Supplementary Information for

Asymmetric Dearomatization of Pyrroles via Ir-Catalyzed Allylic Substitution Reaction: Enantioselective Synthesis of Spiro-2*H*-pyrroles

Chun-Xiang Zhuo, Wen-Bo Liu, Qing-Feng Wu and Shu-Li You*

State Key Laboratory of Organometallic Chemistry
Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences
345 Lingling Lu, Shanghai 200032, China

E-mail: slyou@sioc.ac.cn

Table of Contents

General methods. Unless stated otherwise, all reactions were carried out in flame-dried glassware under a dry argon atmosphere. All solvents were purified and dried according to standard methods prior to use.

^{1}H and ^{13}C NMR spectra were recorded on a Varian instrument (300, 400 MHz and 75, 100 MHz, respectively) and internally referenced to tetramethylsilane signal or residual protio solvent signals. Data for ^{1}H NMR are recorded as follows: chemical shift (δ, ppm), multiplicity (s = singlet, d = doublet, t = triplet, m = multiplet or unresolved, br = broad singlet, coupling constant(s) in Hz, integration). Data for ^{13}C NMR are reported in terms of chemical shift (δ, ppm).

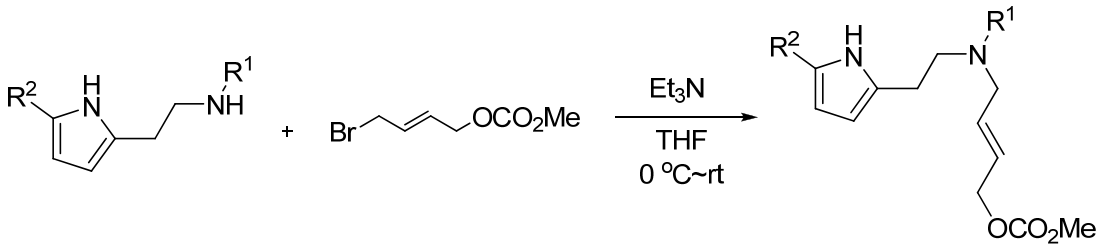
The phosphoramidite ligands[1], the substituted 2-(1H-pyrrole-2yl) ethanamines[2] and (*E*)-4-bromo-but-2-enyl methyl ester[3] were prepared according to the reported procedures.

(1) W.-B. Liu, H. He, L.-X. Dai and S.-L. You, *Synthesis.*, 2009, 2076.

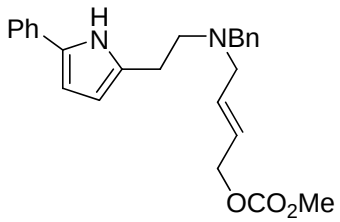
(2) (a) D. B. C. Martin and C. D. Vanderwal, *J. Am. Chem. Soc.*, 2009, **131**, 3472; (b) J. Leonard, A. B. Hague and M. F. Jones, *Tetrahedron Lett.*, 1997, **38**, 3071; (c) P. R. Jenkins, J. Wilson, D. Emmerson, M. D. Garcia, M. R. Smith, S. J. Gray, R. G. Britton, S. Mahale and B. Chaudhuri, *Bioorg. Med. Chem.*, 2008, **16**, 7728; (d) W. Chen, E. K. Stephenson, M. P. Cava and Y. A. Jackson, *Org. Syn.*, 1992, **70**, 151; (e) L. H. Thoresen, H. Kim, M. B. Welch, A. Burghart and K. Burgess, *Synlett*, 1998, 1276.

(3) B. M. Trost, K. L. Sacchi, G. M. Schroeder and N. Asakawa, *Org. Lett.*, 2002, **4**, 3427.

General Procedure for the Synthesis of Substituted Allylic Carbonates:

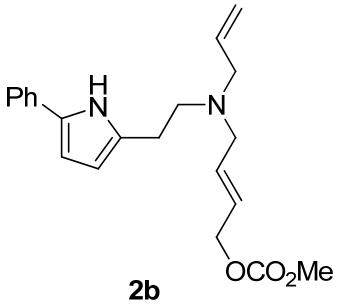


To a solution of the substituted 2-(1H-pyrrole-2yl) ethanamines [2] (2 mmol, 1.0 equiv) and Et_3N (0.4 mL, 2.4 mmol) in dry THF (25 mL), carbonic acid (*E*)-4-bromo-but-2-enyl methyl ester[3] (832 mg, 4 mmol) was added at 0 °C. The ice bath was removed and the reaction mixture was stirred at rt for 6-12 h. After the reaction was complete (monitored by TLC), the crude reaction mixture was filtrated with celite and washed with EtOAc. The solvents were removed under reduced pressure. Then the residue was purified by silica gel column chromatography (PE/EA = 2/1) to afford the desired product **2**.



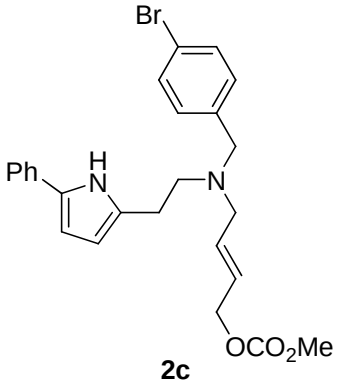
2a

Brown oil, yield 75%. ^{1}H NMR (300 MHz, $CDCl_3$) δ 9.97 (s, 1H), 7.41 (d, *J* = 7.5 Hz, 2H), 7.36-7.24 (m, 7H), 7.16 (t, *J* = 6.9 Hz, 1H), 6.40 (t, *J* = 3.0 Hz, 1H), 5.93-5.77 (m, 3H), 4.57 (d, *J* = 6.0 Hz, 2H), 3.74 (s, 3H), 3.67 (s, 2H), 3.21 (d, *J* = 5.4 Hz, 2H), 2.84 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.5, 138.4, 133.1, 133.0, 131.9, 130.6, 129.2, 128.7, 128.4, 127.3, 127.2, 125.4, 123.2, 106.9, 105.3, 67.7, 58.2, 54.8, 54.5, 53.6, 24.3. IR (thin film): ν_{max} (cm^{-1}) = 3026, 2953, 2813, 1747, 1604, 1513, 1449, 1260, 1028, 756, 695; MS (ESI): 405 $[M+H]^+$; HRMS (MALDI) calcd for $C_{25}H_{29}N_2O_3$ $[M+H]^+$: 405.2185, Found: 405.2173.



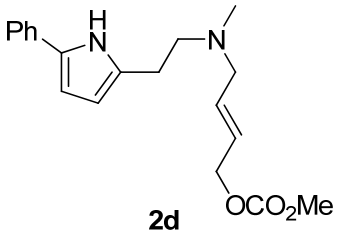
2b

Brown oil, yield 90%. ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.03 (s, 1H), 7.42 (d, *J* = 7.5 Hz, 2H), 7.33 (t, *J* = 7.5 Hz, 2H), 7.13 (t, *J* = 7.5 Hz, 1H), 6.40 (t, *J* = 3.3 Hz, 1H), 5.94-5.79 (m, 4H), 5.23-5.16 (m, 2H), 4.59 (d, *J* = 5.7 Hz, 2H), 3.74 (s, 3H), 3.22 (d, *J* = 6.6 Hz, 2H), 3.20 (d, *J* = 7.2 Hz, 2H), 2.78 (m, 4H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 155.5, 134.7, 133.2, 132.0, 130.4, 128.7, 127.0, 125.3, 123.1, 118.4, 106.8, 105.3, 67.7, 56.5, 54.79, 54.75, 53.1, 24.2. IR (thin film): ν_{max} (cm^{-1}) = 3025, 2954, 2814, 1747, 1605, 1513, 1443, 1259, 1039, 755, 693; MS (ESI): 355 $[M+H]^+$; HRMS (MALDI) calcd for $C_{21}H_{27}N_2O_3$ $[M+H]^+$: 355.2023, Found: 355.2016.



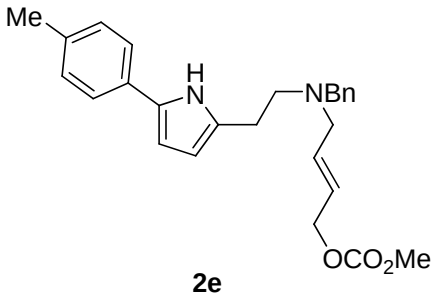
2c

Brown oil, yield 71%. ^{1}H NMR (300 MHz, $CDCl_3$) δ 9.65 (s, 1H), 7.41-7.30 (m, 6H), 7.17-7.13 (m, 3H), 6.40 (t, *J* = 2.7 Hz, 1H), 5.93-5.74 (m, 3H), 4.57 (d, *J* = 5.7 Hz, 2H), 3.73 (s, 3H), 3.58 (s, 2H), 3.17 (d, *J* = 6.3 Hz, 2H), 2.83-2.76 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.6, 137.7, 133.1, 132.8, 131.8, 131.6, 130.8, 130.7, 128.9, 127.4, 125.6, 123.3, 121.1, 107.2, 105.5, 67.7, 57.7, 54.9, 54.6, 53.5, 24.6. IR (thin film): ν_{max} (cm^{-1}) = 3025, 2954, 2814, 1747, 1605, 1513, 1443, 1259, 1039, 755, 693; MS (ESI): 483 $[M+H]^+$; HRMS (MALDI) calcd for $C_{25}H_{28}N_2O_3Br$ $[M+H]^+$: 483.1284, Found: 483.1278.



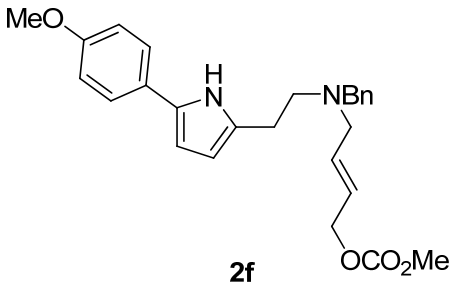
2d

Brown oil, yield 70%. ^{1}H NMR (300 MHz, CDCl3) δ 10.15 (s, 1H), 7.35 (d, *J* = 7.5 Hz, 2H), 7.24 (t, *J* = 7.2 Hz, 2H), 7.05 (t, *J* = 7.5 Hz, 1H), 6.31 (t, *J* = 3.3 Hz, 1H), 5.85-5.70 (m, 3H), 4.52 (d, *J* = 5.7 Hz, 2H), 3.67 (s, 3H), 3.05 (d, *J* = 6.0 Hz, 2H), 2.74 (t, *J* = 6.3 Hz, 2H), 2.63 (t, *J* = 6.0 Hz, 2H), 2.25 (s, 3H). ^{13}C NMR (75 MHz, CDCl3) δ 155.4, 133.0, 132.9, 131.8, 130.4, 128.6, 127.1, 125.2, 123.0, 106.7, 105.1, 67.5, 59.0, 56.9, 54.7, 41.3, 24.1. IR (thin film): νmax (cm^{-1}) = 3025, 2954, 2814, 1748, 1606, 1513, 1445, 1262, 1040, 758, 694; MS (ESI): 329 $[M+H]^{+}$; HRMS (MALDI) calcd for $C_{19}H_{25}N_2O_3$ $[M+H]^{+}$: 329.1859, Found: 329.1860.



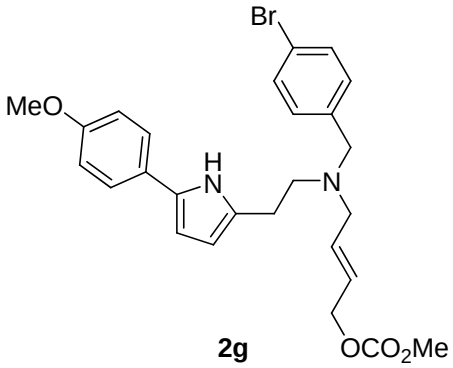
2e

Brown oil, yield 68%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.86 (s, 1H), 7.29-7.12 (m, 7H), 7.11 (d, *J* = 8.0 Hz, 2H), 6.31 (t, *J* = 2.8 Hz, 1H), 5.69-5.88 (m, 3H), 4.53 (d, *J* = 6.0 Hz, 2H), 3.71 (s, 3H), 3.65 (s, 2H), 3.17 (d, *J* = 6.4 Hz, 2H), 2.81 (m, 4H), 2.31 (s, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 155.5, 138.1, 135.0, 132.4, 131.6, 130.7, 130.4, 129.4, 129.2, 128.5, 127.3, 123.2, 106.7, 104.6, 67.7, 58.1, 54.8, 54.4, 53.4, 24.3, 21.0. IR (thin film): νmax (cm^{-1}) = 3026, 2954, 2852, 1748, 1525, 1443, 1261, 1038, 771, 700; MS (EI): 418 $[M]^{+}$; HRMS (EI) calcd for $C_{26}H_{30}N_2O_3$ $[M]^{+}$: 418.2256, Found: 418.2253.



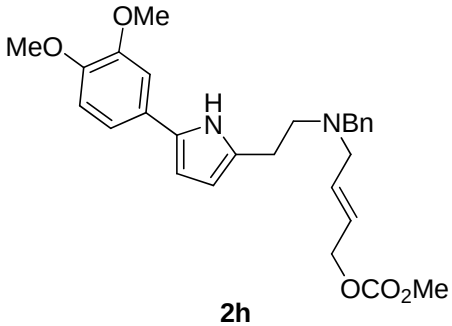
2f

Brown oil, yield 67%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.75 (s, 1H), 7.35-7.24 (m, 7H), 6.89-6.87 (m, 2H), 6.27 (t, *J* = 3.2 Hz, 1H), 5.91-5.71 (m, 3H), 4.56 (d, *J* = 6.0 Hz, 2H), 3.80 (s, 3H), 3.73 (s, 3H), 3.65 (s, 2H), 3.19 (d, *J* = 6.4 Hz, 2H), 2.83-2.80 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.3, 155.6, 138.6, 132.3, 132.1, 130.7, 129.2, 128.5, 127.3, 127.1, 126.4, 124.7, 114.3, 106.7, 104.2, 67.8, 58.2, 55.3, 54.8, 54.6, 53.6, 24.5. IR (thin film): νmax (cm^{-1}) = 3027, 2954, 2834, 1747, 1523, 1442, 1259, 1029, 771, 700; MS (ESI): 435 $[M+H]^+$; HRMS (MALDI) calcd for $C_{26}H_{31}N_2O_4$ $[M+H]^+$: 435.2291, Found: 435.2278.



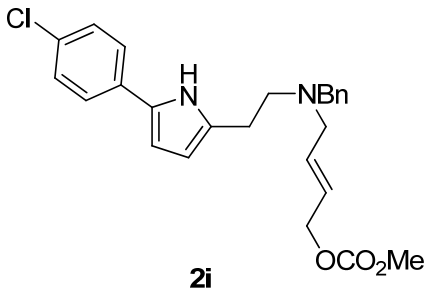
2g

Brown oil, yield 65%. ^{1}H NMR (300 MHz, $CDCl_3$) δ 9.55 (s, 1H), 7.42 (d, *J* = 8.1 Hz, 1H), 7.37 (d, *J* = 8.4 Hz, 1H), 7.20 (d, *J* = 8.1 Hz, 2H), 6.94 (d, *J* = 8.7 Hz, 1H), 6.32 (t, *J* = 3.3 Hz, 1H), 5.95-5.74 (m, 3H), 4.62 (d, *J* = 5.7 Hz, 2H), 3.85 (s, 3H), 3.79 (s, 3H), 3.62 (s, 2H), 3.21 (d, *J* = 6.0 Hz, 2H), 2.87-2.82 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.7, 155.5, 137.6, 131.9, 131.8, 131.5, 130.7, 130.6, 127.3, 126.2, 124.6, 121.0, 114.2, 106.9, 104.3, 67.7, 57.5, 55.3, 54.8, 54.5, 53.5, 24.6. IR (thin film): ν_{max} (cm^{-1}) = 2953, 2833, 1746, 1522, 1485, 1441, 1259, 1030, 770, 735; MS (ESI): 513 $[M+H]^+$; HRMS (ESI) calcd for $C_{26}H_{29}N_2BrNaO_4$ $[M+Na]^+$: 535.1212, Found: 535.1203.



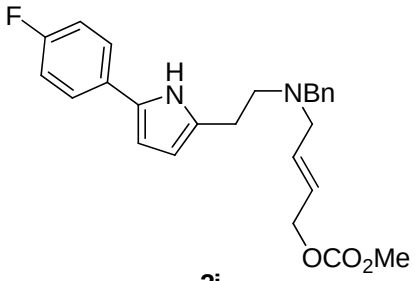
2h

Brown oil, yield 67%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.85 (s, 1H), 7.31-7.22 (m, 5H), 6.97-6.94 (m, 2H), 6.84 (d, *J* = 8.4 Hz, 1H), 6.29 (d, *J* = 2.8 Hz, 1H), 5.92-5.74 (m, 3H), 4.54 (d, *J* = 6.4 Hz, 2H), 3.87 (s, 3H), 3.84 (s, 3H), 3.72 (s, 3H), 3.65 (s, 2H), 3.18 (d, *J* = 6.4 Hz, 2H), 2.84-2.81 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.4, 149.1, 147.1, 138.3, 132.3, 131.8, 130.6, 129.1, 128.4, 127.2, 126.7, 115.5, 111.5, 107.3, 106.6, 104.3, 67.6, 58.0, 55.8, 55.7, 54.7, 54.5, 53.5, 24.3. IR (thin film): ν_{max} (cm^{-1}) = 3025, 2960, 2835, 1747, 1591, 1442, 1261, 1025, 765, 700; MS (ESI): 465 $[M+H]^+$; HRMS (MALDI) calcd for $C_{27}H_{33}N_2O_5$ $[M+H]^+$: 465.2390, Found: 465.2384.



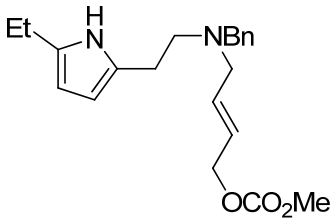
2i

Brown oil, yield 73%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 10.00 (s, 1H), 7.32-7.24 (m, 9H), 6.38 (t, *J* = 3.2 Hz, 1H), 5.93-5.76 (m, 3H), 4.57 (d, *J* = 5.6 Hz, 2H), 3.74 (s, 3H), 3.66 (s, 2H), 3.19 (d, *J* = 6.4 Hz, 2H), 2.85 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.4, 138.2, 133.4, 131.6, 130.5, 129.3, 129.1, 128.7, 128.4, 127.24, 127.18, 124.2, 107.1, 105.7, 67.5, 58.0, 54.7, 54.3, 53.3, 24.1. IR (thin film): ν_{max} (cm^{-1}) = 3025, 2955, 2818, 1747, 1602, 1443, 1261, 1029, 772, 699; MS (ESI): 439 $[M+H]^+$; HRMS (MALDI) calcd for $C_{25}H_{28}N_2O_3Cl$ $[M+H]^+$: 439.1787, Found: 439.1783.



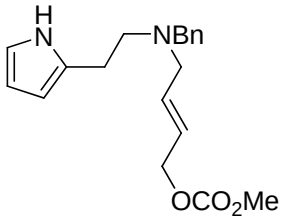
2j

Yellow oil, yield 73%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.90 (s, 1H), 7.34-7.22 (m, 7H), 7.00 (t, *J* = 8.8 Hz, 2H), 6.29 (t, *J* = 3.2 Hz, 1H), 5.90-5.69 (m, 3H), 4.55 (d, *J* = 5.6 Hz, 2H), 3.72 (s, 3H), 3.64 (s, 2H), 3.18 (d, *J* = 6.4 Hz, 2H), 2.81 (m, 4H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 161.0 (d, *J* = 243.0 Hz), 155.5, 138.4, 133.1, 131.8, 129.7, 129.5, 129.2, 128.8, 128.5, 128.2, 127.3 (d, *J* = 4.0 Hz), 124.8 (d, *J* = 7.4 Hz), 115.6 (d, *J* = 21.2 Hz), 106.9, 105.1, 67.7, 58.2, 54.8, 54.4, 53.4, 24.2. ^{19}F NMR (282 MHz, $CDCl_3$) δ -117.80 (m, 1F). IR (thin film): ν_{max} (cm^{-1}) = 3028, 2957, 2811, 1748, 1576, 1444, 1261, 1026, 792, 700; MS (ESI): 423 $[M+H]^+$; HRMS (MALDI) calcd for $C_{25}H_{28}N_2O_3F$ $[M+H]^+$: 423.2080, Found: 423.2079.



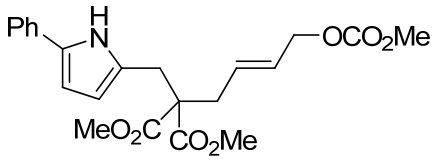
2k

Brown oil, yield 63%. ^{1}H NMR (300 MHz, $CDCl_3$) δ 9.03 (s, 1H), 7.36-7.29 (m, 5H), 5.92-5.63 (m, 4H), 4.65 (d, *J* = 5.7 Hz, 2H), 3.82 (s, 3H), 3.67 (s, 2H), 3.21 (d, *J* = 6.0 Hz, 2H), 2.81 (m, 4H), 2.63 (q, *J* = 7.5 Hz, 2H), 1.28 (t, *J* = 7.5 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 155.6, 138.77, 138.76, 132.7, 132.6, 129.8, 129.1, 128.4, 127.2, 126.8, 104.7, 103.4, 67.9, 58.3, 54.8, 54.7, 53.5, 24.5, 20.9, 13.8. IR (thin film): ν_{max} (cm^{-1}) = 3027, 2962, 2806, 1749, 1590, 1450, 1263, 1027, 794, 700; MS (ESI): 357.0 $[M+H]^+$; HRMS (MALDI) calcd for $C_{21}H_{29}N_2O_3$ $[M+H]^+$: 357.2182, Found: 357.2173.



2l

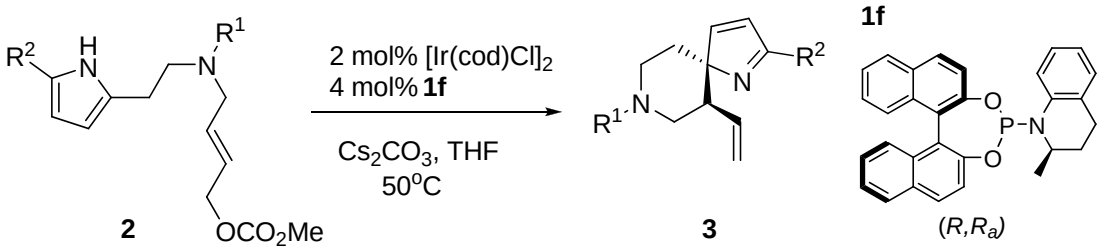
Brown oil, yield 63%. ^{1}H NMR (300 MHz, $CDCl_3$) δ 9.21 (s, 1H), 7.48-7.38 (m, 5H), 6.75 (m, 1H), 6.24 (m, 1H), 6.03-5.84 (m, 3H), 4.72 (d, *J* = 5.7 Hz, 2H), 3.88 (s, 3H), 3.76 (s, 2H), 3.28 (d, *J* = 5.7 Hz, 2H), 2.93-2.86 (m, 4H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 155.7, 138.8, 132.8, 131.2, 129.1, 128.4, 127.2, 126.8, 116.8, 107.8, 105.2, 67.9, 58.2, 54.9, 54.8, 53.5, 24.7. IR (thin film): ν_{max} (cm^{-1}) = 3027, 2962, 2806, 1749, 1590, 1450, 1263, 1027, 794, 700; MS (ESI): 329 $[M+H]^+$; HRMS (ESI) calcd for $C_{19}H_{25}N_2O_3$ $[M+H]^+$: 329.1862, Found: 329.1860.



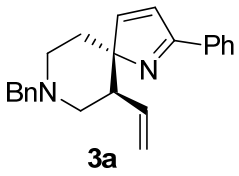
2m

Red oil, yield 58 %. ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.95 (s, 1H), 7.43 (d, *J* = 7.5 Hz, 2H), 7.33 (t, *J* = 7.5 Hz, 2H), 7.16 (d, *J* = 7.2 Hz, 1H), 6.37 (m, 1H), 5.92 (m, 1H), 5.67-5.62 (m, 2H), 4.53 (d, *J* = 4.5 Hz, 2H), 3.76 (s, 3H), 3.69 (s, 6H), 3.18 (s, 2H), 2.68 (d, *J* = 5.4 Hz, 2H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 171.5, 155.5, 132.7, 131.4, 130.0, 128.7, 128.1, 127.0, 125.7, 123.3, 110.0, 105.6, 67.7, 58.8, 54.7, 52.6, 36.7, 32.2. IR (thin film): ν_{max} (cm^{-1}) = 3003, 2954, 2850, 1732, 1606, 1441, 1266, 1048, 793, 694; MS (MALDI): 416 $[M+H]^+$; HRMS (MALDI) calcd for $C_{22}H_{25}NO_7$ $[M+H]^+$: 416.1707, Found: 416.1704.

General Procedure for Iridium-Catalyzed Enantioselective Allylic Alkylation of Pyrroles:



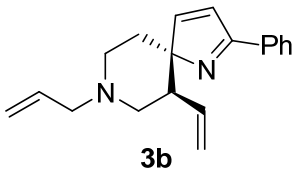
A flame-dried Schlenk tube was cooled to room temperature and filled with argon. To this flask were added $[Ir(cod)Cl]_2$ (1.4 mg, 0.002 mmol, 2 mol%), phosphoramidite ligand **1f** (1.9 mg, 0.004 mmol, 4 mol%), THF (0.5 mL) and propylamine (0.3 mL). The reaction mixture was heated at 50°C for 30 min and then the volatile solvents and reagents were removed *in vacuo* to give white solid. After that, allylic carbonate **2** (0.10 mmol, dissolved in 1.0 mL THF), cesium carbonate (0.10 mmol, 100 mol%) were added. The reaction mixture was heated at 50°C overnight. After the reaction was complete (monitored by TLC), the crude reaction mixture was filtrated with celite and washed with DCM. The solvents were removed under reduced pressure. The diastereomeric ratio was determined by ^{1}H NMR of the crude reaction mixture. Then the residue was purified by silica gel column chromatography (PE/Acetone = 1/1) to afford the desired product **3**. The characterization of the major isomers are summarized below.



3a

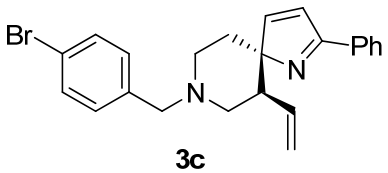
Yellow oil, yield 80%. dr = 99/1, 93% ee [Daicel Chiralpak OD-H (0.46 cm x 25 cm), *n*-hexane/2-propanol = 90/10, v = 1.0 mL·min^{-1}, λ = 254 nm, t (minor) = 4.97 min, t (major) = 10.82 min]; $[\alpha]_D^{20}$ = +71.6 (c = 0.5, acetone). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.84-7.81 (m, 2H), 7.54 (d, J = 5.1 Hz, 1H), 7.34-7.16 (m, 8H), 6.80 (d, J = 5.1 Hz, 1H), 5.17 (m, 1H), 4.82 (d, J = 17.4 Hz, 1H), 4.69 (d, J = 11.1 Hz, 1H), 3.61 (AB, J_{AB} = 13.5 Hz, 1H), 3.54 (BA, J_{BA} = 13.2 Hz, 1H), 3.01-2.90 (m, 3H), 2.29-2.22

(m, 3H), 1.25-1.17 (m, 1H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 170.2, 155.5, 138.4, 135.0, 134.0, 130.2, 128.9, 128.5, 128.2, 127.6, 127.0, 126.5, 116.1, 84.2, 62.8, 56.7, 52.2, 45.8, 33.0. IR (thin film): ν_{max} (cm^{-1}) = 3064, 3028, 2922, 1719, 1640, 1576, 1026, 758, 695; MS (ESI): 329 $[M+H]^+$; HRMS (MALDI) calcd for $C_{23}H_{25}N_2$ $[M+H]^+$: 329.2013, Found: 329.2012.



3b

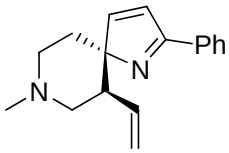
Brown oil, yield 85%. dr = 95/5, 86% ee [Daicel Chiralpak AD-H (0.46 cm x 25 cm), *n*-hexane/2-propanol = 95/5, *v* = 0.6 mL · min^{-1}, λ = 254 nm, t (minor) = 12.21 min, t (major) = 13.21 min]; $[\alpha]_D^{20}$ = +70.6 (c = 1.0, acetone). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.94-7.91 (m, 2H), 7.65 (d, *J* = 5.4 Hz, 1H), 7.66-7.64 (m, 3H), 6.91 (d, *J* = 4.8 Hz, 1H), 5.89-6.02 (m, 1H), 5.27-5.20 (m, 3H), 4.94 (d, *J* = 16.8 Hz, 1H), 4.80 (d, *J* = 10.8 Hz, 1H), 3.17-3.07 (m, 5H), 2.48-2.25 (m, 3H), 1.39-1.34 (m, 1H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 170.3, 155.2, 135.2, 134.8, 134.0, 130.2, 128.6, 127.6, 126.7, 117.8, 116.1, 84.2, 61.7, 56.7, 52.4, 45.7, 33.1. IR (thin film): ν_{max} (cm^{-1}) = 3075, 2923, 2790, 1642, 1605, 1576, 1494, 1448, 785, 693; MS (ESI): 279 $[M+H]^+$; HRMS (MALDI) calcd for $C_{19}H_{23}N_2$ $[M+H]^+$: 279.1867, Found: 279.1856.



3c

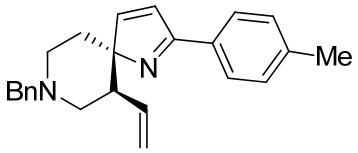
Yellow oil, yield 79%. dr = 96/4, 90% ee [Daicel Chiralpak OD-H (0.46 cm x 25 cm), *n*-hexane/2-propanol = 95/5, *v* = 1.0 mL · min^{-1}, λ = 254 nm, t (minor) = 5.88 min, t (major) = 17.07 min]; $[\alpha]_D^{20}$ = +50.9 (c = 1.0, acetone). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95-7.92 (m, 2H), 7.64 (d, *J* = 4.8 Hz, 1H), 7.48-7.43 (m, 5H), 7.27 (d, *J* = 8.4 Hz, 2H), 6.91 (d, *J* = 5.2 Hz, 1H), 5.27 (m, 1H), 4.92 (d, *J* = 17.2 Hz, 1H), 4.80 (d, *J* = 11.2 Hz, 1H), 3.64 (AB, J_{AB} = 13.6 Hz, 1H), 3.58 (BA, J_{BA} = 13.2 Hz, 1H), 3.06-2.98

(m, 3H), 2.38-2.28 (m, 3H), 1.43-1.36 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 155.5, 137.6, 135.0, 134.0, 131.4, 130.6, 130.3, 128.6, 127.7, 126.6, 120.8, 116.2, 84.2, 62.2, 56.8, 52.3, 45.8, 33.0. IR (thin film): ν_{max} (cm^{-1}) = 3077, 2922, 2801, 1736, 1605, 1575, 1486, 1362, 796, 692; MS (ESI): 407 $[M+H]^+$; HRMS (MALDI) calcd for $C_{23}H_{24}N_2Br$ $[M+H]^+$: 407.1116, Found: 407.1117.



3d

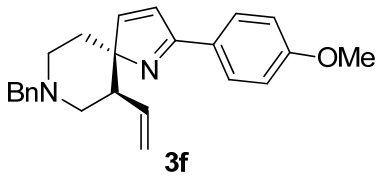
Brown solid, mp = 54.1-56.5 °C, yield 77%. dr > 99/1, 94% ee [Daicel Chiralpak OD-H (0.46 cm x 25 cm), *n*-hexane/2-propanol = 70/30, v = 0.5 mL·min^{-1}, λ = 254 nm, t (minor) = 9.23 min, t (major) = 20.38 min]; $[\alpha]_D^{20}$ = +25.6 (c = 0.5, acetone). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.94-7.90 (m, 2H), 7.64 (d, J = 4.8 Hz, 1H), 7.45-7.43 (m, 3H), 6.91 (d, J = 4.8 Hz, 1H), 5.24 (m, 1H), 4.95 (d, J = 17.4 Hz, 1H), 4.81 (d, J = 10.5 Hz, 1H), 3.10-3.00 (m, 3H), 2.60-2.20 (m, 3H), 2.42 (s, 3H), 1.36-1.25 (m, 1H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 171.0, 155.8, 135.5, 134.6, 130.9, 129.2, 128.2, 127.4, 116.8, 84.4, 59.6, 55.2, 46.9, 46.3, 33.8. IR (thin film): ν_{max} (cm^{-1}) = 3075, 2923, 2790, 1642, 1605, 1576, 1494, 1448, 785, 693; MS (ESI): 253 $[M+H]^+$; HRMS (MALDI) calcd for $C_{17}H_{21}N_2$ $[M+H]^+$: 253.1700, Found: 253.1699.



3e

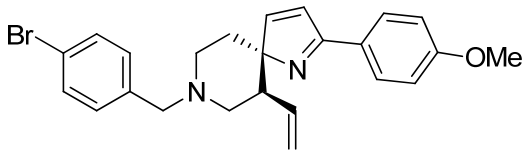
Brown oil, yield 83%. dr = 93/7, 84% ee [Daicel Chiralpak OD-H (0.46 cm x 25 cm), *n*-hexane/2-propanol = 90/10, v = 0.5 mL·min^{-1}, λ = 254 nm, t (minor) = 9.96 min, t (major) = 21.38 min]; $[\alpha]_D^{20}$ = +40.0 (c = 0.5, acetone). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 (d, J = 7.6 Hz, 2H), 7.65 (d, J = 4.8 Hz, 1H), 7.38-7.22 (m, 7H), 6.87 (d, J = 4.8 Hz, 1H), 5.24 (m, 1H), 4.89 (d, J = 17.2 Hz, 1H), 4.76 (d, J =9.6 Hz, 1H), 3.68 (AB, J_{AB} = 13.2 Hz, 1H), 3.63 (BA, J_{BA} = 12.8 Hz, 1H), 3.08-2.99 (m, 3H),

2.38-2.30 (m, 6H), 1.32-1.24 (m, 1H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 170.0, 155.2, 140.4, 138.4, 135.1, 131.2, 129.2, 128.9, 128.2, 127.5, 126.9, 126.5, 115.9, 84.0, 62.8, 56.7, 52.2, 45.7, 33.0, 21.4. IR (thin film): ν_{max} (cm^{-1}) = 3063, 3027, 2922, 2803, 1716, 1640, 1569, 1071, 1019, 771, 698; MS (EI): 342 $[M]^+$; HRMS (EI) calcd for $C_{24}H_{26}N_2$ $[M]^+$: 342.2096, Found: 342.2098.



3f

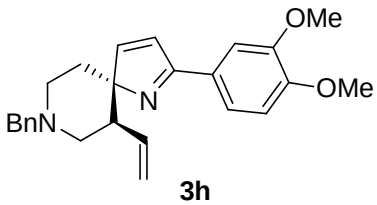
White solid, mp = 98.2-102.7 °C, yield 88%. dr = 97/3, 95% ee [Daicel Chiralpak OD-H (0.46 cm x 25 cm), *n*-hexane/2-propanol = 90/10, *v* = 1.0 mL · min^{-1}, λ = 254 nm, t (minor) = 6.66 min, t (major) = 14.34 min]; $[\alpha]_D^{20}$ = +80.5 (c = 1.0, acetone). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.4 Hz, 2H), 7.61 (d, *J* = 5.1 Hz, 1H), 7.40-7.26 (m, 5H), 6.95 (d, *J* = 8.4 Hz, 2H), 6.87 (d, *J* = 4.8 Hz, 1H), 5.25 (m, 1H), 4.90 (d, *J* = 17.4 Hz, 10.5 Hz, 1H), 4.78 (d, *J* = 10.5 Hz, 1H), 3.83 (s, 3H), 3.70 (AB, J_{AB} = 13.5 Hz, 1H), 3.63 (BA, J_{BA} = 13.5 Hz, 1H), 3.09-2.99 (m, 3H), 2.37-2.26 (m, 3H), 1.38-1.26 (m, 1H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 169.5, 161.3, 155.1, 138.4, 135.0, 129.2, 128.9, 128.3, 127.0, 126.7, 126.5, 116.0, 113.9, 84.0, 62.9, 56.8, 55.3, 52.3, 45.8, 33.2. IR (thin film): ν_{max} (cm^{-1}) = 3066, 3023, 2925, 2805, 1712, 1606, 1501, 1067, 1028, 773, 696; MS (ESI): 359 $[M+H]^+$; HRMS (MALDI) calcd for $C_{24}H_{27}N_2O[M+H]^+$: 359.2121, Found: 359.2118.



3g

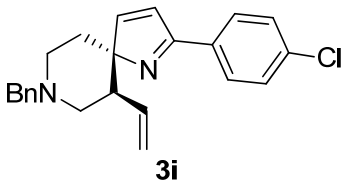
White solid, mp = 137.3-139.4 °C, yield 82%. dr = 97/3, 95% ee [Daicel Chiralpak OD-H (0.46 cm x 25 cm), *n*-hexane/2-propanol = 90/10, *v* = 1.0 mL · min^{-1}, λ = 254 nm, t (minor) = 8.68 min, t (major) = 21.29 min]; $[\alpha]_D^{20}$ = +495.5 (c = 0.5, acetone). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.7 Hz, 2H), 7.61 (d, *J* = 5.1 Hz,

1H), 7.47 (d, J = 8.7 Hz, 2H), 7.28 (d, J = 8.4 Hz, 2H), 6.96 (d, J = 8.7 Hz, 2H), 6.89 (d, J = 5.4 Hz, 1H), 5.27 (m, 1H), 4.91 (d, J = 17.1 Hz, 2H), 4.79 (d, J = 10.8 Hz, 1H), 3.85 (s, 3H), 3.64 (AB, J_{AB} = 19.2 Hz, 1H), 3.61 (BA, J_{BA} = 13.5 Hz, 1H), 3.06-2.97 (m, 3H), 2.37-2.30 (m, 3H), 1.37-1.27 (m, 1H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 169.5, 161.3, 155.0, 137.6, 135.1, 131.3, 130.5, 129.2, 126.7, 126.5, 120.7, 116.0, 113.9, 83.8, 62.1, 56.7, 55.3, 52.3, 45.8, 33.1. IR (thin film): ν_{max} (cm^{-1}) = 3076, 2925, 2805, 1637, 1606, 1501, 1069, 1029, 793, 773; MS (ESI): 437 $[M+H]^+$; HRMS (MALDI) calcd for $C_{24}H_{26}N_2BrO$ $[M+H]^+$: 437.1227, Found: 437.1223.



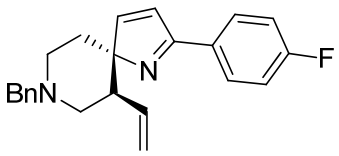
3h

Brown oil, yield 82%. dr = 94/6, 91% ee [Daicel Chiralpak OD-H (0.46 cm x 25 cm), *n*-hexane/2-propanol = 95/5, v = 0.5 mL · min^{-1}, λ = 254 nm, t (minor) = 23.88 min, t (major) = 27.38 min]; $[\alpha]_D^{20}$ = +59.5 (c = 1.0, acetone). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (d, J = 4.8 Hz, 1H), 7.56 (s, 1H), 7.39-7.23 (m, 6H), 6.98-6.85 (m, 2H), 5.24 (m, 1H), 4.88 (d, J = 17.2 Hz, 1H), 4.76 (d, J = 10.8 Hz, 1H), 3.94 (s, 3H), 3.89 (s, 3H), 3.67 (AB, J_{AB} = 13.2 Hz, 1H), 3.61 (BA, J_{BA} = 13.2 Hz, 1H), 3.07-2.97 (m, 3H), 2.53-2.26 (m, 3H), 1.39-1.35 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.6, 155.0, 150.9, 149.2, 138.5, 135.2, 128.9, 128.2, 127.1, 127.0, 126.5, 121.2, 115.9, 110.5, 109.9, 84.1, 62.9, 56.8, 56.1, 55.9, 52.3, 45.7, 33.3. IR (thin film): ν_{max} (cm^{-1}) = 3080, 3001, 2925, 2804, 1736, 1604, 1523, 1267, 1024, 775, 699; MS (ESI): 389 $[M+H]^+$; HRMS (MALDI) calcd for $C_{25}H_{29}N_2O_2$ $[M+H]^+$: 389.2218, Found: 389.2224.



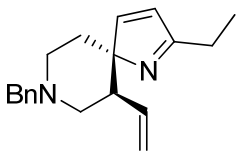
3i

Yellow oil, yield 88%. dr = 92/8, 86% ee [Daicel Chiralpak IC (0.46 cm x 25 cm), *n*-hexane/2-propanol = 70/30, v = 0.5 mL·min^{-1}, λ = 254 nm, t (minor) = 10.29 min, t (major) = 11.38 min]; $[\alpha]_D^{20}$ = +32.2 (c = 1.0, acetone). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.88-7.84 (m, 2H), 7.66 (d, J = 5.4 Hz, 1H), 7.42-7.26 (m, 7H), 6.86 (d, J = 5.1 Hz, 1H), 5.27 (m, 1H), 4.90 (d, J = 17.1 Hz, 1H), 4.88 (d, J = 11.4 Hz, 1H), 3.70 (AB, J_{AB} = 13.2 Hz, 1H), 3.64 (BA, J_{BA} = 13.2 Hz, 1H), 3.09-3.04 (m, 3H), 2.38-2.27 (m, 3H), 1.36-1.26 (m, 1H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 169.4, 156.4, 138.7, 136.5, 135.2, 132.7, 129.2, 129.1, 128.5, 127.3, 126.4, 116.5, 84.8, 63.2, 57.1, 52.5, 46.1, 33.2. IR (thin film): ν_{max} (cm^{-1}) = 3081, 3028, 2923, 1641, 1603, 1567, 1091, 772, 699; MS (ESI): 363 $[M+H]^+$; HRMS (MALDI) calcd for $C_{23}H_{24}N_2Cl$ $[M+H]^+$: 363.1619, Found: 363.1623.



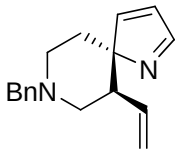
3j

Yellow oil, yield 90%. dr = 92/8, 89% ee [Daicel Chiralpak IC (0.46 cm x 25 cm), *n*-hexane/2-propanol = 70/30, v = 0.5 mL·min^{-1}, λ = 254 nm, t (minor) = 9.97 min, t (major) = 11.13 min]; $[\alpha]_D^{20}$ = +33.0 (c = 1.0, acetone). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.94-7.89 (m, 2H), 7.65 (d, J = 5.1 Hz, 1H), 7.40-7.25 (m, 5H), 7.12 (t, J = 8.7 Hz, 1H), 6.86 (d, J = 5.1 Hz, 1H), 5.24 (m, 1H), 4.91 (d, J = 17.1 Hz, 2H), 4.79 (d, J =13.5 Hz, 1H), 3.67 (AB, J_{AB} = 13.5 Hz, 1H), 3.64 (BA, J_{BA} = 13.5 Hz, 1H), 3.09-3.00 (m, 3H), 2.38-2.27 (m, 3H), 1.40-1.34 (m, 1H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 169.1, 164.0 (d, J = 248.7 Hz), 155.9, 138.4, 135.0, 130.3 (d, J = 2.9 Hz), 129.6 (d, J = 8.6 Hz), 128.9, 128.3, 127.0, 126.3, 116.2, 115.6 (d, J = 21.7 Hz), 84.4, 62.9, 56.8, 52.3, 45.9, 33.0. ^{19}F NMR (282 MHz, $CDCl_3$) δ -110.69 (m, 1F). IR (thin film): ν_{max} (cm^{-1}) = 3066, 3028, 2962, 1640, 1605, 1586, 1094, 774, 699; MS (ESI): 347 $[M+H]^+$; HRMS (MALDI) calcd for $C_{23}H_{24}N_2F[M+H]^+$: 347.1913, Found: 347.1918.



3k

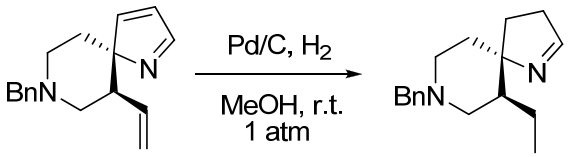
Brown solid, mp = 43.2-45.9 °C, yield 83%. dr = 90/10, 96% ee [Daicel Chiralpak IC (0.46 cm x 25 cm), *n*-hexane/2-propanol = 80/20, v = 0.7 mL · min^{-1}, λ = 214 nm, t (minor) = 9.72 min, t (major) = 16.46 min]; $[\alpha]_D^{20}$ = +40.8 (c = 0.5, acetone). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.39 (d, J = 4.8 Hz, 1H), 7.30-7.18 (m, 5H), 6.28 (d, J = 4.8 Hz, 1H), 5.09 (m, 1H), 4.82 (d, J = 17.1 Hz, 1H), 4.73(d, J = 10.8 Hz, 1H), 3.59 (AB, J_{AB} = 12.9 Hz, 1H), 3.53 (BA, J_{BA} = 13.2 Hz, 1H), 3.96-2.87 (m, 3H), 2.46 (q, J = 7.8 Hz, 2H), 2.23-2.16 (m, 3H), 1.13-1.08 (m, 1H), 1.11 (t, J = 7.5 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 175.6, 154.2, 138.2, 134.8, 128.8, 128.3, 128.1, 126.8, 115.8, 82.7, 62.7, 56.7, 52.2, 45.3, 32.7, 25.7, 11.6. IR (thin film): ν_{max} (cm^{-1}) = 3079, 2974, 2918, 2803, 1644, 1611, 1522, 1366, 1071, 783, 698; MS (ESI): 281 $[M+H]^+$; HRMS (MALDI) calcd for $C_{19}H_{25}N_2$ $[M+H]^+$: 281.2015, Found: 281.2012



3l

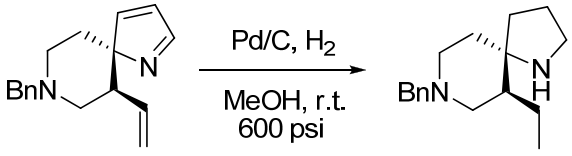
White solid, mp = 58.2-61.2 °C, yield 61%. dr = 97/3, 96% ee [Daicel Chiralpak OD-H (0.46 cm x 25 cm), *n*-hexane/2-propanol = 95/5, v = 0.7 mL · min^{-1}, λ = 230 nm, t (minor) = 11.56 min, t (major) = 13.62 min]; $[\alpha]_D^{20}$ = +80.5 (c = 0.5, acetone). ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.03 (s, 1H), 7.55 (d, J = 5.1 Hz, 1H), 7.40-7.26 (m, 5H), 6.44 (d, J = 5.1 Hz, 1H), 5.26 (m, 1H), 4.92 (d, J = 17.1 Hz, 1H), 4.85 (d, J = 10.8 Hz, 1H), 3.72 (AB, J_{AB} = 12.9 Hz, 1H), 3.63 (BA, J_{BA} = 12.9 Hz, 1H), 3.08-2.99 (m, 3H), 2.37-2.31 (m, 3H), 1.35-1.25 (m, 1H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 162.3, 154.9, 138.2, 134.7, 128.9, 128.2, 127.4, 126.9, 116.3, 84.3, 62.9, 56.8, 52.3, 45.4, 32.2. IR (thin film): ν_{max} (cm^{-1}) = 3056, 2924, 2853, 2807, 1751, 1644, 1589, 1497, 1072, 770, 700; MS (ESI): 253 $[M+H]^+$; HRMS (ESI) calcd for $C_{17}H_{21}N_2$ $[M+H]^+$: 253.1703, Found: 253.1699

General Procedure for the Pd/C catalyzed hydrogenation:



3l **6**

To a solution of **3l** (25.2 mg, 0.1 mmol, 93% ee) in anhydrous MeOH (2.0 mL), Pd/C (5.0 mg) was added. The reaction mixture was stirred under H_2 atmosphere (1 atm) at rt for 12 h. After the reaction was complete (monitored by TLC), the crude reaction mixture was filtrated with celite and washed with EtOAc. The solvents were removed under reduced pressure. Then the residue was purified by silica gel column chromatography (PE/Acetone = 1/1) to afford the desired product **6**. Pale yellow oil, yield 65%, 91% ee [Daicel Chiralpak IC (0.46 cm x 25 cm), *n*-hexane/2-propanol = 80/20, v = 0.5 mL · min^{-1}, λ = 214 nm, t (major) = 25.37 min, t (minor) = 37.80 min]; $[\alpha]_D^{20}$ = +2.0 (c = 0.25, acetone). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.54 (s, 1H), 7.35-7.27 (m, 5H), 3.65 (AB, J_{AB} = 13.2 Hz, 1H), 3.47 (BA, J_{BA} = 12.6 Hz, 1H), 3.02 (d, J = 8.7 Hz, 1H), 2.86-2.82 (m, 1H), 2.65-2.40 (m, 2H), 2.06-1.62 (m, 7H), 1.48-1.28 (m, 2H), 0.84 (m, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 164.2, 138.1, 129.1, 128.1, 126.9, 79.0, 63.4, 55.1, 50.5, 45.5, 37.9, 37.2, 24.8, 19.7, 12.1. IR (thin film): ν_{max} (cm^{-1}) = 3002, 2960, 2932, 2874, 2756, 1715, 1627, 1457, 1290, 1220, 802, 743; MS (ESI): 257 $[M+H]^+$; HRMS (ESI) calcd for $C_{17}H_{25}N_2$ $[M+H]^+$: 257.2012, Found: 257.2012.

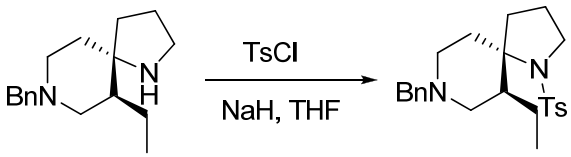


3l **7**

To a solution of **3l** (25.2 mg, 0.1 mmol, 93% ee) in anhydrous MeOH (2 mL), Pd/C (5.0 mg) was added. The reaction mixture was stirred under H_2 atmosphere (600

psi) at rt for 12 h. After the reaction was complete (monitored by TLC), the crude reaction mixture was filtrated with celite and washed with EtOAc. The solvents were removed under reduced pressure. Then the residue was purified by silica gel column chromatography (DCM/MeOH = 10/1) to afford the desired product **7**. Pale yellow oil, yield 75%, $[\alpha]_D^{20}$ = +17.0 (c = 0.5, acetone). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.32-7.25 (m, 5H), 3.58 (AB, J_{AB} = 12.9 Hz, 1H), 3.41 (BA, J_{BA} = 12.9 Hz, 1H), 3.00-2.97 (m, 3H), 2.76-2.64 (m, 2H), 2.21(m, 1H), 1.97 (m, 1H), 1.77-1.49 (m, 8H), 1.22 (m, 1H), 0.86 (t, J = 7.2, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 138.6, 128.9, 128.1, 126.8, 64.3, 63.0, 55.0, 51.1, 47.1, 45.9, 37.1, 31.1, 25.6, 20.4, 12.6. IR (thin film): ν_{max} (cm^{-1}) = 2957, 2927, 2856, 1647, 1460, 1377, 1292, 802, 761, 699; MS (ESI): 259 $[M+H]^+$; HRMS (ESI) calcd for $C_{17}H_{27}N_2$ $[M+H]^+$: 259.2161, Found: 259.2169.

Compound 7 was transformed to compound 9 to determine its ee.

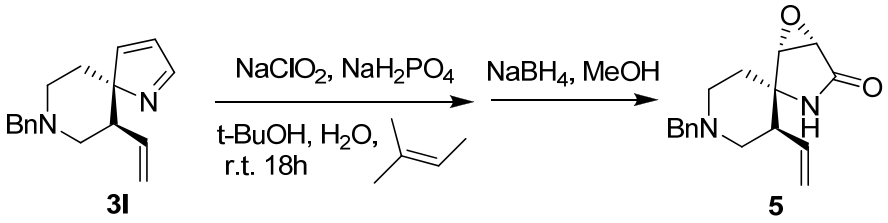


7 **9**

To a solution of **7** (19.0 mg, 0.07 mmol) and NaH (5.0 mg, 0.21 mmol) in dry THF (2.0 mL) was stirred at rt for 0.5 h, *p*-toluenesulfonyl chloride (29.2 mg, 0.15 mmol) was added at rt. The reaction mixture was stirred at rt for 18 h, then heated to 50^{o}C for 35 h. The crude reaction mixture was quenched by water and extracted with Et_2O. The combined organic layers were washed with brine, dried over $MgSO_4$, and concentrated in vacuo. Then the residue was purified by silica gel column chromatography (PE/EA = 1/1) to afford the desired product **9**. Viscous pale yellow oil, yield 27%, 92% ee [Daicel Chiralcel AD-H (0.46 cm x 15 cm), *n*-hexane/2-propanol = 85/15, v = 0.5 mL · min^{-1}, λ = 214 nm, t (minor) = 11.28 min, t (major) = 14.78 min]; $[\alpha]_D^{20}$ = +64.0 (c = 0.5, acetone). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.74 (d, J = 8.1 Hz, 2H), 7.35-7.25 (m, 7H), 3.62 (AB, J_{AB} = 13.2 Hz, 1H), 3.45 (BA, J_{BA} = 13.2 Hz, 1H), 3.36-3.34 (m, 2H), 3.00 (d, J = 11.4 Hz, 1H), 2.81 (d, J = 11.7 Hz,

1H), 2.72-2.67 (m, 2H), 2.40 (s, 3H), 2.04-1.79 (m, 4H), 1.75-1.66 (m, 4H), 1.52-1.47 (m, 1H), 1.34-1.25 (m, 1H), 0.86 (m, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.5, 138.9, 138.4, 129.3, 129.0, 128.1, 127.1, 126.9, 71.9, 62.5, 56.5, 51.3, 49.7, 45.0, 36.7, 31.6, 23.1, 21.4, 20.4, 12.0. IR (thin film): ν_{max} (cm^{-1}) = 3062, 3029, 2961, 2874, 2804, 1494, 1454, 1262, 1155, 1070, 813, 748, 700; MS (ESI): 413 $[M+H]^+$; HRMS (MALDI) calcd for $C_{24}H_{33}N_2O_2S$ $[M+H]^+$: 413.2259, Found: 413.2257.

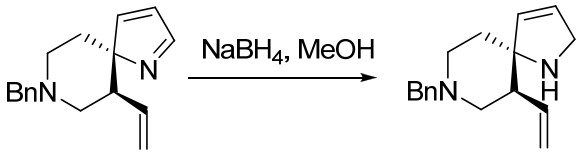
Procedure for Oxidation of Compound 3l:



A solution of sodium chlorite (27.0 mg, 0.3 mmol) and sodium dihydrogen orthophosphate hydrate (32.0 mg, 0.27 mmol) in water (0.5 mL) was added dropwise to a stirring solution of spiro-2H-pyrrole **3l** (18.0 mg, 0.07mmol, 96% ee) in *tert*-butyl alcohol (1.0 mL) and 2-methyl-2-butene (0.14 mL) at 0 °C. The solution was stirred for 14 h and then concentrated in vacuo. The product was partitioned between water and Et_2O. The layers were separated, and the aqueous layer was extracted with Et_2O. The combined organic layers were washed with brine, dried over $MgSO_4$, and concentrated in vacuo to give a colorless oil. The crude material was dissolved in MeOH (2 mL), and sodium borohydride (7.5 mg, 0.19 mmol) was added slowly. The solution was stirred for 1 h and then concentrated in vacuo to give a colorless oil. The product was partitioned between water and Et_2O, the layers were separated, and the aqueous layer was extracted with Et_2O. The combined organic layers were dried over $MgSO_4$ and concentrated in vacuo to give a colorless oil. The crude material was purified by column chromatography using petroleum ether and EtOAc (1:1) to give **5**. Colorless oil, yield 75%, 95% ee [Daicel Chiralpak AD-H (0.46 cm x 25 cm), *n*-hexane/2-propanol = 90/10, v = 1.0 mL · min^{-1}, λ = 220 nm, t (major) = 20.00 min, t (minor) = 62.63 min]; $[\alpha]_D^{20}$ = -24.3 (c = 0.5, acetone). ^{1}H NMR (400 MHz, $CDCl_3$) δ

7.35-7.25 (m, 5H), 6.23 (s, 1H), 5.76-5.72 (m, 1H), 5.18 (dd, J = 10, 0.8 Hz, 1H), 5.12 (d, J = 17.2 Hz, 1H), 3.87 (t, J = 2.4 Hz, 1H), 3.57 (s, 2H), 3.53 (t, J = 2.4 Hz, 1H), 2.88 (d, J = 10.4 Hz, 1H), 2.82-2.79 (m, 1H), 2.58-2.52 (m, 1H), 2.42-2.32 (m, 2H), 2.05 (dt, J =13.2, 3.2 Hz, 1H), 1.72 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.8, 137.8, 133.0, 128.9, 128.3, 127.2, 119.5, 62.7, 59.9, 54.1, 53.7, 50.7, 47.9, 31.8. IR (thin film): ν_{max} (cm^{-1}) = 3065, 3030, 2961, 2927, 2808, 2767, 1712, 1495, 1397, 1219, 1097, 804, 700; MS (ESI): 285 $[M+H]^+$; HRMS (ESI) calcd for $C_{17}H_{21}N_2O_2$ $[M+H]^+$: 285.1599, Found: 285.1598.

Procedure for the reduction of 3l:

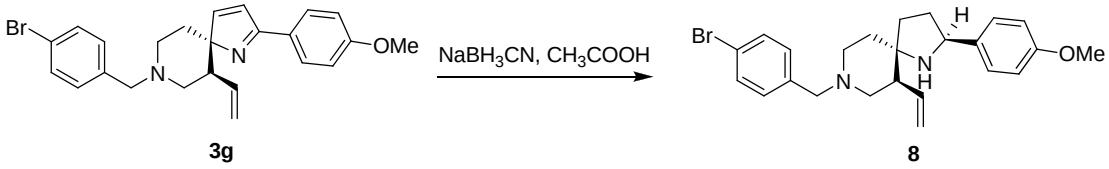


3l **4**

To a solution of **3l** (31 mg, 0.12 mmol, 96% ee) in MeOH (2 mL), $NaBH_4$ (7 mg, 0.18 mmol) was added. The reaction mixture was stirred at rt for 11 h. After the reaction was complete (monitored by TLC), the crude reaction mixture was concentrated in vacuo, then quenched with water. The product was partitioned between water and DCM. The layers were separated, and the aqueous layer was extracted with DCM. The combined organic layers were washed with brine, dried over Na_2SO_4, and concentrated in vacuo. The crude material was purified by column chromatography using DCM/MeOH (10:1) to give **4**. Yellow oil, yield 90%, 96% ee [Daicel Chiralpak AD-H (0.46 cm x 25 cm), *n*-hexane/2-propanol/Et_3N = 90/10/0.0001, v = 0.5 mL · min^{-1}, λ = 230 nm, t (major) = 9.30 min, t (minor) = 13.63 min]; $[\alpha]_D^{20}$ = +38.6 (c = 1.0, acetone). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.33-7.25 (m, 5H), 6.00 (d, J = 5.4 Hz, 1H), 5.90 (d, J = 6.9 Hz, 1H), 5.67 (m, 1H), 5.12 (d, J = 17.7 Hz, 1H), 5.05 (d, J = 12.3 Hz, 1H), 3.68 (s, 2H), 3.58 (AB, J_{AB} = 13.5 Hz, 1H), 3.51 (BA, J_{BA} = 13.5 Hz, 1H), 2.79-2.75 (m, 2H), 2.42-2.35 (m, 1H), 2.27-2.18 (m, 3H), 1.79-1.74 (m, 1H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 138.3, 137.4, 131.0, 129.6, 129.0,

128.2, 127.0, 117.5, 70.3, 62.9, 56.7, 53.2, 51.4, 51.0, 39.1. IR (thin film): ν_{max} (cm^{-1}) = 3066, 3027, 2921, 2847, 2800, 1639, 1495, 1392, 1259, 1073, 800, 737; MS (ESI): 255 $[M+H]^+$; HRMS (ESI) calcd for $C_{17}H_{23}N_2$ $[M+H]^+$: 255.1856, Found: 255.1856.

Procedure for Reduction of Compound 3g:



3g **8**

To a solution of **3g** (69 mg, 0.16 mmol, 95% ee) in acetic acid (2 mL), $NaBH_3CN$ (32 mg, 0.47 mmol) was added. The reaction mixture was stirred at rt for 22 h. After the reaction was complete (monitored by TLC), the crude reaction mixture was quenched with sat. Na_2CO_3. The product was partitioned between water and DCM. The layers were separated, and the aqueous layer was extracted with DCM. The combined organic layers were washed with brine, dried over Na_2SO_4, and concentrated in vacuo. The crude material was purified by column chromatography using DCM/MeOH (25:1) to give **8**. Pale yellow oil, yield 92%, 94% ee [Phenomenex Lux 5u Celluloxe-2 PC-2 (0.46 cm x 25 cm), *n*-hexane/2-propanol = 90/10, v = 0.5 $mL \cdot min^{-1}$, λ = 214 nm, t (minor) = 10.50 min, t (major) = 11.53 min]; $[\alpha]_D^{20}$ = +13.4 (c = 1.0, acetone). ^1H NMR (400 MHz, $CDCl_3$) δ 7.43 (d, J = 8.4 Hz, 2H), 7.29 (d, J = 8.8 Hz, 2H), 7.20 (d, J = 8.8 Hz, 2H), 7.43 (d, J = 8.4 Hz, 2H), 6.05-5.94 (m, 1H), 5.15 (dd, J = 10.4, 1.2 Hz, 1H), 5.10 (d, J = 17.6 Hz, 1H), 4.15 (m, 1H), 3.78 (s, 3H), 3.48 (AB, J_{AB} = 13.6 Hz, 1H), 3.43 (BA, J_{BA} = 13.2 Hz, 1H), 2.80-2.67 (m, 2H), 2.40 (t, J = 10.0 Hz, 1H), 2.12-2.07 (m, 4H), 1.89-1.82 (m, 2H), 1.73-1.66 (m, 1H), 1.55-1.53 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.6, 137.6, 135.8, 131.3, 130.6, 127.7, 120.7, 117.3, 113.7, 62.5, 62.2, 60.6, 56.3, 55.3, 51.0, 49.5, 39.4, 35.9, 31.9. IR (thin film): ν_{max} (cm^{-1}) = 3072, 2998, 2850, 2802, 1665, 1611, 1512, 1487, 1299, 878,

802; MS (ESI): 441 $[M+H]^+$; HRMS (ESI) calcd for $C_{24}H_{30}N_2OBr$ $[M+H]^+$: 441.1529, Found: 441.1536.

X-ray of **3g**

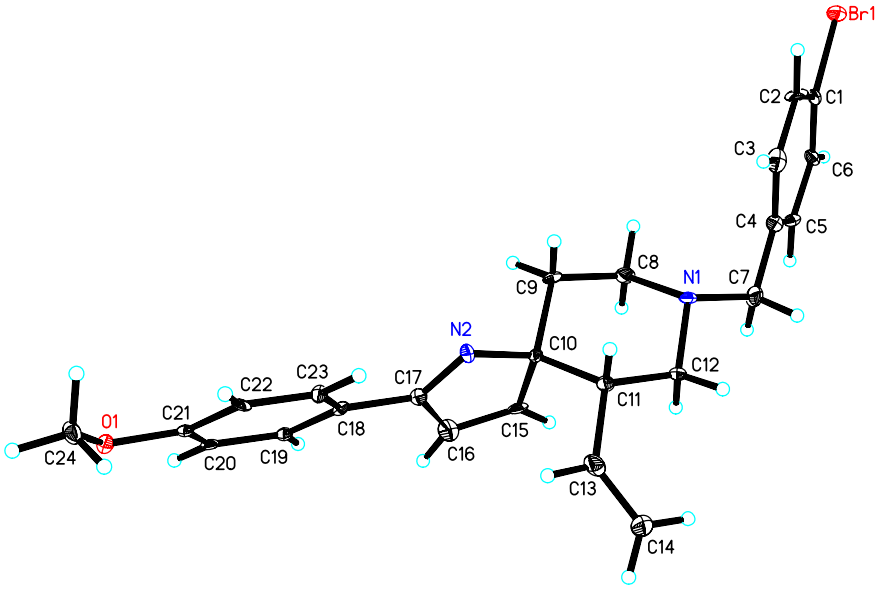
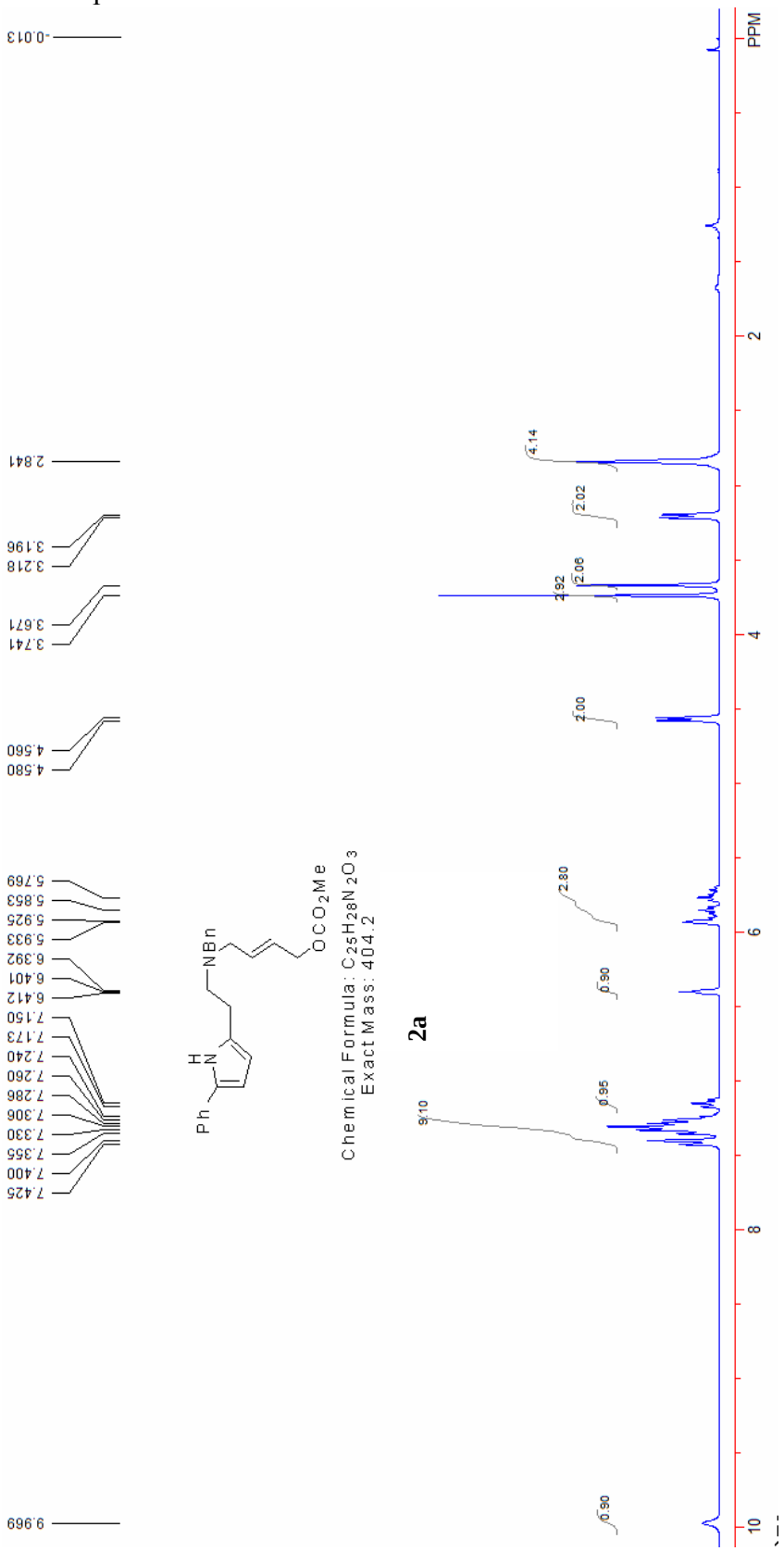


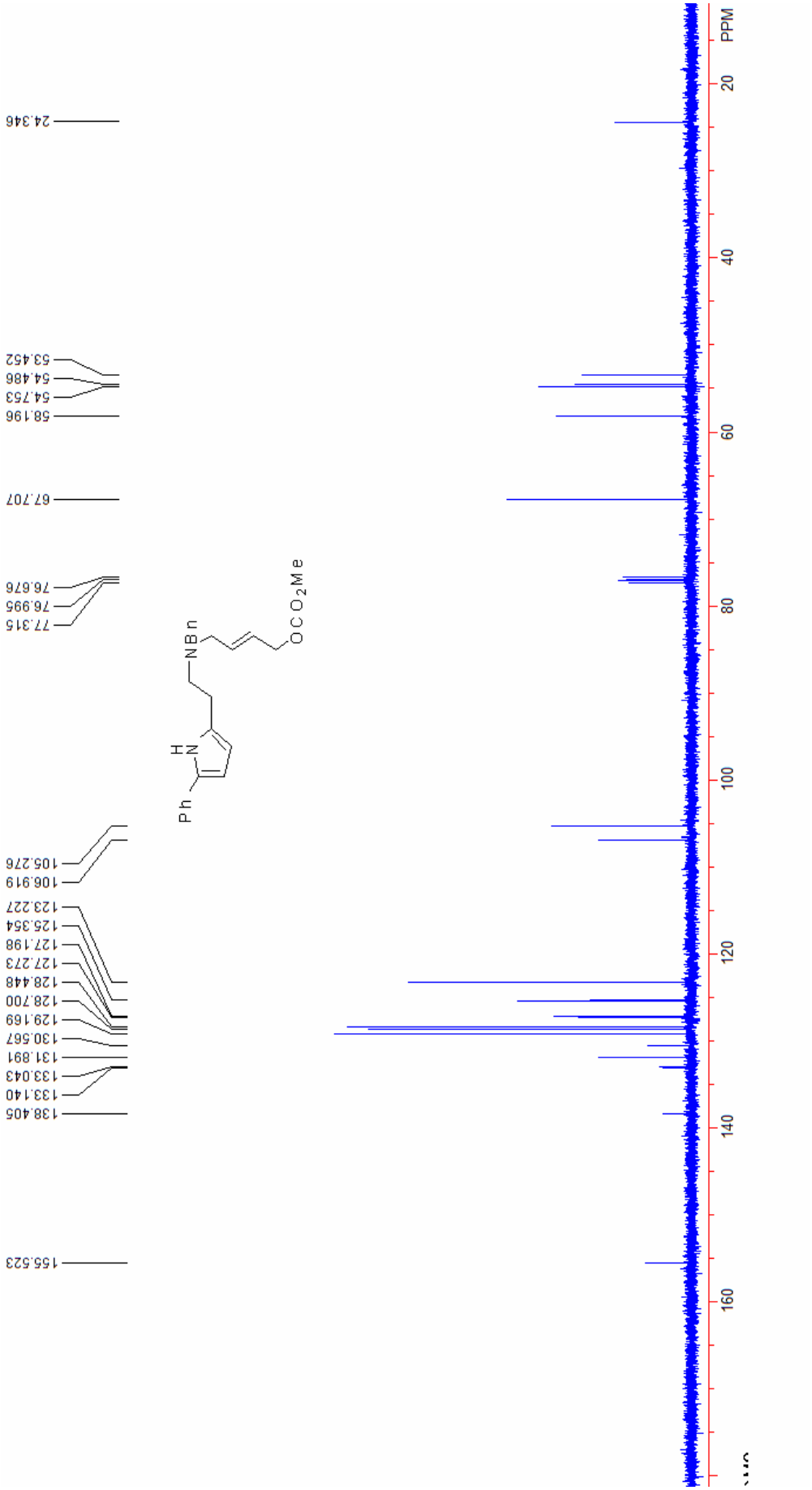
Table 1. Crystal data and structure refinement for p212121.

Identification code	p212121
Empirical formula	C24 H25 Br N2 O
Formula weight	437.37
Temperature	133(2) K
Wavelength	0.71073 A
Crystal system, space group	Orthorhombic, P2(1)2(1)2(1)
Unit cell dimensions	a = 7.4734(19) A alpha = 90 deg.
	b = 46.036(12) A beta = 90 deg.
	c = 6.1199(16) A gamma = 90 deg.
Volume	2105.5(9) A^3
Z, Calculated density	4, 1.380 Mg/m^3
Absorption coefficient	1.969 mm^-1
F(000)	904
Crystal size	0.40 x 0.05 x 0.02 mm
Theta range for data collection	0.88 to 25.99 deg.
Limiting indices	-9<=h<=9, -56<=k<=45, -7<=l<=7

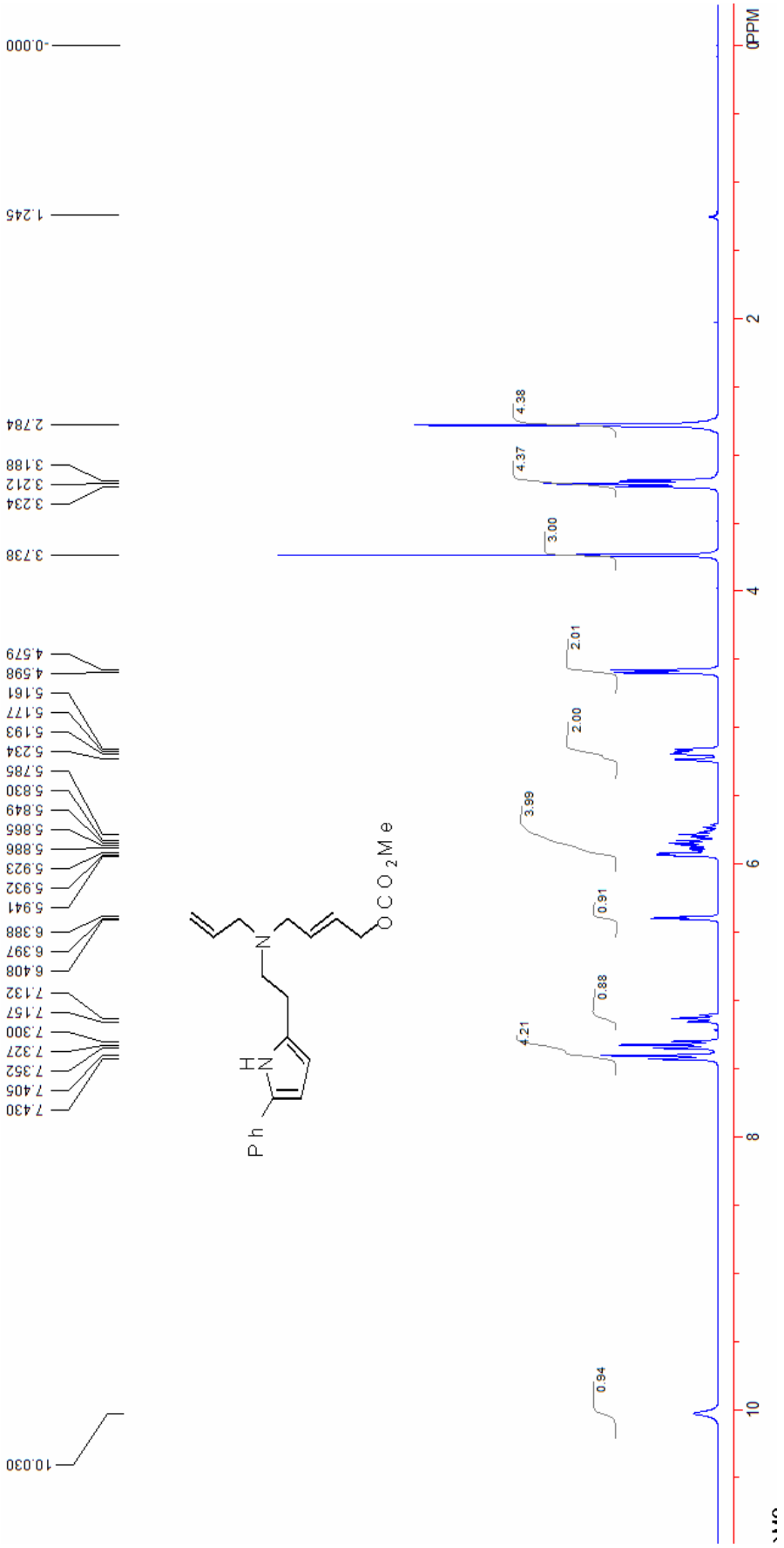
Reflections collected / unique	13525 / 4128 [R(int) = 0.0737]
Completeness to theta = 25.99	99.7 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.9617 and 0.5064
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	4128 / 18 / 255
Goodness-of-fit on F^2	1.004
Final R indices [I>2sigma(I)]	R1 = 0.0750, wR2 = 0.1864
R indices (all data)	R1 = 0.0819, wR2 = 0.1938
Absolute structure parameter	0.12(2)
Largest diff. peak and hole	1.305 and -1.565 e.A^-3

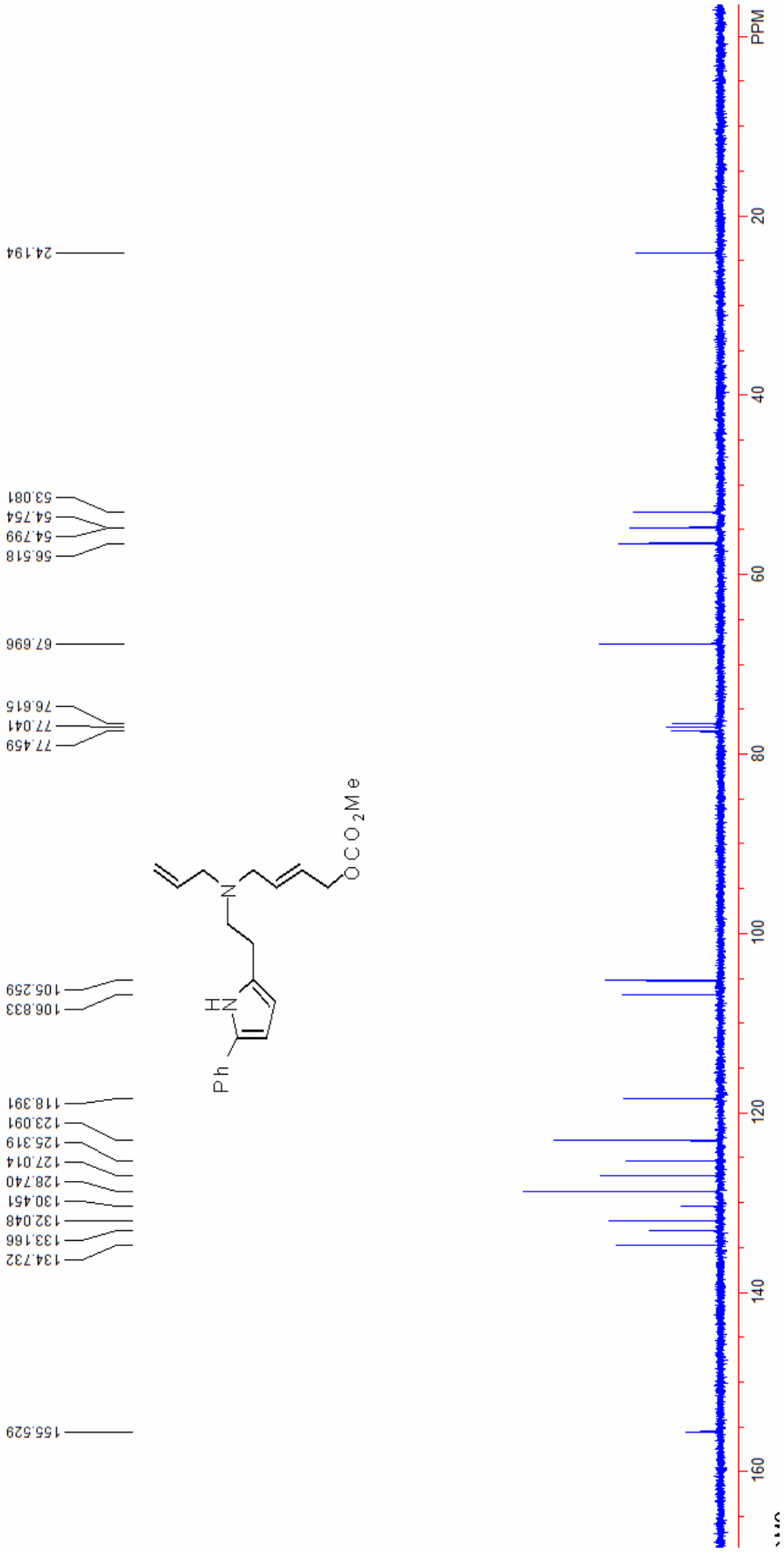
NMR Spectra of **2a**



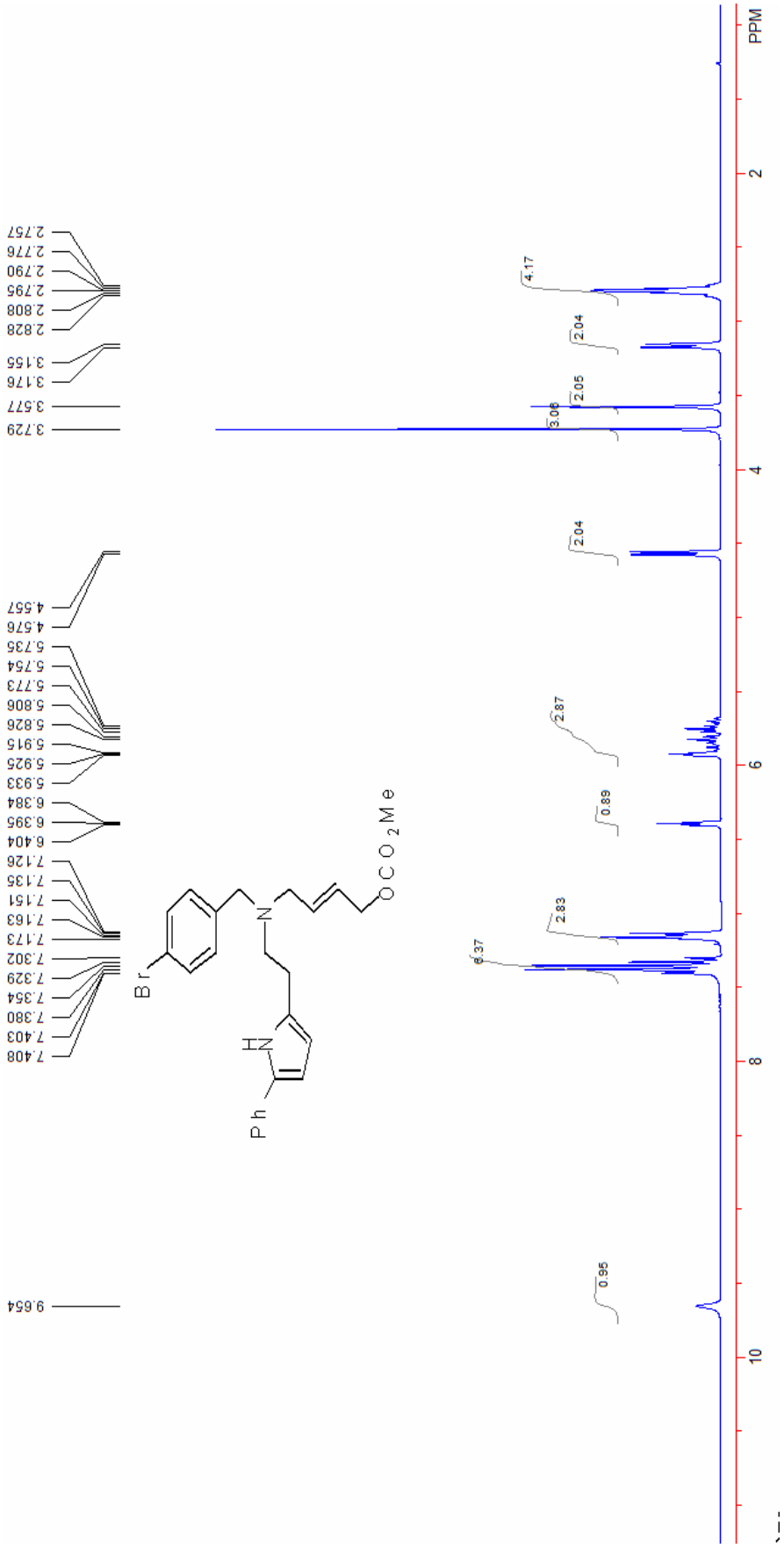


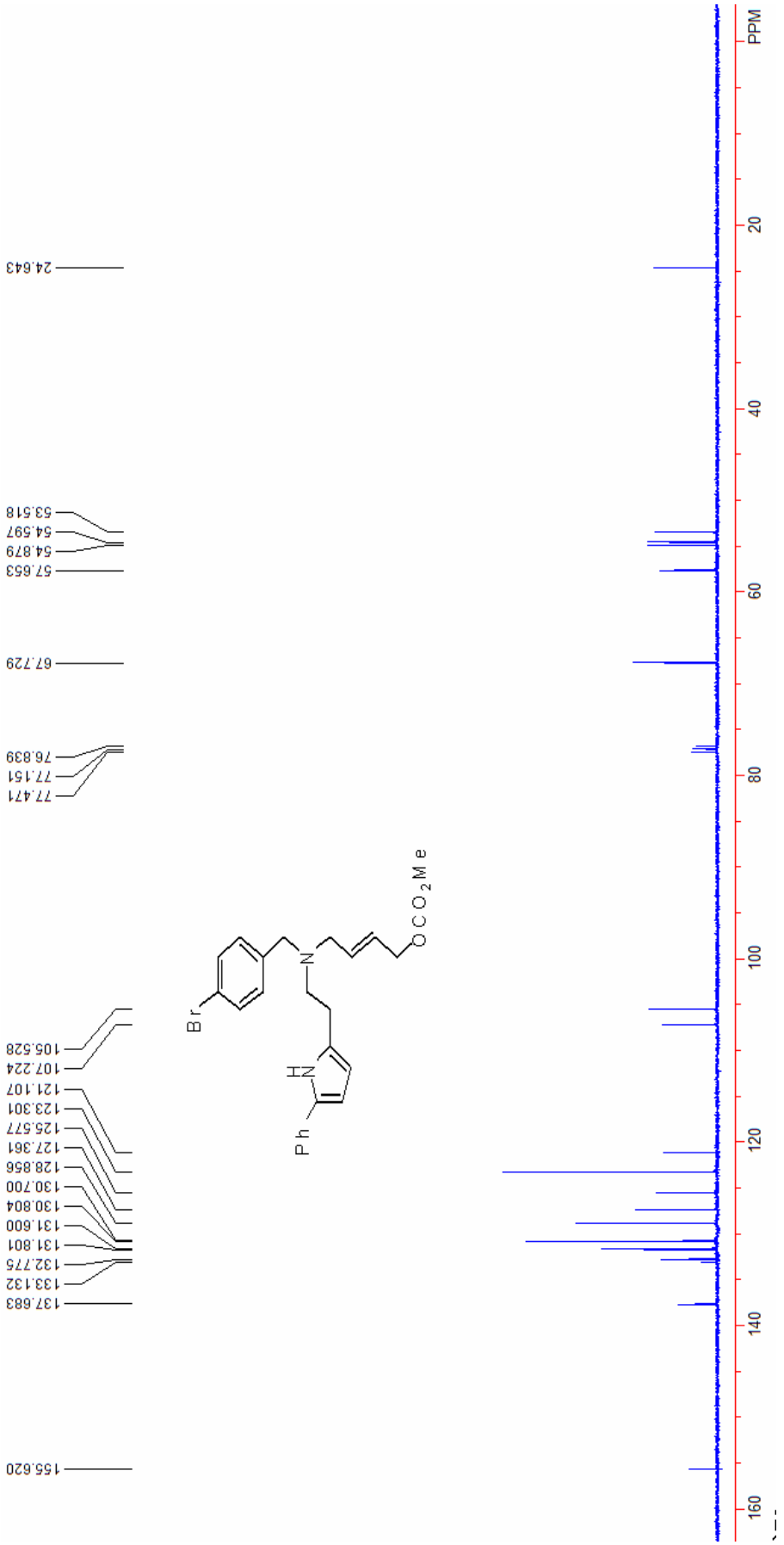
NMR Spectra of **2b**



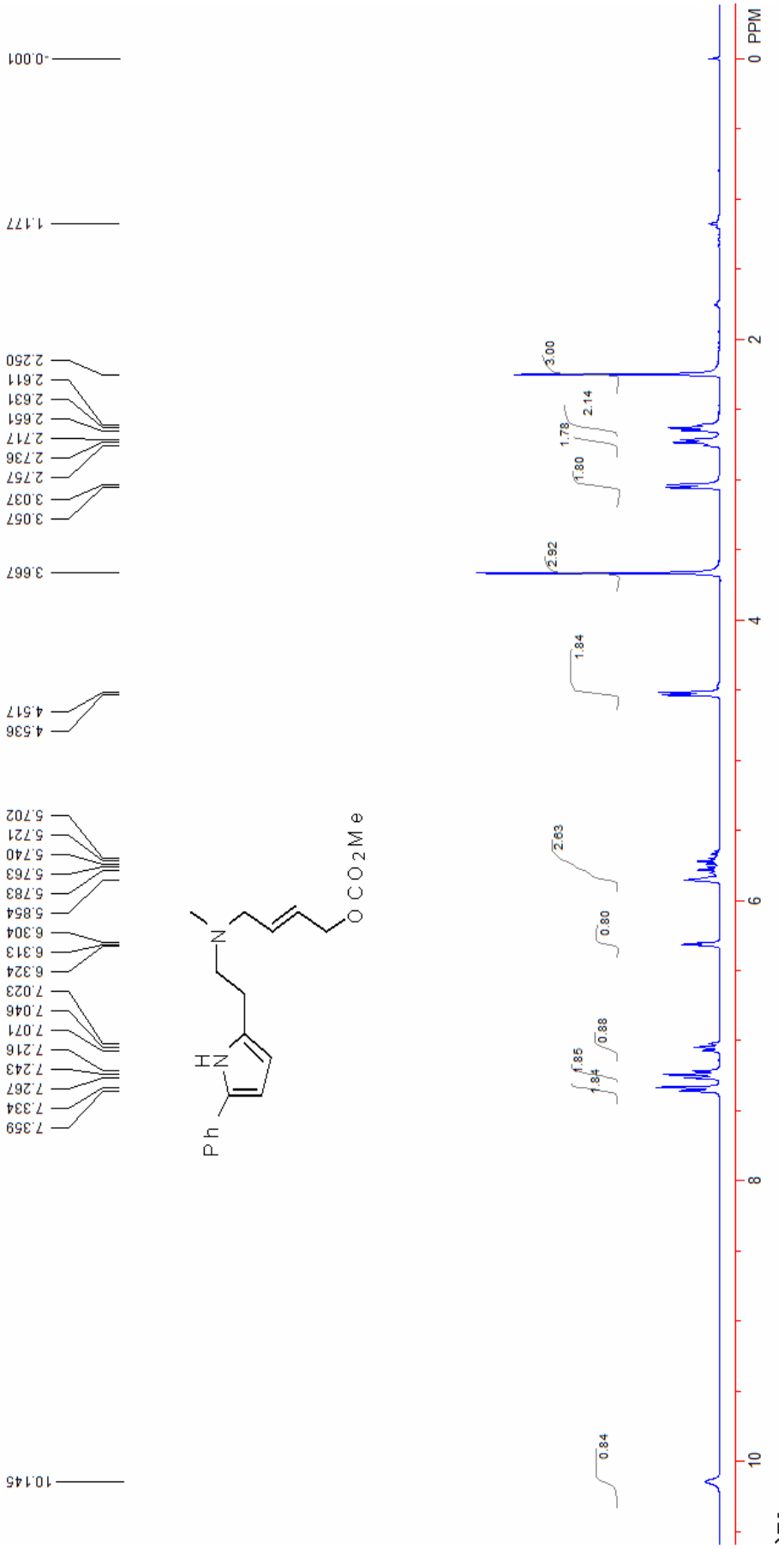

24.194
53.081
54.754
54.799
56.518
67.696
76.615
77.041
77.459
105.259
106.833
118.391
123.091
125.319
127.014
128.740
130.451
132.048
133.166
134.732
155.529
Ph
H
N
N
O
O
O
Me
PPM
20
40
60
80
100
120
140
160

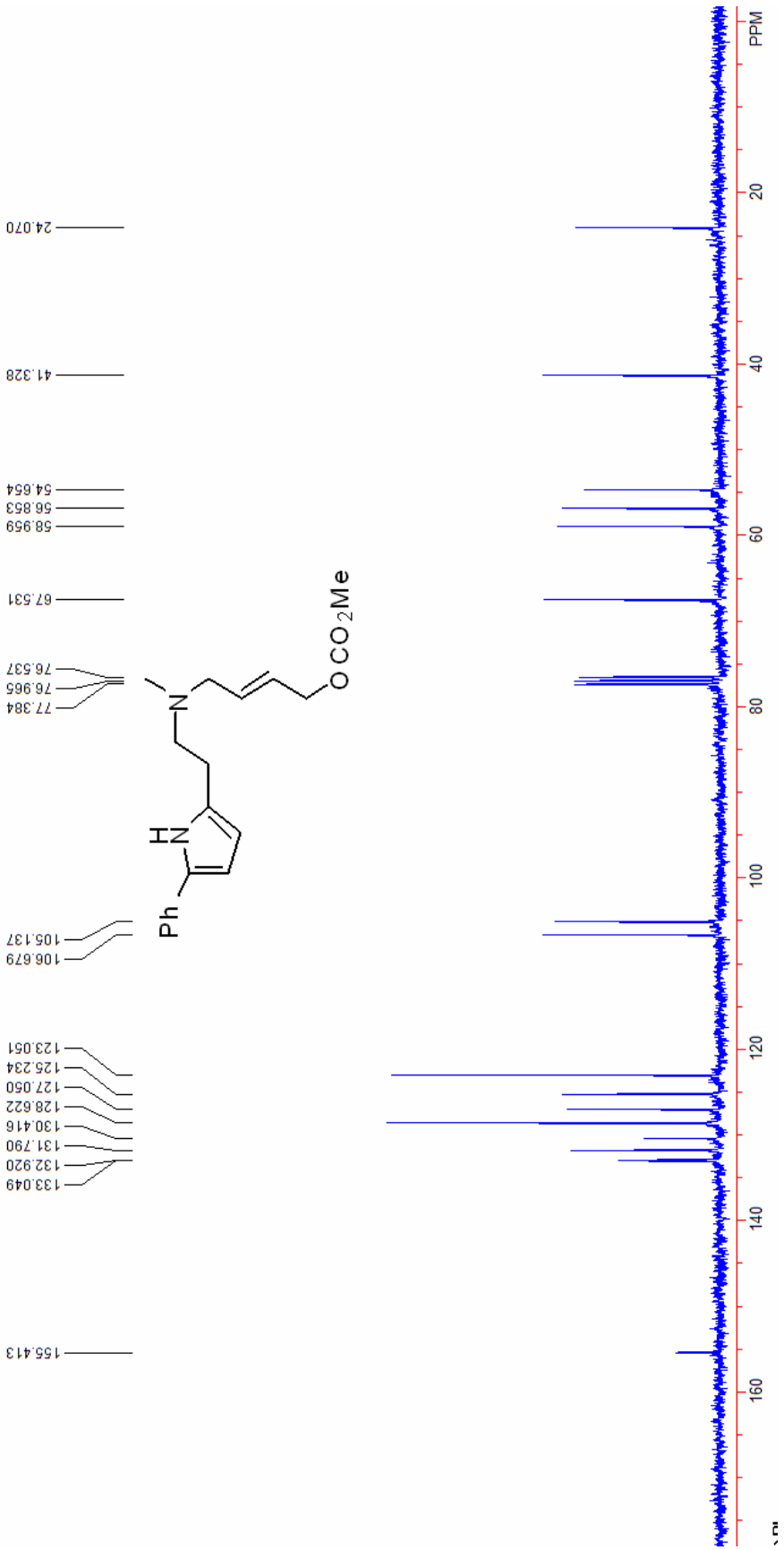
NMR Spectra of **2c**



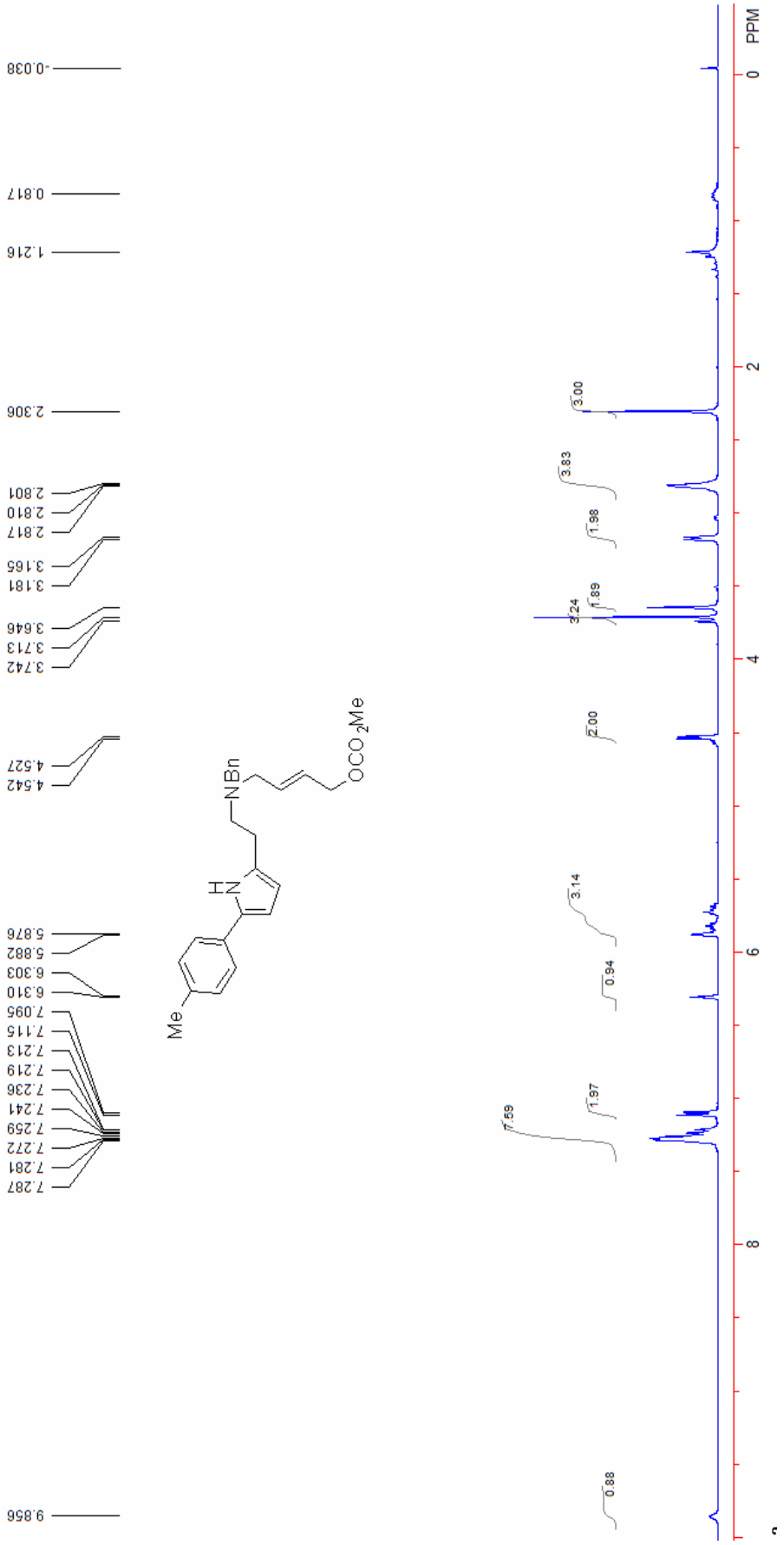


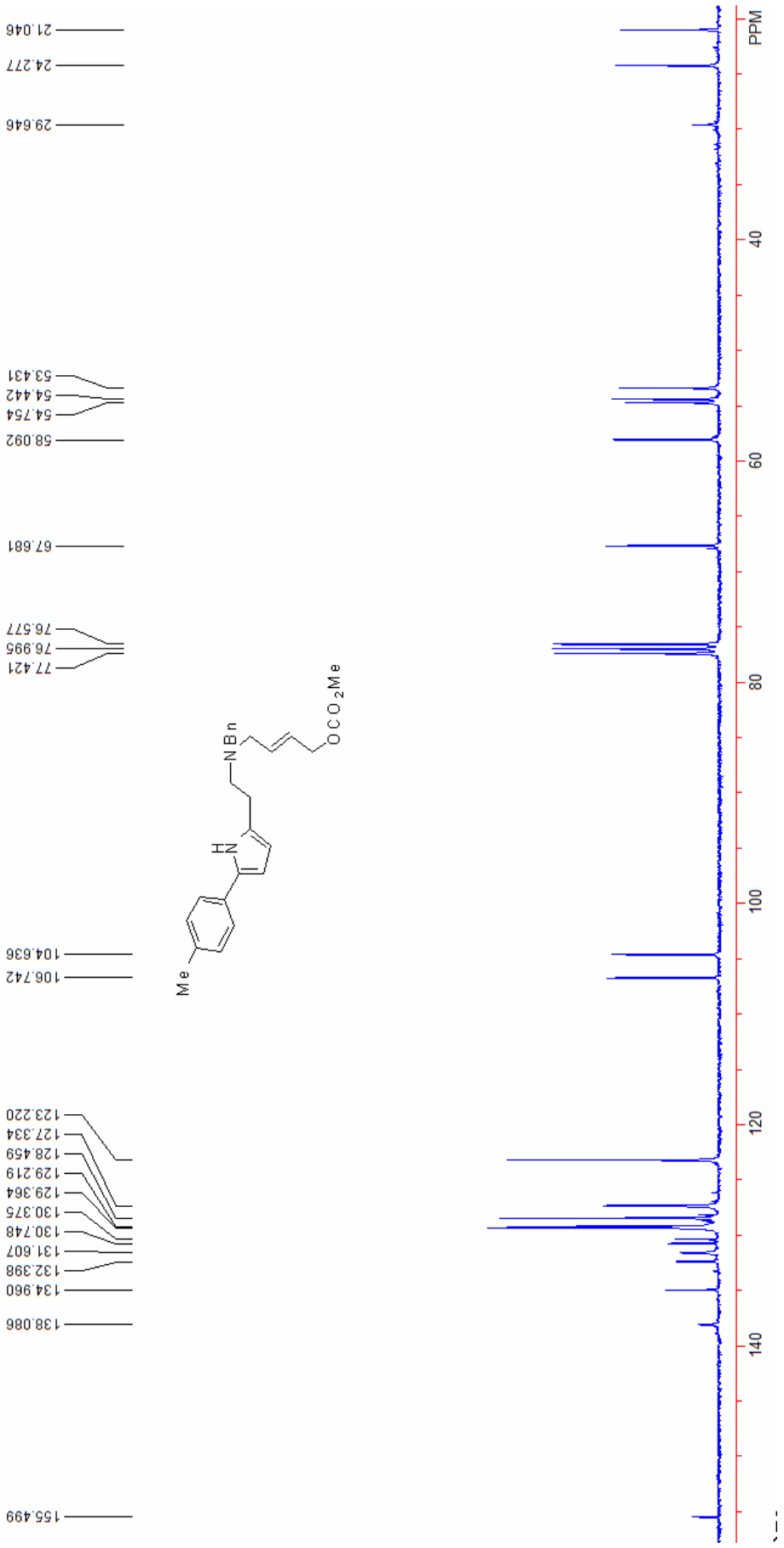
NMR Spectra of **2d**



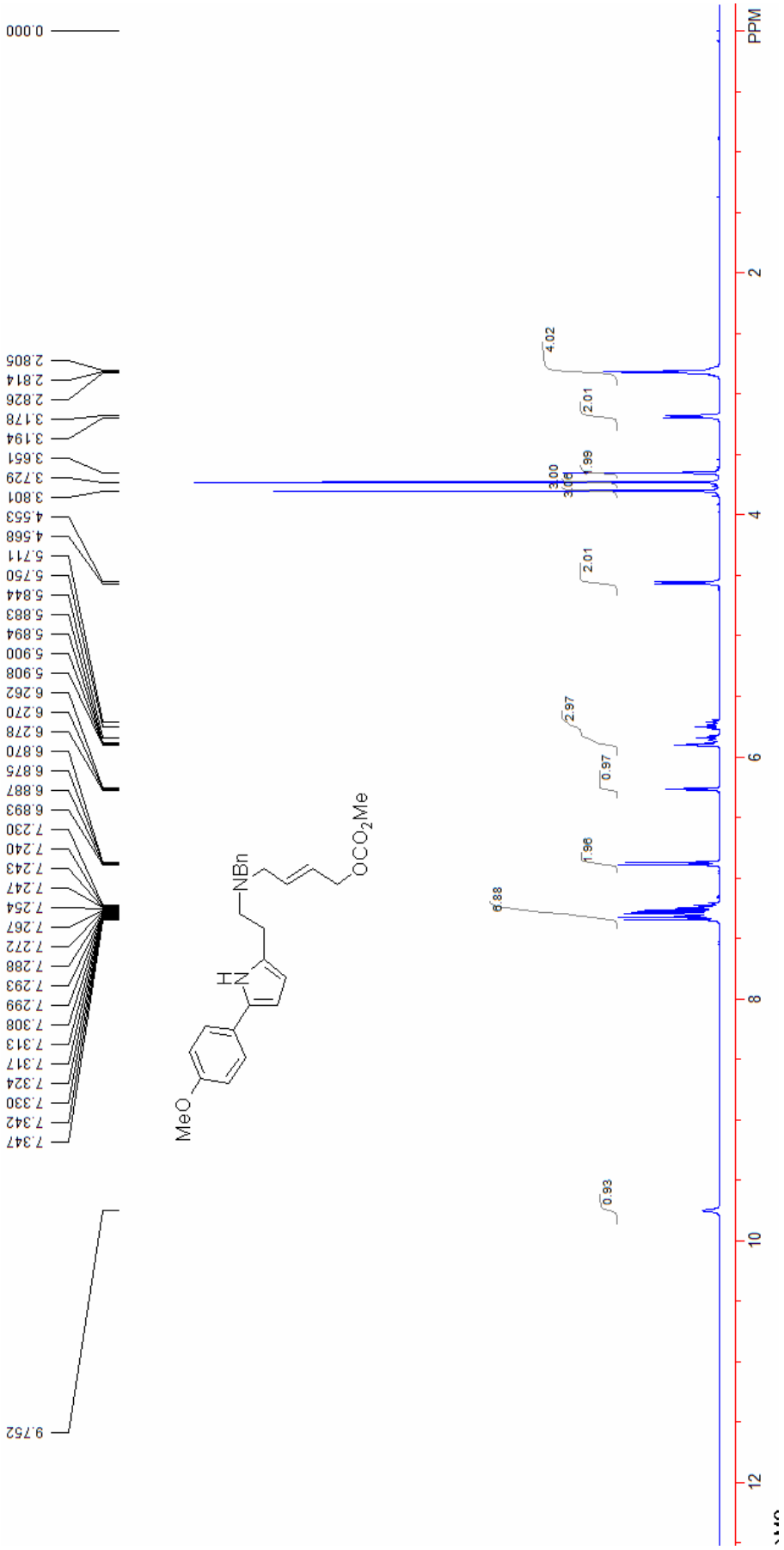


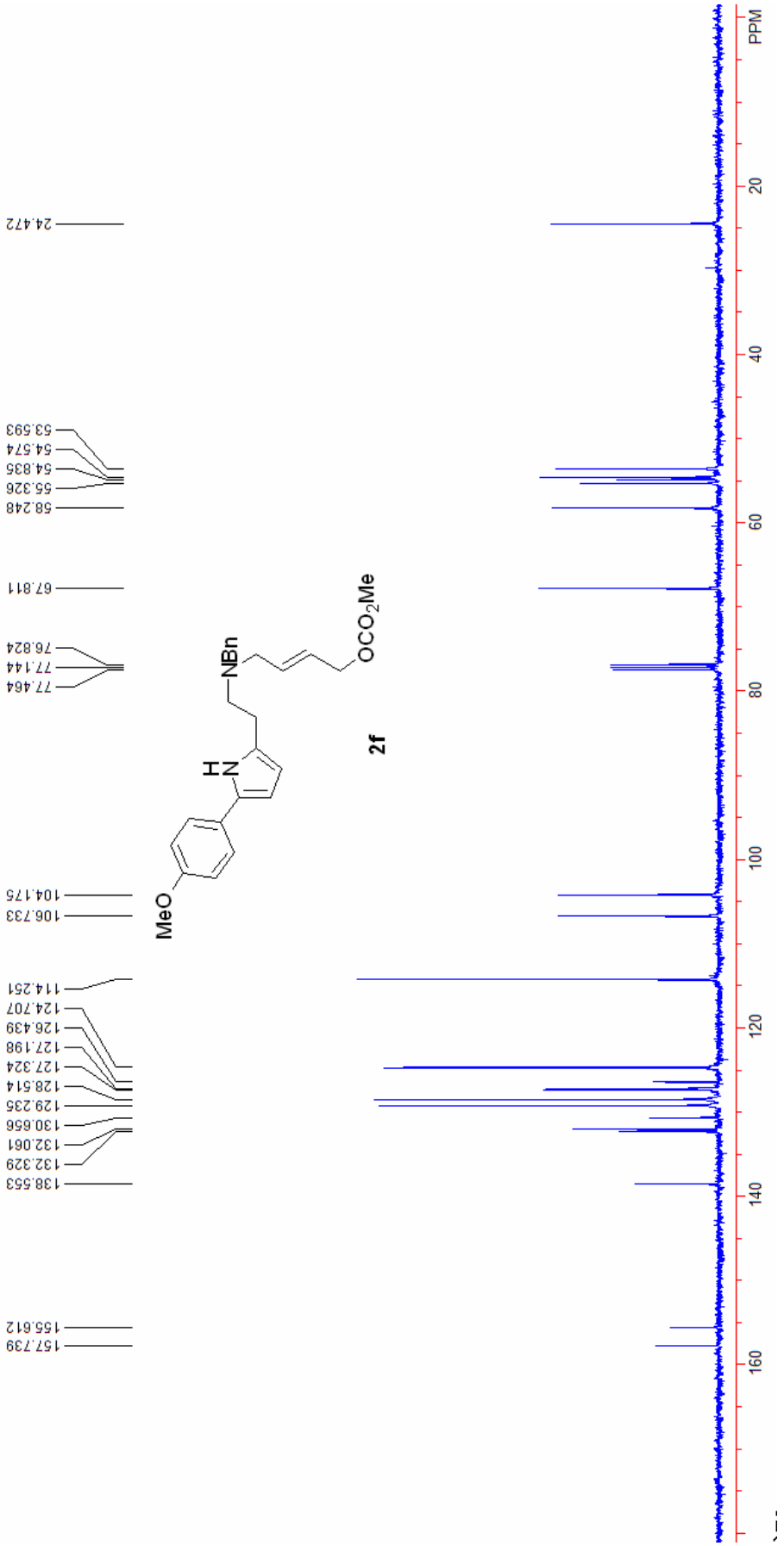
NMR Spectra of **2e**



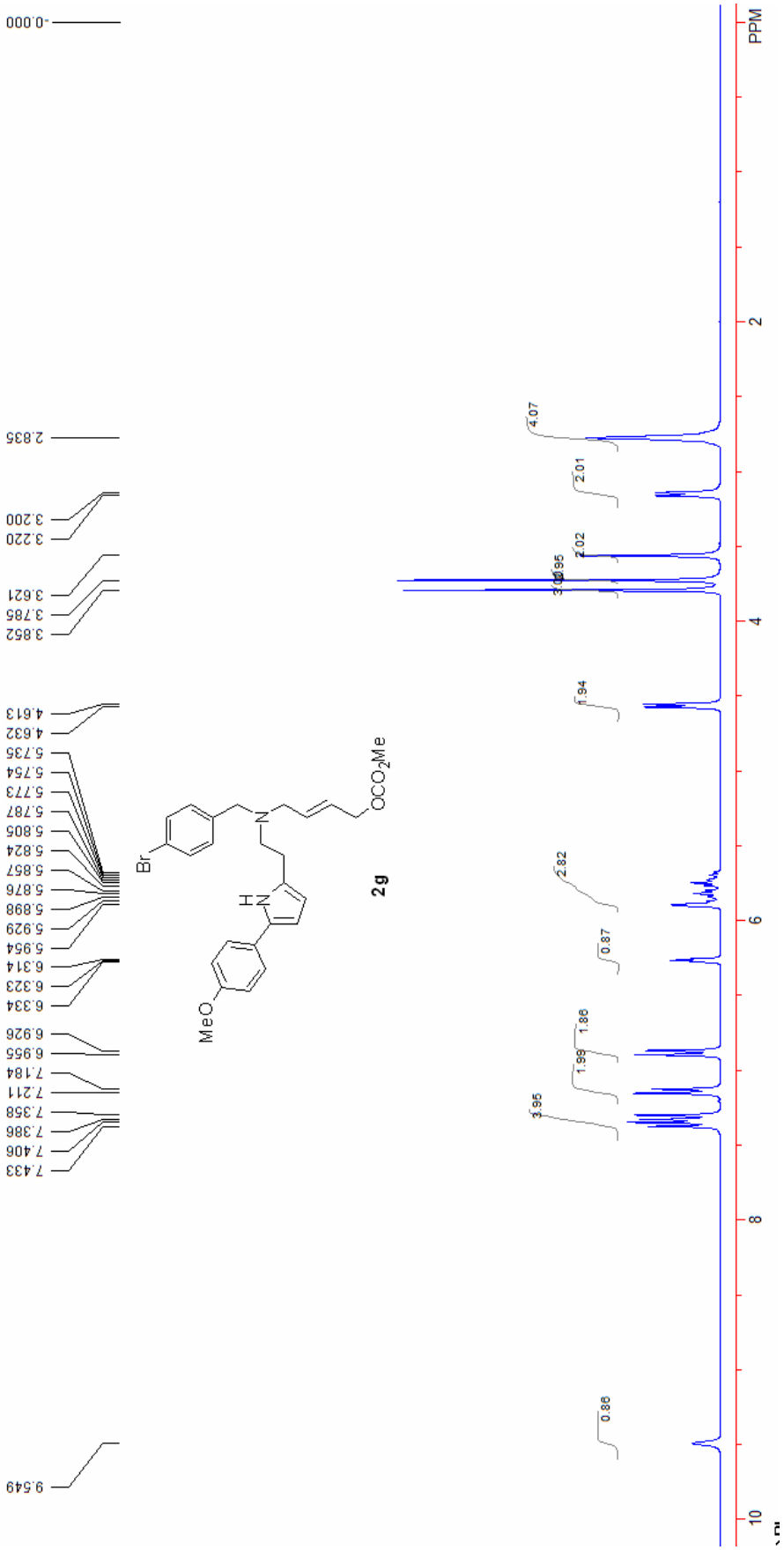

21.046
24.277
29.646
53.431
54.442
54.754
58.092
67.681
76.577
76.995
77.421
104.636
106.742
123.220
127.334
128.459
129.219
129.364
130.375
130.748
131.607
132.398
134.960
138.086
155.499
PPM
40
60
80
100
120
140
NBn
OCO2Me
H
N
Me

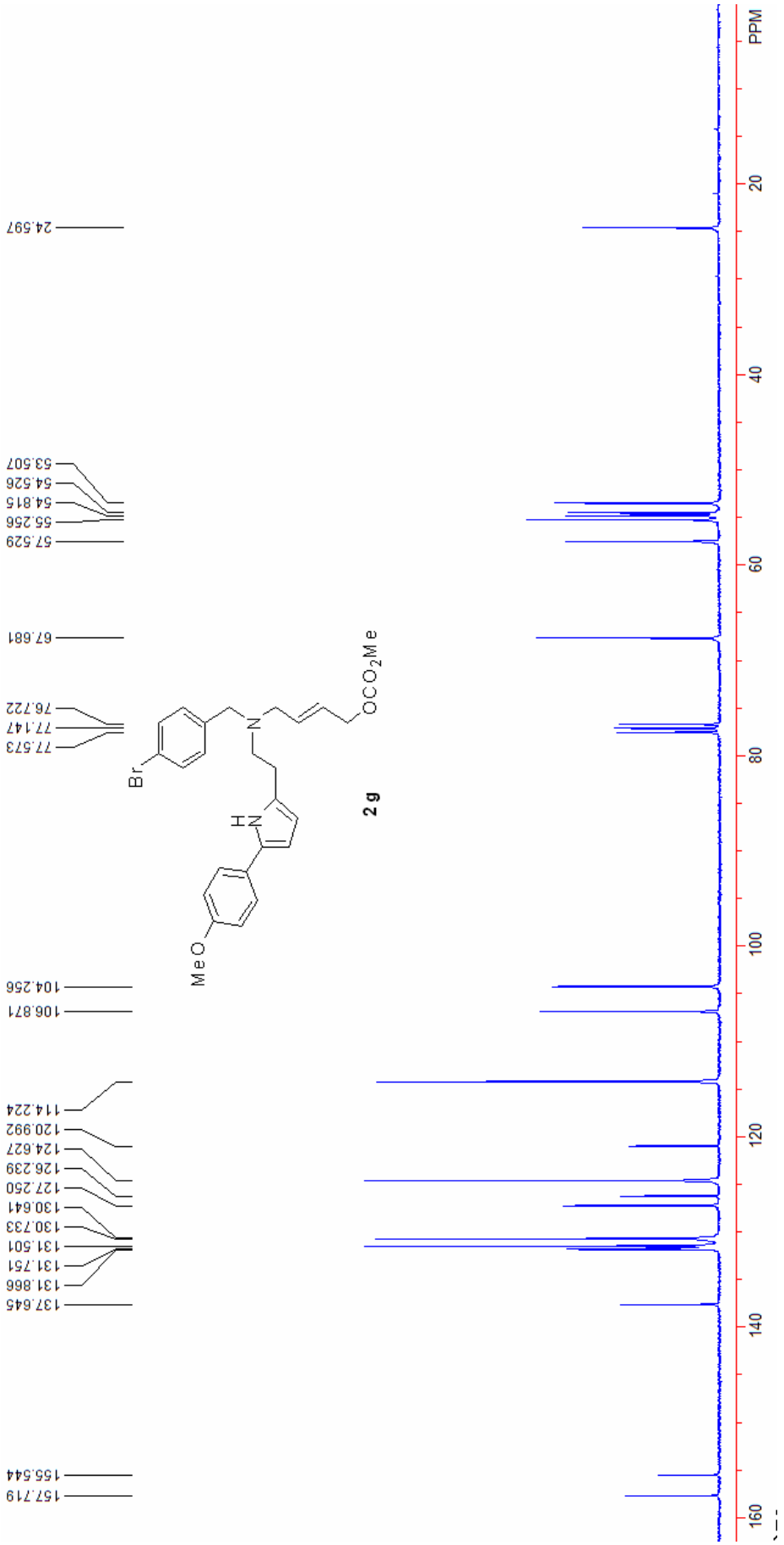
NMR Spectra of **2f**



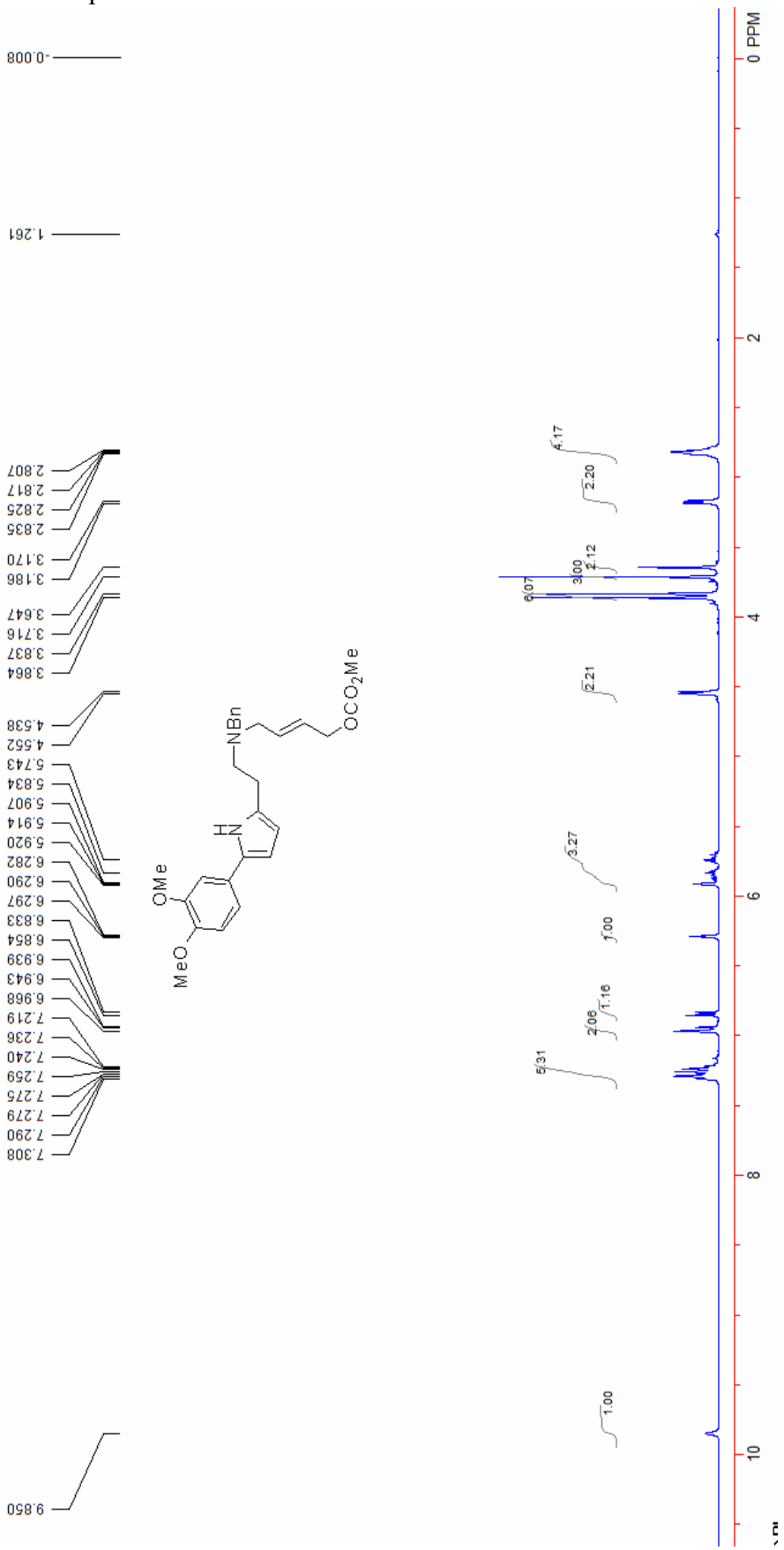


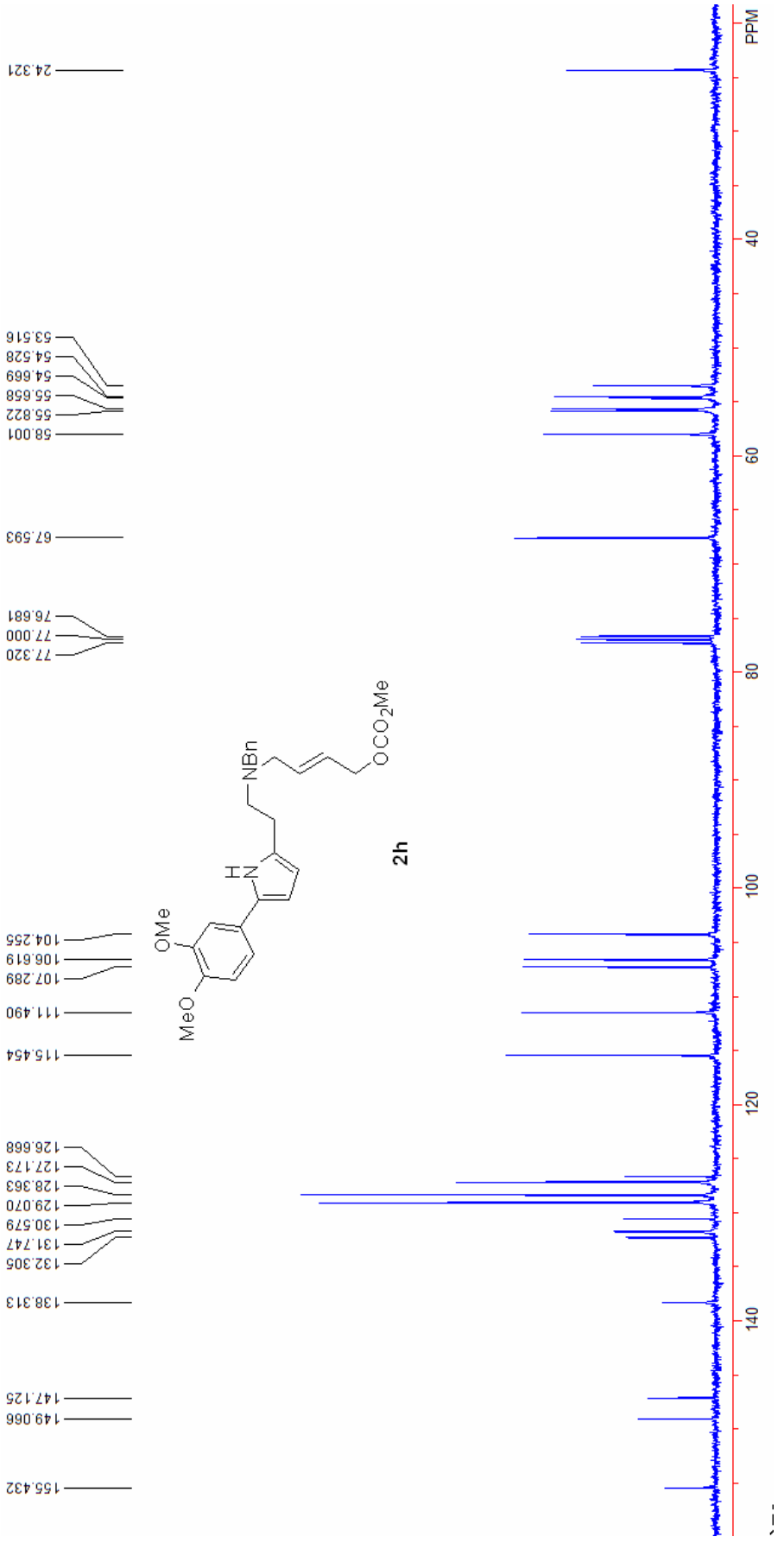
NMR Spectra of **2g**



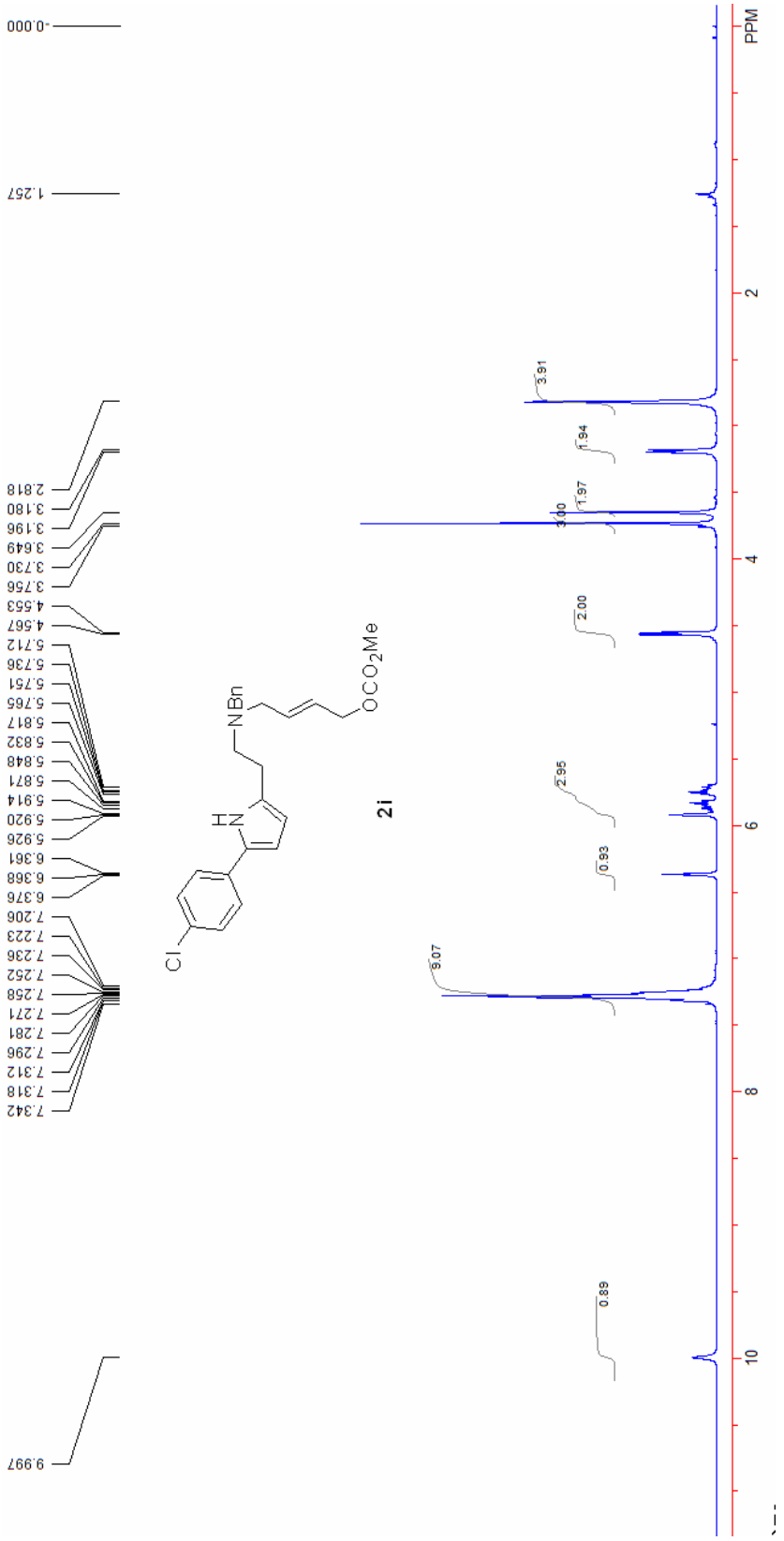

24.597
53.507
54.526
54.815
55.256
57.529
67.681
76.722
77.147
77.573
104.256
106.871
114.224
120.992
124.627
126.239
127.250
130.641
130.733
131.501
131.751
131.866
137.645
155.544
157.719
Br
N
OCO2Me
H
N
MeO
2g
PPM
20
40
60
80
100
120
140
160

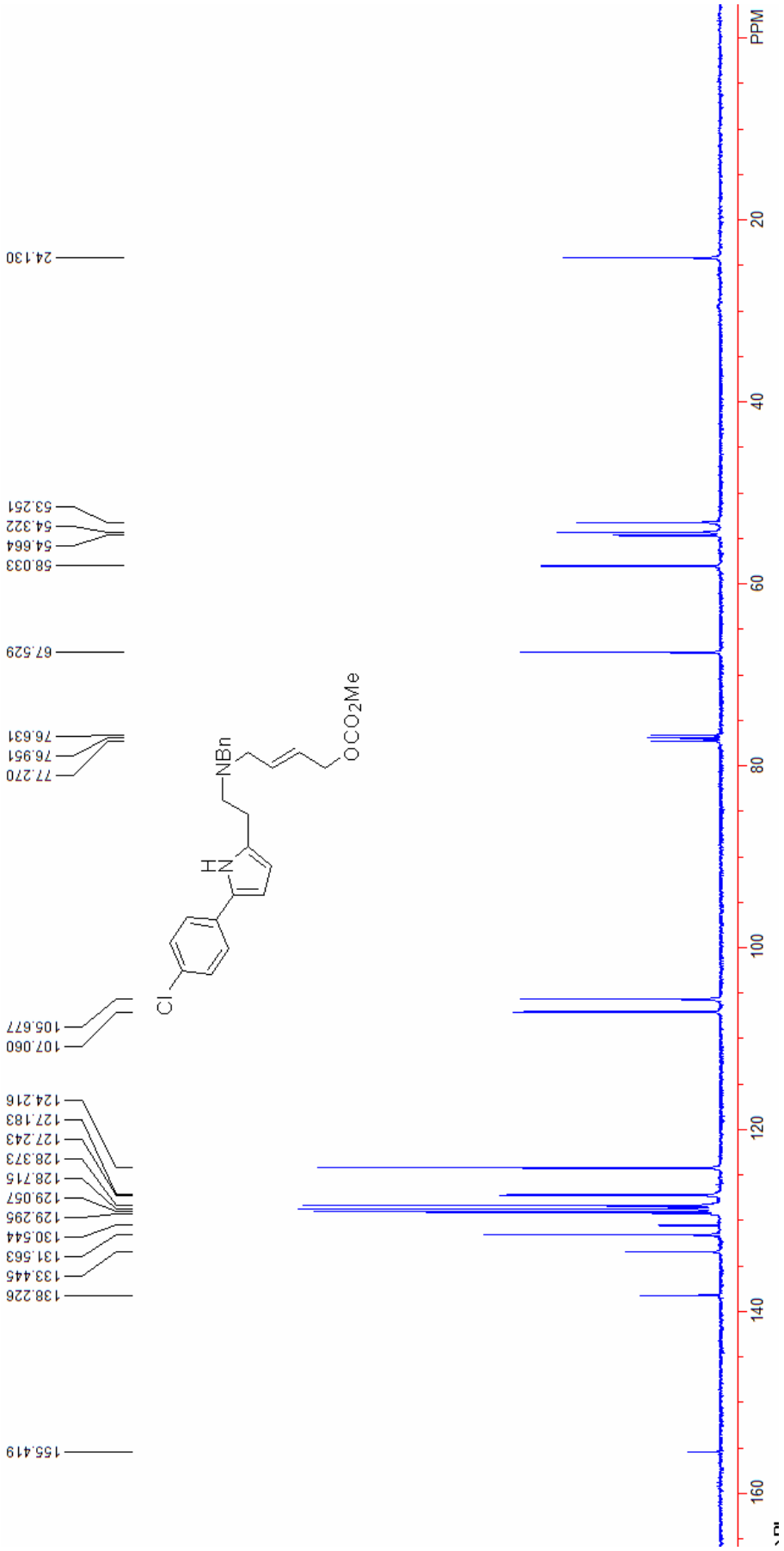
NMR Spectra of **2h**



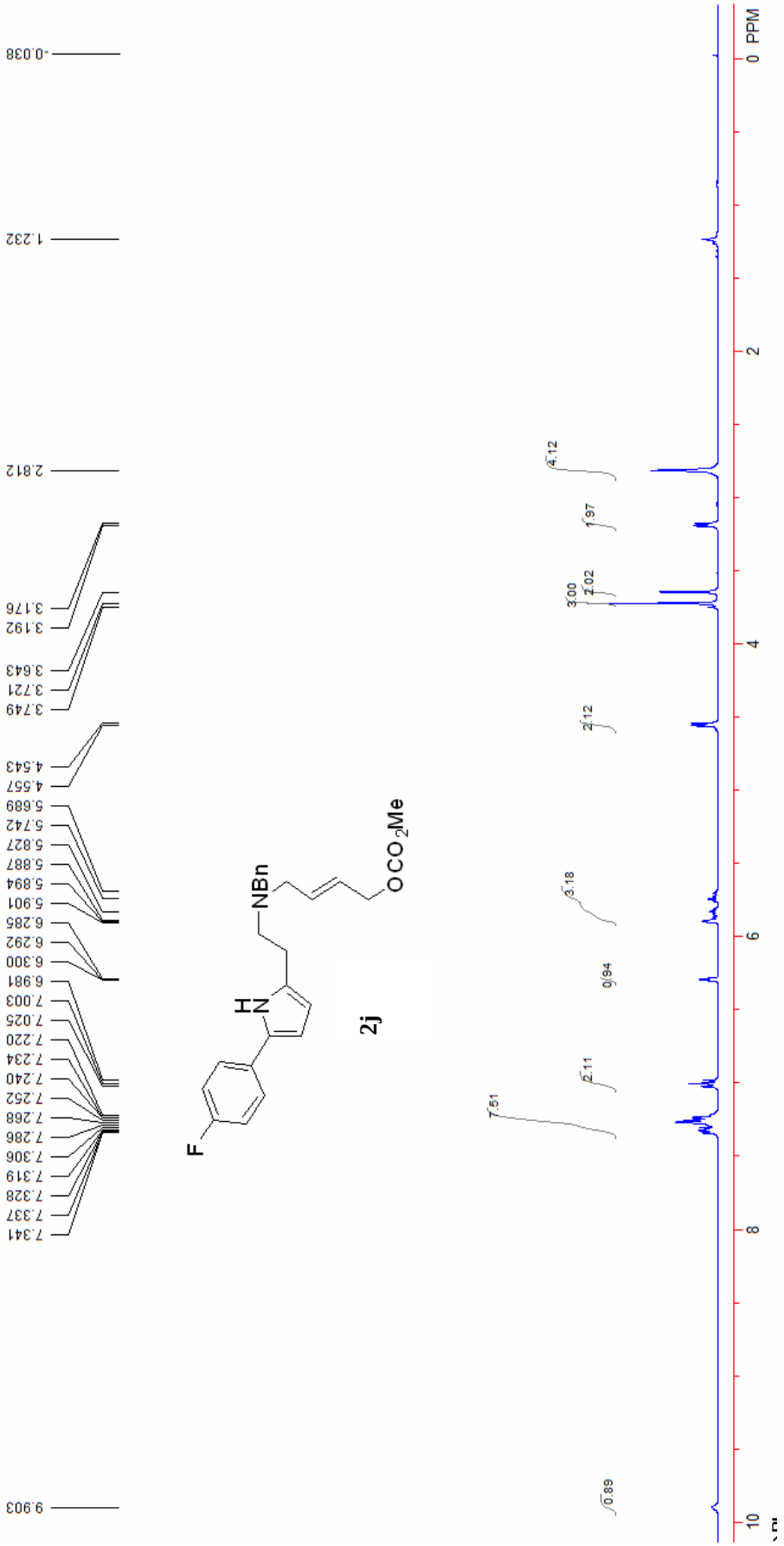


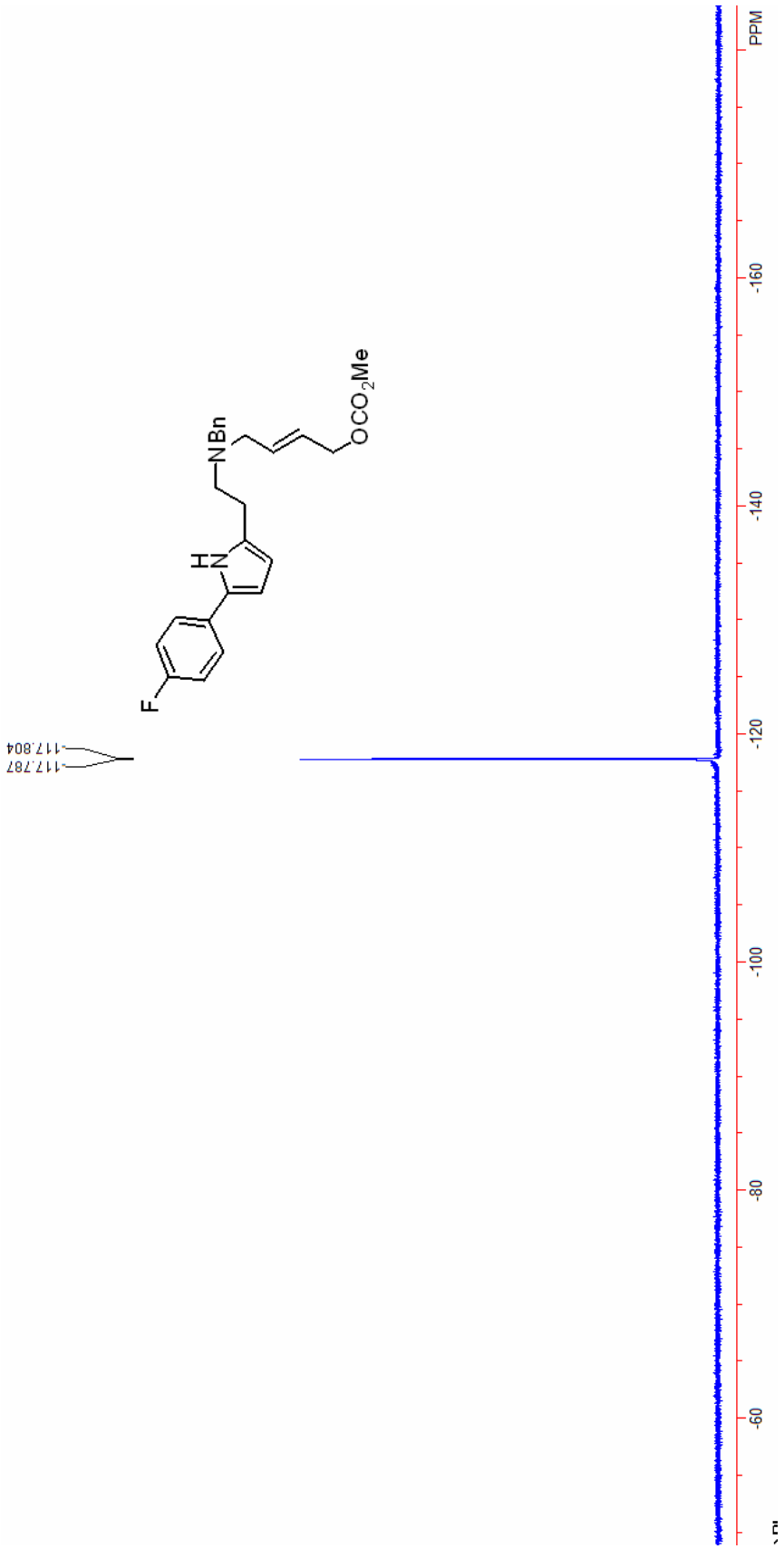
NMR Spectra of **2i**

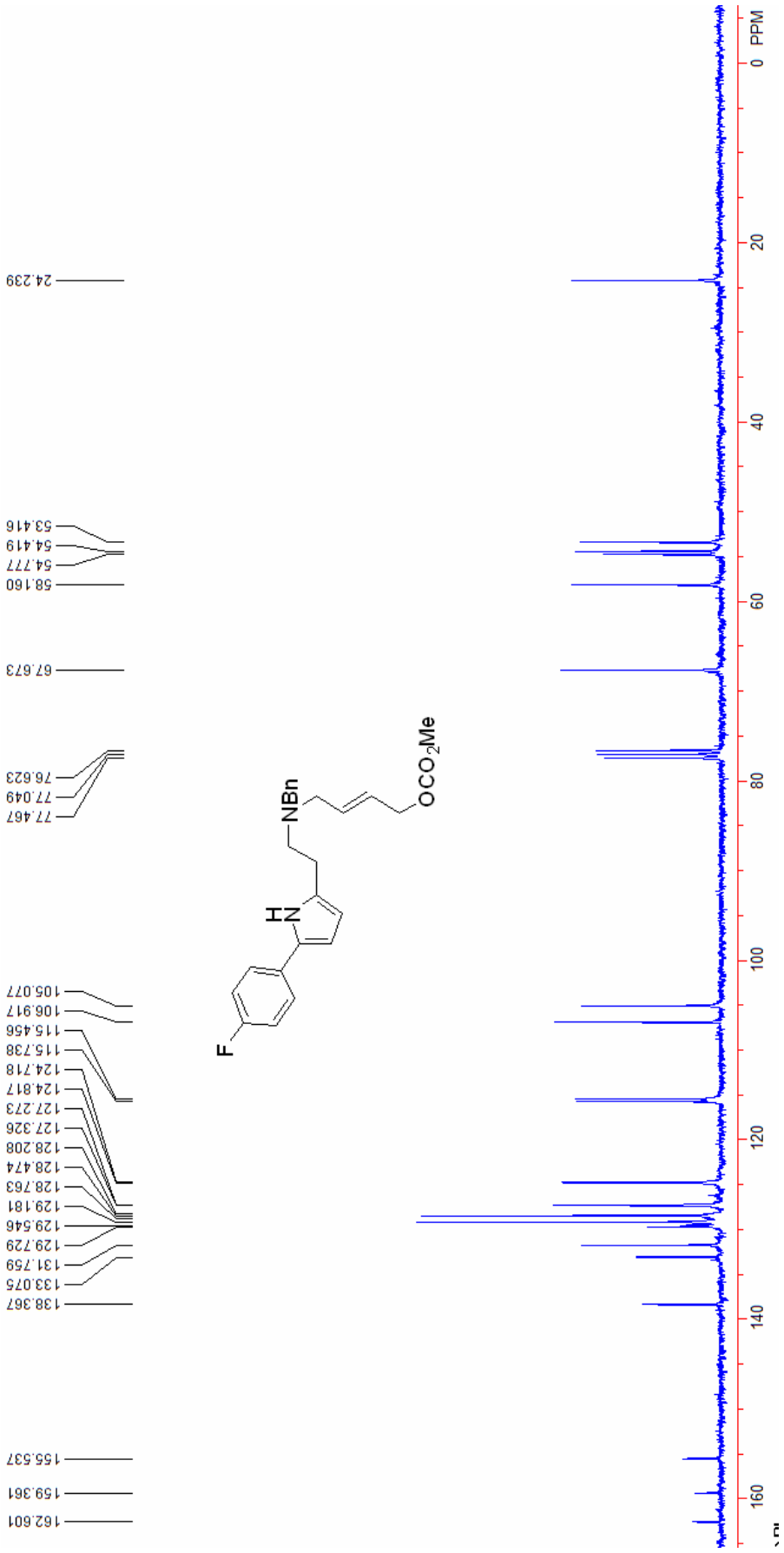



24.130
53.251
54.322
54.664
58.033
67.529
76.631
76.951
77.270
105.677
107.060
124.216
127.183
127.243
128.373
128.715
129.057
129.295
130.544
131.563
133.445
138.226
155.419
NBn
OCO2Me
Cl
H
N
PPM
20
40
60
80
100
120
140
160

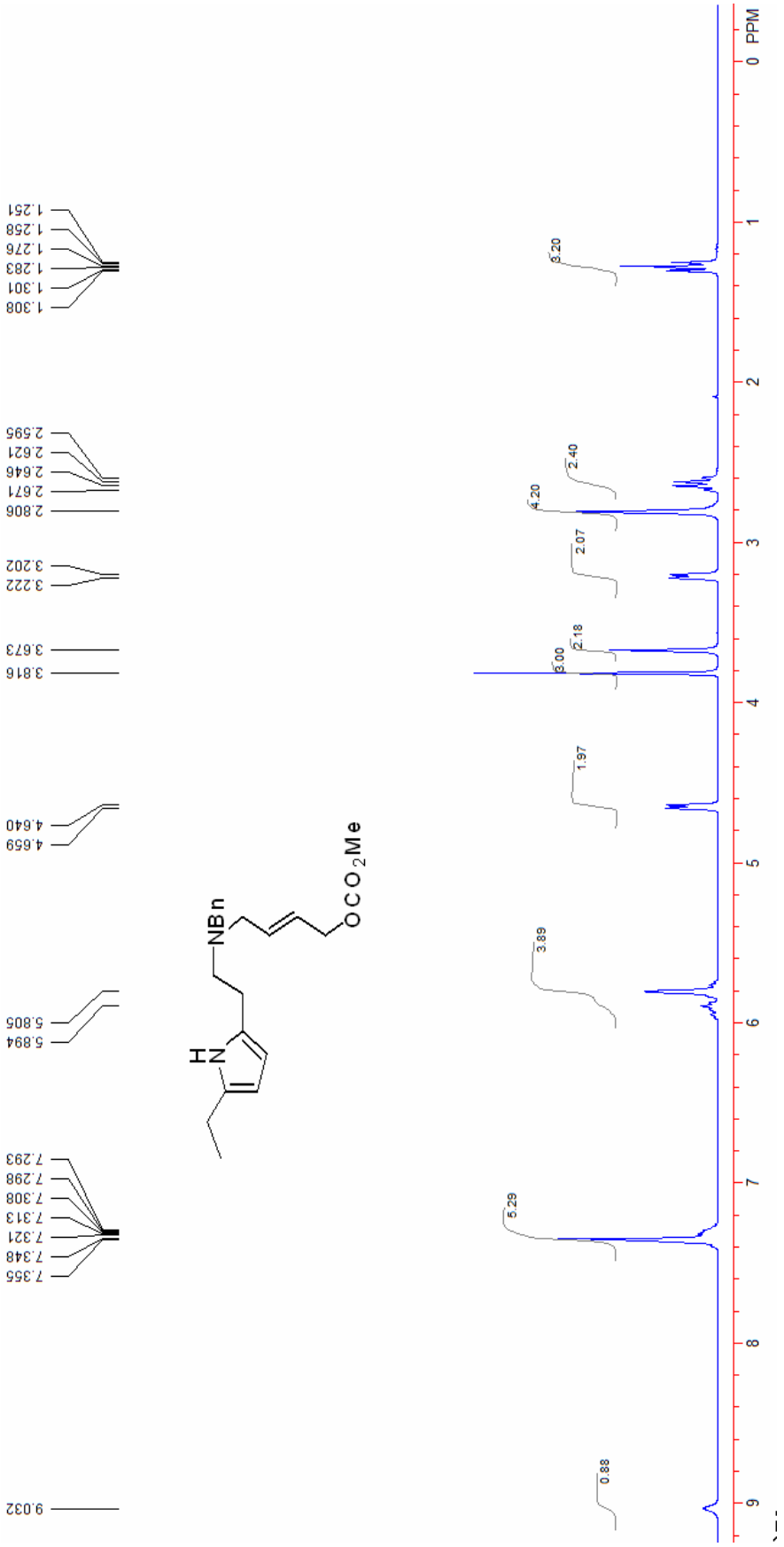
NMR Spectra of **2j**

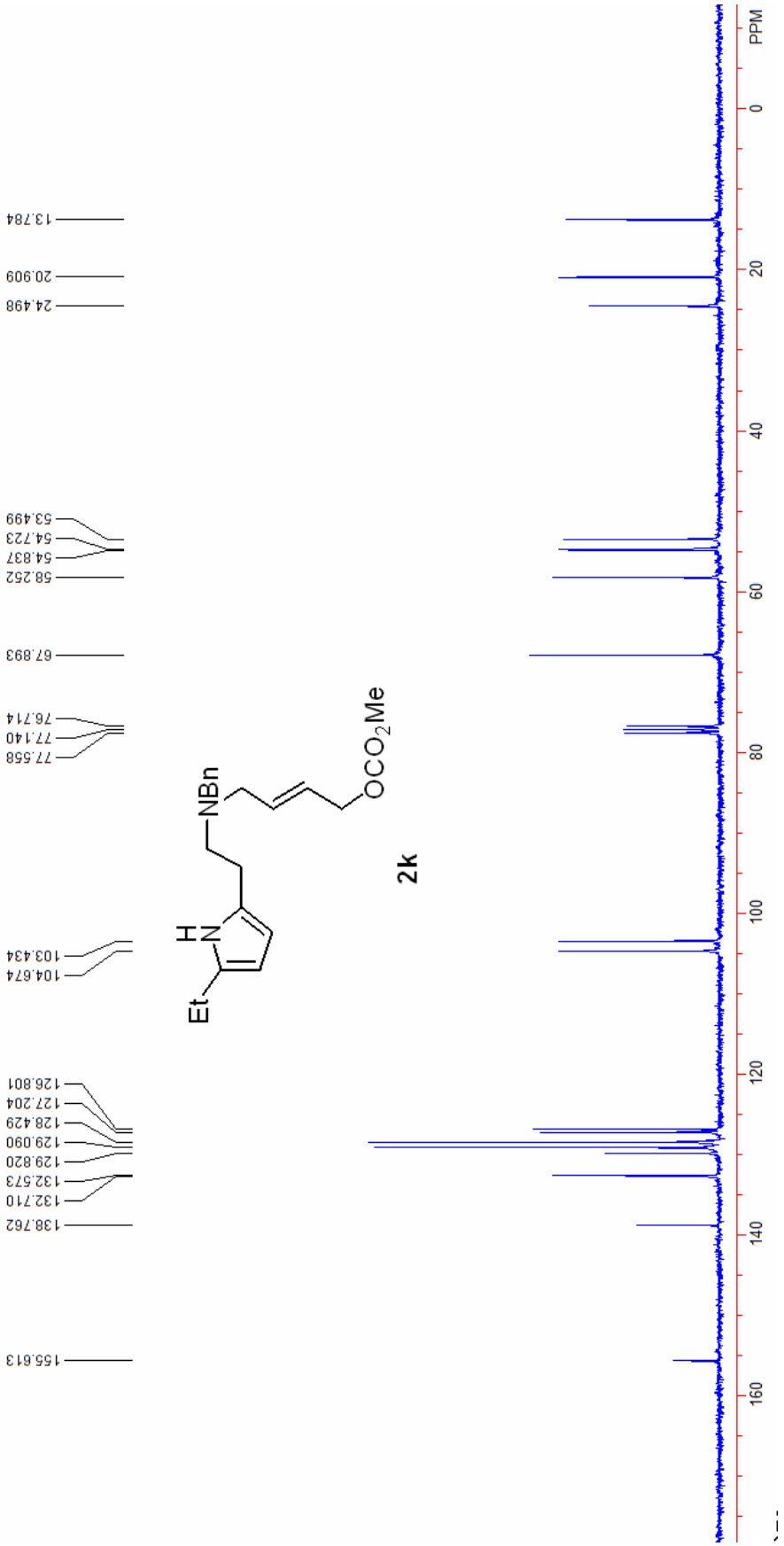




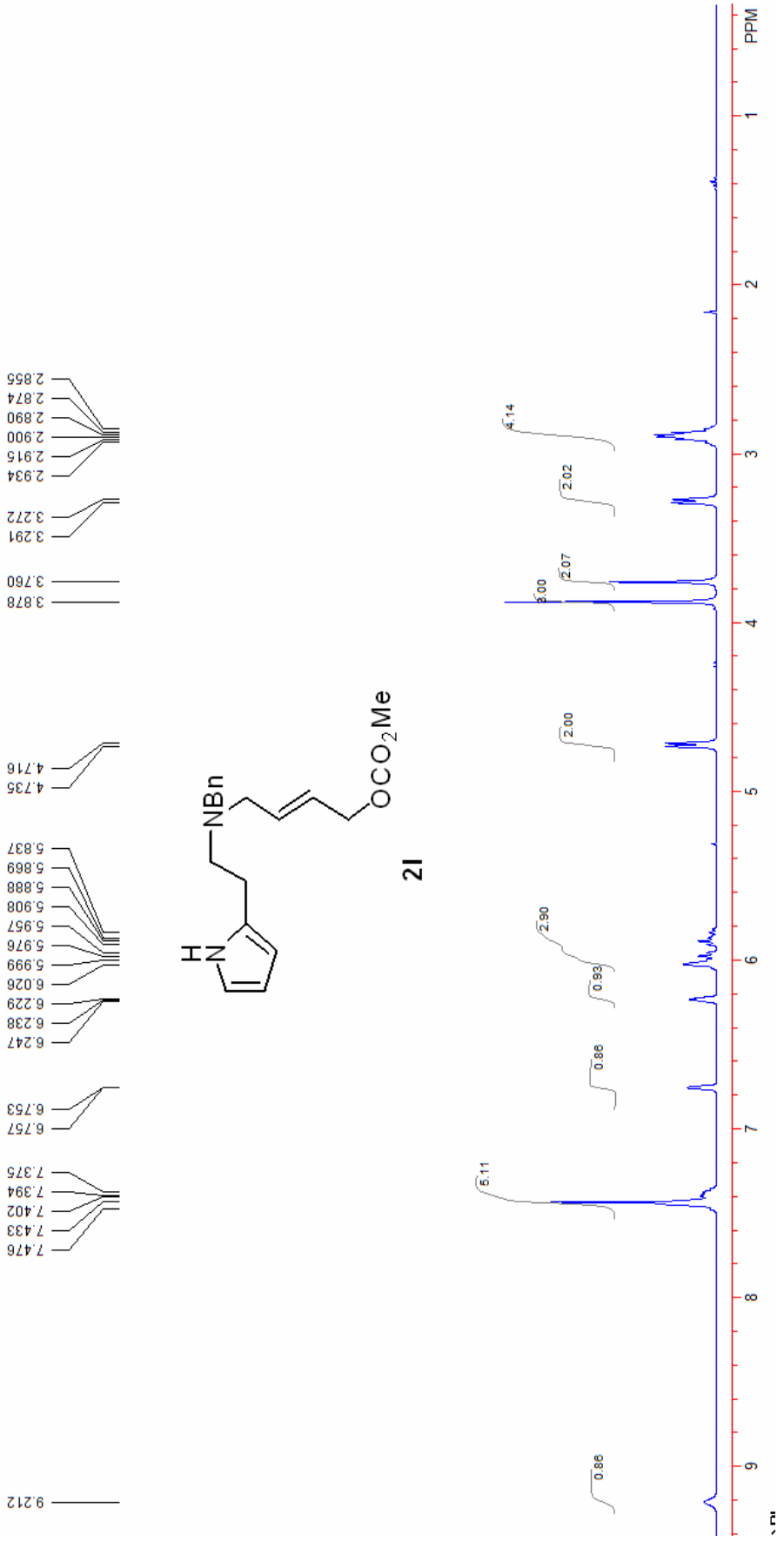

24.239
53.416
54.419
54.777
58.160
67.673
76.623
77.049
77.467
105.077
106.917
115.456
115.738
124.718
124.817
127.273
127.326
128.208
128.474
128.763
129.181
129.546
129.729
131.759
133.075
138.367
155.537
159.361
162.601
NBn
OCO2Me
F
H
N
0
20
40
60
80
100
120
140
160
PPM

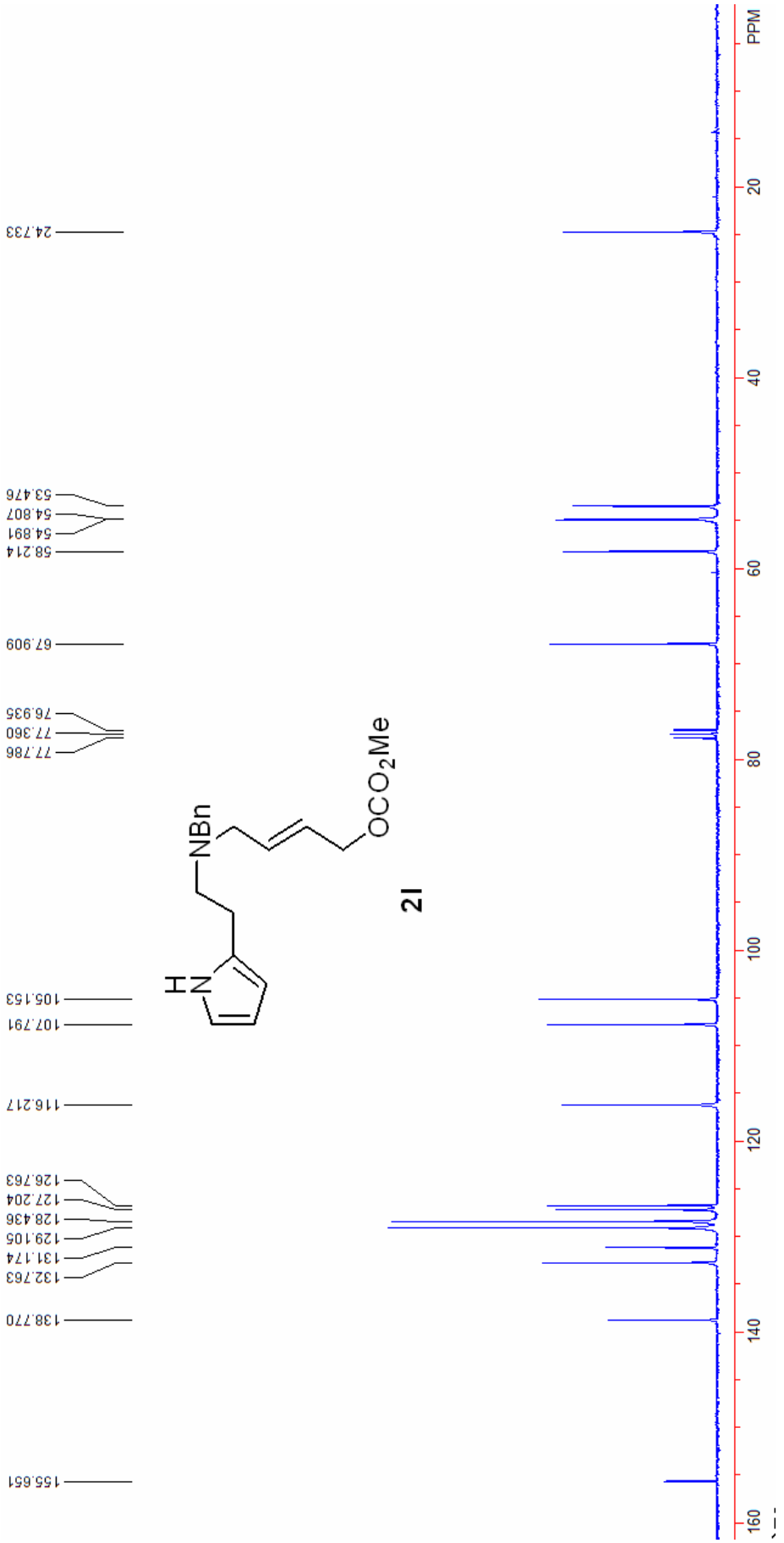
NMR Spectra of **2k**



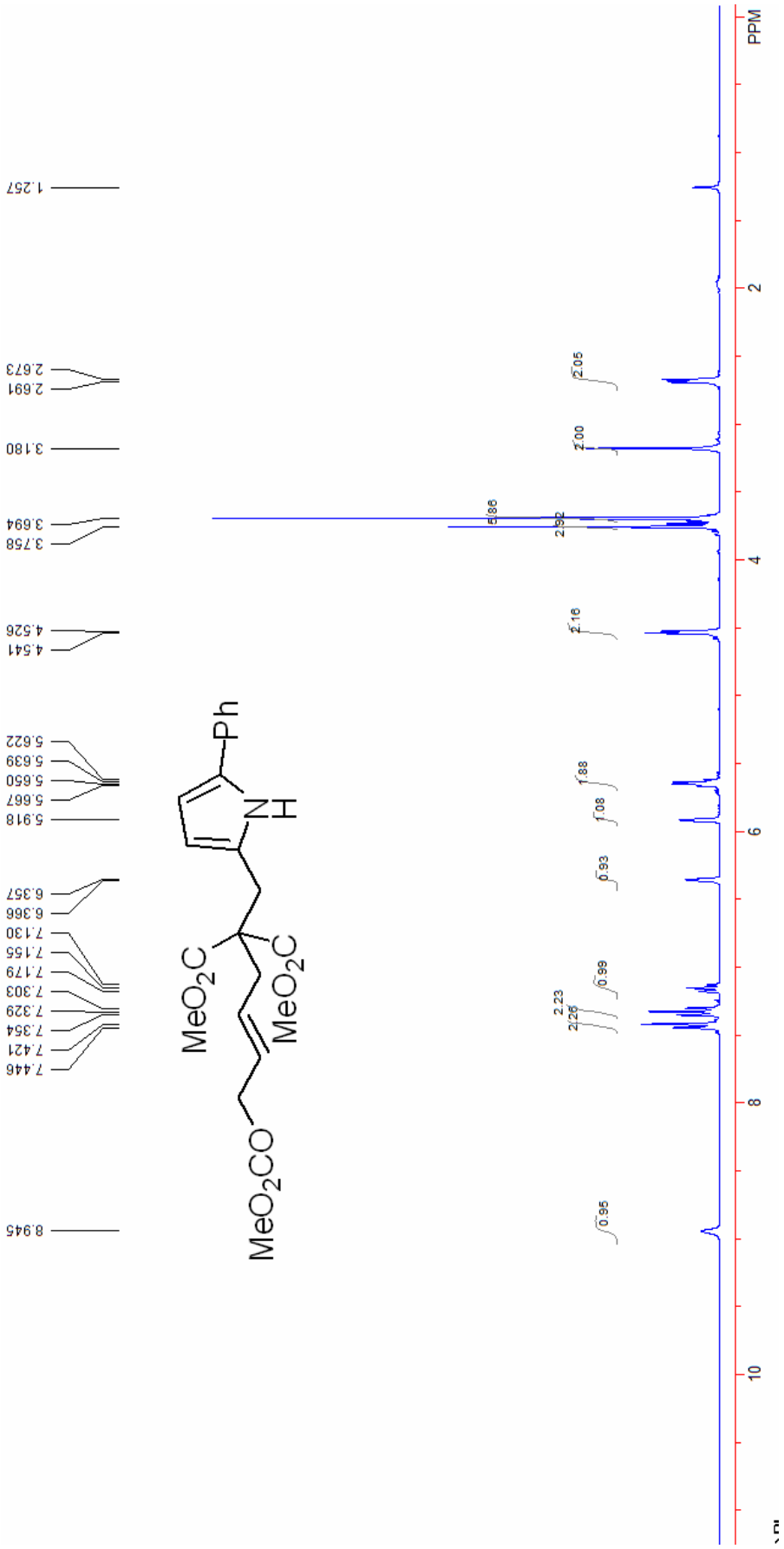


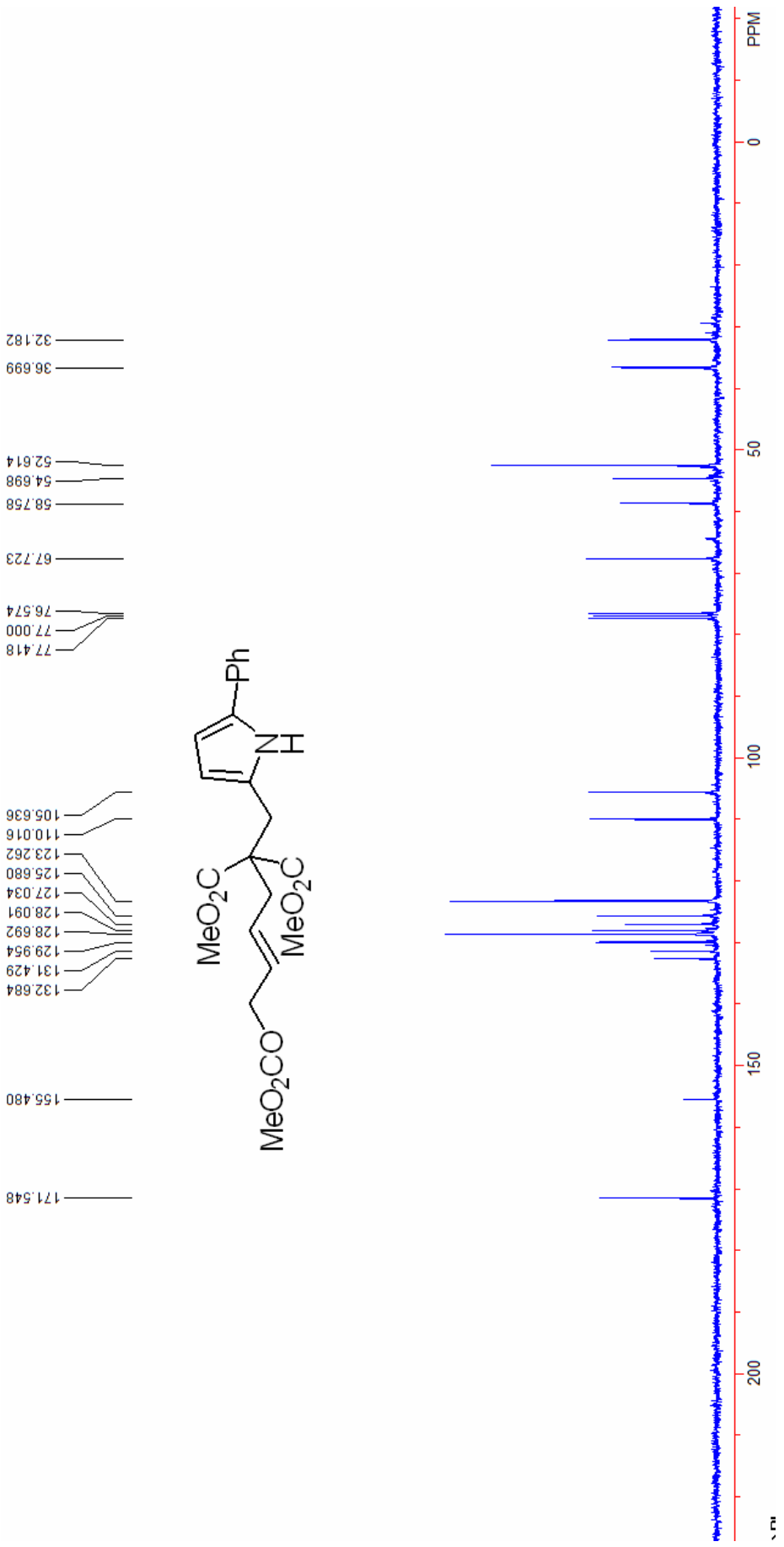
NMR Spectra of **2l**



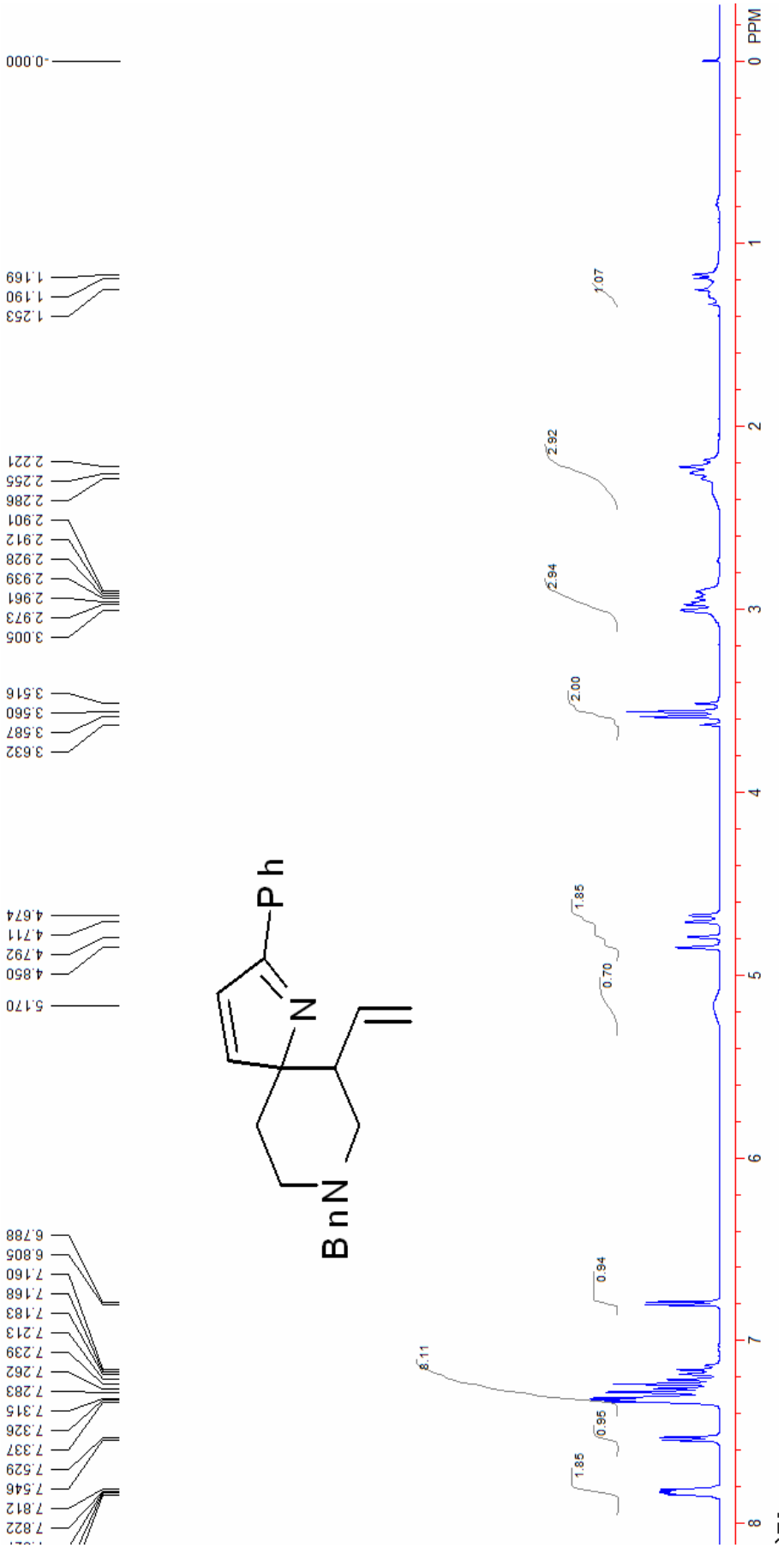

24.733
53.476
54.807
54.891
58.214
67.909
76.935
77.360
77.786
105.153
107.791
116.217
126.763
127.204
128.436
129.105
131.174
132.763
138.770
155.651
PPM
20
40
60
80
100
120
140
160
NBn
OCO2Me
H
N
2l

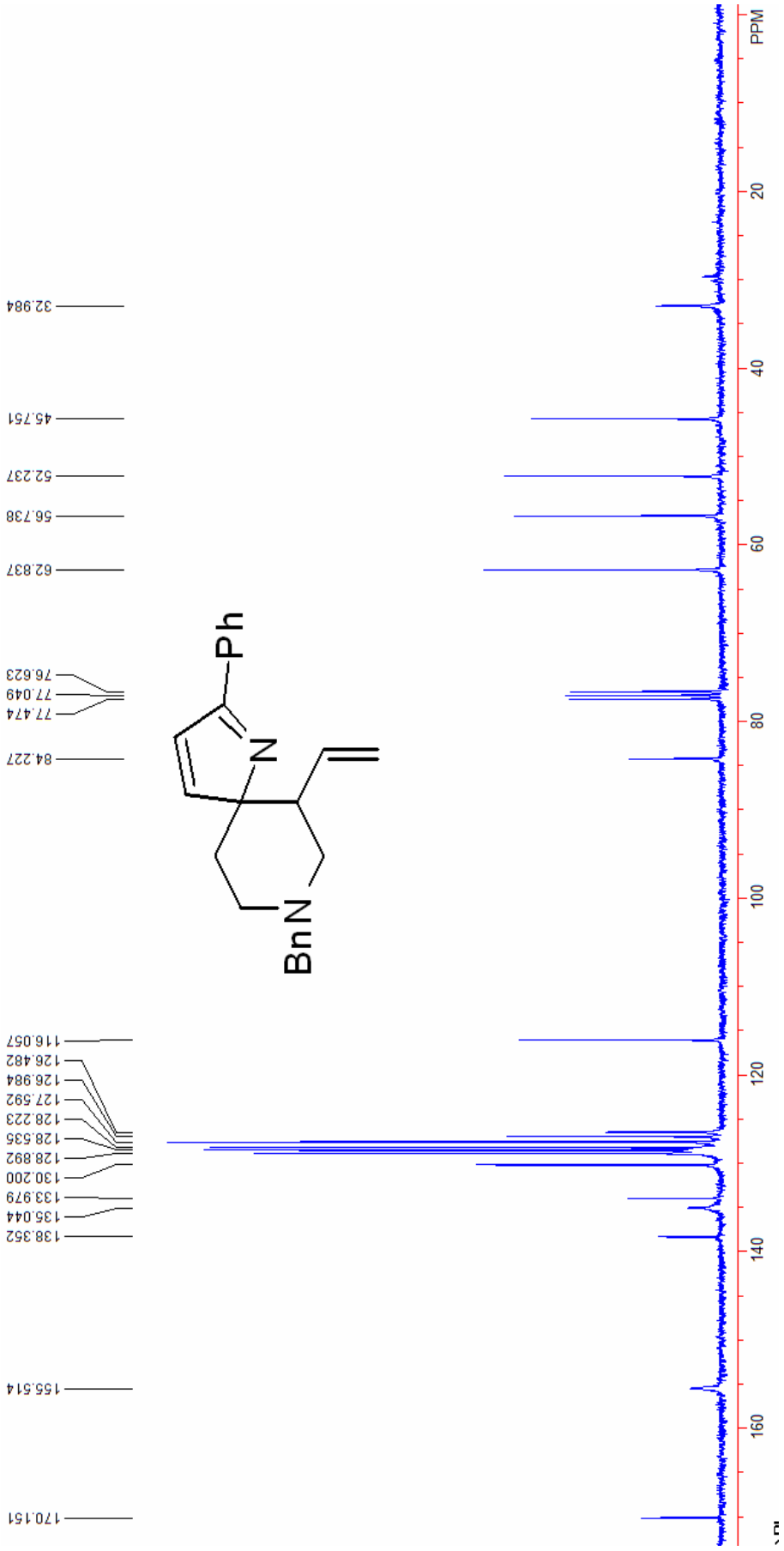
NMR Spectra of **2l**

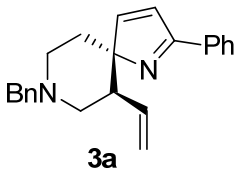




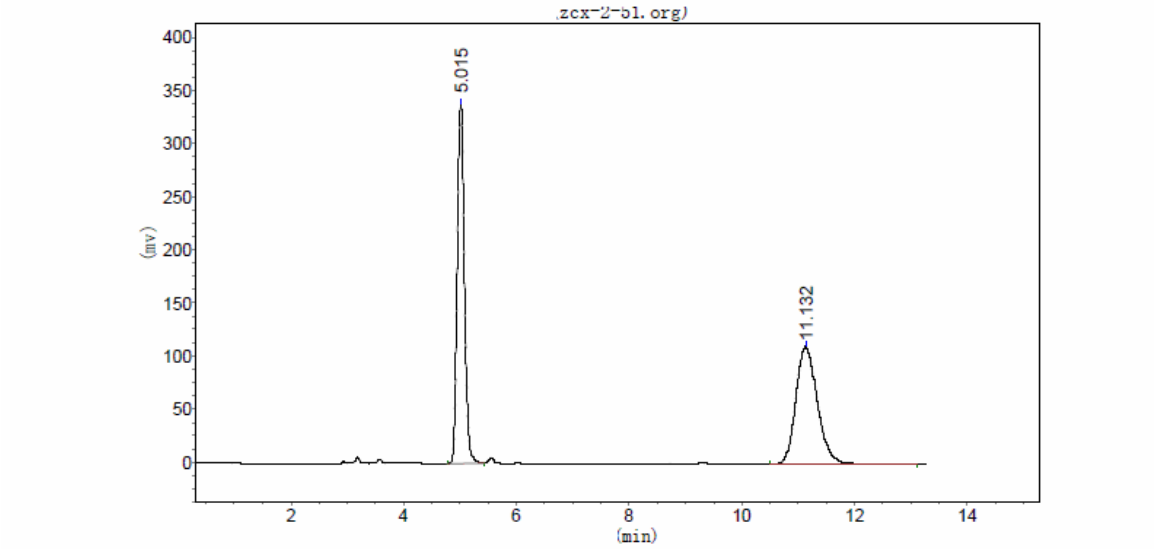
NMR Spectra and HPLC Spectra of **3a**



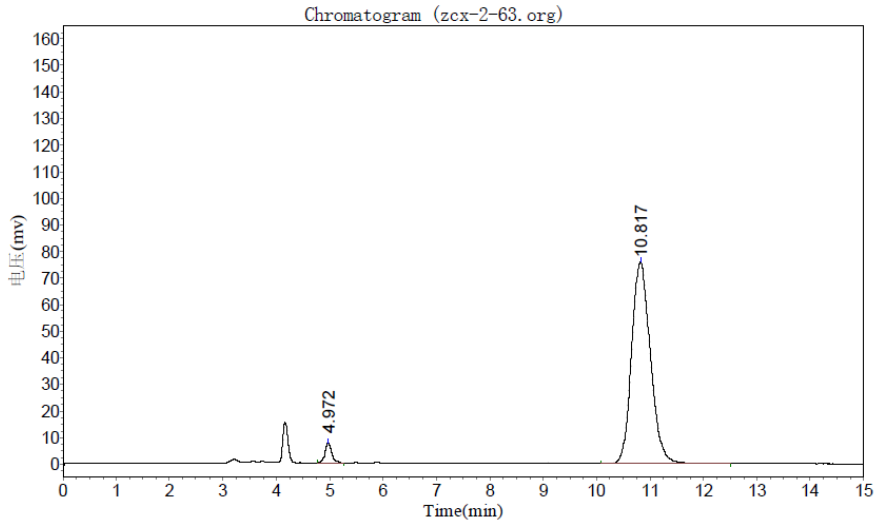




3a



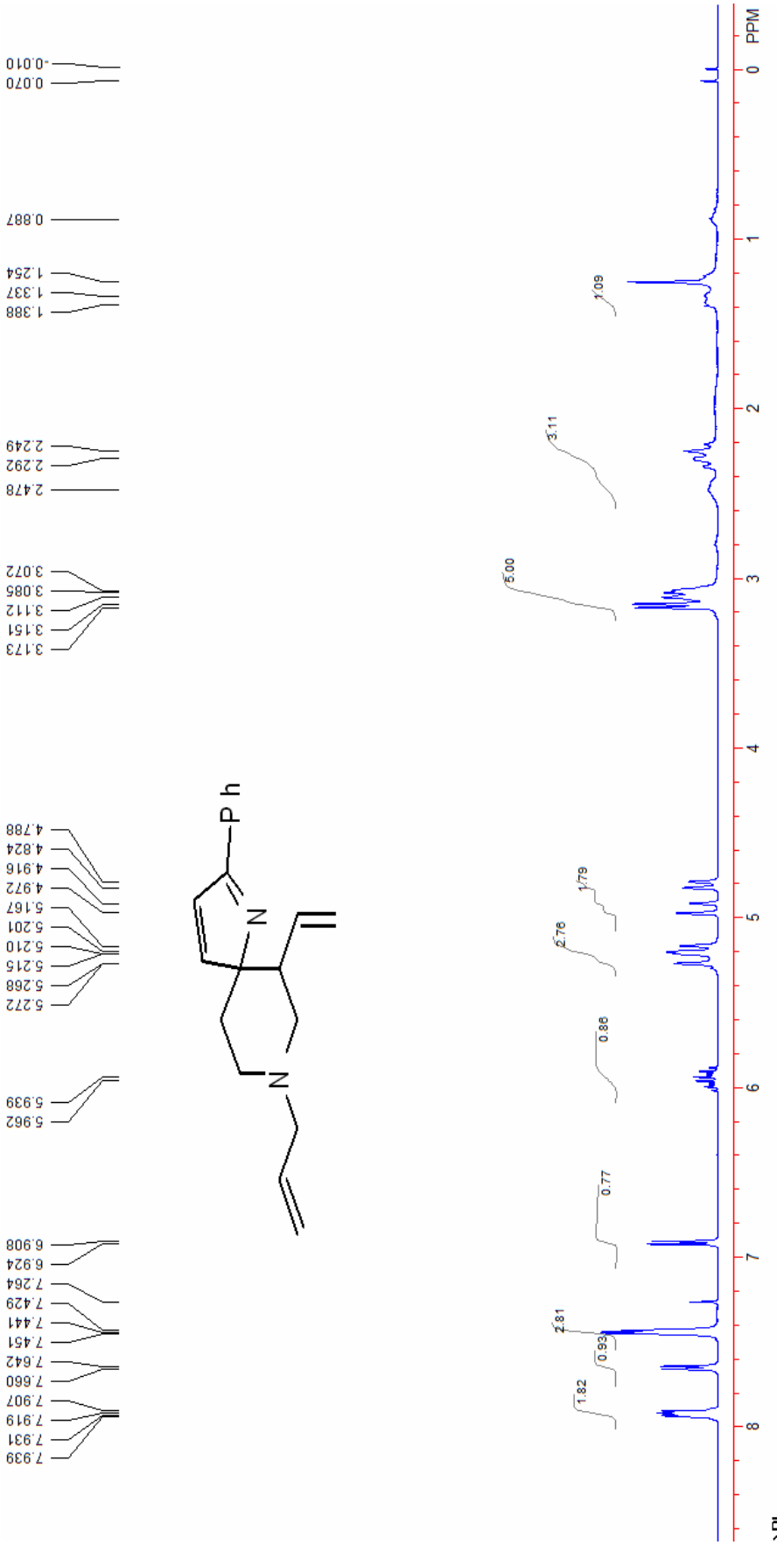
Peak No.	R. Time	Peak Height	Peak Area	Percent
1	5.015	340005.375	2938940.250	50.0110
2	11.132	110938.625	2937651.250	49.9890
Total		450944.000	5876591.500	100.0000

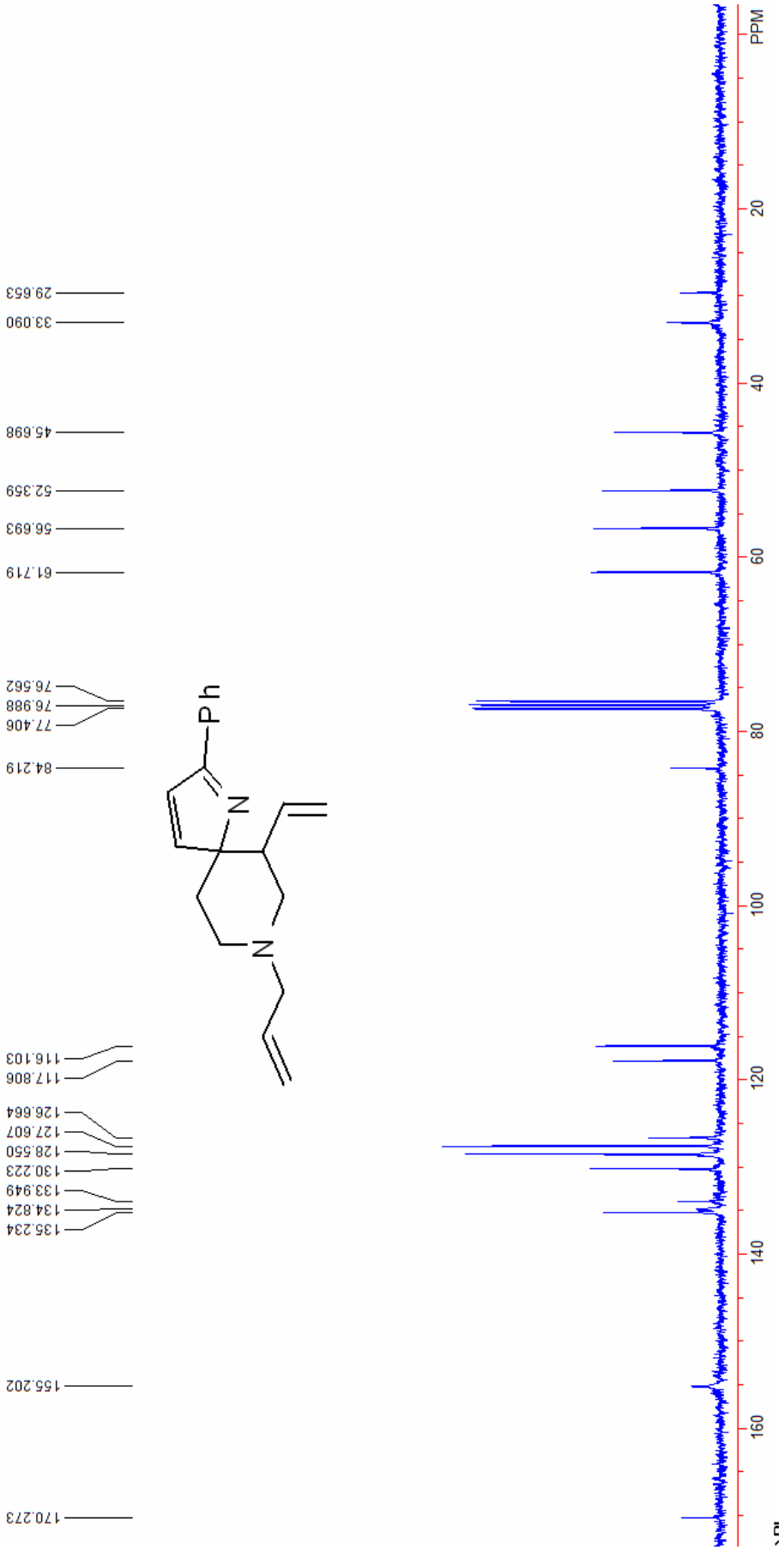


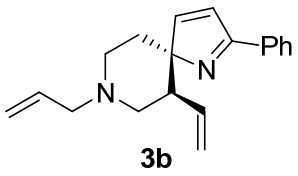
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		4.972	7574.522	68004.445	3.5214
2		10.817	75963.148	1863155.625	96.4786
Total			83537.670	1931160.070	100.0000

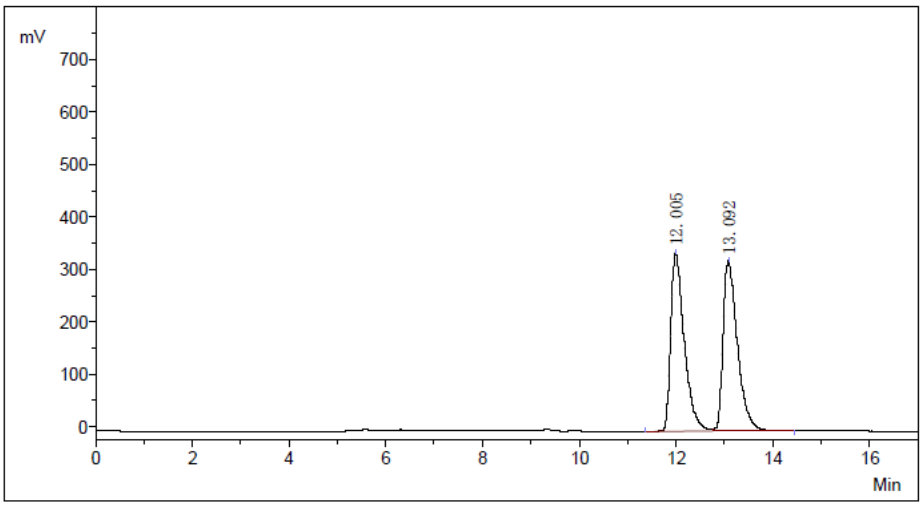
NMR Spectra and HPLC Spectra of **3b**



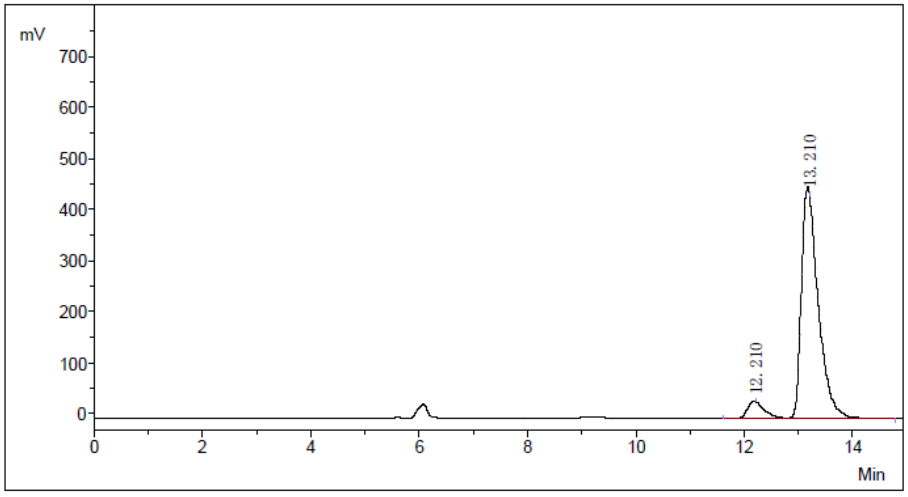




3b

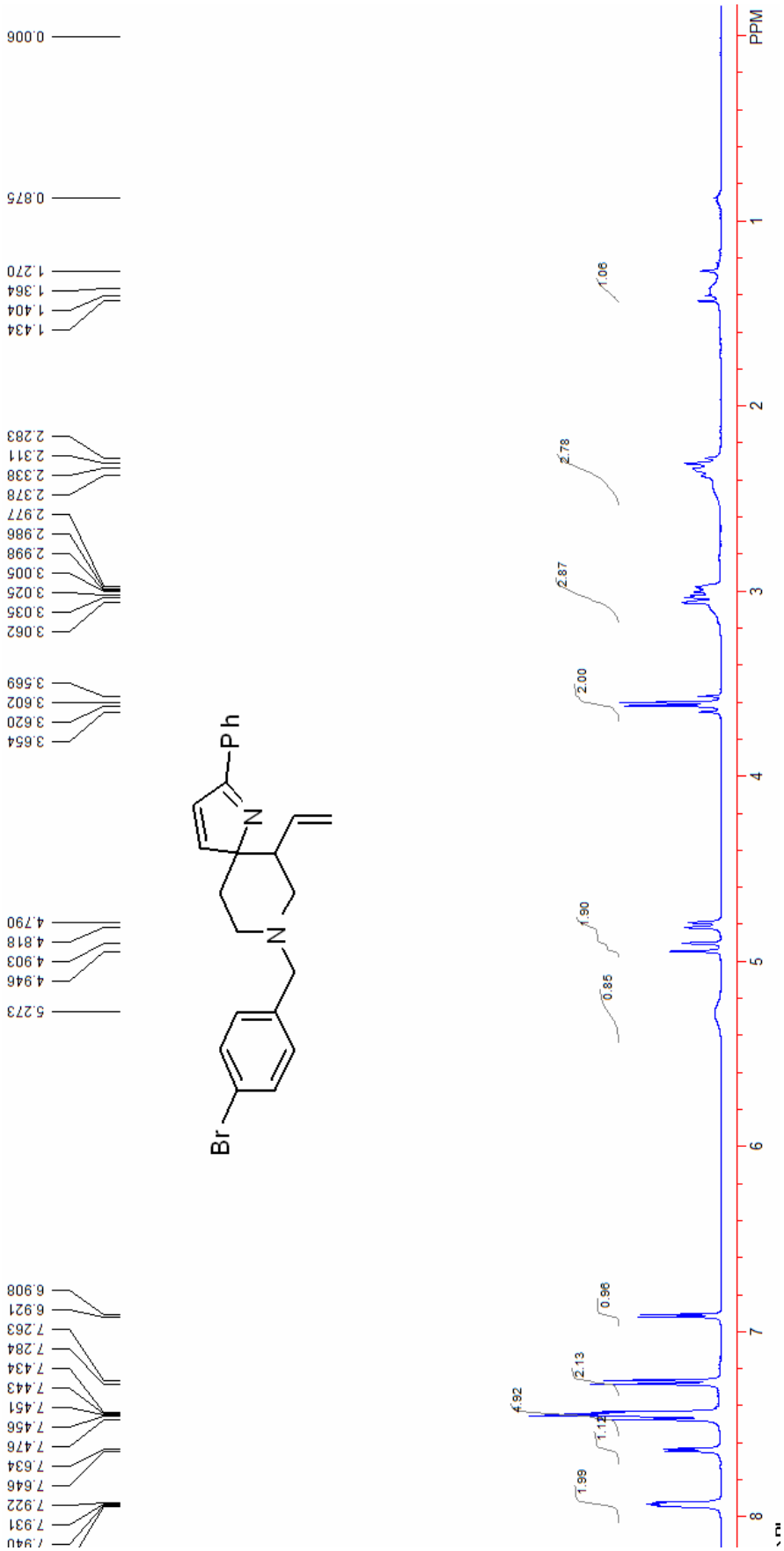


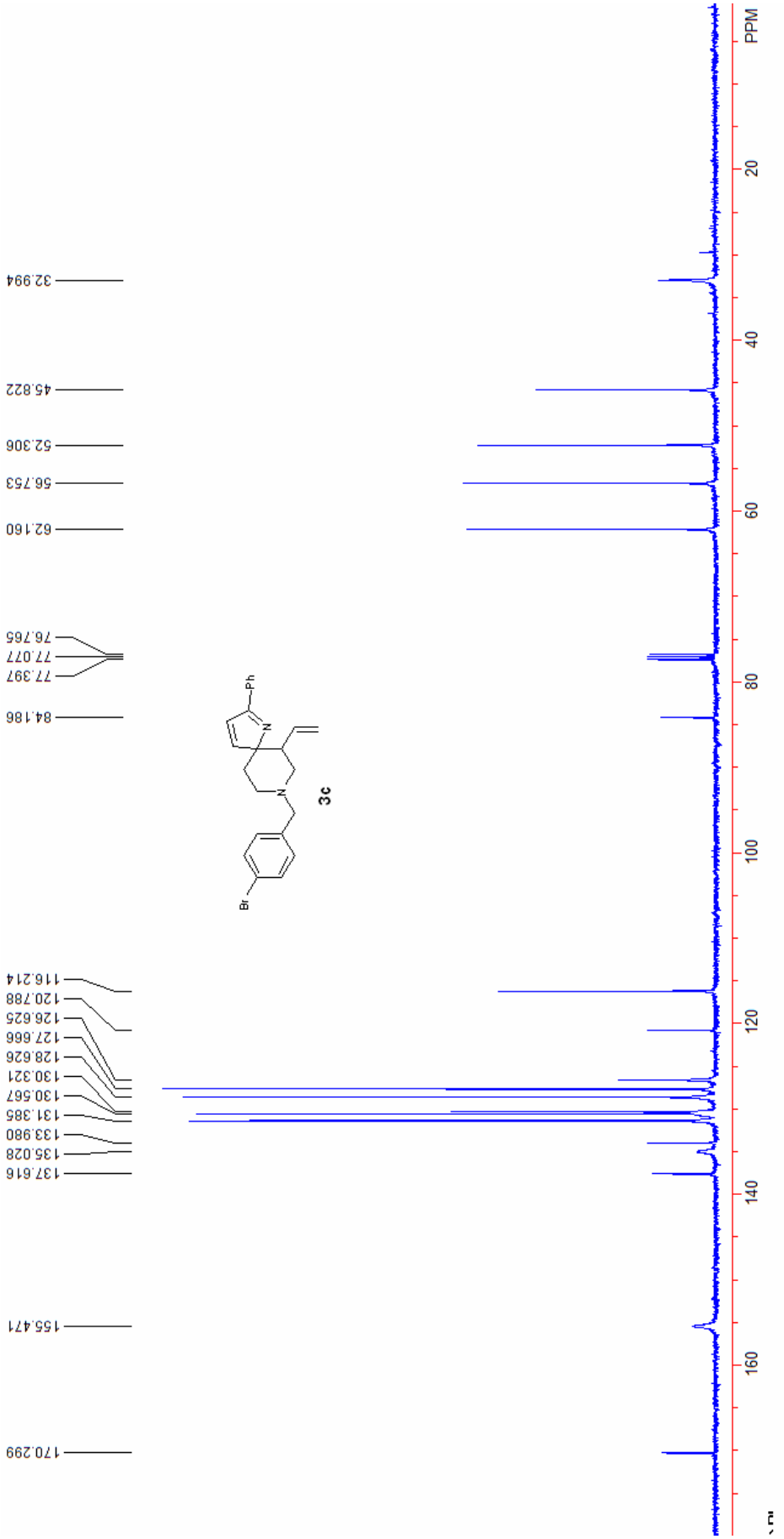
No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	12.005	340256.1	6635495.5	49.5479
2	2	Unknown	13.092	323838.8	6756584.9	50.4521
Total				664094.8	13392080.4	100.0000

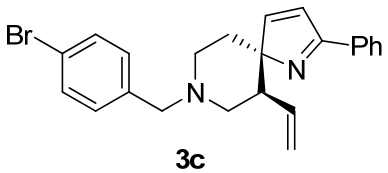


No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	12.210	33304.0	741890.6	7.0652
2	2	Unknown	13.210	438555.0	9758728.6	92.9348
Total				471859.0	10500619.2	100.0000

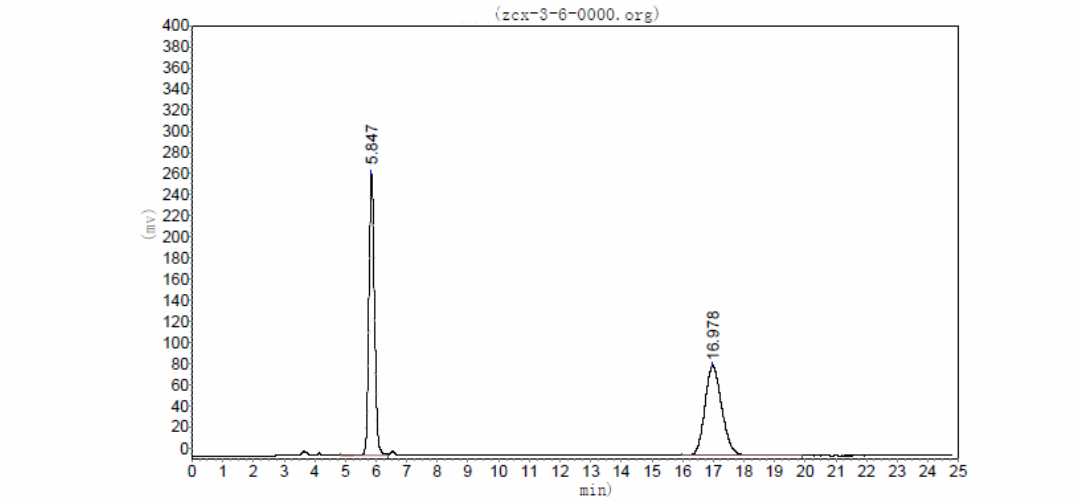
NMR Spectra and HPLC Spectra of **3c**



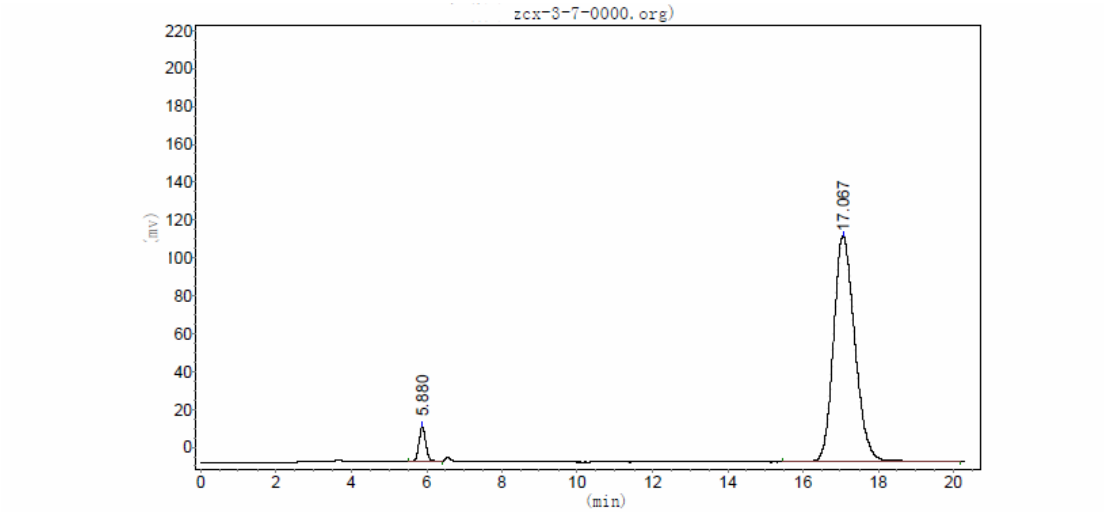

PPM
20
40
60
80
100
120
140
160
32.994
45.822
52.306
56.753
62.160
76.765
77.077
77.397
84.186
116.214
120.788
126.625
127.666
128.626
130.321
130.567
131.385
133.980
135.028
137.616
155.471
170.299
Ph
N
N
Br
3c



3c

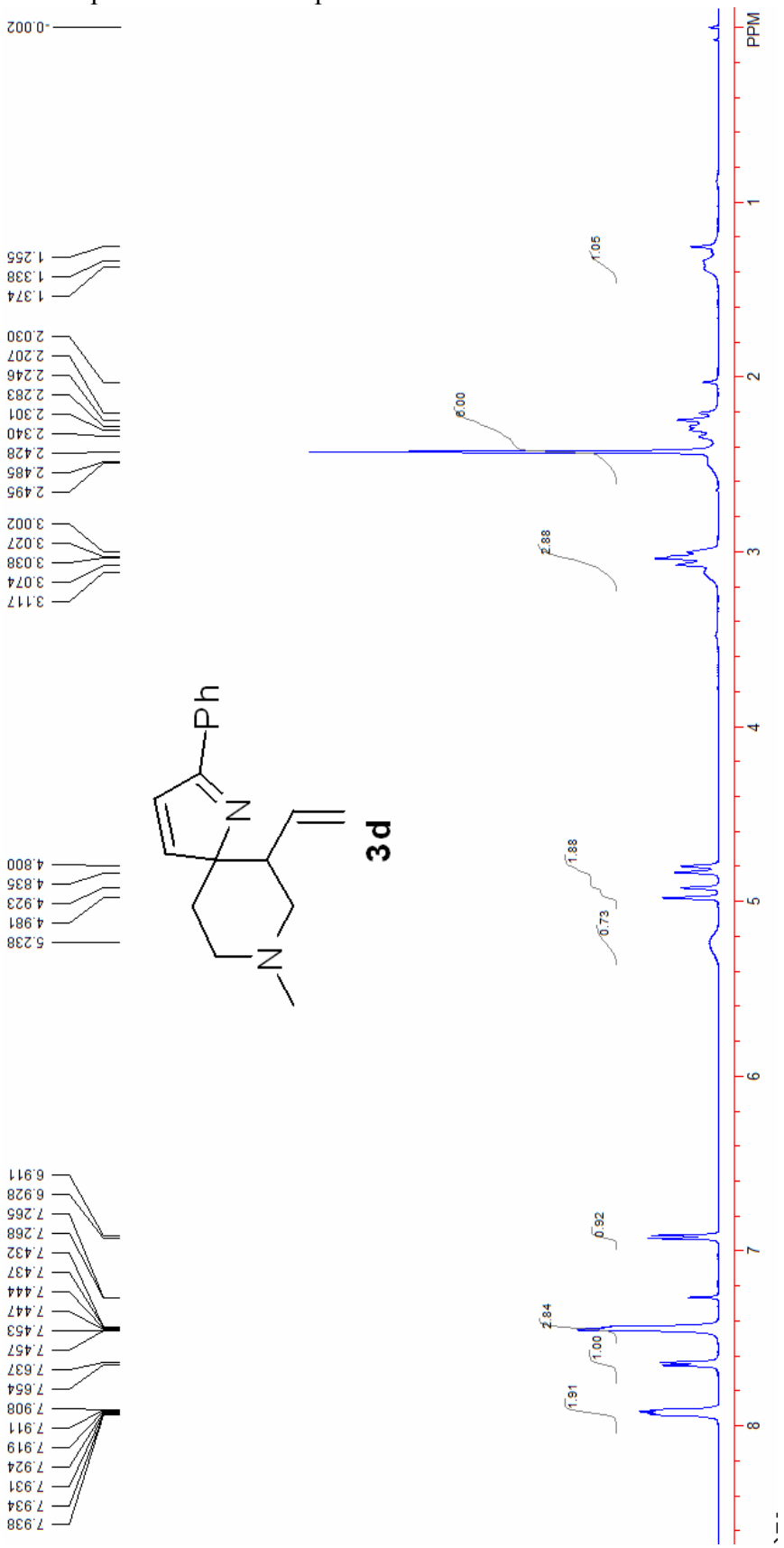


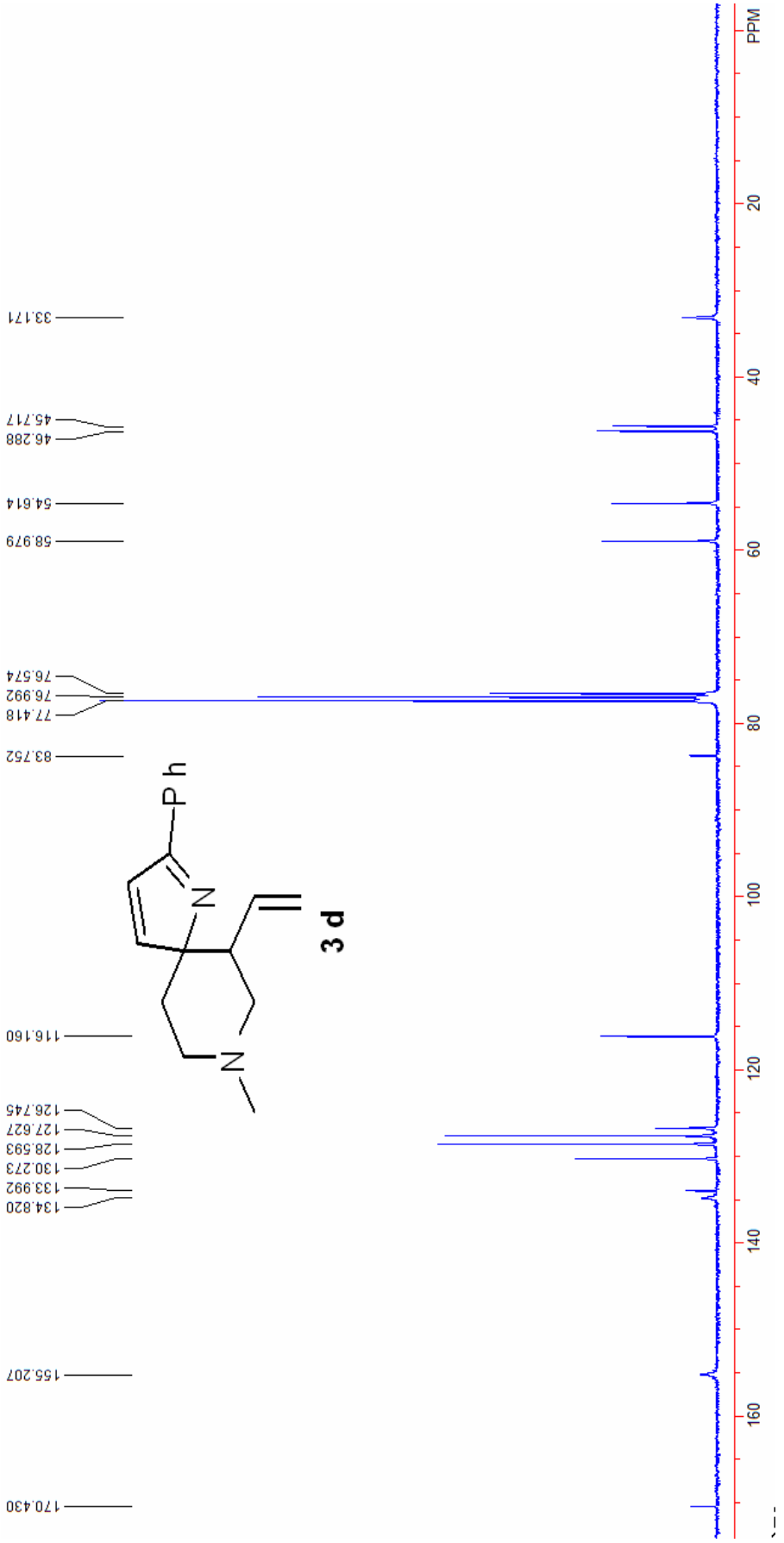
Peak No.	R. Time	Peak Height	Peak Area	Percent
1	5.847	266449.781	3297470.250	49.8699
2	16.978	85271.219	3314675.500	50.1301
Total		351721.000	6612145.750	100.0000

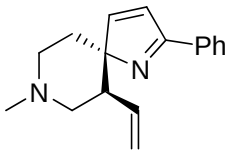


Peak No.	R. Time	Peak Height	Peak Area	Percent
1	5.880	18791.270	241995.672	4.9148
2	17.067	119367.594	4681839.500	95.0852
Total		138158.863	4923835.172	100.0000

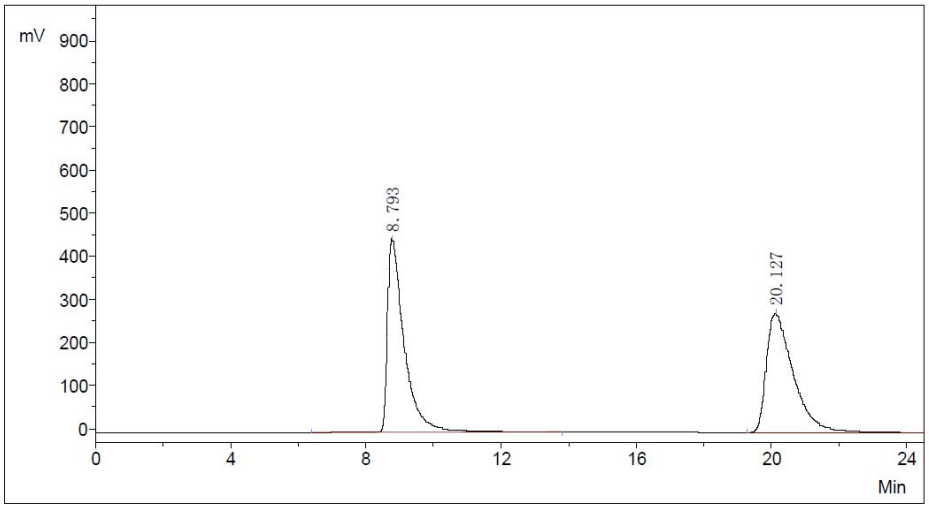
NMR Spectra and HPLC Spectra of **3d**



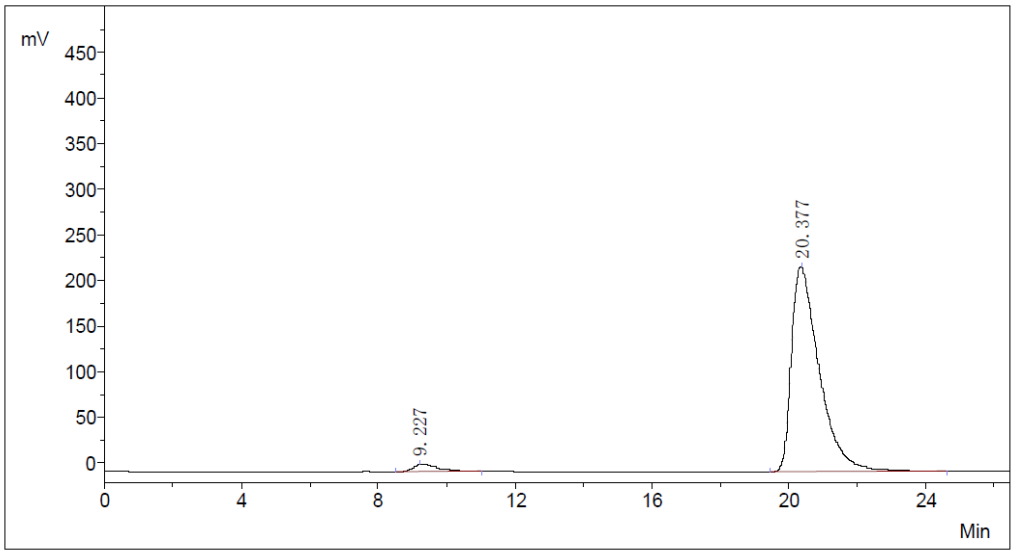

PPM
20
40
60
80
100
120
140
160
33.171
45.717
46.288
54.614
58.979
76.574
76.992
77.418
83.752
116.160
126.745
127.627
128.593
130.273
133.992
134.820
155.207
170.430
Ph
N
N
3 d



3d

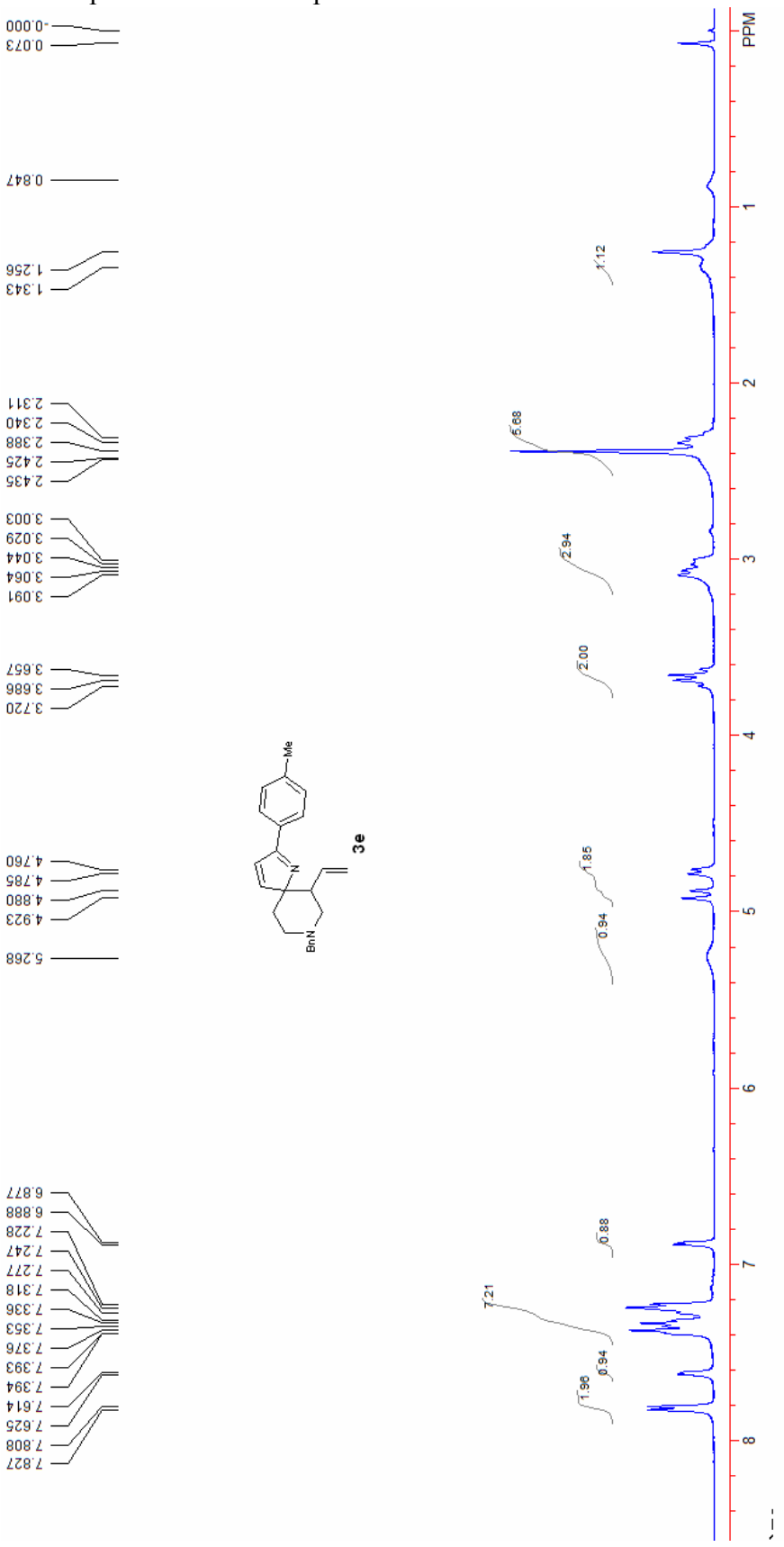


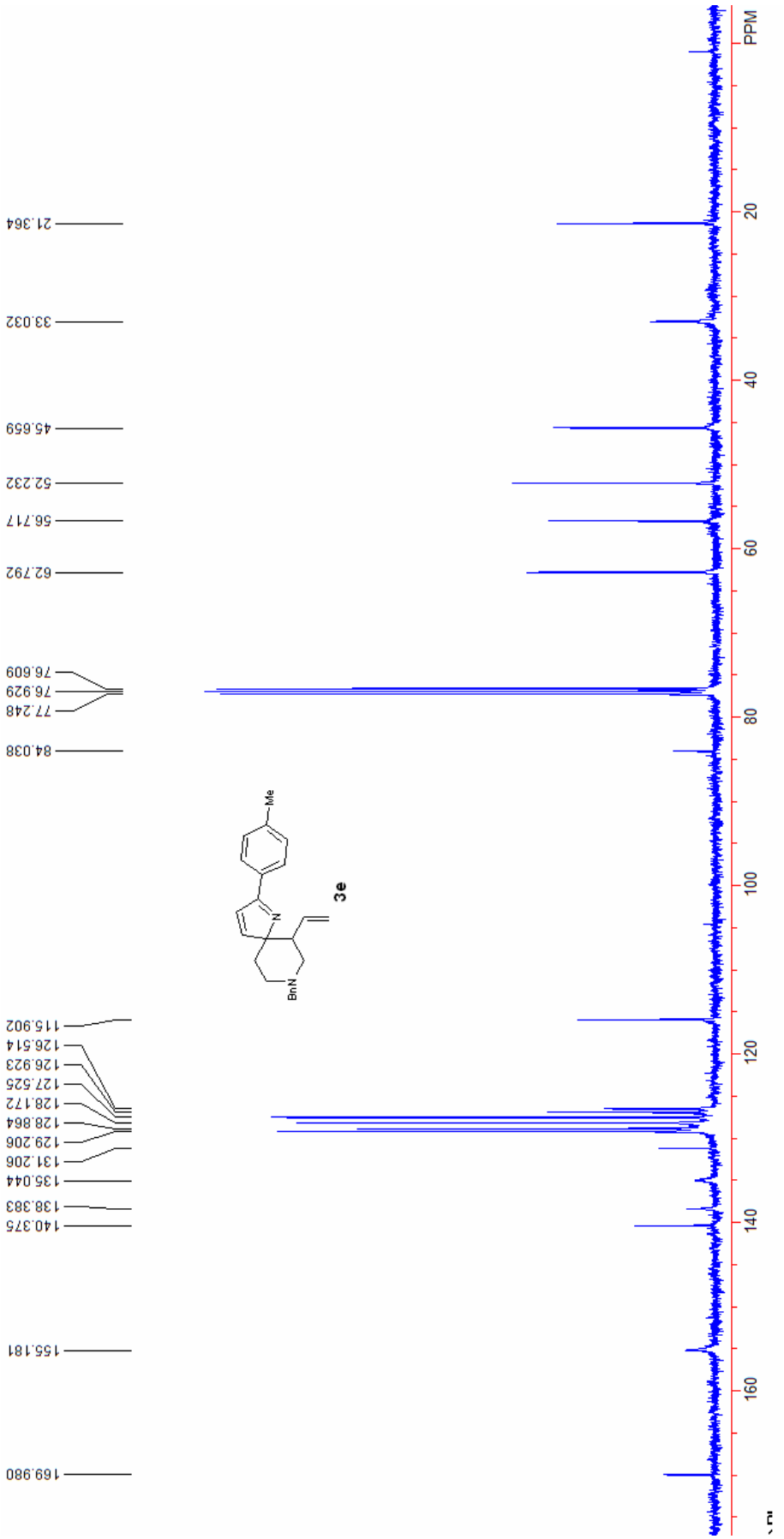
No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	8.793	447429.3	15575594.1	50.4314
2	2	Unknown	20.127	275851.3	15309141.7	49.5686
Total				723280.6	30884735.8	100.0000

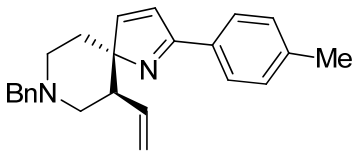


No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	9.227	8436.5	407453.5	3.1093
2	2	Unknown	20.377	224454.5	12696836.9	96.8907
Total				232891.0	13104290.4	100.0000

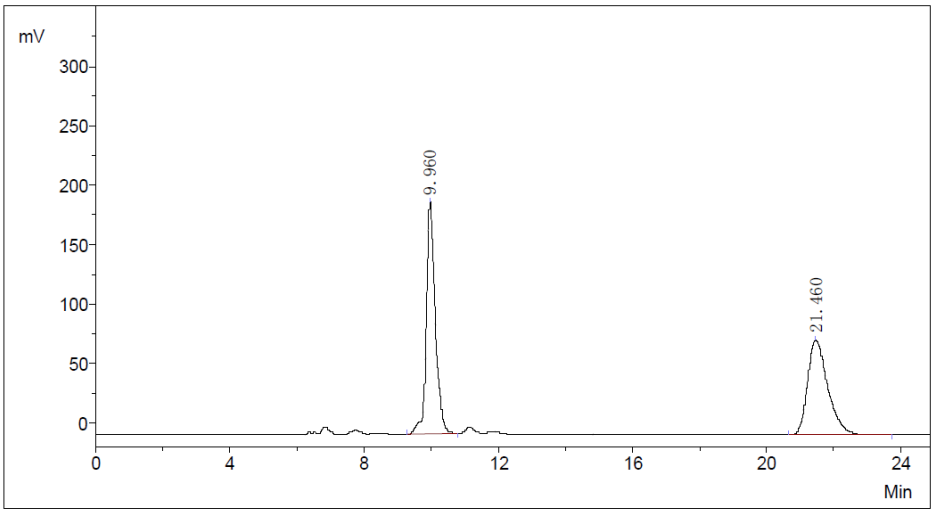
NMR Spectra and HPLC Spectra of **3e**



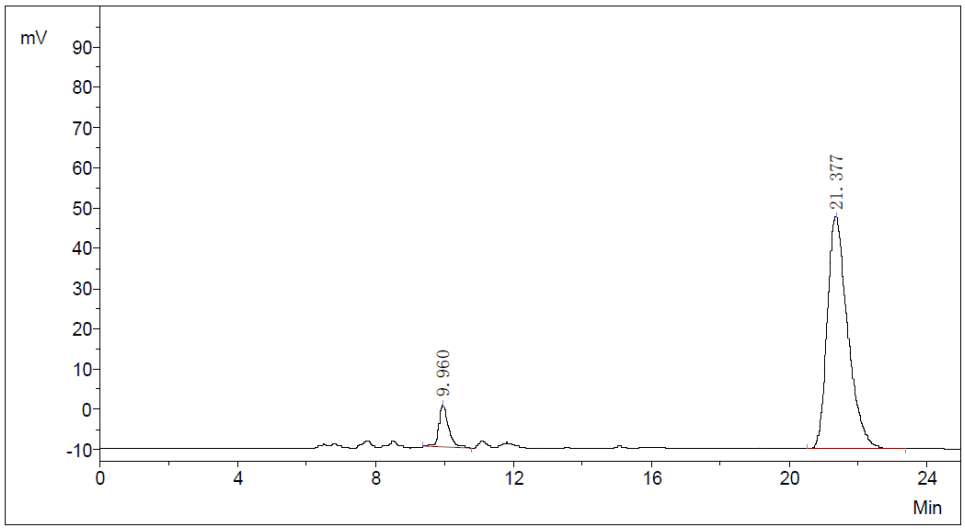




3e

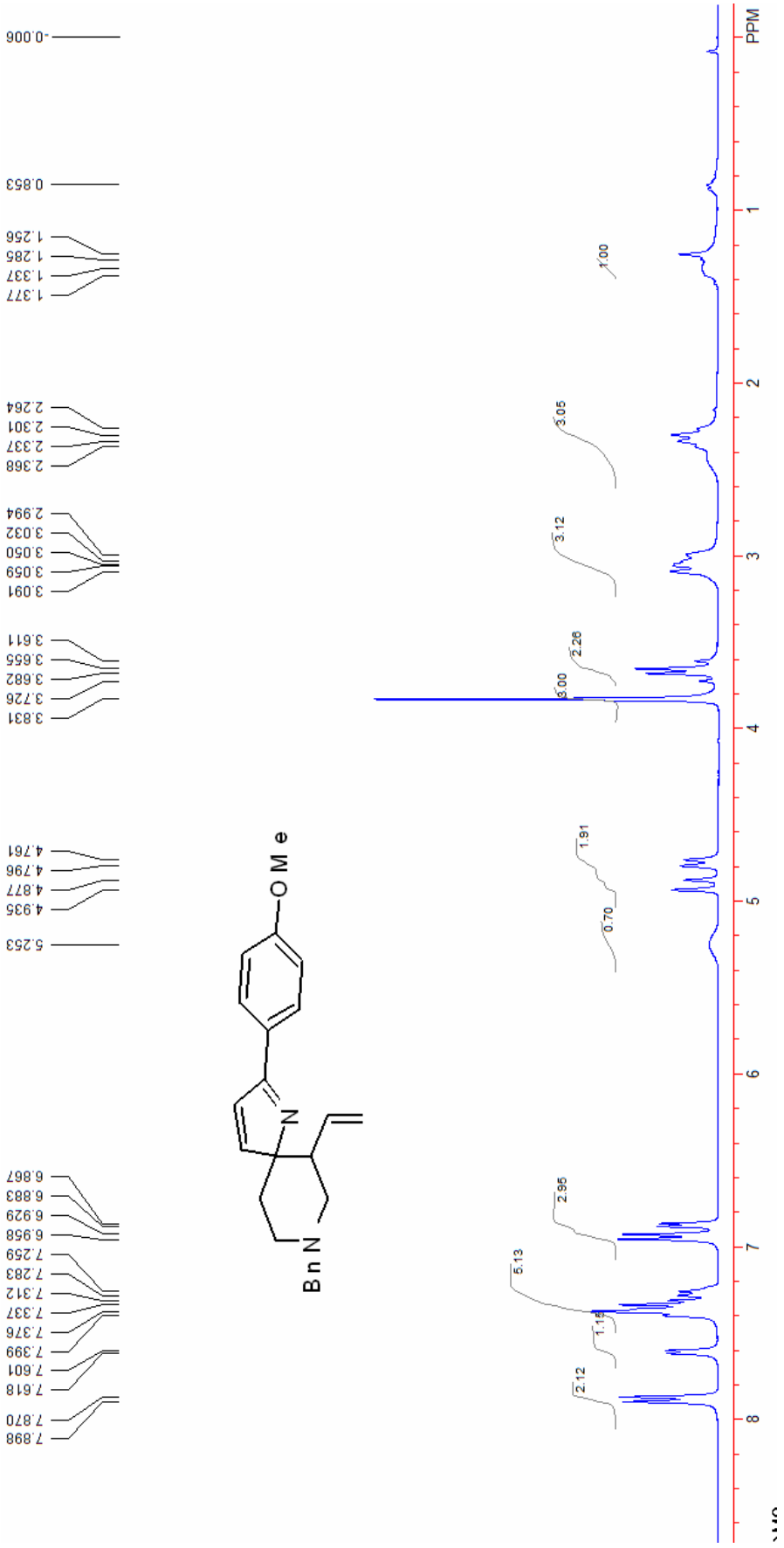


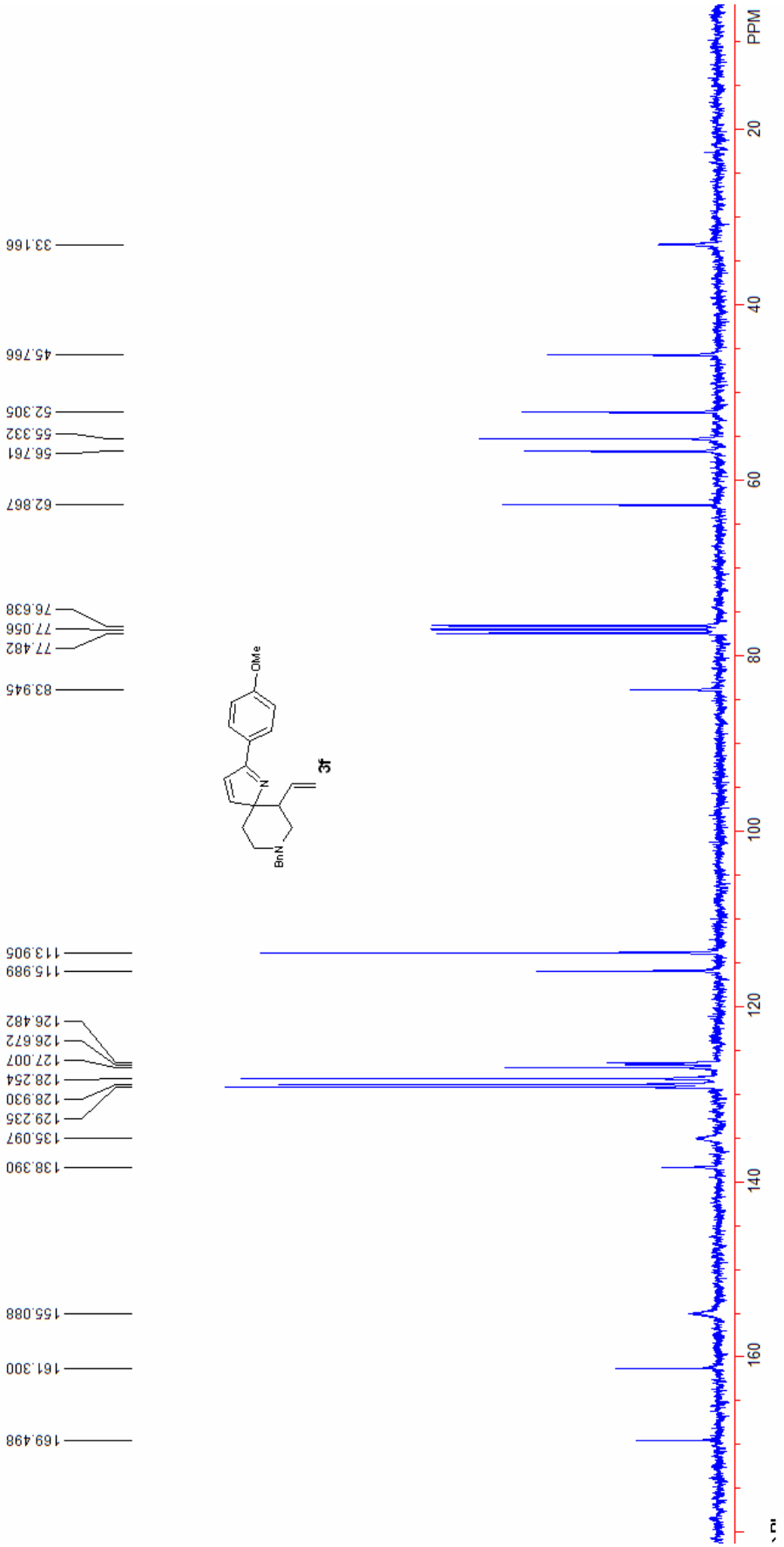
No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	9.960	193981.6	3585739.8	51.9907
2	2	Unknown	21.460	79555.1	3311148.0	48.0093
Total				273536.7	6896887.8	100.0000

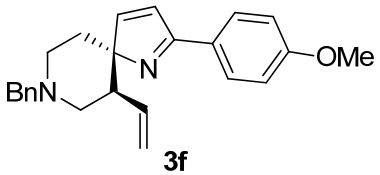


No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	9.960	10414.4	202102.1	7.8136
2	2	Unknown	21.377	57490.4	2384449.9	92.1864
Total				67904.8	2586552.0	100.0000

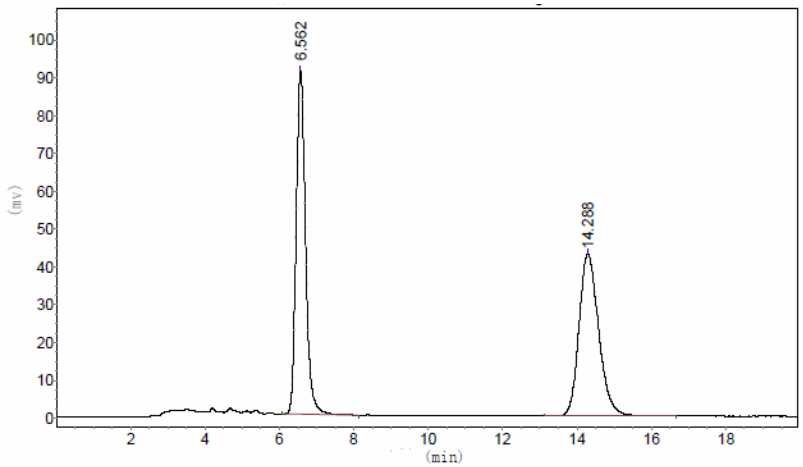
NMR Spectra and HPLC Spectra of **3f**



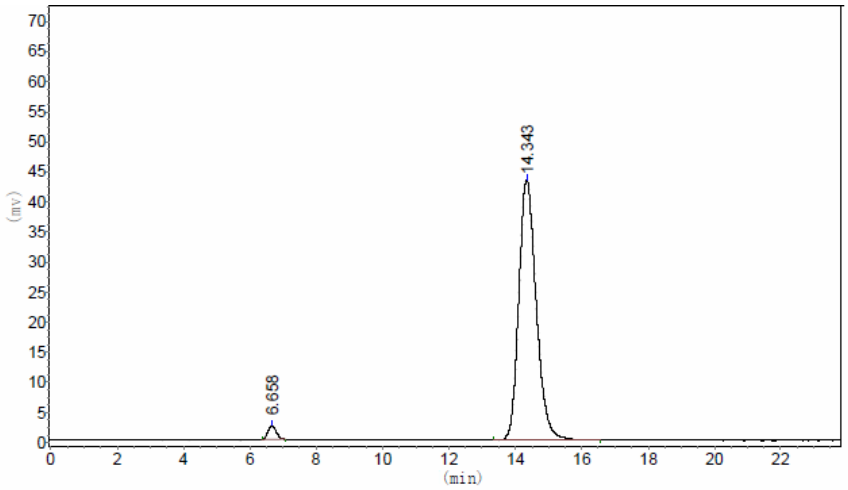




3f

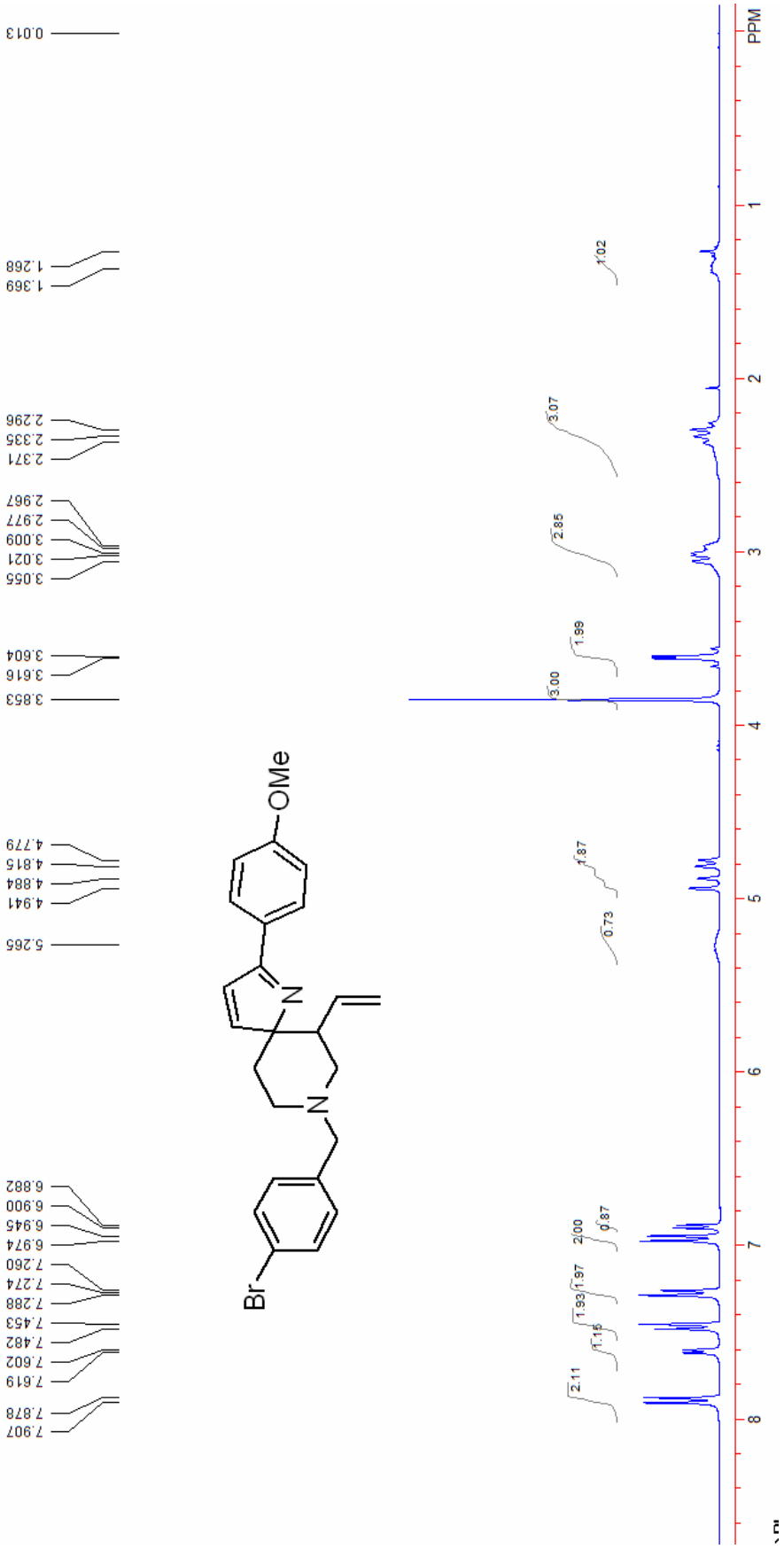


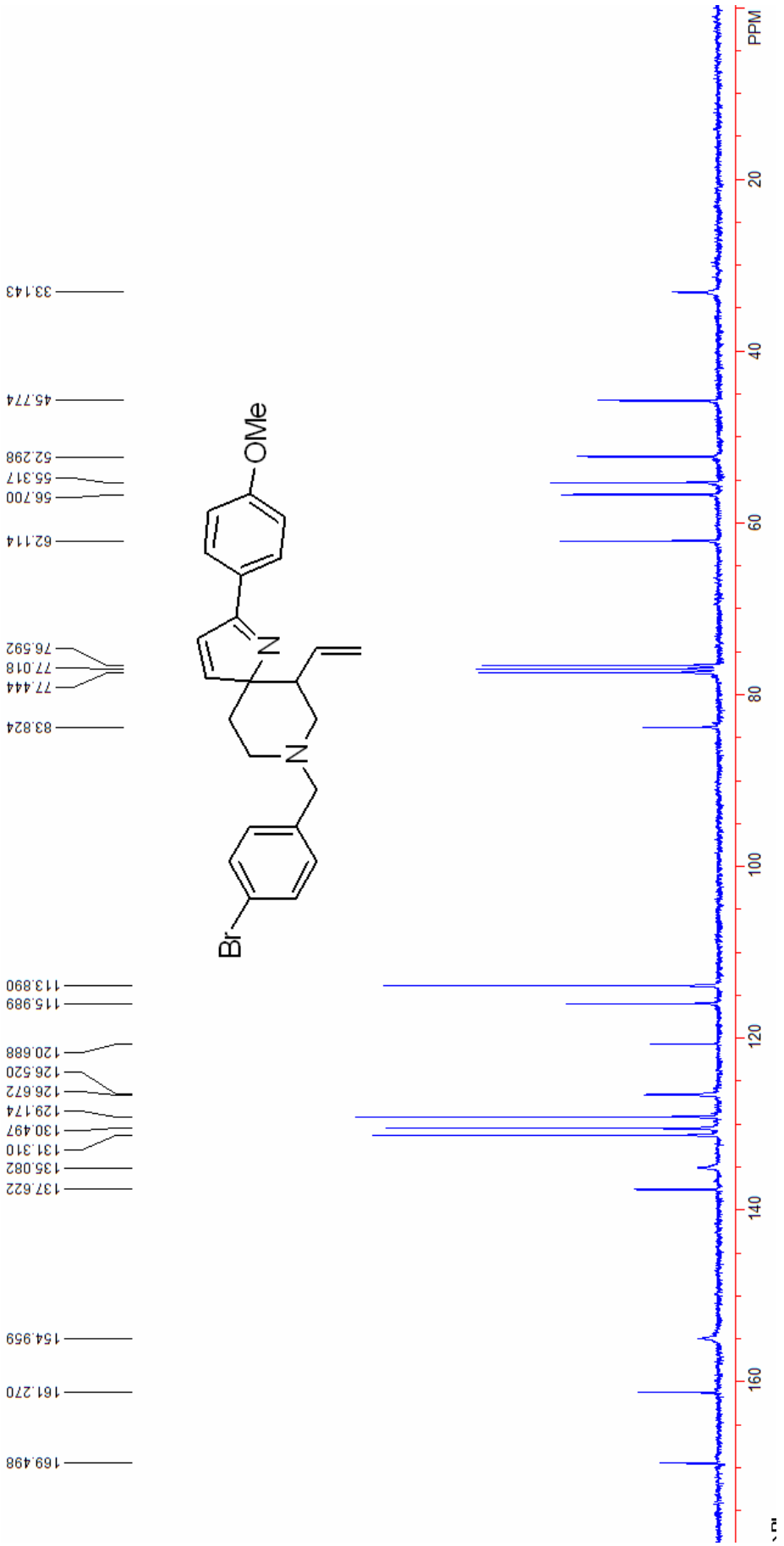
Peak No.	R. Time	Peak Height	Peak Area	Percent
1	6.562	91235.070	1595230.250	50.0635
2	14.288	43046.316	1591185.000	49.9365
Total		134281.387	3186415.250	100.0000

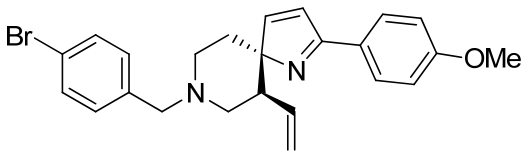


Peak No.	R. Time	Peak Height	Peak Area	Percent
1	6.658	2359.758	39910.699	2.4667
2	14.343	43305.121	1578065.875	97.5333
Total		45664.879	1617976.574	100.0000

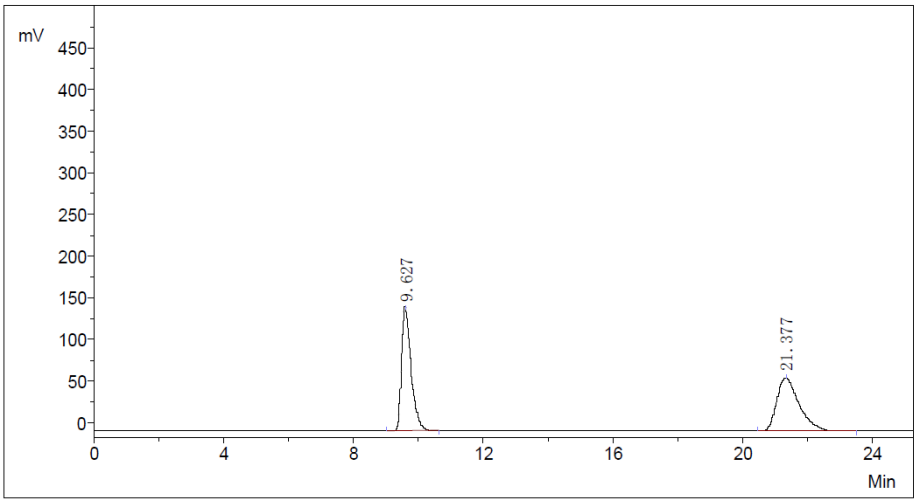
NMR Spectra and HPLC Spectra of **3g**



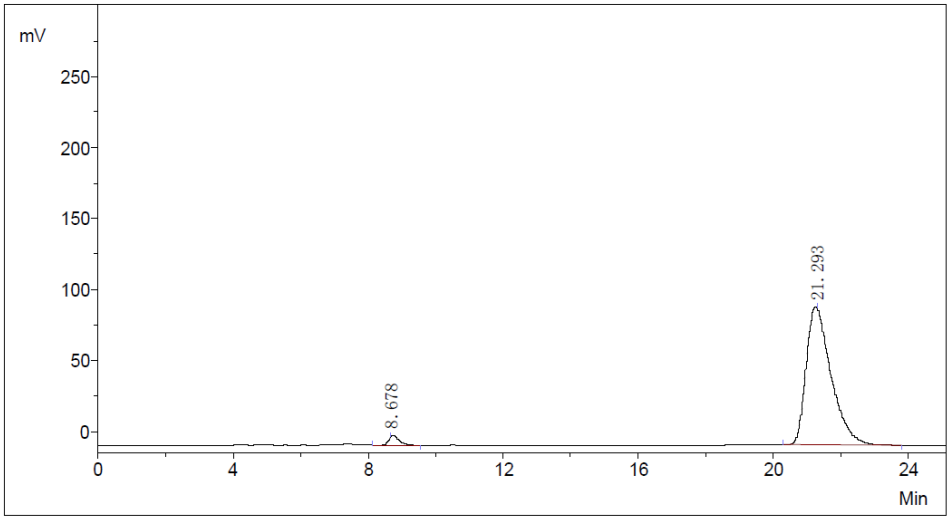

33.143
45.774
52.298
55.317
56.700
62.114
76.592
77.018
77.444
83.824
113.890
115.989
120.688
126.520
126.672
129.174
130.497
131.310
135.082
137.622
154.959
161.270
169.498
OMe
Br
N
N
PPM
20
40
60
80
100
120
140
160



3g

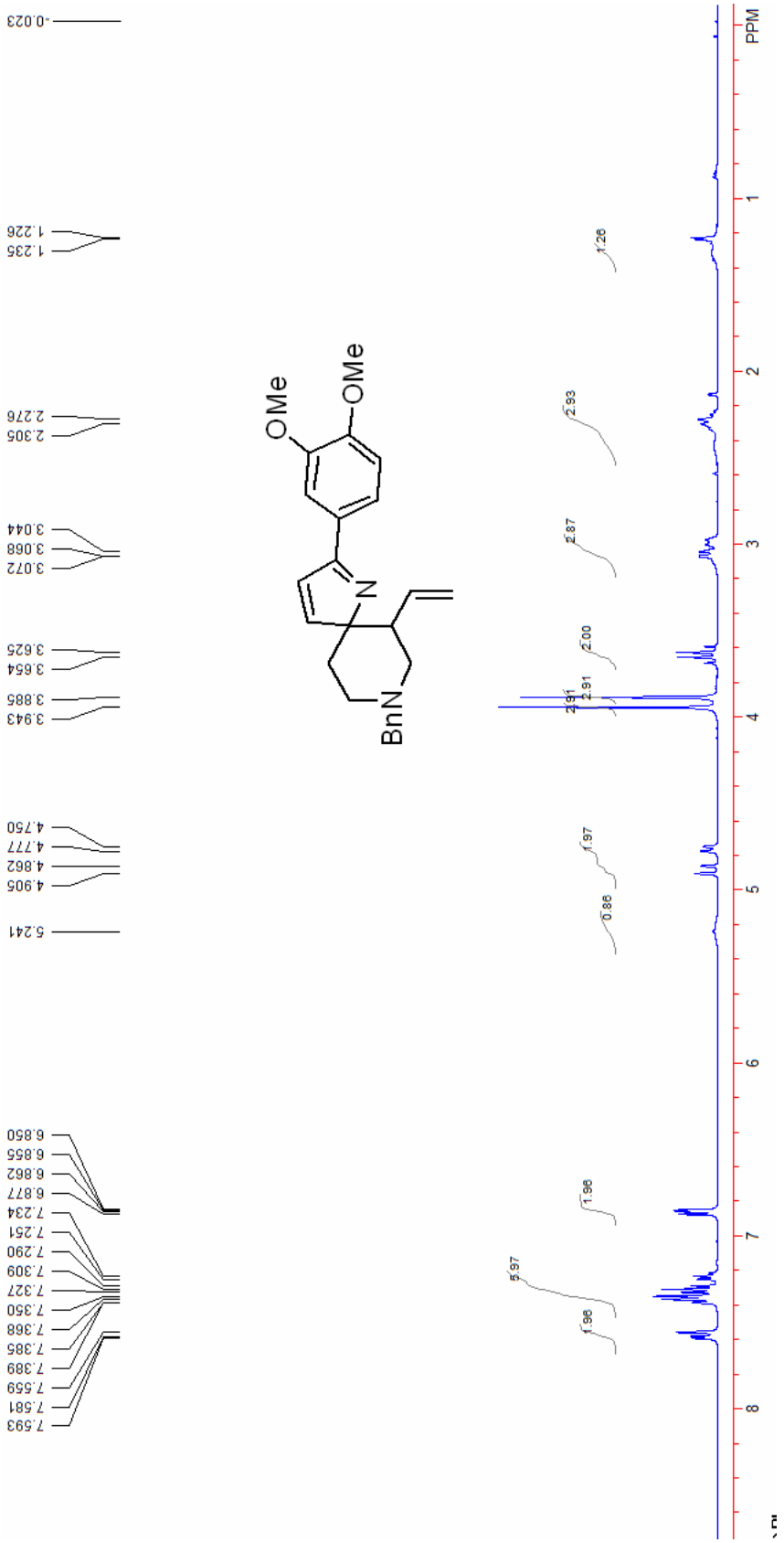


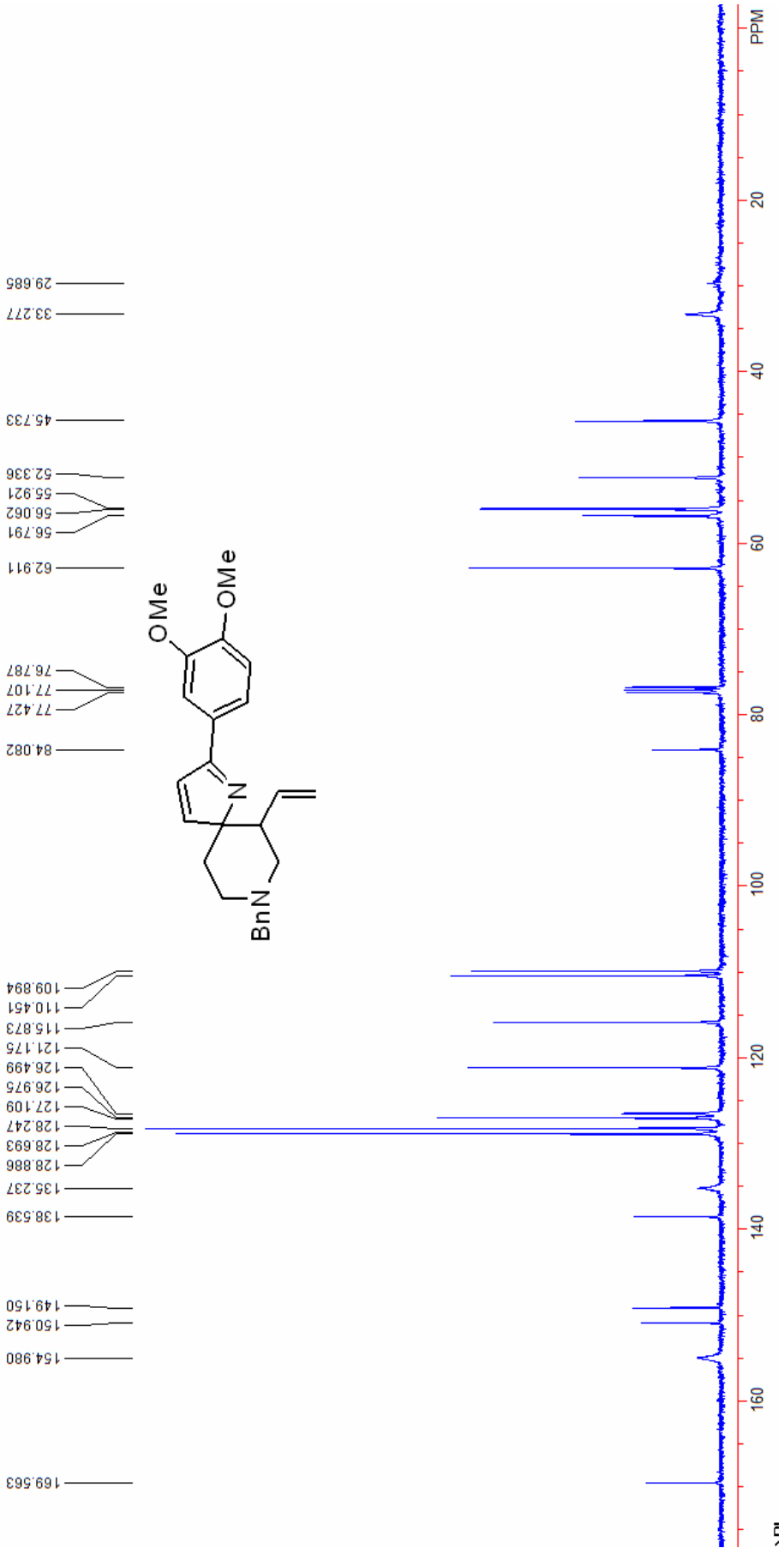
No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	9.627	145639.1	3053137.3	49.8282
2	2	Unknown	21.377	63532.6	3074185.6	50.1718
Total				209171.7	6127322.9	100.0000

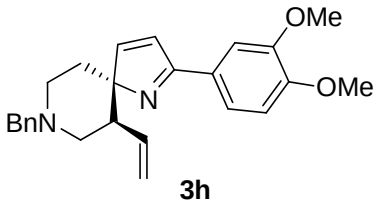


No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	8.678	5705.4	135209.4	2.6503
2	2	Unknown	21.293	96233.6	4966489.1	97.3497
Total				101939.0	5101698.5	100.0000

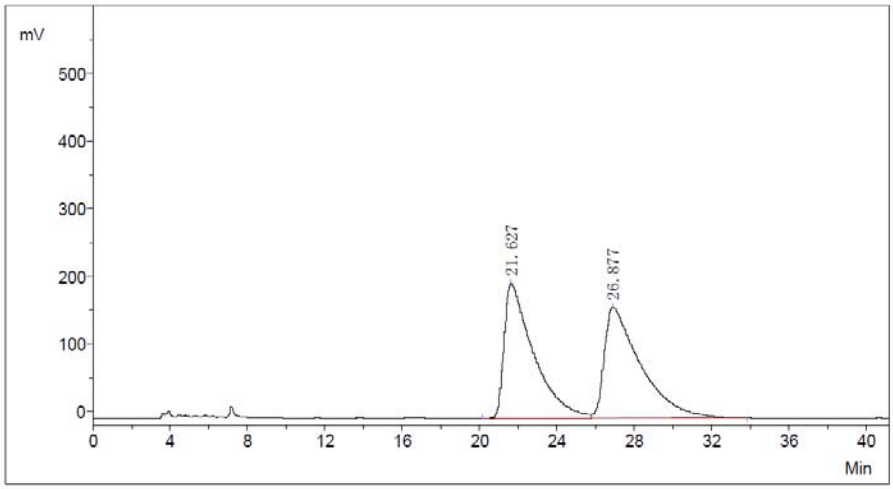
NMR Spectra and HPLC Spectra of **3h**



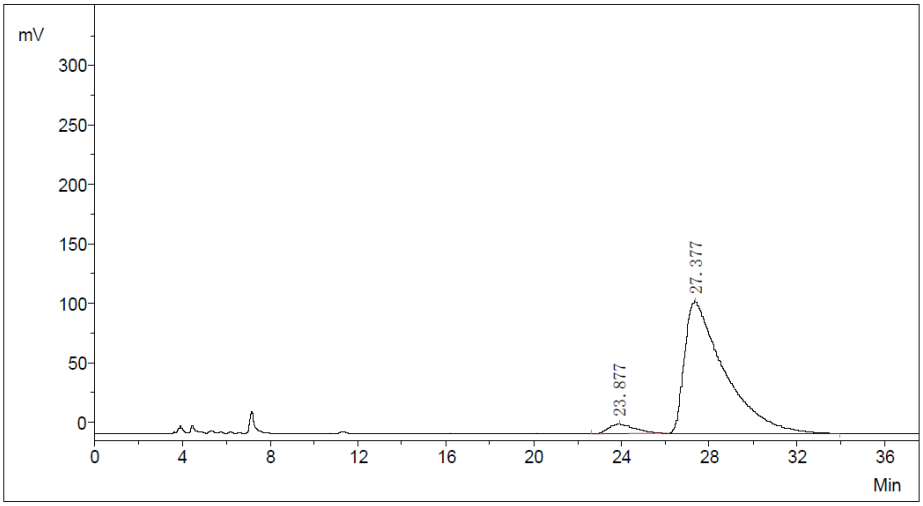




3h

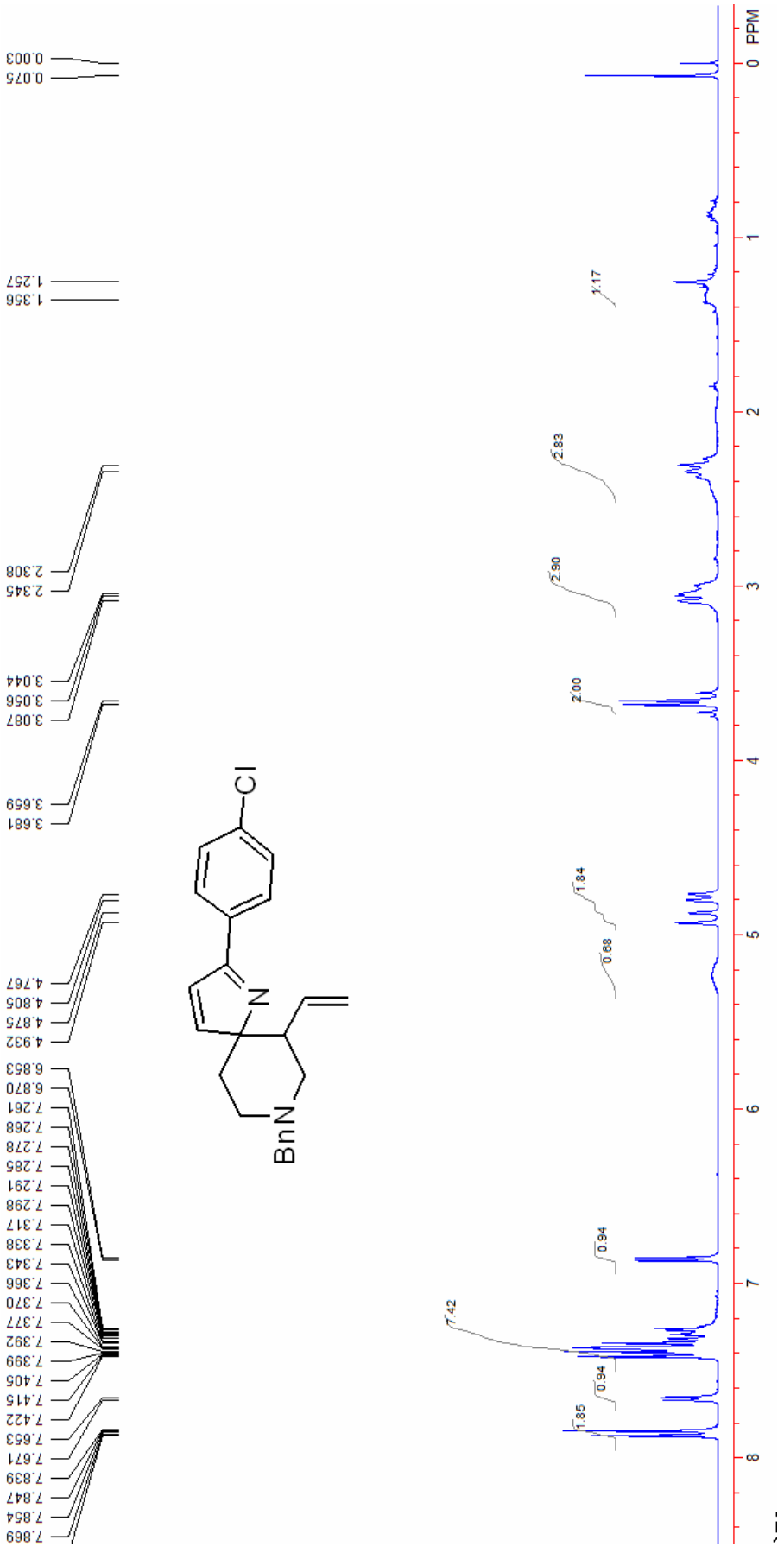


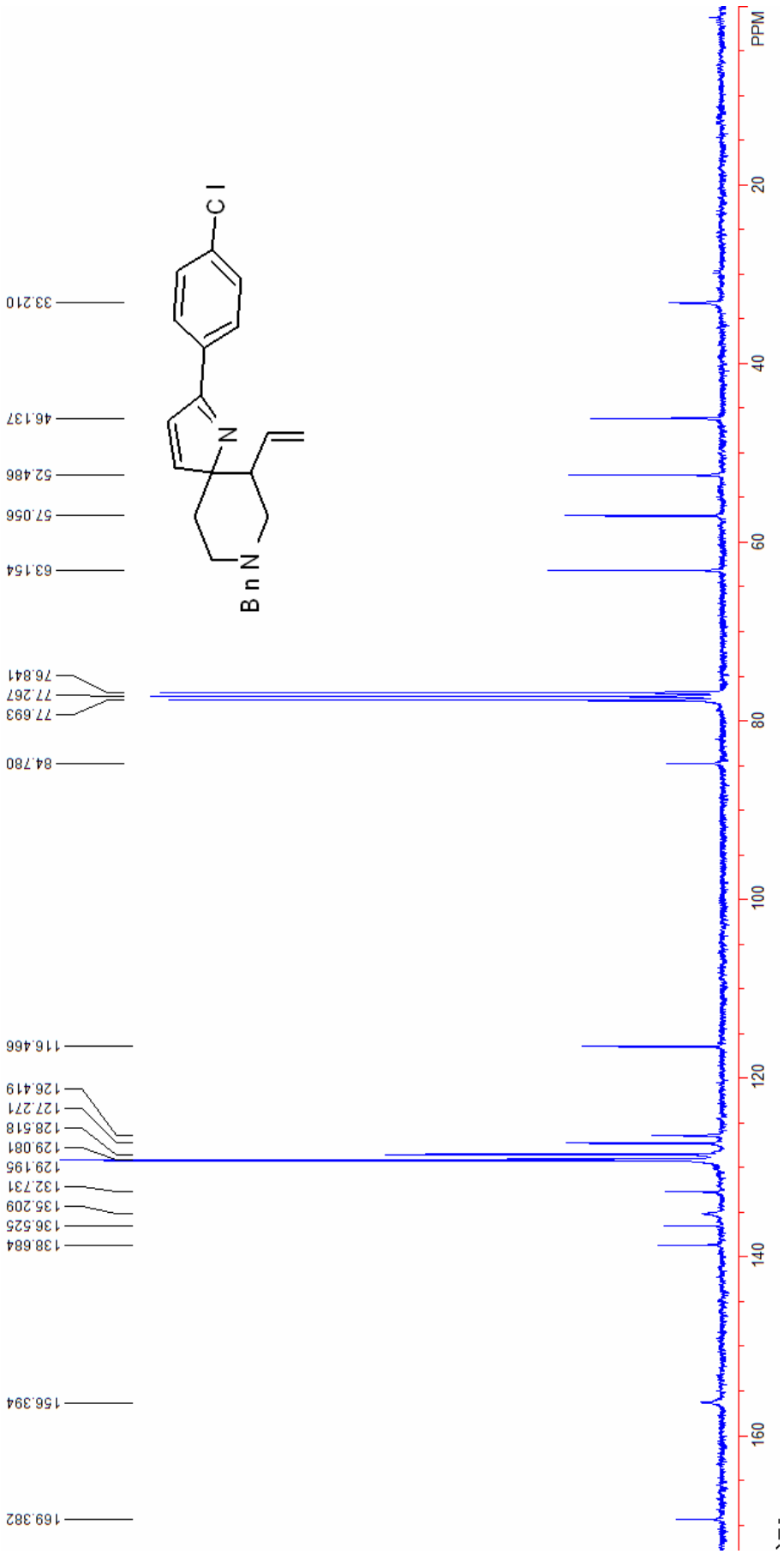
No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	21.627	199793.2	21010160.2	49.7160
2	2	Unknown	26.877	163617.4	21250161.2	50.2840
Total				363410.6	42260321.4	100.0000

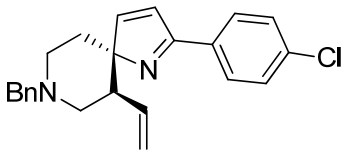


No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	23.877	7841.8	694302.9	4.7302
2	2	Unknown	27.377	110515.3	13983800.4	95.2698
Total				118357.1	14678103.3	100.0000

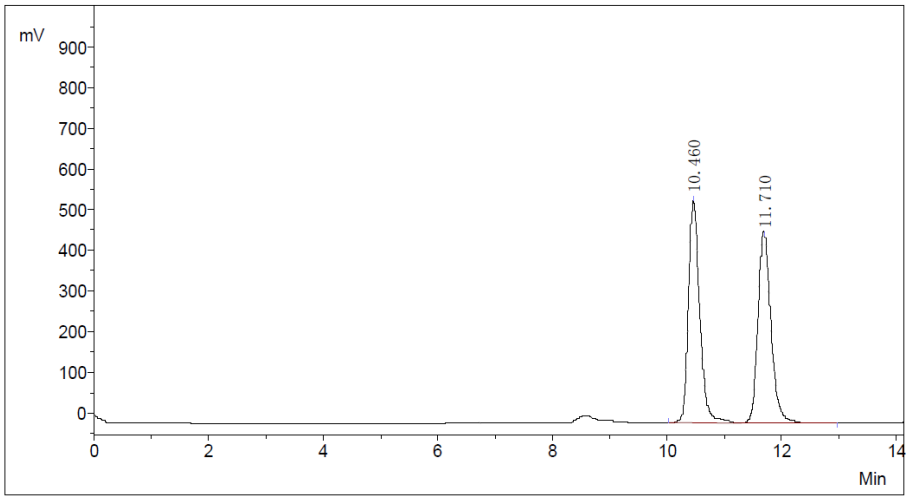
NMR Spectra and HPLC Spectra of **3i**



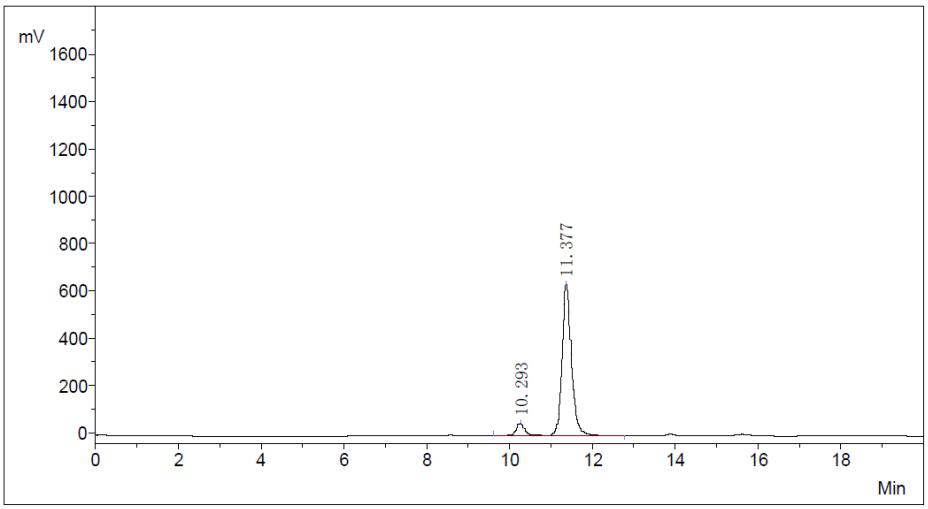




3i

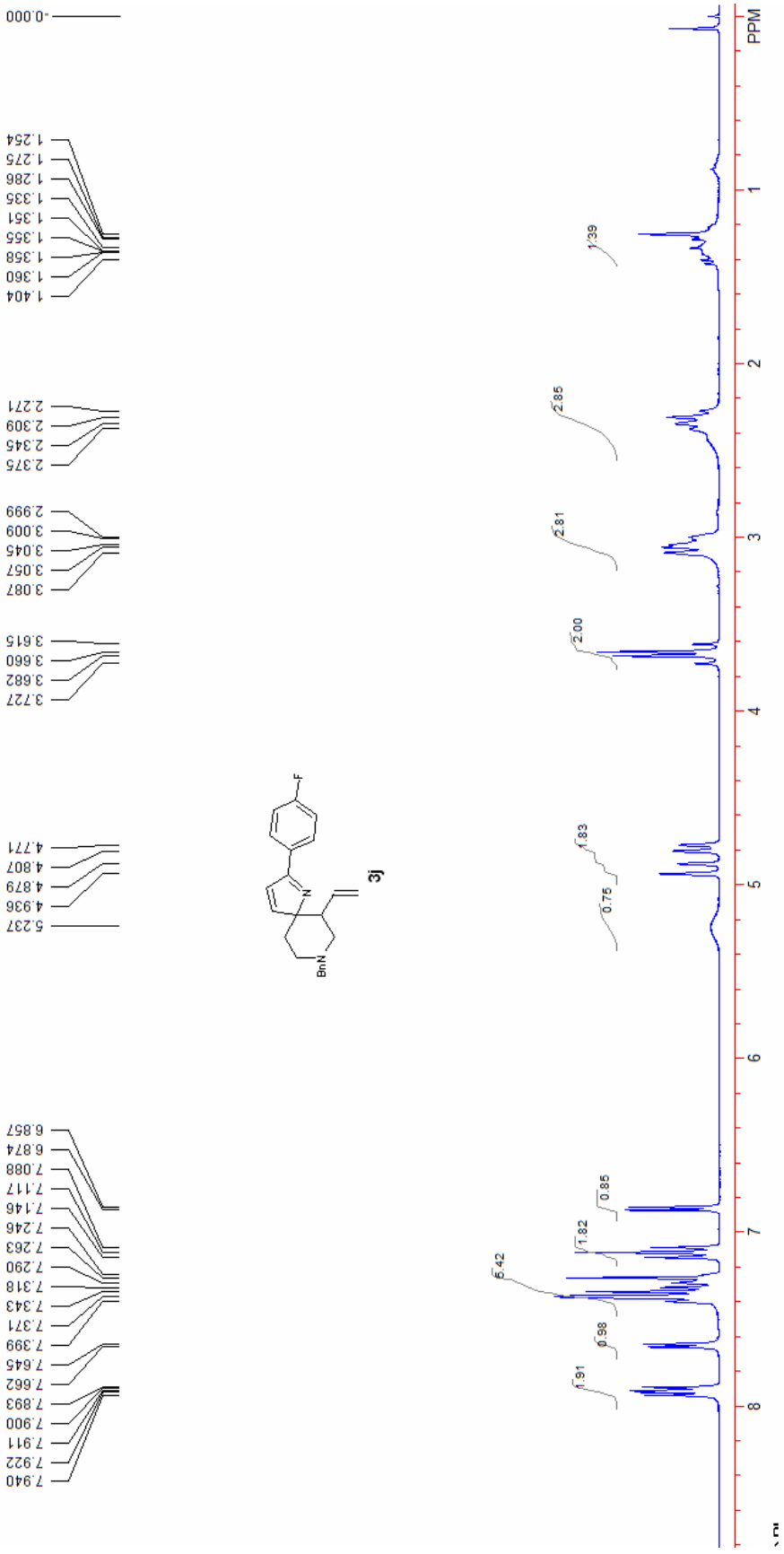


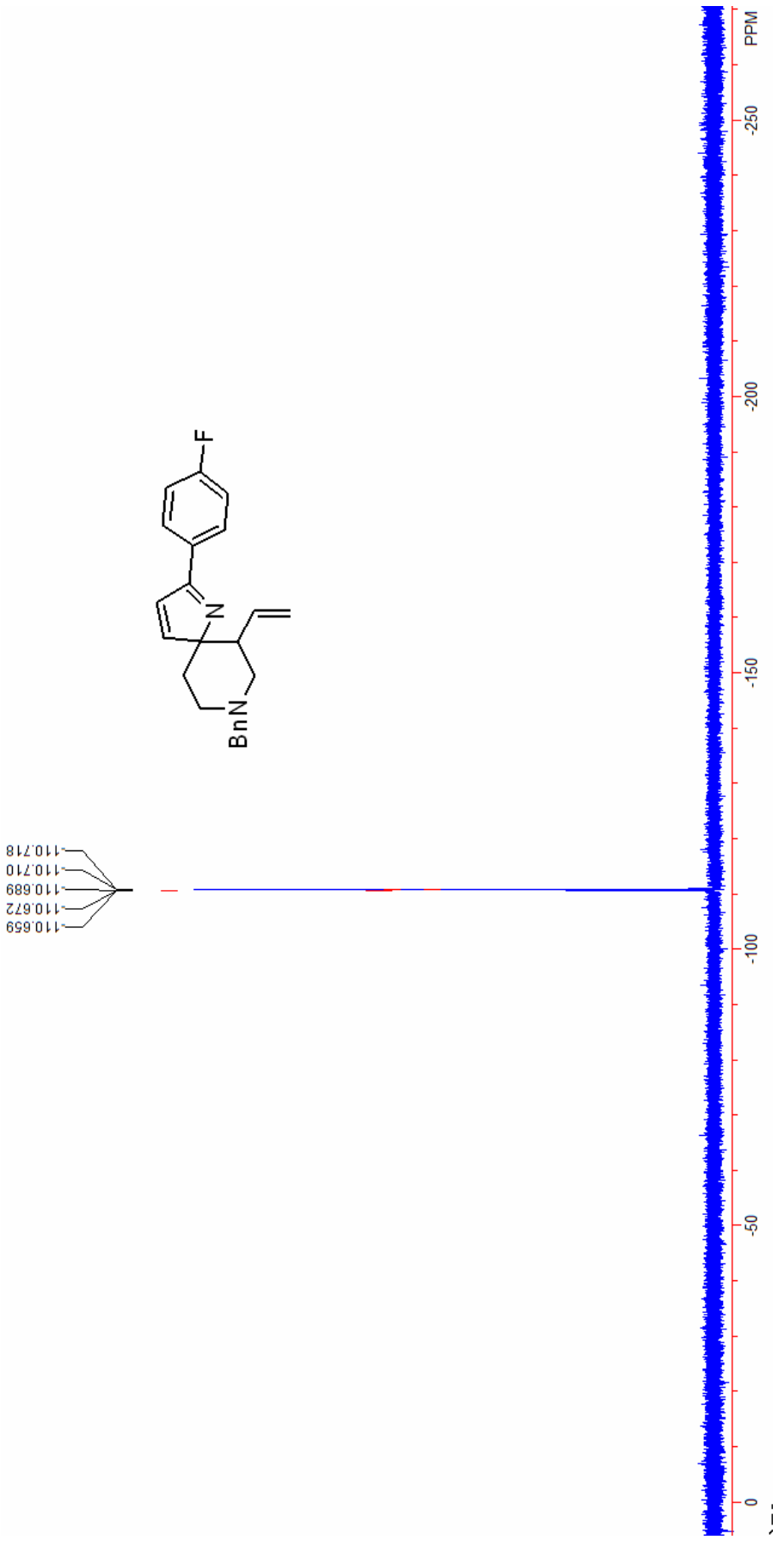
No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	10.460	545520.8	7521739.9	50.1769
2	2	Unknown	11.710	459842.5	7468703.6	49.8231
Total				1005363.3	14990443.5	100.0000

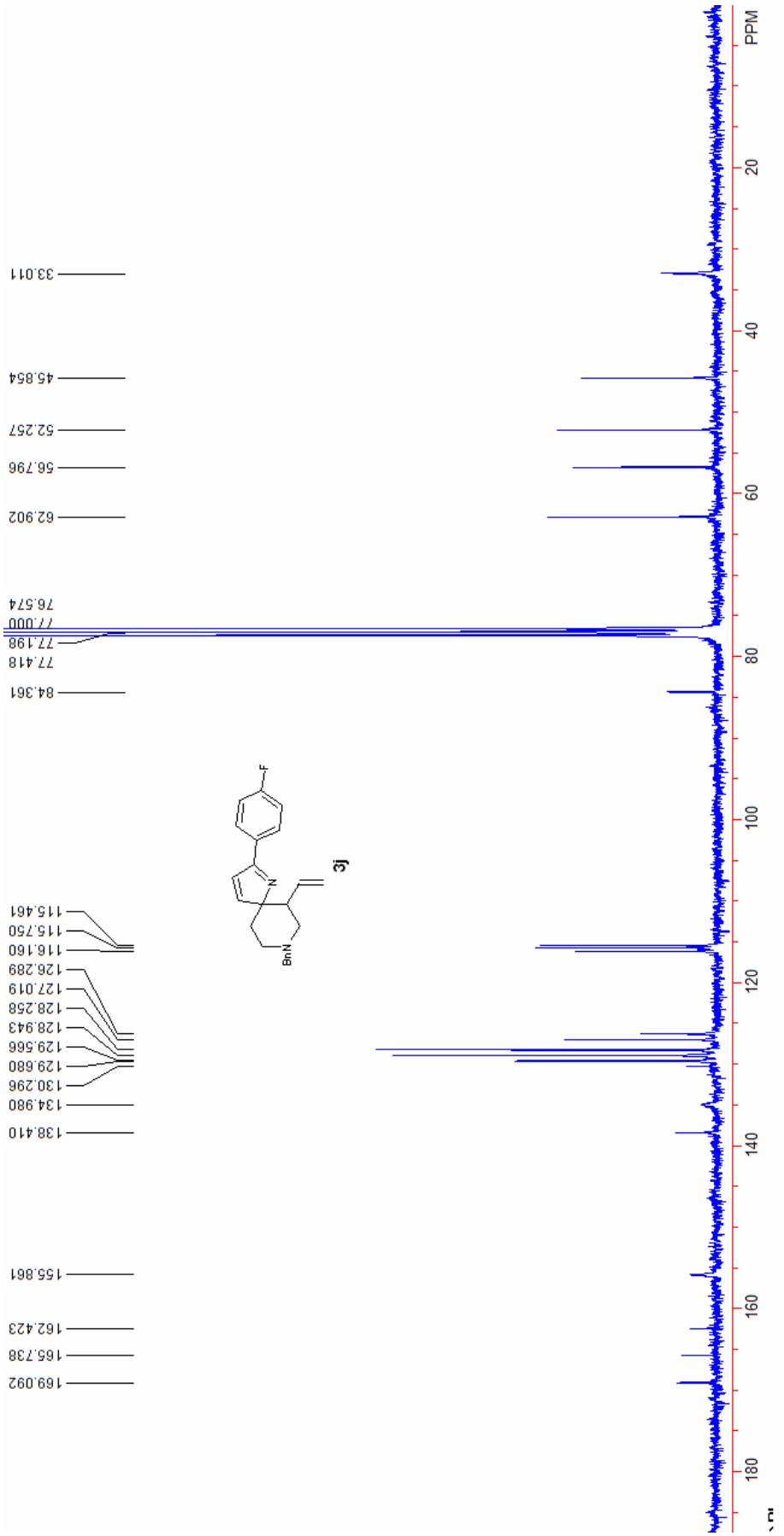


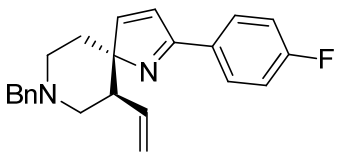
No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	10.293	48390.5	769132.2	7.0780
2	2	Unknown	11.377	639819.3	10097325.8	92.9220
Total				688209.8	10866457.9	100.0000

NMR Spectra and HPLC Spectra of **3j**

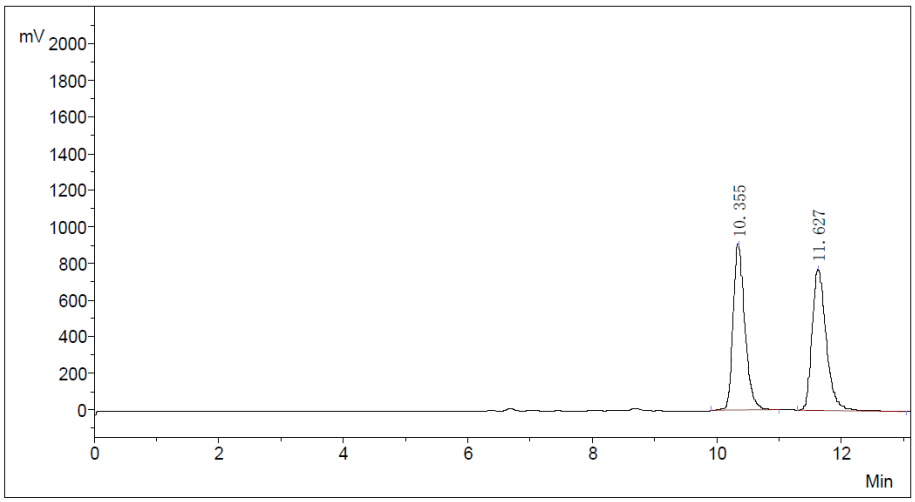




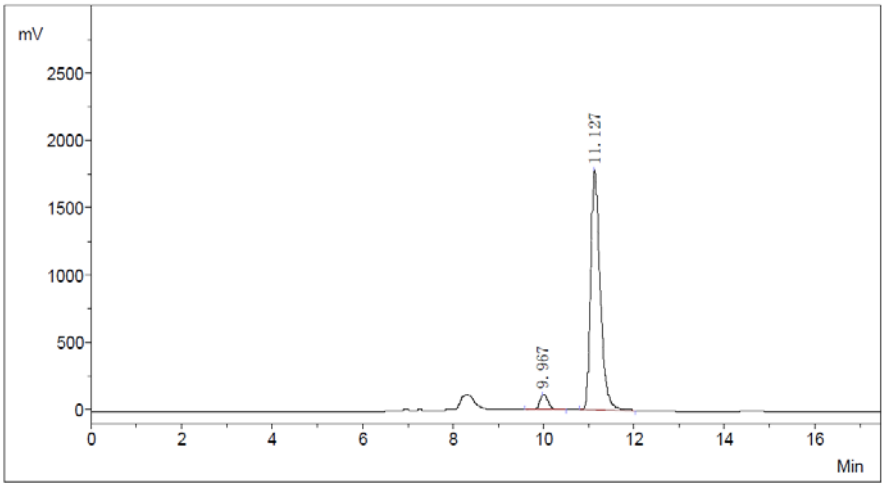




3j

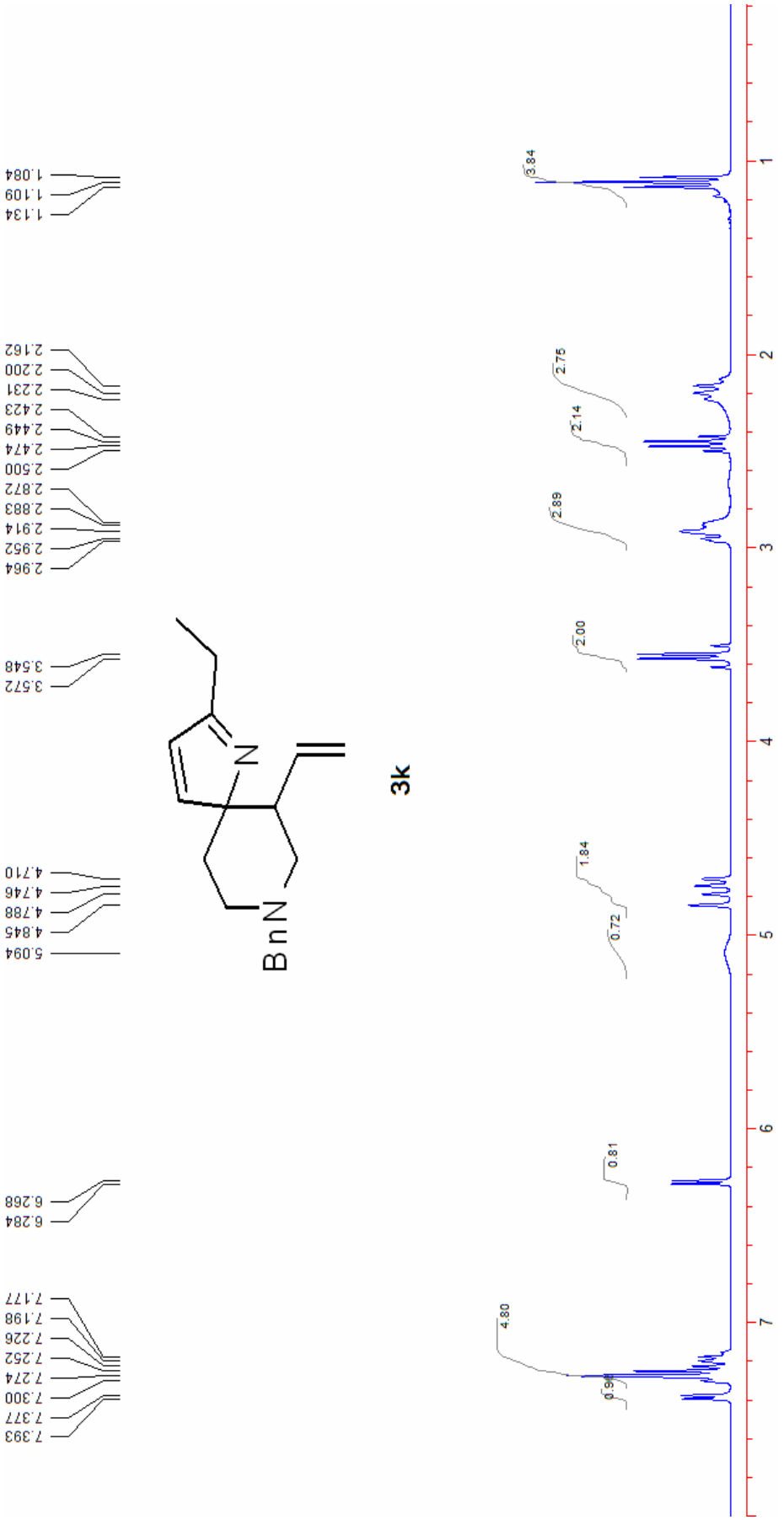


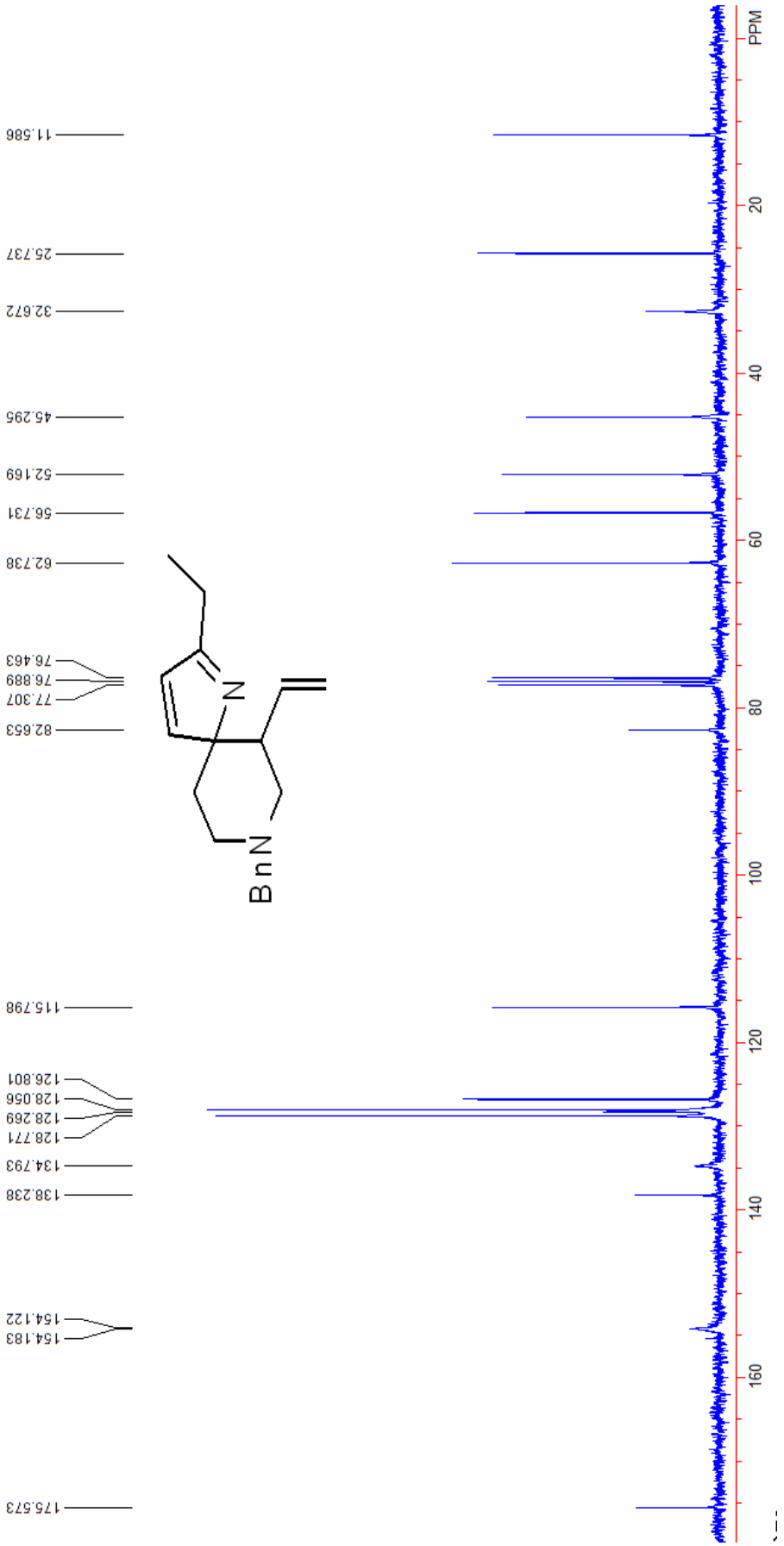
No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	10.355	901061.2	11989441.0	49.8478
2	2	Unknown	11.627	769747.1	12062652.6	50.1522
Total				1670808.2	24052093.6	100.0000

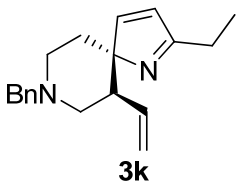


No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	9.967	104138.3	1494706.8	5.3846
2	2	Unknown	11.127	1775549.9	26264158.2	94.6154
Total				1879688.2	27758865.0	100.0000

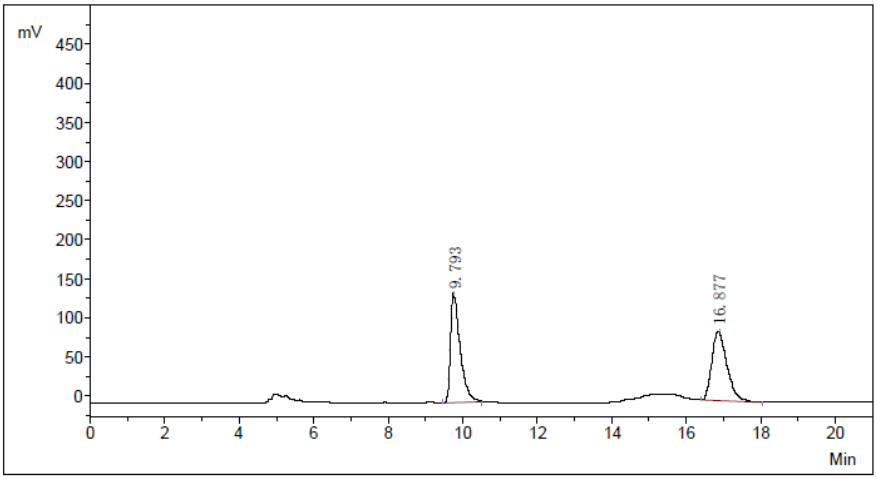
NMR Spectra and HPLC Spectra of **3k**



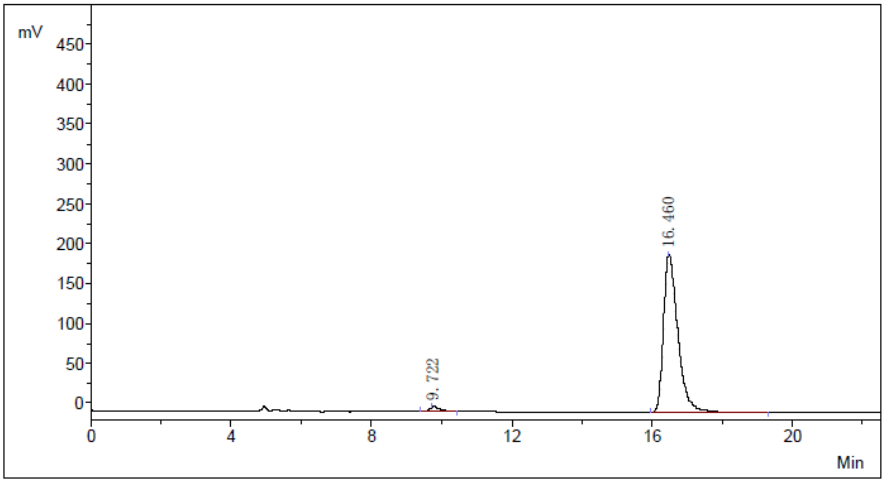




3k

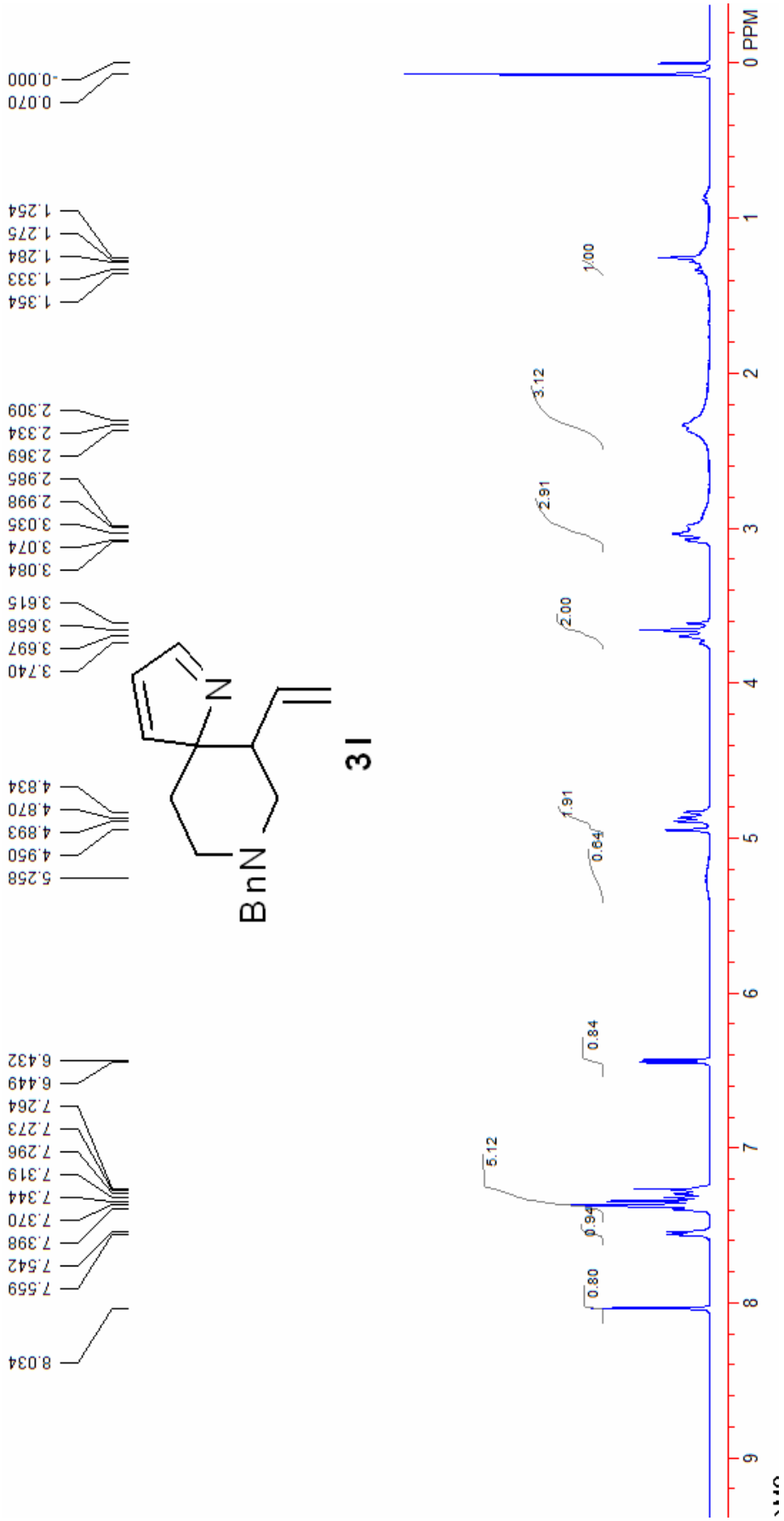


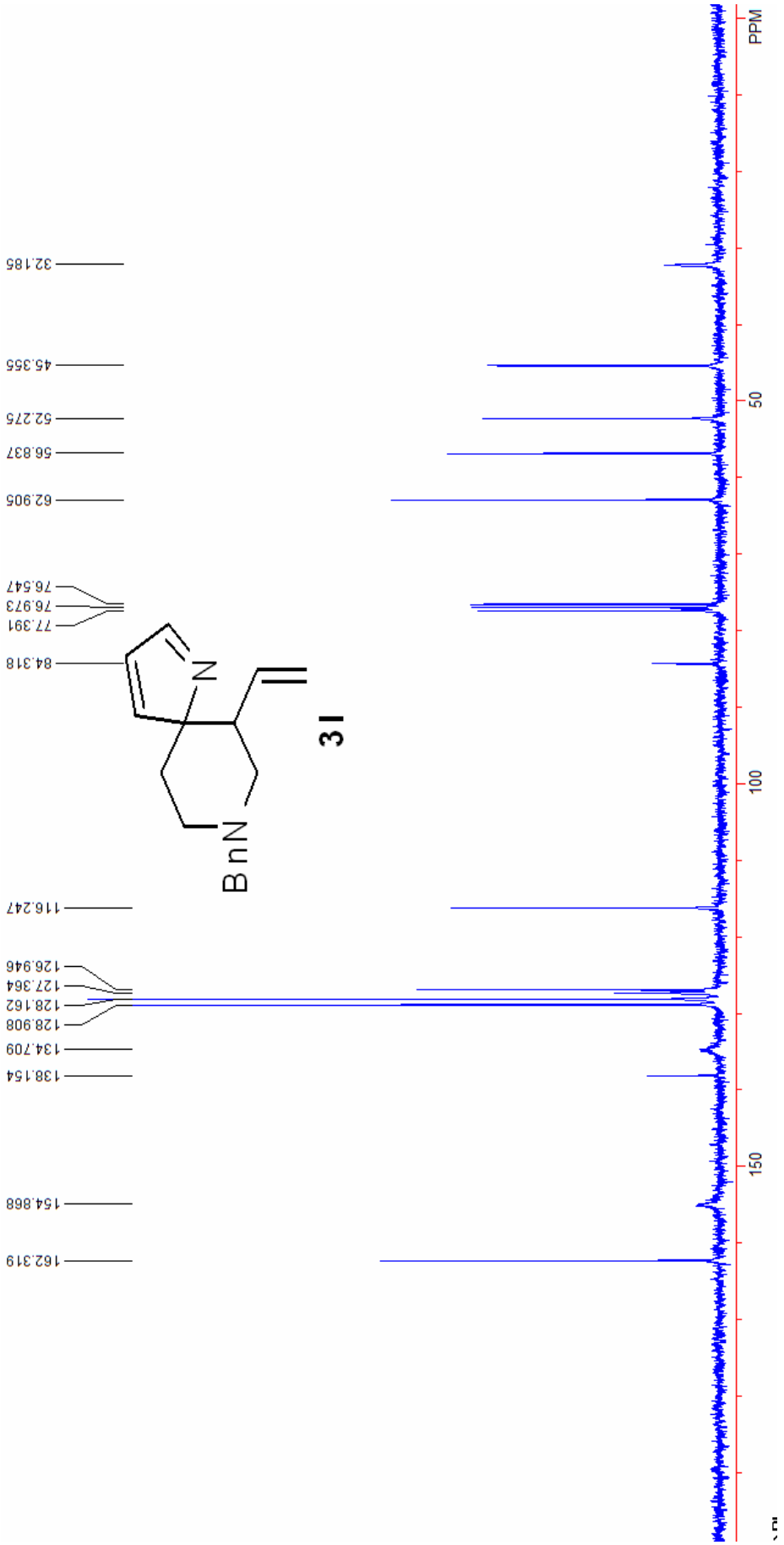
No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	9.793	136060.6	2550130.3	50.6989
2	2	Unknown	16.877	88136.9	2479821.5	49.3011
Total				224197.5	5029951.8	100.0000

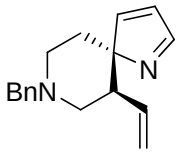


No.	PeakNo	ID.Name	R.Time	PeakHeight	PeakArea	PerCent
1	1	Unknown	9.722	4688.3	103161.2	1.8137
2	2	Unknown	16.460	197408.5	5584740.4	98.1863
Total				202096.8	5687901.6	100.0000

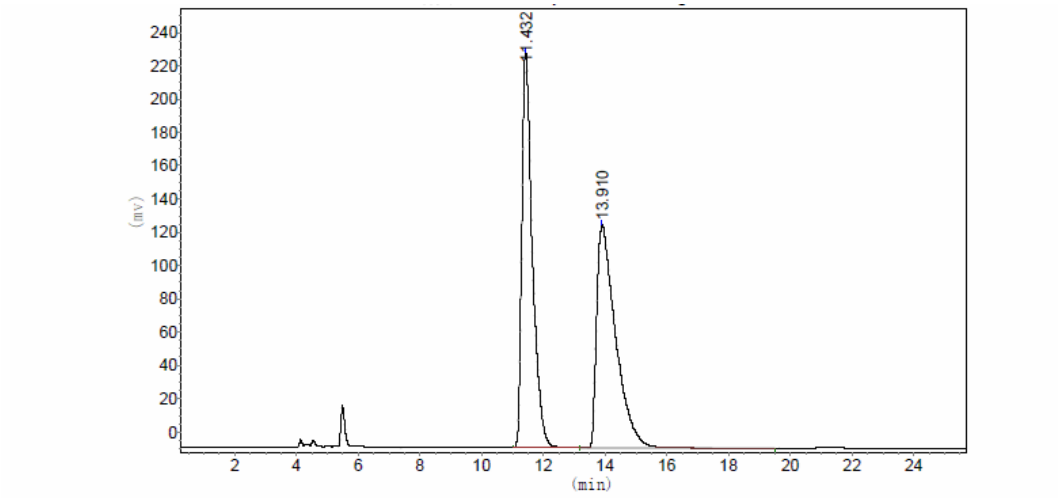
NMR Spectra and HPLC Spectra of **3l**



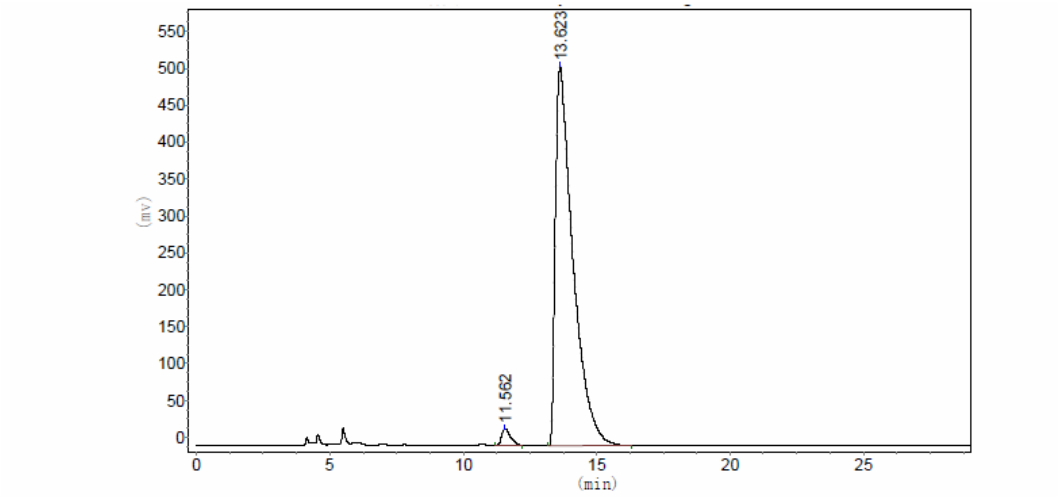

32.185
45.355
52.275
56.837
62.905
76.547
76.973
77.391
84.318
116.247
126.946
127.364
128.162
128.908
134.709
138.154
154.868
162.319
PPM
50
100
150
BnN
3l



3l

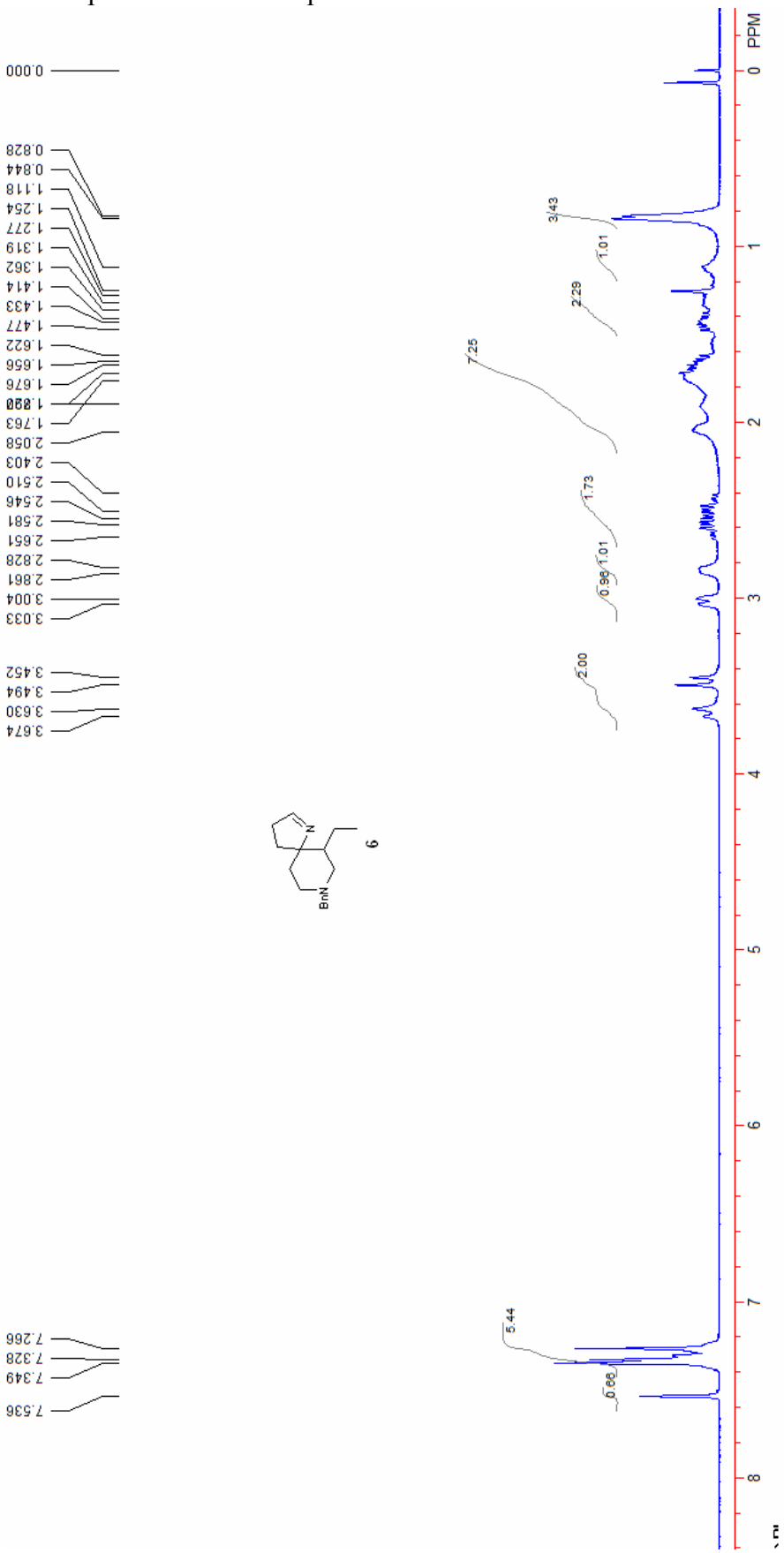


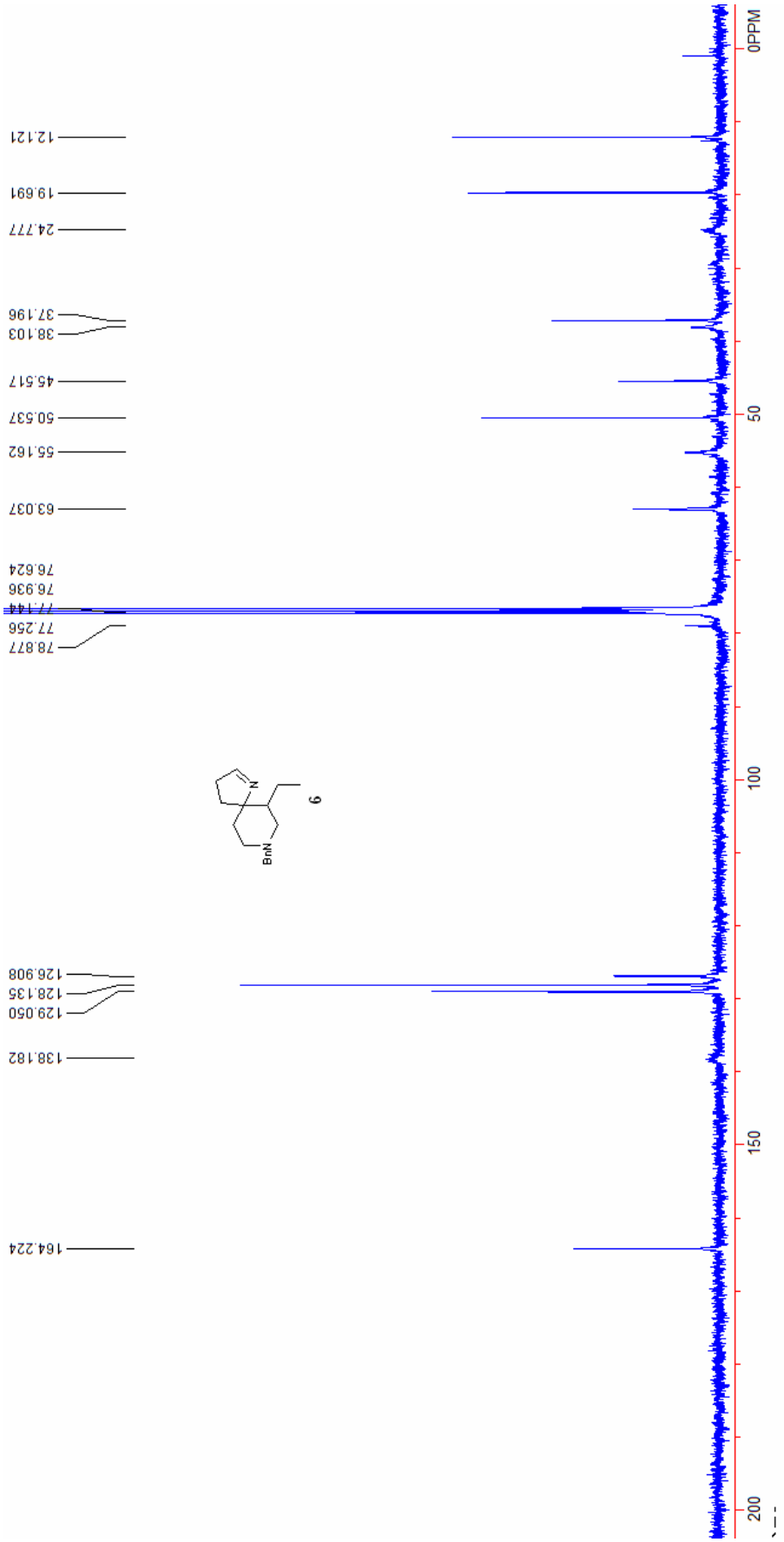
Peak No.	R. Time	Peak Height	Peak Area	Percent
1	11.432	237176.969	5635360.000	49.5057
2	13.910	133858.797	5747888.500	50.4943
Total		371035.766	11383248.500	100.0000

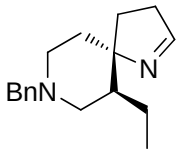


Peak No.	R. Time	Peak Height	Peak Area	Percent
1	11.562	22435.457	516012.094	2.1437
2	13.623	514500.500	23554528.000	97.8562
Total		536935.957	24070540.094	100.0000

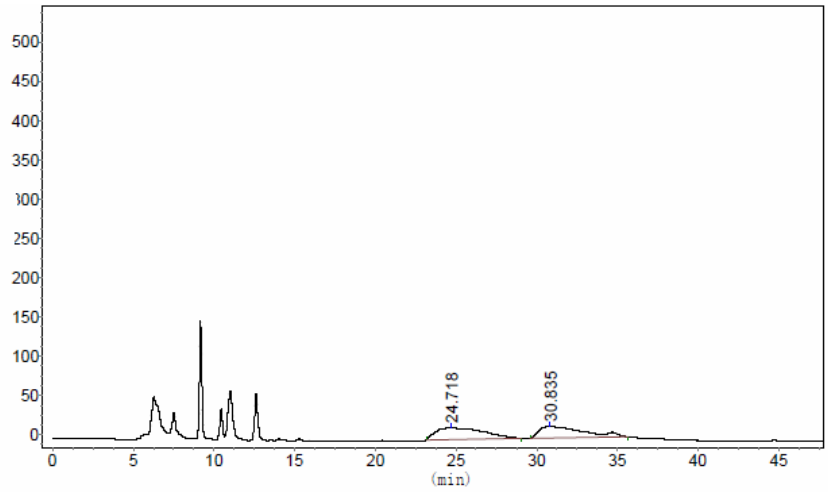
NMR Spectra and HPLC Spectra of **6**



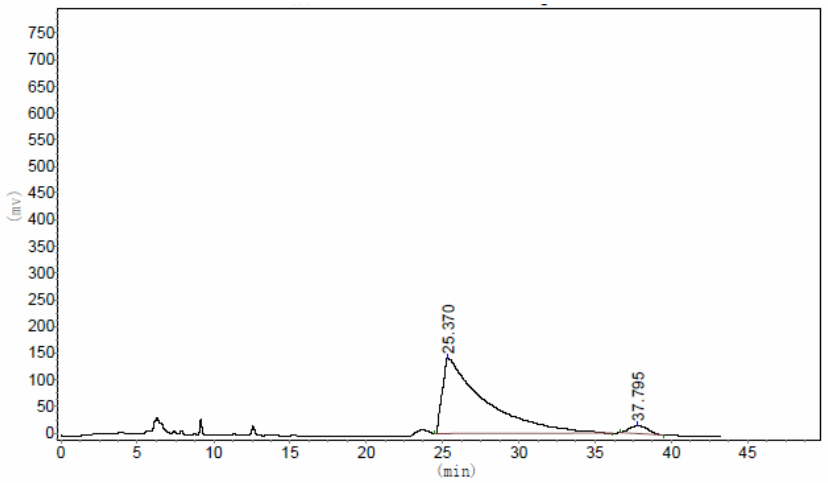

12.121
19.691
24.777
37.196
38.103
45.517
50.537
55.162
63.037
76.624
76.936
77.144
77.256
78.877
126.908
128.135
129.050
138.182
164.224
0PPM
50
100
150
200
BnN
9



6

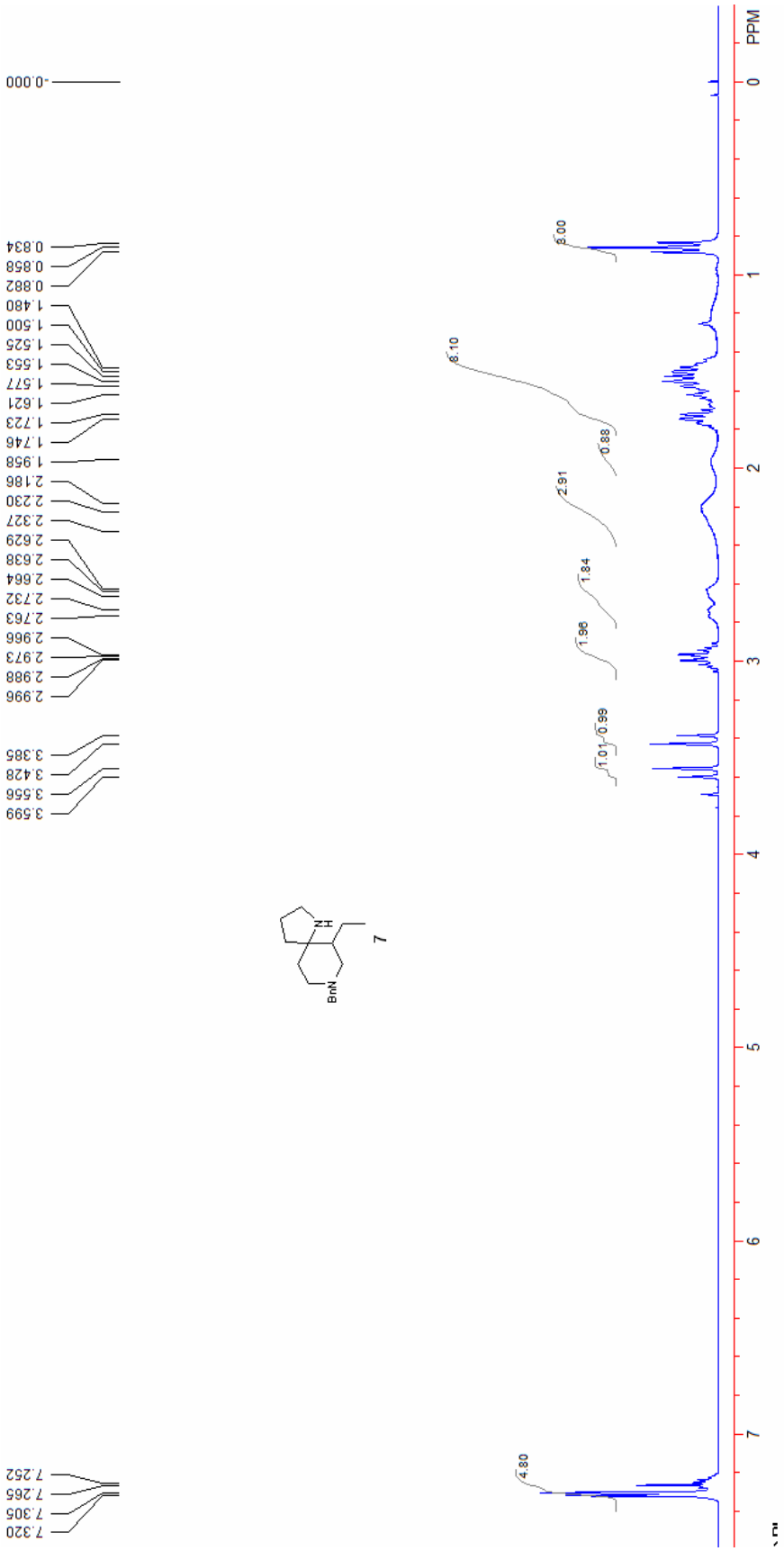


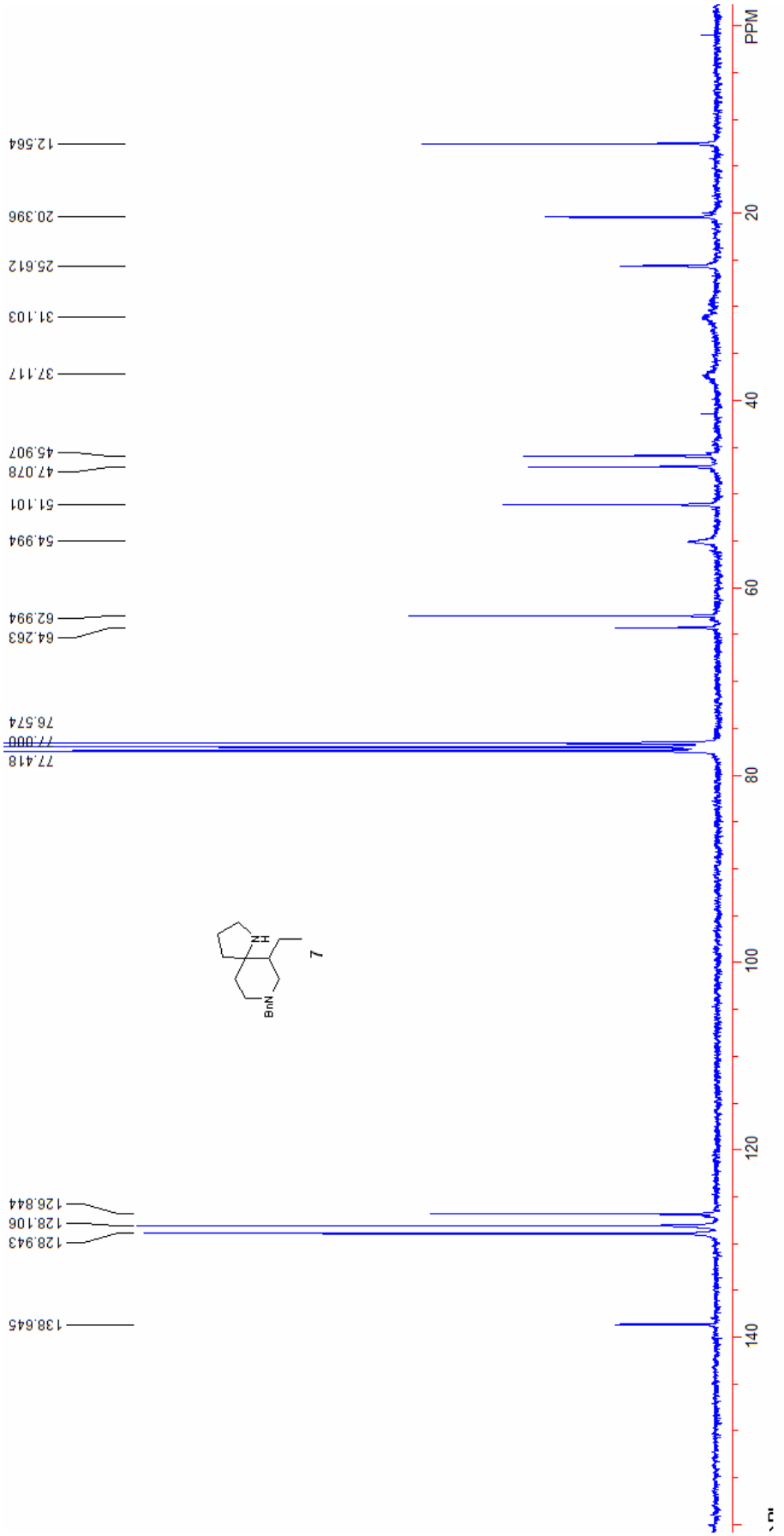
Peak No.	R. Time	Peak Height	Peak Area	Percent
1	24.718	15140.635	2973290.000	50.9010
2	30.835	14909.321	2868029.250	49.0990
Total		30049.956	5841319.250	100.0000



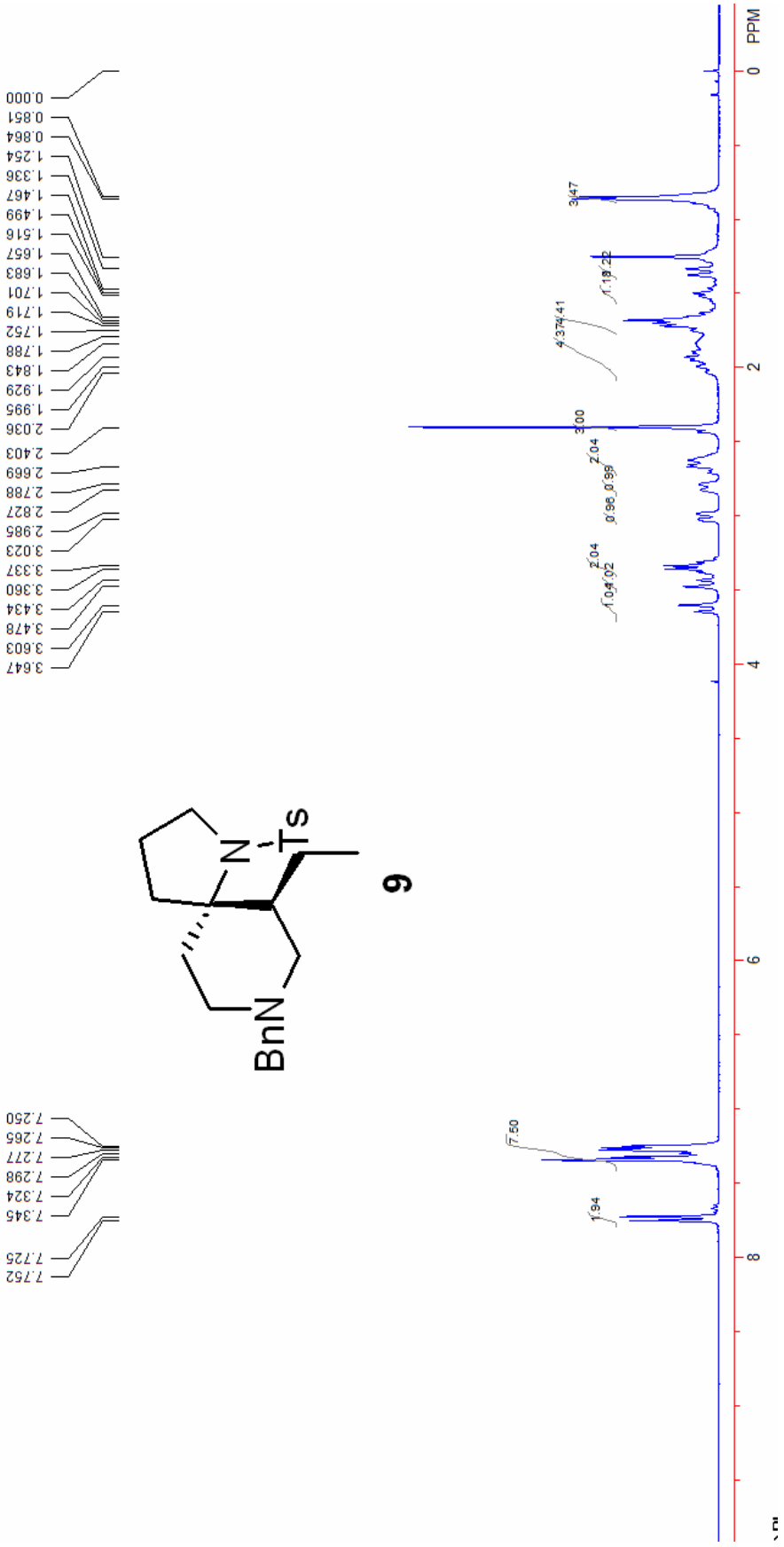
Peak No.	R. Time	Peak Height	Peak Area	Percent
1	25.370	141491.797	27071610.000	95.6141
2	37.795	14735.577	1241794.500	4.3859
Total		156227.374	28313404.500	100.0000

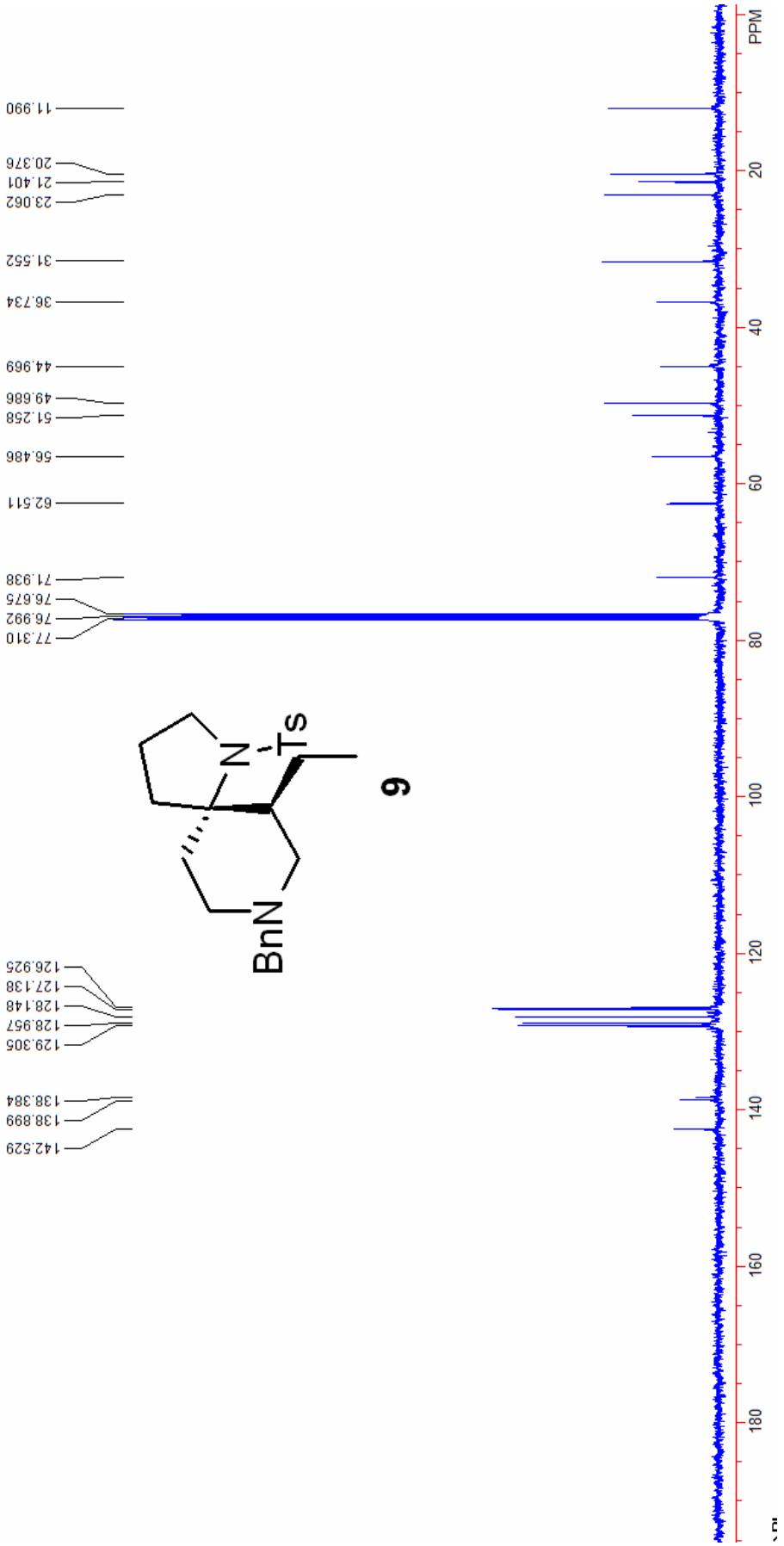
NMR Spectra of **7**

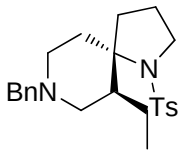




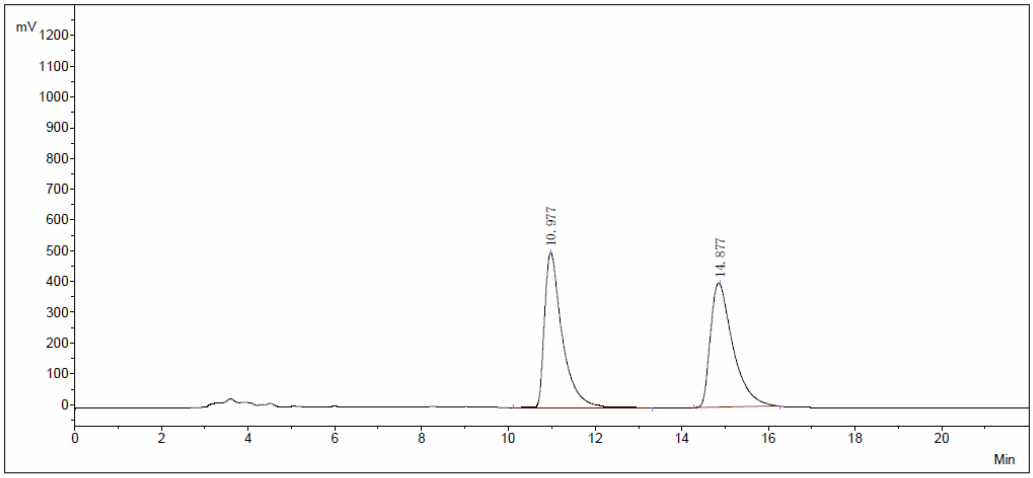
NMR Spectra and HPLC Spectra of **9**



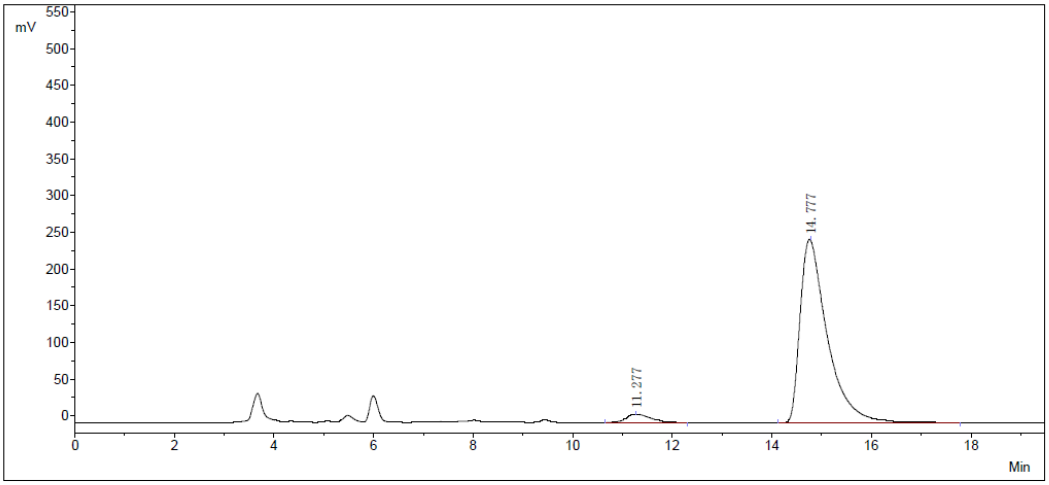




9

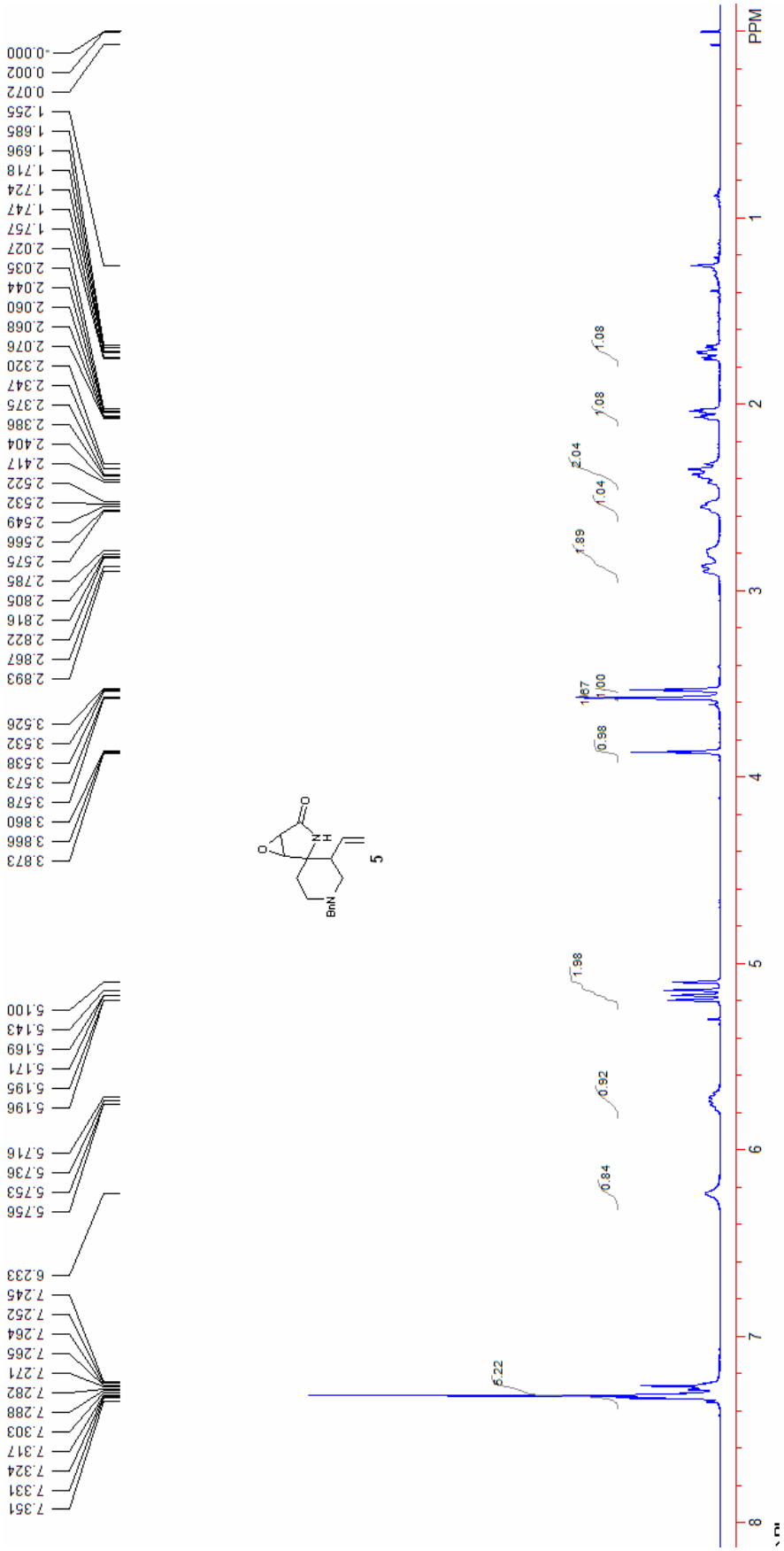


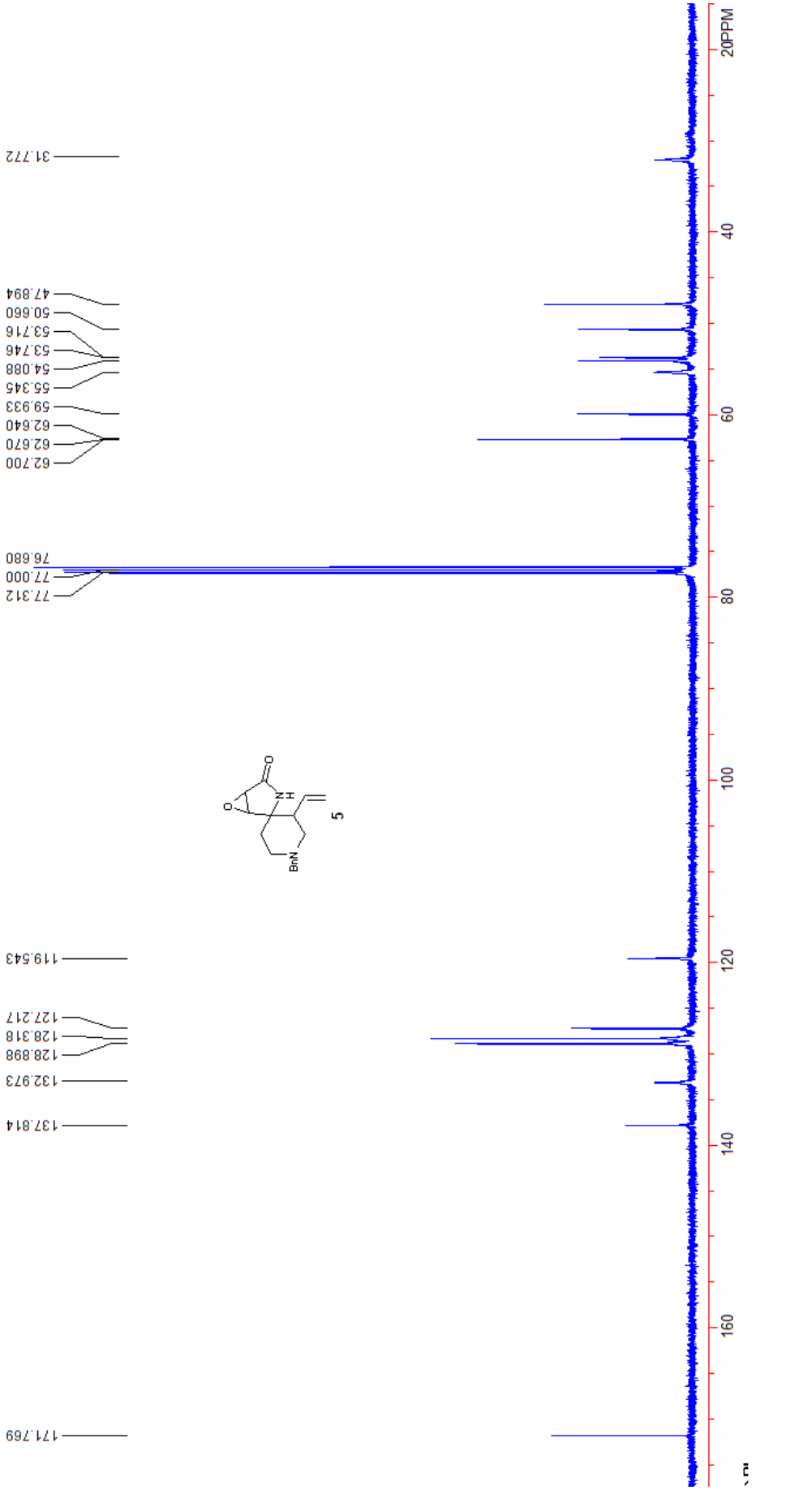
No.	PeakNo	R.Time	PeakHeight	PeakArea	PerCent
1	1	10.977	504062.9	14171868.4	49.4991
2	2	14.877	401386.5	14458696.3	50.5009
Total			905449.3	28630564.7	100.0000

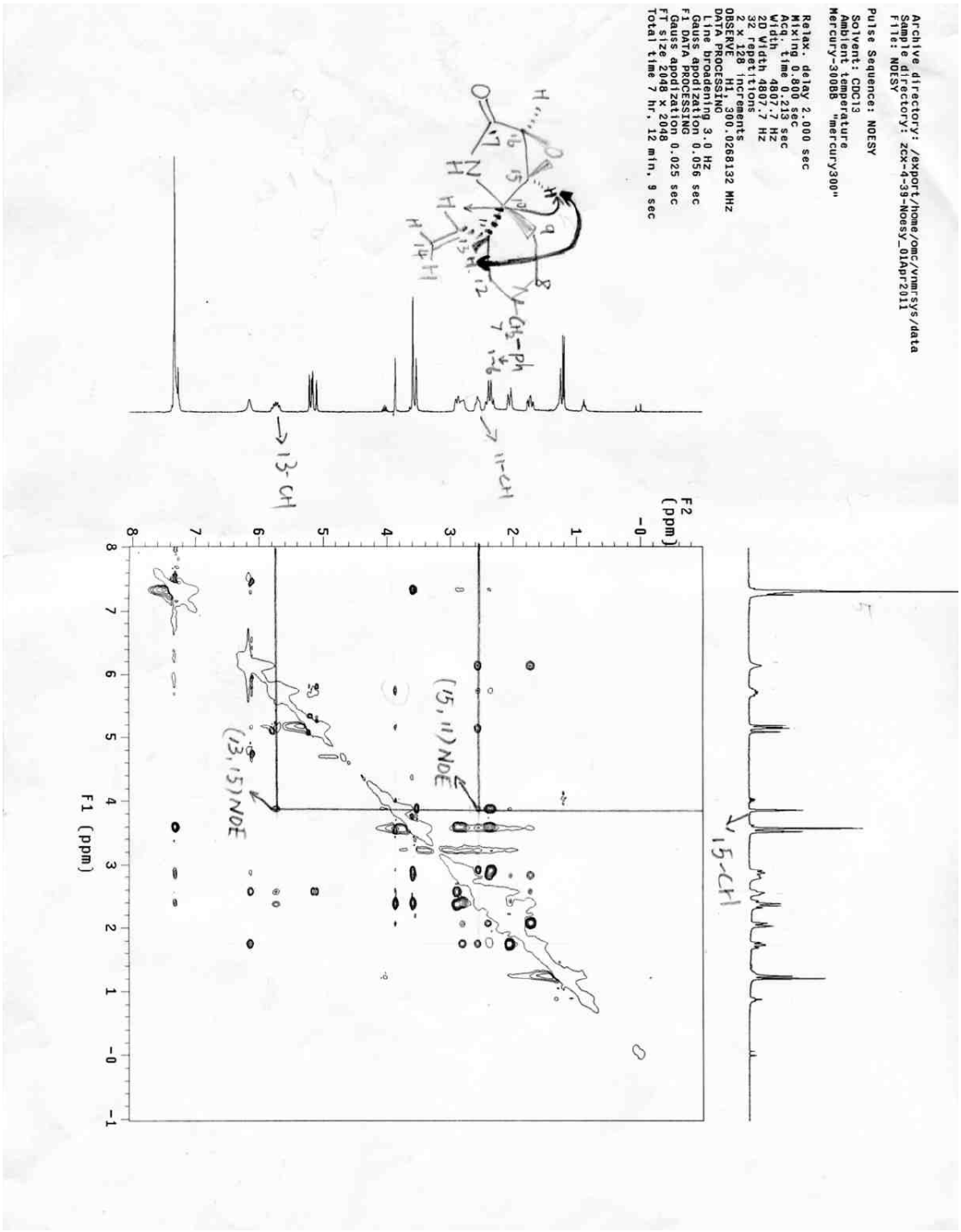


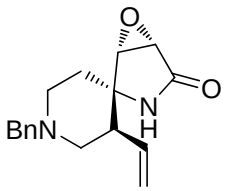
No.	PeakNo	R.Time	PeakHeight	PeakArea	PerCent
1	1	11.277	11763.7	402894.9	4.0853
2	2	14.777	248814.6	9459057.6	95.9147
Total			260578.3	9861952.4	100.0000

NMR Spectra, NOE Spectra and HPLC of **5**

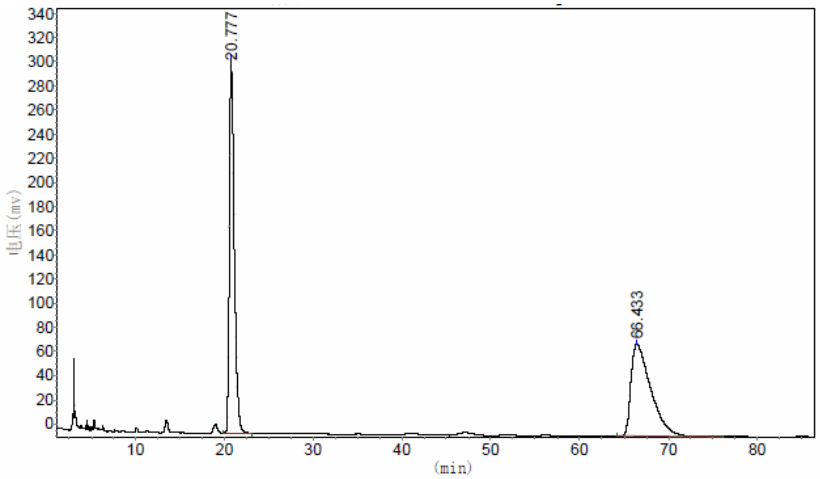



31.772
47.894
50.660
53.716
53.746
54.088
55.345
59.933
62.640
62.670
62.700
76.680
77.000
77.312
119.543
127.217
128.318
128.898
132.973
137.814
171.769
20PPM
40
60
80
100
120
140
160
BnN
5

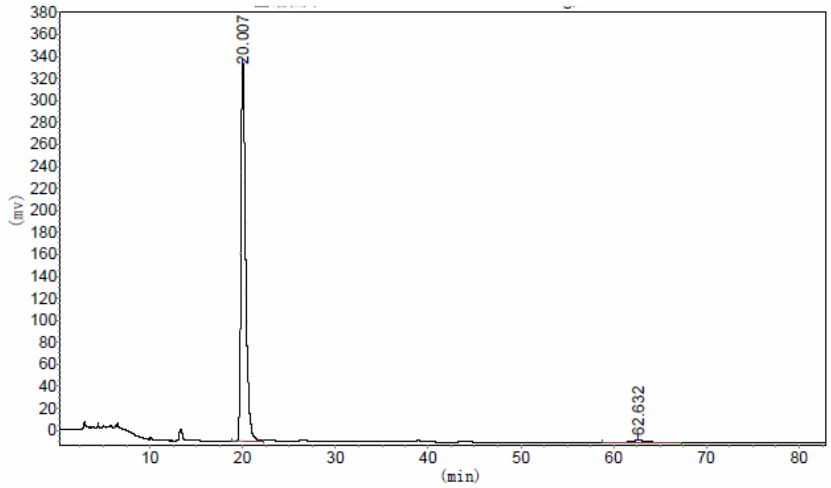

Archive directory: /export/home/omc/vnmrsys/data
Sample directory: zcx-4-39-Noesy_01Apr2011
File: NOESY
Pulse Sequence: NOESY
Solvent: CDCl3
Ambient temperature
Mercury-300BB "mercury300"
Relax. delay 2.000 sec
Mixing 0.800 sec
Acq. time 0.213 sec
Width 4807.7 Hz
2D width 4807.7 Hz
32 repetitions
2 x 128 increments
OBSERVE H1, 300.0268132 MHz
DATA PROCESSING
Line broadening 3.0 Hz
Gauss apodization 0.056 sec
F1 DATA PROCESSING
Gauss apodization 0.025 sec
FT size 2048 x 2048
Total time 7 hr, 12 min, 9 sec
13-CH
11-CH
15-CH
(15, 11) NOE
(13, 15) NOE
F2 (ppm)
F1 (ppm)



5

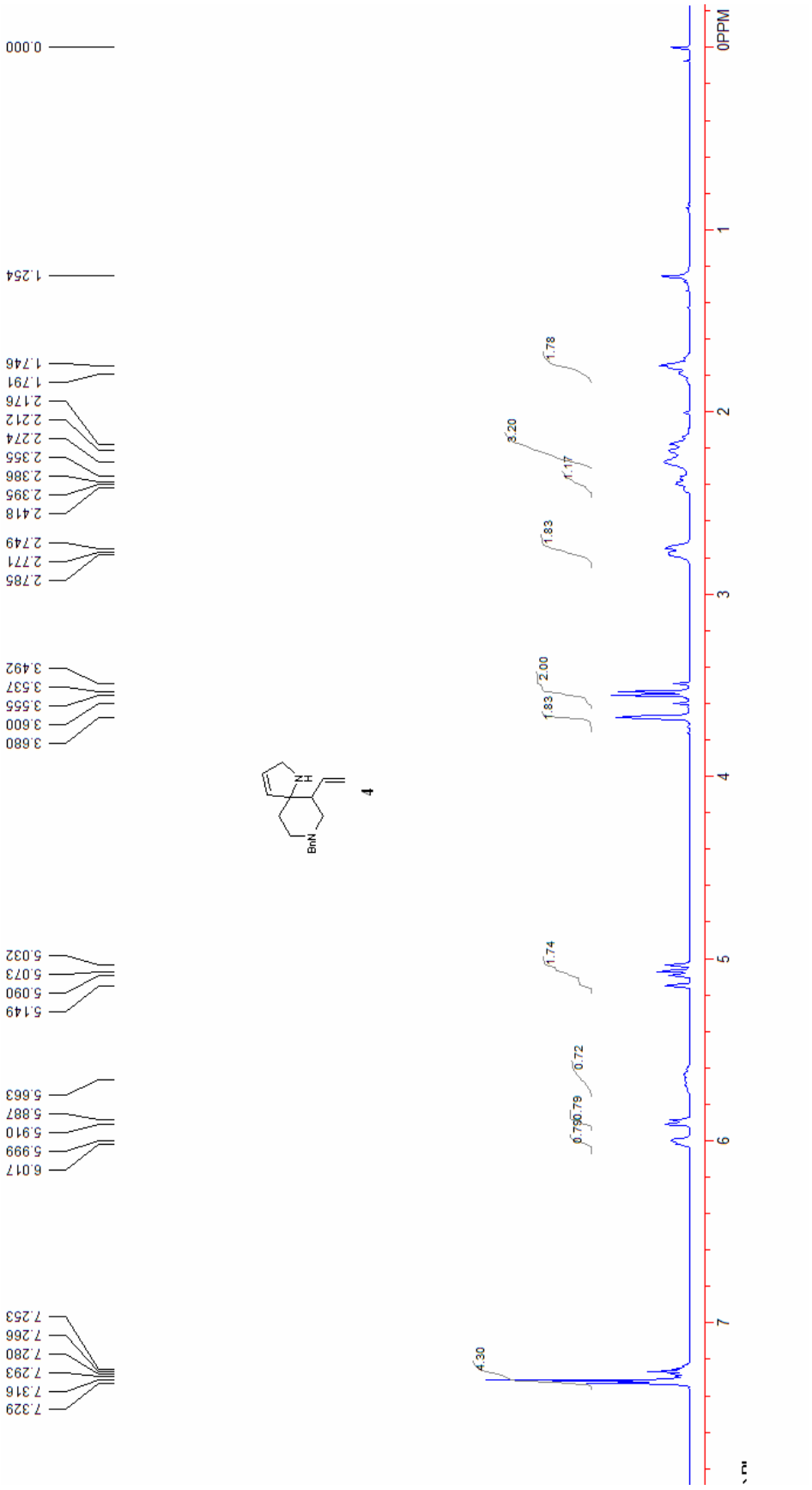


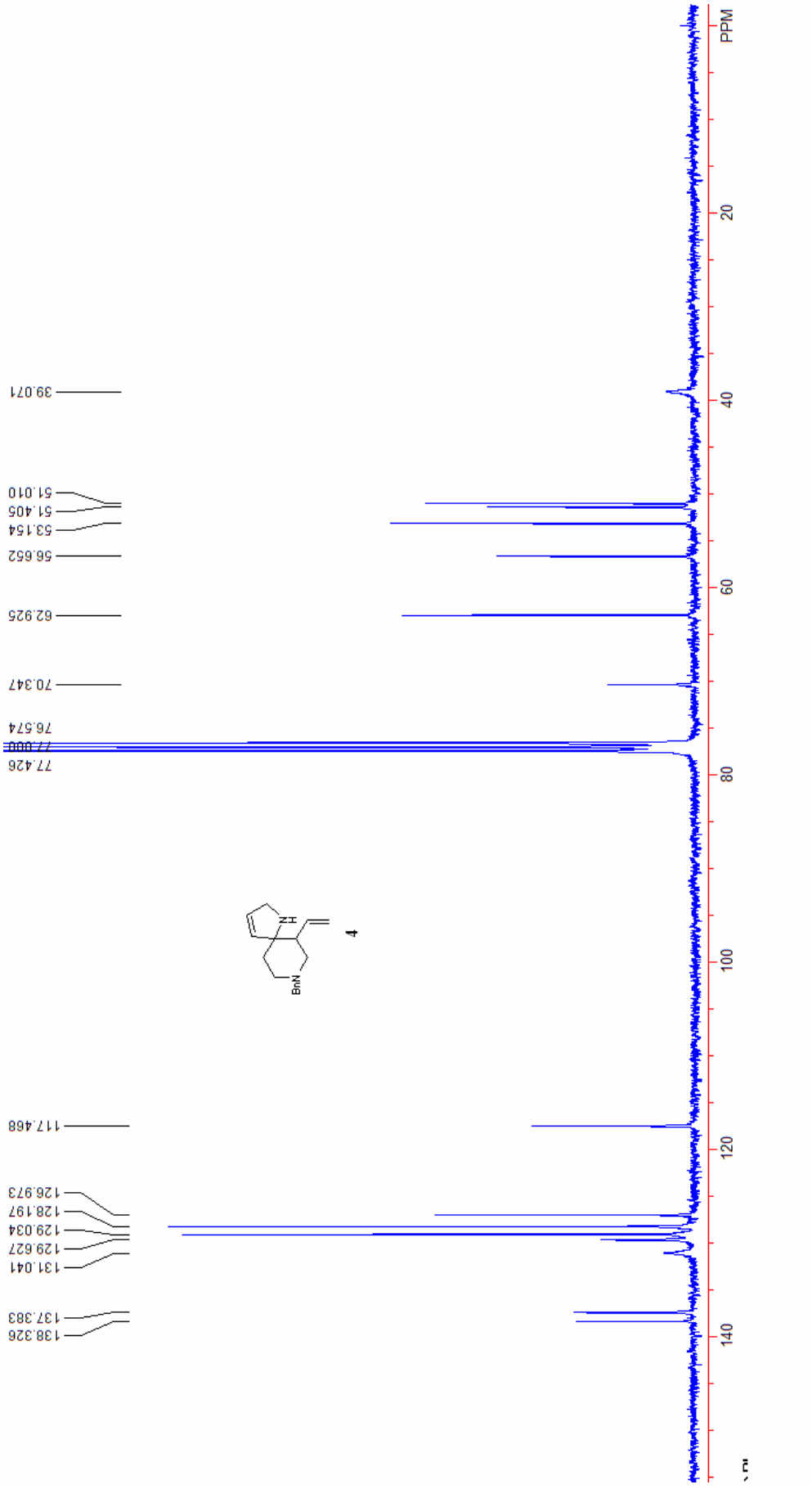
Peak No.	R. Time	Peak Height	Peak Area	Percent
1	20.777	310876.469	11838062.000	50.2554
2	66.433	76084.422	11717746.000	49.7446
Total		386960.891	23555808.000	100.0000

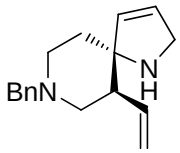


Peak No.	R. Time	Peak Height	Peak Area	Percent
1	20.007	343577.156	12288929.000	97.5150
2	62.632	2291.010	313156.875	2.4850
Total		345868.166	12602085.875	100.0000

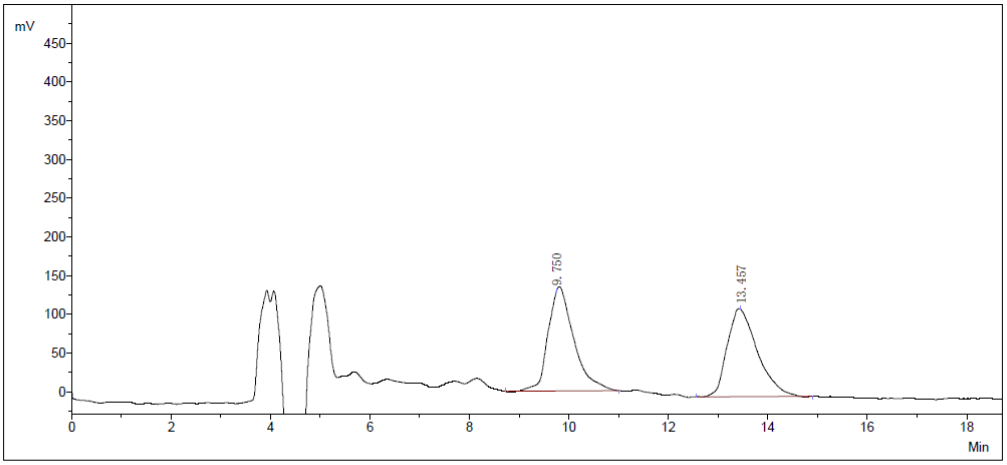
NMR Spectra and HPLC of **4**



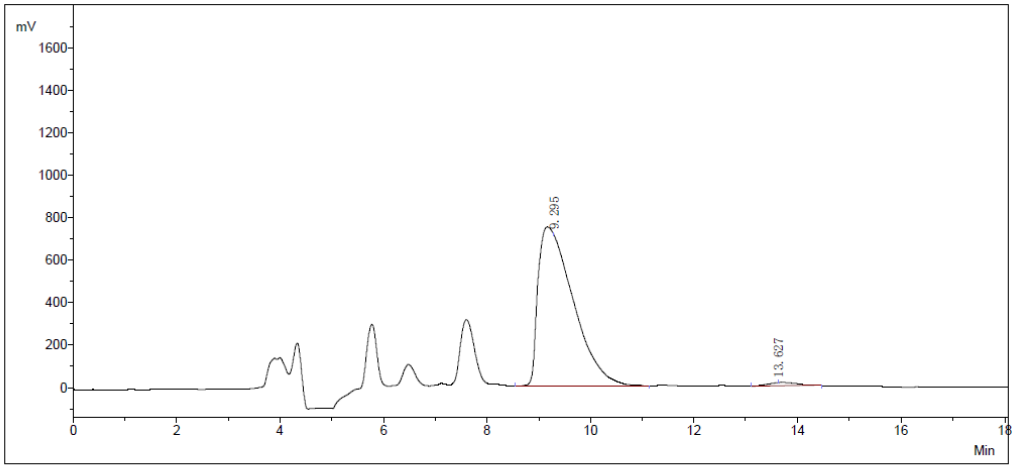




4

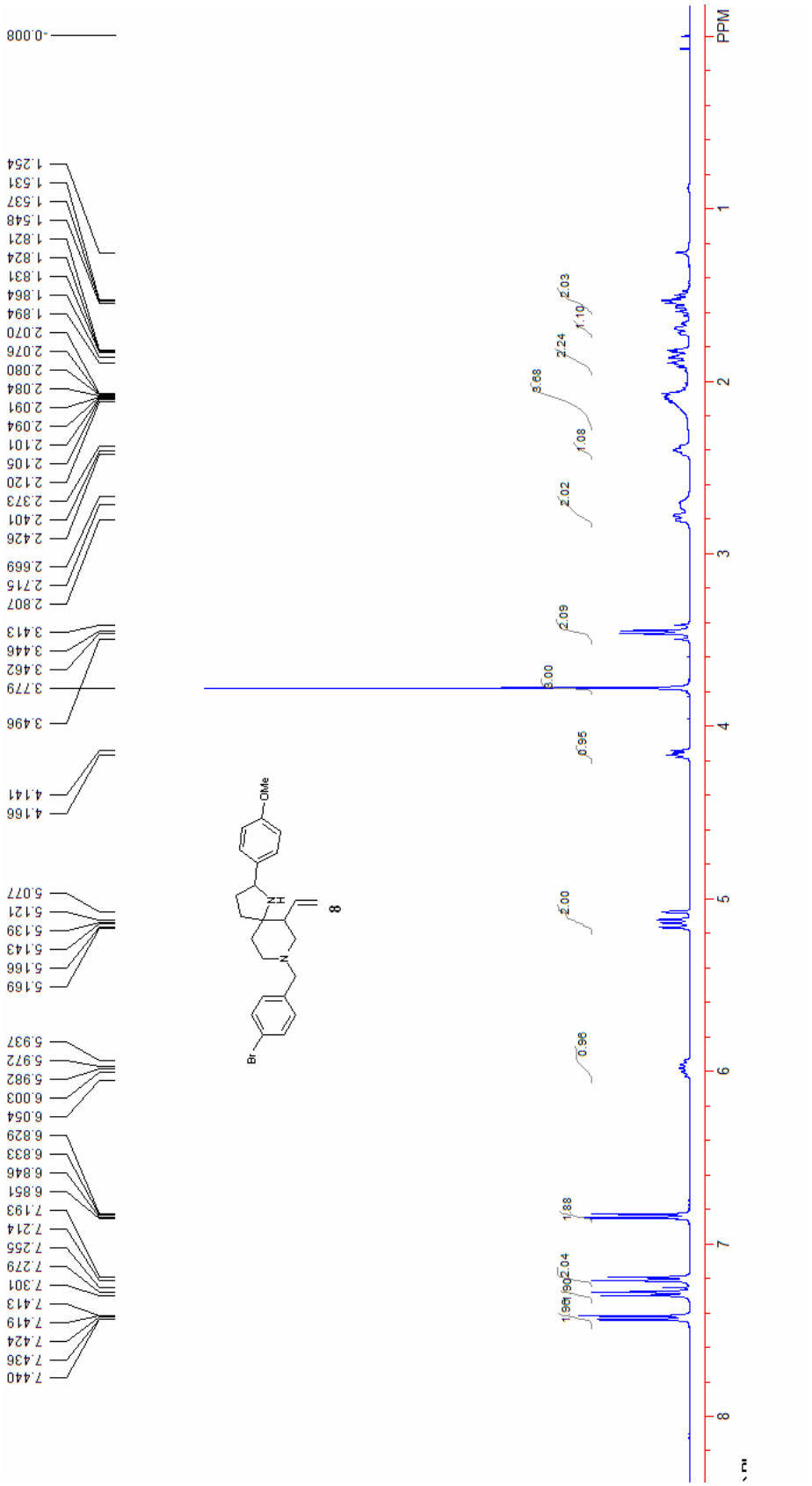


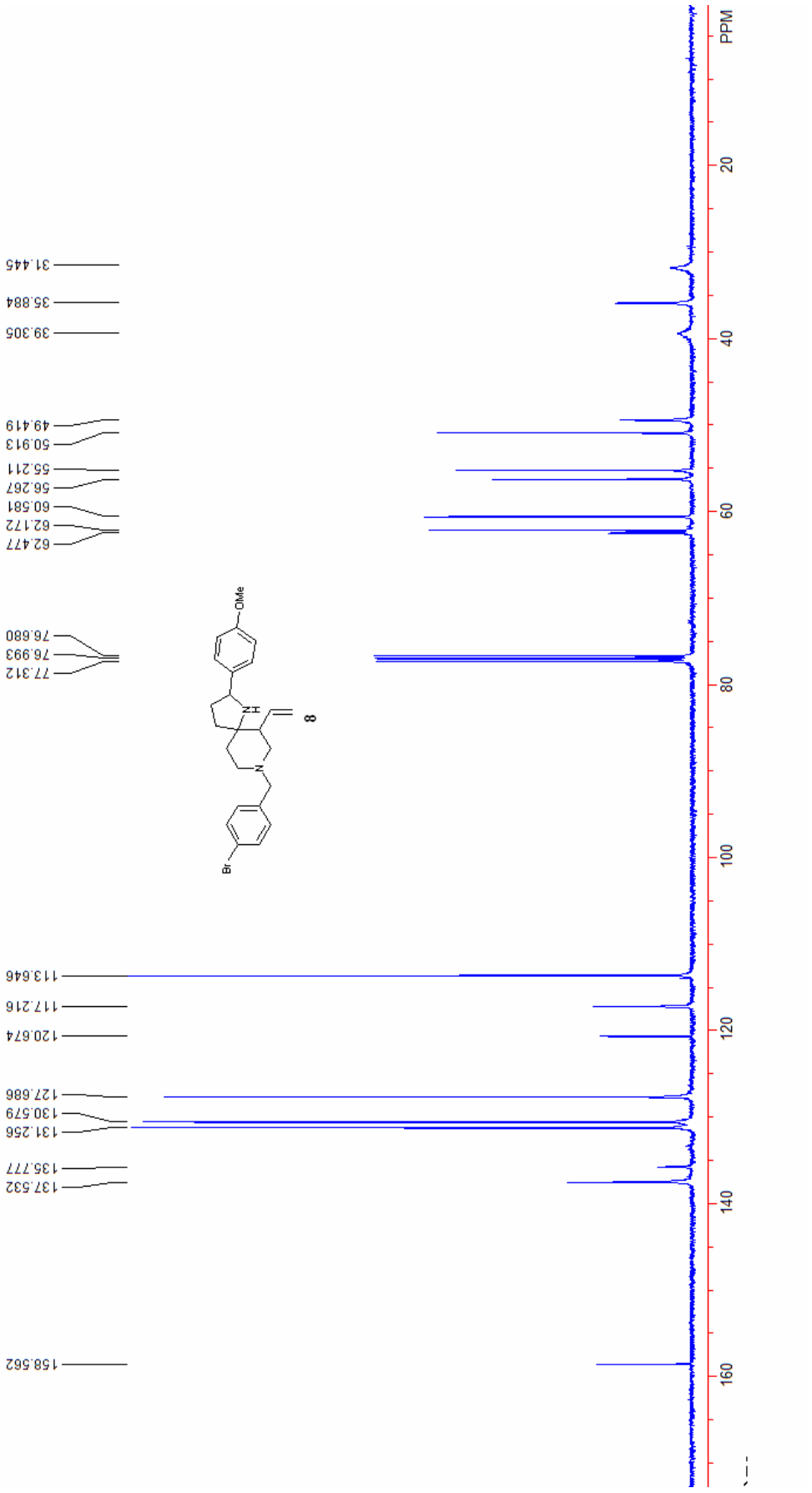
No.	PeakNo	R.Time	PeakHeight	PeakArea	PerCent
1	1	9.750	128334.1	4829520.1	50.2272
2	2	13.457	112765.8	4785825.5	49.7728
Total			241099.9	9615345.6	100.0000

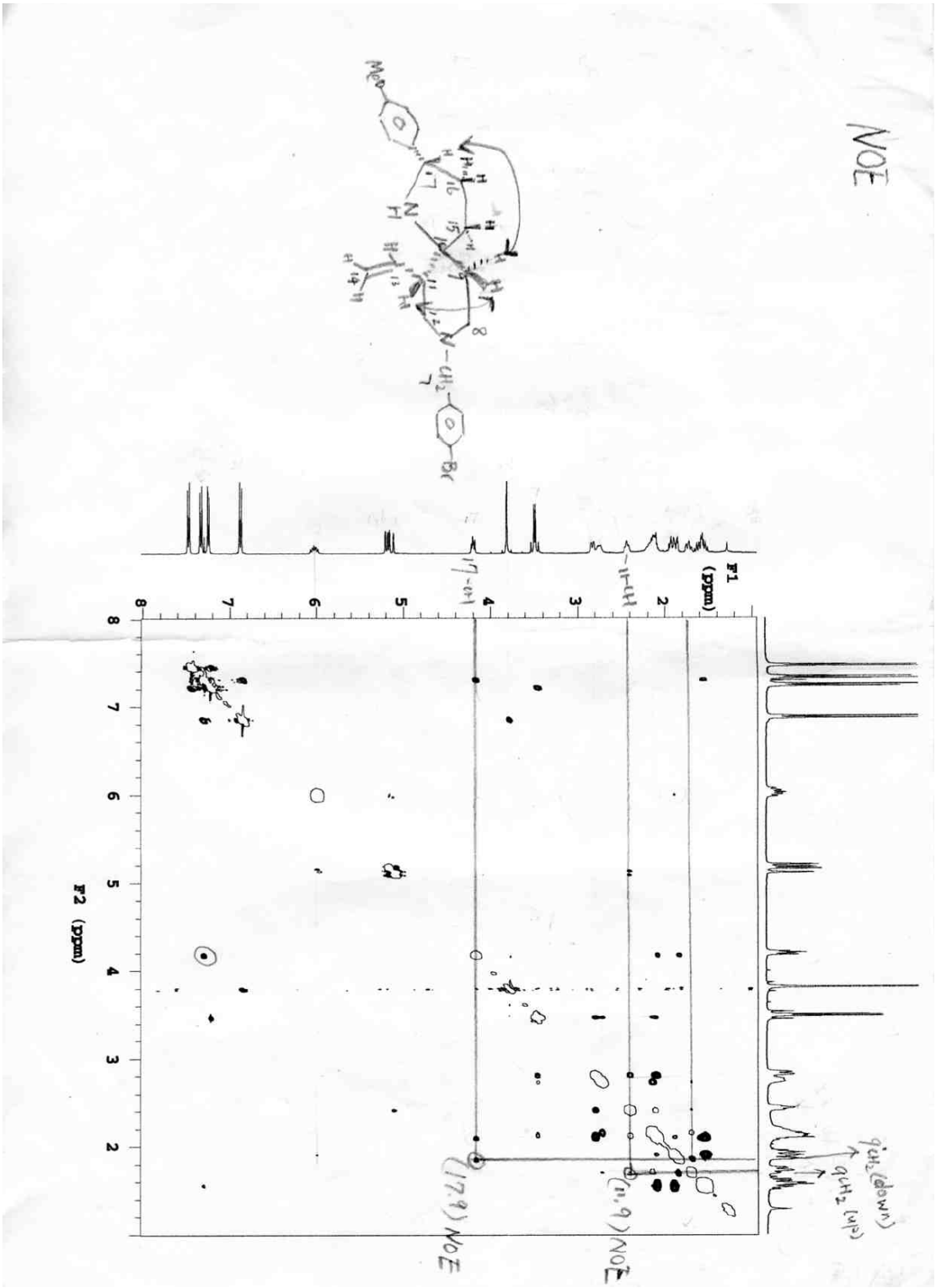


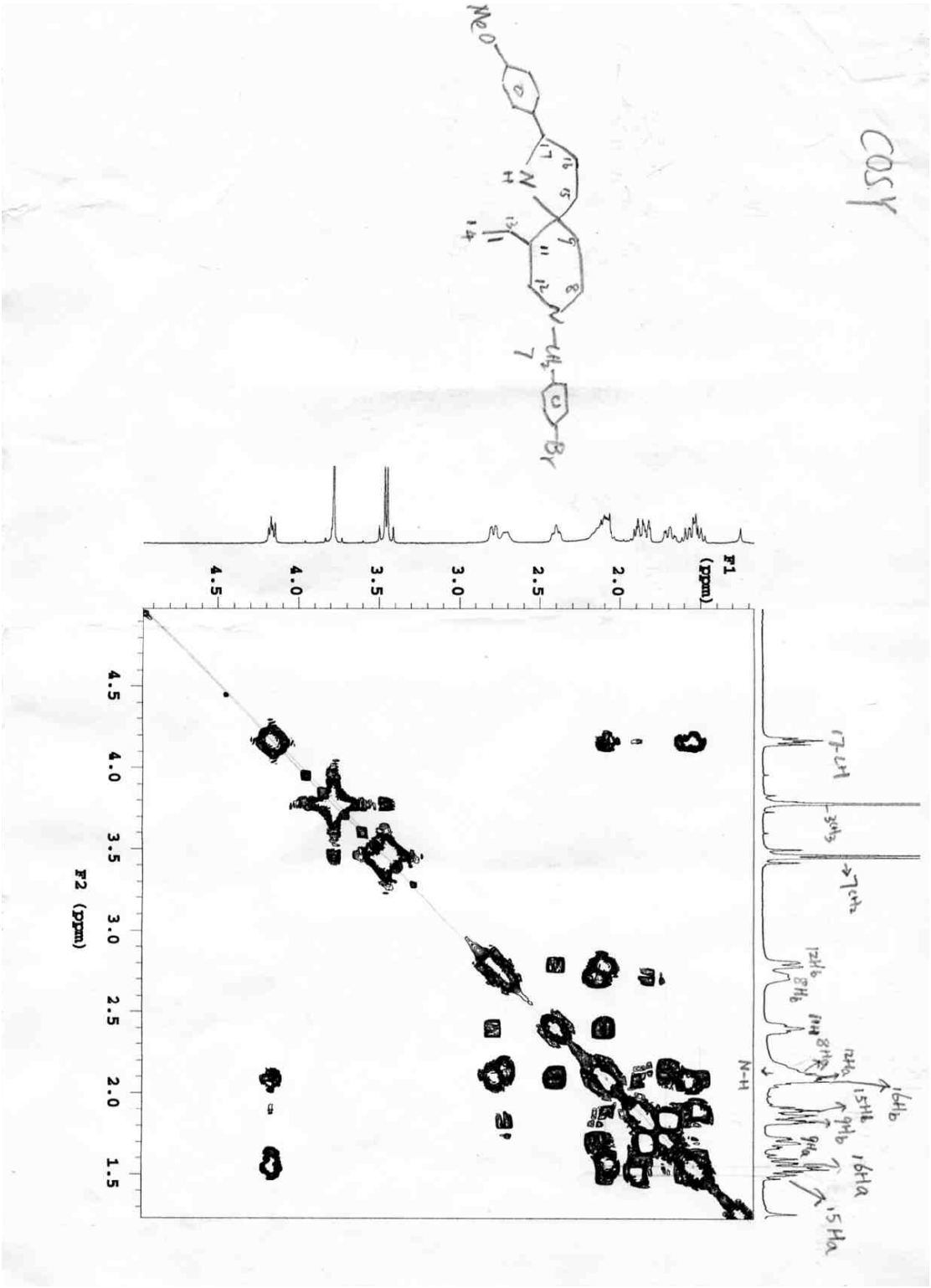
No.	PeakNo	R.Time	PeakHeight	PeakArea	PerCent
1	1	9.295	707816.7	35092109.2	98.2715
2	2	13.627	14990.4	617228.5	1.7285
Total			722807.1	35709337.7	100.0000

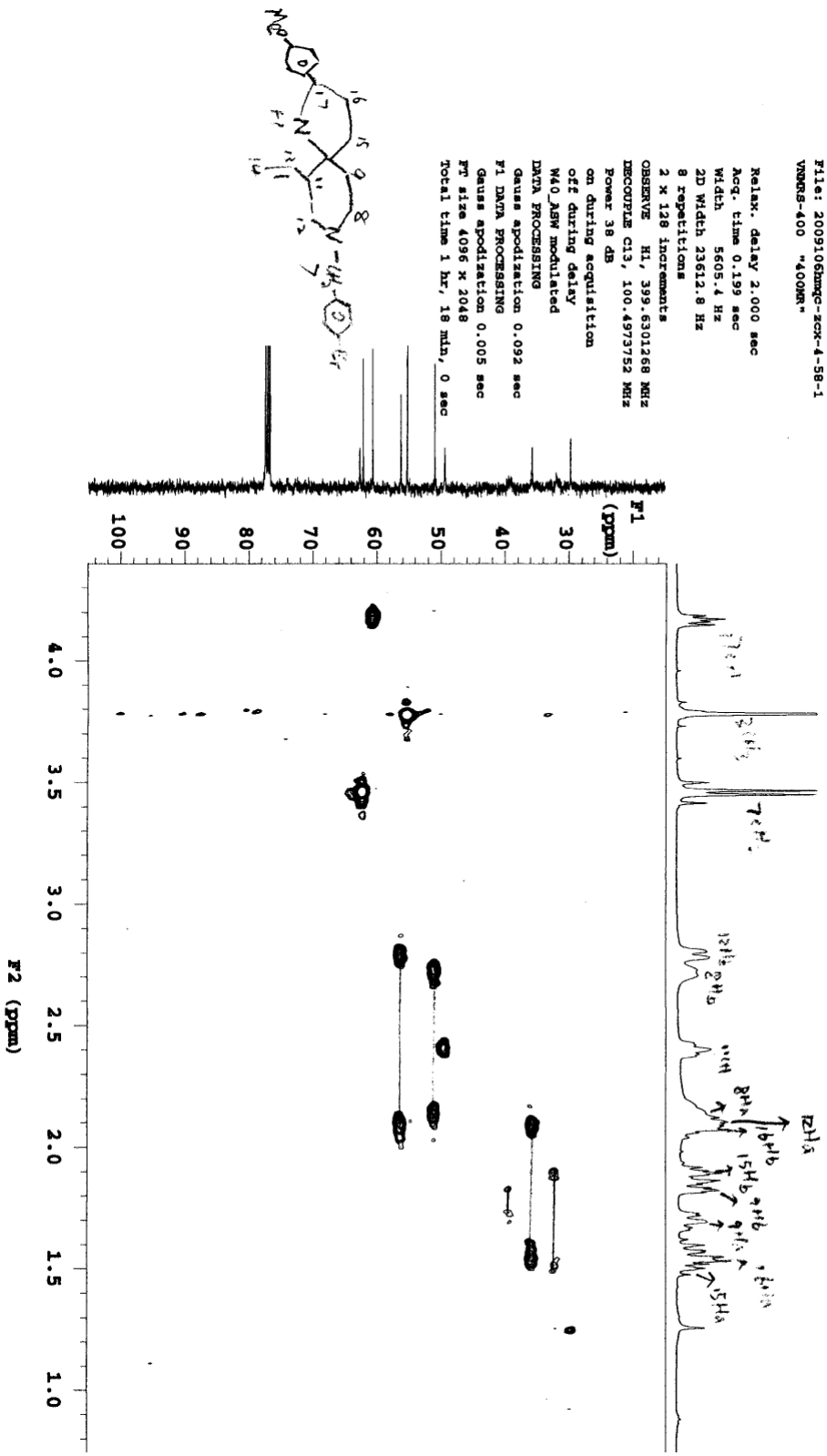
NMR Spectra, NOE, COSY, HSQC Spectra and HPLC of **8**

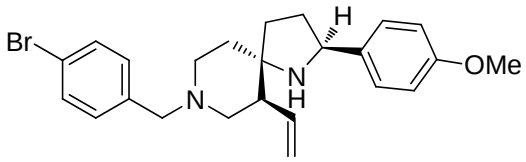




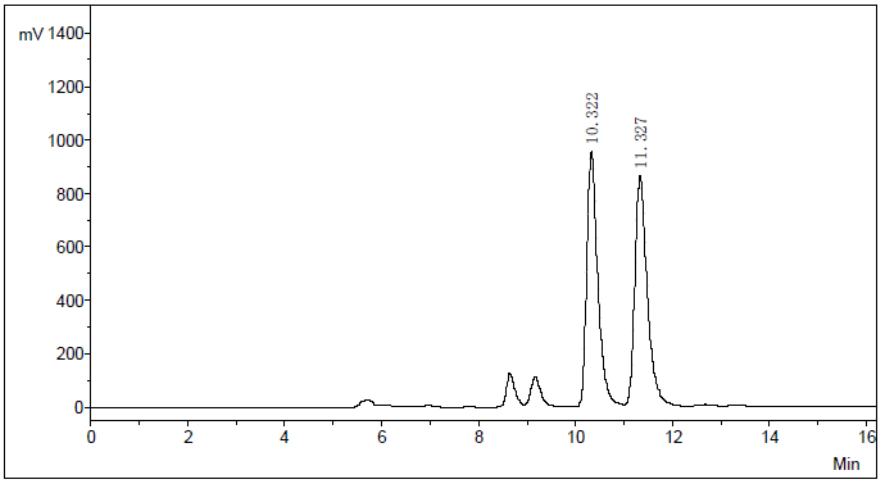



COSY
MeO
Br
F1 (ppm)
F2 (ppm)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
N-H
16Hb
15Hb
9Hb
16Ha
15Ha

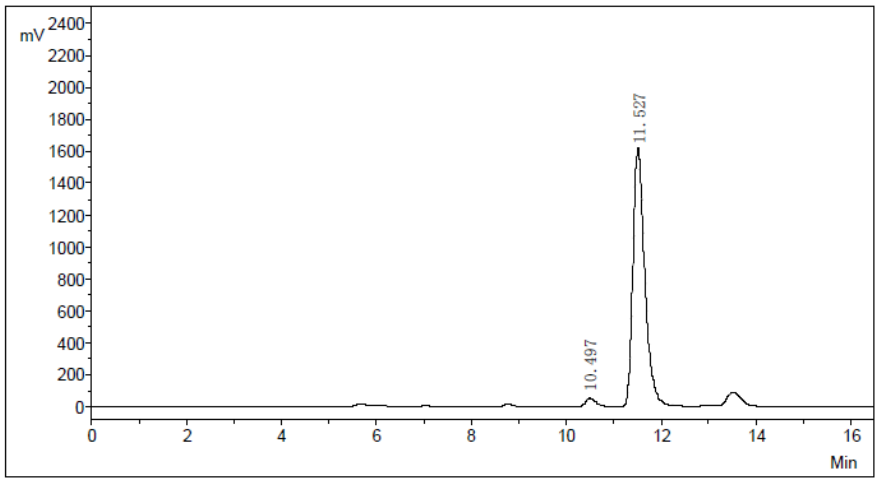

Std proton
File: home/SIOC/vnmrsys/data/20091106hmqc-zcx-4-58-1.fid
Pulse Sequence: gHSQC
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: vnmr1
File: 20091106hmqc-zcx-4-58-1
VNMRS-400 "400MR"
Relax. delay 2.000 sec
Acq. time 0.199 sec
Width 5605.4 Hz
2D Width 23612.8 Hz
8 repetitions
2 x 128 increments
OBSERVE H1, 399.6301268 MHz
DECOUPLE C13, 100.4973752 MHz
Power 38 dB
on during acquisition
off during delay
WALTZ16 modulated
DATA PROCESSING
Gauss apodization 0.092 sec
F1 DATA PROCESSING
Gauss apodization 0.005 sec
FT size 4096 x 2048
Total time 1 hr, 18 min, 0 sec
F1 (ppm)
F2 (ppm)



8



No.	PeakNo	R.Time	PeakHeight	PeakArea	PerCent
1	1	10.322	950703.2	14902965.1	49.6771
2	2	11.327	856159.5	15096698.0	50.3229
Total			1806862.7	29999663.1	100.0000



No.	PeakNo	R.Time	PeakHeight	PeakArea	PerCent
1	1	10.497	54384.7	828761.1	2.8572
2	2	11.527	1596559.8	28176844.2	97.1428
Total			1650944.5	29005605.4	100.0000