One-pot Organocatalyzed Synthesis of Polycyclic Indolizines

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SUPPORTING INFORMATION

^{1}H NMR and ^{13}C NMR spectra

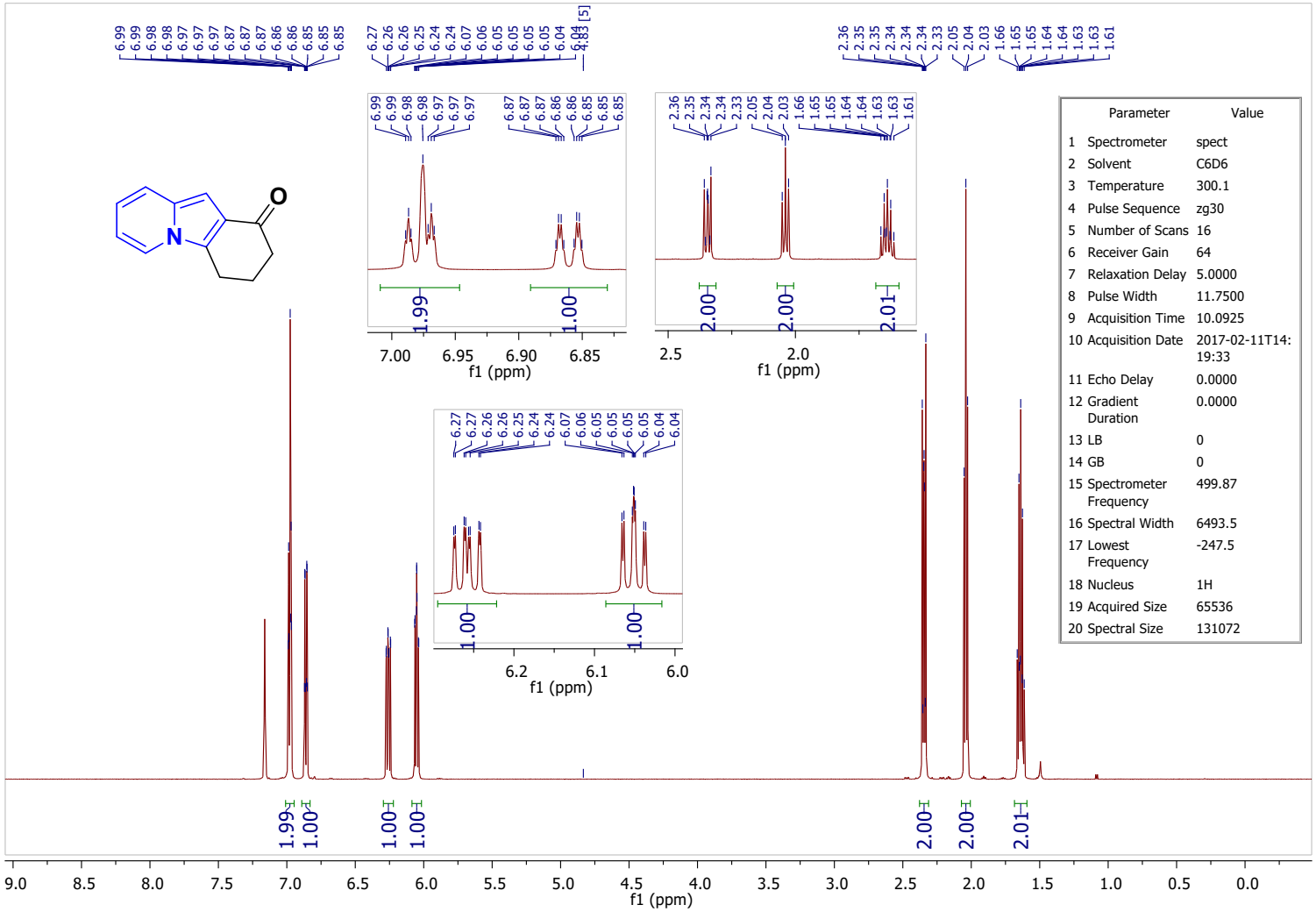


Figure S1. ^{1}H NMR spectrum (500 MHz, C_6D_6) of compound **5aa**.

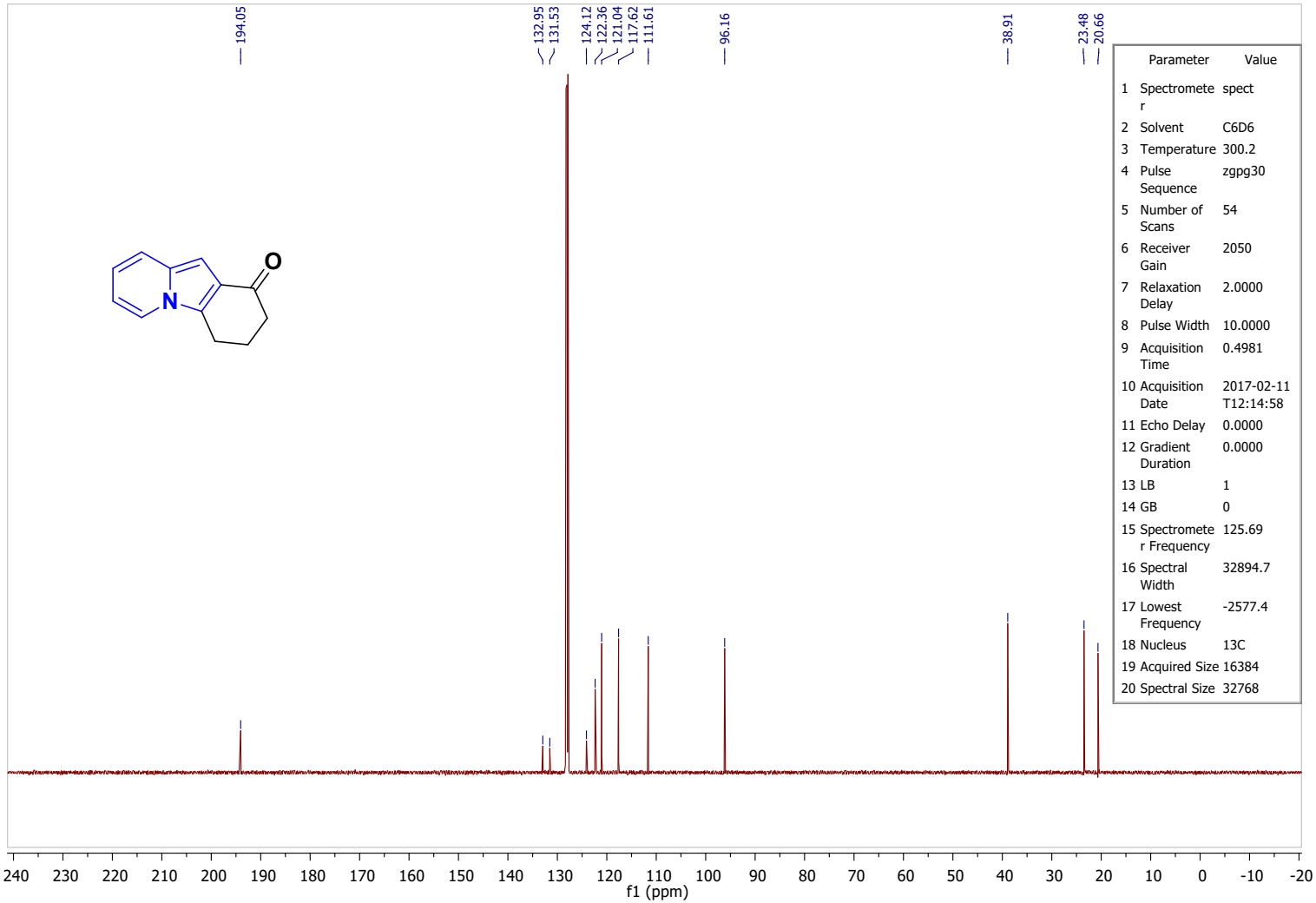


Figure S2. ^{13}C NMR spectrum (126 MHz, C_6D_6) of compound **5aa**.

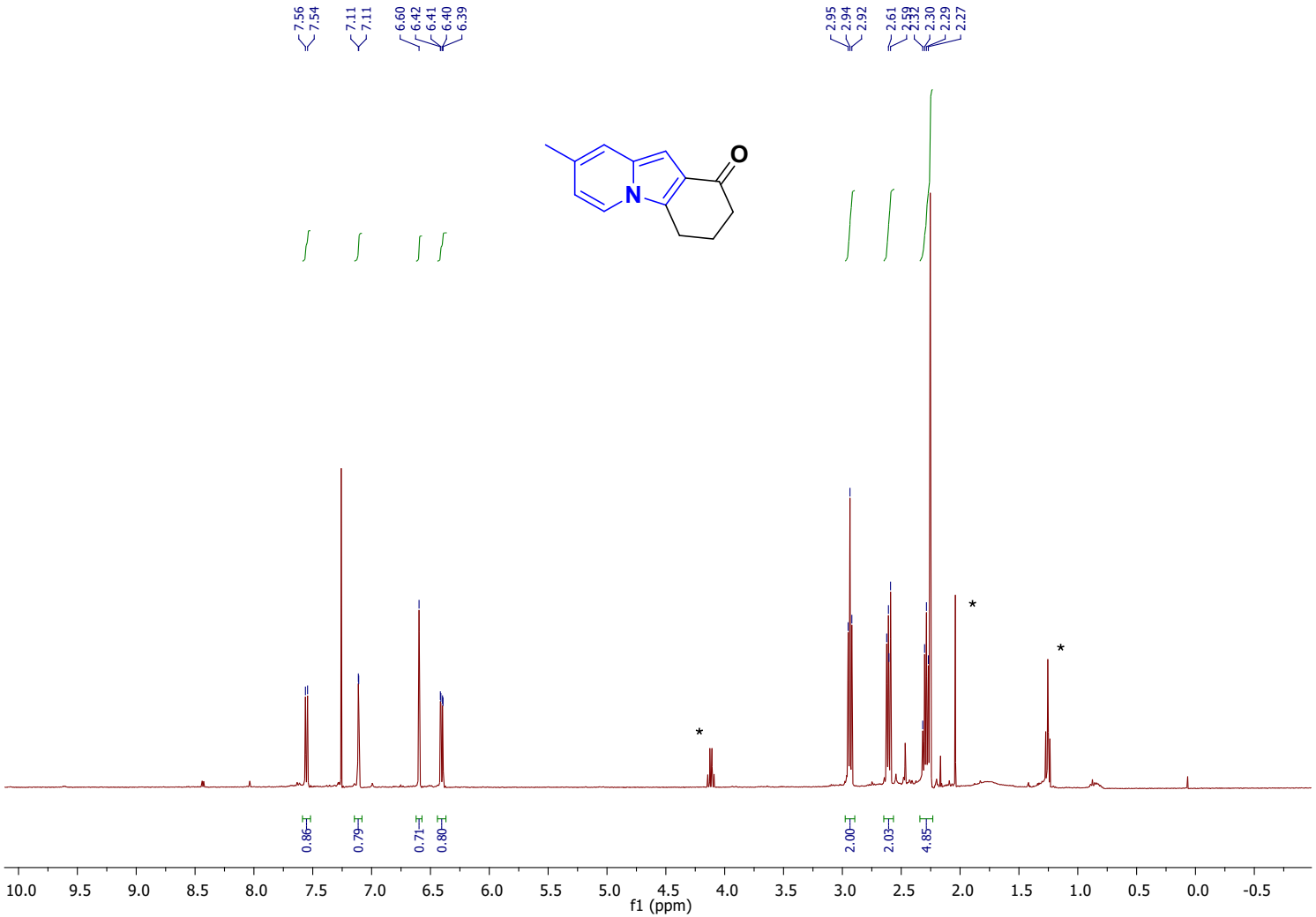


Figure S3. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **5ba** (* = residual peaks from ethyl acetate).

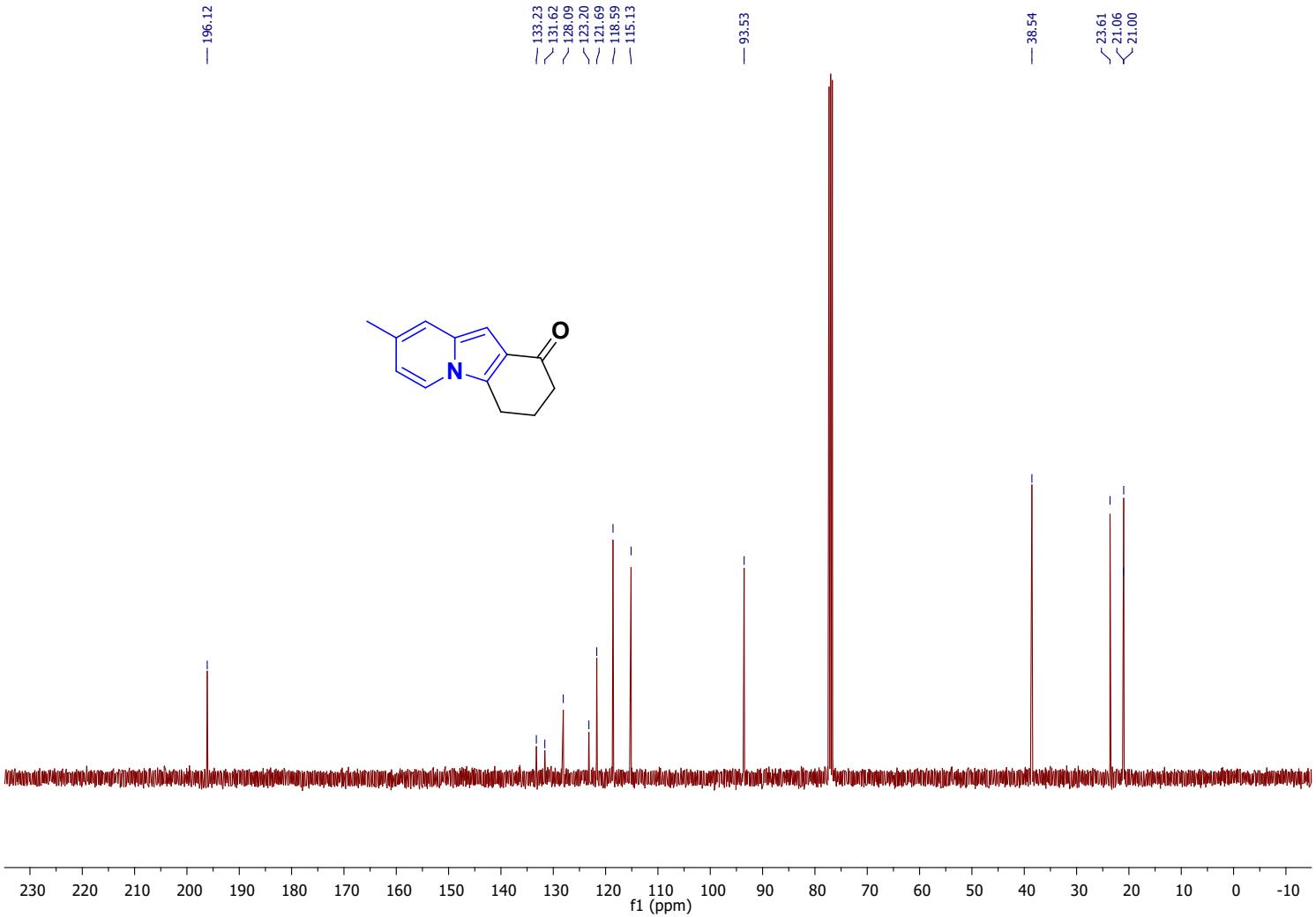


Figure S4. ^{13}C NMR spectrum (101 MHz, $CDCl_3$) of compound **5ba**.

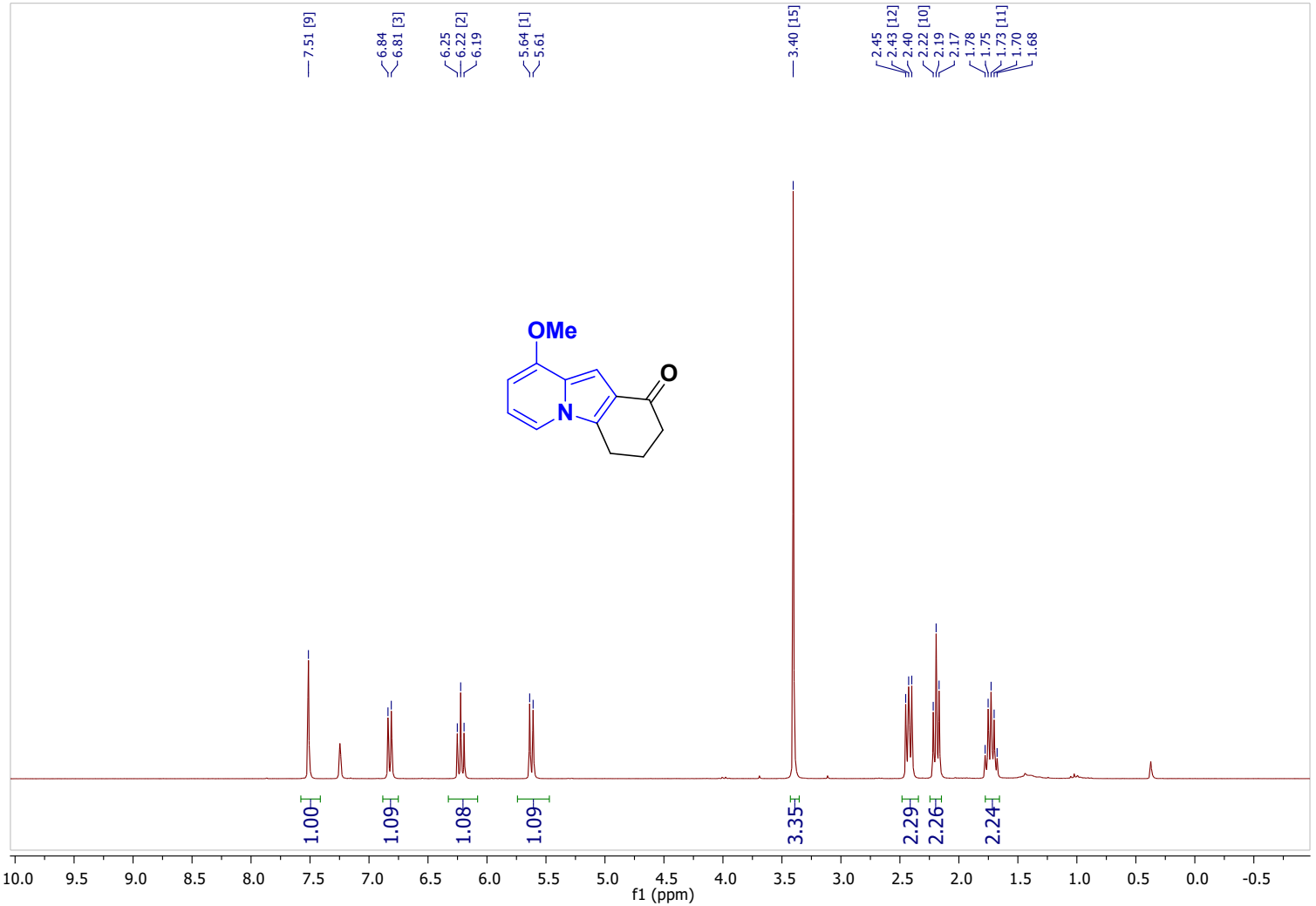


Figure S5. ^{1}H NMR spectrum (250 MHz, C_6D_6) of compound **5ca**.

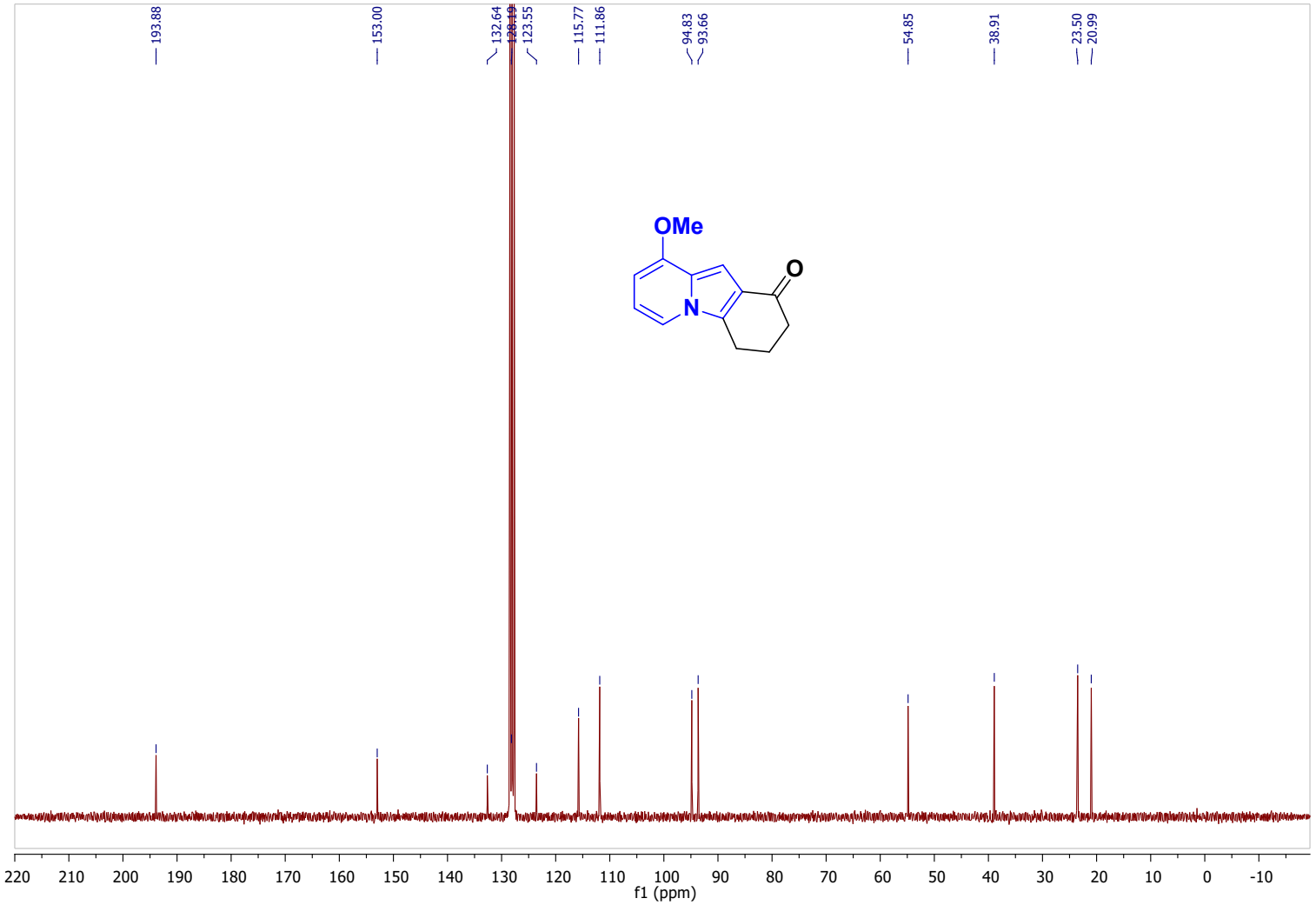


Figure S6. ^{13}C NMR spectrum (62.5 MHz, C_6D_6) of compound **5ca**.

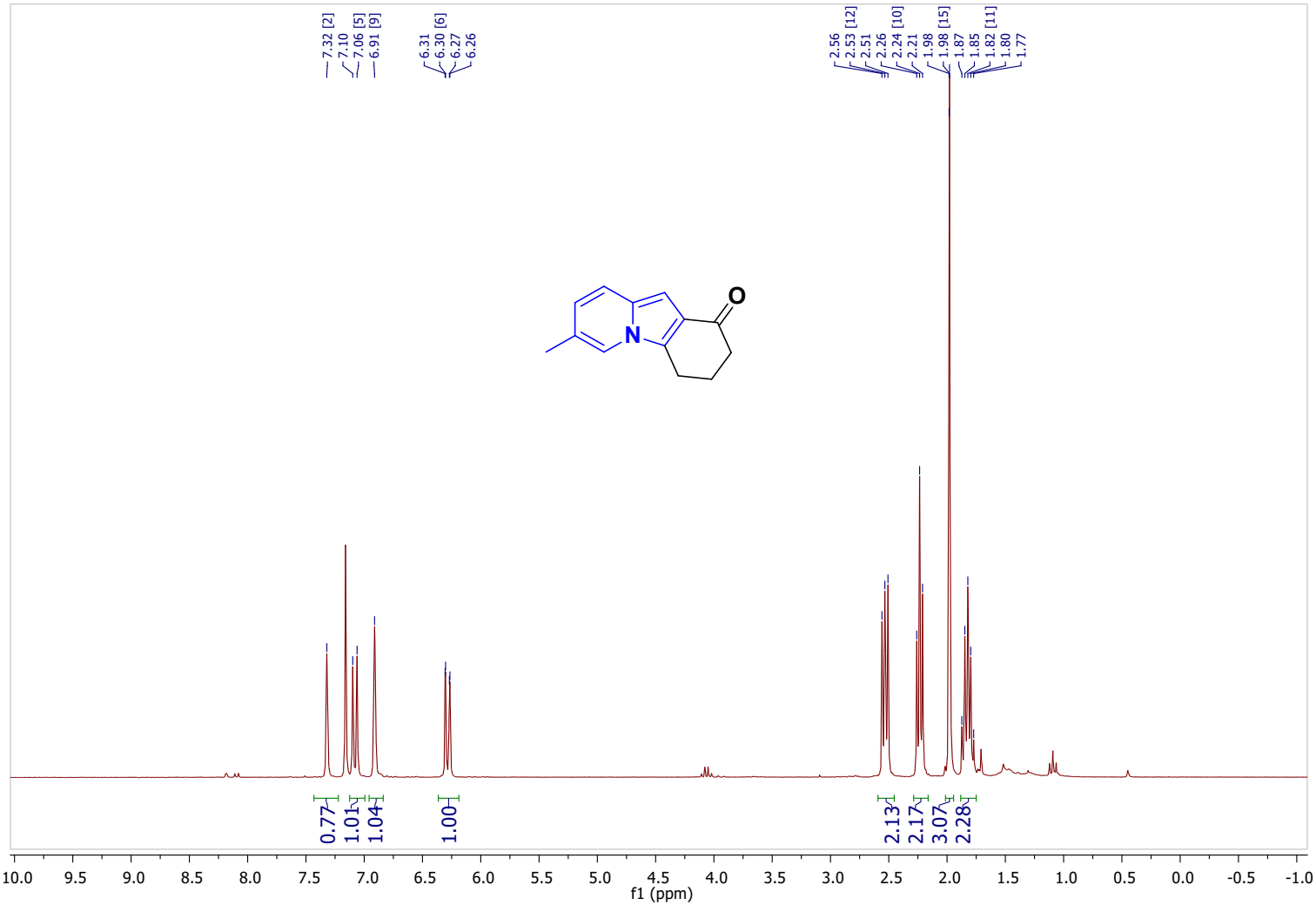


Figure S7. ^{1}H NMR spectrum (250 MHz, C_6D_6) of compound **5da**.

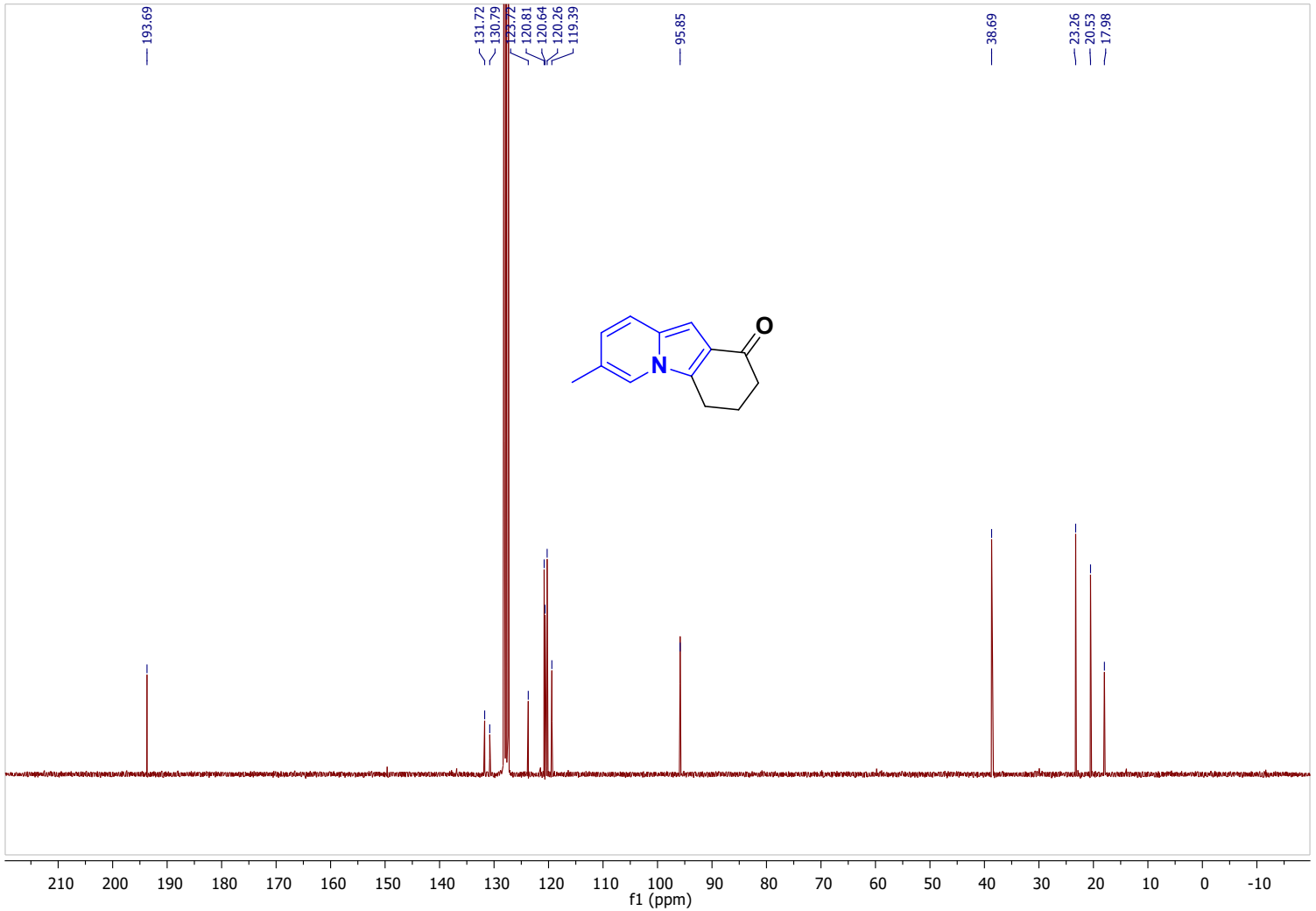


Figure S8. ^{13}C NMR spectrum (62.5 MHz, C_6D_6) of compound **5da**.

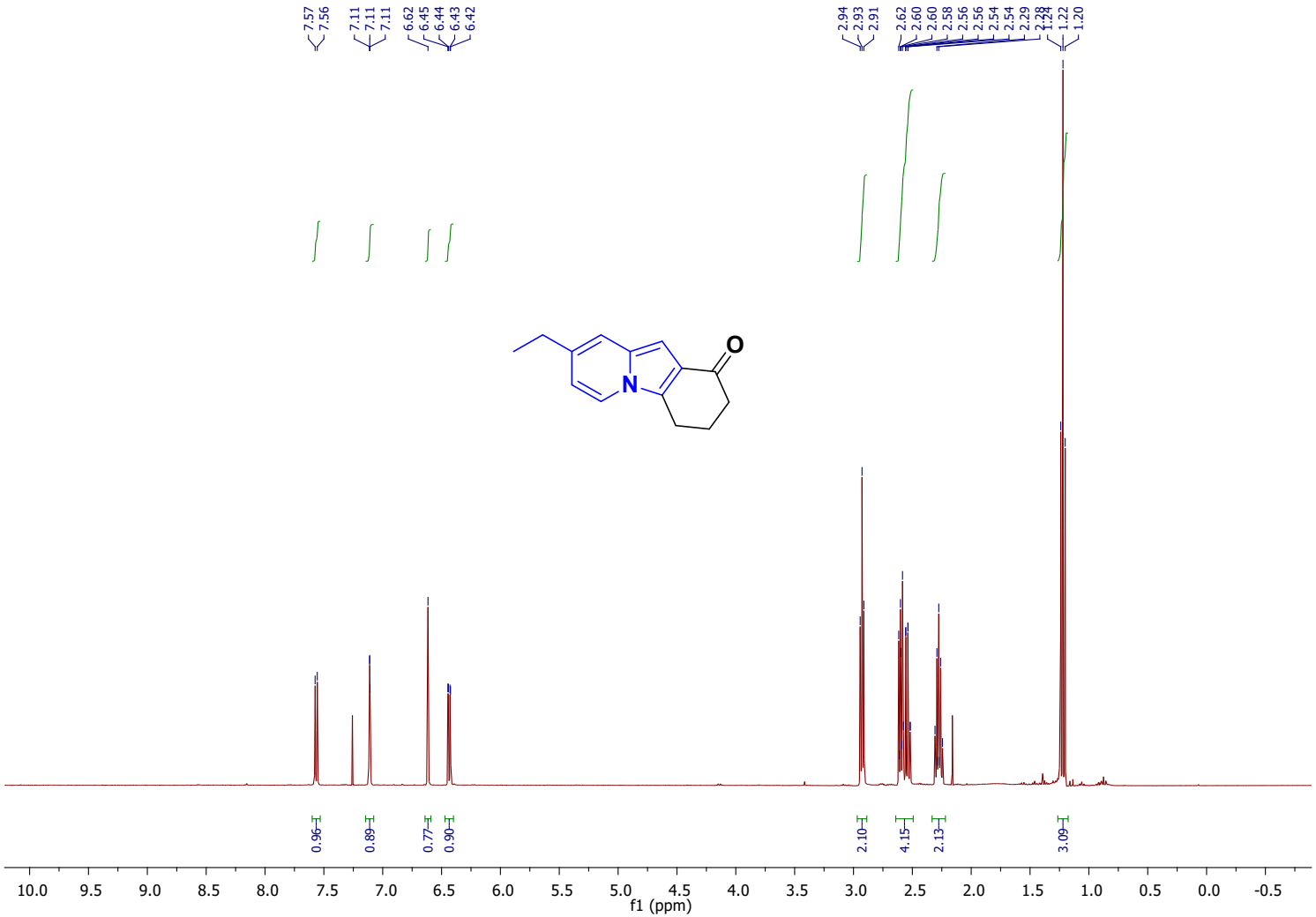


Figure S9. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **5ea**.

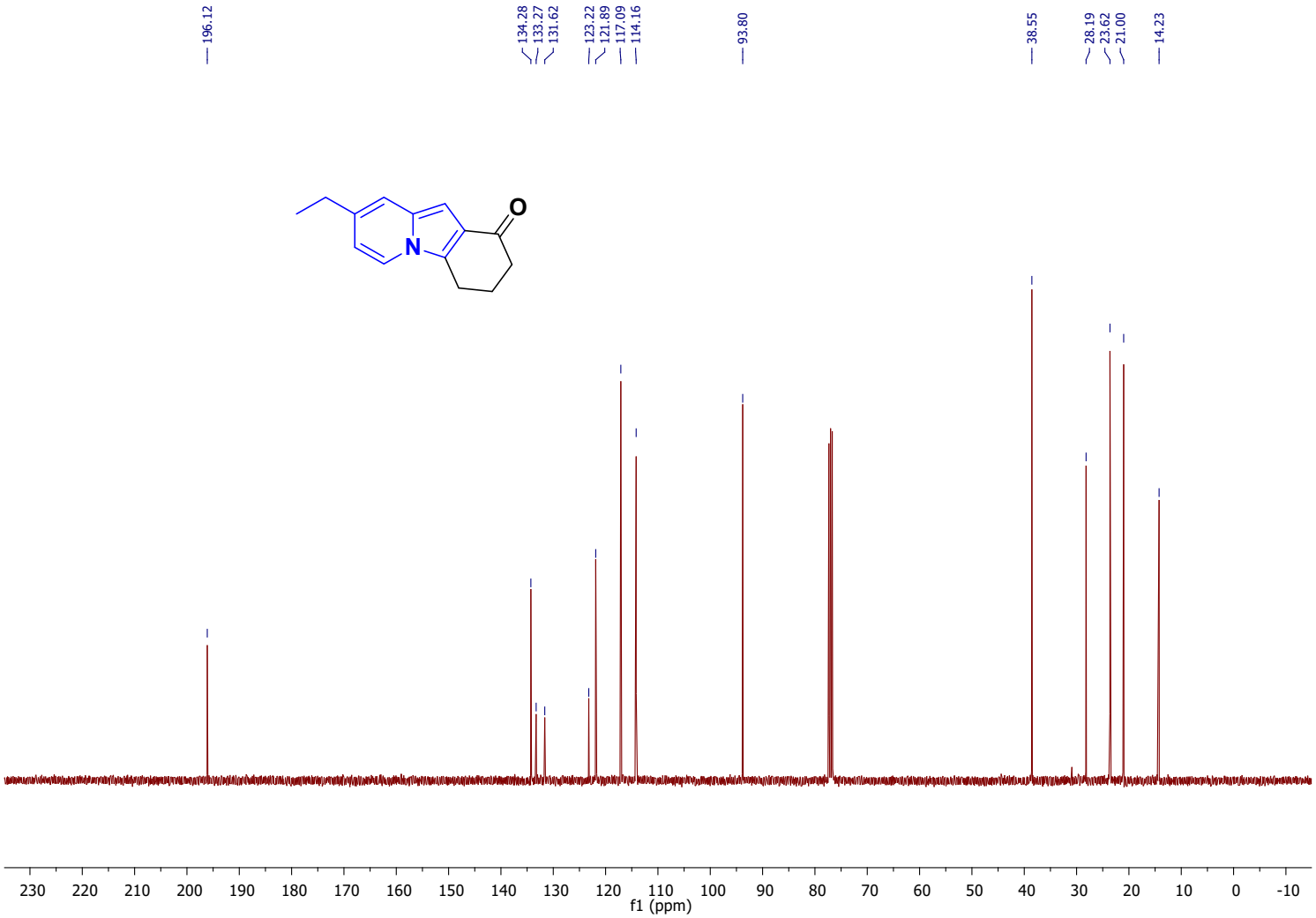


Figure S10. ^{13}C NMR spectrum (101 MHz, $CDCl_3$) of compound **5ea**.

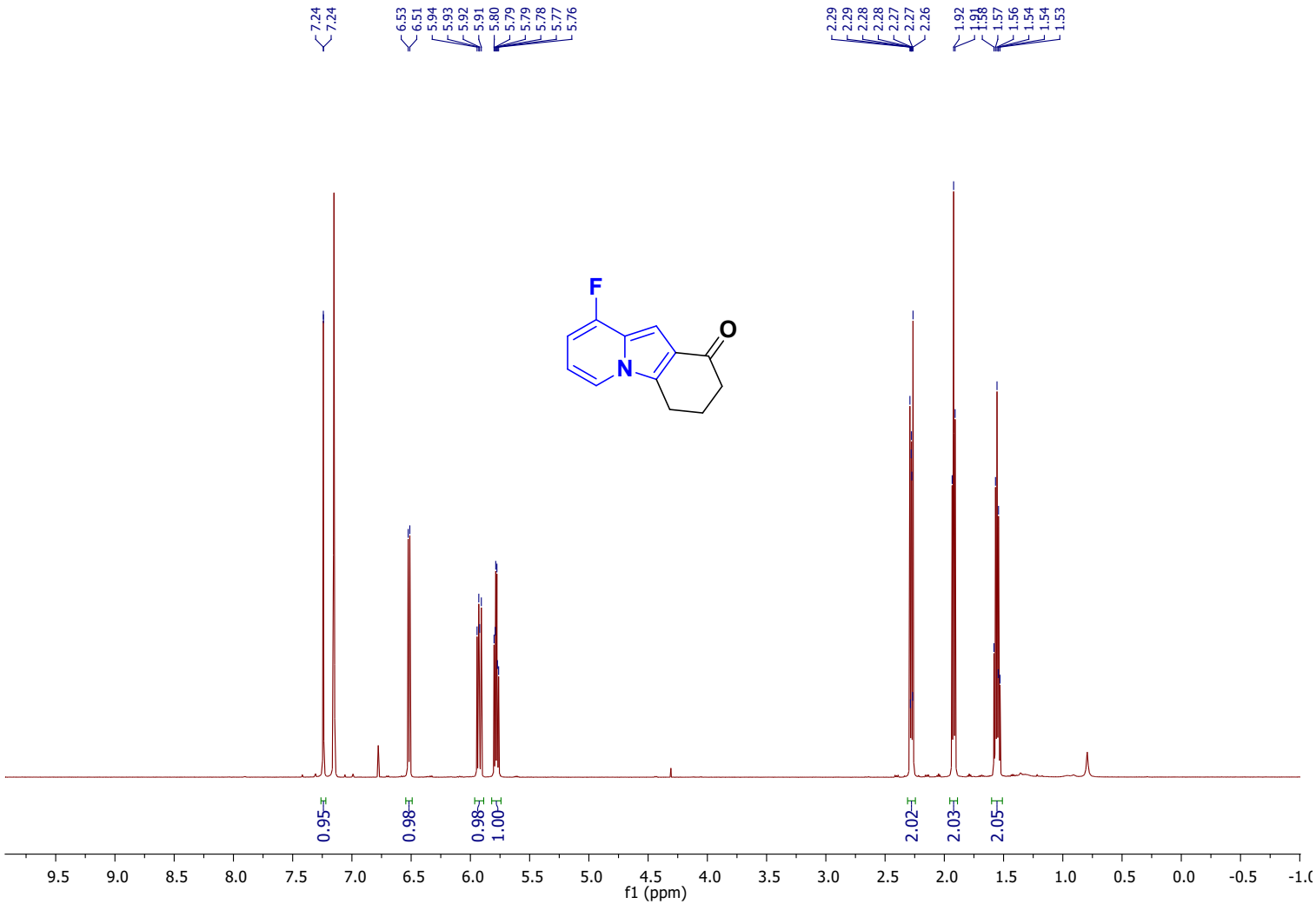


Figure S11. ^{1}H NMR spectrum (500 MHz, C_6D_6) of compound **5fa**.

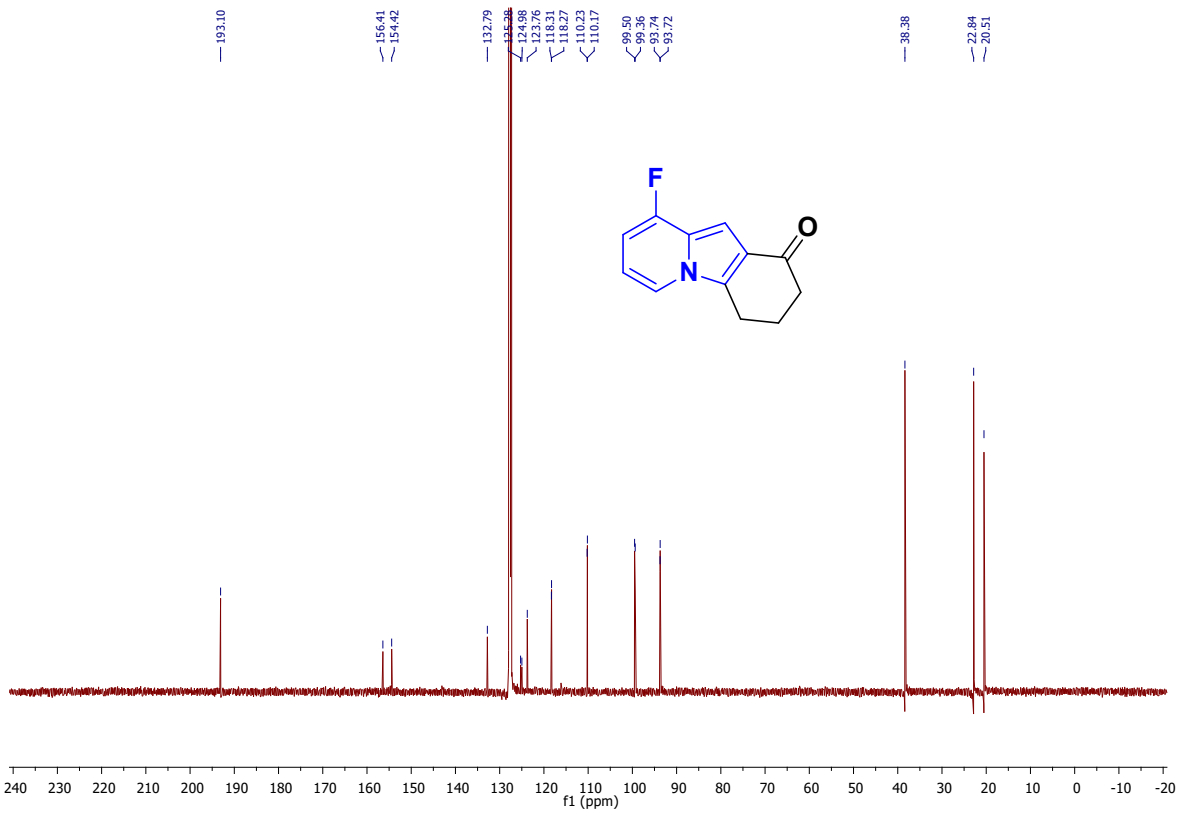


Figure S12. ^{13}C NMR spectrum (126 MHz, C_6D_6) of compound **5fa**.

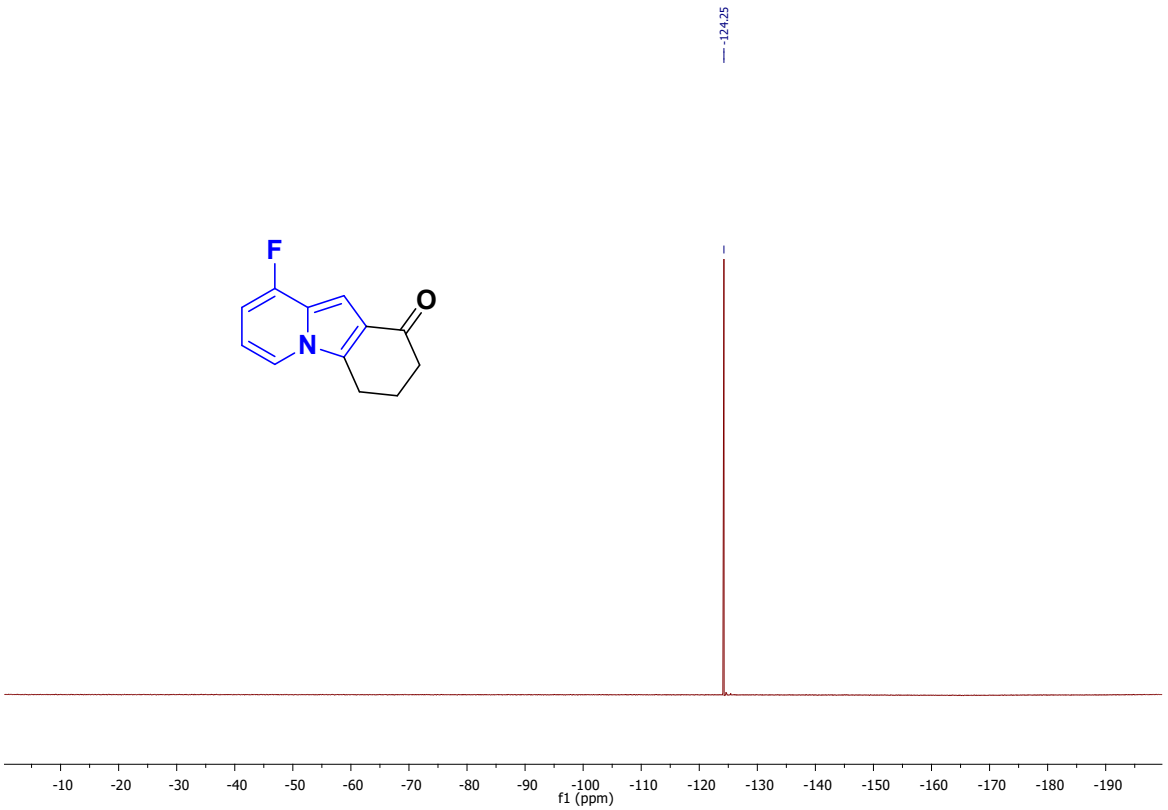


Figure S13. ^{19}F NMR spectrum (470 MHz, C_6D_6) of compound **5fa**.

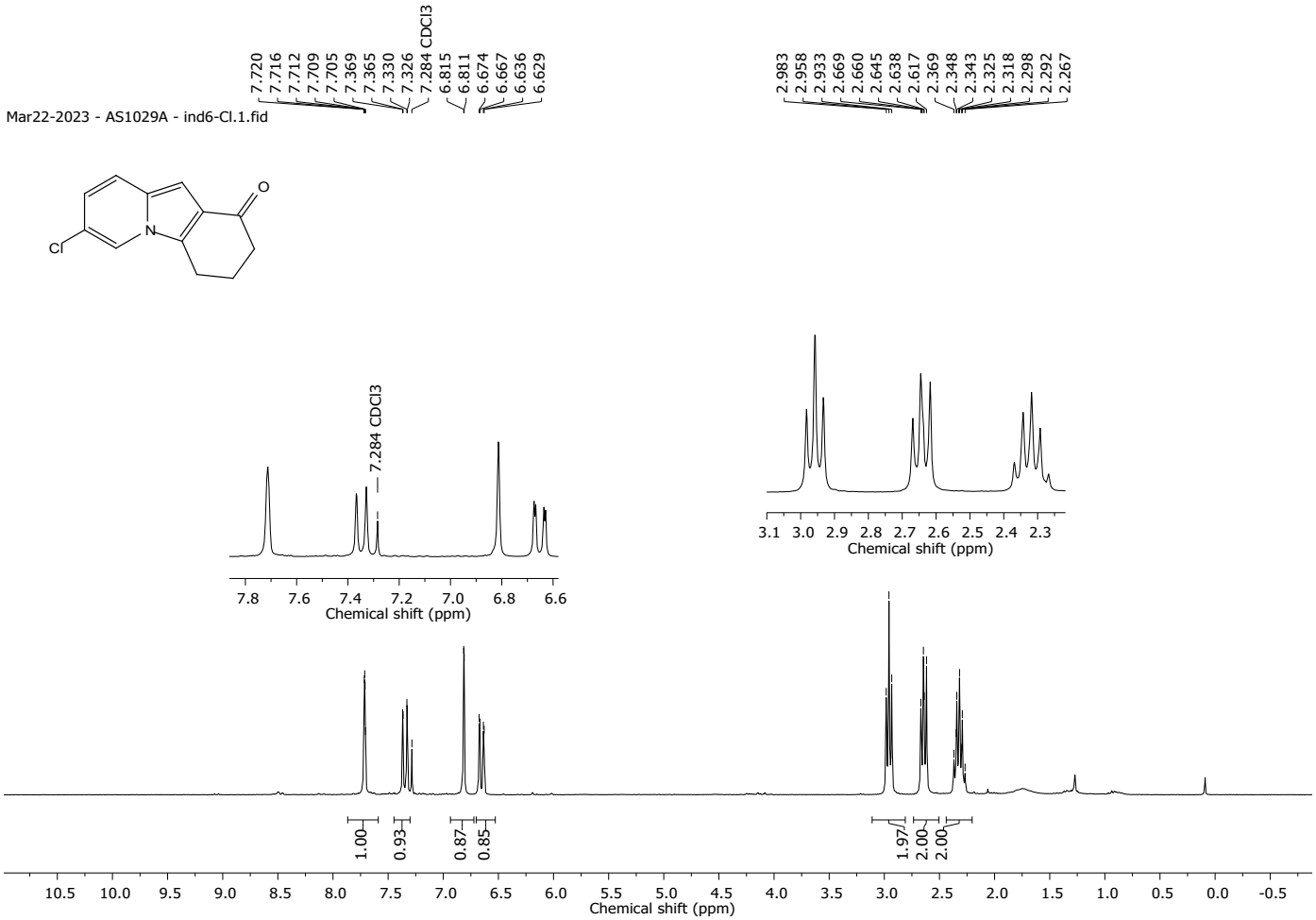


Figure S14. ^{1}H NMR spectrum (250 MHz, $CDCl_3$) of compound **5ga**.

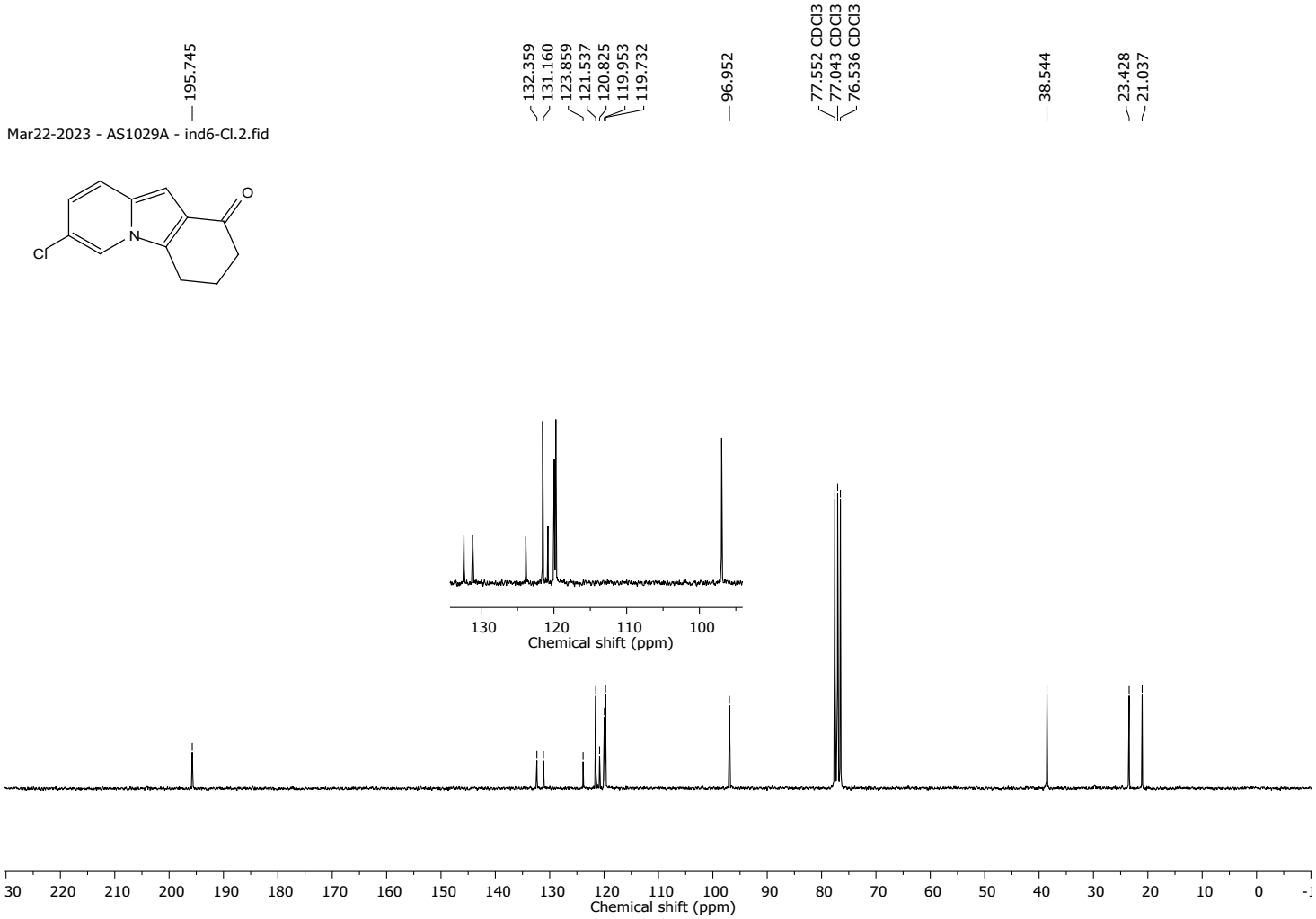


Figure S15. ^{13}C NMR spectrum (63 MHz, $CDCl_3$) of compound **5ga**.

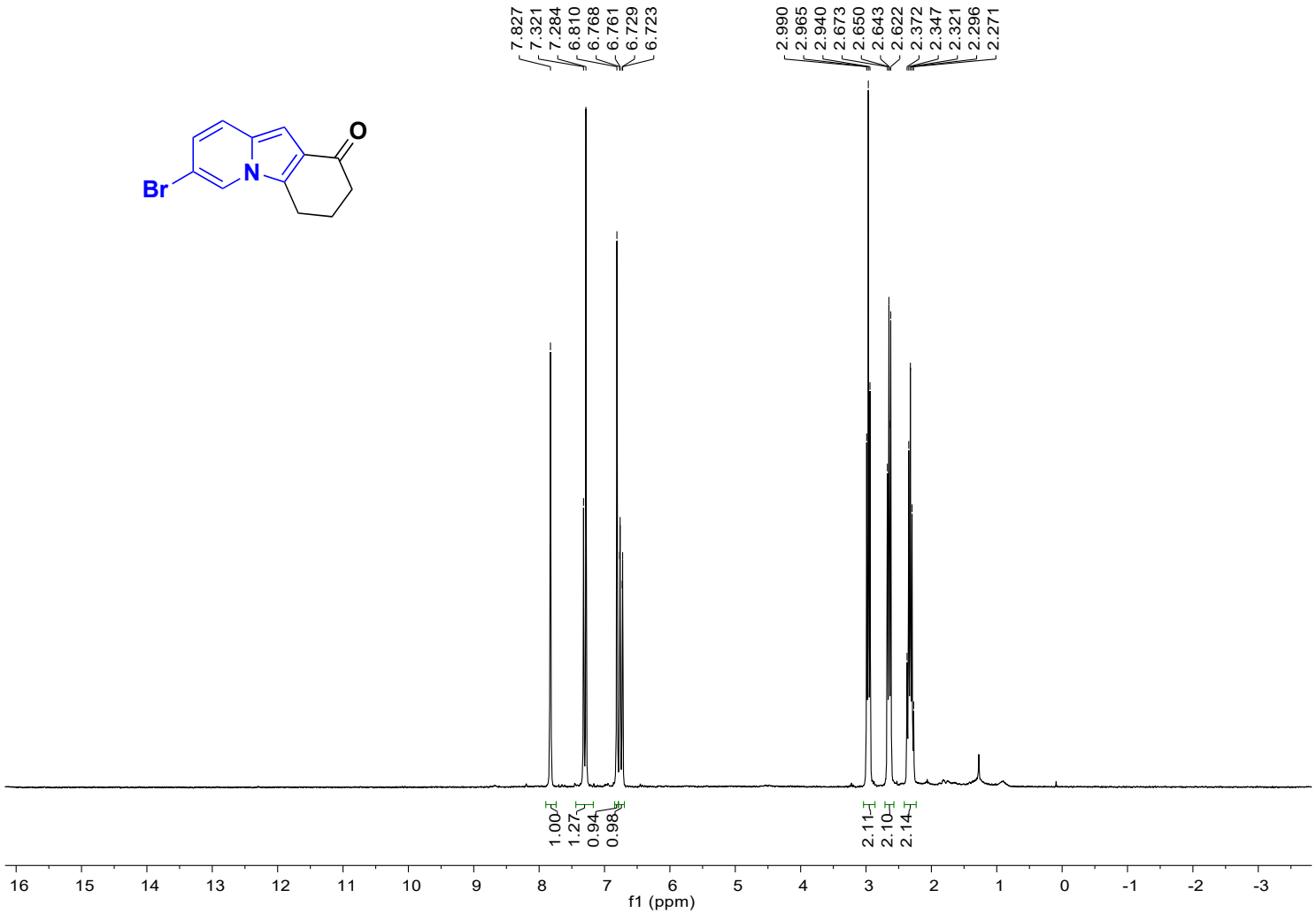


Figure S16. ^{1}H NMR spectrum (500 MHz, C_6D_6) of compound **5ia**.

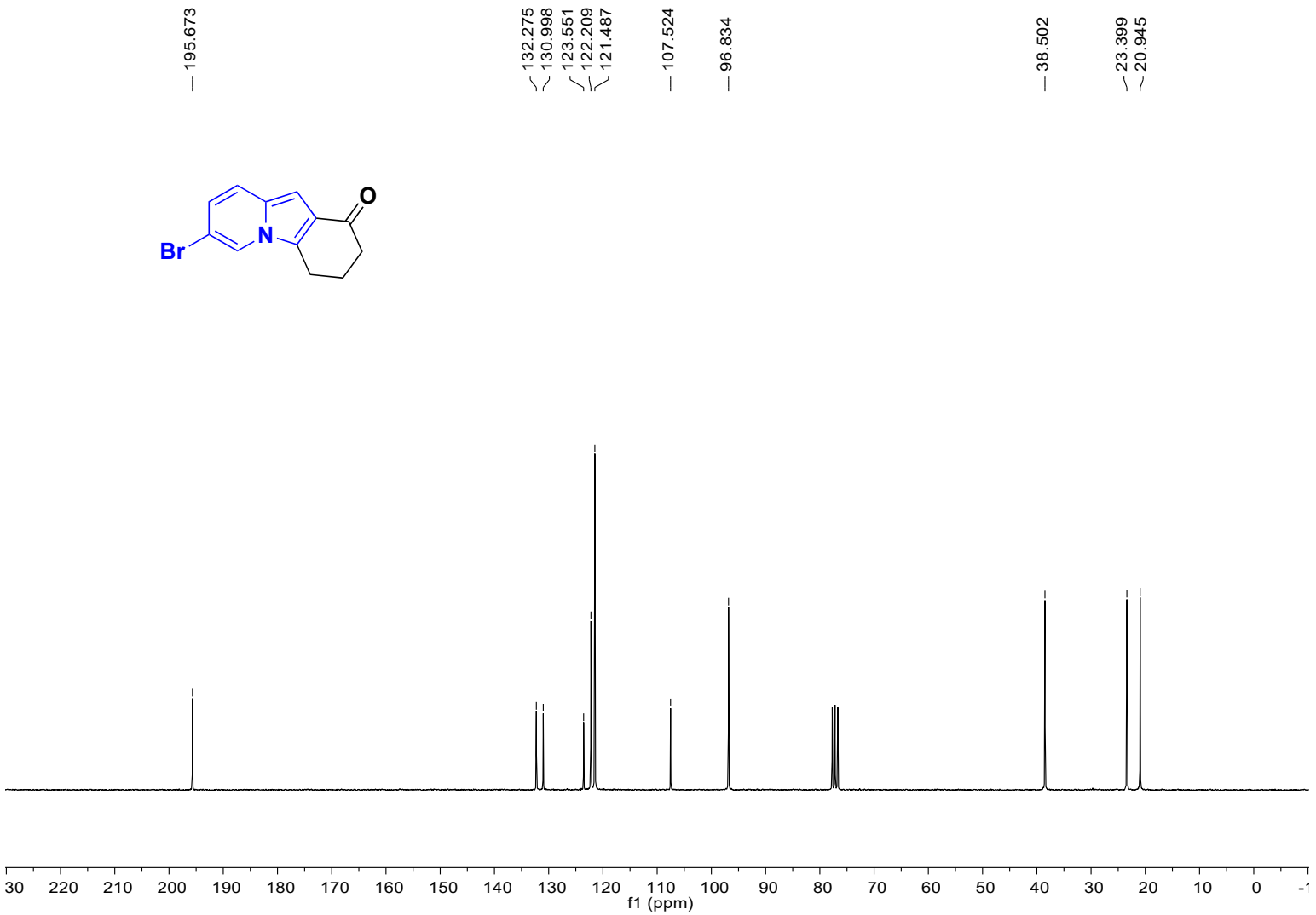


Figure S17. ^{13}C NMR spectrum (126 MHz, C_6D_6) of compound **5ia**.

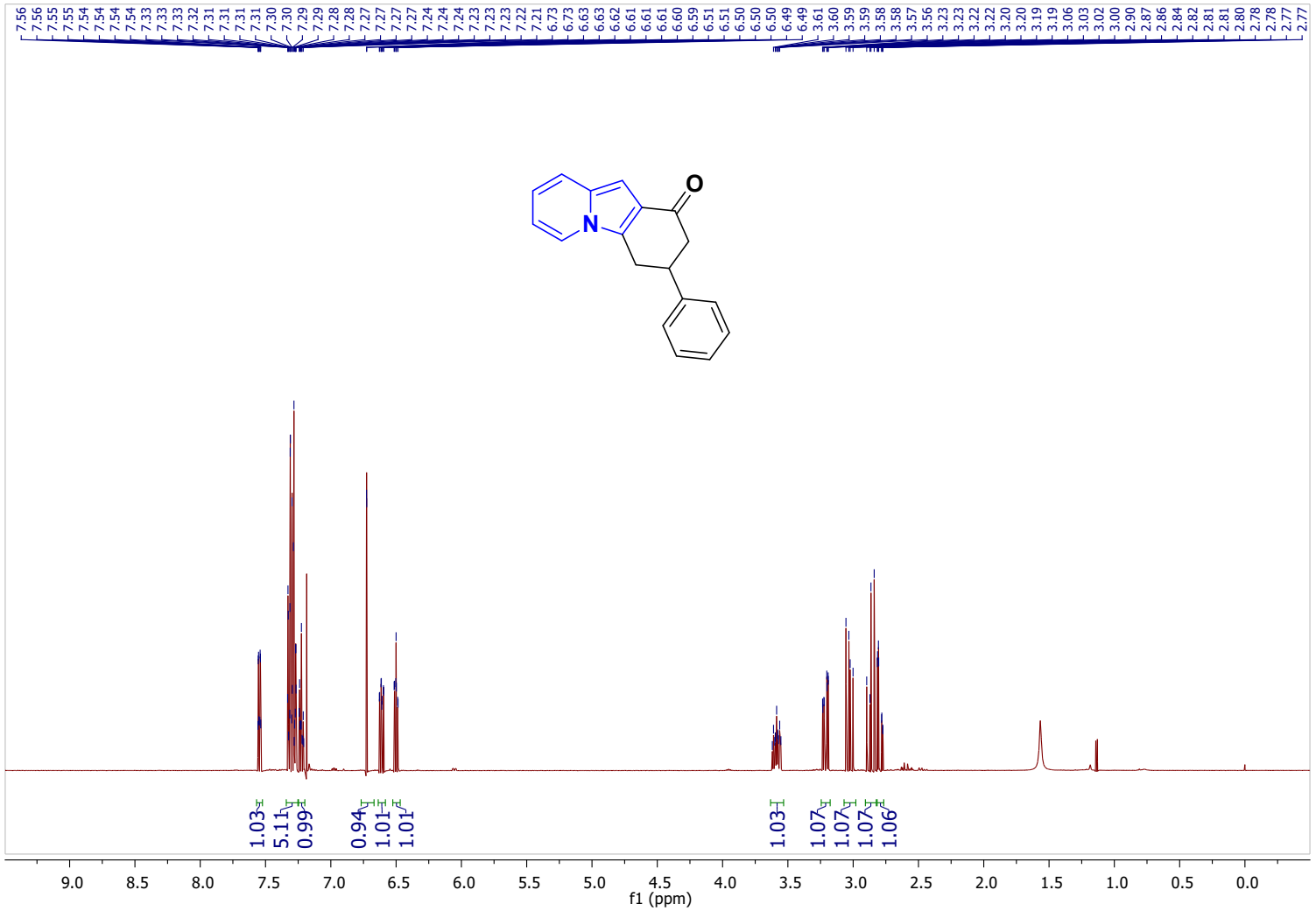


Figure S18. ^{1}H NMR spectrum (500 MHz, $CDCl_3$) of compound **5ae**.

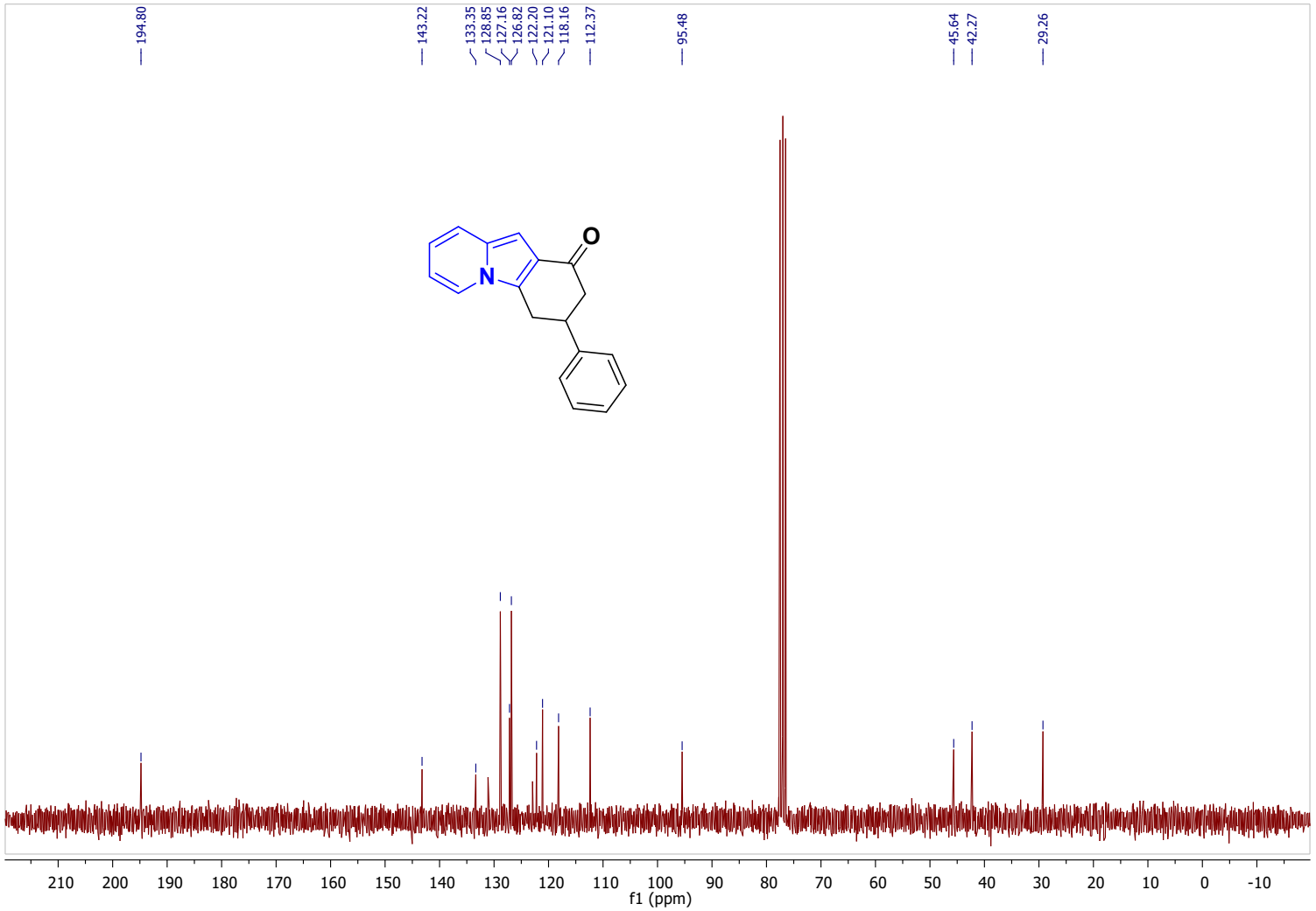


Figure S19. ^{13}C NMR spectrum (63 MHz, $CDCl_3$) of compound **5ae**.

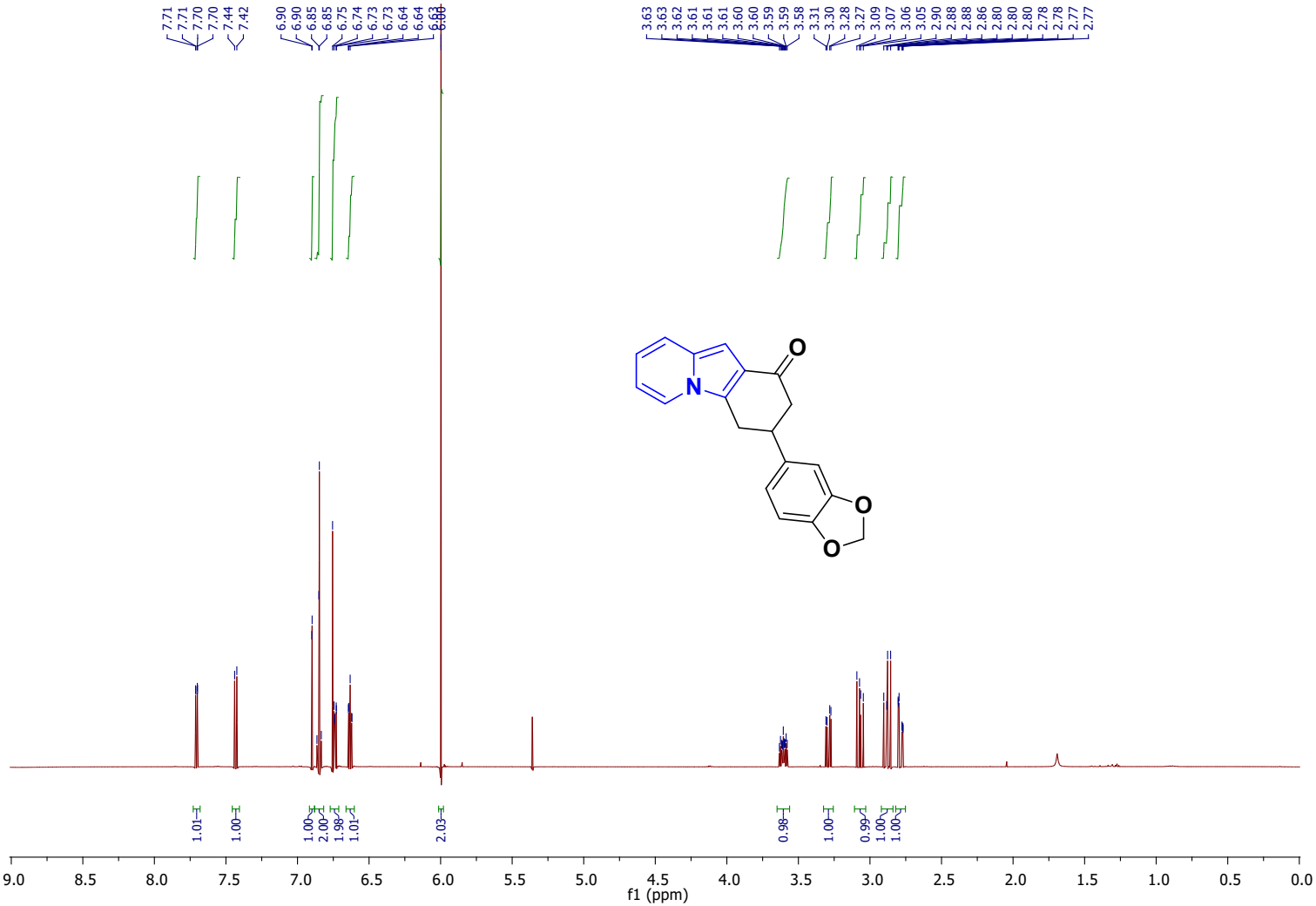


Figure S20. ^{1}H NMR spectrum (600 MHz, CD_2Cl_2) of compound **5af**.

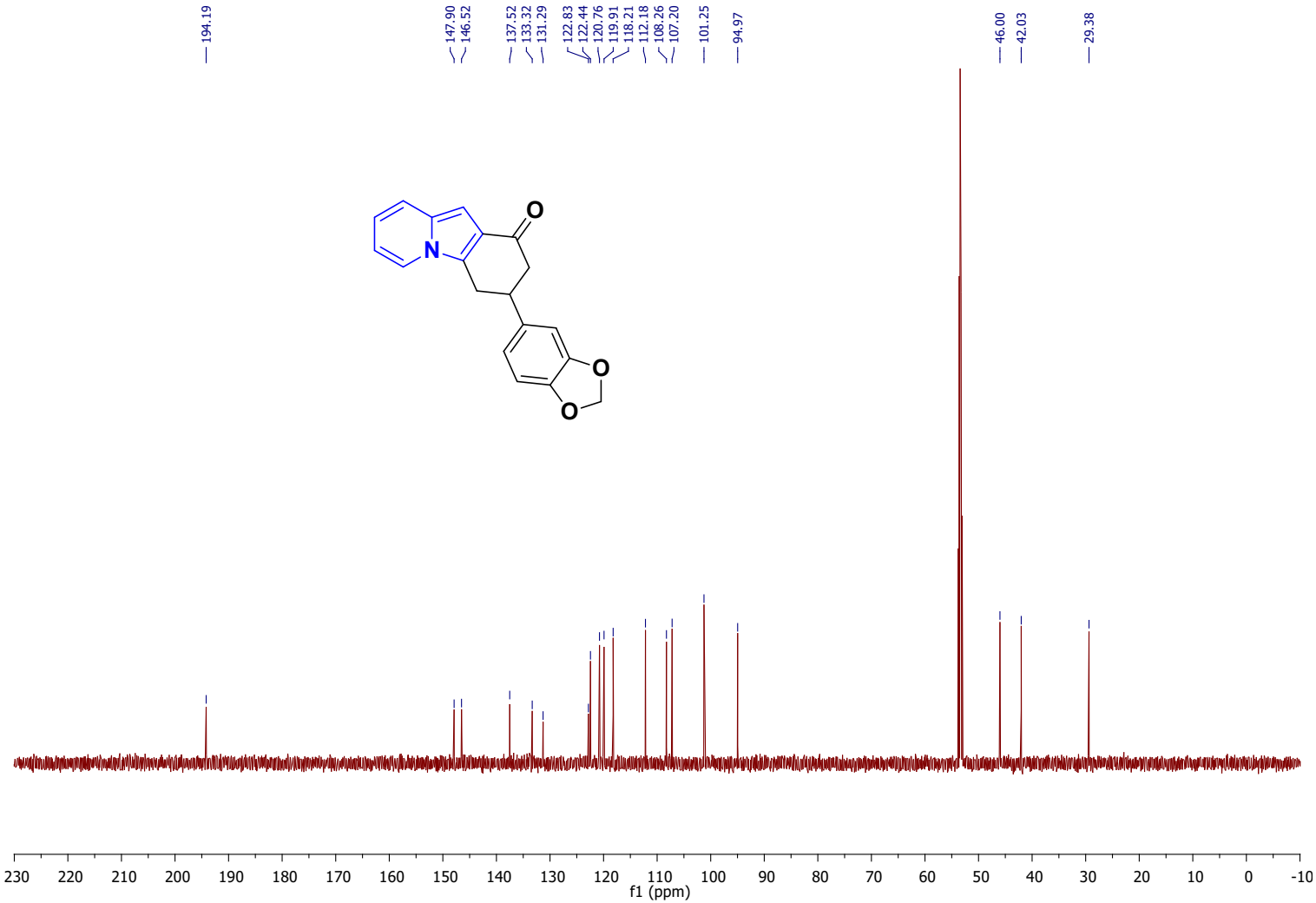


Figure S21. ^{13}C NMR spectrum (151 MHz, CD_2Cl_2) of compound **5af**.

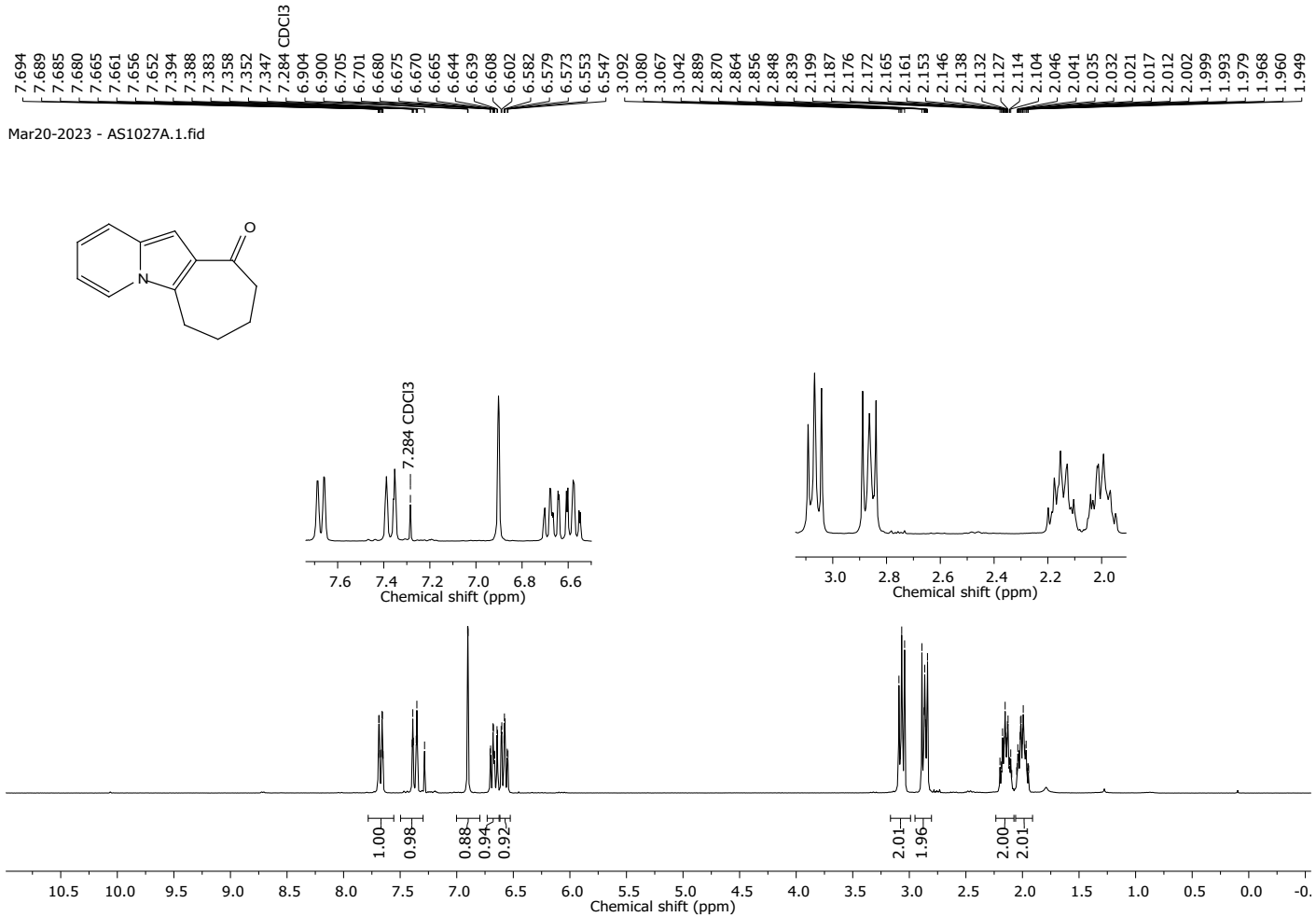


Figure S22. ^{1}H NMR spectrum (250 MHz, $CDCl_3$) of compound **5ac**.

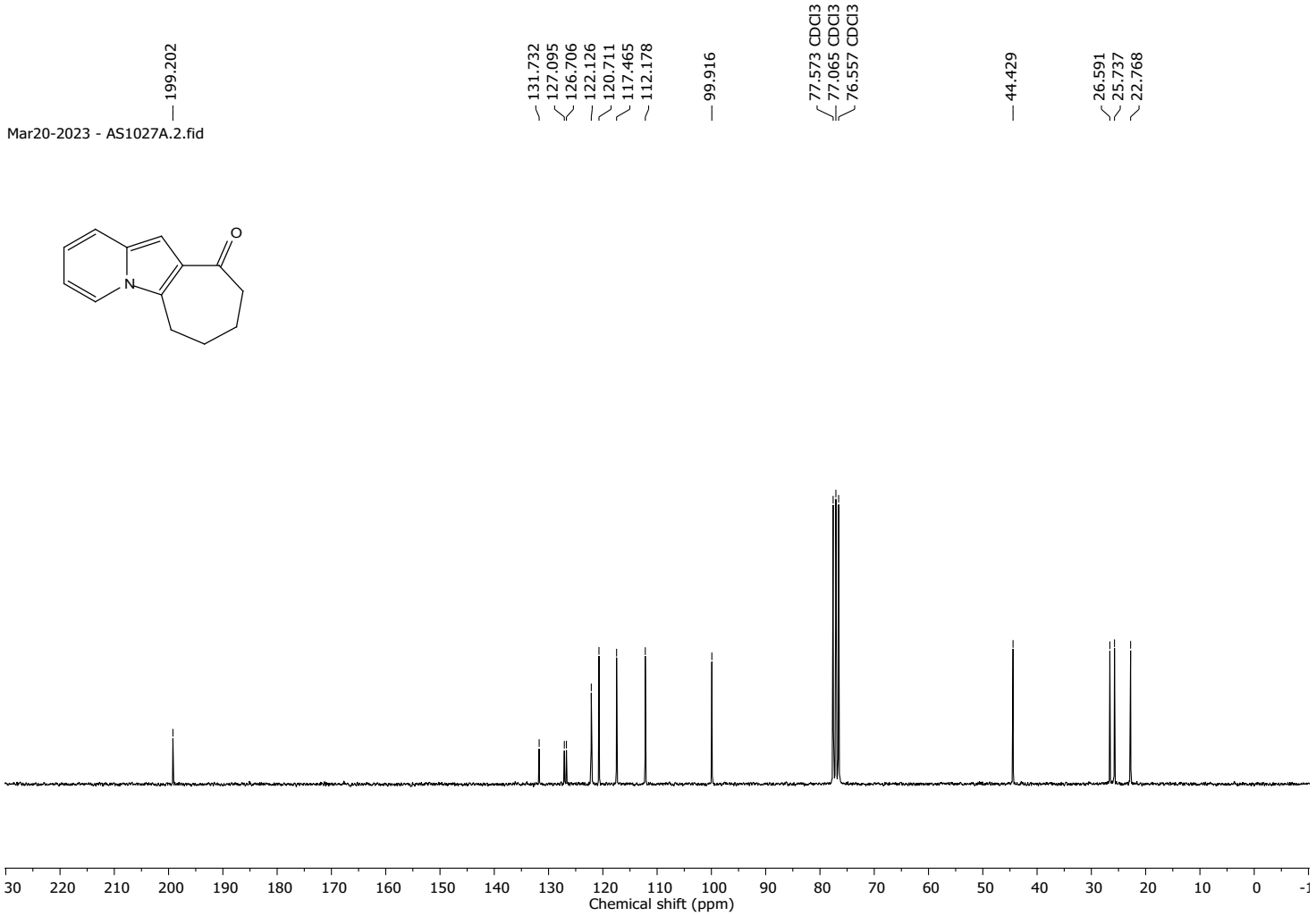


Figure S23. ^{13}C NMR spectrum (63 MHz, $CDCl_3$) of compound **5ac**.

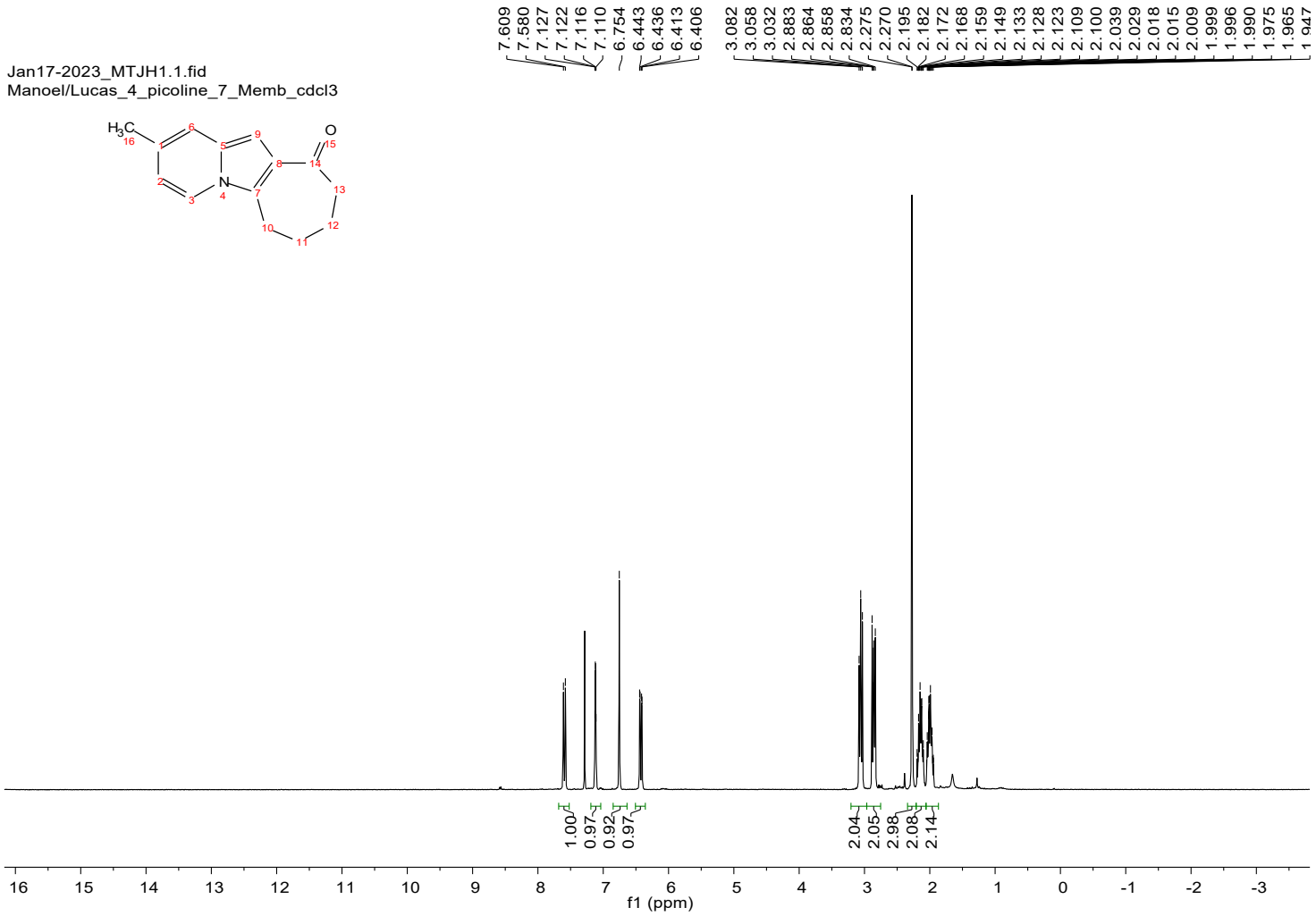


Figure S24. ^{1}H NMR spectrum (250 MHz, $CDCl_3$) of compound **5bc**.

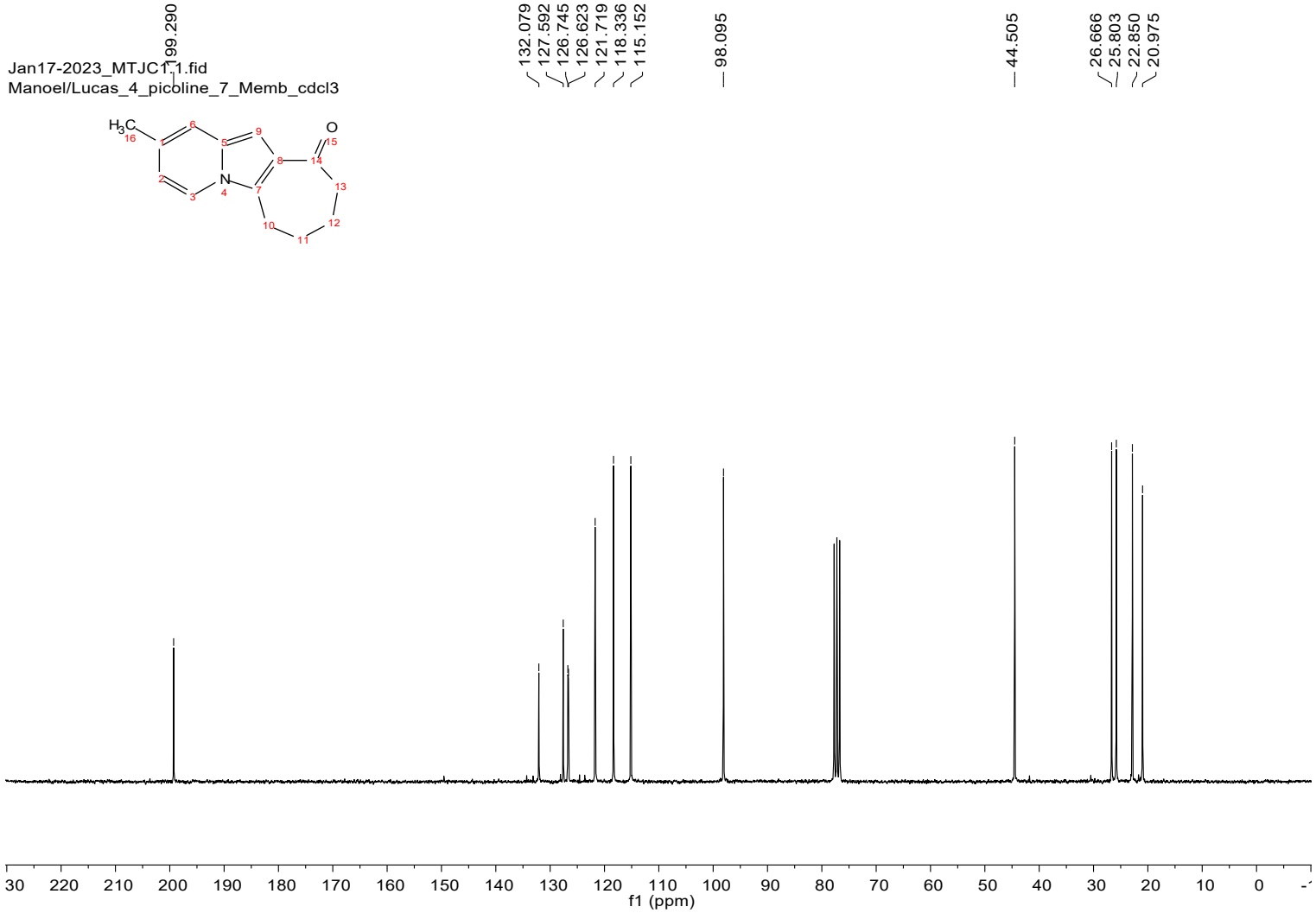


Figure S25. ^{13}C NMR spectrum (63 MHz, $CDCl_3$) of compound **5bc**.

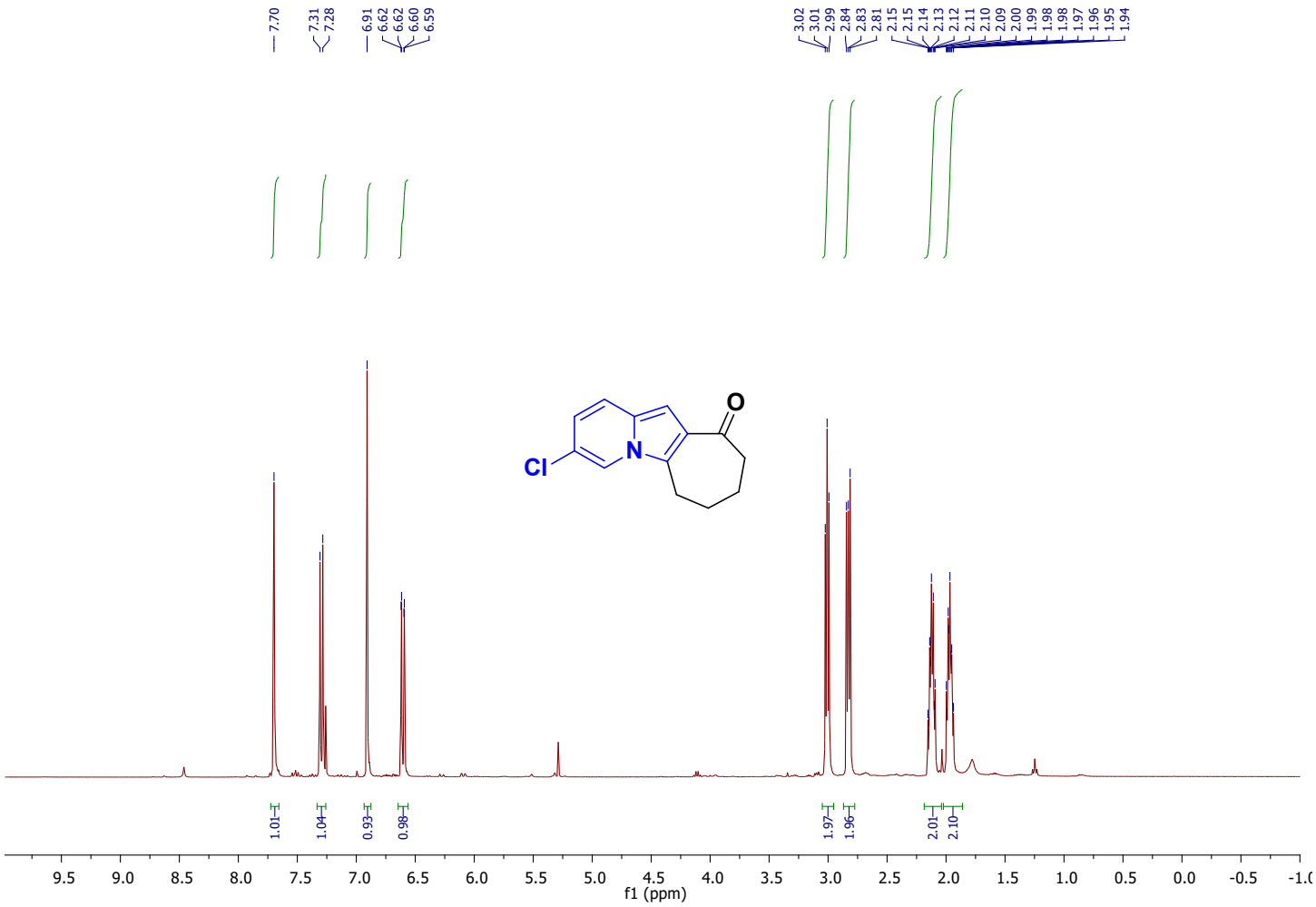


Figure S26. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **5gc**.

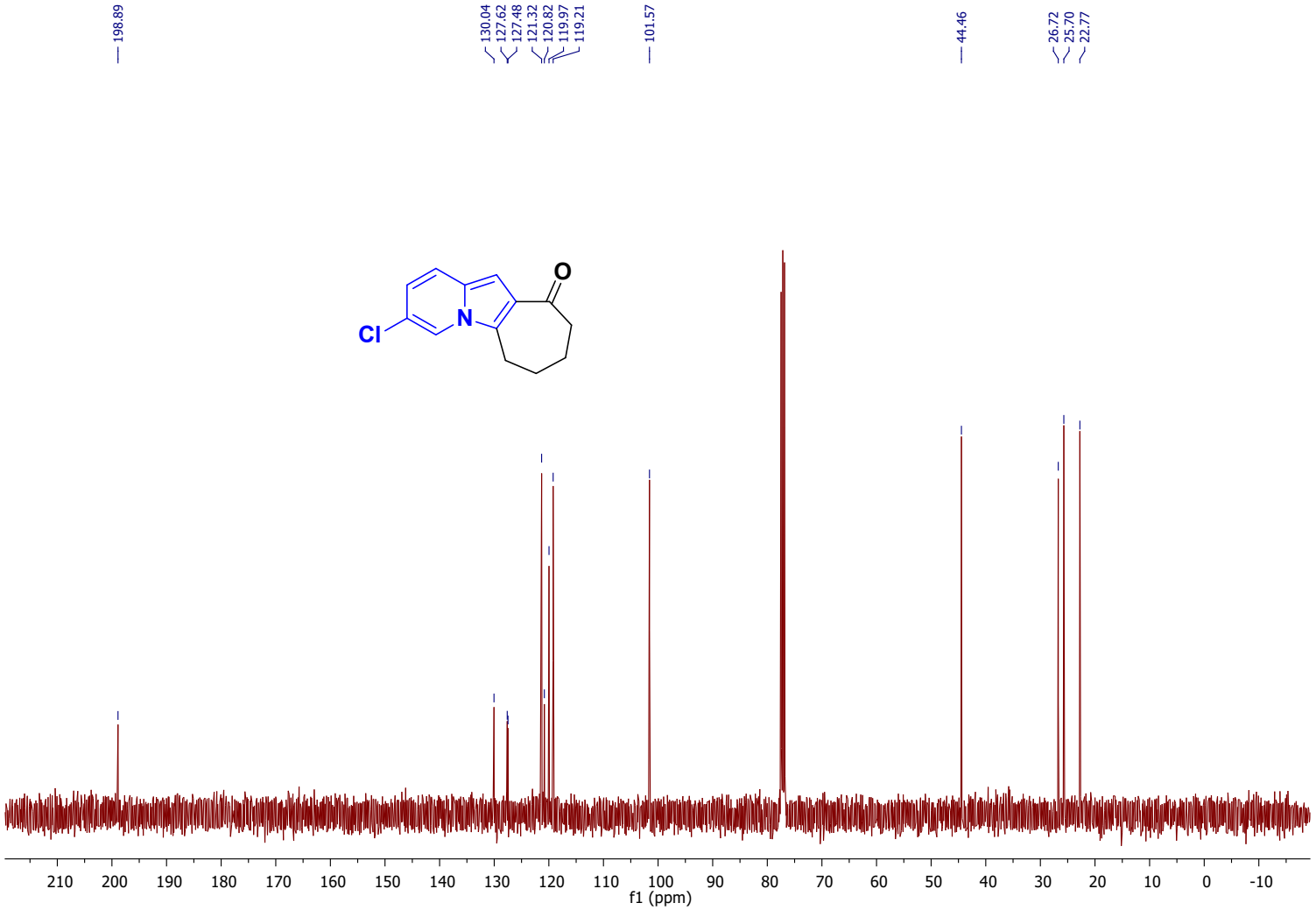


Figure S27. ^{13}C NMR spectrum (101 MHz, $CDCl_3$) of compound **5gc**.

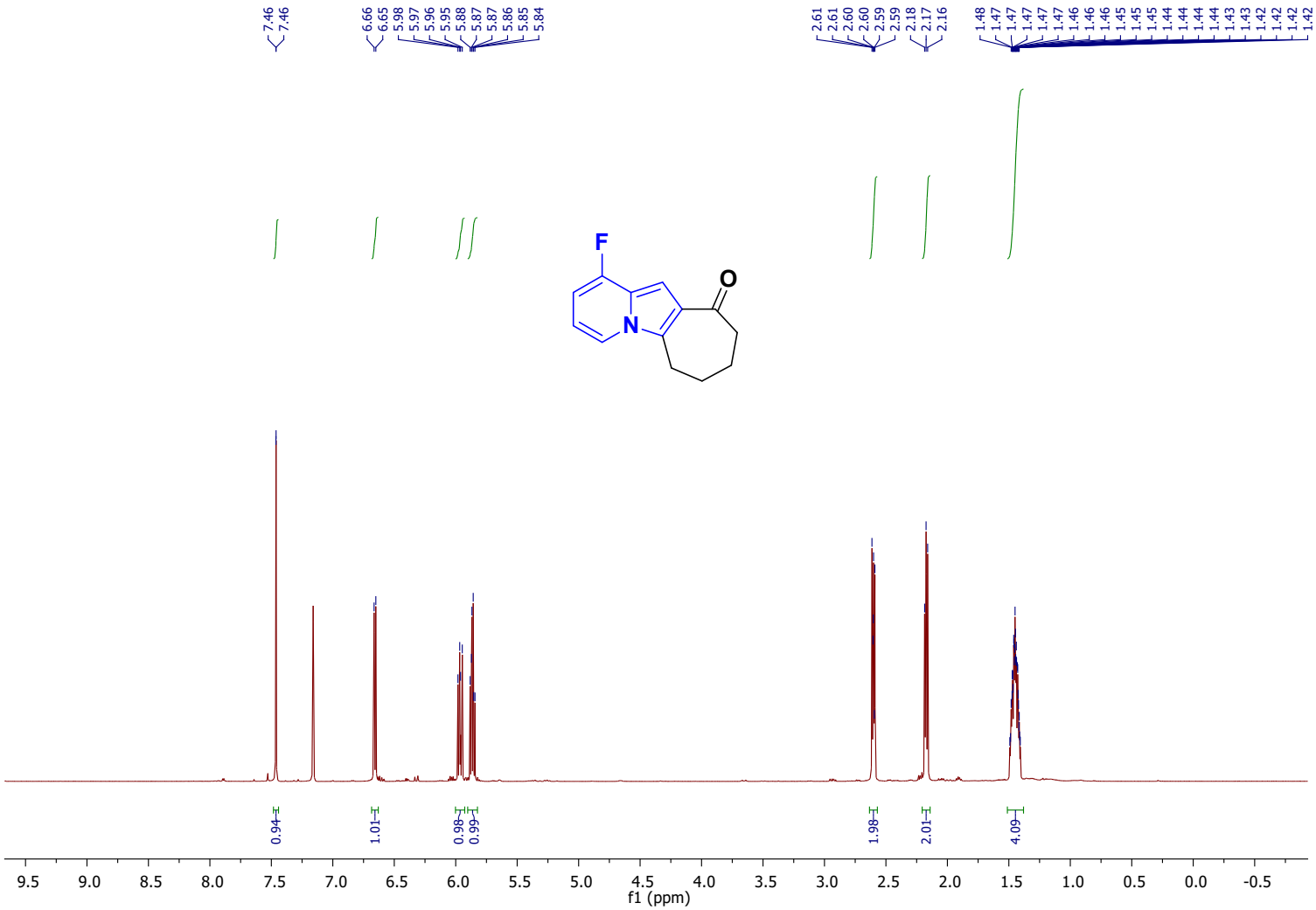


Figure S28. ^{1}H NMR spectrum (500 MHz, C_6D_6) of compound **5fc.**

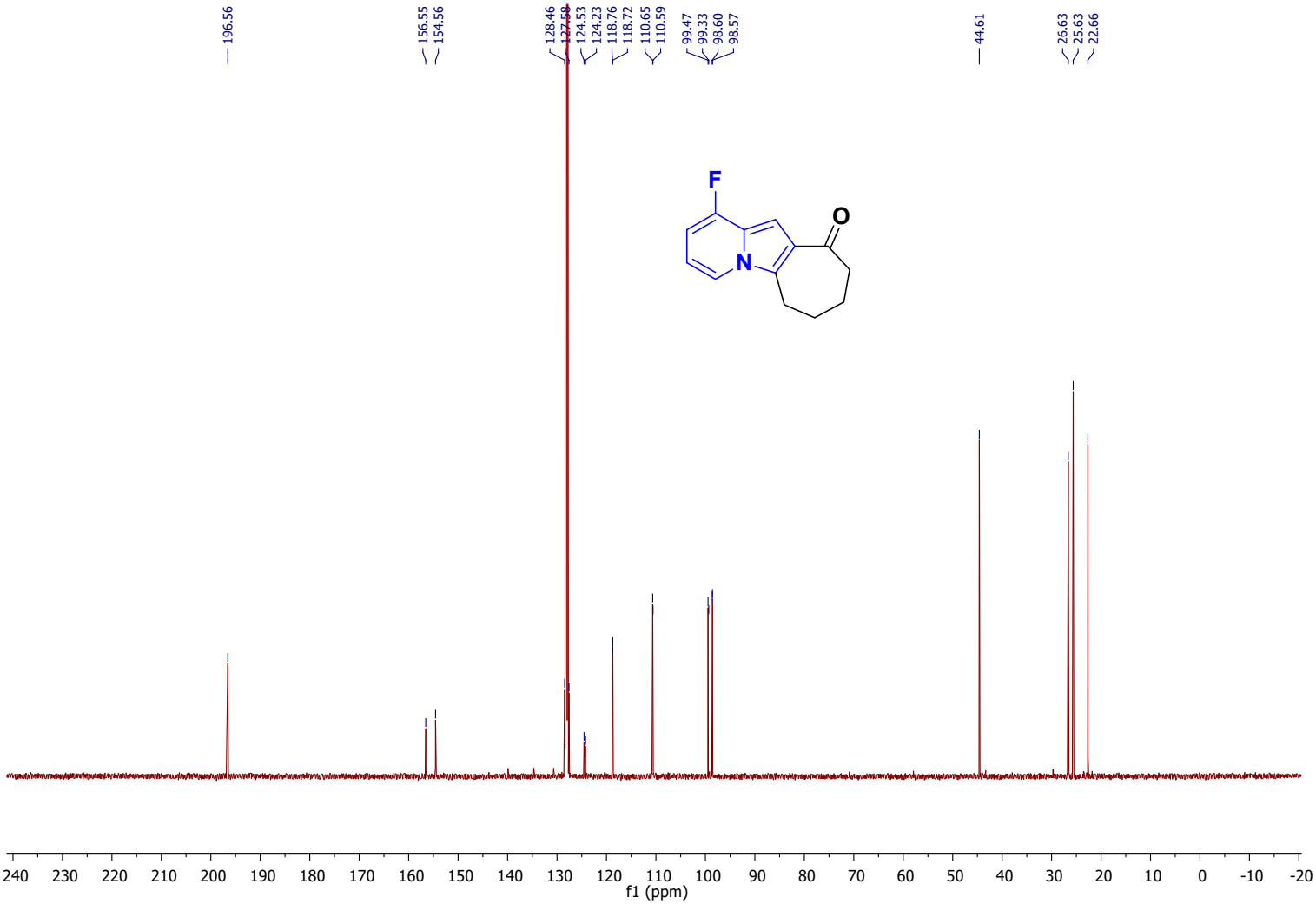


Figure S29. ^{13}C NMR spectrum (126 MHz, C_6D_6) of compound **5fc.**

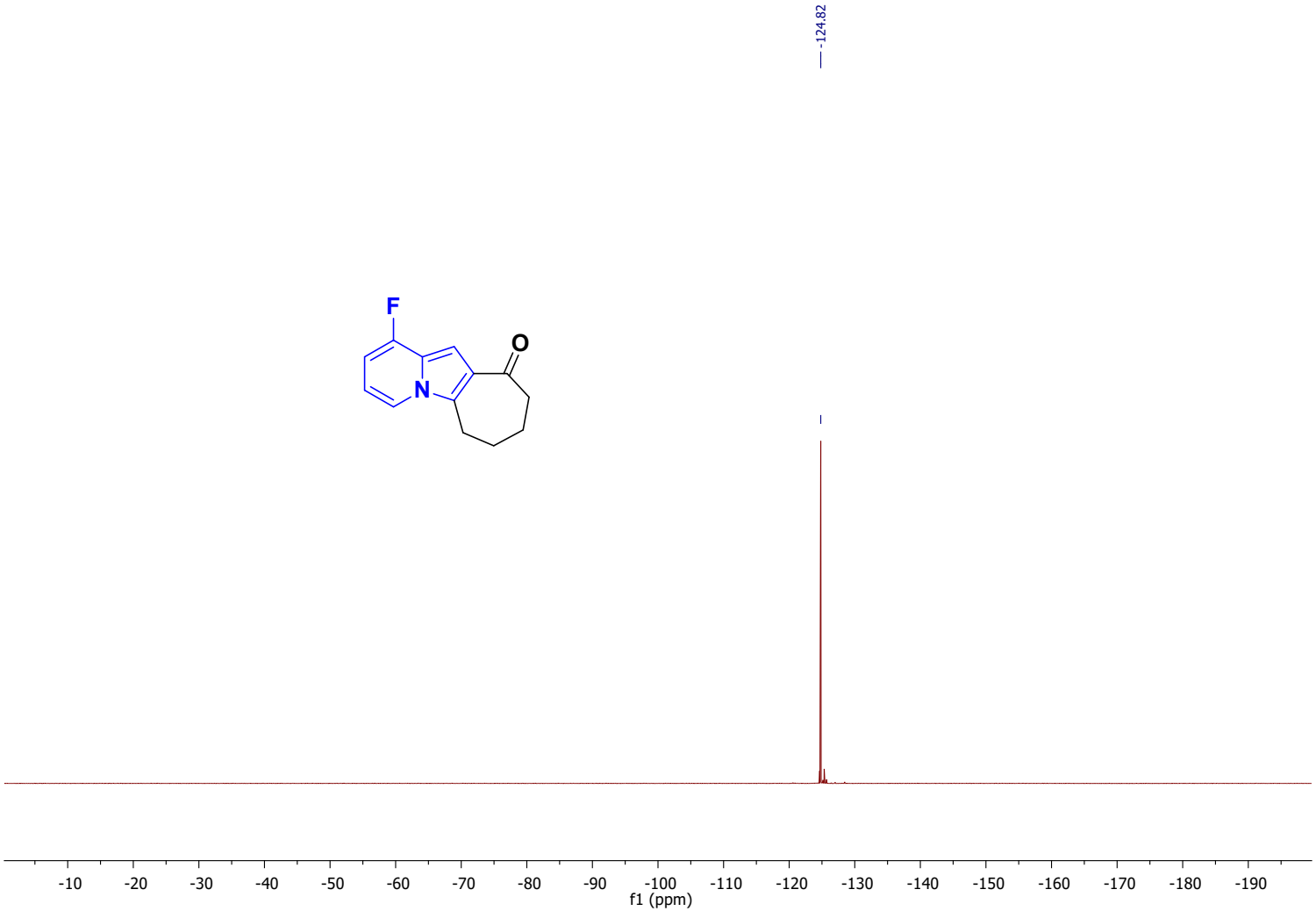


Figure S30. ^{19}F NMR spectrum (470 MHz, C_6D_6) of compound **5fc**.

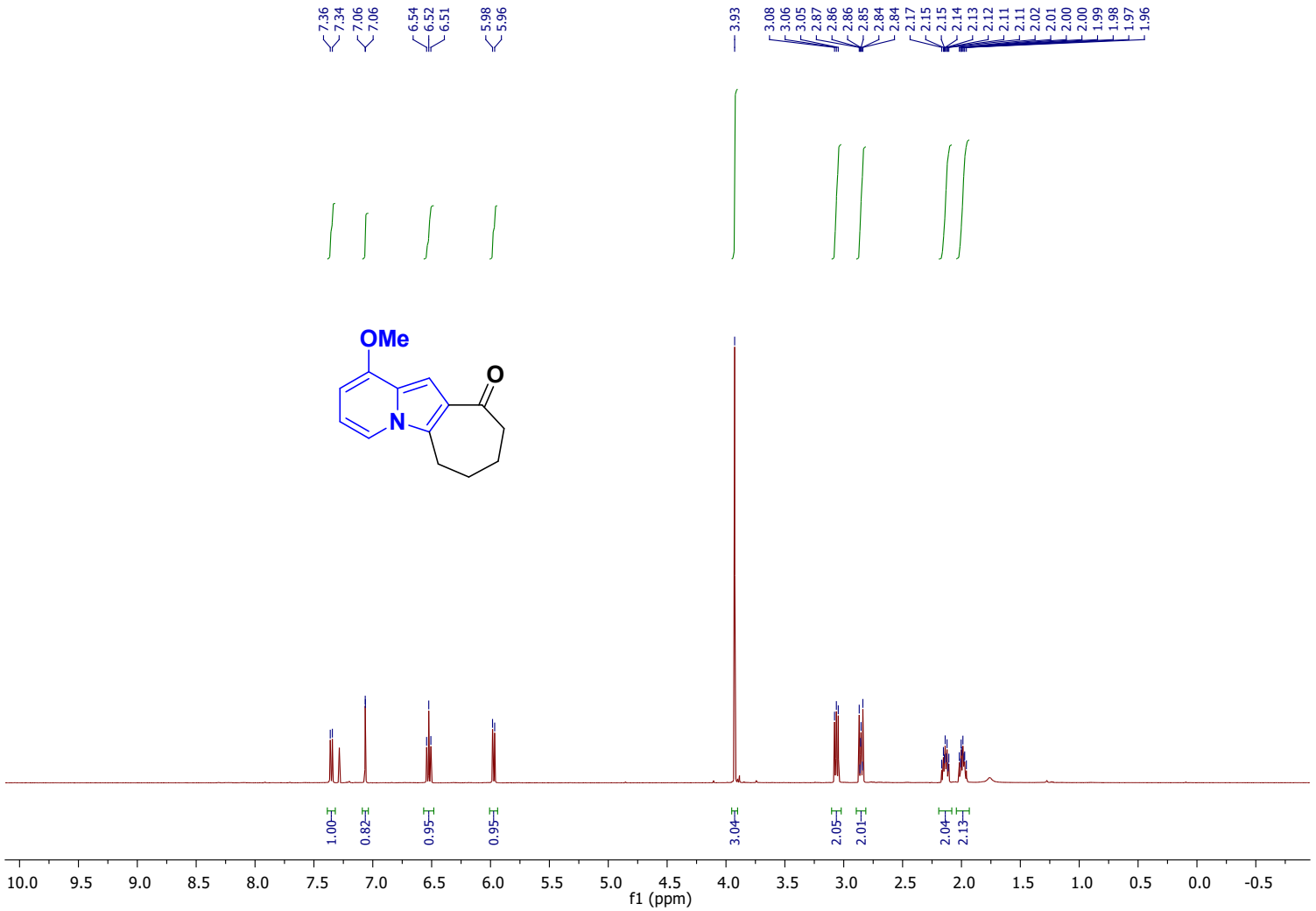


Figure S31. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **5cc.**

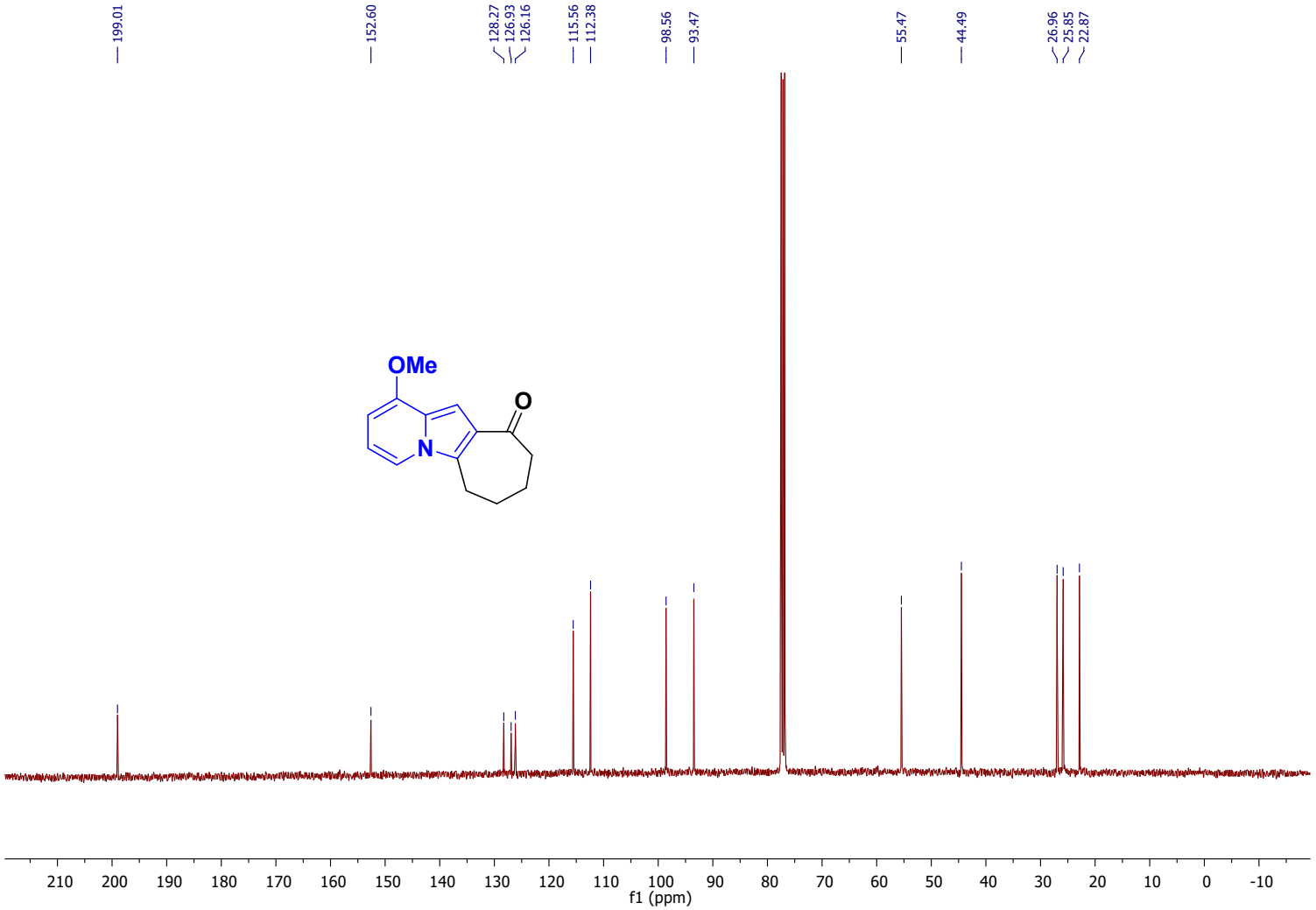


Figure 32. ^{13}C NMR spectrum (101 MHz, $CDCl_3$) of compound **5cc.**

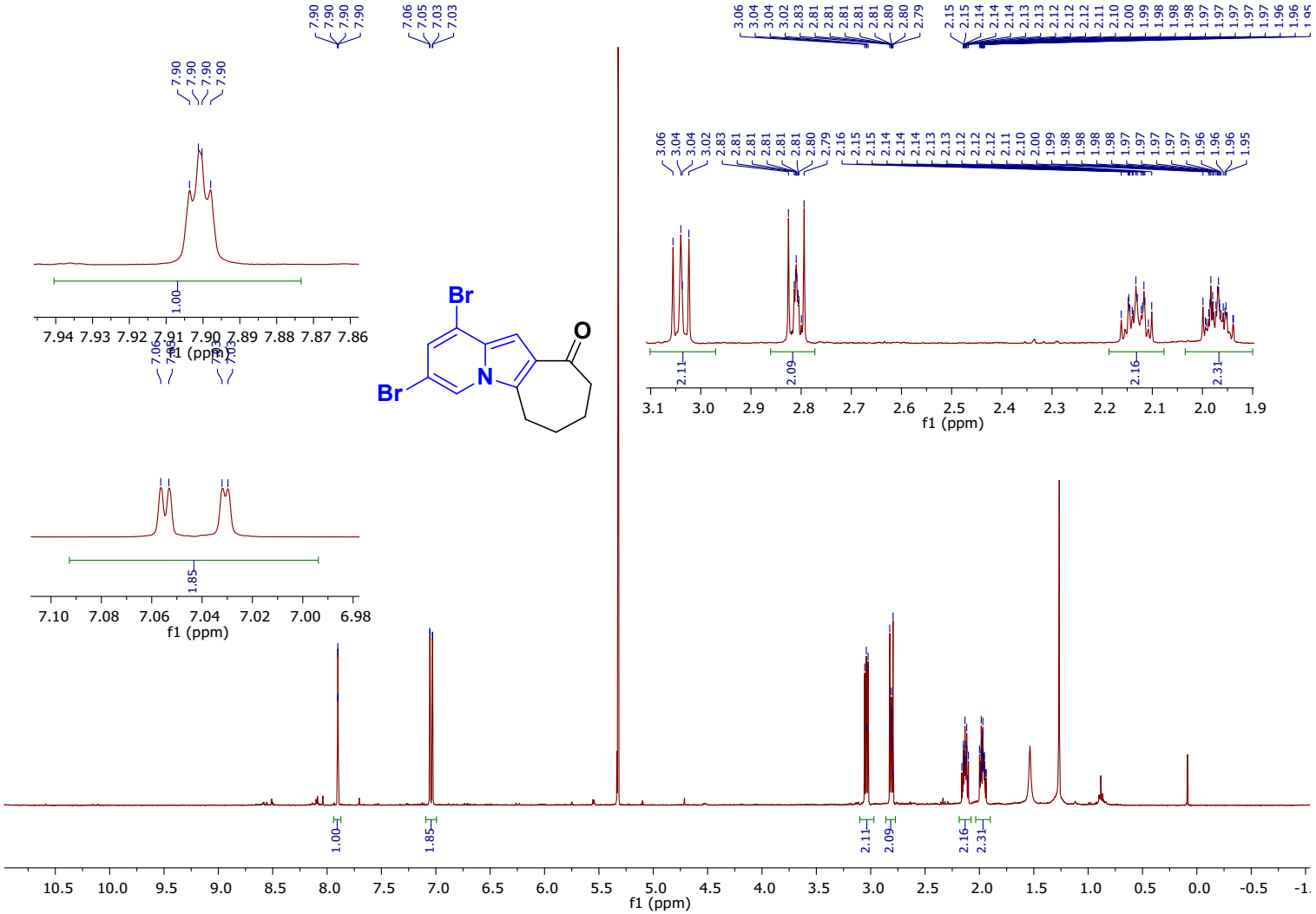


Figure S33. ^{1}H NMR spectrum (400 MHz, CD_2Cl_2) of compound **5hc.**

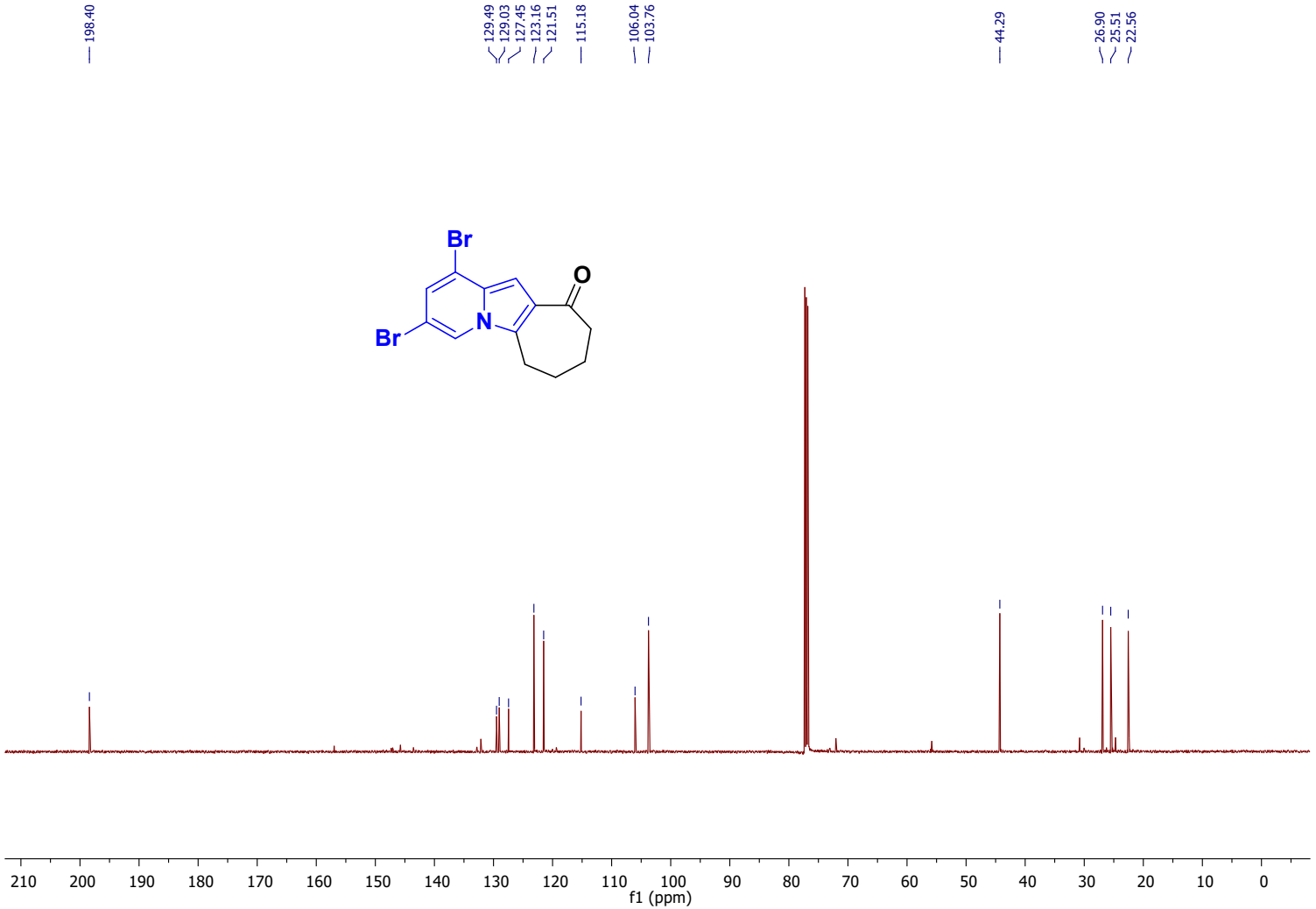


Figure S34. ^{13}C NMR spectrum (126 MHz, $CDCl_3$) of compound **5hc.**

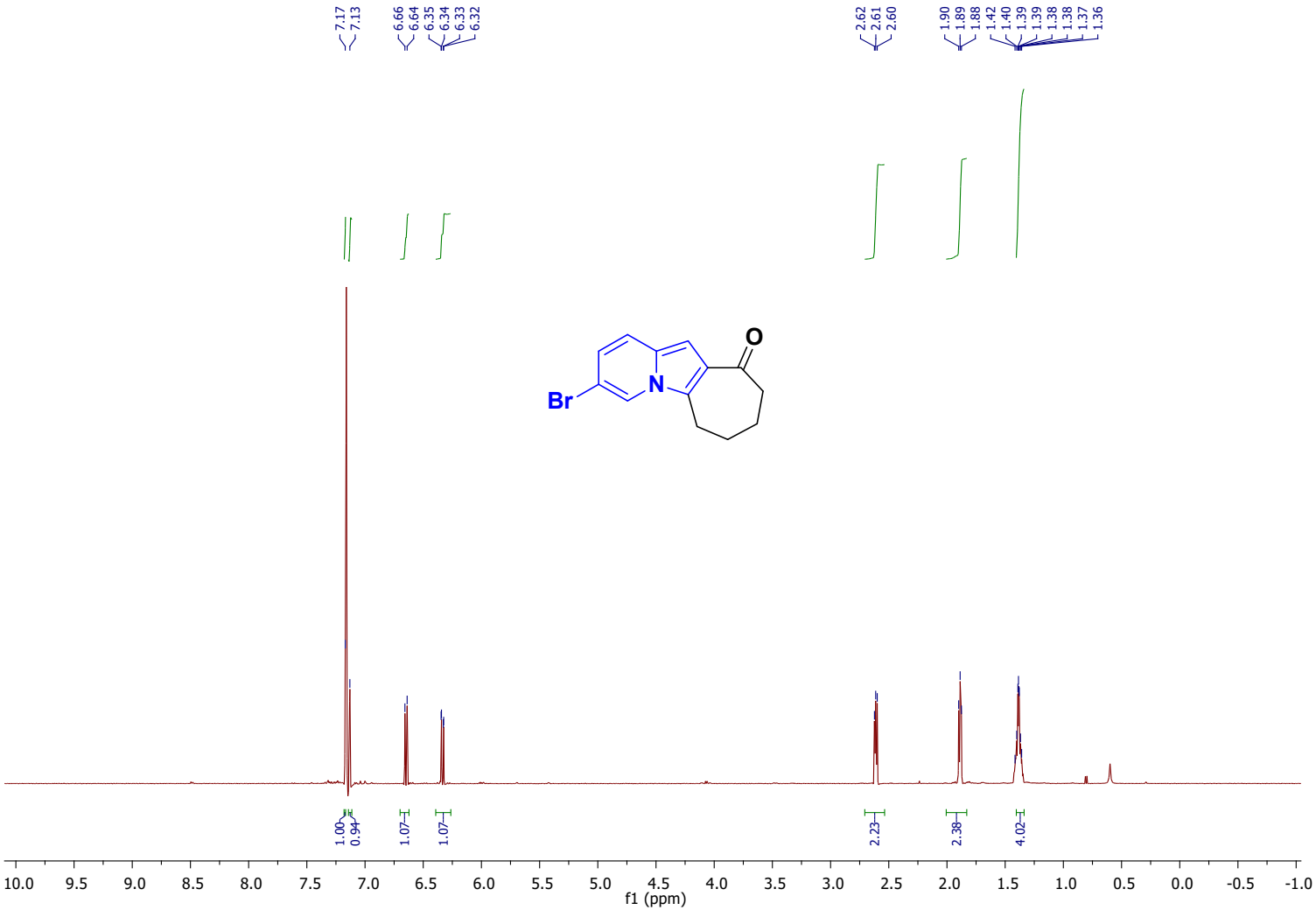


Figure S35. ^{1}H NMR spectrum (250 MHz, $CDCl_3$) of compound **5ic.**

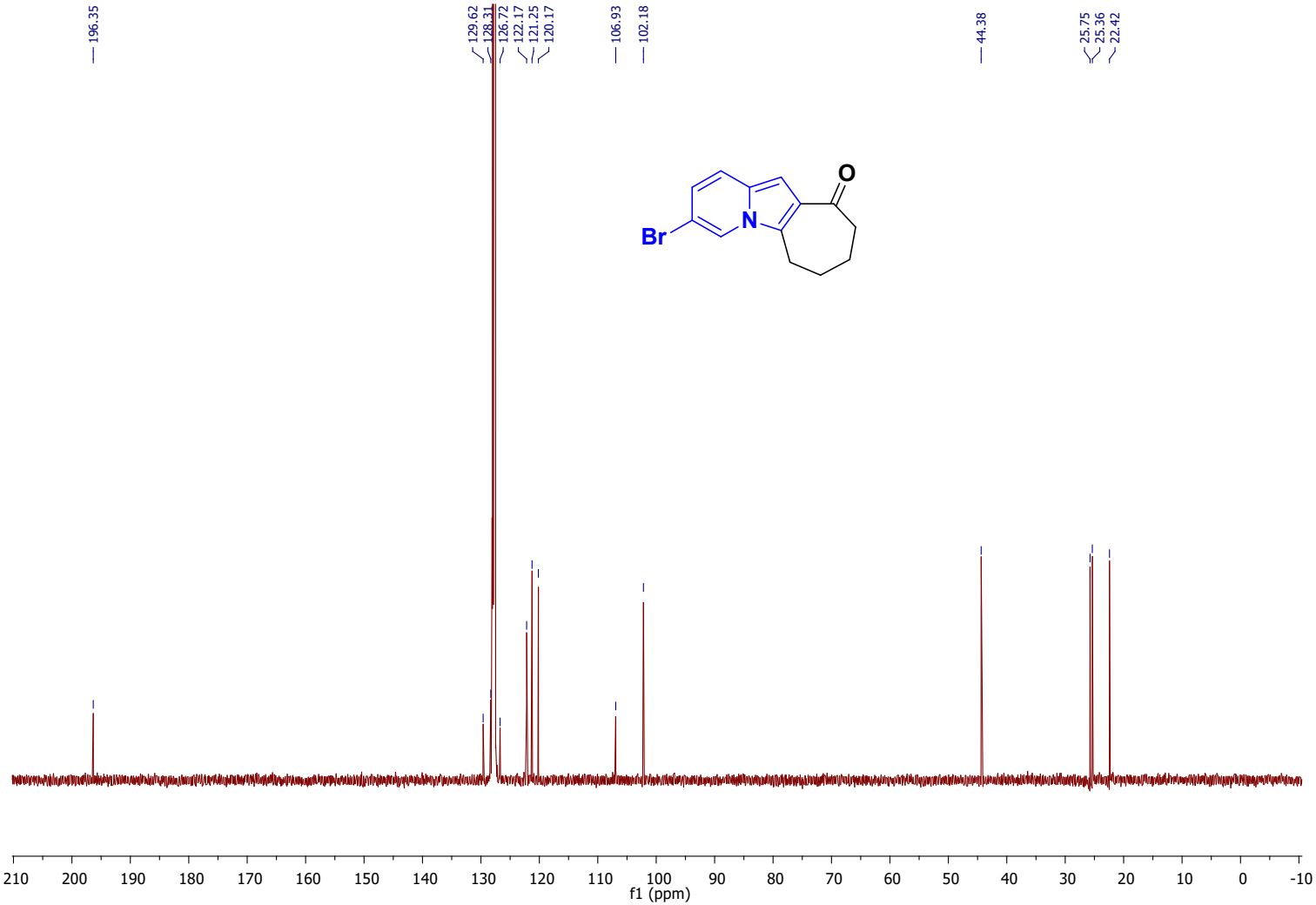


Figure S36. ^{13}C NMR spectrum (62.5 MHz, $CDCl_3$) of compound **5ic.**

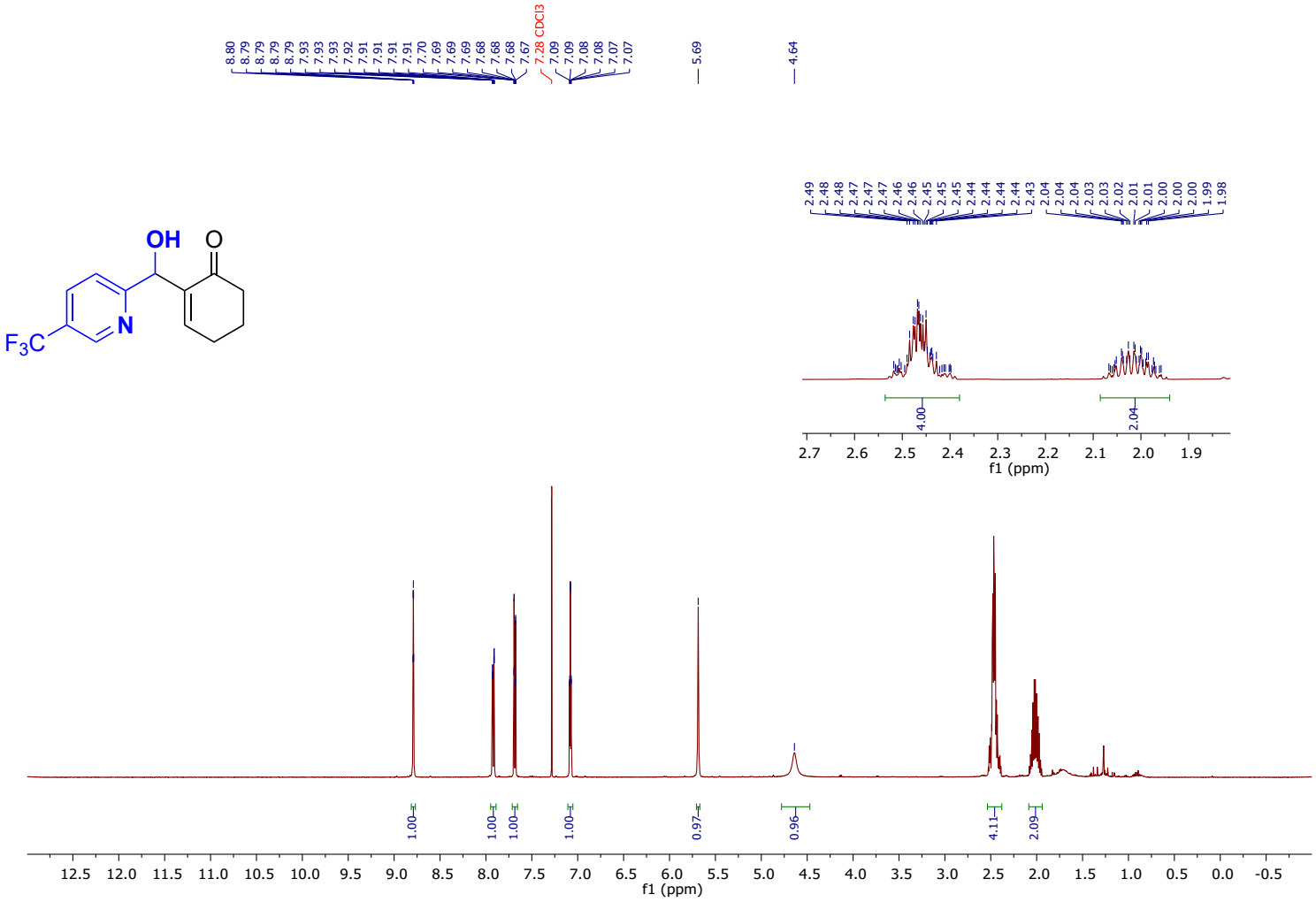


Figure S37. ^{1}H NMR spectrum (500 MHz, $CDCl_3$) of compound **4ja.**

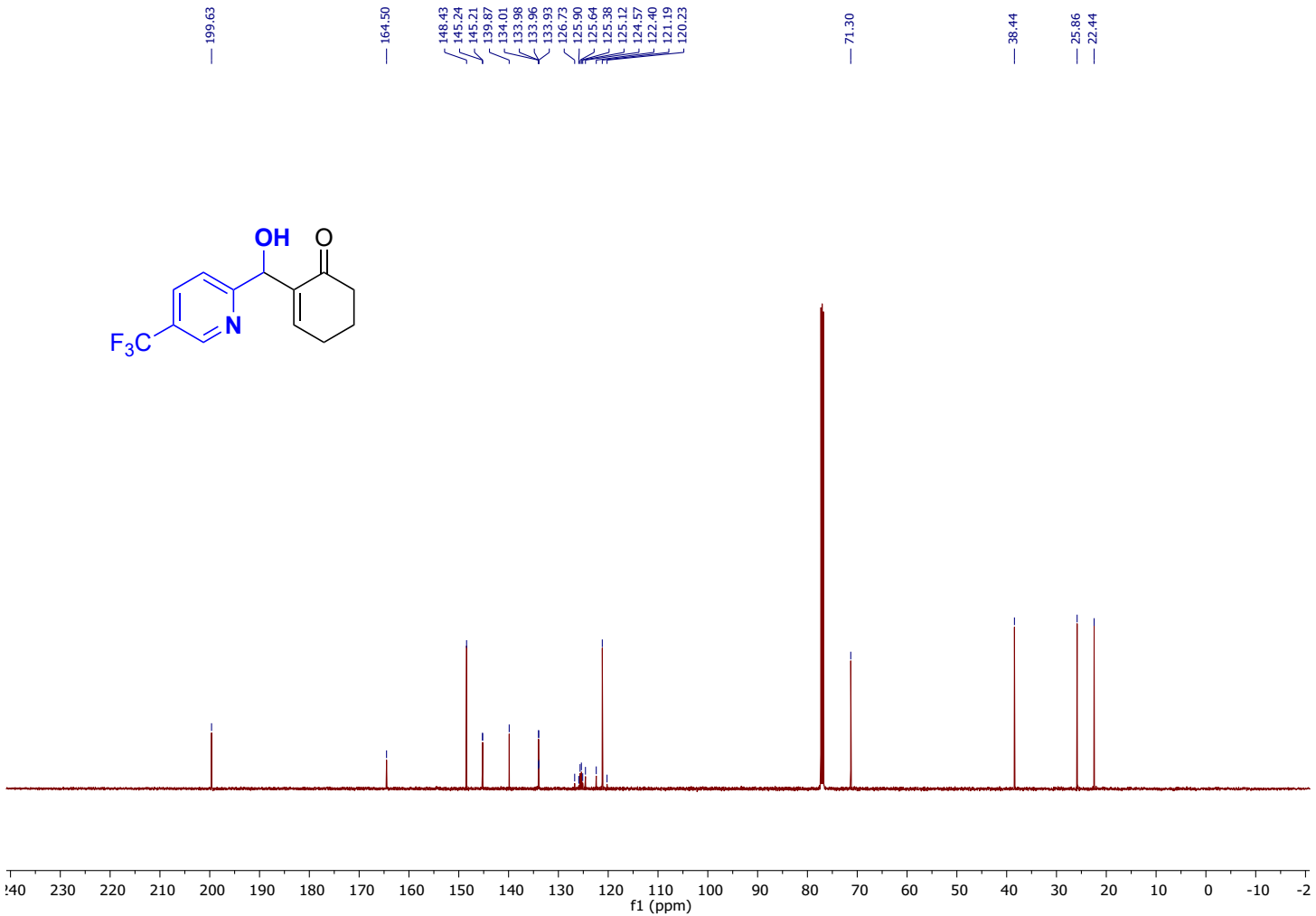


Figure S38. ^{13}C NMR spectrum (126 MHz, $CDCl_3$) of compound **4ja.**

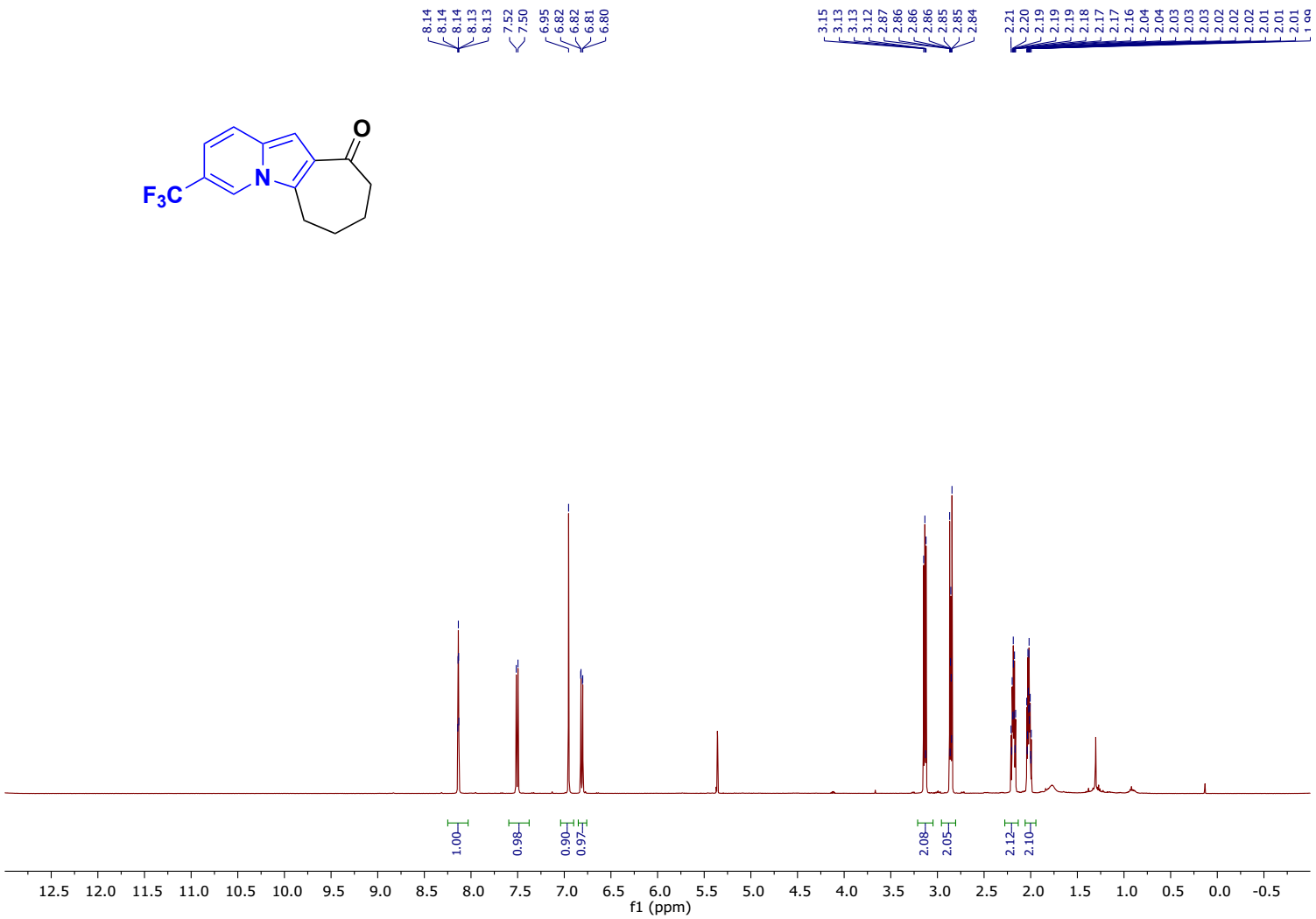


Figure S39. ^{1}H NMR spectrum (500 MHz, CD_2Cl_2) of compound **5jc.**

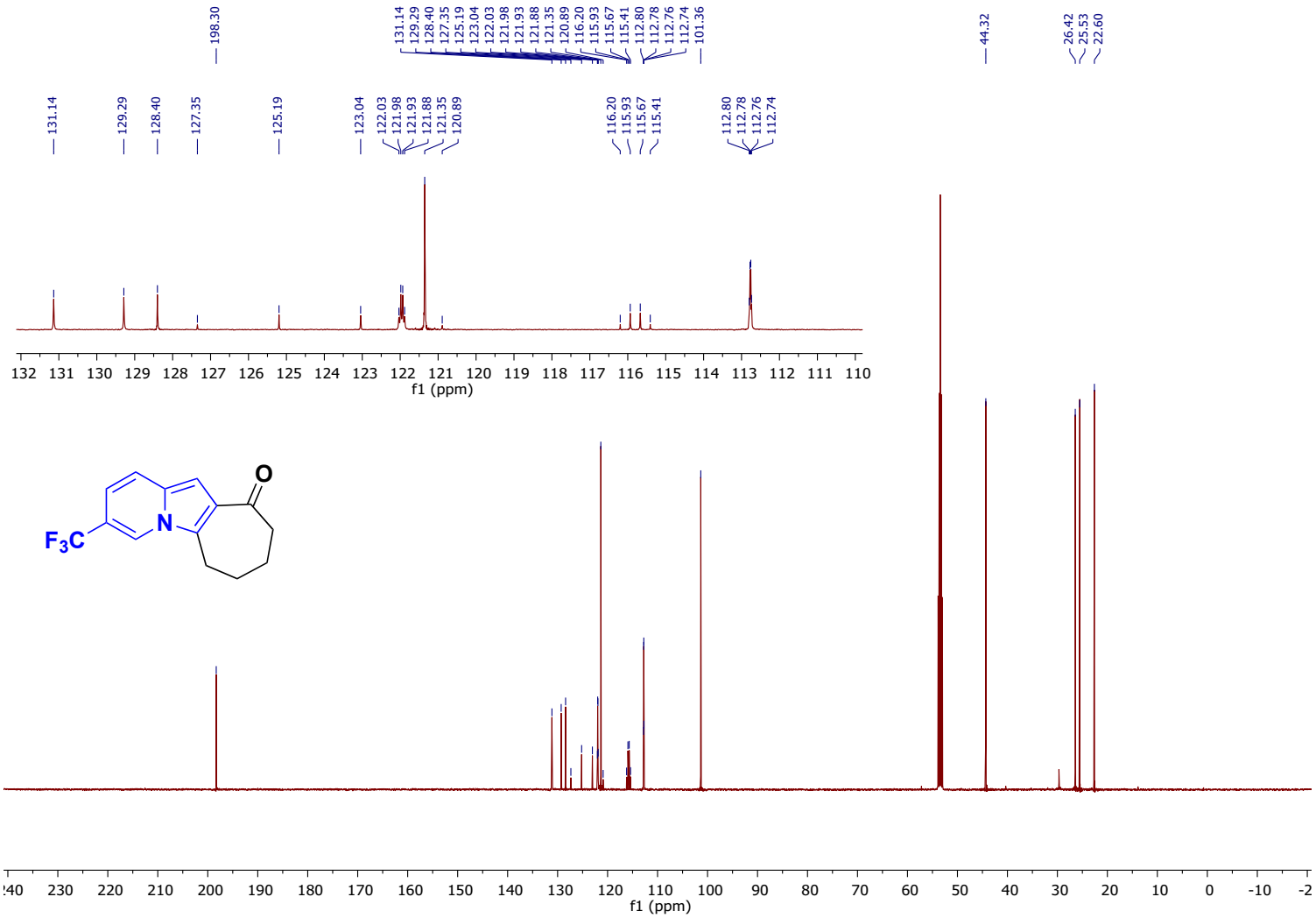


Figure S40. ^{13}C NMR spectrum (126 MHz, $CDCl_3$) of compound **5jc.**

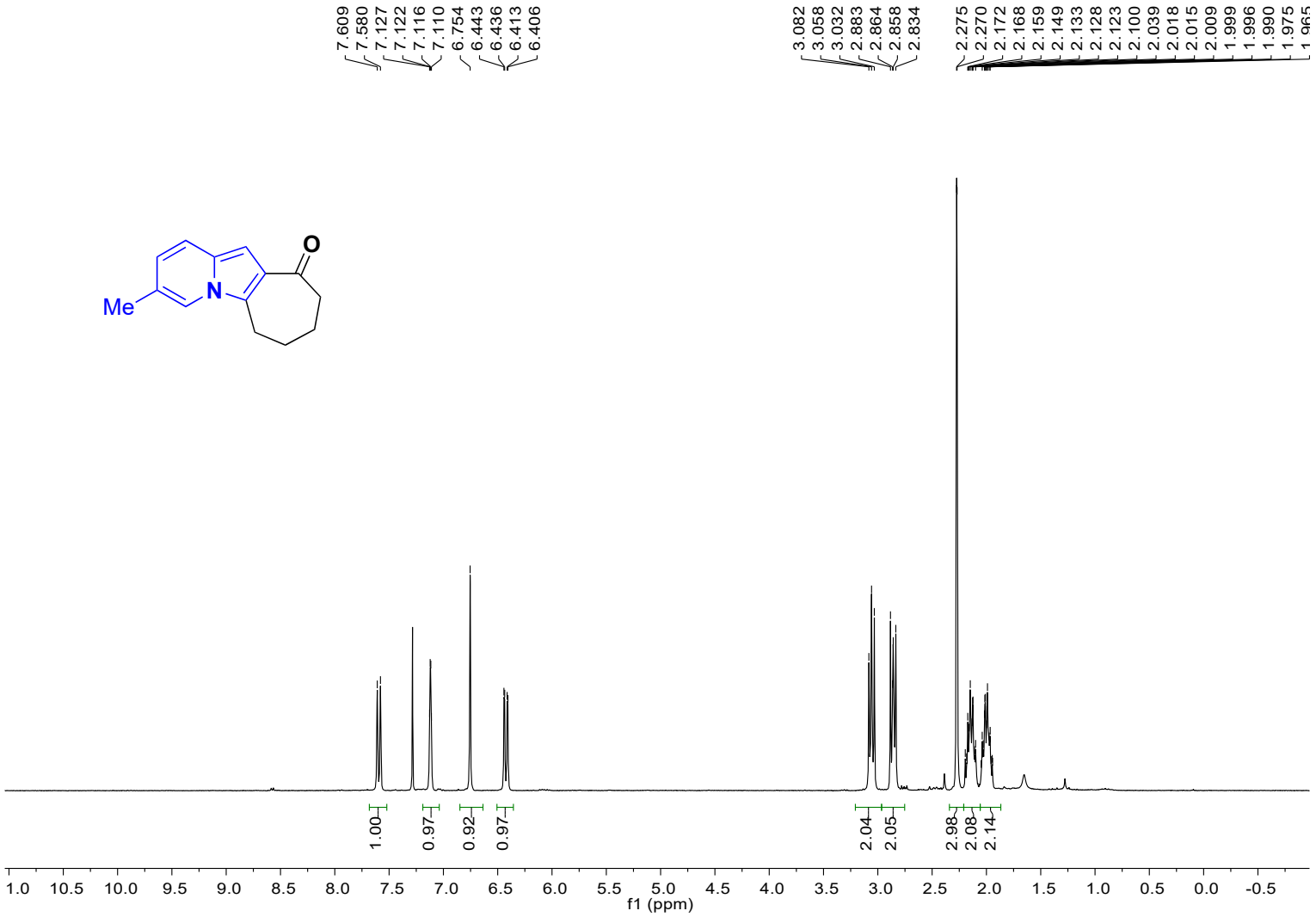


Figure S41. ^{1}H NMR spectrum (250 MHz, $CDCl_3$) of compound **5dc.**

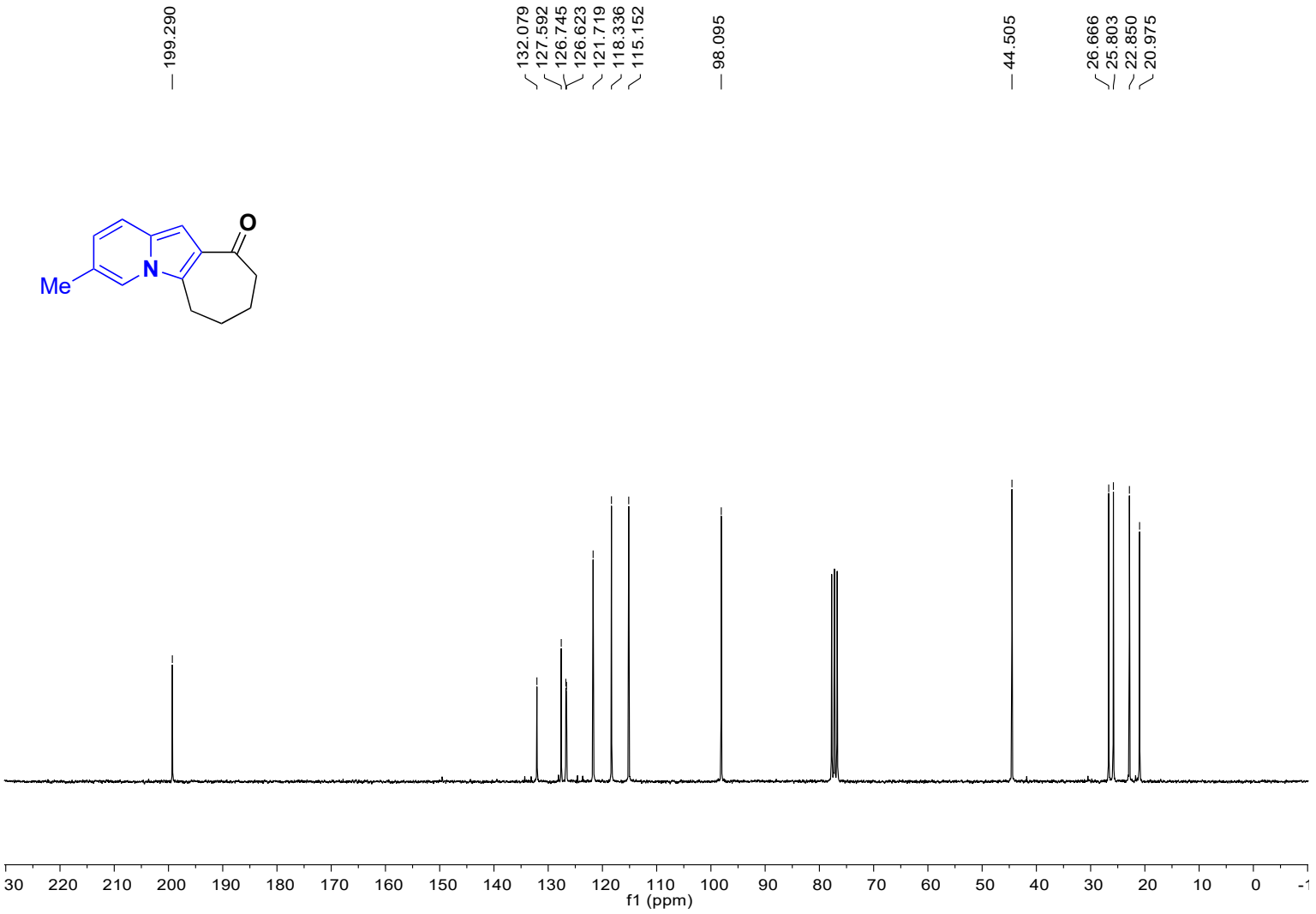


Figure S42. ^{13}C NMR spectrum (62.5 MHz, $CDCl_3$) of compound **5dc.**

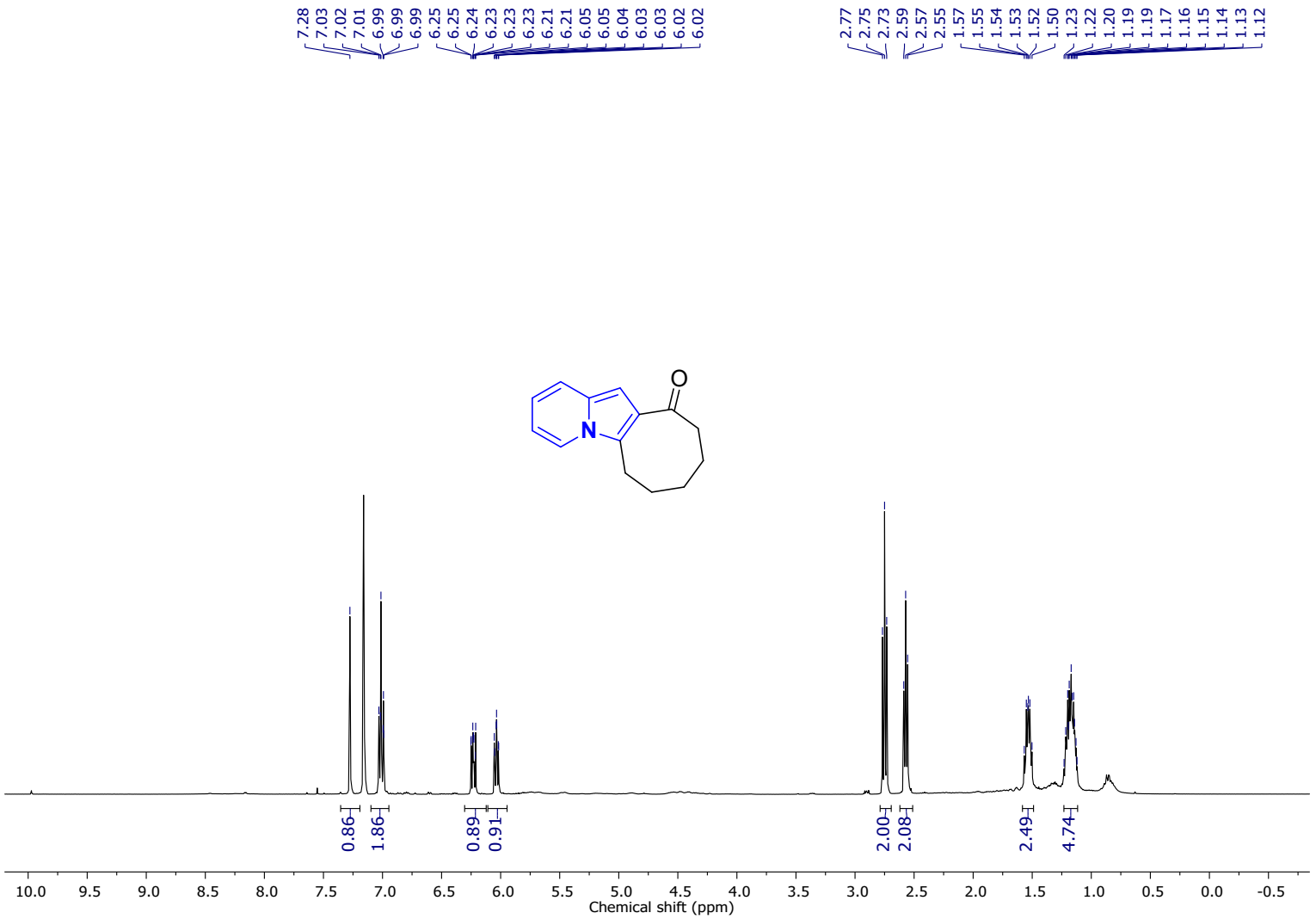
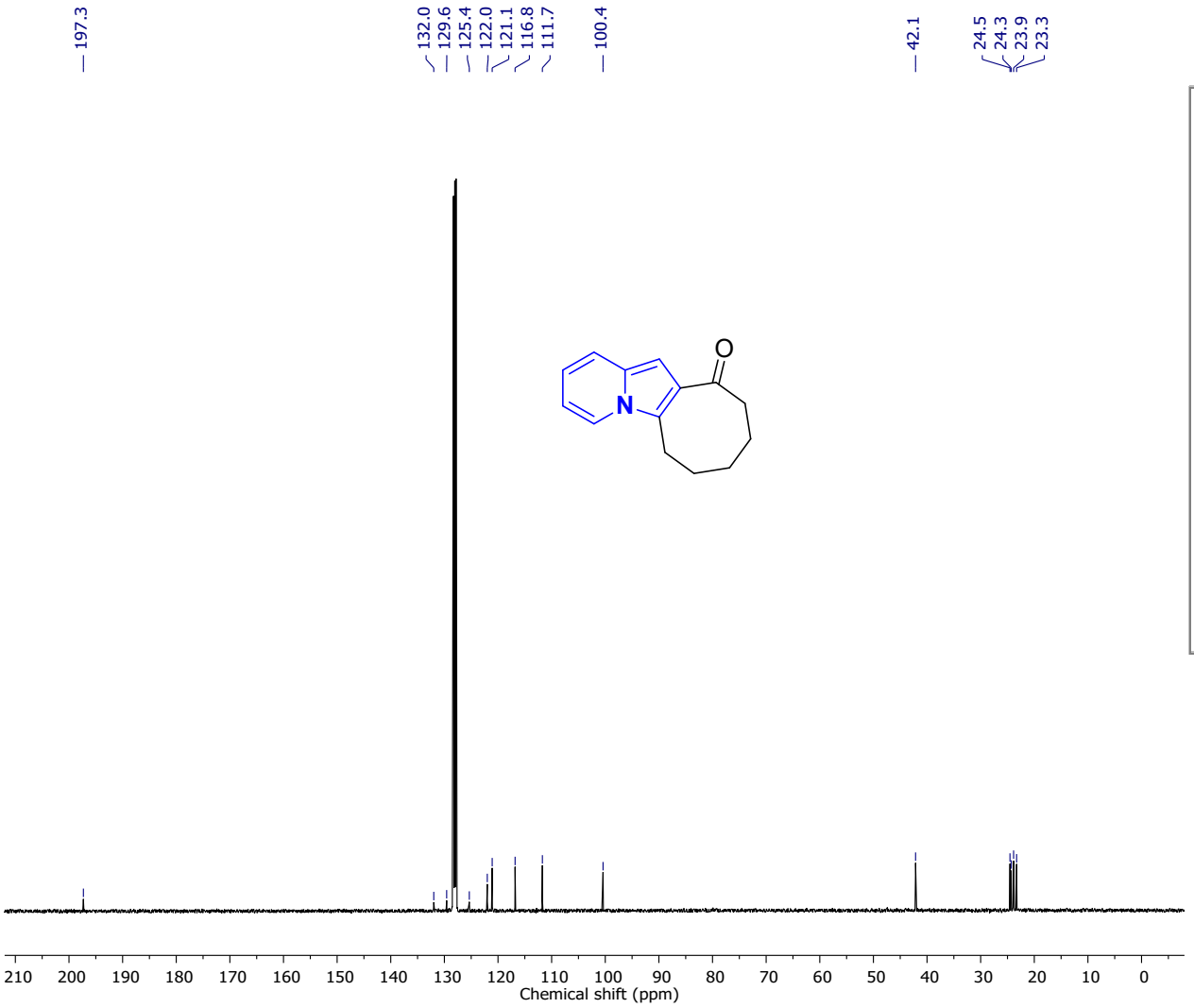


Figure S43. ^{1}H NMR spectrum (400 MHz, C_6D_6) of compound **5ag.**



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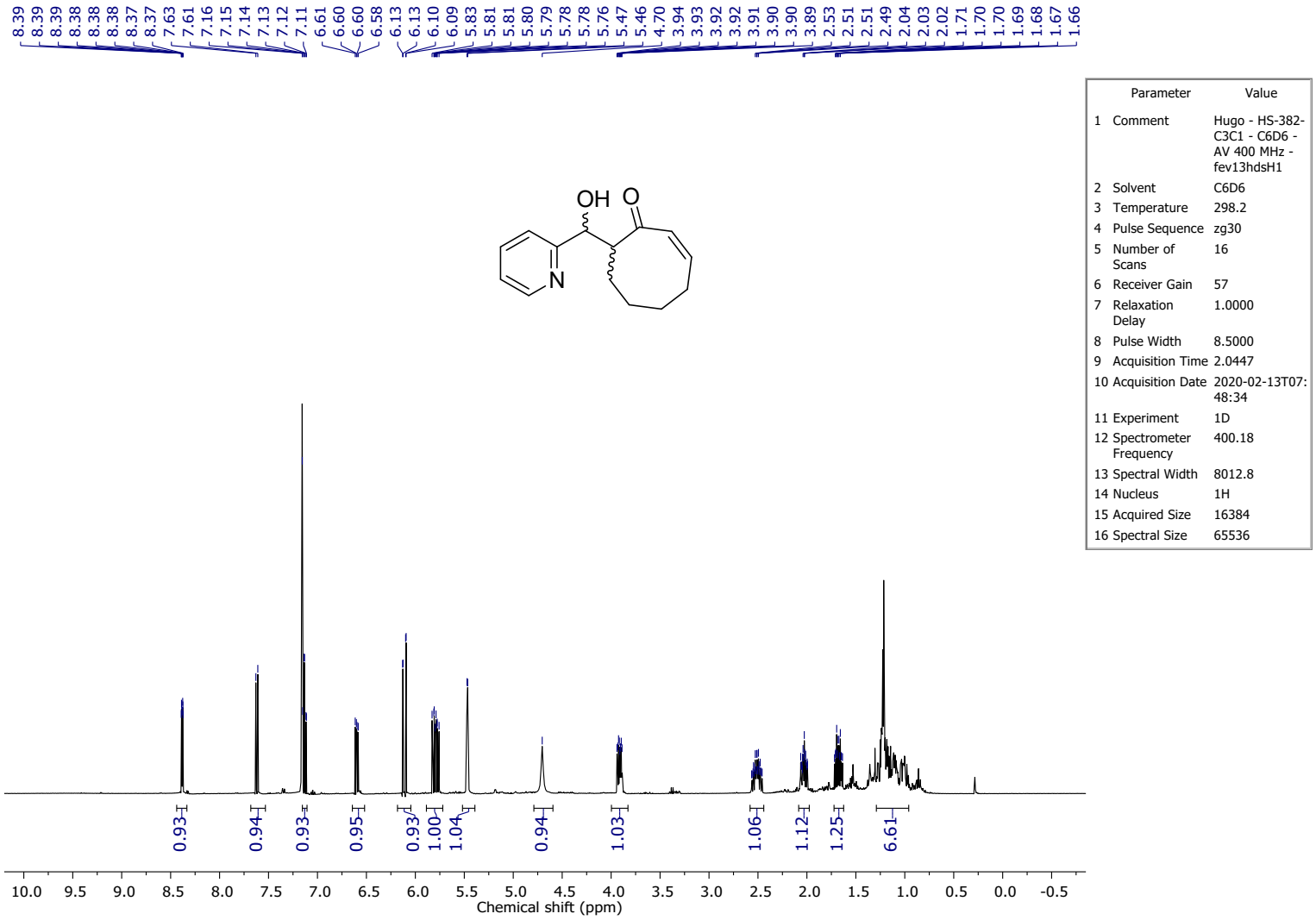
9	Acquisition Time	0.6816
10	Acquisition Date	2020-02-10T14:34:50
11	Experiment	1D
12	Spectrometer Frequency	100.64
13	Spectral Width	24038.5
14	Nucleus	13C
15	Acquired Size	16384
16	Spectral Size	65536

Figure S44. ^{13}C NMR spectrum (101 MHz, C_6D_6) of compound **5ag.**



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11	Experiment	1D
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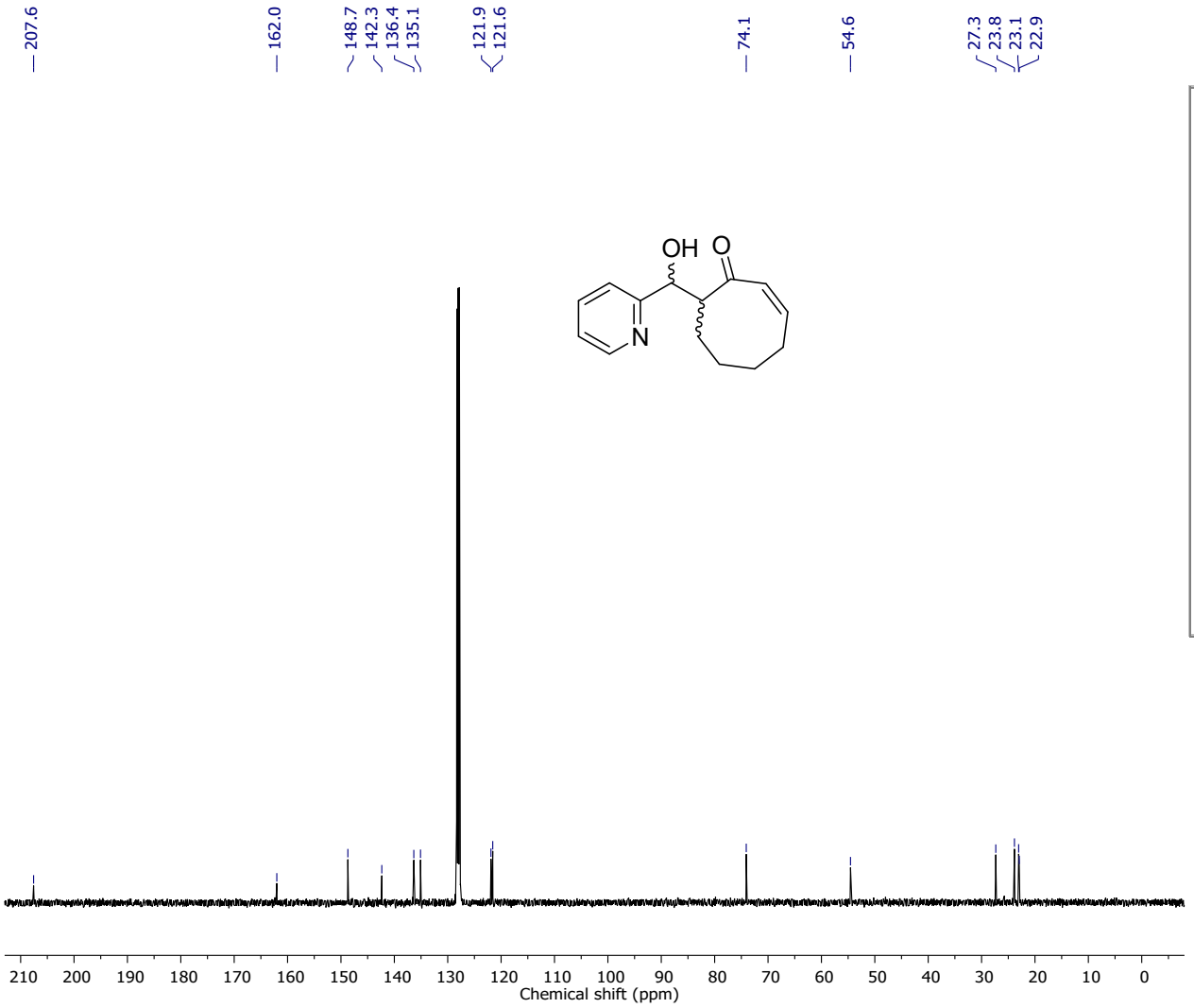
Figure S45. ^{1}H NMR spectrum (500 MHz, C_6D_6) of compound **6ag** (major).



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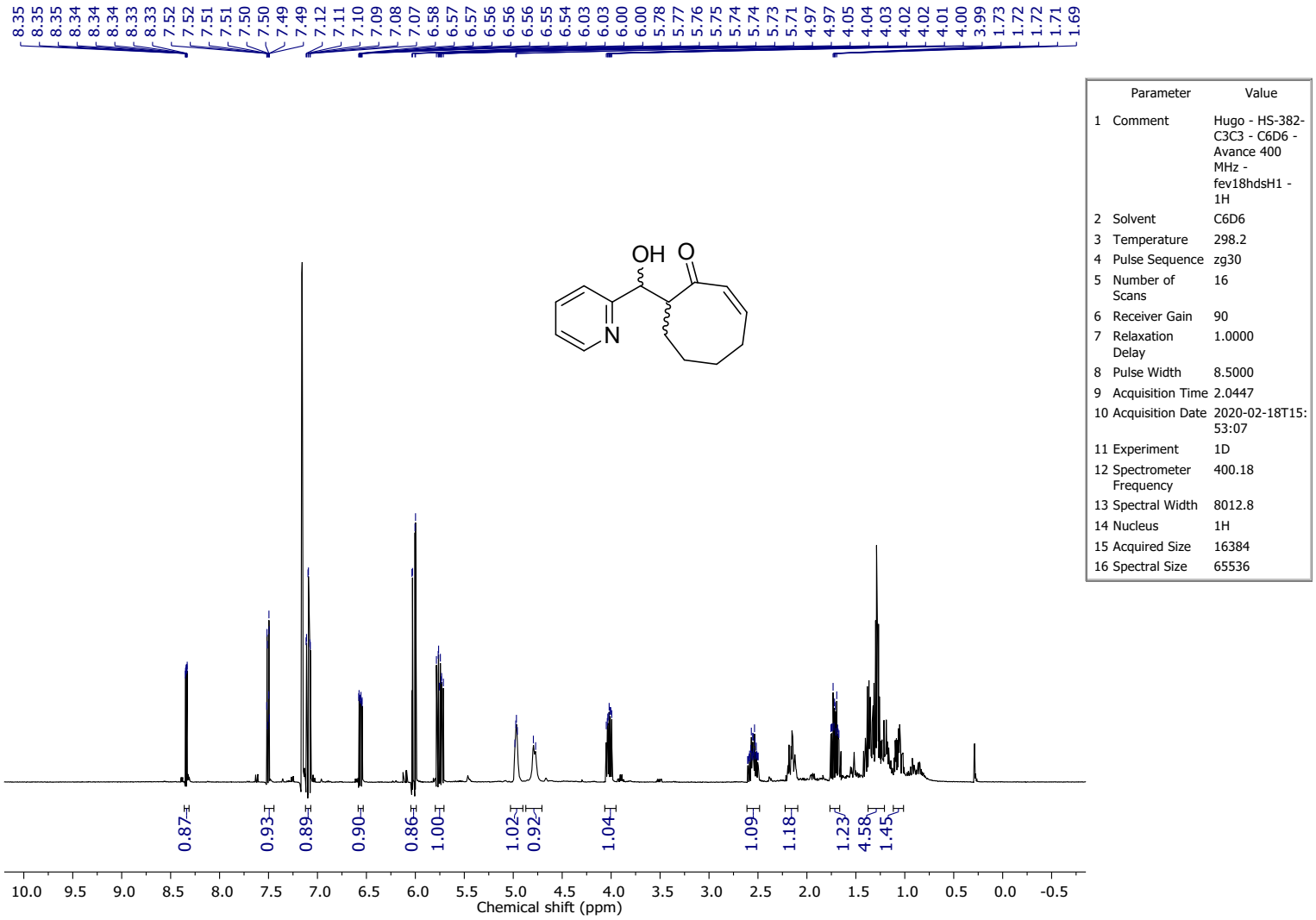
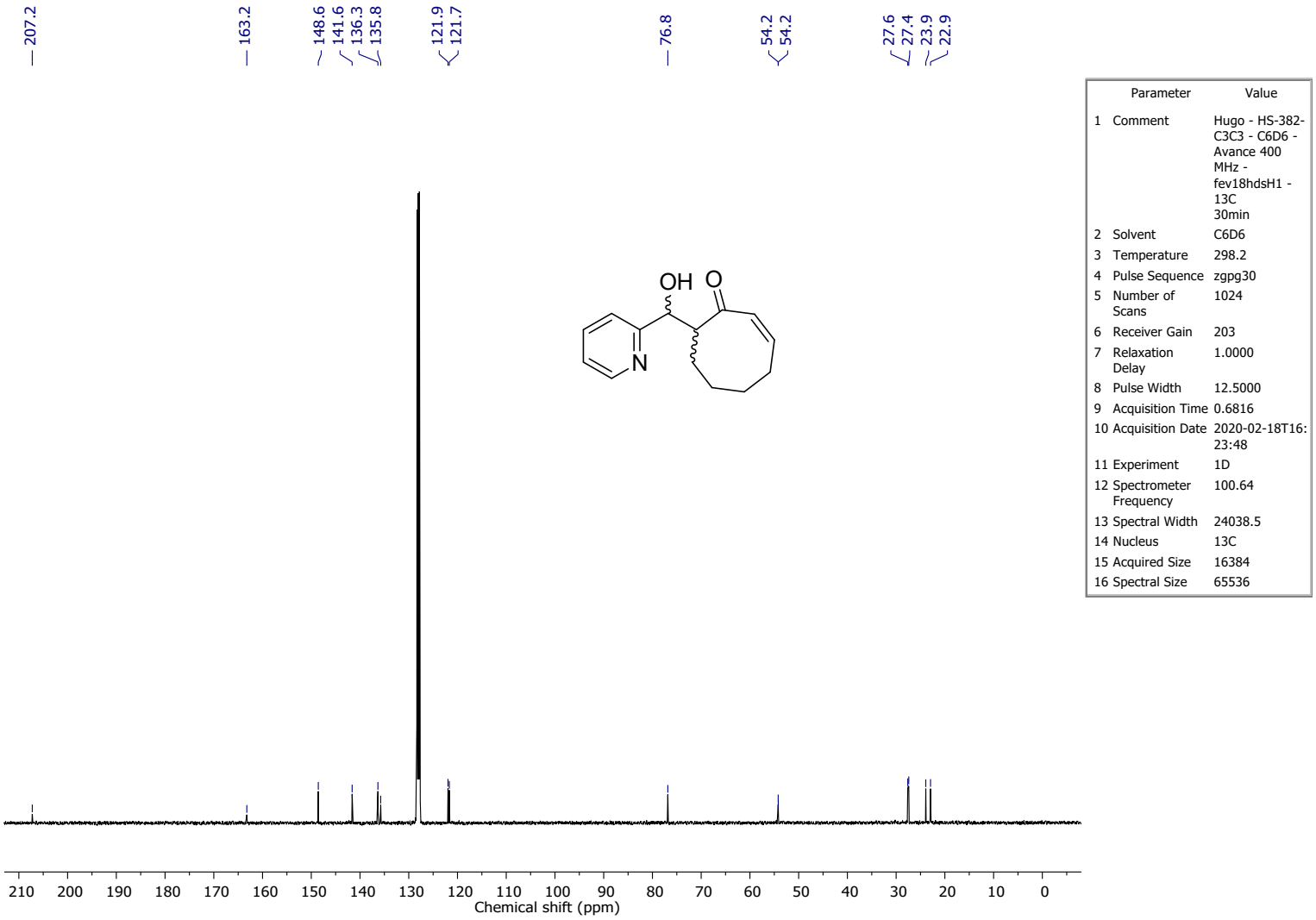
4	Pulse Sequence	zgpg30
5	Number of Scans	128
6	Receiver Gain	203
7	Relaxation Delay	1.0000
8	Pulse Width	12.5000
9	Acquisition Time	0.6816
10	Acquisition Date	2020-02-13T07:53:13
11	Experiment	1D
12	Spectrometer Frequency	100.64
13	Spectral Width	24038.5
14	Nucleus	13C
15	Acquired Size	16384
16	Spectral Size	65536

Figure S46. ^{13}C NMR spectrum (101 MHz, C_6D_6) of compound **6ag** (major).



	Parameter	Value
1	Comment	Hugo - HS-382-C3C3 - C6D6 - Avance 400 MHz - fev18hdsH1 - 1H
2	Solvent	C6D6
3	Temperature	298.2
4	Pulse Sequence	zg30
5	Number of Scans	16
6	Receiver Gain	90
7	Relaxation Delay	1.0000
8	Pulse Width	8.5000
9	Acquisition Time	2.0447
10	Acquisition Date	2020-02-18T15:53:07
11	Experiment	1D
12	Spectrometer Frequency	400.18
13	Spectral Width	8012.8
14	Nucleus	1H
15	Acquired Size	16384
16	Spectral Size	65536

Figure S47. ^{1}H NMR spectrum (500 MHz, C_6D_6) of compound **6ag** (minor).



	Parameter	Value
1	Comment	Hugo - HS-382-C3C3 - C6D6 - Avance 400 MHz - fev18hdsH1 - 13C 30min
2	Solvent	C6D6
3	Temperature	298.2
4	Pulse Sequence	zgpg30
5	Number of Scans	1024
6	Receiver Gain	203
7	Relaxation Delay	1.0000
8	Pulse Width	12.5000
9	Acquisition Time	0.6816
10	Acquisition Date	2020-02-18T16:23:48
11	Experiment	1D
12	Spectrometer Frequency	100.64
13	Spectral Width	24038.5
14	Nucleus	13C
15	Acquired Size	16384
16	Spectral Size	65536

Figure S48. ^{13}C NMR spectrum (101 MHz, C_6D_6) of compound **6ag** (minor).

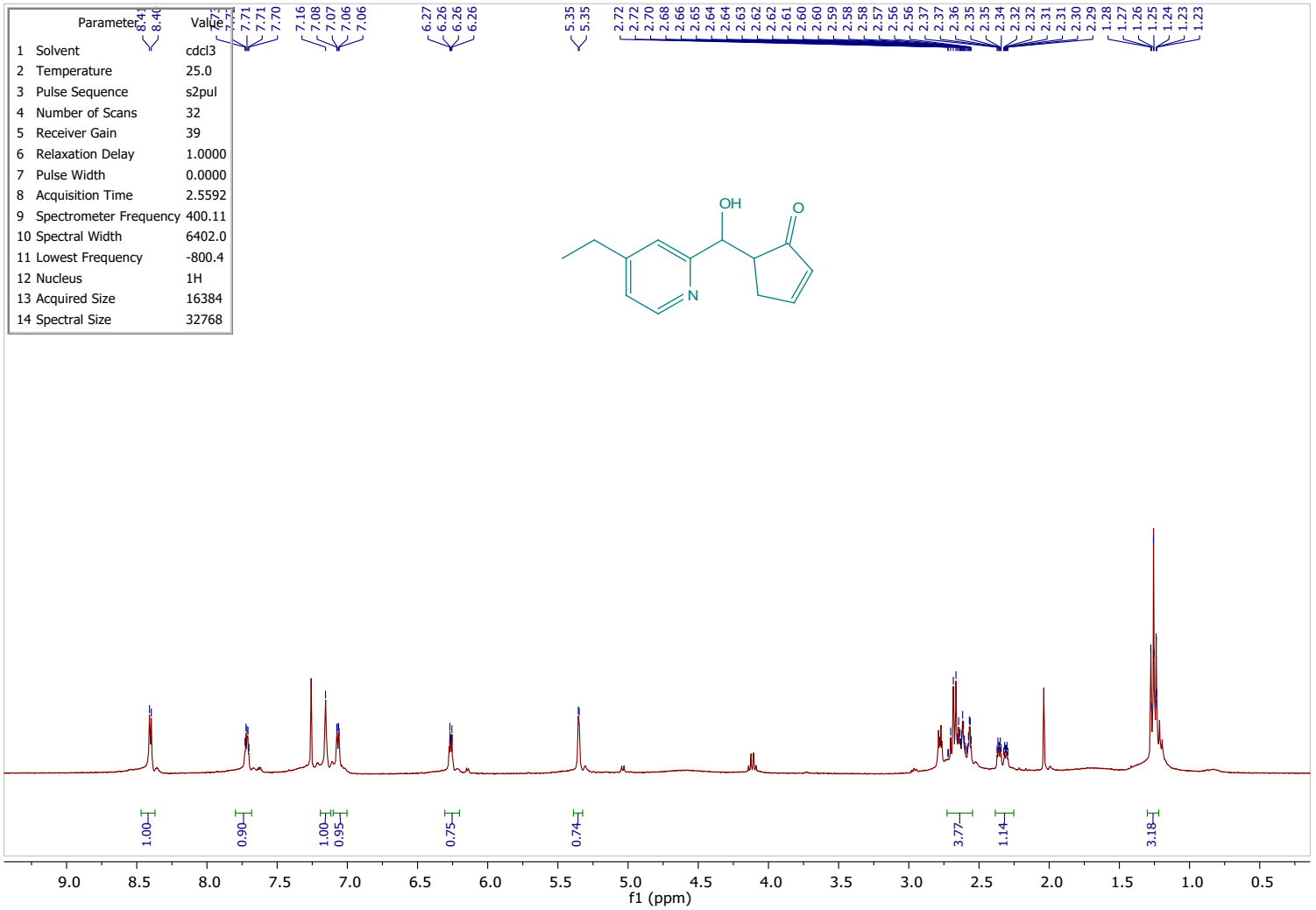


Figure S49. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **6eb.**

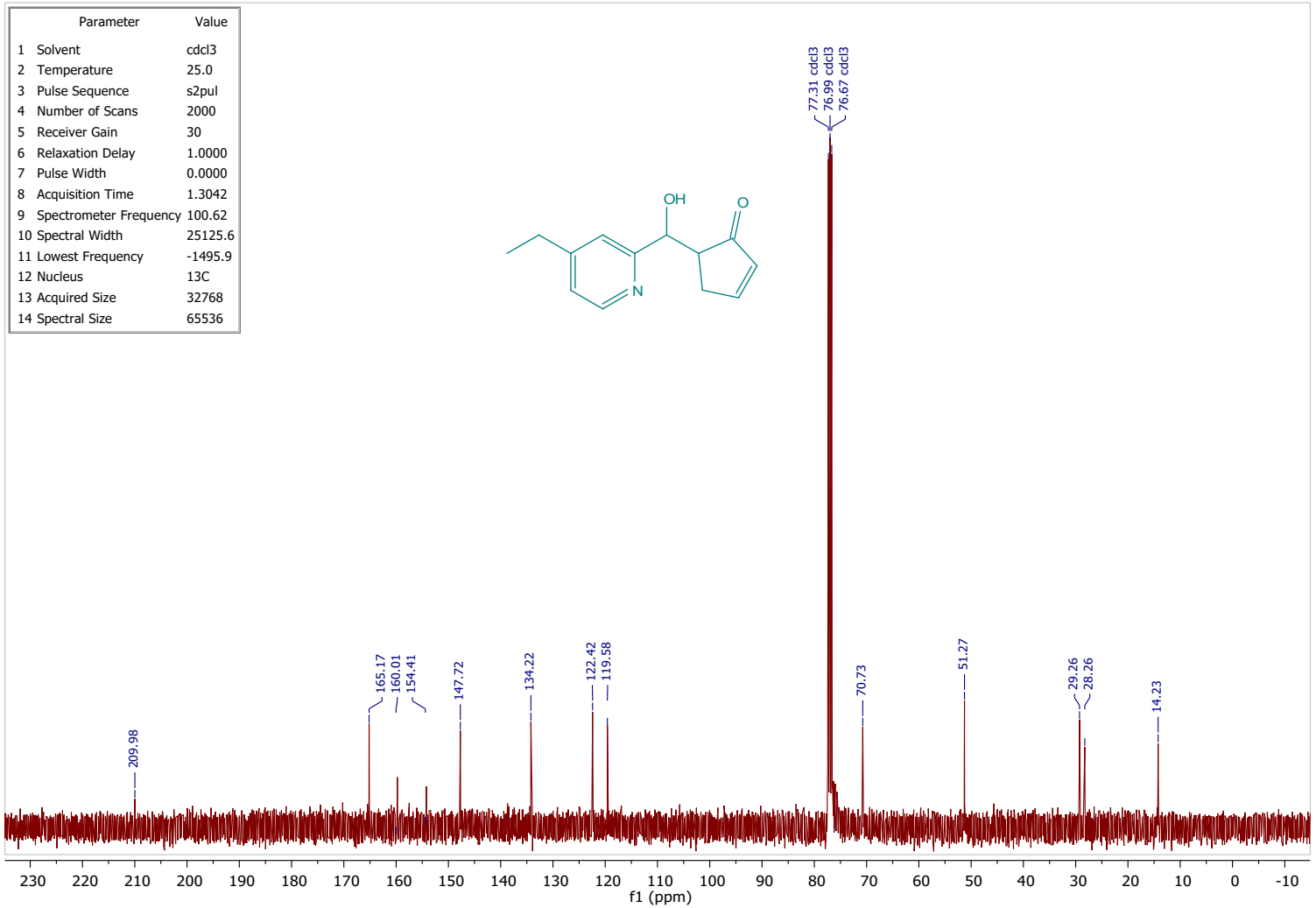


Figure S50. ^{13}C NMR spectrum (101 MHz, $CDCl_3$) of compound **6eb.**

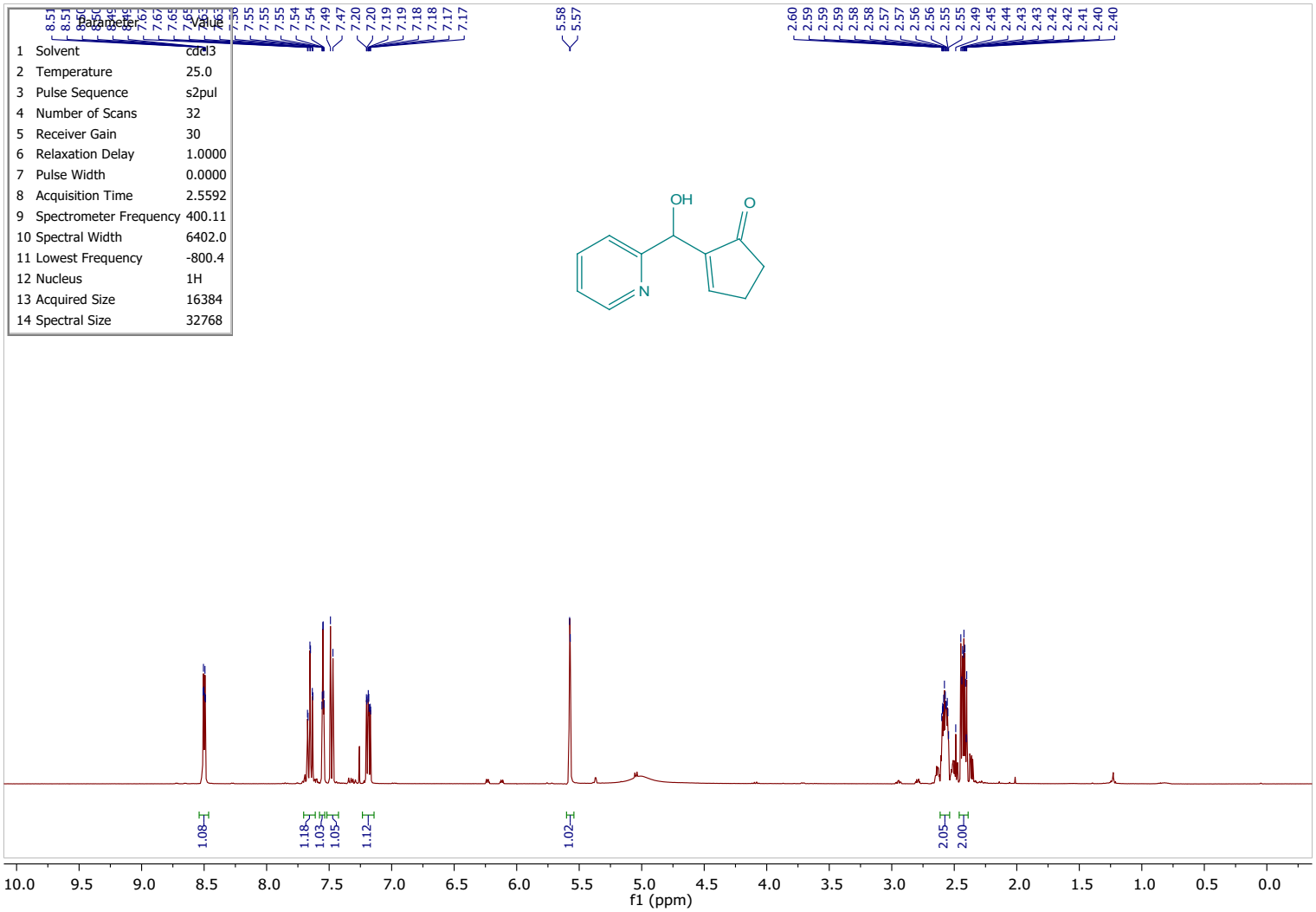


Figure S51. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **4ab.**

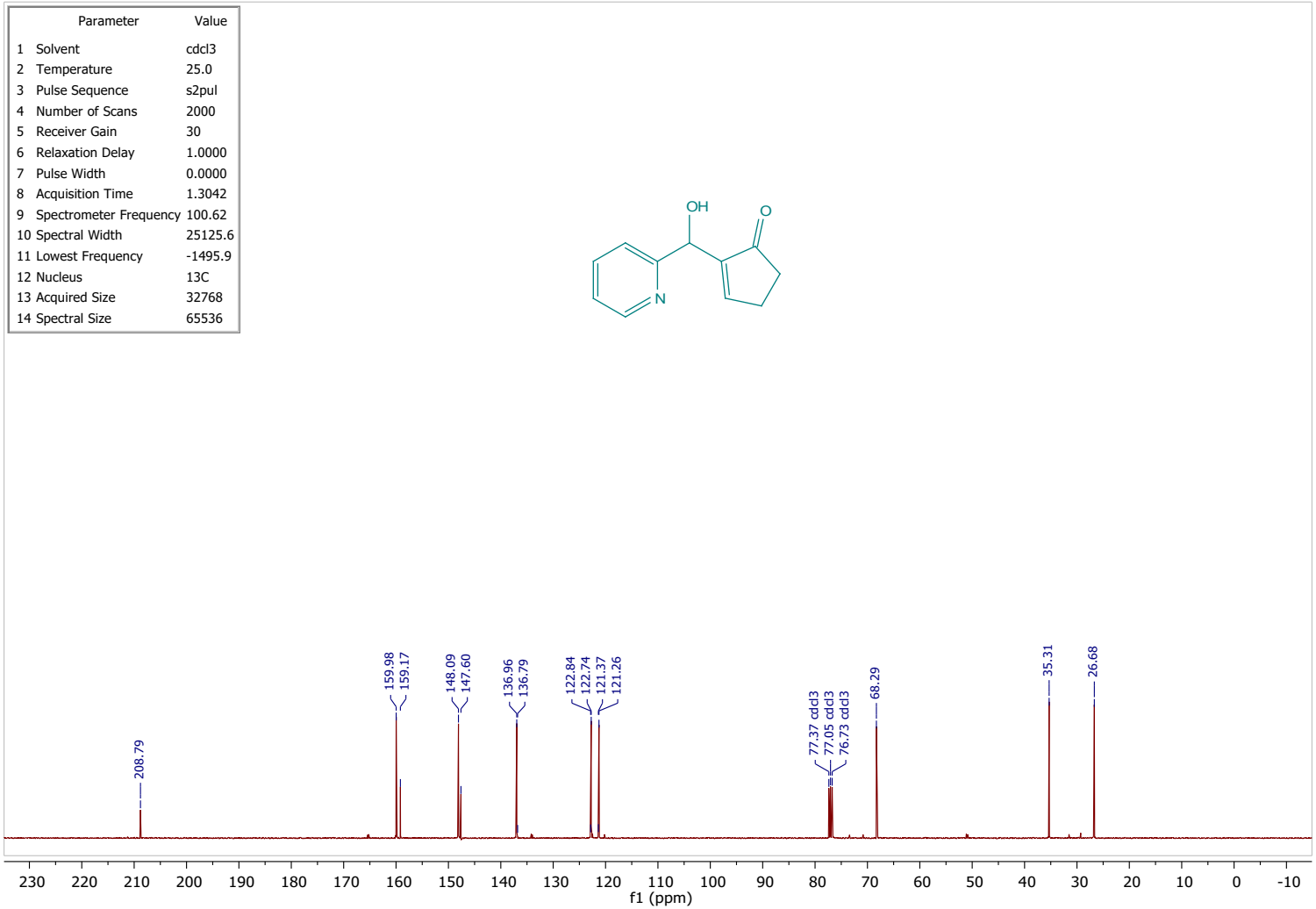


Figure S52. ^{13}C NMR spectrum (101 MHz, $CDCl_3$) of compound **4ab.**

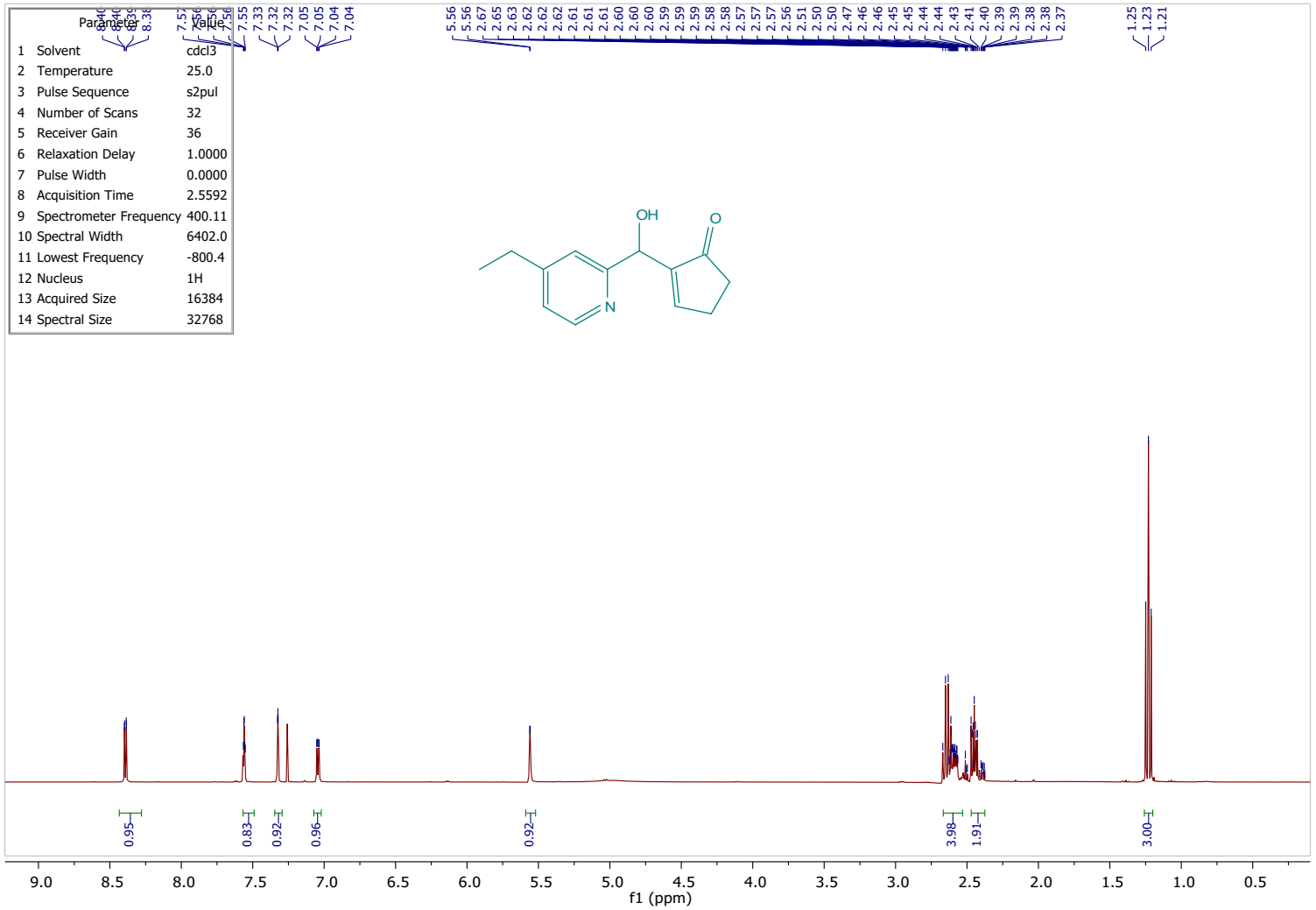


Figure S53. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **4eb.**

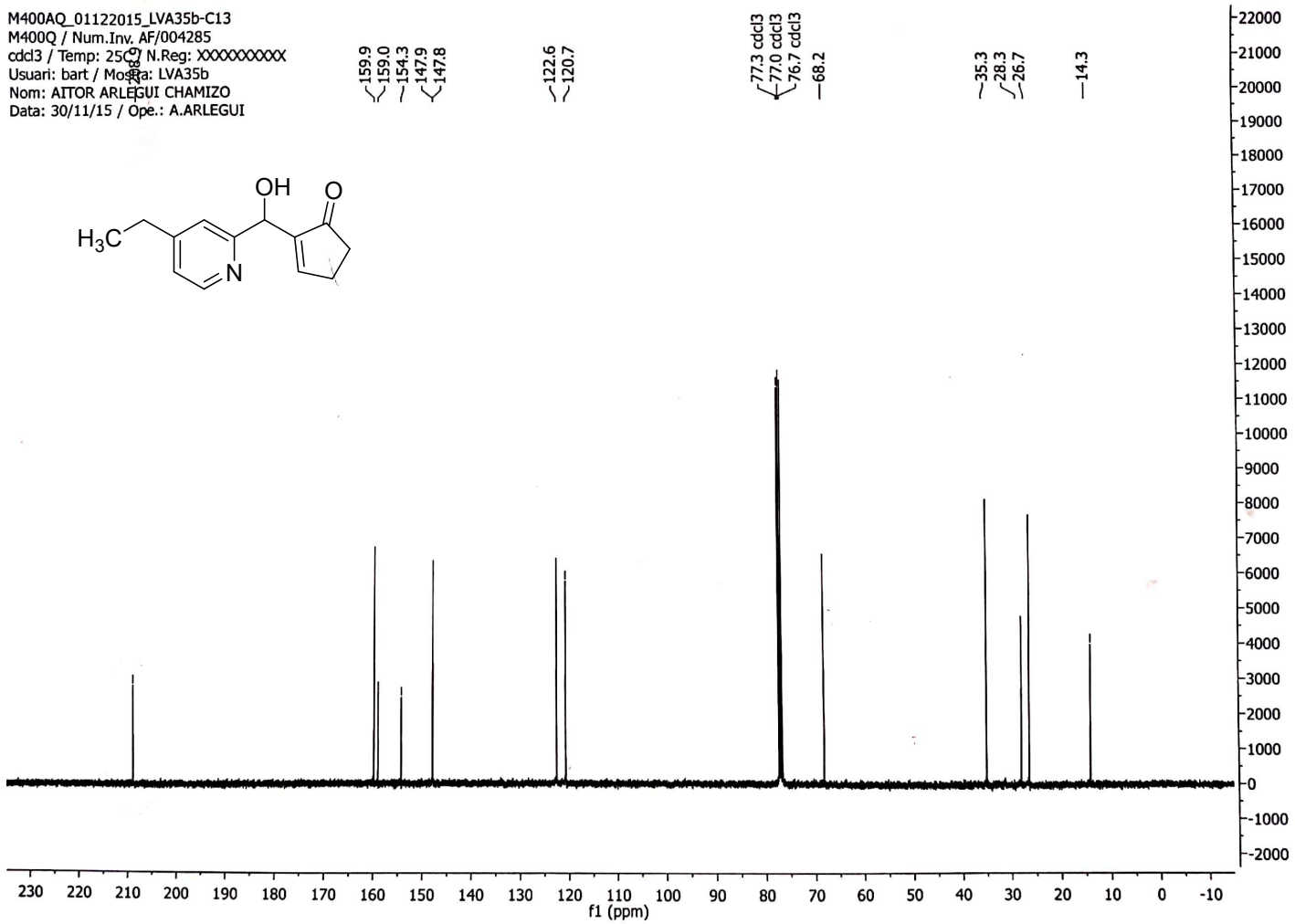


Figure S54. ^{13}C NMR spectrum (101 MHz, $CDCl_3$) of compound **4eb**

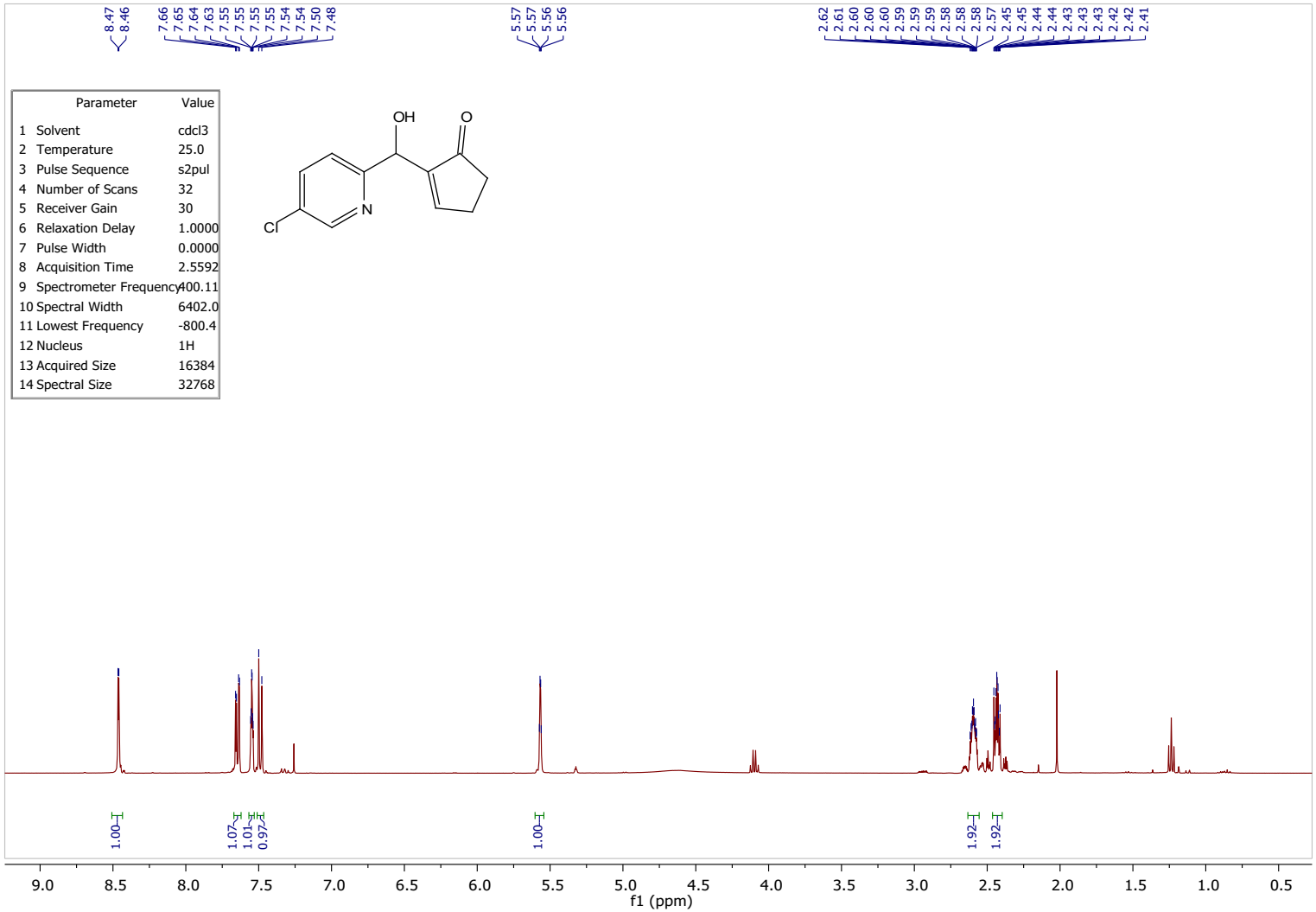


Figure S55. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **4gb.**

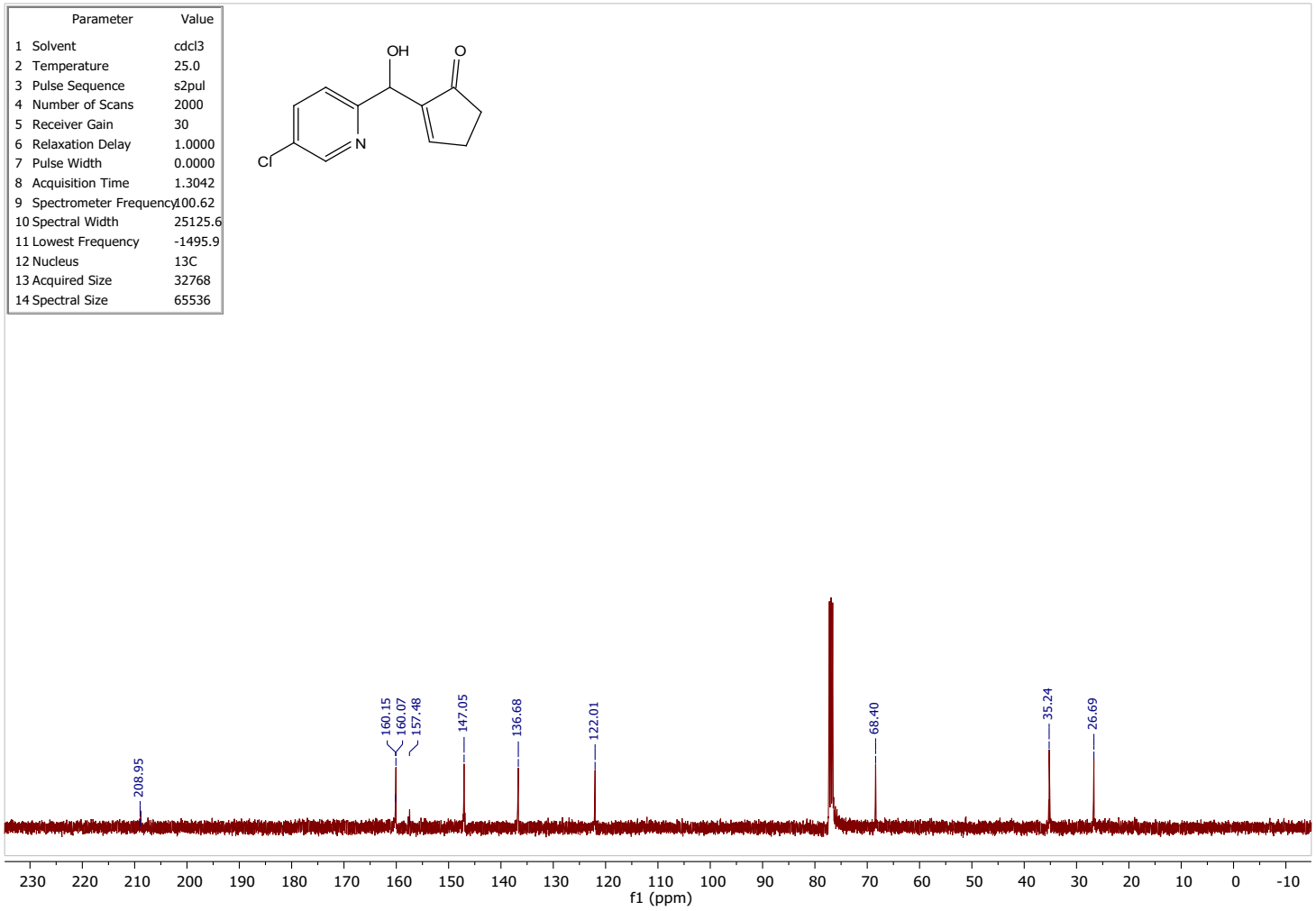


Figure S56. ^{13}C NMR spectrum (101 MHz, $CDCl_3$) of compound **4gb.**

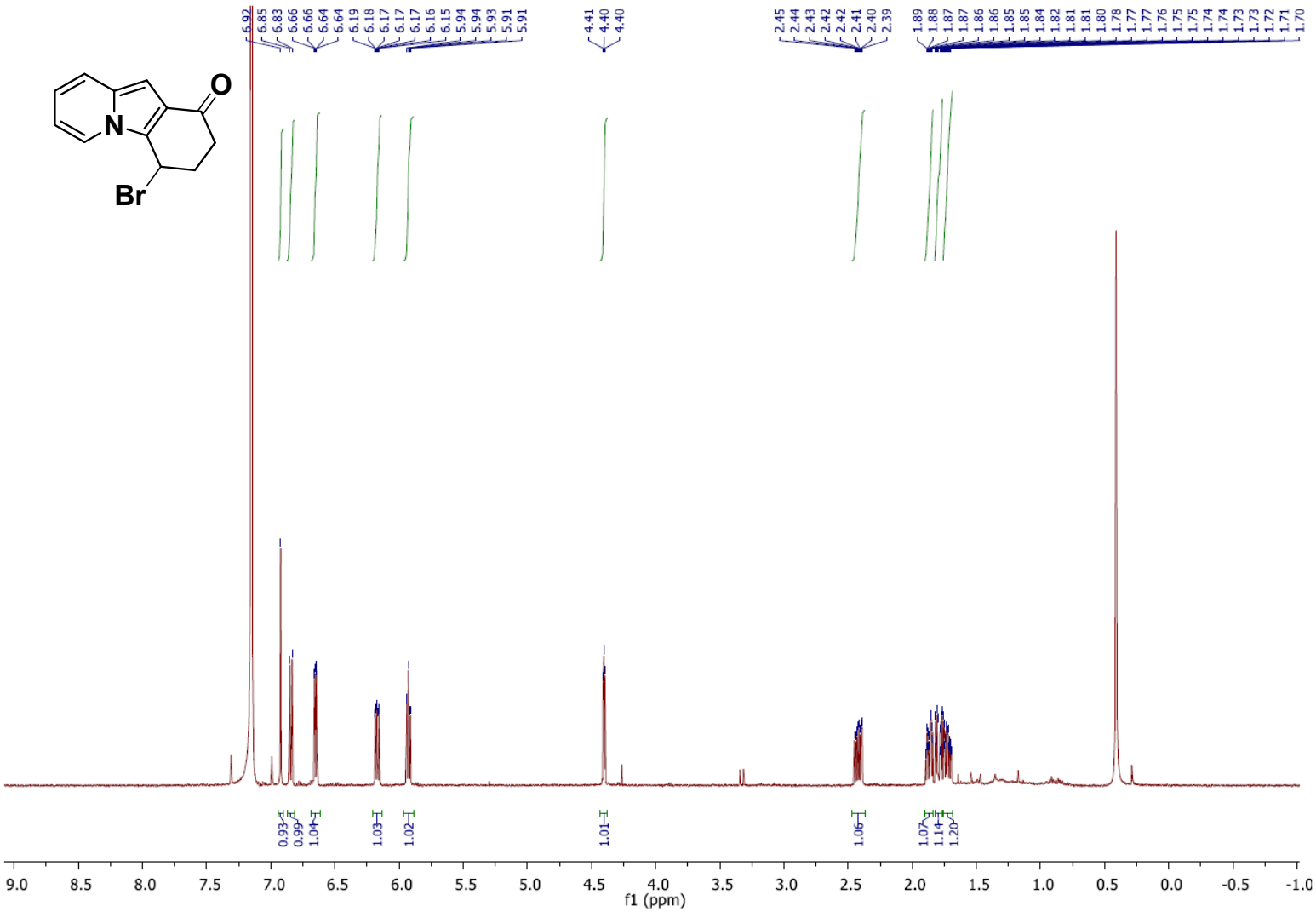


Figure S57. ^{1}H NMR spectrum (500 MHz, C_6D_6) of compound **7**.

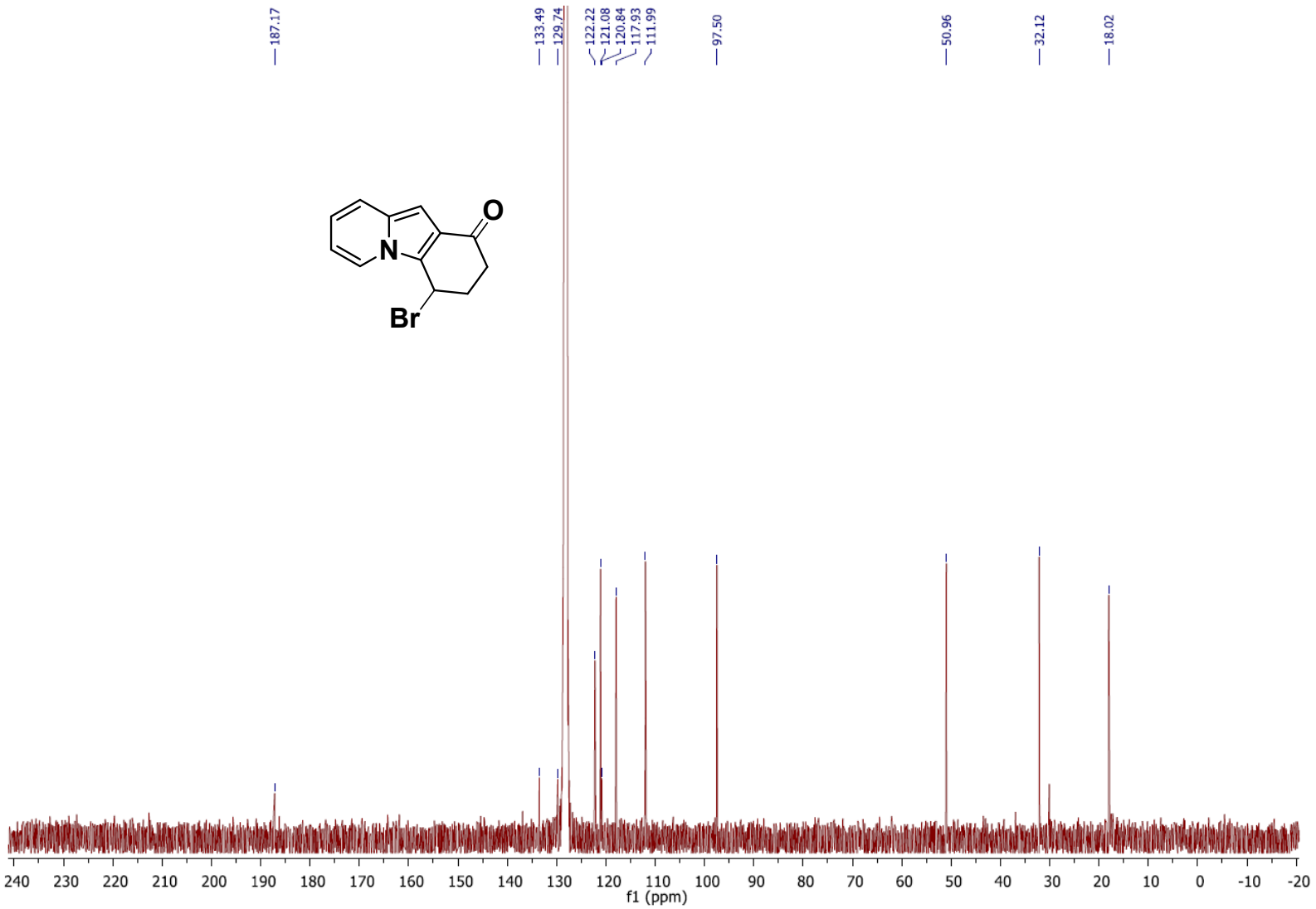


Figure S58. ^{13}C NMR spectrum (151 MHz, C_6D_6) of compound **7**.

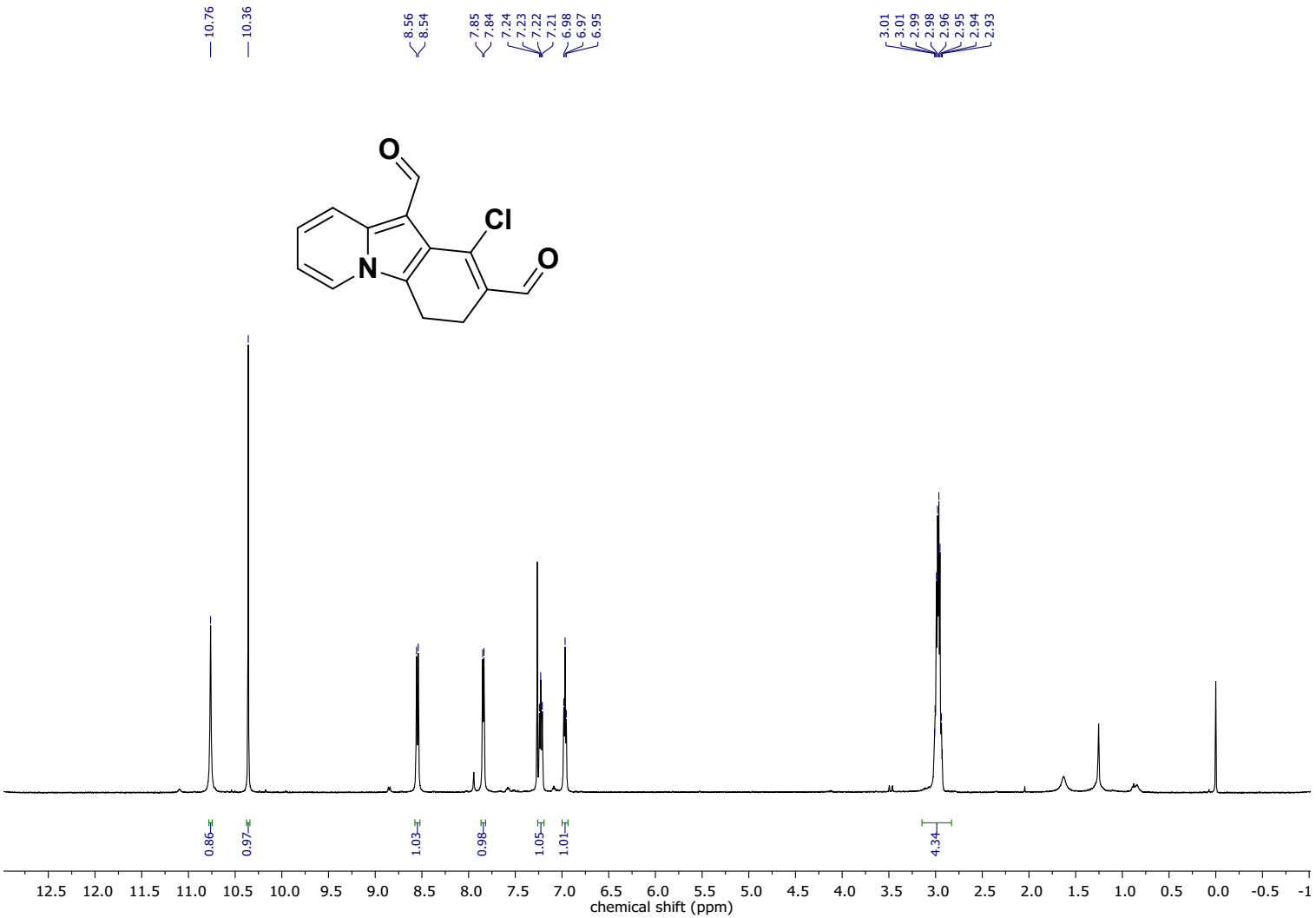


Figure S59. ^{1}H NMR spectrum (500 MHz, $CDCl_3$) of compound **8**.

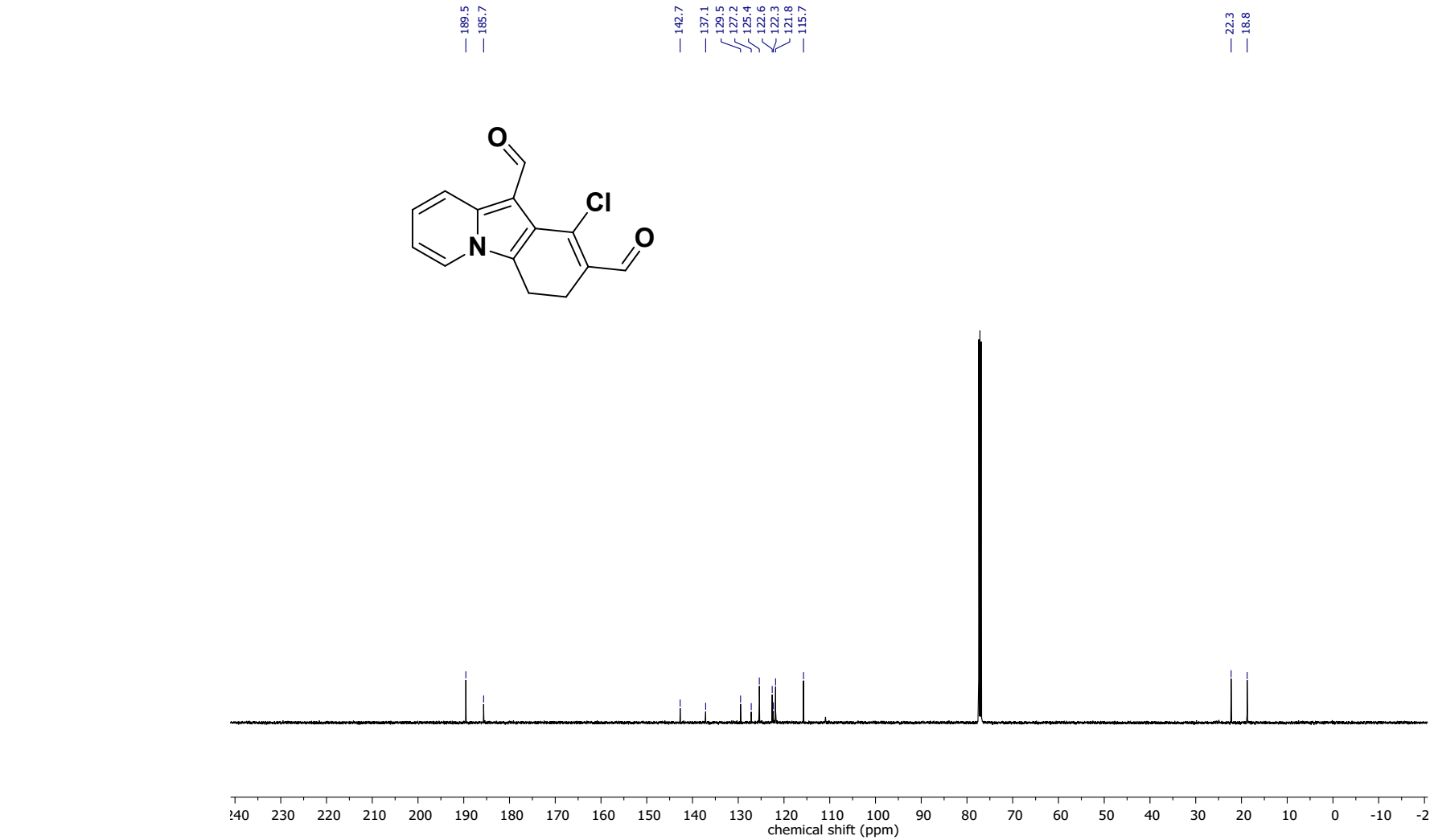


Figure S60. ^{13}C NMR spectrum (126 MHz, $CDCl_3$) of compound **8**.

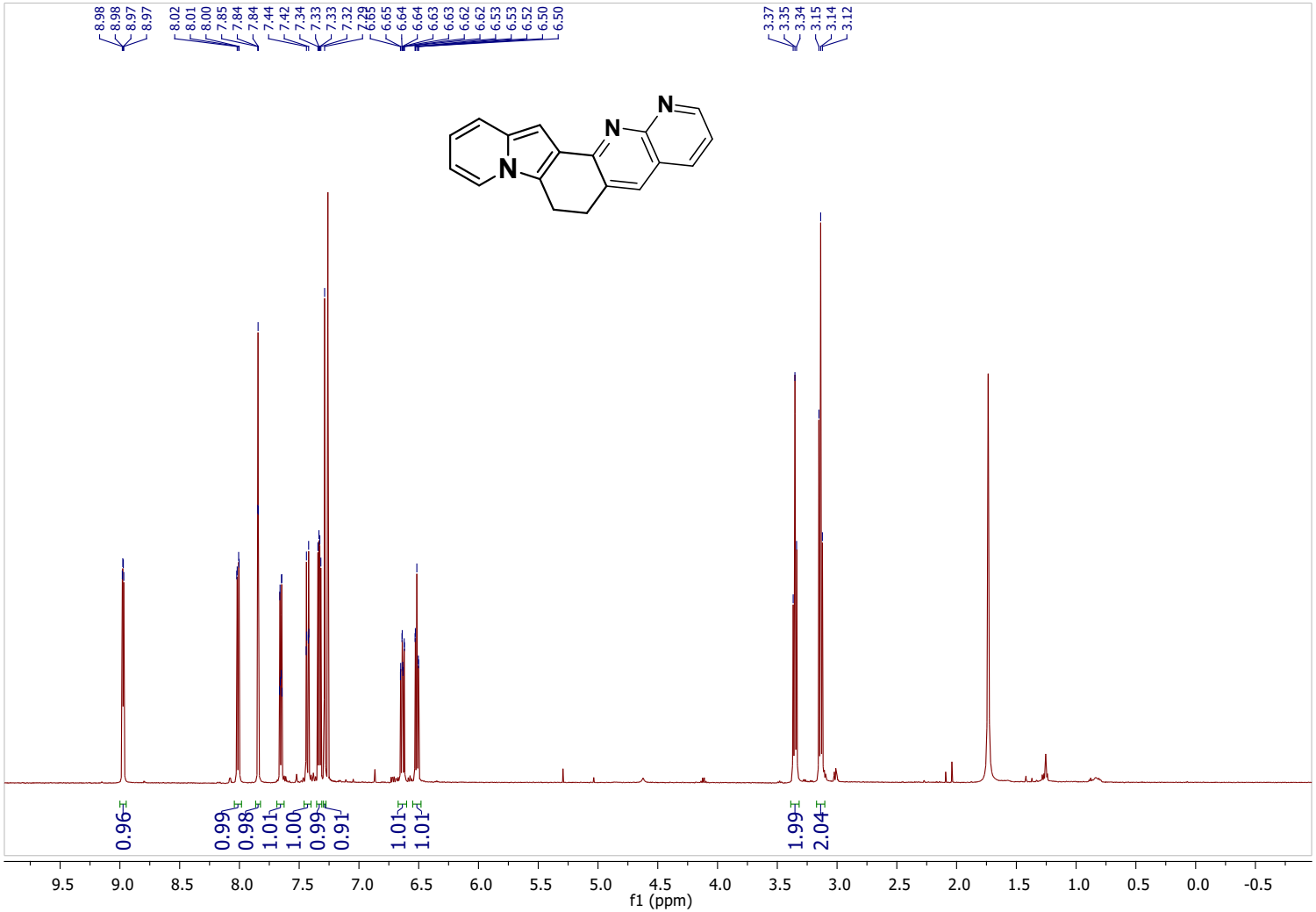


Figure S61. ^{1}H NMR spectrum (500 MHz, $CDCl_3$) of compound **10.**

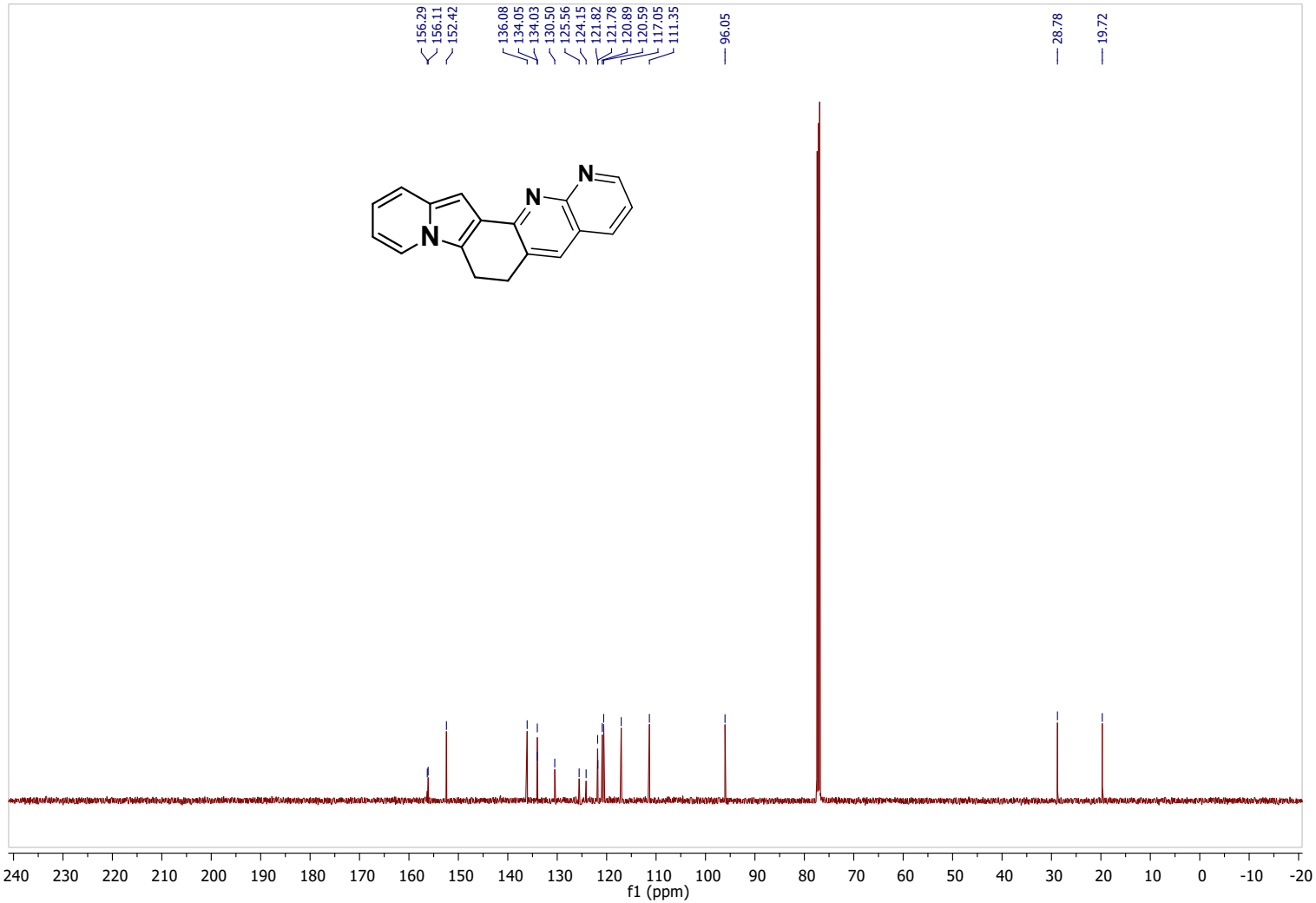


Figure S62. ^{13}C NMR spectrum (126 MHz, $CDCl_3$) of compound **10**.

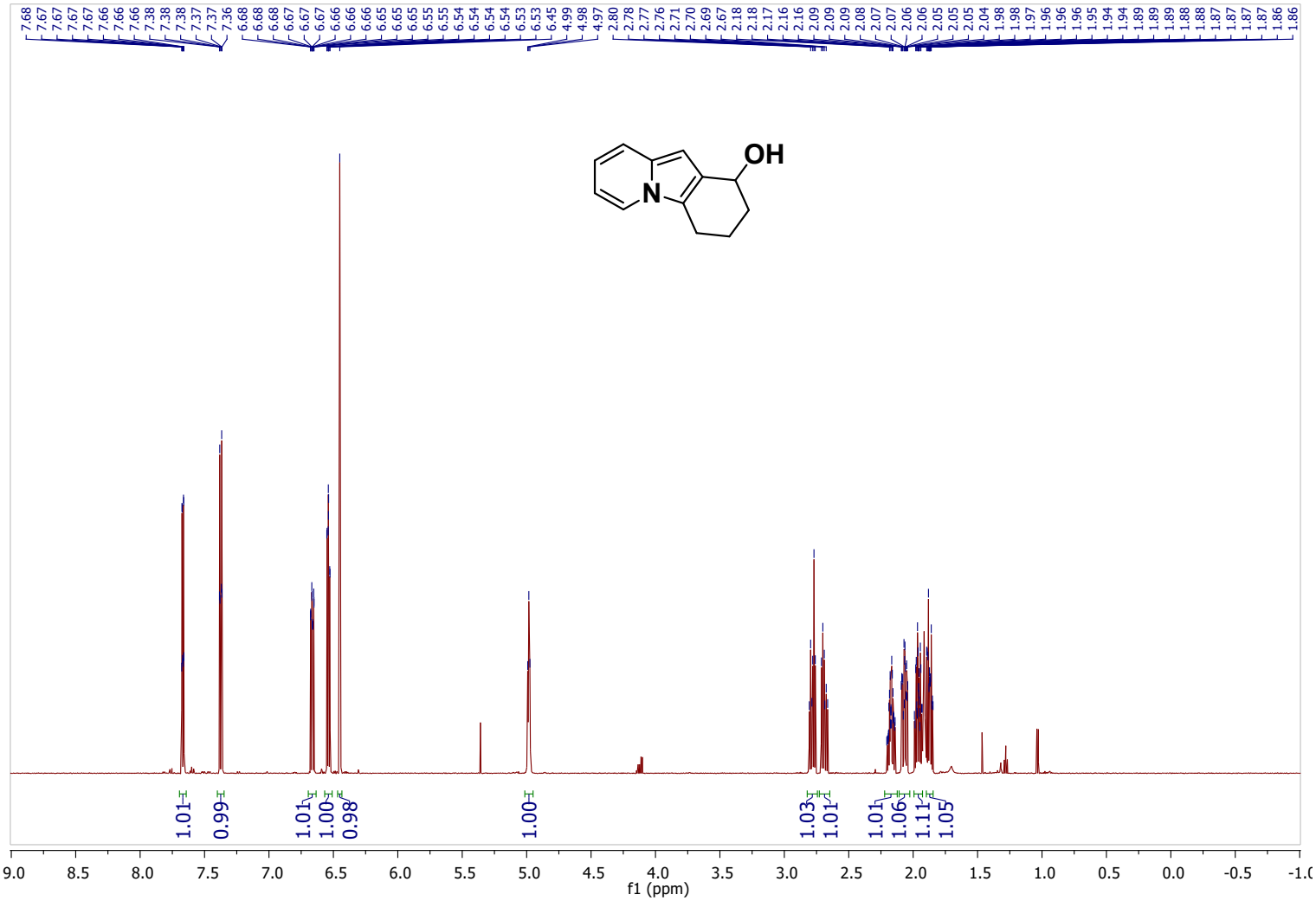


Figure S63. ^{1}H NMR spectrum (600 MHz, CD_2Cl_2) of compound *rac*-**11.**

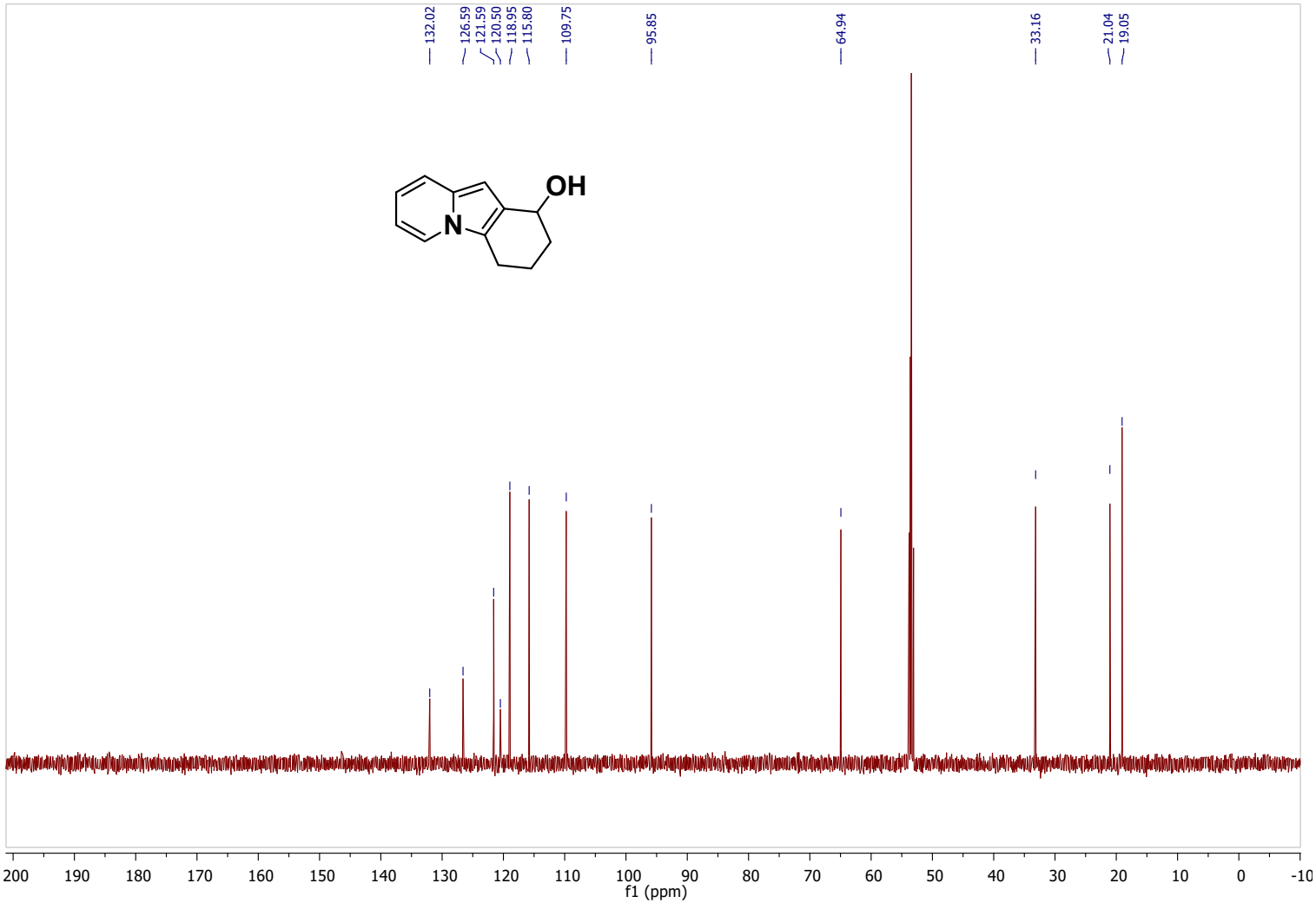


Figure S64. ^{13}C NMR spectrum (151 MHz, CD_2Cl_2) of compound *rac*-**11.**

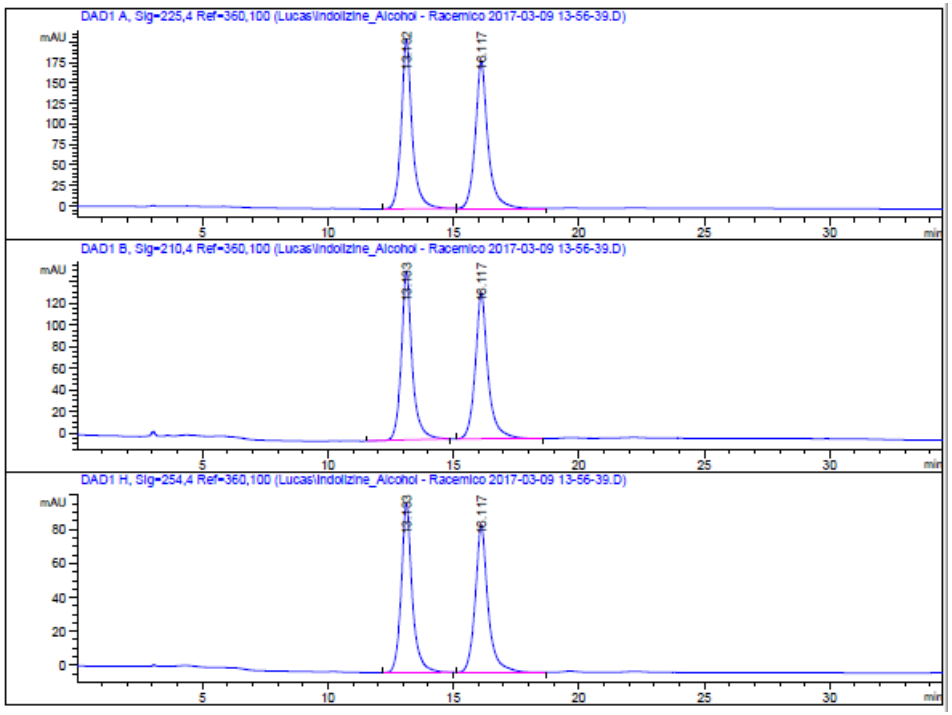
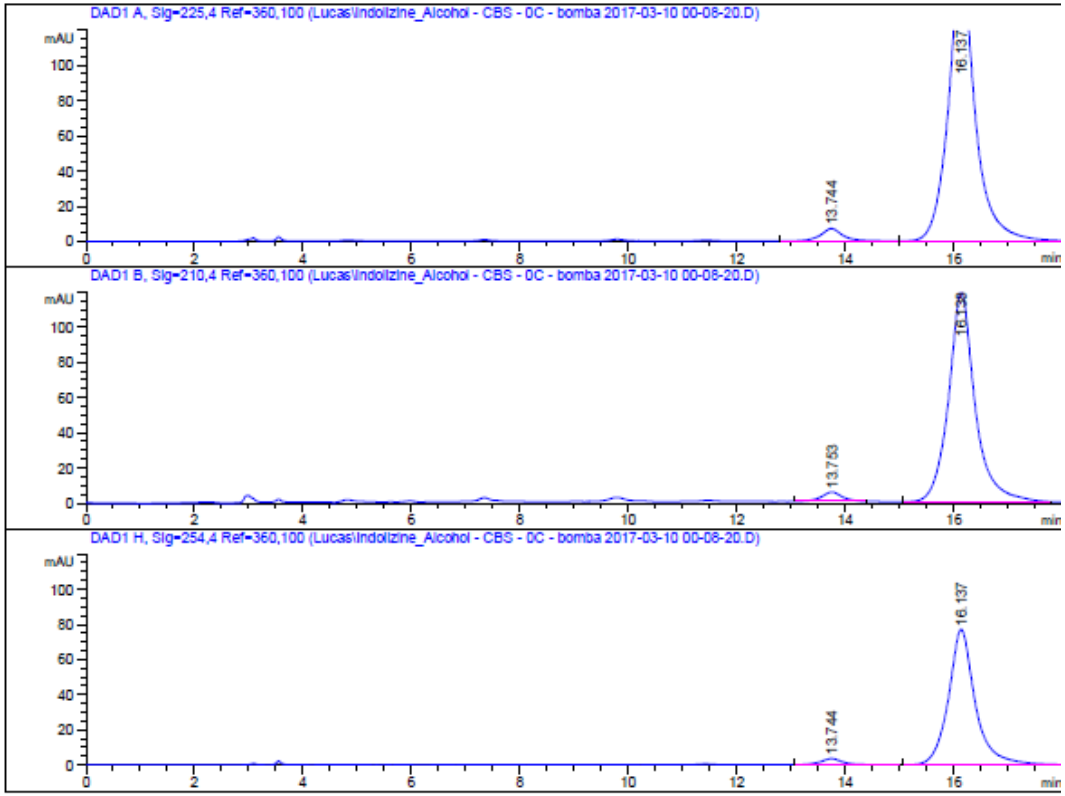


Figure S65. HPLC chromatogram of *rac*-**11.**



Signal 1: DAD1 A, Sig=225,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.744	BB	0.4112	200.18442	7.00837	3.5798
2	16.137	BB	0.4878	5391.90723	158.93221	96.4202
Totals :				5592.09164	165.94057	

Signal 2: DAD1 B, Sig=210,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.753	BB	0.3736	134.34132	5.19612	3.2085
2	16.138	BB	0.4884	4052.70044	119.27126	96.7915
Totals :				4187.04176	124.46738	

Signal 3: DAD1 H, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.744	BB	0.4132	98.85618	3.48174	3.5997
2	16.137	BB	0.4953	2647.38110	76.96729	96.4003
Totals :				2746.23728	80.44903	

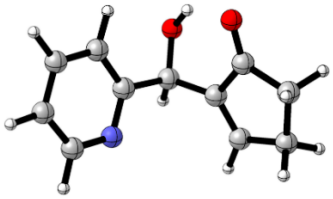
*** End of Report ***

Figure S66. HPLC chromatogram of (*R*)-**11.**

Computational Calculations

Table S1: Cartesian coordinates obtained for each species at the ωB97xD/aug-cc-pVTZ level in water using the IEFPCM implicit solvent model. The corresponding Gibbs free energies (hartrees) and lowest harmonic vibrational frequency (LHVF) are given for each case.

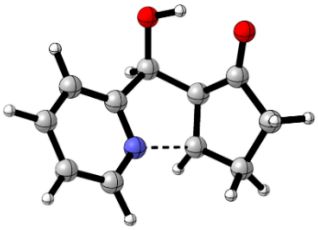
Starting material 5 members



Gibbs free energy = -630.842490 hartrees
LHVF = 25.3465 cm^{-1}

C	1.202747	0.110553	0.503400
C	1.950722	1.033882	-0.210873
C	3.093354	0.600620	-0.863834
C	3.450500	-0.733484	-0.776978
C	2.642108	-1.579300	-0.033940
N	1.541967	-1.174863	0.593366
H	3.695506	1.297146	-1.430802
H	1.648198	2.069182	-0.249392
H	4.333717	-1.114991	-1.267800
H	2.891485	-2.629292	0.062975
C	-0.078661	0.496072	1.236481
H	-0.010944	0.067828	2.236752
C	-1.271001	-0.091378	0.532482
C	-1.919501	-1.229850	0.782182
C	-1.890808	0.570866	-0.625482
H	-1.674656	-1.909154	1.587658
C	-3.016939	-0.304212	-1.126859
C	-3.039580	-1.501579	-0.172919
H	-2.813580	-0.587484	-2.159281
H	-3.945656	0.264836	-1.124760
H	-2.881604	-2.450872	-0.686040
H	-3.985388	-1.590985	0.362763
O	-1.557424	1.650247	-1.085665
O	-0.220856	1.891489	1.396823
H	-0.562247	2.240801	0.563150

Transition state 5 members

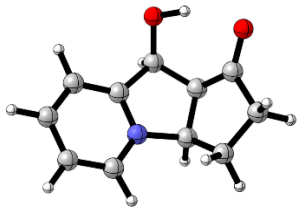


Gibbs free energy = -630.801502 hartrees
LHVF = -317.8570cm^{-1}

C	1.034254	0.562897	0.348795
C	2.197540	1.159225	-0.099531
C	3.217126	0.345998	-0.566855
C	3.060278	-1.033718	-0.555427
C	1.876982	-1.558658	-0.074220
N	0.903887	-0.757645	0.344187
H	4.133182	0.783543	-0.937873
H	2.291438	2.234811	-0.089079
H	3.837267	-1.691195	-0.914209
H	1.689445	-2.622951	-0.030203
C	-0.211809	1.301137	0.890207
H	-0.001256	1.529149	1.940611
C	-1.278783	0.271336	0.712734
C	-0.866205	-1.036015	1.018804
C	-2.130779	0.250532	-0.409633
H	-0.485453	-1.325314	1.990240
C	-2.538725	-1.185035	-0.703969
C	-1.679407	-2.037810	0.239344
H	-2.350288	-1.390394	-1.757637
H	-3.605618	-1.326783	-0.531891
H	-1.030918	-2.728953	-0.298150
H	-2.273405	-2.638623	0.927239
O	-2.480344	1.225847	-1.106713
O	-0.450717	2.512873	0.220141
H	-1.165941	2.331137	-0.417277

Prod 5 members

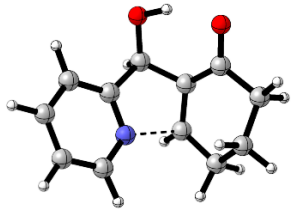
Starting material 6 members



Gibbs free energy = -630.810268hartrees
LHVF = 36.2989 cm^{-1}

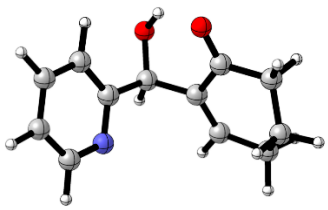
C	1.000157	0.709484	0.291584
C	2.173938	1.284800	-0.143809
C	3.218873	0.460092	-0.523516
C	3.081382	-0.920918	-0.442075
C	1.894705	-1.446715	0.008674
N	0.894006	-0.626986	0.342443
H	4.144793	0.888576	-0.878899
H	2.254635	2.360025	-0.187147
H	3.883375	-1.583351	-0.726124
H	1.708768	-2.505683	0.102778
C	-0.291247	1.379919	0.754902
H	-0.098564	1.777717	1.760742
C	-1.225802	0.210423	0.707850
C	-0.473294	-1.057801	0.838985
C	-2.264219	0.095654	-0.184874
H	-0.283488	-1.425522	1.850028
C	-2.503690	-1.380721	-0.488919
C	-1.208865	-2.085862	-0.040030
H	-2.704569	-1.507872	-1.552424
H	-3.375402	-1.752089	0.052559
H	-0.596963	-2.337313	-0.906426
H	-1.392747	-3.010006	0.502476
O	-2.917228	1.033540	-0.740824
O	-0.668226	2.443926	-0.085431
H	-1.525864	2.174571	-0.477258

Transition State 6 members



Gibbs free energy = -670.094889 hartrees
LHVF = -308.8975 cm^{-1}

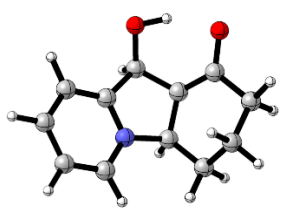
C	1.281823	0.560325	0.314085



Gibbs free energy = -670.131597 hartrees
LHVF = 93.4506 cm^{-1}

C	1.436026	0.098708	0.493650
C	2.321084	0.904421	-0.207372
C	3.388974	0.310828	-0.859870
C	3.541068	-1.062898	-0.786597
C	2.610991	-1.783554	-0.054920
N	1.580742	-1.223832	0.572059
H	4.092208	0.914679	-1.416779
H	2.178825	1.973549	-0.238514
H	4.359133	-1.568105	-1.278643
H	2.698988	-2.860005	0.033168
C	0.230753	0.665471	1.240038
H	0.283164	0.270328	2.255053
C	-1.060958	0.176901	0.616917
C	-1.791630	-0.796547	1.169720
C	-1.514432	0.821893	-0.630335
C	-3.023628	-1.378593	0.560671
H	-1.474981	-1.204538	2.123556
C	-2.802113	0.337647	-1.243936
C	-3.085258	-1.126400	-0.939559
H	-3.894728	-0.938230	1.058668
H	-3.061774	-2.445687	0.780142
H	-2.769000	0.542724	-2.312473
H	-3.593772	0.966237	-0.820966
H	-2.338710	-1.749457	-1.436795
H	-4.058607	-1.410505	-1.335930
O	-0.896700	1.760086	-1.116123
O	0.270373	2.070901	1.358693
H	0.019423	2.420671	0.494106

Prod 6 members

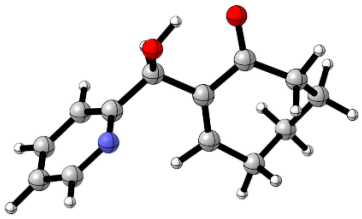


Gibbs free energy = -670.104937 hartrees
LHVF = 46.7080 cm^{-1}

C	1.231304	0.728872	0.257049

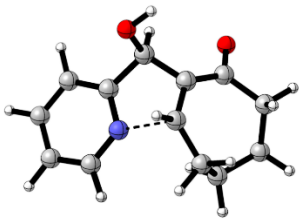
C	2.464173	1.041788	-0.214279	C	2.422760	1.196165	-0.250403
C	3.393941	0.127786	-0.684034	C	3.388331	0.279143	-0.628560
C	3.132003	-1.232804	-0.594304	C	3.154359	-1.080767	-0.467297
C	1.935053	-1.638179	-0.035414	C	1.952882	-1.495563	0.056519
N	1.048162	-0.743532	0.382275	N	1.024927	-0.591248	0.379707
H	4.322037	0.472462	-1.117943	H	4.326296	0.619096	-1.043172
H	2.640382	2.105847	-0.261958	H	2.576065	2.259439	-0.350967
H	3.837300	-1.966424	-0.953707	H	3.893016	-1.815475	-0.745240
H	1.668822	-2.681356	0.069093	H	1.709697	-2.533834	0.214960
C	0.124332	1.403552	0.883971	C	0.016824	1.503601	0.738827
H	0.356523	1.538838	1.948661	H	0.242219	1.815225	1.772286
C	-1.057951	0.491533	0.695596	C	-1.031414	0.424291	0.665452
C	-0.735940	-0.802398	1.144776	C	-0.352834	-0.863047	0.982100
C	-2.003220	0.702405	-0.324252	C	-2.153423	0.542123	-0.109077
C	-1.487714	-2.005333	0.671172	C	-1.054918	-2.118010	0.485806
H	-0.310682	-0.903862	2.138270	H	-0.128212	-0.976880	2.047151
C	-2.898672	-0.461877	-0.700997	C	-2.876792	-0.729063	-0.517606
C	-2.123880	-1.775896	-0.690916	C	-1.887758	-1.865233	-0.762300
H	-2.258844	-2.212730	1.420106	H	-1.713283	-2.441070	1.294518
H	-0.828702	-2.873829	0.670189	H	-0.347799	-2.933340	0.336620
H	-3.319512	-0.255292	-1.683738	H	-3.446710	-0.506765	-1.419366
H	-3.731501	-0.512865	0.006412	H	-3.595882	-1.019348	0.254062
H	-1.340636	-1.737426	-1.452298	H	-1.235222	-1.601590	-1.598960
H	-2.778876	-2.608196	-0.945623	H	-2.412017	-2.779446	-1.041064
O	-2.151702	1.803090	-0.914072	O	-2.602641	1.666387	-0.545192
O	0.029429	2.667004	0.287615	O	-0.237918	2.635085	-0.046180
H	-0.758940	2.613402	-0.294160	H	-1.174103	2.505875	-0.350861

Starting material 7 members



Gibbs free energy = -709.406403 hartrees
LHVF = 29.1817 cm^{-1}

Transition state 7 members

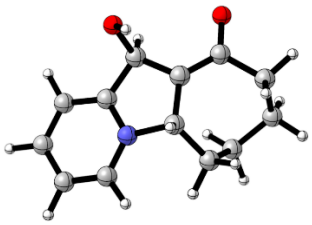


Gibbs free energy = -709.371720 hartrees
LHVF = -305.5719 cm^{-1}

C	-1.818358	0.406377	-0.172140	C	-1.475932	0.653840	-0.223745
C	-2.523341	-0.044091	-1.279415	C	-2.730326	0.879871	-0.755300
C	-3.716968	-0.719814	-1.087352	C	-3.684135	-0.114412	-0.662104
C	-4.169610	-0.913818	0.205463	C	-3.376774	-1.307971	-0.016711
C	-3.400683	-0.423021	1.249346	C	-2.117990	-1.483772	0.498636
N	-2.248583	0.217271	1.075295	N	-1.199280	-0.518507	0.361811
H	-4.284214	-1.082952	-1.933003	H	-4.669416	0.035833	-1.078723
H	-2.140451	0.132625	-2.274802	H	-2.942707	1.827489	-1.225513
H	-5.095841	-1.431462	0.407535	H	-4.106087	-2.095222	0.087725
H	-3.725143	-0.555462	2.274724	H	-1.819543	-2.377962	1.021321
C	-0.499995	1.122214	-0.350306	C	-0.303557	1.589786	-0.132775

H	-0.412034	1.390599	-1.408151	H	-0.082127	2.041178	-1.100575
O	-0.534539	2.312899	0.422727	O	-0.669553	2.701189	0.718973
H	0.250018	2.811265	0.174366	H	-0.350551	2.479123	1.596993
C	0.713231	0.261260	-0.013403	C	0.778799	0.703534	0.350653
C	0.633247	-1.056510	0.198966	C	0.207750	-0.582283	0.899576
C	2.002313	1.003710	-0.035219	C	2.099486	0.958523	0.018344
C	1.744064	-2.055430	0.347761	C	0.894954	-1.907237	0.517198
C	3.191367	0.428977	0.685616	C	3.141437	-0.105847	0.327408
C	2.946594	-1.802268	-0.566893	C	1.654855	-1.868742	-0.804756
H	1.327365	-3.037884	0.130242	H	0.152047	-2.703700	0.500629
H	2.065864	-2.098553	1.393659	H	1.573434	-2.171805	1.328386
C	3.892233	-0.713702	-0.062770	C	3.064988	-1.284483	-0.651669
H	2.850132	0.063812	1.655898	H	3.015284	-0.470972	1.348702
H	3.894164	1.240964	0.860484	H	4.127162	0.354350	0.272934
H	3.504961	-2.730461	-0.685623	H	1.728436	-2.878046	-1.210371
H	2.569062	-1.537972	-1.556600	H	1.083458	-1.285122	-1.528966
H	4.617282	-1.146625	0.627202	H	3.740573	-2.067178	-0.298971
H	4.457502	-0.303497	-0.899798	H	3.433702	-0.971036	-1.630256
O	2.066471	2.098835	-0.574395	O	2.485368	2.012559	-0.567633
H	-0.358597	-1.492471	0.202214	H	0.063453	-0.582192	1.984745

Prod 7 members



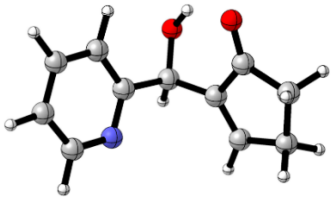
Gibbs free energy = -709.386840 hartrees
LHVF = 24.1811 cm^{-1}

C	-1.475670	0.509343	-0.224707
C	-2.754271	0.613863	-0.735978
C	-3.636593	-0.431494	-0.546840
C	-3.234882	-1.552815	0.172086
C	-1.955654	-1.608222	0.663545
N	-1.107389	-0.597184	0.433911
H	-4.639029	-0.376497	-0.945612
H	-3.040675	1.509237	-1.265567
H	-3.906956	-2.376604	0.351684
H	-1.585798	-2.441006	1.239324
C	-0.367193	1.524212	-0.232143
H	-0.198864	1.918341	-1.235014
O	-0.787595	2.667638	0.549191
H	-0.434356	2.530699	1.431497
C	0.783153	0.747869	0.282280
C	0.312681	-0.529771	0.935758
C	2.075725	1.064278	-0.103475

C	1.078598	-1.830918	0.628587
C	3.193770	0.095469	0.250713
C	1.803729	-1.837923	-0.713288
H	0.390814	-2.673471	0.688548
H	1.791738	-1.991411	1.437308
C	3.174460	-1.153023	-0.640641
H	3.115893	-0.202710	1.298232
H	4.144771	0.614153	0.136832
H	1.935792	-2.866797	-1.048860
H	1.177912	-1.346617	-1.460657
H	3.909103	-1.862359	-0.252615
H	3.498742	-0.887309	-1.648644
O	2.376255	2.096437	-0.772500
H	0.193579	-0.461062	2.021809

Table S2: Cartesian coordinates obtained for each species at the ωB97xD/aug-cc-pVTZ level in the gas phase. The corresponding Gibbs free energies (hartrees) and lowest harmonic vibrational frequency (LHVF) are given for each case.

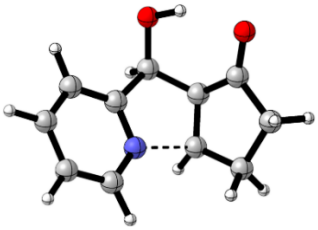
Starting material 5 members



Gibbs free energy = -630.830711 hartrees
LHVF = 31.1128 cm^{-1}

C	1.208096	0.145195	0.479537
C	2.012372	1.043103	-0.204864
C	3.151278	0.565085	-0.830393
C	3.448543	-0.783664	-0.744454
C	2.585006	-1.598806	-0.029688
N	1.487434	-1.153066	0.568701
H	3.798519	1.238646	-1.375782
H	1.748821	2.089130	-0.233041
H	4.328015	-1.199178	-1.214821
H	2.785331	-2.659706	0.067449
C	-0.068029	0.586972	1.191592
H	0.009852	0.223941	2.217752
C	-1.259915	-0.057386	0.537409
C	-1.827771	-1.231999	0.804831
C	-1.949418	0.564565	-0.608475
H	-1.501183	-1.898955	1.591202
C	-3.054834	-0.372092	-1.058071

Transition state 5 members

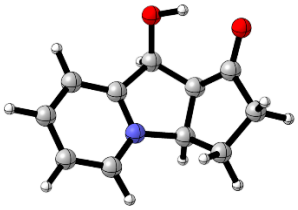


Gibbs free energy = -630.780543 hartrees
LHVF = -274.1821 cm^{-1}

C	0.999188	0.610367	0.367658
C	2.150162	1.190511	-0.132928
C	3.151560	0.365108	-0.611926
C	2.999642	-1.016434	-0.556046
C	1.836258	-1.528951	-0.023092
N	0.876629	-0.712356	0.399267
H	4.051980	0.791219	-1.032678
H	2.226787	2.267297	-0.162945
H	3.765097	-1.682092	-0.925183
H	1.645912	-2.590889	0.059086
C	-0.260376	1.337035	0.895085
H	-0.045832	1.589949	1.942876
C	-1.286765	0.261988	0.739974
C	-0.756508	-1.027240	1.012706
C	-2.110982	0.209791	-0.403857
H	-0.443645	-1.318571	2.013563
C	-2.442590	-1.250200	-0.710892

C	-2.965545	-1.572885	-0.111052
H	-2.893433	-0.635862	-2.102612
H	-4.009082	0.150367	-1.002925
H	-2.764393	-2.506867	-0.638519
H	-3.885546	-1.728814	0.454789
O	-1.682545	1.640781	-1.101821
O	-0.205874	1.983267	1.260388
H	-0.600288	2.277849	0.428831

Prod 5 members



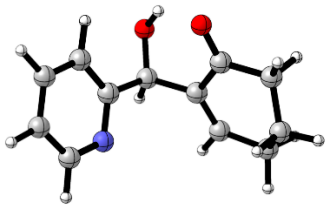
Gibbs free energy = -630.781914 hartrees
LHVF = 41.5761 cm^{-1}

C	0.969707	0.687733	0.343300
C	2.123152	1.258057	-0.160040
C	3.134279	0.429314	-0.608241
C	2.994126	-0.953045	-0.518365
C	1.832723	-1.467952	0.006510
N	0.857891	-0.644052	0.394858
H	4.036474	0.851338	-1.029011
H	2.190852	2.334287	-0.213478
H	3.771443	-1.620264	-0.857371
H	1.645033	-2.526515	0.112799
C	-0.308087	1.373045	0.848729
H	-0.092442	1.700791	1.878260
C	-1.266798	0.224497	0.758470
C	-0.550282	-1.038561	0.945861
C	-2.157707	0.128696	-0.310824
H	-0.314528	-1.360897	1.965354
C	-2.377181	-1.345541	-0.655525
C	-1.304115	-2.107640	0.140276
H	-2.274227	-1.462484	-1.734033
H	-3.385772	-1.661636	-0.391254
H	-0.630440	-2.662980	-0.514705
H	-1.735670	-2.833349	0.827209
O	-2.663306	1.060364	-0.966786
O	-0.627797	2.487336	0.078261
H	-1.426023	2.236863	-0.440469

Transition State 6 members

C	-1.530825	-2.065234	0.218489
H	-2.253634	-1.430889	-1.768579
H	-3.498398	-1.450059	-0.531955
H	-0.857594	-2.722936	-0.333933
H	-2.089406	-2.700898	0.904834
O	-2.479598	1.157614	-1.110193
O	-0.506249	2.516298	0.196056
H	-1.243476	2.322622	-0.417895

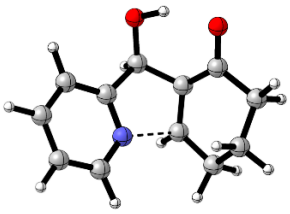
Starting material 6 members

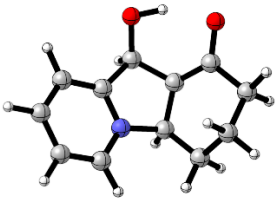


Gibbs free energy = -670.119474 hartrees
LHVF = 27.8603 cm^{-1}

C	1.433253	0.118863	0.481194
C	2.353977	0.900104	-0.200977
C	3.409147	0.273504	-0.840591
C	3.513617	-1.104849	-0.771403
C	2.549064	-1.796720	-0.056894
N	1.529582	-1.206850	0.555397
H	4.141069	0.855200	-1.384663
H	2.243017	1.973076	-0.220257
H	4.321826	-1.635152	-1.254135
H	2.598248	-2.876279	0.029053
C	0.241227	0.727755	1.216785
H	0.303592	0.369664	2.245662
C	-1.052986	0.209495	0.622655
C	-1.731950	-0.796757	1.177498
C	-1.542982	0.837042	-0.623371
C	-2.953937	-1.423638	0.586944
H	-1.371475	-1.207514	2.114174
C	-2.837025	0.317259	-1.203667
C	-3.055504	-1.160172	-0.909752
H	-3.836046	-1.027072	1.103161
H	-2.943528	-2.494691	0.792740
H	-2.840200	0.538942	-2.269215
H	-3.638057	0.911294	-0.749555
H	-2.291188	-1.746331	-1.424908
H	-4.022591	-1.484458	-1.292961
O	-0.955613	1.771362	-1.139560
O	0.288149	2.129576	1.281780
H	0.012567	2.452462	0.414837

Prod 6 members





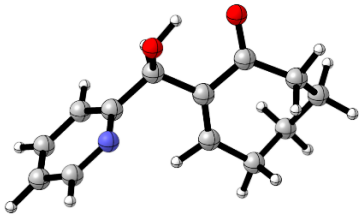
Gibbs free energy = -670.074700 hartrees
LHVF = -281.5936 cm^{-1}

C	1.252313	0.610327	0.327645
C	2.423263	1.069713	-0.245497
C	3.330171	0.140507	-0.723219
C	3.066557	-1.218947	-0.592929
C	1.888789	-1.606384	0.011112
N	1.019765	-0.693238	0.429815
H	4.243430	0.468296	-1.200668
H	2.585245	2.134136	-0.328599
H	3.756490	-1.963627	-0.960070
H	1.617127	-2.644337	0.149944
C	0.085360	1.450787	0.879385
H	0.327063	1.616034	1.942402
C	-1.061737	0.490900	0.717501
C	-0.628389	-0.799171	1.133557
C	-2.010112	0.668576	-0.306401
C	-1.356592	-2.026358	0.657595
H	-0.270868	-0.892044	2.159990
C	-2.851187	-0.539452	-0.690339
C	-2.006689	-1.809772	-0.701638
H	-2.123236	-2.248824	1.405527
H	-0.685121	-2.887699	0.652729
H	-3.285113	-0.338262	-1.667893
H	-3.676003	-0.642867	0.020282
H	-1.228978	-1.715563	-1.465115
H	-2.611303	-2.676969	-0.969083
O	-2.198207	1.750583	-0.898637
O	-0.019804	2.679737	0.243559
H	-0.833488	2.617474	-0.308165

Gibbs free energy = -670.076294 hartrees
LHVF = 48.4528 cm^{-1}

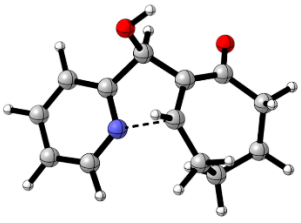
C	1.220322	0.705479	0.300642
C	2.394675	1.157111	-0.268178
C	3.320043	0.227797	-0.703828
C	3.074548	-1.131611	-0.532743
C	1.896547	-1.525482	0.057092
N	1.002183	-0.608318	0.429354
H	4.235961	0.552924	-1.177620
H	2.540106	2.220939	-0.380630
H	3.783029	-1.876701	-0.860067
H	1.637955	-2.559984	0.223511
C	0.024596	1.502573	0.810348
H	0.267329	1.759089	1.859490
C	-1.047340	0.449524	0.710658
C	-0.412878	-0.836042	1.052953
C	-2.089731	0.579498	-0.195191
C	-1.122546	-2.087963	0.569087
H	-0.163133	-0.943034	2.116768
C	-2.830520	-0.686730	-0.602660
C	-1.866880	-1.861457	-0.739797
H	-1.840040	-2.352100	1.349047
H	-0.434605	-2.933596	0.502455
H	-3.335827	-0.475751	-1.543385
H	-3.601552	-0.918264	0.137495
H	-1.152360	-1.648341	-1.540676
H	-2.397323	-2.772029	-1.021900
O	-2.437278	1.673672	-0.713703
O	-0.169507	2.663727	0.078447
H	-1.065549	2.549712	-0.338218

Starting material 7 members



Gibbs free energy = -709.391351 hartrees
LHVF = 28.4687 cm^{-1}

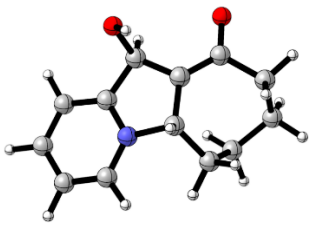
Transition state 7 members



Gibbs free energy = -709.350448 hartrees
LHVF = -292.2495 cm^{-1}

C	1.826901	0.379732	0.151907	C	-1.491738	0.610238	-0.109127
C	2.648138	0.140190	1.245190	C	-2.710906	0.799773	-0.738355
C	3.851650	-0.516826	1.051666	C	-3.553787	-0.285268	-0.894122
C	4.195967	-0.905078	-0.229899	C	-3.181118	-1.528211	-0.395636
C	3.310373	-0.621270	-1.259367	C	-1.965756	-1.639777	0.246636
N	2.151069	-0.002429	-1.081726	N	-1.159465	-0.590601	0.349597
H	4.510055	-0.715136	1.886532	H	-4.503313	-0.167920	-1.397940
H	2.348856	0.470907	2.230190	H	-2.982924	1.783472	-1.090609
H	5.126242	-1.415442	-0.434330	H	-3.816372	-2.393756	-0.508322
H	3.544711	-0.910592	-2.277597	H	-1.611924	-2.571706	0.667628
C	0.511966	1.104379	0.325835	C	-0.425124	1.654633	0.175204
H	0.440160	1.412679	1.375773	H	-0.262841	2.297941	-0.691499
O	0.550466	2.254006	-0.493883	O	-0.960118	2.416970	1.270198
H	-0.212045	2.786315	-0.250594	H	-0.216939	2.893753	1.643742
C	-0.711365	0.237520	0.045846	C	0.797560	0.858220	0.451370
C	-0.657956	-1.091735	-0.060130	C	0.450093	-0.321285	1.171764
C	-1.988713	1.004774	-0.007331	C	1.935854	1.039343	-0.393696
C	-1.793490	-2.072907	-0.155318	C	1.220390	-1.614891	1.104129
C	-3.153771	0.419143	-0.766053	C	3.149653	0.143305	-0.166463
C	-3.030731	-1.705505	0.669441	C	1.695079	-1.973204	-0.303402
H	-1.416246	-3.039349	0.179412	H	0.586764	-2.407741	1.507896
H	-2.069189	-2.216886	-1.205991	H	2.063720	-1.542882	1.796008
C	-3.924331	-0.651978	0.016736	C	2.995158	-1.276796	-0.717750
H	-2.770246	-0.014079	-1.691573	H	3.364224	0.097987	0.903313
H	-3.818735	1.240321	-1.025628	H	3.995855	0.629836	-0.647472
H	-3.619176	-2.604485	0.855528	H	1.825687	-3.053536	-0.380504
H	-2.692474	-1.349746	1.644862	H	0.901458	-1.707374	-1.005524
H	-4.612946	-1.133358	-0.679732	H	3.847869	-1.868214	-0.375953
H	-4.535066	-0.169454	0.780271	H	3.052214	-1.250520	-1.806838
O	-2.064558	2.108638	0.498456	O	2.011868	1.930304	-1.242998
H	0.323513	-1.548474	-0.022771	H	-0.033376	-0.179799	2.137984

Prod 7 members



Gibbs free energy = -709.355765 hartrees
LHVF = 28.7933 cm^{-1}

C	-1.461956	0.658739	-0.199038
C	-2.716587	0.884599	-0.742172
C	-3.656978	-0.122299	-0.698370
C	-3.346299	-1.333639	-0.084146
C	-2.097484	-1.500634	0.458624
N	-1.189918	-0.523290	0.368775

H	-4.637724	0.028691	-1.127405
H	-2.928785	1.849416	-1.176088
H	-4.064971	-2.136009	-0.024722
H	-1.793361	-2.403061	0.964977
C	-0.298492	1.592038	-0.089086
H	-0.053645	2.055732	-1.049700
O	-0.742928	2.638584	0.807703
H	0.052606	3.130330	1.024074
C	0.780163	0.694510	0.359608
C	0.219738	-0.554723	0.949146
C	2.097429	0.970313	-0.029963
C	0.929697	-1.881798	0.647121
C	3.167880	-0.088754	0.208905
C	1.607865	-1.924997	-0.719323
H	0.223780	-2.707946	0.754696
H	1.665222	-2.039330	1.436623
C	3.015905	-1.311369	-0.703882
H	3.149334	-0.402492	1.255930
H	4.133756	0.380833	0.033678
H	1.671440	-2.957943	-1.064834
H	0.983185	-1.392493	-1.439253
H	3.731847	-2.072441	-0.382760
H	3.292245	-1.034658	-1.722336
O	2.422898	2.034847	-0.587521
H	0.019462	-0.514962	2.029695

Table S3: Calculated relative energies (in kcal mol^{-1}) between two conformers of **6mem** transition state obtained from several DFT functionals and the DLPNO-CCSD(T) theoretical method. The DLPNO-CCSD(T)/CBS energy was used as the benchmark to obtain the mean absolute deviations (MAD).

	ΔG	MAD
B3LYP aug-cc-pVTZ	1.05	0.37
B3LYP-D3/aug-cc-pVTZ	1.46	0.17
PBE1PBE/aug-cc-pVTZ	1.27	0.27
PBE1PBE-D3/aug-cc-pVTZ	1.53	0.14
M06L/aug-cc-pVTZ	1.54	0.13
wB97xD/aug-cc-pVTZ	1.68	0.06
X3LYP/aug-cc-pVTZ	1.11	0.35
O3LYP/aug-cc-pVTZ	0.94	0.43
CAM-B3LYP/aug-cc-pVTZ	1.29	0.26
M11/aug-cc-pVTZ	1.59	0.11
M052X/aug-cc-pVTZ	1.52	0.14
HF/aug-cc-pVTZ	1.34	0.23
DLPNO-CCSD(T)/def2-TZVP	1.80	0.00

Table S4: Calculated relative energies (in kcal mol^{-1}) for 21 conformers (conformer 11 is the lowest in energy) of **7mem** transition state obtained from several DFT functionals and the DLPNO-CCSD(T) theoretical method. The DLPNO-CCSD(T)/CBS energy was used as the benchmark to obtain the mean absolute deviations (MAD).

	Conf 1	Conf 2	Conf 3	Conf 4	Conf 5	Conf 6	Conf 7	Conf 8	Conf 9	Conf 10	Conf 11	Conf 12	Conf 13	Conf 14	Conf 15	Conf 16	Conf 17	Conf 18	Conf 19	Conf 21	MAD
B3LYP aug-cc-pVTZ	3.55	3.04	3.83	4.73	5.52	3.46	3.55	5.40	4.73	5.52	0.00	18.73	18.73	22.24	18.54	0.04	3.04	0.00	3.34	2.14	**1.16**
B3LYP-D3/aug-cc-pVTZ	3.68	3.23	4.78	5.79	6.83	3.58	3.68	6.46	5.79	6.83	0.00	18.55	18.50	22.66	19.43	0.92	3.23	0.00	4.33	3.43	**1.06**
PBE1PBE/aug-cc-pVTZ	4.47	3.98	5.06	5.66	7.21	4.40	4.47	6.35	5.66	7.21	0.00	21.81	21.74	25.38	21.22	0.36	3.98	0.00	4.59	2.83	**1.90**
PBE1PBE-D3/aug-cc-pVTZ	4.55	4.09	5.67	6.30	8.02	4.48	4.55	6.99	6.30	8.02	0.00	21.78	21.62	25.69	21.86	0.92	4.09	0.00	5.22	3.63	**2.13**
M06L/aug-cc-pVTZ	4.16	3.81	5.30	6.52	8.14	4.25	4.16	7.23	6.52	8.14	0.00	18.37	18.92	22.28	19.63	0.94	3.81	0.00	4.96	4.18	**1.45**
wB97xD/aug-cc-pVTZ	3.87	3.32	5.14	5.80	7.43	3.82	3.87	6.59	5.80	7.43	0.00	19.14	18.65	23.48	19.67	1.09	3.32	0.00	4.62	3.89	**1.25**
X3LYP/aug-cc-pVTZ	3.69	3.17	4.05	4.86	5.76	3.62	3.69	5.58	4.86	5.76	0.00	18.93	18.95	22.53	18.75	0.13	3.17	0.00	3.55	2.26	**1.16**
O3LYP/aug-cc-pVTZ	2.82	2.42	2.68	3.62	4.28	2.58	2.82	4.03	3.62	4.28	0.00	19.51	19.28	22.44	18.79	-0.42	2.42	0.00	2.31	1.43	**1.57**
CAM-B3LYP/aug-cc-pVTZ	4.11	3.47	4.74	5.21	6.59	4.14	4.11	6.16	5.21	6.59	0.00	19.18	23.40	18.96	0.41	3.47	0.00	4.13	1.17	4.14	**2.44**
M11/aug-cc-pVTZ	4.44	3.81	5.80	7.10	9.20	4.51	4.44	8.15	7.10	9.20	0.00	17.22	17.20	22.15	18.01	1.21	3.81	0.00	5.20	5.27	**1.56**
M052X/aug-cc-pVTZ	4.15	3.47	5.30	6.29	8.10	4.17	4.16	7.34	6.29	8.10	0.00	19.65	19.55	24.08	20.36	0.95	3.47	0.00	4.66	4.36	**1.60**
HF/aug-cc-pVTZ	1.43	0.55	1.87	2.23	3.34	1.61	1.43	3.74	2.23	3.34	0.00	12.55	12.28	17.67	13.56	0.13	0.55	0.00	1.03	2.65	**2.03**
DLPNO-CCSD(T)/def2-TZVP	2.79	2.40	4.04	5.15	6.92	2.87	2.79	5.97	5.15	6.92	0.00	14.79	14.65	20.00	16.93	1.06	2.40	0.00	3.63	4.27	**0.00**