Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Fe-catalyzed reductive N-O-bond cleavage for the diastereoselective 1,4-aminohydroxylation of 1,3-dienes

Supporting information

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General remarks

All chemicals were purchased from Sigma Aldrich, Acros Organics or Alfa Aesar and were used without further purification, if not otherwise mentioned. All Solvents were dried and purified by standard techniques. The reactions, if sensitive to air and moisture were performed under a dry nitrogen atmosphere using standard Schlenk technique. The iron catalyst TBAFe was prepared according to a previously published procedure.[1] NMR spectra were recorded on a Bruker Avance 500 spectrometer (^{1}H-NMR at 500 MHz, ^{13}C-NMR at 125 MHz), a Bruker Ascend 400 spectrometer (^{1}H-NMR at 400 MHz, ^{13}C-NMR at 100 MHz) and on a Bruker Avance 300 spectrometer (^{1}H-NMR at 300 MHz, ^{31}P-NMR at 121 MHz and ^{13}C-NMR at 75 MHz) with tetramethylsilane (TMS) as internal standard. All IR-spectra were recorded on a Bruker Vektor 22 FT-IR spectrometer in an ATR mode as film or solid. For mass analysis a Bruker Micro-TQF-Q with electronspray ionization was used. All products – shown in the following as enantiomers – were obtained as mixtures of both enantiomers. For clarity, only one of those is shown.

Synthesis of the substrates

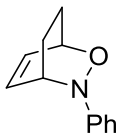
All 1,2-oxazines were synthesized according to literature known procedures in a Hetero-Diels-Alder reaction starting from different 1,3-dienes and nitroso-compounds which were used as purchased or oxidized in situ from the corresponding amines or hydroxamic acids.

1,2-Oxazines synthesized from 1,3-dienes and nitrosobenzene

General Procedure (GP-I): 1,2-Oxazines were synthesized based on standard Diels-Alder conditions in a round bottom flask in either DCM or $CHCl_3$ at 0 °C to RT or -78 °C to RT for better control of regioselectivity of substrates **30**, **32**, **34, 36, 38** and **40**. The 1,3-diene was therefore slowly added to a solution of nitrosobenzene at the given temperature. The reaction progress was monitored via TLC while the mixture was allowed to warm to RT. The solvent was evaporated in vacuo and the crude product was purified using column chromatography on silica with petroleum ether and ethyl acetate as eluent.[2]

Dienes **30a**, and **32a** were synthesized according to a literature known procedure[3] as well as dienes **34a**, **36a** and **38a**.[4] The synthesis of these dienes is not described in detail but the substrates are listed below for completeness.

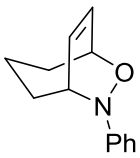
3-Phenyl-2-oxa-3-azabicyclo[2.2.2]oct-5-ene (1)



Following GP-I, starting from cyclohexa-1,3-diene (13 mmol, 1.2 ml) and nitrosobenzene (10 mmol, 1.07 g) in DCM at 0 °C to RT for 1 h. After purification via column chromatography on silica (petroleum ether/ethyl acetate 4:1), the product was obtained as a pale yellow solid (1.83 g, 98 %).

$\mathbf{R_f}$ = 0.32 (petroleum ether/ethyl acetate 10:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.25 – 7.17 (m, 2H), 7.04 – 6.97 (m, 2H), 6.96 – 6.89 (m, 1H), 6.58 (ddd, *J* = 8.3 Hz, 5. 9 Hz, 1.7 Hz, 1H), 6.14 (ddd, *J* = 8.3 Hz, 5.8 Hz, 1.5 Hz, 1H), 4.74 – 4.67 (m, 1H), 4.46 – 4.39 (m, 1H), 2.36 – 2.17 (m, 2H), 1.64 – 1.52 (m, 1H), 1.43 – 1.32 (m, 1H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 152.3, 131.6, 130.0, 128.4 (2C), 122.0, 117.5 (2C), 69.2, 56.5, 24.0, 21.4; **IR** (cm^{-1}) = 2933 (m), 1594 (s), 1486 (s), 1449 (m), 935 (s), 760 (s), 695 (s); **MS** (EI, 70 eV): m/z = 187.0 (M^+).

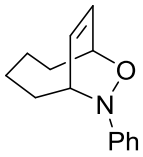
7-Phenyl-6-oxa-7-azabicyclo[3.2.2]non-8-ene (8)



Following GP-I, starting from cyclohepta-1,3-diene (6.5 mmol, 0.70 ml) and nitrosobenzene (5 mmol, 536 mg) in DCM at RT for 2 h. After purification via column chromatography on silica (petroleum ether/ethyl acetate 20:1) the product was obtained as a pale yellow solid (979 mg, 97 %).

$\mathbf{R_f}$ = 0.28 (petroleum ether/ethyl acetate 20:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.25 – 7.17 (m, 2H), 7.01 – 6.94 (m, 2H), 6.93 – 6.85 (m, 1H), 6.14 (ddd, *J* = 9.3 Hz, 6.2 Hz, 1.5 Hz, 1H), 6.02 (ddd, *J* = 9.3 Hz, 6.7 Hz, 0.9 Hz, 1H), 4.83 – 4.76 (m, 1H), 4.51 – 4.43 (m, 1H), 2.11 – 2.01 (m, 2H), 2.00 – 1.87 (m, 1H), 1.77 – 1.66 (m, 1H), 1.65 – 1.54 (m, 1H), 1.50 – 1.32 (m, 1H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 152.4, 128.5 (2C), 128.4, 126.5, 121.3, 117.1 (2C), 73.1, 61.4, 31.6, 27.8, 18.7; **IR** (cm^{-1}) = 3057 (w), 3033 (w), 2932 (m), 2910 (m), 1595 (s), 1485 (s), 755 (s), 693 (m); **MS** (EI, 70 eV): m/z = 201.1 (M^+).

8-Phenyl-7-oxa-8-azabicyclo[4.2.2]dec-9-ene (10)



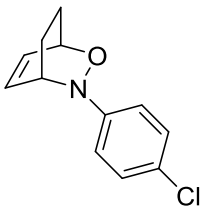
Following GP-I, starting from cycloocta-1,3-diene (2 mmol, 0.25 ml) and nitrosobenzene (2.2 mmol, 236 mg) in $CHCl_3$ at RT for 24 h. After purification via column chromatography on silica (petroleum ether/ethyl acetate 20:1) the product was obtained as a pale yellow solid (170 mg, 39 %).

$\mathbf{R_f}$ = 0.41 (petroleum ether/ethyl acetate 15:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.28 – 7.18 (m, 2H), 7.02 – 6.94 (m, 2H), 6.92 – 6.84 (m, 1H), 6.15 (dd, *J* = 10.1 Hz, 6.8 Hz, 1H), 5.80 (dd, *J* = 10.1 Hz, 4.5 Hz, 1H), 4.98 – 4.91 (m, 1H), 4.38 – 4.31 (m, 1H), 2.36 – 2.24 (m, 1H), 2.21 – 2.03 (m, 2H), 1.93 – 1.80 (m, 1H), 1.80 – 1.56 (m, 4H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 152.3, 129.6, 128.7 (2C), 126.7, 121.0, 115.7 (2C), 72.9, 58.3, 34.7, 32.8, 26.3, 22.4; **IR** (cm^{-1}) = 3037 (w), 2907 (s), 1597 (s), 1489 (s), 789 (s), 753 (s), 692 (s); **MS** (EI, 70 eV): m/z = 215.1 (M^+).

1,2-Oxazines synthesized from 1,3-dienes and in situ oxidized amines

General procedure (GP-II):[5] Under a nitrogen atmosphere, the corresponding amine, H_2O_2 (30 % in water, 2.2 eq.) and diphenyldiselenide (0.05 eq.) were dissolved in $CHCl_3$ and stirred at RT for 2 h. Cyclohexa-1,3-diene was slowly added and the reaction mixture was stirred for another 2-6 h at RT. The organic phase was separated and the solvent was evaporated in vacuo. The crude product was purified using column chromatography on silica with petroleum ether and ethyl acetate as eluent.

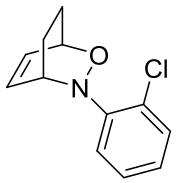
3-(4-Chlorophenyl)-2-oxa-3-azabicyclo[2.2.2]oct-5-ene (12)



Starting from 4-chloroaniline (10 mmol, 1.28 g) and following GP-II, the product was obtained as a brownish solid after purification via column chromatography on silica with petroleum ether/ethyl acetate 4:1 (590 mg, 27 %).

R_f = 0.50 (petroleum ether/ethyl acetate 4:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.20 – 7.12 (m, 2H), 6.97 – 6.90 (m, 2H), 6.57 (ddd, *J* = 8.1 Hz, 6.0 Hz, 1.8 Hz, 1H), 6.13 (ddd, *J* = 8.2 Hz, 5.8 Hz, 1.4 Hz, 1H), 4.73 – 4.67 (m, 1H), 4.41 – 4.34 (m, 1H), 2.34 – 2.15 (m, 2H), 1.64 – 1.52 (m, 1H), 1.42 – 1.31 (m, 1H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 151.0, 131.7, 129.8, 128.4 (2C), 127.0, 118.8 (2C), 69.3, 56.7, 23.8, 21.3; **IR** (cm^{-1}) = 3054 (w), 2970 (w), 2934 (m), 1883 (w), 1587 (m), 1481 (s), 735 (s) 704 (s), 671 (s); **MS** (EI, 70 eV): m/z = 221.1 (M^+).

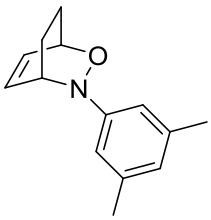
3-(2-Chlorophenyl)-2-oxa-3-azabicyclo[2.2.2]oct-5-ene (14)



Starting from 2-chloroaniline (10 mmol, 1.05 ml) and following GP-II, the product was obtained as an orange liquid after purification via column chromatography on silica with petroleum ether/ethyl acetate 20:1 (860 mg, 39 %).

R_f = 0.45 (petroleum ether/ethyl acetate 10:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.30 – 7.23 (m, 1H), 7.15 – 7.07 (m, 2H), 7.00 – 6.90 (m, 1H), 6.71 (ddd, *J* = 8.2 Hz, 6.0 Hz, 1.7 Hz, 1H), 6.04 (ddd, *J* = 8.2 Hz, 6.1 Hz, 1.4 Hz, 1H), 4.79 – 4.71 (m, 1H), 4.57 – 4.50 (m, 1H), 2.42 – 2.21 (m, 2H), 1.60 – 1.48 (m, 1H), 1.45 – 1.33 (m, 1H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 147.9, 132.1, 129.7, 129.1, 126.5, 124.5, 124.4, 122.4, 69.5, 54.5, 23.7, 21.6; **IR** (cm^{-1}) = 3057 (w), 2968 (m), 2932 (m), 1584 (m), 1462 (s), 935 (s), 754 (s) 680 (s); **MS** (ESI): m/z = 244.05 (MNa^+).

3-(3,5-Dimethylphenyl)-2-oxa-3-azabicyclo[2.2.2]oct-5-ene (16)



Starting from 3,5-dimethylaniline (5 mmol, 0.62 ml) and following GP-II, the product was obtained as an orange liquid after purification via column chromatography on silica with petroleum ether/ethyl acetate 20:1 (135 mg, 13 %).

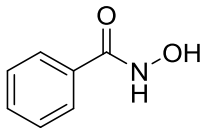
R_f = 0.33 (petroleum ether/ethyl acetate 10:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 6.63 (s, 2H), 6.58 – 6.55 (m, 1H), 6.57 (ddd, *J* = 8.1 Hz, 5.9 Hz, 1.7 Hz, 1H), 6.17 (ddd, *J* = 8.1 Hz, 5.8 Hz, 1.5 Hz, 1H), 4.71 – 4.65 (m, 1H), 4.45 – 4.38 (m, 1H), 2.32 – 2.15 (m, 2H), 2.24 (s, 6H), 1.62 – 1.48 (m, 1H), 1.44 – 1.30 (m, 1H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 152.4, 137.9 (2C), 131.5, 130.0, 123.8, 115.2 (2C), 69.1, 56.3, 24.1, 21.6 (2C), 21.4; **IR** (cm^{-1}) = 3052 (w), 2966 (m), 2933 (m), 2857 (w), 1592 (s), 1469 (m), 1450 (m) 935 (s), 908 (s), 831 (s), 710 (s); **MS** (EI, 70 eV): m/z = 238.12 (MNa^+).

1,2-Oxazines synthesized from 1,3-dienes and in situ oxidized hydroxamic acids

General procedure (GP-III):[6] Bu_4NIO_4 (1 eq.) and cyclohexa-1,3-diene (1.25 eq.) were dissolved in DCM at 0 °C. The corresponding hydroxamic acid (1.5 eq.) was added in portions over 10 min. The reaction mixture was stirred for another 45 min at 0 °C and was then allowed to warm to RT. After washing with 10 % $Na_2S_2O_3$ solution, 2*N* NaOH solution and Brine, the organic phase was dried over Na_2SO_4 and evaporated to dryness. The crude product was purified using column chromatography with petroleum ether and ethyl acetate as eluent.

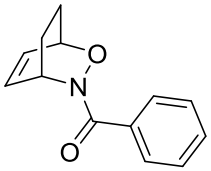
The hydroxamic acids **18a**, **20a**, **22a, 26a** and **38a** were prepared from literature known procedures starting from the corresponding acids or acid chlorides. [7],[8],[9]

***N*-Hydroxybenzamide (18a)**[7]



Yield = 49 % (white solid); **R_f** = 0.17 (petroleum ether/ethyl acetate 1:1); **^{1}H-NMR** (D_2O, 300 MHz): δ in ppm = 7.63 – 7.55 (m, 2H), 7.55 – 7.47 (m, 1H), 7.46 – 7.37 (m, 2H); **^{13}C-NMR** (D_2O, 75 MHz): δ in ppm = 168.5, 132.3, 131.0, 128.8 (2C), 126.9 (2C); **IR** (cm^{-1}) = 3292 (s), 3066 (m), 2982 (m), 2760 (br), 1641 (s), 1600 (s), 1545 (s), 705 (s), 689 (s); **MS** (EI, 70 eV): m/z = 137.1 (M^+).

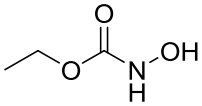
2-Oxa-3-azabicyclo[2.2.2]oct-5-en-3-yl)(phenyl)methanone (18)



Starting from *N*-hydroxybenzamide **18a** (1.8 mmol, 247 mg) and following GP-III, the product was obtained as an off-white solid after purification via column chromatography on silica with petroleum ether/ethyl acetate 2:1 (188 mg, 70 %).

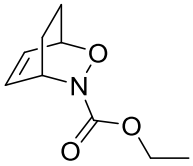
$\mathbf{R_f}$ = 0.35 (petroleum ether/ethyl acetate 1:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.78 – 7.53 (m, 2H), 7.49 – 7.32 (m, 3H), 6.78 – 6.47 (m, 2H), 5.36 (s, 1H), 4.81 (s, 1H), 2.43 – 2.13 (m, 2H), 1.62 – 1.44 (m, 2H); **IR** (cm^{-1}) = 3059 (w), 3065 (w), 2951 (m), 2932 (m), 1639 (s), 1577 (s), 728 (s) 691 (s); **MS** (ESI): m/z = 238.08 (MNa^+).

Ethyl hydroxycarbamate (20a)[8]



Yield = 68 % (pale yellow liquid); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.29 (s, 1H), 7.04 (s, 1H), 4.22 (q, *J* = 7.1 Hz, 2H), 1.29 (t, *J* = 7.1 Hz, 3H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 159.6, 62.4, 14.4; **IR** (cm^{-1}) = 3271 (br), 2984 (m), 1698 (s), 1285 (s), 1115 (s), 772 (m); **MS** (EI, 70 eV): m/z = 105.0 (M^+).

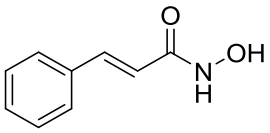
Ethyl-2-oxa-3-azabicyclo[2.2.2]oct-5-ene-3-carboxylate (20)



Starting from ethyl hydroxycarbamate **20a** (2.5 mmol, 263 mg) and following a slightly different synthesis than GP-III (for detailed informations see reference [10]), the product was obtained as an orange liquid after purification via column chromatography on silica with petroleum ether/ethyl acetate 1:1 (332 mg, 72 %).

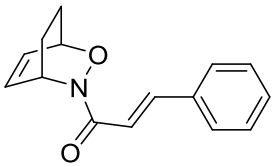
R_f = 0.55 (petroleum ether/ethyl acetate 1:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 6.63 – 6.50 (m, 2H), 4.85 – 4.79 (m, 1H), 4.79 – 4.73 (m, 1H), 4.29 – 4.10 (m, 2H), 2.27 – 2.08 (m, 2H), 1.57 – 1.45 (m, 1*H*), 1.45 – 1.34 (m, 1*H*), 1.28 (t, *J* = 7.2 Hz, 3*H*); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 158.4, 132.0, 131.6, 71.0, 62.3, 50.0, 23.5, 20.6, 14.5; **IR** (cm^{-1}) = 2979 (m), 2936 (m), 1738 (s), 1697 (s), 1264 (s), 1075 (s), 769 (m), 708 (m); **MS** (EI, 70 eV): m/z = 183.1 (M^+).

***N*-Hydroxycinnamamide (22a)**[9]



Yield = 43 % (off-white solid); **^{1}H-NMR** (DSMO-d_6, 300 MHz): δ in ppm = 10.78 (s, 1H), 9.06 (s, 1H), 7.60 – 7.52 (m, 2H), 7.51 – 7.35 (m, 4H), 4.47 (d, *J* = 15.8 Hz, 1H); **^{13}C-NMR** (DSMO-d_6, 75 MHz): δ in ppm = 162.7, 138.3, 134.8, 129.4, 128.9 (2C), 127.4 (2C), 119.0; **IR** (cm^{-1}) = 3257 (br), 3029 (w), 2667 (br), 1666 (s), 1562 (s), 1065 (s), 966 (s), 760 (s), 711 (m); **MS** (EI, 70 eV): m/z = 163.1 (M^+).

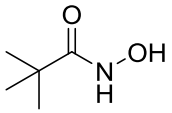
2-Oxa-3-azabicyclo[2.2.2]oct-5-en-3-yl)-3-phenylprop-2-en-1-one (22)



Starting from *N*-hydroxycinnamamide **22a** (1.8 mmol, 294 mg) and following GP-III, the product was obtained as a yellow liquid after purification via column chromatography on silica with petroleum ether/ethyl acetate 1:1 (243 mg, 67 %).

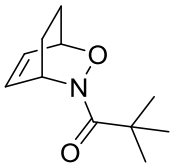
R_f = 0.33 (petroleum ether/ethyl acetate 1:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.65 (d, *J* = 16.0 Hz, 1H), 7.57 – 7.49 (m, 2H), 7.39 – 7.30 (m, 2H), 6.92 (d, *J* = 16.0 Hz, 1H), 6.73 – 6.63 (m, 1H), 6.54 (ddd, *J* = 8.2 Hz, 5.9 Hz, 1.5 Hz, 1H), 5.41 (br, 1H), 4.88 – 4.79 (m, 1H), 2.35 – 2.08 (m, 2H), 1.61 – 1.46 (m, 2H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 165.1, 142.2, 135.3, 133.2, 131.4, 129.6, 128.7 (2C), 128.0 (2C), 117.1, 72.1, 46.5, 23.6, 21.1; **IR** (cm^{-1}) = 3059 (w), 3025 (w), 2970 (w), 2936 (m), 1648 (s), 1604 (s), 760 (s) 698 (s); **MS** (EI, 70 eV): m/z = 241.1 (M^+).

***N*-Hydroxypivalamide (24a)**[9]



Yield = 17 % (white solid); **^{1}H-NMR** (DMSO-d_6, 300 MHz): δ in ppm = 10.31 (s, 1H), 8.53 (s, 1H), 1.08 (s, 9H); **^{13}C-NMR** (DMSO-d_6, 75 MHz): δ in ppm = 174.4, 36.9, 27.2 (3C); **IR** (cm^{-1}) = 3258 (br), 2969 (m), 2871 (m), 1609 (s), 1520 (s), 1227 (s), 1054 (s), 1014 (s), 942 (s), 611 (s); **MS** (EI, 70 eV): m/z = 117.1 (M^+).

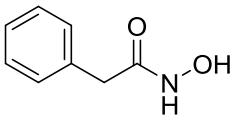
1-(2-Oxa-3-azabicyclo[2.2.2]oct-5-en-3-yl)-2,2-dimethylpropan-1-one (24)



Starting from *N*-hydroxypivalamide **24a** (1.2 mmol, 141 mg) and following GP-III, the product was obtained as an off-white solid after purification via column chromatography on silica with petroleum ether/ethyl acetate 4:1 (108 mg, 55 %).

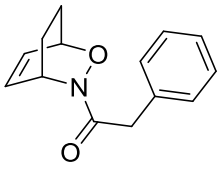
R_f = 0.43 (petroleum ether/ethyl acetate 4:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 6.64 (ddd, *J* = 8.2 Hz, 6.0 Hz, 1.3 Hz, 1H), 6.50 (ddd, *J* = 8.2 Hz, 5.6 Hz, 1.5 Hz, 1H), 5.35 – 5.27 (m, 1H), 4.79 – 4.71 (m, 1H), 2.29 – 2.15 (m, 1H), 2.14 – 1.99 (m, 1H), 1.55 – 1.36 (m, 2H), 1.17 (s, 9H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 133.6, 131.0, 71.6, 47.1, 39.0, 26.3 (3C), 23.6, 20.6; **IR** (cm^{-1}) = 3061 (w), 2972 (m), 2933 (m), 1633 (s), 1612 (s), 1203 (s), 941 (s), 711 (m); **MS** (EI, 70 eV): m/z = 195.1 (M^+).

***N*-Hydroxy-2-phenylacetamide (26a)**[9]



Yield = 60 % (white solid); **^{1}H-NMR** (DSMO-d_6, 300 MHz): δ in ppm = 10.67 (s, 1H), 8.84 (s, 1H), 7.35 – 7.18 (m, 5H), 3.28 (s, 2H); **^{13}C-NMR** (DSMO-d_6, 75 MHz): δ in ppm = 167.0, 136.0, 128.9 (2C), 128.2 (2C), 126.4, 39.4; **IR** (cm^{-1}) = 3186 (br), 3031 (w), 2903 (br), 1630 (s), 1546 (s), 1052 (s), 977 (s), 691 (s), 540 (s); **MS** (EI, 70 eV): m/z = 151.0 (M^+).

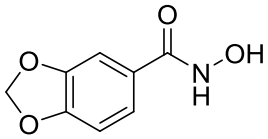
1-(2-Oxa-3-azabicyclo[2.2.2]oct-5-en-3-yl)-2-phenylethan-1-one (26)



Starting from *N*-hydroxy-2-phenylacetamide **26a** (2.7 mmol, 408 mg) and following GP-III, the product was obtained as a white solid after purification via column chromatography on silica with petroleum ether/ethyl acetate 2:1 (429 mg, 99 %).

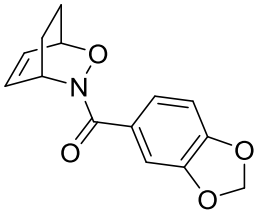
$\mathbf{R_f}$ = 0.30 (petroleum ether/ethyl acetate 2:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.35 – 7.16 (m, 5H), 6.60 (ddd, *J* = 8.2 Hz, 6.1 Hz, 1.3 Hz, 1H), 6.43 (ddd, *J* = 8.2 Hz, 5.6 Hz, 1.5 Hz, 1H), 5.30 – 5.22 (m, 1H), 4.78 – 4.69 (m, 1H), 3.69 – 3.53 (m, 2H), 2.19 – 1.97 (m, 2H), 1.54 – 1.37 (m, 2H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 170.6, 134.8, 133.0, 131.3, 129.5 (2C), 128.3 (2C), 126.5, 71.9, 46.6, 40.1, 23.4, 21.0; **IR** (cm^{-1}) = 3058 (w), 2944 (w), 1640 (s), 1410 (s), 1362 (s), 953 (s), 697 (s); **MS** (EI, 70 eV): m/z = 229.1 (M^+).

***N*-hydroxybenzo[d][1,3]dioxole-5-carboxamide (28a)**[9]



Yield = 40 % (white solid); **^{1}H-NMR** (DMSO-d_6, 400 MHz): δ in ppm = 11.07 (s, 1H), 8.98 (s, 1H), 7.35 (d, *J* = 8.2 Hz, 1H), 7.28 (s, 1H), 6.98 (d, *J* = 8.2 Hz, 1H), 6.09 (s, 2H); **^{13}C-NMR** (DMSO-d_6, 100 MHz): δ in ppm = 164.0, 150.1, 147.8, 127.0, 122.2, 108.5, 107.3, 102.1; **IR** (cm^{-1}) = 3308 (br), 2775 (br), 1597 (s), 1562 (s), 1490 (s), 1263 (s), 1243 (s), 926 (s), 738 (s), 597 (s); **HRMS** (ESI) calculated for $C_8H_7NO_4$ = 181.0375 (M^+), found 181.0368 (M^+).

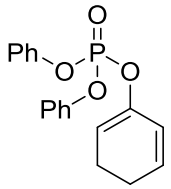
Benzo[d][1,3]dioxol-5-yl(2-oxa-3-azabicyclo[2.2.2]oct-5-en-3-yl)methanone (28)



Starting from *N*-hydroxybenzo[d][1,3]dioxole-5-carboxamide **28a** (0.65 mmol, 118 mg) and following GP-III, the product was obtained as an off-white solid after purification via column chromatography on silica with petroleum ether/ethyl acetate 1:1 (157 mg, 82 %).

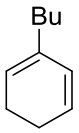
R_f = 0.26 (petroleum ether/ethyl acetate 2:1); **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ in ppm = 7.29 (s, 1H), 7.20 (s, 1H), 6.81 (d, *J* = 7.9 Hz, 1H), 6.65 (br, 1H), 6.58 – 6-50 (m, 1H), 5.99 (s, 2H), 5.20 (br, 1H), 4.81 (s, 1H), 2.38 – 2.14 (m, 2H), 1.61 – 1.45 (m, 2H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 168.8, 149.8, 147.1, 131.7, 127.9, 124.0, 109.4, 107.8, 101.4, 72.0, 23.6, 14.2; **IR** (cm^{-1}) = 3015 (w), 2968 (w), 1635 (s), 1602 (s), 1439 (s), 1260 (s), 1034 (s) 872 (s); **HRMS** (ESI) calculated for $C_{14}H_{13}NO_4$ = 282.0737 (MNa^+), found 282.0738 (Mna^+).

Cyclohexa-1,5-dien-1-yl diphenyl phosphate (44)[3]



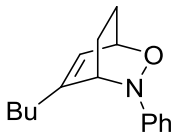
Yield = 88 % (white solid); **R_f** = 0.51 (petroleum ether/ethyl acetate 4:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.40 – 7.30 (m, 4H), 7.28 – 7.15 (m, 6H), 5.97 – 5.88 (m, 1H), 5.85 – 5.77 (m, 1H), 5.58 – 5.51 (m, 1H), 2.37 – 2.11 (m, 4H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 150.6, 150.5, 145.3, 145.1, 130.4, 129.8 (2C), 125.5, 122.5, 122.4, 120.2 (2C), 120.1 (2C), 108.8, 108.7, 21.9, 21.4; **^{31}P-NMR** ($CDCl_3$, 121 MHz): δ in ppm = -17.4; **IR** (cm^{-1}) = 3072 (w), 2938 (w), 1652 (m), 1589 (m), 1487 (s), 1296 (s), 1132 (s), 937 (s), 752 (s), 687 (s); **MS** (EI, 70 eV): m/z = 328.1 (M^+).

2-Butylcyclohexa-1,3-diene (30a)[3]



Yield = 90 %; **R_f** = 0.99 (petroleum ether/ethyl acetate 20:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 5.84 – 5.80 (m, 2H), 5.49 – 5.43 (m, 1H), 2.13 – 2.07 (m, 4H), 2.04 – 1.96 (m, 2H), 1.44 – 1.23 (m, 4H), 0.89 (t, *J* = 7.1 Hz, 3H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 136.0, 127.3, 126.5, 119.9, 35.3, 30.6, 22.5, 22.4, 22.3, 14.0; **IR** (cm^{-1}) = 3032 (w), 2927 (s), 1259 (s), 1099 (s), 1014 (s), 801 (s); **MS** (EI, 70eV): m/z = 136.1 (M^+).

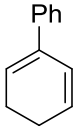
5-Butyl-3-phenyl-2-oxa-3-azabicyclo[2.2.2]oct-5-ene (30)



Following GP-I, starting from 2-butylcyclohexa-1,3-diene **30a** (15.4 mmol, 2.10 g) and nitrosobenzene (14 mmol, 1.50 g) in DCM at -78 °C to RT for 3 h. After purification via column chromatography on silica (petroleum ether/ethyl acetate 20:1), the product was obtained as a pale yellow liquid (2.64 g, 77 %).

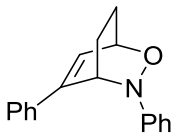
$\mathbf{R_f}$ = 0.22 (petroleum ether/ethyl acetate 20:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.23 – 7.14 (m, 2H), 7.03 – 6.95 (m, 2H), 6.94 – 6.86 (m, 1H), 6.15 – 6.08 (m, 1H), 4.69 (ddd, *J* = 6.0 Hz, 3.9 Hz, 1.4 Hz, 1H), 4.21 – 4.15 (m, 1H), 2.35 – 2.11 (m, 2H), 1.81 – 1.69 (m, 2H), 1.52 (tt, *J* = 12.1 Hz, 2.9 Hz, 1H), 1.38 – 1.29 (m, 1H), 1.21 – 1.03 (m, 4H), 0.76 (t, *J* = 7.1 Hz, 3H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 152.6, 142.7, 128.2 (2C), 122.4, 122.0, 117.5 (2C), 69.8, 61.3, 34.4, 28.4, 25.0, 22.2, 21.7, 13.8; **IR** (cm^{-1}) = 2957 (m), 2928 (m), 1595 (s), 1486 (s), 949 (s), 759 (s), 694 (s); **HRMS** (ESI) calculated for $C_{16}H_{21}NO$ = 266.1521 (MNa^+), found 266.1515.

2-Phenylcyclohexa-1,3-diene (32a)[3]



Yield = 63 % (colorless liquid); **bp** = 80 °C (0.2 mbar); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.41 – 7.28 (m, 4H), 7.28 – 7.22 (m, 1H), 6.36 – 6.28 (m, 1H), 6.12 – 6.05 (m, 1H), 6.05 – 5.97 (m, 1H), 2.38 – 2.27 (m, 2H), 2.26 – 2.14 (m, 2H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 140.7, 135.8, 128.4 (2C), 127.8, 126.9, 125.8, 125.4 (2C), 123.0, 23.0, 22.0; **IR** (cm^{-1}) = 3033 (m), 2933 (m), 1599 (w), 1494 (m), 762 (s), 729 (s), 695 (s); **MS** (EI, 70eV): m/z = 156.1 (M^+).

3,5-Diphenyl-2-oxa-3-azabicyclo[2.2.2]oct-5-ene (32)

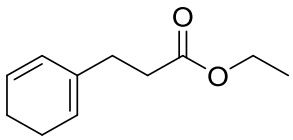


Following GP-I, starting from 2-phenylcyclohexa-1,3-diene **32a** (2.6 mmol, 406 mg) and nitrosobenzene (2 mmol, 214 mg) in DCM at -78 °C to RT for 3 h. After purification via column

chromatography on silica (petroleum ether/ethyl acetate 10:1), the product was obtained as an off-white solid (526 mg, 99 %). The regioselectivity of the product was confirmed by COSY and NOESY experiments.

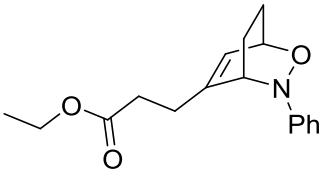
R_f = 0.19 (petroleum ether/ethyl acetate 20:1); **^{1}H-NMR** ($CDCl_3$, 500 MHz): δ in ppm = 7.22 – 7.13 (m, 5H), 7.08 – 7.00 (m, 4H), 6.90 – 6.85 (m, 1H), 6.73 (dd, *J* = 6.1 Hz, 2.1 Hz, 1H), 4.90 – 4.86 (m, 1H), 4.78 – 4.74 (m, 1H), 2.52 – 2.44 (m, 1H), 2.36 – 2.28 (m, 1H), 1.68 (tt, *J* = 12.2 Hz, 3.2 Hz, 1H), 1.50 – 1.42 (m, 1H); **^{13}C-NMR** ($CDCl_3$, 125 MHz): δ in ppm = 151.8, 140.8, 136.9, 128.4 (2C), 128.4 (2C), 127.7, 125.0 (2C), 124.0, 122.7, 118.1 (2C), 69.6, 60.4, 24.2, 22.0; **IR** (cm^{-1}) = 2967 (w), 2929 (w), 1594 (m), 1488 (m), 1448 (m), 953 (s), 752 (s), 692 (s); **HRMS** (ESI) calculated for $C_{18}H_{17}NO$ = 263.1310 (M^+), found 263.1309.

Ethyl 3-(cyclohexa-1,5-dien-1-yl)propanoate (34a)[4]



Yield = 71 % (colorless liquid); **R_f** = 0.42 (petroleum ether/ethyl acetate 20:1); **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ in ppm = 5.90 – 5.76 (m, 2H), 5.54 – 5.47 (m, 1H), 4.13 (q, *J* = 7.1 Hz, 2H), 2.44 – 2.30 (m, 4H), 2.16 – 2.03 (m, 4H), 1.25 (t, *J* = 7.1 Hz, 3H); **^{13}C-NMR** ($CDCl_3$, 100 MHz): δ in ppm = 173.3, 134.3, 127.2, 126.6, 120.7, 60.3, 33.5, 30.7, 22.3 (2C), 14.2; **IR** (cm^{-1}) = 3032 (w), 2933 (m), 2823 (m), 1733 (s), 1160 (m), 1041 (w); **MS** (EI, 70eV): m/z = 180 (M^+).

Ethyl 3-(3-phenyl-2-oxa-3-azabicyclo[2.2.2]oct-5-en-5-yl)propanoate (34)

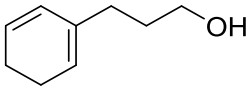


Following GP-I, starting from ethyl 3-(cyclohexa-1,5-dien-1-yl)propanoate **34a** (1.5 mmol, 270 mg) and nitrosobenzene (1.5 mmol, 161 mg) in DCM at -78 °C to RT for 3 h. After purification via column chromatography on silica (petroleum ether/ethyl acetate 2:1), the product was obtained as an off-white solid (402 mg, 93 %).

R_f = 0.55 (petroleum ether/ethyl acetate 2:1); **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ in ppm = 7.23 – 7.16 (m, 2H), 7.01 – 6.95 (m, 2H), 6.95 – 6.88 (m, 1H), 6.20 – 6.14 (m, 1H), 4.73 – 4.67 (m, 1H),

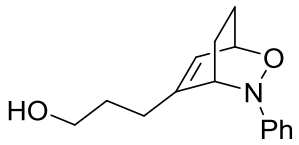
4.22 – 4.17 (m, 1H), 4.06 (q, *J* = 7.2 Hz, 2H), 2.35 – 2.25 (m, 1H), 2.23 – 1.97 (m, 5H), 1.61 – 1.50 (m, 1H), 1.36 – 1.26 (m, 1H), 1.20 (t, *J* = 7.2 Hz, 3H); **^{13}C-NMR** ($CDCl_3$, 100 MHz): δ in ppm = 172.7, 152.4, 140.9, 128.3 (2C), 123.2, 122.2, 117.5 (2C), 69.6, 61.4, 60.4, 31.2, 29.5, 24.7, 21.6, 14.2; **IR** (cm^{-1}) = 2966 (w), 2934 (w), 1728 (s), 1594 (m), 1486 (m), 1158 (s), 950 (s), 760 (s), 695 (s); **HRMS** (EI) calculated for $C_{17}H_{21}NO_3$ = 287.1521 (M^+), found 287.1516.

3-(Cyclohexa-1,5-dien-1-yl)propan-1-ol (36a)[4]



Yield = 96 % (colorless liquid); $\mathbf{R_f}$ = 0.67 (petroleum ether/ethyl acetate 1:1); **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ in ppm = 5.89 – 5.80 (m, 2H), 5.54 – 5.49 (m, 1H), 3.65 (t, *J* = 7.2 Hz, 2H), 2.18 – 2.04 (m, 6H), 1.73 – 1.64 (m, 2H), 1.42 (br, 1H); **^{13}C-NMR** ($CDCl_3$, 100 MHz): δ in ppm = 135.2, 127.0, 126.9, 120.5, 62.6, 31.8, 31.2, 22.4, 22.3; **IR** (cm^{-1}) = 3320 (br), 3030 (m), 2932 (s), 2870 (s), 1426 (m), 1057 (s), 734 (s), 589 (s); **MS** (EI, 70eV): m/z = 138 (M^+).

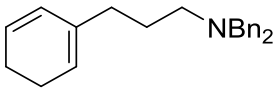
3-(3-Phenyl-2-oxa-3-azabicyclo[2.2.2]oct-5-en-5-yl)propan-1-ol (36)



Following GP-I, starting from 3-(cyclohexa-1,5-dien-1-yl)propan-1-ol **36a** (1.5 mmol, 207 mg) and nitrosobenzene (1.5 mmol, 161 mg) in DCM at -78 °C to RT for 3 h. After purification via column chromatography on silica (petroleum ether/ethyl acetate 1:1), the product was obtained as a colorless liquid (322 mg, 88 %).

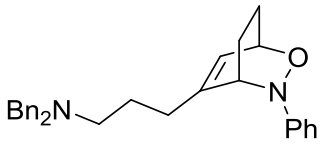
$\mathbf{R_f}$ = 0.32 (petroleum ether/ethyl acetate 1:1); **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ in ppm = 7.23 – 7.15 (m, 2H), 7.02 – 6.96 (m, 2H), 6.95 – 6.88 (m, 1H), 6.16 – 6.11 (m, 1H), 4.72 – 4.66 (m, 1H), 4.19 – 4.15 (m, 1H), 3.35 (ddt, *J* = 26.1 Hz, *J* = 11.0 Hz, *J* = 6.3 Hz, 2H), 2.33 – 2.23 (m, 1H), 2.22 – 2.12 (m, 1H), 1.93 – 1.73 (m, 2H), 1.55 (br, 1H), 1.52 (tt, *J* = 12.2 Hz, *J* = 3.1 Hz, 1H), 1.46 – 1.27 (m, 3H); **^{13}C-NMR** ($CDCl_3$, 100 MHz): δ in ppm = 152.4, 141.9, 128.3 (2C), 122.9, 122.1, 117.6 (2C), 69.7, 61.9, 61.5, 30.5, 29.0; 24.9; 21.5; **IR** (cm^{-1}) = 3362 (br), 3055 (w), 2933 (m), 1594 (m), 1485 (m), 947 (s), 762 (s), 695 (s); **HRMS** (ESI) calculated for $C_{15}H_{19}NO_2Na$ = 268.1308 (MNa^+), found 268.1302.

***N,N*-Dibenzyl-3-(cyclohexa-1,5-dien-1-yl)propan-1-amine (38a)**[4]



Yield = 48 % starting from alcohol **36a** via the corresponding tosylate (colorless liquid); $\mathbf{R_f}$ = 0.48 (petroleum ether/ethyl acetate 20:1); **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ in ppm = 7.39 – 7.33 (m, 4H), 7.33 – 7.26 (m, 4H), 7.25 – 7.18 (m, 2H), 5.84 – 5.73 (m, 2H), 5.39 – 5.33 (m, 1H), 3.55 (s, 4H), 2.41 (t, *J* = 7.3 Hz, 2H), 2.12 – 1.95 (m, 6H), 1.71 – 1.56 (m, 2H); **^{13}C-NMR** ($CDCl_3$, 100 MHz): δ in ppm = 140.0, 135.6, 128.8, 128.1, 127.2, 126.7, 126.7, 120.1, 58.3, 52.9, 33.2, 25.7, 22.4, 22.3; **IR** (cm^{-1}) = 3027 (m), 2932 (m), 2820 (m), 1494 (m), 1453 (m), 736 (s), 689 (s); **MS** (EI, 70eV): m/z = 317 (M^+).

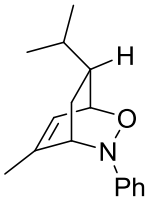
***N,N*-Dibenzyl-3-(3-phenyl-2-oxa-3-azabicyclo[2.2.2]oct-5-en-5-yl)propan-1-amine (38)**



Following GP-I, starting from *N*,*N*-dibenzyl-3-(cyclohexa-1,5-dien-1-yl)propan-1-amine **38a** (1 mmol, 317 mg) and nitrosobenzene (1 mmol, 107 mg) in DCM at -78 °C to RT for 3 h. After purification via column chromatography on silica (petroleum ether/ethyl acetate 10:1), the product was obtained as a colorless liquid (312 mg, 74 %).

$\mathbf{R_f}$ = 0.24 (petroleum ether/ethyl acetate 10:1); **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ in ppm = 7.34 – 7.13 (m, 12H), 6.98 – 6.91 (m, 2H), 6.91 – 6.85 (m, 1H), 5.91 (d, *J* = 5.9 Hz, 1H), 4.63 – 4.58 (m, 1H), 4.10 – 4.06 (m, 1H), 3.48 – 3.37 (m, 4H), 2.28 – 2.06 (m, 4H), 1.80 – 1.62 (m, 2H), 1.46 – 1.14 (m, 4H); **^{13}C-NMR** ($CDCl_3$, 100 MHz): δ in ppm = 152.6; 142.1; 139.9; 128.8; 128.2; 128.1; 126.8; 122.7; 122.1; 117.6; 69.8; 61.4; 58.4; 52.7; 32.1; 24.8; 23.8; 21.7; **IR** (cm^{-1}) = 3026 (w), 2933 (m), 1595 (m), 1488 (m), 1452 (m), 952 (m), 747 (m), 697 (s); **HRMS** (ESI) calculated for $C_{29}H_{32}N_2O$ = 425.2587 (MH^+), found 425.2599.

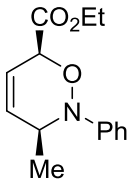
7-Isopropyl-5-methyl-3-phenyl-2-oxa-3-azabicyclo[2.2.2]oct-5-ene (40)



Following GP-I, starting from a racemic mixture of α-Phellandren (4 mmol, 0.65 ml) and nitrosobenzene (2 mmol, 214 mg) in DCM at -78 °C to RT for 2 h. After purification via column chromatography on silica (petroleum ether/ethyl acetate 20:1), the product was obtained as an off-white solid (340 mg, 70 %). The regioselectivity and stereochemistry on C-7 was determined by NOESY and COSY experiments.

$\mathbf{R_f}$ = 0.32 (petroleum ether/ethyl acetate 20:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.24 – 7.15 (m, 2H), 7.04 – 6.97 (m, 2H), 6.95 – 6.86 (m, 1H), 6.08 – 6.02 (m, 1H), 4.68 (dd, *J* = 6.0 Hz, 3.6 Hz, 1H), 4.19 – 4.13 (m, 1H), 2.39 (ddd, *J* = 12.6 Hz, 8.9 Hz, 3.5 Hz, 1H), 1.95 – 1.83 (m, 1H), 1.50 (d, *J* = 1.7 Hz, 3H), 1.18 (ddd, *J* = 12.9 Hz, 4.0 Hz, 2.6 Hz, 1H), 1.07 – 0.95 (m, 1H), 0.91 (d, *J* = 6.2 Hz, 3H), 0.84 (d, *J* = 6.2 Hz, 3H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 152.6, 139.3, 128.3 (2C), 121.9, 121.0, 117.4 (2C), 72.7, 62.2, 44.0, 32.5, 28.2, 20.7, 20.7, 20.1; **IR** (cm^{-1}) = 2956 (s), 1654 (m), 1596 (s), 759 (s), 694 (s); **HRMS** (ESI) calculated for $C_{16}H_{21}NO$ = 244.1696 (MH^+), found 244.1677.

Ethyl-3-methyl-2-phenyl-3,6-dihydro-2*H*-1,2-oxazine-6-carboxylate (42)

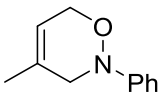


Following GP-I, starting from ethyl sorbate (5 mmol, 701 mg) and nitrosobenzene (5 mmol, 536 mg) in $CHCl_3$ at -78 °C to RT. After purification via column chromatography on silica (petroleum ether/ethyl acetate 10:1), the product was obtained as an orange liquid (636 mg, 51 %).

$\mathbf{R_f}$ = 0.23 (petroleum ether/ethyl acetate 20:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.37 – 7.28 (m, 2H), 7.25 – 7.18 (m, 2H), 7.10 – 7.02 (m, 1H), 6.08 – 5.99 (m, 2H), 5.07 – 5.01 (m, 1H), 4.28 (qd, *J* = 7.2 Hz, 2.4 Hz, 2H), 4.14 – 4.03 (m, 1H), 1.32 (t, *J* = 7.2 Hz, 3H), 1.1 (d, *J* = 6.6 Hz, 3H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 169.1, 148.1, 131.8, 128.8, 123.7, 123.2 (2C), 119.1,

76.5, 61.3, 55.3, 15.7, 14.2; **IR** (cm^{-1}) = 2980 (m), 1755 (s), 1731 (s), 1597 (s), 1491 (s), 757 (s), 693 (s); **HRMS** (ESI) calculated for $C_{14}H_{17}NO_3$ = 279.1101 (MNa^+), found 270.1099.

4-Methyl-2-phenyl-3,6-dihydro-2*H*-1,2-oxazine (44)



Following GP-I, starting from freshly distilled isoprene (4 mmol, 0.40 ml) and nitrosobenzene (2 mmol, 214 mg) in DCM at RT. After purification via column chromatography on silica (petroleum ether/ethyl acetate 20:1) followed by kugelrohr distillation, the product was obtained as a colorless liquid (60 mg, 17 %).

$\mathbf{R_f}$ = 0.42 (petroleum ether/ethyl acetate 20:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.35 – 7.27 (m, 2H), 7.17 – 7.10 (m, 2H), 7.03 – 6.96 (m, 1H), 5.67 – 5.60 (m, 1H), 4.52 – 4.45 (m, 2H), 3.73 – 3.67 (m, 2H), 1.85 – 1.78 (m, 3H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 150.4, 130.7, 128.8 (2C), 122.4, 119.8, 115.9 (2C), 68.5, 56.1, 20.2; IR (cm^{-1}) = 3060 (w), 3026 (w), 2970 (w), 2932 (w), 2838 (w), 1599 (s), 1491 (s), 1216 (s), 1083 (s), 752 (s), 691 (s); **HRMS** (ESI) calculated for $C_{11}H_{13}NO$ = 175.0997 (M^+), found 175.0995.

Iron-catalyzed N-O-bond cleavage

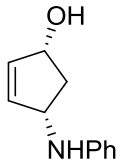
General procedure for the Iron-catalyzed reductive N-O-bond cleavage (GP-IV)

In a 10 ml Schlenk tube, $[Bu_4N][Fe(CO)_3NO]$ (8.3 mg, 0.02 mmol), malononitrile (19.8 mg, 0.3 mmol) and the oxazine (0.2 mmol) were dissolved in dry THF (0.5 ml) and stirred at 80 °C for 16 h. The crude reaction mixture was purified by column chromatography on silica using a gradient of petroleum ether and ethyl acetate to yield the corresponding 1,4-aminoalcohol.

General procedure for the tandem Hetero-Diels-Alder/Iron-catalyzed reductive N-O-bond cleavage (GP-V)

In a 10 ml Schlenk tube, the nitroso compound (0.18 mmol) and the diene (0.2 mmol) were dissolved in THF (0.5 ml) and stirred for 2-3 h at room temperature or from -78 °C to room temperature until the green solution turned orange. Then $[Bu_4N][Fe(CO)_3NO]$ (8.3 mg, 0.02 mmol) and malononitrile (19.8 mg, 0.3 mmol) were added and the reaction mixture was stirred at 80 °C for 16 h. The crude reaction mixture was purified by column chromatography on silica using a gradient of petroleum ether ethyl acetate to yield the corresponding 1,4-aminoalcohol.

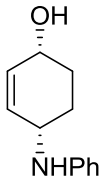
cis-4-(Phenylamino)cyclopent-2-en-1-ol (7)



Starting from nitrosobenzene (0.18 mmol, 19 mg) and freshly distilled cyclopentadiene (0.2 mmol, 17 µl) in THF (0.5 ml) following GP-V. The product was obtained as a brown liquid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 4:1 to 1:1 (14 mg, 43 %).

$\mathbf{R_f}$ = 0.34 (petroleum ether/ethyl acetate 1:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.24 – 7.11 (m, 2H), 6.81 – 6.57 (m, 3H), 6.13 – 5.93 (m, 2H), 4.88 – 4.70 (m, 1H), 4.50 – 4.30 (m, 1H), 2.90 – 2.72 (m, 1H), 1.59 – 1.41 (m, 1H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 147.2, 135.9, 135.3, 129.4 (2C), 117.8, 113.5 (2C), 75.5, 57.5, 42.2; **IR** (cm^{-1}) = 3319 (br), 3052 (w), 2934 (w), 2221 (w), 1602 (s), 1500 (s), 751 (s), 694 (m); **HRMS** (ESI) calculated for $C_{11}H_{13}NO$ = 198.0889 (MNa^+), found 198.0875.

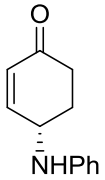
***cis*-4-(Phenylamino)cyclohex-2-en-1-ol (4)**



Starting from 3-phenyl-2-oxa-3-azabicyclo[2.2.2]oct-5-ene **1** and following GP-IV, the product was obtained as an orange liquid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 2:1 to 1:1 (30 mg, 80 %) or using GP-V, resulting in a yield of 83 %.

$\mathbf{R_f}$ = 0.38 (petroleum ether/ethyl acetate 1:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.22 – 7.13 (m, 2H), 6.75 – 6.67 (m, 1H), 6.65 – 6.58 (m, 2H), 5.93 – 5.84 (m, 2H), 4.25 – 4.18 (m, 1H), 3.98 – 3.91 (m, 1H), 1.95 – 1.67 (m, 4H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 146.9, 132.2, 131.4, 129.4 (2C), 117.6, 113.3 (2C), 65.2, 47.8, 28.9, 24.9; **IR** (cm^{-1}) = 3360 (br), 3023 (w), 2942 (m), 2204 (w), 1599 (s), 1501 (s), 749 (s), 692 (s); **MS** (EI, 70 eV): m/z = 189.1 (M^+).

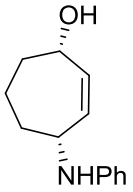
4-(Phenylamino)cyclohex-2-en-1-one (5)



Starting from 3-phenyl-2-oxa-3-azabicyclo[2.2.2]oct-5-ene **1** and following GP-IV, the product was obtained as an orange liquid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 2:1 to 1:1 (4 mg, 10 %).

$\mathbf{R_f}$ = 0.46 (petroleum ether/ethyl acetate 2:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.25 – 7.18 (m, 2H), 6.96 (ddd, J = 10.2 Hz, 2.6 Hz, 1.5 Hz, 1H), 6.78 (tt, J = 7.4 Hz, 1.0 Hz, 1H), 6.69 – 6.63 (m, 2H), 6.05 (ddd, J = 10.2 Hz, 2.1 Hz, 1.0 Hz, 1H), 4.38 – 4.27 (m, 1H), 3.70 (br, 1H), 2.68 – 2.56 (m, 1H), 2.55 – 2.46 (m, 1H), 2.46 – 2.36 (m, 1H), 2.03 – 1.87 (m, 1H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 198.7, 151.3, 146.0, 129.9, 129.6 (2C), 118.5, 113.6 (2C), 49.2, 36.3, 30.0; **IR** (cm^{-1}) = 3342 (br), 3052 (w), 2954 (w), 2191 (m), 1678 (s), 1600 (s), 1495 (s), 750 (s), 694 (s); **HRMS** calculated for $C_{12}H_{13}NO$ = 187.0997 (M^+), found 187.1000.

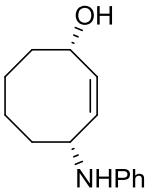
***cis*-4-(Phenylamino)cyclohept-2-en-1-ol (9)**



Starting from 7-phenyl-6-oxa-7-azabicyclo[3.2.2]non-8-ene **8** and following GP-IV, the product was obtained as a brown solid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 4:1 to 1:1 (29 mg, 70 %) or using GP-V, resulting in a yield of 66 %.

$\mathbf{R_f}$ = 0.52 (petroleum ether/ethyl acetate 1:1); **^{1}H-NMR** ($CDCl_3$ 300 MHz): δ in ppm = 7.22 – 7.12 (m, 2H), 6.75 – 6.67 (m, 1H), 6.61 – 6.54 (m, 2H), 5.84 – 5.76 (m, 1H), 5.68 – 5.60 (m, 1H), 4.53 – 4.44 (m, 1H), 4.00 – 3.91 (m, 1H), 2.11 – 2.00 (m, 1H), 1.94 – 1.82 (m, 2H), 1.82 – 1.70 (m, 1H), 1.68 – 1.44 (m, 2H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 146.8, 137.2, 135.0, 129.3 (2C), 117.6, 113.6 (2C), 71.8, 54.0, 36.2, 33.4, 25.2; **IR** (cm^{-1}) = 3403 (br), 3050 (w), 3022 (w), 2926 (m), 2853 (m), 1601 (s), 1502 (s), 750 (m), 693 (m); **HRMS** calculated for $C_{13}H_{17}NO$ = 226.1202 (MNa^+), found 226.1192.

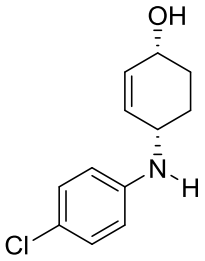
***cis*-4-(Phenylamino)cyclooct-2-en-1-ol (11)**



Starting from 8-phenyl-7-oxa-8-azabicyclo[4.2.2]dec-9-ene **10** and following GP-IV, the product was obtained as a brown solid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 4:1 to 2:1 (9 mg, 21 %).

$\mathbf{R_f}$ = 0.23 (petroleum ether/ethyl acetate 4:1); **^{1}H-NMR** ($CDCl_3$ 300 MHz): δ in ppm = 7.20 - 7.10 (m, 2H), 6.74 - 6.66 (m, 1H), 6.62 - 6.55 (m, 2H), 5.68 (ddd, *J* = 10.9 Hz, 6.8 Hz, 1.4 Hz, 1H), 5.35 (ddd, *J* = 10.9 Hz, 8.3 Hz, 1.6 Hz, 1H), 4.79 - 4.68 (m, 1H), 4.17 - 4.04 (m, 1H), 2.03 - 1.87 (m, 2H), 1.80 - 1.40 (m, 6H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 147.6, 134.9, 133.4, 129.2 (2C), 117.6, 113.3 (2C), 70.0, 51.3, 39.0, 36.7, 24.1, 23.7; **IR** (cm^{-1}) = 3400 (br), 3018 (w), 2931 (m), 1601 (s), 1502 (s), 1032 (s), 749 (s), 693 (s); **HRMS** calculated for $C_{14}H_{19}NO$ = 240.1359 (MNa^+), found 240.1340.

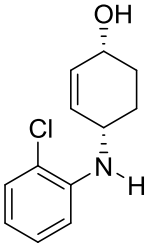
***cis*-4-((4-Chlorophenyl)amino)cyclohex-2-en-1-ol (13)**



Starting from 3-(4-chlorophenyl)-2-oxa-3-azabicyclo[2.2.2]oct-5-ene **12** and following GP-IV, the product was obtained as a brownish liquid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 4:1 to 1:1 (34.5 mg, 77 %) or using GP-V, resulting in a yield of 81 %.

$\mathbf{R_f}$ = 0.33 (petroleum ether/ethyl acetate 1:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.15 – 7.08 (m, 2H), 7.55 – 7.36 (m, 3H), 6.56 – 6.49 (m, 2H), 5.94 – 5.88 (m, 1H), 5.85 (dd, *J* = 10.2 Hz, 2.6 Hz, 1H), 4.26 – 4.18 (m, 1H), 3.93 – 3.85 (m, 1H), 2.63 (br, 1H), 1.96 – 1.67 (m, 4H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 145.4, 132.4, 131.0, 129.2 (2C), 122.1, 114.4 (2C), 65.1, 48.0, 28.8, 24.7; **IR** (cm^{-1}) = 3417 (br), 3022 (w), 2944 (w), 2863 (w), 1597 (m), 1493 (s), 755 (s), 667 (m); **MS** (EI, 70 eV): m/z = 223.1 (M^+).

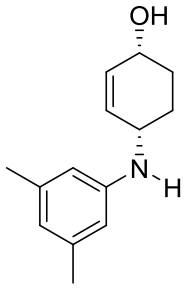
***cis*-4-((2-chlorophenyl)amino)cyclohex-2-en-1-ol (15)**



Starting from 3-(2-chlorophenyl)-2-oxa-3-azabicyclo[2.2.2]oct-5-ene **14** and following GP-IV, the product was obtained as an orange liquid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 4:1 to 2:1 (33 mg, 74 %).

$\mathbf{R_f}$ = 0.28 (petroleum ether/ethyl acetate 4:1); **^{1}H-NMR**($CDCl_3$, 300 MHz): δ in ppm = 7.26 (dd, *J* = 7.9 Hz, 1.5 Hz, 1H), 7.17 – 7.09 (m, 1H), 6.69 (dd, *J* = 8.2 Hz, 1.3 Hz, 1H), 6.63 (td, *J* = 7.9 Hz, 1.5 Hz, 1H), 5.98 – 5.91 (m, 1H), 5.88 (dd, *J* = 10.2 Hz, 2.6 Hz, 1H), 4.36 (br, 1H), 4.27 – 4.19 (m, 1H), 4.03 – 3.93 (m, 1H), 1.97 – 1.70 (m, 4H), 1.62 (br, 1H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 142.8, 132.8, 130.8, 129.4, 127.8, 119.4, 117.3, 111.6, 65.3, 47.6, 28.9, 24.8; **IR** (cm^{-1}) = 3418 (br), 3065 (w), 3027 (w), 2944 (m), 2860 (m), 1594 (s), 1496 (s), 1031 (s), 736 (s), 690 (m); **HRMS** calculated for $C_{12}H_{14}ClNO$ = 246.0656 (MNa^+), found 246.0638.

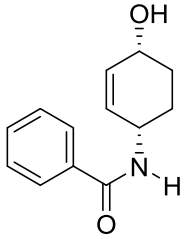
***cis*-4-((3,5-Dimethylphenyl)amino)cyclohex-2-en-1-ol (17)**



Starting from 3-(3,5-dimethylphenyl)-2-oxa-3-azabicyclo[2.2.2]oct-5-ene **16** and following GP-IV, the product was obtained as an orange liquid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 4:1 to 1:1 (32 mg, 74 %).

$\mathbf{R_f}$ = 0.19 (petroleum ether/ethyl acetate 2:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 6.37 (s, 1*H*), 6.25 (s, 2H), 5.89 – 5.85 (m, 2H), 4.24 – 4.17 (m, 1H), 3.96 – 3.88 (m, 1H), 2.23 (s, 6H), 1.93 – 1.67 (m, 4H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 146.9, 139.1 (2C), 132.0, 131.7, 119.6, 111.2 (2C), 65.3, 47.8, 29.0, 24.5, 21.5 (2C); **IR** (cm^{-1}) = 3343 (br), 3024 (w), 2943 (m), 2914 (m), 2855 (m), 2359 (w), 1597 (s), 819 (s), 741 (m), 691 (m); **HRMS** calculated for $C_{14}H_{19}NO$ = 218.1539 (MH^+), found 218.1514.

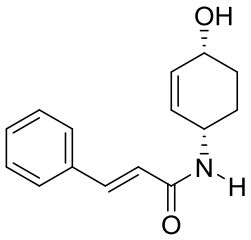
***cis*-*N*-(4-hydroxycyclohex-2-en-1-yl)benzamide (19)**



Starting from 2-oxa-3-azabicyclo[2.2.2]oct-5-en-3-yl)(phenyl)methanone **18** and following GP-IV, the product was obtained as an orange liquid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 4:1 to 1:1 (25 mg, 58 %).

$\mathbf{R_f}$ = 0.26 (petroleum ether/ethyl acetate 4:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.75 (d, *J* = 7.4 Hz, 2H), 7.55 – 7.36 (m, 3H), 6.31 (d, *J* = 7.3 Hz, 1H), 6.03 – 5.90 (m, 1H), 5.81 (dd, *J* = 9.8 Hz, 2.7 Hz, 1H), 5.64 (br, 1H), 4.24 (br, 1H), 2.29 (br, 1H), 2.01 – 1.66 (m, 4H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 167.0, 134.4, 133.1, 131.6, 130.5, 128.6 (2C), 126.9 (2C), 64.5, 45.1, 29.0, 25.3; **IR** (cm^{-1}) = 3274 (br), 3063 (w), 3028 (w), 2944 (m), 2863 (w), 1632 (s), 1536 (s), 1487 (m), 712 (m), 693 (m); **HRMS** = calculated for $C_{13}H_{15}NO_2$ = 240.0995 (MNa^+), found 240.0984.

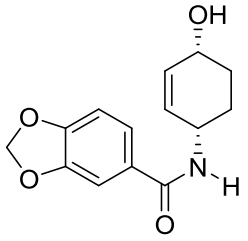
***cis-N*-(4-hydroxycyclohex-2-en-1-yl)cinnamamide (23)**



Starting from 2-Oxa-3-azabicyclo[2.2.2]oct-5-en-3-yl)-3-phenylprop-2-en-1-one **22** and following GP-IV, the product was obtained as a brown solid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 2:1 to ethyl acetate (28 mg, 58 %).

$\mathbf{R_f}$ = 0.38 (ethyl acetate); **^{1}H-NMR** (DSMO-d_6, 300 MHz): δ in ppm = 8.25 (d, *J* = 7.9 Hz, 1H), 7.54 (d, *J* = 7.0 Hz, 2H), 7.48 – 7.32 (m, 4H), 6.70 (d, *J* = 16.0 Hz, 1H), 5.80 (dt, *J* = 9.9 Hz, 2.3 Hz, 1H), 5.60 (dd, *J* = 9.9 Hz, 2.3 Hz, 1H), 4.84 (d, *J* = 4.5 Hz, 1H), 4.37 – 4.25 (br, 1H), 4.07 – 3.96 (m, 1H), 1.81 – 1.52 (m, 4H); **^{13}C-NMR** (DSMO-d_6, 75 MHz): δ in ppm = 164.2, 138.6, 134.9, 133.7, 129.3, 128.9 (2C), 128.9, 127.4 (2C), 122.3, 63.2, 43.8, 28.6, 25.3; **IR** (cm^{-1}) = 3271 (br), 3026 (w), 2943 (w), 2860 (w), 1653 (s), 1616 (s), 1537 (s), 1220 (s), 713 (m), 683 (m); **HRMS** calculated for $C_{15}H_{17}NO_2$ = 266.1157 (MNa^+), found 266.1156.

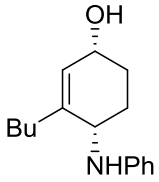
***N*-(4-hydroxycyclohex-2-en-1-yl)benzo[d][1,3]dioxole-5-carboxamide (29)**



Starting from Benzo[d][1,3]dioxol-5-yl(2-oxa-3-azabicyclo[2.2.2]oct-5-en-3-yl)methanone **28** and following GP-IV, the product was obtained as a brown colorless oil after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 2:1 to 1:1 (38 mg, 79 %).

$\mathbf{R_f}$ = 0.12 (petrol ether/ethyl acetate 1:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.35 – 7.20 (m, 2H), 6.80 (d, *J* = 7.3 Hz, 1H), 6.29 (s, 1H), 6.00 (s, 2H), 5.95 (d, *J* = 8.1 Hz, 1H), 5.79 (d, *J* = 8.1 Hz, 1H), 4.60 (s, 1H), 4.23 (s, 1H), 2.50 (s, 1H), 2.00 – 1.63 (m, 4H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 166.3, 150.4, 147.9, 133.0, 130.5, 128.6, 121.6, 108.0, 107.6, 101.7, 64.5, 45.2, 29.0, 25.3; **IR** (cm^{-1}) = 3306 (br), 2942 (w), 1638 (m), 1482 (s), 1255 (s), 1037 (s), 923 (m), 730 (s); **HRMS** calculated for $C_{14}H_{15}NO_4$ = 284.0893 (MNa^+), found 284.0892.

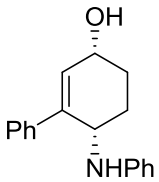
***cis*-3-Butyl-4-(phenylamino)cyclohex-2-enol (31)**



Starting from 5-butyl-3-phenyl-2-oxa-3-azabicyclo[2.2.2]oct-5-ene **30** and following GP-IV, the product was obtained as a reddish liquid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 4:1 to 2:1 (33 mg, 67 %).

$\mathbf{R_f}$ = 0.27 (petroleum ether/ethyl acetate 4:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.21 – 7.13 (m, 2H), 6.68 (tt, *J* = 7.3 Hz, 0.9 Hz, 1H), 6.63 – 6.57 (m, 2H), 5.63–5.59 (m, 1H), 4.26 – 4.18 (m, 1H), 3.86 – 3.80 (m, 1H), 2.21 – 1.80 (m, 4H), 1.68 – 1.18 (m, 6H), 0.88 (t, *J* = 7.2 Hz, 3H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 147.5, 141.7, 129.4 (2C), 128.5, 117.1, 112.8 (2C), 67.3, 49.0, 33.9, 30.2, 27.8, 25.6, 22.5, 14.0; **IR** (cm^{-1}) = 3300 (br), 3050 (w), 2928 (m), 1600 (s), 1502 (s), 749 (m), 694 (m), 632 (s), 531 (s); **HRMS** (ESI) calculated for $C_{16}H_{23}NO$ = 268.1672 (MNa^+), found 268.1663.

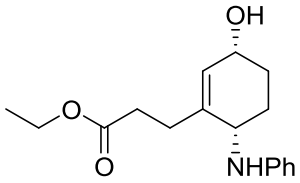
***cis*-6-(Phenylamino)-3,4,5,6-tetrahydro-[1,1'-biphenyl]-3-ol (33)**



Starting from 3,5-diphenyl-2-oxa-3-azabicyclo[2.2.2]oct-5-ene **32** and following GP-IV, the product was obtained as a red liquid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 4:1 to 2:1 (30 mg, 56 %).

$\mathbf{R_f}$ = 0.10 (petroleum ether/ethyl acetate 4:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.50 – 7.42 (m, 2H), 7.33 – 7.22 (m, 3H), 7.22 – 7.13 (m, 2H), 6.70 (tt, *J* = 7.4 Hz, 1.1 Hz, 1H), 6.63 – 6.57 (m, 2H), 6.31 – 6.28 (m, 1H), 4.48 – 4.37 (m, 2H), 2.23 – 2.14 (m, 1H), 2.05 – 1.95 (m, 1H), 1.76 – 1.68 (m, 2H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 146.8, 139.0, 138.6, 131.3, 129.4 (2C), 128.6 (2C), 127.9, 125.9 (2C), 117.3, 112.8 (2C), 67.8, 47.8, 27.3, 25.6; **IR** (cm^{-1}) = 3370 (br), 3050 (w), 2942 (w), 1598 (s), 1495 (s), 747 (s), 691 (s); **HRMS** (ESI) calculated for $C_{18}H_{19}NO$ = 288.1359 (MNa^+), found 288.1338.

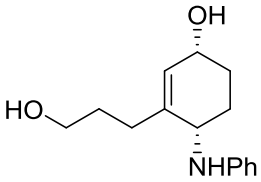
***cis*-Ethyl 3-(3-hydroxy-6-(phenylamino)cyclohex-1-en-1-yl)propanoate (35)**



Starting from ethyl 3-(3-phenyl-2-oxa-3-azabicyclo[2.2.2]oct-5-en-5-yl)propanoate **34** and following GP-IV on a 0.3 mmol scale, the product was obtained as a red liquid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 4:1 to 1:1 (69 mg, 79 %).

$\mathbf{R_f}$ = 0.23 (petroleum ether/ethyl acetate 2:1); **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ in ppm = 7.21 – 7.13 (m, 2H), 6.72 – 6.65 (m, 1H), 6.64 – 6.57 (m, 2H), 5.65 – 5.60 (m, 1H), 4.24 – 4.16 (m, 1H), 4.10 (q, *J* = 7.1 Hz, 2H), 3.87 – 3.81 (m, 1H), 2.54 – 2.39 (m, 4H), 2.01 – 1.93 (m, 1H), 1.93 – 1.85 (m, 1H), 1.67 – 1.50 (m, 2H), 1.24 (t, *J* = 7.1 Hz, 3H); **^{13}C-NMR** ($CDCl_3$, 100 MHz): δ in ppm = 173.1, 147.4, 139.6, 129.4 (2C), 129.3, 117.2, 112.9 (2C), 67.1, 60.5, 49.4, 32.7, 29.4, 27.7, 25.5, 14.3; **IR** (cm^{-1}) = 3378 (br), 3050 (w), 2938 (w), 1720 (s), 1599 (s), 1499 (s), 1155 (s), 748 (s), 693 (s); **HRMS** (EI) calculated for $C_{17}H_{23}NO_3$ = 289.1678 (M^+), found 289.1686.

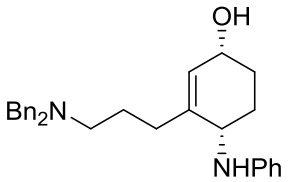
***cis*-3-(3-Hydroxypropyl)-4-(phenylamino)cyclohex-2-en-1-ol (37)**



Starting from 3-(3-phenyl-2-oxa-3-azabicyclo[2.2.2]oct-5-en-5-yl)propan-1-ol **36** and following GP-IV on a 0.3 mmol scale, the product was obtained as a dark liquid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 1:1 to 1:4 (53 mg, 68 %).

$\mathbf{R_f}$ = 0.14 (petroleum ether/ethyl acetate 1:2); **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ in ppm = 7.21 – 7.13 (m, 2H), 6.72 – 6.66 (m, 1H), 6.64 – 6.57 (m, 2H), 5.67 – 5.62 (m, 1H), 4.26 – 4.18 (m, 1H), 3.87 – 3.82 (m, 1H), 3.63 (t, *J* = 6.5 Hz, 2H), 2.25 – 2.12 (m, 2H), 2.00 – 1.93 (m, 1H), 1.93 – 1.84 (m, 1H), 1.82 – 1.51 (m, 4H); **^{13}C-NMR** ($CDCl_3$, 100 MHz): δ in ppm = 147.4, 140.9, 129.4 (2C), 128.9, 117.3, 113.0 (2C), 67.1, 62.4, 49.4, 30.8, 30.5, 27.8, 25.5; **IR** (cm^{-1}) = 3342 (br), 3050 (w), 2938 (m), 1599 (s), 1500 (s), 1052 (m), 749 (s), 693 (s); **HRMS** (EI) calculated for $C_{15}H_{21}NO_2$ = 247.1572 (M^+), found 247.1562.

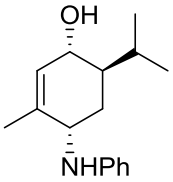
3-(3-(Dibenzylamino)propyl)-4-(phenylamino)cyclohex-2-en-1-ol (39)



Starting from *N*,*N*-dibenzyl-3-(3-phenyl-2-oxa-3-azabicyclo[2.2.2]oct-5-en-5-yl)propan-1-amine **38** and following GP-IV on a 0.3 mmol scale, the product was obtained as a colourless liquid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 4:1 to 2:1 (70 mg, 55 %).

$\mathbf{R_f}$ = 0.25 (petroleum ether/ethyl acetate 2:1); **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ in ppm = 7.35 – 7.13 (m, 12H), 6.71 – 6.65 (m, 1H), 6.60 – 6.54 (m, 2H), 5.48 – 5.42 (m, 1H), 4.14 – 4.04 (m, 1H), 3.78 – 3.70 (m, 1H), 3.61 (br, 1H), 3.57 – 3.46 (m, 4H), 2.38 (t, *J* = 7.2 Hz, 2H), 2.12 – 2.04 (m, 2H), 1.94 – 1.86 (m, 1H), 1.86 – 1.78 (m, 1H), 1.78 – 1.64 (m, 1H), 1.64 – 1.42 (m, 3H), 1.36 (br, 1H); **^{13}C-NMR** ($CDCl_3$, 100 MHz): δ in ppm = 147.5, 141.1, 139.9, 129.4, 128.9, 128.6, 128.2, 126.8, 117.1, 112.8, 67.1, 58.4, 52.5, 49.1, 31.4, 27.8, 25.6, 25.0; **IR** (cm^{-1}) = 3352 (br), 3025 (w), 2937 (m), 1599 (s), 1497 (s), 745 (s), 695 (s); **HRMS** (ESI) calculated for $C_{29}H_{34}N_2O$ = 427.2744 (MH^+), found 427.2759.

***cis*-6-Isopropyl-3-methyl-4-(phenylamino)cyclohex-2-enol (41)**

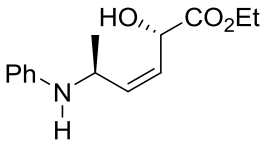


Starting from 7-isopropyl-5-methyl-3-phenyl-2-oxa-3-azabicyclo[2.2.2]oct-5-ene **40** and following GP-IV, the product was obtained as an orange liquid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 10:1 to 2:1 (33 mg, 67 %) or using GP-V, resulting in a yield of 30 %.

$\mathbf{R_f}$ = 0.50 (petroleum ether/ethyl acetate 2:1); **^{1}H-NMR** ($CDCl_3$, 500 MHz): δ in ppm = 7.20 – 7.13 (m, 2H), 6.69 (t, *J* = 7.6 Hz, 1H), 6.61 (d, *J* = 7.8 Hz, 2H), 5.56 (s, 1H), 4.00 (d, *J* = 8.7 Hz, 1H), 3.83 – 3.79 (m, 1H), 2.06 (septet d, *J* = 6.8 Hz, 3.5 Hz, 1H), 1.85 (dt, *J* = 13.0 Hz, 2.3 Hz, 1H), 1.80 – 1.78 (m, 3H), 1.48 – 1.40 (m, 1H), 1.33 (td, *J* = 13.1 Hz, 4.2 Hz, 1H), 0.86 (d, *J* = 6.9 Hz, 3H), 0.83 (d, *J* = 6.8 Hz, 3H); **^{13}C-NMR** ($CDCl_3$, 125 MHz): δ in ppm = 147.7, 136.7, 129.7, 129.4 (2C), 117.2, 113.0 (2C), 69.2, 51.5, 42.8, 26.6, 26.3, 21.0, 20.9, 17.2; **IR** (cm^{-1}) =

3400 (br), 3051 (w), 2957 (m), 1598 (s), 1500 (s), 746 (m), 692 (m); **HRMS** (ESI) calculated for $C_{16}H_{23}NO$ = 268.1672 (MNa^+), found 268.1675.

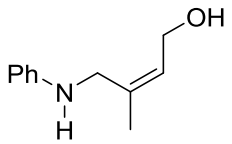
Ethyl (*Z*)-2-hydroxy-5-(phenylamino)hex-3-enoate (43)



Starting from ethyl-3-methyl-2-phenyl-3,6-dihydro-2*H*-1,2-oxazine-6-carboxylate **42** and following GP-IV, the product was obtained as an orange liquid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 4:1 to 2:1 (20 mg, 40 %).

$\mathbf{R_f}$ = 0.23 (petroleum ether/ethyl acetate 4:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.21 – 7.13 (m, 2H), 6.75 – 6.68 (m, 1H), 6.66 – 6.59 (m, 2H), 5.58 (ddd, *J* = 11.0 Hz, 8.6 Hz, 1.2 Hz, 1H), 5.44 (ddd, *J* = 11.0 Hz, 8.6 Hz, 1.1 Hz, 1H), 5.06 (dd, *J* = 8.6 Hz, 1.2 Hz, 1H), 4.44 – 4.33 (m, 1H), 4.26 (qd, *J* = 7.1 Hz, 2.2 Hz, 2H), 1.36 (d, *J* = 6.6 Hz, 3H), 1.31 (t, *J* = 7.1 Hz, 3H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 173.5, 147.1, 139.3, 129.3 (2C), 126.8, 118.0, 113.7 (2C), 67.7, 62.2, 47.2, 21.8, 14.1; **IR** (cm^{-1}) = 3403 (br), 3052 (w), 2982 (w), 2205 (w), 1729 (s), 1601 (s), 1501 (s), 1254 (s), 1198 (s), 1080 (s) 751 (s), 694 (s); **HRMS** (ESI) calculated for $C_{14}H_{19}NO_3$ 272.1257 (MNa^+), found 272.1251.

(*Z*)-3-Methyl-4-(phenylamino)but-2-en-1-ol (45)



Starting from 4-methyl-2-phenyl-3,6-dihydro-2*H*-1,2-oxazine **44** and following GP-IV, the product was obtained as a yellow solid after purification via gradient column chromatography on silica with petroleum ether/ethyl acetate 4:1 to 1:1 (15 mg, 42 %).

$\mathbf{R_f}$ = 0.27 (petroleum ether/ethyl acetate 2:1); **^{1}H-NMR** ($CDCl_3$, 300 MHz): δ in ppm = 7.23 – 7.15 (m, 2H), 6.77 – 6.70 (m, 1H), 6.66 – 6.60 (m, 2H), 5.69 – 5.60 (m, 1H), 4.23 (dd, *J* = 7.0 Hz, 0.9 Hz, 2H), 3.76 (s, 2H), 1.84 (d, *J* = 1.1 Hz, 3H), 1.59 – 1.41 (m, 1H); **^{13}C-NMR** ($CDCl_3$, 75 MHz): δ in ppm = 148.2, 137.4, 129.3 (2C), 127.3, 117.9, 113.1 (2C), 58.7, 45.0, 22.5; **IR** (cm^{-1}) = 3361 (br), 3050 (w), 2970 (w), 1601 (s), 1503 (s), 750 (s), 693 (s); **HRMS** (EI) calculated for $C_{11}H_{15}NO$ = 177.1154 (M^+), found 177.1158.

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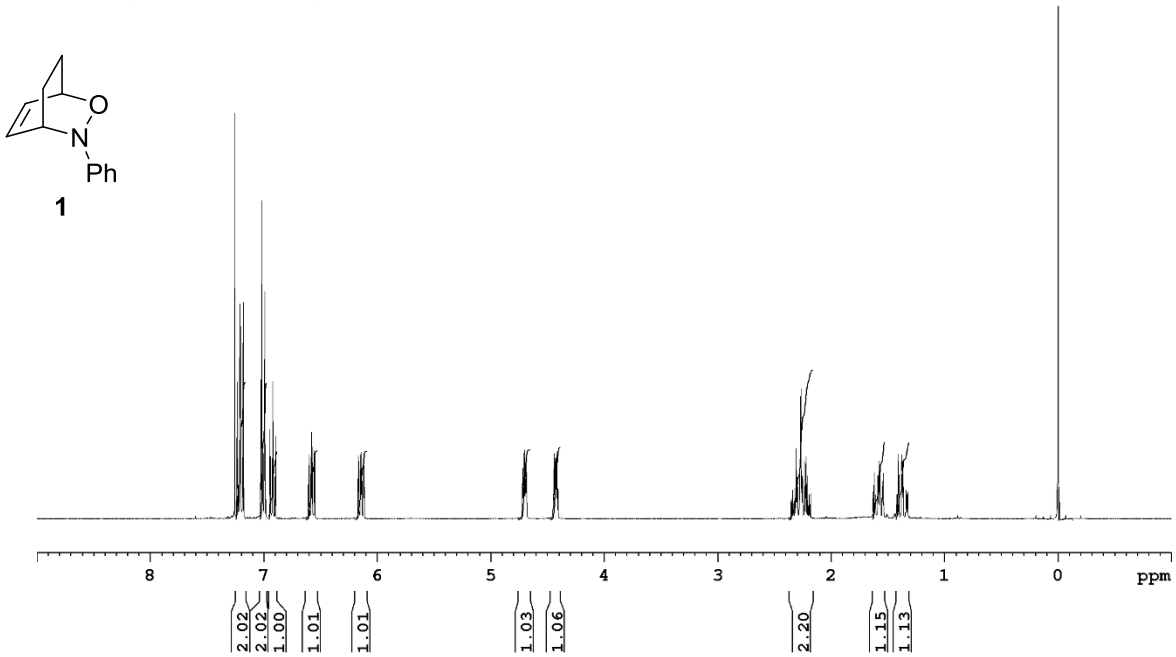
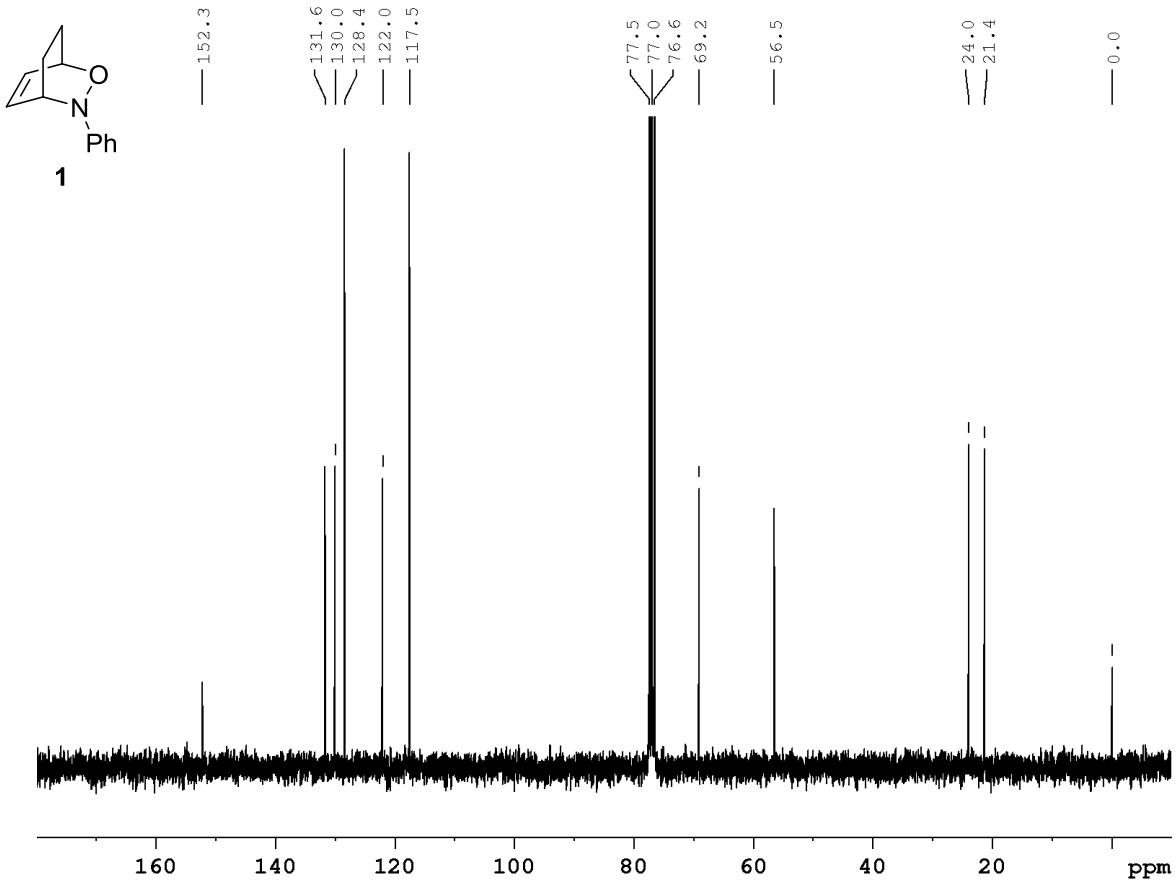
W. T. McElroy P. DeShong, *Org. Lett.* 2006, **8**, 4183–4186.

NMR-spectra

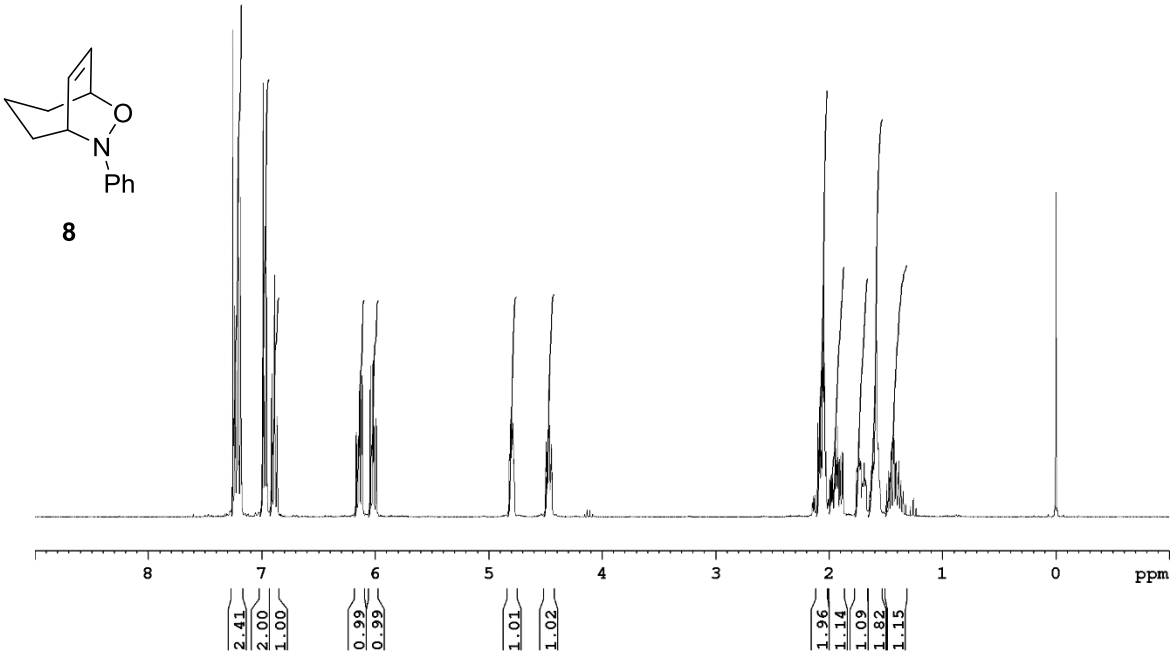
^{1}H-NMR ($CDCl_3$, 300 MHz)



^{13}C-NMR ($CDCl_3$, 75 MHz)



^{1}H-NMR ($CDCl_3$, 300 MHz)



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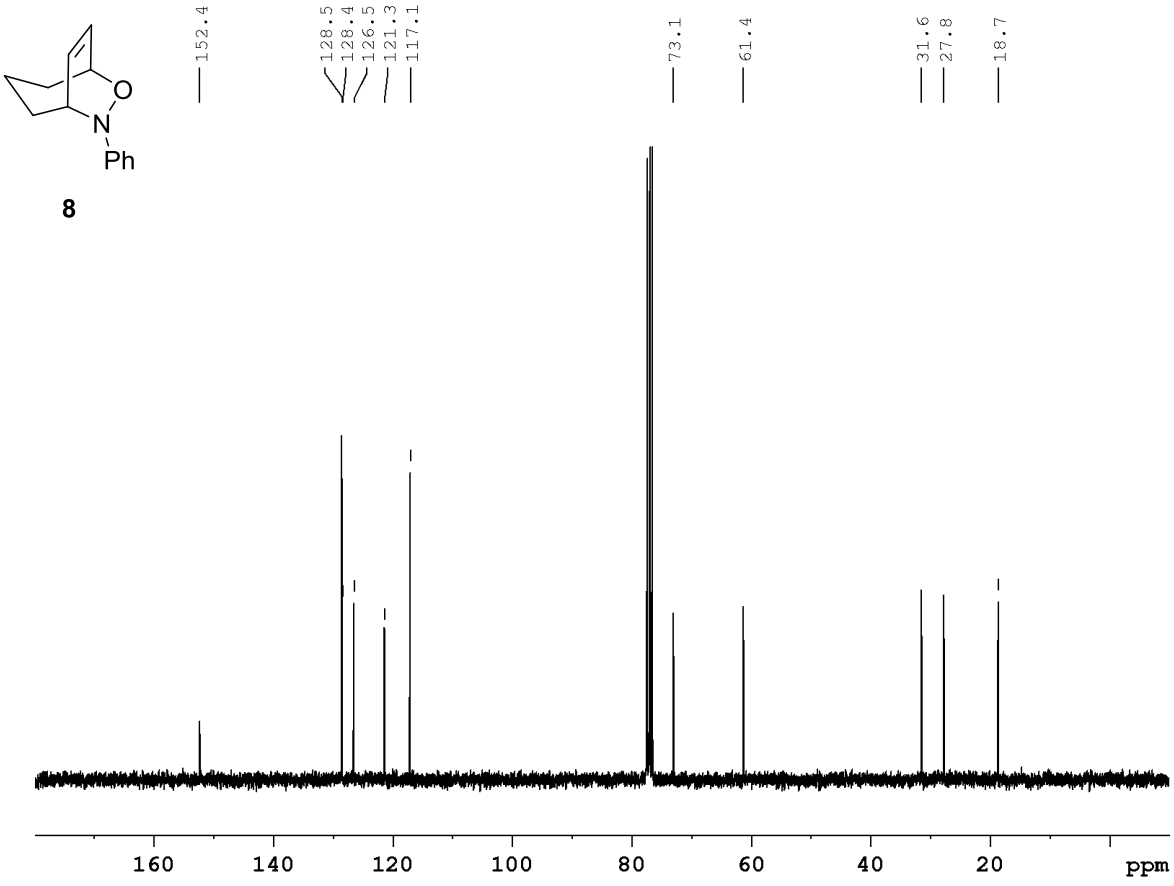

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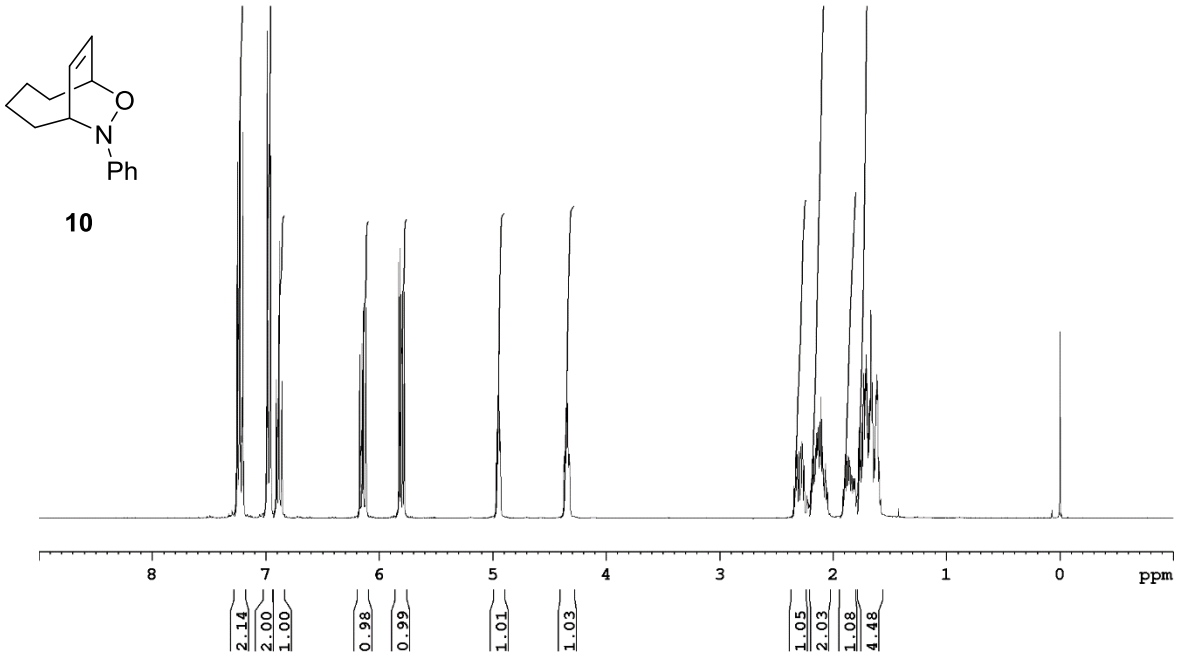
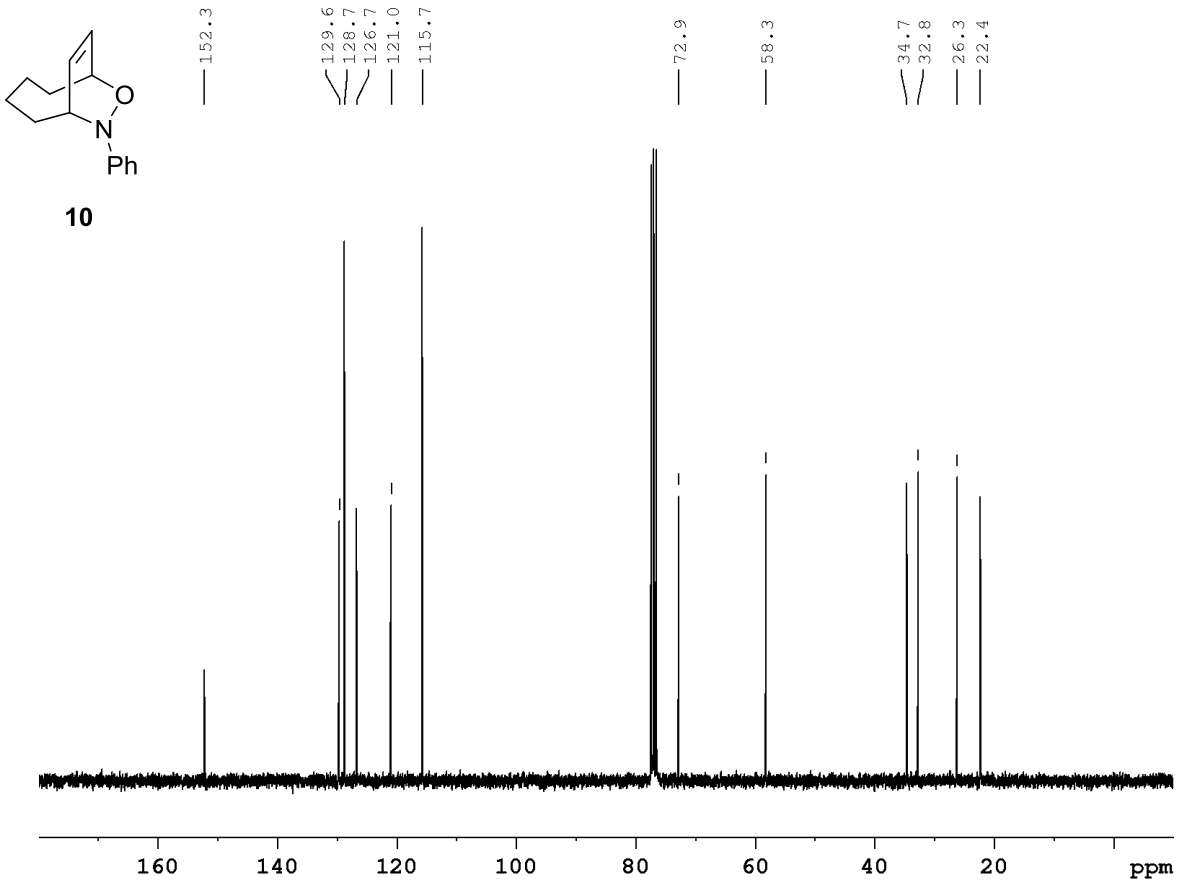


10

^{13}C-NMR ($CDCl_3$, 75 MHz)



10

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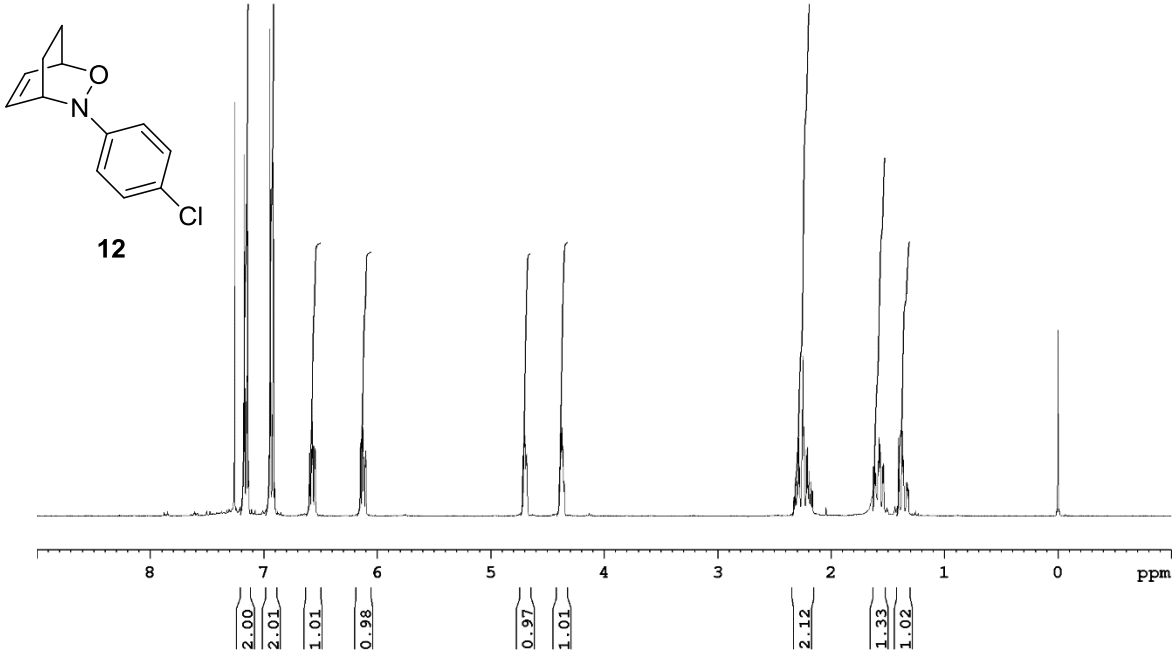
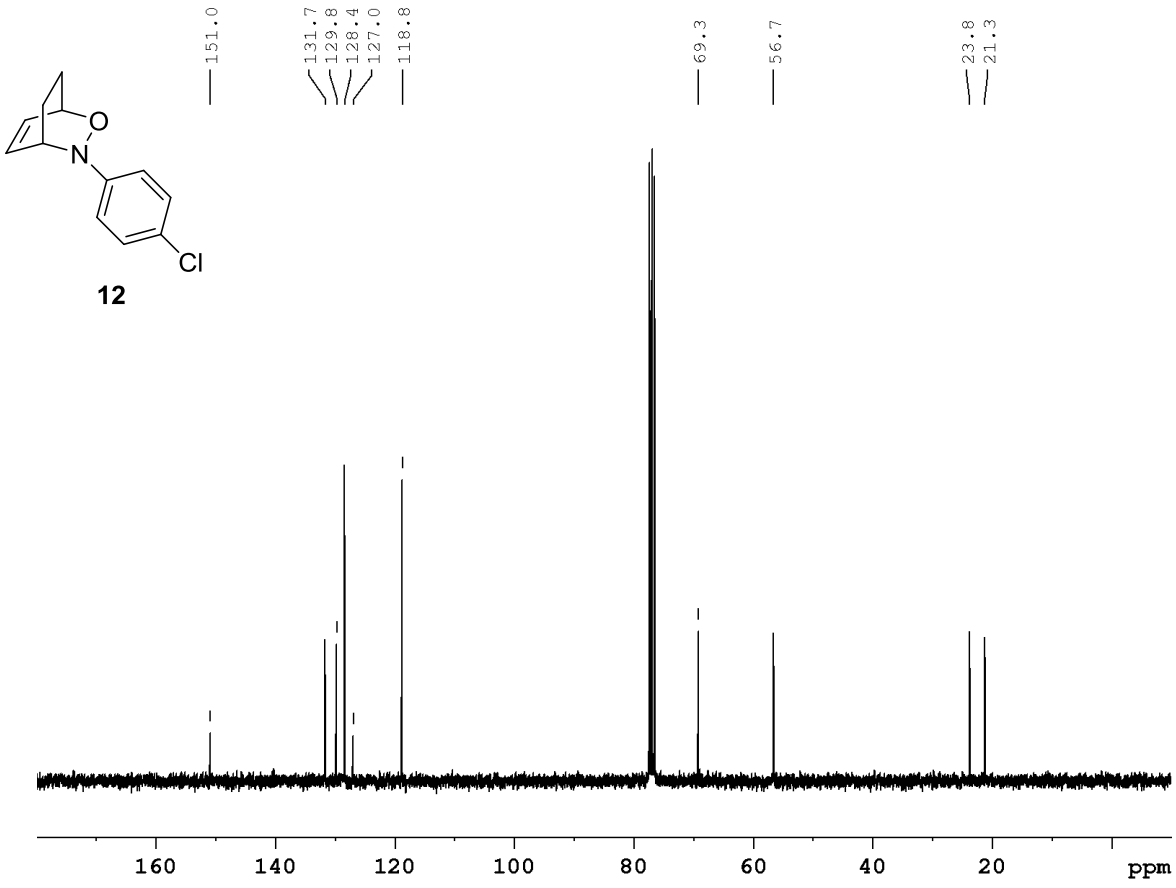


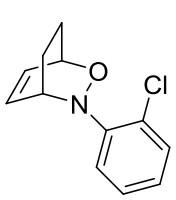
12

^{13}C-NMR ($CDCl_3$, 75 MHz)



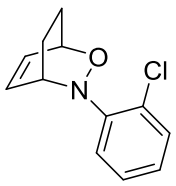
12

^{1}H-NMR ($CDCl_3$, 300 MHz)



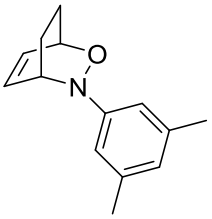
14

^{13}C-NMR ($CDCl_3$, 75 MHz)



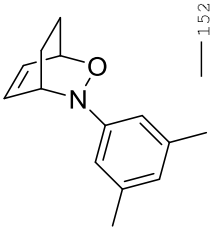
14

^{1}H-NMR ($CDCl_3$, 300 MHz)



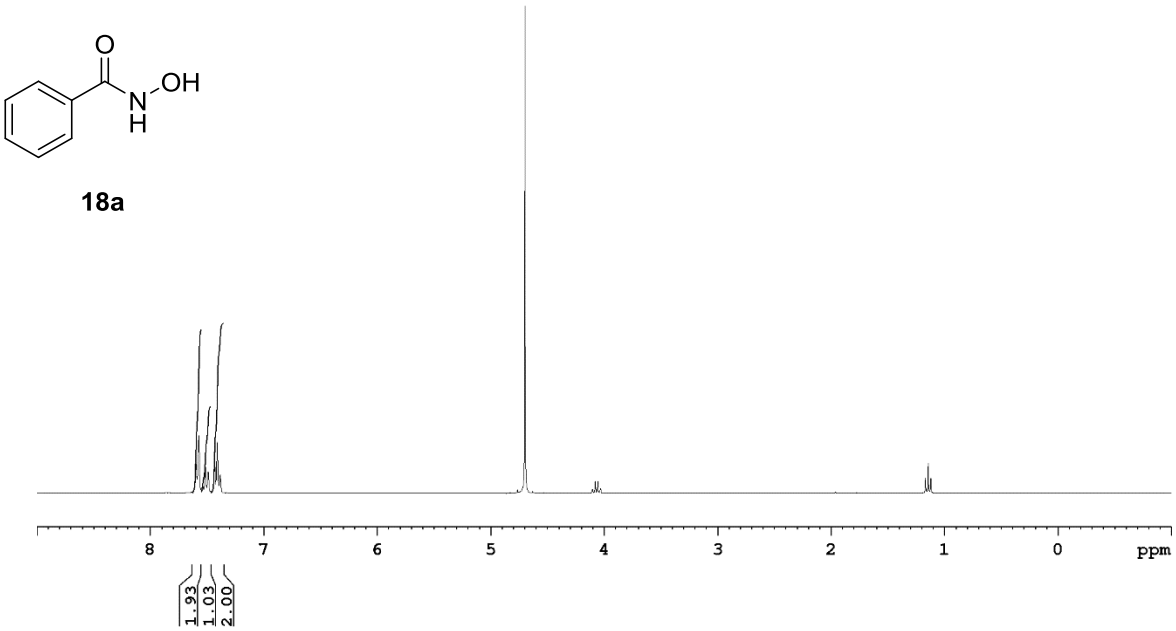
16

^{13}C-NMR ($CDCl_3$, 75 MHz)

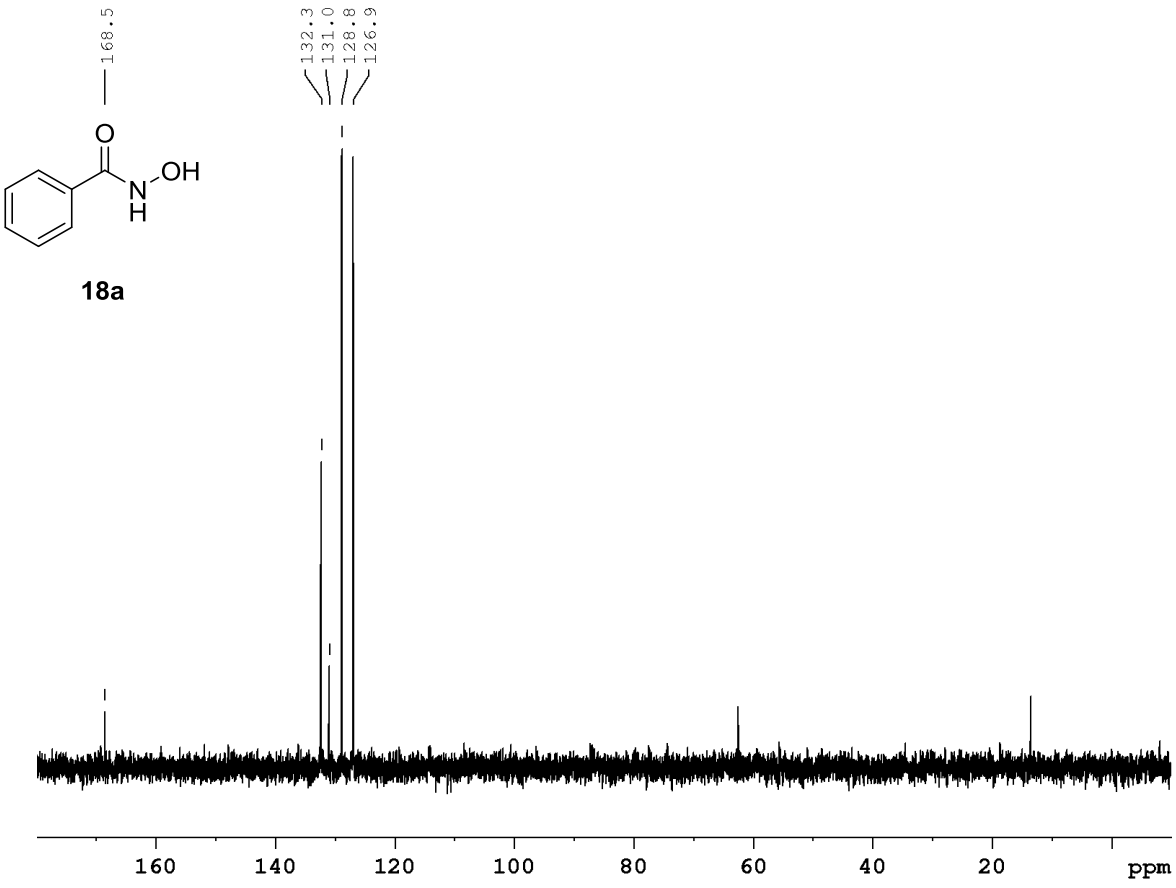


16

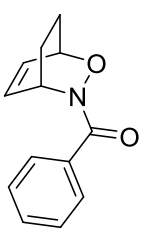
^{1}H-NMR (D_2O, 300 MHz)



^{13}C-NMR (D_2O, 75 MHz)

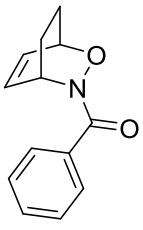


^{1}H-NMR ($CDCl_3$, 300 MHz)



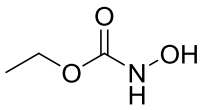
18

^{13}C-NMR ($CDCl_3$, 75 MHz)



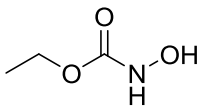
18

^{1}H-NMR ($CDCl_3$, 300 MHz)



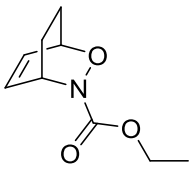
20a

^{13}C-NMR ($CDCl_3$, 75 MHz)



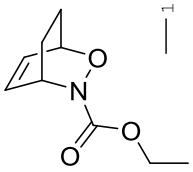
20a

^{1}H-NMR ($CDCl_3$, 300 MHz)



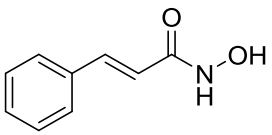
20

^{13}C-NMR ($CDCl_3$, 75 MHz)



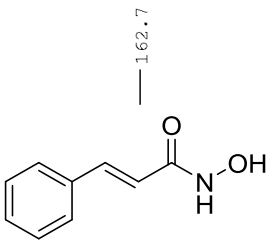
20

^{1}H-NMR (DMSO-d6, 300 Hz)



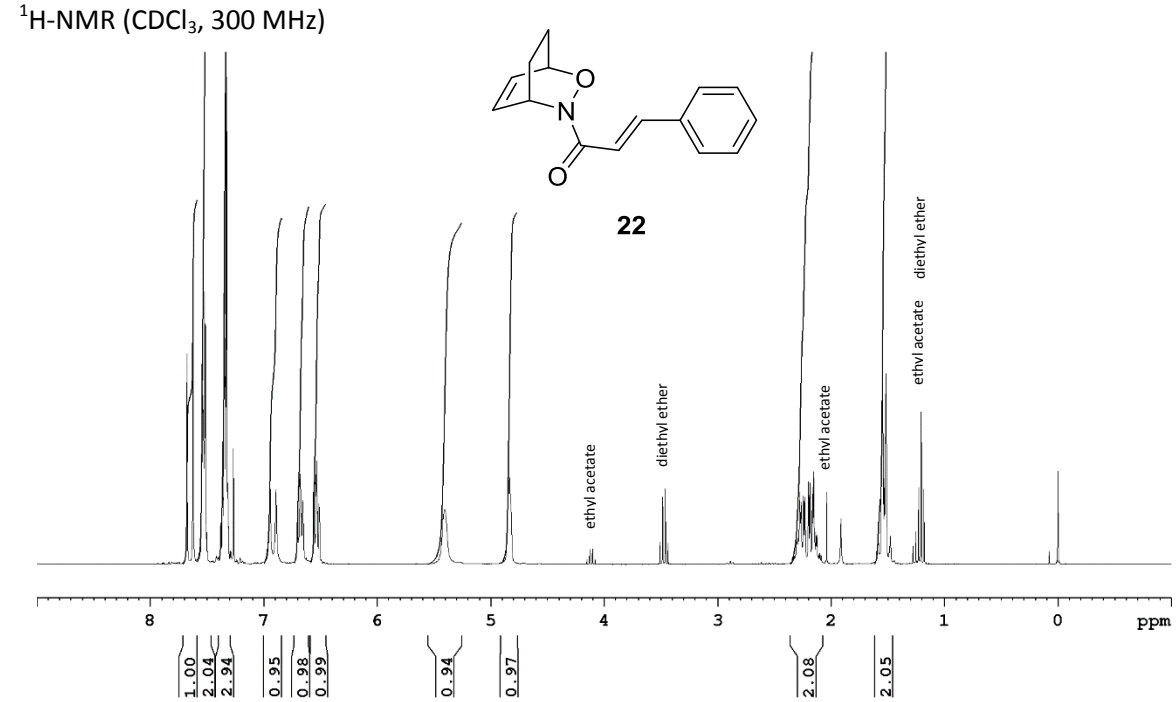
22a

^{13}C-NMR (DMSO-d6, 75 MHz)

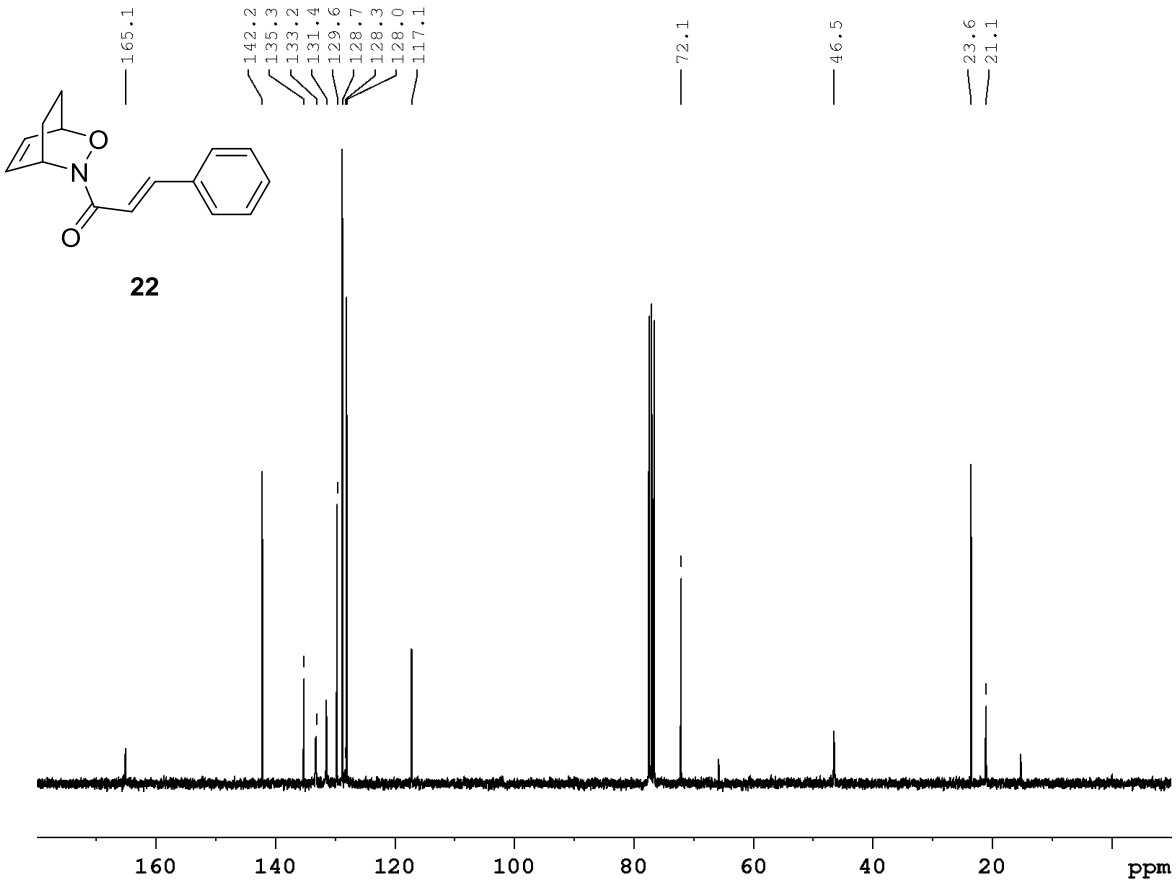


22a

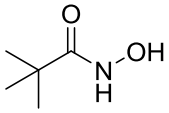
^{1}H-NMR ($CDCl_3$, 300 MHz)



^{13}C-NMR ($CDCl_3$, 75 MHz)

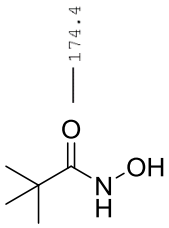


^{1}H-NMR (DMSO-d6, 300 Hz)



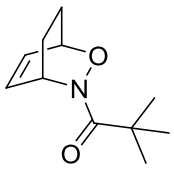
24a

^{13}C-NMR (DMSO-d6, 75 MHz)



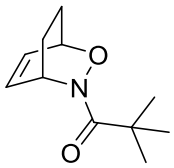
24a

^{1}H-NMR ($CDCl_3$, 300 MHz)



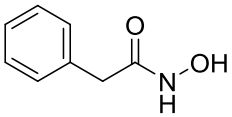
24

^{13}C-NMR ($CDCl_3$, 75 MHz)



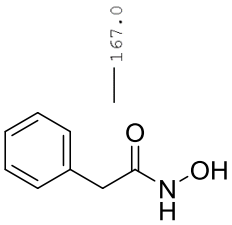
24

^{1}H-NMR (DMSO-d6, 300 Hz)



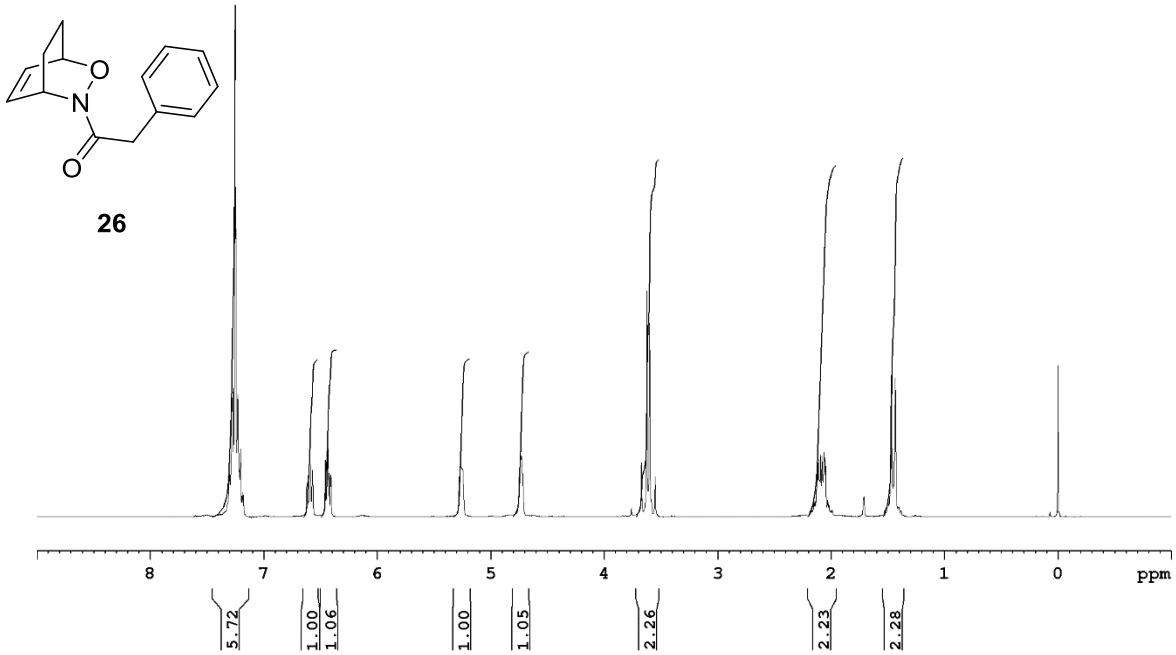
26a

^{13}C-NMR (DMSO-d6, 75 MHz)



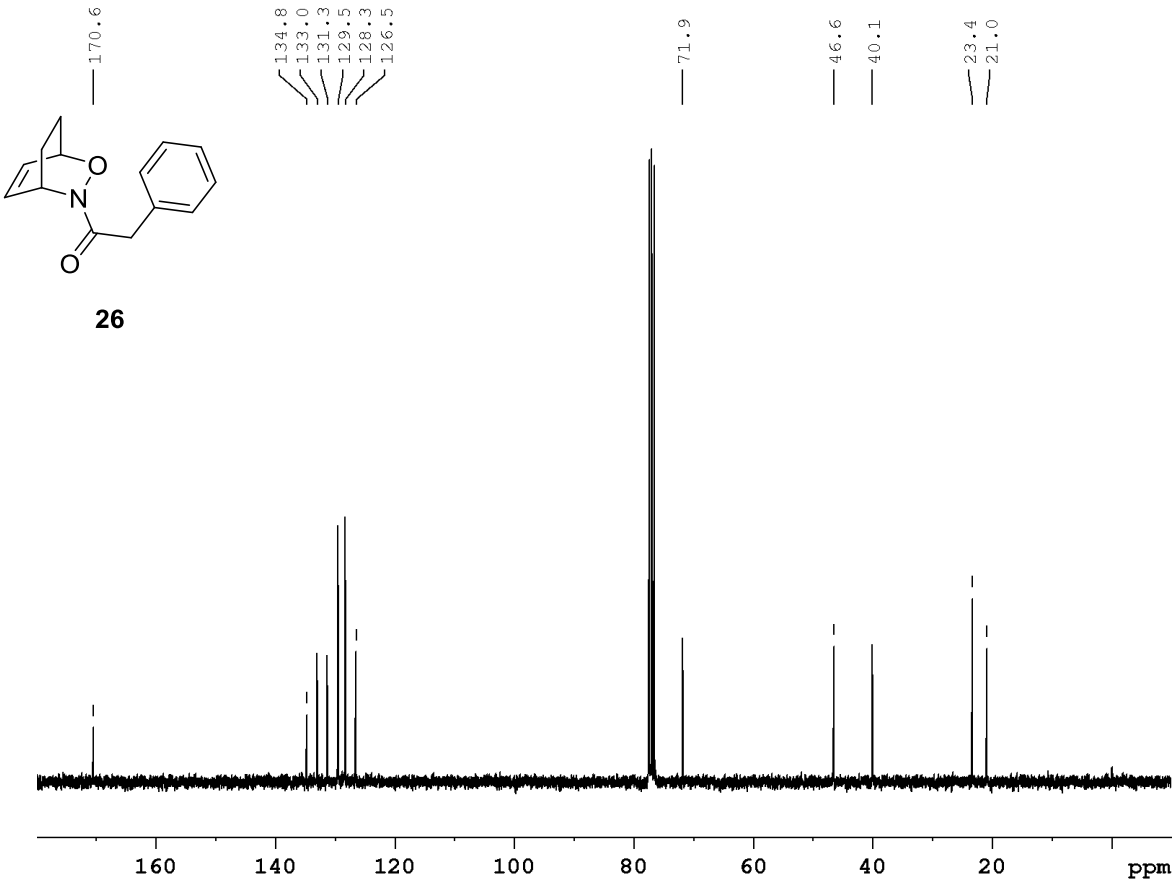
26a

^{1}H-NMR ($CDCl_3$, 300 MHz)



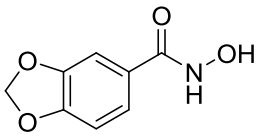
26

^{13}C-NMR ($CDCl_3$, 75 MHz)



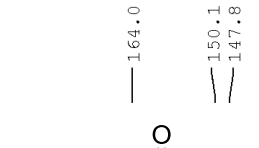
26

^{1}H-NMR (DMSO-d6, 400 Hz)



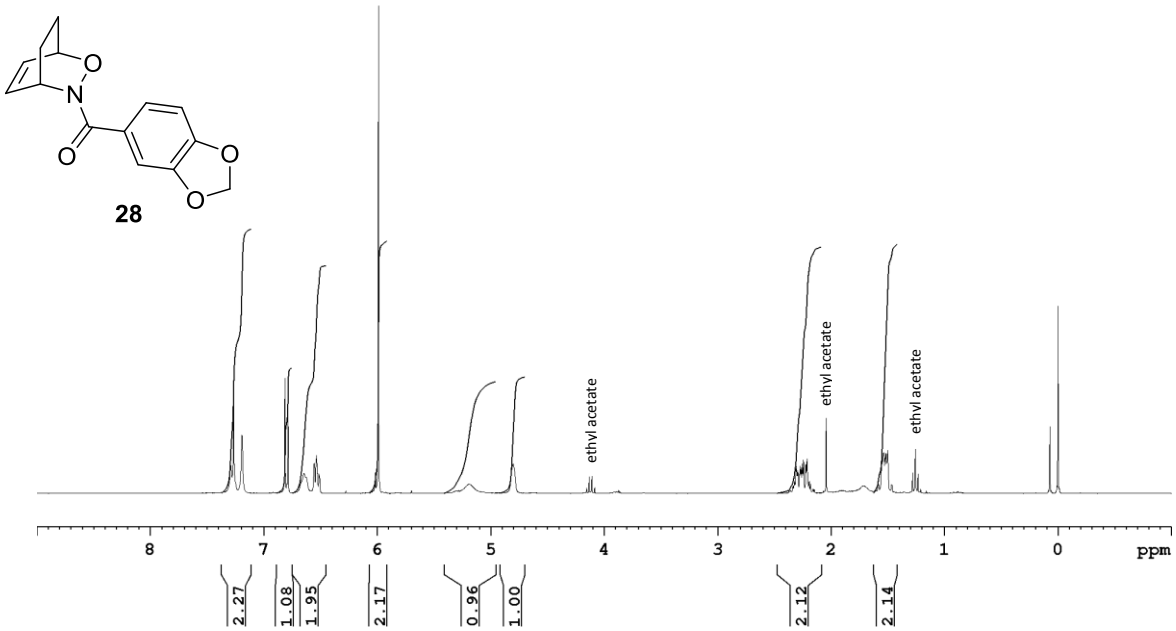
28a

^{13}C-NMR (DMSO-d6, 100 MHz)

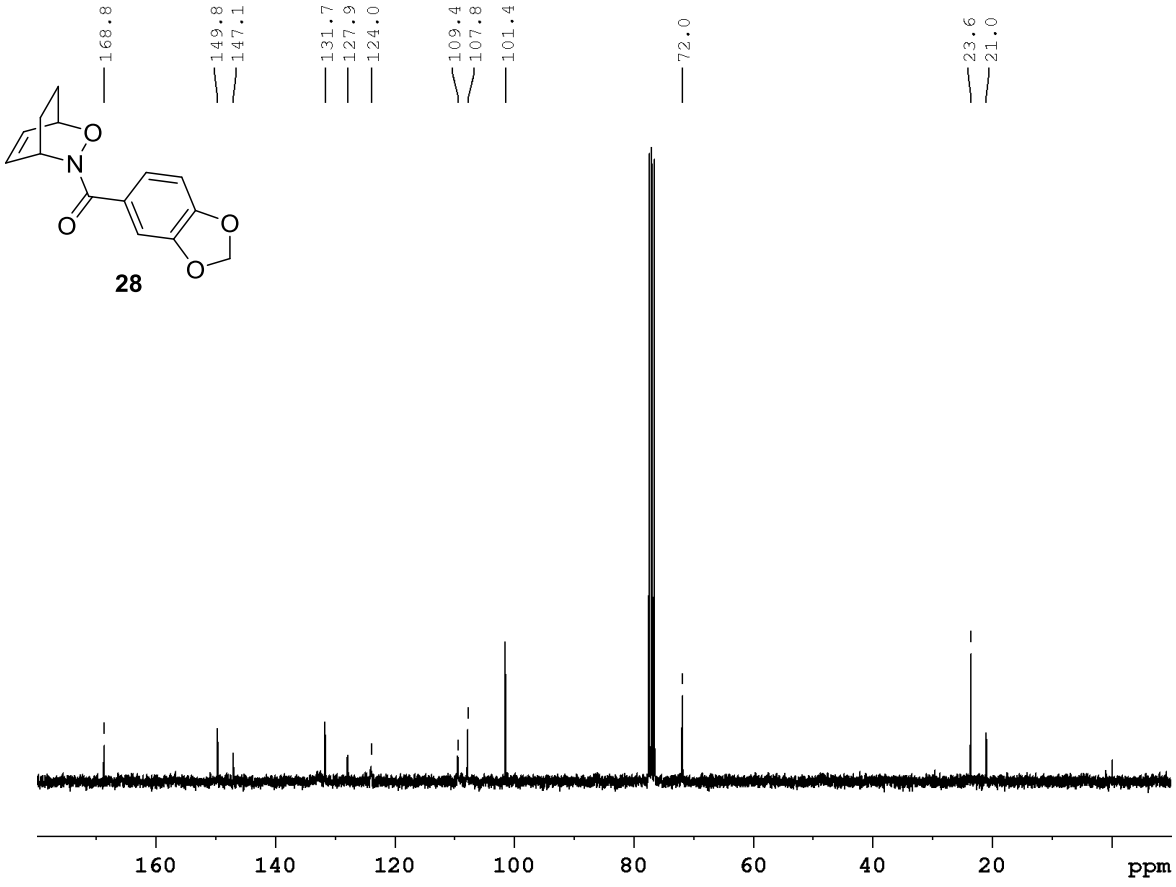


28a

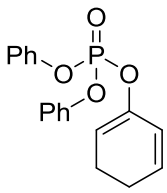
^{1}H-NMR ($CDCl_3$, 300 Hz)



^{13}C-NMR ($CDCl_3$, 75 MHz)

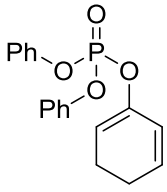


^{1}H-NMR ($CDCl_3$, 300 MHz)



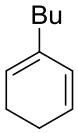
44

^{13}C-NMR ($CDCl_3$, 75 MHz)



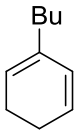
44

^{1}H-NMR ($CDCl_3$, 300 MHz)



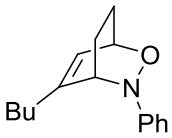
30a

^{13}C-NMR ($CDCl_3$, 75 MHz)



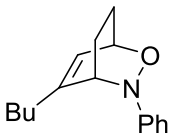
30a

^{1}H-NMR ($CDCl_3$, 300 MHz)



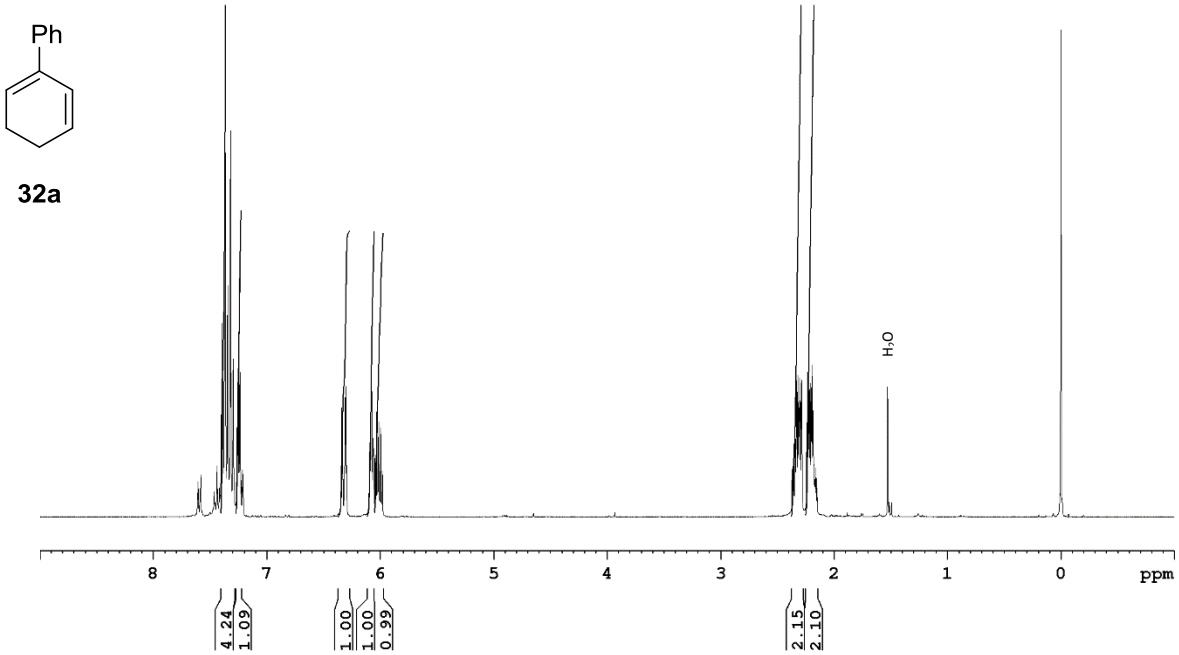
30

^{13}C-NMR ($CDCl_3$, 75 MHz)

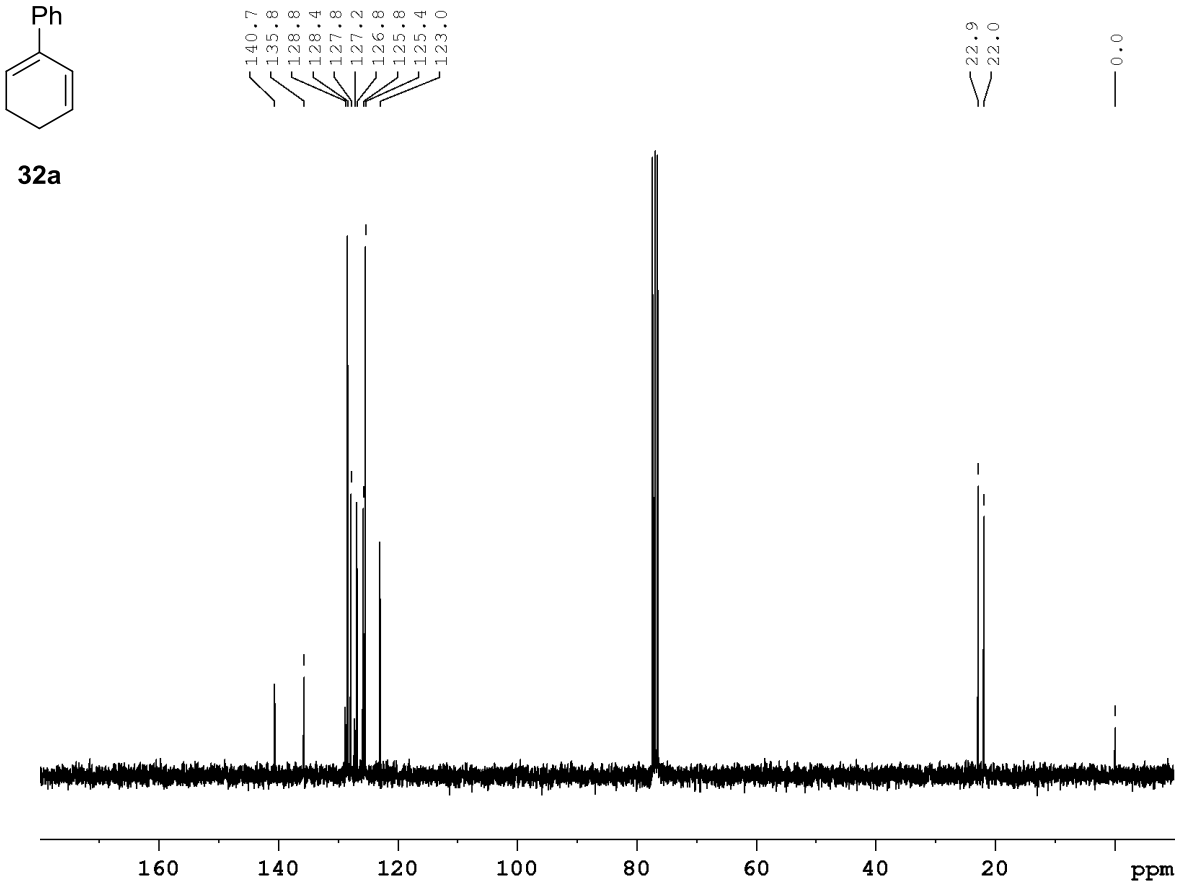


30

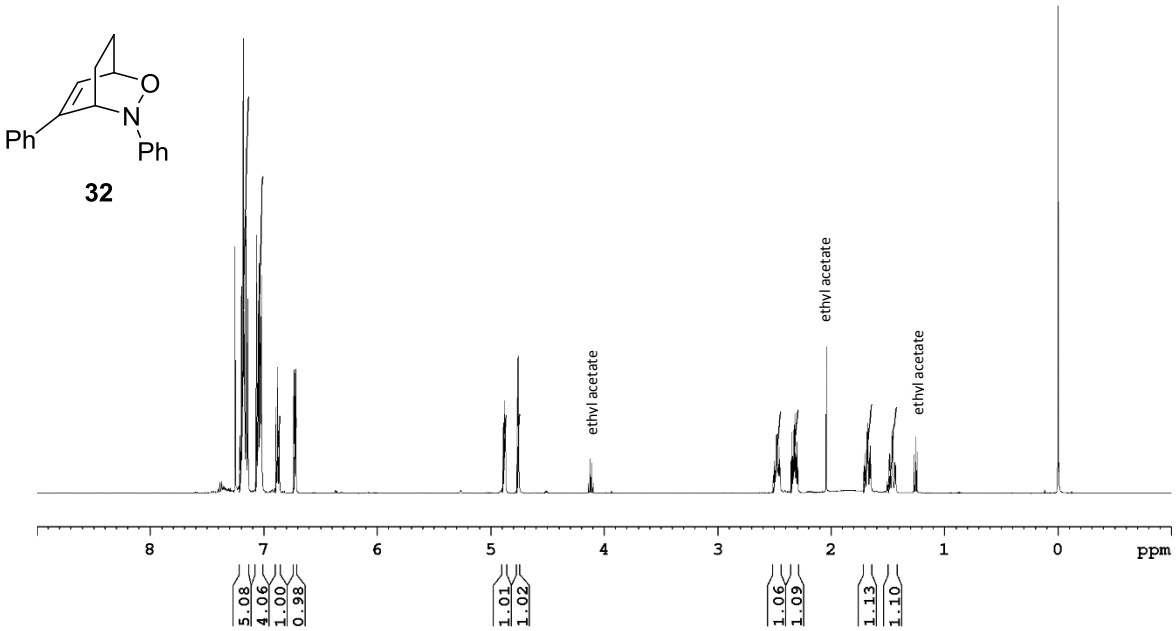
^{1}H-NMR ($CDCl_3$, 300 MHz)



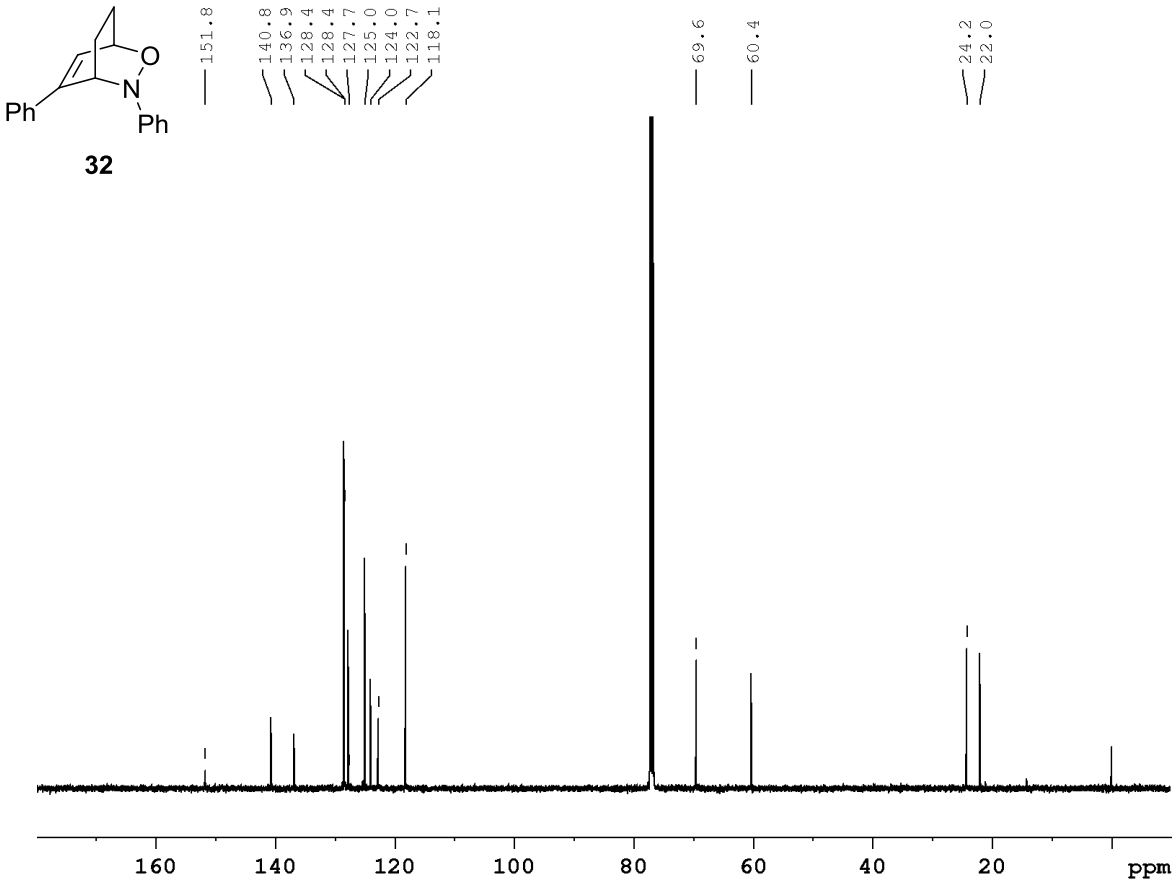
^{13}C-NMR ($CDCl_3$, 75 MHz)



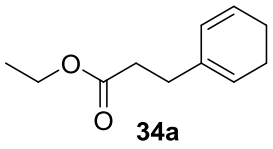
^{1}H-NMR ($CDCl_3$, 500 MHz)



^{13}C-NMR ($CDCl_3$, 125 MHz)

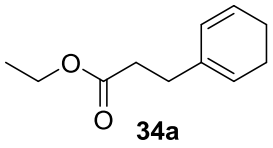


^{1}H-NMR ($CDCl_3$, 400 MHz)



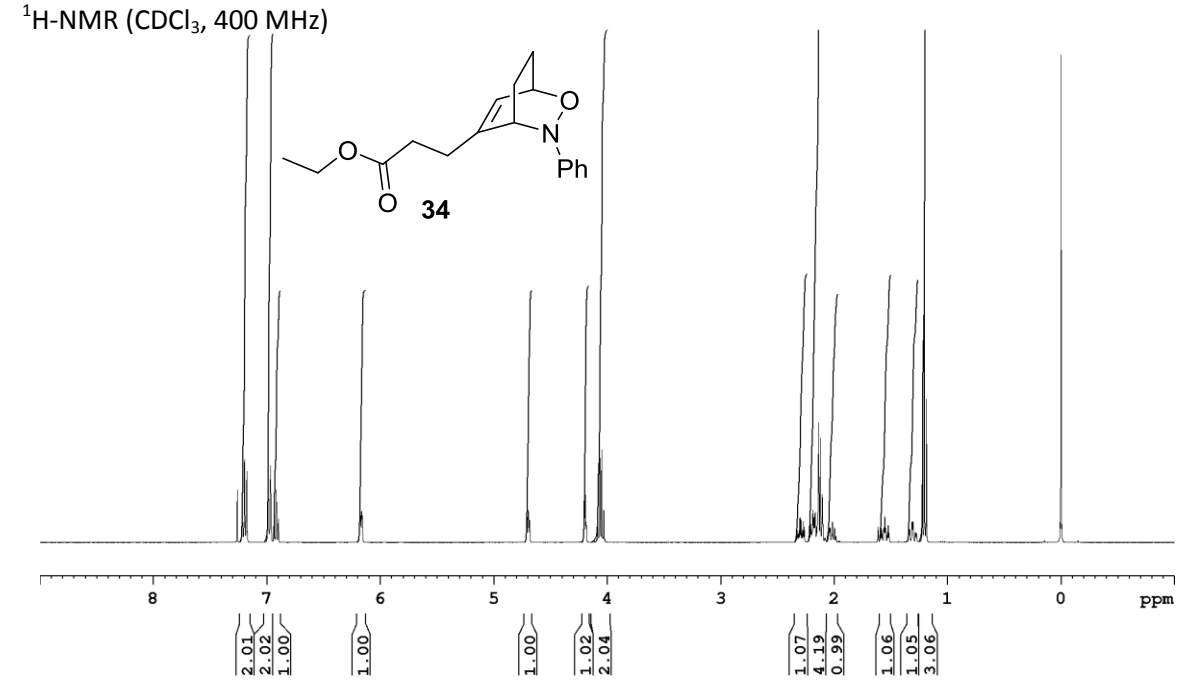
34a

^{13}C-NMR ($CDCl_3$, 100 MHz)

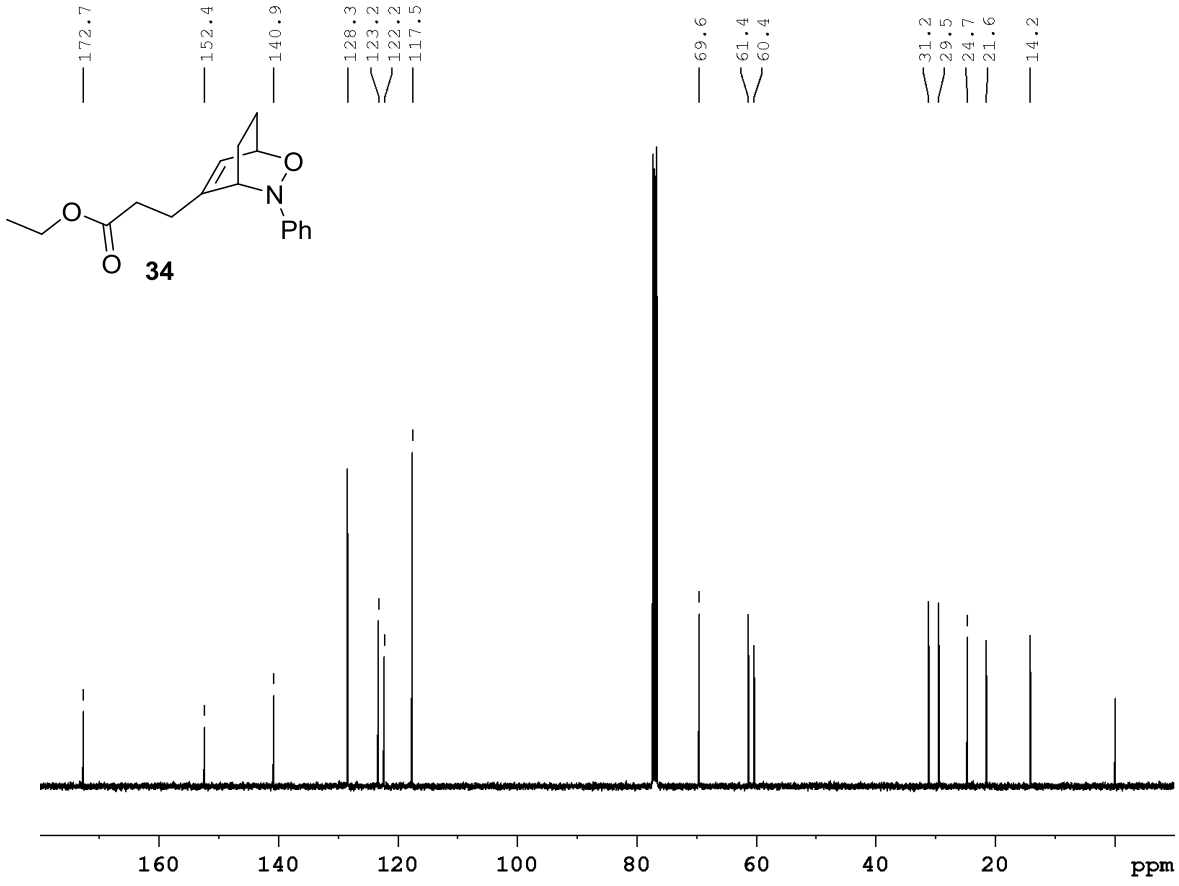


34a

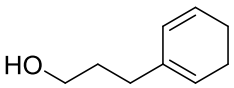
^{1}H-NMR ($CDCl_3$, 400 MHz)



^{13}C-NMR ($CDCl_3$, 100 MHz)

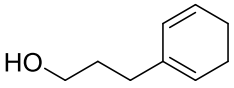


^{1}H-NMR ($CDCl_3$, 400 MHz)



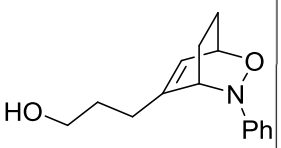
36a

^{13}C-NMR ($CDCl_3$, 100 MHz)



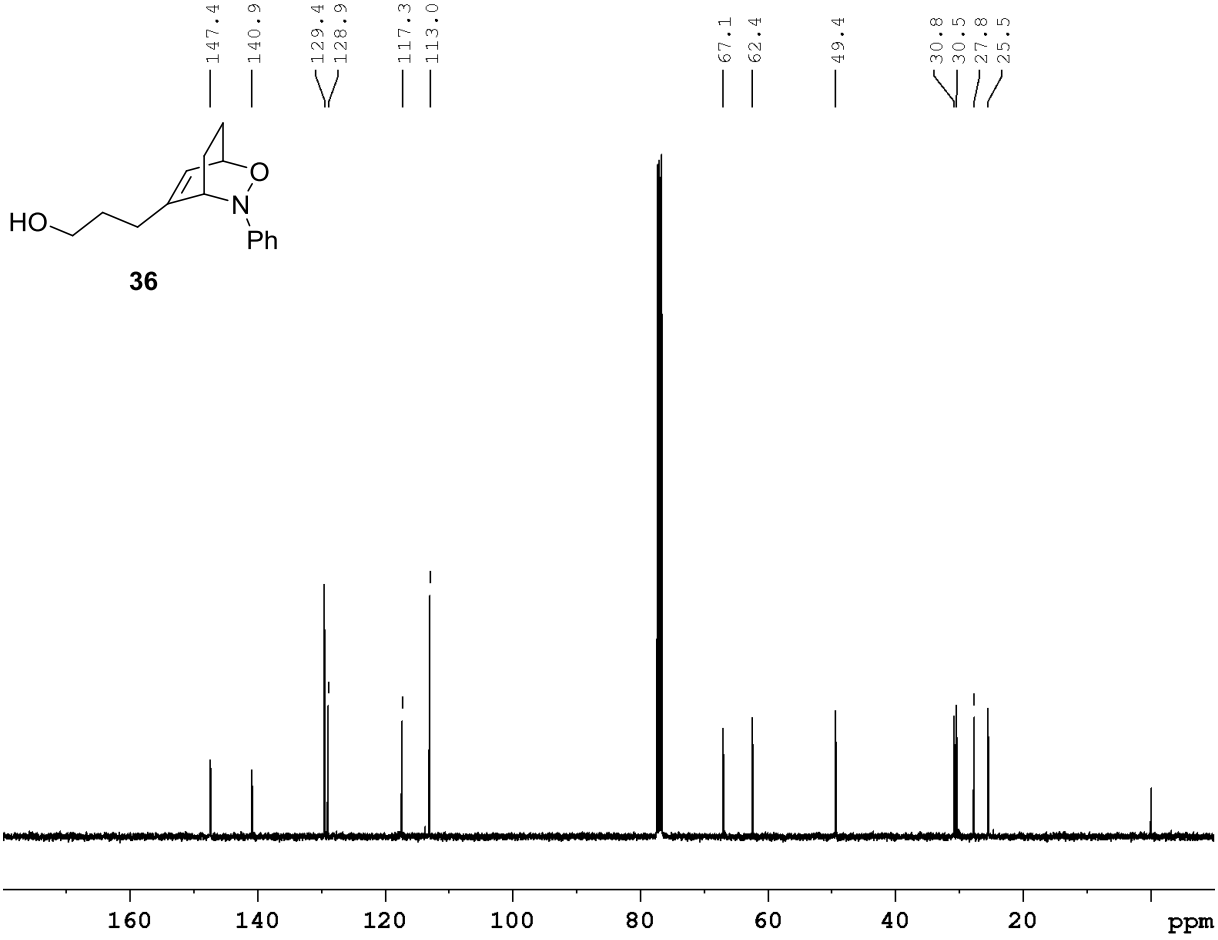
36a

^{1}H-NMR ($CDCl_3$, 400 MHz)



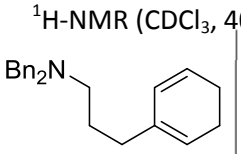
36

^{13}C-NMR ($CDCl_3$, 100 MHz)



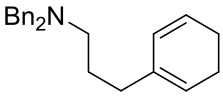
36

^{1}H-NMR ($CDCl_3$, 400 MHz)



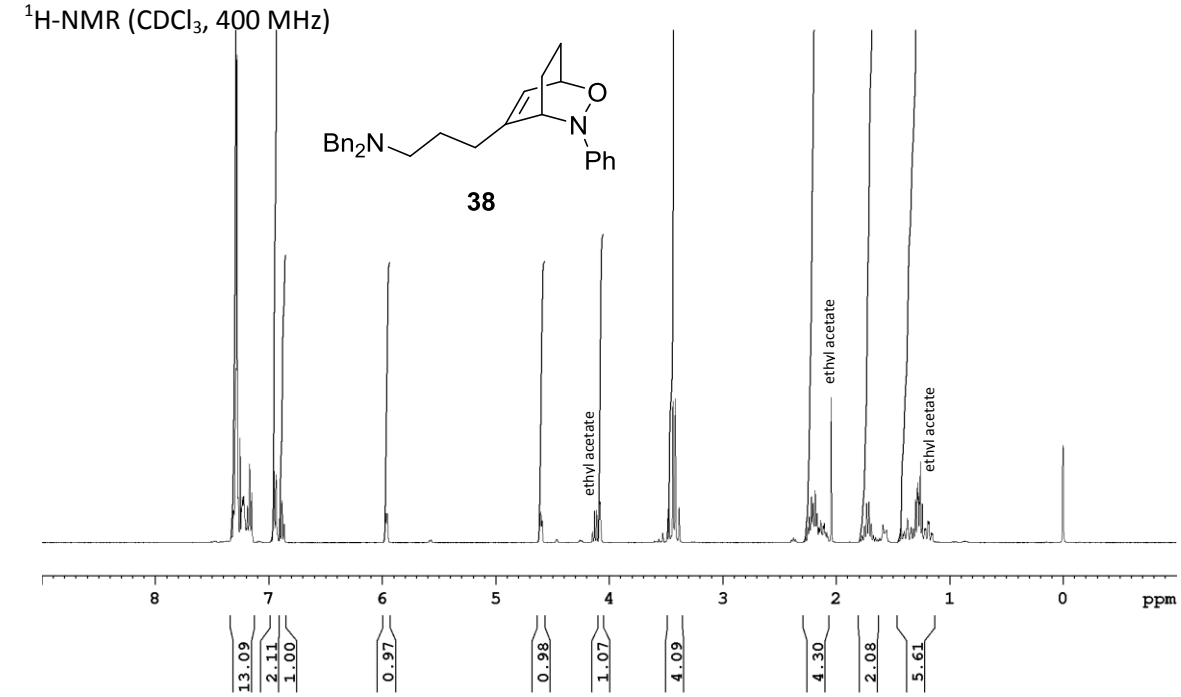
38a

^{13}C-NMR ($CDCl_3$, 100 MHz)

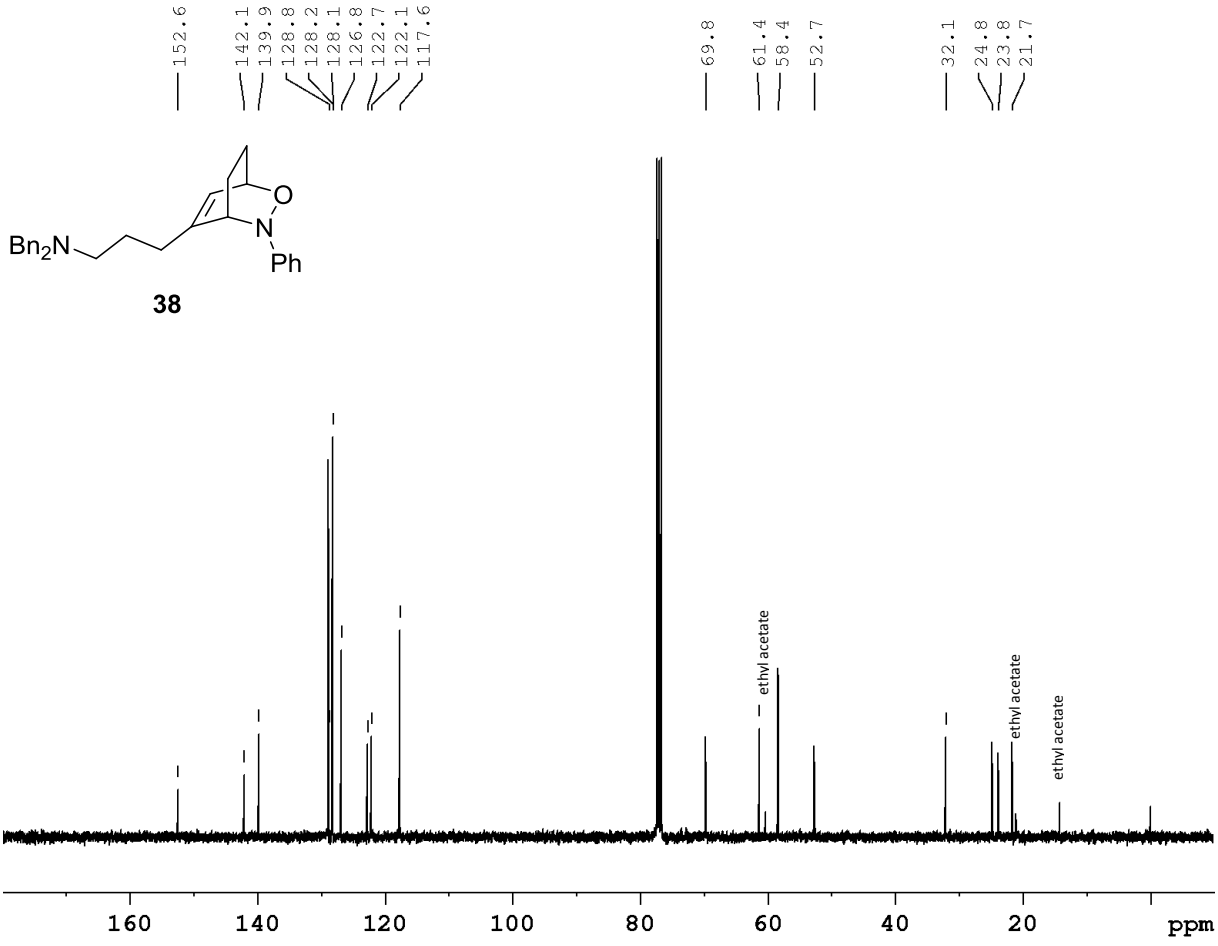


38a

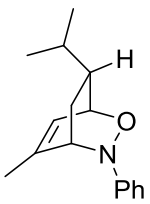
^{1}H-NMR ($CDCl_3$, 400 MHz)



^{13}C-NMR ($CDCl_3$, 100 MHz)

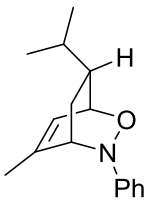


^{1}H-NMR ($CDCl_3$, 300 MHz)



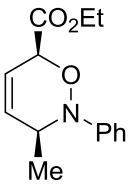
40

^{13}C-NMR ($CDCl_3$, 75 MHz)



40

^{1}H-NMR ($CDCl_3$, 300 MHz)

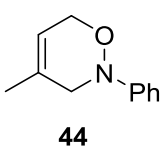


42

^{13}C-NMR ($CDCl_3$, 75 MHz)

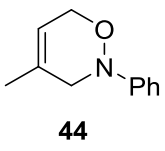
42

^{1}H-NMR ($CDCl_3$, 300 MHz)



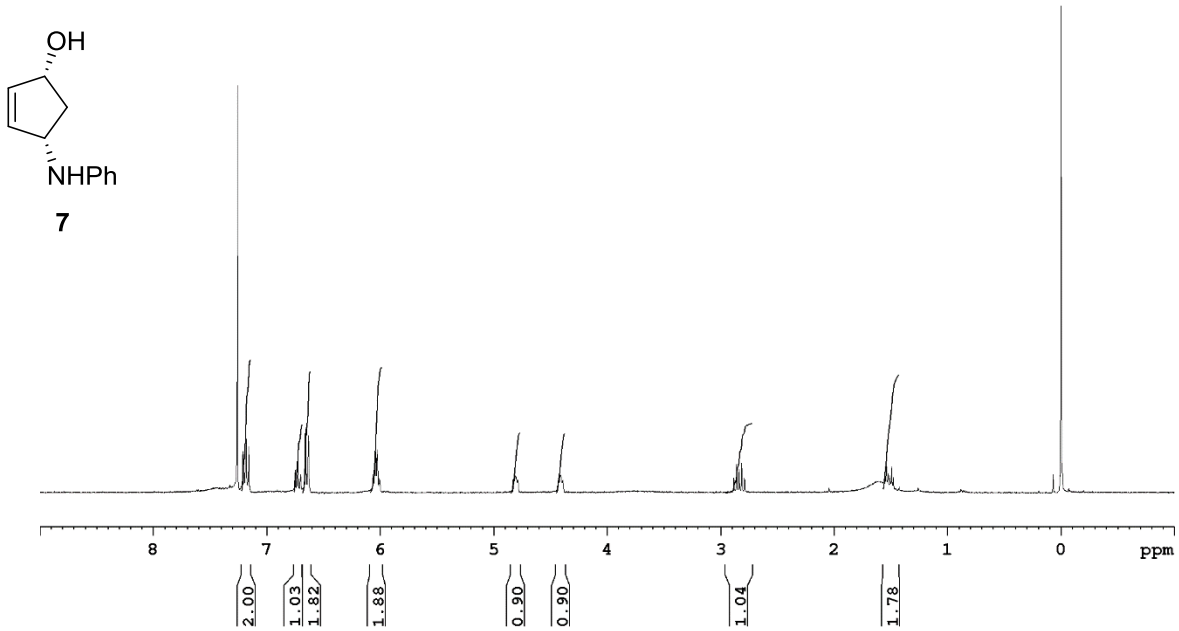
44

^{13}C-NMR ($CDCl_3$, 75 MHz)

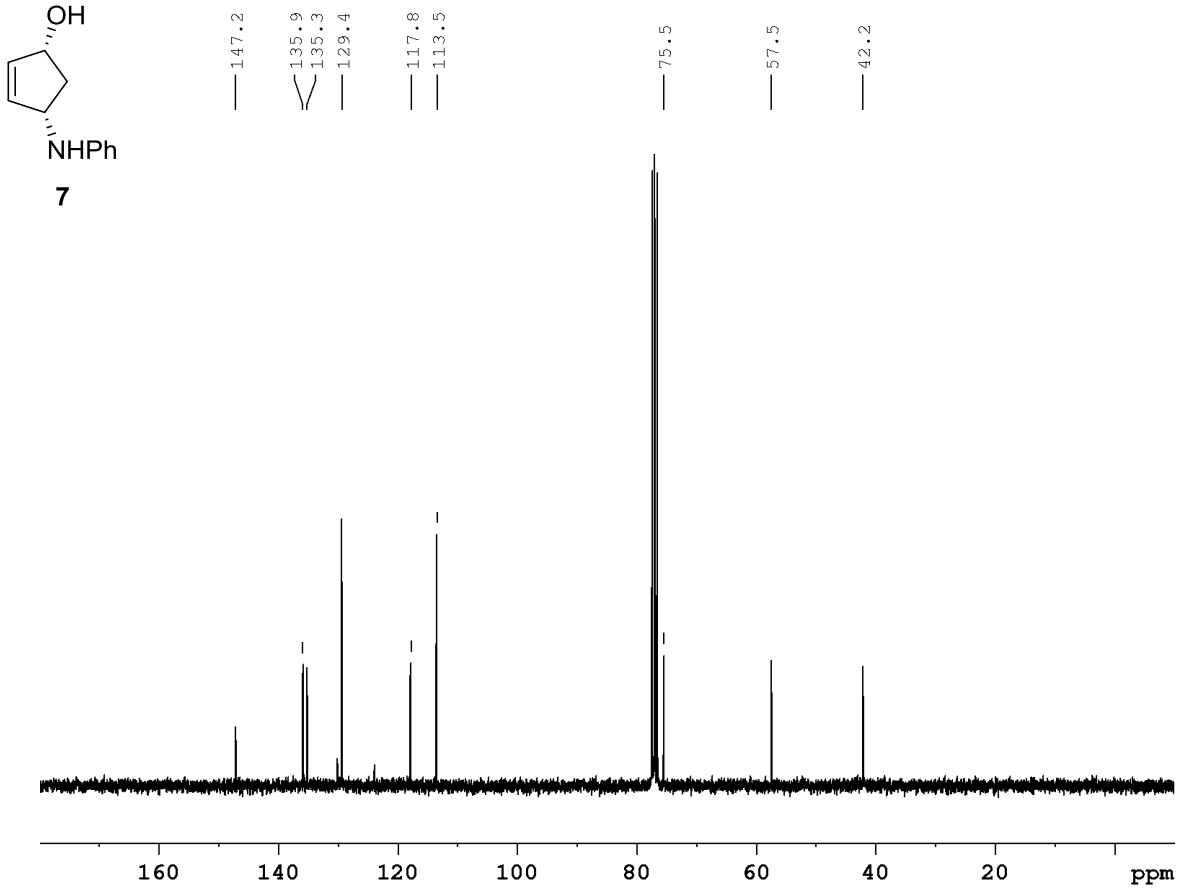


44

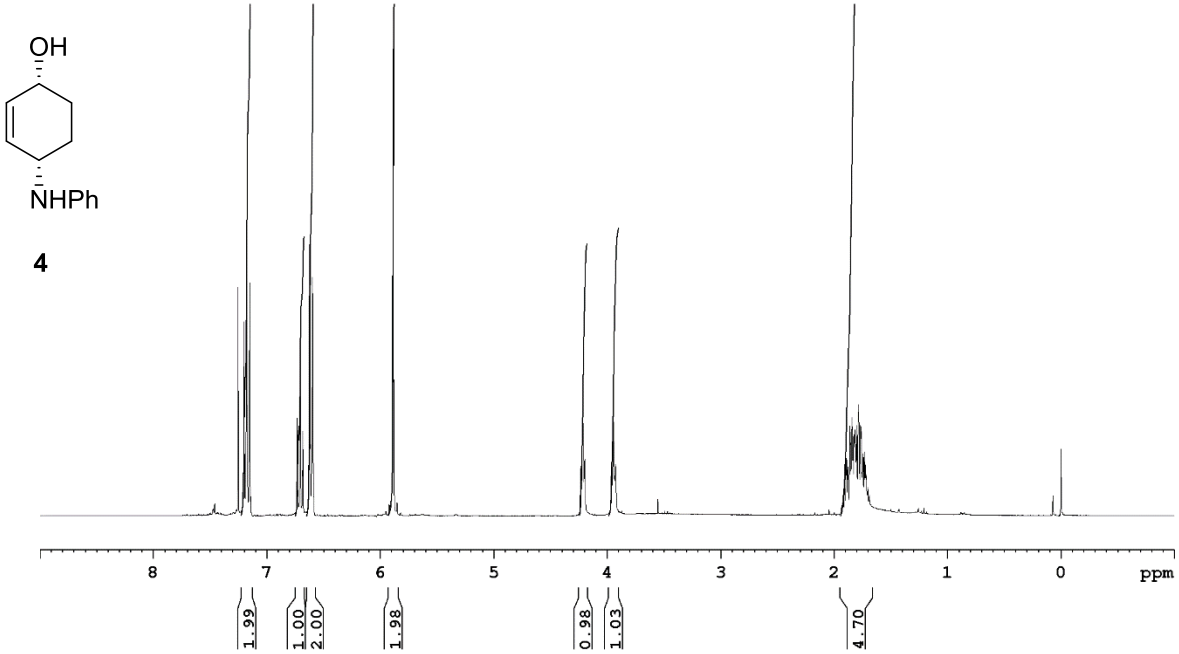
^{1}H-NMR ($CDCl_3$, 300 MHz)



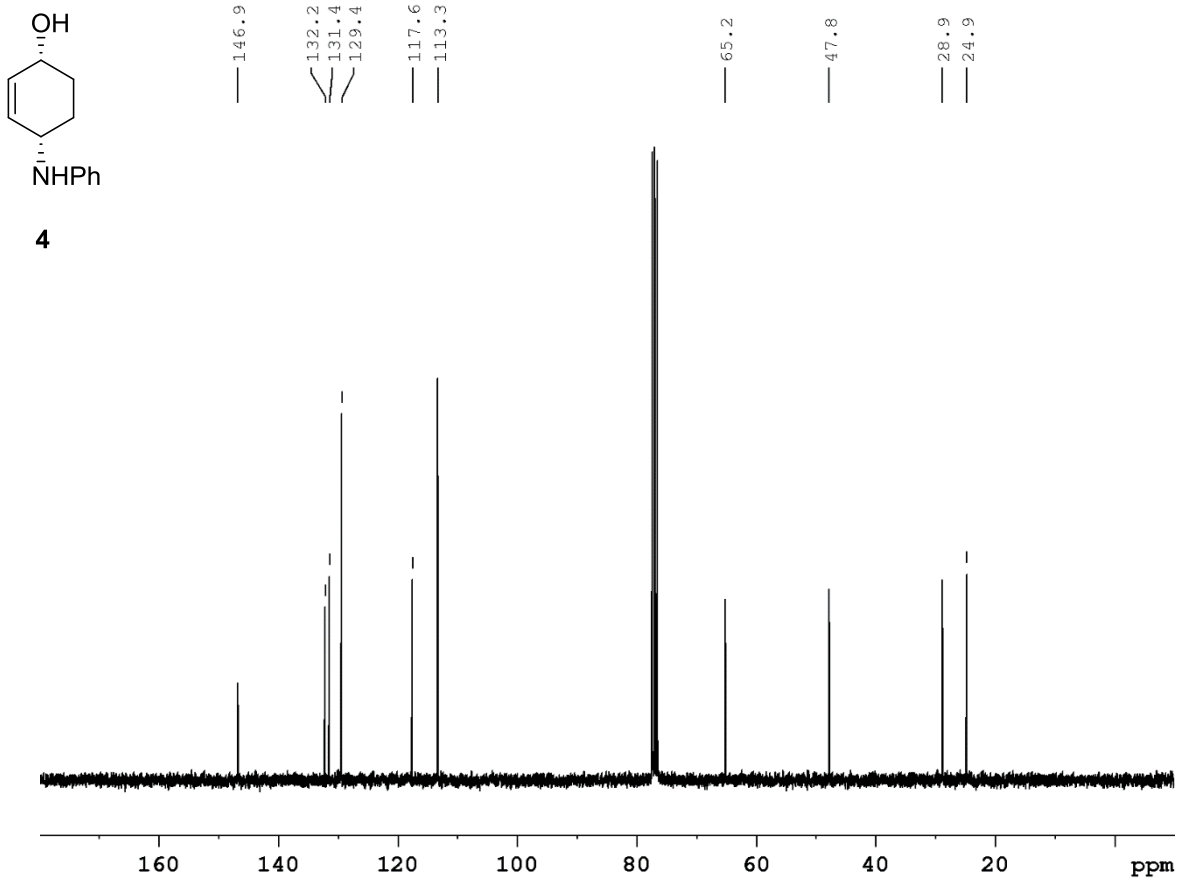
^{13}C-NMR ($CDCl_3$, 75 MHz)



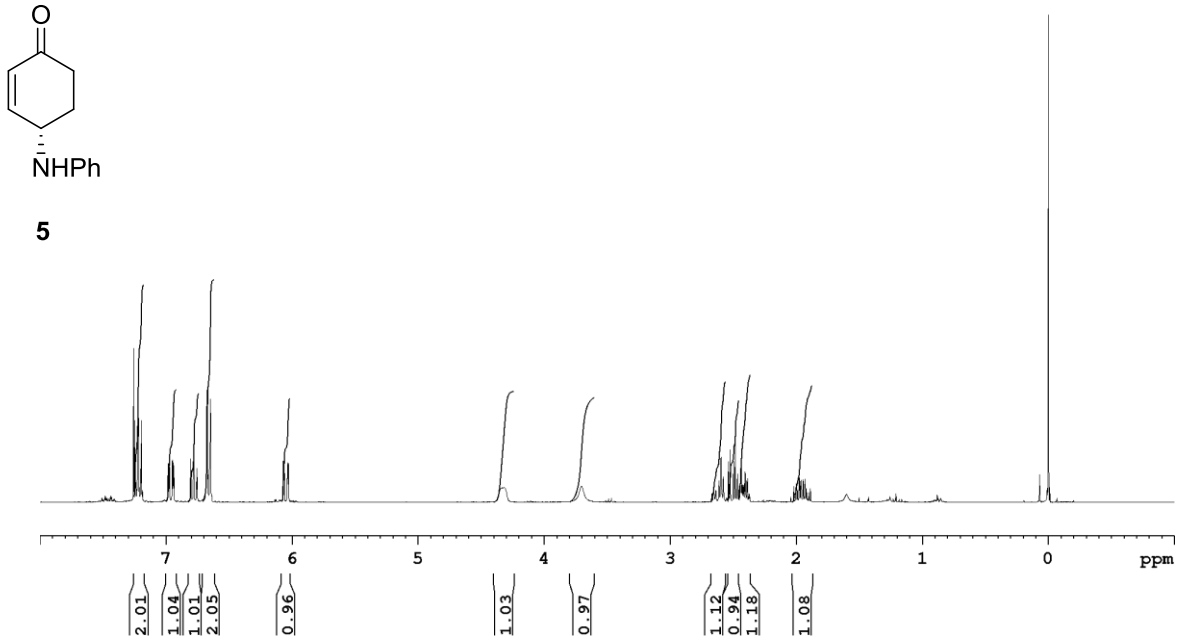
^{1}H-NMR ($CDCl_3$, 300 MHz)



^{13}C-NMR ($CDCl_3$, 75 MHz)

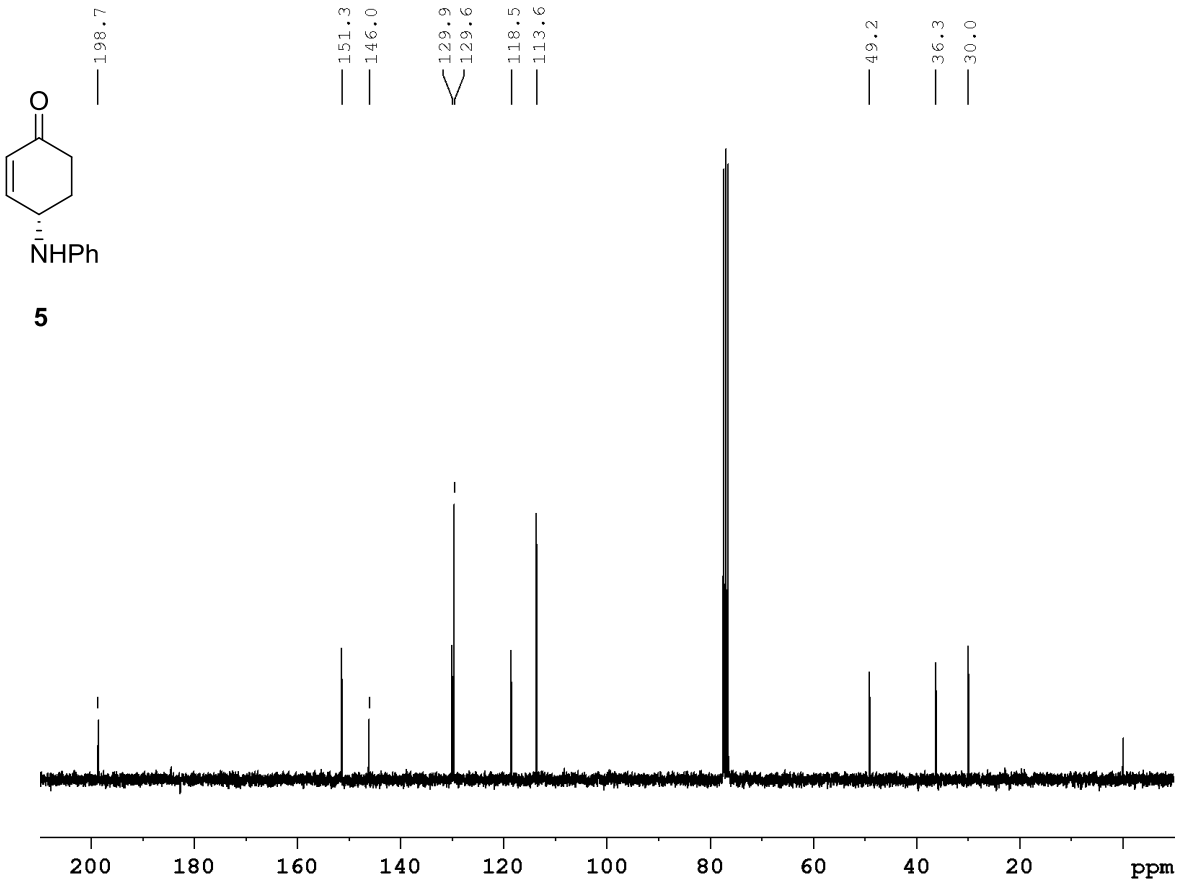


^{1}H-NMR ($CDCl_3$, 300 MHz)



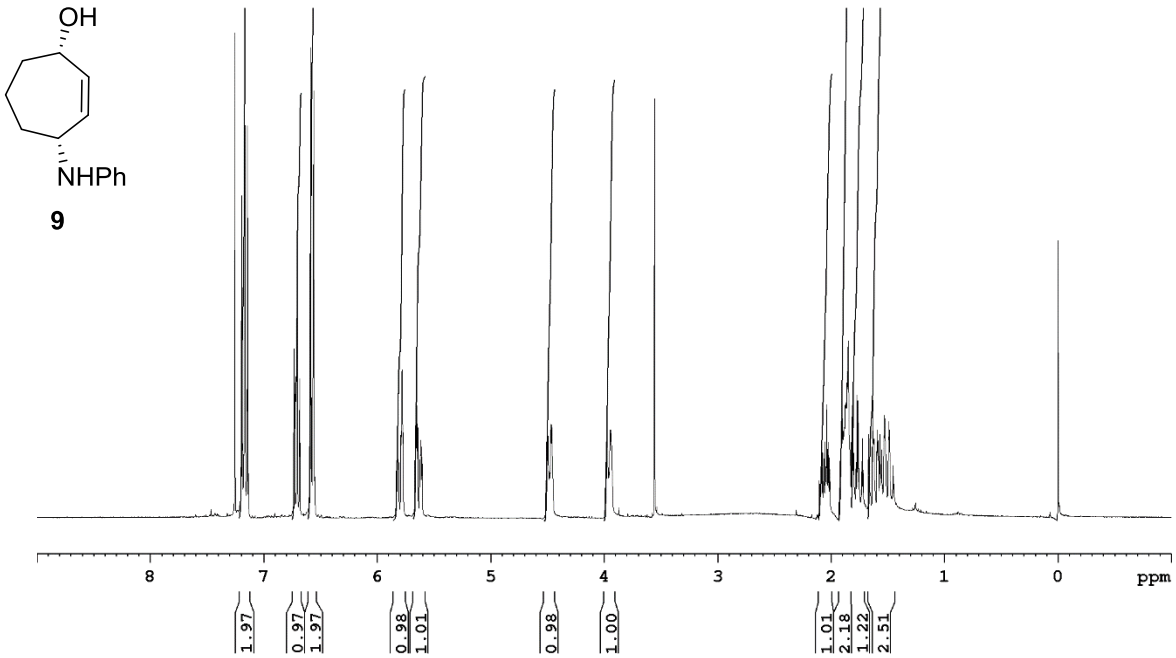
5

^{13}C-NMR ($CDCl_3$, 75 MHz)

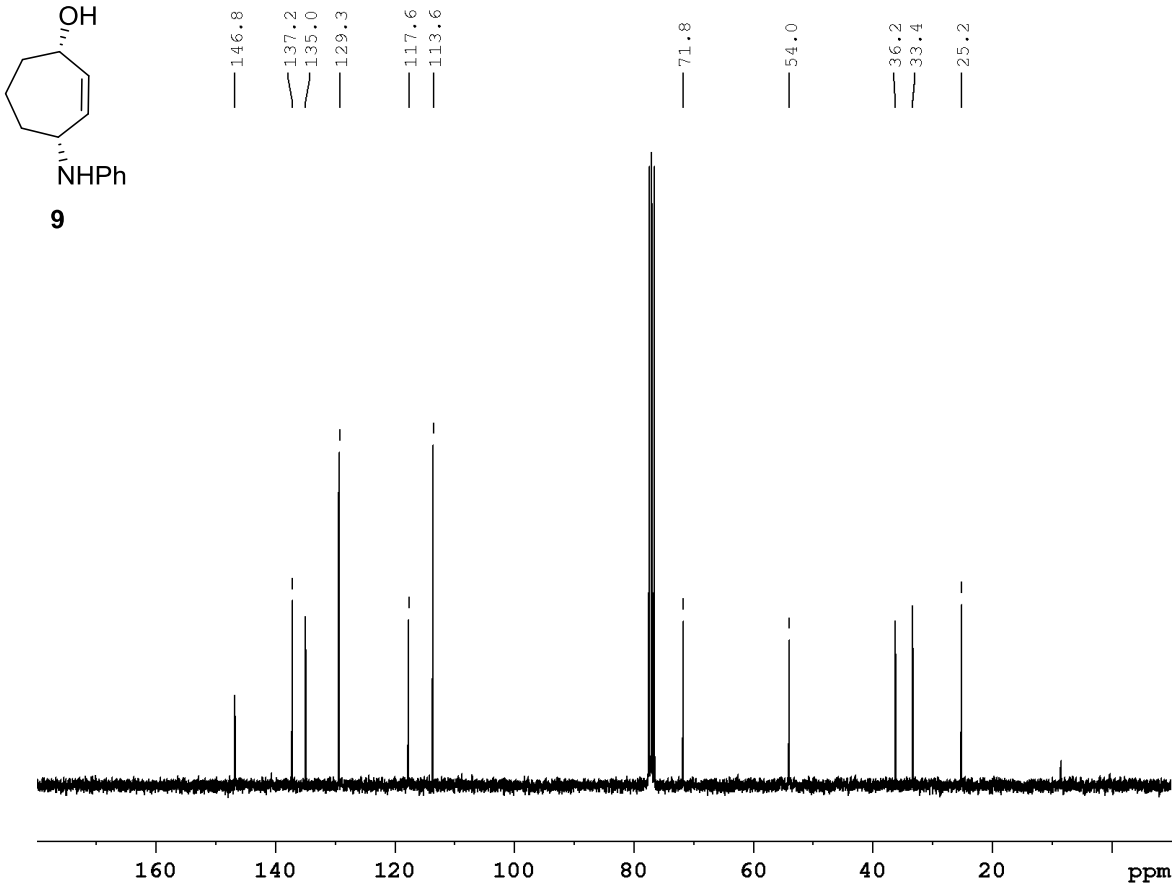


5

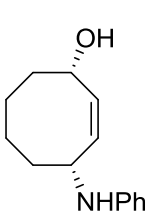
^{1}H-NMR ($CDCl_3$, 300 MHz)



^{13}C-NMR ($CDCl_3$, 75 MHz)

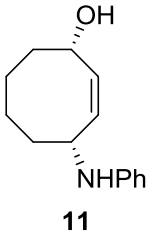


^{1}H-NMR ($CDCl_3$, 300 MHz)



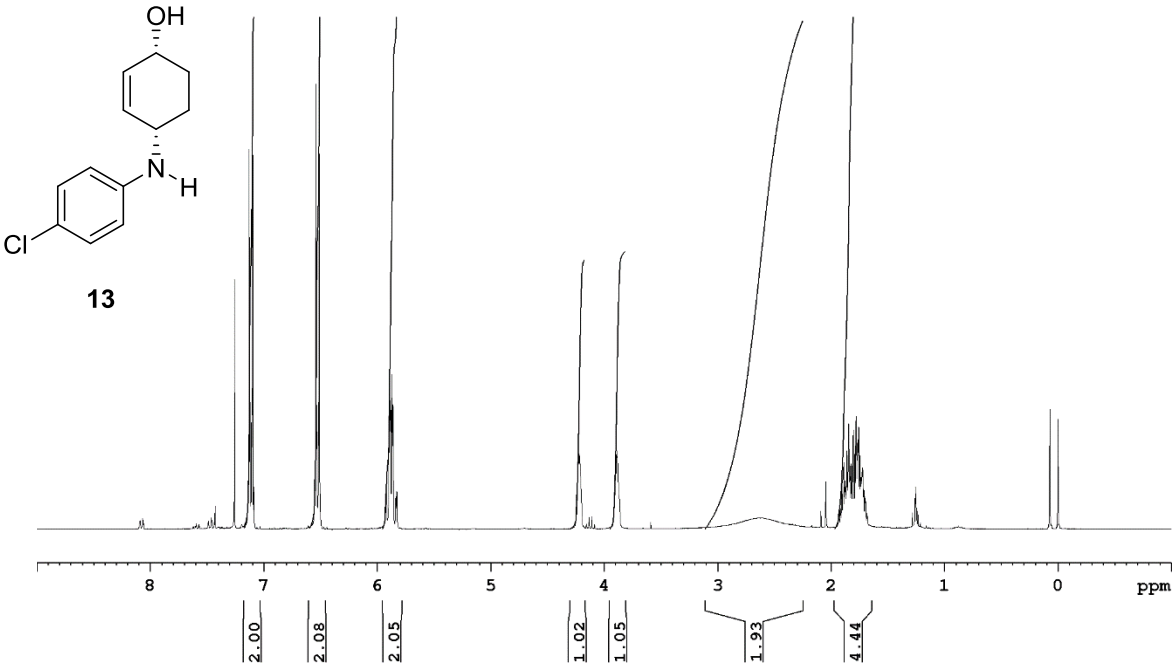
11

^{13}C-NMR ($CDCl_3$, 75 MHz)

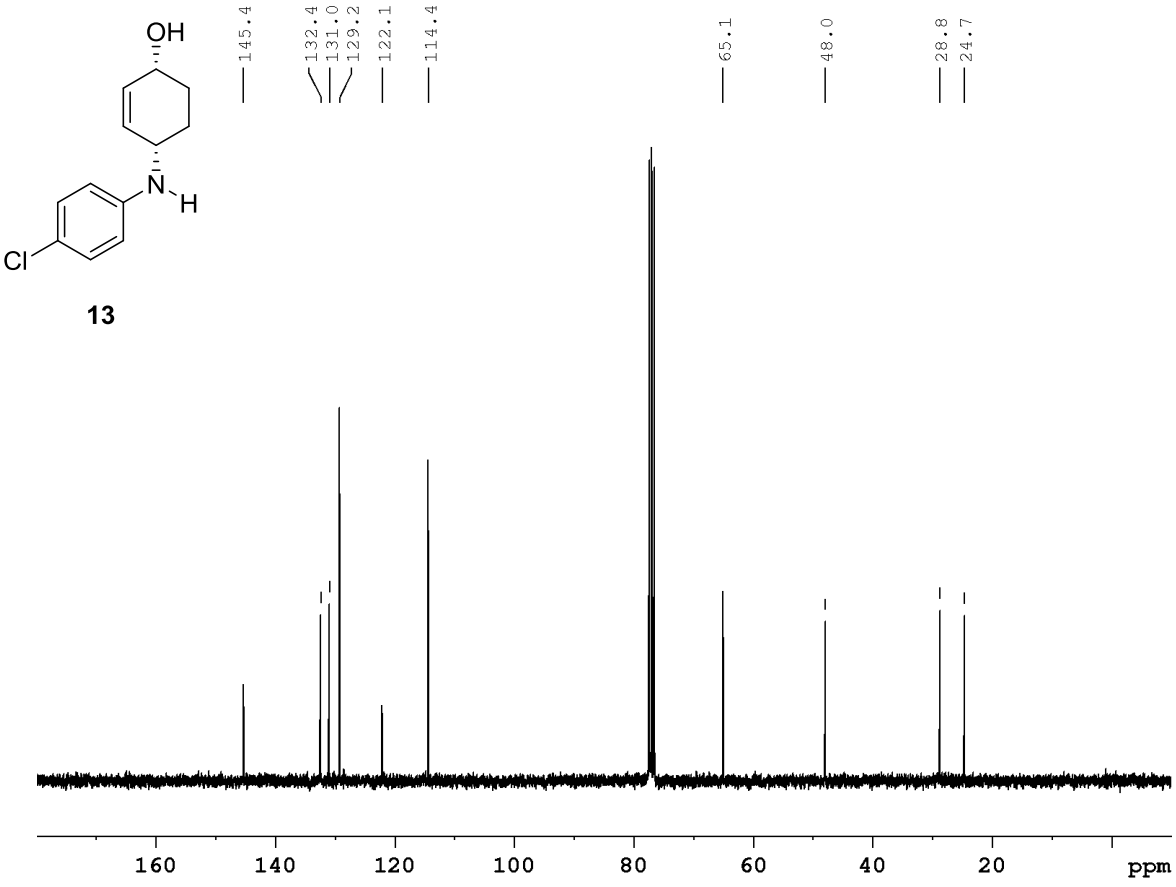


11

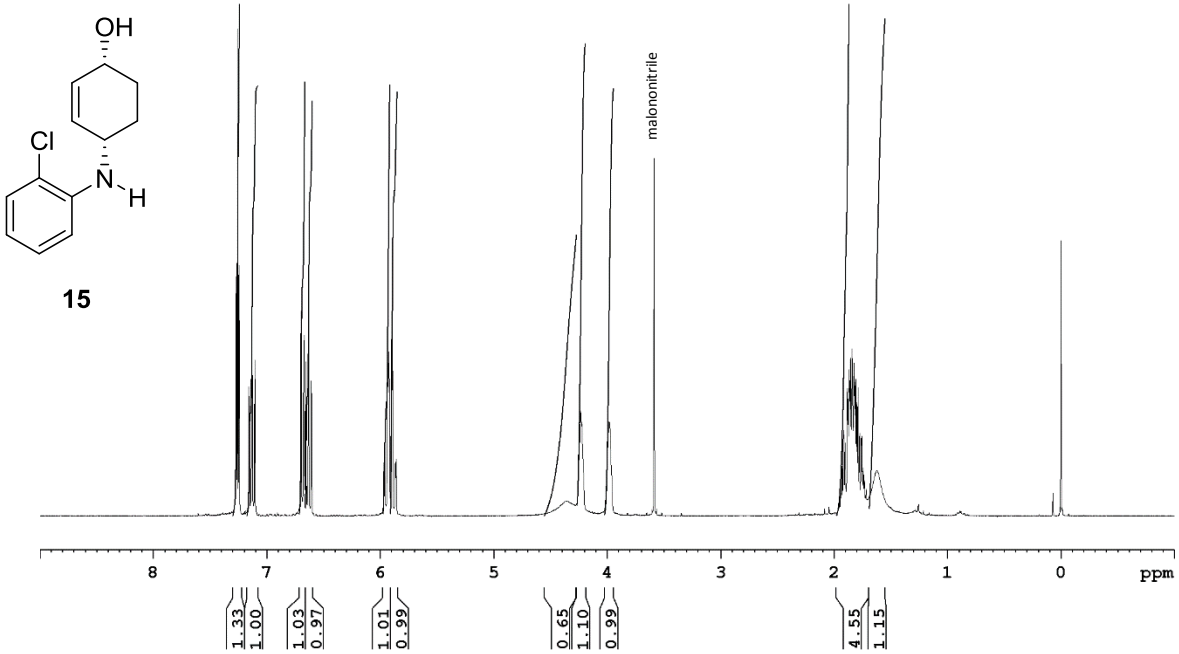
^{1}H-NMR ($CDCl_3$, 300 MHz)



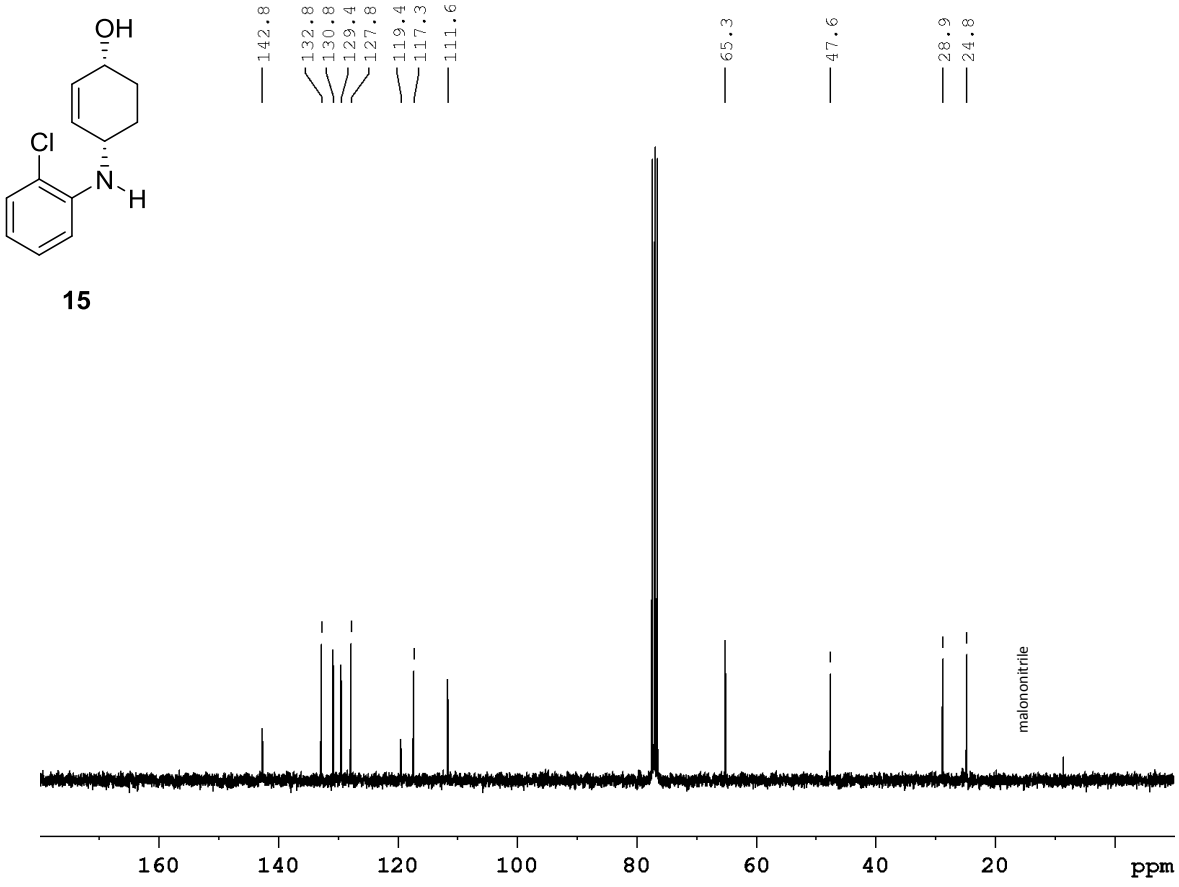
^{13}C-NMR ($CDCl_3$, 75 MHz)



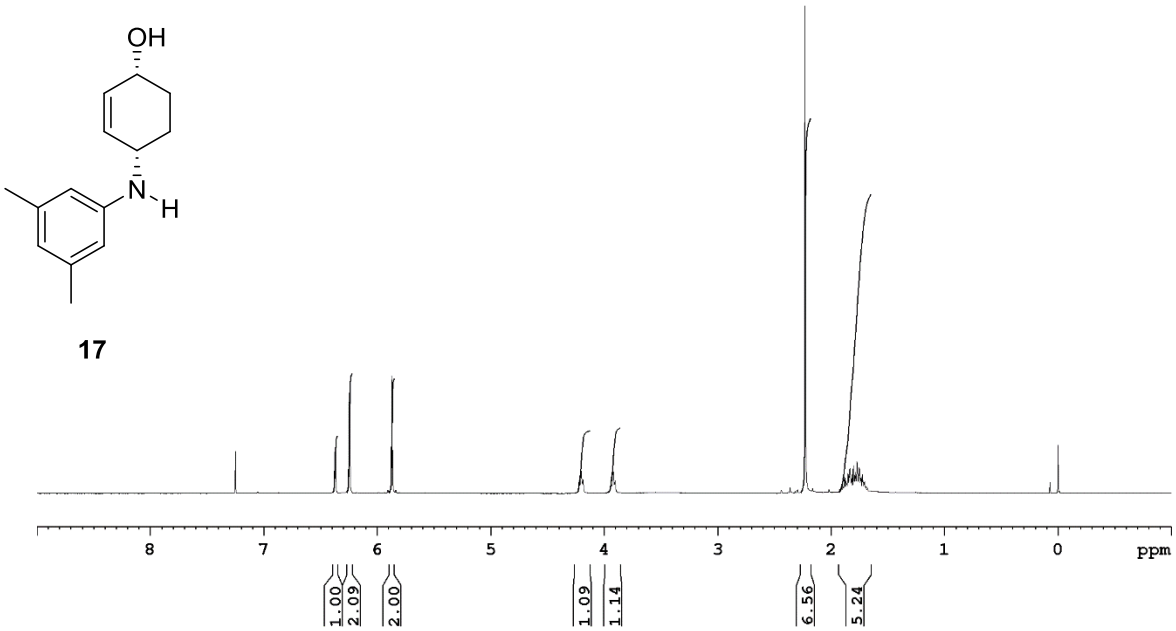
^{1}H-NMR ($CDCl_3$, 300 MHz)



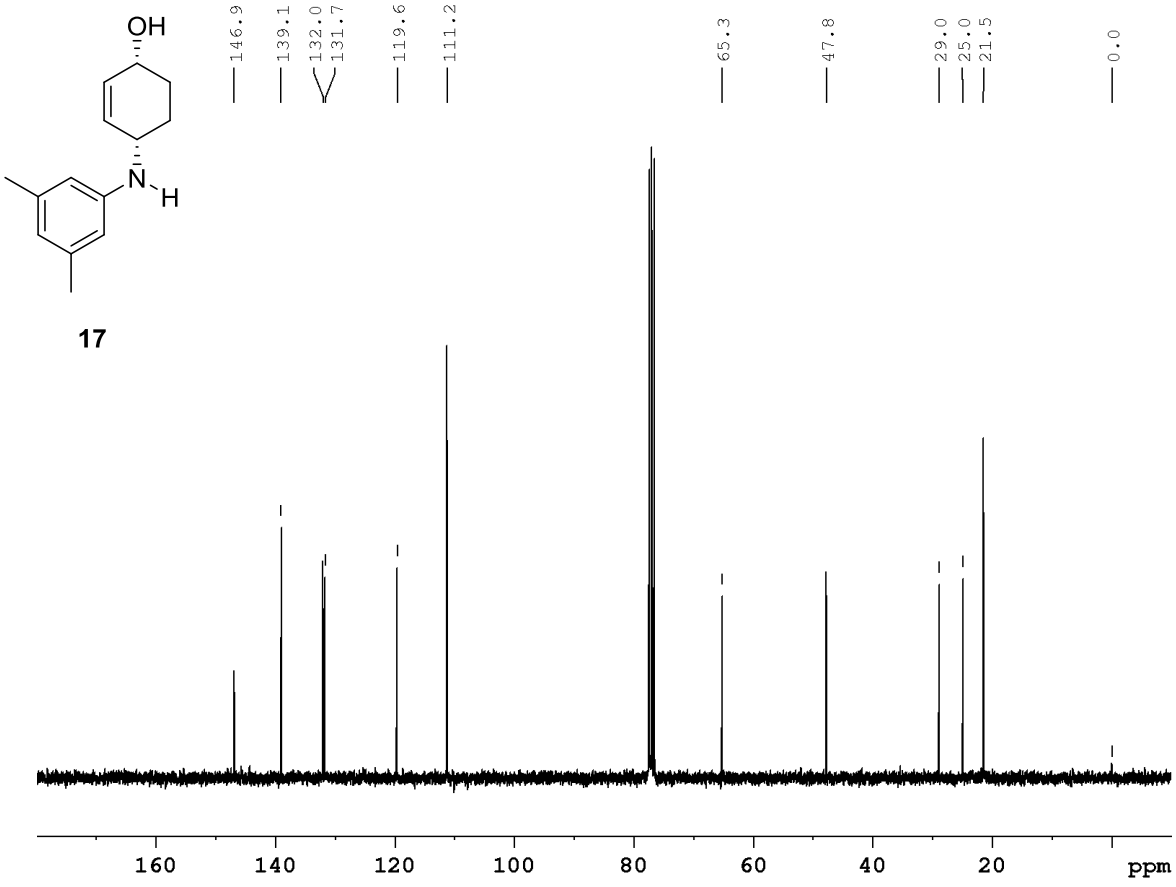
^{13}C-NMR ($CDCl_3$, 75 MHz)



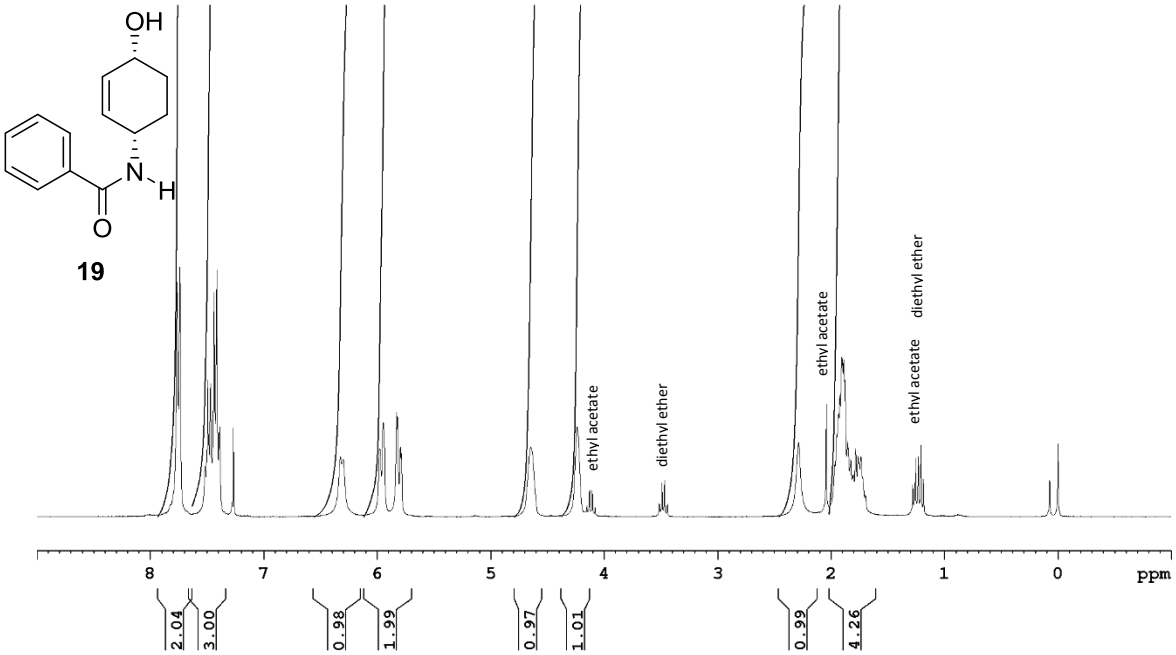
^{1}H-NMR ($CDCl_3$, 300 MHz)



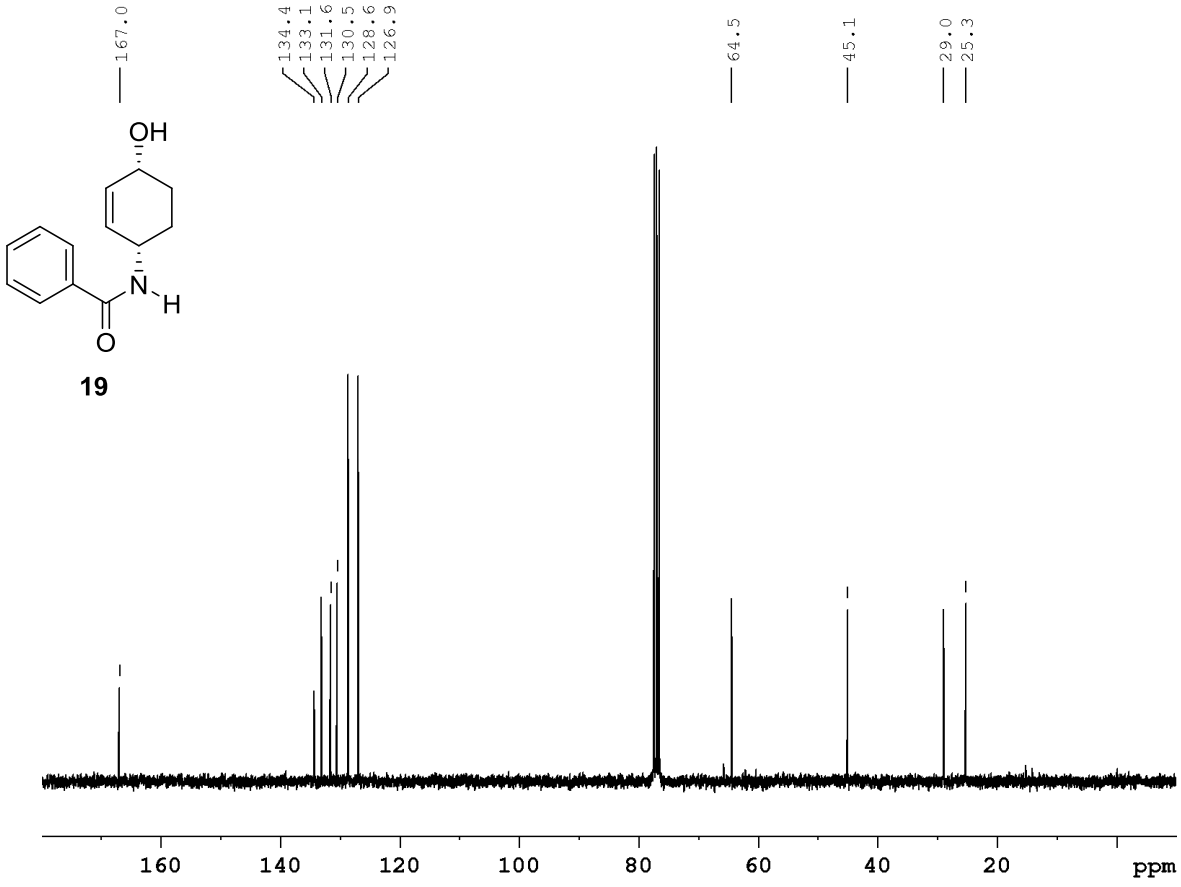
^{13}C-NMR ($CDCl_3$, 75 MHz)



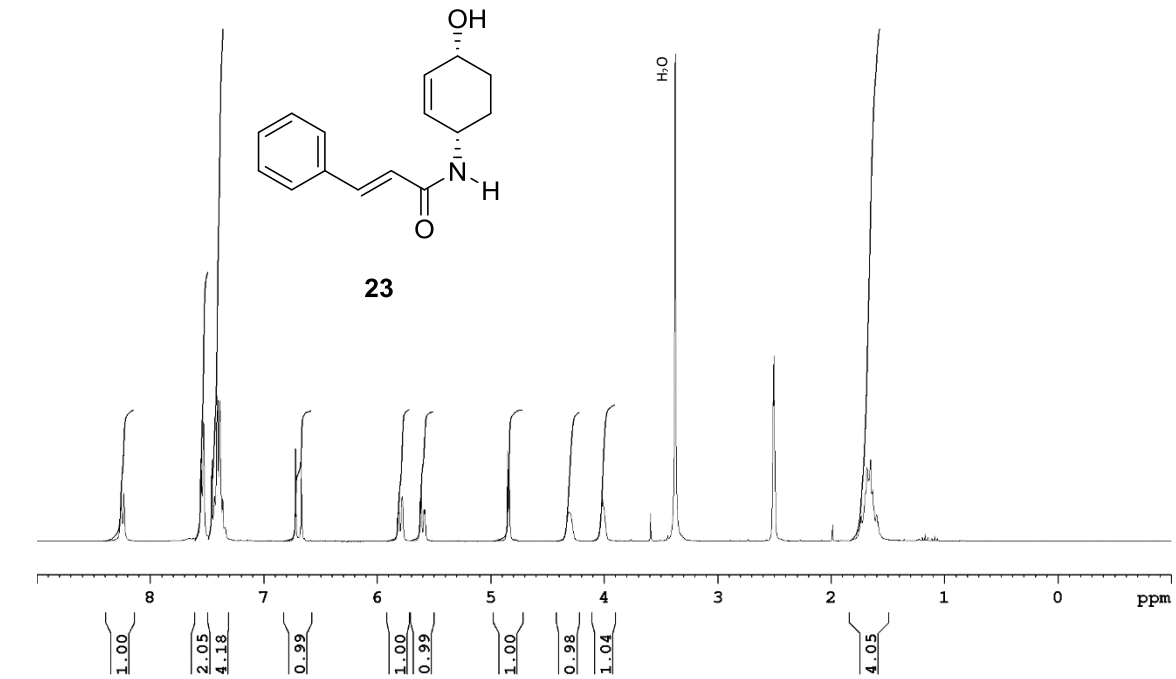
^{1}H-NMR ($CDCl_3$, 300 MHz)



^{13}C-NMR ($CDCl_3$, 75 MHz)

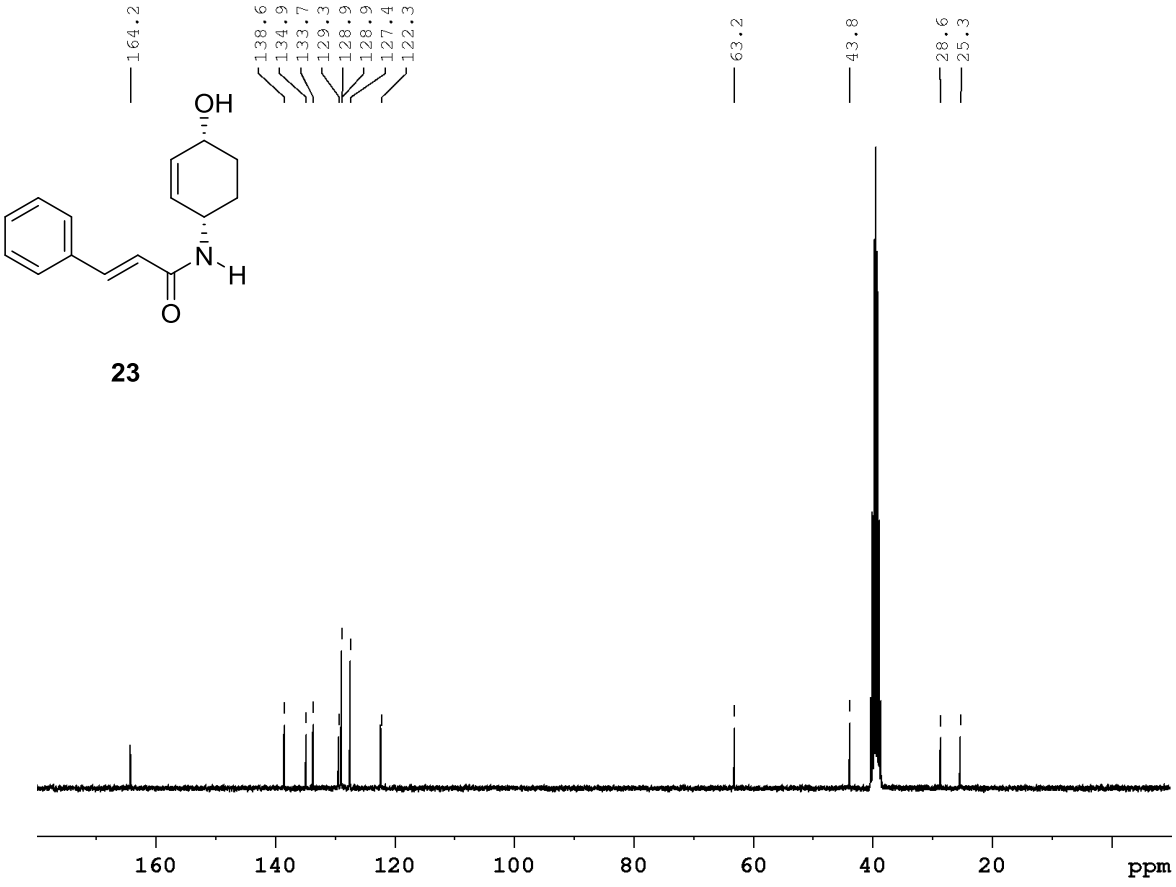


^{1}H-NMR (DMSO-d6, 300 MHz)



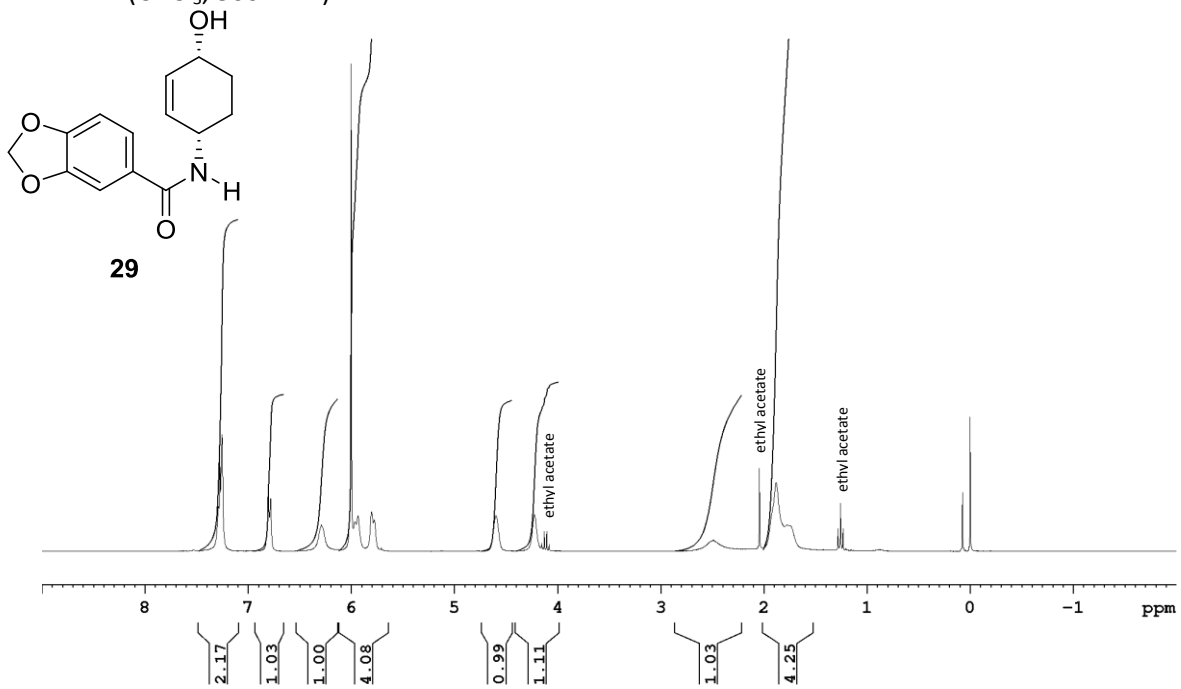
23

^{13}C-NMR (DMSO-d6, 75 MHz)



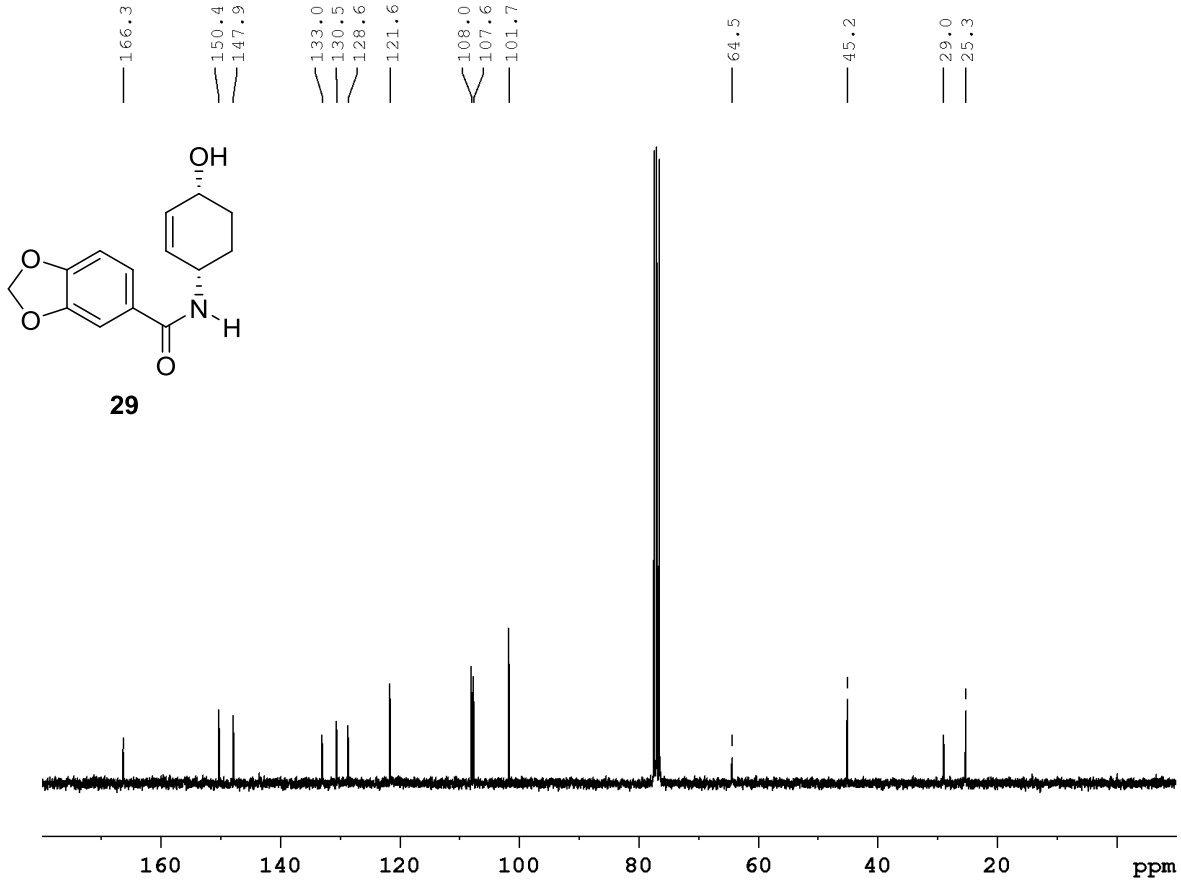
23

^{1}H-NMR ($CDCl_3$, 300 MHz)



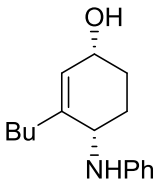
29

^{13}C-NMR ($CDCl_3$, 75 MHz)



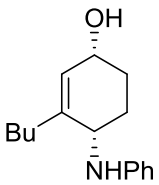
29

^{1}H-NMR ($CDCl_3$, 300 MHz)



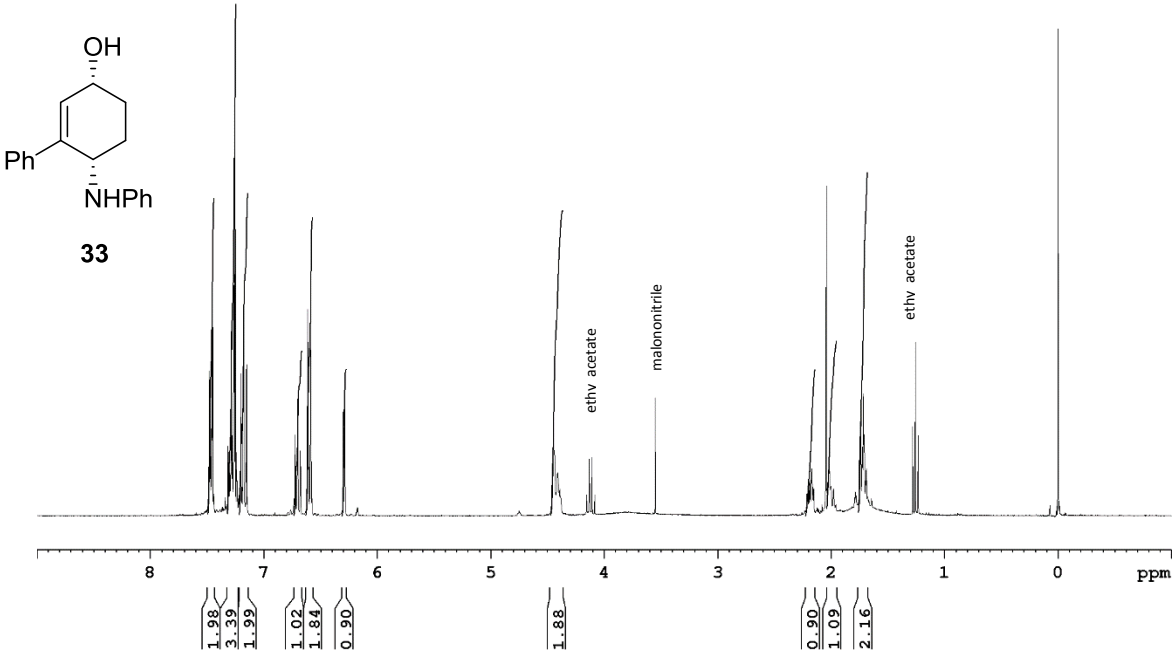
31

^{13}C-NMR ($CDCl_3$, 75 MHz)

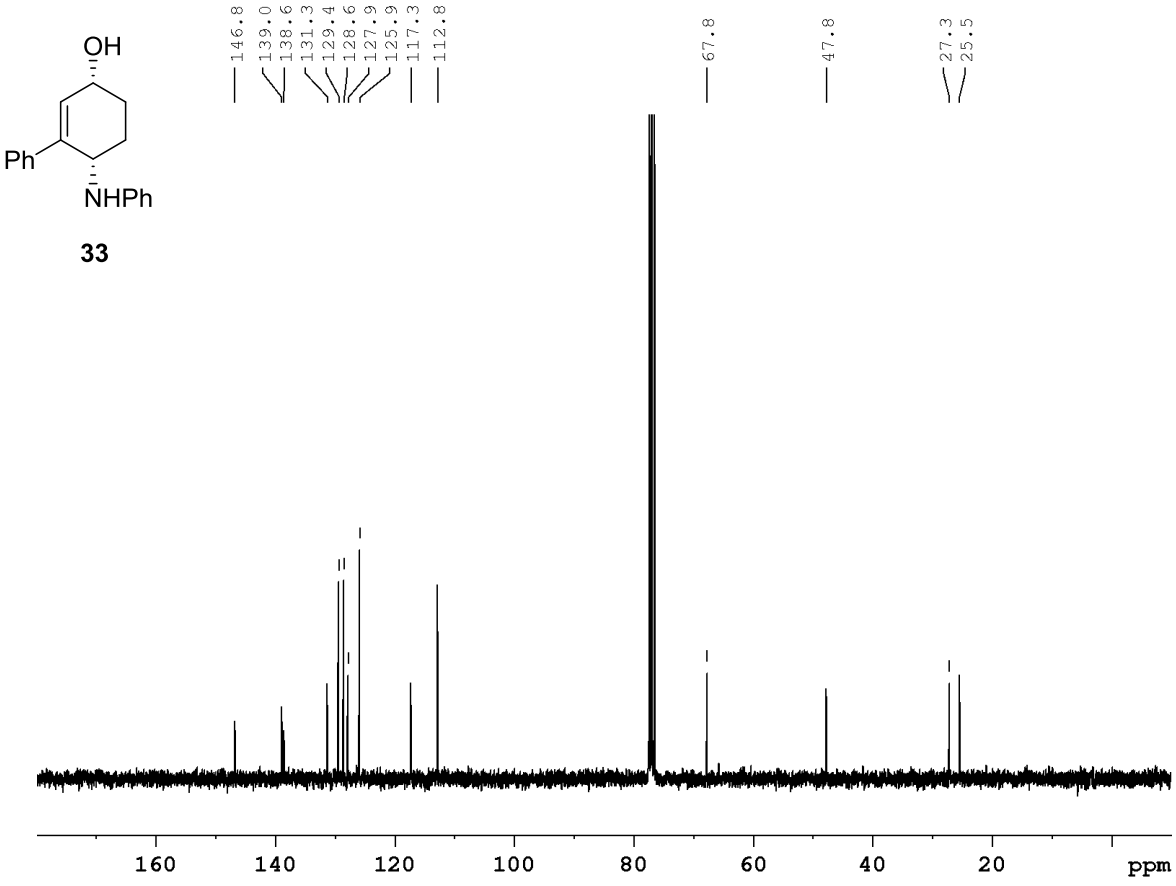


31

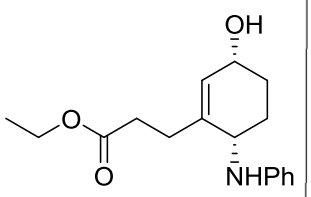
^{1}H-NMR ($CDCl_3$, 300 MHz)



^{13}C-NMR ($CDCl_3$, 75 MHz)

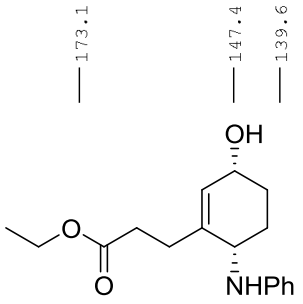


^{1}H-NMR ($CDCl_3$, 400 MHz)



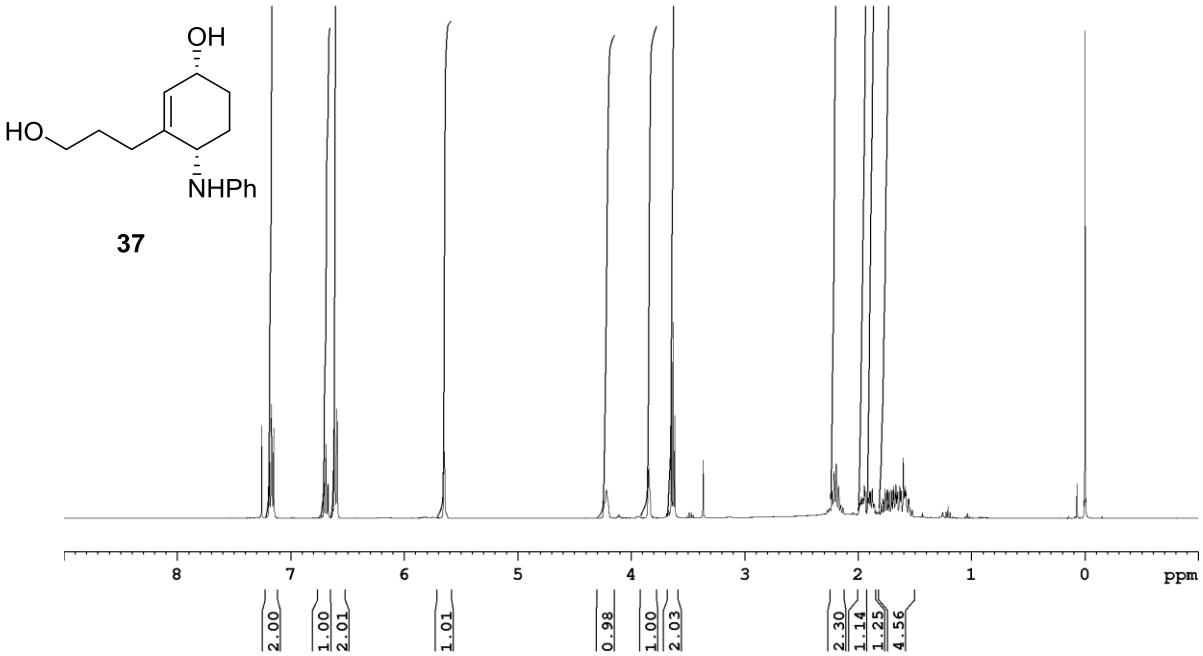
35

^{13}C-NMR ($CDCl_3$, 100 MHz)



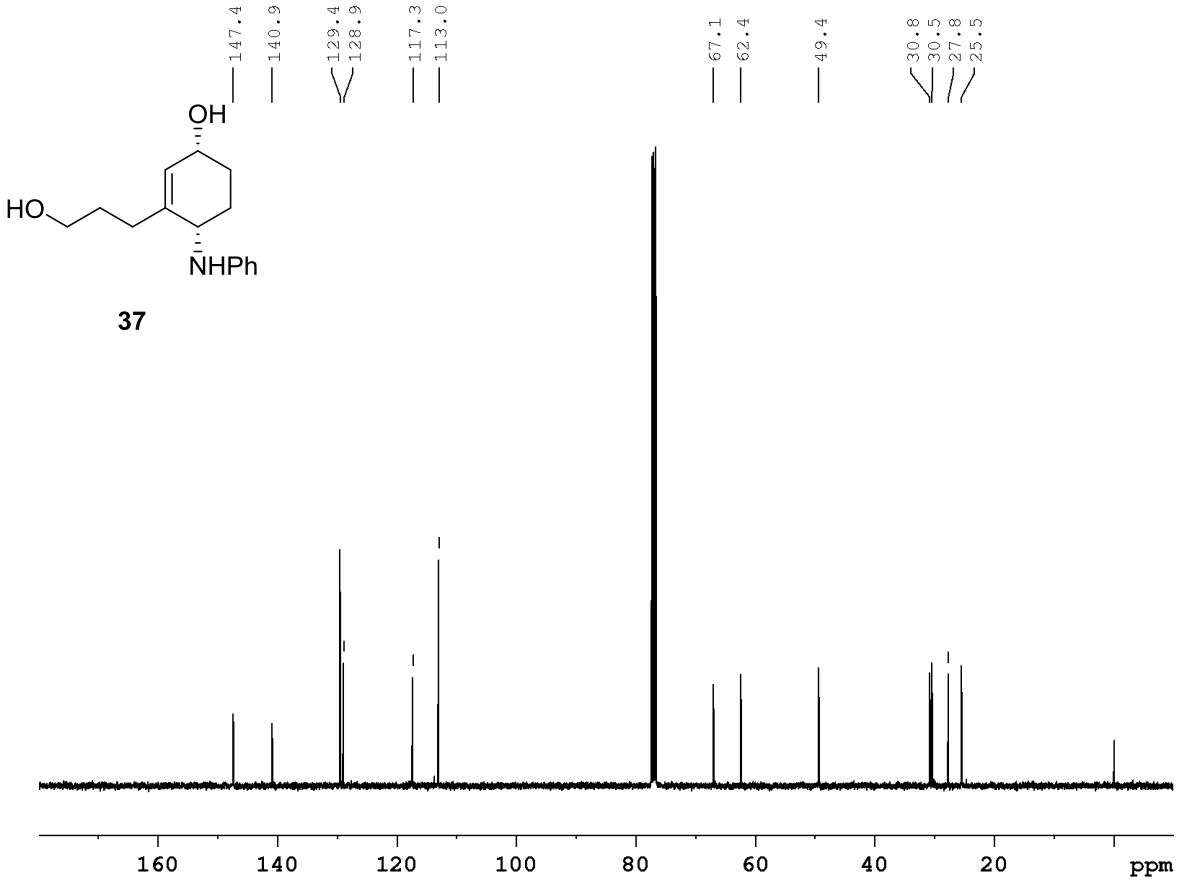
35

^{1}H-NMR ($CDCl_3$, 400 MHz)



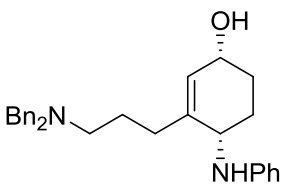
37

^{13}C-NMR ($CDCl_3$, 100 MHz)



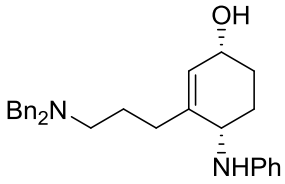
37

^{1}H-NMR ($CDCl_3$, 400 MHz)



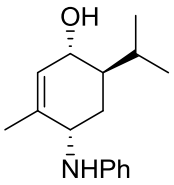
39

^{13}C-NMR ($CDCl_3$, 100 MHz)



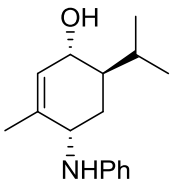
39

^{1}H-NMR ($CDCl_3$, 500 MHz)



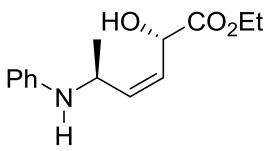
41

^{13}C-NMR ($CDCl_3$, 75 MHz)



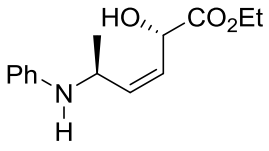
41

^{1}H-NMR ($CDCl_3$, 300 MHz)



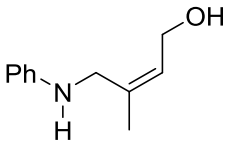
43

^{13}C-NMR ($CDCl_3$, 75 MHz)



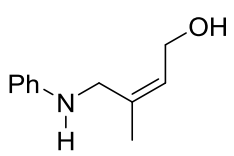
43

^{1}H-NMR ($CDCl_3$, 300 MHz)



45

^{13}C-NMR ($CDCl_3$, 75 MHz)



45