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Supporting Information

Experimental and Computational Studies on Regiodivergent Chiral Phosphoric Acid Catalyzed Cycloisomerization of Mupirocin Methyl Ester

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I. General Information

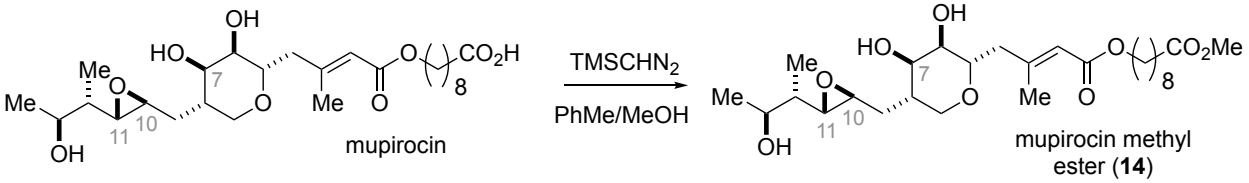
Methods and Reagents:

Unless otherwise stated, all reagents were purchased from commercial suppliers and used without further purification. Tetrahydrofuran (THF), dichloromethane (DCM) and diethyl ether (Et_2O) were filtered through a column (Innovative Technology PS-MD-5) of activated alumina under nitrogen atmosphere. All reactions were carried out under an atmosphere of nitrogen in flame- or oven-dried glassware with magnetic stirring. Reactions were cooled using Neslab Cryocool CB-80 immersion cooler (0 to –60 °C) and Neslab Cryocool immersion cooler CC-100 II, or via external cooling baths: ice water (0 °C), sodium chloride/ ice water (–10 °C), or dry ice/acetone (–78°C). Heating was achieved by use of a silicone bath with heating controlled by electronic contact thermometer. Deionized water was used in the preparation of all aqueous solutions and for all aqueous extractions. Solvents used for extraction and chromatography were ACS or HPLC grade. Purification of reactions mixtures was performed by flash chromatography using SiliCycle SiliaFlash P60 (230-400 mesh). Diastereomeric ratios were determined by RP HPLC analysis using a Shimadzu SBM-20A Separations Module with a photodiode array detector equipped with C18 Nova-Pack® column (60 Å, 4 μM, 3.9 x150 mm).

Instrumentation:

All spectra were recorded on Varian vnmrs 700 (700 MHz), Varian vnmrs 500 (500 MHz), Varian MR400 (400 MHz), Varian Inova 500 (500 MHz) spectrometers and chemical shifts (δ) are reported in parts per million (ppm) and referenced to the ^1H signal of the internal tetramethylsilane according to IUPAC recommendations. Data are reported as (br = broad, s = singlet, d = doublet, t = triplet, q = quartet, qn = quintet, sext = sextet, m = multiplet; coupling constant(s) in Hz; integration). High resolution mass spectra (HRMS) were recorded on MicromassAutoSpecUltima or VG (Micromass) 70-250-S Magnetic sector mass spectrometers in the University of Michigan mass spectrometry laboratory. Infrared (IR) spectra were recorded as thin films on NaCl plates on a Perkin Elmer Spectrum BX FT-IR spectrometer. Absorption peaks were reported in wavenumbers (cm^{-1}).

II. Synthesis of mupirocin methyl ester.



Mupirocin (2.0 g, 4.0 mmol) was initially dissolved in toluene (16 mL) and methanol (4.0 mL). Then trimethylsilyldiazomethane (2.4 mL, 4.8 mmol, 1.2 eq) was added in dropwise. The reaction mixture was stirred for 1h at room temperature under N_2. After reaction is completed, the reaction was diluted with EtOAc (15 mL) and quenched with 10 v/v % AcOH (15 mL). Then the organic layer was separated from aqueous layer, which was extracted with EtOAc (15 mL x 3). The combined organic layer was washed with brine, dried over with Na_2SO_4, and concentrated *in vacuo* to obtain white solid. The crude product was purified by recrystallization via hexane (10 mL) and diethyl ether (20 mL) and filtered through a Büchner funnel to afford mupirocin methyl ester **14** (1.93 g, 85%) as a white solid.

IR (thin film, cm^{-1}): 3564, 3399 (br), 1737, 1712, 1647, 1218, 1142, 1110, 1075, 941, 922, 890, 814, 754, 669.

^{1}H NMR (700 MHz, Chloroform-*d*) δ 5.73 (s, 1H), 4.05 (t, *J* = 6.5 Hz, 2H), 3.90 (t, *J* = 3.6 Hz, 1H), 3.85 (dd, *J* = 11.8, 2.9 Hz, 1H), 3.79 (p, *J* = 6.4 Hz, 1H), 3.74 (td, *J* = 8.9, 3.0 Hz, 1H), 3.52 (dd, *J* = 11.8, 2.6 Hz, 1H), 3.45 (dd, *J* = 8.5, 3.1 Hz, 1H), 2.84 – 2.75 (m, 1H), 2.71 (dd, *J* = 7.9, 2.2 Hz, 1H), 2.58 (dd, *J* = 14.9, 3.0 Hz, 1H), 2.31 (t, *J* = 7.4 Hz, 2H), 2.25 (dd, *J* = 14.7, 9.2 Hz, 1H), 2.18 (s, 3H), 1.99 (dt, *J* = 7.1, 3.5 Hz, 1H), 1.71 (ddt, *J* = 27.3, 14.5, 6.5 Hz, 2H), 1.61 (h, *J* = 7.9, 7.4 Hz, 5H), 1.39 – 1.25 (m, 10H), 1.20 (d, *J* = 6.3 Hz, 3H), 0.92 (d, *J* = 7.0 Hz, 3H).

^{13}C NMR (176 MHz, Chloroform-*d*) δ 178.29, 166.88, 156.71, 117.57, 74.82, 71.34, 70.31, 68.98, 65.33, 63.86, 61.29, 55.66, 42.71, 39.39, 33.94, 31.53, 28.94, 28.86, 28.81, 28.52, 25.87, 24.63, 20.68, 19.08, 12.70.

HRMS (ESI+) (m/z): $[M+Na]^+$ calcd for $C_{27}H_{46}O_9$, 537.3040, found 537.3014.

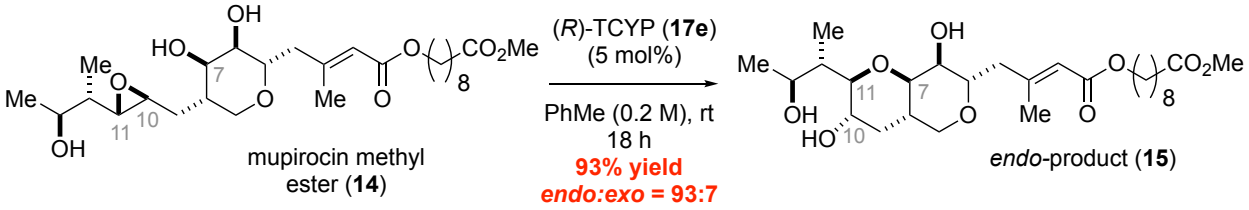
$[\alpha]_D^{25} = -9.4^\circ$ (c = 2.06, $CHCl_3$).

General Experimental Procedure for studies summarized in Tables S1–S3 and focused on optimizing the selective formation of *endo*-product (15).

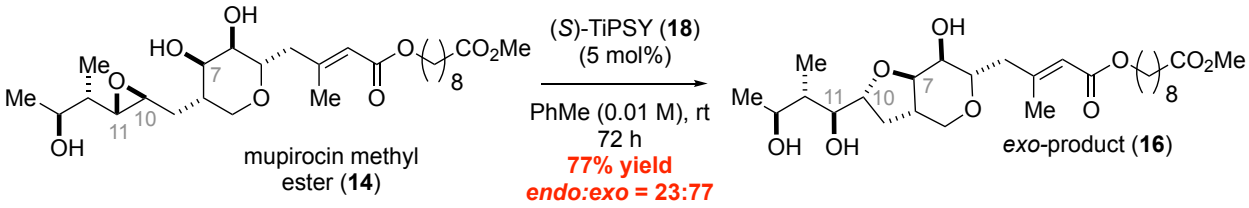
To a flame dried, N_2 flushed 1 dram vial, a stir bar and mupirocin methyl ester (10 mg, 0.020 mmol) was placed. Then chiral phosphoric acids (0.0010 mmol, 0.05 equiv.) was added in and dissolved in toluene (0.20 mL). The reaction was stirred for 18 h (unless noted otherwise) at room temperature.

General Experimental Procedure for the studies summarized in Tables S4–S6 and focused on optimizing the selective formation of *exo*-product (16).

To a flame dried, N_2 flushed 1 dram vial, a stir bar and mupirocin methyl ester (10 mg, 0.020 mmol) was placed. Then catalyst (0.0010 mmol, 0.05 equiv.) was added in and dissolved in toluene (2.0 mL). The reaction was stirred for 18 h (unless noted otherwise) at room temperature.



***Endo*-selective (*R*)-TCYP (17e)-catalyzed cyclization leading to 15**. To a flame dried, N_2 flushed 1-dram vial, a stir bar and mupirocin methyl ester **14** (104 mg, 0.20 mmol) were added. This followed by the addition of chiral phosphoric acid (*R*)-**17e** (10 mg, 0.01 mmol, 0.05 equiv.) was added in and dissolved in toluene (1.0 mL, 0.2 M). The reaction was stirred for 18 h at room temperature before being concentrated on rotatory evaporator and chromatographed on silica gel using 10:9:1 hexanes:dichloromethane:methanol (R_f = 0.2). This provided 97 mg of purified *endo*-product **15** in 93% yield.



***Exo*-selective (*S*)-TiPSY (18)-catalyzed cyclization leading to 16.** To a flame dried, N_2 flushed 1-dram vial, a stir bar and mupirocin methyl ester **14** (100 mg, 0.2 mmol) were added. This followed by the addition of chiral phosphoric acid (*S*)-**18** (10 mg, 0.01 mmol, 0.05 equiv.) was added in and dissolved in toluene (20 mL, 0.01 M). The reaction was stirred for 72 h at room temperature before being concentrated on rotatory evaporator and chromatographed on silica gel using 10:9:1 hexanes:dichloromethane:methanol (R_f = 0.2). This provided 77 mg of purified *exo*-product **16** in 77% yield.

Endo-product (**15**).

IR (thin film, cm^{-1}): 3407(br), 2930, 2856, 1713, 1646, 1436, 1223, 1149, 1095, 1056, 997, 914, 862, 808, 753, 610.

^{1}H NMR (700 MHz, Chloroform-*d*) δ 5.69 (d, *J* = 1.9 Hz, 1H), 4.22 (ddd, *J* = 10.0, 5.3, 1.4 Hz, 1H), 4.06 (t, *J* = 6.7 Hz, 2H), 3.79 (p, *J* = 6.5 Hz, 1H), 3.74 (t, *J* = 2.0 Hz, 1H), 3.65 (s, 3H), 3.63 (d, *J* = 2.0 Hz, 1H), 3.60 (ddd, *J* = 16.2, 10.8, 5.1 Hz, 2H), 3.33 – 3.24 (m, 2H), 2.57 (dd, *J* = 14.2, 9.9 Hz, 1H), 2.28 (t, *J* = 7.5 Hz, 2H), 2.24 – 2.17 (m, 5H), 2.17 – 2.08 (m, 1H), 2.01 (dt, *J* = 11.7, 3.9 Hz, 1H), 1.93 (pd, *J* = 7.1, 1.8 Hz, 1H), 1.66 – 1.55 (m, 5H), 1.37 – 1.27 (m, 10H), 1.25 (d, *J* = 6.3 Hz, 3H), 0.96 (d, *J* = 7.1 Hz, 3H).
^{13}C NMR (176 MHz, Chloroform-*d*) δ 174.31, 166.40, 155.05, 118.27, 82.03, 77.05, 75.94, 70.15, 69.11, 66.34, 64.16, 63.93, 53.41, 51.45, 39.96, 39.86, 34.58, 34.05, 32.90, 29.08, 29.03, 29.00, 28.62, 25.91, 24.87, 22.16, 18.28, 10.78.
HRMS (ESI+) (m/z): $[M+Na]^+$ calcd for $C_{27}H_{46}O_9$, 537.3040, found 537.3054.

$[\alpha]_D^{25} = -8.5^\circ$ (c = 1.91, $CHCl_3$).

Exo-product (**16**).
IR (thin film, cm^{-1}): 3407(br), 2929, 2856, 1714, 1646, 1436, 1223, 1149, 1059, 993, 913, 842, 800, 755, 667, 610.
^{1}H NMR (700 MHz, Chloroform-*d*) δ 5.70 (s, 1H), 4.28 (ddd, *J* = 9.4, 5.9, 3.3 Hz, 1H), 4.14 (ddd, *J* = 9.5, 5.4, 1.8 Hz, 1H), 4.07 (t, *J* = 6.7 Hz, 2H), 4.03 – 3.98 (m, 2H), 3.91 (dd, *J* = 9.5, 3.3 Hz, 1H), 3.89 – 3.83 (m, 1H), 3.66 (s, 3H), 3.64 (dd, *J* = 11.3, 3.1 Hz, 1H), 2.50 (dd, *J* = 14.2, 9.4 Hz, 1H), 2.41 (qq, *J* = 13.5, 8.0, 6.6 Hz, 1H), 2.30 (t, *J* = 7.5 Hz, 2H), 2.25 (dd, *J* = 14.1, 5.4 Hz, 1H), 2.20 (d, *J* = 1.3 Hz, 3H), 1.91 (dt, *J* = 11.6, 5.9 Hz, 1H), 1.80 (td, *J* = 12.1, 9.8 Hz, 1H), 1.61 (hept, *J* = 6.8 Hz, 5H), 1.49 (dp, *J* = 9.1, 7.1 Hz, 1H), 1.38 – 1.27 (m, 10H), 1.19 (d, *J* = 6.2 Hz, 3H), 0.81 (d, *J* = 6.9 Hz, 3H).
^{13}C NMR (176 MHz, Chloroform-*d*) δ 174.29, 166.42, 155.15, 118.27, 81.14, 80.59, 77.29, 76.16, 72.24, 68.98, 65.62, 63.88, 51.45, 41.98, 41.40, 36.27, 34.06, 29.09, 29.03, 29.01, 28.63, 26.36, 25.92, 24.88, 20.93, 18.38, 12.54.
HRMS (ESI+) (m/z): $[M+Na]^+$ calcd for $C_{27}H_{46}O_9$, 537.3040, found 537.3041.
$[\alpha]_D^{25} = -2.1^\circ$ (c = 2.23, $CHCl_3$).

III. Control Studies

LiCl, $ZnCl_2$, and $Sc(OTf)_3$ catalyzed cyclizations of 14 (Table S1, entries 1-3). To a flame dried, N_2 flushed 1-dram vial, a stir bar and mupirocin methyl ester (10 mg, 0.020 mmol) was placed. Then the entitled catalysts (0.0010 mmol, 0.2 equiv.) were added in, followed by dissolved in dichloromethane (0.01M). The reaction was stirred for 18 h at room temperature. And the results were analyzed by rp-HPLC.

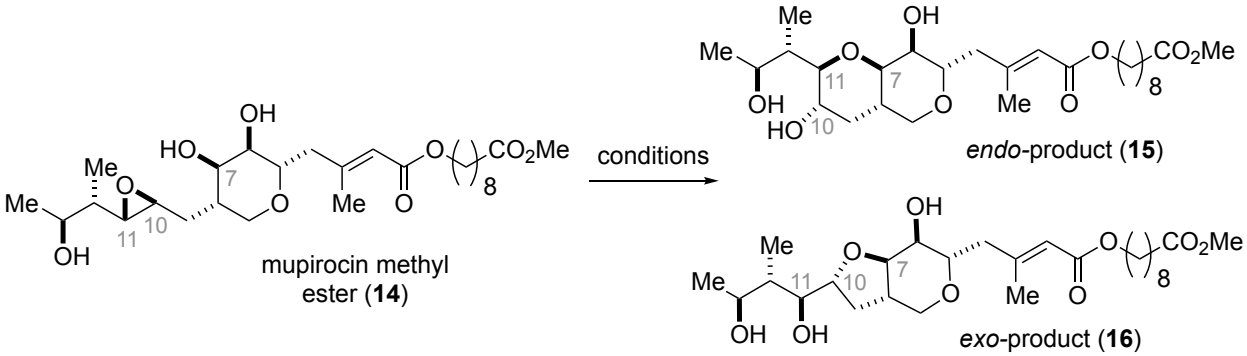
H_2O and pH 7 buffer promoted cyclizations of 14 (Table S1, entries 4-5). To a flame dried, N_2 flushed 1-dram vial, a stir bar and mupirocin methyl ester (10 mg, 0.020 mmol) was placed. Water or KH_2PO_4 buffer with a pH of 7 aqueous solution were directly used as solvent and catalyst. The reaction concentration was 0.2 M. Then the reaction was stirred at 70 ^oC for 96 h. The result was analyzed by rp-HPLC.

Cs_2CO_3 promoted cyclization of 14 (Table S1, entry 6). To a flame dried, N_2 flushed 1-dram vial, a stir bar and mupirocin methyl ester (10 mg, 0.020 mmol) was placed. Then Cs_2CO_3(10 equiv.) was added in, followed by dissolved in methanol (0.002 M). The reaction was stirred for 90 h at room temperature. The result was analyzed by rp-HPLC.

LiHMDS promoted cyclization (Table S1, entry 7). To a flame dried, N_2 flushed 1-dram vial, a stir bar and mupirocin methyl ester (10 mg, 0.020 mmol) was placed. Then lithium bis(trimethylsilyl)amide (LiHMDS) (3 equiv.) was added in, followed by dissolved in tetrahydrofuran (0.01 M). The reaction was stirred for 90 h at room temperature. The result was analyzed by rp-HPLC.

(p-NO_2-$C_6H_4O)_2PO_2H$ catalyzed cyclization of 14 (Table S1, entry 8). To a flame dried, N_2 flushed 1-dram vial, a stir bar and mupirocin methyl ester (10 mg, 0.020 mmol) was placed. Then achiral phosphoric acid (p-NO_2-$C_6H_4O)_2PO_2H$ (0.2 equiv.) was added in, followed by dissolved in dichloromethane (0.2 M). The reaction was stirred for 120 h at room temperature. And the result was analyzed by rp-HPLC.

Table S1. Initial control experiments for the intramolecular cyclizations of **14** leading to **15** and **16**.



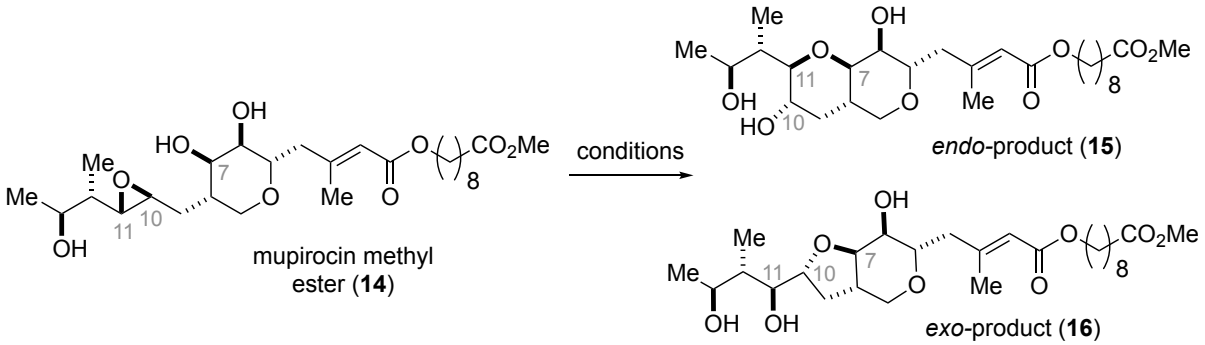
entry	catalyst (mol%)	solvent (conc.)	T (°C)	time (h)	conversion (%)	16:15[b]
1[a]	LiCl	CH_2Cl_2 (0.01 M)	rt	12	<5	-
2[a]	$ZnCl_2$	CH_2Cl_2 (0.01 M)	rt	12	82	52:48
3[c]	$Sc(OTf)_3$	CH_2Cl_2 (0.2 M)	rt	12	77	43:57
4[d]	-	H_2O (0.2 M)	70	96	24	29:71
5	KH_2PO_4 buffer (pH 7)	H_2O (0.2 M)	70	96	>98	52:48
6[e]	Cs_2CO_3 (10 eq)	MeOH (0.002 M)	rt	96	nr	-
7[f]	LiHMDS (3 eq)	THF (0.01 M)	rt	96	nr	-
8[g]	(p-NO_2-$C_6H_4O)_2PO_2H$	CH_2Cl_2 (0.2 M)	rt	120	>98	30:70

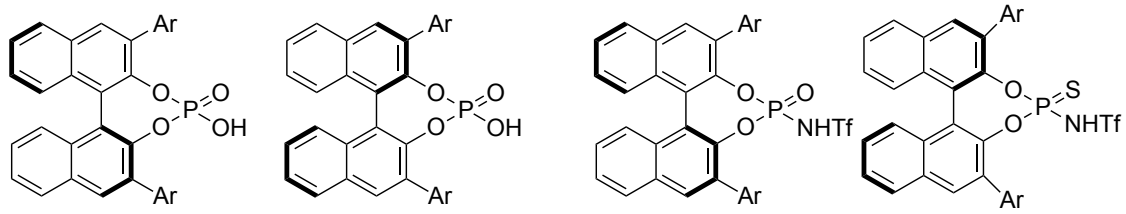
[a] Conditions: catalyst (20 mol%), CH_2Cl_2 (0.01 M); [b] Determined by RP-HPLC; [c] Conditions: catalyst (20 mol%), CH_2Cl_2 (0.2 M); [d] 70 ºC; [e] Cs_2CO_3 (10 equiv), CH_2Cl_2 (0.02 M); [f] LiHMDS (3 equiv), CH_2Cl_2 (0.01 M); [g] catalyst (20 mol%), CH_2Cl_2 (0.2 M).

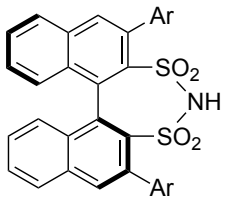
IV. Optimization of the reaction conditions and catalysts for the selective formation of the *endo*-product 15

Unless noted otherwise, the general experimental procedure for the *endo*-product (**15**) provided on SI-page 5 was followed.

Table S2. Catalyst screening for the selective formation of *endo*-product **15**.





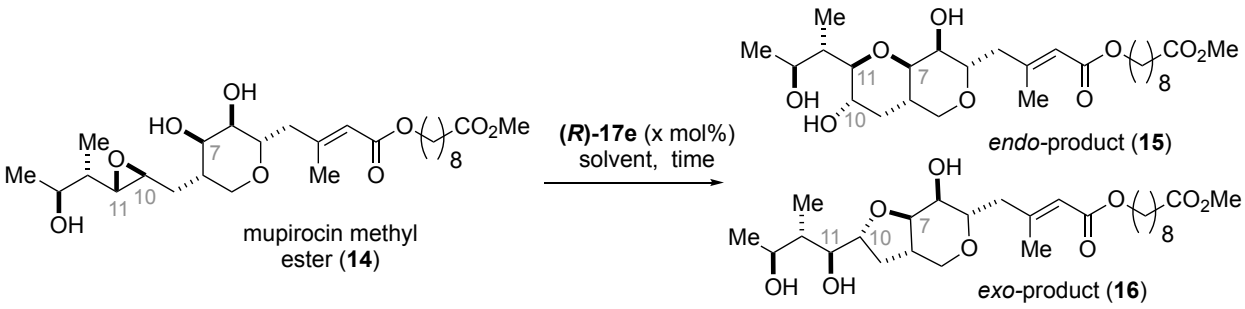


a: Ar = 3,5-$Cl_2C_6H_3$–
b: Ar = 3,5-$(CF_3)_2C_6H_3$–
c: Ar = 3,5-$(SF_5)_2C_6H_3$–
d: Ar = 2,4,6-(*i*Pr)$_3C_6H_2$–
e: Ar = 2,4,6-$(Cy)_3C_6H_2$–
f: Ar = 9-anthracenyl–
g: Ar = phenanthryl–

entry[a]	catalyst (mol%)	solvent (conc.)	T(°C)	time (h)	conversion (%)	16:15[b]
1	(*S*)-**17a** (20)	CH_2Cl_2 (0.2 M)	rt	12	>98	34:66
2	(*R*)-**17a** (20)	CH_2Cl_2 (0.2 M)	rt	12	>98	26:74
3	(*S*)-**17b** (20)	CH_2Cl_2 (0.2 M)	rt	12	95	38:62
4	(*R*)-**17b** (20)	CH_2Cl_2 (0.2 M)	rt	12	>98	20:80
5	(*S*)-**17c** (20)	CH_2Cl_2 (0.2 M)	rt	12	>98	34:66
6	(*R*)-**17c** (20)	CH_2Cl_2 (0.2 M)	rt	12	>98	27:73
7	(*S*)-**17d** (20)	CH_2Cl_2 (0.2 M)	rt	12	>98	43:57
8	(*R*)-**17d** (20)	CH_2Cl_2 (0.2 M)	rt	12	>98	7:93
9	(*S*)-**17e** (20)	CH_2Cl_2 (0.2 M)	rt	12	>98	55:45
10	**(*R*)-17e (20)**	**CH_2Cl_2 (0.2 M)**	**rt**	**12**	**>98**	**6:94**
11	(*S*)-**17f** (20)	CH_2Cl_2 (0.2 M)	rt	12	>98	45:55
12	(*R*)-**17f** (20)	CH_2Cl_2 (0.2 M)	rt	12	>98	23:77
13	(*S*)-**17g** (20)	Toluene (0.2 M)	rt	12	>98	43:57
14	(*S*)-**17_SI_1c** (20)	CH_2Cl_2 (0.2 M)	rt	12	>98	28:72
15	(*S*)-**17_SI_1d** (20)	CH_2Cl_2 (0.2 M)	rt	12	97	52:48
16	(*R*)-**17_SI_2c** (20)	CH_2Cl_2 (0.2 M)	rt	12	>98	45:55
17	(*S*)-**17_SI_3b** (20)	CH_2Cl_2 (0.2 M)	rt	12	90	40:60
18	(*R*)-**17_SI_3b** (20)	CH_2Cl_2 (0.2 M)	rt	12	>98	43:57

[a] Run on 0.020 mmol scale; [b] Determined by RP-HPLC.

Table S3. Solvent screening and catalyst loading optimization for the selective formation of *endo*-product **15**.



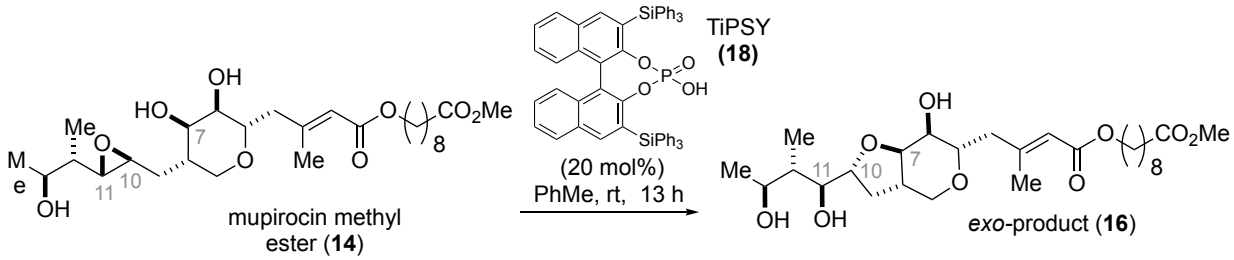
entry[a]	(*R*)-17e loading (mol%)	solvent (concentration)	T(°C)	time (h)	conversion (%)	16:15[b]
1[c]	20	CH_2Cl_2 (0.2 M)	rt	12	>98	6:94
2	20	CH_2Cl_2 (0.2 M)	rt	12	>98	6:94
3	20	cyclohexane (0.2 M)	rt	12	33	12:88
4	20	hexanes (0.2 M)	rt	12	47	15:85
5	20	diethyl ether (0.2 M)	rt	12	81	12:88
6	20	THF (0.2 M)	rt	12	86	11:89
7	20	ethyl acetate (0.2 M)	rt	12	>98	8:92
8	20	chloroform (0.2 M)	rt	12	>98	8:92
9	20	acetonitrile (0.2 M)	rt	12	94	15:85
10	20	$PhCF_3$ (0.2 M)	rt	12	>98	8:92
11	20	PhMe (0.2 M)	rt	12	>98	5:95
12	10	PhMe (0.2 M)	rt	12	>98	5:95
14	**5**	**PhMe (0.2 M)**	**rt**	**12**	**97**	**5:95**
15	2.5	PhMe (0.2 M)	rt	12	44	6:94
16	1	PhMe (0.2 M)	rt	12	32	7:93
17	**1**	**PhMe (0.2 M)**	**rt**	**120**	**92**	**5:95**
18	0.5	PhMe (0.2 M)	rt	120	51	6:94
19	100	PhMe (0.2 M)	rt	12	>98	3:97

[a] Run on 0.020 mmol scale; [b] Determined by RP-HPLC; [c] 4 Å MS were used.

V. Optimization of the reaction conditions and catalysts for the selective formation of the *exo*-product (16)

Unless noted otherwise, the general experimental procedure for the *exo*-product (**16**) provided on SI-page 5 was followed.

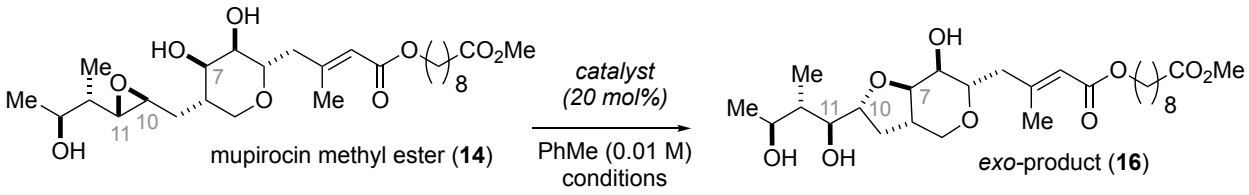
Table S4. Evaluation of TiPSY catalysts and optimization of the concentration to favor the *exo*-product **16**

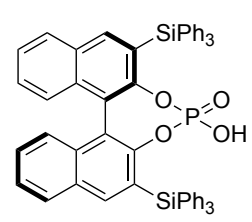


entry[a]	catalyst	concentraion (M)	conversion (%)	16:15[b]
1	(*R*)-TiPSY **(18)**	0.5 M	98	28:72
2	(*S*)-TiPSY **(18)**	0.5 M	90	45:55
3	(*S*)-TiPSY **(18)**	0.2 M	85	52:48
4	(*S*)-TiPSY **(18)**	0.1 M	90	62:38
5	(*S*)-TiPSY **(18)**	0.05 M	83	62:38
6	(*S*)-TiPSY **(18)**	0.025 M	95	65:35
7[c]	(*S*)-TiPSY **(18)**	**0.01 M**	**95**	**74:26**

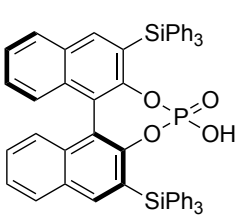
[a] Run on 0.020 mmol scale; [b] Determined by RP-HPLC; [c] Performed on both 0.020 and 0.2 mmol scale for 72 h without changes in yield and selectivity.

Table S5. Further catalyst screening for the formation of *exo*-product (**16**).

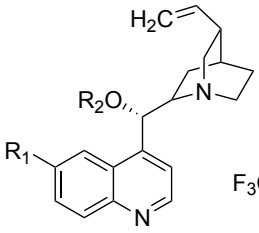




(*R*)-18

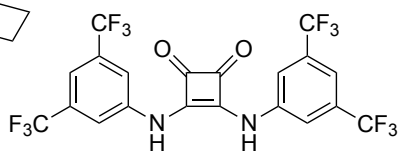


(*S*)-18

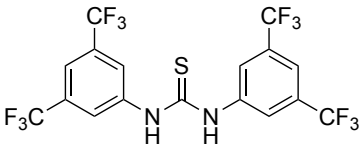


SI-19

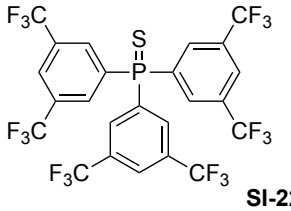
a: R_1=H, R_2=H
b: R_1=OMe, R_2=H
c: R_1=OMe, R_2=C(O)-4-Cl-Ph



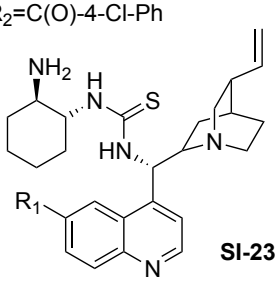
SI-20



SI-21



SI-22

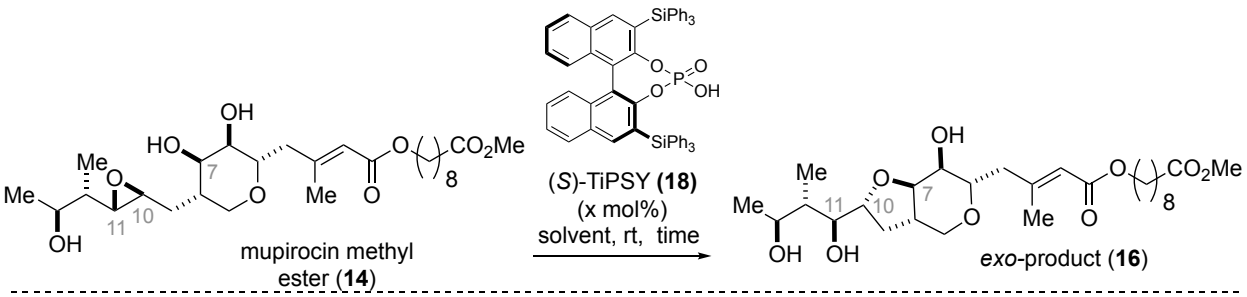


SI-23

entry[a]	catalyst (20 mol%)	T(°C)	t (h)	conversion (%)	16:15[b]
1	(*S*)-TiPSY **(18)**	**rt**	**12**	**>98**	**77:23**
2	(*R*)-TiPSY **(18)**	rt	12	>98	28:72
3	(*S*)-TiPSY **(18)**	–78	68	94	75:25
4	(*S*)-TiPSY **(18)**	110	12	>98	76:24
5	**SI-19a**	rt	12	<5	–
6	**SI-19b**	rt	12	<5	–
7	**SI-19c**	rt	12	<5	–
8	**SI-20**	rt	12	10	61:39
9	**SI-21**	rt	12	6	63:37
10	**SI-22**	rt	12	10	60:40
11	**SI-23**	rt	12	<5	–

[a] Run on 0.020 mmol scale except for entry 1 that was also reproduced on 0.2 mmol scale; [b] Determined by RP-HPLC.

Table S6. Further solvent screening to optimize the formation of *exo*-product (**16**).



entry[a]	catalyst loading (mol%)	solvent (concentration)	time (h)	conversion (%)	16:15[b]
1	20	Cyclohexane (0.01 M)	12	91	44:56
2	20	Hexanes (0.01 M)	12	93	38:62
3	20	Diethyl Ether (0.01 M)	12	22	50:50
4	20	Tetrahydrofuran (0.01 M)	12	46	52:48
5	20	Ethyl acetate (0.01 M)	12	40	55:45
6	20	Chloroform (0.01 M)	12	75	67:33
7	20	Acetonitrile (0.01 M)	12	67	52:48
8	20	Trifluorotoluene (0.01 M)	12	98	55:45
9	20	PhMe (0.01 M)	12	>98	77:23
10	15	PhMe (0.01 M)	13	88	73:27
11	10	PhMe (0.01 M)	13	74	70:30
12	5	PhMe (0.01 M)	13	51	73:27
13[c]	**5**	**PhMe (0.01 M)**	**72**	**77**	**77:23**
14[d]	5	PhMe (0.01 M)	13	44	55:45
15	1	PhMe (0.01 M)	13	38	68:32
16	0.5	PhMe (0.01 M)	13	30	70:30

[a] Carried on 0.020 mmol scale; [b] Determined by RP-HPLC; [c] Carried on 0.20 mmol scale; [d] Carried in the presence of 5 mol% of H_2O.

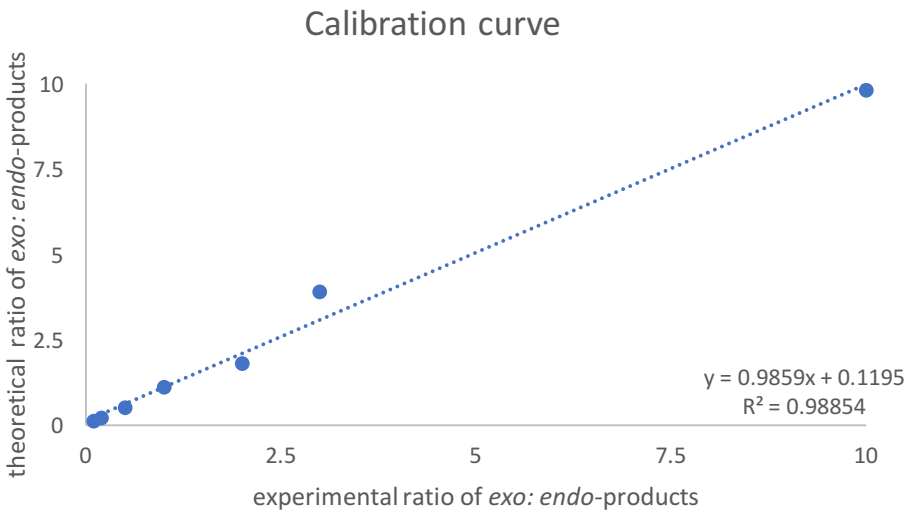
VI. Calibration curve for the determination of the *exo*:*endo* ratios by rp-HPLC

The isolated *endo*- and *exo*-products **15** and **16** were initially dissolved in toluene to make stock solutions (0.10 mg/mL). Afterwards, different volumes of *exo*-product to *endo*-product were mixed to prepare the theoretical ratio of *exo*-product (**16**) to *endo*-product (**15**). The mixtures were then analyzed rp-HPLC using C18 Nova-Pack® column (60 Å, 4 µM, 3.9 x150 mm) to determine the experimental *exo*-product to *endo*-product ratio.

Table S7. Measurements of *exo*:*endo* ratios of established mixtures of **15** and **16** by rp-HPLC.

stock solution *exo* **(16)** : *endo* (**15**) ratio	*exo* **(16)** : *endo* (**15**) ratio determined by rp HPLC
10	9.8
3	3.9
2	1.8
1	1.1
0.5	0.5
0.2	0.2
0.1	0.1

Figure S1. Calibration curve for the measurement of *exo*:*endo* product ratios by rp-HPLC.



VII. Mechanistic Studies

The experiments were set up following the general experimental procedure for (*R*)-TCYP (**17e**) catalyzed formation of *endo*-product (**15**) and (*S*)-TiPSY (**18**) catalyzed formation of *exo*-product (**16**) described on page S5. These reaction was run for the specified periods of time to analyze the reaction conversion and the *exo:endo* product ratio.

Table S8. Studies of *exo:endo* selectivity vs. conversion and time for the (*R*)-TiPSY (**18**)-catalyzed cyclization of mupirocin methyl ester (**14**).[a]

time (h)	conversion (%)	*exo* (**16**) : *endo* (**15**)[b]
0.17	18	60:40
0.5	40	62:38
1	47	70:30
2	52	72:28
3	62	73:27
4	70	75:25
5	76	76:24
6	80	77:23
8	85	77:23
12	90	77:23
24	100	77:23

[a] Condition: 1 equiv. of mupirocin methyl ester (**14**), (*S*)-TiPSY (**18**) (5 mol%), Toluene (0.01 M).
[b] Determined by rp-HPLC.

Figure S2. The plot of conversion vs. time (h) and *exo*:*endo* ratio for the (*S*)-TiPSY (**18**) catalyzed cycloisomerization to **15** and **16**.

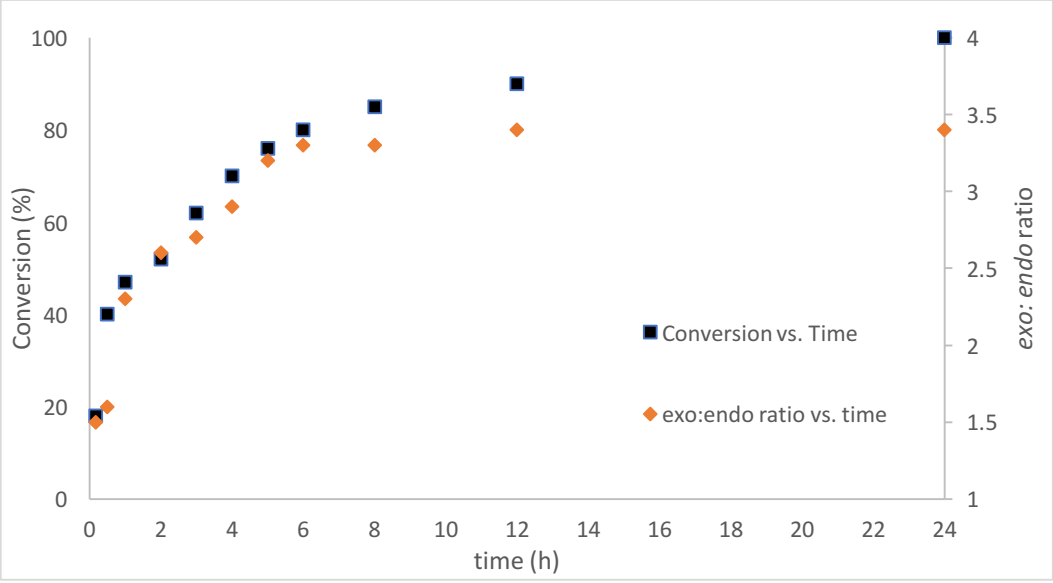


Figure S3. The plot of *exo*:*endo*-product ratio vs. conversion (%) for the (*S*)-TiPSY (**18**)-catalyzed cyclization of mupirocin methyl ester (**14**).

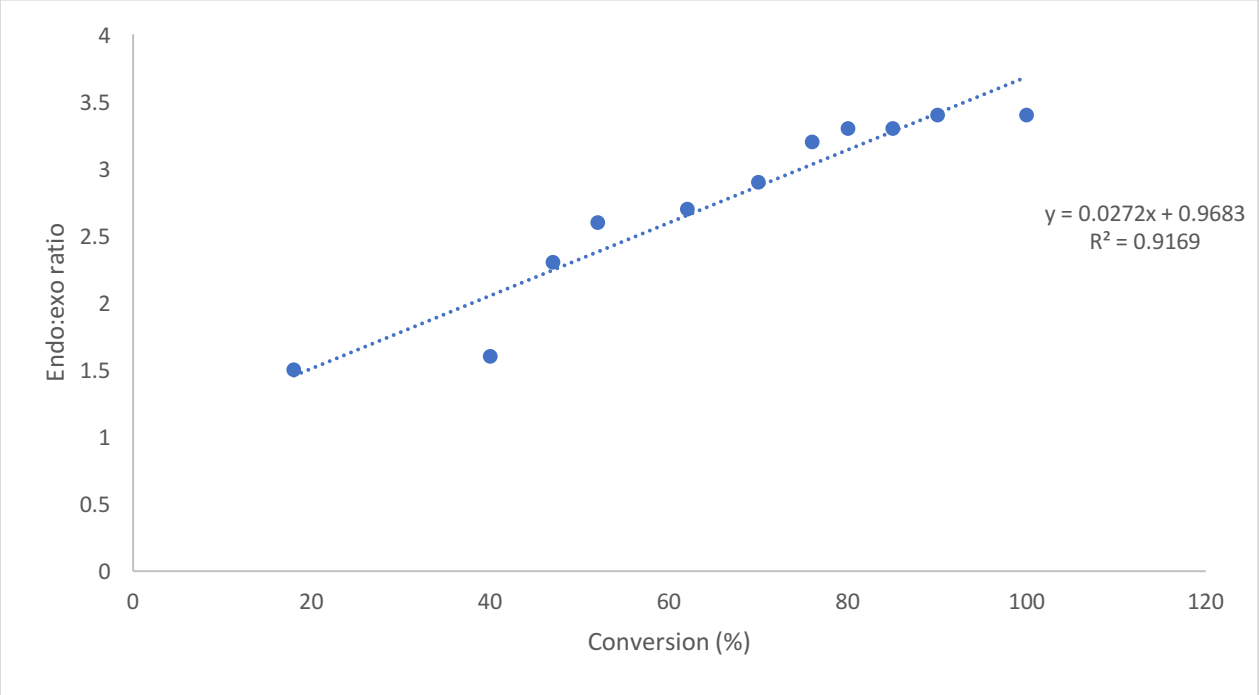


Table S9. Studies of *exo:endo* selectivity vs. conversion and time for the (*R*)-TCYP (**17e**)-catalyzed cyclization of mupirocin methyl ester (**14**).[a]

time (h)	conversion (%)	*exo* (**16**) : *endo* (**15**)[b]
0.17	8	13:87
0.5	12	13:87
1	22	13:87
2	25	11:89
4	32	11:89
8	54	6:94
12	67	6:94
24	86	5:95
48	99	5:95

[a] Conditions: 1 equiv. of mupirocin methyl ester (**14**), (*R*)-TCYP (**17e**) (5 mol%), toluene (0.2 M). [b] Determined by rp-HPLC.

Figure S4. The plot of conversion vs. time (h) and *exo*:*endo* ratio for the (*R*)-TCYP (**17e**) catalyzed cycloisomerization to **15** and **16**.

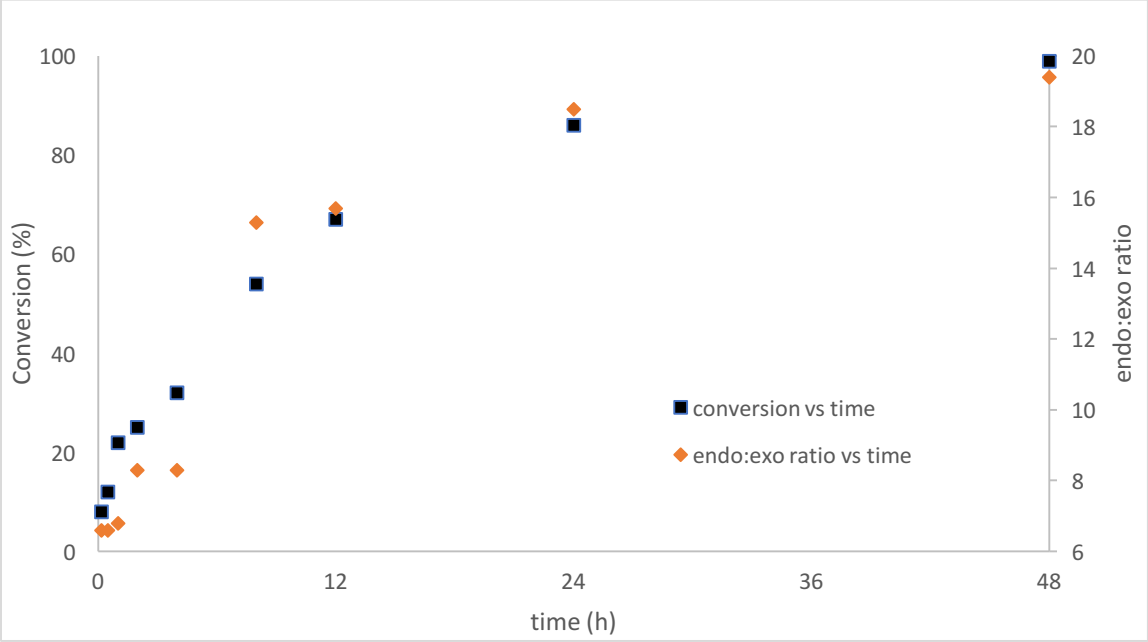
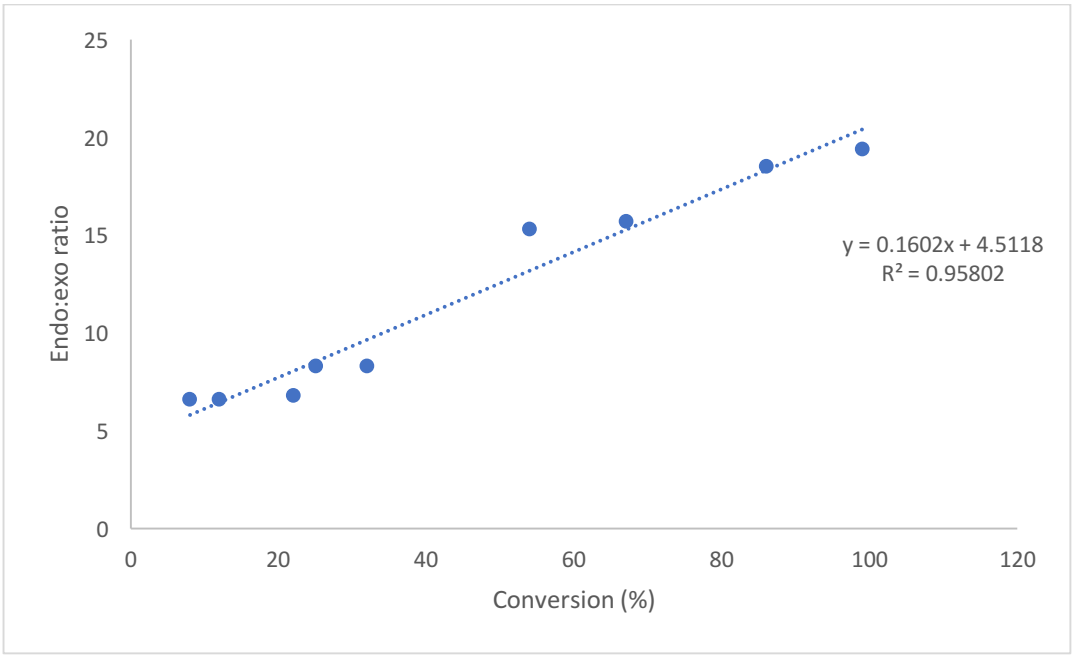
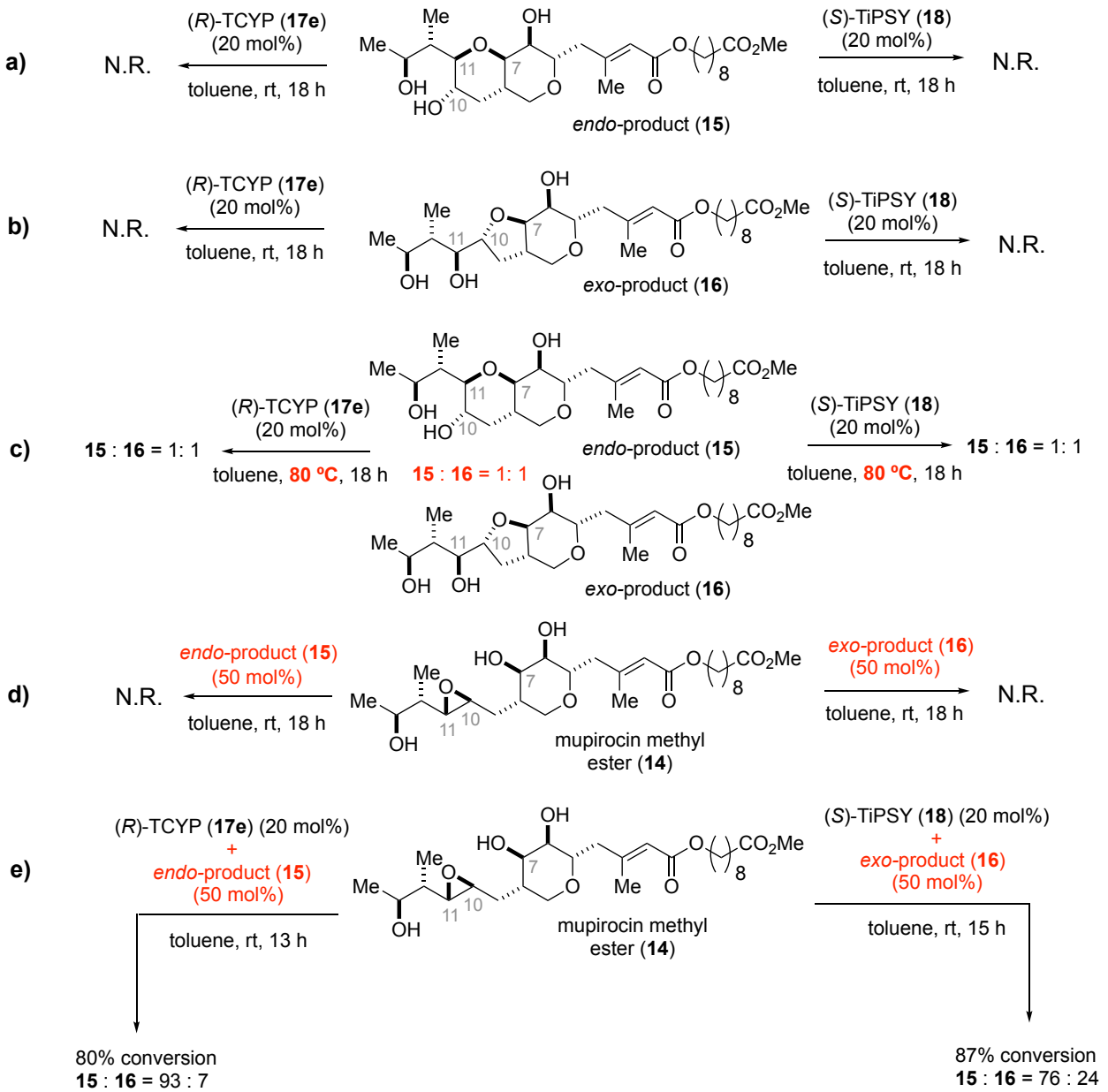


Figure S5. The plot of *exo*:*endo*-product ratio vs. conversion (%) for the (*R*)-TCYP (**17e**)-catalyzed cyclization of mupirocin methyl ester (**14**).



VIII. Mechanistic studies by probing the stability of products and their effect on reaction selectivity

For the control studies of **reaction 1a-d**, the reaction procedures are following the general experimental procedures for the *exo*-product or the *endo*-product formation described on page S5, except for replacing mupirocin methyl ester (**14**) by either *exo*-product **16**) and/or the *endo*-product (**15**) as well as running these reactions with 20 mol% of the catalysts. For the **reaction 1d** and **1e**, in addition of the general experimental procedure, 0.5 equiv. of the *exo*-product (**16**) or the *endo*-product (**15**) were added to the reactions.



IX. Computational Studies

All quantum chemical calculations were performed using the Q-Chem 4.3 package.[1] Geometry optimizations were evaluated using the B97-D density functional[2,3] using the double-ζ- quality basis set with polarization functions on all atoms, 6-31G**.[4,5] Pictorial representations of important stationary points were generated in Discovery Studio 4.1 Visualizer.[6]

For the growing string reaction path optimizations, between 7-15 nodes were used, including the end points. In the initial phase, termed growth phase, new nodes were added when the perpendicular gradient magnitude on the frontier node was less than 0.10 Hartree/Å for double-ended strings, or when the RMS gradient was less than 0.005 Hartree/Å for single-ended strings. Additionally, an initial maximum optimization step size of 0.1 Å-radians was used. When the total perpendicular gradient magnitude over all nodes, F, reached a value of less than 0.3, the climbing image search was initiated. When $F < 0.1$, or when the node of highest energy had a RMS gradient below double the nodal convergence criterion and $F < 0.2$, the exact transition state search was initiated. The string is considered fully converged when an RMS gradient < 0.0005 Hartree/Å was obtained for the node representing the transition state. Further detail regarding the growing string implementation developed in the Zimmerman group can be found in the references.[7–10]

The electronic Gibbs free energy values of all stationary points were computed through solvent corrected (dichloromethane) single point energies using the SMD implicit solvent model[11] and the ORCA quantum chemistry package.[12] For these calculations the ωB97X-D3 exchange functional[13] was employed with a 6-31G** basis set. The final Gibbs free energy values were obtained by correcting the electronic free energy with the enthalpic and entropic contributions from vibrations, rotations, and translations at 298.15 K. These frequency computations were performed using the B97-D functional and 6-31G** basis set. For the enthalpic and entropic corrections to the free energies from the harmonic oscillator approximation, all frequencies below 50 cm^{-1} were treated as if they were 50 cm^{-1}.

A model system consisting of biphenyl hydrogen phosphate (**BPA, 19**) and truncated mupirocin **20** was utilized to explore various pathways leading to the intramolecular epoxide opening to either the *exo*-product **21** or the *endo*-product **22**. Single-ended growing string calculations were performed starting from optimized **20** (phosphate intermediate pathway), **21** (concerted *exo*-pathway), and **22** (concerted *endo*-pathway) as the fixed nodes, with appropriate driving coordinates according to the pathways explored. To account for variation in conformations and binding complexes, the most stable conformations were sampled for the growing string calculations. These were obtained in part by manually sampling relevant torsions and angles of approach, and also by using an algorithm which allowed a thorough conformational analysis by ranking a vast number of unique conformers generated by the systematic variation of the torsional angles.[14]

A summary of calculated values, including solvent corrected single point electronic energies, as well as enthalpic and entropic corrections associated with vibrational, rotational, and translational energy at 298 K are provided below.

Figure S.6. Energy diagram for the intramolecular ERO of a truncated mupirocin model.

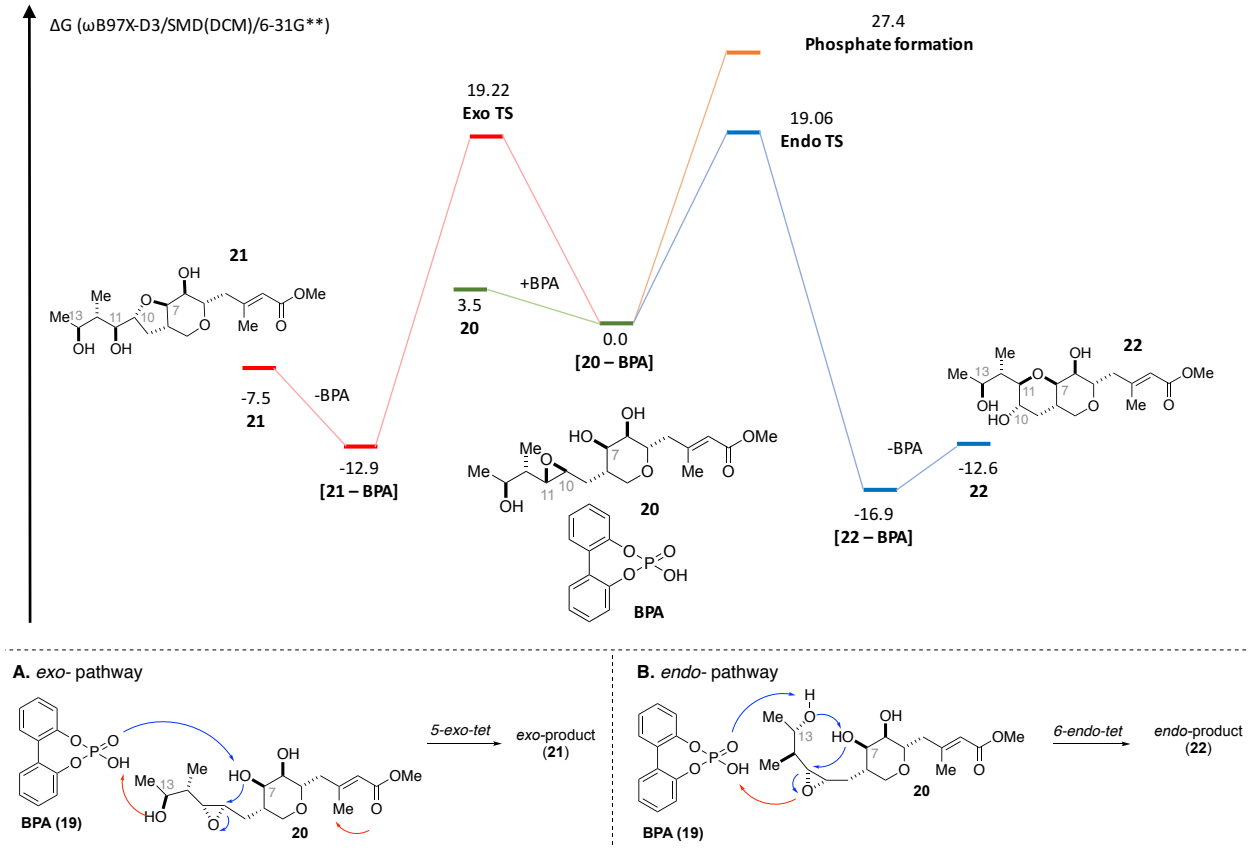


Table S10. Calculated energy values of relevant geometries for the intramolecular ERO of **20**.

	G_{SMD} [kcal/mol][a]	H_{vrt} [kcal/mol][b]	S_{vrt} [kcal/mol•K][b]	G_{corr} [kcal/mol][c]
BPA	-693279.38	124.90	113.94	-693188.43
Truncated mupirocin **20**	-771958.45	308.30	180.35	-771703.89
20-BPA complex	-1465259.56	435.04	238.69	-1464895.66
exo-product **21**	-771972.45	309.58	174.45	-771714.85
21-BPA complex	-1465274.50	436.72	237.76	-1464908.64
endo-product **22**	-771977.47	309.49	174.55	-771720.00
22-BPA complex	-1465279.88	435.93	230.46	-1464912.63
Concerted *endo* cyclization TS_{endo}	-1465239.96	433.97	237.38	-1464876.73
Concerted *exo* cyclization TS_{exo}	-1465241.98	433.19	227.42	-1464876.57
TS for phosphate formation from **20** TS_P	-1465230.80	434.60	242.34	-1464868.42

[a] SMD electronic energy (ωB97X-D/SMD/6-31G**). [b] Vibrational, rotational, and translational entropic and enthalpic contributions (B97-D/6-31G**) at 298K. [c] Corrected free energy values at 298K.

Cartesian coordinates for starting geometries, transition states, and products are described below.

- **BPA 19**

26

H -5.72428523 -0.48831442 0.98697438
C -6.28439443 -0.36620410 0.06007891
C -7.68832232 -0.36341207 0.07668617
H -8.21878366 -0.49755063 1.01925451
C -8.40824701 -0.17254738 -1.11938955
H -9.49782706 -0.16110110 -1.11076079
C -7.71851142 0.00685161 -2.33069717
H -8.24375641 0.14914534 -3.27295870
C -6.31717770 -0.00517093 -2.33003536
O -5.65460079 0.06060007 -3.58302558
C -5.56356336 -0.18448078 -1.14510677
H -3.92068644 -1.85692296 0.21829797
H -1.42723110 -1.89050223 0.23304154
C -3.36034227 -1.13416699 -0.37500477
C -1.95668993 -1.15639827 -0.37407259
C -4.08202246 -0.20016108 -1.15752358
C -1.23660574 -0.24141830 -1.16732597
H -0.14707102 -0.25756904 -1.17597693
C -3.32891776 0.71387622 -1.93510103
C -1.92724273 0.69920244 -1.95046188
O -3.97830017 1.76149982 -2.63449179
H -1.40039703 1.42919197 -2.56173595
P -4.87333364 1.44496470 -3.96867356
O -5.65780224 2.62401335 -4.40603117
O -3.84439723 0.82979409 -5.06646961
H -3.81574089 1.43633068 -5.82391071

- **Truncated mupirocin 20**

55

C 30.46969421 82.65695276 81.87093348
C 29.31945566 82.36830261 80.98829127
C 28.19469668 83.11508470 80.86386709
C 27.11437851 82.66829940 79.90198393
C 25.75056866 82.47698501 80.57583024
C 24.64738105 82.12760823 79.54463137
C 23.32645641 81.80750548 80.26937525
C 23.54187039 80.73370825 81.36544576
C 23.85756170 79.33977800 80.77047134
C 22.87357544 78.94783680 79.68801136
C 23.20734392 79.04765479 78.25374782
C 22.17549447 79.36792245 77.17434054
C 22.02790869 78.18620134 76.17461356
C 21.14442686 78.53744447 74.97397423
C 27.89468888 84.37860880 81.63211101
C 24.68462653 81.20938530 82.28385867
C 32.61517540 81.85908811 82.49565071
O 31.43082470 81.69002873 81.68851281
O 30.61118571 83.58413098 82.66103862
O 25.88667475 81.41431785 81.53515823
O 22.88044945 83.05809002 80.83931021
O 24.46392775 83.16204946 78.57959183
O 23.16257774 77.75236548 78.92973295
C 22.59806715 80.68617289 76.49103974
O 21.42182629 77.06038279 76.81007174
H 29.41064052 81.46076086 80.38995242
H 26.96742499 83.43296792 79.12174697
H 27.39609710 81.72579715 79.40767635
H 25.44930384 83.40697710 81.09350950
H 24.96641800 81.23246879 78.99282473
H 22.59479175 81.46511518 79.51860358
H 22.61167610 80.66575587 81.95787173
H 24.87571520 79.34024572 80.35730700
H 23.83512000 78.59473685 81.58237906
H 21.81240921 79.05322427 79.95709932
H 24.23568197 79.33952868 78.00318402
H 21.18663417 79.48932851 77.64790948
H 23.04522723 77.93021653 75.80591269
H 20.98347196 77.63668003 74.36582859
H 21.61527963 79.30851310 74.34962310
H 20.16505974 78.90277786 75.31963254
H 27.40314093 85.11387247 80.97452186
H 28.79214143 84.80731414 82.08582055
H 27.17939643 84.14617209 82.43907514
H 24.38304372 82.14604018 82.78582502
H 24.92287912 80.44836367 83.04007014
H 32.36270286 81.82172969 83.56536579
H 33.09267376 82.82658933 82.28360509
H 21.94598440 82.95236423 81.06706051
H 23.93027887 83.83763248 79.03369032
H 21.79437927 81.06711385 75.84829254
H 23.48634881 80.51607046 75.86159940
H 22.85765329 81.46710154 77.22149745
H 21.91824578 76.91472027 77.63566925
H 33.27664289 81.02875646 82.22271214

- **20-BPA complex**

81

C -5.93507924 -0.41246604 -0.92033089
C -5.22771240 -1.51682474 -1.73059982
C -4.06639864 -0.81569852 -2.46609831
O -3.13022686 -0.22467236 -1.56048179
C -3.68699417 0.70884724 -0.62265652
C -4.92551016 0.14755375 0.11178278
O -4.44483263 -0.85073416 1.01079272
C -3.97646939 2.08703404 -1.29732141
C -4.16461822 3.18640160 -0.27511002
C -2.88986993 3.74526299 0.30313056
C -5.42229060 3.55747290 0.08000265
C -5.78977190 4.54488448 1.11500340
O -5.06641806 5.31370963 1.73572944
O -7.17126857 -0.78486157 -0.31535505
C -6.97560062 -3.30106929 -1.93173900
C -6.15987032 -2.28218661 -2.69745666
C -7.37742244 -4.63989756 -2.40126346
C -8.62634401 -5.31020559 -1.80230227
C -8.25027968 -6.42551788 -0.79155183
O -7.52005219 -5.85655656 0.33337976
O -6.22848464 -4.48171745 -1.50735397
O -7.15475813 4.49222308 1.32009588
C -7.65126232 5.40971201 2.31901037
C -9.45827685 -7.14592718 -0.19766037
C -9.52547463 -5.82082720 -2.94258314
H -6.20883957 0.39634834 -1.61903347
H -4.78175356 -2.23004436 -1.02236522
H -4.47988000 -0.05699340 -3.16391120
H -3.48447473 -1.53989761 -3.05428465
H -2.89362528 0.84295552 0.12523638
H -5.41726002 0.96811876 0.66252031
H -5.19931974 -1.33108965 1.39490158
H -3.10609307 2.30909486 -1.93387240
H -4.85966220 2.00686118 -1.94544785
H -2.36988587 4.33163109 -0.47410013
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H -7.59816518 -2.87882080 -1.14248394
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H -5.56437046 -2.80518405 -3.46360004
H -7.08624306 -4.97250824 -3.40592057
H -9.17723437 -4.55347962 -1.21965026
H -7.58291455 -7.15200644 -1.28824971
H -8.32722054 -4.93887918 1.21578814
H -6.81242033 -5.28941948 -0.07103061

H -8.72422323 5.20175529 2.39736001
H -7.14742140 5.24381699 3.28201790
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H -10.14303772 -6.41923160 0.26573944
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H -9.70505572 -5.01976070 -3.67454841
H -9.04794149 -6.66263204 -3.46950130
O -7.36531001 -3.42321469 3.84487199
O -6.65134363 -2.85696903 1.45970694
H -7.99510846 0.31839256 6.40298188
H -7.46640555 2.42897833 5.18574034
H -8.18159028 -5.45946973 5.21893418
H -6.97806411 -1.50527504 0.32270418
C -8.05348718 0.35447229 5.31482471
C -7.75159859 1.53660429 4.62749937
C -8.57655877 -4.51777459 5.59795708
C -8.26424398 -3.33590802 4.91953279
H -9.62325453 -5.37774951 7.28108783
C -9.37160480 -4.45887793 6.75059478
C -8.73215049 -2.07374540 5.35131063
C -8.40830293 -0.82447728 4.62369688
C -7.79743639 1.56837895 3.22377458
H -7.55554010 2.47913568 2.67651266
P -7.85798098 -3.11507228 2.31778549
C -9.84021791 -3.21911311 7.21473859
C -9.52437288 -2.04581799 6.51945653
C -8.45380102 -0.75325851 3.21466361
C -8.15411641 0.41555838 2.50996672
H -10.46079050 -3.16806439 8.10981309
H -9.90440996 -1.08359619 6.86423496
H -8.18030333 0.39840005 1.42219910
O -8.82804314 -4.26292183 1.82993444
O -8.89810177 -1.87387466 2.47916123

- ***Exo*-product 21**

55

C -4.77009321 -0.96377823 -0.40117379
C -3.50004789 -1.80177314 -0.46332413
C -2.65499626 -1.29277927 -1.63082172
O -2.35868009 0.10263204 -1.42906488
C -3.49052184 0.96790935 -1.23841644
C -4.45515644 0.49582478 -0.11117274
O -3.79792143 0.66833625 1.14214846
C -4.22935774 1.19971294 -2.59114496
C -5.42888388 2.11470139 -2.47821251
C -5.13621765 3.50870655 -1.98438081
C -6.65731810 1.62469841 -2.78358834
C -7.94568074 2.34894716 -2.70672735
O -8.15205016 3.50257136 -2.35009589
O -5.54242625 -1.60664763 0.62494515
C -5.41249647 -3.04388936 0.37065702
C -4.08881232 -3.22000817 -0.45226648
C -6.64210875 -3.58099825 -0.39570170
C -8.02686961 -3.42559645 0.29144146
C -8.66016059 -1.99748514 0.27701728
O -8.16549538 -1.13934124 1.30254459
O -6.38969076 -4.96198403 -0.71886635
O -8.95292380 1.50540816 -3.11059533
C -10.27807901 2.07917141 -3.06860223
C -8.58581370 -1.31342467 -1.09862817
C -8.04069424 -3.98937275 1.72323969
H -5.31173593 -1.02288477 -1.36457208
H -2.94474147 -1.60684634 0.46538374
H -3.18674375 -1.46251074 -2.58776338
H -1.67587854 -1.78663318 -1.69138523
H -3.04829817 1.91483700 -0.90099103
H -5.37784444 1.10133427 -0.15802835
H -4.32838171 0.17500612 1.78868715
H -3.48446857 1.63970472 -3.27366977
H -4.53476285 0.23233561 -3.01383374
H -4.27474416 3.92381560 -2.53245968
H -6.00235844 4.16852106 -2.07815861
H -4.83947543 3.46819156 -0.92280653
H -6.73522401 0.59161404 -3.12544975
H -5.35138227 -3.52386770 1.35889048
H -4.32793514 -3.56294287 -1.47013632
H -3.42097262 -3.96219405 0.00304146
H -6.67278587 -3.07738874 -1.37282490
H -8.69016501 -4.04370842 -0.33712471
H -9.72301146 -2.15130637 0.52781223
H -7.20220209 -1.08952698 1.14036238
H -6.42808342 -5.45513579 0.11623654
H -10.95160639 1.27986188 -3.39743970
H -10.52384981 2.40405800 -2.04771982
H -10.34219268 2.94752059 -3.73980512
H -9.18764518 -0.39648118 -1.09500702
H -7.55120017 -1.02252898 -1.33114460
H -8.94846391 -1.97307409 -1.90349558
H -9.07108242 -4.02544842 2.10457662
H -7.63735468 -5.01419639 1.77805579
H -7.46451310 -3.33966692 2.39435971

- **21-BPA complex**

81

C -4.90139140 -1.10555506 -0.61101869
C -3.87262091 -1.99993154 -1.28578414
C -2.90647637 -1.09357226 -2.05380040
O -2.31800410 -0.12581900 -1.15977133
C -3.23366705 0.66954471 -0.39321320
C -4.24863851 -0.19291236 0.42092031
O -3.51039606 -0.89669991 1.41355239
C -3.92647231 1.73910723 -1.31032164
C -5.05740550 2.46193787 -0.61612044
C -4.64376776 3.40736755 0.48082037
C -6.33505135 2.13475182 -0.94140806
C -7.56195786 2.55712526 -0.23528159
O -7.70086866 3.46810544 0.57484924
O -5.88504264 -2.02650685 -0.09426216
C -6.05528939 -3.07040113 -1.14025541
C -4.78277767 -2.98795850 -2.03733672
C -7.36198398 -2.78640894 -1.90883342
C -8.62854712 -2.74396231 -0.99617201
C -9.30387967 -4.13722980 -0.87737203
O -8.33176833 -5.19670133 -0.74520279
O -7.46619348 -3.71651779 -2.98848221
O -8.58558786 1.71487753 -0.59102735
C -9.83559534 1.92233851 0.11000713
C -10.33193588 -4.20701217 0.25825226
C -9.62554755 -1.70054445 -1.53999403
H -5.40540110 -0.47956149 -1.36573753
H -3.31436420 -2.50929200 -0.48723351
H -3.44428871 -0.59622142 -2.88520141
H -2.05613589 -1.64428959 -2.47616984
H -2.59895353 1.17972910 0.34301963
H -4.99587134 0.47057144 0.88307890
H -4.14230449 -1.26128721 2.05353350
H -3.13960943 2.44337126 -1.62070412
H -4.29975601 1.24243951 -2.21592449
H -3.99579763 4.19385434 0.05921052
H -5.50007058 3.87170852 0.97669353
H -4.02946567 2.86778823 1.22119490
H -6.49715387 1.40776058 -1.73864679
H -6.13915140 -4.02051901 -0.60092035
H -5.06038580 -2.59999837 -3.02890006

H -4.32289781 -3.97360888 -2.17811721
H -7.23922131 -1.79759469 -2.38393598
H -8.31171483 -2.43061643 0.00859549
H -9.79923602 -4.34455692 -1.83948048
H -7.96510827 -5.14120983 0.16270286
H -7.57761777 -4.58006695 -2.54353063
H -10.55128236 1.24988556 -0.37471243
H -9.71462108 1.65942822 1.17029406
H -10.15416804 2.97002318 0.02761396
H -10.76033680 -5.21809519 0.30110459
H -9.84771335 -3.98800372 1.21994294
H -11.14936240 -3.48732299 0.10644813
H -10.53871285 -1.65812868 -0.92938235
H -9.17049074 -0.69932659 -1.54444768
H -9.91202599 -1.95684202 -2.57225520
O -6.63402354 -3.75372839 4.23416413
O -5.47874006 -3.00671531 2.20011961
H -8.13422273 0.08655804 6.25658716
H -7.67270268 2.15854742 4.95083093
H -7.49583500 -5.74988218 5.63212553
H -5.55640860 -2.65374948 1.23466068
C -7.99162134 0.03468339 5.17672796
C -7.72594659 1.19581142 4.44204331
C -8.04388560 -4.83211145 5.83996718
C -7.72504756 -3.68095236 5.11394635
H -9.29914835 -5.66811254 7.38618960
C -9.04480895 -4.77262599 6.81878533
C -8.38757083 -2.45007695 5.32524933
C -8.06438048 -1.22869013 4.55037185
C -7.52294779 1.12435212 3.05354043
H -7.33256974 2.02935504 2.47937861
P -6.87363102 -3.64438428 2.62727204
C -9.71524051 -3.56292325 7.06161138
C -9.38915011 -2.42159326 6.32008842
C -7.85672545 -1.26708962 3.15467316
C -7.58716691 -0.11770765 2.40374893
H -10.49915721 -3.51160629 7.81757107
H -9.92402725 -1.48592009 6.48582712
H -7.45493151 -0.21223383 1.32743749
O -7.32526887 -4.87547170 1.91882646
O -8.01821529 -2.47797317 2.46653894

- ***Endo*-product 22**

55

C -5.68748840 -0.49279435 -0.10390782
C -4.73698579 0.60444261 -0.60538368
C -3.41591345 0.50743580 0.16989836
O -2.83627319 -0.80366748 0.03517658
C -3.67763483 -1.85078928 0.56690883
C -5.01887479 -1.87694597 -0.21134149
O -4.78720712 -2.24440014 -1.57111266
C -3.84519886 -1.77903118 2.10594050
C -2.52625527 -1.56233954 2.81848029
C -1.44035284 -2.55386645 2.48990659
C -2.40412199 -0.50513298 3.65902604
C -1.19967152 -0.12678244 4.43171445
O -0.10300732 -0.67275776 4.45088551
O -6.90079648 -0.52481667 -0.84778609
C -7.64984749 0.71743505 -0.86704020
C -6.75573081 1.90754837 -1.29951468
C -5.45260528 1.95196763 -0.47784657
C -8.85221537 0.42222254 -1.79572652
C -8.46404923 0.42230635 -3.30121535
O -7.19963146 -0.20468375 -3.58045229
O -7.53240435 3.09858575 -1.10973749
O -1.48213434 0.99527284 5.17358583
C -0.38413878 1.48245549 5.97529307
C -9.54646735 -0.24269236 -4.16439048
C -10.03645811 1.36879271 -1.52255094
H -5.92354230 -0.28292142 0.95912342
H -4.53637580 0.40750715 -1.67082443
H -3.58109788 0.74887498 1.23500795
H -2.66772858 1.20615954 -0.22871656
H -3.13561509 -2.77264244 0.31646040
H -5.68864665 -2.64299282 0.20617752
H -4.01595081 -1.72495156 -1.85476415
H -4.56354133 -0.99943587 2.39400063
H -4.27772660 -2.74675464 2.41511501
H -1.07085856 -2.34391741 1.47309204
H -0.60144785 -2.49254341 3.18782968
H -1.85415973 -3.57560111 2.47730341
H -3.26502404 0.15062809 3.80430265
H -8.01145771 0.93058464 0.15837291
H -6.49119196 1.76225335 -2.35924911
H -4.81599152 2.77980390 -0.83466244
H -5.70187226 2.15069586 0.57868311
H -9.16376074 -0.60362536 -1.53332918
H -8.36470105 1.47924715 -3.61192070
H -6.93469276 -0.71840432 -2.79479122
H -7.03086918 3.81985374 -1.51774151
H -0.76763730 2.37380830 6.48469552
H -0.06984187 0.72066592 6.70319639
H 0.47594662 1.73467834 5.33830168
H -9.22036333 -0.25299983 -5.21361799
H -9.69604394 -1.28395810 -3.83827251
H -10.50634777 0.29112730 -4.09990013
H -10.93690715 1.02458086 -2.04949002
H -10.26255097 1.39934857 -0.44609381
H -9.79833746 2.38996580 -1.84559835

- **22-BPA complex**

81

C -5.84381390 -0.21018497 -0.38739799
C -5.06182232 0.99675055 -0.92226540
C -3.62233825 0.92700879 -0.40332480
O -3.00161135 -0.31615545 -0.79194826
C -3.67327829 -1.47517619 -0.25433710
C -5.13246090 -1.51892360 -0.77767843
O -5.14770757 -1.70724550 -2.19467794
C -3.56003061 -1.58310221 1.28848673
C -2.14870014 -1.31523250 1.77176998
C -1.07487197 -2.17219341 1.15457838
C -1.94950440 -0.31366728 2.66420576
C -0.65075135 0.12360977 3.22263379
O 0.46720768 -0.31745742 2.98468980
O -7.17896973 -0.25676545 -0.90078886
C -7.97532458 0.94536780 -0.67126073
C -7.21068858 2.18169560 -1.21459409
C -5.82004643 2.27954198 -0.57089884
C -9.32485970 0.62682736 -1.35204944
C -9.25462227 0.65398890 -2.90127805
O -8.03177046 0.02816013 -3.43191535
O -7.94458990 3.39171789 -1.04623848
O -0.86737718 1.16308729 4.09546393
C 0.32831584 1.70142878 4.70048319
C -10.44183159 -0.05820618 -3.55039915
C -10.44968751 1.55089033 -0.84619935
H -5.90004476 -0.12949370 0.71567748
H -5.03129457 0.91561342 -2.02131839
H -3.59727900 1.04219997 0.69472850
H -3.00606757 1.71920621 -0.84844820
H -3.13699852 -2.32163686 -0.70410566
H -5.66746868 -2.37875585 -0.34815275
H -4.46745927 -1.10916727 -2.54841988
H -4.26415882 -0.90431595 1.78804427
H -3.85893322 -2.61272545 1.55317168

H -0.92273094 -1.83963099 0.11475898
H -0.12548404 -2.09354647 1.69048943
H -1.40825433 -3.22198008 1.11258915
H -2.81572704 0.24667278 3.02059485
H -8.12756466 1.06728203 0.41794877
H -7.04796749 1.98097693 -2.27662220
H -5.30361975 3.16042649 -0.97134835
H -5.91361653 2.39520909 0.52255750
H -9.55927355 -0.40808702 -1.04827701
H -9.22257953 1.70117611 -3.23199330
H -7.50839354 -0.33766877 -2.67841064
H -8.18609553 3.67597880 -1.95169074
H -0.01686571 2.48330132 5.38649208
H 0.87442259 0.91702697 5.24334990
H 0.99206066 2.12274846 3.93151636
H -10.32631972 -0.05465010 -4.64278541
H -10.49291207 -1.10163403 -3.20424652
H -11.38468522 0.44716283 -3.29879574
H -11.42407793 1.23283522 -1.24066944
H -10.49909851 1.51727127 0.25177036
H -10.25867389 2.58881607 -1.14284792
O -5.55129267 3.60086762 -3.57022194
O -6.60822885 1.66036553 -4.75215962
H -2.19988844 5.52754494 -5.92991549
H -1.68416091 4.28866707 -8.03174227
H -6.16145978 5.15297189 -1.55013434
H -7.21774587 0.99927366 -4.21742639
C -2.96263702 4.90956487 -6.40490583
C -2.67364571 4.20744063 -7.58079961
C -5.56115411 5.65541113 -2.30833037
C -5.22805690 4.96349473 -3.47697463
H -5.38513566 7.53452142 -1.25774542
C -5.13083926 6.98224445 -2.16298892
C -4.51600500 5.56302066 -4.53792561
C -4.22721289 4.81764149 -5.78472547
C -3.65228248 3.38737203 -8.16569069
H -3.43211606 2.83080017 -9.07716935
P -6.84641785 3.20165856 -4.50574101
C -4.38469214 7.59712956 -3.18221962
C -4.09042393 6.89612488 -4.35864076
C -5.19542160 3.99424198 -6.40655958
C -4.91945050 3.28128276 -7.57698052
H -4.05098348 8.62917118 -3.06962990
H -3.54667218 7.38238629 -5.16933208
H -5.70376308 2.66230330 -8.00988132
O -8.15953275 3.65109041 -3.94716033
O -6.51100427 3.94877236 -5.91837538

- **TS$_{endo}$**

81

C -5.784503 -0.542422 -0.295462
C -5.002851 0.678860 -0.829826
C -3.567008 0.637611 -0.278634
O -2.904142 -0.593512 -0.606897
C -3.563179 -1.749069 -0.043414
C -4.997929 -1.837668 -0.613709
O -4.960208 -2.062090 -2.023796
C -3.505847 -1.787330 1.504802
C -2.123369 -1.458402 2.032421
C -1.003567 -2.314945 1.501786
C -1.985332 -0.414765 2.887847
C -0.721487 0.082220 3.476908
O 0.416117 -0.337827 3.303093
O -7.123489 -0.642835 -0.784797
C -8.178903 1.418189 -0.809187
C -6.974827 2.080794 -1.309136
C -5.687766 2.024593 -0.516354
C -9.339776 0.883672 -1.596965
C -9.069513 0.602821 -3.102538
O -7.806822 -0.063680 -3.306086
O -7.835099 3.235216 -1.161759
O -1.000997 1.153430 4.290287
C 0.152871 1.753151 4.918797
C -10.171267 -0.275572 -3.706113
C -10.569882 1.807122 -1.402956
H -5.885562 -0.437413 0.796287
H -4.937585 0.588953 -1.927146
H -3.572452 0.792638 0.815127
H -2.966182 1.435804 -0.733140
H -2.989847 -2.597391 -0.439289
H -5.531172 -2.695367 -0.178028
H -4.263733 -1.479855 -2.368137
H -4.248191 -1.108596 1.946201
H -3.787379 -2.812657 1.802331
H -0.804740 -2.020304 0.458190
H -0.083915 -2.194446 2.079811
H -1.312499 -3.372894 1.486000
H -2.878187 0.138731 3.184997
H -8.315846 1.461525 0.273950
H -6.767042 1.868042 -2.355375
H -5.045809 2.849753 -0.860400
H -5.866275 2.147494 0.564026
H -9.556682 -0.078805 -1.101922
H -9.047117 1.572756 -3.621855
H -7.132851 -0.624579 -1.784608
H -7.989199 3.559003 -2.212665
H -0.241855 2.565650 5.539320
H 0.686714 1.014302 5.533315
H 0.845602 2.143397 4.159222
H -9.935343 -0.470013 -4.760473
H -10.217060 -1.239776 -3.176750
H -11.156695 0.207836 -3.650257
H -11.472145 1.323166 -1.798486
H -10.733709 2.028816 -0.338605
H -10.407724 2.754830 -1.933518
O -5.412572 3.808923 -3.584005
O -6.664525 1.902361 -4.708239
H -2.523442 5.753224 -6.514673
H -2.513186 4.664112 -8.757872
H -5.575234 5.325407 -1.447694
H -7.250214 0.592302 -3.808784
C -3.396915 5.199329 -6.859847
C -3.391707 4.582070 -8.117087
C -5.095603 5.813062 -2.294282
C -5.035476 5.150240 -3.526809
H -4.633642 7.631683 -1.224084
C -4.585129 7.113534 -2.182603
C -4.516029 5.782053 -4.681732
C -4.512208 5.107581 -6.000389
C -4.511919 3.851844 -8.543036
H -4.511873 3.360585 -9.516548
P -6.816367 3.367591 -4.368971
C -4.024009 7.746689 -3.302589
C -4.004377 7.088245 -4.537823
C -5.630548 4.373958 -6.461709
C -5.635081 3.746249 -7.712711
H -3.625689 8.758446 -3.219063
H -3.609651 7.589836 -5.422182
H -6.521053 3.189468 -8.013229
O -8.016076 3.851214 -3.534384
O -6.801678 4.337221 -5.699353

- **TS$_{exo}$**

81

C -5.019010 -0.843776 -0.623416
C -4.116971 -1.892251 -1.279148

C -3.096899 -1.112529 -2.139860
O -2.343612 -0.172146 -1.363747
C -3.116818 0.749354 -0.573138
C -4.150498 0.019498 0.312793
O -3.433036 -0.746458 1.268482
C -3.770325 1.854537 -1.483625
C -4.830563 2.644465 -0.746465
C -4.319019 3.551195 0.341645
C -6.138447 2.393287 -1.016272
C -7.307594 2.827646 -0.223155
O -7.372277 3.706745 0.629581
O -6.125181 -1.434509 0.038416
C -6.178422 -3.356192 -1.323540
C -4.940916 -2.932825 -2.080910
C -7.527285 -3.063560 -1.795138
C -8.733014 -2.981969 -0.836658
C -9.335159 -4.385712 -0.557789
O -8.249803 -5.364968 -0.400386
O -7.123442 -4.401096 -2.304863
O -8.379414 2.029982 -0.552450
C -9.571909 2.249040 0.238190
C -10.264271 -4.446522 0.650702
C -9.799470 -2.019355 -1.388444
H -5.455421 -0.198485 -1.399404
H -3.571175 -2.400960 -0.471049
H -3.645679 -0.602556 -2.959093
H -2.349003 -1.778115 -2.593359
H -2.381781 1.220990 0.091980
H -4.801569 0.758665 0.806793
H -4.070162 -1.217824 1.838427
H -2.956825 2.509038 -1.831588
H -4.209539 1.371112 -2.366645
H -3.641884 4.302065 -0.098829
H -5.127509 4.057489 0.875643
H -3.712042 2.966432 1.053030
H -6.373941 1.693050 -1.818850
H -6.070437 -3.902504 -0.386274
H -5.241321 -2.526299 -3.060003
H -4.317114 -3.820763 -2.258847
H -7.560658 -2.336215 -2.614492
H -8.350138 -2.574767 0.106048
H -9.866643 -4.729375 -1.459070
H -7.757457 -5.116153 0.474571
H -7.553927 -5.048135 -1.452148
H -10.342604 1.618578 -0.220132
H -9.393002 1.944125 1.279004
H -9.863764 3.307926 0.213997
H -10.605905 -5.482017 0.786829
H -9.762984 -4.113715 1.568896
H -11.146741 -3.811458 0.485594
H -10.641969 -1.938275 -0.688888
H -9.370042 -1.014762 -1.520789
H -10.185221 -2.368527 -2.359685
O -6.665569 -3.790088 4.138258
O -5.331958 -2.734707 2.232445
H -8.405749 -0.113640 6.317585
H -7.833805 2.062186 5.242828
H -7.661509 -5.881358 5.241521
H -5.781007 -1.899040 0.854683
C -8.169861 -0.072294 5.253684
C -7.846765 1.148622 4.647559
C -8.242319 -4.986729 5.462143
C -7.844358 -3.776759 4.877394
H -9.653599 -5.965673 6.771872
C -9.348585 -5.020637 6.320327
C -8.547444 -2.570833 5.131543
C -8.167486 -1.277176 4.516776
C -7.521896 1.193094 3.281086
H -7.239842 2.131366 2.803521
P -6.643798 -3.441792 2.525187
C -10.056550 -3.839237 6.595699
C -9.655693 -2.636206 6.004179
C -7.844418 -1.200125 3.145700
C -7.529697 0.012797 2.521841
H -10.921934 -3.856731 7.258616
H -10.213167 -1.717831 6.194048
H -7.300772 0.009966 1.458780
O -7.050026 -4.651782 1.704416
O -7.912543 -2.365463 2.377601

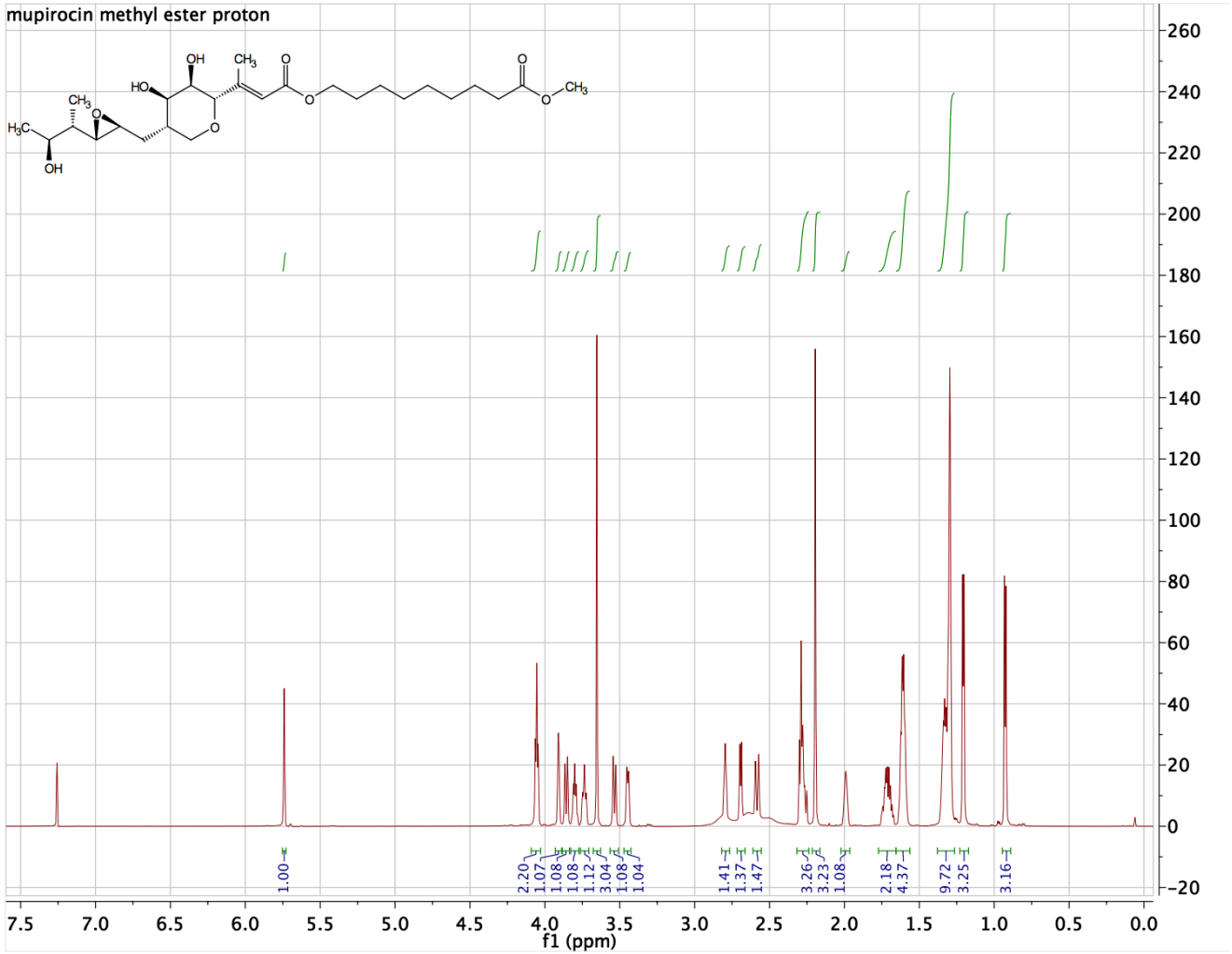
- **TS_P (Phosphate formation)**

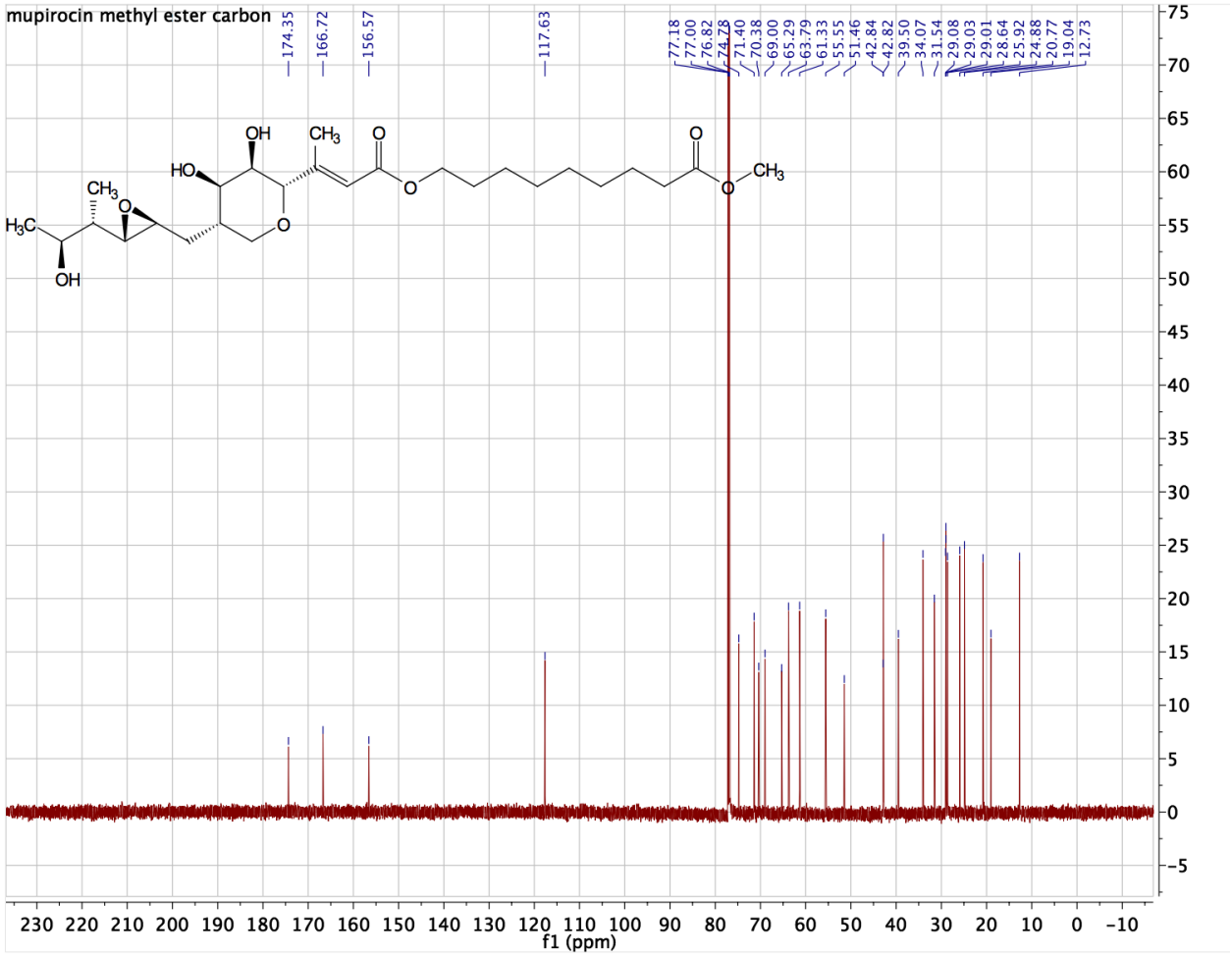
81

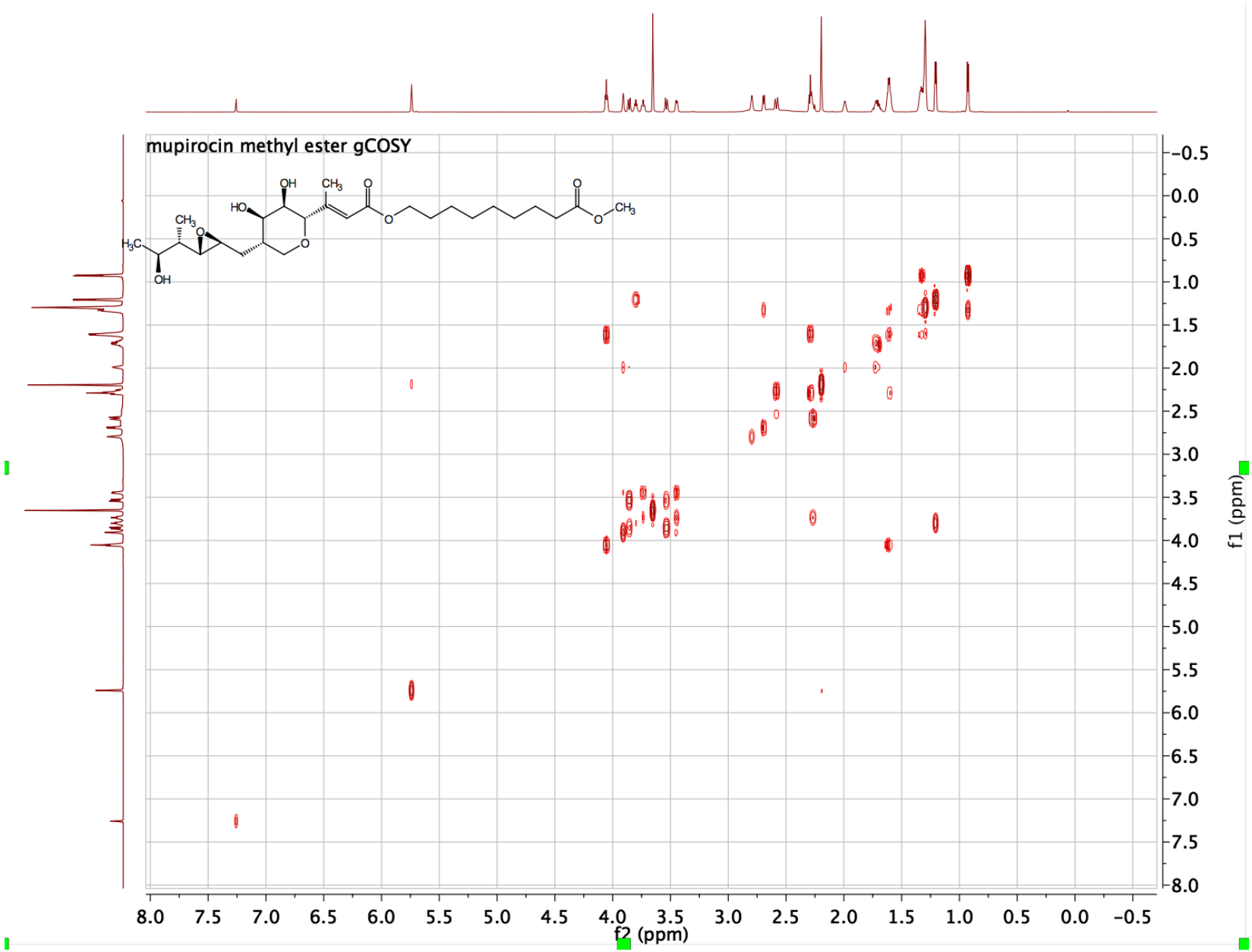
C 30.511550 84.528693 81.481703
C 29.332561 84.094506 80.709292
C 28.045190 84.261972 81.099361
C 26.927373 83.725569 80.235638
C 26.152067 82.601070 80.931492
C 24.908532 82.169333 80.115618
C 24.230714 80.940086 80.747394
C 25.239782 79.816912 81.082469
C 25.730965 79.056998 79.812583
C 24.607761 78.366114 79.117644
C 24.015277 78.881655 77.871868
C 22.552401 78.627818 77.451824
C 22.395464 77.252261 76.741412
C 20.941810 76.795692 76.649166
C 27.622381 84.916375 82.396078
C 26.432236 80.429991 81.835044
C 32.883159 84.594887 81.452111
O 31.658686 84.223248 80.785472
O 30.528817 85.074404 82.580393
O 27.045820 81.483182 81.086207
O 23.595619 81.385680 81.960176
O 23.973287 83.233349 79.957971
O 25.051280 77.948362 77.362608
C 22.054115 79.774076 76.551099
O 23.199082 76.240576 77.413349
H 29.539443 83.595889 79.761768
H 26.192740 84.519387 80.025258
H 27.312053 83.344338 79.276874
H 25.806240 82.940589 81.926702
H 25.257409 81.894431 79.105858
H 23.461310 80.574513 80.057157
H 24.738737 79.092485 81.737731
H 26.224606 79.766759 79.134480
H 26.470295 78.308780 80.132569
H 24.361573 77.353720 79.419698
H 24.352258 79.902091 77.652990
H 21.967123 78.609661 78.379577
H 22.843110 77.333129 75.738131
H 20.894188 75.809849 76.168372
H 20.345319 77.505995 76.059317
H 20.519241 76.718232 77.660485
H 26.550867 85.162910 82.376887
H 28.214574 85.815070 82.603457
H 27.803821 84.230679 83.238915
H 26.056340 80.816806 82.798951
H 27.216867 79.682168 82.022253
H 32.975980 84.067255 82.412684
H 32.906515 85.677869 81.646017
H 22.916490 80.715607 82.150721
H 23.459162 83.228754 80.786077
H 20.990448 79.645720 76.309014
H 22.620566 79.806149 75.606562
H 22.169582 80.743641 77.057272
H 24.502575 77.062782 77.343471
H 33.689740 84.303838 80.768133
O 21.034524 77.102247 81.998062

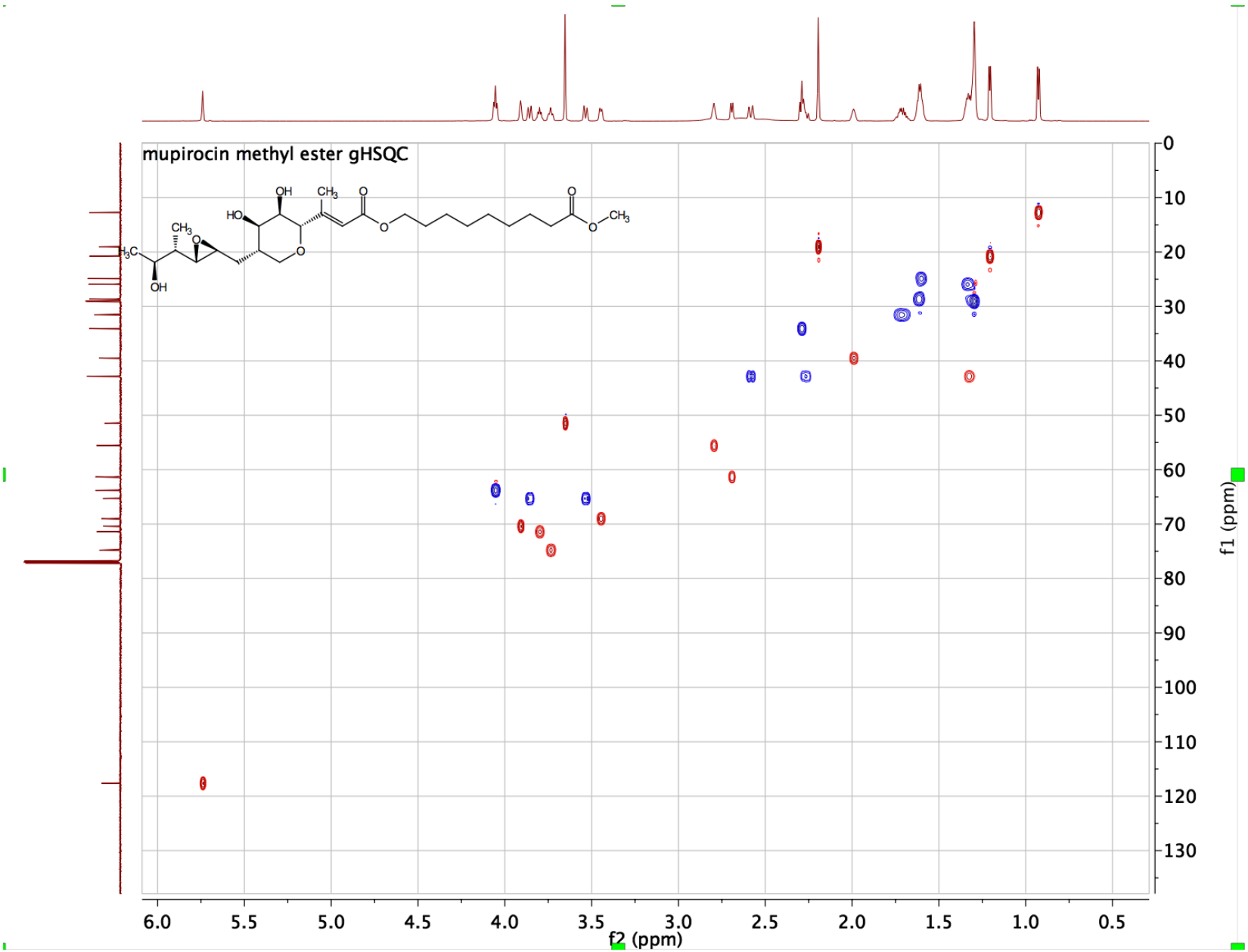
O 21.996838 76.171516 79.799401
H 22.226819 75.285730 85.986504
H 23.483559 73.142931 85.757014
H 20.009615 79.455780 82.454679
H 22.794165 76.131798 78.329624
C 22.777567 75.065444 85.069745
C 23.477407 73.860473 84.937042
C 20.609006 79.089029 83.287677
C 21.237202 77.843531 83.165075
H 20.267611 80.789406 84.579623
C 20.754839 79.819016 84.475949
C 22.040214 77.306069 84.196584
C 22.748162 76.016162 84.027507
C 24.164216 73.578747 83.745670
H 24.714816 72.642819 83.638620
P 22.272441 77.165870 80.906830
C 21.524097 79.296738 85.528785
C 22.156977 78.055682 85.386629
C 23.455812 75.711562 82.838174
C 24.152803 74.504631 82.694843
H 21.641103 79.862344 86.453755
H 22.782748 77.662186 86.189232
H 24.686792 74.319222 81.763305
O 22.615171 78.611488 80.575984
O 23.581502 76.660231 81.830213

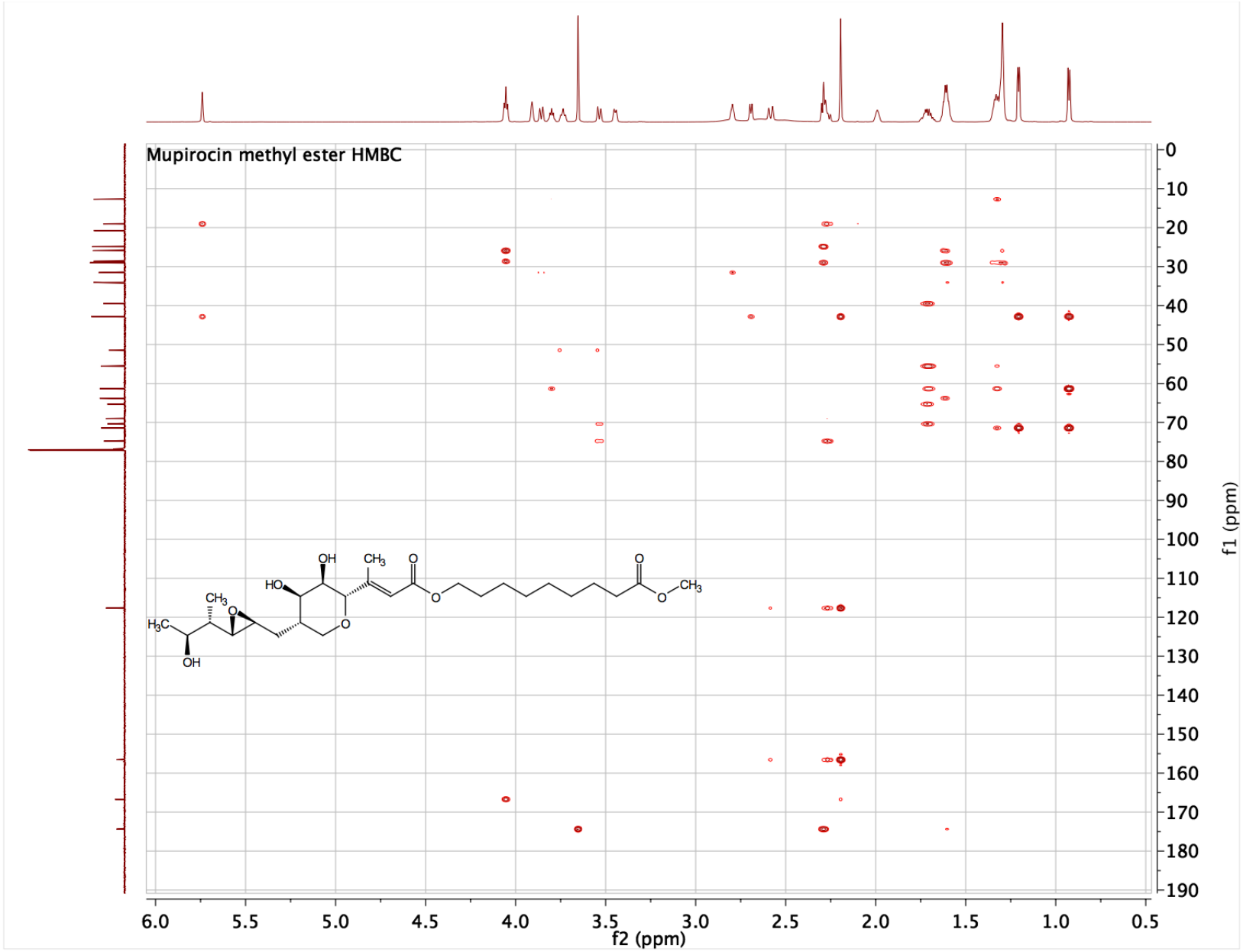
X. NMR Spectra

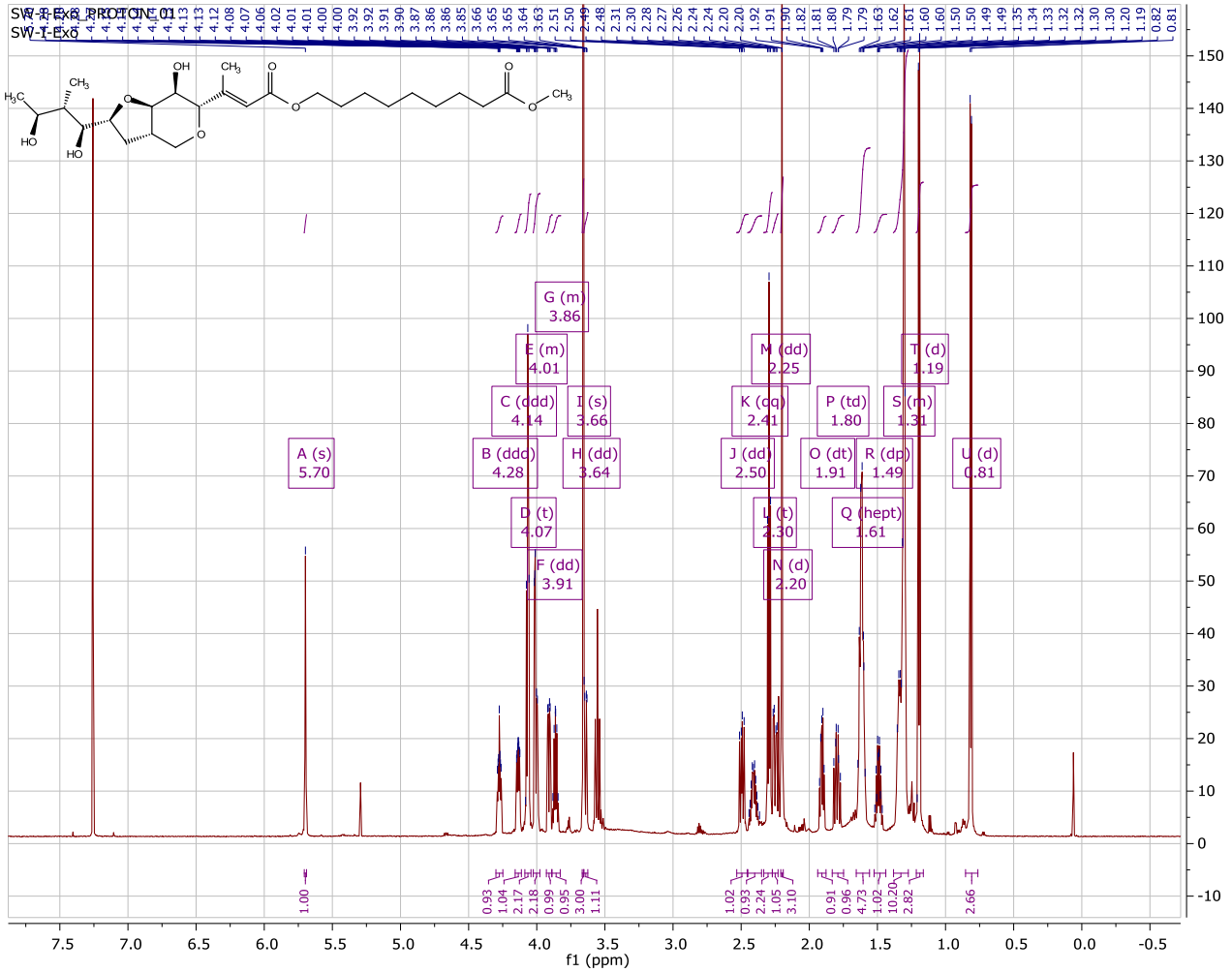


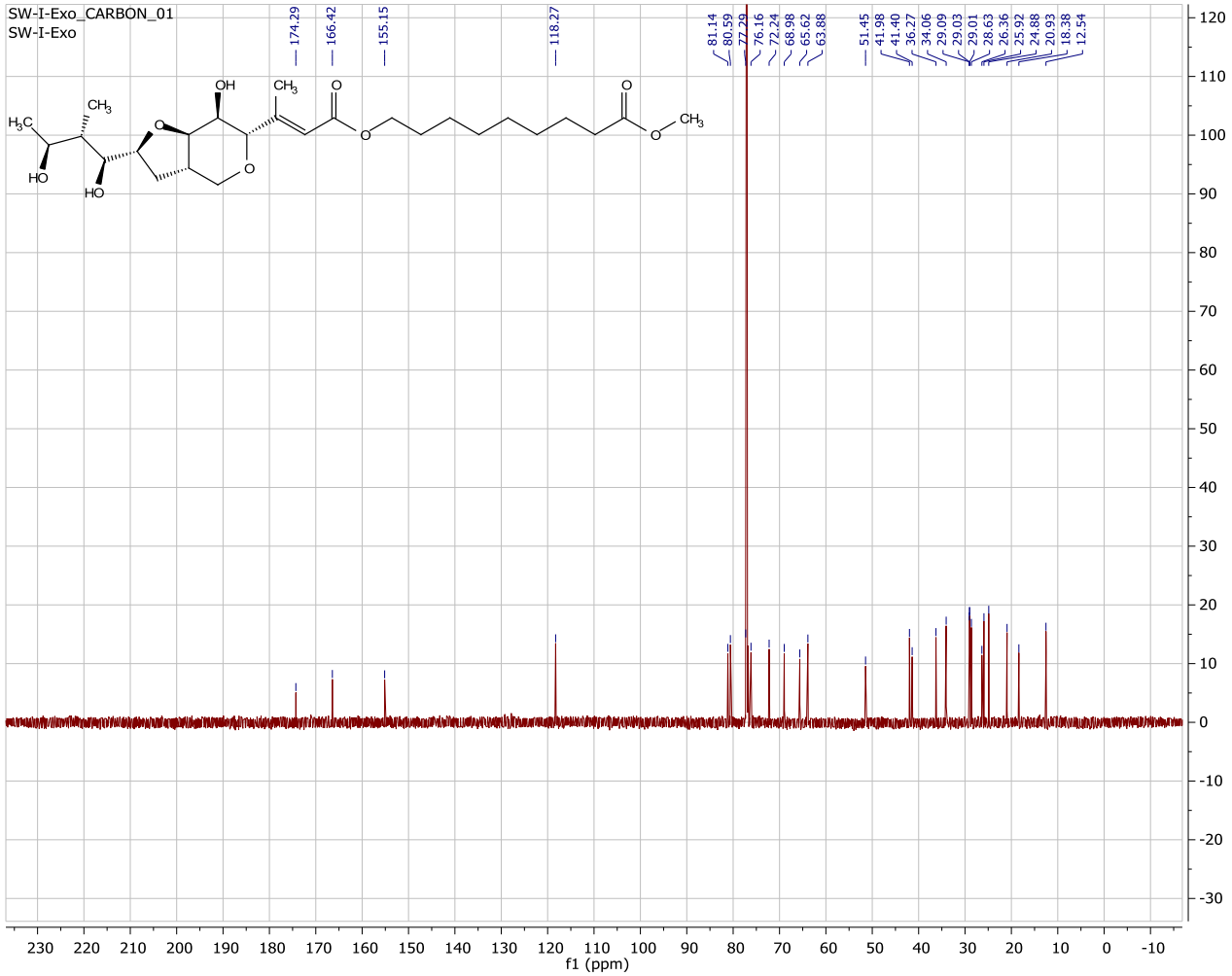

mupirocin methyl ester carbon
174.35
166.72
156.57
117.63
77.18
77.00
76.82
74.78
71.40
70.38
69.00
65.29
63.79
61.33
55.55
51.46
42.84
42.82
39.50
34.07
31.54
29.08
29.03
29.01
28.64
25.92
24.88
20.77
19.04
12.73
OH
CH3
O
HO
O
O
O
CH3
CH3
O
H3C
OH
f1 (ppm)

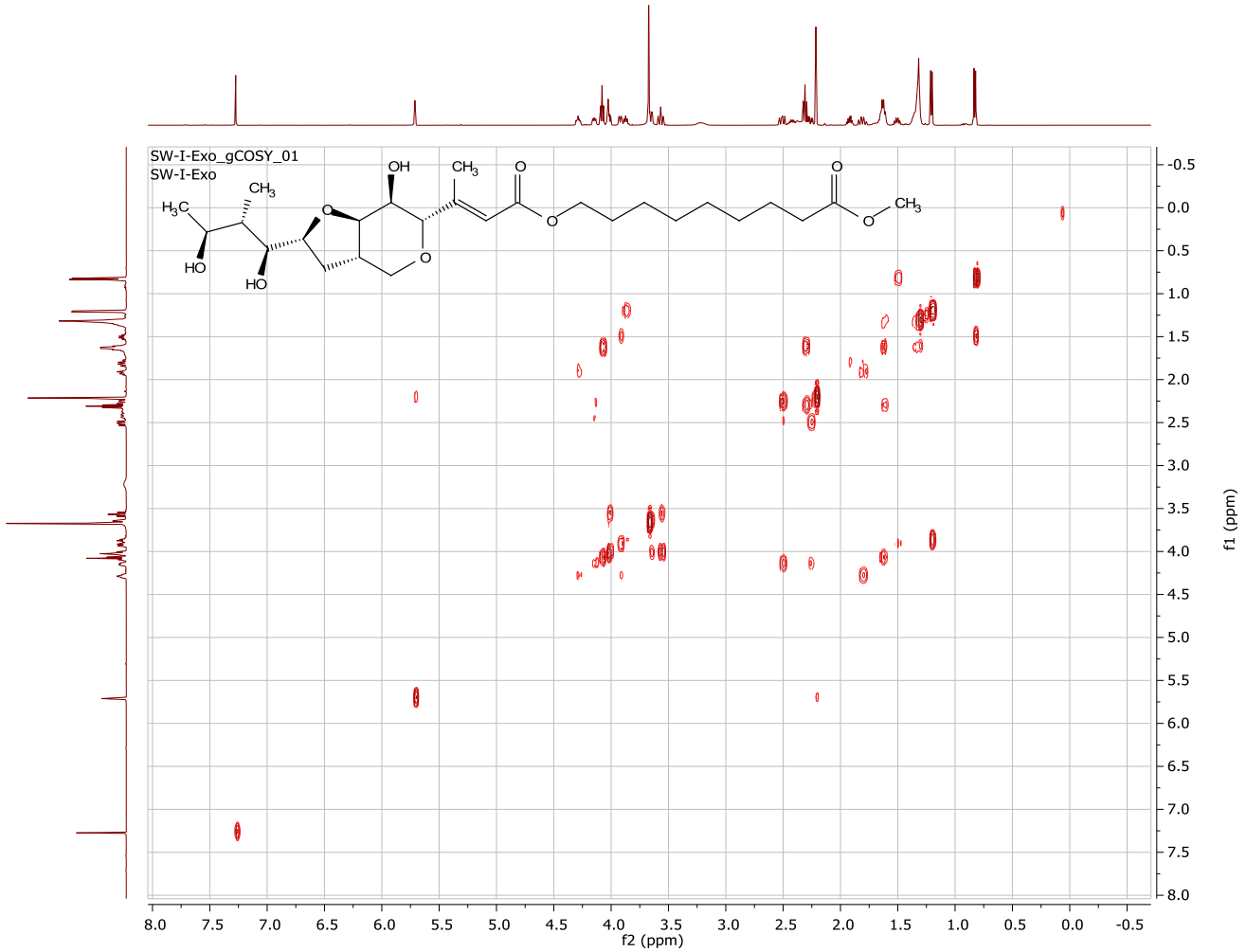

mupirocin methyl ester gCOSY
f2 (ppm)
f1 (ppm)

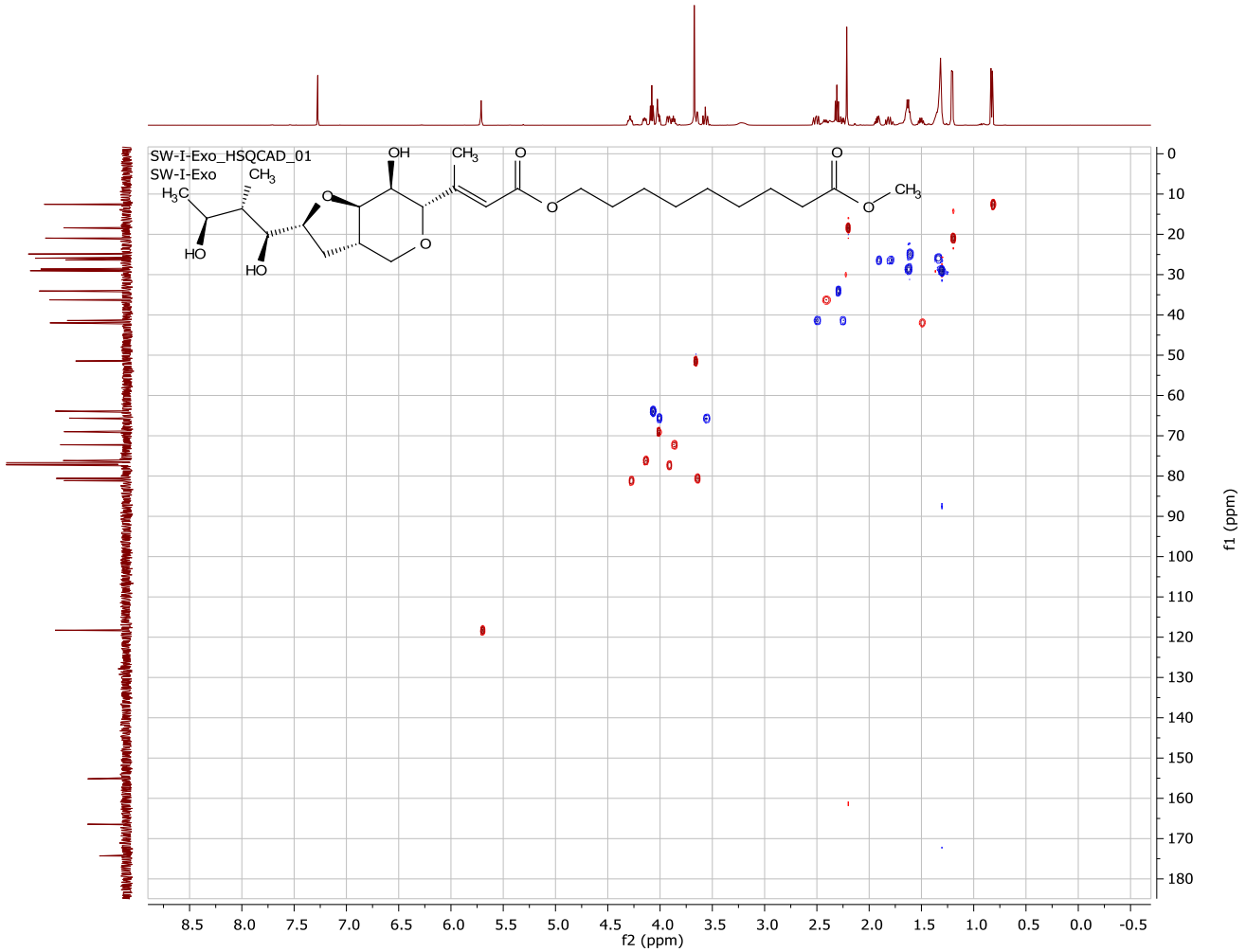

mupirocin methyl ester gHSQC
f2 (ppm)
f1 (ppm)

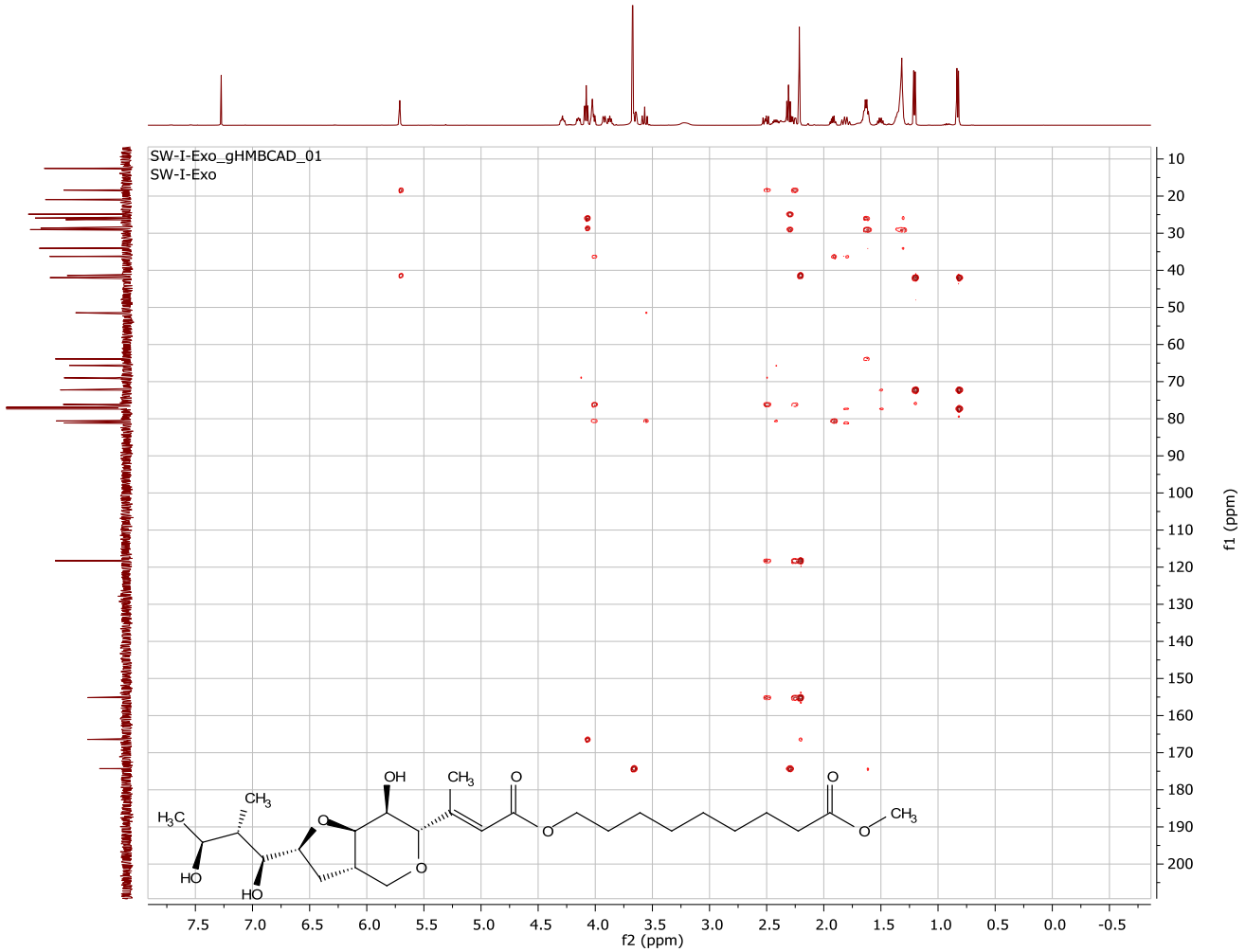

Mupirocin methyl ester HMBC
f2 (ppm)
f1 (ppm)
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
OH
CH3
O
HO
O
O
CH3
CH3
O
H3C
OH
O

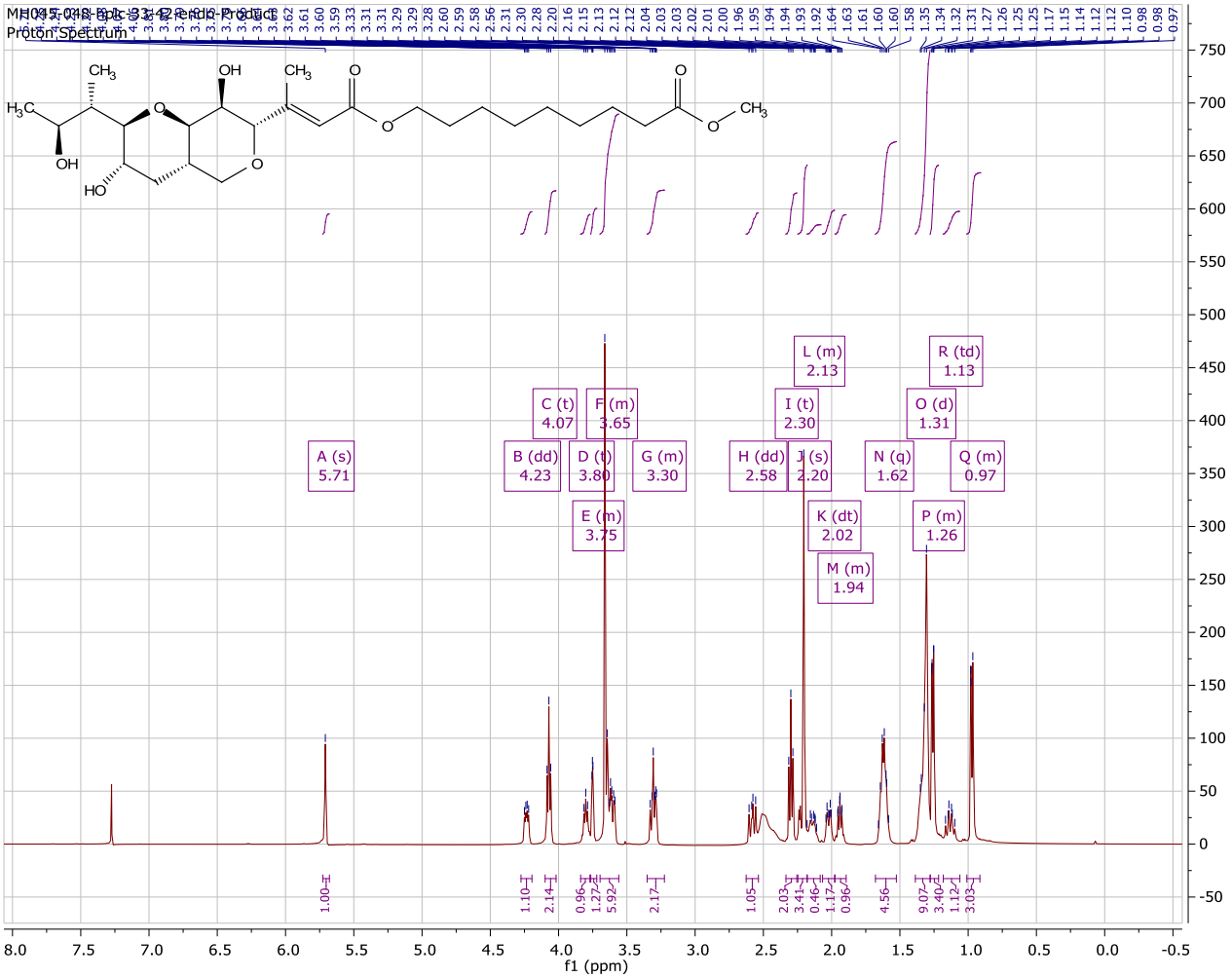

SW-1-EX6 PROTON_01
SW-1-EX6
A (s) 5.70
B (ddd) 4.28
C (ddd) 4.14
D (t) 4.07
E (m) 4.01
F (dd) 3.91
G (m) 3.86
H (dd) 3.64
I (s) 3.66
J (dd) 2.50
K (qq) 2.41
L (t) 2.30
M (dd) 2.25
N (d) 2.20
O (dt) 1.91
P (td) 1.80
Q (hept) 1.61
R (dp) 1.49
S (m) 1.31
T (d) 1.19
U (d) 0.81
f1 (ppm)

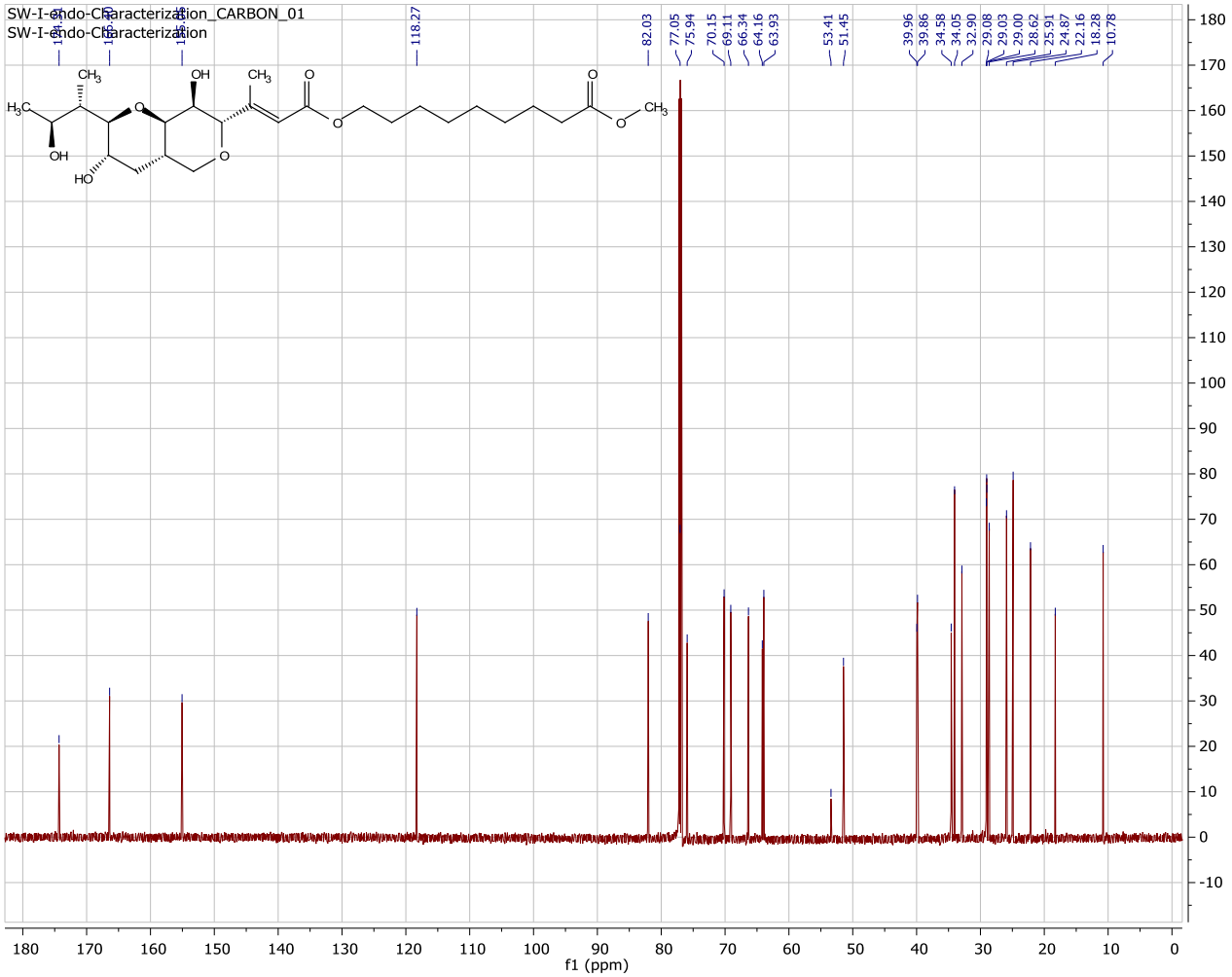

SW-I-Exo_CARBON_01
SW-I-Exo
174.29
166.42
155.15
118.27
81.14
80.59
77.29
76.16
72.24
68.98
65.62
63.88
51.45
41.98
41.40
36.27
34.06
29.09
29.03
29.01
28.63
26.36
25.92
24.88
20.93
18.38
12.54
f1 (ppm)

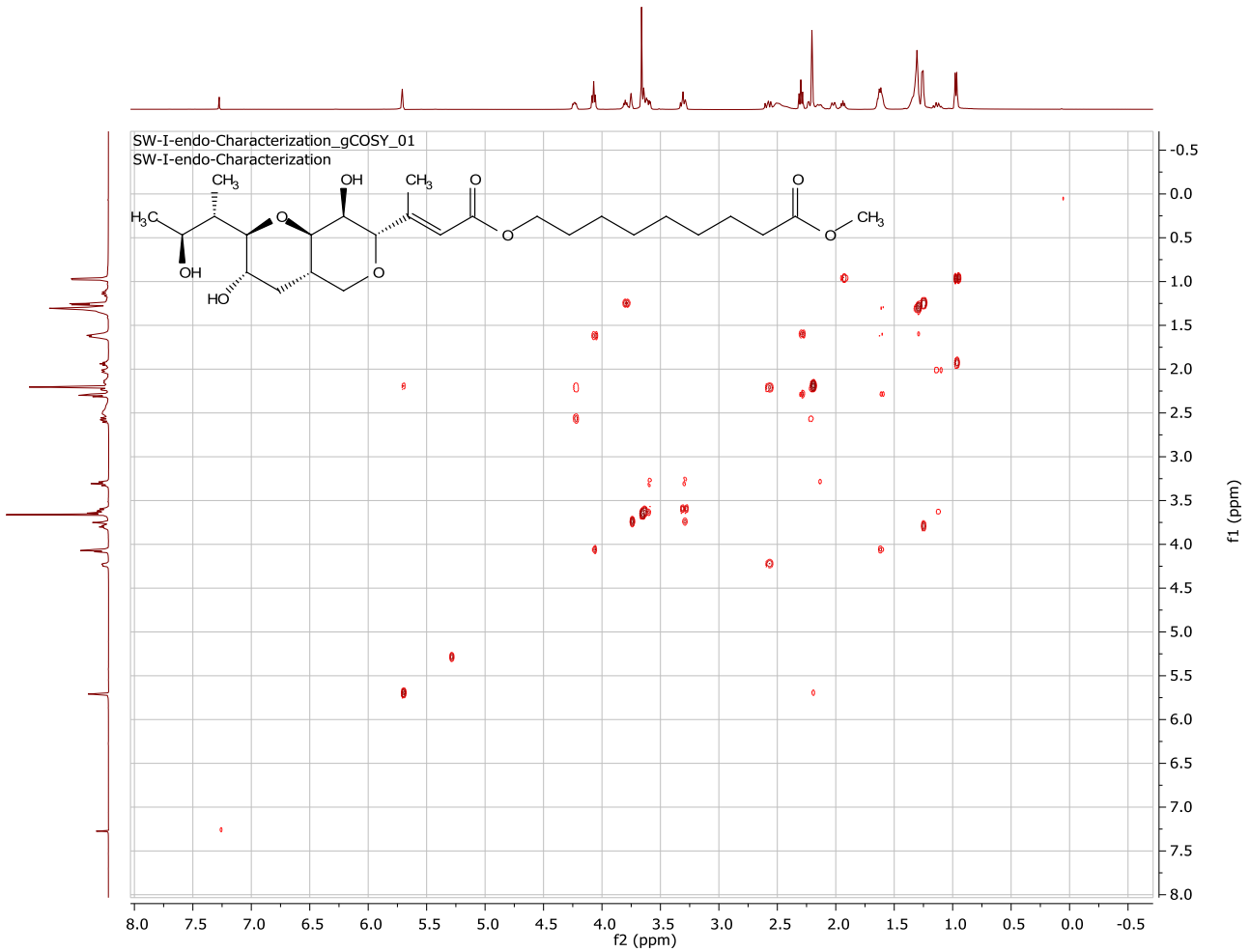

SW-I-Exo_gCOSY_01
SW-I-Exo
OH
CH3
O
O
O
CH3
H3C
CH3
HO
HO
O
O
f2 (ppm)
f1 (ppm)
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
-0.5 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0

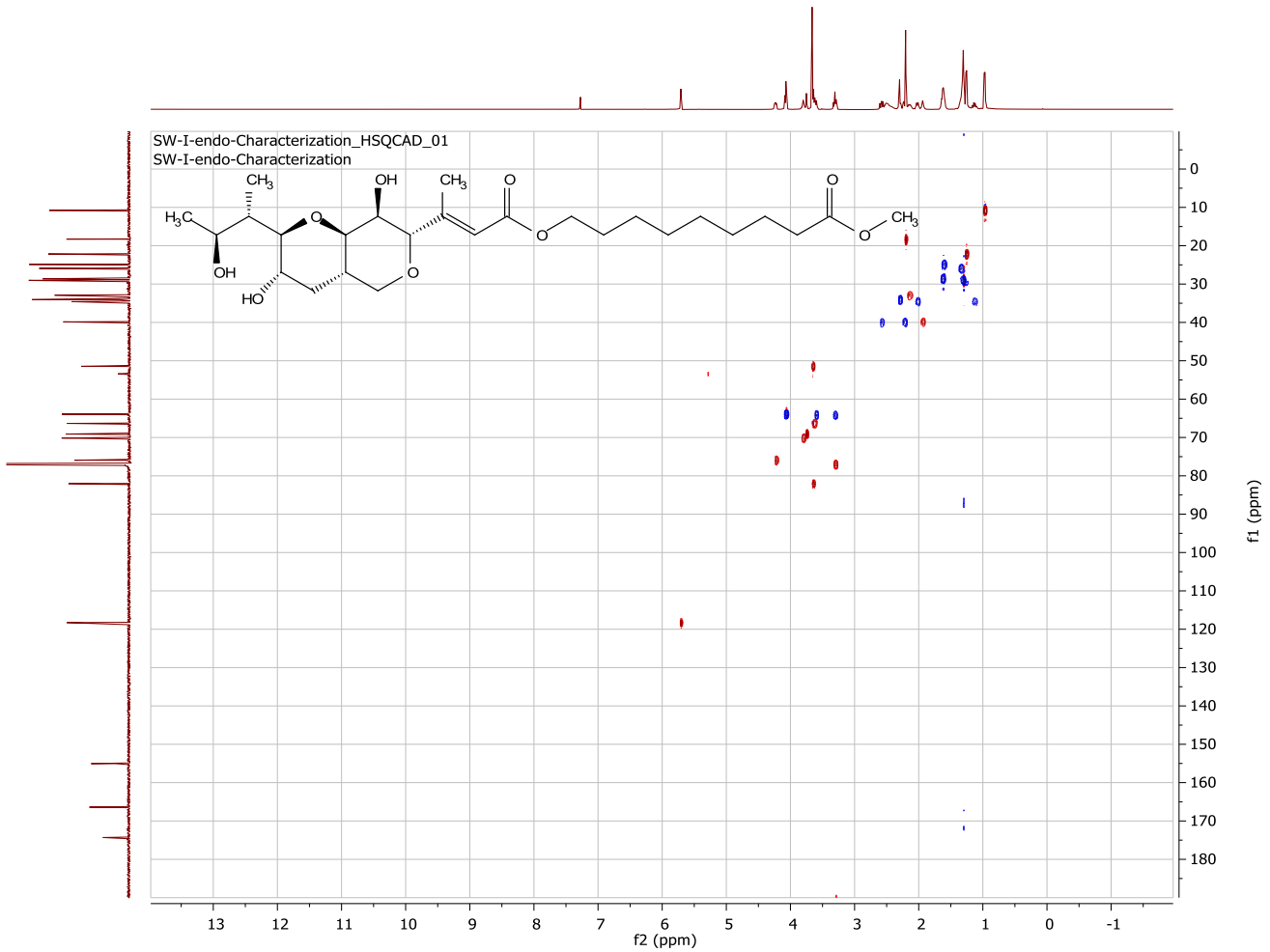

SW-I-Exo_HSQCAD_01
SW-I-Exo
f2 (ppm)
f1 (ppm)

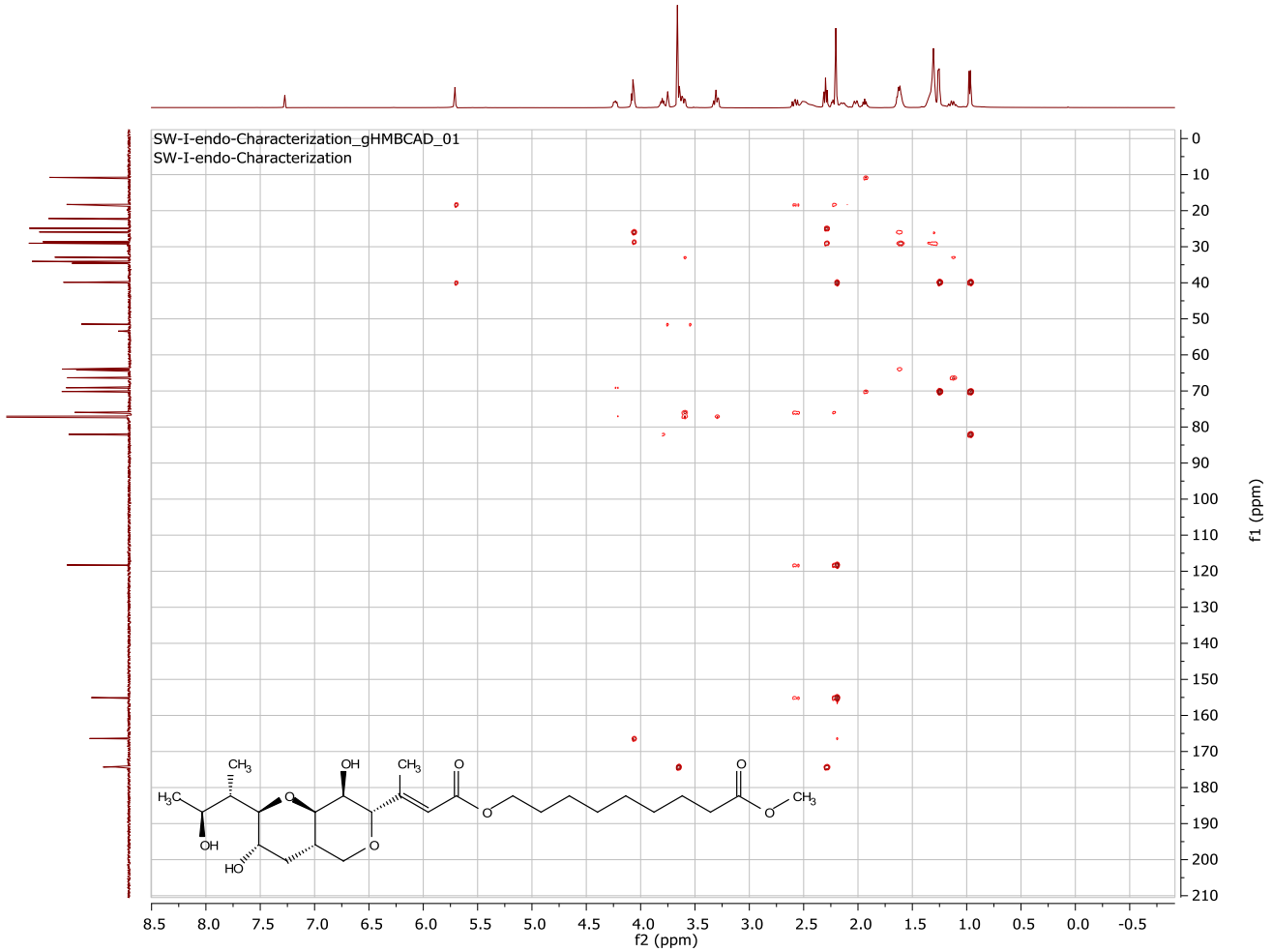

SW-I-Exo_gHMBCAD_01
SW-I-Exo
f2 (ppm)
f1 (ppm)
OH
CH3
O
H3C
HO
HO
CH3


Proton Spectrum
A (s) 5.71
B (dd) 4.23
C (t) 4.07
D (t) 3.80
E (m) 3.75
F (m) 3.65
G (m) 3.30
H (dd) 2.58
I (t) 2.30
J (s) 2.20
K (dt) 2.02
L (m) 2.13
M (m) 1.94
N (q) 1.62
O (d) 1.31
P (m) 1.26
Q (m) 0.97
R (td) 1.13
f1 (ppm)


SW-I-endo-Characterization_CARBON_01
SW-I-endo-Characterization
118.27
82.03
77.05
75.94
70.15
69.11
66.34
64.16
63.93
53.41
51.45
39.96
39.86
34.58
34.05
32.90
29.08
29.03
29.00
28.62
25.91
24.87
22.16
18.28
10.78
f1 (ppm)


SW-I-endo-Characterization_gCOSY_01
SW-I-endo-Characterization
f2 (ppm)
f1 (ppm)


SW-I-endo-Characterization_HSQCAD_01
SW-I-endo-Characterization
CH3
OH
CH3
O
O
H3C
O
O
CH3
OH
O
HO
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
f2 (ppm)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
f1 (ppm)


SW-I-endo-Characterization_gHMBCAD_01
SW-I-endo-Characterization
f2 (ppm)
f1 (ppm)

I. Reverse Phase HPLC (C18)

35% Acetonitrile/ 65% water

Endo-product (**16**)

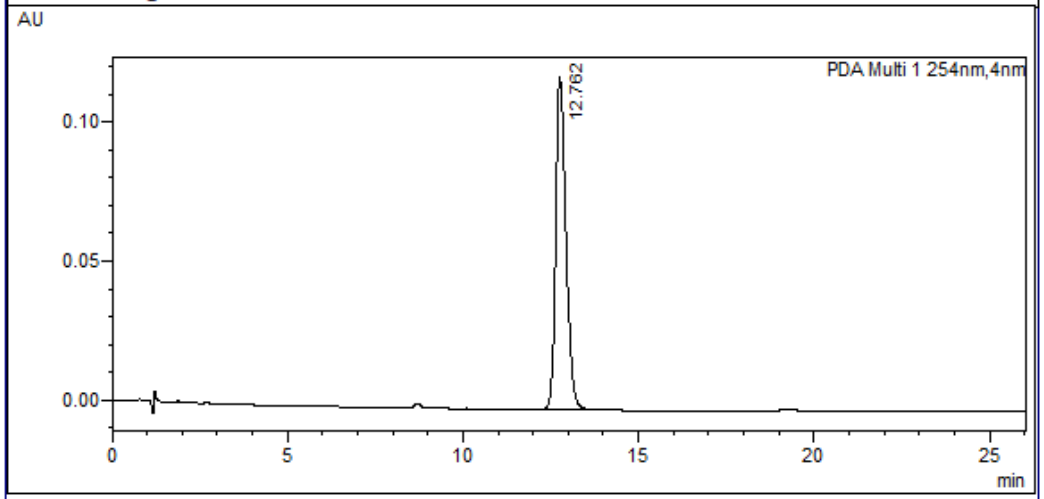
SHIMADZU LabSolutions

Analysis Report

<Sample Information>

Sample Name	: SW-6-member-ring		
Sample ID	: SW-6-member-ring		
Data Filename	: SW-6-member-ring.lcd		
Method Filename	: SW-MYU-5.lcm		
Batch Filename	:		
Vial #	: 1-1	Sample Type	: Unknown
Injection Volume	: 20 uL		
Date Acquired	: 1/15/2018 5:06:11 PM	Acquired by	: System Administrator
Date Processed	: 11/1/2019 9:42:05 AM	Processed by	: Yaroslav Khomutnyk

<Chromatogram>



<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	12.762	2433579	100.000
Total		2433579	100.000

Exo-product (**15**)

SHIMADZU LabSolutions

Analysis Report

<Sample Information>

Sample Name	: SW-5-member-ring		
Sample ID	: SW-5-member-ring		
Data Filename	: SW-5-member-ring.lcd		
Method Filename	: SW-MYU-5.lcm		
Batch Filename	:		
Vial #	: 1-1	Sample Type	: Unknown
Injection Volume	: 20 uL		
Date Acquired	: 1/15/2018 3:00:12 PM	Acquired by	: System Administrator
Date Processed	: 1/15/2018 3:26:16 PM	Processed by	: System Administrator

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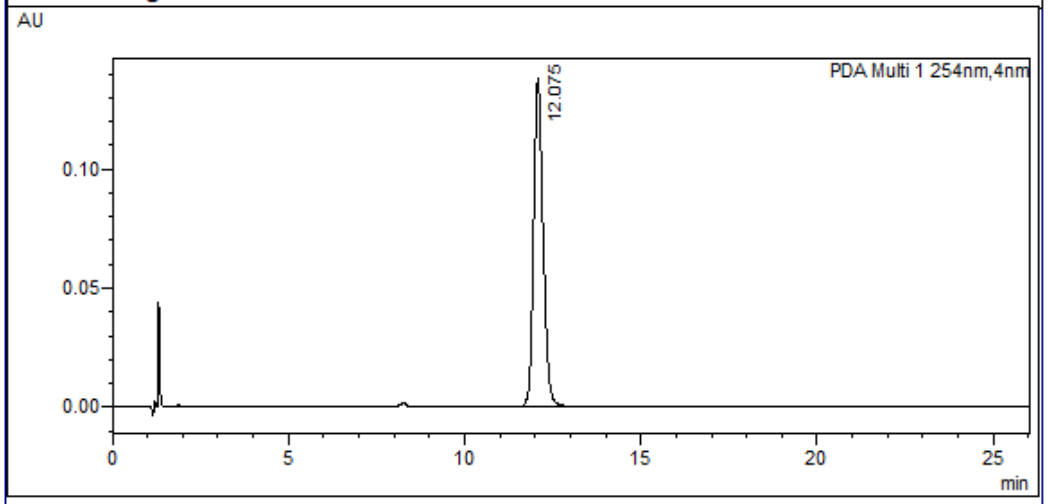

<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	12.075	2593680	100.000
Total		2593680	100.000

Starting material of mupirocin methyl ester (**14**)

SHIMADZU LabSolutions

Analysis Report

<Sample Information>

Sample Name	: SW-mupiracinMethylEster		
Sample ID	: SW-mupiracinMethylEster		
Data Filename	: SW-mupiracinMethylEster.lcd		
Method Filename	: SW-MYU-5.lcm		
Batch Filename	:		
Vial #	: 1-1	Sample Type	: Unknown
Injection Volume	: 20 uL		
Date Acquired	: 1/15/2018 5:37:15 PM	Acquired by	: System Administrator
Date Processed	: 1/25/2018 1:17:27 PM	Processed by	: System Administrator

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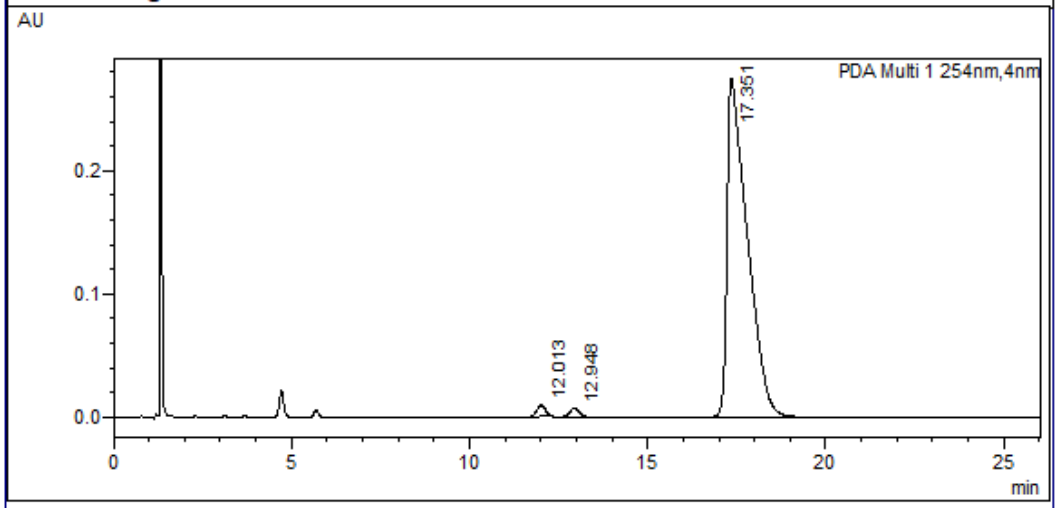

<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	12.013	162322	1.455
2	12.948	125142	1.122
3	17.351	10865597	97.423
Total		11153062	100.000

Detecting rp-HPLC peaks due to residual toluene

SHIMADZU LabSolutions

Analysis Report

<Sample Information>

Sample Name	: SW-I-TolueneSolutionTest		
Sample ID	: SW-I-TolueneSolutionTest		
Data Filename	: SW-I-TolueneSolutionTest.lcd		
Method Filename	: SW-MYU-5.lcm		
Batch Filename	:		
Vial #	: 1-1	Sample Type	: Unknown
Injection Volume	: 20 uL		
Date Acquired	: 1/25/2018 1:26:10 PM	Acquired by	: System Administrator
Date Processed	: 10/26/2018 11:23:18 AM	Processed by	: Yaroslav Khomutnyk

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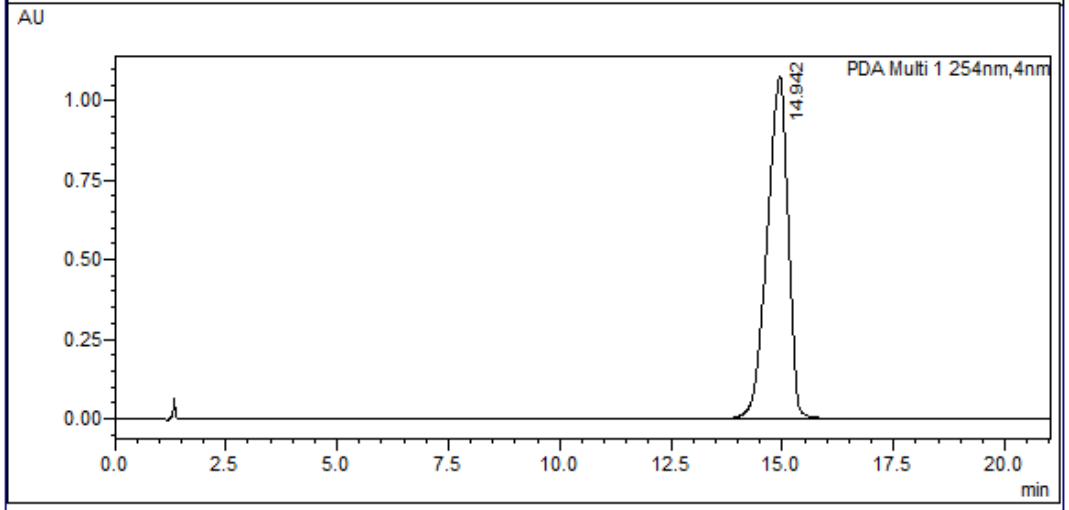

<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	14.942	35168277	100.000
Total		35168277	100.000

Reaction of (*R*)-TCYP (**17e**) catalyst for the formation of *endo*-enriched product

SHIMADZU LabSolutions

Analysis Report

<Sample Information>

Sample Name	: MH069-(R)-TCYP-overnight		
Sample ID	: MH069-(R)-TCYP-overnight		
Data Filename	: MH069-(R)-TCYP-overnight.lcd		
Method Filename	: SW-MYU-5.lcm		
Batch Filename	:		
Vial #	: 1-1	Sample Type	: Unknown
Injection Volume	: 20 uL		
Date Acquired	: 1/23/2018 10:42:51 AM	Acquired by	: System Administrator
Date Processed	: 11/1/2019 4:36:52 PM	Processed by	: Yaroslav Khomutnyk

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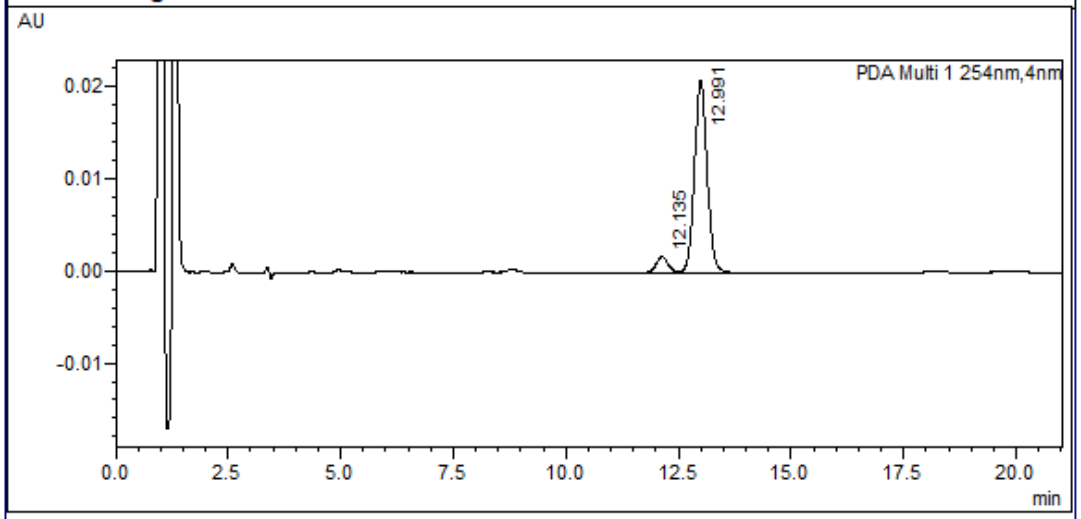

<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	12.135	31124	7.090
2	12.991	407851	92.910
Total		438975	100.000

(*S*)-TiPSY (**18**) catalyzed formation of *exo*-enriched product

SHIMADZU LabSolutions

Analysis Report

<Sample Information>

Sample Name	: SW-I-TIPSY-InToluneneAtRT-3.lcd		
Sample ID	: SW-I-TIPSY-InToluneneAtRT-3.lcd		
Data Filename	: SW-I-TIPSY-InToluneneAtRT-3.lcd		
Method Filename	: SW-MYU-5.lcm		
Batch Filename	:		
Vial #	: 1-1	Sample Type	: Unknown
Injection Volume	: 20 uL		
Date Acquired	: 1/24/2018 1:42:50 PM	Acquired by	: System Administrator
Date Processed	: 6/10/2019 9:02:41 PM	Processed by	: Yaroslav Khomutnyk

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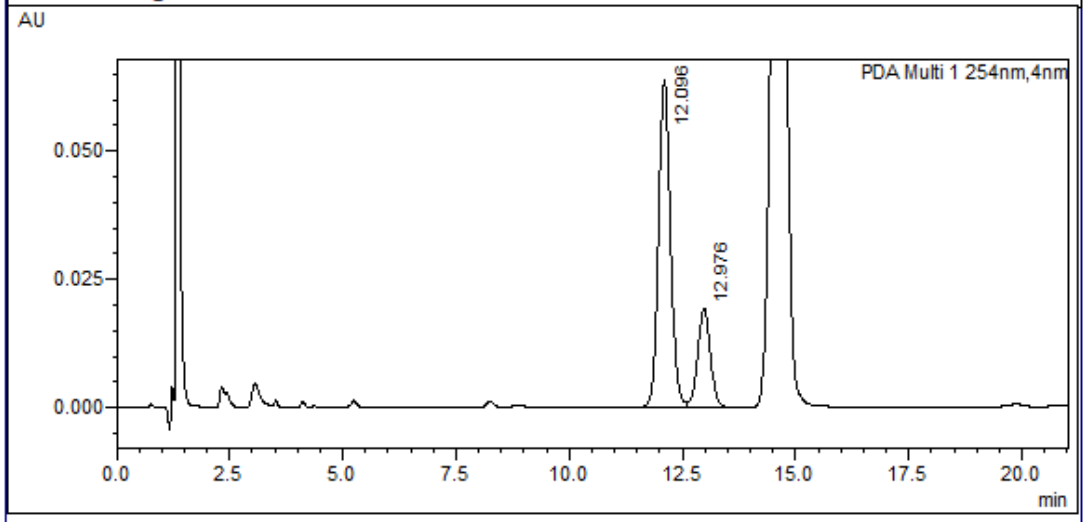

<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	12.096	1168813	75.546
2	12.976	378340	24.454
Total		1547153	100.000

Calibration curve of using 1:1 of *exo*- and *endo*-products

SHIMADZU LabSolutions

Analysis Report

<Sample Information>

Sample Name	: SW-I-205-1to1RatioOf5To6MemberRing		
Sample ID	: SW-I-205-1to1RatioOf5To6MemberR		
Data Filename	: SW-I-205-1to1RatioOf5To6MemberRing.lcd		
Method Filename	: SW-MYU-5.lcm		
Batch Filename	:		
Vial #	: 1-1	Sample Type	: Unknown
Injection Volume	: 1000 uL		
Date Acquired	: 2/13/2018 1:52:18 PM	Acquired by	: Yaroslav Khomutnyk
Date Processed	: 11/1/2019 5:06:55 PM	Processed by	: Yaroslav Khomutnyk

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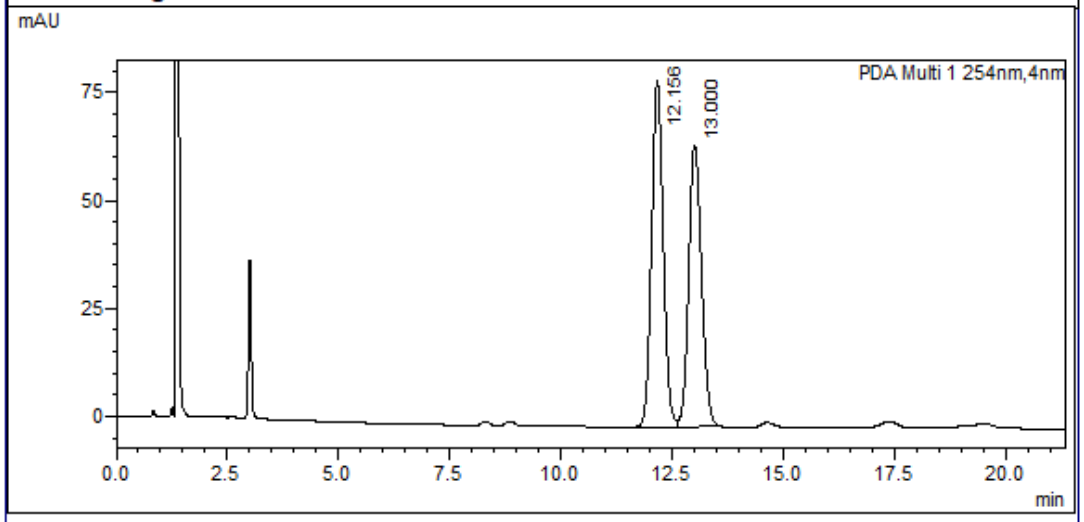

<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	12.156	1462673	52.973
2	13.000	1298485	47.027
Total		2761158	100.000

Calibration curve of using 1:1 of *exo*- and *endo*-products

SHIMADZU LabSolutions

Analysis Report

<Sample Information>

Sample Name	: SW-I-205-1to2RatioOf5to6MemberRing		
Sample ID	: SW-I-205-1to2RatioOf5to6MemberR		
Data Filename	: SW-I-205-1to2RatioOf5to6MemberRing.lcd		
Method Filename	: SW-MYU-5.lcm		
Batch Filename	:		
Vial #	: 1-1	Sample Type	: Unknown
Injection Volume	: 1000 uL		
Date Acquired	: 2/13/2018 10:41:58 AM	Acquired by	: Yaroslav Khomutnyk
Date Processed	: 11/1/2019 5:07:55 PM	Processed by	: Yaroslav Khomutnyk

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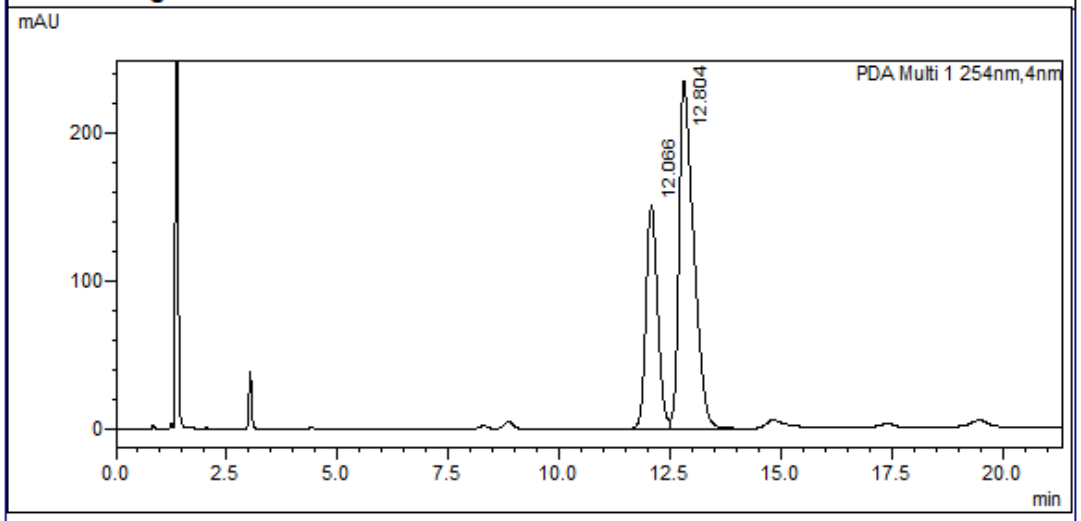

<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	12.066	2718711	33.561
2	12.804	5382191	66.439
Total		8100902	100.000

Calibration curve of using 1:3 of *exo*- and *endo*-products

SHIMADZU LabSolutions

Analysis Report

<Sample Information>

Sample Name	: SW-I-205-1to5RatioOf5To6MemberRing-2		
Sample ID	: SW-I-205-1to5RatioOf5To6MemberR		
Data Filename	: SW-I-205-1to3RatioOf5To6MemberRing-2.lcd		
Method Filename	: SW-MYU-5.lcm		
Batch Filename	:		
Vial #	: 1-1	Sample Type	: Unknown
Injection Volume	: 1000 uL		
Date Acquired	: 2/14/2018 1:44:03 PM	Acquired by	: Yaroslav Khomutnyk
Date Processed	: 11/1/2019 5:09:57 PM	Processed by	: Yaroslav Khomutnyk

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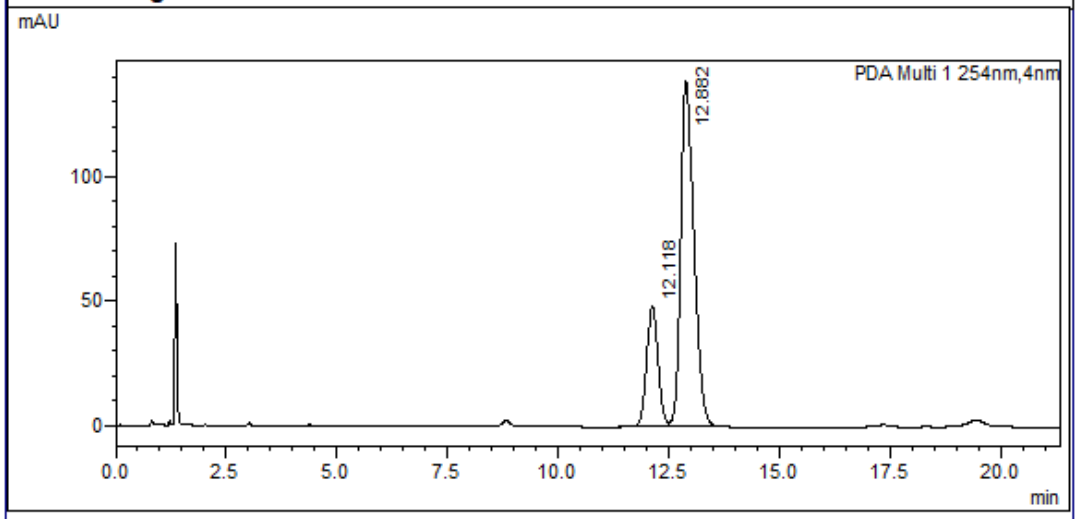

<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	12.118	864599	23.097
2	12.882	2878667	76.903
Total		3743266	100.000

Calibration curve of using 1:5 of *exo*- and *endo*-products

SHIMADZU LabSolutions

Analysis Report

<Sample Information>

Sample Name	: SW-I-205-1to5RatioOf5To6MemberRing		
Sample ID	: SW-I-205-1to5RatioOf5To6MemberR		
Data Filename	: SW-I-205-1to5RatioOf5To6MemberRing.lcd		
Method Filename	: SW-MYU-5.lcm		
Batch Filename	:		
Vial #	: 1-1	Sample Type	: Unknown
Injection Volume	: 1000 uL		
Date Acquired	: 2/13/2018 3:22:24 PM	Acquired by	: Yaroslav Khomutnyk
Date Processed	: 11/1/2019 5:33:26 PM	Processed by	: Yaroslav Khomutnyk

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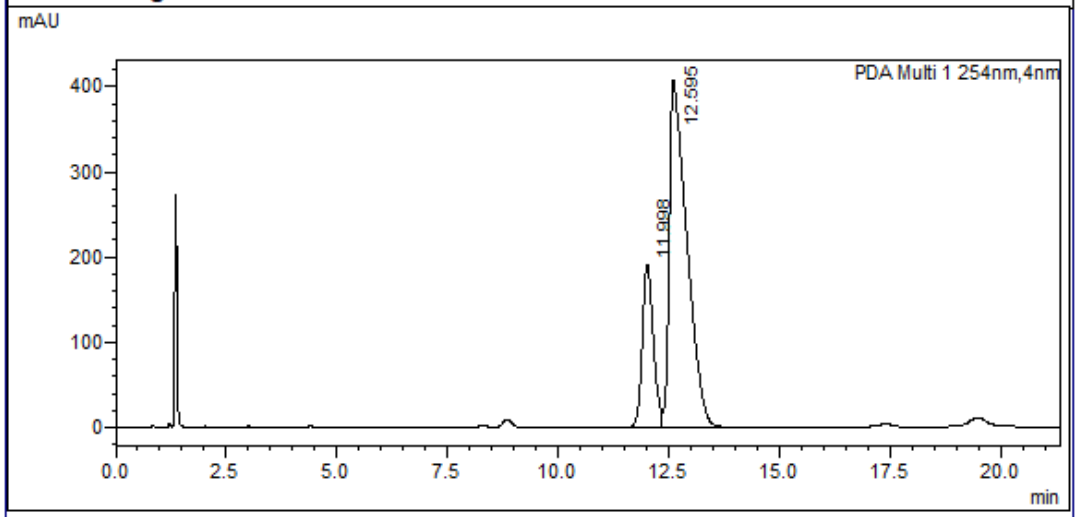

<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	11.998	3334778	22.982
2	12.595	11175707	77.018
Total		14510485	100.000

Calibration curve of using 1:10 of *exo*- and *endo*-products

SHIMADZU LabSolutions

Analysis Report

<Sample Information>

Sample Name	: SW-I-205-1to10RatioOf5To6MemberRing		
Sample ID	: SW-I-205-1to10RatioOf5To6Member		
Data Filename	: SW-I-205-1to10RatioOf5To6MemberRing.lcd		
Method Filename	: SW-MYU-5.lcm		
Batch Filename	:		
Vial #	: 1-1	Sample Type	: Unknown
Injection Volume	: 1000 uL		
Date Acquired	: 2/13/2018 3:51:37 PM	Acquired by	: Yaroslav Khomutnyk
Date Processed	: 11/1/2019 5:11:40 PM	Processed by	: Yaroslav Khomutnyk

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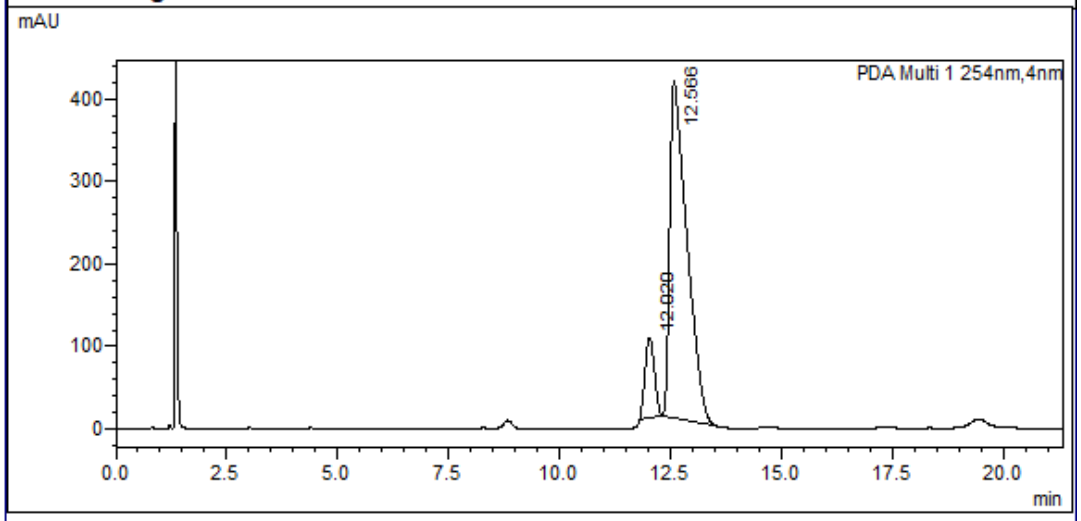

<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	12.020	1400639	11.319
2	12.566	10974084	88.681
Total		12374724	100.000

Calibration curve of using 2:1 of *exo*- and *endo*-products

SHIMADZU LabSolutions

Analysis Report

<Sample Information>

Sample Name	: SW-I-205-2to1RatioOf5to6MemberRing		
Sample ID	: SW-I-205-2to1RatioOf5to6MemberR		
Data Filename	: SW-I-205-2to1RatioOf5to6MemberRing.lcd		
Method Filename	: SW-MYU-5.lcm		
Batch Filename	:		
Vial #	: 1-1	Sample Type	: Unknown
Injection Volume	: 1000 uL		
Date Acquired	: 2/13/2018 12:54:21 PM	Acquired by	: Yaroslav Khomutnyk
Date Processed	: 11/1/2019 5:12:20 PM	Processed by	: Yaroslav Khomutnyk

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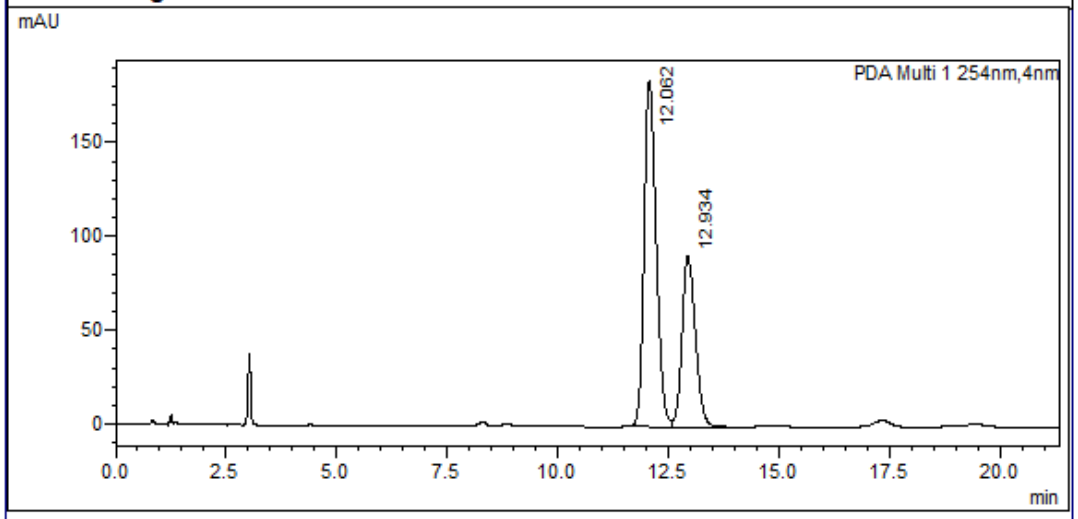

<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	12.062	3441790	64.318
2	12.934	1909443	35.682
Total		5351232	100.000

Calibration curve of using 3:1 of *exo*- and *endo*-products

SHIMADZU LabSolutions

Analysis Report

<Sample Information>

Sample Name	: SW-I-205-3to1RatioOf5To6MemberRing		
Sample ID	: SW-I-205-3to1RatioOf5To6MemberR		
Data Filename	: SW-I-205-3to1RatioOf5To6MemberRing.lcd		
Method Filename	: SW-MYU-5.lcm		
Batch Filename	:		
Vial #	: 1-1	Sample Type	: Unknown
Injection Volume	: 1000 uL		
Date Acquired	: 2/13/2018 2:27:07 PM	Acquired by	: Yaroslav Khomutnyk
Date Processed	: 11/1/2019 5:14:02 PM	Processed by	: Yaroslav Khomutnyk

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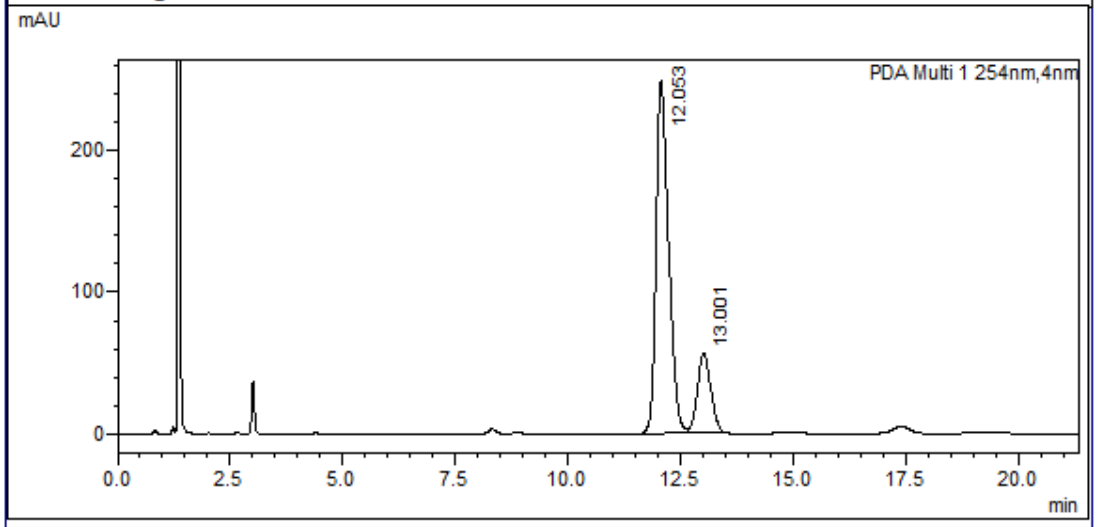

<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	12.053	4789991	81.046
2	13.001	1120204	18.954
Total		5910195	100.000

Calibration curve of using 10:1 of *exo*- and *endo*-products

SHIMADZU LabSolutions

Analysis Report

<Sample Information>

Sample Name	: SW-I-205-10to1RatioOf5To6MemberRing		
Sample ID	: SW-I-205-10to1RatioOf5To6Member		
Data Filename	: SW-I-205-10to1RatioOf5To6MemberRing.lcd		
Method Filename	: SW-MYU-5.lcm		
Batch Filename	:		
Vial #	: 1-1	Sample Type	: Unknown
Injection Volume	: 1000 uL		
Date Acquired	: 2/13/2018 2:57:12 PM	Acquired by	: Yaroslav Khomutnyk
Date Processed	: 9/24/2018 4:54:56 PM	Processed by	: Yaroslav Khomutnyk

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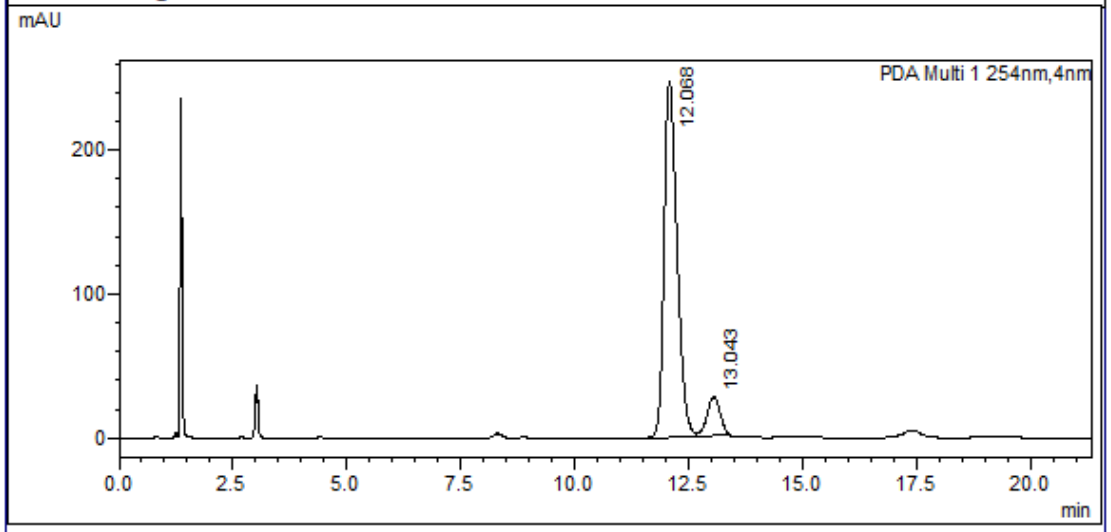

<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	12.068	4808730	89.934
2	13.043	538233	10.066
Total		5346963	100.000

XI. References

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