Antiproliferative Dimeric Aporphinoid Alkaloids from the Roots of *Thalictrum cultratum*

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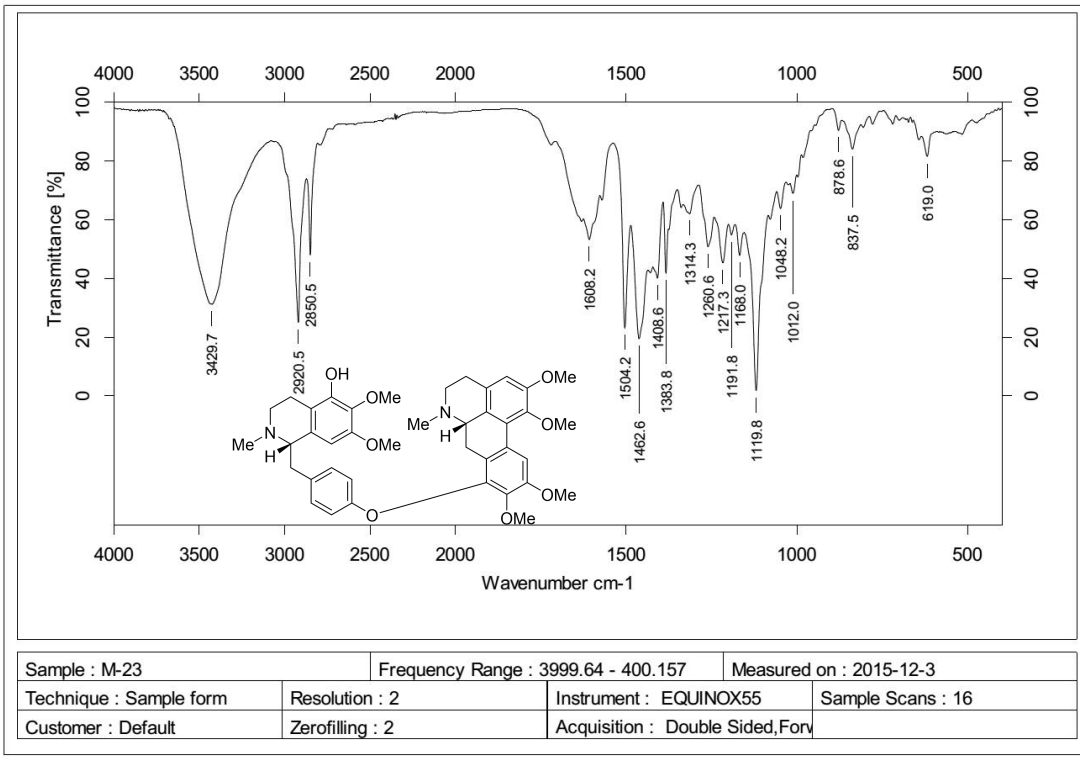
CONTENT

Abstract

Inspired by the intriguing structures and bioactivities of dimeric alkaloids, 11 new thalifaberine-type aporphine-benzylisoquinoline alkaloids thalicultratines A–K, a tetrahydroprotoberberine-aporphine alkaloid thalicultratine L, and five known ones were isolated from the roots of *Thalictrum cultratum* Wall. Their structures were defined on the basis of NMR and HRESIMS data. The antiproliferative activities of compounds **1**–**17** were evaluated against human leukemia HL-60 and prostate cancer PC-3 cells. Most alkaloids showed potent cytotoxicity against selected cancer cells. Preliminary SARs are discussed. The most active new compound **3** with an IC_{50} value of 1.06 μM against HL-60 cells was selected for mechanism of action studies. The results revealed that compound **3** induced apoptosis and arrest the HL-60 cell cycle at the S phase with the loss of mitochondria membrane potential. The nuclear morphological Hoechst 33258 staining assay was also carried out and the results confirmed apoptosis.

The spectra of all new compounds

Figure S1.1. IR spectrum of compound **1**



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Technique : Sample form	Resolution : 2	Instrument : EQUINOX55	Sample Scans : 16
Customer : Default	Zerofilling : 2	Acquisition : Double Sided,Forv	

Figure S1.2. UV spectrum of compound **1**

Spectrum Peak Pick Report

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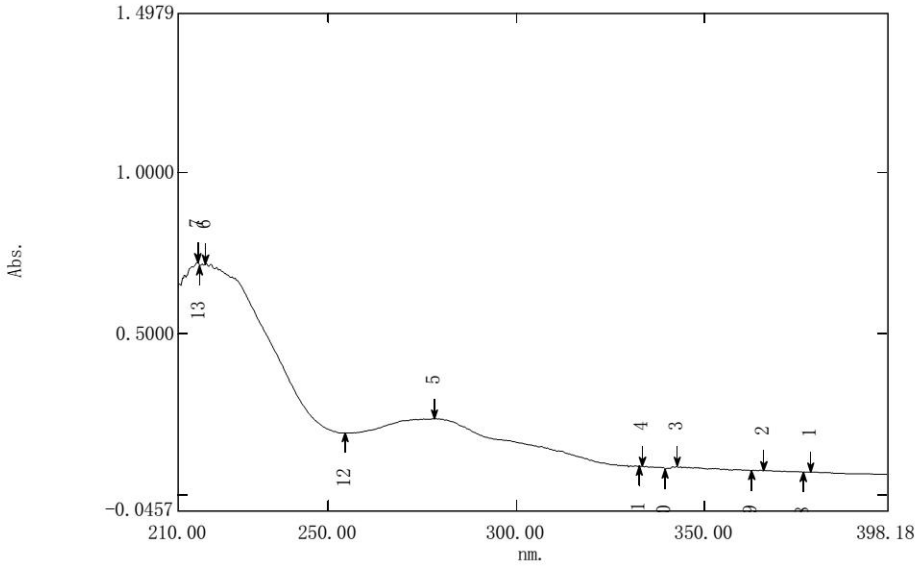

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采样间隔: 0.2
自动采样间隔: 启用
扫描模式: 自动

试样准备属性
重量:
体积 :
稀释:
光程长:
附加信息:

仪器属性
仪器类型: UV-1700
测定方式: 吸收值
狭缝宽: 1.0 nm
光源改变波长: 340.8 nm
S/R 转换: 标准

附件属性
附件: 无

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4	↑	333.40	.0911	
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7	↑	215.20	.7240	
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9	↓	362.20	.0758	
10	↓	339.40	.0831	
11	↓	332.60	.0901	
12	↓	254.40	.1937	
13	↓	215.80	.7161	
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Figure S1.3. ^{1}H NMR (600 MHz, $CDCl_3$) spectrum of compound **1**

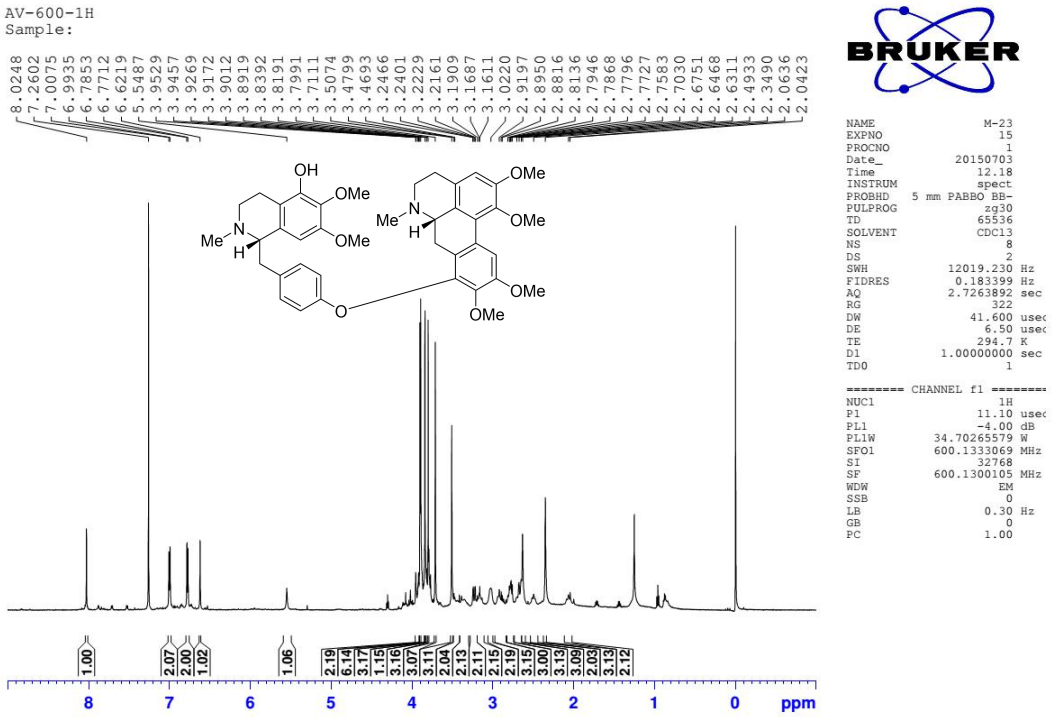


Figure S1.4. ^{13}C NMR (150 MHz, $CDCl_3$) spectrum of compound **1**

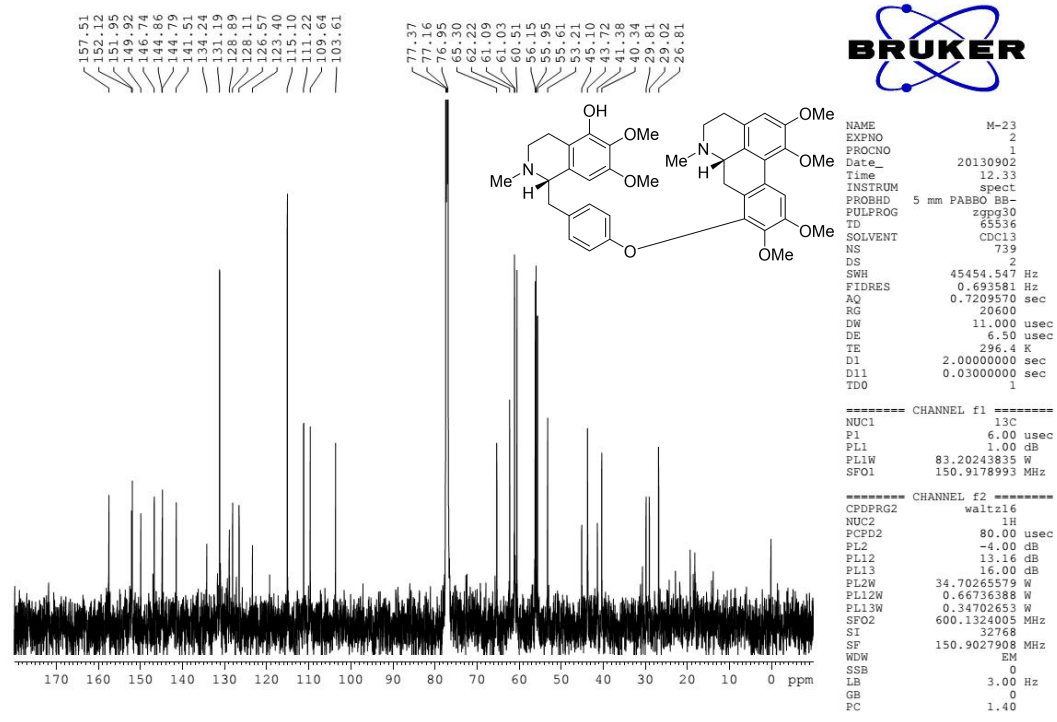


Figure S1.5. HSQC (600 MHz, $CDCl_3$) spectrum of compound **1**

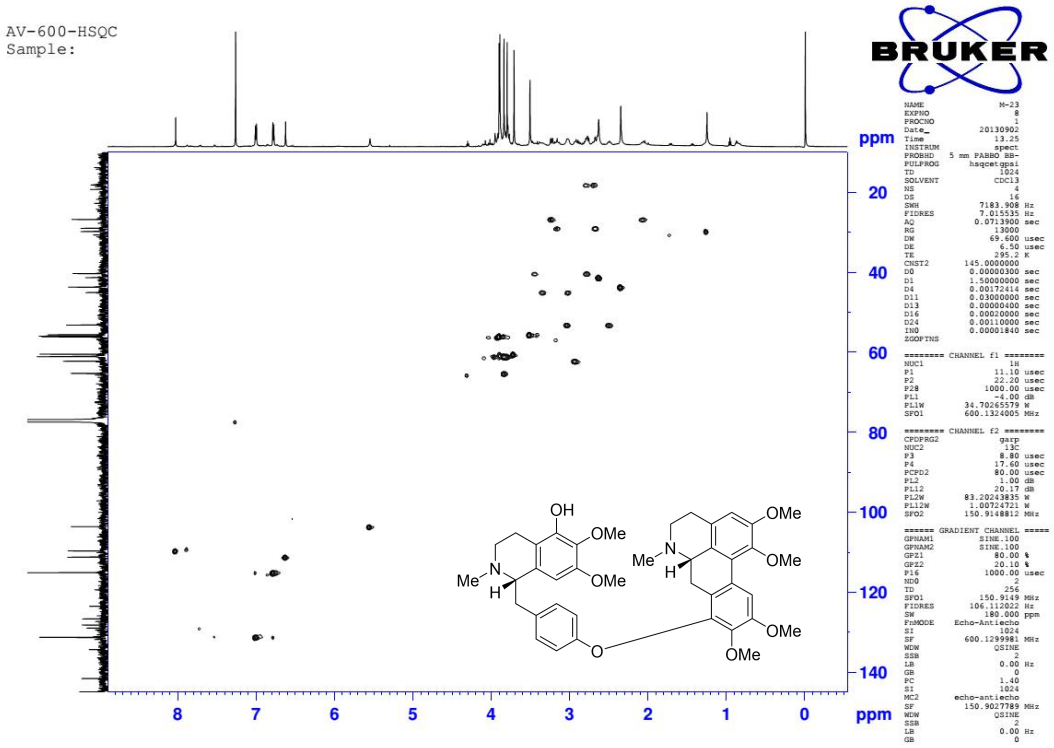


Figure S1.6. HMBC (600 MHz, $CDCl_3$) spectrum of compound **1**

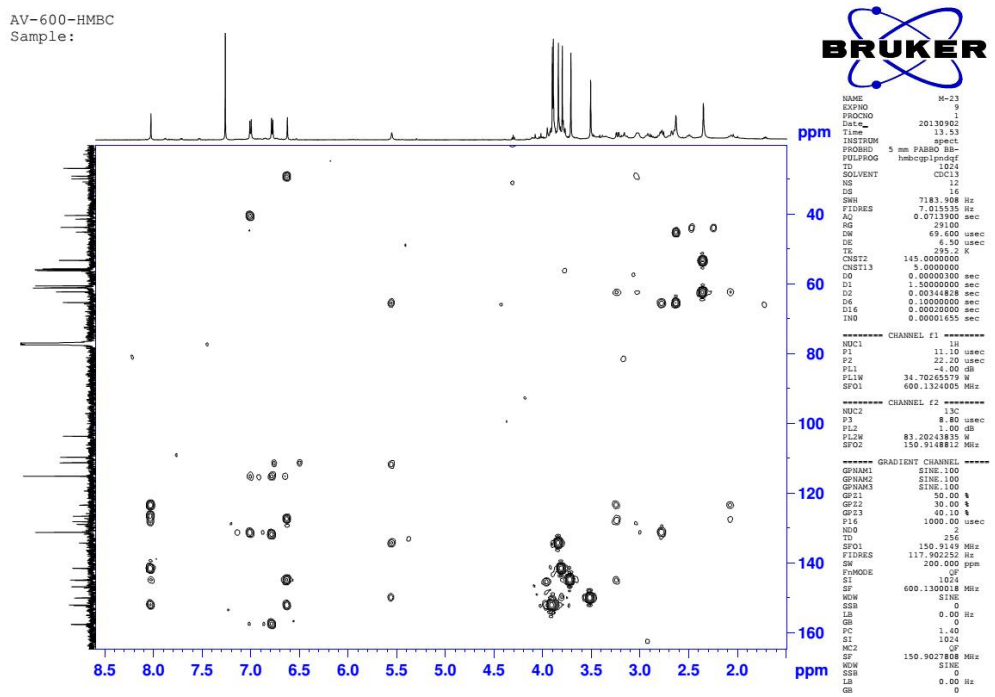


Figure S1.7. NOESY (600 MHz, $CDCl_3$) spectrum of compound **1**

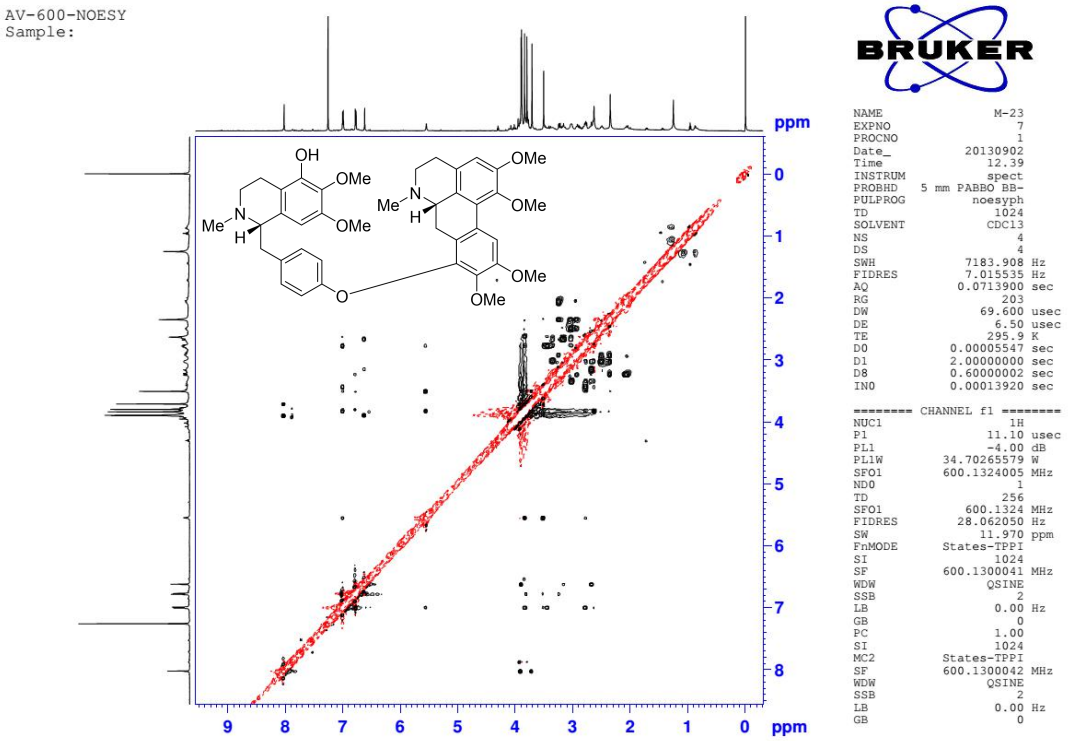


Figure S1.8. HRESIMS of compound **1**

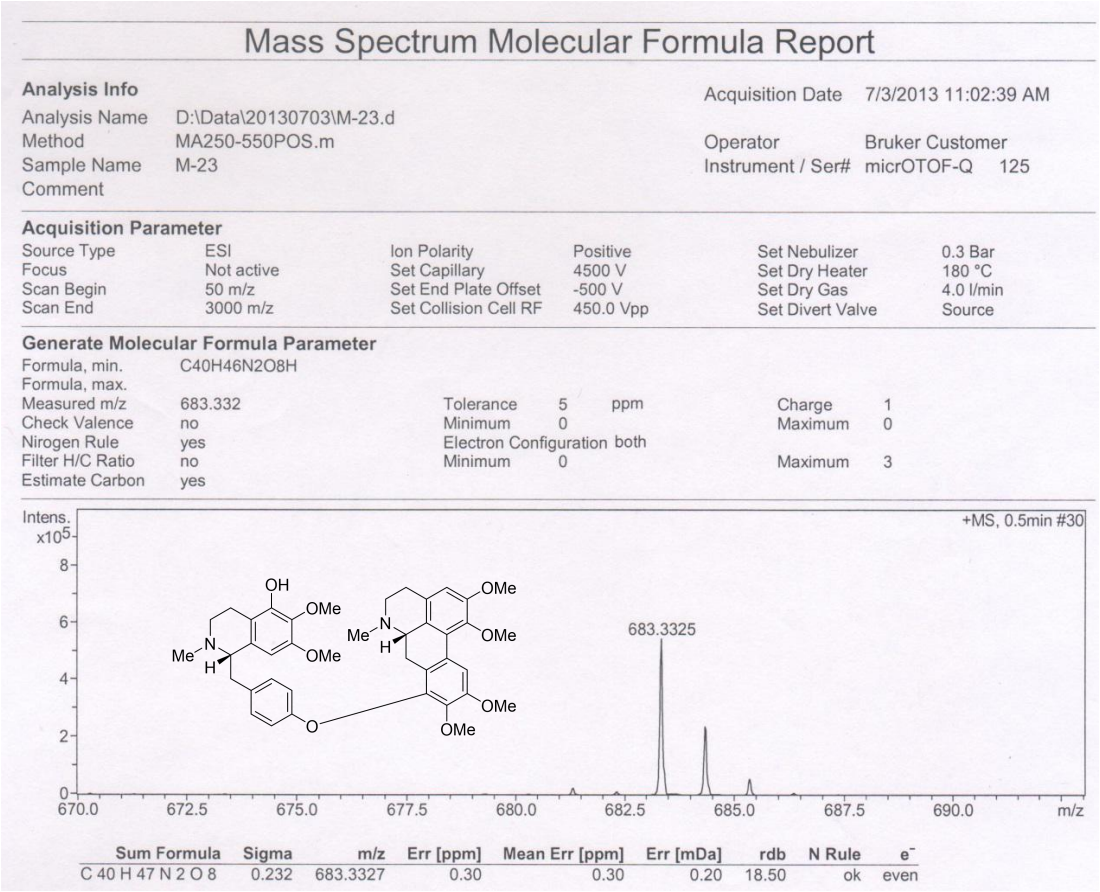
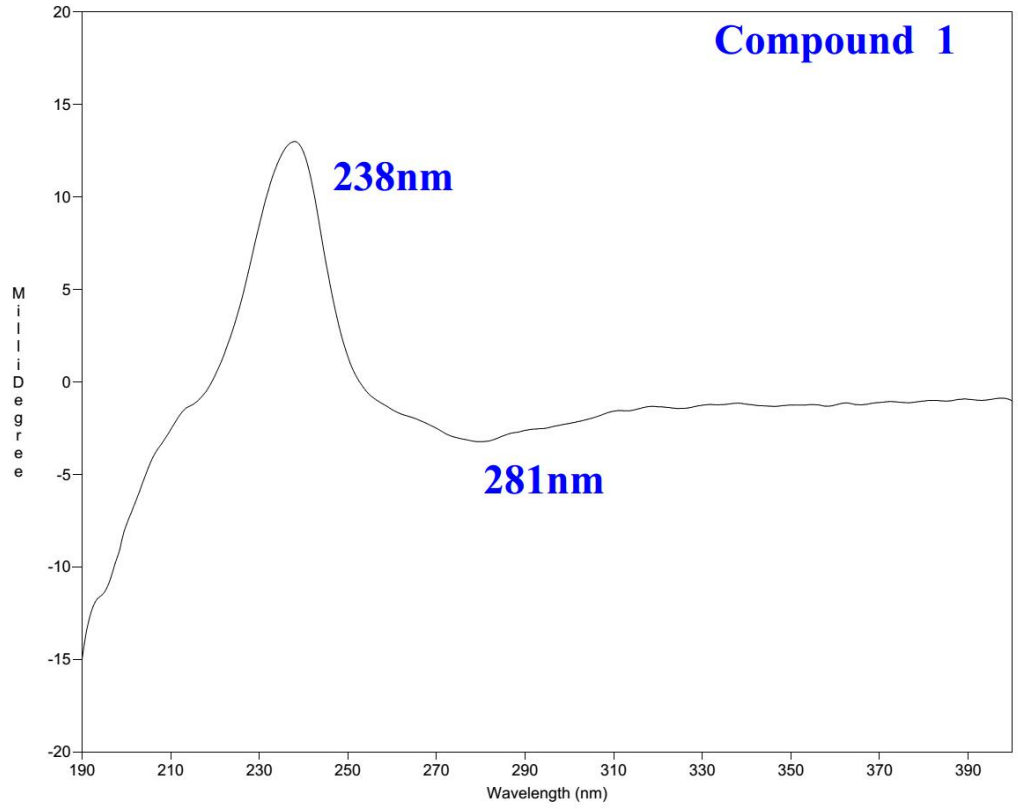


Figure S1.9. ECD spectrum of compound **1**



Bio-Kine Software V4.71 Date : 2014-3-7 Time : 13:55:46

COMMENTS :
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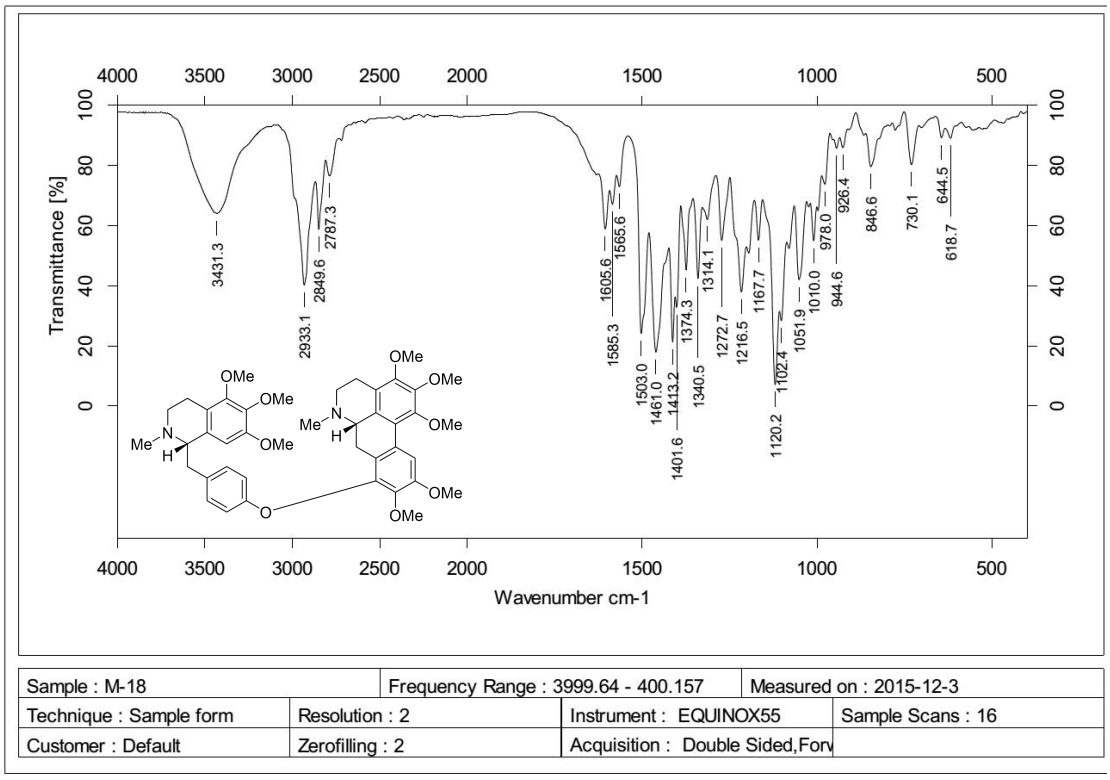
Savitzky-Golay Smooth of sav-golay
Window Points=15
Polynomial Order=3
Derivative=0

Figure S2.1. IR spectrum of compound **2**



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Customer : Default	Zerofilling : 2	Acquisition : Double Sided,For	

Figure S2.2. UV spectrum of compound **2**

Spectrum Peak Pick Report

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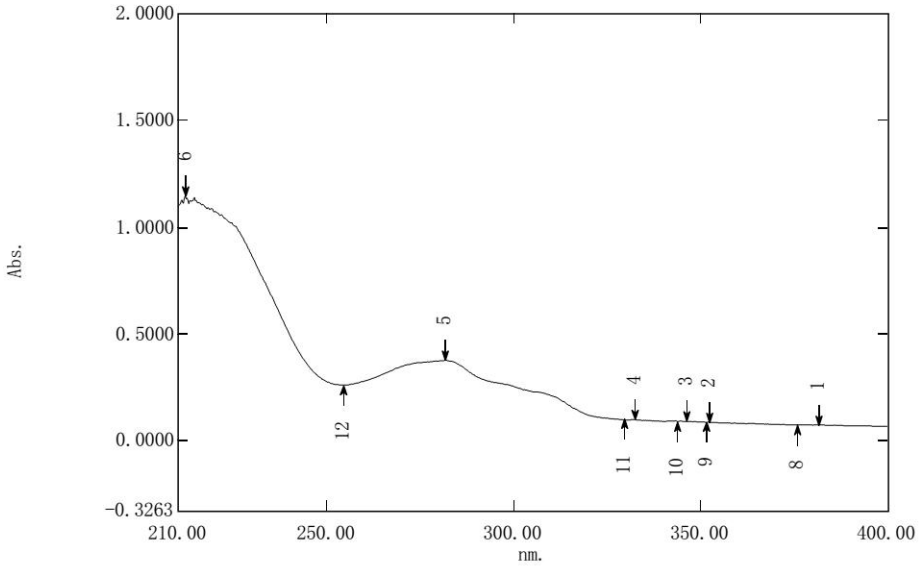

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采样间隔: 0.2
自动采样间隔: 启用
扫描模式: 自动

试样准备属性
重量:
体积 :
稀释:
光程长:
附加信息:

仪器属性
仪器类型: UV-1700
测定方式: 吸收值
狭缝宽: 1.0 nm
光源改变波长: 340.8 nm
S/R 转换: 标准

附件属性
附件: 无

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Figure S2.3. ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **2**

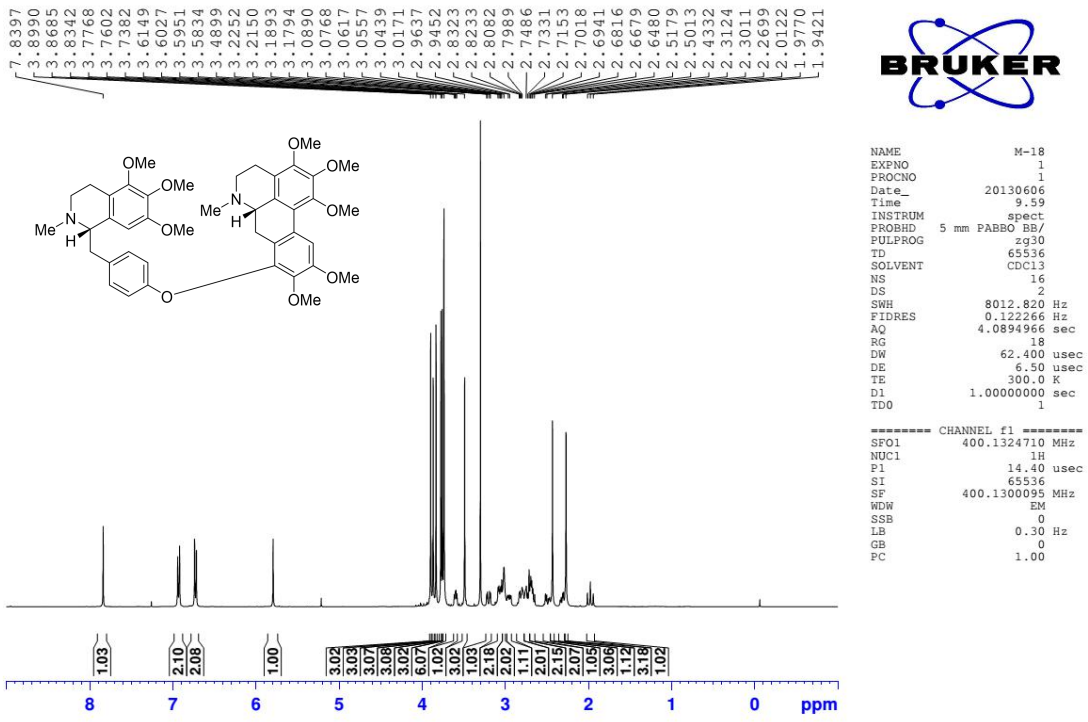


Figure S2.4. ^{13}C NMR (150 MHz, $CDCl_3$) spectrum of compound **2**

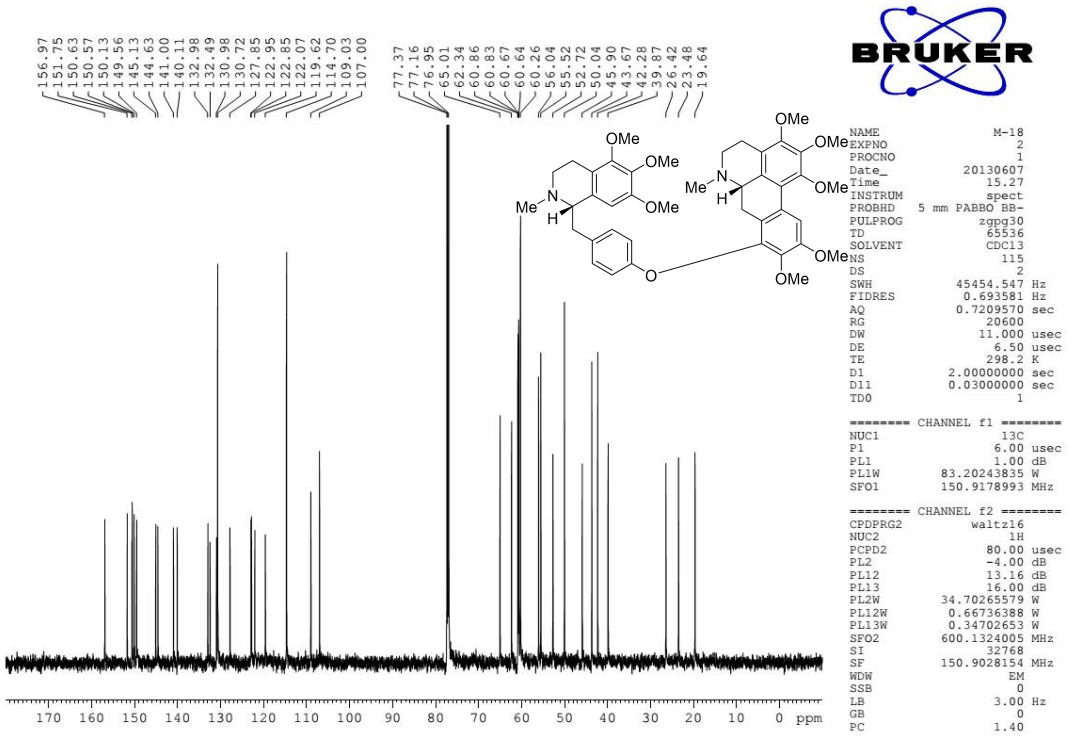


Figure S2.5. HSQC (600 MHz, $CDCl_3$) spectrum of compound **2**

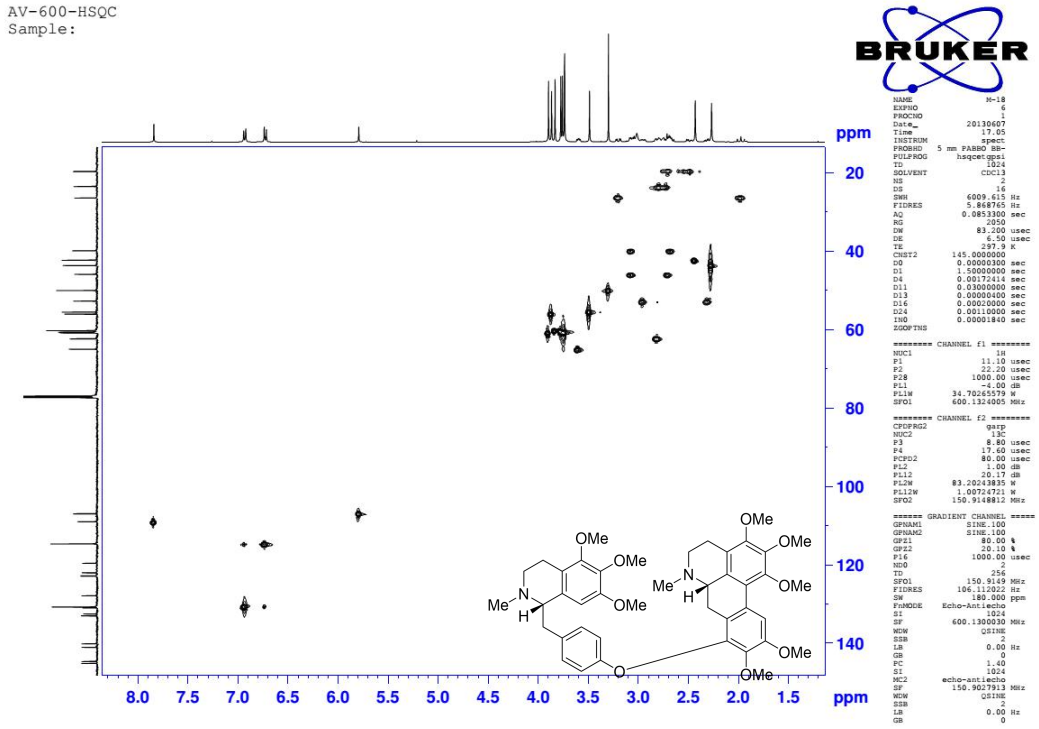


Figure S2.6. HMBC (600 MHz, $CDCl_3$) spectrum of compound **2**

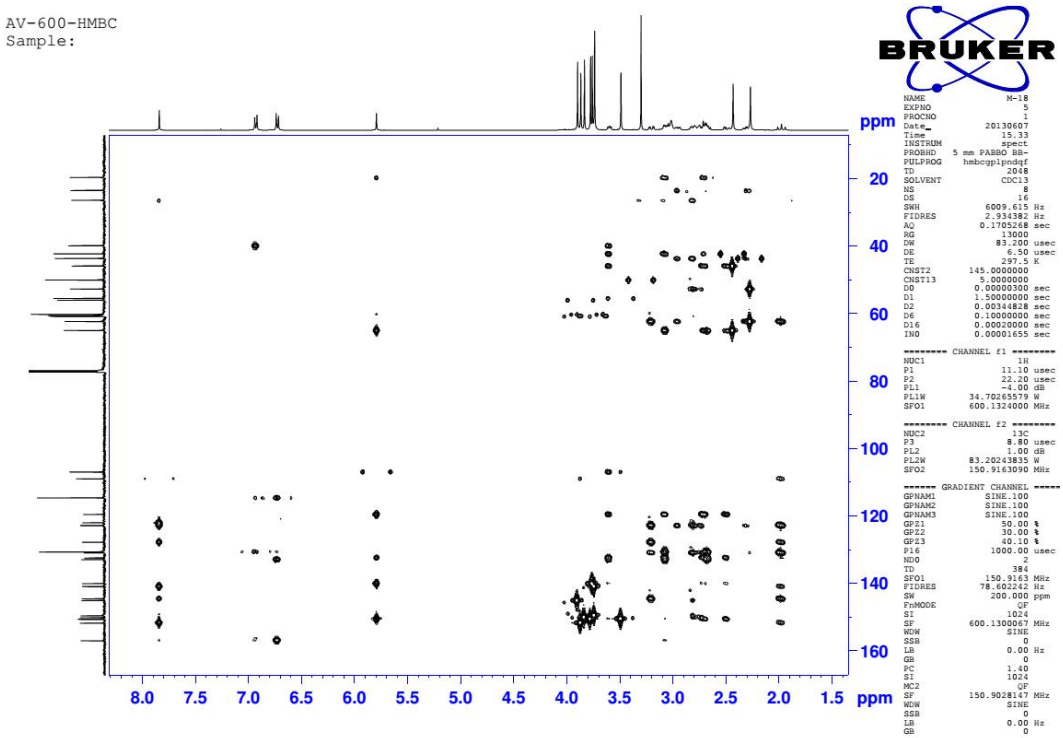
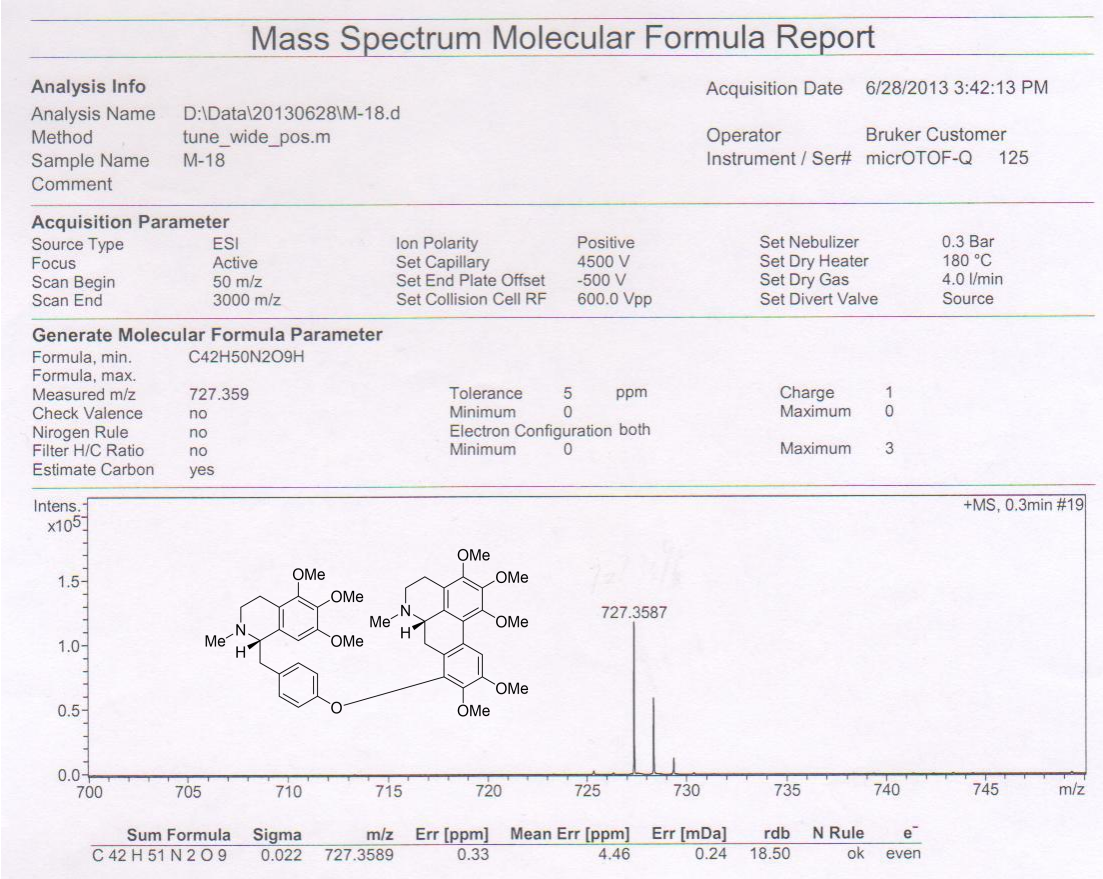


Figure S2.7. HRESIMS of compound **2**



Mass Spectrum Molecular Formula Report

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Sample Name	M-18	Instrument / Ser#	micrOTOF-Q 125
Comment			

Acquisition Parameter

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Scan End	3000 m/z	Set Collision Cell RF	600.0 Vpp	Set Divert Valve	Source

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Formula, max.					
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Filter H/C Ratio	no	Minimum	0	Maximum	3
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Figure S2.8. ECD spectrum of compound **2**

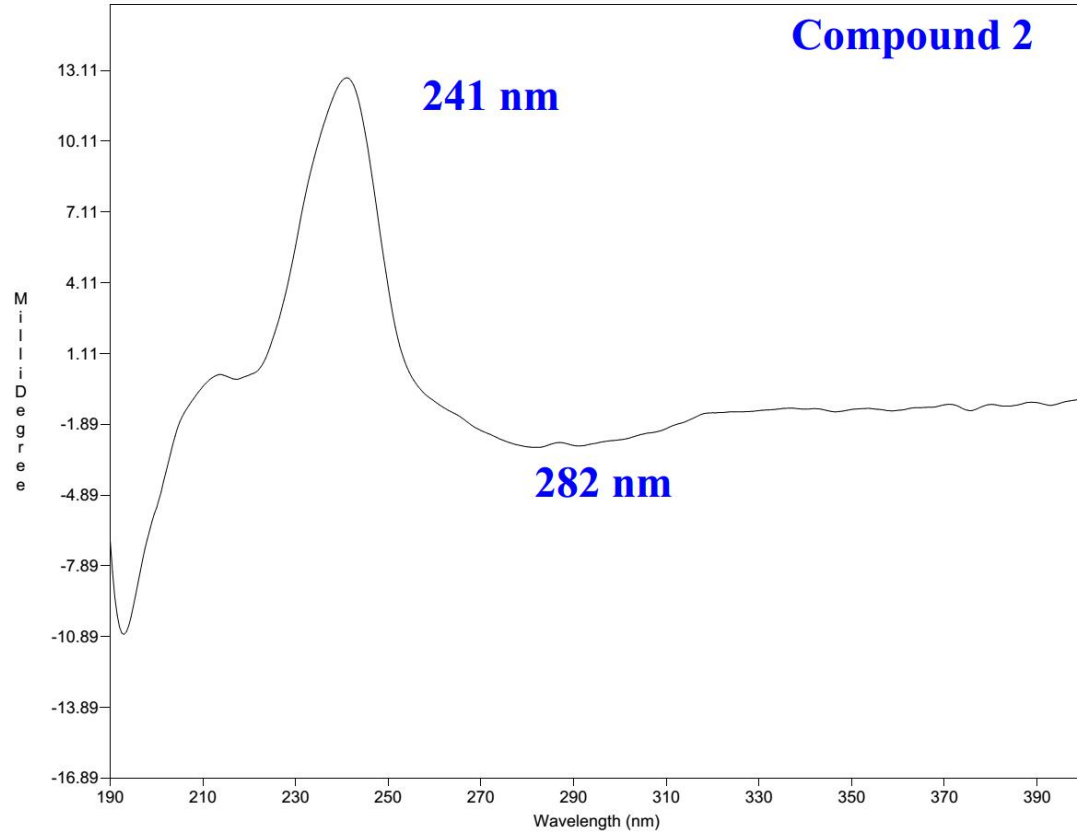


Figure S2.9. Key HMBC correlations of compound **2**

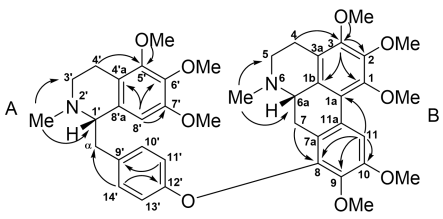
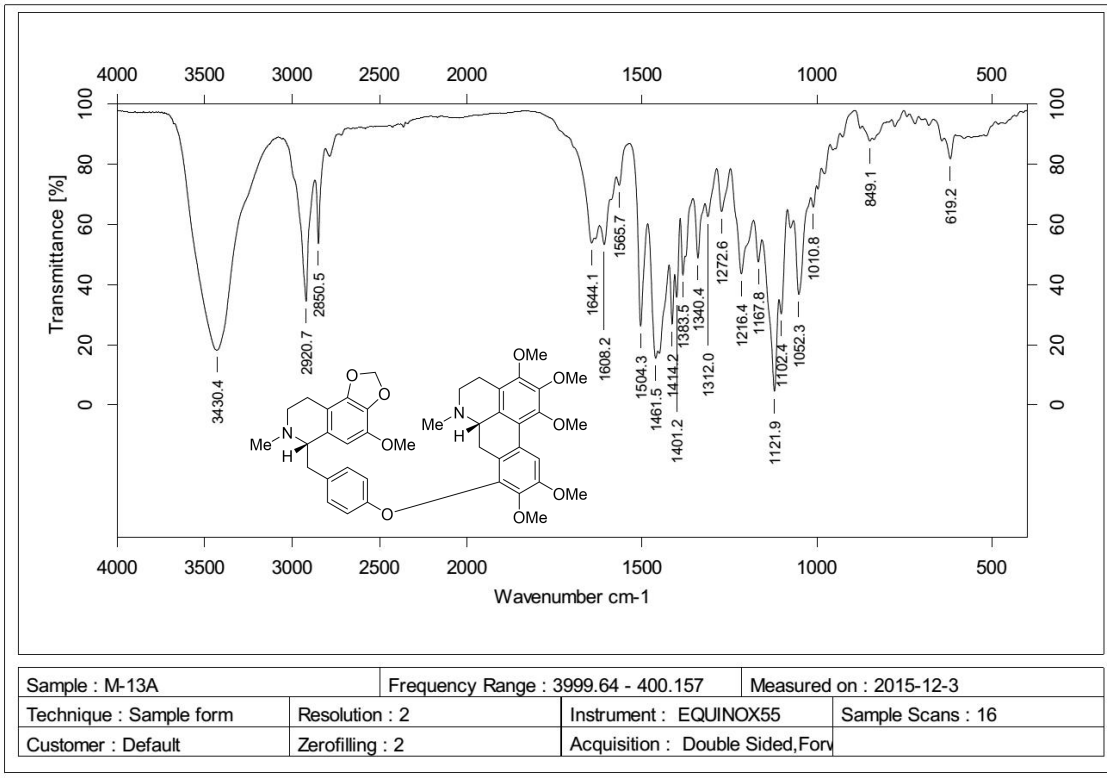


Figure S3.1. IR spectrum of compound **3**



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Customer : Default	Zerofilling : 2	Acquisition : Double Sided,For	

Figure S3.2. UV spectrum of compound **3**

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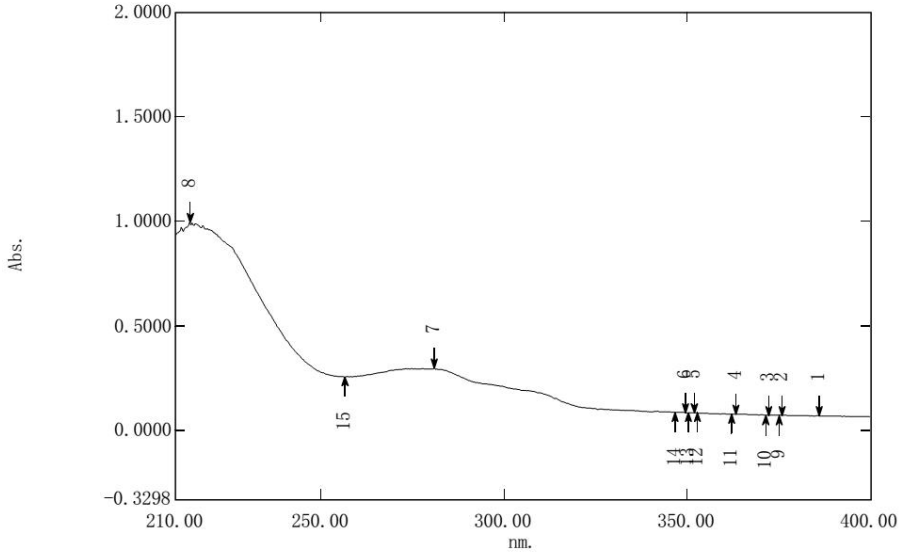

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自动采样间隔: 启用
扫描模式: 自动

试样准备属性
重量:
体积 :
稀释:
光程长:
附加信息:

仪器属性
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光源改变波长: 340.8 nm
S/R 转换: 标准

附件属性
附件: 无

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Figure S3.3. ^{1}H NMR (600 MHz, $CDCl_3$) spectrum of compound **3**

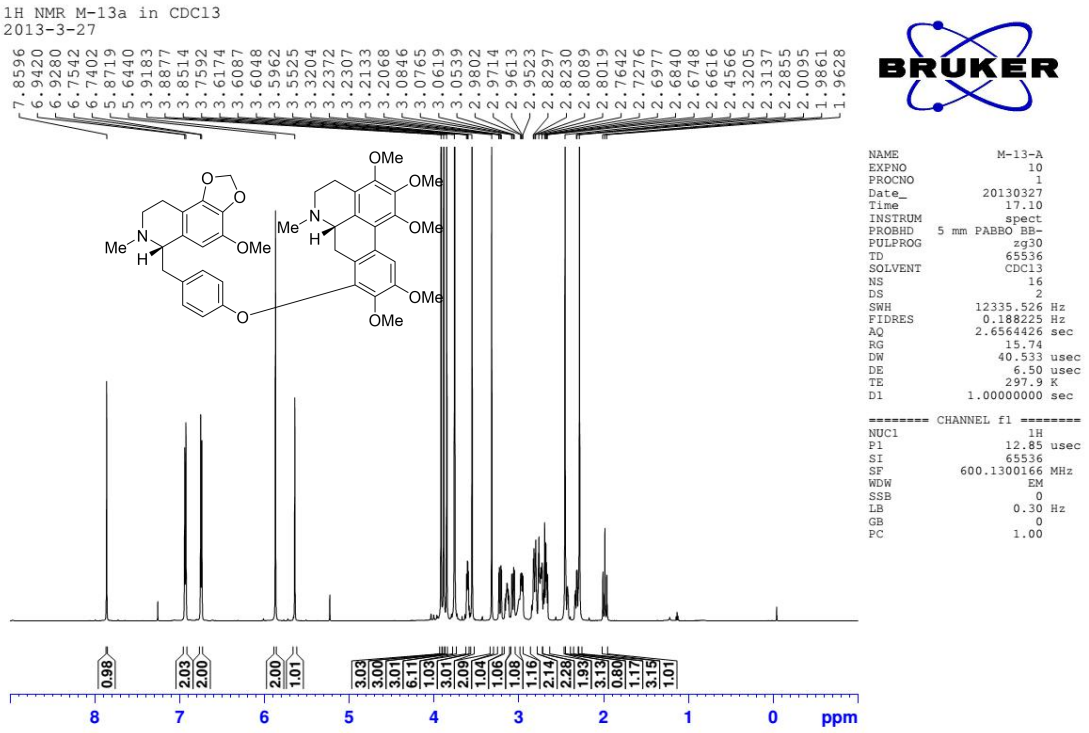


Figure S3.4. ^{13}C NMR (150 MHz, $CDCl_3$) spectrum of compound **3**

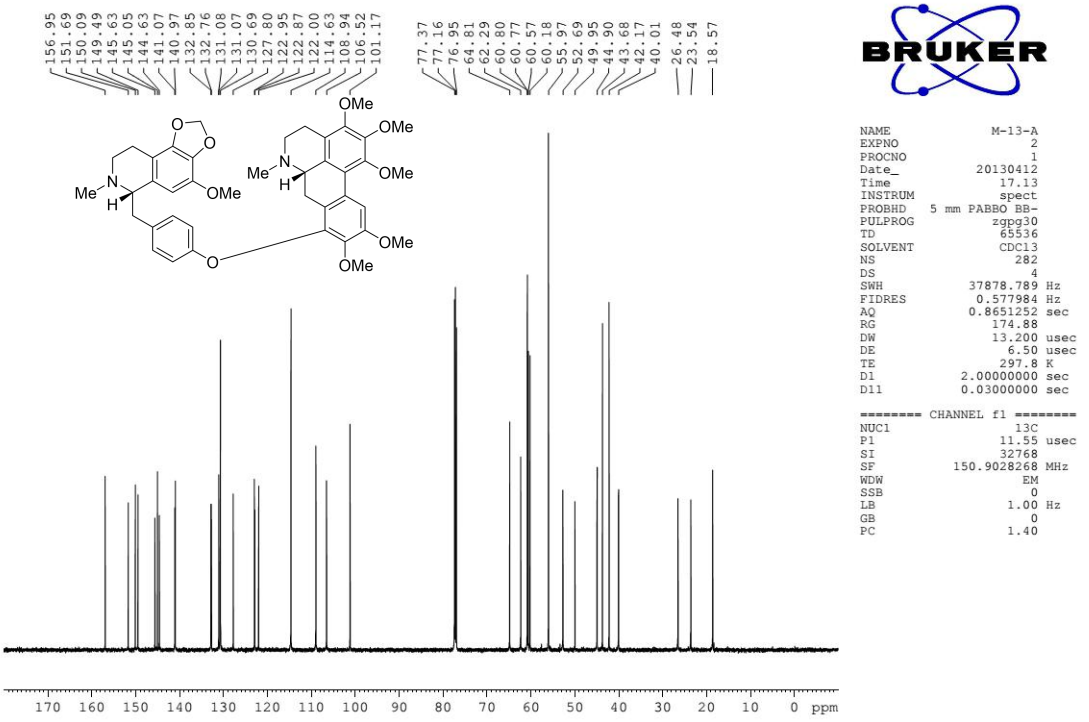


Figure S3.5. HSQC (600 MHz, $CDCl_3$) spectrum of compound **3**

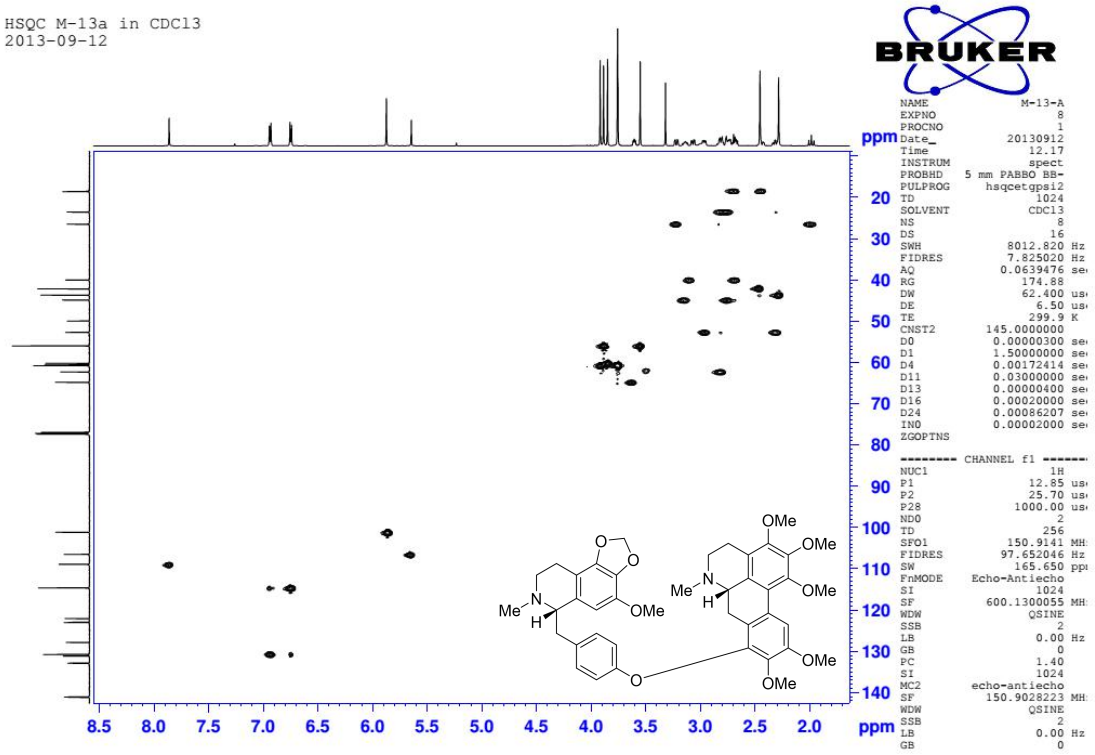


Figure S3.6. HMBC (600 MHz, $CDCl_3$) spectrum of compound **3**

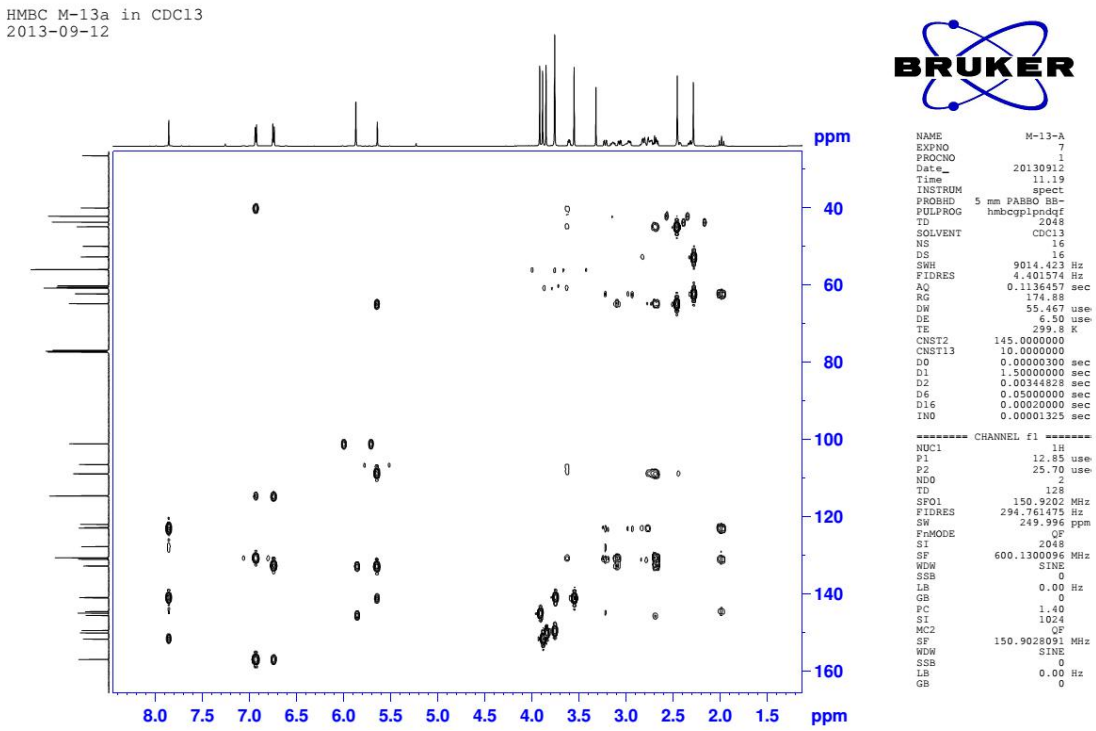


Figure S3.7. NOESY (600 MHz, $CDCl_3$) spectrum of compound **3**

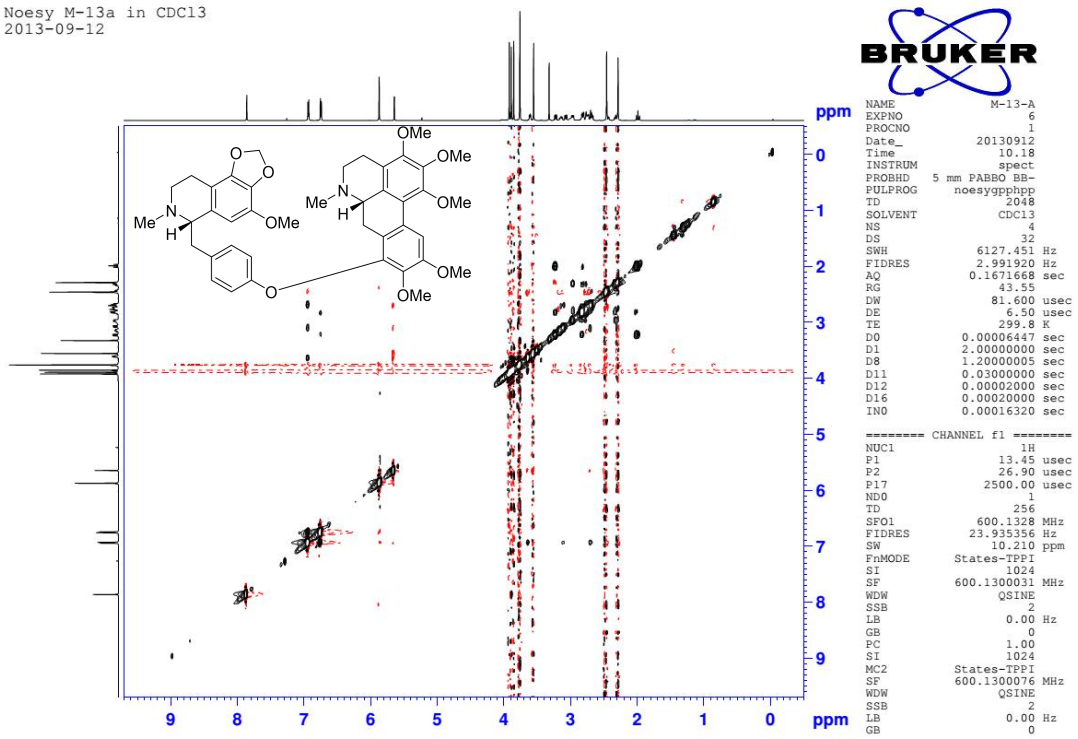
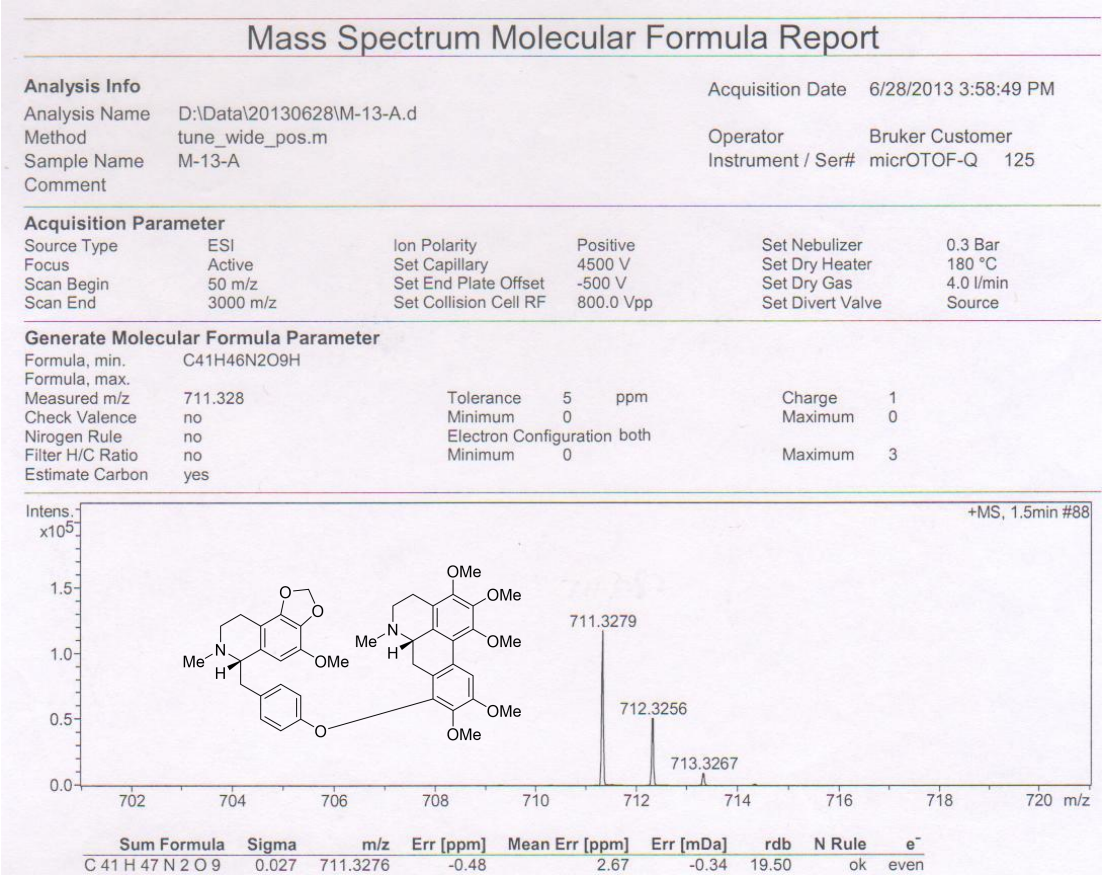


Figure S3.8. HRESIMS of compound **3**



Mass Spectrum Molecular Formula Report

Analysis Info

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Sample Name	M-13-A	Instrument / Ser#	micrOTOF-Q 125
Comment			

Acquisition Parameter

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Scan End	3000 m/z	Set Collision Cell RF	800.0 Vpp	Set Divert Valve	Source

Generate Molecular Formula Parameter

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Formula, max.					
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Nirogen Rule	no	Electron Configuration	both		
Filter H/C Ratio	no	Minimum	0	Maximum	3
Estimate Carbon	yes				

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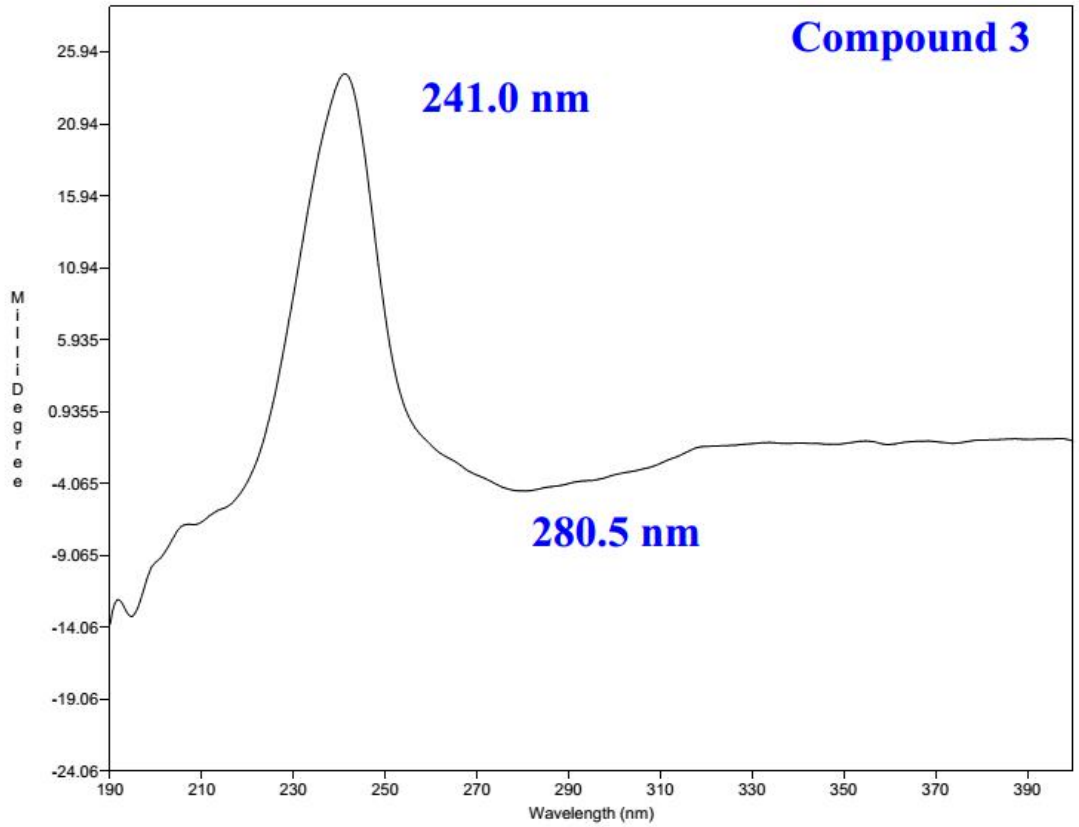
Figure S3.9. ECD spectrum of compound **3**



Bio-Kine Software V4.71 Date : 2014-3-7 Time : 13:25:08

COMMENTS :
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Savitzky-Golay Smooth of sav-golay
Window Points=15
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Figure S3.10. Key HMBC correlations of compound **3**

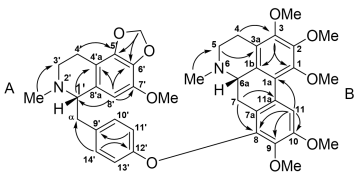


Figure S3.11. Key NOESY correlations of compound **3**

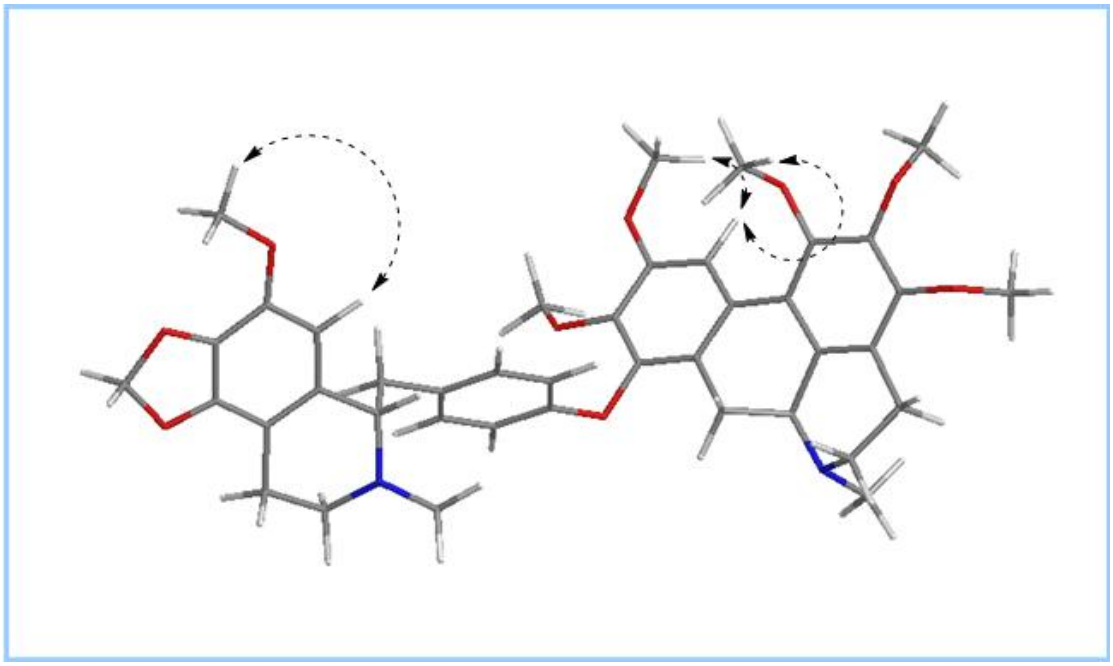
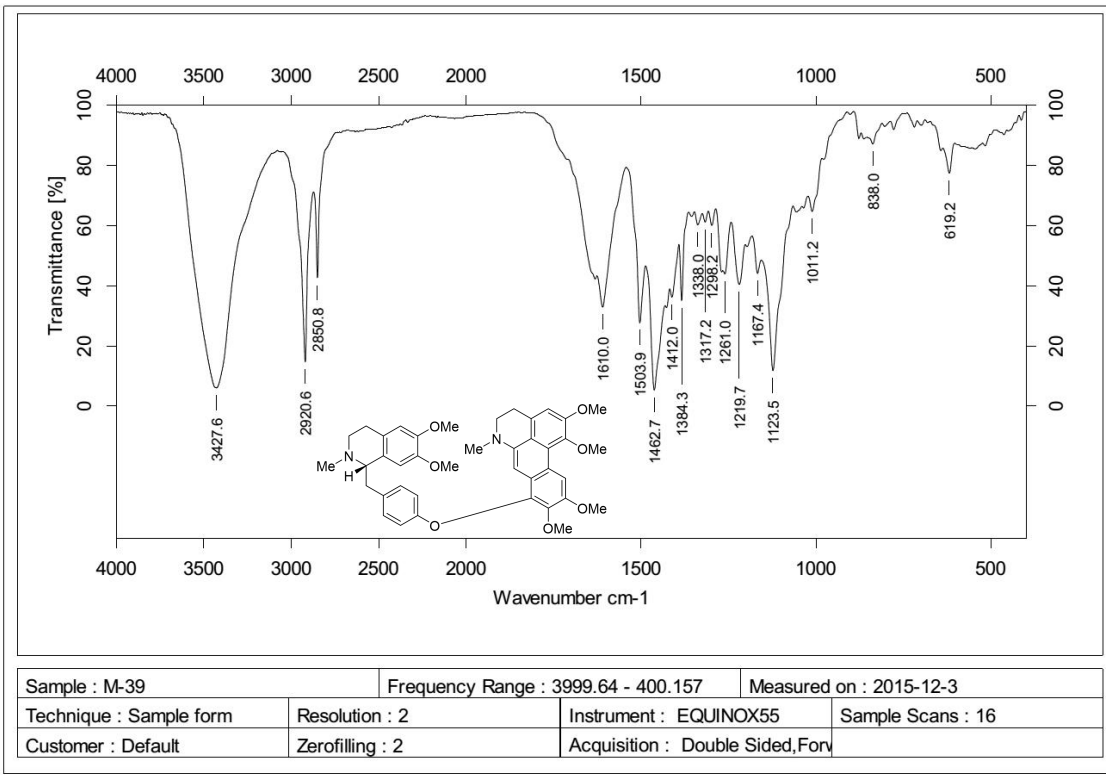


Figure S4.1. IR spectrum of compound **7**



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Customer : Default	Zerofilling : 2	Acquisition : Double Sided,For	

Figure S4.2. UV spectrum of compound **7**

Spectrum Peak Pick Report

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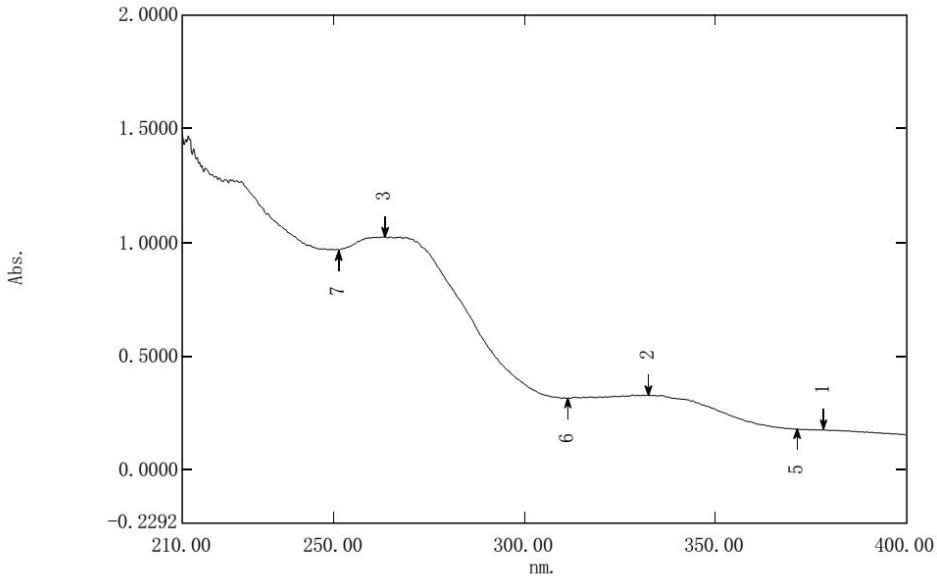

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采样间隔: 0.2
自动采样间隔: 启用
扫描模式: 自动

试样准备属性
重量:
体积 :
稀释:
光程长:
附加信息:

仪器属性
仪器类型: UV-1700
测定方式: 吸收值
狭缝宽: 1.0 nm
光源改变波长: 340.8 nm
S/R 转换: 标准

附件属性
附件: 无

No.	P/V	Wavelength	Abs.	描述
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5	↓	371.60	.1785	
6	↓	311.20	.3147	
7	↓	251.20	.9670	
8	↓	202.60	2.6903	

FIELD TEXT

Figure S4.3. ^{1}H NMR (600 MHz, $CDCl_3$) spectrum of compound **7**

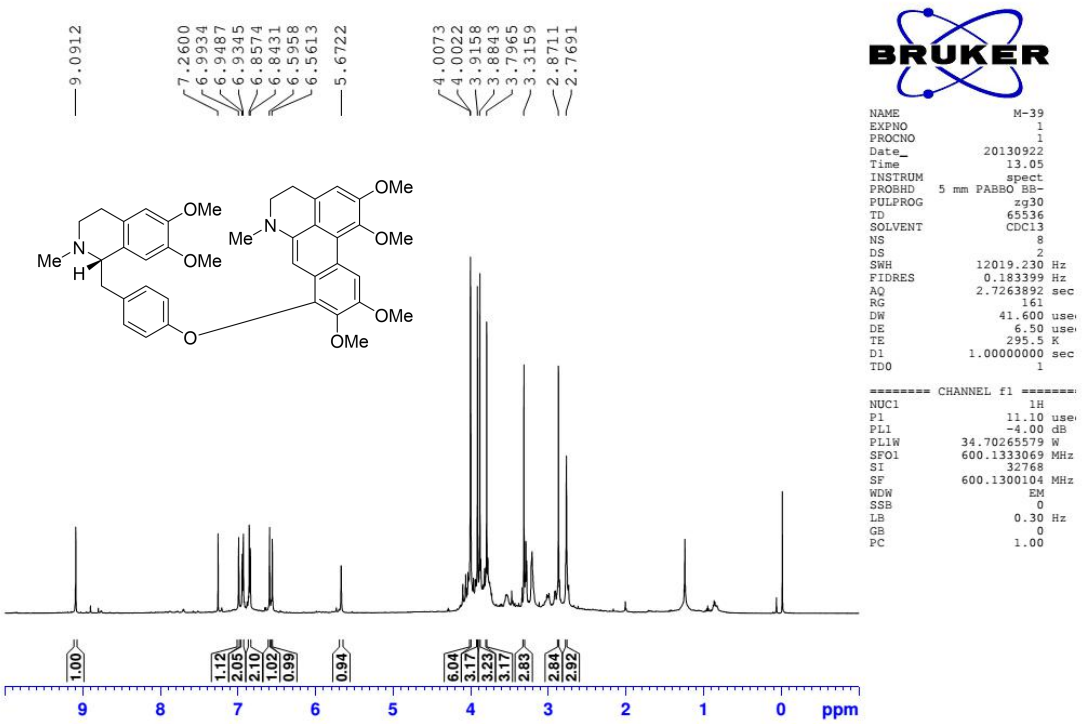


Figure S4.4. ^{13}C NMR (150 MHz, $CDCl_3$) spectrum of compound **7**

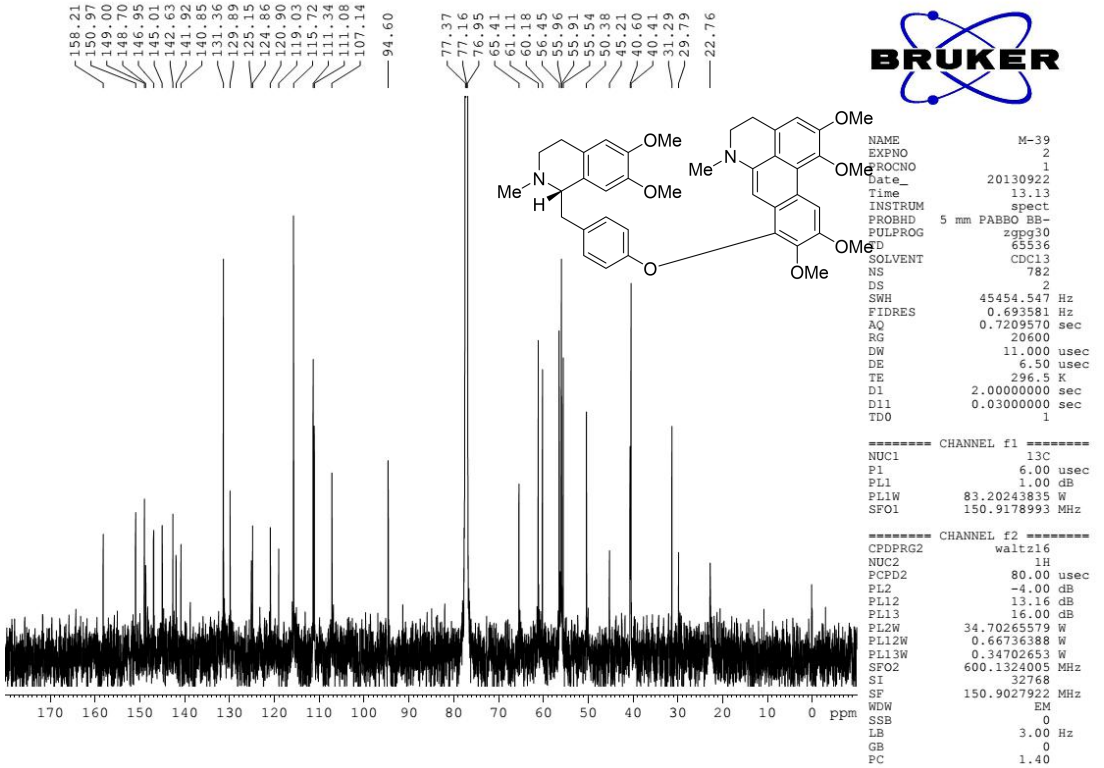


Figure S4.5. HSQC (600 MHz, $CDCl_3$) spectrum of compound **7**

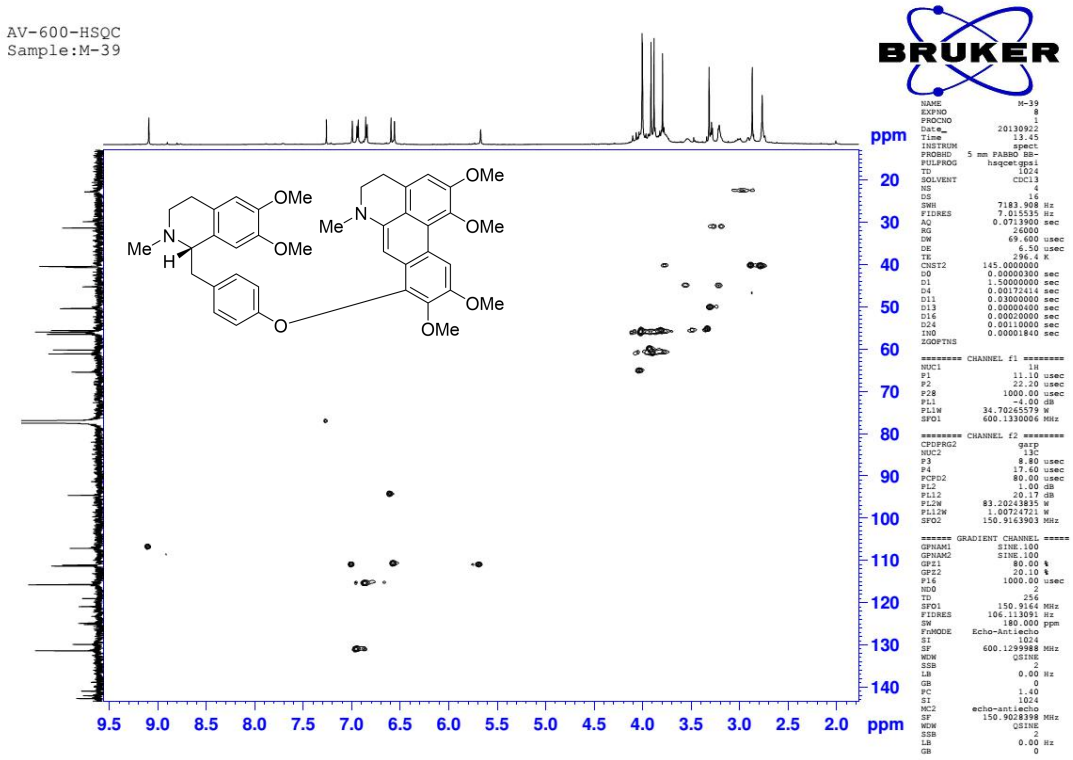


Figure S4.6. HMBC (600 MHz, $CDCl_3$) spectrum of compound **7**

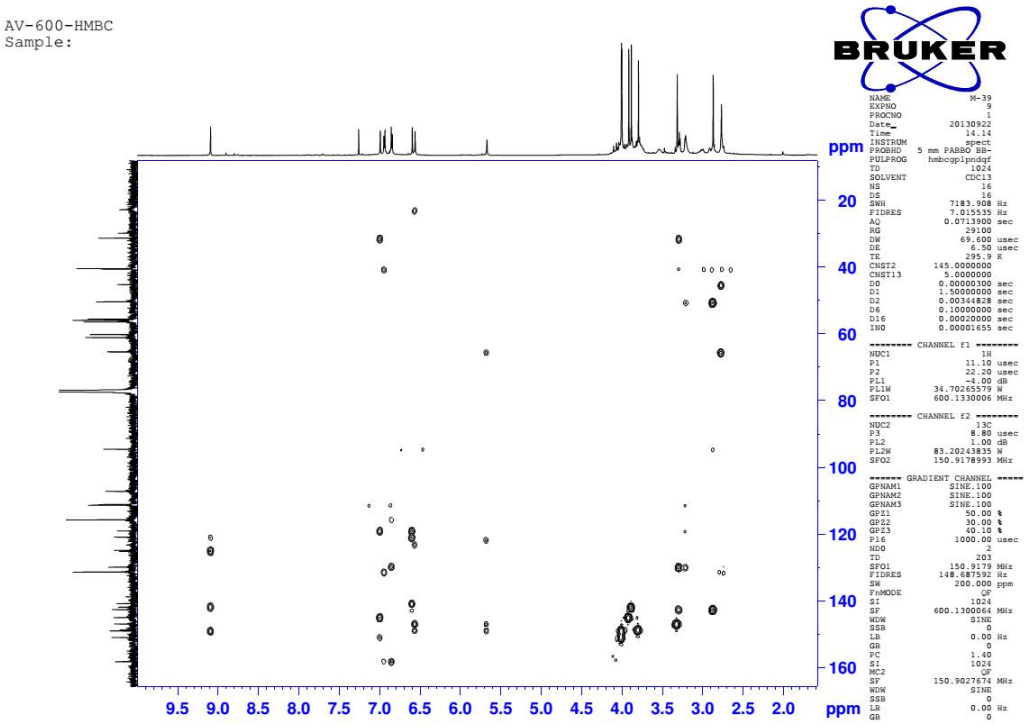


Figure S4.7. HRESIMS of compound **7**

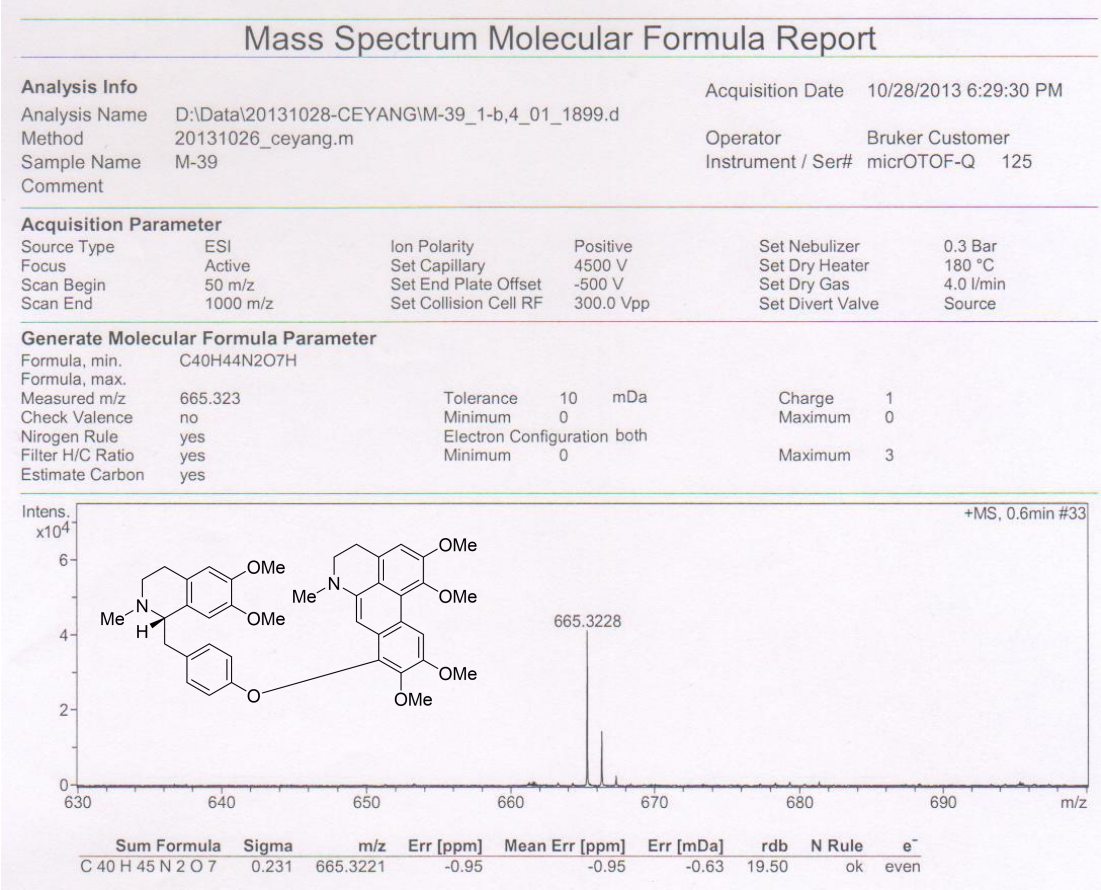
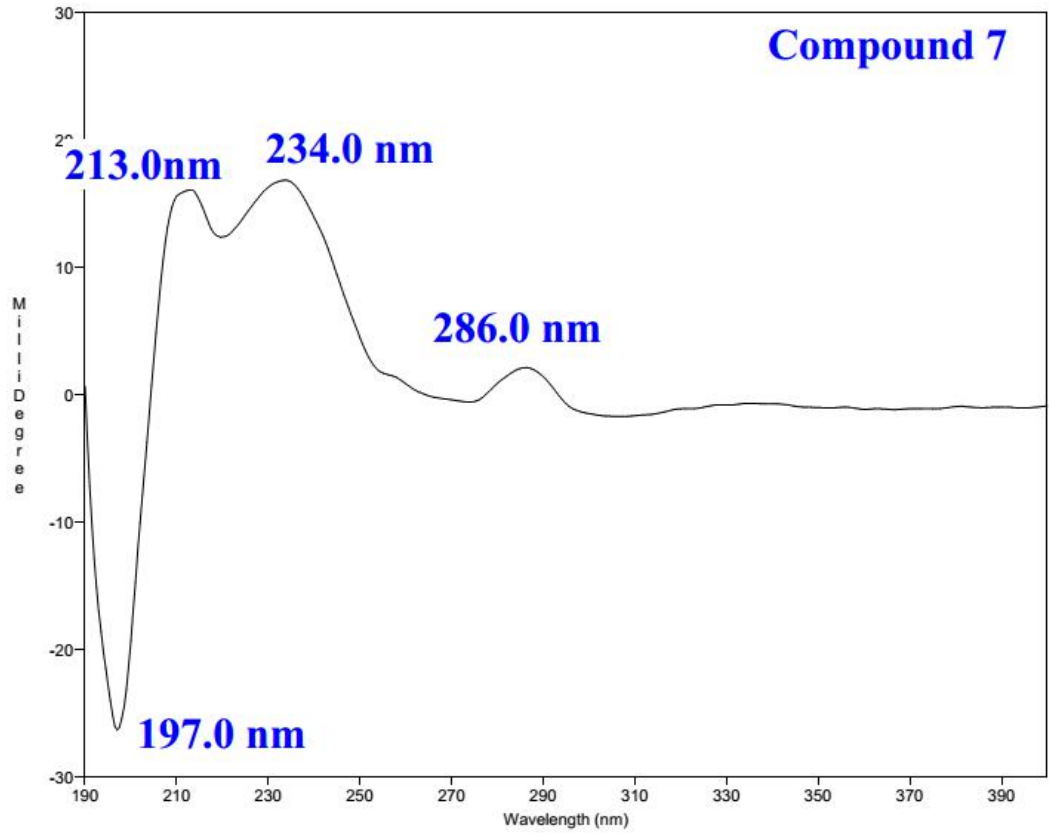


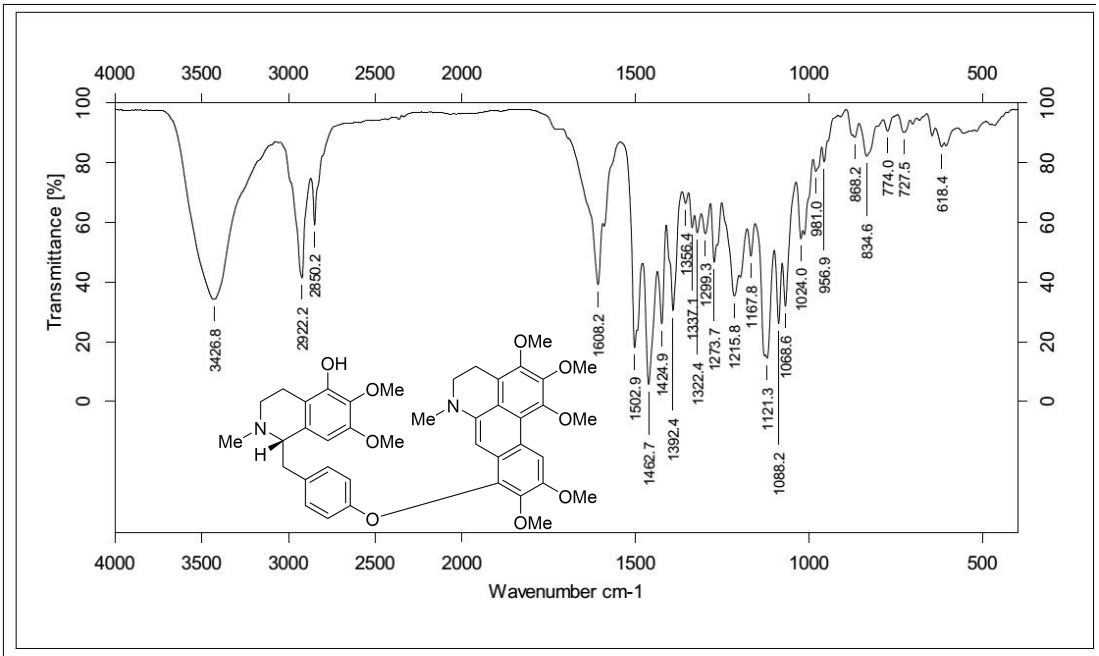
Figure S4.8. ECD spectrum of compound **7**



Bio-Kine Software V4.71 Date : 2014-3-7 Time : 14:28:30

COMMENTS :
File name : sav-golay
Savitzky-Golay Smooth of sav-golay
Window Points=15
Polynomial Order=3
Derivative=0

Figure S5.1. IR spectrum of compound **8**



Sample : M-20	Frequency Range : 3999.64 - 400.157	Measured on : 2015-12-3	
Technique : Sample form	Resolution : 2	Instrument : EQUINOX55	Sample Scans : 16
Customer : Default	Zerofilling : 2	Acquisition : Double Sided,Forv	

Figure S5.2. UV spectrum of compound **8**

Spectrum Peak Pick Report

FIELD FIELD TEXT

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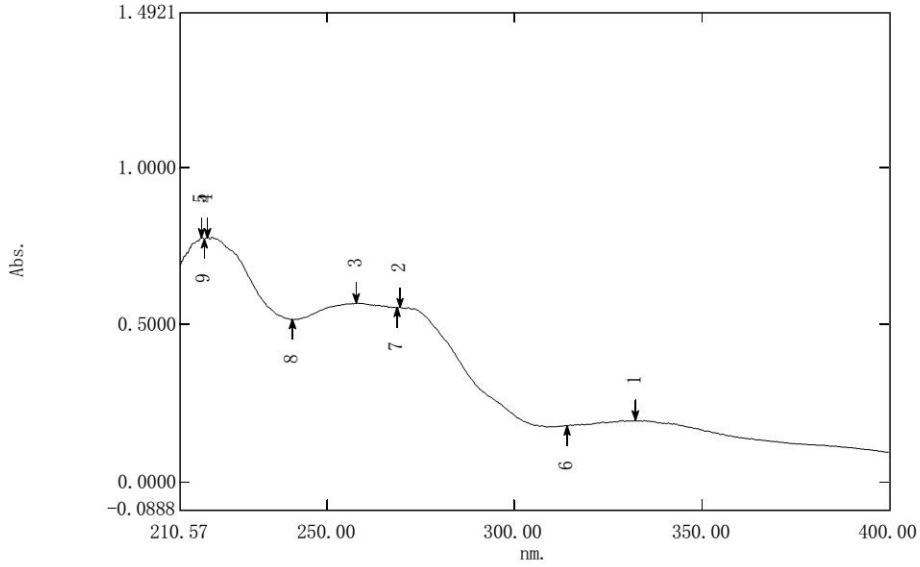

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扫描速度: 高速
采样间隔: 0.2
自动采样间隔: 启用
扫描模式: 自动

试样准备属性
重量:
体积 :
稀释:
光程长:
附加信息:

仪器属性
仪器类型: UV-1700
测定方式: 吸收值
狭缝宽: 1.0 nm
光源改变波长: 340.8 nm
S/R 转换: 标准

附件属性
附件: 无

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3	↑	257.60	.5682	
4	↑	218.00	.7784	
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6	↓	314.00	.1774	
7	↓	268.60	.5520	
8	↓	240.60	.5142	
9	↓	217.00	.7716	
10	↓	205.80	.5170	

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Figure S5.3. ^{1}H NMR (600 MHz, $CDCl_3$) spectrum of compound **8**

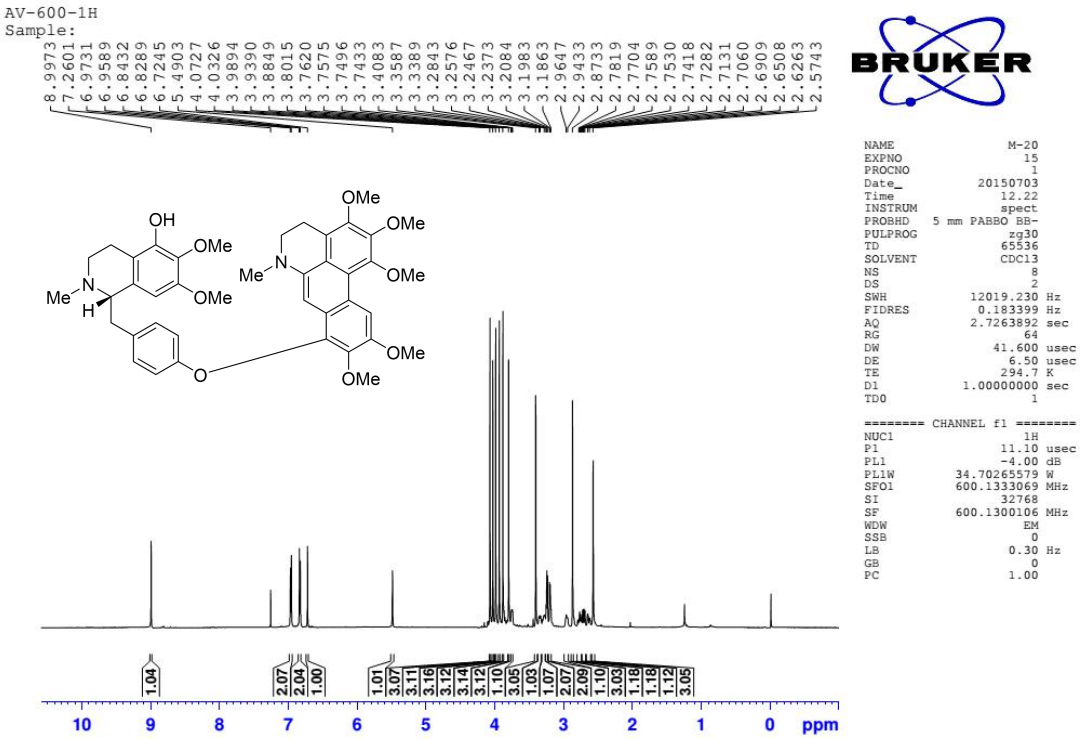


Figure S5.4. ^{13}C NMR (150 MHz, $CDCl_3$) spectrum of compound **8**

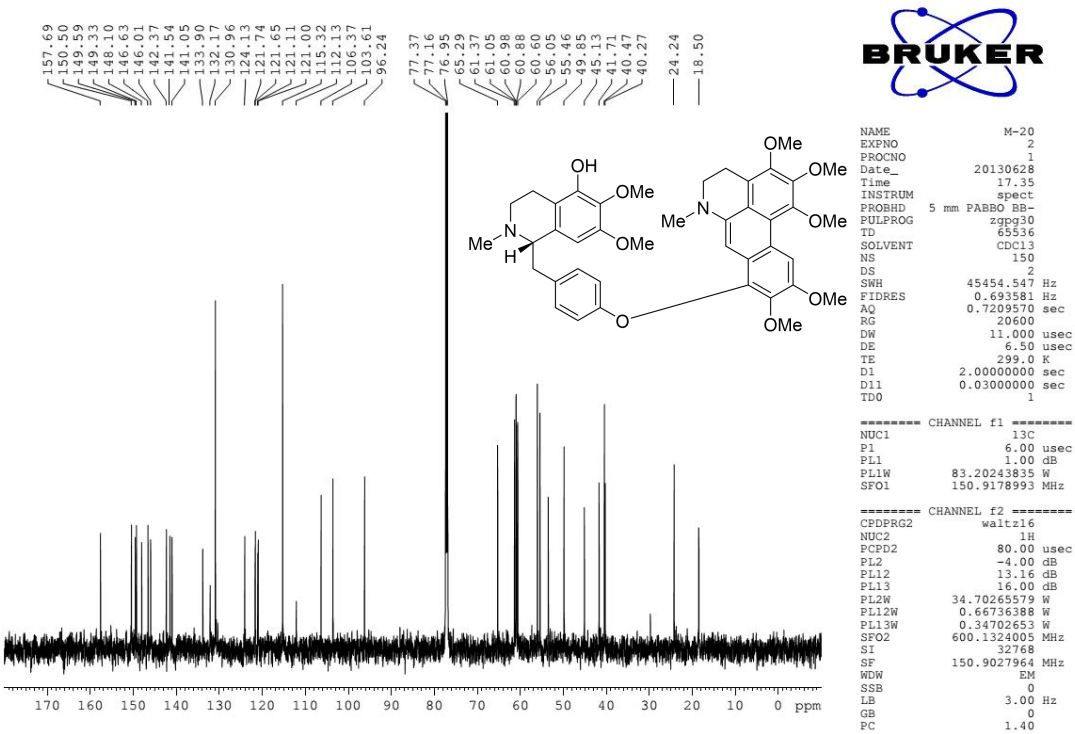


Figure S5.5. HSQC (600 MHz, $CDCl_3$) spectrum of compound **8**

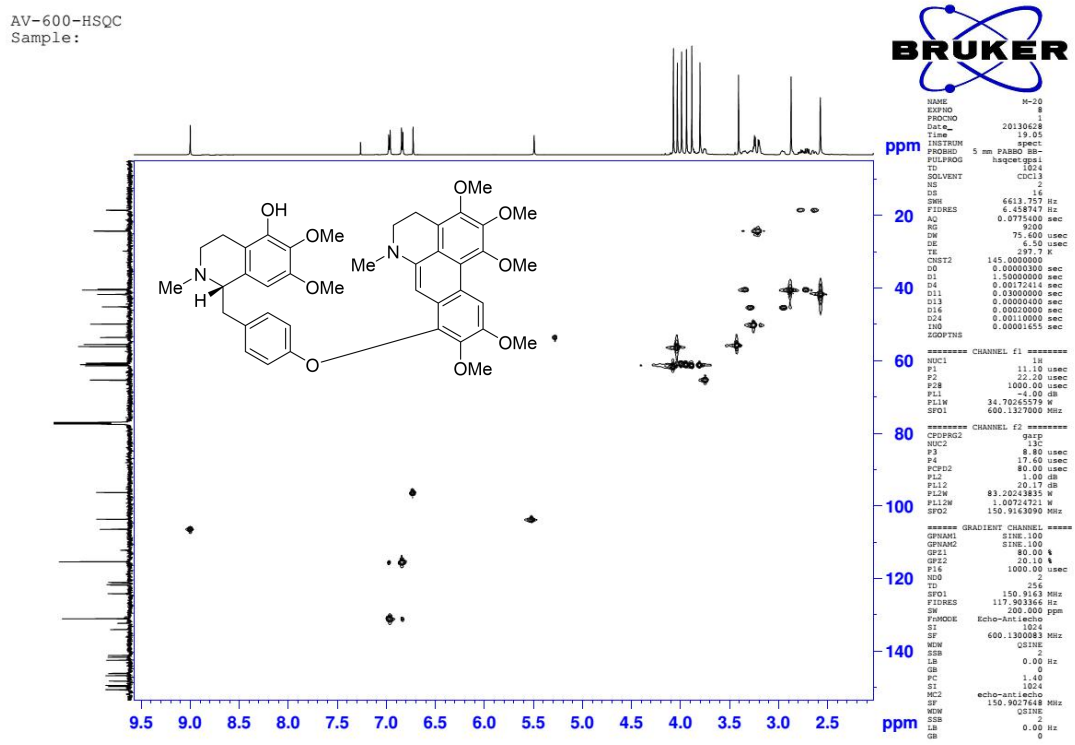


Figure S5.6. HMBC (600 MHz, $CDCl_3$) spectrum of compound **8**

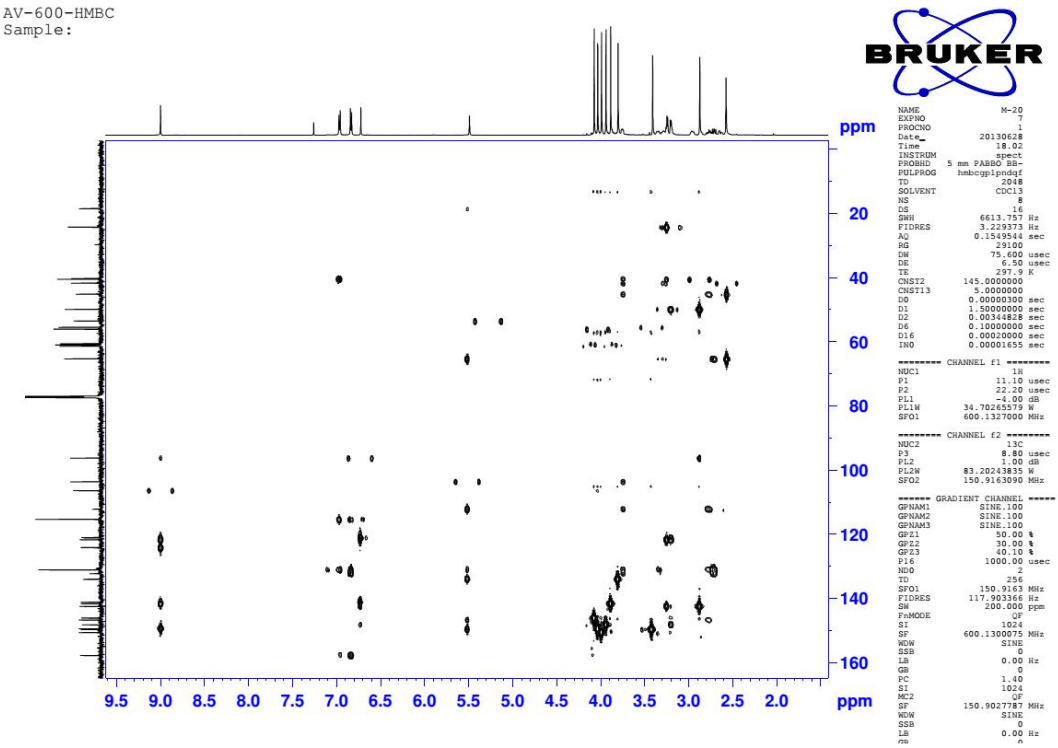


Figure S5.7. NOESY (600 MHz, $CDCl_3$) spectrum of compound **8**

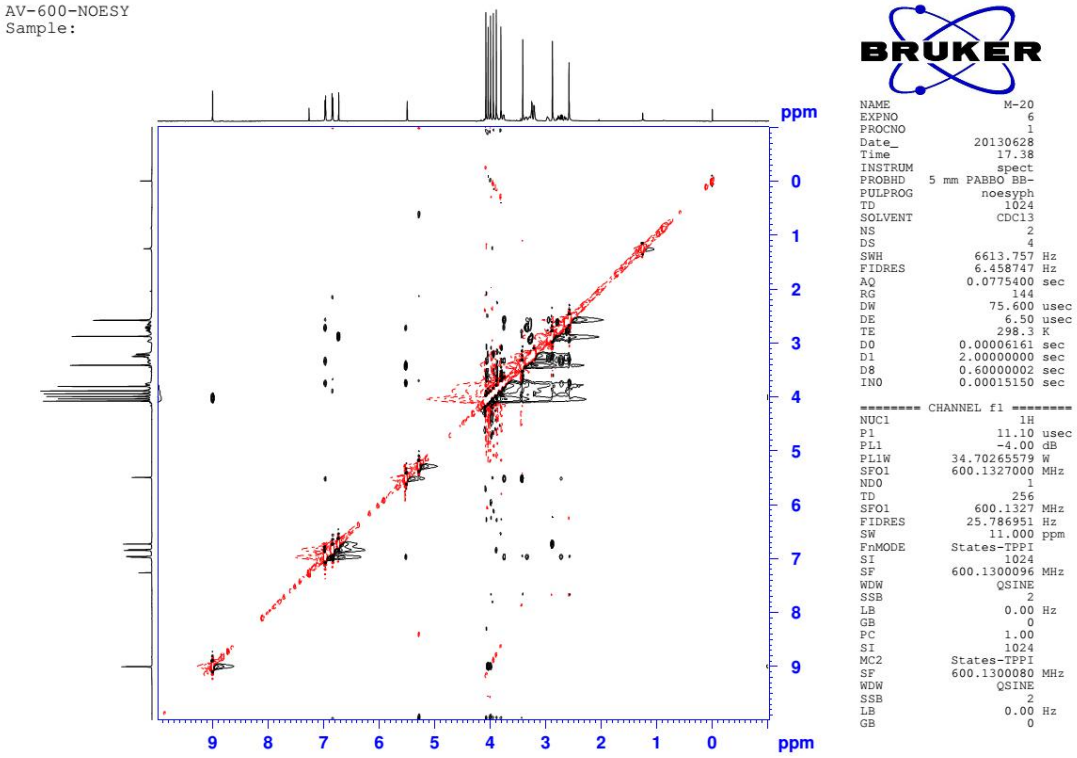


Figure S5.8. HRESIMS of compound **8**

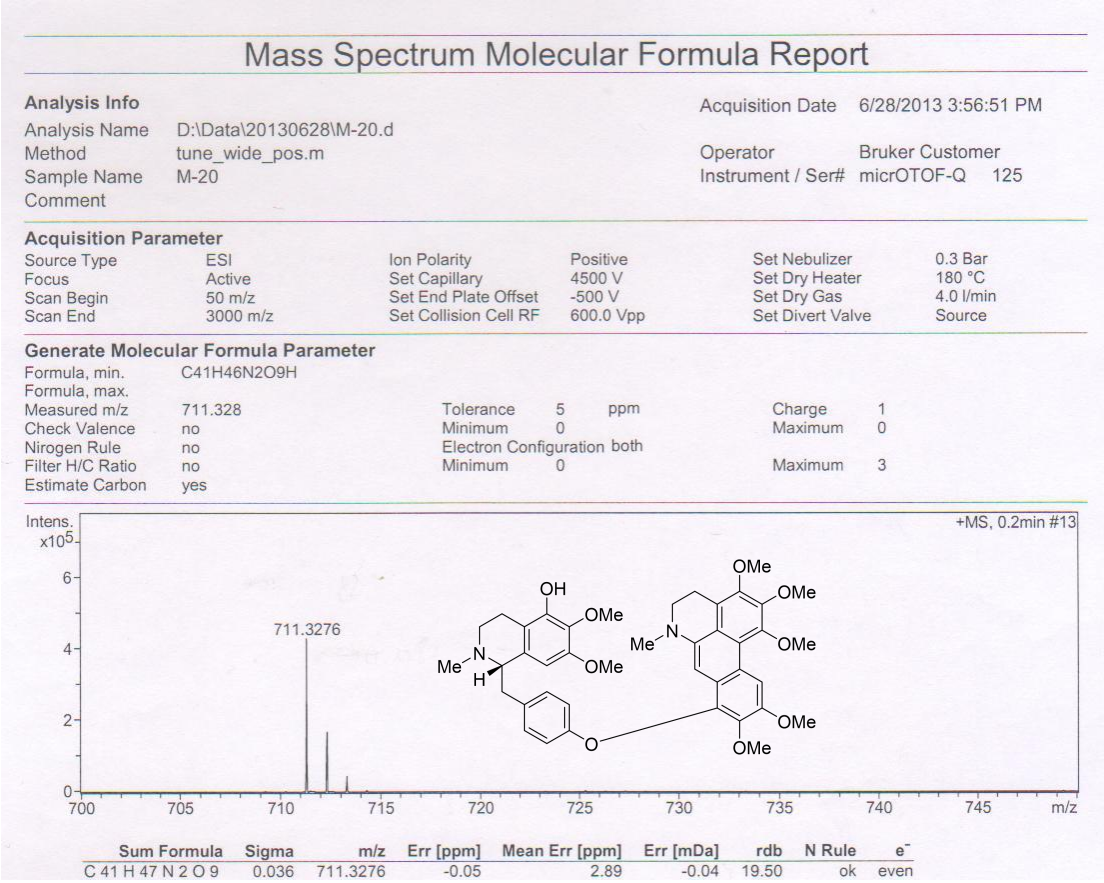
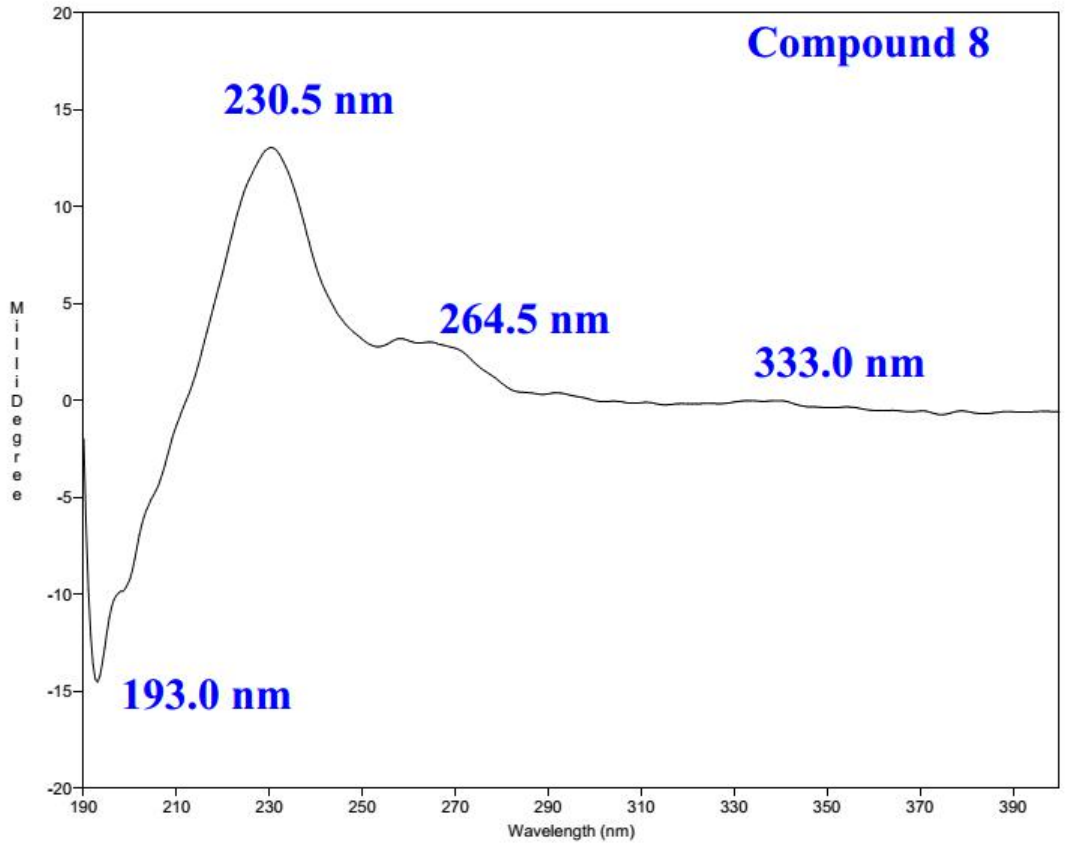


Figure S5.9. ECD spectrum of compound **8**



Bio-Kine Software V4.71 Date : 2014-3-7 Time : 13:48:40

COMMENTS :
File name : sav-golay
Savitzky-Golay Smooth of sav-golay
Window Points=15
Polynomial Order=3
Derivative=0

Figure S5.10. Key HMBC correlations of compound **8**

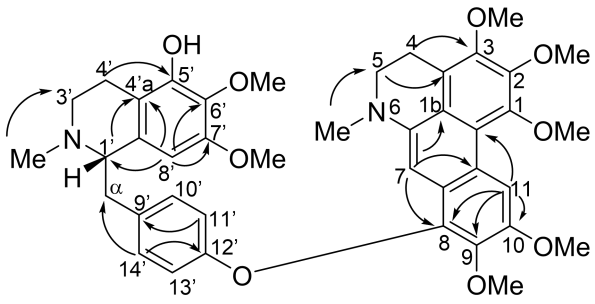


Figure S5.11. Key NOESY correlations of compound **8**

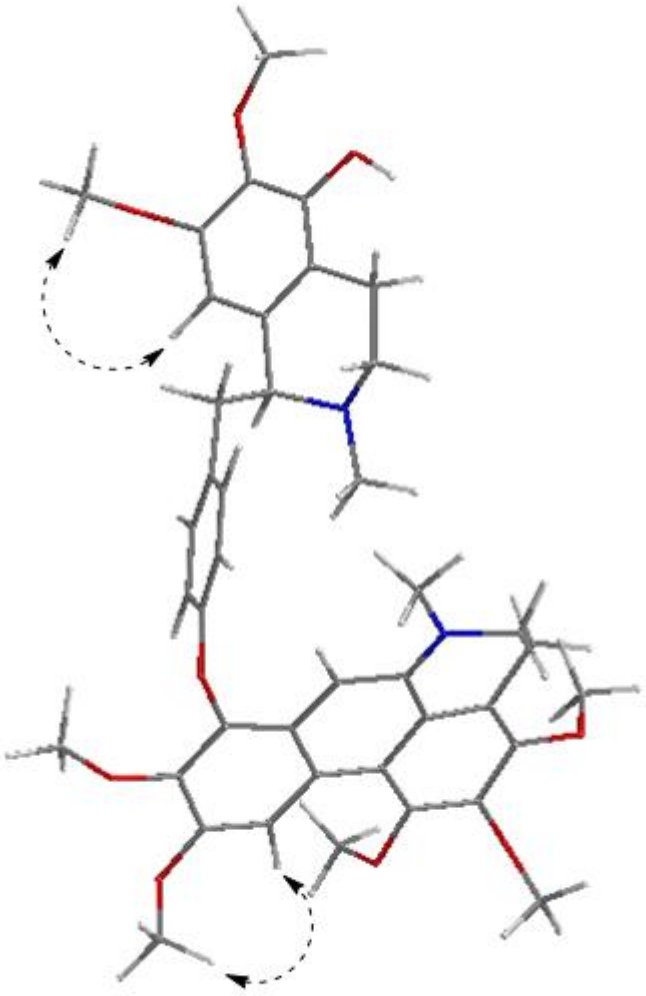
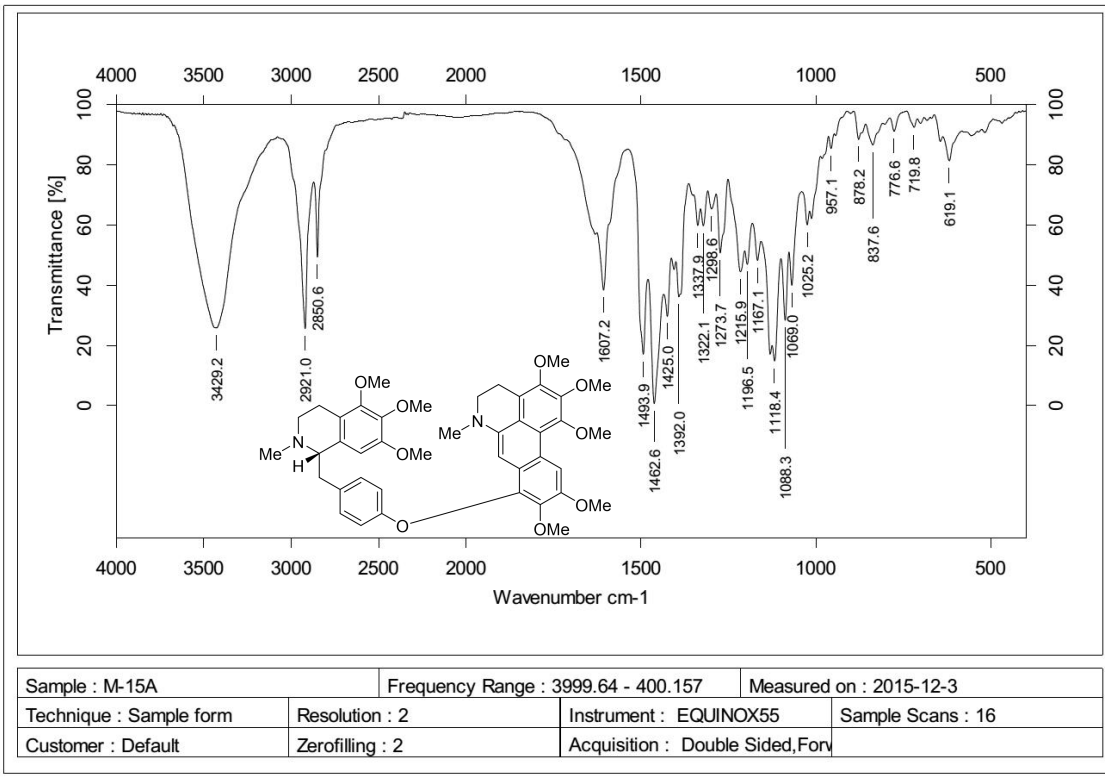


Figure S6.1. IR spectrum of compound **9**



Sample : M-15A	Frequency Range : 3999.64 - 400.157	Measured on : 2015-12-3	
Technique : Sample form	Resolution : 2	Instrument : EQUINOX55	Sample Scans : 16
Customer : Default	Zerofilling : 2	Acquisition : Double Sided,For	

Figure S6.2. UV spectrum of compound **9**

Spectrum Peak Pick Report

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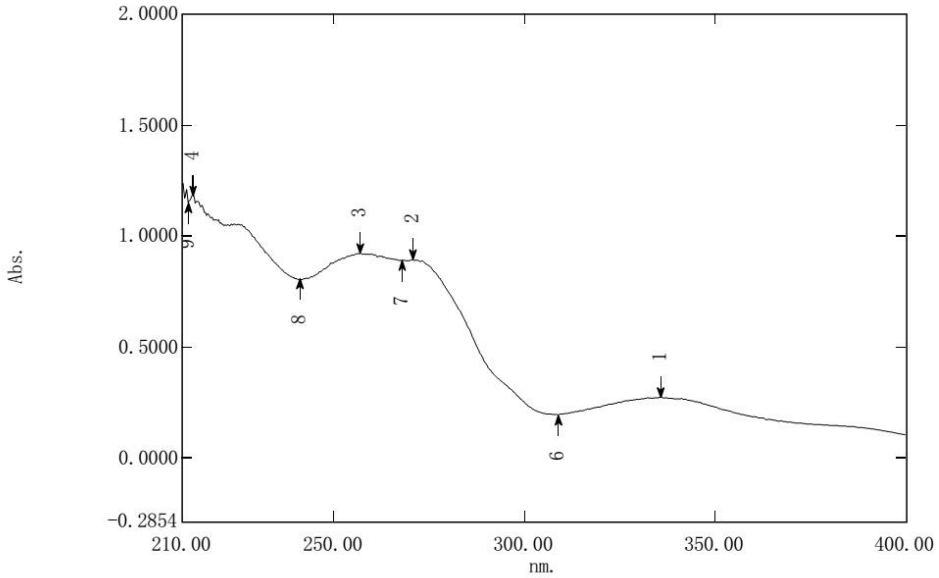

测定属性
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扫描速度: 高速
采样间隔: 0.2
自动采样间隔: 启用
扫描模式: 自动

试样准备属性
重量:
体积 :
稀释:
光程长:
附加信息:

仪器属性
仪器类型: UV-1700
测定方式: 吸收值
狭缝宽: 1.0 nm
光源改变波长: 340.8 nm
S/R 转换: 标准

附件属性
附件: 无

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2	↑	270.60	.8933	
3	↑	256.80	.9224	
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6	↓	308.80	.1930	
7	↓	267.60	.8859	
8	↓	240.80	.8030	
9	↓	211.60	1.1492	
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FIELD TEXT

Figure S6.3. ^{1}H NMR (600 MHz, $CDCl_3$) spectrum of compound **9**

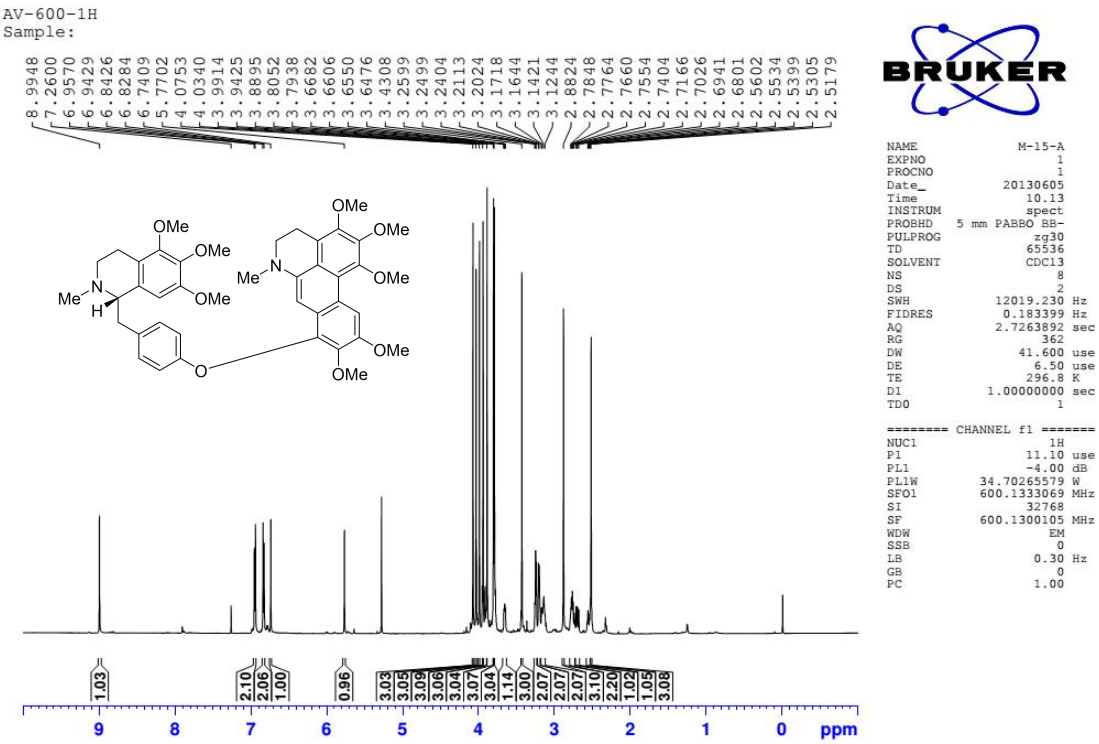


Figure S6.4. ^{13}C NMR (150 MHz, $CDCl_3$) spectrum of compound **9**

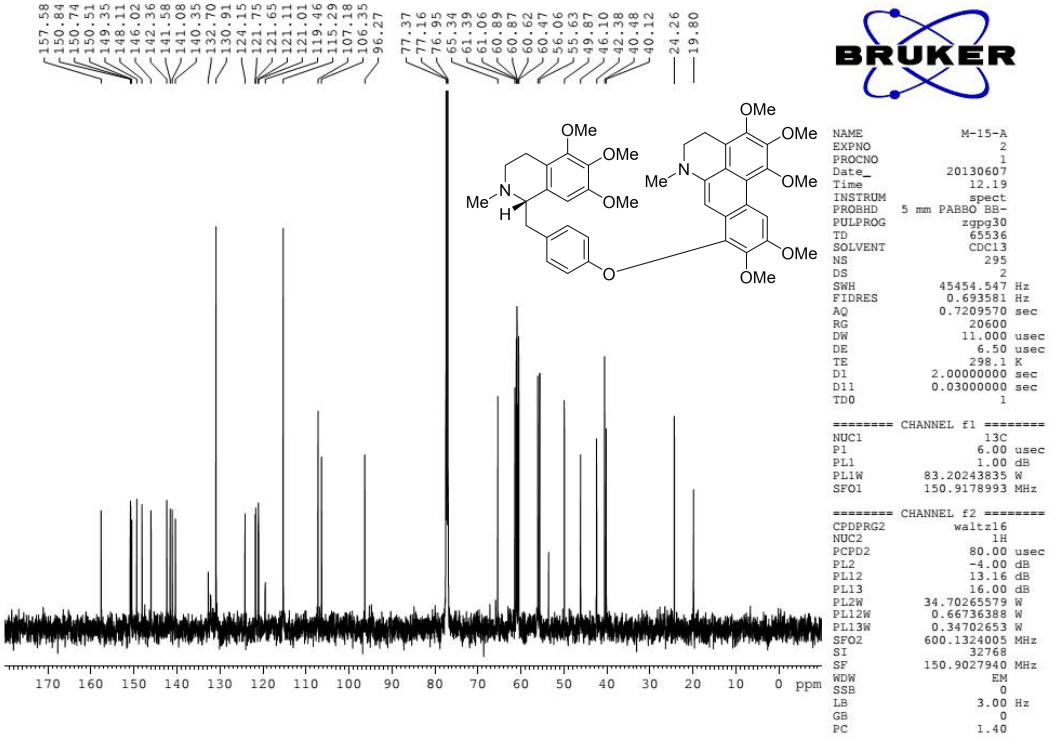


Figure S6.5. HSQC (600 MHz, $CDCl_3$) spectrum of compound **9**

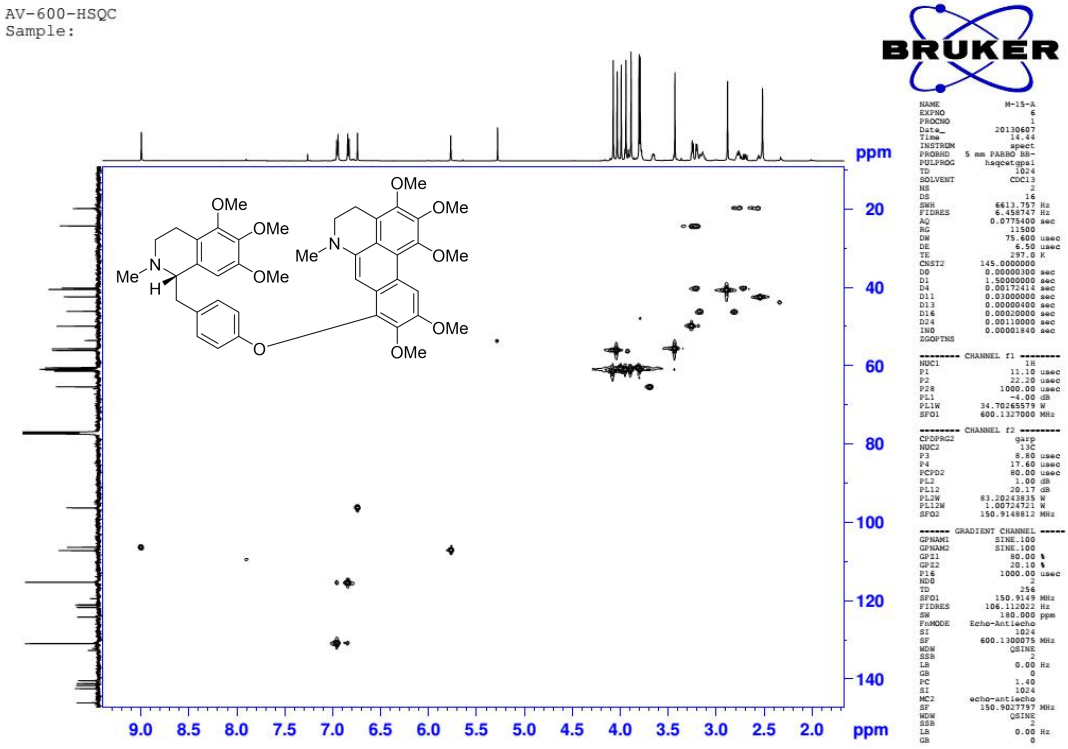


Figure S6.6. HMBC (600 MHz, $CDCl_3$) spectrum of compound **9**

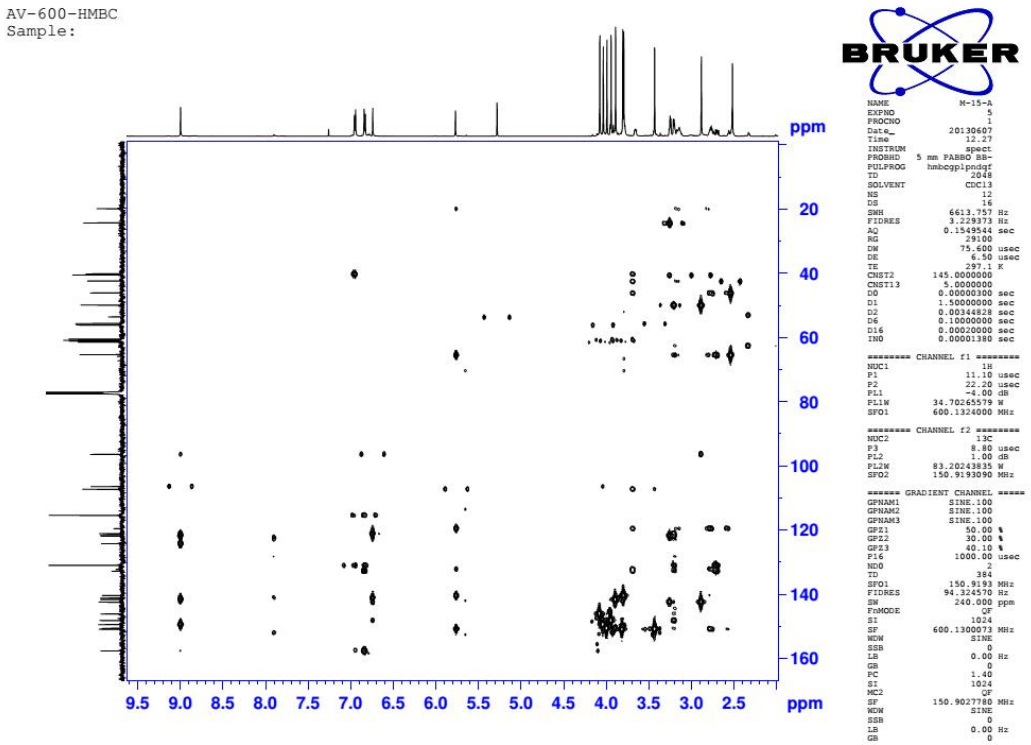
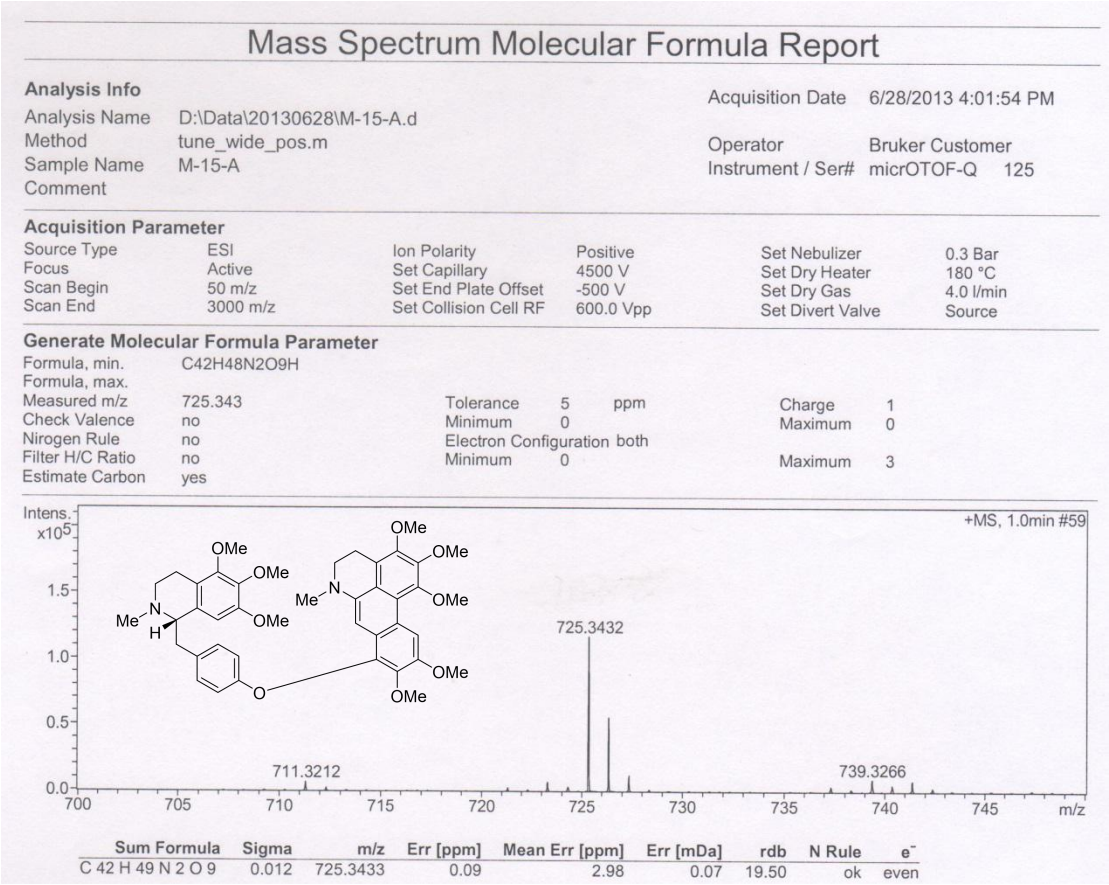


Figure S6.7. HRESIMS of compound **9**



Mass Spectrum Molecular Formula Report

Analysis Info

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Method	tune_wide_pos.m	Operator	Bruker Customer
Sample Name	M-15-A	Instrument / Ser#	micrOTOF-Q 125
Comment			

Acquisition Parameter

Source Type	ESI	Ion Polarity	Positive	Set Nebulizer	0.3 Bar
Focus	Active	Set Capillary	4500 V	Set Dry Heater	180 °C
Scan Begin	50 m/z	Set End Plate Offset	-500 V	Set Dry Gas	4.0 l/min
Scan End	3000 m/z	Set Collision Cell RF	600.0 Vpp	Set Divert Valve	Source

Generate Molecular Formula Parameter

Formula, min.	C42H48N2O9H				
Formula, max.					
Measured m/z	725.343	Tolerance	5 ppm	Charge	1
Check Valence	no	Minimum	0	Maximum	0
Nirogen Rule	no	Electron Configuration	both		
Filter H/C Ratio	no	Minimum	0	Maximum	3
Estimate Carbon	yes				

Sum Formula	Sigma	m/z	Err [ppm]	Mean Err [ppm]	Err [mDa]	rdb	N Rule	e⁻
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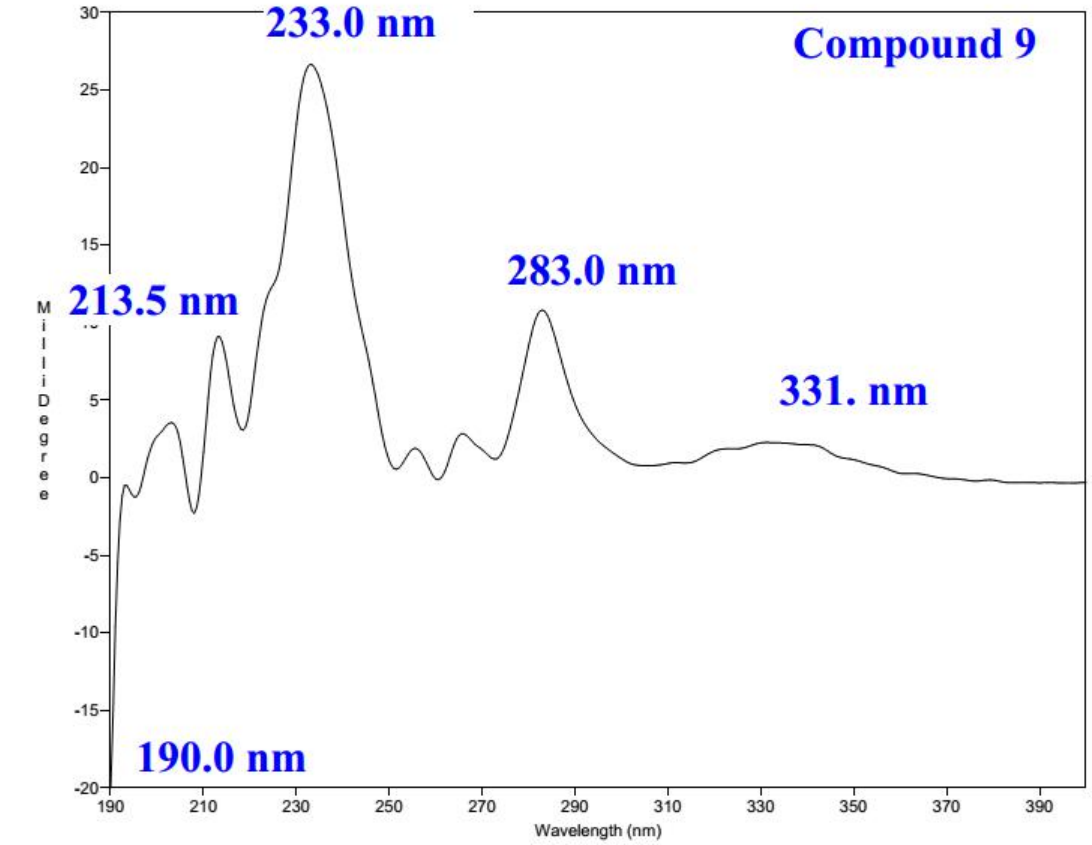
Figure S6.8. ECD spectrum of compound **9**



Bio-Kine Software V4.71 Date : 2014-3-7 Time : 13:30:38

COMMENTS :
File name : sav-golay
Savitzky-Golay Smooth of sav-golay
Window Points=15
Polynomial Order=3
Derivative=0

Figure S6.9. Key HMBC correlations of compound **9**

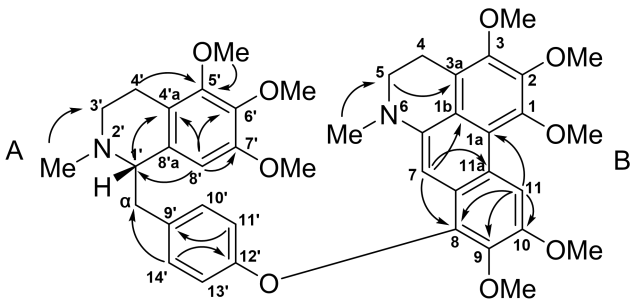
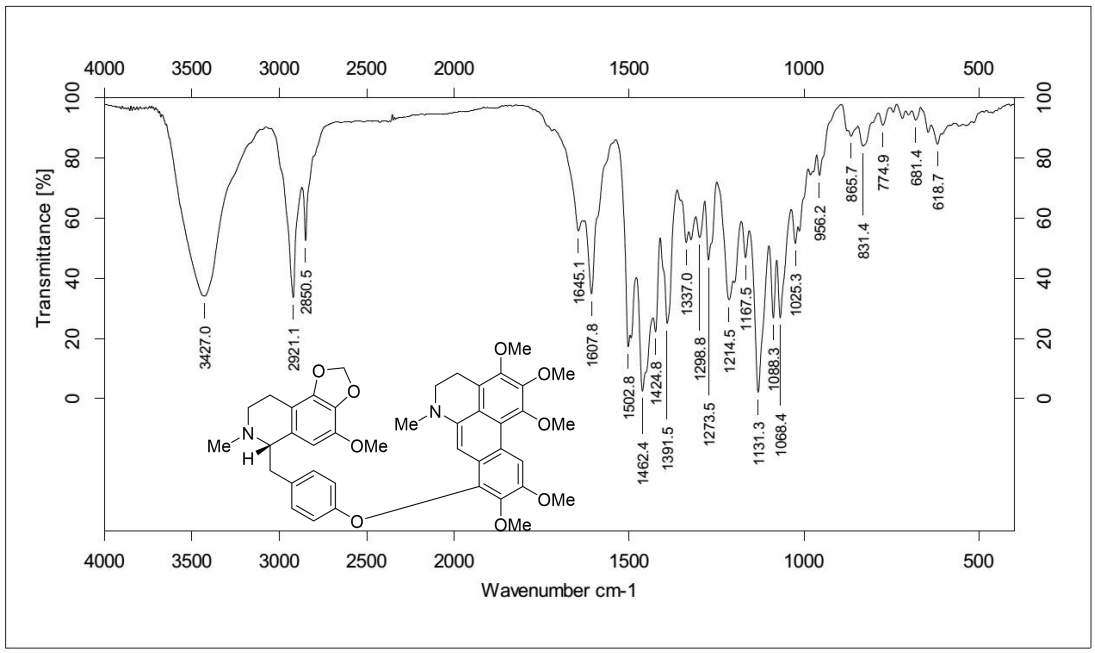


Figure S7.1. IR spectrum of compound **10**



Sample : M-26	Frequency Range : 3999.64 - 400.157	Measured on : 2015-12-3	
Technique : Sample form	Resolution : 2	Instrument : EQUINOX55	Sample Scans : 16
Customer : Default	Zerofilling : 2	Acquisition : Double Sided,For	

Figure S7.2. UV spectrum of compound **10**

Spectrum Peak Pick Report

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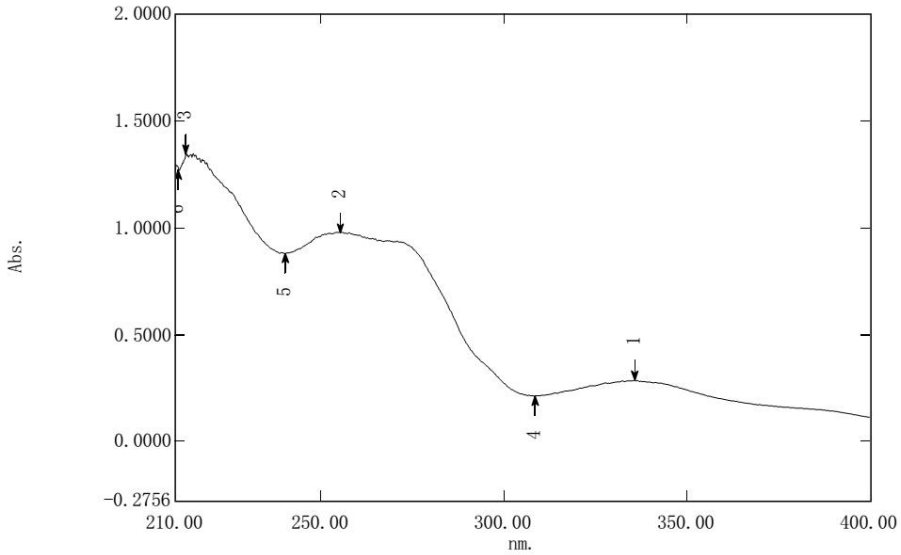

No.	P/V	Wavelength	Abs.	描述
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2	↑	255.00	.9792	
3	↑	213.00	1.3489	
4	↓	308.40	.2123	
5	↓	240.20	.8787	
6	↓	211.00	1.2686	

测定属性
波长范围 (nm.): 200.00到400.00
扫描速度: 高速
采样间隔: 0.2
自动采样间隔: 启用
扫描模式: 自动

试样准备属性
重量:
体积 :
稀释:
光程长:
附加信息:

仪器属性
仪器类型: UV-1700
测定方式: 吸收值
狭缝宽: 1.0 nm
光源改变波长: 340.8 nm
S/R 转换: 标准

附件属性
附件: 无

FIELD TEXT

Figure S7.3. ^{1}H NMR (600 MHz, $CDCl_3$) spectrum of compound **10**

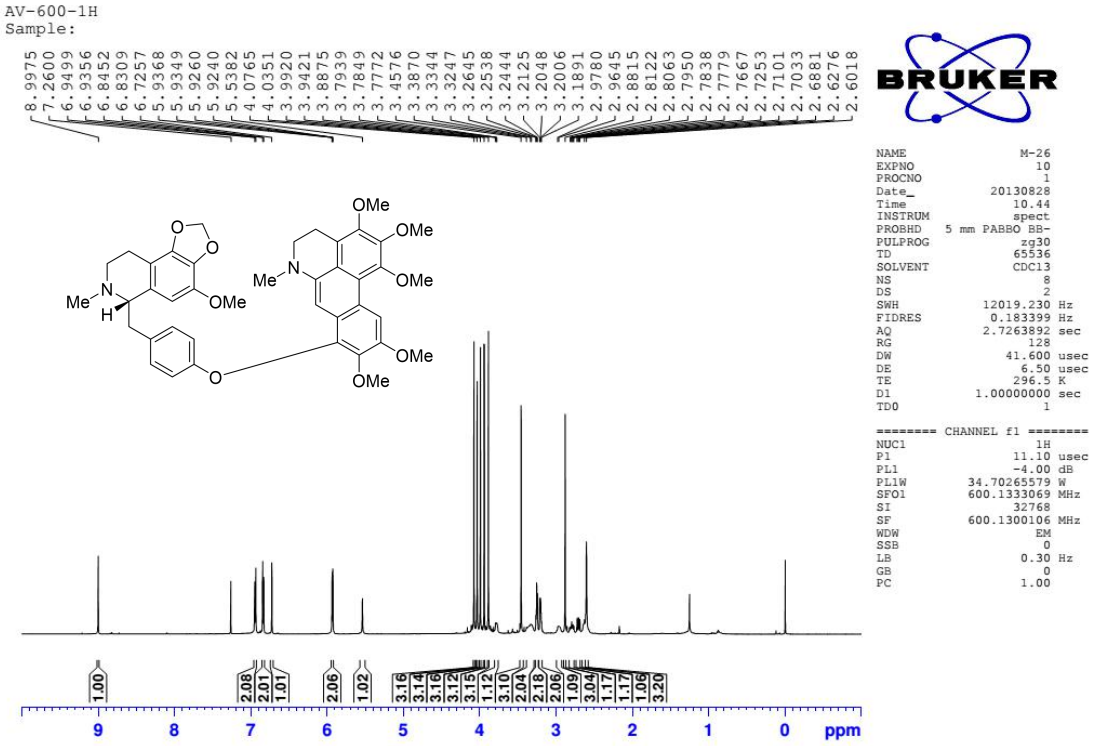


Figure S7.4. ^{13}C NMR (150 MHz, $CDCl_3$) spectrum of compound **10**

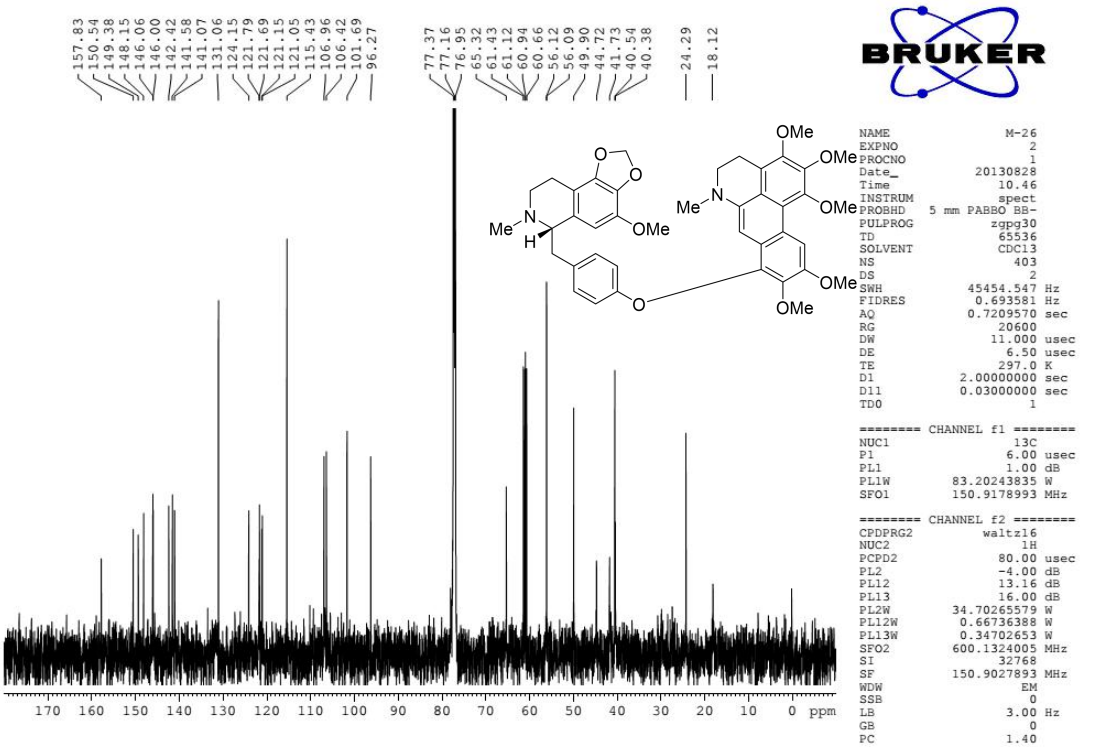


Figure S7.5. HSQC (600 MHz, $CDCl_3$) spectrum of compound **10**

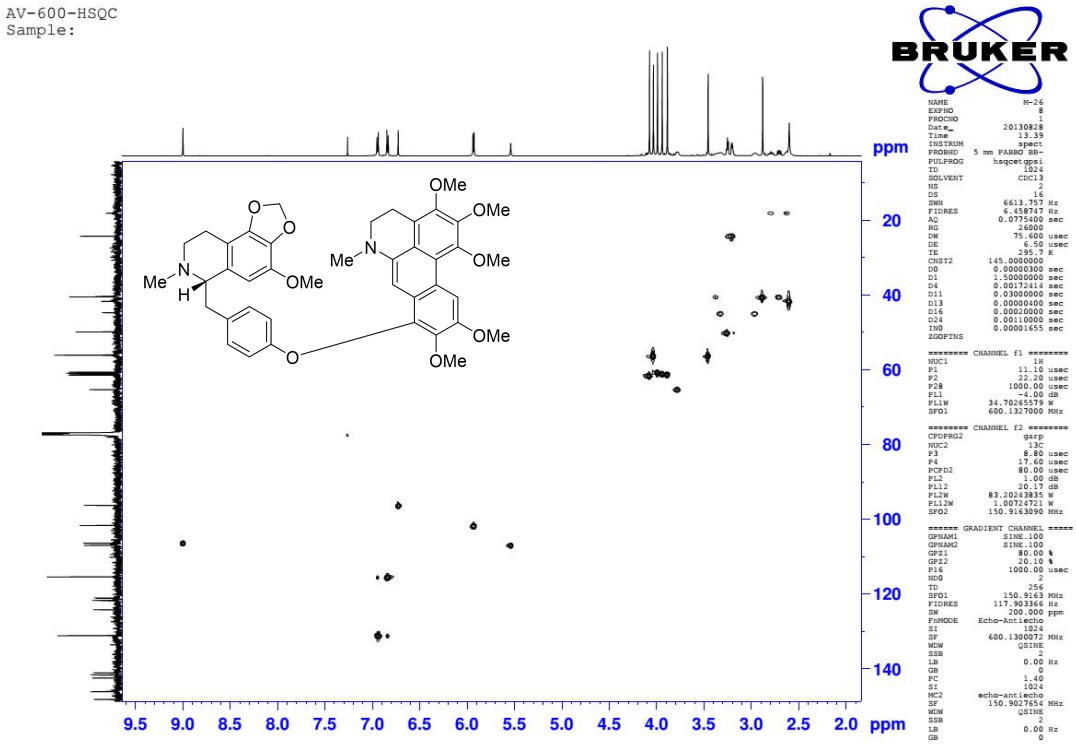


Figure S7.6. HMBC (600 MHz, $CDCl_3$) spectrum of compound **10**

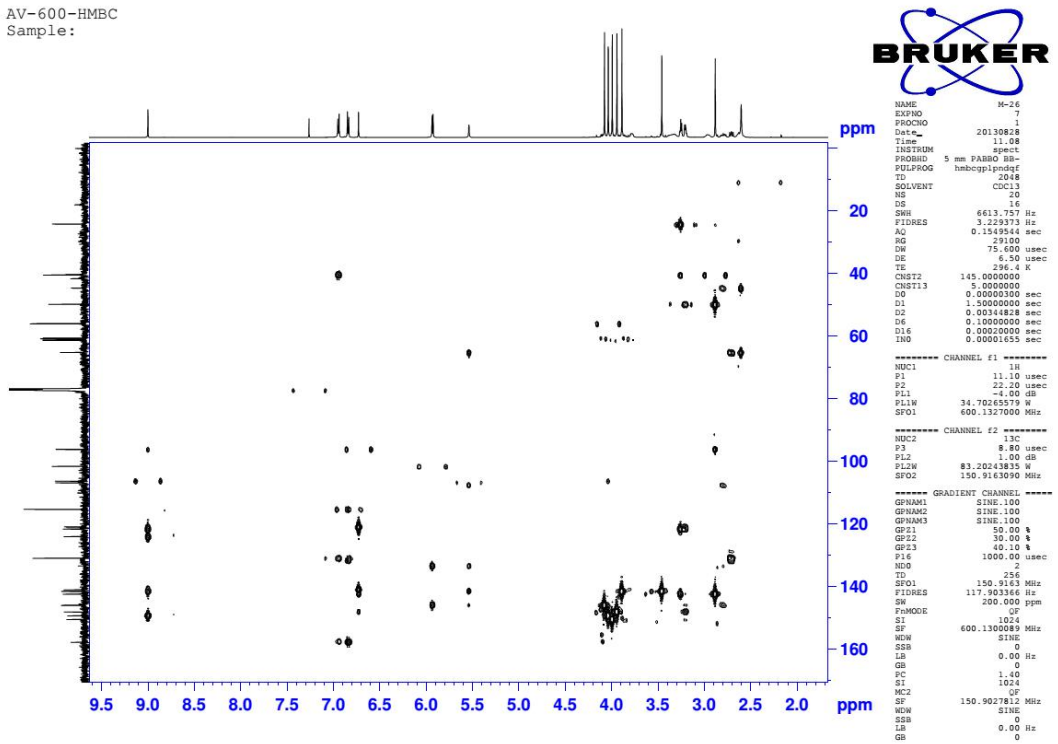


Figure S7.7. NOESY (600 MHz, $CDCl_3$) spectrum of compound **10**

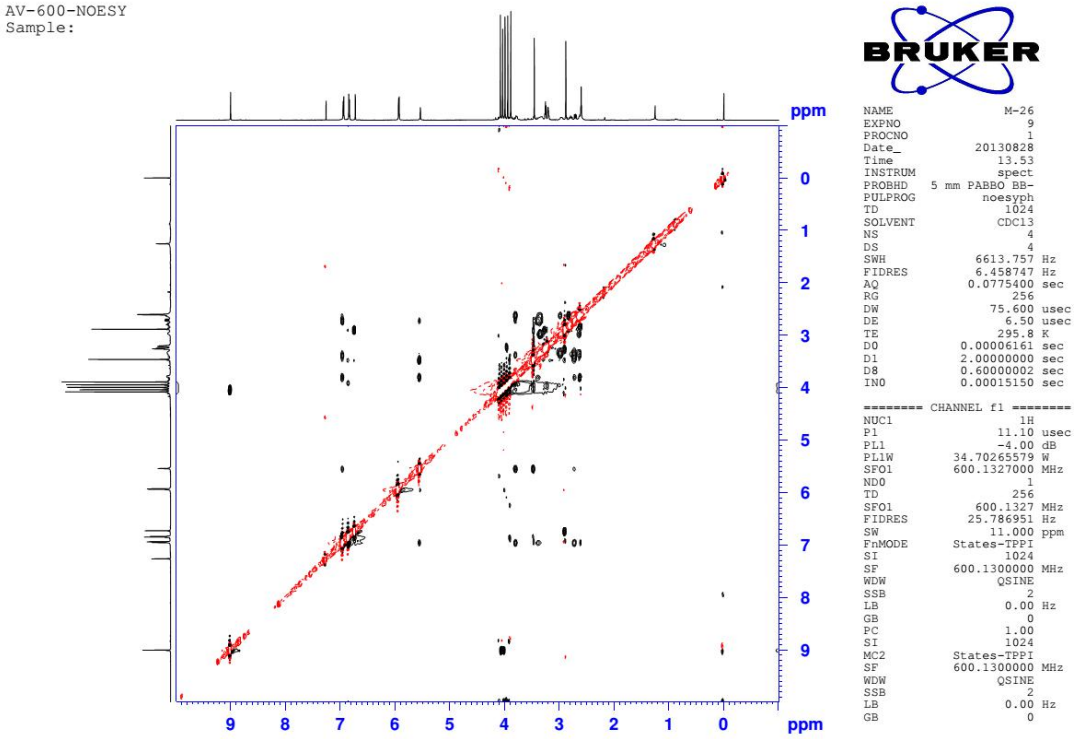
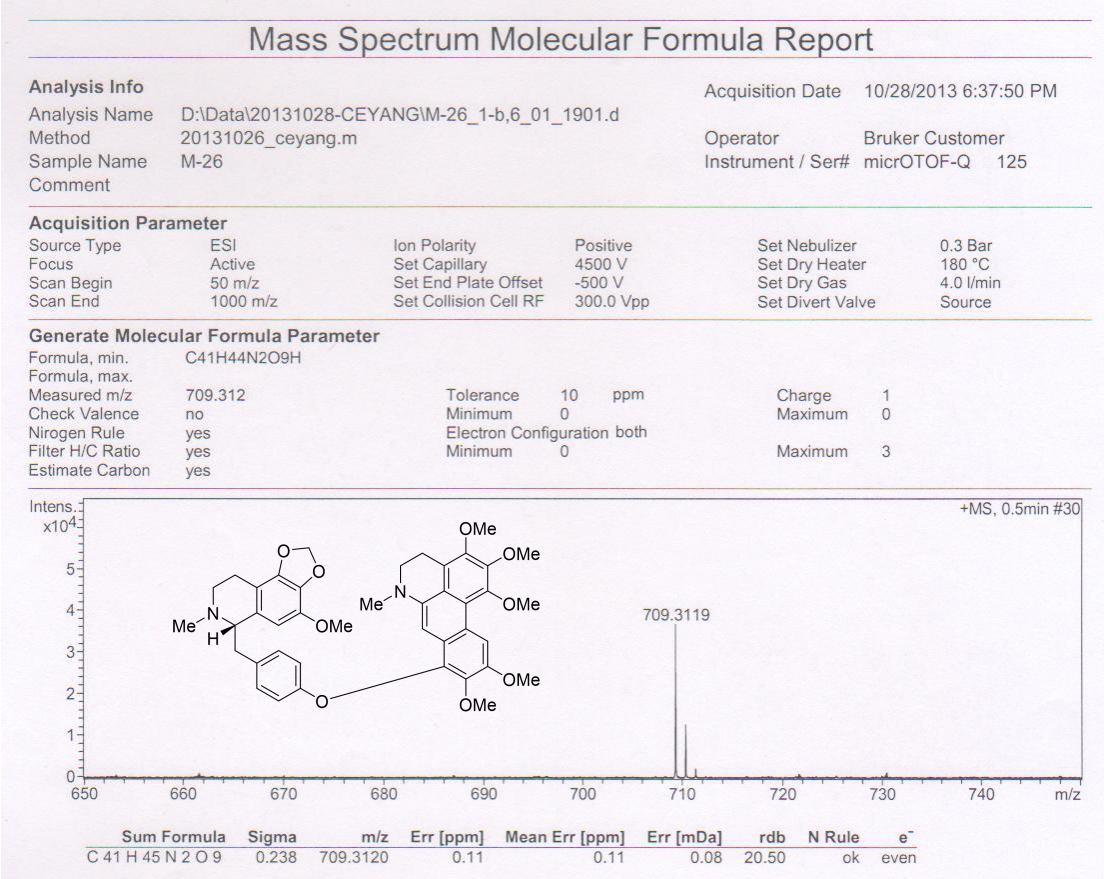


Figure S7.8. HRESIMS of compound **10**



Mass Spectrum Molecular Formula Report

Analysis Info

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Method	20131026_ceyang.m	Operator	Bruker Customer
Sample Name	M-26	Instrument / Ser#	micrOTOF-Q 125
Comment			

Acquisition Parameter

Source Type	ESI	Ion Polarity	Positive	Set Nebulizer	0.3 Bar
Focus	Active	Set Capillary	4500 V	Set Dry Heater	180 °C
Scan Begin	50 m/z	Set End Plate Offset	-500 V	Set Dry Gas	4.0 l/min
Scan End	1000 m/z	Set Collision Cell RF	300.0 Vpp	Set Divert Valve	Source

Generate Molecular Formula Parameter

Formula, min.	C41H44N2O9H				
Formula, max.					
Measured m/z	709.312	Tolerance	10 ppm	Charge	1
Check Valence	no	Minimum	0	Maximum	0
Nirogen Rule	yes	Electron Configuration	both		
Filter H/C Ratio	yes	Minimum	0	Maximum	3
Estimate Carbon	yes				

Sum Formula	Sigma	m/z	Err [ppm]	Mean Err [ppm]	Err [mDa]	rdb	N Rule	e⁻
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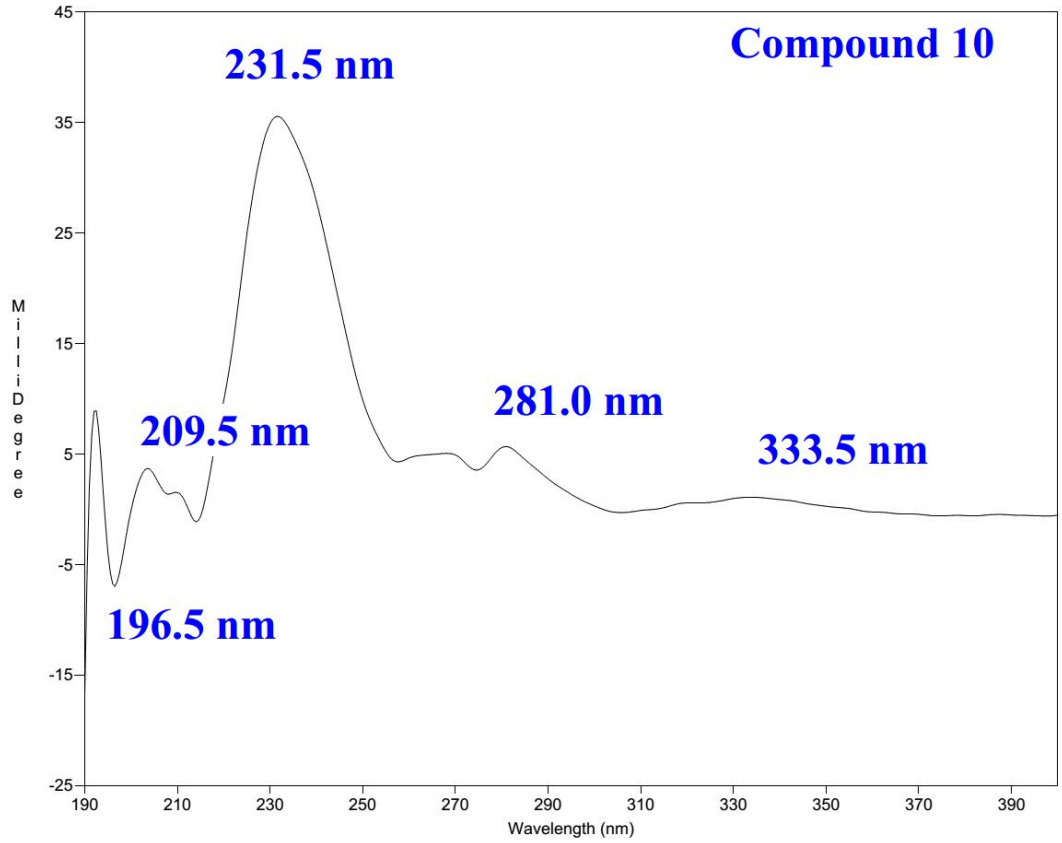
Figure S7.9. ECD spectrum of compound **10**



Bio-Kine Software V4.71 Date : 2014-3-7 Time : 14:09:03

COMMENTS :
File name : sav-golay
Savitzky-Golay Smooth of sav-golay
Window Points=15
Polynomial Order=3
Derivative=0

Figure S7.10. Key HMBC correlations of compound **10**

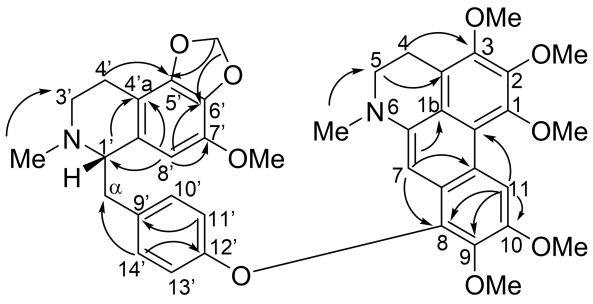


Figure S7.11. Key NOESY correlations of compound **10**

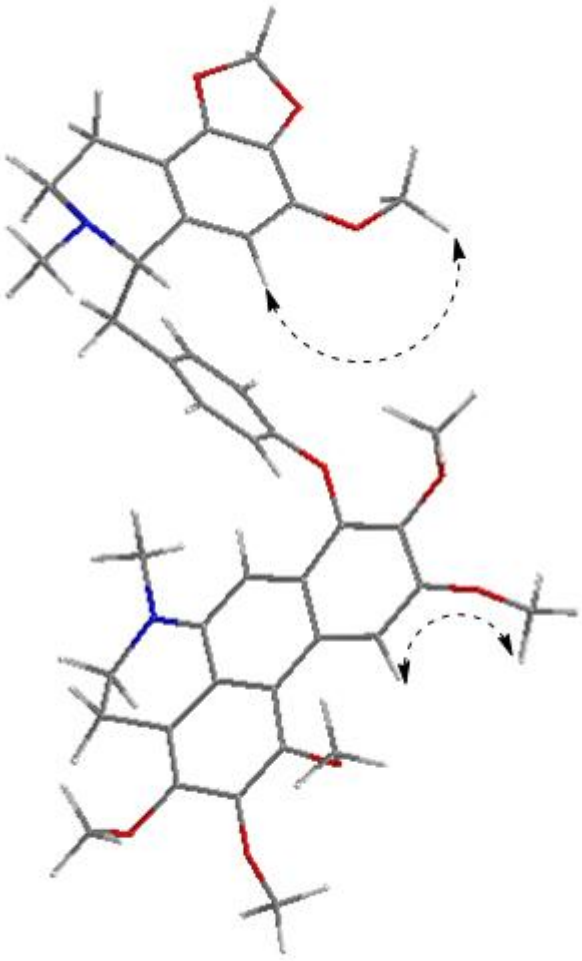
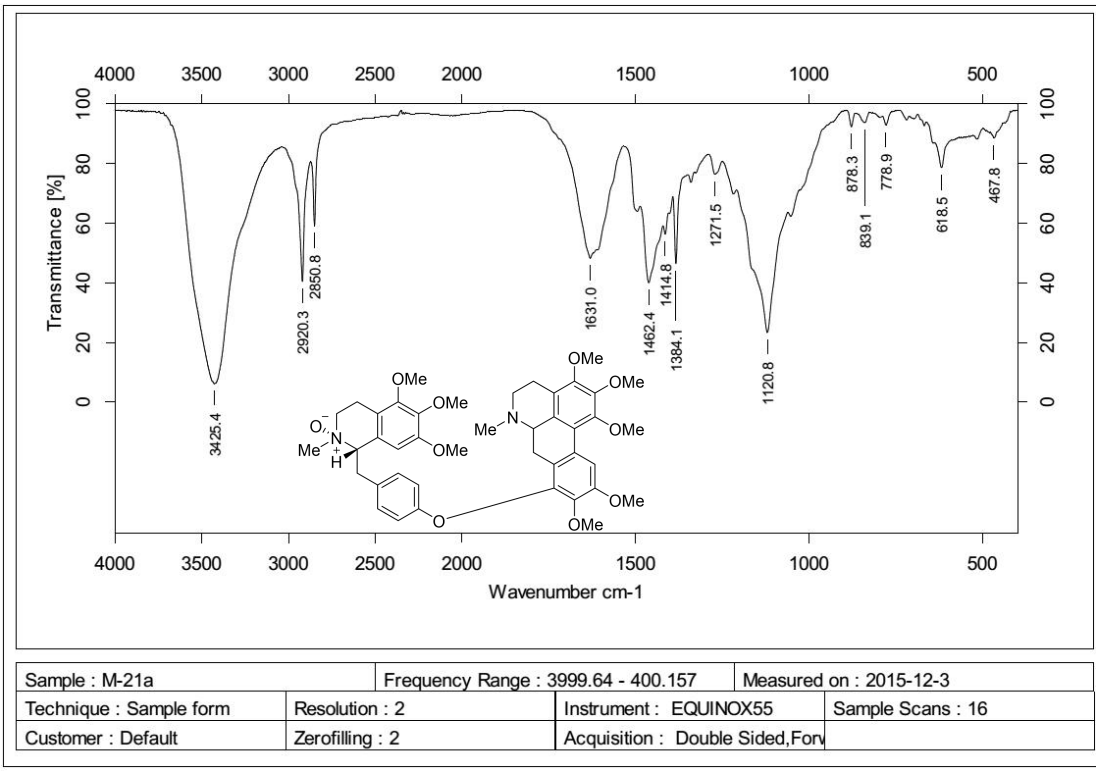


Figure S8.1. IR spectrum of compound **12**



Sample : M-21a	Frequency Range : 3999.64 - 400.157	Measured on : 2015-12-3	
Technique : Sample form	Resolution : 2	Instrument : EQUINOX55	Sample Scans : 16
Customer : Default	Zerofilling : 2	Acquisition : Double Sided,Forv	

Figure S8.2. UV spectrum of compound **12**

Spectrum Peak Pick Report

FIELD FIELD TEXT

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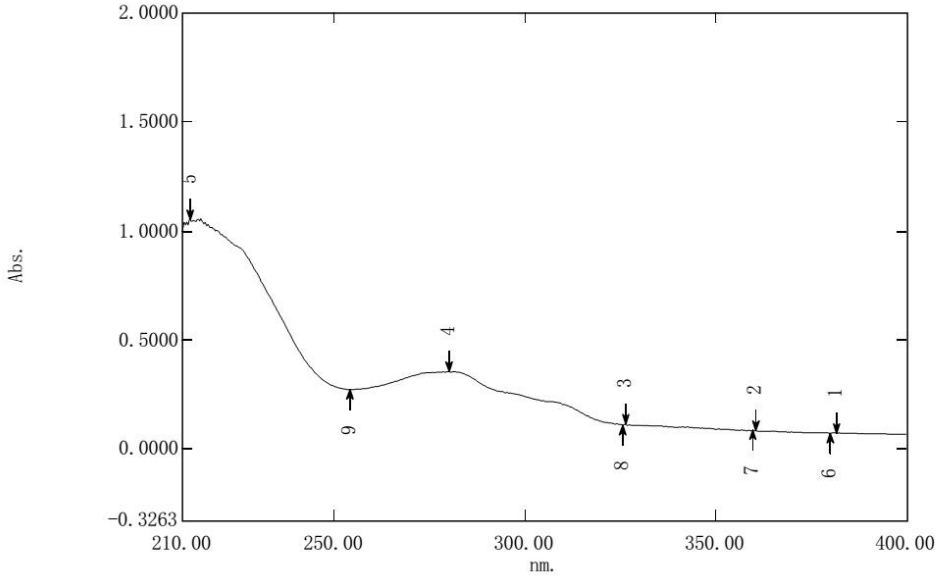

测定属性
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扫描速度: 高速
采样间隔: 0.2
自动采样间隔: 启用
扫描模式: 自动

试样准备属性
重量:
体积 :
稀释:
光程长:
附加信息:

仪器属性
仪器类型: UV-1700
测定方式: 吸收值
狭缝宽: 1.0 nm
光源改变波长: 340.8 nm
S/R 转换: 标准

附件属性
附件: 无

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3	↑	326.40	.1124	
4	↑	280.00	.3547	
5	↑	212.00	1.0574	
6	↓	380.20	.0717	
7	↓	359.60	.0833	
8	↓	325.60	.1108	
9	↓	253.80	.2717	
10	↓	205.80	.8616	

FIELD TEXT

Figure S8.3. ^{1}H NMR (600 MHz, $CDCl_3$) spectrum of compound **12**

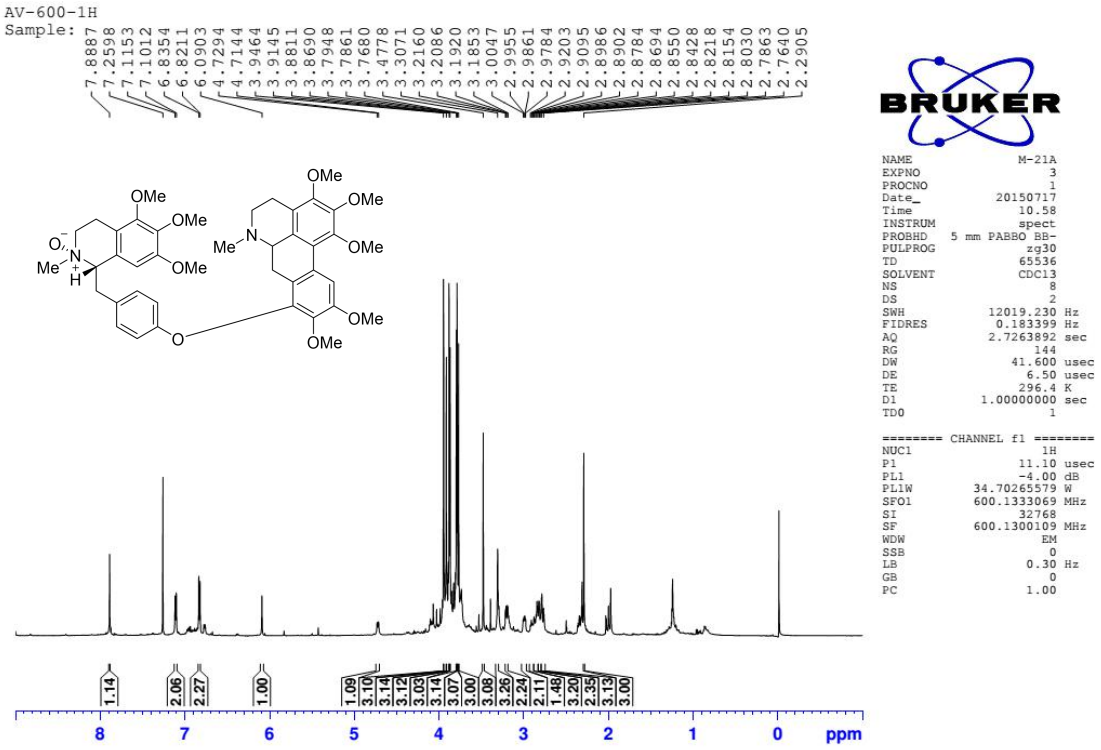


Figure S8.4. ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **12**

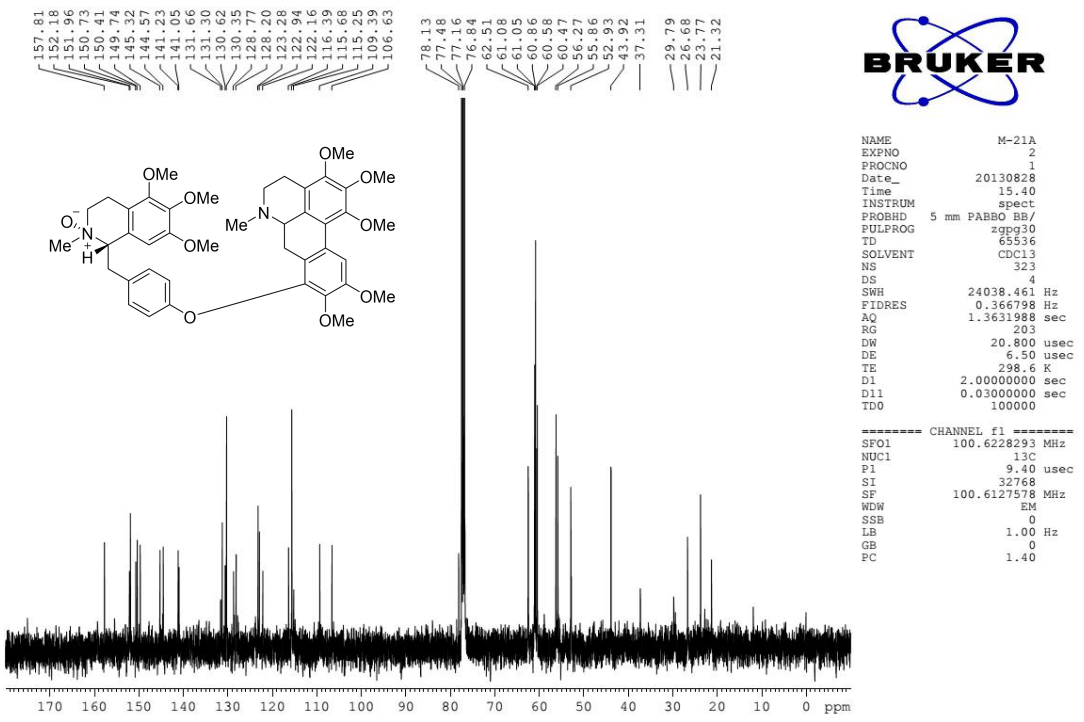


Figure S8.5. HSQC (600 MHz, $CDCl_3$) spectrum of compound **12**

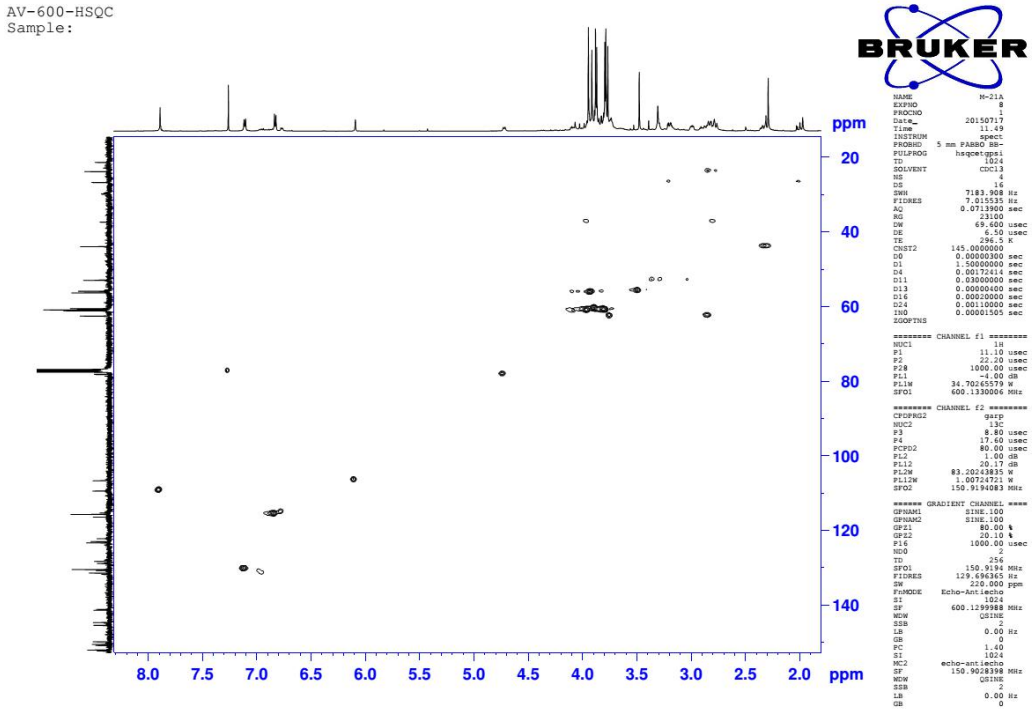


Figure S8.6. HMBC (600 MHz, $CDCl_3$) spectrum of compound **12**

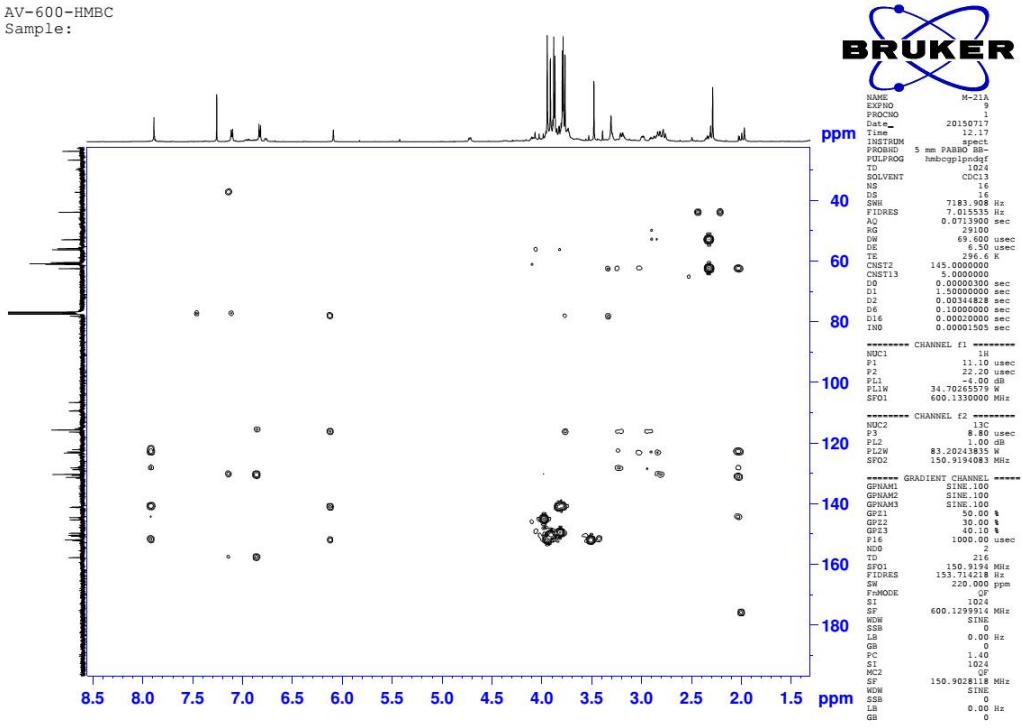
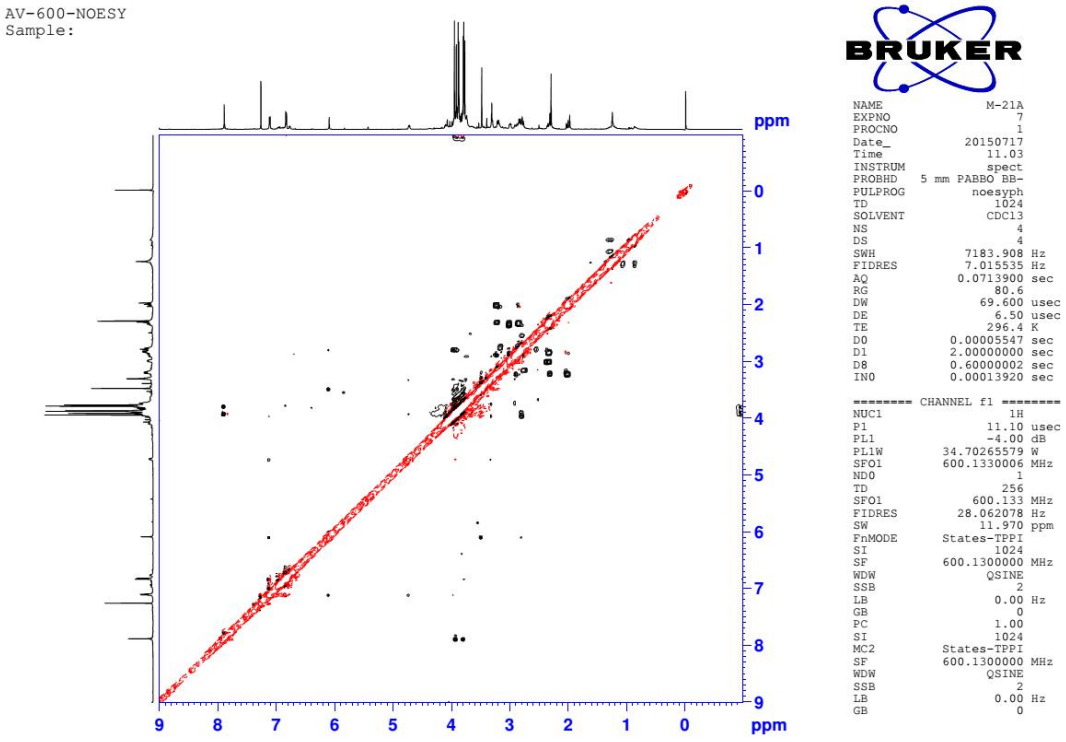


Figure S8.7. NOESY (600 MHz, $CDCl_3$) spectrum of compound **12**



BRUKER

NAME	M-21A
EXPNO	7
PROCNO	1
Date_	20150717
Time	11.03
INSTRUM	spect
PROBHD	5 mm PABBO BB-
PULPROG	noesyph
TD	1024
SOLVENT	CDCl3
NS	4
DS	4
SWH	7183.908 Hz
FIDRES	7.015535 Hz
AQ	0.0713900 sec
RG	80.6
DW	69.600 usec
DE	6.50 usec
TE	296.4 K
D0	0.00005547 sec
D1	2.00000000 sec
D8	0.60000002 sec
IN0	0.00013920 sec
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NUC1	1H
P1	11.10 usec
PL1	-4.00 dB
PL1W	34.70265579 W
SFO1	600.1330006 MHz
ND0	1
TD	256
SFO1	600.133 MHz
FIDRES	28.062078 Hz
SW	11.970 ppm
FnMODE	States-TPPI
SI	1024
SF	600.1300000 MHz
WDW	QSINE
SSB	2
LB	0.00 Hz
GB	0
PC	1.00
SI	1024
MC2	States-TPPI
SF	600.1300000 MHz
WDW	QSINE
SSB	2
LB	0.00 Hz
GB	0

Figure S8.8. HRESIMS of compound **12**

Mass Spectrum Molecular Formula Report

Analysis Info

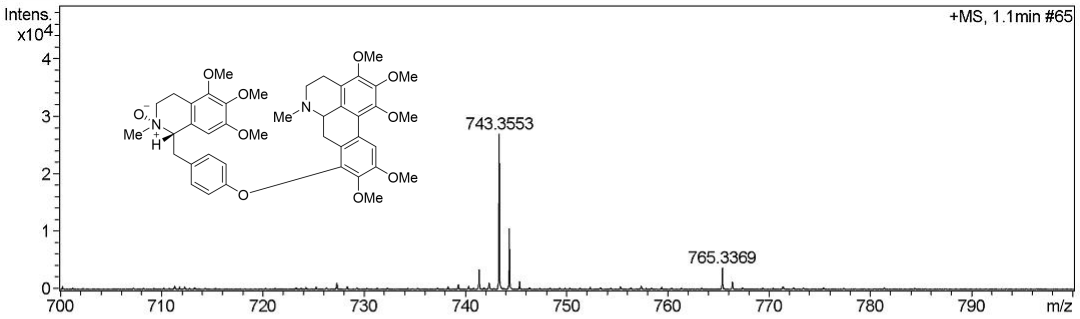
Analysis Name	D:\Data\20140424CEYANG\M-21A_1-c,2_01_3207.d	Acquisition Date	4/24/2014 3:09:56 PM
Method	20131026_ceyang.m	Operator	Bruker Customer
Sample Name	M-21A	Instrument / Ser#	micrOTOF-Q 125
Comment			

Acquisition Parameter

Source Type	ESI	Ion Polarity	Positive	Set Nebulizer	1.2 Bar
Focus	Active	Set Capillary	4500 V	Set Dry Heater	180 °C
Scan Begin	50 m/z	Set End Plate Offset	-500 V	Set Dry Gas	8.0 l/min
Scan End	1000 m/z	Set Collision Cell RF	300.0 Vpp	Set Divert Valve	Source

Generate Molecular Formula Parameter

Formula, min.	C42H50N2O10H						
Formula, max.							
Measured m/z	743.355	Tolerance	5	ppm	Charge	1	
Check Valence	no	Minimum	0		Maximum	0	
Nirogen Rule	no	Electron Configuration	both				
Filter H/C Ratio	no	Minimum	0		Maximum	3	
Estimate Carbon	yes						



Sum Formula	Sigma	m/z	Err [ppm]	Mean Err [ppm]	Err [mDa]	rdb	N Rule	e⁻
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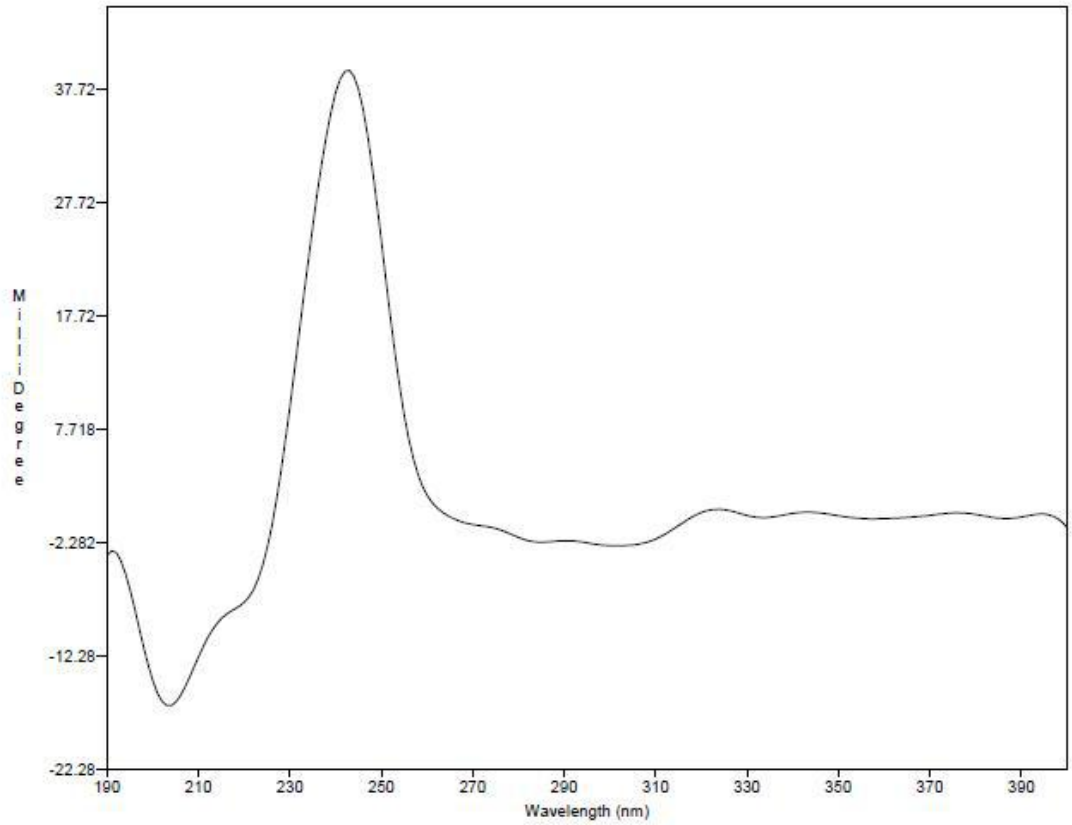
Figure S8.9. ECD spectrum of compound **12**



Bio-Kine Software V4.74 Date : 2016-10-27 Time : 20:44:07

COMMENTS :
File name : d:\华会明\胡旭\m-21a.bka
Savitzky-Golay Smooth of sav-golay
Window Points=15
Polynomial Order=3
Derivative=0

Figure S8.10. Key HMBC correlations of compound 12

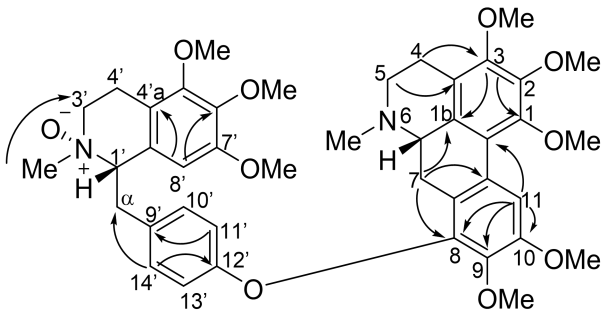


Figure S8.11. Key NOESY correlations of compound 12

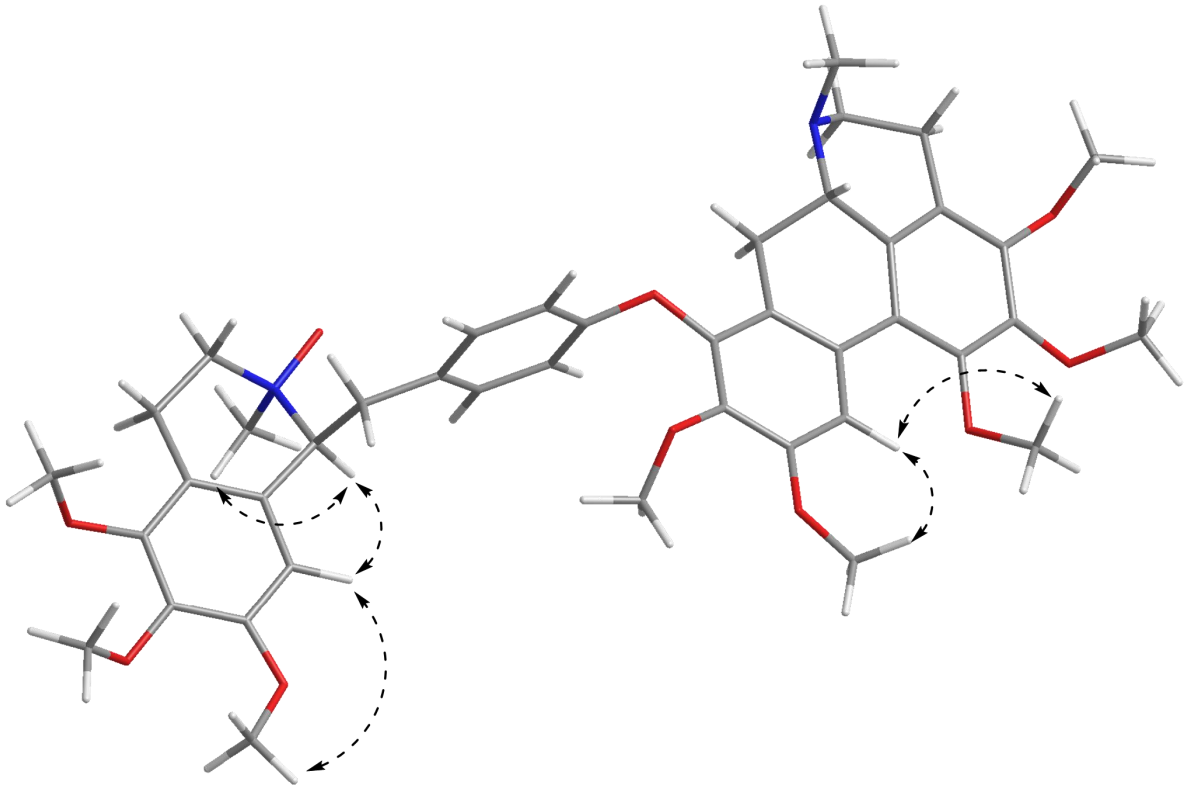
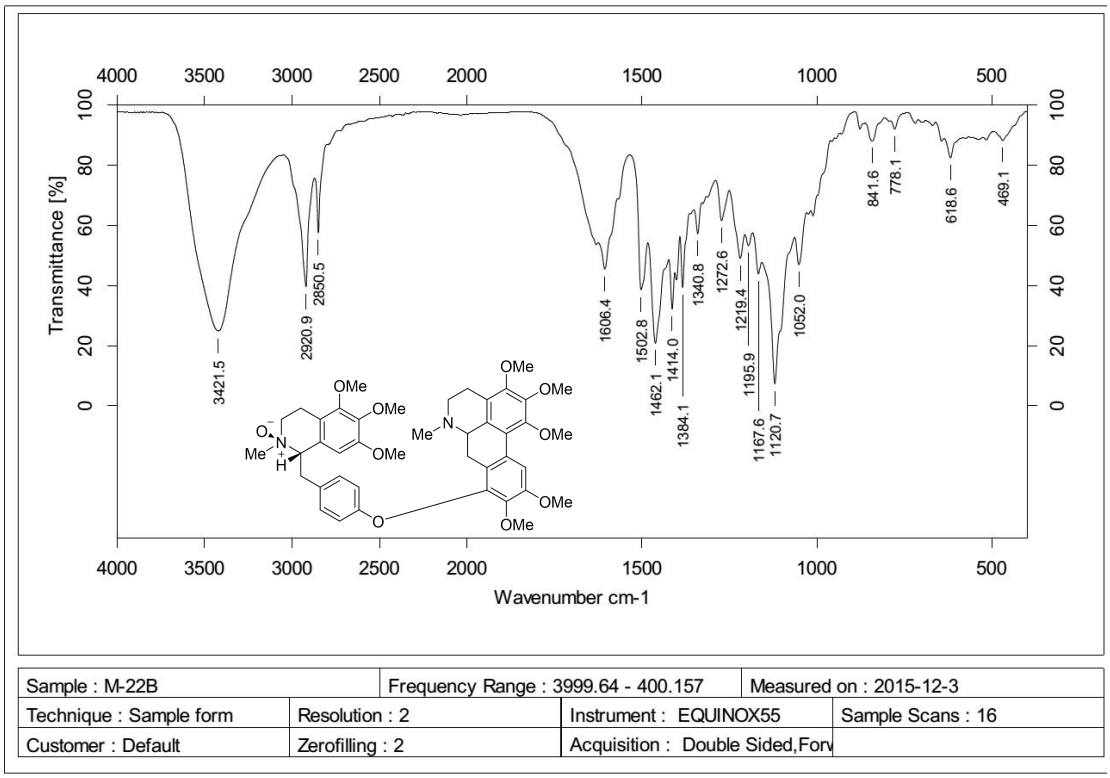


Figure S9.1. IR spectrum of compound **13**



Sample : M-22B	Frequency Range : 3999.64 - 400.157	Measured on : 2015-12-3	
Technique : Sample form	Resolution : 2	Instrument : EQUINOX55	Sample Scans : 16
Customer : Default	Zerofilling : 2	Acquisition : Double Sided,For	

Figure S9.2. ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **13**

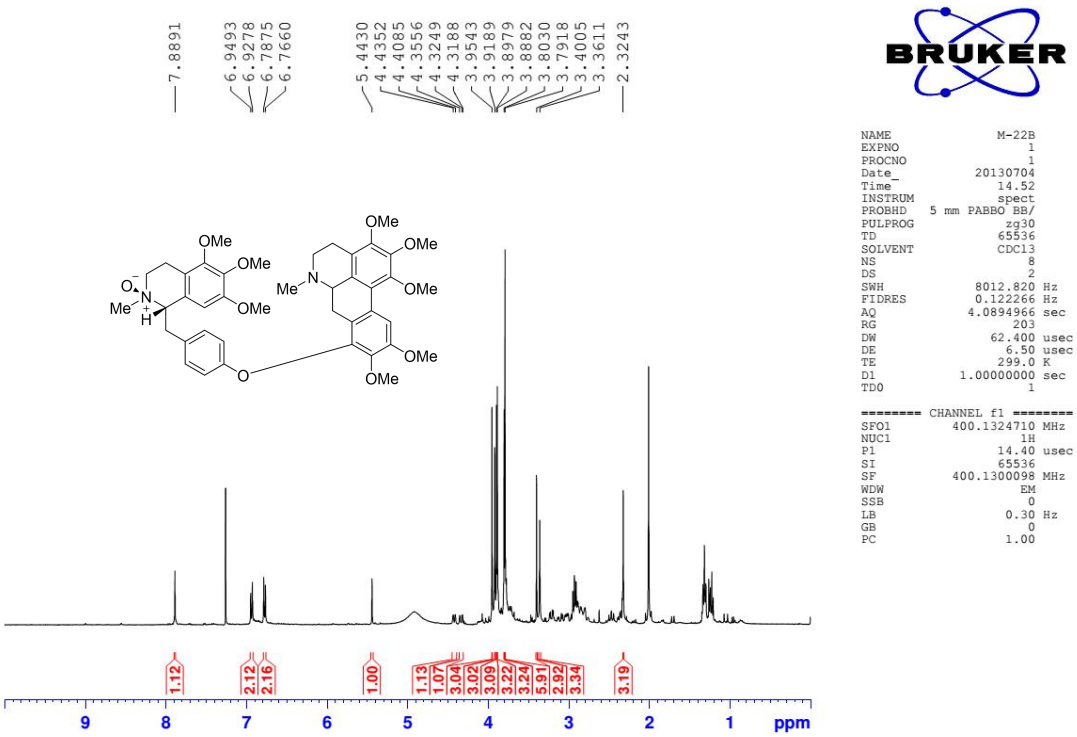


Figure S9.3. ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **13**

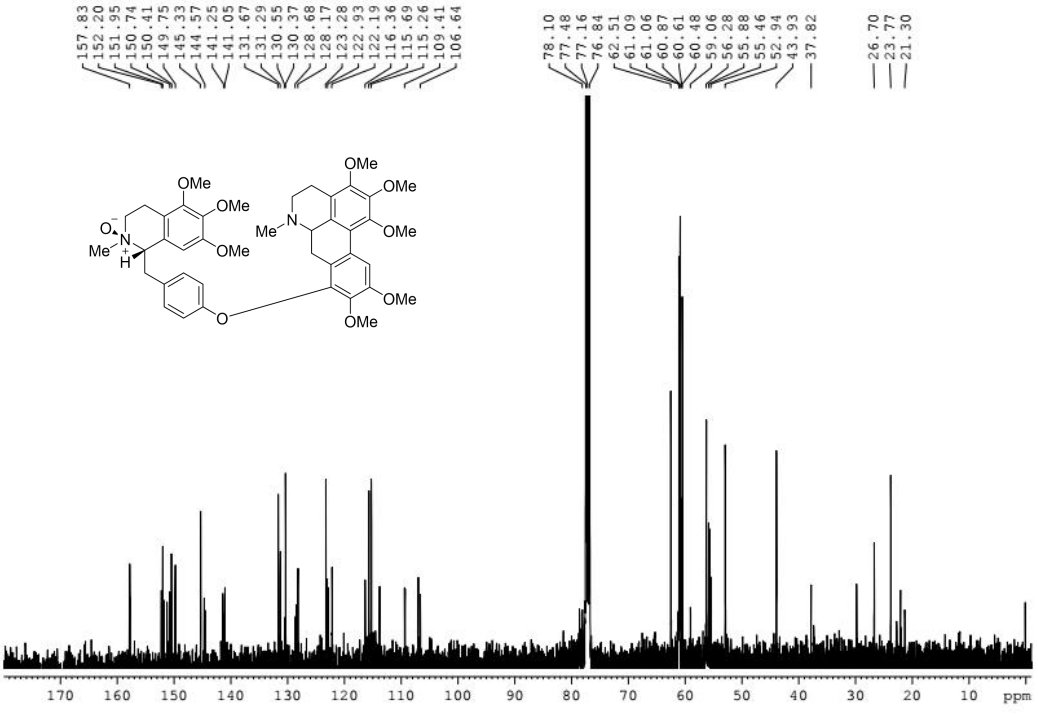


Figure S9.4. HSQC (600 MHz, $CDCl_3$) spectrum of compound **13**

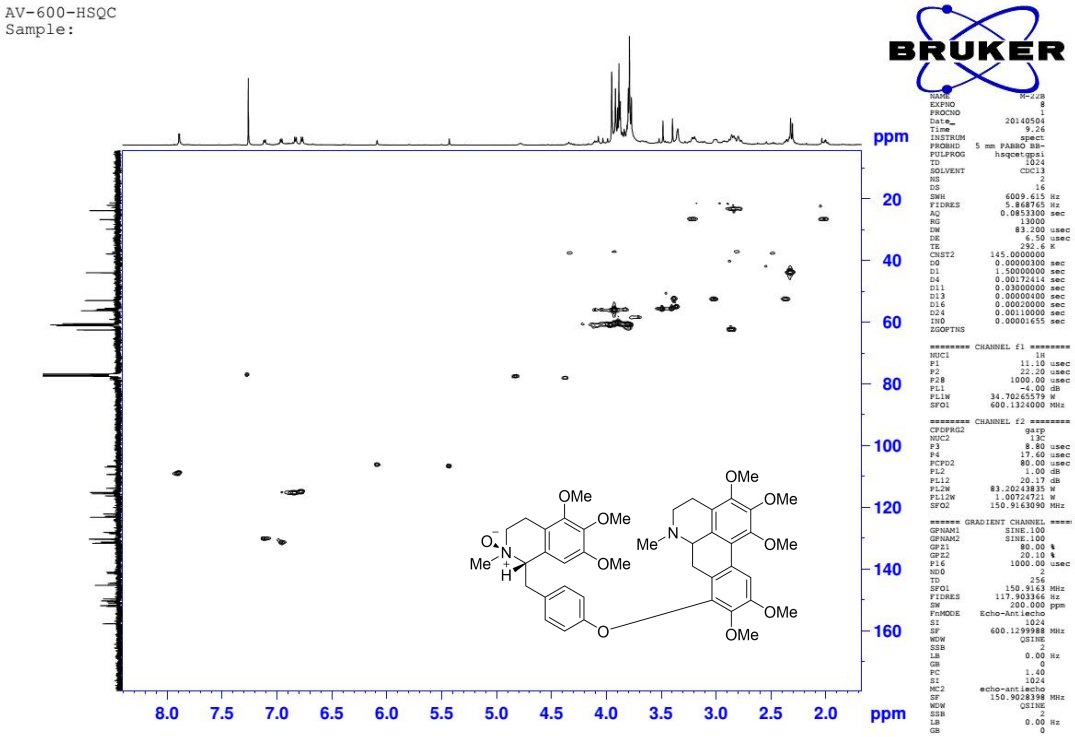


Figure S9.5. HMBC (600 MHz, $CDCl_3$) spectrum of the new compound **13**

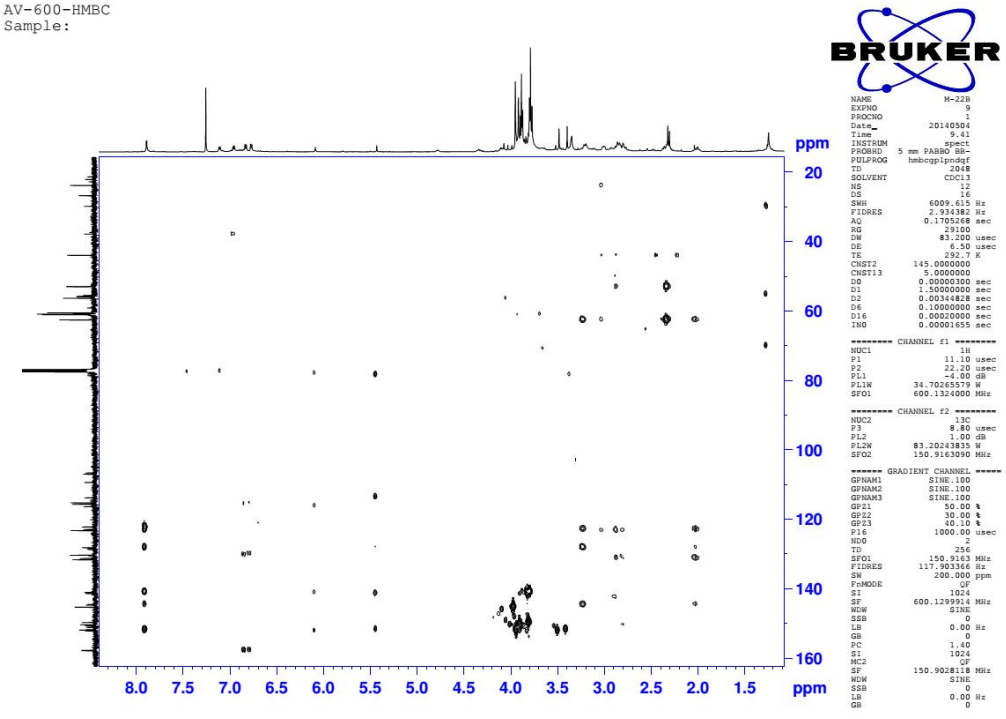


Figure S9.6. NOESY (600 MHz, $CDCl_3$) spectrum of compound **13**

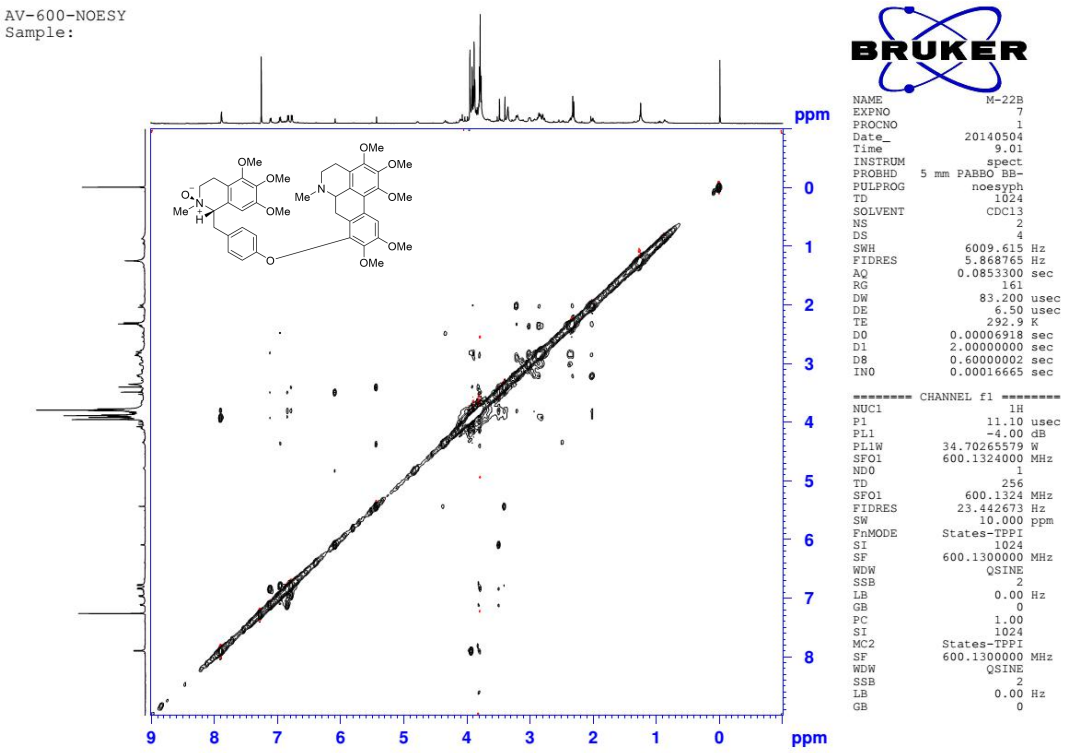


Figure S9.7. HRESIMS of compound **13**

Mass Spectrum Molecular Formula Report

Analysis Info

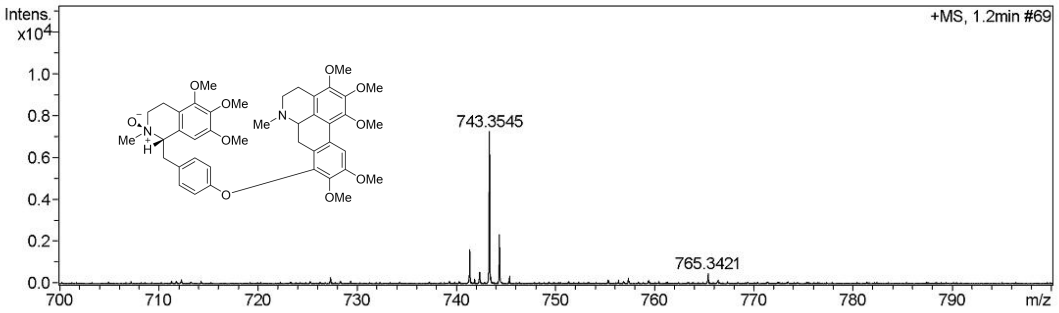
Analysis Name	D:\Data\20140424CEYANG\M-22B_1-c,1_01_3206.d	Acquisition Date	4/24/2014 3:05:44 PM
Method	20131026_ceyang.m	Operator	Bruker Customer
Sample Name	M-22B	Instrument / Ser#	micrOTOF-Q 125
Comment			

Acquisition Parameter

Source Type	ESI	Ion Polarity	Positive	Set Nebulizer	1.2 Bar
Focus	Active	Set Capillary	4500 V	Set Dry Heater	180 °C
Scan Begin	50 m/z	Set End Plate Offset	-500 V	Set Dry Gas	8.0 l/min
Scan End	1000 m/z	Set Collision Cell RF	300.0 Vpp	Set Divert Valve	Source

Generate Molecular Formula Parameter

Formula, min.	C42H50N2O10H						
Formula, max.							
Measured m/z	743.355	Tolerance	5	ppm	Charge	1	
Check Valence	no	Minimum	0		Maximum	0	
Nirogen Rule	no	Electron Configuration	both				
Filter H/C Ratio	no	Minimum	0		Maximum	3	
Estimate Carbon	yes						



Sum Formula	Sigma	m/z	Err [ppm]	Mean Err [ppm]	Err [mDa]	rdb	N Rule	e⁻
C 42 H 51 N 2 O 10	0.086	743.3538	-0.97	-2.06	-0.72	18.50	ok	even

Figure S9.8. ECD spectrum of compound **13**

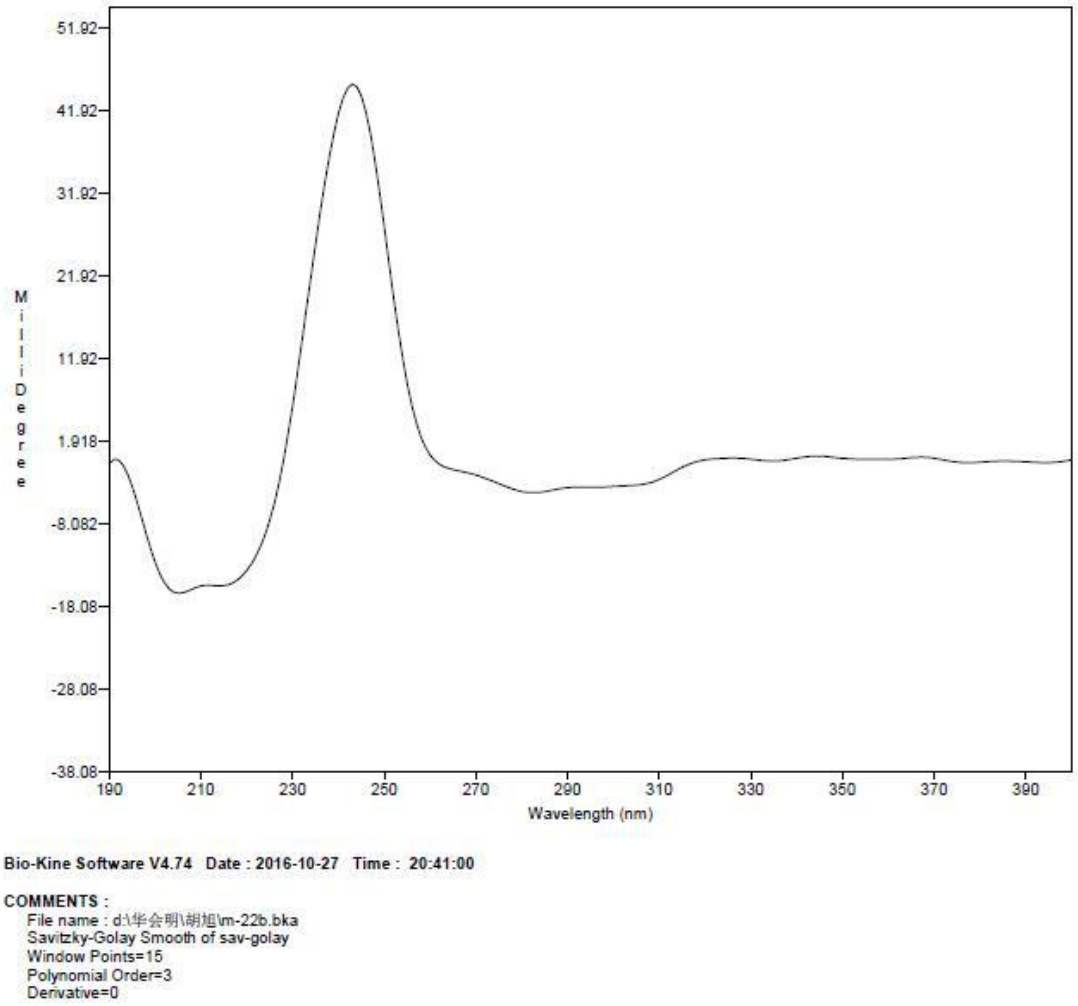


Figure S9.9. Key HMBC correlations of compound **13**

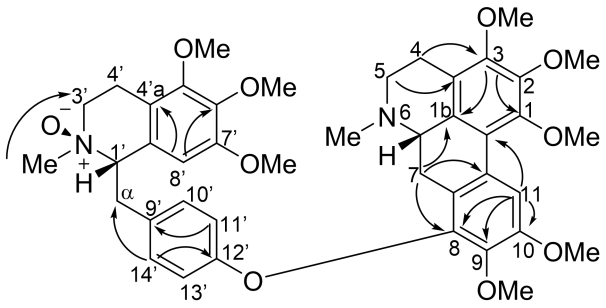
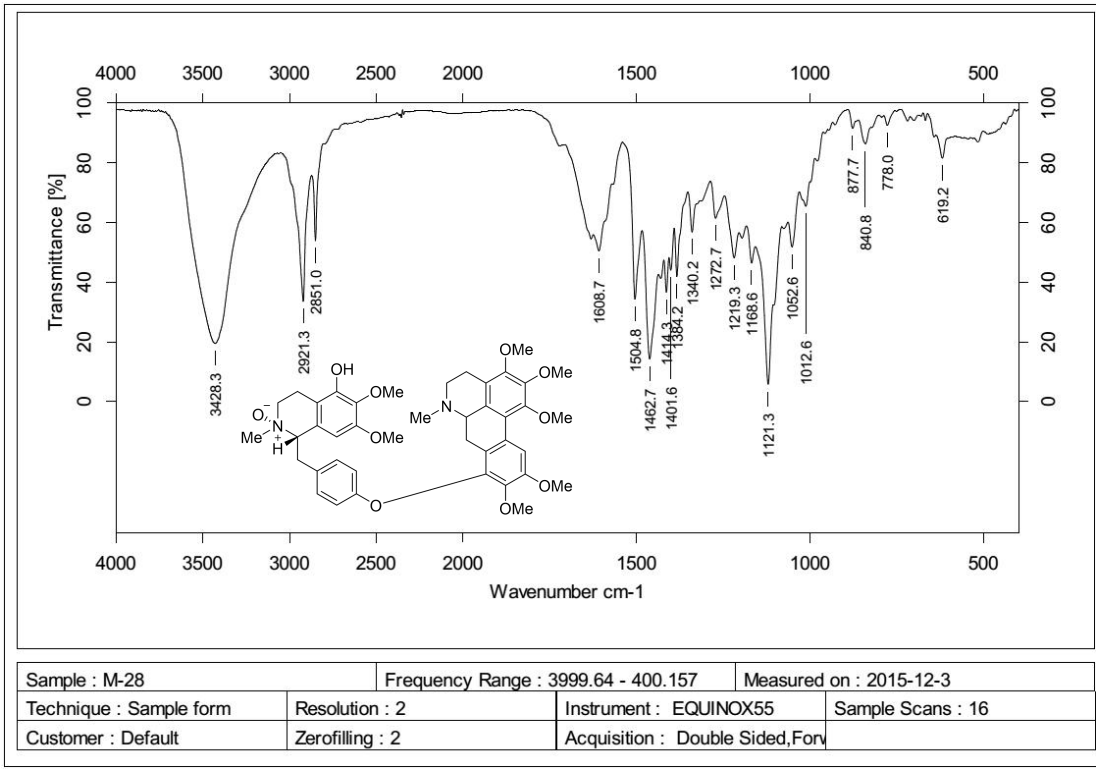


Figure S10.1. IR spectrum of compound **14**



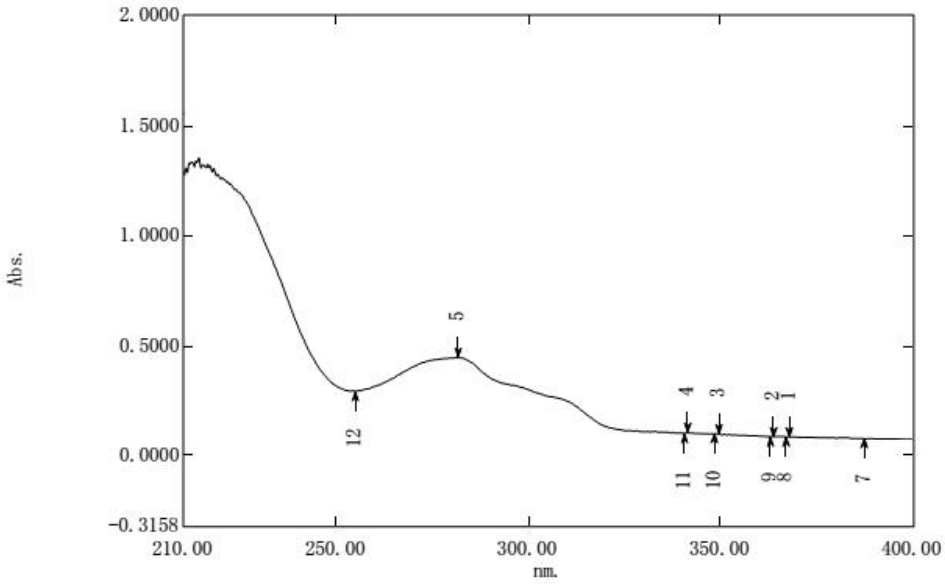
Sample : M-28	Frequency Range : 3999.64 - 400.157	Measured on : 2015-12-3	
Technique : Sample form	Resolution : 2	Instrument : EQUINOX55	Sample Scans : 16
Customer : Default	Zerofilling : 2	Acquisition : Double Sided,Forv	

Figure S10.2. UV spectrum of compound **14**

Spectrum Peak Pick Report

FIELD FIELD TEXT

Data Set: 没有



测定属性
波长范围 (nm.): 200.00到400.00
扫描速度: 高速
采样间隔: 0.2
自动采样间隔: 启用
扫描模式: 自动

试样准备属性
重量:
体积 :
稀释:
光程长:
附加信息:

仪器属性
仪器类型: UV-1700
测定方式: 吸收值
狭缝宽: 1.0 nm
光源改变波长: 340.8 nm
S/R 转换: 标准

附件属性
附件: 无

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3	↑	349.40	.1010	
4	↑	341.40	.1069	
5	↑	281.80	.4471	
6	↑	208.60	1.3712	
7	↓	387.40	.0795	
8	↓	367.00	.0872	
9	↓	362.80	.0896	
10	↓	348.40	.1001	
11	↓	340.60	.1033	
12	↓	254.80	.2947	
13	↓	206.60	1.1870	

FIELD TEXT

Figure S10.3. ^{1}H NMR (600 MHz, $CDCl_3$) spectrum of compound **14**

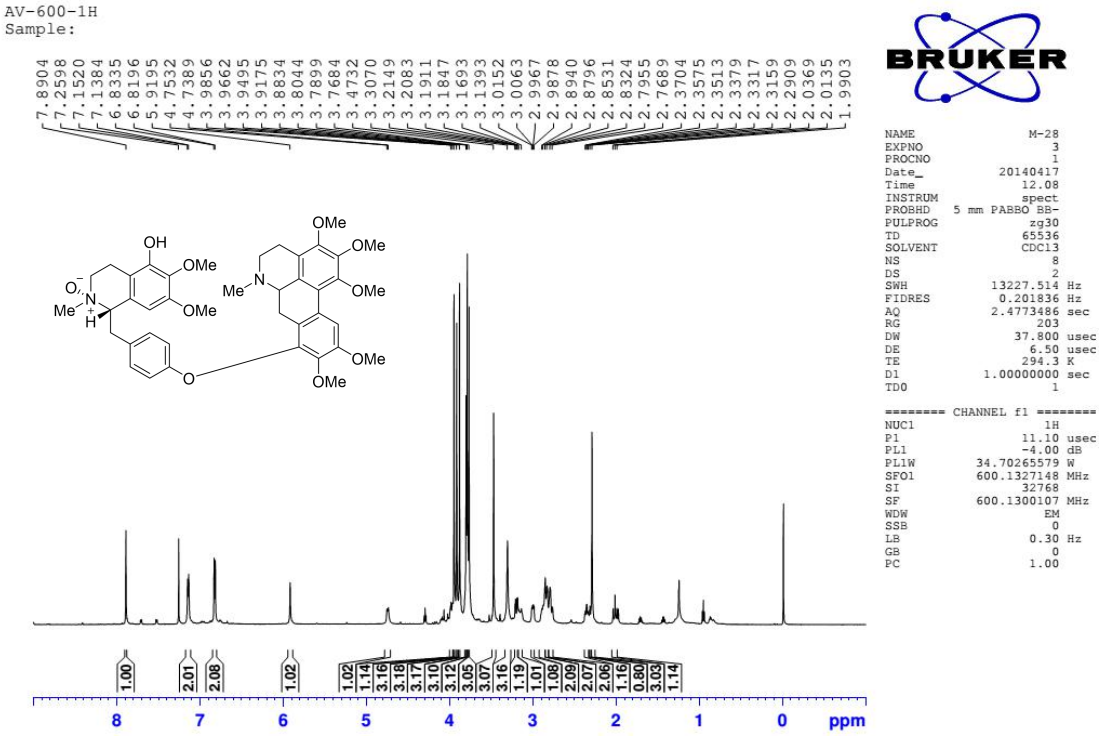


Figure S10.4. ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **14**

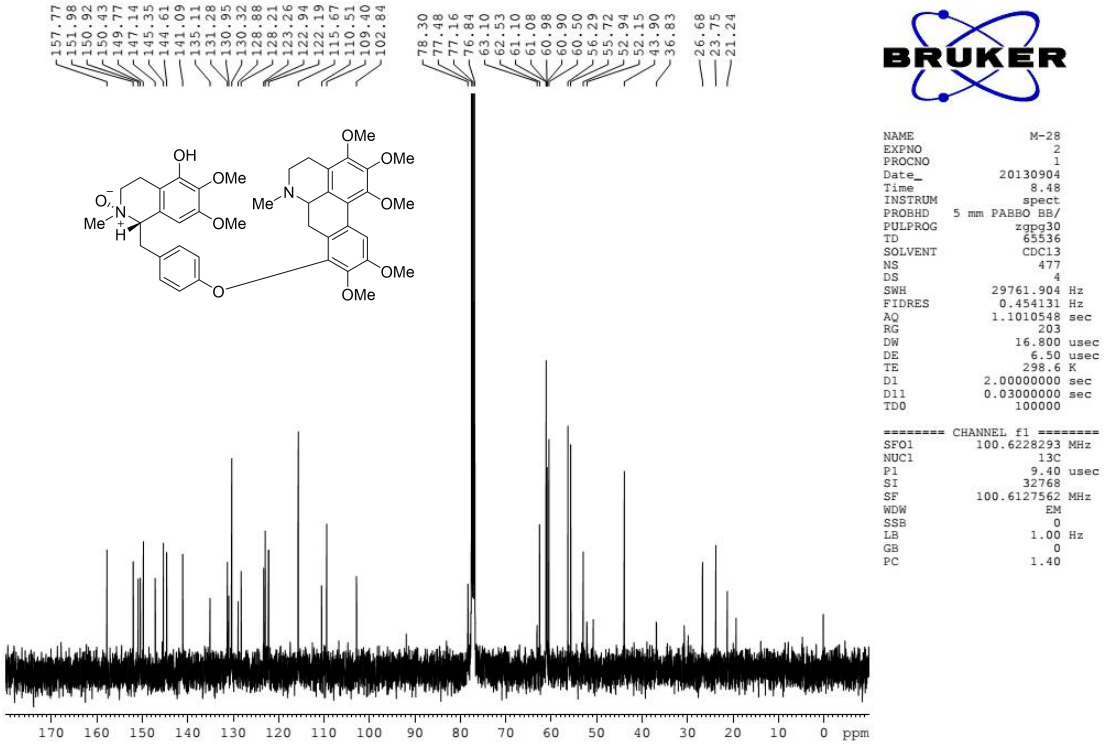


Figure S10.5. HSQC (600 MHz, $CDCl_3$) spectrum of compound **14**

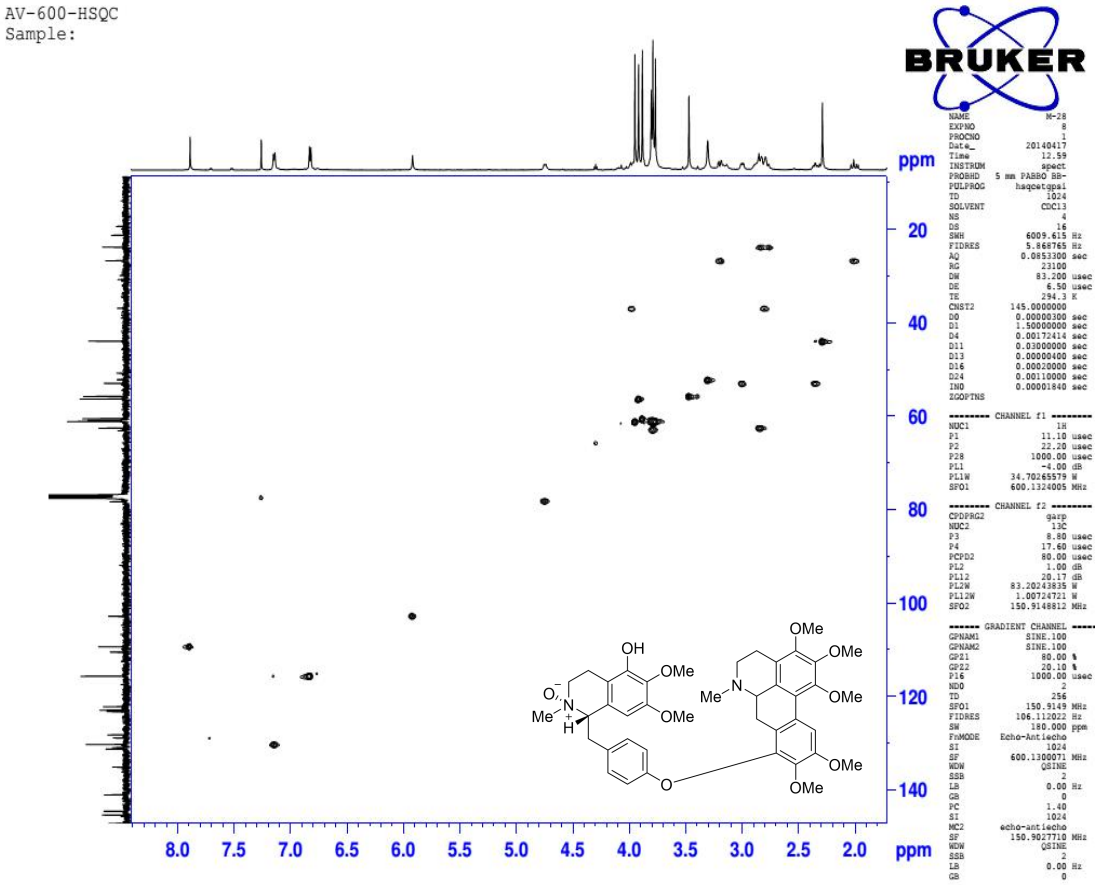


Figure S10.6. **HMBC (600 MHz, $CDCl_3$) spectrum of compound** 14

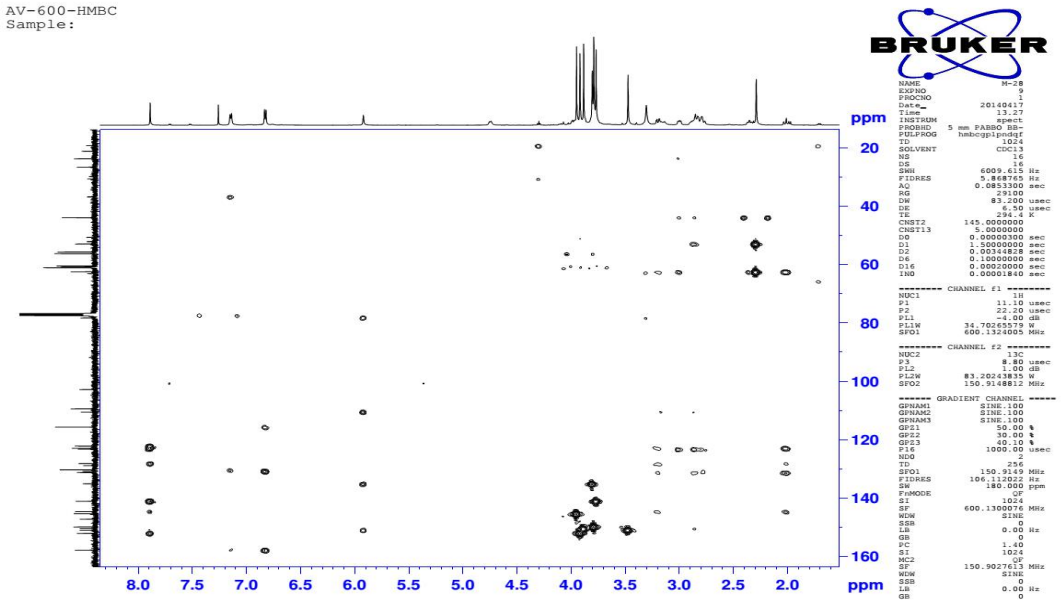


Figure S10.7. NOESY (600 MHz, $CDCl_3$) spectrum of compound **14**

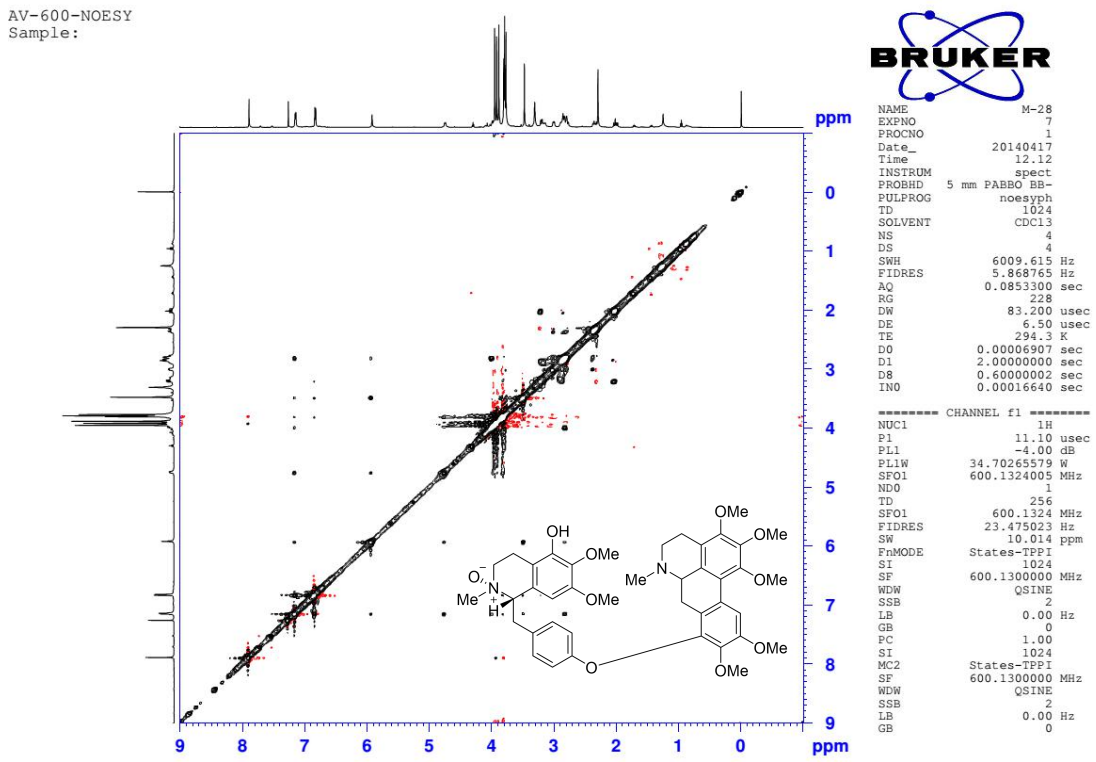


Figure S10.8. HRESIMS of compound **14**

Mass Spectrum Molecular Formula Report

Analysis Info

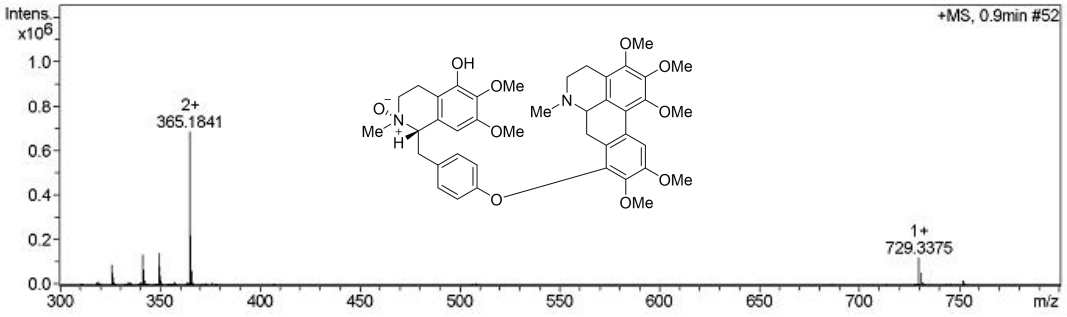
Analysis Name	D:\Data\20140412CEYANG\M-28_2-d,7_01_3124.d	Acquisition Date	4/12/2014 4:33:40 PM
Method	20131026_ceyang.m	Operator	Bruker Customer
Sample Name	M-28	Instrument / Ser#	micrOTOF-Q 125
Comment			

Acquisition Parameter

Source Type	ESI	Ion Polarity	Positive	Set Nebulizer	1.2 Bar
Focus	Active	Set Capillary	4500 V	Set Dry Heater	180 °C
Scan Begin	50 m/z	Set End Plate Offset	-500 V	Set Dry Gas	8.0 l/min
Scan End	1000 m/z	Set Collision Cell RF	300.0 Vpp	Set Divert Valve	Source

Generate Molecular Formula Parameter

Formula, min.	C41H48N2O10H						
Formula, max.							
Measured m/z	729.337	Tolerance	5	ppm	Charge	1	
Check Valence	no	Minimum	0		Maximum	0	
Nirogen Rule	no	Electron Configuration	both				
Filter H/C Ratio	no	Minimum	0		Maximum	3	
Estimate Carbon	yes						



Sum Formula	Sigma	m/z	Err [ppm]	Mean Err [ppm]	Err [mDa]	rdb	N Rule	e⁻
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Figure S10.9. ECD spectrum of compound **14**

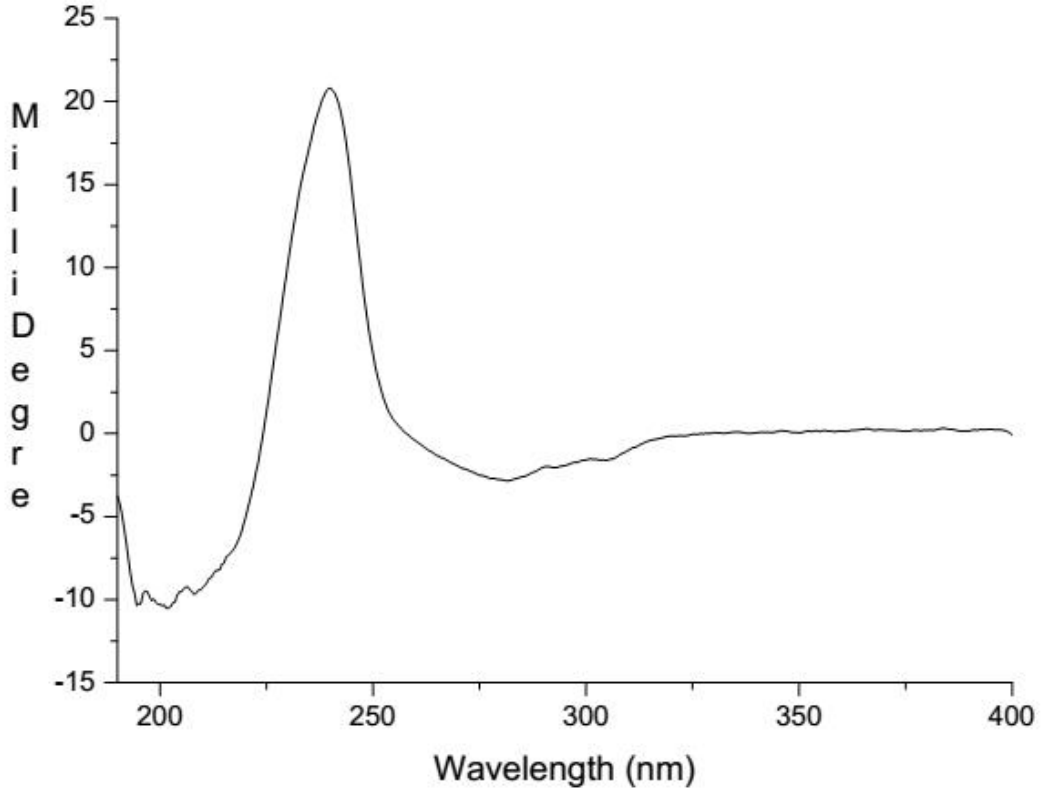


Figure S10.10. Key NOESY correlations of compound **14**

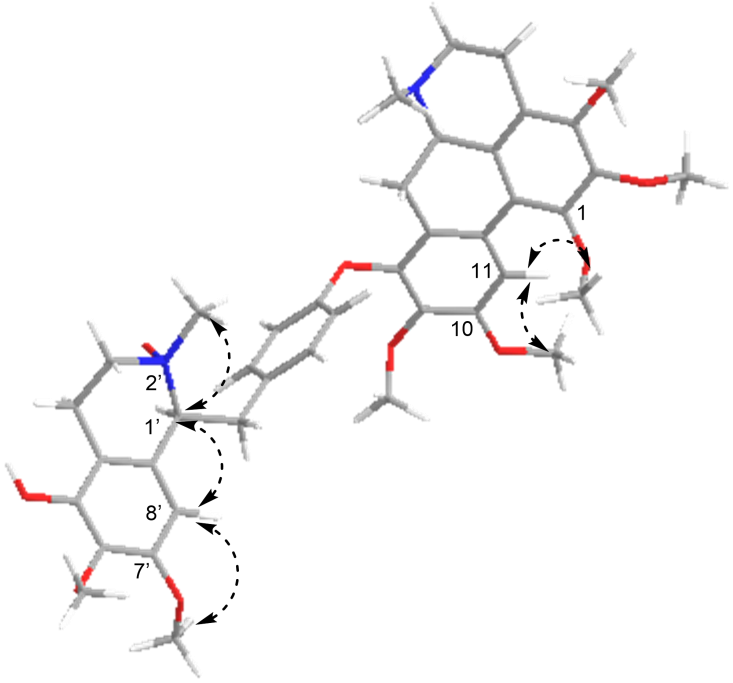
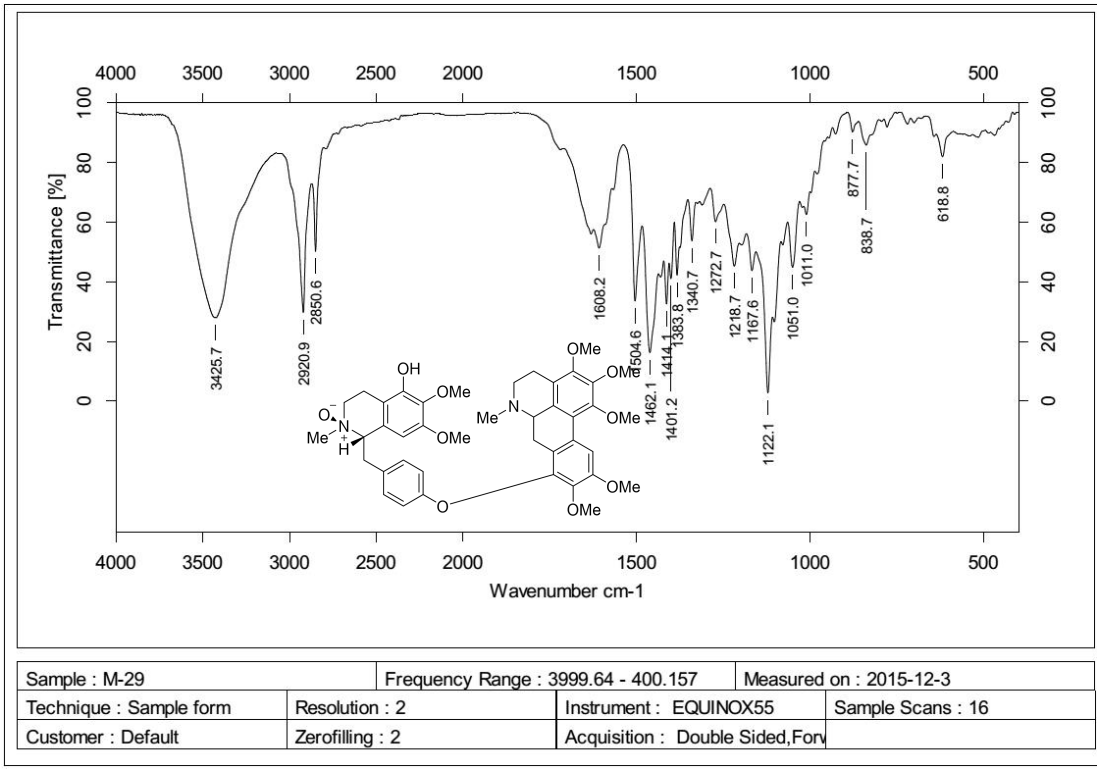


Figure S11.1. IR spectrum of compound **15**



Sample : M-29	Frequency Range : 3999.64 - 400.157	Measured on : 2015-12-3	
Technique : Sample form	Resolution : 2	Instrument : EQUINOX55	Sample Scans : 16
Customer : Default	Zerofilling : 2	Acquisition : Double Sided,Forv	

Figure S11.2. ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **15**

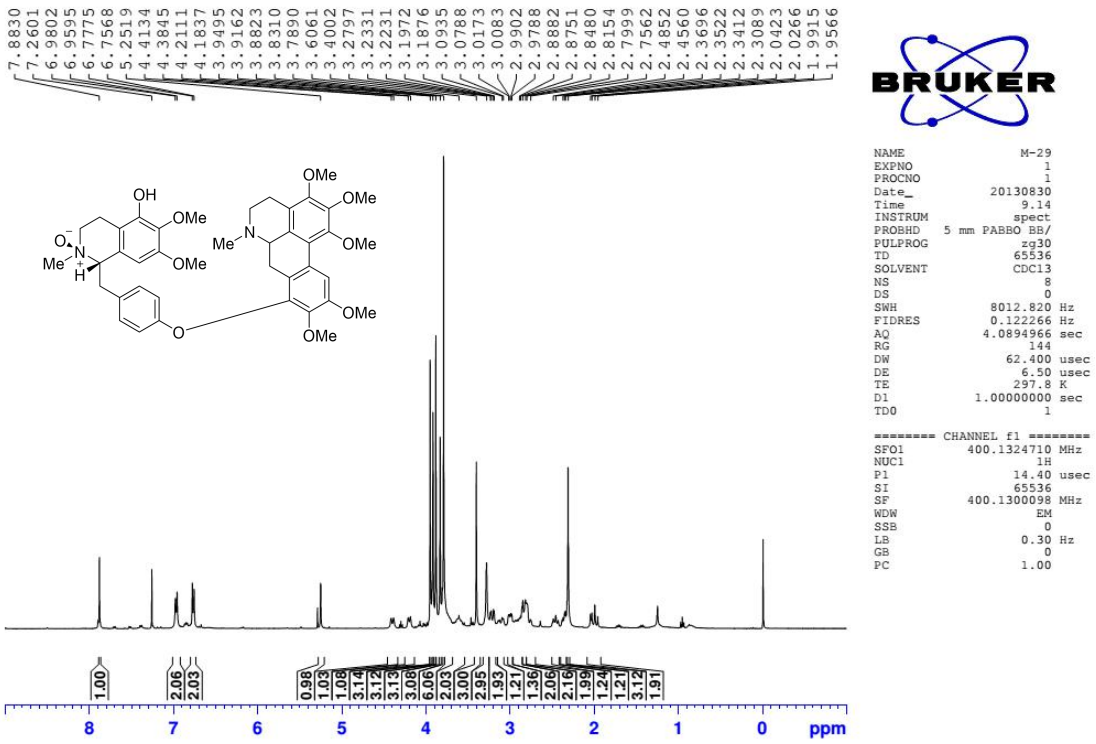


Figure S11.3. ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **15**

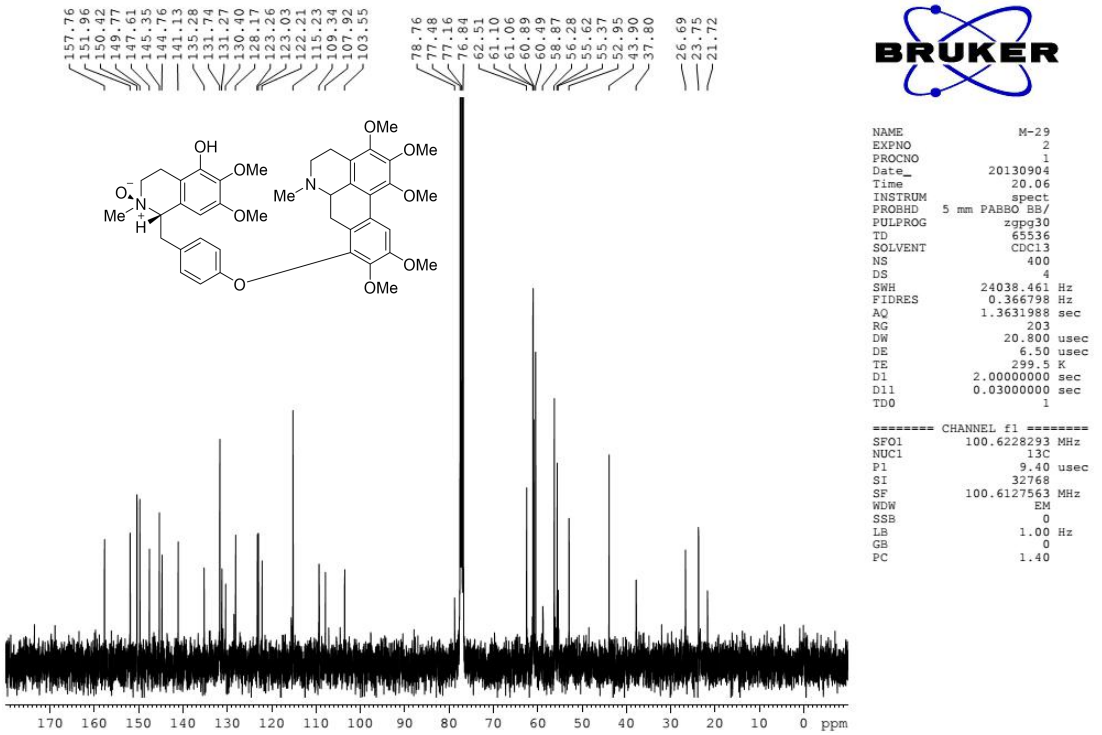


Figure S11.4. NOESY (600 MHz, $CDCl_3$) spectrum of compound **15**

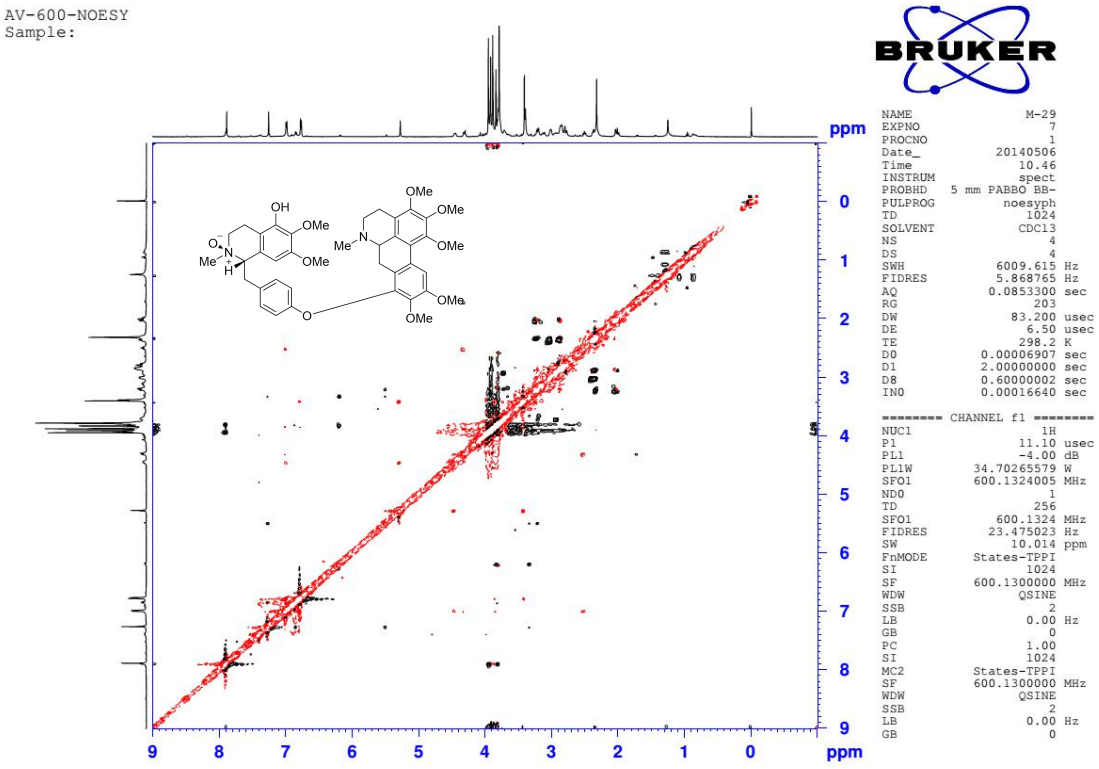


Figure S11.5. HRESIMS of compound **15**

Mass Spectrum Molecular Formula Report

Analysis Info

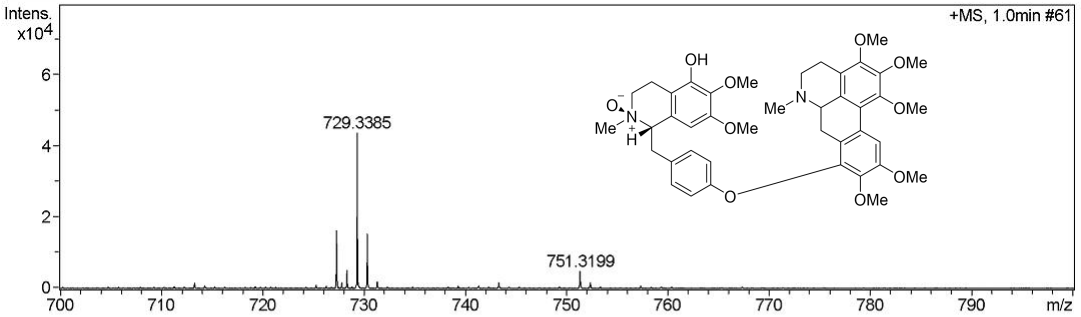
Analysis Name	D:\Data\20140424CEYANG\M-29_1-c,3_01_3208.d	Acquisition Date	4/24/2014 3:14:07 PM
Method	20131026_ceyang.m	Operator	Bruker Customer
Sample Name	M-29	Instrument / Ser#	micrOTOF-Q 125
Comment			

Acquisition Parameter

Source Type	ESI	Ion Polarity	Positive	Set Nebulizer	1.2 Bar
Focus	Active	Set Capillary	4500 V	Set Dry Heater	180 °C
Scan Begin	50 m/z	Set End Plate Offset	-500 V	Set Dry Gas	8.0 l/min
Scan End	1000 m/z	Set Collision Cell RF	300.0 Vpp	Set Divert Valve	Source

Generate Molecular Formula Parameter

Formula, min.	C41H48N2O10H						
Formula, max.							
Measured m/z	729.338	Tolerance	5	ppm	Charge	1	
Check Valence	no	Minimum	0		Maximum	0	
Nirogen Rule	no	Electron Configuration	both				
Filter H/C Ratio	no	Minimum	0		Maximum	3	
Estimate Carbon	yes						



Sum Formula	Sigma	m/z	Err [ppm]	Mean Err [ppm]	Err [mDa]	rdb	N Rule	e⁻
C 41 H 49 N 2 O 10	0.071	729.3382	-0.48	0.75	-0.35	18.50	ok	even

Figure S11.6. ECD spectrum of compound **15**

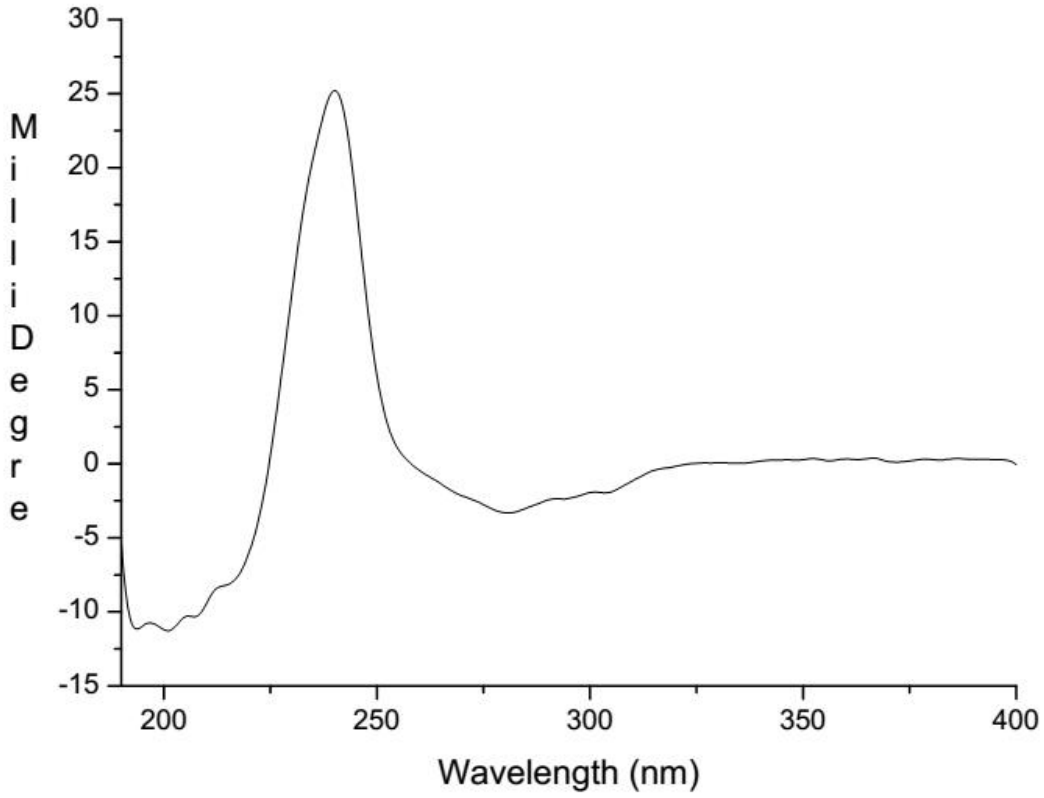
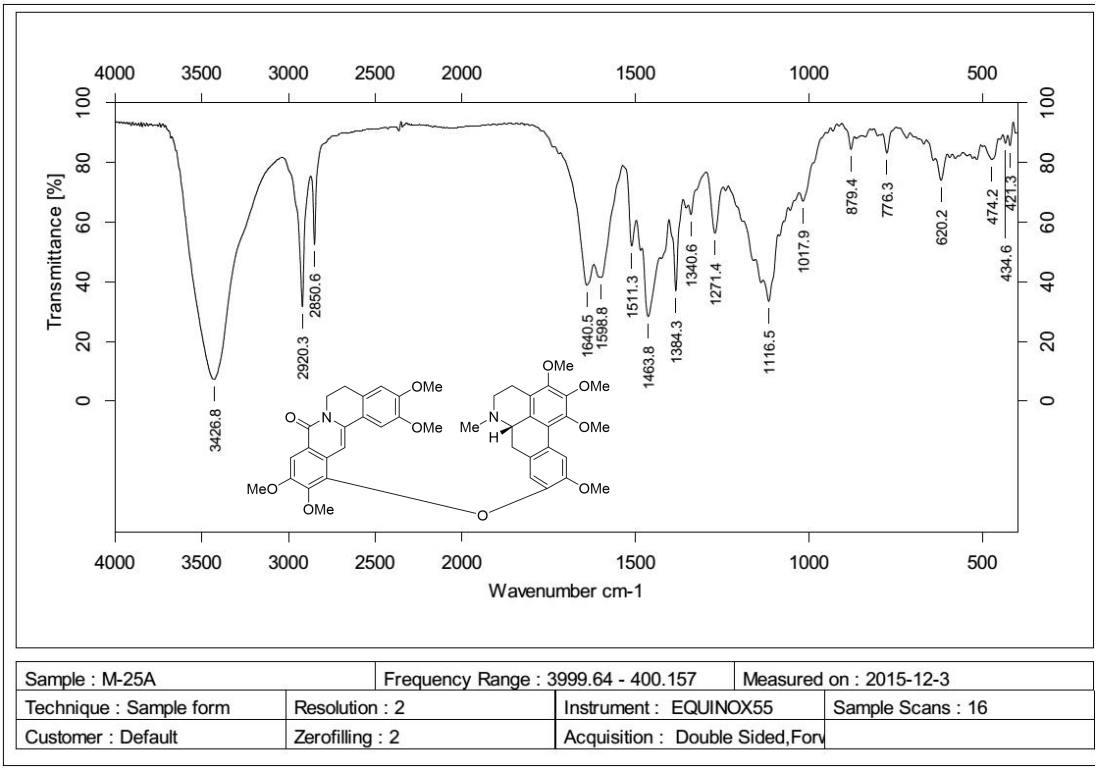


Figure S12.1. IR spectrum of compound **16**



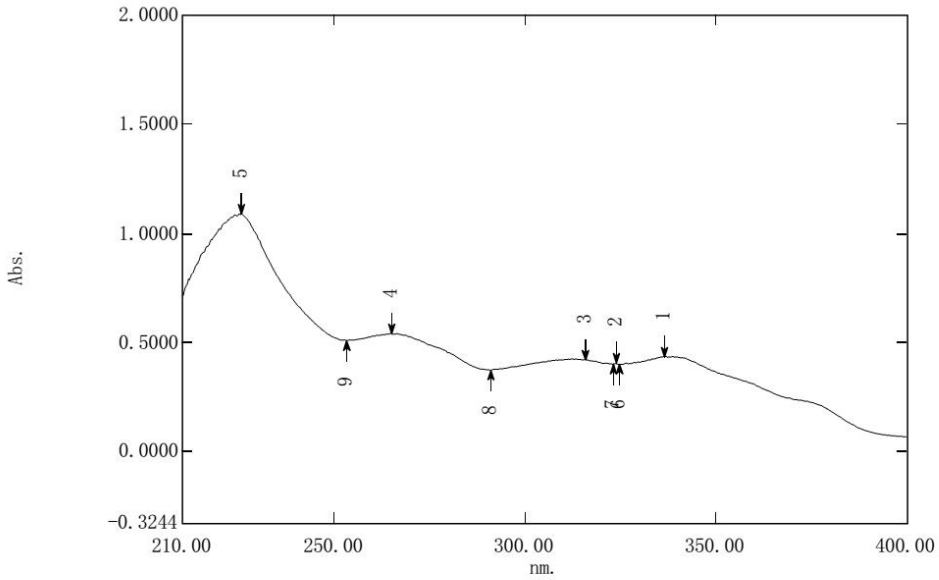
Sample : M-25A	Frequency Range : 3999.64 - 400.157	Measured on : 2015-12-3	
Technique : Sample form	Resolution : 2	Instrument : EQUINOX55	Sample Scans : 16
Customer : Default	Zerofilling : 2	Acquisition : Double Sided,For	

Figure S12.2. UV spectrum of compound **16**

Spectrum Peak Pick Report

FIELD FIELD TEXT

Data Set: 没有



测定属性
波长范围 (nm.): 200.00到400.00
扫描速度: 高速
采样间隔: 0.2
自动采样间隔: 启用
扫描模式: 自动

试样准备属性
重量:
体积 :
稀释:
光程长:
附加信息:

仪器属性
仪器类型: UV-1700
测定方式: 吸收值
狭缝宽: 1.0 nm
光源改变波长: 340.8 nm
S/R 转换: 标准

附件属性
附件: 无

No.	P/V	Wavelength	Abs.	描述
1	↑	336.40	.4371	
2	↑	323.80	.4045	
3	↑	315.60	.4229	
4	↑	264.80	.5416	
5	↑	225.60	1.0906	
6	↓	324.60	.4008	
7	↓	323.00	.4021	
8	↓	290.80	.3746	
9	↓	253.20	.5099	
10	↓	202.60	.4175	

FIELD TEXT

Figure S12.3. ^{1}H NMR (600 MHz, $CDCl_3$) spectrum of compound **16**

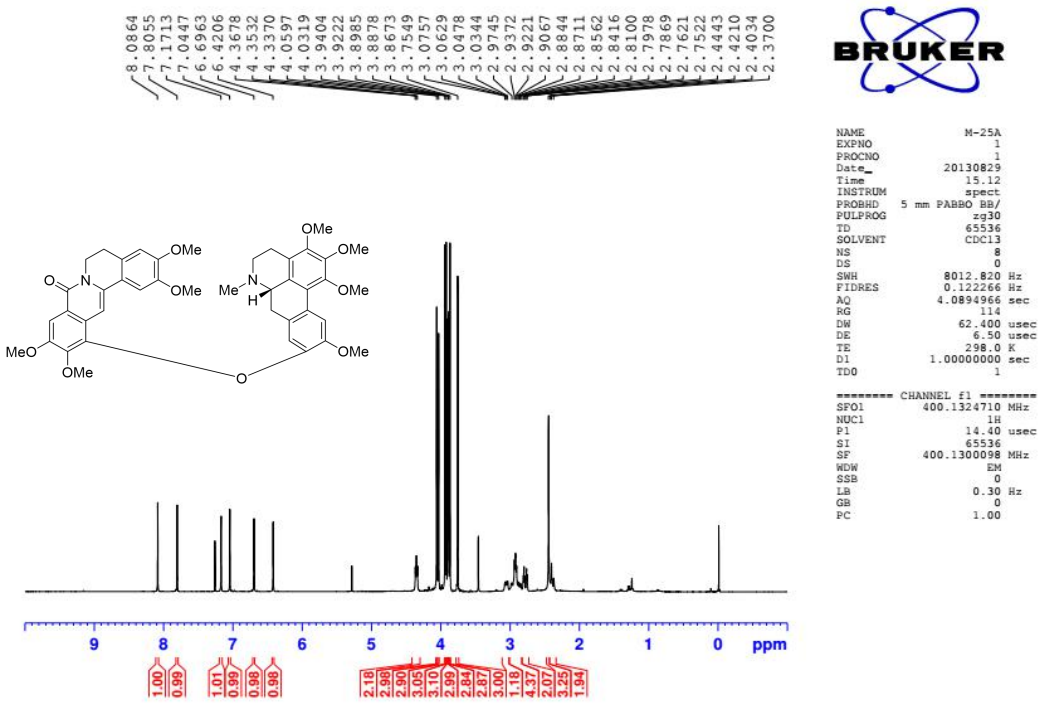


Figure S12.4. ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **16**

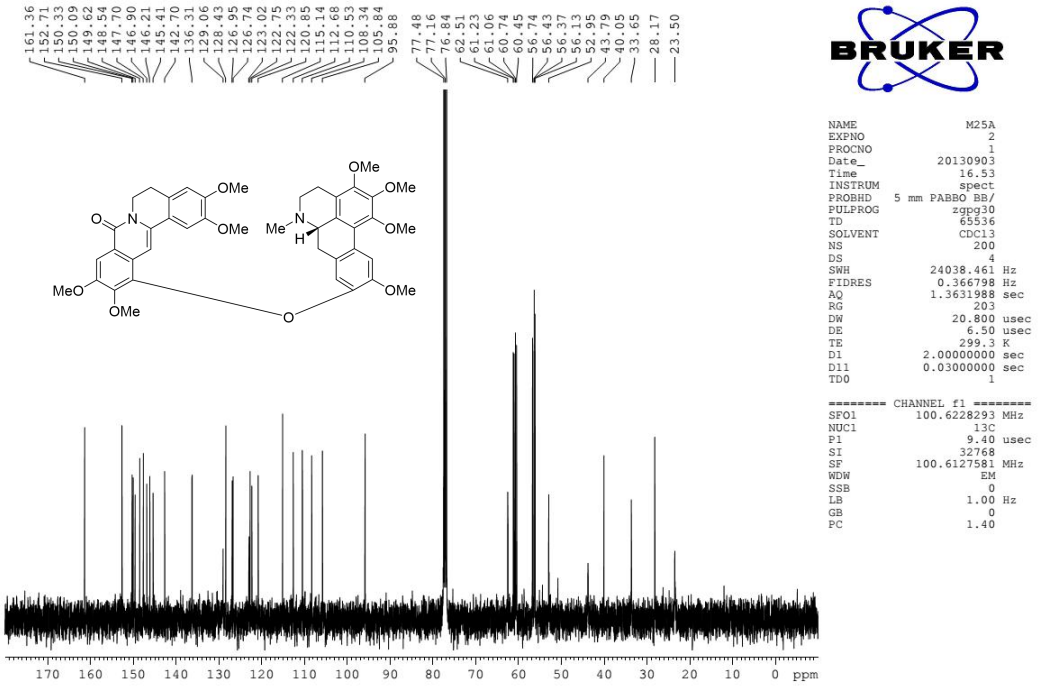


Figure S12.5. HSQC (600 MHz, $CDCl_3$) spectrum of compound **16**

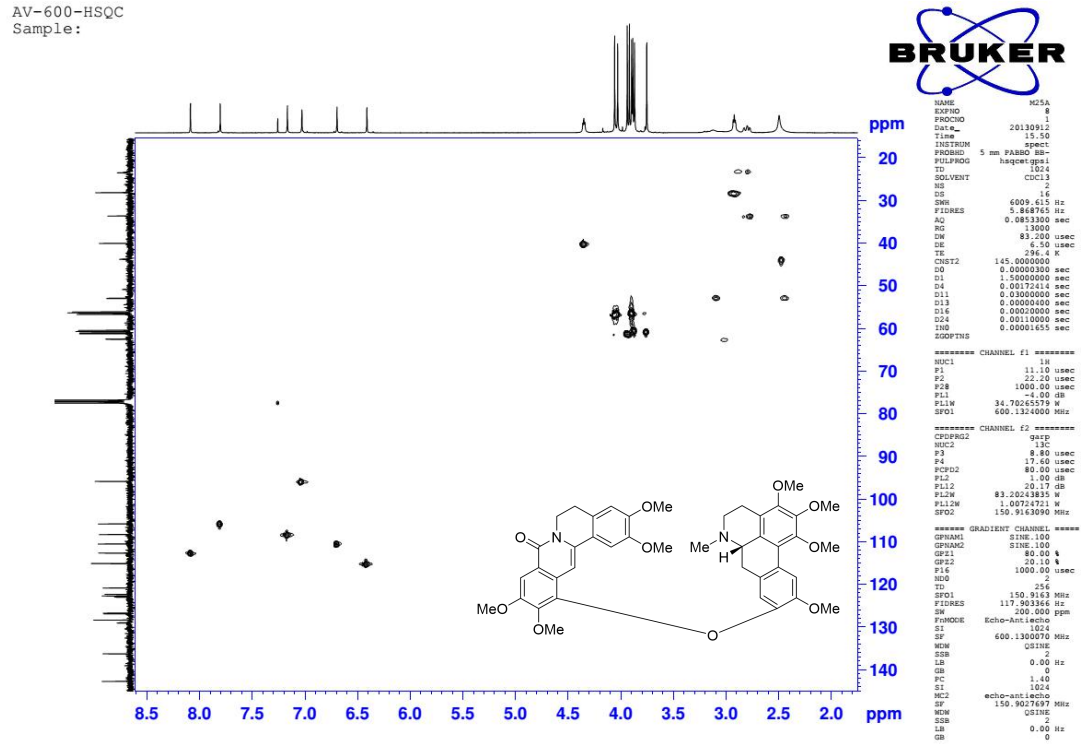


Figure S12.6. HMBC (600 MHz, $CDCl_3$) spectrum of compound **16**

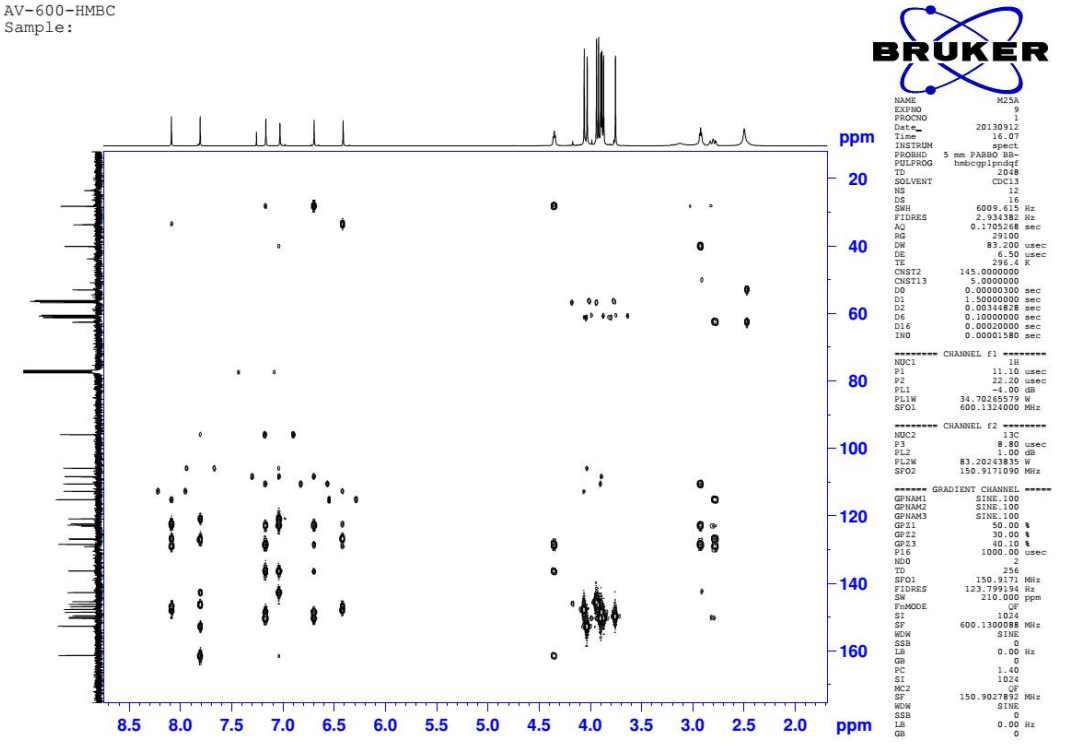


Figure S12.7. NOESY (600 MHz, $CDCl_3$) spectrum of compound **16**

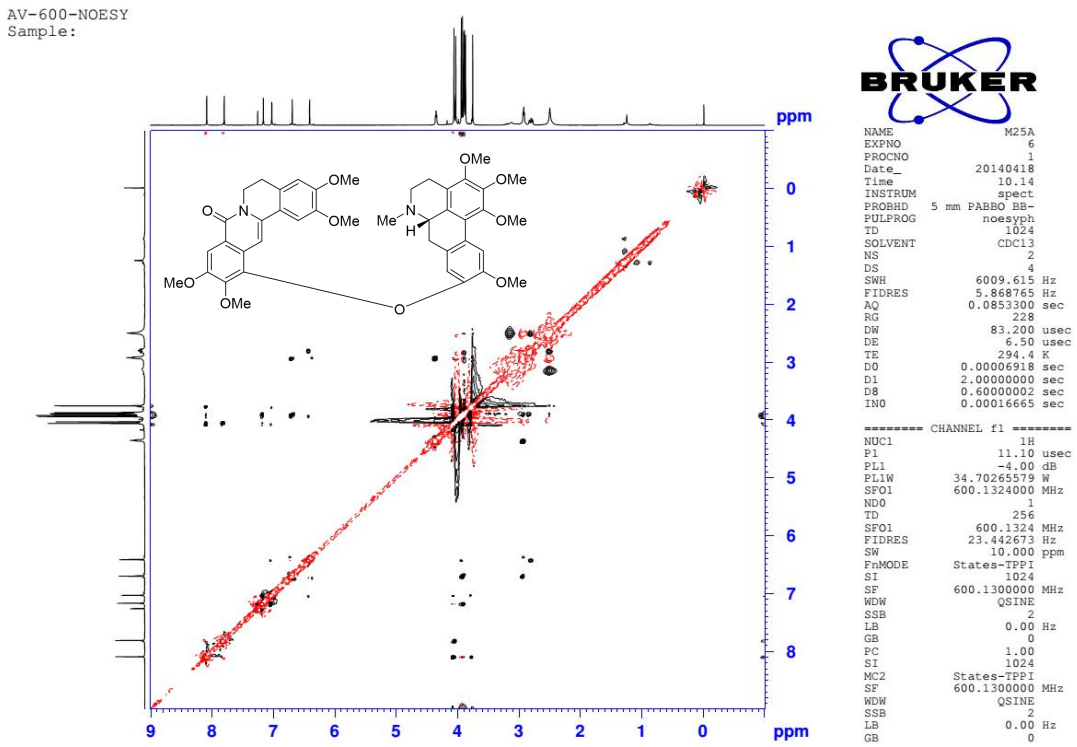
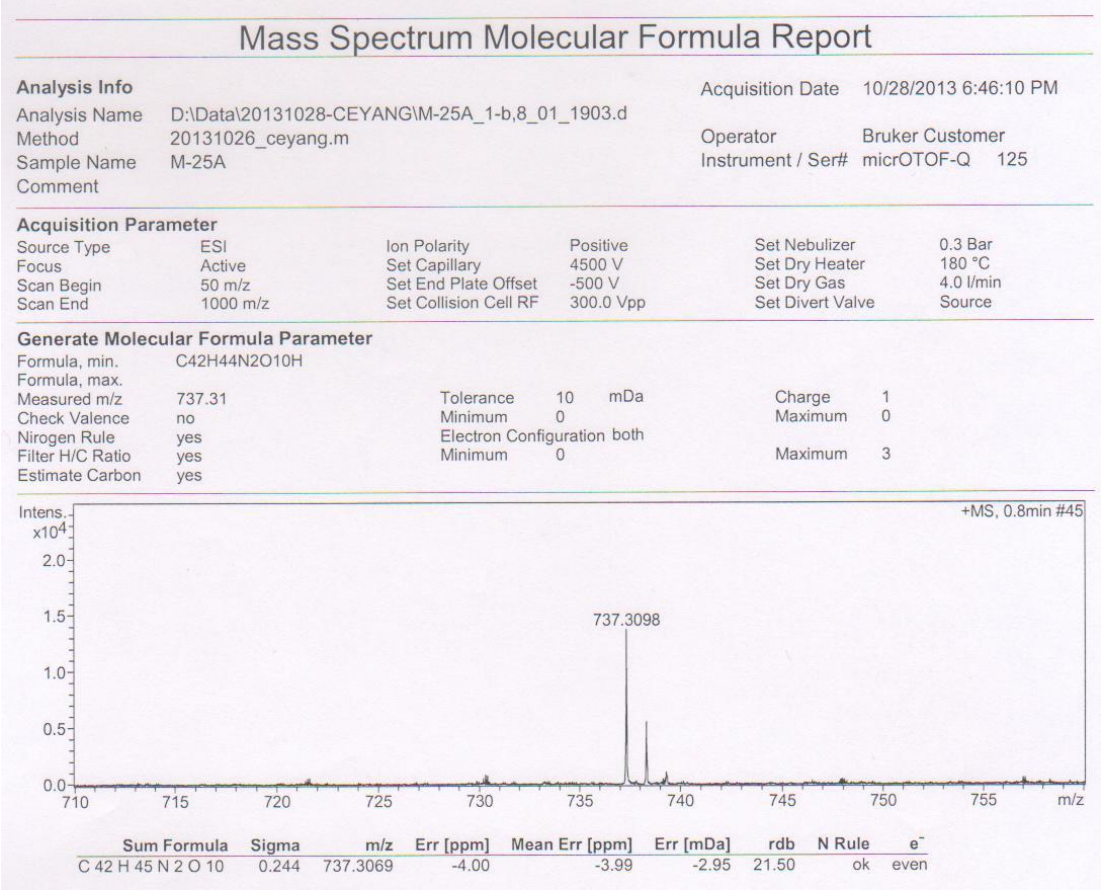


Figure S12.8. HRESIMS of compound **16**



Mass Spectrum Molecular Formula Report

Analysis Info

Analysis Name	D:\Data\20131028-CEYANG\M-25A_1-b,8_01_1903.d	Acquisition Date	10/28/2013 6:46:10 PM
Method	20131026_ceyang.m	Operator	Bruker Customer
Sample Name	M-25A	Instrument / Ser#	micrOTOF-Q 125
Comment			

Acquisition Parameter

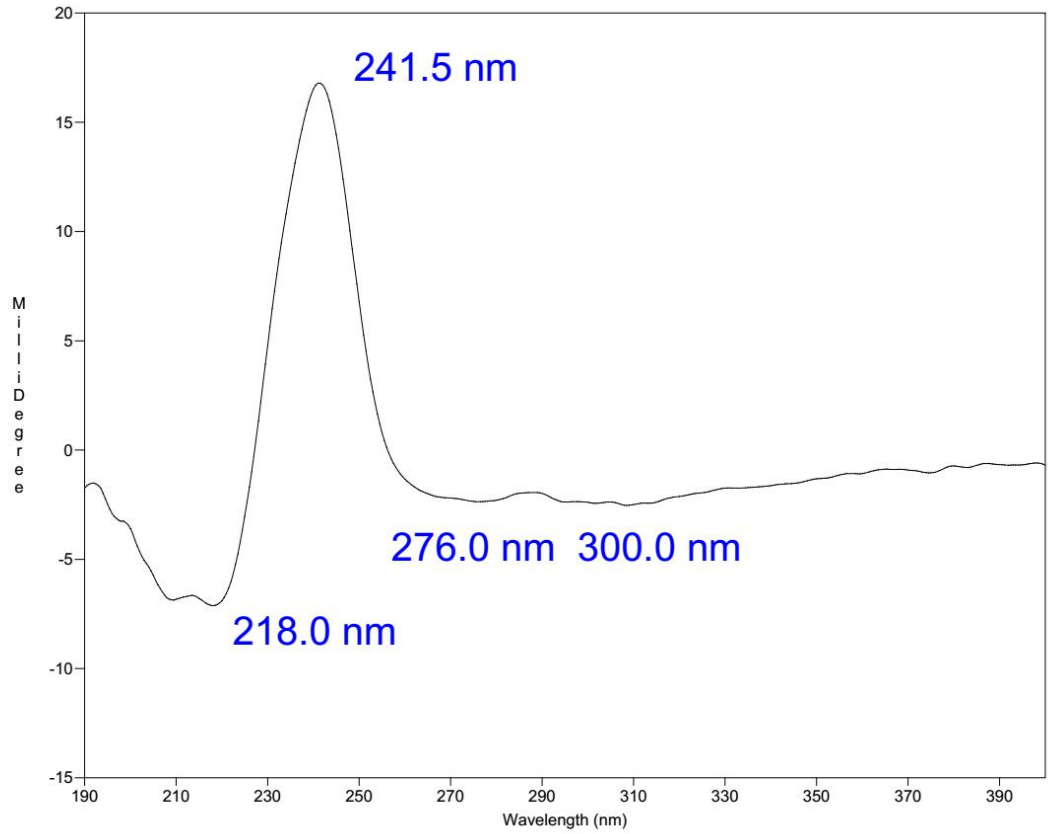
Source Type	ESI	Ion Polarity	Positive	Set Nebulizer	0.3 Bar
Focus	Active	Set Capillary	4500 V	Set Dry Heater	180 °C
Scan Begin	50 m/z	Set End Plate Offset	-500 V	Set Dry Gas	4.0 l/min
Scan End	1000 m/z	Set Collision Cell RF	300.0 Vpp	Set Divert Valve	Source

Generate Molecular Formula Parameter

Formula, min.	C42H44N2O10H				
Formula, max.					
Measured m/z	737.31	Tolerance	10 mDa	Charge	1
Check Valence	no	Minimum	0	Maximum	0
Nirogen Rule	yes	Electron Configuration	both		
Filter H/C Ratio	yes	Minimum	0	Maximum	3
Estimate Carbon	yes				

Sum Formula	Sigma	m/z	Err [ppm]	Mean Err [ppm]	Err [mDa]	rdb	N Rule	e⁻
C 42 H 45 N 2 O 10	0.244	737.3069	-4.00	-3.99	-2.95	21.50	ok	even

Figure S12.9. ECD spectrum of compound **16**



Bio-Kine Software V4.71 Date : 2014-3-7 Time : 14:03:50

COMMENTS :
File name : sav-golay
Savitzky-Golay Smooth of sav-golay
Window Points=15
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