Acylphloroglucinols from *Elaphoglossum crassipes*: Antidepressant-like Activity of Crassipin A

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Supplementary data

S1. ^{1}H NMR spectrum of crassipin A (**1**) (acetone-d_6, 500 MHz)

S2. ^{1}H NMR spectrum (partial enlarged) of crassipin A (**1**) (acetone-d_6, 500 MHz)

S3. ^{13}C NMR spectrum of crassipin A (**1**) (acetone-d_6, 125 MHz)

S4. ^{1}H ^{1}H COSY spectrum of crassipin A (**1**) in acetone-d_6

S5. HSQC spectrum of crassipin A (**1**) in acetone-d_6

S6. HMBC spectrum of crassipin A (**1**) in acetone-d_6

S7. ^{1}H NMR spectrum of crassipin B (**2**) (acetone-d_6, 500 MHz)

S8. ^{1}H NMR spectrum (partial enlarged) of crassipin B (**2**) (acetone-d_6, 500 MHz)

S9. ^{13}C NMR spectrum of crassipin B (**2**) (acetone-d_6, 125 MHz)

S10. ^{1}H NMR spectrum of crassipin C (**3a**) (acetone-d_6, 500 MHz)

S11. ^{1}H NMR spectrum (partial enlarged) of crassipin C (**3a**) (acetone-d_6, 500 MHz)

S12. ^{13}C NMR spectrum of crassipin C (**3a**) (acetone-d_6, 125 MHz)

S13. ^{1}H NMR spectrum of crassipin D (**3b**) (acetone-d_6, 500 MHz)

S14. ^{1}H NMR spectrum (partial enlarged) of crassipin D (**3b**) (acetone-d_6, 500 MHz)

S15. ^{13}C NMR spectrum of crassipin D (**3b**) (acetone-d_6, 125 MHz)

S16. ^{1}H NMR spectrum of crassipin E (**4**) (acetone-d_6, 500 MHz)

S17. ^{1}H NMR spectrum (partial enlarged) of crassipin E (**4**) (acetone-d_6, 500 MHz)

S18. ^{13}C NMR spectrum of crassipin E (**4**) (acetone-d_6, 125 MHz)

S19. ^{1}H NMR spectrum of crassipin F (**5a**) (acetone-d_6, 500 MHz)

S20. ^{1}H NMR spectrum (partial enlarged) of crassipin F (**5a**) (acetone-d_6, 500 MHz)

S21. ^{13}C NMR spectrum of crassipin F (**5a**) (acetone-d_6, 125 MHz)

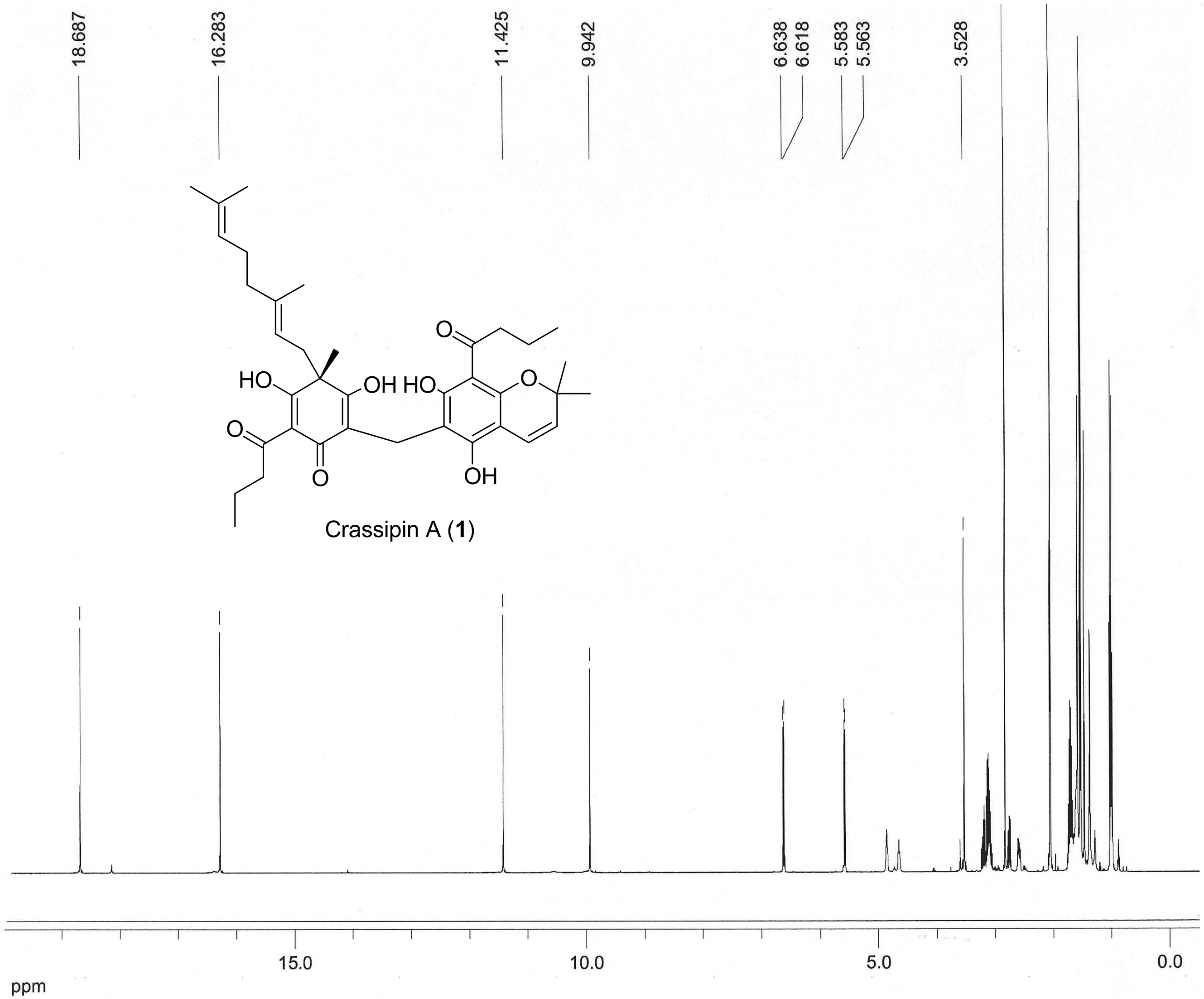
S22. ^{1}H NMR spectrum of crassipin G (**5b**) (acetone-d_6, 500 MHz)

S23. ^{1}H NMR spectrum (partial enlarged) of crassipin G (**5b**) (acetone-d_6, 500 MHz)

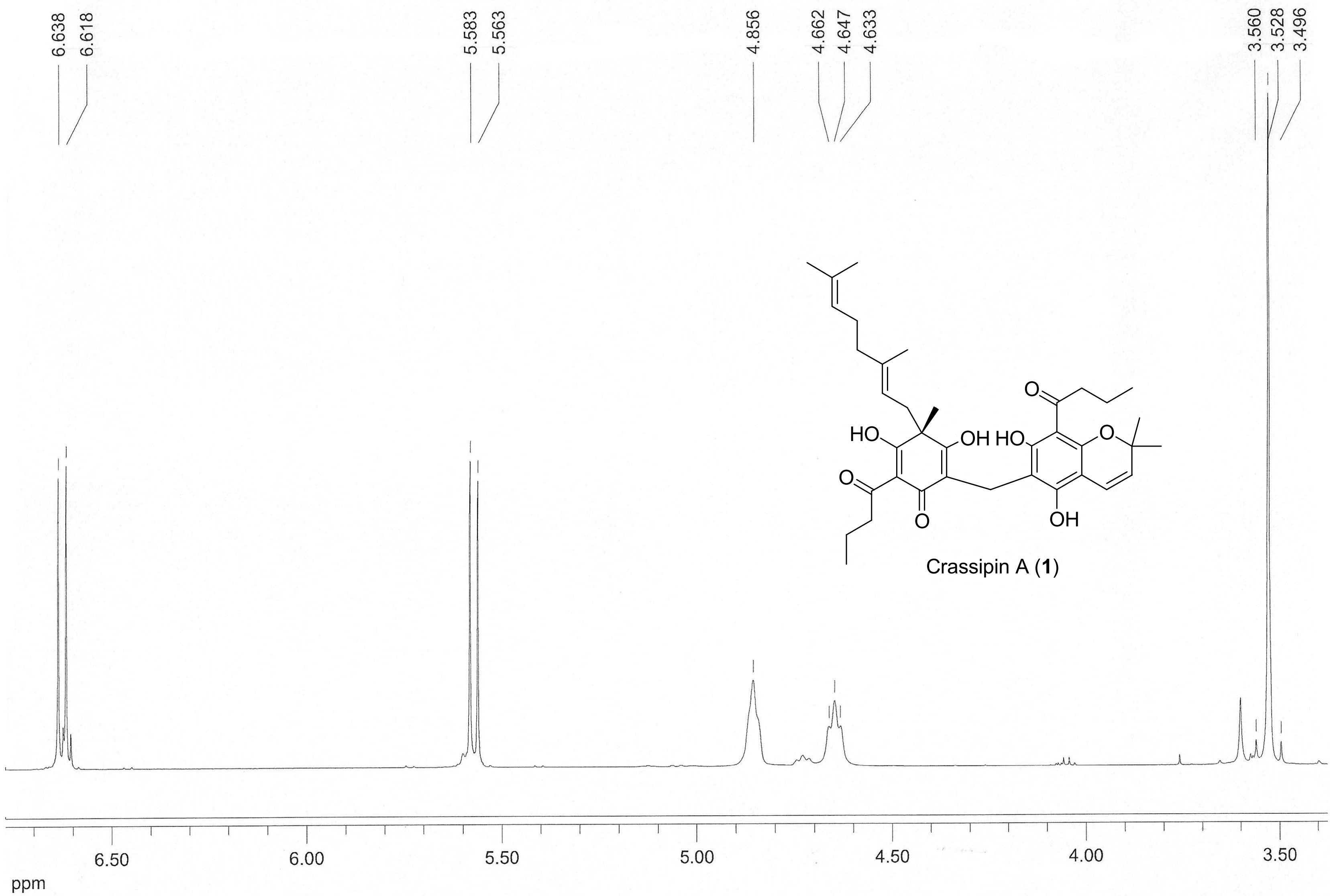
S24. ^{13}C NMR spectrum of crassipin G (**5b**) (acetone-d_6, 125 MHz)

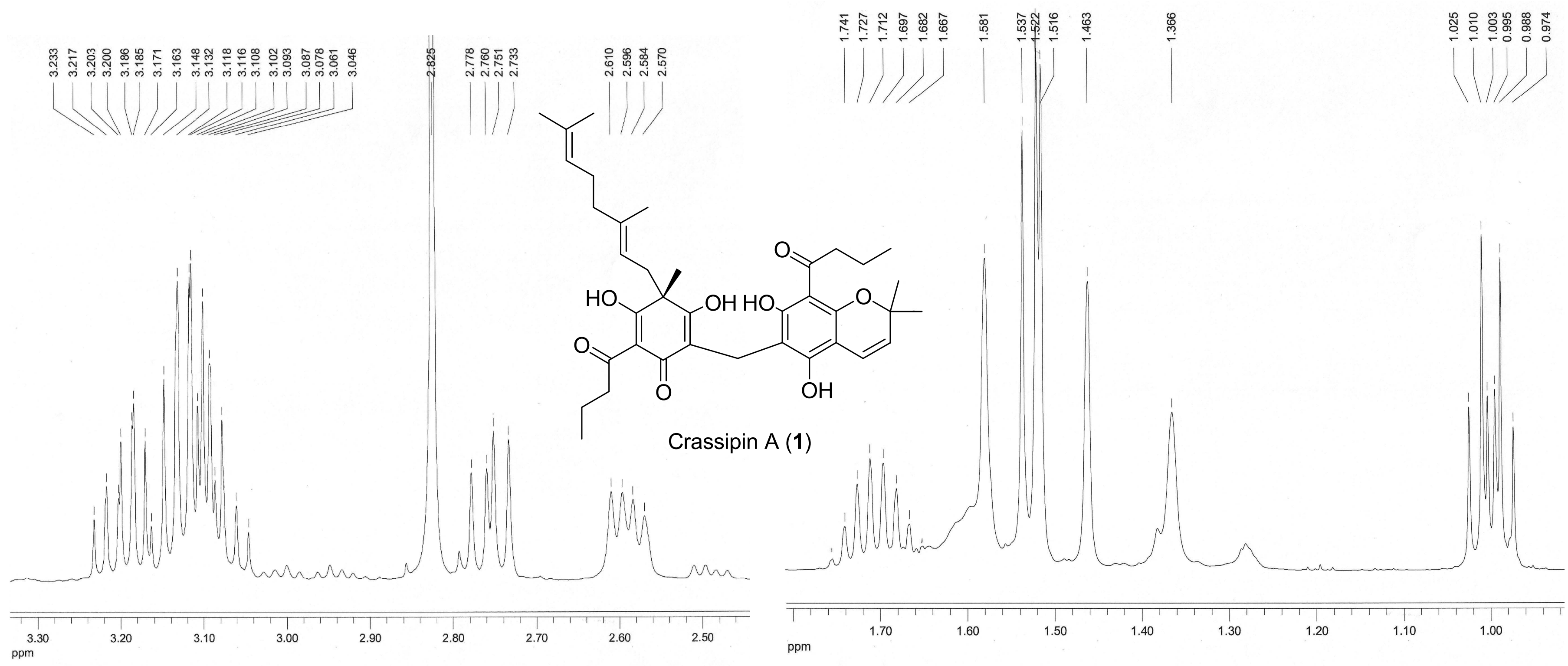
S25. ^{1}H NMR spectrum of crassipin H (**6**) (acetone-d_6, 500 MHz)

S1. ^{1}H NMR spectrum of crassipin A (**1**) (acetone-d_6, 500 MHz)



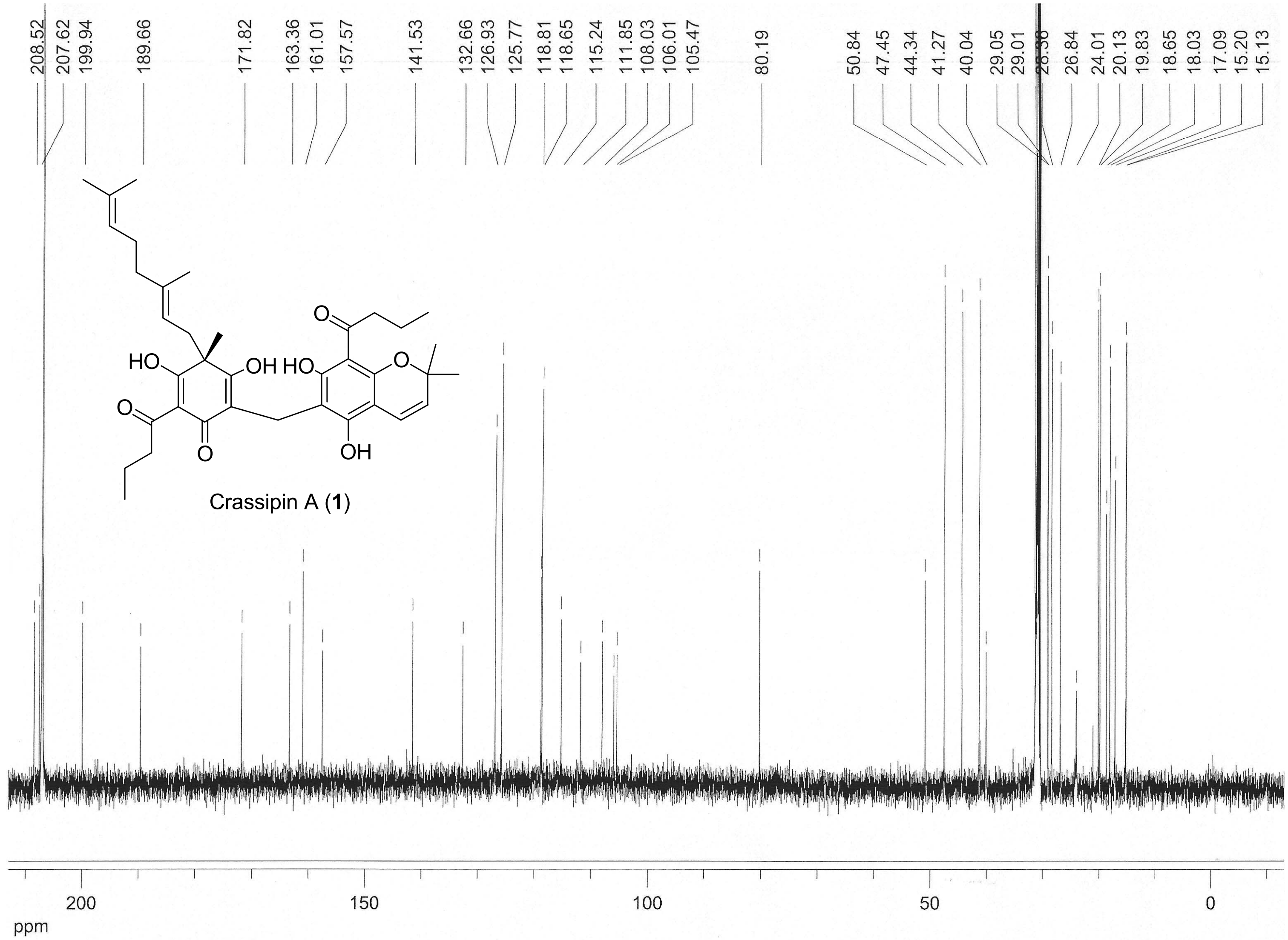
S2. ^{1}H NMR spectrum (partial enlarged) of crassipin A (**1**) (acetone-d_6, 500 MHz)



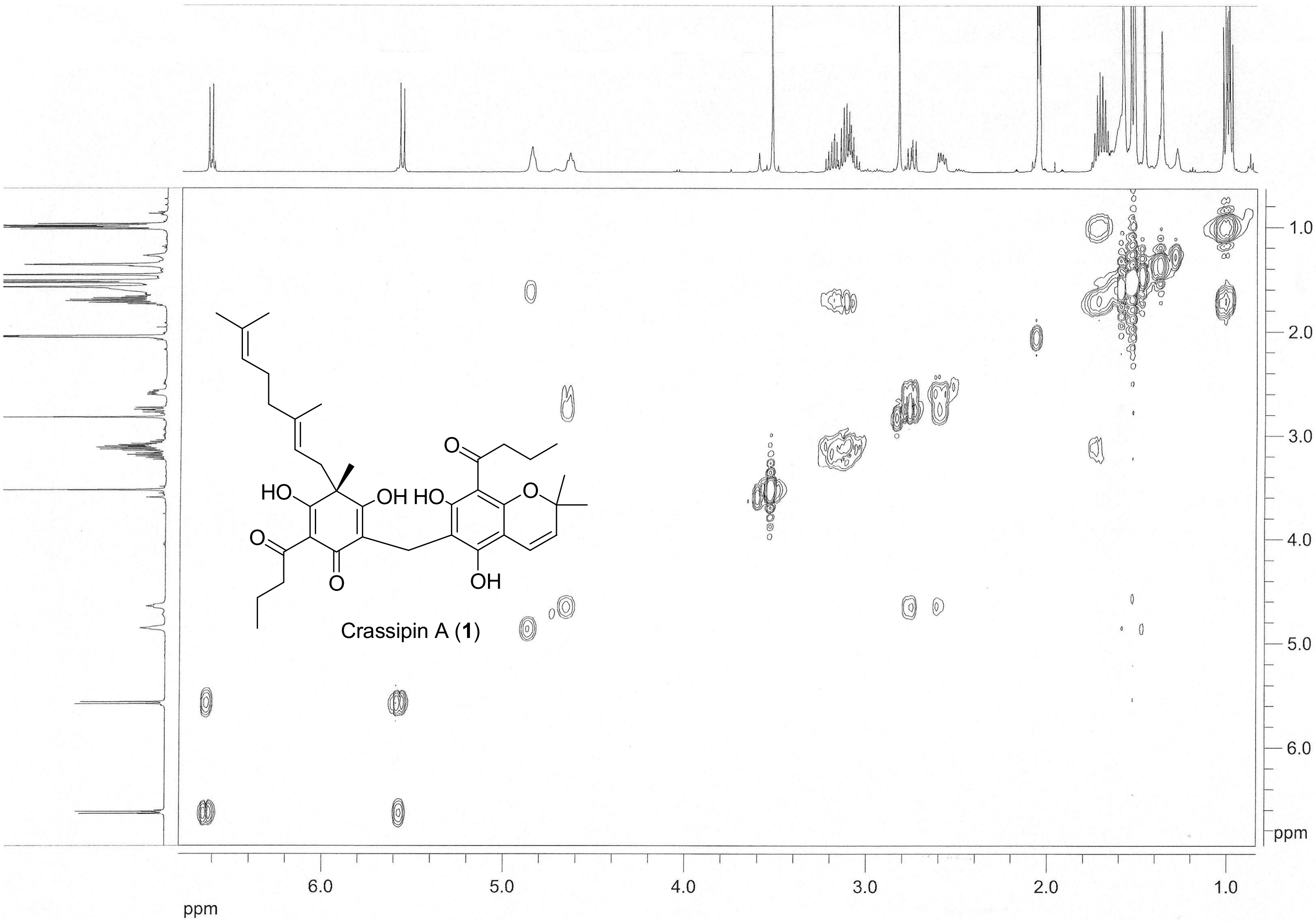


Crassipin A (**1**)

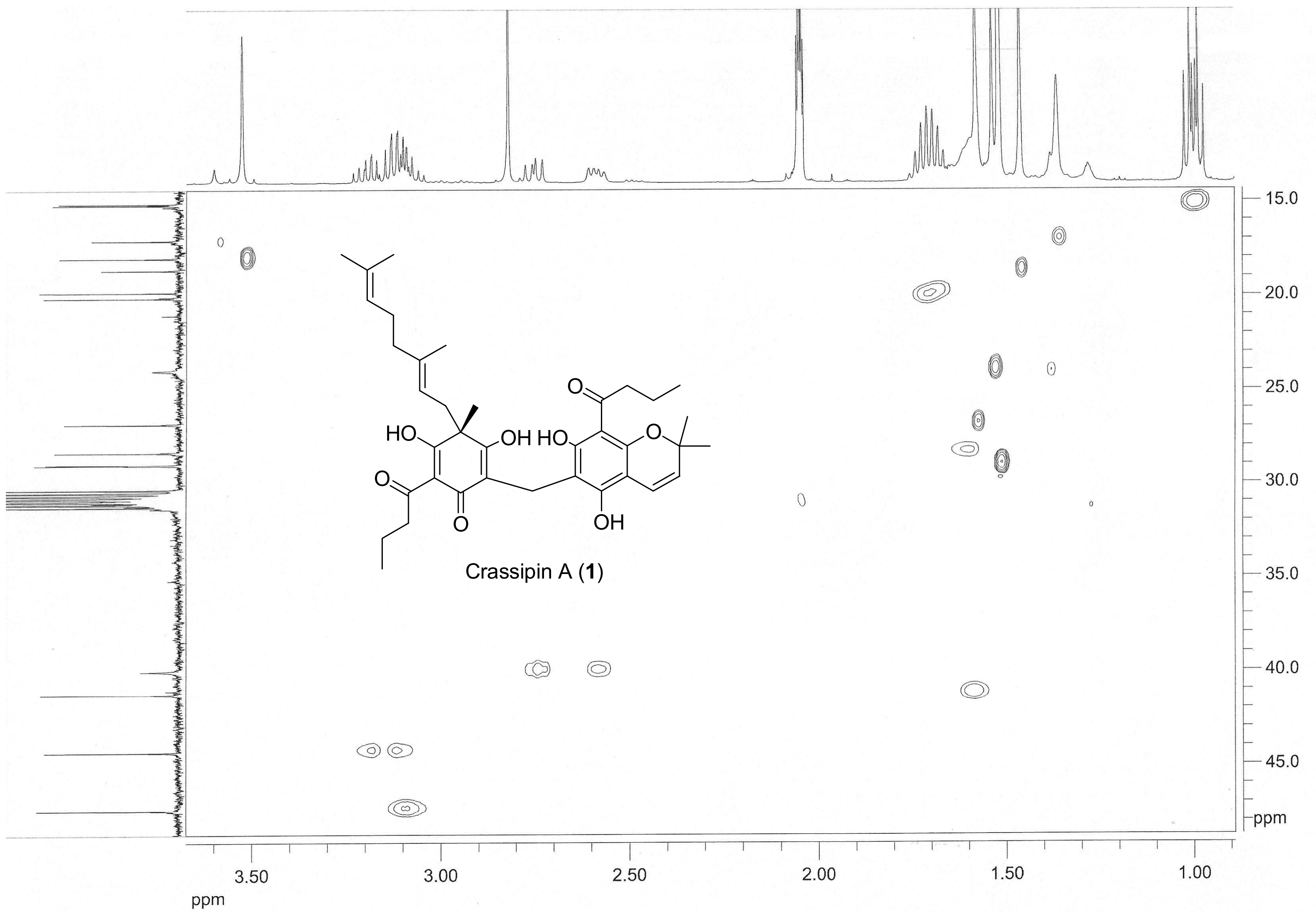
S3. ^{13}C NMR spectrum of crassipin A (**1**) (acetone-d_6, 125 MHz)



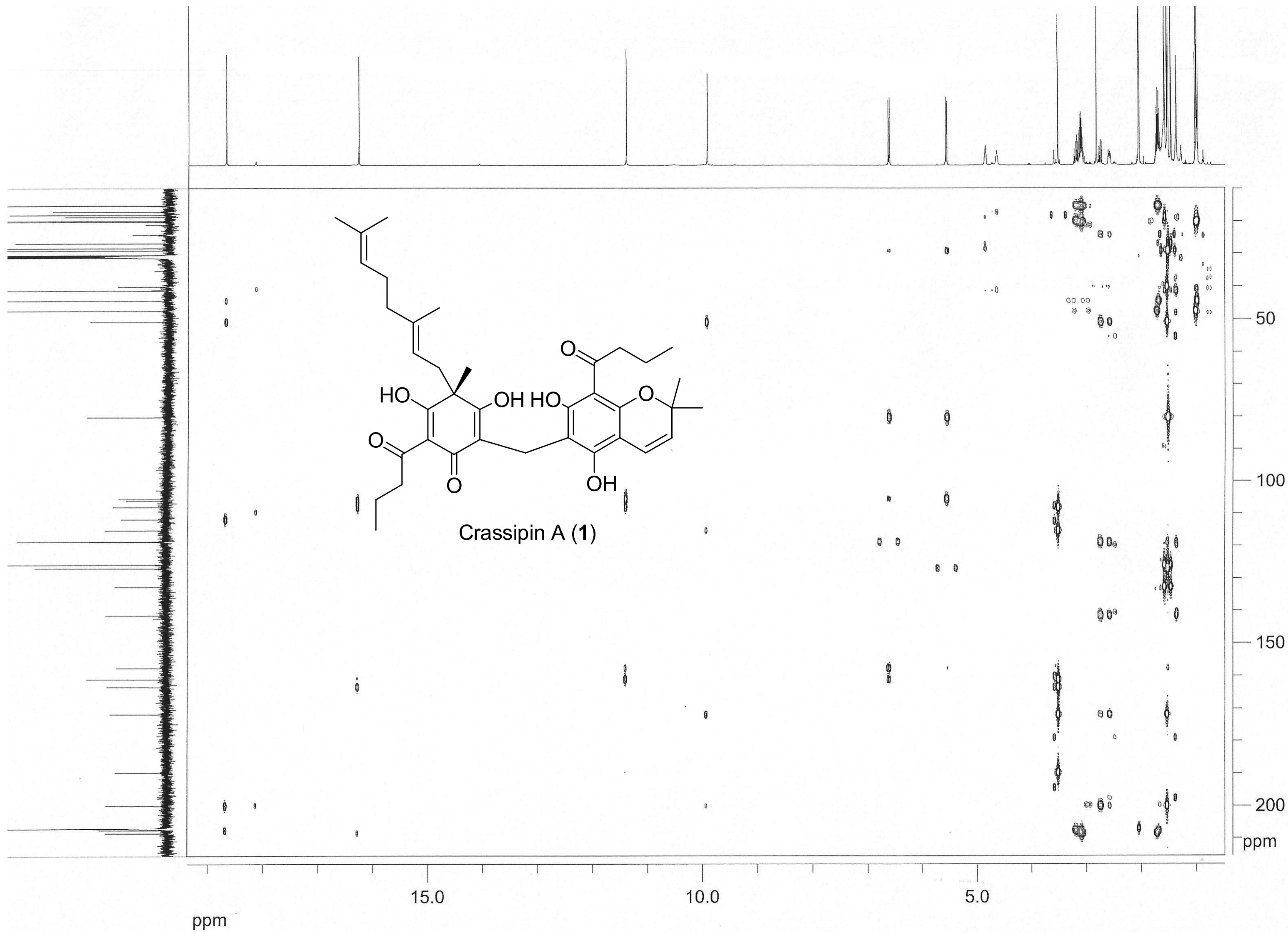
S4. ^{1}H ^{1}H COSY spectrum of crassipin A (**1**) in acetone-d_6



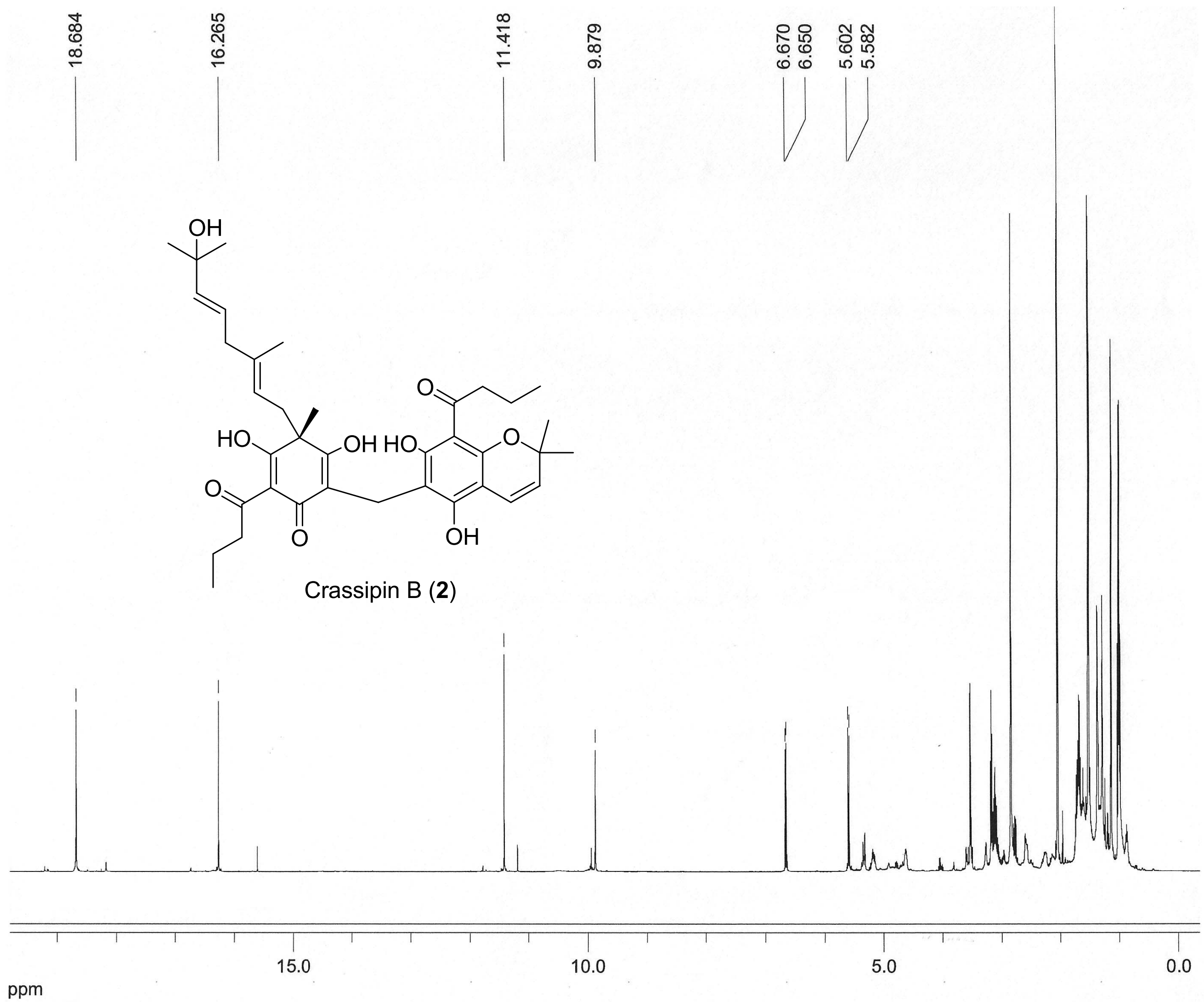
S5. HSQC spectrum of crassipin A (**1**) in acetone-d_6



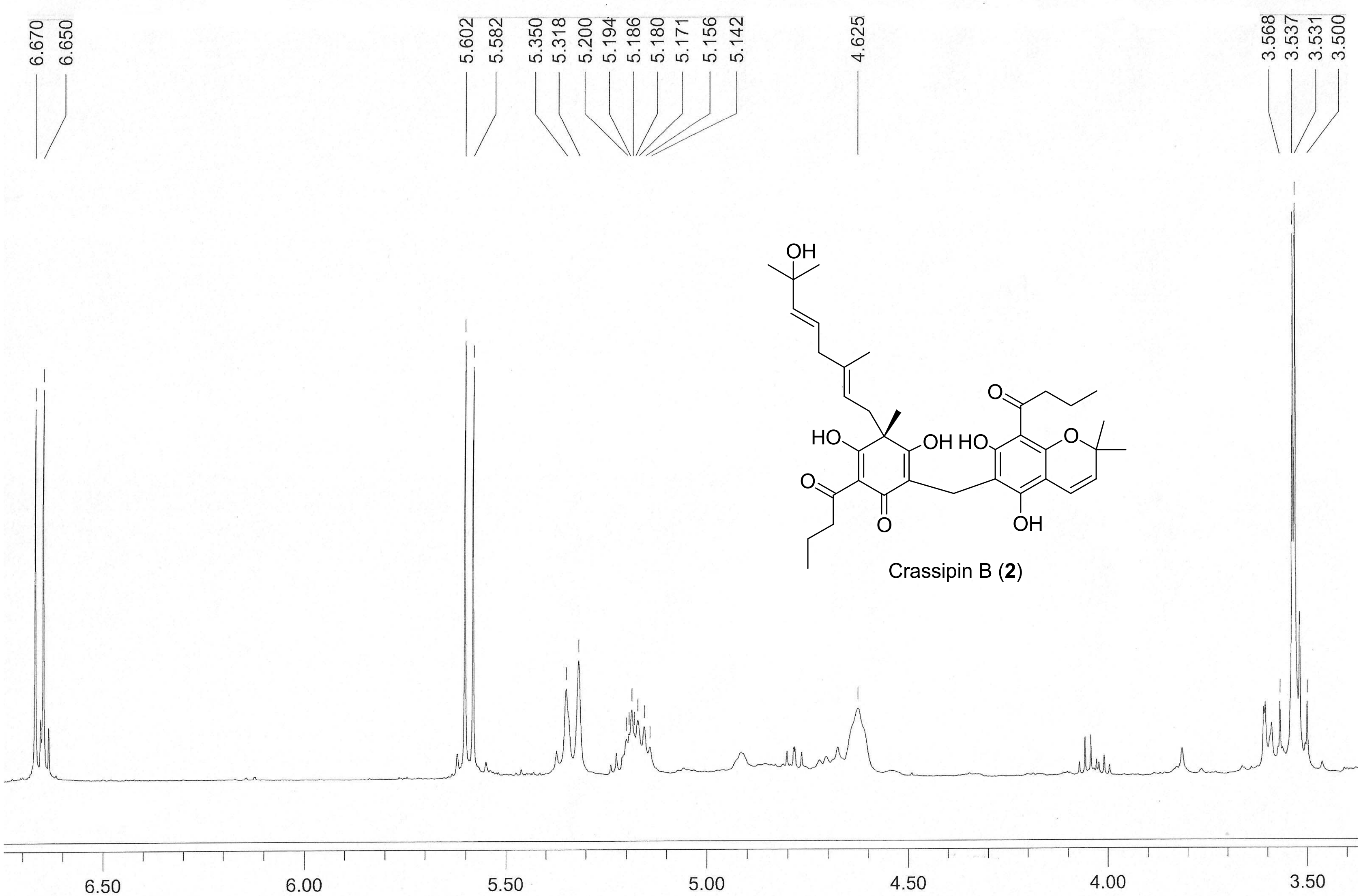
S6. HMBC spectrum of crassipin A (**1**) in acetone-d_6

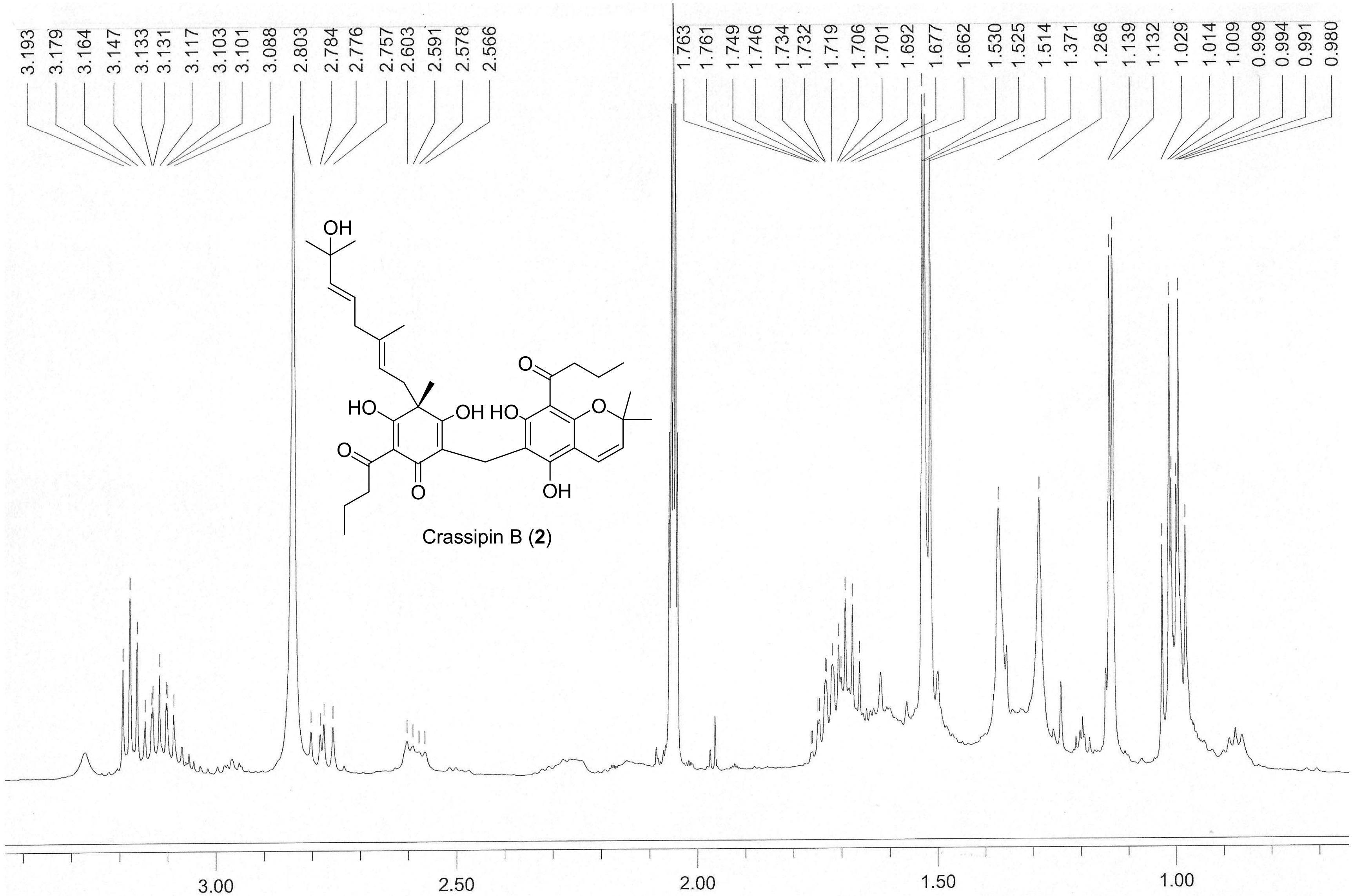


S7. ^{1}H NMR spectrum of crassipin B (**2**) (acetone-d_6, 500 MHz)

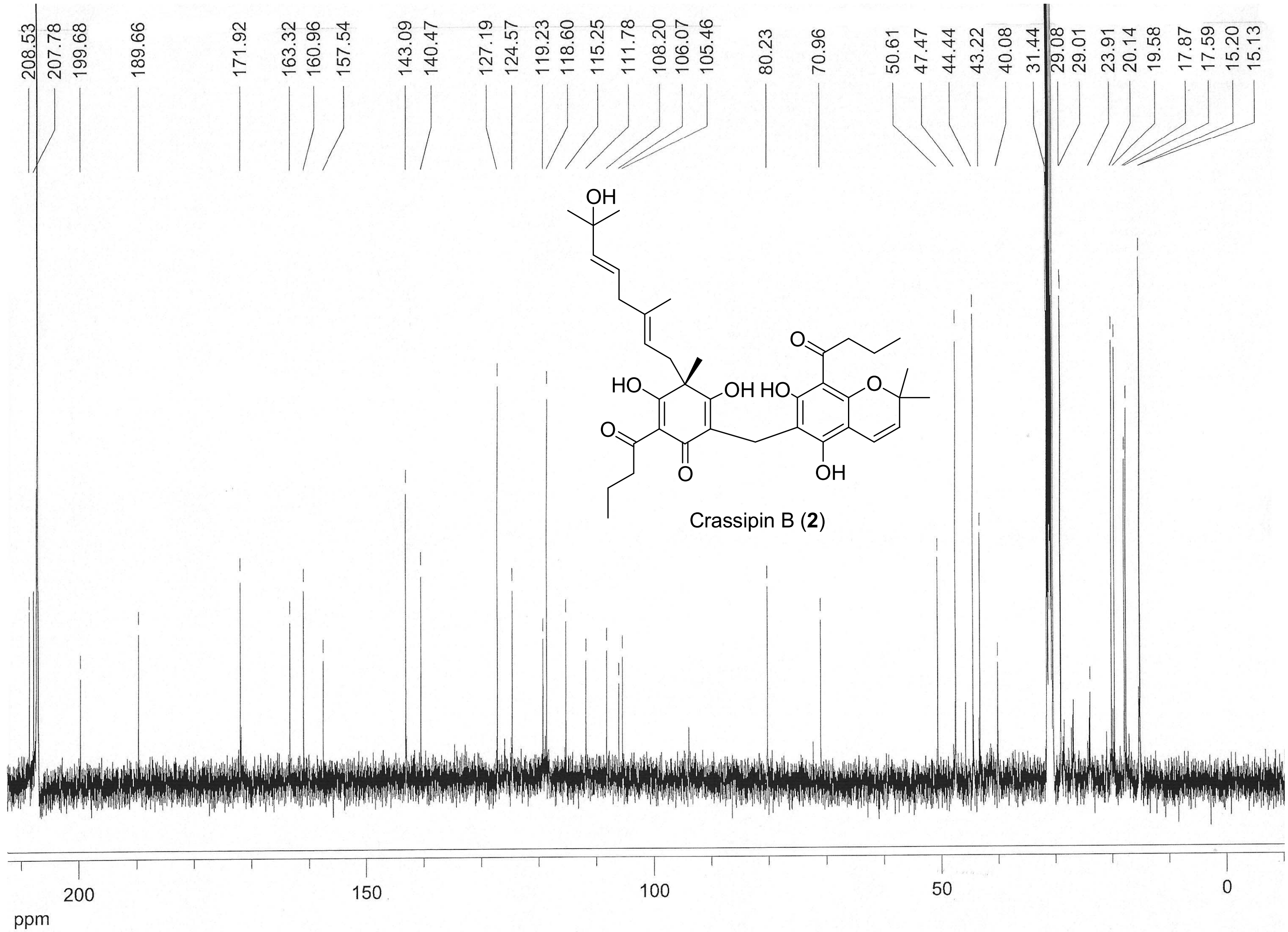


S8. [1]H NMR spectrum (partial enlarged) of crassipin B (**2**) (acetone-d_6, 500 MHz)

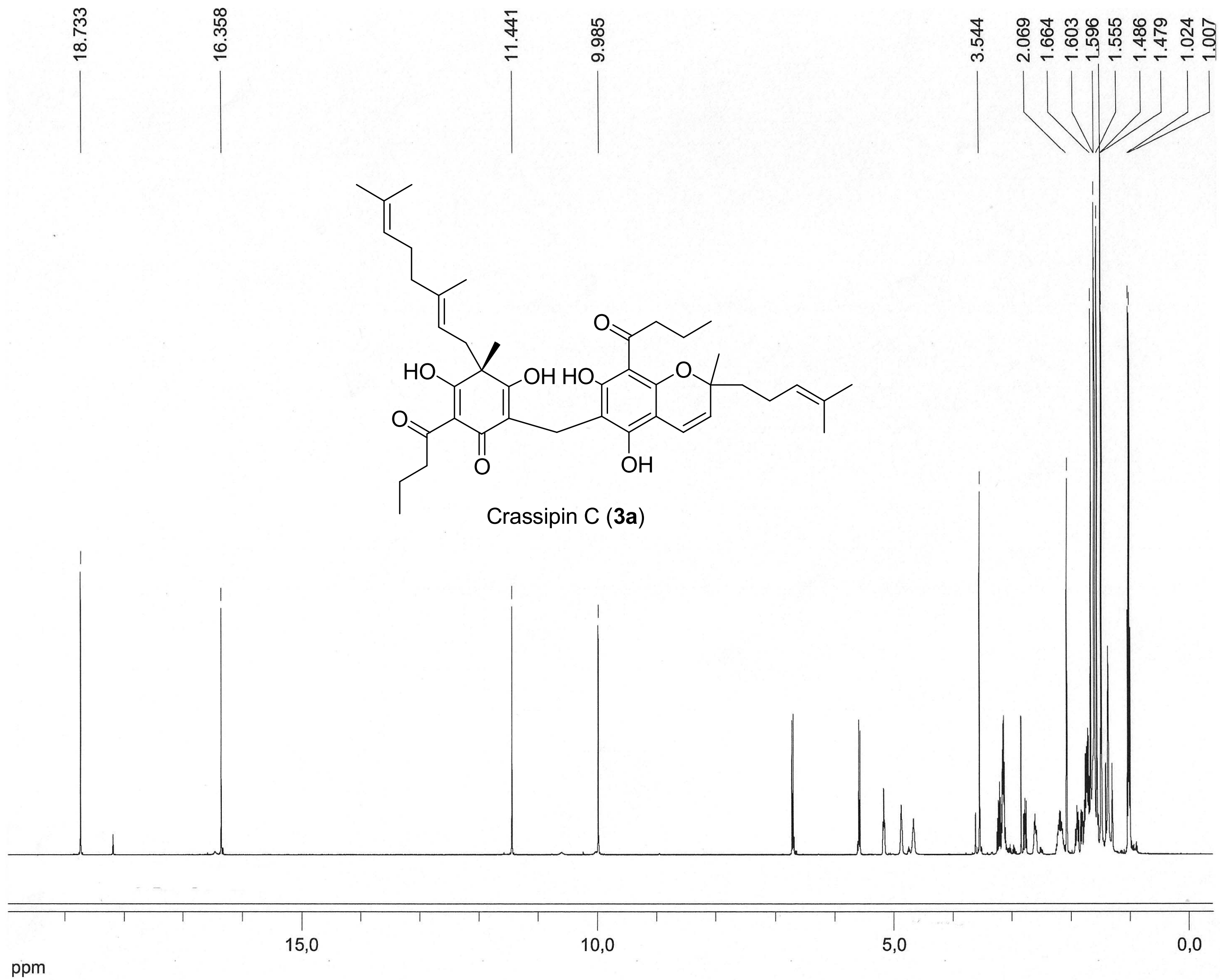



3.193
3.179
3.164
3.147
3.133
3.131
3.117
3.103
3.101
3.088
2.803
2.784
2.776
2.757
2.603
2.591
2.578
2.566
1.763
1.761
1.749
1.746
1.734
1.732
1.719
1.706
1.701
1.692
1.677
1.662
1.530
1.525
1.514
1.371
1.286
1.139
1.132
1.029
1.014
1.009
0.999
0.994
0.991
0.980
OH
HO
OH
HO
O
O
O
O
OH
Crassipin B (2)
3.00
2.50
2.00
1.50
1.00

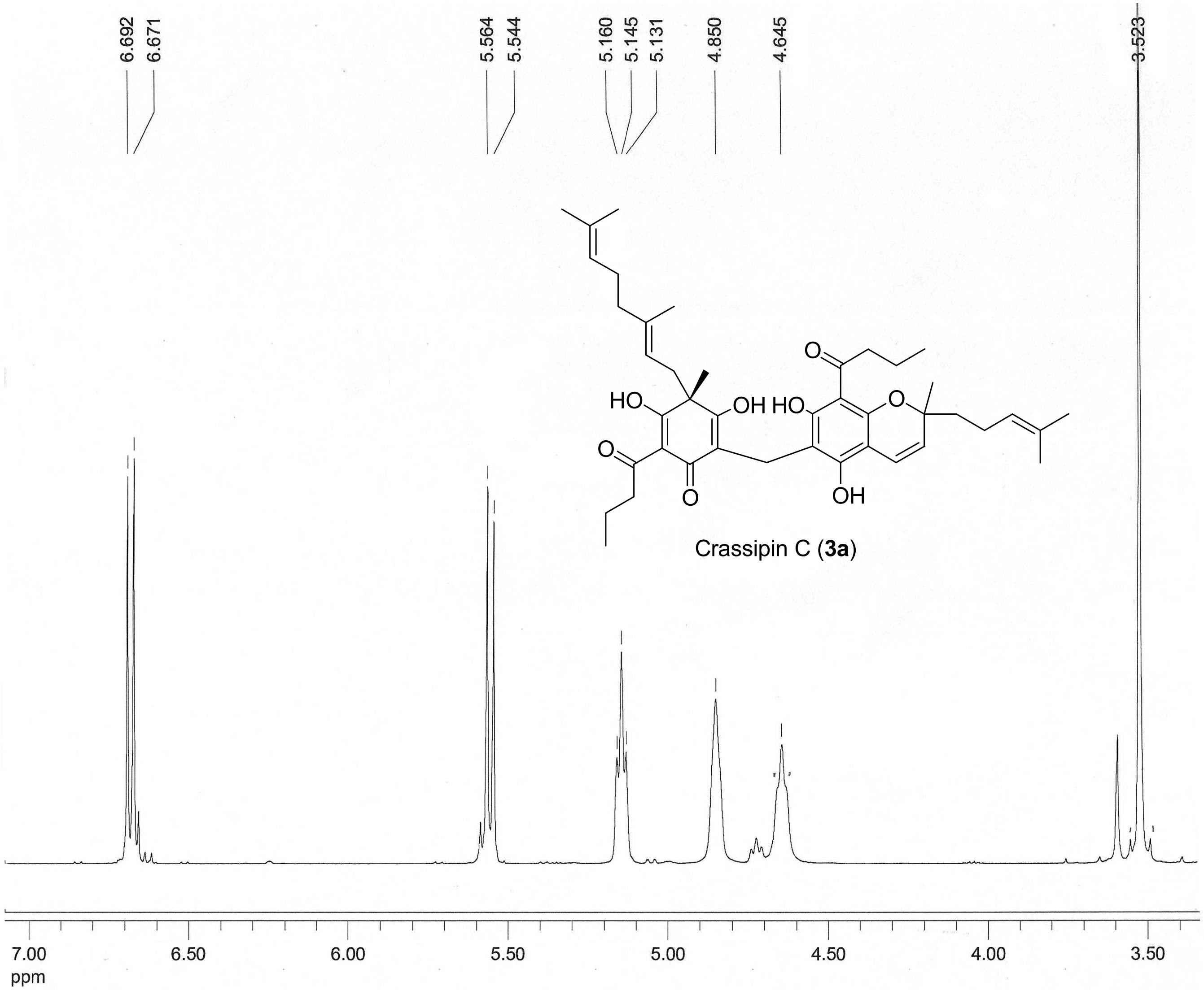
S9. ^{13}C NMR spectrum of crassipin B (**2**) (acetone-d_6, 125 MHz)

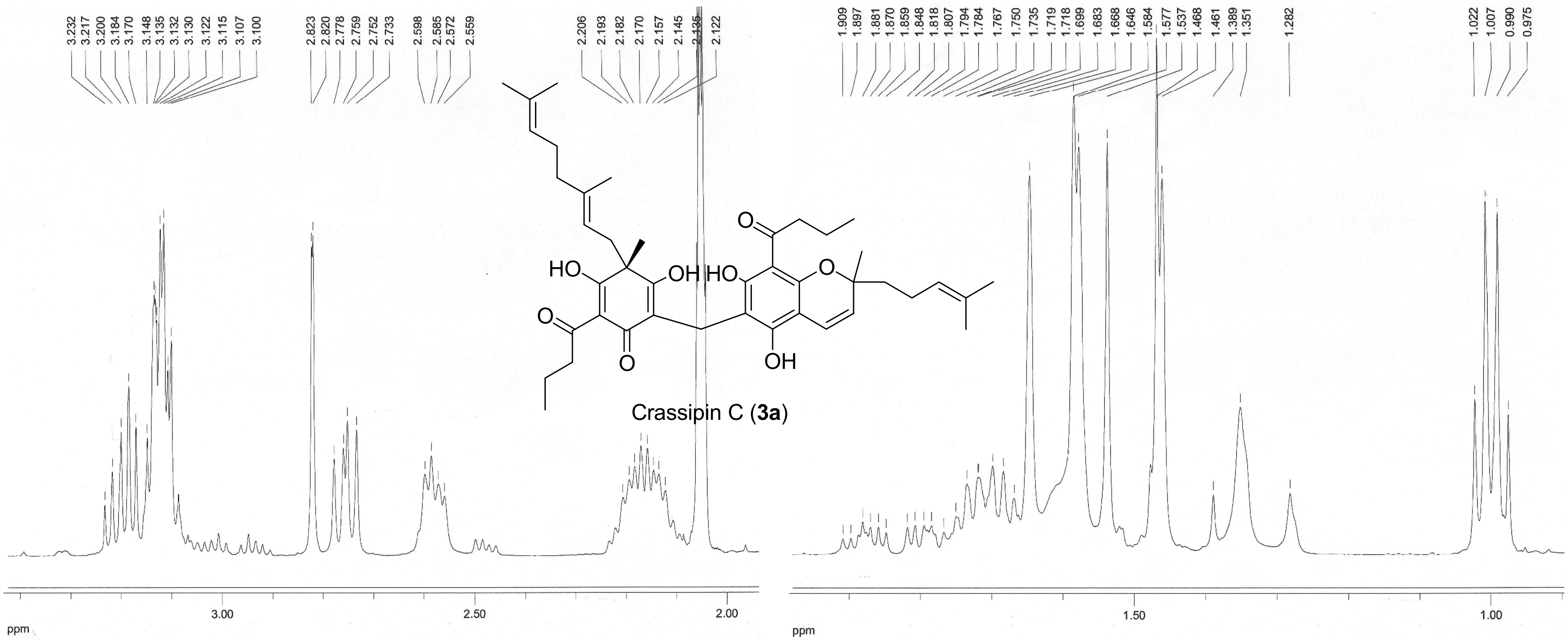


S10. ^{1}H NMR spectrum of crassipin C (**3a**) (acetone-d_6, 500 MHz)



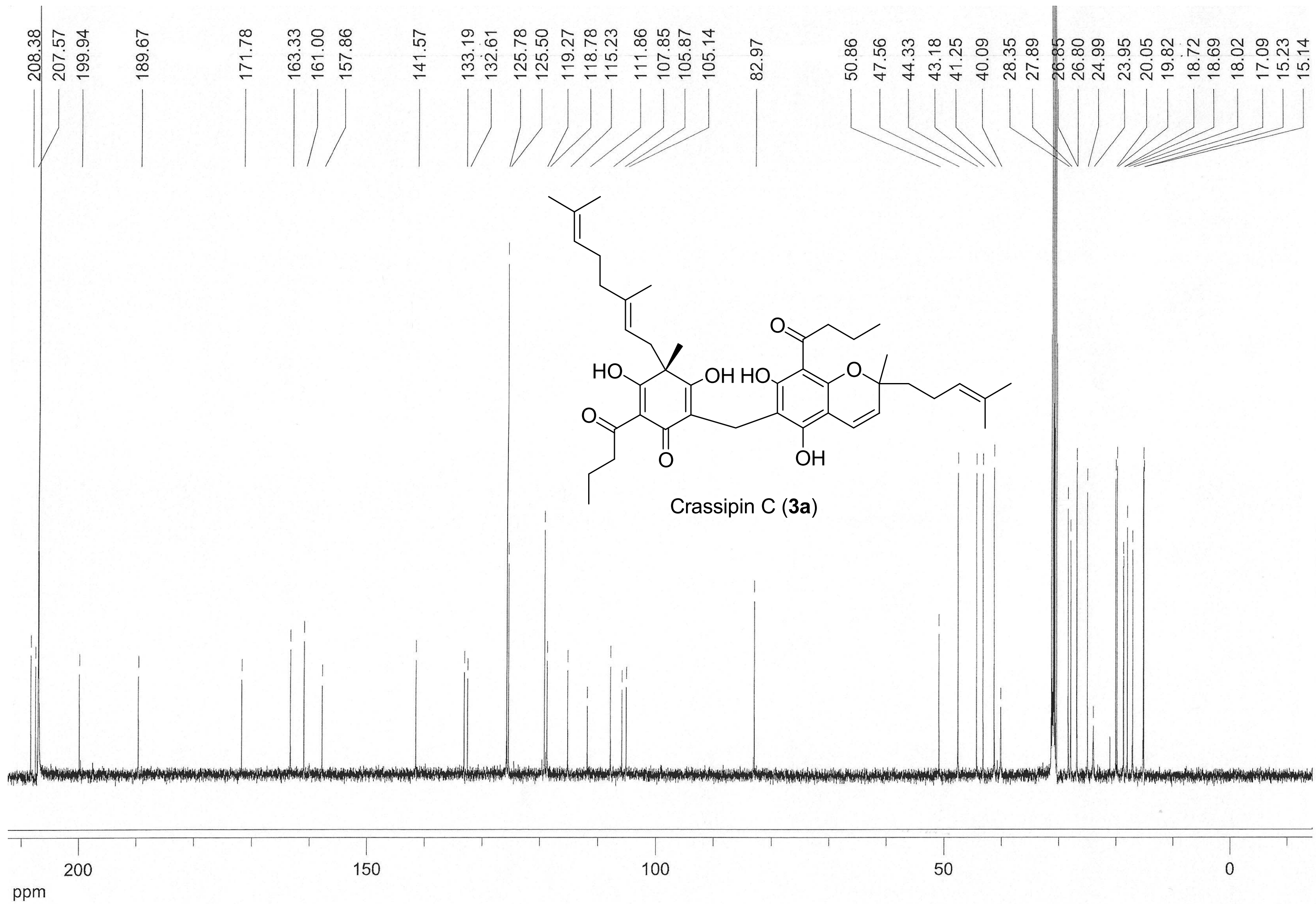
S11. [1]H NMR spectrum (partial enlarged) of crassipin C (**3a**) (acetone-d_6, 500 MHz)



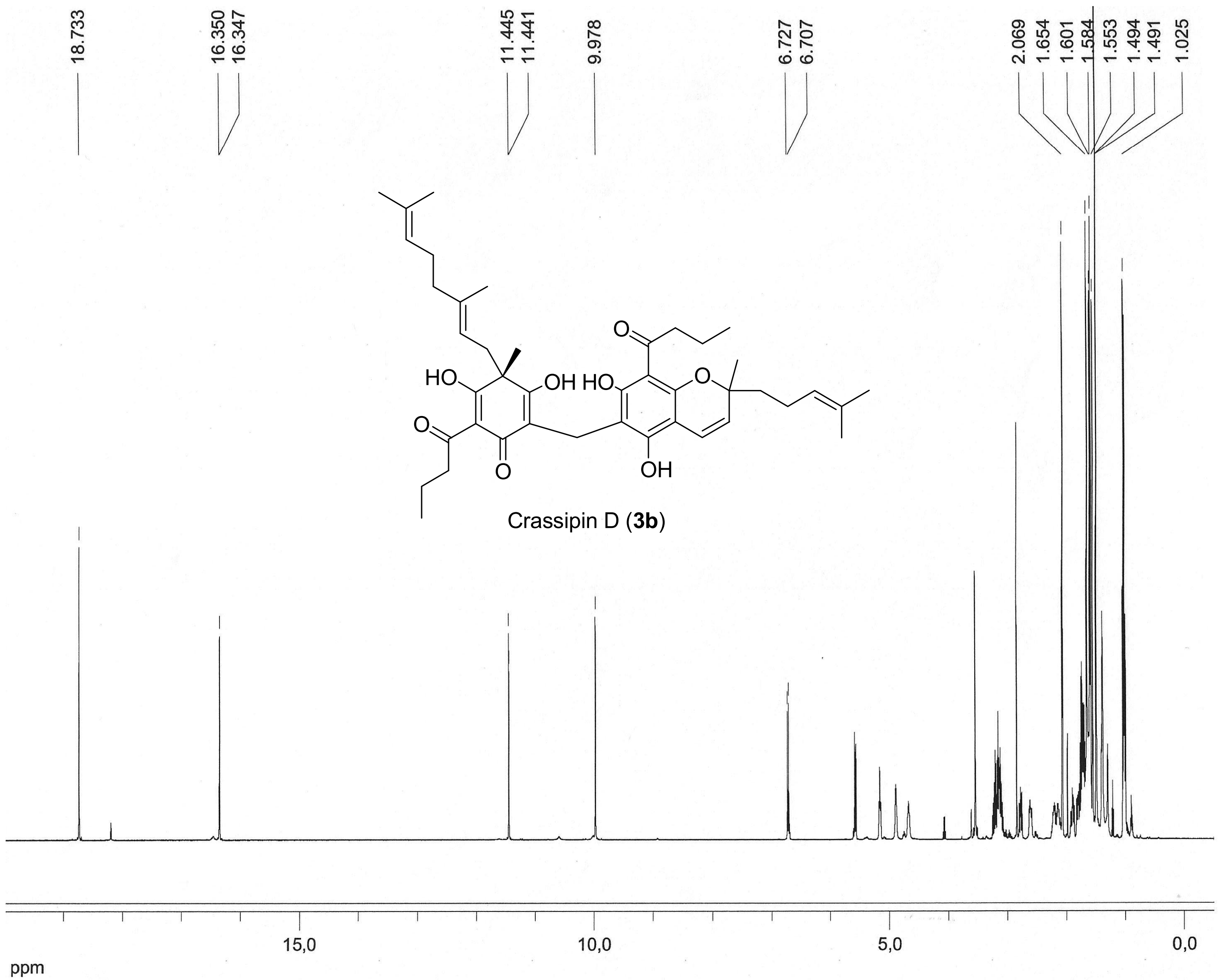


Crassipin C (**3a**)

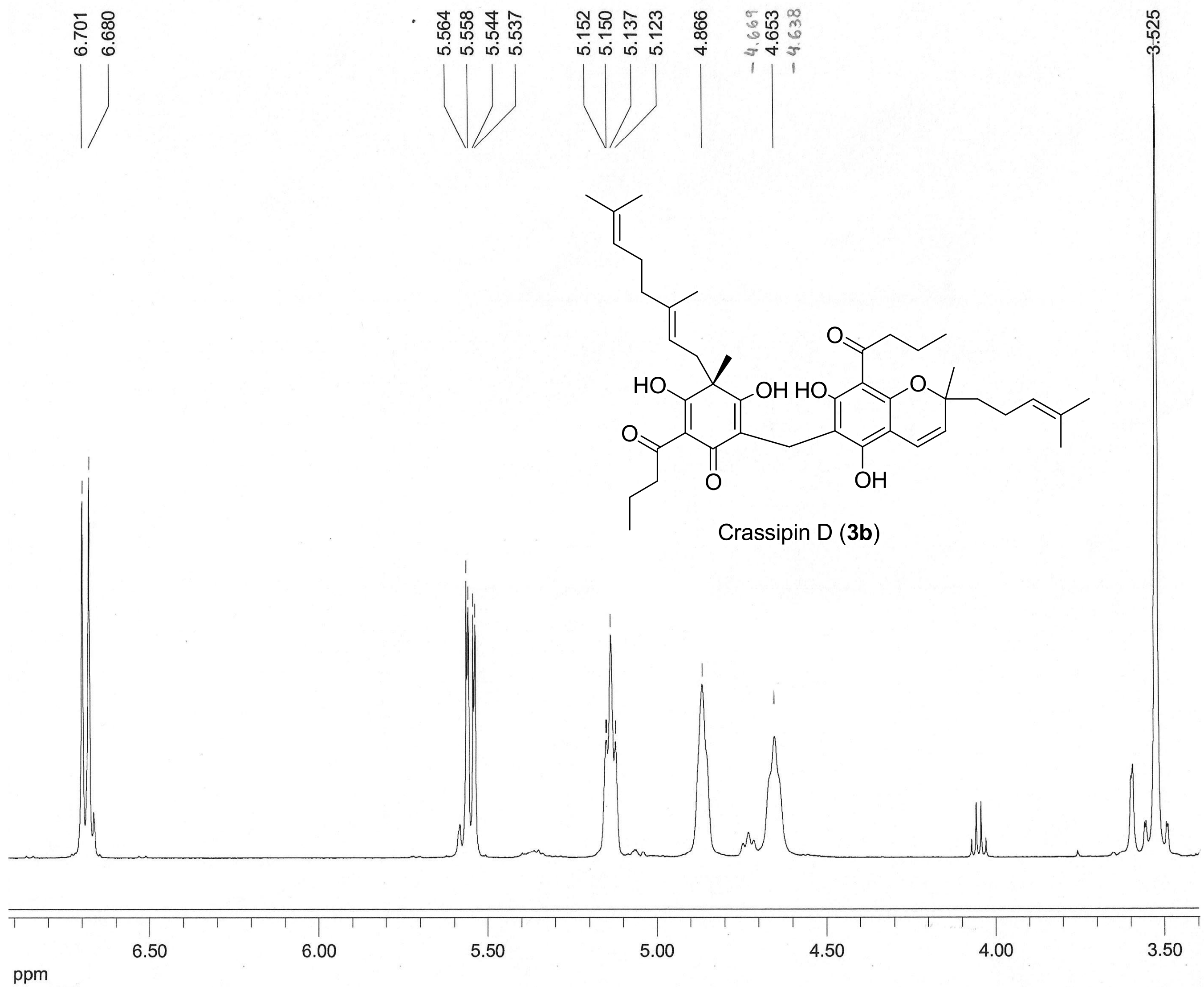
S12. ^{13}C NMR spectrum of crassipin C (**3a**) (acetone-d_6, 125 MHz)

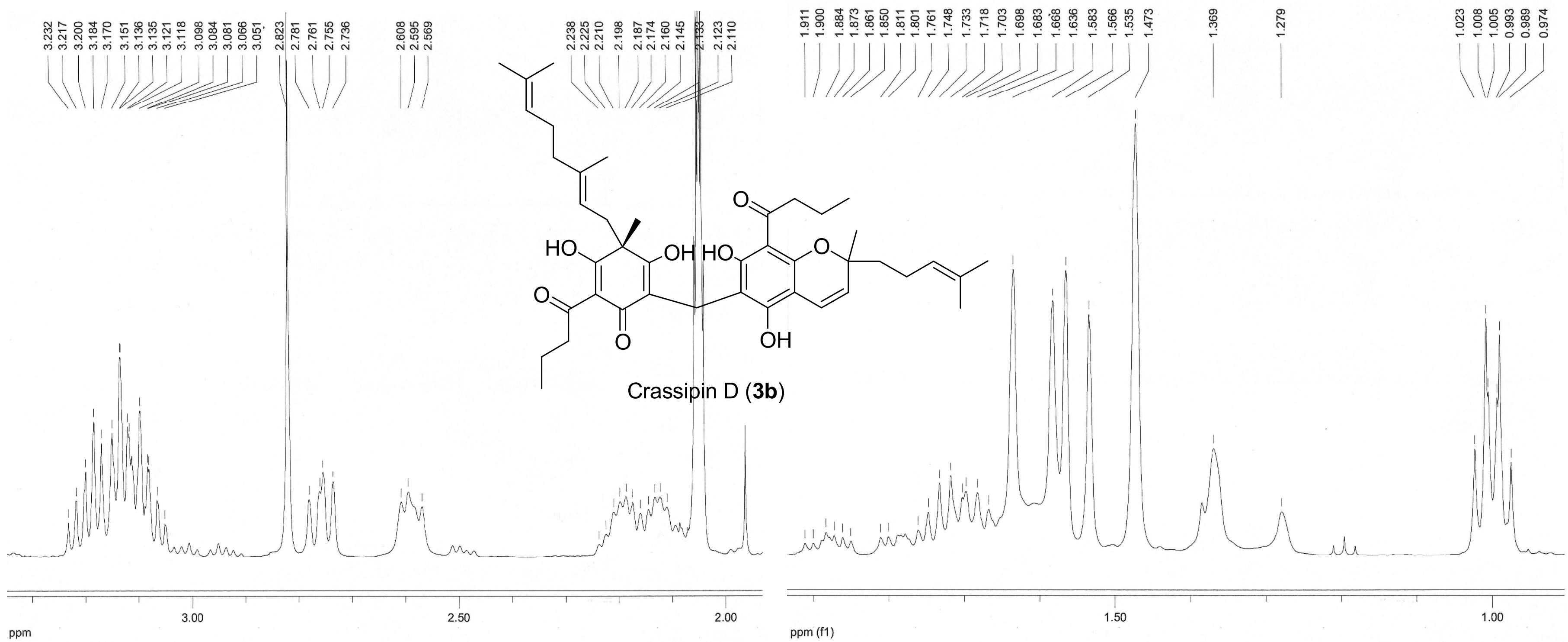


S13. ^{1}H NMR spectrum of crassipin D (**3b**) (acetone-d_6, 500 MHz)



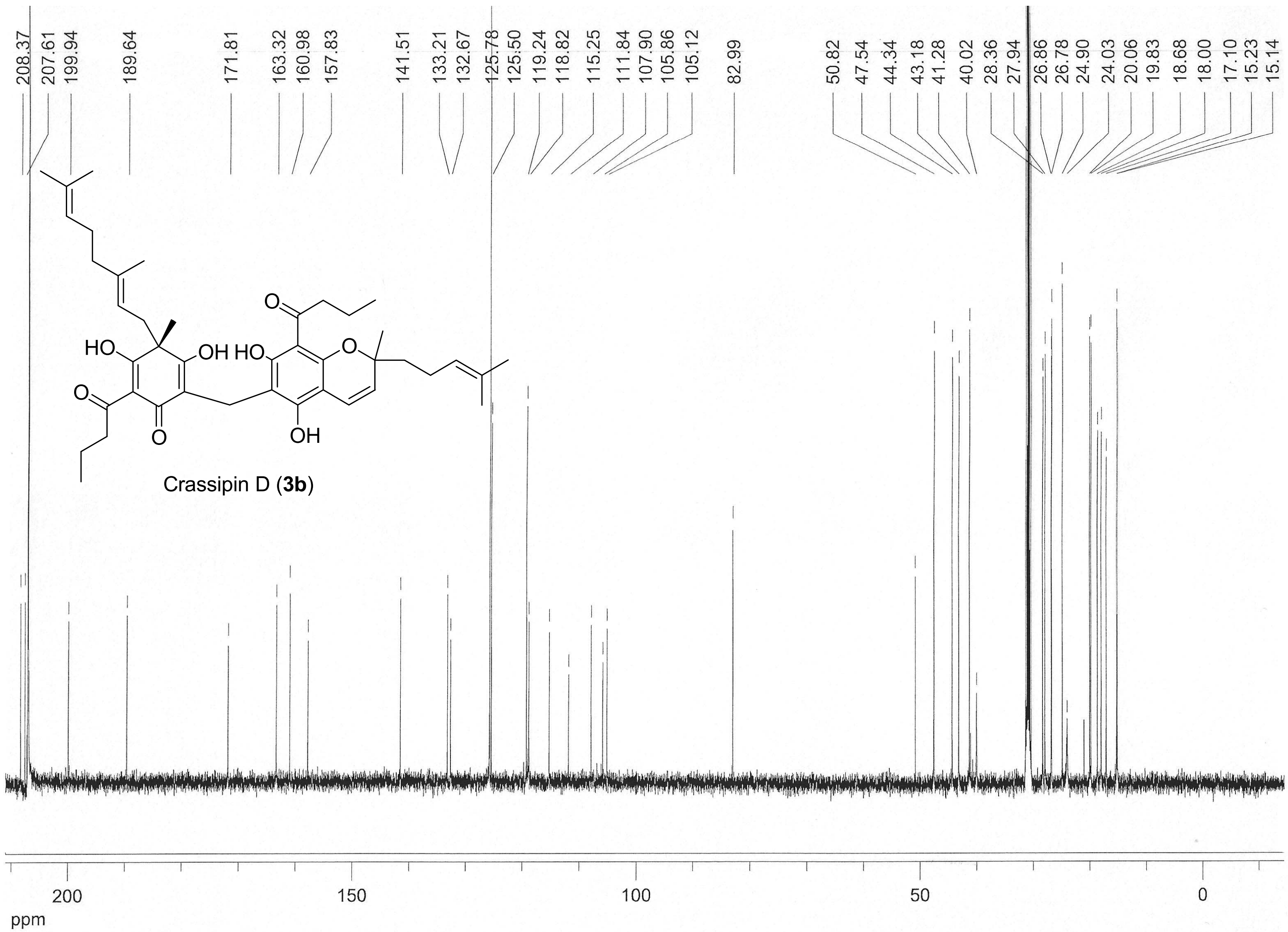
S14. [1]H NMR spectrum (partial enlarged) of crassipin D (**3b**) (acetone-d_6, 500 MHz)



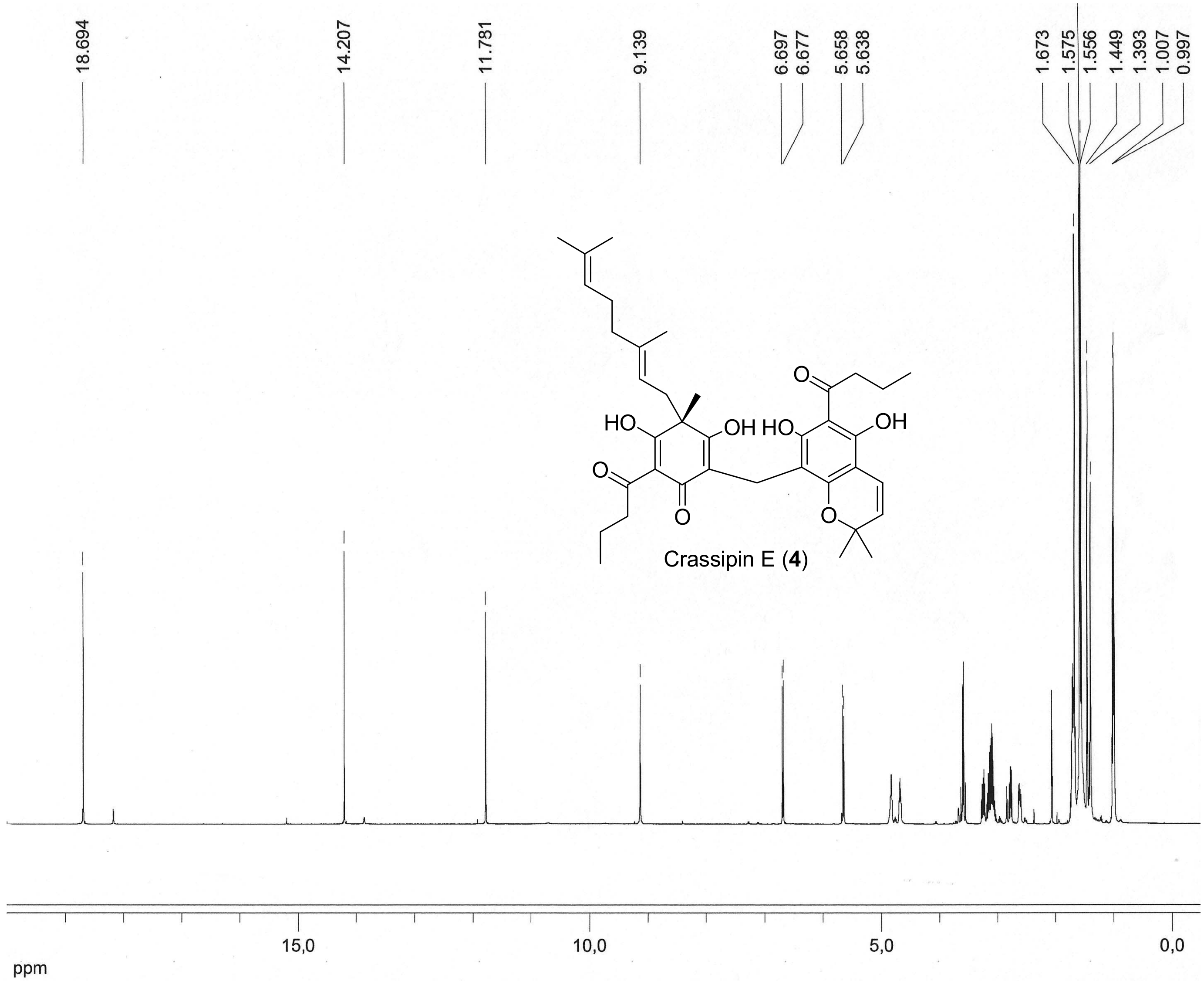


Crassipin D (**3b**)

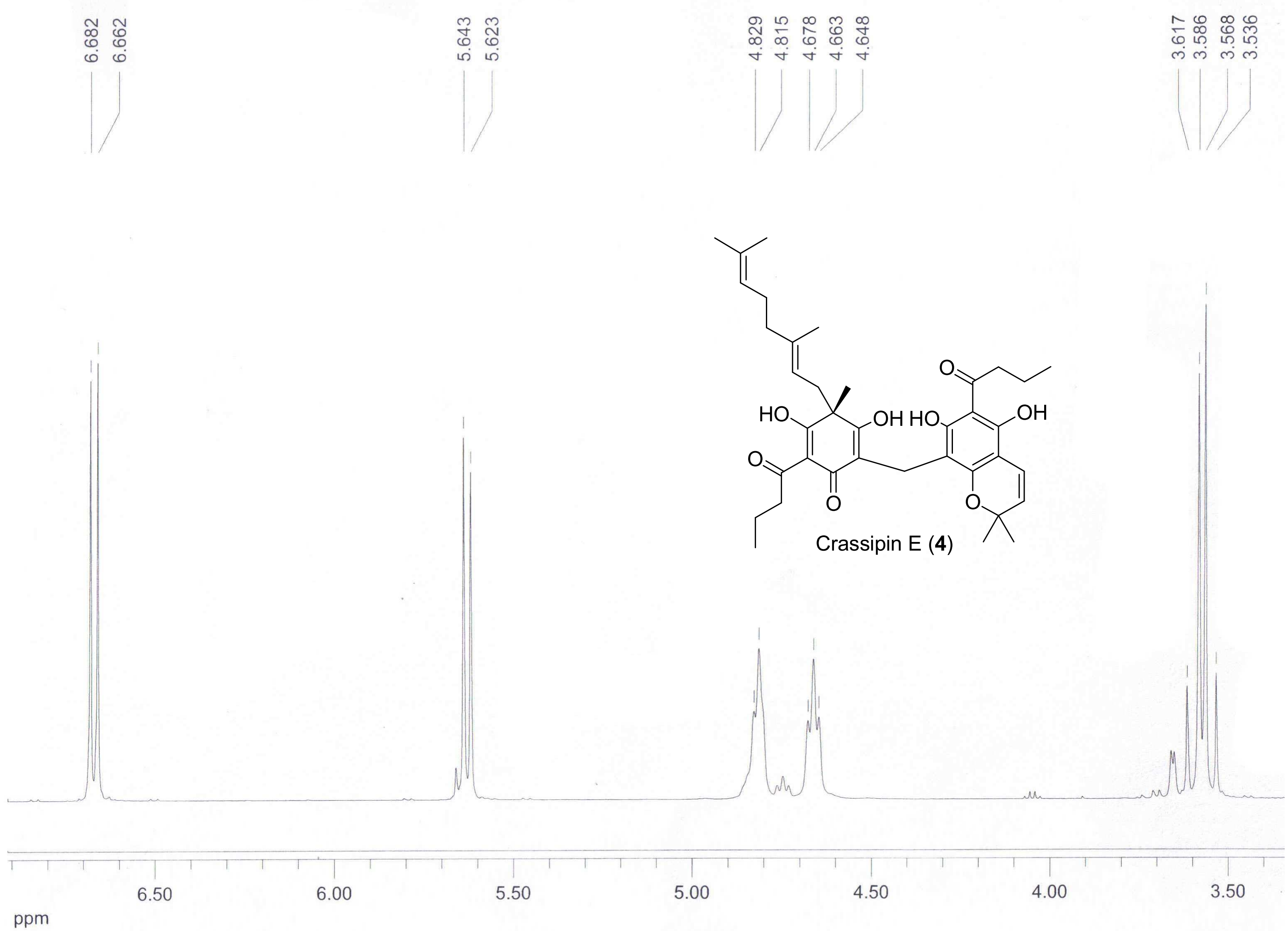
S15. ^{13}C NMR spectrum of crassipin D (**3b**) (acetone-d_6, 125 MHz)

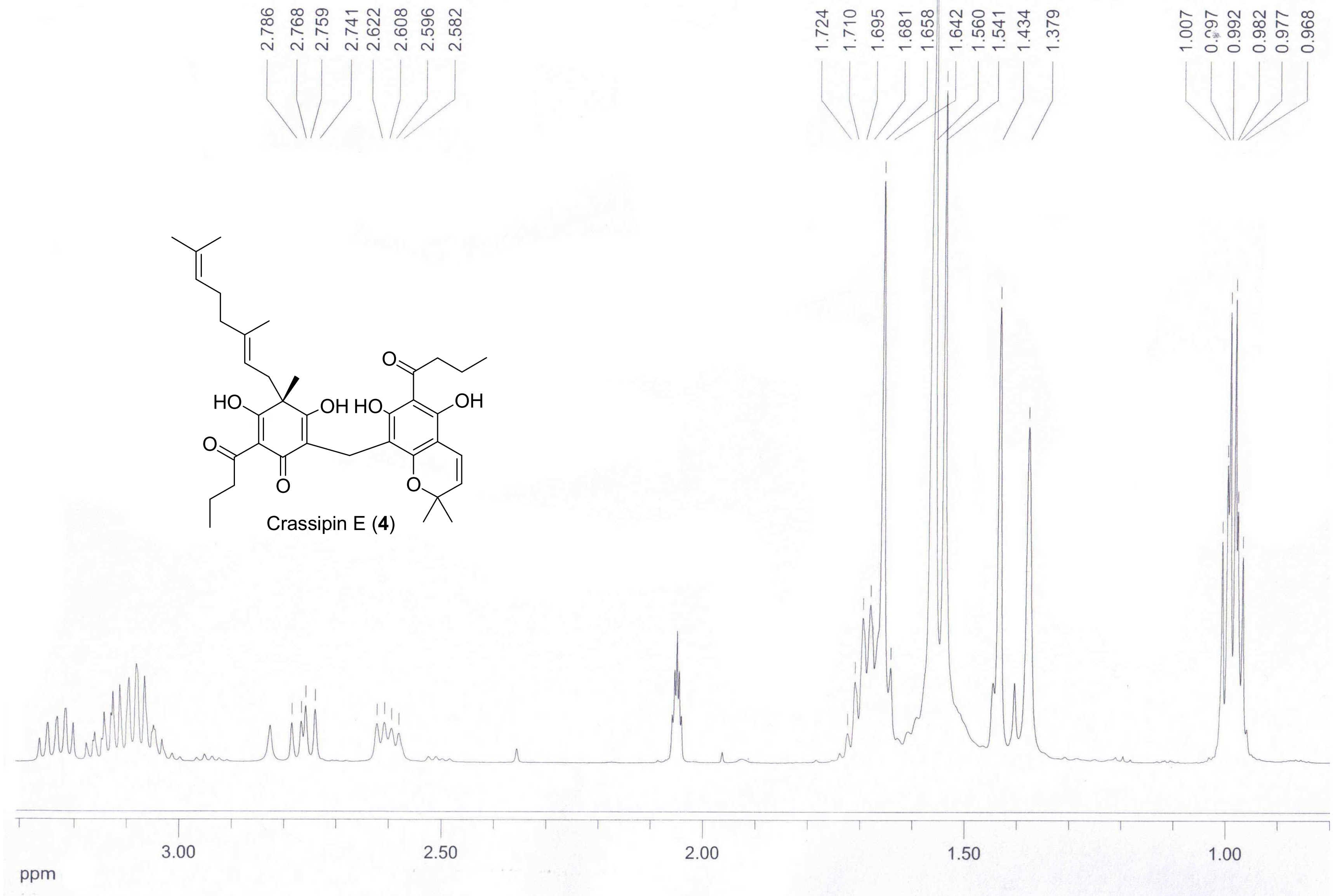


S16. ^{1}H NMR spectrum of crassipin E (**4**) (acetone-d_6, 500 MHz)

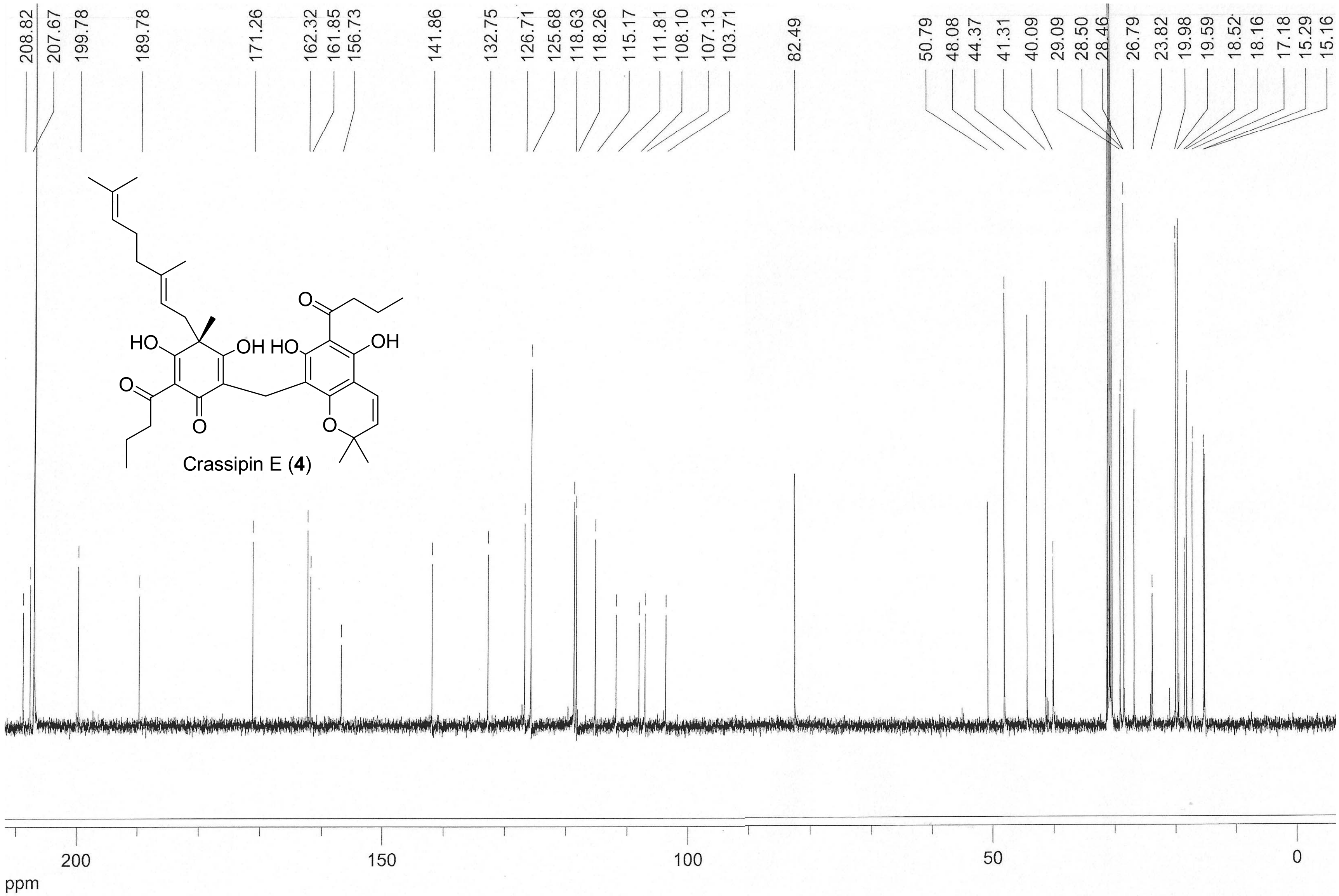


S17. ^{1}H NMR spectrum (partial enlarged) of crassipin E (**4**) (acetone-d_6, 500 MHz)

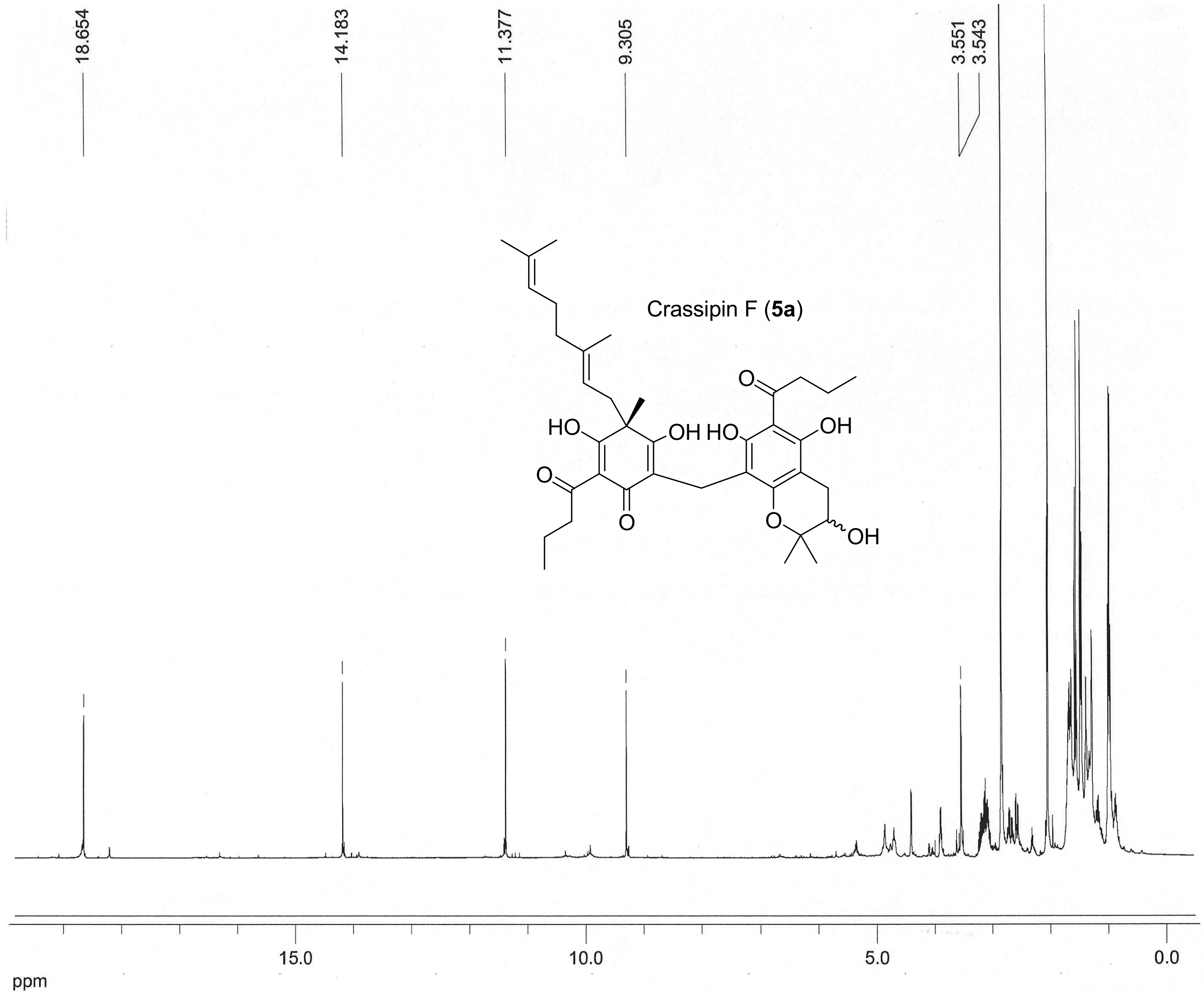



2.786
2.768
2.759
2.741
2.622
2.608
2.596
2.582
1.724
1.710
1.695
1.681
1.658
1.642
1.560
1.541
1.434
1.379
1.007
0.992
0.982
0.977
0.968
HO
OH
HO
OH
O
O
O
O
Crassipin E (4)
3.00
2.50
2.00
1.50
1.00
ppm

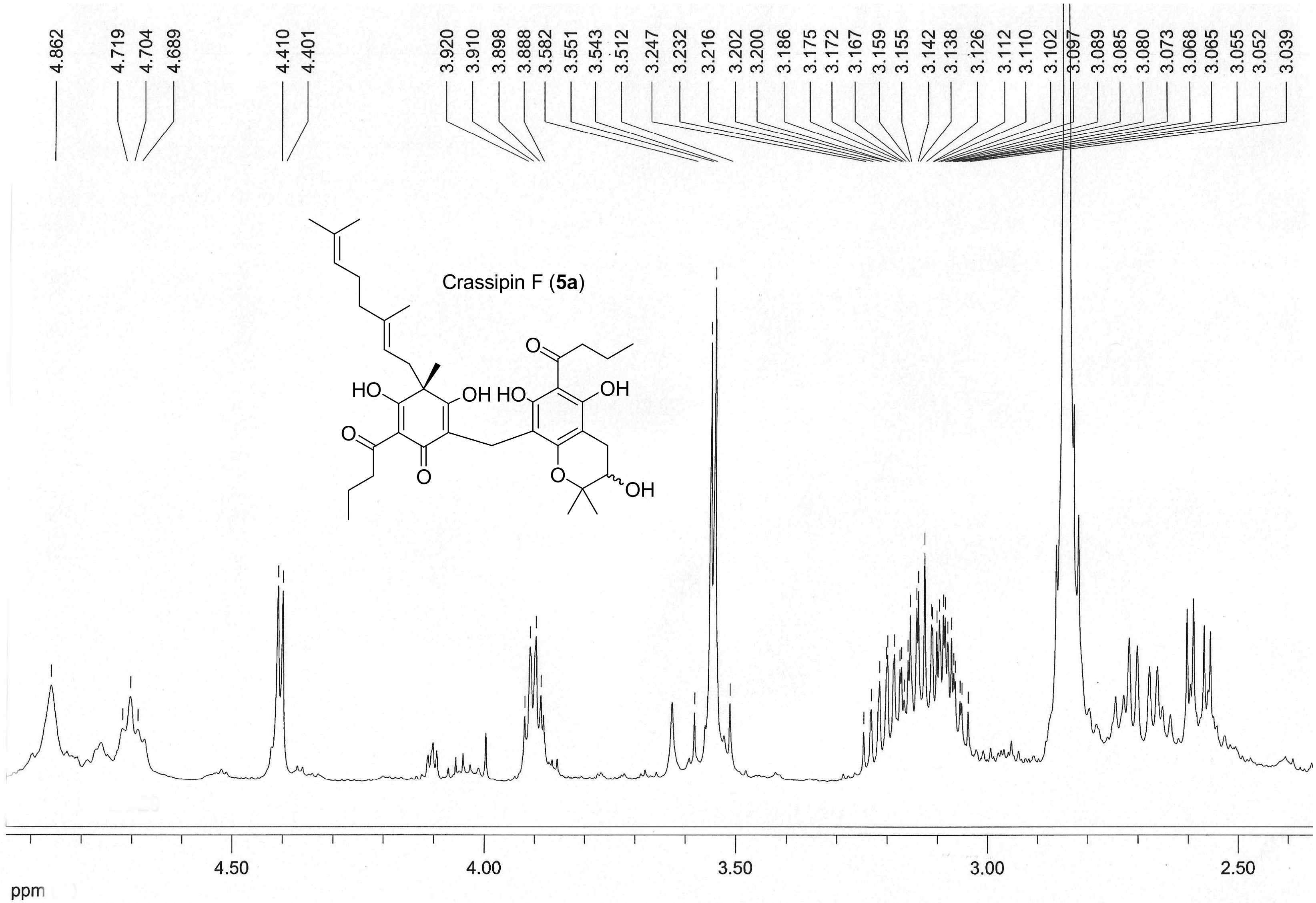
S18. ^{13}C NMR spectrum of crassipin E (**4**) (acetone-d_6, 125 MHz)

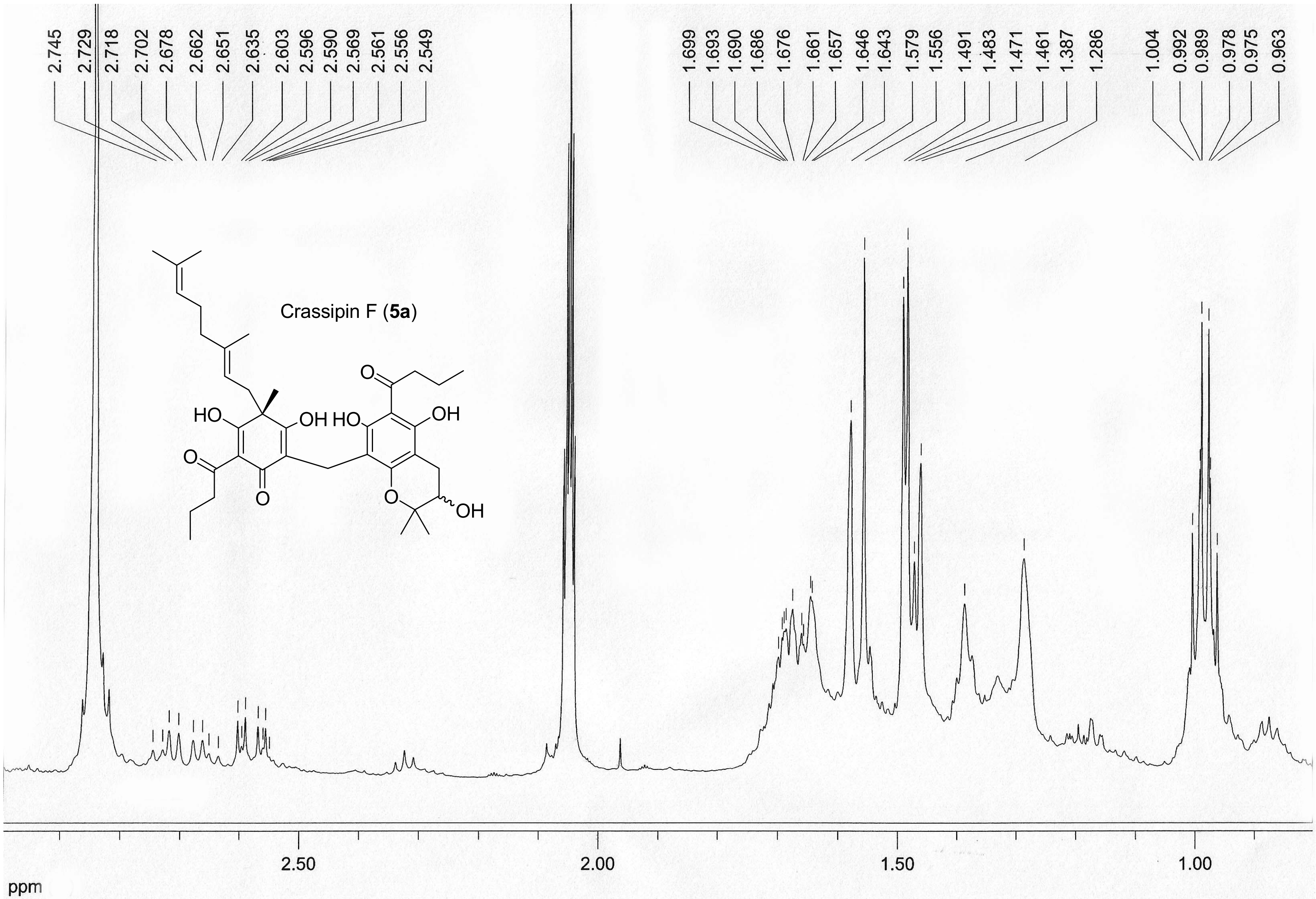


S19. ^{1}H NMR spectrum of crassipin F (**5a**) (acetone-d_6, 500 MHz)

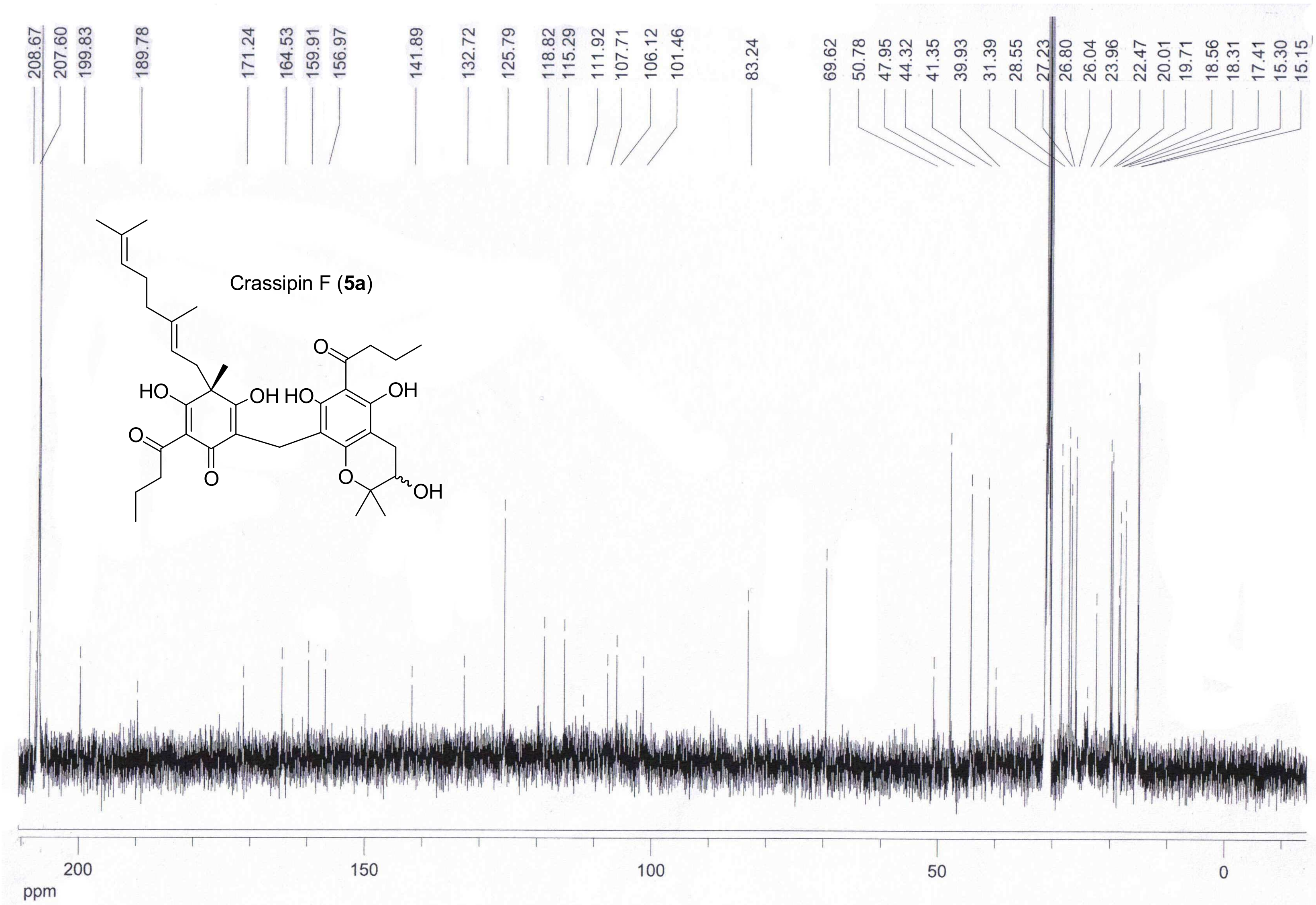


S20. ^{1}H NMR spectrum (partial enlarged) of crassipin F (**5a**) (acetone-d_6, 500 MHz)

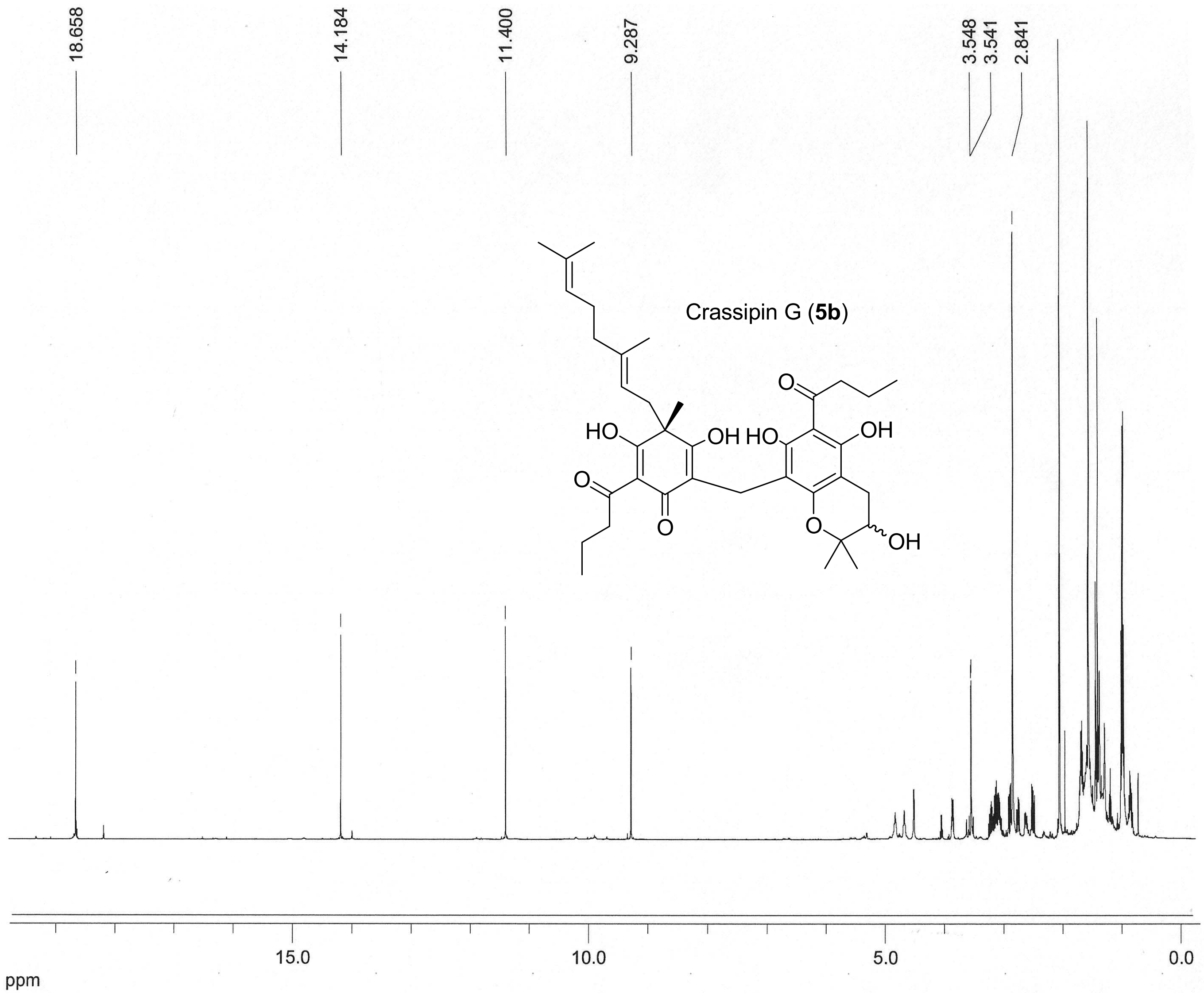



2.745
2.729
2.718
2.702
2.678
2.662
2.651
2.635
2.603
2.596
2.590
2.569
2.561
2.556
2.549
1.699
1.693
1.690
1.686
1.676
1.661
1.657
1.646
1.643
1.579
1.556
1.491
1.483
1.471
1.461
1.387
1.286
1.004
0.992
0.989
0.978
0.975
0.963
Crassipin F (5a)
HO
OH
HO
OH
O
O
O
O
OH
2.50
2.00
1.50
1.00
ppm

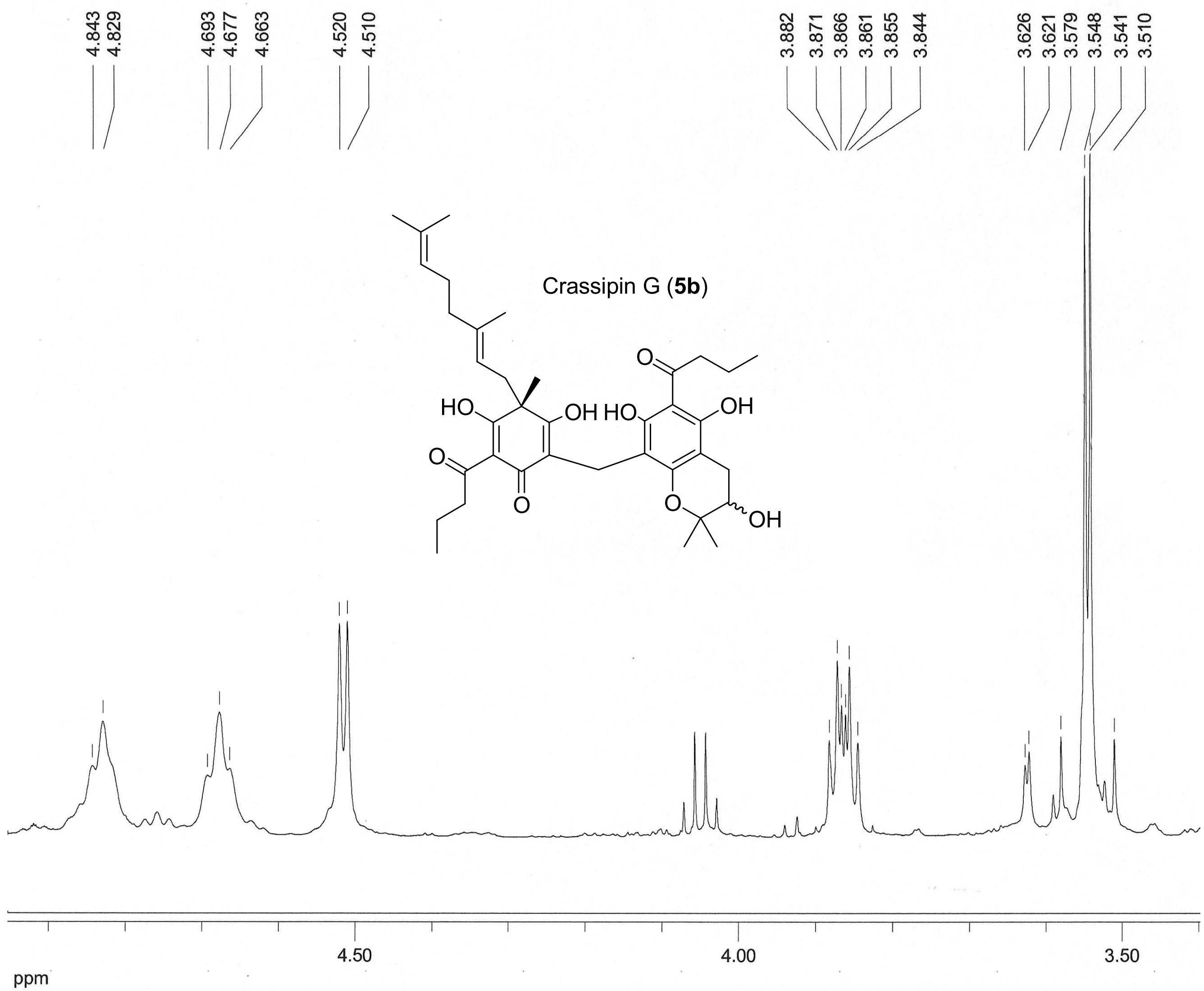
S21. ^{13}C NMR spectrum of crassipin F (**5a**) (acetone-d_6, 125 MHz)

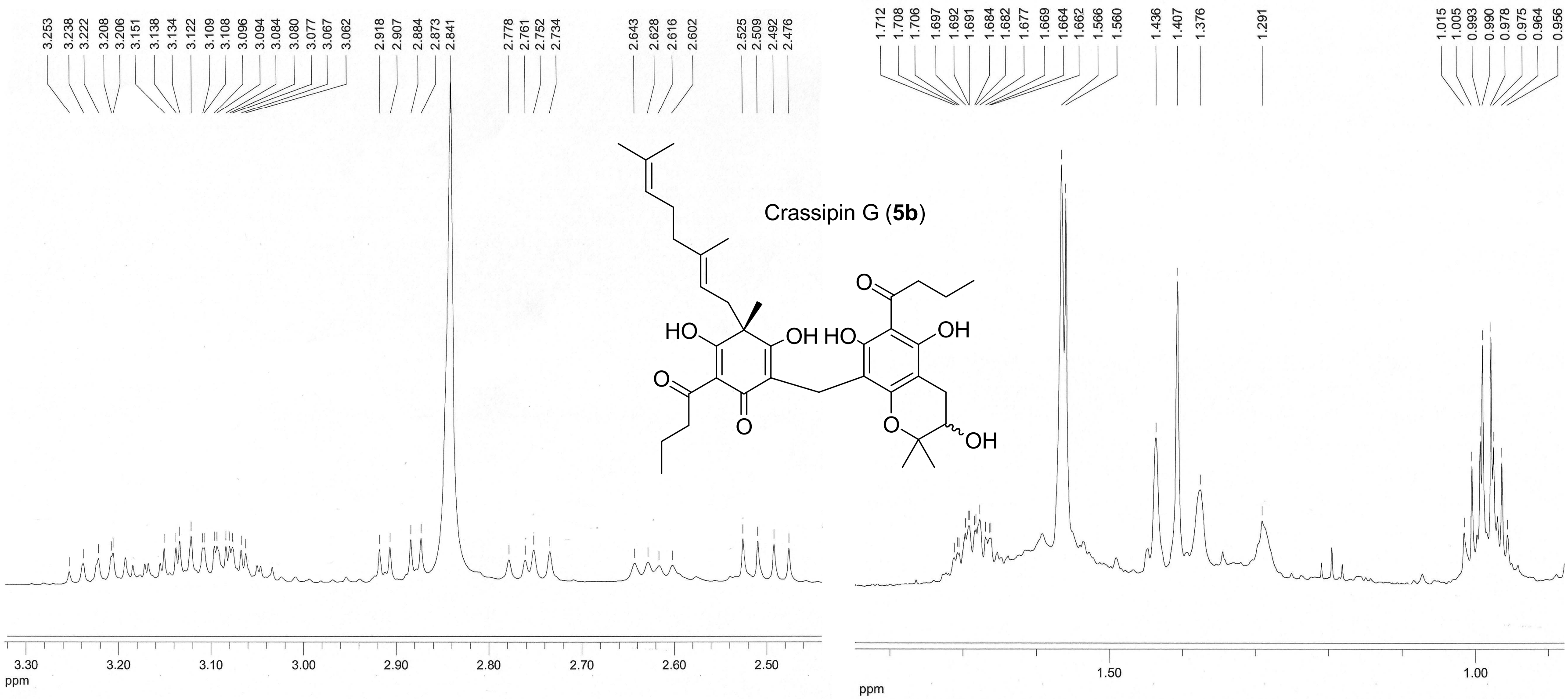


S22. ^{1}H NMR spectrum of crassipin G (**5b**) (acetone-d_6, 500 MHz)



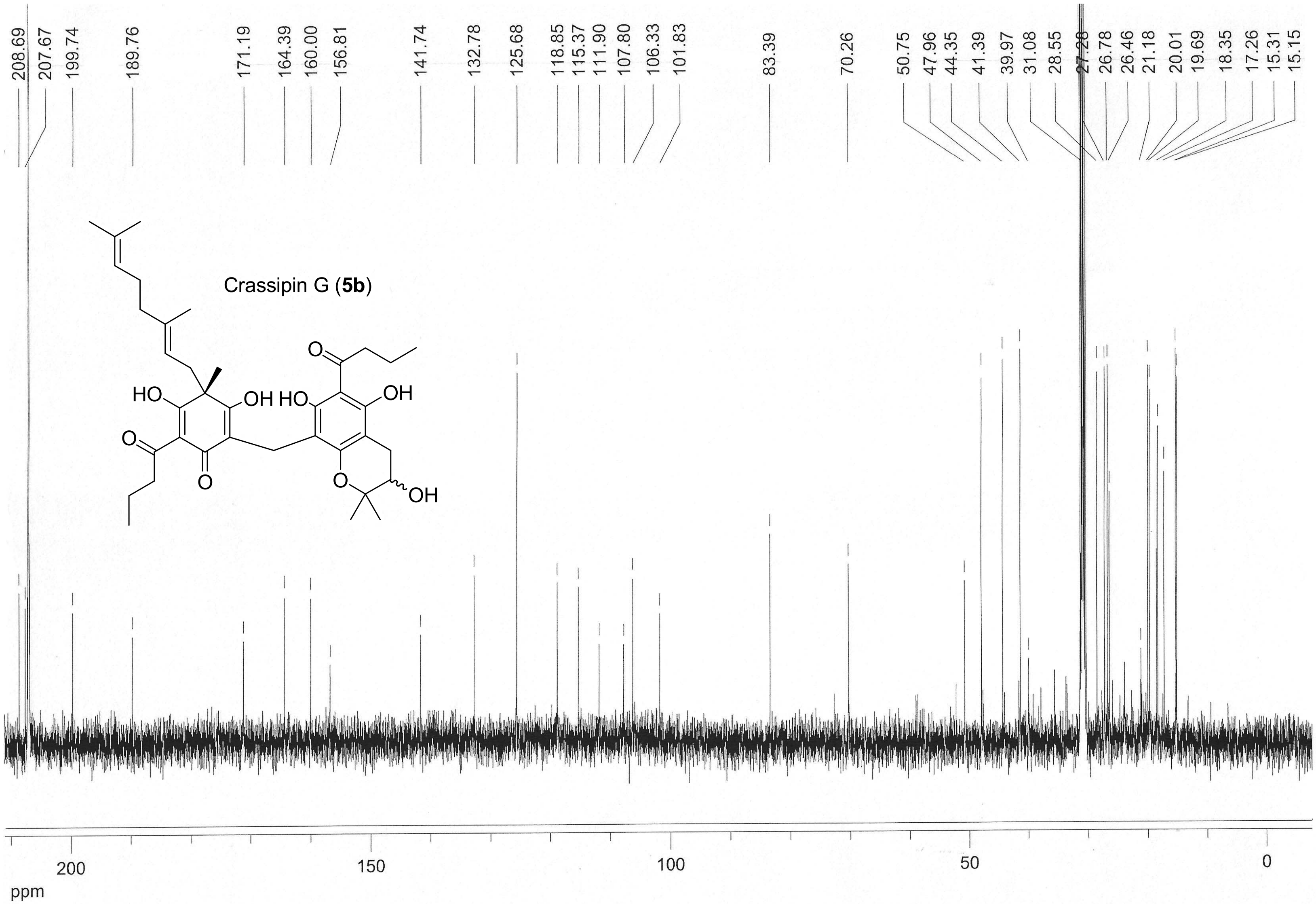
S23. ^{1}H NMR spectrum (partial enlarged) of crassipin G (**5b**) (acetone-d_6, 500 MHz)



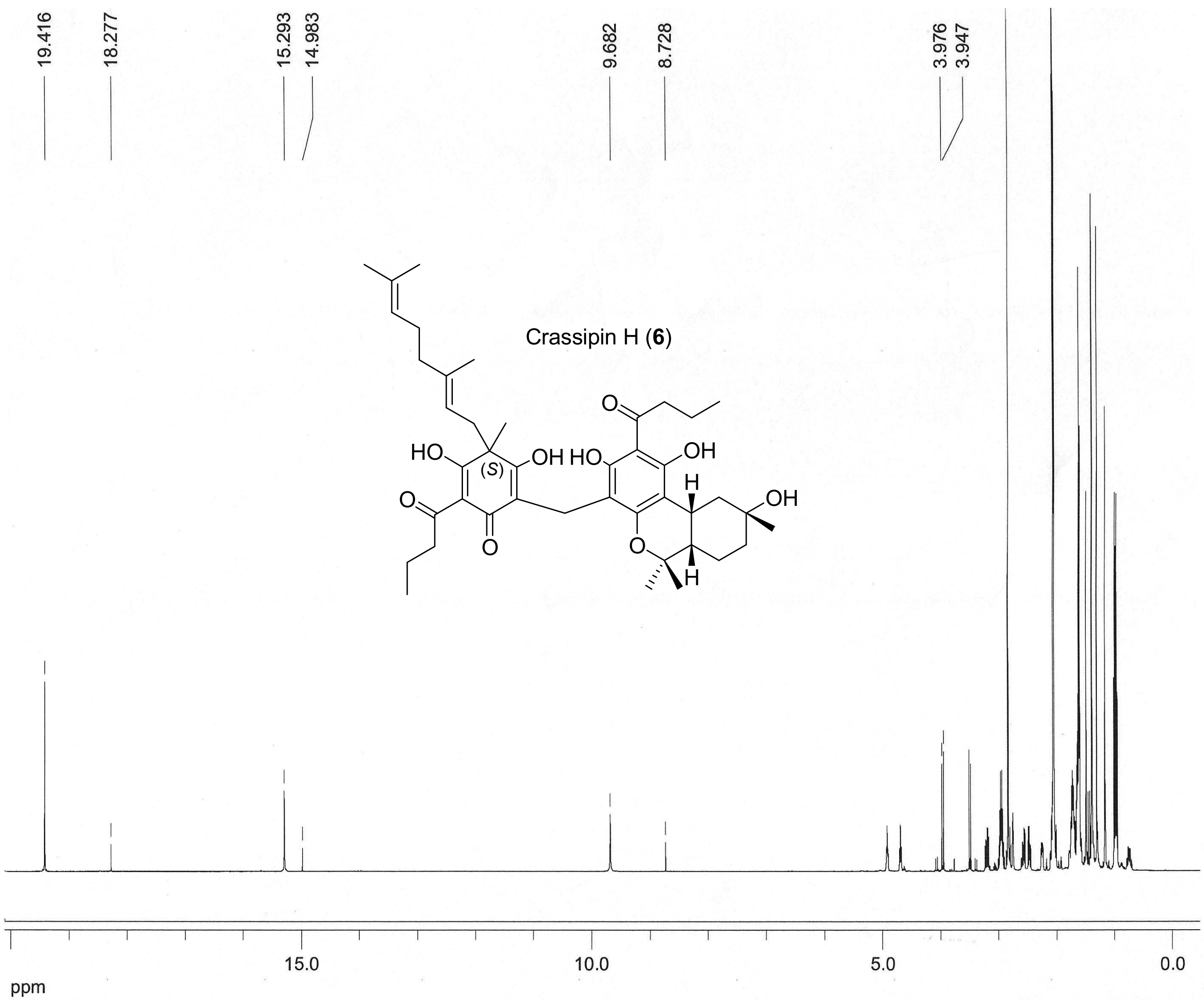


Crassipin G (**5b**)
HO
OH
HO
OH
O
O
O
O
OH
3.253 3.238 3.222 3.208 3.206 3.151 3.138 3.134 3.122 3.109 3.108 3.096 3.094 3.084 3.080 3.077 3.067 3.062
2.918 2.907 2.884 2.873 2.841
2.778 2.761 2.752 2.734
2.643 2.628 2.616 2.602
2.525 2.509 2.492 2.476
1.712 1.708 1.706 1.697 1.692 1.691 1.684 1.682 1.677 1.669 1.664 1.662 1.566 1.560
1.436 1.407 1.376
1.291
1.015 1.005 0.993 0.990 0.978 0.975 0.964 0.956
3.30 3.20 3.10 3.00 2.90 2.80 2.70 2.60 2.50
ppm
1.50 1.00
ppm

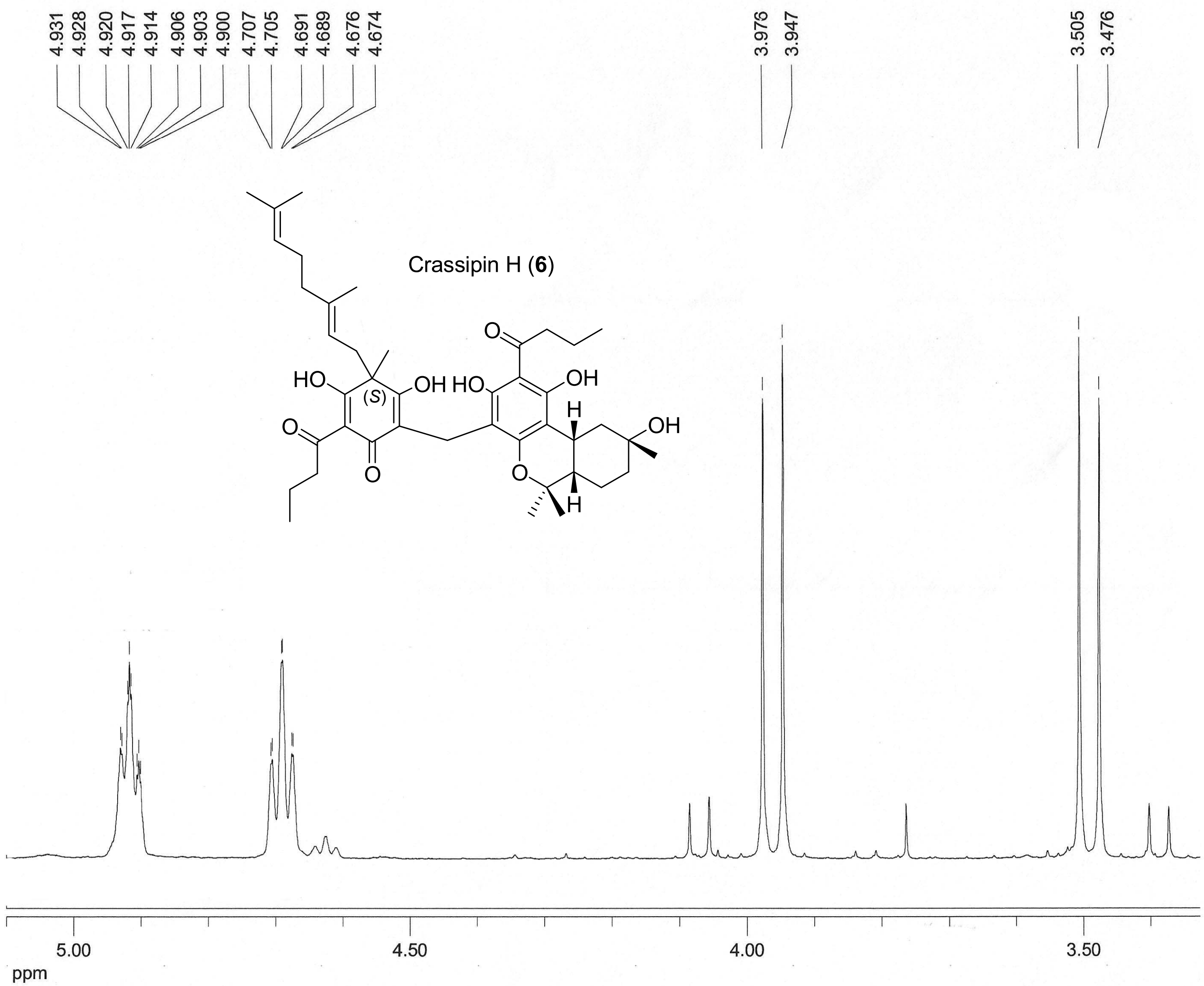
S24. ^{13}C NMR spectrum of crassipin G (**5b**) (acetone-d_6, 125 MHz)

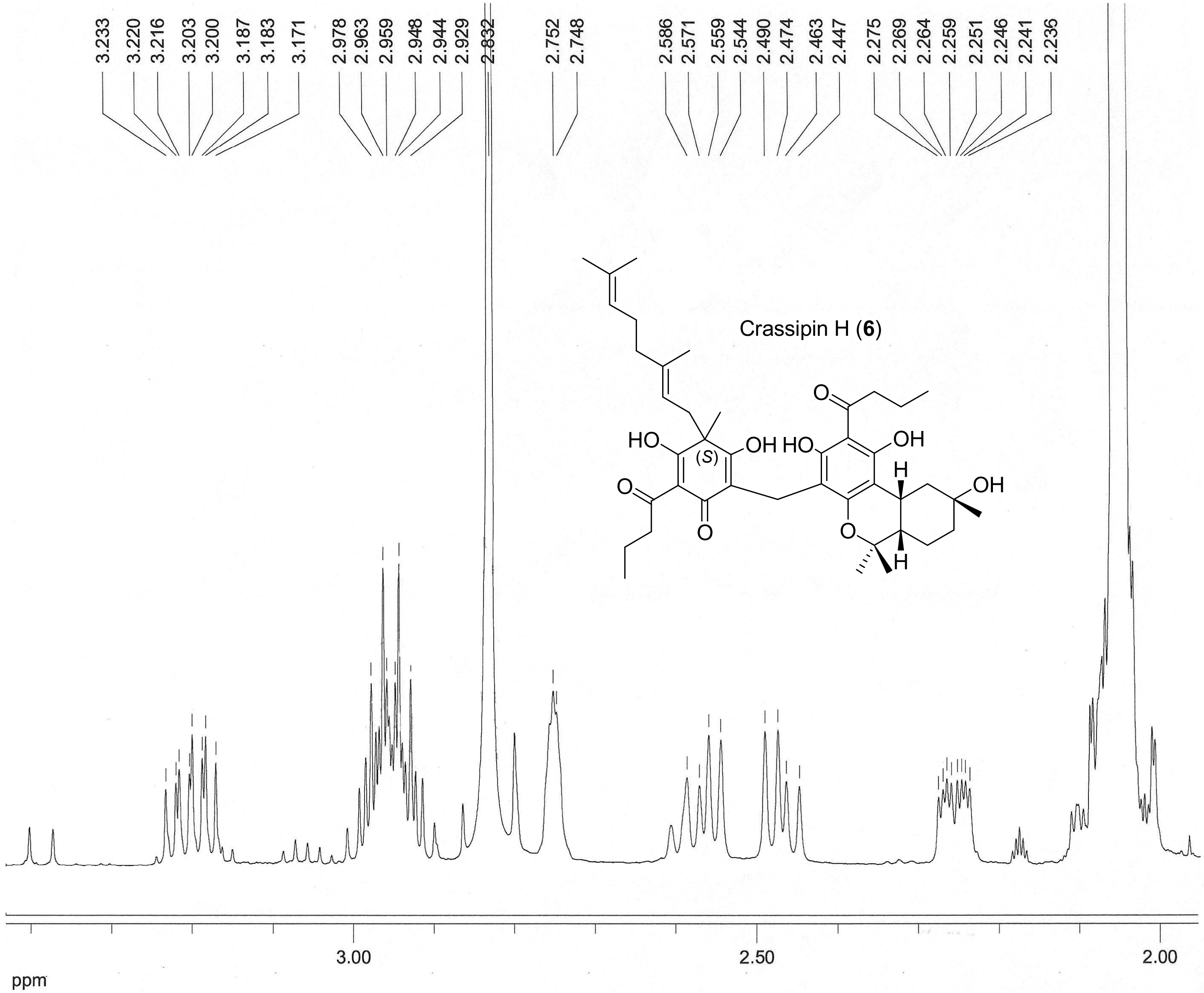


S25. ^{1}H NMR spectrum of crassipin H (**6**) (acetone-d_6, 500 MHz)

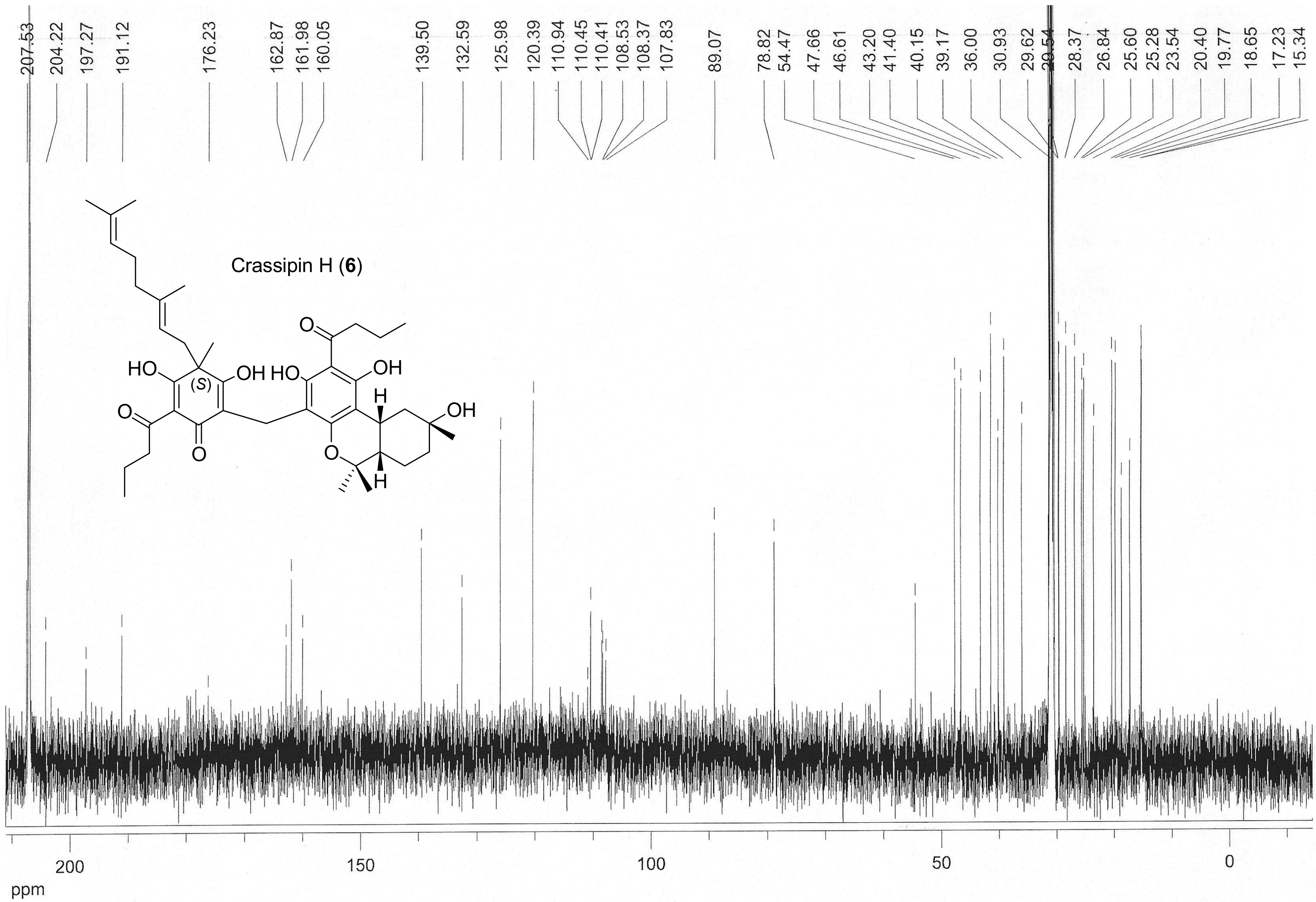


S26. ^{1}H NMR spectrum (partial enlarged) of crassipin H (**6**) (acetone-d_6, 500 MHz)

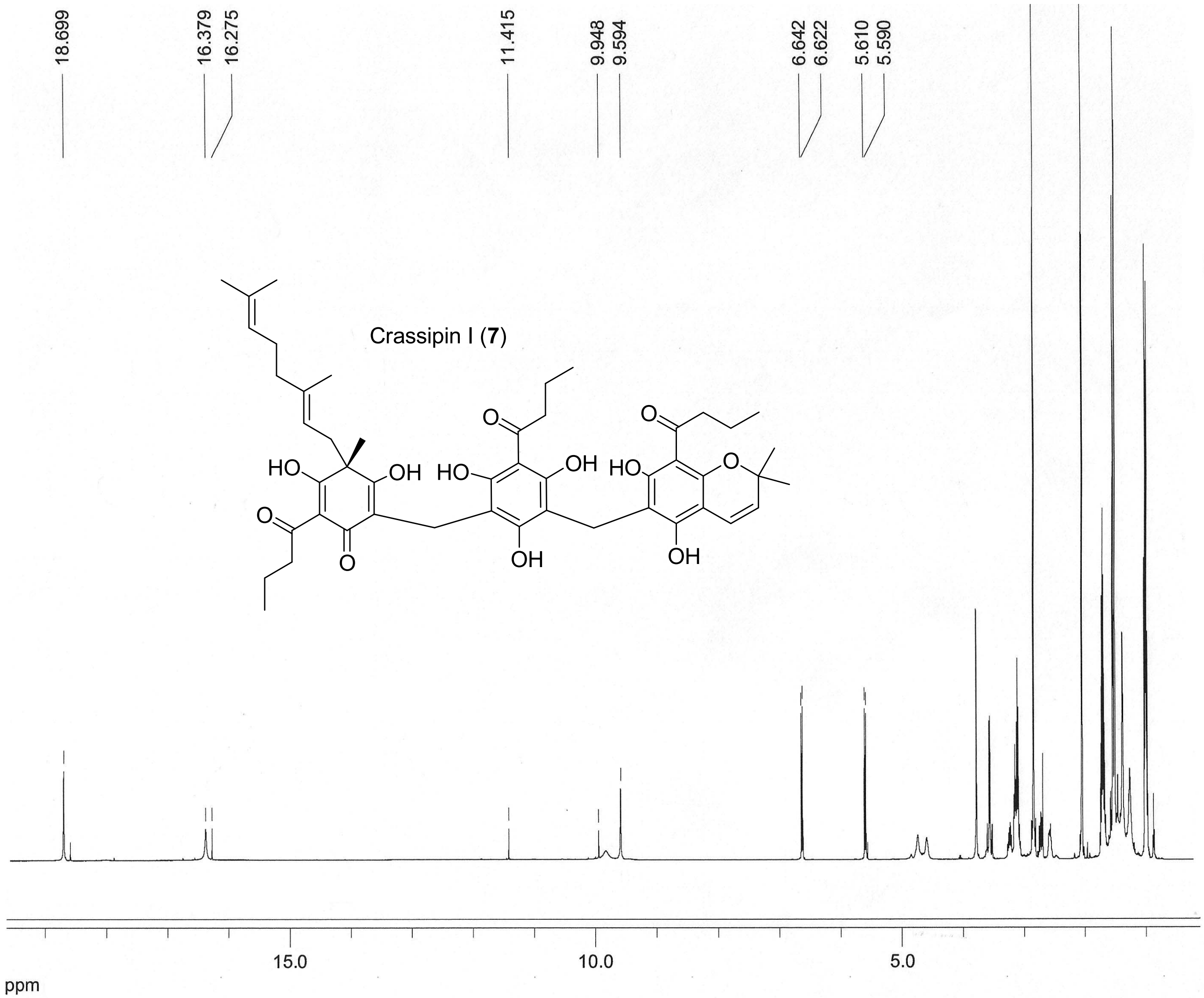



3.233
3.220
3.216
3.203
3.200
3.187
3.183
3.171
2.978
2.963
2.959
2.948
2.944
2.929
2.832
2.752
2.748
2.586
2.571
2.559
2.544
2.490
2.474
2.463
2.447
2.275
2.269
2.264
2.259
2.251
2.246
2.241
2.236
Crassipin H (6)
HO
OH
HO
OH
(S)
O
O
O
H
OH
O
H
3.00
2.50
2.00
ppm

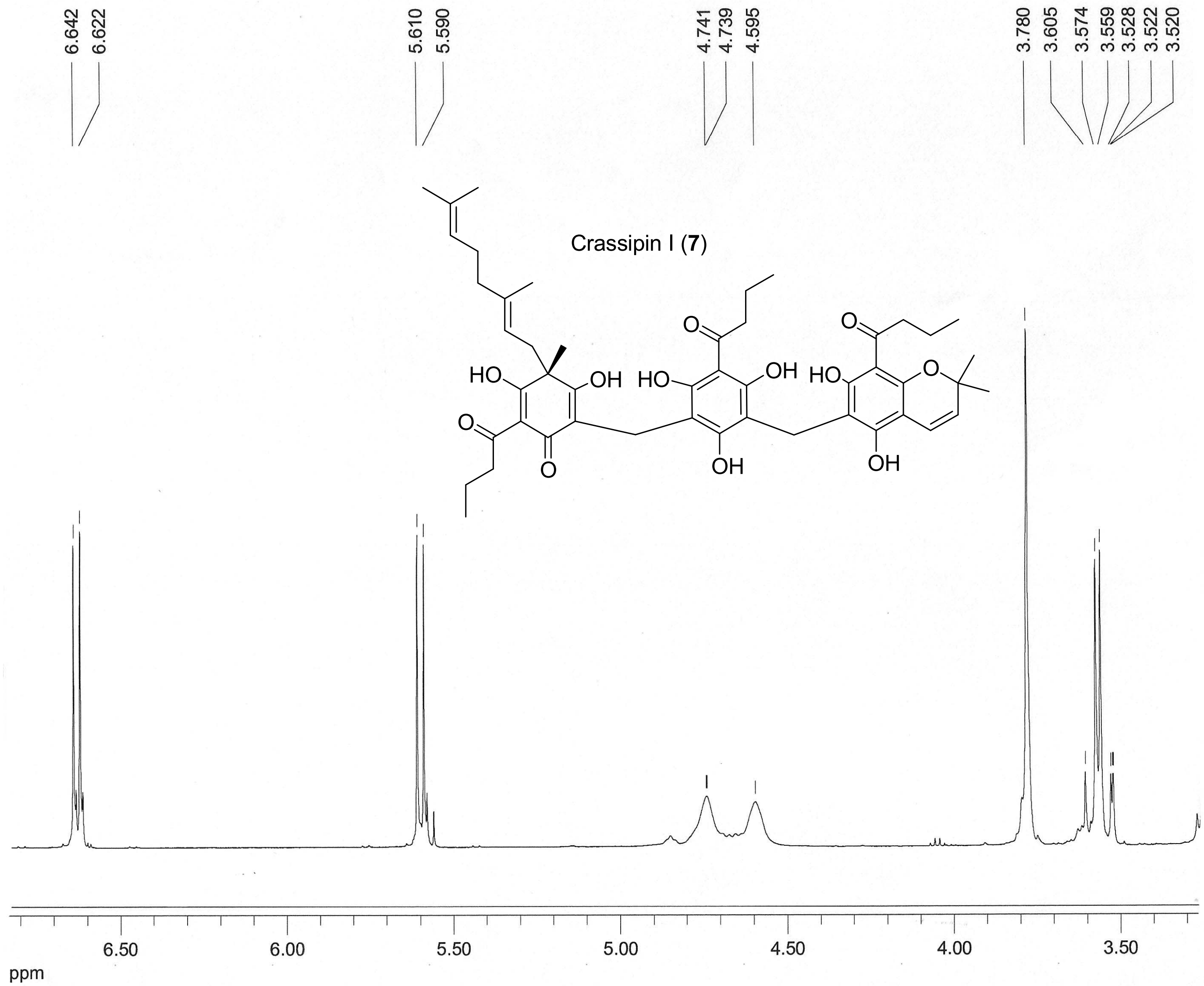
S27. ^{13}C NMR spectrum of crassipin H (**6**) (acetone-d_6, 125 MHz)

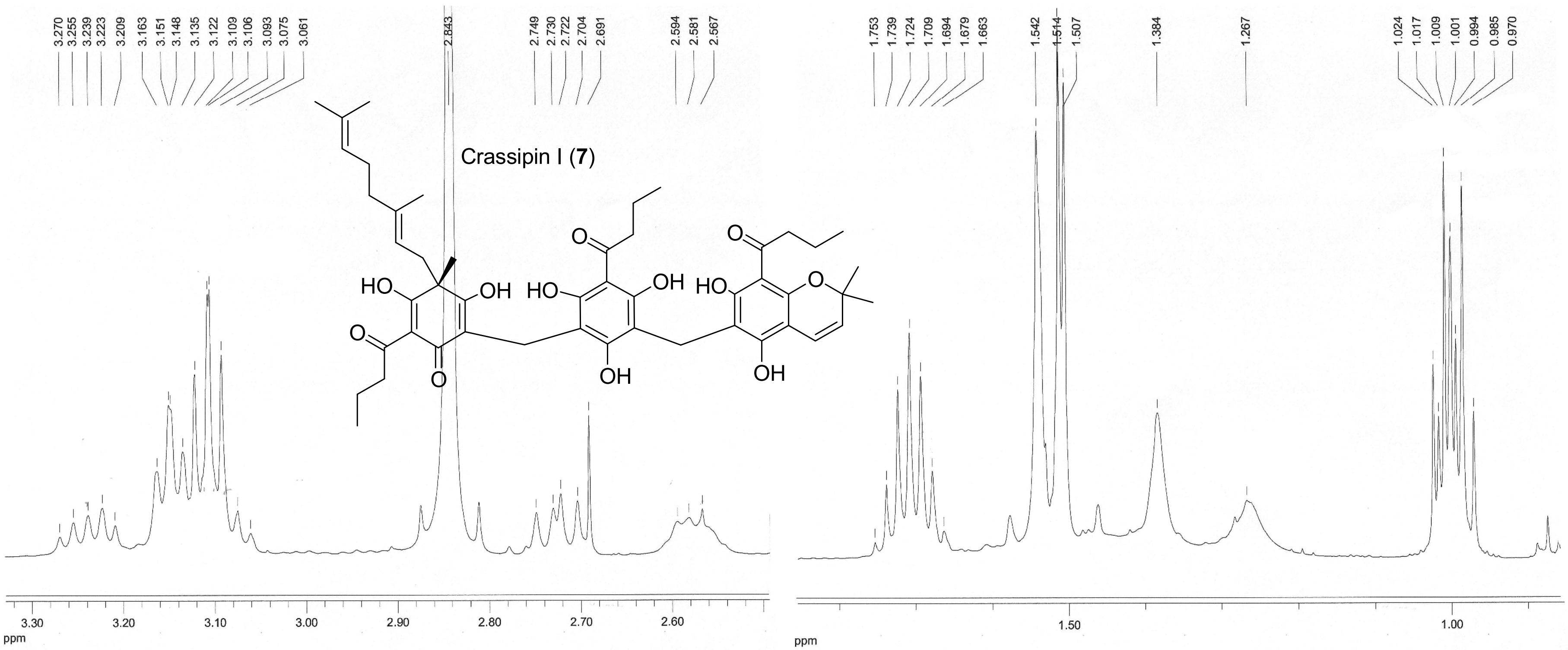


S28. ^{1}H NMR spectrum of crassipin I (**7**) (acetone-d_6, 500 MHz)



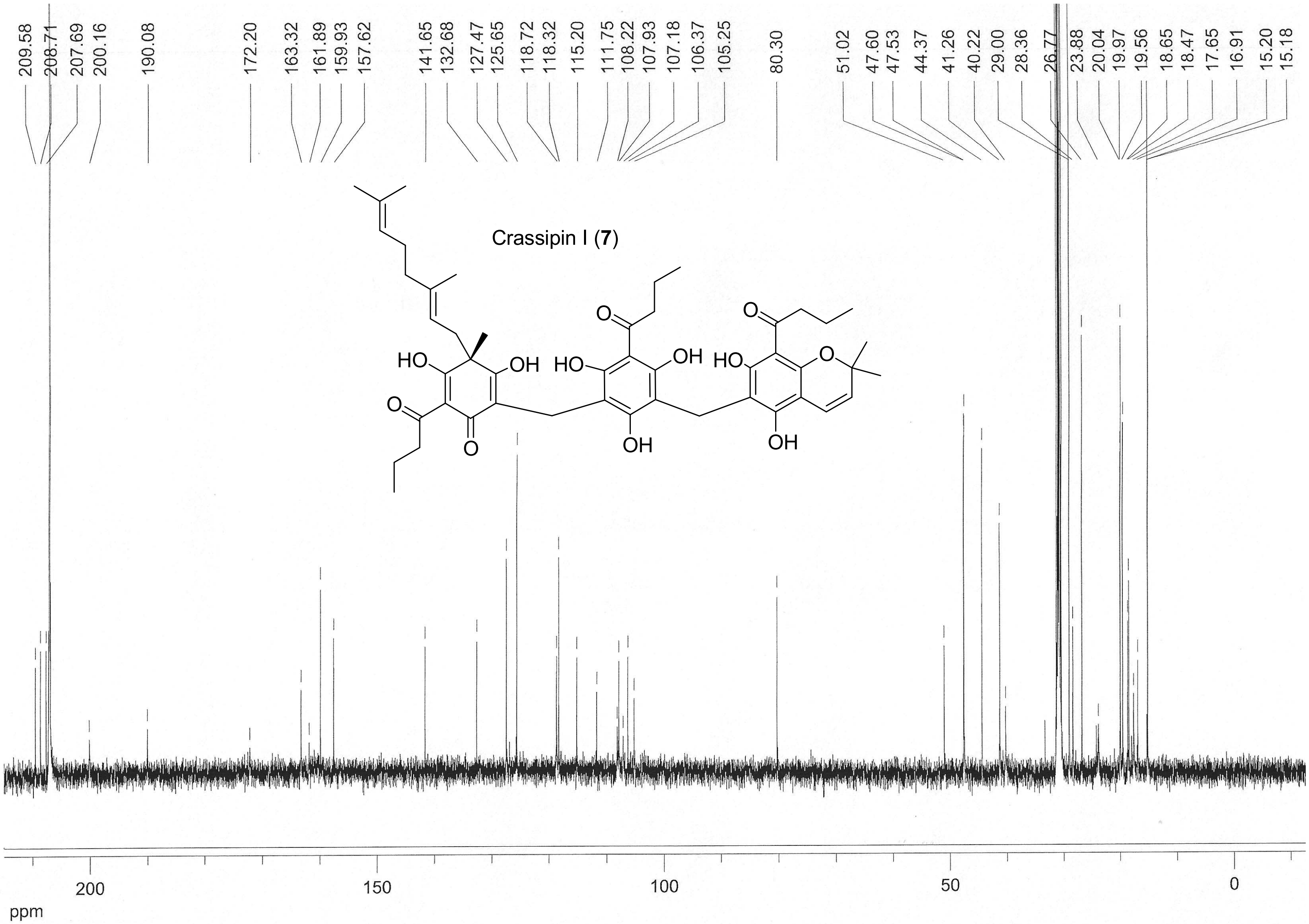
S29. ^{1}H NMR spectrum (partial enlarged) of crassipin I (**7**) (acetone-d_6, 500 MHz)



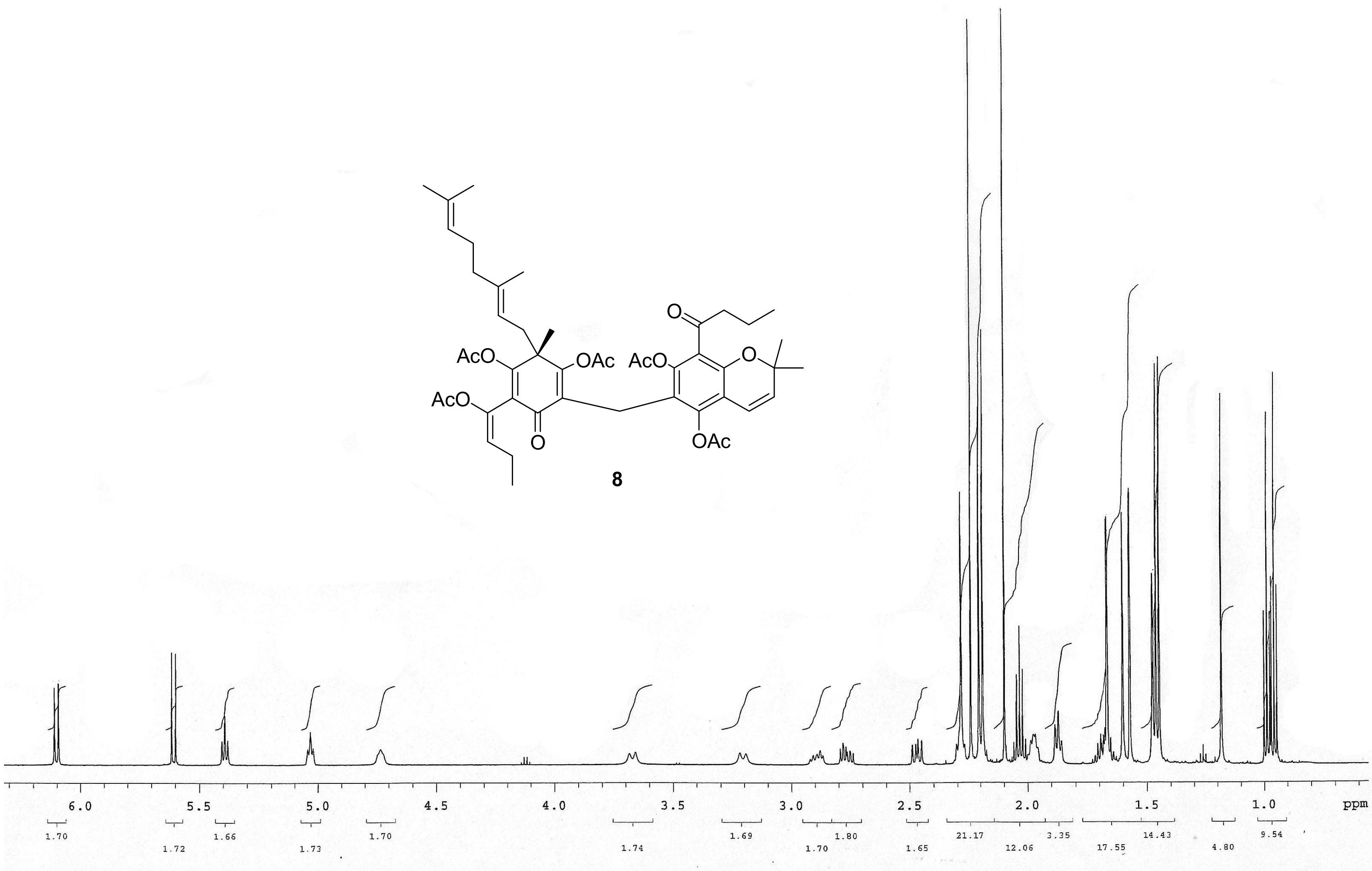


Crassipin I (**7**)
3.270 3.255 3.239 3.223 3.209 3.163 3.151 3.148 3.135 3.122 3.109 3.106 3.093 3.075 3.061
2.843
2.749 2.730 2.722 2.704 2.691
2.594 2.581 2.567
1.753 1.739 1.724 1.709 1.694 1.679 1.663
1.542 1.514 1.507
1.384
1.267
1.024 1.017 1.009 1.001 0.994 0.985 0.970
3.30 3.20 3.10 3.00 2.90 2.80 2.70 2.60
ppm
1.50 1.00
ppm

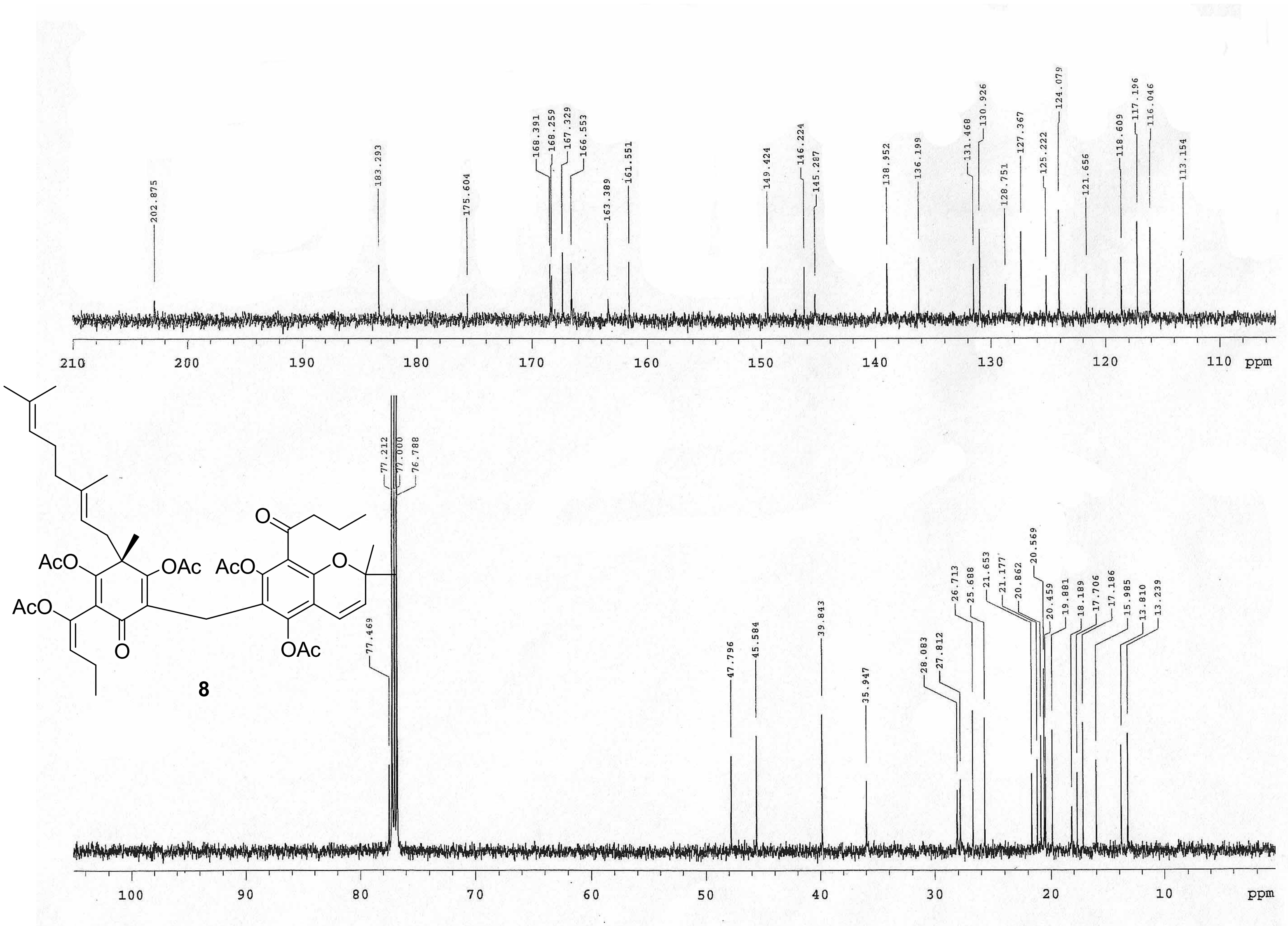
S30. ^{13}C NMR spectrum of crassipin I (**7**) (acetone-d_6, 125 MHz)



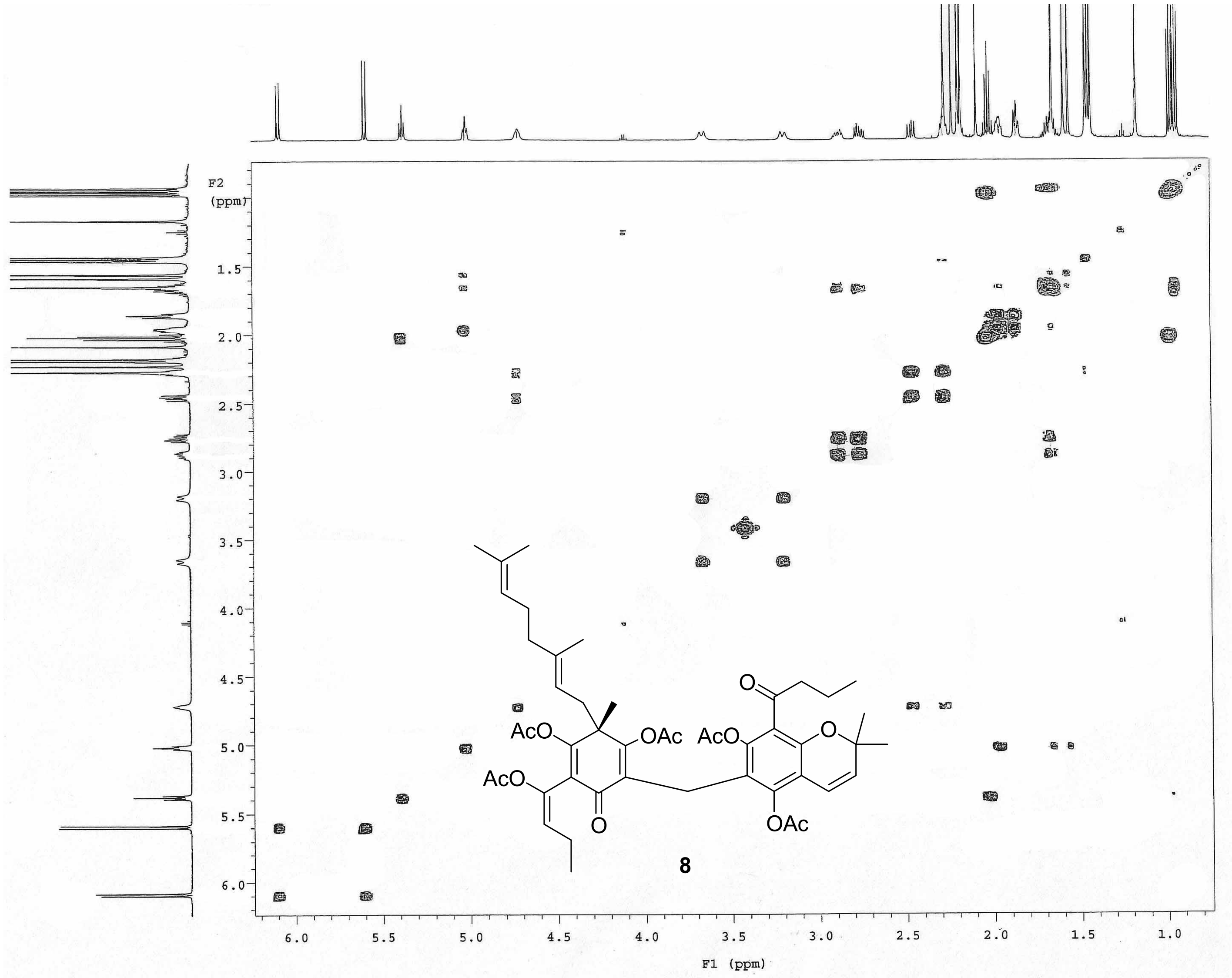
S31. ^{1}H NMR spectrum of compound **8** (acetone-d_6, 600 MHz)



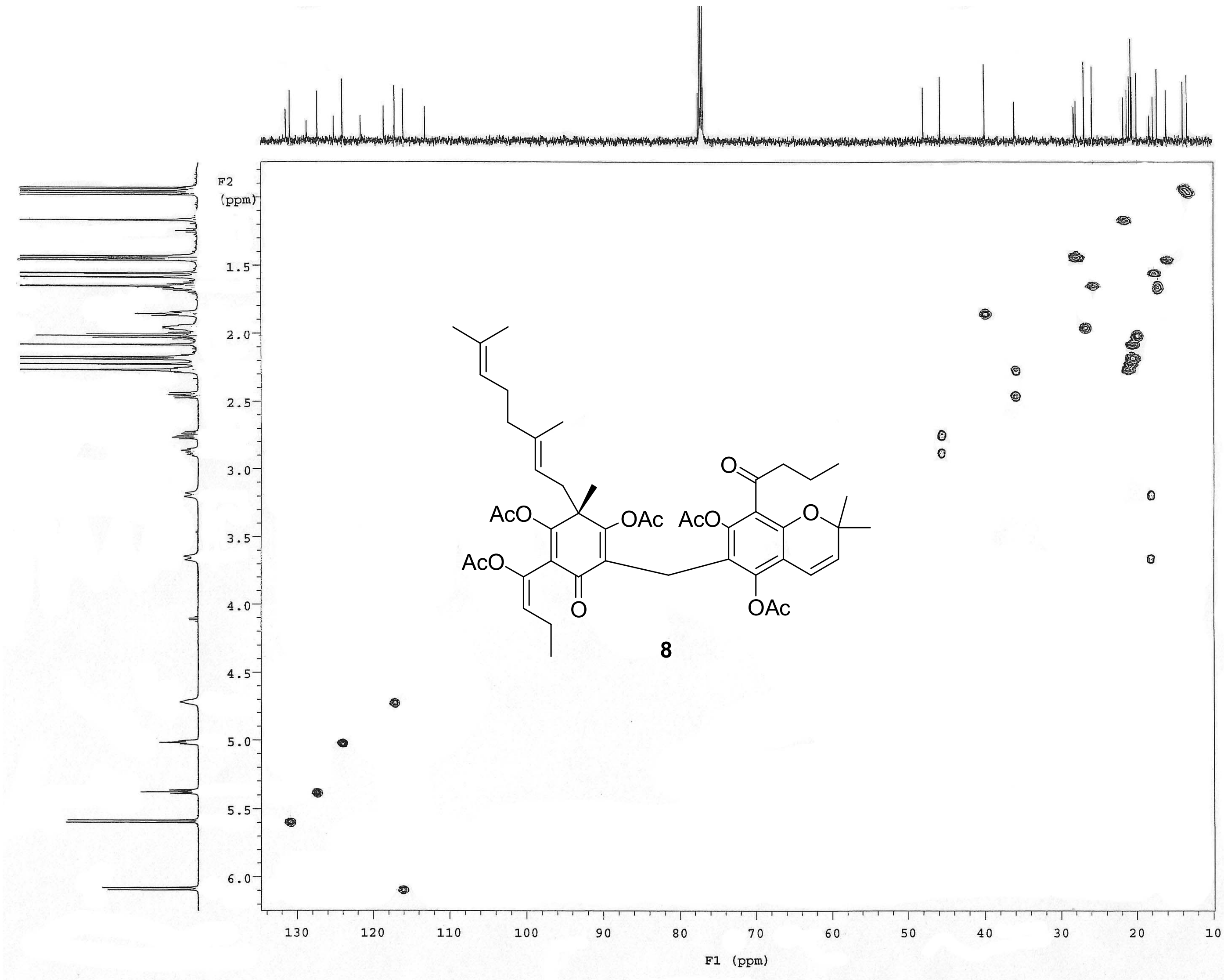
S32. ^{13}C NMR spectrum of compound **8** (acetone-d_6, 150 MHz)



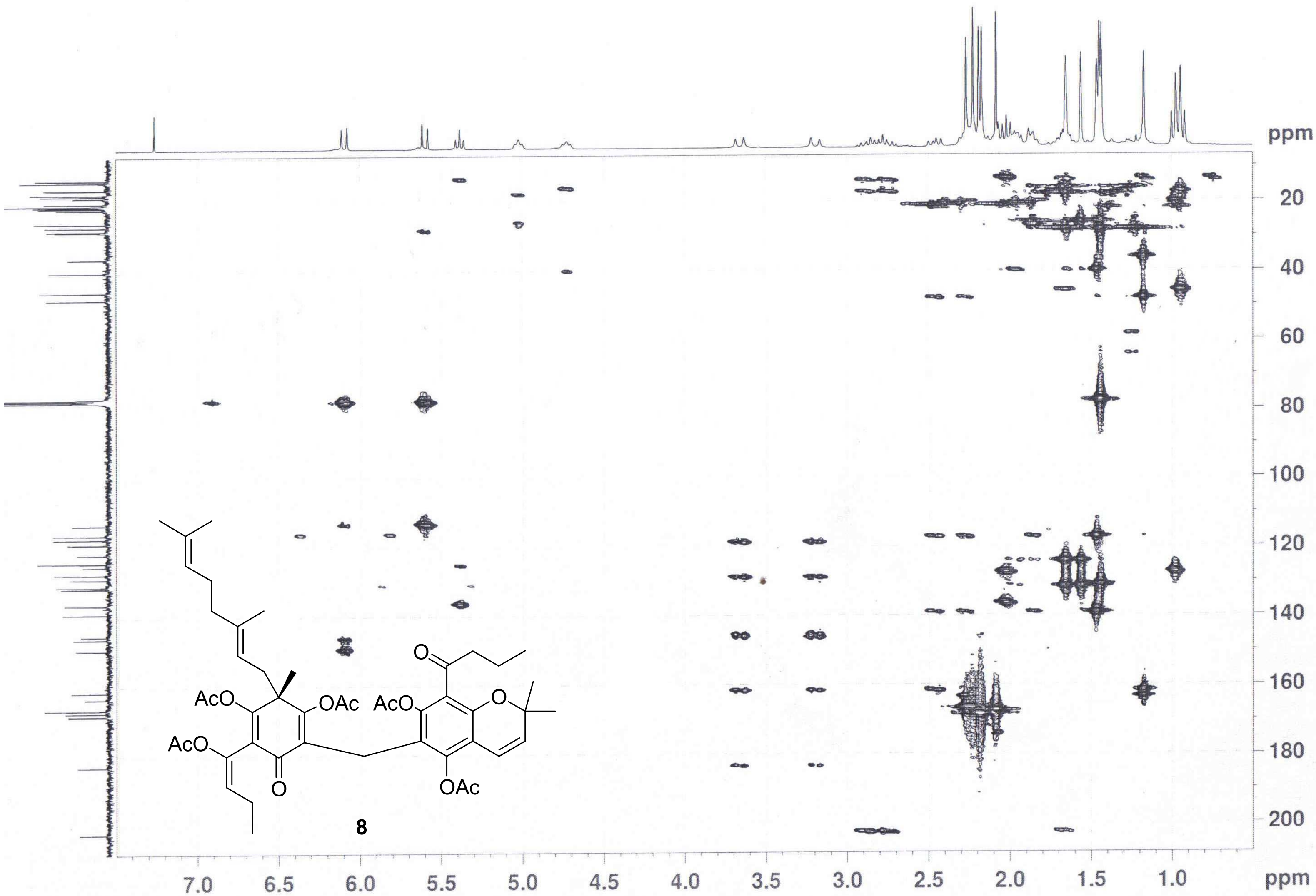
S33. ^1H ^1H COSY spectrum of compound **8** in acetone-d_6



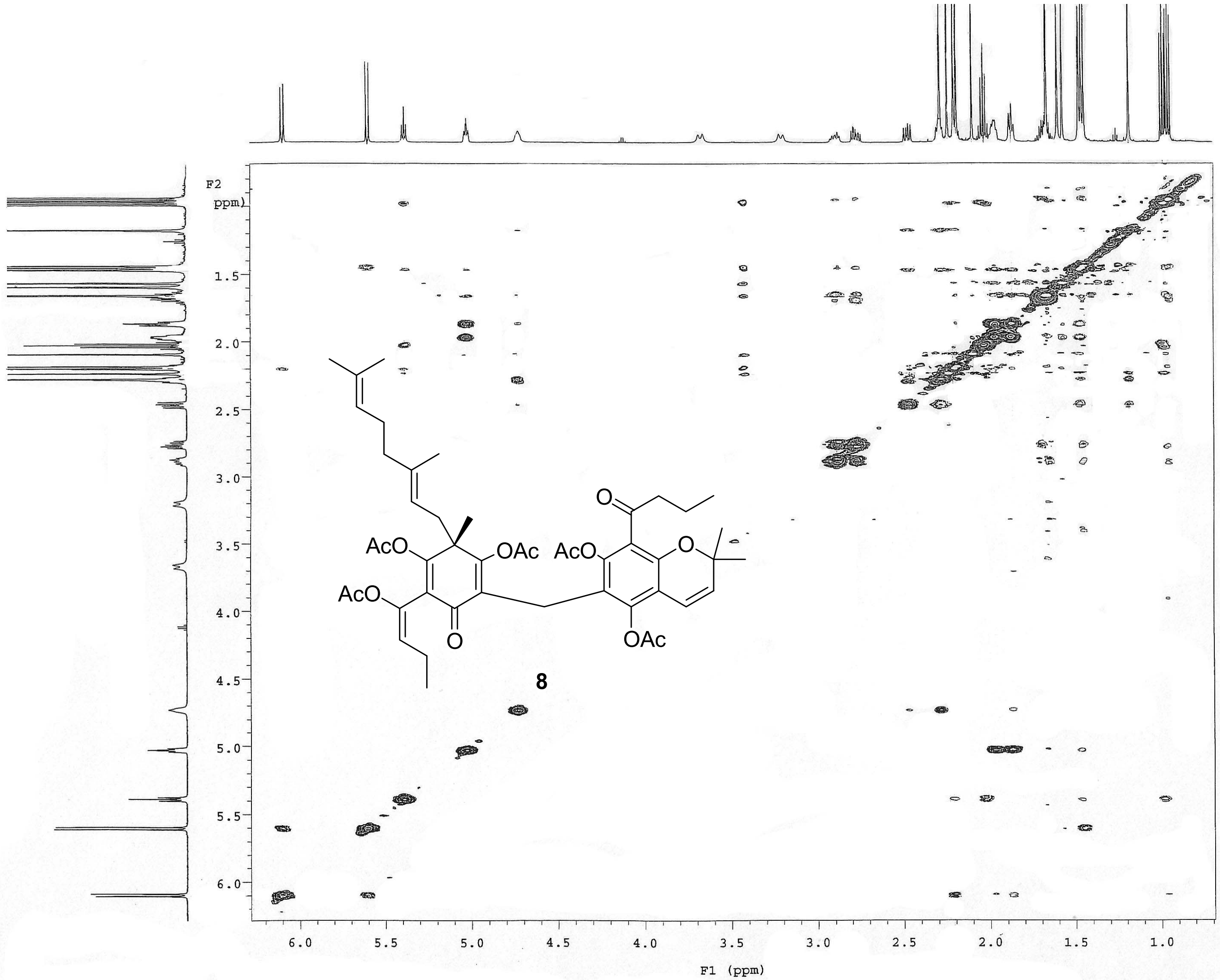
S34. HSQC spectrum of compound **8** in acetone-d_6



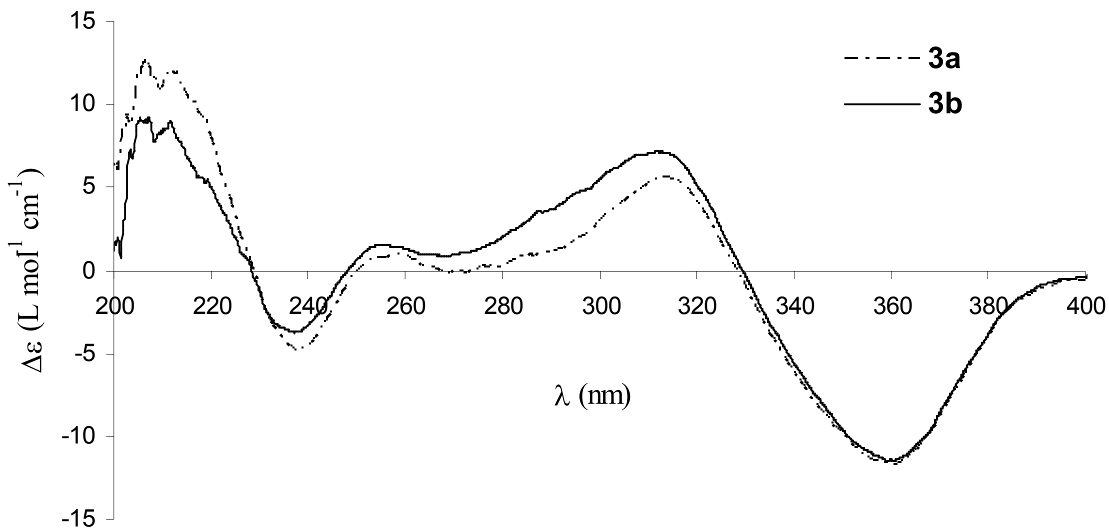
S35. HMBC spectrum of compound **8** in acetone-d_6



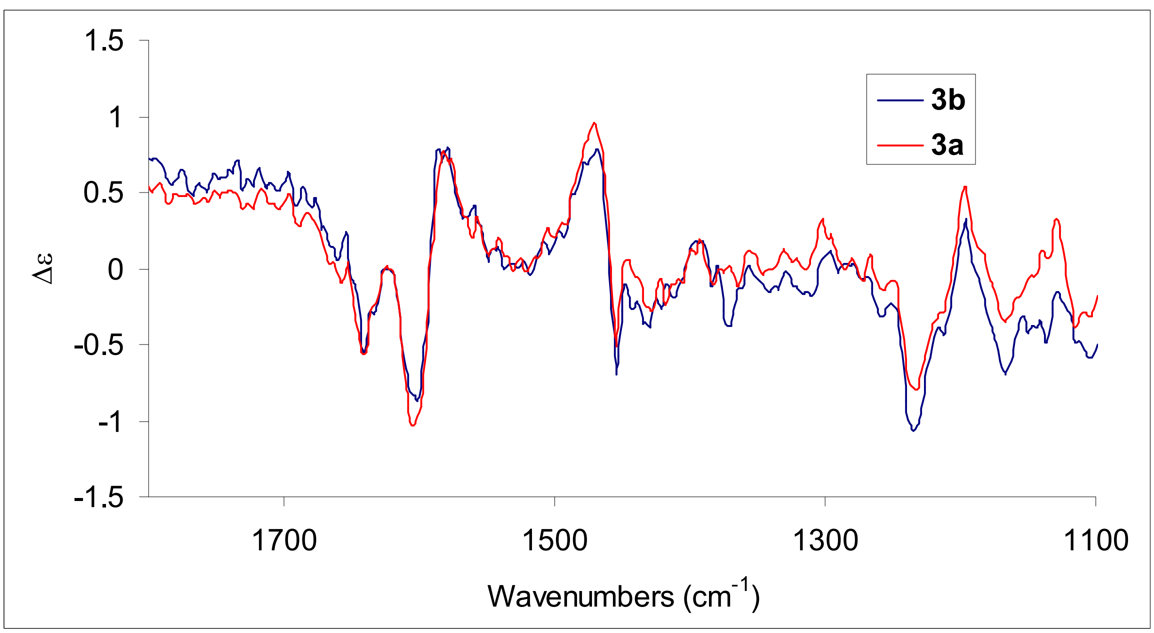
S36. NOESY spectrum of compound **8** in acetone-d_6



S37. Experimental ECD spectra of compounds **3a** and **3b**.



S38. Experimental VCD spectra of compounds **3a** and **3b**.



S39. Computational details

Table S1. TD-DFT results for crassipin A (**1**) (*4R*)

Transition	Excitation Energy (nm)	Rotatory Strength[a] (R x 10^{40} cgs)	Oscillator Strength f	Contributions	Weight
1	315.66	25.9040	0.0919	163 → 168	-0.25336
				164 → 168	0.18402
				165 → 168	0.61370
2	298.74	20.4789	0.0601	160 → 169	-0.13314
				161 → 168	-0.10149
				163 → 168	-0.10437
				163 → 169	0.11738
				164 → 168	-0.10001
				164 → 169	0.18226
				166 → 169	0.59418
3	291.33	16.1132	0.0363	160 → 168	-0.12954
				160 → 169	0.54241
				161 → 169	-0.11951
				162 → 169	0.11735
				163 → 168	0.12132
				164 → 168	-0.12141
				164 → 169	-0.15658
				165 → 168	0.10399
				166 → 169	0.20008
				167 → 171	-0.11668
4	289.17	43.4292	0.0173	159 → 170	-0.11612
				160 → 169	0.11794
				161 → 168	0.43403
				161 → 170	0.19935
				162 → 168	0.21753
				162 → 170	0.10638
				163 → 168	-0.33308
				165 → 168	-0.16631
				166 → 170	-0.13771
5	287.25	-34.4044	0.0347	159 → 168	0.16062
				161 → 170	-0.14064
				163 → 168	-0.22261
				164 → 168	0.35564
				165 → 168	-0.12048
				166 → 170	0.41797
				167 → 171	-0.22704

Table S1. (Continued)

6	285.70	-34.4712	0.0461	159 → 168	0.37244
				159 → 170	-0.13792
				161 → 170	-0.21474
				162 → 168	-0.12746
				162 → 170	-0.10650
				163 → 168	-0.12447
				165 → 170	0.12257
				166 → 170	-0.24883
				167 → 171	0.34155
7	283.69	-38.2813	0.1059	159 → 168	-0.19344
				160 → 169	0.12792
				163 → 169	0.16868
				164 → 169	0.15770
				165 → 169	-0.28368
				166 → 170	0.28724
				167 → 171	0.42977
8	277.28	14.6301	0.0861	163 → 169	-0.14265
				164 → 169	-0.24886
				164 → 170	0.24558
				165 → 169	0.14161
				165 → 170	0.50433
				166 → 169	0.14839
				166 → 170	0.10410
				167 → 171	0.10459
9	276.73	63.0566	0.2241	160 → 169	0.15825
				163 → 169	0.28257
				164 → 169	0.39423
				164 → 170	0.12709
				165 → 170	0.33115
				166 → 169	-0.17287
				167 → 171	-0.20689
10	268.48	11.6922	0.0656	161 → 168	-0.16463
				162 → 168	0.18085
				163 → 170	0.34428
				164 → 170	0.48656
				165 → 170	-0.20442
11	259.73	11.7161	0.1580	163 → 170	0.12086
				164 → 170	-0.13357
				165 → 171	-0.15519
				166 → 171	0.60894
				167 → 173	-0.15542
12	258.07	10.1531	0.0175	159 → 168	0.11835
				163 → 170	0.53259
				164 → 170	-0.31145
				165 → 170	0.20321
				166 → 171	-0.16467

Table S1. (Continued)

13	243.24	-17.6412	0.3785	159 → 170	-0.20947
				161 → 168	-0.31301
				161 → 170	0.12085
				162 → 168	0.45739
				162 → 170	-0.20301
				163 → 170	-0.11070
				164 → 170	-0.18335
14	241.66	-18.8395	0.0420	160 → 168	0.65488
				160 → 169	0.14987
				162 → 170	0.13362
15	236.63	-16.3229	0.0106	158 → 169	-0.17006
				163 → 171	0.26404
				164 → 171	0.47130
				165 → 171	0.32387
				166 → 171	0.20661
				167 → 173	0.10608
16	230.65	-25.9109	0.0633	158 → 168	0.29449
				158 → 169	0.46787
				158 → 170	0.11524
				161 → 170	0.15340
				162 → 168	-0.14313
				162 → 170	-0.27890
				164 → 171	0.12894
17	227.56	27.2456	0.1648	158 → 168	0.38269
				158 → 169	0.18692
				161 → 170	-0.25362
				162 → 168	0.11767
				162 → 170	0.40491
18	211.54	31.0910	0.0835	155 → 169	0.13596
				157 → 168	-0.17819
				157 → 169	0.43064
				160 → 171	0.40299
				161 → 171	-0.12654
				167 → 173	-0.19856
19	201.82	62.7233	0.4022	158 → 171	0.14024
				162 → 171	0.20687
				165 → 172	0.29308
				165 → 173	-0.11026
				166 → 172	0.41482
				166 → 173	0.34874
20	200.63	-37.9565	0.0344	158 → 171	-0.11613
				162 → 171	-0.11562
				164 → 172	-0.15675
				165 → 172	0.58331
				166 → 172	-0.11595
				166 → 173	-0.23445

[a] Excited states with $-10 < R < 10$ were not presented.

Table S2. TD-DFT results for crassipin A (**1**) (*4S*)

Transition	Excitation Energy (nm)	Rotatory Strength[a] (R x 10^{40} cgs)	Oscillator Strength f	Contributions	Weight
1	315.88	-29.1310	0.0998	163 → 168	-0.25862
				164 → 168	0.15048
				165 → 168	0.61482
2	299.07	-13.3365	0.0599	160 → 169	-0.13246
				163 → 168	-0.11163
				163 → 169	0.10240
				164 → 169	0.18939
				165 → 169	-0.11156
				166 → 169	0.58812
3	291.39	-14.6999	0.0326	160 → 168	-0.13570
				160 → 169	0.54218
				161 → 169	-0.13886
				162 → 169	0.10433
				163 → 168	0.11196
				164 → 168	-0.12557
				164 → 169	-0.16005
				166 → 169	0.18447
				167 → 171	-0.11124
4	289.38	-39.3065	0.0119	159 →170	-0.14562
				160 →169	0.13844
				161 →168	0.43424
				161 →170	0.17411
				162 →168	0.27825
				162 →170	0.12324
				163 →168	-0.30256
				165 →168	-0.15147
5	287.34	39.2129	0.0346	159 →168	0.14531
				161 →170	-0.13835
				163 →168	-0.18112
				164 →168	0.34836
				166 →170	0.44297
				167 →171	-0.24272
6	285.54	23.5535	0.0356	159 →168	0.38742
				159 →170	-0.14615
				161 →170	-0.21002
				162 →168	-0.12965
				162 →170	-0.12909
				163 →168	-0.14507
				164 →168	0.11081
				165 →169	-0.11723
				165 →170	0.14975
				166 →170	-0.24091
				167 →171	0.28985

Table S1. (Continued)

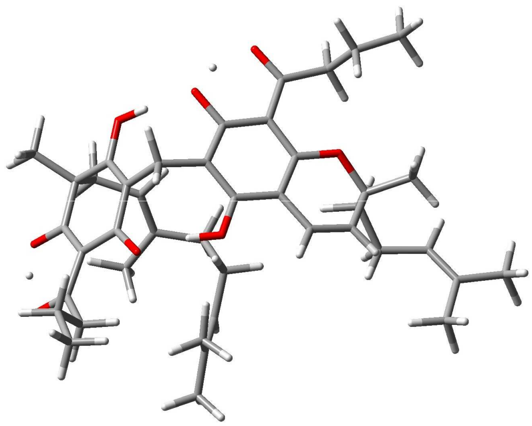
7	283.43	41.7794	0.1266	159 →168	-0.17732
				160 →169	0.12323
				163 →169	0.16437
				164 →169	0.16020
				165 →169	-0.27848
				166 →170	0.26413
				167 →171	0.46122
8	276.77	-77.3726	0.2821	160 →169	0.17501
				163 →169	0.32644
				164 →169	0.45504
				165 →170	0.12681
				166 →169	-0.21080
				167 →171	-0.23202
9	267.85	-15.7552	0.0845	161 →168	-0.17781
				162 →168	0.16953
				163 →170	0.36788
				164 →170	0.47704
				165 →170	-0.17584
				166 →170	-0.10373
10	258.64	-10.7996	0.0138	159 →168	0.11389
				163 →169	0.10343
				163 →170	0.52864
				164 →170	-0.32277
				165 →170	0.18944
				166 →171	-0.16661
11	246.00	-10.1225	0.0247	159 →168	0.31955
				159 →169	-0.11063
				159 →170	0.53046
				162 →168	0.23377
12	243.07	14.1975	0.3735	159 →170	-0.22394
				161 →168	-0.35548
				161 →170	0.13752
				162 →168	0.41984
				162 →170	-0.18863
				164 →170	-0.19323
13	241.56	17.4098	0.0425	160 →168	0.65465
				160 →169	0.14955
				161 →170	-0.10165
				162 →170	0.12303
14	237.36	11.1254	0.0071	158 →169	-0.13677
				163 →171	0.20946
				164 →171	0.42154
				165 →171	0.39784
				166 →171	0.27251

Table S1. (Continued)

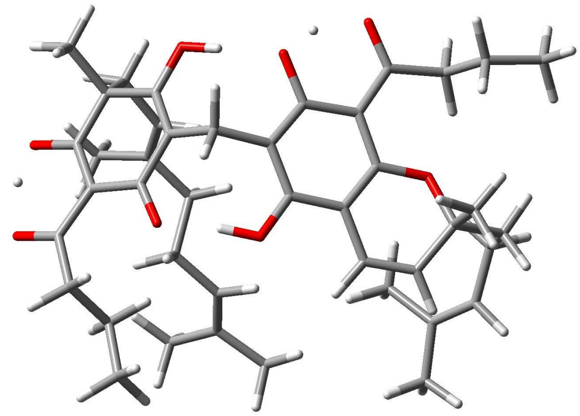
15	234.26	13.4038	0.0137	158 →168	-0.13725
				158 →169	0.24838
				163 →171	-0.27249
				164 →171	-0.27308
				165 →171	0.48931
				166 →171	0.11245
16	230.57	29.8348	0.0656	158 →168	0.30217
				158 →169	0.45332
				158 →170	0.11340
				161 →170	0.18344
				162 →168	-0.14222
				162 →170	-0.27331
				163 →171	0.10081
				164 →171	0.12805
17	227.50	-30.0375	0.1654	158 →168	0.39027
				158 →169	0.18963
				161 →170	-0.28609
				162 →168	0.10752
				162 →170	0.37603
				164 →170	-0.10082
18	211.59	-31.4846	0.0983	155 →169	0.13717
				157 →168	-0.17853
				157 →169	0.42210
				160 →171	0.40260
				161 →171	-0.13370
				167 →172	-0.10367
				167 →173	-0.21944
19	204.08	14.5373	0.0171	158 →171	0.12078
				160 →171	0.21745
				161 →171	0.46051
				162 →171	-0.39206
				166 →172	-0.13587
				166 →173	0.16634
20	202.20	-50.2057	0.3788	156 →168	-0.11012
				158 →171	-0.11715
				161 →171	0.10581
				162 →171	-0.20547
				165 →172	0.22162
				165 →173	0.14836
				166 →172	0.48607
				166 →173	-0.26108
21	200.66	17.3713	0.0196	154 →168	-0.17753
				156 →168	0.42192
				158 →171	-0.11377
				162 →171	-0.10978
				165 →172	-0.38274
				166 →173	-0.24307

[a] Excited states with $-10 < R < 10$ were not presented.

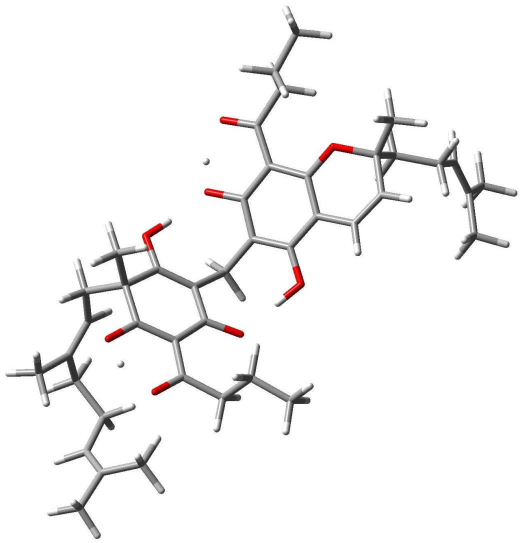
Figure 1. Optimized geometries of the four calculated lowest-energy (*4R*,*2'R*) conformers of crassipin C (**3a**)



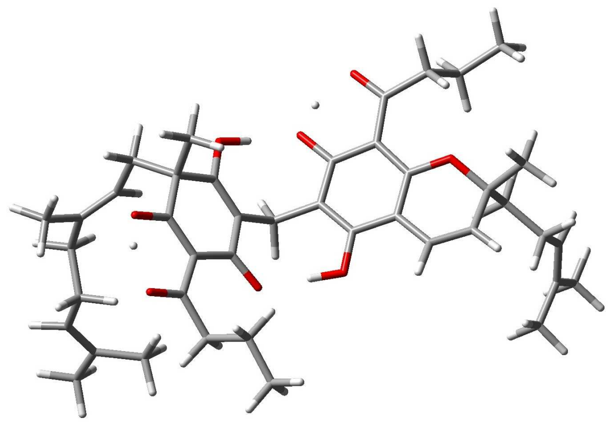
Conformer a, ΔE = 0 Kcal/mol



Conformer b, ΔE = 0.46 Kcal/mol

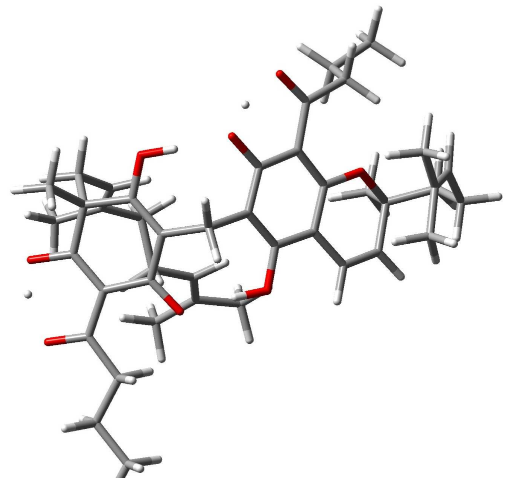


Conformer c, ΔE = 0.68 Kcal/mol

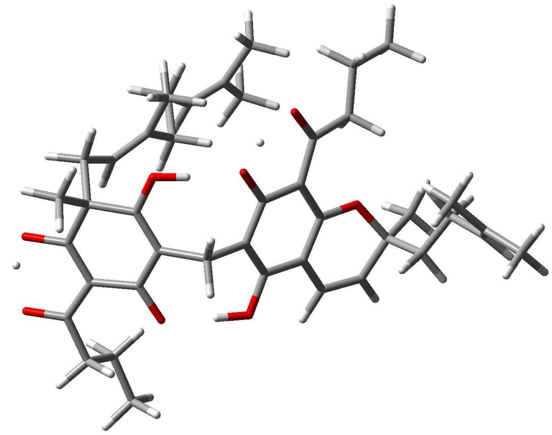


Conformer d, ΔE = 0.86 Kcal/mol

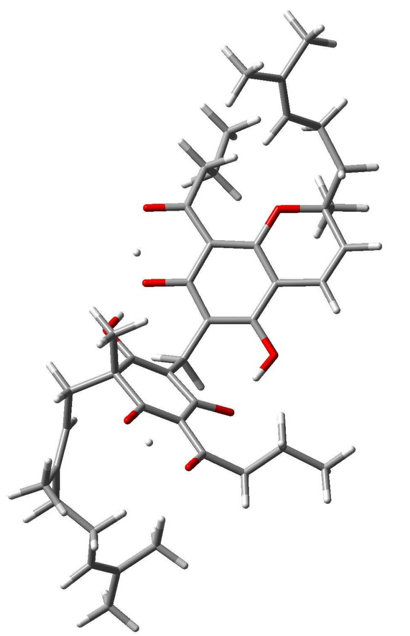
Figure 2. Geometries and relative energies of the calculated lowest-energy (*4R*,*2'S*) conformers of crassipin C (**3a**)



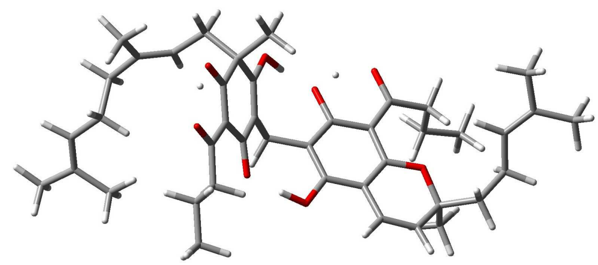
Conformer a, ΔE = 0 Kcal/mol



Conformer b, ΔE = 0.21 Kcal/mol



Conformer c, ΔE = 0.24 Kcal/mol



Conformer d, ΔE = 0.74 Kcal/mol

Figure 3. Theoretical Boltzmann-weighted IR spectra for both diastereomers (*4R*,*2'R*, and *4R2'S*) of compounds **3a** and **3b** in comparison with their experimental IR spectra.

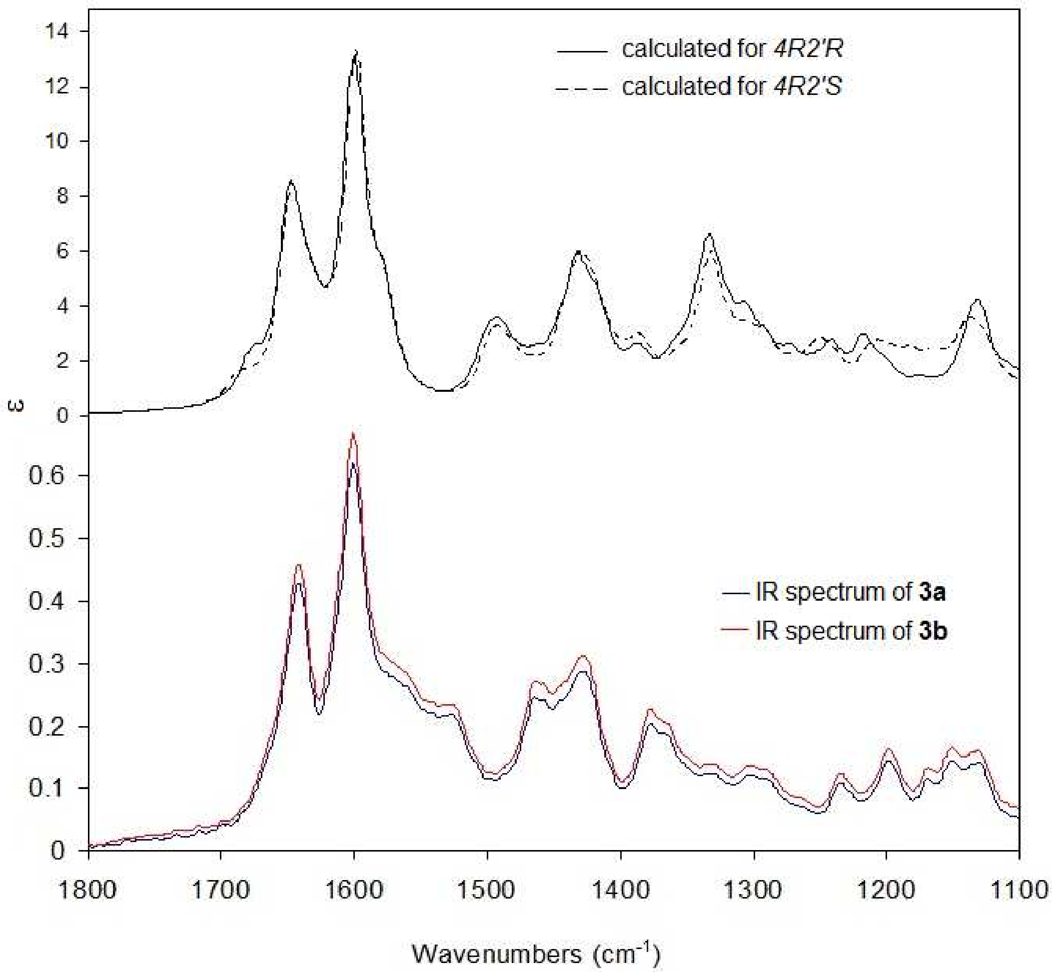
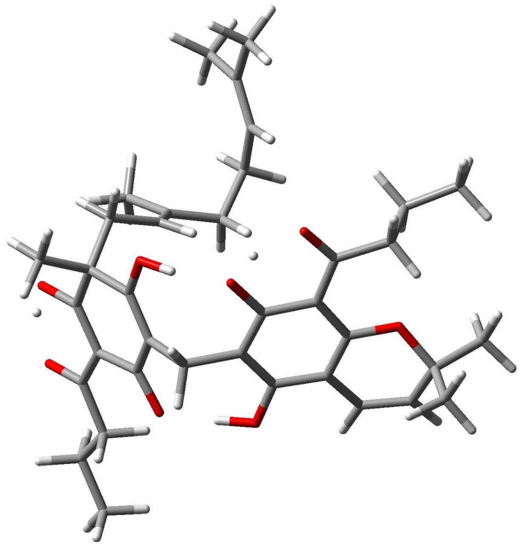
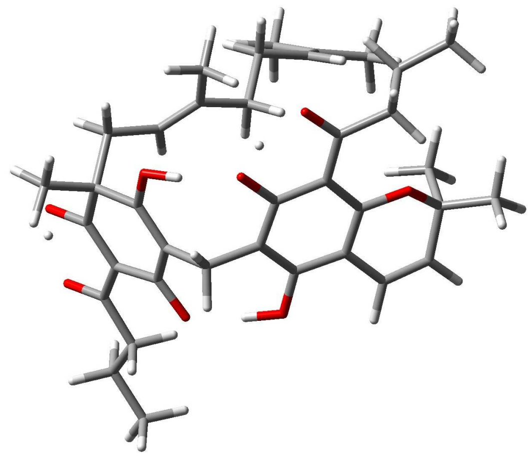


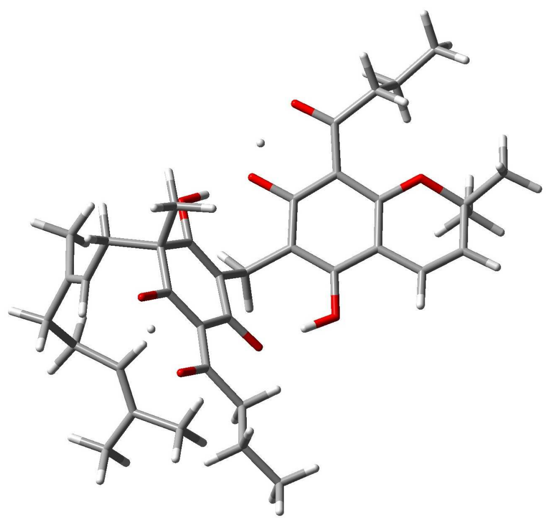
Figure 4. Structures and relative energies of the four lowest-energy (*S*) conformers of crassipin A (**1**). Optimized geometries of the four calculated lowest-energy (*R*) conformers of



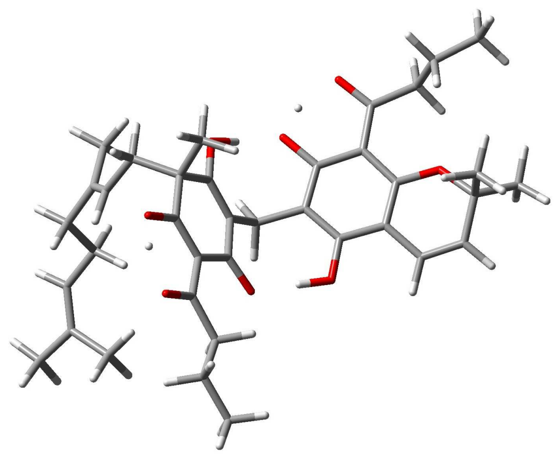
Conformer a, ΔE = 0 Kcal/mol



Conformer b, ΔE = 0.29 Kcal/mol



Conformer c, ΔE = 0.45 Kcal/mol



Conformer d, ΔE = 0.68 Kcal/mol

S40. Photograph of the scaly rhizomes of *Elaphoglossum crassipes*