Supporting Information

Chiral Binaphthyl Box-Copper-Catalyzed Enantioselective Tandem Michael−Ketalization Annulations for Optically Active Aryl and Heteroaryl Fused Bicyclicnonanes

Wei-Tai Fan,† Xiao-Peng Yang,† Hao-Peng Lv,† Xing-Wang Wang*† and Zheng Wang*‡

†*Key Laboratory of Organic Synthesis of Jiangsu Province, College of Chemistry, Chemical Engineering and Materials Science, Soochow University, Suzhou 215123, the People's Republic of China*

Fax: +86-512-65882916

‡*State Key Laboratory of Organometallic Chemistry, Center for Excellence in Molecular Synthesis, Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences, Shanghai 200032, the People's Republic of China*

Fax:+86-21-54925146

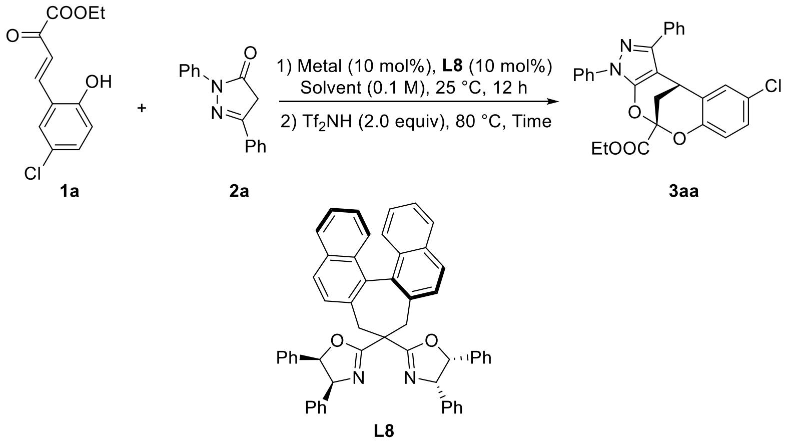
E-mail: wangxw@suda.edu.cn; wzsioc@mail.sioc.ac.cn

1. General methods

Unless otherwise noted, all reactions were carried out under an argon atmosphere as well as anhydrous conditions, and all reagents were purchased from commercial suppliers without further purification. Some commonly used solvents for asymmetric catalysis were dried with different drying agents through stardand methods reported, including of toluene, dichloromethane (DCM), 1,2-dichloroethane (DCE), tetrahdrofuran (THF), *m*-xylene, benzotrifluoride (BTF), ethylbenzene as well as fluorobenzene. Flash Chromatography was performed with silica gel (300–400 mesh) from Yantai Chemical Industry Research Institute, P. R. China. Analyical thin-layer chromatography (TLC) was performed with 0.2 ± 0.03 mm coated commercial silica gel plates (GF-254, particle size 0.04–0.05 mm). The ^{1}H and ^{13}C NMR spectra were recorded in $CDCl_3$, DMSO-d_6 on Varian Inova (400 MHz and 100 MHz, respectively) spectrometer. Chemical shifts (δ ppm) are relative to the resonance of the deuterated solvent as the internal standard ($CDCl_3$, δ 7.26 ppm for proton NMR, δ 77.23 ppm for carbon NMR; DMSO-d_6, δ 2.50 ppm for proton NMR, δ 39.52 ppm for carbon NMR). ^{1}H NMR data are reported as follows: chemical shift (δ, ppm), multiplicity (s = singlet, d = doublet, m = multiplet, td = triplet of doublets, dd= doublet of doublets), coupling constants (*J*) and assignment. The Data for ^{13}C NMR are reported in terms of chemical shift (δ, ppm). The IR spectra were recorded on a Varian 1000 FT-IR spectrometer. High-resolution mass spectra (HRMS) for all the compounds were determined on Micromass GCT-TOF mass spectrometer with ESI resource. High performance liquid chromatography (HPLC) was performed on an Agilent 1200 Series chromatographs using CHIRALCEL OD-H, ChIRALPAK AD-H, IA and IC columns. The X-ray data were recorded on a Rigaku Mercury CCD/AFC diffractomrter. Optical rotations were performed on Rudolph Aupol IV and reported as follows: $[\alpha]_D^{25}$ (*c* g per 100 mL, solvent).

2. Optimization of the reaction conditions

Table S1. Screening of metal salts and solvents[a]

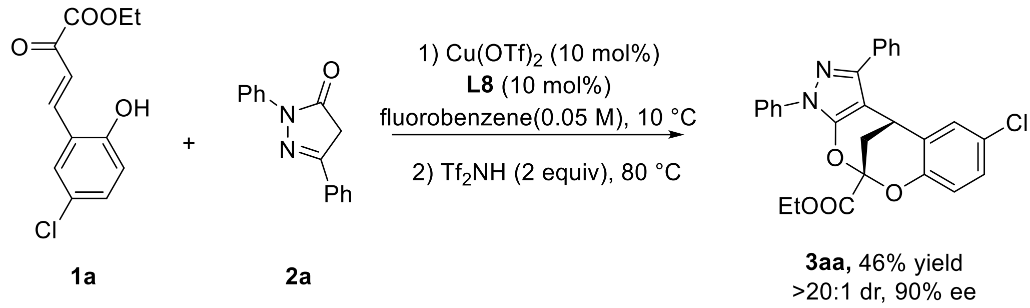


Entry[a]	Metal	Ligand	Solvent	Time (h)	Yield (%)[b]	*ee* (%)[c]
1	$Sc(OTf)_3$	**L8**	toluene	0.5	55	3
2	$Zn(OTf)_2$	**L8**	toluene	0.5	60	83
3	$Cu(OAc)_2$	**L8**	toluene	0.5	40	49
4	$Cu(OTf)_2$	**L8**	DCM	1.0	55	84
5	$Cu(OTf)_2$	**L8**	DCE	1.0	52	89
6	$Cu(OTf)_2$	**L8**	THF	0.5	26	80
7	$Cu(OTf)_2$	**L8**	PhEt	0.5	54	90
8	$Cu(OTf)_2$	**L8**	m-xylene	0.5	59	89
9	$Cu(OTf)_2$	**L8**	$PhCF_3$	0.5	30	90

[a]Unless otherwise noted, the reactions were carried out with **1a** (0.1 mmol), **2a** (0.13 mmol, 1.3 equiv), $Cu(OTf)_2$ (0.01 mmol, 10 mol%), and **L8** (0.01 mmol, 10 mol%) in the specified solvent (1.0 mL) at 25 ^{o}C for 12 h, followed by treatment of the reaction mixture with Tf_2NH (0.2 mmol, 2.0 equiv) at 80 ℃ in oil bath. [b]Isolated yield. [c]Determined by ^{1}H NMR for the crude products.

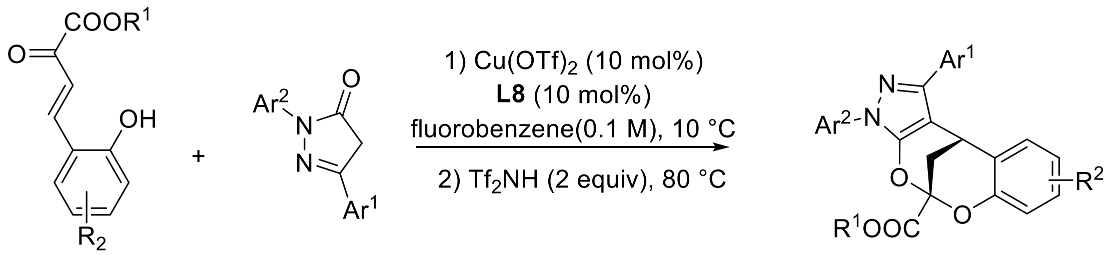
3. General and typical experimental procedure and data

3.1 Scale up synthesis of 3aa



Under N_2 atmosphere, $Cu(OTf)_2$ (72 mg, 0.2 mmol, 10 mol%) and **L8** (147.2 mg, 0.2 mmol, 10 mol%) were combined into a vessel, and fluorobenzene (5.0 mL) was added via syringe. After the reaction mixture was stirred at 10 ℃ for 0.5 hours, the substrates of (*E*)-2-hydroxyaryl-2-oxobut-3-enoate **1a** (508 mg, 2.0 mmol) and 2,5-diphenyl-2,4-dihydro-3H-pyrazol-3-one **2a** (566 mg, 2.4 mmol, 1.2 equiv) were included. The reaction mixture was further stirred until the reaction was complete (detected by TLC). Then Tf_2NH (4.0 mmol, 2.0 equiv) was introduced into the reaction mixture at 80 ℃ in oil bath for 1.0 hour. After the reaction was detected complete (by TLC analysis), the solvent was evaporated under reduced pressure and the residue was purified by column chromatography on silica gel with EtOAc/petroleum ether (1/10) as the eluent to give **3aa** as white solids in 46 % yield (434 mg) with >20:1 *dr* and 90 % *ee*.

3.2 General procedure for the preparation of 3aa–3ha

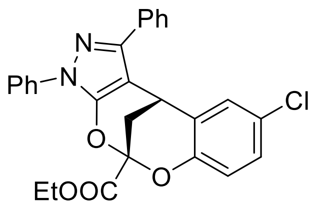


Under N_2 atmosphere, $Cu(OTf)_2$ (0.01 mmol, 10 mol%) and **L8** (0.01 mmol, 10 mol%) were combined into a vessel, and fluorobenzene (1.0 mL) was added via syringe. After the system was stirred at 10 ℃ for 0.5 hours, the substrates (*E*)-2-hydroxyaryl-2-oxobut-3-enoate **1** (0.1 mmol) and 2,5-diphenyl-2,4-dihydro-3H-pyrazol-3-one **2** (0.13 mmol, 1.3 equiv) were included. The reaction mixture was further stirred until the reaction was complete (detected by TLC). Then Tf_2NH (0.2 mmol, 2.0 equiv) was introduced into the reaction mixture at 80 ℃ in oil bath. After the reaction was detected complete (by TLC analysis), the solvent was evaporated under reduced pressure and the residue was purified by column chromatography on silica gel with EtOAc/petroleum ether (1/10) as the eluent to give **3** as solids.

All racemic samples described in this work were synthesized according above procedure, which were catalyzed by racemic Takemoto-thiourea as catalysts.

The substrates of (*E*)-2-hydroxyaryl-2-oxobut-3-enoates **1a−f** were prepared by the Wittig reaction between the corresponding phosphorus ylides and salicylaldehyde or salicylaldehyde derivatives according to the procedure of literatures reported.[1] The pyrazolone derivatives **2a−x** were synthesized by Knorr pyrazolone synthesis method according to the literatures reported, and the corresponding reaction proceeded through the condensation of ethyl 3-oxo-3-arylpropanoates with arylhydrazines and then cyclization.[2]

Ethyl-(5S,11S)-9-chloro-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylatee 3aa

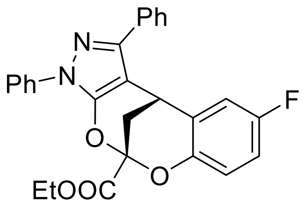


3aa

White solid; mp 138−139 ℃; 62% yield (29.3 mg), >20:1 dr, 92% ee [Daicel Chiralcel OD-H, hexanes/i-PrOH = 80/20, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 5.694, t (minor) = 11.075]; $[\alpha]_D^{25}$ = +20.0 (c 0.05, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ 7.91 – 7.81 (m, 4H), 7.54 – 7.47 (m, 2H), 7.46 – 7.38 (m, 3H), 7.28 – 7.23 (m, 1H), 7.20 (d, *J* = 2.4 Hz, 1H), 7.11 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.95 (d, *J* = 8.4 Hz, 1H), 4.50 – 4.37 (m, 2H), 4.34 (t, *J* = 3.2 Hz, 1H), 2.56 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.47 (dd, *J* = 13.6, 2.8 Hz, 1H), 1.42 (t, *J* = 6.8 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.7, 149.9, 147.7, 146.9, 138.3, 133.3, 129.2, 128.9, 128.5, 128.5, 128.2, 127.3, 127.2, 126,6, 126.4, 120.7, 118.5, 100.6, 98.3, 63.2, 29.3, 27.0, 14.2; IR (KBr) νmax: 2921, 1763, 1570, 1487, 1477, 1433, 1382, 1302, 1264, 1227, 1179, 1158, 1118, 1089, 1031, 1003, 985, 846, 819, 717, 694, 671, 664.cm^{-1}; HRMS (ESI): m/z = 495.1063 (calcd for $C_{27}H_{21}ClN_2O_4+Na^+$ = 495.1082).

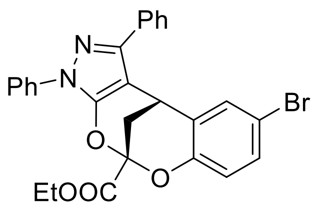
Ethyl-(5S,11S)-9-fluoro-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ba

White solid; mp 140−141 ℃; 66% yield (30.1 mg), >20:1 dr, 92% ee [Daicel Chiralcel OD-H, hexanes/i-PrOH = 80/20, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 5.699, t (minor) = 11.690]; $[\alpha]_D^{25}$ = −57.6 (c 0.13, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 – 7.87 (m, 2H), 7.87 – 7.82 (m, 2H), 7.53 – 7.46 (m, 2H), 7.46 – 7.37 (m, 3H), 7.28 – 7.21 (m, 1H), 6.99 – 6.90 (m, 2H), 6.88 – 6.80 (m, 1H), 4.50 – 4.38 (m, 2H), 4.35 (t, *J* = 2.8 Hz, 1H), 2.57 (dd, *J* = 13.6, 3.6 Hz, 1H), 2.47 (dd, *J* = 13.6, 3.2 Hz, 1H), 1.42 (t, *J* = 6.8 Hz, 3H); ^{19}F NMR (376 MHz, $CDCl_3$) δ –120.80; ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.9, 156.4, 147.9, 147.3(d, *J* = 2.4 Hz), 146.9, 138.3, 133.4, 129.2, 128.9, 128.5, 128.2 (d, *J* = 7.3 Hz), 127.2, 126.4, 120.7, 118.2 (d, *J* = 8.2 Hz), 114.8 (d, *J* = 23.5 Hz), 113.2 (d, *J* = 23.9 Hz), 100.6, 98.4, 63.1, 29.3, 27.1, 14.2; IR (KBr) νmax: 2918, 1594, 1584, 1517, 1457, 1340, 1285, 1222, 1211, 933, 903, 740, 733, 719, 673, 624, 607, 602.cm^{-1}; HRMS (ESI): m/z = 457.1552 (calcd for $C_{27}H_{21}FN_2O_4$+H^+ = 457.1558).



3ba

Ethyl-(5S,11S)-9-bromo-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylatee 3ca

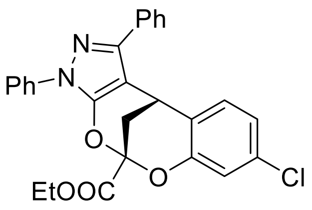


3ca

White solid; mp 132−133 ℃; 57% yield (29.4 mg), >20:1 dr, 92% ee [Daicel Chiralcel OD-H, hexanes/i-PrOH = 80/20, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 5.807, t (minor) = 10.087]; $[\alpha]_D^{25}$ = +89.3 (c 0.15, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 – 7.86 (m, 2H), 7.86 – 7.81 (m, 2H), 7.54 – 7.47 (m, 2H), 7.46 – 7.39 (m, 3H), 7.35 (d, *J* = 2.0 Hz, 1H), 7.29 – 7.20 (m, 2H), 6.89 (d, *J* = 8.4 Hz, 1H), 4.48 – 4.38 (m, 2H), 4.33 (t, *J* = 2.8 Hz, 1H), 2.55 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.46 (dd, *J* = 13.6, 2.8 Hz, 1H), 1.41 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.7, 150.5, 147.7, 147.0, 138.3, 133.3, 131.2, 129.5, 129.2, 129.0, 128.8, 128.5, 127.3, 126.4, 120.7, 118.9, 114.6, 100.6, 98.3, 63.2, 29.3, 26.9, 14.2; IR (KBr) νmax: 2923, 1754, 1518, 1457, 1267, 1221, 1130, 1119, 1092, 1070, 1058, 903, 853, 833, 758, 751, 703, 694, 671, 621, 613, 608cm^{-1}; HRMS (ESI): m/z = 517.0752 (calcd for $C_{27}H_{21}BrN_2O_4$+H^+ = 517.0757).

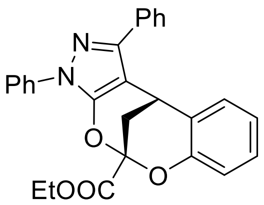
Ethyl-(5S,11S)-8-chloro-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3da

White solid; mp 173−174 ℃; 62% yield (29.3 mg), >20:1 dr, 91% ee [Daicel Chiralcel OD-H, hexanes/i-PrOH = 80/20, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 5.596, t (minor) = 9.360]; $[\alpha]_D^{25}$ = −12.0 (c 0.03, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ 7.90 – 7.86 (m, 2H), 7.86 – 7.81 (m, 2H), 7.52 – 7.36 (m, 5H), 7.29 – 7.22 (m, 1H), 7.13 (d, *J* = 8.4 Hz, 1H), 7.03 (d, *J* = 2.0 Hz, 1H), 6.91 (dd, *J* = 8.0, 2.0 Hz, 1H), 4.50 – 4.40 (m, 2H), 4.37 (t, *J* = 3.2 Hz, 1H), 2.58 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.47 (dd, *J* = 13.6, 3.2 Hz, 1H), 1.42 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.7, 151.9, 147.6, 146.9, 138.3, 133.4, 129.2, 128.8, 128.5, 127.5, 127.3, 126.4, 125.6, 122.6, 120.7, 117.6, 100.9, 98.2, 63.2, 29.4, 26.6, 14.2; IR (KBr) νmax: 2988, 1745, 1409, 1386, 1374, 1153, 1133, 1076, 914, 901, 883, 840, 754, 730, 717, 687, 619, 609, 603.cm^{-1}; HRMS (ESI): m/z = 473.1273 (calcd for $C_{27}H_{21}ClN_2O_4+H^+$ = 473.1263).



3da

Ethyl-(5S,11S)-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c] pyrazole-5-carboxylate 3ea



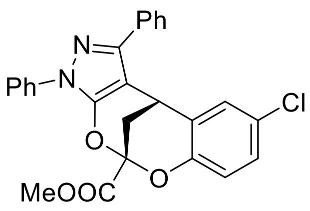
3ea

White solid; mp 144−145 ℃; 70% yield (34.7 mg), >20:1 dr, 96% ee [Daicel Chiralcel OD-H, hexanes/i-PrOH = 80/20, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 5.569, t (minor) = 9.622]; $[\alpha]_D^{25}$ = −12.0 (c 0.03, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ 7.90 – 7.75 (m, 4H), 7.46 – 7.29 (m, 5H), 7.21 – 7.18 (m, 1H), 7.17 – 7.14 (m, 1H), 7.08 (td, *J* = 7.6, 1.6 Hz, 1H), 6.94 (d, *J* =8.0 Hz, 1H), 6.87 (t, *J* = 7.6 Hz, 1H), 4.41 – 4.34 (m, 2H), 4.32 (t, *J* = 2.8 Hz, 1H), 2.50 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.43 (dd, *J* = 13.2, 2.8 Hz, 1H), 1.35 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.1, 151.3, 147.8, 146.9, 138.4, 133.6, 129.1, 128.7, 128.4, 128.3, 127.4, 126.9, 126.8, 126.3, 122.5, 120.7, 117.2, 101.3, 98.4, 63.0, 29.6, 27.0, 14.2; IR (KBr) νmax: 2850, 1595, 1513, 1384, 1313, 1215, 1153, 1108, 1002, 990, 851, 733, 692, 678, 656.cm^{-1}; HRMS (ESI): m/z = 439.1625 (calcd for $C_{27}H_{22}N_2O_4+H^+$ = 439.1652).

Methyl-(5S,11S)-9-chloro-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino [4,5-c]pyrazole-5-carboxylatee 3fa

White solid; mp 137−138 ℃; 63% yield (28.9 mg), >20:1 dr, 92% ee [Daicel Chiralcel OD-H, hexanes/i-PrOH = 80/20, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 6.440, t (minor) = 16.512]; $[\alpha]_D^{25}$ = −17.0 (c 0.03, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ 7.91 – 7.78 (m, 4H), 7.54 –

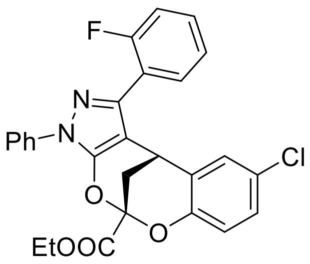
7.47 (m, 2H), 7.46 – 7.38 (m, 3H), 7.30 – 7.23 (m, 1H), 7.20 (d, *J* = 2.4 Hz, 1H), 7.11 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.94 (d, *J* = 8.8 Hz, 1H), 4.34 (t, *J* = 3.2 Hz, 1H), 3.98 (s, 3H), 2.57 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.46 (dd, *J* = 13.6, 2.8 Hz, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.3, 149.9, 147.7, 147.6, 147.0, 138.3, 133.3, 129.2, 128.9, 128.6, 128.5, 128.3, 127.3, 126.6, 126.5, 120.8, 118.4, 100.5, 98.4, 53.9, 29.4, 26.9; IR (KBr) νmax: 1766, 1571, 1458, 1381, 1285, 1202, 1174, 1019, 987, 906, 841, 816, 782, 716, 689, 671, 654.cm^{-1}; HRMS (ESI): m/z = 481.0924 (calcd for $C_{26}H_{19}ClN_2O_4$+Na^+ = 481.0926).



3fa

Ethyl-(5S,11S)-9-chloro-1-(2-fluorophenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8] [1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ab

White solid; mp 135−136 ℃; 58% yield (28.4 mg), >20:1 dr, 90% ee [Daicel Chiralcel IA-H, hexanes/i-PrOH = 97/3, flow rate: 0.5 mL/min, λ = 254.4 nm, t (major) = 14.934, t (minor) = 14.095]; $[\alpha]_D^{25}$ = +43.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 – 7.82 (m, 2H), 7.71 (td, *J* = 7.6, 2.0 Hz, 1H), 7.49 – 7.37 (m, 3H), 7.30 – 7.19 (m, 3H), 7.06 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.94 – 6.87 (m, 2H), 4.50 – 4.35 (m, 2H), 4.32 (t, *J* = 3.2 Hz, 1H), 2.63 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.47 (dd, *J* = 13.6, 3.2 Hz, 1H), 1.42 (t, *J* = 7.2 Hz, 3H); ^{19}F NMR (376 MHz, $CDCl_3$) δ –113.79; ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.8, 161.1, 158.6, 149.8, 147.6, 142.5, 138.2, 131.2 (d, *J* = 3.8 Hz), 130.6, 130.5, 129.2, 128.5, 128.0, 126.8 (d, *J* = 2.5 Hz), 126.5, 124.7 (d, *J* = 3.3 Hz), 120.7, 118.3, 116.1 (d, *J* = 22.2 Hz), 102.6, 98.5 , 63.2 29.1, 26.7, 14.2; IR (KBr) νmax: 2962, 1763, 1415, 1383, 1341, 1301, 1127, 1119, 945, 853, 837, 822, 802, 774, 766, 706, 693, 674, 668, 663, 650, 636, 614, 610.cm^{-1}; HRMS (ESI): m/z = 513.0976 (calcd for $C_{27}H_{20}ClFN_2O_4$+Na^+ = 513.0988).

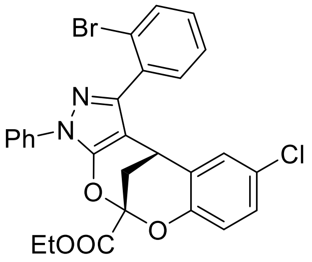


3ab

Ethyl-(5S,11S)-1-(2-bromophenyl)-9-chloro-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8] [1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ac

White solid; mp 110−111 ℃; 39% yield (21.5 mg), >20:1 dr, 93% ee [Daicel Chiralcel IA-H, hexanes/i-PrOH = 95/5, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 6.613, t (minor) = 5.996]; $[\alpha]_D^{25}$ = +47.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 – 7.81 (m, 2H), 7.73 (dd, *J* = 7.6, 1.2 Hz, 1H), 7.45 – 7.39 (m, 3H), 7.38 – 7.30 (m, 2H), 7.28 – 7.21 (m, 1H), 7.06 (dd, *J* = 8.8, 2.8 Hz, 1H), 6.92 (d, J = 8.8 Hz, 1H), 6.65 (d, *J* = 2.8 Hz, 1H), 4.49 – 4.47 (m, 2H), 4.08 (t, *J* =

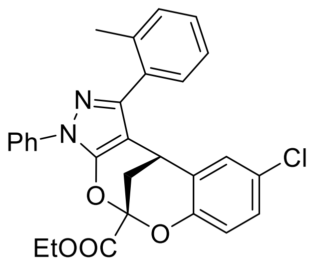
3.2 Hz, 1H), 2.63 (dd, *J* = 13.2, 3.2 Hz, 1H), 2.46 (dd, *J* = 13.6, 3.0 Hz, 1H), 1.43 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.1, 149.2, 146.6, 146.4, 137.6, 133.5, 132.5, 131.5, 129.9, 128.5, 127.8, 127.4, 127.0, 126.5, 126.0, 125.8, 122.7, 119.9, 117.6, 102.2, 98.1, 62.6, 28.1, 26.2, 13.6; IR (KBr) νmax: 2919, 1749, 1515, 1455, 1385, 1266, 1180, 1090, 1048, 1025, 903, 878, 822, 755, 724, 644; HRMS (ESI): m/z = 573.0185 (calcd for $C_{27}H_{20}BrClN_2O_4$+Na^+ = 573.0187).



3ac

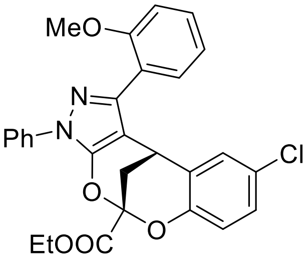
Ethyl-(5S,11S)-9-chloro-3-phenyl-1-(o-tolyl)-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3ad

White solid; mp 143−144 ℃; 65% yield (31.6 mg), >20:1 dr, 88% ee [Daicel Chiralcel IA-H, hexanes/i-PrOH = 95/5, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 5.962, t (minor) = 5.519]; $[\alpha]_D^{25}$ = +81.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 – 7.77 (m, 2H), 7.45 – 7.39 (m, 2H), 7.36 – 7.27 (m, 4H), 7.23 (d, *J* = 7.6 Hz, 1H), 7.09 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.93 (d, *J* = 8.8 Hz, 1H), 6.82 (d, *J* = 2.4 Hz, 1H), 4.52 – 4.36 (m, 2H), 3.89 (t, *J* = 3.2 Hz, 1H), 2.55 (dd, *J* = 13.6, 3.6 Hz, 1H), 2.43 (dd, *J* = 13.6, 2.8 Hz, 1H), 2.27 (s, 3H), 1.43 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.8, 149.9, 147.9, 147.2, 138.4, 137.5, 132.1, 130.7, 130.2, 129.1, 128.8, 128.6, 128.0, 127.1, 126.7, 126.2, 125.6, 120.3, 118.3, 102.1, 98.6, 63.2, 29.2, 26.5, 20.3, 14.2; IR (KBr) νmax: 1767, 1579, 1482, 1384, 1286, 1224, 1174, 1108, 1034, 1002, 901, 768, 732, 616.cm^{-1}; HRMS (ESI): m/z = 509.1214 (calcd for $C_{28}H_{23}ClN_2O_4$+Na^+ = 509.1239).



3ad

Ethyl-(5S,11S)-1-(2-methoxyphenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3ae

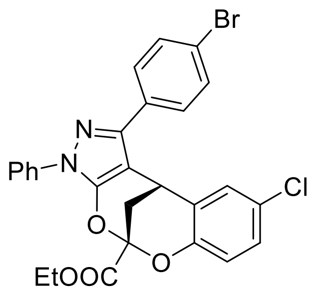


3ae

White solid; mp 109−110 ℃; 45% yield (22.6 mg), >20:1 dr, 87% ee [Daicel Chiralcel IC-H, hexanes/i-PrOH = 80/20, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 8.362, t (minor) = 6.968]; $[\alpha]_D^{25}$ = +45.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 – 7.76 (m, 2H), 7.49 – 7.33 (m, 4H), 7.27 – 7.15 (m, 1H), 7.09 – 6.97 (m, 3H), 6.91 (d, *J* = 8.4 Hz, 1H), 6.78 (d, *J* = 2.8 Hz, 1H), 4.49 – 4.47 (m, 2H), 4.13 (t, *J* = 3.2 Hz, 1H), 3.85 (s, 3H), 2.59 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.42 (dd, *J* = 13.2, 2.8 Hz, 1H), 1.42 (t, J = 6.8 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.9, 157.1, 149.9, 147.1, 145.4, 138.4, 131.7, 130.3, 129.1, 128.7, 127.8, 127.1, 126.7, 126.1, 122.1, 121.1, 120.5, 118.1, 111.2, 103.0, 98.6, 63.1, 55.8, 29.1, 26.8, 14.2; IR (KBr) νmax: 1752, 1600, 1520, 1467, 1390, 1262, 1231, 1178, 1064, 1047, 999, 911, 852, 800, 758, 706, 691.cm^{-1}; HRMS (ESI): m/z = 525.1190 (calcd for $C_{28}H_{23}ClN_2O_5$+Na^+ = 525.1188).

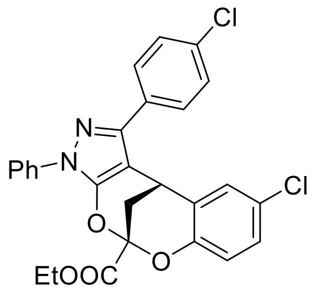
Ethyl-(5S,11S)-1-(4-bromophenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3af

White solid; mp 140−141 ℃; 51% yield (28.1 mg), >20:1 dr, 90% ee [Daicel Chiralcel OD-H, hexanes/i-PrOH = 95/5, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 10.303, t (minor) = 12.629]; $[\alpha]_D^{25}$ = +53.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (dd, J = 8.8, 1.2 Hz, 2H), 7.73 (d, J = 8.4 Hz, 2H), 7.63 (d, J = 8.4 Hz, 2H), 7.50 – 7.41 (m, 2H), 7.32 – 7.24 (m, 1H), 7.16 (d, J = 2.4 Hz, 1H), 7.12 (dd, J = 8.8, 2.8 Hz, 1H), 6.95 (d, J = 8.8 Hz, 1H), 4.50 – 4.37 (m, 2H), 4.31 (t, J = 3.2 Hz, 1H), 2.57 (dd, J = 13.6, 2.8 Hz, 1H), 2.47 (dd, J = 13.6, 3.2 Hz, 1H), 1.42 (t, J = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.6, 149.9, 147.8, 145.8, 138.2, 132.3, 132.0, 129.2, 128.7, 128.4, 128.3, 127.3, 126.6, 126.4, 122.7, 120.7, 118.6, 100.5, 98.3, 63.2, 29.3, 27.0, 14.2; IR (KBr) νmax: 2920, 1759, 1479, 1453, 1407, 1260, 1238, 1224, 1197, 1177, 1119, 901, 882, 852, 815, 671, 664, 657cm^{-1}; HRMS (ESI): m/z = 573.0176 (calcd for $C_{27}H_{20}BrClN_2O_4$+Na^+ = 573.0187).



3af

Ethyl-(5S,11S)-9-chloro-1-(4-chlorophenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ag

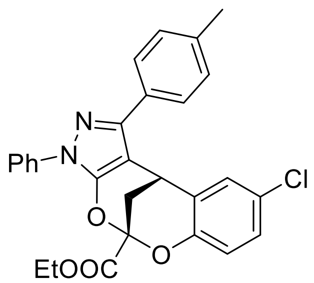


3ag

White solid; mp 125−126 ℃; 57% yield (28.8 mg), >20:1 dr, 94% ee [Daicel Chiralcel OD-H, hexanes/i-PrOH = 95/5, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 9.834, t (minor) = 12.007]; $[\alpha]_D^{25}$ = +67.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 – 7.84 (m, 2H), 7.79 (d, J = 8.4 Hz, 2H), 7.51 – 7.39 (m, 4H), 7.30 – 7.22 (m, 1H), 7.16 (d, J = 2.4 Hz, 1H), 7.11 (dd, J = 8.8, 2.8 Hz, 1H), 6.95 (d, J = 8.8 Hz, 1H), 4.50 – 4.40 (m, 2H), 4.31 (t, J = 3.2 Hz, 1H), 2.57 (dd, J = 13.6, 3.2 Hz, 1H), 2.48 (dd, J = 13.6, 3.2 Hz, 1H), 1.42 (t, J = 6.8 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.7, 149.9, 147.8, 145.8, 138.2, 134.4, 131.9, 129.2, 129.1, 128.5, 128.4, 128.3, 127.3, 126.6, 126.4, 120.7, 118.6, 100.5, 98.3, 63.2, 29.3, 27.0, 14.2; IR (KBr) νmax: 1742, 1562, 1513, 1477, 1312, 1222, 1174, 1119, 1060, 993, 901, 831, 799, 754, 729, 691, 613.cm^{-1}; HRMS (ESI): m/z = 507.0880 (calcd for $C_{27}H_{20}Cl_2N_2O_4$+H^+ = 507.0873).

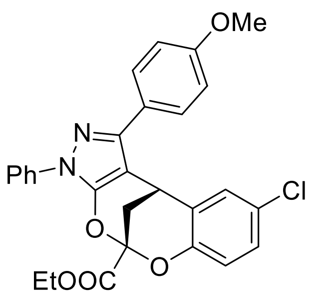
Ethyl-(5S,11S)-9-chloro-3-phenyl-1-(p-tolyl)-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3ah

White solid; mp 120−121 ℃; 50% yield (24.3 mg), >20:1 dr, 92% ee [Daicel Chiralcel OD-H, hexanes/i-PrOH = 80/20, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 5.804, t (minor) = 7.772]; $[\alpha]_D^{25}$ = +27.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 – 7.84 (m, 2H), 7.74 (d, *J* = 6.4 Hz, 2H), 7.42 (dd, *J* = 7.6, 2.0 Hz, 2H), 7.31 (d, *J* = 8.0 Hz, 2H), 7.27 – 7.18 (m, 2H), 7.10 (dd, *J* = 8.4, 2.4 Hz, 1H), 6.94 (d, *J* = 8.4 Hz, 1H), 4.49 – 4.37 (m, 2H), 4.33 (t, *J* = 3.2 Hz, 1H), 2.55 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.49 – 2.36 (m, 4H), 1.41 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.8, 149.9, 147.6, 147.0, 138.4, 138.3, 130.4, 129.6, 129.1, 128.5, 128.2, 127.2, 127.1, 126.6, 126.3, 120.6, 118.4, 100.4, 98.3, 63.1, 29.3, 27.0, 21.5, 14.2; IR (KBr) νmax: 1767, 1579, 1454, 1301, 1262, 1174, 1108, 1034, 1002, 852, 768, 732, 699, 663, 616.cm^{-1}; HRMS (ESI): m/z = 509.1241 (calcd for $C_{28}H_{23}ClN_2O_4$+Na^+ = 509.1239).



3ah

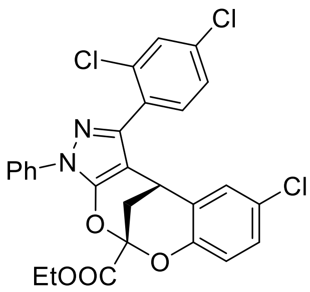
Ethyl-(5S,11S)-9-chloro-1-(4-methoxyphenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo [7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ai



3ai

White solid; mp 146−147 ℃; 53% yield (26.6 mg), >20:1 dr, 90% ee [Daicel Chiralcel AD-H, hexanes/i-PrOH = 85/15, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 7.955, t (minor) = 10.435]; $[\alpha]_D^{25}$ = +122.0 (c 0.1, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 – 7.83 (m, 2H), 7.77 (d, *J* = 8.8 Hz, 2H), 7.47 – 7.37 (m, 2H), 7.28 – 7.22 (m, 1H), 7.19 (d, *J* = 3.2 Hz, 1H), 7.10 (dd, *J* = 8.4, 2.4 Hz, 1H), 7.03 (d, *J* = 8.8 Hz, 2H), 6.94 (d, *J* = 8.8 Hz, 1H), 4.49 – 4.37 (m, 2H), 4.31 (t, *J* = 3.2 Hz, 1H), 3.89 (s, 3H), 2.56 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.46 (dd, *J* = 13.6, 2.8 Hz, 1H), 1.42 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.8, 159.9, 149.9, 147.6, 146.9, 138.4, 129.1, 128.6, 128.5, 128.2, 127.2, 126.5, 126.2, 125.9, 120.6, 118.5, 114.3, 100.2, 98.3, 63.2, 55.5, 29.3, 27.0, 14.2; IR (KBr) νmax: 2961, 1760, 1517, 1455, 1370, 1342, 1300, 1224, 1204, 1116, 1062, 1031, 986, 887, 854, 798, 770, 756, 712, 693, 656, 618.cm^{-1}; HRMS (ESI): m/z = 525.1169 (calcd for $C_{28}H_{23}ClN_2O_5$+Na^+ = 525.1188).

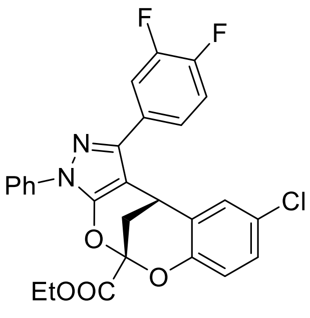
Ethyl-(5S,11S)-9-chloro-1-(2,4-dichlorophenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo [7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3aj



3aj

White solid; mp 146−147 ℃; 53% yield (28.6 mg), >20:1 dr, 91% ee [Daicel Chiralcel IA-H, hexanes/i-PrOH = 95/5, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 7.360, t (minor) = 6.178]; $[\alpha]_D^{25}$ = +67.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (dd, *J* = 8.8, 1.6 Hz, 2H), 7.57 (t, *J* = 1.2 Hz, 1H), 7.42 (dd, *J* = 7.6, 1.2 Hz, 2H), 7.36 (d, *J* = 1.6 Hz, 2H), 7.29 – 7.22 (m, 1H), 7.07 (dd, *J* = 8.4, 2.4 Hz, 1H), 6.92 (d, *J* = 8.4 Hz, 1H), 6.71 (d, *J* = 2.4 Hz, 1H), 4.52 – 4.35 (m, 2H), 4.09 (t, *J* = 3.2 Hz, 1H), 2.62 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.47 (dd, *J* = 13.6, 3.2 Hz, 1H), 1.42 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.6, 149.8, 147.3, 144.5, 138.1, 135.5, 134.1, 132.9, 130.8, 129.9, 129.2, 128.3, 128.1, 127.5, 127.2, 126.6, 126.5, 120.6, 118.3, 103.0, 98.6, 63.2, 28.8, 26.9, 14.2; IR (KBr) νmax: 1752, 1552, 1543, 1487, 1332, 1272, 1184, 1149, 1030, 993, 831, 799, 764, 749, 653.cm^{-1}; HRMS (ESI): m/z = 563.0272 (calcd for $C_{27}H_{19}Cl_3N_2O_4$+Na^+ = 563.0303).

Ethyl-(5S,11S)-9-chloro-1-(3,4-difluorophenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo [7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ak

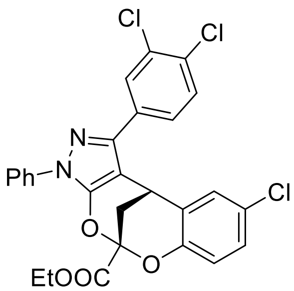


3ak

White solid; mp 147−148 ℃; 56% yield (28.4 mg), >20:1 dr, 86% ee [Daicel Chiralcel IA-H, hexanes/i-PrOH = 80/20, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 6.989, t (minor) = 6.449]; $[\alpha]_D^{25}$ = +45.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 – 7.83 (m, 2H), 7.73 – 7.65 (m, 1H), 7.60 – 7.53 (m, 1H), 7.44 (dd, *J* = 9.2, 1.6 Hz, 2H), 7.34 – 7.29 (m, 1H), 7.26 (d, *J* = 8.0 Hz, 1H), 7.16 (d, *J* = 2.8 Hz, 1H), 7.12 (dd, *J* = 8.4, 2.4 Hz, 1H), 6.95 (d, *J* = 8.8 Hz, 1H), 4.50-4.36 (m, 2H), 4.30 (t, *J* = 3.2 Hz, 1H), 2.57 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.48 (dd, *J* = 13.6, 3.2 Hz, 1H), 1.42 (t, *J* = 7.2 Hz, 3H); ^{19}F NMR (376 MHz, $CDCl_3$) δ –136.92 (d, *J* = 15.8 Hz), –137.78 (d, *J* = 16.2 Hz); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.6, 151.9, 149.9, 149.4, 147.9, 144.9, 138.1, 129.2, 128.4, 128.2, 127.4, 126.7, 126.3, 123.4 – 122.4 (m), 120.7, 118.6, 117.72 (d, *J* = 17.4 Hz), 116.3 (d, *J* = 18.4 Hz), 100.5, 98.3, 63.2, 29.2, 26.9, 14.2; IR (KBr) νmax: 1752, 1514, 1486, 1374, 1309, 1217, 1104, 1057, 921, 848, 821, 757, 723, 664.cm^{-1}; HRMS (ESI): m/z = 509.1073 (calcd for $C_{27}H_{19}ClF_2N_2O_4+H^+$ = 509.1074).

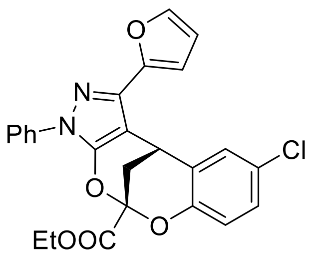
Ethyl-(5S,11S)-9-chloro-1-(3,4-dichlorophenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo [7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3al

White solid; mp 154–155 ℃; 51% yield (27.5 mg), >20:1 dr, 90% ee [Daicel Chiralcel IA-H, hexanes/i-PrOH = 95/5, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 8.994, t (minor) = 10.505]; $[\alpha]_D^{25}$ = +56.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, *J* = 2.0 Hz, 1H), 7.89 – 7.78 (m, 2H), 7.70 (dd, *J* = 8.4, 2.0 Hz, 1H), 7.56 (d, *J* = 8.4 Hz, 1H), 7.44 (dd, *J* = 7.6, 1.2 Hz, 2H), 7.31 – 7.24 (m, 1H), 7.22 (d, *J* = 2.8 Hz, 1H), 7.13 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.96 (d, *J* = 8.4 Hz, 1H), 4.50 – 4.36 (m, 2H), 4.29 (t, *J* = 3.2 Hz, 1H), 2.56 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.48 (dd, *J* = 13.6, 2.8 Hz, 1H), 1.42 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.5, 149.9, 147.9, 144.6, 138.0, 133.4, 133.1, 132.4, 130.9, 129.2, 129.0, 128.5, 128.1, 127.5, 126.8, 126.4, 126.2, 120.7, 118.6, 100.5, 98.3, 63.2, 29.3, 27.0, 14.2; IR (KBr) νmax: 2920, 1751, 1515, 1454, 1285, 1161, 1139, 1114, 898, 860, 817, 707, 670, 665, 614.cm^{-1}; HRMS (ESI): m/z = 541.0483 (calcd for $C_{27}H_{19}Cl_3N_2O_4+H^+$ = 541.0483).



3al

Ethyl-(5S,11S)-9-chloro-1-(furan-2-yl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3am

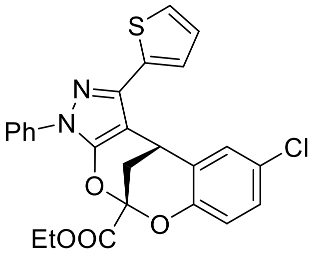


3am

White solid; mp 134–135 ℃; 49% yield (22.6 mg), >20:1 dr, 79% ee [Daicel Chiralcel OD-H, hexanes/i-PrOH = 80/20, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 5.346, t (minor) = 7.796]; $[\alpha]_D^{25}$ = +37.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 – 7.73 (m, 2H), 7.63 (dd, *J* = 2.0, 0.8 Hz, 1H), 7.46 – 7.36 (m, 3H), 7.28 – 7.21 (m, 1H), 7.08 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.92 (d, *J* = 8.8 Hz, 1H), 6.87 (dd, *J* = 3.6, 0.8 Hz, 1H), 6.55 (dd, *J* = 3.6, 2.0 Hz, 1H), 4.51 (t, *J* = 2.8 Hz, 1H), 4.49 – 4.36 (m, 2H), 2.56 (dd, *J* = 13.6, 3.6 Hz, 1H), 2.48 (dd, *J* = 13.6, 3.2 Hz, 1H), 1.41 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.7, 149.8, 148.9, 147.5, 142.3, 139.0, 138.1, 129.2, 128.5, 128.0, 127.2, 127.1, 126.5, 120.7, 118.1, 111.7, 106.7, 100.4, 98.7, 63.1, 28.9, 26.5, 14.2; IR (KBr) νmax: 1742, 1595, 1519, 1310, 1282, 1153, 1136, 1081, 923, 879, 871, 849, 818, 753, 709, 689.cm^{-1}; HRMS (ESI): m/z = 463.1047 (calcd for $C_{25}H_{19}ClN_2O_5+H^+$ = 463.1055).

Ethyl-(5S,11S)-9-chloro-3-phenyl-1-(thiophen-2-yl)-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3an

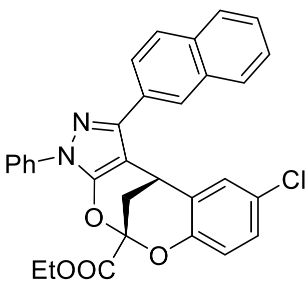
White solid; mp 156–157 ℃; 56% yield (26.8 mg), >20:1 dr, 86% ee [Daicel Chiralcel OD-H, hexanes/i-PrOH = 80/20, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 6.400, t (minor) = 12.444]; $[\alpha]_D^{25}$ = +14.0 (c 0.06, $CHCl_3$); ^{1}H NMR (400 MHz, DMSO-d6) δ 7.85 (dd, *J* = 3.6, 3.2 Hz, 1H), 7.80 – 7.73 (m, 2H), 7.63 (dd, *J* = 4.8, 0.8 Hz, 1H), 7.58 – 7.50 (m, 4H), 7.40 – 7.33 (m, 1H), 7.28 – 7.21 (m, 2H), 7.03 (d, *J* = 8.8 Hz, 1H), 4.72 (t, *J* = 3.2 Hz, 1H), 4.42 – 4.35 (m, 2H), 2.74 (dd, *J* = 14.0, 3.2 Hz, 1H), 1.33 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.6, 149.8, 147.7, 141.7, 138.1, 135.6, 129.2, 128.3, 128.1, 127.7, 127.2, 126.7, 126.5, 125.4, 124.8, 120.7, 118.4, 100.1, 98.4, 63.2, 29.2, 26.7, 14.2; IR (KBr) νmax:, 1753, 1595, 1512, 1487, 1477, 1405, 1369, 1331, 1260, 1213,1134, 1054, 957, 915, 882, 844, 800, 769, 686, 667, 660.cm^{-1}; HRMS (ESI): m/z = 479.0821 (calcd for $C_{25}H_{19}ClN_2O_4S+H^+$ = 479.0827).



3an

Ethyl-(5S,11S)-9-chloro-1-(naphthalen-2-yl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ao

White solid; mp 178–179 ℃; 65% yield (33.9 mg), >20:1 dr, 94% ee [Daicel Chiralcel OD-H, hexanes/i-PrOH = 80/20, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 7.403, t (minor) = 11.850]; $[\alpha]_D^{25}$ = –35.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.28 (d, *J* = 3.2 Hz, 1H), 8.04 – 7.94 (m, 3H), 7.94 – 7.87 (m, 3H), 7.60 – 7.50 (m, 2H), 7.48 – 7.41 (m, 2H), 7.35 (d, *J* = 2.4 Hz, 1H), 7.30 – 7.27 (m, 1H), 7.14 (dd, *J* = 8.4, 2.4 Hz, 1H), 6.98 (d, *J* = 8.8 Hz, 1H), 4.52 – 4.34 (m, 3H), 2.60 (dd, *J* = 13.6, 3.6 Hz, 1H), 2.50 (dd, *J* = 13.6, 3.2 Hz, 1H), 1.43 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.1, 149.5, 147.2, 146.5, 137.7, 132.9, 132.8, 130.2, 128.6, 128.0, 127.9, 127.8, 127.7, 127.4, 126.6, 126.2, 126.1, 125.9, 125.8, 124.6, 120.1, 118.0, 117.9, 100.1, 97.8, 62.6, 28.8, 26.5, 13.6; IR (KBr) νmax: 1752, 1595, 1455, 1371, 1221, 1140, 1058, 1032, 1002, 914, 884, 856, 826, 744, 706, 615.cm^{-1}; HRMS (ESI): m/z = 523.1403 (calcd for $C_{31}H_{23}ClN_2O_4+H^+$ = 523.1419).

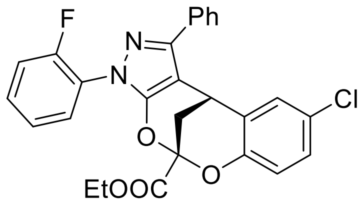


3ao

Ethyl-(5S,11S)-9-chloro-3-(2-fluorophenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8]

[1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ap

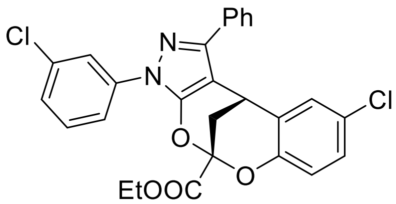
White solid; mp 182–183 ℃; 63% yield (30.9 mg), >20:1 dr, 67% ee [Daicel Chiralcel IA-H, hexanes/i-PrOH = 97/3, flow rate: 0.5 mL/min, λ = 254.4 nm, t (major) = 33.667, t (minor) = 31.406]; $[\alpha]_D^{25}$ = +60.0 (c 0.1, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 – 7.77 (m, 2H), 7.58 – 7.53 (m, 1H), 7.52 – 7.47 (m, 2H), 7.44 – 7.40 (m, 1H), 7.40 – 7.32 (m, 1H), 7.25 – 7.18 (m, 3H), 7.11 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.96 (d, *J* = 8.4 Hz, 1H), 4.44 – 4.29 (m, 3H), 2.61 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.44 (dd, *J* = 13.6, 3.2 Hz, 1H), 1.36 (t, *J* = 7.2 Hz, 3H); ^{19}F NMR (376 MHz, $CDCl_3$) δ –120.66; ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.6, 157.5, 154.9, 150.0, 148.7, 148.1, 133.2, 129.9, 129.8, 128.9, 128.6, 128.5, 128.2, 127.9, 127.3, 127.2, 126.6, 124.6(d, *J* = 3.4 Hz), 118.6, 116.8(d, *J* = 19.8 Hz), 99.7, 98.3, 63.1, 27.0, 14.1; IR (KBr) νmax: 2962, 1417, 1386, 1368, 1306, 1180, 1104, 1065, 1032, 866, 773, 768, 760, 648, 636, 613, 603.cm^{-1}; HRMS (ESI): m/z = 513.0978 (calcd for $C_{27}H_{20}ClFN_2O_4$+Na^+ = 513.0988).



3ap

Ethyl-(5S,11S)-9-chloro-3-(3-chlorophenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8] [1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3aq

White solid; mp 153–154 ℃; 67% yield (33.9 mg), >20:1 dr, 88% ee [Daicel Chiralcel IA-H, hexanes/i-PrOH = 95/5, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 7.221, t (minor) = 8.245]; $[\alpha]_D^{25}$ = +66.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (t, *J* = 2.0 Hz, 1H), 7.89 – 7.79 (m, 3H), 7.55 – 7.47 (m, 2H), 7.46 – 7.40 (m, 1H), 7.35 (t, *J* = 4.0 Hz, 1H), 7.24 – 7.16 (m, 2H), 7.11 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.95 (d, *J* = 8.0 Hz, 1H), 4.52 – 4.39 (m, 2H), 4.34 (t, *J* = 3.2 Hz, 1H), 2.54 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.49 (dd, *J* = 13.6, 3.6 Hz, 1H), 1.46 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, CDCl3) δ 165.6, 149.8, 148.0, 147.4, 139.3, 134.9, 133.0, 130.2, 128.9, 128.8, 128.4, 128.3, 127.3, 127.2, 126.6, 126.2, 120.4, 118.5, 118.2, 101.0, 98.5, 63.3, 29.2, 26.9, 14.2; IR (KBr) νmax: 2301, 1752, 1433, 1415, 1284, 1224, 1154, 1076, 1060, 1004, 994, 892, 865, 780, 756, 713, 694, 653, 632, 619, 611.cm^{-1}; HRMS (ESI): m/z = 507.0874 (calcd for $C_{27}H_{20}Cl_2N_2O_4$+H^+ = 507.0873).

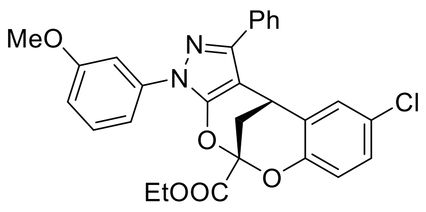


3aq

Ethyl-(5S,11S)-9-chloro-3-(3-methoxyphenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8]

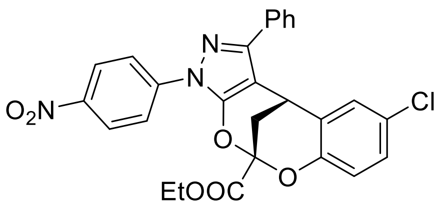
[1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ar

White solid; mp 125−126 ℃; 55% yield (27.6 mg), >20:1 dr, 87% ee [Daicel Chiralcel IA-H, hexanes/i-PrOH = 90/10, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 6.780, t (minor) = 7.788]; $[\alpha]_D^{25}$ = +29.0 (c 0.25, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 – 7.78 (m, 2H), 7.55 – 7.46 (m, 4H), 7.45 – 7.39 (m, 1H), 7.36 – 7.29 (m, 1H), 7.19 (d, *J* = 2.4 Hz, 1H), 7.10 (dd, *J* = 8.4, 2.4 Hz, 1H), 6.94 (d, *J* = 8.4 Hz, 1H), 6.87 – 6.77 (m, 1H), 4.48 – 4.38 (m, 2H), 4.33 (t, *J* = 3.2 Hz, 1H), 3.86 (s, 3H), 2.55 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.47 (dd, *J* = 13.6, 3.2 Hz, 1H), 1.41 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.7, 160.3, 149.9, 147.8, 146.9, 139.3, 133.2, 129.9, 128.8, 128.6, 128.5, 128.2, 127.3, 127.2, 126.5, 118.4, 112.8, 112.6, 106.1, 100.6, 98.3, 63.2, 55.6, 29.3, 26.9, 14.2; IR (KBr) νmax: 2979, 1263, 1057, 835, 795, 756, 741, 720, 706, 680, 625, 618, 614, 607.cm^{-1}; HRMS (ESI): m/z = 525.1169 (calcd for $C_{28}H_{23}ClN_2O_5$+Na^+ = 525.1188).



3ar

Ethyl-(5S,11S)-9-chloro-3-(4-nitrophenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8] [1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3as



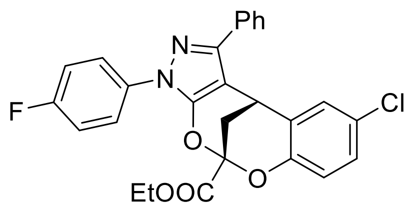
3as

White solid; mp 203−204 ℃; 80% yield (41.4 mg), >20:1 dr, 74% ee [Daicel Chiralcel IA-H, hexanes/i-PrOH = 95/5, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 17.428, t (minor) = 16.337]; $[\alpha]_D^{25}$ = +64.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 (d, *J* = 9.2 Hz, 2H), 8.16 (d, *J* = 9.2 Hz, 2H), 7.90 – 7.79 (m, 2H), 7.53 (td, *J* = 7.6, 2.0 Hz, 2H), 7.50 – 7.43 (m, 1H), 7.19 (d, *J* = 2.4 Hz, 1H), 7.13 (dd, *J* = 8.4, 2.4 Hz, 1H), 6.96 (d, *J* = 8.8 Hz, 1H), 4.54 – 4.43 (m, 2H), 4.36 (t, *J* = 3.2 Hz, 1H), 2.57 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.52 (dd, *J* = 13.6, 3.2 Hz, 1H), 1.46 (t, *J* = 6,8 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.4, 149.7, 148.7, 145.1, 143.3, 132.5, 129.2, 129.1, 129.0, 128.5, 128.0, 127.5, 127.3, 126.6, 125.1, 119.7, 118.5, 101.9, 98.7, 63.4, 29.1, 26.7, 14.3; IR (KBr) νmax: 2215, 1748, 1594,1478, 1312, 1222, 1160, 1119, 1058, 1023, 911, 852, 829, 748, 694, 667.cm^{-1}; HRMS (ESI): m/z = 540.0925 (calcd for $C_{27}H_{20}ClN_3O_6$+Na^+ = 540.0933).

Ethyl-(5S,11S)-9-chloro-3-(4-fluorophenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8]

[1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3at

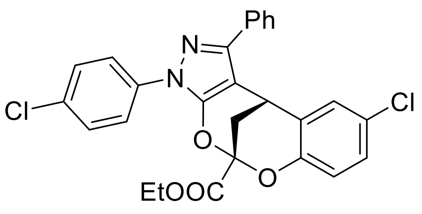
White solid; mp 99–100 ℃; 72% yield (35.3 mg), >20:1 dr, 91% ee [Daicel Chiralcel IA-H, hexanes/i-PrOH = 95/5, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 8.053, t (minor) = 8.862];



3at

$[\alpha]_D^{25}$ = +145.0 (c 0.15, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 – 7.79 (m, 4H), 7.54 – 7.47 (m, 2H), 7.45 – 7.38 (m, 1H), 7.20 (d, *J* = 2.4 Hz, 1H), 7.15 – 7.07 (m, 3H), 6.95 (d, *J* = 8.8 Hz, 1H), 4.48 – 4.37 (m, 2H), 4.34 (t, *J* = 3.2 Hz, 1H), 2.56 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.47 (dd, *J* = 13.6, 3.2 Hz, 1H), 1.42 (t, *J* = 7.2 Hz, 3H); ^{19}F NMR (376 MHz, $CDCl_3$) δ –115.93; ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.7, 162.2, 159.8, 149.9, 147.6, 147.0, 134.5 (d, *J* = 2.8 Hz), 133.2, 128.9, 128.6, 128.4, 128.3, 127.3, 127.2, 126.6, 122.4 (d, *J* = 8.3 Hz), 118.5, 116.1, 115.8, 100.6, 98.4, 63.2, 29.3, 26.9, 14.2; IR (KBr) νmax: 1757, 1174, 1058, 1032, 1021, 994, 987, 816, 805, 796, 727, 722, 705, 698, 682, 614, 607.cm^{-1}; HRMS (ESI): m/z = 513.0979 (calcd for $C_{27}H_{20}ClFN_2O_4$+Na^+ = 513.0988).

Ethyl-(5S,11S)-9-chloro-3-(4-chlorophenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8] [1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3au

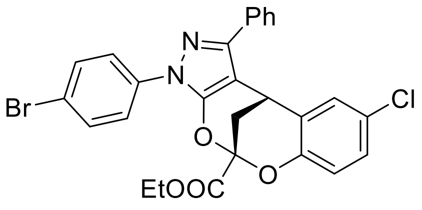


3au

White solid; mp 185−186 ℃; 70% yield (35.4 mg), >20:1 dr, 89% ee [Daicel Chiralcel IA-H, hexanes/i-PrOH = 98/2, flow rate: 0.7 mL/min, λ = 254.4 nm, t (major) = 19.363, t (minor) = 20.915]; $[\alpha]_D^{25}$ = +38.0 (c 0.04, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 – 7.72 (m, 4H), 7.54 – 7.47 (m, 2H), 7.46 – 7.35 (m, 3H), 7.19 (d, *J* = 2.4 Hz, 1H), 7.11 (dd, *J* = 8.4, 2.4 Hz, 1H), 6.94 (d, *J* = 8.4 Hz, 1H), 4.50 – 4.37 (m, 2H), 4.33 (t, *J* = 2.8 Hz, 1H), 2.55 (dd, *J* = 13.6, 3.6 Hz, 1H), 2.47 (dd, *J* = 13.6, 2.8 Hz, 1H), 1.42 (t, *J* = 6.8 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.6, 149.8, 147.8, 147.2, 136.9, 133.1, 131.7, 129.2, 128.9, 128.7, 128.3, 128.3, 127.3, 127.2, 126.6, 121.6, 118.5, 100.8, 98.4, 63.2, 29.2, 26.9, 14.2; IR (KBr) νmax: 2962, 1763, 1594, 1507, 1450, 1384, 1170, 1058, 902, 884, 876, 727, 696, 671.cm^{-1}; HRMS (ESI): m/z = 529.0736 (calcd for $C_{27}H_{20}Cl_2N_2O_4$+Na^+ = 529.0692).

Ethyl-(5S,11S)-3-(4-bromophenyl)-9-chloro-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8] [1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3av

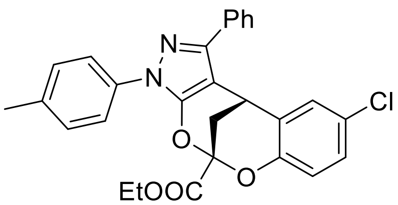
White solid; mp 153−154 ℃; 79% yield (43.5 mg), >20:1 dr, 90% ee [Daicel Chiralcel IA-H, hexanes/i-PrOH = 95/5, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 10.831, t (minor) =



3av

10.125]; $[\alpha]_D^{25}$ = +134.0 (c 0.10, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ 7.89 – 7.70 (m, 4H), 7.57 – 7.47 (m, 4H), 7.46 – 7.40 (m, 1H), 7.19 (d, J = 2.8 Hz, 1H), 7.11 (dd, J = 8.8, 2.4 Hz, 1H), 6.95 (d, J = 8.4 Hz, 1H), 4.50 – 4.37 (m, 2H), 4.33 (t, J = 2.8 Hz, 1H), 2.55 (dd, J = 14.0, 3.6 Hz, 1H), 2.47 (dd, J = 13.6, 3.2 Hz, 1H), 1.42 (t, J = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.6, 149.8, 147.8, 147.3, 137.4, 133.1, 132.2, 128.9, 128.7, 128.7, 128.3, 127.3, 127.2, 126.6, 121.9, 119.6, 118.5, 100.9, 98.4, 63.3, 29.3, 26.9, 14.2; IR (KBr) νmax: 2962, 1763, 1594, 1507, 1450, 1384, 1170, 1058, 902, 884, 876, 727, 696, 671.cm^{-1}; HRMS (ESI): m/z = 573.0169 (calcd for $C_{27}H_{20}BrClN_2O_4+Na^+$ = 573.0187).

Ethyl-(5S,11S)-9-chloro-1-phenyl-3-(p-tolyl)-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3aw



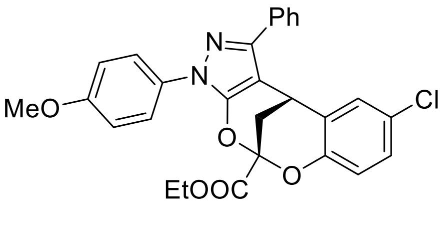
3aw

White solid; mp 197−198 ℃; 69% yield (33.5 mg), >20:1 dr, 92% ee [Daicel Chiralcel IA-H, hexanes/i-PrOH = 97/3, flow rate: 0.8 mL/min, λ = 254.4 nm, t (major) = 14.175, t (minor) = 15.555]; $[\alpha]_D^{25}$ = +320.0 (c 0.08, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ 7.87 – 7.79 (m, 2H), 7.77 – 7.70 (m, 2H), 7.50 (dd, *J* = 7.6, 1.6 Hz, 2H), 7.44 – 7.36 (m, 1H), 7.29 – 7.16 (m, 3H), 7.10 (dd, *J* = 8.4, 2.4 Hz, 1H), 6.94 (d, *J* = 8.8 Hz, 1H), 4.49 – 4.37 (m, 2H), 4.33 (t, *J* = 3.2 Hz, 1H), 2.55 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.45 (dd, *J* = 13.6, 2.8 Hz, 1H), 2.36 (s, 3H), 1.41 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.8, 149.9, 147.5, 146.6, 136.2, 135.9, 133.4, 129.7, 128.8, 128.6, 128.5, 128.2, 127.2, 127.2, 126.6, 120.7, 118.4, 100.4, 98.3, 63.1, 29.3, 27.0, 21.1, 14.2; IR (KBr) νmax: 2305, 1763, 1451, 1368, 1303, 1178, 1121, 1063, 1031, 913, 854, 816, 779, 717, 667, 624.cm^{-1}; HRMS (ESI): m/z = 509.1241 (calcd for $C_{28}H_{23}ClN_2O_4+Na^+$ = 509.1239).

Ethyl-(5S,11S)-9-chloro-3-(4-methoxyphenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8] [1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ax

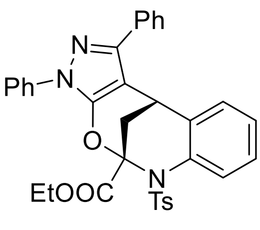
White solid; mp 143−144 ℃; 66% yield (33.1 mg), >20:1 dr, 90% ee [Daicel Chiralcel IA-H, hexanes/i-PrOH = 95/5, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 13.181, t (minor) =

14.495]; $[\alpha]_D^{25}$ = +35.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 – 7.80 (m, 2H), 7.75 (d, *J* = 9.2 Hz, 2H), 7.53 – 7.45 (m, 2H), 7.44 – 7.37 (m, 1H), 7.20 (d, *J* = 2.4 Hz, 1H), 7.10 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.98 – 6.88 (m, 3H), 4.47 – 4.36 (m, 2H), 4.33 (t, J = 3.2 Hz, 1H), 3.82 (s, 3H), 2.55 (dd, *J* = 13.6, 3.2 Hz, 1H), 2.45 (dd, *J* = 13.6, 2.8 Hz, 1H), 1.41 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.8, 158.1, 149.9, 147.3, 146.5, 133.4, 131.6, 128.8, 128.6, 128.4, 128.2, 127.2, 127.1, 126.6, 122.4, 118.4, 114.3, 100.2, 98.3, 63.1, 55.6, 29.4, 27.0, 14.2; IR (KBr) νmax: 1759, 1523, 1501, 1254, 1179, 1135, 1121, 1062, 1011, 913, 757, 718, 695.cm^{-1}; HRMS (ESI): m/z = 525.1182 (calcd for $C_{28}H_{23}ClN_2O_5$+Na^+ = 525.1188).



3ax

Ethyl-(5S,11S)-1,3-diphenyl-6-tosyl-6,11-dihydro-5,11-methanobenzo[d]pyrazolo[4,3-g][1,3] oxazocine-5(3H)-carboxylate 3ga

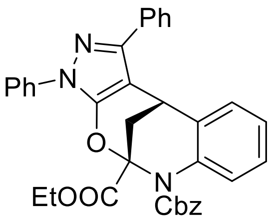


3ga

White solid; mp 140−141 ℃; 85% yield (50.2 mg), >20:1 dr, 66% ee [Daicel Chiralcel AD-H, hexanes/i-PrOH = 95/5, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 24.263, t (minor) = 21.014]; $[\alpha]_D^{25}$ = +353.0 (c 0.10, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.17 (d, J = 8.4 Hz, 1H), 7.99 – 7.88 (m, 2H), 7.73 – 7.62 (m, 2H), 7.47 – 7.34 (m, 4H), 7.33 – 7.27 (m, 1H), 7.25 – 7.09 (m, 5H), 6.98 (td, J = 7.6, 1.2 Hz, 1H), 6.54 (d, J = 8.0 Hz, 2H), 4.53 – 4.30 (m, 2H), 4.11 (t, J = 3.2 Hz, 1H), 2.45 (dd, J = 13.2, 3.6 Hz, 1H), 2.22 (dd, J = 13.2, 3.6 Hz, 1H), 2.04 (m, 3H), 1.38 (t, J = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.7, 147.6, 147.3, 144.1, 138.7, 135.8, 135.1, 133.4, 132.1, 129.3, 129.2, 128.6, 128.4, 128.0, 127.5, 127.1, 127.0, 126.0, 124.4, 120.3, 119.8, 98.4, 89.0, 63.3, 35.4, 29.2, 21.6, 14.2; IR (KBr) νmax: 1763, 1484, 1354, 1186, 1163, 1129, 1109, 1037, 1003, 915, 897, 757, 736, 692, 664, 637, 628.cm^{-1}; HRMS (ESI): m/z = 614.1680 (calcd for $C_{34}H_{29}N_3O_5S$+Na^+ = 614.1720).

6-Benzyl-5-ethyl-(5S,11S)-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[d]pyrazolo[4,3-g] [1,3]oxazocine-5,6-dicarboxylate 3ha

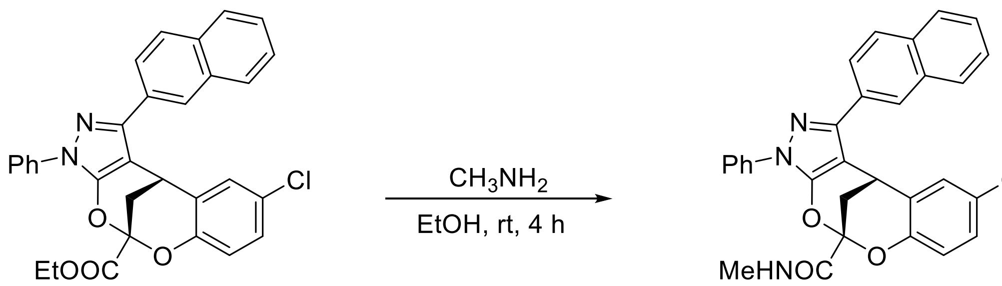
White solid; mp 135−136 ℃; 72% yield (41.1 mg), >20:1 dr, 97% ee [Daicel Chiralcel OD-H, hexanes/i-PrOH = 80/20, flow rate: 1.0 mL/min, λ = 254.4 nm, t (major) = 6.950, t (minor) = 9.558]; $[\alpha]_D^{25}$ = −54.0 (c 0.10, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (d, *J* = 8.0 Hz, 2H), 7.77 (dt, J = 6.8, 1.6 Hz, 3H), 7.40 (t, J = 7.2 Hz, 2H), 7.34 – 7.24 (m, 6H), 7.22 (q, J = 3.6 Hz, 2H), 7.20 – 7.08 (m, 3H), 7.03 (t, J = 7.6 Hz, 1H), 5.20 (d, J = 12.0 Hz, 1H), 5.07 (d, J = 12.0 Hz,



3ha

1H), 4.19 – 3.93 (m, 3H), 2.44 (dd, J = 13.0, 3.6 Hz, 1H), 2.06 (dd, J = 13.2, 2.4 Hz, 1H), 1.10 (t, J = 7.2 Hz, 3H).; ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.9, 153.4, 148.2, 147.7, 138.6, 135.2, 135.0, 133.6, 133.2, 129.1, 128.7, 128.6, 128.6, 128.5, 128.3, 127.6, 127.4, 126.4, 126.0, 124.4, 123.3, 120.4, 97.6, 87.7, 69.0, 62.8, 35.0, 29.6, 14.0; IR (KBr) νmax: 1729, 1457, 1187, 1136, 1071, 1046, 1004, 993, 835, 822, 812, 805, 795, 789, 763, 714, 697, 681, 618, 614, 607.cm^{-1}; HRMS (ESI): m/z = 572.2171 (calcd for $C_{35}H_{29}N_3O_5$+H^+ = 572.2180).

3.3 General procedure for the preparation of 4aa



3ao, >20:1 *dr*, 94% *ee*

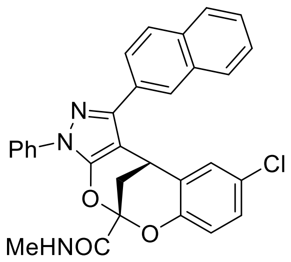
4aa, 95% yield
>20:1 *dr*, 94% *ee*

The compound **3ao** (0.1 mmol) was added into a vessel, and methylamine alcohol solution (2 mL) was added *via* syringe. The reaction system was stirred at room temperature for 4 hours. Then the solvent was evaporated under reduced pressure and the residue was purified by column chromatography on silica gel with EtOAc/petroleum ether (1/2) as eluent to give **4aa** as a white solid.

(5S,11S)-9-Chloro-N-methyl-1-(naphthalen-2-yl)-3-phenyl-3,11-dihydro-5,11-methanobenzo [7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxamide 4aa

White solid; mp 232−233 ℃; 95% yield (48.2 mg), >20:1 *dr*, 94% *ee* [Daicel Chiralcel IA-H, hexanes/*i*-PrOH = 80/20, flow rate: 1.0 mL min^{-1}, λ = 254.4 nm, t (major) = 9.496, t (minor) = 13.391]; $[\alpha]_D^{25}$ = −30.0 (c 0.03, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.26 (d, J = 1.6 Hz, 1H), 8.01 – 7.92 (m, 3H), 7.90 – 7.86 (m, 1H), 7.81 – 7.75 (m, 2H), 7.58 – 7.47 (m, 2H), 7.48 – 7.40 (m, 2H), 7.32 – 7.25 (m, 2H), 7.10 (dd, J = 8.8, 2.4 Hz, 1H), 6.91 (d, J = 8.4 Hz, 2H), 4.37 (t, J = 2.8

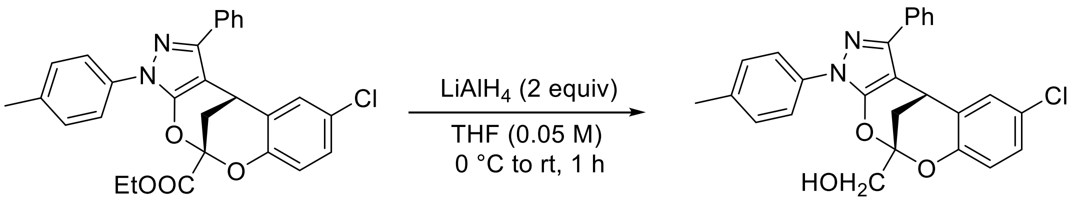
Hz, 1H), 2.98 (d, J = 4.8 Hz, 3H), 2.67 (dd, J = 13.6, 3.2 Hz, 1H), 2.35 (dd, J = 13.6, 2.8 Hz, 1H);



4aa

^{13}C NMR (101 MHz, $CDCl_3$) δ 166.2, 149.9, 147.7, 147.2, 138.1, 133.4, 133.3, 130.7, 129.3, 128.8, 128.6, 128.3, 128.2, 127.9, 127.3, 126.9, 126.7, 126.6, 126.5, 126.4, 125.1, 121.3, 118.1, 100.8, 99.3, 29.3, 27.0, 26.7; IR (KBr) ν_{max}: 2983, 1673, 1453, 1393, 1140, 1111, 1082, 992, 951, 914, 901, 888, 859, 729, 703, 695, 672, 611, 602.cm^{-1}; HRMS (ESI): m/z = 508.1426 (calcd for $C_{30}H_{22}ClN_3O_3+H^+$ = 508.1422).

3.4 General procedure for the preparation of 5aa

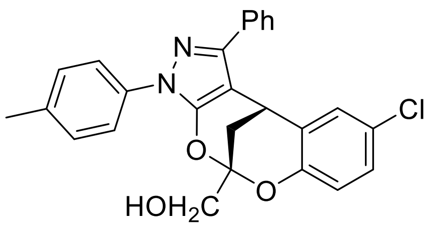


3aw, >20:1 *dr*, 92% *ee*

5aa, 90% yield
>20:1 *dr*, 93% *ee*

The compound **3aw** (0.1 mmol) was added into a vessel, and THF (2.0 mL) was added *via* syringe. Then, $LiAlH_4$ (0.2 mmol, 2 equiv) was added carefully to the reaction at 0 ℃. The mixture was stirred at room temperature for 1 hour. After the reaction was complete, a little water was added to quench the reaction, and the organic product was extracted with ethyl acetate (10 mL × 3). The residue was purified by column chromatography on silica gel with EtOAc/petroleum ether (1/2) as the eluent to give **5aa** as a white solid.

Ethyl-(3S,6'R,12'R)-3'-bromo-8'-chloro-1-methyl-2-oxo-6'H,12'H-spiro[indoline-3,5'-[6,12] methanobenzo[g]pyrrolo[2,1-*c*][1,4]oxazocine]-12'-carboxylate 5aa

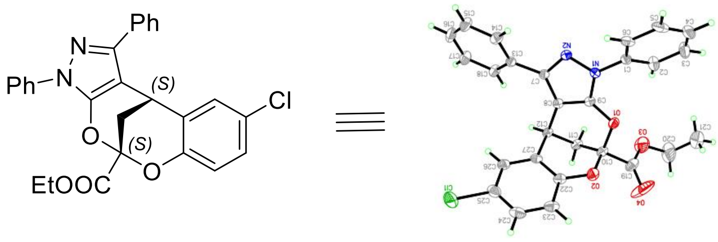


5aa

White solid; mp 210−211 ℃; 90% yield (40.0 mg), >20:1 *dr*, 93% *ee* [Daicel Chiralcel AD-H, hexanes/*i*-PrOH = 80/20, flow rate: 1.0 mL min^{-1}, λ = 254.4 nm, t (major) = 12.392, t (minor) = 9.170]; $[\alpha]_D^{25}$ = +20.0 (c 0.03, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ 7.86 – 7.78 (m, 2H), 7.70 – 7.61 (m, 2H), 7.54 – 7.46 (m, 2H), 7.44 – 7.36 (m, 1H), 7.24 – 7.19 (m, 2H), 7.16 (d, J = 2.4 Hz, 1H), 7.06 (dd, J = 8.8, 2.8 Hz, 1H), 6.84 (d, J = 8.8 Hz, 1H), 4.30 (t, J = 2.8 Hz, 1H), 4.11 – 3.93 (m, 2H), 2.42 – 2.34 (m, 4H), 2.30 (dd, J = 13.2, 2.8 Hz, 1H), 2.17 (t, J = 3.2 Hz, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 150.7, 148.4, 146.8, 136.3, 135.9, 133.5, 129.7, 129.0, 128.8, 128.5, 128.4, 128.0, 127.3, 126.6, 121.1, 118.0, 102.3, 100.9, 66.7, 28.7, 27.2, 21.2; IR (KBr) ν_{max}: 3300, 1742, 1608, 1478, 1467,1242, 1231, 1202, 1177, 1129, 1110, 1090, 1051, 943, 740, 703, 696, 652 cm^{-1}; HRMS (ESI): m/z = 445.1317 (calcd for $C_{26}H_{21}ClN_2O_3$+H^+ = 445.1313).

4. X-ray data of the compound 3aa

Empirical formula	$C_{27}H_{21}ClN_2O_4$
Formula weight	472.91
Temperature	193(2) K
Wavelength	0.71073 Å
Crystal system, space group	monoclinic, $P\ 2_1$
	a = 10.5251(4) Å, α = 90 deg.
Unit cell dimensions	b = 9.5253(4) Å, β = 106.873(2) deg.
	c = 12.1849(5) Å, γ = 90 deg.
Volume	1169.00(8) $Å^3$
Z, Calculated density	1.344 Mg/cm^3
Absorption coefficient	0.200 mm^{-1}
F(000)	492
Crystal size	0.600 x 0.200 x 0.100 mm
Radiation type	MoK\a
Theta range for data collection	2.76 to 30.43 deg.
Limiting indices	$-15\leq h \leq 15$, $-11 \leq k \leq 14$, $-18\leq l \leq 17$
Reflections collected / unique	23266 [R(int) = 0.0522]
Completeness to theta = 25.242	99.8%
Absorption correction	multi-scan
Max. and min. transmission	0.7463 and 0.6853
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	6747/1/308
Goodness-of-fit on F^2	0.997
Final R indexes [I>=2σ (I)]	R_1 = 0.0574, wR_2 = 0.1188
Final R indexes [all data]	R_1 = 0.1005, wR_2 = 0.1360
Highest diff. peak/deepest hole ($eÅ^{-3}$)	0.532 and –0.419
Absolute structure parameter	0.01(2)



3aa

Figure S1. OPTEP drawing of **3aa** (40% thermal ellipsoids)

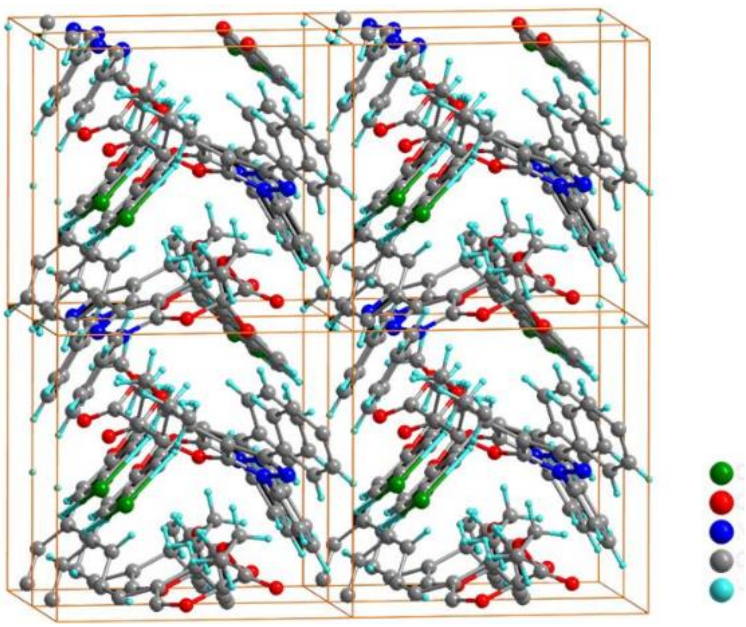


Figure S2. Packing of moleculars in a unit cell of **3aa**

The crystal was prepared from the solution of **3aa** in EtOAc and petroleum ether. CCDC 1815121 contains the supplementary crystallographic data for this paper. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk/data request/cif.

5. Reference

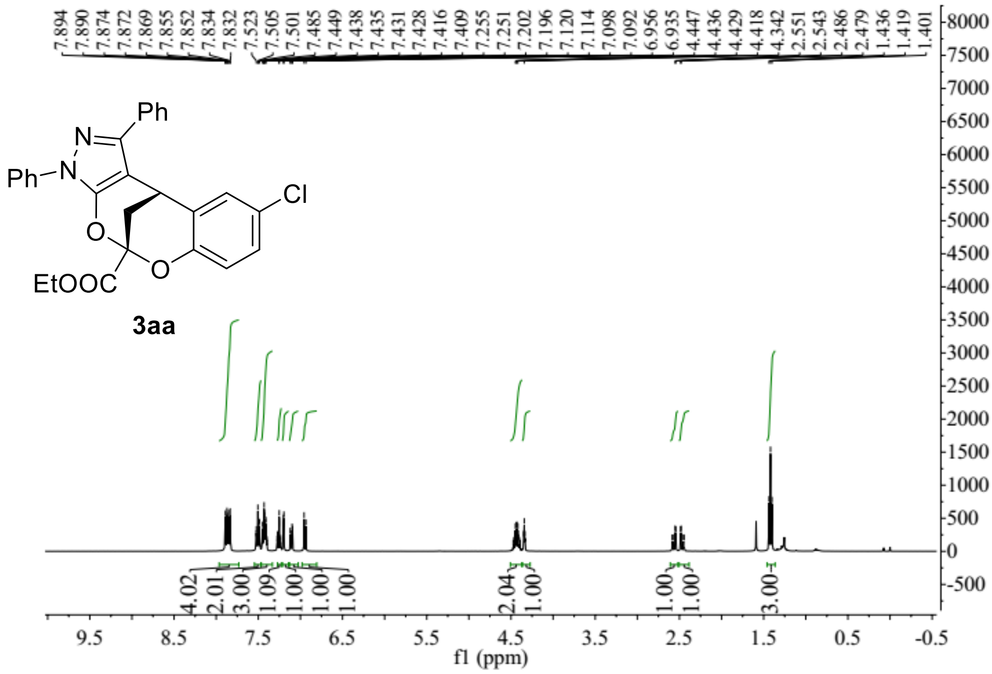
1. (a) Choe, Y.; Brinen, L. S.; Price, M. S.; Engel, J. C.; Lange, M.; Grisostomi, C.; Weston, S. G.; Pallai, P. V.; Cheng, H.; Hardy, L. W.; Hartsough, D. S.; McMakin, M.; Tilton, R. F.; Baldino, C. M.; Craik, C. S. Development of α-keto-based Inhibitors of Cruzain, a Cysteine Protease Implicated in Chagas Disease. *Bioorg. Med. Chem*. **2005**, *13*, 2141–2156. (b) Yang, H.-B.; Zhao, Y.-Z.; Sang, R.; Wei, Y.; Shi, M. Asymmetric Synthesis of Bioxindole-substituted Hexahydrofuro[2,3-*b*]furans via Hydroquinine Anthraquinone-1,4-diyl Diether-Catalyzed Domino Annulation of Acylidenoxindoles/isatins, Acylidenoxindoles and Allenoates. *Adv. Synth. Catal.* **2014**, *356*, 3799–3808. (c) Geng, Z.-C.; Zhang, S.-Y.; Li, N.-K.; Li, N.; Chen, J.; Li, H.-Y.; Wang, X.-W. Organocatalytic Diversity-Oriented Asymmetric Synthesis of Tricyclic Chroman Derivatives. *J. Org. Chem*. **2014**, *79*, 10772−10785. (d) Fan, W.-T.; Li, N.-K.; Xu, L.; Qiao, C.; Wang, X.-W. Organo-Catalyzed Asymmetric Michael–Hemiketalization–Oxa-Pictet–Spengler Cyclization for Bridged and Spiro Heterocyclic Skeletons: Oxocarbenium Ion as a Key Intermediate. *Org. Lett*. **2017**, *19*, 6626−6629.

2. (a) Kumar, V.; Chang, C.-K.; Tan, K.-P.; Jung, Y.-S.; Chen, S.-H.; Cheng, Y. -S.; Liang, P.-H. Identification, Synthesis, and Evaluation of New Neuraminidase Inhibitors. *Org. Lett*. **2014**, *16*, 5060−5063. (b) Li, H.; Gontla, R.; Flegel, J.; Merten, C.; Ziegler, S.; Antonchick, A. P.; Waldmann, H. Enantioselective Formal C(sp^3)−H Bond Activation in the Synthesis of Bioactive Spiropyrazolone Derivatives. *Angew. Chem., Int. Ed*. **2019**, *58*, 307−311. (c) Kimata, A.; Nakagawa, H.; Ohyama, R.; Fukuuchi, T.; Ohta, S.; Suzuki, T.; Miyata, N. New Series of Antiprion Compounds: Pyrazolone Derivatives Have the Potent Activity of Inhibiting Protease-resistant Prion Protein Accumulation. *J. Med. Chem*. **2007**, 50, 5053−5056.

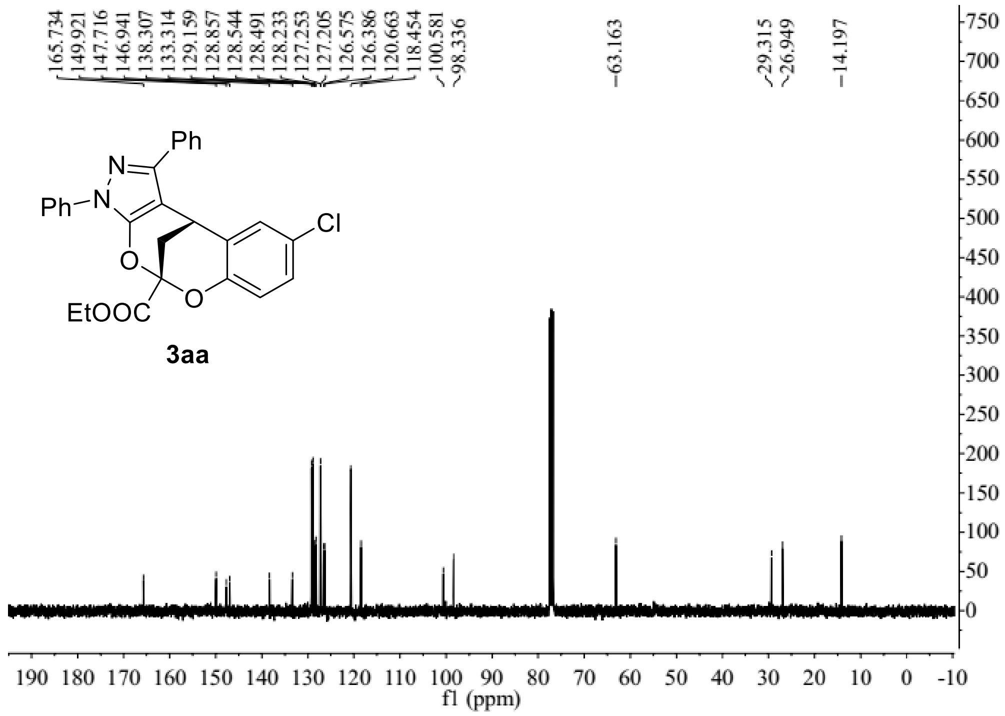
6. ^{1}H NMR, ^{19}F NMR and ^{13}C NMR spectra

Ethyl-(5S,11S)-9-chloro-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylatee 3aa

^{1}H NMR of 3aa ($CDCl_3$, 400MHz)



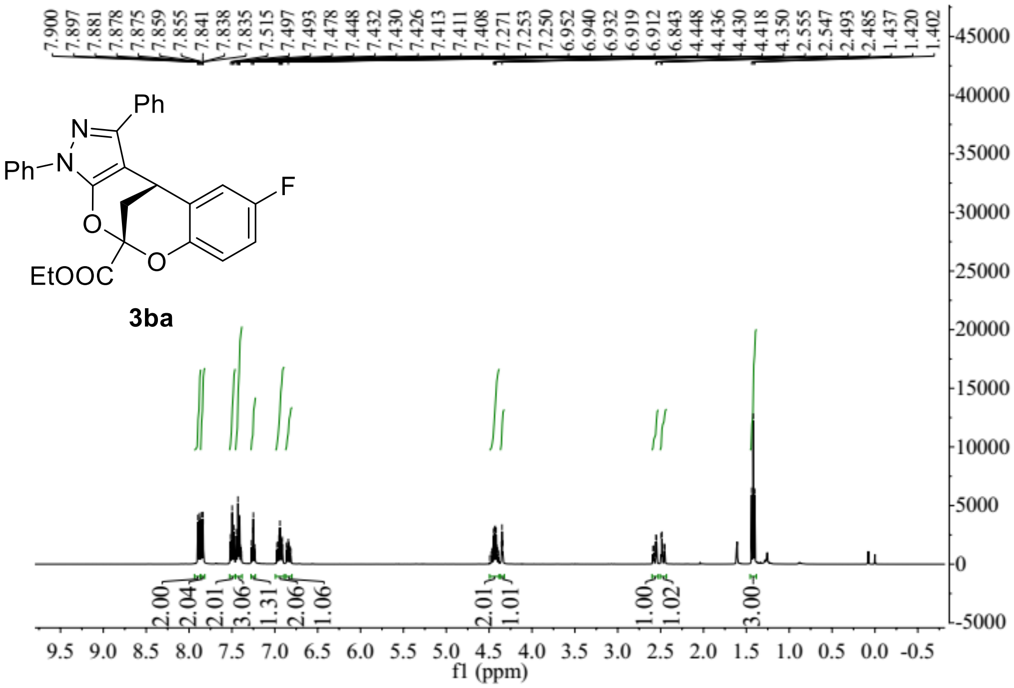
^{13}C NMR of 3aa ($CDCl_3$, 400MHz)



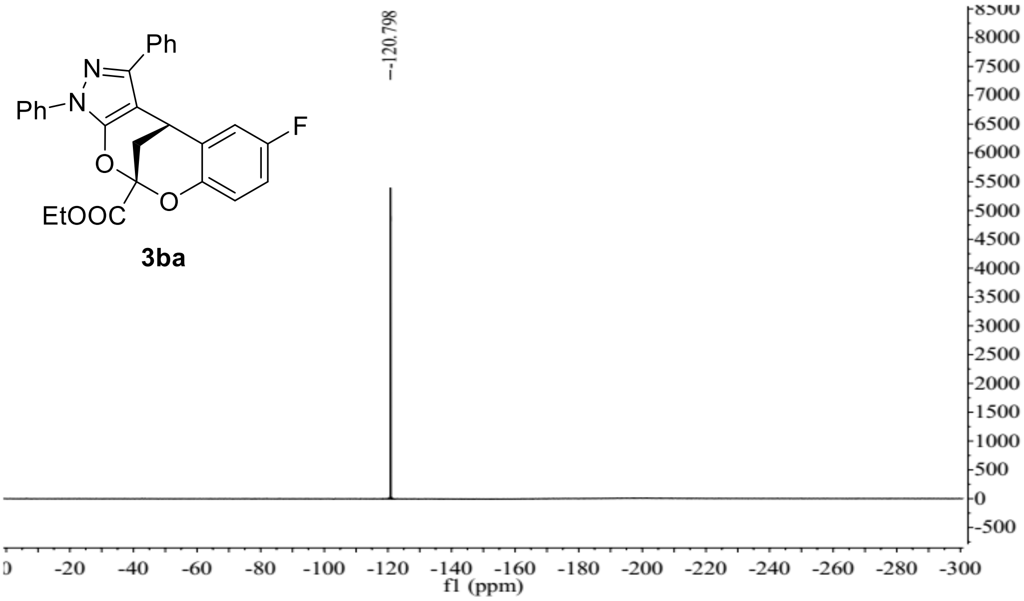
Ethyl-(5S,11S)-9-fluoro-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]

dioxocino[4,5-c]pyrazole-5-carboxylate 3ba

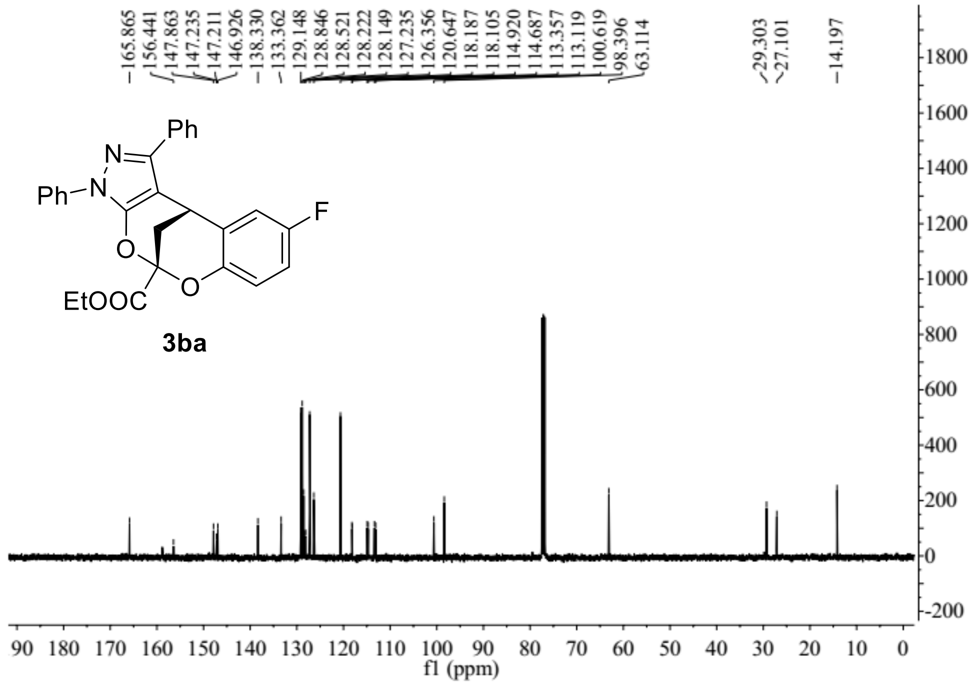
[1]H NMR of 3ba ($CDCl_3$, 400MHz)



[19]F NMR of 3ba ($CDCl_3$, 400MHz)



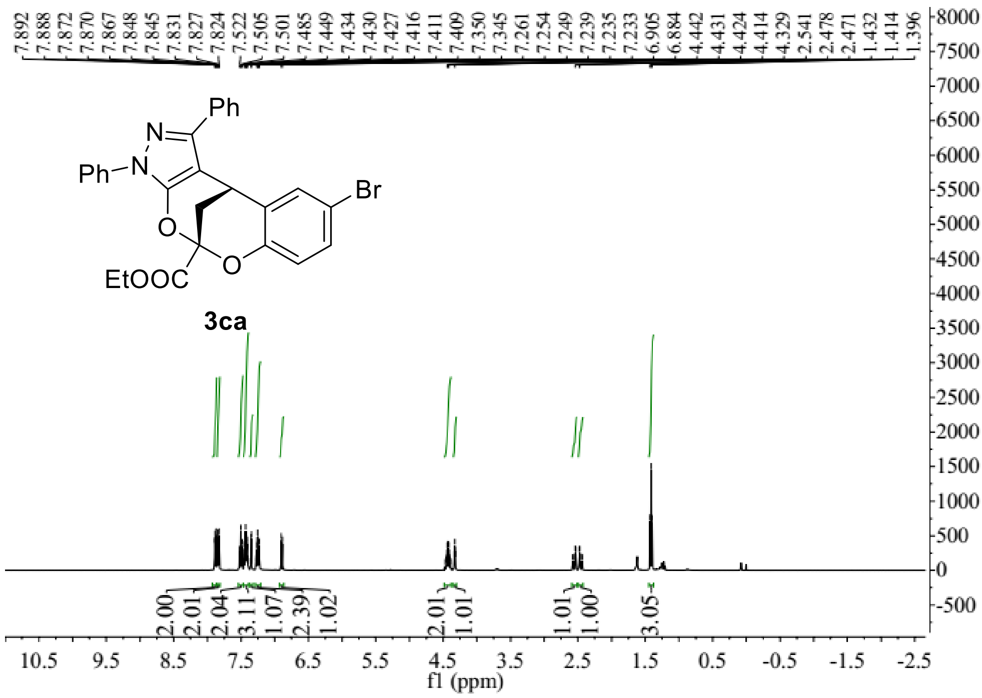
^{13}C NMR of 3ba ($CDCl_3$, 400MHz)



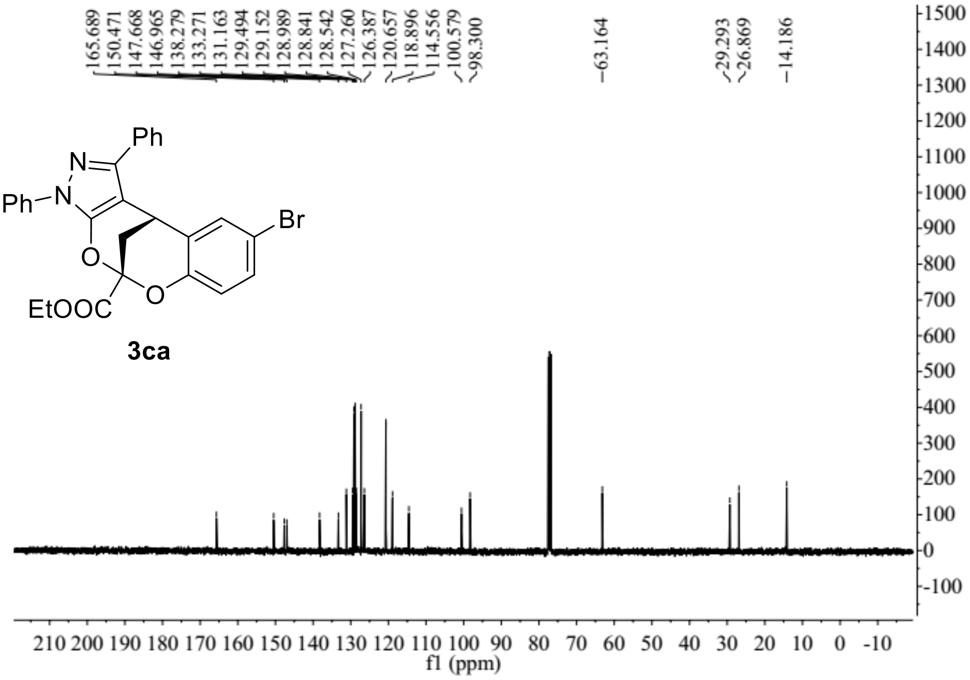
Ethyl-(5S,11S)-9-bromo-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]

dioxocino[4,5-c]pyrazole-5-carboxylatee 3ca

^{1}H NMR of 3ca ($CDCl_3$, 400MHz)



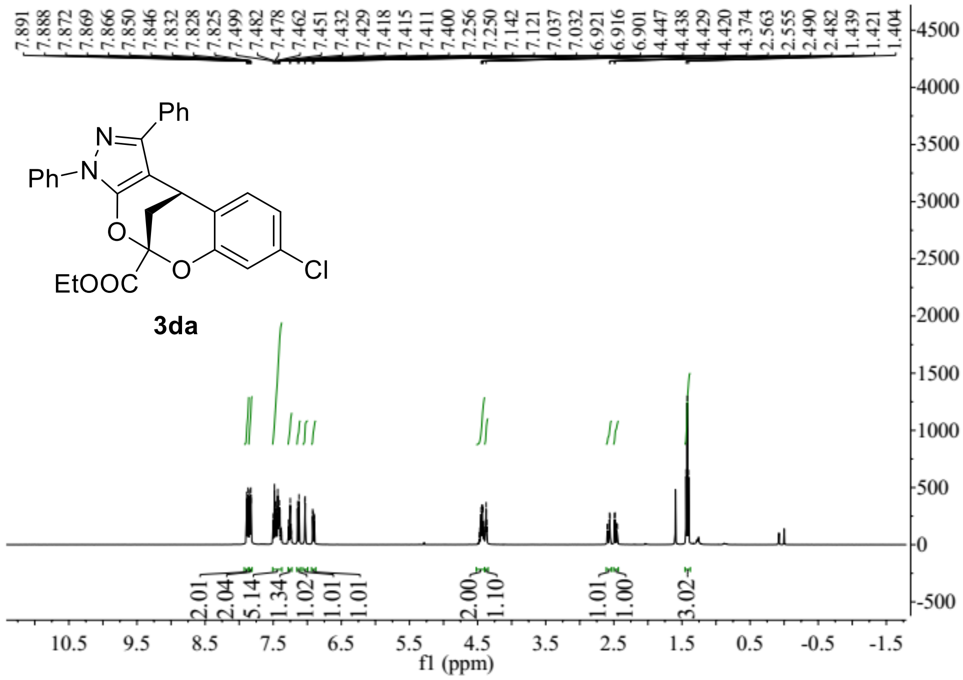
^{13}C NMR of 3ca (CDCl$_3$, 400MHz)



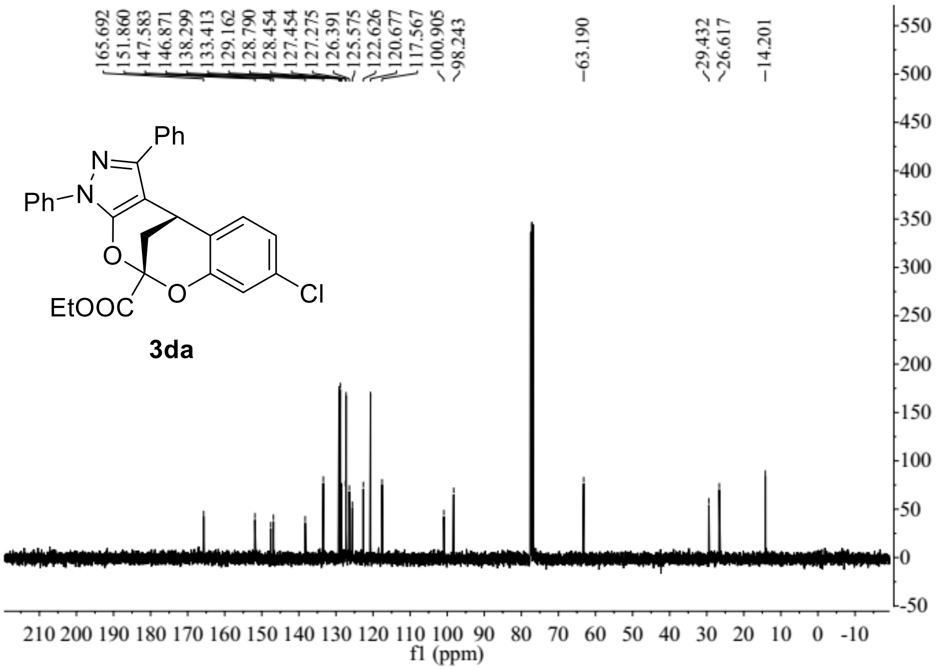
Ethyl-(5S,11S)-8-chloro-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]

dioxocino[4,5-c]pyrazole-5-carboxylate 3da

^{1}H NMR of 3da (CDCl$_3$, 400MHz)

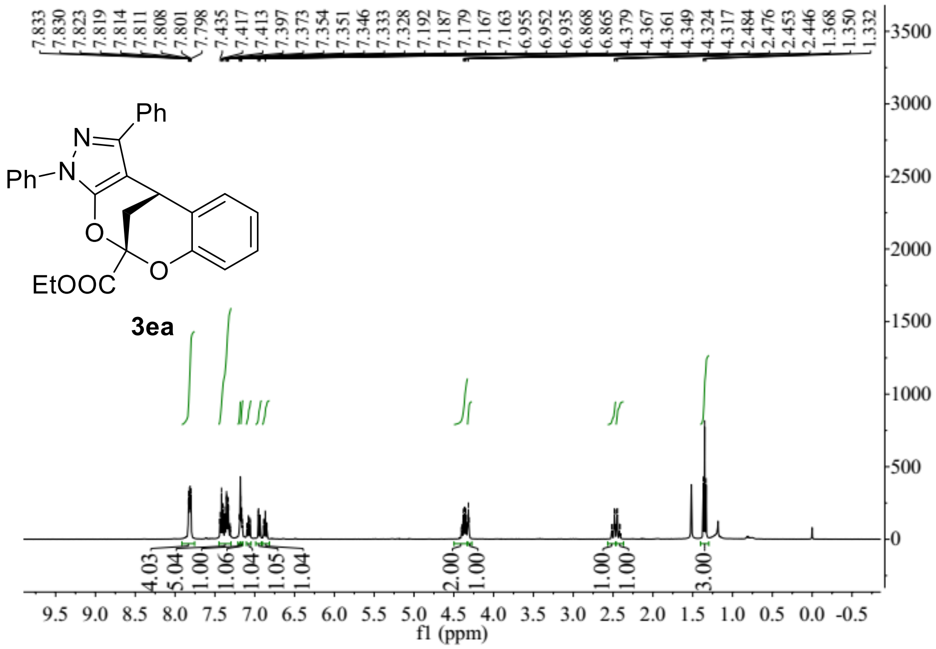


^{13}C NMR of 3da ($CDCl_3$, 400MHz)

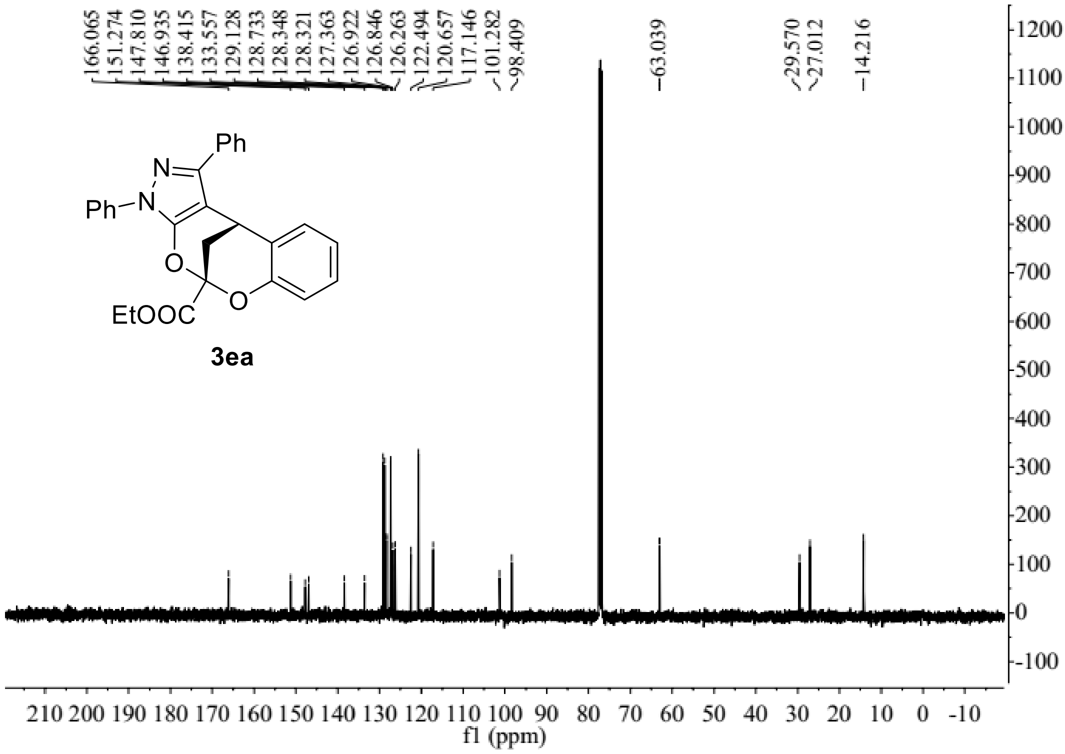


Ethyl-(5S,11S)-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ea

^{1}H NMR of 3ea ($CDCl_3$, 400MHz)

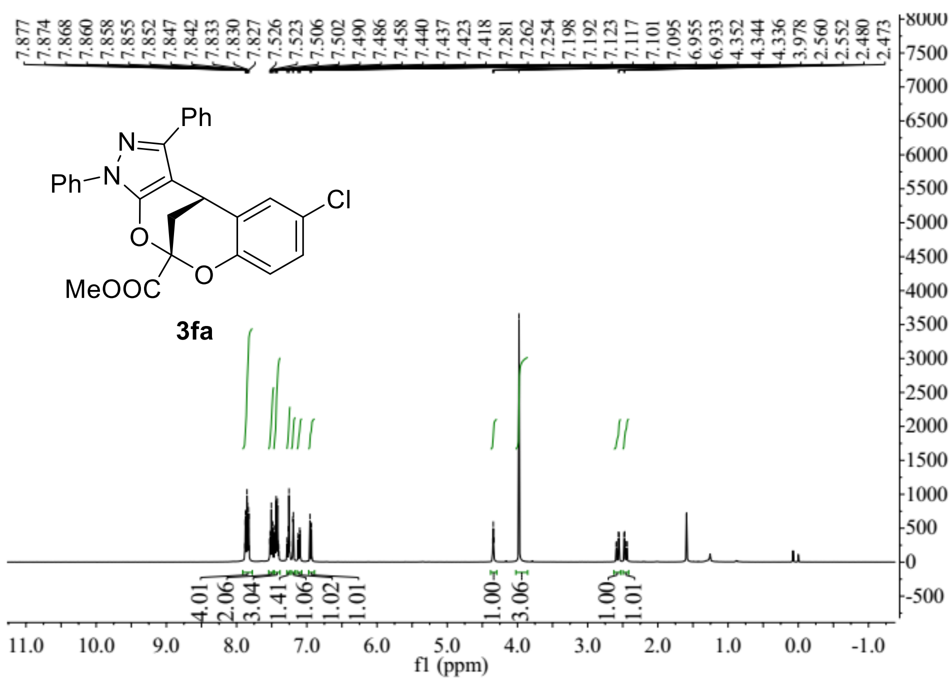


[13]C NMR of 3ea (CDCl$_3$, 400MHz)

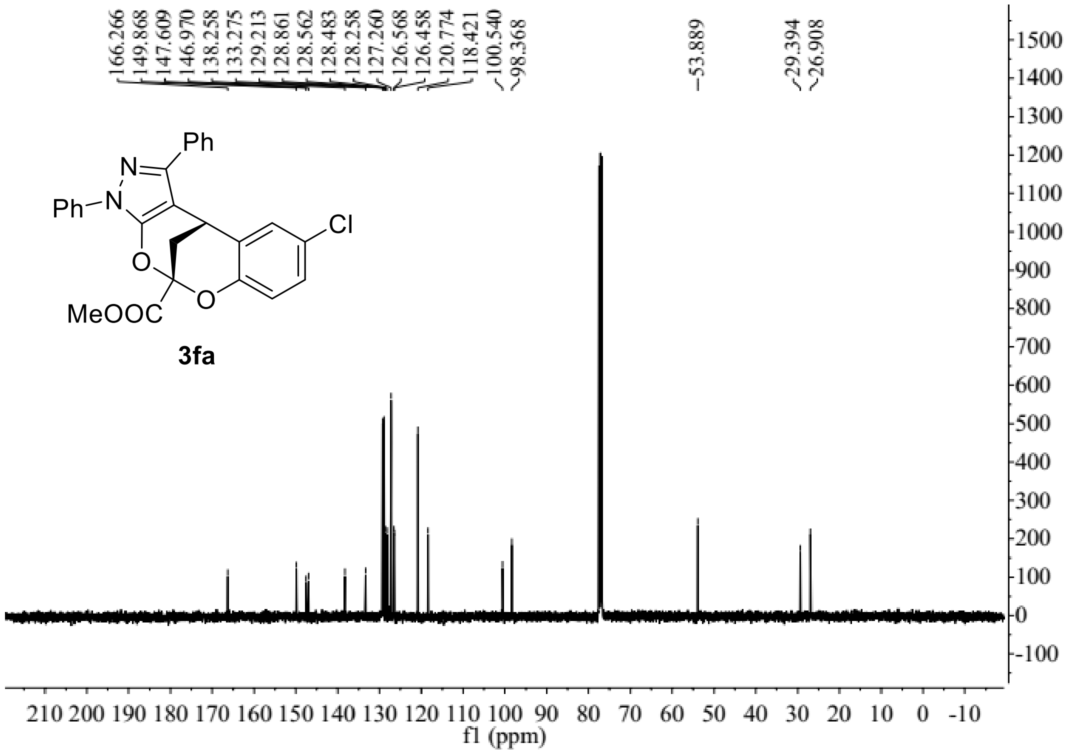


Methyl-(5S,11S)-9-chloro-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino [4,5-c]pyrazole-5-carboxylatee 3fa

[1]H NMR of 3fa (CDCl$_3$, 400MHz)

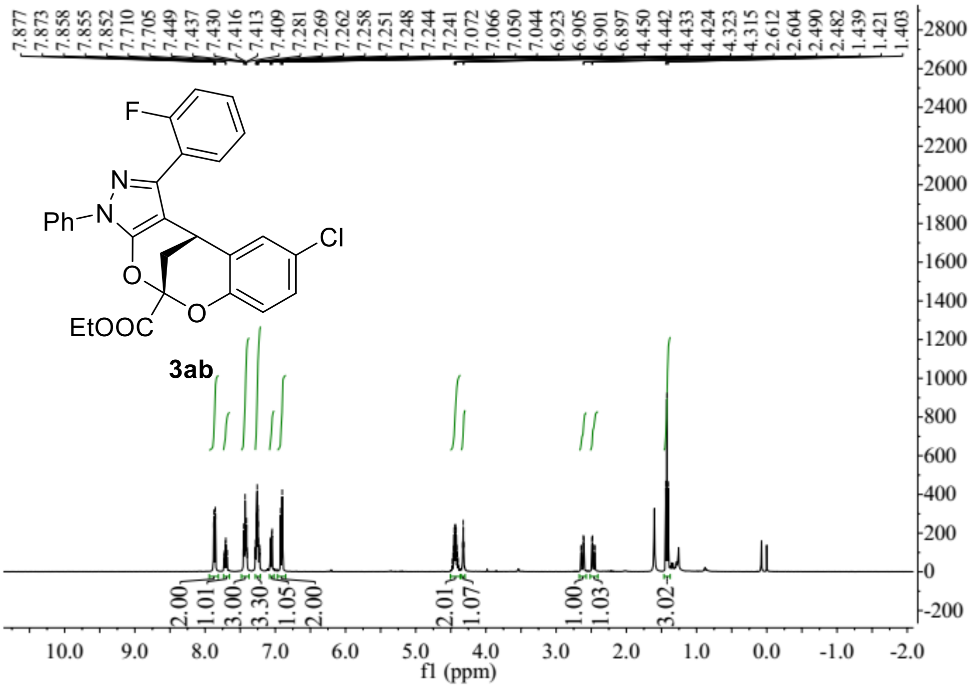


^{13}C NMR of 3fa (CDCl$_3$, 400MHz)

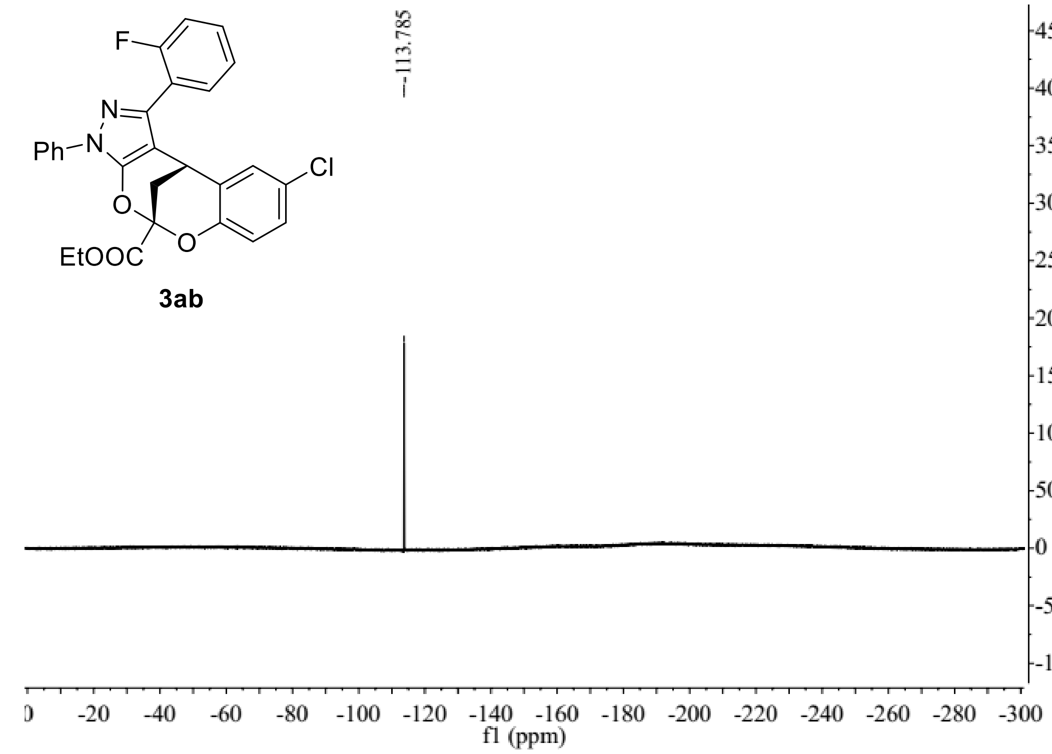


Ethyl-(5S,11S)-9-chloro-1-(2-fluorophenyl)-3-phenyl-3,11-dihydro-5,11-methano benzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ab

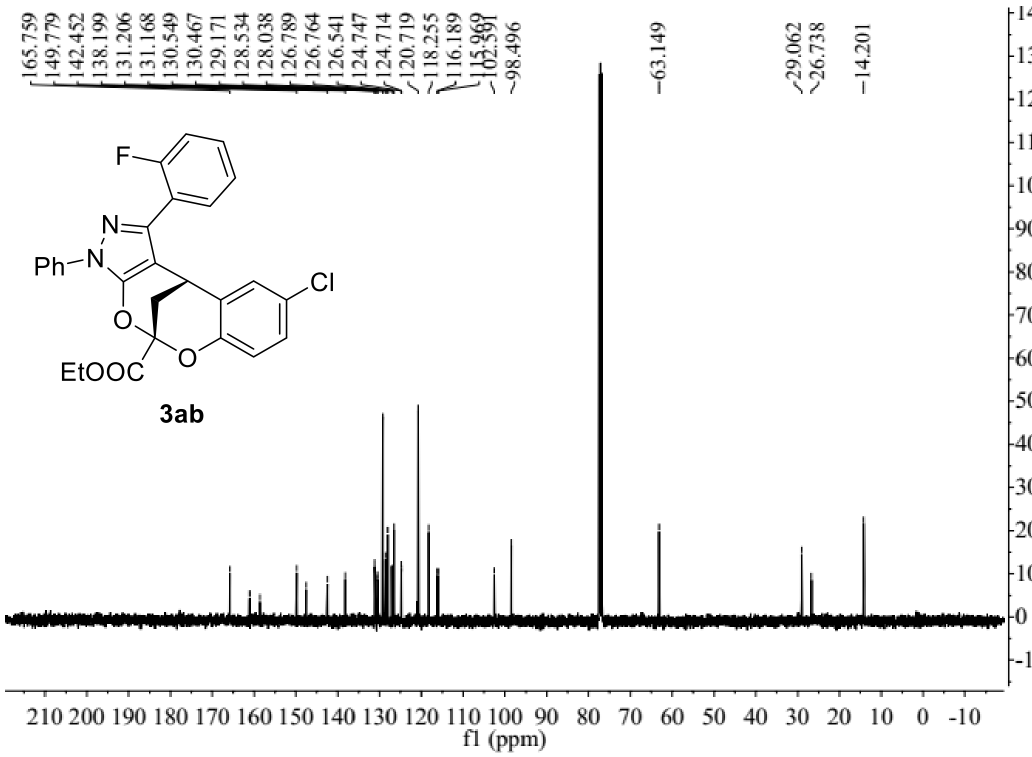
^{1}H NMR of 3ab (CDCl$_3$, 400MHz)



^{19}F NMR of 3ab ($CDCl_3$, 400MHz)

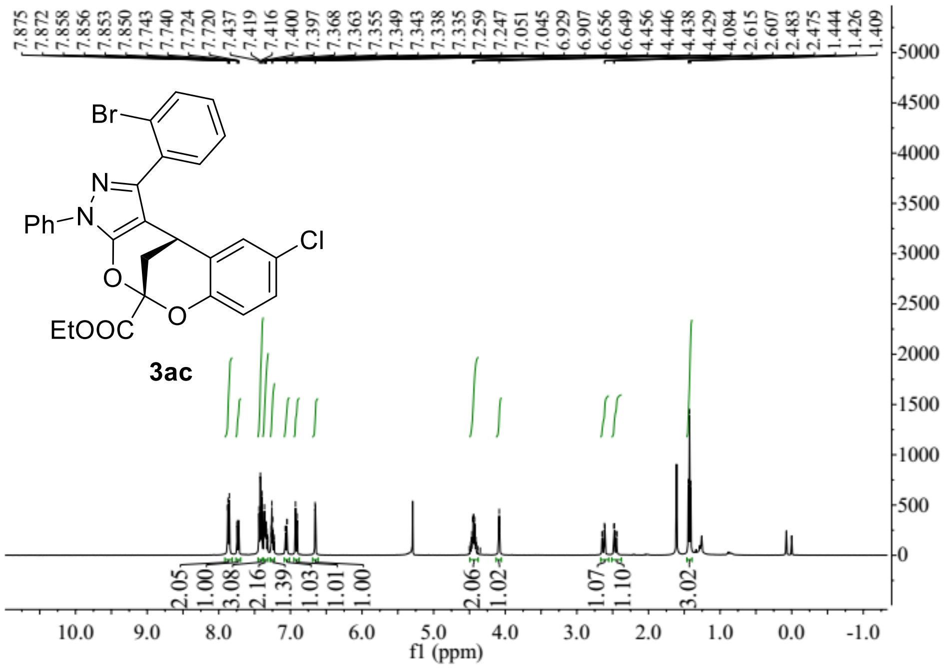


^{13}C NMR of 3ab ($CDCl_3$, 400MHz)

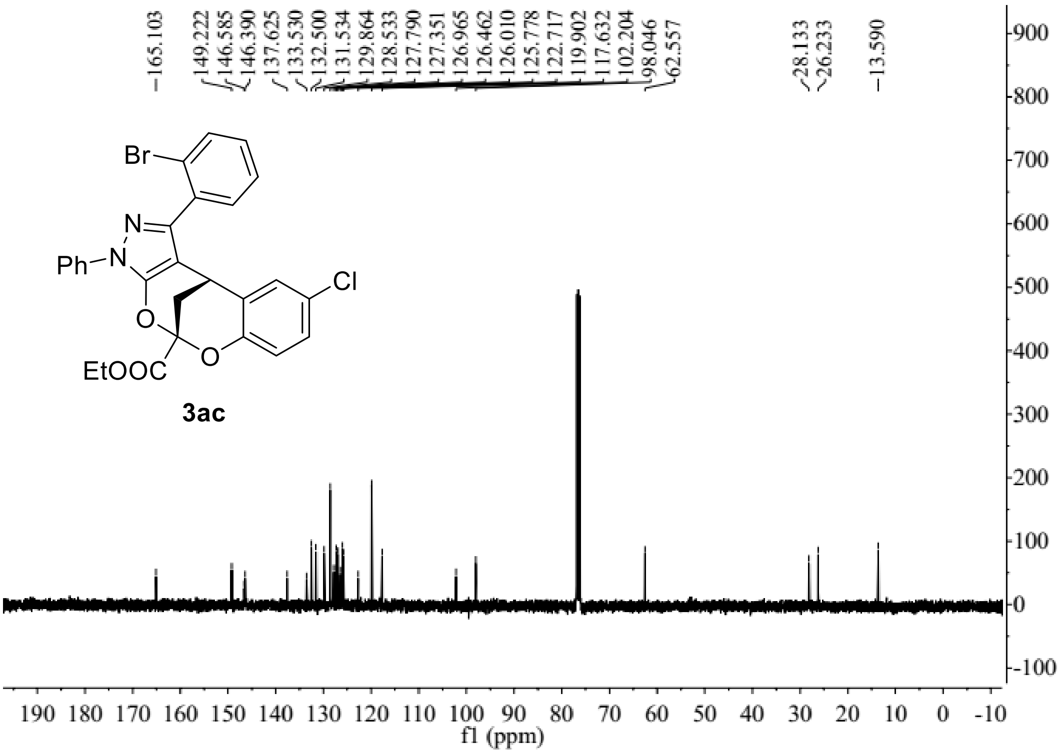


Ethyl-(5S,11S)-1-(2-bromophenyl)-9-chloro-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8] [1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ac

^{1}H NMR of 3ac (CDCl$_3$, 400MHz)

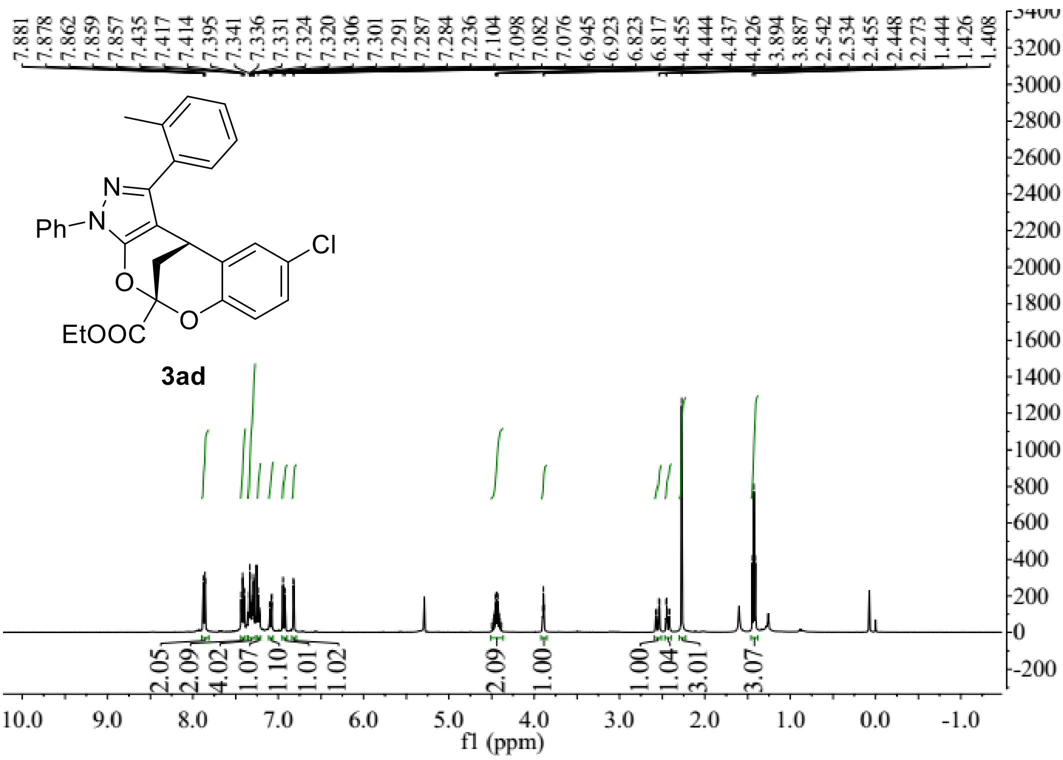


^{13}C NMR of 3ac (CDCl$_3$, 400MHz)

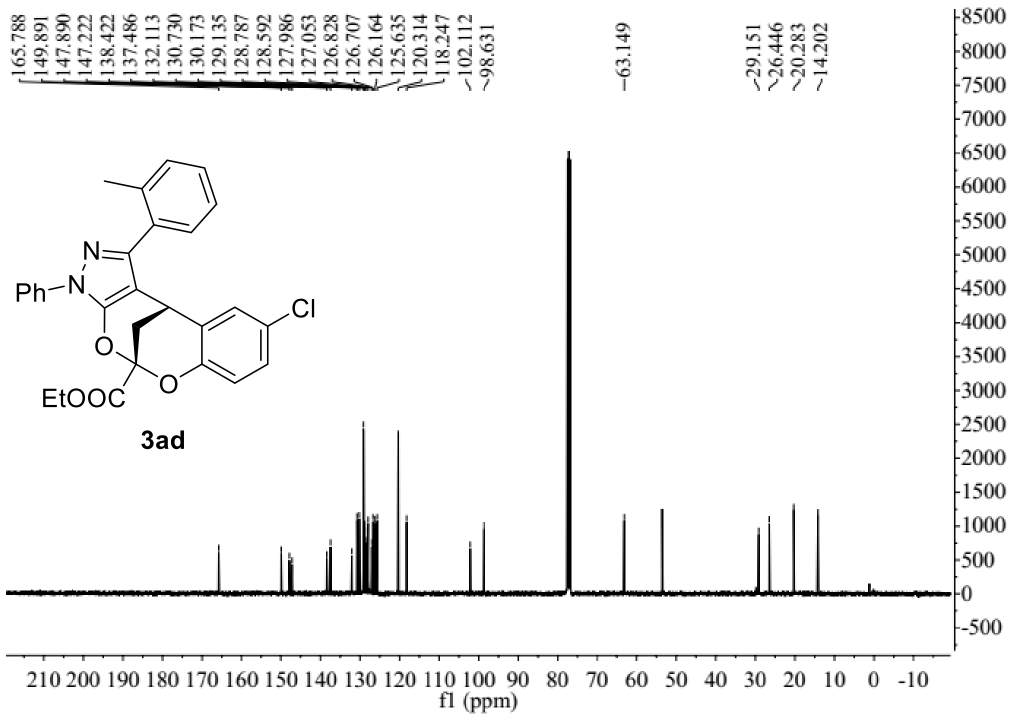


Ethyl-(5S,11S)-9-chloro-3-phenyl-1-(o-tolyl)-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3ad

[1]H NMR of 3ad ($CDCl_3$, 400MHz)

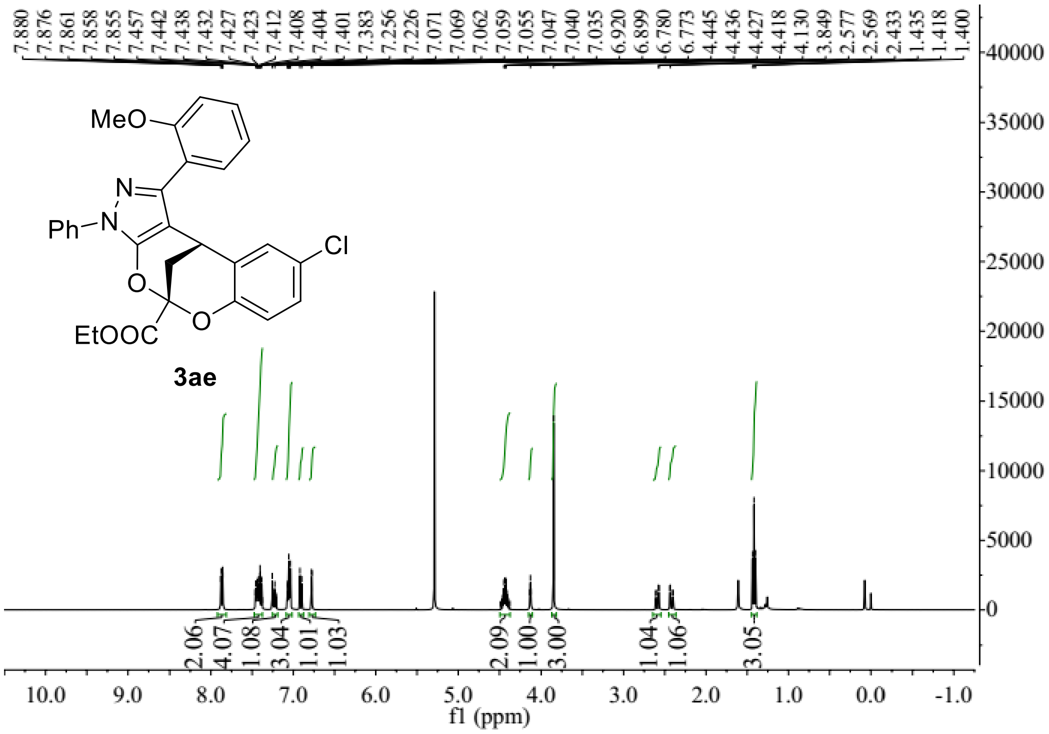


[13]C NMR of 3ad ($CDCl_3$, 400MHz)

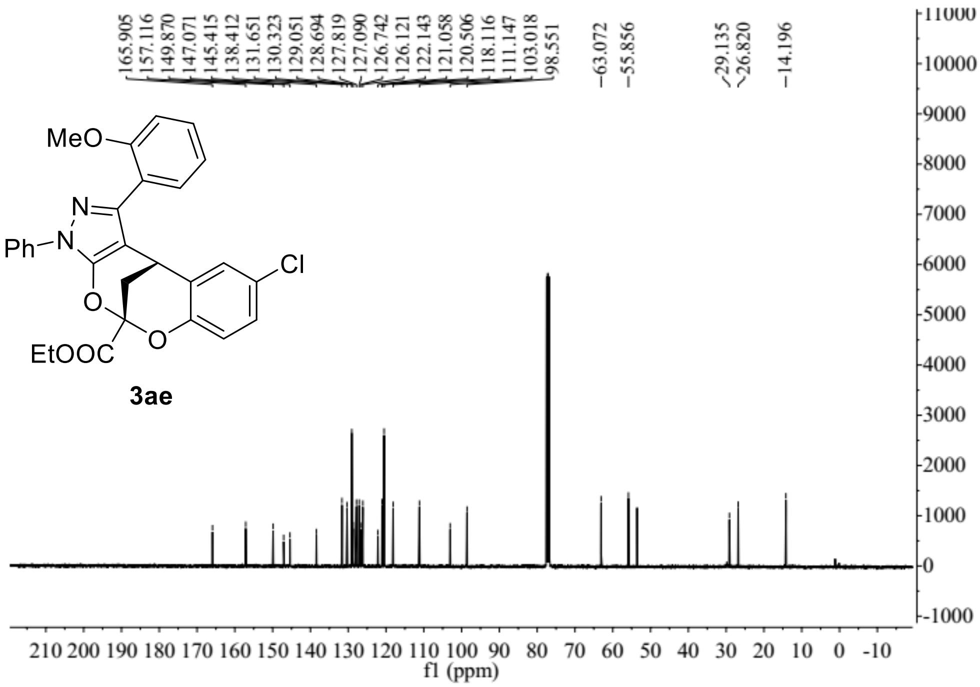


Ethyl-(5S,11S)-1-(2-methoxyphenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3ae

^{1}H NMR of 3ae ($CDCl_3$, 400MHz)

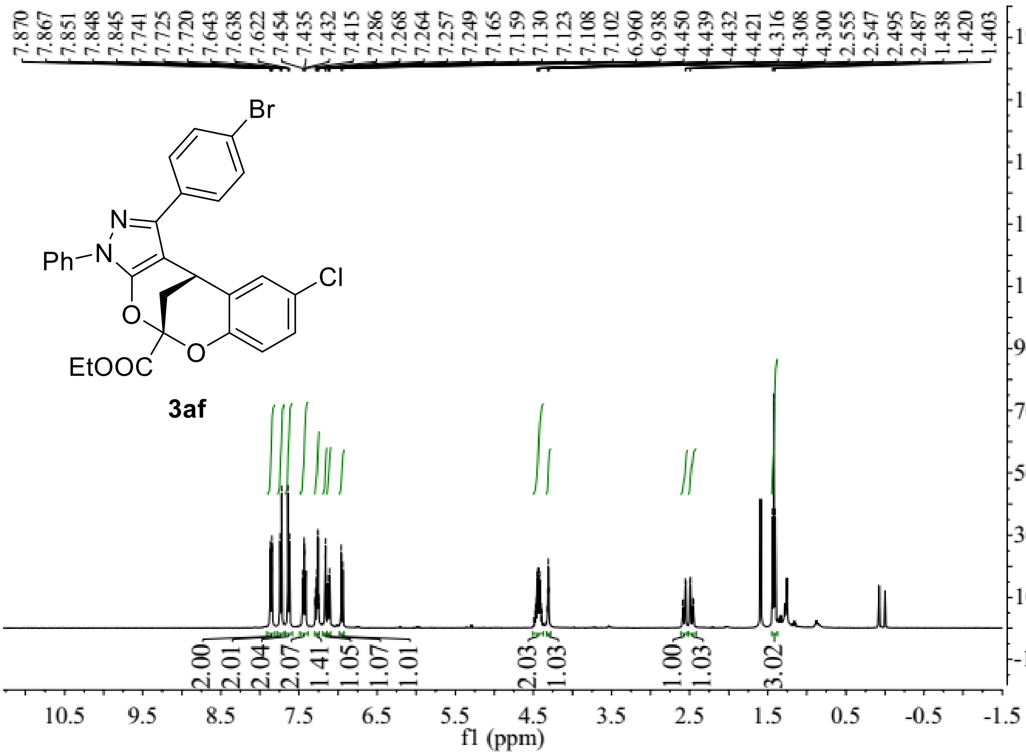


^{13}C NMR of 3ae ($CDCl_3$, 400MHz)

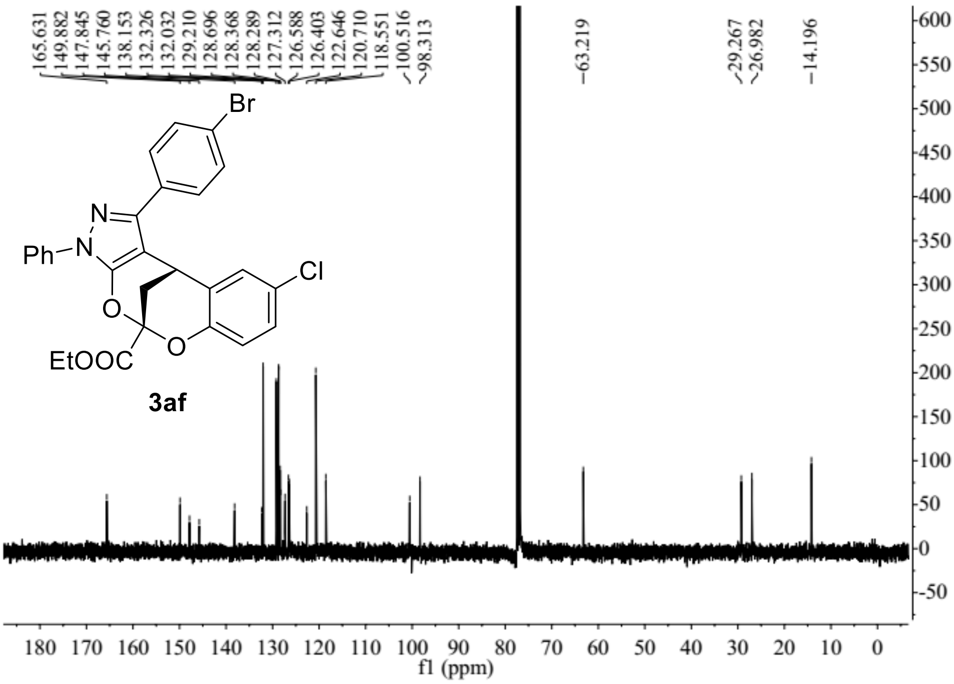


Ethyl-(5S,11S)-1-(4-bromophenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3af

^{1}H NMR of 3af ($CDCl_3$, 400MHz)

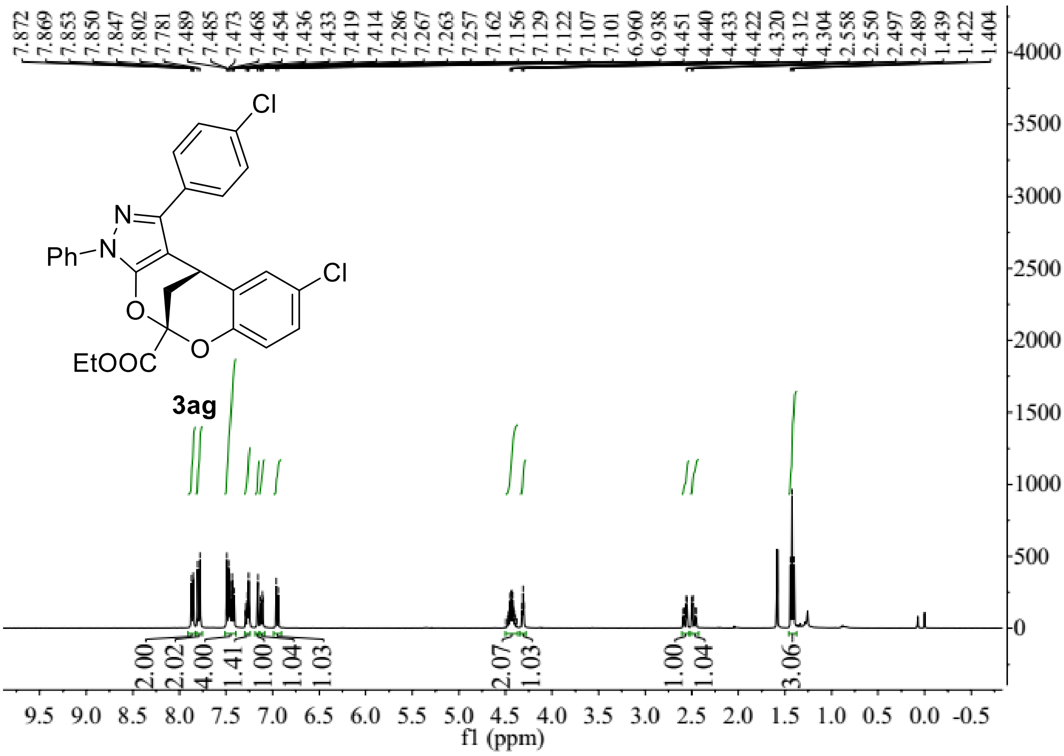


^{13}C NMR of 3af ($CDCl_3$, 400MHz)

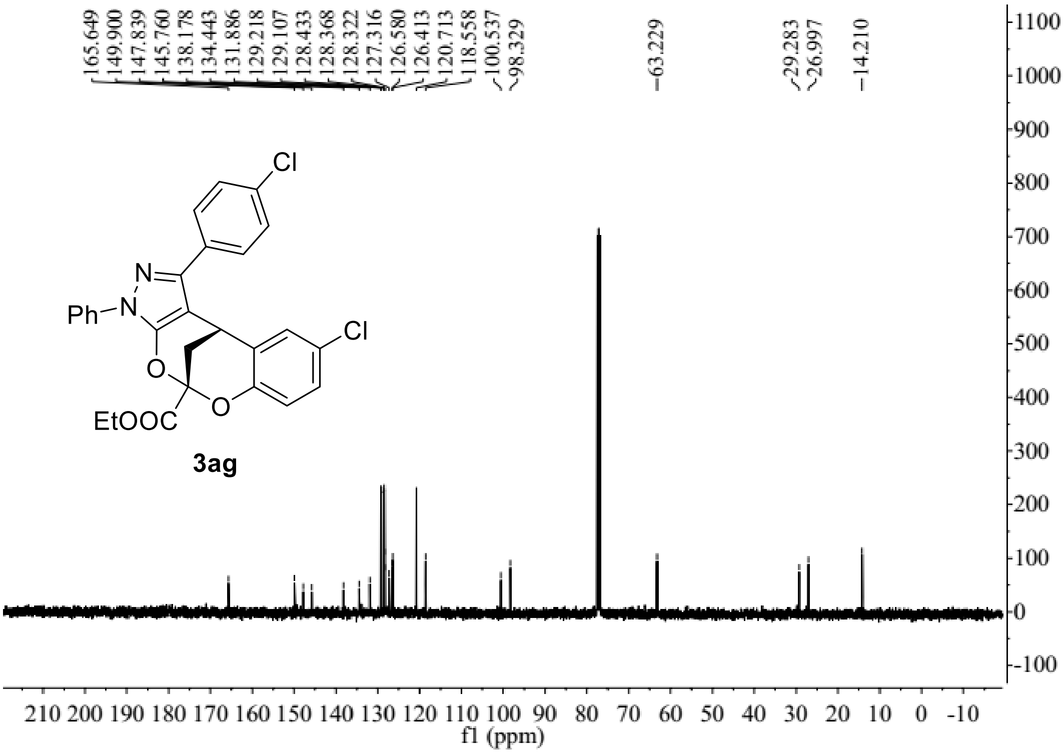


Ethyl-(5S,11S)-9-chloro-1-(4-chlorophenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ag

^{1}H NMR of 3ag ($CDCl_3$, 400MHz)

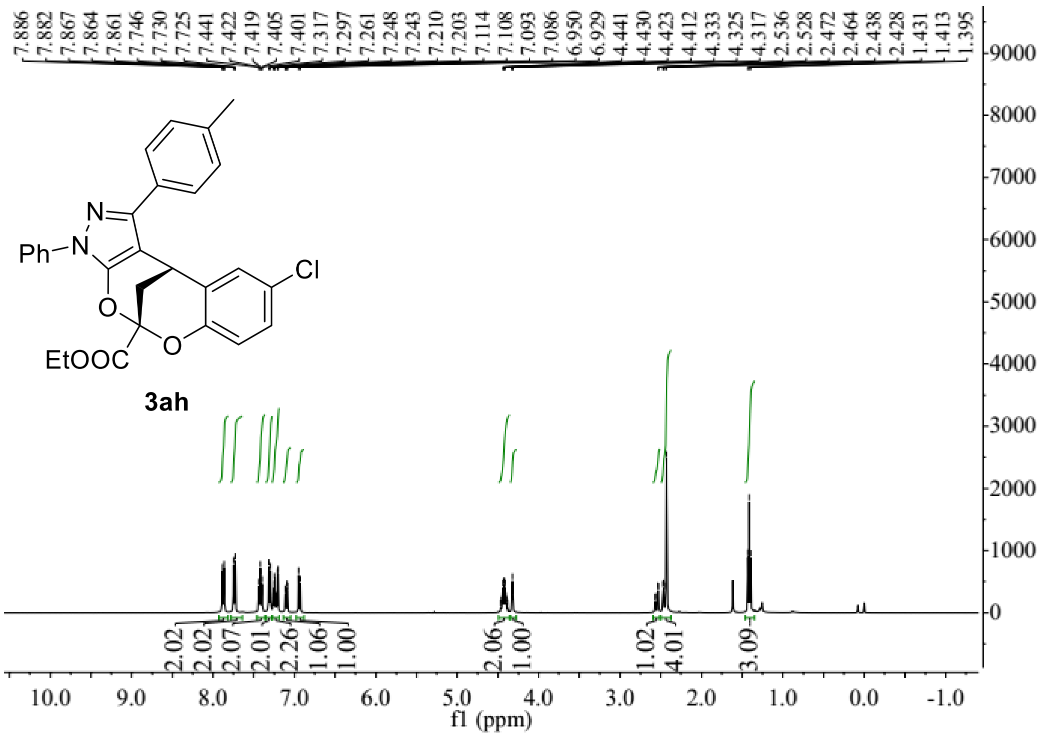


^{13}C NMR of 3ag ($CDCl_3$, 400MHz)

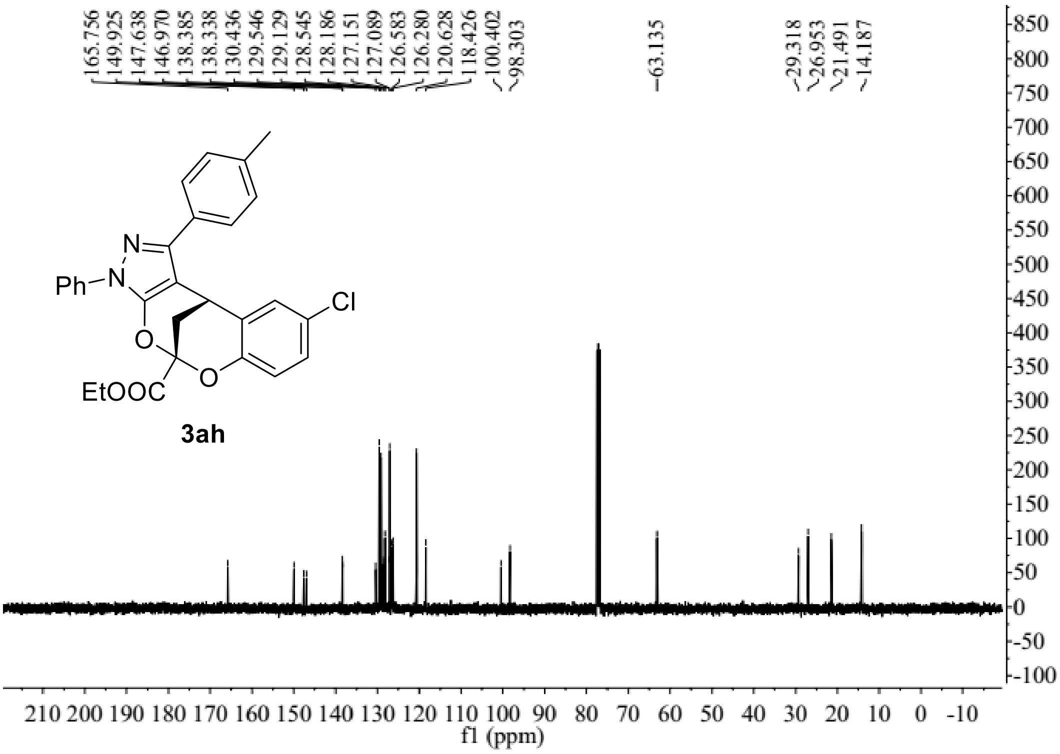


Ethyl-(5S,11S)-9-chloro-3-phenyl-1-(p-tolyl)-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3ah

^{1}H NMR of 3ah ($CDCl_3$, 400MHz)

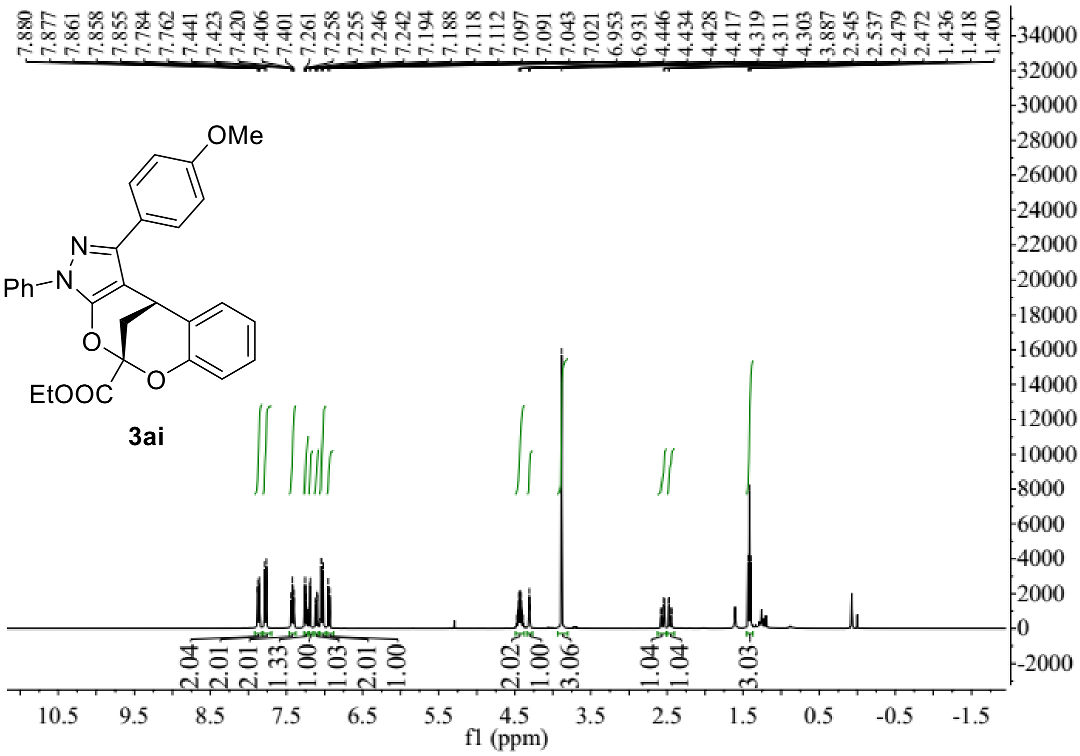


^{13}C NMR of 3ah ($CDCl_3$, 400MHz)

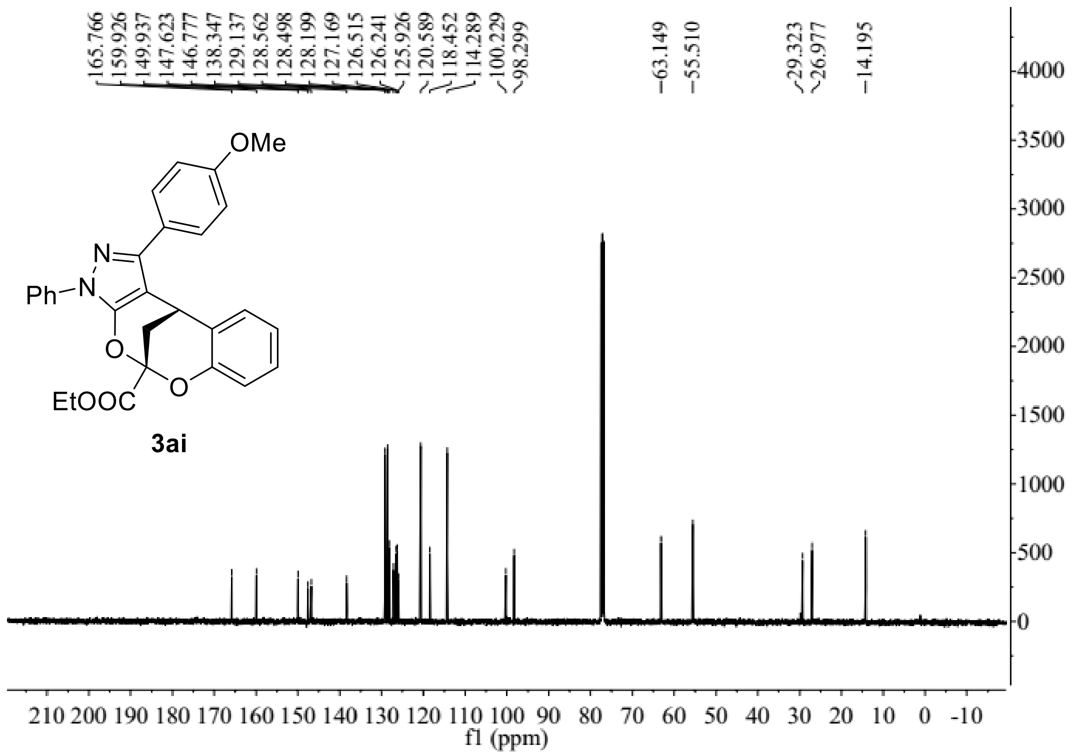


Ethyl-(5S,11S)-9-chloro-1-(4-methoxyphenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ai

^{1}H NMR of 3ai ($CDCl_3$, 400MHz)

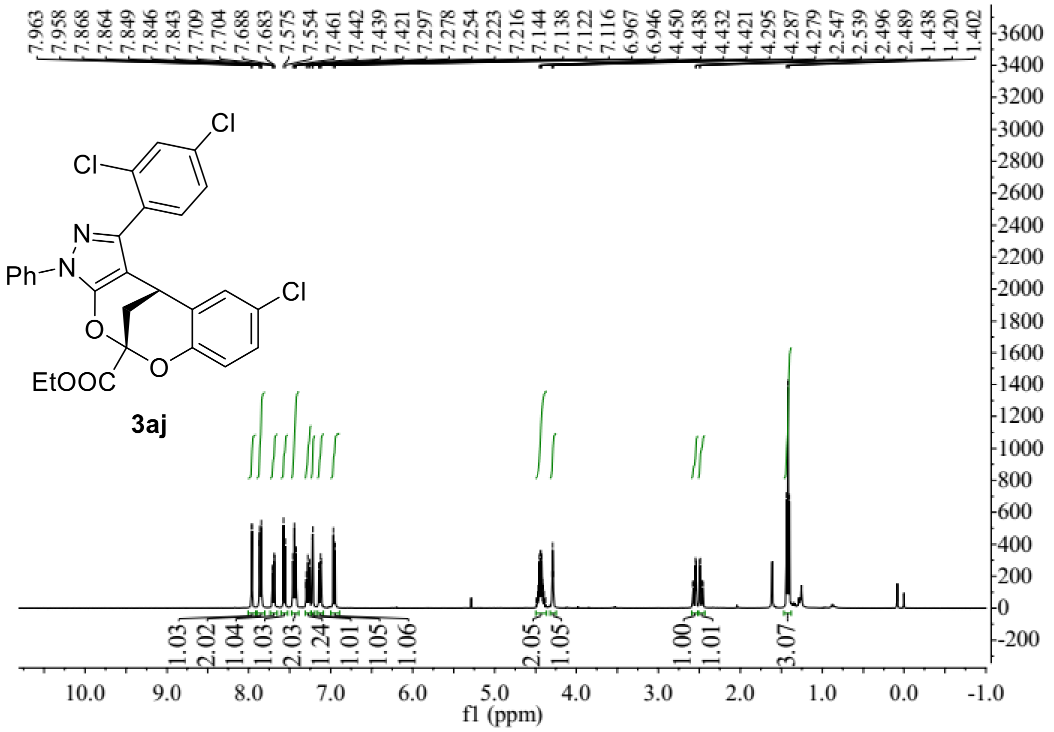


^{13}C NMR of 3ai ($CDCl_3$, 400MHz)

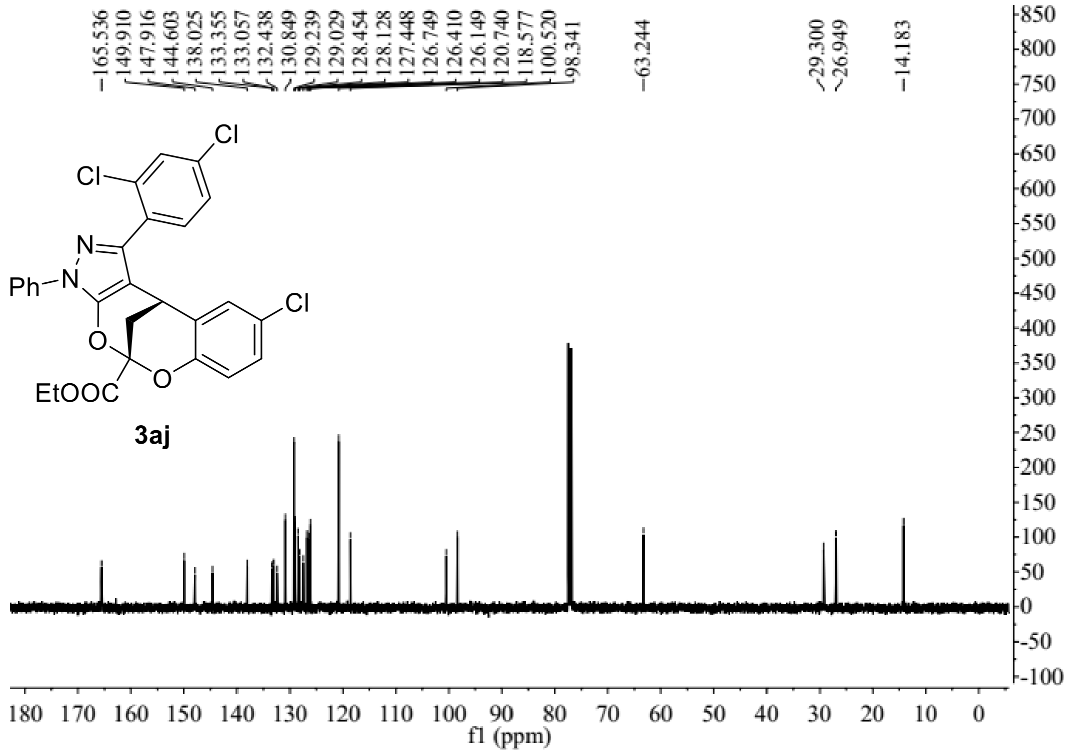


Ethyl-(5S,11S)-9-chloro-1-(2,4-dichlorophenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo [7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3aj

^{1}H NMR of 3aj ($CDCl_3$, 400MHz)

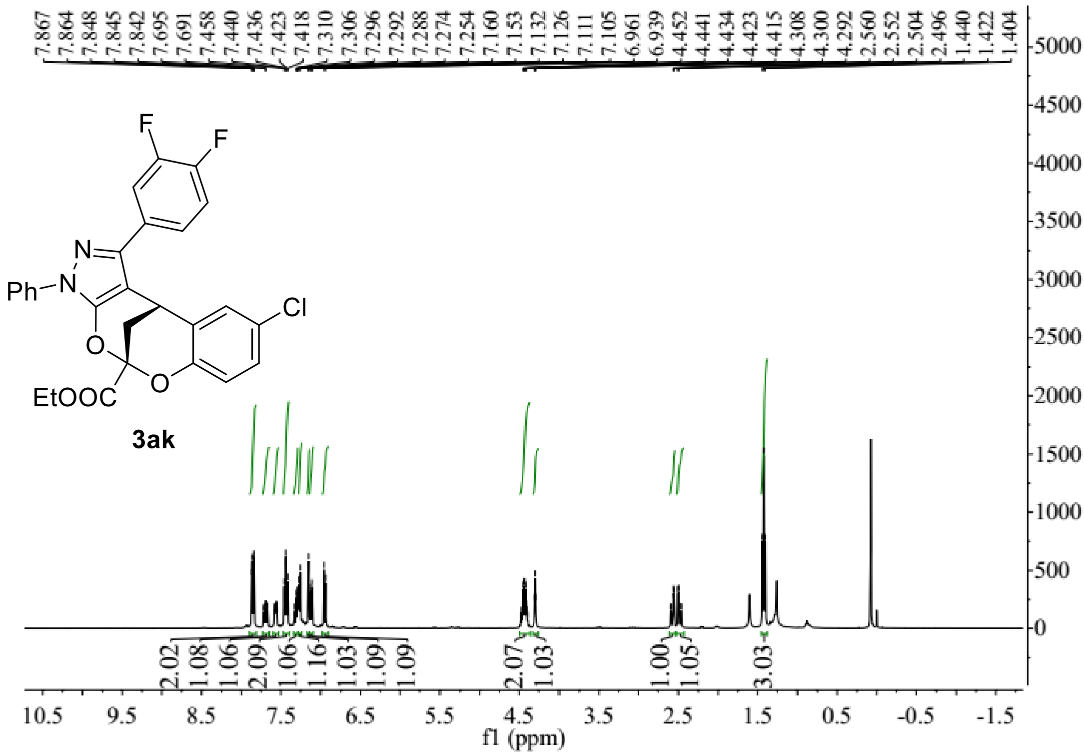


^{13}C NMR of 3aj ($CDCl_3$, 400MHz)

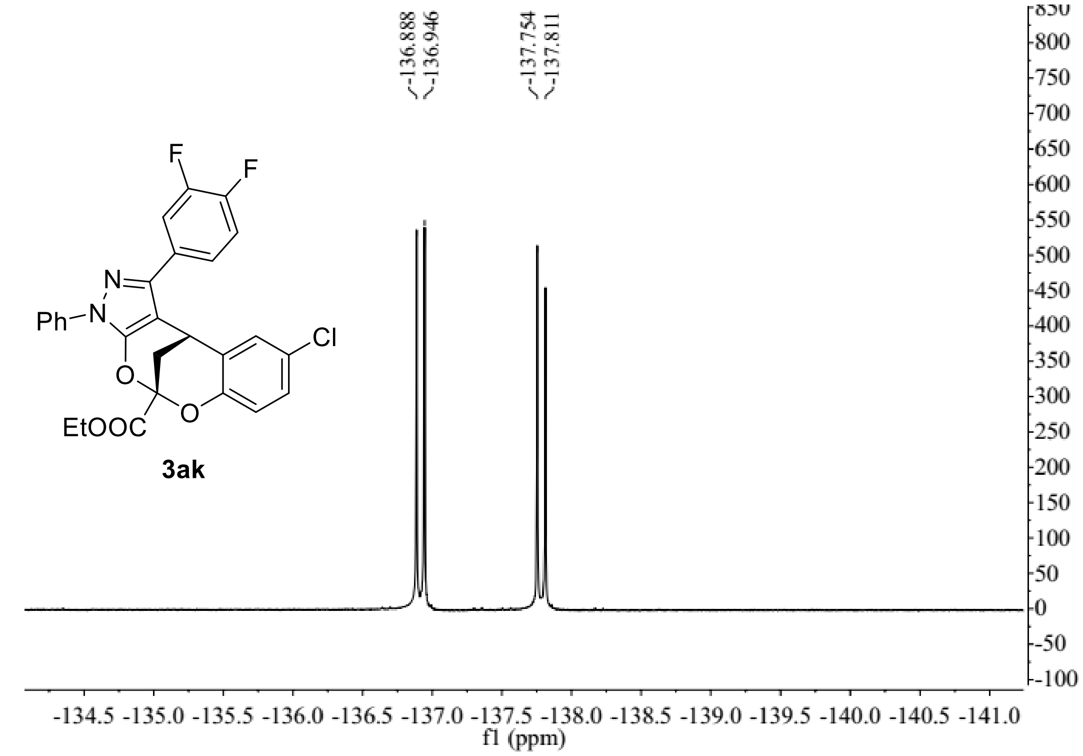


Ethyl-(5S,11S)-9-chloro-1-(3,4-difluorophenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ak

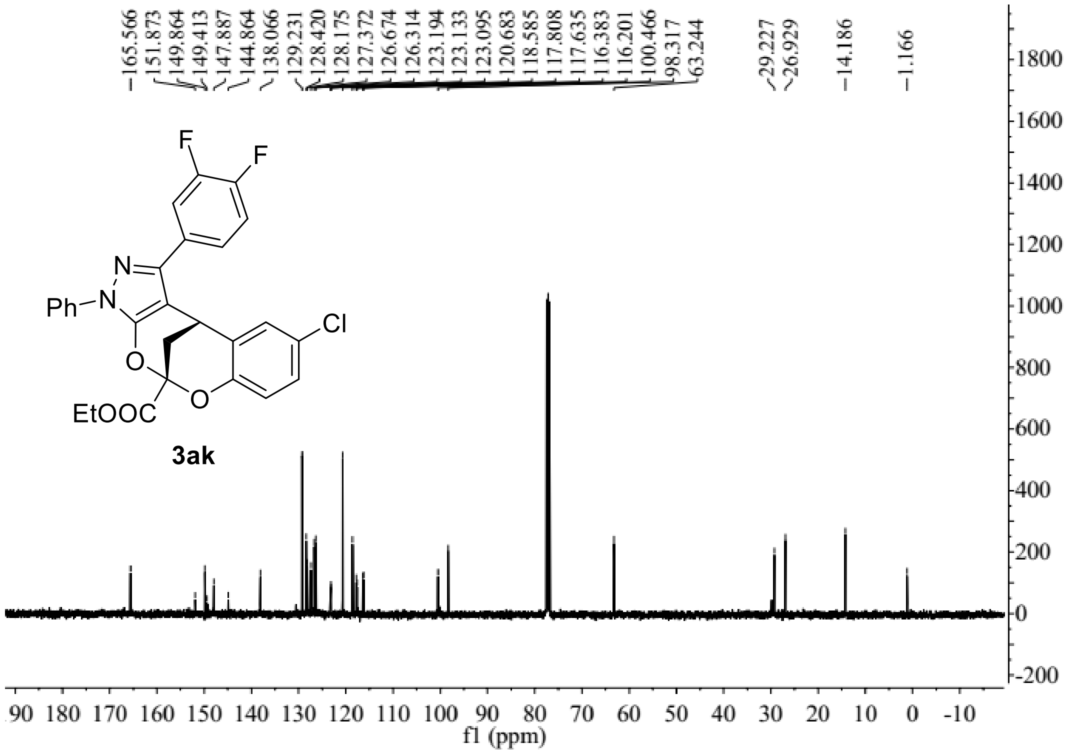
^{1}H NMR of 3ak ($CDCl_3$, 400MHz)



^{19}F NMR of 3ak ($CDCl_3$, 400MHz)

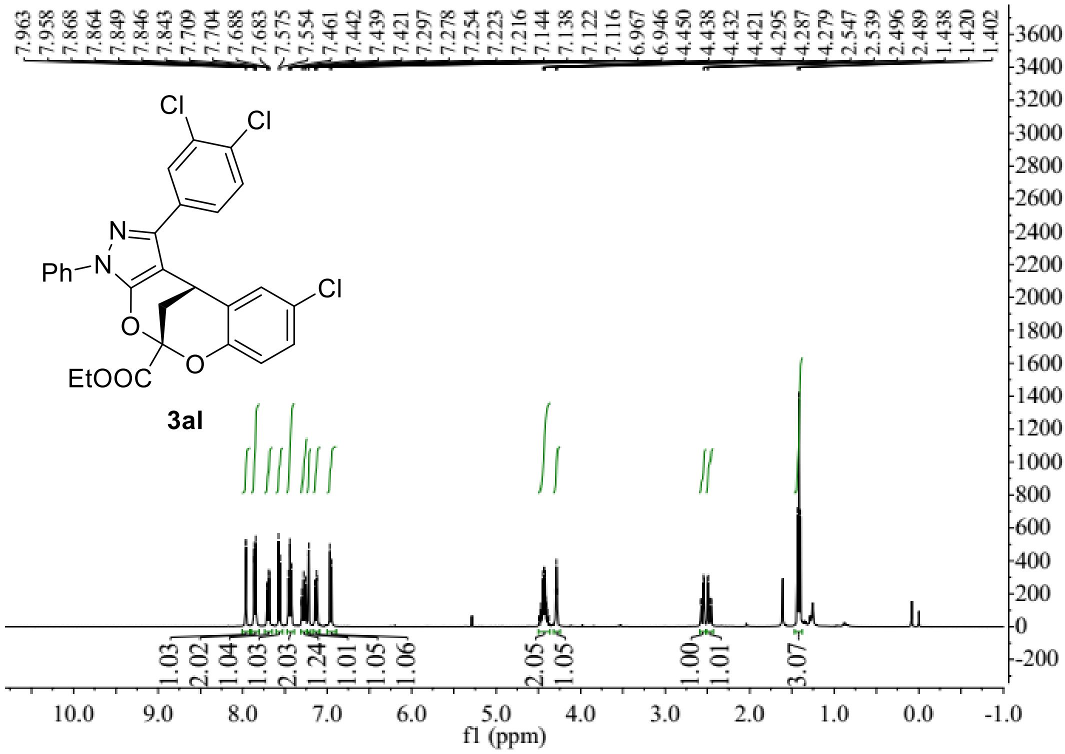


^{13}C NMR of 3ak ($CDCl_3$, 400MHz)

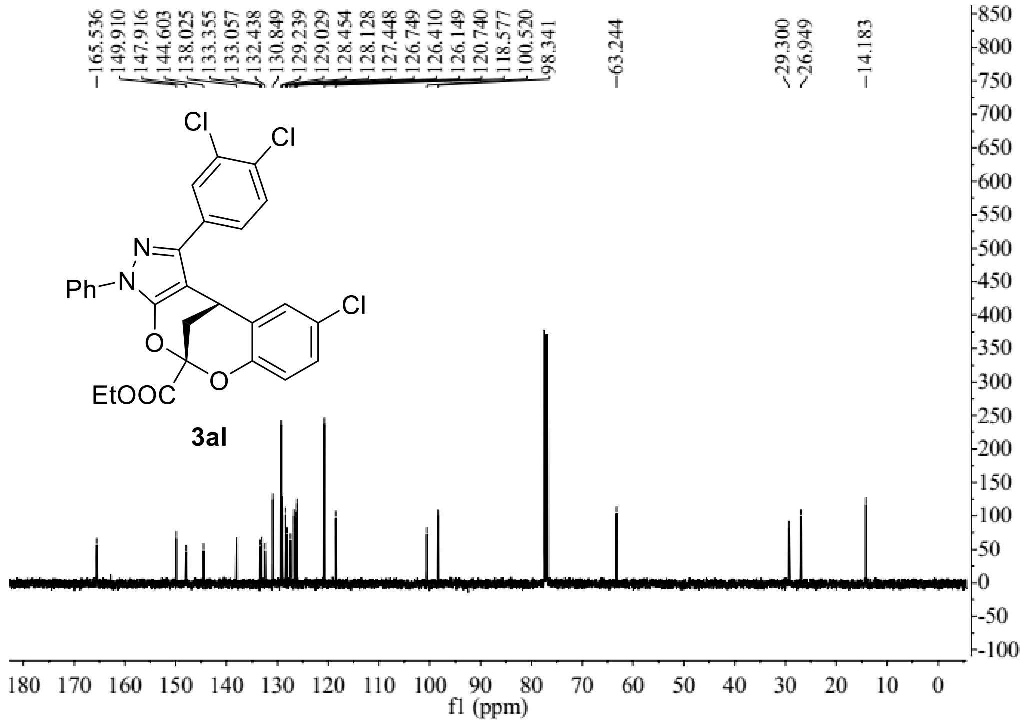


Ethyl-(5S,11S)-9-chloro-1-(3,4-dichlorophenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo [7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3al

^{1}H NMR of 3al ($CDCl_3$, 400MHz)



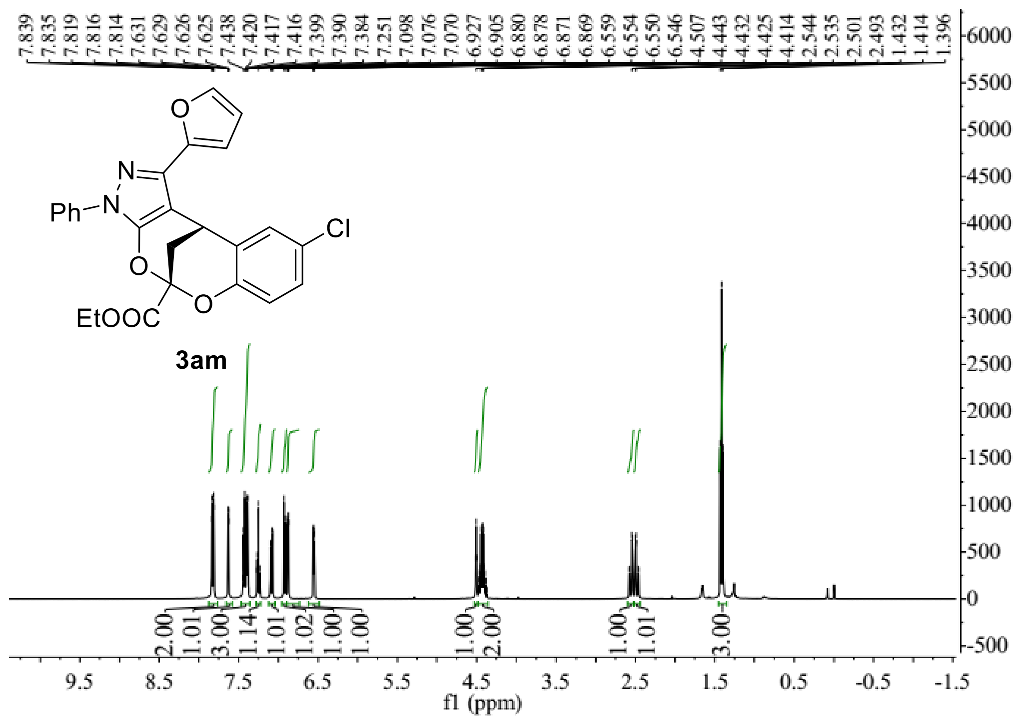
^{13}C NMR of 3al ($CDCl_3$, 400MHz)



Ethyl-(5S,11S)-9-chloro-1-(furan-2-yl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]

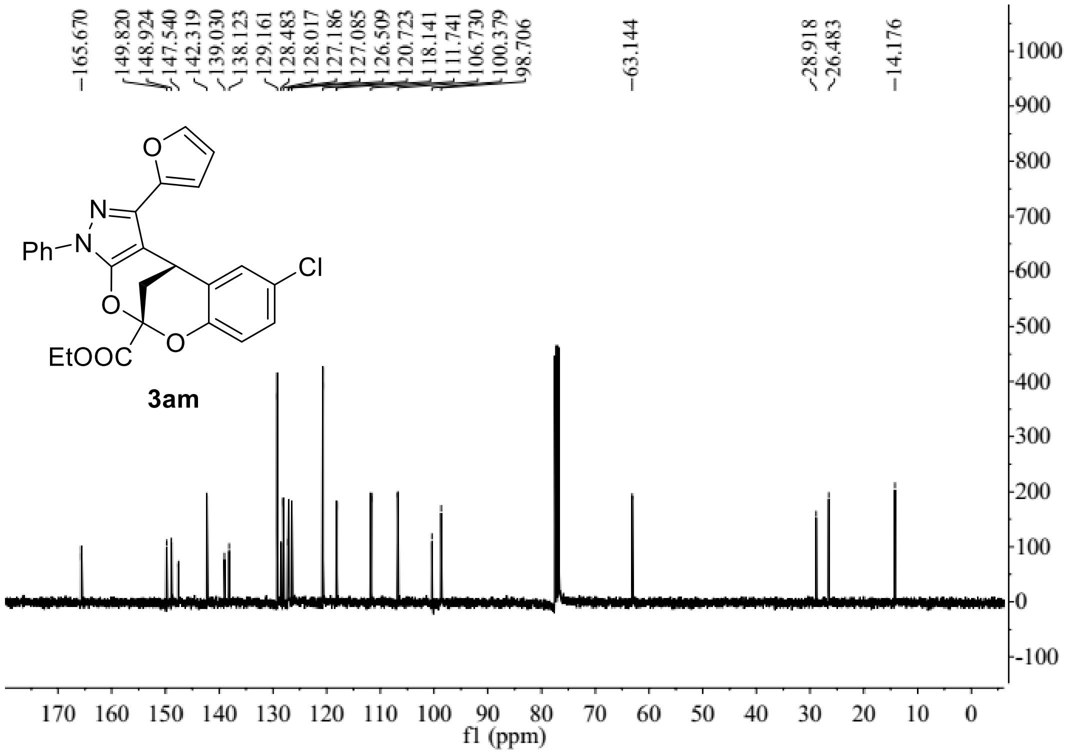
dioxocino[4,5-c]pyrazole-5-carboxylate 3am

^{1}H NMR of 3am ($CDCl_3$, 400MHz)



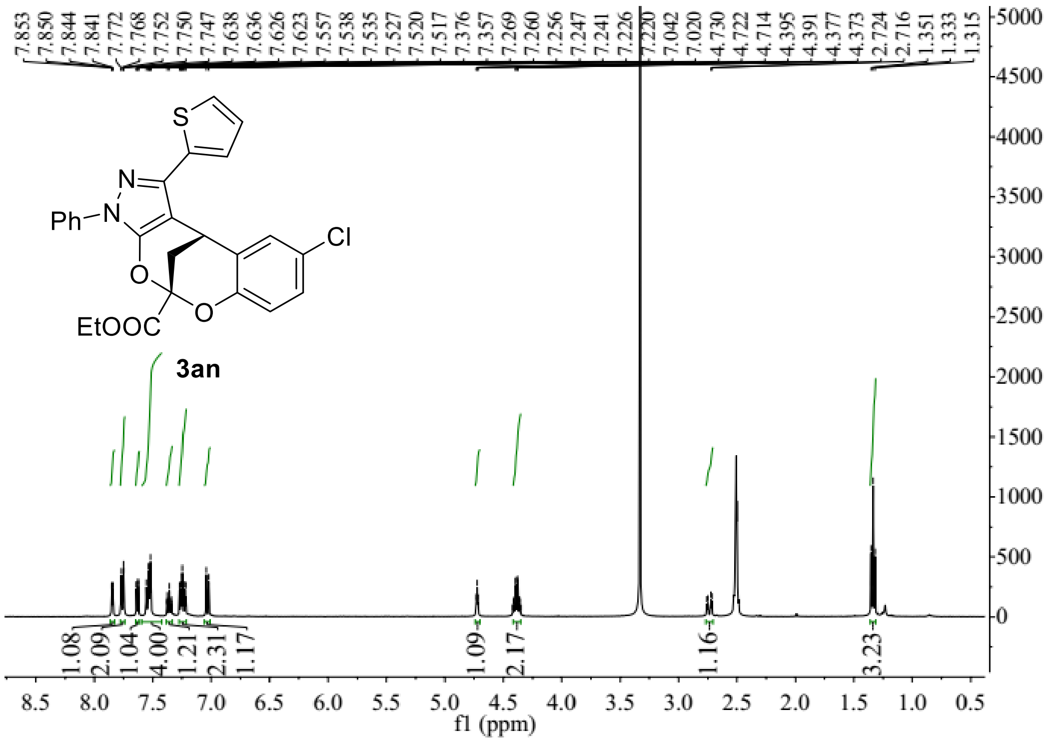
^{13}C

NMR of 3am ($CDCl_3$, 400MHz)

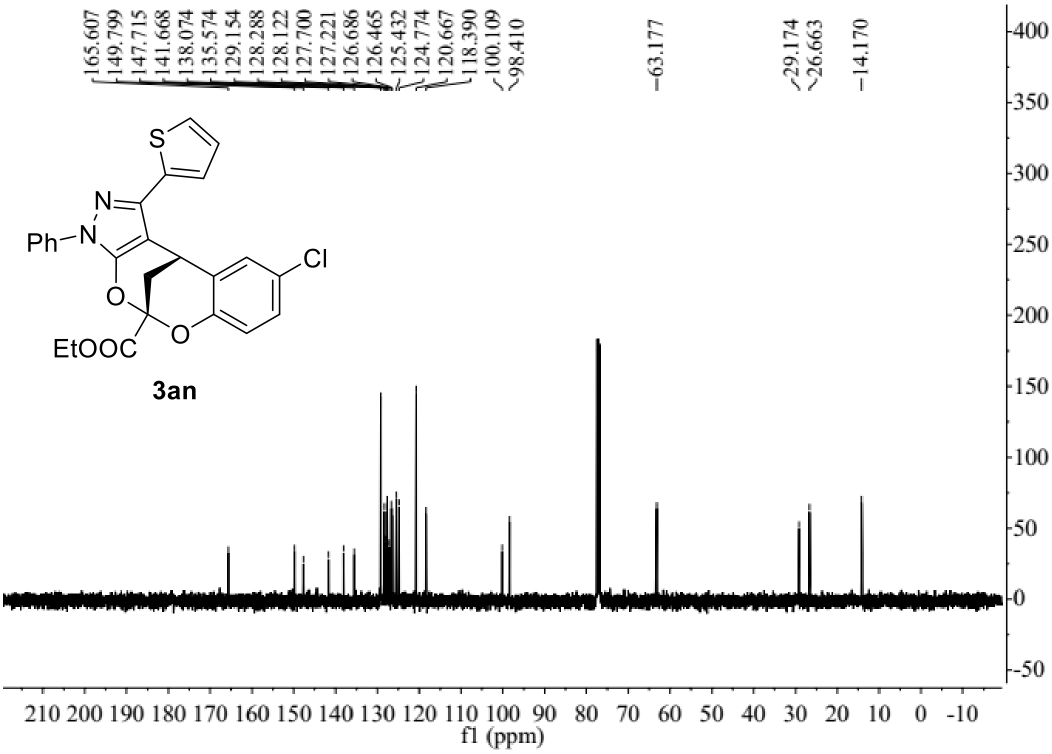


Ethyl-(5S,11S)-9-chloro-3-phenyl-1-(thiophen-2-yl)-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3an

^{1}H NMR of 3an (DMSO-d_6, 400MHz)

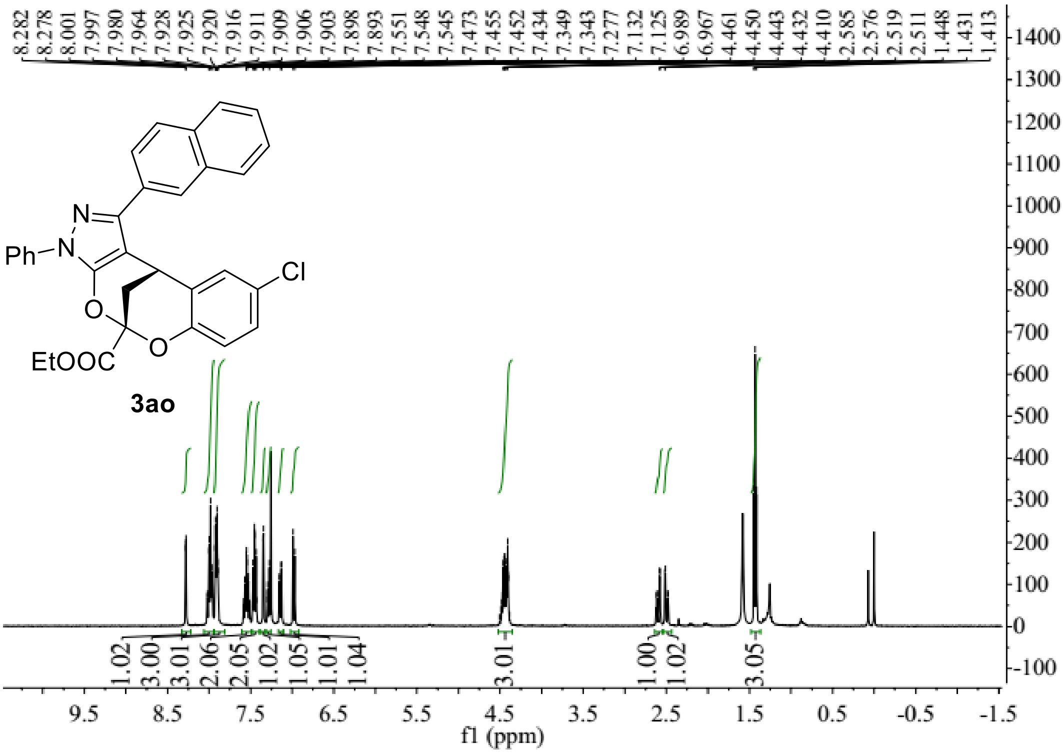


^{13}C NMR of 3an ($CDCl_3$, 400MHz)

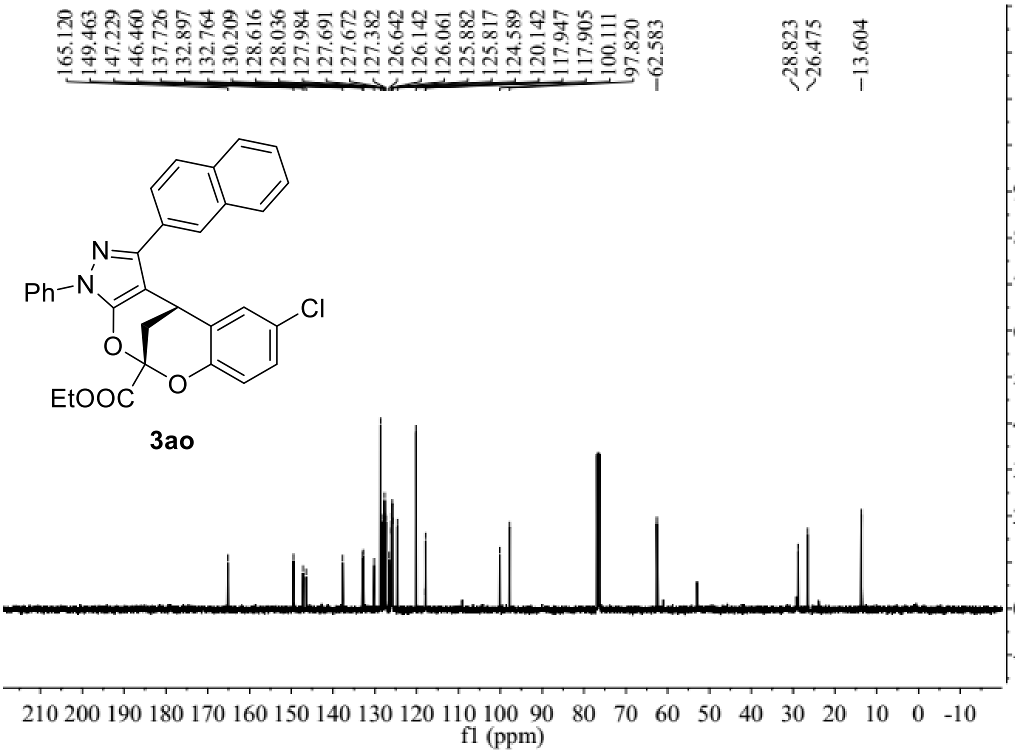


Ethyl-(5S,11S)-9-chloro-1-(naphthalen-2-yl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ao

^{1}H NMR of 3ao ($CDCl_3$, 400MHz)

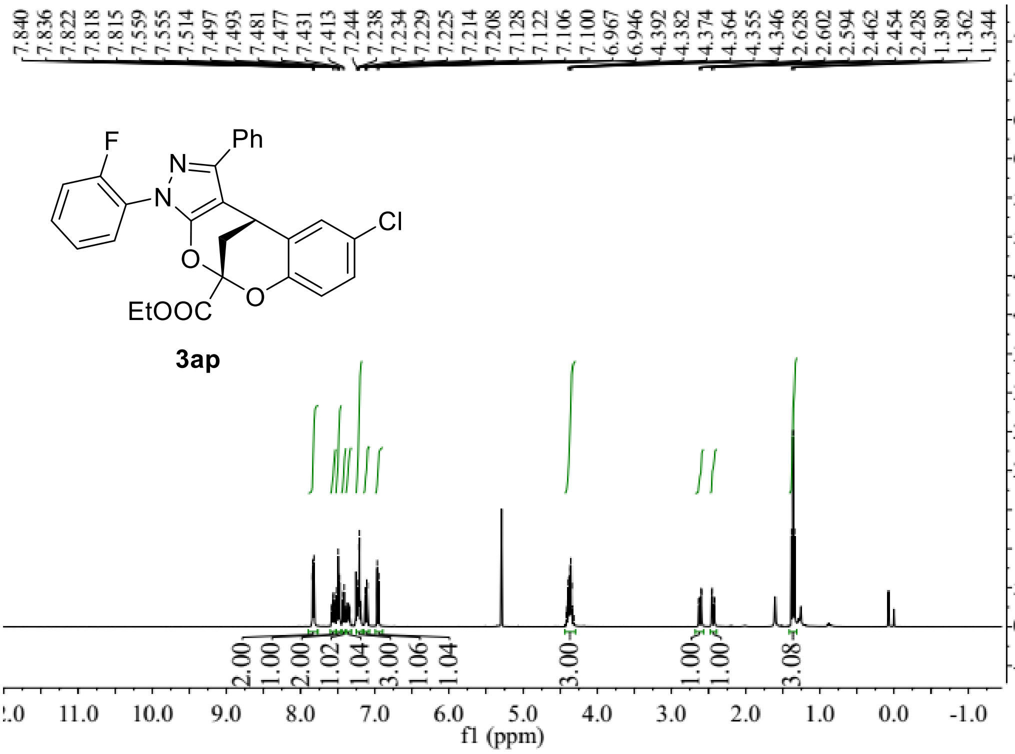


^{13}C NMR of 3ao ($CDCl_3$, 400MHz)

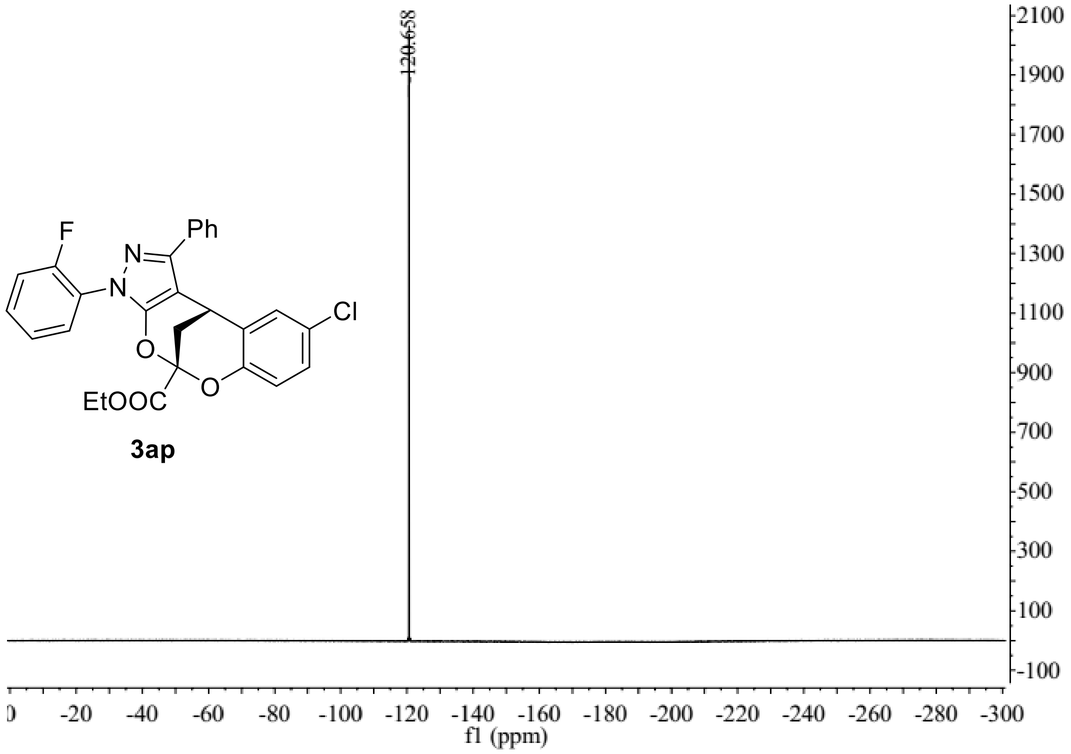


Ethyl-(5S,11S)-9-chloro-3-(2-fluorophenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ap

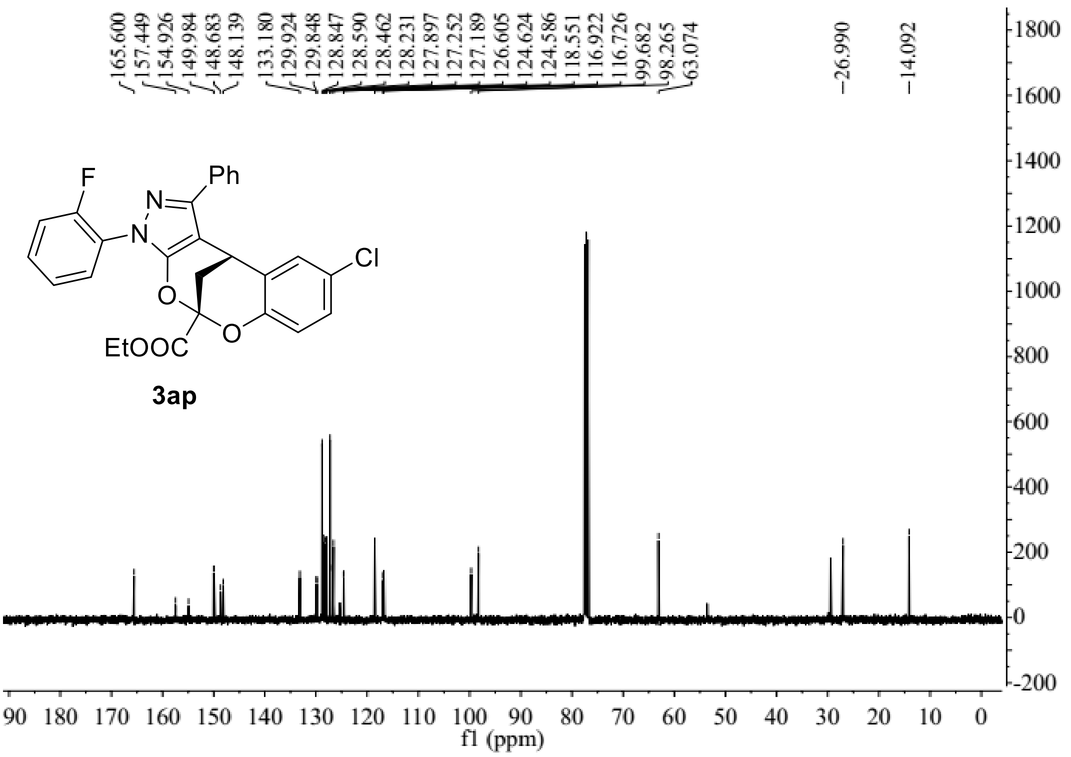
^{1}H NMR of 3ap ($CDCl_3$, 400MHz)



^{19}F NMR of 3ap ($CDCl_3$, 400MHz)

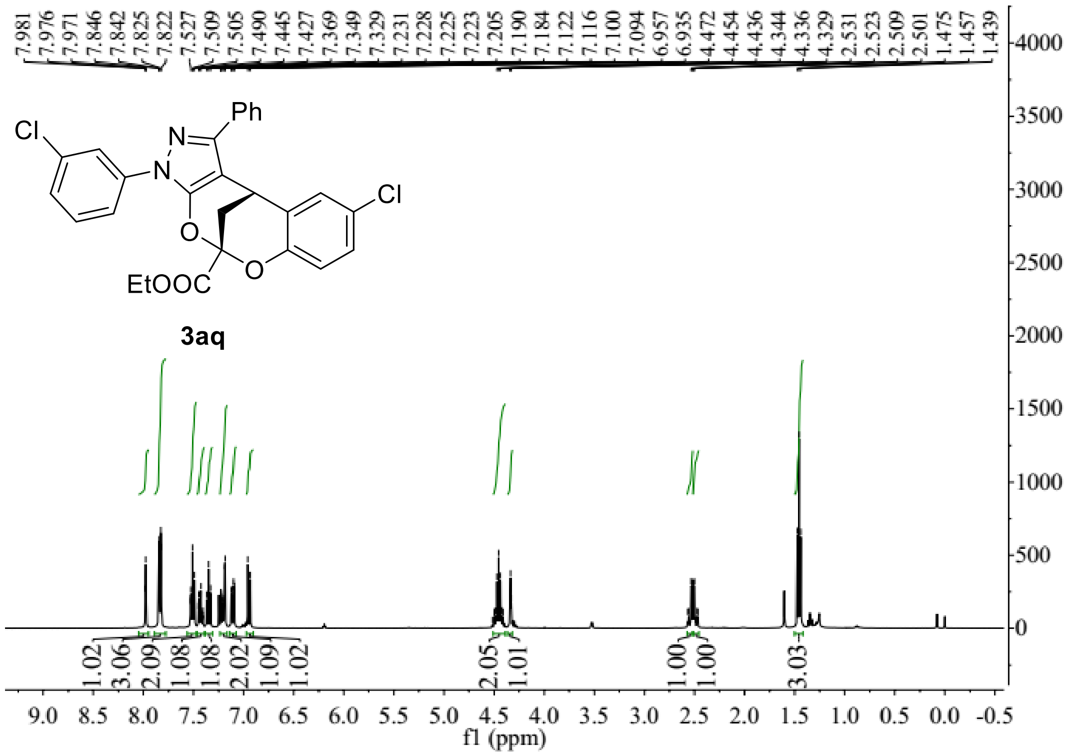


^{13}C NMR of 3ap ($CDCl_3$, 400MHz)

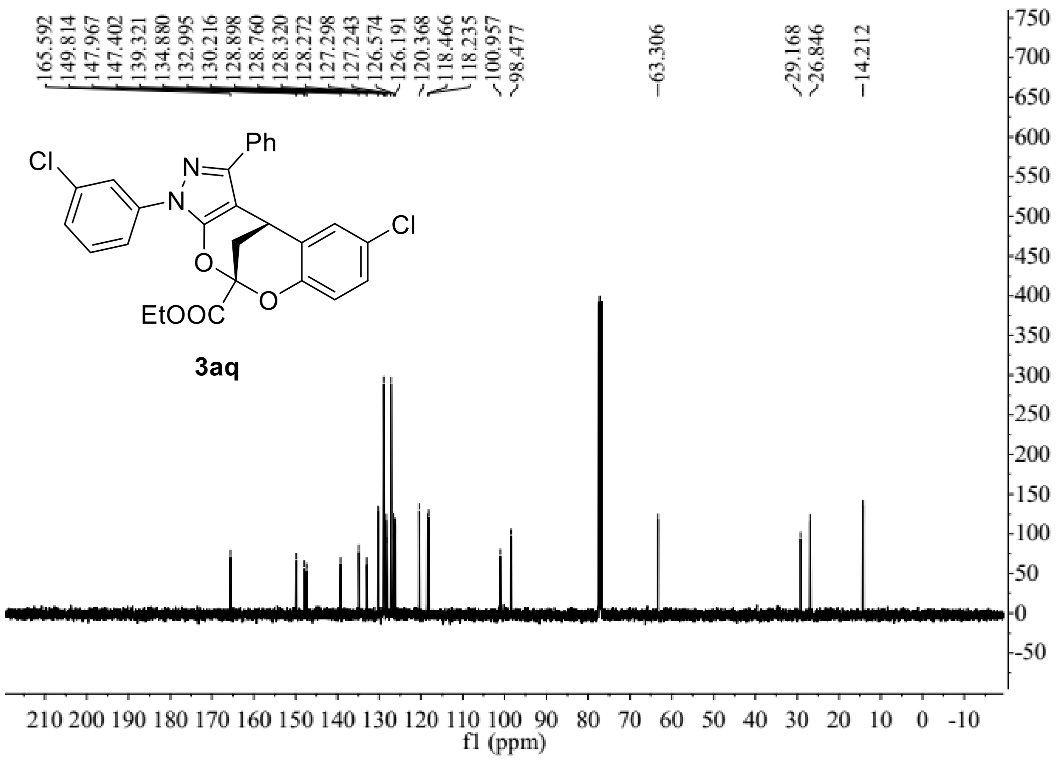


Ethyl-(5S,11S)-9-chloro-3-(3-chlorophenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3aq

^{1}H NMR of 3aq ($CDCl_3$, 400MHz)

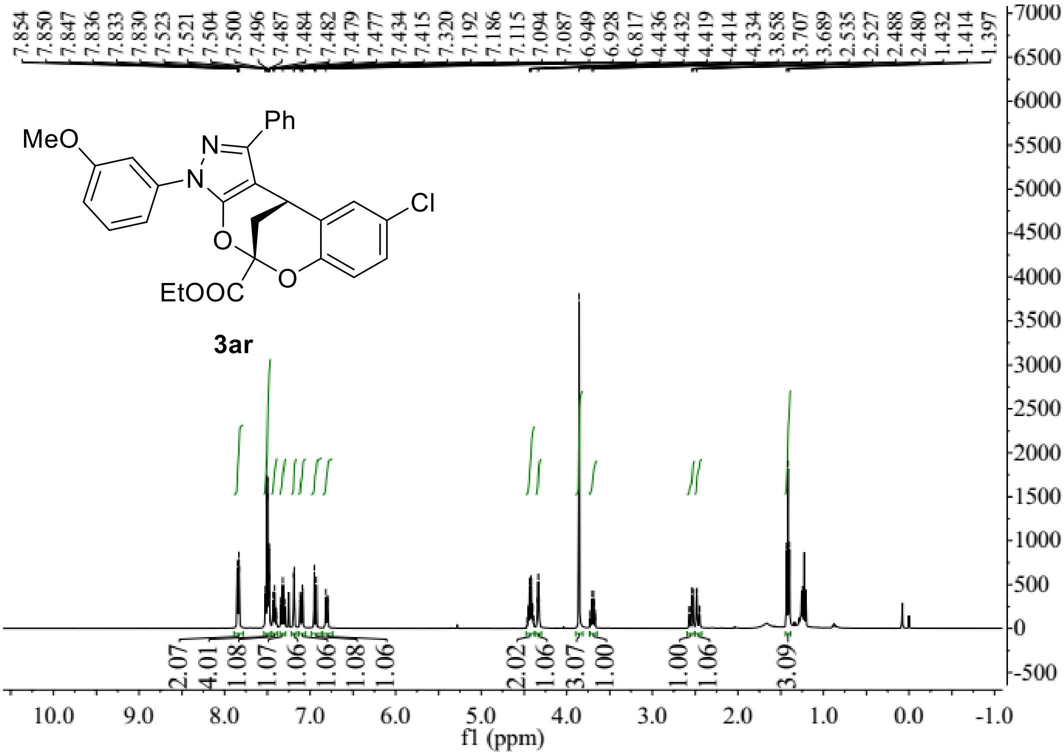


^{13}C NMR of 3aq ($CDCl_3$, 400MHz)

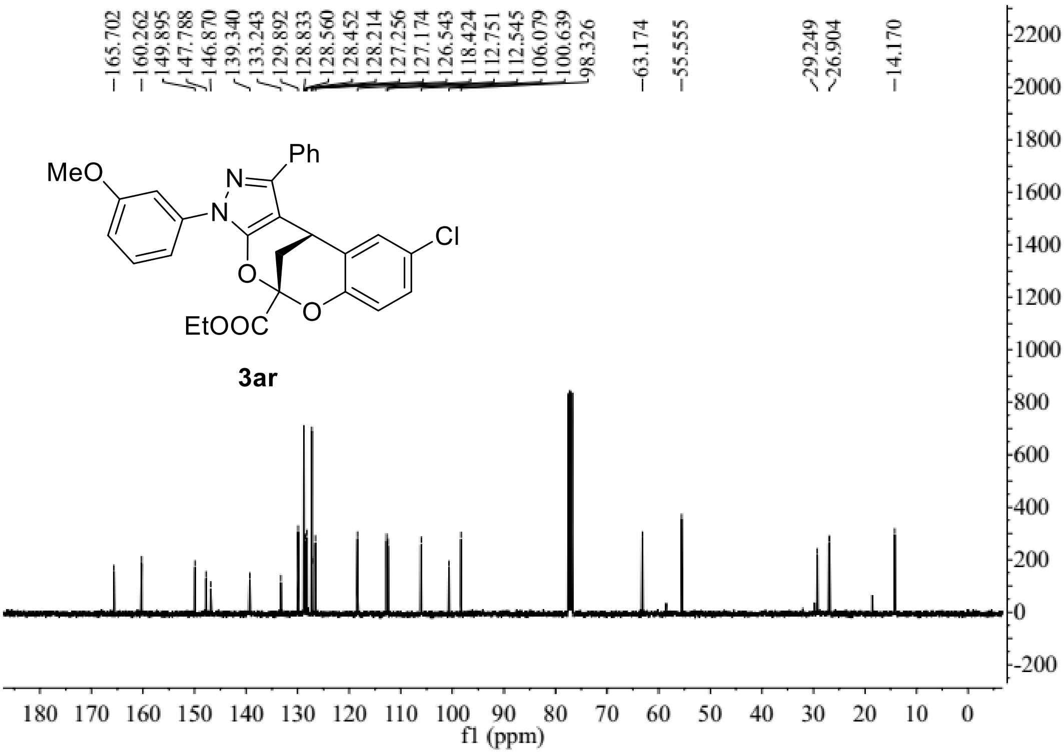


Ethyl-(5S,11S)-9-chloro-3-(3-methoxyphenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ar

^{1}H NMR of 3ar ($CDCl_3$, 400MHz)

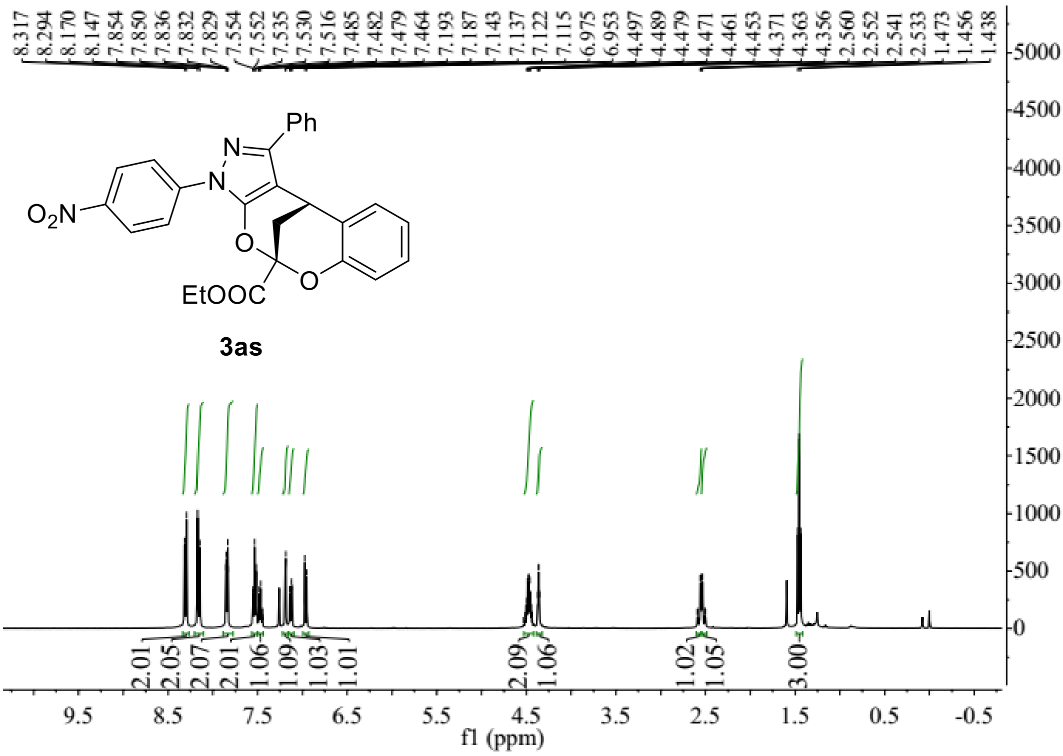


^{13}C NMR of 3ar ($CDCl_3$, 400MHz)

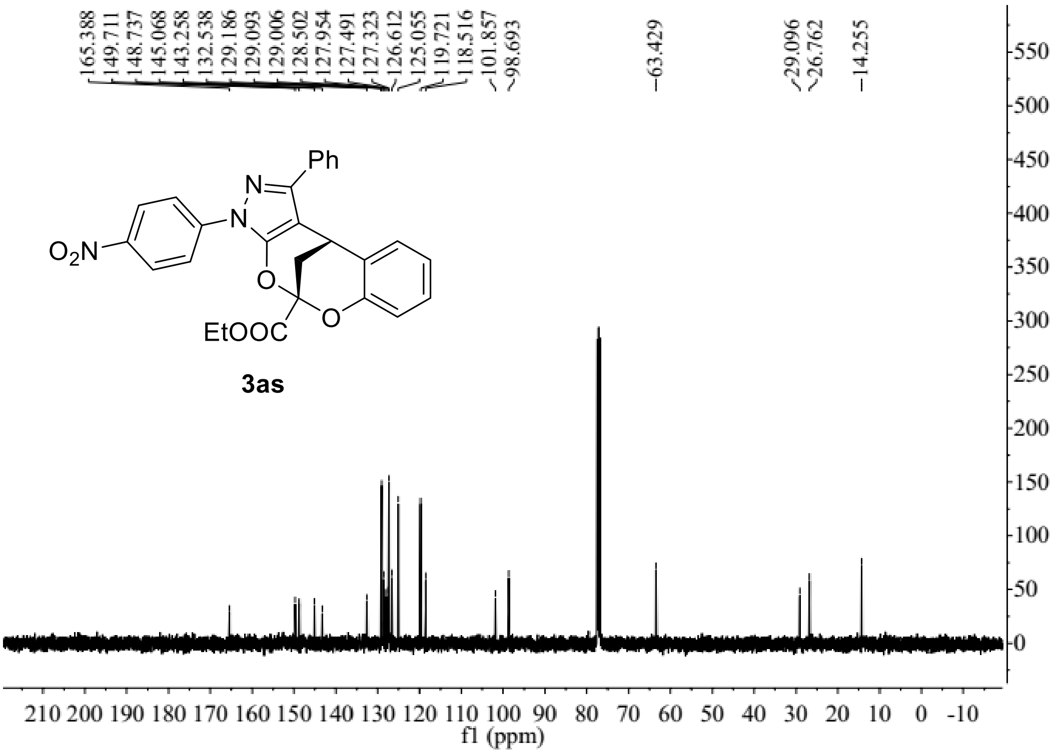


Ethyl-(5S,11S)-9-chloro-3-(4-nitrophenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3as

^{1}H NMR of 3as ($CDCl_3$, 400MHz)

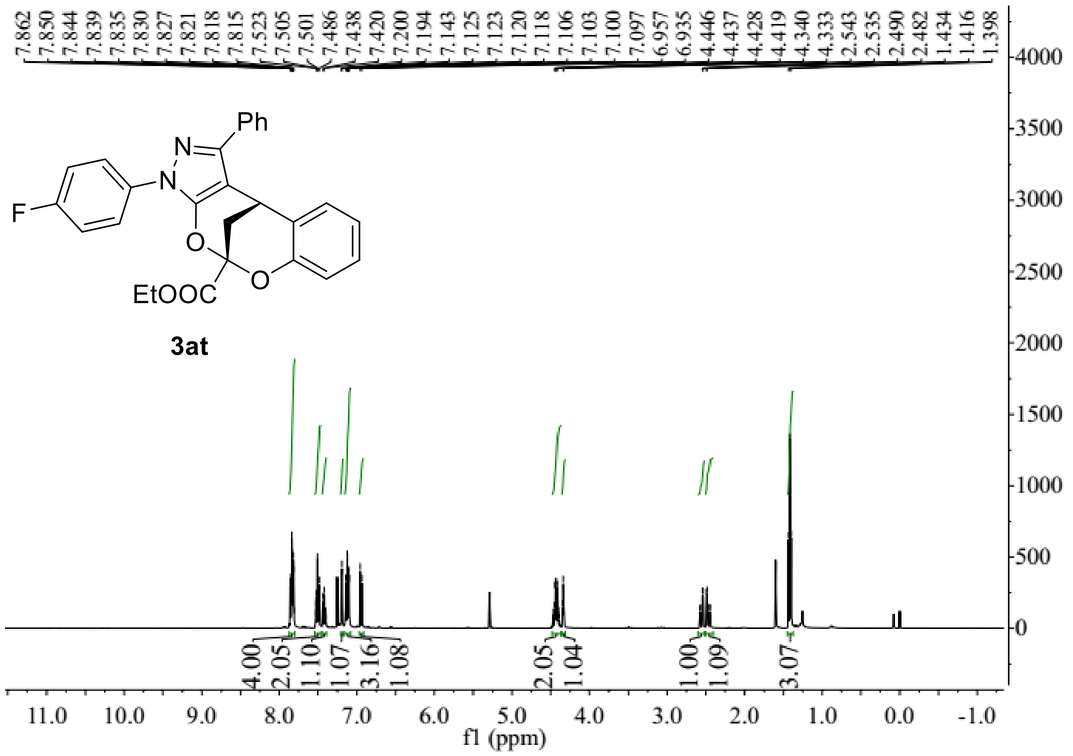


^{13}C NMR of 3as ($CDCl_3$, 400MHz)

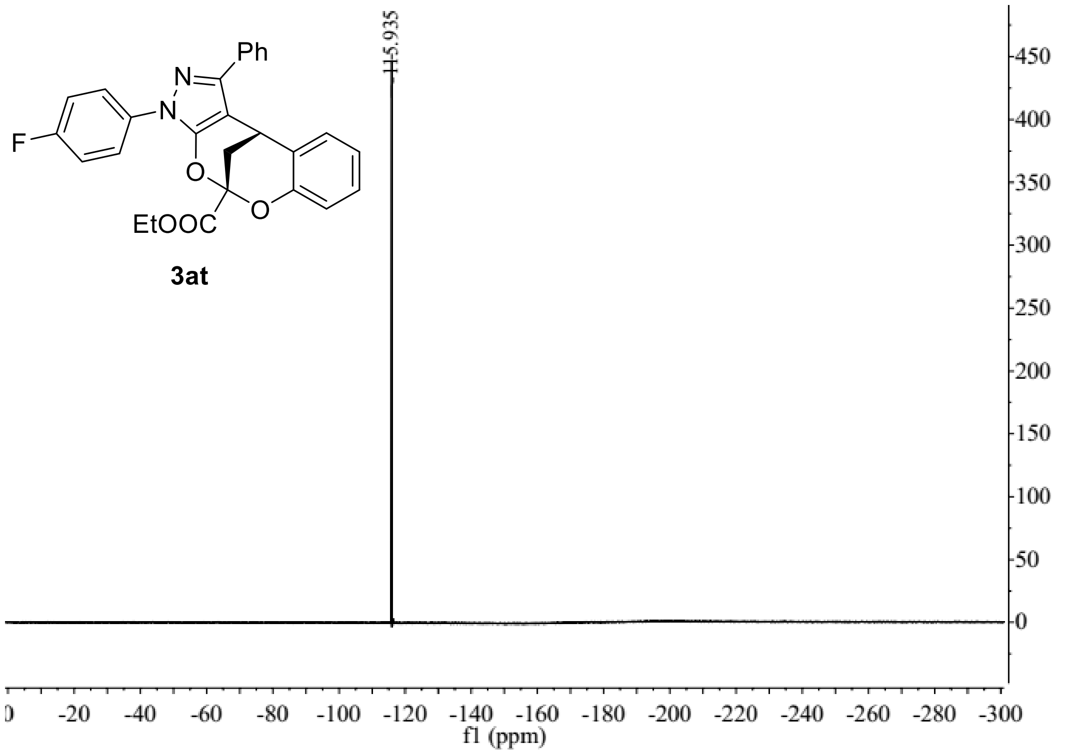


Ethyl-(5S,11S)-3-(4-fluorophenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3at

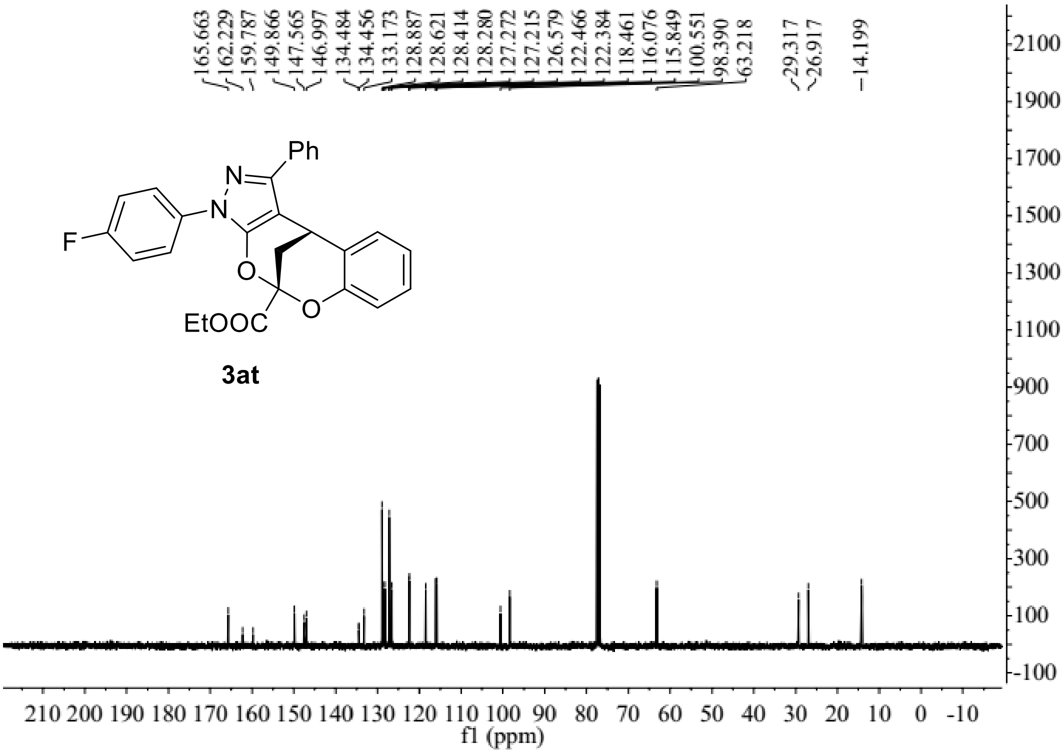
^{1}H NMR of 3at ($CDCl_3$, 400MHz)



^{19}F NMR of 3at ($CDCl_3$, 400MHz)



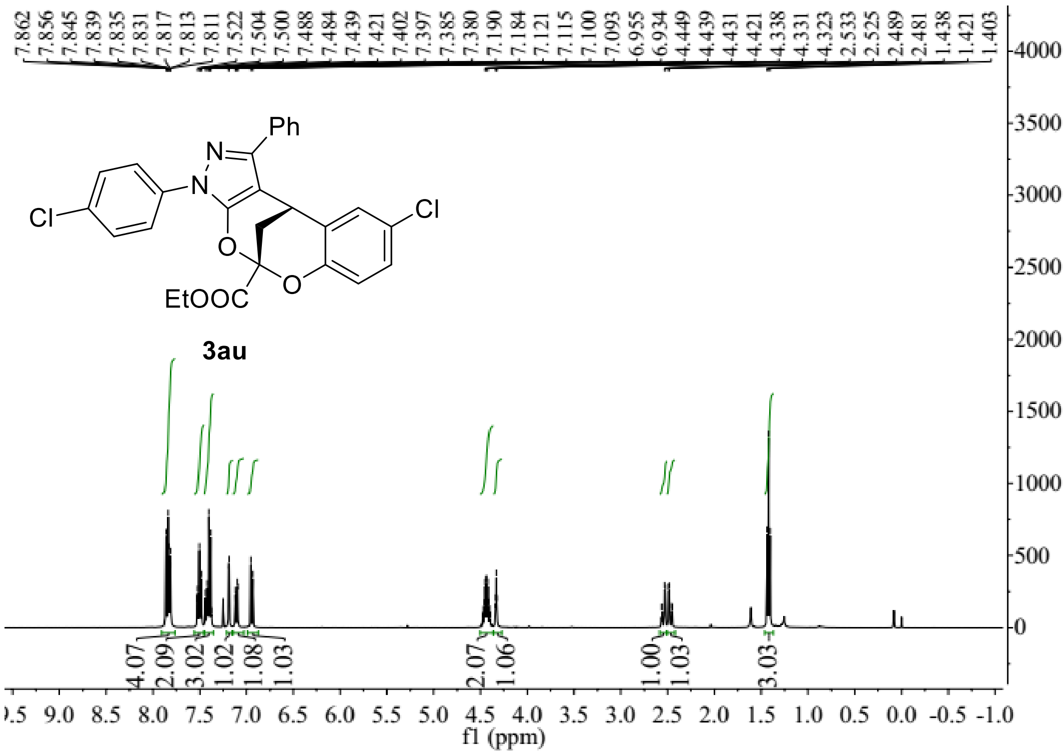
^{13}C NMR of 3at (CDCl$_3$, 400MHz)



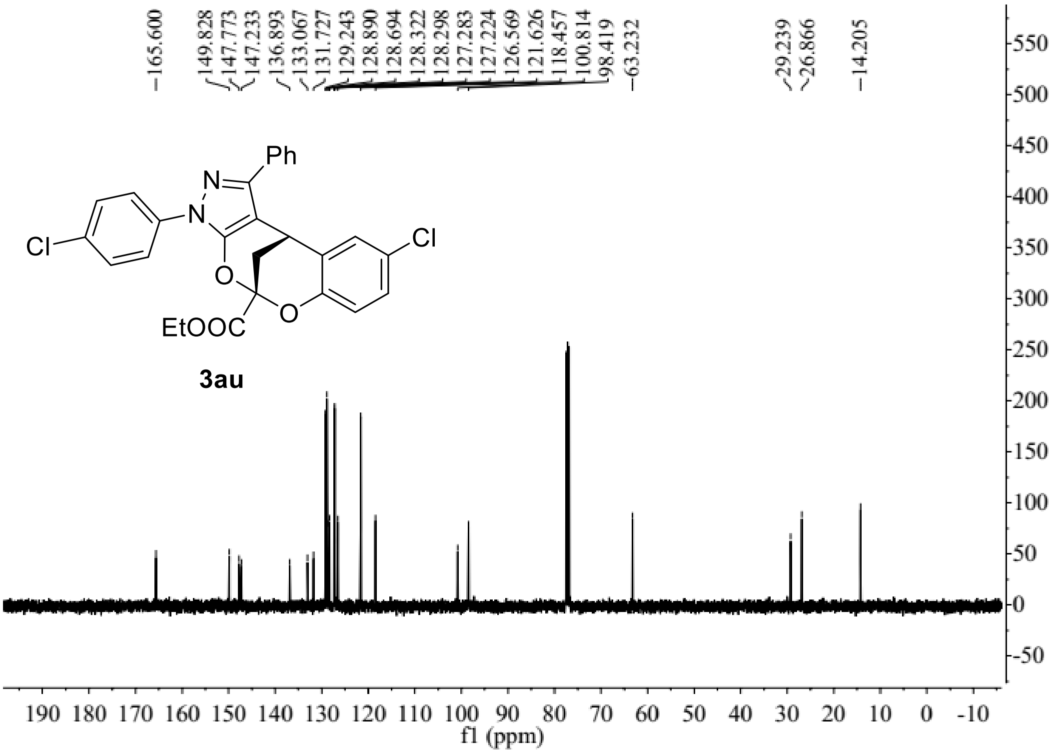
Ethyl-(5S,11S)-9-chloro-3-(4-chlorophenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8]

[1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3au

^{1}H NMR of 3au (CDCl$_3$, 400MHz)

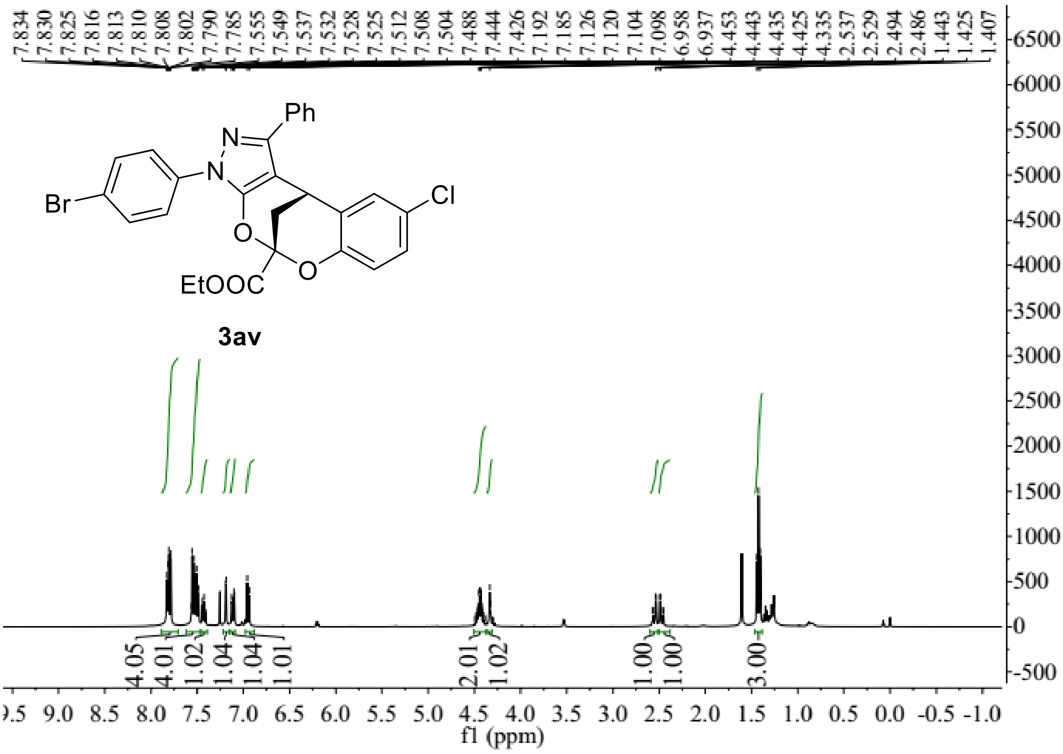


^{13}C NMR of 3au ($CDCl_3$, 400MHz)

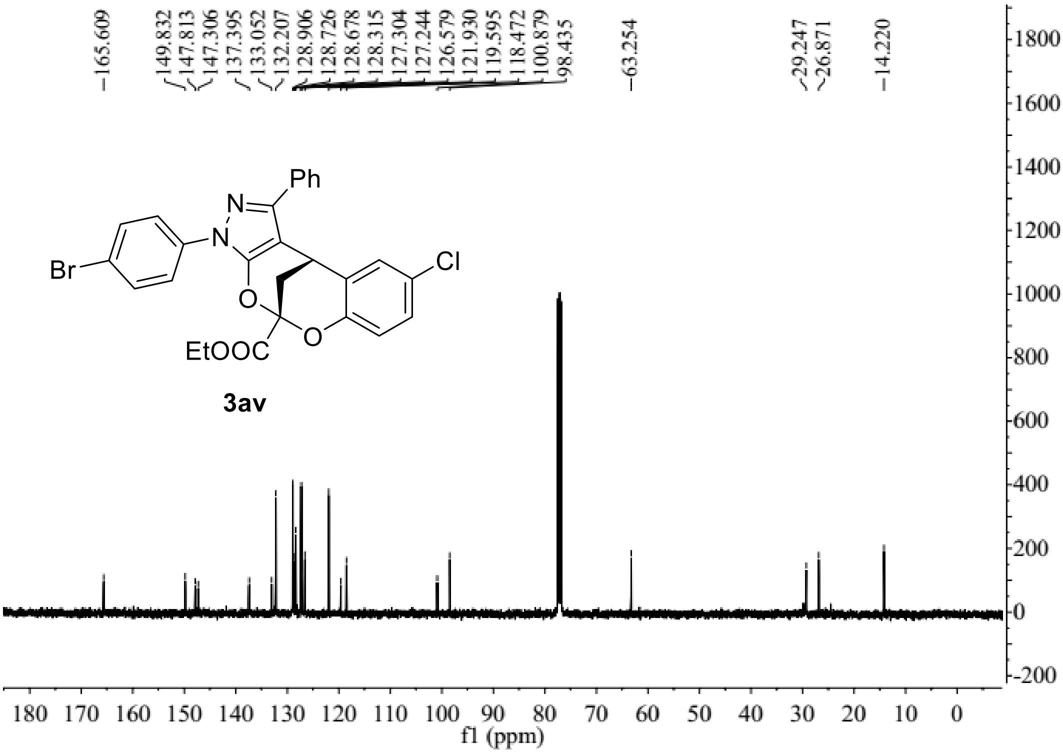


Ethyl-(5S,11S)-3-(4-bromophenyl)-9-chloro-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3av

^{1}H NMR of 3av ($CDCl_3$, 400MHz)

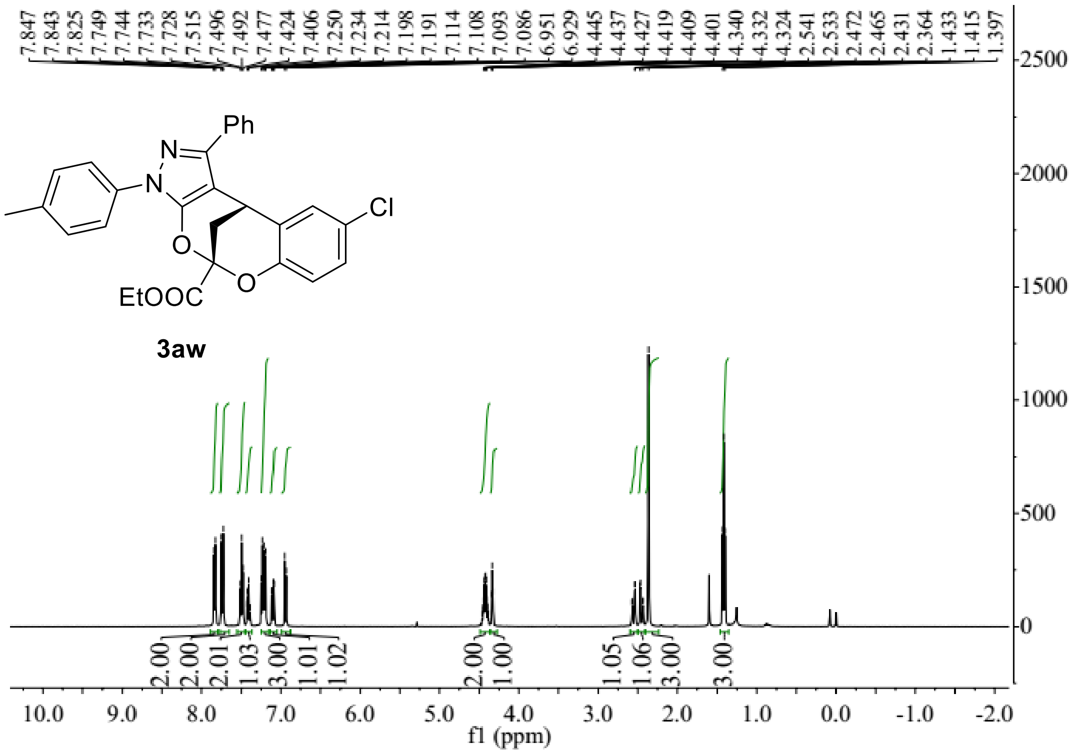


^{13}C NMR of 3av ($CDCl_3$, 400MHz)

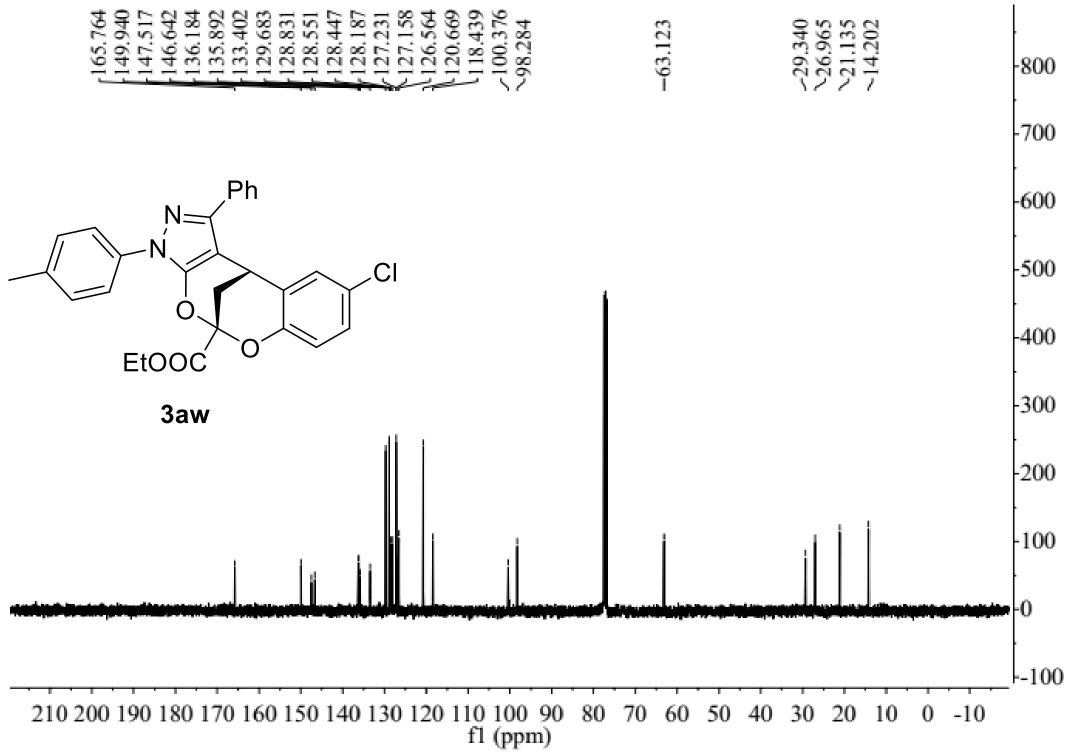


Ethyl-(5S,11S)-9-chloro-1-phenyl-3-(p-tolyl)-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3aw

^{1}H NMR of 3aw ($CDCl_3$, 400MHz)



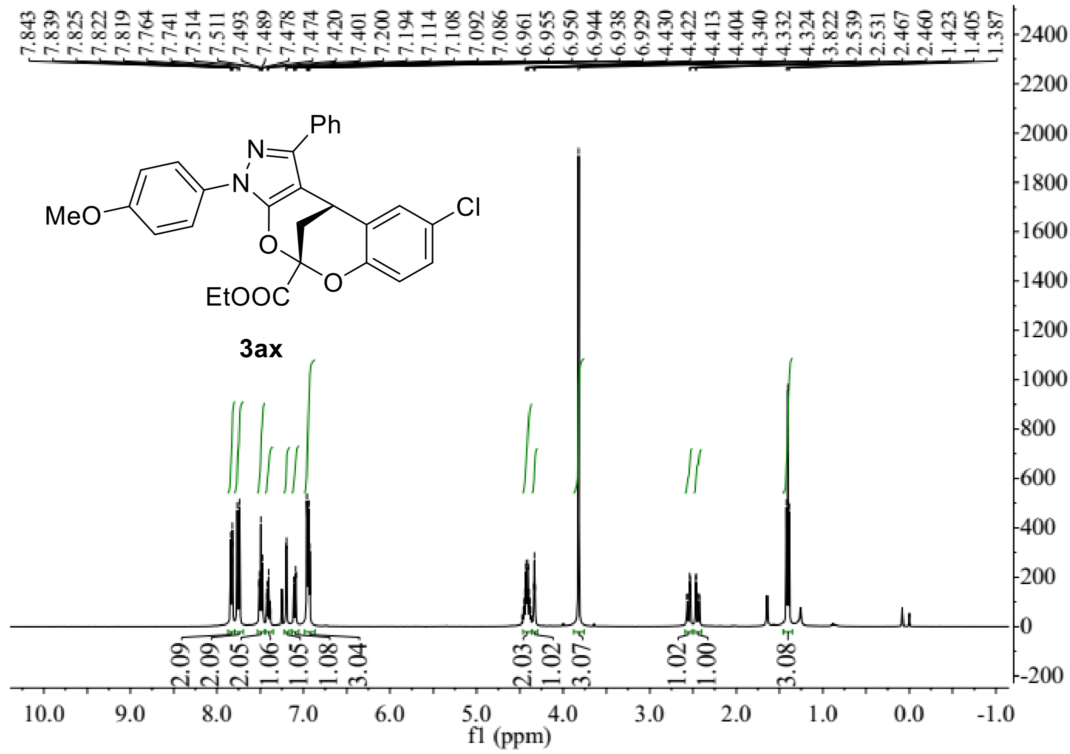
[13]C NMR of 3aw ($CDCl_3$, 400MHz)



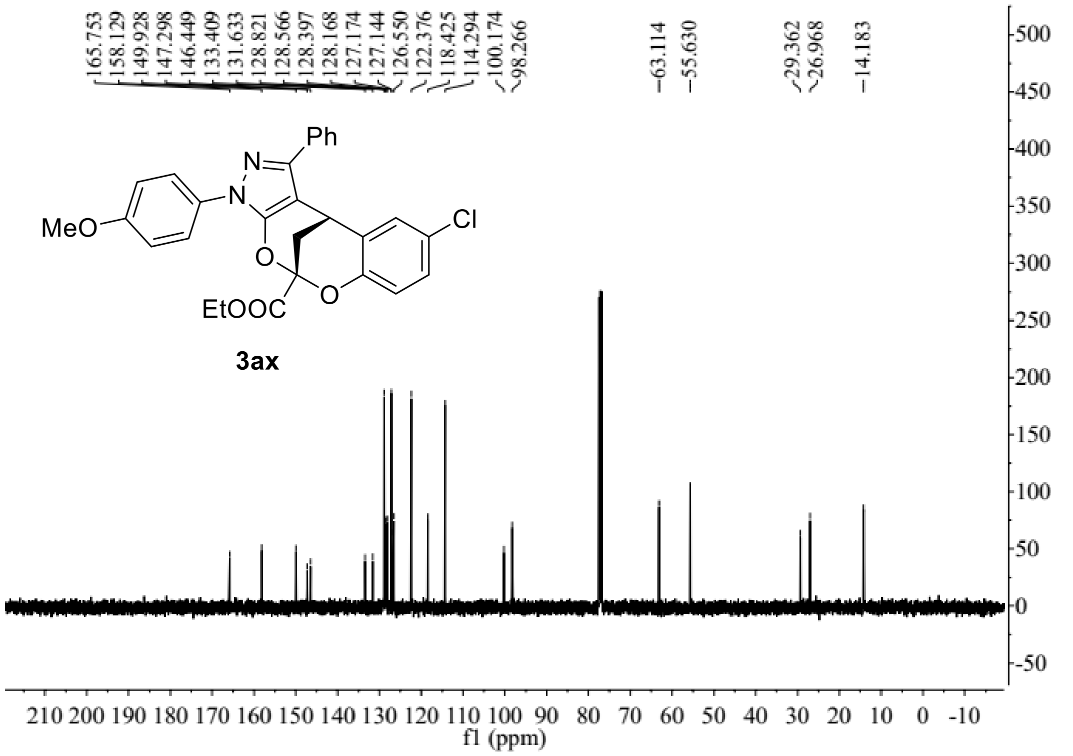
Ethyl-(5S,11S)-9-chloro-3-(4-methoxyphenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8]

[1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ax

[1]H NMR of 3ax ($CDCl_3$, 400MHz)

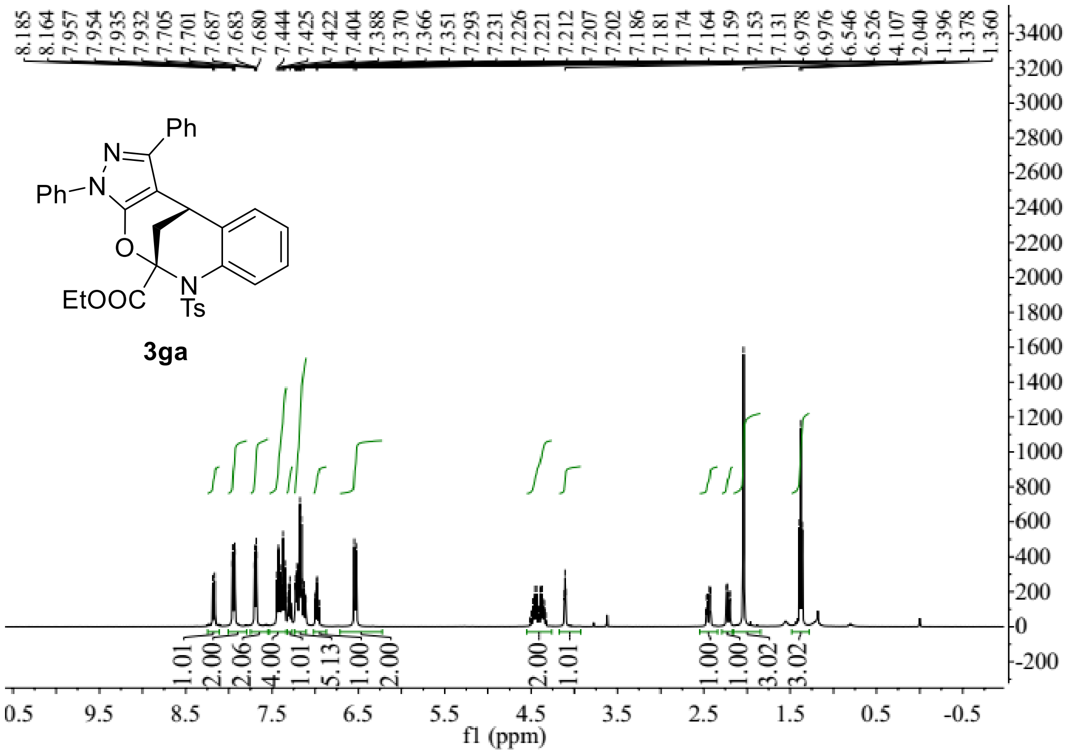


^{13}C NMR of 3ax ($CDCl_3$, 400MHz)

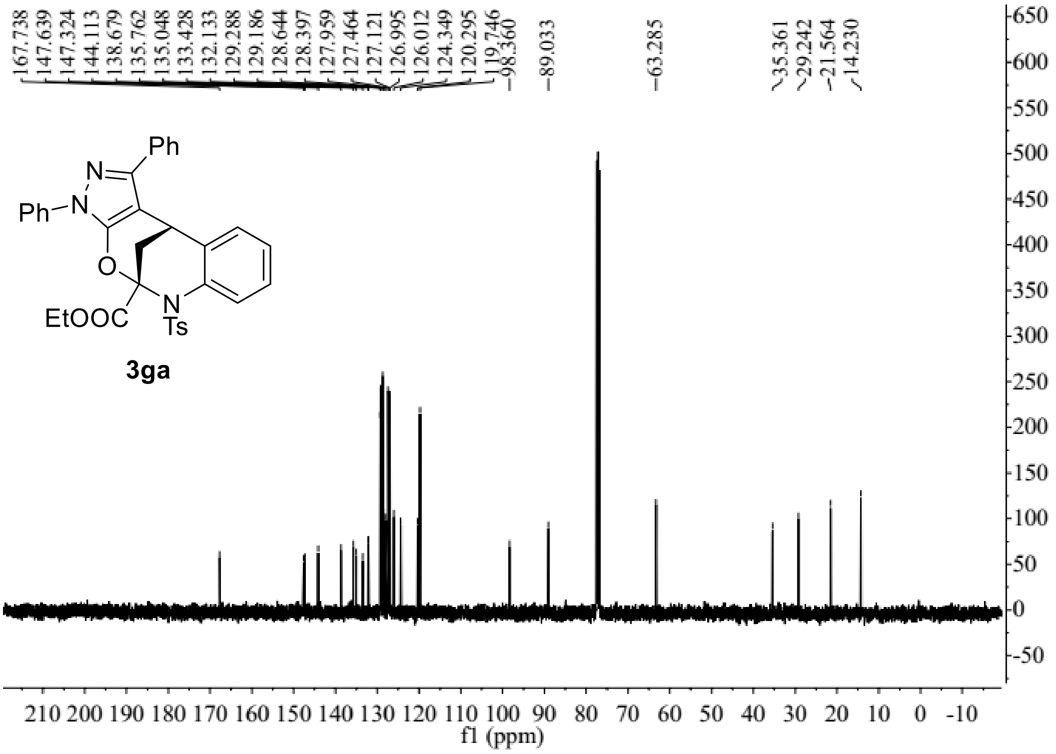


Ethyl-(5S,11S)-1,3-diphenyl-6-tosyl-6,11-dihydro-5,11-methanobenzo[d]pyrazolo[4,3-g][1,3]oxazocine-5(3H)-carboxylate 3ga

^{1}H NMR of 3ga ($CDCl_3$, 400MHz)



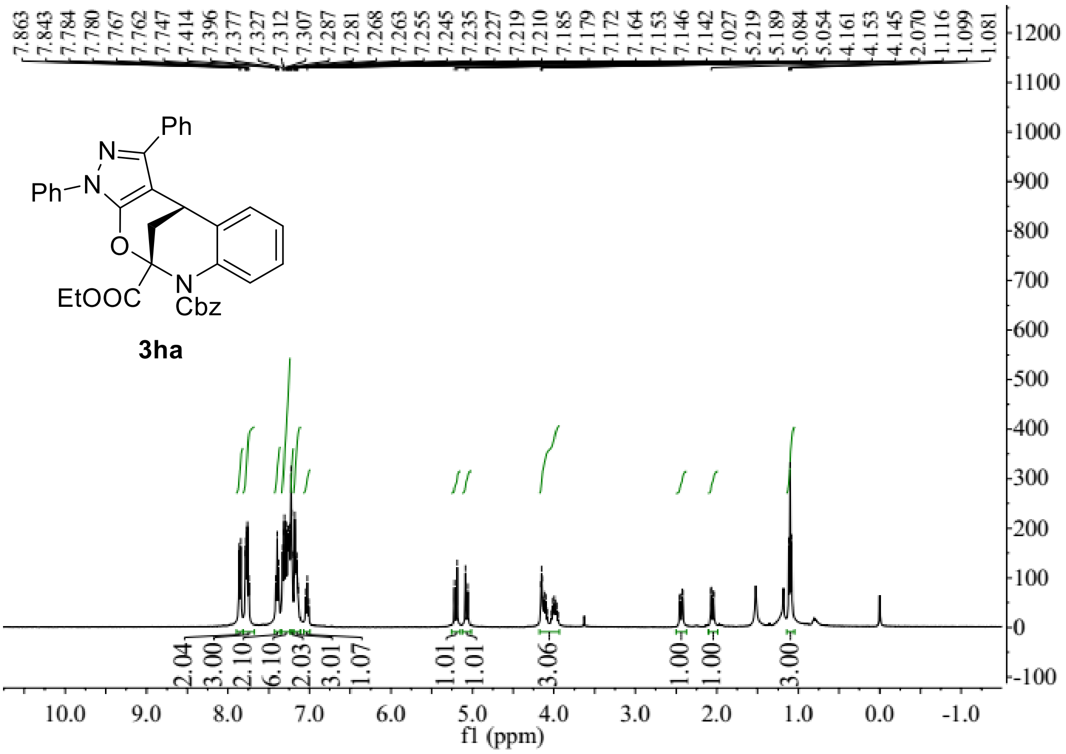
^{13}C NMR of 3ga ($CDCl_3$, 400MHz)



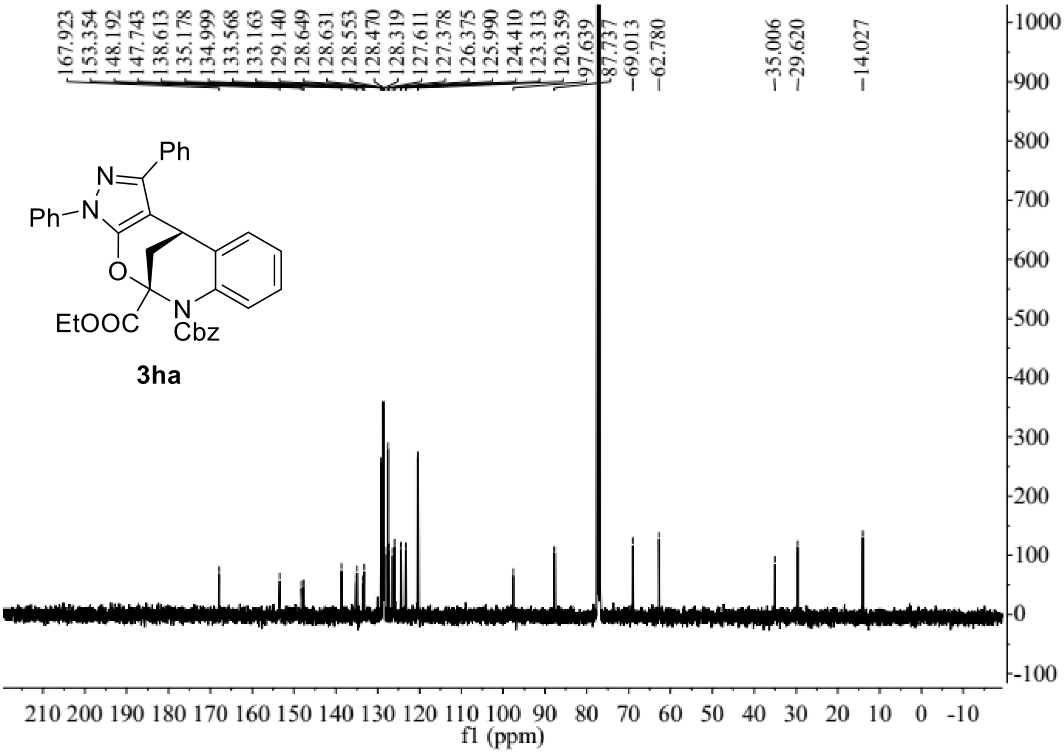
6-Benzyl-5-ethyl-(5S,11S)-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[d]pyrazolo[4,3-g]

[1,3]oxazocine-5,6-dicarboxylate 3ha

^{1}H NMR of 3ha ($CDCl_3$, 400MHz)



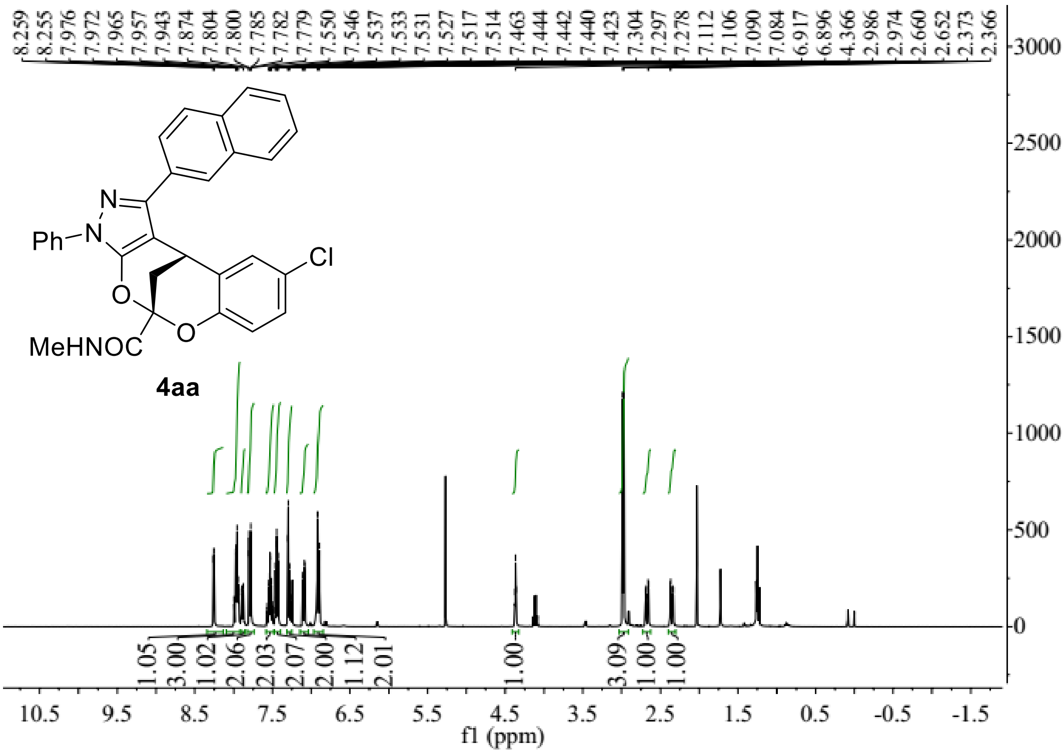
^{13}C NMR of 3ha (CDCl$_3$, 400MHz)



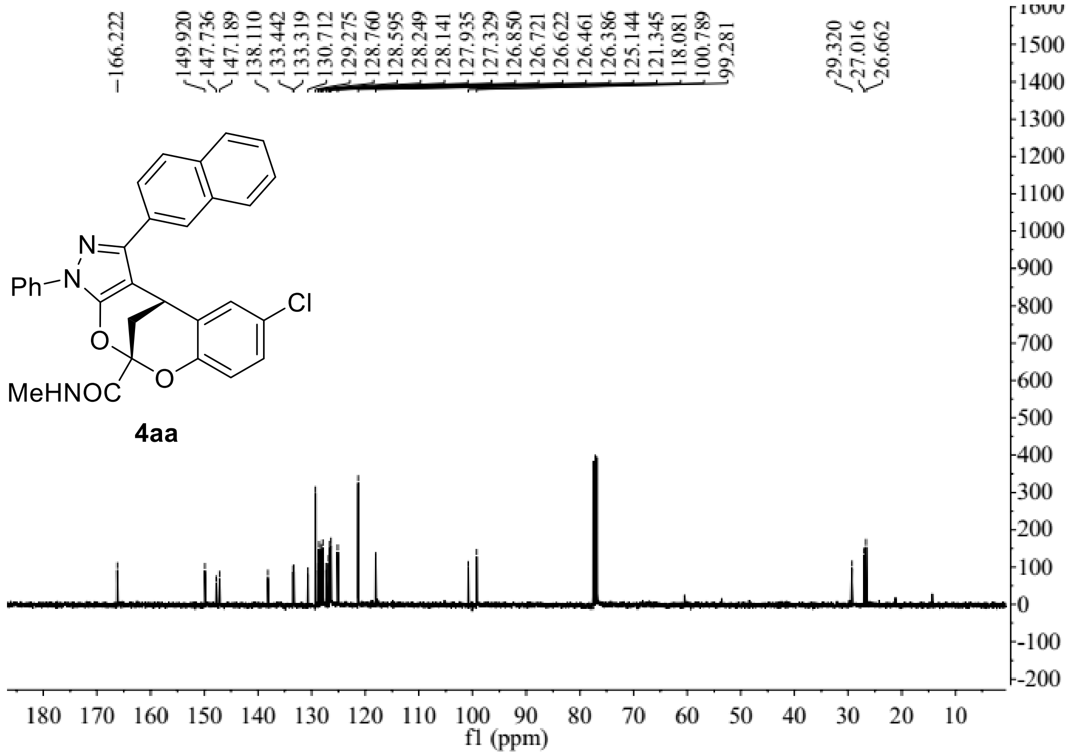
(5S,11S)-9-Chloro-N-methyl-1-(naphthalen-2-yl)-3-phenyl-3,11-dihydro-5,11-methanobenzo

[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxamide 4aa

^{1}H NMR of 4aa (CDCl$_3$, 400MHz)



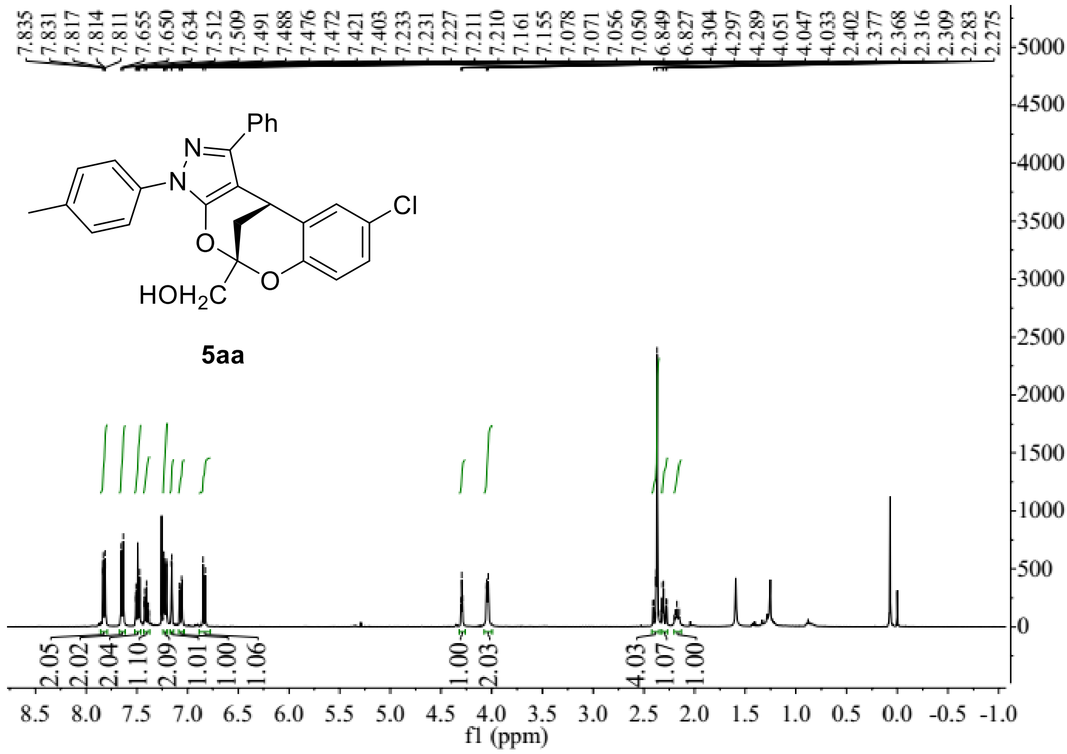
^{13}C NMR of 4aa (CDCl$_3$, 400MHz)



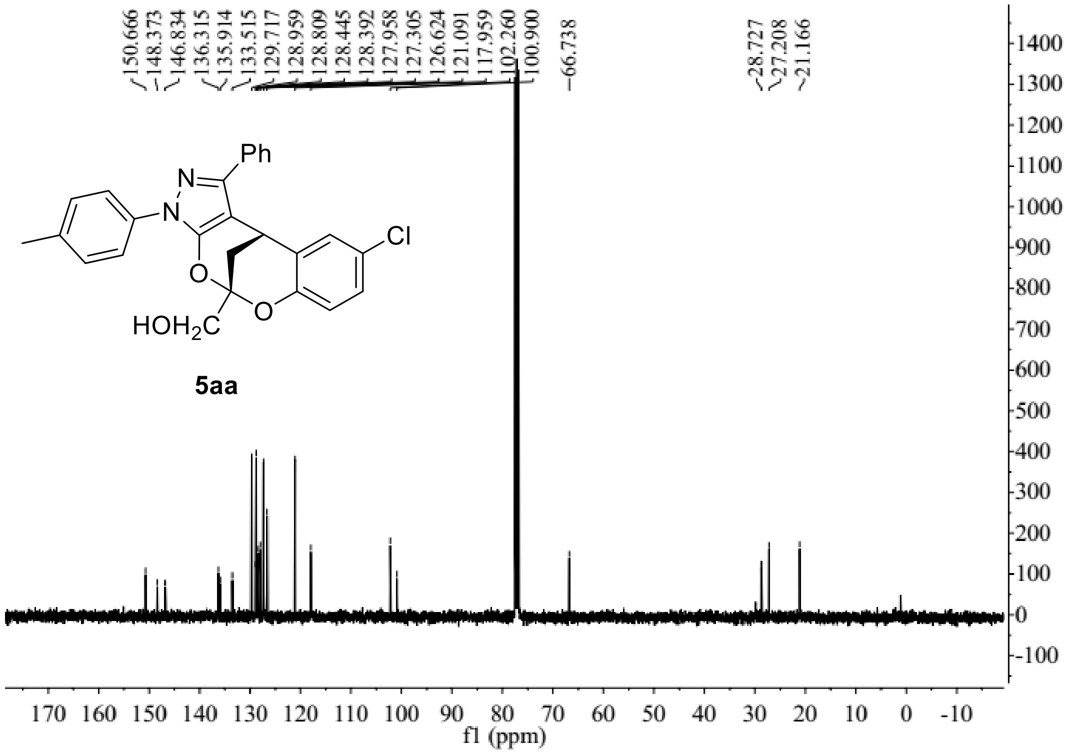
Ethyl-(3S,6'R,12'R)-3'-bromo-8'-chloro-1-methyl-2-oxo-6'H,12'H-spiro[indoline-3,5'-[6,12]

methanobenzo[g]pyrrolo[2,1-*c*][1,4]oxazocine]-12'-carboxylate 5aa

^{1}H NMR of 5aa (CDCl$_3$, 400MHz)



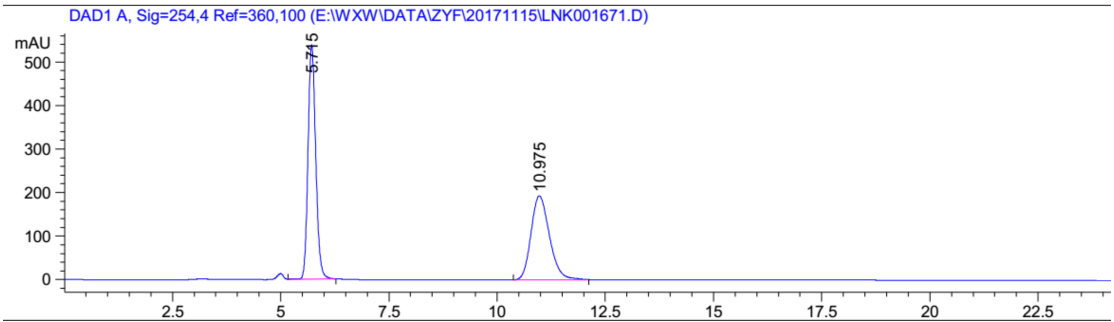
^{13}C NMR of 3ca (CDCl$_3$, 400MHz)



7. HPLC spectra

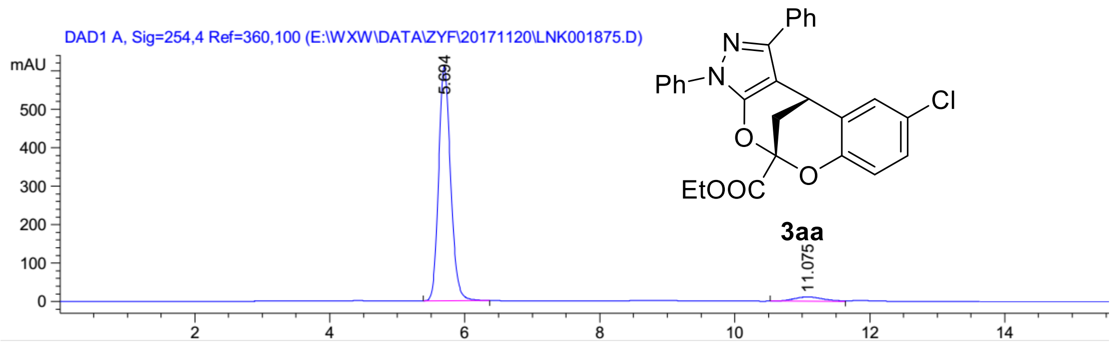
Ethyl-(5S,11S)-9-chloro-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]

dioxocino[4,5-c]pyrazole-5-carboxylatee 3aa



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

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.715	VB	0.1924	6665.48877	538.39008	53.7711
2	10.975	BB	0.4560	5730.56104	193.24348	46.2289

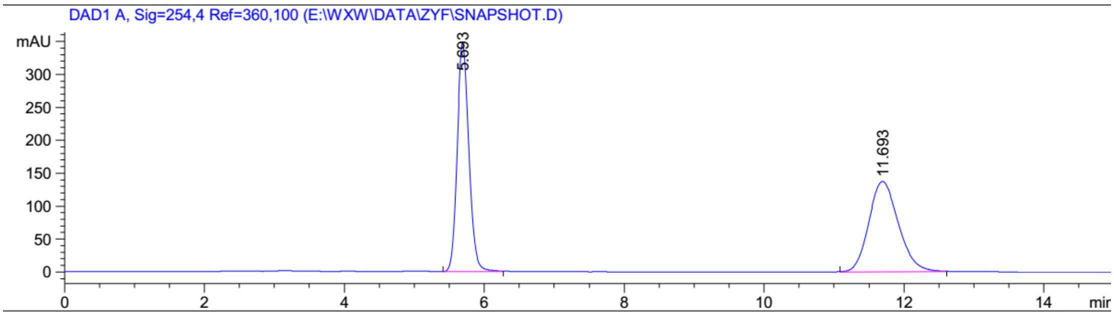


Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.694	BB	0.1900	7514.92285	609.00208	95.8131
2	11.075	BV	0.4645	328.39032	10.99403	4.1869

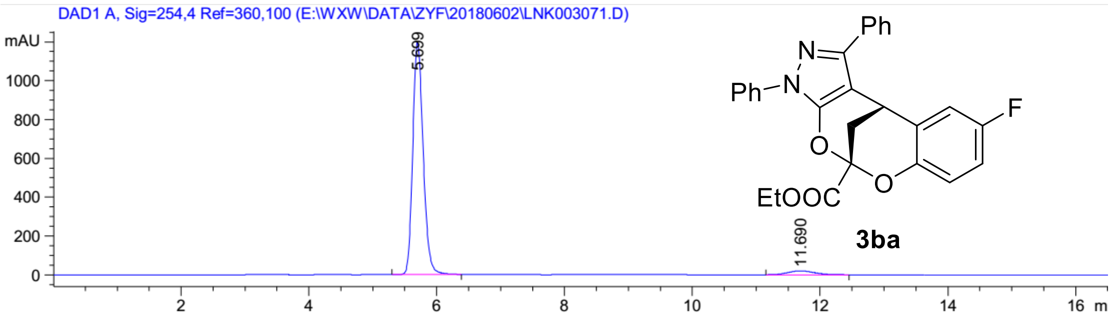
Ethyl-(5S,11S)-9-fluoro-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]

dioxocino[4,5-c]pyrazole-5-carboxylate 3ba



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

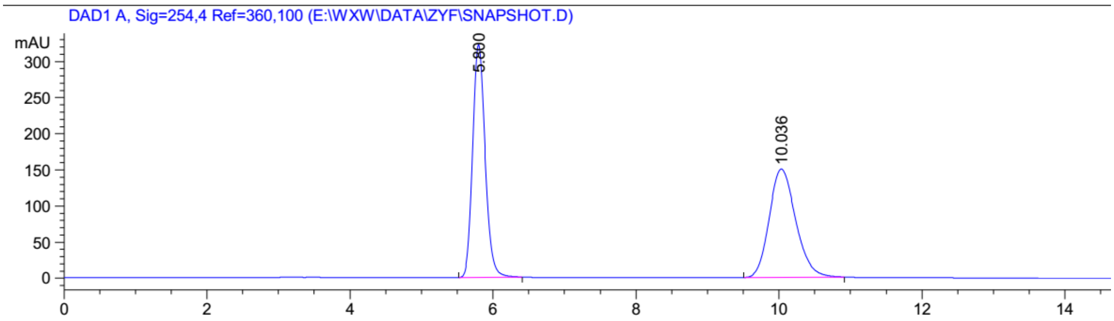
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.693	BB	0.1797	4030.41699	346.51962	50.0783
2	11.693	BB	0.4564	4017.81763	136.90616	49.9217



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

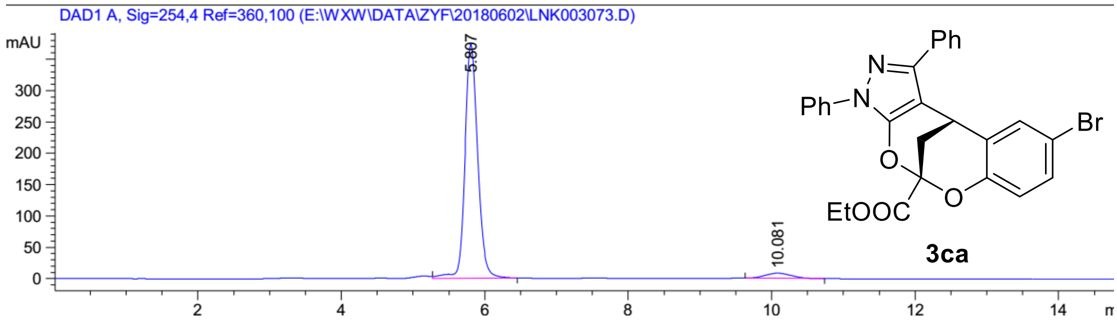
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.699	VB	0.1763	1.35593e4	1195.30505	95.9355
2	11.690	BB	0.4513	574.47461	19.75394	4.0645

Ethyl-(5S,11S)-9-bromo-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylatee 3ca



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

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.800	BB	0.1877	3917.05688	322.39386	50.2068
2	10.036	BB	0.3997	3884.79321	150.21167	49.7932

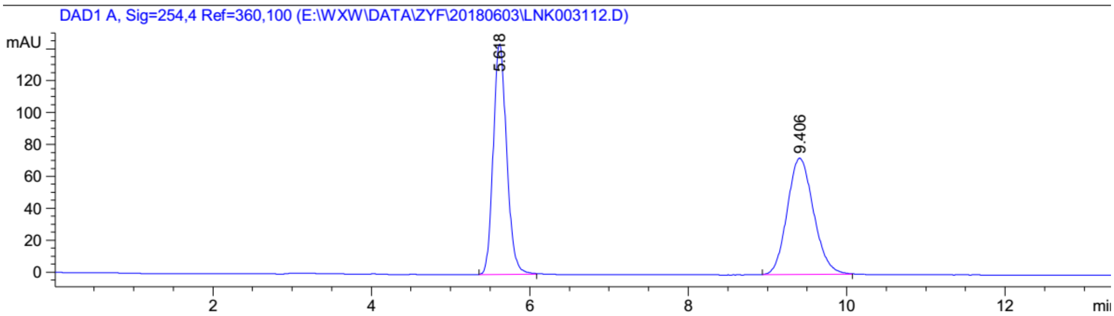


Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.807	VB	0.1909	4628.84424	372.81726	95.7133
2	10.081	BB	0.3861	207.30907	8.22255	4.2867

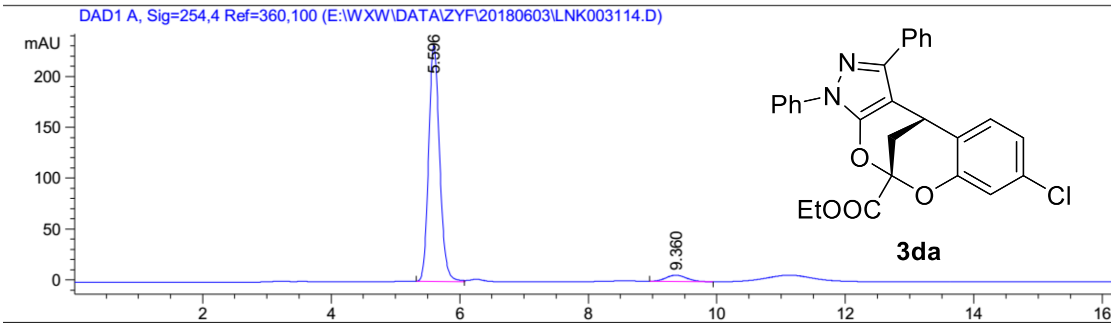
Ethyl-(5S,11S)-8-chloro-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]

dioxocino[4,5-c]pyrazole-5-carboxylate 3da



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

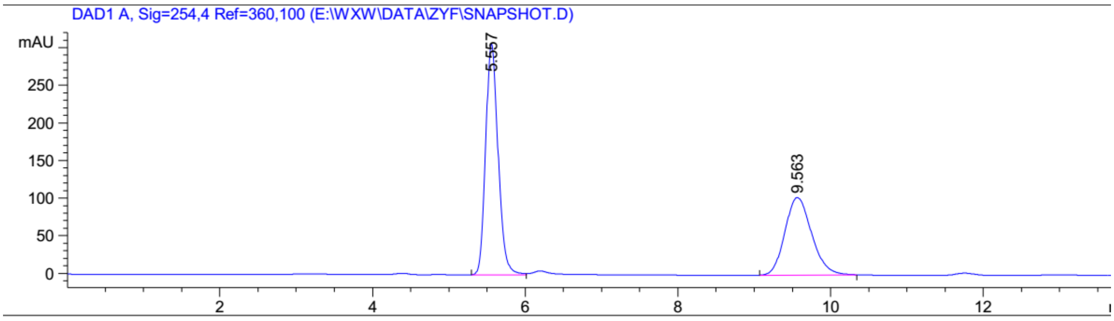
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.618	BB	0.1817	1702.68640	144.30534	50.1292
2	9.406	BB	0.3607	1693.91089	73.00362	49.8708



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

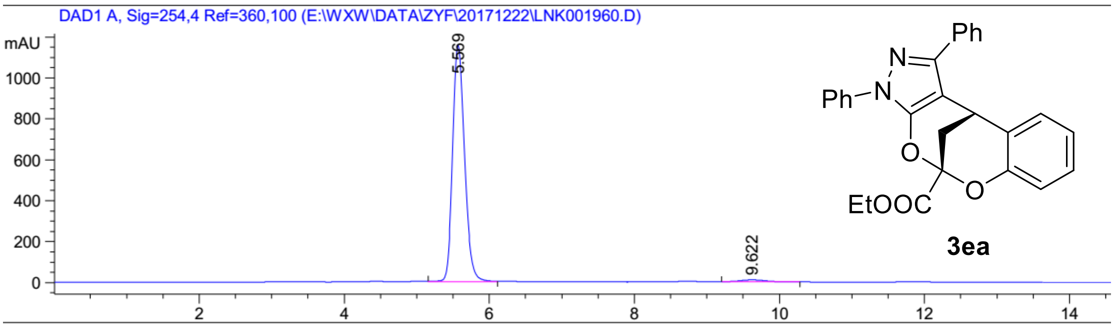
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.596	BB	0.1821	2745.40405	231.92184	95.2515
2	9.360	BB	0.3423	136.86507	6.13434	4.7485

Ethyl-(5S,11S)-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino [4,5-c]pyrazole-5-carboxylate 3ea



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

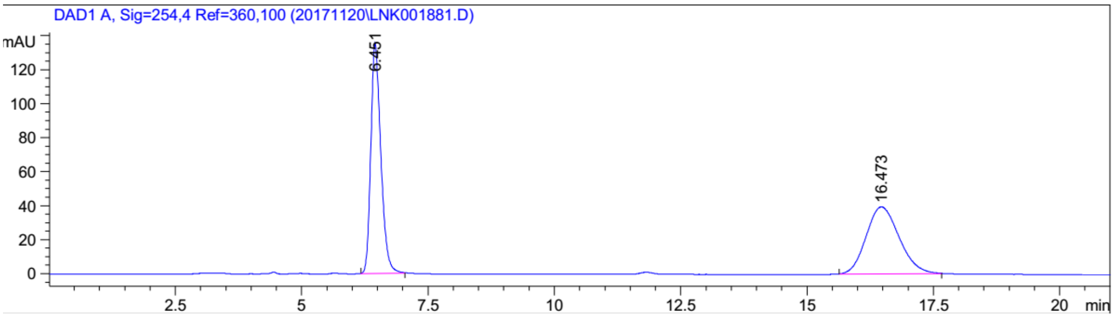
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.557	BV	0.1767	3493.06470	307.01831	57.9941
2	9.563	BB	0.3777	2530.07129	103.30003	42.0059



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

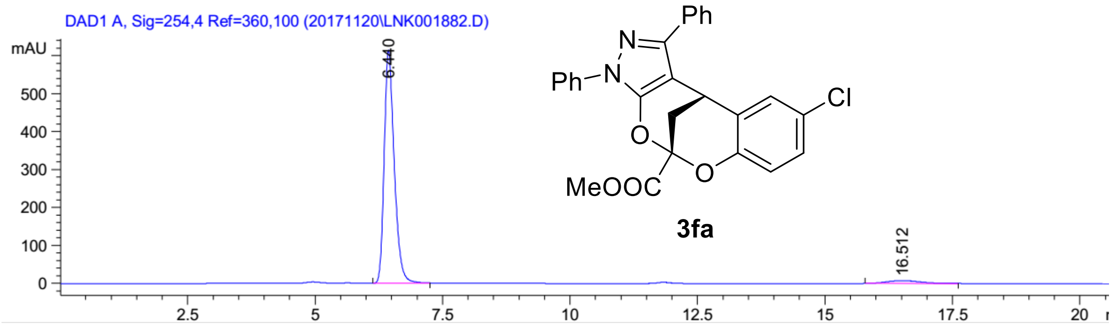
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.569	VB	0.1753	1.31980e4	1155.41345	98.3821
2	9.622	BB	0.3665	217.04575	9.22585	1.6179

Methyl-(5S,11S)-9-chloro-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino [4,5-c]pyrazole-5-carboxylatee 3fa



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

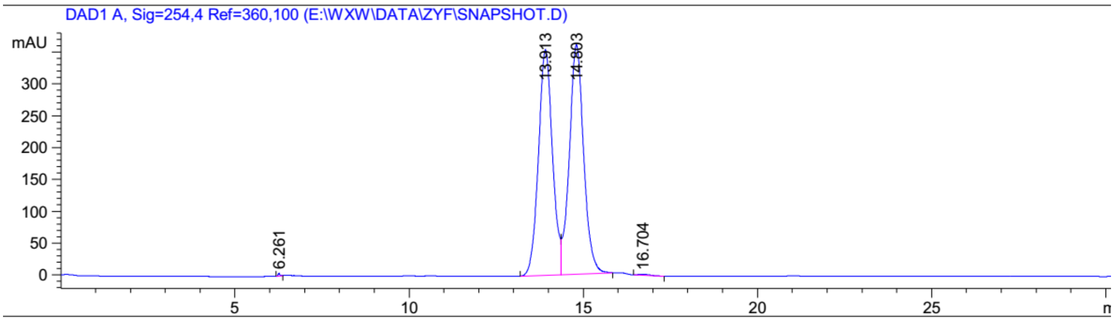
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.451	BB	0.2130	1865.80981	135.19339	50.8956
2	16.473	BB	0.7022	1800.14612	39.46490	49.1044



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

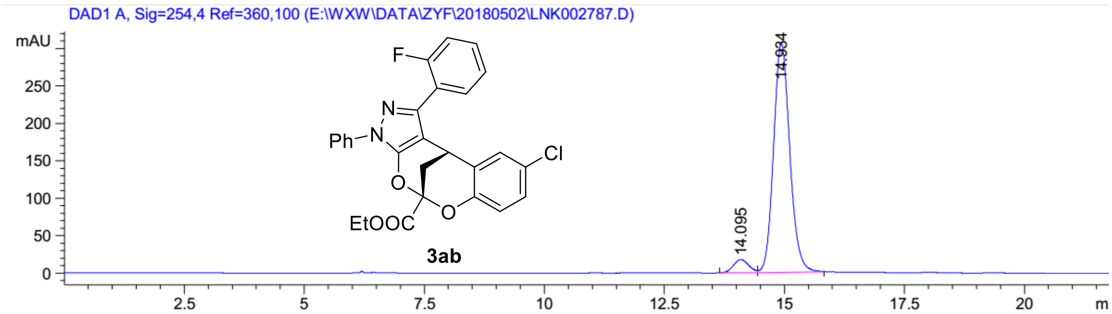
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.440	BB	0.2018	8416.40234	614.51611	96.0848
2	16.512	BB	0.6692	342.94388	7.58921	3.9152

Ethyl-(5S,11S)-9-chloro-1-(2-fluorophenyl)-3-phenyl-3,11-dihydro-5,11-methano benzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ab



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

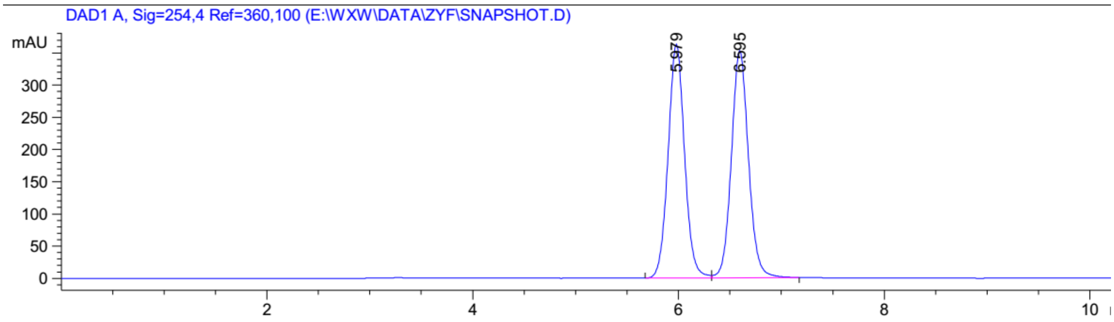
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.913	BV	0.4269	9915.03418	353.87610	49.0870
2	14.803	VB	0.4307	1.02839e4	360.58813	50.9130



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

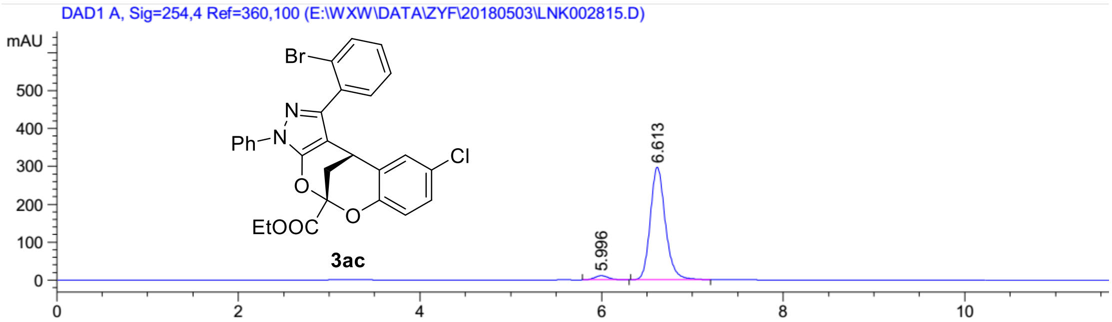
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.095	BV	0.3490	390.34164	17.58547	5.1493
2	14.934	VB	0.3620	7190.16797	306.17389	94.8507

Ethyl-(5S,11S)-1-(2-bromophenyl)-9-chloro-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ac



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

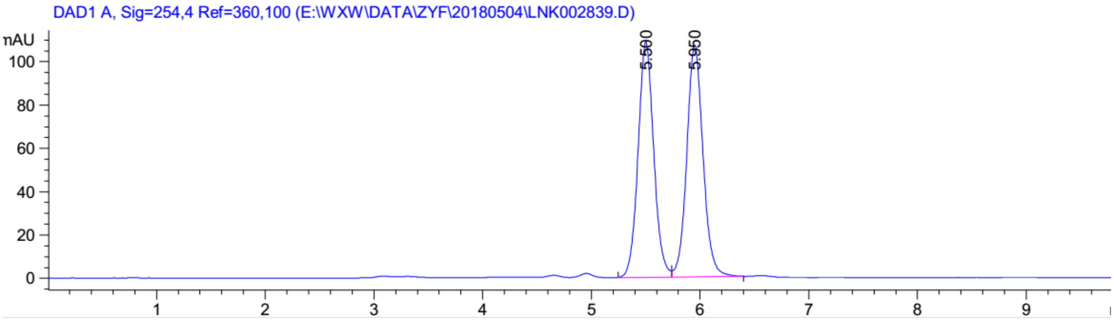
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.979	BV	0.1701	4046.44946	362.88980	49.7600
2	6.595	VB	0.1770	4085.48071	352.94202	50.2400



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

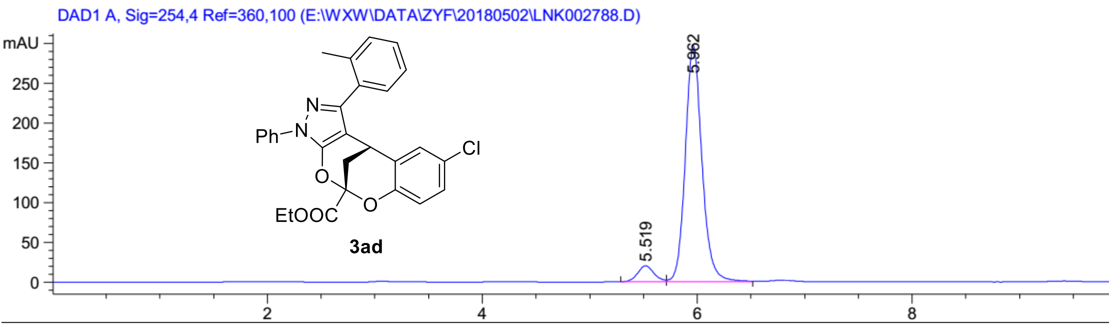
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.996	BB	0.1637	116.17833	10.95951	3.2780
2	6.613	BB	0.1767	3428.00366	296.89456	96.7220

Ethyl-(5S,11S)-9-chloro-3-phenyl-1-(o-tolyl)-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3ad



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

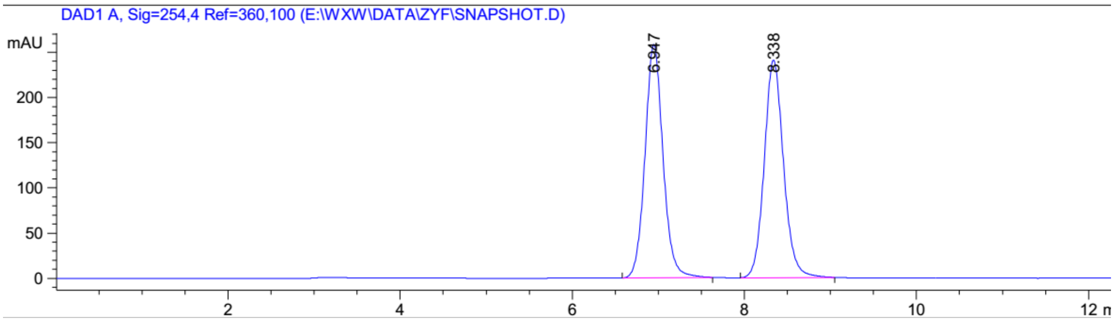
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.500	BV	0.1548	1088.04761	108.70302	49.4366
2	5.950	VB	0.1591	1112.84814	107.19674	50.5634



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

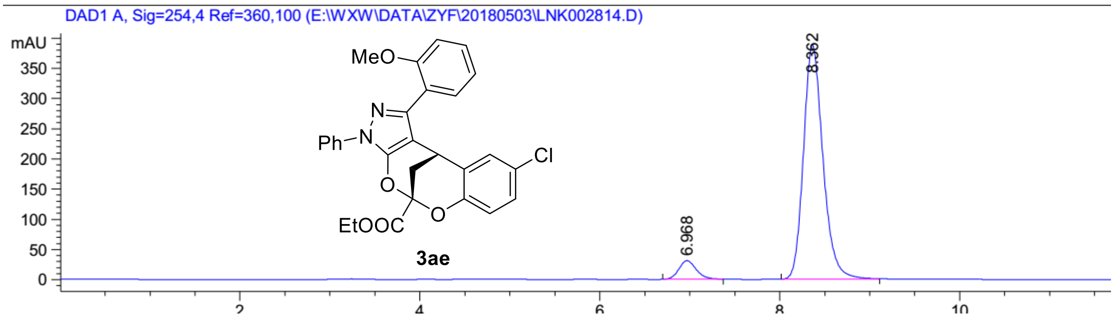
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.519	BV	0.1633	218.97728	20.39038	6.3752
2	5.962	VB	0.1640	3215.85034	297.67822	93.6248

Ethyl-(5S,11S)-1-(2-methoxyphenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3ae



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

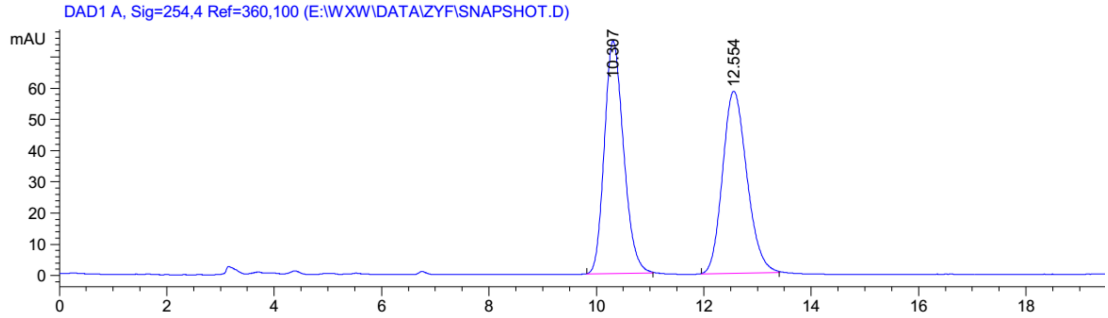
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.947	BB	0.2221	3763.77393	258.08539	50.0225
2	8.338	BB	0.2404	3760.38086	240.49716	49.9775



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

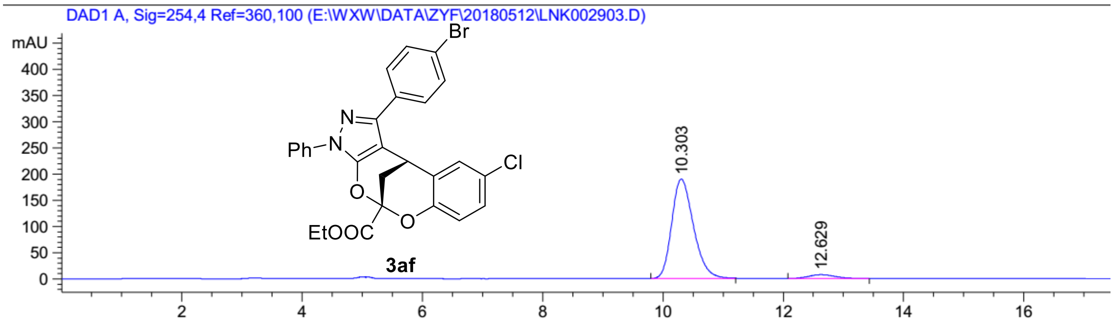
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.968	BB	0.2086	420.82547	30.95333	6.7198
2	8.362	BB	0.2315	5841.64258	388.25391	93.2802

Ethyl-(5S,11S)-1-(4-bromophenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3af



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

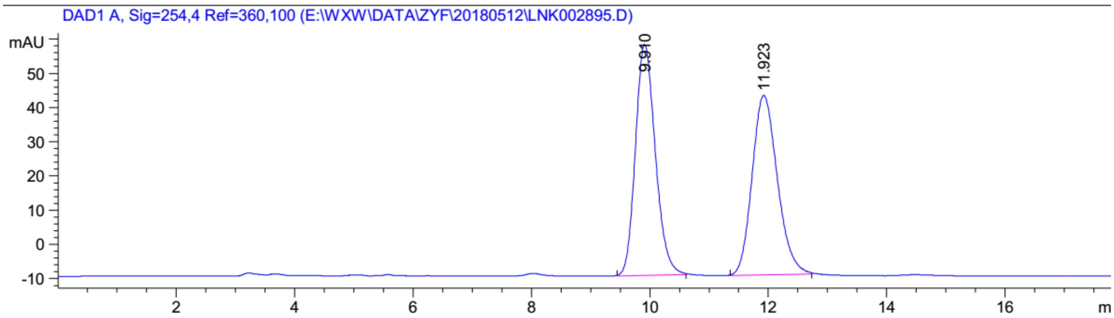
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.307	BB	0.3852	1862.41064	74.60390	50.2502
2	12.554	BB	0.4864	1843.86511	58.39490	49.7498



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

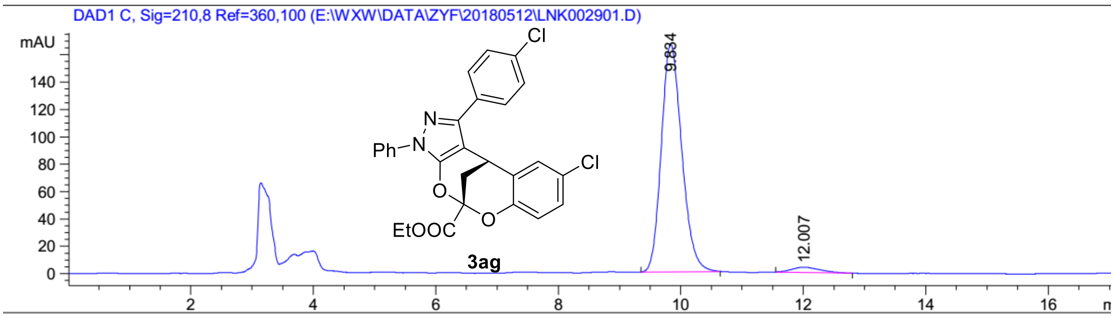
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.303	BB	0.3872	4776.31738	190.05183	95.2450
2	12.629	BB	0.4768	238.45056	7.46155	4.7550

Ethyl-(5S,11S)-9-chloro-1-(4-chlorophenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ag



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

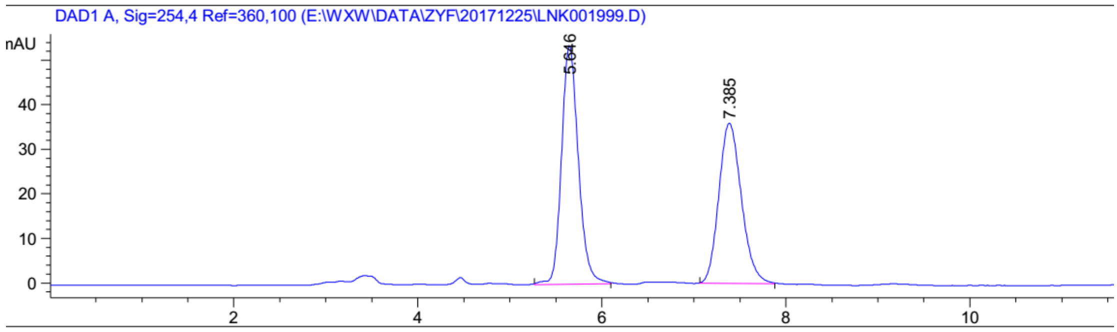
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.910	BB	0.3626	1575.97815	67.44556	50.2890
2	11.923	BB	0.4604	1557.86682	52.47512	49.7110



Signal 2: DAD1 C, Sig=210,8 Ref=360,100

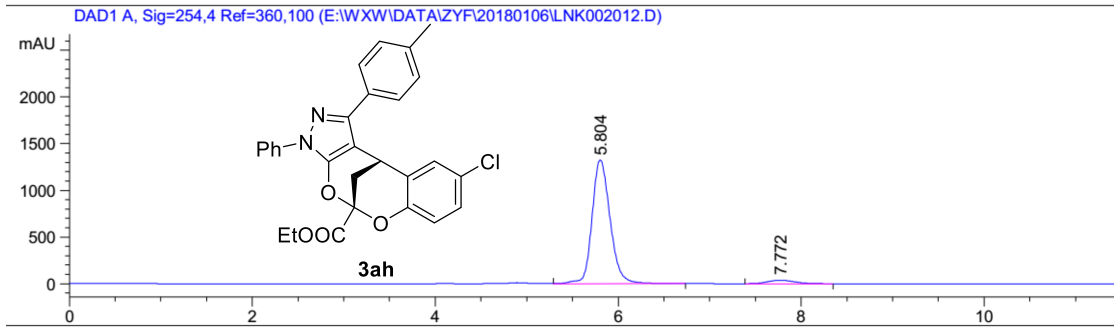
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.834	BB	0.3598	3880.19043	166.56339	96.8372
2	12.007	BB	0.4488	126.73157	3.82296	3.1628

Ethyl-(5S,11S)-9-chloro-3-phenyl-1-(p-tolyl)-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3ah



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

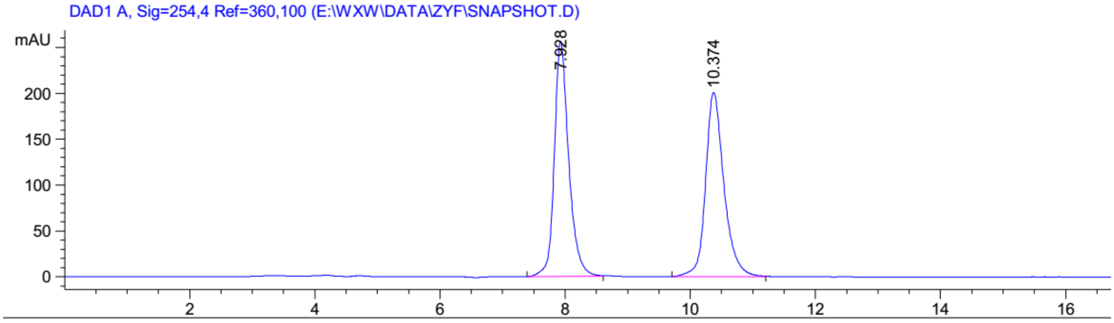
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.646	BB	0.1946	681.79095	53.53521	52.6158
2	7.385	BB	0.2651	614.00110	35.98489	47.3842



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

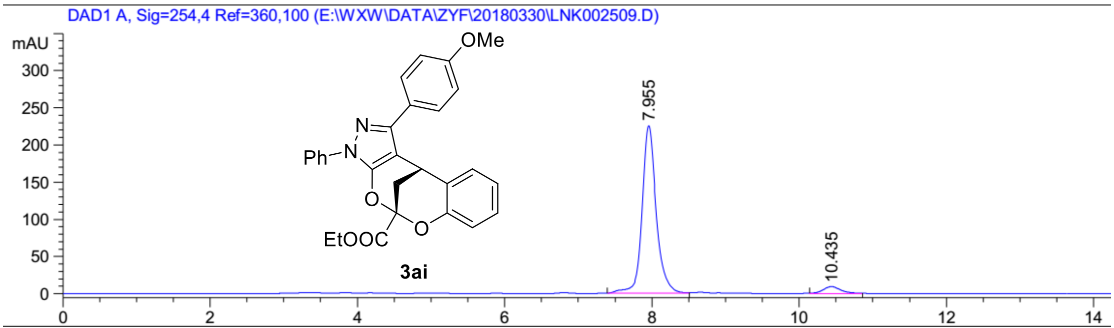
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.804	VB	0.2121	1.81830e4	1325.27185	95.8748
2	7.772	BB	0.3144	782.36371	38.29391	4.1252

Ethyl-(5S,11S)-9-chloro-1-(4-methoxyphenyl)-3-phenyl-3,11-dihydro-5,11- methanobenzo [7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ai



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

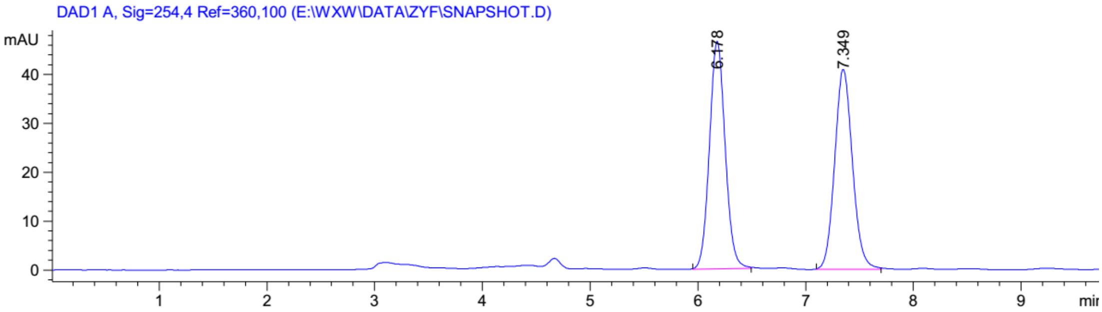
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.928	BB	0.2403	4084.62622	255.78358	49.8808
2	10.374	BB	0.3042	4104.14893	200.97794	50.1192



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

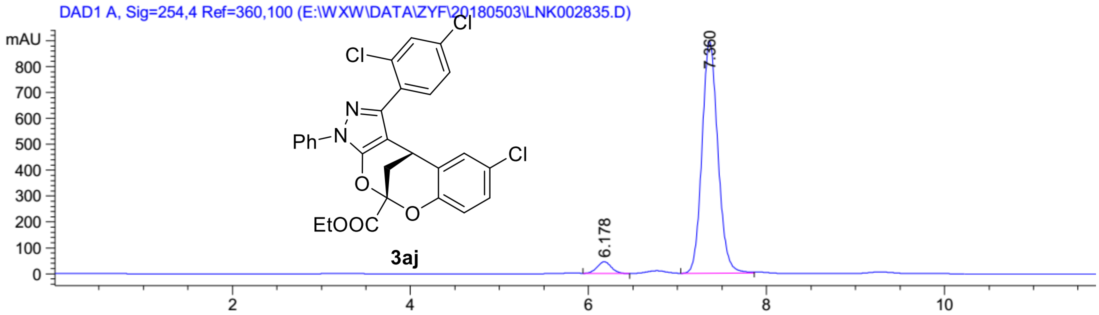
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.955	BB	0.1998	3013.53125	225.63914	95.1451
2	10.435	BB	0.2516	153.76790	9.26863	4.8549

Ethyl-(5S,11S)-9-chloro-1-(2,4-dichlorophenyl)-3-phenyl-3,11-dihydro-5,11- methanobenzo [7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3aj



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

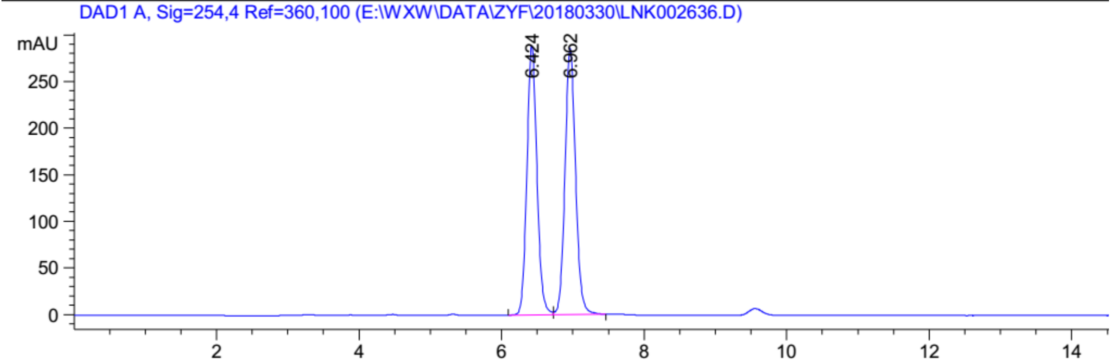
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.178	BB	0.1562	471.28787	46.52377	49.9592
2	7.349	BB	0.1787	472.05835	40.89528	50.0408



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

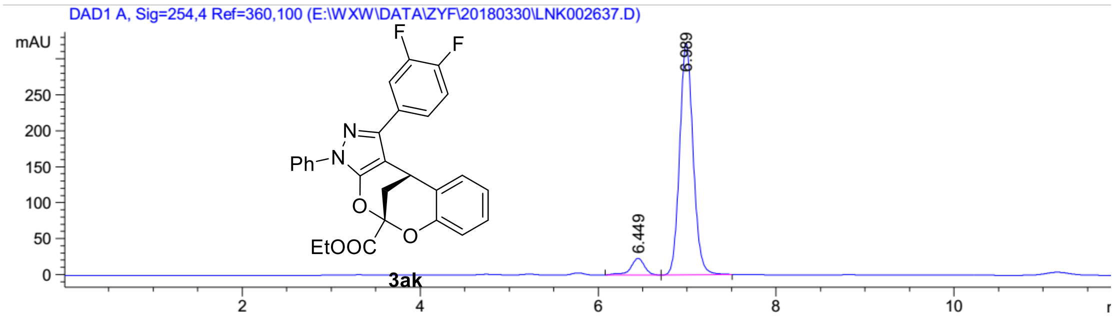
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.178	VV	0.1727	510.38205	45.56299	4.4071
2	7.360	VB	0.1922	1.10706e4	895.39923	95.5929

Ethyl-(5S,11S)-9-chloro-1-(3,4-difluorophenyl)-3-phenyl-3,11-dihydro-5,11- methanobenzo [7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ak



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

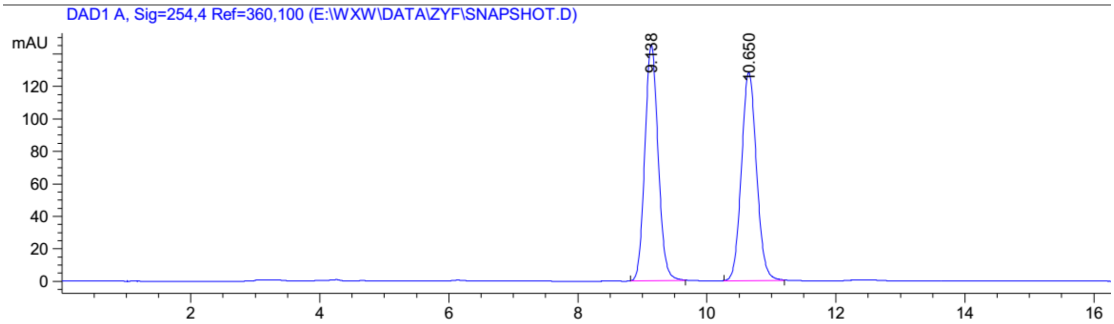
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.424	BV	0.1503	2831.61646	288.98071	48.9039
2	6.962	VB	0.1586	2958.54492	286.11865	51.0961



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

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.449	BV	0.1648	254.35718	23.41121	6.9850
2	6.989	VB	0.1627	3387.13818	322.01257	93.0150

Ethyl-(5S,11S)-9-chloro-1-(3,4-dichlorophenyl)-3-phenyl-3,11-dihydro-5,11-methanobenzo [7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3al

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Signal 1: DAD1 A, Sig=254,4 Ref=360,100
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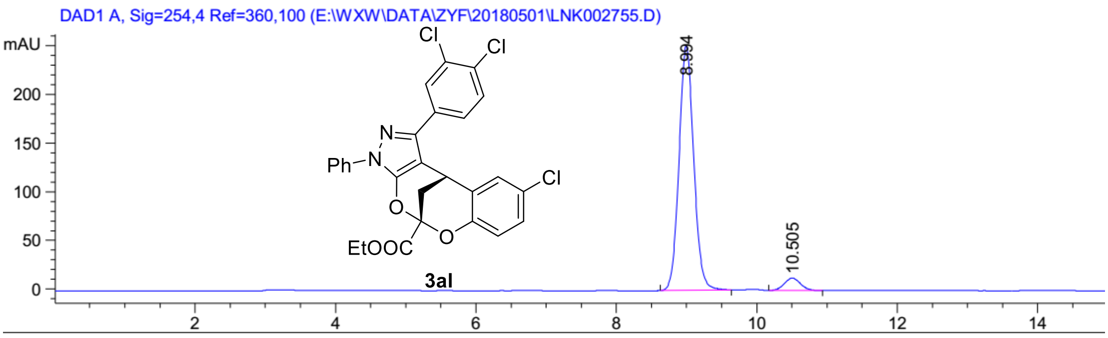
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.138	BB	0.2231	2083.35986	145.41803	49.9410
2	10.650	BB	0.2517	2088.28320	128.40549	50.0590

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Signal 1: DAD1 A, Sig=254,4 Ref=360,100
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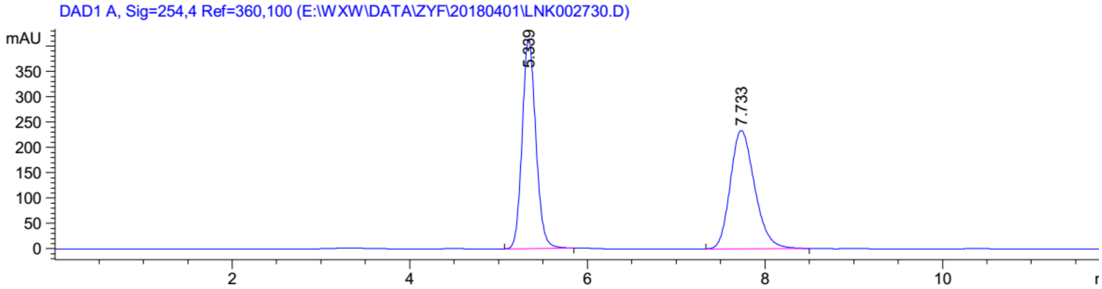
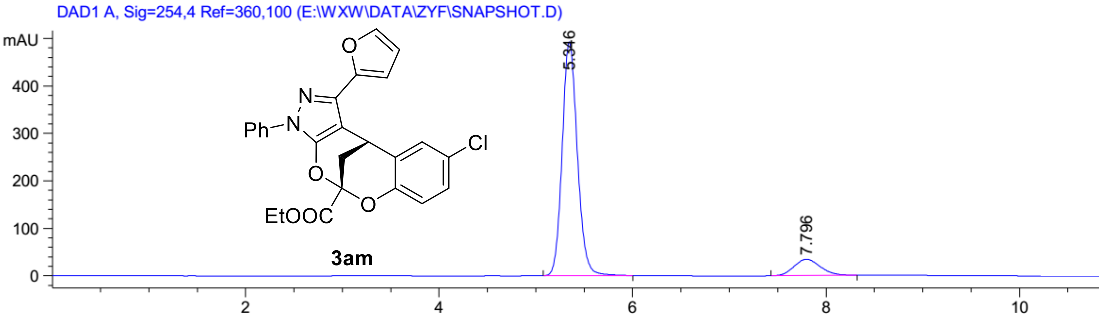
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.994	BB	0.2263	3659.25439	250.75215	94.7188
2	10.505	VB	0.2516	204.02698	12.68750	5.2812

Ethyl-(5S,11S)-9-chloro-1-(furan-2-yl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3am



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

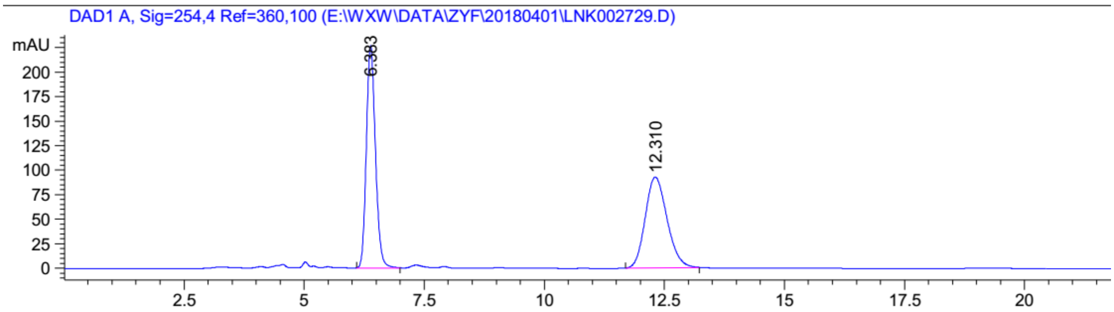
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.339	BB	0.1648	4423.25391	413.49994	49.8026
2	7.733	BB	0.2947	4458.31201	233.56653	50.1974



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

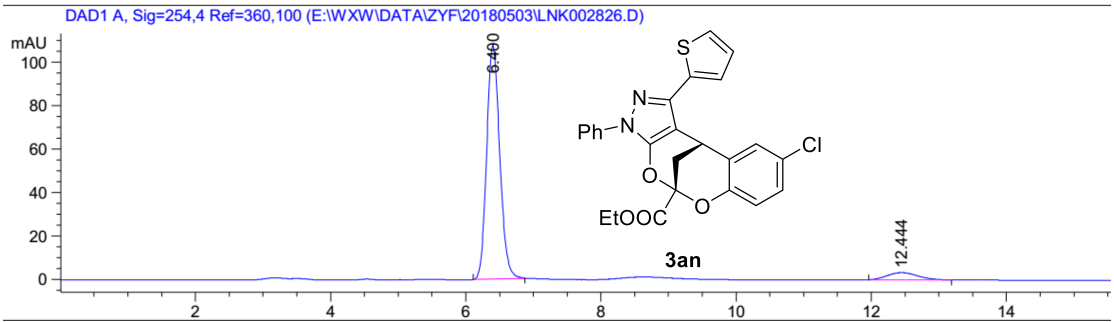
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.346	BB	0.1694	5377.18945	492.48257	89.2653
2	7.796	BB	0.2946	646.63947	34.19866	10.7347

Ethyl-(5S,11S)-9-chloro-3-phenyl-1-(thiophen-2-yl)-3,11-dihydro-5,11-methano benzo [7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3an



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

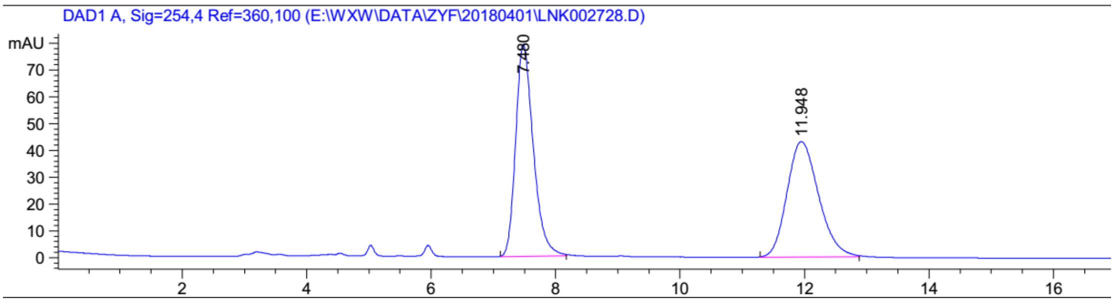
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.383	BB	0.2039	2988.04077	226.55450	50.3524
2	12.310	BB	0.4899	2946.21924	92.91272	49.6476



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

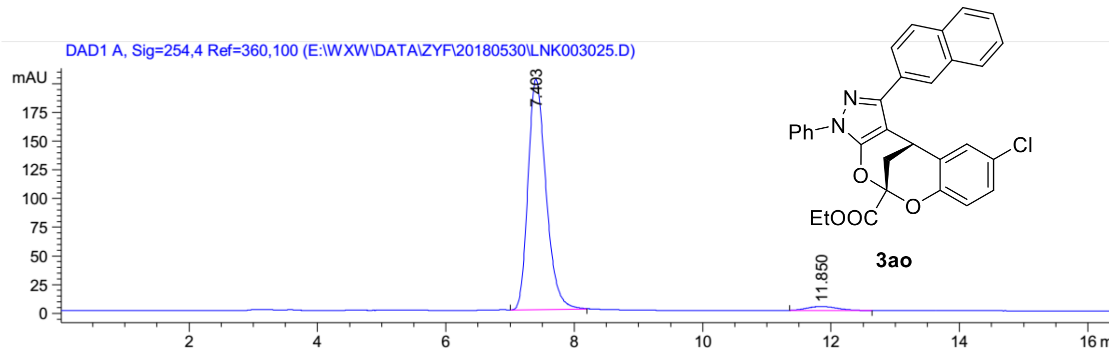
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.400	BB	0.2081	1443.91504	107.94367	93.1503
2	12.444	BB	0.4420	106.17709	3.34797	6.8497

Ethyl-(5S,11S)-9-chloro-1-(naphthalen-2-yl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ao



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

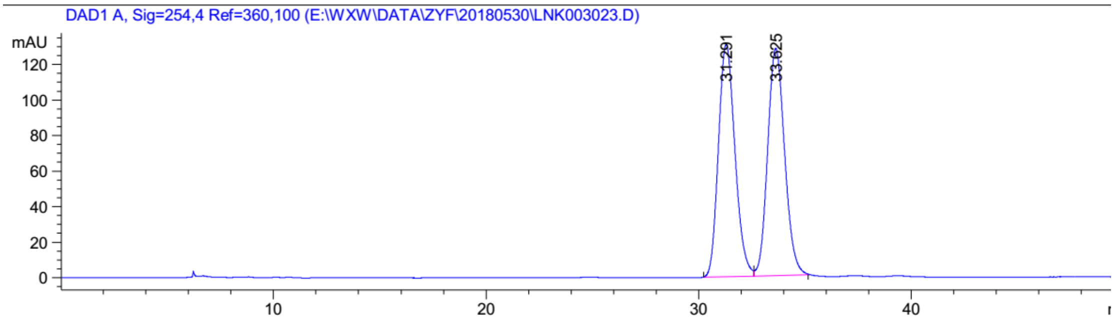
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.480	BB	0.3014	1555.89380	79.13875	50.6314
2	11.948	BB	0.5470	1517.08948	43.06490	49.3686



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

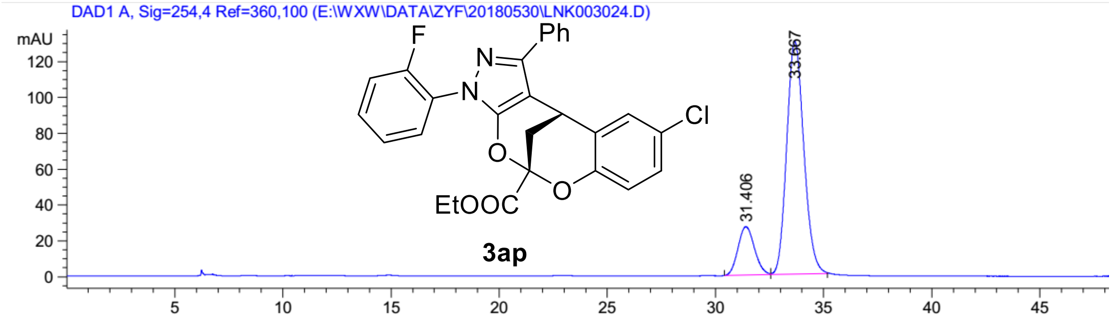
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.403	VB	0.3020	3920.25269	200.61816	97.2151
2	11.850	BB	0.4849	112.30383	3.36866	2.7849

Ethyl-(5S,11S)-9-chloro-3-(2-fluorophenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ap



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

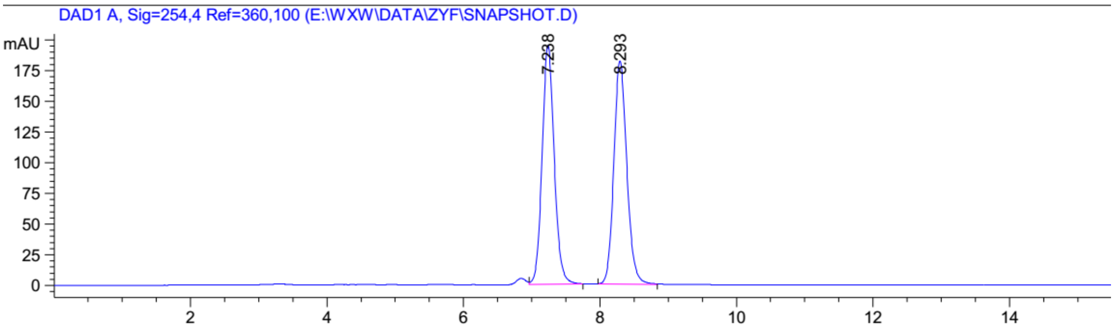
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	31.291	BV	0.8440	7084.64551	130.78029	49.9324
2	33.625	VB	0.8621	7103.82129	127.87756	50.0676



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

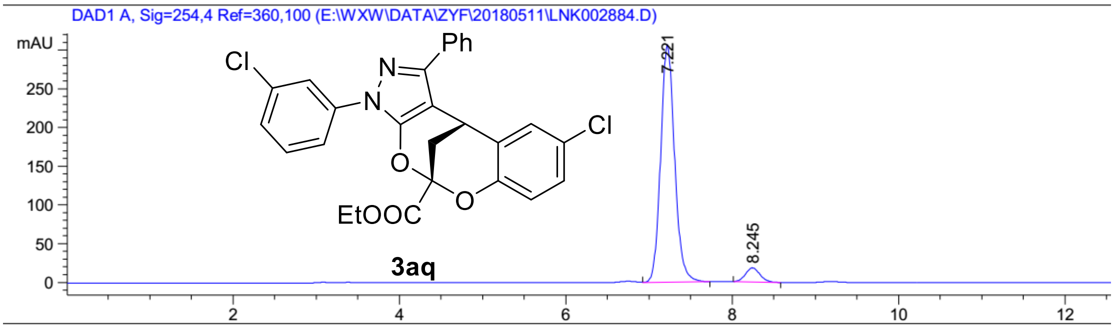
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	31.406	BV	0.8223	1429.73242	27.06482	16.6781
2	33.667	VB	0.8535	7142.76318	129.90495	83.3219

Ethyl-(5S,11S)-9-chloro-3-(3-chlorophenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3aq



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

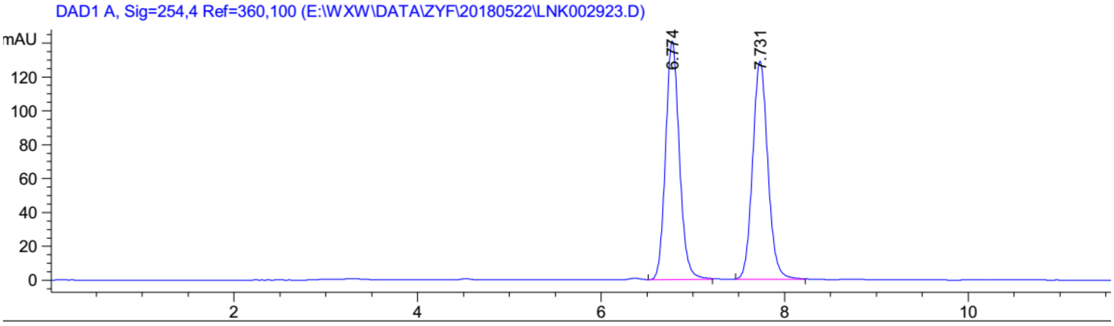
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.238	VB	0.1880	2400.90894	194.52869	50.0278
2	8.293	BB	0.2020	2398.24316	181.70409	49.9722



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

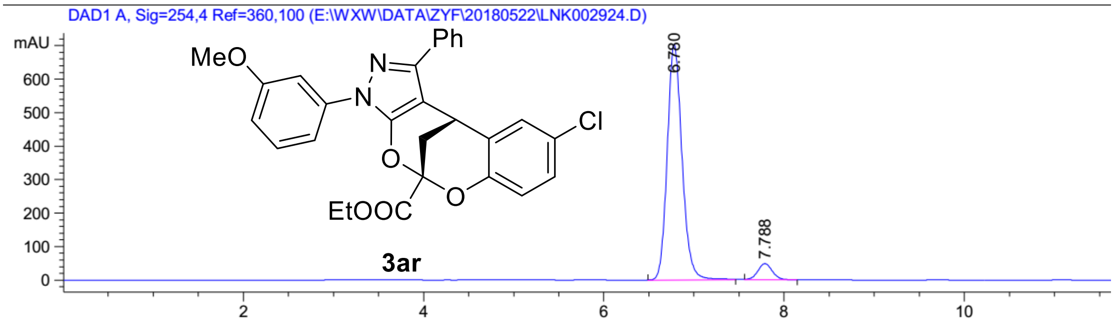
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.221	VB	0.1799	3566.58984	306.19870	94.0906
2	8.245	BB	0.1885	224.00111	18.33909	5.9094

Ethyl-(5S,11S)-9-chloro-3-(3-methoxyphenyl)-1-phenyl-3,11-dihydro-5,11- methanobenzo [7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ar



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

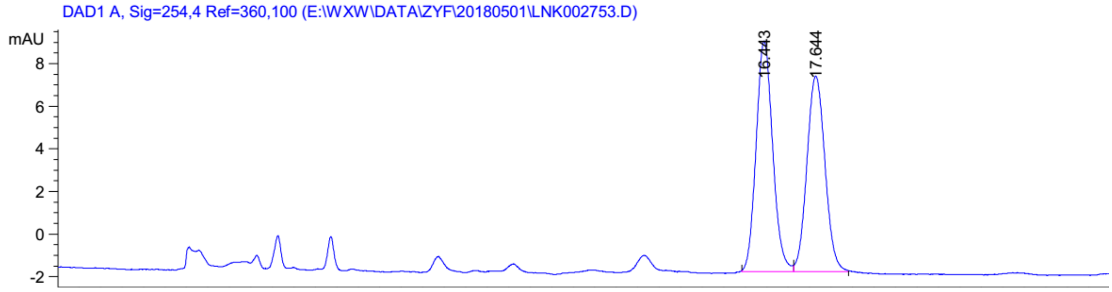
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.774	VB	0.1602	1473.86108	140.70338	49.8816
2	7.731	BB	0.1783	1480.85950	128.66095	50.1184



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

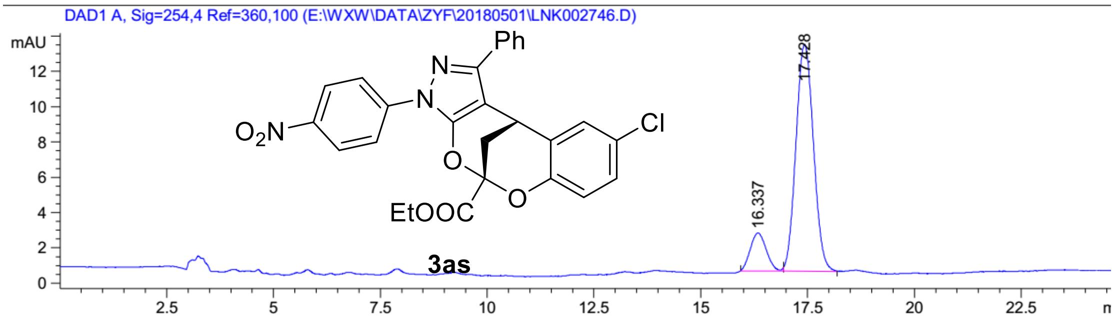
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.780	BB	0.1775	8048.13867	703.47186	93.5229
2	7.788	BB	0.1772	557.38617	48.82001	6.4771

Ethyl-(5S,11S)-9-chloro-3-(4-nitrophenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo [7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3as



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

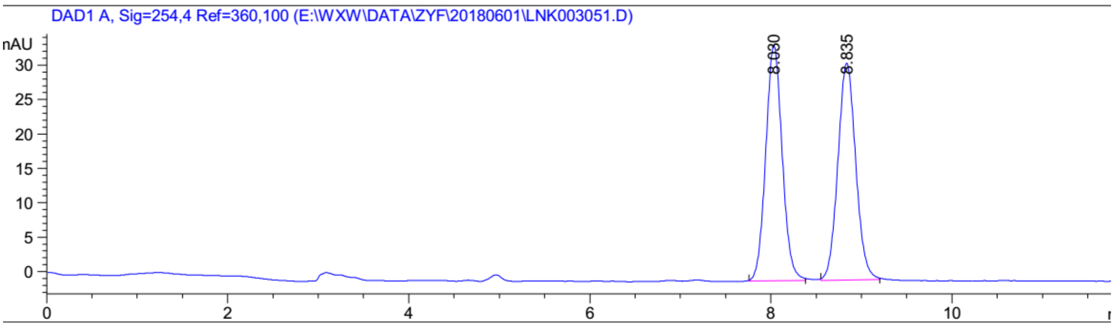
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.443	BB	0.4154	290.37305	10.80886	51.9309
2	17.644	BB	0.4557	268.77942	9.17615	48.0691



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

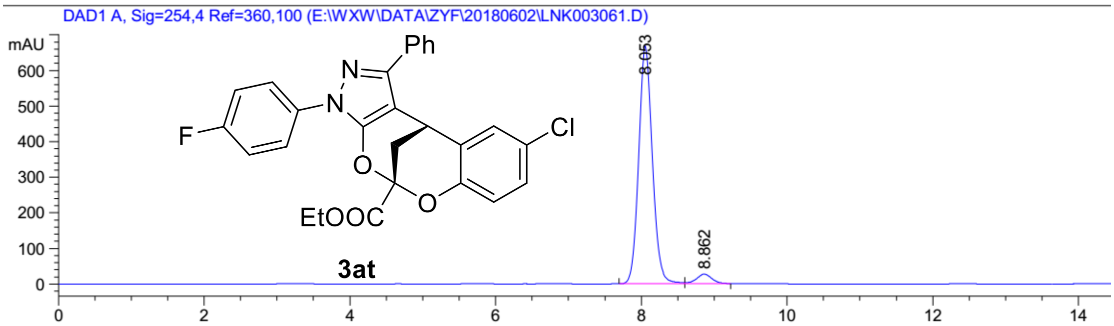
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.337	BB	0.3505	55.97310	2.14479	13.2531
2	17.428	BB	0.4468	366.36588	12.84362	86.7469

Ethyl-(5S,11S)-3-(4-fluorophenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3] dioxocino[4,5-c]pyrazole-5-carboxylate 3at



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

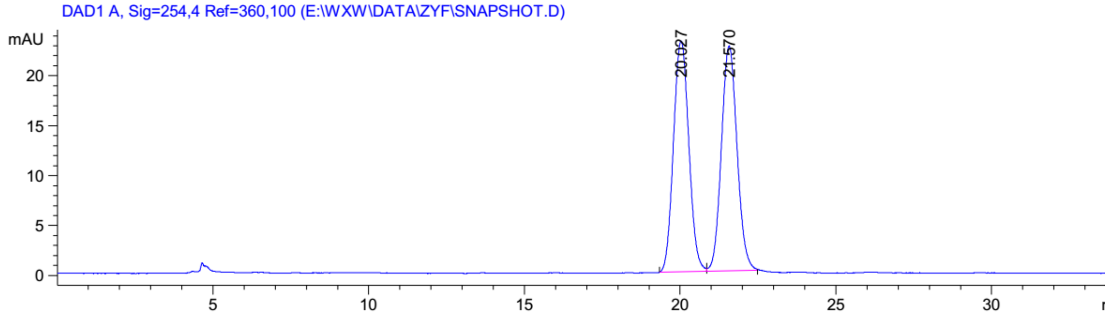
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.030	BB	0.1959	433.54370	34.20902	50.0419
2	8.835	BB	0.2120	432.81854	31.55100	49.9581



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

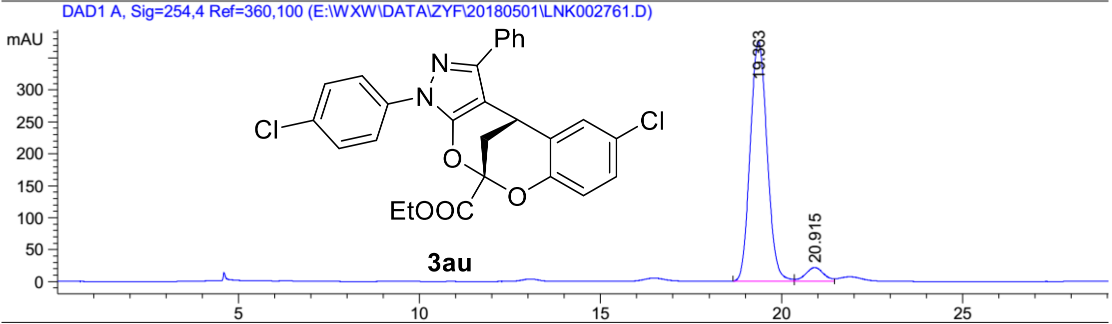
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.053	BV	0.2028	8755.31543	668.65942	95.6940
2	8.862	VB	0.2240	393.96945	26.72508	4.3060

Ethyl-(5S,11S)-9-chloro-3-(4-chlorophenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3au



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

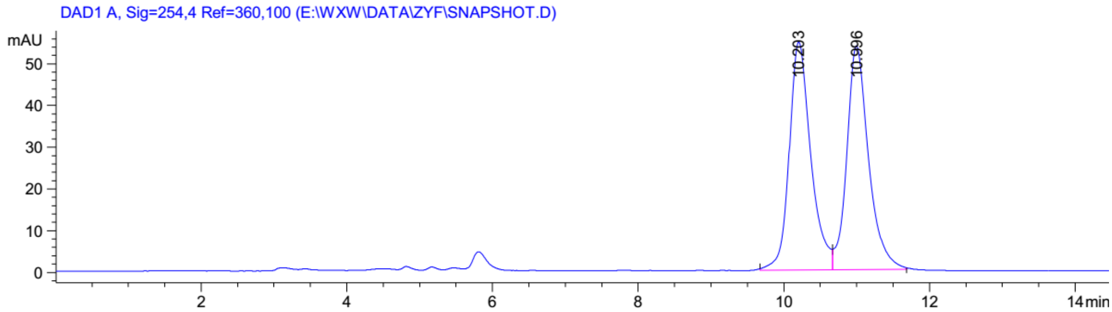
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.027	BV	0.5399	792.34698	23.11724	50.1099
2	21.570	VB	0.5445	788.87207	22.52737	49.8901



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

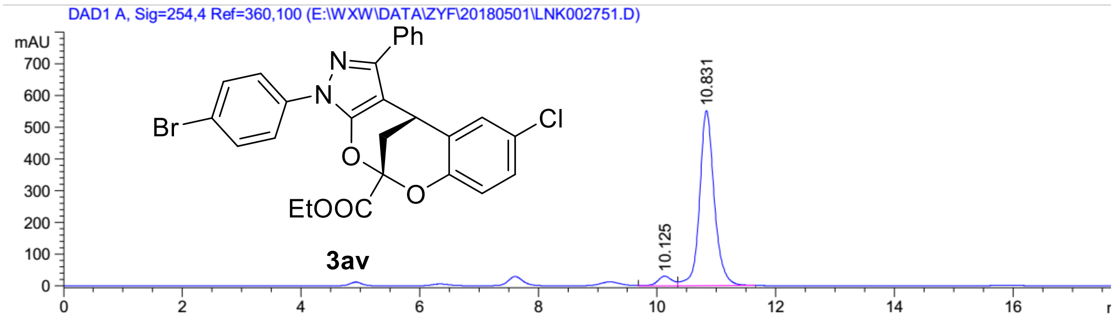
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	19.363	BB	0.5138	1.22178e4	375.28610	94.2408
2	20.915	BV	0.5314	746.65497	21.48524	5.7592

Ethyl-(5S,11S)-3-(4-bromophenyl)-9-chloro-1-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3av



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

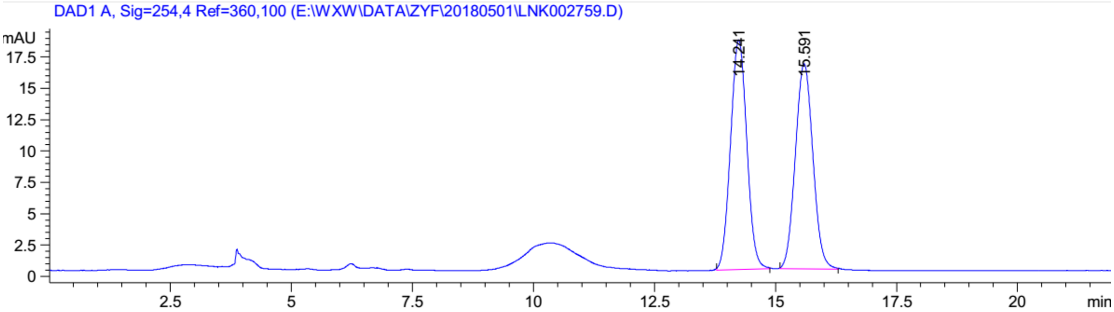
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.203	BV	0.3080	1123.94763	54.63291	50.0805
2	10.996	VB	0.3118	1120.33472	53.60175	49.9195



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

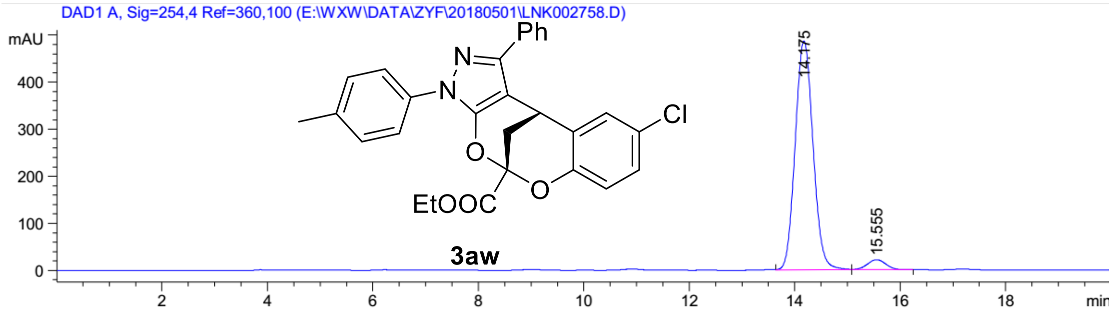
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.125	VV	0.2491	499.03433	29.84266	5.0088
2	10.831	VB	0.2585	9464.20117	550.82245	94.9912

Ethyl-(5S,11S)-9-chloro-1-phenyl-3-(p-tolyl)-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3aw



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

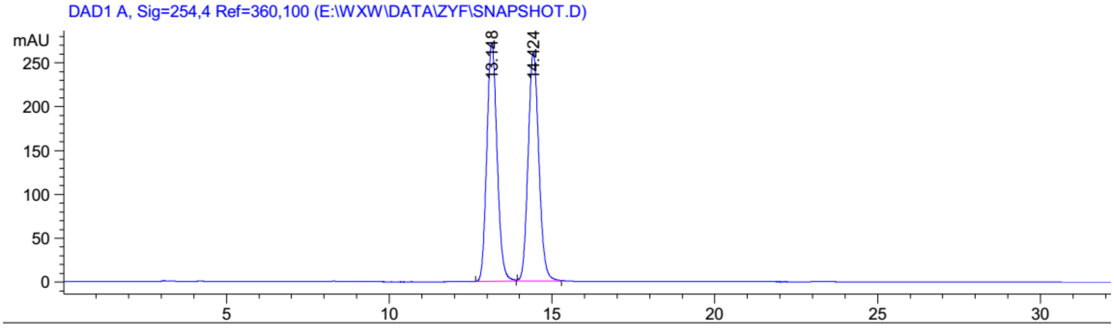
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.241	BB	0.3691	428.70703	18.31575	50.9638
2	15.591	BB	0.3980	412.49161	16.36645	49.0362



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

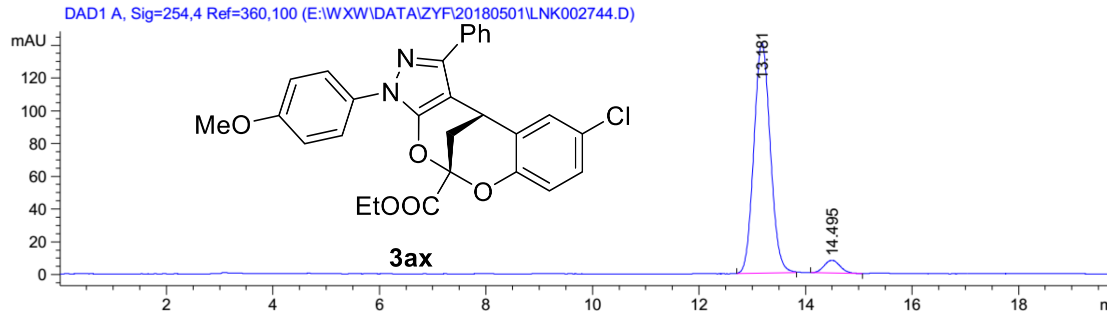
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.175	BB	0.3709	1.14450e4	485.72784	95.7398
2	15.555	BB	0.3875	509.27014	20.96015	4.2602

Ethyl-(5S,11S)-9-chloro-3-(4-methoxyphenyl)-1-phenyl-3,11-dihydro-5,11-methanobenzo [7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxylate 3ax



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

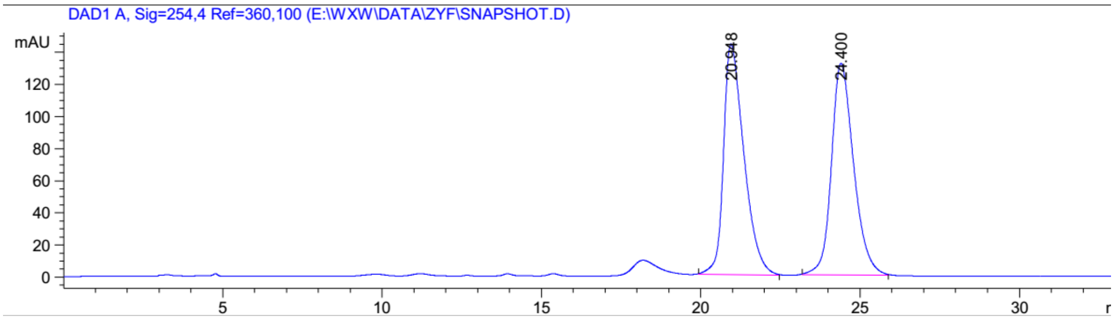
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.148	BB	0.3413	5970.73145	272.81876	49.9781
2	14.424	BB	0.3575	5975.95459	260.60321	50.0219



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

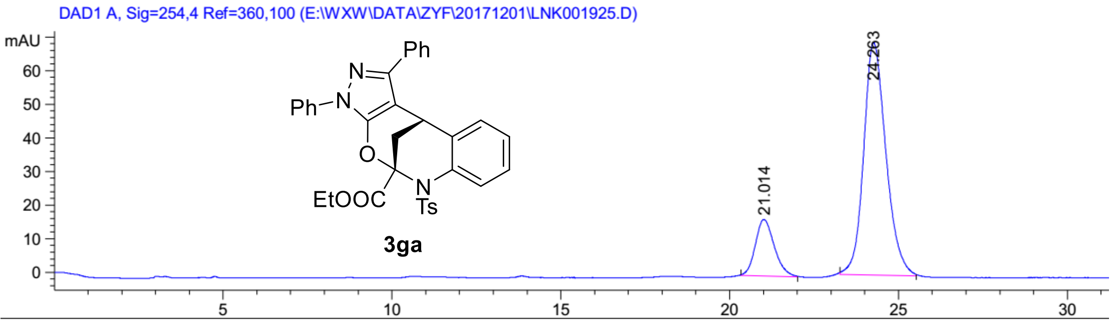
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.181	BB	0.3341	3016.21899	140.71498	94.8853
2	14.495	BB	0.3239	162.58684	7.84185	5.1147

Ethyl-(5S,11S)-1,3-diphenyl-6-tosyl-6,11-dihydro-5,11-methanobenzo[d]pyrazolo[4,3-g][1,3]oxazocine-5(3H)-carboxylate 3ga



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

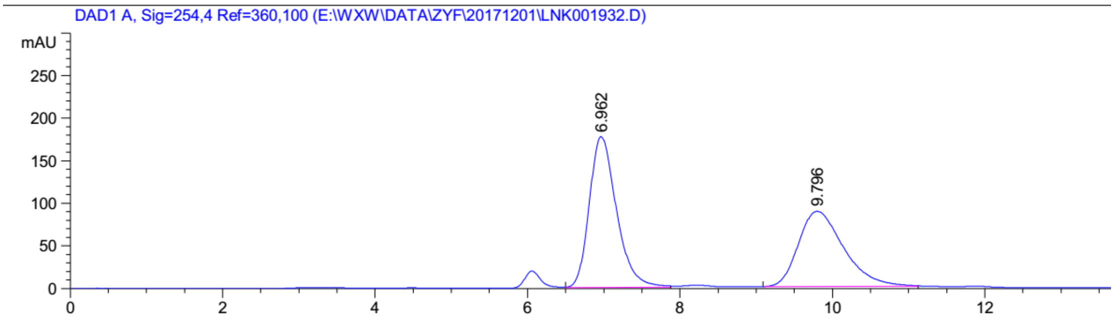
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.948	BB	0.6752	6390.29688	143.60292	50.0147
2	24.400	BB	0.7371	6386.55078	131.85347	49.9853



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

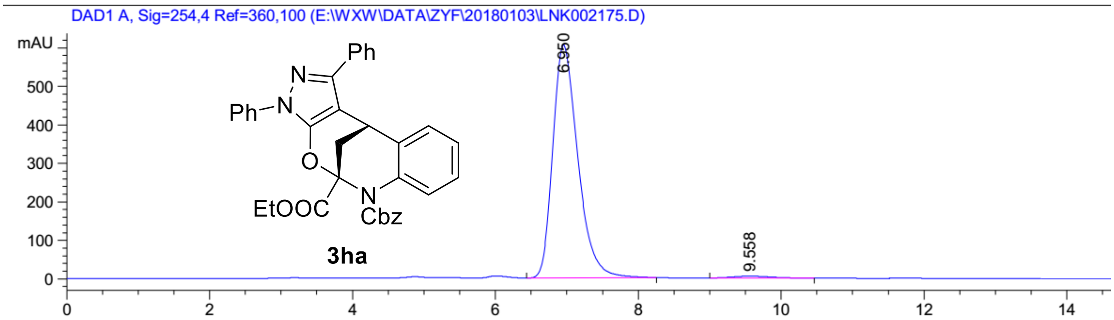
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.014	BB	0.5964	655.48157	16.82856	17.1368
2	24.263	BB	0.6974	3169.51123	69.07059	82.8632

6-Benzyl-5-ethyl-(5S,11S)-1,3-diphenyl-3,11-dihydro-5,11-methanobenzo[d]pyrazolo [4,3-g][1,3]oxazocine-5,6-dicarboxylate 3ha



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

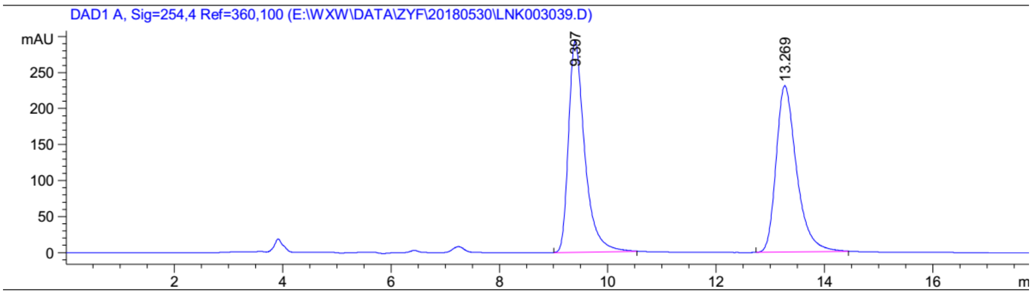
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.962	BB	0.3803	4412.44580	177.32515	54.7458
2	9.796	BB	0.6317	3647.43408	88.33873	45.2542



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

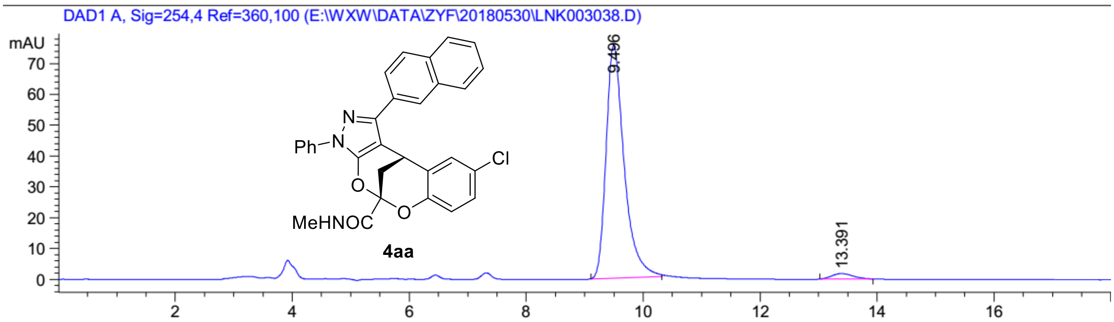
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.950	VB	0.3745	1.47656e4	605.48273	98.7423
2	9.558	BB	0.5537	188.07887	4.94526	1.2577

(5S,11S)-9-Chloro-N-methyl-1-(naphthalen-2-yl)-3-phenyl-3,11-dihydro-5,11-methanobenzo[7,8][1,3]dioxocino[4,5-c]pyrazole-5-carboxamide 4aa



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

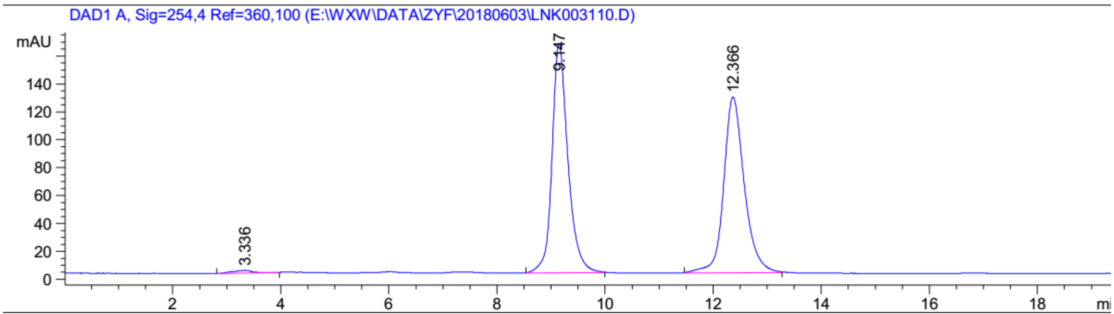
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.397	BB	0.3125	6095.62207	293.24985	50.0407
2	13.269	BB	0.3993	6085.69580	231.07535	49.9593



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

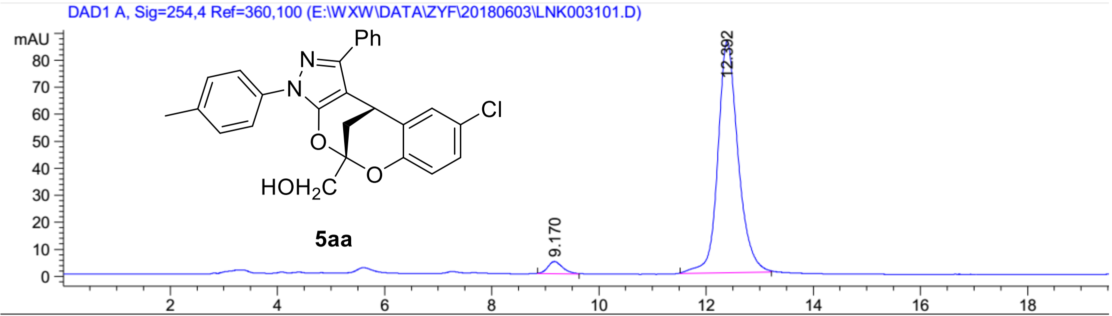
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.496	BB	0.3248	1625.82715	75.62146	97.1714
2	13.391	BB	0.3574	47.32725	1.81960	2.8286

Ethyl-(3S,6'R,12'R)-3'-bromo-8'-chloro-1-methyl-2-oxo-6'H,12'H-spiro[indoline-3,5'-[6,12] methanobenzo[g]pyrrolo[2,1-*c*][1,4]oxazocine]-12'-carboxylate 5aa



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

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	3.336	BB	0.3235	45.00465	1.83921	0.6687
2	9.147	BB	0.3062	3353.68530	164.24127	49.8283
3	12.366	BB	0.3964	3331.79565	126.04583	49.5030



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

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.170	BB	0.2888	84.57864	4.46874	3.6085
2	12.392	BB	0.3954	2259.27515	85.74226	96.3915