Supporting Information

Mild rhodium (I) catalyzed ring opening of cyclopropane appended spirotricyclic olefins through C-H activation of aryl boronic acids

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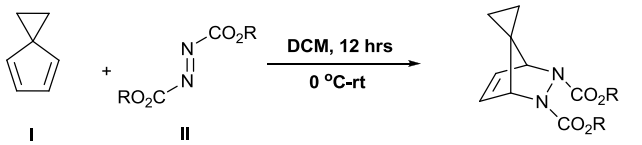
General Methods

All chemicals were of the best grade commercially available and are used without further purification. All the solvents were purified according to standard procedure; dry solvents were obtained according to the literature methods and stored over molecular sieves. Analytical thin layer chromatography was performed on glass plates coated with silica gel containing calcium sulfate binder. Gravity column chromatography was performed using 60-120 or 100-200 mesh silica gel and mixtures of hexane-ethyl acetate were used for elution.

Melting points was determined on a Buchi melting point apparatus and is uncorrected. Proton nuclear magnetic resonance spectra (^{1}H NMR) were recorded on a Bruker Avance DPX 300 and Bruker AMX 500 spectrophotometer ($CDCl_3$ as solvent. Chemical shifts for ^{1}H NMR spectra are reported as δ in units of parts per million (ppm) downfield from $SiMe_4$ (δ 0.0) and relative to the signal of chloroform-d (δ 7.25, singlet). Multiplicities were given as: s (singlet); d (doublet); t (triplet); q (quadret); dd (double doublet); m (multiplet). Coupling constants are reported as *J* value in Hz. Carbon nuclear magnetic resonance spectra (^{13}C NMR) are reported as δ in units of parts per million (ppm) downfield from $SiMe_4$ (δ 0.0) and relative to the signal of chloroform-d (δ 77.03, triplet). Mass spectra were recorded under ESI/HRMS at 5000 resolution using Thermoscientific Exactive mass spectrometer. IR spectra were recorded on Bruker FT-IR spectrometer.

General procedure for the preparation of spirotricyclic olefins



I II

1, a = CO_2Et
b = $CO_2{}^i$Pr
c = $CO_2{}^t$Bu
d = CO_2Bn

Spiro[2.4]hepta-4,6-diene **I,** prepared as per the literature procedure[1] was dissolved in DCM and cooled to 0 ^{o}C. Dialkylazodicarboxylate **II** was added to this and allowed to stir at room temperature for 12 hours. The solvent was evaporated in *vacuo* and the residue on silica gel (100-200 mesh) column chromatography yielded the cycloadducts **1a-d** in excellent yield.

General procedure for the reaction of spirotricyclic olefin with boronic acids

A mixture of spirotricyclic olefin (1.8 eqiuv.), boronic acid (1.0 equiv.), $[RhCl(COD)]_2$ (5 mol%) and Cs_2CO_3 (1.5 equiv.) were weighed in a schlenk tube and

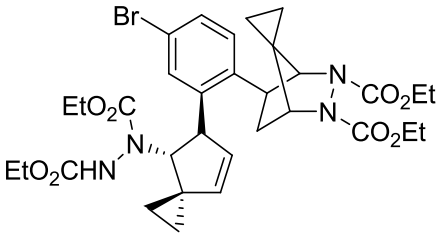
degassed for 10 minutes. Dry THF (2 mL) was added and the reaction mixture was purged with argon and allowed to stir at 60 ^{0}C for 12 hours. The solvent was evaporated in *vacuo* and the residue on silica gel (100-200 mesh) column chromatography yielded densely functionalized aromatic compounds.

General procedure for the copper assisted cross coupling reaction

A mixture of compound **3ba** (1.0 equiv.), indole (1.5 equiv.), CuI (10 mol%), cyclohexyldiamine (1 equiv.) and KO^{t}Bu (1.5 equiv.) were weighed in a schlenk tube and degassed for 10 minutes. Dry toluene (2 ml) was added and the reaction mixture was purged with argon and allowed to stir at 110 ^{o}C for 12 hours. The solvent was removed and the residue on silica gel (100-200 mesh) column chromatography yielded the coupled product **6** in 72% yield.

Characterization of the Products

Compound 3aa



Yield: 75% as yellow viscous liquid.
R_f: 0.26 (5:5 hexane/EtOAc).
IR (Neat) ν_{max}: 3289, 3059, 2981, 2928, 2853, 1748, 1706, 1606, 1496, 1468, 1413, 1316, 1256, 1156, 1124, 1018, 957, 921, 866, 765, 727, 605 cm^{-1}.

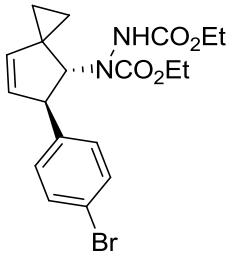
^{1}H NMR (500 MHz, $CDCl_3$, TMS): δ 8.39-8.29 (m, 1H), 7.37 (s, 1H), 7.27 (m, 1H), 7.16-7.12 (m, 1H), 5.61-5.57 (m, 2H), 4.86-4.80 (m, 1H), 4.50-4.39 (m, 1H), 4.26-4.02 (m, 9H), 3.65-3.60 (m, 2H), 2.60 (s, 1H), 2.20-2.17 (m, 1H), 1.33-1.26 (m, 12H), 1.01-0.80 (m, 6H), 0.60-0.52 (m, 2H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 158.4, 157.1, 156.2, 145.8, 140.0, 135.5, 130.9, 129.4, 129.1, 128.8, 121.8, 69.2, 66.3, 63.6, 63.0, 62.6, 61.5, 50.2, 44.0, 32.6, 31.2, 30.0, 15.7, 14.8, 14.7, 9.6, 7.7, 7.4, 2.7.

HRMS (ESI): Calcd for $C_{32}H_{41}BrN_4O_8$, (M+Na): 711.20055; Found: 711.20034.

Compound 4aa

Yield: 20% as colourless viscous liquid.
R_f: 0.44 (7:3 hexane/EtOAc).
IR (Neat) ν_{max}: 3374, 2957, 2919, 2851, 1744, 1689, 1462, 1257, 1122, 1039, 930,



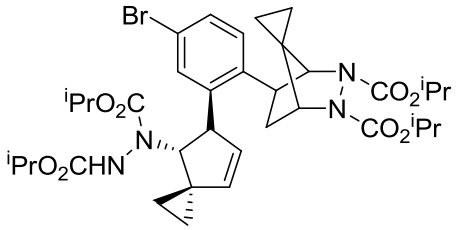
860,774cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$, TMS): δ 7.41 (d, *J* = 8.1 Hz, 2H), 7.19 (d, *J* = 7.8 Hz, 2H), 6.34 (m, 1H), 5.69 (s, 1H), 5.41-5.39 (m, 1H), 4.25-4.12 (m, 6H), 1.33-1.25 (m, 6H), 0.85-0.73 (m, 4H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 156.2, 156.0, 142.8, 137.1, 131.8, 129.3, 127.5, 127.1, 124.5, 120.3, 70.3, 62.6, 62.1, 54.9, 31.4, 14.4, 14.1, 9.2.

LRMS (FAB): Calcd for $C_{19}H_{23}BrN_2O_4$,: 422.08; Found: 423.18 (M+1).

Compound 3ba



Yield: 60% as colourless viscous liquid.
R_f: 0.35 (5:5 hexane/EtOAc).
IR (Neat) ν_{max}: 3328, 3056, 2978, 2928, 2853, 1748, 1711, 1607, 1496, 1468, 1415, 1318, 1258, 1156, 1124, 1017, 956, 921, 867, 765, 727, 605 cm^{-1}.

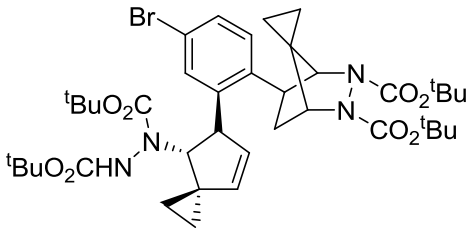
^{1}H NMR (500 MHz, $CDCl_3$, TMS): δ 8.44-8.28 (m, 1H), 7.35 (s, 1H), 7.26 (s, 1H), 7.12 (s, 1H), 5.64-5.55 (m, 2H), 5.01-4.93 (m, 4H), 4.81-4.79 (m, 1H), 4.29-4.06 (m, 2H), 3.65-3.60 (m, 2H), 2.60 (s, 1H), 2.17-2.13 (m, 1H), 1.31-1.20 (m, 24H), 0.89-0.83 (m, 6H), 0.61-0.48 (m, 2H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 159.4, 156.5, 156.2, 155.8, 146.0, 139.8, 131.6, 131.1, 129.2, 128.9, 121.7, 70.7, 70.1, 69.2, 68.6, 66.2, 49.8, 43.8, 32.6, 32.1, 29.9, 22.3, 22.2, 22.1, 22.0, 15.7, 9.7, 7.6, 2.6.

HRMS (ESI): Calcd for $C_{36}H_{49}BrN_4O_8$, (M+Na): 767.26315; Found: 767.26334.

Compound 3ca

Yield: 64% as white solid.
R_f: 0.84 (5:5 hexane/EtOAc).
Mp: 140-150 ^{o}C

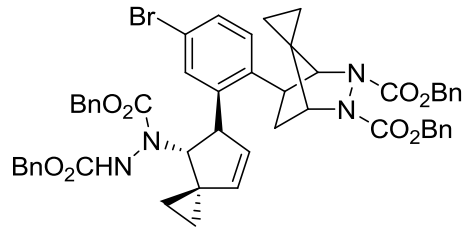


IR (Neat) ν_{max}: 3331, 3059, 2978, 2931, 1748, 1701, 1676, 1588, 1511, 1479, 1454, 1394, 1367, 1335, 1295, 1276, 1254, 1157, 1115, 1051, 1017, 992, 971, 958, 921, 899, 857, 814, 767, 703, 670 cm^{-1}.

^1H NMR (500 MHz, $CDCl_3$, TMS): δ 8.23 (s, 1H), 7.41 (m, 1H), 7.23 (d, *J* = 7 Hz, 1H), 7.10-7.09 (m, 1H), 5.59-5.50 (m, 2H), 4.88 (m, 1H), 4.18-4.12 (m, 2H), 3.79-3.78 (m, 1H), 3.62 (m, 1H), 2.67-2.65 (m, 1H), 2.17 (brs, 1H), 1.56-1.38 (m, 36H), 0.89-0.83 (m, 4H), 0.73-0.34 (m, 4H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 157.2, 155.4, 154.3, 145.4, 138.9, 134.6, 131.3, 130.2, 128.6, 121.3, 81.9, 81.7, 80.6, 79.4, 69.1, 65.7, 49.3, 43.5, 32.5, 30.9, 29.7, 28.7, 28.4, 28.1, 28.0, 16.1, 10.2, 7.1, 2.5.
HRMS (ESI): Calcd for $C_{40}H_{57}BrN_4O_8$, , (M+Na): 823.32575; Found: 823.32512.

Compound 3da

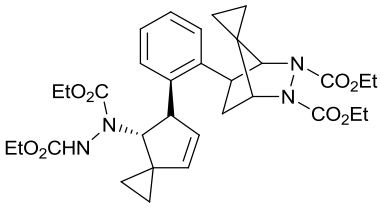


Yield: 77% as light yellow viscous liquid.
R_f: 0.68 (5:5 hexane/EtOAc).
IR (Neat) ν_{max}: 3301, 3062, 3032, 3001, 2954, 1752, 1711, 1682, 1608, 1587, 1496, 1452, 1408, 1311, 1255, 1212, 1156, 1109, 1052, 1023, 970, 913, 822, 738, 698 cm^{-1}.

^1H NMR (500 MHz, $CDCl_3$, TMS): δ 8.52-8.44 (m, 1H), 7.27-7.23 (m, 23H), 5.59 (m, 2H), 5.47-4.94 (m, 8H), 4.87-4,85 (m, 1H), 4.28-4.10 (m, 2H), 3.64-3.51 (m, 2H), 2.53 (s, 1H), 2.21-2.16 (m, 1H), 0.90-0.79 (m, 6H), 0.54-0.33 (m, 2H).

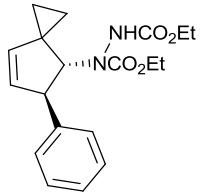
^{13}C NMR (125 MHz, $CDCl_3$): δ 157.9, 156.6, 156.2, 155.9, 145.2, 140.0, 136.1, 135.7, 130.8, 128.7, 128.6, 128.4, 128.2, 127.8, 121.7, 70.4, 70.3, 69.2, 68.4, 67.3, 49.9, 43.9, 32.5, 31.2, 29.9, 15.8, 11.1, 9.6, 7.8, 2.6.
HRMS (ESI): Calcd for $C_{52}H_{49}BrN_4O_8$, (M+Na): 959.26315; Found: 959.26329.

Compound 3ab



Yield: 70% as white solid.
R_f: 0.69 (5:5 hexane/EtOAc).
Mp: 65-70 ^{o}C.
^{1}H NMR (300 MHz, $CDCl_3$, TMS): δ 8.34 (brm, 1H), 7.47-7.19 (m, 4H), 5.64-5.53 (m, 2H), 4.91 (brs, 1H), 4.50 (brs, 1H), 4.24-4.11 (m, 9H), 3.87-3.69 (m, 2H), 2.65 (s, 1H), 2.20 (s, 1H), 1.33-1.26 (m, 12H), 0.92-0.61 (m, 8H).
^{13}C NMR (125 MHz, $CDCl_3$): δ 159.7, 158.3, 157.4, 156.2, 143.1, 139.1, 136.0, 130.1, 129.5, 127.4, 125.9, 70.4, 66.5, 63.6, 62.8, 62.4, 61.3, 50.0, 44.3, 32.5, 31.2, 29.9, 15.6, 14.6, 9.6, 7.7, 2.6.
HRMS (ESI): Calcd for $C_{32}H_{42}N_4O_8$, (M+Na): 633.29003; Found: 633.29114.

Compound 4ab

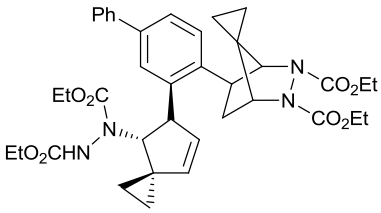


Yield: 24% as colourless viscous liquid.
R_f: 0.54 (7:3 hexane/EtOAc).
IR (Neat) ν_{max}: 3286, 3060, 2983, 2931, 2854, 1748, 1710, 1411, 1224, 1061, 925, 861,758 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$, TMS): δ 7.37-7.22 (m, 5H), 6.37-6.24 (m, 1H), 5.74-5.61 (m, 1H), 5.40 (s, 1H), 4.50-4.14 (m, 6H), 1.31-1.26 (m, 6H), 0.86-0.77 (m, 4H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 156.3, 156.0, 143.5, 136.5, 130.7, 128.5, 127.5, 126.5, 70.3, 62.6, 62.5, 55.6, 31.7, 14.4, 14.1, 9.2.
LRMS (FAB): Calcd for $C_{19}H_{24}N_2O_4$,: 344.1736; Found: 345.1758 (M+1).

Compound 3ac



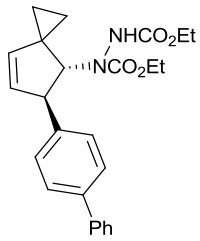
Yield: 72% as colourless viscous liquid.
R_f: 0.28 (5:5 hexane/EtOAc).
IR (Neat) ν_{max}: 3292, 3058, 2982, 2929, 2855, 1751, 1709, 1680, 1604, 1565, 1512, 1468, 1414, 1376, 1314, 1215, 1172, 1106, 1060, 1019, 956, 921, 866, 836, 764, 698 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$, TMS): δ 8.43-8.31 (m, 1H), 7.54-7.50 (m, 3H), 7.43-7.30

(m, 5H), 5.74-5.69 (m, 1H), 5.58 (s, 1H), 4.96-4.86 (m, 1H), 4.52 (m, 1H), 4.26-4.04 (m, 9H), 3.70-3.68 (m, 2H), 2.69-2.67 (m, 1H), 2.23 (brs, 1H), 1.33-1.26 (m, 12H), 1.05-0.88 (m, 8H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 158.3, 156.9, 156.1, 140.8, 139.8, 129.9, 129.4, 128.8, 127.9, 127.2, 126.9, 126.8, 126.3, 124.4, 69.2, 66.6, 62.7, 62.3, 61.1, 49.8, 43.9, 32.4, 31.1, 29.7, 15.5, 14.4, 14.1, 9.4, 7.6, 2.5.
HRMS (ESI): Calcd for $C_{38}H_{46}N_4O_8$, (M+Na): 709.32133; Found: 709.32179.

Compound 4ac



Yield: 11% as colourless viscous liquid.
R_f: 0.54 (7:3 hexane/EtOAc).
IR (Neat) ν_{max}: 3288, 3058, 2978, 2922, 2848, 1746, 1712, 1408, 1228, 1051, 922, 859,756 cm^{-1}.

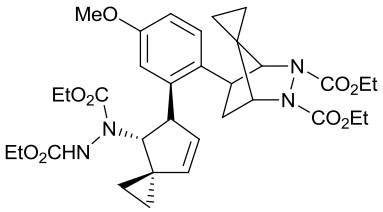
^{1}H NMR (500 MHz, $CDCl_3$, TMS): δ 7.58-7.54 (m, 4H), 7.44-7.33 (m, 5H), 6.46-6.41 (m, 1H), 5.77 (s, 1H), 5.43 (d, J = 5 Hz, 1H), 4.35-4.13 (m, 6H), 1.33-1.25 (m, 6H), 0.88-0.87 (m, 4H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 156.3, 156.0, 139.4, 136.6, 130.7, 128.8, 128.7, 128.2, 127.9, 127.3, 127.0, 69.9, 62.5, 62.1, 55.2, 31.7, 14.4, 14.1, 9.2.
LRMS (FAB): Calcd for $C_{25}H_{28}N_2O_4$,: 420.2049; Found: 421.2046 (M+1).

Compound 3ad

Yield: 69% as yellow viscous liquid.
R_f: 0.26 (5:5 hexane/EtOAc).
IR (Neat) ν_{max}: 3288, 3056, 2981, 2929, 2855, 1750, 1708,1677, 1608,1575, 1497, 1466, 1414, 1377, 1314, 1255, 1217, 1171, 1153, 1122, 1102, 1059, 1018, 958, 923, 864, 837, 815, 763, 726 cm^{-1}.

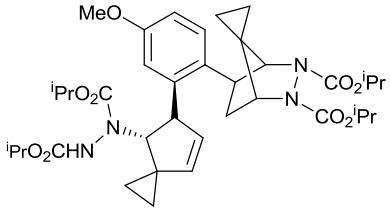
^{1}H NMR (500 MHz, $CDCl_3$, TMS): δ 8.45-8.33 (m, 1H), 7.18-7.12 (m, 1H), 6.84 (s. 1H), 6.70 (s, 1H), 5.63-5.53 (m, 2H), 4.85-



4.79 (m, 1H), 4.49-4.41 (m, 1H), 4.25-4.02 (m, 9H), 3.76 (s, 3H), 3.65-3.58 (m, 2H), 2.58 (s, 1H), 2.22-2.17 (m, 1H), 1.32-1.21 (m, 12H), 1.00-0.50 (m, 8H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 159.7, 159.0, 157.2, 156.3, 145.1, 139.3, 137.3, 129.6, 129.3, 128.8, 128.5, 113.5, 111.1, 69.6, 66.9, 62.9, 62.5, 61.4, 55.4, 50.7, 43.8, 32.6, 31.5, 30.0, 15.8, 14.9, 14.8, 14.7, 11.1, 9.7, 7.7, 2.7.
HRMS (ESI): Calcd for $C_{33}H_{44}N_4O_9$, (M+Na): 663.30060; Found: 663.30865.

Compound 3bd



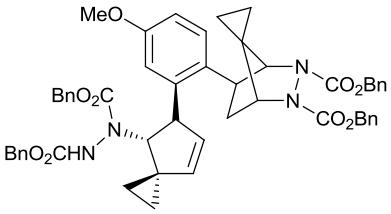
Yield: 65% as white viscous liquid.
R_f: 0.25 (5:5 hexane/EtOAc).
IR (Neat) ν_{max}: 3286, 3052, 2971, 2918, 2852, 1750, 1706,1673, 1609,1565, 1487, 1463, 1412, 1371, 1312, 1251, 1212, 1170, 1151, 1124, 1106, 1057, 1017, 956, 921, 861, 833, 812, 753, 7126 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$, TMS): δ 8.50-8.33 (m, 1H), 7.14 (brs, 1H), 6.94-6.85 (m, 1H), 6.69 (s, 1H), 5.61-5.50 (m, 2H), 5.00-4.98 (m, 4H), 4.82-4.78 (m, 1H), 4.23 (m, 2H), 3.76 (m, 4H), 3.62 (brs, 1H), 2.59 (brs, 1H), 2.16-2.03 (m, 1H), 1.38-1.17 (m, 24H), 0.94-0.83 (m, 6H), 0.56 (m, 2H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 158.8, 158.2, 156.5, 156.1, 144.9, 139.1, 130.0, 128.7, 128.6, 128.5, 113.5, 111.1, 70.5, 69.9, 69.7, 68.5, 66.4, 55.3, 50.5, 43.5, 32.5, 32.0, 29.9, 22.3, 22.2, 22.1, 22.0, 15.9, 9.9, 7.6, 2.6.
HRMS (ESI): Calcd for $C_{37}H_{52}N_4O_9$, (M+Na): 719.36320; Found: 719.36670.

Compound 3dd

Yield: 62% as brown viscous liquid.
R_f: 0.50 (5:5 hexane/EtOAc).
IR (Neat) ν_{max}: 3302, 3062, 3033, 3001, 2954, 2855, 1752, 1711, 1682, 1608, 1577, 1498, 1454, 1410, 1312, 1255, 1213, 1123, 1047, 1025, 971, 913, 860, 822, 741, 698 cm^{-}



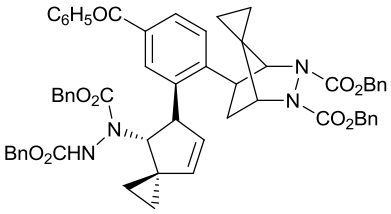
[1].

^{1}H NMR (500 MHz, $CDCl_3$, TMS): δ 8.57-8.47 (m, 1H), 7.31-7.08 (m, 20H), 6.98-6.93 (m, 1H), 6.81 (s, 1H), 6.66 (s, 1H), 5.61-5.54 (m, 2H), 5.29-4.95 (m, 8H), 4.88-4.85 (m, 1H), 4.26-4.12 (m, 2H), 3.75 (s, 3H), 3.60-3.52 (m, 2H), 2.55 (brs, 1H), 2.19 (brm, 1H), 0.90-0.76 (m, 6H), 0.57 (brs, 1H), 0.33 (brs, 1H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 158.8, 158.0, 156.7, 156.0, 139.5, 135.9, 130.0, 129.5, 128.7, 128.6, 128.4, 128.2, 127.8, 113.4, 111.0, 69.6, 68.3, 67.2, 55.3, 43.7, 32.5, 31.4, 29.9, 16.1, 9.6, 7.7, 2.6.
HRMS (ESI): Calcd for $C_{53}H_{52}N_4O_9$, (M+Na): 911.36320; Found: 911.36066.

Compound 3de

Yield: 58% as light yellow solid.
R_f: 0.26 (5:5 hexane/EtOAc).
Mp: 58-62 ^{o}C.
IR (Neat) ν_{max}: 3313, 3061, 3031, 2954, 2922, 2853, 1740, 1707, 1681, 1660, 1599, 1494, 1454, 1406, 1381, 1344, 1310, 1252, 1212, 1177, 1156, 1119, 1047, 1024, 970, 917, 846, 768, 696, 664 cm^{-1}.

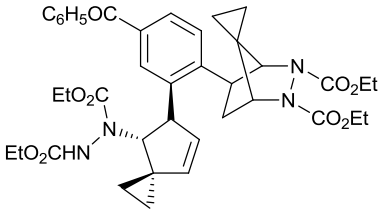


^{1}H NMR (500 MHz, $CDCl_3$, TMS): δ 8.53-8.34 (m, 1H), 7.76-7.75 (m, 3H), 7.65-7.64 (m, 2H), 7.56-7.55 (m, 1H), 7.47-7.44 (m, 3H), 7.28-7.23 (m, 17H), 7.09-6.95 (m, 2H), 5.58 -5.39 (m, 2H), 5.29-4.97 (m, 9H), 4.46-4.17 (m, 2H), 3.78 -3.66 (m, 2H), 2.67 (s, 1H), 2.35-2.26 (m, 1H), 0.90-0.83 (m, 5H), 0.65-0.36 (m, 3H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 196.5, 158.0, 156.5, 155.3, 137.5, 136.4, 136.0, 135.5, 132.5, 130.1, 128.5, 128.4, 128.3, 128.1, 127.6, 70.5, 69.0, 68.3, 67.1, 49.8, 44.5, 32.6, 31.1, 29.7, 15.9, 9.6, 7.7, 2.6.
HRMS (ESI): Calcd for $C_{59}H_{54}N_4O_9$, (M+Na): 985.37885; Found: 985.37634.

Compound 3ae

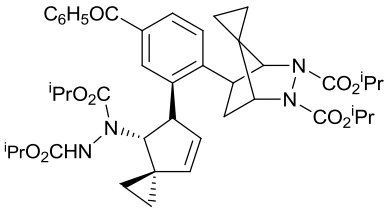
Yield: 71% off-white solid.
R_f: 0.02 (5:5 hexane/EtOAc).



Mp: 53-58 ^{o}C.
IR (Neat) ν_{max}: 3298, 3059, 2982, 2933, 2873, 1751, 1706, 1676, 1560, 1511, 1470, 1444, 1411, 1376, 1314, 1255, 1217, 1173, 1124, 1103, 1060, 1019, 956, 922, 899, 865, 839, 764, 724, 702,662 cm^{-1}

^{1}H NMR (500 MHz, $CDCl_3$, TMS): δ 8.39-8.17 (m, 1H), 7.78-7.75 (m, 2H), 7.66 (d, *J* = 6 Hz, 2H), 7.59-7.56 (m, 1H), 7.48-7.45 (m, 3H), 5.65-5.61 (m, 1H), 5.49 (s, 1H), 4.96-4.89 (m, 1H), 4.50-4.44 (m, 1H), 4.23-4.07 (m, 9H), 3.71 (m, 2H), 2.71-2.69 (m, 1H), 2.26 (brs, 1H), 1.33-1.26 (m, 12H), 0.94-0.55 (m, 8H).
^{13}C NMR (125 MHz, $CDCl_3$): δ 196.3, 159.9, 158.0, 156.7, 156.1, 139.6, 137.6, 136.4, 132.4, 130.1, 129.9, 128.2, 69.0, 66.2, 62.7, 62.4, 61.2, 50.0, 44.3, 32.5, 31.0, 29.7, 15.7, 14.6, 14.5, 14.4, 9.5, 7.6, 2.6.
HRMS (ESI): Calcd for $C_{39}H_{46}N_4O_9$, (M+Na): 737.31625; Found: 737.31415.

Compound 3be



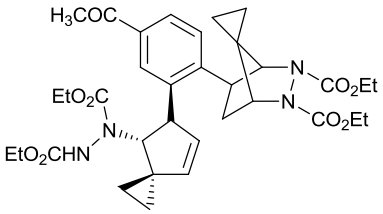
Yield: 64% as white solid.
R_f: 0.55 (5:5 hexane/EtOAc).
Mp: 136-145 ^{o}C.
IR (Neat) ν_{max}: 3304, 3059, 2980, 2929, 2854, 1749, 1703, 1673, 1601, 1560, 1509, 1493, 1467, 1451, 1407, 1376, 1310, 1289, 1256, 1218, 1178, 1144, 1107, 1043, 1018 960, 922, 831, 767, 719,700, 663 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$, TMS): δ 8.48-8.08 (m, 1H), 7.78-7.75 (m, 3H), 7.67 (s, 2H), 7.59-7.56 (m, 1H), 7.48-7.40 (m, 2H), 5.64-5.57 (m, 1H), 5.46 (s, 1H), 5.01-4.93 (m, 4H), 4.85-4.80 (m, 1H), 4.35-4.29 (m, 2H), 3.94-3.60 (m, 2H), 2.73 (s, 1H), 2.23-2.18 (m, 1H), 1.29-1.13 (m, 24H), 0.89-0.50 (m, 8H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 196.4, 159.7, 157.9, 156.2, 143.6, 139.6, 137.7, 136.3, 132.4, 132.2, 130.1, 130.0, 129.9, 128.5, 128.3, 128.2, 127.5, 127.2, 126.9, 70.6, 70.0, 69.2, 68.4, 66.1, 50.2, 44.2, 32.5, 31.6, 29.7, 22.1, 22.0, 21.9, 21.8, 21.5, 15.9, 9.7, 7.5,

2.6.
HRMS (ESI): Calcd for $C_{43}H_{54}N_4O_9$, (M+Na): 793.37885; Found: 793.37683.

Compound 3af

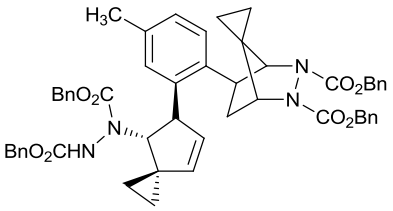


Yield: 67% as yellow solid.
R_f: 0.22 (5:5 hexane/EtOAc).
Mp: 77-84 °C.
IR (Neat) ν_{max}: 3298, 3058, 2982, 2933, 2873, 1751, 1708, 1678, 1604, 1509, 1480, 1411, 1377, 1314, 1254, 1216, 1172,1156, 1124, 1104, 1060, 1019, 956, 922, 900, 866, 834, 762, 730, 699 cm^{-1}.

^1H NMR (500 MHz, $CDCl_3$, TMS): δ 8.39-8.28 (m, 1H), 7.99 (m, 1H), 7.75 (s, 1H), 7.35 (d, J = 7.5 Hz, 1H), 5.63-5.59 (m, 2H), 4.93 (m, 1H), 4.49 (m, 1H), 4.30-4.03 (m, 9H), 3.66 (m, 2H), 2.74 (brs, 1H), 2.58 (s, 3H), 2.26-2.22 (brs, 1H), 1.34-1.23 (m, 12H), 1.02-0.84 (m, 8H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 192.5, 159.3, 158.1, 156.8, 156.0, 140.7, 139.9, 129.4, 128.8, 127.2, 126.9, 126.3, 124.4, 69.2, 66.2, 62.7, 62.3, 61.2, 50.1, 43.9, 32.5, 31.1, 29.7, 15.5, 14.5, 9.4, 7.6, 6.5, 2.5.
HRMS (ESI): Calcd for $C_{34}H_{44}N_4O_9$, (M+Na): 675.30060; Found: 675.30058.

Compound 3dg

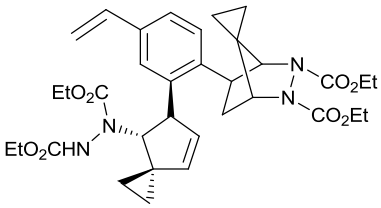


Yield: 74% as off-white solid.
R_f: 0.60 (5:5 hexane/EtOAc).
Mp: 55-60 °C.
IR (Neat) ν_{max}: 3305, 3062, 3032, 3003,2934, 2925, 2854, 2732, 1749, 1709, 1678, 1609, 1586, 1498,1453,1409, 1312, 1255, 1213, 1176,1151, 1122, 1104, 1081, 1052, 1025, 975, 914, 822, 739, 697 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$, TMS): δ 8.54 (m, 1H), 7.29-6.98 (m, 23H), 5.61-5.53 (m, 2H), 5.14-5.00 (m, 9H), 4.24 (m, 2H), 3.64 (m, 2H), 2.58 (brs, 1H), 2.29 (m, 4H), 0.88-0.34 (m, 3H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 156.5, 155.9, 155.6, 138.9, 128.5, 128.4, 128.2, 128.0, 127.6, 127.1, 126.5, 68.1, 67.0, 49.8, 43.8, 32.4, 30.9, 21.1, 15.5, 9.4, 7.7, 2.3.
HRMS (ESI): Calcd for $C_{53}H_{52}N_4O_8$, (M+Na): 895.36828; Found: 895.36639.

Compound 3ah

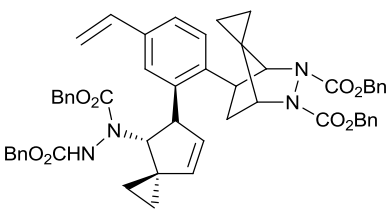


Yield: 54% as light yellow solid.
R_f: 0.26 (5:5 hexane/EtOAc).
Mp: 62-68 ^{o}C.
IR (Neat) ν_{max}: 3289, 3058, 2981, 2928, 2853, 1747, 1706, 1678, 1606, 1496, 1468, 1413, 1377, 1316, 1256, 1220, 1173,1156, 1124, 1104, 1061, 1018, 957, 921, 903, 866, 837, 765, 727, 696 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$, TMS): δ 8.32 (brs, 1H), 7.30-7.22 (m, 3H), 6.71-6.62 (m, 1H), 5.72-5.66 (m, 2H), 5.56-5.41 (m, 1H), 5.23-5.20 (m, 1H), 4.89 (m, 1H), 4.49 (brs, 1H), 4.24 (m, 9H), 3.77 (m, 2H), 2.63 (s, 1H), 2.20 (brs, 1H), 1.34-1.27 (m, 12H), 0.99-0.62 (m, 8H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 158.2, 156.3, 156.0, 136.6, 127.6, 125.8, 125.7, 123.5, 115.6, 113.7, 69.2, 66.1, 62.7, 62.3, 61.5, 61.2, 50.2, 44.2, 32.5, 30.9, 29.7, 15.4, 14.6, 14.5, 14.1, 9.4, 7.6, 2.6.
HRMS (ESI): Calcd for $C_{34}H_{44}N_4O_8$, (M+Na): 659.30568; Found: 659.30359.

Compound 3dh



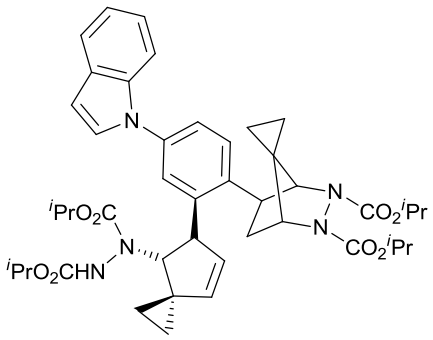
Yield: 48% as yellow viscous liquid.
R_f: 0.35 (5:5 hexane/EtOAc).
IR (Neat) ν_{max}: 3308, 3063,3032, 3003, 2954, 2928, 2854, 1752, 1709, 1677, 1630, 1606, 1586, 1497, 1454, 1407, 1312,1254, 1213, 1178,1156, 1103, 1052, 1026, 987, 906, 829, 739, 696 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$, TMS): δ 8.51 (m, 1H), 7.29-7.26 (m, 23H), 6.66-6.62 (m, 1H), 5.72-5.57 (m, 3H), 5.20-5.01 (m, 10H), 4.27 (m, 2H), 3.66 (m, 2H), 2.60 (brs, 1H), 2.17 (m,

1H), 0.99-0.21 (m, 8H).

^{13}C NMR (125 MHz, $CDCl_3$): δ 159.1, 157.9, 156.0, 139.2, 136.5, 136.4, 136.1, 129.8, 129.3, 129.0, 128.5, 128.4, 128.2, 128.0, 127.6, 125.5, 123.5, 113.7, 68.2, 67.0, 50.3, 44.0, 32.4, 31.2, 29.7, 15.5, 9.5, 7.6, 2.4.
HRMS (ESI): Calcd for $C_{54}H_{52}N_4O_8$, (M+Na): 907.36828; Found: 907.36353.

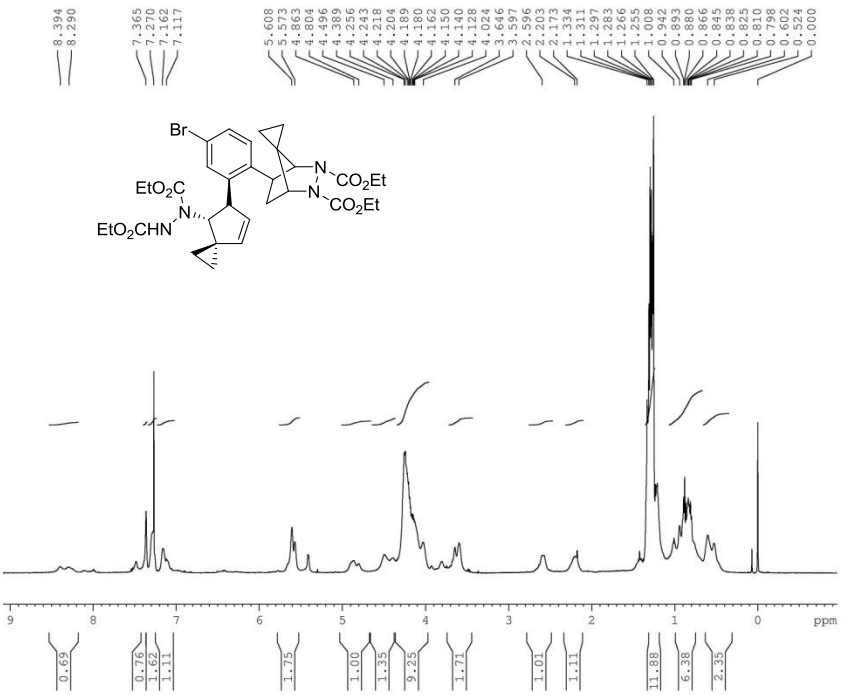
Compound 6



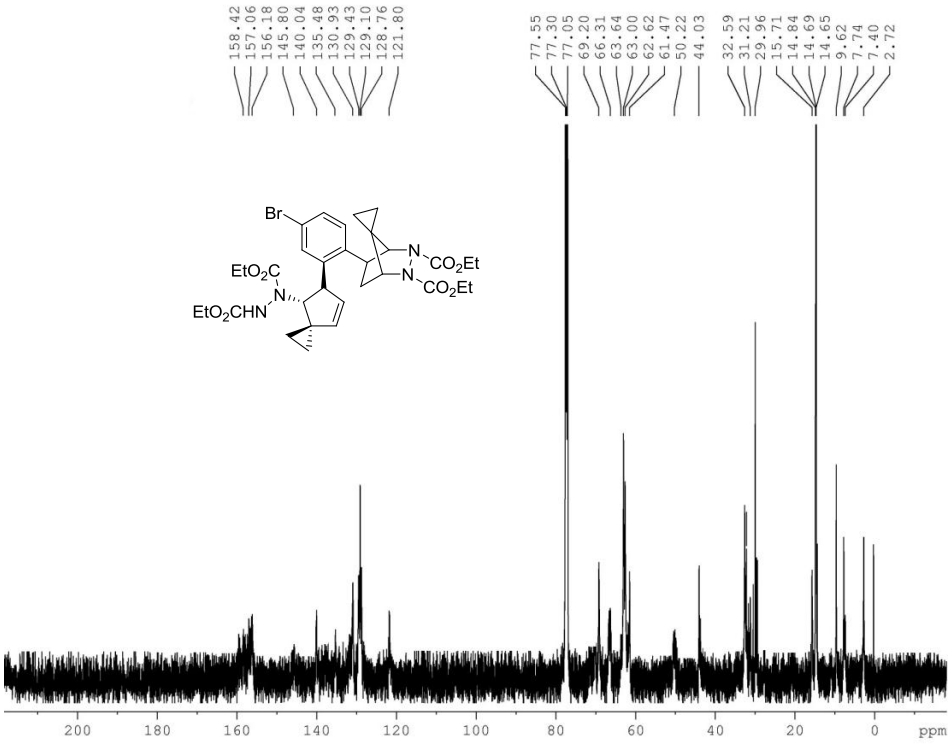
Yield: 72% as off-white solid.
R_f: 0.52 (5:5 hexane/EtOAc).
Mp: 68-75 ^{o}C.
IR (Neat) ν_{max}: 3291, 2979, 2925, 2856, 2308, 1748, 1709, 1673, 1510, 1462, 1378, 1310, 1254, 1219, 1108, 1021, 966, 926, 831, 768, 718, 666, 611, 558 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$, TMS): δ 8.27 (m, 1H), 7.65 (d, J = 7 Hz, 1H), 7.56-7.53 (m, 1H), 7.47 (s, 1H), 7.35 (brs, 1H), 7.28-7.26 (m, 2H), 7.20-7.14 (m, 2H), 6.65 (s, 1H), 5.63-5.52 (m, 2H), 5.01-4.94 (m, 4H), 4.84-4.79 (m, 1H), 4.29-4.24 (m, 2H), 3.78-3.60 (m, 2H), 2.70-2.60 (m, 1H), 2.24-2.13 (m, 1H), 1.43-1.20 (m, 24H), 0.90-0.84 (m, 6H), 0.61-0.48 (m, 2H).

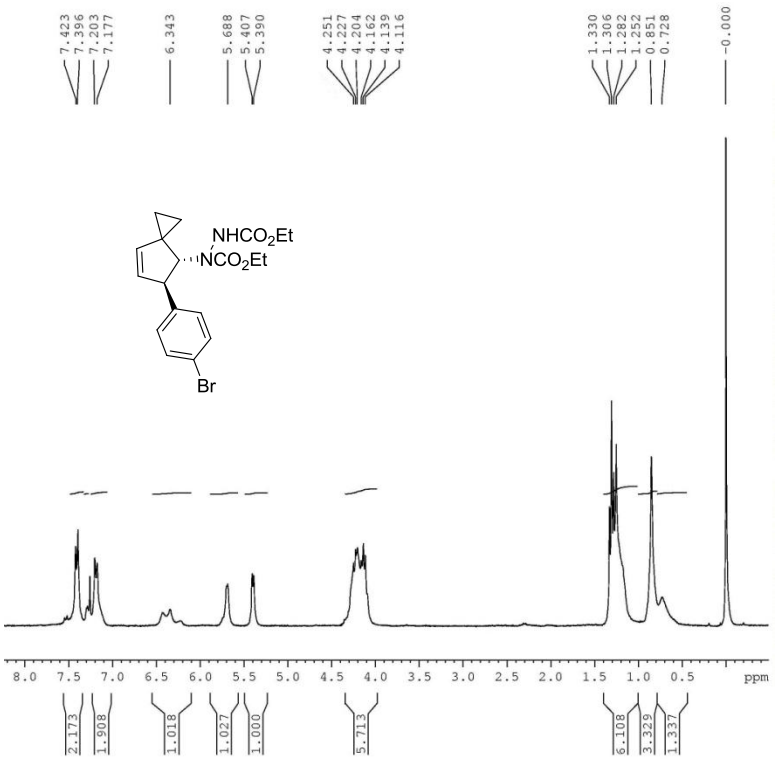
^{13}C NMR (125 MHz, $CDCl_3$): δ 155.3, 153.7, 137.2, 136.4, 133.2, 128.4, 126.9, 126.6, 126.3, 125.1, 119.8, 119.1, 118.6, 117.9, 68.8, 68.0, 67.5, 66.7, 65.9, 47.7, 41.2, 30.0, 19.7, 19.6, 19.5, 19.4, 12.9, 11.8, 7.0, 4.9.
HRMS (ESI): Calcd for $C_{54}H_{52}N_4O_8$, (M+H): 782.41289; Found: 782.41003.



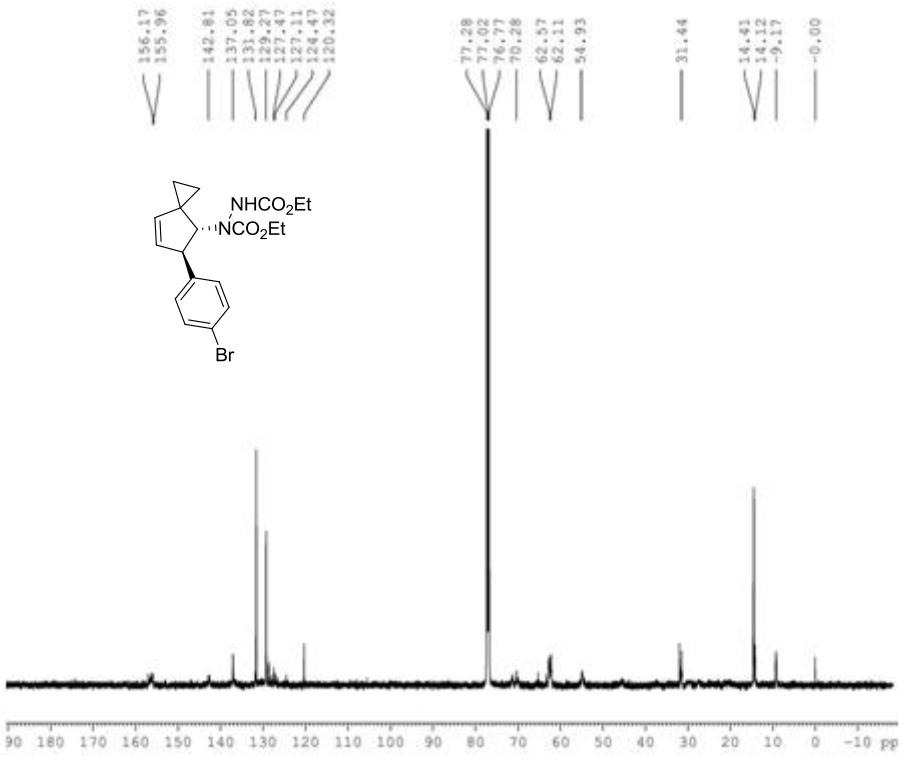
^{1}H NMR of **3aa**



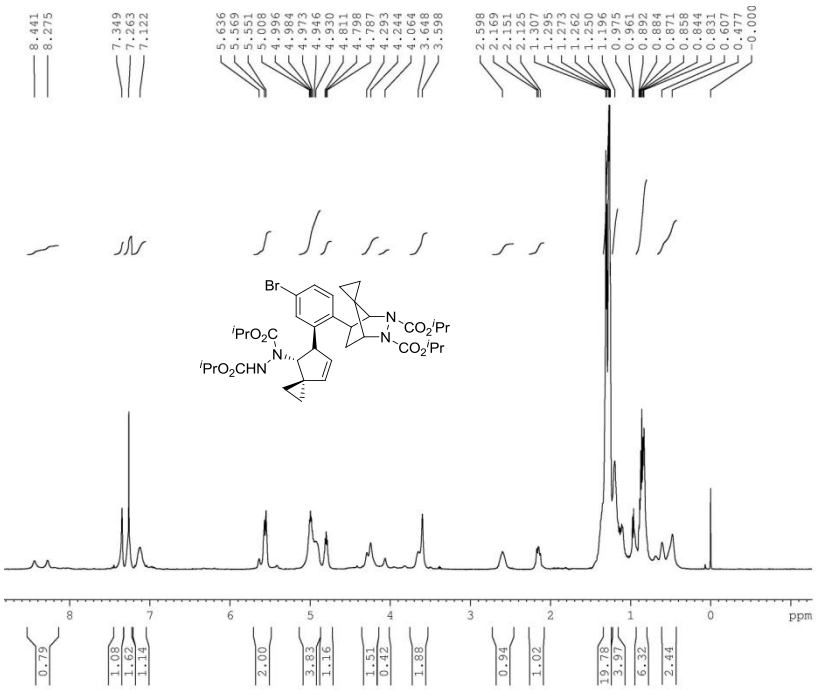
^{13}C NMR of **3aa**



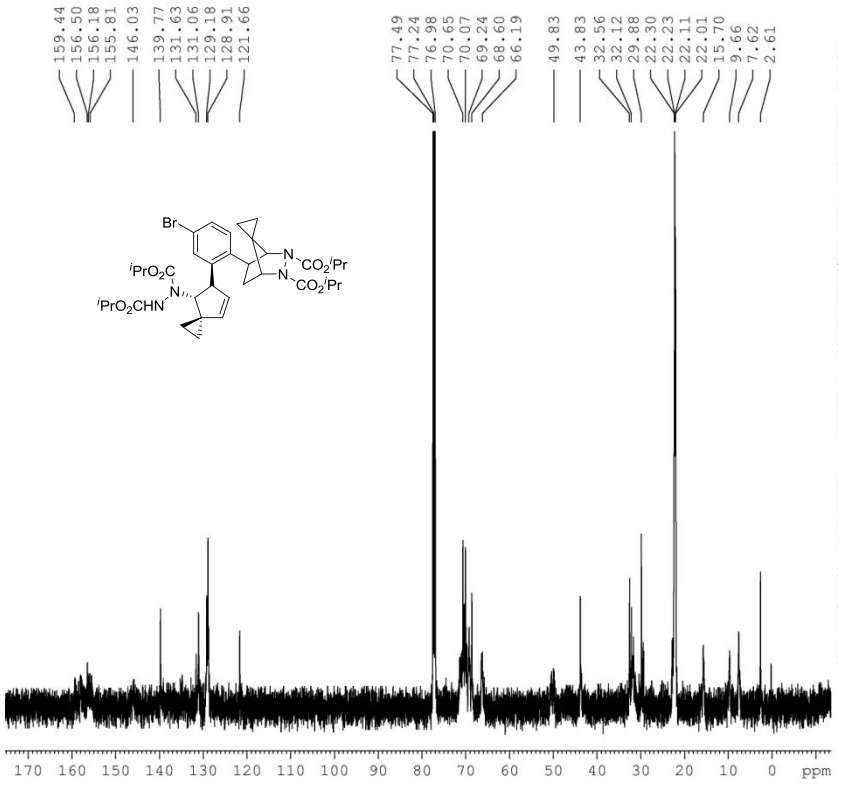
^{1}H NMR of **4aa**



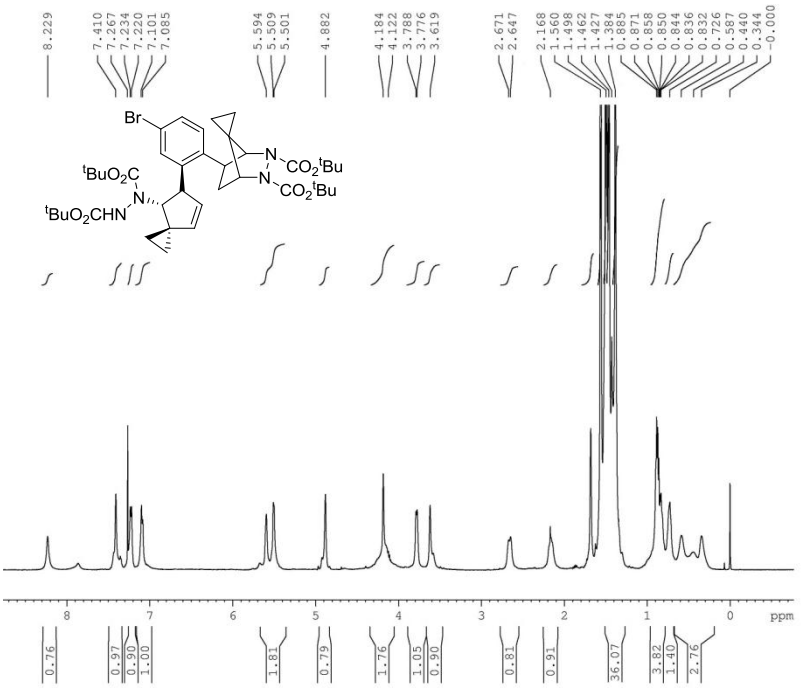
^{13}C NMR of **4aa**



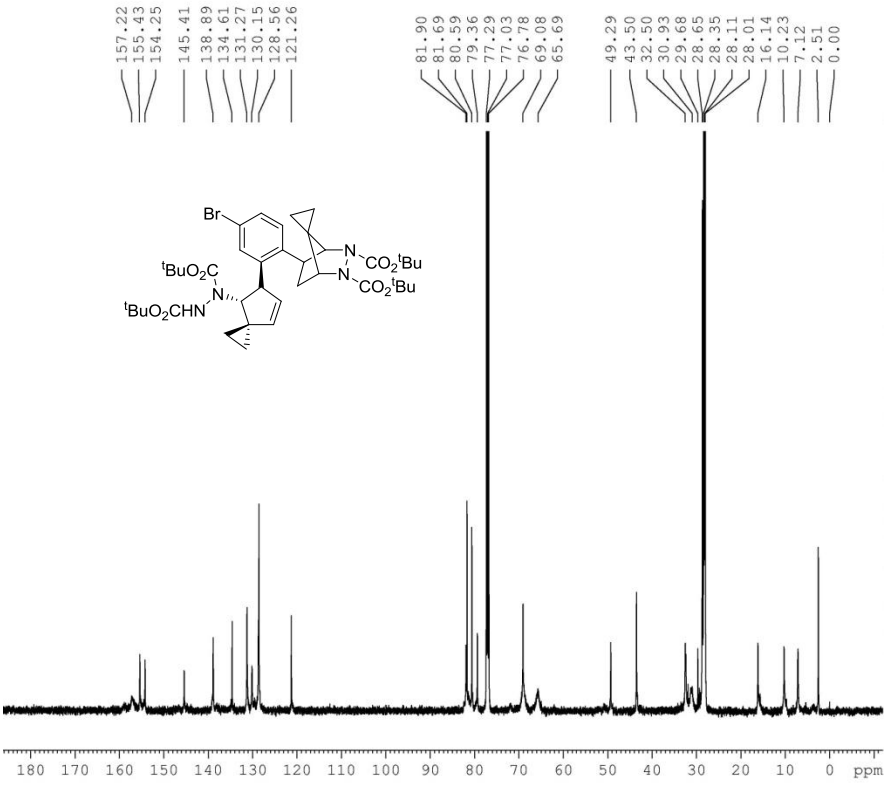
^{1}H NMR of **3ba**



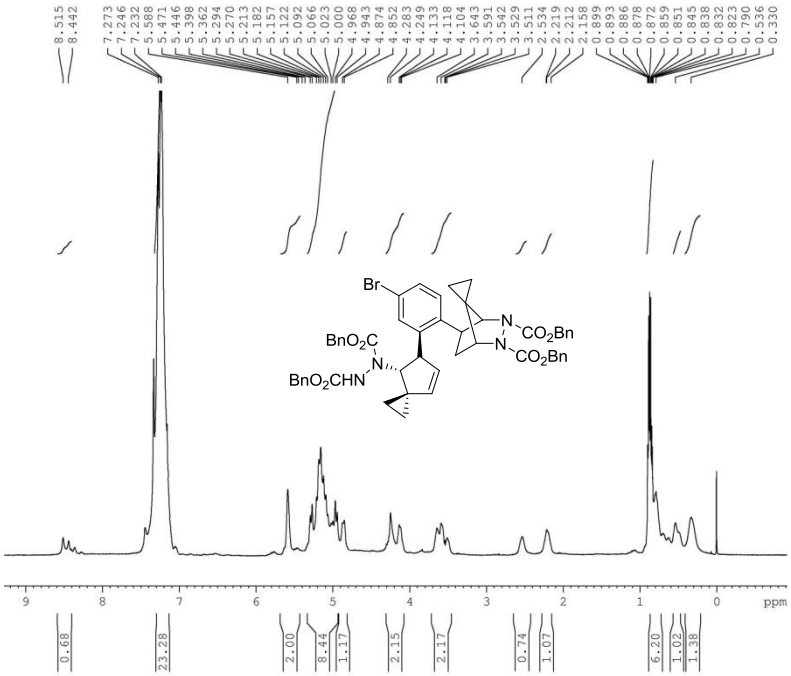
^{13}C NMR of **3ba**



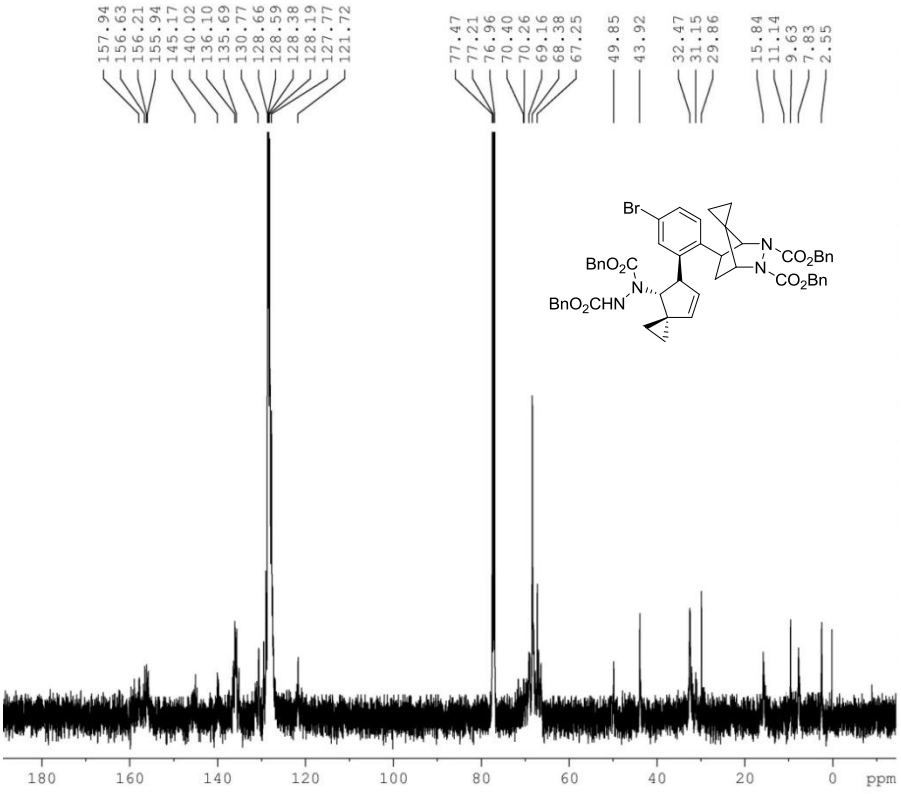
^{1}H NMR of **3ca**



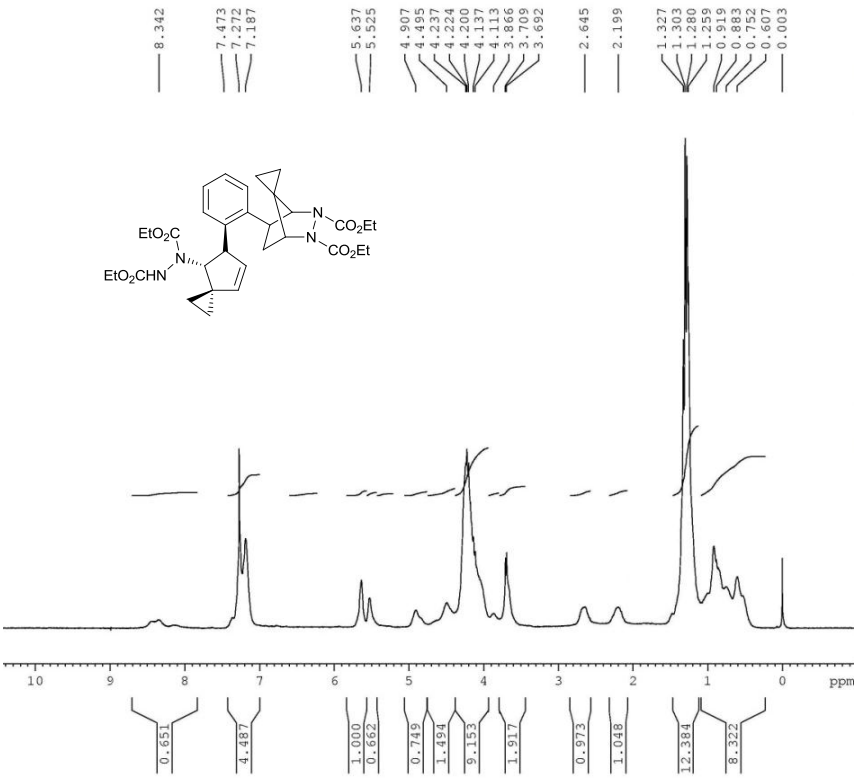
^{13}C NMR of **3ca**



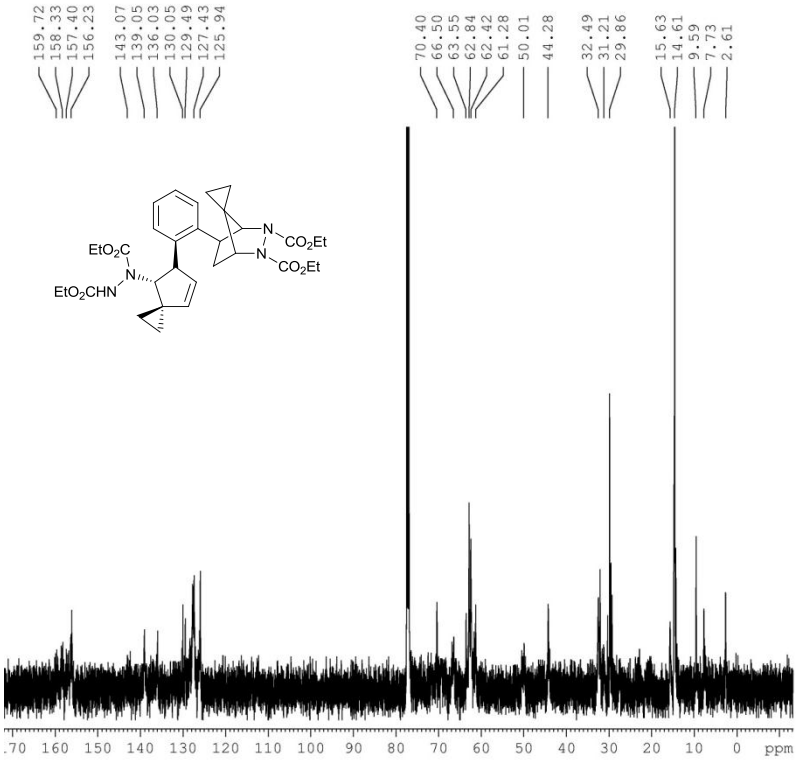
^{1}H NMR of **3da**



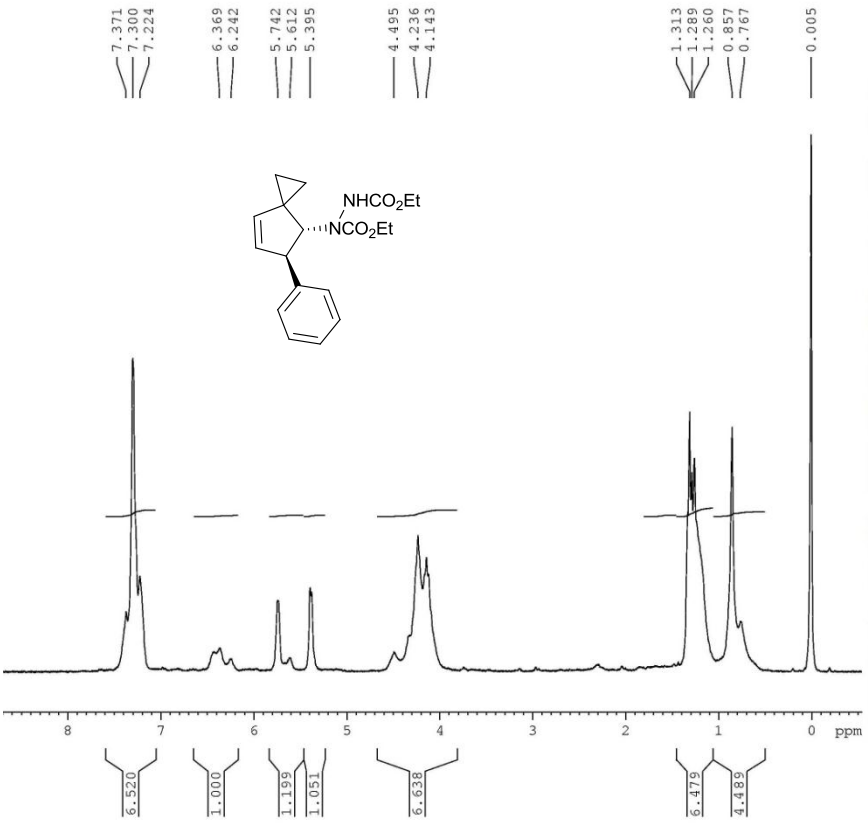
^{13}C NMR of **3da**



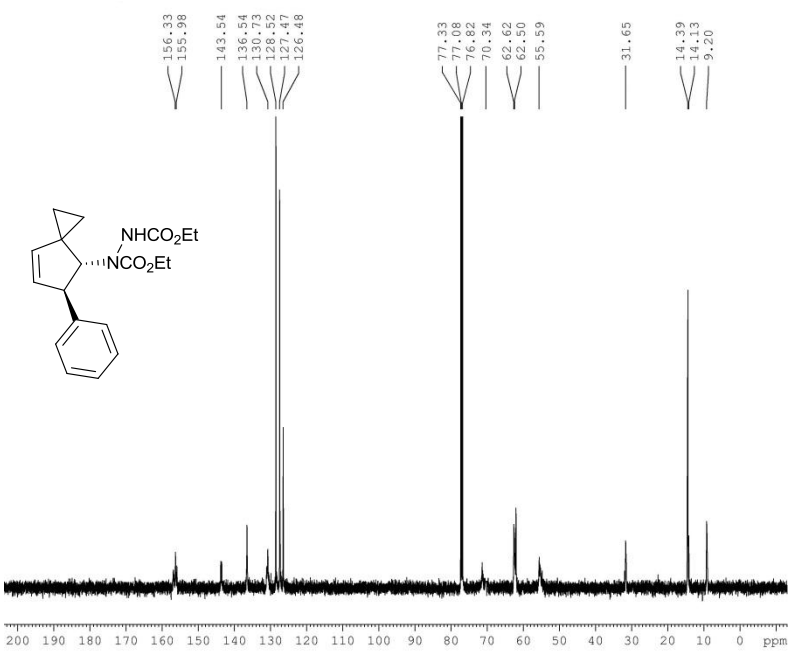
^{1}H NMR of **3ab**



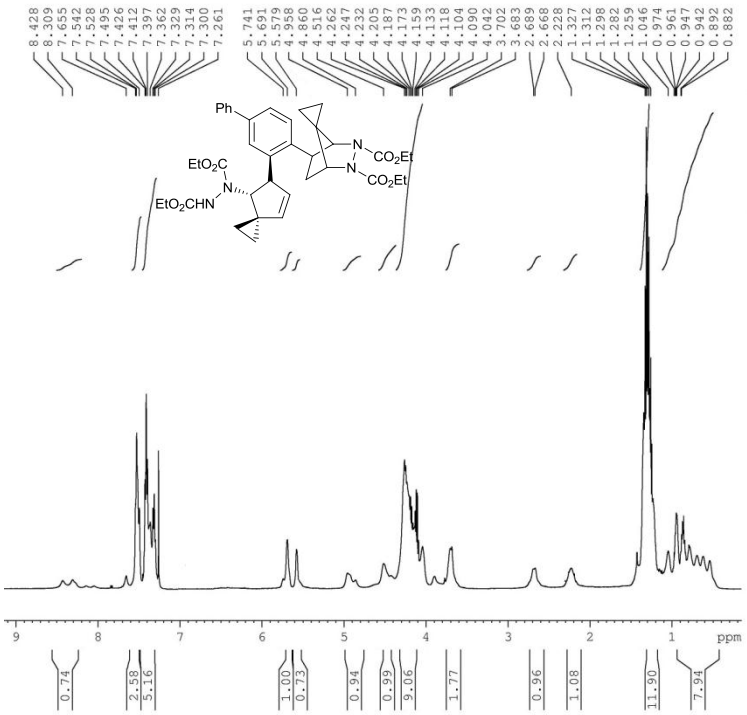
^{13}C NMR of **3ab**



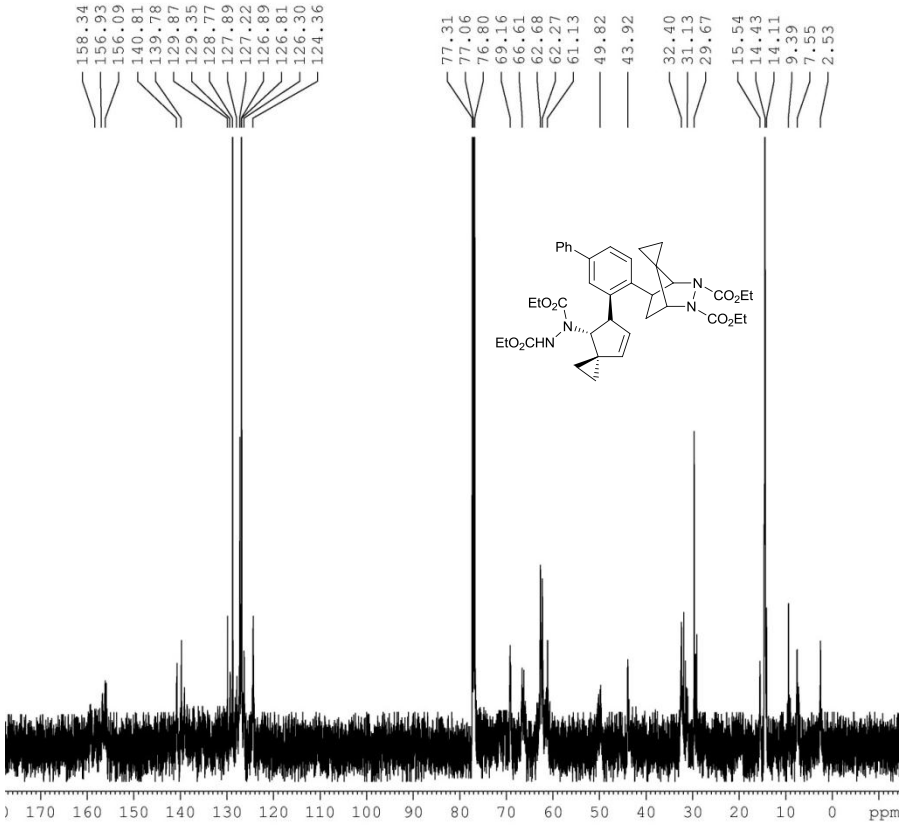
^{1}H NMR of **4ab**



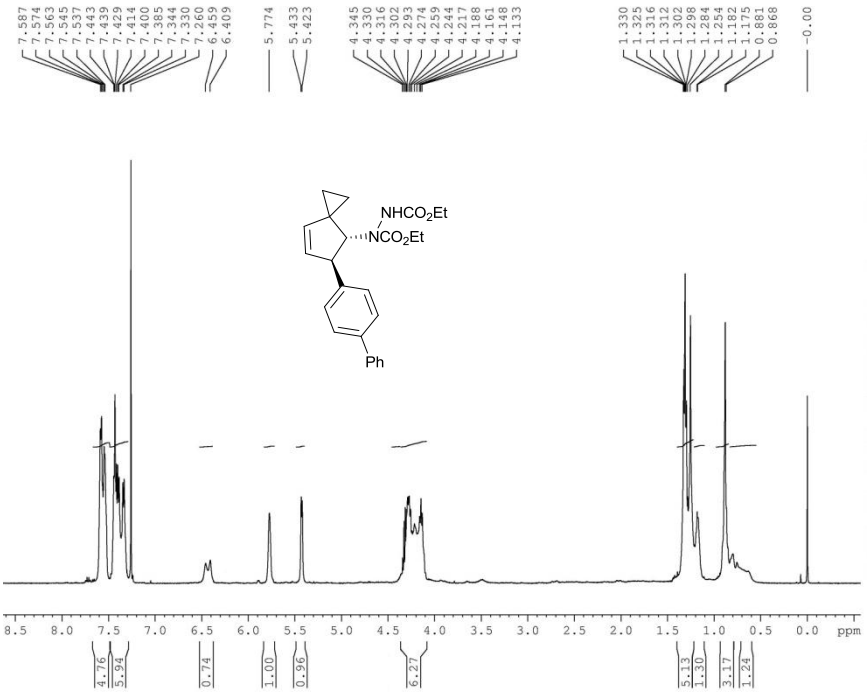
^{13}C NMR of **4ab**



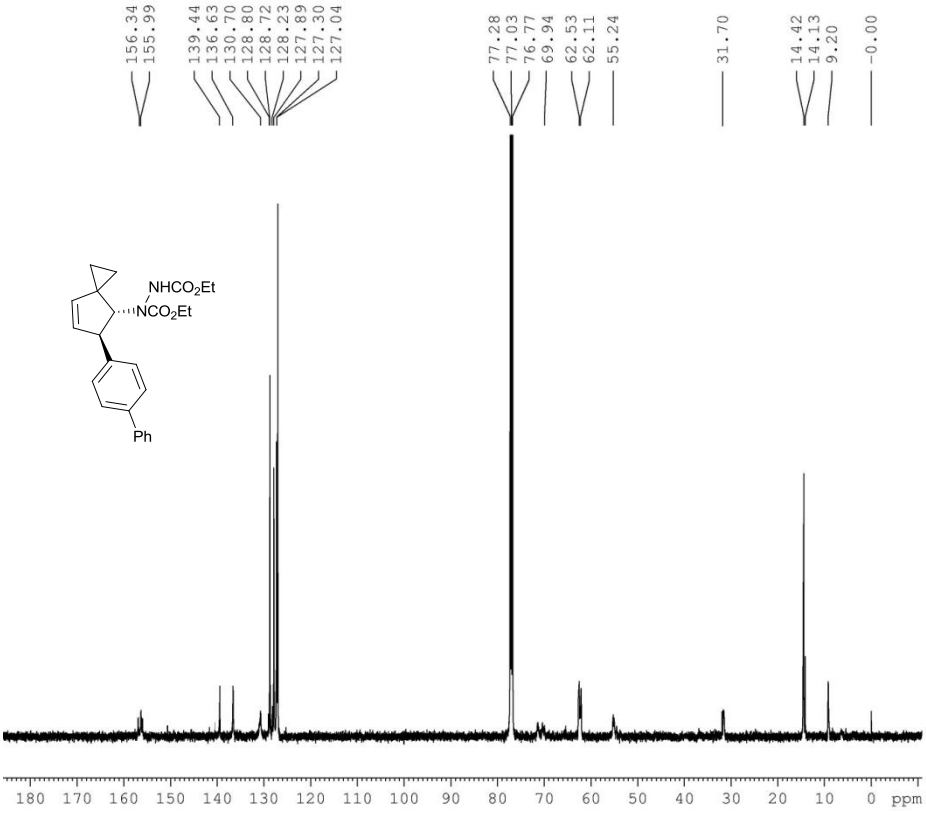
^{1}H NMR of **3ac**



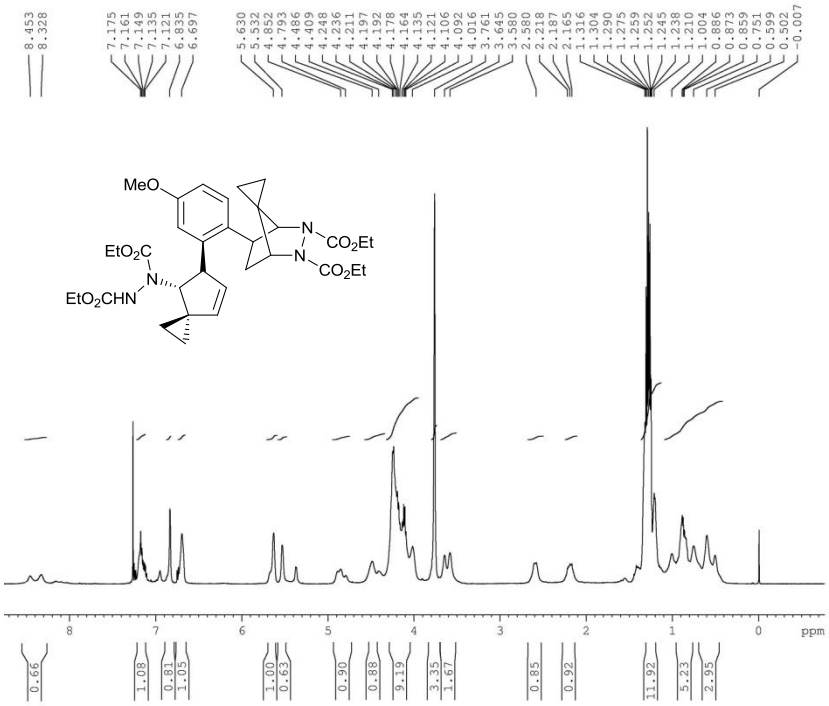
^{13}C NMR of **3ac**



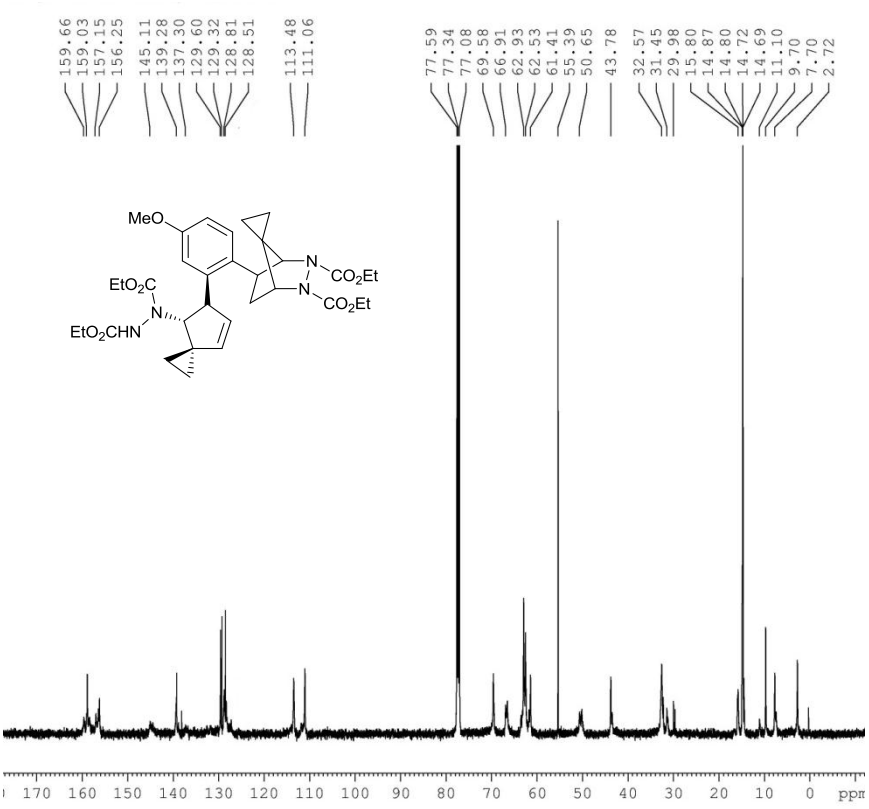
^{1}H NMR of **4ac**



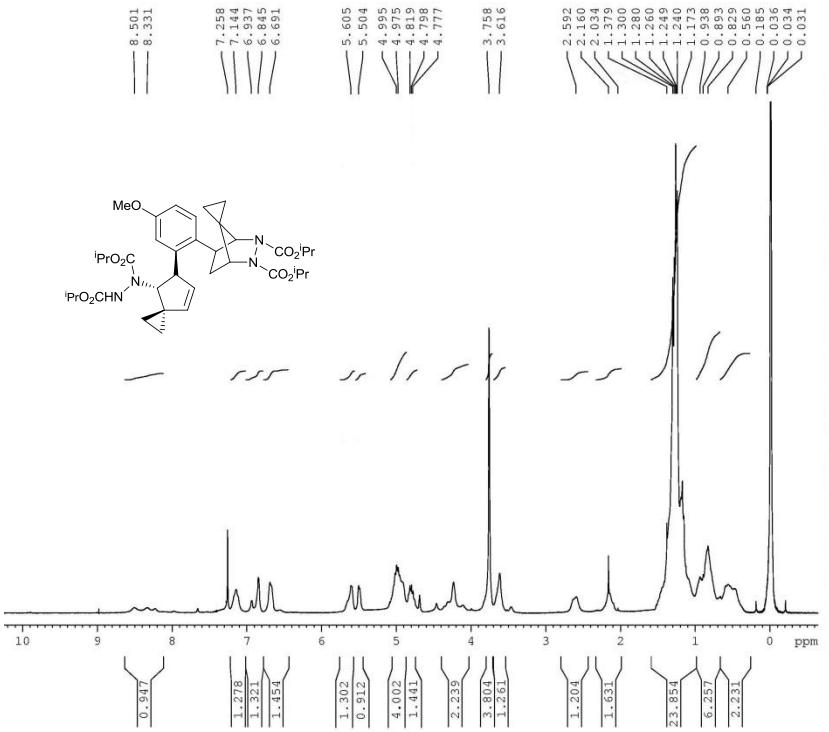
^{13}C NMR of **4ac**



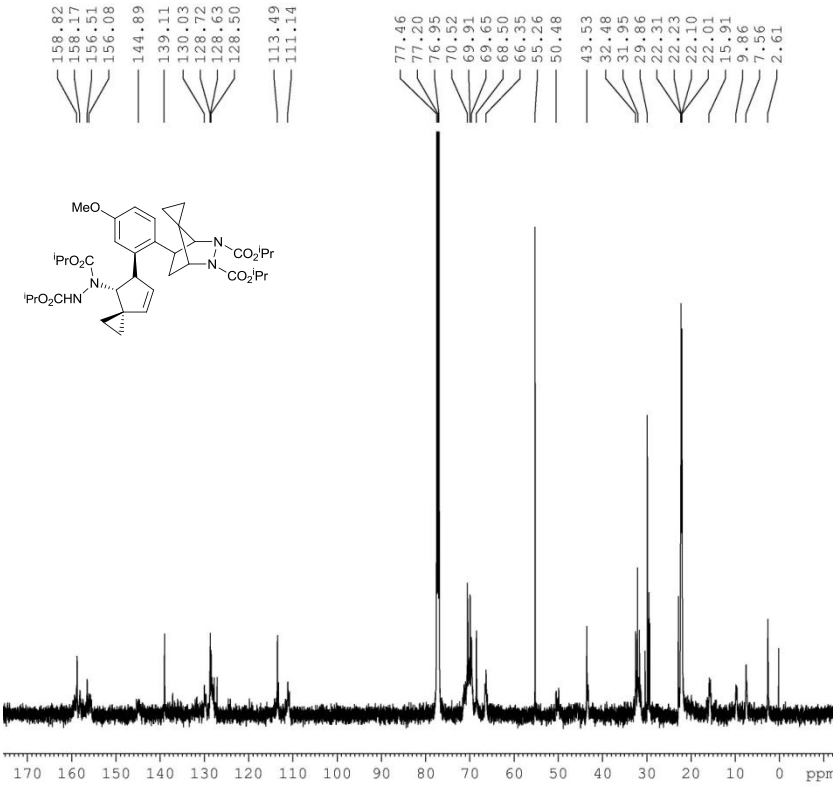
^{1}H NMR of **3ad**



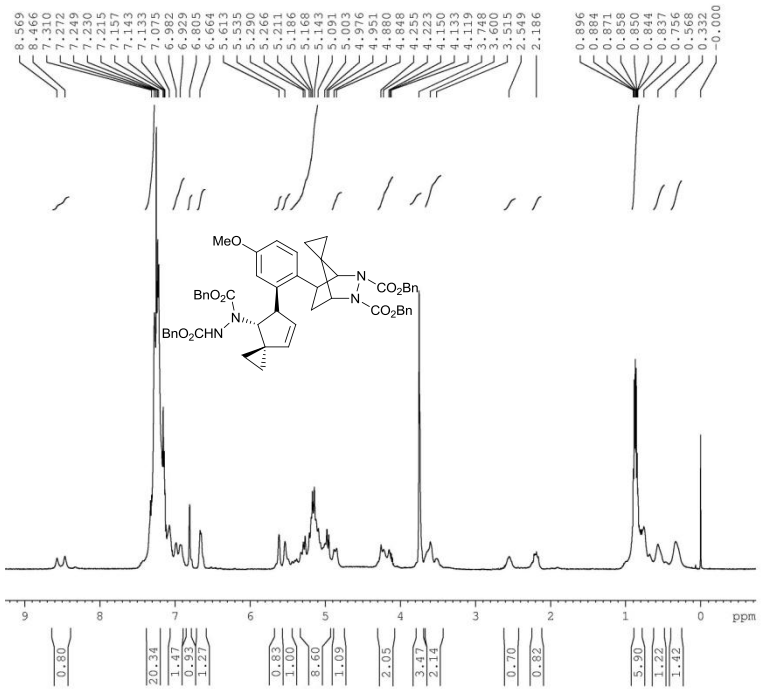
^{13}C NMR of **3ad**



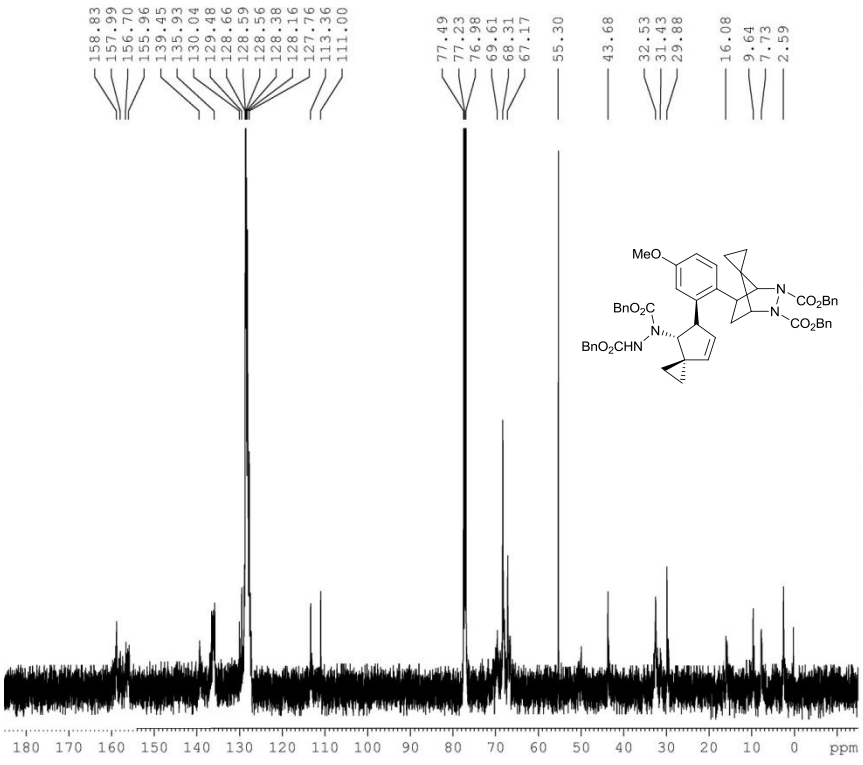
^{1}H NMR of **3bd**



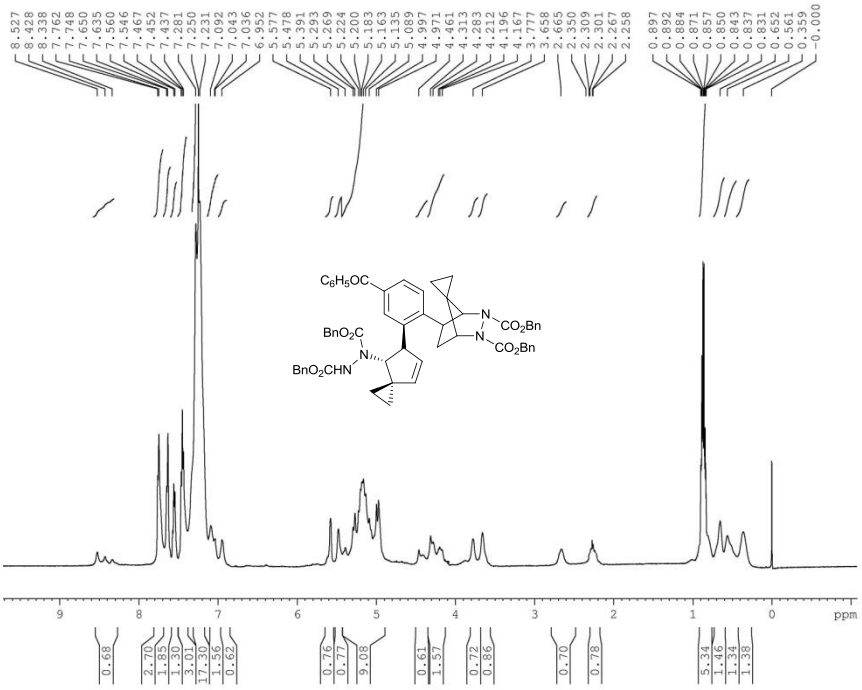
^{13}C NMR of **3bd**



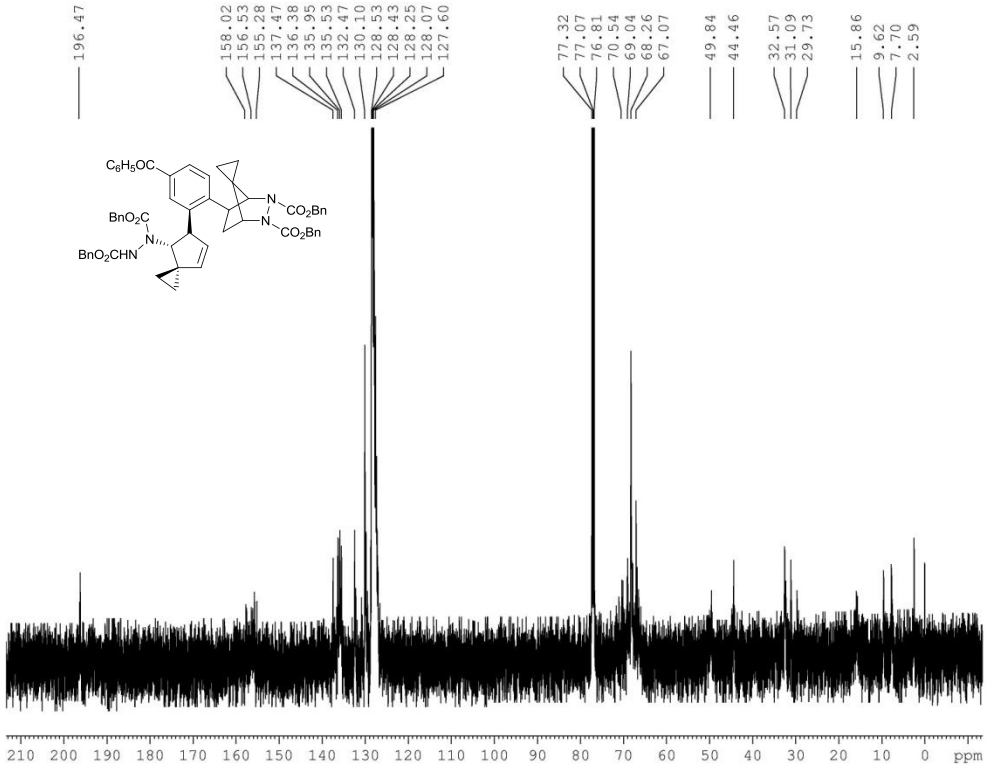
^{1}H NMR of **3dd**



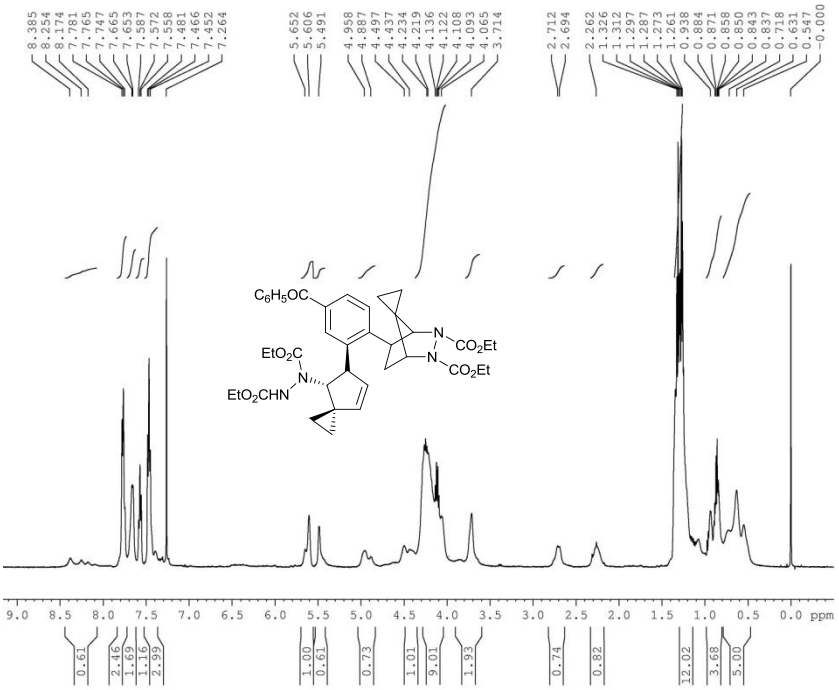
^{13}C NMR of **3dd**



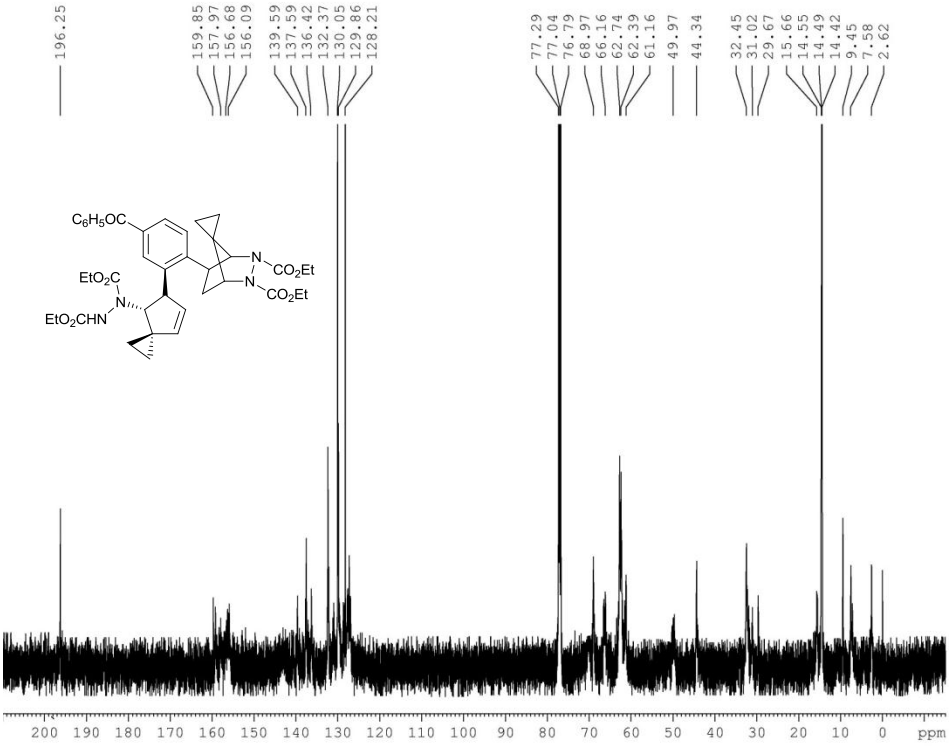
^{1}H NMR of **3de**



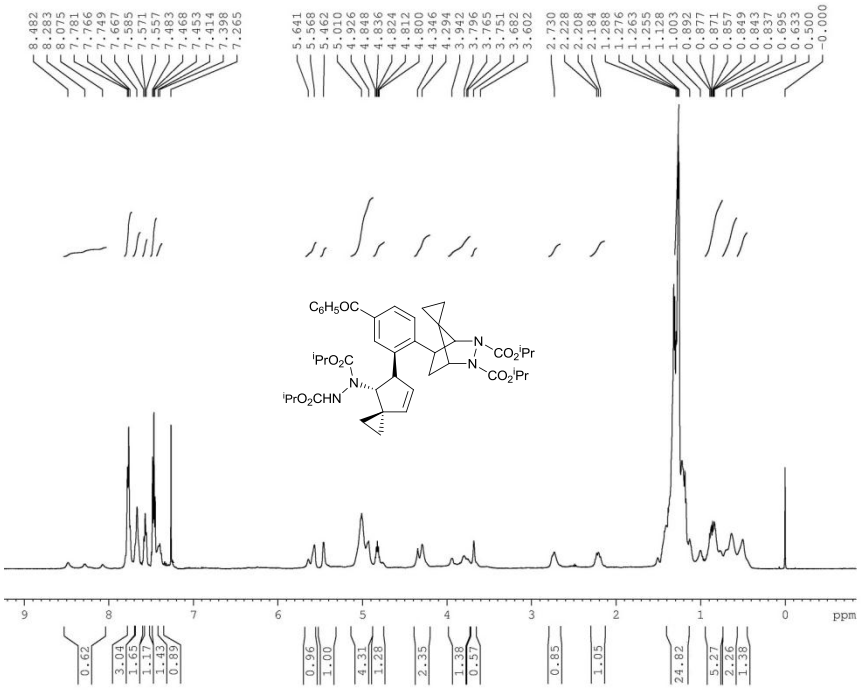
^{13}C NMR of **3de**



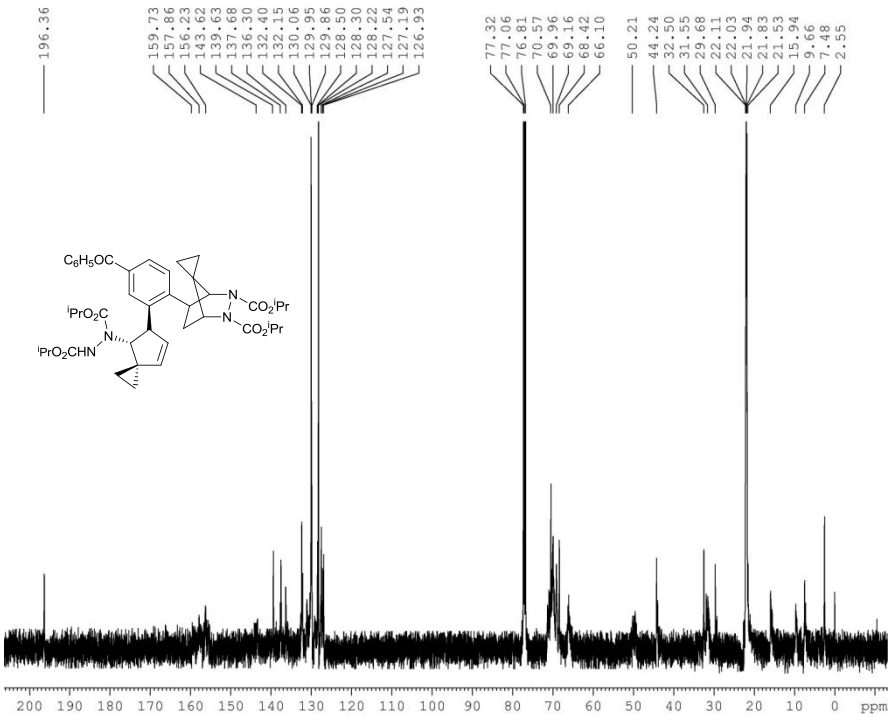
^{1}H NMR of **3ae**



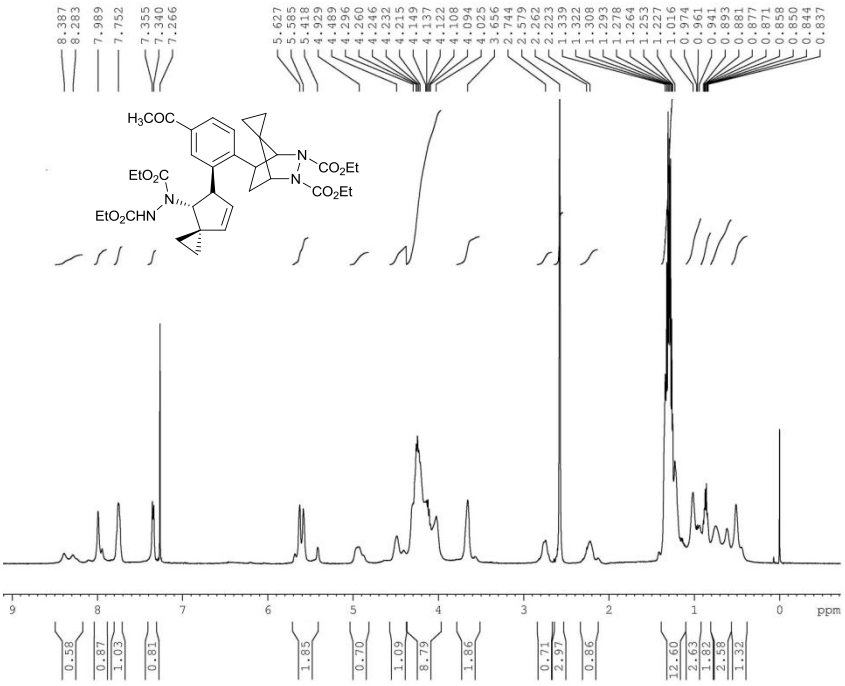
^{13}C NMR of **3ae**



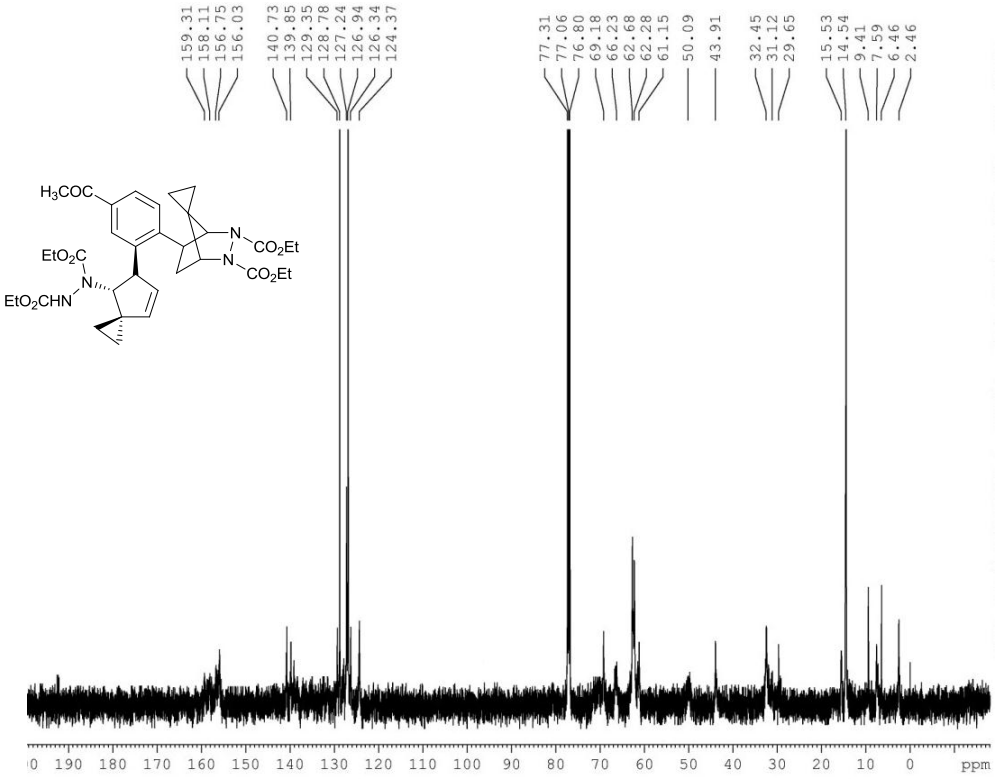
^{1}H NMR of **3be**



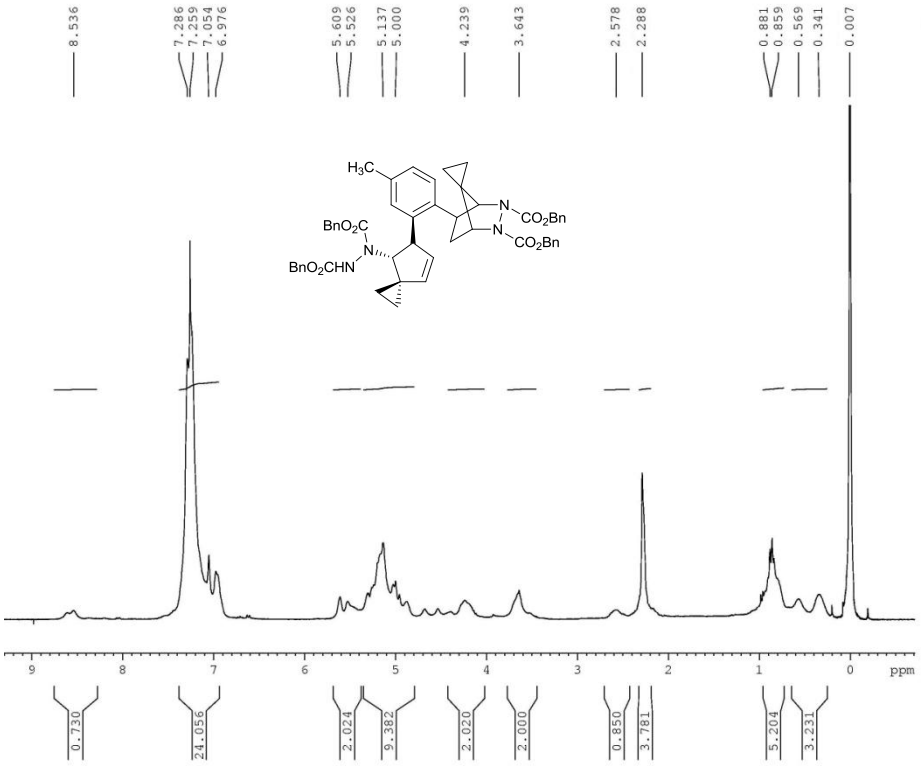
^{13}C NMR of **3be**



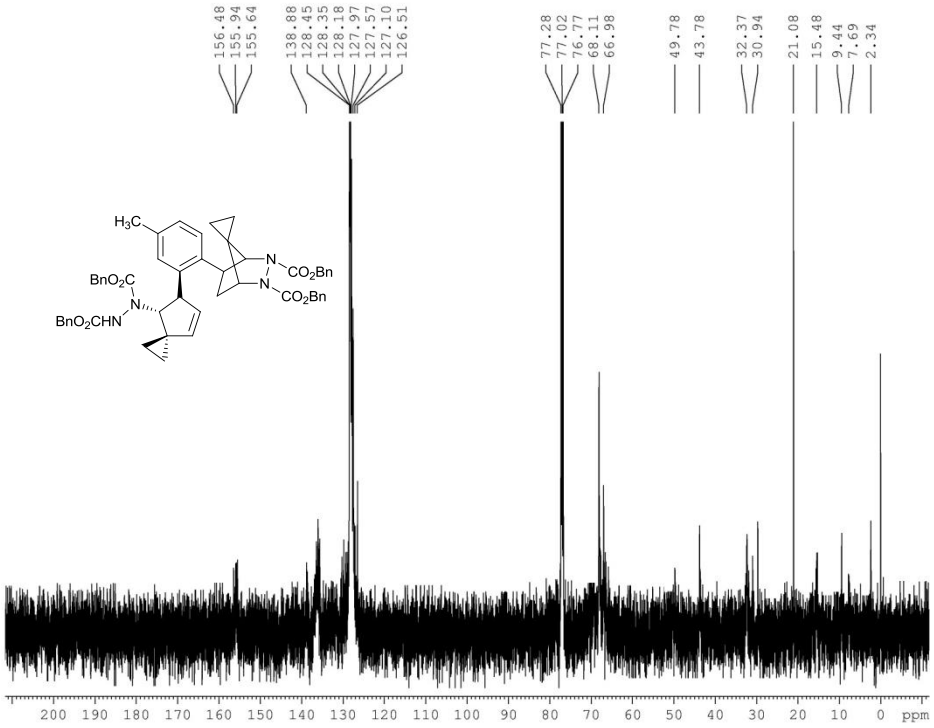
^{1}H NMR of **3af**



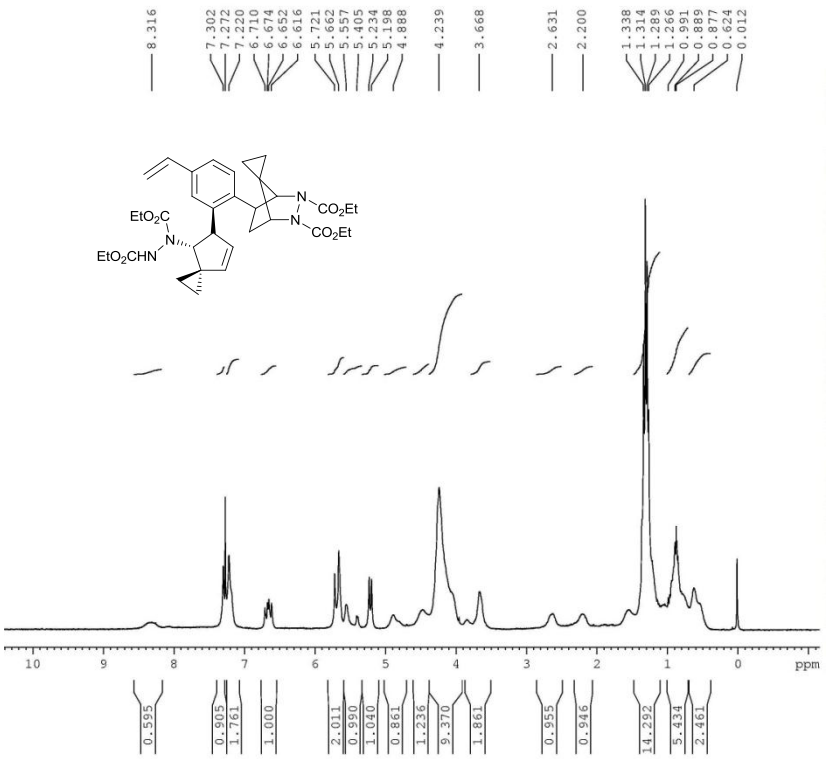
^{13}C NMR of **3af**



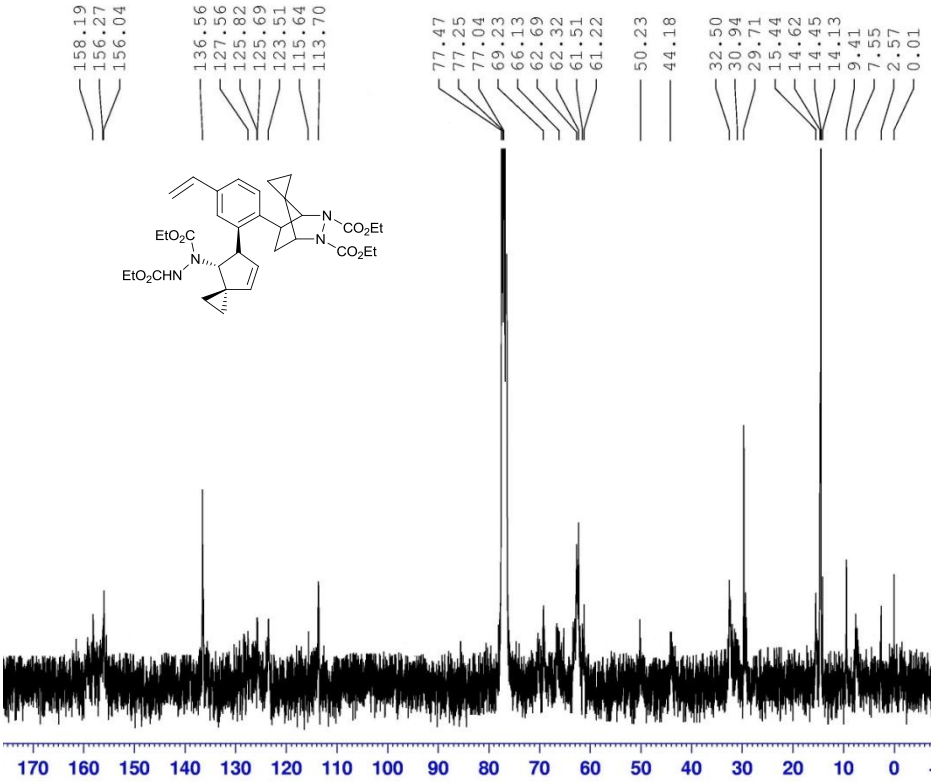
^{1}H NMR of **3dg**



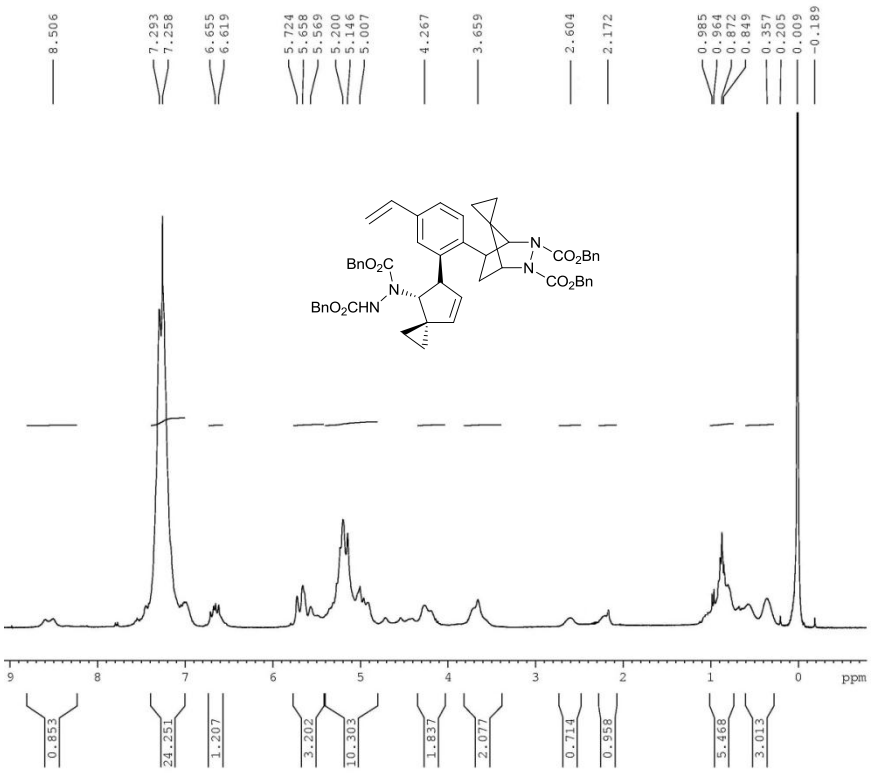
^{13}C NMR of **3dg**



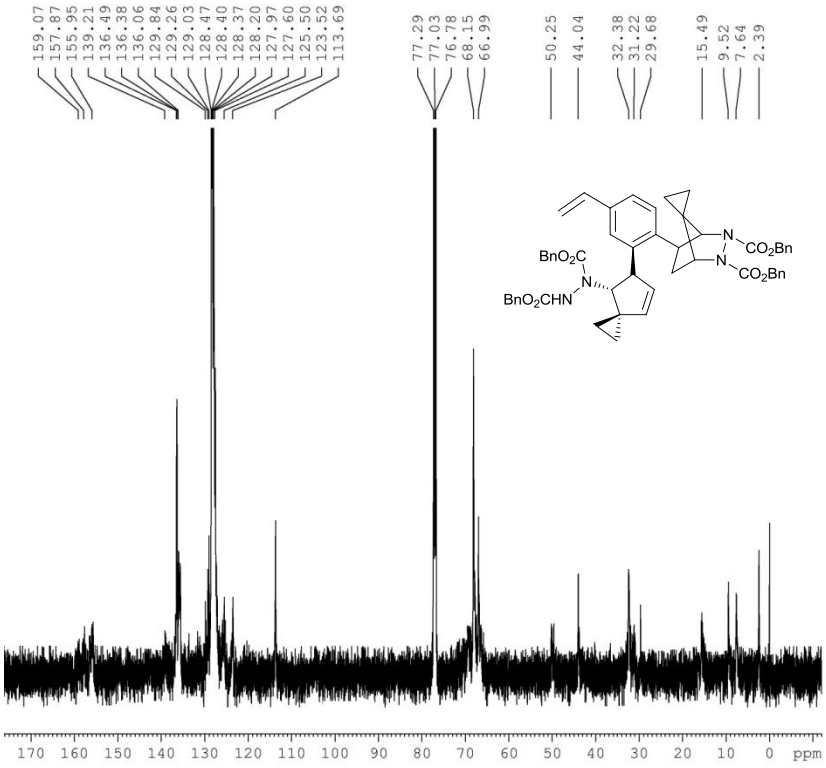
^{1}H NMR of **3ah**



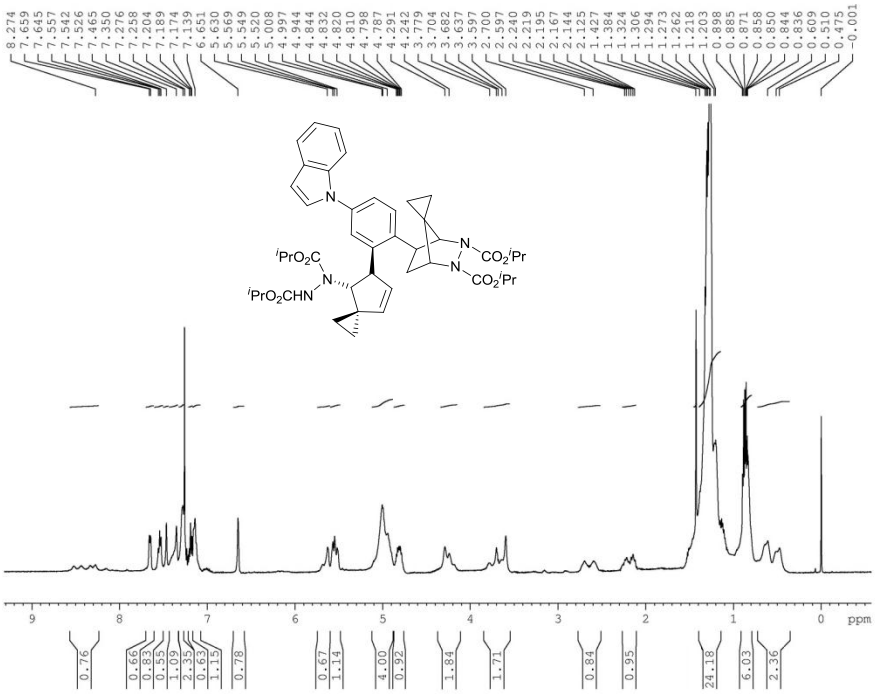
^{13}C NMR of **3ah**



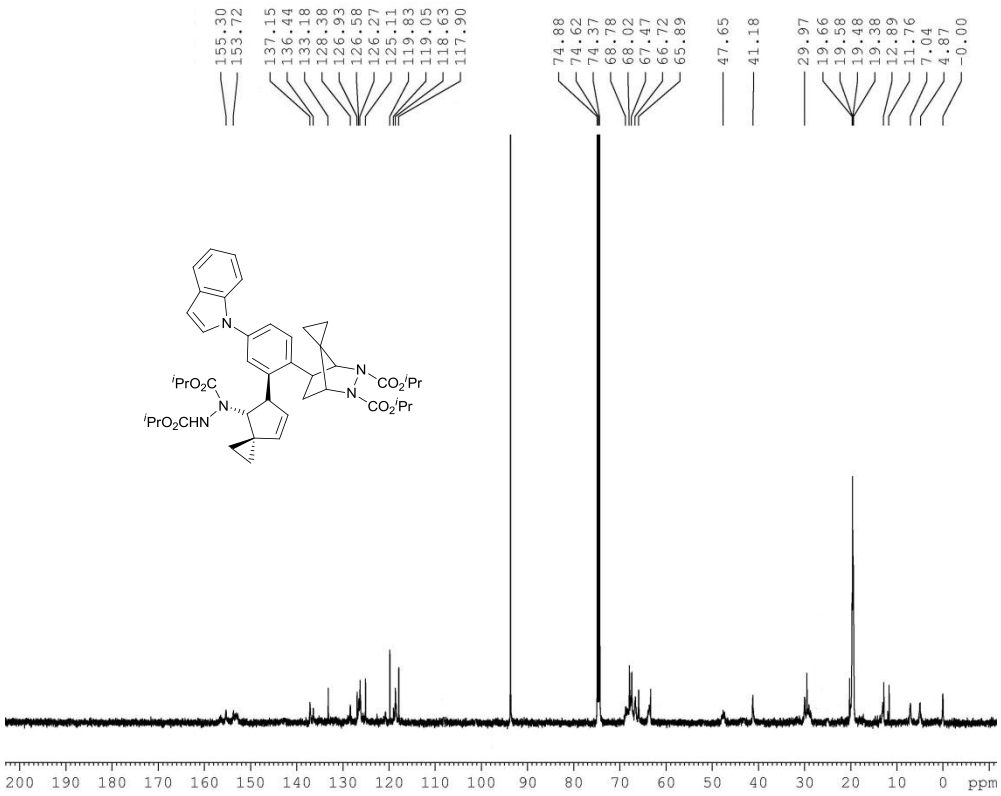
^{1}H NMR of **3dh**



^{13}C NMR of **3dh**

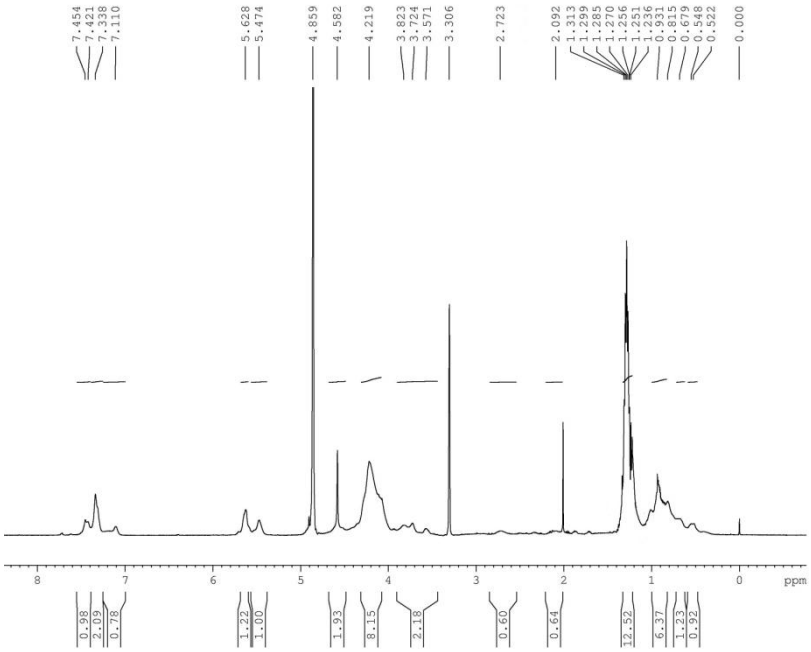


^{1}H NMR of **6**

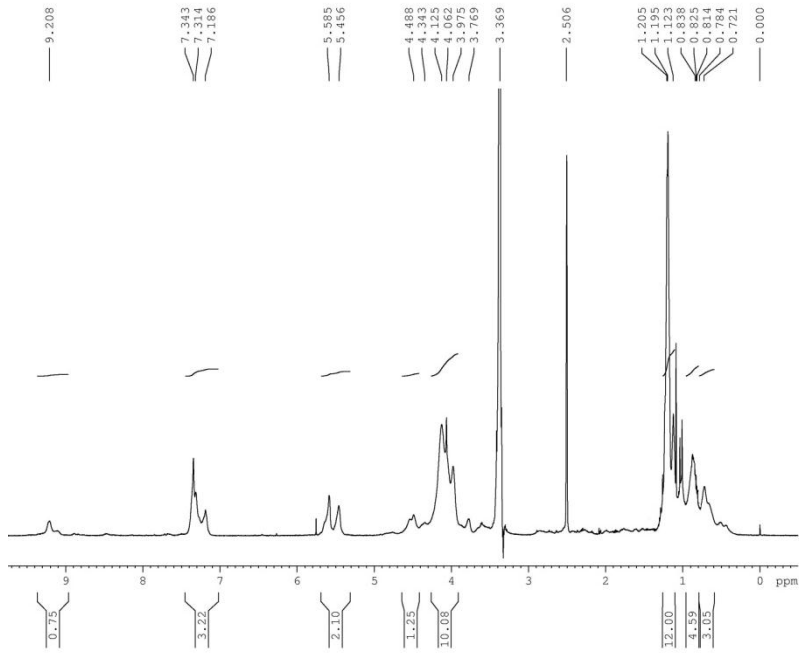


^{13}C NMR of **6**

NMR of compound **3aa** in different solvents



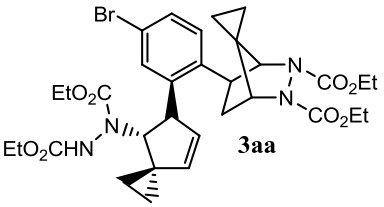
^{1}H NMR of **3aa** in d_4-MeOH



^{1}H NMR of **3aa** in d_6-DMSO

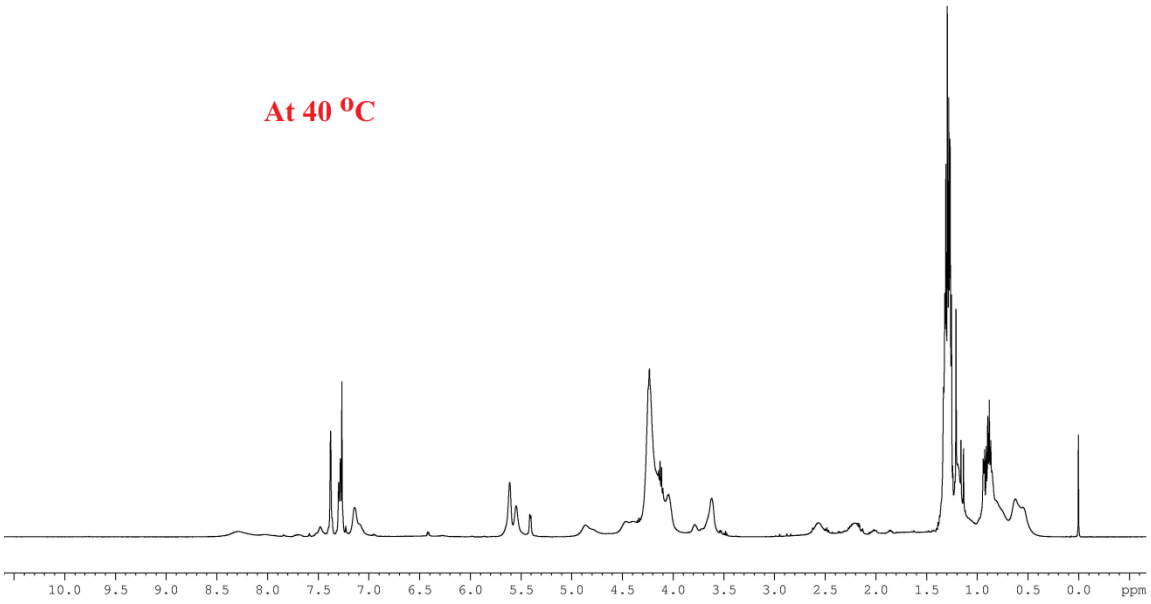
NMR of compound **3aa** at different temperatures

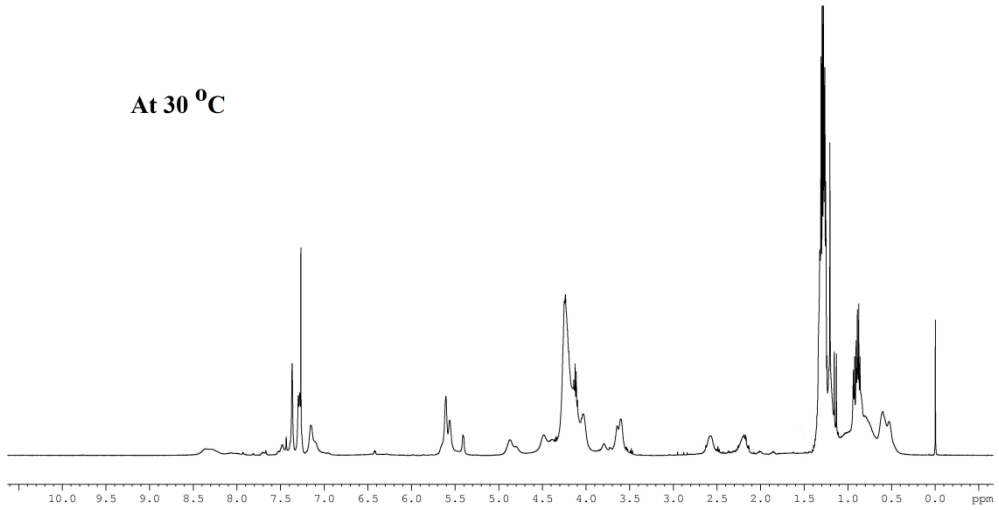
At 50 °C



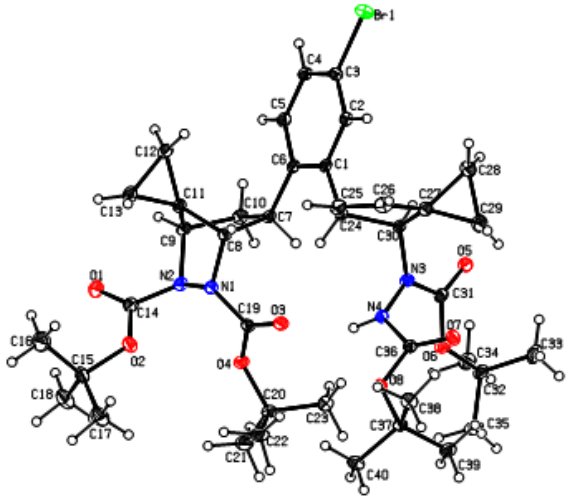
3aa

At 40 °C





ORTEP Drawing: 3ca



CCDC Number: 933879

Chemical formula moiety	$C_{40}H_{57}BrN_4O_8$
Chemical formula sum	$C_{40}H_{57}BrN_4O_8$
Chemical formula weight	801.81
Symmetry cell setting	Monoclinic
Symmetry space group name H-M	C2/c
Cell length a	25.610(3)
Cell length b	16.1687(17)
Cell length c	22.954(2)
Cell angle alpha	90.00
Cell angle beta	111.185(2)
Cell angle gamma	90.00
Cell volume	8862.4(16)

Cell formula units Z	8
Cell measurement temperature	110(2)
Cell measurement reflns used	5136
Cell measurement theta min	2.18
Cell measurement theta max	27.81
Exptl crystal description	Prism
Exptl crystal colour	colourless
Exptl crystal size max	0.45
Exptl crystal size mid	0.39
Exptl crystal size min	0.32
Exptl crystal density diffrn	1.202
Exptl crystal_density_method	'not measured'
Exptl crystal F 000	3392
Exptl absorpt coefficient mu	0.978
Exptl absorpt correction_type	'multi-scan'
Exptl absorpt correction T min	0.6673
Exptl absorpt correction T max	0.7449
Diffrn ambient temperature	296(2)
Diffrn radiation wavelength	0.71073