Synthesis of Skeletally Diverse and Stereochemically Complex Library Templates Derived from Steviol and Isosteviol

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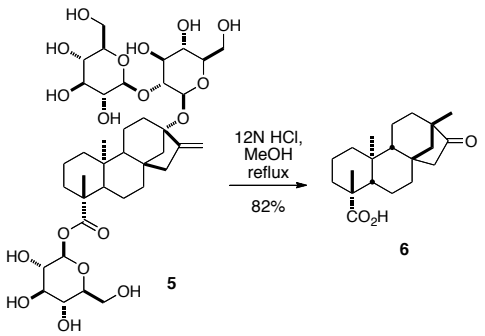
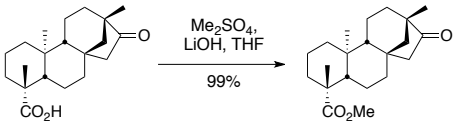
Supporting Information

1. General Methods. Unless otherwise stated, reactions were carried out open to air with reagent grade solvents directly from the bottle. Purified tetrahydrofuran (THF), toluene, diethyl ether (Et_2O), and dichloromethane (CH_2Cl_2) were purified by passage through a bed of activated alumina. Purification of reaction products was carried out by flash column chromatography using silica gel 60 (230-400 mesh). Analytical thin layer chromatography (TLC) was performed on 0.25 mm silica gel 60-F plates. Visualization was accomplished with UV light and cerium molybdate stain followed by heating. Infrared spectra (IR) were reported on NaCl or KBr plates using a FT-IR spectrometer. High-resolution mass spectral data were acquired utilizing the electrospray ionization technique. Optical rotations were measured using a polarimeter. ^{1}H NMR spectra were recorded at ambient temperature at 400 MHz and are reported in ppm using a solvent as an internal standard ($CDCl_3$ at 7.26 ppm). Proton-decoupled ^{13}C NMR spectra were recorded at 100 MHz and are reported in ppm using a solvent as an internal standard ($CDCl_3$ at 77.16 ppm). The data are reported as follows: chemical shift on the δ scale, multiplicity (b = broad, s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), coupling constants (Hz), and integration.
Solvent abbreviations: hexane (Hex), ethyl acetate (EtOAc), methanol (MeOH), and dichloromethane (CH_2Cl_2).
Steviol and steviol methyl ester data were in agreement with those reported.[1]

2. Experimental Procedures.

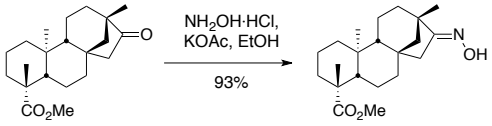


Isosteviol (6). To a 3L 3-necked round-bottomed flask, mounted on a heating mantle, was added stevioside **5** (201 g, 250.0 mmol) and MeOH (1 L) at ambient temperature. Upon dissolution of the stevioside, concentrated HCl (75 mL) was carefully added. A reflux condenser was fitted to the flask and the temperature slowly increased until reflux. After 2 h the heating mantle was turned off and the reaction allowed to cool to room temperature overnight. The methanolic solution was then poured with care into a 5 L Erlenmeyer flask (fitted with a mechanical stirrer) of stirring water (3 L). After stirring for 30 minutes, the precipitate was collected by filtration in a 200 mm diameter Buchner flask. The flask was left under vacuum overnight to dry the precipitate to yield 75 g of crude isosteviol as an off-white powder. The crude compound was then dissolved in ethanol (400 mL) and allowed to crystallized overnight to give isosteviol (**6**) as colorless crystals (65 g, 82 %): R_f = 0.6 (Hex:EtOAc 2:1); mp 230-232 °C (Lit 230-231 ºC);[2] ^{1}H NMR (400 MHz, $CDCl_3$): δ 11.66 (br s, 1 H), 2.63 (dd, *J* = 18.7, 3.7 Hz, 1H), 2.14 (d, *J* = 13.3 Hz, 1H), 1.87 (dd, *J* = 13.9, 1.9 Hz, 1H), 1.81 (d, *J* = 18.7 Hz, 2H), 1.73 (d, *J* = 12.9 Hz, 2H), 1.65 (ddd, *J* = 26.4, 14.2, 5.0 Hz, 3H), 1.55 (dd, *J* = 11.6, 2.5 Hz, 1H), 1.34-1.51 (m, 4H), 1.24 (s, 3H), 1.18 (ddd, *J* = 14.0, 12.1, 4.7 Hz, 3H), 0.98-1.06 (m, 1H), 0.97 (s, 3H), 0.90 (td, *J* = 13.2, 13.1, 4.1 Hz, 1H), 0.76 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 222.8, 183.9, 57.0, 54.7, 54.3, 48.7, 48.4, 43.7, 41.4, 39.7, 39.5, 38.2, 37.6, 37.3, 28.9, 21.6, 20.3, 19.8, 18.8, 13.3; IR (film) 2957, 1736, 1693, 1455, 1108 cm^{-1}; HRMS (ESI) (*m*/*z*): $[M+Na]^+$ calcd for $C_{20}H_{30}O_3Na$ 341.2087, found 341.2080; $[\alpha]_D^{23}$ –89.1 (*c* 1.00, $CHCl_3$).



6 **7**

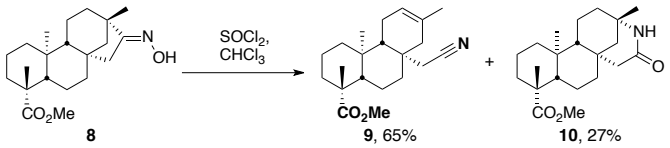
(4*R*,4a*S*,6a*R*,9*S*,11a*R*,11b*S*)-Methyl 4,9,11b-Trimethyl-8-oxotetradecahydro-6a,9-methanocyclohepta[a]naphthalene-4-carboxylate (7). To a flame-dried 500 mL round-bottomed flask was added isosteviol (**6**, 20 g, 63 mmol) and dry THF (120 mL). Upon dissolution, LiOH•H_2O (2.9 g, 68 mmol) was added and the reaction stirred for 1 h at room temperature under an atmosphere of nitrogen. Me_2SO_4 (6.5 mL, 69 mmol) was slowly added, then a reflux condenser was fitted to the flask and the temperature was raised to 80 °C for 18 h. The colorless precipitate was then recovered through filtration. The cake was washed repeatedly with Et_2O and then concentrated *in vacuo* to furnish methyl ester **7** (18.3 g, 88%). The mother liquor was quenched with 10% NaOH and then washed with brine and dried over $MgSO_4$. Filtration and removal of the solvent under reduced pressure afforded an additional 2.2 g (11%) of ester **7**: R_f = 0.3 (Hex:EtOAc 9:1); mp 200-202 ºC (Lit 202-203 ºC)[1]; ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.63 (s, 3H), 2.62 (dd, *J* = 18.6, 3.8 Hz, 1H), 2.18 (d, *J* = 13.3 Hz, 1H), 1.89 (dd, *J* = 13.6, 2.9 Hz, 1H), 1.74-1.85 (m, 2H), 1.57-1.74 (m, 5H), 1.52 (ddd, *J* = 17.8, 12.5, 3.3 Hz, 2H), 1.33-1.45 (m, 3H), 1.19-1.30 (m, 2H), 1.19 (s, 3H), 1.10-1.16 (m, 1H), 0.99-1.06 (m, 1H), 0.97 (s, 3H), 0.92 (dd, *J* = 13.2, 4.2 Hz, 1H), 0.68 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 222.4, 177.8, 57.0, 54.7, 54.3, 51.2, 48.7, 48.5, 48.4, 43.8, 41.5, 39.8, 39.4, 37.9, 37.3, 28.8, 21.7, 20.3, 19.9, 18.9, 13.2; IR (film) 2952, 1744, 1720, 1452, 1240, 1175, 1153 cm^{-1}; HRMS (ESI) (*m*/*z*): $[M+Na]^+$ calcd for $C_{21}H_{32}O_3Na$ 355.2244; found 355.2234; $[\alpha]_D^{23}$–82.2 (*c* 1.00, $CHCl_3$); reported $[\alpha]_D^{25}$–69.0 (*c* 1.02, $CHCl_3$).[3]



7 **8**

(4*R*,4a*S*,6a*R*,9*S*,11a*R*,11b*S*,*E*)-Methyl 8-(Hydroxyimino)-4,9,11b-trimethyltetradecahydro-6a,9-methanocyclohepta[*a*]naphthalene-4-carboxylate (8). To a 1 L round-bottomed flask was added **7** (18 g, 55 mmol), EtOH (250 mL), CH_2Cl_2 (150 mL), NH_2OH•HCl (10.6 g, 165 mmol) and KOAc (16.2 g, 165 mmol). The mixture was heated to 50 °C for 1 h after which time TLC analysis indicated the starting material was consumed. The mixture was then filtered and the solvent was removed under reduced pressure. The colorless residue was taken up in CH_2Cl_2 (200 mL). The organic layer wash then washed with 10% HCl (100 mL), 1M NaOH (100 mL), and brine (100 mL). The aqueous layers were then re-extracted with CH_2Cl_2 (200 mL) and the combined organic layers dried over $MgSO_4$ and filtered. The solvent was then removed under reduced pressure and the

residue chromatographed on silica gel (Hex:EtOAc 9:1 → 4:1) to yield oxime **8** (18 g, 93%): R_f = 0.2 (Hex:EtOAc 4:1); mp 154-156 ºC (Lit 153-155 ºC);[3] ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.42 (br s, 1H), 3.63 (s, 3H), 2.96 (dd, *J* = 18.6, 3.2 Hz, 1H), 2.17 (d, *J* = 13.5 Hz, 1H), 1.97 (d, *J* = 18.6 Hz, 1H), 1.54-1.89 (m, 8H), 1.38-1.47 (m, 4H), 1.19-1.31 (m, 2H), 1.18 (s, 3H), 1.10 (d, *J* = 3.3 Hz, 3H), 1.07 (t, *J* = 3.3, 3.3 Hz, 1H) 1.00 (td, *J* = 13.5, 13.4, 4.2 Hz, 1H), 0.88 (td, *J* = 13.2, 13.1, 4.2 Hz, 1H), 0.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 178.0, 170.4, 57.1, 56.3, 54.9, 51.2, 43.8, 43.8, 40.9, 40.3, 39.9, 39.5, 38.05, 38.00, 36.8, 28.7, 22.1, 21.7, 20.4, 18.9, 13.1; IR (film) 3292, 2948, 1724, 1453, 1235, 1153, 930, 737 cm^{-1}; HRMS (ESI) (*m*/*z*): $[M+Na]^+$ calcd for $C_{21}H_{33}NO_3Na$ 370.2353; found 370.2338; $[\alpha]_D^{23}$–57.1 (*c* 1.00, $CHCl_3$).

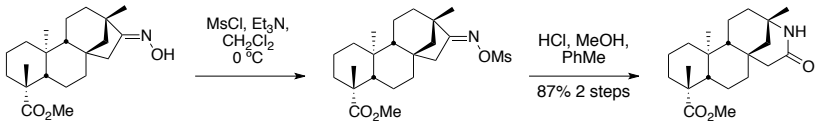


8 **9**, 65% **10**, 27%

1*R*,4a*R*,4b*R*,8a*R*,10a*R*)-Methyl 8a-(Cyanomethyl)-4a,7-dimethyl-1,2,3,4,4a,4b,5,8,8a,9,10,10a-dodecahydrophenanthrene-1-carboxylate (9) and (3*S*,6a*R*,8a*R*,9*R*,12a*R*,12b*R*)-Methyl 3,12a-Dimethyl-5-oxotetradecahydro-1H-3,6a-methanonaphtho[2,1-d]azocine-9-carboxylate (10). To a 500 mL flame-dried round-bottomed flask of oxime **8** (10.0 g, 28.8 mmol) in chloroform (200 mL), was added thionyl chloride (6.25 mL, 86.3 mmol). The flask was flushed with nitrogen and heated to 60 °C for 10 h until TLC analysis had indicated the consumption of starting material. After the reaction had cooled to room temperature, the organic layer was then washed with 1 M NaOH (10 mL) and brine and the aqueous layers were re-extracted with EtOAc (2x20 mL). The combined organic layers were then dried over $MgSO_4$, filtered and the solvent removed under reduced pressure. The residue was chromatographed on silica gel (Hex:EtOAc 9:1→ CH_2Cl_2:MeOH 9:1) to give nitrile **9** (6.23g, 65%) as white needle-like crystals and lactam **10** (2.70 g, 27%) as an off-white solid.

9: R_f = 0.5 (Hex:EtOAc 4:1); mp 186-187 ºC; IR (film) 2949, 2242, 1720, 1451, 1150 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 5.36 (d, *J* = 1.7 Hz, 1H), 3.65 (s, 3H), 2.57, 2.42 (dABq, *J* = 16.6, 1.9 Hz, 2H), 2.01-2.19 (m, 4H), 1.93-1.68 (m, 6H), 1.65 (s, 3H), 1.44 (ddd, *J* = 12.8, 4.8, 2.0 Hz, 1H), 1.30 (dd, *J* = 11.8, 5.4 Hz, 1H), 1.19 (s, 3H), 1.12 (dd, *J* = 12.2, 2.3 Hz, 2H), 0.96-1.04 (m, 1H), 0.88 (td, *J* = 13.2, 13.1, 4.2 Hz, 1H), 0.65 (s, 3H); ^{13}C NMR (100 MHz $CDCl_3$): δ 177.7, 131.2, 119.8, 119.0, 57.1, 51.7, 51.3, 45.7, 43.7, 39.8, 39.0, 37.8, 37.3, 35.2, 28.6, 23.3, 22.2, 20.0, 19.8, 18.9, 13.3; HRMS (ESI) (*m*/*z*): $[M+Na]^+$ calcd for $C_{21}H_{31}NO_2Na$ requires 352.2247; found 352.2241; $[\alpha]_D^{23}$–86.2 (*c* 1.00, $CHCl_3$).

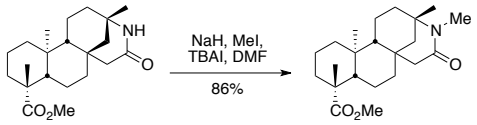
10: R_f = 0.2 (10% MeOH: CH_2Cl_2); mp 163-165 °C; IR (film) 3193, 1723, 1657 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 5.59 (br s, 1H), 3.62 (s, 3H), 2.91 (dd, *J* = 18.4, 2.2 Hz, 1H), 2.17 (d, *J* = 13.40 Hz, 1H), 1.90 (d, *J* =18.4 Hz, 1H), 1.72-1.89 (m, 4H), 1.58-1.71 (m, 3H), 1.55 (d, *J* = 13.0 Hz, 1H), 1.36-1.50 (m, 3H), 1.28-1.33 (m, 1H), 1.20-1.25 (m, 1H), 1.17 (s, 3H), 1.16 (s, 3H), 1.07 (dd, *J* = 11.4, 3.2 Hz, 1H), 1.00 (td, *J* = 13.5, 13.4, 4.4 Hz, 1H), 0.85 (ddd, *J* = 17.8, 12.9, 3.8 Hz, 2H), 0.77 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 177.7, 173.6, 57.4, 56.8, 51.8, 51.2, 49.4, 44.2, 43.8, 40.4, 39.9, 39.7, 38.0, 37.8, 35.2, 28.9, 28.5, 19.6, 18.9, 18.8, 13.6; HRMS (ESI) (*m*/*z*): $[M+Na]^+$ calcd for $C_{21}H_{33}NO_3Na$ requires 370.2353; found 370.2345; $[\alpha]_D^{23}$–15.3 (*c* 0.300, $CHCl_3$).



8 **11** **10**

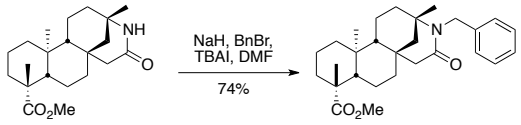
(3*S*,6a*R*,8a*S*,9*R*,12a*S*,12b*R*)-Methyl 3,9,12a-Trimethyl-5-oxotetradecahydro-1*H*-3,6a-methanonaphtho[2,1-*d*]azocine-9-carboxylate (10) via (4*R*,4a*S*,6a*R*,9*S*,11a*R*,11b*S*,*E*)-Methyl 4,9,11b-Trimethyl-8-(((methylsulfonyl)oxy)imino)tetradecahydro-6a,9-methanocyclohepta[*a*]naphthalene-4-carboxylate (11). To a flame dried 100 mL round-bottomed flask was added oxime (1.00 g, 2.88 mmol) and dichloromethane (40 mL). The flask was cooled to 0 °C (ice bath) then flushed with nitrogen. Triethylamine (5.00 mL) and MsCl (0.450 mL, 5.76 mmol) were added. After 30 min TLC analysis indicated that the starting material was consumed and then

sat. $NaHCO_3$ (10 mL) was added and the mixture was stirred for 10 min. The organic layer was then washed with brine and the aqueous layers re-extracted with CH_2Cl_2 (20 mL). The combined organic layers were then dried over $MgSO_4$, filtered and the solvent removed under reduced pressure to give the mesylate ester (1.22 g, 99% crude), which was then carried on without further purification. Then, to another 100 mL flame-dried round-bottomed flask solution of mesylate ester (1.22 g, 2.86 mmol) in MeOH (25 mL) and toluene (5 mL), was added concentrated HCl (416 mg, 11.4 mmol). The mixture was then heated to 60 °C and stirred overnight. The reaction was allowed to cool to room temperature then partitioned with saturated aqueous bicarbonate and toluene. The organic phase was dried over $MgSO_4$, filtered, and the solvent removed under reduced pressure to yield lactam **10** (870 mg, 87%).



10 **12**

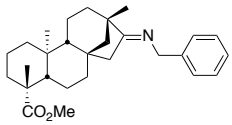
(3*S*,8a*S*,9*R*,12a*S*,12b*R*)-Methyl 3,4,9,12a-Tetramethyl-5-oxotetradecahydro-1*H*-3,6a-methanonaphtho[2,1-*d*]azocine-9-carboxylate (12). To a 50 mL flame-dried round-bottomed flask of lactam **9** (100 mg, 0.29 mmol) in DMF (15 mL) under nitrogen, was added sodium hydride (35 mg, 0.86 mmol, pre-washed with hexanes), methyl iodide (90 μL, 1.44 mmol) and a catalytic amount of tetrabutylammonium iodide (11 mg, 0.029 mmol). The reaction flask was heated to 90 °C and allowed to stir overnight. At this time TLC analysis indicated the consumption of starting material and the reaction was carefully quenched with water (2 mL). The organic layer was then washed with brine and the aqueous layers were re-extracted with Et_2O (2x15 mL). The combined organic layers were then dried over $MgSO_4$, filtered and the Et_2O was removed under reduced pressure, while a centrifugal evaporator was used to remove the DMF to give methyl alkylated lactam **12** (90 mg, 86%) as an off-white solid. R_f = 0.2 (Hex:EtOAc 4:1); mp 168-172 °C; IR (film) 2926, 1722, 1636 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 3.62 (s, 3H), 2.98 (dd, *J* = 18.3, 2.9 Hz, 1H), 2.84 (s, 3H), 2.16 (d, *J* = 13.3 Hz, 1 H), 2.04 (d, *J* = 18.3 Hz, 1H), 1.83-1.92 (m, 2H), 1.55-1.83 (m, 6H), 1.51 (dt, J= 12.9, 3.2, 3.2 Hz, 1H), 1.40-1.47 (m, 1H), 1.30 (dd, *J* = 12.8, 2.9 Hz, 1H), 1.25 (s, 3H), 1.18-1.23 (m, 1H), 1.16 (s, 3H), 1.11 (dd, *J* = 12.8, 3.8 Hz, 1H), 1.04-1.06 (m, 1H), 1.03-0.95 (m, 1H), 0.86 (d, *J* = 17.65, 2H), 0.75 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 177.7, 171.9, 57.4, 56.8, 55.3, 51.1, 51.0, 44.3, 43.7, 41.0, 39.9, 38.0, 37.8, 35.7, 33.9, 28.5, 27.4, 26.8, 19.7, 18.8, 18.7, 13.5; HRMS (ESI) (*m*/*z*): $[M+H]^+$ calcd for $C_{22}H_{36}NO_3$ 362.2695; found 362.2677;
$[\alpha]_D^{23}$ –18.9 (*c* 0.800, $CHCl_3$).



10 **13**

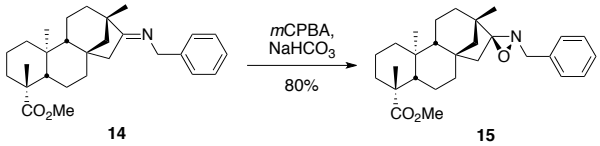
(3*S*,6a*R*,8a*S*,9*R*,12a*S*,12b*R*)-Methyl 4-Benzyl-3,9,12a-trimethyl-5-oxotetradecahydro-1*H*-3,6a-methanonaphtho[2,1-*d*]azocine-9-carboxylate (13). To a 50 mL flame-dried round-bottomed flask of lactam **9** (100 mg, 0.29 mmol) in DMF (15 mL) under nitrogen, was added NaH (35 mg, 0.86 mmol, cleaned with hexanes) and benzyl bromide (172 μL, 1.44 mmol) and tetrabutylammonium iodide (10 mg, 0.029 mmol). The reaction flask was heated to 90 °C and allowed to stir overnight. After TLC analysis had indicated the consumption of starting material, the reaction was carefully quenched with water (2 mL). The organic layer was then washed with brine and the aqueous layers were re-extracted with Et_2O (2x15 mL). The combined organic layers were then dried over $MgSO_4$, filtered and the Et_2O was removed under reduced pressure, while a centrifugal evaporator was used to remove the DMF to give benzyl alkylated lactam **13** (94 mg, 74%) as a yellowish solid: R_f = 0.5 (Hex:EtOAc 4:1); mp 209-211 °C; IR (film) 2946, 2848, 1722, 1633, 145, 1399, 1151 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.27-7.29 (m, 1H), 7.17-7.22 (m, 3H), 5.00, 4.19 (ABq, *J* = 15.8 Hz, 2H), 3.64 (s, 3H), 3.08, 2.19 (dABq, J_{AB}= 18.4, 2.7 Hz, 2 H), 2.15-2.19 (m, 1 H), 1.85-1.95 (m, 1H), 1.74-1.83 (m, 4H), 1.70 (dd, *J* = 13.0, 2.7 Hz, 1H), 1.55-1.58 (m, 3H), 1.42-1.46 (m, 1H), 1.30 (dd, *J* = 13.0, 2.8 Hz, 1H), 1.20-1.25 (m, 2H), 1.17 (s, 3H), 1.12 (s, 3H), 0.96-1.09 (m, 3H), 0.80-0.91 (m, 2H), 0.79 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 177.7, 172.4, 139.8, 128.3, 126.8, 126.5, 57.4, 56.9, 56.5, 51.6, 51.2, 44.6, 44.3, 43.7, 41.1, 39.9, 38.0, 37.8, 37.0, 34.1, 28.5,

28.0, 19.7, 18.8, 18.6, 13.6; HRMS (ESI) (*m*/*z*): $[M+H]^+$ calcd for $C_{28}H_{40}NO_3$ requires 438.3008; found 438.3001; $[\alpha]_D^{23}$–53.5 (*c* 1.00, $CHCl_3$).



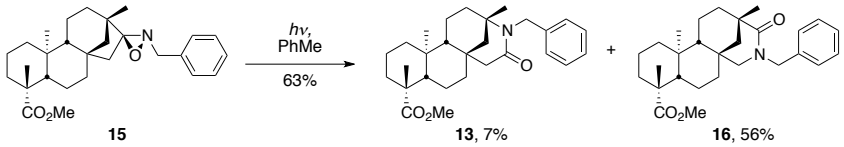
14

(4*R*,4a*S*,6a*R*,9*S*,11a*R*,11b*S*,*E*)-Methyl 8-(Benzylimino)-4,9,11b-trimethyltetradecahydro-6a,9-methanocyclohepta[*a*]naphthalene-4-carboxylate (14).
This compound was prepared from the isosteviol methyl ester **7** in a 7:1 isomeric ratio of *E*:*Z* using a known procedure.[4]



14 **15**

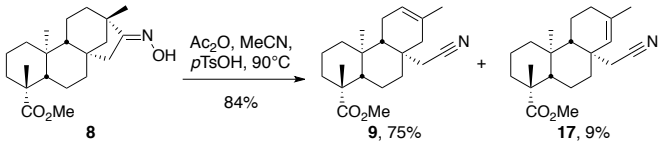
(3'*S*,4*R*,4a*S*,6a*R*,9*S*,11a*R*,11b*S*)-Methyl 2'-Benzyl-4,9,11b-trimethyldodecahydro-1*H*-spiro[6a,9-methanocyclohepta[*a*]naphthalene-8,3'-[1,2]oxaziridine]-4-carboxylate (15). To a 100 mL round-bottomed flask was added benzylimine (**14**) (1.0 g, 2.35 mmol) in CH_2Cl_2 (50 mL). After cooling to 0 °C *m*CPBA (520 mg, 2.80 mmol) and $NaHCO_3$ (240 mg, 2.80 mmol) were added. The mixture was allowed to stir for 10 min, at which time TLC analysis indicated that the starting material was consumed. The reaction was quenched with an aqueous solution of NaS_2O_3 (15 mL) then washed with 1M NaOH (100 mL) and brine (100 mL). The aqueous layers were then re-extracted with CH_2Cl_2 (50 mL) and the combined organic layers dried over $MgSO_4$ and filtered. The solvent was then removed under reduced pressure and the residue chromatographed on silica gel (Hex:EtOAc 9:1) to yield benzyl oxaziridine **15** (822 mg, 80%): R_f = 0.6 (Hex:EtOAc 2:1); mp 192-198 °C; IR (film) 2949, 2906, 1741, 1719 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.36 (s, 1H), 7.27-7.35 (m, 2H), 7.18-7.26 (m, 2H), 3.87, 3.75 (ABq, J_{AB} = 13.8 Hz, 2H), 3.59 (s, 3H), 2.54 (dd, *J* = 15.3, 2.6 Hz, 1H), 2.11 (d, *J* = 13.3 Hz, 1H), 1.80 (dd, *J* = 14.9, 3.5 Hz, 1H), 1.50-1.74 (m, 7H), 1.30-1.43 (m, 3H), 1.16 (ddd, *J* = 8.4, 5.4, 2.3 Hz, 1H), 1.12 (s, 3H), 1.08 (d, *J* = 2.4 Hz, 1H), 0.92 (dddd, *J* = 35.9, 18.4, 12.7, 7.8 Hz, 4H), 0.73-0.81 (m, 1H), 0.64 (s, 3H), 0.57 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 177.5, 136.3, 128.06, 128.05, 127.1, 94.0, 60.9, 56.6, 54.7, 54.2, 50.8, 43.3, 41.0, 40.9, 40.7, 39.4, 37.5, 37.4, 36.1, 35.4, 28.4, 21.3, 19.5, 19.3, 18.5, 12.9; HRMS (ESI) (*m*/*z*): $[M+H]^+$ calcd for $C_{28}H_{40}NO_3$ requires 438.3008; found 438.3003; $[\alpha]_D^{23}$–97.6 (*c* 1.00, $CHCl_3$).



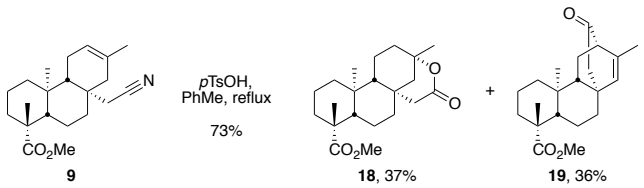
15 **13**, 7% **16**, 56%

(3*S*,6a*S*,8a*S*,9*R*,12a*S*,12b*S*)-Methyl 5-Benzyl-3,9,12a-trimethyl-4-oxotetradecahydro-1*H*-3,6a-methanonaphtho[2,1-*c*]azocine-9-carboxylate (16). To a 25 mL round-bottomed flask was added benzyl oxaziridine **15** (110 mg, 0.25 mmol) in toluene (5 mL) and was allowed to stir under an Hg lamp (254 nm) for 1.5 h, at which time TLC analysis indicated the starting material was consumed. The reaction was then chromatographed on silica gel (Hex:EtOAc 4:1) to yield benzyl lactam **16** (69 mg, 56%) and benzyl lactam **13** (8 mg, 7%): R_f = 0.21 (Hex:EtOAc 4:1); mp 145-151 °C; IR (film) 2947, 2848, 2235, 1723, 1638, 1453, 1233, 1154 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.29 (d, *J* = 4.35 Hz, 4H), 7.21-7.26 (m, 1H), 5.00, 4.04 (ABq, J_{AB} = 14.0 Hz, 2H), 3.63 (dd, *J* = 12.7, 2.1 Hz, 1H), 3.60 (s, 3H), 2.87 (d, *J* = 12.7 Hz, 1H), 2.11 (d, *J* =13.4 Hz, 1H), 1.99 (dd, *J* = 11.6, 2.4 Hz, 1H), 1.59-1.82 (m, 5H), 1.45-1.59 (m, 3H), 1.34-1.43 (m, 1H), 1.23 (ddd, *J* = 7.7, 9.4, 3.5 Hz, 2H), 1.18 (s, 3H), 1.16 (d, *J* = 3.6 Hz, 1H), 1.13 (s, 3H), 0.93-1.10 (m, 2H), 0.89 (dd, *J* = 12.4, 3.2 Hz, 1H), 0.78 (td, *J* = 13.4, 13.3, 4.3 Hz, 1H), 0.26 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 177.6, 174.9, 137.6, 128.8, 128.7, 128.4, 127.9, 127.2, 126.9, 57.5, 57.0, 55.5, 51.1. 50.0, 48.9, 43.7, 43.3, 39.7, 39.3, 39.0, 37.7, 34.2, 28.6,

25.3, 20.1, 20.0, 18.8, 12.7; HRMS (ESI) (*m*/*z*): $[M+H]^+$ calcd for $C_{28}H_{40}NO_3$ requires 438.3008; found 438.3011; $[\alpha]_D^{23}$–250.0 (*c* 1.00, $CHCl_3$).



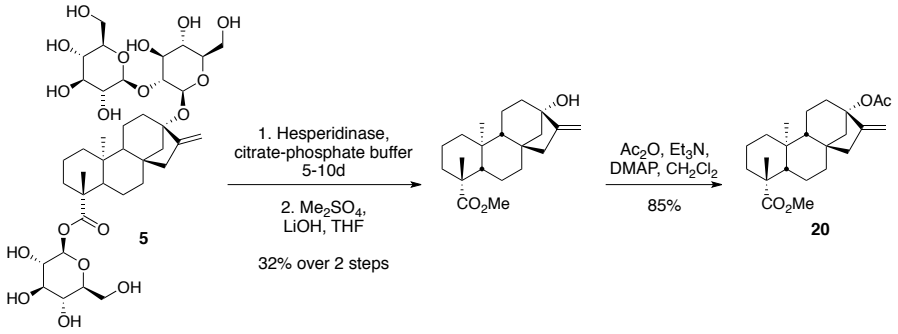
(1*R*,4a*S*,4b*R*,8a*R*,10a*S*)-Methyl 8a-(Cyanomethyl)-1,4a,7-trimethyl-1,2,3,4,4a,4b,5,8,8a,9,10,10a-dodecahydrophenanthrene-1-carboxylate (9) and (1*R*,4a*S*,4b*S*,8a*S*,10a*S*)-Methyl 8a-(Cyanomethyl)-1,4a,7-trimethyl-1,2,3,4,4a,4b,5,6,8a,9,10,10a-dodecahydrophenanthrene-1-carboxylate (17). To a 10 mL flame-dried round-bottomed flask was added oxime **8** (10 mg, .029 mmol) and MeCN (5 mL). The flask was then flushed with nitrogen and Ac_2O (6.0 μL, .064 mmol) added. After 10 min TLC indicated all the starting material was consumed and *p*TsOH (5.5 mg, .032 mmol) was added. The reaction was stirred for 10 min after which time TLC analysis indicated that the reaction was complete. The MeCN was removed under reduced pressure and residue taken up in Et_2O (10 mL) and washed with 10% NaOH, and brine. The aqueous layers were then re-extracted with Et_2O (2x10 mL) and the combined organic layers were dried over $MgSO_4$, filtered, and the solvent was removed under reduced pressure. The residue was chromatographed on silica gel (Hex:EtOAc 9:1→4:1) to yield the nitriles **9** and **17** (7.9 mg, 84%) as a 8:1 mixture with nitrile **9** as the major alkene (7 mg, 75%). Recrystallisation from CH_2Cl_2 : EtOAc enriched the mixture to 20:1.



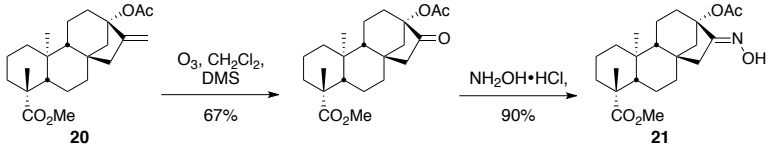
(3*S*,6a*R*,8a*S*,9*R*,12a*S*,12b*R*)-Methyl 3,9,12a-Trimethyl-5-oxotetradecahydro-3,6a-methanonaphtho[2,1-*d*]oxocine-9-carboxylate (18) and (3*S*,4a*S*,4b*S*,8*R*,8a*S*,10a*S*)-Methyl 2,4b,8-Trimethyl-12-oxo-4,4a,4b,5,6,7,8,8a,9,10-decahydro-3*H*-3,10a-ethanophenanthrene-8-carboxylate (19). To a 50 mL flame-dried round-bottomed flask was added nitrile ester **9** (100 mg, 0.30 mmol) in toluene (10 mL). Then *p*TsOH (57 mg, 0.30 mmol) was added. The reaction was heated to 90 °C for 24 h. After the flask was cooled to ambient temperature, the reaction mixture was passed through a silica plug (Hex:EtOAc 9:1). The solvent was then removed under reduced pressure and the residue chromatographed on silica gel (Hex:EtOAc 9:1) to yield both the ketone **18** (36 mg, 36%) and lactone **19** (39 mg, 37%).

18: R_f = 0.1 (Hex:EtOAc 4:1)**;** mp 194-202 °C; IR (film) 2935, 2848, 1732, 1693, 1216 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 3.63 (s, 3H), 3.07 (dd, *J* = 18.6, 2.7 Hz, 1H), 2.16 (s, 1H), 2.02 (d, *J* = 18.6 Hz, 1H), 1.94-2.00 (m, 1H), 1.67-1.89 (m, 5H), 1.53-1.59 (m, 2H), 1.44 (d, *J* = 8.2 Hz, 1H), 1.36-1.40 (m, 1H), 1.34 (s, 3H), 1.24 (ddd, *J* = 14.3, 9.5, 4.2 Hz, 3H), 1.17 (s, 3H), 1.07 (dd, *J* = 11.8, 2.7 Hz, 1H), 1.00 (d, *J* = 4.4 Hz, 1H), 0.94 (dd, *J* = 12.7, 3.1 Hz, 1H), 0.85 (d, *J* = 4.4 Hz, 1H), 0.75 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 117.6, 172.6, 80.3, 57.2, 55.8, 51.3, 47.7, 43.7, 43.6, 39.0, 38.7, 38.4, 37.9, 37.8, 34.9, 28.6, 28.3, 19.5, 18.8, 18.6, 13.4; HRMS (ESI) (*m*/*z*): $[M+H]^+$ calcd for $C_{21}H_{33}O_4$ requires 349.2379; found 349.2366 ; $[\alpha]_D^{23}$–86.0 (*c* 1.03, $CHCl_3$).

19: R_f = 0.4 (Hex:EtOAc 4:1)**;** mp 163-165 °C; IR (film) 2947, 2848, 1721, 1466, 1444, 1235, 1164 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 5.78 (t, *J* = 1.46 Hz, 1H), 3.63 (s, 3H), 2.87 (dt, *J* = 3.5, 1.8, 1.8 Hz, 1H), 2.54 (d, *J* = 18.7 Hz, 1H), 2.17 (d, *J* = 14.0 Hz, 1H), 1.99 (dt, *J* = 13.3, 3.2, 3.2 Hz, 1H), 1.86-1.90 (m, 1H), 1.78-1.85 (m, 1H), 1.77 (d, *J* = 1.5 Hz, 3H), 1.70-1.75 (m, 2H), 1.51-1.57 (m, 4H), 1.37-1.44 (m, 1H), 1.25 (ddd, *J* = 11.4, 6.6, 1.7 Hz, 1H), 1.20 (s, 3H), 1.15 (dd, *J* = 12.0, 2.4 Hz, 1H), 1.02 (td, J= 13.5, 13.5, 4.2 Hz, 1H), 0.92 (td, *J* = 13.5, 13.4, 4.3 Hz, 1H), 0.71 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 213.9, 177.6, 138.4, 135.5, 56.6, 54.4, 51.8, 51.2, 43.6, 42.8, 40.9, 40.3, 38.1, 37.9, 36.8, 28.6, 24.8, 20.2, 19.8, 18.5, 12.5; HRMS (ESI) (*m*/*z*): $[M+H]^+$ calcd for $C_{21}H_{31}O_3$ requires 331.2273; found 331.2274; $[\alpha]_D^{23}$–93.5 (*c* 0.26, $CHCl_3$).

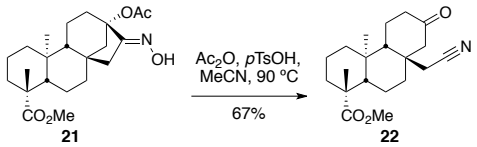


(4*R*,4a*S*,6a*R*,9*S*,11a*R*,11b*S*)-Methyl 9-Acetoxy-4,11b-dimethyl-8-methylenetetradecahydro-6a,9-methanocyclohepta[*a*]naphthalene-4-carboxylate (20). To a 2 L round-bottomed flask containing stevioside (**5**) (100 g, 124 mM) in citrate-phosphate buffer (1 L, pH 4) was added hesperidinase enzyme[5] from *Aspergillus niger* (330 g, 100 units). The reaction was allowed to stir at 50 °C for a week, at which time TLC analysis indicated that the starting material was consumed. The precipitate was collected by filtration in a Buchner flask to yield 30 g of crude steviol (**1**) as a colorless powder. The crude compound was then dissolved in ethanol (50 mL) and allowed to crystallized overnight to give steviol (**1**, 21 g, 53%). The steviol was then converted to the steviol methyl ester. To a flame-dried 500 mL round-bottomed flask was added steviol (**1**, 10 g, 32 mmol) and dry THF (200 mL). Upon dissolution, $LiOH•H_2O$ (1.5 g, 34 mmol) was added and the reaction stirred for 1 h at room temperature under an atmosphere of nitrogen. Me_2SO_4 (650 μL, 35 mmol) was slowly added, then a reflux condenser was fitted to the flask and the temperature was raised to 80 °C for 18 h. The colorless precipitate was then recovered through filtration. The cake was washed repeatedly with Et_2O and then concentrated *in vacuo* to yield the steviol methyl ester (6.4 g, 60%). Then, the steviol methyl ester (5.0 g, 15.0 mmol) was taken up in dry CH_2Cl_2 (200 mL) and under an atmosphere of nitrogen cooled to 0 °C. Et_3N (28 mL, 200 mmol) and Ac_2O (19 mL, 200 mmol) where added. After 30 min DMAP (200 mg) was added and the ice bath removed and the reaction was allowed to stir for 18 h. The reaction was cooled to 0 °C and H_2O (10 mL) added and the reaction was stirred for 30 minutes. The organic layer was then washed with water (100 mL), 10% HCl (100 mL), 1M NaOH (100 mL) and brine (100 mL). The aqueous layers were then re-extracted with ether (100 mL) and the combined organic layers dried over $MgSO_4$, filtered, and the solvent removed under reduced pressure to give an oil which was then chromatographed on silica gel (9:1 Hex:EtOAc) to provide the acetoxy methyl ester **20** as an oil (4.79 g, 85%): R_f = 0.7 (Hex:EtOAc 4:1); IR (KBr) 2948, 1726, 1447, 1366, 1236, 1149, 1047 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 4.90 (dd, *J* = 2.7, 2.0 Hz, 1H), 4.86 (d, *J* = 0.6 Hz, 1H), 3.63 (s, 3H), 2.57 (dd, *J* = 10.9, 2.6 Hz, 1H), 2.25 (ddd, *J* = 13.2, 4.9, 2.4 Hz, 2H), 2.14-2.20 (m, 1H), 1.98-2.05 (m, 1H), 2.02 (s, 3H), 1.85 (dd, *J* = 9.9, 7.6 Hz, 3H), 1.70-1.78 (m, 3H), 1.63 (dd, *J* = 7.5, 6.0 Hz, 1H), 1.56 (t, *J* = 3.26, 3.26, 1H), 1.44 (ddd, *J* = 15. 0, 11.3, 7.6 Hz, 3H), 1.16 (s, 3H), 1.1 (ddd, *J* = 22.3, 12.6, 5.6 Hz, 3H), 0.86 (s, 3H), 0.80 (d, *J* = 4.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 177.9, 169.9, 152.1, 103.4, 87.6, 556.9, 53.7, 51.2, 46.9, 43.8, 42.6, 42.1, 41.1, 40.7, 39.2 (x2), 38.1, 36.7, 28.7, 21.8, 20.0, 19.1, 15.1; HRMS (ESI) (*m*/*z*): $[M+Na]^+$ calcd for $C_{23}H_{34}O_4Na$ requires 397.2347; found 355.2356 $[(M+Na)-Ac]^+$; $[\alpha]_D^{23}$ –55.8 (*c* 1.00, $CHCl_3$).

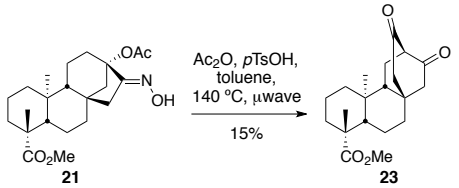


(4*R*,4a*S*,6a*R*,9*S*,11a*R*,11b*S*,*E*)-Methyl 9-Acetoxy-8-(hydroxyimino)-4,11b-dimethyltetradecahydro-6a,9-methanocyclohepta[*a*]naphthalene-4-carboxylate (21). To a 50 mL flame-dried round-bottomed flask of acetoxy methyl ester **20** (904 mg, 2.4 mmol) in CH_2Cl_2 (30 mL) that was cooled to -78 °C, ozone was bubbled through the solution until the distinctive blue color was maintained for 30 min. The ozone line was then removed and nitrogen was bubbled through the solution until it was clear. Dimethylsulfide (703 mL, 9.6 mmol) was then added and the reaction was allowed to warm to ambient temperature and stir for 18 h. The CH_2Cl_2 was then removed under reduced pressure and residue dissolved in Et_2O (50 mL). The organic layer was washed with H_2O (10 mL) and brine (10 mL). The aqueous layers were then re-extract with Et_2O (x2, 50 mL) and the combined

organic layers where then dried over $MgSO_4$, filtered, and the solvent removed under reduced pressure. The resulting keto-acetoxy methyl ester was chromatographed on silica gel (25:1→7:1) Hex:EtOAc. From there, a 50 mL round-bottomed flask of the keto-acetoxy methyl ester (437 mg, 1.2 mmol) in dry THF (25 mL) and EtOH (2 mL), was added $NH_2OH•H_2O$ (240 mg, 3.5 mmol) and KOAc (354 g, 3.5 mmol). The mixture was heated to 50 °C for 1 h after which time TLC analysis indicated that the starting material was consumed. The mixture was then filtered and the solvent removed under reduced pressure. The colorless residue was taken up in CH_2Cl_2 (50 mL) and the organic layer was then washed with 10% HCl (10 mL), 1M NaOH (10 mL), and brine (10 mL). The aqueous layers were then re-extracted with CH_2Cl_2 (20 mL) and the combined organic layers dried over $MgSO_4$ and filtered. The solvent was then removed under reduced pressure and the residue chromatographed on silica gel (Hex:EtOAc 9:1 → 4:1) to give the 13-acetoxy oxime **21** (422 mg, 60% over 2 steps) as a colorless solid: R_f = 0.44 (Hex:EtOAc 4:1); mp 178-180 °C; IR (film) 3293, 2946, 1723, 1462, 1446, 1237 1149 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 8.17 (s, 1H), 3.63 (s, 3H), 2.53 (dd, *J* = 11.1, 2.0 Hz, 1H), 2.28 (d, *J* = 2.2 Hz, 1H), 2.17-2.22 (m, 2H), 2.03 (s, 3H), 1.98 (dd, *J* = 11.1, 2.3 Hz, 1H), 1.84 (ddd, *J* = 13.3, 10.7, 6.9 Hz, 5H), 1.66-1.77 (m, 2H), 1.55-1.65 (m, 2H), 1.47 (dd, *J* = 39.3, 15.9 Hz, 2H), 1.17 (s, 3H), 1.03 (ddd, *J* = 20.2, 9.9, 3.2 Hz, 3H), 0.86 (s, 3H), 0.77-0.83 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 177.8, 169.7, 163.3, 84.9, 56.6, 53.2, 51.3, 43.7, 42.3, 41.8, 41.7, 40.7, 40.6, 39.2, 37.9, 35.6, 28.6, 21.9, 21.4, 19.5, 18.9, 15.3; HRMS (ESI) (*m*/*z*): $[M+H]^+$ calcd for $C_{22}H_{34}NO_5$ requires 392.2437; found 392.2439; $[\alpha]_D^{23}$–47.7 (*c* 0.98, $CHCl_3$).



(1*R*,4a*S*,4b*R*,8a*R*,10a*S*)-Methyl 8a-(Cyanomethyl)-1,4a-dimethyl-7-oxotetradecahydrophenanthrene-1-carboxylate (22). To a 100 mL flame-dried round-bottomed flask containing 13-acetoxy oxime **21** (13 g, 39 mmol) and dry acetonitrile (100 mL) flushed with nitrogen, Ac_2O (7.4 mL, 86 mmol) was added. After 10 min TLC indicated that all the starting material was consumed and then *p*TsOH (8 g, 43 mmol) was added. The reaction was heated to reflux for 2 h and then cooled with an ice bath. NaOH (17 g, 390 mmol) dissolved in H_2O (300 mL) was then added and stirred for 5 min. The layers where then partitioned and the aqueous layer was re-extracted with EtOAc (2x100 mL). The combined organic layers where dried over $MgSO_4$, filtered, and then the solvent was removed under reduced pressure. The residue was chromatographed on silica gel (400 mL) with 3 L of 9:1 Hex:EtOAc to furnish ketone nitrile **22** (8.66 g, 67%): R_f = 0.6 (Hex:EtOAc 2:1); mp 136-138 °C; IR (film) 2951, 1759, 1724, 1464, 1447, 1368, 1238, 1150 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 3.66 (s, 3H), 2.96 (d, *J* = 15.5 Hz, 1H), 2.47 (ddd, *J* = 16.8, 12.9, 8.3 Hz, 1H), 2.29-2.39 (m, 2H), 2.13-2.28 (m, 3H), 1.78-2.01 (m, 6H), 1.61-1.76 (m, 3H), 1.53 (d, *J* = 14.4 Hz, 1H), 1.47 (d, *J* = 7.0 Hz, 1H), 1.23 (s, 3H), 1.06 (dd, *J* = 7.4, 4.5 Hz, 2H), 0.98 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 211.0, 177.6, 117.1, 56.0, 51.4, 48.2, 43.7, 41.2, 39.4, 39.3, 38.3, 37.5, 31.2, 28.6, 20.8, 19.8, 19.1, 16.4; HRMS (ESI) (*m*/*z*): $[M+H]^+$ calcd for $C_{20}H_{30}NO_3$ requires 332.2226; found 332.2231; $[\alpha]_D^{23}$–75.5 (*c* 1.24, $CHCl_3$).



(3*S*,4a*R*,4b*S*,8*R*,8a*S*,10a*S*)-Methyl 4b,8-Dimethyl-2,12-dioxododecahydro-1*H*-3,10a-ethanophenanthrene-8-carboxylate (23).[6] To a 0.5-2.0 mL microwave vial of 13-acetoxy oxime **21** (50 mg, 0.100 mmol) and toluene (1 mL) was added Ac_2O (25 μL, 0.25 mmol). After 10 min, *p*TsOH (23 mg, 0.100 mmol, 1 equiv) was added. The vial was capped and the reaction was heated to 140 °C and stirred for 30 min in the microwave. The reaction mixture was then taken up in EtOAc (35 mL) and washed with 10% NaOH, and brine. The aqueous layers were then re-extracted with EtOAc (2x50 mL) and the combined organic layers were dried over $MgSO_4$, filtered, and the solvent removed under reduced pressure. The residue was chromatographed on silica gel (Hex:EtOAc 9:1) to give diketone **23** (13 mg, 15 %): R_f = 0.35 (Hex:EtOAc 2:1); mp 238-239 °C; IR (film) 2953, 1743, 1715 cm^{-1};

^{1}H NMR (400 MHz, $CDCl_3$): δ 3.65 (s, 3H), 3.18 (t, *J* = 3.0 Hz, 1H), 2.90 (dd, *J* = 19.7, 3.5 Hz, 1H), 2.26-2.07 (m, 4H), 1.96-1.77 (m, 6H), 1.59-1.35 (m, 4H), 1.21 (s, 3H), 1.15 (dd, *J* = 11.9, 2.8 Hz, 1H), 1.08-1.00 (m, 1H), 0.93 (d, *J* = 4.3 Hz, 1H), 0.70 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 207.0, 206.9, 177.4, 64.6, 56.4, 55.5, 51.5, 50.5, 46.3, 43.8, 39.6, 38.2, 38.1, 37.9, 37.6, 28.8, 25.5, 19.9, 18.6, 12.4; HRMS (ESI) (*m*/*z*): $[M+Na]^+$ calcd for $C_{20}H_{28}O_4Na$ requires 355.1880; found 355.1891; $[\alpha]_D^{23}$ –65.8 (*c* 0.25, $CHCl_3$).

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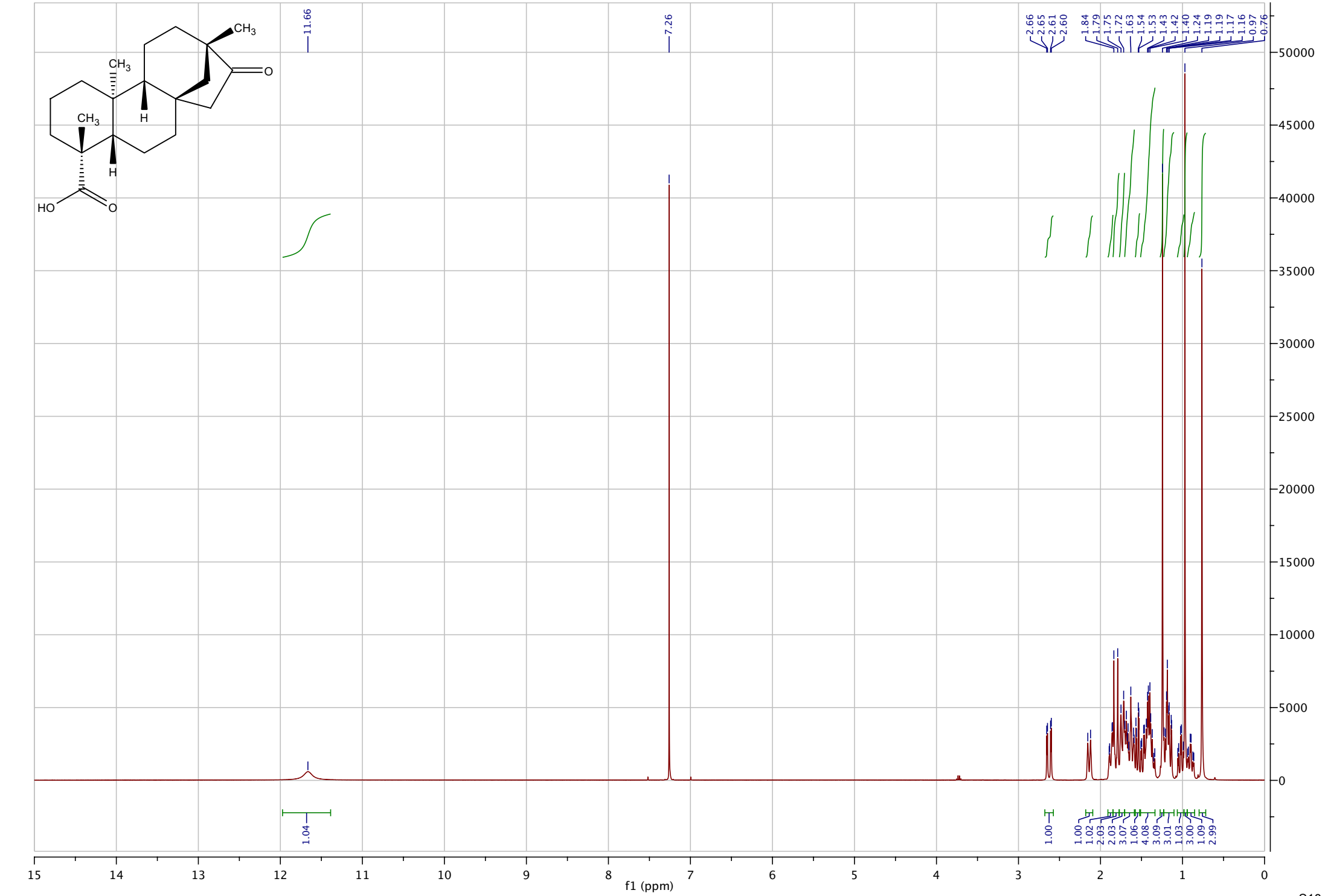
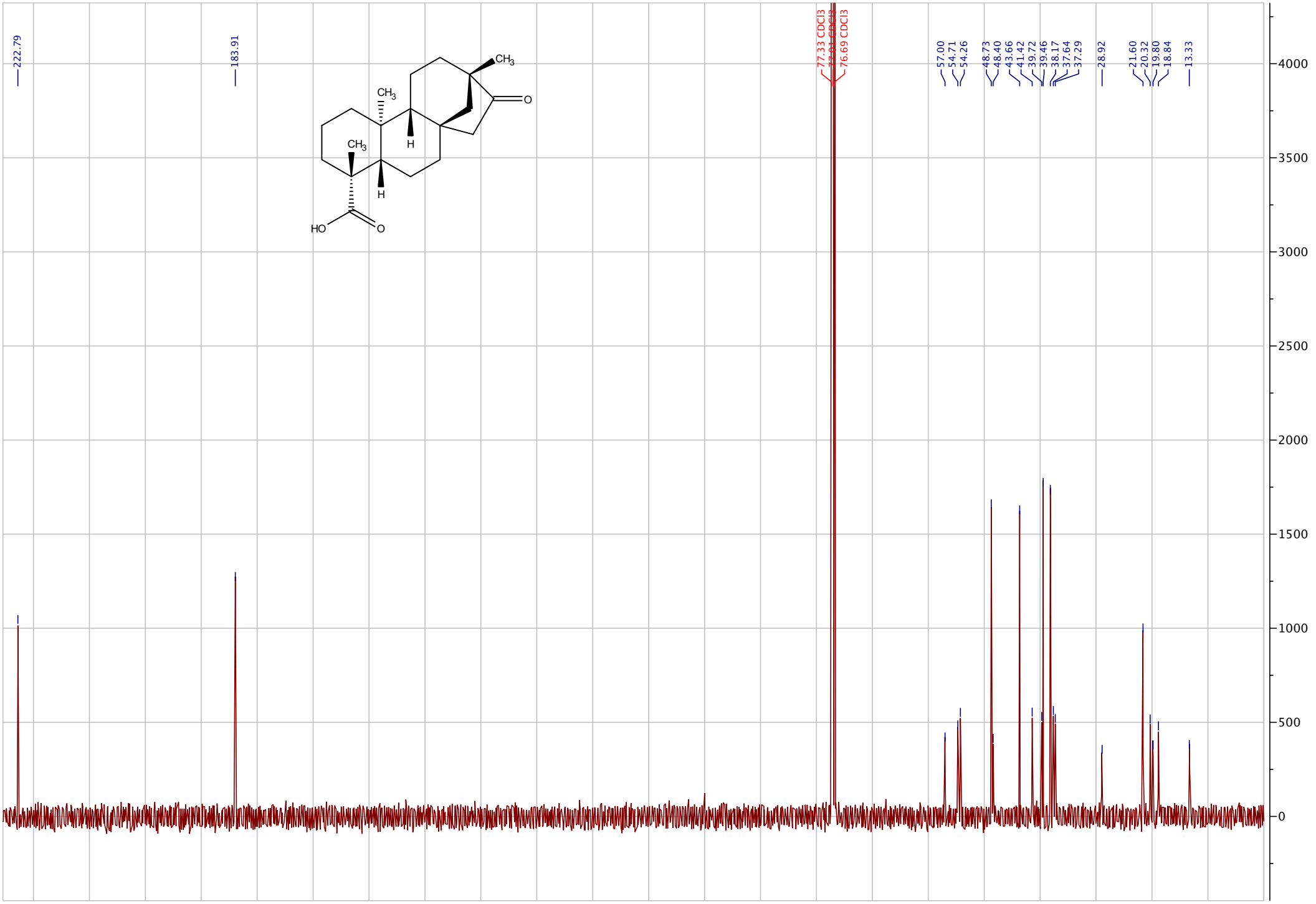
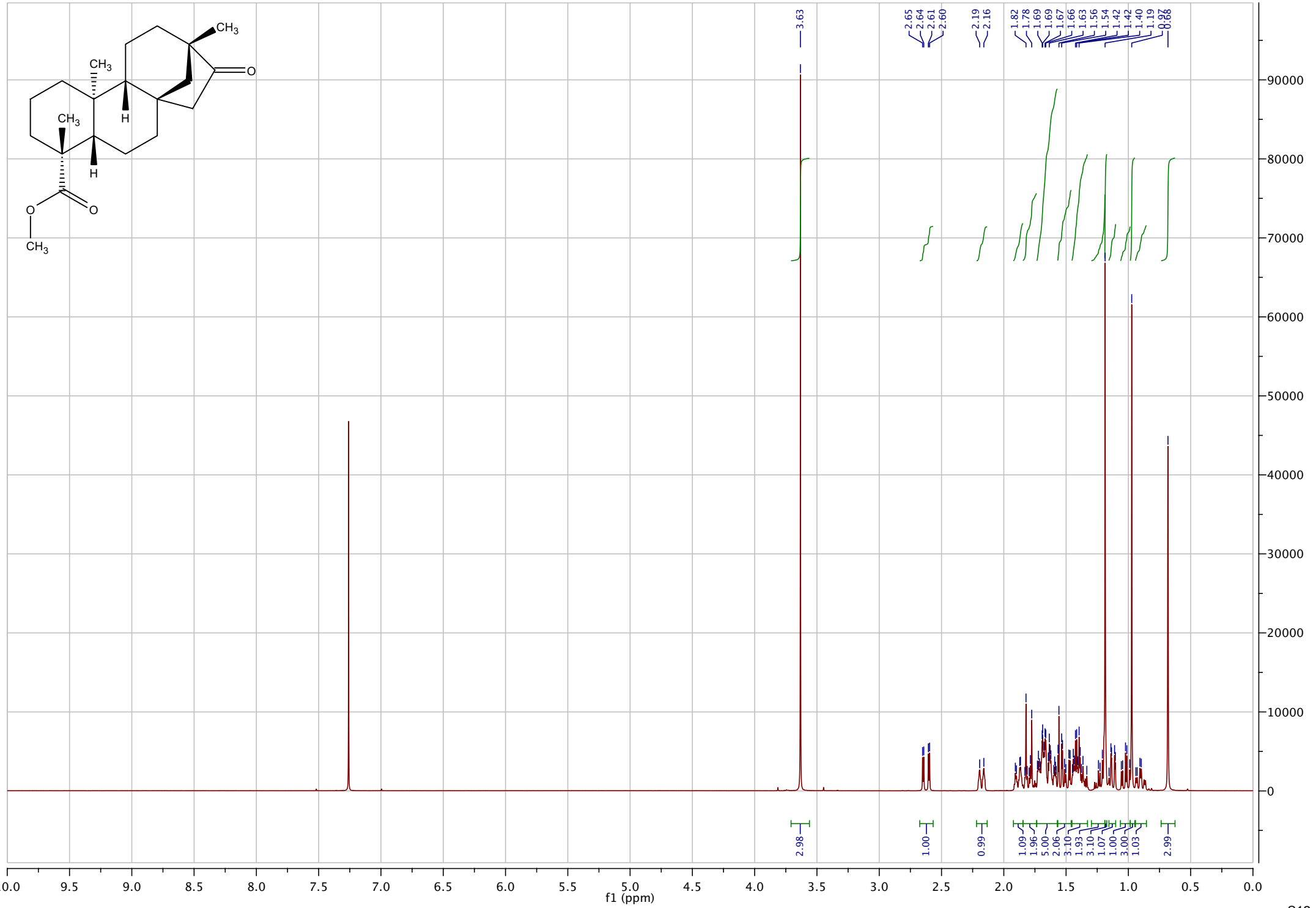


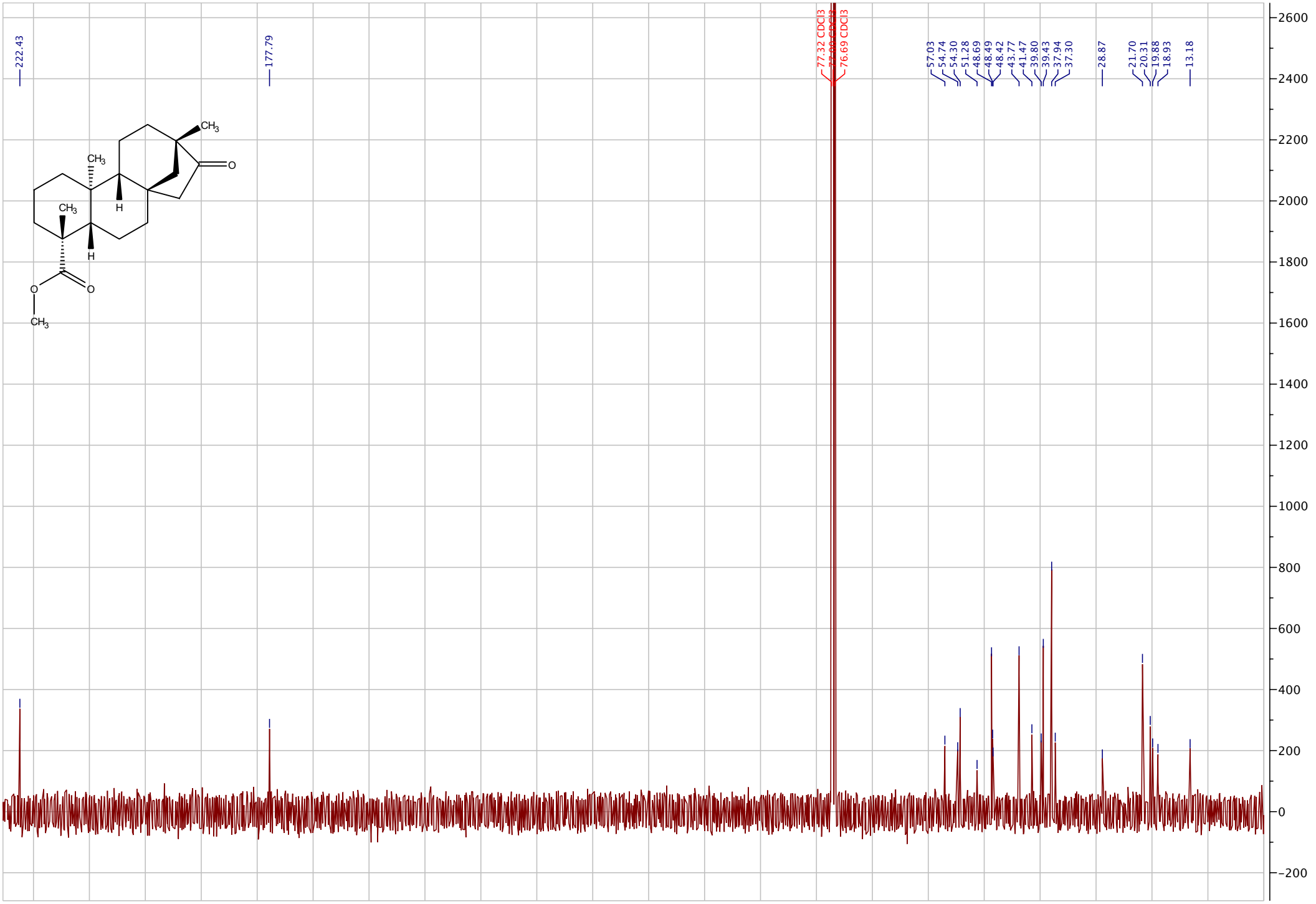
400 MHz 1H NMR Spectrum of Isosteviol (6)



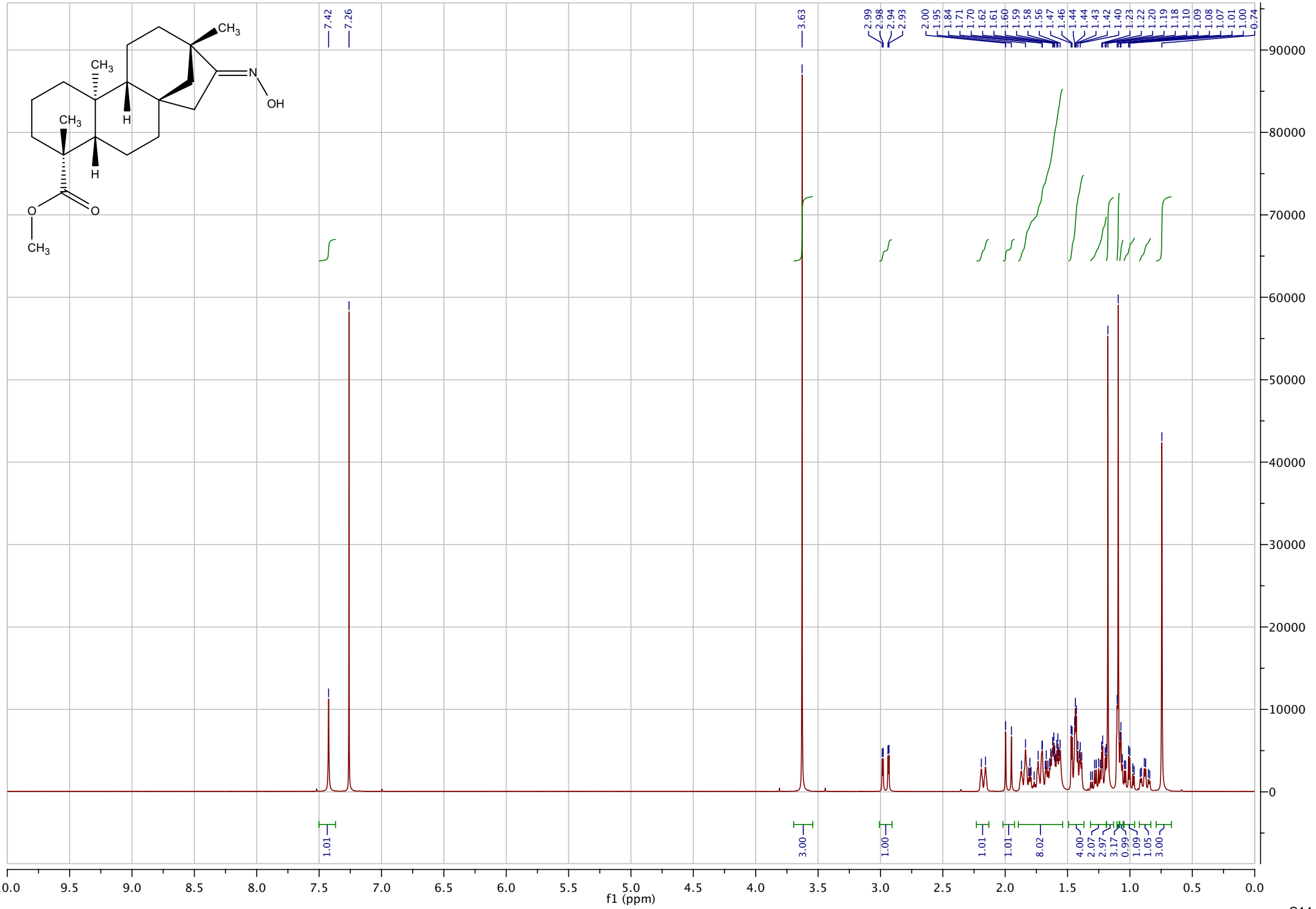
100 MHz 13C NMR Spectrum of Isosteviol (6)



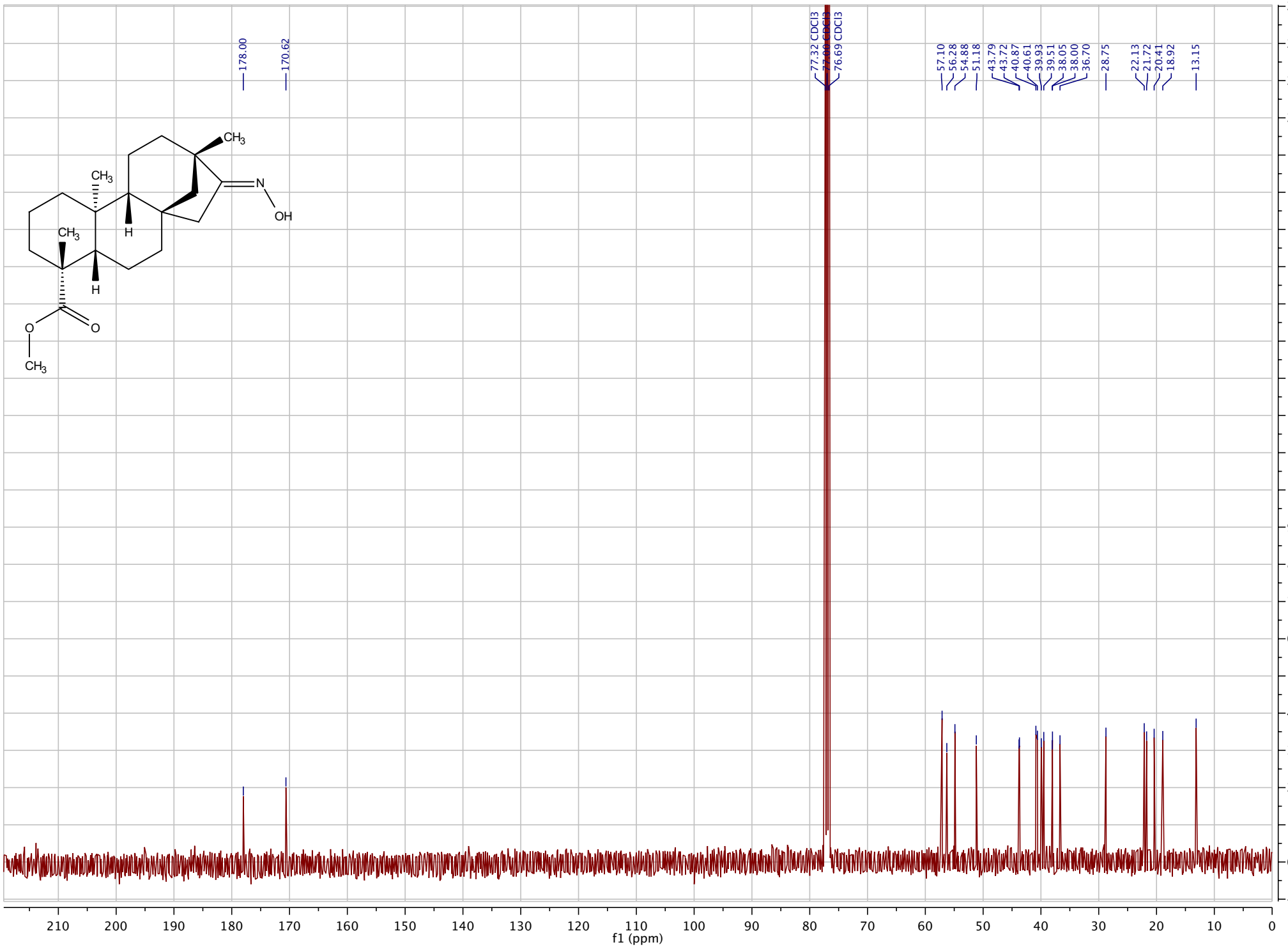
400 MHz 1H NMR Spectrum of Isosteviol Methyl Ester (7)



100 MHz 13C NMR Spectrum of Isosteviol Methyl Ester (7)

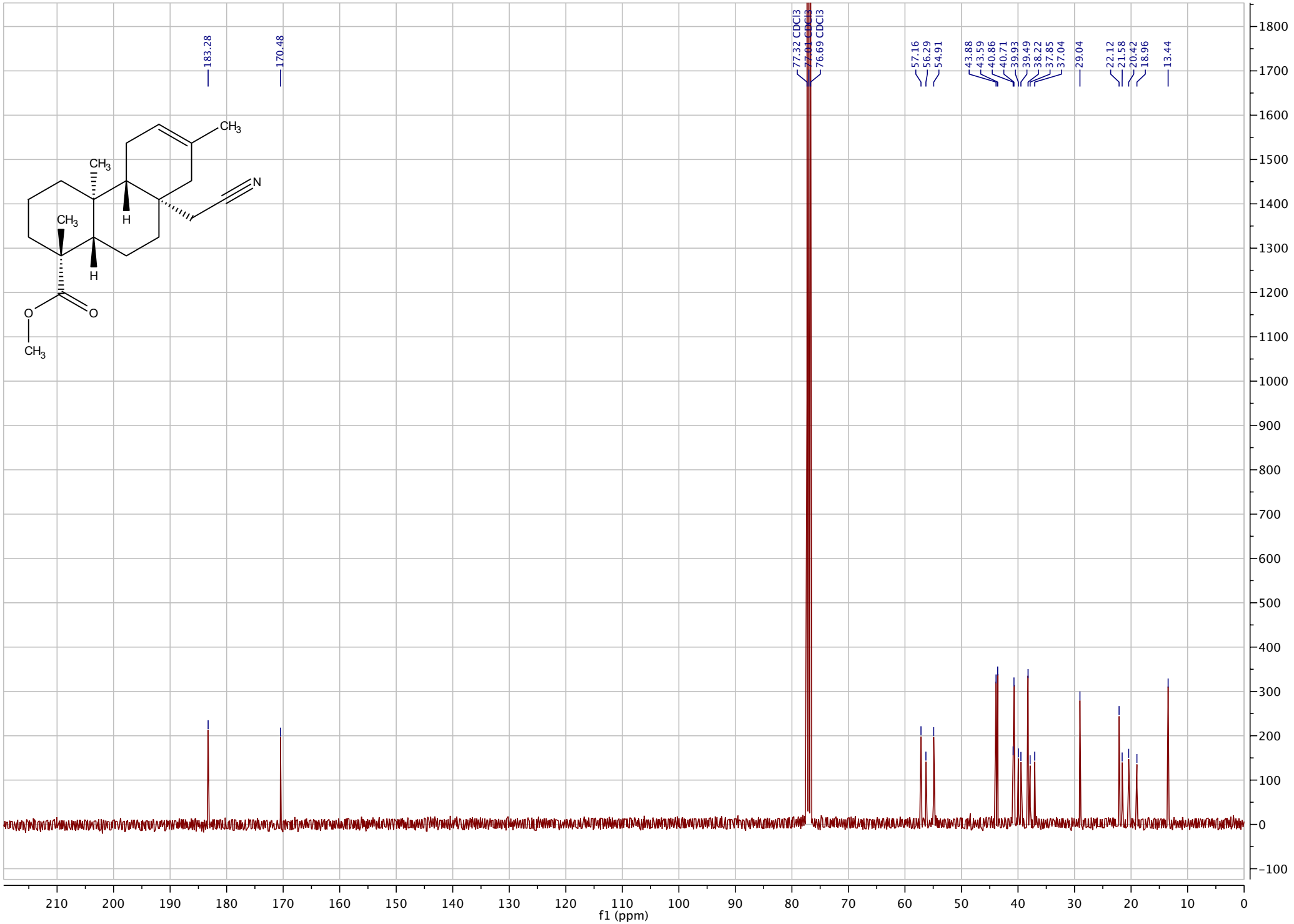


400 MHz 1H NMR Spectrum of Oxime (8)

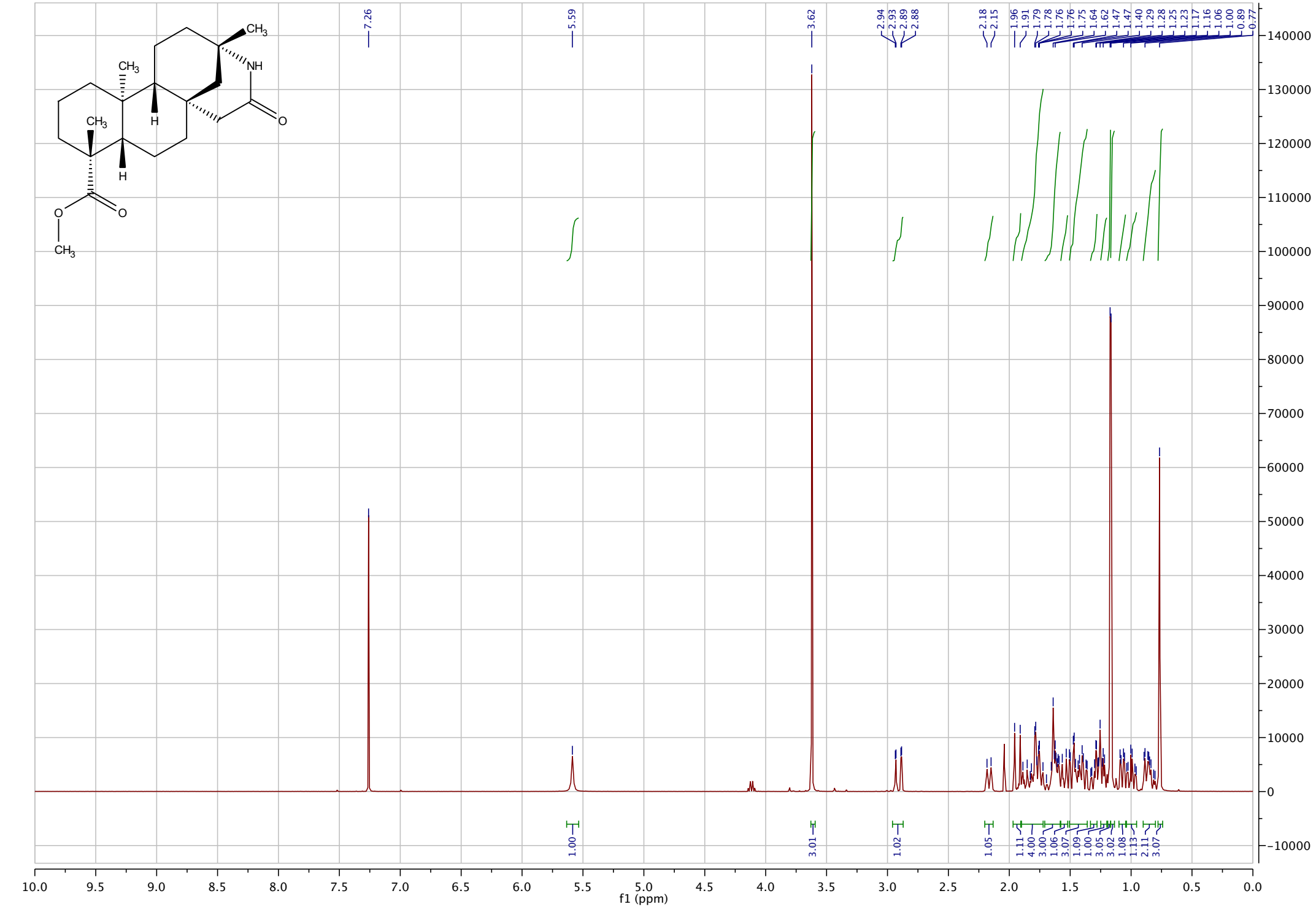


100 MHz 13C NMR Spectrum of Oxime (8)

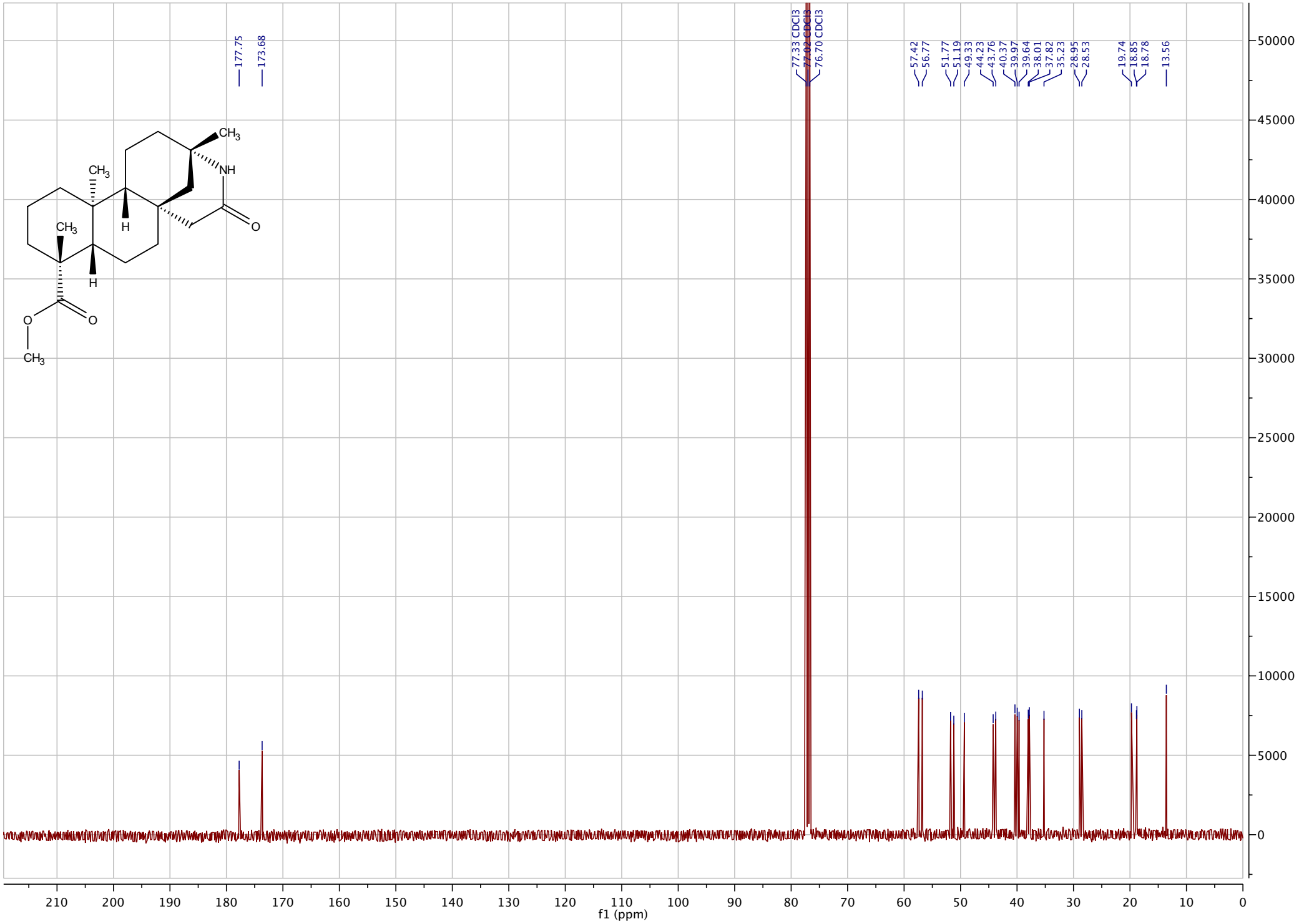
400 MHz 1H NMR Spectrum of Nitrile (9)



100 MHz 13C NMR Spectrum of Nitrile (9)

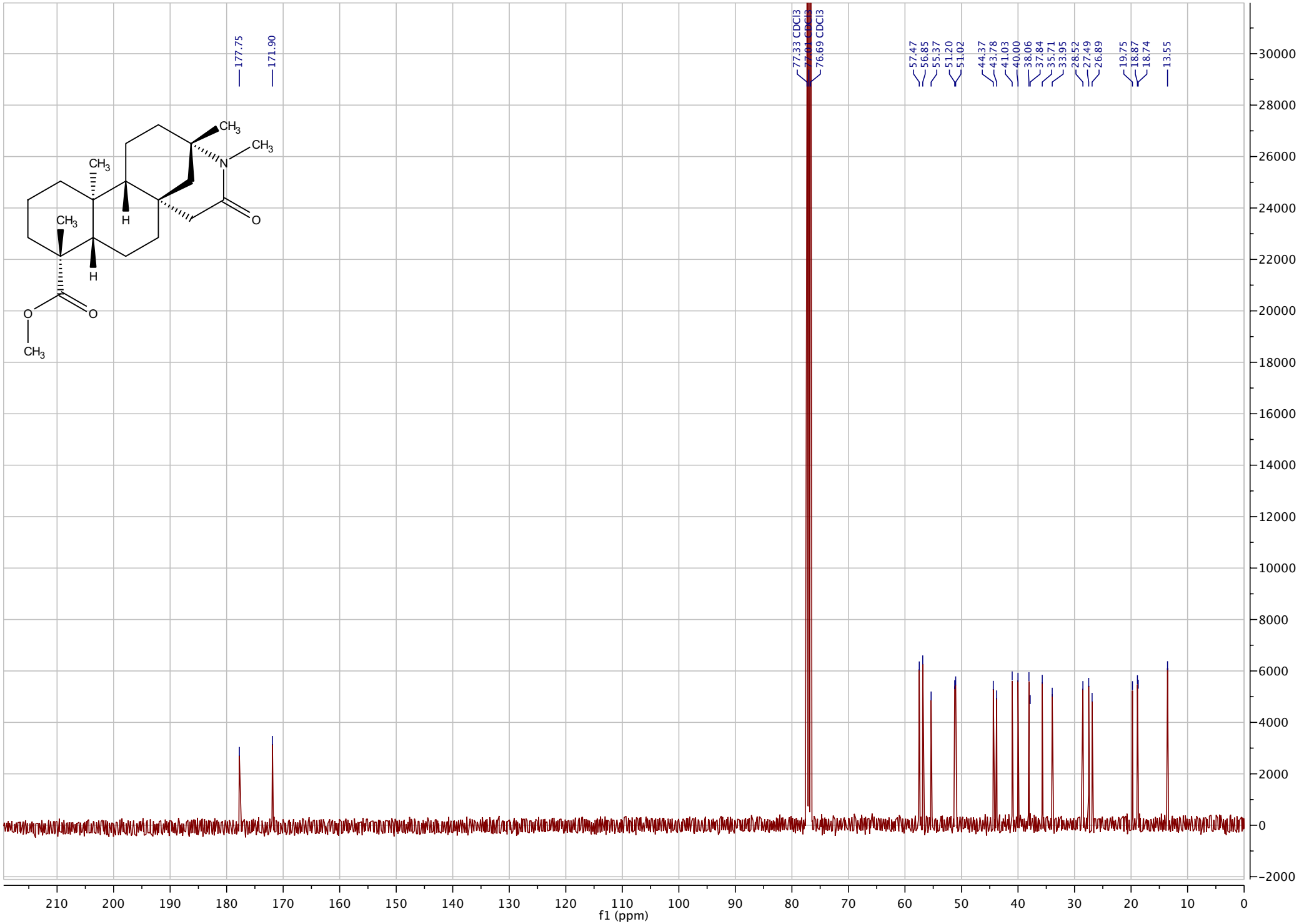


400 MHz 1H NMR Spectrum of Lactam (10)

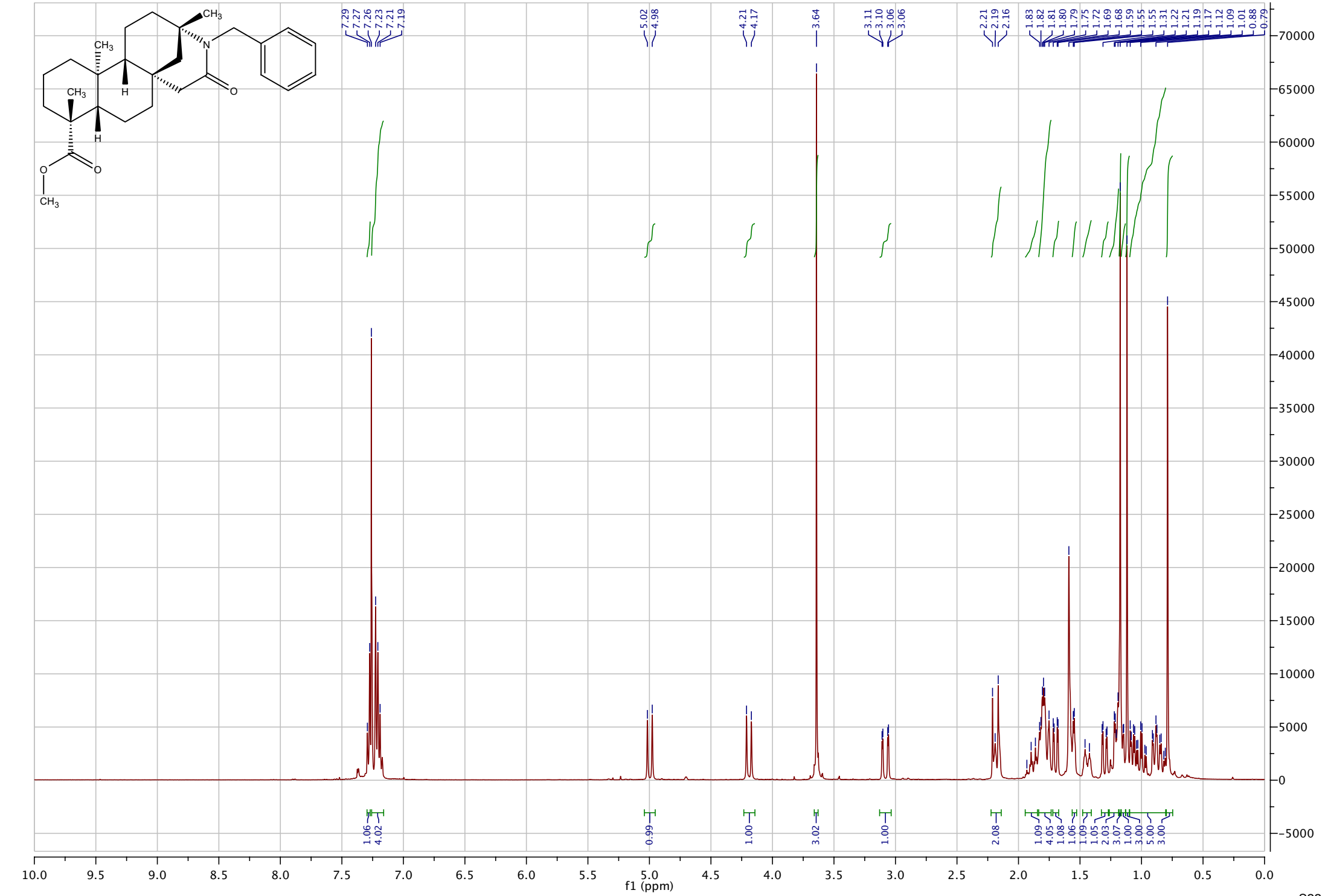


100 MHz 13C NMR Spectrum of Lactam (10)

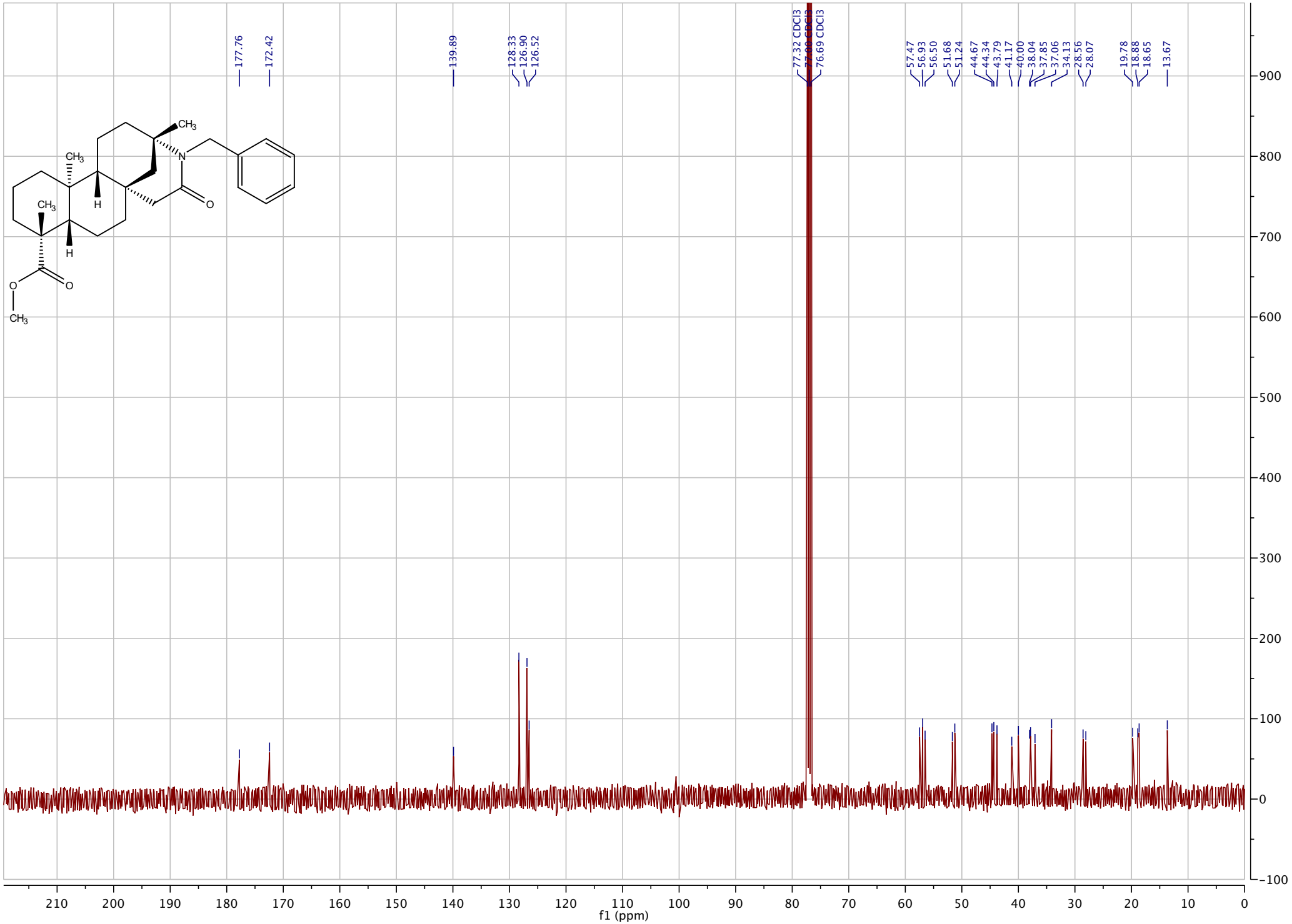
400 MHz 1H NMR Spectrum of Methyl Lactam (12)



100 MHz 13C NMR Spectrum of Methyl Lactam (12)

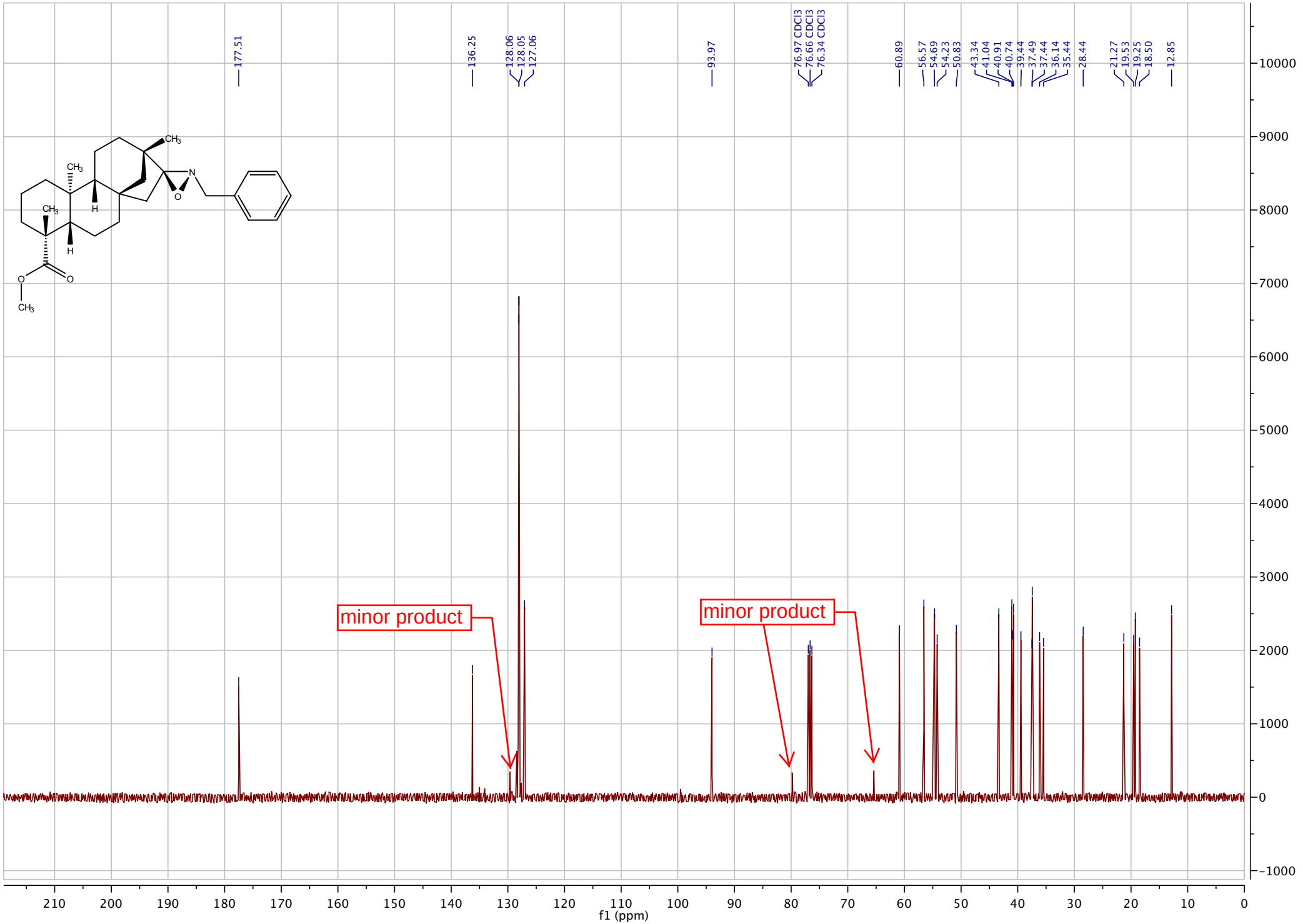


400 MHz 1H NMR Spectrum of 4-Benzyl Lactam (13)

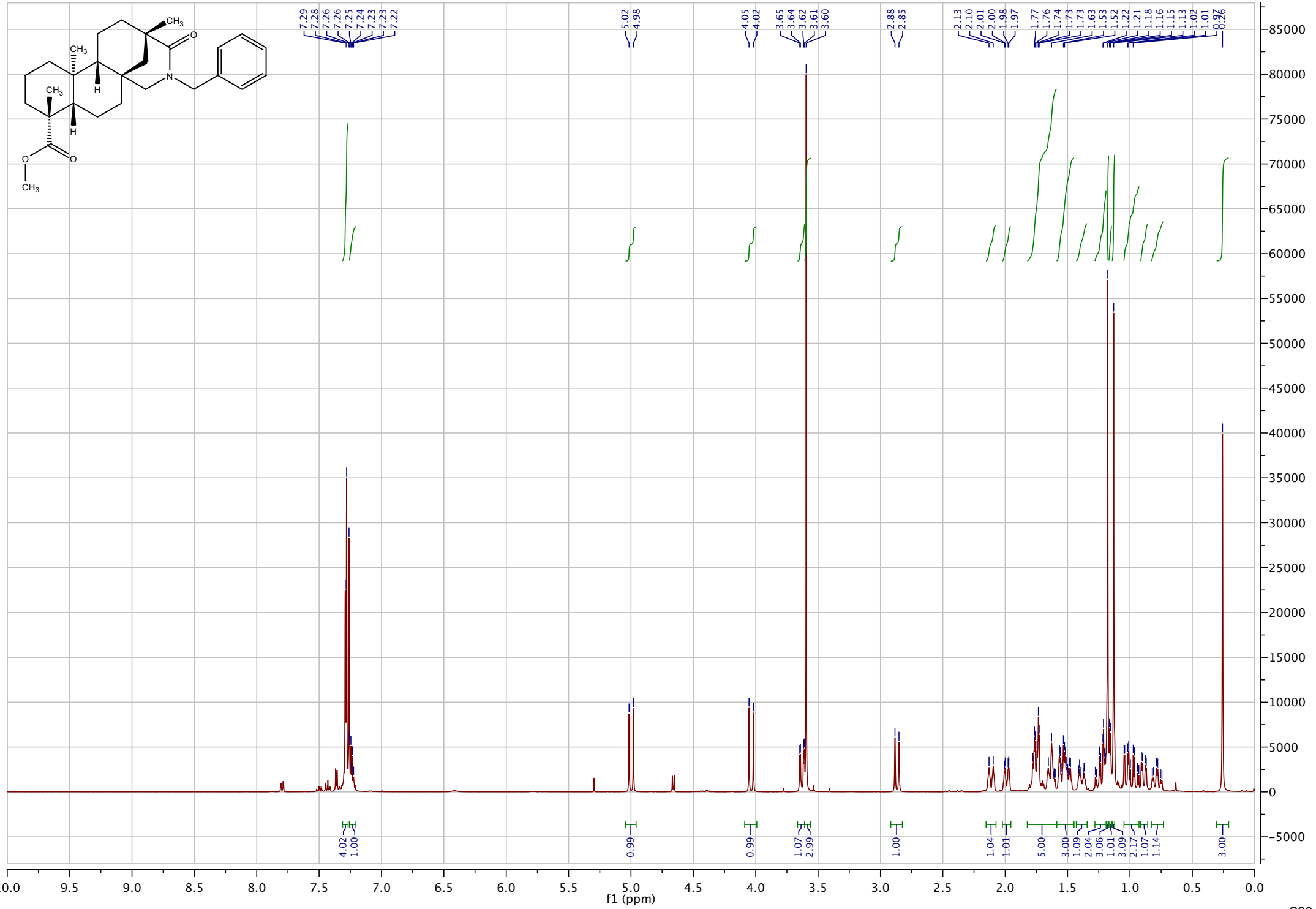


100 MHz 13C NMR Spectrum of 4-Benzyl Lactam (13)

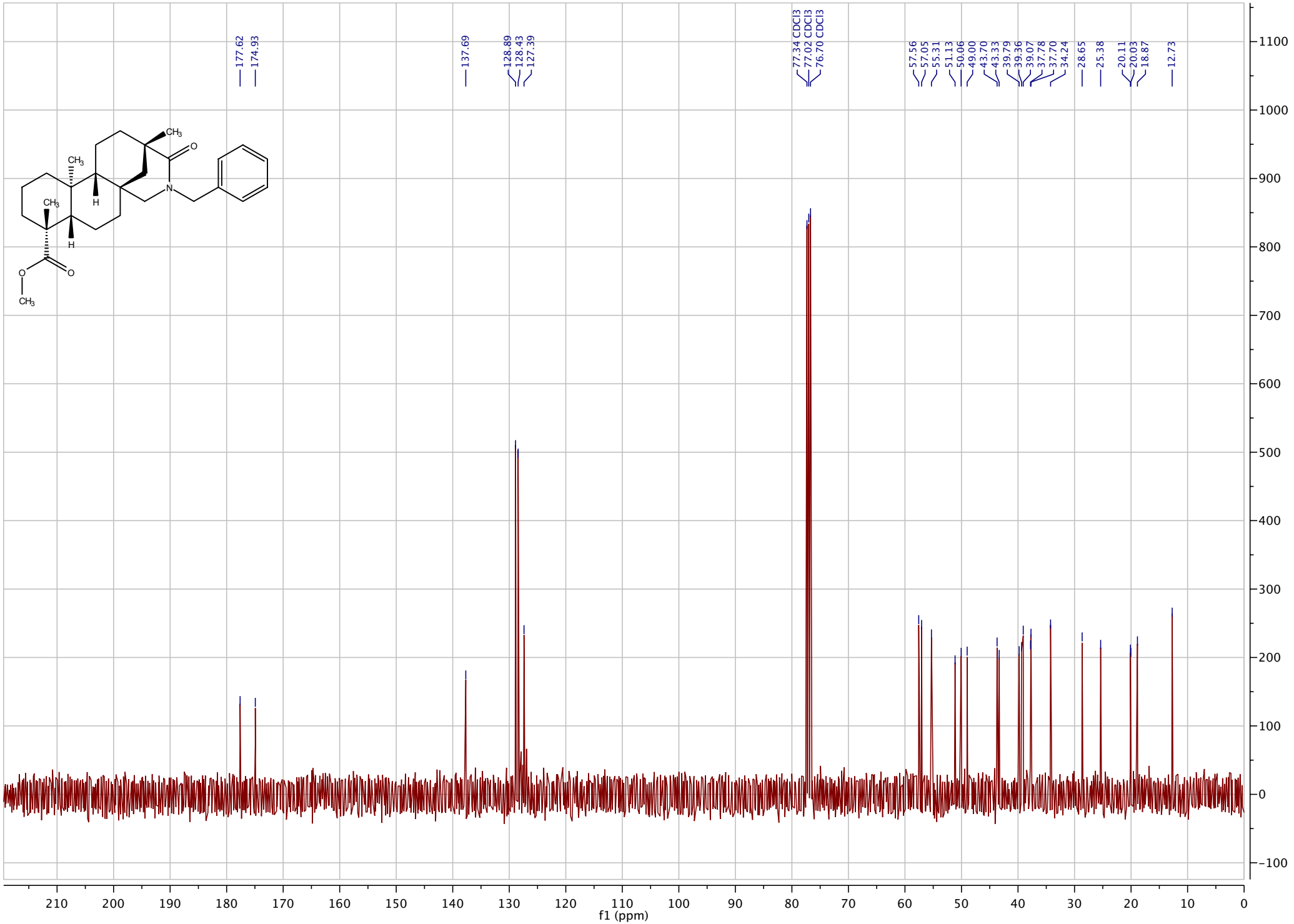
400 MHz 1H NMR Spectrum of Benzyl Oxaziridine (15)



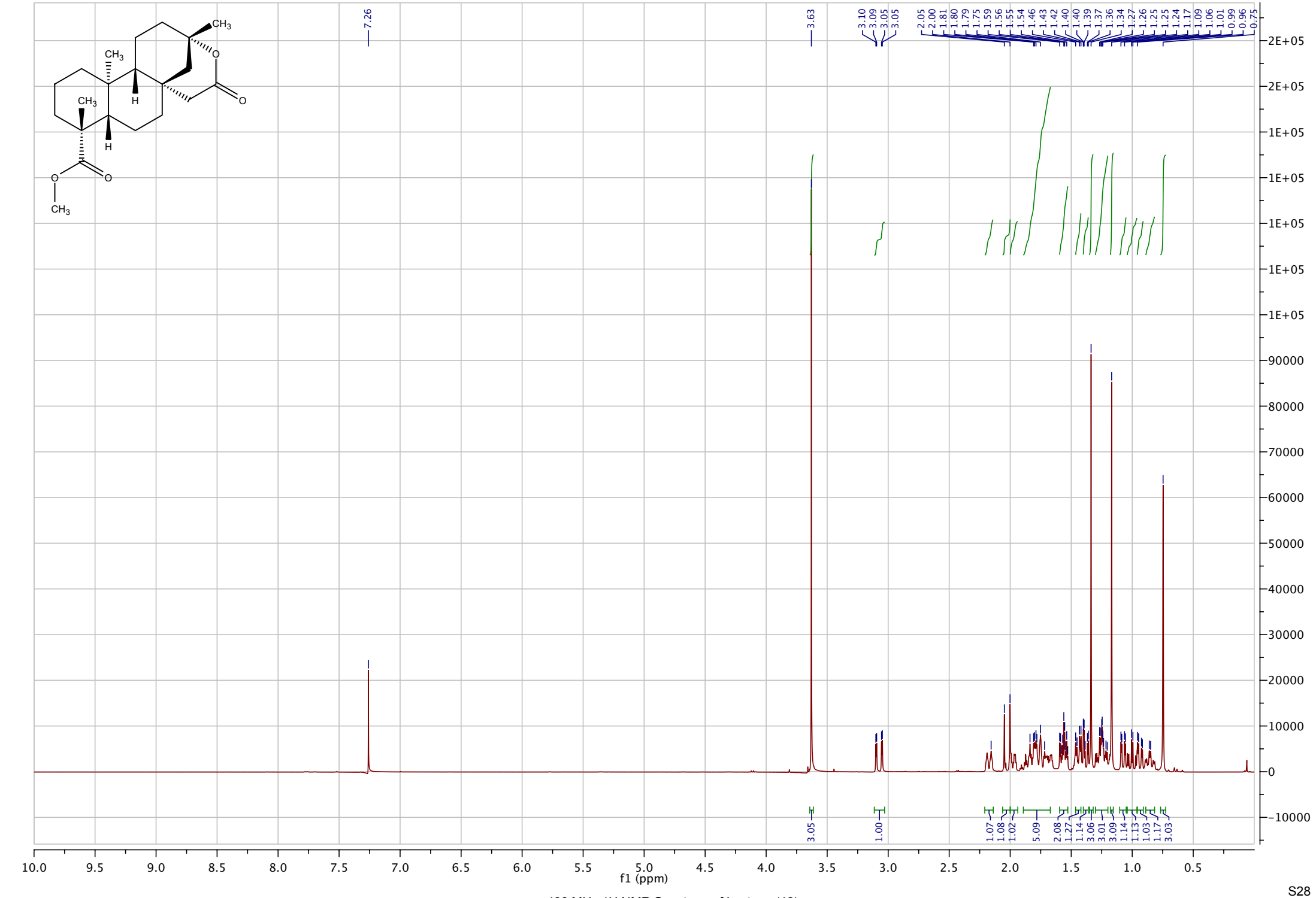
100 MHz 13C NMR Spectrum of Benzyl Oxaziridine (15)



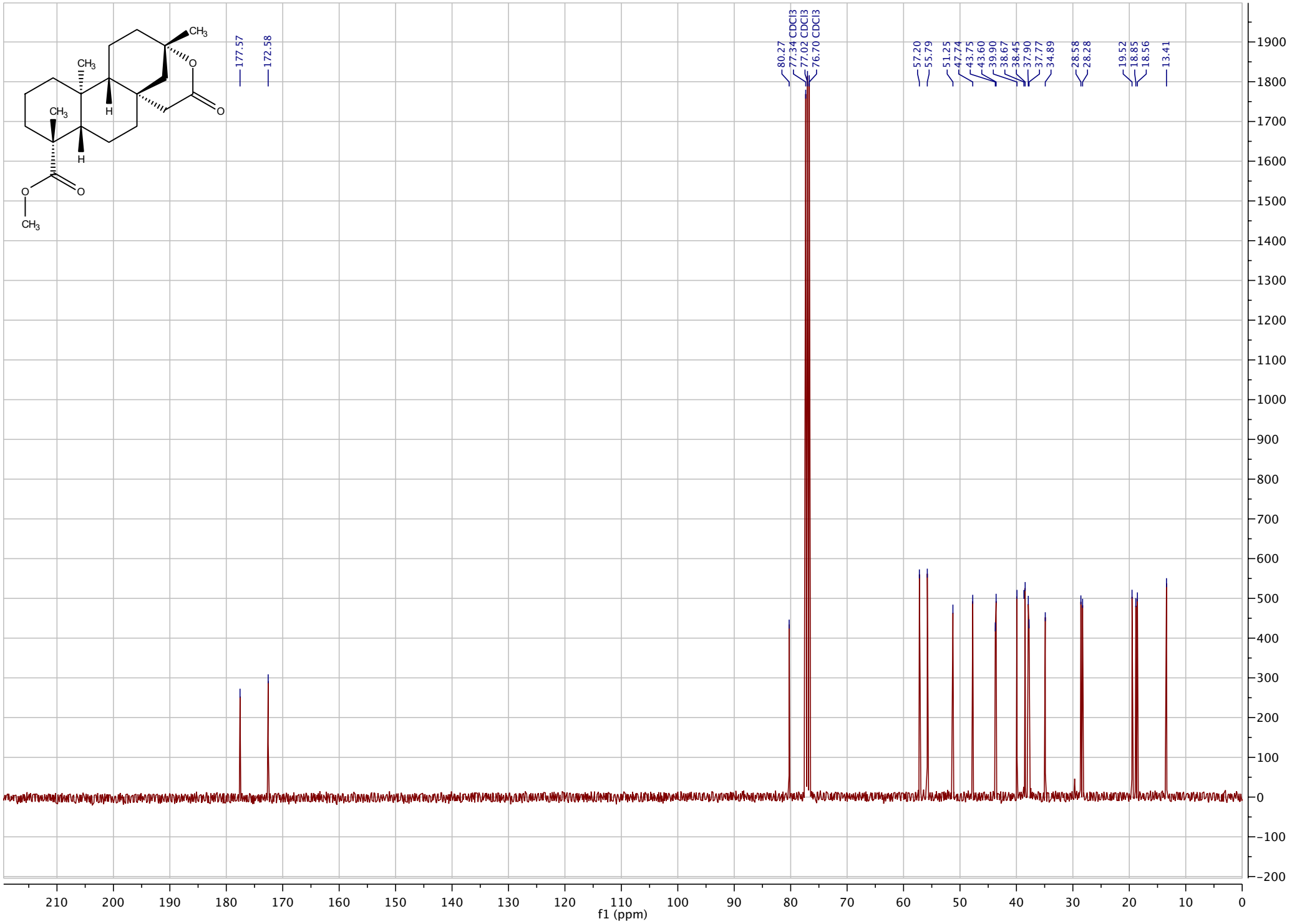
400 MHz 1H NMR Spectrum of 5-Benzyl Lactam (16)



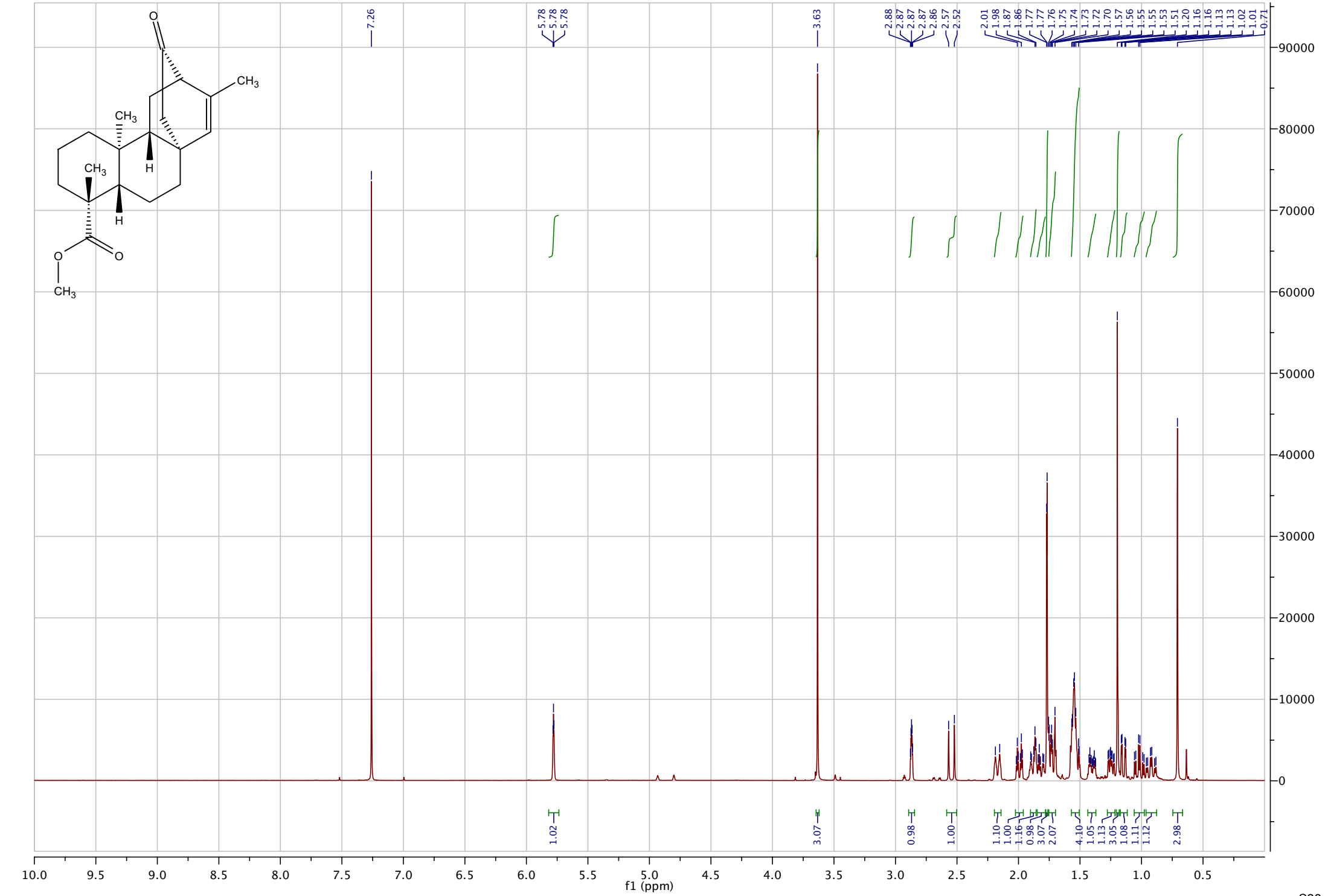
100 MHz 13C NMR Spectrum of 5-Benzyl Lactam (16)



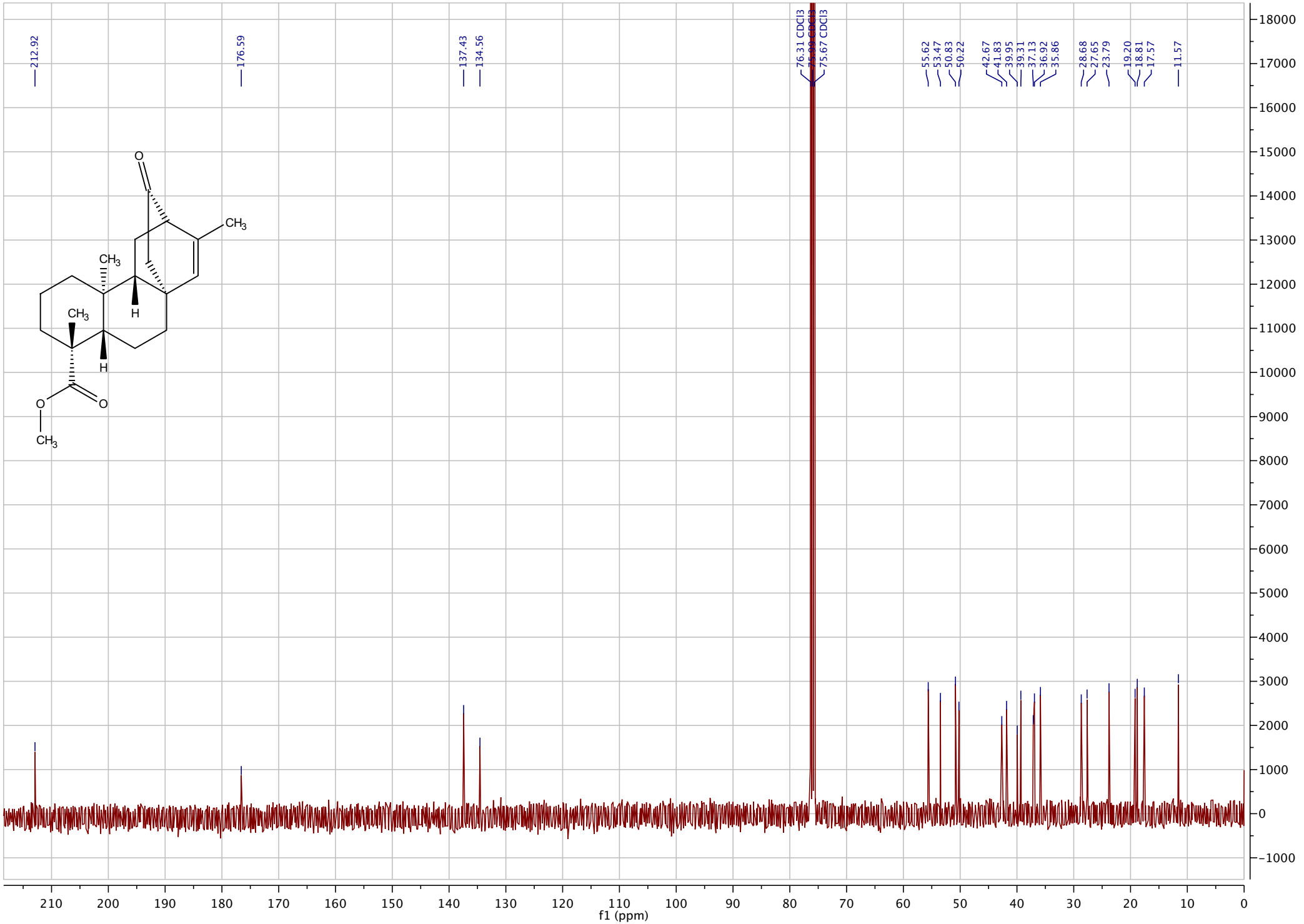
400 MHz 1H NMR Spectrum of Lactone (18)



100 MHz 13C NMR Spectrum of Lactone (18)

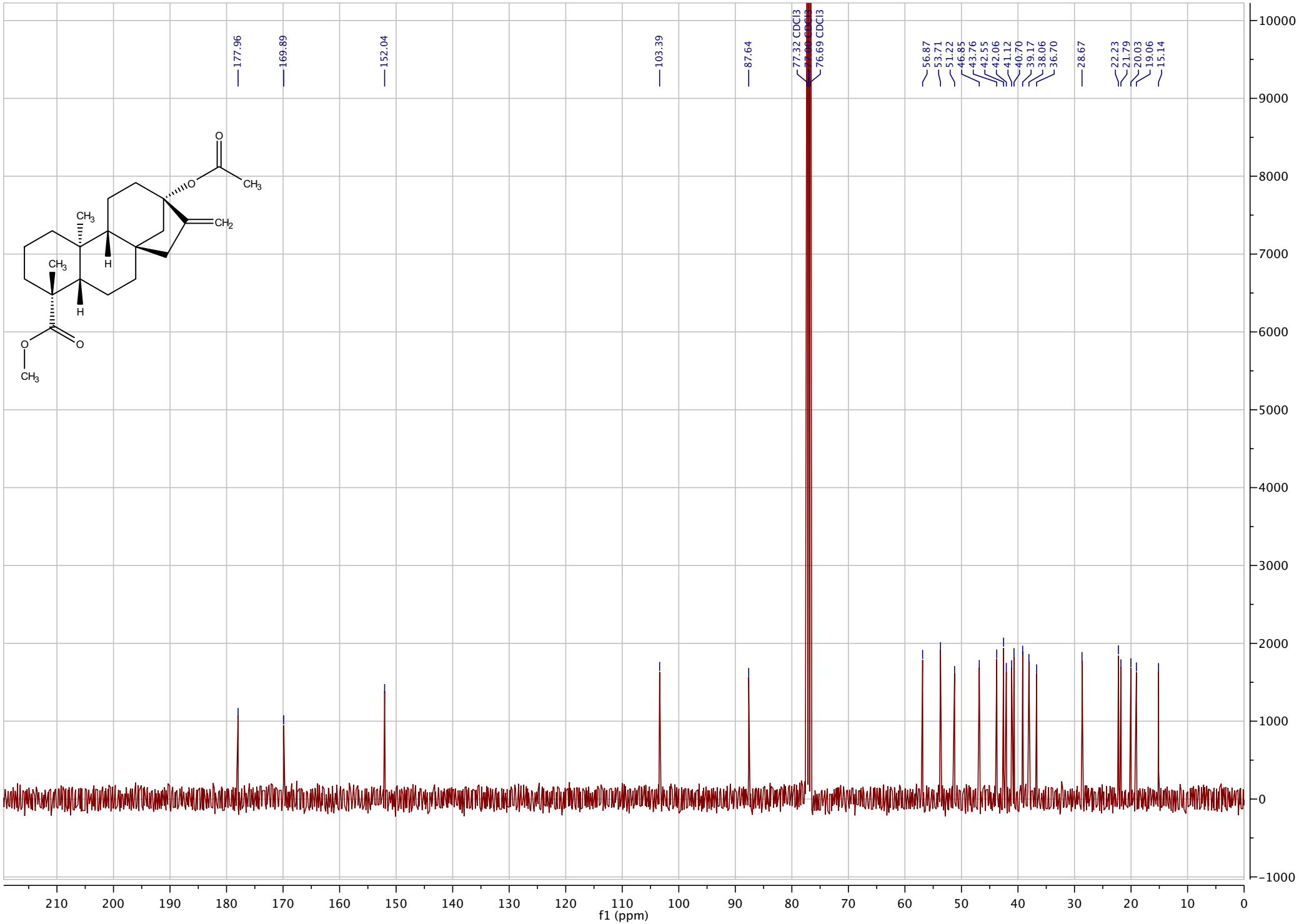


400 MHz 1H NMR Spectrum of Ketone (19)

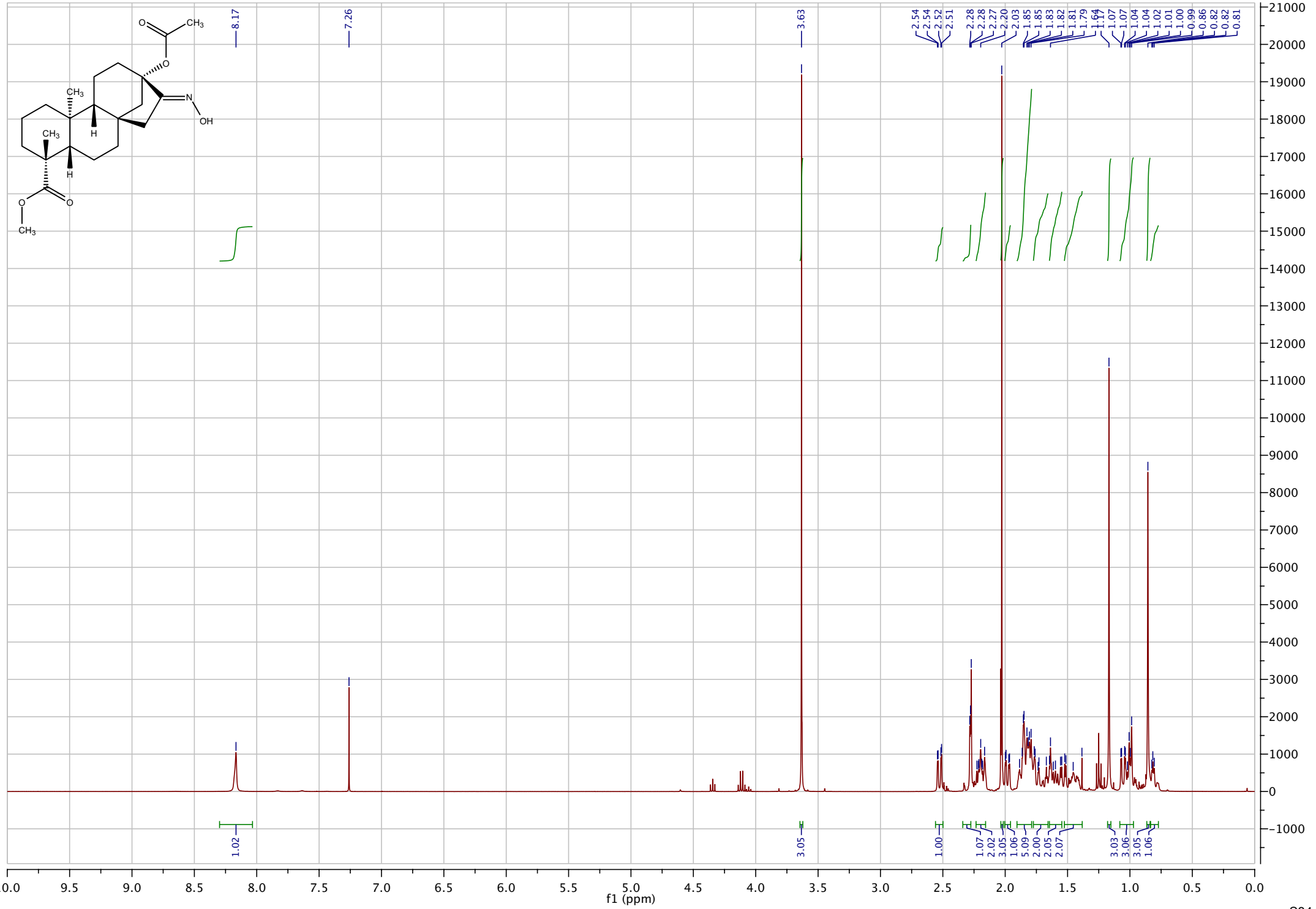


100 MHz 13C NMR Spectrum of Ketone (19)

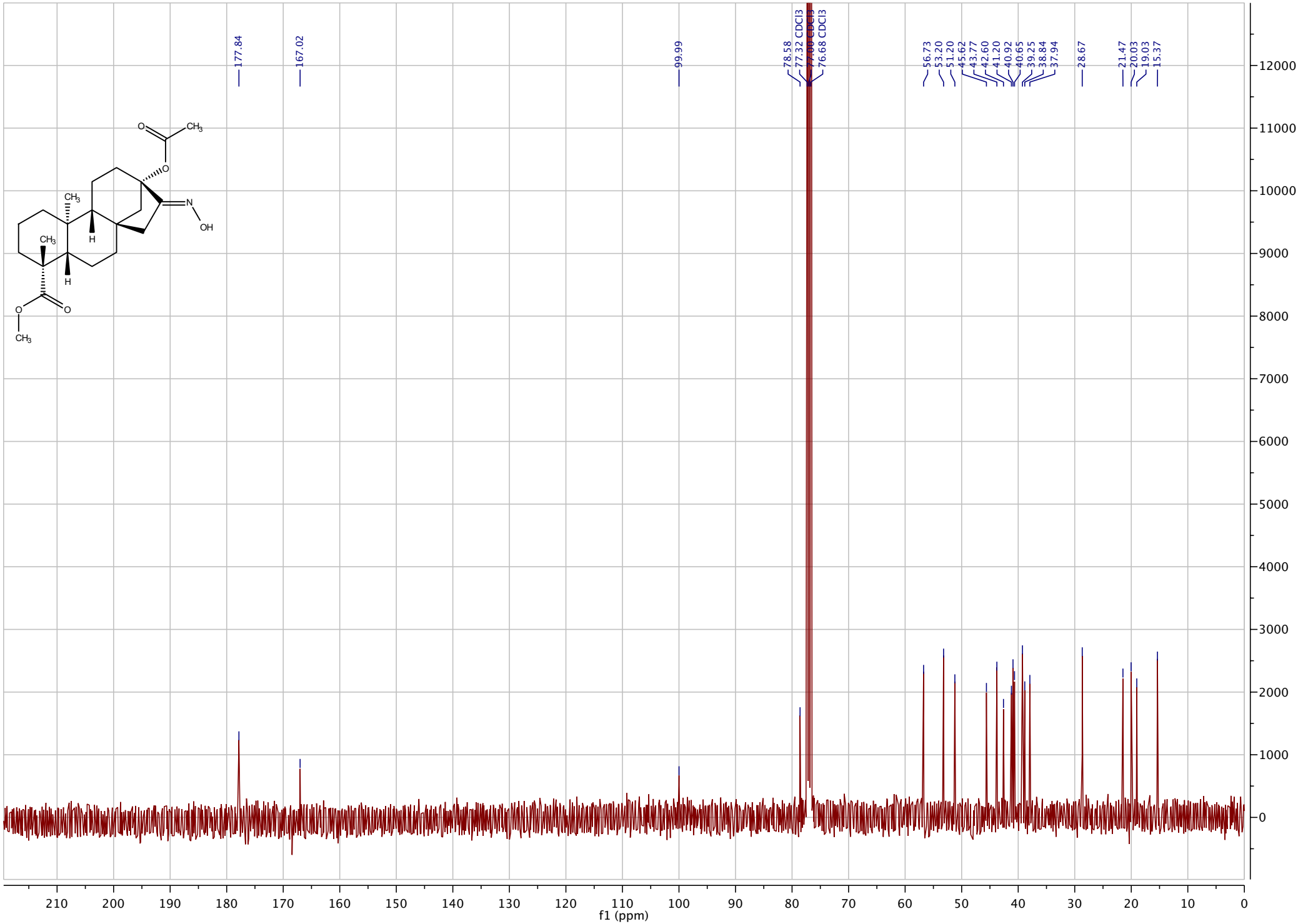
400 MHz 1H NMR Spectrum of 13-Acetoxy Steviol Methyl Ester (20)



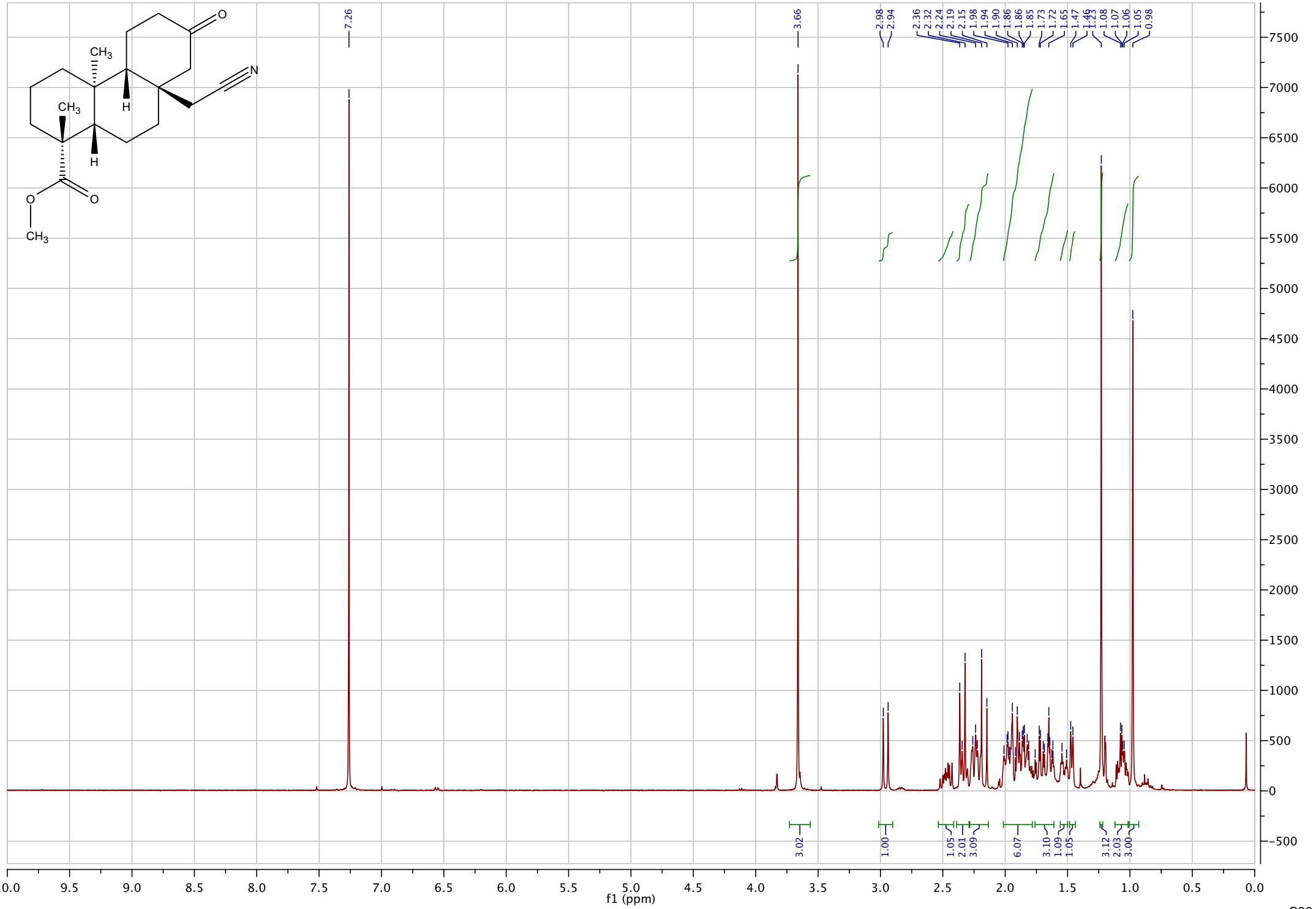
100 MHz 13C NMR Spectrum of 13-Acetoxy Steviol Methyl Ester (20)



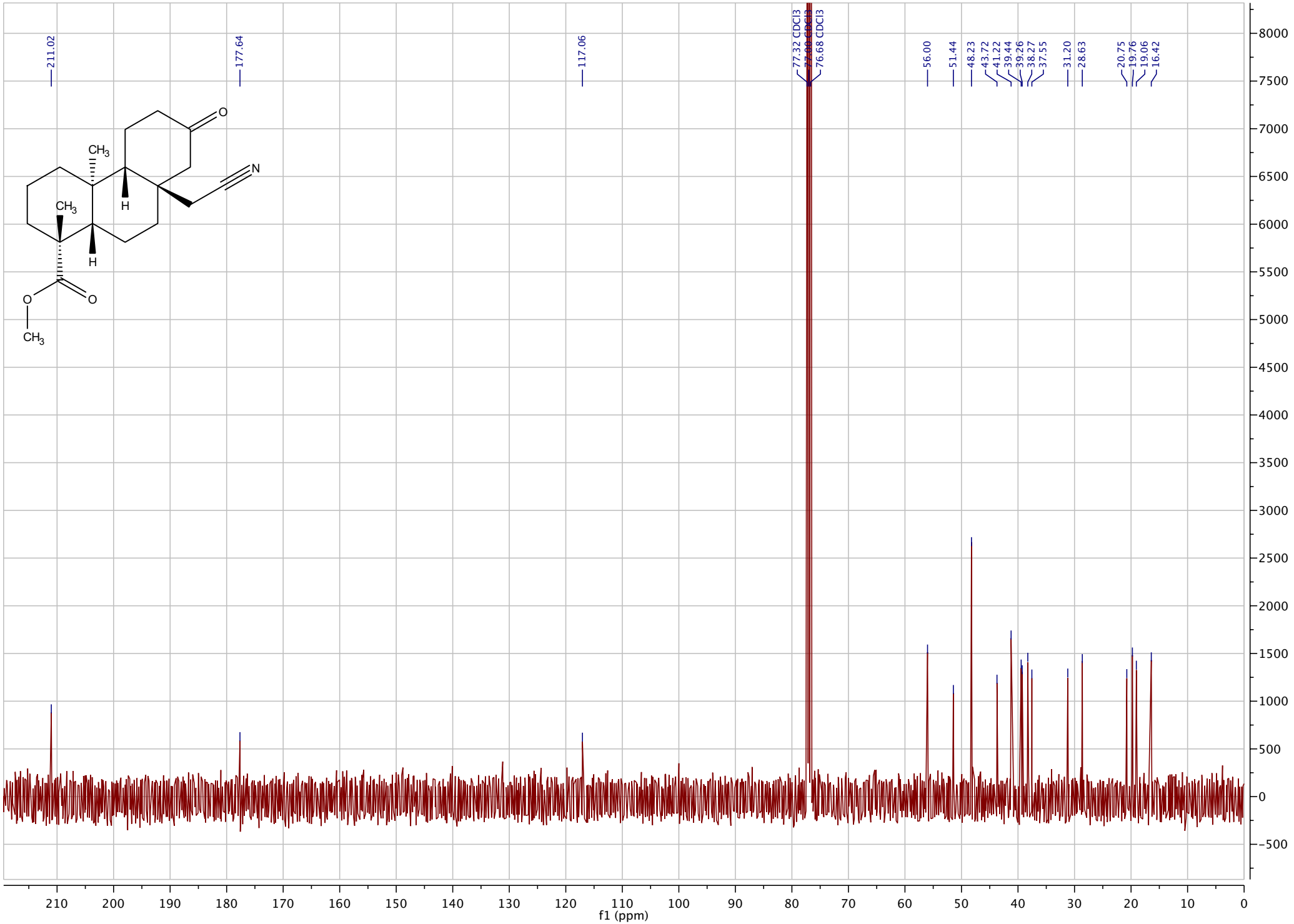
400 MHz 1H NMR Spectrum of 13-Acetoxy Oxime (21)



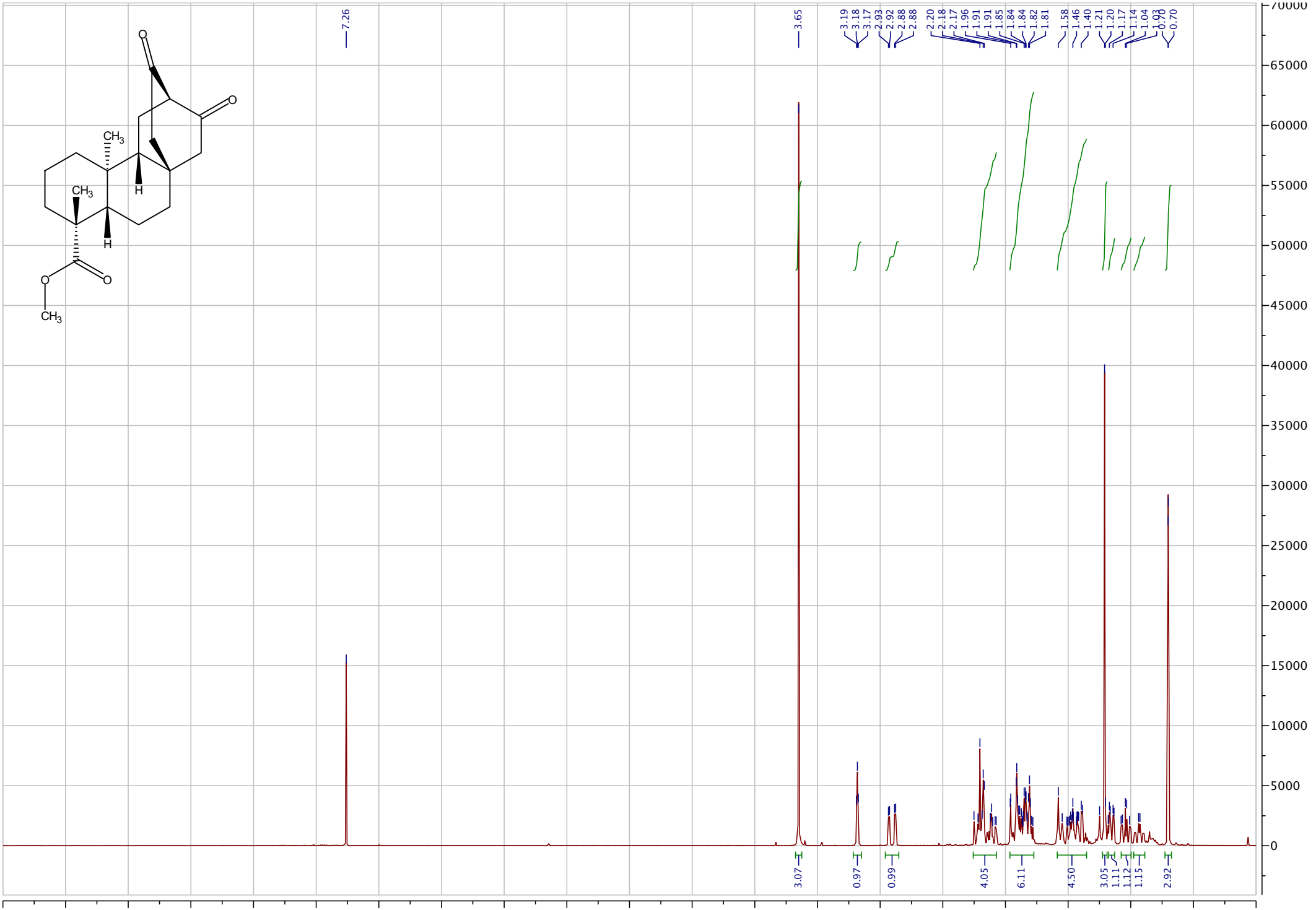
100 MHz 13C NMR Spectrum of 13-Acetoxy Oxime (21)



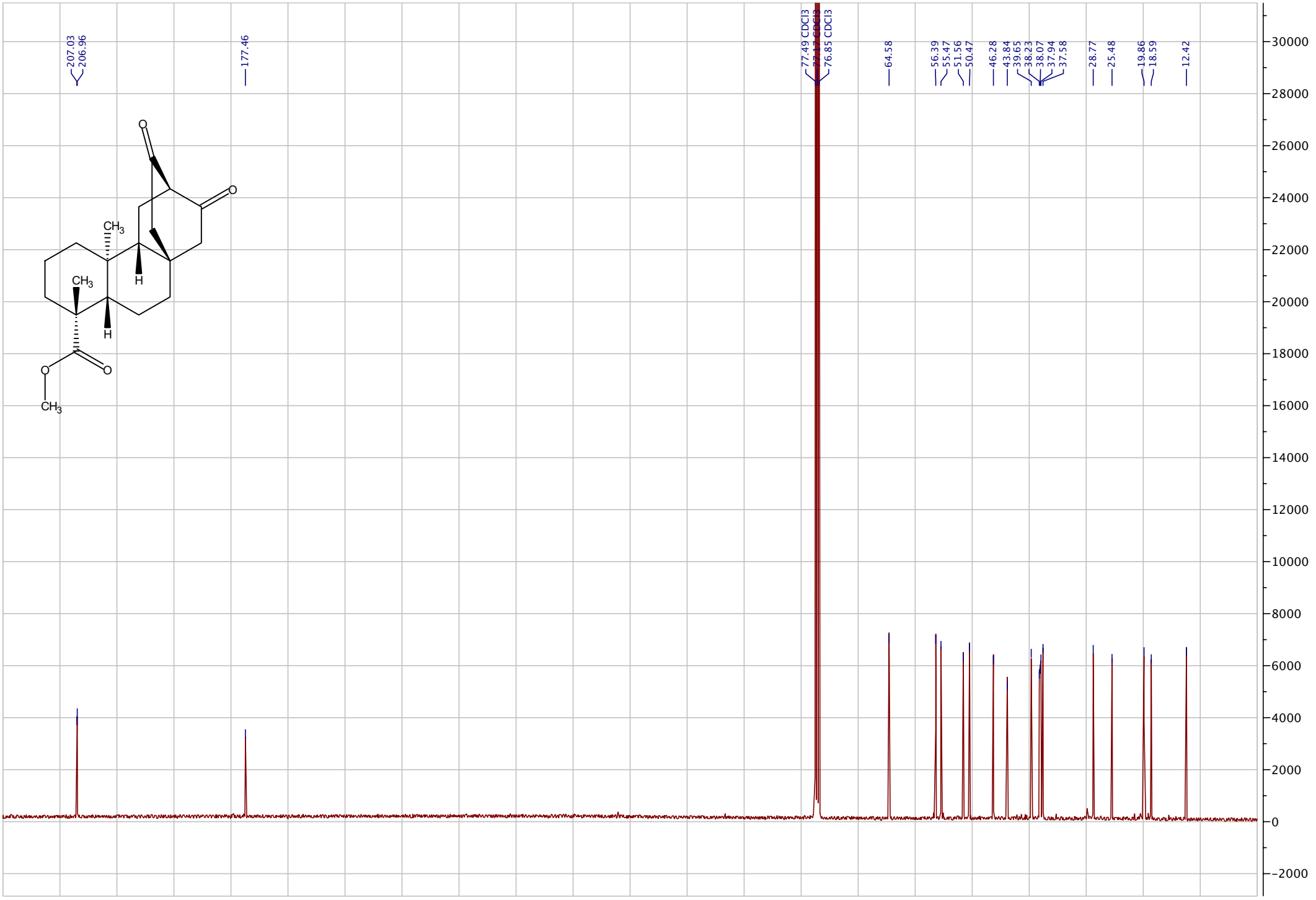
400 MHz 1H NMR Spectrum of Ketone Nitrile (22)



100 MHz 13C NMR Spectrum of Ketone Nitrile (22)



400 MHz 1H NMR Spectrum of Diketone (23)



100 MHz 13C NMR Spectrum of Diketone (23)