_2$: 185.1073; found: 185.1070;

9-methoxy-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ga)



Colorless oil, isolated yield 95% (38 mg);

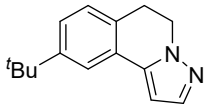
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.52 (d, J = 1.6 Hz, 1H), 7.17 (d, J = 8.4 Hz, 1H), 7.06 (d, J = 2.6 Hz, 1H), 6.80 (dd, J = 8.4, 2.6 Hz, 1H), 6.53 (d, J = 1.9 Hz, 1H), 4.34 (t, J = 6.9 Hz, 2H), 3.84 (s, 3H), 3.13 (t, J = 6.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 158.9, 139.1, 138.6, 129.2, 127.9, 123.9, 113.7, 109.2, 100.6, 55.4, 46.5, 28.4;

IR (neat): v 3855, 3752, 3630, 2971, 2366, 1685, 1499, 1406, 1259, 1049, 879, 800 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{12}H_{13}N_2O$: 201.1022; found: 201.1018;

9-(*tert*-butyl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ha)



Yellow oil, isolated yield 77% (36 mg);

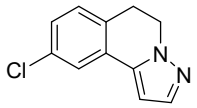
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.56 (d, J = 1.7 Hz, 1H), 7.53 (d, J = 1.7 Hz, 1H), 7.30 (dd, J = 8.0, 1.9 Hz, 1H), 7.21 (d, J = 8.0 Hz, 1H), 6.57 (d, J = 1.8 Hz, 1H), 4.35 (t, J = 6.9 Hz, 2H), 3.17 (t, J = 6.9 Hz, 2H), 1.35 (s, 9H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 150.4, 139.1, 139.0, 128.8, 127.9, 126.6, 125.2, 120.8, 100.2, 46.3, 34.6, 31.3, 28.7;

IR (neat): v 3902, 3855, 3751, 3467, 2977, 2360, 2086, 1638, 1406, 1259, 1045, 668 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{15}H_{19}N_2$: 227.1543; found: 227.1538;

9-chloro-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ia)



Yellow oil, isolated yield 60% (24 mg);

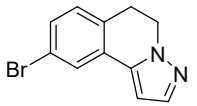
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.53 (d, J = 1.8 Hz, 1H), 7.51 (s, 1H), 7.20 (m, 2H), 6.54 (d, J = 1.9 Hz, 1H), 4.35 (t, J = 6.9 Hz, 2H), 3.17 (t, J = 7.0 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 139.4, 137.5, 133.1, 129.9, 129.5, 128.6, 127.8, 123.9, 101.1, 46.0, 28.7;

IR (neat): v 3904, 3749, 3653, 3432, 2969, 23669, 1650, 1405, 1258, 1049, 876, 800 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{11}H_{10}ClN_2$: 205.0527; found: 205.0523;

9-bromo-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ja)



Yellow solid, isolated yield 80% (40 mg);

mp: 70.4-71.3 °C;

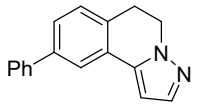
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.66 (d, J = 2.0 Hz, 1H), 7.53 (d, J = 2.0 Hz, 1H), 7.36 (dd, J = 8.1, 2.0 Hz, 1H), 7.14 (dd, J = 8.1 Hz, 1H), 6.54 (d, J = 2.0 Hz, 1H), 4.35 (t, J = 6.9 Hz, 2H), 3.15 (t, J = 6.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 139.4, 137.3, 130.7, 130.4, 129.8, 128.9, 126.8, 121.0, 101.1, 46.0, 28.7;

IR (neat): v 3902, 3749, 3434, 2977, 2901, 2360, 1644, 1406, 1259, 1047, 879, 668 cm^{-1};

HRMS (ESI): m/z $[M +H]^+$ calcd. for $C_{11}H_{10}BrN_2$: 249.0022; found: 249.0016;

9-phenyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ka)



Colorless oil, isolated yield 90% (44 mg);

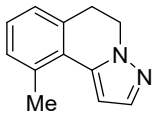
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.75 (s, 1H), 7.63 (s, 1H), 7.61 (s, 1H), 7.56 (s, 1H), 7.49-7.45 (m, 3H), 7.40-7.34 (m, 2H), 6.62 (s, 1H), 4.40 (t, J = 6.8 Hz, 2H), 3.25 (t, J = 6.7 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 140.6, 140.5, 139.3, 130.6, 128.8, 128.6, 127.5, 127.4, 127.0, 126.8, 122.7, 111.4, 100.8, 46.2, 28.9;

IR (neat): v 3856, 3748, 2924, 2364, 1700, 1542, 1468, 1408, 1259, 1044, 758, 668 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{17}H_{15}N_2$: 247.1230; found: 247.1225;

10-methyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3la)[4]



Yellow solid, isolated yield 85% (32 mg);

mp: 45.4-46.3 °C;

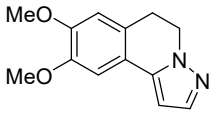
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.57 (d, J = 2.0 Hz, 1H), 7.17-7.12 (m, 3H), 6.59 (d, J = 2.0 Hz, 1H), 4.36 (t, J = 6.9 Hz, 2H), 3.16 (t, J = 6.8 Hz, 2H), 2.54 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 138.4, 137.1, 134.5, 133.2, 130.1, 127.6, 126.2, 126.0, 105.0, 46.3, 30.3, 22.2;

IR (neat): v 3902, 3856, 3748, 3652, 3568, 2921, 2363, 1650, 1510, 1258, 1072, 780 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{12}H_{13}N_2$: 185.1073; found: 185.1071;

8,9-dimethoxy-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ma)



Colorless oil, isolated yield 85% (38 mg);

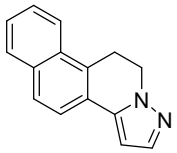
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.50 (d, J = 1.8 Hz, 1H), 7.01 (s, 1H), 6.76 (s, 1H), 6.44 (d, J = 1.8 Hz, 1H), 4.33 (t, J = 7.0 Hz, 2H), 3.93 (s, 3H), 3.91 (s, 3H), 3.13 (t, J = 7.0 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 148.9, 148.2, 139.1, 138.7, 124.4, 119.7, 111.2, 107.1, 99.5, 56.1, 56.0, 46.2, 28.8;

IR (neat): v 3934, 3746, 3569, 3449, 2971, 2371, 1654, 1406, 1261, 1066, 879, 795 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{13}H_{15}N_2O_2$: 231.1128; found: 231.1123;

10,11-dihydrobenzo[f]pyrazolo[5,1-*a*]isoquinoline (3na)



Yellow solid, isolated yield 81% (36 mg);

mp: 104.4-105.2 °C;

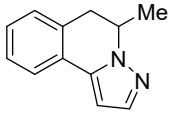
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.03 (d, J = 8.2 Hz, 1H), 7.86 (d, J = 7.9 Hz, 1H), 7.80 (d, J = 8.5 Hz, 1H), 7.67 (d, J = 8.5 Hz, 1H), 7.59 (d, J = 1.8 Hz, 1H), 7.57-7.55(m, 1H), 7.52-7.48 (m, 1H), 6.63 (d, J = 1.9 Hz, 1H), 4.49 (t, J = 7.2 Hz, 2H), 3.60 (t, J = 7.2 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 139.4, 139.0, 133.1, 131.2, 128.8, 127.7, 126.9, 126.8, 125.9, 124.1, 123.3, 122.1, 101.2, 45.7, 24.6;

IR (neat): v 3905, 3855, 3713, 3434, 2979, 2369, 1639, 1508, 1406, 1046, 879, 850 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{15}H_{13}N_2$: 221.1073; found: 221.1069;

5-methyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3oa)



Yellow oil, isolated yield 90% (44 mg);

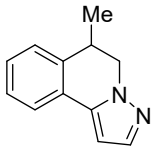
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.55-7.54 (m, 2H), 7.31-7.28 (m, 3H), 6.56 (s, 1H), 4.58 (q, J = 6.2 Hz, 1H), 3.32 (dd, J = 15.8, 5.4 Hz, 1H), 2.94 (dd, J = 15.7 Hz, 1H), 1.51 (d, J = 6.5 Hz, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 139.2, 138.1, 130.9, 128.5, 128.0, 127.2, 126.7, 123.8, 100.7, 52.3, 36.6, 19.5;

IR (neat): v 3910, 3855, 3673, 2972, 2361, 1735, 1538, 1459, 1397, 1256, 1052, 880 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{12}H_{13}N_2$: 185.1073; found: 185.1070;

6-methyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3pa)



Yellow solid, isolated yield 60% (22 mg);

mp: 44.5-45.3 °C;

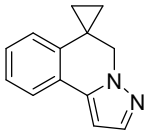
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.57-7.53 (m, 2H), 7.32-7.28 (m, 3H), 6.55 (d, J = 2.0 Hz, 1H), 4.37 (dd, J = 5.2, 5.2 Hz, 1H), 4.15 (dd, J = 5.2, 5.2 Hz, 1H), 3.36-3.28 (m, 1H), 1.32 (d, J = 7.0 Hz, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 139.2, 138.1, 137.0, 128.3, 127.3, 126.8, 126.1, 124.1, 100.4, 52.3, 33.9, 19.0;

IR (neat): v 3837, 3673, 3651, 2971, 2362, 1699, 1538, 1459, 1396, 1052, 880, 798 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{12}H_{13}N_2$: 185.1073; found: 185.1070;

5'H-spiro[cyclopropane-1,6'-pyrazolo[5,1-*a*]isoquinoline] (3qa)



Yellow oil, isolated yield 85% (34 mg);

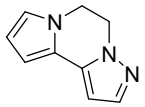
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.60-7.58 (m, 1H), 7.55 (d, J = 1.8 Hz, 1H), 7.30-7.25 (m, 2H), 6.97-6.95 (m, 1H), 6.60 (d, J = 1.9 Hz, 1H), 4.14 (s, 2H), 1.15-1.12 (m, 2H), 1.05-1.02 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 139.1, 138.9, 136.1, 128.4, 127.6, 126.7, 124.1, 121.9, 100.5, 54.8, 19.5, 14.7;

IR (neat): v 3856, 3838, 3651, 3444, 2971, 2362, 1650, 1538, 1459, 1398, 1049, 754 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{13}H_{13}N_2$: 197.1073; found: 197.1070;

5,6-dihydropyrazolo[1,5-*a*]pyrrolo[2,1-*c*]pyrazine (3ra)



Blue oil, isolated yield 70% (22 mg);

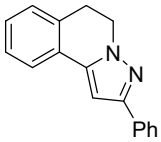
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.48 (s, 1H), 6.72 (s, 1H), 6.42 (d, J = 2.7 Hz, 1H), 6.32 (s, 1H), 6.24-6.23 (m, 1H), 4.48 (t, J = 5.6 Hz, 2H), 4.31 (t, J = 6.3 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 139.6, 134.2, 122.6, 121.0, 109.6, 105.7, 99.2, 46.4, 44.3;

IR (neat): v 3856, 3748, 3616, 3029, 2924, 2365, 1737, 1542, 1486, 1099, 760, 693 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_9H_{10}N_3$: 160.0869; found: 160.0867;

2-phenyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ab)[5]



Yellow oil, isolated yield 93% (46 mg);

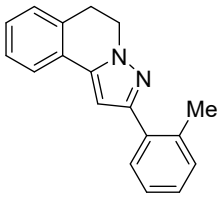
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.87-7.85 (m, 2H), 7.61 (d, J = 7.5 Hz, 1H), 7.44-7.40 (m, 2H), 7.34-7.27 (m, 4H), 6.86 (s, 1H), 4.41 (t, J = 6.9 Hz, 2H), 3.25 (t, J = 6.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 151.3, 140.0, 133.4, 131.6, 128.6, 128.2, 128.1, 127.6, 127.4, 126.9, 125.4, 124.0, 97.6, 46.2, 29.1;

IR (neat): v 3854, 3735, 3650, 2972, 2360, 1654, 1540, 1394, 1250, 1066, 879, 788 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{17}H_{15}N_2$: 247.1230; found: 247.1226;

3-(*o*-tolyl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ac)[5]



Yellow solid, isolated yield 80% (42 mg);

mp: 92.4-92.9 °C;

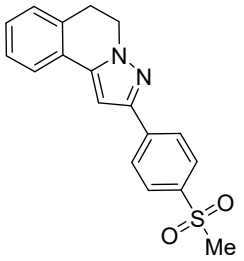
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.63-7.58 (m, 2H), 7.34-7.24 (m, 6H), 6.70 (s, 1H), 4.42 (t, J = 7.0 Hz, 2H), 3.26 (t, J = 6.9 Hz, 2H), 2.53 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 151.5, 139.1, 135.9, 133.3, 131.6, 130.7, 129.2, 128.2, 128.0, 127.6, 127.3, 127.0, 125.8, 123.9, 100.7, 46.2, 29.2, 21.2;

IR (neat): v 3856, 3748, 3673, 3565, 2970, 2363, 1736, 1649, 1258, 1050, 799, 758 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{18}H_{17}N_2$: 261.1386; found: 261.1383;

2-(4-(methylsulfonyl)phenyl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ad)



Yellow solid, isolated yield 92% (60 mg);

mp: 145.2-146.1 °C;

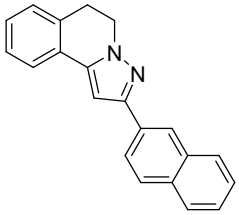
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.04 (d, J = 8.1 Hz, 2H), 7.97 (d, J = 8.2 Hz, 2H), 7.60 (d, J = 7.3 Hz, 1H), 7.37-7.30 (m, 3H), 6.93 (s, 1H), 4.42 (t, J = 6.9 Hz, 2H), 3.26 (t, J = 6.9 Hz, 2H), 3.09 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 149.1, 140.5, 138.9, 138.8, 131.6, 128.5, 128.3, 127.8, 127.5, 126.4, 126.0, 124.0, 98.3, 46.4, 44.6, 29.0;

IR (neat): v 3904, 3871, 3751, 3676, 3650, 3567, 2971, 2361, 1734, 1260, 1066, 669 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{18}H_{17}N_2O_2S$: 325.1005; found: 325.1000;

2-(naphthalen-2-yl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ae)[6]



Yellow solid, isolated yield 92% (54 mg);

mp: 140.1-140.7 °C;

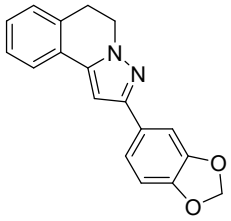
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.32 (s, 1H), 8.03 (d, J = 8.5 Hz, 1H), 7.90 (d, J = 8.3 Hz, 2H), 7.85 (d, J = 7.7 Hz, 1H), 7.64 (d, J = 7.5 Hz, 1H), 7.51-7.45 (m, 2H), 7.37-7.33 (m, 1H), 7.30-7.29 (m, 2H), 7.00 (s, 1H), 4.46 (t, J = 6.9 Hz, 2H), 3.27 (t, J = 6.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 151.2, 140.2, 133.6, 133.0, 131.6, 130.8, 128.3, 128.23, 128.19, 128.16, 127.7, 127.4, 126.8, 126.2, 125.7, 124.0, 123.92, 123.89, 97.8, 46.3, 29.2;

IR (neat): v 3902, 3748, 3673, 3615, 2972, 2362, 1650, 1538, 1397, 1254, 1052, 756 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{21}H_{17}N_2$: 297.1386; found: 297.1382;

2-(benzo[d][1,3]dioxol-5-yl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3af)



Yellow solid, isolated yield 87% (50 mg);

mp: 71.4-72.2 °C;

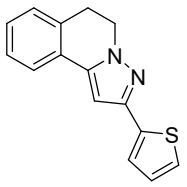
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.58 (d, J = 7.4 Hz, 1H), 7.35-7.28 (m, 5H), 6.86 (d, J = 8.0 Hz, 1H), 6.75 (s, 1H), 5.99 (s, 2H), 4.38 (t, J = 6.9 Hz, 2H), 3.23 (t, J = 6.8 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 151.0, 147.9, 147.2, 140.0, 131.6, 128.2, 128.1, 127.8, 127.4, 126.9, 123.9, 119.1, 108.4, 106.1, 101.0, 97.2, 46.2, 29.2;

IR (neat): v 3983, 3922, 3690, 3621, 2988, 2901, 1559, 1066, 1027, 893, 867, 794 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{18}H_{15}N_2O_2$: 291.1128; found: 291.1122;

2-(thiophen-2-yl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ag)[7]



Yellow oil, isolated yield 95% (48 mg);

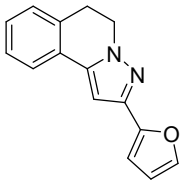
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.57 (d, J = 7.4 Hz, 1H), 7.37 (d, J = 3.2 Hz, 1H), 7.34-7.27 (m, 3H), 7.26-7.25 (m, 1H), 7.07 (t, J = 4.2 Hz, 1H), 6.76 (s, 1H), 4.38 (t, J = 7.0 Hz, 2H), 3.22 (t, J = 6.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 146.5, 140.0, 136.8, 131.7, 128.3, 128.2, 127.44, 127.38, 126.6, 124.3, 124.0, 123.4, 97.5, 46.2, 29.1;

IR (neat): v 3854, 3735, 3567, 2988, 2360, 1772, 1684, 1541, 1457, 1250, 1066, 892 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{15}H_{13}N_2S$: 253.0794; found: 253.0791;

2- (furan-2-yl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ah)



Yellow oil, isolated yield 78% (36 mg);

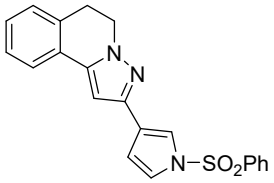
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.58 (d, J = 7.4 Hz, 1H), 7.77 (s, 1H), 7.35-7.27 (m, 3H), 6.77 (s, 1H), 6.70 (d, J = 3.0 Hz, 1H), 6.48 (s, 1H), 4.39 (t, J = 6.9 Hz, 2H), 3.23 (t, J = 6.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 148.9, 143.7, 141.7, 139.8, 131.7, 128.3, 128.2, 127.4, 126.6, 124.1, 111.3, 105.5, 97.4, 46.3, 29.1;

IR (neat): v 3857, 3749, 3674, 2923, 2369, 1790, 1717, 1454, 1260, 1015, 798, 752 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{15}H_{13}N_2O$: 237.1022; found: 237.1019;

2- (1-(phenylsulfonyl)-1H-pyrrol-3-yl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ai)



Colorless oil, isolated yield 80% (60 mg);

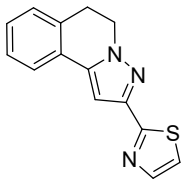
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.90 (d, J = 7.8 Hz, 2H), 7.59-7.48 (m, 5H), 7.32-7.27 (m, 3H), 7.21 (s, 1H), 6.70 (s, 1H), 6.63 (s, 1H), 4.34 (t, J = 6.9 Hz, 2H), 3.20 (t, J = 6.8 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 145.5, 139.9, 138.9, 133.9, 131.6, 129.4, 128.23, 128.21, 127.4, 126.9, 126.7, 124.0, 123.1, 121.5, 116.7, 112.4, 97.8, 46.1, 29.1;

IR (neat): v 3857, 3748, 3673, 3651, 2971, 2362, 1700, 1650, 1255, 1060, 893, 798 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{21}H_{18}N_3O_2S$: 376.1114; found: 376.1107;

2-(5,6-dihydropyrazolo[5,1-*a*]isoquinolin-2-yl)thiazole (3aj)



Colorless oil, isolated yield 88% (44 mg);

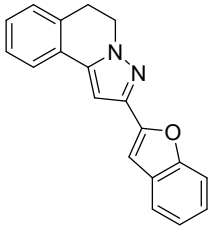
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.85 (d, J = 3.1 Hz, 1H), 7.59 (d, J = 7.3 Hz, 1H), 7.34-7.29 (m, 4H), 7.13 (s, 1H), 4.42 (t, J = 7.0 Hz, 2H), 3.25 (t, J = 6.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 162.1, 146.6, 143.1, 140.4, 131.6, 128.6, 128.2, 127.6, 126.4, 124.2, 118.3, 98.6, 46.5, 29.0;

IR (neat): v 3904, 3854, 3650, 3567, 2972, 2361, 1734, 1654, 1599, 1259, 1066, 761 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{14}H_{12}N_3S$: 254.0746; found: 254.0743;

2-(benzofuran-2-yl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ak)



Yellow solid, isolated yield 91% (52 mg);

mp: 86.5-87.4 °C;

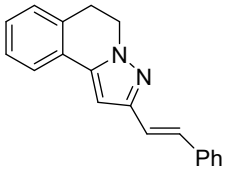
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.62-7.56 (m, 3H), 7.37-7.27 (m, 4H), 7.24-7.22 (m, 1H), 7.05 (s, 1H), 6.95 (s, 1H), 4.45 (t, J = 7.0 Hz, 2H), 3.25 (t, J = 6.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 154.6, 150.8, 143.2, 140.0, 131.6, 128.9, 128.5, 128.2, 127.5, 126.5, 124.2, 124.1, 122.9, 120.9, 111.3, 101.8, 98.5, 46.4, 29.0;

IR (neat): v 3946, 3858, 3741, 3464, 2982, 2571, 1550, 1438, 1359, 1298, 1049, 754 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{19}H_{15}N_2O$: 287.1179; found: 287.1174;

(*E*)-2-styryl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3al)



Yellow oil, isolated yield 60% (32 mg);

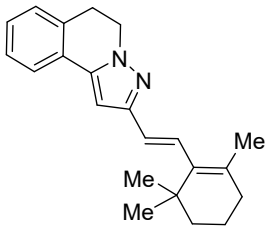
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.58 (d, J = 7.4 Hz, 1H), 7.52 (d, J = 7.6 Hz, 2H), 7.38-7.27 (m, 6H), 7.16 (s, 2H), 6.76 (s, 1H), 4.37 (t, J = 6.5 Hz, 2H), 3.23 (t, J = 6.8 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 150.4, 139.8, 137.2, 131.7, 129.6, 128.7, 128.2 (2C), 127.6, 127.4, 126.7, 126.4, 124.0, 120.6, 97.6, 46.2, 29.1;

IR (neat): v 3854, 3752, 2988, 2361, 1717, 1654, 1541, 1457, 1394, 1250, 1066, 892 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{19}H_{17}N_2$: 273.1386; found: 273.1381;

(*E*)-2-(2-(2,6,6-trimethylcyclohex-1-en-1-yl)vinyl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3am)



Yellow oil, isolated yield 68% (44 mg);

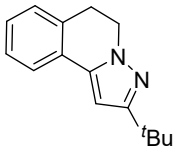
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.56 (d, J = 7.4 Hz, 1H), 7.33-7.26 (m, 3H), 6.74 (d, J = 16.5 Hz, 1H), 6.67 (s, 1H), 6.38 (d, J = 16.5 Hz, 1H), 4.33 (t, J = 6.9 Hz, 2H), 3.20 (t, J = 6.8 Hz, 2H), 2.04 (t, J = 5.8 Hz, 2H), 1.79 (s, 3H), 1.67-1.61 (m, 2H), 1.51-1.48 (m, 2H), 1.79 (s, 6H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 151.1, 139.6, 137.2, 131.7, 129.9, 128.8, 128.2, 128.1, 127.3, 126.9, 124.7, 124.0, 96.8, 46.1, 39.6, 34.2, 33.0, 29.1, 28.9, 21.7, 19.2;

IR (neat): v 3901, 3855, 3802, 3649, 3444, 2972, 2361, 1649, 1538, 1397, 1049, 757 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{22}H_{27}N_2$: 319.2169; found: 319.2161;

2-(*tert*-butyl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3an)



Yellow oil, isolated yield 85% (38 mg);

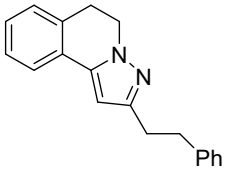
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.52 (d, J = 7.6 Hz, 1H), 7.30-7.27 (m, 1H), 7.24-7.20 (m, 2H), 6.41 (s, 1H), 4.30 (t, J = 6.8 Hz, 2H), 3.18 (t, J = 6.8 Hz, 2H), 1.36 (s, 9H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 162.0, 138.9, 131.6, 128.1, 127.7, 127.2 (2C), 123.8, 96.8, 45.9, 32.1, 30.7, 29.2;

IR (neat): v 3946, 3838, 3677, 3546, 2971, 2562, 1678, 1536, 1460, 1408, 1066, 669 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{15}H_{19}N_2$: 227.1543; found: 227.1547;

2-phenethyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ao)



Yellow solid, isolated yield 99% (54 mg);

mp: 72.4-73.3 °C;

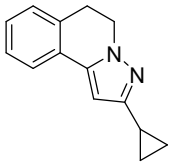
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.50 (d, J = 7.4 Hz, 1H), 7.34-7.27 (m, 5H), 7.24-7.22 (m, 3H), 6.35 (s, 1H), 4.32 (t, J = 6.9 Hz, 2H), 3.20 (t, J = 6.9 Hz, 2H), 3.05-2.97 (m, 4H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 152.4, 141.9, 139.3, 131.6, 128.4, 128.3, 128.1, 127.9, 127.3, 127.1, 125.9, 123.8, 99.2, 45.9, 36.1, 30.4, 29.2;

IR (neat): v 3904, 3751, 3650, 3567, 2988, 2360, 1772, 1734, 1394, 1250, 1066, 892 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{19}H_{19}N_2$: 275.1543; found: 275.1535;

2-cyclopropyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ap)



Yellow oil, isolated yield 95% (40 mg);

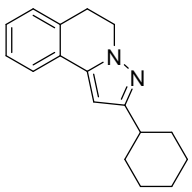
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.48 (d, J = 7.4 Hz, 1H), 7.29-7.26 (m, 1H), 7.23-7.20 (m, 2H), 6.21 (s, 1H), 4.26 (t, J = 6.9 Hz, 2H), 3.17 (t, J = 6.9 Hz, 2H), 2.00-1.93 (m, 1H), 0.96-0.92 (m, 2H), 0.79-0.75 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 155.1, 139.3, 131.6, 128.1, 127.9, 127.2, 127.0, 123.8, 96.7, 45.9, 29.2, 9.2, 7.9;

IR (neat): v 3904, 3855, 3752, 3677, 3650, 3568, 2971, 2364, 2344, 1654, 1050, 758 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{14}H_{15}N_2$: 211.1230; found: 211.1226;

2-cyclohexyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3aq)



Colorless oil, isolated yield 93% (46 mg);

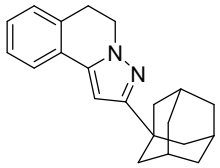
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.51 (d, J = 7.5 Hz, 1H), 7.29-7.26 (m, 1H), 7.23-7.2 (m, 2H), 6.35 (s, 1H), 4.29 (t, J = 6.9 Hz, 2H), 3.18 (t, J = 6.9 Hz, 2H), 2.70-2.64 (m, 1H), 2.03 (d, J = 11.7 Hz, 2H), 1.84 (d, J = 11.9 Hz, 2H), 1.73 (d, J = 12.6 Hz, 1H), 1.52-1.35 (m, 5H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 158.4, 139.0, 131.6, 128.1, 127.8, 127.21, 127.17, 123.8, 97.3, 45.9, 37.7, 33.4, 29.2, 26.4, 26.1;

IR (neat): v 3902, 3820, 3651, 3395, 2975, 2898, 2362, 1650, 1453, 1083, 1047, 879 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{17}H_{21}N_2$: 253.1699; found: 253.1695;

2- ((3*r*,5*r*,7*r*)-adamantan-1-yl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ar)



Yellow solid, isolated yield 80% (48 mg);

mp: 98.8-99.6 °C;

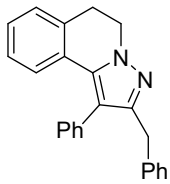
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.51 (d, J = 7.4 Hz, 1H), 7.29-7.26 (m, 1H), 7.23-7.21 (m, 2H), 6.39 (s, 1H), 4.30 (t, J = 6.8 Hz, 2H), 3.18 (t, J = 6.8 Hz, 2H), 2.08 (s, 3H), 2.00 (s, 6H), 1.79 (s, 6H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 162.4, 138.8, 131.6, 128.1, 127.7, 127.25, 127.19, 123.8, 96.3, 46.0, 42.8, 36.8, 34.0, 29.2, 28.7;

IR (neat): v 3857, 3820, 3673, 3565, 2972, 2903, 2362, 1736, 1538, 1397, 1052, 893 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{21}H_{25}N_2$: 305.2012; found: 305.2006;

2-benzyl-1-phenyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3as)



Yellow solid, isolated yield 99% (68 mg);

mp: 82.9-83.7 °C;

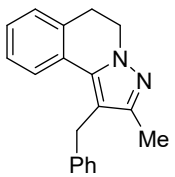
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.40-7.35 (m, 3H), 7.24-7.12 (m, 9H), 7.07 (d, J = 7.7 Hz, 1H), 7.00 (s, 1H), 4.36 (t, J = 6.8 Hz, 2H), 3.92 (s, 2H), 3.22 (t, J = 6.8 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 149.4, 140.2, 135.1, 133.8, 132.5, 130.4, 128.59, 128.58, 128.18, 128.15, 127.6, 127.3, 127.1, 126.9, 125.8, 124.2, 117.6, 46.3, 32.5, 29.6;

IR (neat): v 3904, 3854, 3751, 3567, 3446, 2988, 2363, 1653, 1558, 1457, 1066, 668 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{24}H_{21}N_2$: 337.1699; found: 337.1696;

1-benzyl-2-methyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3at)



Yellow oil, isolated yield 92% (50 mg);

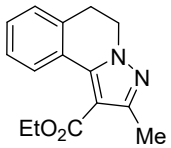
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.40 (d, J = 7.2 Hz, 1H), 7.30-7.28 (m, 2H), 7.26-7.25 (m, 1H), 7.21-7.17 (m, 5H), 4.32 (t, J = 6.7 Hz, 2H), 4.11 (s, 2H), 3.16 (t, J = 6.7 Hz, 2H), 2.21 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 147.8, 140.0, 135.8, 132.7, 128.5, 128.3, 127.9, 127.7, 127.5, 127.3, 126.0, 123.9, 112.4, 46.1, 29.9, 29.8, 11.7;

IR (neat): ν 3854, 3751, 3650, 2972, 2360, 1558, 1541, 1507, 1457, 1419, 1050, 668 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{19}H_{19}N_2$: 275.1543; found: 275.1538;

ethyl 2-methyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline-1-carboxylate (3au)



Yellow solid, isolated yield 98% (50 mg);

mp: 63.2-64.1 °C;

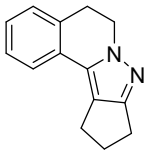
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.40 (d, J = 8.9 Hz, 1H), 7.36-7.25 (m, 3H), 4.35 (q, J = 7.1 Hz, 2H), 4.24 (t, J = 6.7 Hz, 2H), 3.12 (t, J = 6.8 Hz, 2H), 2.48 (s, 3H), 1.39 (t, J = 7.1 Hz, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 164.6, 151.2, 140.7, 133.5, 129.2, 128.0, 127.7, 127.1, 126.1, 108.0, 60.1, 46.3, 29.6, 14.8, 14.3;

IR (neat): ν 3904, 3854, 3751, 3567, 3274, 2971, 2360, 1654, 1558, 1541, 1049, 669 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{15}H_{17}N_2O_2$: 257.1285; found: 257.1280;

5,9,10,11-tetrahydro-6H-cyclopenta[3,4]pyrazolo[5,1-*a*]isoquinoline (5aa)



Yellow oil, isolated yield 60% (24 mg);

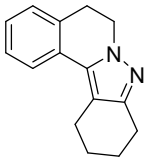
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.44 (d, J = 7.5 Hz, 1H), 7.30-7.21 (m, 3H), 4.30 (t, J = 6.9 Hz, 2H), 3.18 (t, J = 6.9 Hz, 2H), 2.86 (t, J = 6.9 Hz, 2H), 2.75 (t, J = 7.2 Hz, 2H), 2.54-2.46 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 161.1, 132.7, 131.9, 128.1, 127.8, 127.4, 127.2, 124.1, 120.9, 46.6, 30.2, 29.6, 24.5, 23.9;

IR (neat): ν 3838, 3748, 3423, 2972, 2361, 1649, 1397, 1258, 1048, 879, 774, 689 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{14}H_{15}N_2$: 211.1230; found: 211.1226;

5,6,9,10,11,12-hexahydroindazolo[3,2-*a*]isoquinoline (5ab)



Yellow oil, isolated yield 94% (42 mg);

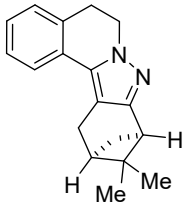
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.53 (d, J = 7.6 Hz, 1H), 7.31-7.28 (m, 1H), 7.25-7.19 (m, 2H), 4.28 (t, J = 6.8 Hz, 2H), 3.16 (t, J = 6.8 Hz, 2H), 2.83-2.81 (m, 2H), 2.72-2.70 (m, 2H), 1.85-1.84 (m, 4H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 148.9, 133.9, 132.1, 128.3, 128.2, 127.2, 127.1, 123.8, 112.2, 46.1, 29.7, 23.6 (2C), 23.1, 22.3;

IR (neat): ν 3838, 3748, 3444, 2974, 2361, 1649, 1396, 1255, 1050, 879, 692, 668 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{15}H_{17}N_2$: 225.1386; found: 225.1381;

(9*R*,11*R*)-10,10-dimethyl-5,6,9,10,11,12-hexahydro-9,11-methanoindazolo[3,2-*a*]isoquinoline (5ac)



Yellow oil, isolated yield 60% (32 mg);

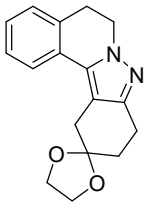
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.53 (d, J = 7.6 Hz, 1H), 7.32-7.27 (m, 1H), 7.25-7.20 (m, 2H), 4.32-4.21 (m, 2H), 3.26-3.17 (m, 2H), 3.03-2.87 (m, 3H), 2.78-2.72 (m, 1H), 2.37-2.32 (m, 1H), 4.14-4.12 (m, 4H), 0.75 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 159.1, 134.3, 132.1, 128.2 (2C), 127.3, 127.1, 124.0, 108.6, 46.0, 41.8, 41.3, 41.1, 32.6, 29.7, 26.4, 26.0, 21.5;

IR (neat): v 3901, 3855, 3747, 3673, 3615, 2922, 2361, 1699, 1649, 1257, 1052, 763 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{18}H_{21}N_2$: 265.1699; found: 265.1694;

5,9,10,12-tetrahydro-6H-spiro[indazolo[3,2-*a*]isoquinoline-11,2'-[1,3]dioxolane] (5ad)



Yellow oil, isolated yield 95% (54 mg);

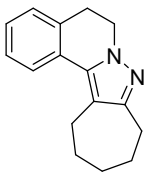
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.45 (d, J = 7.6 Hz, 1H), 7.30-7.26 (m, 1H), 7.25-7.20 (m, 2H), 4.28 (t, J = 6.8 Hz, 2H), 4.06 (s, 4H), 3.15 (t, J = 6.8 Hz, 2H), 3.05 (s, 2H), 2.92 (t, J = 6.6 Hz, 2H), 2.03 (t, J = 6.6 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 147.0, 134.6, 132.2, 128.2, 127.9, 127.4, 127.1, 123.6, 110.2, 108.9, 64.7, 46.2, 33.3, 31.7, 29.6, 21.3;

IR (neat): v 3903, 3856, 3749, 3652, 3449, 2919, 2365, 1650, 1260, 1058, 798, 671 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{17}H_{19}N_2O_2$: 283.1141; found: 283.1143;

5,9,10,11,12,13-hexahydro-6H-cyclohepta[3,4]pyrazolo[5,1-*a*]isoquinoline (5ae)



Yellow solid, isolated yield 93% (44 mg);

mp: 41.3-42.1 °C;

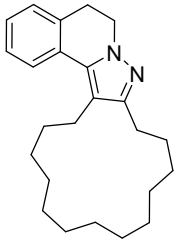
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.64 (d, J = 7.7 Hz, 1H), 7.30-7.28 (m, 2H), 7.24-7.20 (m, 1H), 4.22 (t, J = 6.6 Hz, 2H), 3.11 (t, J = 6.6 Hz, 2H), 2.90 (t, J = 5.4 Hz, 2H), 2.80 (t, J = 5.4 Hz, 2H), 1.87-1.86 (m, 2H), 1.73-1.72 (m, 4H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 153.6, 134.3, 133.2, 128.6, 128.3, 127.2, 127.1, 124.2, 117.0, 45.9, 32.1, 30.1, 29.4, 29.0, 27.5, 25.4;

IR (neat): v 3837, 3801, 3747, 3444, 2975, 2903, 2360, 1649, 1556, 1252, 1051, 879 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{16}H_{19}N_2$: 239.1543; found: 239.1537;

5,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23-hexadecahydro-6H-cycloheptadeca[3,4]pyrazolo[5,1-*a*]isoquinoline (5af)



Yellow solid, isolated yield 75% (56 mg);

mp: 84.1-84.9 °C;

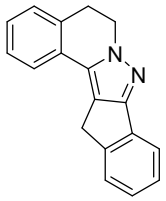
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.57 (d, J = 7.6 Hz, 1H), 7.31 (t, J = 7.3 Hz, 1H), 7.25-7.20 (m, 2H), 4.26 (t, J = 6.6 Hz, 2H), 3.13 (t, J = 6.5 Hz, 2H), 2.68-2.58 (m, 4H), 1.73–1.30 (m, 20H), 1.05–0.83 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 151.4, 134.6, 132.7, 128.3 (2C), 127.23, 127.15, 123.6, 115.4, 46.1, 29.9, 29.7, 28.8, 28.7, 27.4, 27.3, 26.8, 26.7, 26.5, 25.9, 25.8, 25.2, 25.0, 24.1;

IR (neat): v 3854, 3650, 3434, 2988, 2360, 1654, 1541, 1458, 1396, 1045, 692, 669 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{24}H_{35}N_2$: 351.2795; found: 351.2788;

5,13-dihydro-6H-indeno[1',2':3,4]pyrazolo[5,1-*a*]isoquinoline (5ag)



Yellow oil, isolated yield 55% (28 mg);

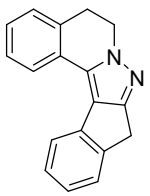
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.80 (d, J = 7.4 Hz, 1H), 7.58 (d, J = 7.5 Hz, 1H), 7.54 (d, J = 7.4 Hz, 1H), 7.39-7.35 (m, 2H), 7.31-7.28 (m, 3H), 4.47 (t, J = 6.8 Hz, 2H), 3.96 (s, 2H), 3.28 (t, J = 6.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 159.3, 148.1, 134.9, 133.4, 132.0, 128.3, 127.9, 127.5, 127.3, 127.0, 126.4, 125.8, 124.5, 119.8, 119.7, 46.9, 29.5, 29.4;

IR (neat): v 3878, 3855, 3621, 3444, 2960, 2365, 1688, 1588, 1449, 1368, 1069, 669 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{18}H_{15}N_2$: 259.1230; found: 259.1226;

5,9-dihydro-6H-indeno[2',1':3,4]pyrazolo[5,1-*a*]isoquinoline (5ah)



Yellow oil, isolated yield 70% (36 mg);

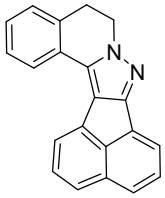
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.96 (d, J = 7.6 Hz, 1H), 7.84 (d, J = 7.6 Hz, 1H), 7.50 (d, J = 7.4 Hz, 1H), 7.47-7.43 (m, 1H), 7.39-7.29 (m, 3H), 7.24-7.20 (m, 1H), 4.43 (t, J = 6.6 Hz, 2H), 3.80 (s, 2H), 3.24 (t, J = 6.6 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 159.7, 145.4, 136.3, 132.7, 131.9, 128.3, 128.0, 127.8, 127.4, 126.9, 125.7, 125.3, 124.9, 122.3, 120.7, 46.9, 30.4, 29.8;

IR (neat): v 3856, 3837, 3748, 3564, 3444, 2975, 2361, 1649, 1556, 1397, 1048, 670 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{18}H_{15}N_2$: 259.1230; found: 259.1225;

9,10-dihydroacenaphtho[1',2':3,4]pyrazolo[5,1-*a*]isoquinoline (5ai)



Colorless oil, isolated yield 70% (42 mg);

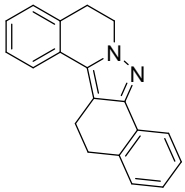
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.02 (d, J = 7.6 Hz, 1H), 7.95 (d, J = 6.9 Hz, 1H), 7.91 (d, J = 6.8 Hz, 1H), 7.82 (d, J = 8.2 Hz, 1H), 7.75 (d, J = 8.3 Hz, 1H), 7.64-7.58 (m, 2H), 7.52-7.48 (m, 1H), 7.37-7.36 (m, 2H), 4.51 (t, J = 6.8 Hz, 2H), 3.31 (t, J = 6.7 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 158.0, 136.5, 133.2, 132.8, 131.0, 130.6, 130.0, 128.41, 128.38, 127.71, 127.66, 127.5, 127.3, 126.8, 125.5, 125.3, 120.2, 120.1, 120.0, 47.0, 29.6;

IR (neat): v 3902, 3856, 3802, 3673, 3566, 2973, 2362, 1736, 1700, 1539, 1052, 893 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{21}H_{15}N_2$: 295.1230; found: 295.1225;

5,6,13,14-tetrahydrobenzo[6,7]indazolo[3,2-*a*]isoquinoline (5aj)



Yellow oil, isolated yield 92% (50 mg);

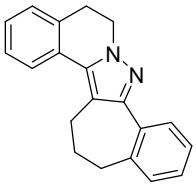
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.87 (d, J = 7.4 Hz, 1H), 7.61 (d, J = 7.6 Hz, 1H), 7.36-7.28 (m, 4H), 7.25-7.24 (m, 2H), 4.40 (t, J = 6.8 Hz, 2H), 3.21 (t, J = 6.8 Hz, 2H), 3.09-3.03 (m, 4H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 147.6, 136.0, 133.9, 132.4, 129.9, 128.3, 128.2, 128.0, 127.5, 127.3, 127.2, 126.8, 124.0, 121.9, 112.4, 46.5, 29.7, 29.5, 20.2;

IR (neat): v 3838, 3748, 3444, 2983, 2361, 1649, 1556, 1397, 1252, 1050, 877, 769 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{19}H_{17}N_2$: 273.1386; found: 273.1381;

5,13,14,15-tetrahydro-6H-benzo[6',7']cyclohepta[1',2':3,4]pyrazolo[5,1-*a*]isoquinoline (5ak)



Colorless oil, isolated yield 87% (50 mg);

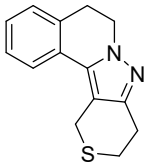
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.06 (d, J = 8.6 Hz, 1H), 7.71 (d, J = 7.6 Hz, 1H), 7.36-7.28 (m, 3H), 7.25-7.18 (m, 3H), 4.41 (t, J = 6.7 Hz, 2H), 3.21 (t, J = 6.8 Hz, 2H), 3.06 (t, J = 6.8 Hz, 2H), 2.90-2.87 (m, 2H), 2.21-2.15 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 149.0, 141.0, 135.2, 133.1, 132.7, 129.2, 128.34, 128.29, 127.4, 127.21, 127.20, 127.1, 126.3, 123.9, 114.9, 46.5, 34.7, 29.9, 27.8, 26.5;

IR (neat): v 3902, 3856, 3748, 3615, 2923, 2368, 1650, 1541, 1459, 1260, 1027, 762 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{20}H_{19}N_2$: 287.1543; found: 287.1536;

5,9,10,12-tetrahydro-6H-thiopyrano[4',3':3,4]pyrazolo[5,1-*a*]isoquinoline (5al)



Yellow oil, isolated yield 72% (34 mg);

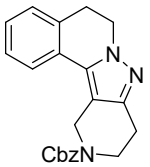
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.48 (d, J = 7.6 Hz, 1H), 7.34-7.27 (m, 2H), 7.25-7.23 (m, 1H), 4.29 (t, J = 6.8 Hz, 2H), 3.96 (s, 2H), 3.17 (t, J = 6.6 Hz, 2H), 3.05-3.02 (m, 2H), 2.97-2.94 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 147.1, 133.6, 132.4, 128.4, 127.7, 127.6, 127.3, 123.8, 108.4, 46.2, 29.7, 26.2, 25.8, 23.9;

IR (neat): v 3904, 3854, 3650, 3567, 2972, 2364, 1869, 1654, 1541, 1457, 1066, 668 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{14}H_{15}N_2S$: 243.0951; found: 243.0944;

benzyl 5,9,10,12-tetrahydropyrido[4',3':3,4]pyrazolo[5,1-*a*]isoquinoline-11(6H)-carboxylate (5am)



Yellow oil, isolated yield 80% (38 mg);

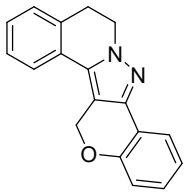
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.39-7.27 (m, 9H), 5.20 (s, 2H), 4.83-4.82 (m, 2H), 4.30 (t, J = 6.8 Hz, 2H), 3.90-3.76 (m, 2H), 3.18 (t, J = 6.8 Hz, 2H), 2.82-2.81 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 155.7, 146.0, 136.7, 133.5, 132.0, 128.5, 128.3, 128.0, 127.9, 127.8, 127.4, 124.1, 123.9, 109.0, 67.3, 46.2, 41.9, 29.5, 24.0, 23.7;

IR (neat): v 3855, 3752, 3650, 3630, 2923, 2364, 1700, 1458, 1419, 1227, 1108, 763 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{22}H_{22}N_3O_2$: 360.1707; found: 360.1704;

11,12-dihydro-6H-chromeno[4',3':3,4]pyrazolo[5,1-*a*]isoquinoline (5an)



Yellow solid, isolated yield 90% (50 mg);

mp: 125.7-126.4 °C;

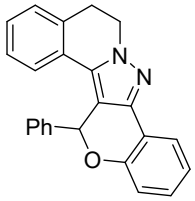
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.76 (dd, J = 7.6, 1.5 Hz, 1H), 7.36-7.28 (m, 3H), 7.24-7.18 (m, 2H), 7.03-6.96 (m, 2H), 5.57 (s, 2H), 4.40 (t, J = 6.8 Hz, 2H), 3.23 (t, J = 6.8 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 153.8, 142.9, 133.3, 132.4, 129.2, 128.5, 128.2, 127.5, 126.9, 124.3, 122.0, 121.8, 118.3, 117.0, 107.8, 64.0, 46.5, 29.5;

IR (neat): v 3874, 3588, 3431, 3244, 2887, 2562, 1750, 1488, 1459, 1378, 1059, 668 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{18}H_{15}N_2O$: 275.1179; found: 275.1174;

5-phenyl-11,12-dihydro-6H-chromeno[4',3':3,4]pyrazolo[5,1-*a*]isoquinoline (5ao)



Colorless oil, isolated yield 60% (42 mg);

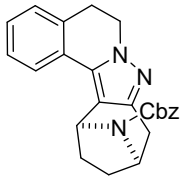
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.79 (d, J = 7.5 Hz, 1H), 7.39 (d, J = 7.0 Hz, 2H), 7.29-7.26 (m, 3H), 7.23-7.21 (m, 2H), 7.18-7.12 (m, 2H), 7.06 (d, J = 7.6 Hz, 1H), 6.98 (t, J = 7.3 Hz, 1H), 6.90 (d, J = 8.1 Hz, 1H), 6.74 (s, 1H), 4.57-4.39 (m, 2H), 3.35-3.18 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 152.1, 142.9, 139.5, 134.2, 132.4, 129.3, 128.6, 128.5, 128.4, 128.2, 127.8, 127.5, 126.6, 124.5, 122.0, 121.7, 118.3, 117.8, 109.8, 75.4, 46.6, 29.5;

IR (neat): v 3904, 3654, 3752, 3676, 3630, 2971, 2360, 1654, 1559, 1395, 1066, 668 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{24}H_{19}N_2O$: 351.1492; found: 351.1489;

Benzyl-5,9,10,11,12,13-hexahydro-6H-10,13-epiminocyclohepta[3,4]pyrazolo[5,1-*a*]isoquinoline-14-carboxylate (5ap)



Yellow oil, isolated yield 98% (76 mg);

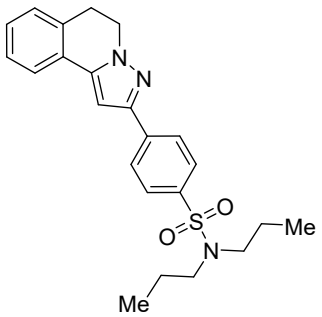
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.52-7.27 (m, 6H), 7.26-7.21 (m, 3H), 5.56-5.40 (m, 1H), 5.16-5.01 (m, 2H), 4.78-4.58 (m, 1H), 4.44-4.11 (m, 2H), 3.50-3.01 (m, 3H), 2.60 (d, J = 15.9 Hz, 1H), 2.46-2.16 (m, 2H), 2.05-1.97 (m, 1H), 1.78-1.72 (m, 1H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 153.8, 144.7, 136.7, 132.34, 132.31, 131.9, 128.4, 128.3, 127.9, 127.8, 127.7, 127.4, 124.3, 117.0, 66.9, 52.1, 51.8, 46.2, 34.8, 32.4, 29.5, 29.2;

IR (neat): v 3855, 3752, 3650, 3630, 2923, 2364, 1700, 1458, 1419, 1227, 1108, 763 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{24}H_{24}N_3O_2$: 386.1863; found: 386.1854;

4-(5,6-dihydropyrazolo[5,1-*a*]isoquinolin-2-yl)-*N*,*N*-dipropylbenzenesulfonamide (7aa)



Yellow oil, isolated yield 67% (54 mg);

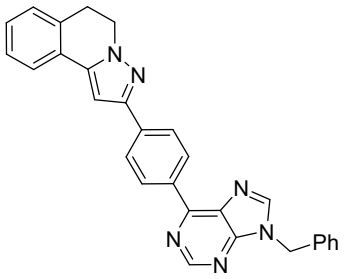
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.96 (d, J = 8.2 Hz, 2H), 7.84 (d, J = 8.2 Hz, 2H), 7.59 (d, J = 7.4 Hz, 1H), 7.36-7.26 (m, 3H), 6.90 (s, 1H), 4.41 (t, J = 6.9 Hz, 2H), 3.24 (t, J = 6.9 Hz, 2H), 3.10 (t, J = 7.6 Hz, 4H), 1.54 (m, 4H), 0.87 (t, J = 7.4 Hz, 6H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 149.5, 140.4, 138.7, 137.3, 131.6, 128.4, 128.3, 127.5, 127.4, 126.5, 125.7, 124.0, 98.1, 49.8, 46.4, 29.0, 21.9, 11.2;

IR (neat): v 3903, 3856, 3748, 3673, 2923, 2369, 1650, 1557, 1459, 1421, 1090, 745 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{23}H_{28}N_3O_2S$: 410.1897; found: 410.1892;

2-(4-(9-benzyl-9H-purin-6-yl)phenyl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (7ab)



Yellow solid, isolated yield 75% (68 mg);

mp: 201.2-201.8 °C;

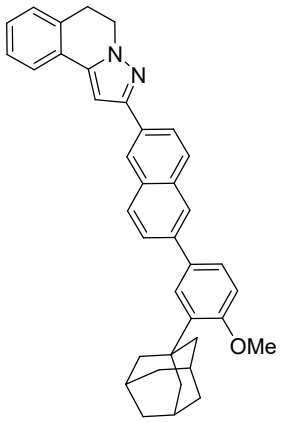
^{1}H NMR (400 MHz, $CDCl_3$): δ 9.06 (s, 1H), 8.91 (d, J = 8.4 Hz, 2H), 8.11 (s, 1H), 8.07 (d, J = 8.4 Hz, 2H), 7.63 (d, J = 7.5 Hz, 1H), 7.37-7.31 (m, 6H), 7.28-7.26 (m, 2H), 6.95 (s, 1H), 5.49 (s, 2H), 4.44 (t, J = 6.9 Hz, 2H), 3.25 (t, J = 6.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 154.5, 152.6, 152.5, 150.6, 144.0, 140.2, 135.9, 135.2, 134.7, 131.6, 130.8, 130.2, 129.1, 128.5, 128.2 (2C), 127.8, 127.4, 126.7, 125.6, 124.0, 98.1, 47.2, 46.3, 29.7;

IR (neat): ν 3972, 3899, 3685, 3566, 2970, 1394, 1249, 1066, 891, 754, 720, 679 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{29}H_{23}N_6$: 455.1979; found: 455.1971;

2-(6-(3-((3*r*,5*r*,7*r*)-adamantan-1-yl)-4-methoxyphenyl)naphthalen-2-yl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (7ac)



Yellow solid, isolated yield 62% (66 mg);

mp: 135.7-136.4 °C;

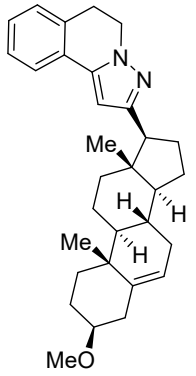
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.32 (s, 1H), 8.05-7.93 (m, 4H), 7.74 (d, J = 8.4 Hz, 1H), 7.67-7.60 (m, 2H), 7.55 (d, J = 10.1 Hz, 1H), 7.39-7.29 (m, 3H), 7.00 (d, J = 8.9 Hz, 2H), 4.46 (t, J = 6.9 Hz, 2H), 3.90 (s, 3H), 3.27 (t, J = 6.9 Hz, 2H), 2.20 (s, 6H), 2.11 (s, 3H), 1.81 (s, 6H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 158.5, 151.3, 140.2, 138.9, 138.8, 133.4, 133.1, 132.4, 131.7, 130.5, 128.5, 128.4, 128.24, 128.19, 127.4, 126.9, 126.0, 125.9, 125.8, 125.5, 124.8, 124.2, 124.0, 123.7, 112.0, 97.8, 55.1, 46.3, 40.6, 37.1, 29.2, 29.1;

IR (neat): ν 3968, 3878, 3654, 3523, 2954, 2346, 1738, 1652, 1545, 1290, 1058, 669 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{38}H_{37}N_2O$: 537.2900; found: 537.2893;

2-((3*S*,8*S*,9*S*,10*R*,13*S*,14*S*,17*S*)-3-methoxy-10,13-dimethyl-2,3,4,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-17-yl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (7ad)



Yellow solid, isolated yield 80% (72 mg);

mp: 41.4-42.3 °C;

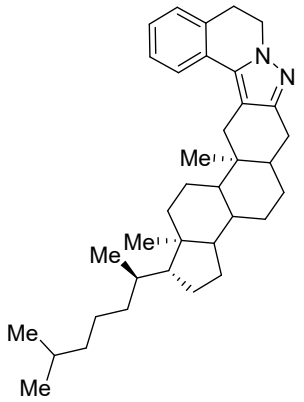
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.52 (d, J = 8.9 Hz, 1H), 7.29-7.20 (m, 3H), 6.37 (s, 1H), 5.39-5.37 (m, 1H), 4.30 (t, J = 6.7 Hz, 2H), 3.36 (s, 3H), 3.18 (t, J = 6.8 Hz, 2H), 3.10-3.03 (m, 1H), 2.73 (t, J = 7.1 Hz, 2H), 2.43-2.38 (m, 1H), 2.20-2.00 (m, 4H), 1.94-1.78 (m, 4H), 1.65-1.16 (m, 9H), 1.00 (s, 3H), 0.59 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 153.2, 140.9, 138.8, 131.6, 128.1, 127.7, 127.2 (2C), 123.7, 121.5, 99.4, 80.3, 56.1, 55.6, 50.4, 50.3, 45.9, 43.5, 38.6, 37.8, 37.2, 37.0, 32.3, 31.9, 29.2, 27.9, 26.5, 24.6, 20.8, 19.4, 13.0;

IR (neat): v 3904, 3854, 3650, 3567, 2971, 2360, 1734, 1654, 1558, 1259, 1066, 669 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{31}H_{41}N_2O$: 457.3213; found: 457.3207;

(1*R*,15a*S*,17a*R*)-15a,17a-dimethyl-1-((*R*)-6-methylheptan-2-yl)2,3,3a,3b,4,5,5a,6,9,10,15,15a,15b,16,17,17a-hexadecahydro-1H-cyclopenta[5',6']naphtho[1',2':5,6]indazolo[3,2-*a*]isoquinoline (7ae)



Yellow oil, isolated yield 55% (56 mg);

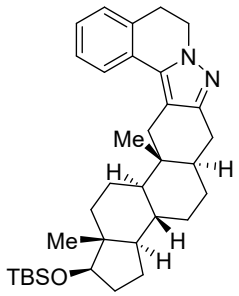
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.41 (d, J = 7.6 Hz, 1H), 7.29-7.27 (m, 1H), 7.24-7.18 (m, 2H), 4.41-4.36 (m, 1H), 4.07-3.99 (m, 1H), 3.32-3.23 (m, 1H), 2.96-2.90 (m, 2H), 2.71-2.54 (m, 2H), 2.29-2.25 (m, 1H), 1.99-1.71 (m, 5H), 1.55-1.30 (m, 12H), 1.12 (s, 3H), 1.04-0.84 (m, 17H), 0.66 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 149.2, 134.5, 133.1, 128.6, 127.8, 127.0, 126.7, 126.0, 115.6, 56.23, 56.21, 46.4, 42.4, 41.8, 40.8, 40.1, 39.5, 36.1, 35.8, 35.4, 34.9, 34.5, 30.2, 28.2, 28.0, 27.7, 24.2, 23.9, 23.8, 22.8, 22.5, 22.3, 21.7, 19.7, 18.6, 11.9;

IR (neat): v 3904, 3854, 3735, 3650, 3567, 2966, 2360, 1654, 1559, 1541, 1507, 669 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{36}H_{53}N_2$: 513.4203; found: 513.4205;

(1*R*,3a*R*,3b*S*,5a*R*,15a*R*,15b*R*,17a*R*)-1-((*tert*-butyldimethylsilyl)oxy)-15a,17a-dimethyl-2,3,3a,3b,4,5,5a,6,9,10,15,15a,15b,16,17,17a-hexadecahydro-1H-cyclopenta[5',6']naphtho[1',2':5,6]indazolo[3,2-*a*]isoquinoline (7af)



Yellow solid, isolated yield 55% (56 mg);

mp: 44.2-45.1 °C;

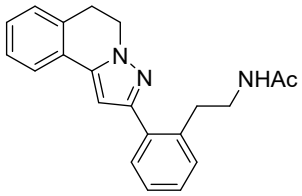
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.50 (d, J = 7.6 Hz, 1H), 7.30 (t, J = 7.4 Hz, 1H), 7.25-7.20 (m, 2H), 4.39-4.33 (m, 1H), 4.23-4.16 (m, 1H), 3.58 (t, J = 8.3 Hz, 1H), 3.29-3.21 (m, 1H), 3.07 (dt, J = 15.7, 4.8 Hz, 1H), 2.87 (d, J = 15.2 Hz, 1H), 2.63 (dd, J = 16.4, 4.7 Hz, 1H), 2.37-2.30 (m, 2H), 1.94-1.72 (m, 4H), 1.53-1.04 (m, 12H), 0.89 (s, 9H), 0.80 (s, 3H), 0.74 (s, 3H), -0.03 (s, 3H), -0.02 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 147.8, 134.4, 132.2, 128.3, 128.2, 127.1, 123.8, 111.8, 81.9, 54.3, 50.6, 46.2, 43.2, 42.1, 37.3, 36.7, 36.4, 35.8, 31.4, 30.9, 29.8, 29.3, 27.6, 25.9, 23.6, 20.9, 18.1, 11.8, 11.3, -4.5, -4.8;

IR (neat): v 3901, 3837, 3747, 3673, 3615, 2922, 2361, 1699, 1649, 1538, 1397, 881 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{34}H_{51}N_2OSi$: 531.3765; found: 531.3757;

_N_-(2-(5,6-dihydropyrazolo[5,1-_a_]isoquinolin-2-yl)phenethyl)acetamide (11)



Yellow oil, isolated yield 60% (40 mg);

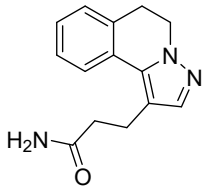
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.92 (s, 1H), 7.60 (d, J = 7.2 Hz, 1H), 7.48 (d, J = 7.4 Hz, 1H), 7.36-7.27 (m, 6H), 6.68 (s, 1H), 4.41 (t, J = 6.9 Hz, 2H), 3.60-3.56 (m, 2H), 3.29 (t, J = 6.8 Hz, 2H), 3.02 (t, J = 12.3 Hz, 2H), 1.91 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 170.4, 151.7, 139.7, 137.8, 133.4, 131.5, 130.4, 130.0, 128.44, 128.37, 128.3, 127.5, 126.52, 126.45, 124.1, 100.8, 46.2, 42.1, 31.4, 29.0, 23.1;

IR (neat): v 3904, 3854, 3735, 3650, 3567, 3274, 2971, 2360, 1654, 1049, 760, 669 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{21}H_{22}N_3O$: 332.1757; found: 332.1753;

3-(5,6-dihydropyrazolo[5,1-_a_]isoquinolin-1-yl)propanamide (13)



Yellow solid, isolated yield 60% (30 mg);

mp: 228.2-229.1 °C;

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.54 (s, 1H), 7.50 (d, J = 7.4 Hz, 1H), 7.35-7.28 (m, 3H), 4.26 (t, J = 6.8 Hz, 2H), 3.20 (t, J = 6.8 Hz, 2H), 3.09 (t, J = 7.6 Hz, 2H), 2.75 (t, J = 7.5 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 170.6, 148.2, 134.4, 132.4, 128.5, 128.2, 127.3, 127.1, 124.0, 97.5, 45.9, 31.6, 29.5, 17.8;

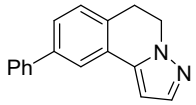
IR (neat): v 3904, 3854, 3650, 3567, 2972, 2360, 1654, 1541, 1419, 1339, 1066, 669 cm^{-1};

HRMS (ESI): m/z [M - H]$^-$ calcd. for $C_{14}H_{14}N_3O$: 240.1131; found: 240.1128;

Procedure for synthesis of 3ka

To a solution of **3ja** (24.8 mg, 0.1 mmol, 1.0 equiv), S-PHOS (4.7 mg, 0.01 mmol, 10 mol %), $PhB(OH)_2$ (27.5 mg, 0.2 mmol, 2.0 equiv), anhydrous K_3PO_4 (47.7 mg, 0.2 mmol, 2.0 equiv) in toluene (2 mL) was added $Pd(OAc)_2$ (2.4 mg, 0.01 mmol, 10 mol %) at room temperature. The resulting mixture was degassed with N_2 and heated to 100 ℃ for 24 h. After cooling to room temperature, the reaction mixture was directly charged to column chromatography on silica gel (Hexanes:EtOAc = 6:1) to afford the product (23 mg, 93% yield);

9-phenyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (3ka)



Colorless oil;

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.75 (s, 1H), 7.63 (s, 1H), 7.61 (s, 1H), 7.56 (s, 1H), 7.49-7.45 (m, 3H), 7.40-7.34 (m, 2H), 6.62 (s, 1H), 4.40 (t, J = 6.8 Hz, 2H), 3.25 (t, J = 6.7 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 140.6, 140.5, 139.3, 130.6, 128.8, 128.6, 127.5, 127.4, 127.0, 126.8, 122.7, 111.4, 100.8, 46.2, 28.9;

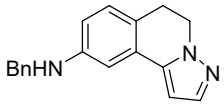
IR (neat): v 3856, 3748, 2924, 2364, 1700, 1542, 1468, 1408, 1259, 1044, 758, 668 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{17}H_{15}N_2$: 247.1230; found: 247.1225;

Procedure for synthesis of 14

To a solution of **3ja** (24.8 mg, 0.1 mmol, 1.0 equiv), benzylamine (64 μL, 0.5 mmol, 5.0 equiv), ^{t}BuOK (95%, 40.0 mg, 0.3 mmol, 3.0 equiv) and *o*-P(*t*-Bu)$_2$-biphenyl (6.0 mg, 0.02 mmol, 20 mol %) in toluene (2 mL) was added $Pd(OAc)_2$ (2.6 mg, 0.01 mmol, 10 mol %) at room temperature. The resulting mixture was degassed with N_2. The mixture was stirred at 110 ℃ for 24 h. After cooling to room temperature, the reaction mixture was directly charged to column chromatography on silica gel (petroleum ether:EtOAc = 6:1) to afford the product (26 mg, 95% yield);

5-N-benzyl-5,6-dihydropyrazolo[5,1-*a*]isoquinolin-9-amine (14)



Yellow oil;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (d, J = 2.0 Hz, 1H), 7.40–7.34 (m, 4H), 7.32–7.27 (m, 1H), 7.07 (d, J = 8.2 Hz, 1H), 6.83 (d, J = 2.4 Hz, 1H), 6.56 (dd, J = 8.2, 2.5 Hz, 1H), 6.45 (d, J = 1.9 Hz, 1H), 4.37 (s, 2H), 4.31 (t, J = 6.9 Hz, 2H), 3.08 (t, J = 6.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 139.0, 138.6, 134.5, 129.7, 129.1 (2C), 129.0, 128.7 (2C), 128.3, 127.9, 127.7, 100.6, 50.1, 46.5, 28.4;

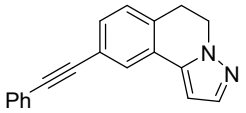
IR (neat): v 3867, 3757, 3661, 3421, 2927, 2407, 1740, 1654, 1513, 1458, 1029, 746 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{18}H_{18}N_3$: 276.1495; found: 276.1497;

Procedure for synthesis of 15

To a solution of **3ja** (24.8 mg, 0.1 mmol, 1.0 equiv), phenylacetylene (16 μL, 0.150 mmol, 1.5 equiv), Cs_2CO_3 (107.0 mg, 0.3 mmol, 3 equiv) and S-PHOS (18.6 mg, 0.03 mmol, 30 mol %) in anhydrous acetonitrile (2 mL) was added $PdCl_2(MeCN)_2$ (3.3 mg, 0.01 mmol, 10 mol %) at room temperature. The resulting mixture was degassed with N_2 and then heated to 90 ℃ for 3 h. The reaction was cooled down to room temperature the solvent was removed in vacuo. The crude mixture was purified by flash column chromatography (Hexanes:EtOAc = 6:1) to afford the product (26 mg, 95% yield);

6-9-(phenylethynyl)-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (15)



Yellow oil;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, J = 1.4 Hz, 1H), 7.57–7.54 (m, 3H), 7.43 (dd, J = 7.8, 1.7 Hz, 1H), 7.38–7.35 (m, 3H), 7.27 (s, 1H), 6.59 (d, J = 2.0 Hz, 1H), 4.38 (t, J = 6.9 Hz, 2H), 3.22 (t, J = 6.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 139.4, 138.0, 131.8, 131.6, 131.0, 128.41, 128.38, 128.3, 127.2, 126.9, 123.0, 122.4, 100.9, 89.7, 88.7, 46.0, 29.2;

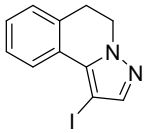
IR (neat): ν 3867, 3819, 3686, 3668, 2995, 2908, 1410, 1253, 1077, 1068, 758, 659 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{19}H_{15}N_2$: 271.1230; found: 271.1234;

Procedure for synthesis of 16

A mixture of **3aa** (291 mg, 1.7 mmol, 1.0 equiv), iodine (522 mg, 2.04 mmol, 1.2 equiv) and CAN (1.128 g, 2.04 mmol, 1.2 equiv) in anhydrous acetonitrile (17 mL) was stirred at 90 ℃ for 3 h. The solvent was then evaporated in vacuo and the resulting residue was dissolved in EtOAc (40 mL). The resulting organic solution was washed with an aqueous solution of $NaHSO_3$ (5%), and finally dried over Na_2SO_4. Removal of the solvent in vacuo gave a crude mixture that was purified by column chromatography (petroleum ether:EtOAc = 5:1) to afford the product (468 mg, 93% yield);

1-iodo-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (16)



Yellow oil;

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.41 (d, J = 7.6 Hz, 1H), 7.53 (s, 1H), 7.37-7.32 (m, 1H), 7.30–7.23 (m, 2H), 4.34 (t, J = 6.7 Hz, 2H), 3.14 (t, J = 6.8 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 145.3, 136.3, 128.6, 128.2, 127.0, 126.5, 124.0 (2C), 52.9, 47.0, 29.7;

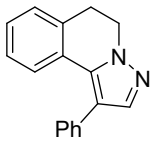
IR (neat): ν 3862, 3756, 3681, 3659, 3452, 2927, 2366, 1739, 1702, 1024, 914, 746 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{11}H_{10}IN_2$: 296.9883; found: 296.9883;

Procedure for synthesis of 17

To a solution of **16** (29.6 mg, 0.1 mmol, 1.0 equiv) in toluene (2 mL) was added phenylboronic acid (24.4 mg, 0.2 mmol, 2.0 equiv), $Pd(PPh_3)_4$ (11.6 mg, 0.01 mmol, 10 mol %). Absolute EtOH (2.0 mL) and aqueous $NaHCO_3$ (2.0 mL) was then added to the reaction mixture. The resulting mixture was degassed with N_2 and then heated to 110 ℃ for 12 h. After cooling to room temperature, the organic layer was separated and the aqueous fraction was extracted with EtOAc. The organic fractions were dried over Na_2SO_4. Removal of the solvents in vacuo gave a crude mixture that was purified by column chromatography (Hexanes:EtOAc = 6:1) to afford the product (23 mg, 92% yield);

6-1-phenyl-5,6-dihydropyrazolo[5,1-*a*]isoquinoline (17)



Yellow solid;

mp: 93.4-93.9 °C;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (s, 1H), 7.49-7.47 (m, 2H), 7.44-7.39 (m, 3H), 7.36–7.32 (m, 1H), 7.29 (d, J = 7.5 Hz, 1H), 7.21 (td, J = 7.4, 1.2 Hz, 1H), 7.11–7.07 (m, 1H), 4.38 (t, J = 6.7 Hz, 2H), 3.23 (t, J = 6.8 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 139.3, 134.0, 133.8, 132.7, 128.9, 128.6, 128.2, 127.9, 127.3, 126.94, 126.93, 124.4, 119.4, 46.6, 29.7;

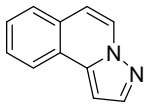
IR (neat): ν 3865, 3700, 3685, 3668, 2995, 2979, 2908, 1409, 1253, 1068, 1017, 894 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{17}H_{15}N_2$: 247.1230; found: 247.1232;

Procedure for synthesis of 18

A mixture of **3aa** (34 mg, 0.20 mmol, 1.0 equiv) and activated MnO_2 (173.8 mg, 2 mmol, 10.0 equiv) in CH_2Cl_2 (2 mL) was refluxed for 36 h. After cooling to room temperature, the mixture was passed through a pad of Celite and evaporated in vacuo. The residue was purified by column chromatography (Hexanes:EtOAc = 6:1) to afford the product (31 mg, 92%);

pyrazolo[5,1-*a*]isoquinoline (18)[7]



Yellow solid;

mp: 33.4-33.9 °C;

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.25 (d, J = 7.4 Hz, 1H), 8.10–8.08 (m, 1H), 7.97 (d, J = 2.1 Hz, 1H), 7.72–7.70 (m, 1H), 7.59-7.51 (m, 2H), 6.99–6.98 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 141.2, 138.3, 128.6, 127.8, 127.6, 127.1, 126.4, 124.5, 123.6, 112.0, 97.5;

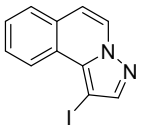
IR (neat): ν 3862, 3756, 3452, 2927, 2368, 1739, 1702, 1653, 1462, 1024, 914, 747 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{11}H_9N_2$: 169.0760; found: 169.0761;

Procedure for synthesis of 19

To a solution of **18** (50.5 mg, 0.3 mmol, 1.0 equiv) in DMF (1.5 mL) was added *N*-iodosuccinimide (74.4 mg, 0.33 mmol) at room temperature. The resulting mixture was stirred at room temperature overnight. The reaction was quenched with an aqueous solution of $Na_2S_2O_3$ and $NaHCO_3$. The mixture was extracted with Et_2O, and the resulting organic solution was washed with brine and dried over Na_2SO_4. Removal of the solvent in vacuo gave a crude mixture that was purified by column chromatography (petroleum ether:EtOAc = 10:1) to afford the product (25 mg, 85%);

1-iodopyrazolo[5,1-*a*]isoquinoline (19)



White solid;

mp: 65.4-65.9 °C;

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.22 (d, J = 8.0 Hz, 1H), 8.23 (d, J = 7.4 Hz, 1H), 7.98 (s, 1H), 7.73 (dd, J = 7.7, 1.2 Hz, 1H), 7.66-7.56 (m, 2H), 7.02 (d, J = 7.4 Hz, 1H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 147.5, 134.8, 129.3, 128.4, 127.3, 127.2, 126.5, 124.7, 123.0, 113.0, 48.3;

IR (neat): ν 3976, 3658, 2864, 2564, 1682, 1542, 1365, 1307, 1258, 1136, 1008, 668 cm^{-1};

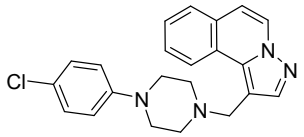
HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{11}H_8IN_2^+$: 294.9727; found: 294.9731;

Procedure for synthesis of III

To a solution of **19** (25 mg, 0.1 mmol, 1.0 equiv) in THF (1 mL) was added isopropylmagnesium chloride (0.4 mL, 0.8 mmol, 2.0 M in THF, 8.0 equiv) at 0 ℃. The resulting solution was warmed up to room temperature and stirred for 30 min. DMF (29 mg, 0.4 mmol, 4.0 equiv) was added and the mixture was stirred at room temperature overnight. The reaction was quenched with an aqueous solution of NH_4Cl. The mixture was

extracted with CH_2Cl_2, and the resulting organic solution was washed with brine and finally dried over Na_2SO_4. The solvent was removed in vacuo and the residue was dissolved in CH_2Cl_2 (2 mL), and to this solution was added 1-(4-chlorophenyl)piperazine (20 mg, 0.1 mmol, 1.0 equiv) and acetic acid (1.2 mg, 0.02 mmol, 0.2 equiv). The resulting mixture was stirred at room temperature for 30 min, then sodium triacetoxyborohydride (64 mg, 0.3 mmol, 3.0 equiv) was added. The reaction was stirred at room temperature for 18 h and was quenched with an aqueous solution of $NaHCO_3$. The mixture was extracted with CH_2Cl_2, and the resulting organic solution was washed with brine and dried over Na_2SO_4. Removal of the solvent in vacuo gave a crude mixture that was purified by column chromatography (petroleum ether:EtOAc = 5:1) to afford the product (30 mg, 80%);

1-((4-(4-chlorophenyl)piperazin-1-yl)methyl)pyrazolo[5,1-*a*]isoquinoline (III)



White solid;

mp: 107.6-107.9 °C;

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.59 (d, J = 7.7 Hz, 1H), 8.25 (d, J = 7.4 Hz, 1H), 7.89 (s, 1H), 7.73-7.71 (m, 1H), 7.61-7.52 (m, 2H), 7.20-7.16 (m, 2H), 7.01 (d, J = 7.4 Hz, 1H), 6.84-6.80 (m, 2H), 3.91 (s, 2H), 3.17-3.15 (m, 4H), 2.74-2.71 (m, 4H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 150.0, 143.0, 135.7, 129.4, 128.9, 127.6, 127.5, 127.0, 126.7, 125.8, 125.5, 124.4, 117.2, 112.4, 111.1, 53.8, 52.8, 49.2;

IR (neat): ν 3942, 2862, 2936, 2568, 1856, 1652, 1632, 1406, 1269, 1002, 788, 668 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{22}H_{22}ClN_4$: 377.1528; found: 377.1523;

3. References

[1] W. B. Cao, S. J. Li, M. M. Xu, H. Li, X. P. Xu, Y. Lan and S. J. Ji, *Angew. Chem. Int. Ed.,* 2020, **59**, 21425-21430.
[2] (*a*) Z. H. Guan, Z. Y. Zhang, Z. H. Ren, Y. Y. Wang and X. M. Zhang, *J. Org. Chem*., 2011, **76**, 339-341; (*b*) J. T. Reeves, Z. L. Tan, Z. S. Han, G. S. Li, Y. D. Zhang, Y. B. Xu, D. C. Reeves, N. C. Gonnella, S. L. Ma, H. Lee, B. Z. Lu and C. H. Senanayake, *Angew. Chem. Int. Ed*., 2012,**51**, 1400-1404; (*c*) M. J. Burk, G. Casy and N. B. Johnson, *J. Org. Chem.,* 1998, **63**, 6084-6085; (*d*) M. G. Barthakur, M. Borthakur and R. C. Boruah, *Steroids*, 2008, **73**, 1137-1142.
[3] Z. Li, H. Yu, H. L. Liu, L. Zhang, H. Jiang, B. Wang and H. C. Guo, *Chem. Eur. J.*, 2014, **20**, 1731-1736.
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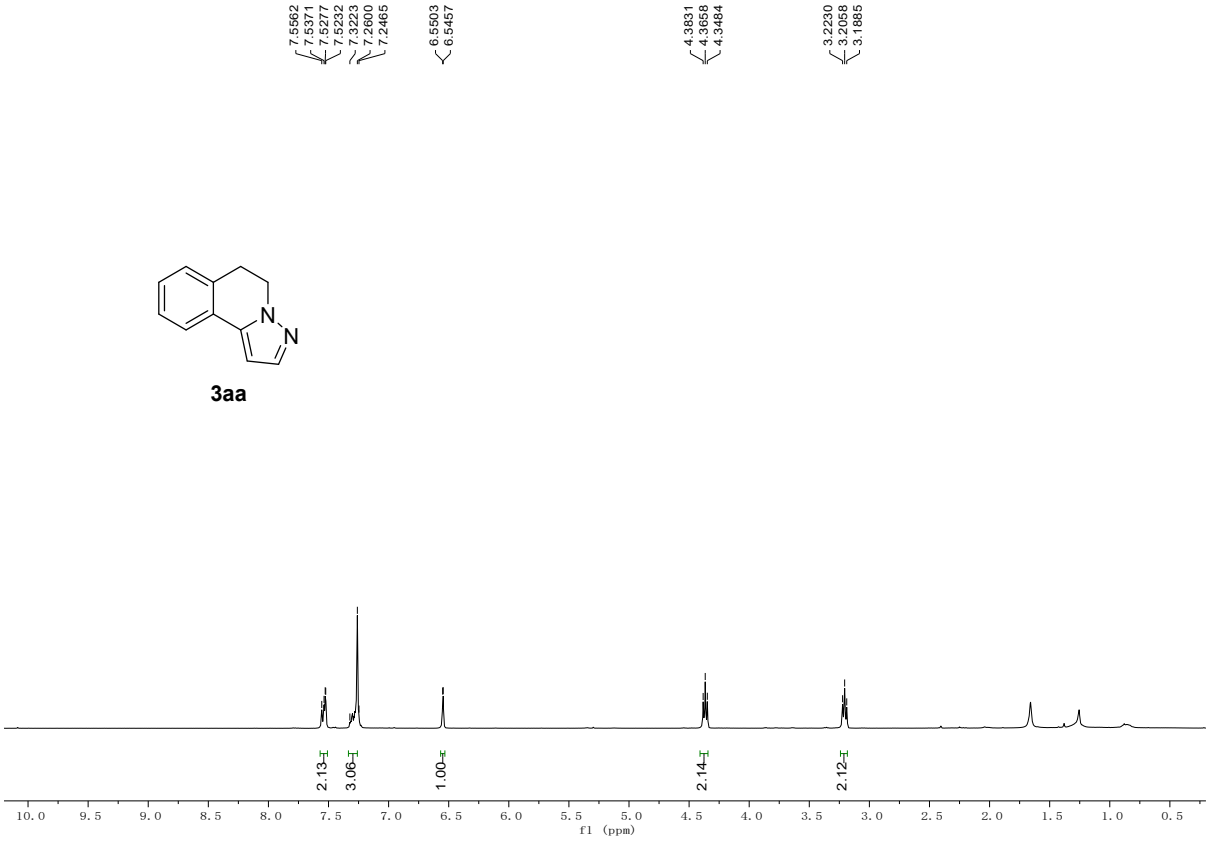
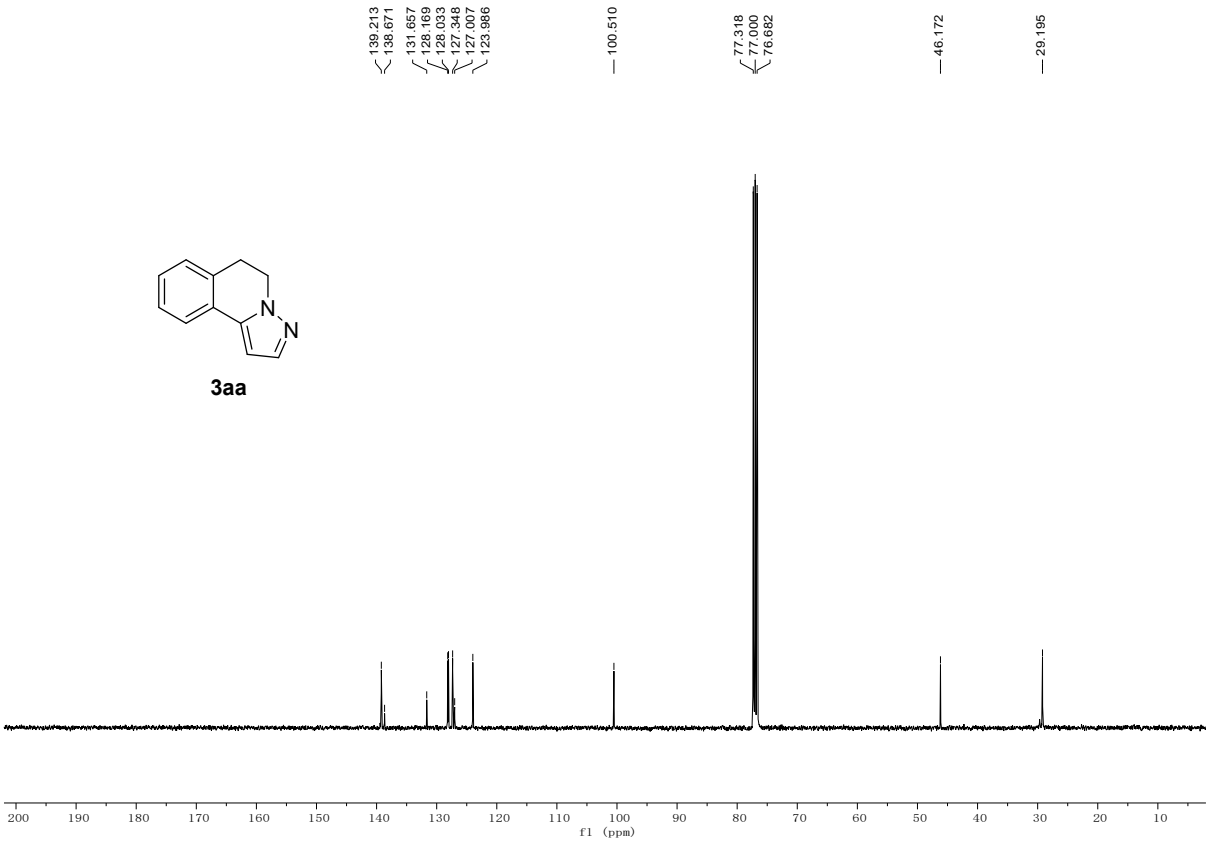
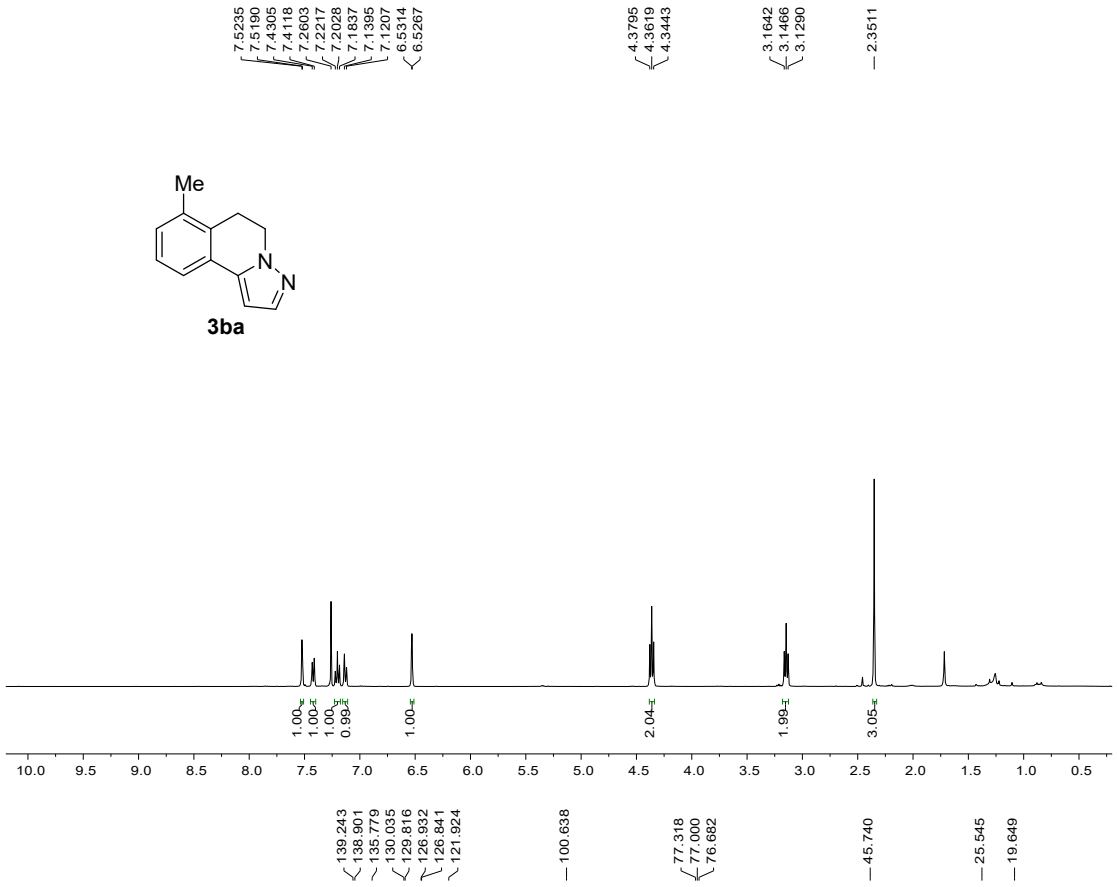
[5] H. Ortega, S. Ahmed and H. Alper, *Synthesis*, 2007, **23**, 3683-3691.
[6] Z. H. Qu, F. Zhang, G. J. Deng and H. W. Huang, *Org. Lett*., 2019, **21**, 8239-8243.
[7] M. Kobayashi, K. Kondo and T. Aoyama, *Tetrahedron Lett*., 2007, **48**, 7019-7021.

4. Copies of NMR spectra



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7.4118
7.2603
7.2217
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6.5267
4.3795
4.3619
4.3443
3.1642
3.1466
3.1290
2.3511
Me
N
N
3ba
1.00
1.00
1.00
0.99
1.00
2.04
1.99
3.05
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
139.243
138.901
135.779
130.035
129.816
126.932
126.841
121.924
100.638
77.318
77.000
76.682
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N
3ba
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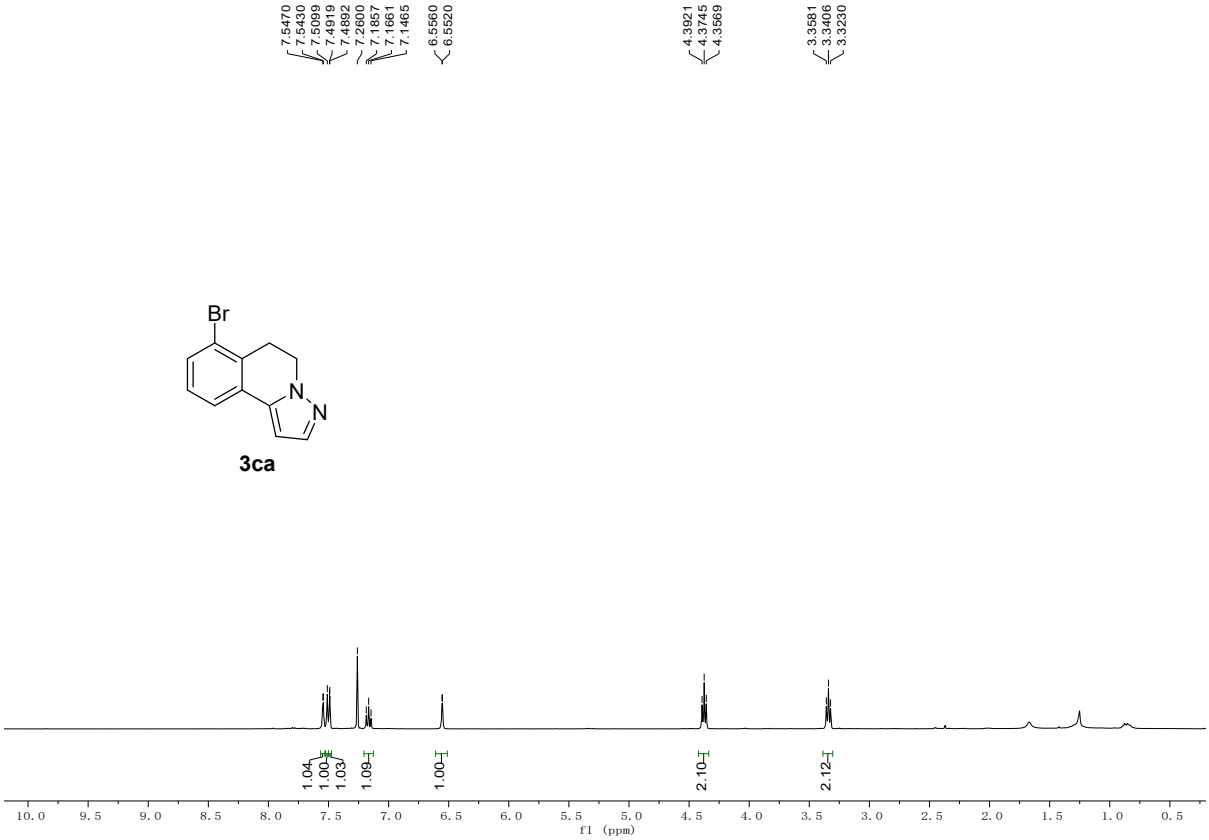
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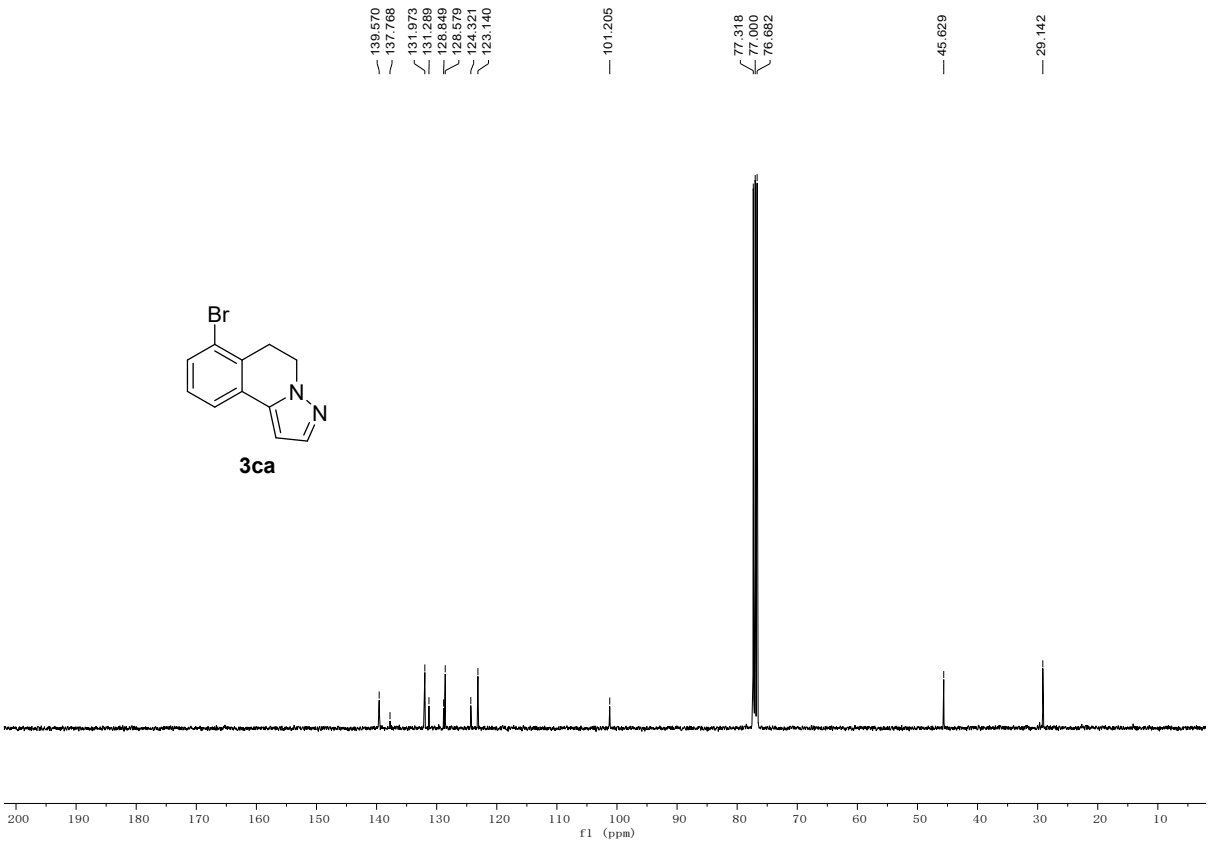
f1 (ppm)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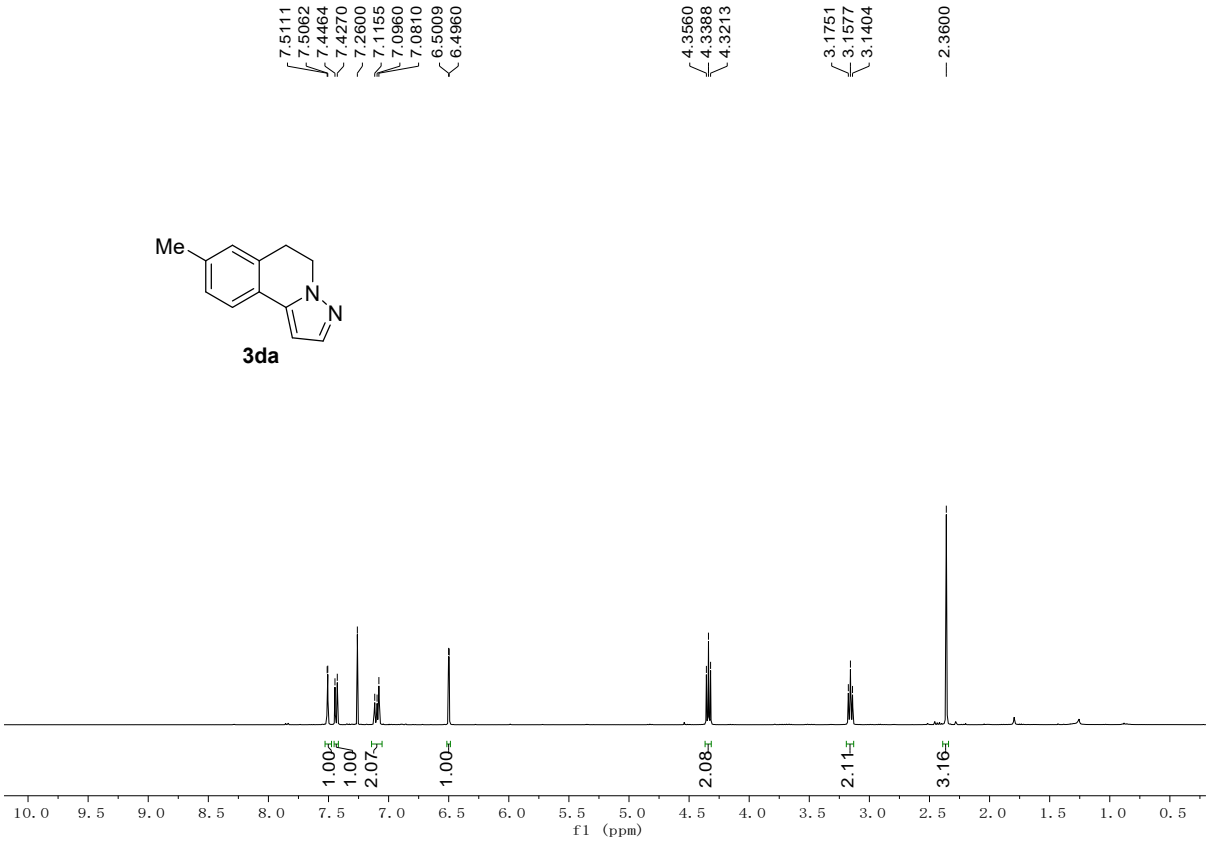
3ca
f1 (ppm)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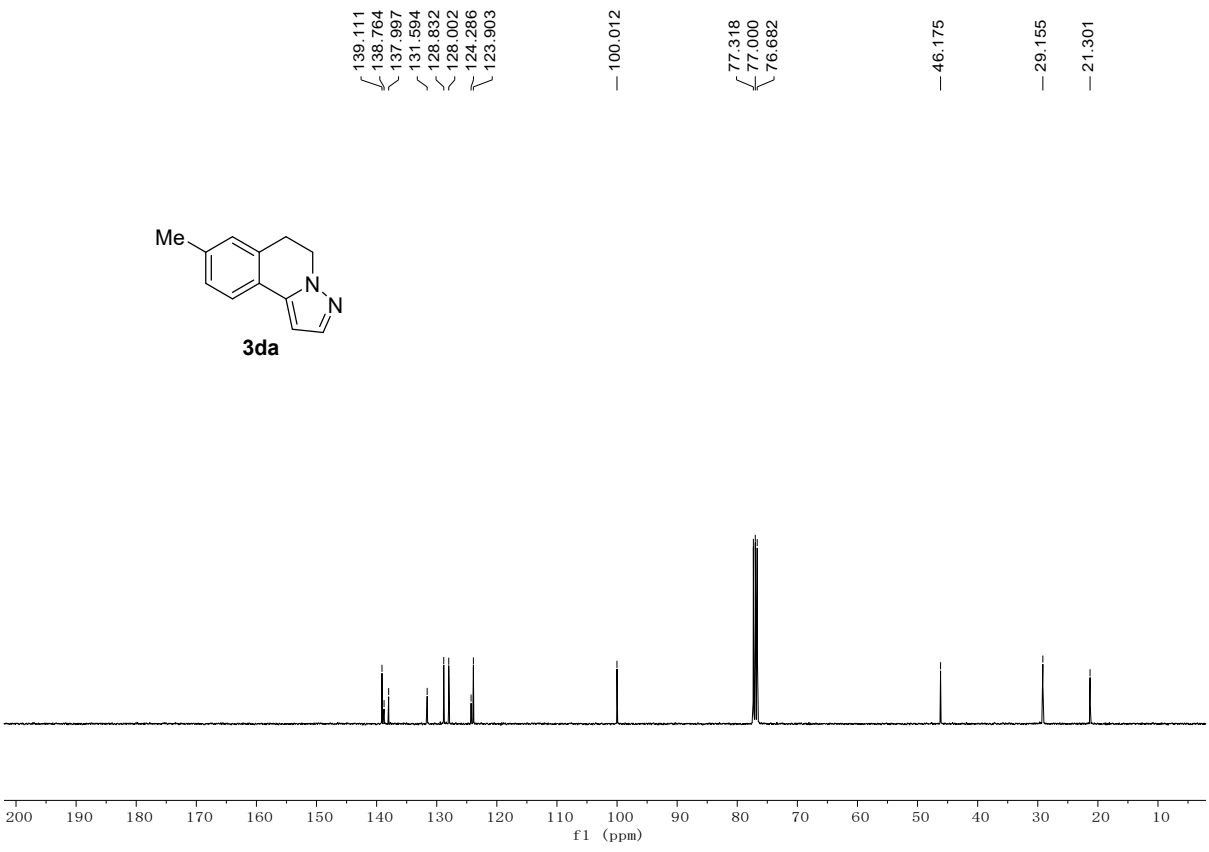
6.4960
4.3560
4.3388
4.3213
3.1751
3.1577
3.1404
2.3600
Me
N
N
3da
1.00
1.00
2.07
1.00
2.08
2.11
3.16
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)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N
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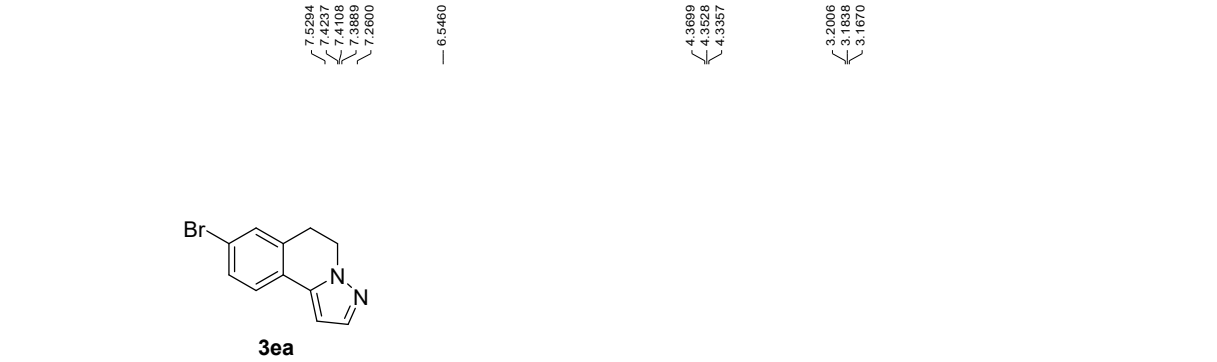
f1 (ppm)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4.3357
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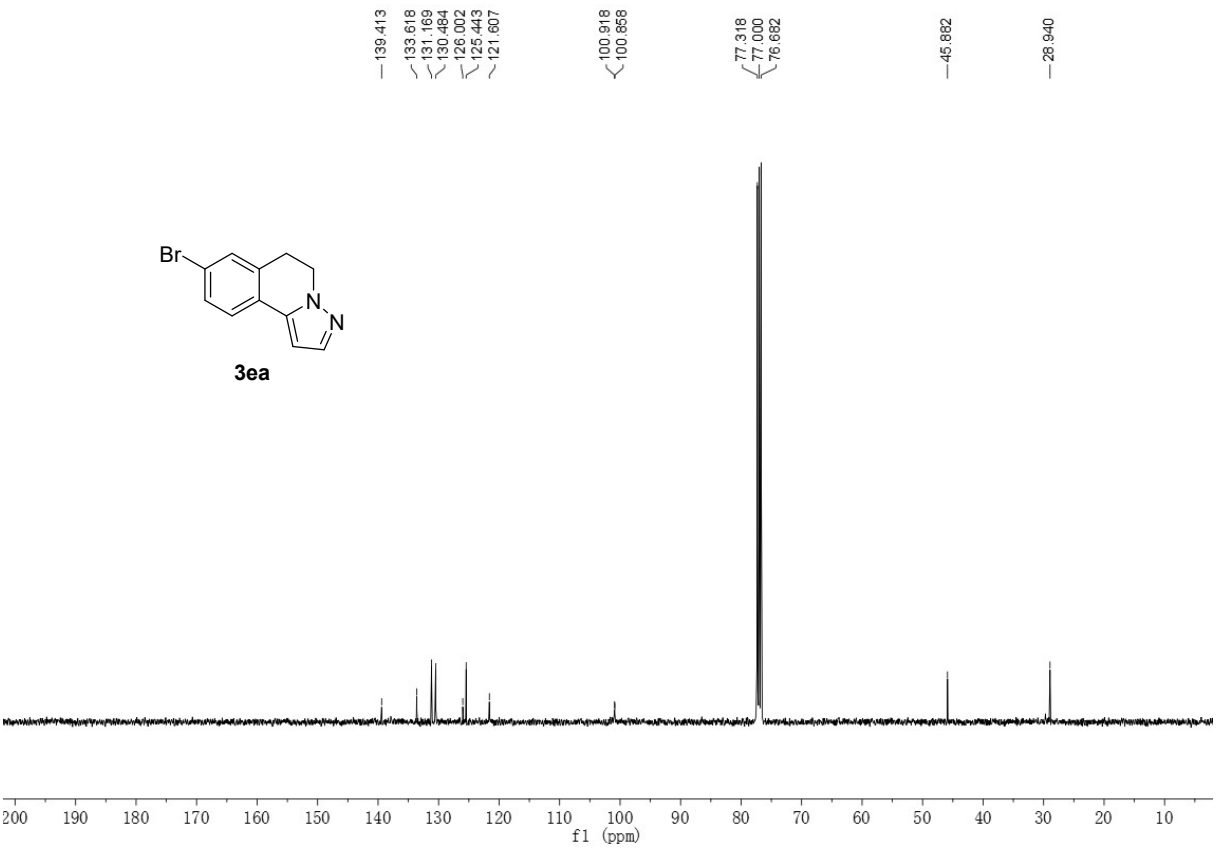
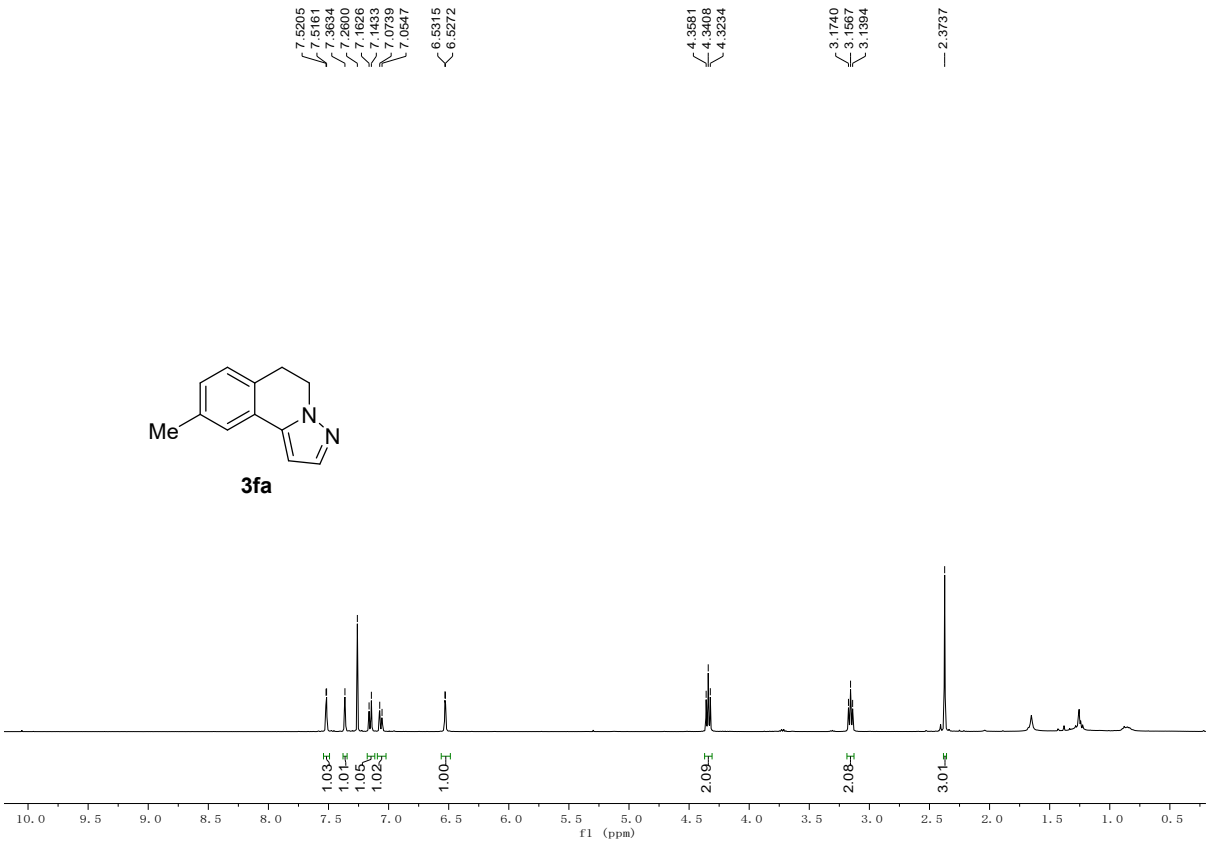
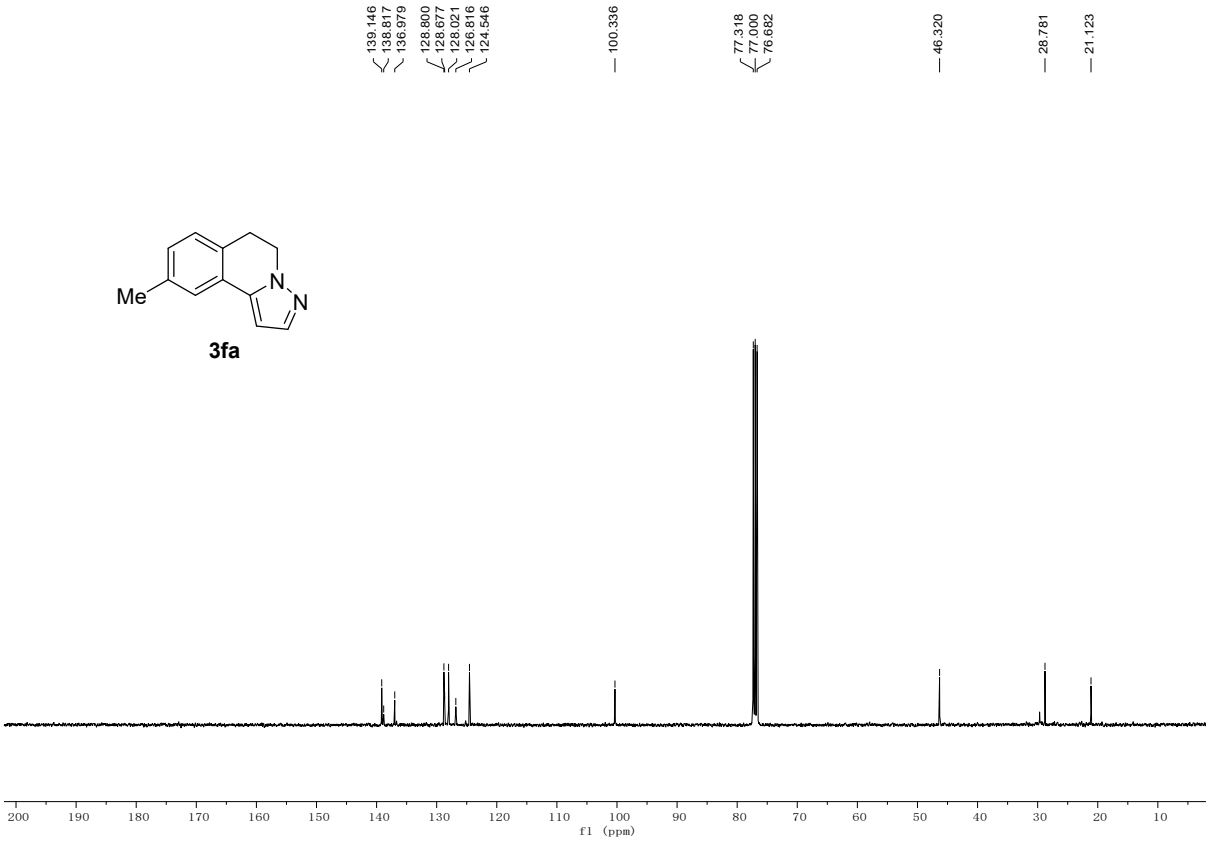
N
1.00
3.12
1.00
2.12
2.09
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

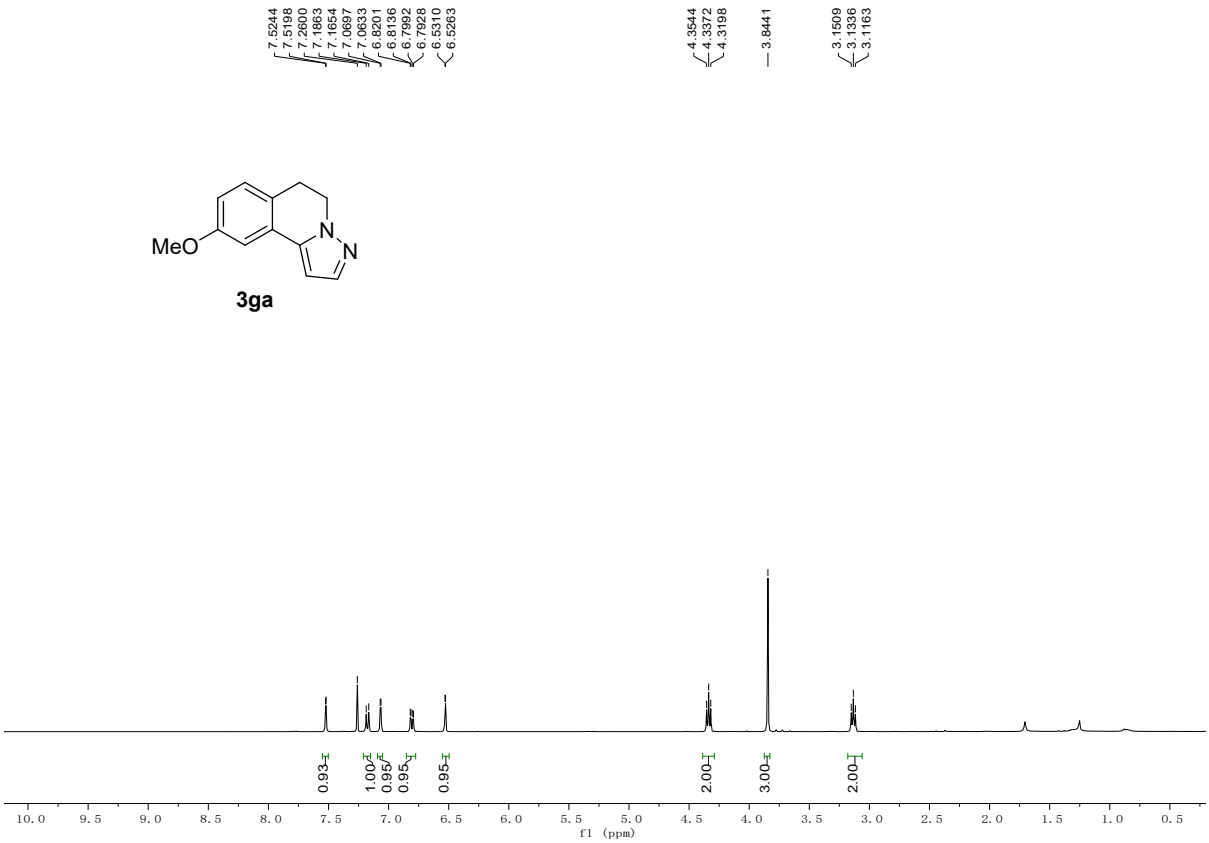
3ea


139.413
133.618
131.169
130.484
126.002
125.443
121.607
100.918
100.858
77.318
77.000
76.682
45.882
28.940
Br
N
N
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

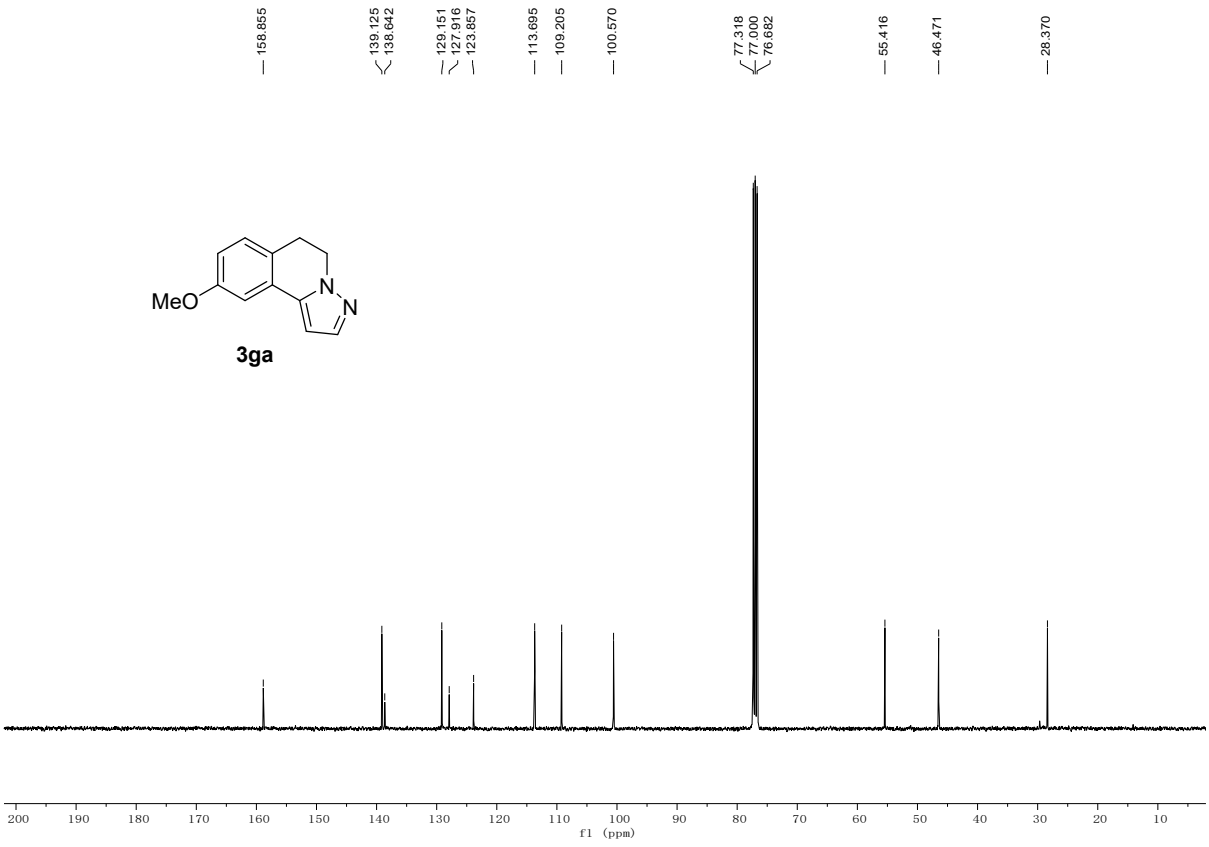
3ea


7.5205
7.5161
7.3634
7.2600
7.1626
7.1433
7.0739
7.0547
6.5315
6.5272
4.3581
4.3408
4.3234
3.1740
3.1567
3.1394
2.3737
Me
N
N
3fa
1.03
1.01
1.05
1.02
1.00
2.09
2.08
3.01
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
f1 (ppm)

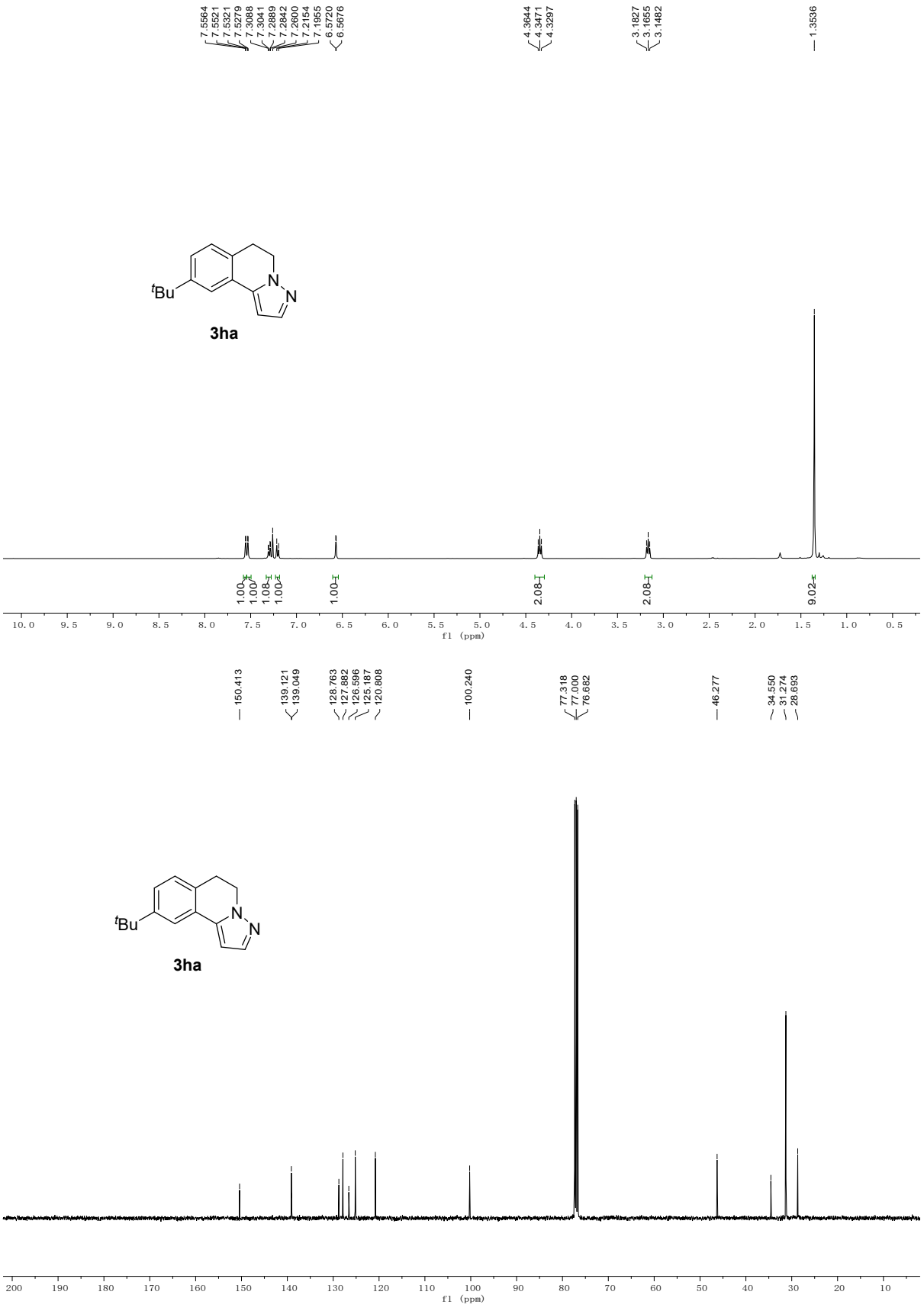

139.146
138.817
136.979
128.800
128.677
128.021
126.816
124.546
100.336
77.318
77.000
76.682
46.320
28.781
21.123
Me
N
N
3fa
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

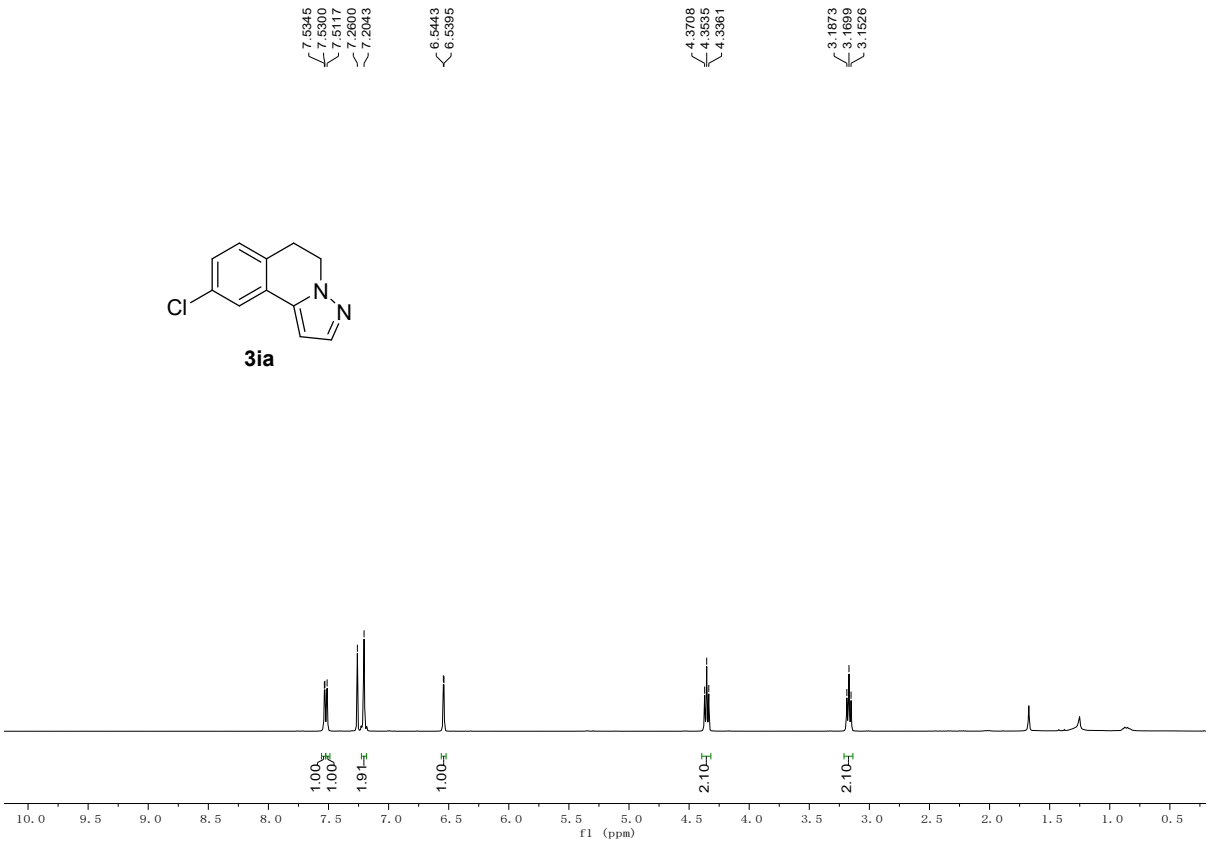

7.5244
7.5198
7.2600
7.1863
7.1654
7.0697
7.0633
6.8201
6.8136
6.7992
6.7928
6.5310
6.5263
4.3544
4.3372
4.3198
3.8441
3.1509
3.1336
3.1163
MeO
N
N
0.93
1.00
0.95
0.95
0.95
2.00
3.00
2.00
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

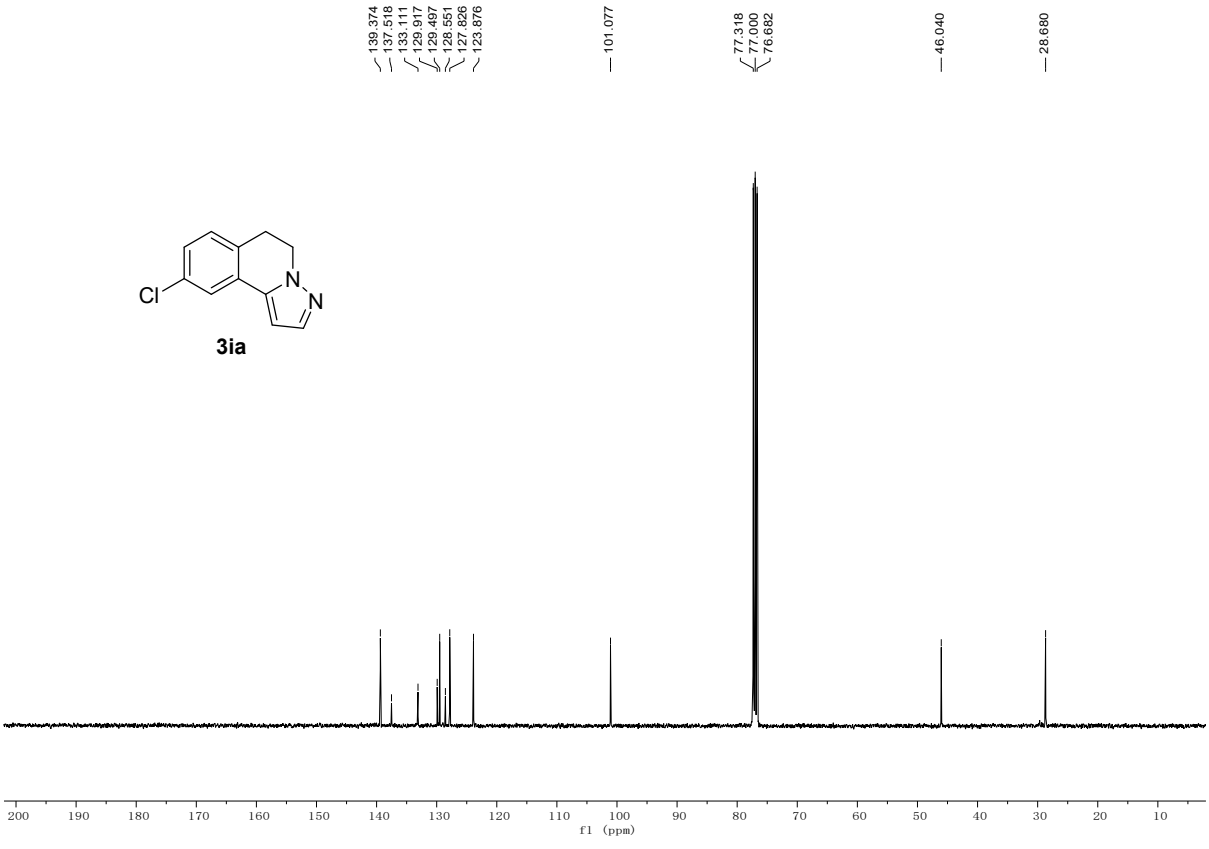
3ga

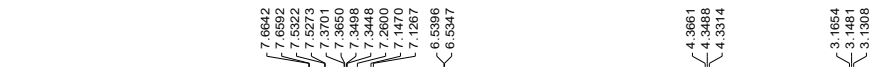

158.855
139.125
138.642
129.151
127.916
123.857
113.695
109.205
100.570
77.318
77.000
76.682
55.416
46.471
28.370
MeO
N
N
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

3ga


7.5564
7.5521
7.5321
7.5279
7.3088
7.3041
7.2889
7.2842
7.2600
7.2154
7.1955
6.5720
6.5676
4.3644
4.3471
4.3297
3.1827
3.1655
3.1482
1.3536
tBu
N
N
3ha
1.00
1.00
1.08
1.00
1.00
2.08
2.08
9.02
f1 (ppm)
150.413
139.121
139.049
128.763
127.882
126.596
125.187
120.808
100.240
77.318
77.000
76.682
46.277
34.550
31.274
28.693
tBu
N
N
3ha
f1 (ppm)


7.5345
7.5300
7.5117
7.2600
7.2043
6.5443
6.5395
4.3708
4.3535
4.3361
3.1873
3.1699
3.1526
Cl
N
N
3ia
1.00
1.00
1.91
1.00
2.10
2.10
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
f1 (ppm)


139.374
137.518
133.111
129.917
129.497
128.551
127.826
123.876
101.077
77.318
77.000
76.682
46.040
28.680
Cl
N
N
3ia
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


7.6642
7.6592
7.5322
7.5273
7.3701
7.3650
7.3498
7.3448
7.2600
7.1470
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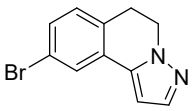
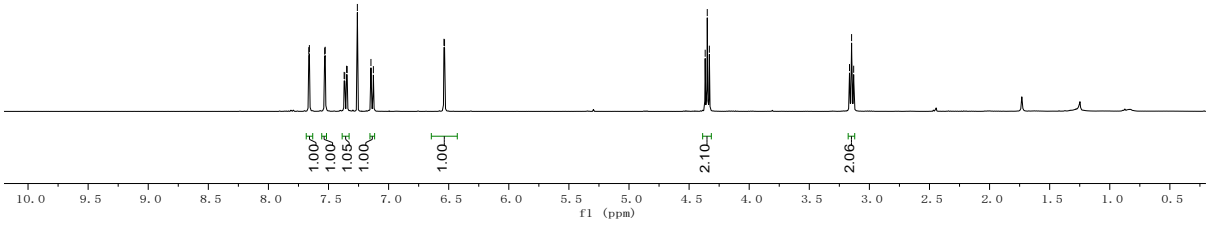
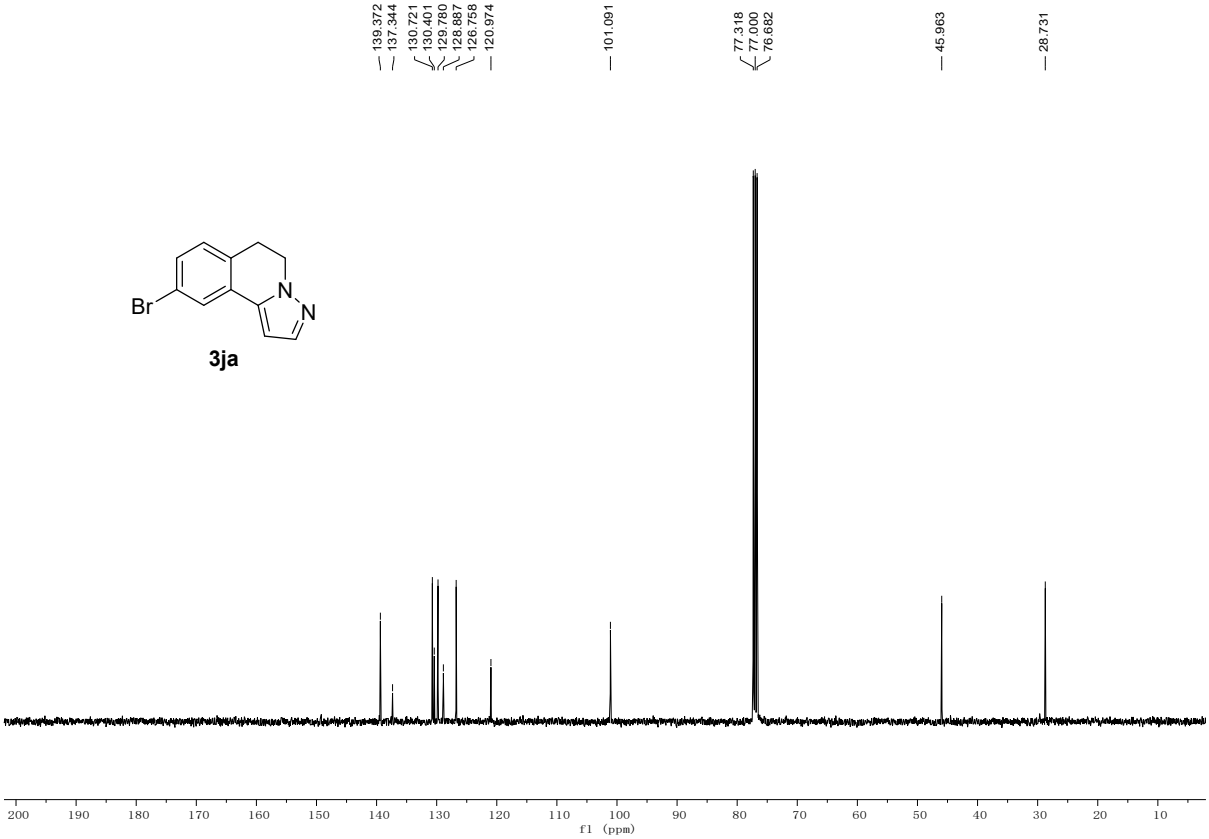
4.3488
4.3314
3.1654
3.1481
3.1308


Br
N
N

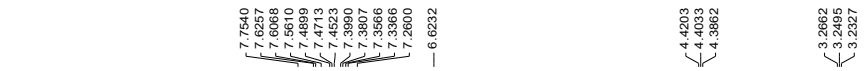
3ja

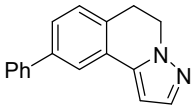

1.00
1.00
1.05
1.00
1.00
2.10
2.06
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


139.372
137.344
130.721
130.401
129.780
128.887
126.758
120.974
101.091
77.318
77.000
76.682
45.963
28.731
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

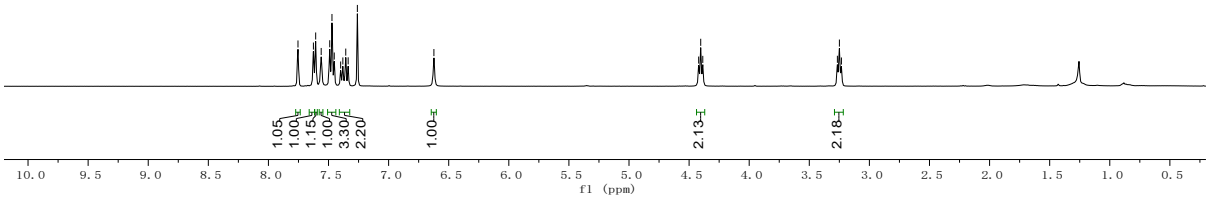
Br
N
N

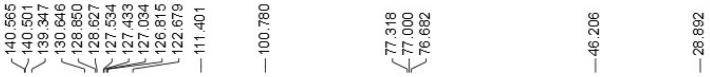
3ja

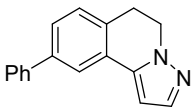

7.7540
7.6257
7.6068
7.5610
7.4899
7.4713
7.4523
7.3990
7.3807
7.3566
7.3366
7.2600
6.6232
4.4203
4.4033
4.3862
3.2662
3.2495
3.2327


Ph
N
N

3ka

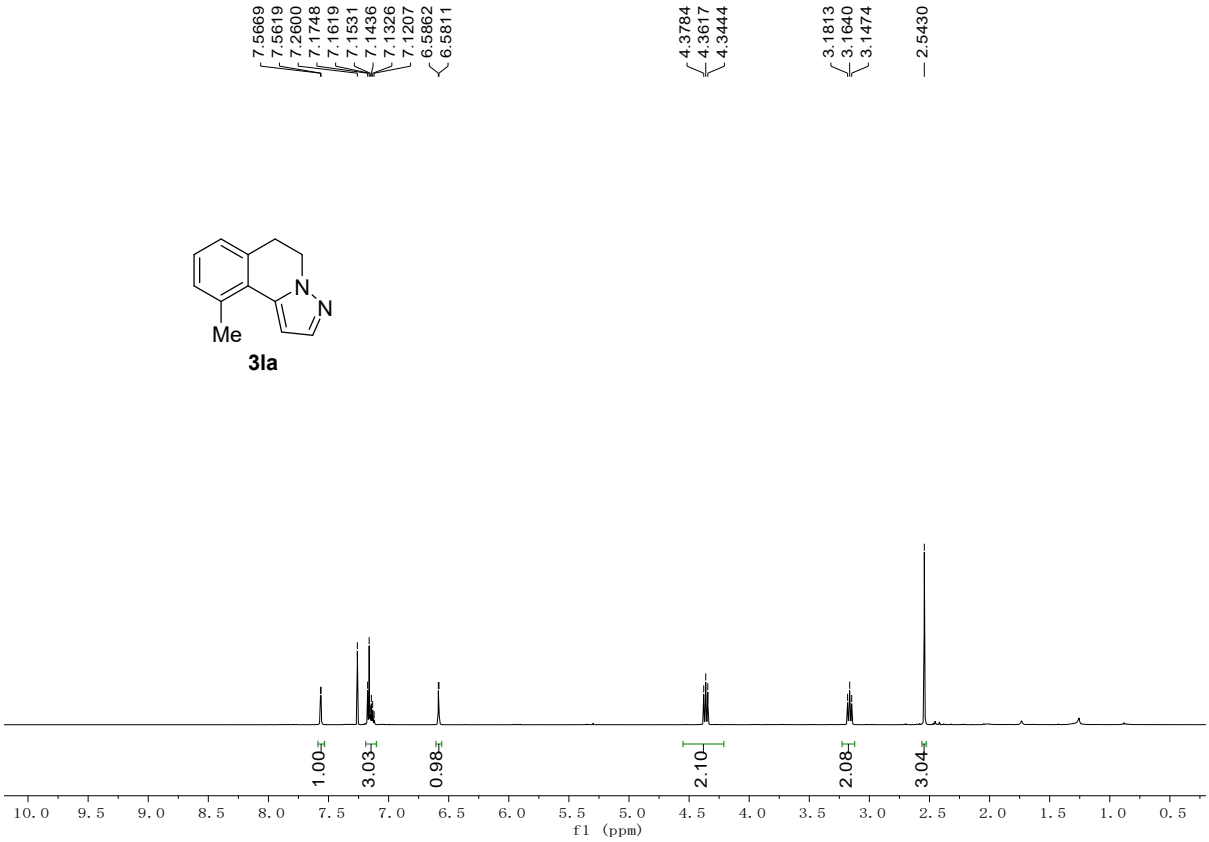

1.05
1.00
1.15
1.00
3.30
2.20
1.00
2.13
2.18
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

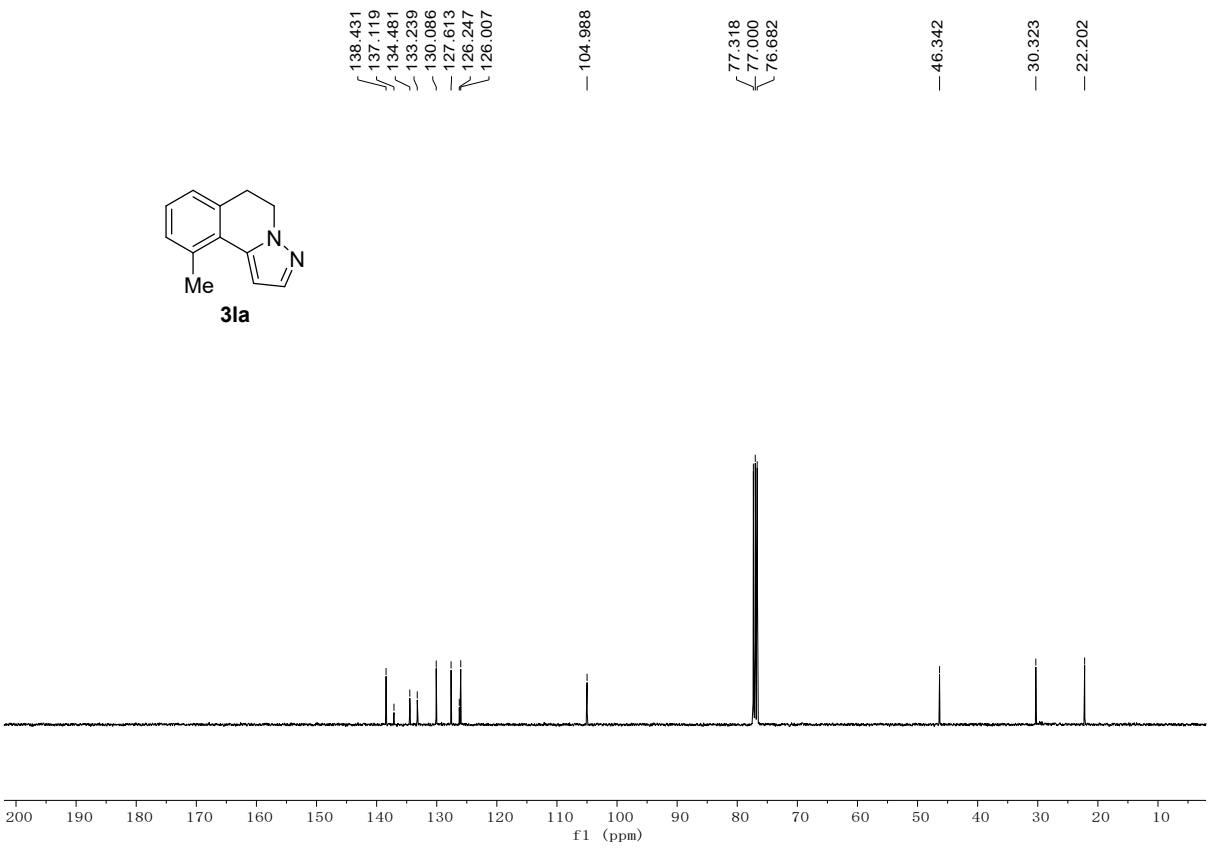

140.565
140.501
139.347
130.646
128.850
128.627
127.534
127.433
127.034
126.815
122.679
111.401
100.780
77.318
77.000
76.682
46.206
28.892

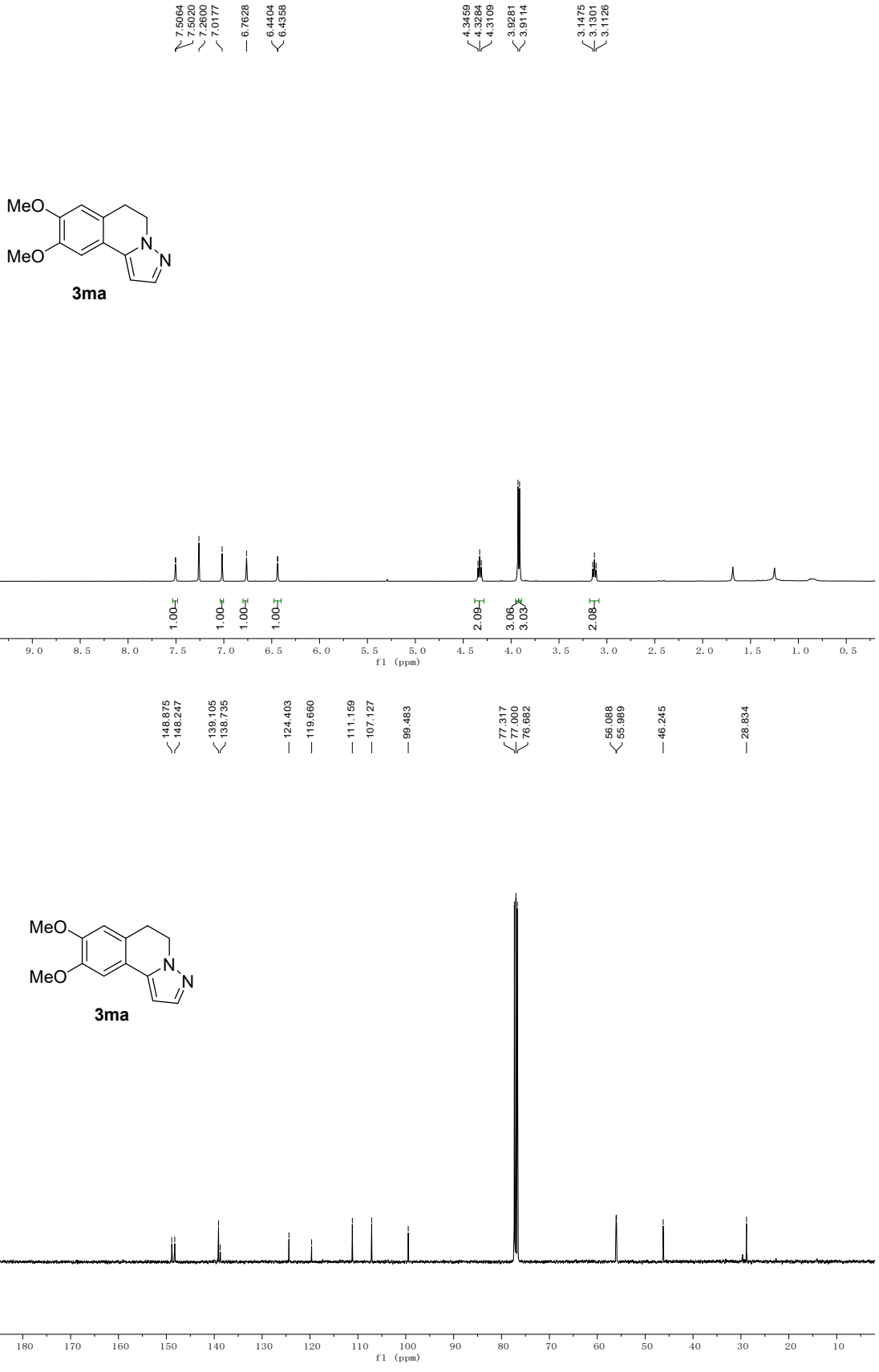

Ph
N
N

3ka

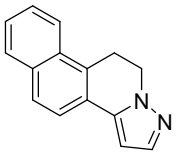
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


7.5669
7.5619
7.2600
7.1748
7.1619
7.1531
7.1436
7.1326
7.1207
6.5862
6.5811
4.3784
4.3617
4.3444
3.1813
3.1640
3.1474
2.5430
N
N
Me
3la
1.00
3.03
0.98
2.10
2.08
3.04
f1 (ppm)

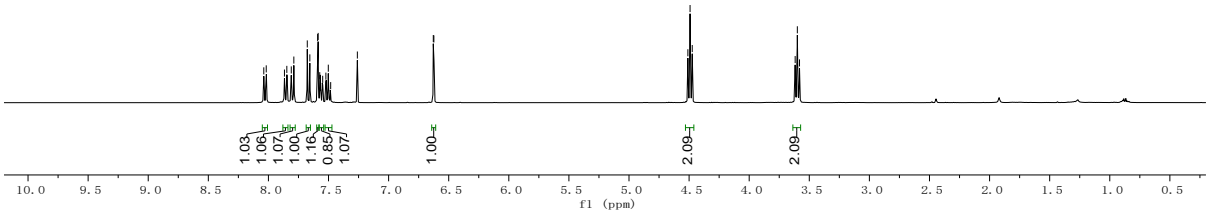

138.431
137.119
134.481
133.239
130.086
127.613
126.247
126.007
104.988
77.318
77.000
76.682
46.342
30.323
22.202
N
N
Me
3la
f1 (ppm)


7.5064
7.5020
7.2600
7.0177
6.7628
6.4404
6.4358
4.3459
4.3284
4.3109
3.9281
3.9114
3.1475
3.1301
3.1126
MeO
MeO
N
N
3ma
1.00
1.00
1.00
1.00
2.09
3.06
3.03
2.08
f1 (ppm)
148.875
148.247
139.105
138.735
124.403
119.660
111.159
107.127
99.483
77.317
77.000
76.682
56.088
55.989
46.245
28.834
MeO
MeO
N
N
3ma
f1 (ppm)

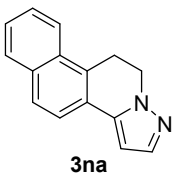

8.0386
8.0182
7.8666
7.8469
7.8098
7.7885
7.6767
7.6554
7.5907
7.5862
7.5730
7.5485
7.5219
7.5018
7.4820
7.2600
6.6283
6.6235
4.5101
4.4920
4.4739
3.6176
3.5995
3.5814



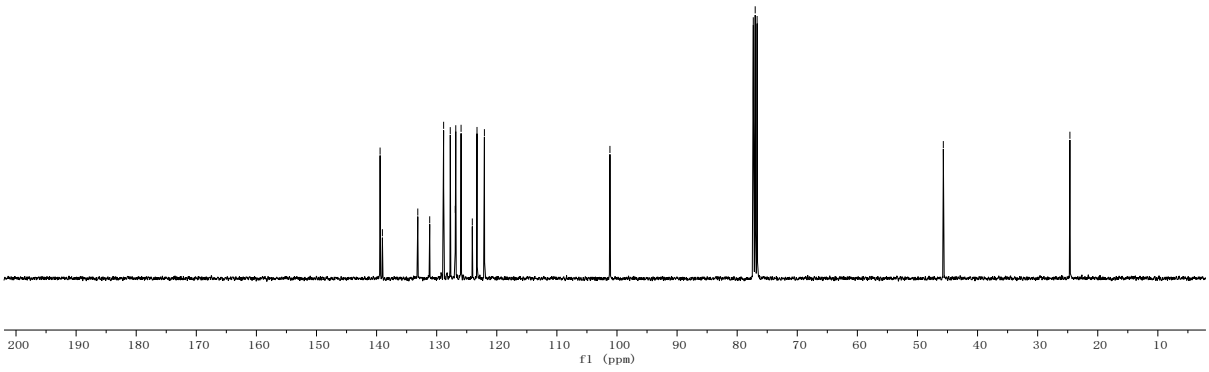
3na

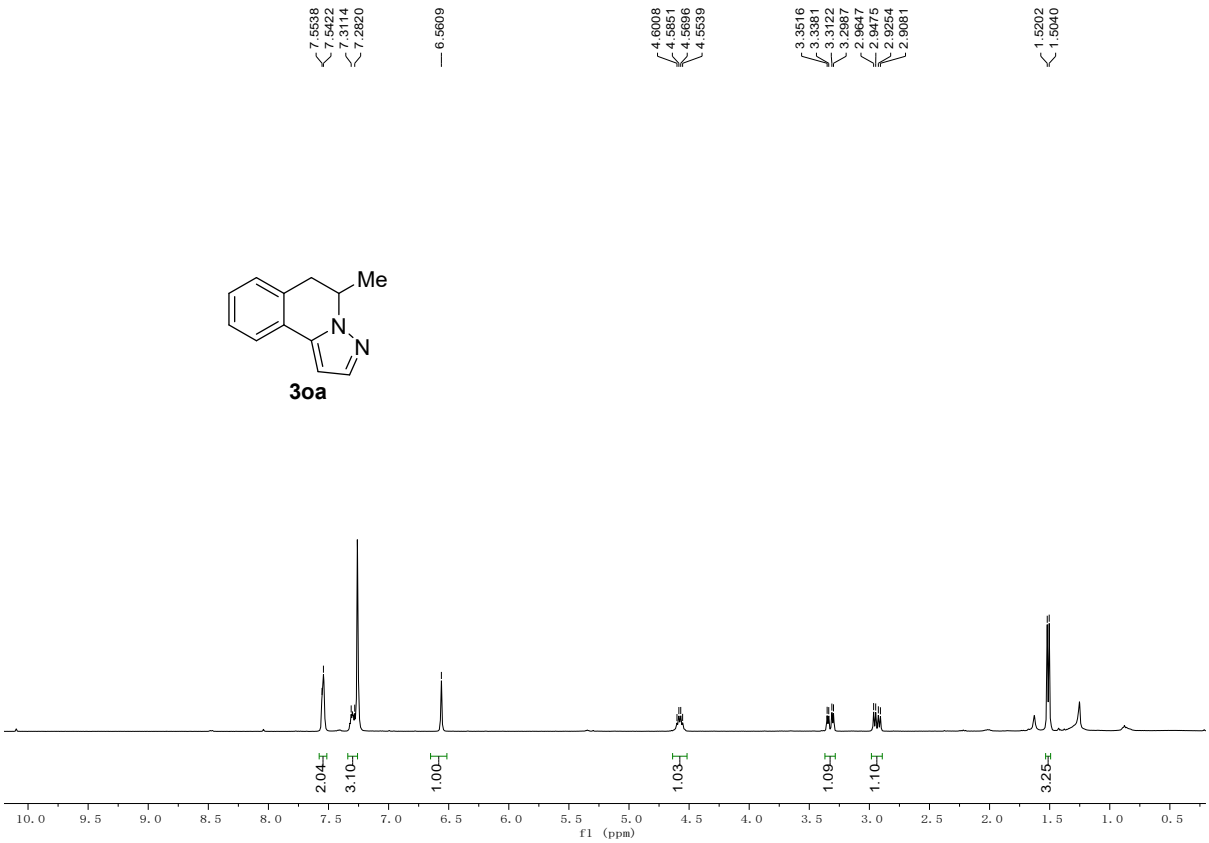

1.03
1.06
1.07
1.00
1.16
0.85
1.07
1.00
2.09
2.09
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

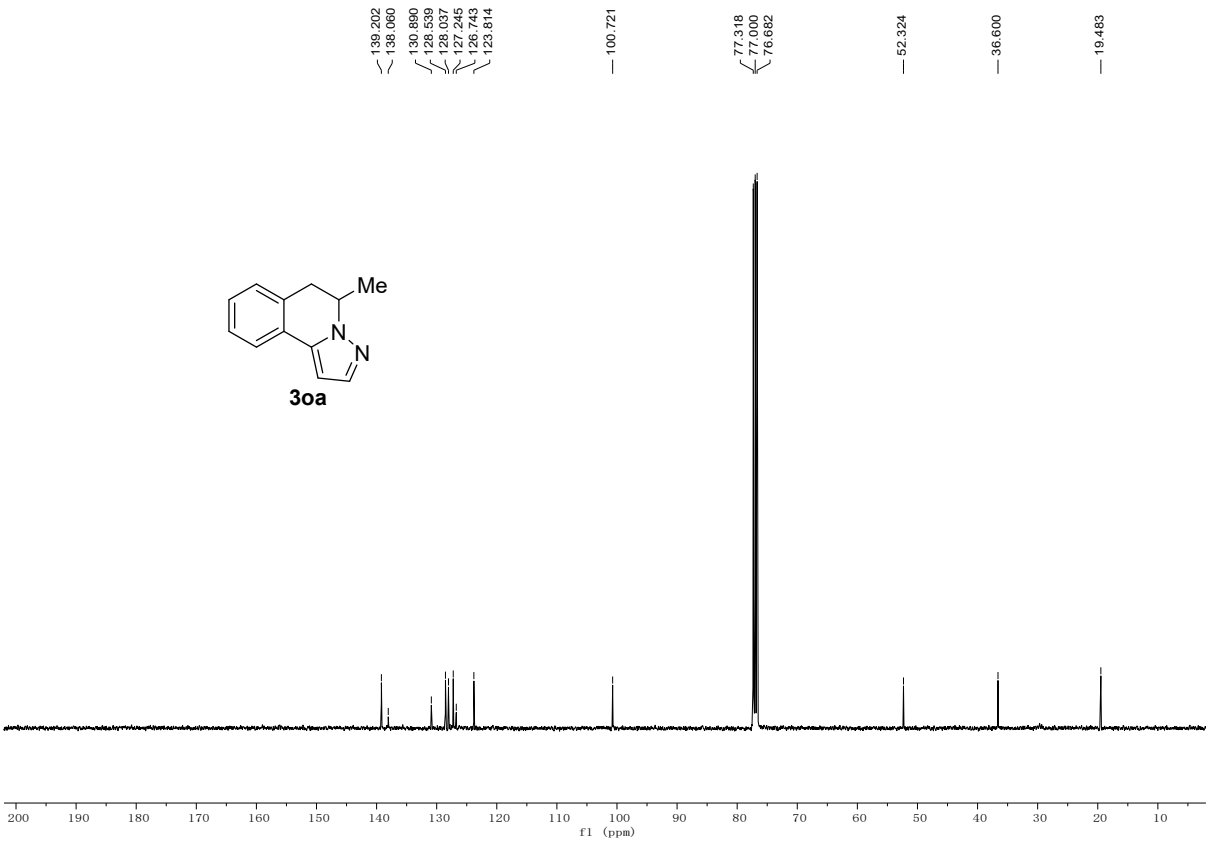

139.419
139.034
133.145
131.162
128.847
127.742
126.906
126.826
125.943
124.073
123.292
122.059
101.172
77.318
77.000
76.682
45.696
24.634

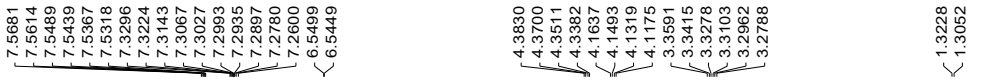


3na


200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


7.5538
7.5422
7.3114
7.2820
6.5609
4.6008
4.5851
4.5696
4.5539
3.3516
3.3381
3.3122
3.2987
2.9647
2.9475
2.9254
2.9081
1.5202
1.5040
Me
N
N
3oa
2.04
3.10
1.00
1.03
1.09
1.10
3.25
f1 (ppm)


139.202
138.060
130.890
128.539
128.037
127.245
126.743
123.814
100.721
77.318
77.000
76.682
52.324
36.600
19.483
Me
N
N
3oa
f1 (ppm)


7.5681
7.5614
7.5489
7.5439
7.5367
7.5318
7.3296
7.3224
7.3143
7.3067
7.3027
7.2993
7.2935
7.2897
7.2780
7.2600
6.5499
6.5449
4.3830
4.3700
4.3511
4.3382
4.1637
4.1493
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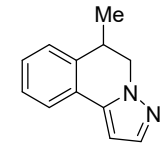
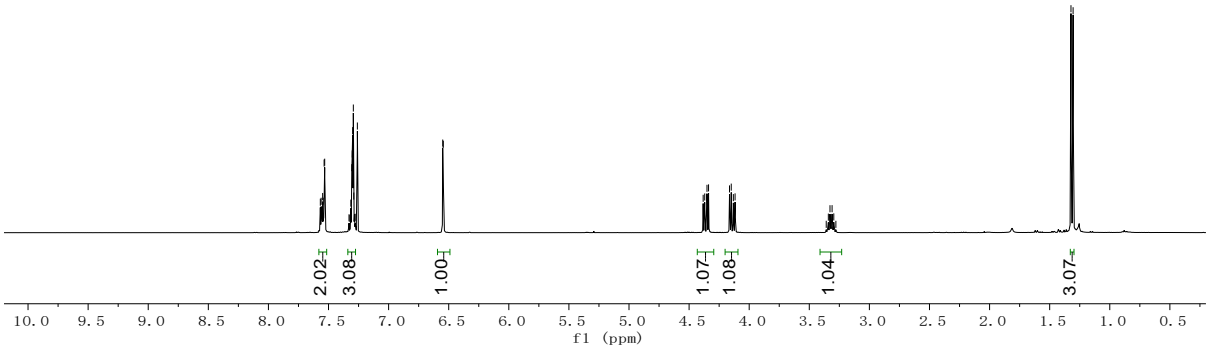
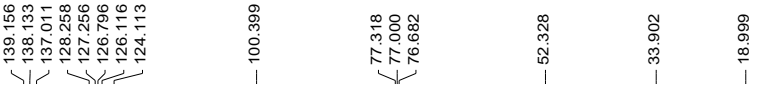
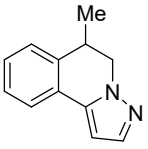
3.3103
3.2962
3.2788
1.3228
1.3052


Me
N
N

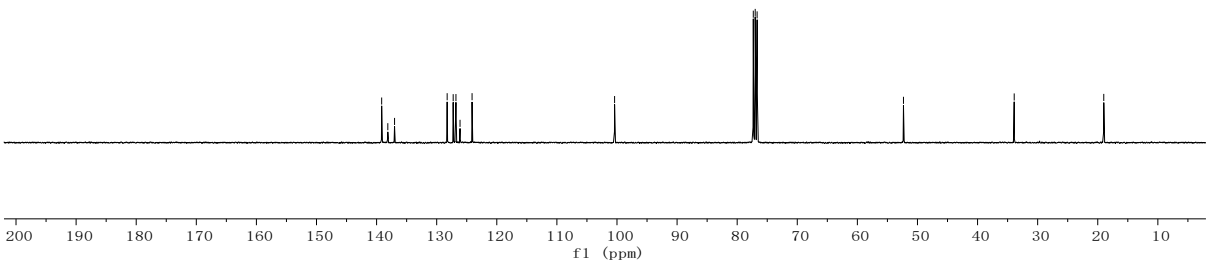
3pa

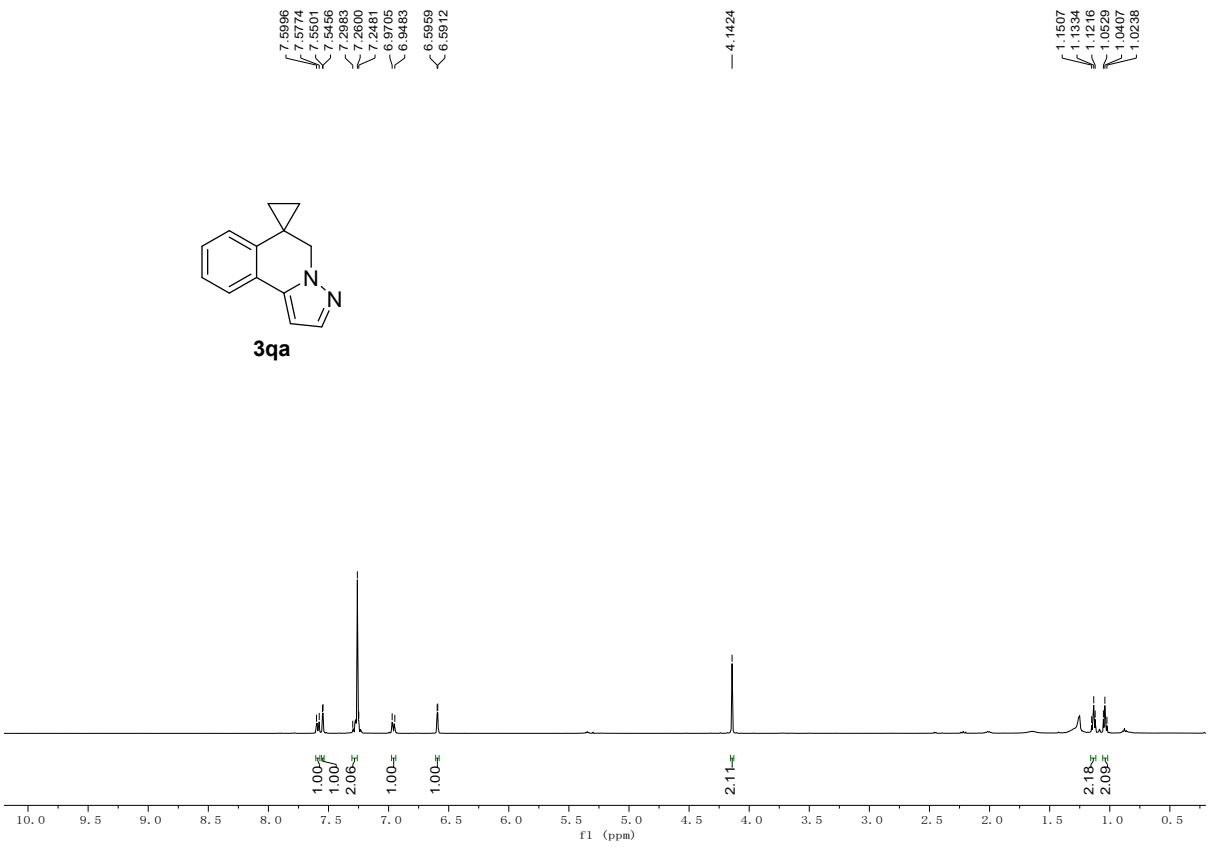

2.02
3.08
1.00
1.07
1.08
1.04
3.07
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

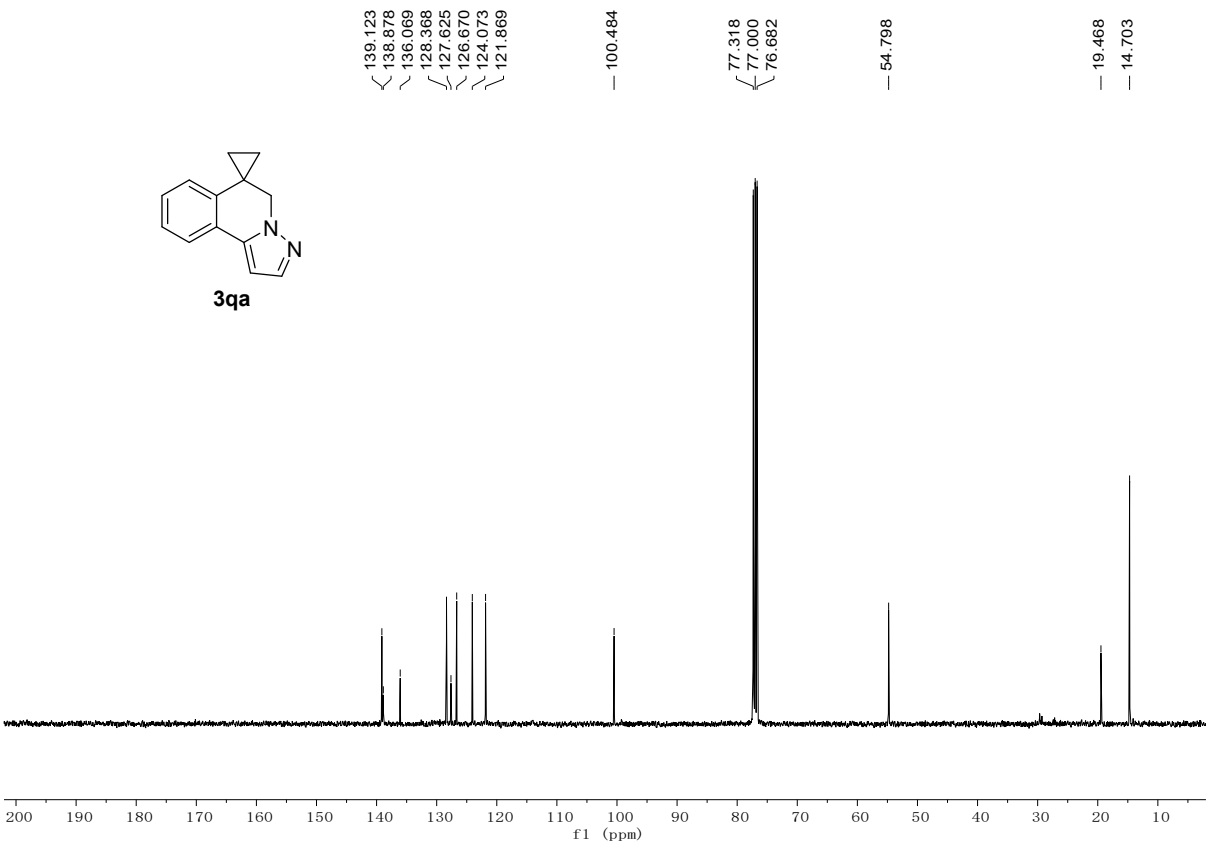

139.156
138.133
137.011
128.258
127.256
126.796
126.116
124.113
100.399
77.318
77.000
76.682
52.328
33.902
18.999

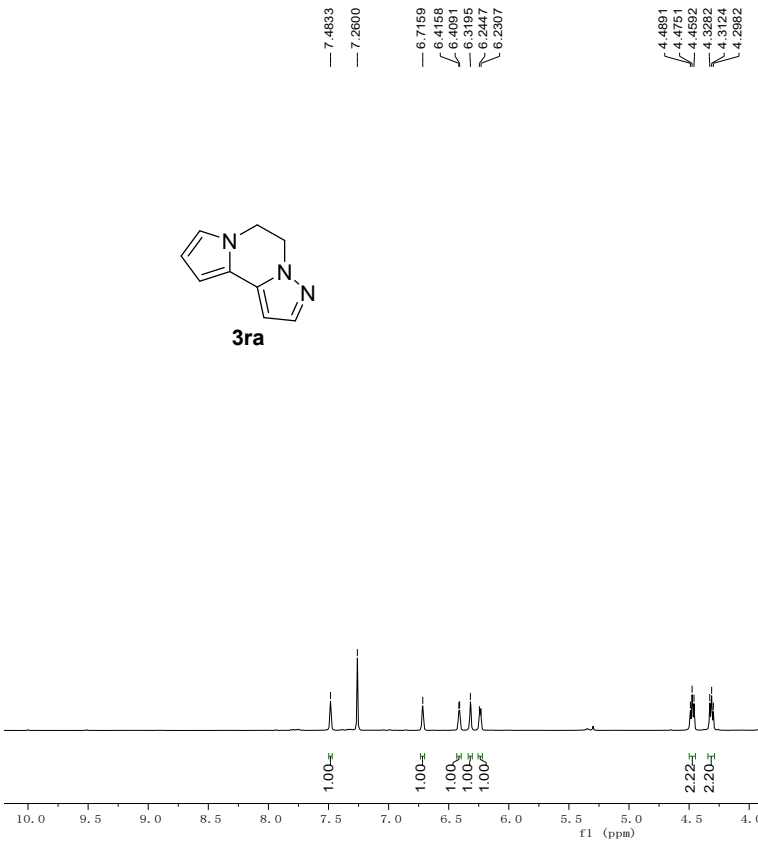

Me
N
N

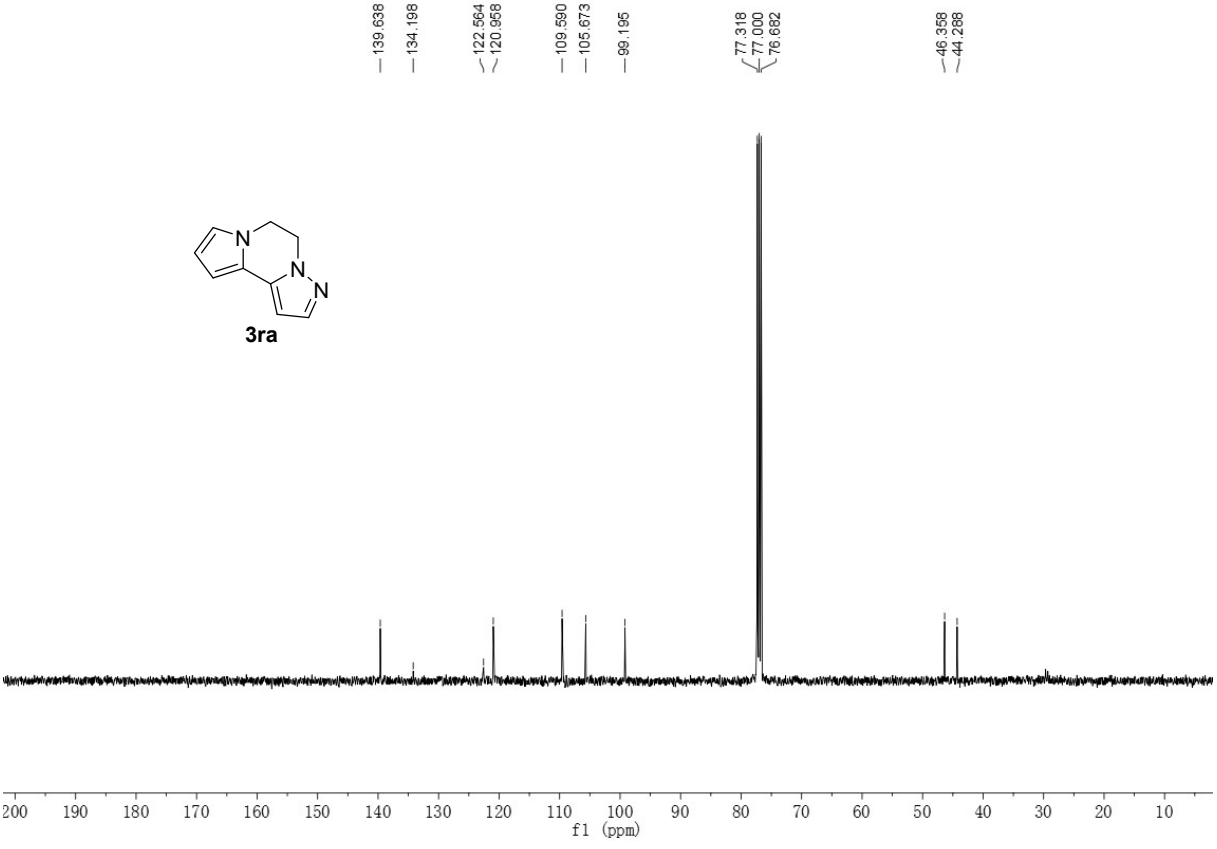
3pa


200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

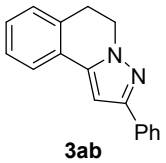

7.5996
7.5774
7.5501
7.5456
7.2983
7.2600
7.2481
6.9705
6.9483
6.5959
6.5912
4.1424
1.1507
1.1334
1.1216
1.0529
1.0407
1.0238
3qa
1.00
1.00
2.06
1.00
1.00
2.11
2.18
2.09
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


139.123
138.878
136.069
128.368
127.625
126.670
124.073
121.869
100.484
77.318
77.000
76.682
54.798
19.468
14.703
3qa
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

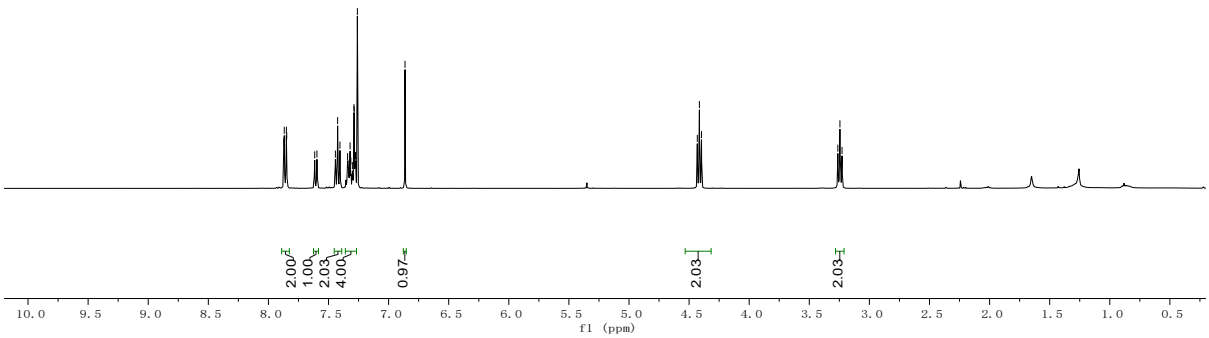

7.4833
7.2600
6.7159
6.4158
6.4091
6.3195
6.2447
6.2307
4.4891
4.4751
4.4592
4.3282
4.3124
4.2982
3ra
1.00
1.00
1.00
1.00
1.00
2.22
2.20
f1 (ppm)

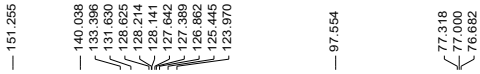

139.638
134.198
122.564
120.958
109.590
105.673
99.195
77.318
77.000
76.682
46.358
44.288
3ra
f1 (ppm)

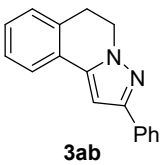

7.8717
7.8682
7.8506
7.8479
7.6149
7.5962
7.4427
7.4243
7.4049
7.3414
7.3205
7.3142
7.3017
7.2883
7.2864
7.2792
7.2750
7.2718
7.2600
6.8635
4.4317
4.4144
4.3970
3.2623
3.2451
3.2276


N
N
Ph

3ab

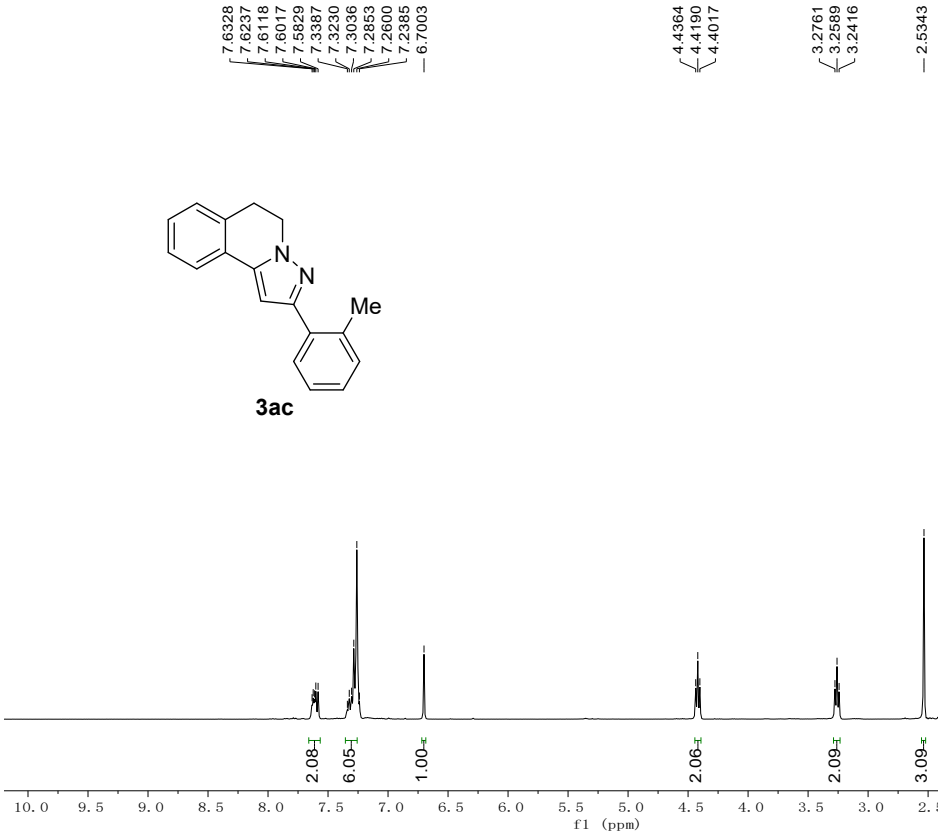

2.00
1.00
2.03
4.00
0.97
2.03
2.03
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

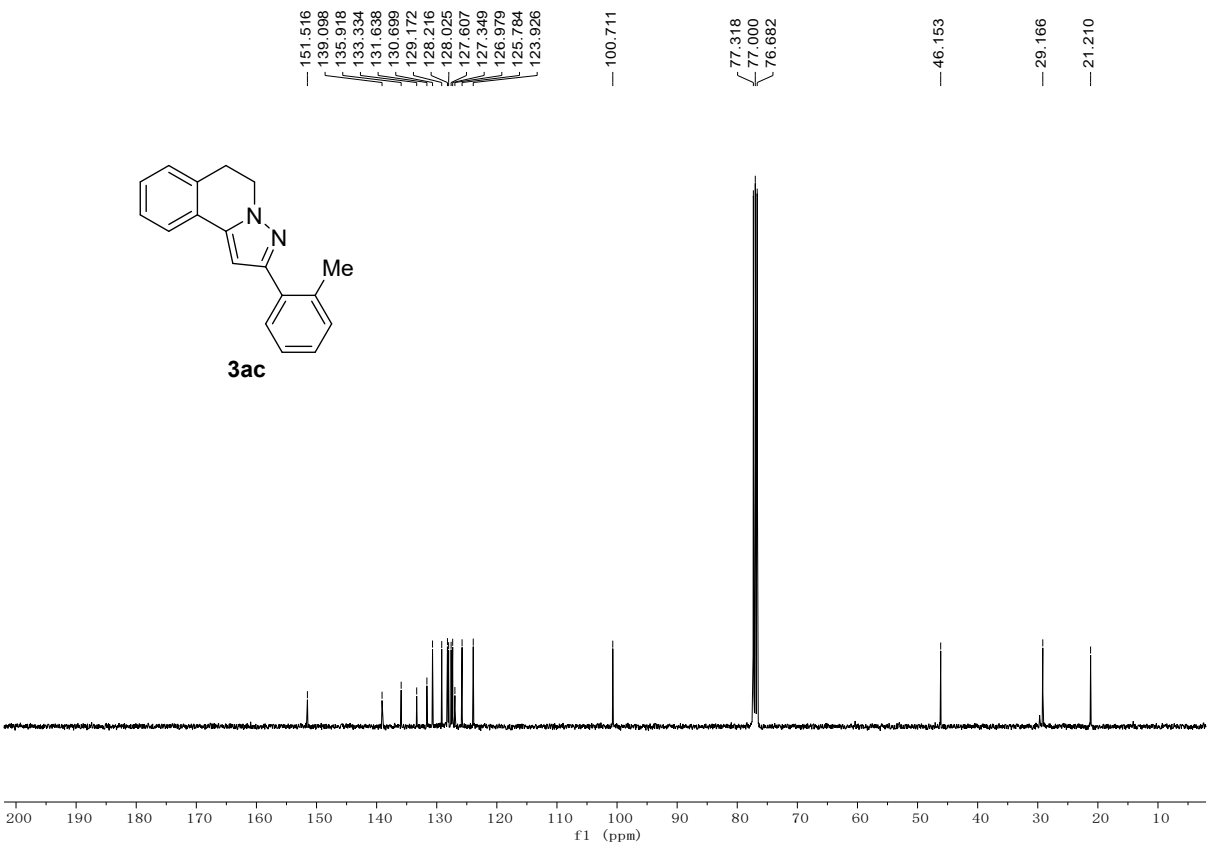

151.255
140.038
133.396
131.630
128.625
128.214
128.141
127.642
127.389
126.862
125.445
123.970
97.554
77.318
77.000
76.682
46.236
29.146

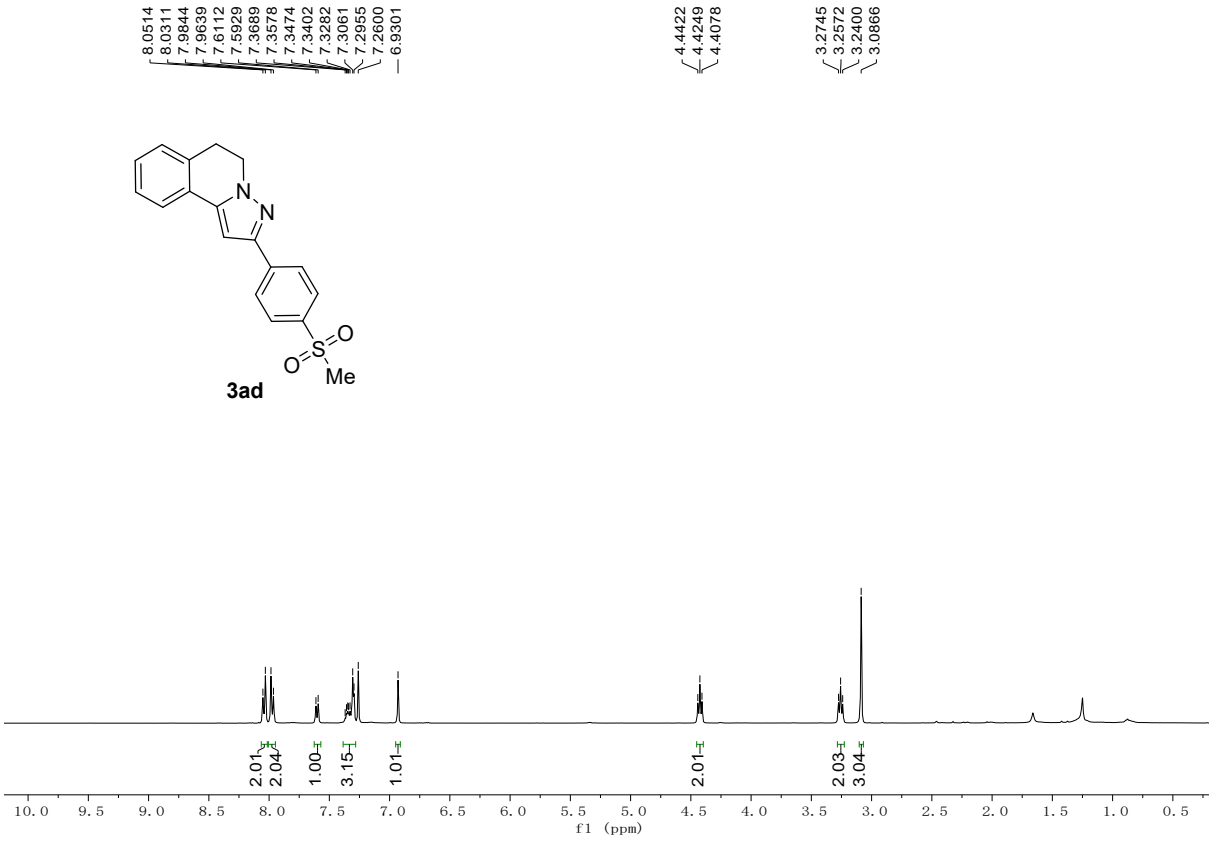

N
N
Ph

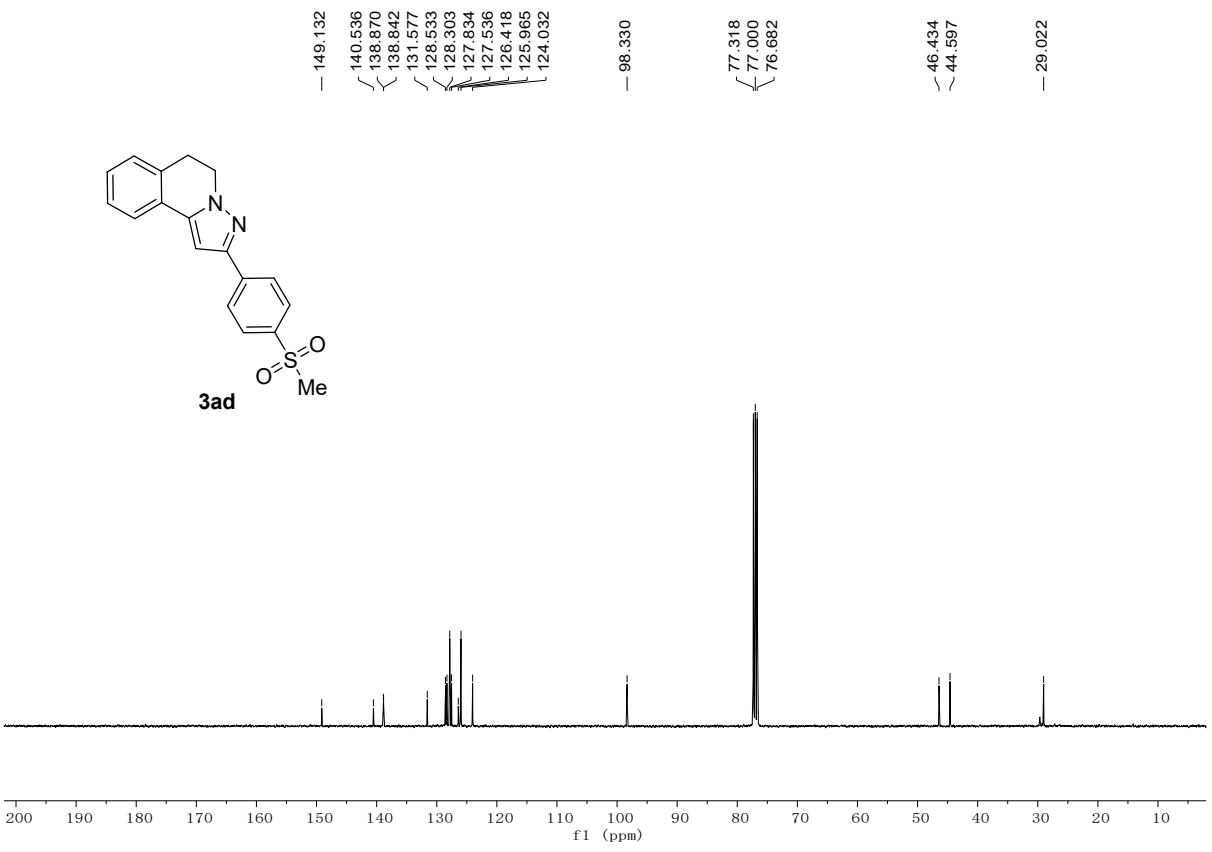
3ab

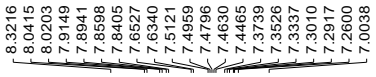
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

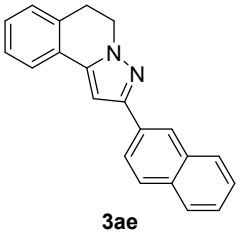

7.6328
7.6237
7.6118
7.6017
7.5829
7.3387
7.3230
7.3036
7.2853
7.2600
7.2385
6.7003
4.4364
4.4190
4.4017
3.2761
3.2589
3.2416
2.5343
N
N
Me
3ac
2.08
6.05
1.00
2.06
2.09
3.09
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


151.516
139.098
135.918
133.334
131.638
130.699
129.172
128.216
128.025
127.607
127.349
126.979
125.784
123.926
100.711
77.318
77.000
76.682
46.153
29.166
21.210
N
N
Me
3ac
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

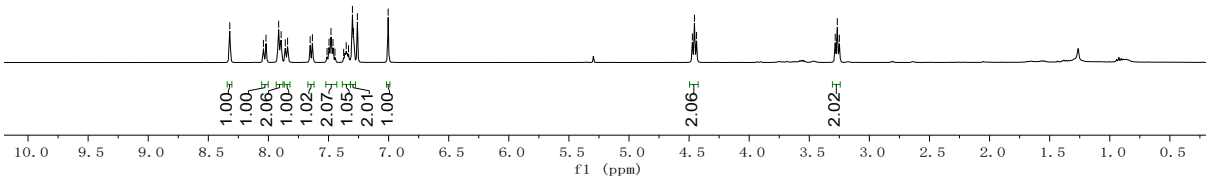

8.0514
8.0311
7.9844
7.9639
7.6112
7.5929
7.3689
7.3578
7.3474
7.3402
7.3282
7.3061
7.2955
7.2600
6.9301
4.4422
4.4249
4.4078
3.2745
3.2572
3.2400
3.0866
N
N
O
S
O
Me
3ad
2.01
2.04
1.00
3.15
1.01
2.01
2.03
3.04
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


149.132
140.536
138.870
138.842
131.577
128.533
128.303
127.834
127.536
126.418
125.965
124.032
98.330
77.318
77.000
76.682
46.434
44.597
29.022
N
N
O
S
O
Me
3ad
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

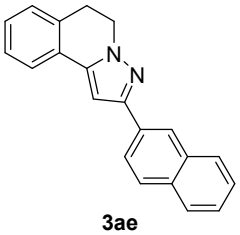

8.3216
8.0415
8.0203
7.9149
7.8941
7.8598
7.8405
7.6527
7.6340
7.5121
7.4959
7.4796
7.4630
7.4465
7.3739
7.3526
7.3337
7.3010
7.2917
7.2600
7.0038
4.4726
4.4554
4.4381
3.2842
3.2669
3.2497



3ae

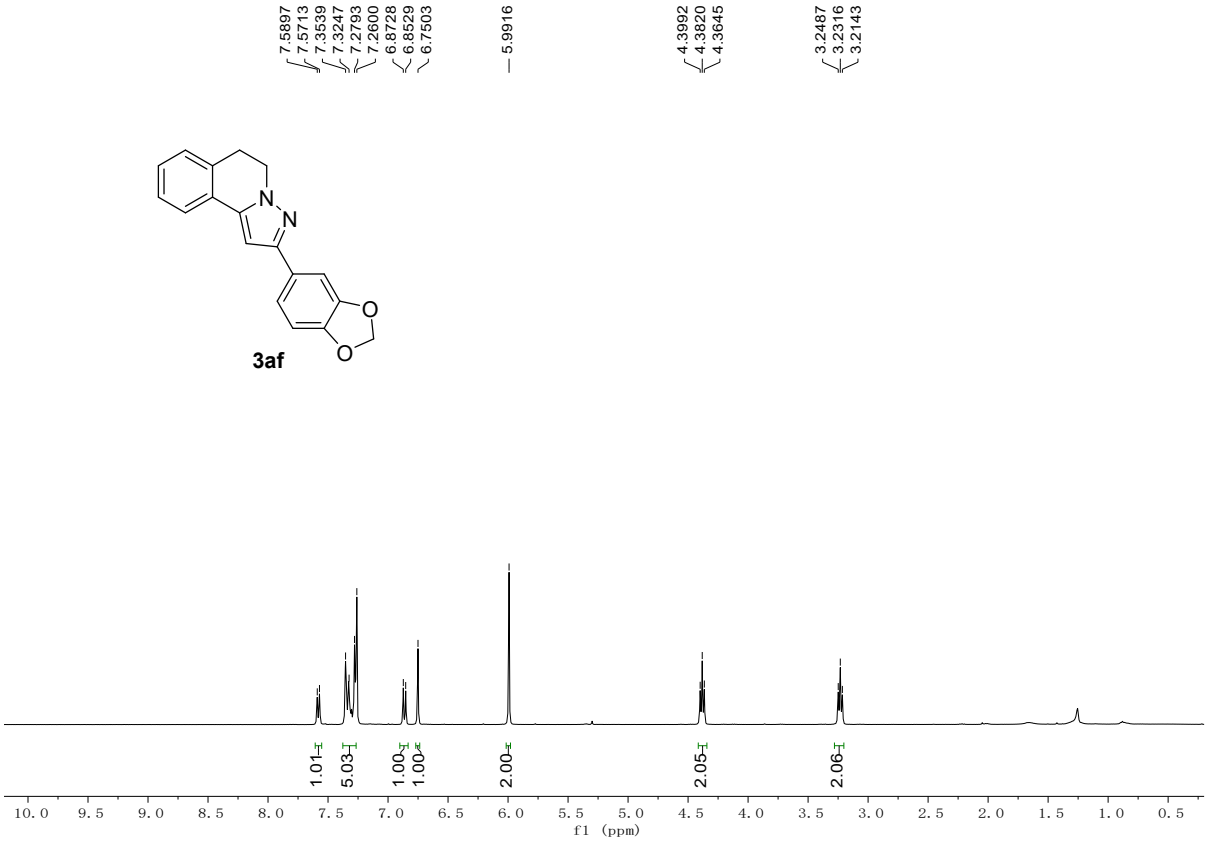

1.00
1.00
2.06
1.00
1.02
2.07
1.05
2.01
1.00
2.06
2.02
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

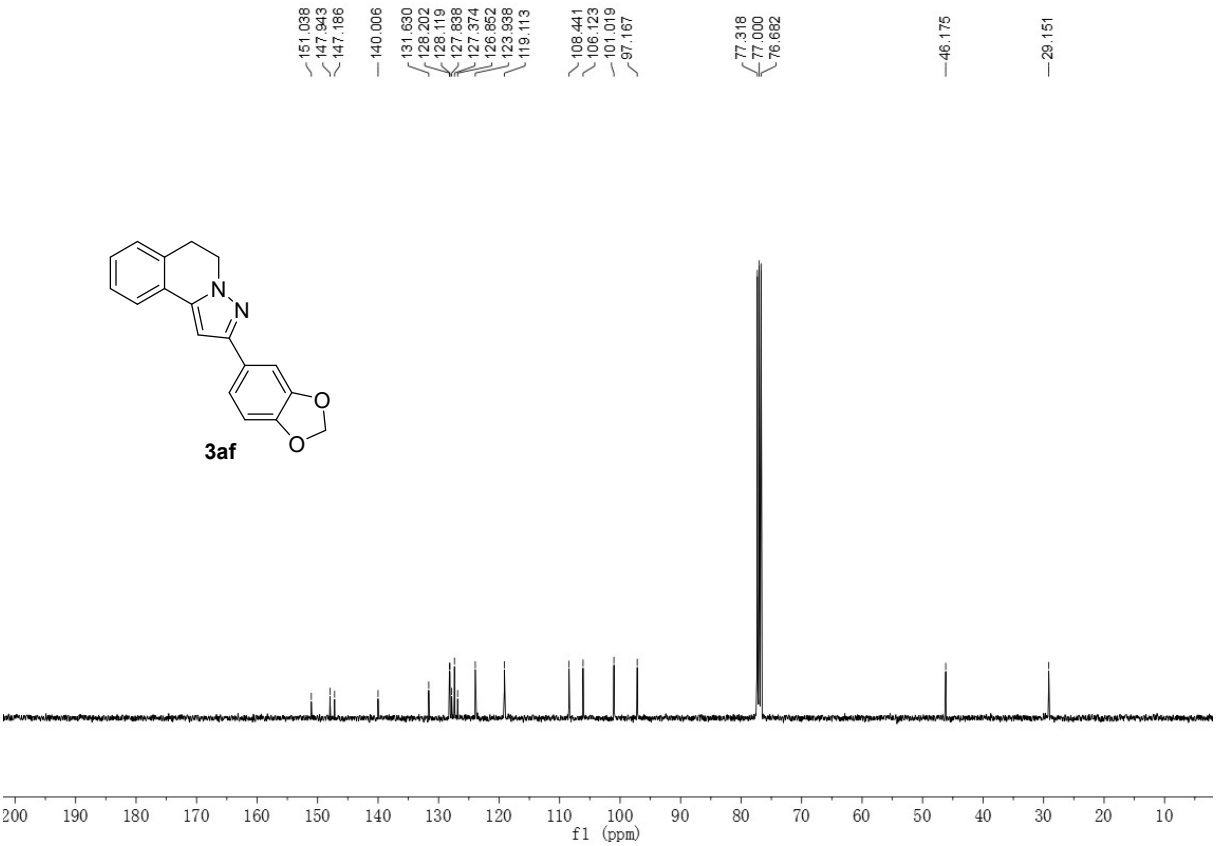

151.215
140.191
133.607
133.002
131.643
130.815
128.264
128.236
128.192
128.163
127.697
127.424
126.846
126.161
125.734
123.998
123.926
123.890
97.842
77.318
77.000
76.682
46.313
29.157



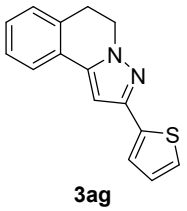
3ae

200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

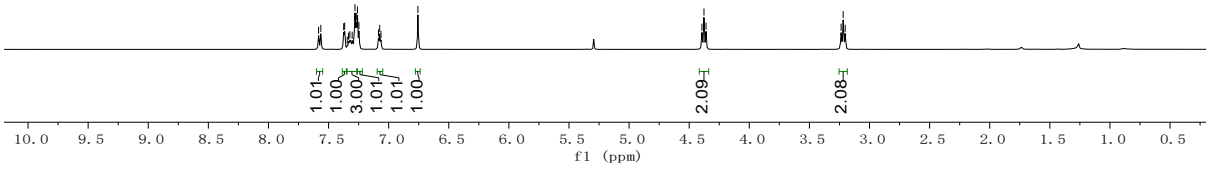

7.5897
7.5713
7.3539
7.3247
7.2793
7.2600
6.8728
6.8529
6.7503
5.9916
4.3992
4.3820
4.3645
3.2487
3.2316
3.2143
3af
1.01
5.03
1.00
1.00
2.00
2.05
2.06
f1 (ppm)


151.038
147.943
147.186
140.006
131.630
128.202
128.119
127.838
127.374
126.852
123.938
119.113
108.441
106.123
101.019
97.167
77.318
77.000
76.682
46.175
29.151
3af
f1 (ppm)

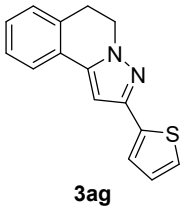

7.5828
7.5644
7.3743
7.3662
7.3445
7.3337
7.3230
7.3036
7.2803
7.2694
7.2600
7.2476
7.0848
7.0743
7.0641
6.7569
4.3944
4.3770
4.3599
3.2364
3.2191
3.2019


N
N
S

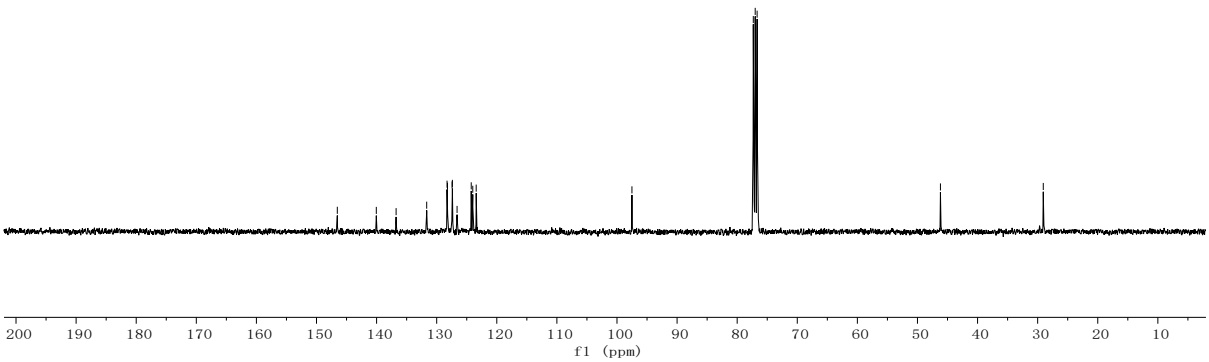
3ag

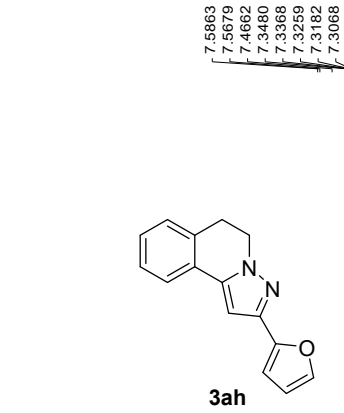

1.01
1.00
3.00
1.01
1.01
1.00
2.09
2.08
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

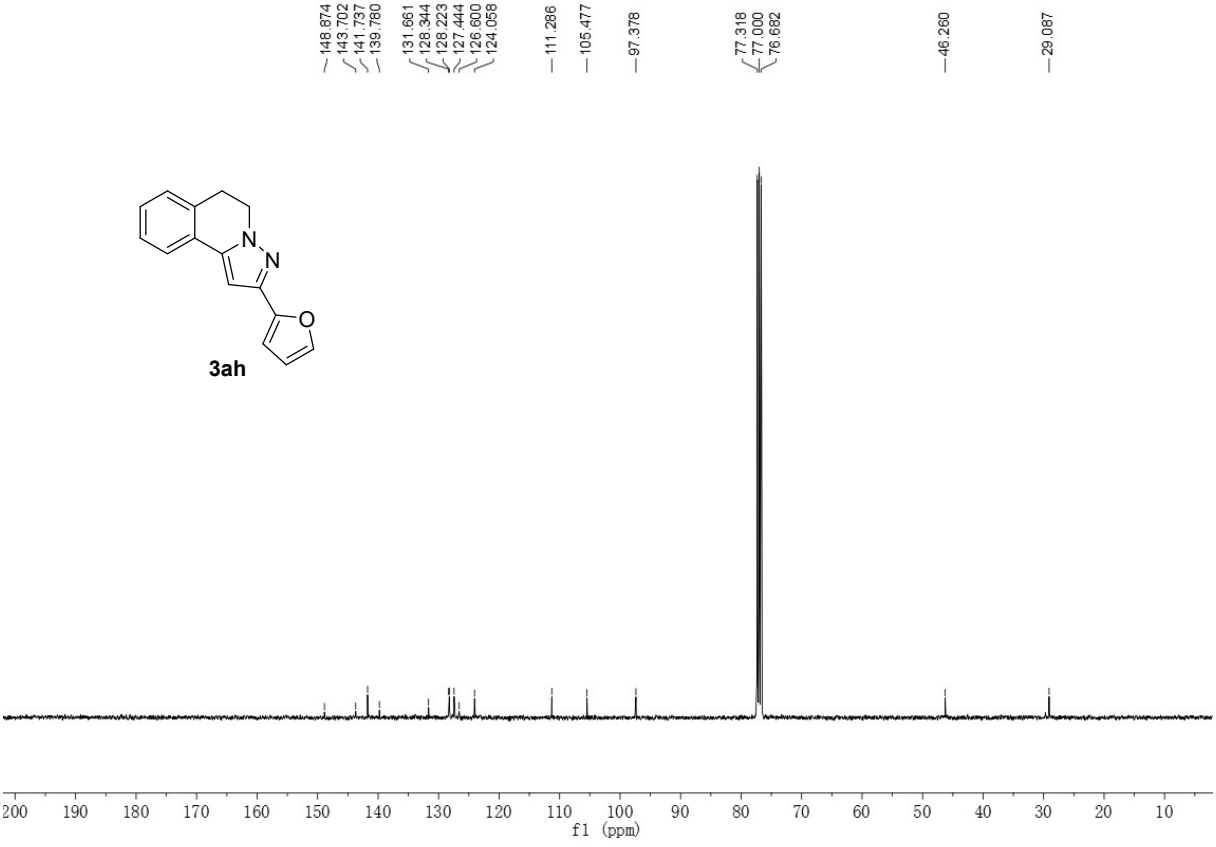

146.538
140.049
136.753
131.663
128.277
128.203
127.442
127.387
126.610
124.253
123.997
123.426
97.510
77.318
77.000
76.682
46.178
29.066


N
N
S

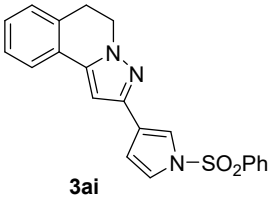
3ag


200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

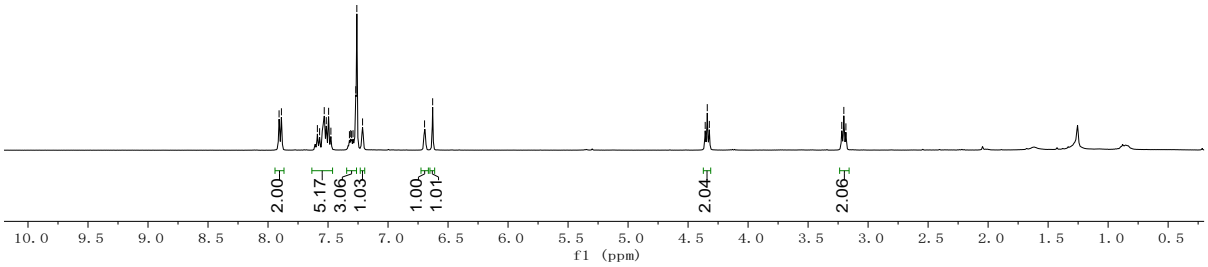

7.5863
7.5679
7.4662
7.3480
7.3368
7.3259
7.3182
7.3068
7.2856
7.2745
7.2600
6.7728
6.6950
6.6876
6.4808
4.4110
4.3937
4.3764
3.2486
3.2314
3.2141
3ah
1.12
1.00
3.05
1.00
1.00
1.00
2.05
2.14
f1 (ppm)


148.874
143.702
141.737
139.780
131.661
128.344
128.223
127.444
126.600
124.058
111.286
105.477
97.378
77.318
77.000
76.682
46.260
29.087
3ah
f1 (ppm)

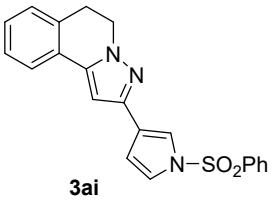

7.9079
7.8884
7.5887
7.5702
7.5315
7.5146
7.4951
7.4762
7.3216
7.3108
7.3031
7.2915
7.2685
7.2600
7.2123
6.6957
6.6282
4.3573
4.3400
4.3227
3.2193
3.2022
3.1849


N
N
N−SO2Ph

3ai

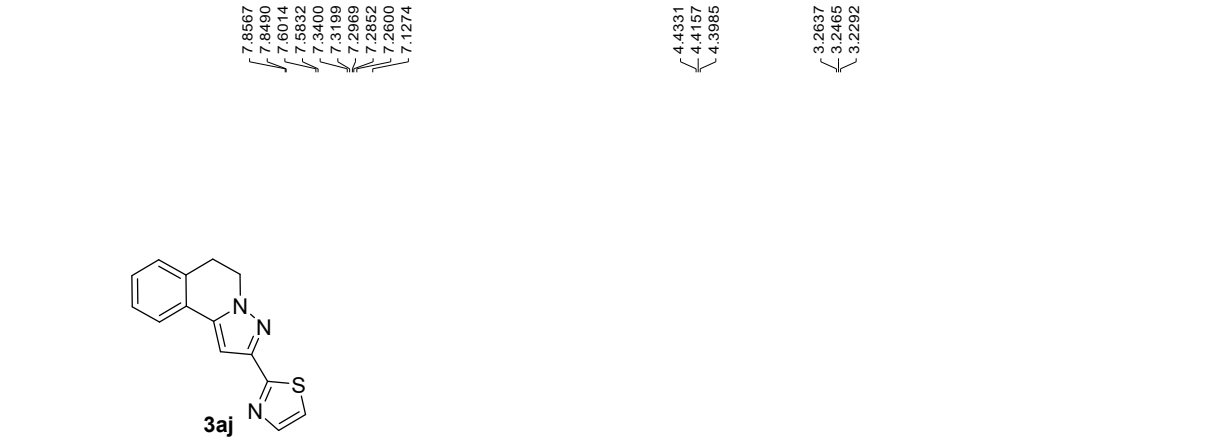

2.00
5.17
3.06
1.03
1.00
1.01
2.04
2.06
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

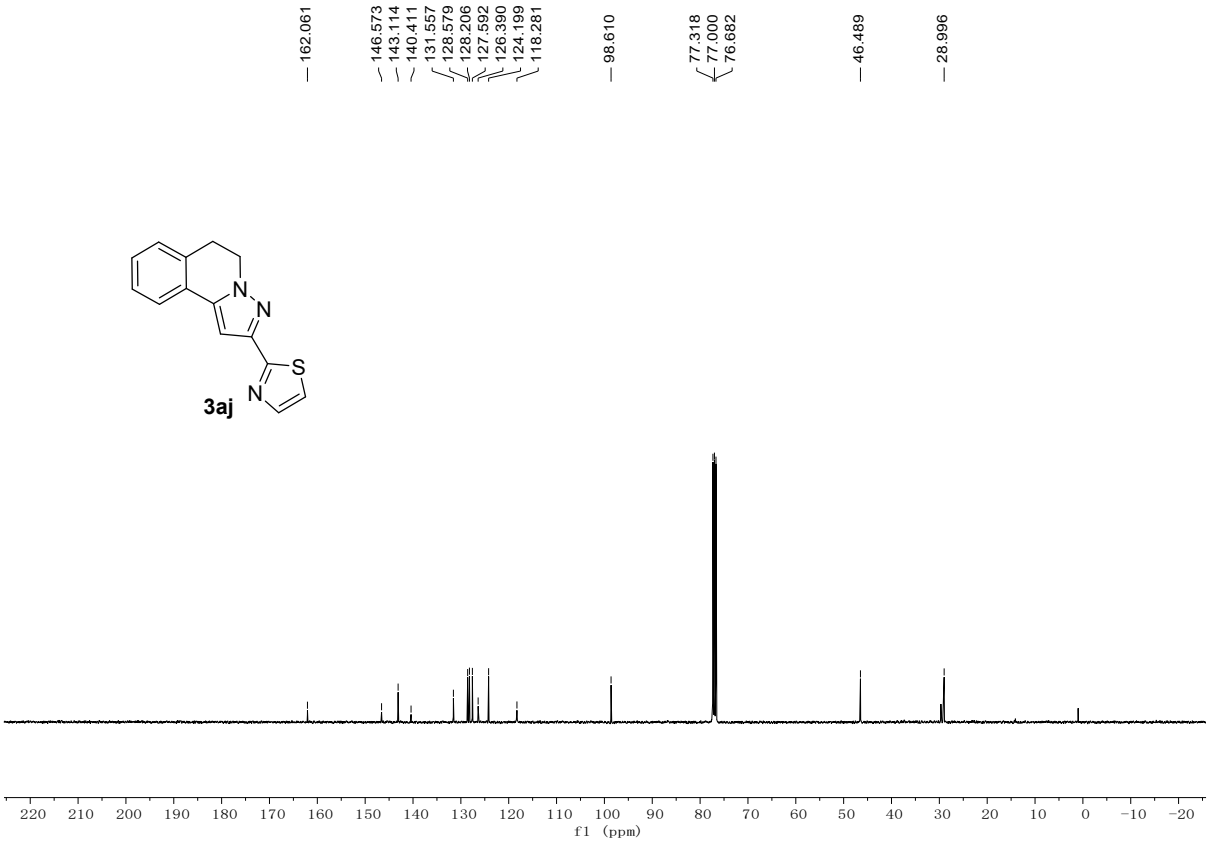

145.503
139.860
138.879
133.864
131.612
129.384
128.230
128.211
127.407
126.855
126.664
123.962
123.051
121.499
116.724
112.360
97.777
77.318
77.000
76.682
46.136
29.104

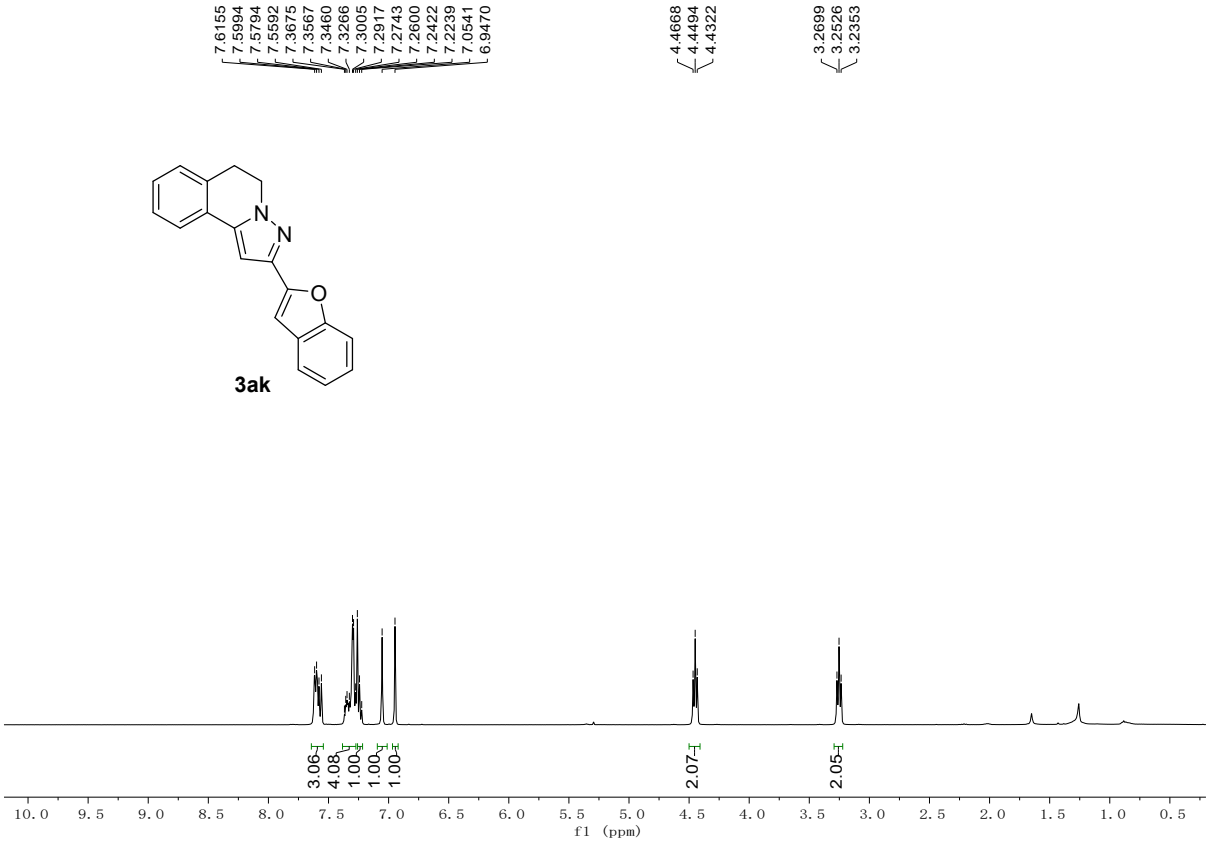

N
N
N−SO2Ph

3ai

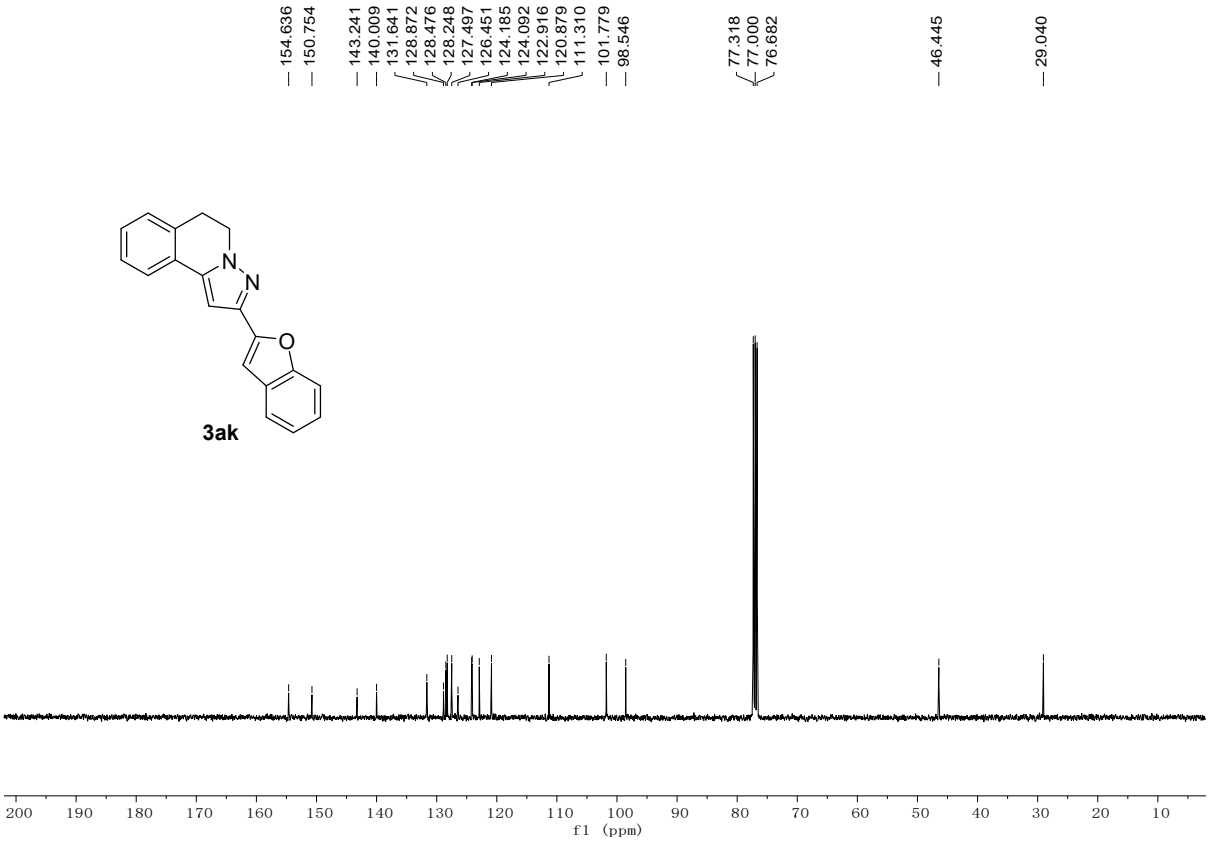
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


7.8567
7.8490
7.6014
7.5832
7.3400
7.3199
7.2969
7.2852
7.2600
7.1274
4.4331
4.4157
4.3985
3.2637
3.2465
3.2292
N
N
S
N
3aj
1.00
1.09
4.08
1.00
2.06
2.07
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
f1 (ppm)

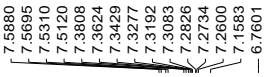

162.061
146.573
143.114
140.411
131.557
128.579
128.206
127.592
126.390
124.199
118.281
98.610
77.318
77.000
76.682
46.489
28.996
N
N
S
N
3aj
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10 −20
f1 (ppm)

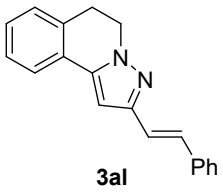

7.6155
7.5994
7.5794
7.5592
7.3675
7.3567
7.3460
7.3266
7.3005
7.2917
7.2743
7.2600
7.2422
7.2239
7.0541
6.9470
4.4668
4.4494
4.4322
3.2699
3.2526
3.2353
3.06
4.08
1.00
1.00
1.00
2.07
2.05
f1 (ppm)

3ak

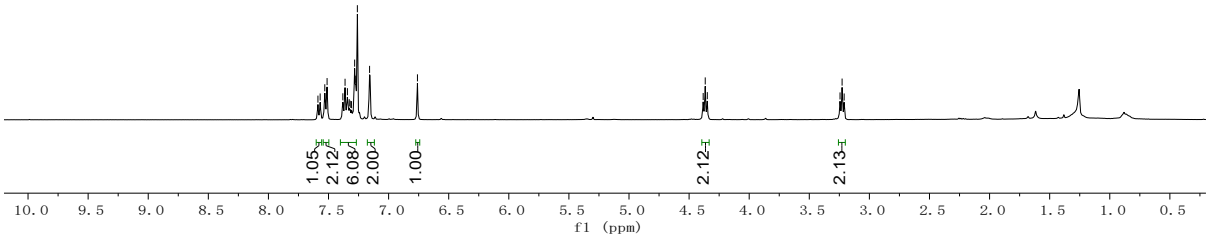

154.636
150.754
143.241
140.009
131.641
128.872
128.476
128.248
127.497
126.451
124.185
124.092
122.916
120.879
111.310
101.779
98.546
77.318
77.000
76.682
46.445
29.040
f1 (ppm)

3ak

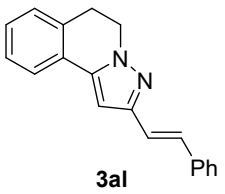

7.5880
7.5695
7.5310
7.5120
7.3808
7.3624
7.3429
7.3277
7.3192
7.3083
7.2826
7.2734
7.2600
7.1583
6.7601
4.3829
4.3657
4.3486
3.2442
3.2271
3.2100


N
N
Ph

3al

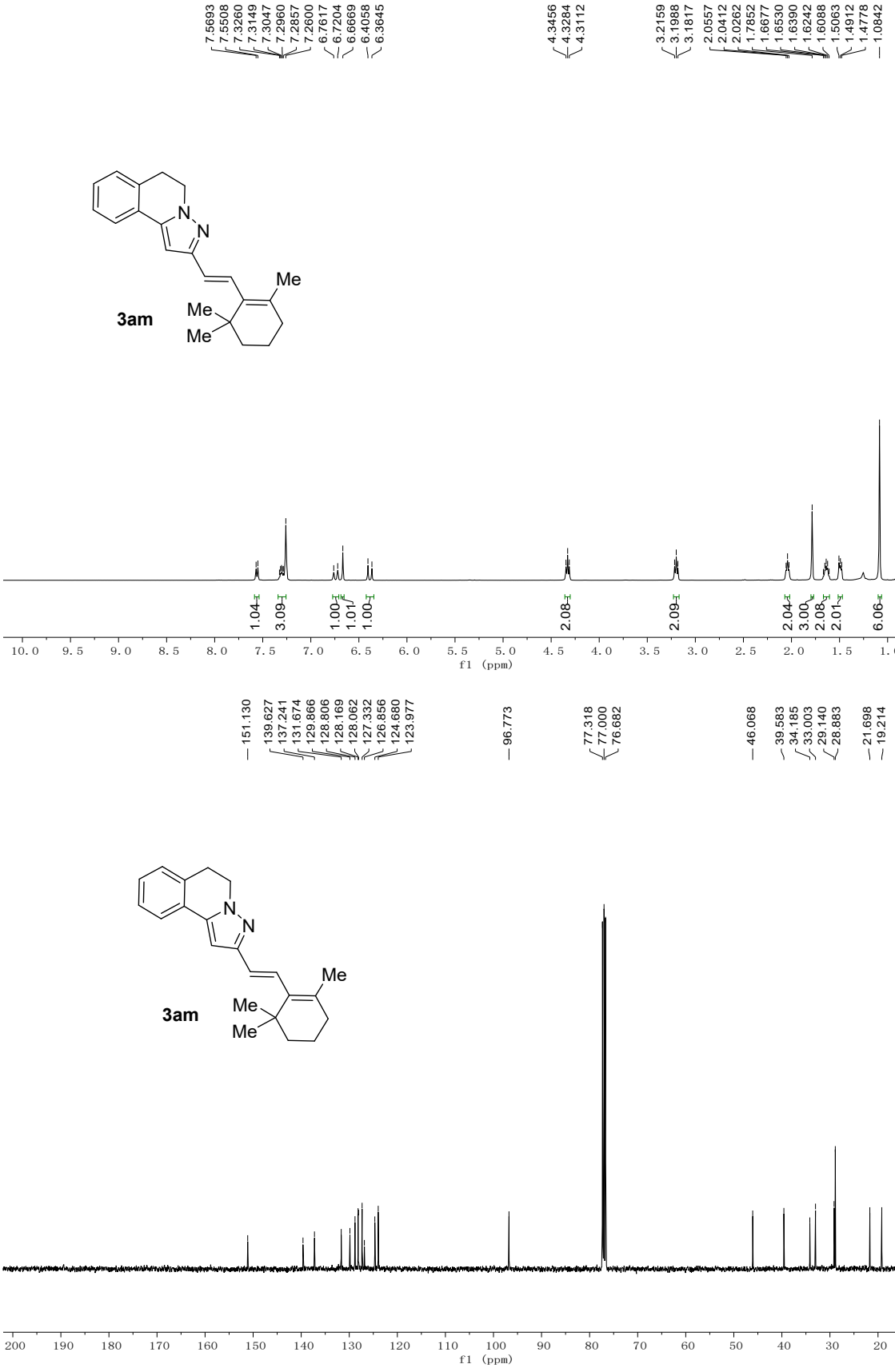

1.05
2.12
6.08
2.00
1.00
2.12
2.13
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

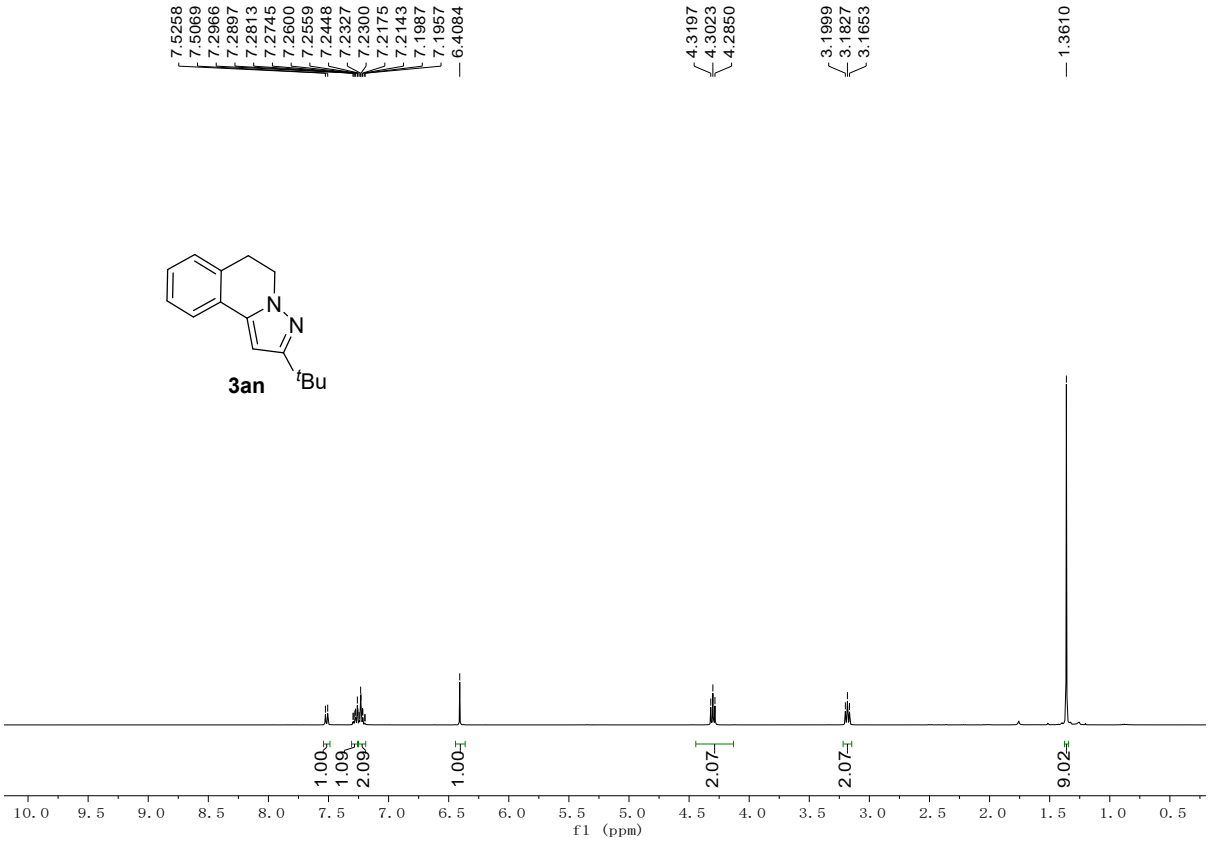

150.366
139.800
137.195
131.665
129.578
128.653
128.218
127.558
127.406
126.738
126.391
124.004
120.630
97.638
77.318
77.000
76.682
46.182
29.091

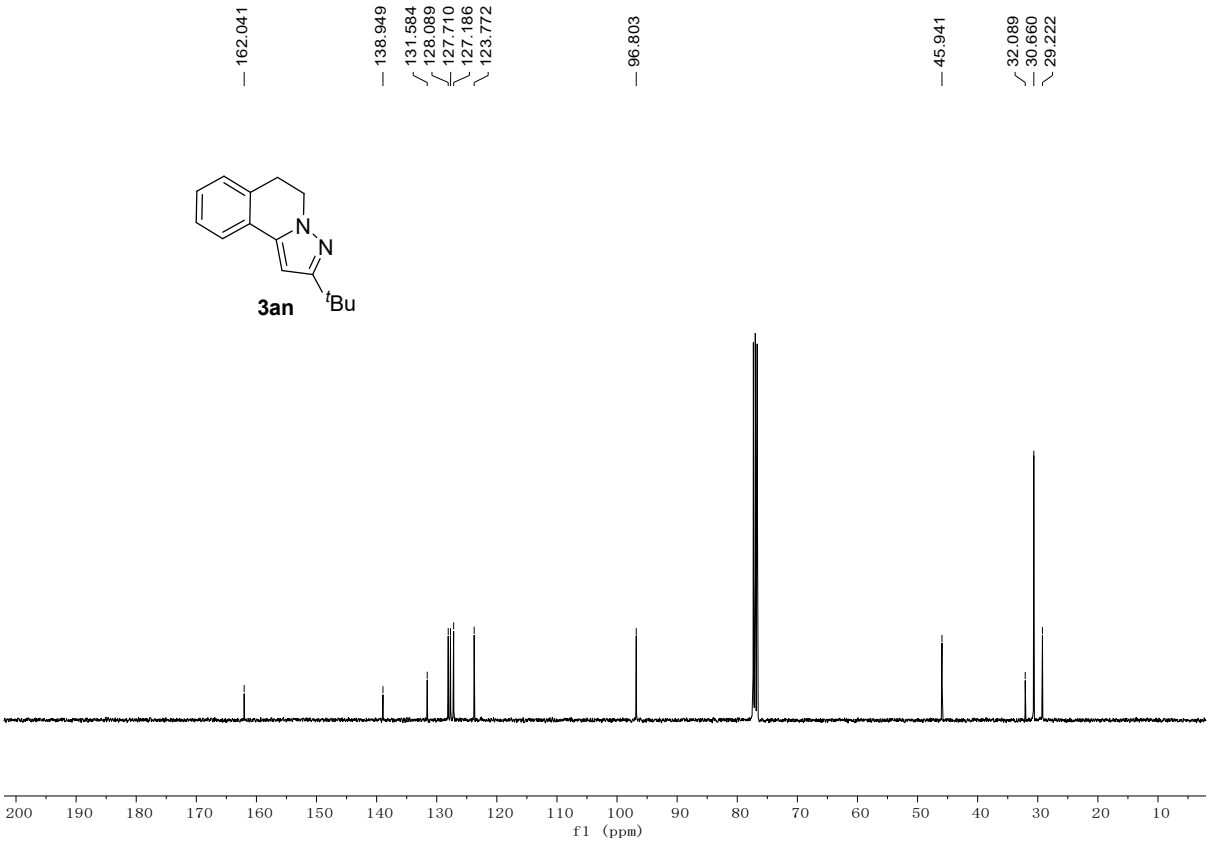

N
N
Ph

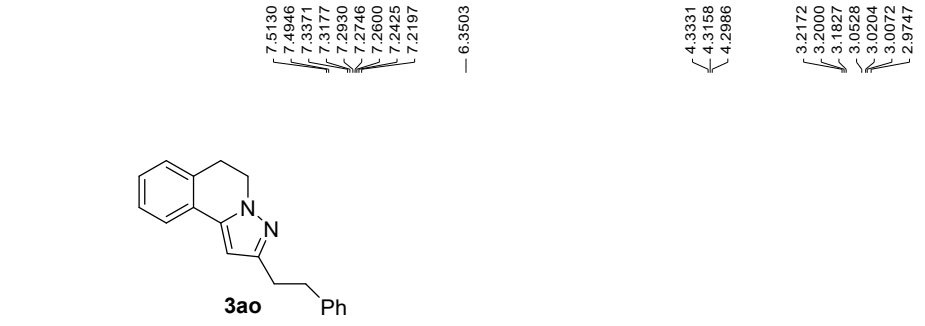
3al

200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

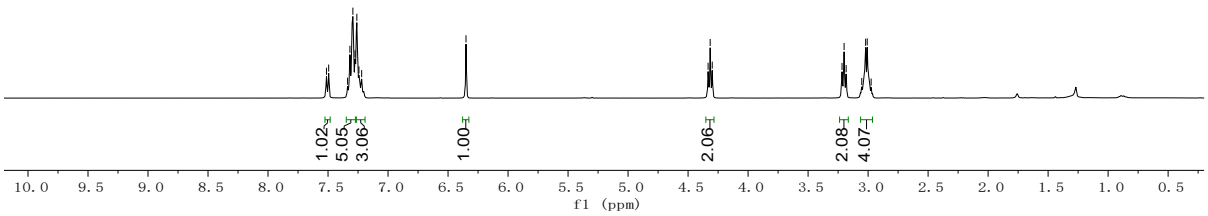

7.5693
7.5508
7.3260
7.3149
7.3047
7.2960
7.2857
7.2600
6.7617
6.7204
6.6669
6.4058
6.3645
4.3456
4.3284
4.3112
3.2159
3.1988
3.1817
2.0557
2.0412
2.0262
1.7852
1.6677
1.6530
1.6390
1.6242
1.6088
1.5063
1.4912
1.4778
1.0842
N
N
Me
Me
Me
3am
1.04
3.09
1.00
1.01
1.00
2.08
2.09
2.04
3.00
2.08
2.01
6.06
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
f1 (ppm)
151.130
139.627
137.241
131.674
129.866
128.806
128.169
128.062
127.332
126.856
124.680
123.977
96.773
77.318
77.000
76.682
46.068
39.583
34.185
33.003
29.140
28.883
21.698
19.214
N
N
Me
Me
Me
3am
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

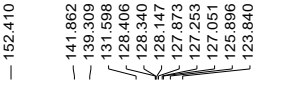

7.5258
7.5069
7.2966
7.2897
7.2813
7.2745
7.2600
7.2559
7.2448
7.2327
7.2300
7.2175
7.2143
7.1987
7.1957
6.4084
4.3197
4.3023
4.2850
3.1999
3.1827
3.1653
1.3610
N
N
tBu
3an
1.00
1.09
2.09
1.00
2.07
2.07
9.02
f1 (ppm)

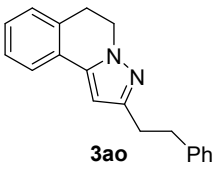

162.041
138.949
131.584
128.089
127.710
127.186
123.772
96.803
45.941
32.089
30.660
29.222
N
N
tBu
3an
f1 (ppm)


7.5130
7.4946
7.3371
7.3177
7.2930
7.2746
7.2600
7.2425
7.2197
6.3503
4.3331
4.3158
4.2986
3.2172
3.2000
3.1827
3.0528
3.0204
3.0072
2.9747

N
N
3ao
Ph

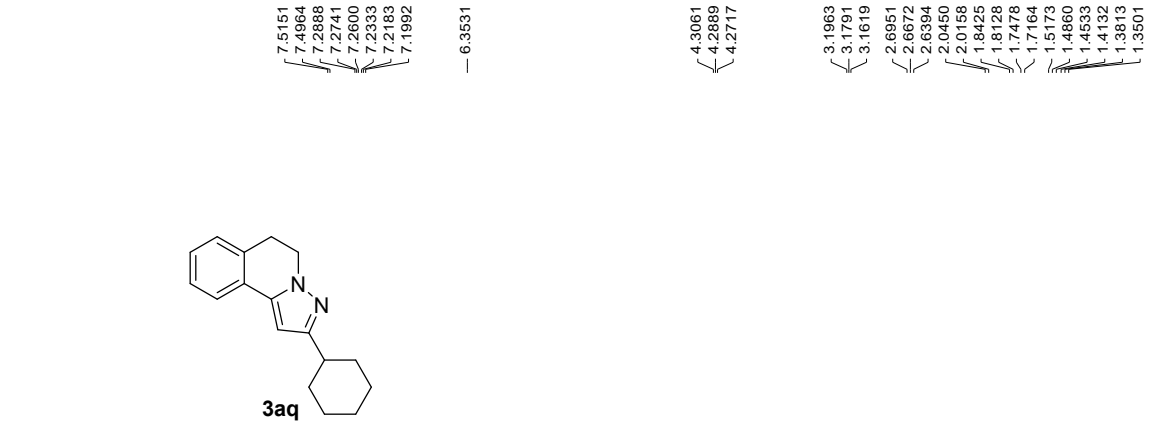

1.02
5.05
3.06
1.00
2.06
2.08
4.07
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


152.410
141.862
139.309
131.598
128.406
128.340
128.147
127.873
127.253
127.051
125.896
123.840
99.193
77.318
77.000
76.682
45.891
36.119
30.397
29.167


N
N
3ao
Ph

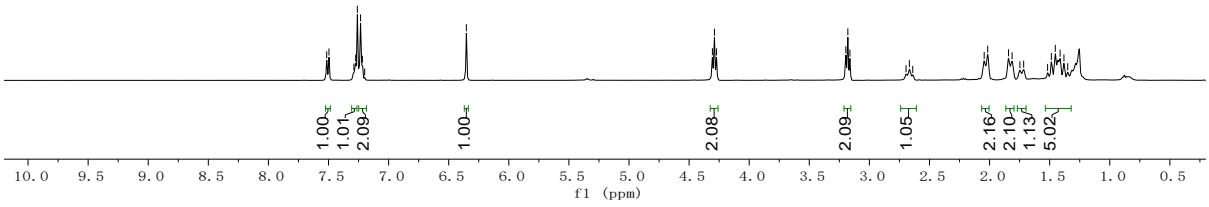
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

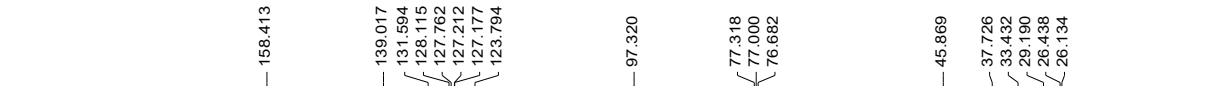

7.4844
7.4660
7.2920
7.2785
7.2697
7.2600
7.2348
7.2016
6.2077
4.2820
4.2647
4.2475
3.1832
3.1660
3.1487
2.0002
1.9874
1.9779
1.9666
1.9548
1.9459
1.9332
0.9625
0.9471
0.9304
0.9266
0.9158
0.7909
0.7782
0.7654
0.7530
3ap
1.02
1.00
2.03
1.00
2.06
2.06
1.01
2.07
2.03
f1 (ppm)
155.073
139.314
131.611
128.126
127.852
127.228
127.006
123.783
96.667
77.318
77.000
76.682
45.855
29.164
9.202
7.869
3ap
f1 (ppm)

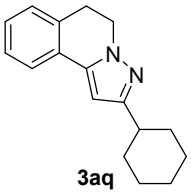

7.5151
7.4964
7.2888
7.2741
7.2600
7.2333
7.2183
7.1992
6.3531
4.3061
4.2889
4.2717
3.1963
3.1791
3.1619
2.6951
2.6672
2.6394
2.0450
2.0158
1.8425
1.8128
1.7478
1.7164
1.5173
1.4860
1.4533
1.4132
1.3813
1.3501

N
N

3aq

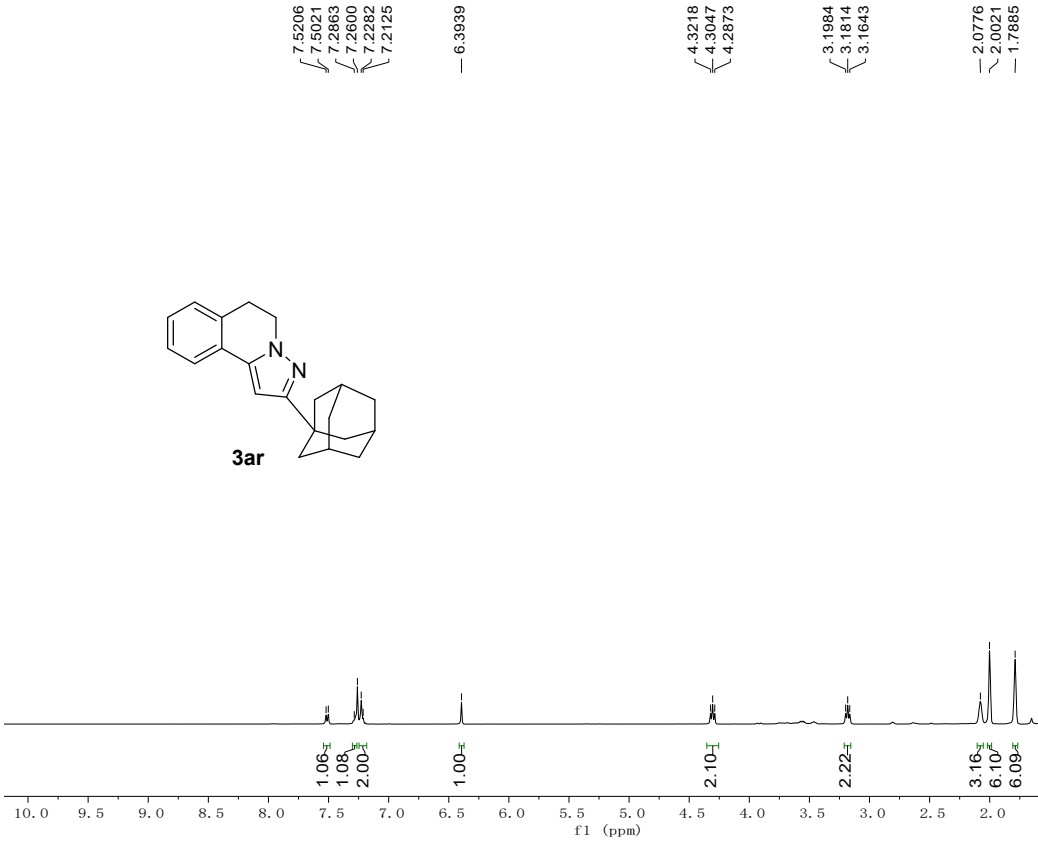

1.00
1.01
2.09
1.00
2.08
2.09
1.05
2.16
2.10
1.13
5.02
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

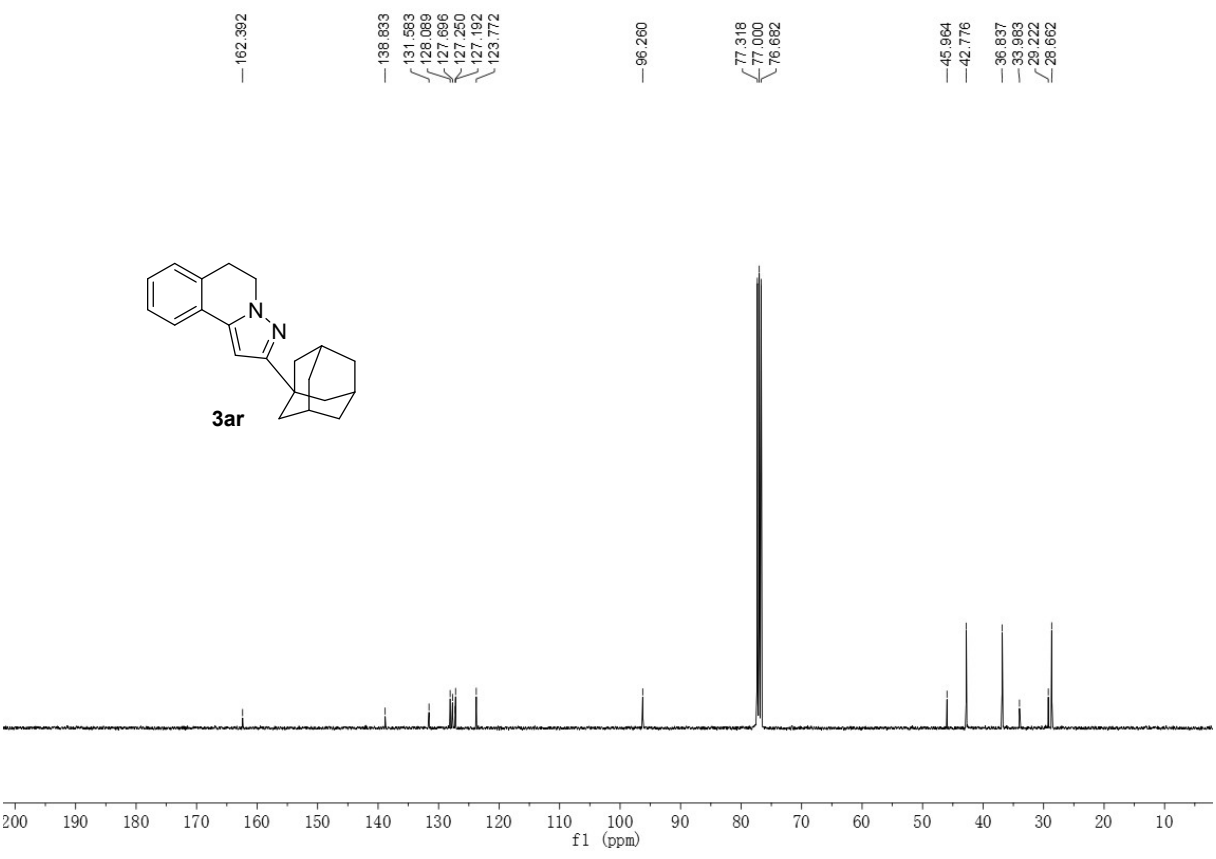

158.413
139.017
131.594
128.115
127.762
127.212
127.177
123.794
97.320
77.318
77.000
76.682
45.869
37.726
33.432
29.190
26.438
26.134

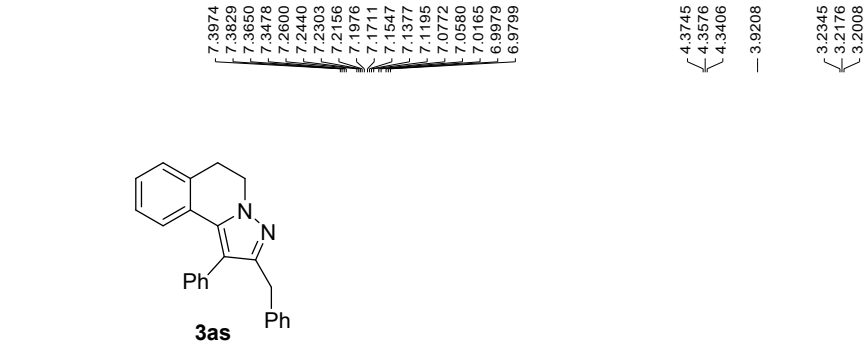

N
N

3aq

200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

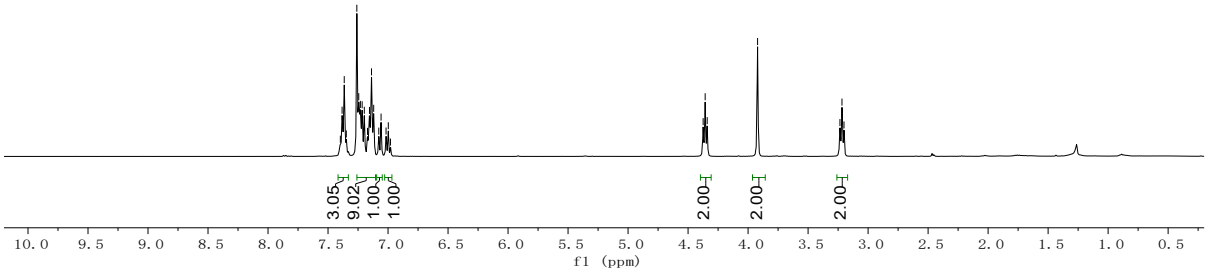

7.5206
7.5021
7.2863
7.2600
7.2282
7.2125
6.3939
4.3218
4.3047
4.2873
3.1984
3.1814
3.1643
2.0776
2.0021
1.7885
3ar
1.06
1.08
2.00
1.00
2.10
2.22
3.16
6.10
6.09
f1 (ppm)

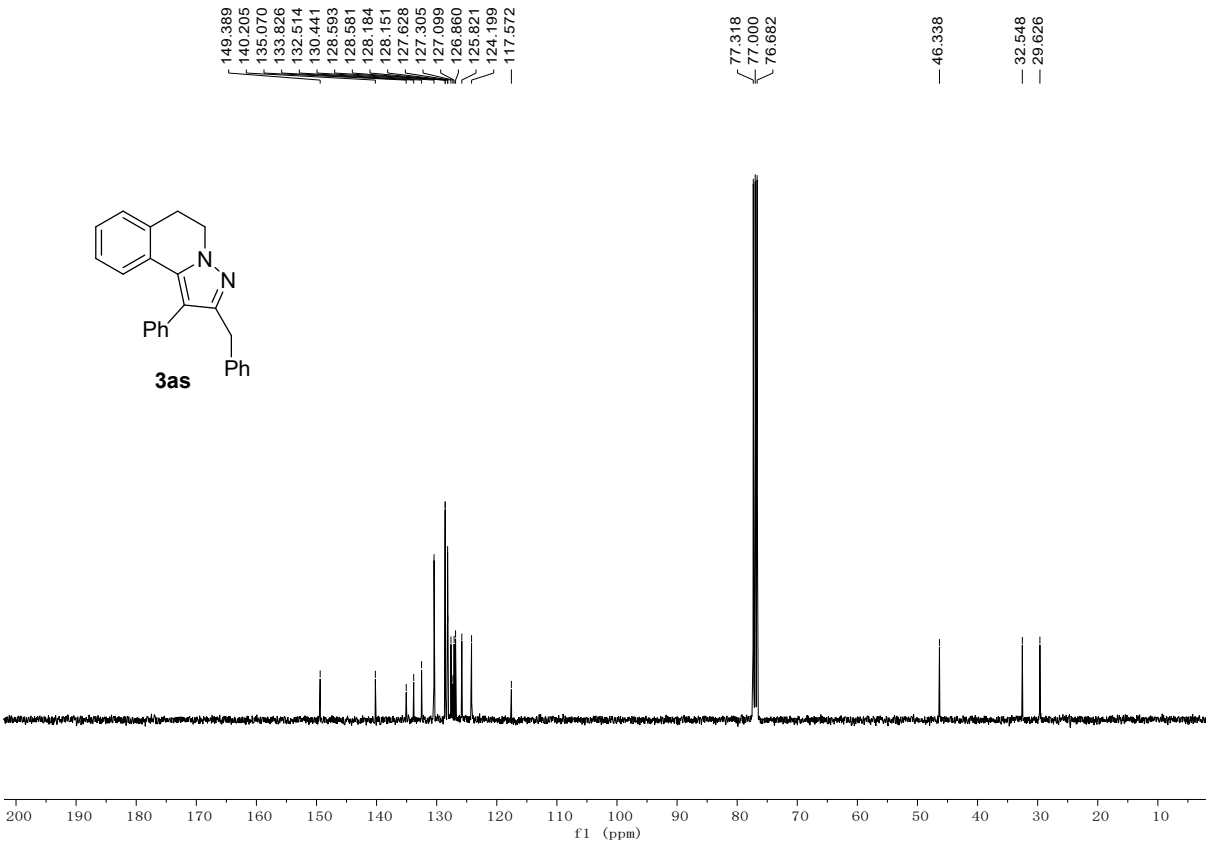

162.392
138.833
131.583
128.089
127.696
127.250
127.192
123.772
96.260
77.318
77.000
76.682
45.964
42.776
36.837
33.983
29.222
28.662
3ar
f1 (ppm)


7.3974
7.3829
7.3650
7.3478
7.2600
7.2440
7.2303
7.2156
7.1976
7.1711
7.1547
7.1377
7.1195
7.0772
7.0580
7.0165
6.9979
6.9799
4.3745
4.3576
4.3406
3.9208
3.2345
3.2176
3.2008

N
N
Ph
Ph

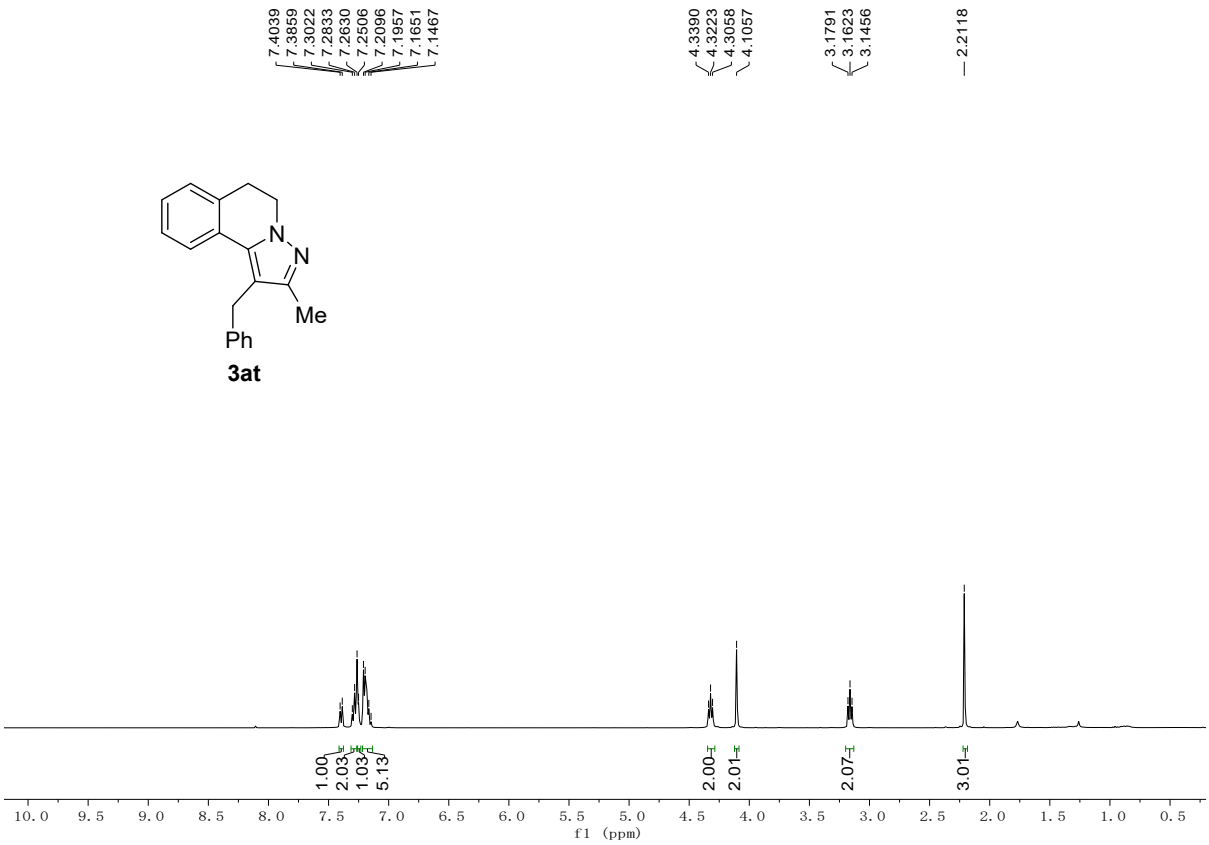
3as


3.05
9.02
1.00
1.00
2.00
2.00
2.00
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
f1 (ppm)

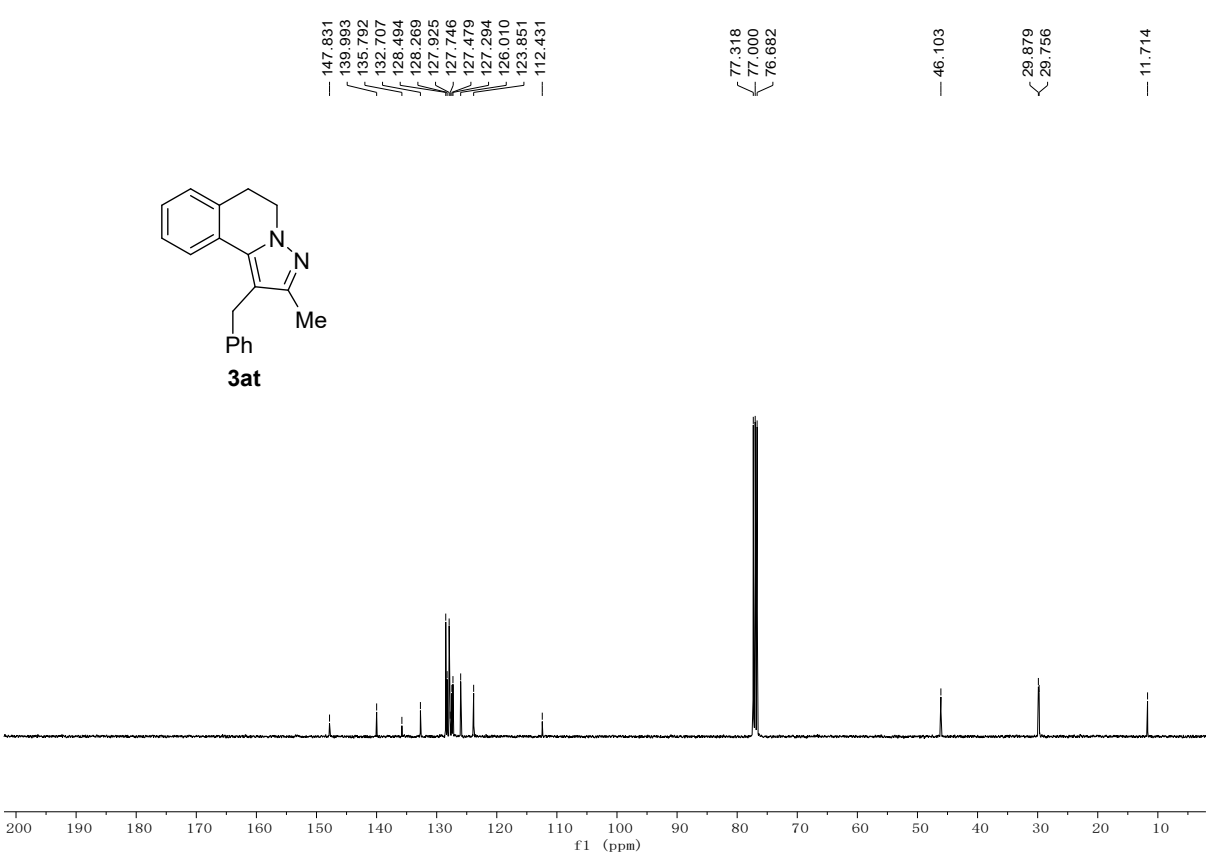

149.389
140.205
135.070
133.826
132.514
130.441
128.593
128.581
128.184
128.151
127.628
127.305
127.099
126.860
125.821
124.199
117.572
77.318
77.000
76.682
46.338
32.548
29.626
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

N
N
Ph
Ph

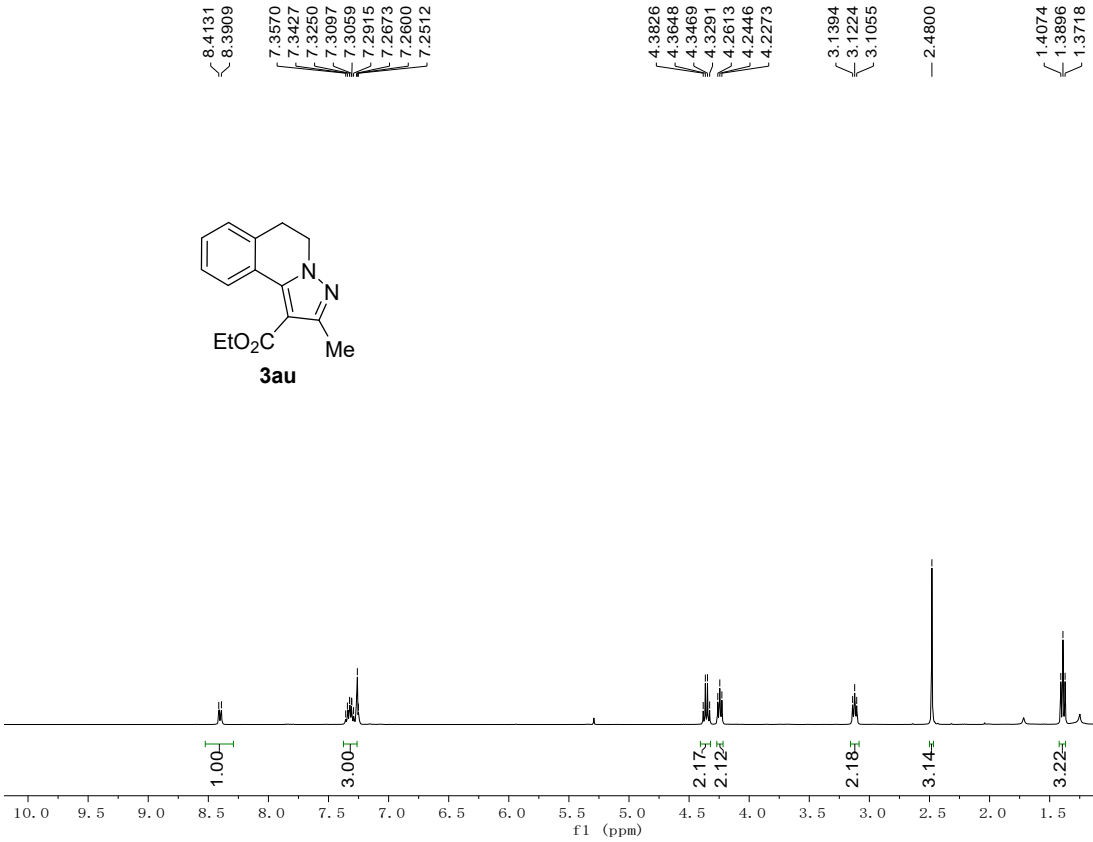
3as

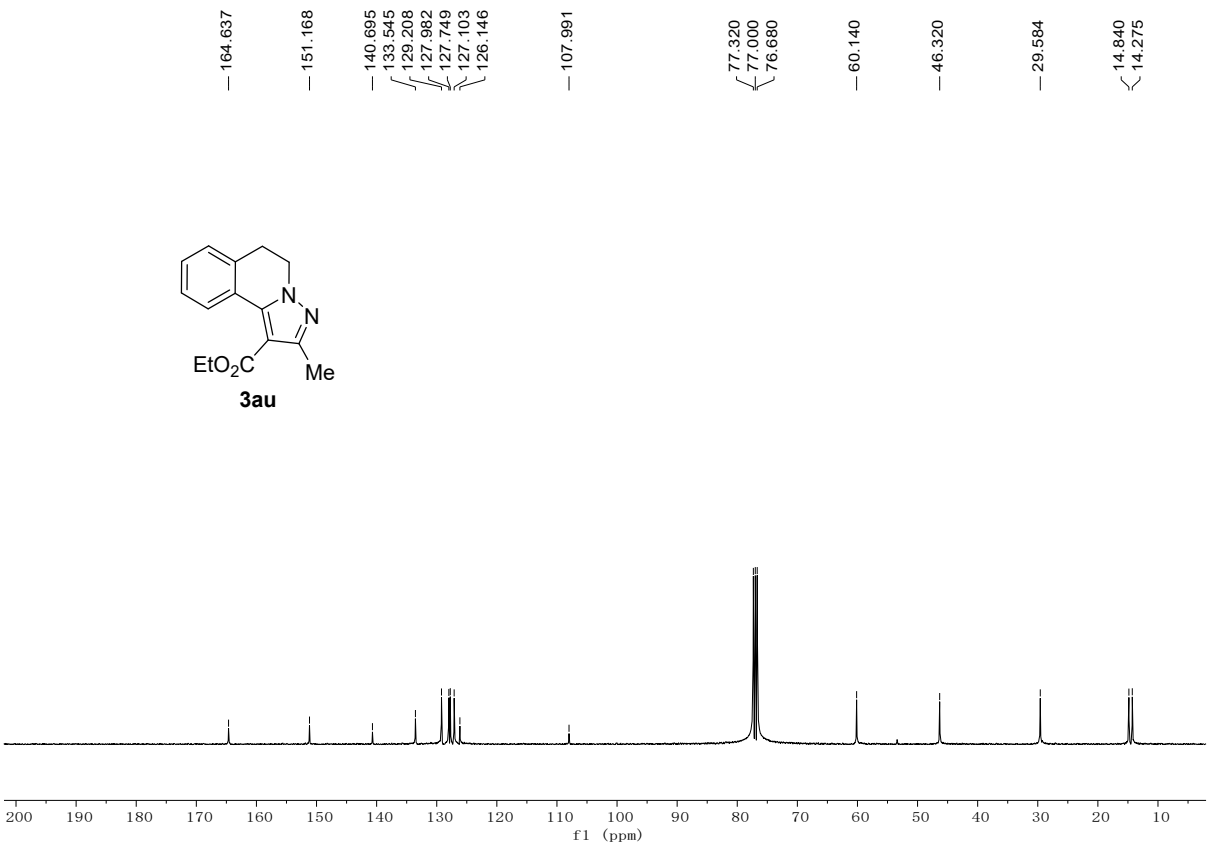

7.4039
7.3859
7.3022
7.2833
7.2630
7.2506
7.2096
7.1957
7.1651
7.1467
4.3390
4.3223
4.3058
4.1057
3.1791
3.1623
3.1456
2.2118
N
N
Me
Ph
1.00
2.03
1.03
5.13
2.00
2.01
2.07
3.01
f1 (ppm)

3at

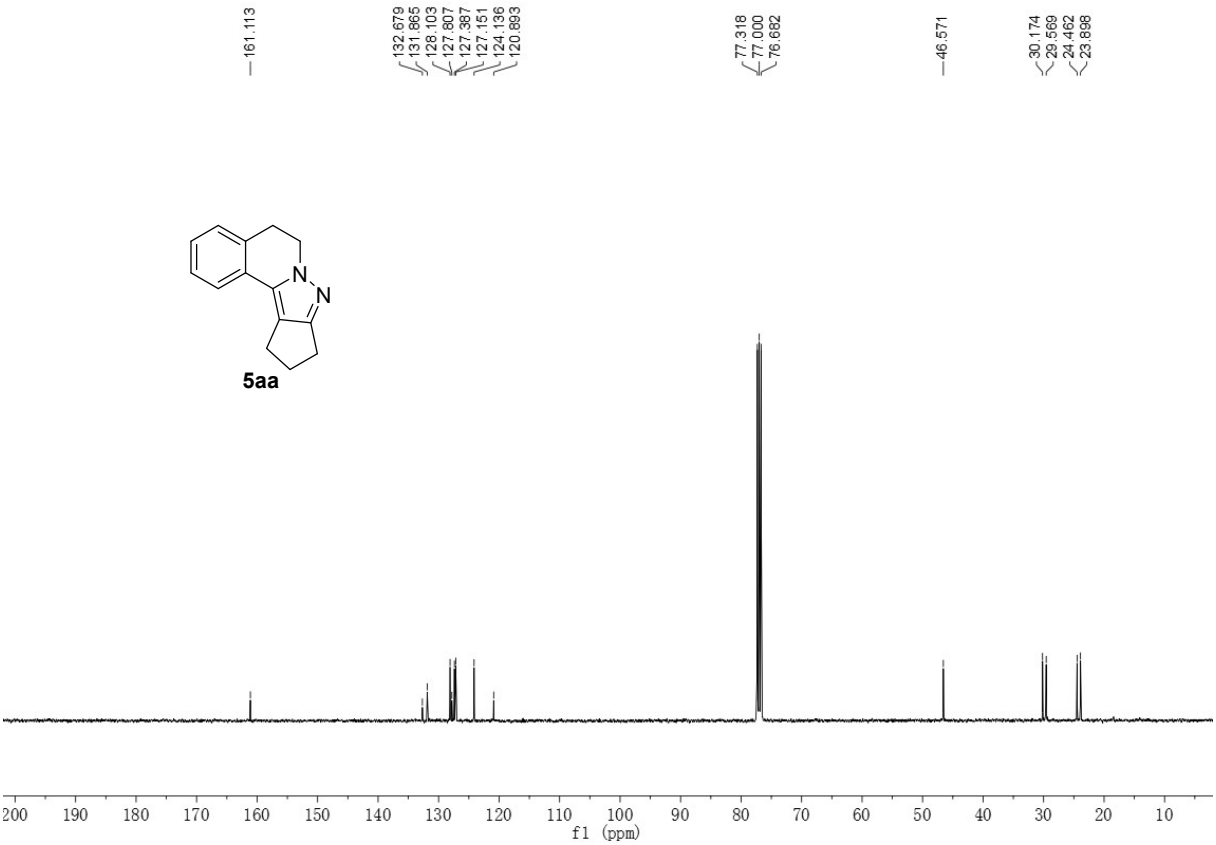

147.831
139.993
135.792
132.707
128.494
128.269
127.925
127.746
127.479
127.294
126.010
123.851
112.431
77.318
77.000
76.682
46.103
29.879
29.756
11.714
N
N
Me
Ph
f1 (ppm)

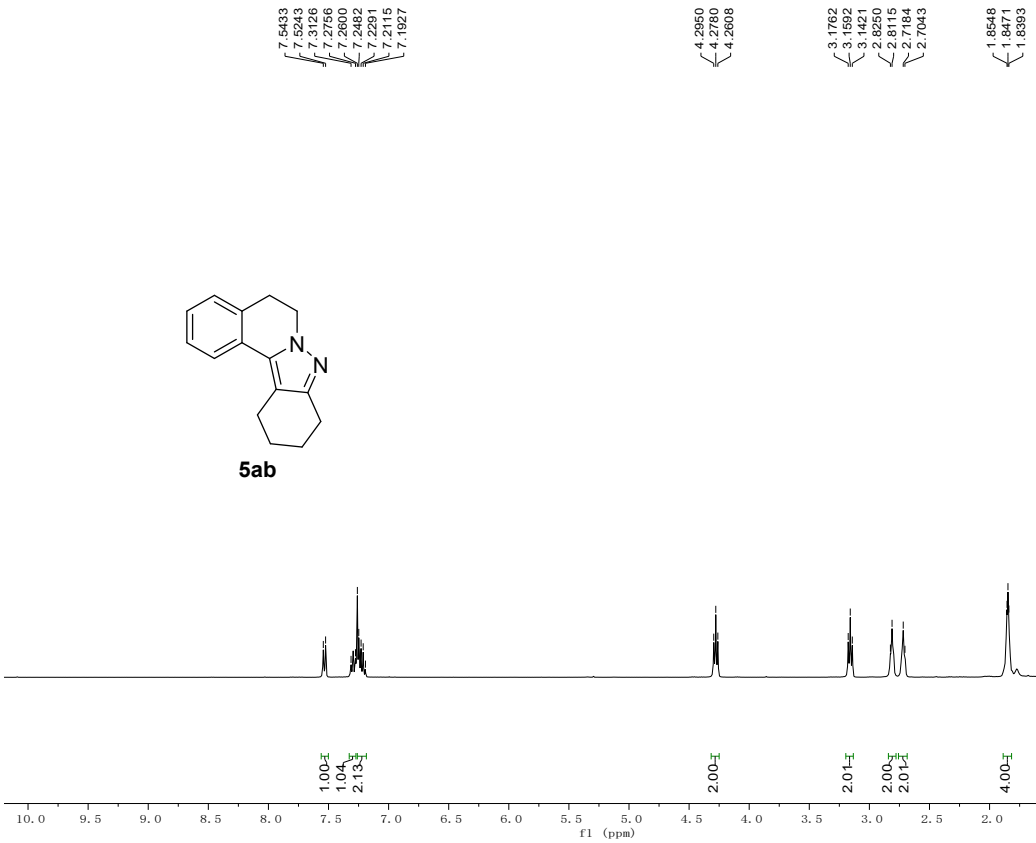
3at

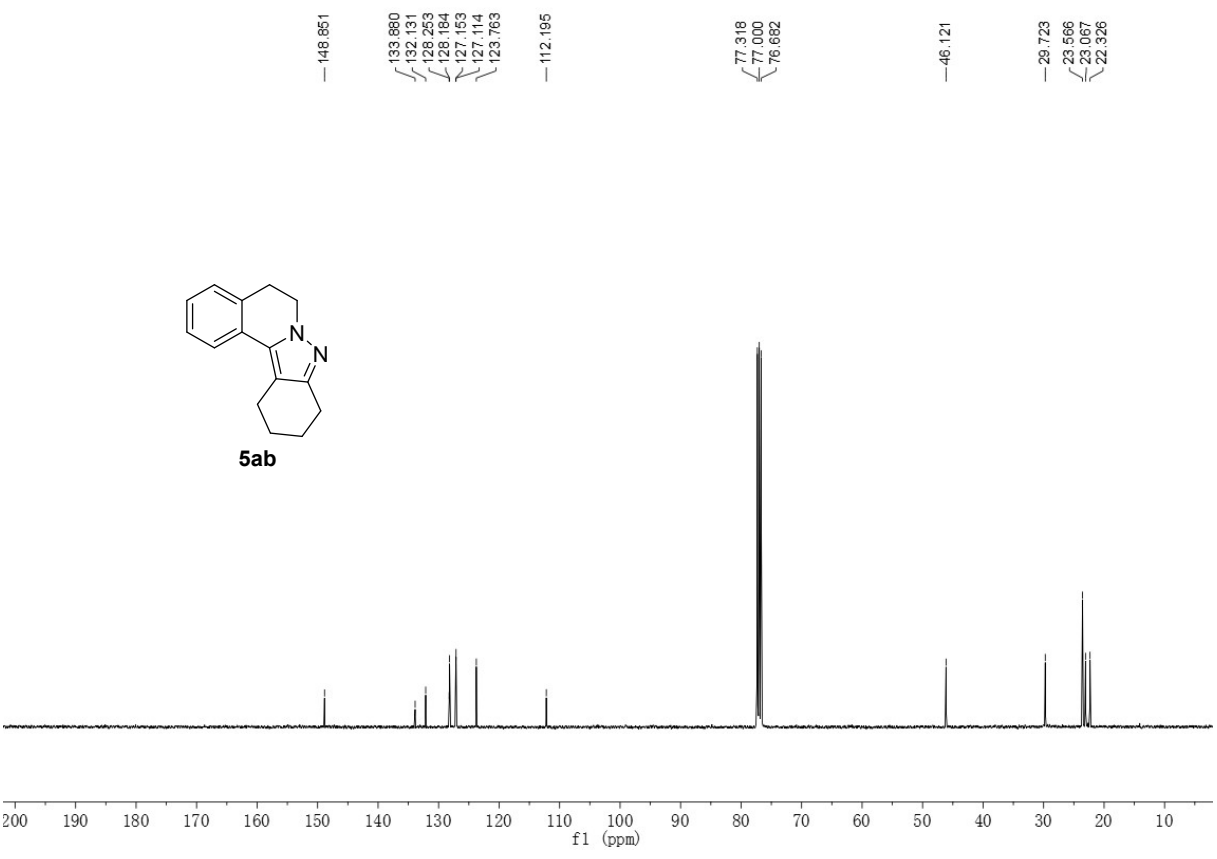

8.4131
8.3909
7.3570
7.3427
7.3250
7.3097
7.3059
7.2915
7.2673
7.2600
7.2512
4.3826
4.3648
4.3469
4.3291
4.2613
4.2446
4.2273
3.1394
3.1224
3.1055
2.4800
1.4074
1.3896
1.3718
N
N
EtO2C
Me
3au
1.00
3.00
2.17
2.12
2.18
3.14
3.22
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


164.637
151.168
140.695
133.545
129.208
127.982
127.749
127.103
126.146
107.991
77.320
77.000
76.680
60.140
46.320
29.584
14.840
14.275
N
N
EtO2C
Me
3au
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

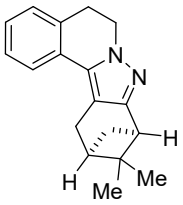

7.4474
7.4286
7.3018
7.2848
7.2800
7.2281
7.2082
4.3208
4.3036
4.2864
3.1997
3.1825
3.1654
2.8775
2.8602
2.8422
2.7708
2.7528
2.7340
2.5401
2.5213
2.5037
2.4857
2.4646
N
N
5aa
1.00
1.00
2.00
2.09
2.10
2.05
2.10
2.17
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


161.113
132.679
131.865
128.103
127.807
127.387
127.151
124.136
120.893
77.318
77.000
76.682
46.571
30.174
29.569
24.462
23.898
N
N
5aa
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


7.5433
7.5243
7.3126
7.2756
7.2600
7.2482
7.2291
7.2115
7.1927
4.2950
4.2780
4.2608
3.1762
3.1592
3.1421
2.8250
2.8115
2.7184
2.7043
1.8548
1.8471
1.8393
N
N
5ab
1.00
1.04
2.13
2.00
2.01
2.00
2.01
4.00
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
f1 (ppm)


148.851
133.880
132.131
128.253
128.184
127.153
127.114
123.763
112.195
77.318
77.000
76.682
46.121
29.723
23.566
23.067
22.326
N
N
5ab
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


7.5401
7.5212
7.3246
7.3030
7.2841
7.2690
7.2600
7.2533
7.2412
7.2382
7.2233
7.2208
7.2049
7.2019
4.3230
4.3055
4.2919
4.2757
4.2576
4.2403
4.2277
4.2093
3.2564
3.2386
3.2168
3.2003
3.1889
3.1825
3.1727
3.0317
3.0241
2.9925
2.9850
2.9516
2.9451
2.9125
2.9058
2.8996
2.8863
2.8732
2.7758
2.7611
2.7519
2.7468
2.7373
2.7229
2.3665
2.3594
2.3457
2.3317
2.3246
1.4405
1.4223
0.7501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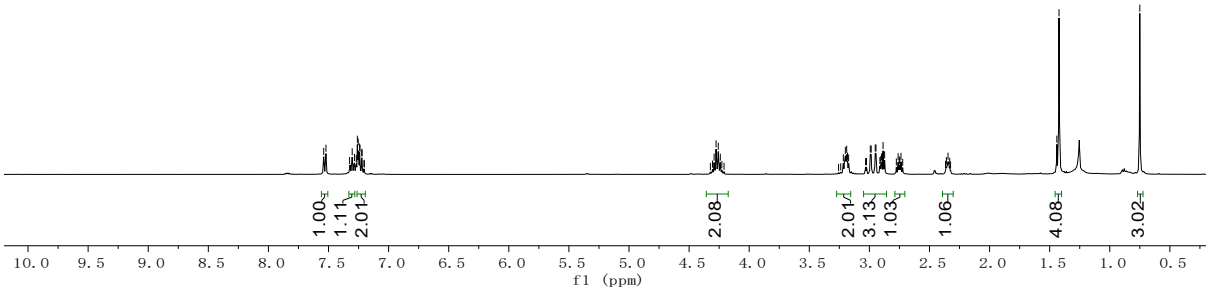
N
H
H
Me
Me

5ac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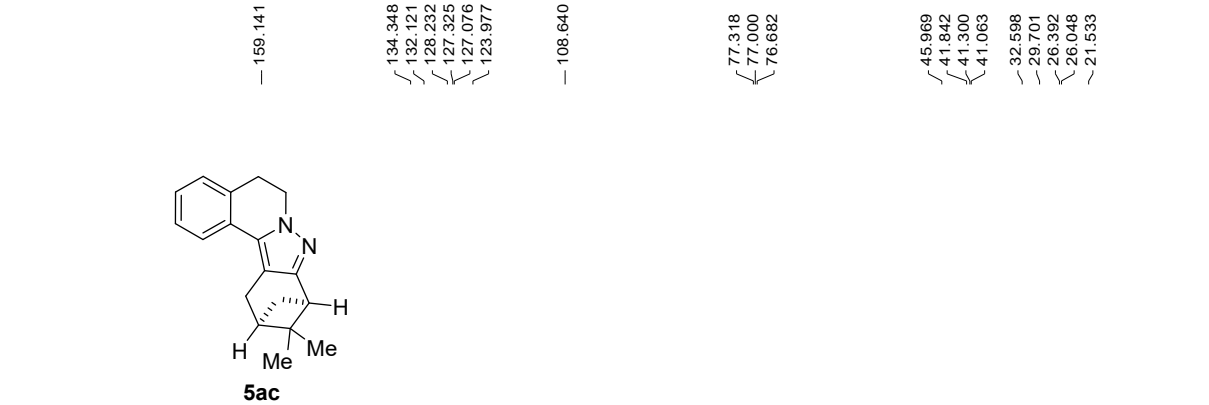
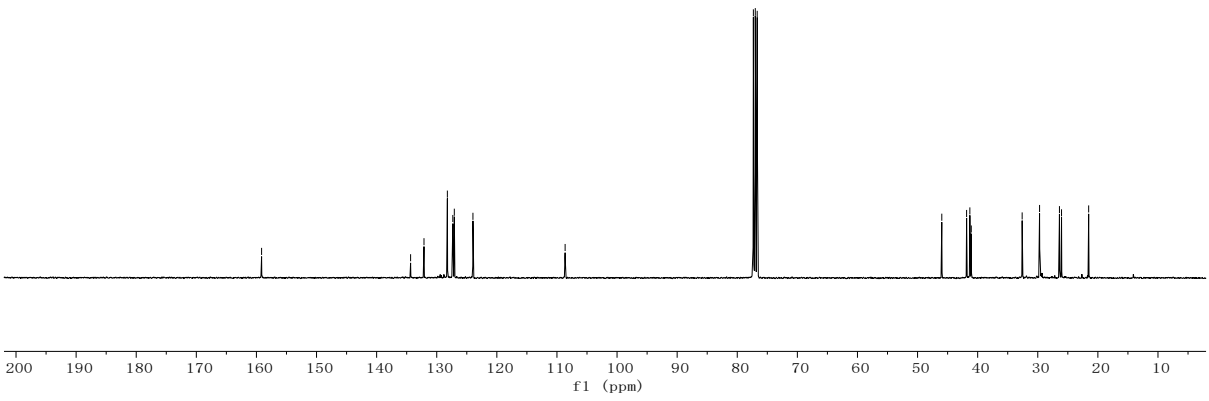
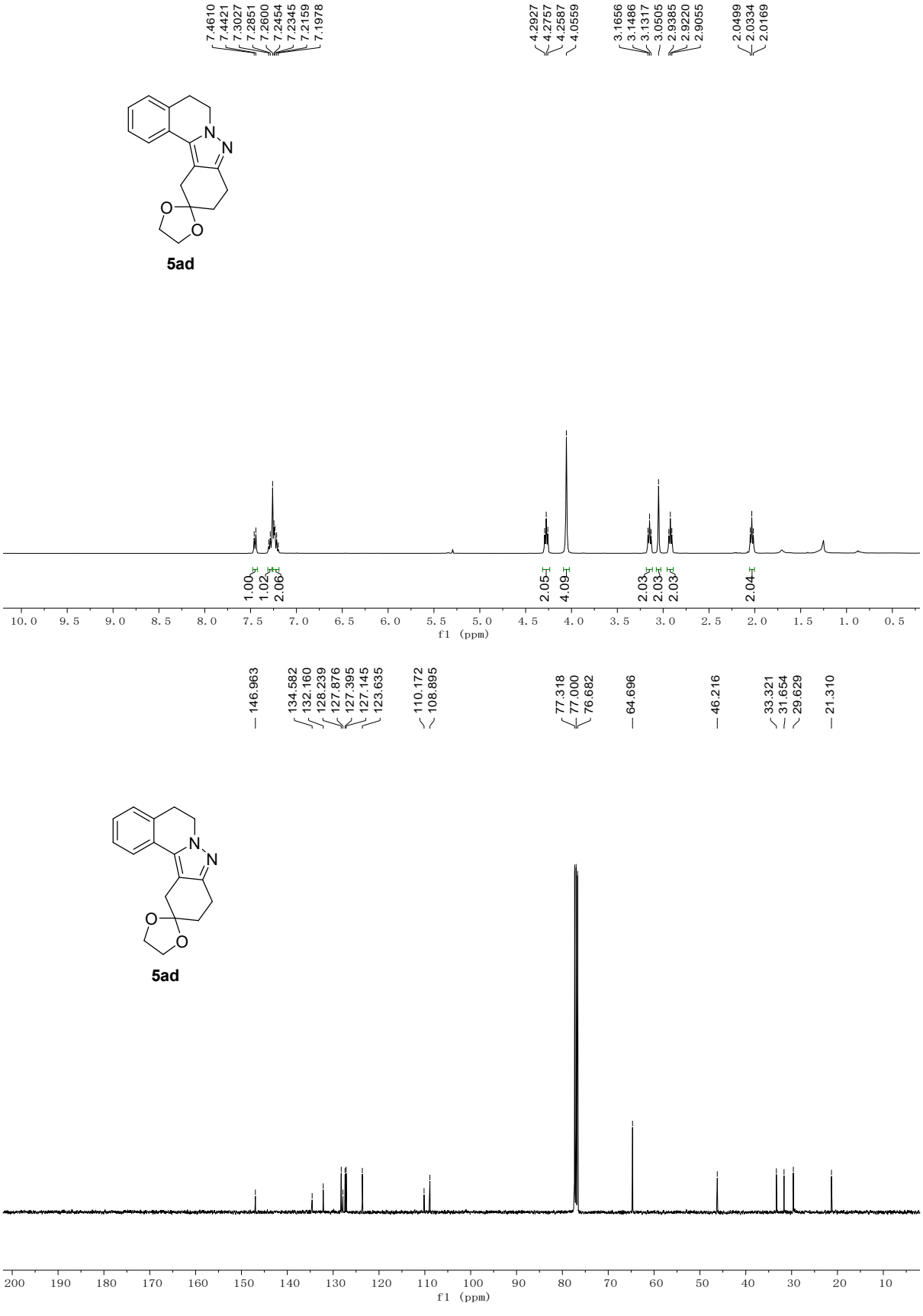
1.11
2.01
2.08
2.01
3.13
1.03
1.06
4.08
3.02
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


159.141
134.348
132.121
128.232
127.325
127.076
123.977
108.640
77.318
77.000
76.682
45.969
41.842
41.300
41.063
32.598
29.701
26.392
26.048
21.533

N
N
H
H
Me
Me

5ac


200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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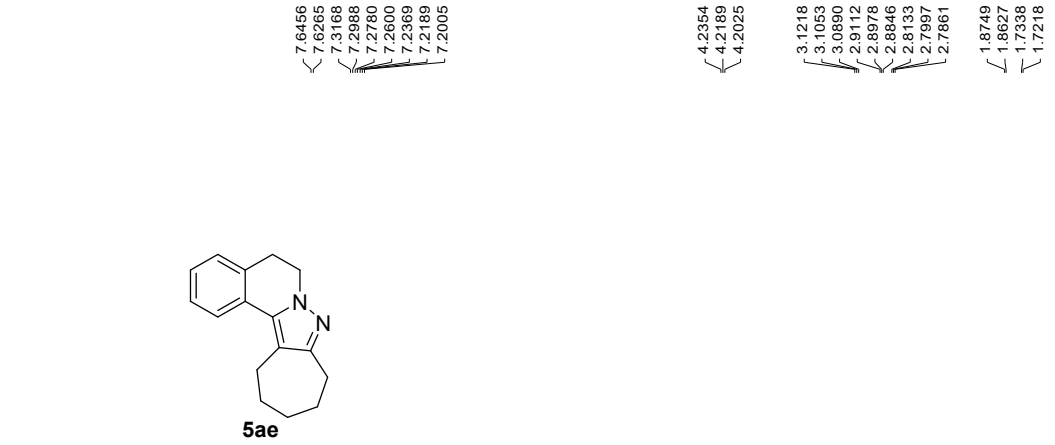
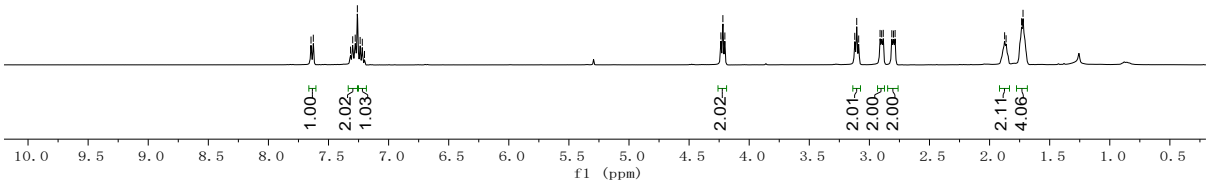
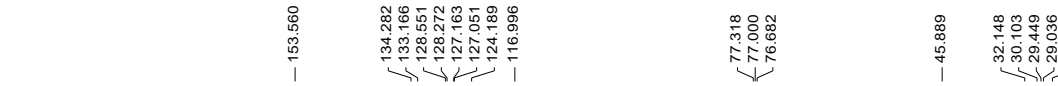
7.4421
7.3027
7.2851
7.2600
7.2454
7.2345
7.2159
7.1978
4.2927
4.2757
4.2587
4.0559
3.1656
3.1486
3.1317
3.0505
2.9385
2.9220
2.9055
2.0499
2.0334
2.0169
5ad
1.00
1.02
2.06
2.05
4.09
2.03
2.03
2.03
2.04
f1 (ppm)
146.963
134.582
132.160
128.239
127.876
127.395
127.145
123.635
110.172
108.895
77.318
77.000
76.682
64.696
46.216
33.321
31.654
29.629
21.310
5ad
f1 (ppm)


7.6456
7.6265
7.3168
7.2988
7.2780
7.2600
7.2369
7.2189
7.2005
4.2354
4.2189
4.2025
3.1218
3.1053
3.0890
2.9112
2.8978
2.8846
2.8133
2.7997
2.7861
1.8749
1.8627
1.7338
1.7218

5ae


1.00
2.02
1.03
2.02
2.01
2.00
2.00
2.11
4.06
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
f1 (ppm)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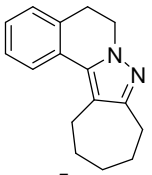
134.282
133.166
128.551
128.272
127.163
127.051
124.189
116.996
77.318
77.000
76.682
45.889
32.148
30.103
29.449
29.036
27.534
25.361



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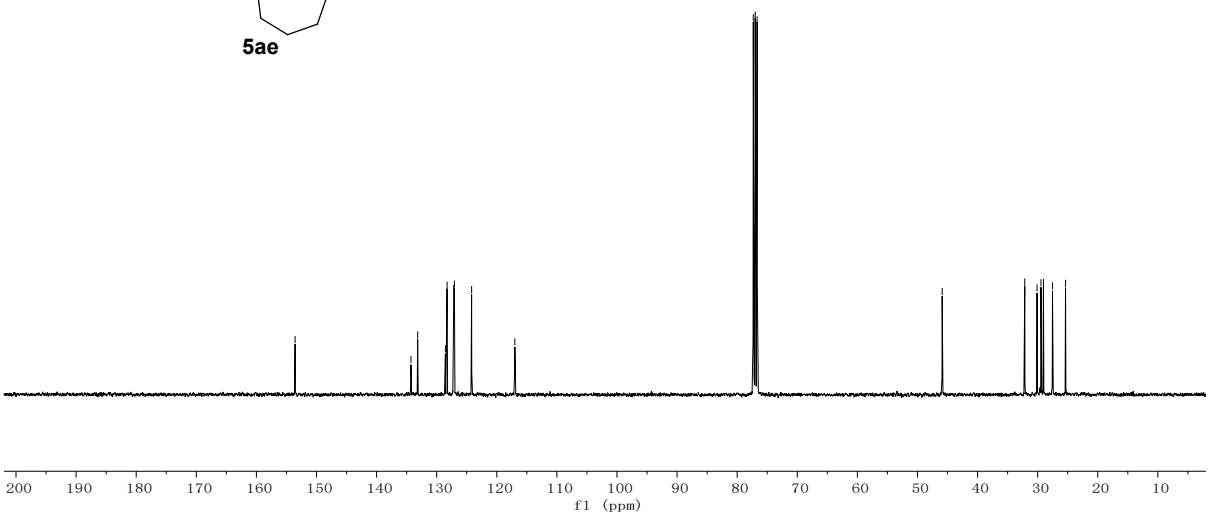
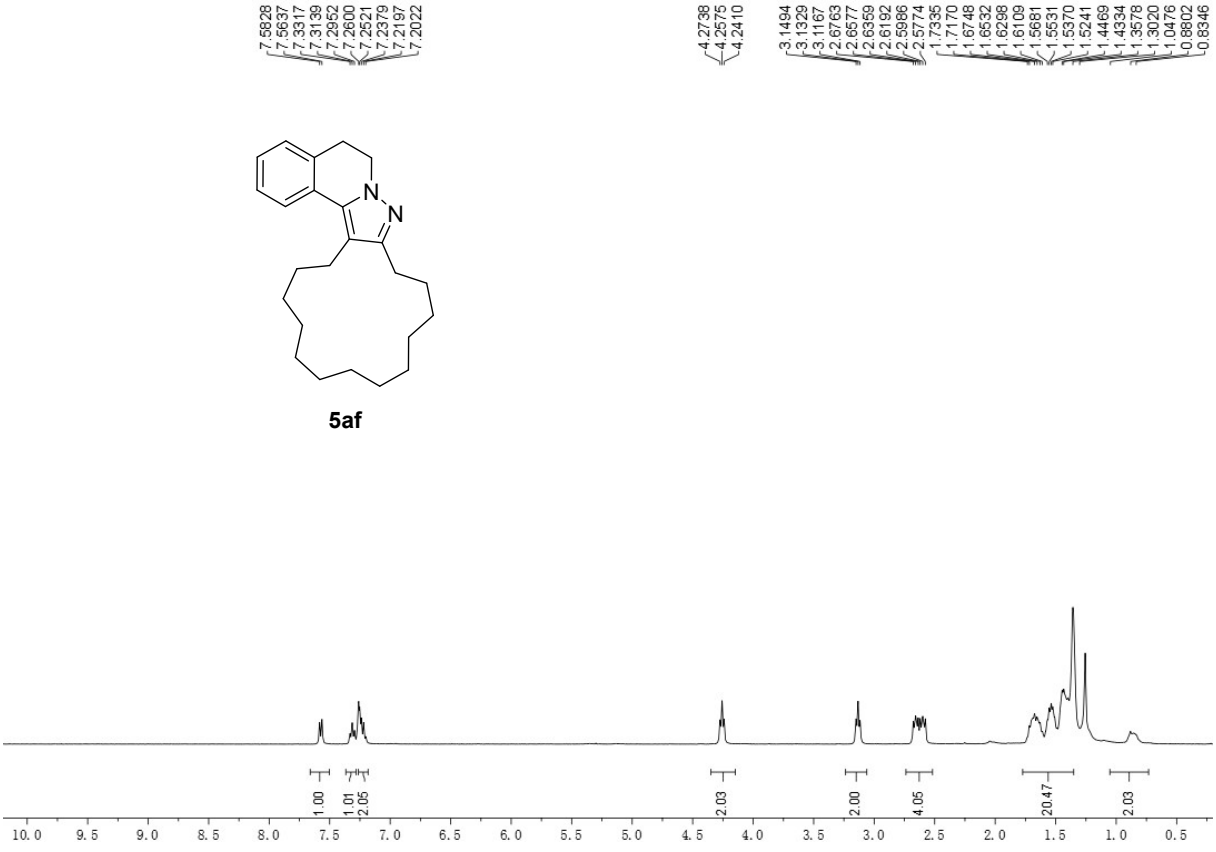

200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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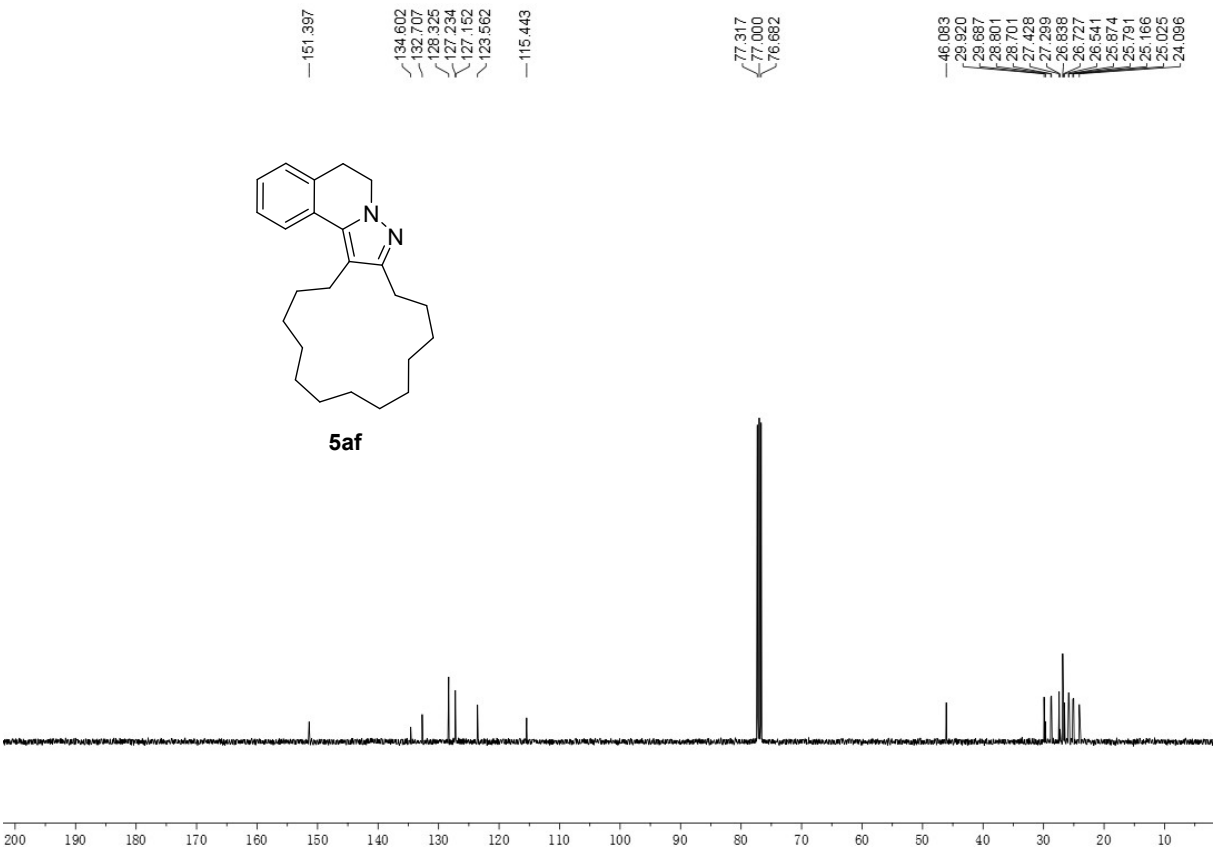
7.5637
7.3317
7.3139
7.2952
7.2600
7.2521
7.2379
7.2197
7.2022
4.2738
4.2575
4.2410
3.1494
3.1329
3.1167
2.6763
2.6577
2.6359
2.6192
2.5986
2.5774
1.7335
1.7170
1.6748
1.6532
1.6298
1.6109
1.5681
1.5531
1.5370
1.5241
1.4469
1.4334
1.3578
1.3020
1.0476
0.8802
0.8346
N
N
5af
1.00
1.01
2.05
2.03
2.00
4.05
20.47
2.03
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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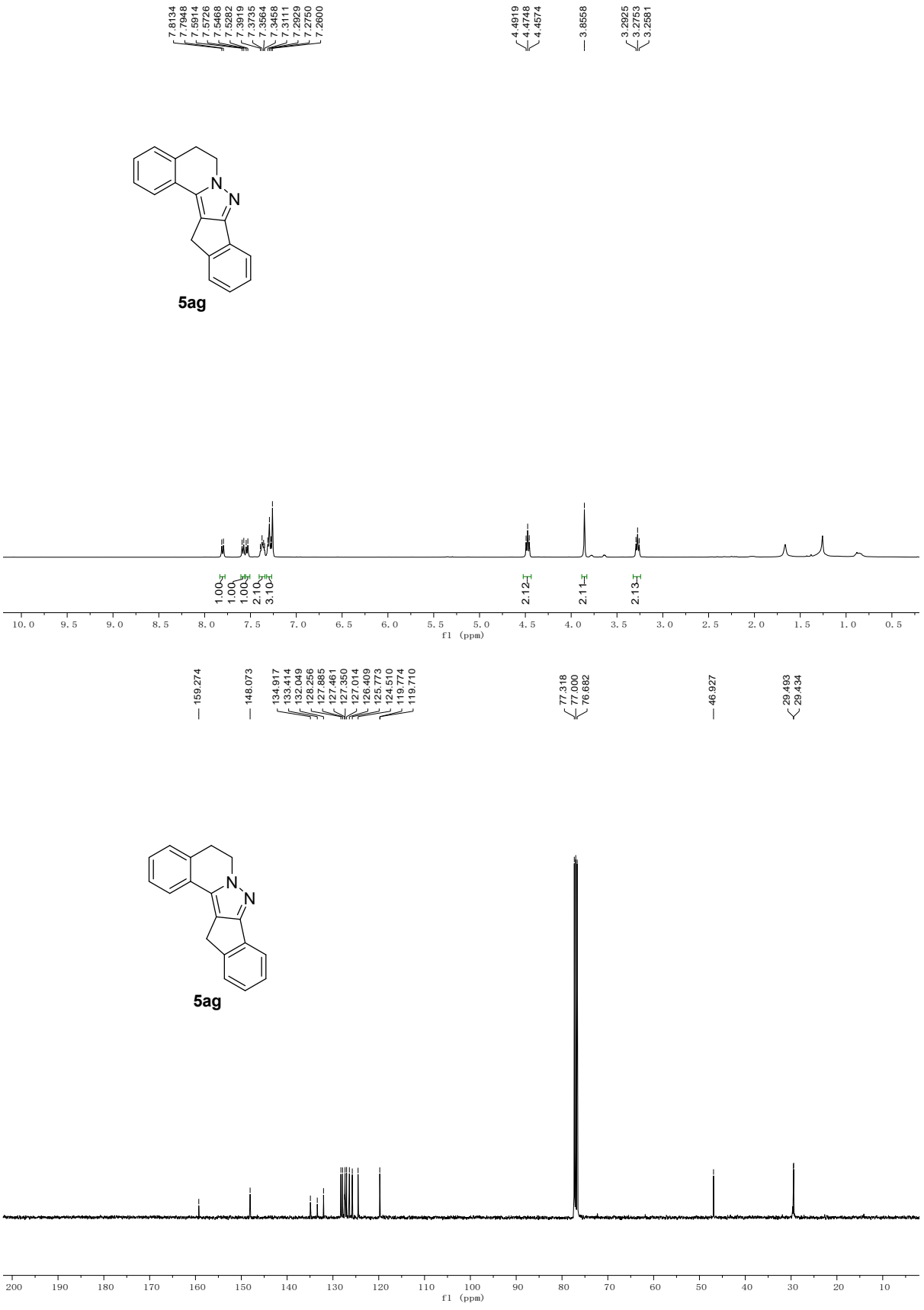
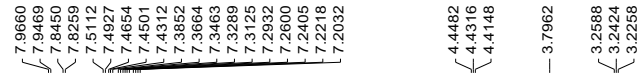
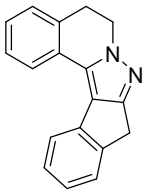
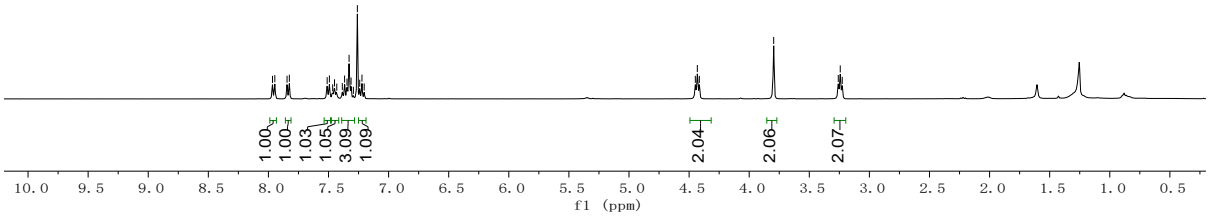
134.602
132.707
128.325
127.234
127.152
123.562
115.443
77.317
77.000
76.682
46.083
29.920
29.687
28.801
28.701
27.428
27.299
26.838
26.727
26.541
25.874
25.791
25.166
25.025
24.096
N
N
5af
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10


7.8134
7.7948
7.5914
7.5726
7.5468
7.5282
7.3919
7.3735
7.3564
7.3458
7.3111
7.2929
7.2750
7.2600
4.4919
4.4748
4.4574
3.8558
3.2925
3.2753
3.2581
5ag
1.00
1.00
1.00
2.10
3.10
2.12
2.11
2.13
f1 (ppm)
159.274
148.073
134.917
133.414
132.049
128.256
127.885
127.461
127.350
127.014
126.409
125.773
124.510
119.774
119.710
77.318
77.000
76.682
46.927
29.493
29.434
5ag
f1 (ppm)

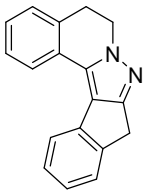

7.9660
7.9469
7.8450
7.8259
7.5112
7.4927
7.4654
7.4501
7.4312
7.3852
7.3664
7.3463
7.3289
7.3125
7.2932
7.2600
7.2405
7.2218
7.2032
4.4482
4.4316
4.4148
3.7962
3.2588
3.2424
3.2258



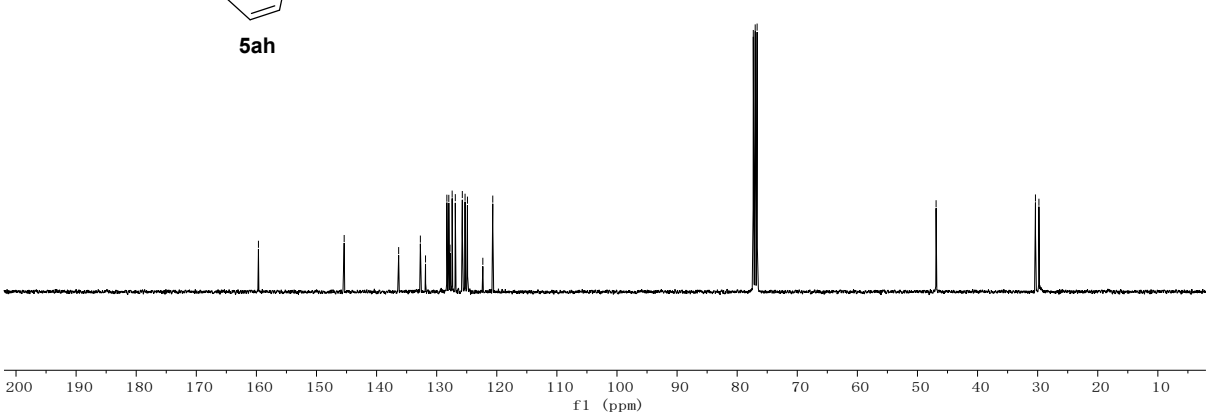
5ah

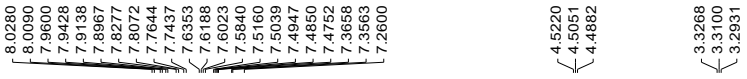

1.00
1.00
1.03
1.05
3.09
1.09
2.04
2.06
2.07
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


159.660
145.395
136.329
132.715
131.860
128.308
127.984
127.780
127.426
126.902
125.735
125.280
124.880
122.322
120.668
77.318
77.000
76.682
46.900
30.366
29.789



5ah


200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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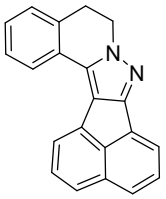
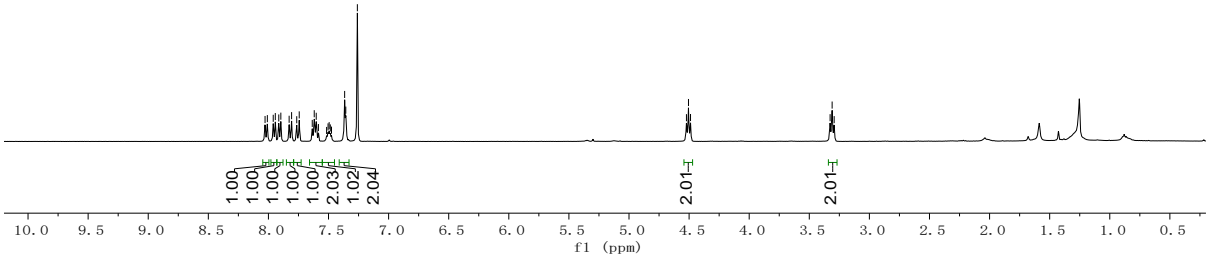
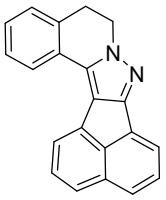
8.0090
7.9600
7.9428
7.9138
7.8967
7.8277
7.8072
7.7644
7.7437
7.6353
7.6188
7.6023
7.5840
7.5160
7.5039
7.4947
7.4850
7.4752
7.3658
7.3563
7.2600
4.5220
4.5051
4.4882
3.3268
3.3100
3.2931



5ai

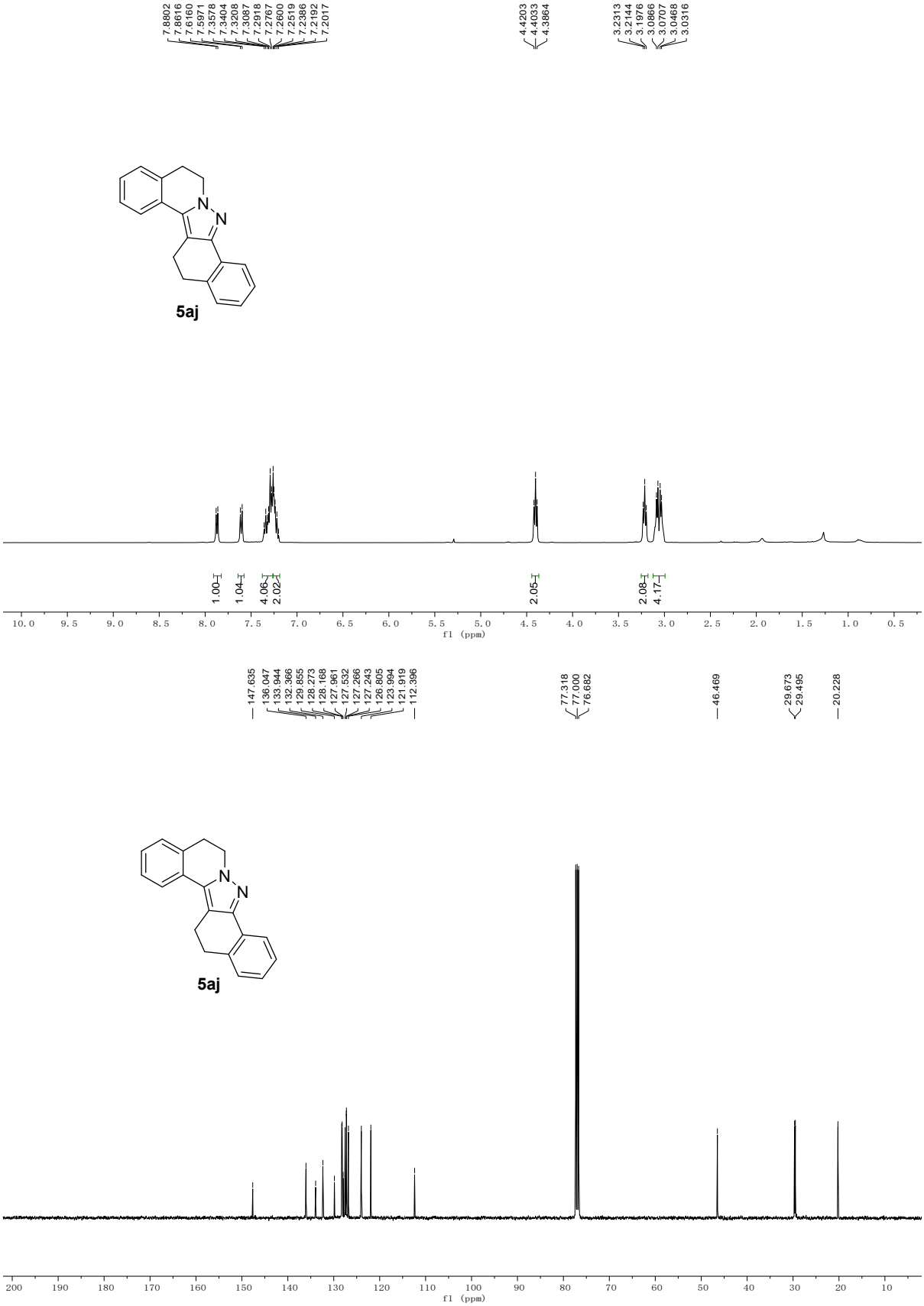

1.00
1.00
1.00
1.00
1.00
2.03
1.02
2.04
2.01
2.01
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


157.973
136.476
133.174
132.770
130.956
130.572
129.980
128.418
128.381
127.718
127.659
127.534
127.317
126.802
125.544
125.330
120.246
120.114
119.999
77.318
77.000
76.682
47.039
29.617



5ai

200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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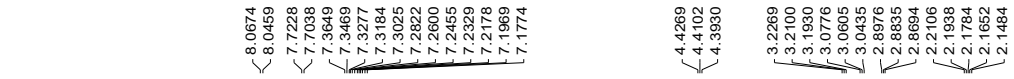
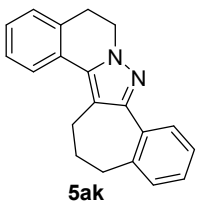
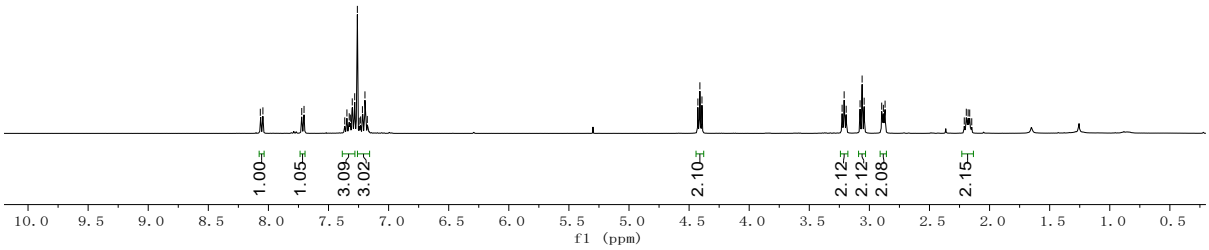
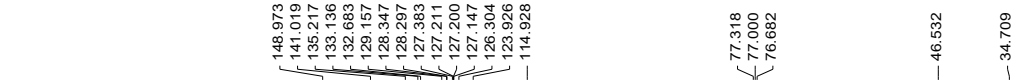
7.8616
7.6160
7.5971
7.3578
7.3404
7.3208
7.3087
7.2918
7.2767
7.2600
7.2519
7.2386
7.2192
7.2017
4.4203
4.4033
4.3864
3.2313
3.2144
3.1976
3.0866
3.0707
3.0468
3.0316
5aj
1.00
1.04
4.06
2.02
2.05
2.08
4.17
f1 (ppm)
147.635
136.047
133.944
132.366
129.855
128.273
128.168
127.961
127.532
127.266
127.243
126.805
123.994
121.919
112.396
77.318
77.000
76.682
46.469
29.673
29.495
20.228
5aj
f1 (ppm)

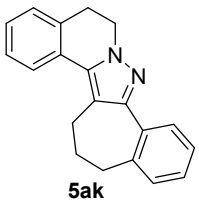

8.0674
8.0459
7.7228
7.7038
7.3649
7.3469
7.3277
7.3184
7.3025
7.2822
7.2600
7.2455
7.2329
7.2178
7.1969
7.1774
4.4269
4.4102
4.3930
3.2269
3.2100
3.1930
3.0776
3.0605
3.0435
2.8976
2.8835
2.8694
2.2106
2.1938
2.1784
2.1652
2.1484



5ak

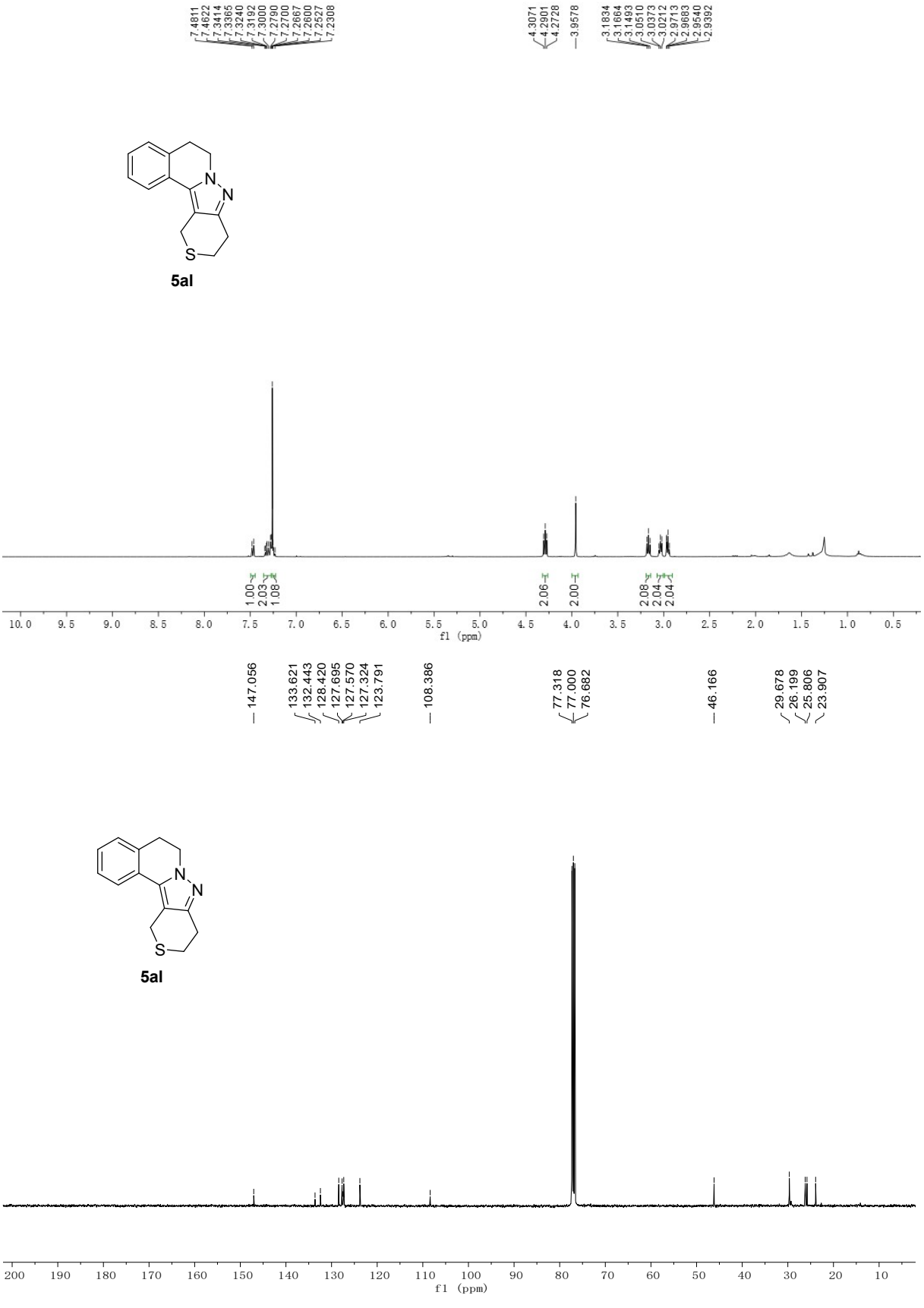

1.00
1.05
3.09
3.02
2.10
2.12
2.12
2.08
2.15
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


148.973
141.019
135.217
133.136
132.683
129.157
128.347
128.297
127.383
127.211
127.200
127.147
126.304
123.926
114.928
77.318
77.000
76.682
46.532
34.709
29.936
27.823
26.478



5ak

200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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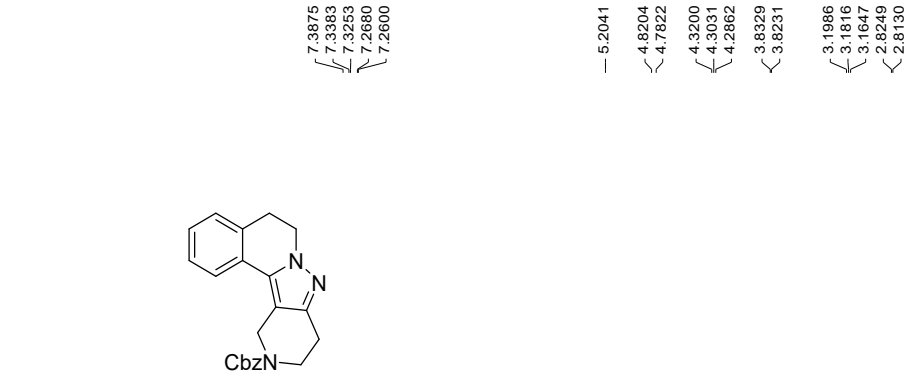
7.4622
7.3414
7.3365
7.3240
7.3192
7.3000
7.2790
7.2700
7.2667
7.2600
7.2527
7.2308
4.3071
4.2901
4.2728
3.9578
3.1834
3.1664
3.1493
3.0510
3.0373
3.0212
2.9713
2.9683
2.9540
2.9392
N
N
S
5al
1.00
2.03
1.08
2.06
2.00
2.08
2.04
2.04
f1 (ppm)
147.056
133.621
132.443
128.420
127.695
127.570
127.324
123.791
108.386
77.318
77.000
76.682
46.166
29.678
26.199
25.806
23.907
N
N
S
5al
f1 (ppm)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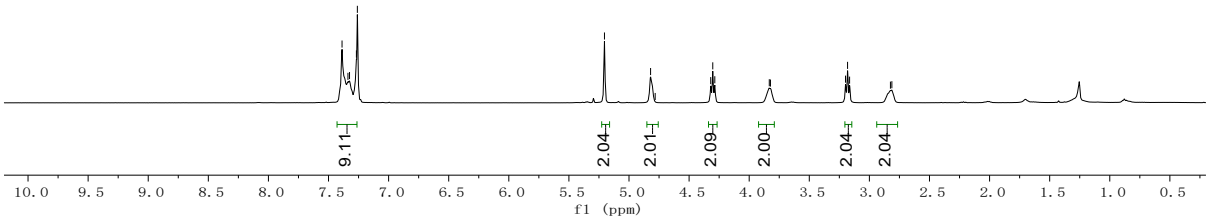
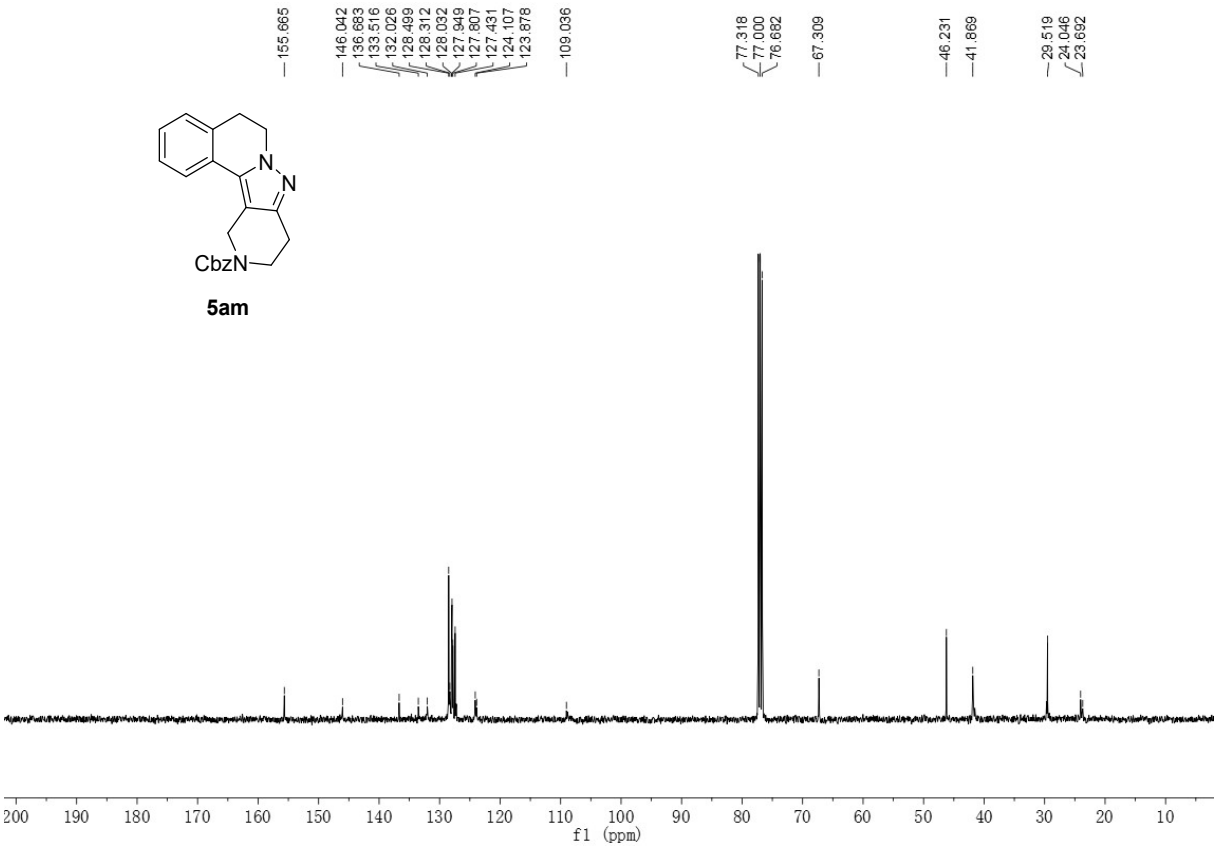
7.3253
7.2680
7.2600
5.2041
4.8204
4.7822
4.3200
4.3031
4.2862
3.8329
3.8231
3.1986
3.1816
3.1647
2.8249
2.8130
N
N
CbzN

5am


9.11
2.04
2.01
2.09
2.00
2.04
2.04
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
f1 (ppm)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136.683
133.516
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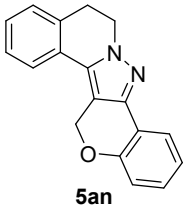
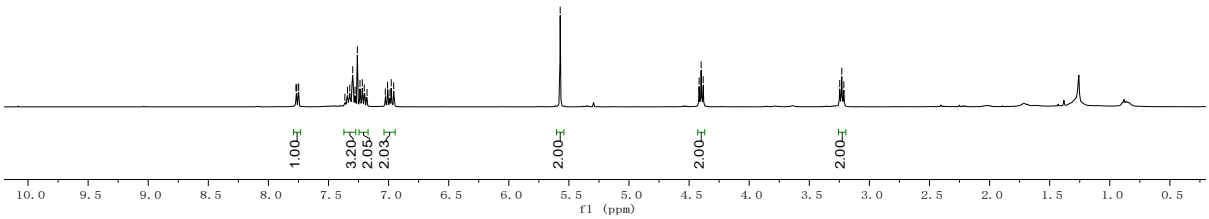
128.312
128.032
127.949
127.607
127.431
124.107
123.878
109.036
77.318
77.000
76.682
67.309
46.231
41.869
29.519
24.046
23.692
N
N
CbzN
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

5am


7.7709
7.7671
7.7519
7.7482
7.3639
7.3418
7.3234
7.2987
7.2793
7.2600
7.2379
7.2186
7.2025
7.1796
7.0276
7.0090
6.9885
6.9782
6.9578
5.5724
4.4167
4.3996
4.3824
3.2468
3.2297
3.2125



5an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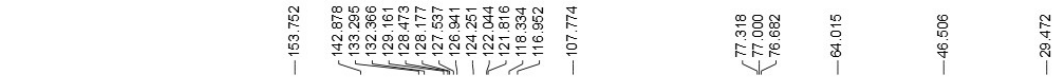
3.20
2.05
2.03
2.00
2.00
2.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)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133.295
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128.177
127.537
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124.251
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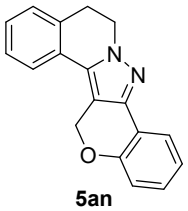
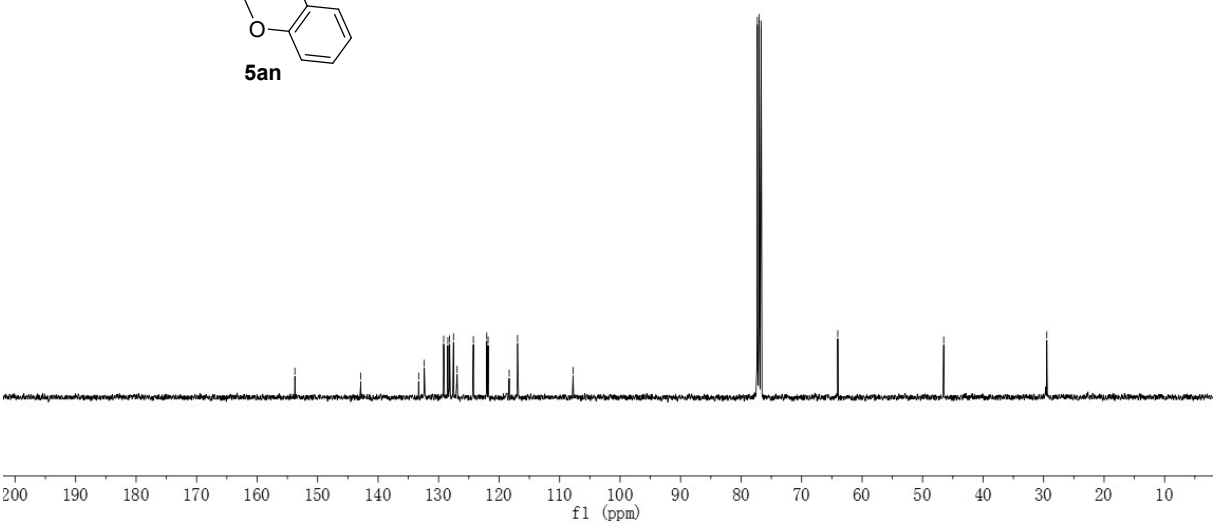
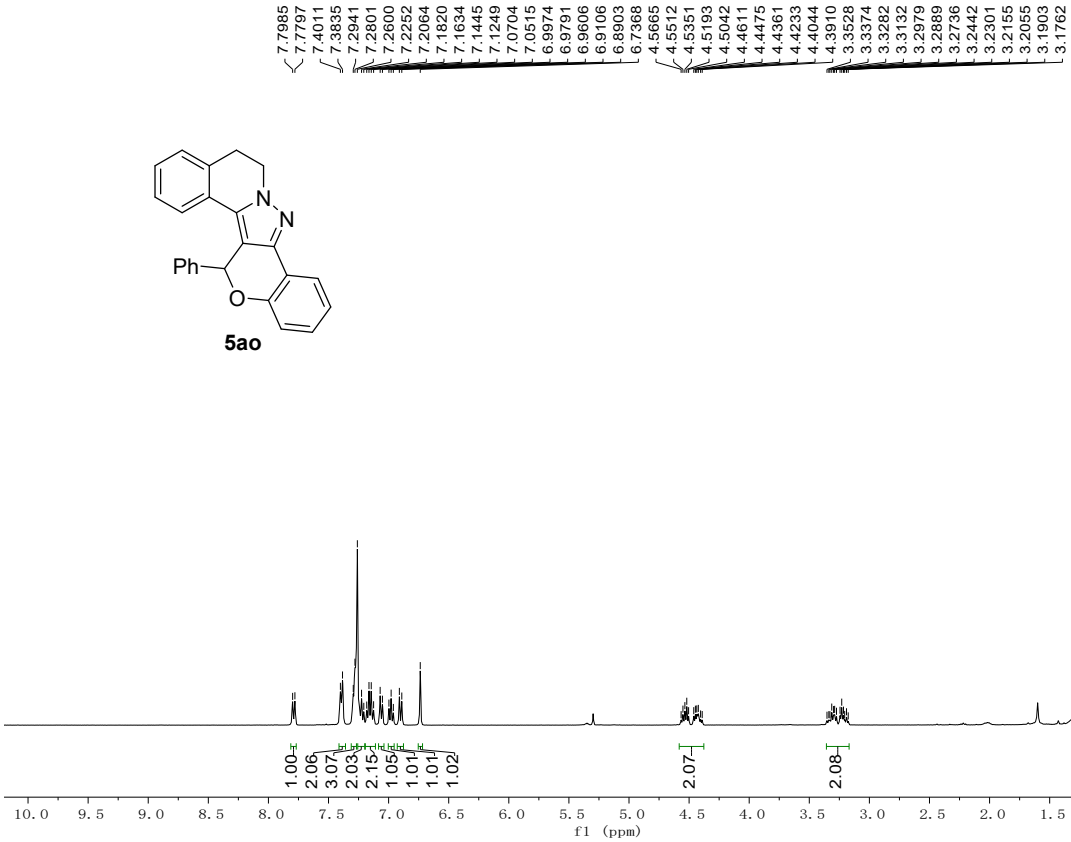
121.816
118.334
116.952
107.774
77.318
77.000
76.682
64.015
46.506
29.472



5an


200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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7.3835
7.2941
7.2801
7.2600
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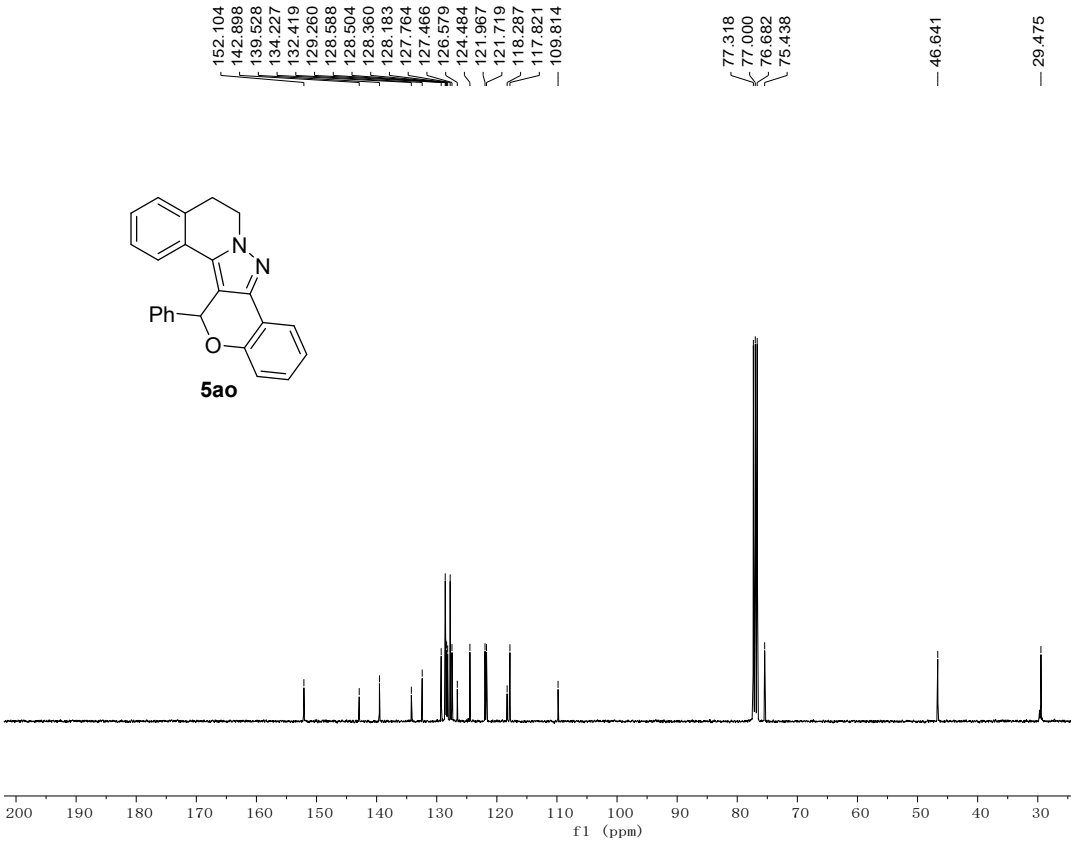
7.2064
7.1820
7.1634
7.1445
7.1249
7.0704
7.0515
6.9974
6.9791
6.9606
6.9106
6.8903
6.7368
4.5665
4.5512
4.5351
4.5193
4.5042
4.4611
4.4475
4.4361
4.4233
4.4044
4.3910
3.3528
3.3374
3.3282
3.3132
3.2979
3.2889
3.2736
3.2442
3.2301
3.2155
3.2055
3.1903
3.1762
N
N
Ph
O
5ao
1.00
2.06
3.07
2.03
2.15
1.05
1.01
1.01
1.02
2.07
2.08
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
f1 (ppm)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142.898
139.528
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132.419
129.260
128.588
128.504
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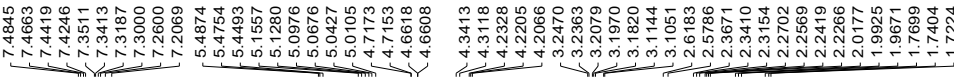
128.183
127.764
127.466
126.579
124.484
121.967
121.719
118.287
117.821
109.814
77.318
77.000
76.682
75.438
46.641
29.475
N
N
Ph
O
5ao
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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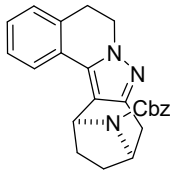
7.4663
7.4419
7.4246
7.3511
7.3413
7.3187
7.3000
7.2600
7.2069
5.4874
5.4754
5.4493
5.1557
5.1280
5.0976
5.0676
5.0427
5.0105
4.7173
4.7153
4.6618
4.6608
4.3413
4.3118
4.2328
4.2205
4.2066
3.2470
3.2363
3.2079
3.1970
3.1820
3.1144
3.1051
2.6183
2.5786
2.3671
2.3410
2.3154
2.2702
2.2569
2.2419
2.2266
2.0177
1.9925
1.9671
1.7699
1.7404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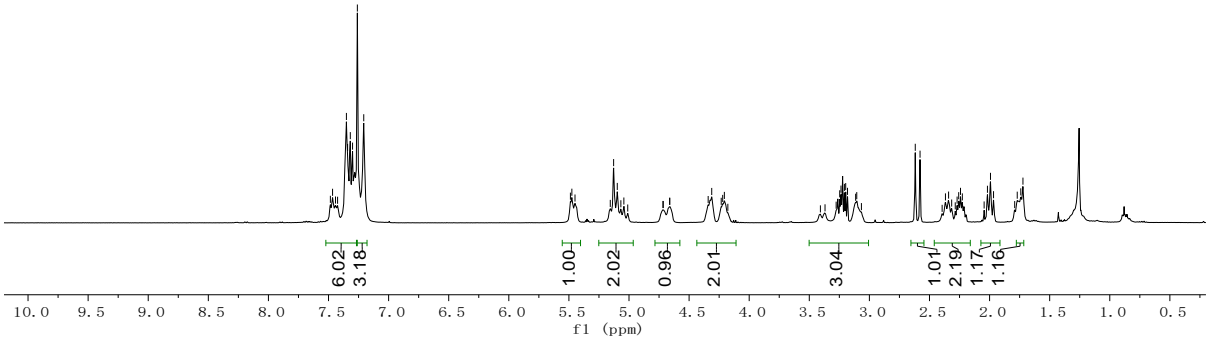
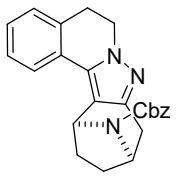
N
Cbz
N

5ap

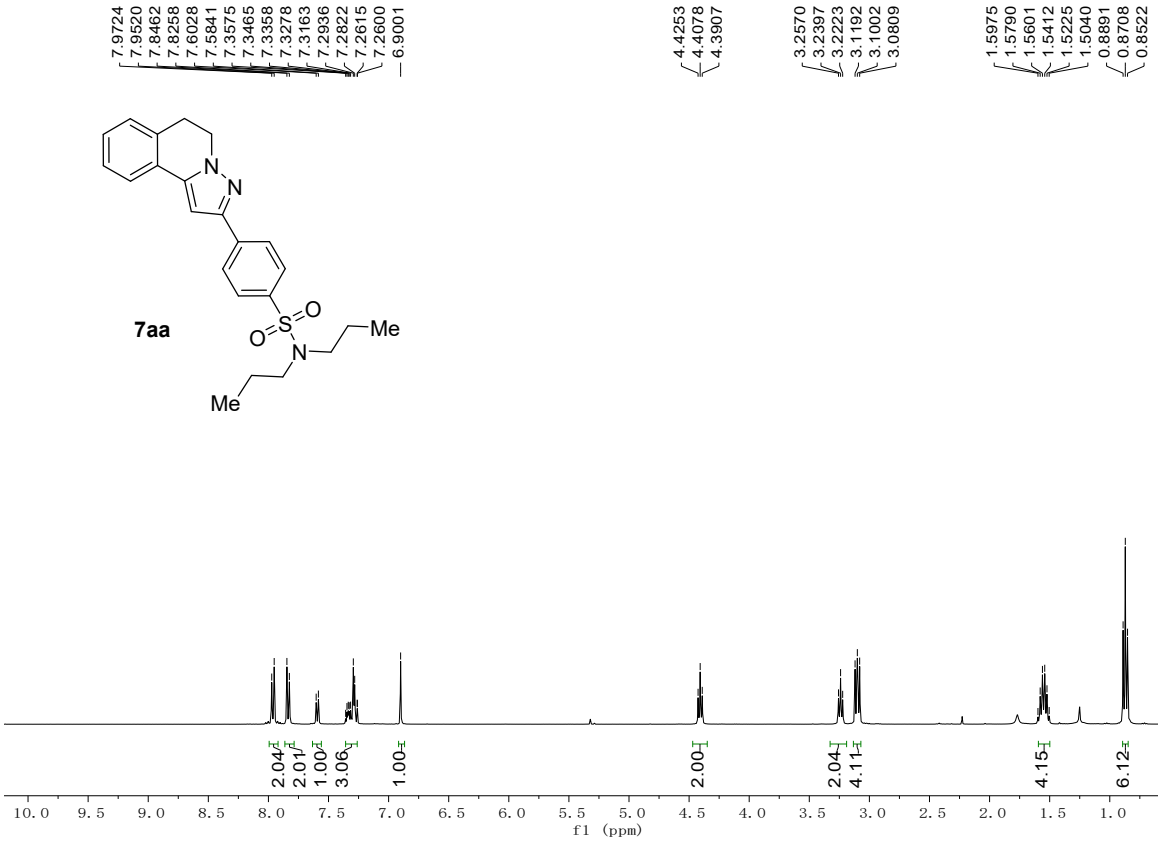

6.02
3.18
1.00
2.02
0.96
2.01
3.04
1.01
2.19
1.17
1.16
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


153.786
145.097
144.669
136.805
136.660
132.344
132.316
131.881
128.449
128.275
127.910
127.766
127.656
127.382
124.272
124.006
117.104
116.972
77.318
77.000
76.682
66.870
66.494
52.300
52.145
52.049
51.836
46.158
35.473
34.811
32.418
31.558
29.657
29.452
29.234
29.234
28.366


N
N
Cbz
N

5ap

200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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7.3575
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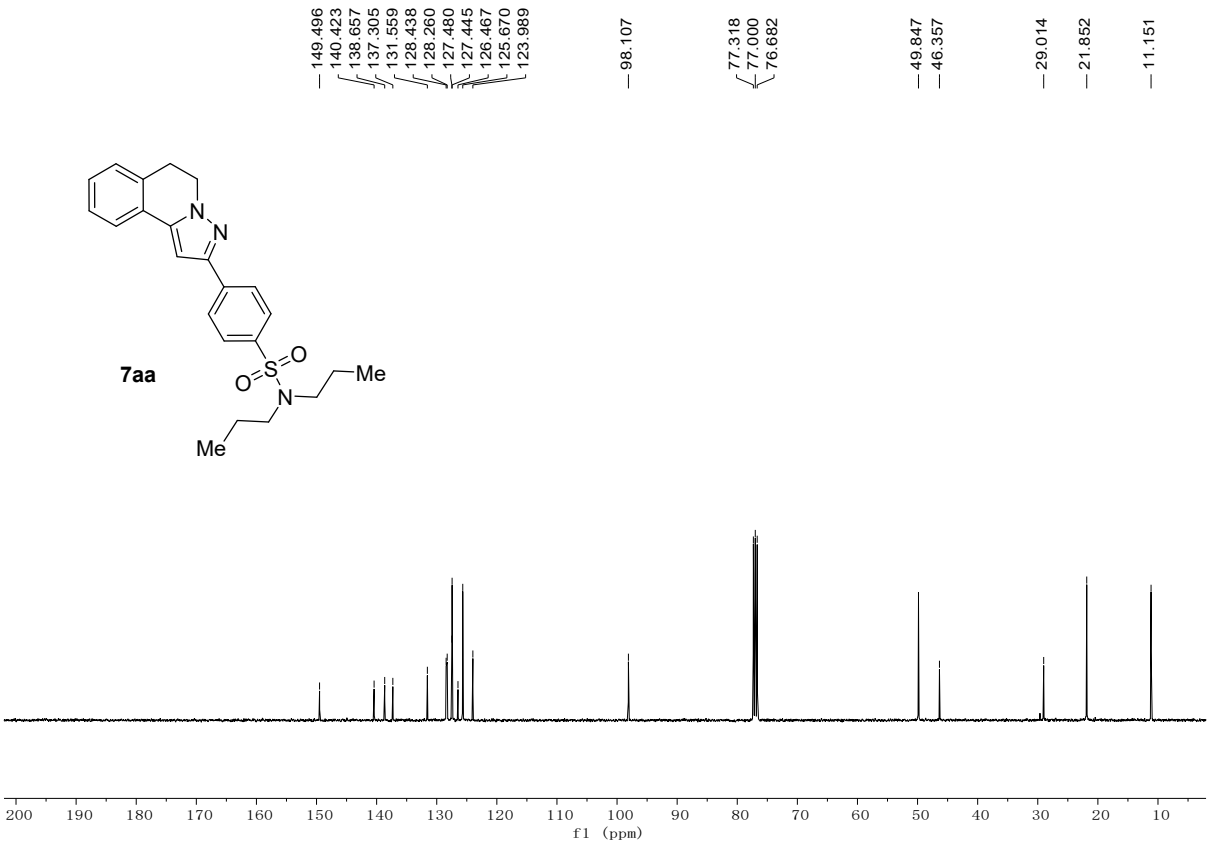
7.3358
7.3278
7.3163
7.2936
7.2822
7.2615
7.2600
6.9001
4.4253
4.4078
4.3907
3.2570
3.2397
3.2223
3.1192
3.1002
3.0809
1.5975
1.5790
1.5601
1.5412
1.5225
1.5040
0.8891
0.8708
0.8522
7aa
Me
Me
2.04
2.01
1.00
3.06
1.00
2.00
2.04
4.11
4.15
6.12
f1 (ppm)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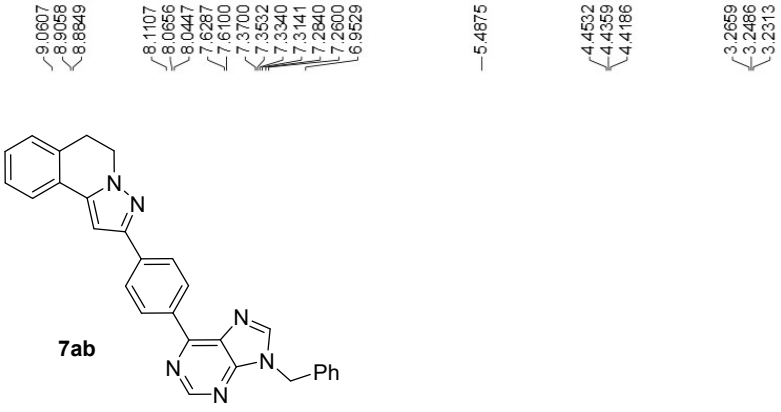
137.305
131.559
128.438
128.260
127.480
127.445
126.467
125.670
123.989
98.107
77.318
77.000
76.682
49.847
46.357
29.014
21.852
11.151
7aa
Me
Me
f1 (ppm)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8.9058
8.8849
8.1107
8.0656
8.0447
7.6287
7.6100
7.3700
7.3532
7.3340
7.3141
7.2840
7.2600
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5.4875
4.4532
4.4359
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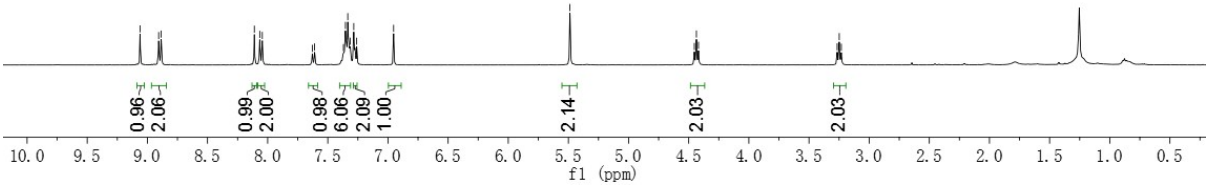
3.2659
3.2486
3.2313
7ab
Ph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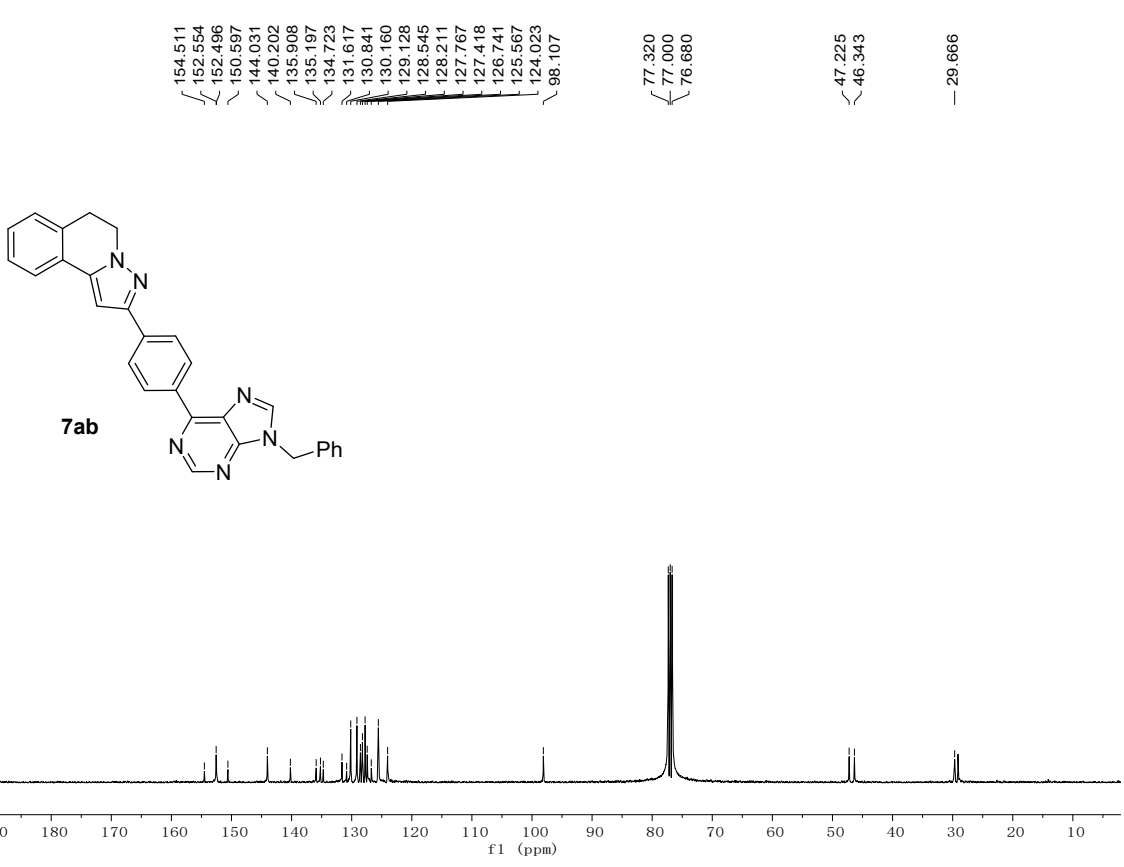
2.09
1.00
2.14
2.03
2.03
f1 (ppm)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135.197
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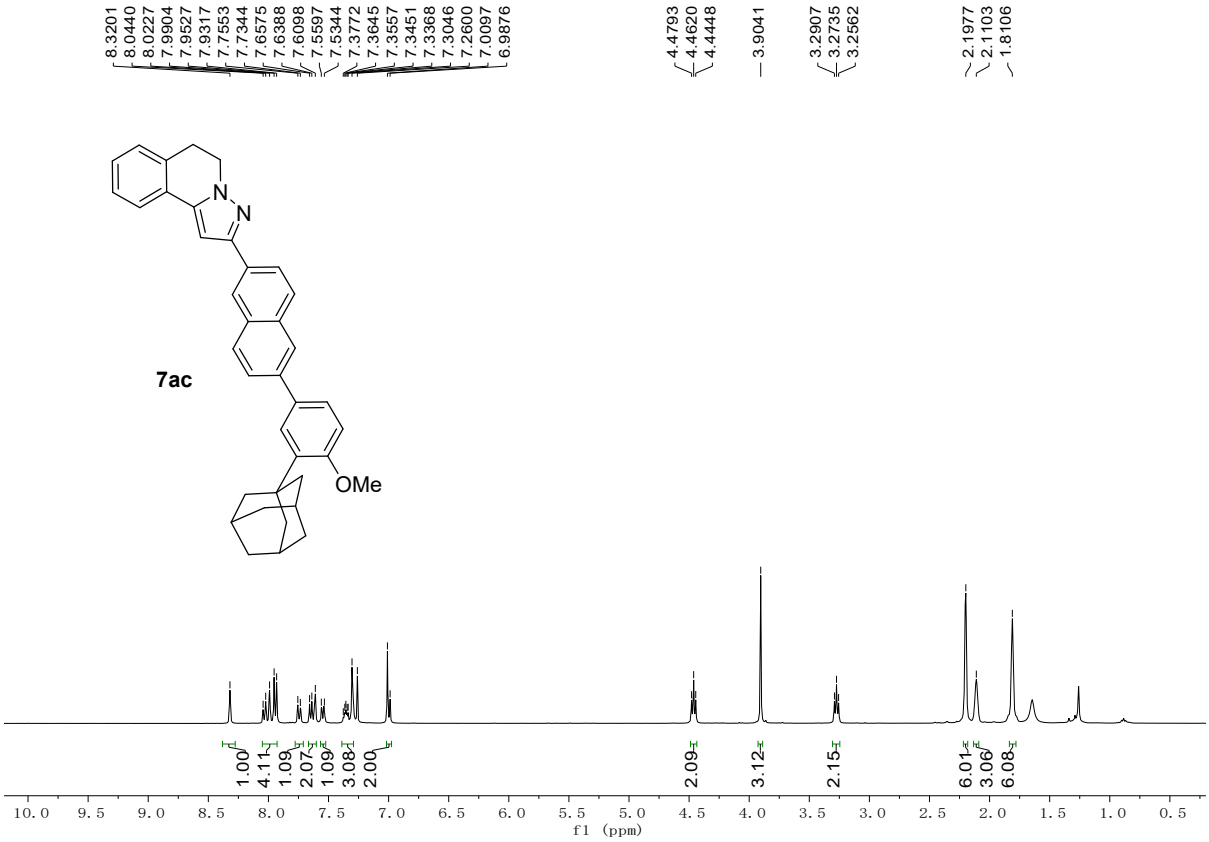
131.617
130.841
130.160
129.128
128.545
128.211
127.767
127.418
126.741
125.567
124.023
98.107
77.320
77.000
76.680
47.225
46.343
29.666
7ab
Ph
f1 (ppm)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7.7344
7.6575
7.6388
7.6098
7.5597
7.5344
7.3772
7.3645
7.3557
7.3451
7.3368
7.3046
7.2600
7.0097
6.9876
4.4793
4.4620
4.4448
3.9041
3.2907
3.2735
3.2562
2.1977
2.1103
1.8106
7ac
OMe
1.00
4.11
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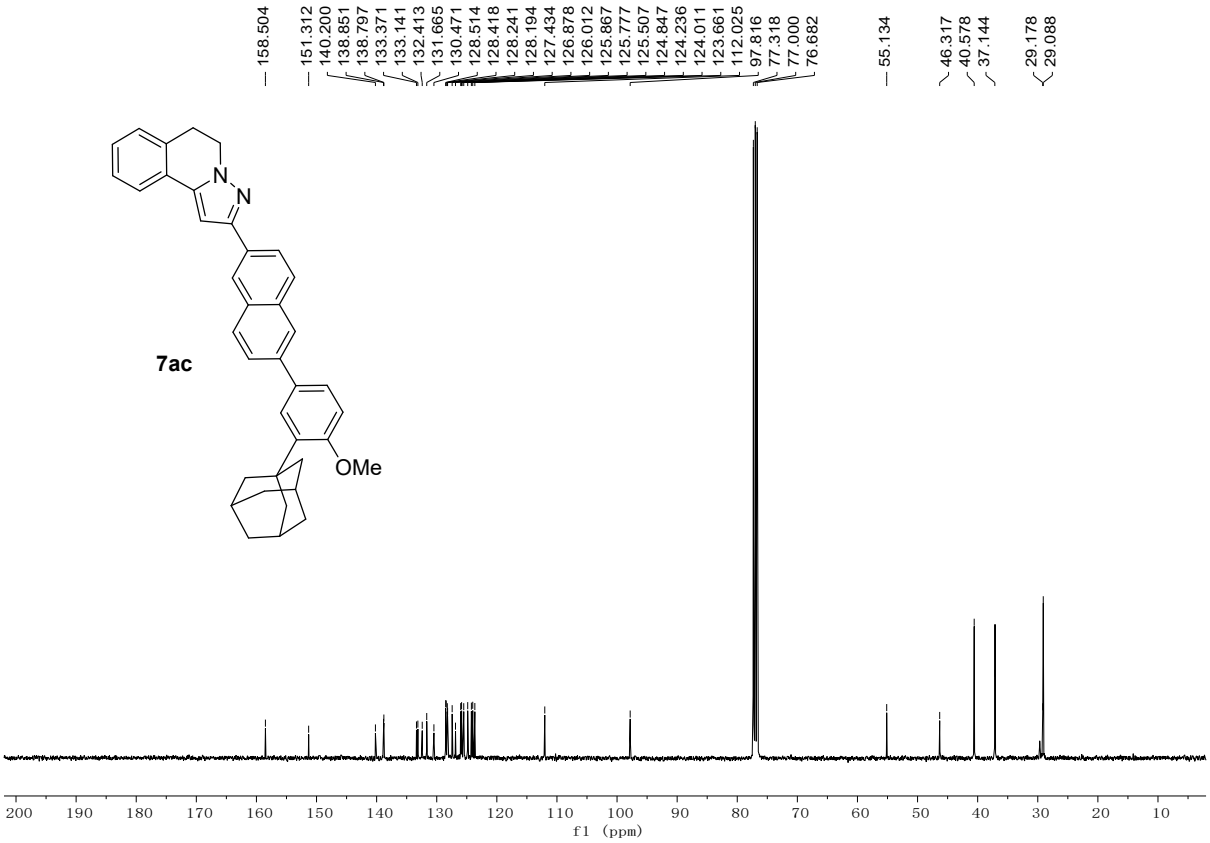
2.07
1.09
3.08
2.00
2.09
3.12
2.15
6.01
3.06
6.08
f1 (ppm)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132.413
131.665
130.471
128.514
128.418
128.241
128.194
127.434
126.878
126.012
125.867
125.777
125.507
124.847
124.236
124.011
123.661
112.025
97.816
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55.134
46.317
40.578
37.144
29.178
29.088
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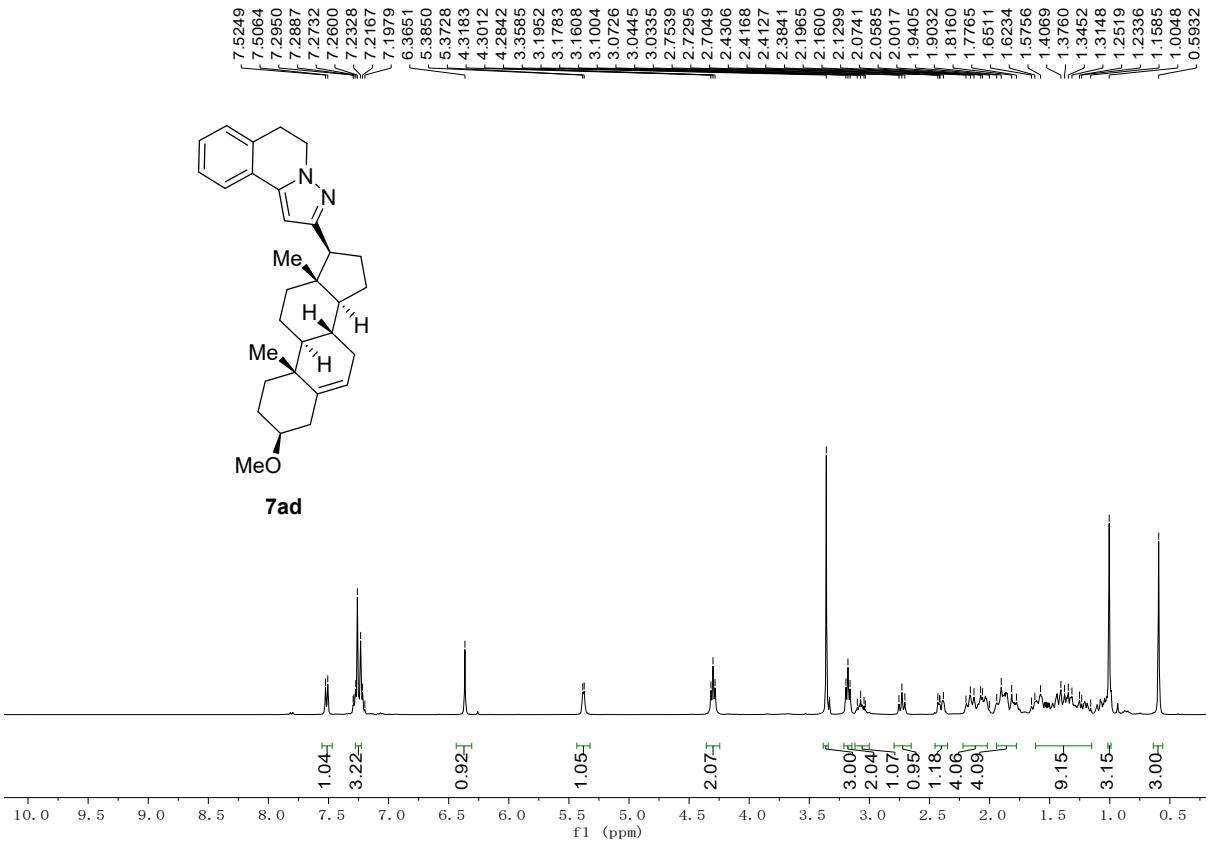
OMe
f1 (ppm)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5.3728
4.3183
4.3012
4.2842
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3.1952
3.1783
3.1608
3.1004
3.0726
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3.0335
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2.7295
2.7049
2.4306
2.4168
2.4127
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2.1600
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2.0741
2.0585
2.0017
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1.9032
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1.7765
1.6511
1.6234
1.5756
1.4069
1.3760
1.3452
1.3148
1.2519
1.2336
1.1585
1.0048
0.5932
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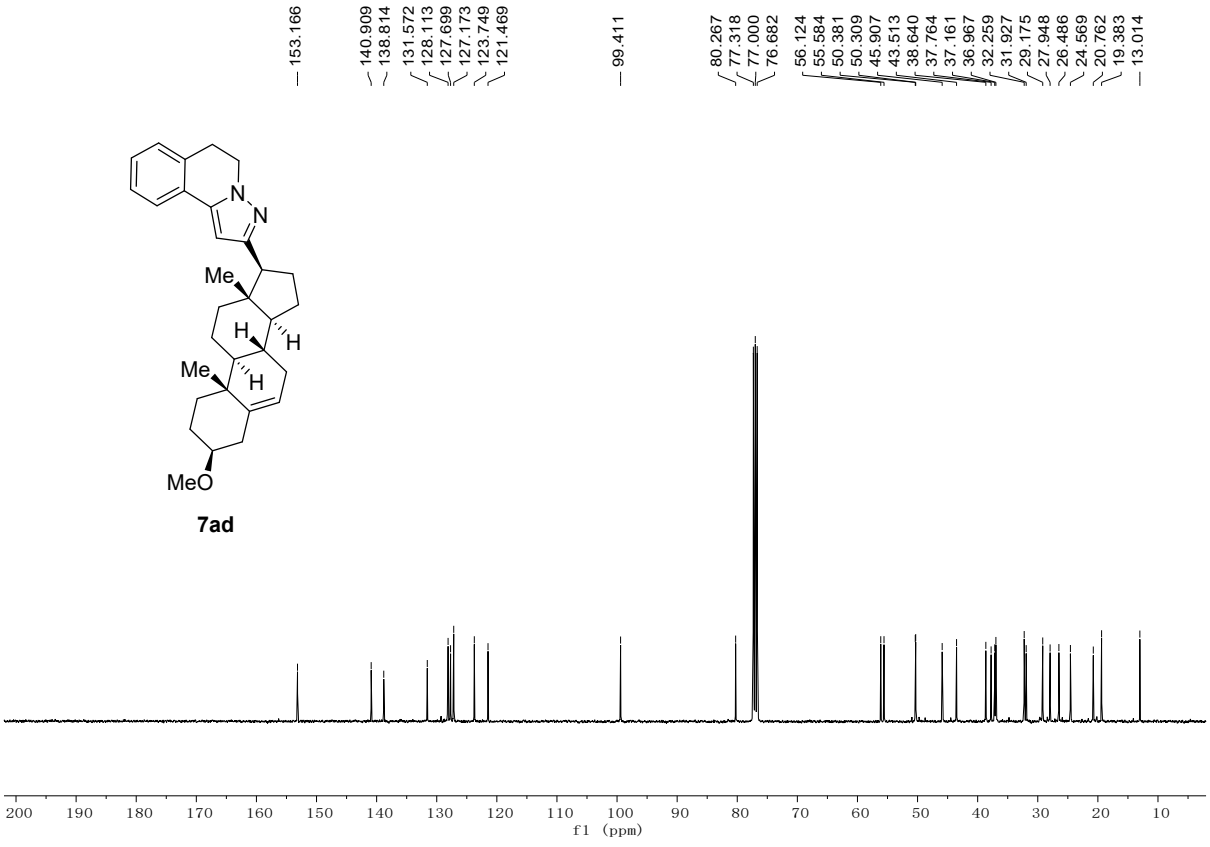
N
Me
H
H
Me
H
MeO
1.04
3.22
0.92
1.05
2.07
3.00
2.04
1.07
0.95
1.18
4.06
4.09
9.15
3.15
3.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

7ad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80.267
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77.000
76.682
56.124
55.584
50.381
50.309
45.907
43.513
38.640
37.764
37.161
36.967
32.259
31.927
29.175
27.948
26.486
24.569
20.762
19.383
13.014
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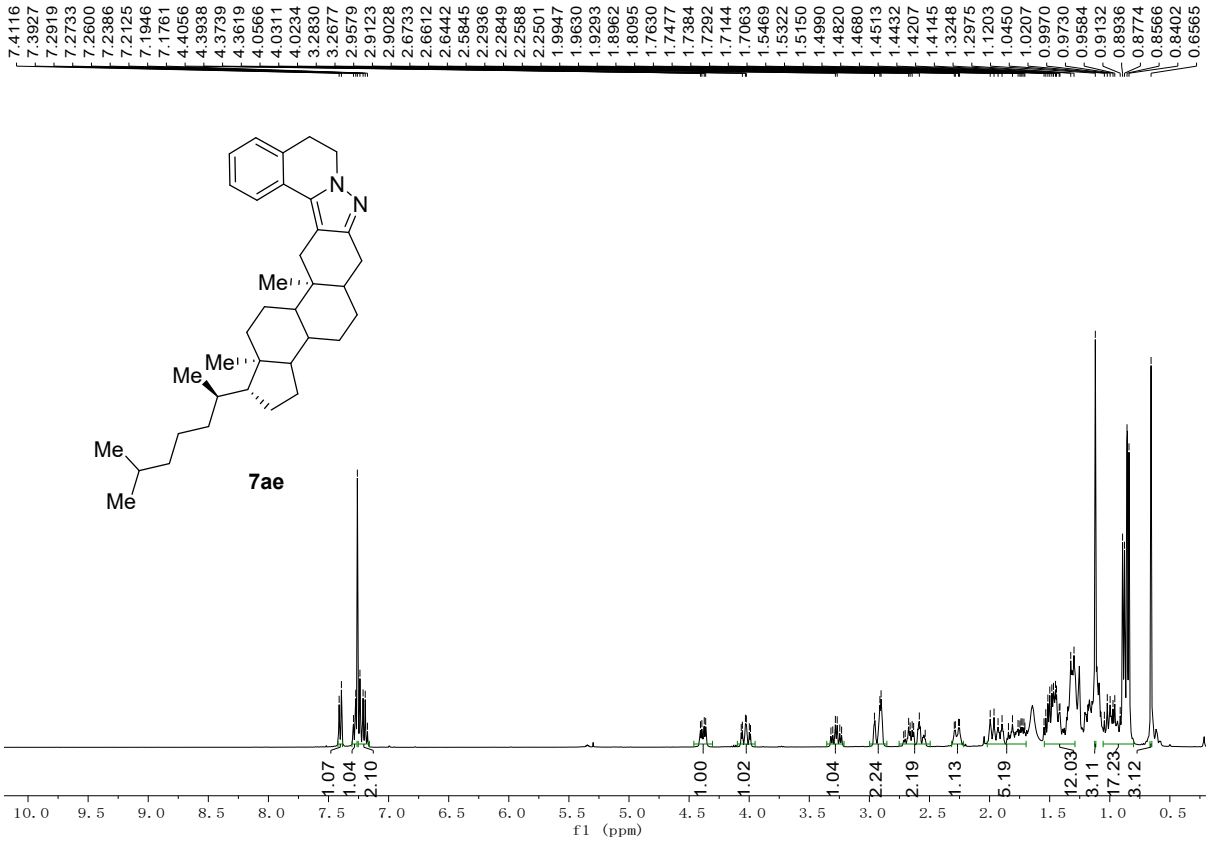
H
H
Me
H
MeO
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

7ad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4.0311
4.0234
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3.2677
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2.9028
2.6733
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2.5845
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1.5150
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1.4680
1.4513
1.4432
1.4207
1.4145
1.3248
1.2975
1.1203
1.0450
1.0207
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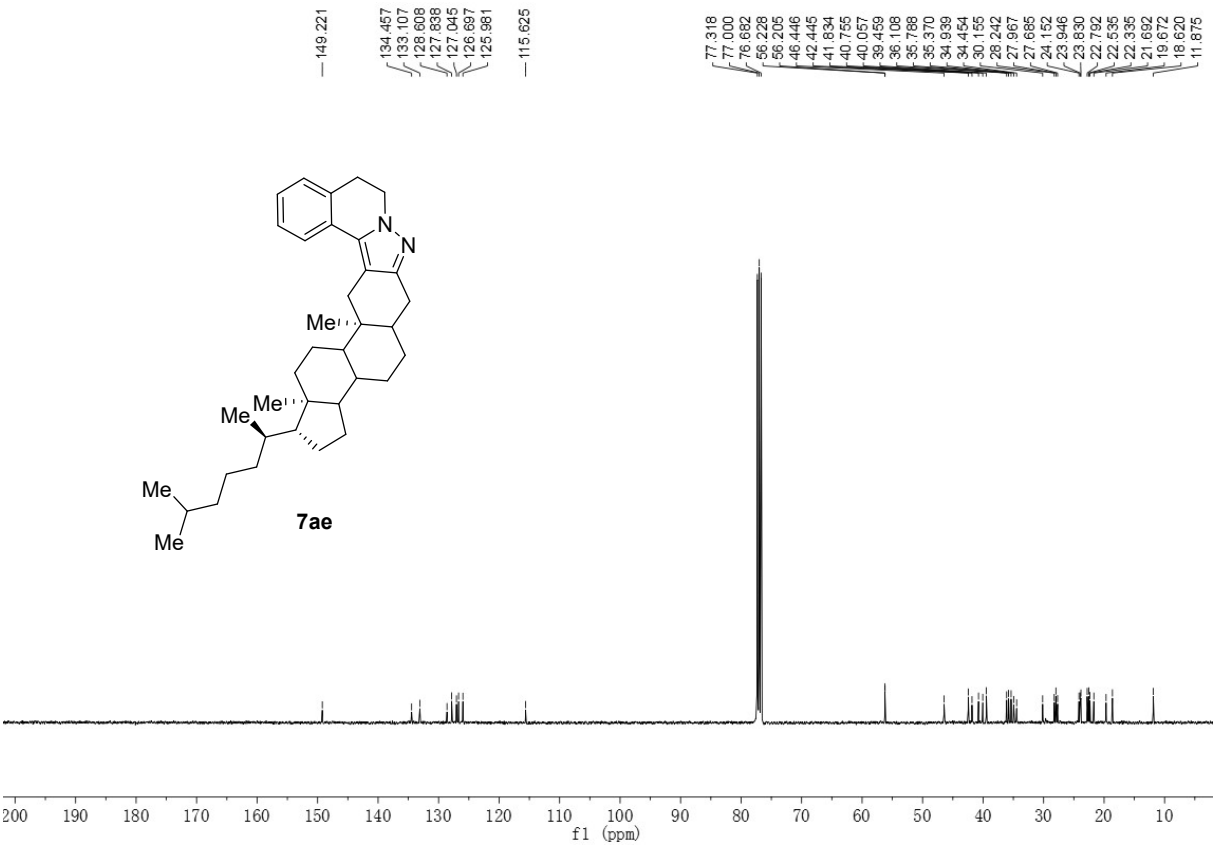
0.9730
0.9584
0.9132
0.8936
0.8774
0.8566
0.8402
0.6565
Me
Me
Me
Me
7ae
1.07
1.04
2.10
1.00
1.02
1.04
2.24
2.19
1.13
5.19
12.03
3.11
17.23
3.12
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)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128.608
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127.045
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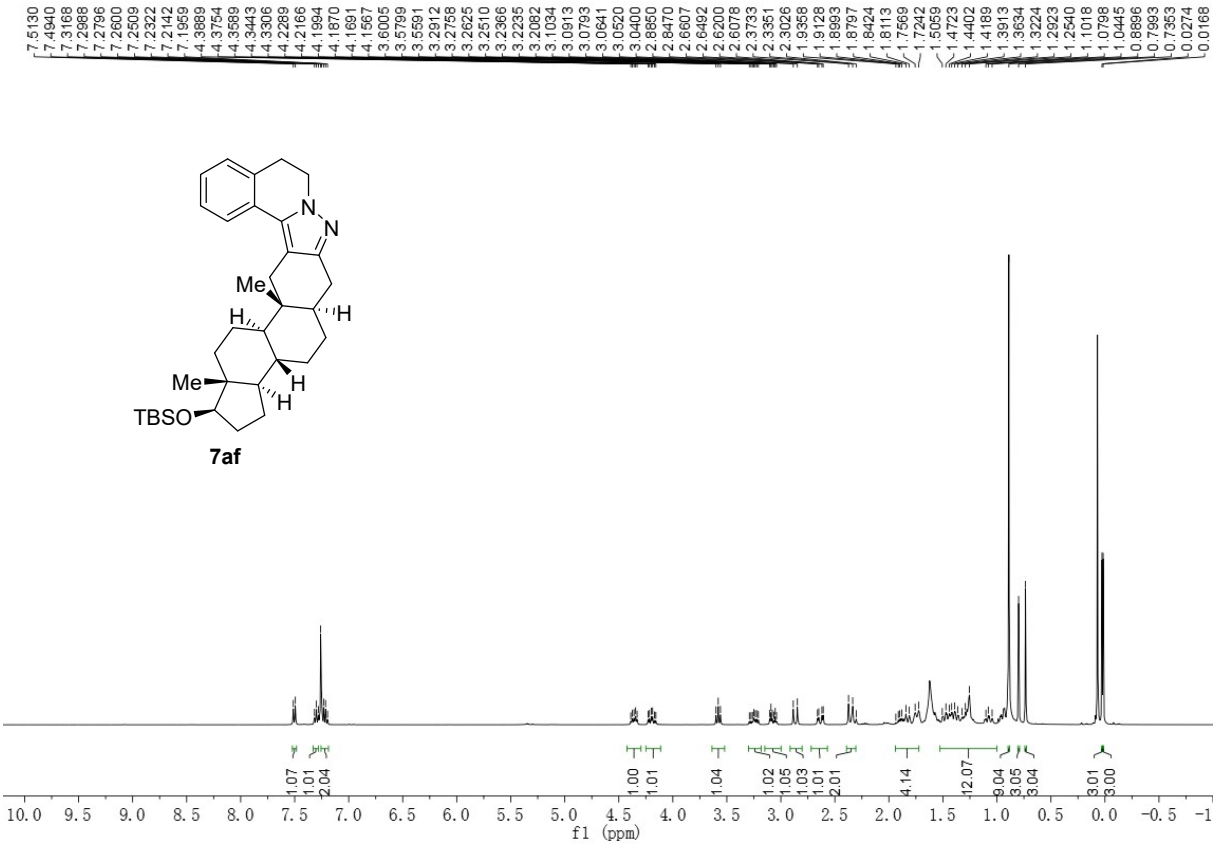
125.981
115.625
77.318
77.000
76.682
56.228
56.205
46.446
42.445
41.834
40.755
40.057
39.459
36.108
35.788
35.370
34.939
34.454
30.155
28.242
27.967
27.685
24.152
23.946
23.830
22.792
22.535
22.335
21.692
19.672
18.620
11.875
Me
Me
Me
Me
7ae
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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4.3754
4.3589
4.3443
4.3306
4.2289
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4.1994
4.1870
4.1691
4.1567
3.6005
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3.2366
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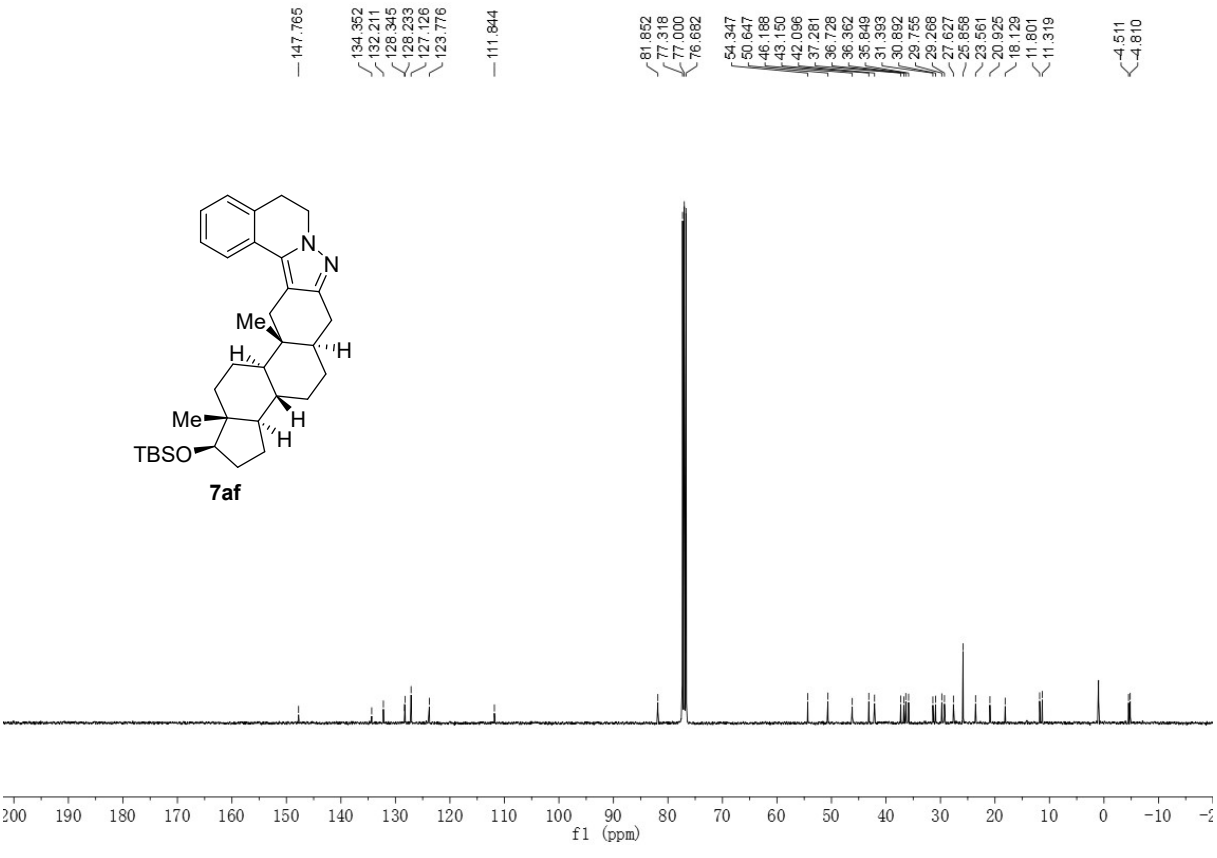
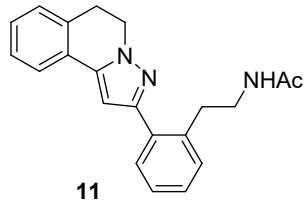
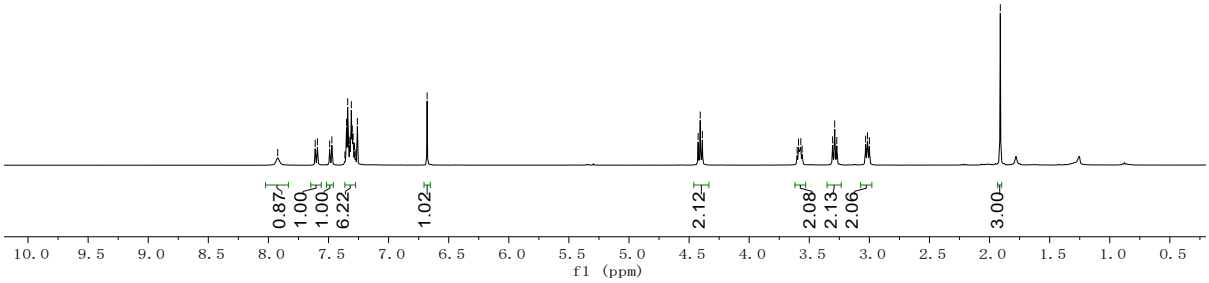
Me
H
H
Me
H
H
TBSO
7af
1.07
1.01
2.04
1.00
1.01
1.04
1.02
1.05
1.03
1.01
2.01
4.14
12.07
9.04
3.05
3.04
3.01
3.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 −0.5 −1
f1 (ppm)


147.765
134.352
132.211
128.345
128.233
127.126
123.776
111.844
81.852
77.318
77.000
76.682
54.347
50.647
46.188
43.150
42.096
37.281
36.728
36.362
35.849
31.393
30.892
29.755
29.268
27.627
25.858
23.561
20.925
18.129
11.801
11.319
-4.511
-4.810
N
N
Me
H
H
Me
H
H
TBSO
7af
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10 −2
f1 (ppm)

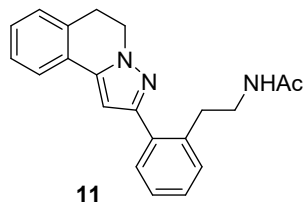

7.9227
7.6107
7.5926
7.4906
7.4722
7.3638
7.3500
7.3406
7.3318
7.3229
7.3103
7.3025
7.2950
7.2838
7.2730
7.2600
6.6797
4.4246
4.4073
4.3898
3.6010
3.5895
3.5706
3.5595
3.3059
3.2886
3.2712
3.0312
3.0155
3.0003
1.9107


N
N
NHAc

11


0.87
1.00
1.00
6.22
1.02
2.12
2.08
2.13
2.06
3.00
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
f1 (ppm)

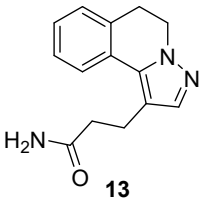

170.358
151.677
139.720
137.813
133.352
131.463
130.439
129.957
128.436
128.374
128.288
127.528
126.522
126.454
124.149
100.840
77.318
77.000
76.682
46.213
42.127
31.356
29.043
23.084


N
N
NHAc

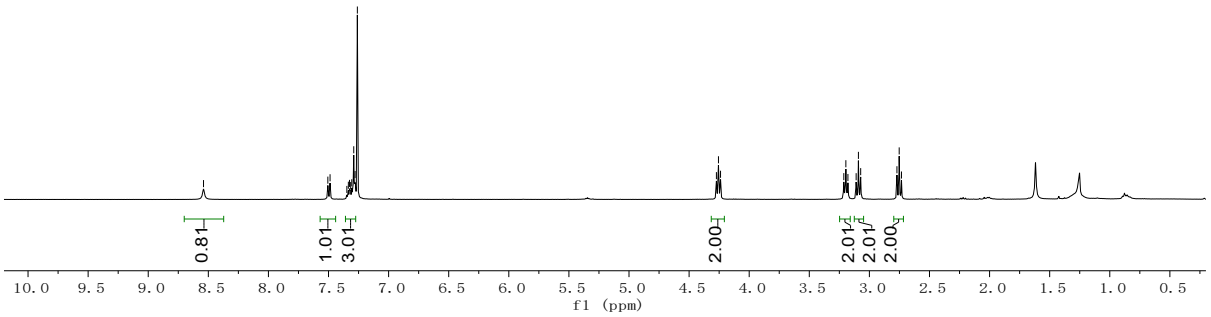
11

200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

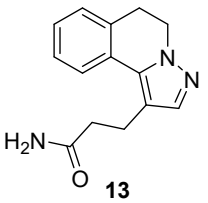

8.5400
7.5056
7.4872
7.3474
7.3349
7.3252
7.3156
7.3065
7.2901
7.2790
7.2600
4.2727
4.2557
4.2384
3.2128
3.1958
3.1786
3.1102
3.0912
3.0724
2.7708
2.7520
2.7330


N
N
H2N
O

13


0.81
1.01
3.01
2.00
2.01
2.01
2.00
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
f1 (ppm)

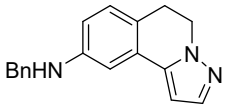

170.605
148.178
134.429
132.410
128.482
128.227
127.335
127.062
124.041
97.497
77.318
77.000
76.682
45.917
31.571
29.462
17.777


N
N
H2N
O

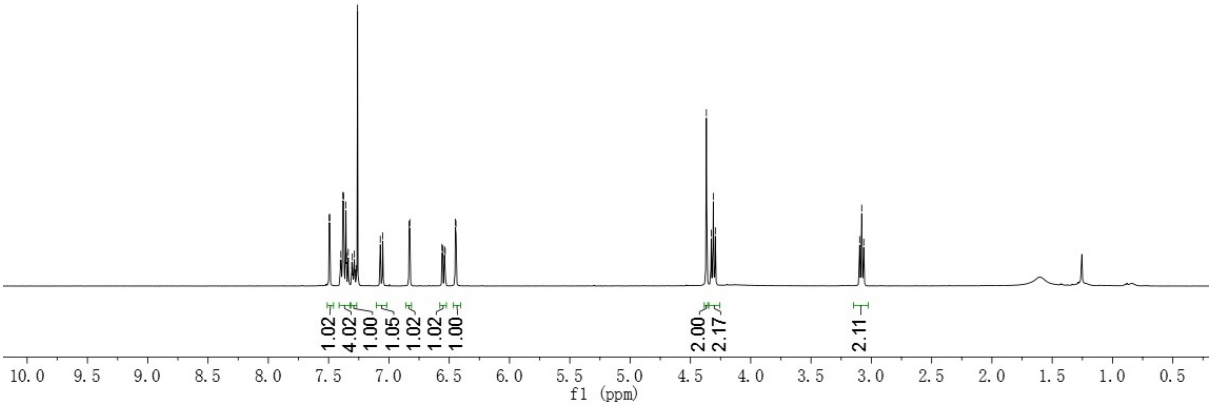
13

90 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

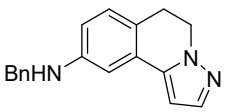

7.4953
7.4904
7.4029
7.3984
7.3818
7.3757
7.3564
7.3520
7.3371
7.3078
7.3036
7.2865
7.2796
7.2733
7.2692
7.2600
7.0712
7.0508
6.8326
6.8265
6.5600
6.5538
6.5395
6.5334
6.4489
6.4441
4.3675
4.3274
4.3102
4.2928
3.0968
3.0795
3.0623


BnHN
N
N

14


1.02
4.02
1.00
1.05
1.02
1.02
1.00
2.00
2.17
2.11
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
f1 (ppm)

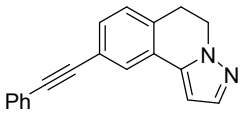

138.979
138.620
134.458
129.742
129.069
128.990
128.718
128.287
127.854
127.747
100.614
77.318
77.000
76.682
50.104
46.464
28.396


BnHN
N
N

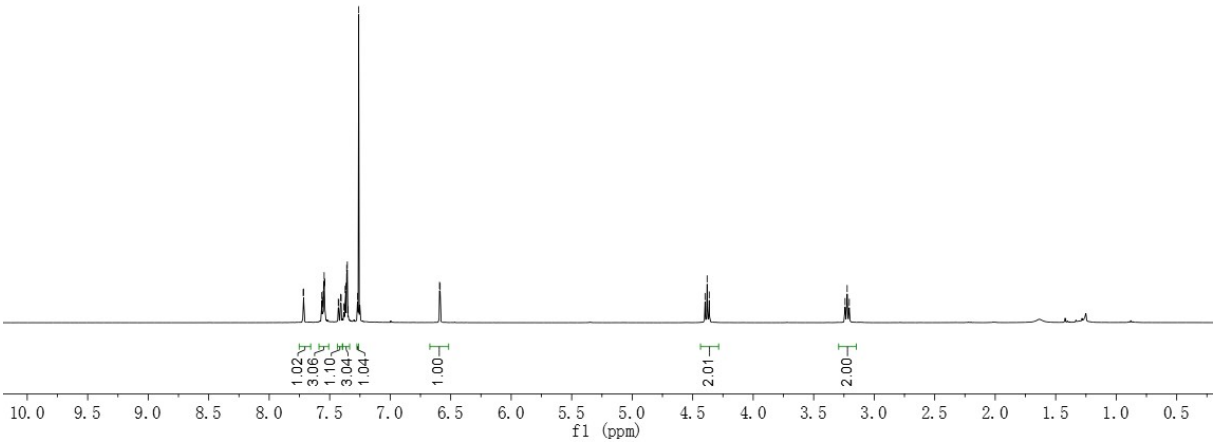
14

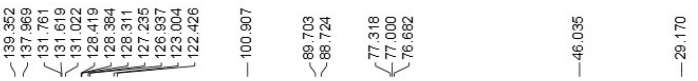
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

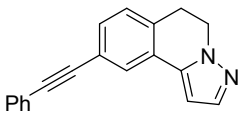

7.7189
7.7153
7.5652
7.5628
7.5597
7.5571
7.5537
7.5459
7.5430
7.5410
7.4290
7.4248
7.4095
7.4053
7.3824
7.3756
7.3719
7.3671
7.3593
7.3544
7.3477
7.2695
7.2600
6.5922
6.5873
4.3978
4.3805
4.3631
3.2406
3.2234
3.2061


Ph
N
N

15


1.02
3.06
1.10
3.04
1.04
1.00
2.01
2.00
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
f1 (ppm)

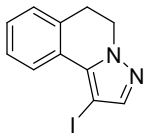

139.352
137.969
131.761
131.619
131.022
128.419
128.384
128.311
127.235
126.937
123.004
122.426
100.907
89.703
88.724
77.318
77.000
76.682
46.035
29.170


Ph
N
N

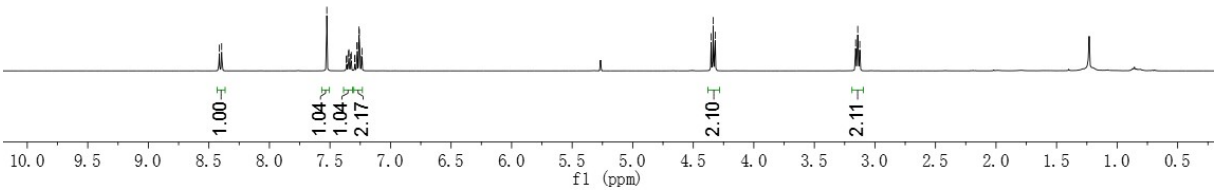
15

200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

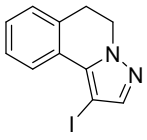

8.4134
8.3944
7.5260
7.3657
7.3607
7.3466
7.3434
7.3292
7.3242
7.2960
7.2929
7.2772
7.2742
7.2600
7.2573
7.2405
7.2345
4.3524
4.3356
4.3183
3.1590
3.1419
3.1250



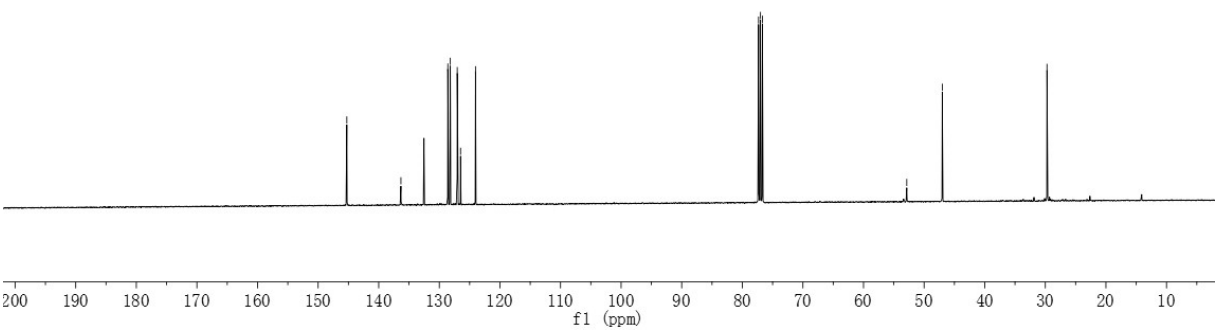
16


1.00
1.04
1.04
2.17
2.10
2.11
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
f1 (ppm)

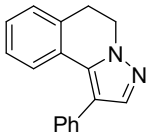

145.261
136.333
128.594
128.183
127.040
126.493
124.028
77.318
77.000
76.682
52.860
46.997
29.723



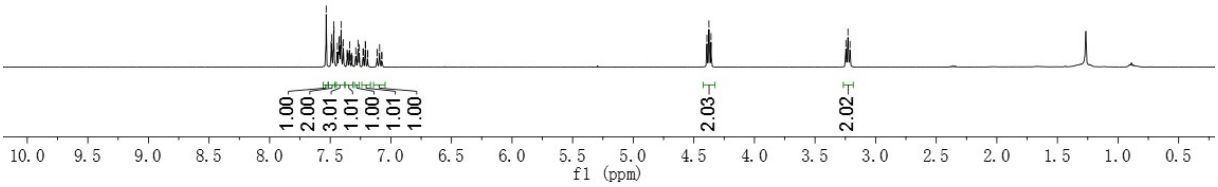
16


200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

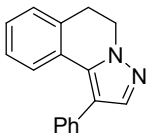

7.5333
7.4925
7.4886
7.4838
7.4712
7.4688
7.4410
7.4285
7.4234
7.4107
7.4069
7.3916
7.3613
7.3544
7.3456
7.3398
7.3336
7.3248
7.3216
7.3183
7.2894
7.2707
7.2600
7.2298
7.2269
7.2112
7.2083
7.1925
7.1896
7.1138
7.1112
7.0927
7.0759
7.0734
4.3922
4.3755
4.3583
3.2452
3.2283
3.2114


N
N
Ph

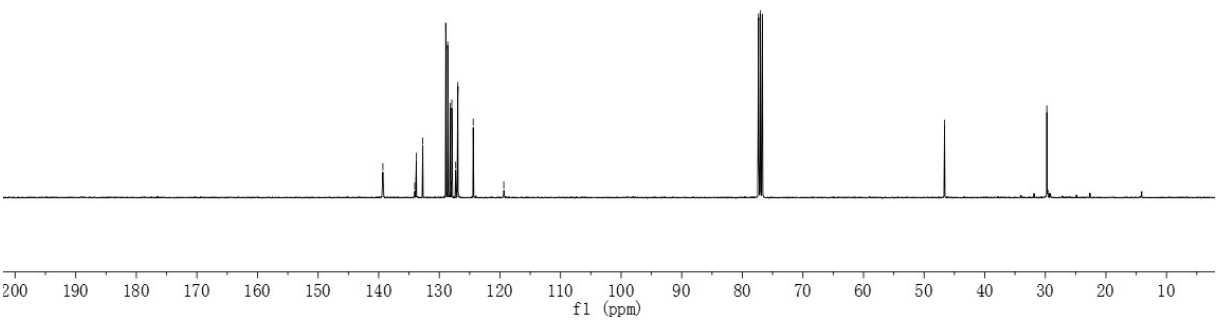
17


1.00
2.00
3.01
1.01
1.00
1.01
1.00
2.03
2.02
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
f1 (ppm)


139.308
134.049
133.797
132.728
128.930
128.614
128.207
127.939
127.293
126.940
126.931
124.411
119.360
77.318
77.000
76.682
46.627
29.749


N
N
Ph

17


200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


8.2622
8.2437
8.1025
8.0987
8.0833
8.0810
8.0794
7.9764
7.9711
7.7212
7.7188
7.7159
7.7028
7.6985
7.5886
7.5847
7.5706
7.5665
7.5518
7.5468
7.5326
7.5286
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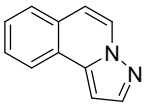
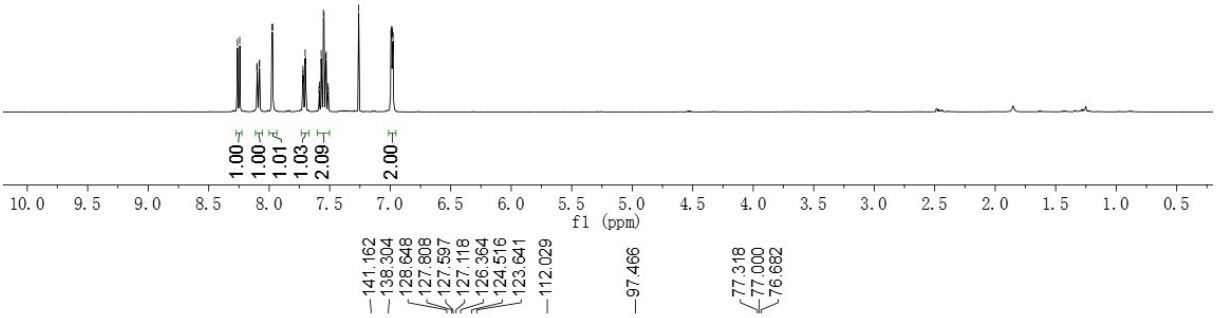
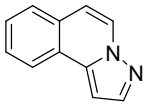
7.5107
7.2600
6.9941
6.9889
6.9871
6.9835
6.9817
6.9756



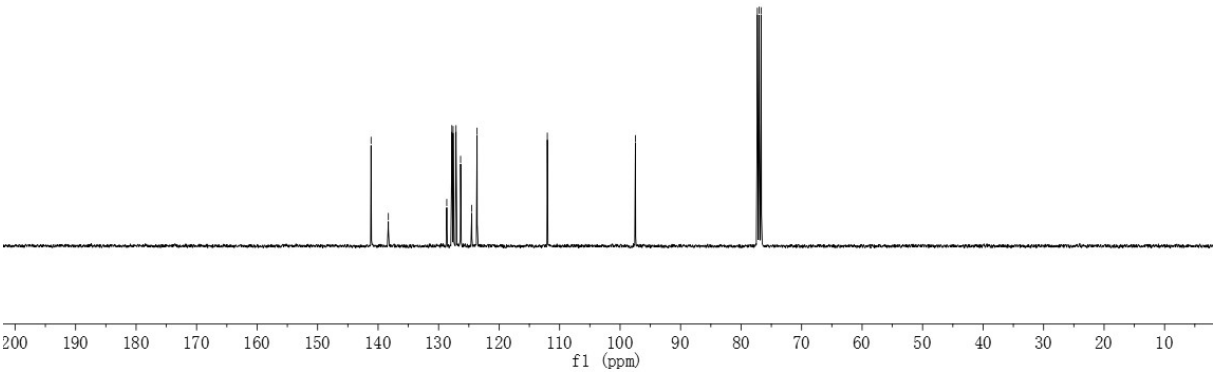
18


1.00
1.00
1.01
1.03
2.09
2.00
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
f1 (ppm)

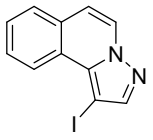
141.162
138.304
128.648
127.808
127.597
127.118
126.364
124.516
123.641
112.029
97.466
77.318
77.000
76.682



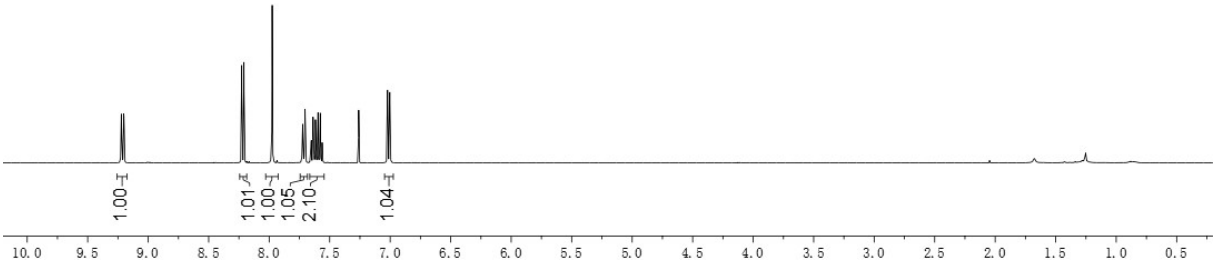
18


200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

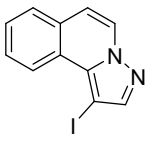

9.2220
9.2019
8.2272
8.2088
7.9752
7.7258
7.7232
7.7068
7.7035
7.6555
7.6519
7.6373
7.6340
7.6176
7.6136
7.5997
7.5962
7.5806
7.5775
7.5623
7.5591
7.2600
7.0219
7.0034


N
N
I

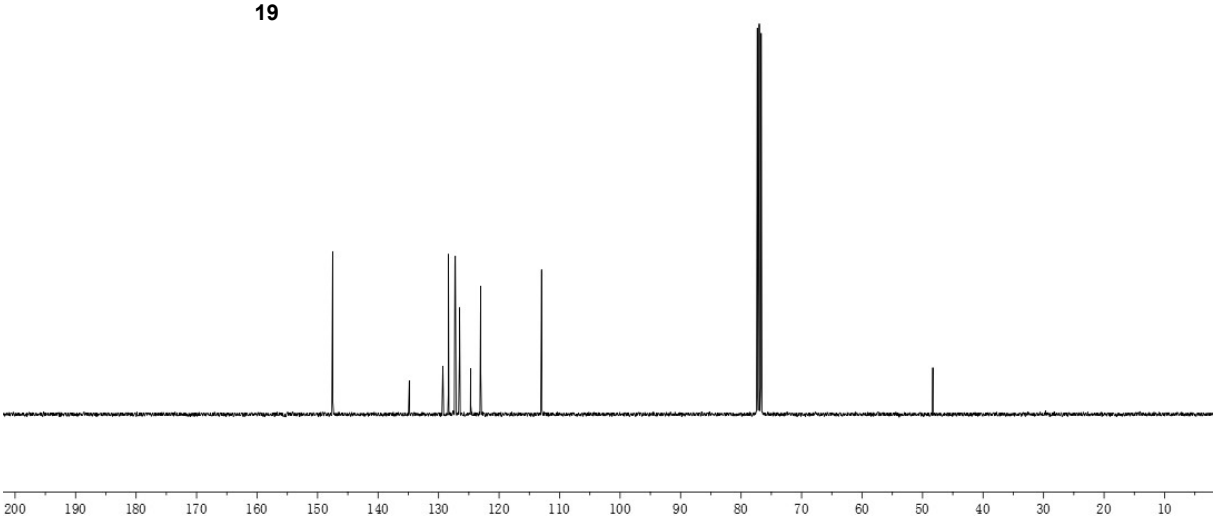
19

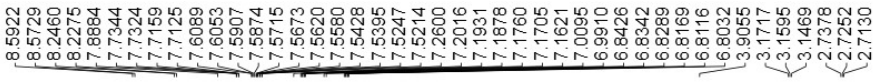

1.00
1.01
1.00
1.05
2.10
1.04
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5

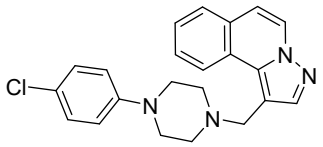

147.512
134.837
129.294
128.365
127.299
127.233
126.531
124.703
123.047
112.978
77.317
77.000
76.682
48.305


N
N
I

19


200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10


8.5922
8.5729
8.2460
8.2275
7.8884
7.7344
7.7324
7.7159
7.7125
7.6089
7.6053
7.5907
7.5874
7.5715
7.5673
7.5620
7.5580
7.5428
7.5395
7.5247
7.5214
7.2600
7.2016
7.1931
7.1878
7.1760
7.1705
7.1621
7.0095
6.9910
6.8426
6.8342
6.8289
6.8169
6.8116
6.8032
3.9055
3.1717
3.1595
3.1469
2.7378
2.7252
2.7130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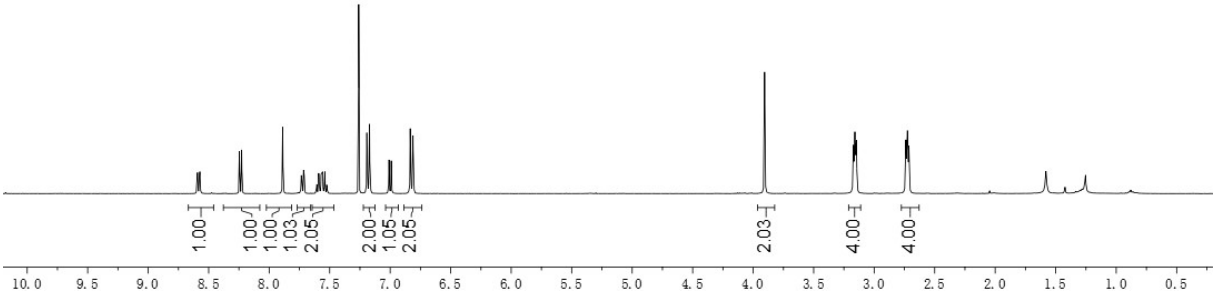
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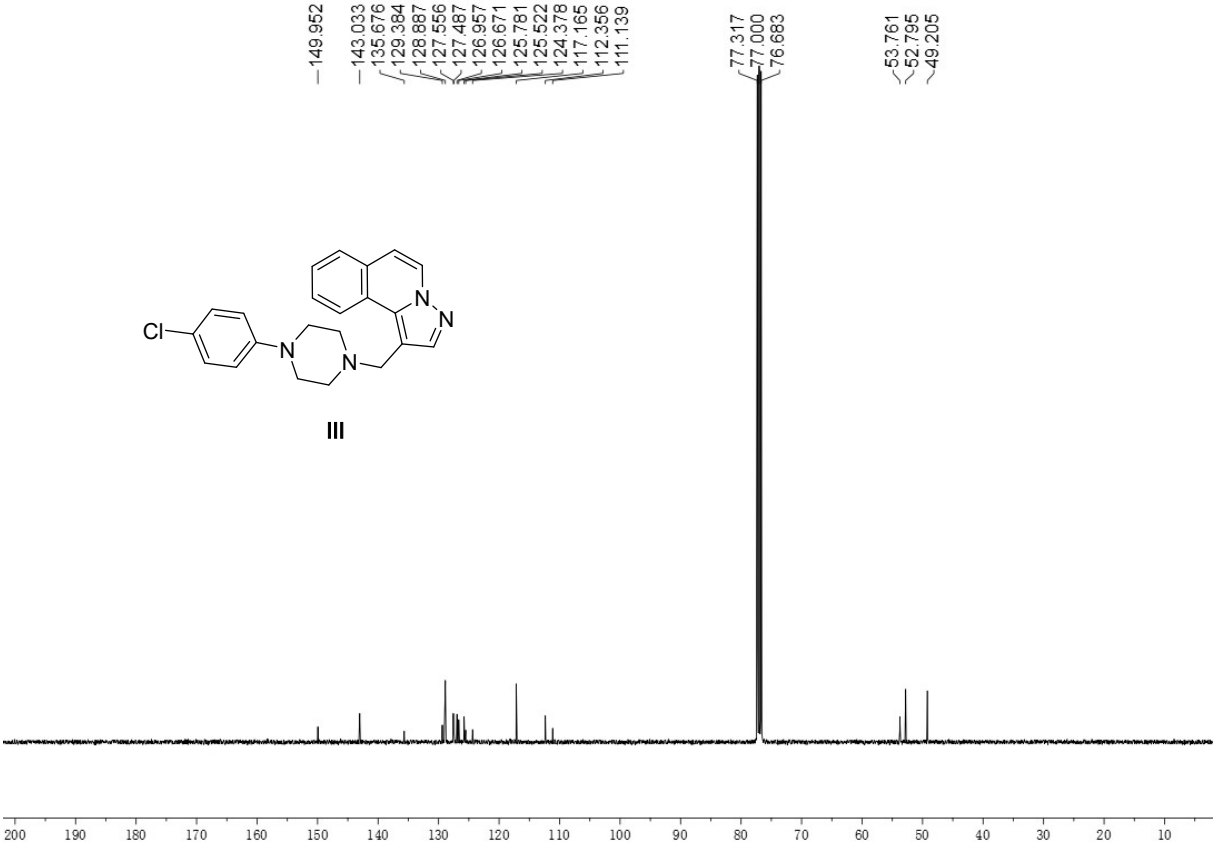
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30
20
10

Cl
N
N
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III