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Supporting Information

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Enantioselective Catalytic Intramolecular Cyclopropanation using Modified Cinchona Alkaloid Catalysts.

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General Experimental

^{1}H NMR Spectra were recorded on Bruker DPX 400, 500 and DPX 600 spectrometers in deuterochloroform, unless stated otherwise, operating at 400, 500 and 600 MHz respectively. ^{13}C NMR Spectra were recorded on a Bruker DPX 600, 500 and DPX 400 spectrometer operating at 150, 125 and 100 MHz. Chemical shifts are quoted relative to residual solvent (7.25 ppm for ^{1}H and 77.0 ppm for ^{13}C of $CDCl_3$) and coupling constants (*J*) are given in Hz. For convenience, the following abbreviations are used to indicate the multiplicity of the signals: s singlet; d doublet; t triplet; q quartet; qu quintet; dd doublet of doublets; dt doublet of triplets; m multiplet; br broad. The temperature of acquisition of the NMR spectra was 298 ± 3 K. DEPT135 and 2-dimensional experiments (COSY, HMBC, HMQC, NOSEY) were used to support assignments where appropriate.

High resolution mass spectral (HRMS) analyses were measured on a Micromass Q-TOF spectrometer using EI (electron impact) or ES (electrospray ionosation) techniques at the Department of Chemistry, University of Cambridge. Compounds with Br or Cl isotopes were quoted as *M* 78.9183 and *M* 34.9689 respectively.

Infrared spectra were recorded on a PerkinElmer Spectrum 1FT-IR Spectrometer fitted with an ATR sampling accessory as neat films, either through direct application or deposited from $CHCl_3$.

Optical rotations were messured in chloroform on a Perkin Elmer 343 Polarimeter. Chiral HPLC analysis was performed on HP Agilant 1100.

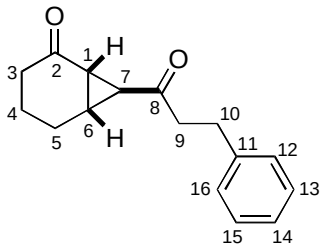
Melting points were recorded using a Reichert hot stage apparatus.

All anhydrous solvents were dried by standard techniques and freshly distilled before use or purchased in anhydrous form from Fluka. All flash chromatography was carried out using dry-packed Merck 9385 Kieselgel 60 silica gel. Reactions were monitored by thin layer chromatography (TLC), carried out on Kieselgel 60 PF_{254} (Merck) 0.2 mM plates.

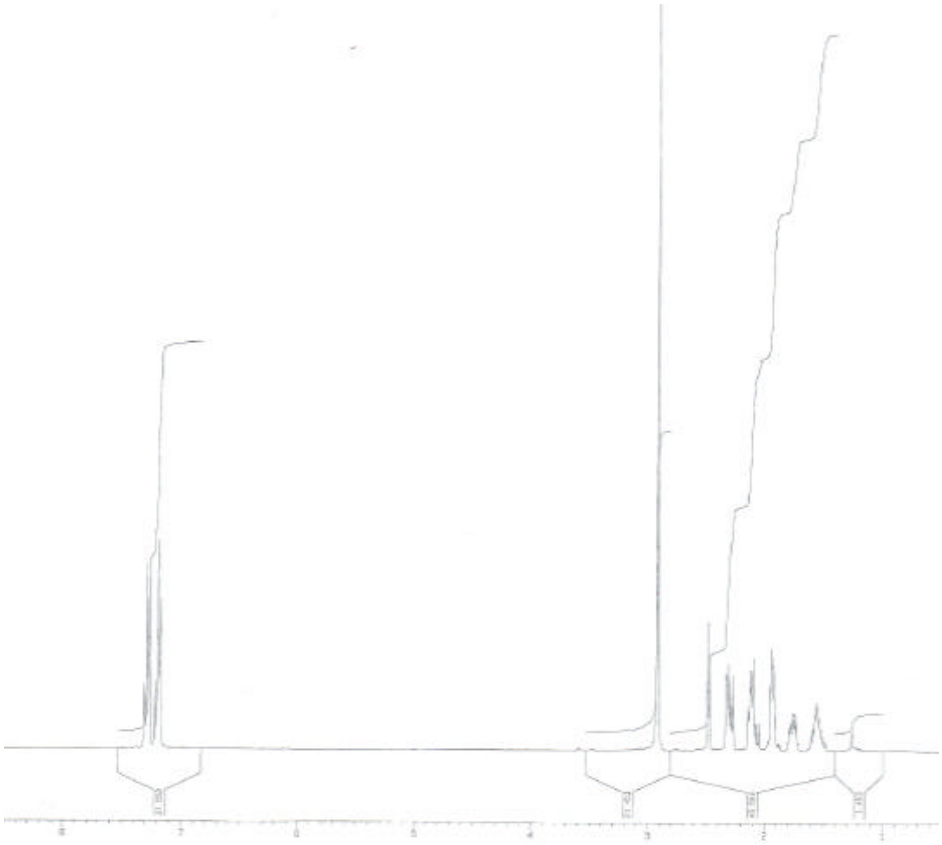
All chemicals were purchased from The Aldrich Chemical Company, Fluka, Lancaster, Avocado or Strem and distilled or recrystallised before use, where possible. All reactions were carried out in oven dried glassware and under an atmosphere of argon unless stated otherwise.

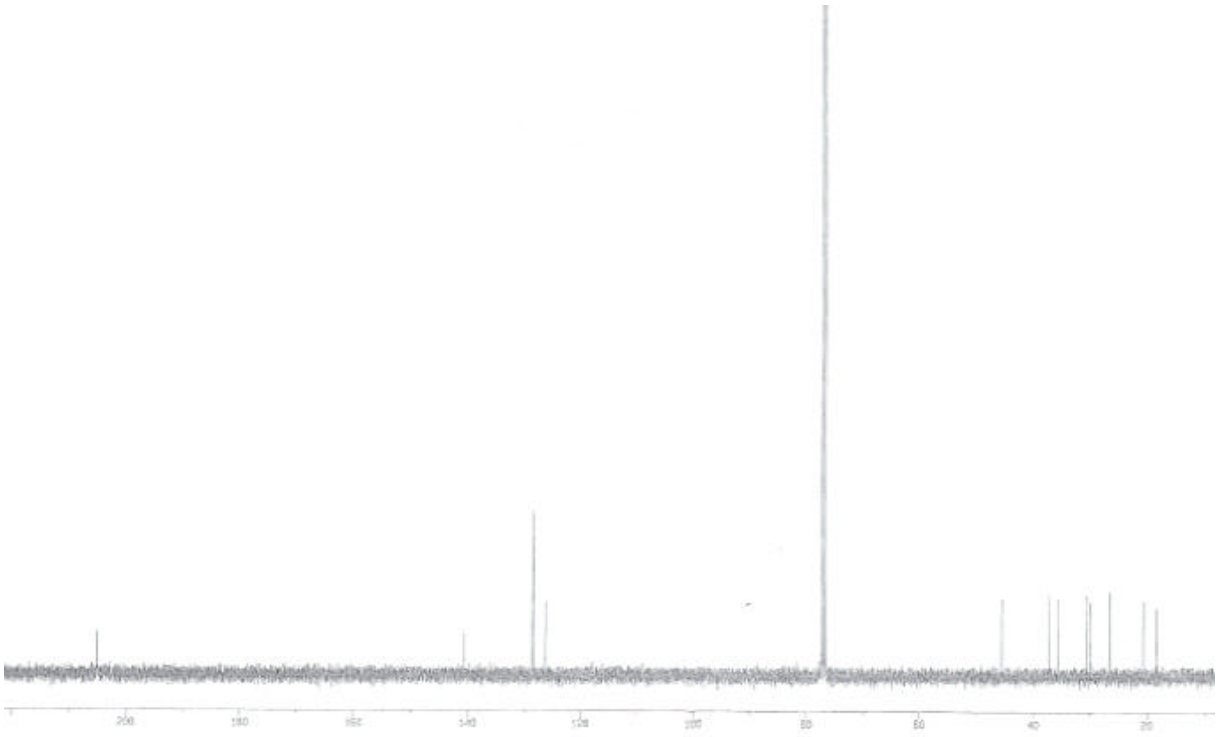
Na_2CO_3 was dried by grinding the pellets and heating the resulting powder to 120 °C under vacuum for 48h.

7-(3-Phenylpropionyl)-bicyclo[4.1.0]heptane-2-one 2a



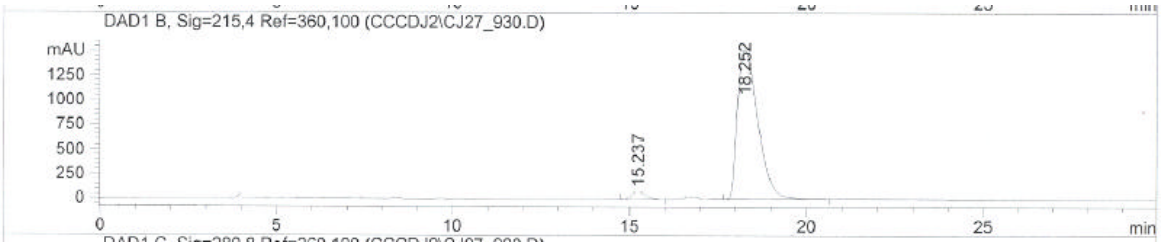
white solid; m.p. 91-94 °C; ν_{max} (film)/ cm^{-1} 2940, 1695, 1497,1416, 1295, 1236, 1172, 1103, 1064, 1031, 880, 749 701; δ_H (600 MHz, $CDCl_3$) 7.30-7.26 (2H, m, H-12, H-16), 7.21-7.17 (3H, m, H-13, H-14, H-15), 2.91 (4H, app s, H-9, H-10), 2.48 (1H, dd, *J* = 4.1, 4.1, H-7), 2.30 (1H, dd, *J* = 8.2, 4.1, H-1), 2.31-2.27 (1H, m, H_a-3), 2.12-2.09 (1H, m, H-6), 2.12-2.05 (1H, m, H_b-3), 1.94-1.90 (2H, m, H-5), 1.79-1.72 (1H, m, H_a-4), 1.58-1.50 (1H, m, H_b-4); δ_C (100 MHz, $CDCl_3$) 205.2 (C-2), 205.1 (C-8), 140.7 (C-11), 128.5 (C-12, C-16), 128.3 (C-13, C-15), 126.2 (C-14), 45.5 (C-9), 37.1 (C-3), 35.7 (C-1) 30.3 (C-7), 29.9 (C-10), 26.6 (C-6), 20.6 (C-5), 18.2 (C-4); HRMS found ES $[M]^+$ 242.1317, $C_{16}H_{18}O_2$ requires *M*, 242.1307.





OD DAICEL Chiralpak, 85:15 hexane/IPA, flow 1ml/min; retention time: (+) enantiomer 18.25 min, (–) enantiomer 20.29 min.

(*1R, 6S, 7R*)- **2a**: $[\alpha]_D^{25}$ = – 66.2 (c = 0.385 in $CHCl_3$) for 93% ee.



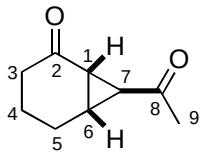
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.237	BB	0.4031	2098.70337	79.72517	3.3345
2	18.252	PB	0.6235	6.08412e4	1524.93579	96.6655
Totals :				6.29399e4	1604.66096	

(*1S, 6R, 7S*)-**2a**: $[\alpha]_D^{25}$ + 66.1 (c = 0.590 in $CHCl_3$) for 97% ee;

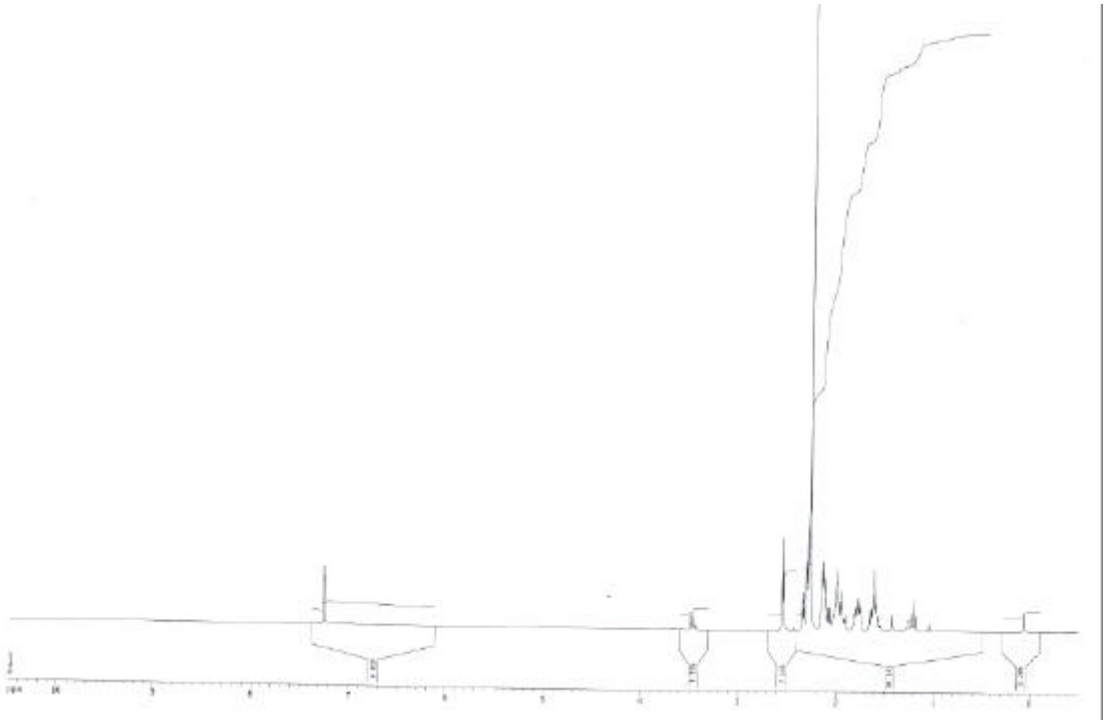
Signal 3: DAD1 B, Sig=215,4 Ref=360,100

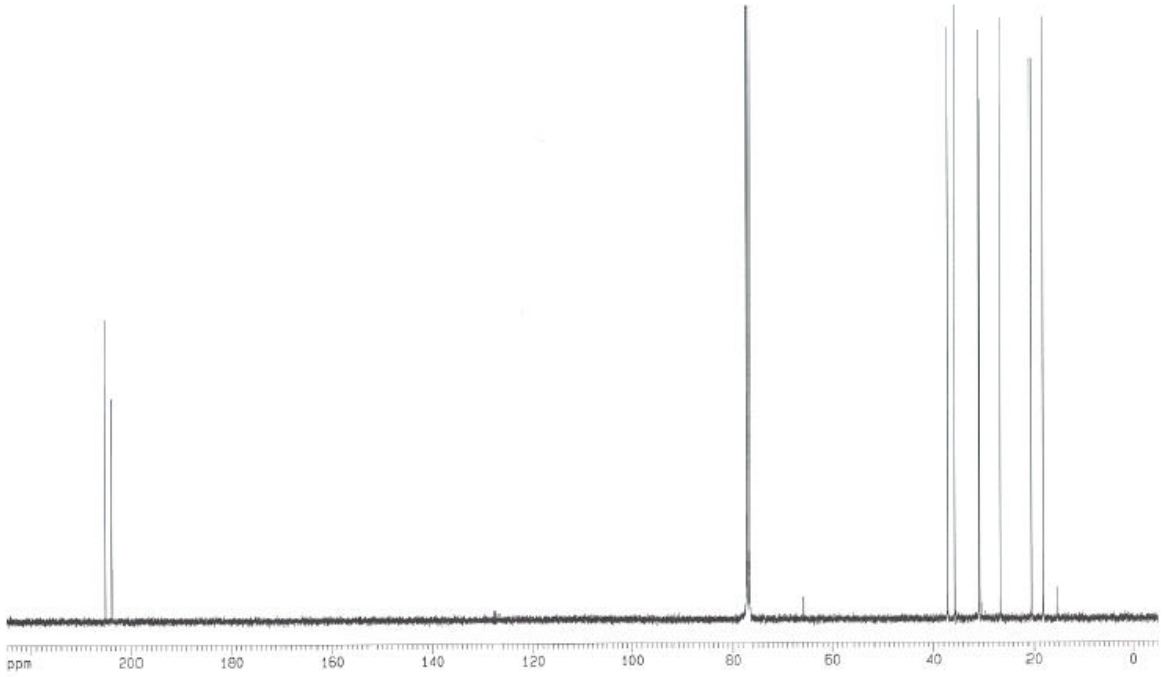
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.292	BB	0.5926	1.38573e4	361.97540	98.5670
2	23.114	BB	0.4763	201.46700	5.08440	1.4330
Totals :				1.40587e4	367.05980	

7-Acetyl-biclo[4.1.0]heptane-2-one 2b



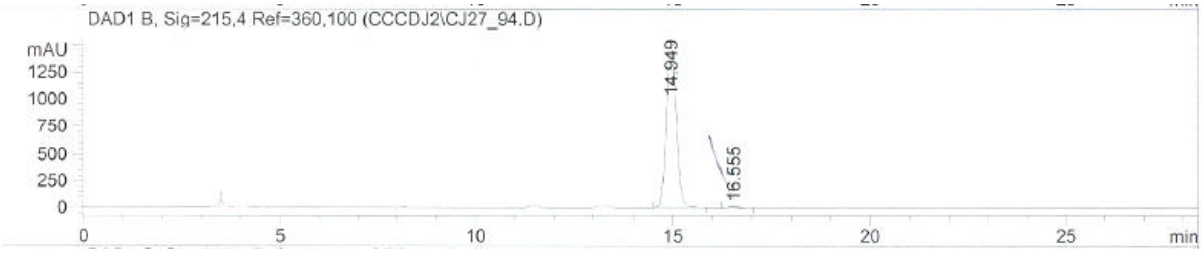
orange oil; ν_{max} (film)/ cm^{-1} 2943, 1692, 1415, 1358, 1290, 1237, 1180, 976, 881; δ_H (400 MHz, $CDCl_3$) 2.54 (1H, dd, *J* = 4.2, 4.2, H-7), 2.31-2.21 (2H, m, H-1, H_a-3), 2.25 (3H, s, H-9), 2.15-2.02 (2H, m, H-6, H_b-3), 2.01-1.88 (2H, m, H-5), 1.80-1.72 (1H, m, H_a-4), 1.65-1.54 (1H, m, H_b-4); δ_C (100 MHz, $CDCl_3$) 205.5 (C-2), 204.2 (C-8), 37.5 (C-3), 36.1 (C-1) 31.2 (C-7), 31.1 (C-9), 27.0 (C-6), 21.0 (C-5), 18.7 (C-4); HRMS found ES $[M]^+$ 152.0837, $C_9H_{12}O_2$ requires *M*, 152.0837.





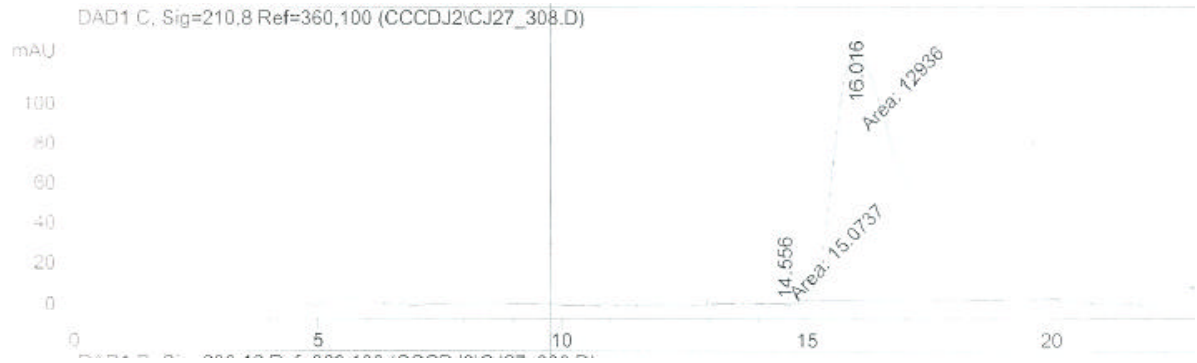
HPLC: AD DAICEL Chiralpak, 95:5 hexane/IPA, flow 1ml/min; retention time: (+) enantiomer x min, (–) enantiomer 14.95 min.

(*1R, 6S, 7R*)-**2b**: $[\alpha]_D^{25}$ – 166.92 (c = 1.625 in MeOH) for 99% ee;



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.949	BB	0.2804	2.64605e4	1481.35950	99.3356
2	16.555	PP	0.2652	176.98146	10.46868	0.6644
Totals :				2.66375e4	1491.82818	

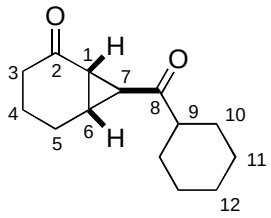
(*1S, 6R, 7S*)-**2b**: $[\alpha]_D^{25}$ + 171.49 (c = 1.105 in MeOH) for 98% ee



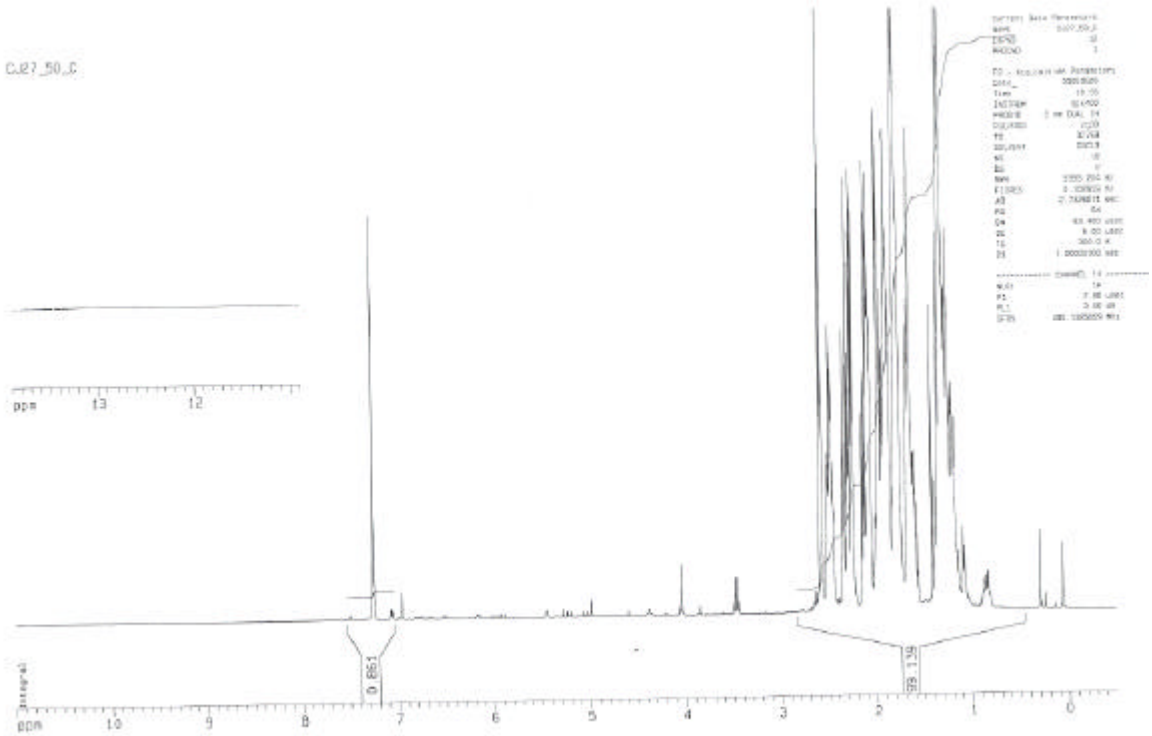
Signal 3: DAD1 C, Sig=210,8 Ref=360,100

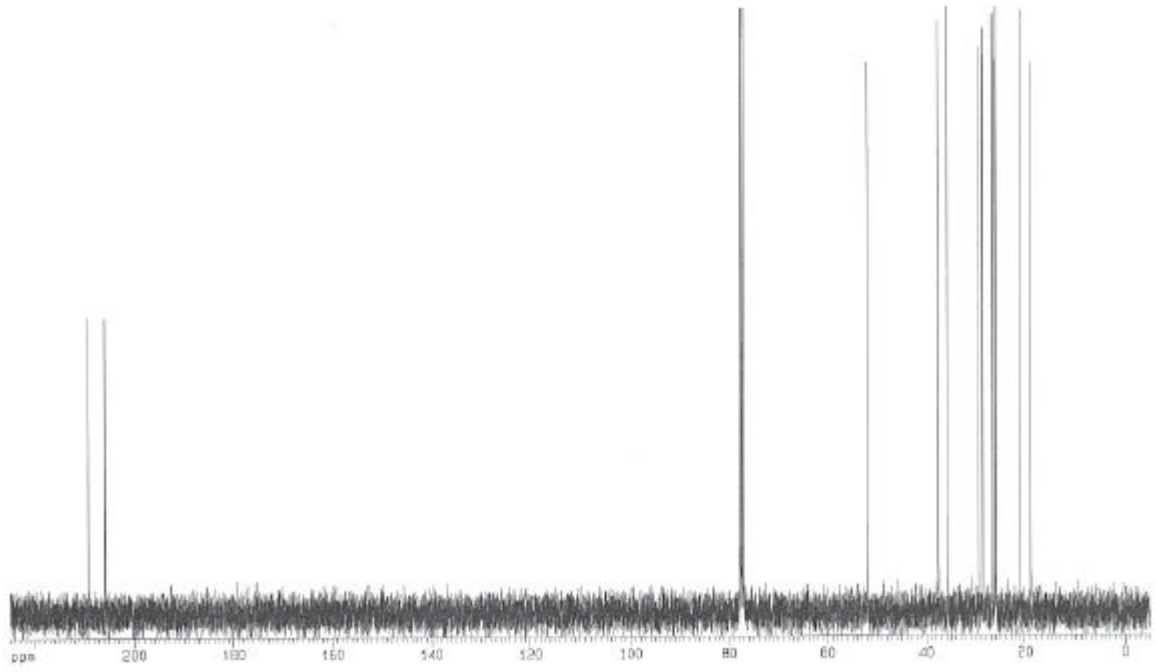
#	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.556	MM	0.7840	15.07368	3.20450e-1	0.1164
2	16.016	MM	1.7556	1.29360e4	122.80917	99.8836
Totals :				1.29511e4	123.12962	

7-Cyclohexanecarbonyl-bicyclo[4.1.0]heptan-2-one 2c



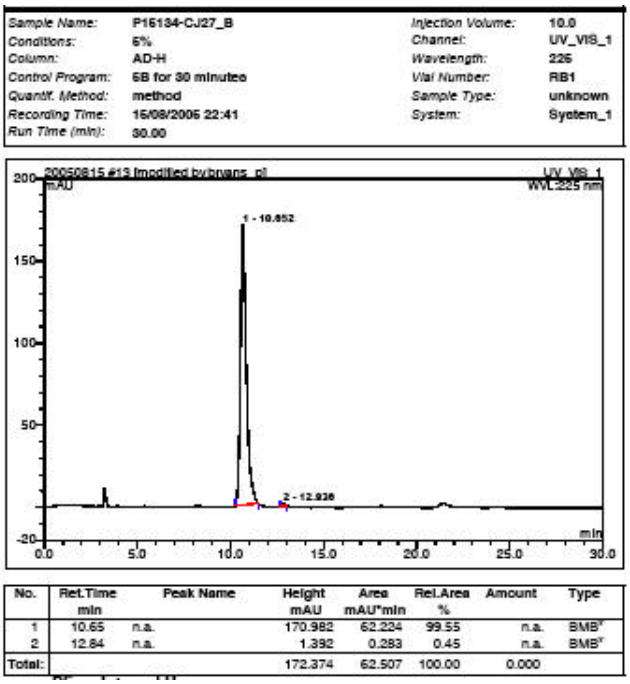
white solid; m.p. 44-47 °C; R_f (3:1 Petrol:Et_2O) 0.10; ν_{max} (thin film)/cm^{-1} 2936, 2852, 1689, 1443, 1278, 1176, 1145, 1097, 1060, 1017, 893, 879, 856; δ_H (400 MHz; $CDCl_3$) 2.58 (1H, t, *J* = 4.2, H-7), 2.48 (1H, td, *J* = 11.0, 3.5, H-9), 2.35-2.24 (2H, m, H-1, H_b-3), 2.15-2.06 (2H, m, H_a-3, H-6), 1.99-1.90 (4H, m, H-5, H_b-10), 1.88-1.77 (3H, m, H_b-4, H_b-11), 1.68-1.59 (2H, m, H_a-4, H_b-12), 1.38-1.18 (5H, m, H_a-10, H_a-11, H_a-12); δ_C (100 MHz; $CDCl_3$) 209.1 (C-2), 205.7 (C-8), 52.0 (C-9), 37.6 (C-3), 35.9 (C-1), 29.4 (C-10), 28.6 (C-7), 26.7 (C-11), 26.0 (C-6), 25.9 (C-12), 21.0 (C-5), 18.8 (C-4); HRMS found $[M+H]^+$ 221.1538, $C_{14}H_{21}O_2^+$ requires *M*, 221.1536).





HPLC: AD-H DAICEL Chiralpak, 95:5 hexane/IPA, flow 1mL/min; retention time (–) enantiomer 10.65 min, (+) enantiomer 13.09 min.

(*1R, 6S, 7R*)-**2c**: $[\alpha]_D^{25}$ – 66.7 (c = 0.500 in $CHCl_3$) for 99% ee

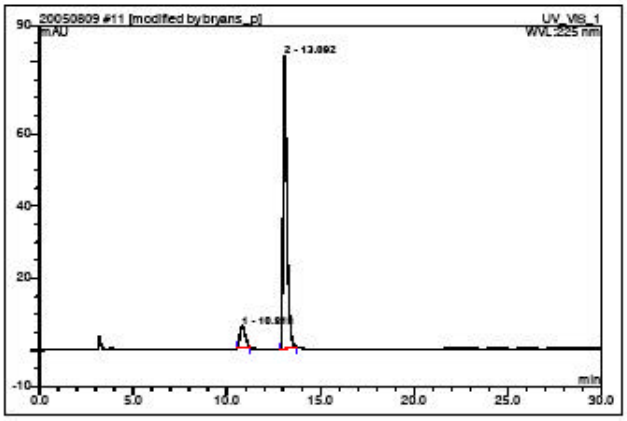


Sample Name:	P15134-CJ27_B	Injection Volume:	10.0
Conditions:	5%	Channel:	UV_VIS_1
Column:	AD-H	Wavelength:	225
Control Program:	5B for 30 minutes	Vial Number:	RB1
Quantit. Method:	method	Sample Type:	unknown
Recording Time:	15/08/2005 22:41	System:	System_1
Run Time (min):	30.00		

No.	Ret.Time min	Peak Name	Height mAU	Area mAU*min	Rel.Area %	Amount	Type
1	10.65	n.a.	170.982	62.224	99.55	n.a.	BMB
2	12.84	n.a.	1.392	0.283	0.45	n.a.	BMB
Total:			172.374	62.507	100.00	0.000	

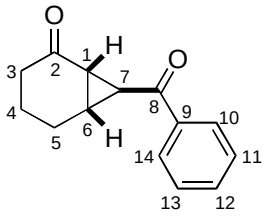
(*1S, 6R, 7S*)-**2c**: $[\alpha]_D^{25}$ + 96.80 (c = 1.015 in MeOH) for 95% ee

Sample Name:	P16134-CJ27_118	*Injection Volume:*	10.0
Conditions:	5%	*Channel:*	UV_VIS_1
Column:	AD-H	*Wavelength:*	226
Control Program:	5B for 30 minutes	*Vial Number:*	RA8
Quantif. Method:	method	*Sample Type:*	unknown
Recording Time:	08/08/2005 20:54	*System:*	System_1
Run Time (min):	30.00		

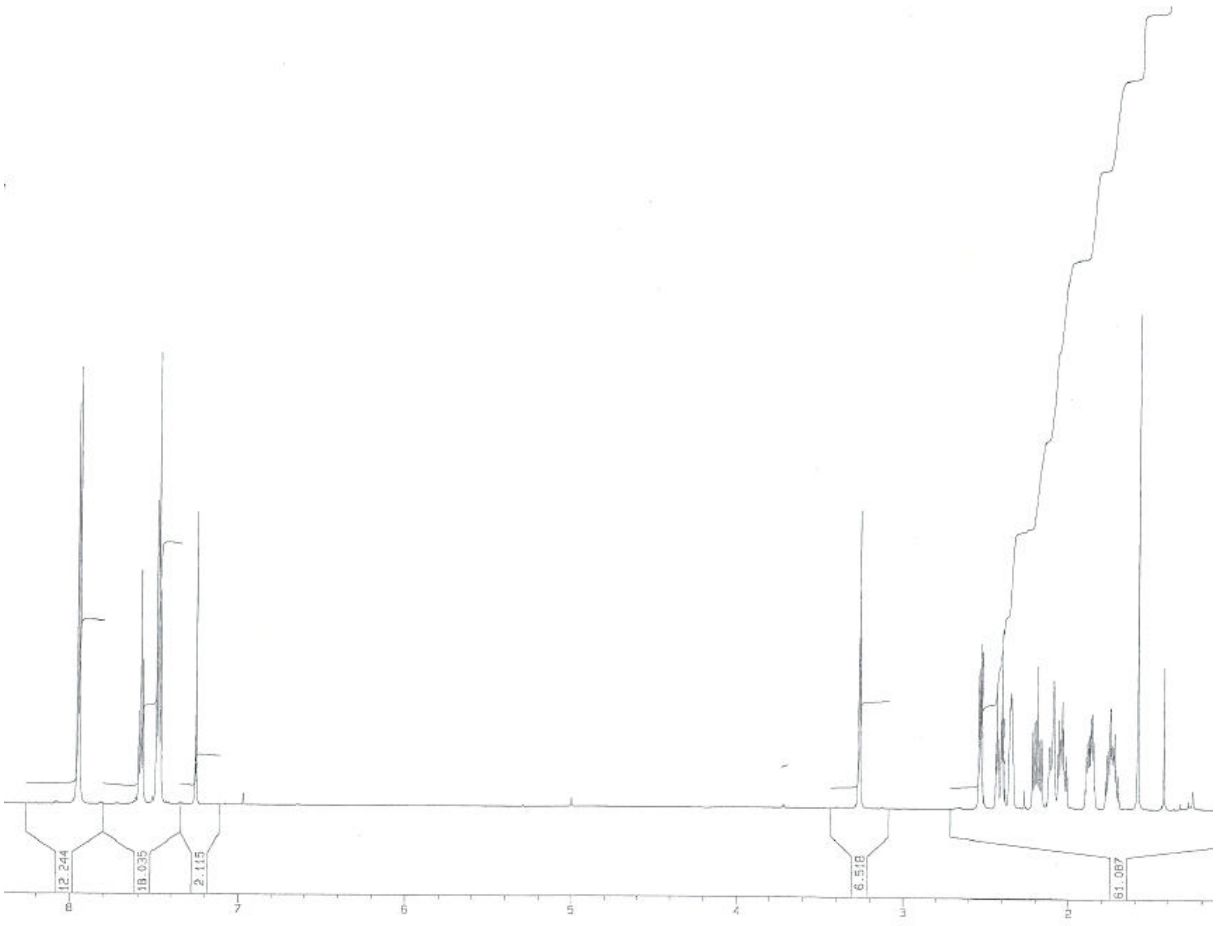


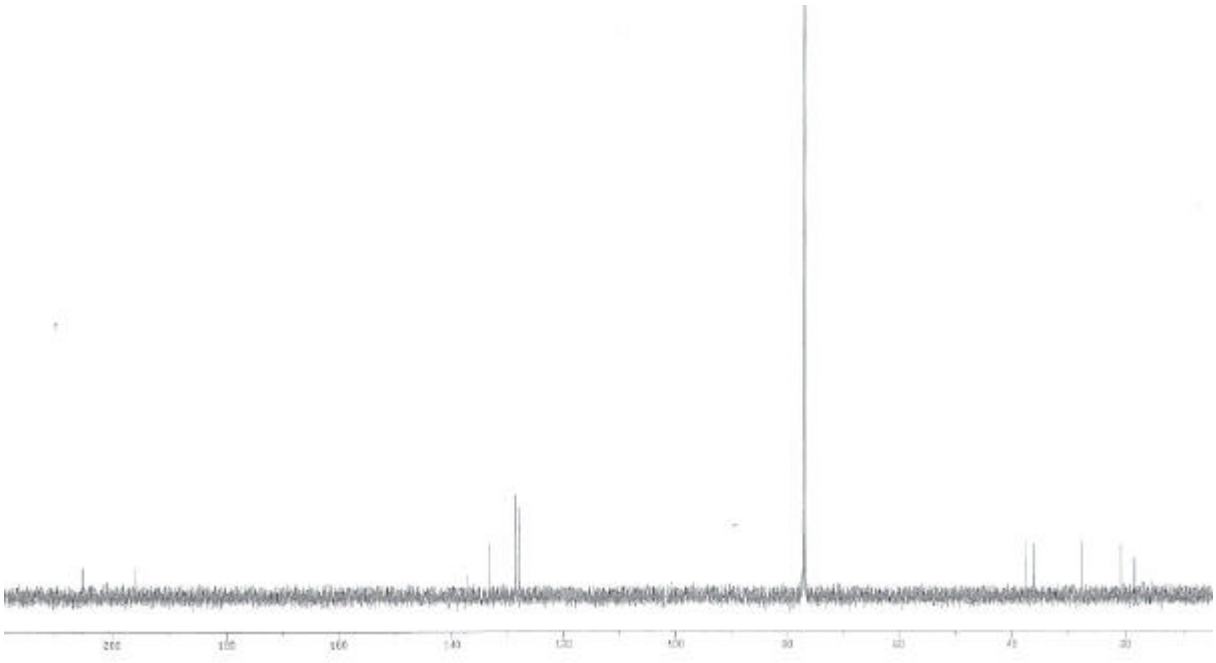
No.	Ret.Time min	Peak Name	Height mAU	Area mAU*min	Rel.Area %	Amount	Type
1	10.82	n.a.	6.014	1.935	9.25	n.a.	BMB
2	13.09	n.a.	81.195	18.987	90.75	n.a.	BMB
Total:			87.208	20.922	100.00	0.000	

7-Benzoyl-bicyclo[4.1.0]heptane-2-one 2d



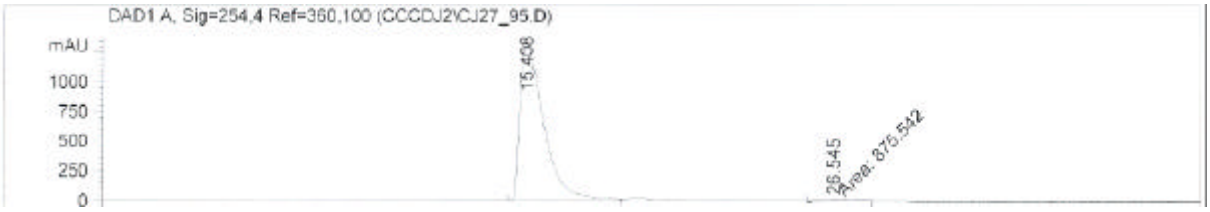
white solid; m.p. 81-87 °C; ν_{max} (film)/ cm^{-1} 2941, 1694, 1668, 1449, 1292, 1222, 1038, 897, 697; δ_H (600 MHz, $CDCl_3$) 7.96-7.94 (2H, m, H-10, H-14), 7.60-7.58 (1H, m, H-12), 7.50-7.47 (2H, m, H-11, H-13), 3.27 (1H, dd, *J* = 4.0, 4.0, H-7), 2.53 (1H, dd, *J* = 8.0, 4.0, H-1), 2.39 (1H, ddd, *J* = 18.0, 4.5, 4.5, H_a-3), 2.37-2.34 (1H, m, H-6), 2.19 (1H, ddd, *J* = 18.0, 11.8, 6.2, H_b-3), 2.13 (1H, m, H_a-5), 2.07-2.01 (1H, m, H_b-5), 1.91-1.85 (1H, m, H_a-4), 1.78-1.70 (1H, m, H_b-4); δ_C (100 MHz, $CDCl_3$) 205.2 (C-2), 195.9 (C-8), 137.3 (C-9), 133.3 (C-12), 128.7 (C-10, C-14), 128.1 (C-11, C-13), 37.3 (C-3), 36.0 (C-1), 27.3 (C-6, C-7), 20.8 (C-5), 18.5 (C-4); HRMS found ES $[M+Na]^+$ 237.0886, $C_{14}H_{14}O_2Na$ requires *M*, 237.0892.





HPLC: AS DAICEL Chiralpak, 85:15 hexane/IPA, flow 1ml/min; retention time: (–) enantiomer 15.41 min, (+) enantiomer x min.

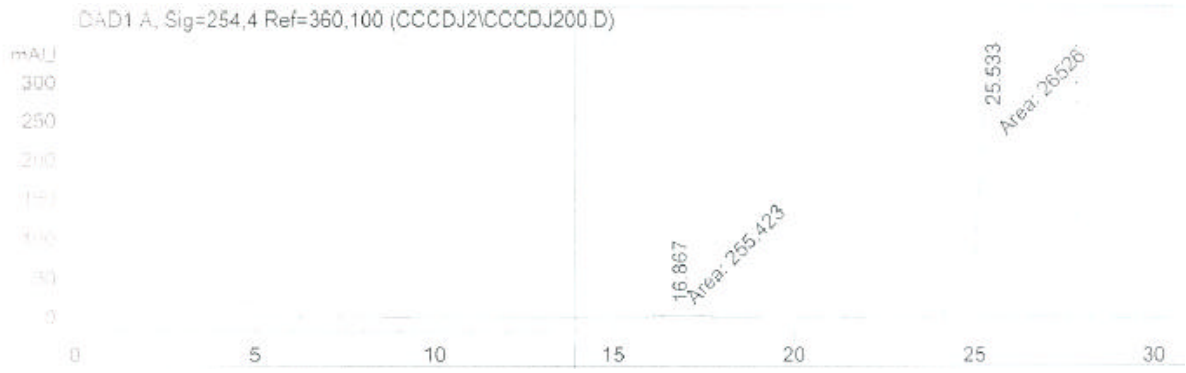
(*1R, 6S, 7R*)-**2d**: $[\alpha]_D^{25}$ – 26.98 (c = 1.01 in MeOH) for 98% ee;



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.408	BB	0.9303	8.15905e4	1328.87622	98.9383
2	26.545	MM	1.1215	875.54218	13.01097	1.0617
Totals :				8.24660e4	1341.88720	

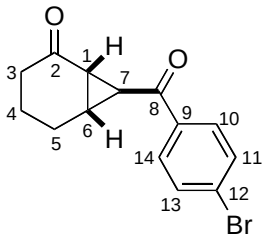
(*1S, 6R, 7S*)-**2d**: $[\alpha]_D^{25}$ + 29.71 (c =1.035 in MeOH) for 98% ee



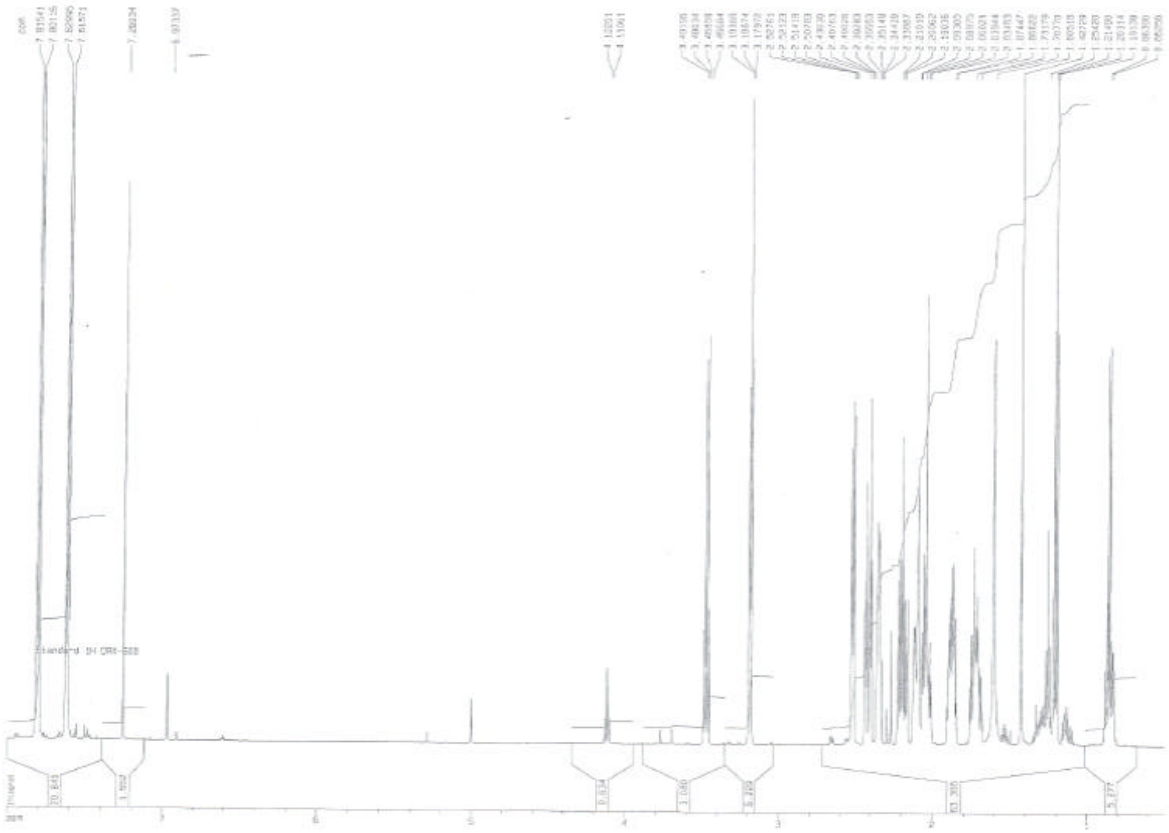
Val: 1: DAD1 A, Sig=254,4 Ref=360,100

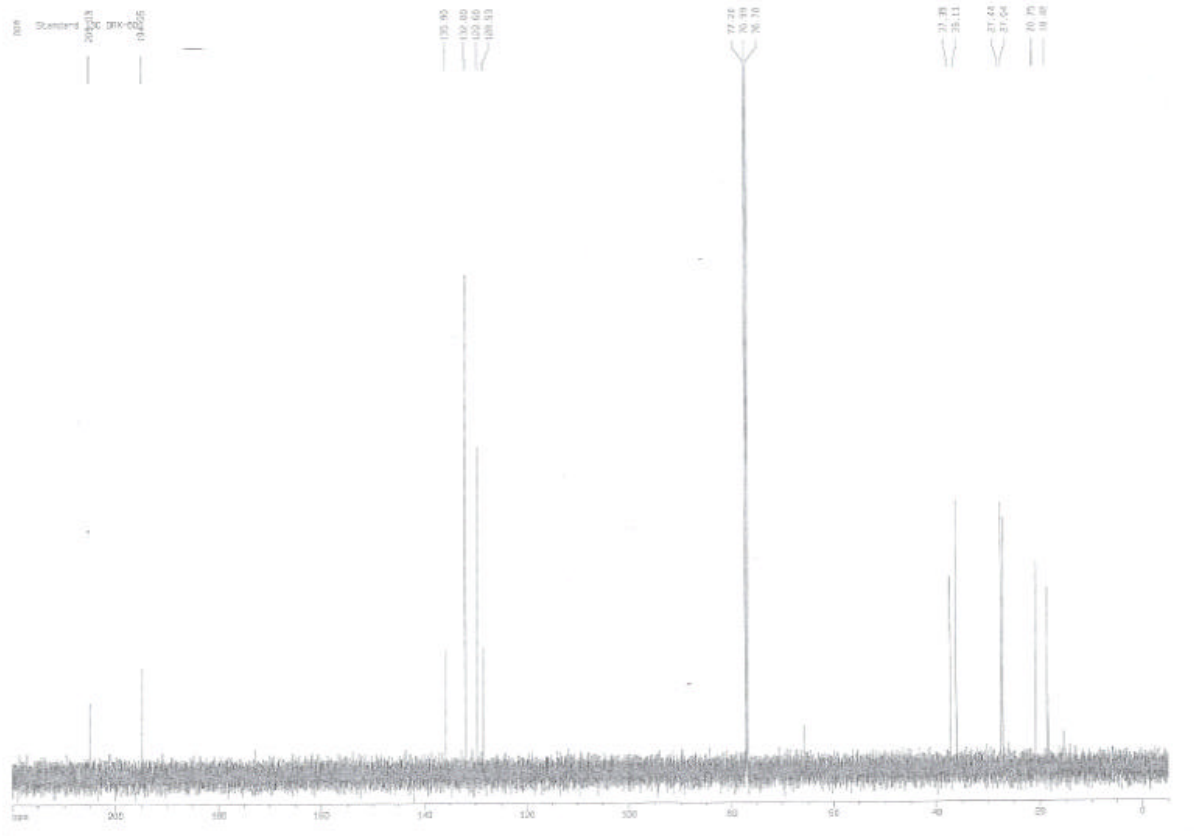
Pk #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.867	MM	0.5410	255.42291	7.86839	0.9537
2	25.533	MM	1.3295	2.65260e4	332.53546	99.0463
Sum:				2.67814e4	340.40386	

7-(*p*-Bromo)benzoyl-bicyclo[4.1.0]heptane-2-one 2e



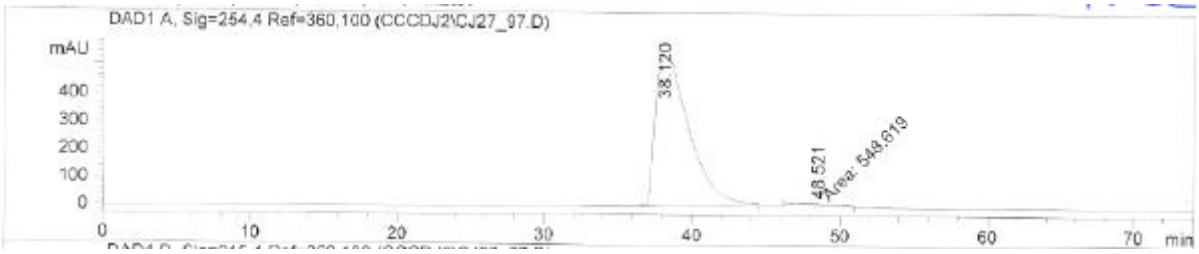
yellow solid; m.p. 87-89 °C; R_f (2:1 Petrol:Et_2O) 0.11; ν_{max} (film)/ cm^{-1} 2953, 2918, 1687, 1667, 1586, 1415, 1291, 1220, 1073, 1039, 1111, 899, 850, 797, 753, 725; δ_H (600 MHz, $CDCl_3$) 7.82 (2H, d, *J* = 8.6, H-10, H-14), 7.62 (2H, d, *J* = 8.6, H-11, H-13), 3.19 (1H, dd, J = 4.0, 4.0, H-7), 2.52 (1H, dd, *J* = 8.1, 4.0, H-1), 2.42 (1H, ddd, *J* = 18.0, 4.4, 4.4, H_a-3), 2.36-2.34 (1H, m, H-6), 2.19 (1H, ddd, *J* = 18.0, 11.9, 6.2, H_b-3), 2.13-2.08 (1H, m, H_a-5), 2.07-2.01 (1H, m, H_b-5), 1.91-1.85 (1H, m, H_a-4), 1.77-1.68 (1H, m, H_b-4); δ_C (125 MHz, $CDCl_3$) 205.0 (C-2), 195.0 (C-8), 135.9 (C-9), 132.0 (C-10, C-14), 129.8, (C-11, C-13), 128.5 (C12), 37.4 (C-3), 36.1 (C-1), 27.4 (C-7), 27.0 (C-6), 20.8 (C-5), 18.4 (C-4); HRMS found ES $[M]^+$ 292.0109, $C_{14}H_{13}O_2Br^+$ requires *M*, 292.0099. X-Ray crystal structure is deposited in the CCDC 607161.





HPLC: AS DAICEL Chiralpak, 95:5 hexane/IPA, flow 1ml/min; retention time: (–) enantiomer 38.12 min, (+) enantiomer x min.

(*1R, 6S, 7R*)-**2e**: $[\alpha]_D^{25}$ –5.0 (c = 0.600 in $CHCl_3$) for 99% ee;

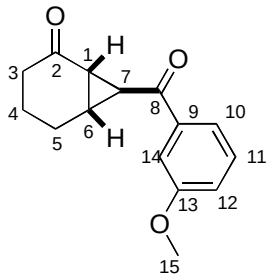


Signal 1: DAD1 A, Sig=254,4 Ref=360,100

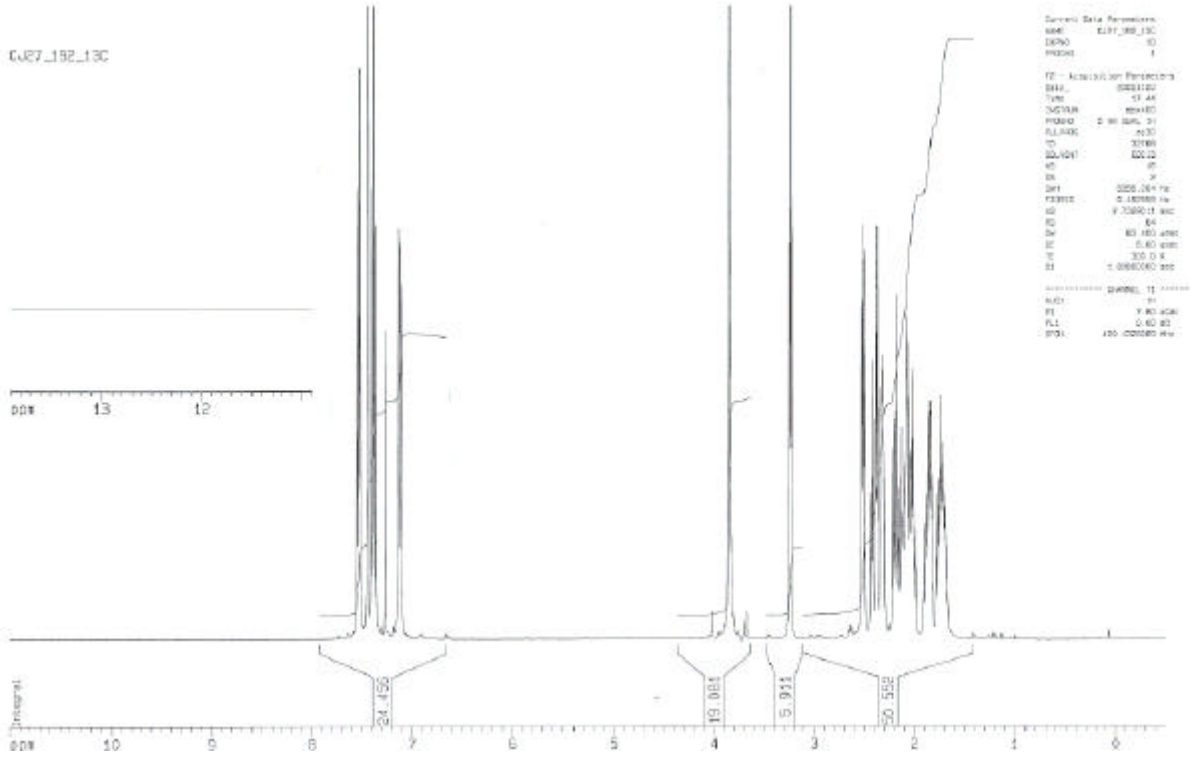
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	38.120	PB	2.3311	8.57996e4	551.49286	99.3646
2	48.521	MM	2.7075	548.61890	3.37719	0.6354
Totals :				8.63482e4	554.87005	

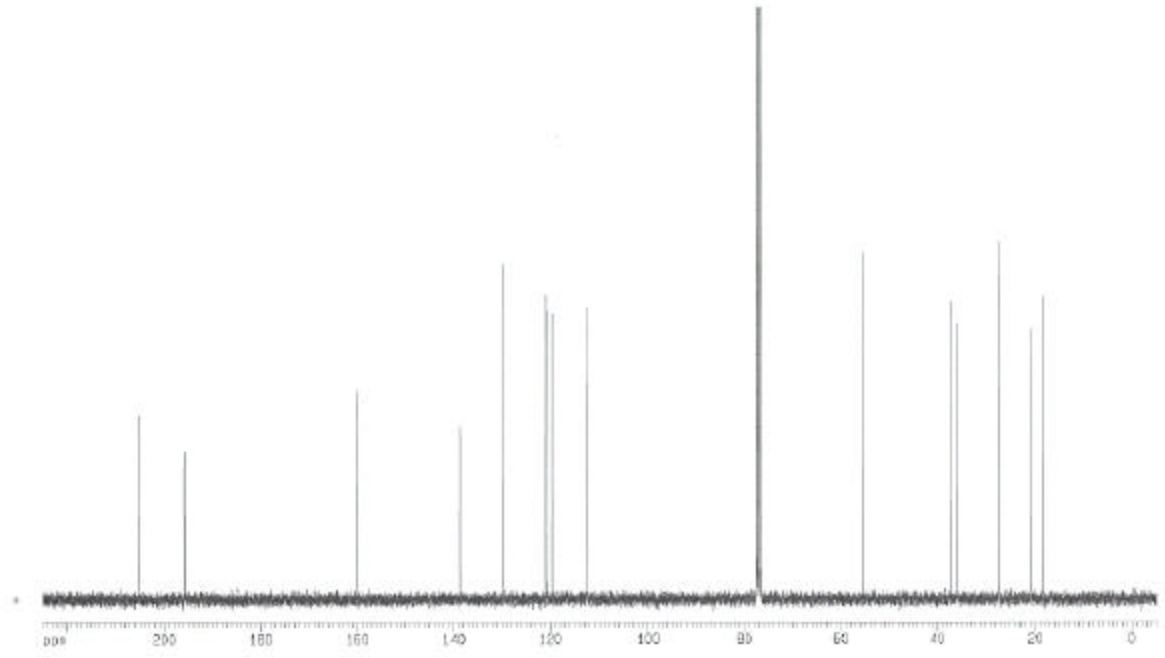
(*1S, 6R, 7S*)-**2e**: $[\alpha]_D^{25}$ + 1.5 (c = 1.01 in MeOH) for 96% ee

7-(3-Methoxy-benzoyl)-bicyclo[4.1.0]heptan-2-one 2f



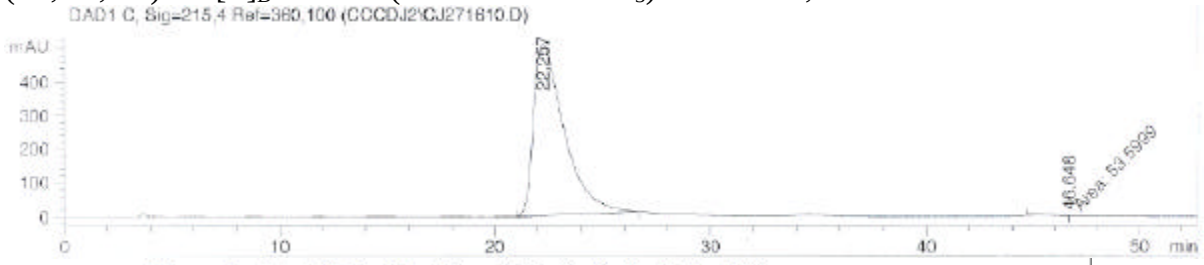
orange oil; ?$_{max}$ (thin film)/cm^{-1} 2943, 2838, 1693, 1667, 1596, 1581, 1488, 1452, 1431, 1342, 1288, 1258, 1199, 1177, 1032, 906, 879, 784, 723, 680; d_H (400 MHz; $CDCl_3$) 7.53 (1H, d, *J* = 7.7, H-10), 7.44 (1H, s, H-14), 7.38 (1H, t, *J* = 8.0, H-11), 7.12 (1H, dd, *J* = 8.1, 2.2, H-12), 3.85 (3H, s, H-15), 3.24 (1H, t, *J* = 4.2, H-7), 2.52 (1H, dd, *J* = 8.0, 3.8, H-1), 2.40 (1H, dt, *J* = 18.0, 4.5, H_a-3), 2.34-2.30 (1H, m, H-6), 2.17 (1H, ddd, *J* = 17.9, 11.7, 6.2, H_b-3), 2.12-1.97 (2H, m, H-5), 1.90-1.82 (1H, m, H_a-4), 1.78-1.67 (1H, m, H_b-4); d_C (100 MHz; $CDCl_3$) 205.2 (C-2), 195.7 (C-8), 159.9 (C-13), 138.6 (C-9), 129.6 (C-11), 120.7 (C-10), 119.6 (C-12), 112.6 (C-14), 55.5 (C-15), 37.3 (C-3), 36.0 (C-1), 27.5 (C-7), 27.4 (C-6), 20.8 (C-5), 18.5 (C-4); HRMS found ES $[M+H]^+$ 245.1168, $C_{15}H_{17}O_3^+$ requires *M*, 245.1178.





HPLC: AS DAICEL Chiralpak, 90:10 hexane/IPA, flow 1mL/min; retention time (–) enantiomer 22.26 min, (+) enantiomer 45.44 min.

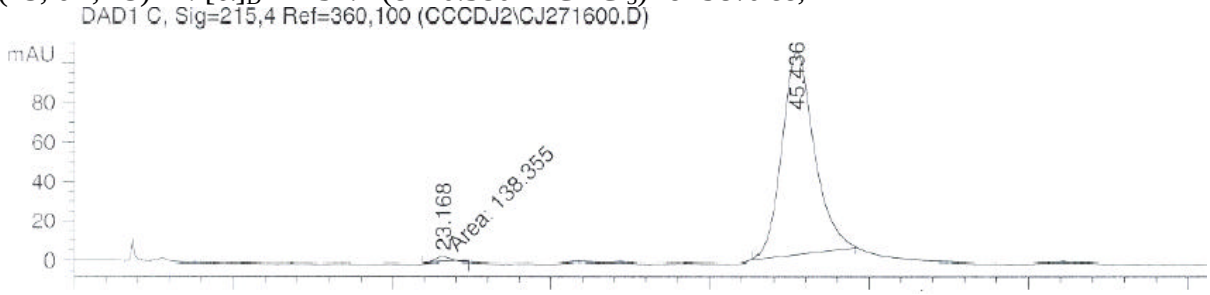
(*1R, 6S, 7R*)-**2f**: $[\alpha]_D^{25}$ – 45.3 (c = 0.500 in $CHCl_3$) for 99% ee;



Signal 2: DAD1 C, Sig=215,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	22.257	BB	1.1568	5.01657e4	506.82269	99.8933
2	46.648	MM	0.6896	53.59990	1.29537	0.1067
Totals :				5.02193e4	508.11806	

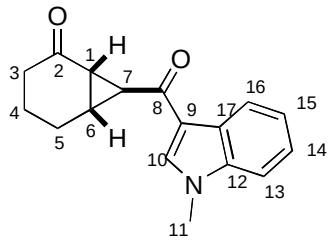
(*1S, 6R, 7S*)-**2f**: $[\alpha]_D^{25}$ + 32.4 (c = 0.580 in $CHCl_3$) for 98% ee;



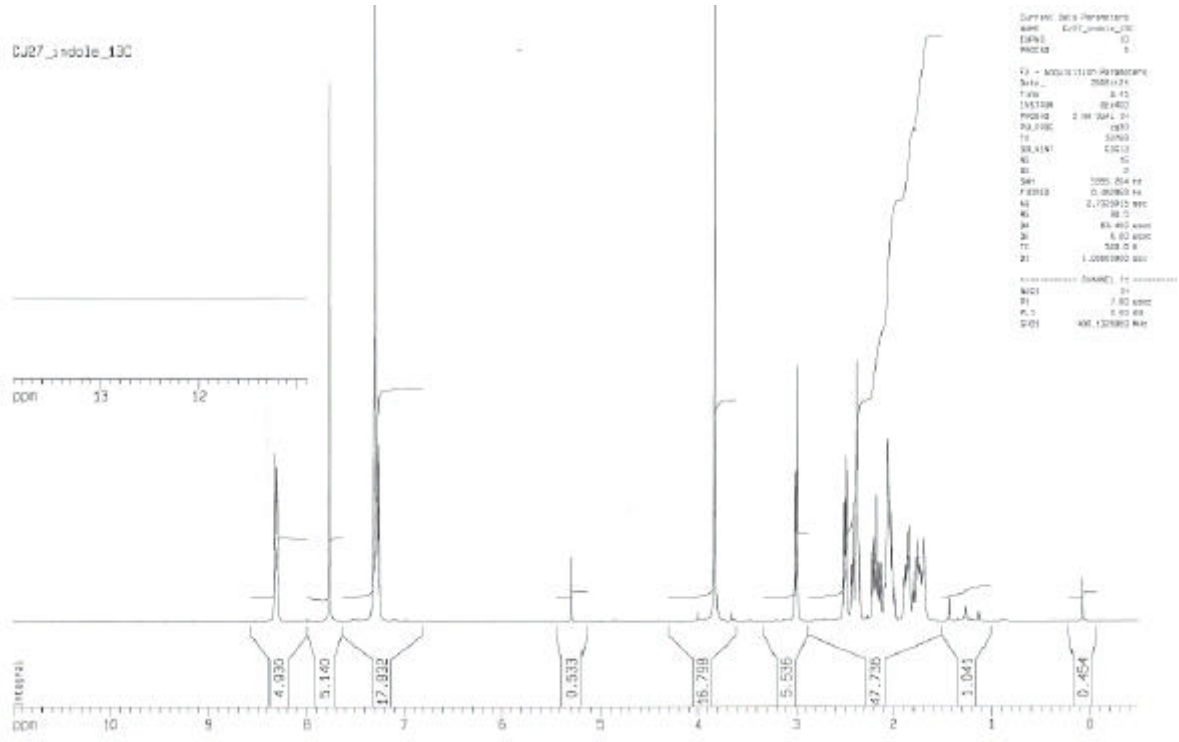
Signal 2: DAD1 C, Sig=215,4 Ref=360,100

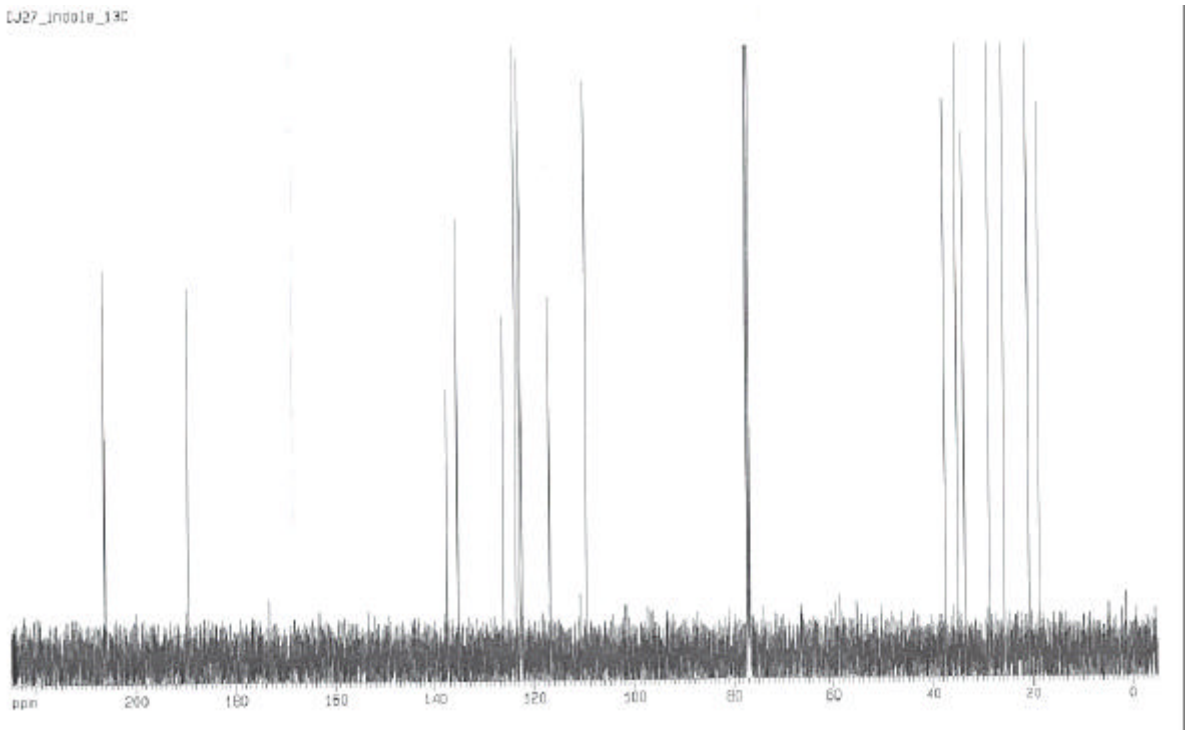
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	23.168	MM	0.9297	138.35509	2.48025	0.9372
2	45.436	BB	1.6676	1.46244e4	102.68547	99.0628
Totals :				1.47628e4	105.16572	

7-(1-Methyl-1H-indole-3-carbonyl)-bicyclo[4.1.0]heptan-2-one 2g



yellow solid; m.p. 182-184 °C; R_f (Et_2O) 0.10; ?$_{max}$ (thin film)/cm^{-1} 2942, 2888, 1688, 1631, 1530, 1465, 1419, 1370, 1338, 1285, 1223, 1169, 1126, 1090, 1071, 985, 901, 746, 727; d_H (400 MHz; $CDCl_3$) 8.32-8.30 (1H, m, H-16), 11.64 (1H, s, H-10), 7.31-7.27 (3H, m, H-13, H-14, H-15), 3.83 (3H, s, H-11), 3.00 (1H, app t, *J* = 4.19, H-7), 2.49 (1H, dd, *J* = 7.93, 3.77, H-1), 2.43-2.36 (2H, m, H-6, H_a-3), 2.18 (1H, ddd, *J* = 17.9, 11.6, 6.2, H_b-3), 2.09-2.01 (2H, m, H-5), 1.89-1.83 (1H, m, H_a-4), 1.79-1.71 (1H, m, H_b-4); d_C (100 MHz; $CDCl_3$) 206.1 (C-2), 189.5 (C-8), 137.5 (C-9), 135.4 (C-10), 126.2 (C-12), 123.6, 122.8 (C-14, C-15), 122.4 (C-16), 116.7 (C-17), 109.7 (C-13), 37.5 (C-3), 35.0 (C-1), 33.5 (C-11), 28.5 (C-7), 25.4 (C-6), 20.8 (C-5), 18.7 (C-4); HRMS found ES $[M+H]^+$ 268.1332, $C_{17}H_{18}NO_2^+$ requires *M*, 268.1332.

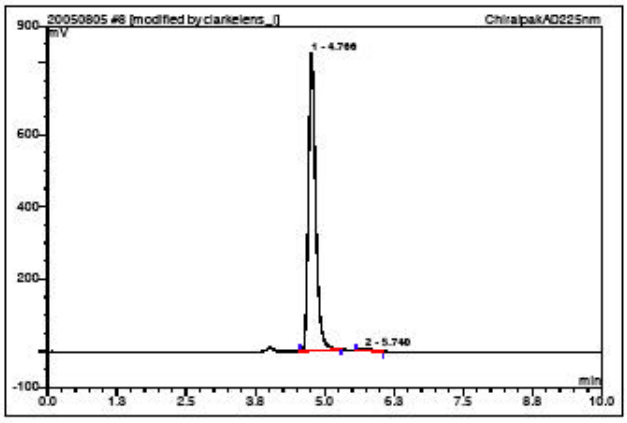




HPLC: AD-H DAICEL Chiralpak, MeCN, flow 1mL/min; retention time (+) enantiomer 4.77 min, (–) enantiomer 5.46 min.

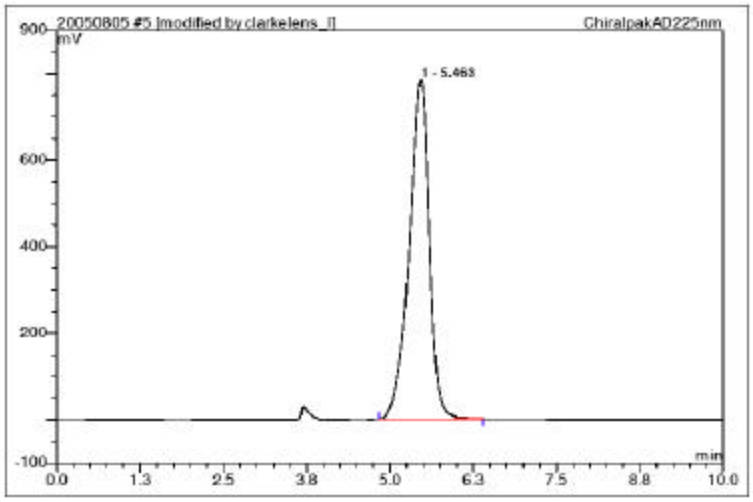
(*1R, 6S, 7R*)-**2g**: $[\alpha]_D^{25}$ – 89.13 (c = 1.035 in MeOH) for 99% ee

Sample Name:	P15123 cj27-108	*Injection Volume:*	60.0
Channel:	ChiralpakAD225nm	*Vial number:*	7
Conditions:	100% MeCN	*Sample type:*	unknown
Control Program:	Run 100% AcCN 10min	*Quantit. Method:*	test
System:	Parallel_System_2		
Recording Time:	06/08/2006 11:48		
Run Time (min):	10.00		



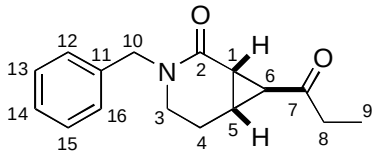
No.	Ret.Time min	Peak Name	Height mV	Area mV*min	Rel.Area %	Amount	Type
1	4.77	n.a.	825.098	126.266	98.91	n.a.	BMB
2	5.74	n.a.	7.204	1.390	1.09	n.a.	BMB^V
Total:			832.302	127.656	100.00	0.000	

(*1S, 6R, 7S*)-**2g**: $[\alpha]_D^{25}$ + 100.49 (c = 1.015 in MeOH) for 98% ee



No.	Ret.Time min	Peak Name	Height mV	Area mV*min	Rel.Area %	Amount	Type
1	5.46	n.a.	783.488	275.815	100.00	n.a.	BMB
Total:			783.488	275.815	100.00	0.000	

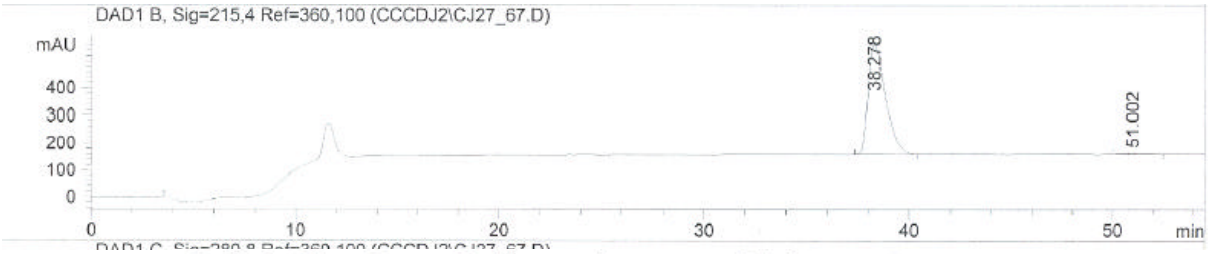
3-Benzyl-7-propionyl-3-azabicyclo[4.1.0]heptane-2-one 2h



ν_{max} (film)/ cm^{-1} 3057, 2939, 2856, 2865, 1691,1630, 1499, 1454, 1359, 1314, 1243, 1217, 1180, 1126, 1087, 1072, 1030, 986, 876, 760, 732; δ_H (400 MHz, $CDCl_3$) 7.35-7.26 (3H, m, H-12, H-14, H-16), 7.23-7.21 (2H, m, H-13, H-15), 4.69 (1H, d, *J* = 14.8, H_a-10), 4.44 (1H, d, *J* = 14.8, H_b-10), 3.13-2.99 (2H, m, H-3), 2.65-2.59 (2H, m, H-8), 2.56 (1H, dd, *J* = 4.1, 3.7, H-6), 2.39 (1H, dd, *J* = 8.3, 3.7, H-1), 2.15-2.12 (1H, m, H-5), 2.00-1.95 (2H, m, H-4), 1.08 (3H, t, *J* = 7.3, H-9); δ_C (100 MHz, $CDCl_3$); 206.7 (C-7), 167.8 (C-2), 136.9 (C-11), 128.7 (C-12, C-C-16), 127.9 (C-13, C-15), 127.5 (C-14), 50.2 (C-10), 41.9 (C-3), 37.0 (C-8), 28.1 (C-6), 27.6 (C-1), 24.6 (C-5), 20.0 (C-4), 7.6 (C-9); HRMS found EI $[M]^+$ 257.1423, $C_{16}H_{19}NO_2$ requires *M*, 257.1416.

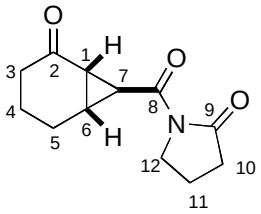
HPLC: AD-H DAICEL Chiralpak, 95:5 hexane/IPA, flow 1mL/min; retention time (+) enantiomer 38.28 min, (–) enantiomer 51.00 min;

(*1S*, *6R*, *7S*)-**2h**: $[\alpha]_D^{25}$ + 33.00 (c = 0.250 in $CHCl_3$) for 97% ee.

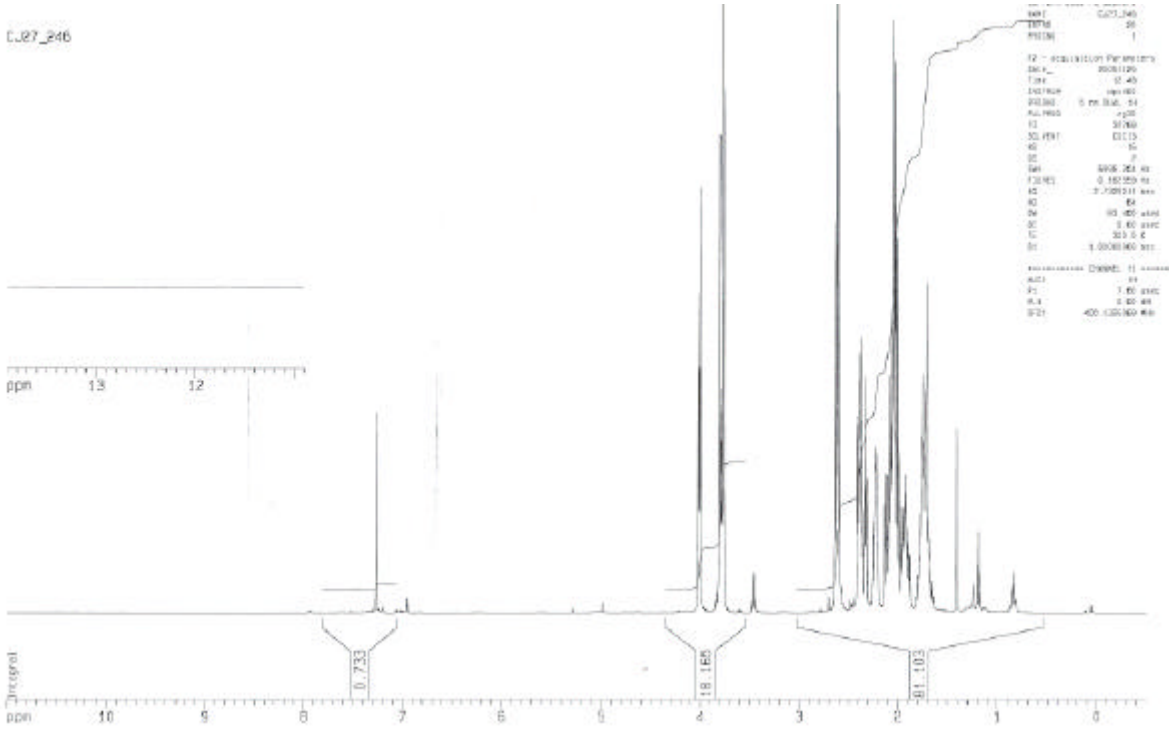


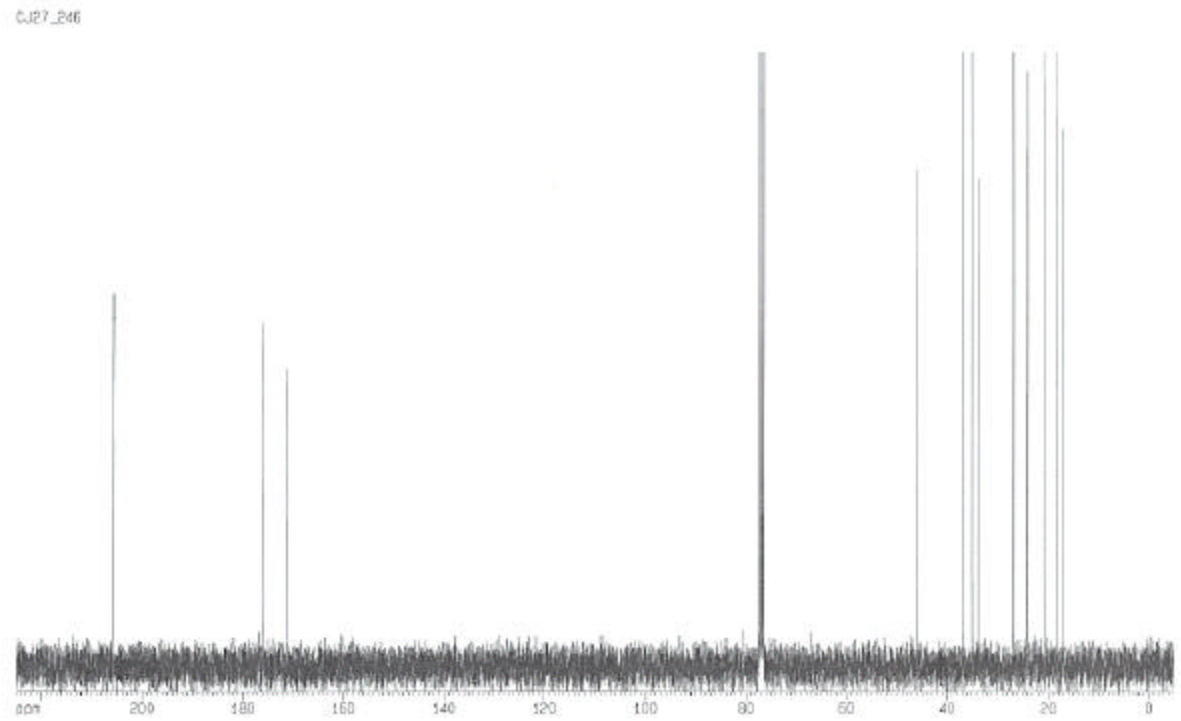
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	38.278	BB	0.8778	2.37218e4	408.29205	98.6349
2	51.002	BB	0.8357	328.31354	4.67304	1.3651
Totals :				2.40501e4	412.96510	

1-(2-Oxo-bicyclo[4.1.0]heptane-7-carbonyl)-pyrrolidin-2-one 2i



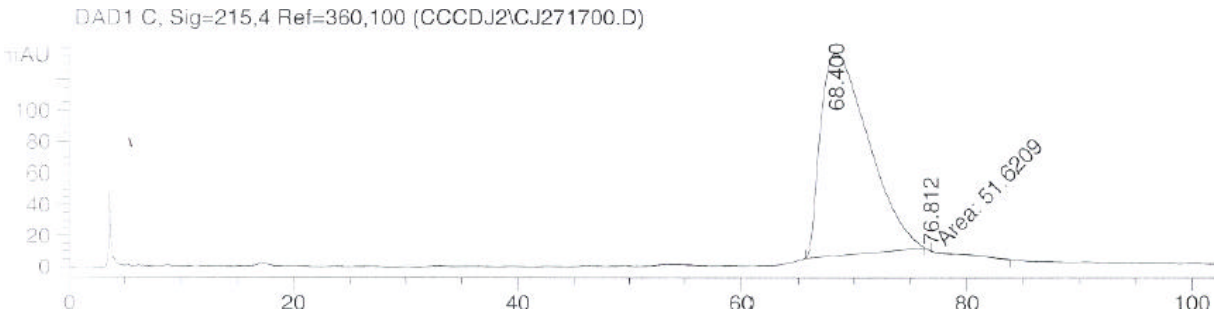
orange oil; ?$_{max}$ (thin film)/cm^{-1} 2944, 2892, 1734, 1678, 1422, 1356, 1307, 1249, 1223, 1187, 1170, 1087, 1063, 1037, 1007, 928, 900, 855, 744, 668; d_H (400 MHz; $CDCl_3$) 4.01 (1H, t, *J* = 4.4, H-7), 3.78 (2H, t, *J* = 7.2, H-12), 2.61 (2H, t, *J* = 7.2, H-10), 2.41-2.31 (2H, m, H-1, H_a-3), 2.24-2.20 (1H, m, H-6), 2.14-1.99 (4H, m, H_b-3, H_a-5, H-11), 1.97-1.89 (1H, m, H_b-5), 1.78-1.68 (2H, m, H-4); d_C (100 MHz; $CDCl_3$) 205.6 (C-2), 175.9 (C-8), 171.3 (C-9), 45.9 (C-12), 37.1 (C-3), 34.9 (C-1), 33.8 (C-10), 26.8 (C-6), 23.9 (C-7), 20.7 (C-5), 18.4 (C-4), 17.1 (C-11); HRMS found ES $[M+Na]^+$ 244.0944, $C_{12}H_{15}NNaO_3^+$ requires *M*, 244.0950;





HPLC: AS DAICEL Chiralpak, 90:10 hexane/IPA, flow 1mL/min; retention time (–) enantiomer 68.40 min, (+) enantiomer 73.79 min.

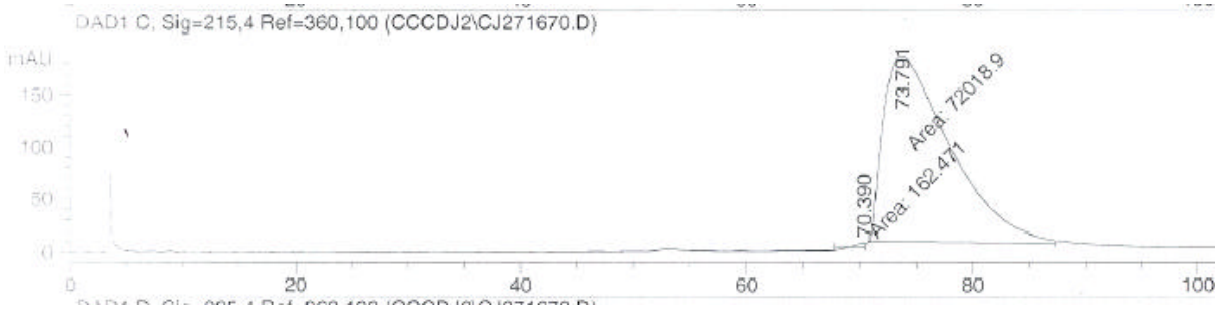
(*1R, 6S, 7R*)-**2i**: $[\alpha]_D^{25}$ – 35.5 (c = 0.583 in $CHCl_3$) for 99% ee



Signal 3: DAD1 C, Sig=215,4 Ref=360,100

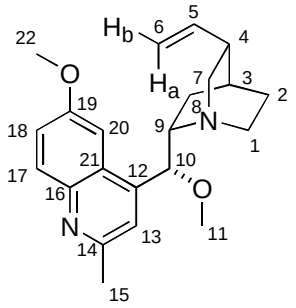
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	68.400	BB	3.4764	3.85792e4	129.73315	99.8664
2	76.812	MM	1.0982	51.62090	5.51203e-1	0.1336
Totals :				3.86308e4	130.28436	

(*1S, 6R, 7S*)-**2i**: $[\alpha]_D^{25}$ + 32.5 (c = 0.533 in $CHCl_3$) for 99% ee



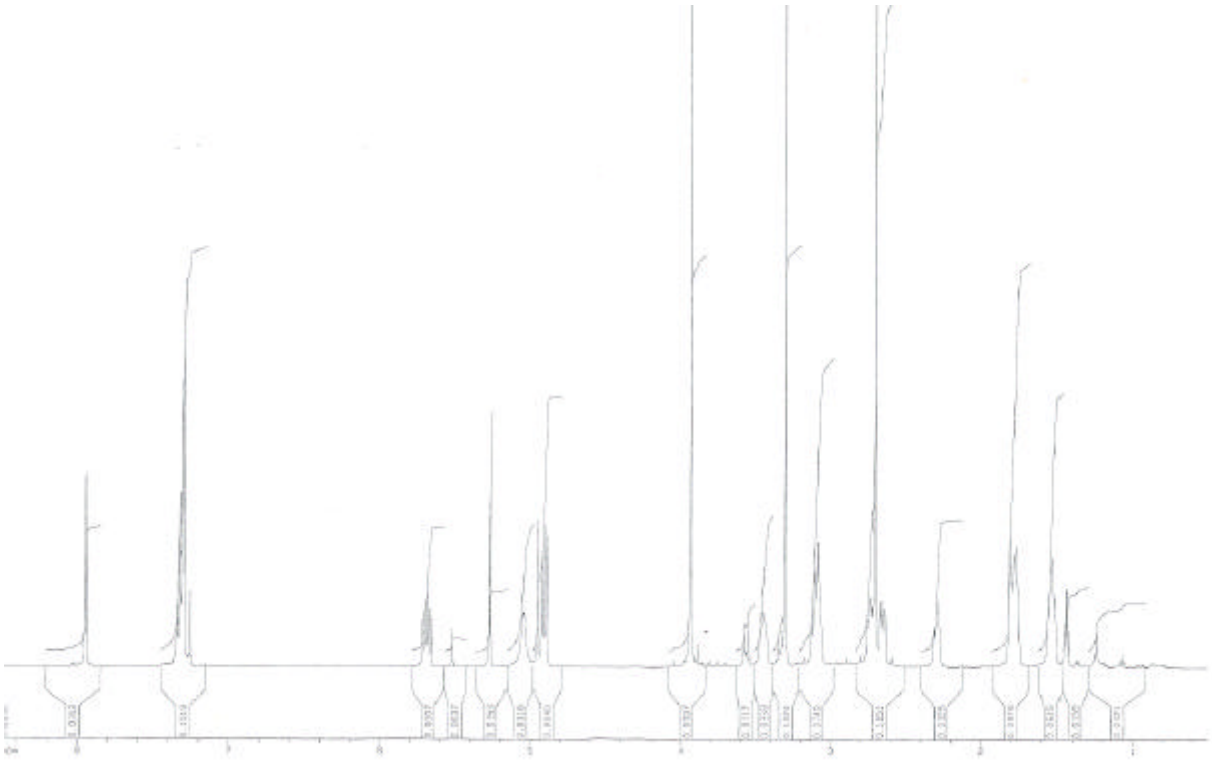
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	70.390	MM	0.7794	162.47075	3.47447	0.2251
2	73.791	MM	6.7804	7.20189e4	177.02617	99.7749
Totals :				7.21813e4	180.50064	

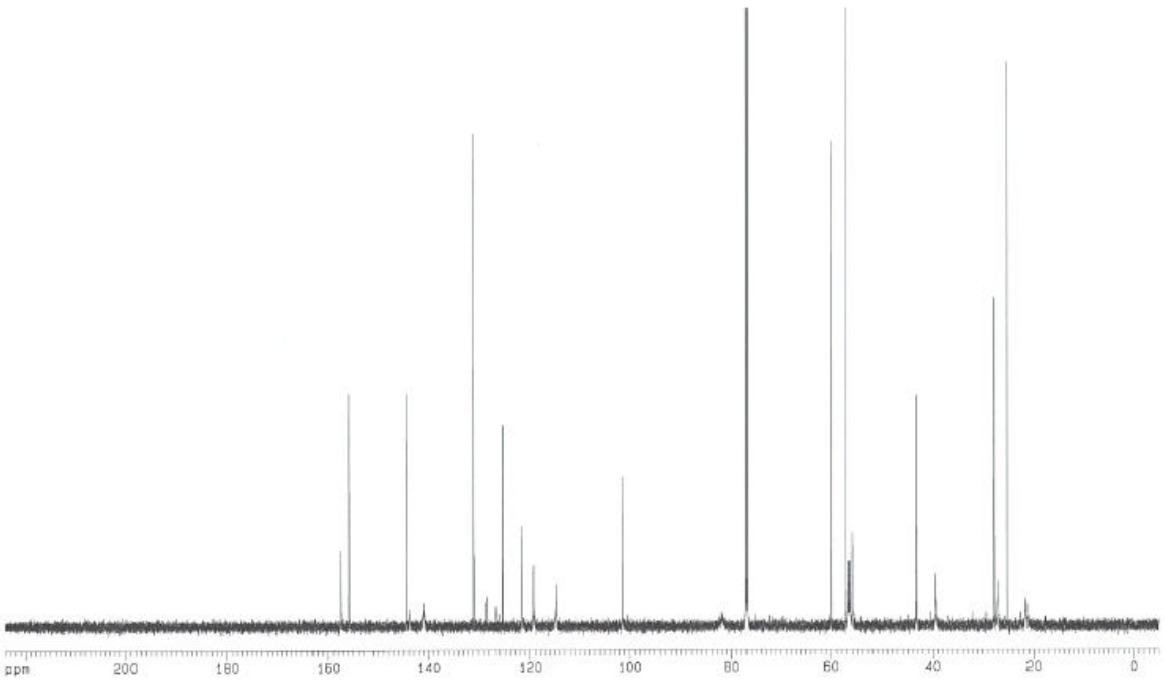
9-*O*-Methyl-2'-methyl quinine Me-Q



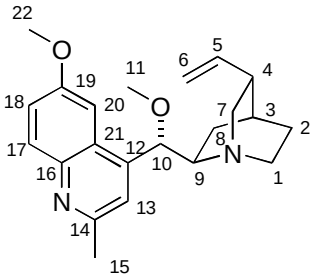
9-*O*-Methylquinine (368 mg, 1.1 mmol, 1.0 eq.) was dissolved in THF (10 ml) and MeLi/LiBr (1.5 M in THF, 1.4 ml, 2.17 mmol, 2.0 eq.) was added dropwise at –78 °C. The reaction mixture was allowed to warm to rt overnight (22h) and it was then cooled to 0 °C before iodine (822 mg, 3.3 mmol, 3 eq.) was added. After 15 min at 0 °C, the reaction mixture was quenched with sodium thiosulfate (10 ml, saturated aqueous solution). The aqueous layer was extracted with CH_2Cl_2 (3 × 10 ml), the combined organic layers were washed with water and dried over $MgSO_4$. The crude product was purified by column chromatography using 4 % MeOH in CH_2Cl_2 to give *amine* **Me-Q** (300 mg, 79 %) as an oil.

orange oil; ν_{max} (film)/ cm^{-1} 2932, 1621, 1602, 1505, 1475, 1452, 1341, 1260, 1231, 1111, 1061, 1030, 991, 909, 832; δ_H (600 MHz, $CDCl_3$) 7.94 (1H, d, *J* = 9.1, H-Ar), 7.33-7.29 (3H, m, H-Ar), 5.69 (1H, ddd, *J* = 17.3, 10.2, 7.6, H-5), 5.50-5.10 (1H, m, H-10), 4.93 (1H, d, *J* = 17.3, H_b-6), 4.89 (1H, d, *J* = 10.2, H_a-6), 3.93 (3H, s, H-22), 3.49-3.41 (1H, m, H_a-1), 3.30 (3H, s, H-11), 3.13-3.08 (2H, m, H_a-7, H-9). 2.74-2.64 (2H, m, H_b-1, H-7), 2.69 (3H, s, H-15), 2.30-2.25 (1H, m, H-4), 1.83-1.74 (3H, m, H_a-2, H-3, H_a-8), 1.57-1.49 (2H, m, H_b-2, H_b-8); δ_C (150 MHz, $CDCl_3$) 157.3 (C-Ar), 155.8 (C-Ar), 144.3 (C-5), 141.5 (C-Ar), 130.9 (CH-Ar, C-Ar), 125.5 (C-Ar), 121.4 (CH-Ar), 119.4 (CH-Ar), 114.5 (C-6), 101.4 (CH-Ar), 82.7 (C-10), 59.9 (C-9), 57.1 (C-11), 56.9 (C-7), 55.8 (C-22), 43.2 (C-1), 39.8 (C-4), 27.8 (C-3), 27.5 (C-2), 25.1 (C-15), 21.9 (C-8); HRMS found ES $[M+H]^+$ 353.2229, $C_{22}H_{29}N_2O_2$ requires *M*, 353.2229; $[\alpha]_D^{25}$ – 126.4 (c = 1.25 in $CHCl_3$).

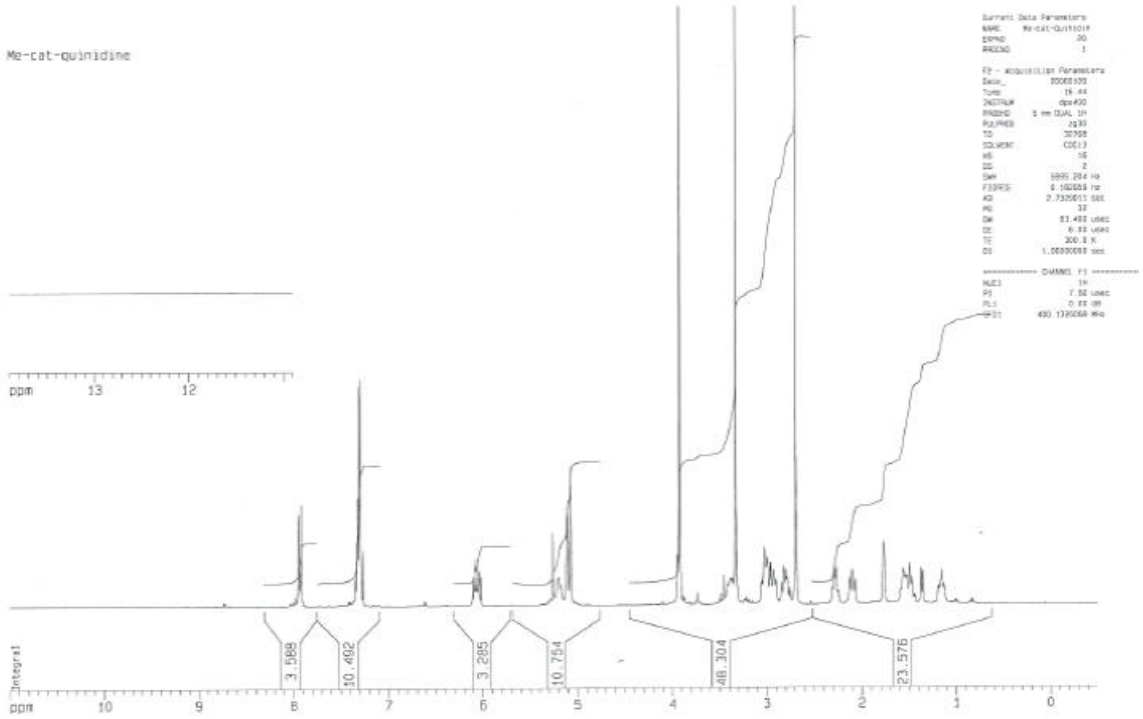


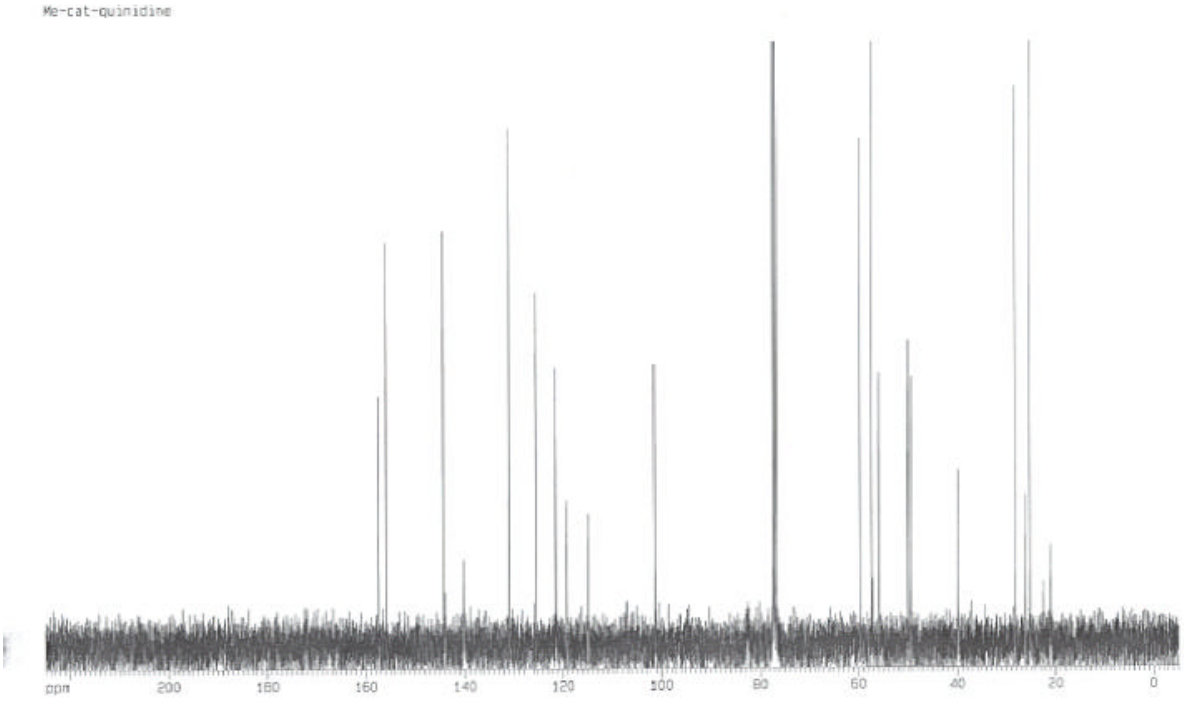

ppm
200
180
160
140
120
100
80
60
40
20
0

9-*O*-Methyl-2'-methyl quinidine Me-QD

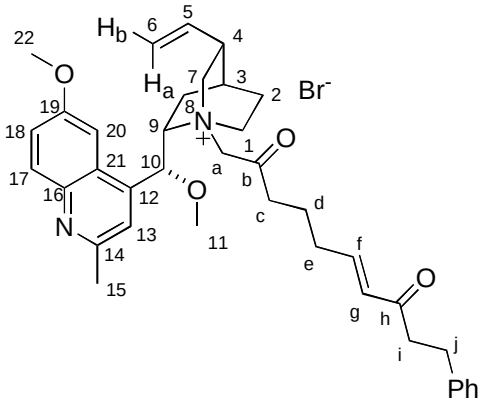


orange solid; m.p. 114-119°C; ν_{max} (film)/ cm^{-1} 2936, 2872, 1621, 1603, 1505, 1476, 1455, 1408, 1378, 1341, 1262, 1233, 1119, 1069, 1049, 1032, 914, 833, 755; δ_H (400 MHz, $CDCl_3$) 7.93 (1 H, d, *J* = 9.8, H-Ar), 7.33-7.29 (3H, m, H-Ar), 6.07 (1H, ddd, *J* = 24.1, 9.7, 6.5, H-5), 5.26-5.20 (1H, m, H-10), 5.11 (1H, dd, J 3.4, 1.2, H_a-6), 5.07 (1H, m, H_b-6), 3.92 (3H, s, H-22), 3.41-3.34 (1H, m, H_a-7), 3.33 (3H, s, H-11), 3.05-2.90 (3H, m, H_b-7, H_a-1, H-9), 2.84-2.79 (1H, m, H_b-1), 2.69 (3H, s, H-15), 2.30-2.24 (1H, m, H-4), 2.13-2.07 (1H, m, H_a-8), 1.77 (1H, m, H-3), 1.56-1.46 (2H, m, H-2), 1.19-1.11 (1H, m, H_b-8); ™$_C$ (150 MHz; $CDCl_3$) 157.3 (C-Ar), 155.9 (C-Ar), 144.3, (C-Ar), 140.2 (C-5), 130.9 (CH-Ar, C-Ar), 125.4 (C-Ar), 121.4 (CH-Ar), 119.2 (CH-Ar), 114.8 (C-6), 101.3 (CH-Ar), 82.4 (C-10), 59.7 (C-9), 57.3 (C-11), 55.9 (C-22), 50.0 (C-1), 49.4 (C-7), 39.8 (C-4), 28.2 (C-3), 26.1 (C-2), 25.2 (C-15), 21.1 (C-8); HRMS found ES $[M+H]^+$ 353.2219, $C_{22}H_{29}N_2O_2$ requires *M*, 353.2229; $[\alpha]_D^{25}$ +211.7 (c = 0.914 in $CHCl_3$).




Me-cat-quinidine
ppm
200
180
160
140
120
100
80
60
40
20
0

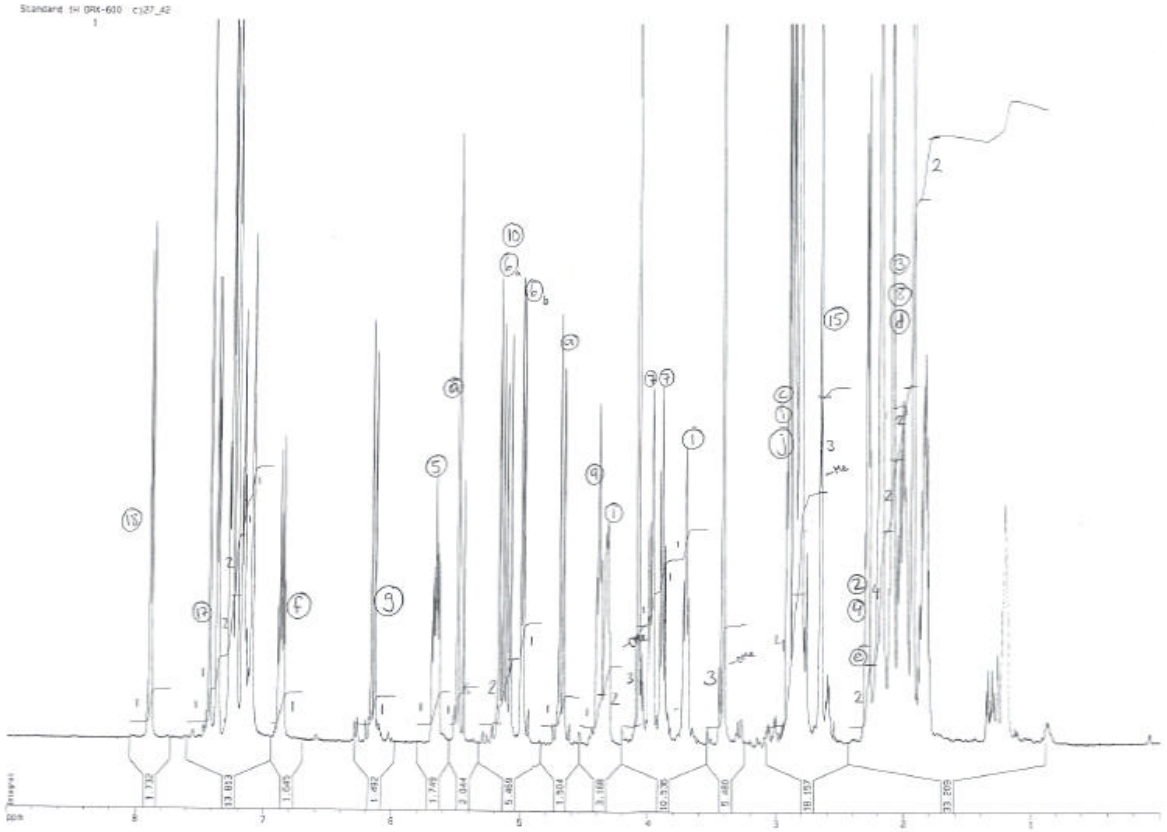
Ammonium salt Me-MQ

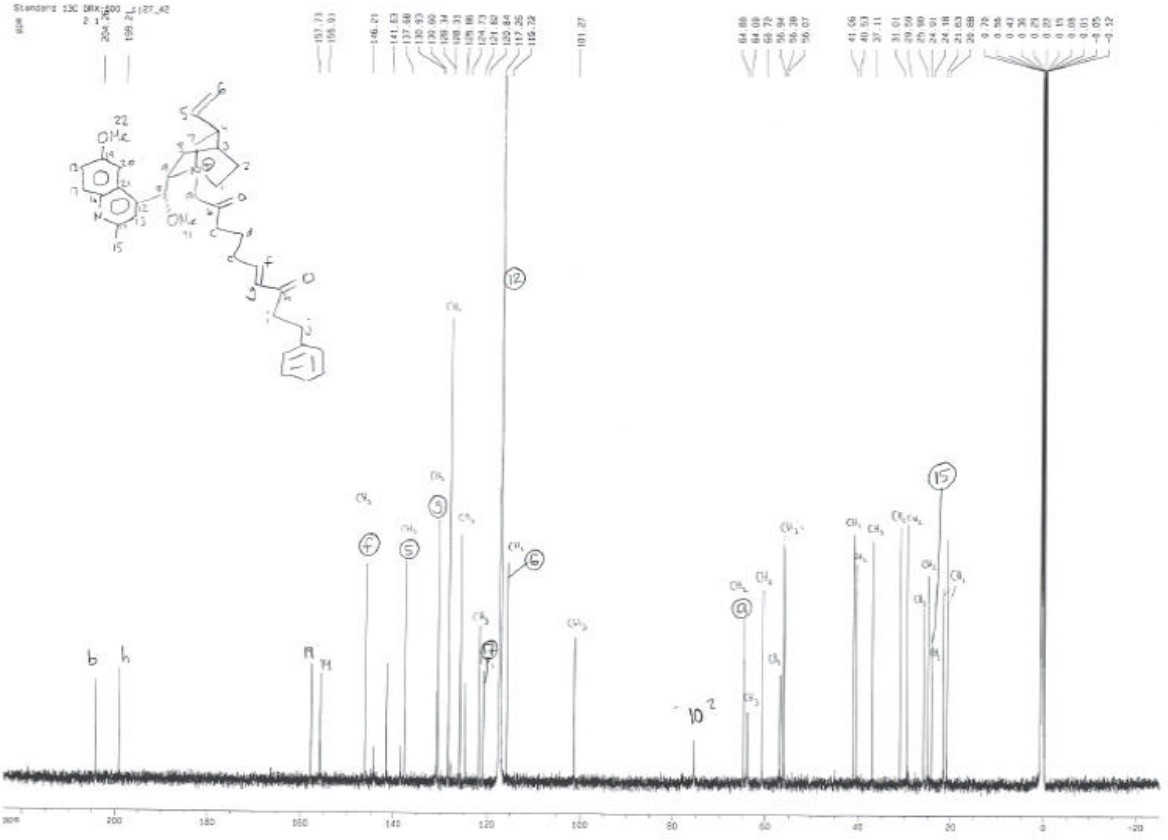


The catalyst **Me-Q** (0.125 mmol, 44 mg, 1.0 eq.) was dissolved in MeCN (1.0 ml), NaBr (13 mg, 0.125mmol, 1.0 eq.) and a solution of chloroketone (35 mg, 0.125 mmol, 1 eq.) in MeCN (0.5 ml) were added and the reaction mixture was stirred at 80 °C for 24 h.

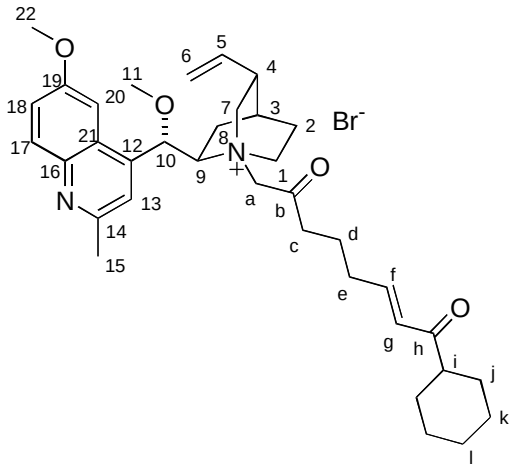
The reaction mixture was purified by flash column chromatography on silica gel using 5 to 20 % MeOH in CH_2Cl_2 to give cyclopropane **2a** (6 mg, 21 %) and the *ammonium salt intermediate* **X** (29 mg, 39 %) as a solid.

ν_{max} (film)/ cm^{-1} 3396, 2942, 1722, 1623, 1501, 1456, 1339, 1234, 1076, 1031, 835, 701; δ_H (600 MHz, CD_3CN) 7.98- 7.96 (1H, d, *J* = 9.2, H-arom.) 7.40-7.13 (7H, m, H-arom.), 6.98-6.91 (1H, m, H-arom.), 6.79 (1H, ddd, *J* = 15.8, 6.9, 6.9, H-f), 6.61 (1H, d, *J* = 18.5, H_a-a), 6.14 (1H, d, *J* = 15.8, H-g), 5.56 (1H, ddd, *J* = 17.2, 10.6, 5.7, H-5), 5.19 (1H, d, *J* = 17.2, H_a-6), 5.09 (1H, d, *J* = 3.1, H-10), 5.06 (1H, d, *J* = 10.6, H_b-6), 4.64-4.57 (2H, m, H-9, H_b-a), 4.51-4.47 (1H, m, H_a-1), 4.43-4.35 (2H, m, H-7), 4.13-3.99 (1H, m, H_b-1), 4.07 (3H, s, H-22), 3.44 (3H, s, H-11), 3.10-3.05 (1H, m, H_a-c) 2.92-2.83 (5H, m, H-i, H-j, H_b-c), 2.73 (3H, s, H-15), 2.34-2.29 (2H, m, H-e), 2.14-2.06 (3H, m, H-4, H-2), 1.96-1.52 (5H, m, H-3, H-8, H-d); δ_C (150 MHz, CD_3CN) 204.3 (C-b), 199.2 (C-h), 157.7 (C-Ar), 155.9 (C-Ar), 146.2 (C-f), 141.6 (C-Ar), 137.7 (C-5), 130.9 (CH-Ar), 130.6 (C-g), 128.3 (CH-Ar), 128.3 (CH-Ar), 125.9 (CH-Ar), 124.7 (C-Ar), 121.8 (CH-Ar), 120.8 (CH-Ar), 117.3 (C-Ar), 115.7 (C-6), 101.3 (CH-Ar), 75.1 (C-10), 64.8 (C-a), 64.0 (C-9), 60.7 (C-7), 56.9 (C-1), 56.4 (C-11), 56.1 (C-22), 41.1 (C-c), 40.5 (C-i), 37.1 (C-3), 31.0 (C-e), 29.6 (C-j), 25.9 (C-4), 24.9 (C-2), 24.2 (C-15), 21.6 (C-d), 20.9 (C-8); HRMS found ES $[M]^+$ 595.3522, $C_{38}H_{47}N_2O_4$ requires *M*, 595.3536; $[\alpha]_D^{25}$ - 62.4 (c = 0.13 in $CHCl_3$).



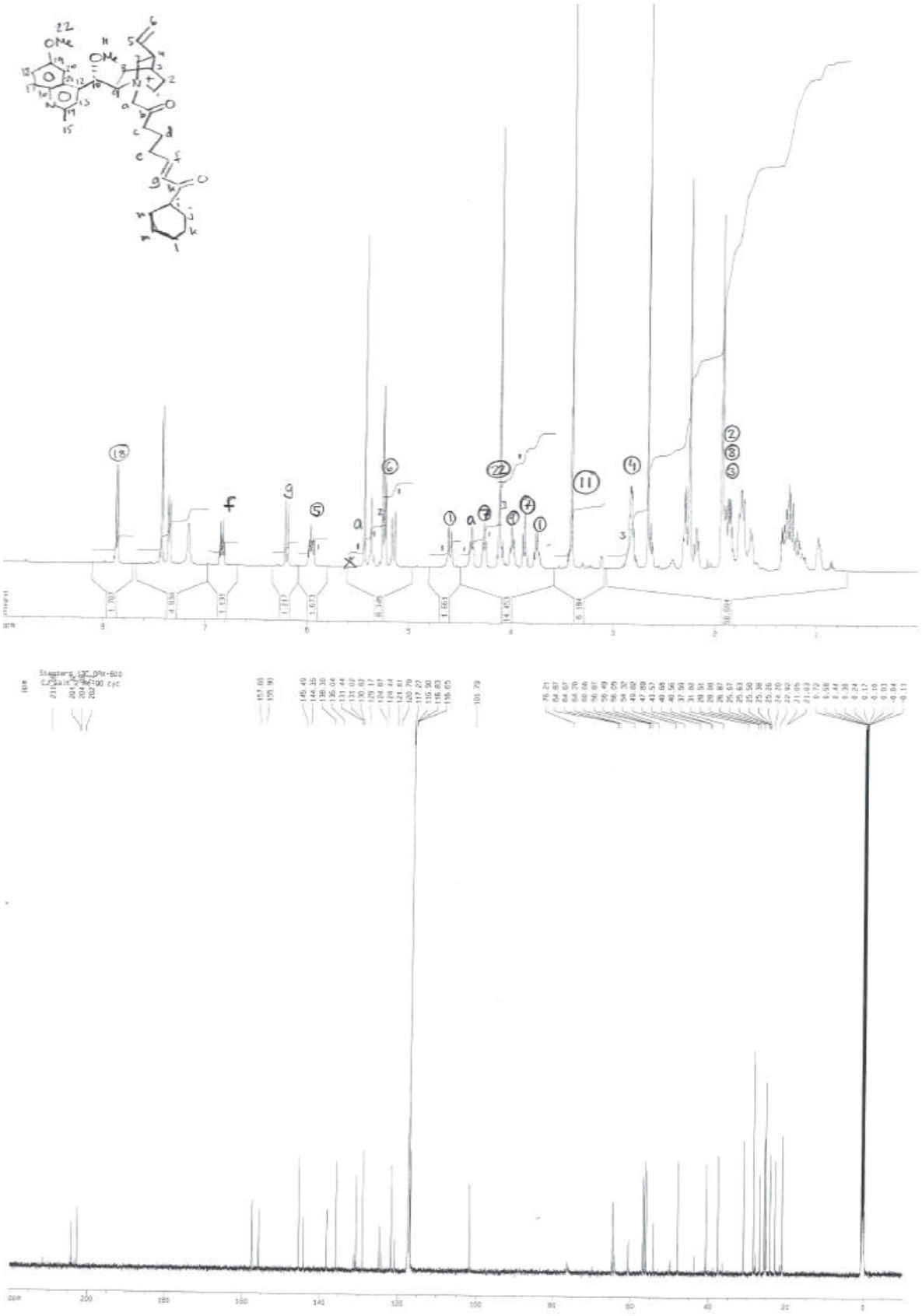


Ammonium salt Me-MQD

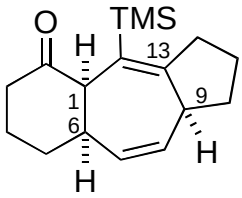


ν_{max} (film)/ cm^{-1} 3443, 2931, 2854, 2543, 1721, 1688, 1656, 1621, 1602, 1505, 1478, 1450, 1408, 1378, 1339, 1263, 1234, 1119, 1068, 1028, 920, 836, 734; δ_H (600 MHz, CD_3CN) 7.88 (1H, d, *J* = 9.2, H-Ar), 7.44 (1H, s, H-Ar), 7.37 (1H, dd, *J* = 9.2, 2.7, H-Ar), 7.18 (1H, app s, H-Ar), 6.85 (1H, dt, *J* = 15.8, 6.9, H-f), 6.21 (1H, dt, *J* = 15.8, 1.5, H-g), 5.98 (1H, ddd, *J* = 18.0, 11.0, 7.0, H-5), 5.38 (1H, d, *J* = 3.2, H-10), 5.27-5.24 (2H, m, H-6), 5.16 (1H, d, *J* = 18.7, H_a-a), 4.61 (1H, d, *J* = 18.7, H_b-a), 4.40 (1H, m, H-9), 4.30-4.26 (1H, m, H_a-7), 4.12 (3H, s, H-22), 4.01-3.99 (1H, m, H_a-1), 3.89-3.85 (1H, m, H_b-7), 3.76-3.71 (1H, m, H_b-1), 3.41 (3H, s, H-11), 2.85-2.80 (3H, m, H-c, H-4), 2.66 (3H, s, H-15), 2.31-2.28 (1H, m, H-i), 2.19-2.16 (1H, m, H_a-e), 1.95-1.85 (7H, m, H_a-l, H-2, H-3, H-8, H_b-e), 1.78-1.63 (4H, m, H_a-j, H_a-k), 1.36-1.12 (6H, m, H-d, H_b-j, H_b-k), 1.01-0.95 (1H, m, H_b-l); δ_C (150 MHz, CD_3CN) 204.3 (C-b), 202.2 (C-h), 157.7 (C-Ar), 155.9 (C-Ar), 145.5 (C-f), 144.4 (C-Ar), 138.3 (C-Ar), 136.04 (C-5), 130.8 (CH-Ar), 129.2 (C-g), 121.8 (CH-Ar), 117.3 (2 x CH-Ar), 116.7 (C-6), 101.8 (CH-Ar), 76.2 (C-10), 64.7 (C-a), 64.2 (C-9), 60.7 (C-7), 56.9 (C-1), 56.5 (C-11), 56.1 (C-22), 47.9 (C-3), 40.6 (C-c), 37.6 (C-4), 31.0 (C-i), 28.5 (C-j), 26.9 (C-15), 25.7, 25.4 (C-2, C-8), 24.2 (C-k), 22.9 (C-d), 21.1 (C-e), 21.0 (C-l); HRMS found ESI $[M-Br]^+$ 573.3687, $C_{36}H_{49}N_2O_4$ requires *M*, 573.3687; $[\alpha]_D^{25}$ + 71.00 (c = 0.100 in $CHCl_3$).

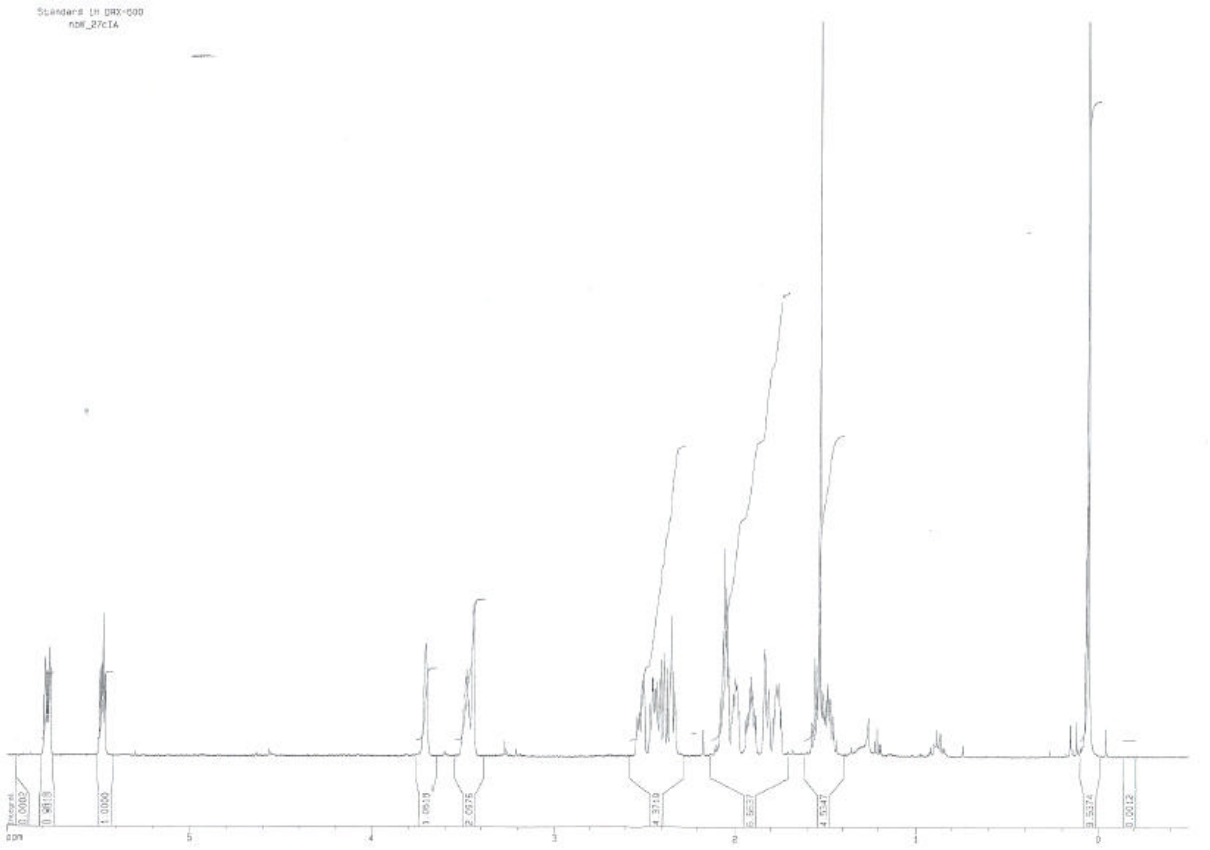
X-ray crystal structure is deposited in the CCDC 607162.

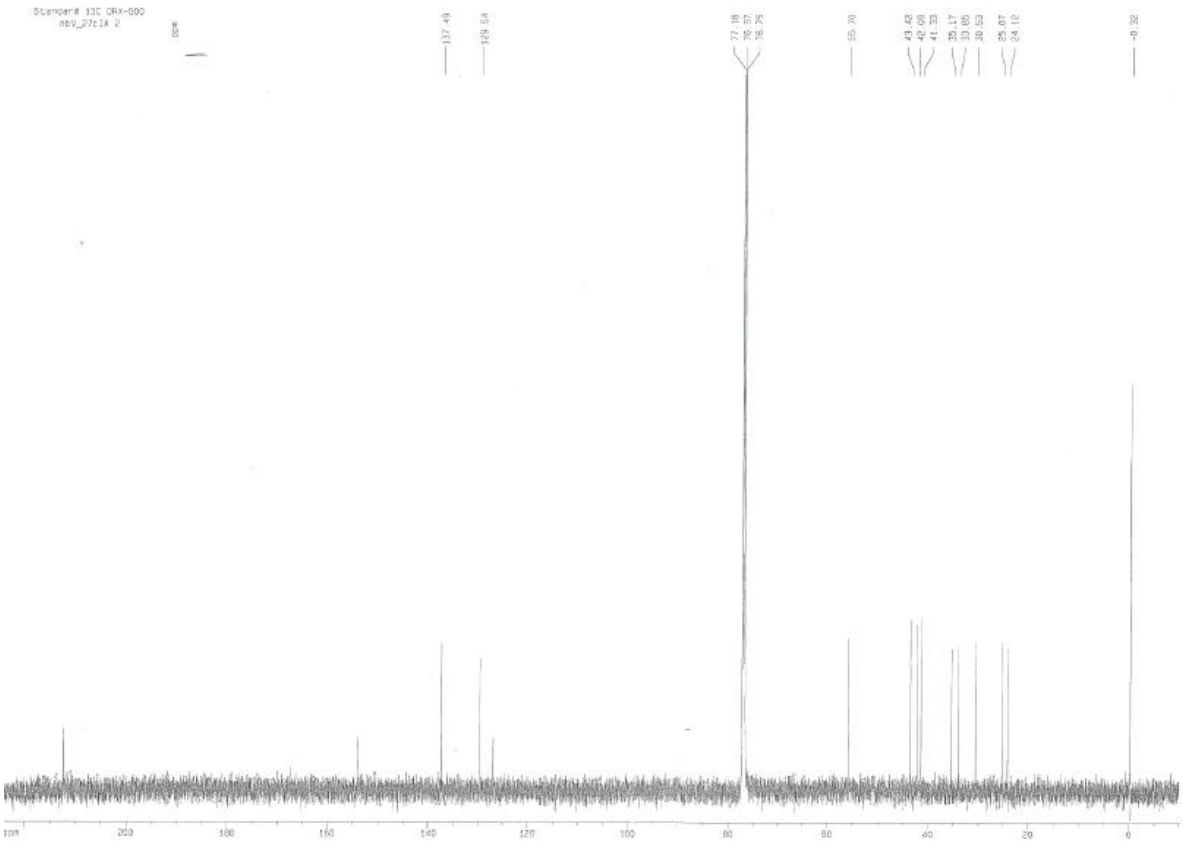


4-(Trimethylsilanyl)-2,3,4a,6,7,8,8a,10a-octahydro-1 H-**benzo[*f*]azulen-5-one 47**[100]



ν_{max} (film)/ cm^{-1} 2945, 1711, 1245, 1133, 884, 835; δ_H (600 MHz, $CDCl_3$) 5.79-5.77 (ddd, *J* = 9.7, 3.5, 2.3, 1 H, H-8), 5.50-5.47 (ddd, *J* = 9.7, 6.3, 2.8, 1 H, H-7), 3.73-3.69 (m, 1 H, H-9), 3.52-3.46 (m, 1 H, H-6), 3.45-3.43 (m, 1 H, H-1), 2.55-2.49 (m, 1 H, H_a-12), 2.48-2.42 (m, 1 H, H_b-12), 2.42-2.36 (m, 1 H, H_a-3), 2.36-2.31 (m, 1 H, H_b-3), 2.10-2.03 (m, 2 H, H-4), 2.03-1.97 (m, 1 H, H_a-10), 4.95-1.88 (m, 1 H, H_a-5), 1.85-1.80 (m, 1 H, H_b-5), 1.80-1.73 (m, 1 H, H_a-11), 1.55-1.43 (m, 2 H, H_b-10, H_b-11), 0.06 (s, 9H, H-15); δ_C (125 MHz, $CDCl_3$) 212.4 (C-2), 153.8 (C-13), 137.5 (C-8), 129.6 (C-7), 126.9 (C-14), 55.7 (C-1), 43.4 (C-9), 42.1 (C-3), 41.3 (C-6), 35.2 (C-12), 33.9 (C-10), 30.5 (C-5), 25.1 (C-11), 24.1 (C-4), -0.3 (C-15) ; HRMS found ES $[MH]^+$ 275.1826, $C_{17}H_{27}OSi$ requires *M*, 275.1831.




137.49
129.64
77.18
76.97
76.76
55.70
43.42
42.06
41.33
35.17
33.86
30.53
25.07
24.12
-0.32
200
180
160
140
120
100
80
60
40
20
0