Supplementary Information

Modification of [2.2]paracyclophane through cobalt-catalyzed ortho-C−H allylation and acyloxylation

Hong Song,[a,#] Ya Li,[a,#] Qi-Jun Yao[a] and Bing-Feng Shi[a,b,*]

[a]Center of Chemistry for Frontier Technologies, Department of Chemistry, Zhejiang University, Hangzhou, Zhejiang, 310027, China

[b]School of Chemistry and Chemical Engineering, Henan Normal University, Xinxiang 453007, China

*Corresponding author, Email: bfshi@zju.edu.cn

[#]These authors contributed equally to this work.

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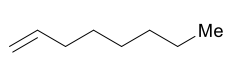
1. General Information

NMR spectra were recorded on a Bruke Avance operating for ^{1}H NMR at 400 MHz, ^{13}C NMR at 100 MHz and ^{19}F NMR at 376 MHz using TMS as internal standard. Chemical shifts were given relative to $CDCl_3$ (7.26 ppm for ^{1}H NMR, 77.16 ppm for ^{13}C NMR).. The following abbreviations (or combinations thereof) were used to explain multiplicities: s = singlet, d = doublet, t = triplet, m = multiplet, brs = broad singlet. Mass spectroscopy data of the products were collected on an HRMS-TOF instrument or a low-resolution MS instrument using EI and ESI and MALDI ionization. The ee value was determined on Shimadzu HPLC using CHIRALPAK column with hexane and isopropanol as eluent, Wavelength = 254 nm. The Crystal data of the products were collected on a Bruker D8 Venture.

All the materials and solvents were purchased from commercial suppliers and used without additional purification. All solvents were analytical grade. Catalytic reactions were carried out in pre-dried Schlenk flask under N_2 atmosphere. [2,2]paracyclophane, cobalt catalysts and other additive chemicals were purchased from commercial companies. Model substrate *rac*-**1** was reported compound and prepared according to the literature.[1] Enantiopure (S_p)-[2,2]paracyclophane carboxylic acid was obtained according to reported method.[2]

2. Reaction partners tested in this manuscript

Table S1. Aliphatic alkenes **2** and α-methyl acrylates **3**



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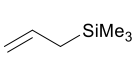

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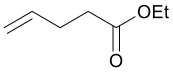

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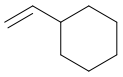

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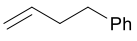

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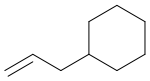

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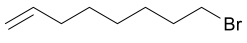

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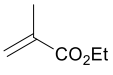

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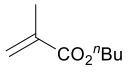

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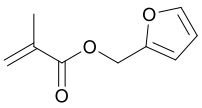

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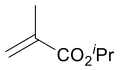

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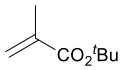

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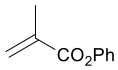

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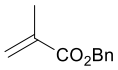

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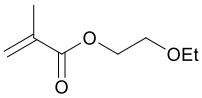

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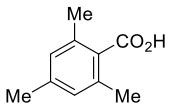
Table S2. Carboxylic acids **6**



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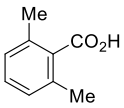

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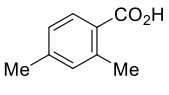

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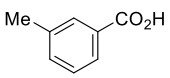

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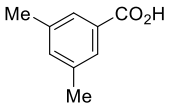

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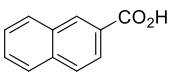

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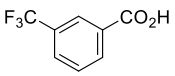

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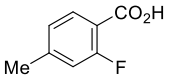

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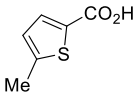

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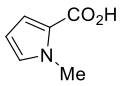

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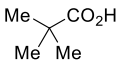

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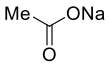

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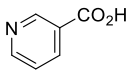
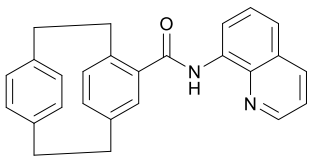
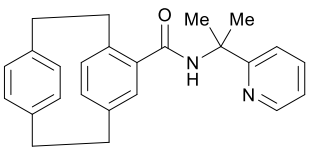


6m

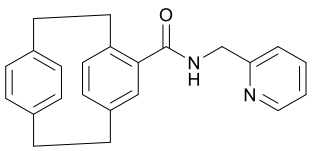
Table S3. [2,2]Paracyclophane amides



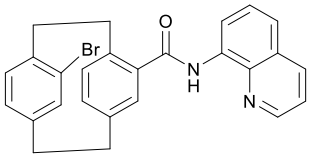
rac-**1a**



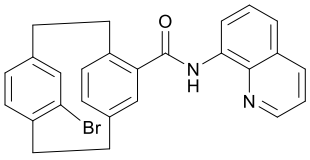
rac-**1b**



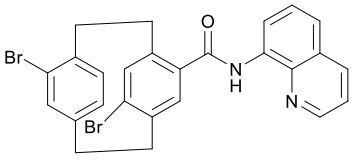
rac-**1c**



rac-**1d**



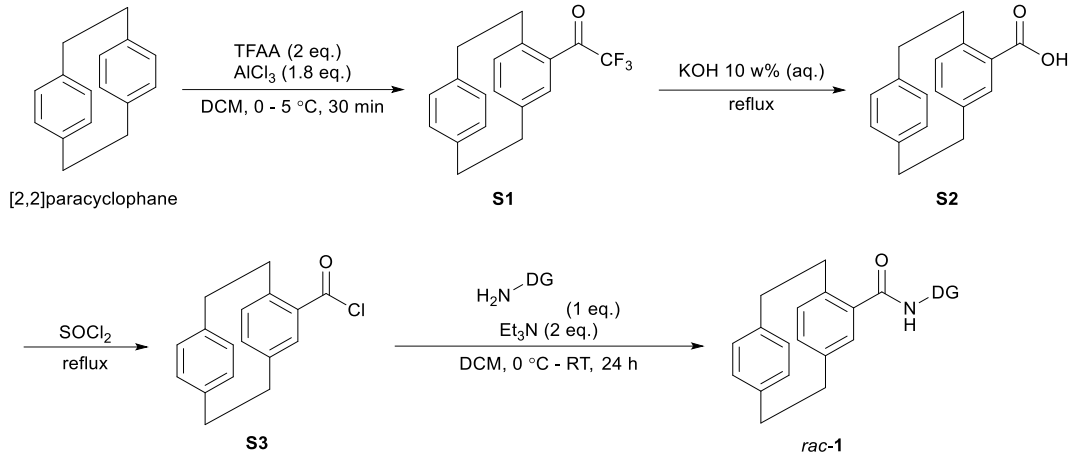
rac-**1e**



rac-**1f**

3. Experimental sections.

3.1 Preparing the [2,2]paracyclophane derivatized amides.



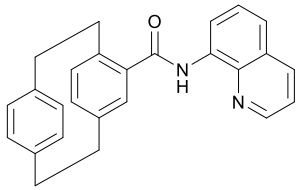
Scheme S1. Synthesis of *rac*-**1a**-**1c**.

Trifluoroacetic acid anhydride (6.75 mL, 47.75 mmol) dissolved in dichloromethane (30 mL) was added to a suspension of $AlCl_3$ (5.7 g, 43.13 mmol) in dichloromethane (120 mL) at 0 °C (ice bath). After 15 min, [2,2]paracyclophane (5 g, 24.03 mmol) was added while the temperature was held under 5 °C. After stirring for 30 min at room temperature, the reaction mixture was quenched at 0 °C by adding concentrated aqueous HCl (4.4 mL). Extraction with dichloromethane and subsequent column chromatography delivered **S1** in 92 % yield.

Compound **S1** (5 g, 16.45 mmol) was incubated in aqueous KOH (10 w%, 125 mL) and heated under reflux (110 ºC, oil bath) for 5 h. The white solid residue was separated by filtration and subsequently washed with DCM. The organic phase was then extracted with water. Titration of the aqueous phase with concentrated aqueous HCl delivered a precipitate **S2** that was purified by recrystallization from a mixture of acetic acid and water (9/1, v/v) (yield 86 %).

In a 100 mL round-bottom flask, thionyl chloride (10.0 mL) was added to Compound **S2** (20 mmol, 1.00 equiv.) and the resulting mixture was stirred at 100 °C (oil bath) for 2 h under N_2. After cooling to room temperature, the excess thionyl chloride was removed under vacuum, the final traces were washed with toluene (2 × 5 mL) and removed under vacuum. The resulting crude acetyl chloride **S3** was dissolved in CH_2Cl_2 (50 mL) and cooled to 0 °C (ice bath). A solution of directing group-tailored amine (20 mmol, 1.00 equiv.) and Et_3N (40 mmol, 2 equiv.) in CH_2Cl_2 (10 mL) was added, the reaction mixture was allowed to warm to room temperature and stirred for 24 h under N_2. Then the solution was washed with aq. HCl solution (1 N, 3 × 40 mL) and brine (100 mL). The organic phase was dried over $MgSO_4$, filtered, concentrated, and dried under vacuum to give the crude amide as brown solid, subsequent column chromatography (DCM:PE 1:1) delivered *rac*-**1** as a pale-yellow solid in 80% yield.

***rac*-4-carbonyl[2,2]paracyclohexaphan-*N*-(quinoline-8-yl)amide (*rac*-1a)**



rac-**1a**

Using the general procedure, the title compound *rac*-**1a** was isolated by reacting the corresponding acetyl chloride with 8-aminoquinoline as pale-yellow solid.

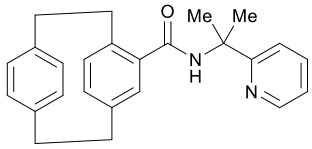
^{1}H NMR (400 MHz, Chloroform-*d*) δ 10.17 (s, 1H), 8.96 (d, *J* = 7.6 Hz, 1H), 8.84 – 8.78 (m, 1H), 8.20 (dd, *J* = 8.3, 1.6 Hz, 1H), 7.63 (t, *J* = 7.9 Hz, 1H), 7.56 (d, *J* = 8.2 Hz, 1H), 7.46 (dd, *J* = 8.4, 4.2 Hz, 1H), 6.99 (s, 1H), 6.89 (d, *J* = 7.8 Hz, 1H), 6.70 – 6.67 (m, 1H), 6.64 – 6.58 (m, 4H), 3.91 (ddd, *J* = 11.6, 9.4, 2.1 Hz, 1H), 3.29 – 2.94 (m, 7H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 167.4, 148.4, 140.4, 140.0, 139.8, 139.5, 138.9, 136.5, 136.4, 136.2, 135.5, 135.2, 132.9, 132.8, 132.6, 132.0, 131.8, 128.2, 127.6, 121.7, 121.6, 116.5, 35.6, 35.5, 35.4, 35.1.

HRMS (ESI) calculated for $([C_{26}H_{23}N_2O]+H)^+$: 379.1810, found: 379.1806

Melting point: 180.5-193.4 °C.

***rac*-4-carbonyl[2,2]paracyclohexaphan-*N*-(2-(pyridin-2-yl)propan-2-yl)amide (*rac*-1b)**



rac-**1b**

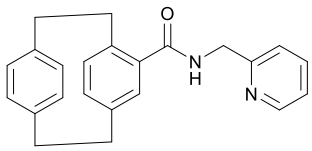
Using the general procedure, the title compound *rac*-**1e** was isolated by reacting the corresponding acetyl chloride with 2-(pyridin-2-yl)propan-2-amine as white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.57 – 8.51 (m, 1H), 8.04 (s, 1H), 7.75 (td, *J* = 7.7, 1.8 Hz, 1H), 7.48 (d, *J* = 8.1 Hz, 1H), 7.21 (dd, *J* = 7.4, 4.8 Hz, 1H), 6.85 (d, *J* = 8.1 Hz, 1H), 6.79 (s, 1H), 6.59 (dd, *J* = 7.8, 1.9 Hz, 1H), 6.54 (d, *J* = 5.5 Hz, 4H), 3.82 (ddd, *J* = 12.9, 8.9, 3.5 Hz, 1H), 3.21 – 2.98 (m, 6H), 2.91 (ddd, *J* = 13.2, 9.2, 6.8 Hz, 1H), 1.92 (s, 3H), 1.91 (s, 3H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 168.26, 164.92, 147.83, 140.04, 139.90, 139.40, 138.82, 137.34, 137.21, 136.07, 134.55, 132.83, 132.73, 132.48, 132.08, 131.96, 121.97, 119.62, 56.99, 35.52, 35.32, 35.07, 27.79, 27.61.

HRMS (ESI) calculated for $([C_{25}H_{27}N_2O]+H)^+$: 371.2118, found: 371.2120.

***rac*-4-carbonyl[2,2]paracyclohexaphan-*N*-(pyridin-2-ylmethyl)amide (*rac*-1c)**



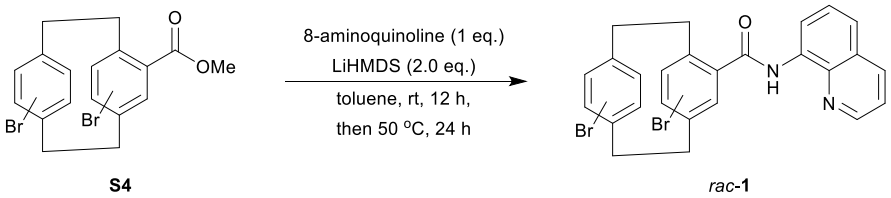
rac-**1c**

Using the general procedure, the title compound *rac*-**1f** was isolated by reacting the corresponding acetyl chloride with pyridin-2-ylmethanamine as off-white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.55 (d, *J* = 4.9 Hz, 1H), 7.70 (td, *J* = 7.7, 1.8 Hz, 1H), 7.35 (d, *J* = 7.8 Hz, 1H), 7.22 (dd, *J* = 7.5, 4.9 Hz, 1H), 6.96 (s, 1H), 6.78 (d, *J* = 5.7 Hz, 1H), 6.77 (s, 1H), 6.60 (dd, *J* = 7.8, 1.9 Hz, 1H), 6.55 (s, 2H), 6.50 (s, 1H), 6.47 (d, *J* = 7.9 Hz, 1H), 4.75 (d, *J* = 4.9 Hz, 2H), 3.76 (ddd, *J* = 12.8, 10.0, 2.5 Hz, 1H), 3.17 (ddd, *J* = 14.3, 11.9, 5.8 Hz, 3H), 3.11 – 2.96 (m, 3H), 2.90 (ddd, *J* = 13.0, 10.1, 5.9 Hz, 1H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 169.23, 156.61, 149.20, 140.26, 140.04, 139.48, 139.37, 136.96, 136.18, 135.26, 135.17, 132.82, 132.72, 132.57, 131.94, 122.54, 122.31, 44.89, 35.54, 35.45, 35.29, 35.03.

HRMS (ESI) calculated for $([C_{23}H_{23}N_2O]+H)^+$: 343.1805, found: 343.1806.

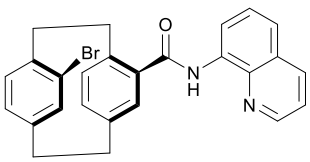


S4 *rac*-**1**

Scheme S2. Synthesis of *rac*-**1d-1f**

Bromo-substituted [2,2]paracyclophane carboxylates **S4** were prepared according reported methods[3-5]. To a pre-dried round-bottomed flask, equipped with a magnetic stirring bar, was added **S4** (4.0 mmol), 8-aminoquinoline (5.0 mmol) and anhydrous toluene (40 mL). The flask was charged with N_2 and cooled to 0 ºC. Then, a solution of LiHMDS (10.0 mL, 1.0 M in THF) was added dropwise via syringe over 5 minutes and the suspension was slowly warm to room temperature and stirred overnight. The reaction mixture was then heated to 50 ºC and stirred for another 24 hours. The reaction was quenched by slowly adding an aqueous solution of NH_4Cl and diluted with EtOAc. The organic phase was collected and washed with 1M HCl aq., water, sat. $NaHCO_3$ aq. and brine. The organic phase was collected, dried over Na_2SO_4 and concentrated under vacuo. The residue was purified through flash column chromatography, eluting with petroleum ether/EtOAc from 1/20 to 1/10.

***rac*-13-bromo-4-carbonyl[2,2]paracyclohexaphan-*N*-(quinoline-8-yl)amide (*rac*-1d)**



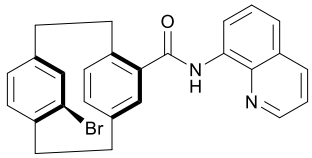
rac-**1d**

Using the general procedure, the title compound *rac*-**1d** was isolated by reacting the corresponding *rac*-13-bromo-4-methoxycarbonyl [2,2]paracyclohexaphane with 8-aminoquinoline as pale-yellow solid. **^{1}H NMR (400 MHz, Chloroform-*d*)** δ 10.41 (s, 1H), 8.98 (d, *J* = 7.6 Hz, 1H), 8.84 (d, *J* = 4.2 Hz, 1H), 8.16 (d, *J* = 8.2 Hz, 1H), 7.61 (t, *J* = 7.9 Hz, 1H), 7.52 (d, *J* = 8.2 Hz, 1H), 7.44 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.38 (s, 1H), 6.74 (s, 1H), 6.71 – 6.57 (m, 4H), 4.26 (ddd, *J* = 14.6, 9.7, 6.0 Hz, 1H), 3.59 (ddd, *J* = 12.9, 9.6, 2.7 Hz, 1H), 3.32 (ddd, *J* = 13.2, 10.1, 2.6 Hz, 1H), 3.23 – 2.99 (m, 4H), 2.95 – 2.85 (m, 1H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 166.34, 148.48, 141.52, 140.98, 139.68, 139.19, 138.77, 136.51, 135.60, 135.24, 134.82, 133.77, 133.69, 132.77, 131.37, 129.47, 128.15, 127.51, 126.76, 121.93, 121.85, 116.50, 35.93, 35.66, 32.29, 32.26.

HRMS (ESI) calculated for $([C_{26}H_{21}BrN_2O]+H)^+$: 457.0910, found: 457.0906.

***rac*-12-bromo-4-carbonyl[2,2]paracyclohexaphan-*N*-(quinoline-8-yl)amide (*rac*-1e)**



rac-**1e**

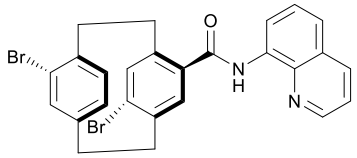
Using the general procedure, the title compound *rac*-**1e** was isolated by reacting the corresponding *rac*-12-bromo-4-methoxycarbonyl [2,2]paracyclohexaphane with 8-aminoquinoline as white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 10.13 (s, 1H), 8.98 (dd, *J* = 7.6, 1.4 Hz, 1H), 8.78 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.16 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.66 – 7.59 (m, 2H), 7.54 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.44 (dd, *J* = 8.3, 4.2 Hz, 1H), 6.99 (d, *J* = 1.8 Hz, 1H), 6.69 – 6.59 (m, 3H), 6.56 (d, *J* = 7.8 Hz, 1H), 3.91 (ddd, *J* = 12.4, 10.1, 1.7 Hz, 1H), 3.51 (ddd, *J* = 13.4, 9.9, 1.6 Hz, 1H), 3.32 – 3.06 (m, 4H), 2.93 (ddd, *J* = 12.8, 10.1, 6.6 Hz, 1H), 2.83 (ddd, *J* = 13.4, 10.3, 6.9 Hz, 1H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 167.32, 148.28, 142.17, 139.99, 139.79, 138.90, 138.87, 136.38, 136.10, 135.80, 135.76, 135.20, 135.05, 134.73, 131.24, 128.13, 127.64, 127.52, 127.08, 121.71, 121.63, 116.59, 35.92, 35.18, 34.71, 32.65.

HRMS (ESI) calculated for $([C_{26}H_{21}BrN_2O]+H)^+$: 457.0910, found: 457.0909.

***rac*-7,15-dibromo-4-carbonyl[2,2]paracyclohexaphan-*N*-(quinoline-8-yl)amide (*rac*-1f)**



rac-**1f**

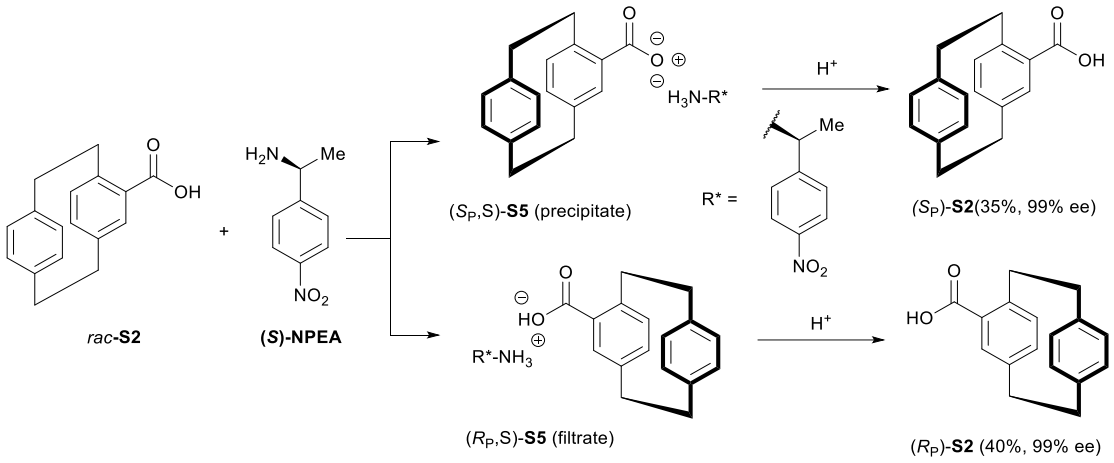
Using the general procedure, the title compound *rac*-**1e** was isolated by reacting the corresponding *rac*-7,15-dibromo-4-methoxycarbonyl [2,2]paracyclohexaphane with 8-amino-quinoline as pale-brown solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 10.11 (s, 1H), 8.92 (d, *J* = 7.6 Hz, 1H), 8.79 (d, *J* = 4.3 Hz, 1H), 8.19 (d, *J* = 8.3 Hz, 1H), 7.62 (t, *J* = 7.9 Hz, 1H), 7.56 (d, *J* = 8.3 Hz, 1H), 7.46 (dd, *J* = 8.6, 4.2 Hz, 1H), 7.32 (s, 1H), 7.25 (d, *J* = 4.6 Hz, 1H), 7.03 (s, 1H), 6.95 (d, *J* = 8.1 Hz, 1H), 6.56 (d, *J* = 8.0 Hz, 1H), 3.73 (dd, *J* = 12.5, 9.5 Hz, 1H), 3.50 (t, *J* = 9.8 Hz, 1H), 3.41 (dd, *J* = 12.7, 9.5 Hz, 1H), 3.24 – 3.03 (m, 4H), 2.89 (dt, *J* = 17.3, 8.8 Hz, 1H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 166.34, 148.48, 141.52, 140.98, 139.68, 139.19, 138.77, 136.51, 135.60, 135.24, 134.82, 133.77, 133.69, 132.77, 131.37, 129.47, 128.15, 127.51, 126.76, 121.93, 121.85, 116.50, 35.93, 35.66, 32.29, 32.26.

HRMS (ESI) calculated for $([C_{26}H_{20}Br_2N_2O]+H)^+$: 535.0915, found: 535.0914.

3.2 Resolution of 4-carbonyl[2.2]Paracyclophan-acid S2[2]

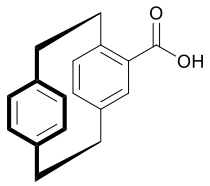


Scheme S3. Isolation of chiral **S2**

A mixture of racemic **S2** (1.0 g, 4.0 mmol) and (-)-(*S*)-α-(*p*-nitrophenyl)ethylamine (0.6 mL, 4.3 mmol) in $CHCl_3$ (35 mL) was stirred at room temperature for 1 h, then at 70 °C (oil bath) for 6 h until the white solid precipitated from the solution. To complete the precipitation the reaction mixture was kept overnight at -5 °C. The filtration and drying of the precipitate formed gave (S_P, *S*)-**S5** as white solid. The salt was dissolved in MeOH and hydrolyzed with 2 N HCl. The precipitated solid was washed twice with H_2O (2 × 50 mL) to yield 0.315 g (35%) of (S_P)-(+)-4-carbonyl[2.2]paracyclophan-acid (***S*P-S2**).

The $CHCl_3$ filtrates, containing partially enriched (R_P,S)-**S5**, after evaporation and hydrolysis gave a partially resolved (R_P)-**S2**. This compound was mixed with (+)-(*R*)-α-(*p*-nitrophenyl)ethylamine in $CHCl_3$ (30 mL). Single crystallization of the resultant diastereomeric mixture from EtOH afforded of diastereomeric salt (R_P, *R*)-**S5**. Hydrolysis of (R_P, *R*)-**S5** gave 0.403 g (40%) of (R_P)-**S2**.

(*S*P)-(+)-4-carbonyl[2.2]paracyclophana (*S*P-S2)


(*S*p)-**S2**

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.28 (s, 1H), 6.71 (dd, *J* = 7.7, 1.9 Hz, 1H), 6.59 (dd, *J* = 7.6, 3.8 Hz, 3H), 6.51 (t, *J* = 6.6 Hz, 2H), 4.20 (ddd, *J* = 11.6, 9.1, 2.2 Hz, 1H), 3.25 – 3.12 (m, 4H), 3.09 – 2.98 (m, 2H), 2.90 (ddd, *J* = 13.1, 10.0, 7.2 Hz, 1H).

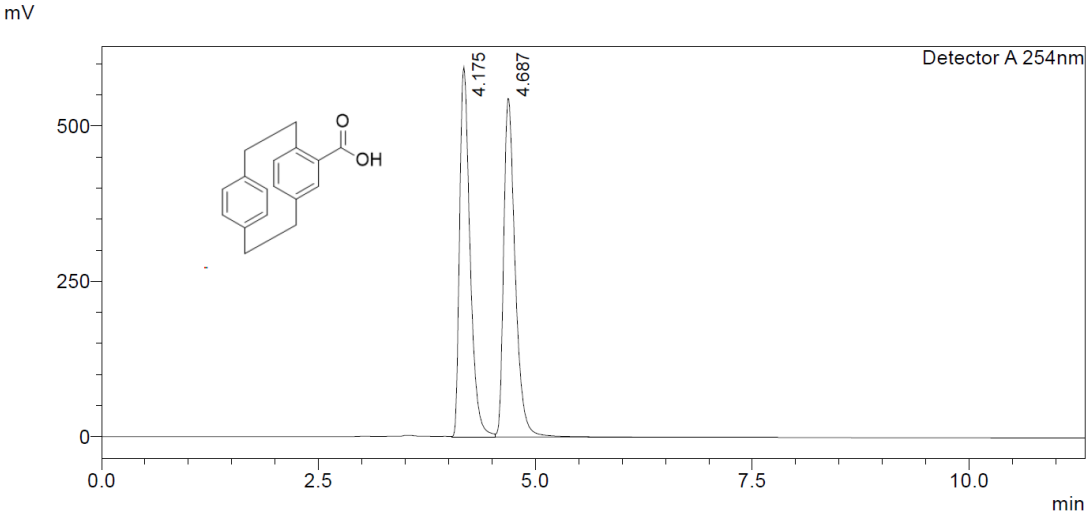
^{13}C NMR (100 MHz, Chloroform-*d*) δ 172.0, 143.9, 140.22, 140.2, 139.6, 137.5, 136.5, 136.3, 133.3, 132.9, 132.5, 131.9, 129.7, 36.4, 35.4, 35.2, 35.1.

HRMS (ESI) calculated for $([C_{17}H_{16}O_2]+Na)^+$: 275.1048, found: 275.1044.

(***S*p-S2**): Enantiomeric excess was determined by HPLC with a Daicel Chiralpak AD-H, n-hexane/isopropanol = 90/10, v = 1.0 mL · min^{-1}, λ = 254 nm, t (major) = 4.2 min, t (minor) = 4.7 min.

Copies of HPLC data:

<Chromatogram>

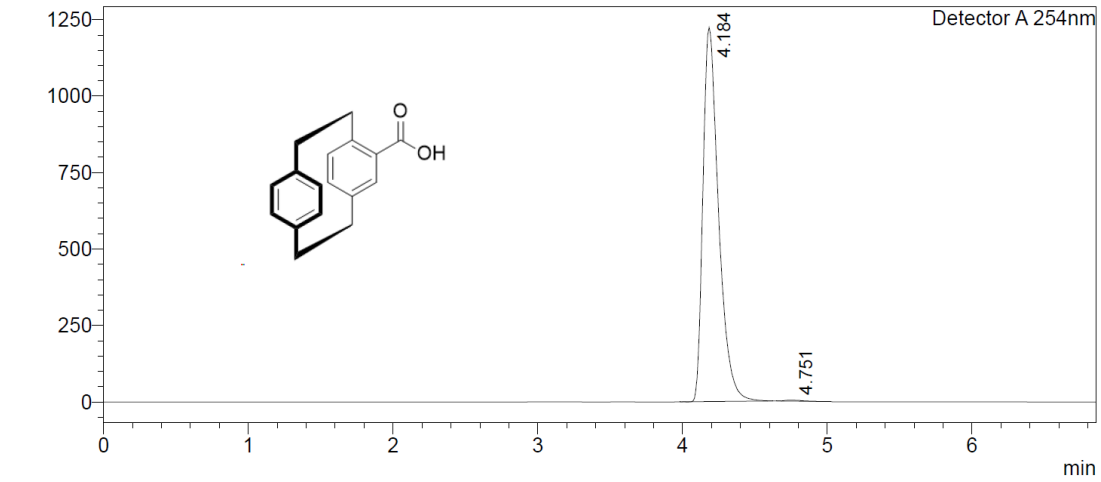


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Area%
1	4.175	4980769	595482	49.640			49.640
2	4.687	5052932	544852	50.360		V	50.360
Total		10033702	1140333				100.000

<Chromatogram>



<Peak Table>

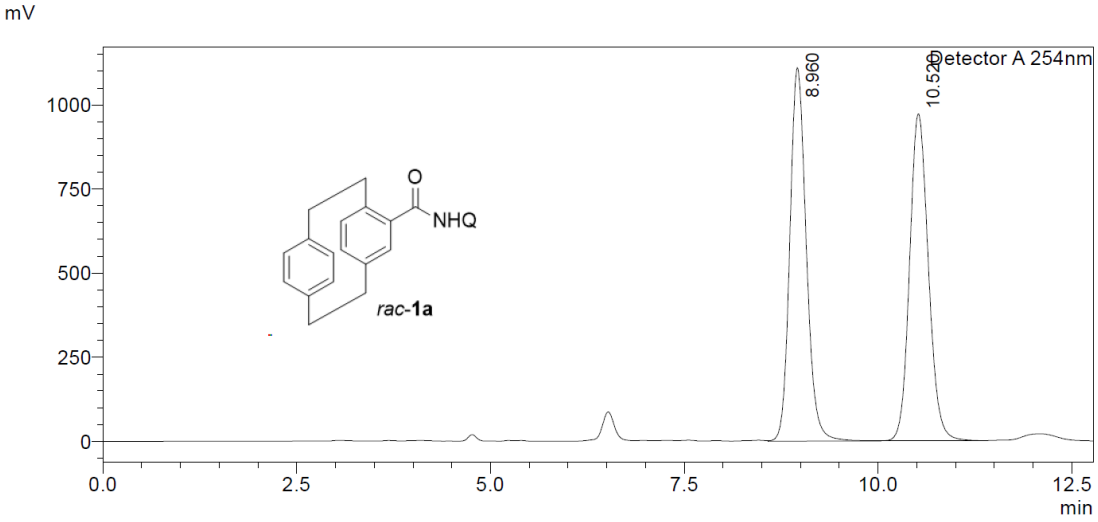
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Area%
1	4.184	9183639	1223449	99.679		M	99.679
2	4.751	29563	3558	0.321			0.321
Total		9213202	1227008				100.000

(S_p)-1a was synthesized as rac-1a using enantiopure **(S_p)-S2.** The enantiomeric excess was determined by HPLC with a Daicel Chiralpak IA, n-hexane/isopropanol = 90/10, v = 1.0 mL · min^{-1}, λ = 254 nm, t (major) = 9.0 min, t (minor) = 10.5 min.

Copies of HPLC data of (S_p)-1a:

<Chromatogram>

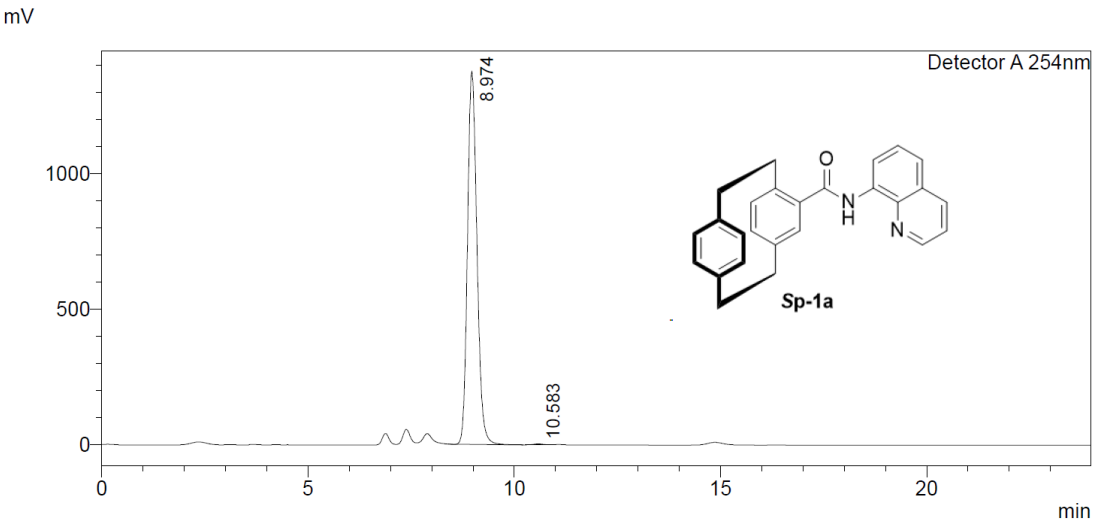


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Area%
1	8.960	16374590	1109704	49.919	49.919
2	10.520	16427888	972250	50.081	50.081
Total		32802478	2081953		100.000

<Chromatogram>



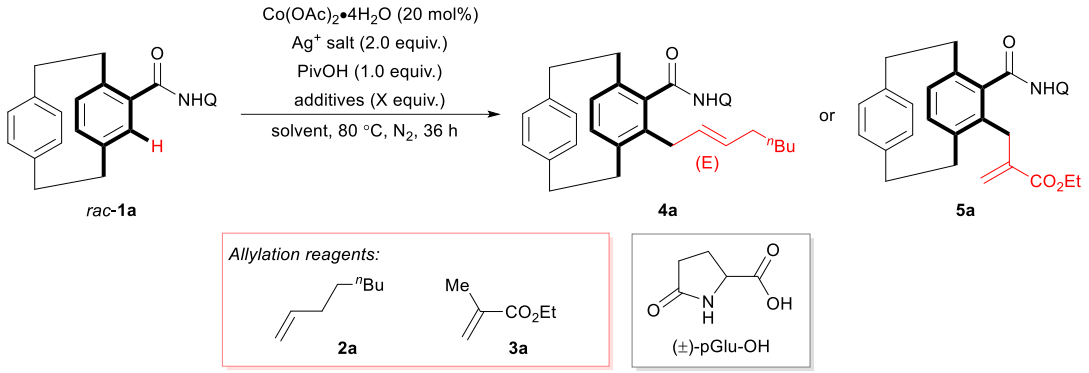
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Area%
1	8.974	21964171	1374145	99.719	99.719
2	10.583	61922	3710	0.281	0.281
Total		22026093	1377855		100.000

3.3 Optimization of Reaction Conditions

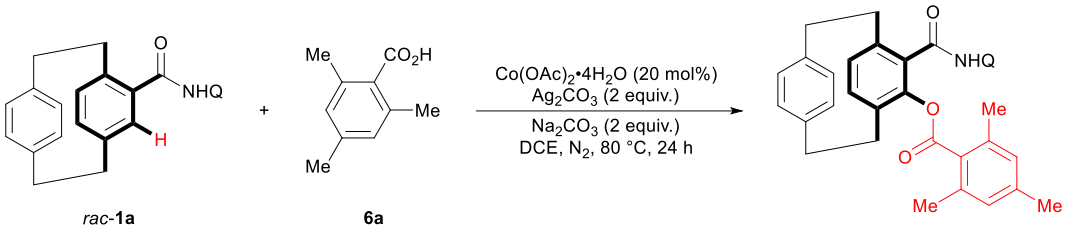
Table S4. Optimization of *ortho*-Allylation Reaction Conditions[a]



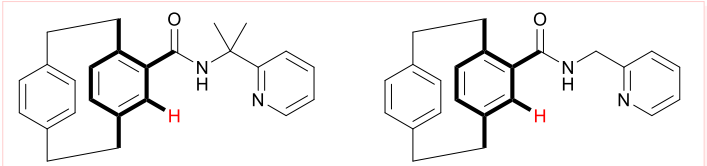
entry	solvent	reagent	silver salt	additives (X equiv.)	yields (%)[b]
1	toluene	**2a**	Ag_2O	---	53
2	toluene	**2a**	Ag_2CO_3	---	31
3	toluene	**2a**	AgOAc	---	28
4	toluene	**2a**	AgF	---	13
5	toluene	**2a**	Ag_2O	Ac-Gly-OH (30 mol%)	55
6	toluene	**2a**	Ag_2O	(±)-Ac-Tle-OH (30 mol%)	57
7	toluene	**2a**	Ag_2O	(±)-Boc-Tle-OH (30 mol%)	53
8	toluene	**2a**	Ag_2O	(±)-Cbz-Phe-OH (30 mol%)	49
9	toluene	**2a**	Ag_2O	(±)-pGlu-OH (30 mol%)	74
10	DCE	**2a**	Ag_2O	(±)-pGlu-OH (30 mol%)	63
11	PhCl	**2a**	Ag_2O	(±)-pGlu-OH (30 mol%)	67
12[c]	toluene	**3a**	Ag_2O	(±)-pGlu-OH (30 mol%)	trace
13[c]	toluene	**3a**	Ag_2O	Na_2CO_3 (3.0 equiv.)	5
14[c]	toluene	**3a**	Ag_3PO_4	Na_2CO_3 (3.0 equiv.)	10
15[c]	toluene	**3a**	$AgNO_3$	Na_2CO_3 (3.0 equiv.)	trace
16[c]	toluene	**3a**	Ag_2SO_4	Na_2CO_3 (3.0 equiv.)	28
17[c]	DCE	**3a**	Ag_2SO_4	Na_2CO_3 (3.0 equiv.)	44
18[c,d]	DCE	**3a**	Ag_2SO_4	Na_2CO_3 (3.0 equiv.)	55

[a]Reactions were performed with *rac*-**1a** (0.1 mmol), **2a** or **3a** (0.3 mmol), $Co(OAc)_2 \cdot 4H_2O$ (20 mol%), silver salt (2.0 equiv.), PivOH (1 equiv.) and additives in 1.0 mL toluene at 80 °C for 36 h under N_2. [b]Isolated yield. [c]Reacted at 100 °C for 24 h. [d]Ag_2SO_4 (1.0 equiv) and PivOH (50 mol%) were used.

Table S5. Optimization of *ortho*-Acyloxylation Reaction Conditions



rac-**1a** **6a** *rac*-**7a**



rac-**1b** *rac*-**1c**

entry	variation from standard conditions	yields (%)[b]
1	---	53
2	without Na_2CO_3	31
3	Ag_2SO_4 instead of Ag_2CO_3	28
4	$Co(acac)_2$ instead of $Co(OAc)\cdot_4H_2O$	13
5	*rac*-**1b** instead of *rac*-**1a**	N.R.
6	*rac*-**1c** instead of *rac*-**1a**	N.R.

Conditions: Reactions were performed with *rac*-**1a** (0.1 mmol), **4a** (0.2 mmol), $Co(OAc)_2\cdot4H_2O$ (20 mol%), Ag_2CO_3 (2 equiv.), Na_2CO_3 (2 equiv.), in 1 mL DCE at 80 °C for 24 h under N_2. [b]Yields of isolated products.

3.4 Co(II)-Catalyzed *ortho*-C-H Allylation of [2,2]paracyclophane

General Procedure I for Cobalt-Catalyzed the *ortho*-Allylation of *rac*-1 with mono-substituted alkenes

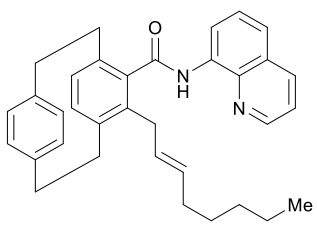
To a 10-mL schlenk tube containing $Co(OAc)_2 \cdot 4H_2O$ (20 mol%), amide *rac*-**1a** (37.8 mg, 1.0 equiv, 0.1 mmol), (±)-pGlu-OH (30 mol%) and Ag_2O (2.0 equiv.) was added toluene (1.0 mL) via syringe. After that, alkenes **2** (3.0 equiv.) and pivalic acid (1.0 equiv.) were added via syringe sequentially. After that, a screw cap was used to cover the tube. Then, the vial was evacuated and filled with N_2 five times, and the reaction mixture was allowed to stir at 80 °C (aluminum heat transfer block) for 36 h. After cooling to ambient temperature, the reaction mixture was diluted with CH_2Cl_2 and EtOAc, filtered through Celite and the filtrate was concentrated. The crude residue was purified through preparative TLC using hexane/EtOAc (10:1–6:1, v/v) as the eluent to afford the racemic product **4**.

General Procedure II for Cobalt-Catalyzed the *ortho*-Allylation of *rac*-1 with α-methyl acylates

To a 10-mL schlenk tube containing $Co(OAc)_2 \cdot 4H_2O$ (20 mol%), amide *rac*-**1a** (37.8 mg, 1.0 equiv, 0.1 mmol), Na_2CO_3 (3 equiv.) and Ag_2SO_4 (1.0 equiv.) was added DCE (1.0 mL) via syringe. After that, alkenes **3** (3.0 equiv) and pivalic acid (0.5 equiv.) were added via syringe sequentially. After that, a screw cap was used to cover the tube. Then, the vial was evacuated and filled with N_2 five times, and the reaction mixture was allowed to stir at 100 °C (aluminum heat transfer block) for 24 h. After cooling to ambient temperature, the reaction mixture was diluted with CH_2Cl_2 and EA, filtered through Celite and the filtrate was concentrated. The crude residue was purified through preparative TLC using hexane/EtOAc (10:1, v/v) as the eluent to afford the racemic product **5**.

***rac*-(*E*)-4-carbonyl-5-(oct-2-en-1-yl)[2,2]paracyclophane-*N*-(quinolin-8-yl)amide (4a)**

The title compound **4a** was prepared under the optimized conditions (General Procedure I) and purified by preparative TLC (petroleum ether: ethyl acetate =10: 1). **4a** was obtained as a yellow oil (36.1 mg, 74%).



4a

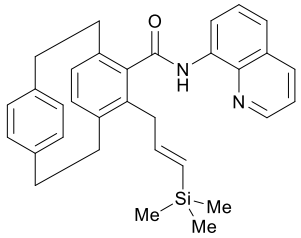
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.58 (s, 1H), 9.01 (dd, *J* = 7.6, 1.4 Hz, 1H), 8.65 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.14 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.62 (t, *J* = 8.0 Hz, 1H), 7.54 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.39 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.21 (dd, *J* = 8.3, 1.5 Hz, 1H), 6.66 (dd, *J* = 8.5, 1.5 Hz, 1H), 6.61 (s, 2H), 6.57 (d, *J* = 7.7 Hz, 1H), 6.51 (d, *J* = 7.7 Hz, 1H), 5.44 – 5.35 (m, 1H), 5.29 – 5.19 (m, 1H), 3.42 – 3.33 (m, 2H), 3.32 – 3.17 (m, 3H), 3.16 – 3.04 (m, 2H), 3.03 – 2.93 (m, 2H), 2.88 (ddd, *J* = 13.5, 10.6, 5.8 Hz, 1H), 1.74 – 1.62 (m, 2H), 1.07 – 0.95 (m, 6H), 0.72 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 168.8, 148.1, 139.5, 139.4, 139.3, 137.9, 136.4, 136.2, 135.9, 135.7, 134.8, 133.3, 132.7, 132.3, 132.0, 131.6, 129.5, 128.1, 127.9, 127.5, 121.7, 121.6, 116.4, 35.3, 34.4, 34.4, 33.5, 33.1, 32.5, 31.5, 28.8, 22.5, 14.1.

HRMS (ESI) calculated for ($[C_{34}H_{36}N_2O]+H^+$): 489.2906, found: 489.2899

***rac*-(*E*)-4-carbonyl-5-(3-(trimethylsilyl)allyl)[2,2]paracyclophan-*N*-(quinolin-8-yl)amide (4b)**

The title compound **4b** was prepared under the optimized conditions (General Procedure I) and purified by preparative TLC (petroleum ether: ethyl acetate =10: 1). **4b** was obtained as a yellow oil (37.7 mg, 77%).



4b

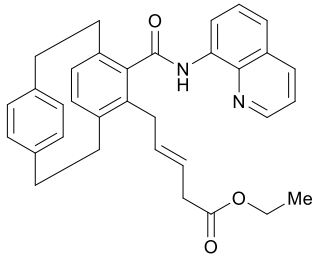
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.59 (s, 1H), 9.01 (dd, *J* = 7.6, 1.4 Hz, 1H), 8.66 (dd, *J* = 4.3, 1.7 Hz, 1H), 8.14 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.62 (t, *J* = 7.9 Hz, 1H), 7.54 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.39 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.22 (d, *J* = 7.9 Hz, 1H), 6.68 (d, *J* = 7.9 Hz, 1H), 6.63 (s, 2H), 6.61 – 6.51 (m, 2H), 5.99 (dt, *J* = 18.4, 5.9 Hz, 1H), 5.53 (dt, *J* = 18.5, 1.7 Hz, 1H), 3.56 (ddd, *J* = 15.8, 6.3, 1.6 Hz, 1H), 3.40 – 3.31 (m, 2H), 3.30 – 3.20 (m, 2H), 3.17 – 3.05 (m, 2H), 3.04 – 2.94 (m, 2H), 2.88 (ddd, *J* = 13.5, 10.6, 5.8 Hz, 1H), -0.25 (s, 9H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 168.7, 148.3, 144.2, 139.6, 139.5, 139.4, 138.6, 137.8, 136.3, 136.0, 135.9, 135.5, 134.8, 133.3, 132.8, 132.3, 132.0, 130.9, 129.5, 128.1, 127.4, 121.7, 121.6, 116.5, 38., 35.32, 34.3, 33.5, 33.2, -1.3.

HRMS (ESI) calculated for ($[C_{32}H34N2OSi]+H^+$): 491.2512, found: 491.2511

***rac*-Ethyl (*E*)-5-(4-(*N*-quinolin-8-ylcarbamoyl))[2,2]paracyclophan-pent-3-enoate (4c)**

The title compound **4c** was prepared under the optimized conditions (General Procedure I) and purified by preparative TLC (petroleum ether: ethyl acetate =10: 1). **4c** was obtained as a yellow oil (38.8 mg, 77%).



4c

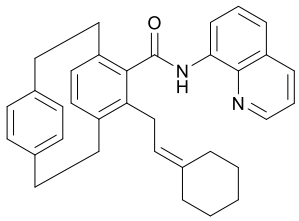
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.59 (s, 1H), 8.99 (dd, *J* = 7.6, 1.4 Hz, 1H), 8.66 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.14 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.61 (t, *J* = 7.9 Hz, 1H), 7.53 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.39 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.19 (dd, *J* = 7.9, 1.4 Hz, 1H), 6.66 – 6.62 (m, 1H), 6.61 (t, *J* = 1.1 Hz, 2H), 6.57 (d, *J* = 7.8 Hz, 1H), 6.51 (d, *J* = 7.7 Hz, 1H), 5.57 (dtt, *J* = 15.3, 6.3, 1.3 Hz, 1H), 5.40 (dtt, *J* = 15.3, 6.9, 1.5 Hz, 1H), 3.96 (qd, *J* = 7.1, 0.9 Hz, 2H), 3.46 – 3.32 (m, 2H), 3.31 – 3.19 (m, 3H), 3.15 – 3.03 (m, 2H), 3.02 – 2.93 (m, 2H), 2.92 – 2.76 (m, 2H), 2.68 (ddd, *J* = 16.4, 6.8, 1.4 Hz, 1H), 1.12 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 171.8, 168.6, 148.1, 139.5, 139.4, 139.4, 138.5, 138.0, 136.3, 136.1, 135.7, 135.4, 134.7, 133.3, 132.9, 132.5, 132.2, 132.1, 129.5, 128.1, 127.5, 122.8, 121.8, 121.6, 116.5, 60.5, 37.9, 35.3, 34.3, 33.5, 33.1, 14.2.

HRMS (ESI) calculated for ($[C_{33}H_{32}N_2O_3]+Na^+$): 527.2311, found: 527.2306

***rac*-(*E*)-4-carbonyl-5-(2-cyclohexylideneethyl)[2,2]paracyclophan-*N*-(quinolin-8-yl)amide (4d)**

The title compound **4d** was prepared under the optimized conditions (General Procedure I) and purified by preparative TLC (petroleum ether: ethyl acetate =10: 1). **4d** was obtained as a yellow oil (23.3 mg, 48%).



4d

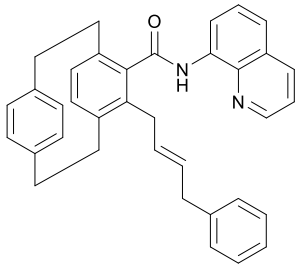
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.61 (s, 1H), 8.67 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.14 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.61 (t, *J* = 7.9 Hz, 1H), 7.53 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.40 (dd, *J* = 8.2, 4.2 Hz, 1H), 7.22 (dd, *J* = 8.1, 1.4 Hz, 1H), 6.75 – 6.68 (m, 1H), 6.62 (dt, *J* = 1.7, 0.8 Hz, 2H), 6.57 (d, *J* = 7.7 Hz, 1H), 6.50 (d, *J* = 7.7 Hz, 1H), 5.09 – 4.96 (m, 1H), 3.47 – 3.31 (m, 2H), 3.30 – 3.11 (m, 4H), 3.08 – 3.01 (m, 1H), 3.01 – 2.95 (m, 2H), 2.88 (ddd, *J* = 13.4, 10.6, 5.9 Hz, 1H), 2.10 (ddd, *J* = 12.4, 7.6, 4.1 Hz, 1H), 1.90 – 1.80 (m, 2H), 1.69 (ddd, *J* = 12.8, 7.8, 4.1 Hz, 1H), 1.37 (qd, *J* = 8.7, 8.2, 4.0 Hz, 1H), 1.30 – 1.22 (m, 3H), 1.14 (qp, *J* = 10.7, 3.6, 2.9 Hz, 3H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 168.9, 148.1, 139.5, 139.4, 139.4, 139.2, 138.6, 137.8, 137.8, 136.3, 136.0, 135.8, 134.9, 133.3, 132.5, 132.3, 132.0, 129.5, 128.0, 127.5, 121.7, 121.6, 119.8, 116.4, 36.9, 35.4, 34.4, 33.5, 33.2, 29.5, 28.8, 28.2, 27.4, 26.8.

HRMS (ESI) calculated for ($[C_{34}H_{34}N_2O]+H^+$): 487.2749, found: 487.2746

***rac*-(*E*)-4-carbonyl-5-(4-phenylbut-2-en-1-yl)[2,2]paracyclophan-*N*-(quinolin-8-yl)amide (4e)**

The title compound **4e** was prepared under the optimized conditions (General Procedure I) and purified by preparative TLC (petroleum ether: ethyl acetate =10: 1). **4e** was obtained as a yellow oil (36.1 mg, 71%).



4e

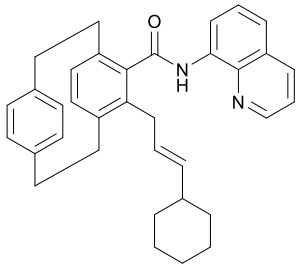
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.64 (s, 1H), 9.02 (dd, *J* = 7.6, 1.4 Hz, 1H), 8.65 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.17 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.63 (t, *J* = 7.9 Hz, 1H), 7.56 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.41 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.22 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.12 – 7.02 (m, 3H), 6.90 (dd, *J* = 7.4, 2.1 Hz, 2H), 6.67 (dd, *J* = 8.2, 1.5 Hz, 1H), 6.63 (s, 3H), 6.59 (d, *J* = 7.8 Hz, 2H), 6.53 (d, *J* = 7.8 Hz, 1H), 5.53 (dt, *J* = 15.3, 5.8 Hz, 1H), 5.44 (dt, *J* = 15.2, 6.3 Hz, 1H), 3.50 – 3.42 (m, 1H), 3.38 (ddd, *J* = 13.0, 10.0, 2.5 Hz, 1H), 3.33 – 3.21 (m, 3H), 3.19 – 3.05 (m, 3H), 3.01 (dd, *J* = 7.6, 5.1 Hz, 3H), 2.89 (ddd, *J* = 13.5, 10.7, 5.8 Hz, 1H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 168.7, 148.2, 140.5, 139.5, 139.4, 139.3, 138.5, 138.0, 136.3, 136.0, 135.7, 134.8, 133.3, 132.8, 132.3, 132.0, 129.9, 129.8, 129.5, 128.4, 128.2, 128.1, 127.5, 125.8, 121.7, 121.7, 116.5, 38.8, 35.3, 34.3, 34.1, 33.5, 33.2.

HRMS (ESI) calculated for ($[C_{36}H_{32}N_2O]+H^+$): 509.2593, found: 509.2587

***rac*-(*E*)-4-carbonyl-5-(3-cyclohexylallyl)[2,2]paracyclophan-*N*-(quinolin-8-yl)amide (4f)**

The title compound **4f** was prepared under the optimized conditions (General Procedure I) and purified by preparative TLC (petroleum ether: ethyl acetate =10: 1). **4f** was obtained as a yellow oil (35.1 mg, 70%).



4f

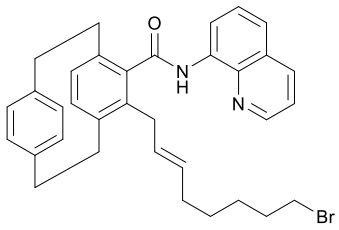
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.58 (s, 1H), 9.02 (dd, *J* = 7.7, 1.4 Hz, 1H), 8.65 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.14 (dd, *J* = 8.2, 1.7 Hz, 1H), 7.62 (t, *J* = 8.0 Hz, 1H), 7.54 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.39 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.24 – 7.18 (m, 1H), 6.69 – 6.66 (m, 1H), 6.62 (s, 2H), 6.57 (d, *J* = 7.8 Hz, 1H), 6.51 (d, *J* = 7.7 Hz, 1H), 5.39 – 5.27 (m, 1H), 5.23 (dd, *J* = 15.4, 6.1 Hz, 1H), 3.43 – 3.32 (m, 2H), 3.31 – 3.17 (m, 3H), 3.17 – 3.05 (m, 2H), 3.04 – 2.95 (m, 2H), 2.87 (ddd, *J* = 13.4, 10.6, 5.8 Hz, 1H), 1.56 (ddt, *J* = 10.1, 6.0, 3.8 Hz, 1H), 1.51 – 1.36 (m, 4H), 1.32 – 1.29 (m, 1H), 1.07 – 0.85 (m, 3H), 0.82 – 0.58 (m, 2H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 168.9, 148.1, 139.5, 139.5, 139.4, 138.6, 137.9, 137.32, 136.5, 136.3, 136.0, 135.8, 134.9, 133.3, 132.7, 132.3, 132.1, 129.6, 128.1, 127.5, 125.5, 121.7, 121.6, 116.53, 40.3, 35.3, 34.4, 34.4, 33.5, 33.2, 32.7, 32.6, 26.2, 26.1, 26.0.

HRMS (ESI) calculated for ($[C_{35}H_{36}N_2O]+H^+$): 501.2906, found: 501.2901

***rac*-(*E*)-4-carbonyl-5-(8-bromooct-2-en-1-yl)[2,2]paracyclophan-*N*-(quinolin-8-yl)amide (4g)**

The title compound **4g** was prepared under the optimized conditions (General Procedure I) and purified by preparative TLC (petroleum ether: ethyl acetate =10: 1). **4g** was obtained as a yellow oil (28.3 mg, 50%).



4g

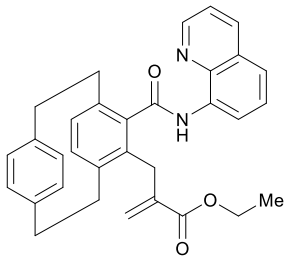
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.58 (s, 1H), 9.01 (dd, *J* = 7.6, 1.4 Hz, 1H), 8.66 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.16 (dd, *J* = 8.2, 1.7 Hz, 1H), 7.62 (t, *J* = 8.0 Hz, 1H), 7.55 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.41 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.20 (dd, *J* = 8.0, 1.4 Hz, 1H), 6.65 (dd, *J* = 8.0, 1.4 Hz, 1H), 6.61 (t, *J* = 1.1 Hz, 2H), 6.57 (d, *J* = 7.8 Hz, 1H), 6.51 (d, *J* = 7.8 Hz, 1H), 5.39 (dddt, *J* = 15.3, 6.9, 5.5, 1.4 Hz, 1H), 5.22 (dtt, *J* = 14.9, 6.6, 1.5 Hz, 1H), 3.44 – 3.33 (m, 2H), 3.30 – 3.10 (m, 6H), 3.09 – 3.03 (m, 1H), 3.02 – 2.95 (m, 2H), 2.88 (ddd, *J* = 13.5, 10.7, 5.8 Hz, 1H), 1.76 – 1.64 (m, 2H), 1.54 (pd, *J* = 7.0, 4.4 Hz, 2H), 1.16 – 1.07 (m, 2H), 1.05 – 0.93 (m, 2H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 168.9, 148.2, 139.6, 139.4, 139.3, 138.6, 138.0, 136.4, 136.4, 136.0, 135.8, 134.8, 133.4, 132.8, 132.3, 132.1, 131.0, 129.6, 128.5, 128.1, 127.6, 121.8, 121.7, 116.52, 35.3, 34.4, 34.2, 33.9, 33.5, 33.2, 32.6, 32.2, 28.2, 27.7.

HRMS (ESI) calculated for ($[C_{34}H_{35}BrN_2O]+H^+$): 567.2011, found: 567.2006

***rac*-Ethyl (*E*)-2-(4-(*N*-quinolin-8-ylcarbamoyl)[2,2]paracyclophan-5-yl)methyl)acrylate (5a)**

The title compound **5a** was prepared under the optimized conditions (General Procedure **II**) and purified by preparative TLC (petroleum ether: ethyl acetate =5: 1). **5a** was obtained as a yellow oil (27.0 mg, 68%).



5a

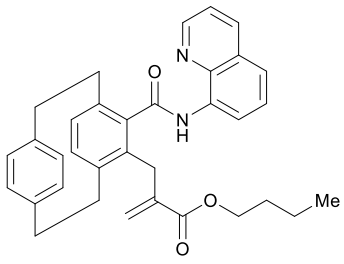
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.55 (s, 1H), 8.95 (dd, *J* = 7.5, 1.3 Hz, 1H), 8.63 (dd, *J* = 4.3, 1.7 Hz, 1H), 8.12 (dd, *J* = 8.2, 1.7 Hz, 1H), 7.59 (t, *J* = 7.9 Hz, 1H), 7.52 (dd, *J* = 8.4, 1.3 Hz, 1H), 7.38 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.22 (d, *J* = 7.9 Hz, 1H), 6.71 (d, *J* = 7.9 Hz, 1H), 6.64 – 6.58 (m, 3H), 6.56 (d, *J* = 7.7 Hz, 1H), 6.10 (s, 1H), 5.26 (s, 1H), 3.90 (q, *J* = 7.1 Hz, 2H), 3.77 (d, *J* = 17.4 Hz, 1H), 3.51 (d, *J* = 17.4, 1H), 3.35 – 3.17 (m, 3H), 3.16 – 3.05 (m, 2H), 3.05 – 2.95 (m, 2H), 2.86 (ddd, *J* = 13.3, 10.6, 5.7 Hz, 1H), 1.00 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 168.4, 166.8, 148.1, 140.0, 139.6, 139.6, 139.4, 138.5, 138.4, 136.2, 136.1, 136.0, 134.7, 134.3, 133.4, 133.4, 132.1, 132.1, 129.5, 128.0, 127.4, 126.2, 121.7, 121.6, 116.5, 60.6, 35.3, 34.3, 33.6, 33.3, 32.5, 13.9.

HRMS (ESI) calculated for ($[C_{32}H_{30}N_2O_3]+Na^+$): 513.2154, found: 513.2151

***rac*-Butyl (*E*)-2-(4-(*N*-quinolin-8-ylcarbamoyl)[2,2]paracyclophan-5-yl)methyl)acrylate (5b)**

The title compound **5b** was prepared under the optimized conditions (General Procedure II) and purified by preparative TLC (petroleum ether: ethyl acetate =5: 1). **5b** was obtained as a yellow oil (30.0 mg, 58%).



5b

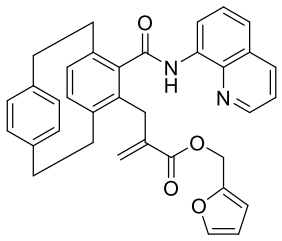
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.55 (s, 1H), 8.95 (dd, *J* = 7.7, 1.4 Hz, 1H), 8.63 (dd, *J* = 4.3, 1.7 Hz, 1H), 8.12 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.59 (t, *J* = 7.9 Hz, 1H), 7.52 (dd, *J* = 8.3, 1.3 Hz, 1H), 7.38 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.22 (d, *J* = 7.9 Hz, 1H), 6.73 – 6.68 (m, 1H), 6.64 – 6.59 (m, 3H), 6.56 (d, *J* = 7.7 Hz, 1H), 6.09 (d, *J* = 1.7 Hz, 1H), 5.25 (d, *J* = 2.0 Hz, 1H), 3.85 (t, *J* = 6.7 Hz, 2H), 3.75 (d, *J* = 17.6, 1H), 3.51 (d, *J* = 17.5, 1H), 3.35 – 2.79 (m, 8H), 1.40 – 1.30 (m, 2H), 1.15 (h, *J* = 7.4 Hz, 2H), 0.80 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 168.3, 166.8, 148.1, 140.0, 139.6, 139.6, 139.4, 138.4, 136.2, 136.0, 134.7, 134.3, 133.4, 133.4, 132.1, 132.1, 129.5, 127.4, 126.2, 121.7, 121.6, 116.5, 64.5, 35.3, 34.3, 33.6, 33.2, 32.5, 30.4, 19.1, 13.7.

HRMS (ESI) calculated for ($[C_{34}H_{34}N_2O_3]+Na^+$): 541.2467, found: 541.2462

***rac*-Furan-2-ylmethyl (*E*)-2-(4-(*N*-quinolin-8-ylcarbamoyl)[2,2]paracyclophan-5-yl)methyl)acrylate (5c)**

The title compound **5c** was prepared under the optimized conditions (General Procedure II) and purified by preparative TLC (petroleum ether: ethyl acetate =5: 1). **5c** was obtained as a yellow oil (27.6 mg, 51%).



5c

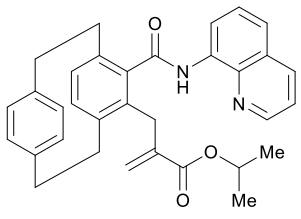
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.56 (s, 1H), 8.94 (dd, *J* = 7.6, 1.4 Hz, 1H), 8.62 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.13 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.59 (t, *J* = 7.9 Hz, 1H), 7.53 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.38 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.33 (d, *J* = 1.8 Hz, 1H), 7.24 – 7.15 (m, 1H), 6.73 – 6.67 (m, 1H), 6.62 (s, 2H), 6.57 (q, *J* = 7.8 Hz, 2H), 6.28 (dd, *J* = 3.3, 1.9 Hz, 1H), 6.22 (d, *J* = 3.2 Hz, 1H), 6.11 (d, *J* = 1.6 Hz, 1H), 5.30 (d, *J* = 2.0 Hz, 1H), 4.91 – 4.78 (m, 2H), 3.78 (d, *J* = 17.3, 1H), 3.52 (d, *J* = 17.3, 1H), 3.34 – 3.25 (m, 2H), 3.24 – 3.16 (m, 2H), 3.13 – 3.03 (m, 1H), 3.02 – 2.94 (m, 2H), 2.82 (ddd, *J* = 13.3, 10.5, 5.7 Hz, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 168.2, 166.3, 149.3, 148.1, 143.0, 140.0, 139.5, 139.3, 138.9, 138.4, 138.2, 136.1, 135.9, 134.6, 134.1, 133.3, 133.2, 132.0, 132.0, 129.4, 127.9, 127.3, 126.9, 121.7, 121.5, 116.5, 110.4, 110.4, 58.2, 35.2, 34.2, 33.5, 33.1, 32.3.

HRMS (ESI) calculated for ($[C_{35}H_{30}N_2O_4]+Na^+$): 565.2103, found: 565.2096

***rac-iso*-Propyl (*E*)-2-(4-(*N*-quinolin-8-ylcarbamoyl)[2,2]paracyclophan-5-yl)methyl)acrylate (5d)**

The title compound **5d** was prepared under the optimized conditions (General Procedure **II**) and purified by preparative TLC (petroleum ether: ethyl acetate =10: 1). **5d** was obtained as a yellow oil (21.7 mg, 43%).



5d

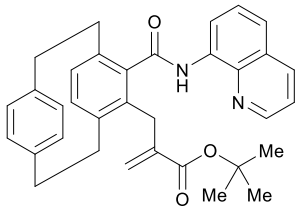
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.55 (s, 1H), 8.95 (dd, *J* = 7.6, 1.3 Hz, 1H), 8.63 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.12 (dd, *J* = 8.2, 1.7 Hz, 1H), 7.59 (t, *J* = 7.9 Hz, 1H), 7.51 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.38 (dd, *J* = 8.2, 4.2 Hz, 1H), 7.23 – 7.18 (m, 1H), 6.72 – 6.68 (m, 1H), 6.64 – 6.52 (m, 4H), 6.07 (d, *J* = 1.7 Hz, 1H), 5.23 (d, *J* = 1.8 Hz, 1H), 4.77 (p, *J* = 6.3 Hz, 1H), 3.77 – 3.69 (m, 1H), 3.49 (dt, *J* = 17.4, 2.0 Hz, 1H), 3.35 – 3.17 (m, 3H), 3.16 – 3.04 (m, 2H), 3.03 – 2.94 (m, 2H), 2.86 (ddd, *J* = 13.3, 10.6, 5.7 Hz, 1H), 0.96 (dd, *J* = 6.3, 1.7 Hz, 6H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 168.4, 166.3, 148.1, 140.1, 139.9, 139.6, 139.4, 138.4, 136.2, 136.0, 134.7, 134.4, 133.4, 133.3, 132.1, 132.1, 129.5, 128.0, 127.4, 126.0, 121.7, 121.6, 116.5, 68.0, 35.3, 34.3, 33.6, 33.3, 32.5, 21.6, 21.6.

HRMS (ESI) calculated for ([C33H32N2O3]+Na^+): 527.2311, found: 527.2308

***rac*-*tert*-Butyl (*E*)-2-(4-(*N*-quinolin-8-ylcarbamoyl)[2,2]paracyclophan-5-yl)methyl)acrylate (5e)**

The title compound **5e** was prepared under the optimized conditions (General Procedure **II**) and purified by preparative TLC (petroleum ether: ethyl acetate =10: 1). **5e** was obtained as a yellow oil (26.0 mg, 50%).



5e

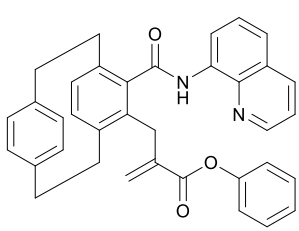
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.53 (s, 1H), 8.96 (d, *J* = 7.5 Hz, 1H), 8.63 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.12 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.59 (t, *J* = 8.0 Hz, 1H), 7.51 (d, *J* = 8.2 Hz, 1H), 7.38 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.24 – 7.19 (m, 1H), 6.72 – 6.68 (m, 1H), 6.61 (d, *J* = 8.1 Hz, 3H), 6.55 (d, *J* = 7.7 Hz, 1H), 6.00 (d, *J* = 1.9 Hz, 1H), 5.16 (d, *J* = 2.1 Hz, 1H), 3.68 (d, *J* = 17.6 Hz, 1H), 3.45 (d, *J* = 17.6, 2.1 Hz, 1H), 3.35 – 2.79 (m, 8H), 1.15 (s, 9H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 168.3, 166.1, 148.1, 141.0, 140.0, 139.7, 139.4, 138.6, 138.5, 136.2, 136.0, 134.7, 134.6, 133.4, 133.3, 132.1, 129.4, 128.0, 127.4, 125.3, 121.6, 121.6, 116.4, 80.5, 35.3, 34.3, 33.6, 33.2, 32.5, 27.8.

HRMS (ESI) calculated for ([$C_{34}H_{34}N_2O_3$]+Na^+): 541.2467, found: 541.2461

***rac*-Phenyl (*E*)-2-(4-(*N*-quinolin-8-ylcarbamoyl)[2,2]paracyclophan-5-yl)methyl)acrylate (5f)**

The title compound **5f** was prepared under the optimized conditions (General Procedure **II**) and purified by preparative TLC (petroleum ether: ethyl acetate =10: 1). **5f** was obtained as a yellow oil (28.0 mg, 52%).



5f

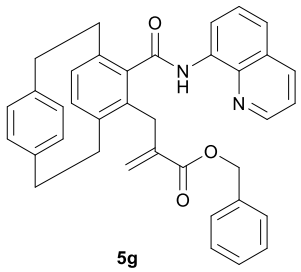
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.62 (s, 1H), 8.99 (dd, *J* = 7.6, 1.4 Hz, 1H), 8.62 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.13 (dd, *J* = 8.2, 1.7 Hz, 1H), 7.61 (t, *J* = 7.9 Hz, 1H), 7.54 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.37 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.26 – 7.20 (m, 3H), 7.13 (t, *J* = 7.4 Hz, 1H), 6.73 (d, *J* = 7.9 Hz, 1H), 6.69 (dd, *J* = 7.7, 1.5 Hz, 2H), 6.66 – 6.62 (m, 3H), 6.60 (d, *J* = 7.7 Hz, 1H), 6.33 (s, 1H), 5.49 (s, 1H), 3.91 (d, *J* = 17.4 Hz, 1H), 3.64 (d, *J* = 17.4, 1H), 3.37 – 3.24 (m, 3H), 3.21 – 3.06 (m, 2H), 3.05 – 2.98 (m, 2H), 2.91 (ddd, *J* = 13.5, 10.6, 5.8 Hz, 1H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 168.3, 165.2, 150.7, 148.2, 140.1, 139.6, 139.4, 138.9, 138.5, 136.2, 136.1, 134.6, 134.0, 133.5, 133.4, 132.1, 129.5, 129.2, 128.1, 128.1, 127.5, 125.6, 121.8, 121.7, 121.4, 116.6, 35.3, 34.4, 33.7, 33.3, 32.5.

HRMS (ESI) calculated for ($[C_{36}H_{30}N_2O_3]+Na^+$): 561.2154, found: 561.2149

***rac*-Benzyl (*E*)-2-(4-(*N*-quinolin-8-ylcarbamoyl)[2,2]paracyclophan-5-yl)methyl)acrylate (5g)**

The title compound **5g** was prepared under the optimized conditions (General Procedure **II**) and purified by preparative TLC (petroleum ether: ethyl acetate =5 : 1). **5g** was obtained as a yellow oil (24.8 mg, 45%).



5g

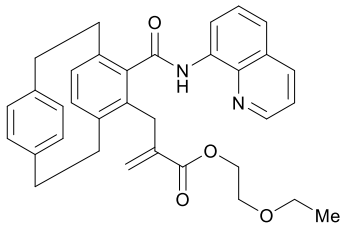
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.57 (s, 1H), 8.95 (d, *J* = 7.5 Hz, 1H), 8.60 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.12 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.60 (t, *J* = 7.9 Hz, 1H), 7.53 (d, *J* = 8.2 Hz, 1H), 7.35 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.25 – 7.17 (m, 2H), 7.15 – 7.06 (m, 2H), 6.70 (d, *J* = 7.9 Hz, 1H), 6.66 – 6.52 (m, 4H), 6.14 (s, 1H), 5.31 (s, 1H), 4.97 – 4.86 (m, 2H), 3.81 (d, *J* = 17.4 Hz, 1H), 3.55 (d, *J* = 17.4 Hz, 1H), 3.35 – 3.16 (m, 3H), 3.15 – 3.04 (m, 2H), 3.00 (dd, *J* = 8.2, 5.8 Hz, 2H), 2.83 (ddd, *J* = 13.3, 10.6, 5.7 Hz, 1H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 168.3, 166.6, 148.1, 140.1, 139.6, 139.4, 139.3, 138.5, 138.4, 136.2, 136.1, 134.7, 134.2, 133.4, 133.4, 132.1, 132.1, 129.5, 128.5, 128.0, 127.8, 127.4, 126.8, 121.8, 121.6, 116.6, 66.3, 35.3, 34.3, 33.7, 33.3, 32.5.

HRMS (ESI) calculated for ($[C_{37}H_{32}N_2O_3]+Na^+$): 575.2311, found: 575.2305

***rac*-2-Ethoxyethyl (*E*)-2-(4-(*N*-quinolin-8-ylcarbamoyl)[2,2]paracyclophan-5-yl)methyl)acrylate (5h)**

The title compound **5h** was prepared under the optimized conditions (General Procedure **II**) and purified by preparative TLC (petroleum ether: ethyl acetate =3 : 1). **5h** was obtained as a yellow oil (26.7 mg, 50%).



5h

^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.56 (s, 1H), 8.95 (d, *J* = 7.6 Hz, 1H), 8.64 (dd, *J* = 4.1, 1.6 Hz, 1H), 8.13 (dd, *J* = 8.3, 1.7 Hz, 1H), 6.71 (d, *J* = 7.9 Hz, 1H), 6.65 – 6.52 (m, 4H), 6.13 (s, 1H), 5.29 (s, 1H), 4.01 (t, *J* = 5.0 Hz, 2H), 3.77 (d, *J* = 17.5 Hz, 1H), 3.53 (d, *J* = 17.5 Hz, 1H), 3.44 – 3.36 (m, 4H), 3.34 – 3.18 (m, 3H), 3.16 – 3.05 (m, 2H), 2.99 (dd, *J* = 8.3, 5.6 Hz, 2H), 2.86 (ddd, *J* = 13.4, 10.5, 5.7 Hz, 1H), 1.12 (t, *J* = 7.0 Hz, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 168.3, 166.7, 148.2, 140.1, 139.6, 139.4, 139.2, 138.3, 136.2, 136.0, 134.7, 134.2, 133.4, 133.4, 132.1, 129.4, 128.0, 127.4, 126.7, 121.7, 121.6, 116.5, 68.1, 66.6, 63.9, 35.3, 34.3, 33.6, 33.2, 32.4, 15.2.

HRMS (ESI) calculated for ($[C_{34}H_{34}N_2O_4]+Na^+$): 557.2416, found: 557.2413

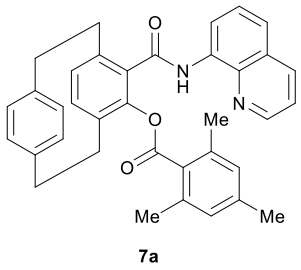
3.5 Co(II)-Catalyzed *ortho*-C-H Acyloxylation of [2,2]paracyclophane

General Procedure III for Cobalt-Catalyzed the *ortho*-Acyloxylation of *rac*-1a

A 10-mL schlenk tube was charged with *rac*-**1a** (0.1 mmol), carboxylic acids **6** (0.2 mmol), $Co(OAc)_2 \cdot 4H_2O$ (5 mg, 0.02 mmol), Ag_2CO_3 (55 mg, 0.2 mmol, 2 eq.), Na_2CO_3 (21.2 mg, 0.2 mmol, 2 eq.) and DCE (1.0 mL), the mixture stirred at 100 °C for 24 h. The mixture was then cooled to room temperature, diluted with EtOAc, filtered through a celite pad, and concentrated under vacuum. The crude residue was purified through preparative TLC using hexane/EtOAc(10:1–5:1, v/v) as the eluent to afford the desired acyoxylated products **7.**

***rac*-4-(*N*-quinolin-8-yl carbamoyl)[2,2]paracyclophan-4-yl 2',4',6'-trimethylbenzoate (7a)**

The title compound **7a** was prepared under the optimized conditions (General Procedure **III**) and purified by preparative TLC (petroleum ether: ethyl acetate =7:1). **7a** was obtained as a beige foamy solid (48.1 mg, 89%).



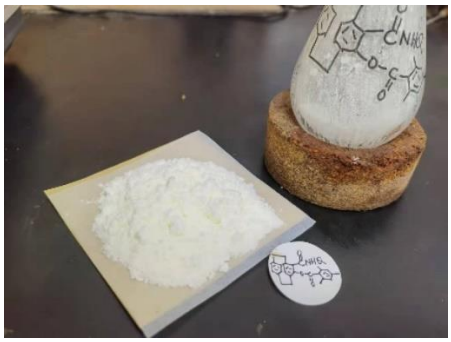
7a

^{1}H NMR (400 MHz, Chloroform-*d*) δ 10.05 (s, 1H), 8.88 (dd, *J* = 7.6, 1.4 Hz, 1H), 8.65 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.08 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.56 (t, *J* = 7.9 Hz, 1H), 7.50 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.35 (dd, *J* = 8.2, 4.2 Hz, 1H), 7.23 (dd, *J* = 8.0, 1.9 Hz, 1H), 6.93 (dd, *J* = 8.0, 1.9 Hz, 1H), 6.72 (d, *J* = 7.9 Hz, 1H), 6.70 – 6.58 (m, 5H), 3.44 – 3.34 (m, 1H), 3.25 (tt, *J* = 13.2, 3.8 Hz, 2H), 3.19 – 2.96 (m, 4H), 2.91 (ddd, *J* = 14.0, 10.2, 4.4 Hz, 1H), 2.34 (s, 6H), 2.16 (s, 3H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 167.9, 164.9, 148.3, 145.8, 140.9, 139.9, 139.6, 139.5, 138.5, 136.8, 136.7, 136.0, 134.7, 133.0, 132.7, 132.6, 132.2, 130.0, 129.9, 129.0, 128.8, 127.9, 127.2, 121.8, 121.6, 116.5, 35.3, 34.5, 33.7, 31.0, 21.1, 20.7.

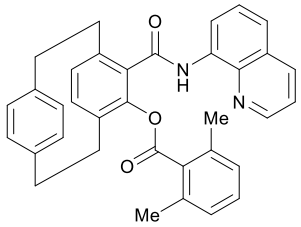
HRMS (ESI) calculated for ($[C_{36}H_{32}N_2O_3]+H^+$): 541.2491, found: 541.2488

The gram-scale synthesis of **7a** were carried out with 10.0 mol% of *rac*-**1,** and the product was isolated 80% yield, 4.32 g)



***rac*-4-(*N*-quinolin-8-yl carbamoyl)[2,2]paracyclophan-4-yl 2',6'-dimethylbenzoate (7b)**

The title compound **7b** was prepared under the optimized conditions (General Procedure **III**) and purified by preparative TLC (petroleum ether: ethyl acetate =7:1). **7b** was obtained as a beige foamy solid (46.3 mg, 88%).



7b

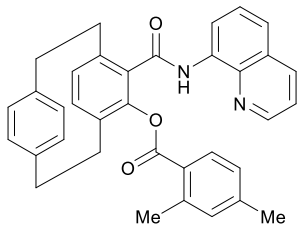
^{1}H NMR (400 MHz, Chloroform-*d*) δ 10.05 (s, 1H), 8.89 (d, *J* = 7.5 Hz, 1H), 8.66 (d, *J* = 4.2 Hz, 1H), 8.09 (d, *J* = 8.2 Hz, 1H), 7.57 (t, *J* = 7.9 Hz, 1H), 7.51 (d, *J* = 8.2 Hz, 1H), 7.35 (dd, *J* = 8.4, 4.1 Hz, 1H), 7.23 (d, *J* = 8.0 Hz, 1H), 7.04 (t, *J* = 7.6 Hz, 1H), 6.91 (d, *J* = 8.1 Hz, 1H), 6.87 (d, *J* = 7.6 Hz, 2H), 6.70 (dd, *J* = 13.6, 7.9 Hz, 2H), 6.63 (dd, *J* = 11.2, 7.8 Hz, 2H), 3.43 – 2.87 (m, 8H), 2.36 (s, 6H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 168.0, 165.0, 148.4, 145.6, 140.8, 139.6, 139.5, 138.6, 136.8, 136.3, 136.1, 134.7, 133.2, 133.2, 132.8, 132.6, 132.3, 132.2, 130.1, 130.0, 129.9, 128.0, 127.3, 122.0, 121.7, 116.7, 35.3, 34.6, 33.7, 31.1, 20.6.

HRMS (ESI) calculated for ($[C_{35}H_{30}N_2O_3]+Na^+$): 549.2154, found: 549.2150.

***rac*-4-(*N*-quinolin-8-yl carbamoyl)[2,2]paracyclophan-4-yl 2',4'-dimethylbenzoate (7c)**

The title compound **7c** was prepared under the optimized conditions (General Procedure **III**) and purified by preparative TLC (petroleum ether: ethyl acetate =7:1). **7c** was obtained as a beige foamy solid (24.7 mg, 47%).



7c

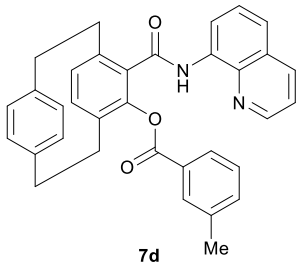
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.95 (s, 1H), 8.87 (dd, *J* = 7.6, 1.4 Hz, 1H), 8.69 (dd, *J* = 4.3, 1.7 Hz, 1H), 8.10 (d, *J* = 7.9 Hz, 1H), 8.07 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.52 (t, *J* = 7.9 Hz, 1H), 7.45 (dd, *J* = 8.3, 1.5 Hz, 1H), 7.36 (dd, *J* = 8.2, 4.2 Hz, 1H), 7.25 – 7.22 (m, 1H), 7.05 (dd, *J* = 7.9, 1.9 Hz, 1H), 6.90 – 6.84 (m, 2H), 6.72 (d, *J* = 7.9 Hz, 1H), 6.69 (dd, *J* = 7.9, 1.9 Hz, 1H), 6.65 – 6.58 (m, 2H), 3.51 – 3.43 (m, 1H), 3.32 (td, *J* = 11.1, 9.9, 3.4 Hz, 1H), 3.15 – 2.97 (m, 5H), 2.92 – 2.80 (m, 1H), 2.43 (s, 3H), 2.25 (s, 3H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 165.1, 164.8, 148.1, 146.2, 143.4, 141.7, 141.4, 139.7, 139.6, 138.5, 136.8, 136.0, 134.7, 133.2, 132.9, 132.8, 132.6, 132.5, 131.9, 131.4, 129.7, 127.9, 127.3, 126.5, 125.0, 121.7, 121.5, 116.4, 35.4, 34.6, 33.7, 31.2, 21.8, 21.5.

HRMS (ESI) calculated for ($[C_{35}H_{30}N_2O_3]+H^+$): 527.2335, found: 527.2330.

***rac*-4-(*N*-quinolin-8-yl carbamoyl)[2,2]paracyclophan-4-yl 3'-dimethylbenzoate (7d)**

The title compound **7d** was prepared under the optimized conditions (General Procedure **III**) and purified by preparative TLC (petroleum ether: ethyl acetate =10:1). **7d** was obtained as a beige foamy solid (37.9 mg, 74%).



7d

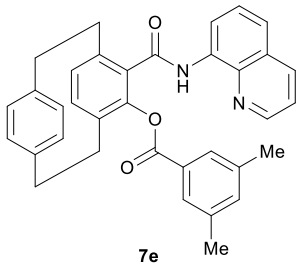
^{1}H NMR (400 MHz, Chloroform-*d*) δ 10.02 (s, 1H), 8.86 (dd, *J* = 7.5, 1.4 Hz, 1H), 8.73 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.07 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.94 (d, *J* = 7.7 Hz, 1H), 7.85 (s, 1H), 7.52 (t, *J* = 7.9 Hz, 1H), 7.45 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.36 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.25 – 7.20 (m, 2H), 7.18 – 7.10 (m, 2H), 6.76 – 6.69 (m, 2H), 6.68 – 6.62 (m, 2H), 3.54 – 3.46 (m, 1H), 3.34 – 3.27 (m, 1H), 3.15 – 3.08 (m, 3H), 3.08 – 3.02 (m, 2H), 2.91 – 2.81 (m, 1H), 2.18 (s, 3H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 164.7, 164.6, 148.2, 141.5, 139.6, 138.2, 136.9, 136.1, 134.7, 134.3, 133.3, 133.0, 132.9, 132.7, 131.7, 130.5, 129.7, 129.5, 128.2, 127.9, 127.4, 127.3, 121.7, 121.5, 116.4, 35.3, 34.7, 33.7, 31.3, 21.2.

HRMS (ESI) calculated for ($[C_{34}H_{28}N_2O_3]+Na^+$):535.1998, found: 535.1993.

***rac*-4-(*N*-quinolin-8-yl carbamoyl)[2,2]paracyclophan-4-yl 3',5'-dimethylbenzoate (7e)**

The title compound **7e** was prepared under the optimized conditions (General Procedure **III**) and purified by preparative TLC (petroleum ether: ethyl acetate =10:1). **7e** was obtained as a beige foamy solid (34.7 mg, 66%).



7e

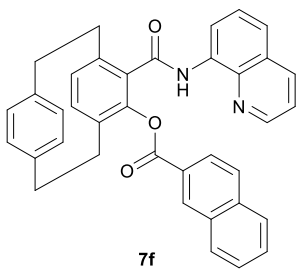
^{1}H NMR (400 MHz, Chloroform-*d*) δ 10.05 (s, 1H), 8.86 (dd, *J* = 7.5, 1.4 Hz, 1H), 8.74 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.08 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.66 (d, *J* = 1.7 Hz, 2H), 7.52 (t, *J* = 7.9 Hz, 1H), 7.45 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.37 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.26 – 7.23 (m, 1H), 7.14 (dd, *J* = 7.9, 1.9 Hz, 1H), 7.02 (s, 1H), 6.75 – 6.68 (m, 2H), 6.67 – 6.59 (m, 2H), 3.52 – 3.44 (m, 1H), 3.34 – 3.23 (m, 1H), 3.15 – 2.99 (m, 5H), 2.85 (ddd, *J* = 13.0, 8.9, 5.4 Hz, 1H), 2.13 (s, 6H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 164.8, 164.6, 148.2, 145.9, 141.4, 139.7, 139.7, 138.5, 138.0, 136.9, 136.1, 135.2, 134.7, 133.3, 133.0, 132.9, 132.7, 131.7, 129.8, 129.5, 128.9, 127.9, 127.8, 127.4, 121.7, 121.5, 116.4, 35.3, 34.6, 33.7, 31.3, 21.0.

HRMS (ESI) calculated for ($[C_{35}H_{30}N_2O_3]+Na^+$): 549.2154, found: 549.2151.

***rac*-4-(*N*-quinolin-8-yl carbamoyl)[2,2]paracyclophan-4-yl 2'-naphthoate (7f)**

The title compound **7f** was prepared under the optimized conditions (General Procedure **III**) and purified by preparative TLC (petroleum ether: ethyl acetate =10:1). **7f** was obtained as a beige foamy solid (29.6 mg, 54%).



7f

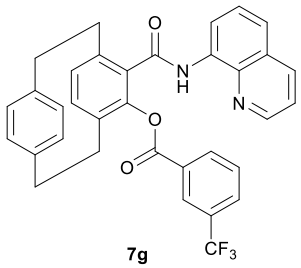
^{1}H NMR (400 MHz, Chloroform-*d*) δ 10.01 (s, 1H), 8.89 – 8.76 (m, 2H), 8.60 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.46 (dd, *J* = 7.3, 1.3 Hz, 1H), 8.02 – 7.97 (m, 1H), 7.90 (d, *J* = 8.2 Hz, 1H), 7.76 (dd, *J* = 8.1, 1.5 Hz, 1H), 7.50 – 7.34 (m, 4H), 7.33 – 7.27 (m, 2H), 7.25 (d, *J* = 4.4 Hz, 1H), 7.06 (dd, *J* = 7.9, 1.9 Hz, 1H), 6.77 (d, *J* = 7.9 Hz, 1H), 6.71 (dd, *J* = 7.8, 1.9 Hz, 1H), 6.67 – 6.62 (m, 2H), 3.54 – 3.45 (m, 1H), 3.38 – 3.30 (m, 1H), 3.24 – 2.99 (m, 5H), 2.96 – 2.85 (m, 1H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 164.8, 164.6, 148.2, 146.1, 141.6, 139.7, 139.7, 138.5, 137.0, 136.1, 135.7, 134.7, 133.4, 133.0, 132.7, 132.3, 131.9, 131.8, 129.6, 129.4, 128.6, 128.2, 127.9, 127.7, 127.3, 126.7, 126.3, 125.5, 121.7, 121.5, 116.5, 35.4, 34.6, 33.8, 31.4.

HRMS (ESI) calculated for ($[C_{37}H_{28}N_2O_3]+Na^+$): 571.1998, found: 571.1994

***rac*-4-(*N*-quinolin-8-yl carbamoyl)[2,2]paracyclophan-4-yl 3'-trifluoromethylbenzoate (7g)**

The title compound **7g** was prepared under the optimized conditions (General Procedure **III**) and purified by preparative TLC (petroleum ether: ethyl acetate =10:1). **7g** was obtained as a beige foamy solid (22.6 mg, 40%).



7g

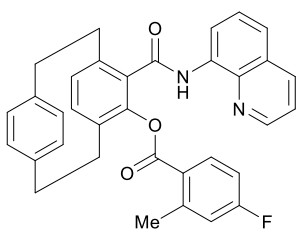
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.92 (s, 1H), 8.82 (dd, *J* = 7.6, 1.4 Hz, 1H), 8.68 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.33 – 8.22 (m, 2H), 8.05 (dd, *J* = 8.3, 1.6 Hz, 1H), 7.65 (d, *J* = 7.8 Hz, 1H), 7.50 (t, *J* = 7.9 Hz, 1H), 7.44 (dd, *J* = 8.4, 1.4 Hz, 1H), 7.41 – 7.33 (m, 2H), 7.23 (dd, *J* = 8.0, 1.9 Hz, 1H), 7.06 (dd, *J* = 8.0, 1.9 Hz, 1H), 6.75 (d, *J* = 7.9 Hz, 1H), 6.71 (dd, *J* = 7.9, 1.9 Hz, 1H), 6.67 – 6.59 (m, 2H), 3.53 – 3.45 (m, 1H), 3.36 – 3.26 (m, 1H), 3.16 – 3.00 (m, 5H), 2.88 (ddd, *J* = 13.3, 8.9, 6.2 Hz, 1H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 164.4, 163.3, 148.3, 145.7, 141.7, 139.7, 139.5, 138.4, 137.0, 136.1, 134.5, 133.4, 133.2, 133.1, 132.8, 132.7, 131.8, 131.1 (q, ^{2}J = 32.9 Hz), 130.04, 129.99 (q, ^{3}J = 3.6 Hz), 129.5, 129.4, 129.1, 127.9, 127.3, 126.9 (q, ^{3}J = 3.8 Hz), 123.5 (q, ^{1}J = 247.0 Hz), 121.8, 121.6, 116.4, 35.3, 34.6, 33.7, 31.2, 29.8.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -62.91.

HRMS (ESI) calculated for ($[C_{34}H_{25}F_3N_2O_3]+H^+$): 589.1715, found: 589.1708

***rac*-4-(*N*-quinolin-8-yl carbamoyl)[2,2]paracyclophan-4-yl 3'-fluoro-2-methylbenzoate (7h)**



7h

The title compound **7h** was prepared under the optimized conditions (General Procedure **III**) and purified by preparative TLC (petroleum ether: ethyl acetate =10:1). **7h** was obtained as a beige foamy solid (24.9 mg, 47%).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.92 (s, 1H), 8.90 – 8.83 (m, 1H),

8.68 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.20 (dd, *J* = 8.7, 6.0 Hz, 1H), 8.09 (dd, *J* = 8.2, 1.5 Hz, 1H), 7.53 (t, *J* = 7.9 Hz, 1H), 7.50 – 7.45 (m, 1H), 7.37 (dd, *J* = 8.2, 4.1 Hz, 1H), 7.23 (dd, *J* = 8.1, 1.9 Hz, 1H), 7.01 (dd, *J* = 8.0, 1.9 Hz, 1H), 6.79 – 6.67 (m, 4H), 6.66 – 6.59 (m, 2H), 3.51 – 3.41 (m, 1H), 3.31 (td, *J* = 11.0, 9.6, 3.1 Hz, 1H), 3.15 – 2.98 (m, 5H), 2.94 – 2.83 (m, 1H), 2.46 (s, 3H)

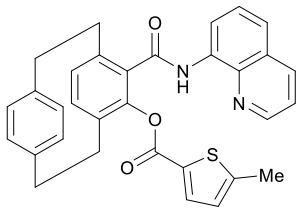
^{13}C NMR (101 MHz, Chloroform-*d*) δ 165.0 (d, ^{1}J = 253.0 Hz), 164.8, 164.2, 148.1, 146.0, 145.3 (d, J = ^{3}9.0 Hz), 141.4, 139.7, 139.6, 138.5, 136.9, 136.2, 134.7, 133.9 (d, J = ^{3}9.5 Hz), 133.3, 133.0, 132.9, 132.7, 131.9, 129.7, 129.6, 128.0, 127.4, 124.1 (d, ^{4}J = 2.8 Hz), 121.9, 121.7, 118.5 (d, ^{2}J = 21.4 Hz), 116.5, 112.9 (d, ^{2}J = 21.5 Hz), 35.4, 34.6, 33.7, 31.1, 22.0.

^{19}F NMR (376 MHz, Chloroform-d) δ -106.32.

HRMS (ESI) calculated for ([$C_{34}H_{27}FN_2O_3$]+Na^+): 553.1903, found: 553.1901

***rac*-4-(*N*-quinolin-8-yl carbamoyl)[2,2]paracyclophan-4-yl 5'-methylthiophene-2'-carboxylate (7i)**

The title compound **7i** was prepared under the optimized conditions (General Procedure **III**) and purified by preparative TLC (petroleum ether: ethyl acetate =7:1). **7i** was obtained as a beige foamy solid (26.4 mg, 51%).



7i

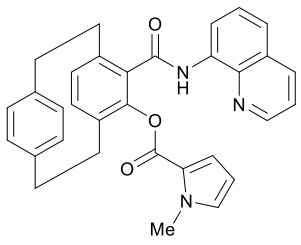
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.94 (s, 1H), 8.86 (dd, *J* = 7.6, 1.4 Hz, 1H), 8.73 (dd, *J* = 4.1, 1.7 Hz, 1H), 8.08 (dd, *J* = 8.2, 1.7 Hz, 1H), 7.67 (d, *J* = 3.8 Hz, 1H), 7.53 (t, *J* = 7.9 Hz, 1H), 7.46 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.37 (dd, *J* = 8.2, 4.2 Hz, 1H), 7.22 (dd, *J* = 7.9, 1.9 Hz, 1H), 7.08 (dd, *J* = 7.9, 1.9 Hz, 1H), 6.71 (d, *J* = 7.9 Hz, 1H), 6.68 (dd, *J* = 7.9, 1.9 Hz, 1H), 6.63 – 6.58 (m, 3H), 3.53 – 3.45 (m, 1H), 3.31 (td, *J* = 11.1, 9.9, 3.5 Hz, 1H), 3.17 – 2.95 (m, 5H), 2.88 – 2.79 (m, 1H), 2.41 (s, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 164.5, 159.9, 149.4, 148.2, 145.8, 141.6, 139.6, 139.6, 138.6, 136.9, 136.0, 135.3, 134.8, 133.2, 133.0, 132.9, 132.6, 131.7, 129.6, 129.5, 127.9, 127.3, 126.5, 121.6, 121.5, 116.5, 35.3, 34.4, 33.8, 31.4, 15.8.

HRMS (ESI) calculated for ([$C_{32}H_{26}N_2O_3S$]+H^+): 519.1742, found: 519.1739.

***rac*-4-(*N*-quinolin-8-yl carbamoyl)[2,2]paracyclophan-4-yl 1'-methyl-1'H-pyrrole-2'-carboxylate (7j)**

The title compound **7j** was prepared under the optimized conditions (General Procedure **III**) and purified by preparative TLC (petroleum ether: ethyl acetate =7:1). **7j** was obtained as a beige foamy solid (37.6 mg, 75%).



7j

^{1}H NMR (400 MHz, Chloroform-*d*) δ 10.07 (s, 1H), 8.90 (dd, *J* = 7.6, 1.4 Hz, 1H), 8.76 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.10 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.53 (t, *J* = 7.9 Hz, 1H), 7.47 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.39 (dd, *J* = 8.2, 4.2 Hz, 1H), 7.27 – 7.24 (m, 1H), 7.20 (dd, *J* = 7.9, 1.9 Hz, 1H), 7.11 (dd,

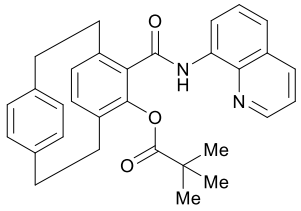
J = 7.9, 1.9 Hz, 1H), 6.71 (d, *J* = 7.9 Hz, 1H), 6.68 (dd, *J* = 8.0, 1.8 Hz, 1H), 6.65 – 6.59 (m, 3H), 5.95 (dd, *J* = 4.0, 2.5 Hz, 1H), 3.72 (s, 3H), 3.49 (ddd, *J* = 13.0, 10.5, 2.5 Hz, 1H), 3.27 (td, *J* = 11.0, 9.7, 3.6 Hz, 1H), 3.18 – 2.94 (m, 5H), 2.88 – 2.77 (m, 1H).

^{13}C NMR (100 MHz, Chloroform-*d*)) δ 164.8, 158.9, 148.0, 145.6, 141.7, 139.7, 139.7, 138.7, 136.8, 136.2, 134.9, 133.3, 133.2, 132.8, 132.7, 131.7, 130.6, 130.1, 129.6, 128.0, 127.4, 121.7, 121.6, 121.2, 119.6, 116.5, 108.2, 36.7, 35.3, 34.5, 33.8, 31.4.

HRMS (ESI) calculated for ([$C_{32}H_{27}N_3O_3$]+H^+): 502.2131, found: 502.2125.

<u>*rac*-4-(*N*-quinolin-8-yl carbamoyl)[2,2]paracyclophan-4-yl pivalate (7k)</u>

The title compound **7k** was prepared under the optimized conditions (General Procedure **III**) and purified by preparative TLC (petroleum ether: ethyl acetate =10:1). **7k** was obtained as a beige foamy solid (27.2 mg, 57%).



7k

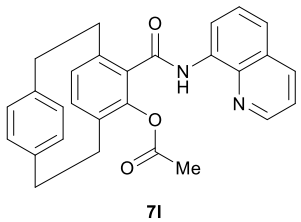
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.76 (s, 1H), 8.93 (d, *J* = 7.5 Hz, 1H), 8.76 – 8.72 (m, 1H), 8.17 –8.11 (m, 1H), 7.59 (t, *J* = 7.9 Hz, 1H), 7.55 – 7.51 (m, 1H), 7.41 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.26 – 7.23 (m, 1H), 6.92 (dd, *J* = 8.0, 1.9 Hz, 1H), 6.69 – 6.63 (m, 2H), 6.61 – 6.54 (m, 2H), 3.34 (tt, *J* = 12.5, 9.2 Hz, 2H), 3.16 – 2.91 (m, 5H), 2.80 (ddd, *J* = 13.6, 9.8, 5.8 Hz, 1H), 1.11 (s, 9H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ176.4, 164.8, 148.4, 146.0, 141.2, 139.7, 139.4, 138.5, 136.9, 136.2, 134.8, 133.3, 132.6, 132.6, 132.5, 132.0, 129.6, 129.3, 128.0, 127.5, 121.8, 121.8, 116.5, 39.0, 35.3, 34.5, 33.5, 30.9, 27.1.

HRMS (ESI) calculated for ([$C_{31}H_{30}N_2O_3$]+H^+): 479.2335, found: 479.2330.

<u>*rac*-4-(*N*-quinolin-8-yl carbamoyl)[2,2]paracyclophan-4-yl acetate (7l)</u>

The title compound **7l** was prepared under the optimized conditions (General Procedure **III**), in which sodium acetate was utilized instead of acetic acid, and purified by preparative TLC (petroleum ether: ethyl acetate =10:1). **7l** was obtained as a beige foamy solid (15 mg, 43%).



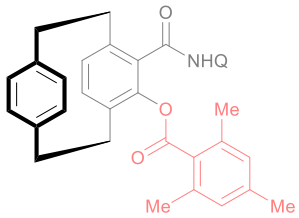
7l

^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.88 (s, 1H), 8.93 (d, *J* = 7.4 Hz, 1H), 8.77 (d, *J* = 4.0 Hz, 1H), 8.16 (dd, *J* = 8.2, 1.7 Hz, 1H), 7.61 (t, *J* = 7.9 Hz, 1H), 7.55 (d, *J* = 8.2 Hz, 1H), 7.44 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.12 (d, *J* = 7.8 Hz, 1H), 6.93 (d, *J* = 7.9 Hz, 1H), 6.67 (dd, *J* = 8.3, 3.3 Hz, 2H), 6.60 (d, *J* = 7.8 Hz, 1H), 6.57 (d, *J* = 7.9 Hz, 1H), 3.47 (m, 1H), 3.29 (td, *J* = 11.5, 4.0 Hz, 1H), 3.06 (m, 5H), 2.84 (m, 1H), 2.10 (s, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 169.21, 164.70, 148.48, 141.62, 139.68, 139.48, 136.85, 136.35, 134.75, 133.11, 133.00, 132.65, 131.86, 129.54, 129.16, 128.11, 127.51, 121.94, 121.85, 116.67, 35.30, 34.39, 33.80, 30.96, 20.92.

HRMS (ESI) calculated for ([$C_{28}H_{24}N_2O_3$]+Na^+): 459.1685, found: 456.1679.

(*R*P)-4-(*N*-quinolin-8-yl carbamoyl)[2,2]paracyclophan-4-yl 2',4',6'-trimethylbenzoate ((*R*P)-7a)



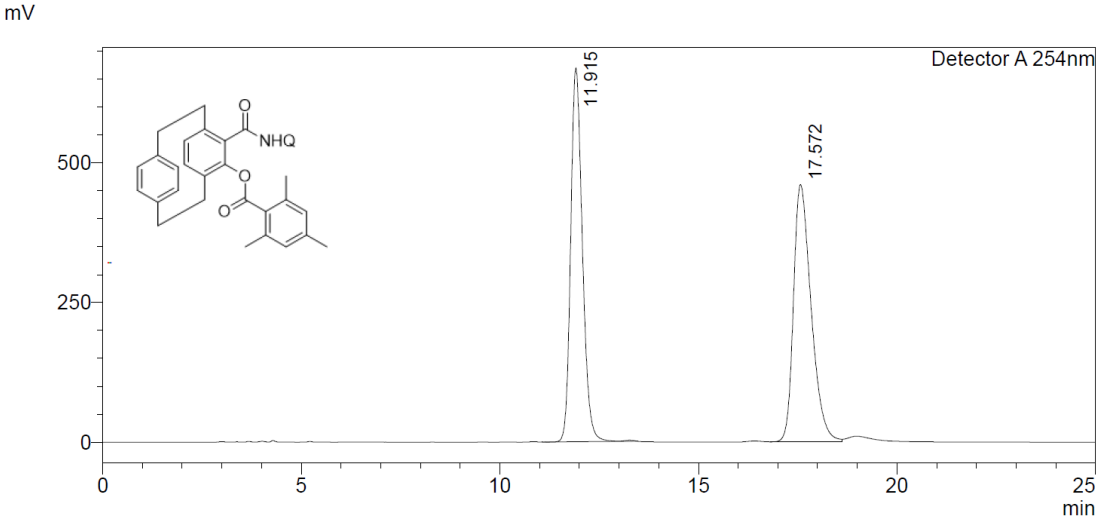
(*R*p)-**7a**

The title compound (*R*P)-**7a** was prepared under the optimized conditions (General Procedure **III**) on a 3.0 mmol scale and purified by preparative TLC (petroleum ether: ethyl acetate =7:1). (*R*P)**7a** was obtained as a beige foamy solid (1.38 g, 85%). The NMR data is consistence with *rac*-**7a**. A single crystal of (*R*P)-**7a** suitable for X-ray crystallography was obtained by crystallization via evaporation from its hexane/EA solution.

((***R*p)-7a**): Enantiomeric excess was determined by HPLC with a Daicel Chiralpak IA, n-hexane/isopropanol = 90/10, v = 1.0 mL · min^{-1}, λ = 254 nm, t (major) = 11.9 min, t (minor) = 17.6 min.

Copies of HPLC data:

<Chromatogram>

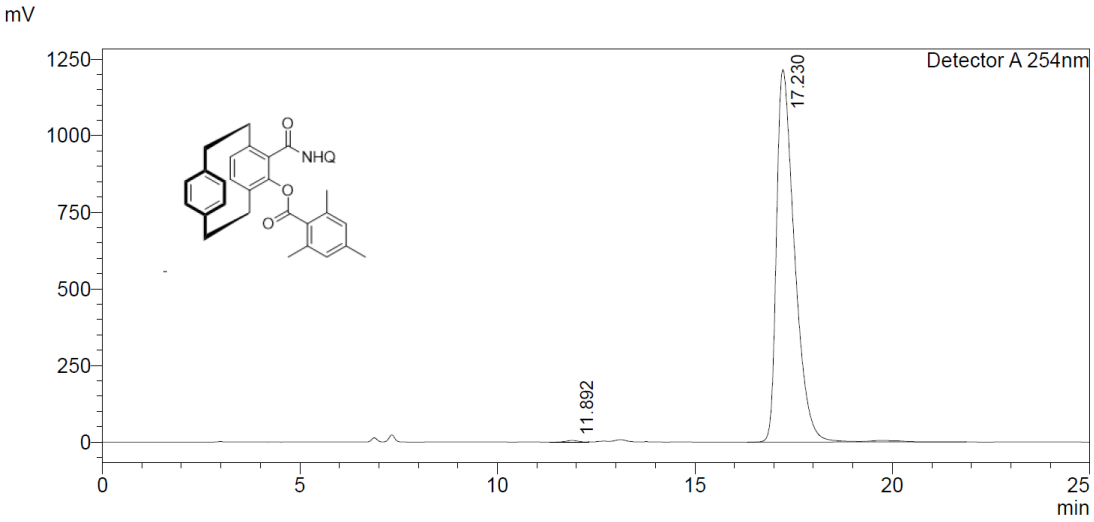


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Area%
1	11.915	13701391	669286	48.961		48.961
2	17.572	14283093	461199	51.039		51.039
Total		27984485	1130485			100.000

<Chromatogram>

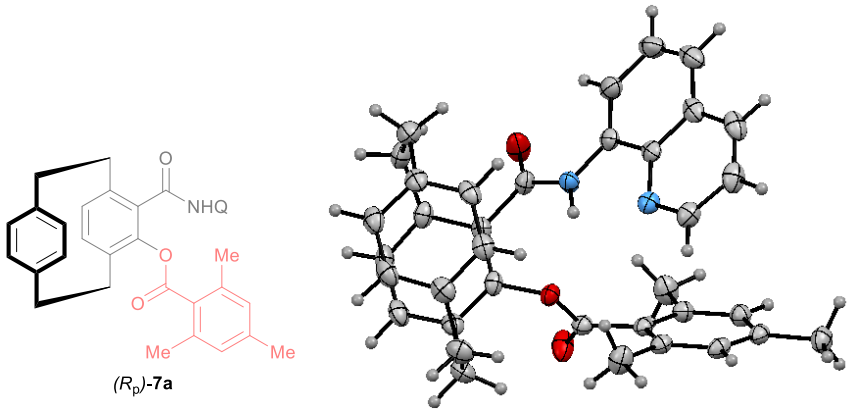


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Area%
1	11.892	108597	5208	0.279	0.279
2	17.230	38752930	1215769	99.721	99.721
Total		38861527	1220976		100.000

X-ray Crystallographic Data:



(*R*$_p$)-**7a**

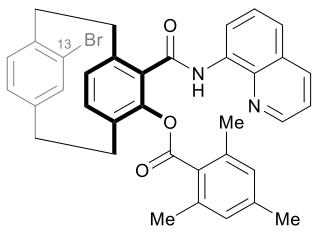
Table S5. X-Ray crystallographic data of (*R*$_P$)-**7a**. The ellipsoids drawn at 30% probability level.

Bond precision:	C-C = 0.0030 A		Wavelength = 1.54178
Cell:	a = 7.9718 (5)	b=16.3516(16)	c=10.9681(11)
	Alpha = 90	beta = 103.980(3)	gamma = 90
Temperature:	170 K		
	Calculated		Reported
Volume	1387.4. (2)		1387.4. (2)
Space group	P 21		P 1 21 1
Hall group	P 2yb		P 2yb

Moiety formula	C36 H32 N2 O3		C36 H32 N2 O3
Sum formula	C36 H32 N2 O3		C36 H32 N2 O3
Mr	540.64		540.63
Dx, g cm^{-3}	1.294		1.294
Z	2		2
Mu (mm^{-1})	0.651		0.651
F000	572.0		572.0
F000'	573.64		
H, k, lmax	9, 19, 13		9, 19, 13
Nref	5111 [2653]		5072
Tmin,Tmax	0.743, 0.812		0.633, 0.753
Tmin'	0.736		
Correction method = # Reported	T Limits: Tmin = 0.633	Tmax = 0.753	AbsCorr = MULTI-SCAN
Data completeness = 1.91/0.99		Theta(max) = 68.365	
R (reflections) = 0.0340 (5055)		wR2(reflections) = 0.0828 (5072)	
S = 1.077		Npar = 373	
Flack parameter	0.06(4)		

<u>*rac*-13-bromo-4-(*N*-quinolin-8-yl carbamoyl)[2,2]paracyclophan-4-yl 2',4',6'-trimethylbenzoate (7n)</u>

The title compound **7n** was prepared under the optimized conditions (General Procedure **III**) and purified by preparative TLC (petroleum ether: ethyl acetate = 10:1). **7n** was obtained as a white foamy solid (46.8 mg, 76%).



7n

^{1}H NMR (400 MHz, Chloroform-*d*) δ 10.84 (s, 1H), 8.86 (dd, *J* = 7.6, 1.4 Hz, 1H), 8.47 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.01 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.51 (t, *J* = 7.9 Hz, 1H), 7.43 (dd, *J* = 8.2, 1.4 Hz, 1H), 7.28 – 7.23 (m, 1H), 7.10 (d, *J* = 1.7 Hz, 1H), 6.80 (d, *J* = 7.8 Hz, 1H), 6.75 – 6.66 (m, 3H), 6.37 (s, 2H), 3.89 (ddd, *J* = 13.9, 9.6, 6.7 Hz, 1H), 3.57 (ddd, *J* = 13.6, 9.7, 1.9 Hz, 1H), 3.39 (ddd, *J* = 13.6, 9.7, 2.0 Hz, 1H), 3.25

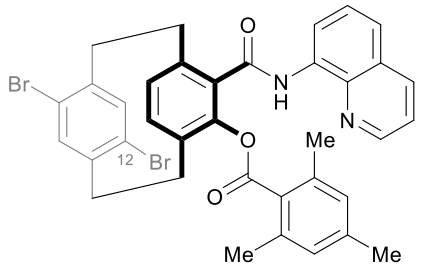
(dddd, *J* = 25.9, 12.8, 10.1, 1.9 Hz, 2H), 3.09 (ddd, *J* = 13.2, 9.7, 6.6 Hz, 1H), 2.91 (tdd, *J* = 13.1, 10.2, 6.6 Hz, 2H), 2.29 (s, 6H), 1.98 (s, 3H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 167.37, 163.18, 147.59, 145.82, 143.32, 141.35, 139.49, 139.32, 138.49, 137.41, 136.23, 135.51, 135.40, 134.68, 133.90, 133.86, 132.16, 131.36, 130.20, 129.07, 128.38, 127.63, 127.17, 126.06, 121.38, 121.03, 116.07, 36.47, 33.96, 32.28, 31.83, 20.97, 20.56.

HRMS (ESI) calculated for ([$C_{36}H_{31}BrN_2O_3$]+H^+): 619.1591, found: 619.1593.

***rac*-7,25-dibromo-4-(*N*-quinolin-8-yl carbamoyl)[2,2]paracyclophan-4-yl 2',4',6'-trimethyl benzoate (7p)**

The title compound **7p** was prepared under the optimized conditions (General Procedure **III**) and purified by preparative TLC (petroleum ether: ethyl acetate = 10:1). **7p** was obtained as a white foamy solid (46.8 mg, 76%).



7p

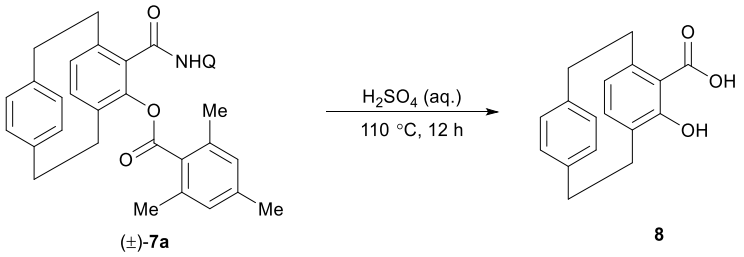
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.97 (s, 1H), 8.84 (dd, *J* = 7.4, 1.6 Hz, 1H), 8.67 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.08 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.56 (t, *J* = 7.9 Hz, 1H), 7.51 (dd, *J* = 8.3, 1.6 Hz, 1H), 7.36 (d, *J* = 3.6 Hz, 1H), 7.34 (d, *J* = 3.8 Hz, 1H), 7.31 (d, *J* = 1.8 Hz, 1H), 7.29 (s, 1H), 6.81 (dd, *J* = 8.0, 1.8 Hz, 1H), 6.73 (s, 2H), 3.47 – 3.37 (m, 1H), 3.21 (qt, *J* = 9.1, 4.8 Hz, 3H), 3.11 – 2.96 (m, 4H), 2.34 (s, 6H), 2.19 (s, 3H).

^{13}C NMR (100 MHz, Chloroform-*d*) δ 167.77, 164.26, 148.51, 147.02, 141.20, 140.93, 140.60, 138.74, 138.48, 137.24, 136.08, 134.42, 134.24, 132.92, 132.82, 132.58, 129.80, 129.52, 129.19, 129.02, 128.23, 127.96, 127.15, 126.59, 122.24, 121.78, 116.70, 35.52, 31.66, 31.51, 29.51, 21.17, 20.97.

HRMS (ESI) calculated for ([$C_{36}H_{30}Br_2N_2O_3$]+H^+): 697.0696, found: 697.0696.

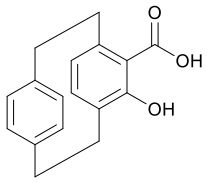
3.6 Synthetic Transformations

Removal of directing group



The *o*-acyloxylation amide *rac*-**7a** (1 mmol, 1 equiv.) was taken in an oven-dried round-bottom flask which was connected through a condenser under an N_2 atmosphere, and 10 mL of 40% H_2SO_4 were added. Then the mixture was stirred for 12 h at 110 °C (oil bath) followed by cooling. EtOAc (10 mL) was added to the solution. The aqueous layer was extracted with EtOAc (3 × 10 mL). The combined organic layers were washed with brine (10 mL), dried over Na_2SO_4, filtered, and concentrated under vacuum. The residue was purified by preparative TLC with silica gel to afford the hydroxyl carboxylic acid **8** as a white solid. (CH_2Cl_2/MeOH=15/1).

***rac*-5-Carboxyl-4-hydroxy[2,2]cyclohexaphane (8)**



8

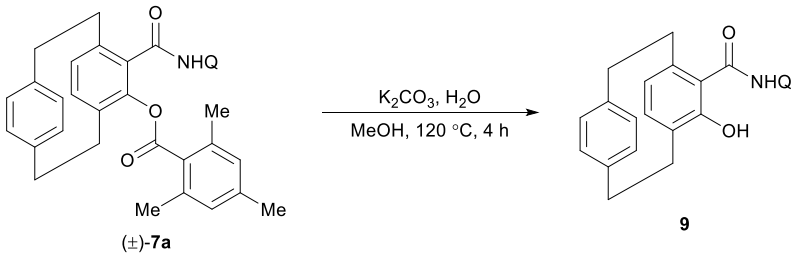
^{1}H NMR (400 MHz, Chloroform-*d*) δ 11.24 (s, 1H), 6.97 (dd, *J* = 8.1, 6.2 Hz, 1H), 6.63 (t, *J* = 8.3 Hz, 2H), 6.44 (t, *J* = 8.2 Hz, 2H), 6.31 (d, *J* = 7.6 Hz, 1H), 4.03 (dd, *J* = 13.1, 9.6 Hz, 1H), 3.48 (ddd, *J* = 13.0, 10.1, 2.8 Hz, 1H), 3.20 (ddd, *J* = 28.5, 14.2, 10.1 Hz, 2H), 3.09 – 3.01 (m, 1H), 2.99 – 2.89 (m, 1H), 2.87 – 2.77 (m, 1H), 2.63 (ddd, *J* = 15.9, 10.7, 5.1 Hz, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 174.1, 162.8, 144.9, 140.2, 140.0, 138.8, 133.9, 132.3, 131.1, 128.9, 127.7, 127.1, 112.9, 37.4, 34.8, 33.8, 30.4.

HRMS (ESI) calculated for ($[C_{17}H_{16}O_3]+H^+$): 269.1178, found: 269.1172.

Melting point: 179.5-186.6 °C.

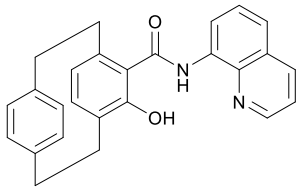
Selective hydrolysis of acyloxyl protecting group[3]



To a solution of K_2CO_3 (0.8 mmol, 4 equiv.) and H_2O (5 equiv.) in MeOH (5 mL), *rac*-**7a** (0.2 mmol) was added at room temperature. The mixture was refluxed at 120 °C (aluminum heat transfer block)

under nitrogen for 4 h. After cooling to room temperature, diluted with EtOAc, filtered through a dried Na_2SO_4 pad, and concentrated under vacuum. After removing the solvent, the residue was purified by preparative TLC with silica gel (petroleum ether/ethyl acetate, 10/1) to give the product **9** (85%) as a white solid.

***rac*-5-Carbonyl-4-hydroxy[2,2]paracyclophan-*N*-(quinolin-8-ylamide (9)**



9

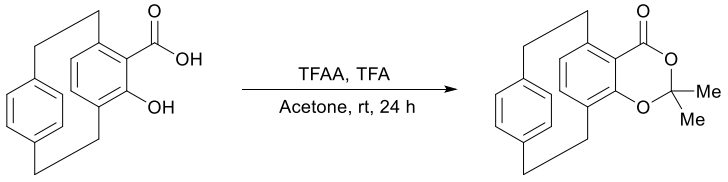
^{1}H NMR (400 MHz, Chloroform-*d*) δ 11.82 (br, 1H), 10.45 (s, 1H), 8.89 (dd, *J* = 7.3, 1.7 Hz, 1H), 8.20 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.66 – 7.56 (m, 2H), 7.49 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.15 (dd, *J* = 7.7, 1.9 Hz, 1H), 6.67 – 6.55 (m, 3H), 6.51 – 6.37 (m, 2H), 4.17 – 4.03 (m, 1H), 3.49 (ddd, *J* = 13.1, 10.3, 2.9 Hz, 1H), 3.23 (ddd, *J* = 12.8, 10.3, 5.0 Hz, 1H), 3.17 – 3.00 (m, 3H), 2.78 (ddd, *J* = 11.5, 9.3, 6.6 Hz, 1H), 2.61 (ddd, *J* = 13.0, 10.7, 5.0 Hz, 1H).

^{13}C NMR (101 MHz, Chloroform-d) δ 169.2, 160.5, 148.8, 140.1, 139.1, 139.0, 138.2, 138.0, 136.6, 134.3, 133.4, 131.9, 131.5, 129.4, 128.3, 127.8, 127.8, 127.6, 122.4, 122.0, 118.7, 117.1, 37.2, 35.4, 34.1, 30.4.

HRMS (ESI) calculated for ([C26H22N2O2]+Na^+): 417.1579, found: 417.1575.

Melting point: 190.0-193.3 °C.

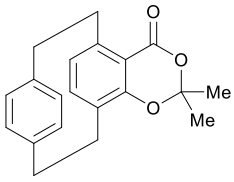
Synthesis of 4,5-disubstituted [2,2]paracyclophane derivative 10



8 **10**

To a stirred solution of **PCP-1** (0.2 mmol) in TFA (0.1mL) was added a solution of acetone (1 mmol) in TFAA (80 μL) at 0 °C and stirred for 24 h at room temperature. After this time, EA was added to the mixture and concentrated (x 3). The residue was diluted with EtOAc and saturated aqueous $NaHCO_3$. The mixture was extracted with EtOAc. The extracts were dried over Na_2SO_4 and concentrated. Purification of the residue by preparative TLC with silica gel (petroleum ether/ethyl acetate, 10/1) gave compound **10** in 82% yield.

***rac*-2',2'-Dimethyl-4'*H*-1(4,5)-benzo[*d*][1',3']dioxina-[2,2]paracyclohexaphan-4'-one (10)**



10

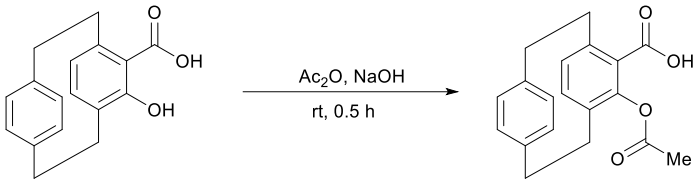
^{1}H NMR (400 MHz, Chloroform-*d*) δ 6.89 (dd, *J* = 7.9, 2.0 Hz, 1H), 6.66 – 6.57 (m, 2H), 6.52 (dd, *J* = 7.8, 2.0 Hz, 1H), 6.43 (dd, *J* = 7.9, 2.0 Hz, 1H), 6.36 (d, *J* = 7.8 Hz, 1H), 4.17 (ddd, *J* = 12.0, 9.6, 1.9 Hz, 1H), 3.31 (ddd, *J* = 13.3, 9.8, 3.5 Hz, 1H), 3.24 – 2.99 (m, 4H), 2.79 (ddd, *J* = 12.4, 10.0, 6.7 Hz,

1H), 2.65 (ddd, *J* = 13.2, 10.2, 5.4 Hz, 1H), 1.85 (s, 3H), 1.45 (s, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 160.2, 155.1, 146.2, 139.9, 139.4, 139.4, 133.6, 132.9, 130.2, 128.6, 128.2, 127.5, 115.2, 104.0, 35.4, 33.9, 33.3, 29.5, 28.3, 24.1.

HRMS (ESI) calculated for ([C20H20O3]+Na^+): 331.1310, found: 331.1307

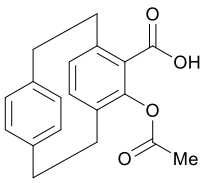
Synthesis of 4,5-disubstituted [2,2]paracyclophane 11



8 **11**

NaOH (0.2 mmol) was added to a stirred solution of **8** (0.2 mmol) in Ac_2O (0.2 mL) at room temperature and stirred for 30 min. Upon completion, the residue was diluted with EtOAc and washed with 1 M HCl (aq.). The combined organic layers were dried over anhydrous Na_2SO_4, filtered, and concentrated in vacuo. The crude residue was purified by preparative TLC (petroleum ether: ethyl acetate =1:1) to afford **11** as a white solid in 97% yield.

***rac*-5-Carboxyl-4-acetoxy[2,2]paracyclohexaphane (11)**



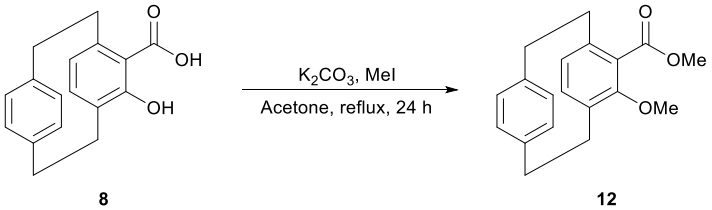
11

^{1}H NMR (400 MHz, Chloroform-*d*) δ 6.79 (qd, *J* = 7.9, 1.8 Hz, 1H), 6.71 (d, *J* = 8.0 Hz, 0H), 6.65 (dd, *J* = 7.9, 1.8 Hz, 1H), 6.58 – 6.51 (m, 1H), 3.64 (ddd, *J* = 12.6, 10.3, 2.0 Hz, 1H), 3.30 (ddd, *J* = 12.6, 10.4, 5.5 Hz, 1H), 3.19 – 2.99 (m, 4H), 2.92 (ddd, *J* = 12.7, 10.5, 5.5 Hz, 1H), 2.85 – 2.76 (m, 1H), 2.36 (s, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 171.1, 169.2, 148.4, 143.9, 139.6, 139.5, 138.4, 133.1, 133.0, 133.0, 132.9, 131.3, 129.5, 124.2, 34.9, 34.8, 34.2, 30.5, 21.0.

HRMS (ESI) calculated for ([$C_{19}H_{18}O_4$]+Na^+): 333.1103, found: 333.1098

Methylation of Hydroxyaromatic Acids

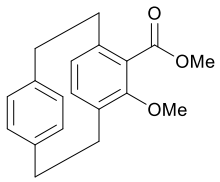


8 **12**

To a solution of K_2CO_3 (2 mmol, 5 equiv.) and the hydroxyl carboxylic acid **8** (0.4 mmol) in acetone (5 mL), methyl iodide (2.4 mmol, 6 equiv.) was added at room temperature. The mixture was refluxed under nitrogen for 24 h. After cooling to room temperature, the mixture was filtrated and concentrated. Then, the residue was extracted with ether (3 x 5 mL), and the combined organic layers were washed by brine (2 x 10 mL), and then dried over anhydrous Na_2SO_4. After removing the solvent, the residue

was purified by preparative TLC with silica gel (petroleum ether/ethyl acetate, 10/1) to give the product **12** (92%) as a white solid.

***rac*-4-Methoxy-5-methoxycarbonyl[2,2]paracyclohexaphane (12)**



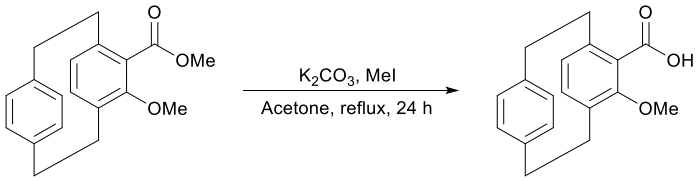
12

^{1}H NMR (400 MHz, Chloroform-*d*) δ 6.87 (d, *J* = 8.0 Hz, 1H), 6.70 (d, *J* = 8.1 Hz, 1H), 6.61 – 6.57 (m, 1H), 6.56 – 6.51 (m, 2H), 6.33 (d, *J* = 7.9 Hz, 1H), 3.88 (d, *J* = 1.3 Hz, 3H), 3.71 (d, *J* = 1.3 Hz, 3H), 3.32 – 3.11 (m, 4H), 3.08 – 2.91 (m, 2H), 2.79 (dddd, *J* = 23.3, 13.7, 9.6, 3.6 Hz, 2H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 168.2, 157.2, 141.4, 139.6, 139.2, 138.0, 132.5, 132.5, 132.3, 131.4, 130.6, 129.4, 126.2, 62.2, 51.7, 34.9, 34.4, 33.8, 30.5.

HRMS (ESI) calculated for ([C19H20O3]+Na^+):319.1310, found: 319.1306

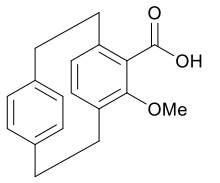
Hydrolysis of esters 12 to carboxylic acid 13



12 13

To a stirred solution of **12** (0.2 mmol) in THF (2.0 mL), H_2O (0.2 mL) and MeOH (2.0 mL) was added NaOH (20 equiv.) and the reaction mixture was stirred at 100 °C (aluminum heat transfer block) for 12 h under N_2. Upon completion, the organic layer was washed with 1 M HCl (aq.). The combined organic layers were dried over anhydrous Na_2SO_4, filtered, and concentrated in vacuo. The crude residue was purified by preparative TLC (petroleum ether: ethyl acetate =1:1) to afford **13** as a white solid in 96% yield.

***rac*-5-Carboxyl-4-methoxy[2,2]paracyclohexaphane (13)**



13

^{1}H NMR (400 MHz, Chloroform-*d*) δ 6.79 (dd, *J* = 7.9, 2.0 Hz, 1H), 6.65 (dd, *J* = 7.9, 1.9 Hz, 2H), 6.60 (dd, *J* = 7.9, 1.9 Hz, 1H), 6.51 (d, *J* = 7.9 Hz, 1H), 6.48 (dd, *J* = 7.9, 2.0 Hz, 1H), 4.02 (ddd, *J* = 12.5, 9.6, 2.3 Hz, 1H), 3.83 (s, 3H), 3.30 (ddd, *J* = 13.5, 9.9, 3.7 Hz, 1H), 3.21 – 2.98 (m, 4H), 2.87 – 2.75 (m, 2H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 168.4, 157.8, 144.8, 139.6, 139.3, 138.9, 133.2, 132.6, 132.2, 132.0, 131.3, 128.9, 124.7, 62.8, 35.2, 34.4, 34.2, 30.9.

HRMS (ESI) calculated for ([$C_{18}H_{18}O_3$]+Na^+): 305.1154, found: 305.1149.

Melting point: 150.5-152.8 °C.

4. References:

[1] Lennartz, P.; Raabe G.; Bolm, C.; Palladium-Catalyzed C-H Bond Acetoxylation: An Approach to *ortho*-Substituted Hydroxy[2.2]paracyclophane Derivatives. *Adv. Synth. Catal.* **2012**, *354*, 3237–3249.

[2] Rozenberg, V.; Dubrovina, N.; Sergeeva, E.; Antonov, D.; Belokon, Y.; An improved synthesis of (S)-(+)- and (R)-(−)-[2.2]paracyclophane-4-carboxylic acid. *Tetrahedron: Asymmetry*, **1998**, *9*, 653–656.

[3] Schneider, J. F.; Falk, F. C.; Fröhlich, R.; Paradies, J. Planar-Chiral Thioureas as Hydrogen-Bond Catalysts. *Eur. J. Org. Chem.* **2010**, 2265–226.

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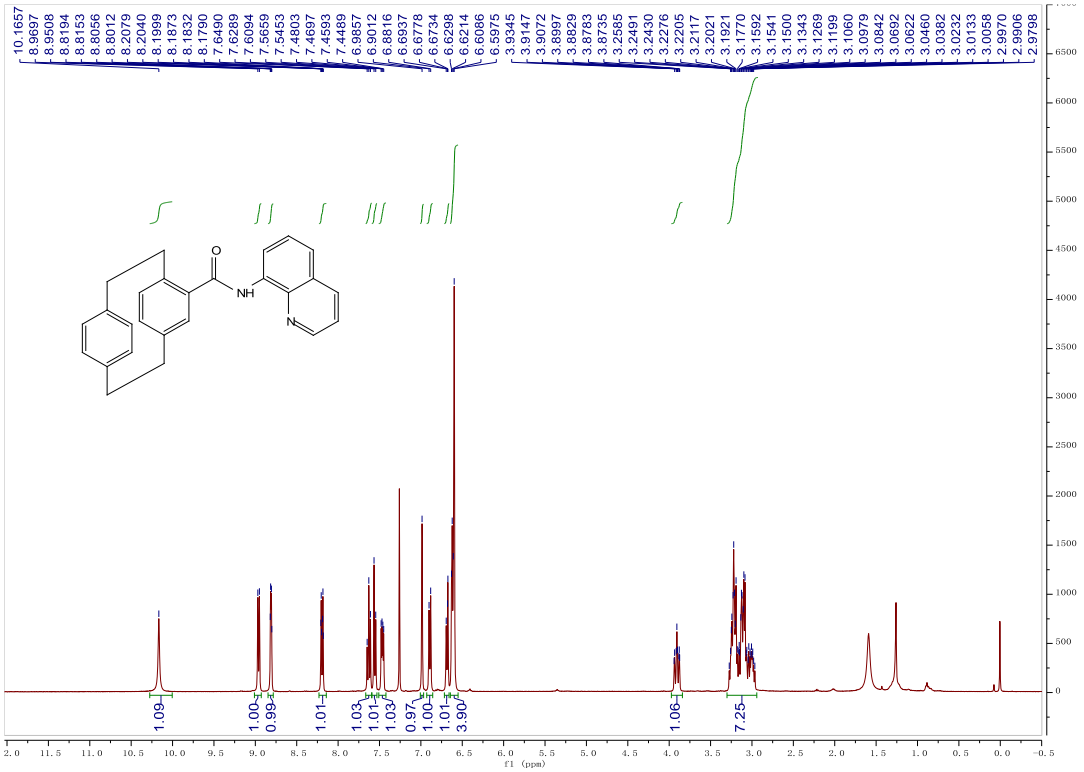
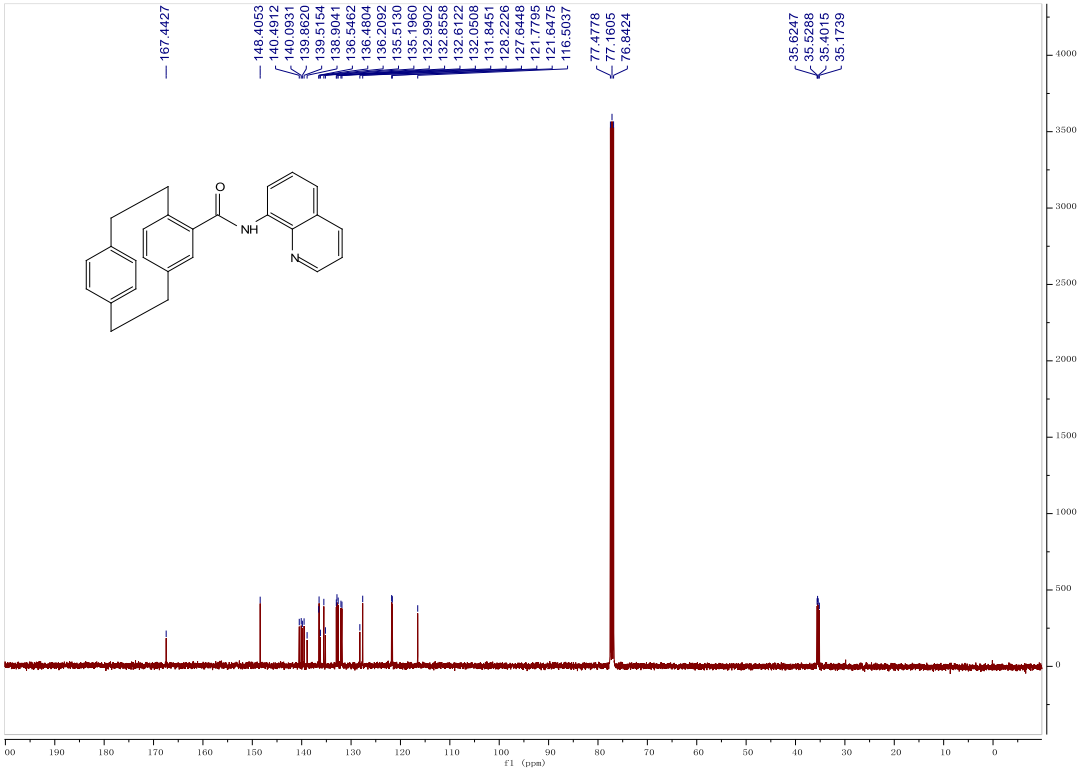
[5] Dominguez, B.; Zanotti-Gerosa, A.; Hems, W. Electrophilic Substitution of Dibromoparacyclophane: A Route to Novel Paracyclophane Phosphine Ligands. *Org. Lett.* **2004**, *6*, 1927–1930.

[6] A. Yamada, S. Fujii, S. Mori and H. Kagechika, Design and Synthesis of 4-(4-Benzoylaminophenoxy)phenol Derivatives As Androgen Receptor Antagonists. *ACS Med. Chem. Lett.* **2013**, *4*, 10, 937–941.

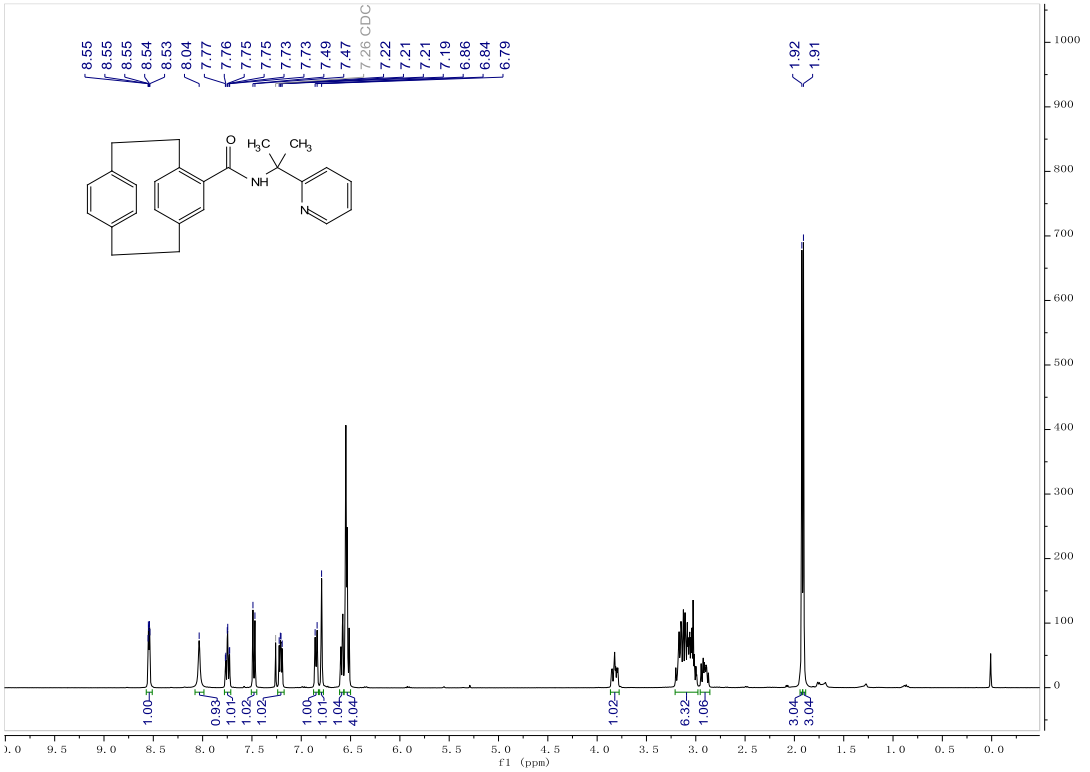
5. NMR spectra

rac-1a





***rac*-1b**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8.55
8.55
8.54
8.53
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7.76
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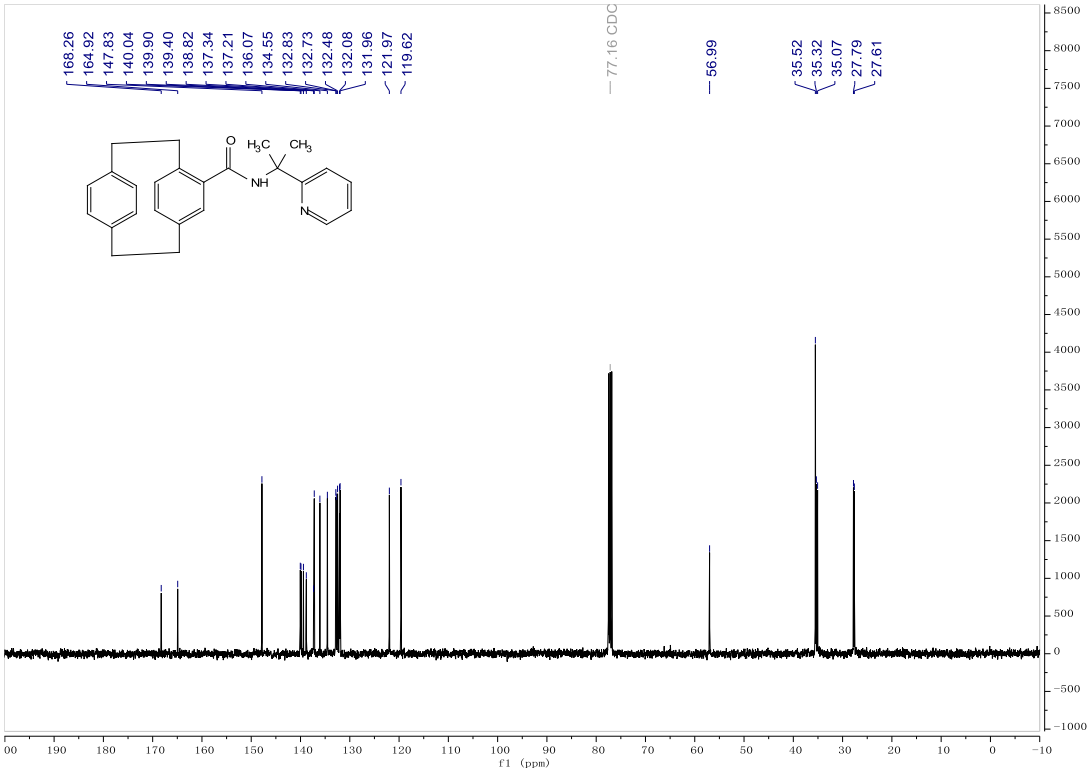
7.75
7.73
7.73
7.49
7.47
7.26 CDC
7.22
7.21
7.21
7.19
6.86
6.84
6.79
1.92
1.91
O
H3C
CH3
NH
N
1.00
0.93
1.01
1.02
1.02
1.00
1.01
1.04
4.04
1.02
6.32
1.06
3.04
3.04
f1 (ppm)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132.48
132.08
131.96
121.97
119.62
77.16 CDC
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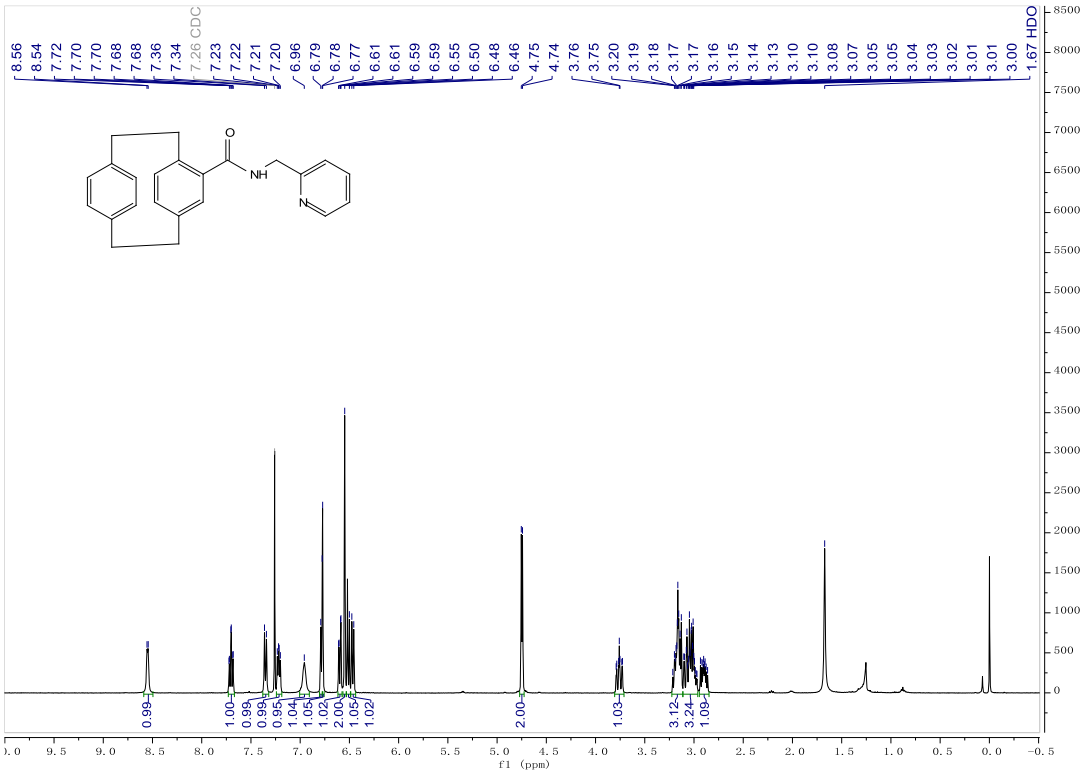
35.07
27.79
27.61
O
H3C
CH3
NH
N
f1 (ppm)

***rac*-1c**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0.99
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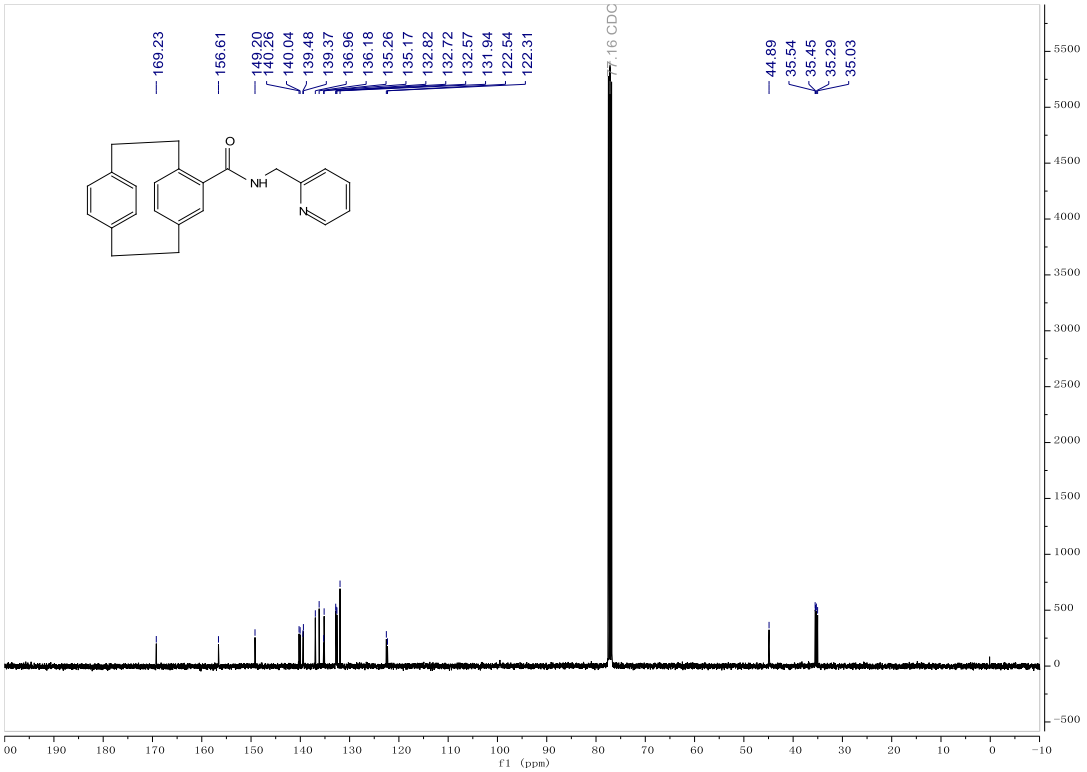
f1 (ppm)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135.17
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132.72
132.57
131.94
122.54
122.31
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35.54
35.45
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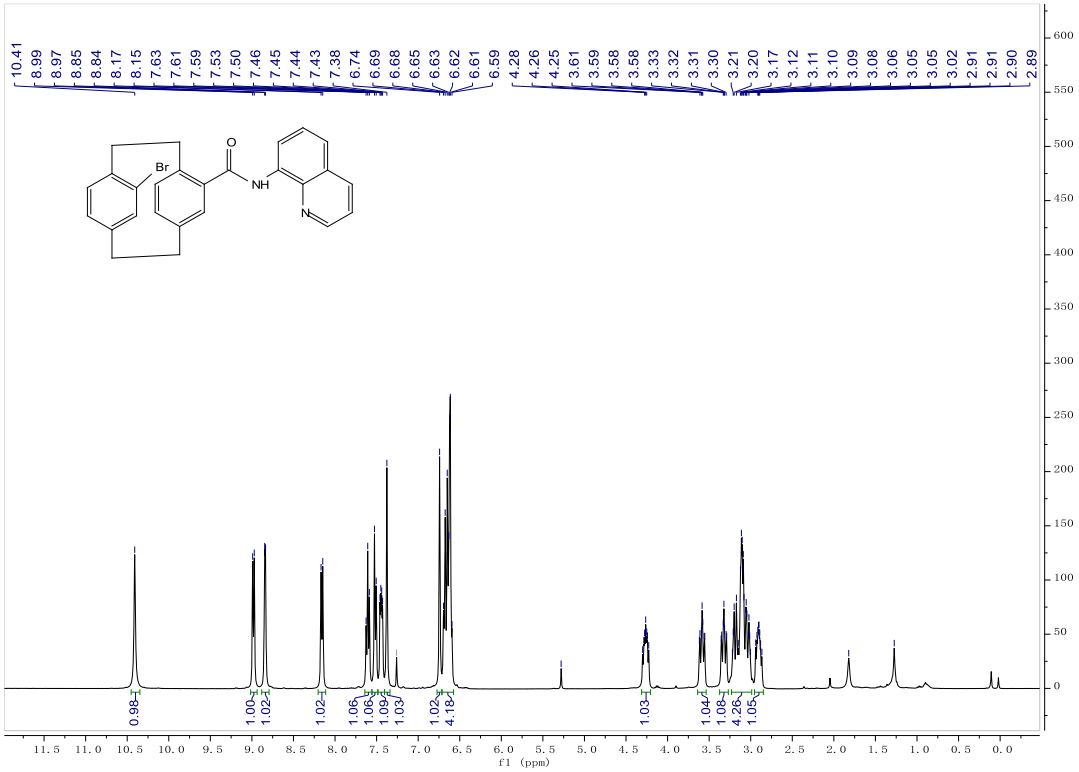
35.03
O
NH
N
f1 (ppm)

***rac*-1d**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6.65
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6.59
4.28
4.26
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3.59
3.58
3.58
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3.32
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3.17
3.12
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3.10
3.09
3.08
3.06
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2.90
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O
NH
N
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1.02
1.02
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1.02
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1.03
1.04
1.08
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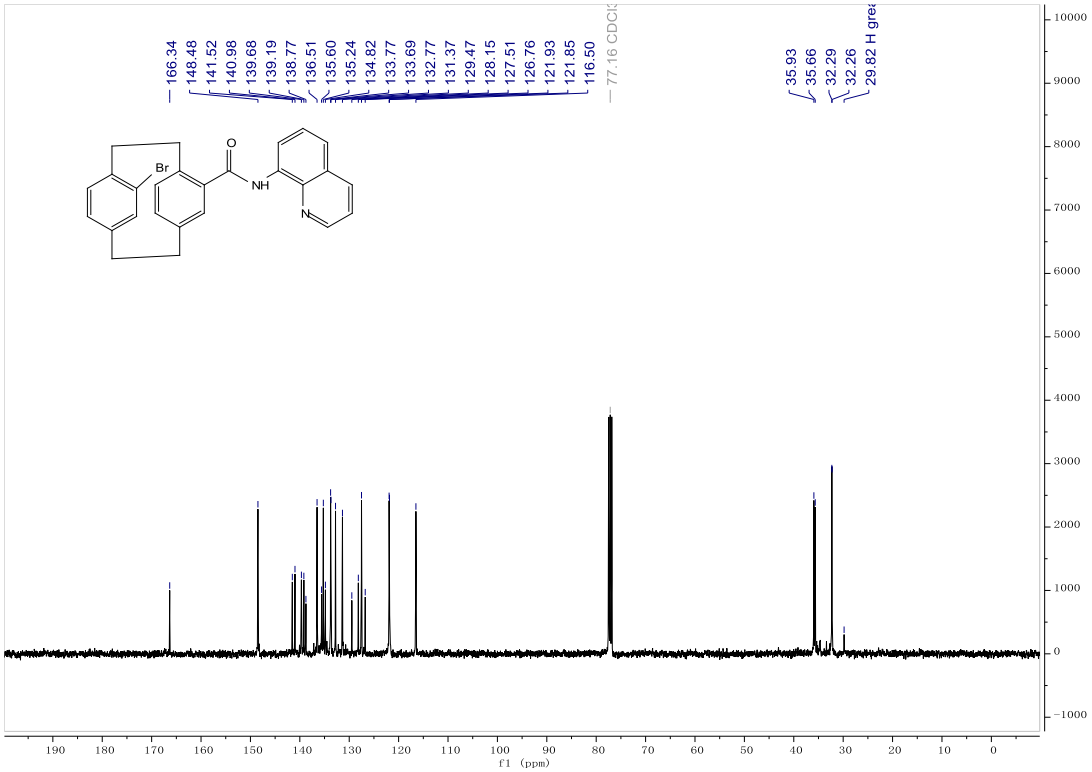
1.05
f1 (ppm)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132.77
131.37
129.47
128.15
127.51
126.76
121.93
121.85
116.50
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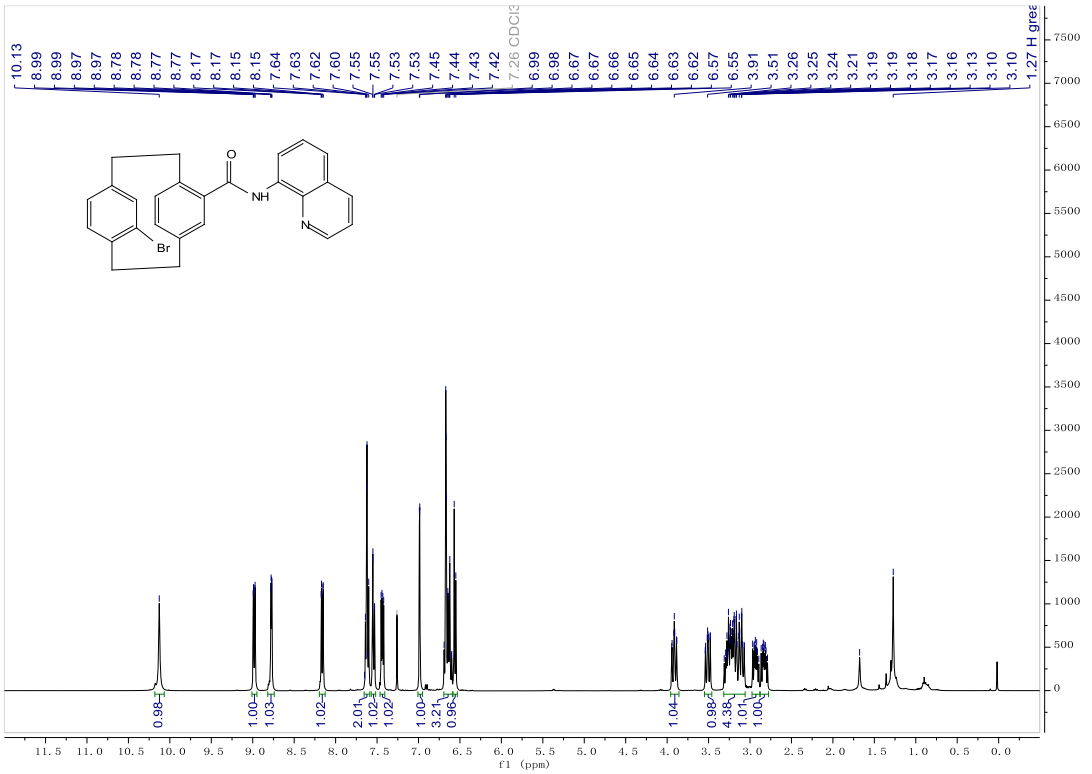
Br
O
NH
N
f1 (ppm)

***rac*-1e**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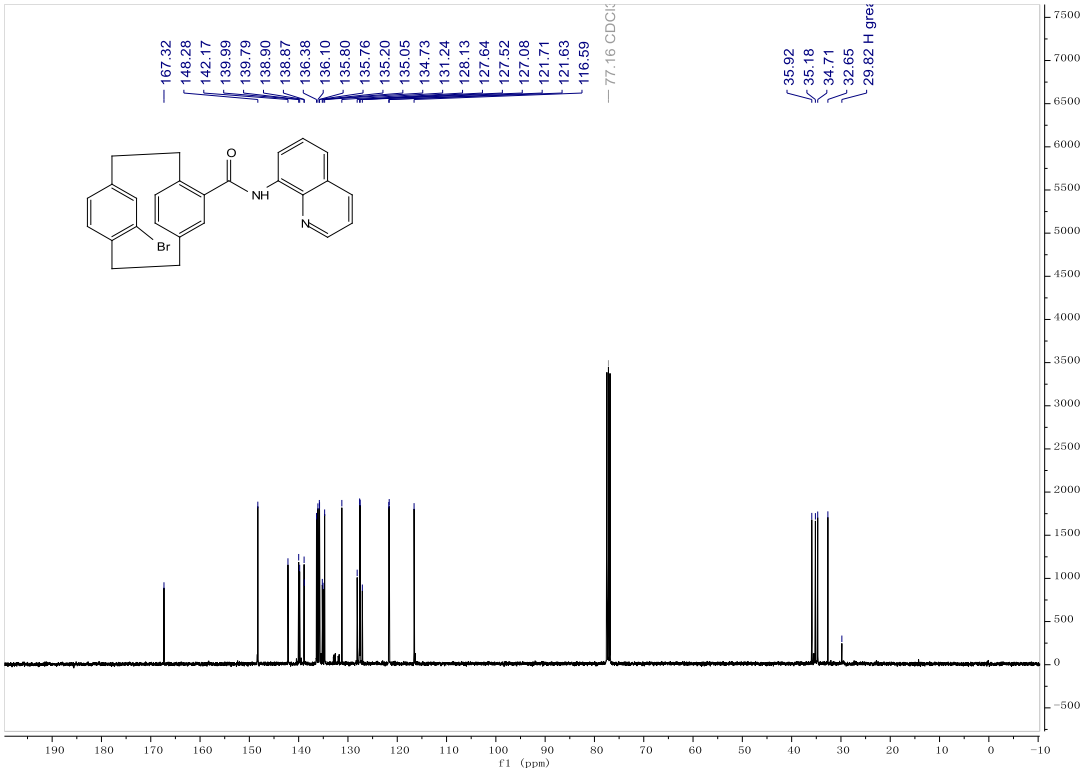
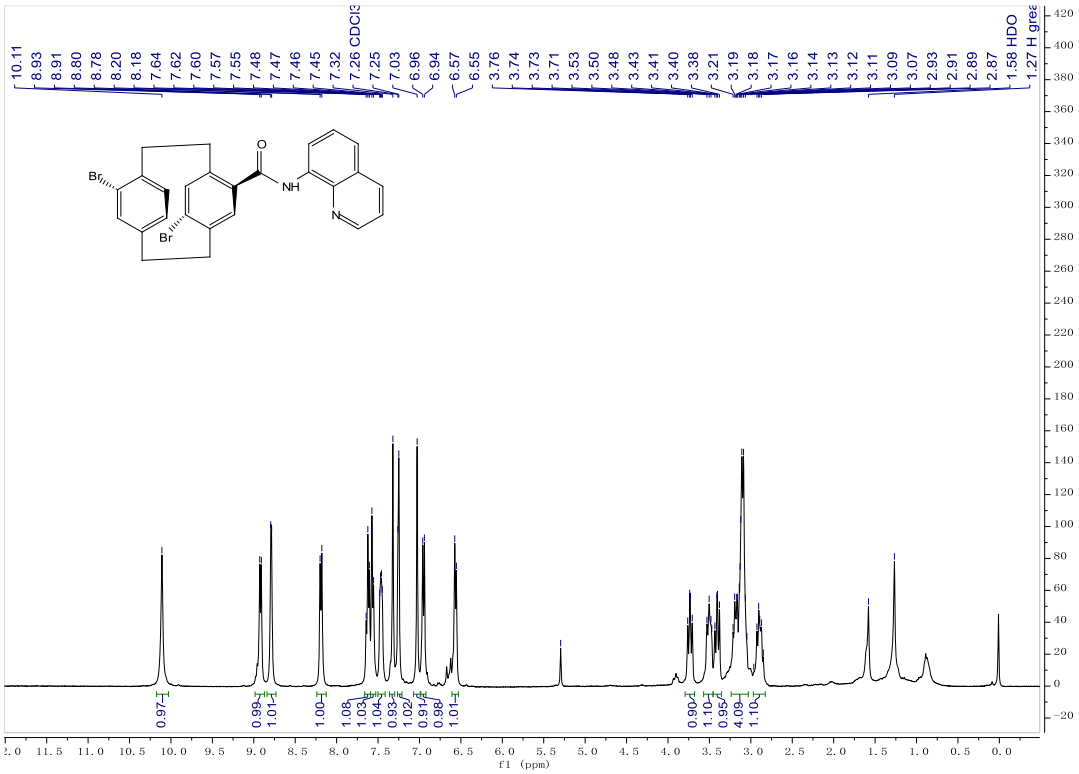
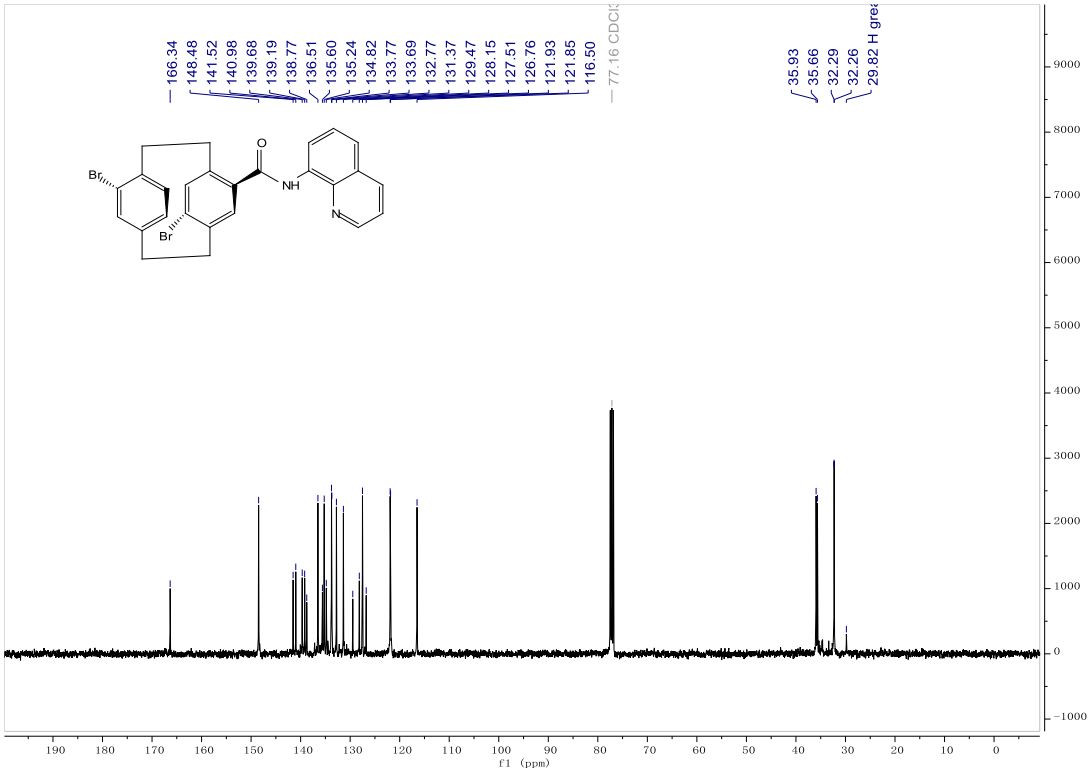
8.99
8.97
8.97
8.78
8.78
8.77
8.77
8.17
8.17
8.15
8.15
7.64
7.63
7.62
7.60
7.55
7.55
7.53
7.53
7.45
7.44
7.43
7.42
7.26 CDCl3
6.99
6.98
6.67
6.67
6.66
6.65
6.64
6.63
6.62
6.57
6.55
3.91
3.51
3.26
3.25
3.24
3.21
3.19
3.19
3.18
3.17
3.16
3.13
3.10
3.10
1.27 H grea
O
NH
N
Br
0.98
1.00
1.03
1.02
2.01
1.02
1.02
1.00
3.21
0.96
1.04
0.98
4.38
1.01
1.00
f1 (ppm)

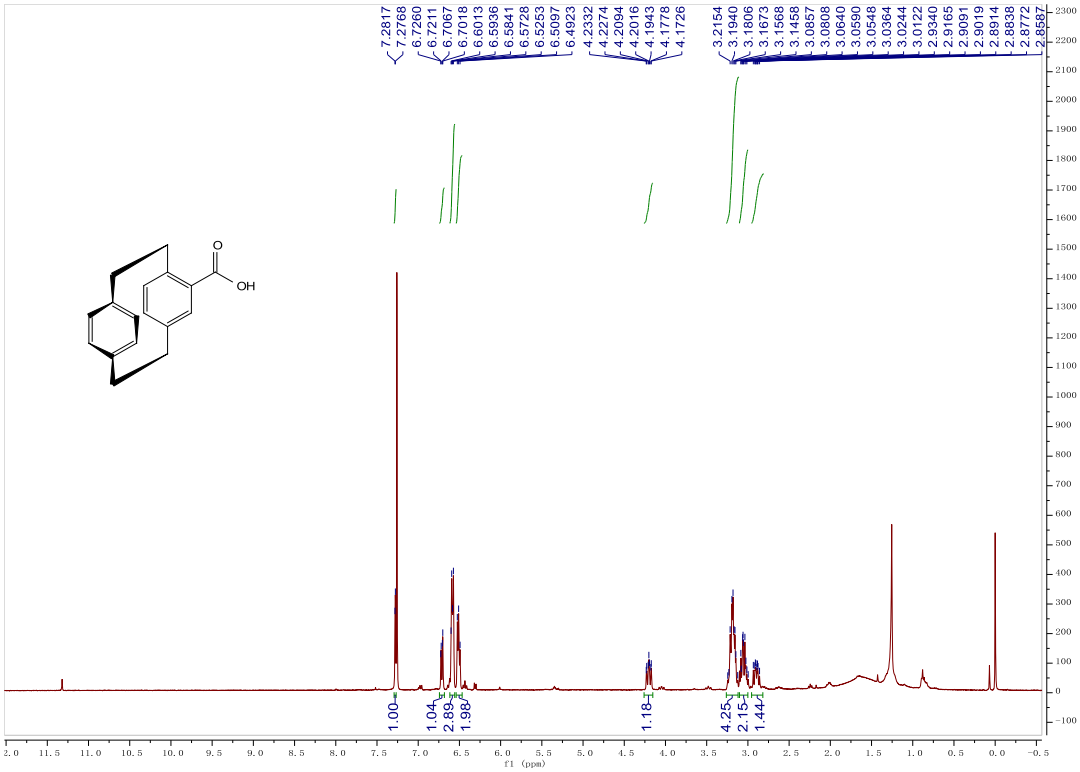

167.32
148.28
142.17
139.99
139.79
138.90
138.87
136.38
136.10
135.80
135.76
135.20
135.05
134.73
131.24
128.13
127.64
127.52
127.08
121.71
121.63
116.59
77.16 CDCl3
35.92
35.18
34.71
32.65
29.82 H grea
O
NH
N
Br
f1 (ppm)

***rac*-1f**


10.11
8.93
8.91
8.80
8.78
8.20
8.18
7.64
7.62
7.60
7.57
7.55
7.48
7.47
7.46
7.45
7.32
7.26 CDCl3
7.25
7.03
6.96
6.94
6.57
6.55
3.76
3.74
3.73
3.71
3.53
3.50
3.48
3.43
3.41
3.40
3.38
3.21
3.19
3.18
3.17
3.16
3.14
3.13
3.12
3.11
3.09
3.07
2.93
2.91
2.89
2.87
1.58 HDO
1.27 H grea
O
NH
N
Br
Br
0.97
0.99
1.01
1.00
1.08
1.03
1.04
0.93
1.02
0.97
0.98
1.01
0.90
1.10
0.95
4.09
1.10
f1 (ppm)


166.34
148.48
141.52
140.98
139.68
139.19
138.77
136.51
135.60
135.24
134.82
133.77
133.69
132.77
131.37
129.47
128.15
127.51
126.76
121.93
121.85
116.50
77.16 CDCl3
35.93
35.66
32.29
32.26
29.82 H grea
O
NH
N
Br
Br
f1 (ppm)

(S_p)-S2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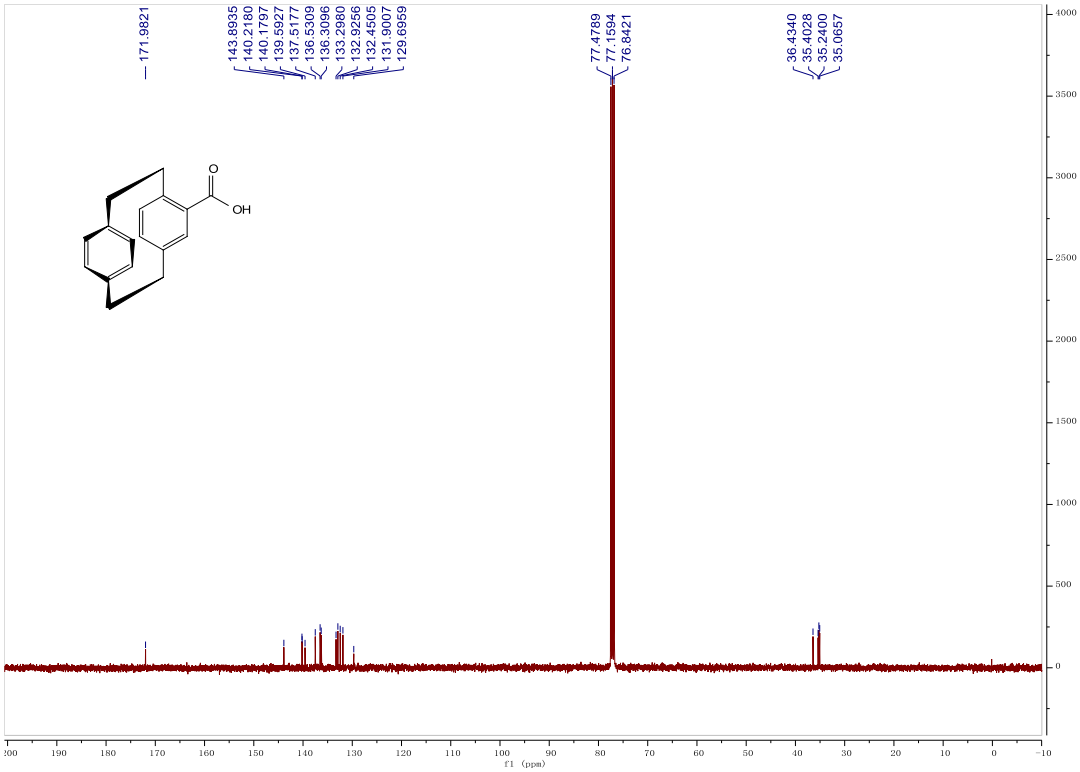
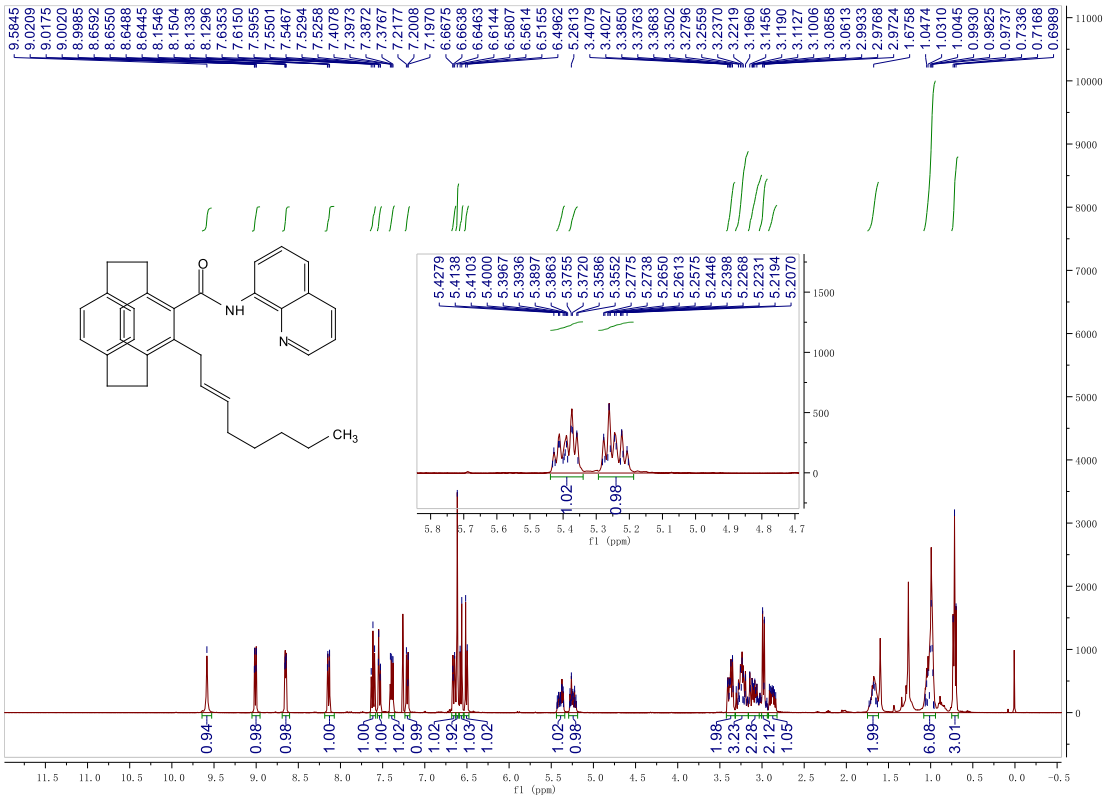
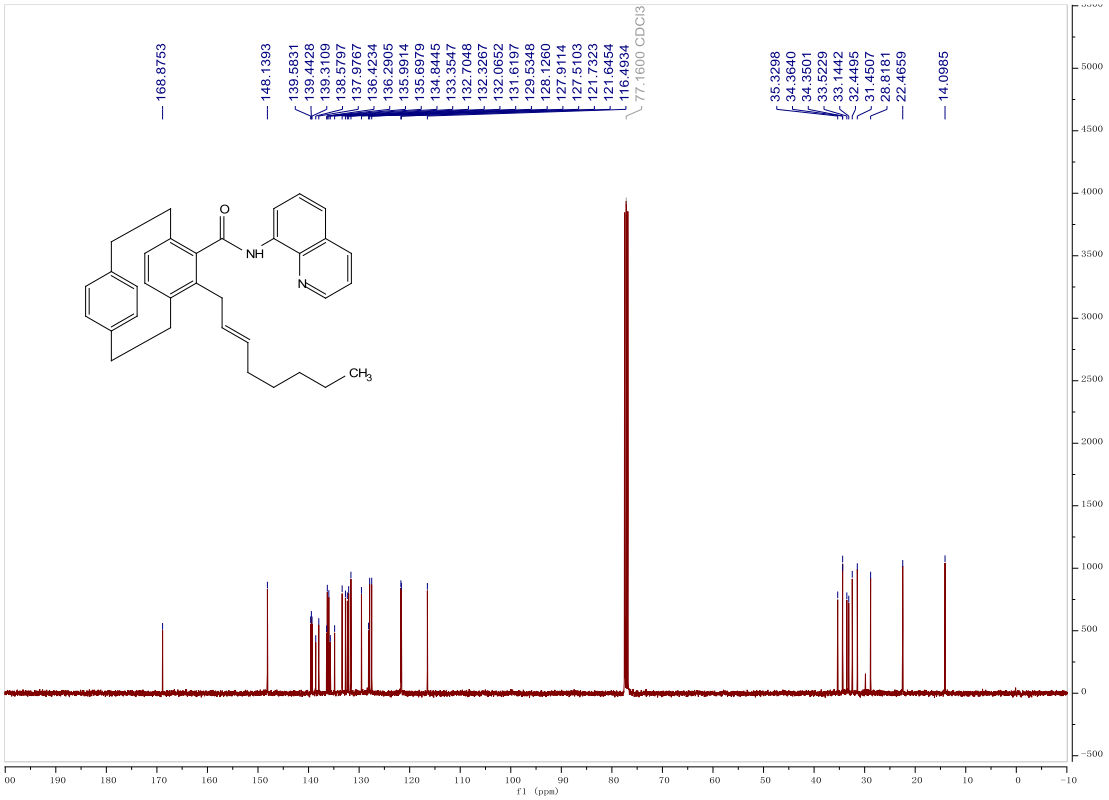
7.2768
6.7260
6.7211
6.7067
6.7018
6.6013
6.5936
6.5841
6.5728
6.5253
6.5097
6.4923
4.2332
4.2274
4.2094
4.2016
4.1943
4.1778
4.1726
3.2154
3.1940
3.1806
3.1673
3.1568
3.1458
3.0857
3.0808
3.0640
3.0590
3.0548
3.0364
3.0244
3.0122
2.9340
2.9165
2.9091
2.9019
2.8914
2.8838
2.8772
2.8587
1.00
1.04
2.89
1.98
1.18
4.25
2.15
1.44
O
OH
f1 (ppm)

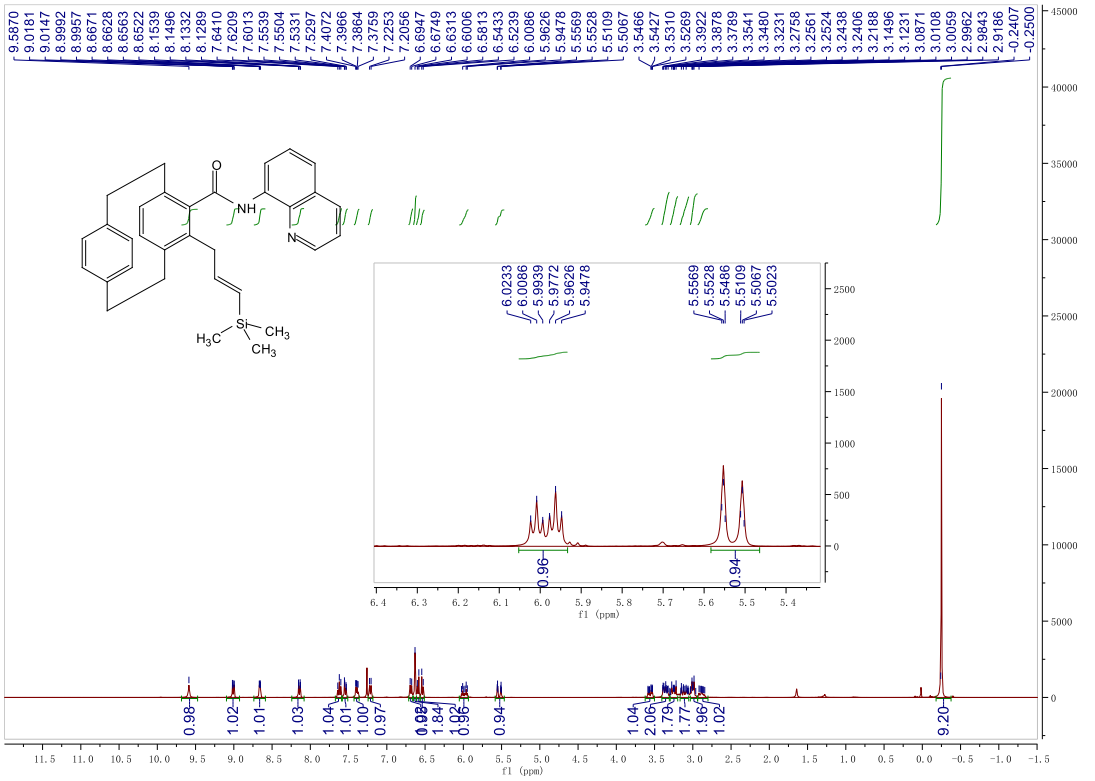

171.9821
143.8935
140.2180
140.1797
139.5927
137.5177
136.5309
136.3096
133.2980
132.9256
132.4505
131.9007
129.6959
77.4789
77.1594
76.8421
36.4340
35.4028
35.2400
35.0657
O
OH
f1 (ppm)

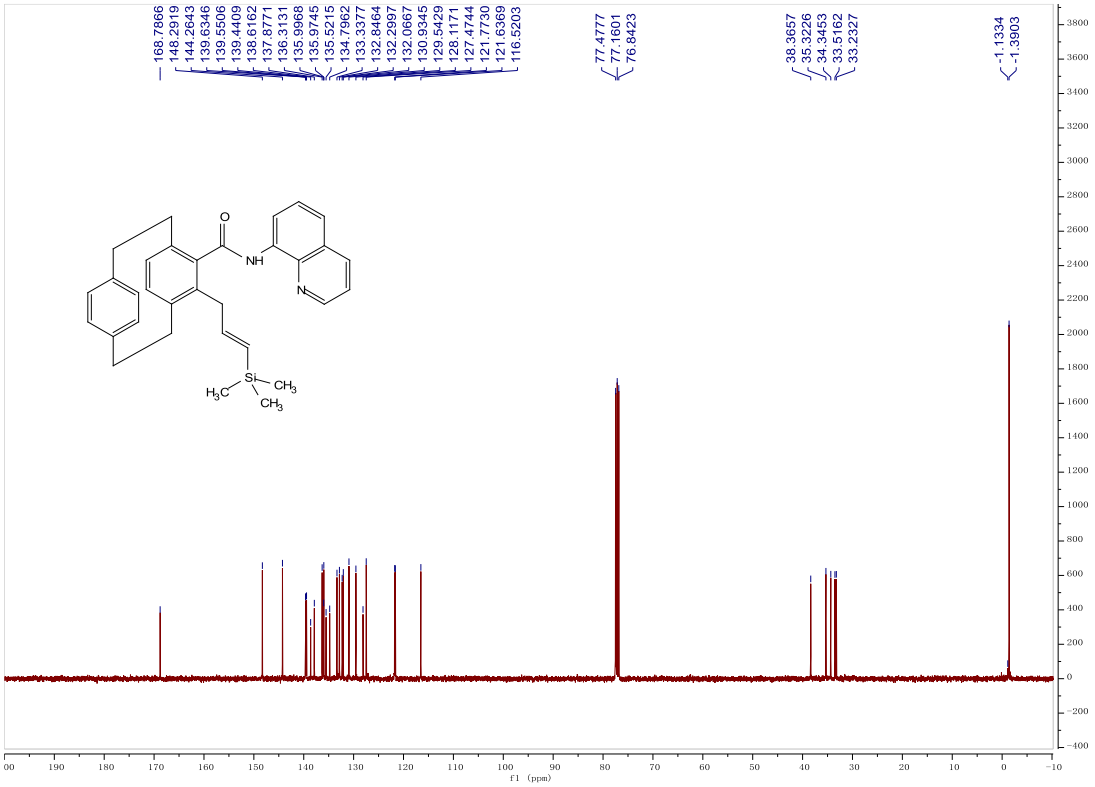
4a



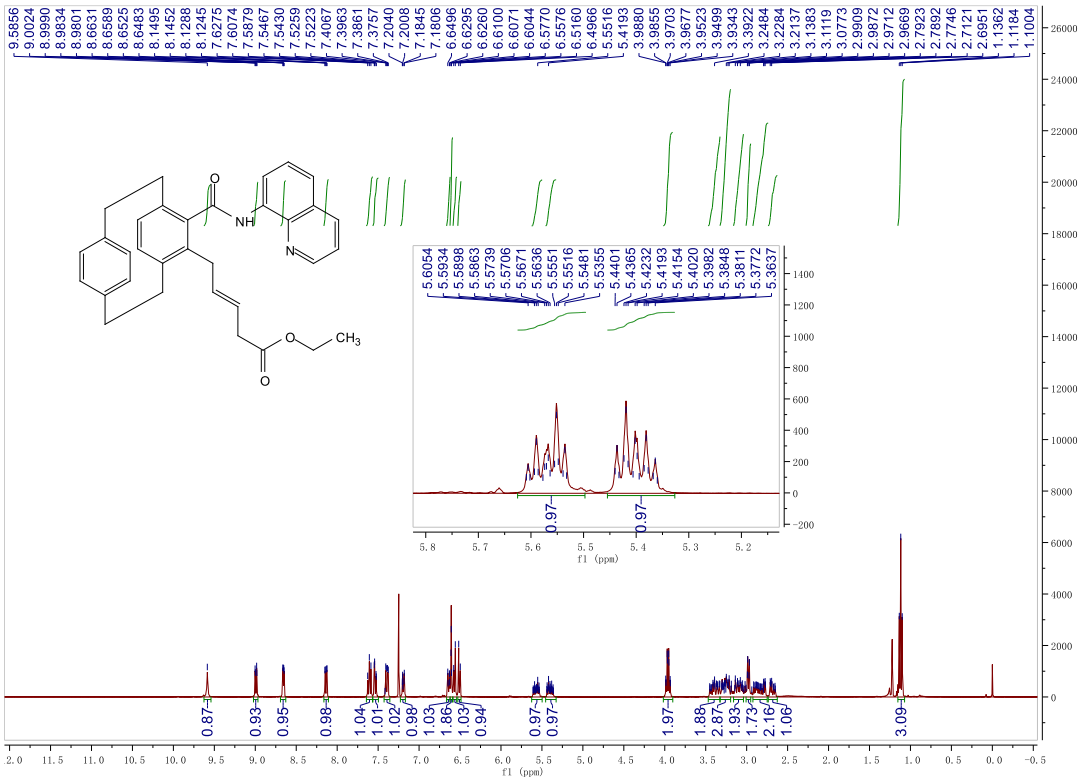


4b





4c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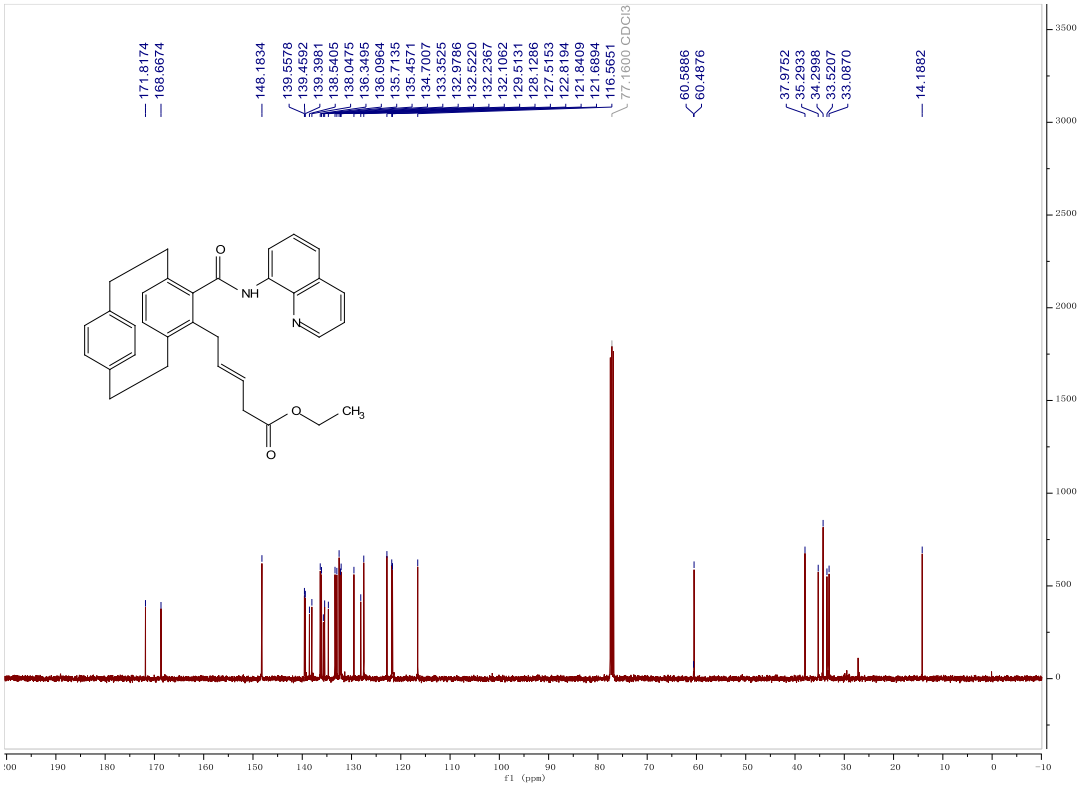
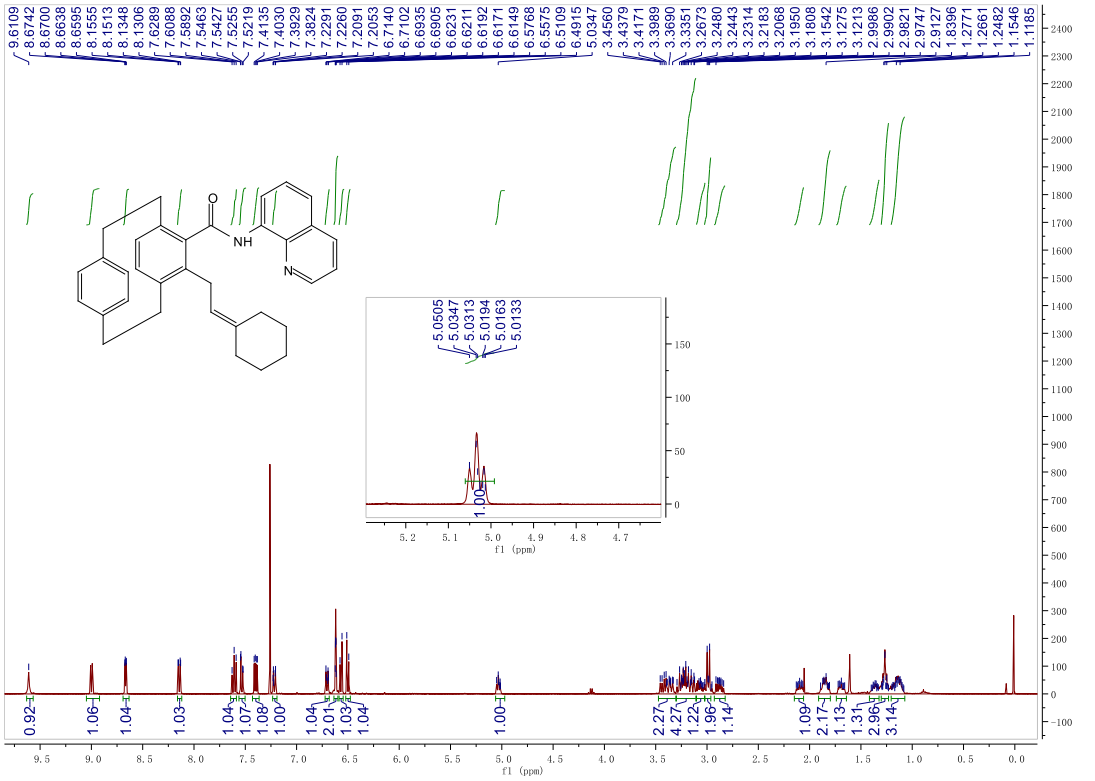
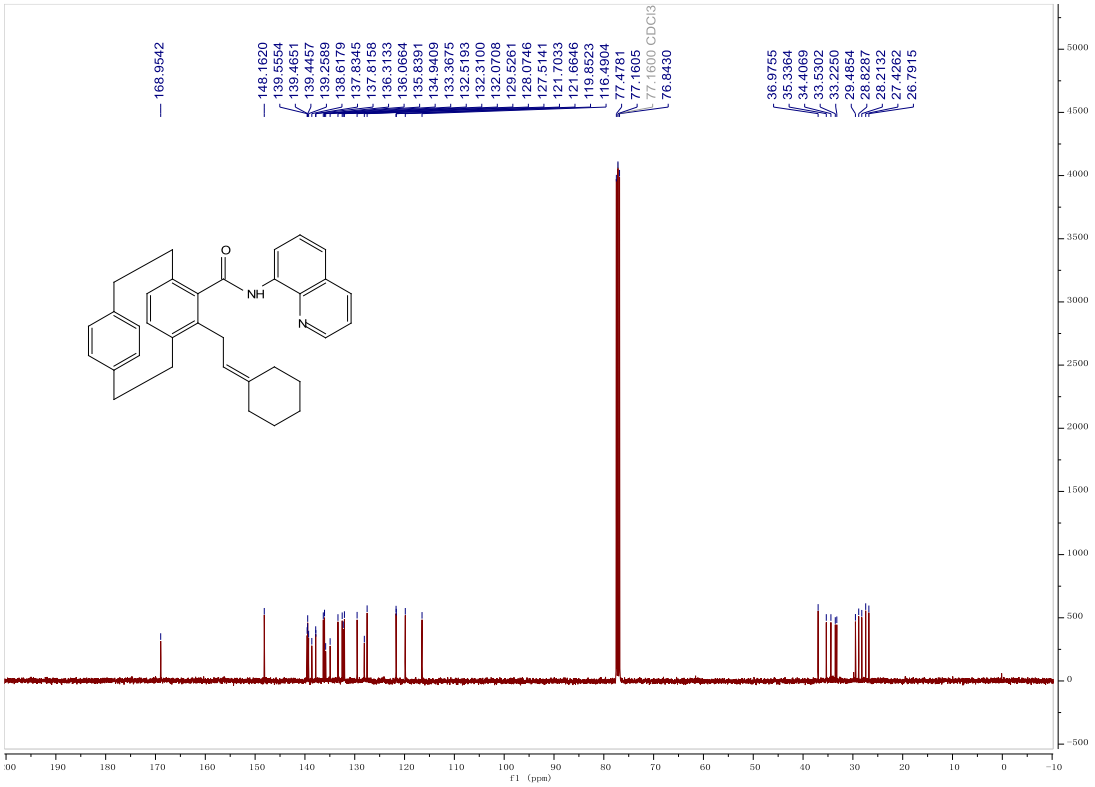
8.9990
8.9834
8.9801
8.6631
8.6589
8.6525
8.6483
8.1495
8.1452
8.1288
8.1245
7.6275
7.6074
7.5879
7.5467
7.5430
7.5259
7.5223
7.4067
7.3963
7.3861
7.3757
7.2040
7.2008
7.1845
7.1806
6.6496
6.6295
6.6260
6.6100
6.6071
6.6044
6.5770
6.5576
6.5160
6.4966
5.5516
5.4193
3.9880
3.9855
3.9703
3.9677
3.9523
3.9499
3.9343
3.3922
3.2484
3.2284
3.2137
3.1383
3.1119
3.0773
2.9909
2.9872
2.9712
2.9669
2.7923
2.7892
2.7746
2.7121
2.6951
1.1362
1.1184
1.1004
NH
N
O
O
O
CH3
5.6054
5.5934
5.5898
5.5863
5.5739
5.5706
5.5671
5.5636
5.5551
5.5516
5.5481
5.5355
5.4401
5.4365
5.4232
5.4193
5.4154
5.4020
5.3982
5.3848
5.3811
5.3772
5.3637
0.97
0.97
f1 (ppm)
0.87
0.93
0.95
0.98
1.04
1.01
1.02
0.98
1.03
1.86
1.03
0.94
0.97
0.97
1.97
1.88
2.87
1.93
1.73
2.16
1.06
3.09
f1 (ppm)


171.8174
168.6674
148.1834
139.5578
139.4592
139.3981
138.5405
138.0475
136.3495
136.0964
135.7135
135.4571
134.7007
133.3525
132.9786
132.5220
132.2367
132.1062
129.5131
128.1286
127.5153
122.8194
121.8409
121.6894
116.5651
77.1600 CDCl3
60.5886
60.4876
37.9752
35.2933
34.2998
33.5207
33.0870
14.1882
NH
N
O
O
O
CH3
f1 (ppm)

4d


9.6109
8.6742
8.6700
8.6638
8.6595
8.1555
8.1513
8.1348
8.1306
7.6289
7.6088
7.5892
7.5463
7.5427
7.5255
7.5219
7.4135
7.4030
7.3929
7.3824
7.2291
7.2260
7.2091
7.2053
6.7140
6.7102
6.6935
6.6905
6.6231
6.6211
6.6192
6.6171
6.6149
6.5768
6.5575
6.5109
6.4915
5.0347
3.4560
3.4379
3.4171
3.3989
3.3690
3.3351
3.2673
3.2480
3.2443
3.2314
3.2183
3.2068
3.1950
3.1808
3.1542
3.1275
3.1213
2.9986
2.9902
2.9821
2.9747
2.9127
1.8396
1.2771
1.2661
1.2482
1.1546
1.1185
O
NH
N
5.0505
5.0347
5.0313
5.0194
5.0163
5.0133
1.00
f1 (ppm)
0.92
1.06
1.04
1.03
1.04
1.07
1.08
1.00
1.04
2.01
1.03
1.04
1.00
2.27
4.27
1.22
1.96
1.14
1.09
2.17
1.13
1.31
2.96
3.14
f1 (ppm)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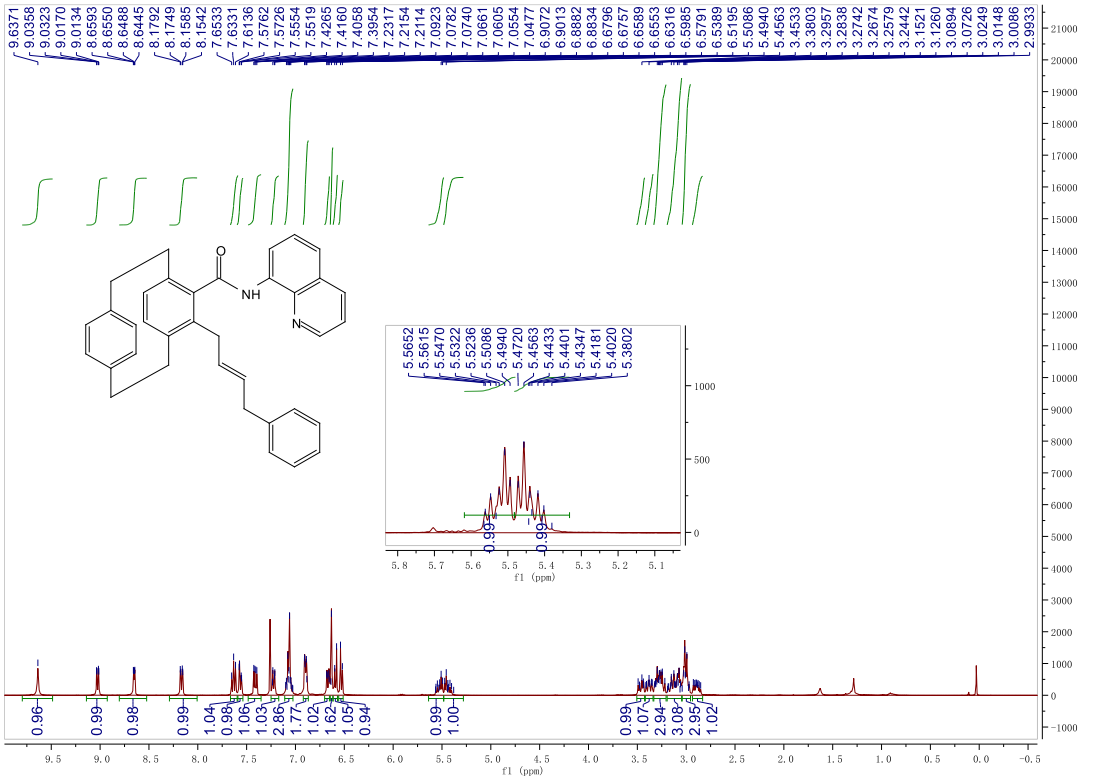
139.5554
139.4651
139.4457
139.2589
138.6179
137.8345
137.8158
136.3133
136.0664
135.8391
134.9409
133.3675
132.5193
132.3100
132.0708
129.5261
128.0746
127.5141
121.7033
121.6646
119.8523
116.4904
77.4781
77.1605
77.1600 CDCl3
76.8430
36.9755
35.3364
34.4069
33.5302
33.2250
29.4854
28.8287
28.2132
27.4262
26.7915
O
NH
N
f1 (ppm)

4e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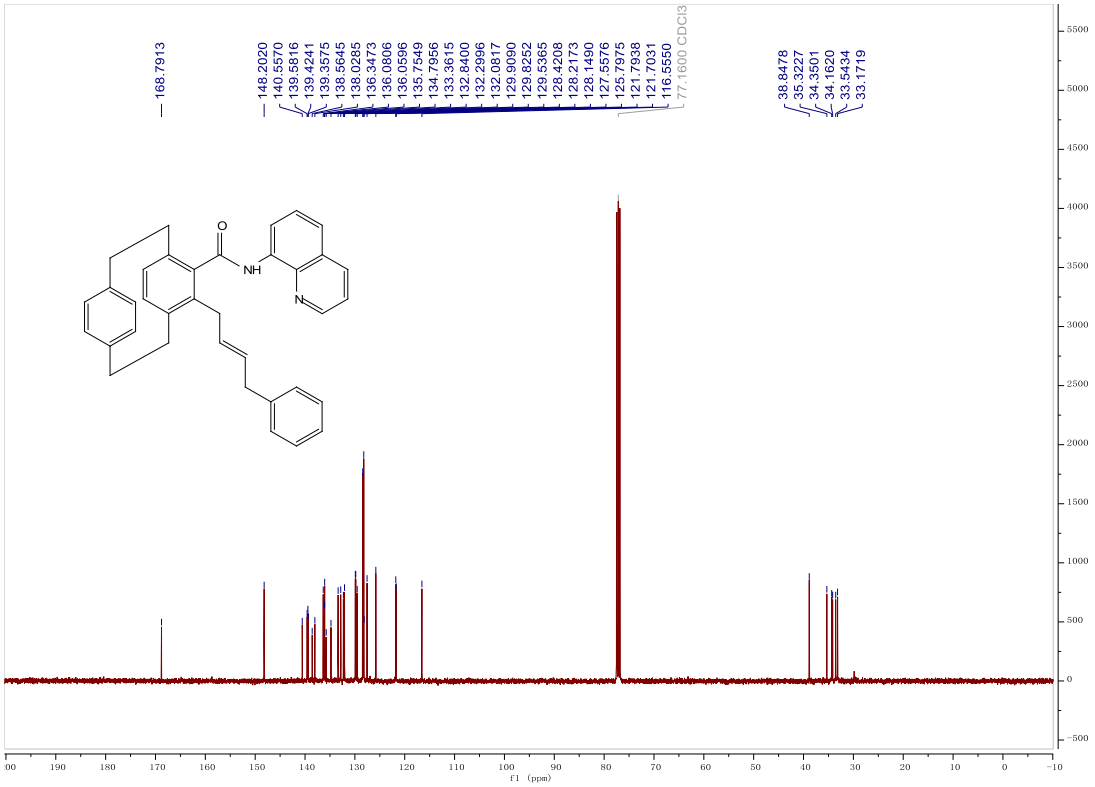
9.0323
9.0170
9.0134
8.6593
8.6550
8.6488
8.6445
8.1792
8.1749
8.1585
8.1542
7.6533
7.6331
7.6136
7.5762
7.5726
7.5554
7.5519
7.4265
7.4160
7.4058
7.3954
7.2317
7.2154
7.2114
7.0923
7.0782
7.0740
7.0661
7.0605
7.0554
7.0477
6.9072
6.9013
6.8892
6.8834
6.8796
6.6757
6.6589
6.6553
6.6316
6.5985
6.5791
6.5389
6.5195
5.5086
5.4940
5.4563
3.4533
3.3803
3.2957
3.2838
3.2742
3.2674
3.2579
3.2442
3.1521
3.1260
3.0894
3.0726
3.0249
3.0148
3.0086
2.9933
O
NH
N
5.5652
5.5615
5.5470
5.5322
5.5236
5.5086
5.4940
5.4720
5.4563
5.4433
5.4401
5.4347
5.4181
5.4020
5.3802
0.99
0.99
f1 (ppm)
0.96
0.99
0.98
0.99
1.04
0.98
1.06
1.03
2.86
1.77
1.02
1.62
1.05
0.94
0.99
1.00
0.99
1.07
2.94
3.08
2.95
1.02
f1 (ppm)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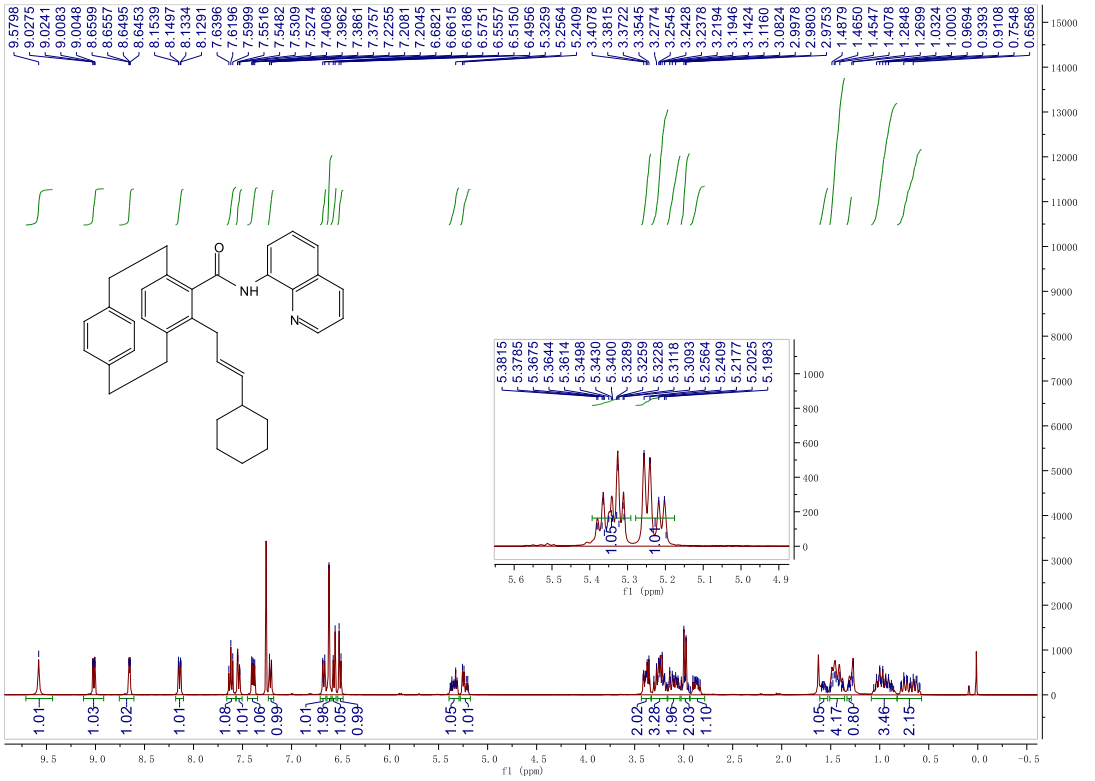
148.2020
140.5570
139.5816
139.4241
139.3575
138.5645
138.0285
136.3473
136.0806
136.0596
135.7549
134.7956
133.3615
132.8400
132.2996
132.0817
129.9090
129.8252
129.5365
128.4208
128.2173
128.1490
127.5576
125.7975
121.7938
121.7031
116.5550
77.1600 CDCl3
38.8478
35.3227
34.3501
34.1620
33.5434
33.1719
O
NH
N
f1 (ppm)

4f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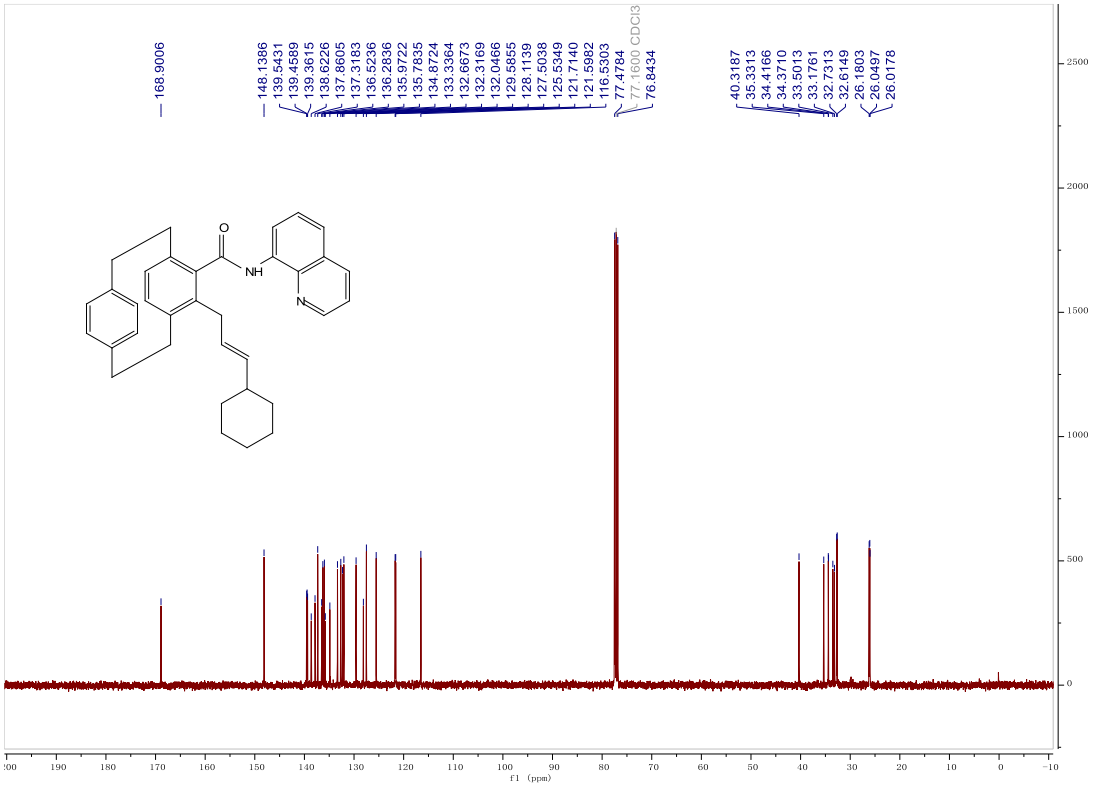
9.0241
9.0083
9.0048
8.6599
8.6557
8.6495
8.6453
8.1539
8.1497
8.1334
8.1291
7.6396
7.6196
7.5999
7.5516
7.5482
7.5309
7.5274
7.4068
7.3962
7.3861
7.3757
7.2255
7.2081
7.2045
6.6821
6.6615
6.6186
6.5751
6.5557
6.5150
6.4956
6.3259
5.2564
5.2409
3.4078
3.3815
3.3722
3.3545
3.2774
3.2545
3.2428
3.2378
3.2194
3.1946
3.1424
3.1160
3.0824
2.9978
2.9803
2.9753
1.4879
1.4650
1.4547
1.4078
1.2848
1.2699
1.0324
1.0003
0.9694
0.9393
0.9108
0.7548
0.6586
O
NH
N
5.3815
5.3785
5.3675
5.3644
5.3614
5.3498
5.3430
5.3400
5.3289
5.3259
5.3228
5.3118
5.3093
5.2564
5.2409
5.2177
5.2025
5.1983
1.05
1.04
f1 (ppm)
1.01
1.03
1.02
1.01
1.08
1.01
1.06
0.99
1.01
1.98
1.05
0.99
1.05
1.01
2.02
3.26
1.96
2.03
1.10
1.05
4.17
0.80
3.46
2.15
f1 (ppm)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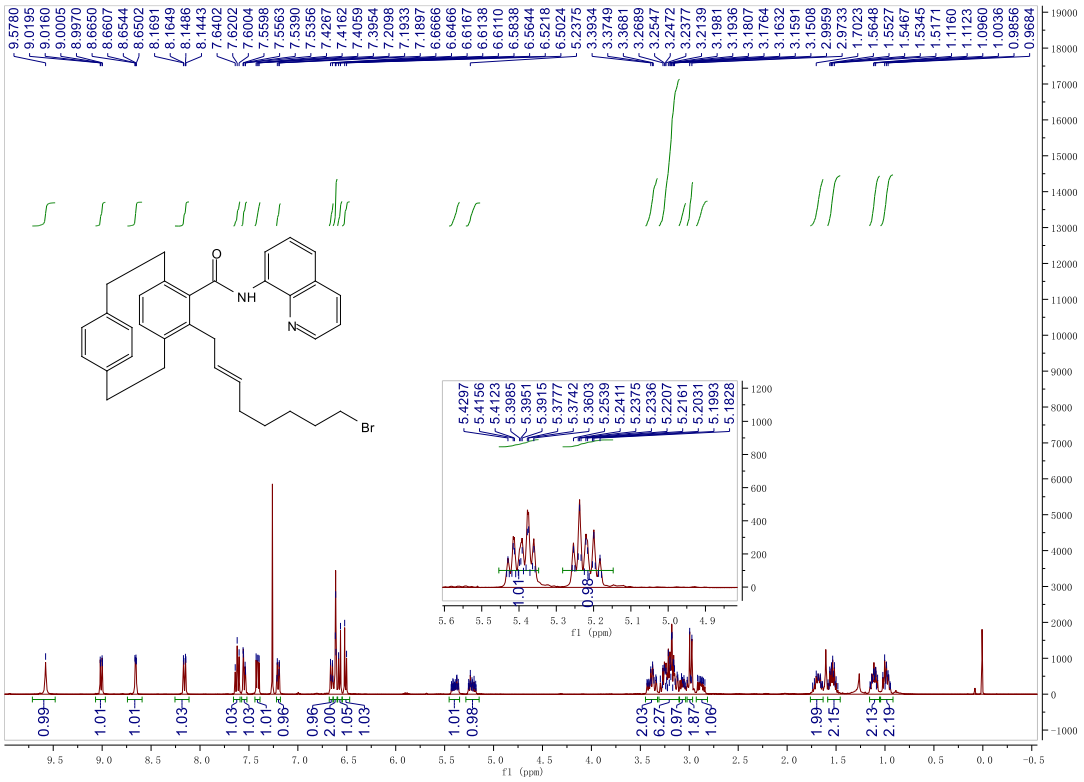
139.5431
139.4589
139.3615
138.6226
137.8605
137.3183
136.5236
136.2836
135.9722
135.7835
134.8724
133.3364
132.6673
132.3169
132.0466
129.5855
128.1139
127.5038
125.5349
121.7140
121.5982
116.5303
77.4784
77.1600 CDCl3
76.8434
40.3187
35.3313
34.4166
34.3710
33.5013
33.1761
32.7313
32.6149
26.1803
26.0497
26.0178
O
NH
N
f1 (ppm)

4g


9.5780
9.0195
9.0160
9.0005
8.9970
8.6650
8.6607
8.6544
8.6502
8.1691
8.1649
8.1486
8.1443
7.6402
7.6202
7.6004
7.5598
7.5563
7.5390
7.5356
7.4267
7.4162
7.4059
7.3954
7.2098
7.1933
7.1897
6.6666
6.6466
6.6167
6.6138
6.6110
6.5838
6.5644
6.5218
6.5024
5.2375
3.3934
3.3749
3.3681
3.2689
3.2547
3.2472
3.2377
3.2139
3.1981
3.1936
3.1807
3.1764
3.1632
3.1591
3.1508
2.9959
2.9733
1.7023
1.5648
1.5527
1.5467
1.5345
1.5171
1.1160
1.1123
1.0960
1.0036
0.9856
0.9684
O
NH
N
Br
5.4297
5.4156
5.4123
5.3985
5.3951
5.3915
5.3777
5.3742
5.3603
5.2539
5.2411
5.2375
5.2336
5.2207
5.2161
5.2031
5.1993
5.1828
1.01
0.98
f1 (ppm)
0.99
1.01
1.01
1.03
1.03
1.03
1.01
0.96
0.96
2.00
1.05
1.03
1.01
0.98
2.03
6.27
0.97
1.87
1.06
1.99
2.15
2.13
2.19
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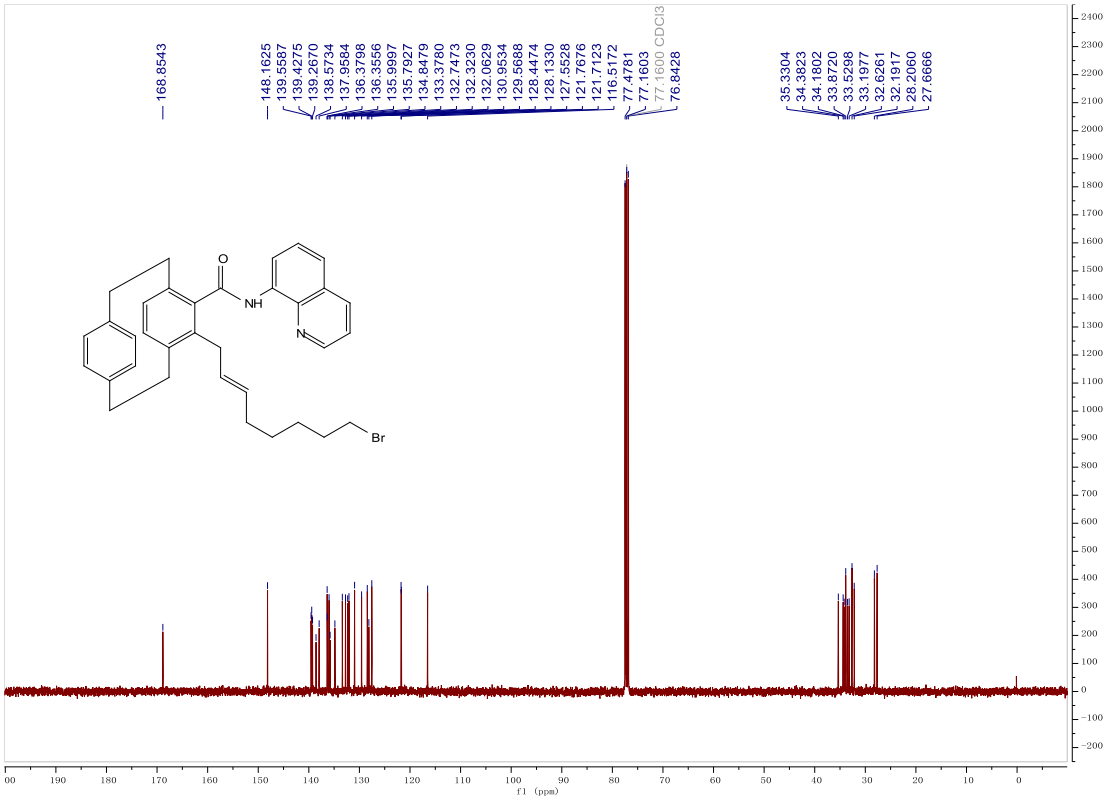
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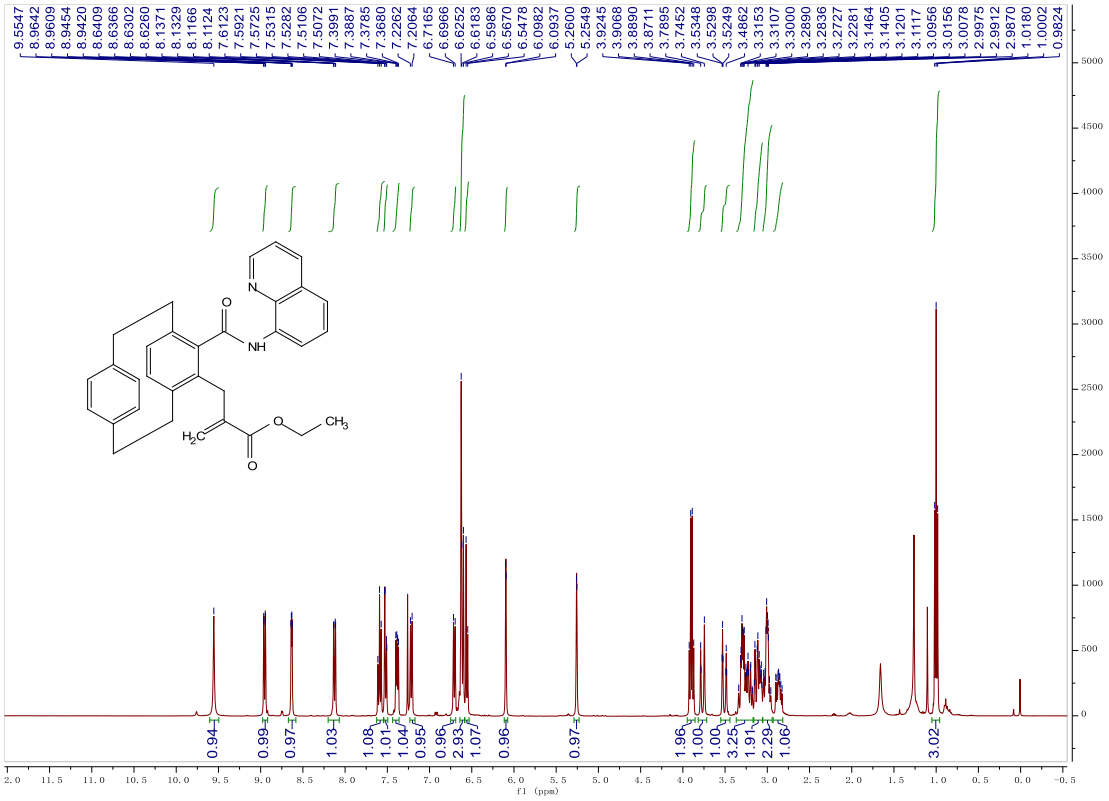
O
NH
N
Br
f1 (ppm)

5a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1.04
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0.96
2.93
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1.00
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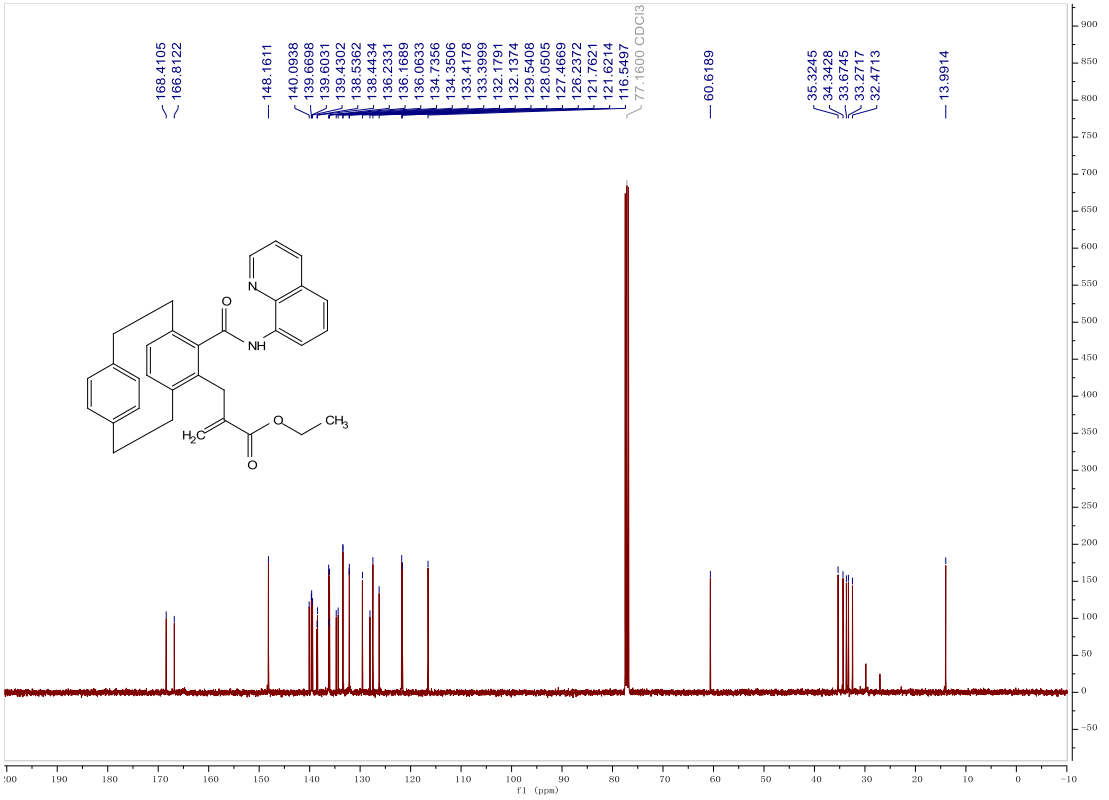
f1 (ppm)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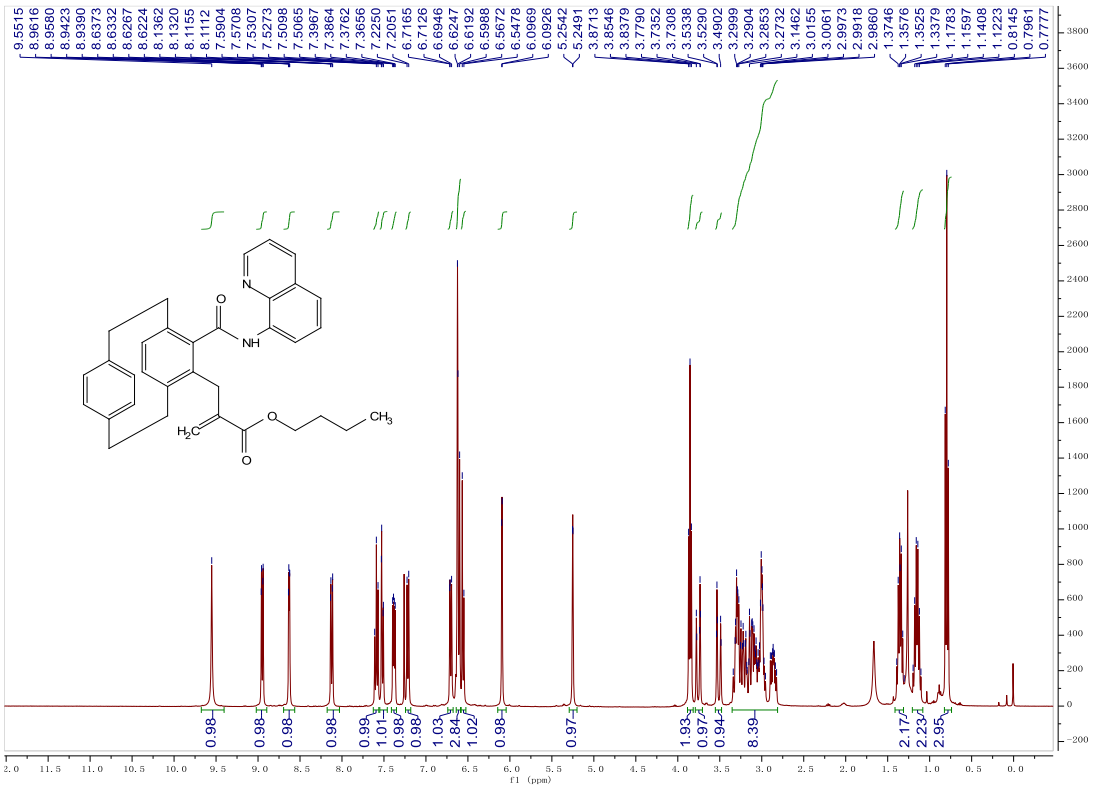
13.9914
f1 (ppm)

5b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8.1112
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7.5307
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7.3967
7.3864
7.3762
7.3656
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3.2732
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3.0061
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2.9918
2.9860
1.3746
1.3576
1.3525
1.3379
1.1783
1.1597
1.1408
1.1223
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0.98
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0.98
0.99
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0.98
0.98
1.03
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1.02
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0.97
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0.97
0.94
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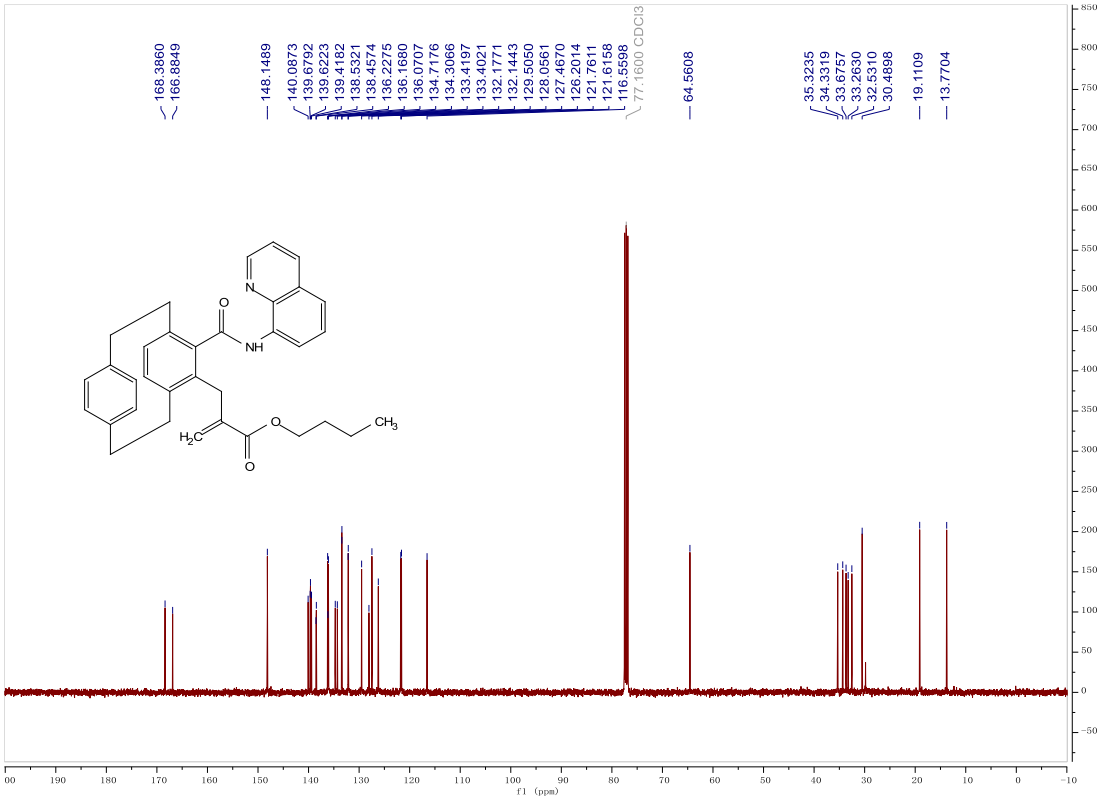
2.95
f1 (ppm)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133.4021
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132.1443
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121.7611
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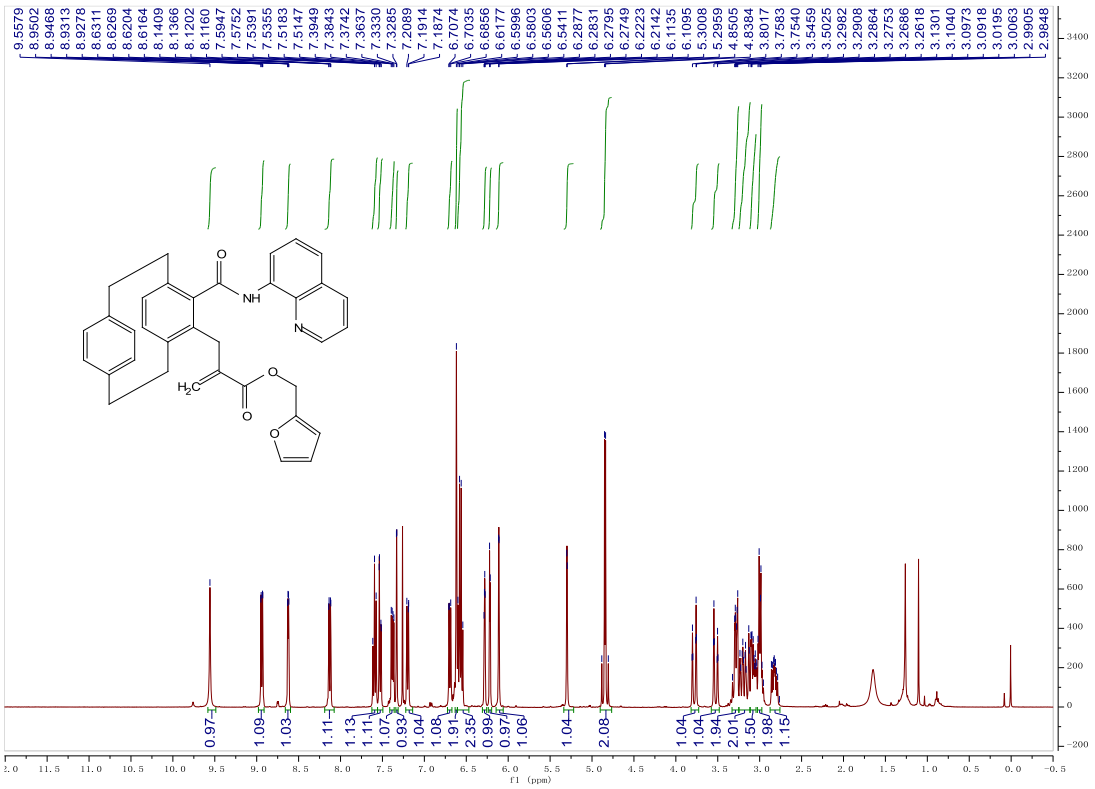
5c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8.1160
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7.5147
7.3949
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7.3742
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7.3330
7.3285
7.2089
7.1914
7.1874
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4.8384
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3.2908
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3.0918
3.0195
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2.9905
2.9848
0.97
1.09
1.03
1.11
1.13
1.11
1.07
0.93
1.04
1.08
1.91
2.35
0.99
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2.08
1.04
1.04
1.94
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1.50
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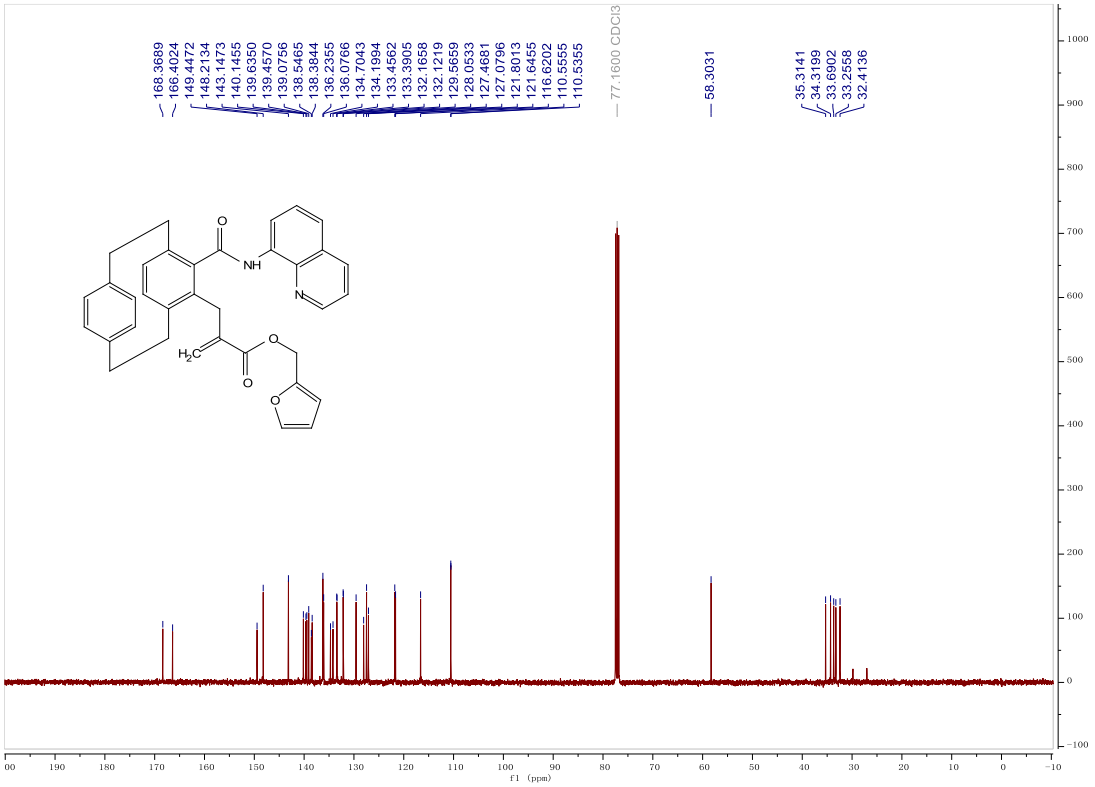
1.15
f1 (ppm)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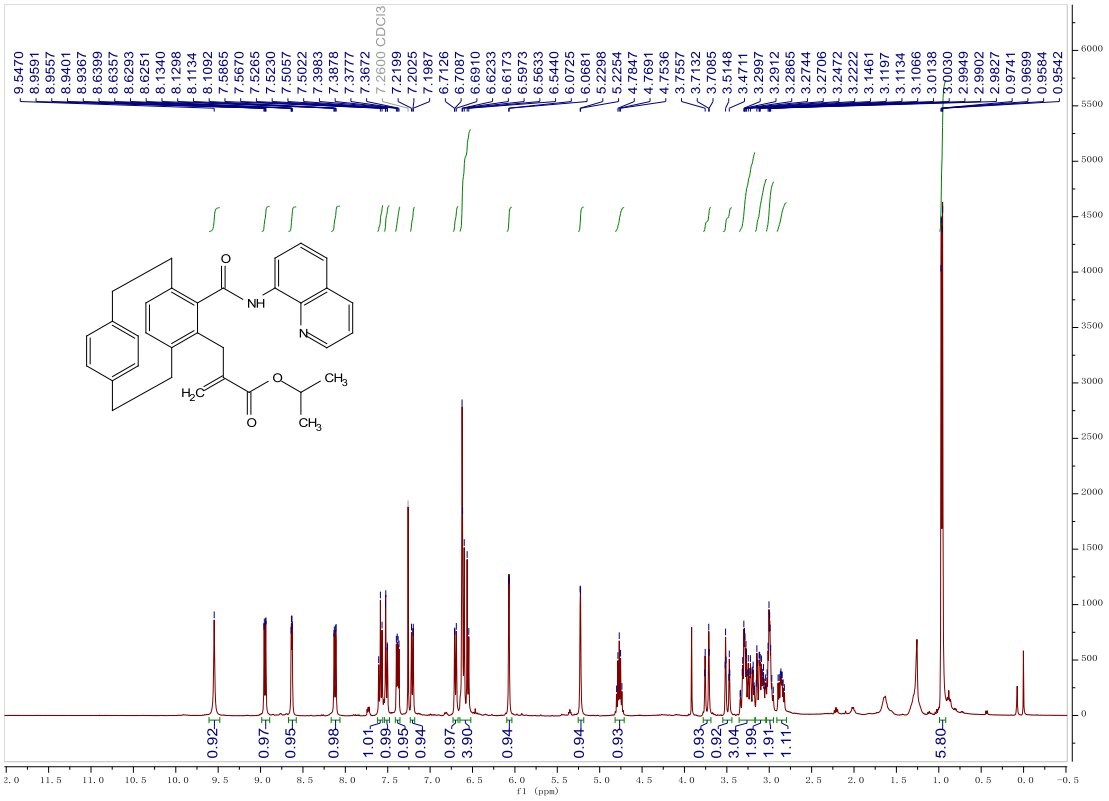
f1 (ppm)

5d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8.1092
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7.5022
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7.3777
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7.1987
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6.5633
6.5440
6.0725
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3.7132
3.7085
3.5148
3.4711
3.2997
3.2912
3.2865
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3.2706
3.2472
3.2222
3.1461
3.1197
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3.1066
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3.0030
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2.9902
2.9827
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0.9699
0.9584
0.9542
0.92
0.97
0.95
0.98
1.01
0.99
0.95
0.94
0.97
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0.94
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0.93
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1.91
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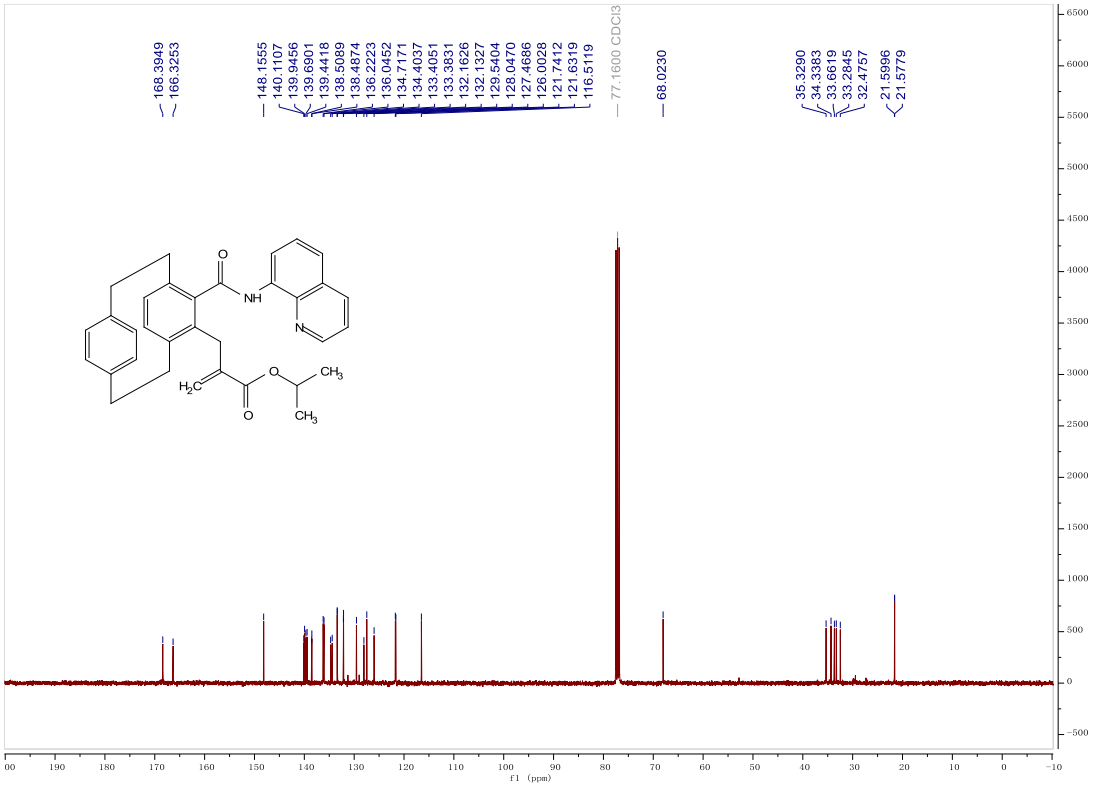
f1 (ppm)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133.3831
132.1626
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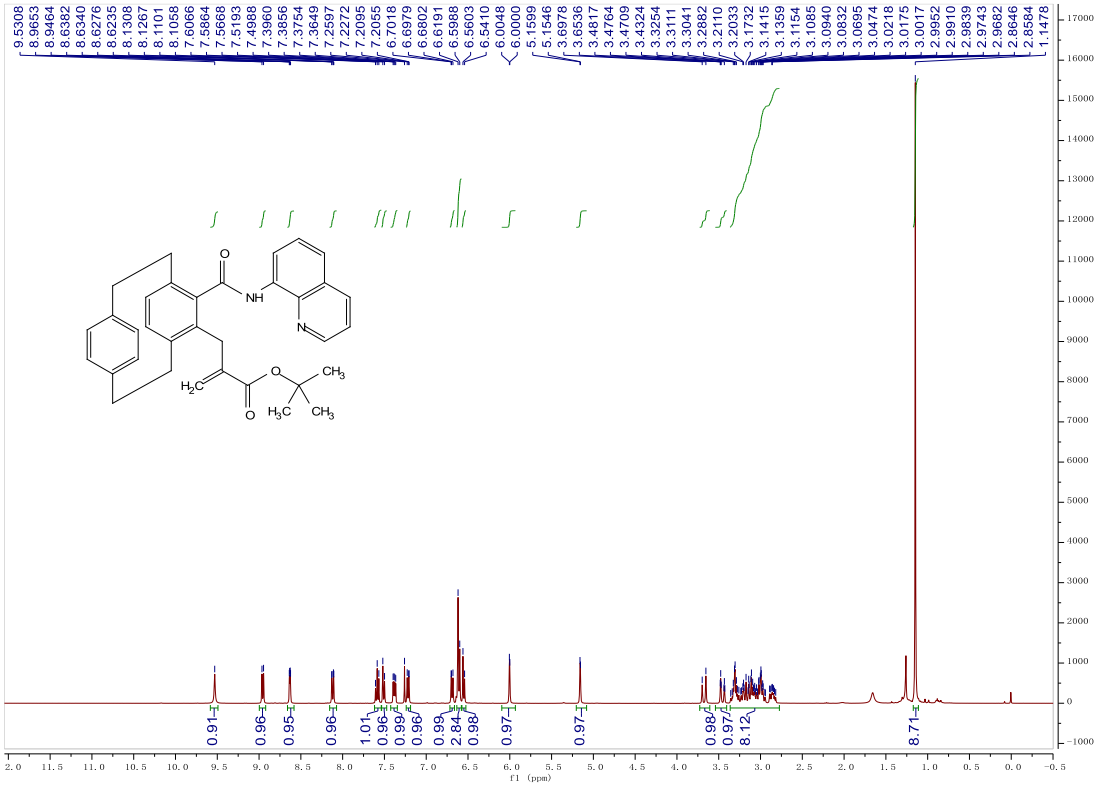
f1 (ppm)

5e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7.5864
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3.0940
3.0832
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2.8646
2.8584
1.1478
0.91
0.96
0.95
0.96
1.01
0.96
0.99
0.96
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0.98
0.97
0.97
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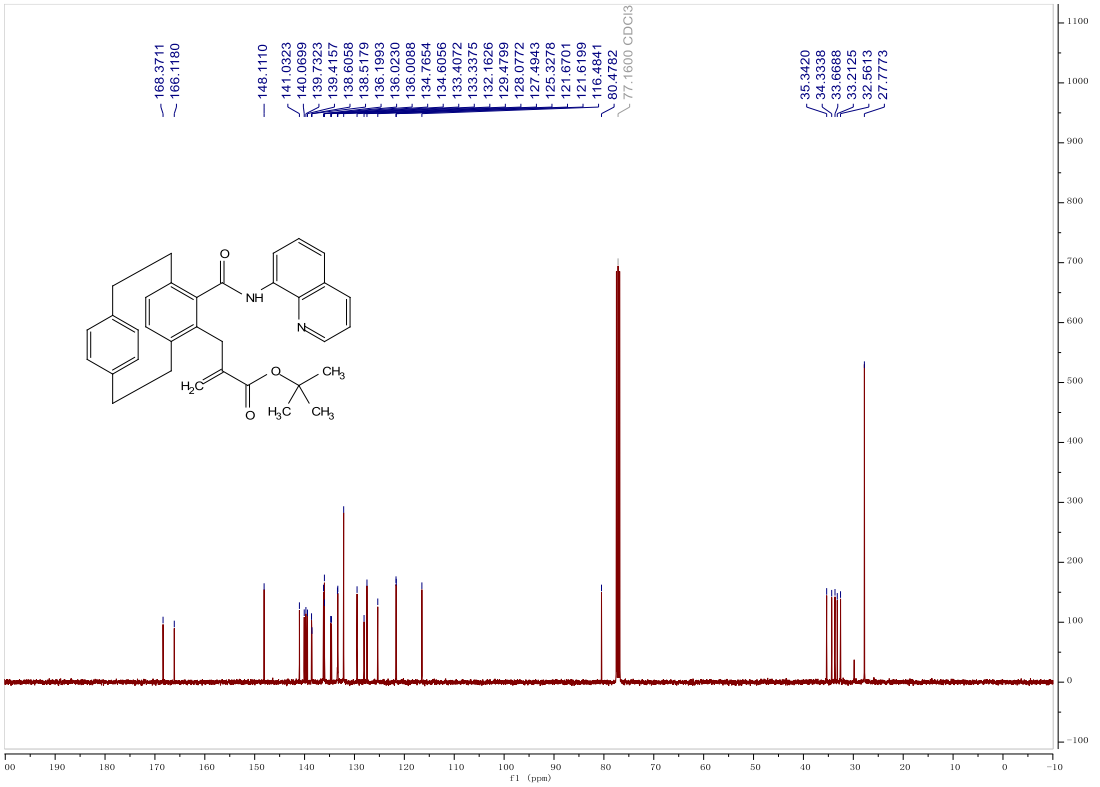
f1 (ppm)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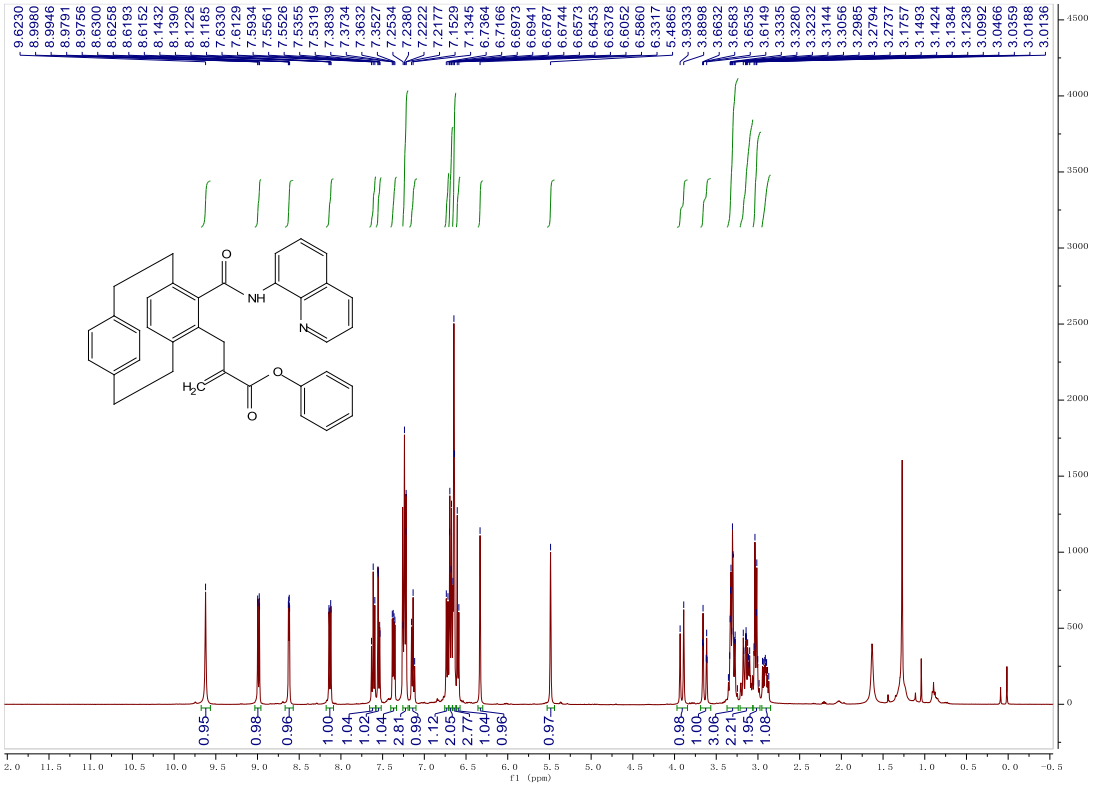
f1 (ppm)

5f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1.04
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0.99
1.12
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0.97
0.98
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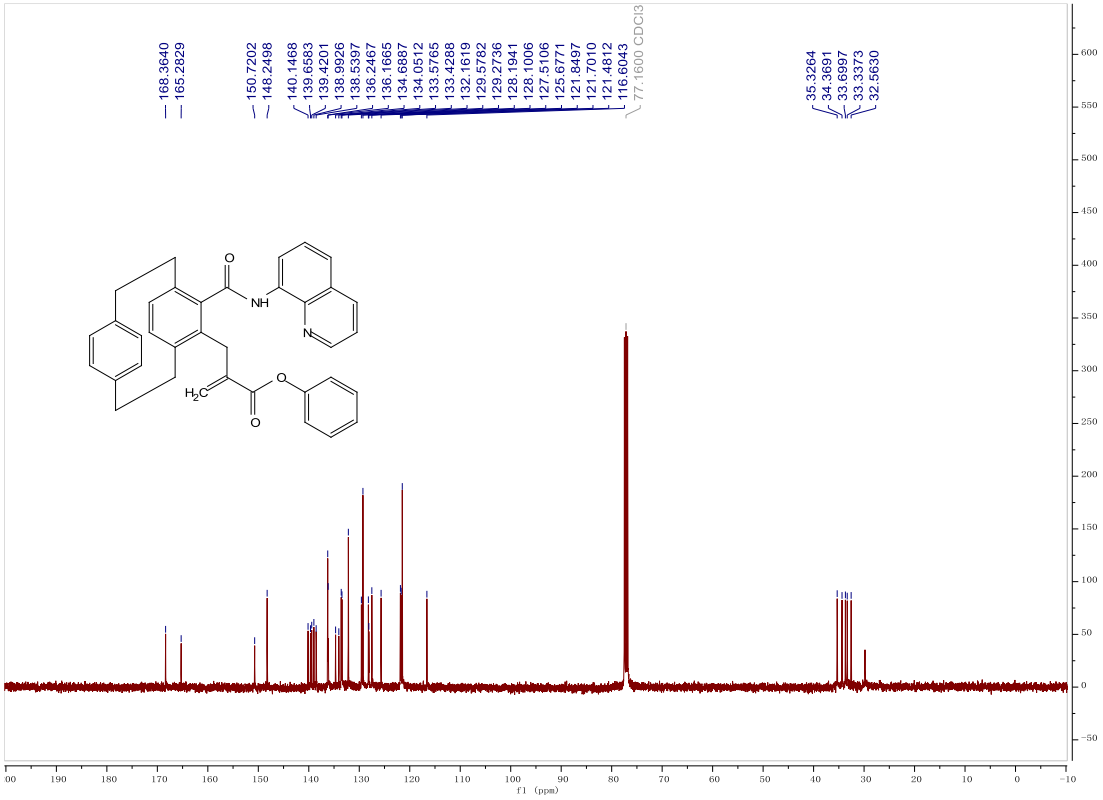
1.08
f1 (ppm)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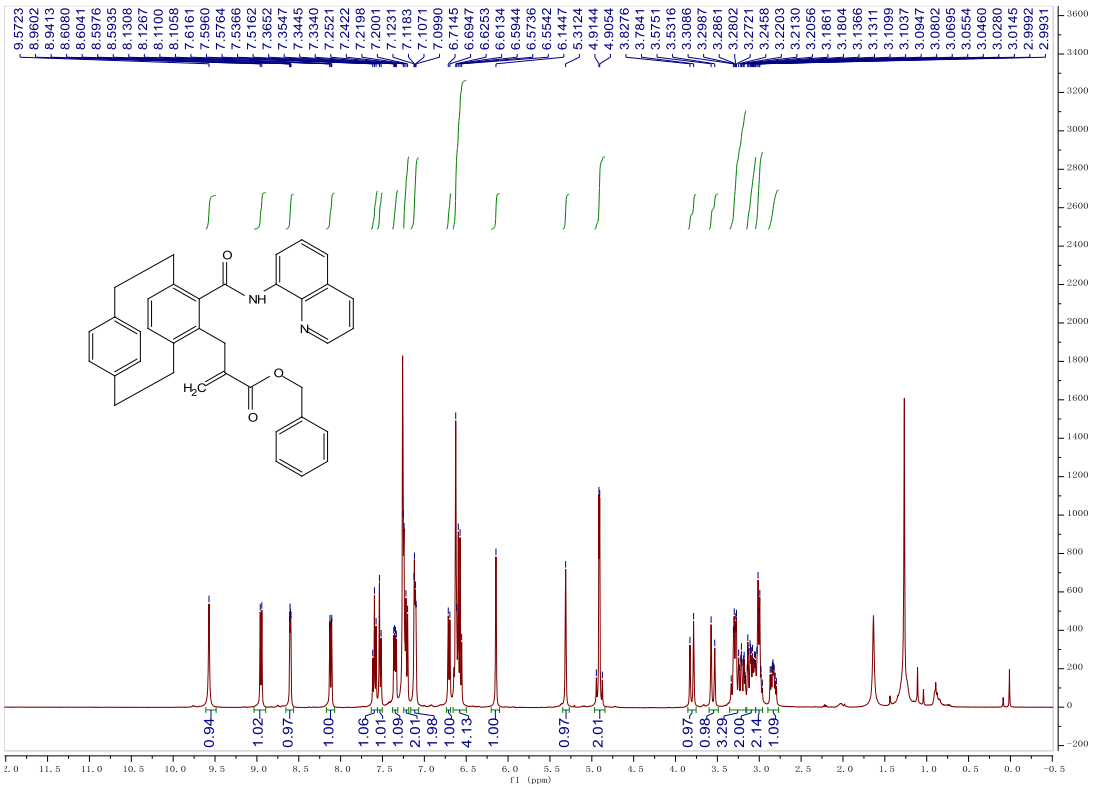
f1 (ppm)

5g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2.9931
O
NH
N
O
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H2C
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1.06
1.01
1.09
2.01
1.98
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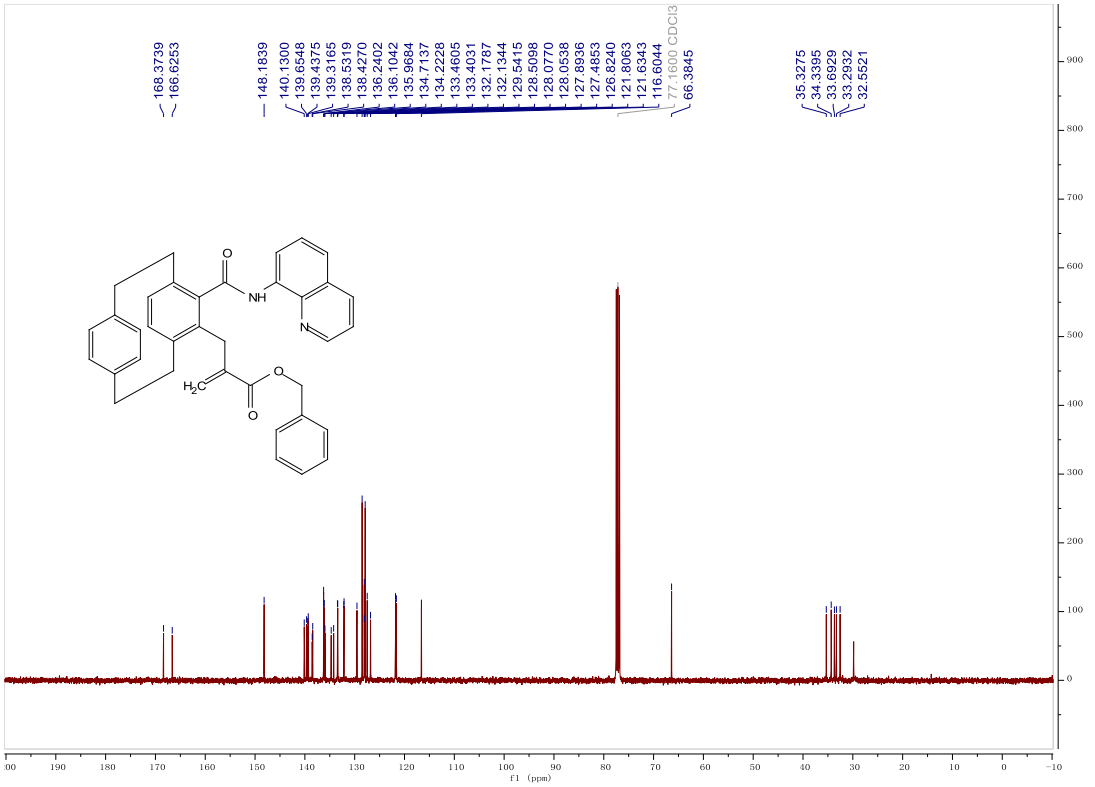
f1 (ppm)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128.0770
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127.4853
126.8240
121.8063
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116.6044
77.1600 CDCl3
66.3845
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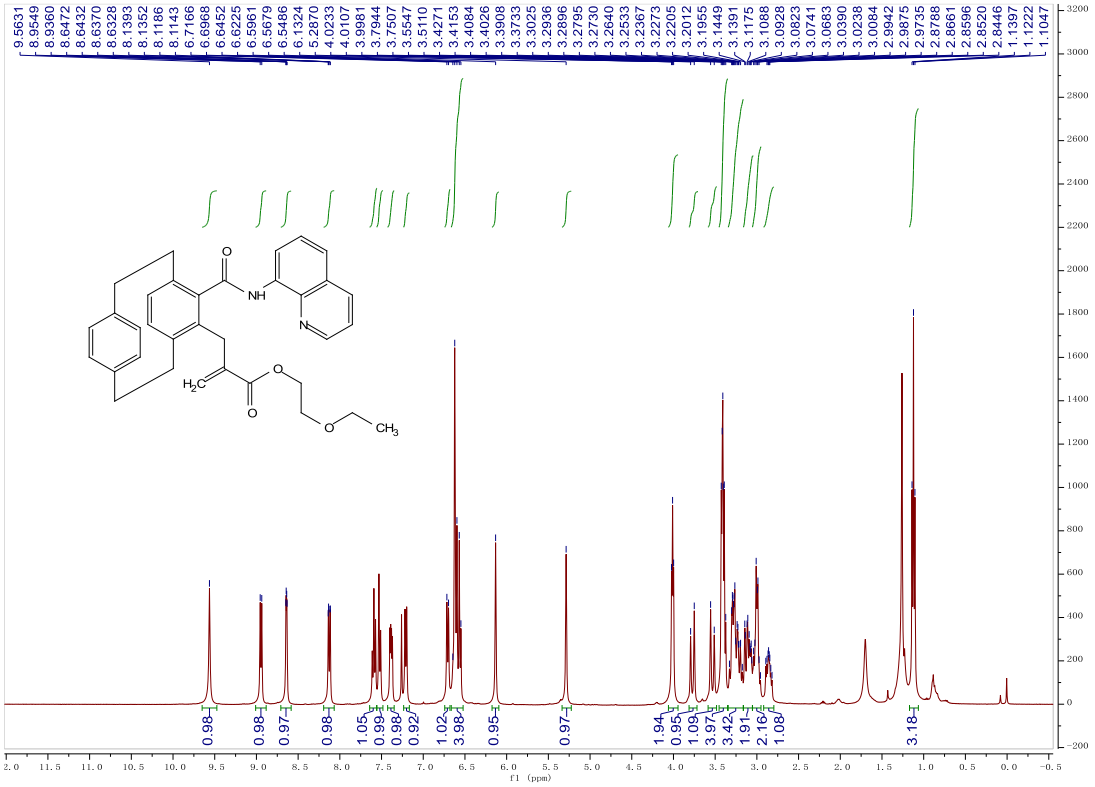
O
NH
N
O
O
H2C
f1 (ppm)

5h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1.05
0.99
0.98
0.92
1.02
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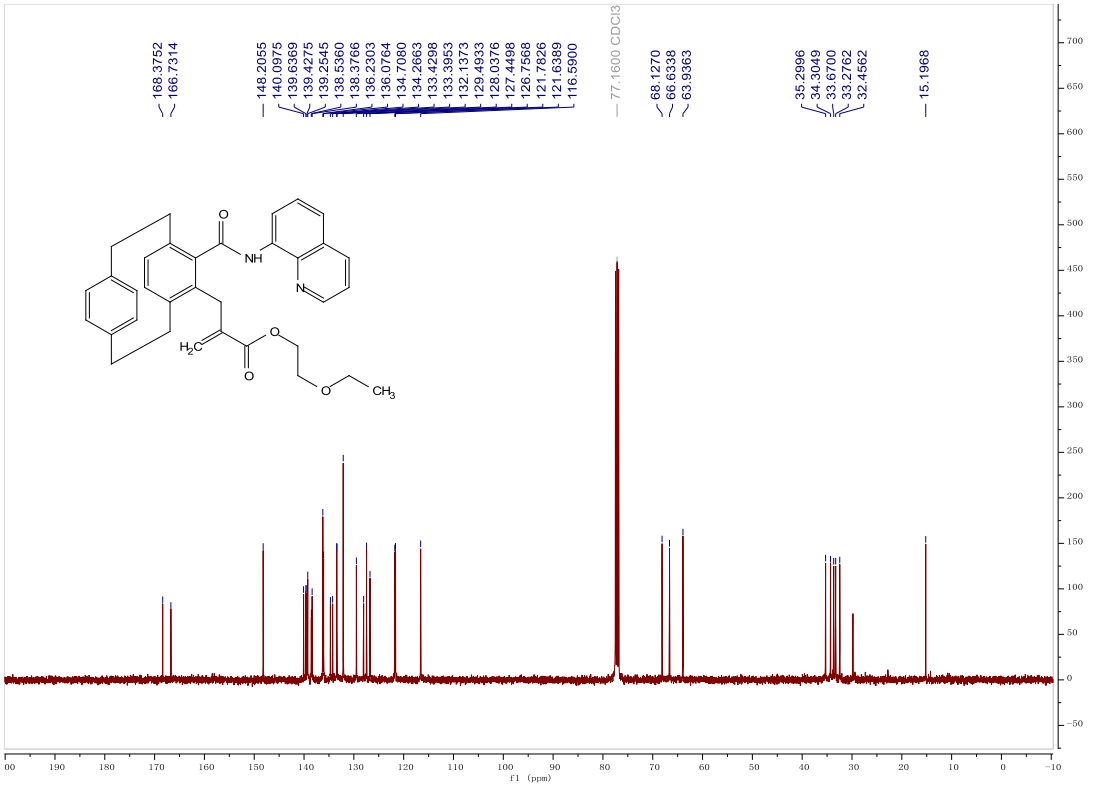
f1 (ppm)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134.2663
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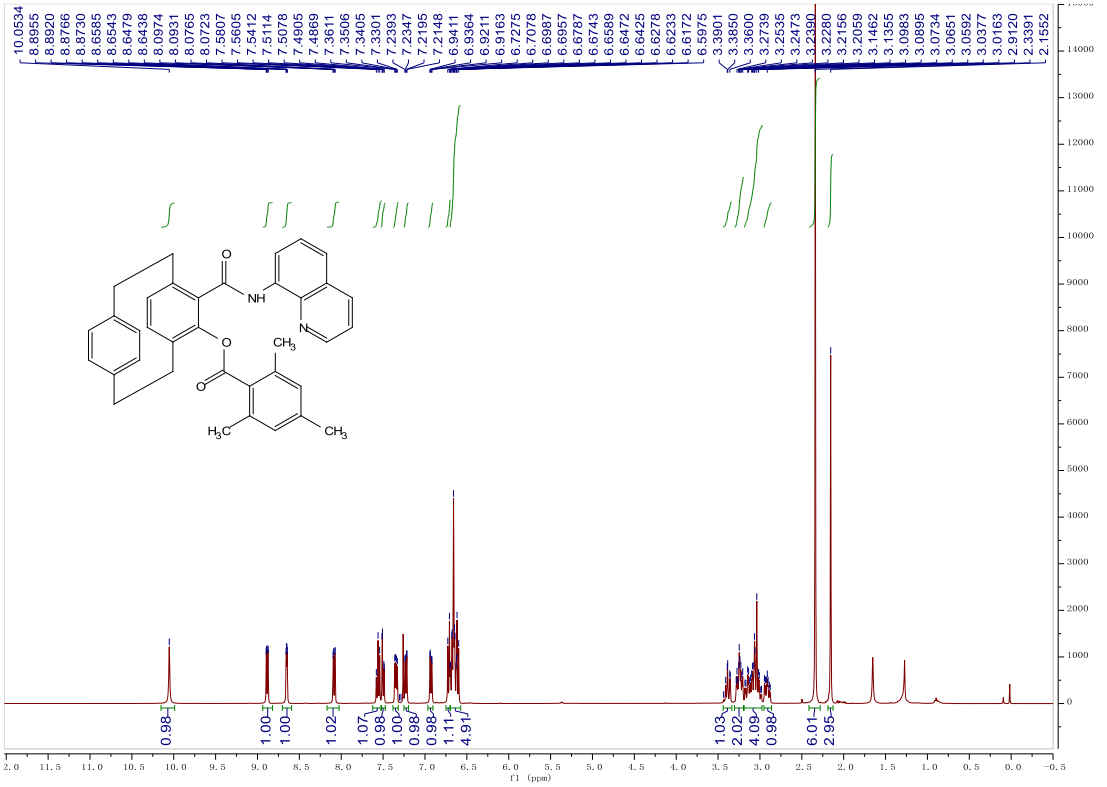
7a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1.00
1.02
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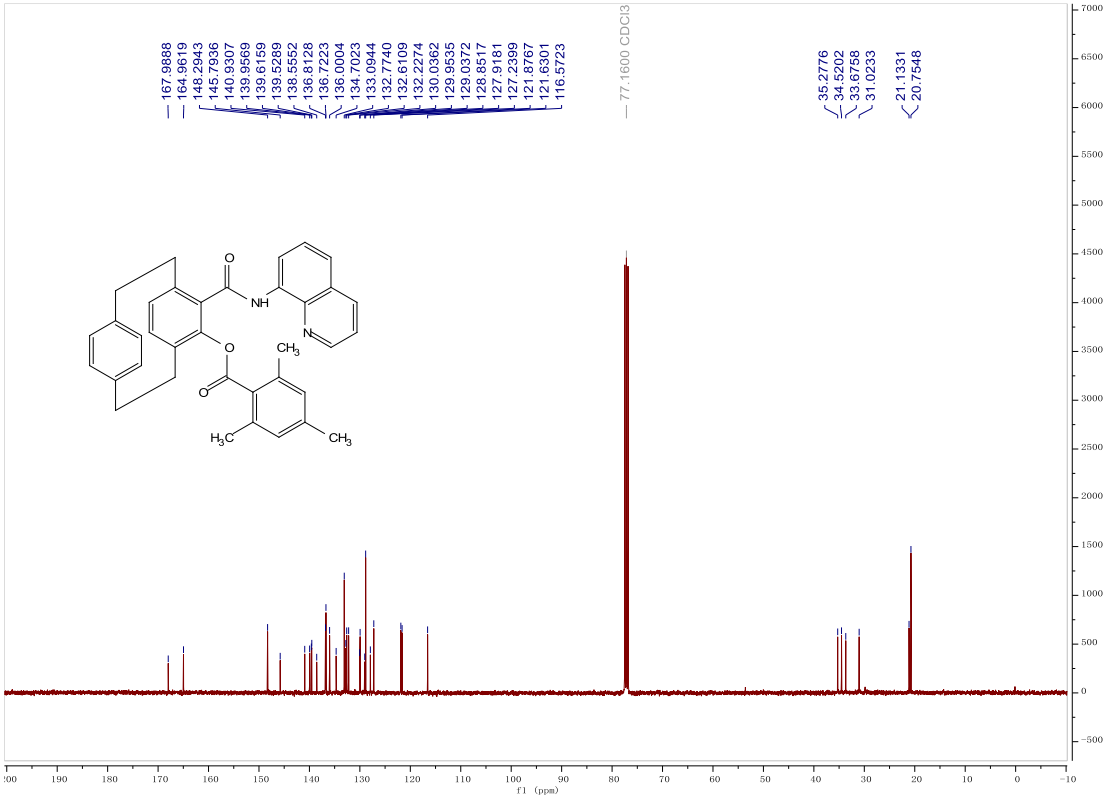
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21.1331
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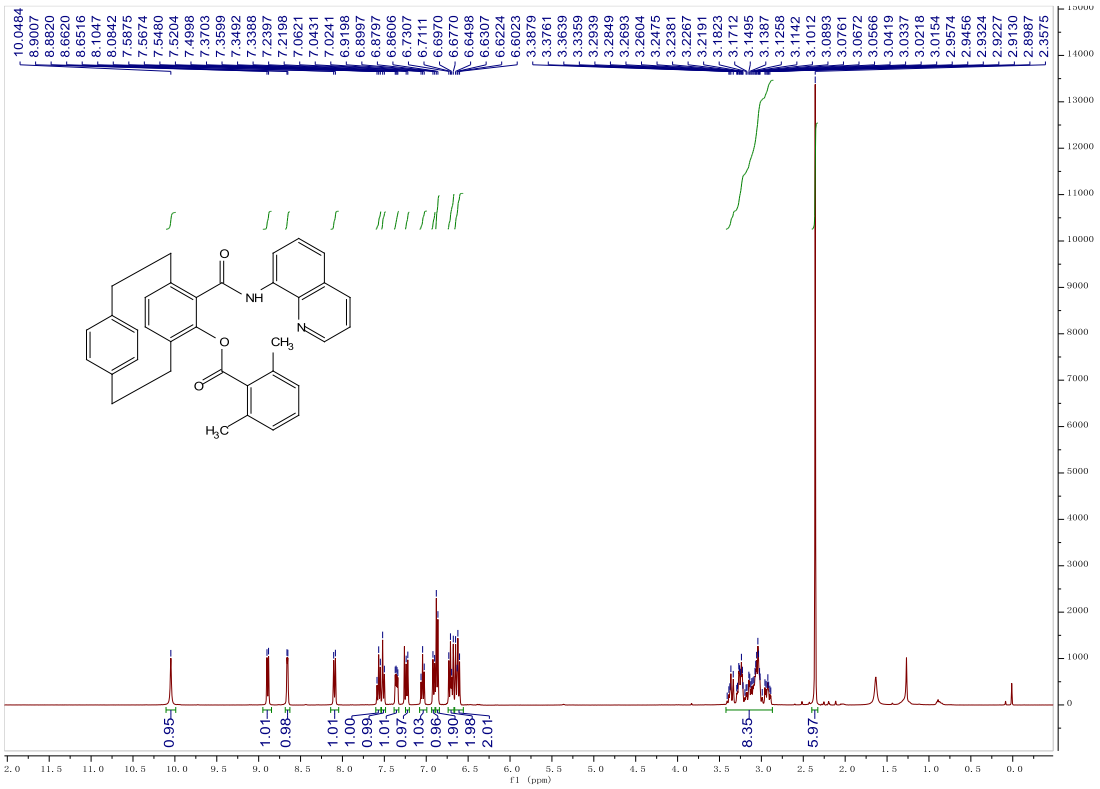
f1 (ppm)

7b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3.1495
3.1387
3.1258
3.1142
3.1012
3.0893
3.0761
3.0672
3.0566
3.0419
3.0337
3.0218
3.0154
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2.9130
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2.3575
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O
O
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H3C
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0.98
1.01
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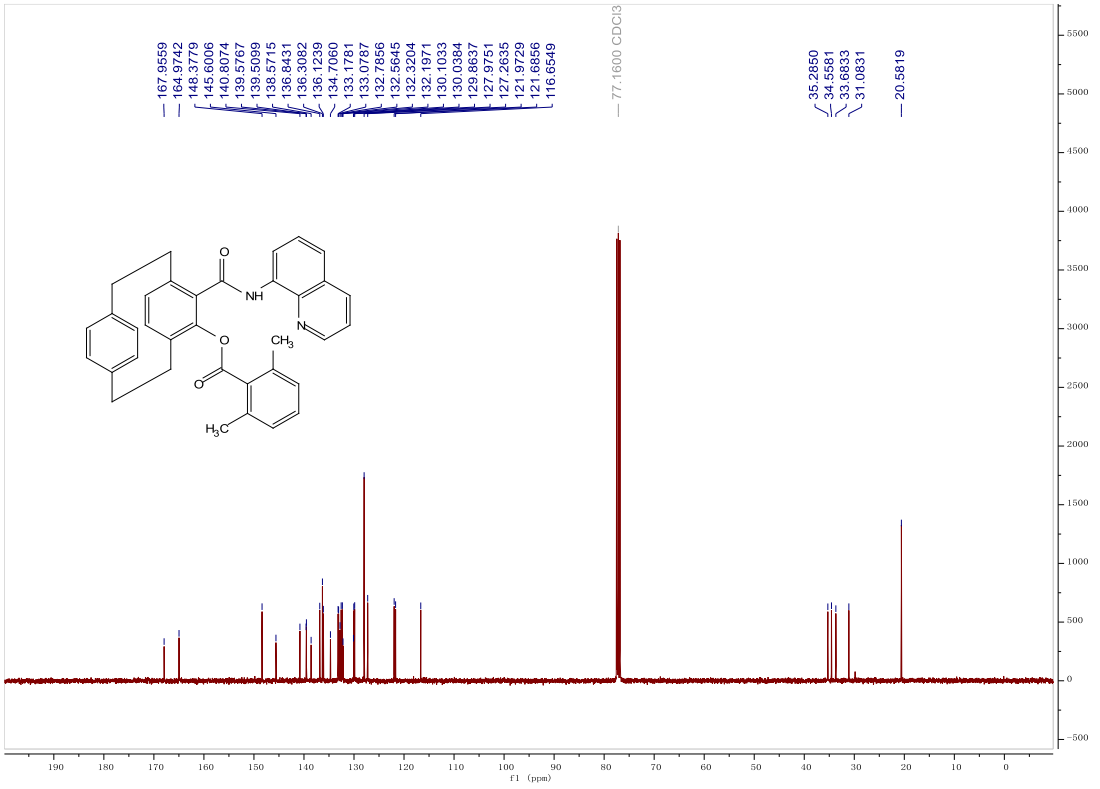
f1 (ppm)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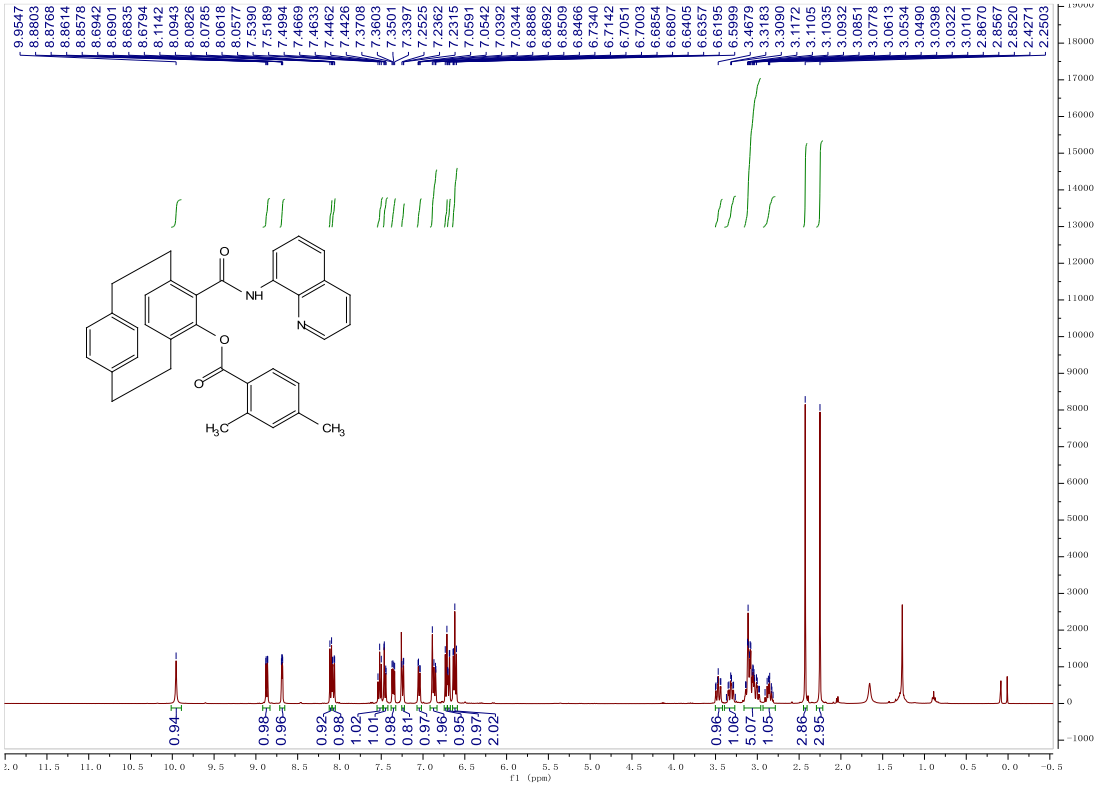
H3C
f1 (ppm)

7c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6.5999
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3.3090
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3.1035
3.0932
3.0851
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2.2503
0.94
0.98
0.96
0.92
0.98
1.02
1.01
0.98
0.81
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0.97
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0.96
1.06
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1.05
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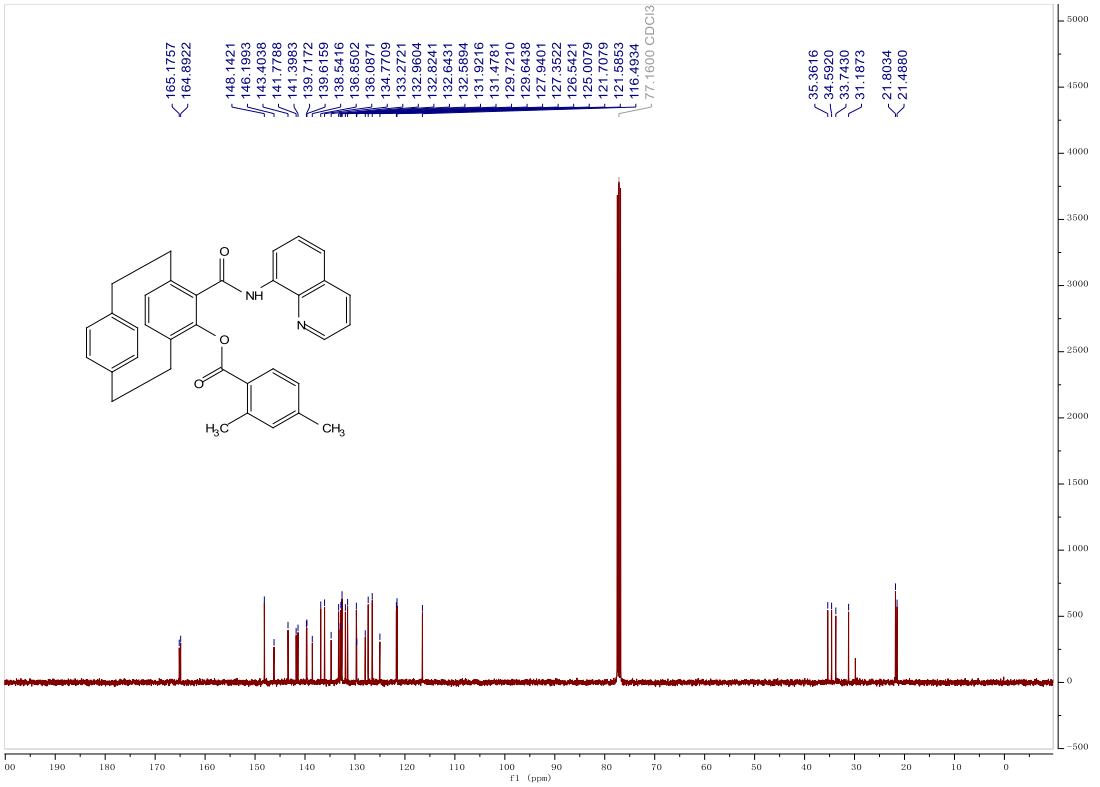
2.95
f1 (ppm)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129.7210
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21.8034
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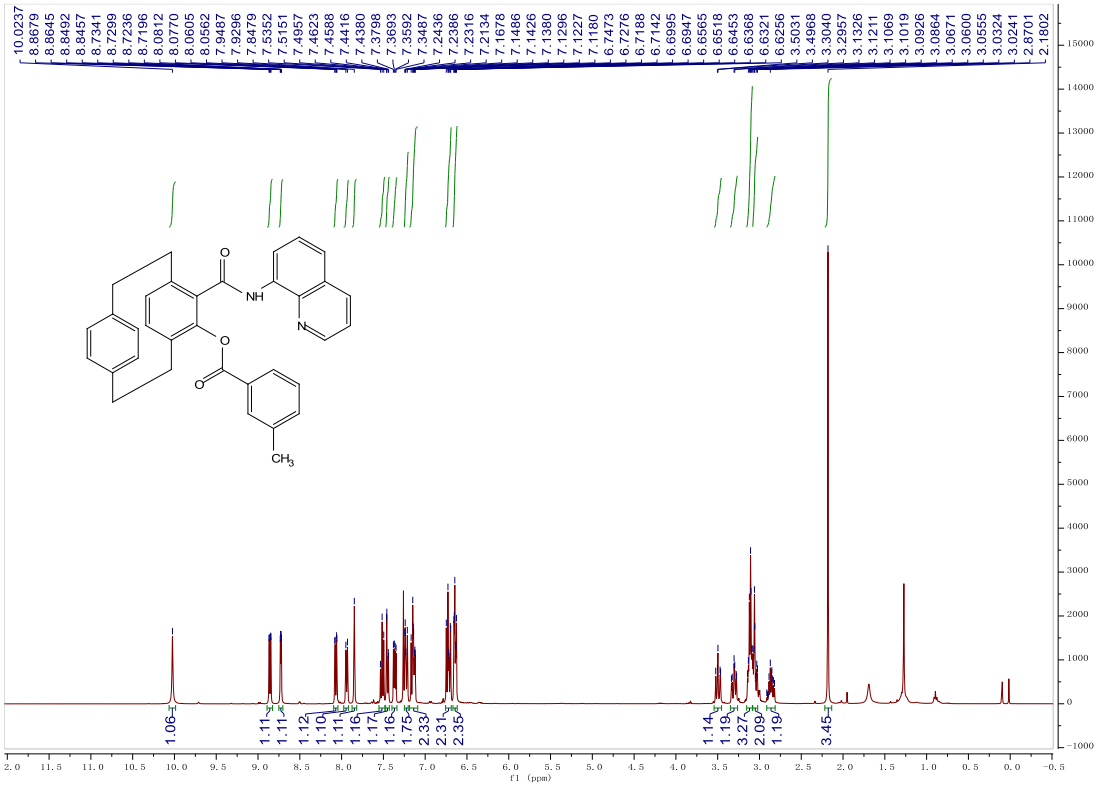
f1 (ppm)

7d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8.0770
8.0605
8.0562
7.9487
7.9296
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7.4416
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1.06
1.11
1.11
1.12
1.10
1.11
1.16
1.17
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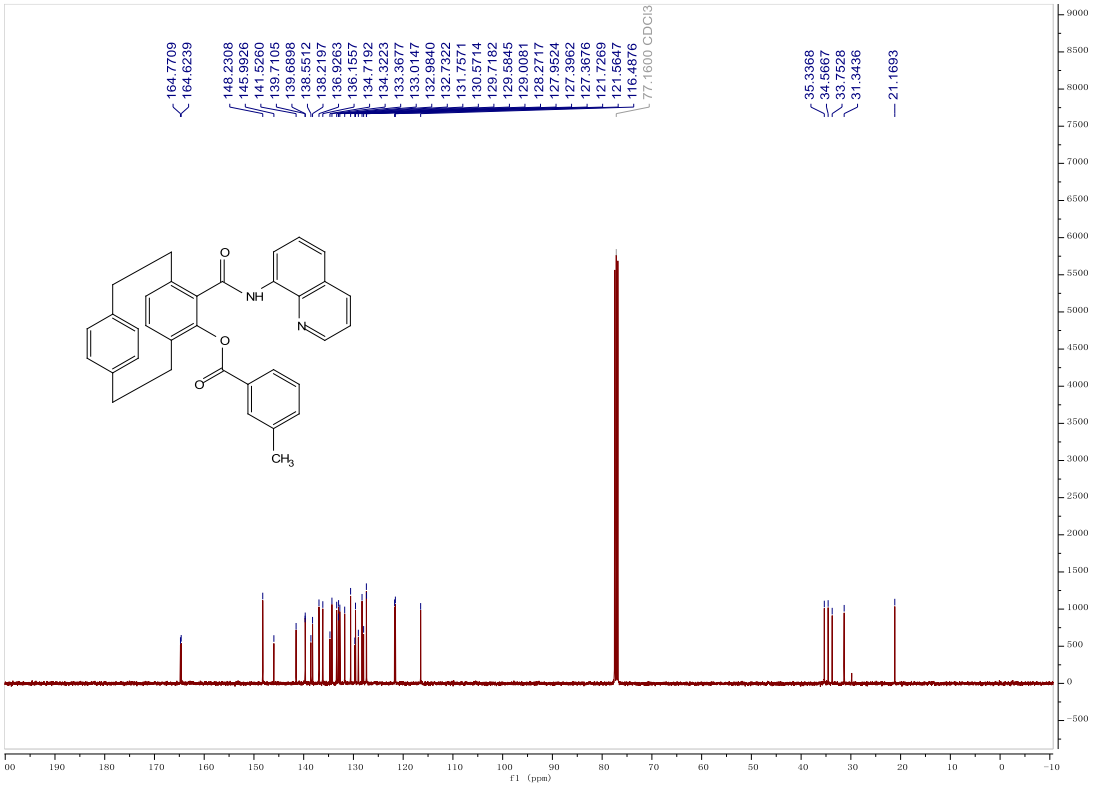
1.19
3.45
f1 (ppm)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121.7269
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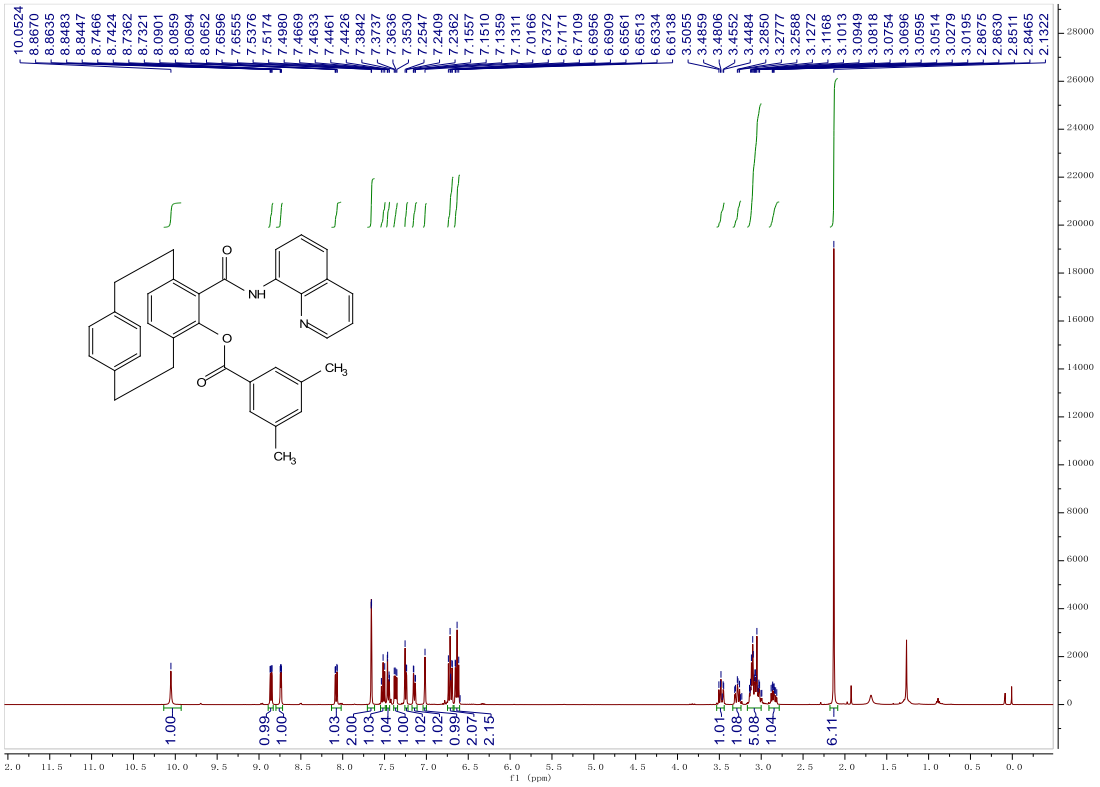
f1 (ppm)

7e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7.6555
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3.1272
3.1168
3.1013
3.0949
3.0818
3.0754
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2.8630
2.8511
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2.1322
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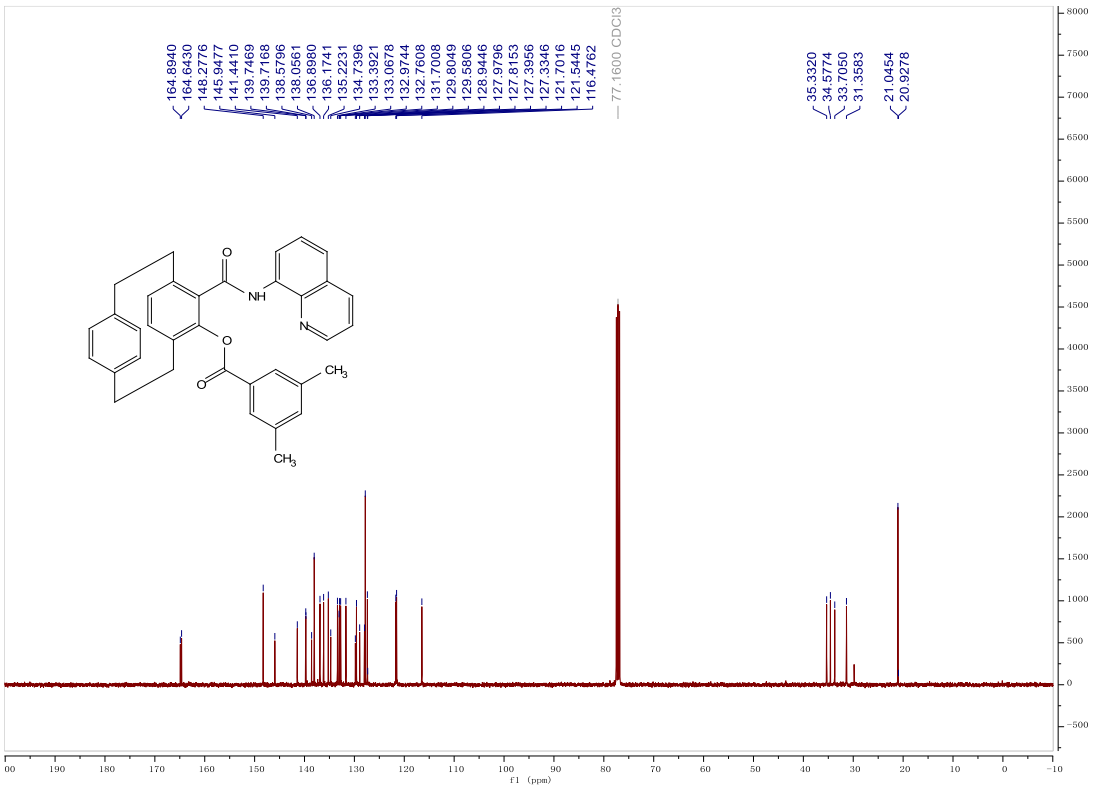
0.99
1.00
1.03
2.00
1.03
1.04
1.00
1.02
1.02
0.99
2.07
2.15
1.01
1.08
5.08
1.04
6.11
f1 (ppm)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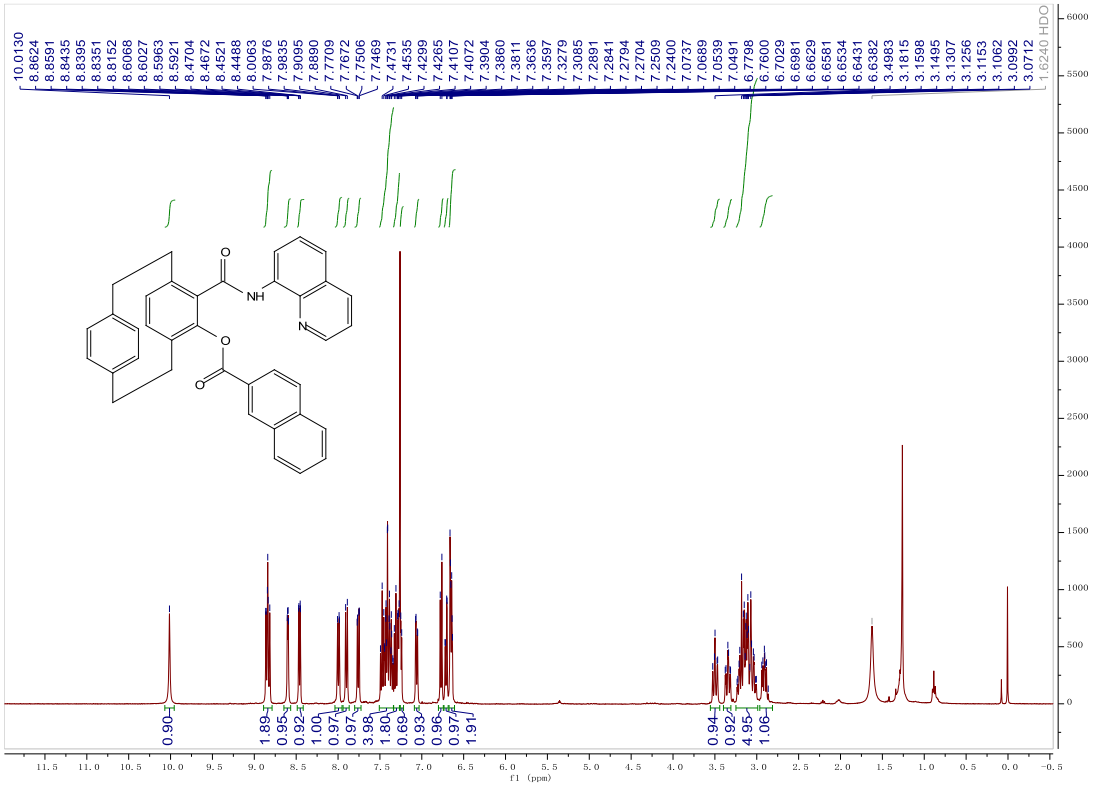
f1 (ppm)

7f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0.97
0.97
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0.96
0.97
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0.92
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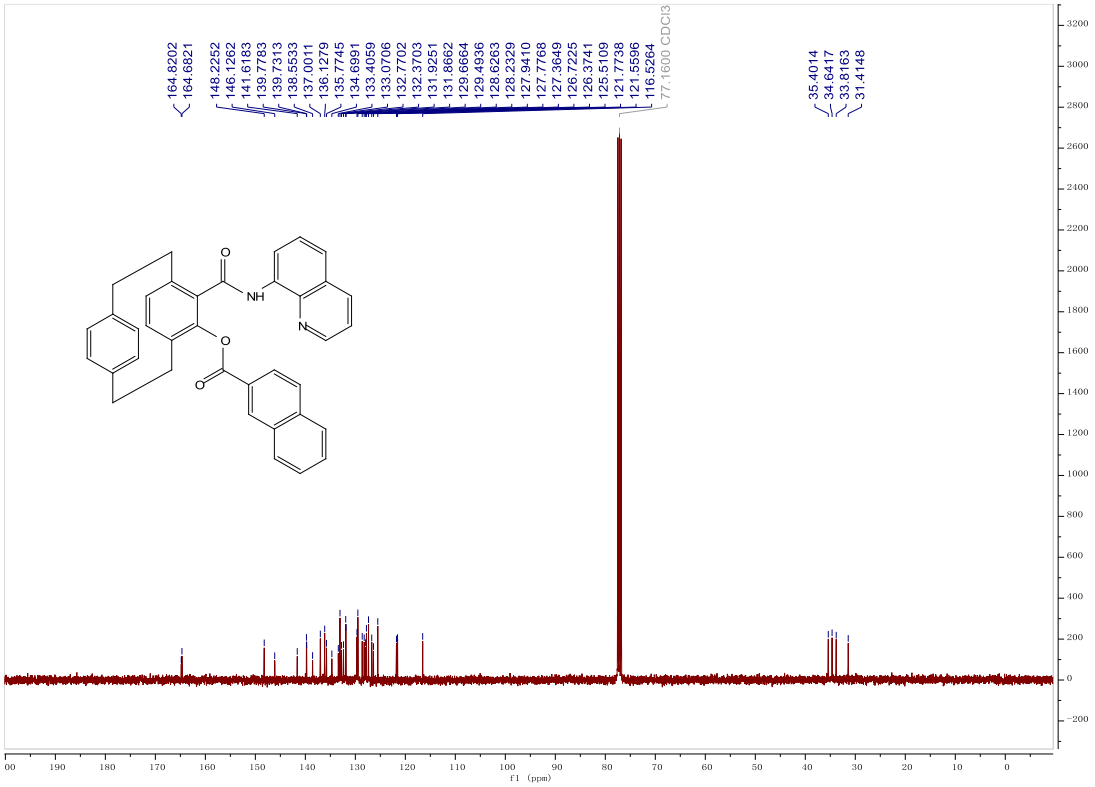
1.06
f1 (ppm)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125.5109
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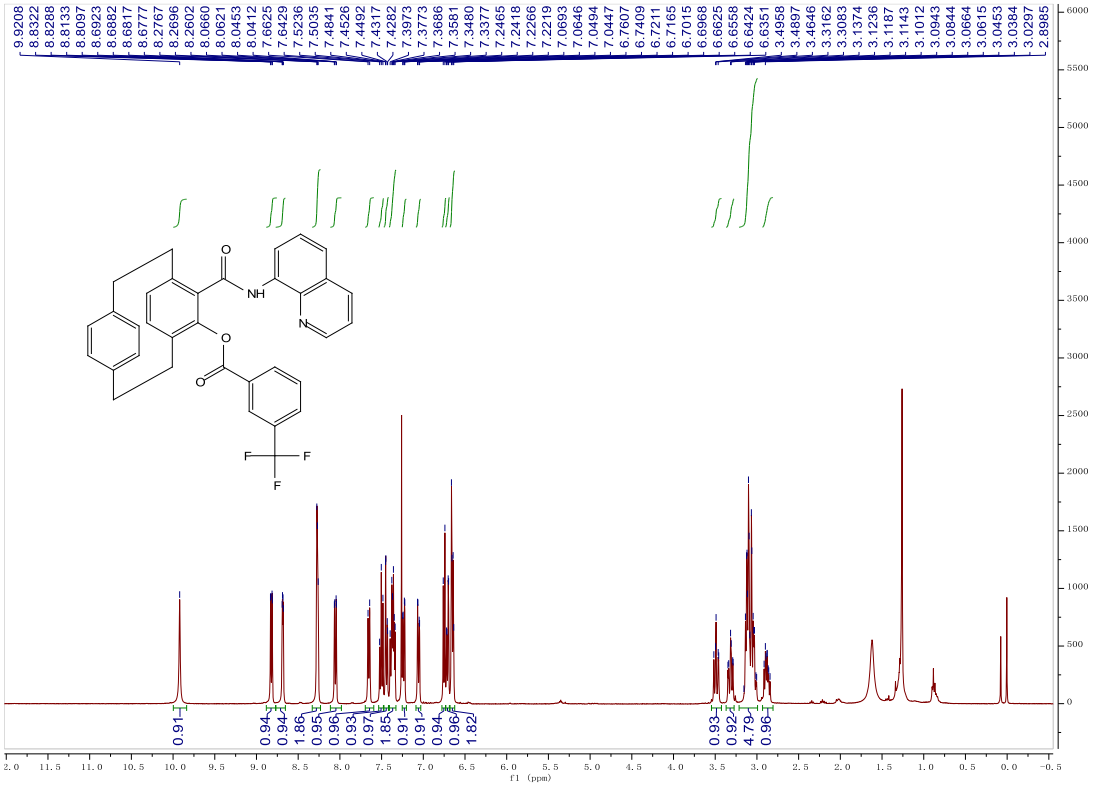
O
O
f1 (ppm)

7g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O
O
F
F
F
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0.96
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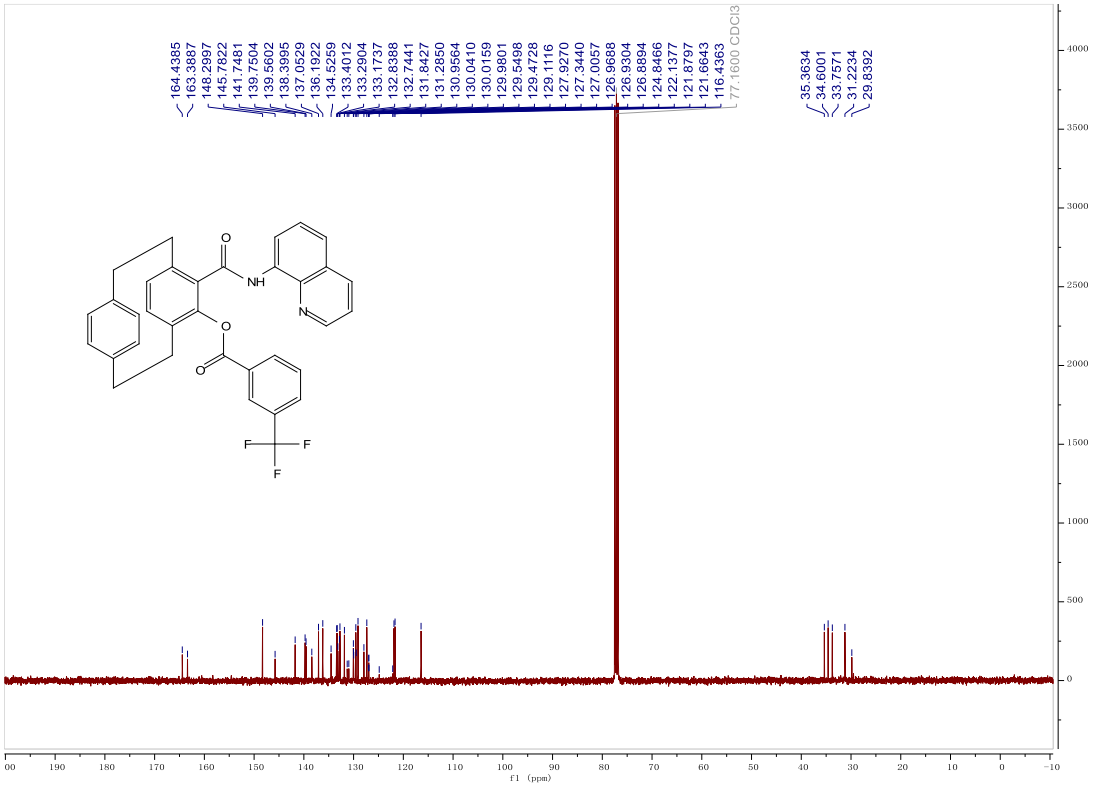
f1 (ppm)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122.1377
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116.4363
77.1600 CDCl3
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31.2234
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NH
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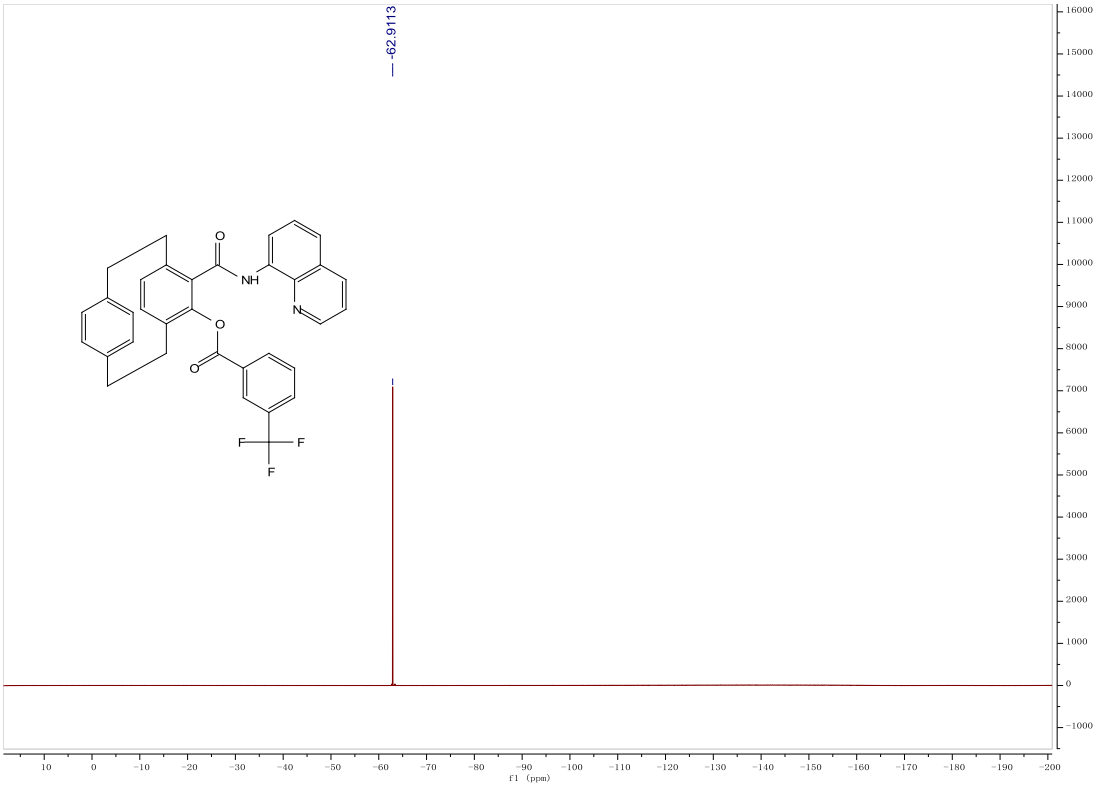
O
O
O
F
F
F
f1 (ppm)


-62.9113
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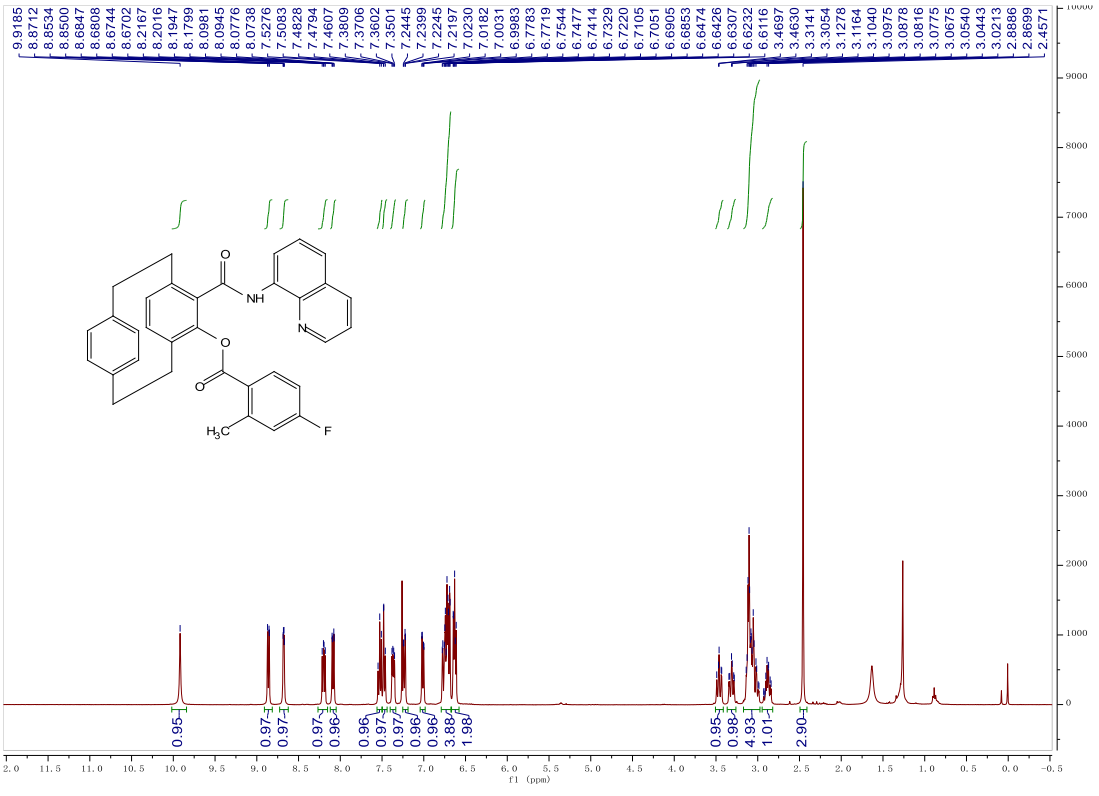
O
F
F
F
f1 (ppm)

7h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O
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F
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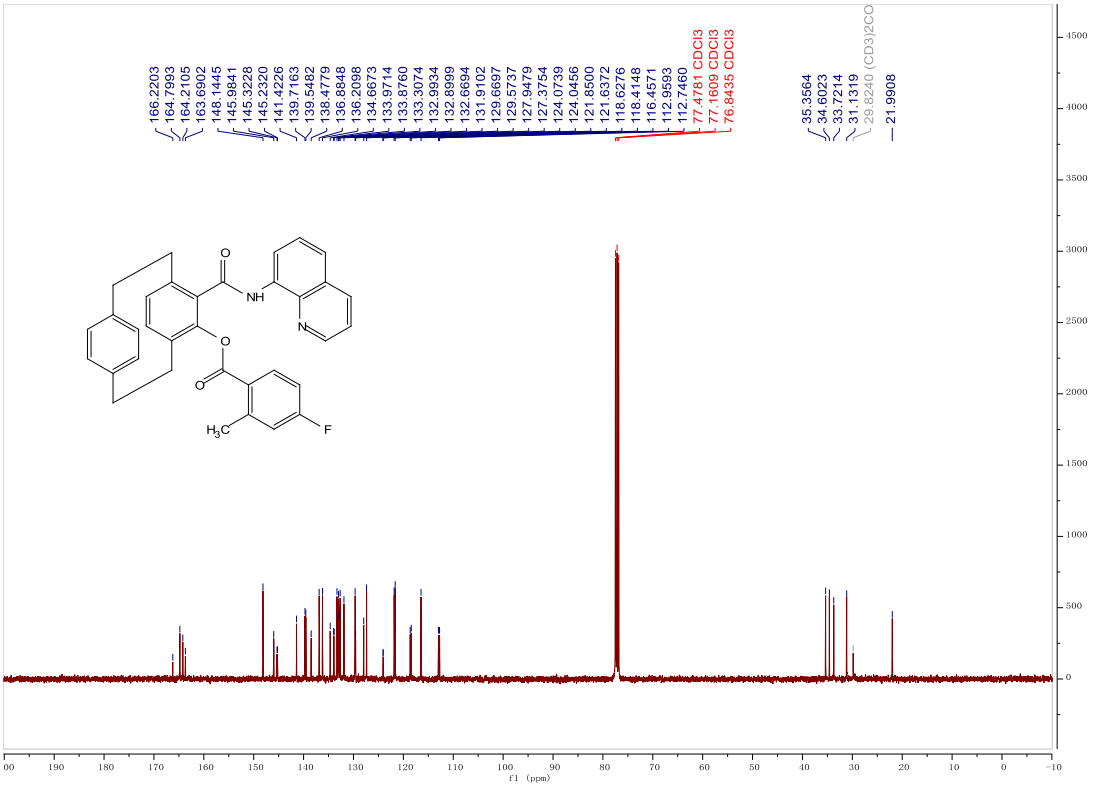
2.90
f1 (ppm)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141.4226
139.7163
139.5482
138.4779
136.8848
136.2098
134.6673
133.9714
133.8760
133.3074
132.9934
132.8999
132.6694
131.9102
129.6697
129.5737
127.9479
127.3754
124.0739
124.0456
121.8500
121.6372
118.6276
118.4148
116.4571
112.9593
112.7460
77.4781 CDCl3
77.1609 CDCl3
76.8435 CDCl3
35.3564
34.6023
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29.6240 (CD3)2CO
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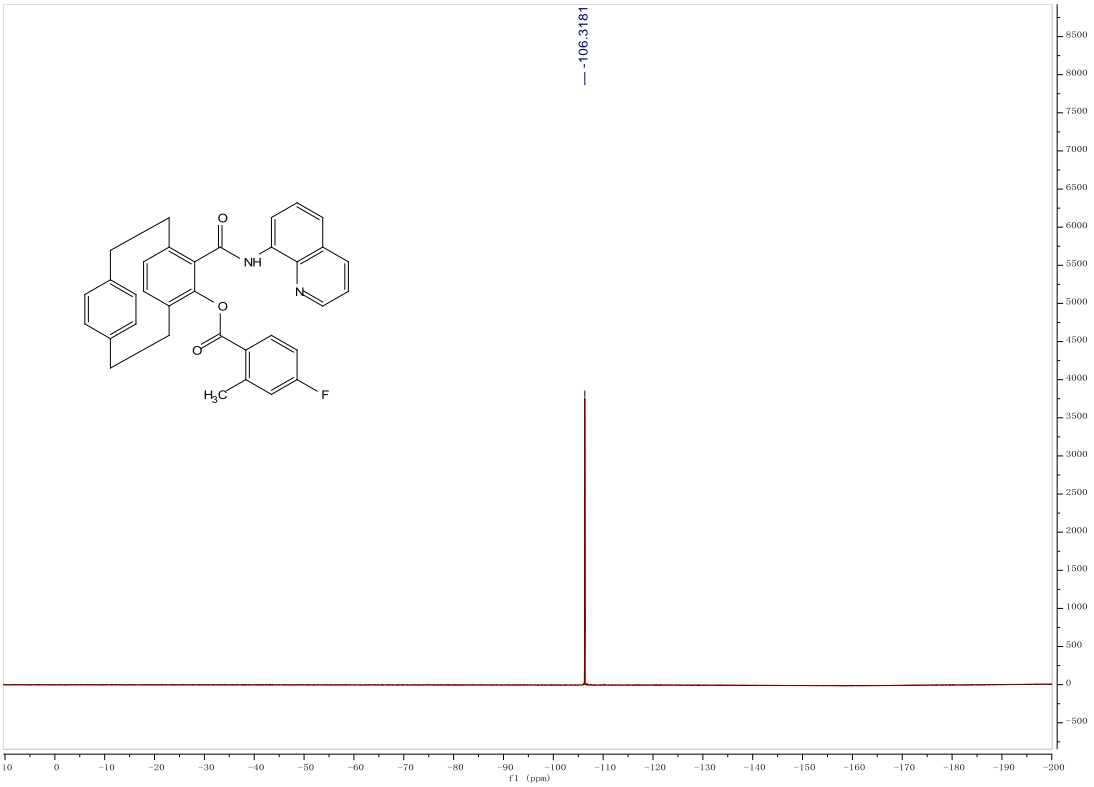
NH
N
O
O
H3C
F
f1 (ppm)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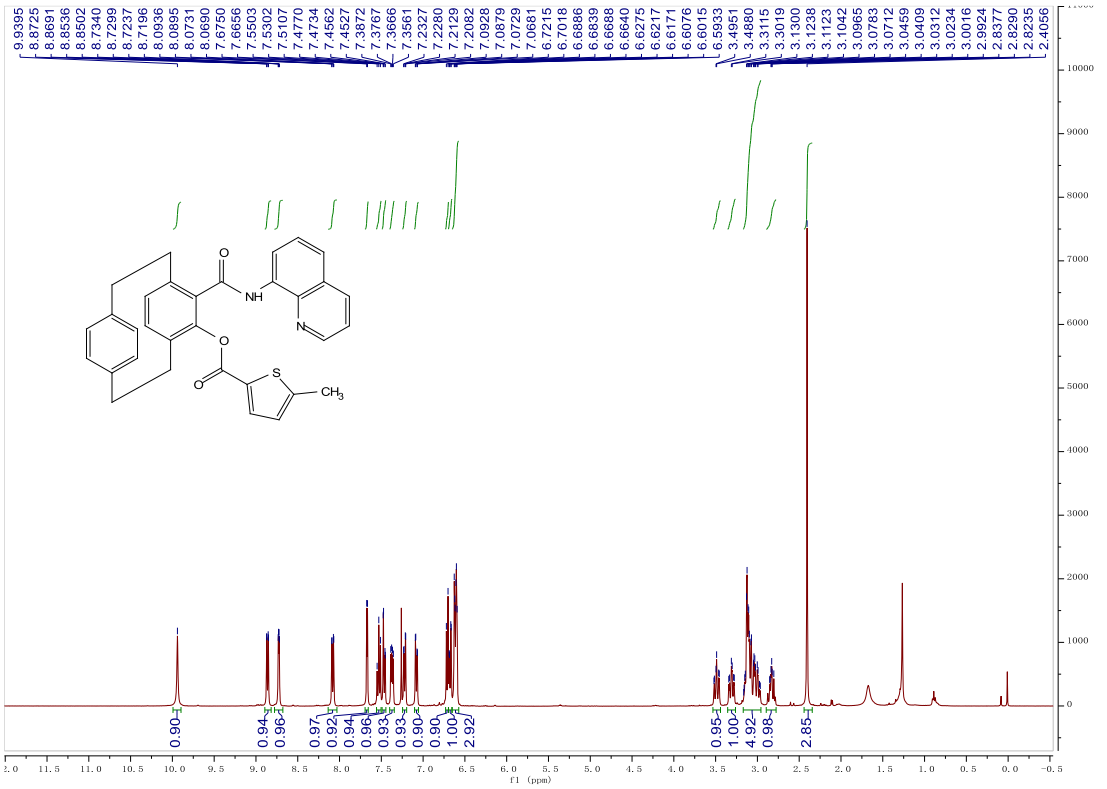
7i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8.0690
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7.4734
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7.4527
7.3872
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7.3666
7.3561
7.2327
7.2280
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7.0928
7.0879
7.0729
7.0681
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6.7018
6.6886
6.6839
6.6688
6.6640
6.6275
6.6217
6.6171
6.6076
6.6015
6.5933
3.4951
3.4880
3.3115
3.3019
3.1300
3.1238
3.1123
3.1042
3.0965
3.0783
3.0712
3.0459
3.0409
3.0312
3.0234
3.0016
2.9924
2.8377
2.8290
2.8235
2.4056
O
NH
N
O
O
S
CH3
0.90
0.94
0.96
0.97
0.92
0.94
0.96
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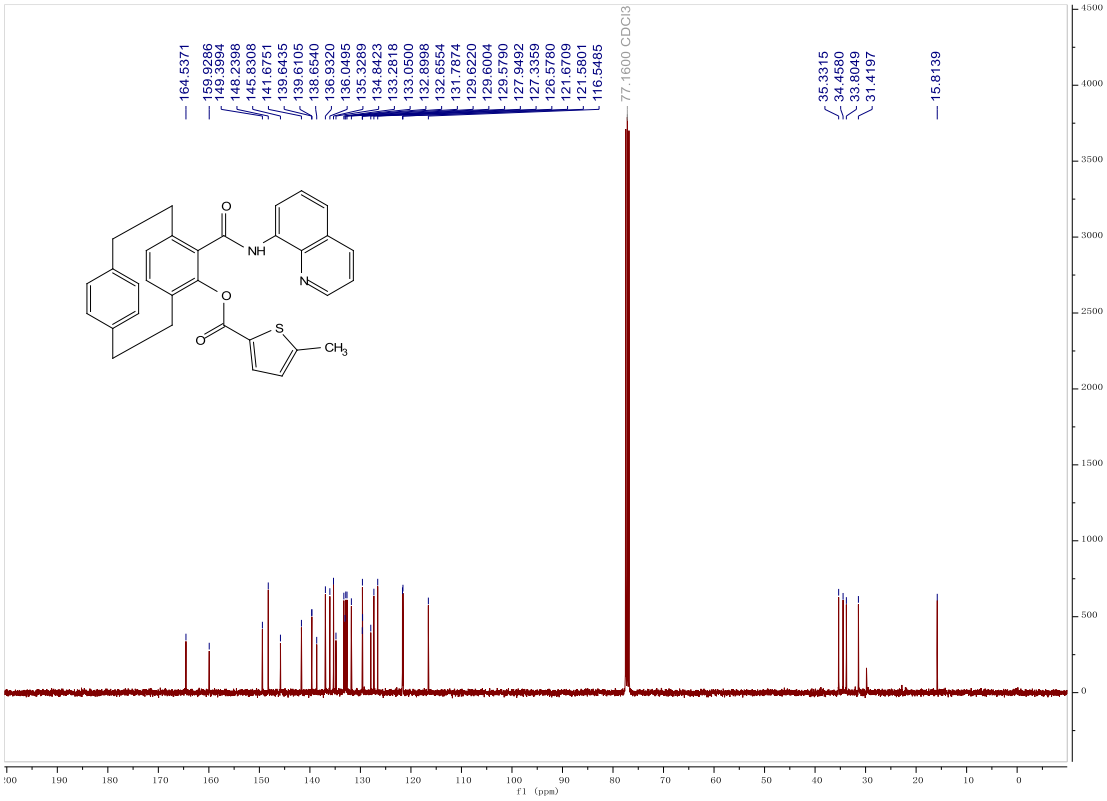
2.85
f1 (ppm)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135.3289
134.8423
133.2818
133.0500
132.8998
132.6554
131.7874
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129.5790
127.9492
127.3359
126.5780
121.6709
121.5801
116.5485
77.1600 CDCl3
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31.4197
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NH
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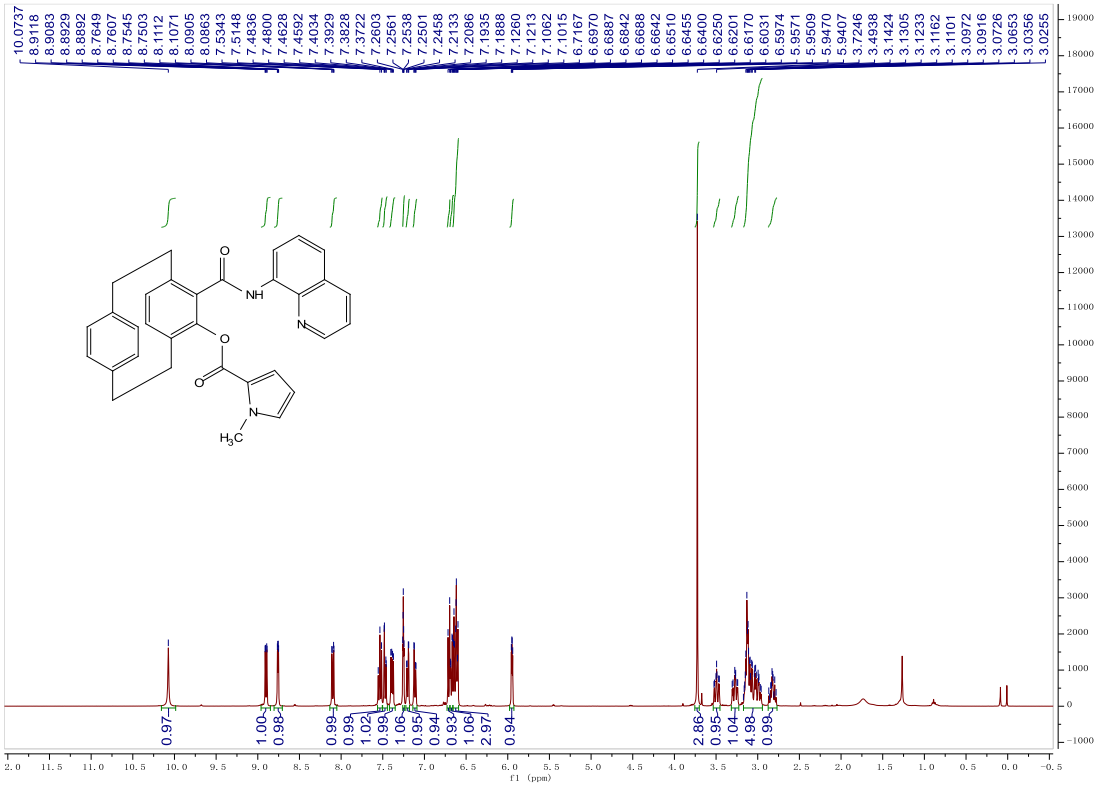
O
O
S
CH3
f1 (ppm)

7j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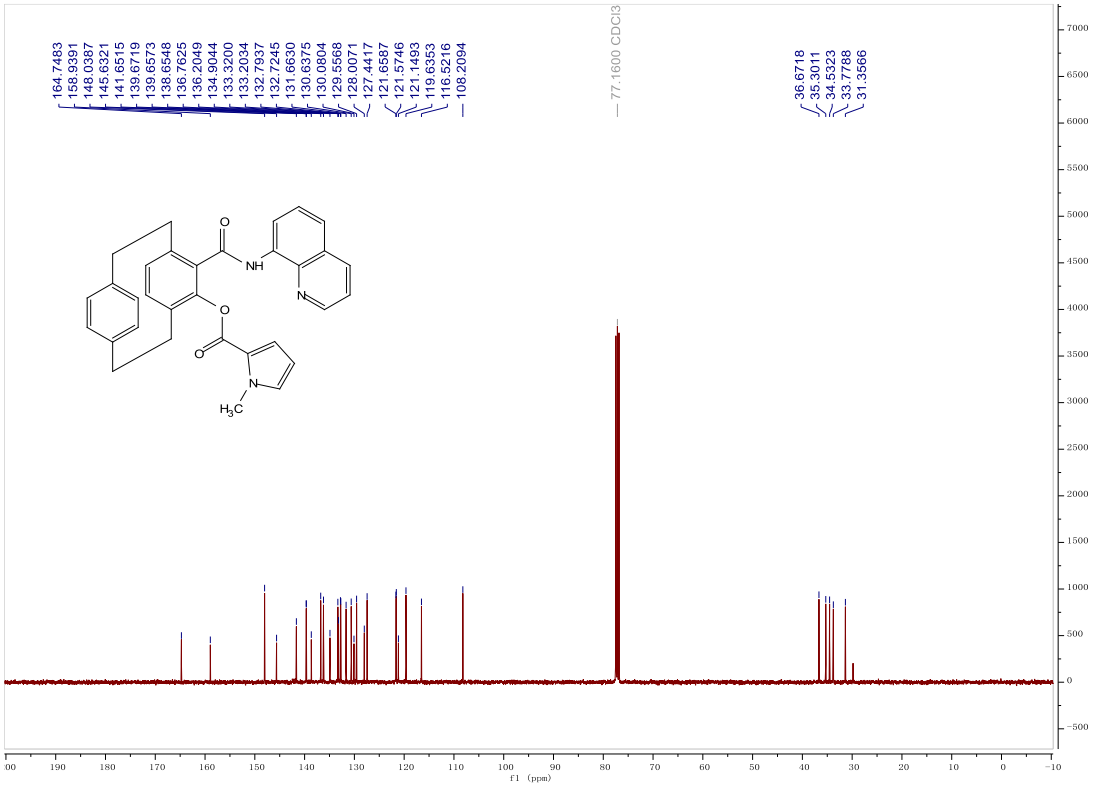
8.0905
8.0863
7.5343
7.5148
7.4836
7.4800
7.4628
7.4592
7.4034
7.3929
7.3828
7.3722
7.2603
7.2561
7.2538
7.2501
7.2458
7.2133
7.2086
7.1935
7.1888
7.1260
7.1213
7.1062
7.1015
6.7167
6.6970
6.6887
6.6842
6.6688
6.6642
6.6510
6.6455
6.6400
6.6250
6.6201
6.6170
6.6031
6.5974
5.9571
5.9509
5.9470
5.9407
3.7246
3.4938
3.1424
3.1305
3.1233
3.1162
3.1101
3.0972
3.0916
3.0726
3.0653
3.0356
3.0255
0.97
1.00
0.98
0.99
0.99
1.02
0.99
1.06
0.95
0.94
0.93
1.06
2.97
0.94
2.86
0.95
1.04
4.98
0.99
f1 (ppm)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133.3200
133.2034
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132.7245
131.6630
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130.0804
129.5568
128.0071
127.4417
121.6587
121.5746
121.1493
119.6353
116.5216
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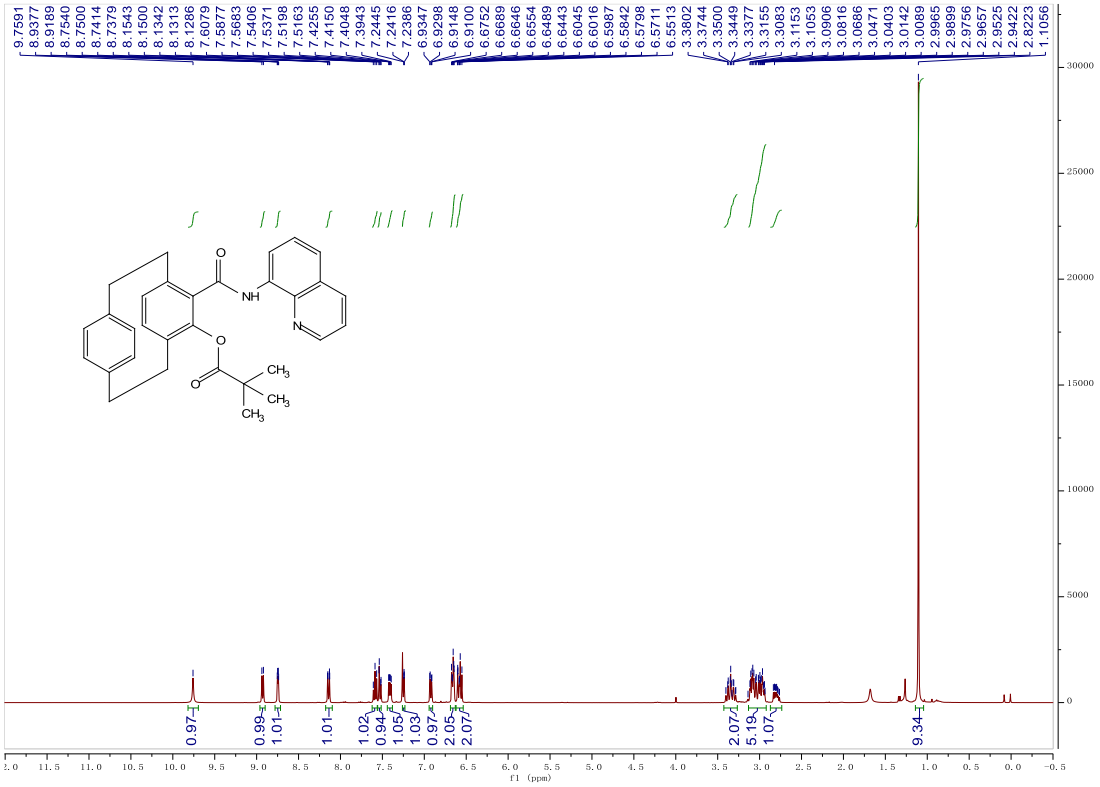
77.1600 CDCl3
36.6718
35.3011
34.5323
33.7788
31.3566
f1 (ppm)

7k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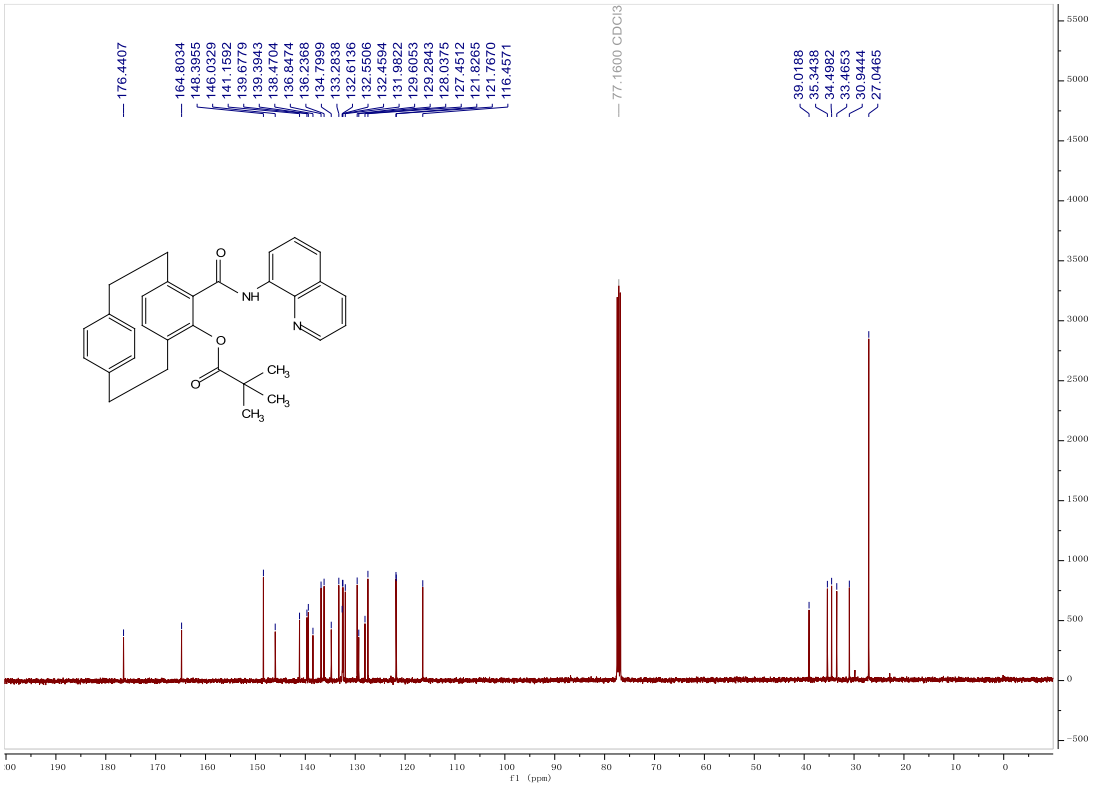
8.1286
7.6079
7.5877
7.5683
7.5406
7.5371
7.5198
7.5163
7.4255
7.4150
7.4048
7.3943
7.2445
7.2416
7.2386
6.9347
6.9298
6.9148
6.9100
6.6752
6.6689
6.6646
6.6554
6.6489
6.6443
6.6045
6.6016
6.5987
6.5842
6.5798
6.5711
6.5513
3.3802
3.3744
3.3500
3.3449
3.3377
3.3155
3.3083
3.1153
3.1053
3.0906
3.0816
3.0686
3.0471
3.0403
3.0142
3.0089
2.9965
2.9899
2.9756
2.9657
2.9525
2.9422
2.8223
1.1056
NH
O
CH3
CH3
CH3
0.97
0.99
1.01
1.01
1.02
0.94
1.05
1.03
0.97
2.05
2.07
2.07
5.19
1.07
9.34
f1 (ppm)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133.2838
132.6136
132.5506
132.4594
131.9822
129.6053
129.2843
128.0375
127.4512
121.8265
121.7670
116.4571
77.1600 CDCl3
39.0188
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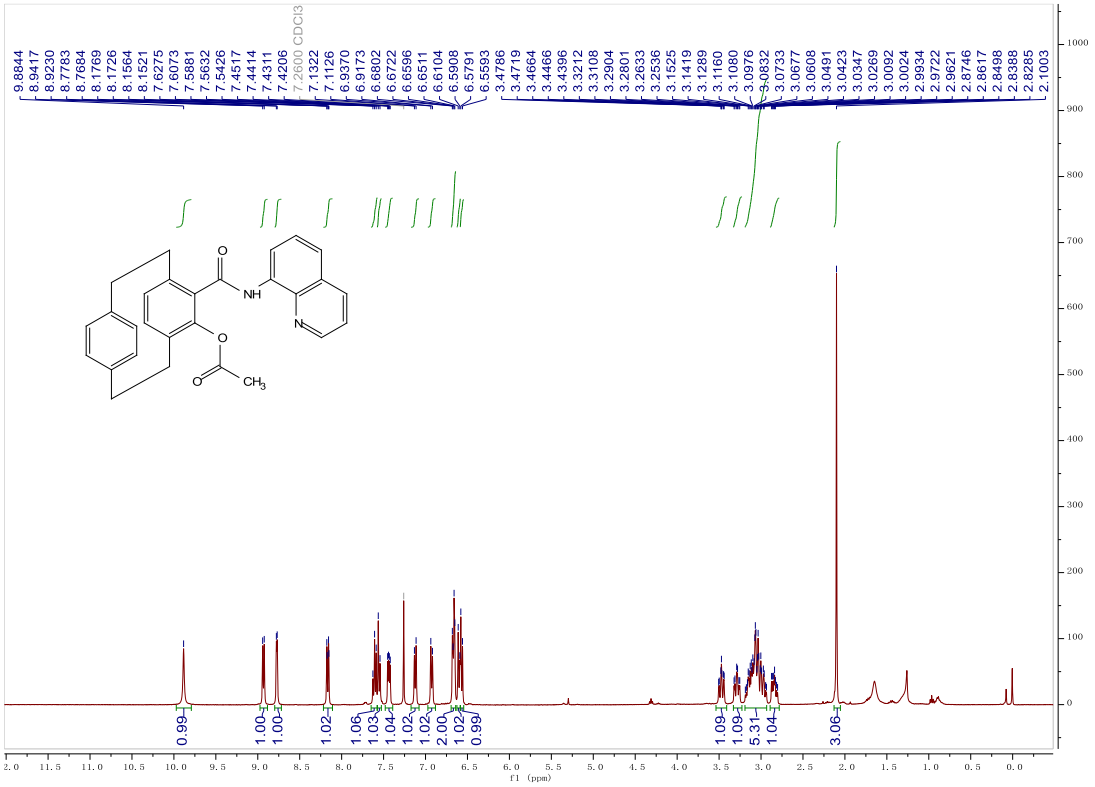
34.4982
33.4653
30.9444
27.0465
NH
O
CH3
CH3
CH3
f1 (ppm)

7l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8.1521
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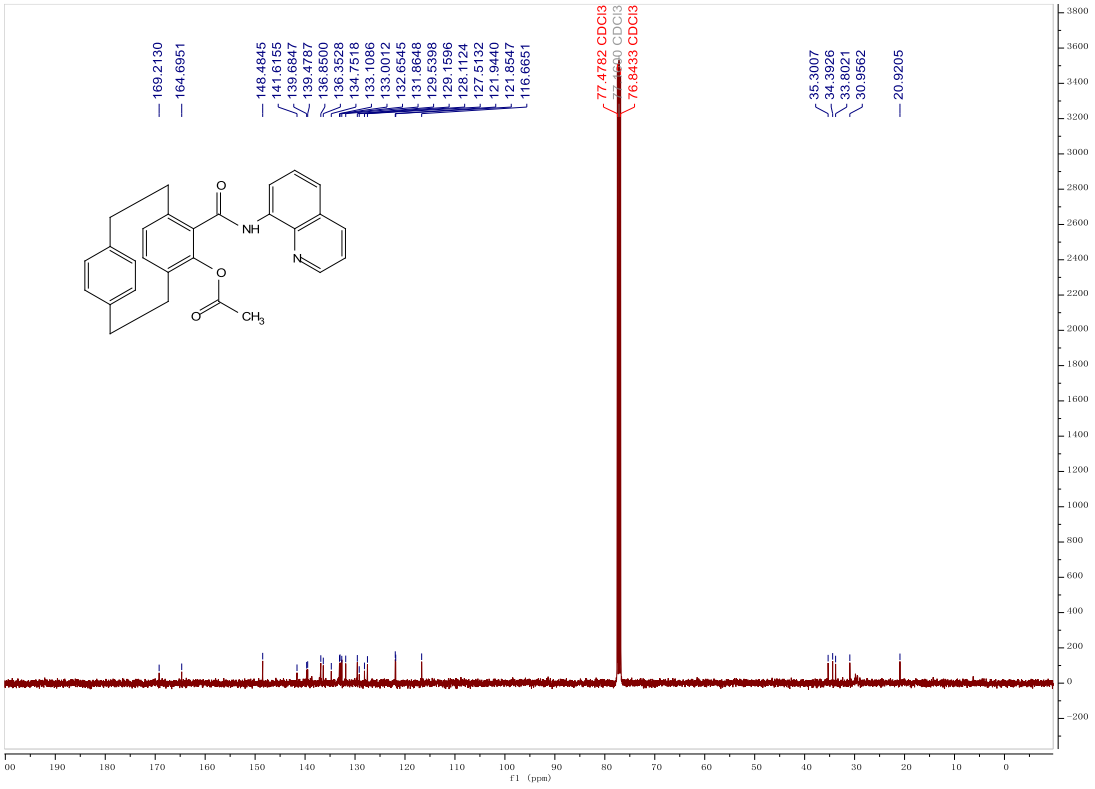
7.5881
7.5632
7.5426
7.4517
7.4414
7.4311
7.4206
7.2600 CDCl3
7.1322
7.1126
6.9370
6.9173
6.6802
6.6722
6.6596
6.6511
6.6104
6.5908
6.5791
6.5593
3.4786
3.4719
3.4664
3.4466
3.4396
3.3212
3.3108
3.2904
3.2801
3.2633
3.2536
3.1525
3.1419
3.1289
3.1160
3.1080
3.0976
3.0832
3.0733
3.0677
3.0608
3.0491
3.0423
3.0347
3.0269
3.0092
3.0024
2.9934
2.9722
2.9621
2.8746
2.8617
2.8498
2.8388
2.8285
2.1003
NH
O
N
O
O
CH3
0.99
1.00
1.00
1.02
1.06
1.03
1.04
1.02
1.02
2.00
1.02
0.99
1.09
1.09
5.31
1.04
3.06
f1 (ppm)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136.8500
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134.7518
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133.0012
132.6545
131.8648
129.5398
129.1596
128.1124
127.5132
121.9440
121.8547
116.6651
77.4782 CDCl3
77.4630 CDCl3
76.8433 CDCl3
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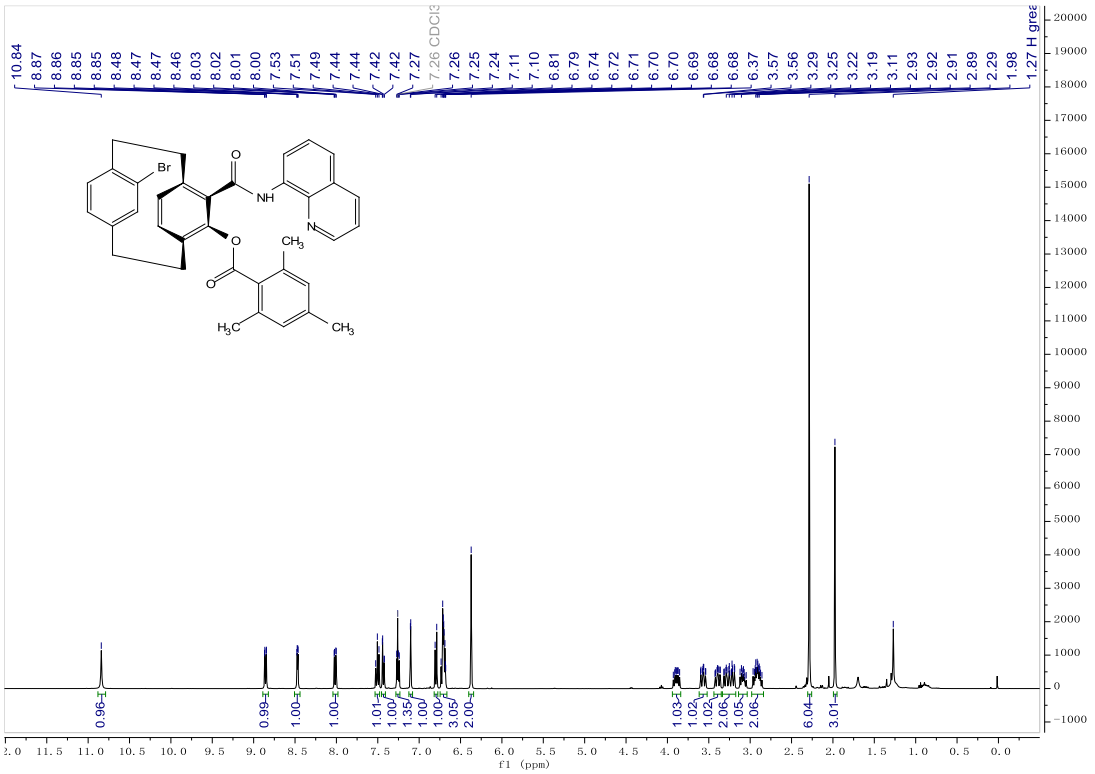
34.3926
33.8021
30.9562
20.9205
NH
O
N
O
O
CH3
f1 (ppm)

7n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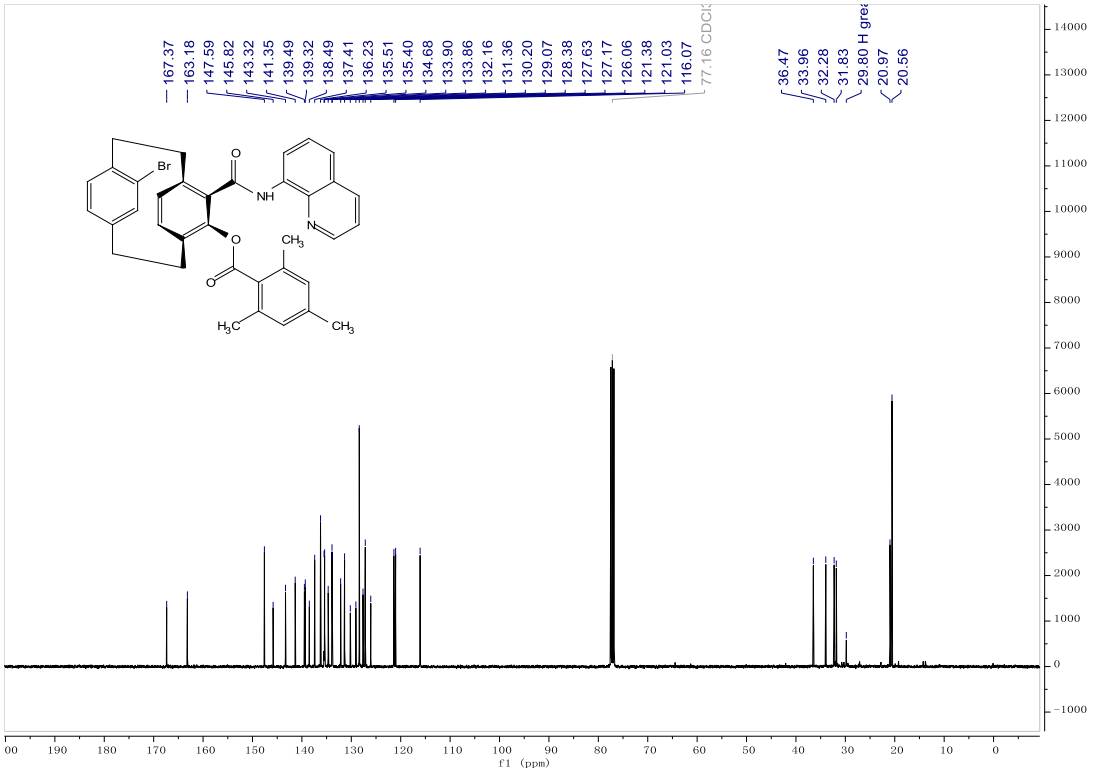
8.86
8.85
8.85
8.48
8.47
8.47
8.46
8.03
8.02
8.01
8.00
7.53
7.51
7.49
7.44
7.44
7.42
7.42
7.27
7.26 CDCl3
7.26
7.25
7.24
7.11
7.10
6.81
6.79
6.74
6.72
6.71
6.70
6.70
6.69
6.68
6.68
6.37
3.57
3.56
3.29
3.25
3.22
3.19
3.11
2.93
2.92
2.91
2.89
2.29
1.98
1.27 H grea
Br
O
NH
N
O
CH3
O
H3C
CH3
0.96
0.99
1.00
1.00
1.01
1.00
1.35
1.00
1.00
3.05
2.00
1.03
1.02
1.02
2.06
1.05
2.06
6.04
3.01
f1 (ppm)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139.49
139.32
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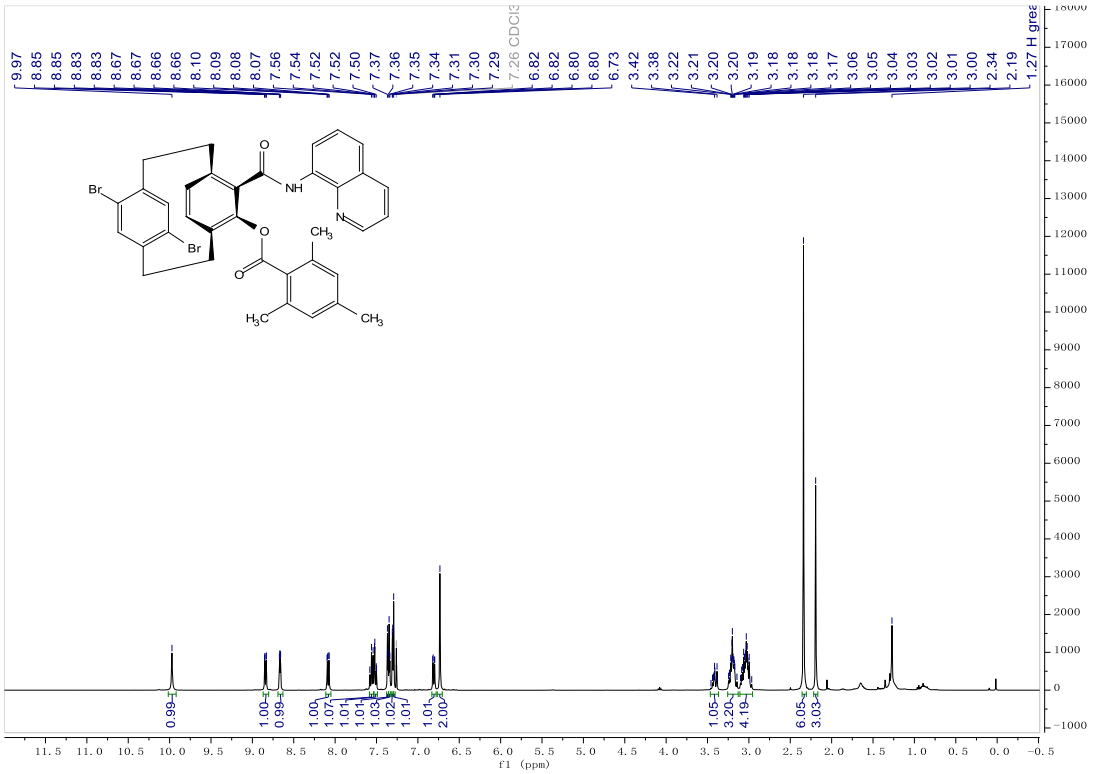
137.41
136.23
135.51
135.40
134.68
133.90
133.86
132.16
131.36
130.20
129.07
128.38
127.63
127.17
126.06
121.38
121.03
116.07
77.16 CDCl3
36.47
33.96
32.28
31.83
29.80 H grea
20.97
20.56
Br
O
NH
N
O
CH3
O
H3C
CH3
f1 (ppm)

7p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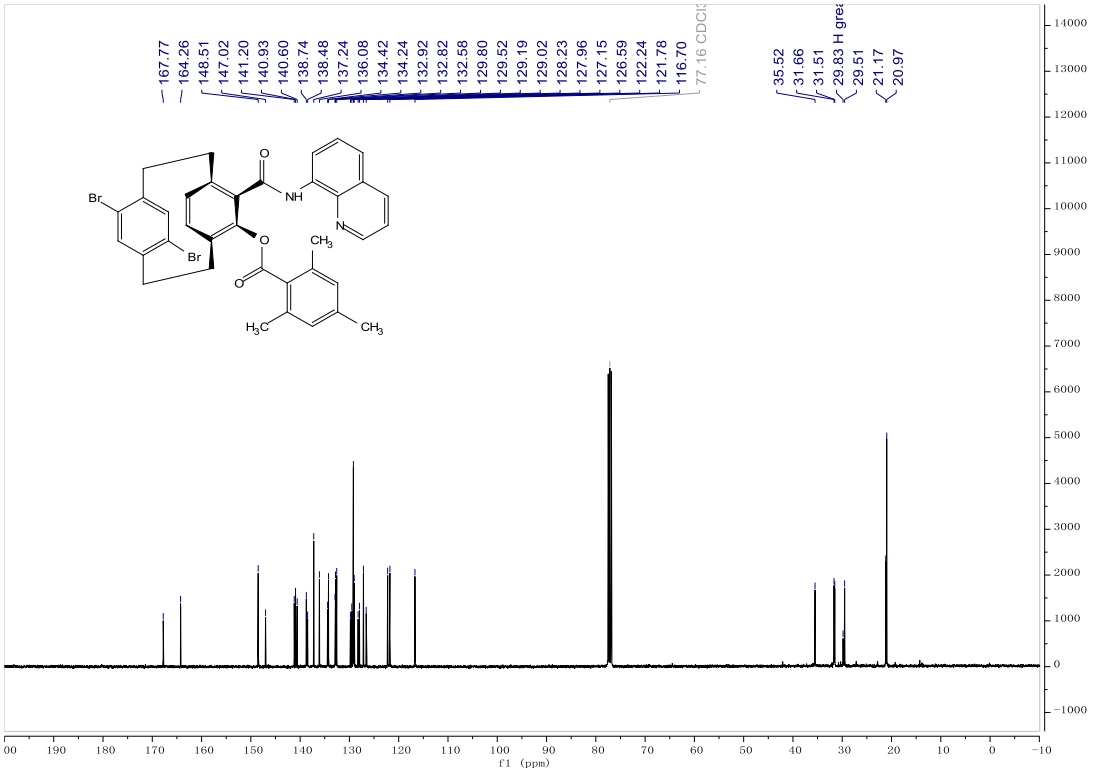
Br
Br
O
NH
N
O
O
CH3
H3C
CH3
0.99 1.00 0.99 1.00 1.07 1.01 1.01 1.03 1.02 1.01 1.01 2.00 1.05 3.20 4.19 6.05 3.03
f1 (ppm)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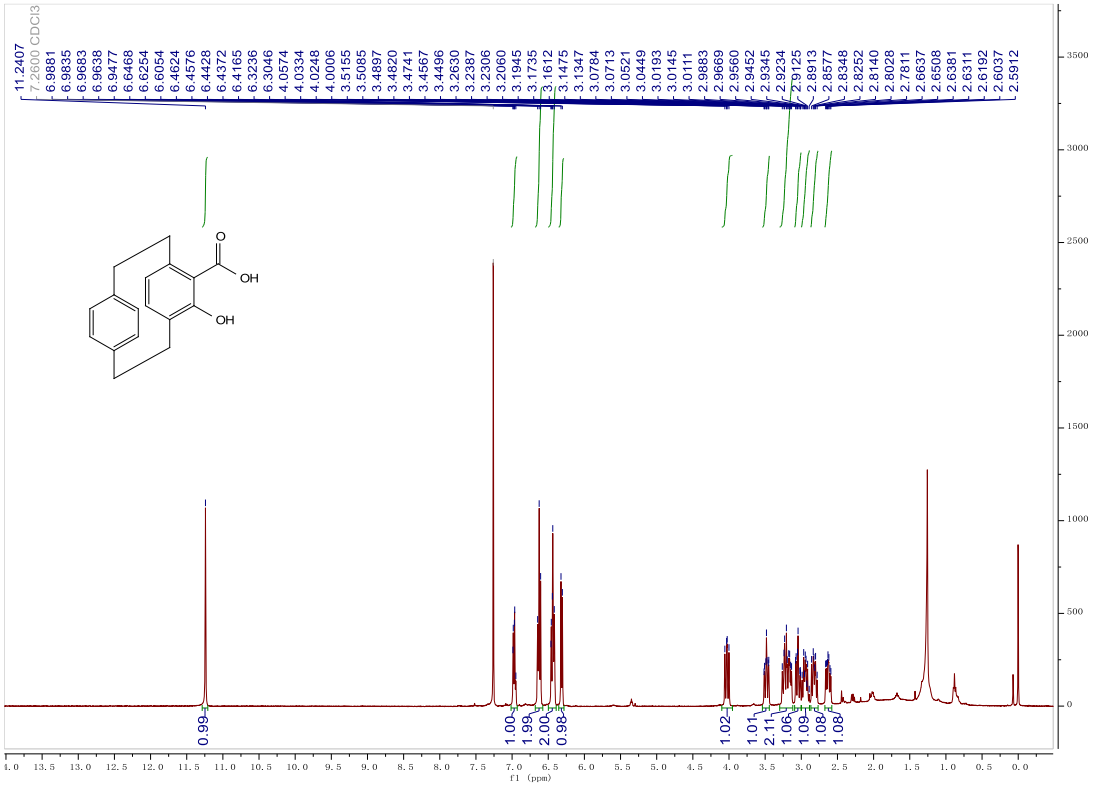
Br
Br
O
NH
N
O
O
CH3
H3C
CH3
f1 (ppm)

8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6.4576
6.4428
6.4372
6.4165
6.3236
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4.0334
4.0248
4.0006
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3.5085
3.4897
3.4820
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3.4567
3.4496
3.2630
3.2387
3.2306
3.2060
3.1945
3.1735
3.1612
3.1475
3.1347
3.0784
3.0713
3.0521
3.0449
3.0193
3.0145
3.0111
2.9983
2.9669
2.9560
2.9452
2.9345
2.9234
2.9125
2.8913
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2.8348
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2.8140
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2.6037
2.5912
OH
OH
0.99
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1.99
2.00
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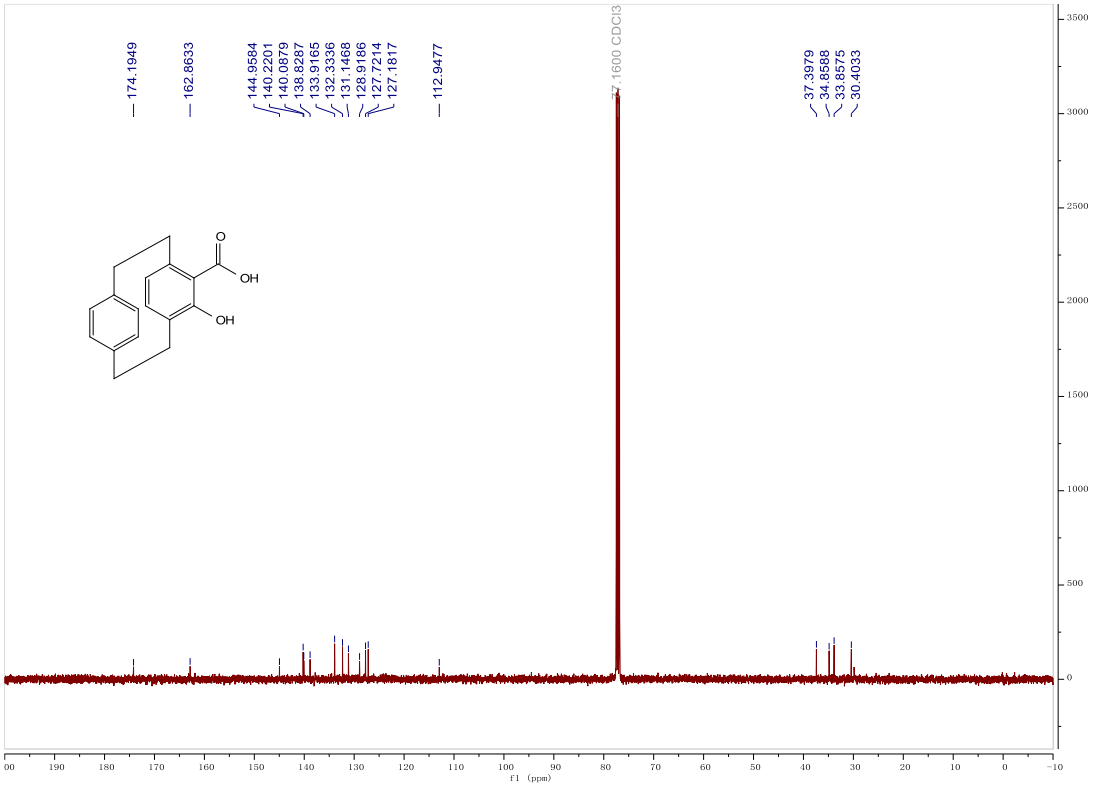
1.01
2.11
1.06
1.09
1.08
1.08
f1 (ppm)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128.9186
127.7214
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112.9477
77.1600 CDCl3
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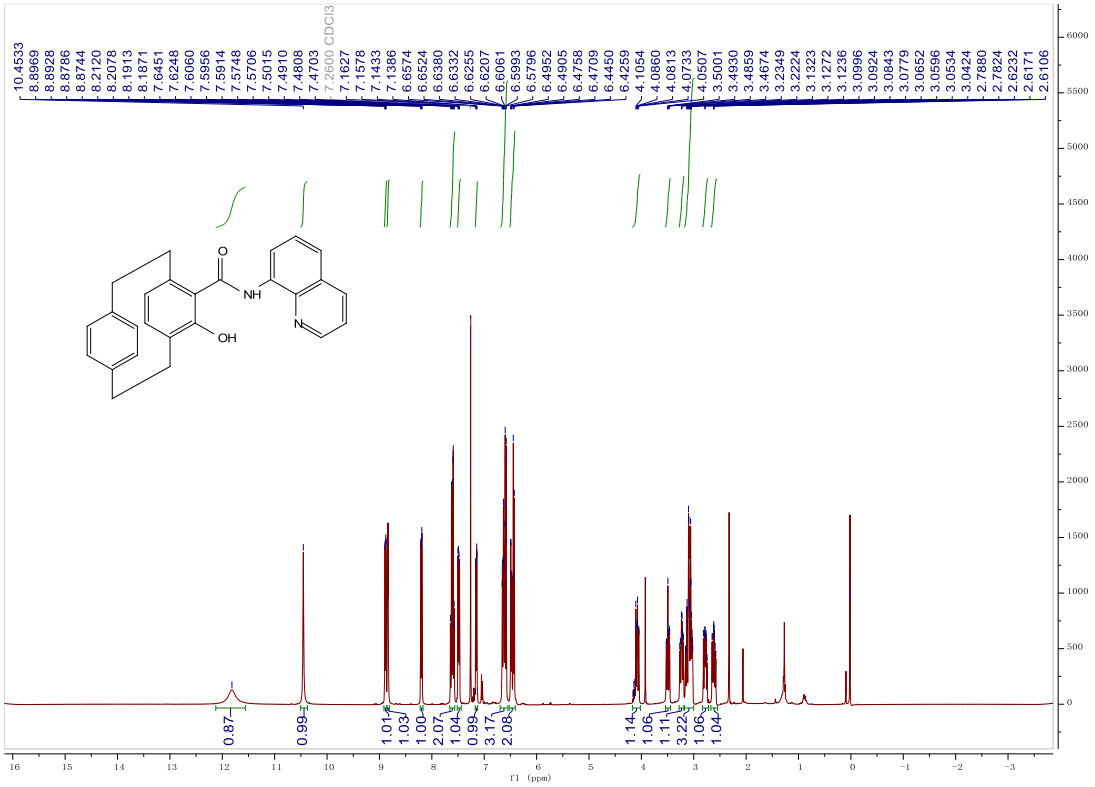
33.8575
30.4033
OH
OH
f1 (ppm)

9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7.6248
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7.5956
7.5914
7.5748
7.5706
7.5015
7.4910
7.4808
7.4703
7.2600 CDCl3
7.1627
7.1578
7.1433
7.1386
6.6574
6.6524
6.6380
6.6332
6.6255
6.6207
6.6061
6.5993
6.5796
6.4952
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6.4259
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4.0813
4.0733
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3.4859
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3.2224
3.1323
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3.0652
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3.0534
3.0424
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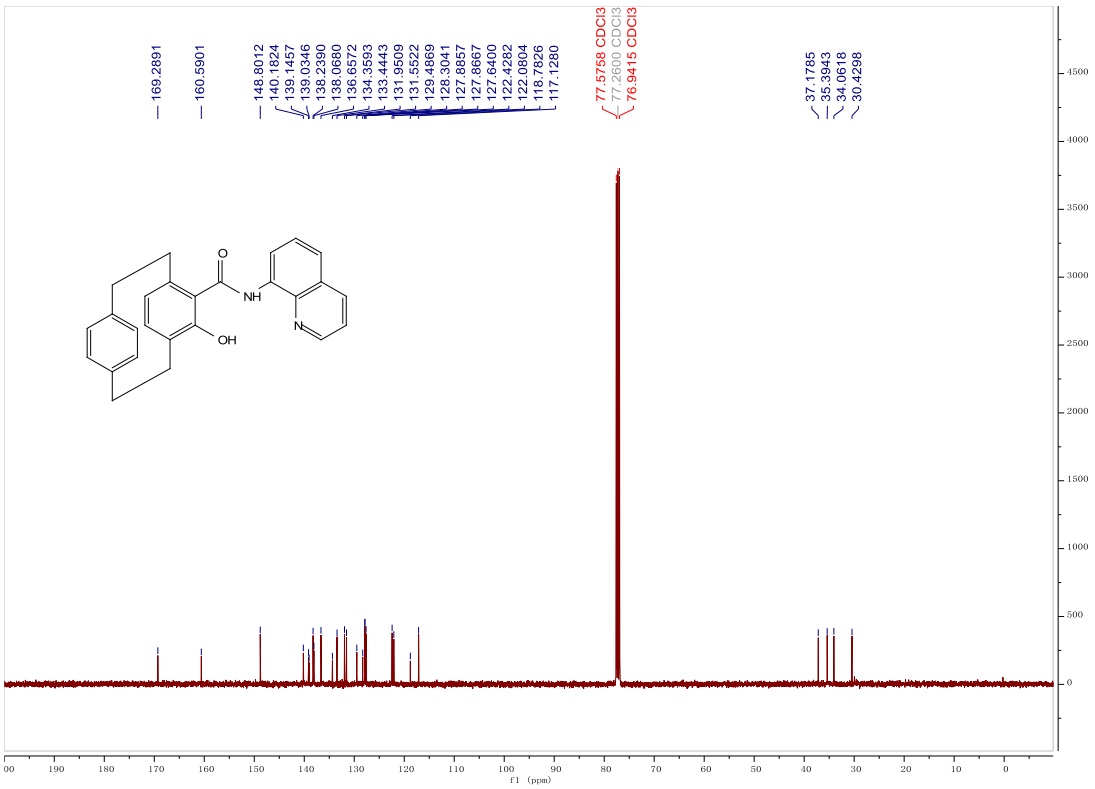
2.7824
2.6232
2.6171
2.6106
0.87
0.99
1.01
1.03
1.00
2.07
1.04
0.99
3.17
2.08
1.14
1.06
1.11
3.22
1.06
1.04
f1 (ppm)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127.6400
122.4282
122.0804
118.7826
117.1280
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76.9415 CDCl3
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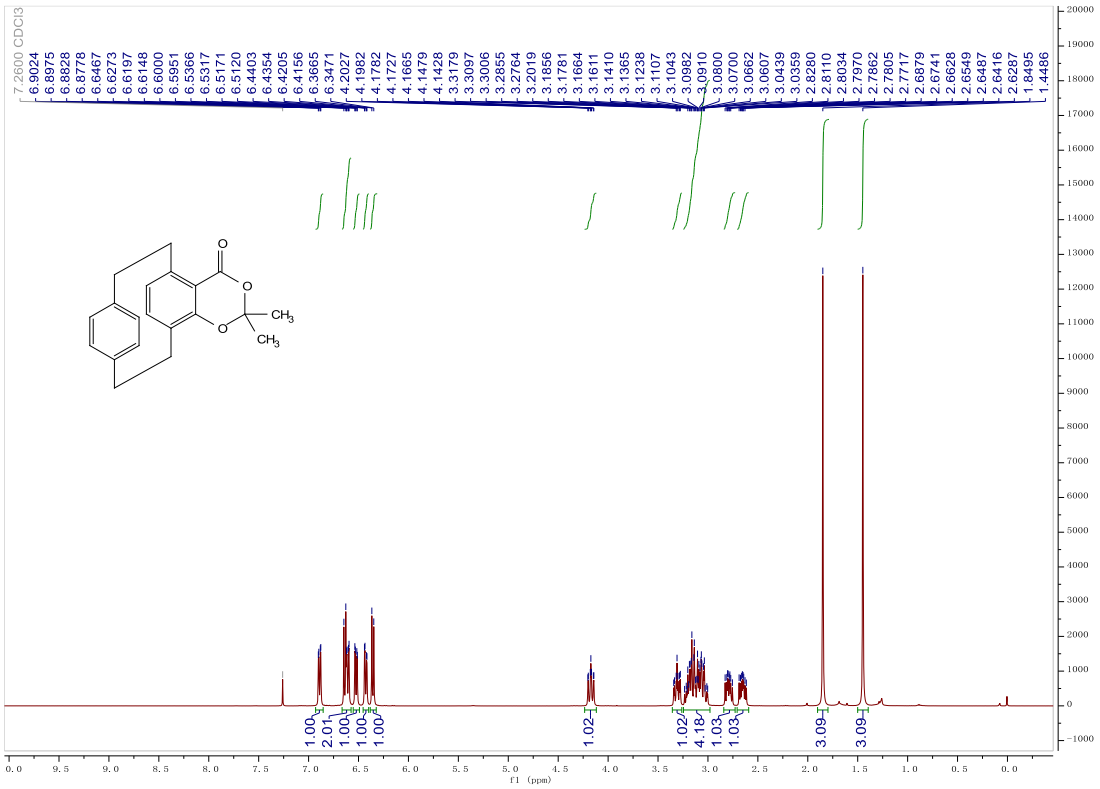
30.4298
f1 (ppm)

10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3.2019
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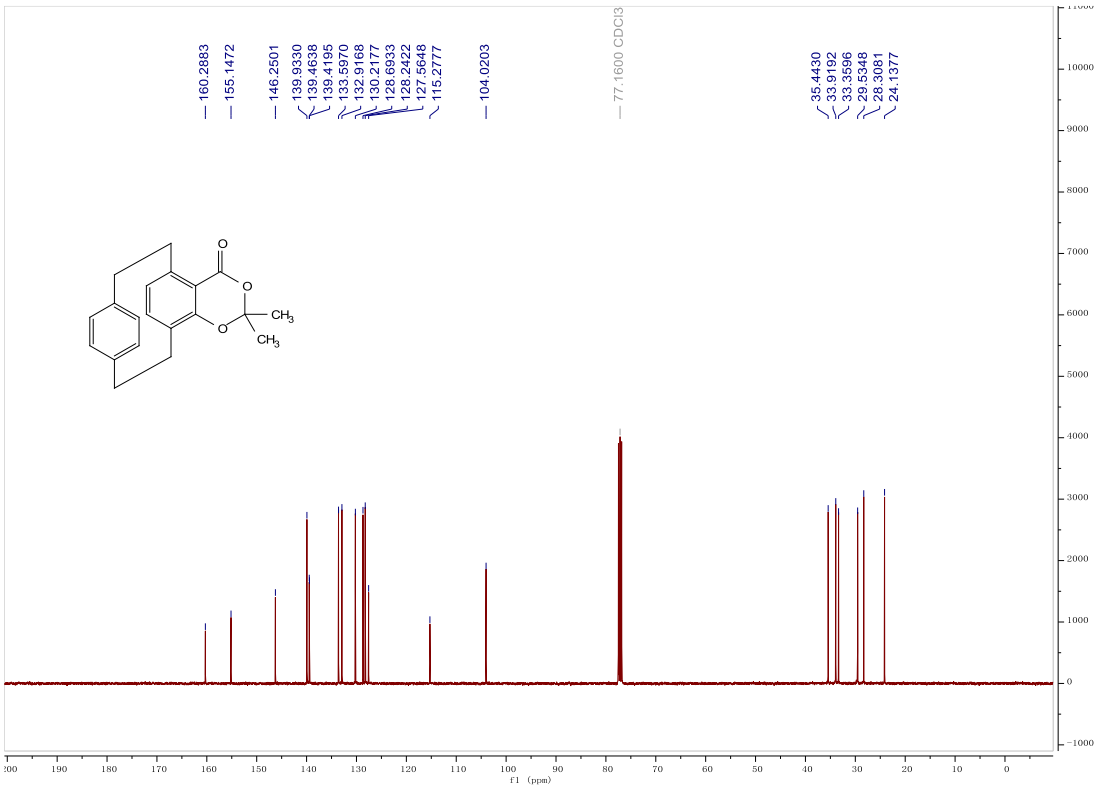
3.0982
3.0910
3.0800
3.0700
3.0662
3.0607
3.0439
3.0359
2.8280
2.8110
2.8034
2.7970
2.7862
2.7805
2.7717
2.6879
2.6741
2.6628
2.6549
2.6487
2.6416
2.6287
1.8495
1.4486
O
O
O
CH3
CH3
1.00
2.01
1.00
1.00
1.00
1.02
1.02
4.18
1.03
1.03
3.09
3.09
f1 (ppm)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130.2177
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128.2422
127.5648
115.2777
104.0203
77.1600 CDCl3
35.4430
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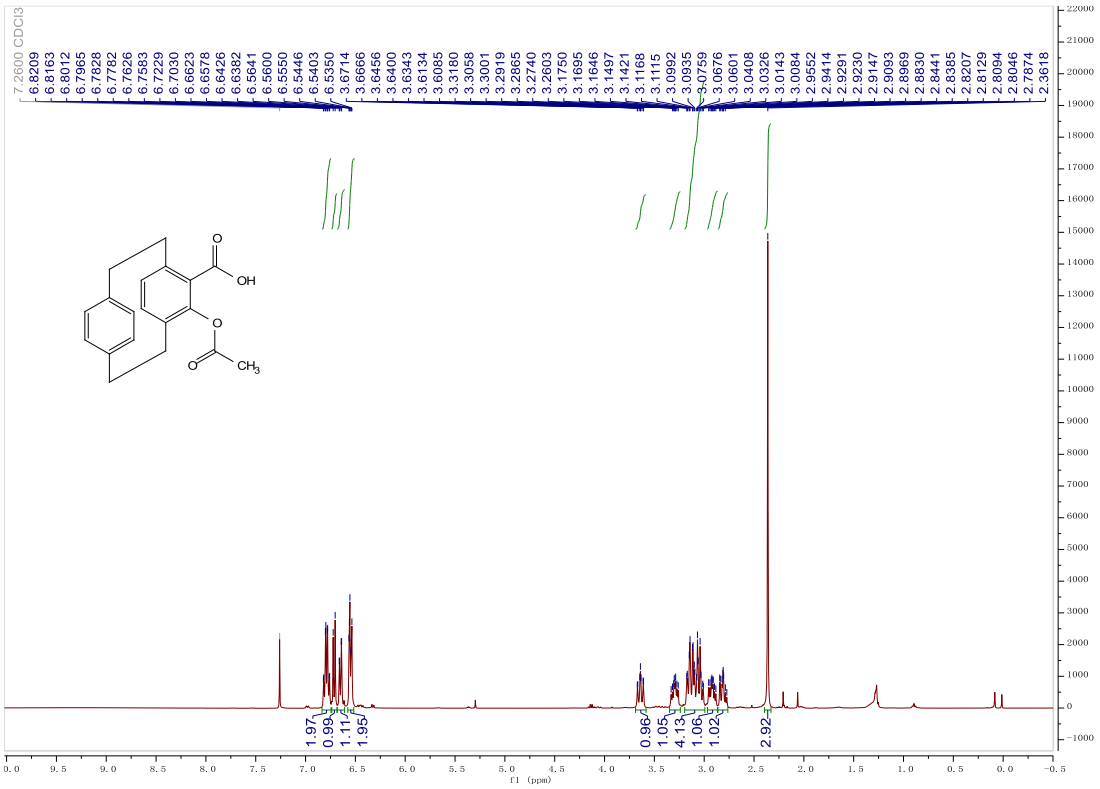
33.3596
29.5348
28.3081
24.1377
O
O
O
CH3
CH3
f1 (ppm)

11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6.7030
6.6623
6.6578
6.6426
6.6382
6.5641
6.5600
6.5550
6.5446
6.5403
6.5350
3.6714
3.6666
3.6456
3.6400
3.6343
3.6134
3.6085
3.3180
3.3058
3.3001
3.2919
3.2865
3.2740
3.2603
3.1750
3.1695
3.1646
3.1497
3.1421
3.1168
3.1115
3.0992
3.0935
3.0759
3.0676
3.0601
3.0408
3.0326
3.0143
3.0084
2.9552
2.9414
2.9291
2.9230
2.9147
2.9093
2.8969
2.8830
2.8441
2.8385
2.8207
2.8129
2.8094
2.8046
2.7874
2.3618
OH
O
O
CH3
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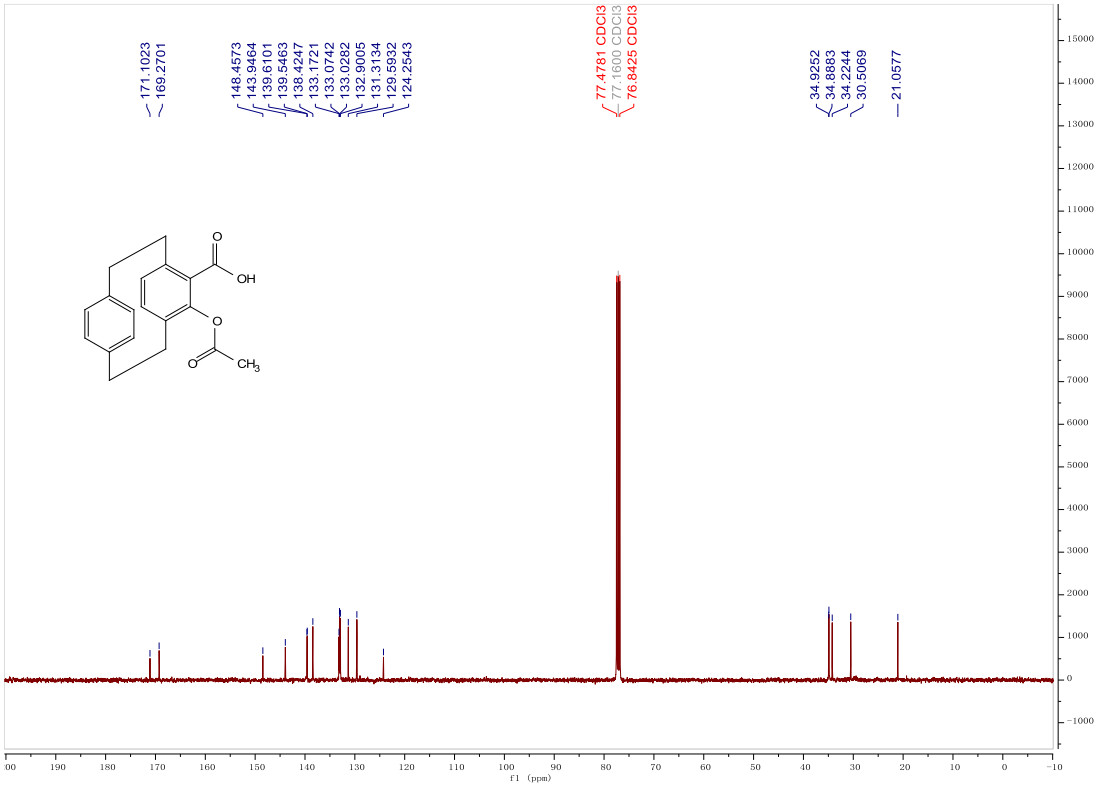
0.99
1.11
1.95
0.96
1.05
4.13
1.06
1.02
2.92
f1 (ppm)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148.4573
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132.9005
131.3134
129.5932
124.2543
77.4781 CDCl3
77.1600 CDCl3
76.8425 CDCl3
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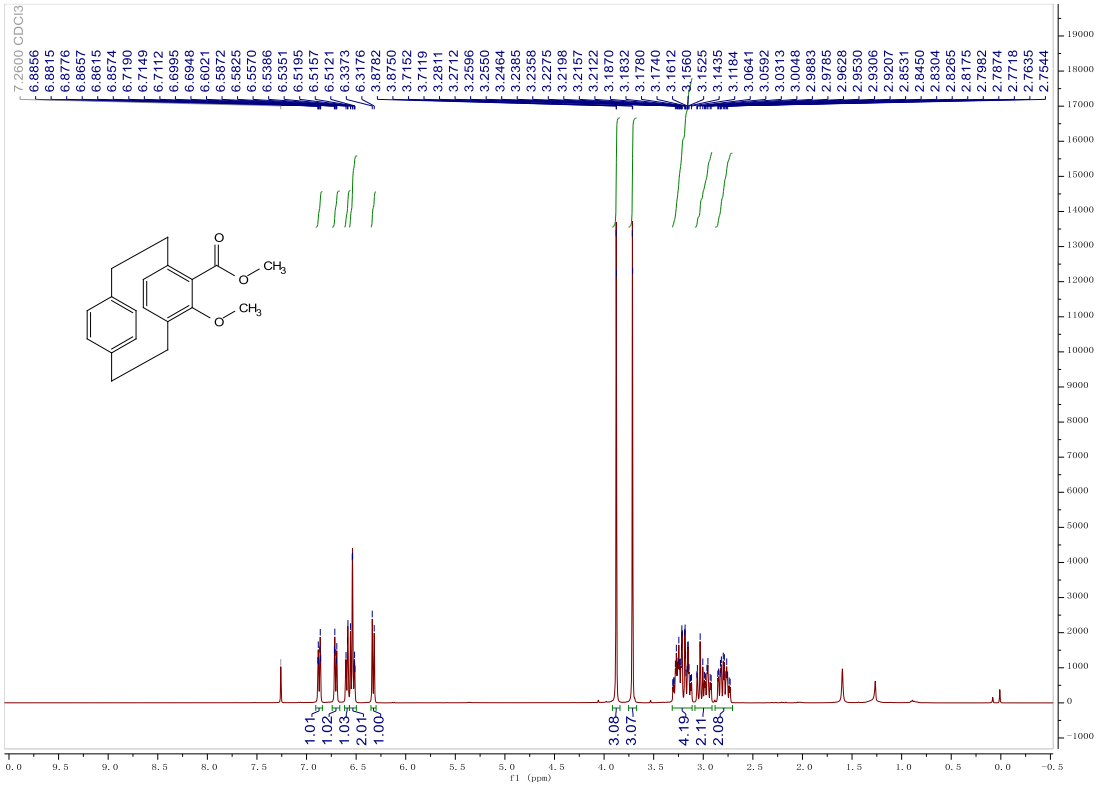
34.8883
34.2244
30.5069
21.0577
OH
O
O
CH3
f1 (ppm)

12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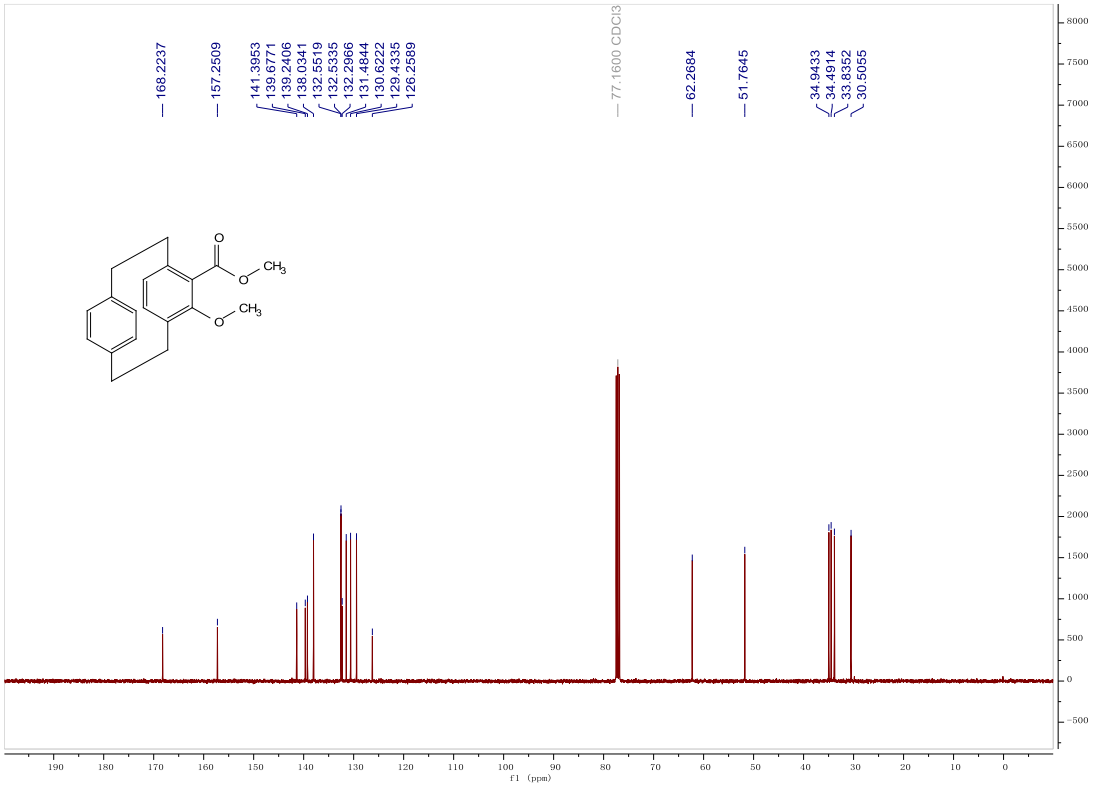
6.6995
6.6948
6.6021
6.5872
6.5825
6.5570
6.5386
6.5351
6.5195
6.5157
6.5121
6.3373
6.3176
3.8782
3.8750
3.7152
3.7119
3.2811
3.2712
3.2596
3.2550
3.2464
3.2385
3.2358
3.2275
3.2198
3.2157
3.2122
3.1870
3.1832
3.1780
3.1740
3.1612
3.1560
3.1525
3.1435
3.1184
3.0641
3.0592
3.0313
3.0048
2.9883
2.9785
2.9628
2.9530
2.9306
2.9207
2.8531
2.8450
2.8304
2.8265
2.8175
2.7982
2.7874
2.7718
2.7635
2.7544
O
O
CH3
O
CH3
1.01
1.02
1.03
2.01
1.00
3.08
3.07
4.19
2.11
2.08
f1 (ppm)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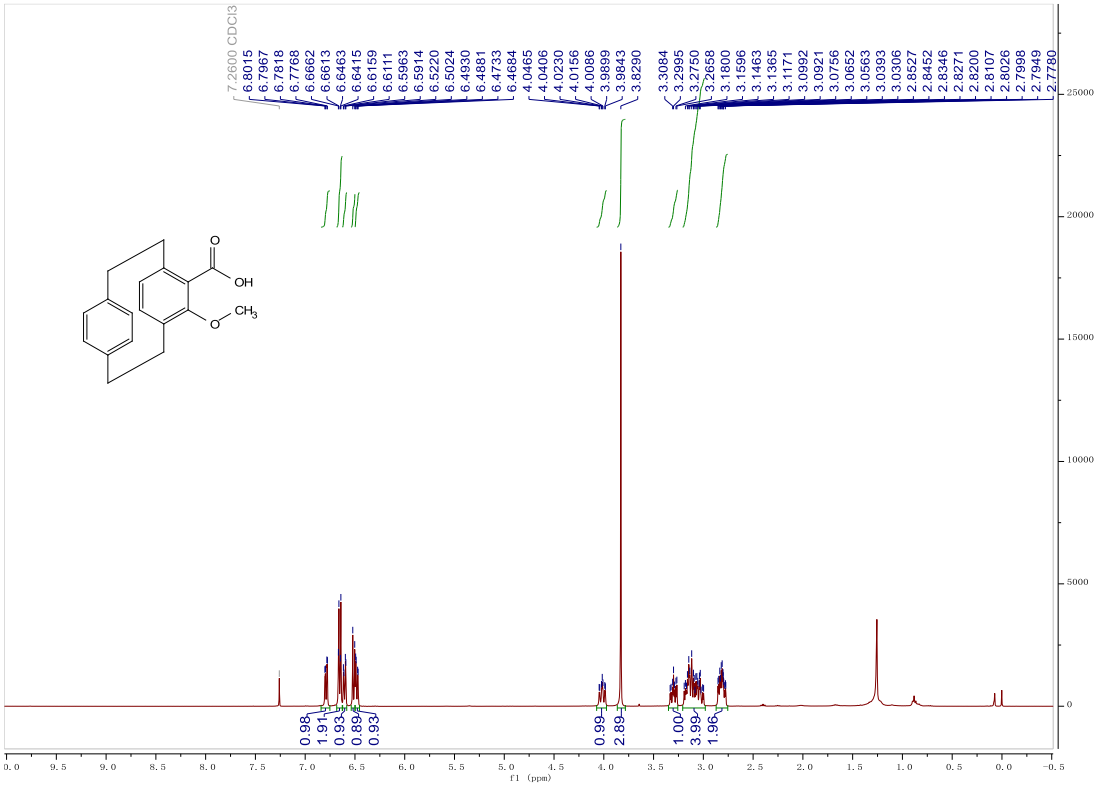
131.4844
130.6222
129.4335
126.2589
77.1600 CDCl3
62.2684
51.7645
34.9433
34.4914
33.8352
30.5055
O
O
CH3
O
CH3
f1 (ppm)

13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6.6613
6.6463
6.6415
6.6159
6.6111
6.5963
6.5914
6.5220
6.5024
6.4930
6.4881
6.4733
6.4684
4.0465
4.0406
4.0230
4.0156
4.0086
3.9899
3.9843
3.8290
3.3084
3.2995
3.2750
3.2658
3.1800
3.1596
3.1463
3.1365
3.1171
3.0992
3.0921
3.0756
3.0652
3.0563
3.0393
3.0306
2.8527
2.8452
2.8346
2.8271
2.8200
2.8107
2.8026
2.7998
2.7949
2.7780
OH
O
CH3
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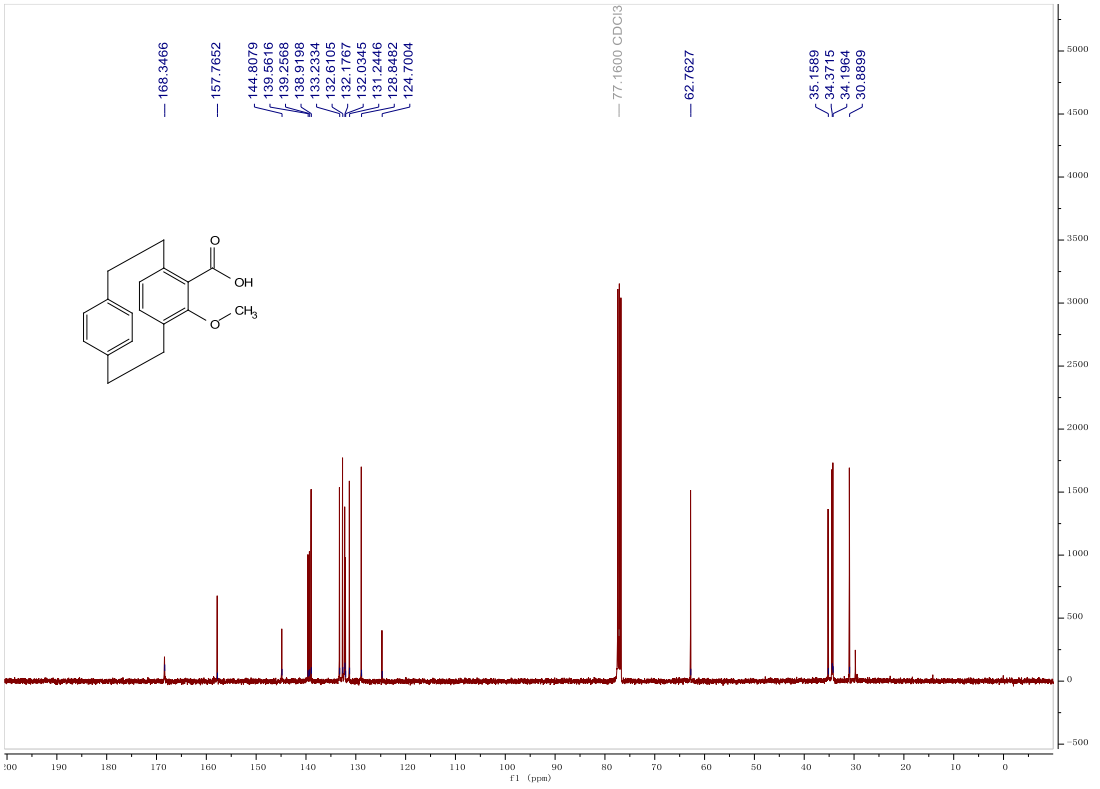
0.93
0.89
0.93
0.99
2.89
1.00
3.99
1.96
f1 (ppm)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139.2568
138.9198
133.2334
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132.1767
132.0345
131.2446
128.8482
124.7004
77.1600 CDCl3
62.7627
35.1589
34.3715
34.1964
30.8899
OH
O
CH3
f1 (ppm)