Supporting Information for

Synthesis of 1-(β-Coumarinyl)-1-(β-Indolyl)Trifluoroethanols through Regioselective Friedel–Crafts Alkylation of Indoles with β-(Trifluoroacetyl)Coumarins Catalyzed by $Sc(OTf)_3$

Lijun Shi,[a‡] Ying Liu,[a‡] Caixia Wang,[a] Xinxin Yuan,[b] Xiaobiao Liu,[a] Lulu Wu,[a] Zhenliang Pan,[a] Qicheng Yu,[c] Cuilian Xu*[a] and Guoyu Yang*[a]

[a.] *School of Science, Henan Agricultural University, Zhengzhou 450002, P. R. China. E-mail: xucuilian666@henau.edu.cn (C. L. Xu); yangguoyulxy@henau.edu.cn (G. Y. Yang).*

[b.] *College of Resource and Environment, Henan Agricultural University, Zhengzhou 450002, P. R. China.*

[c.] *College of Animal Science and Veterinary Medicine, Henan Agricultural University, Zhengzhou 450002, P. R. China.*

‡ *These two authors contributed equally to this work.*

* *Corresponding authors.*

Contents

1. Experimental Section

1.1. Gereral

All solvents and reagents used are commercially available and were used without further purification. All ^{1}H and ^{13}C NMR spectra used d_6-DMSO as a solvent to avoid the interference of peaks from residual non-deuterium solvent. The NMR data were obtained on a Bruker DPX-400 or 500 Spectrometer, respectively. The MestReNova Software was used to deal with the NMR spectra. Chemical shifts (δ) are reported in ppm and J values are given in hertz. In ^{1}H NMR, the signal of TMS was set as 0.00 ppm unless noted. In ^{13}C NMR, the middle signal of d_6-DMSO was set as 39.60 ppm. All the signals represent 1H or 1C except as noted. HPLC analyses for the qualitative and quantitative analysis of the products were carried out using an Agilent 1200 pump equipped with an Agilent 1200 detector. Melting points were determined on an X-5 digital microscopic melting-point apparatus (Beijing Tech Instruments Co., Beijing, China) and are uncorrected. High resolution mass spectrometry were obtained using a Waters Q-Tof MicroTM instrument. X-ray Crystallography parameters for data collection and refinement of the compounds are summarized in **Table 3**. Intensities were collected on a Rigaku Saturn 724 CCD diffractometer (Mo-Kα, λ = 0.71073 Å) at a temperature of 293 K using the SMART and SAINT programs. The structures were solved by direct method and refined on F2 by full-matrix least-squares methods with SHELXTL-97 crystallographic software package. All the non-hydrogen atoms were refined with anisotropic thermal displacement coefficients. The hydrogen atoms were assigned with common isotropic displacement factors and included in the final refinement by using geometrical restrains.

1.2. Preparation of β-(trifluoroacetyl)coumarins 1a-f

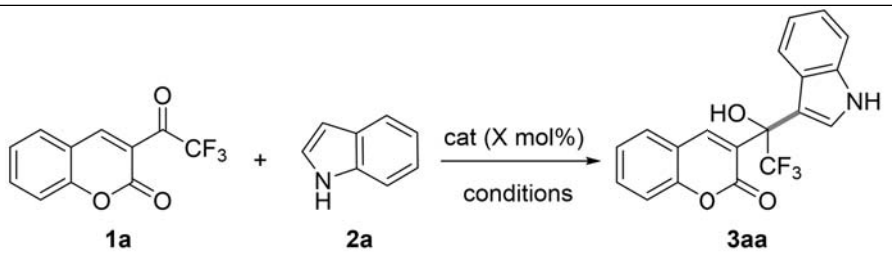
β-(trifluoroacetyl)coumarins **1a-f** were prepared according the microwave assisted solvent-free route via Knoevenagel condensation of substituted salicylaldehydes with ethyl trifluoroacetoacetate in the presence of silica-immobilized L-proline and subsequently rearrangement (see ref[31]).

Indole **2a** and substituted indoles **2b-h** were used commercially.

1.3 Optimization of reaction conditions

To optimize reaction condition, the effects of the catalyst (containing different Lewis acids or protic acids), the effects of the solvent, the effects of reaction temperature, the amount of catalyst, the ratio of the reactants and the moisture were investigated and shown in Table S1, which contains another 15 entries compared the Table 1 in the published article.

Table S1. Optimization of Reaction Conditions[a]



1a **2a** **3aa**

Entry	Catalyst	X	Solvent	*T*/°C	Time/min[b]	Yield/%[c]
1	None	-	CH_2Cl_2	25	120	N. R.
2	$AlCl_3$	5	CH_2Cl_2	25	120	15
3	$FeCl_3$	5	CH_2Cl_2	25	120	30
4	$Pb(OAc)_2$	5	CH_2Cl_2	25	120	20
5	$Cu(OTf)_2$	5	CH_2Cl_2	25	120	17
6	$Fe(OTf)_3$	5	CH_2Cl_2	25	120	25
7	$Y(OTf)_3$	5	CH_2Cl_2	25	120	45
8	*p*-TSA	5	CH_2Cl_2	25	120	N. R.
9	TfOH	5	CH_2Cl_2	25	120	8
10	$Sc(OTf)_3$	5	CH_2Cl_2	25	120	93
11	$Sc(OTf)_3$	5	CH_2Cl_2	25	300	95
12	$Sc(OTf)_3$	5	CH_2Cl_2	25	30	91
13	$Sc(OTf)_3$	5	$CHCl_3$	25	120	90
14	$Sc(OTf)_3$	5	CCl_4	25	120	87
15	$Sc(OTf)_3$	5	DCE	25	120	82
16	$Sc(OTf)_3$	5	Toluene	25	120	75
17	$Sc(OTf)_3$	5	CH_3CN	25	120	38
18	$Sc(OTf)_3$	5	EtOH	25	120	72
19	$Sc(OTf)_3$	5	HOAc	25	120	65
20	**$Sc(OTf)_3$**	**5**	**CH_2Cl_2**	**reflux**	**20**	**95**
21	$Sc(OTf)_3$	5	CH_2Cl_2	reflux	30	92
22	$Sc(OTf)_3$	5	CH_2Cl_2	reflux	90	88
23	$Sc(OTf)_3$	5	$CHCl_3$	45	30	83

24	$Sc(OTf)_3$	5	$CHCl_3$	45	90	88
25	$Sc(OTf)_3$	5	$CHCl_3$	45	120	88
26	$Sc(OTf)_3$	5	$CHCl_3$	reflux	20	81
27	$Sc(OTf)_3$	5	$CHCl_3$	reflux	40	83
28	$Sc(OTf)_3$	5	$CHCl_3$	reflux	60	80
29	$Sc(OTf)_3$	5	$CHCl_3$	reflux	100	70
30	$Sc(OTf)_3$	7.5	CH_2Cl_2	reflux	30	91
31	$Sc(OTf)_3$	10	CH_2Cl_2	reflux	30	90
32[d]	$Sc(OTf)_3$	5	CH_2Cl_2	reflux	20	92
33[e]	$Sc(OTf)_3$	5	CH_2Cl_2	reflux	10	20
34[e]	$Sc(OTf)_3$	5	CH_2Cl_2	reflux	20	45
35[e]	$Sc(OTf)_3$	5	CH_2Cl_2	reflux	60	61

[a] The reactions were performed on a 0.2 mmol scale using **1a** (1.0 equiv.) and **2a** (1.0 equiv in entries 1-31 and 33-35; 1.1 equiv in entry 32) in 2.0 mL of solvent under air atmosphere. The reactants, catalysts and solvents were used without further treatment (except entries 33-35).

[b] The reactions were monitored by HPLC analysis using a ^{18}C chromatographic column. Mobile phase was MeOH:H_2O = 75%:25% and flow velocity was 1.0 mL/min.

[c] Isolated yield.

[d] The ratio of **1a**:**2a** =1:1.1

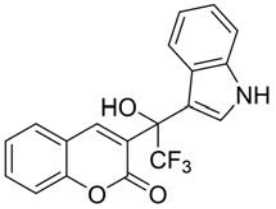
[e] The reactants and catalyst (**1a**, **2a** and $Sc(OTf)_3$) were dried under vacuum at room temperature in a desiccator for 2 hours to remove moisture. The solvent (CH_2Cl_2) was distilled over phosphorus pentoxide.

1.4 Preparation of 1-(β-coumarinyl)-1-(β-indolyl)trifluoroethanols 3aa-3fa

In a typical experiment of Friedel-Crafts alkylation of indoles, a solution of β-(trifluoroacetyl)coumarin **1a** (0.2 mmol), indole **2a** (0.2 mmol) and $Sc(OTf)_3$ (0.01 mmol, 5% eq) in 2 mL CH_2Cl_2 was stirred under atmosphere at 45 °C for 20 minutes. The reaction was monitored by HPLC. When the reaction completed, the mixture was washed by water (5 mL×3). Then the water phase was extracted by CH_2Cl_2 (5 mL×3). The combined solution was evaporated under reduced pressure. The crude product was recrystallized from ethyl acetate and petroleum ether (1:10), to afford the product **3aa** as a light yellow powder (95% yield).

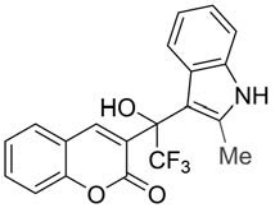
1.5 Characterization data of new compounds

1-(coumarin-3-yl)-1-(1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3aa**).



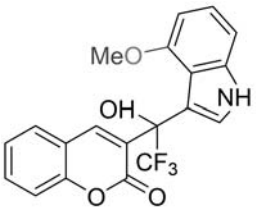
Yield 95%, light yellow powder, mp 244.6-244.9 °C. ^{1}H-NMR (400 MHz) δ 11.30 (s, N*H*), 8.69 (s), 7.99 (d, *J* = 7.4 Hz), 7.64 (t, *J* = 7.6 Hz), 7.48 (s), 7.44-7.34(m, 5H), 7.07 (t, *J* = 7.5 Hz), 6.89 (t, *J* = 7.5 Hz). ^{13}C NMR (101 MHz) δ 157.46(*C*=O), 153.55(*C*–O), 143.05, 136.30, 132.73, 129.68, 125.47(q, *J* = 287.9 Hz, *C*F_3), 125.39, 125.34, 124.80, 124.37, 121.28, 119.65, 119.12, 118.42, 115.87, 111.91, 110.40, 74.49(q, *J* = 30.0 Hz, *C*-CF_3). ^{19}F NMR (376 MHz) δ –74.21(s, 3F, C*F*$_3$). (The chemical shift was obtained from the MestReNova software without correction.) HRMS: *m/z* calcd for $C_{19}H_{11}F_3NO_3$: 358.0691 $[M-H]^+$; found: 358.0689.

1-(coumarin-3-yl)-1-(2-methyl-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3ab**).



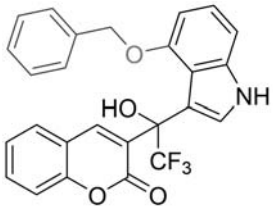
Yield 82%, brown powder, mp 161.2-163.7 °C. ^{1}H NMR (500 MHz) δ 11.07 (s, N*H*), 8.43 (s), 8.03 (dd, *J* = 7.7, 1.2 Hz), 7.66 (td, *J* = 7.8, 1.2 Hz), 7.42 (td, *J* = 7.4, 0.6 Hz, 2H), 7.41 (d, *J* = 8.4 Hz), 7.32 (d, *J* = 7.6 Hz), 7.25 (d, *J* = 8.0 Hz), 6.97 – 6.91 (m, 2H), 6.80 (t, *J* = 7.6 Hz), 2.41 (s, 3H, C*H*$_3$). ^{13}C NMR (126 MHz) δ 157.14 (*C*=O), 153.21 (*C*-O), 140.21, 134.80, 134.49, 132.67, 129.82, 126.99, 126.08, 125.86 (q, *J* = 284.5 Hz, *C*F_3), 124.84, 119.95, 119.33, 118.71, 118.05, 115.86, 110.61, 105.89, 75.93 (q, *J* = 29.6 Hz, *C*-CF_3), 13.76(*C*H_3). HRMS: *m/z* calcd for $C_{20}H_{13}F_3NO_3$: 372.0848 $[M-H]^+$; found: 372.0845.

1-(coumarin-3-yl)-1-(4-methoxy-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3ac**).



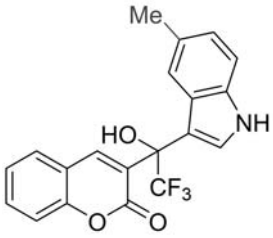
Yield 80%, light yellow powder, mp 190.7-193.7 °C. ^{1}H NMR (500 MHz) δ 11.31 (s, N*H*), 8.22 (s), 7.87 (d, *J* = 7.7 Hz), 7.64 (td, *J* = 8.0, 1.0 Hz), 7.43 (d, *J* = 8.3 Hz), 7.39 – 7.35 (m, 2H), 7.13 – 7.08 (m), 7.06 – 7.03 (m), 7.01 (t, *J* = 7.7 Hz), 6.40 (dd, *J* = 7.3, 0.7 Hz), 3.46 (s, 3H, OC*H*$_3$). ^{13}C NMR (126 MHz) δ 159.15 (*C*=O), 153.08 (*C*–O), 152.37 (*C*–O), 143.04, 138.10, 132.48, 129.18, 126.12, 125.68 (q, *J* = 287.7 Hz, *C*F$_3$), 124.86, 123.22, 122.55, 118.70, 115.83, 115.25, 111.35, 105.30, 100.36, 75.17 (q, *J* = 28.9 Hz, *C*-CF$_3$), 54.90 (O*C*H$_3$). HRMS: *m/z* calcd for $C_{20}H_{13}F_3NO_4$: 388.0797 $[M-H]^+$; found: 388.0795.

1-(coumarin-3-yl)-1-(4-benzyloxy-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3ad**).



Yield 85%, light yellow powder, mp 251.0-253.1 °C. ^{1}H NMR (500 MHz) δ 11.35 (s, N*H*), 8.05 (s), 7.59 (t, *J* = 7.8 Hz), 7.50 (d, *J* = 7.7 Hz), 7.39 (s), 7.28 (t, *J* = 7.5 Hz), 7.24 (tt, *J* = 7.0, 1.6 Hz), 7.19 – 7.10 (m, 5H), 7.03 (d, *J* = 8.1 Hz), 6.95 (t, *J* = 7.9 Hz), 6.40 (d, *J* = 7.8 Hz), 5.04 (d, *J* = 12.8 Hz, C*H*H-O), 4.91 (d, *J* = 12.8 Hz, C*H*H-O). ^{13}C NMR (126 MHz) δ 158.90 (*C*=O), 153.08 (*C*–O), 151.21 (*C*–O), 143.55, 138.28, 136.93, 132.42, 129.17, 128.25 (2C), 127.62, 127.23 (2C), 125.84, 125.69 (q, *J* = 288.2 Hz, *C*F$_3$), 124.62, 123.55, 122.40, 118.45, 115.73, 115.36, 110.95, 105.32, 101.47, 75.27 (q, *J* = 29.5 Hz, *C*-CF$_3$), 69.16 (O*C*H$_2$). HRMS *m/z* calcd for $C_{26}H_{17}F_3NO_4$: 464.1110 $[M-H]^+$; found: 464.1106.

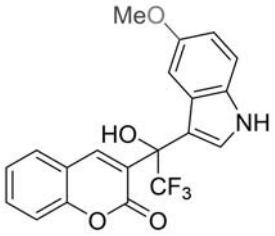
1-(coumarin-3-yl)-1-(5-methyl-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3ae**).



Yield 88%, white powder, mp 181.6-183.2 °C. ^{1}H NMR (500 MHz) δ 11.14 (s, N*H*), 8.63 (s), 7.99 (d, *J* = 7.0 Hz), 7.65 (d, *J* = 7.0 Hz), 7.42 – 7.38 (m, 3H), 7.32 – 7.24 (m, 2H), 7.20 – 7.15 (m), 6.92 – 6.87 (m), 2.21 (s, 3H, C*H*$_3$). ^{13}C NMR (126 MHz) δ

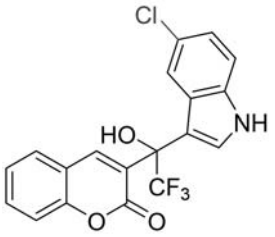
157.53 (*C*=O), 153.47 (*C*–O), 142.92, 134.63, 132.70, 129.62, 127.36, 125.60, 125.44 (q, *J* = 287.6 Hz, *C*F_3), 125.24, 124.79, 124.39, 122.85, 119.32, 118.37, 115.83, 111.55, 109.76, 74.65 (q, *J* = 29.7 Hz, *C*-CF_3), 21.43 (*C*H_3). HRMS *m/z* calcd for $C_{20}H_{13}F_3NO_3$: 372.0848 $[M-H]^+$; found: 372.0846.

1-(coumarin-3-yl)-1-(5-methoxy-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3af**).



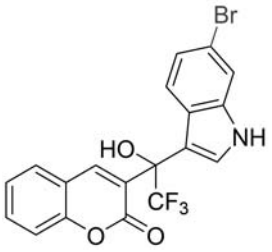
Yield 79%, gray powder, mp 172.4-174.0 °C. ^{1}H NMR (500 MHz) δ 11.12 (s, N*H*), 8.66 (s), 8.00 (dd, *J* = 8.3, 1.5 Hz), 7.66 (td, *J* = 7.9, 1.1 Hz), 7.43 – 7.39 (m, 3H), 7.31 (d, *J* = 8.8 Hz), 7.25 (s, O*H*), 6.80 (s), 6.74 (dd, *J* = 8.8, 2.3 Hz), 3.51 (s, 3H, OC*H*$_3$). ^{13}C NMR (126 MHz) δ 157.45 (*C*=O), 153.46 (*C*–O), 153.04 (*C*–O), 142.80, 132.72, 131.46, 129.58, 125.75, 125.42 (q, *J* = 287.6 Hz, *C*F_3), 125.29, 125.02, 124.81, 118.32, 115.81, 112.45, 110.81, 109.93, 102.04, 74.56 (q, *J* = 30.1 Hz, *C*-CF_3), 55.14 (O*C*H_3). HRMS *m/z* calcd for $C_{20}H_{13}F_3NO_4$: 388.0797 $[M-H]^+$; found: 388.0795.

1-(coumarin-3-yl)-1-(5-chloro-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3ag**).



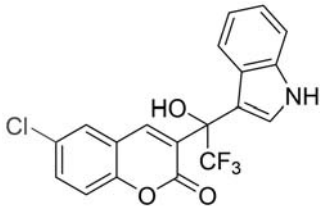
Yield 93%, white powder, mp 207.2~207.8 °C. ^{1}H NMR (400 MHz) δ 11.49 (d, *J* = 1.9 Hz, N*H*), 8.65 (s), 8.01 (dd, *J* = 7.7, 1.2 Hz), 7.68 (td, *J* = 8.2, 1.5 Hz), 7.52 (s, O*H*), 7.45 – 7.40 (m, 4H), 7.38 (d, *J* = 1.9 Hz), 7.08 (dd, *J* = 8.6, 2.1 Hz). ^{13}C NMR (101 MHz, DMSO) δ 157.37 (*C*=O), 153.49 (*C*–O), 142.91, 134.72, 132.84, 129.72, 126.48, 126.25, 125.29 (q, *J* = 288.1 Hz, *C*F_3), 124.88, 124.84, 123.58, 121.26, 118.88, 118.30, 115.88, 113.45, 110.30, 74.40 (q, *J* = 30.2 Hz, *C*-CF_3). HRMS *m/z* calcd for $C_{19}H_{11}ClF_3NNaO_3$: 416.0277 $[M+Na]^+$; found:416.0273.

1-(coumarin-3-yl)-1-(6-bromo-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3ah**).



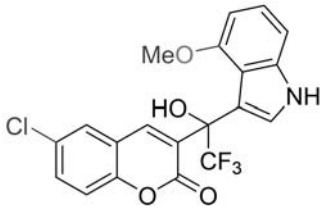
Yield 92%, white powder, mp 218.2~219.0 °C. ^{1}H NMR (400 MHz) δ 11.40 (d, *J* = 1.6 Hz, N*H*), 8.66 (s), 7.99 (dd, *J* = 7.8, 1.1 Hz), 7.66 (td, *J* = 7.8, 1.4 Hz), 7.61 (d, *J* = 1.6 Hz), 7.49 (s, O*H*), 7.44 – 7.38 (m, 3H), 7.30 (d, *J* = 8.6 Hz), 7.04 (dd, *J* = 8.6, 1.7 Hz). ^{13}C NMR (101 MHz) δ 157.32 (*C*=O), 153.52 (*C*–O), 143.11, 137.12, 132.79, 129.71, 125.39, 125.30 (q, *J* = 288.3 Hz, *C*F$_3$), 124.97, 124.79, 124.44, 122.01, 121.33, 118.33, 115.86, 114.38, 114.04, 110.80, 74.06 (q, *J* = 30.3 Hz, *C*-CF$_3$). HRMS *m/z* calcd for $C_{19}H_{11}BrF_3NNaO_3$: 459.9772 $[M+Na]^+$; found:459.9770.

1-(6-chlorocoumarin-3-yl)-1-(1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3ba**).



Yield 88%, yellow powder, mp 252.8-252.9 °C. ^{1}H NMR (400 MHz) δ 11.27 (s, N*H*), 8.70 (s), 8.18 (d, *J* = 2.5 Hz), 7.69 (dd, *J* = 8.8, 2.5 Hz), 7.45 – 7.41 (m, 2H), 7.40 (d, *J* = 8.2 Hz), 7.35 (s), 7.32 (d, *J* = 8.0 Hz), 7.05 (t, *J* = 7.5 Hz), 6.87 (t, *J* = 7.5 Hz). ^{13}C NMR (101 MHz) δ 156.74 (*C*=O), 152.13 (*C*–O), 141.90, 136.19, 132.24, 128.72, 128.51, 126.51, 125.28 (q, *J* = 287.4 Hz, *C*F$_3$), 125.24, 124.33, 121.21, 119.74, 119.53, 119.08, 117.85, 111.82, 110.05, 74.35 (q, *J* = 29.8 Hz, *C*-CF$_3$). HRMS *m/z* calcd for $C_{19}H_{10}ClF_3NO_3$: 392.0301 $[M-H]^+$; found: 392.0294.

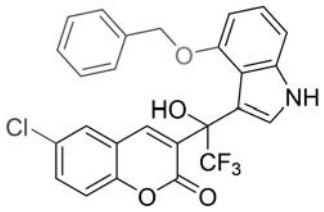
1-(6-chlorocoumarin-3-yl)-1-(4-methoxy-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3bc**).



Yield 83%, yellow-green powder, mp 203.7-204.8 °C. ^{1}H NMR (400 MHz) δ 11.32 (d,

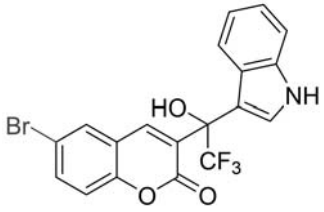
J = 1.9 Hz), 8.34 (s), 8.10 (d, *J* = 2.5 Hz), 7.66 (dd, *J* = 8.8, 2.5 Hz), 7.46 (d, *J* = 8.9 Hz), 7.38 (s, O*H*), 7.06 – 6.98 (m, 3H), 6.41 (dd, *J* = 7.1, 1.1 Hz), 3.47 (s, 3H).^{13}C NMR (101 MHz) δ 158.21 (*C*=O), 152.36 (*C*–O), 151.81, 141.91, 138.07, 132.00, 128.62, 128.26, 127.59, 125.59 (q, *J* = 287.7 Hz), 123.32, 122.53, 120.15, 117.84, 115.25, 111.09, 105.32, 100.32, 74.94 (q, *J* = 29.2 Hz), 54.90 (O*C*H$_3$). HRMS *m/z* calcd for $C_{20}H_{13}ClF_3NNaO_4$: 446.0383 $[M+Na]^+$; found: 446.0376.

1-(6-chlorocoumarin-3-yl)-1-(4-benzyloxy-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3bd**).



Yield 75%, light yellow powder, mp 256.7-256.9 °C. ^{1}H NMR (400 MHz) δ 11.34 (d, *J* = 1.5 Hz), 8.08 (s), 7.58 (dd, *J* = 8.8, 2.4 Hz), 7.43 (d, *J* = 2.3 Hz), 7.36 (s, O*H*), 7.32 (d, *J* = 8.8 Hz), 7.30 – 7.26 (m), 7.24 – 7.16 (m, 4H), 7.07 (s), 7.03 (d, *J* = 8.0 Hz), 6.96 (t, *J* = 7.9 Hz), 6.43 (d, *J* = 7.7 Hz), 5.00 (d, *J* = 12.5 Hz), 4.85 (d, *J* = 12.5 Hz). ^{13}C NMR (101 MHz) δ 157.75(*C*=O), 151.68(*C*–O), 151.45(*C*–O), 142.49, 138.20, 136.83, 131.75, 128.21 (2C), 128.18, 127.58, 127.41 (2C), 127.17, 125.57 (q, *J* = 288.5 Hz, *C*-CF$_3$), 123.52, 123.50, 122.34, 119.68, 117.55, 115.39, 110.65, 105.31, 101.40, 74.76 (q, *J* = 29.7 Hz, *C*-CF$_3$), 69.28 (O*C*H$_2$). HRMS *m/z* calcd for $C_{26}H_{16}ClF_3NO_4$: 498.0720 $[M-H]^+$; found: 498.0709.

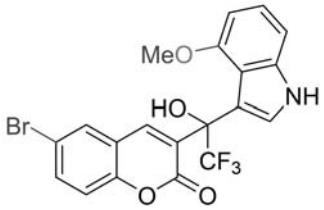
1-(6-bromocoumarin-3-yl)-1-(1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3ca**).



Yield 84%, yellow powder, mp 253.2-255.0 °C. ^{1}H NMR (400 MHz) δ 11.27 (d, *J* = 1.2 Hz), 8.69 (s), 8.31 (d, *J* = 2.3 Hz), 7.81 (dd, *J* = 8.8, 2.4 Hz), 7.43 (s, O*H*), 7.39 (d, *J* = 8.3 Hz), 7.38 – 7.34 (m, 2H), 7.31 (d, *J* = 8.1 Hz), 7.05 (t, *J* = 7.6 Hz), 6.87 (t, *J* = 7.5 Hz). ^{13}C NMR (101 MHz) δ 156.75 (*C*=O), 152.56 (*C*–O), 141.84, 136.22, 135.01,

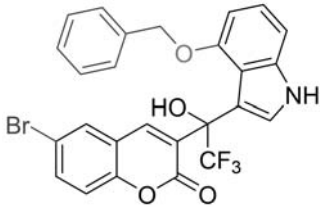
131.71, 126.48, 125.30 (q, *J* = 288.2 Hz, *C*F_3), 125.27, 124.36, 121.24, 120.26, 119.58, 119.10, 118.13, 116.35, 111.84, 110.10, 74.41 (q, *J* = 29.9 Hz, *C*-CF_3). HRMS *m/z* calcd for $C_{19}H_{10}BrF_3NO_3$: 435.9796 $[M-H]^+$; found: 435.9786.

1-(6-bromocoumarin-3-yl)-1-(4-methoxy-1H-indol-3-yl)-2,2,2-trifluoroethanol (**3cc**).



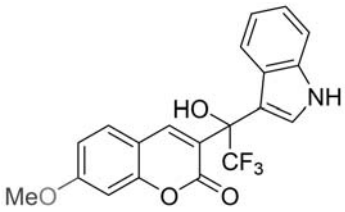
Yield 76%, yellow powder, mp 234.1-235.5 °C. ^{1}H NMR (400 MHz) δ 11.32 (d, *J* = 1.5 Hz, N*H*), 8.32 (s), 8.23 (d, *J* = 2.2 Hz), 7.79 (dd, *J* = 8.8, 2.2 Hz), 7.39 (d, *J* = 8.8 Hz), 7.35 (s, O*H*), 7.05 – 6.99 (m, 3H), 6.39 (dd, *J* = 6.6, 1.5 Hz), 3.45 (s, 3H, OCH_3). ^{13}C NMR (101 MHz, DMSO) δ 158.15 (*C*=O), 152.33 (*C*–O), 152.21 (*C*–O), 141.82, 138.05, 134.78, 131.24, 127.53, 125.58 (q, *J* = 287.5 Hz), 123.32, 122.51, 120.63, 118.12, 116.44, 115.24, 111.07, 105.31, 100.32, 74.93 (q, *J* = 29.4 Hz), 54.91 (O*C*H_3). HRMS *m/z* calcd for $C_{20}H_{12}BrF_3NO_4$: 465.9902 $[M-H]^+$; found: 465.9890.

1-(6-bromocoumarin-3-yl)-1-(4-benzyloxy-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3cd**).



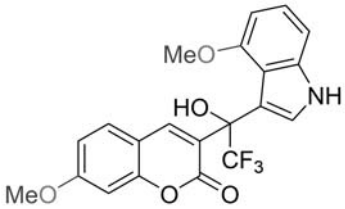
Yield 79%, yellow powder, mp 213.3-215.3 °C. ^{1}H NMR (400 MHz) δ 11.35 (s, N*H*), 8.06 (s), 7.70 (dd, *J* = 8.8, 2.3 Hz), 7.53 (d, *J* = 2.2 Hz), 7.36 (s, O*H*), 7.32 – 7.16 (m, 6H), 7.07 (d, *J* = 1.4 Hz), 7.03 (d, *J* = 7.9 Hz), 6.96 (t, *J* = 7.9 Hz), 6.43 (d, *J* = 7.7 Hz), 5.00 (d, *J* = 12.4 Hz, C*H*H), 4.84 (d, *J* = 12.4 Hz, CH*H*). ^{13}C NMR (101 MHz) δ 157.69 (*C*=O), 152.09 (*C*–O), 151.46 (*C*–O), 142.45, 138.20, 136.81, 134.52, 131.14, 128.23(2C), 127.59, 127.48(2C), 127.11, 125.57 (d, *J* = 287.6 Hz, *C*F_3), 123.52, 123.49, 122.34, 120.15, 117.82, 116.06, 115.39, 110.64, 105.33, 101.40, , 74.75 (q, *J* = 29.6 Hz, *C*-CF_3), 69.33 (O*C*H_2). HRMS *m/z* calcd for $C_{26}H_{16}BrF_3NO_4$: 542.0215 $[M-H]^+$; found: 542.0201.

1-(7-methoxycoumarin-3-yl)-1-(1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3da**).



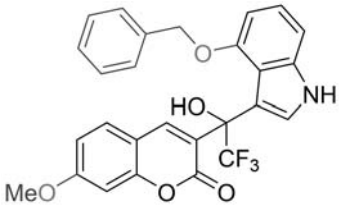
Yield 82%, white powder, mp 186.7-188.4 °C. ^{1}H NMR (400 MHz) δ 11.27 (d, *J* = 2.1 Hz, N*H*), 8.56 (s), 7.88 (d, *J* = 9.4 Hz), 7.45 (s, O*H*), 7.42 (d, *J* = 8.1 Hz), 7.35 (d, *J* = 8.0 Hz), 7.24 (s), 7.07 (td, *J* = 7.8, 1.0 Hz), 7.01 – 6.97 (m, 2H), 6.88 (t, *J* = 7.5 Hz), 3.85 (s, 3H, OC*H*$_3$). ^{13}C NMR (101 MHz) δ 163.15(*C*=O), 157.98(*C*–O), 155.52(*C*–O), 143.17, 136.29, 130.69, 125.56 (d, *J* = 287.8 Hz, *C*F$_3$), 125.42, 124.25, 121.35, 121.24, 119.70, 119.04, 112.93, 111.97, 111.87, 110.67, 100.14, 74.42 (q, *J* = 30.1 Hz, *C*-CF$_3$), 56.10(O*C*H$_3$). HRMS: *m/z* calcd for $C_{20}H_{13}F_3NO_4$: 388.0797 $[M-H]^+$; found: 388.0790.

1-(7-methoxycoumarin-3-yl)-1-(4-methoxy-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3dc**).



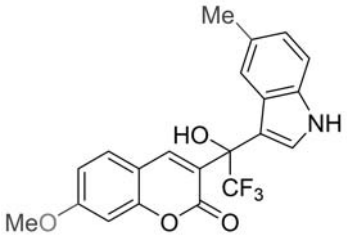
Yield 72%, yellow powder, mp 214.4-215.1 °C. ^{1}H NMR (400 MHz) δ 11.09 (d, *J* = 1.6 Hz, N*H*), 8.54 (s), 7.90 (d, *J* = 9.3 Hz), 7.36 (s, O*H*), 7.29 (d, *J* = 8.7 Hz), 7.16 (s), 7.03 – 6.98 (m, 2H), 6.76 (d, *J* = 2.0 Hz), 6.72 (dd, *J* = 8.8, 2.3 Hz), 3.86 (s, 3H, OC*H*$_3$), 3.50 (s, 3H, OC*H*$_3$). ^{13}C NMR (101 MHz) δ 163.08(*C*=O), 157.90(*C*–O), 155.40(*C*–O), 152.96(*C*–O), 142.90, 131.44, 130.62, 125.77, 125.49 (q, *J* = 288.3 Hz, *C*F$_3$), 124.88, 121.31, 112.90, 112.38, 111.85, 110.74, 110.18, 102.08, 100.10, 74.46 (q, *J* = 30.2 Hz, *C*-CF$_3$), 56.09(O*C*H$_3$), 55.14(O*C*H$_3$). HRMS: *m/z* calcd for $C_{21}H_{15}F_3NO_5$: 418.0902 $[M-H]^+$; found: 418.0895.

1-(7-methoxycoumarin-3-yl)-1-(4-benzyloxy-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3dd**).



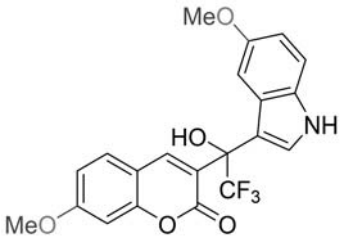
Yield 85%, yellow powder, mp 206.9-208.0 °C. ^{1}H NMR (400 MHz) δ 11.33 (d, *J* = 1.9 Hz, N*H*), 7.93 (s), 7.42 (d, *J* = 8.7 Hz), 7.36 (s, O*H*), 7.27 – 7.22 (m), 7.21 – 7.13 (m, 4H), 7.09 (s), 7.02 (d, *J* = 8.0 Hz), 6.96 – 6.91 (m, 2H), 6.88 (dd, *J* = 8.7, 2.4 Hz), 6.39 (d, *J* = 7.7 Hz), 5.04 (d, *J* = 12.9 Hz, OC*H*H), 4.93 (d, *J* = 12.9 Hz, OCH*H*), 3.83 (s, 3H, OC*H*$_3$). ^{13}C NMR (101 MHz) δ 162.89 (*C*=O), 159.48 (*C*–O), 155.01(*C*–O), 151.18, 143.61, 138.29, 136.98, 130.22, 128.25(2C), 127.58, 127.19(2C), 125.82 (q, *J* = 292.1 Hz, *C*F$_3$), 123.43, 123.41, 122.38, 121.92, 115.33, 112.81, 112.05, 111.21, 105.27, 101.42, 100.02, 75.30 (q, *J* = 29.2 Hz, *C*-CF$_3$), 69.10(O*C*H$_2$), 56.07(O*C*H$_3$). HRMS: *m/z* calcd for $C_{27}H_{19}F_3NO_5$: 494.1215 $[M-H]^+$; found: 494.1206.

1-(7-methoxycoumarin-3-yl)-1-(5-methyl-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3de**).



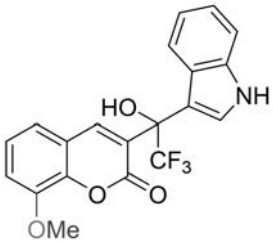
Yield 78%, yellow powder, mp 230.1-231.5 °C. ^{1}H NMR (400 MHz) δ 11.13 (d, *J* = 2.1 Hz, N*H*), 8.51 (s), 7.88 (d, *J* = 8.9 Hz), 7.38 (s, O*H*), 7.30 (d, *J* = 8.3 Hz), 7.18 (s), 7.17 (s), 7.01 (s), 6.99 (t, *J* = 2.4 Hz), 6.89 (dd, *J* = 8.3, 1.1 Hz), 3.86 (s, 3H, OC*H*$_3$), 2.22 (s, 3H, C*H*$_3$). ^{13}C NMR (101 MHz) δ 163.12 (*C*=O), 158.10 (*C*–O), 155.45 (*C*–O), 143.12, 134.65, 130.68, 127.32, 125.66, 125.57 (q, *J* = 287.8 Hz), 124.30, 122.85, 121.27, 119.40, 112.92, 111.95, 111.54, 110.06, 100.15, 74.62 (q, *J* = 29.9 Hz), 56.09 (O*C*H$_3$), 21.46 (*C*H$_3$). HRMS: *m/z* calcd for $C_{21}H_{15}F_3NO_4$: 402.0953 $[M-H]^+$; found: 402.0946.

1-(7-methoxycoumarin-3-yl)-1-(5-methoxy-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3df**).



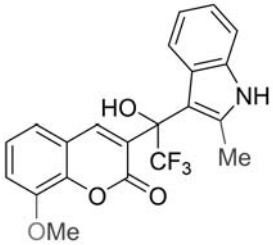
Yield 85%, white powder, mp 218.4-220.6 °C. ^{1}H NMR (400 MHz) δ 11.30 (d, *J* = 1.7 Hz, N*H*), 8.08 (s), 7.76 (d, *J* = 8.7 Hz), 7.34 (s, O*H*), 7.10 (s), 7.06 – 6.98 (m, 3H), 6.95 (dd, *J* = 8.7, 2.3 Hz), 6.40 (dd, *J* = 6.7, 1.4 Hz), 3.85 (s, 3H, OC*H*$_3$), 3.49 (s, 3H, OC*H*$_3$).^{13}C NMR (101 MHz) δ 162.90 (*C*=O), 159.81 (*C*–O), 154.96 (*C*–O), 152.40 (*C*–O), 143.23, 138.11, 130.24, 125.77 (q, *J* = 288.1 Hz, *C*F$_3$), 123.11, 122.55, 122.12, 115.25, 113.00, 112.22, 111.58, 105.26, 100.38, 100.13, 75.24 (q, *J* = 29.2 Hz, *C*-CF$_3$), 56.07(O*C*H$_3$), 54.97(O*C*H$_3$). HRMS: *m/z* calcd for $C_{21}H_{15}F_3NO_5$: 418.0902 $[M-H]^+$; found: 418.0893.

1-(8-methoxycoumarin-3-yl)-1-(1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3ea**).



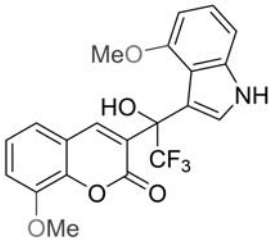
Yield 84%, white powder, mp 244.3-247.2 °C. ^{1}H NMR (400 MHz) δ 11.28 (d, *J* = 1.8 Hz, N*H*), 8.64 (s), 7.53 (m), 7.46 (s, O*H*), 7.42 (d, *J* = 8.1 Hz), 7.36 – 7.31 (m, 4H), 7.06 (t, *J* = 7.3 Hz), 6.88 (t, *J* = 7.3 Hz), 3.89 (s, 3H, OC*H*$_3$). ^{13}C NMR (101 MHz) δ 157.13 (*C*=O), 146.24 (*C*–O), 143.22 (*C*–O), 142.87, 136.26, 125.49, 125.43 (q, *J* = 288.2 Hz, *C*-CF$_3$), 125.34, 124.75, 124.35, 121.26, 120.67, 119.56, 119.10, 118.95, 114.77, 111.88, 110.32, 74.39 (q, *J* = 30.0 Hz, *C*-CF$_3$), 56.17 (O*C*H$_3$). HRMS: *m/z* calcd for $C_{20}H_{13}F_3NO_4$: 388.0797 $[M-H]^+$; found: 388.0794.

1-(8-methoxycoumarin-3-yl)-1-(2-methyl-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3eb**).



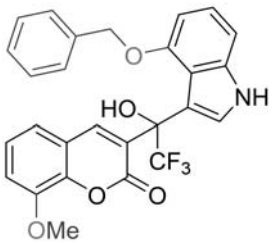
Yield 72%, yellow powder, mp 200.8-203.4 °C. ^{1}H NMR (400 MHz) δ 11.08 (s, N*H*), 8.38 (s), 7.60 – 7.54 (m), 7.38 – 7.34 (m, 2H), 7.28 (d, *J* = 8.1 Hz), 7.24 (d, *J* = 8.0 Hz), 6.98 – 6.91 (m, 2H), 6.79 (t, *J* = 7.6 Hz), 3.89 (s, 3H, C*H*$_3$), 2.39 (s, 3H, C*H*$_3$). ^{13}C NMR (101 MHz) δ 156.86(*C*=O), 146.18(*C*–O), 142.54, 140.36, 134.80, 134.50, 126.97, 126.27, 125.86 (q, *J* = 287.5 Hz, *C*F$_3$), 124.77, 120.80, 119.94, 119.28, 118.71, 118.59, 114.76, 110.60, 105.85, 75.93 (q, *J* = 29.5 Hz, *C*-CF$_3$), 56.14 (O*C*H$_3$), 14.15 (*C*H$_3$). HRMS: *m/z* calcd for $C_{21}H_{15}F_3NO_4$: 402.0953 $[M-H]^+$; found: 402.0948.

1-(8-methoxycoumarin-3-yl)-1-(4-methoxy-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3ec**).



Yield 80%, light-yellow powder, mp 245.6-247.1 °C. ^{1}H NMR (400 MHz) δ 11.31 (d, *J* = 1.8 Hz, N*H*), 8.19 (s), 7.41 (dd, *J* = 6.9, 2.1 Hz), 7.35 (s, O*H*), 7.34 – 7.27 (m, 2H), 7.10 (s), 7.04 – 6.98 (m, 2H), 6.39 (dd, *J* = 6.8, 1.4 Hz), 3.90 (s, 3H, C*H*$_3$), 3.45 (s, 3H, C*H*$_3$). ^{13}C NMR (101 MHz) δ 158.85 (*C*=O), 152.36 (*C*-O), 146.19, 143.23, 142.38, 138.07, 126.24, 125.65 (d, *J* = 288.4 Hz, *C*F$_3$), 124.81, 123.20, 122.54, 120.21, 119.26, 115.23, 114.57, 111.28, 105.28, 100.37, 75.13 (q, *J* = 28.8 Hz, *C*-CF$_3$), 56.16 (O*C*H$_3$), 54.91 (O*C*H$_3$). HRMS: *m/z* calcd for $C_{21}H_{15}F_3NO_5$: 418.0902 $[M-H]^+$; found: 418.0897.

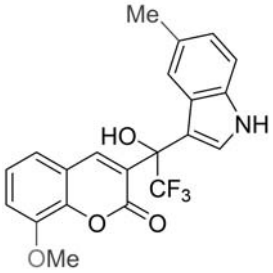
1-(8-methoxycoumarin-3-yl)-1-(4-benzyloxy-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3ed**).



Yield 80%, cyan gray powder, mp 232.3-233.4 °C. ^{1}H NMR (400 MHz) δ 11.35 (s, N*H*), 8.03 (s), 7.37 (s, O*H*), 7.29 – 7.11 (m, 8H), 7.05 (d, *J* = 7.3 Hz), 7.02 (dd, *J* =

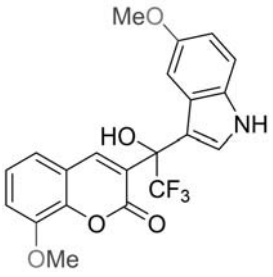
8.2, 1.9 Hz), 6.93 (t, *J* = 7.8 Hz), 6.37 (d, *J* = 7.7 Hz), 5.02 (d, *J* = 13.0 Hz, C*H*H), 4.90 (d, *J* = 13.0 Hz, CH*H*), 3.86 (s, 3H, CH_3). ^{13}C NMR (101 MHz) δ 158.69 (*C*=O), 151.19 (*C*–O), 146.16 (C–O), 143.70, 142.45, 138.29, 136.95, 128.19 (2C), 127.55, 127.10 (2C), 126.03, 125.68 (q, *J*=288.0 Hz, *C*F_3), 124.57, 123.55, 122.41, 120.22, 119.05, 115.35, 114.52, 110.99, 105.31, 101.46, 75.28 (q, *J*= 29.0 Hz, *C*-CF_3), 69.10(O*C*H_2), 56.12 (O*C*H_3). HRMS: *m/z* calcd for $C_{27}H_{19}F_3NO_5$: 494.1215 $[M-H]^+$; found: 494.1206.

1-(8-methoxycoumarin-3-yl)-1-(5-methyl-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3ee**).



Yield 89%, light-yellow powder, mp 254.1-255.3 °C. ^{1}H NMR (400 MHz) δ 11.13 (d, *J* = 1.7 Hz, N*H*), 8.58 (s), 7.56 – 7.50 (m), 7.36 (s, O*H*), 7.35 (s), 7.34 (s), 7.28 (d, *J* = 8.3 Hz), 7.24 (s), 7.12 (s), 6.88 (d, *J* = 8.3 Hz), 3.89 (s, 3H, OCH_3), 2.21 (s, 3H, CH_3). ^{13}C NMR (101 MHz) δ 157.20 (*C*=O), 146.19 (*C*-O), 143.08, 142.78, 134.59, 127.32, 125.55, 125.39 (q, *J*= 287.1 Hz, *C*F_3) 125.36, 124.74, 124.34, 122.82, 120.63, 119.25, 118.90, 114.80, 111.51, 109.69, 74.57 (q, *J*= 30.0 Hz, *C*-CF_3), 56.17 (O*C*H_3), 21.43 (*C*H_3). HRMS: *m/z* calcd for $C_{21}H_{15}F_3NO_4$: 402.0953 $[M-H]^+$; found: 402.0950.

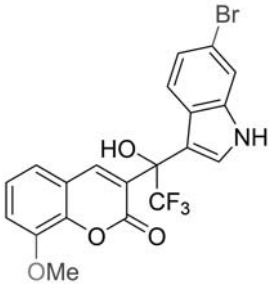
1-(8-methoxycoumarin-3-yl)-1-(5-methoxy-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3ef**).



Yield 87%, light-yellow powder, mp 235.5-237.8 °C. ^{1}H NMR (400 MHz) δ 11.11(d, *J*=1.7 Hz, N*H*), 8.61(s), 7.53 (m,), 7.38 (s, O*H*), 7.35 (s), 7.34 (s), 7.29 (d, *J*=8.7 Hz), 7.25 (s), 6.75 (d, *J* = 2.0 Hz), 6.72 (dd, *J* = 8.7, 2.3 Hz), 3.89 (s, 3H, OCH_3), 3.50 (s, 3H, OCH_3). ^{13}C NMR (101 MHz) δ 157.13 (*C*=O), 152.99 (*C*-O), 146.18, 142.94, 142.77, 131.44, 125.71, 125.43, 125.37 (q, *J*=288.9 Hz, *C*F_3), 124.99, 124.76, 120.58,

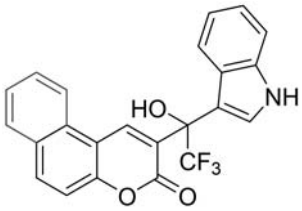
118.86, 114.81, 112.41, 110.73, 109.85, 102.04, 74.51 (q, *J*=30.2 Hz, *C*-CF_3), 56.18 (O*C*H_3), 55.13 (O*C*H_3). HRMS: *m/z* calcd for $C_{21}H_{15}F_3NO_5$: 418.0902 $[M-H]^+$; found: 402.0899.

1-(8-methoxycoumarin-3-yl)-1-(6-bromo-1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3eh**).



Yield 85%, white powder, mp 164.2~165.7 °C. ^{1}H NMR (400 MHz) δ 11.39 (s), 8.60 (s), 7.59 (d, *J* = 1.6 Hz), 7.55 – 7.49 (m), 7.47 (s, O*H*), 7.37 (s), 7.35 (s), 7.34 (s), 7.27 (d, *J* = 8.6 Hz), 7.03 (dd, *J* = 8.6, 1.8 Hz), 3.89 (s, 3H). ^{13}C NMR (101 MHz) δ 157.02, 146.22, 143.29, 142.86, 137.10, 125.38, 125.27 (q, *J* = 287.9 Hz), 125.14, 124.75, 124.42, 122.00, 121.27, 120.70, 118.87, 114.88, 114.36, 114.02, 110.76, 74.17 (q, *J* = 29.9 Hz), 56.19 (O*C*H_3). HRMS: *m/z* calcd for $C_{20}H_{13}BrF_3NNaO_4$: 489.9878 $[M+Na]^+$; found: 489.9870.

1-(benzo[*f*]coumarin-3-yl)-1-(1*H*-indol-3-yl)-2,2,2-trifluoroethanol (**3fa**).



Yield 84%, light-yellow powder, mp 276.3-276.8 °C. ^{1}H NMR (400 MHz) δ 11.29 (s, N*H*), 9.34 (s), 8.54 (d, *J* = 8.4 Hz), 8.26 (d, *J* = 9.1 Hz), 8.12 (d, *J* = 8.1 Hz), 7.83 (t, *J* = 7.6 Hz), 7.69 (t, *J* = 7.5 Hz), 7.58 (d, *J* = 9.0 Hz), 7.49 (s, O*H*), 7.47 (s), 7.41 (d, *J* = 8.1 Hz), 7.35 (d, *J* = 8.1 Hz), 7.04 (t, *J* = 7.5 Hz), 6.84 (t, *J* = 7.5 Hz). ^{13}C NMR (101 MHz) δ 157.20 (C=O), 153.55 (C-O), 138.16, 136.18, 134.12, 130.03, 129.19, 128.93, 128.91, 126.37, 125.45 (q, *J*= 288.7 Hz, *C*F_3), 125.35, 124.67, 124.34, 121.91, 121.21, 119.60, 119.06, 116.38, 112.08, 111.80, 110.22, 74.42 (q, *J*= 30.2 Hz, *C*-CF_3). HRMS: *m/z* calcd for $C_{23}H_{13}F_3NO_3$: 408.0848 $[M-H]^+$; found: 408.0838.

2. NMR Spectra for compounds 3aa-3fa

Contents of NMR Data

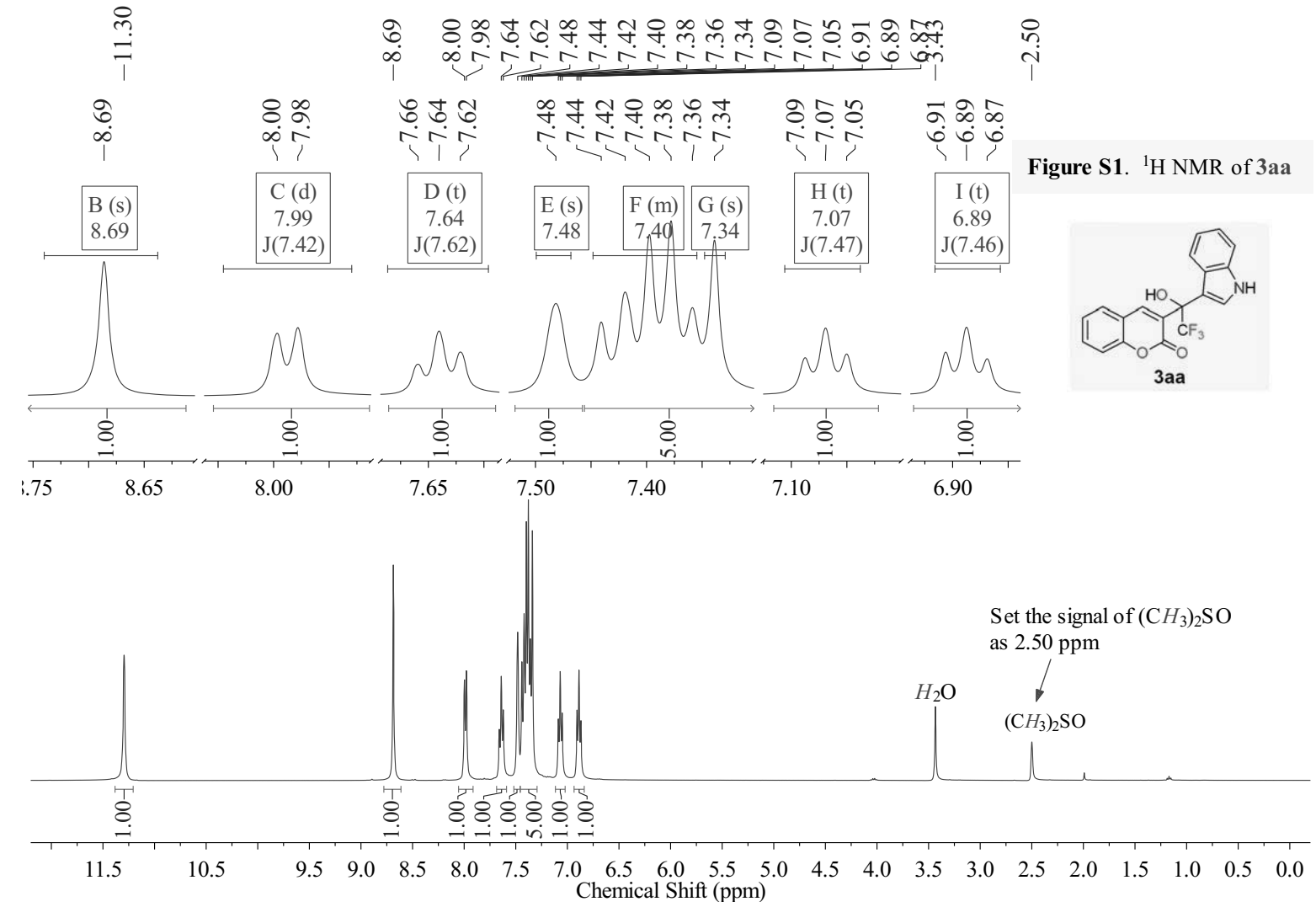


Figure S1. ^{1}H NMR of **3aa**

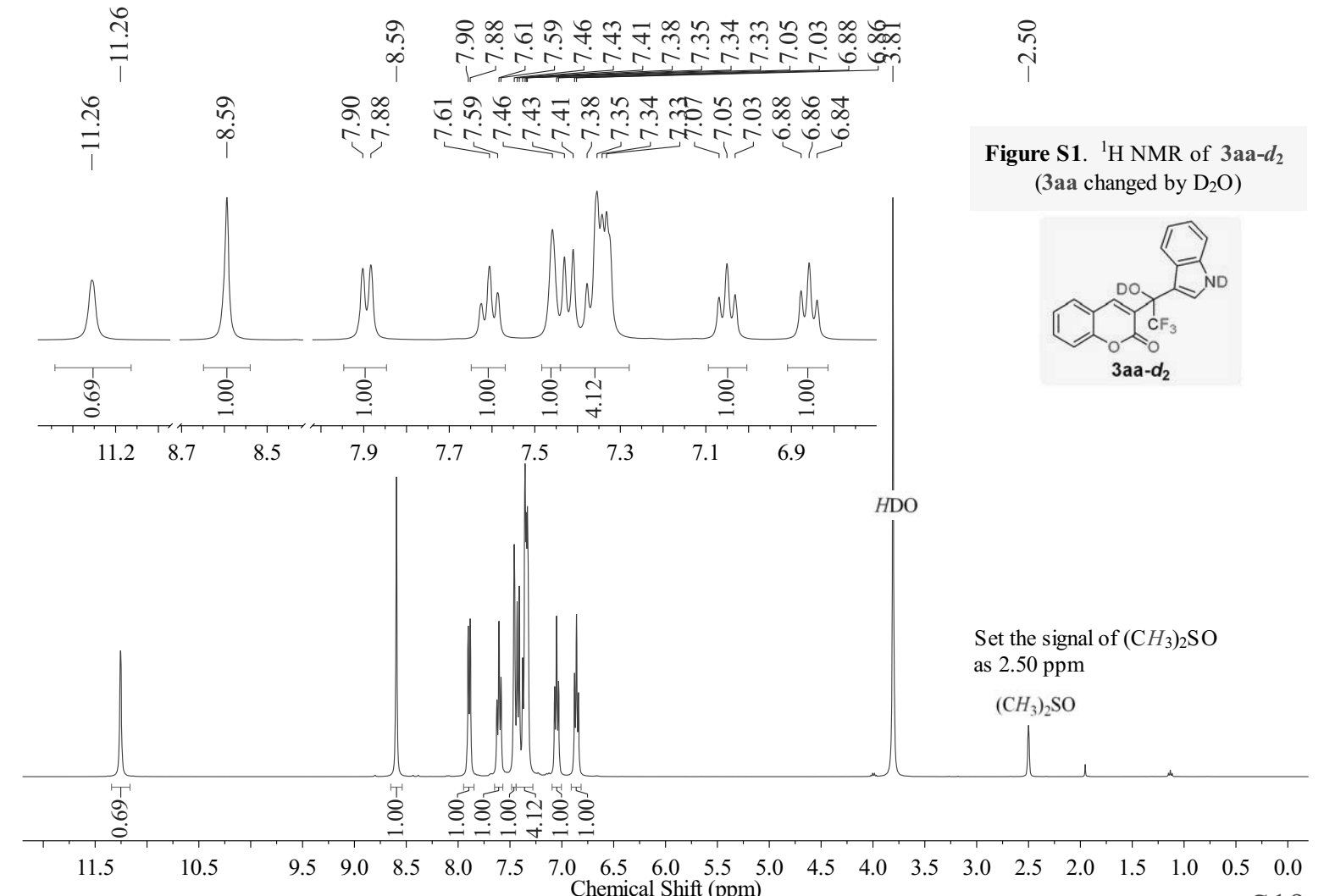


Figure S1. ^{1}H NMR of **3aa-d_2** (**3aa** changed by D_2O)

Figure S3. Comparison of ^{1}H NMR between **3aa** and **3aa-d_2**

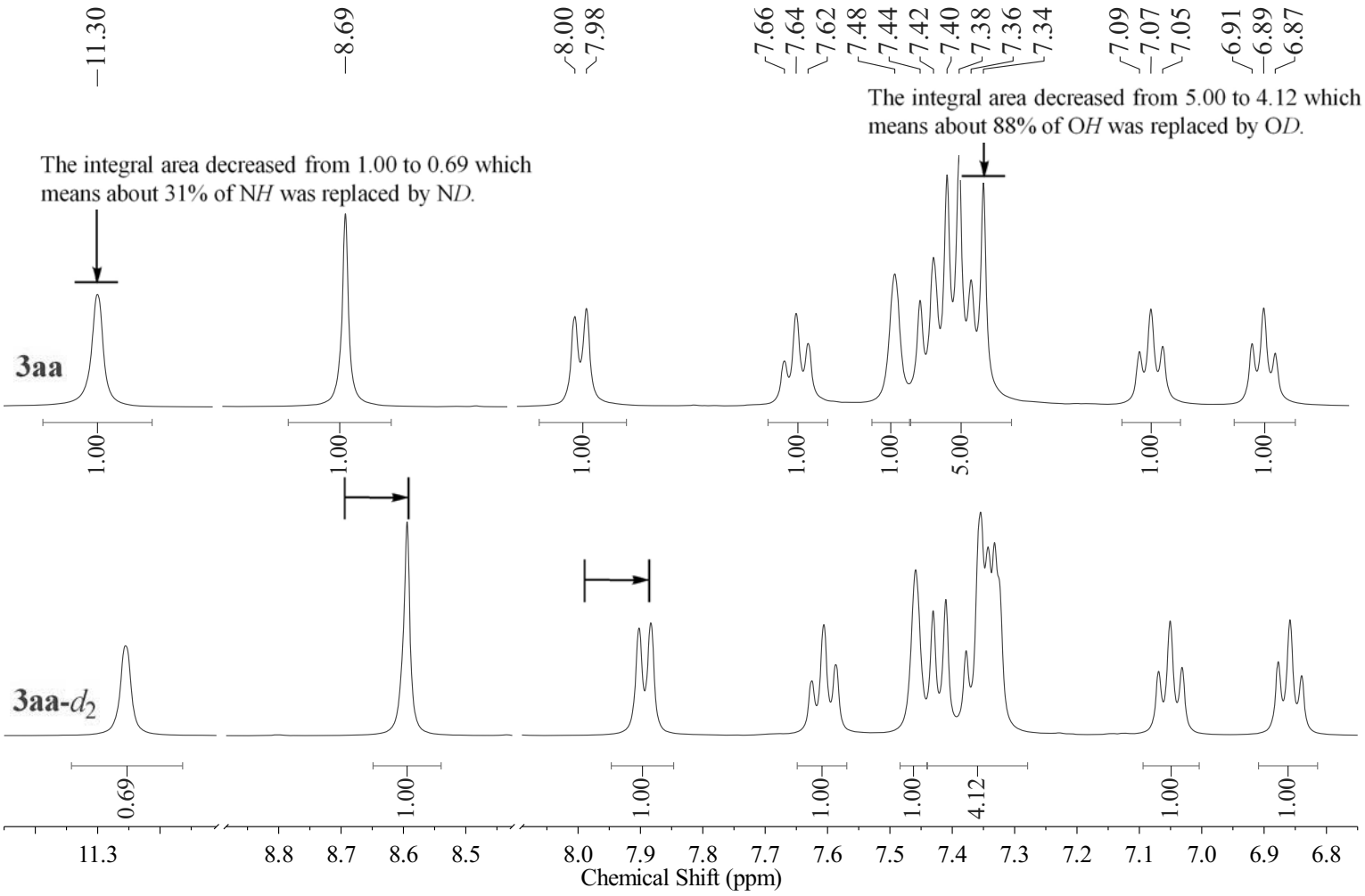


Figure S4. ^{13}C NMR of **3aa**

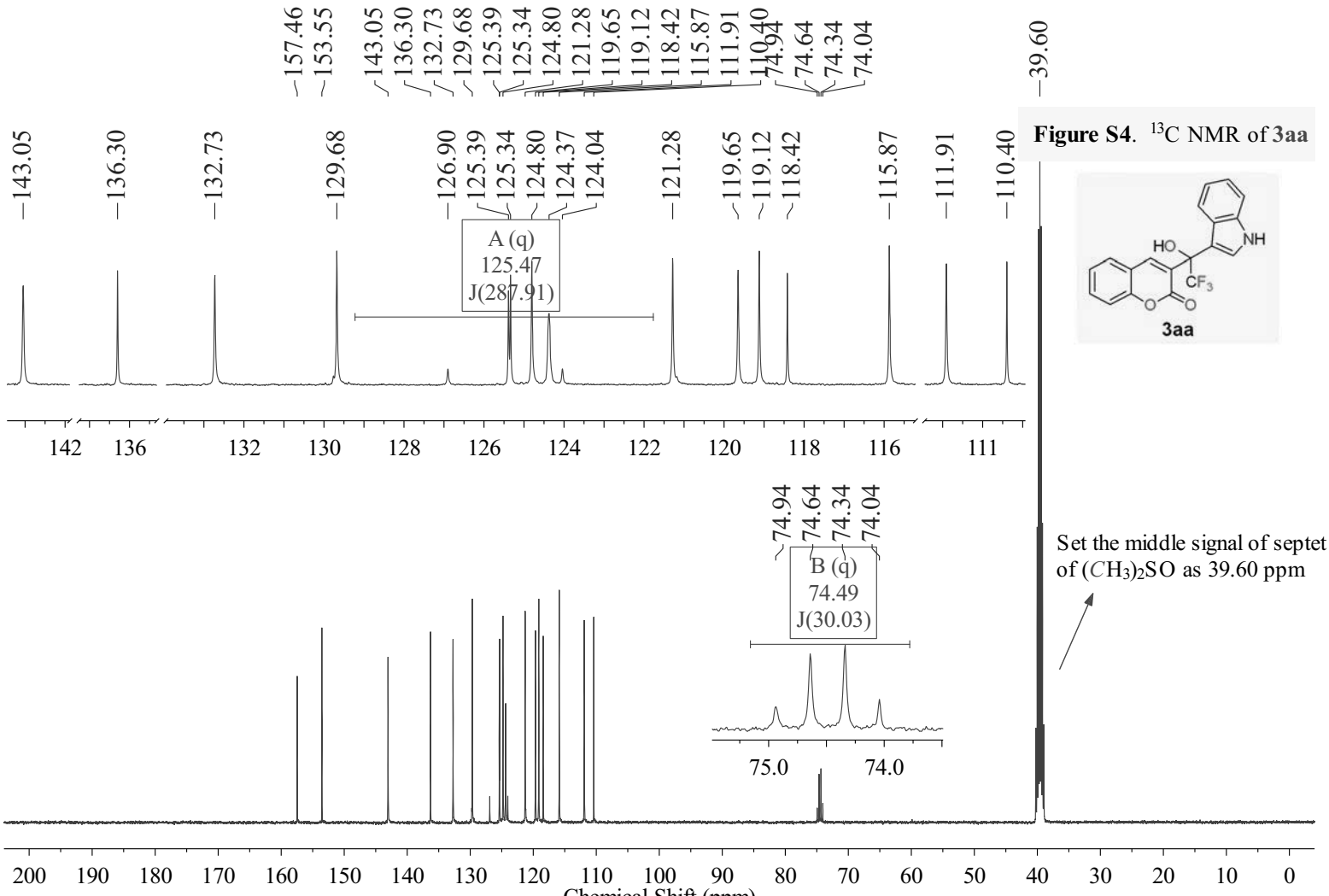


Figure S5. ^{19}F NMR of **3aa**

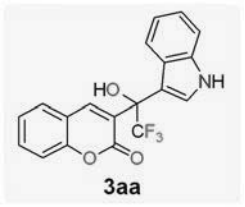


Figure S6. ^{1}H-^{13}C COSY Spectrum of **3aa** (Full Spectrum)

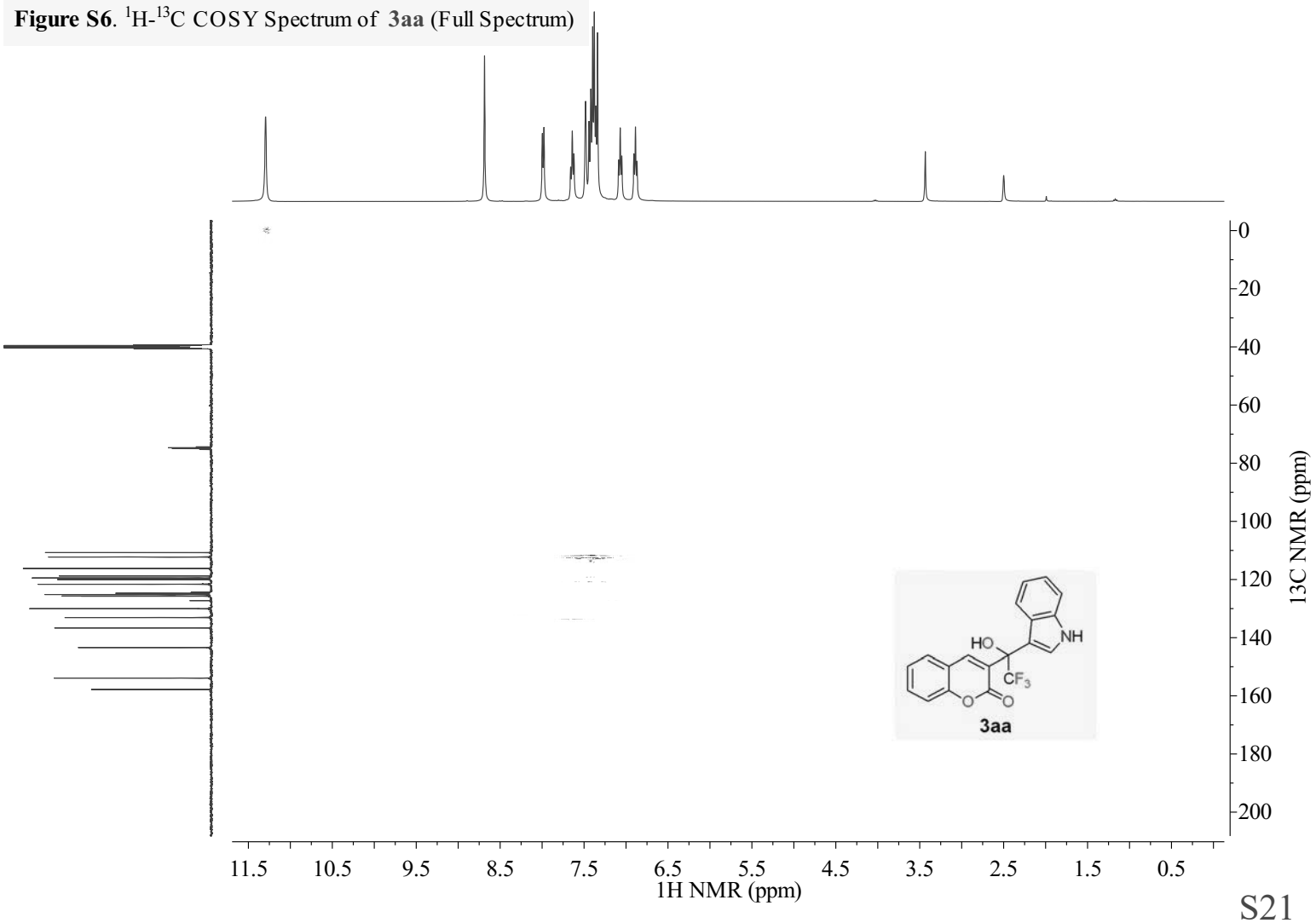
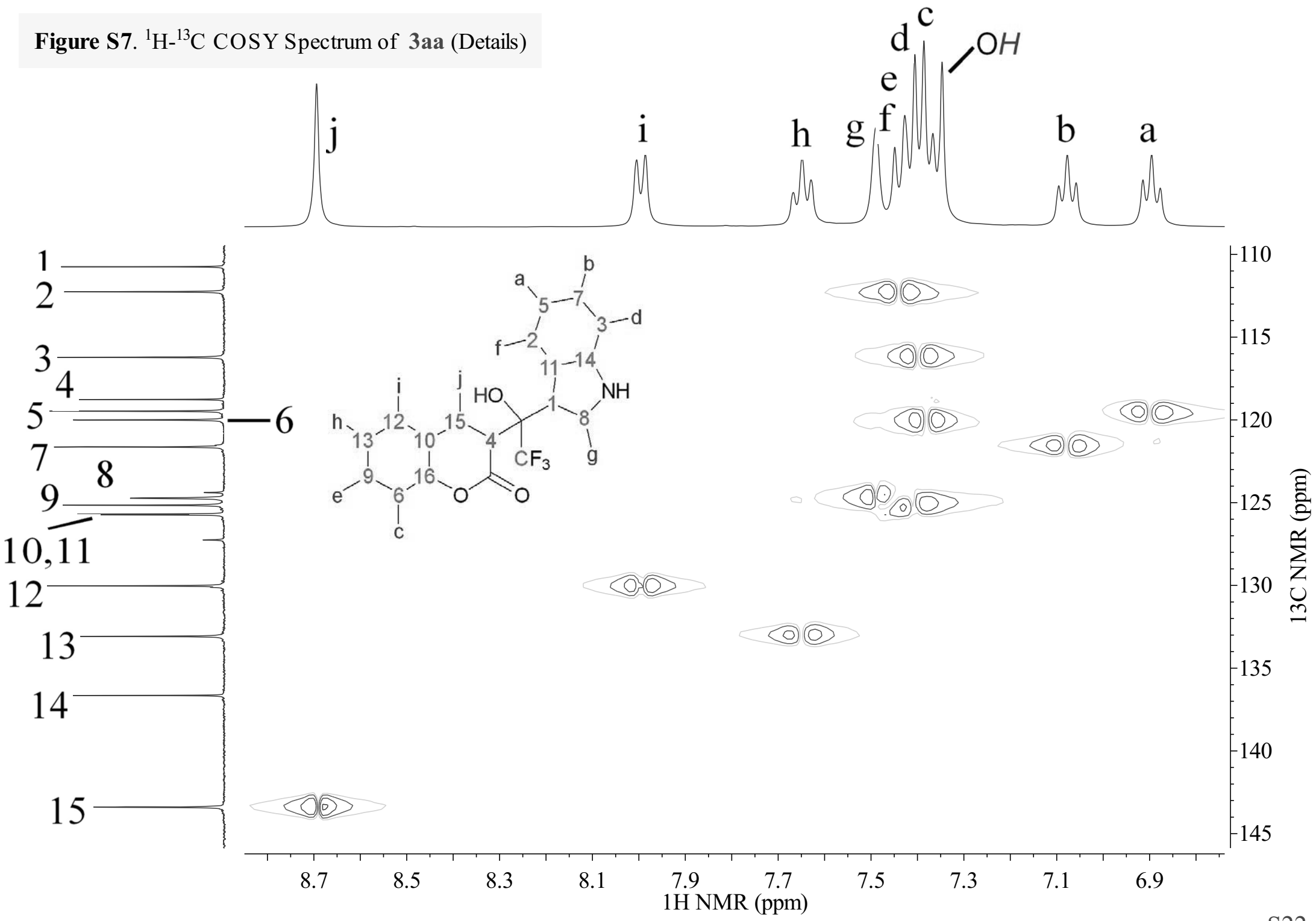


Figure S7. ^{1}H-^{13}C COSY Spectrum of **3aa** (Details)



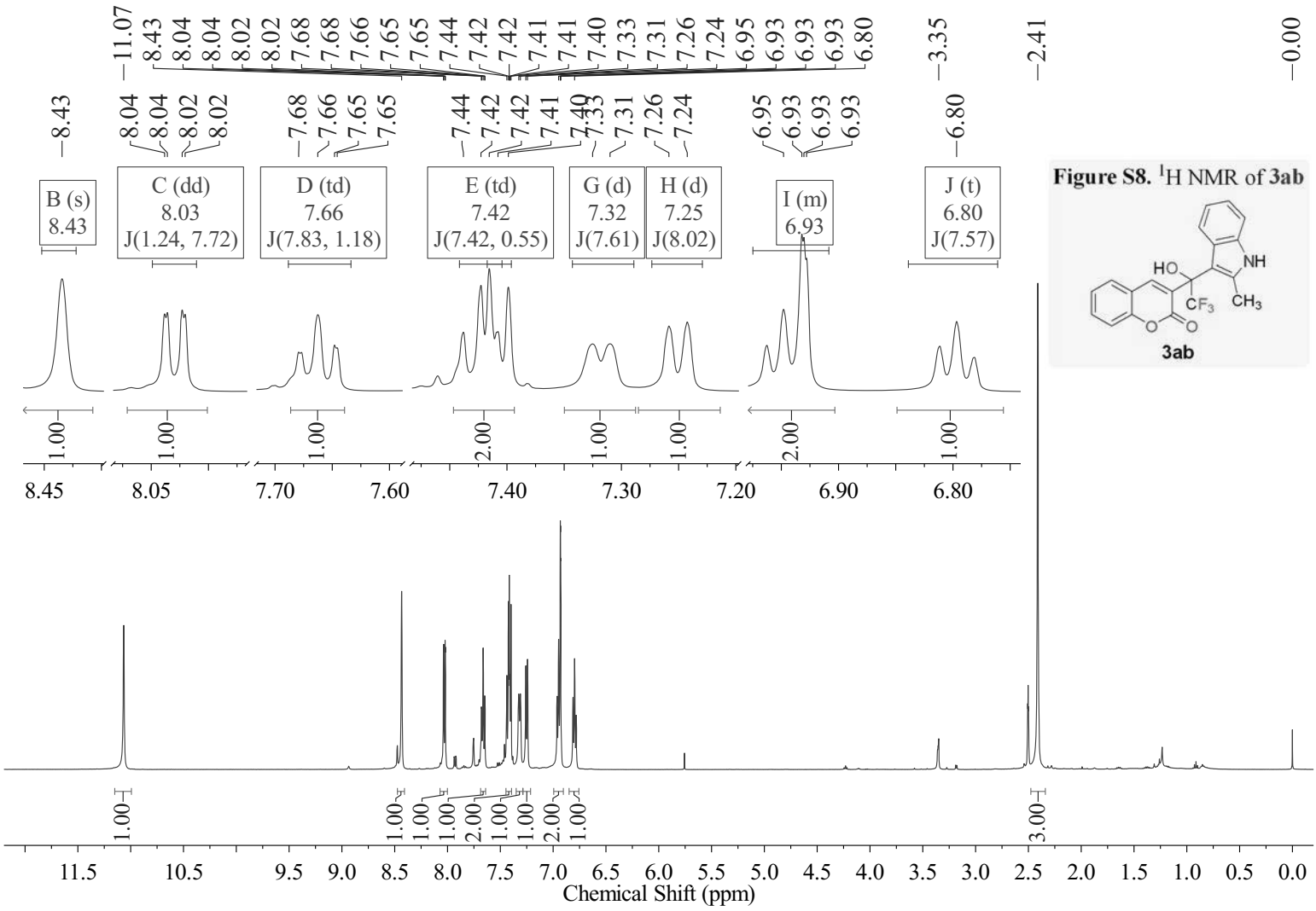


Figure S8. ^{1}H NMR of **3ab**

3ab

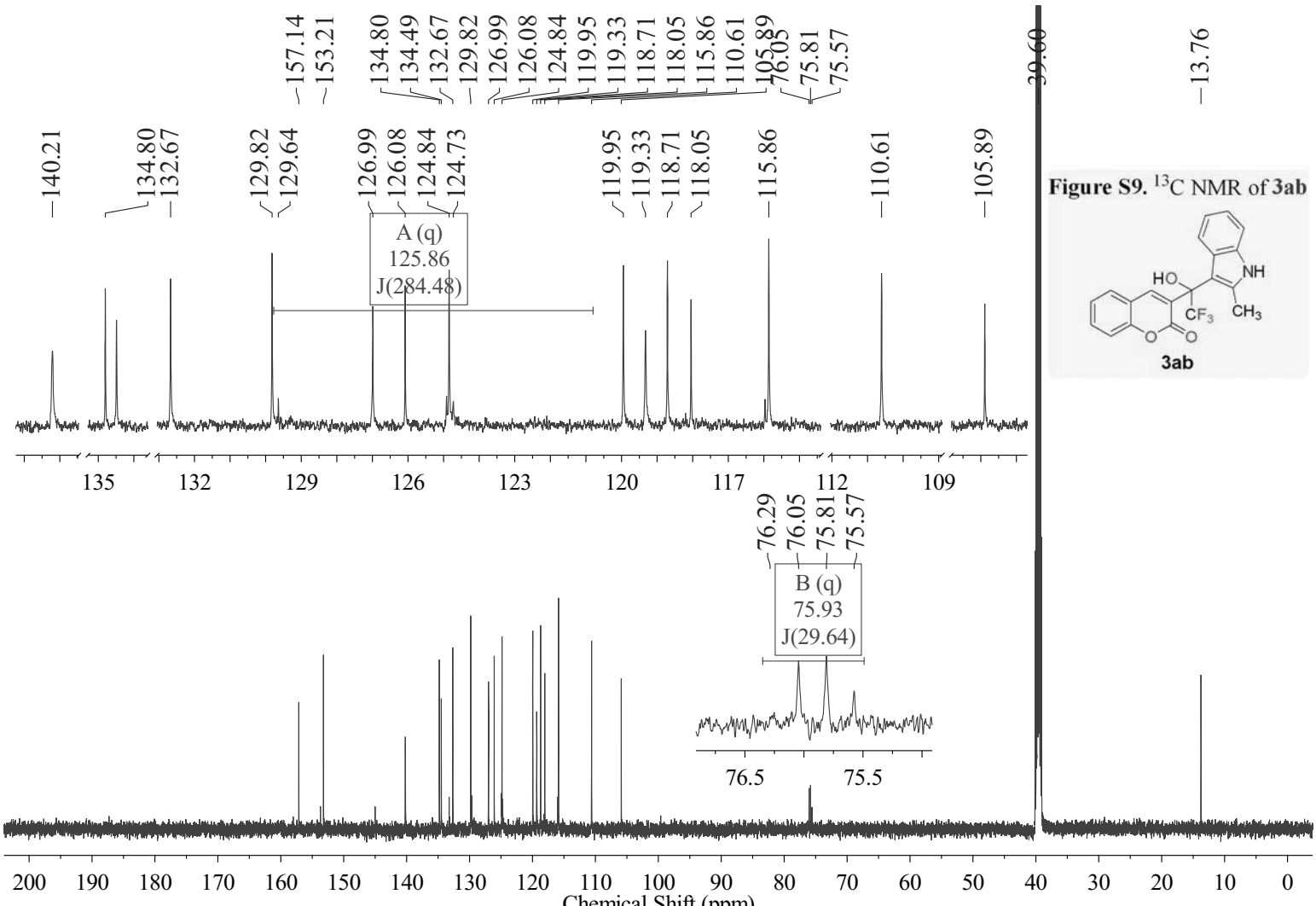


Figure S9. ^{13}C NMR of **3ab**

3ab

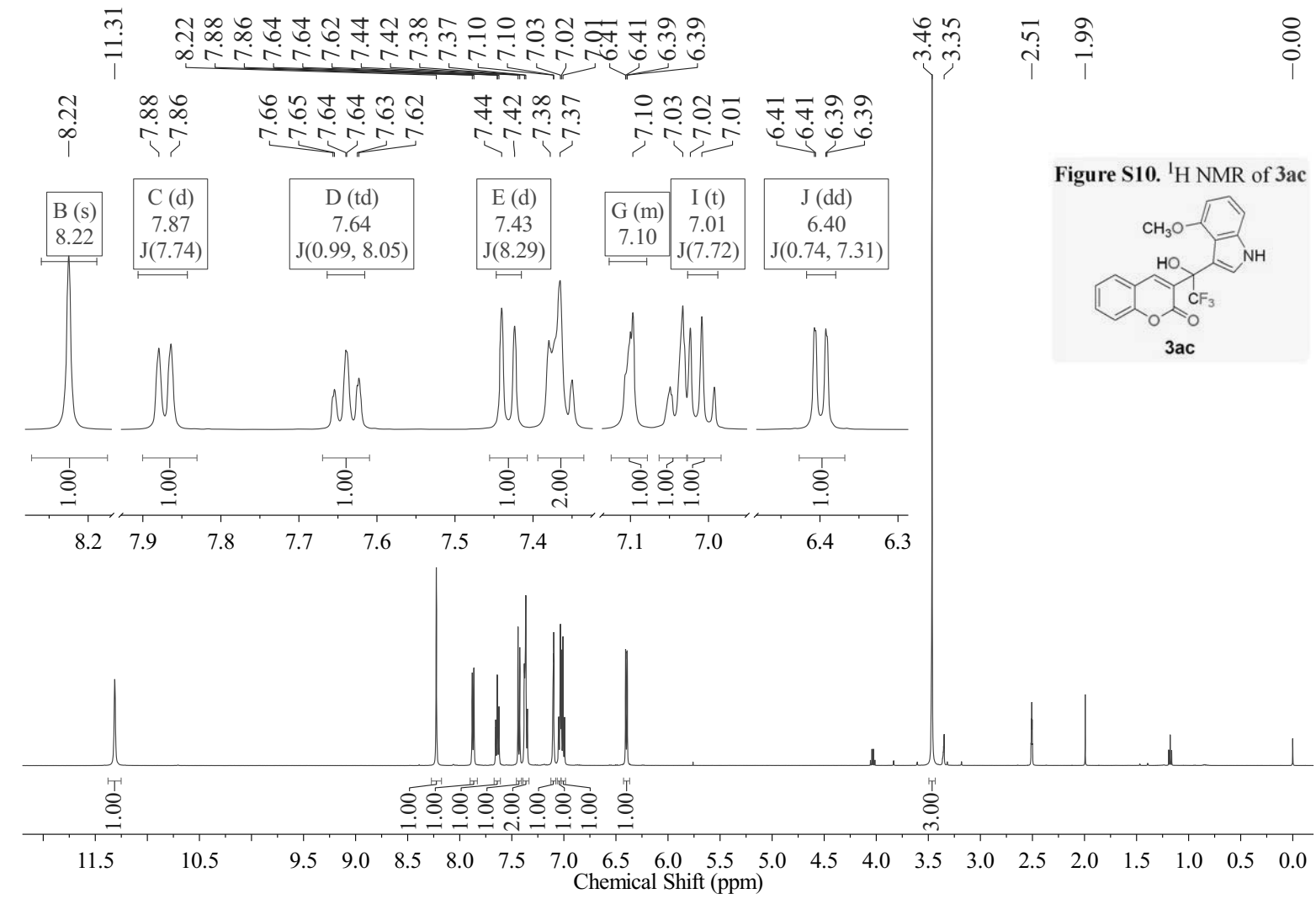


Figure S10. ^{1}H NMR of **3ac**

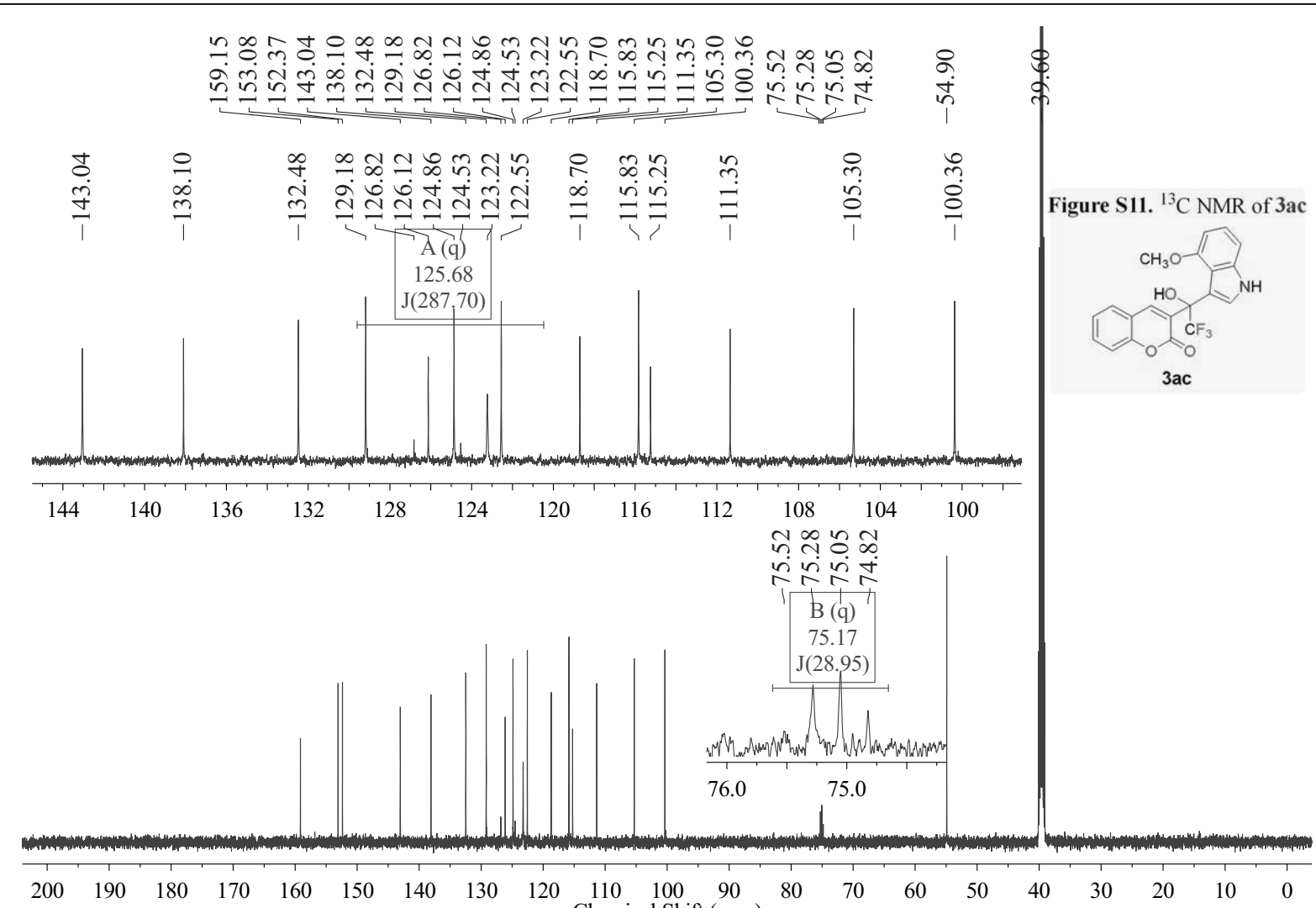


Figure S11. ^{13}C NMR of **3ac**

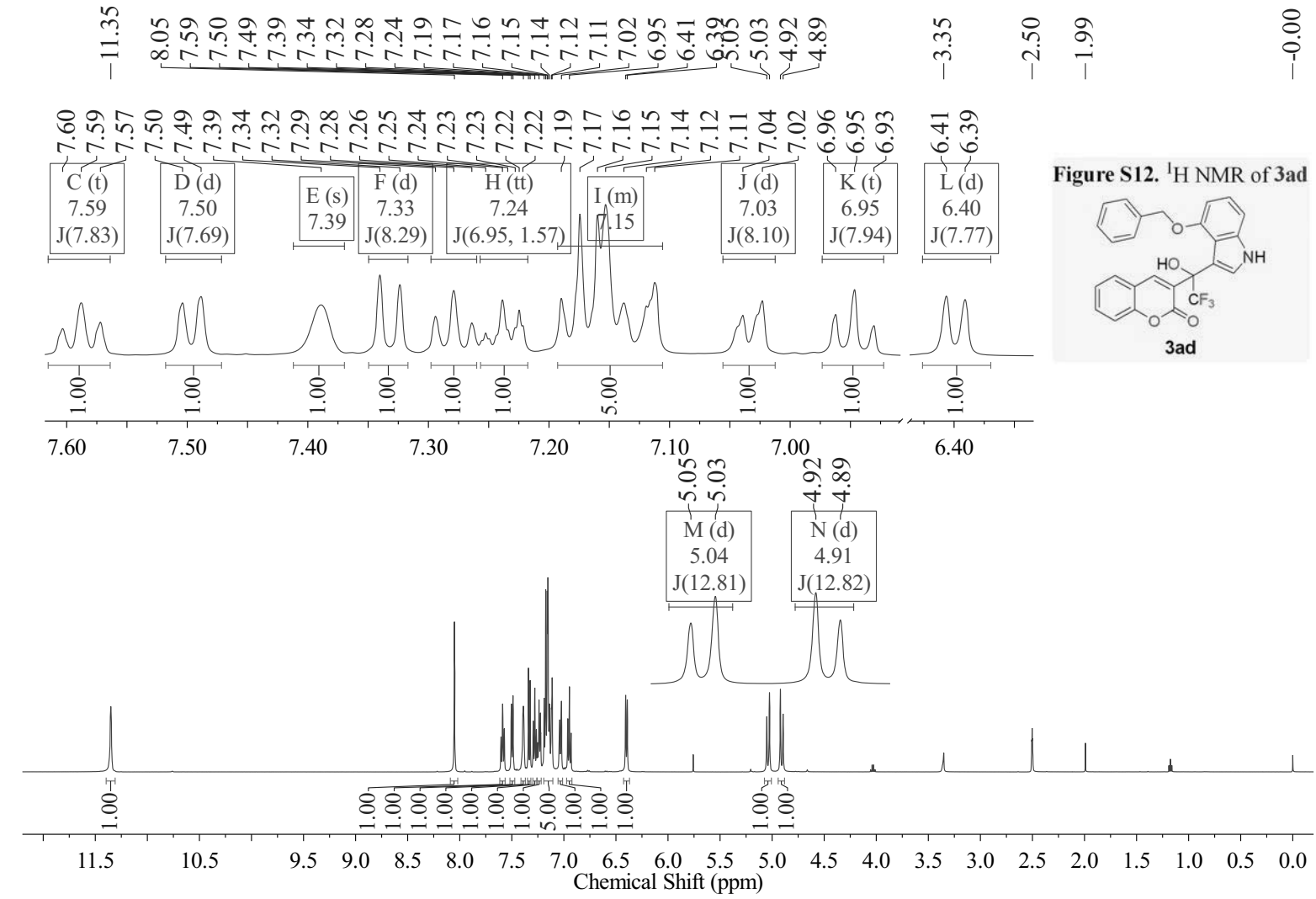


Figure S12. ^{1}H NMR of **3ad**

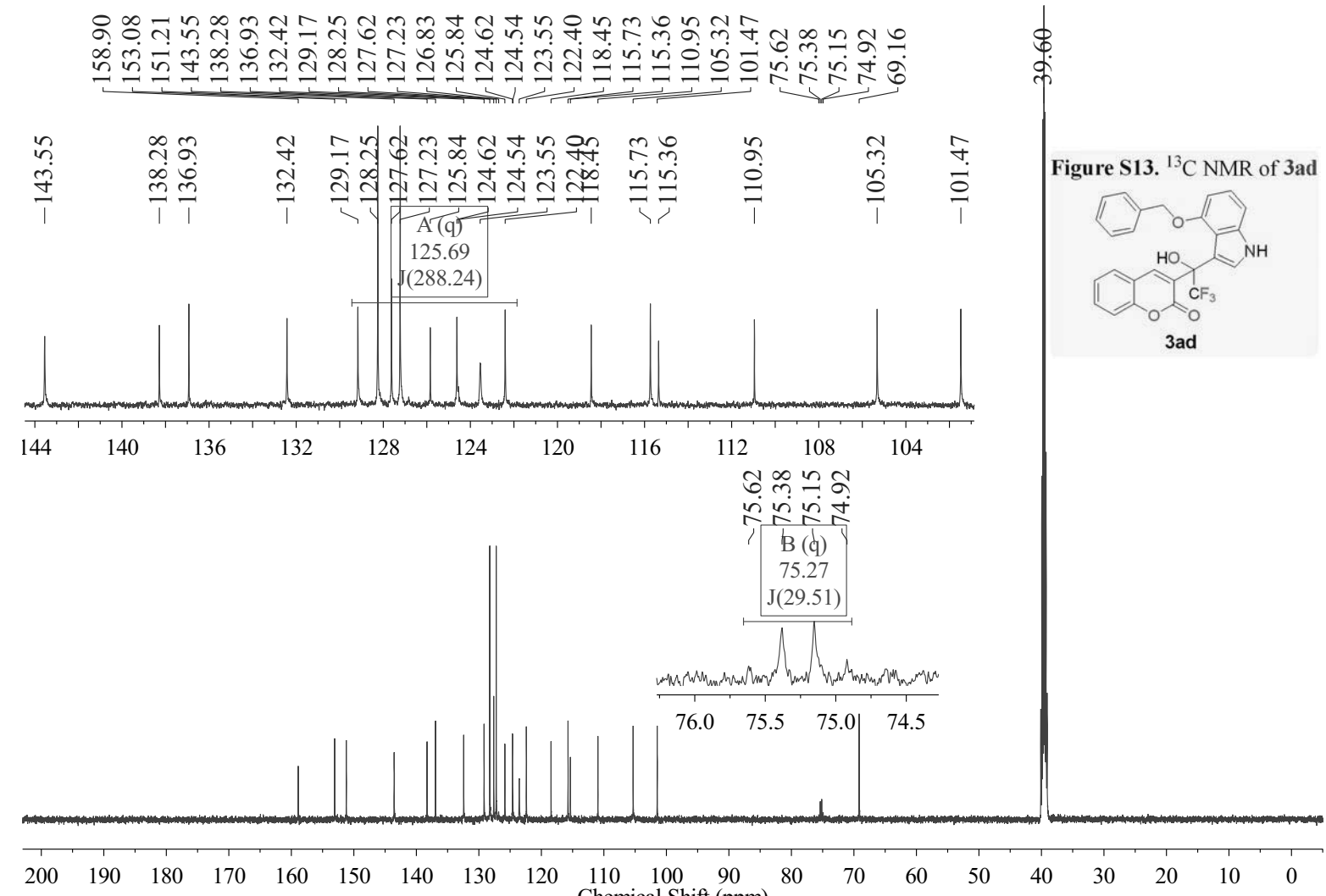


Figure S13. ^{13}C NMR of **3ad**

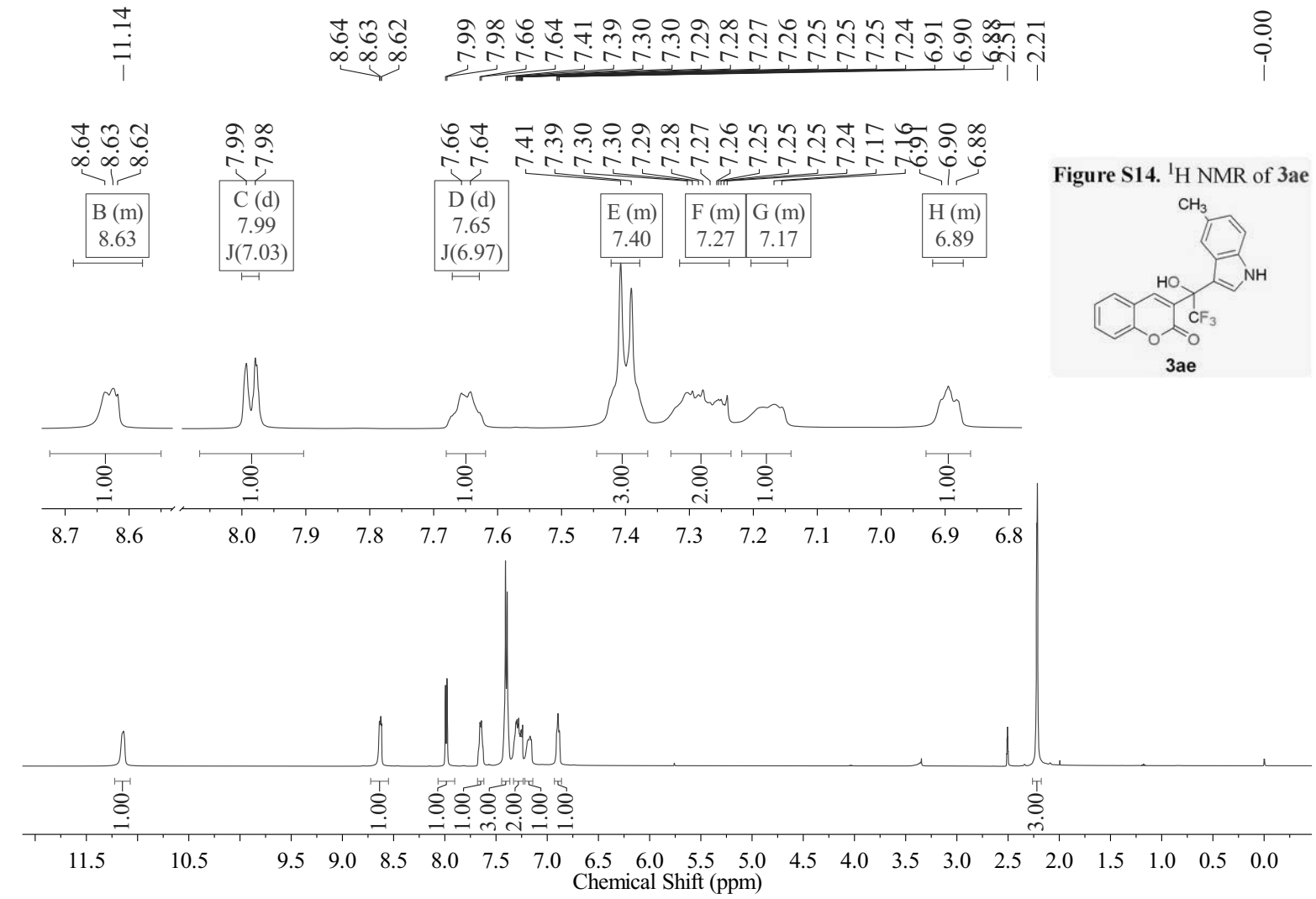


Figure S14. ^{1}H NMR of **3ae**

3ae

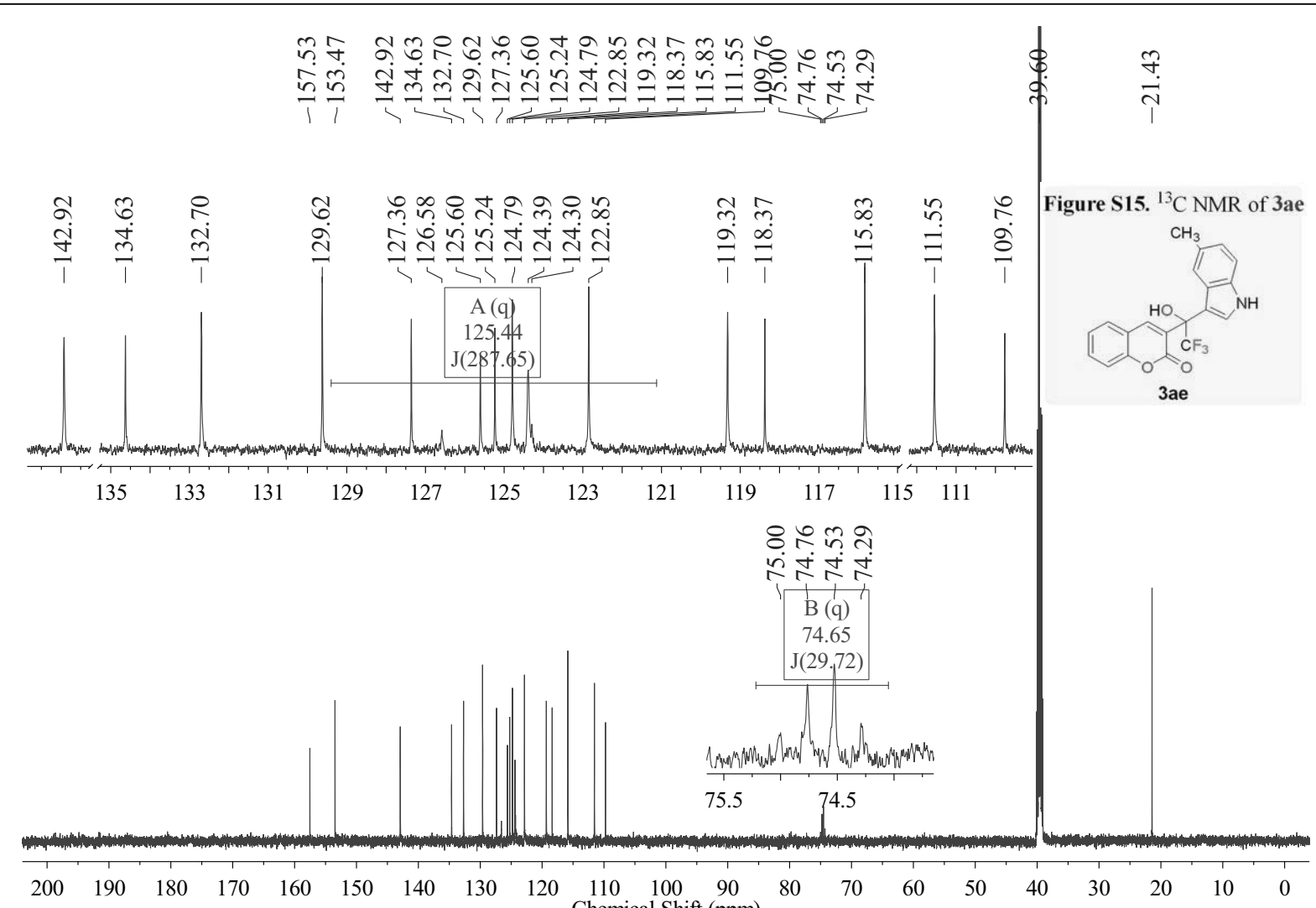


Figure S15. ^{13}C NMR of **3ae**

3ae

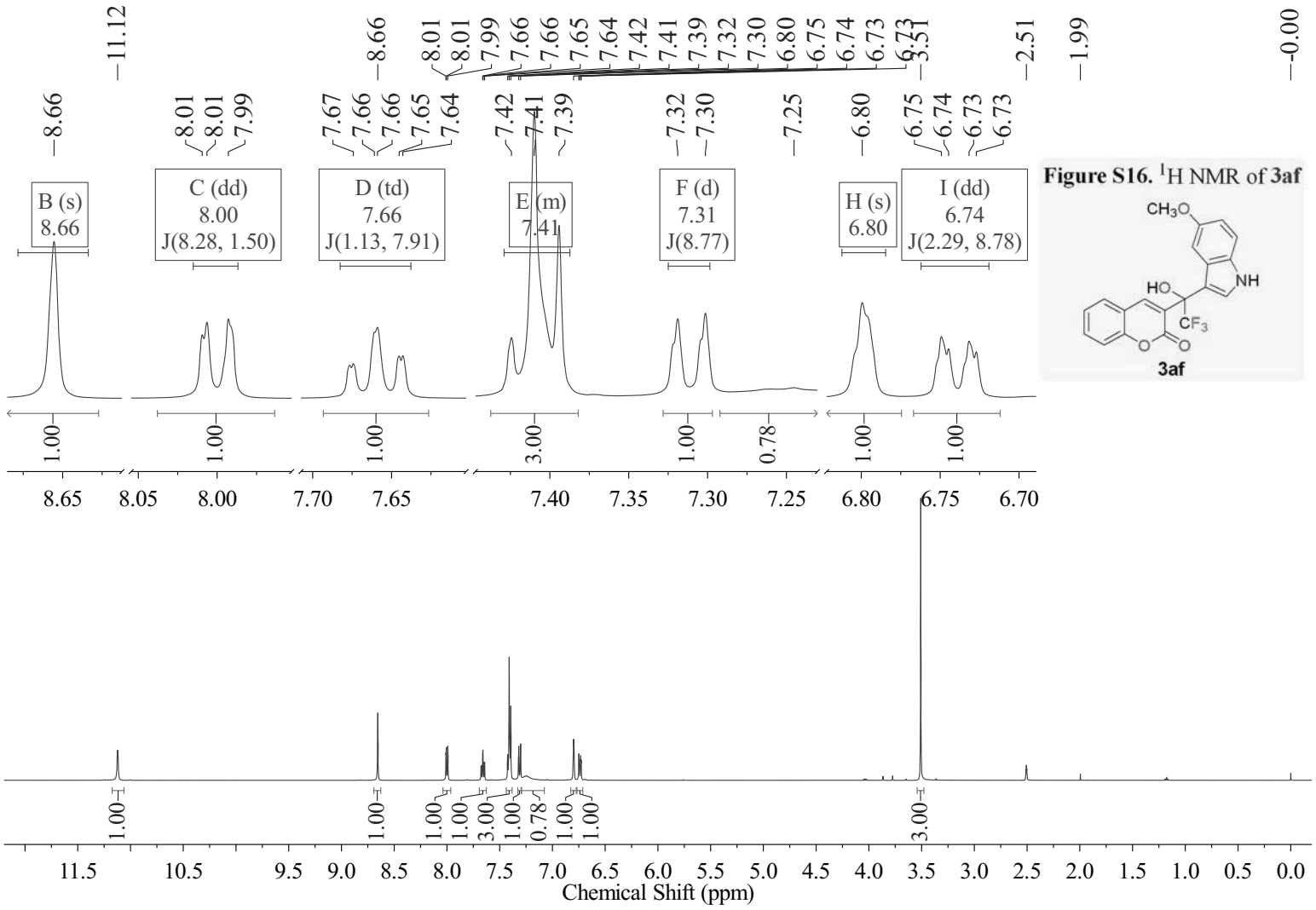


Figure S16. ^{1}H NMR of **3af**

3af

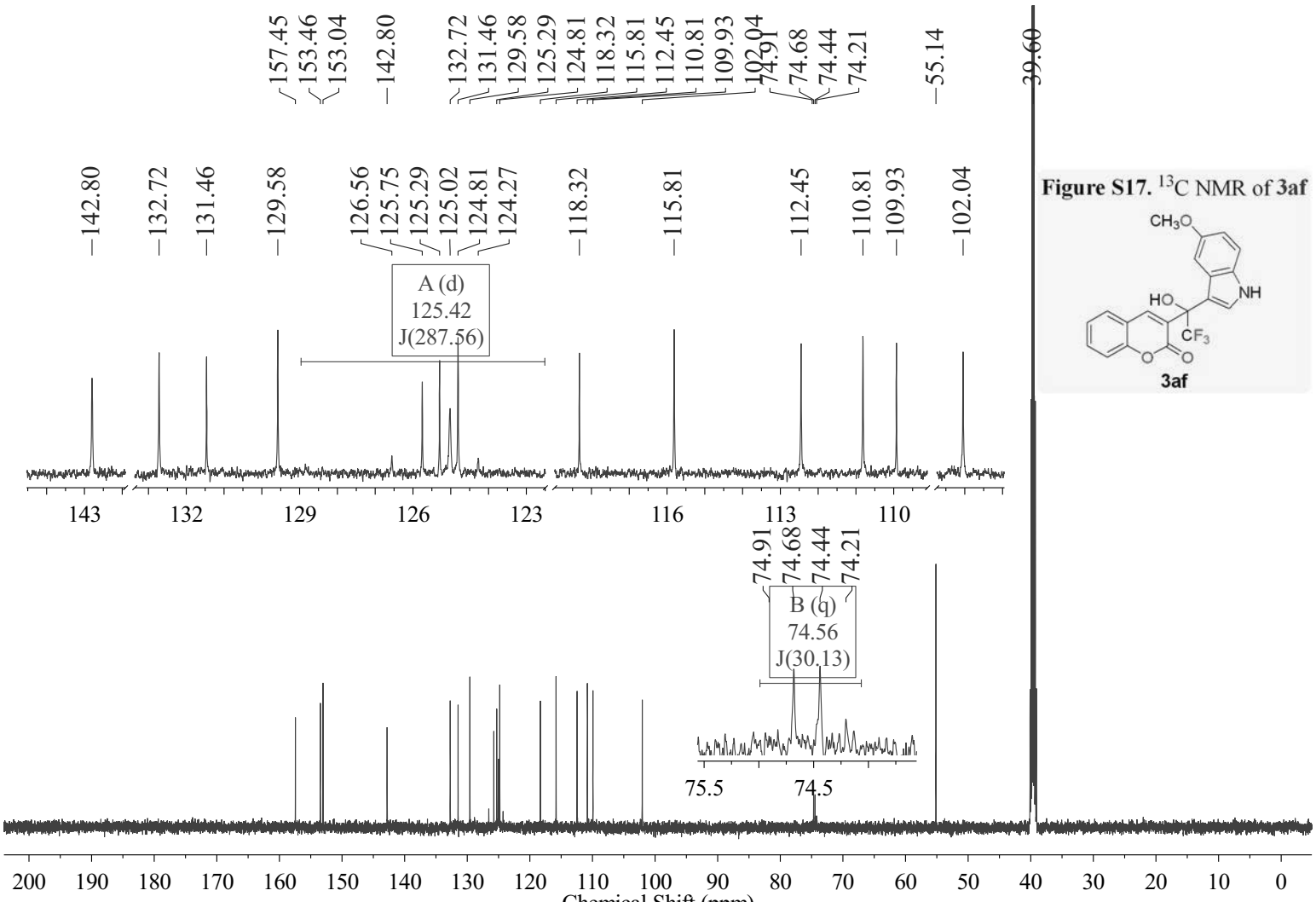


Figure S17. ^{13}C NMR of **3af**

3af

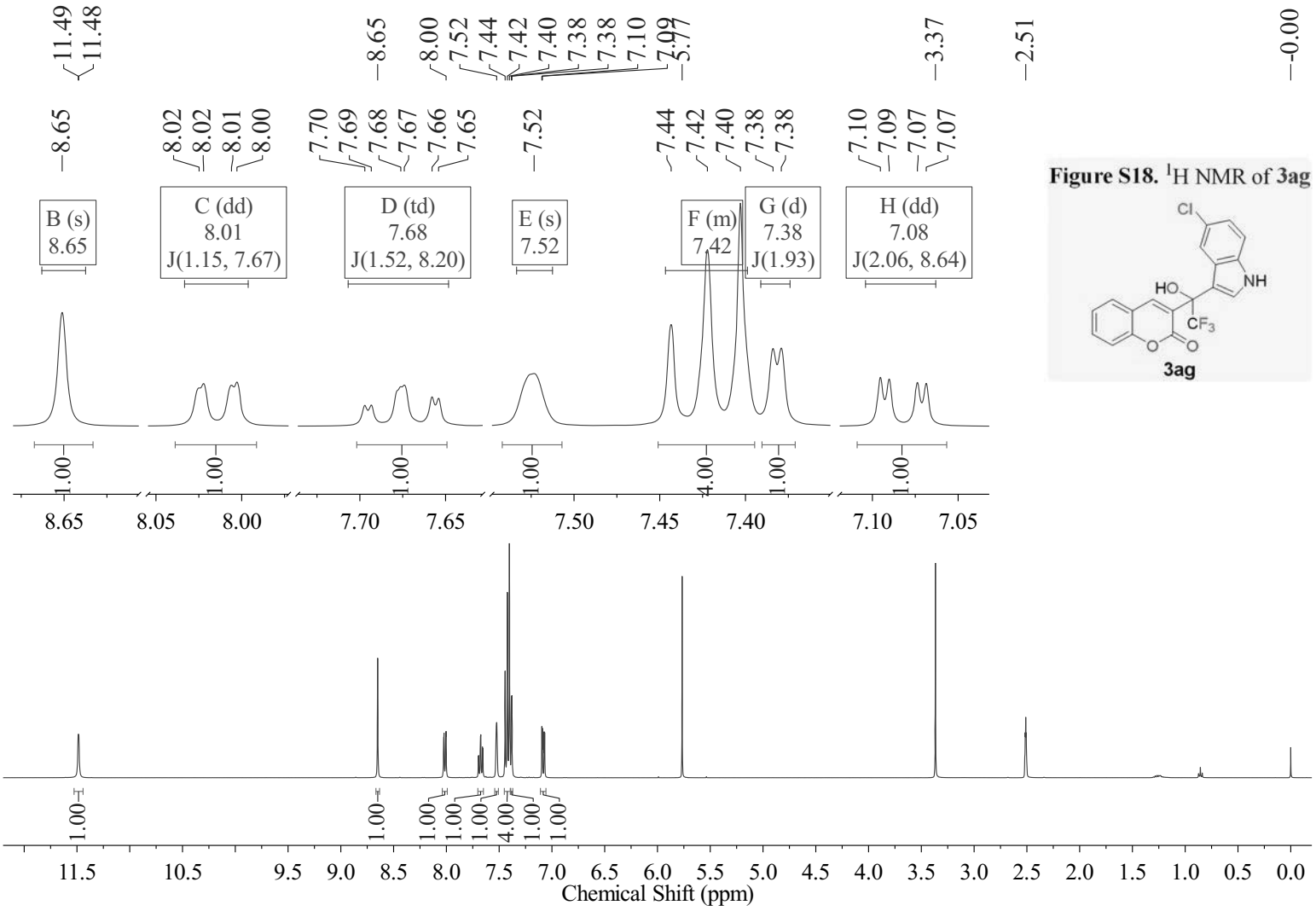


Figure S18. ^{1}H NMR of **3ag**

3ag

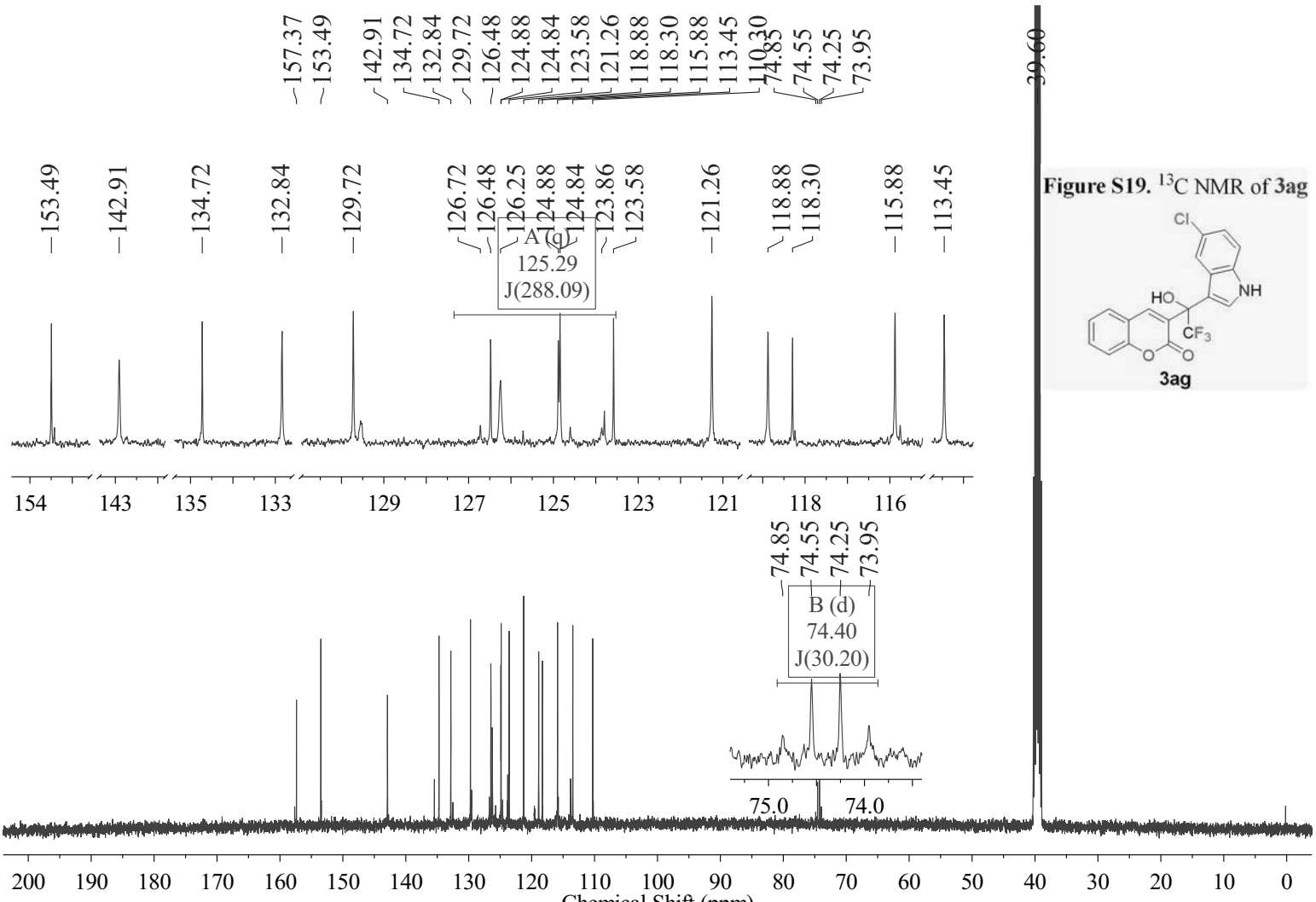


Figure S19. ^{13}C NMR of **3ag**

3ag

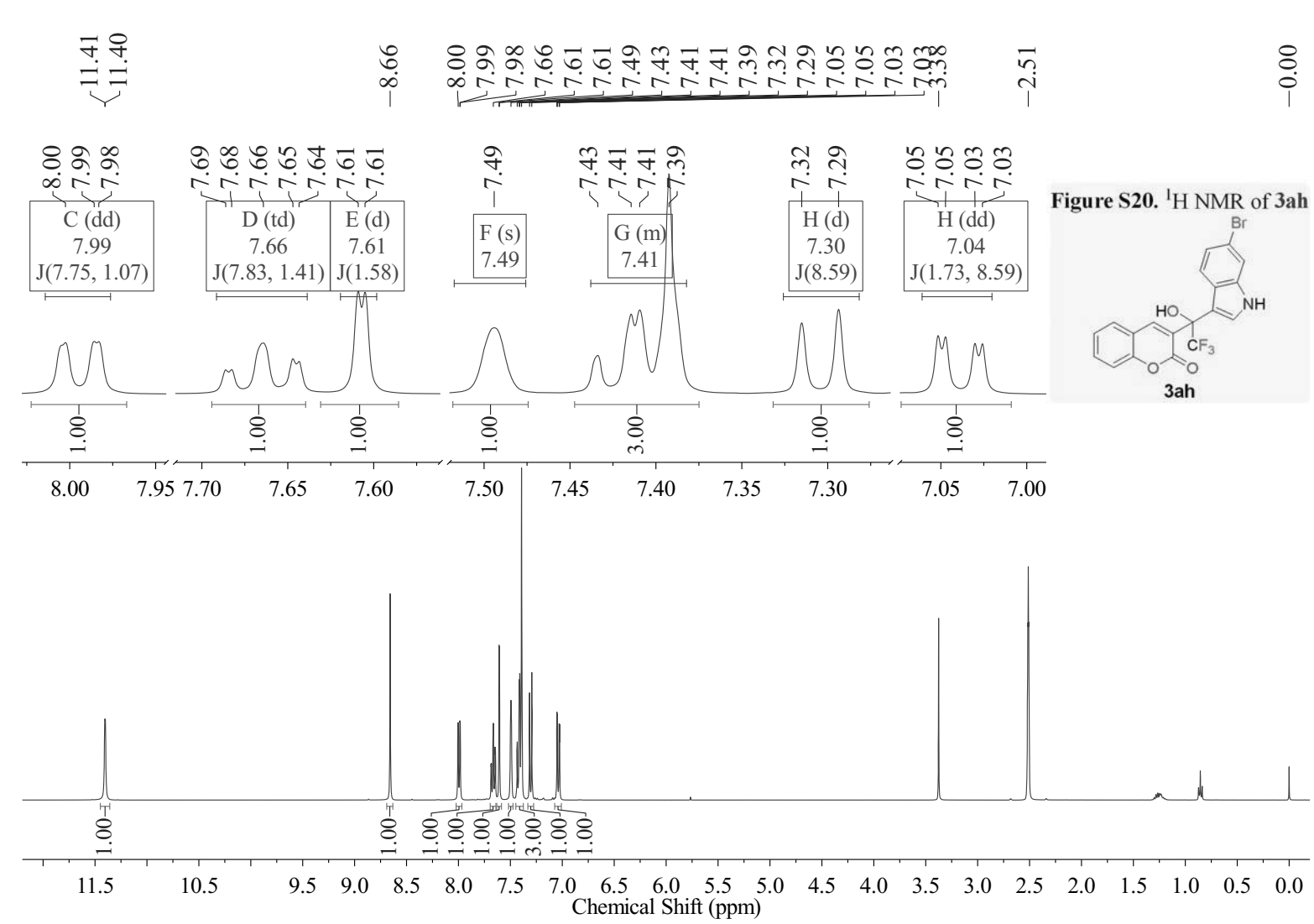


Figure S20. ^{1}H NMR of **3ah**

3ah

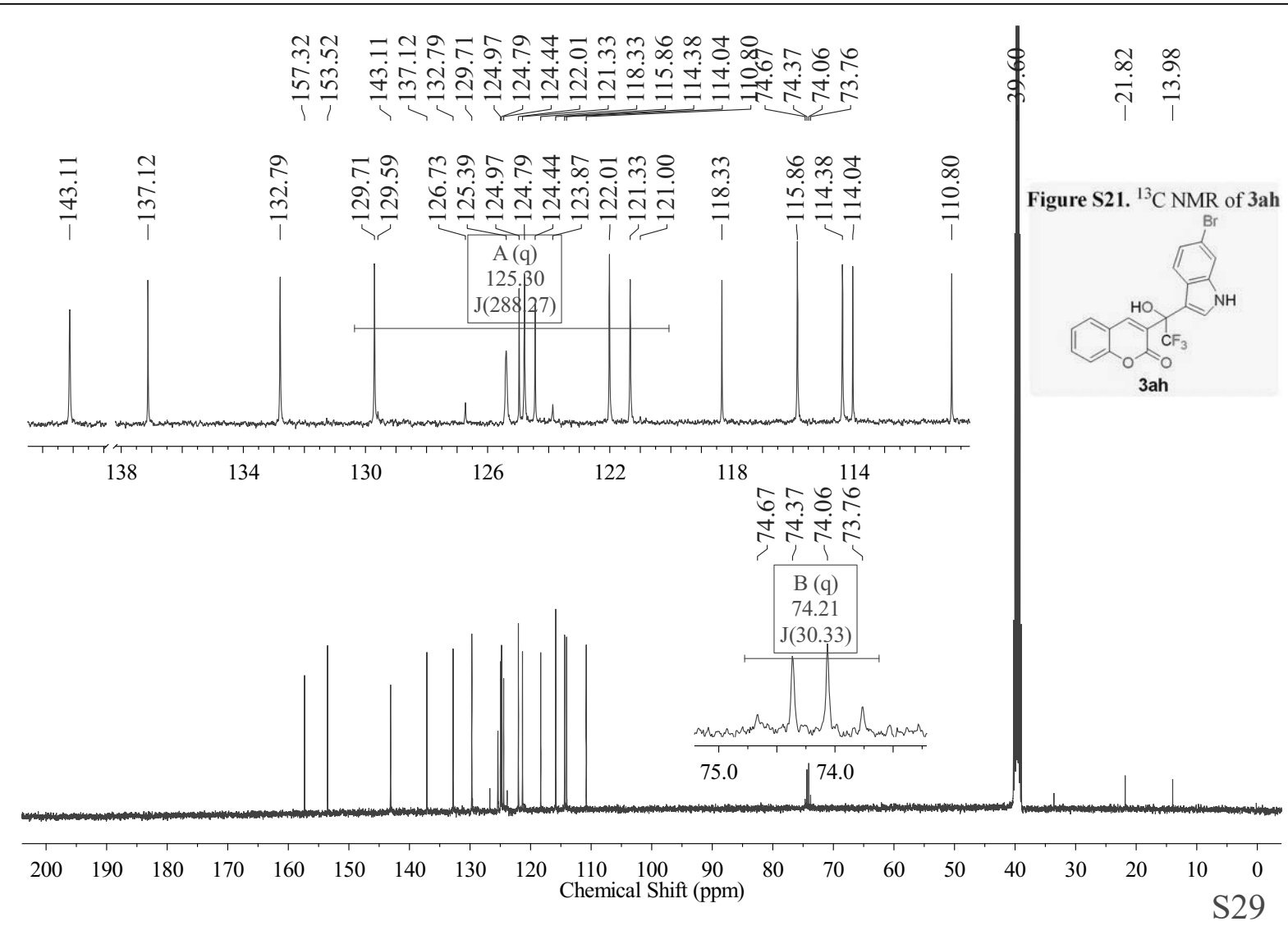


Figure S21. ^{13}C NMR of **3ah**

3ah

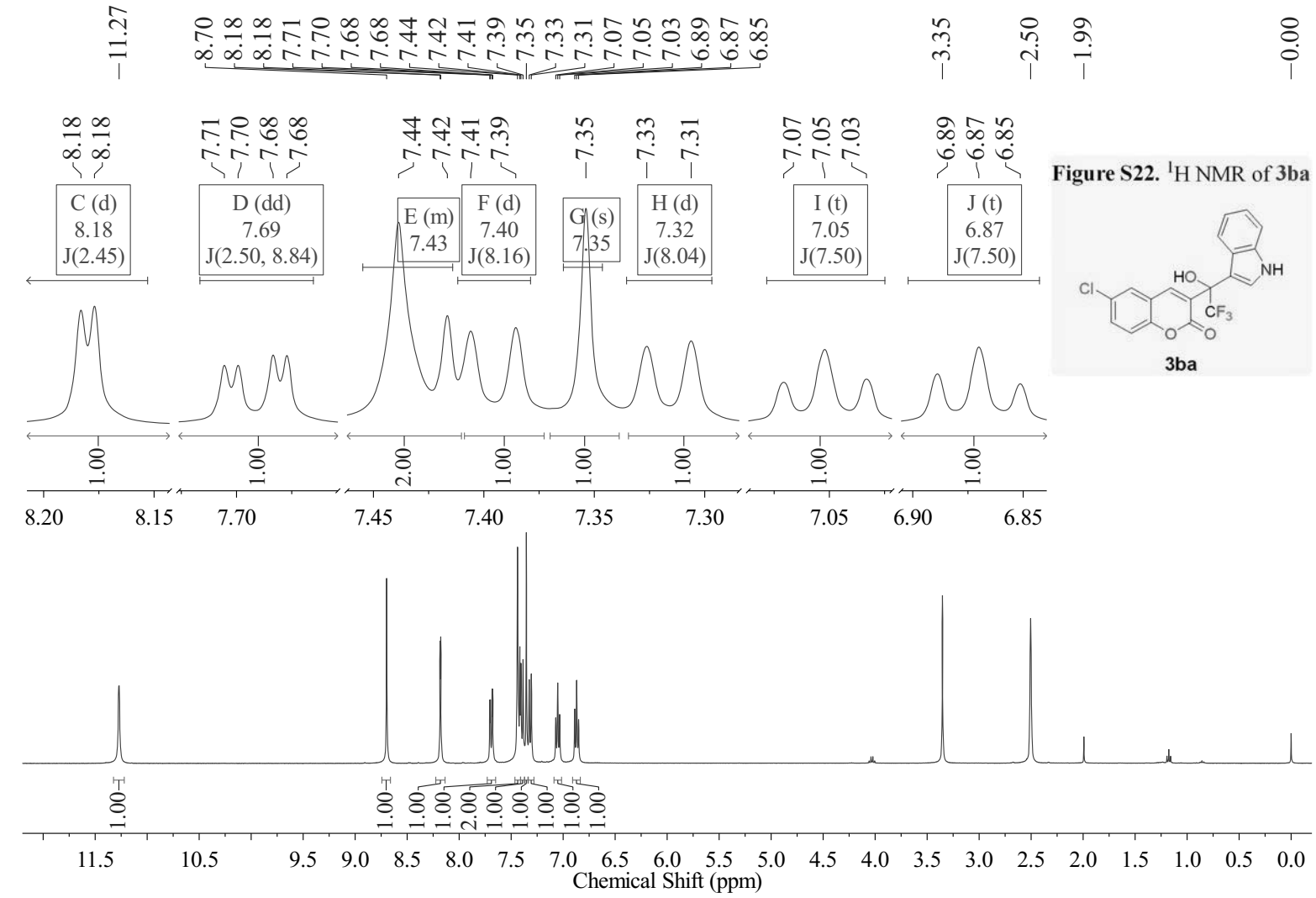


Figure S22. ^{1}H NMR of **3ba**

3ba

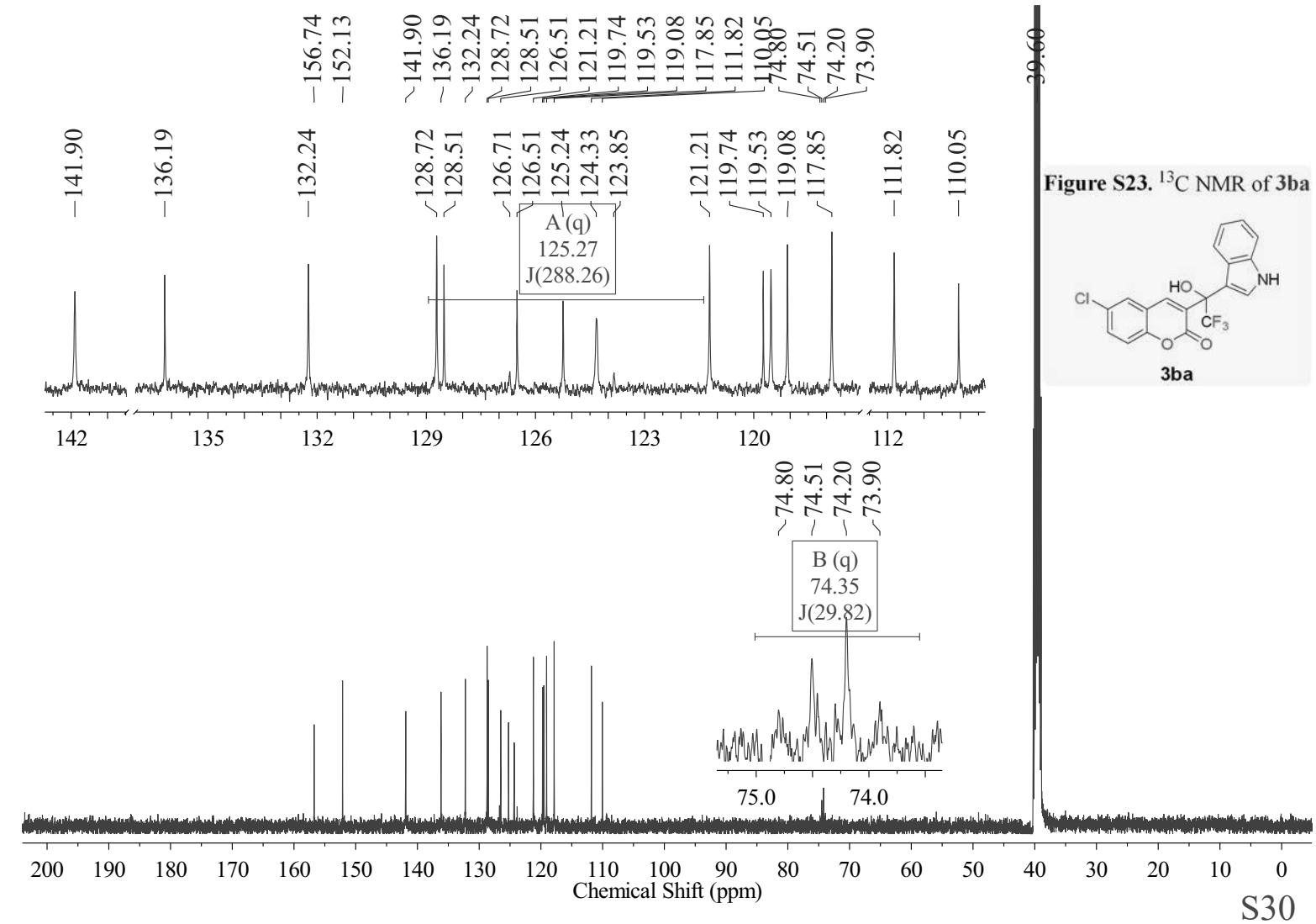


Figure S23. ^{13}C NMR of **3ba**

3ba

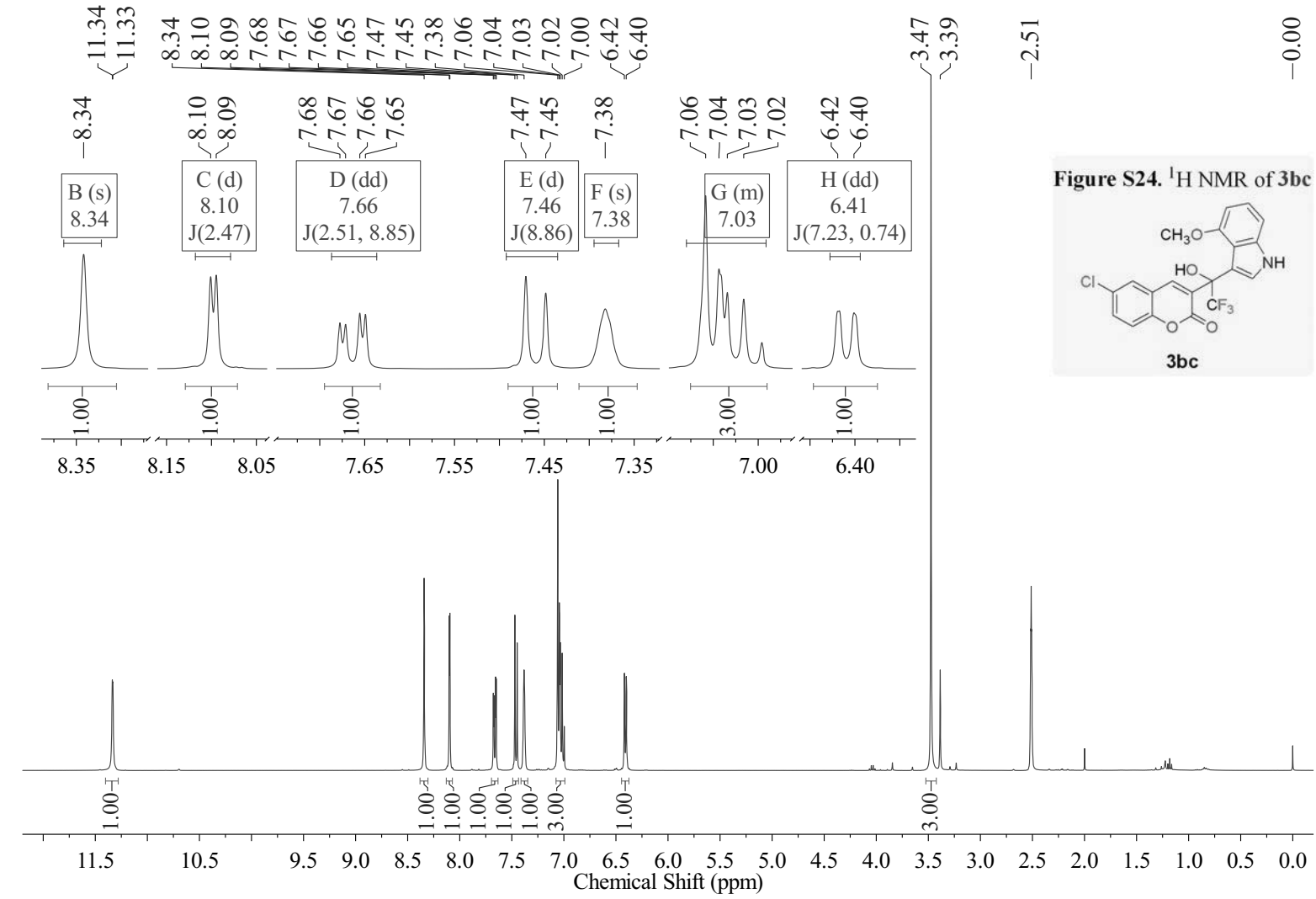


Figure S24. ^{1}H NMR of **3bc**

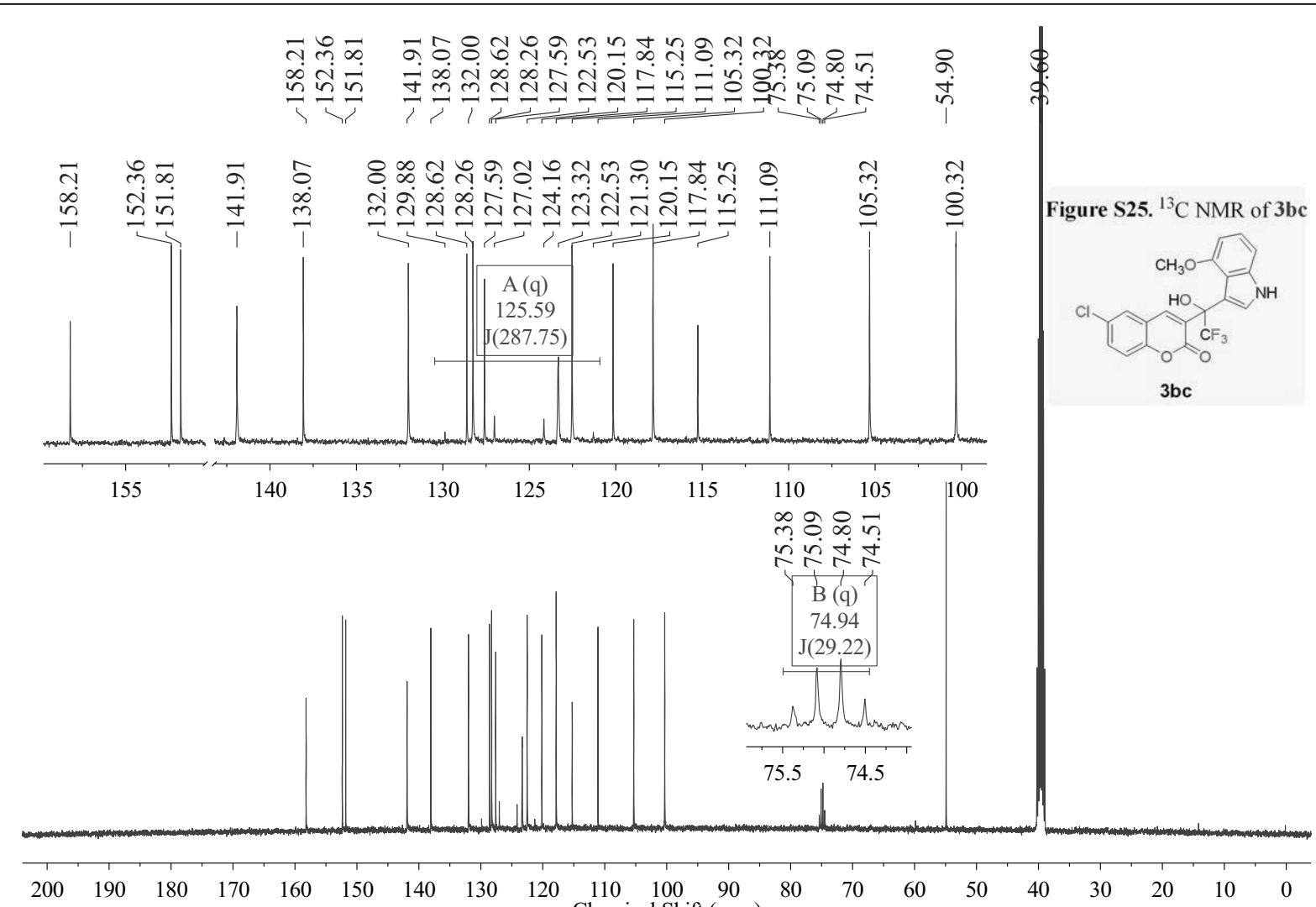


Figure S25. ^{13}C NMR of **3bc**

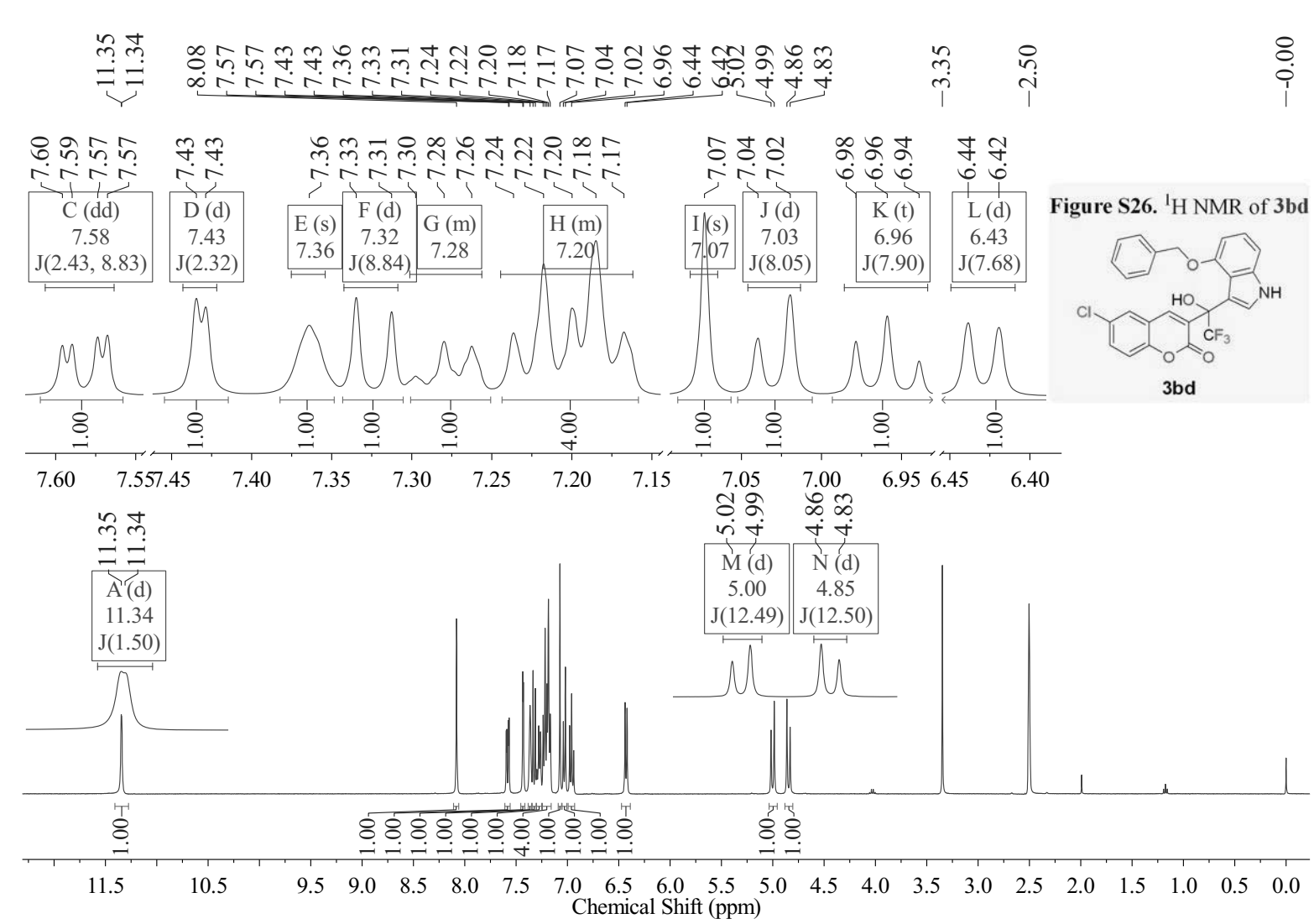


Figure S26. ^{1}H NMR of **3bd**

3bd

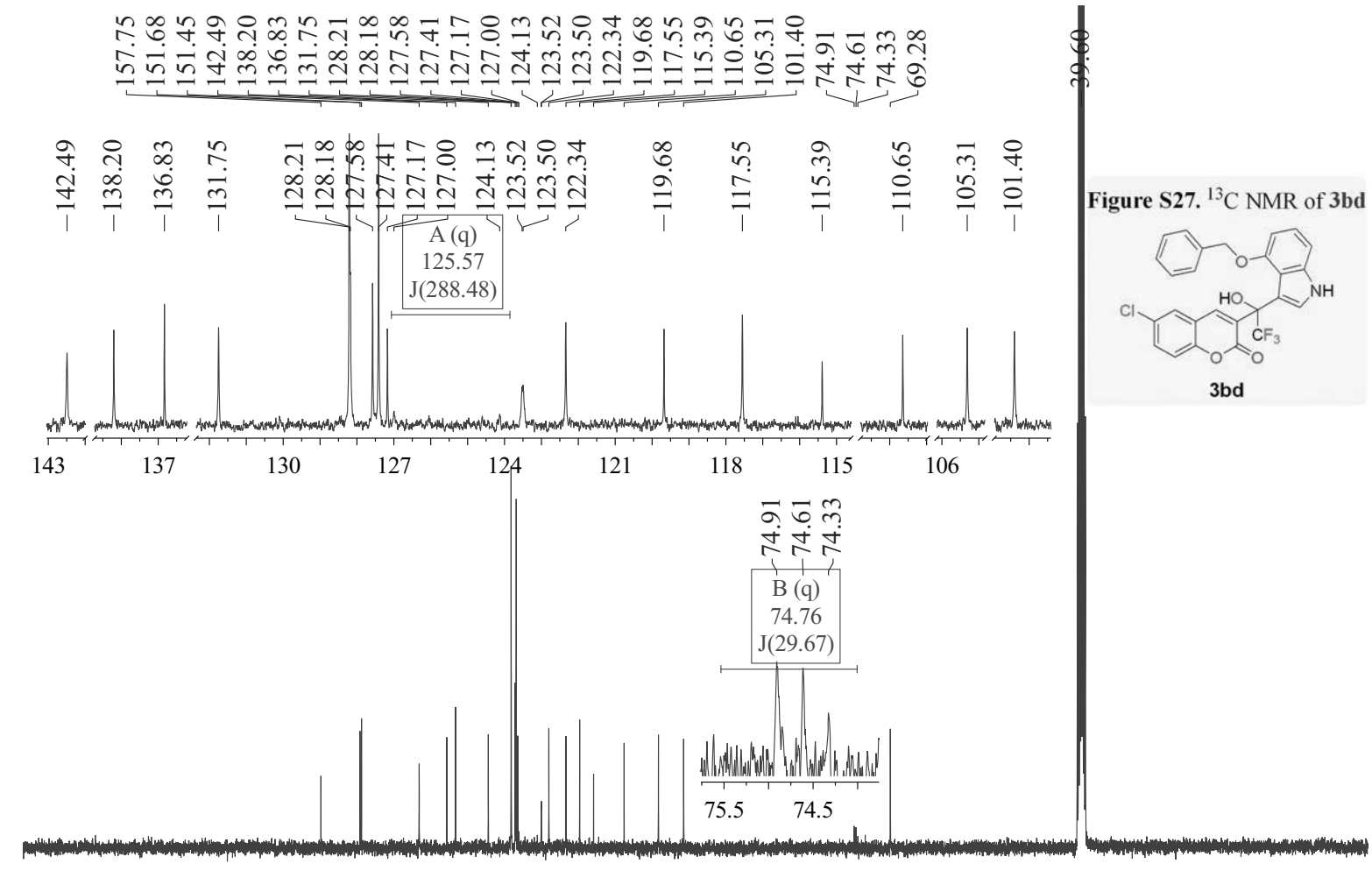


Figure S27. ^{13}C NMR of **3bd**

3bd

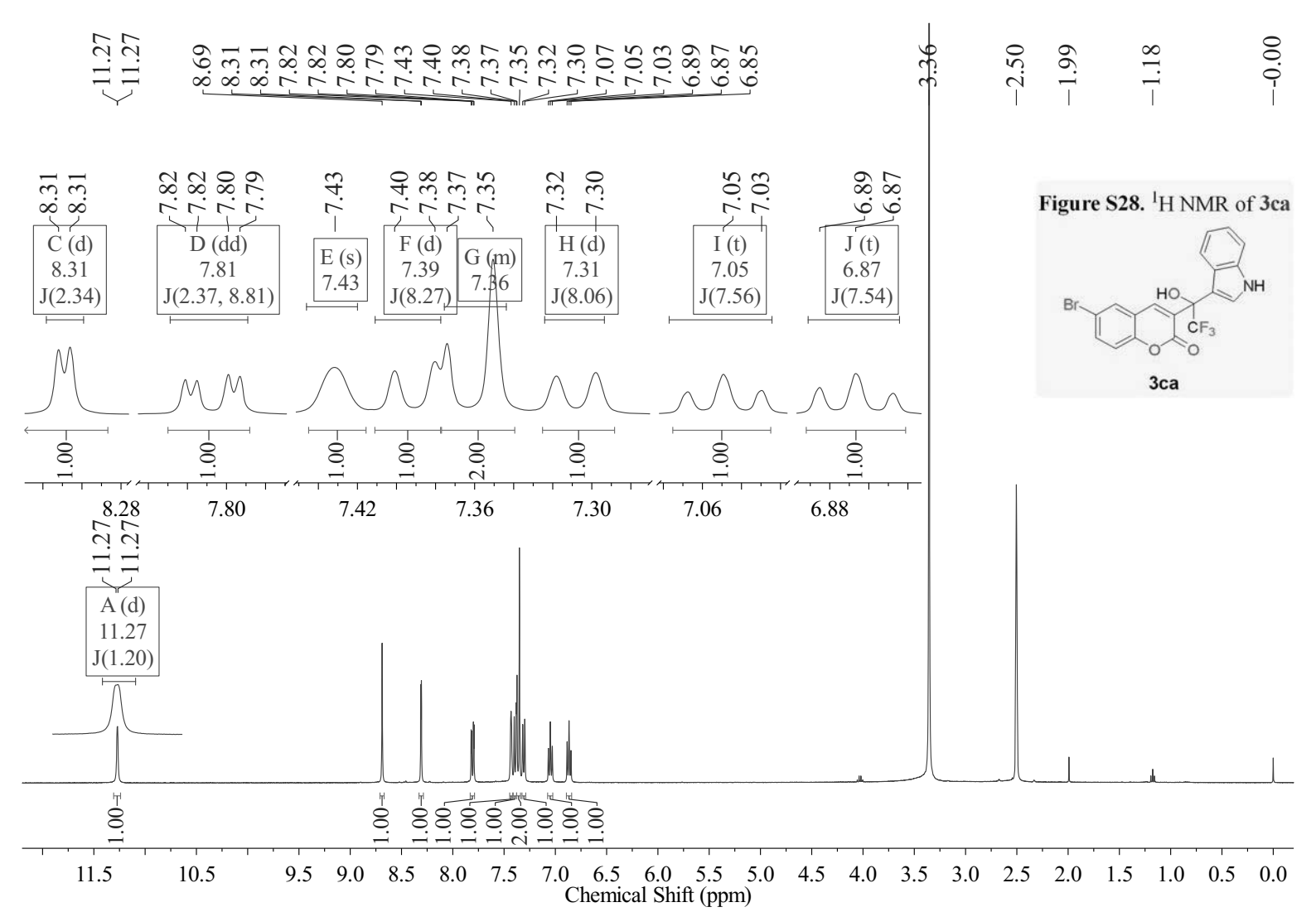


Figure S28. ^{1}H NMR of **3ca**

3ca

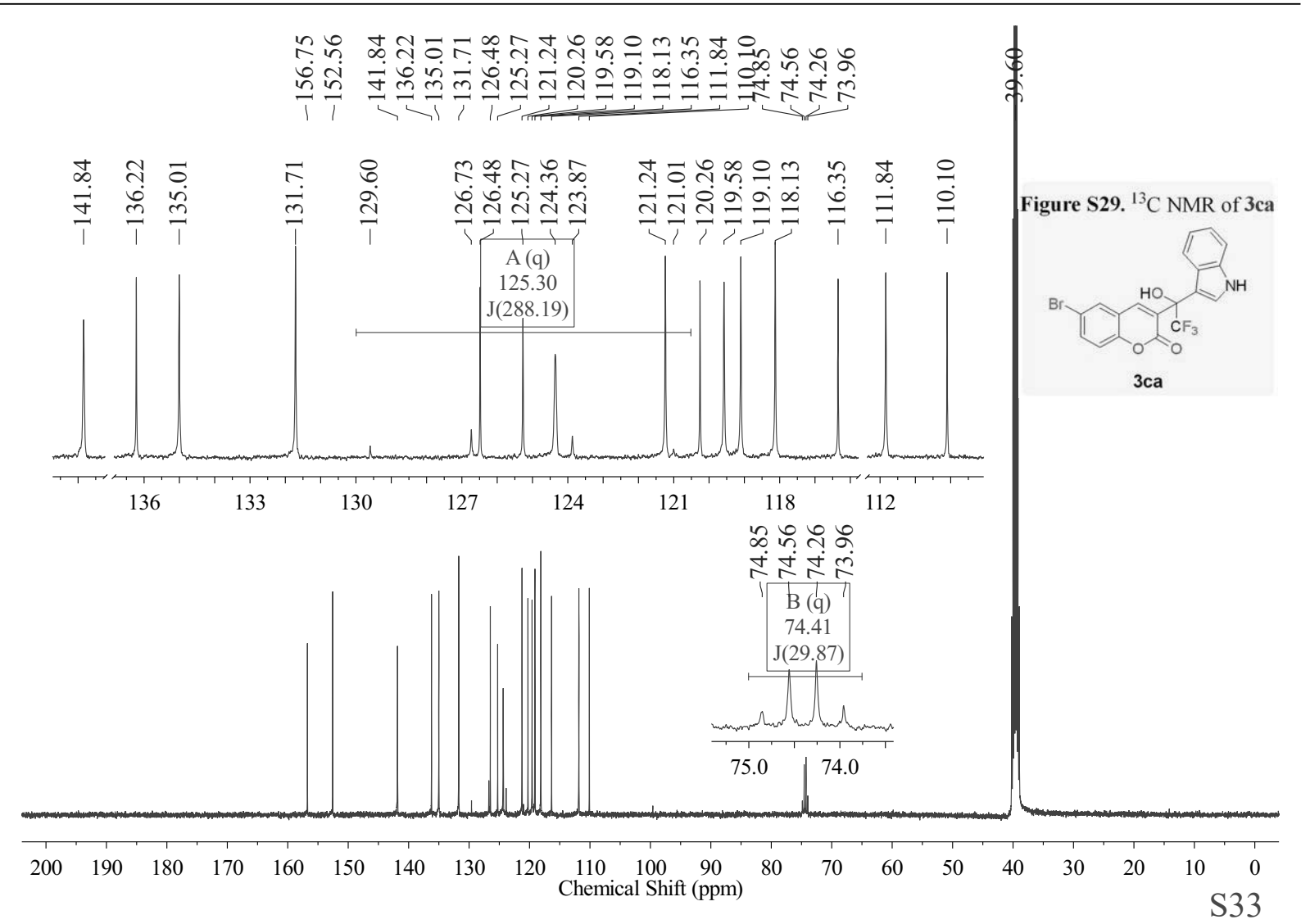


Figure S29. ^{13}C NMR of **3ca**

3ca

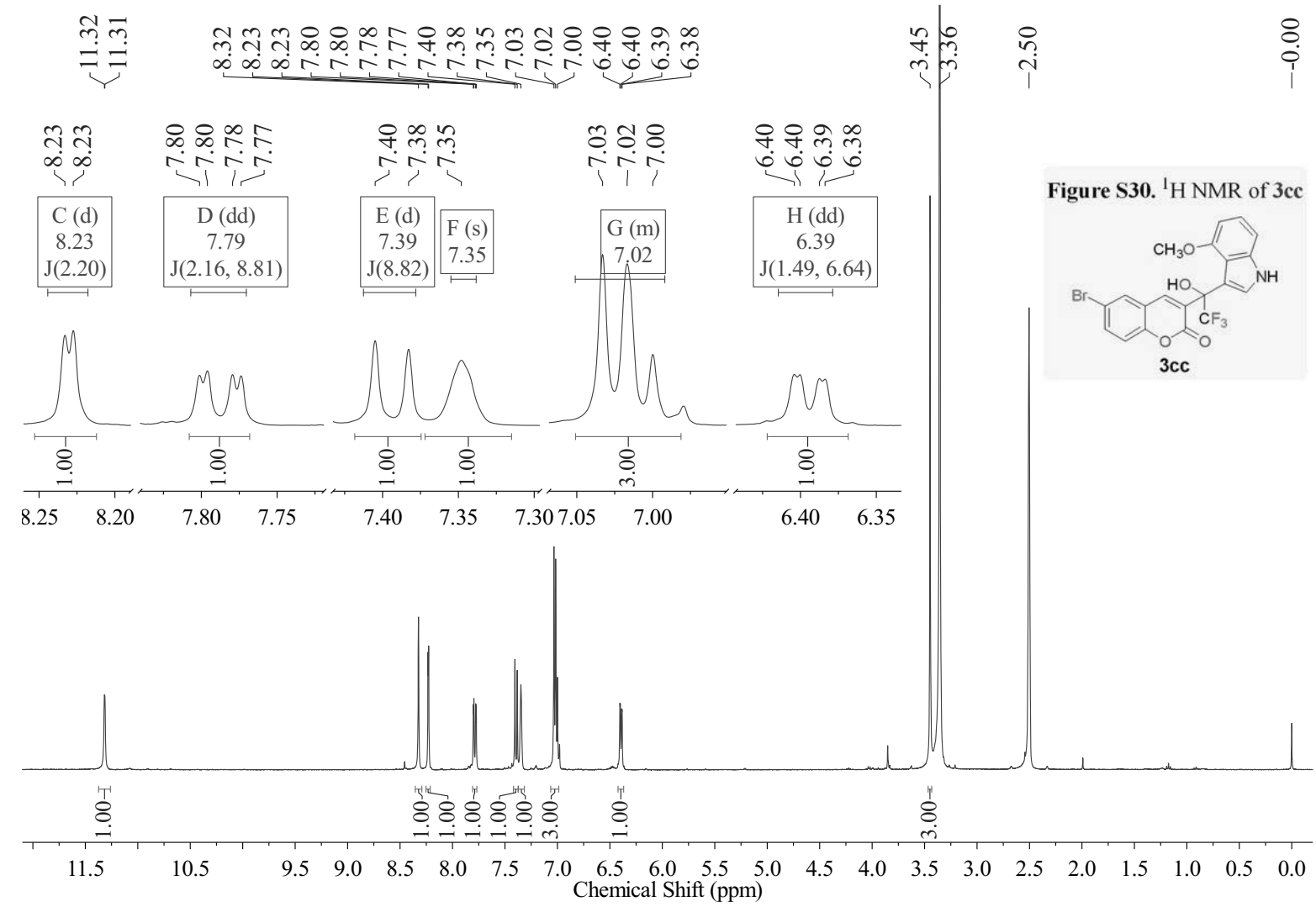


Figure S30. ^{1}H NMR of **3cc**

3cc

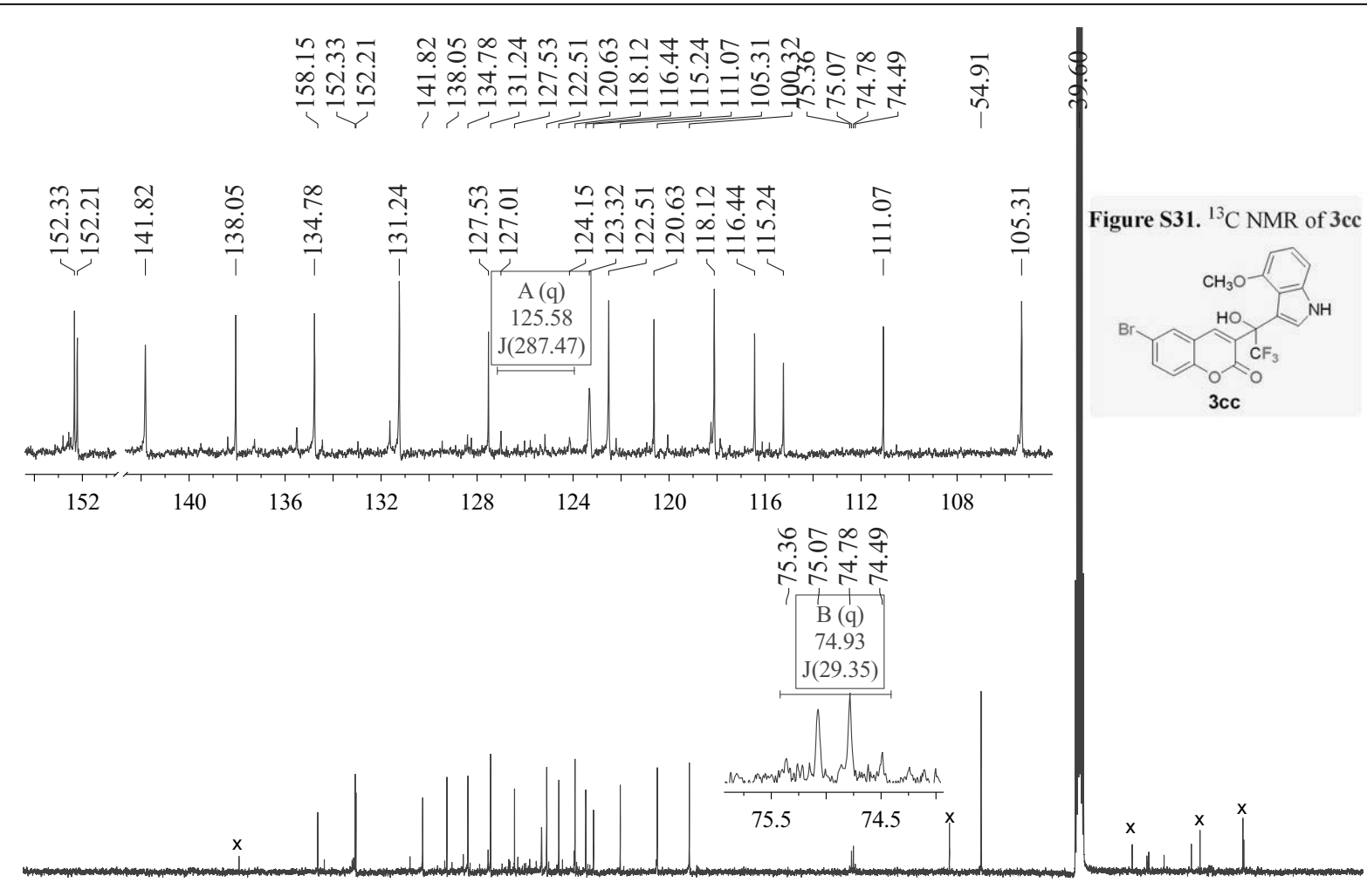


Figure S31. ^{13}C NMR of **3cc**

3cc

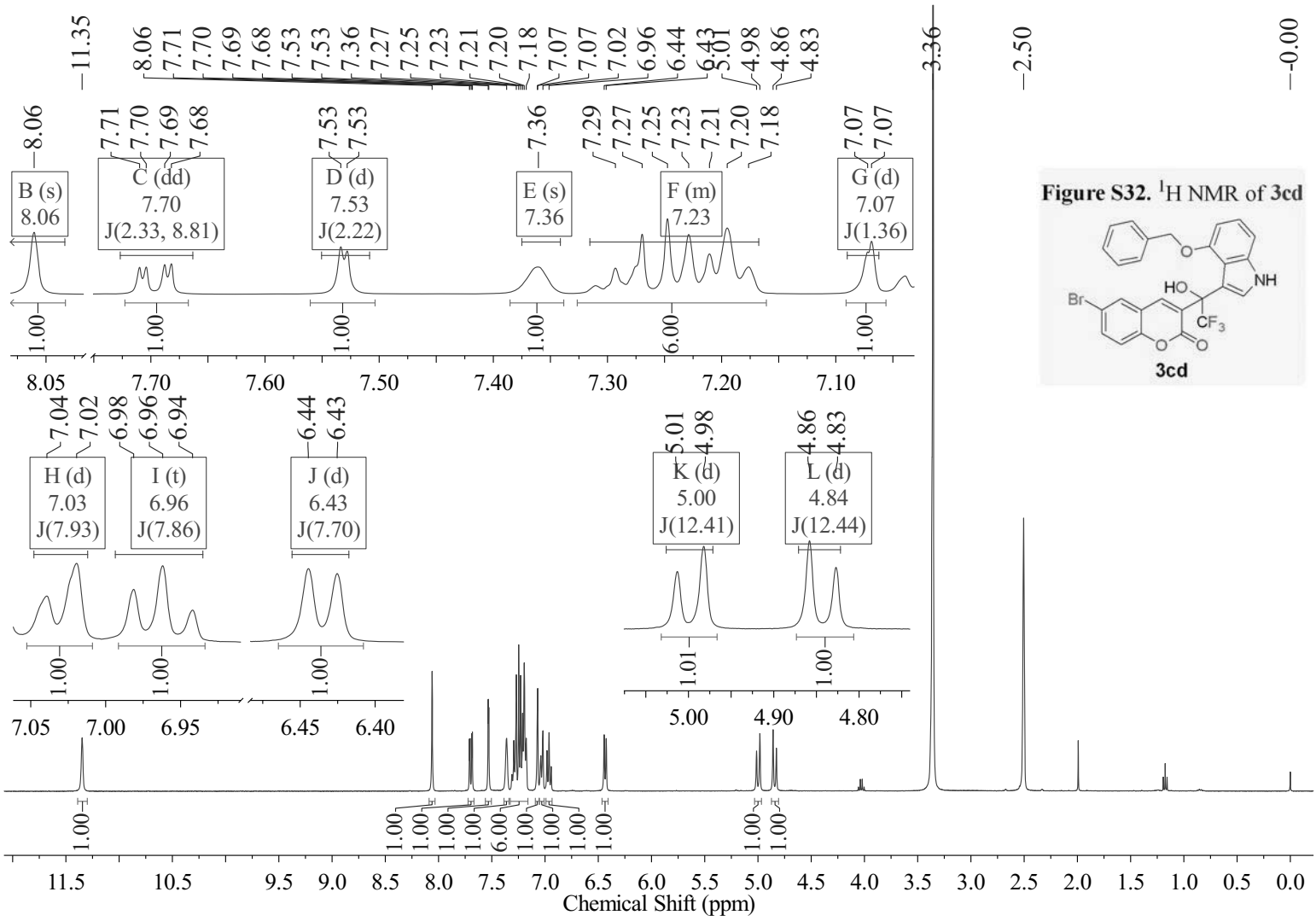


Figure S32. ^{1}H NMR of **3cd**

3cd

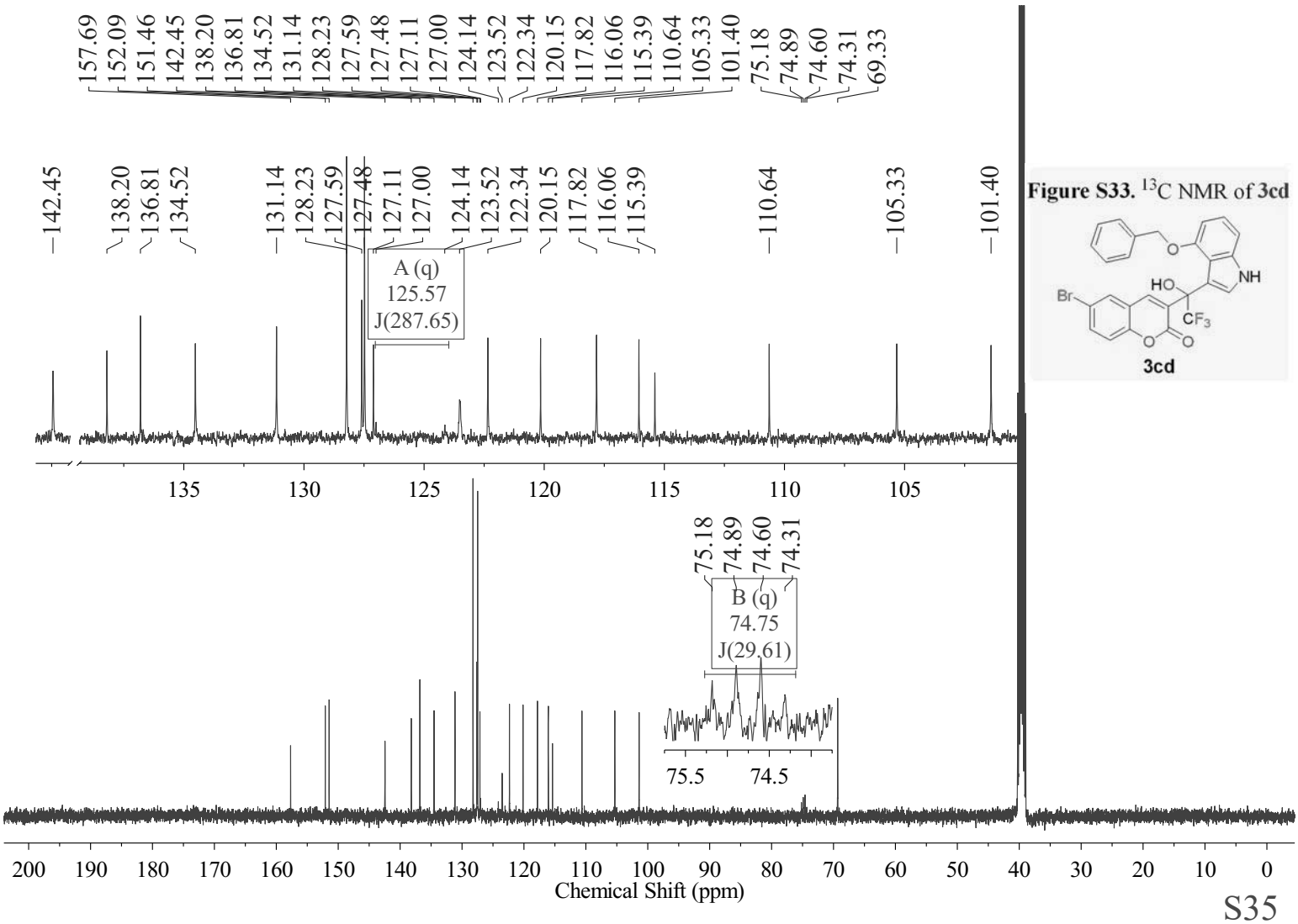


Figure S33. ^{13}C NMR of **3cd**

3cd

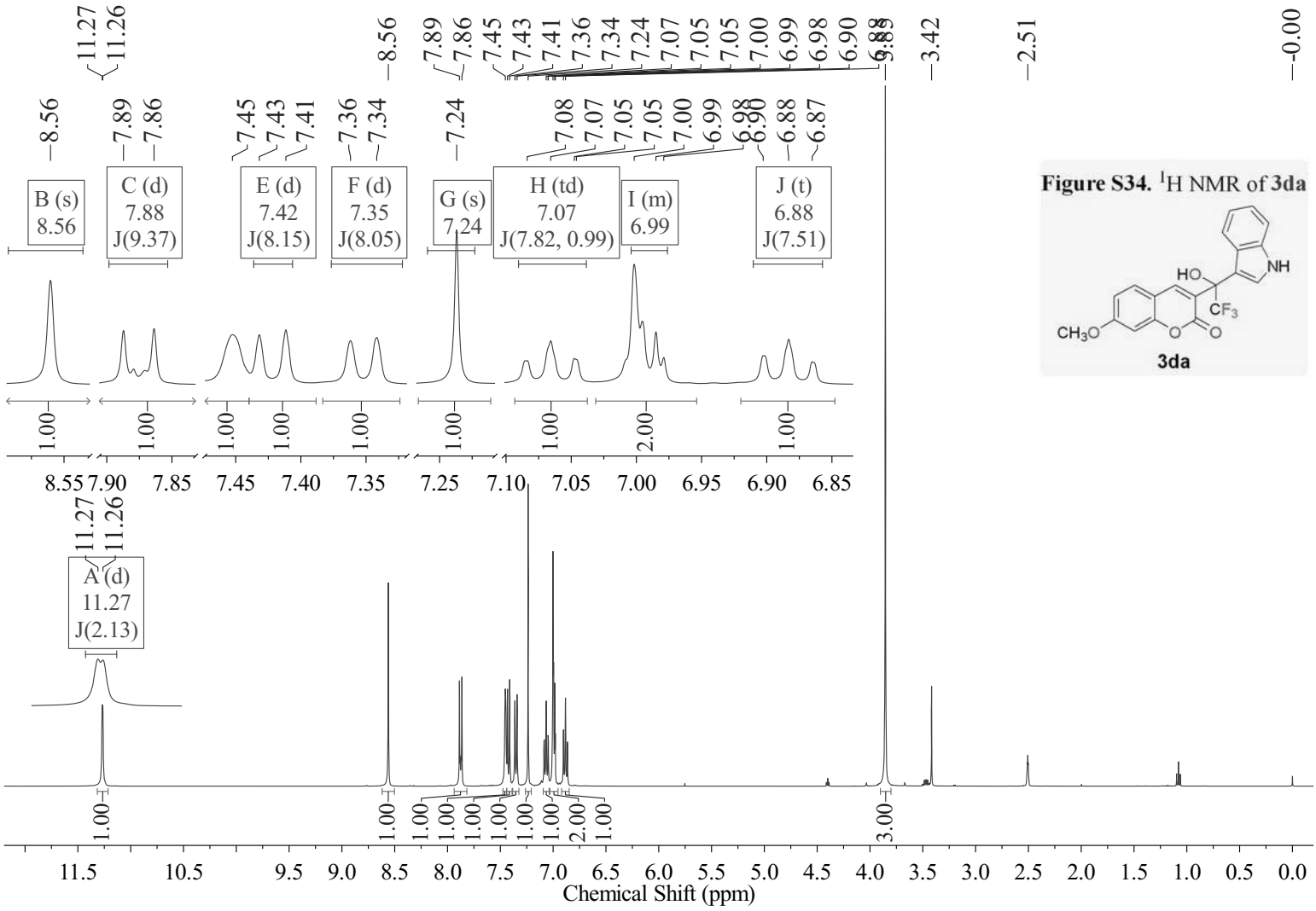


Figure S34. ^{1}H NMR of **3da**

3da

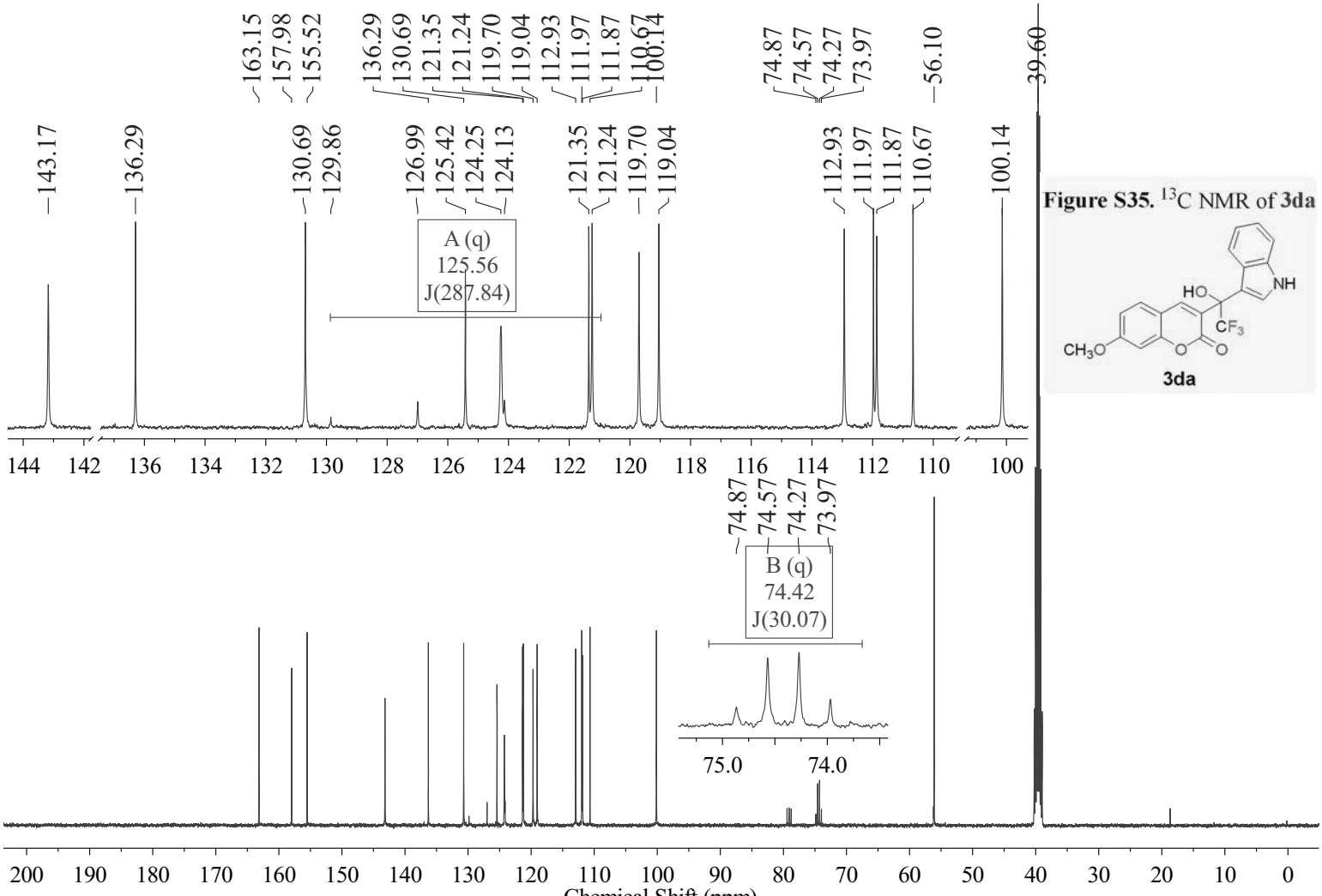


Figure S35. ^{13}C NMR of **3da**

3da

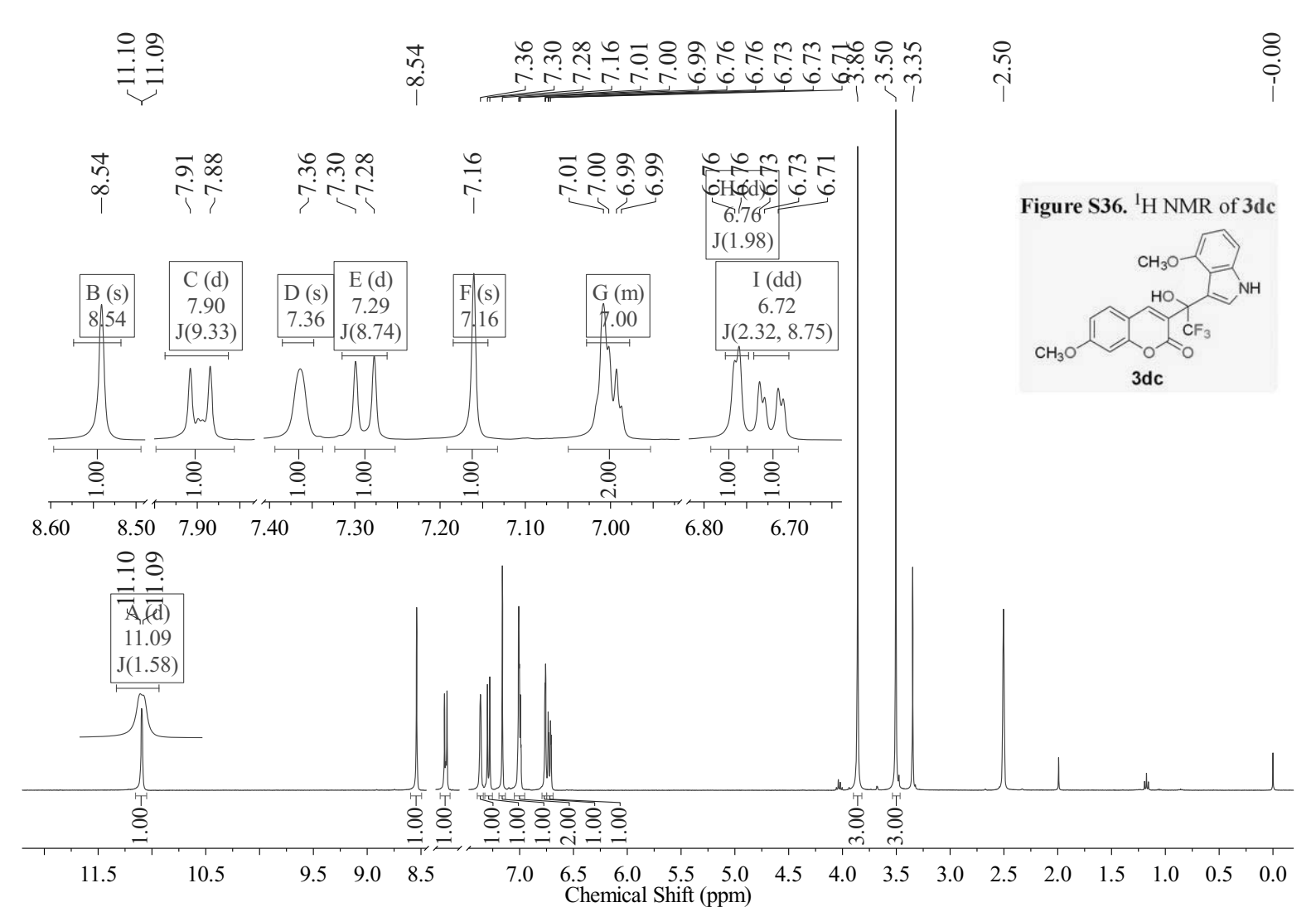


Figure S36. ^{1}H NMR of **3dc**

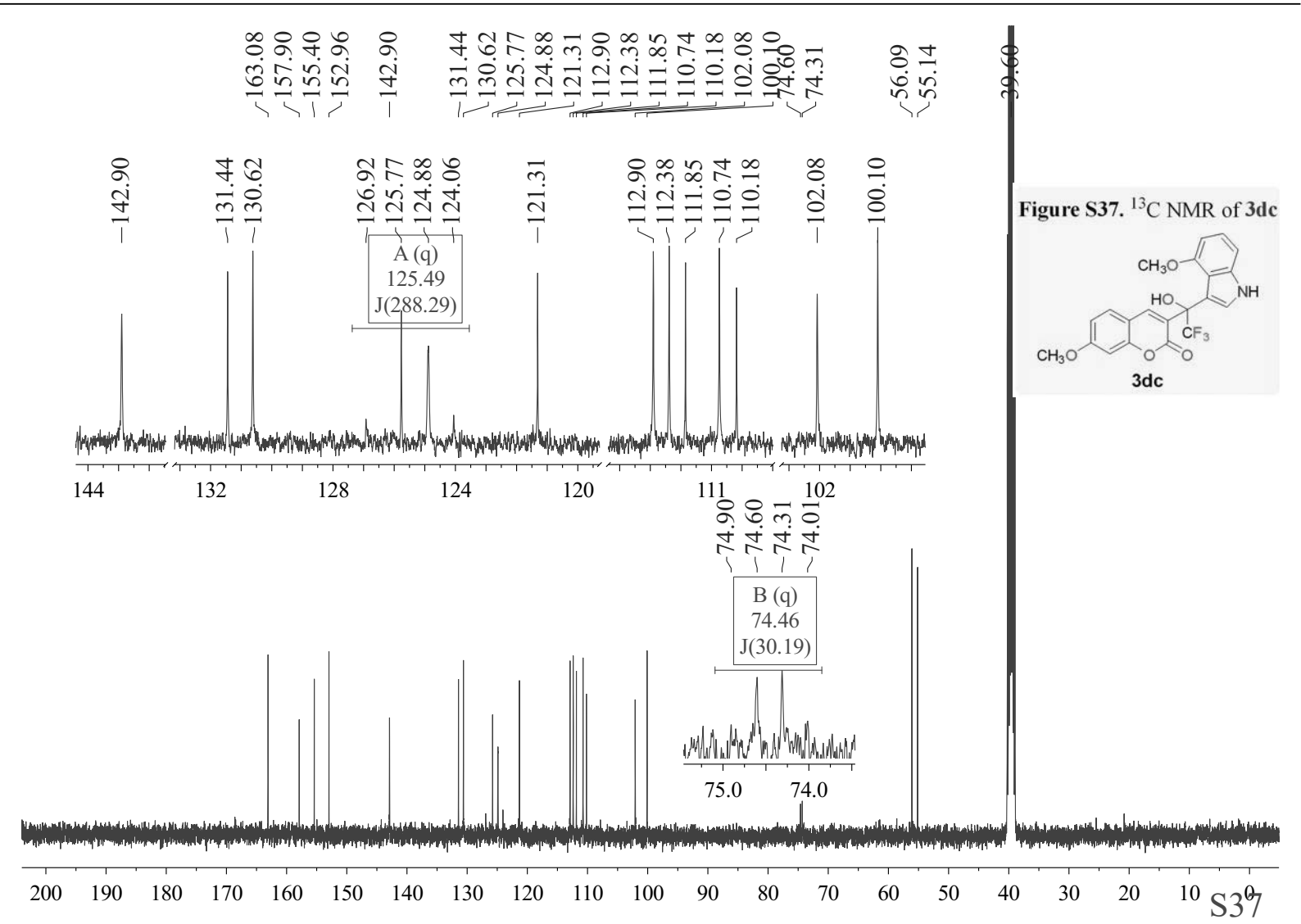


Figure S37. ^{13}C NMR of **3dc**

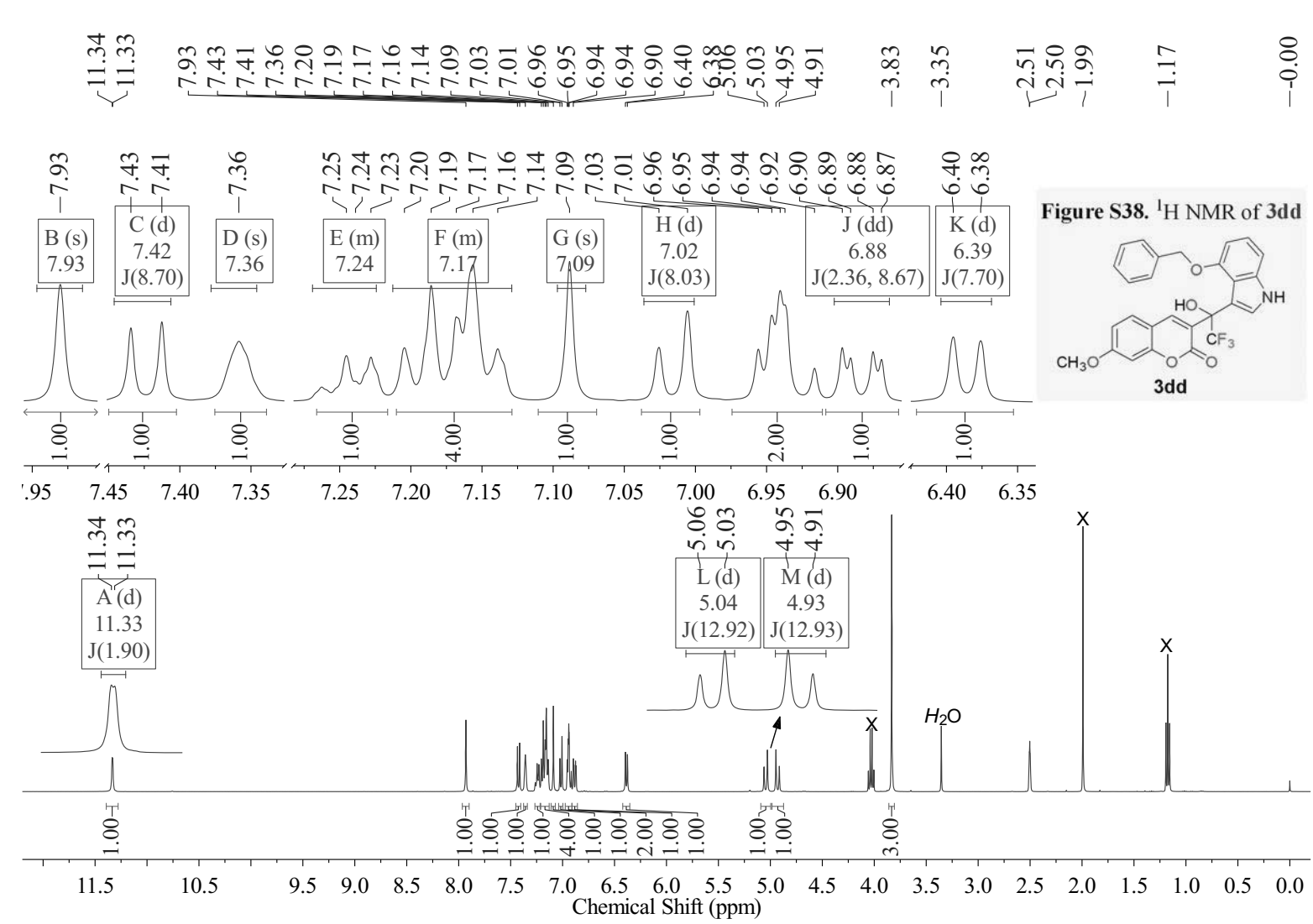


Figure S38. ^{1}H NMR of **3dd**

3dd

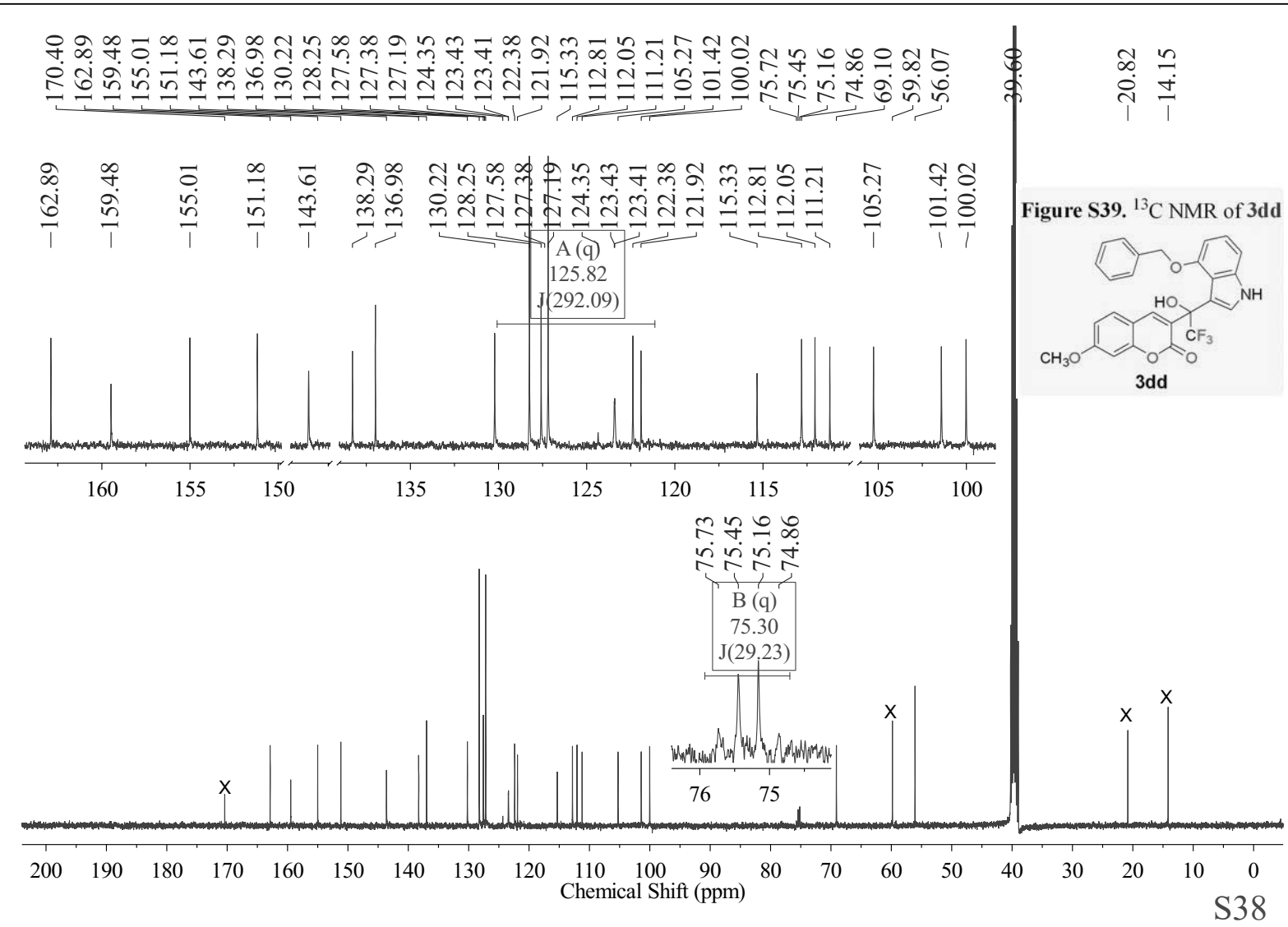


Figure S39. ^{13}C NMR of **3dd**

3dd

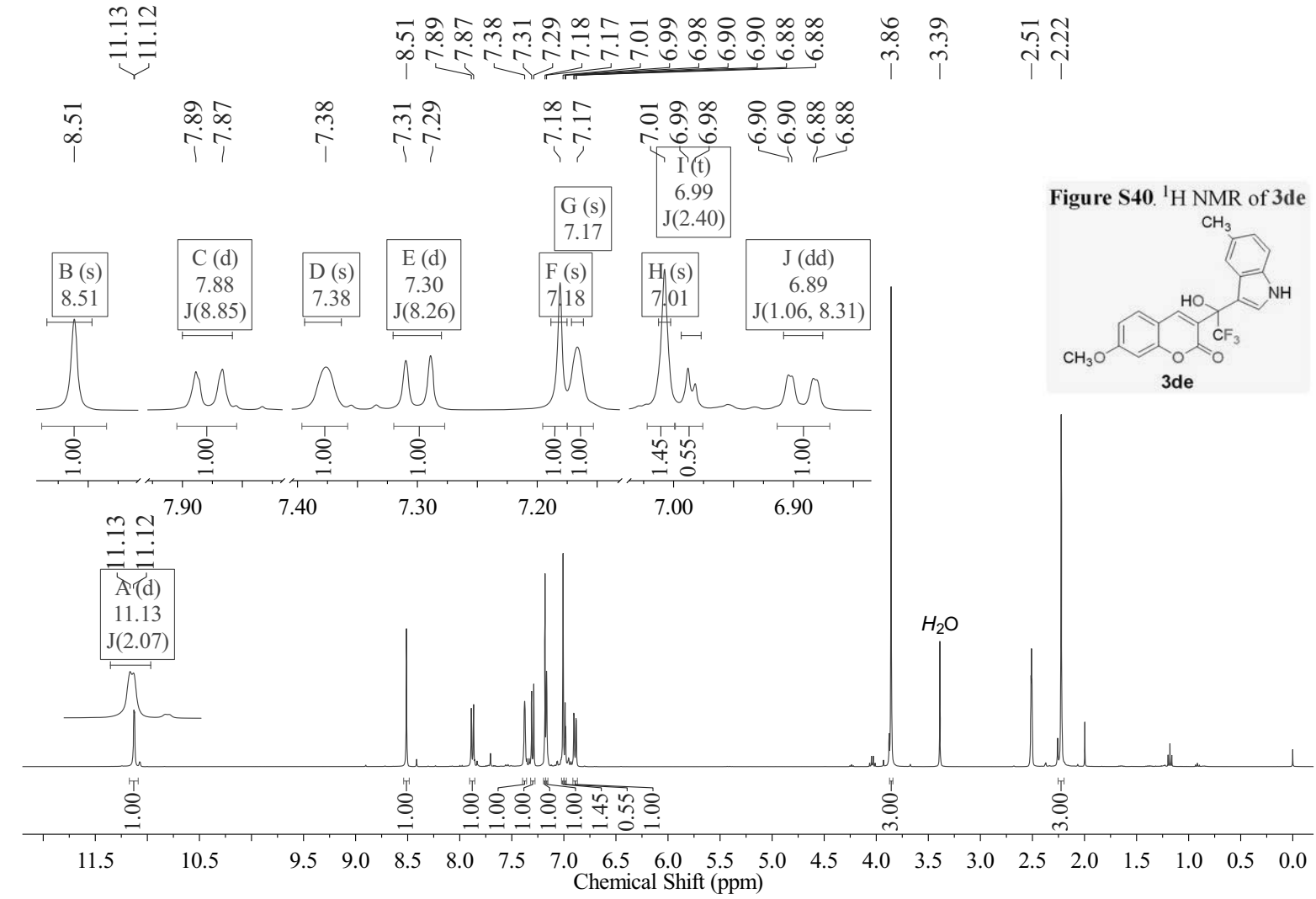


Figure S40. ^{1}H NMR of **3de**

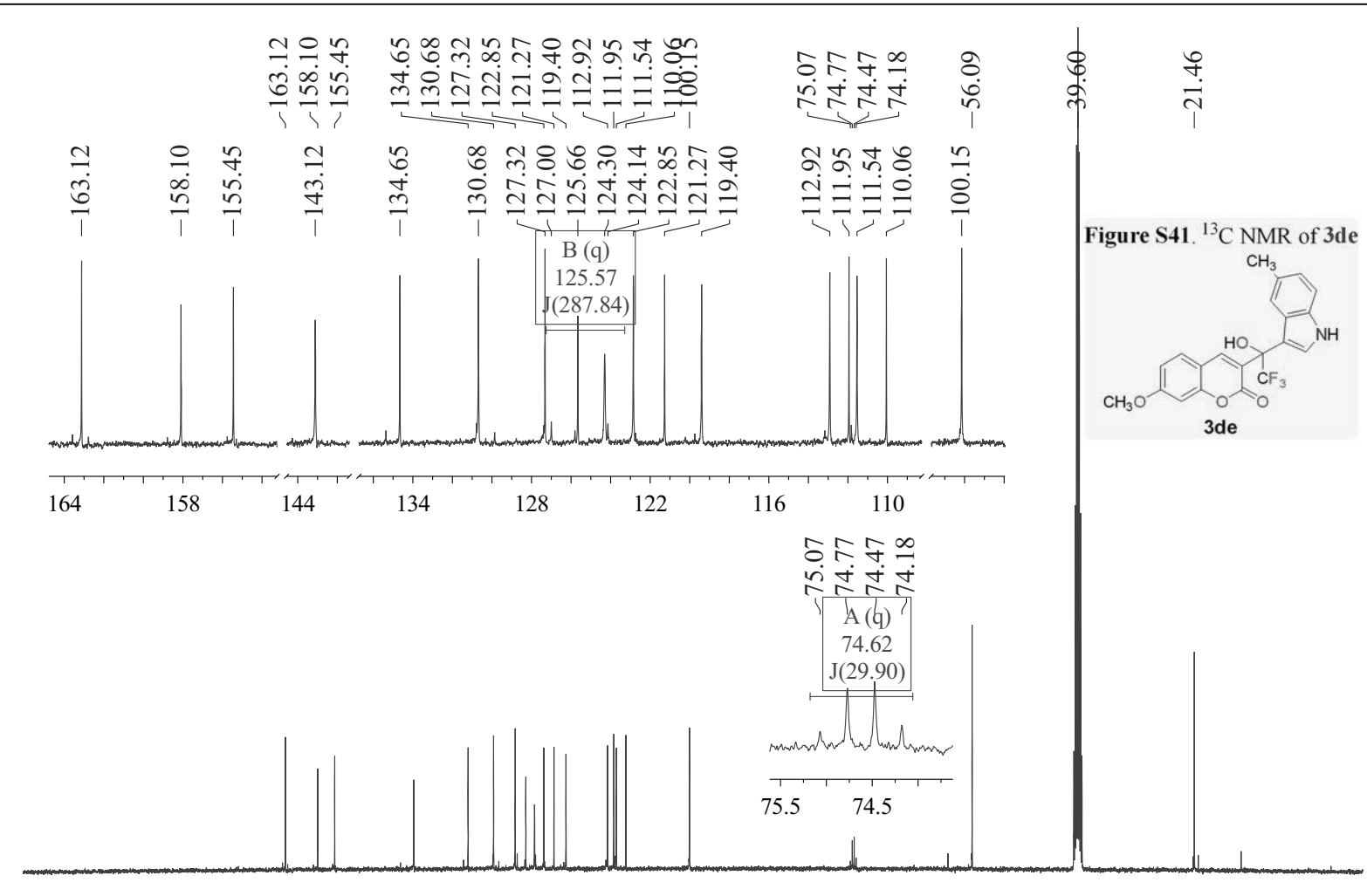


Figure S41. ^{13}C NMR of **3de**

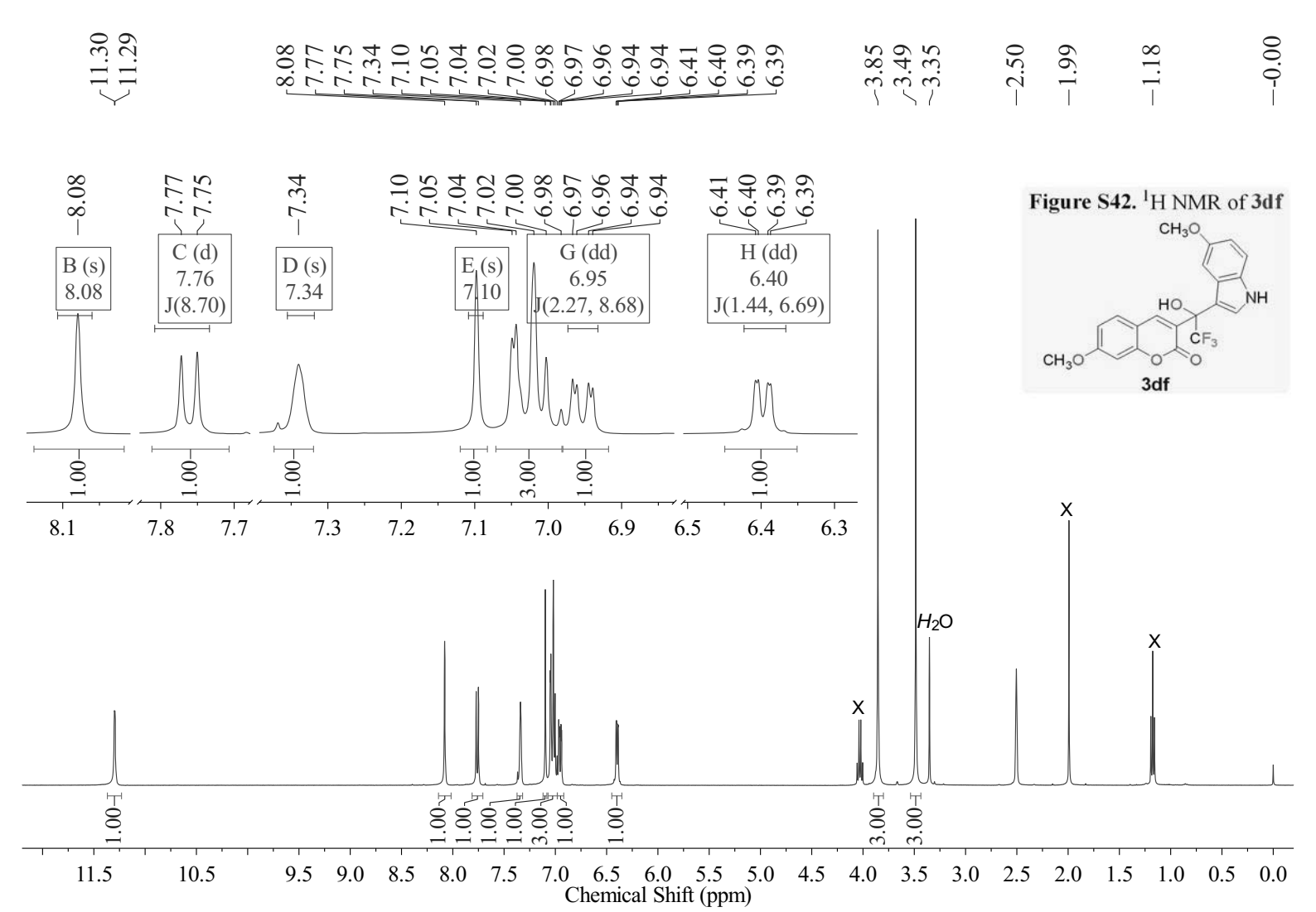


Figure S42. ^{1}H NMR of **3df**

3df

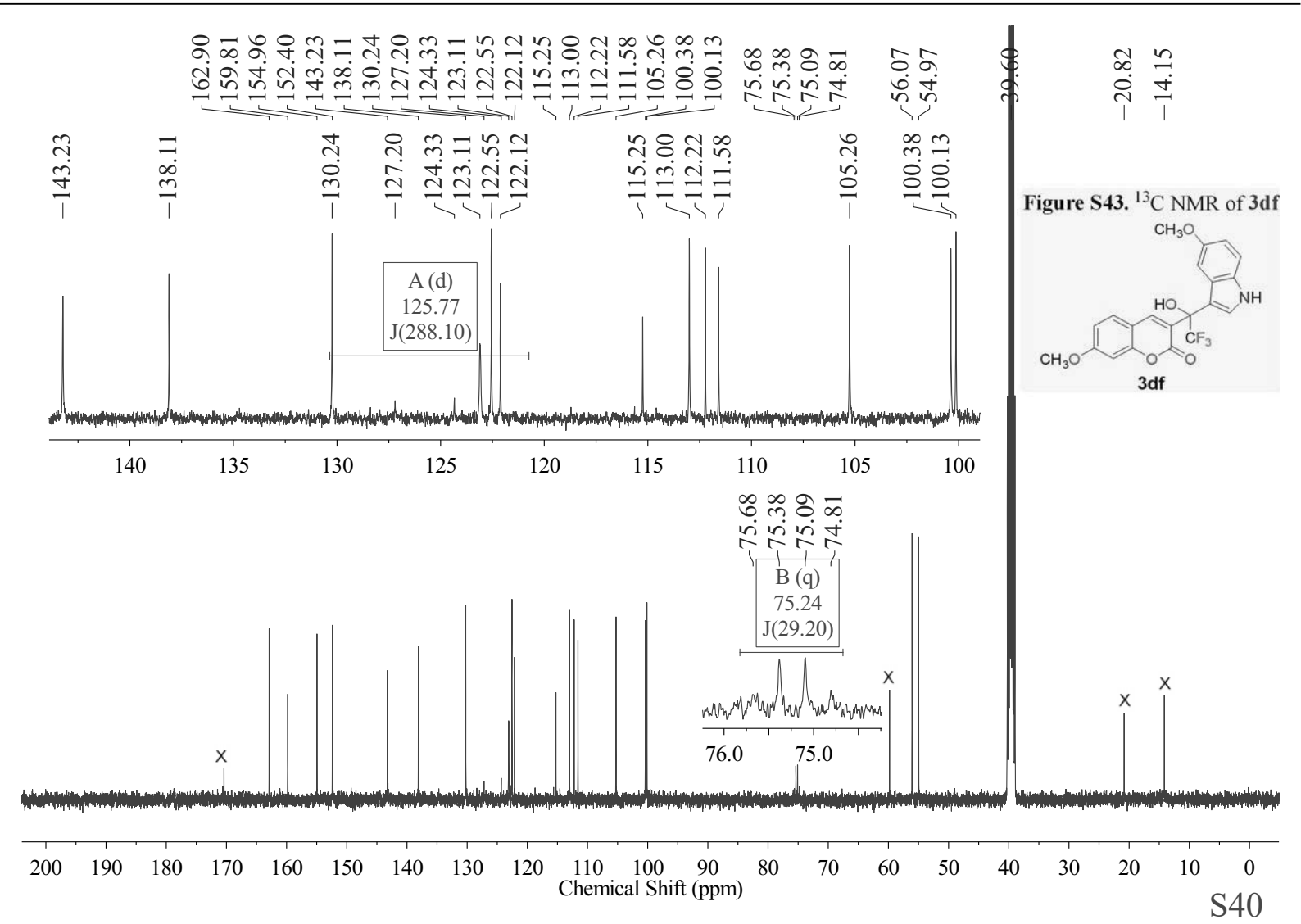


Figure S43. ^{13}C NMR of **3df**

3df

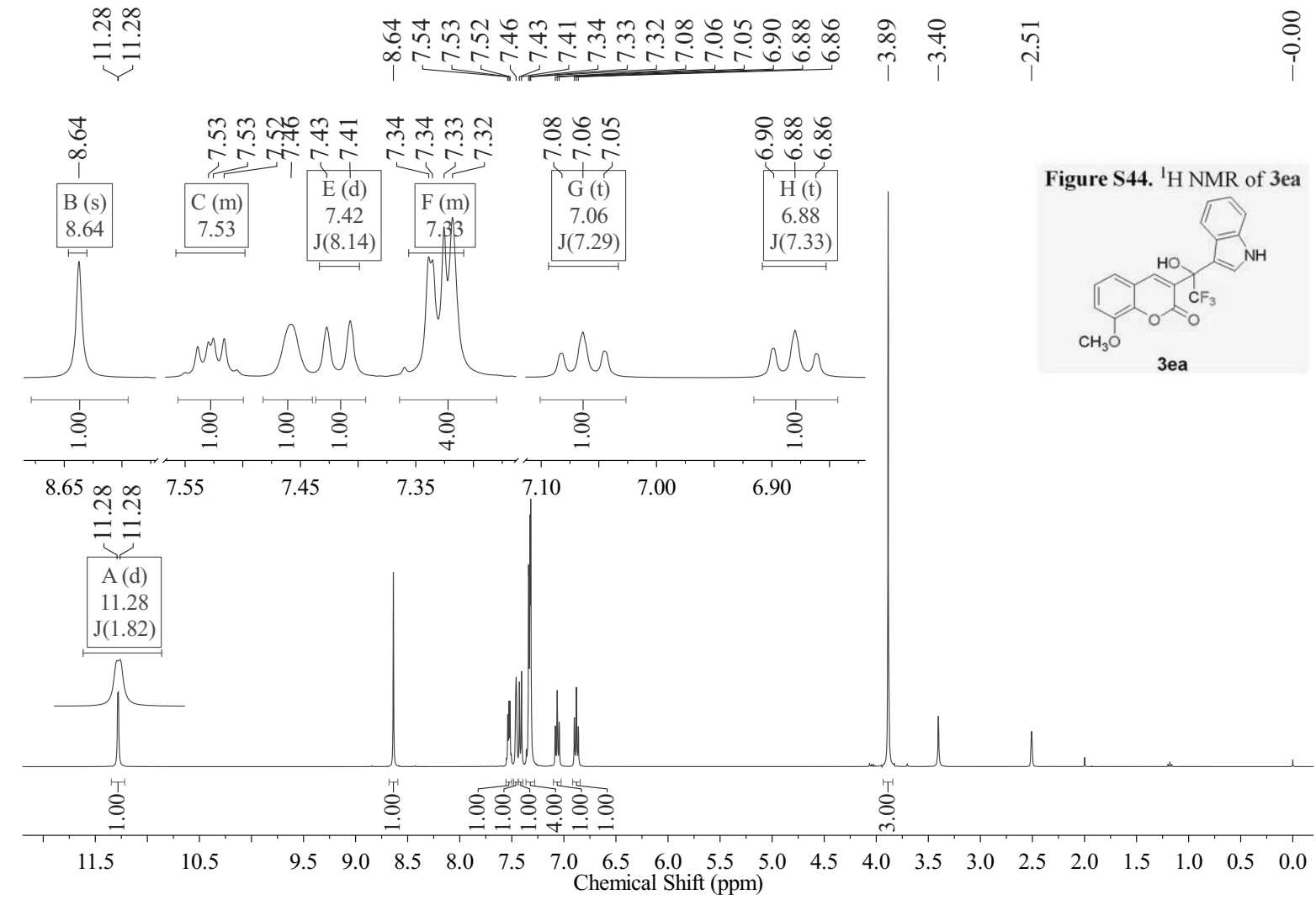


Figure S44. ^{1}H NMR of **3ea**

3ea

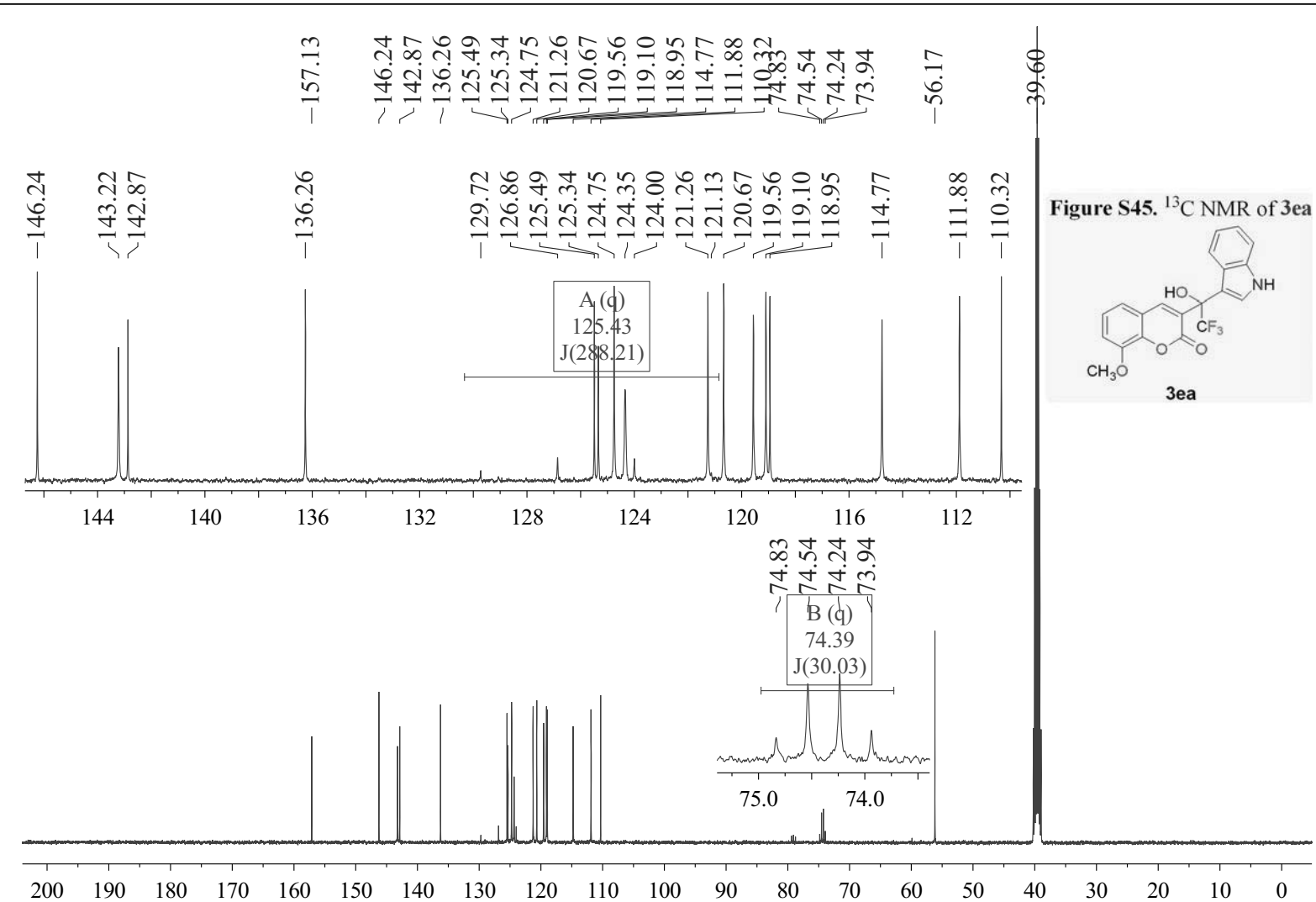


Figure S45. ^{13}C NMR of **3ea**

3ea

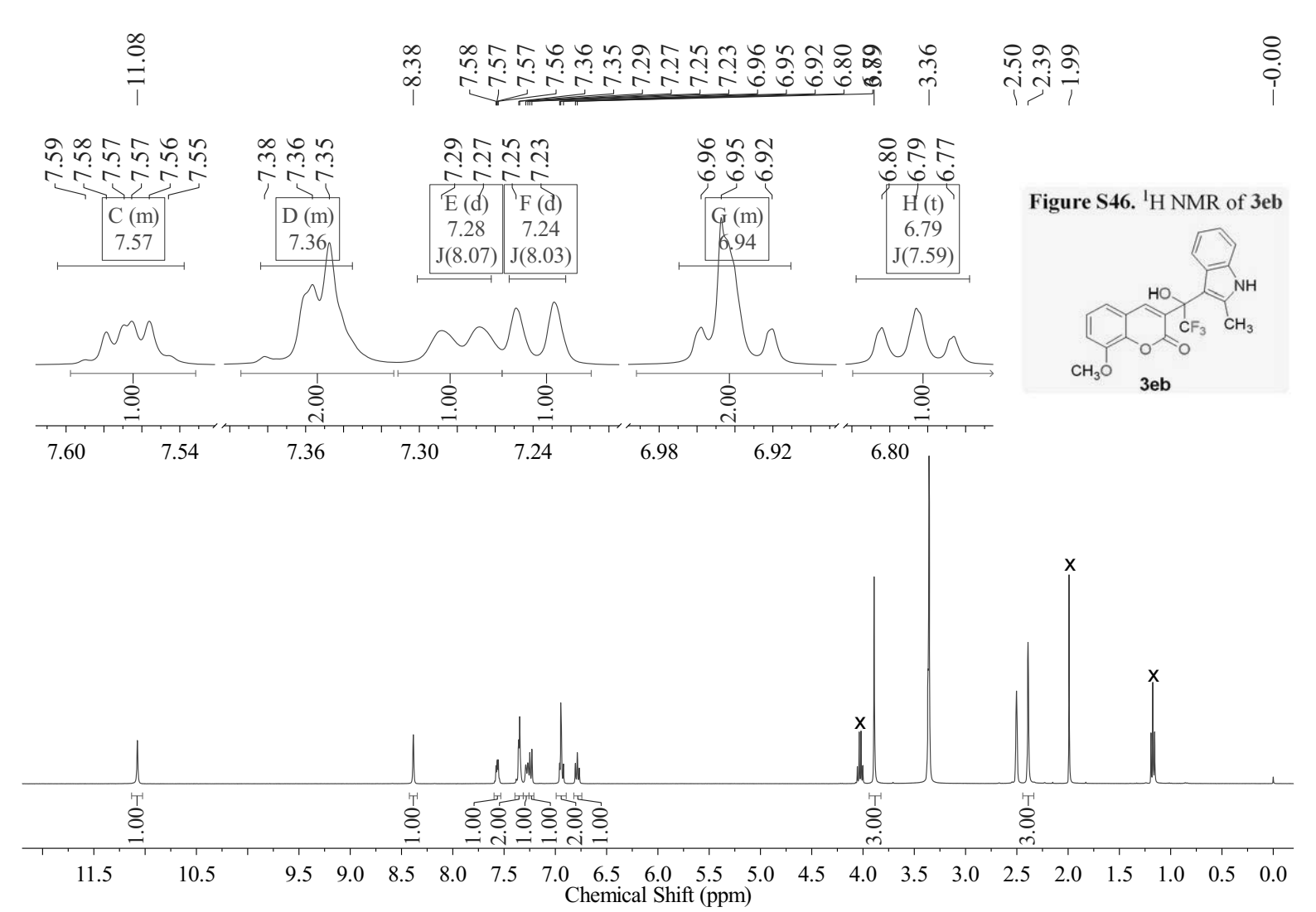


Figure S46. ^{1}H NMR of **3eb**

3eb

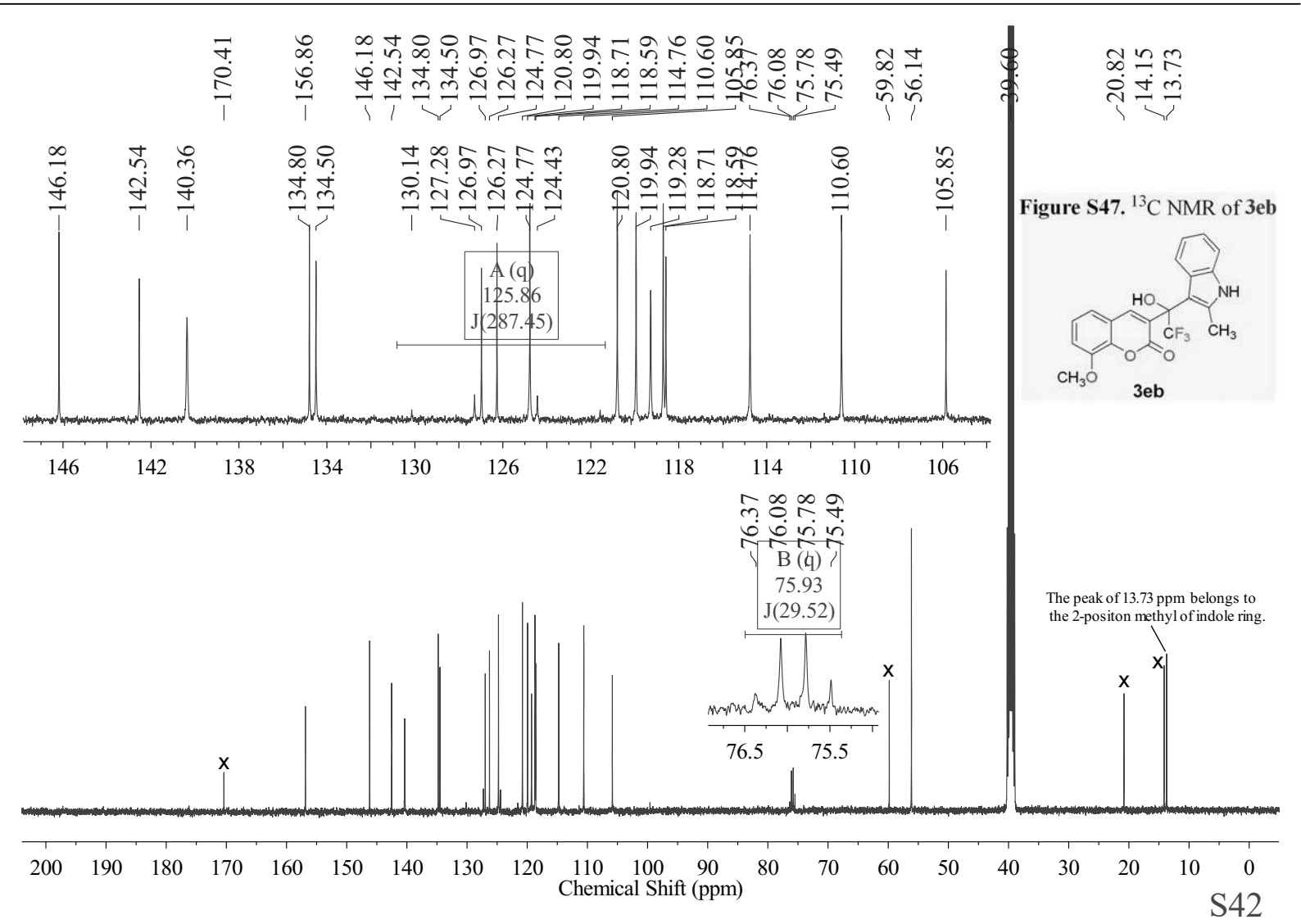


Figure S47. ^{13}C NMR of **3eb**

3eb

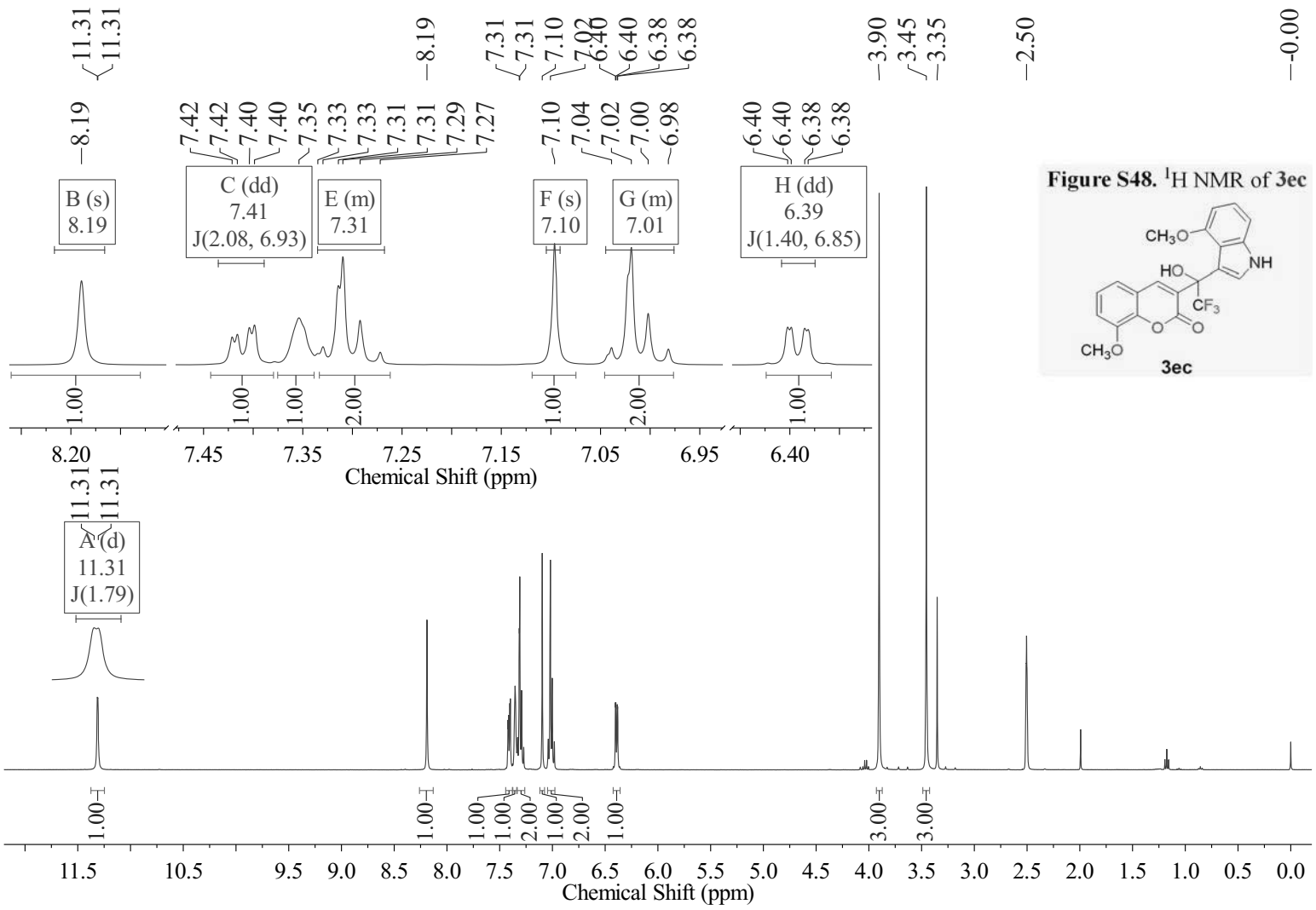


Figure S48. ^{1}H NMR of **3ec**

3ec

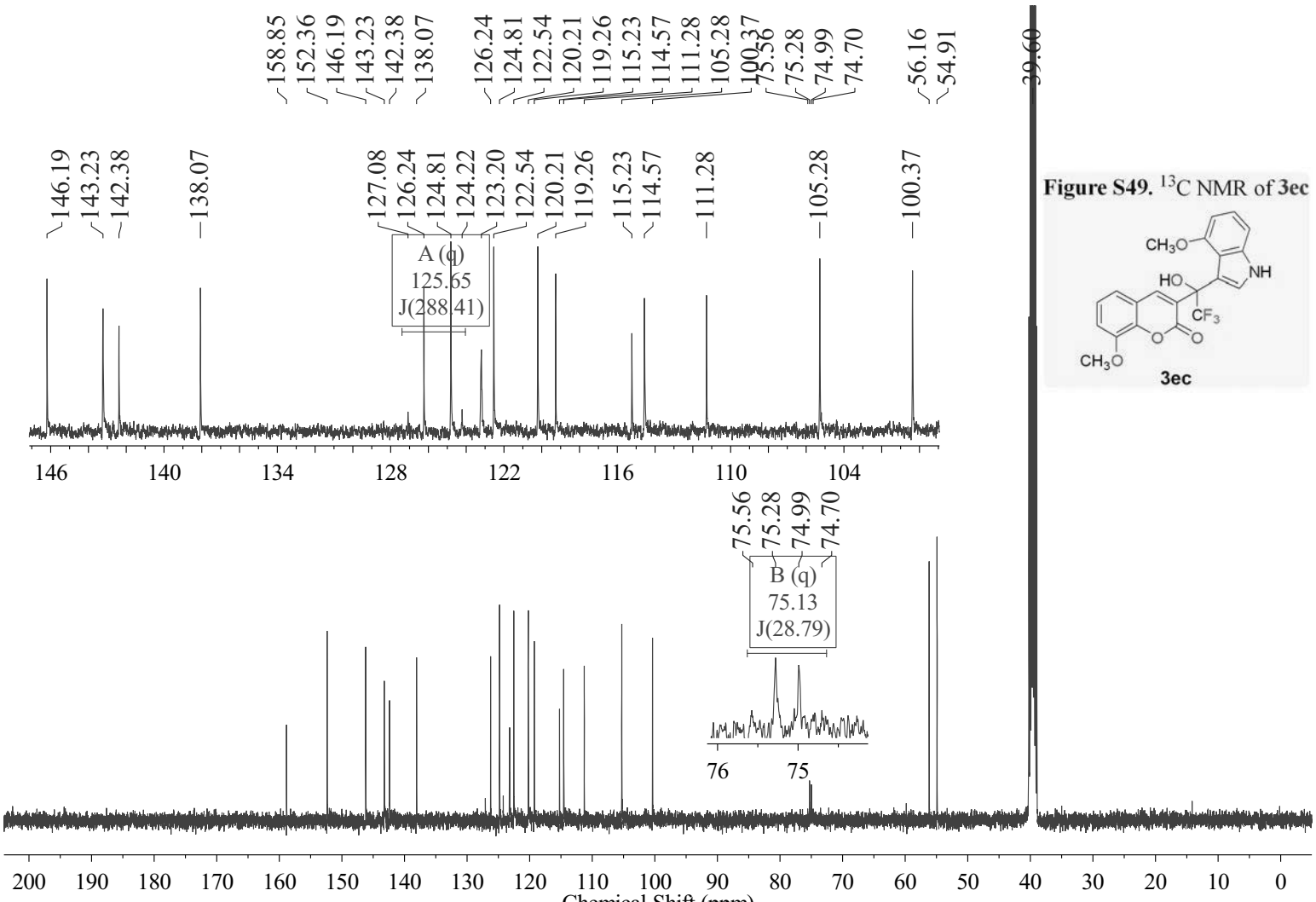


Figure S49. ^{13}C NMR of **3ec**

3ec

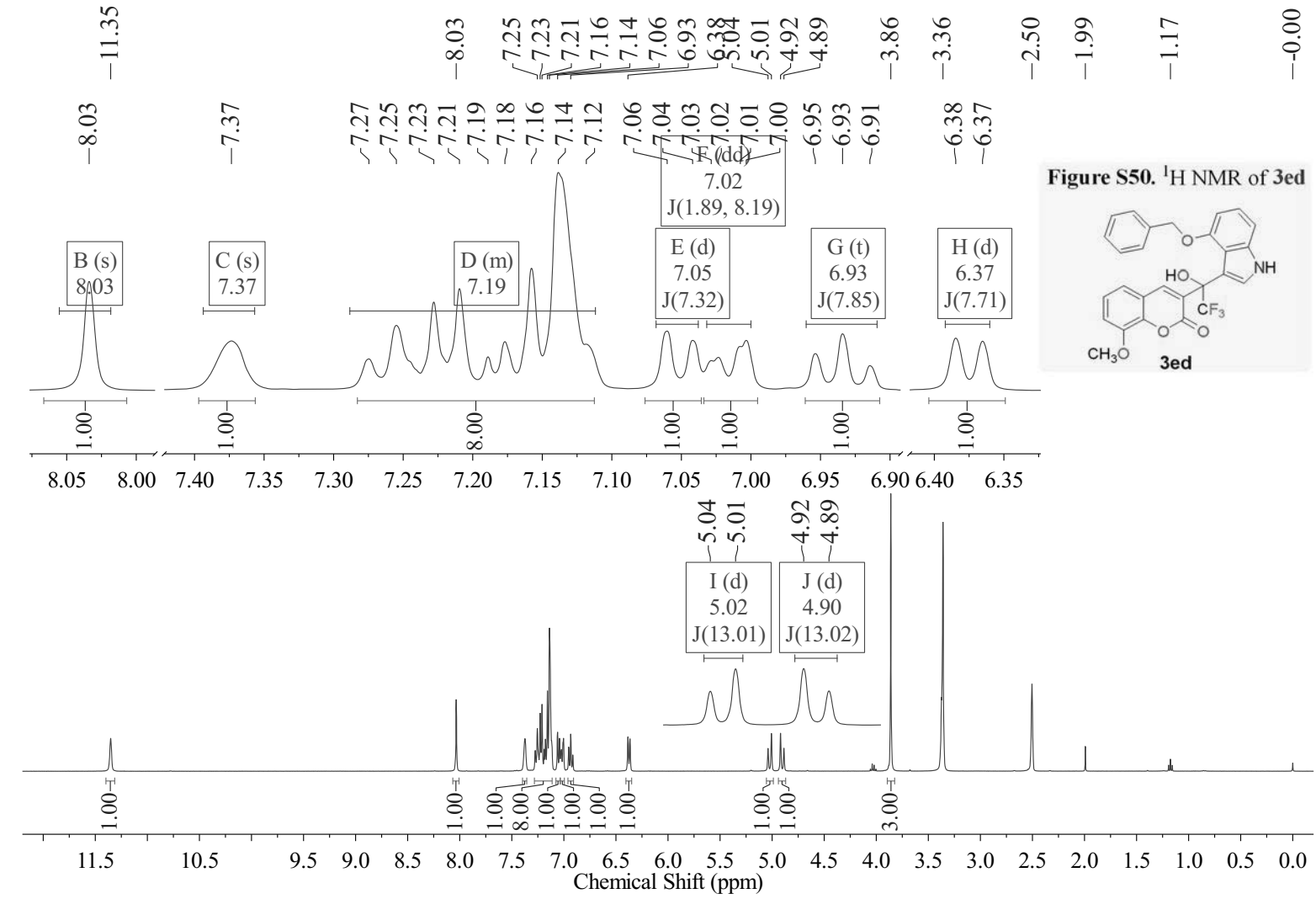


Figure S50. ^{1}H NMR of **3ed**

3ed

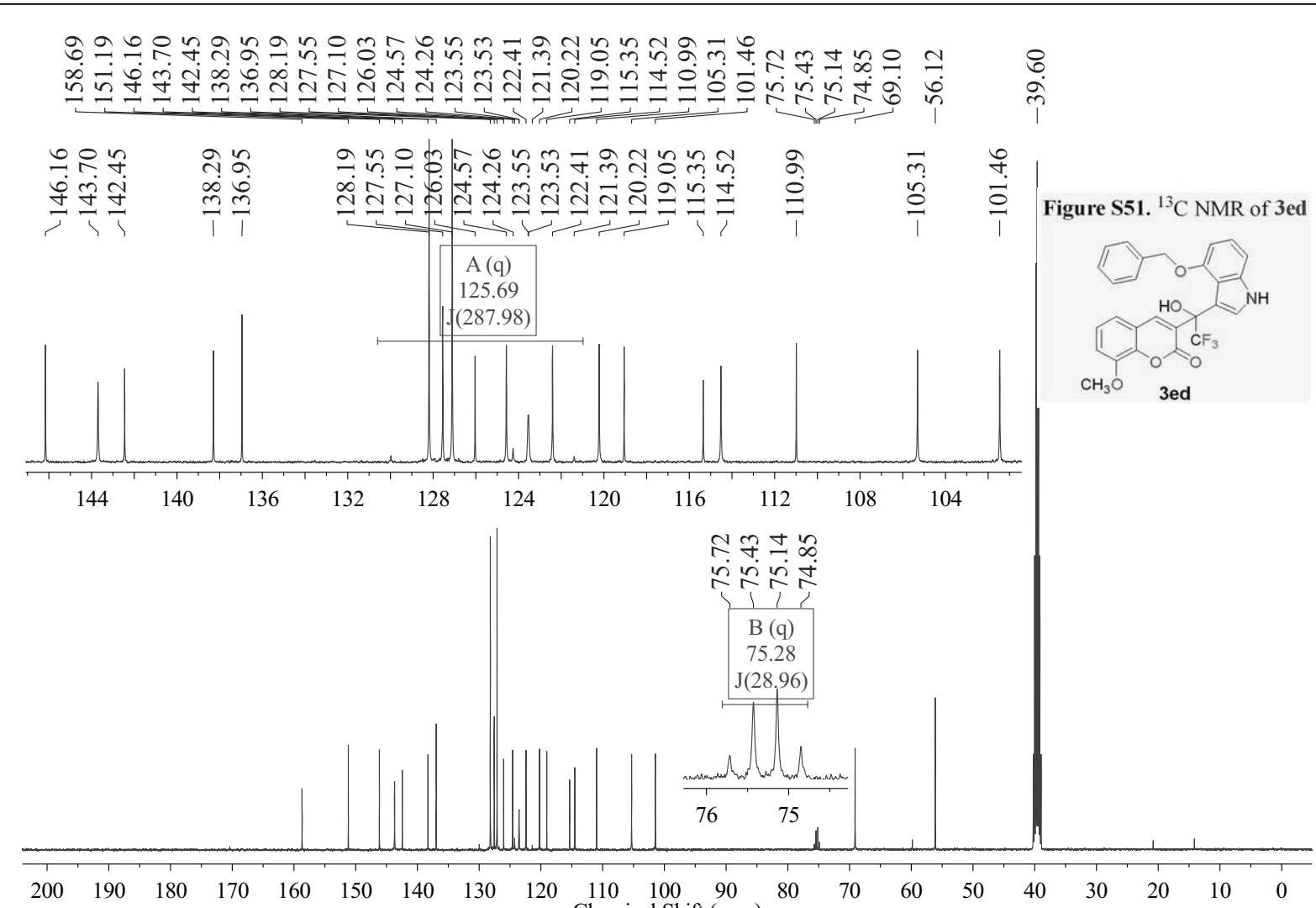


Figure S51. ^{13}C NMR of **3ed**

3ed

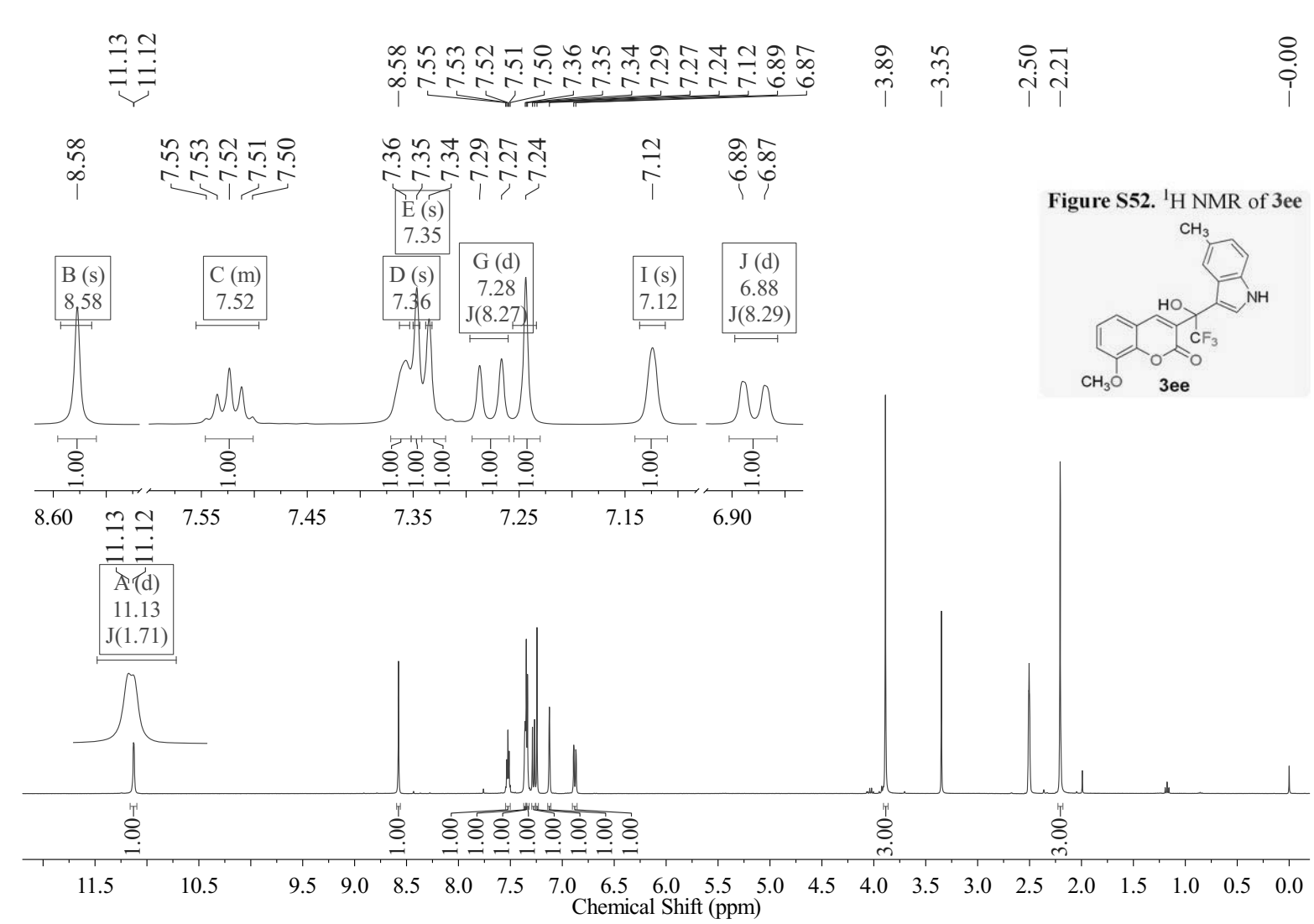


Figure S52. ^{1}H NMR of **3ee**

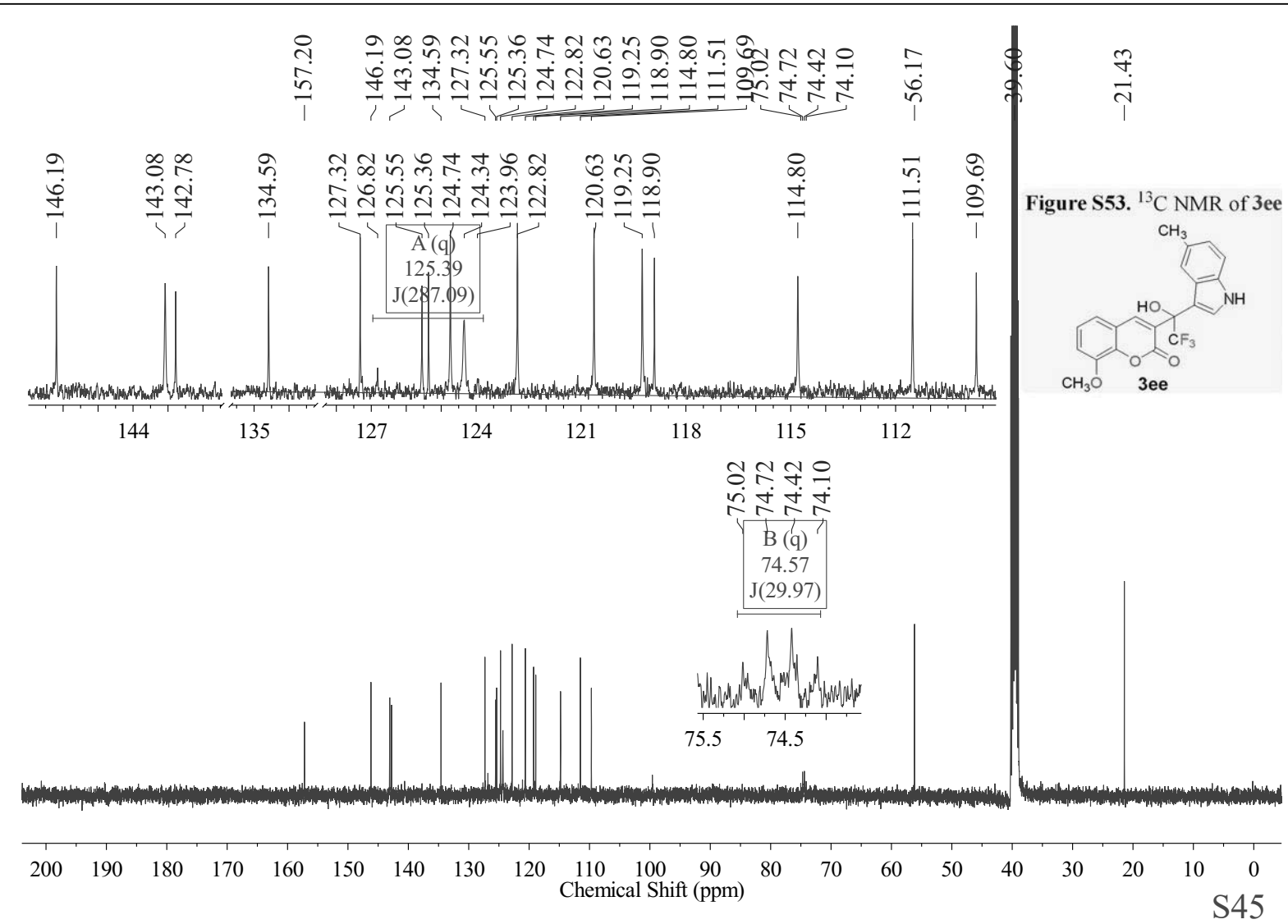


Figure S53. ^{13}C NMR of **3ee**

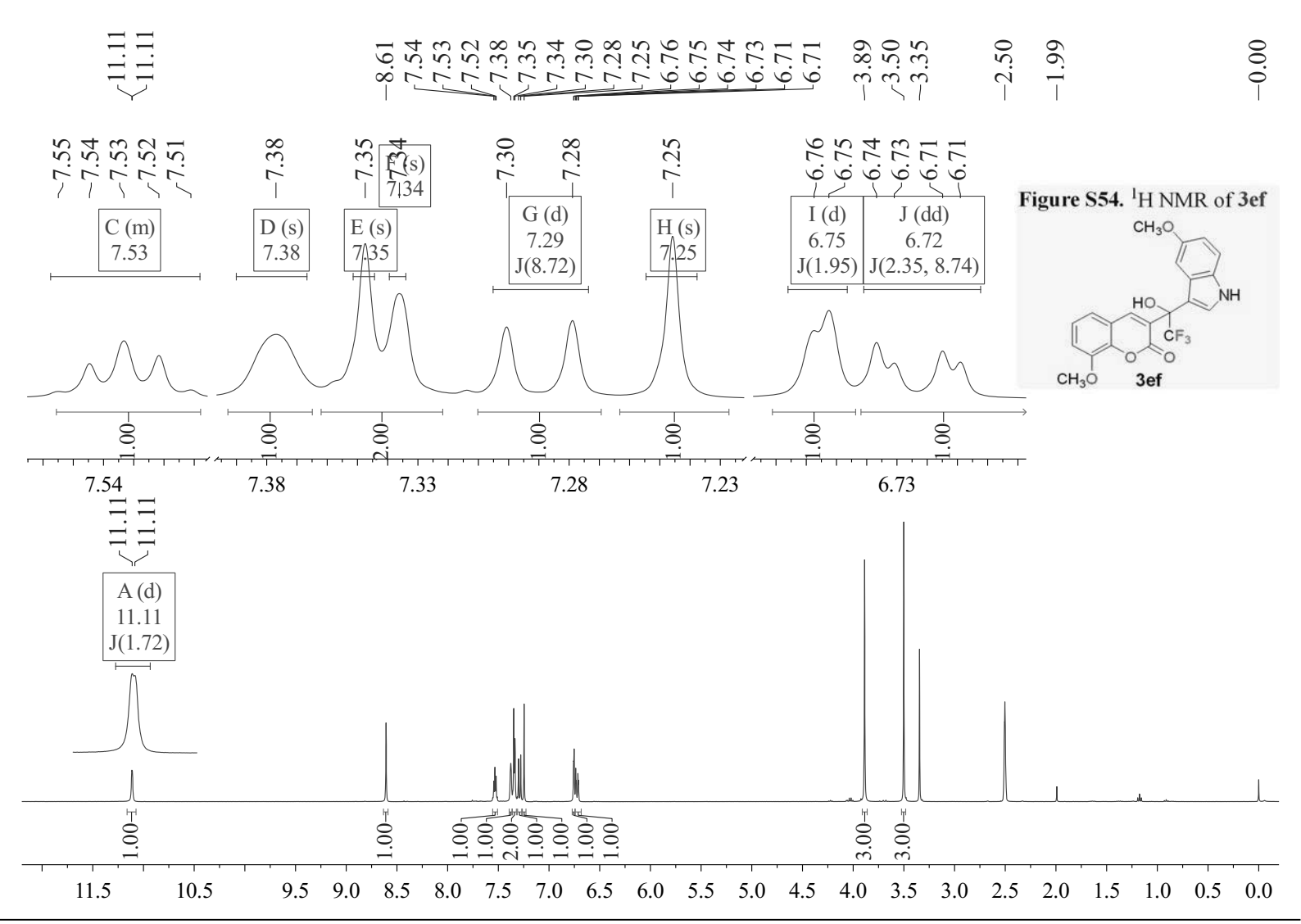


Figure S54. ^{1}H NMR of **3ef**

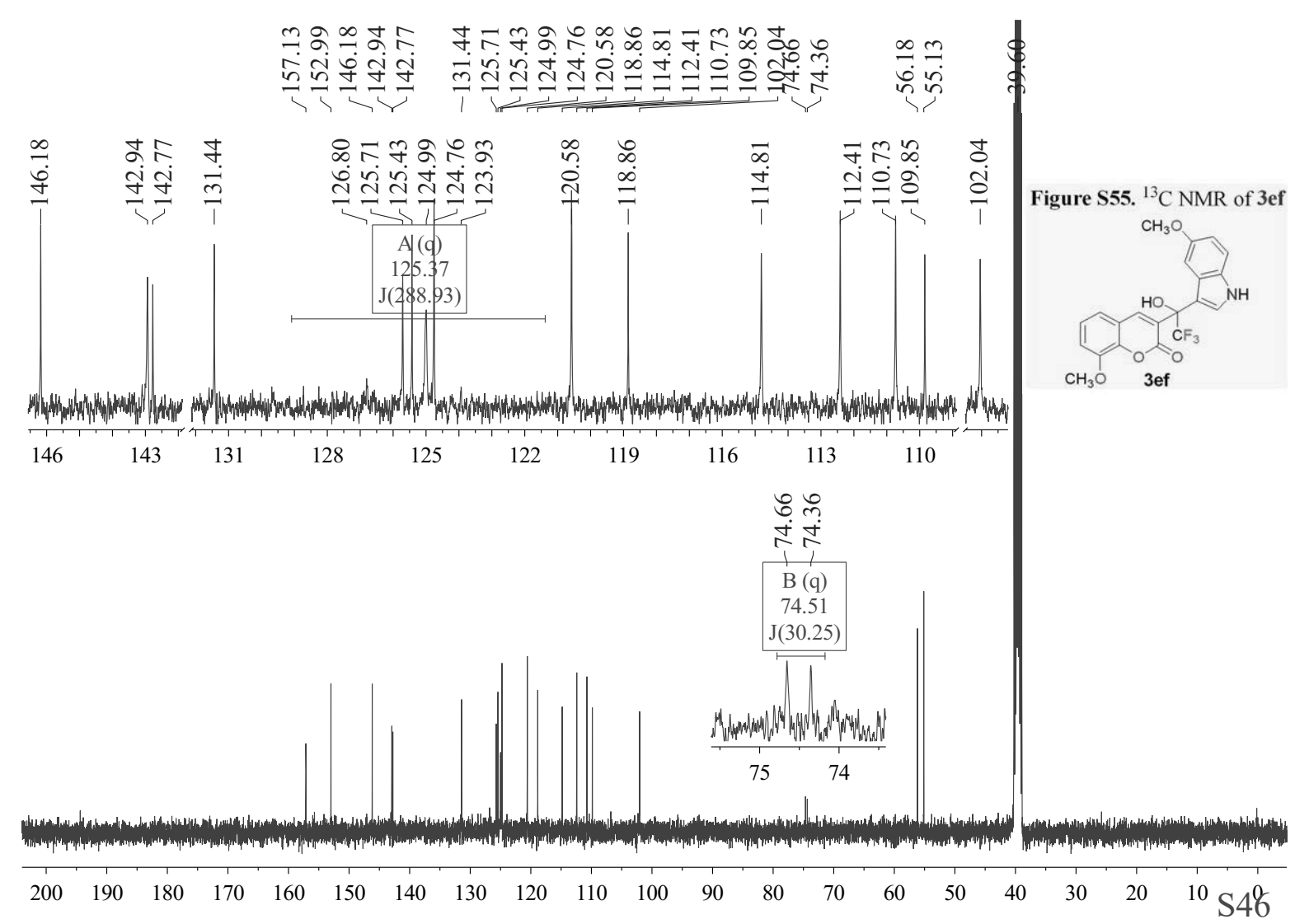


Figure S55. ^{13}C NMR of **3ef**

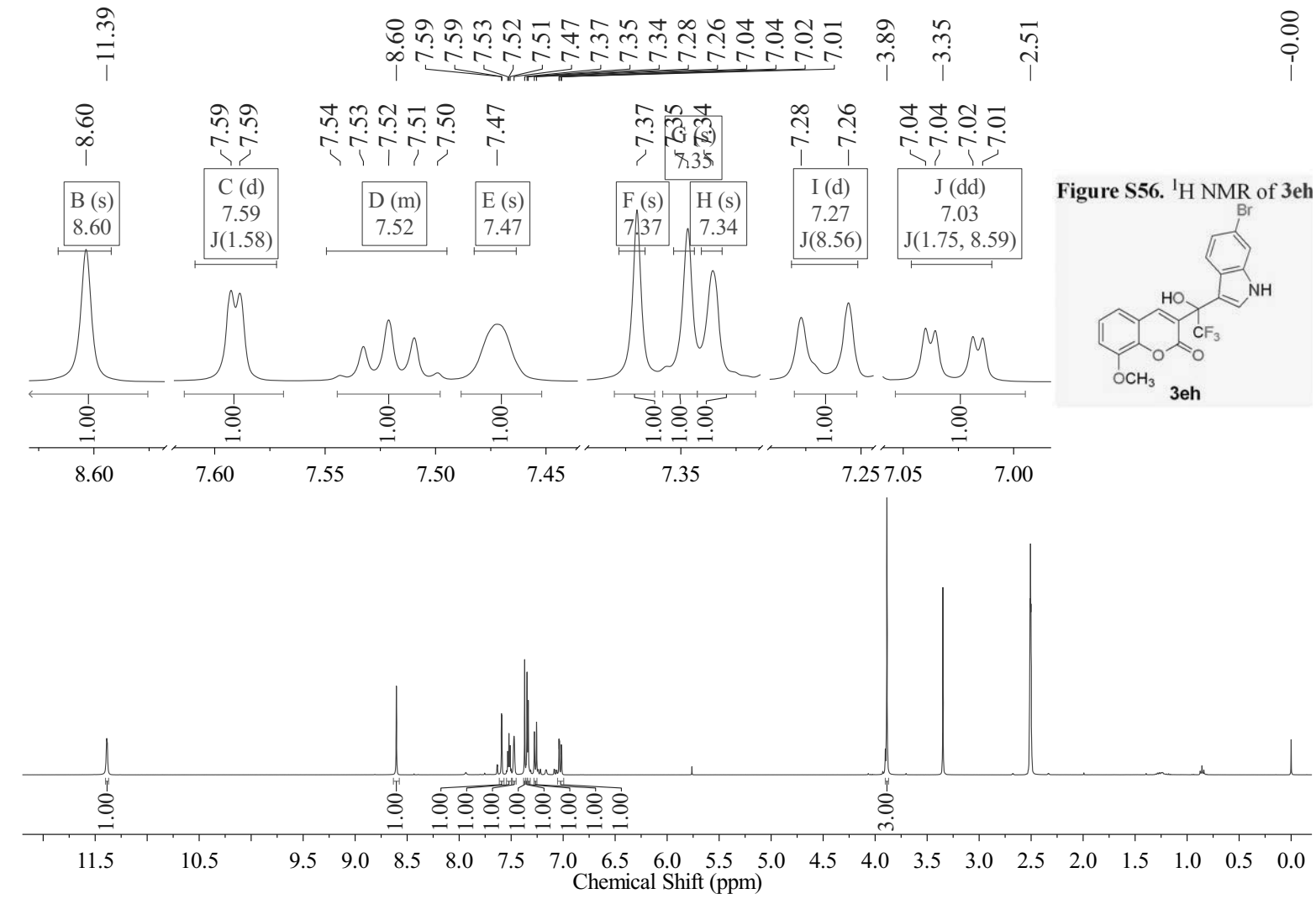


Figure S56. ^{1}H NMR of **3eh**

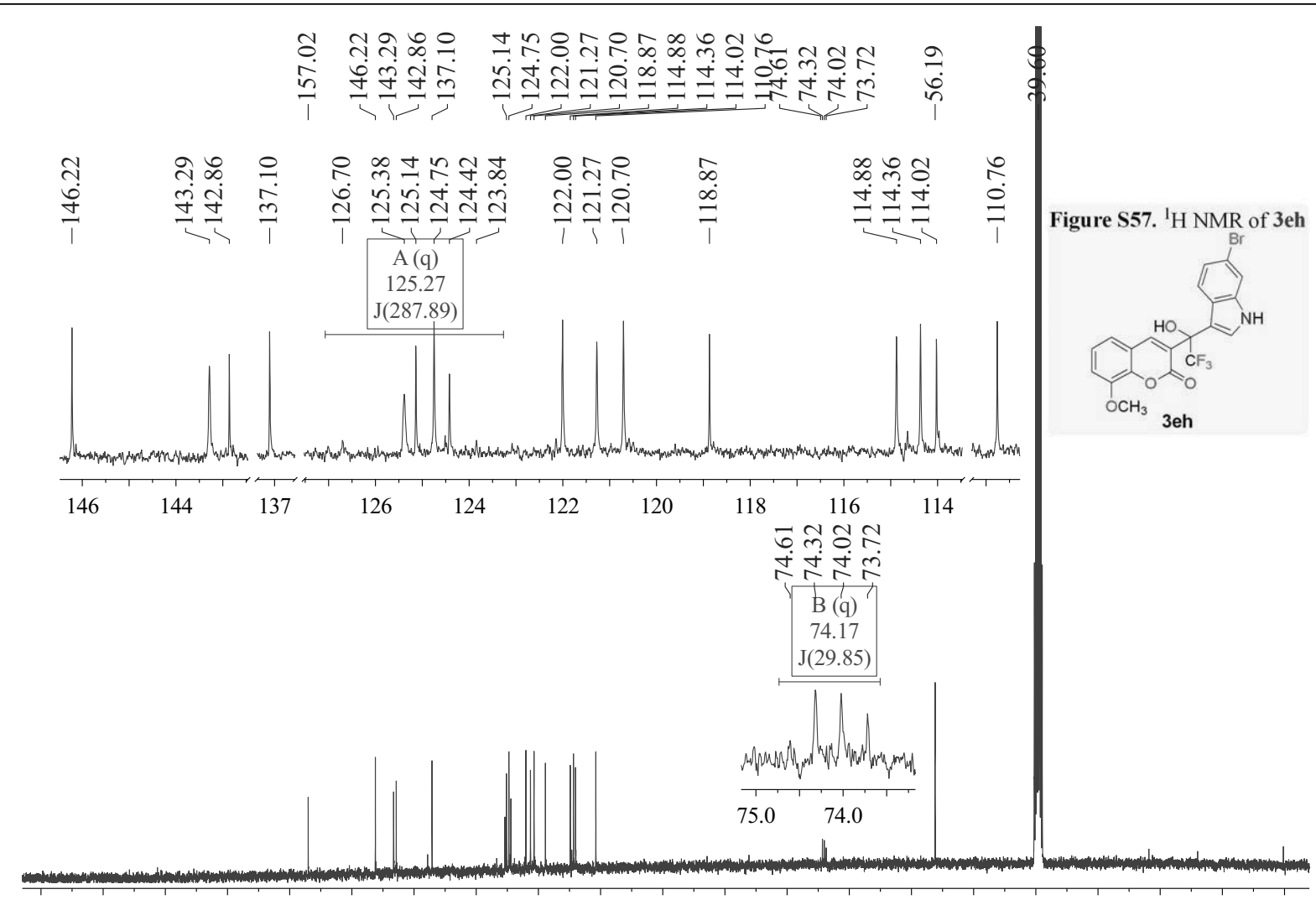
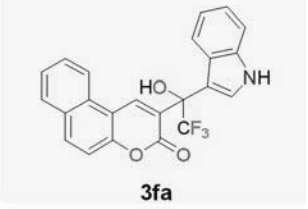


Figure S57. ^{1}H NMR of **3eh**

Figure S58. ^{1}H NMR of **3fa**



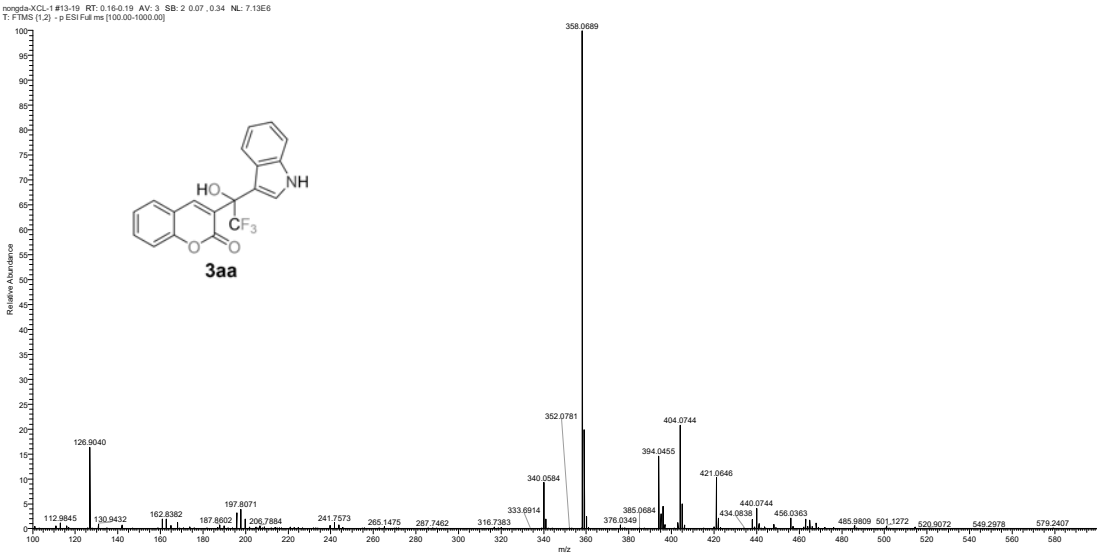
3fa

Figure S59. ^{13}C NMR of **3fa**

3fa

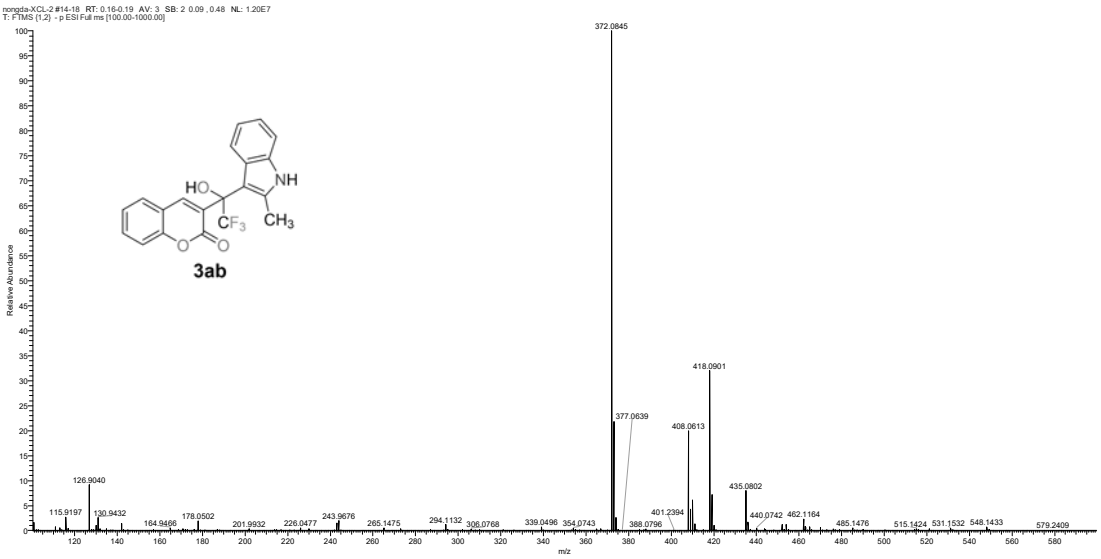
3. High Resolution Mass Spectra for compounds 3aa-3fa

Contents of HRMS Data



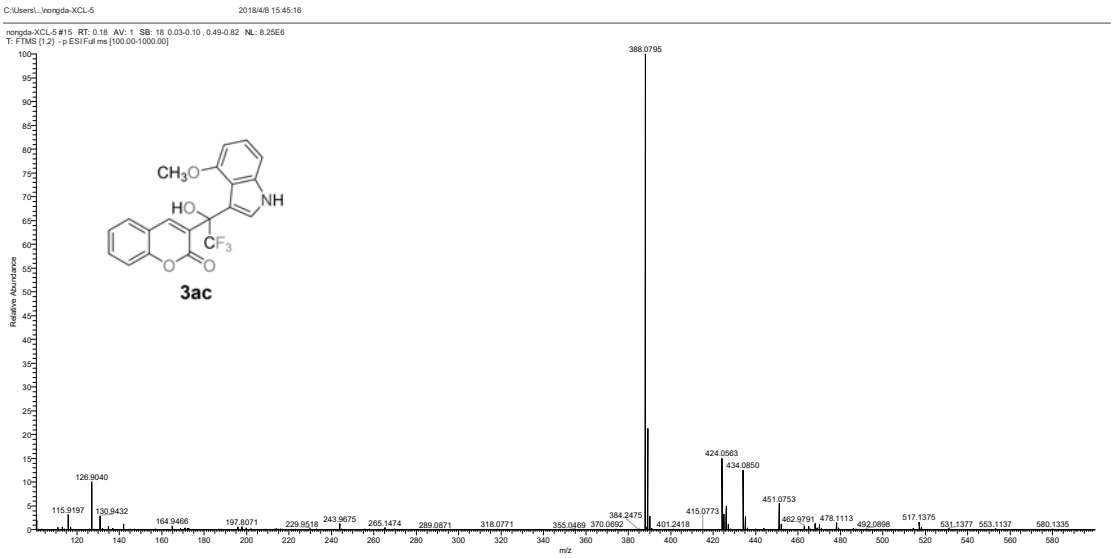
HRMS: *m/z* calcd for $C_{19}H_{11}F_3NO_3$: 358.0691 $[M-H]^+$; found: 358.0689.

Figure S60. HRMS of **3aa**



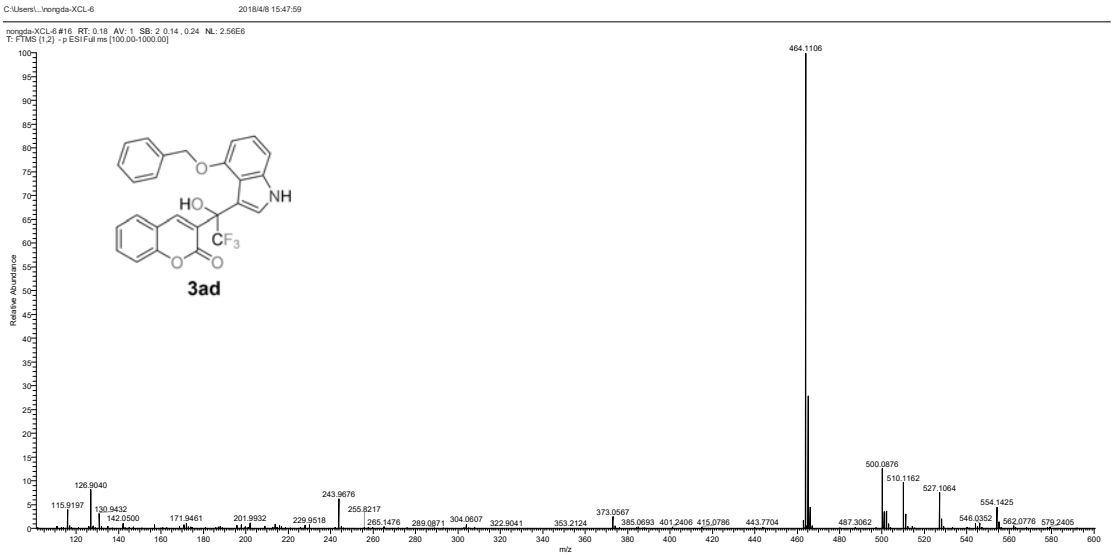
HRMS: *m/z* calcd for $C_{20}H_{13}F_3NO_3$: 372.0848 $[M-H]^+$; found: 372.0845.

Figure S61. HRMS of **3ab**



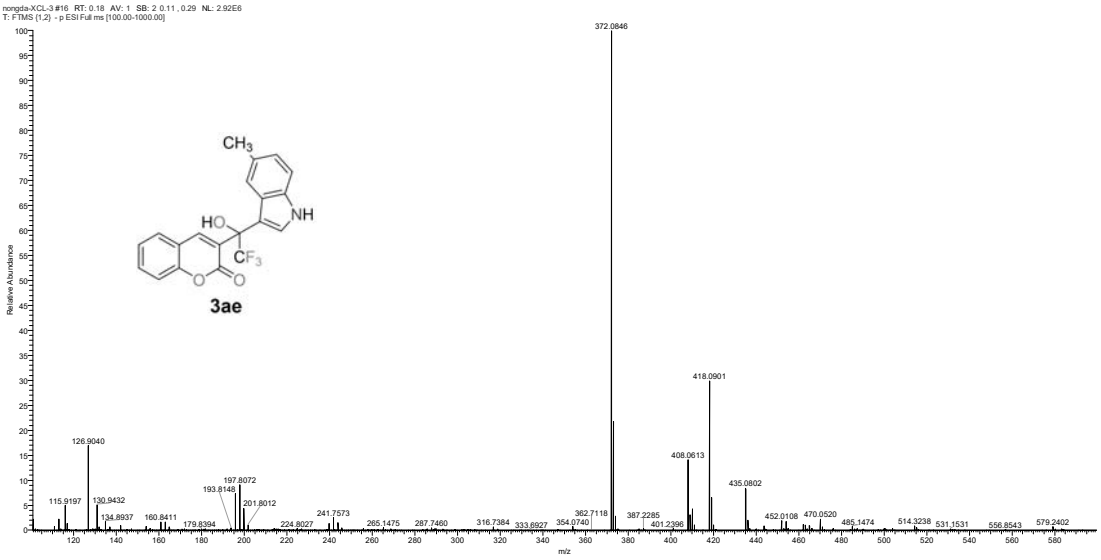
HRMS *m/z* calcd for $C_{20}H_{13}F_3NO_4$: 388.0797 $[M-H]^+$; found: 388.0795.

Figure S62. HRMS of 3ac



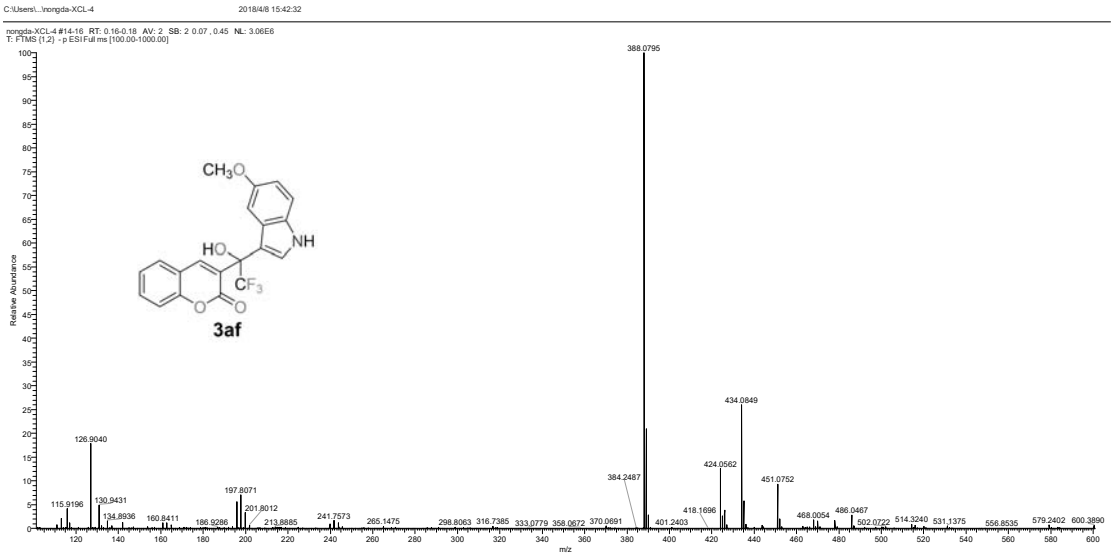
HRMS *m/z* calcd for $C_{26}H_{17}F_3NO_4$: 464.1110 $[M-H]^+$; found: 464.1106.

Figure S63. HRMS of 3ad



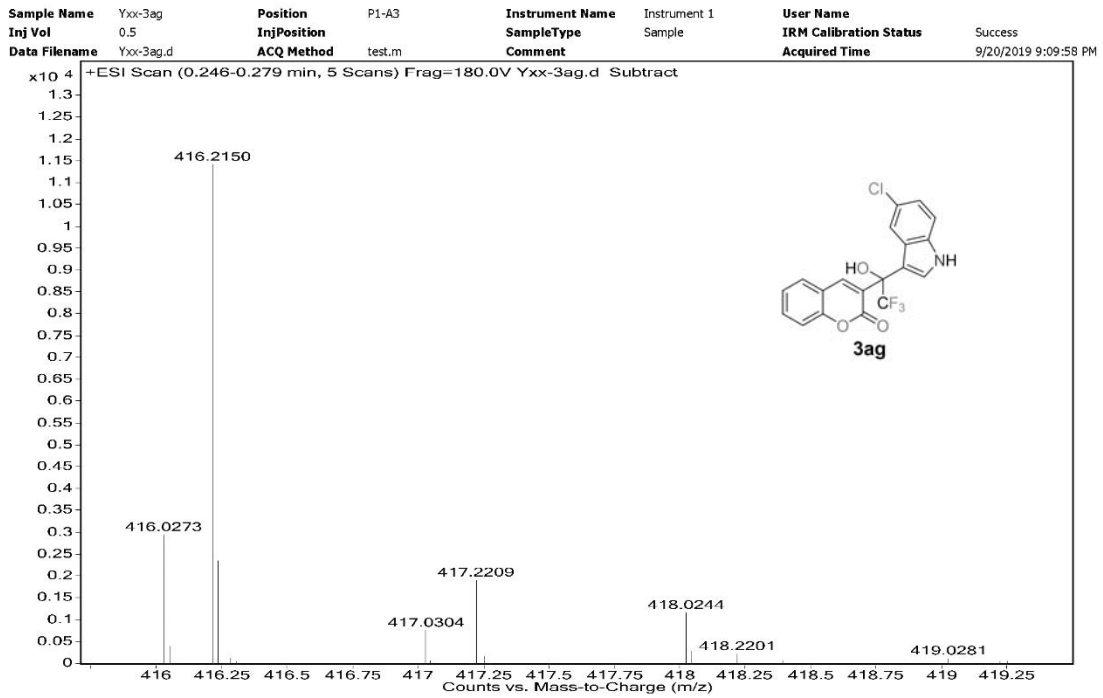
HRMS: *m/z* calcd for $C_{20}H_{13}F_3NO_3$: 372.0848 $[M-H]^+$; found: 372.0846.

Figure S64. HRMS of 3ae



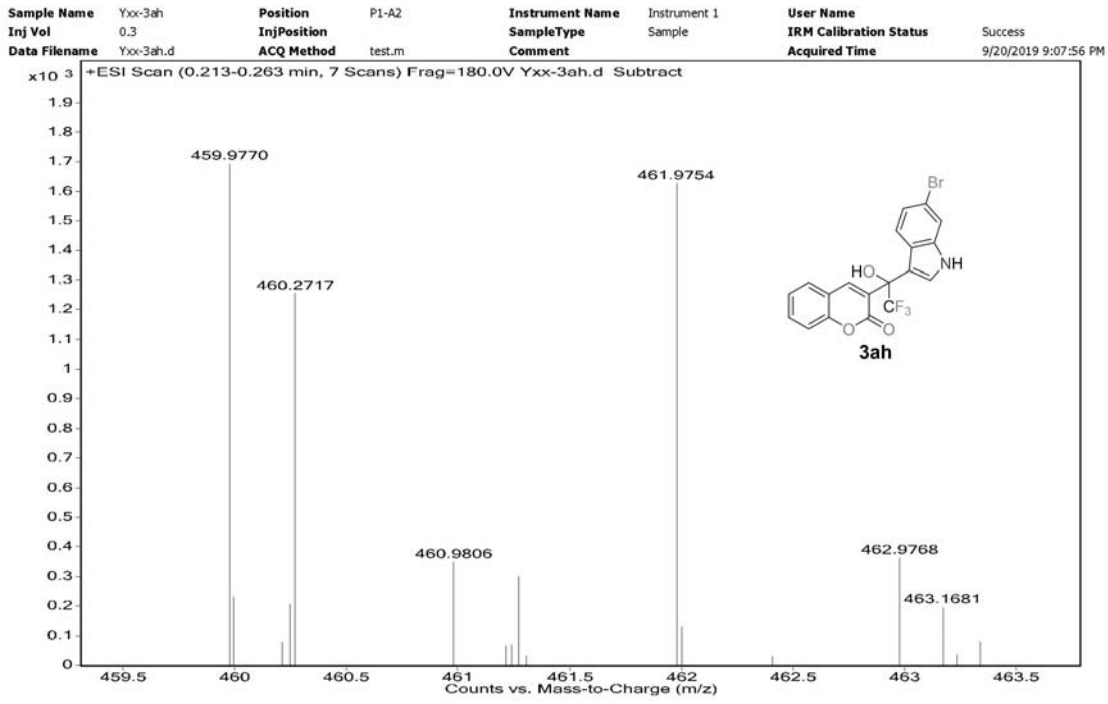
HRMS *m/z* calcd for $C_{20}H_{13}F_3NO_4$: 388.0797 $[M-H]^+$; found: 388.0795.

Figure S65. HRMS of 3af



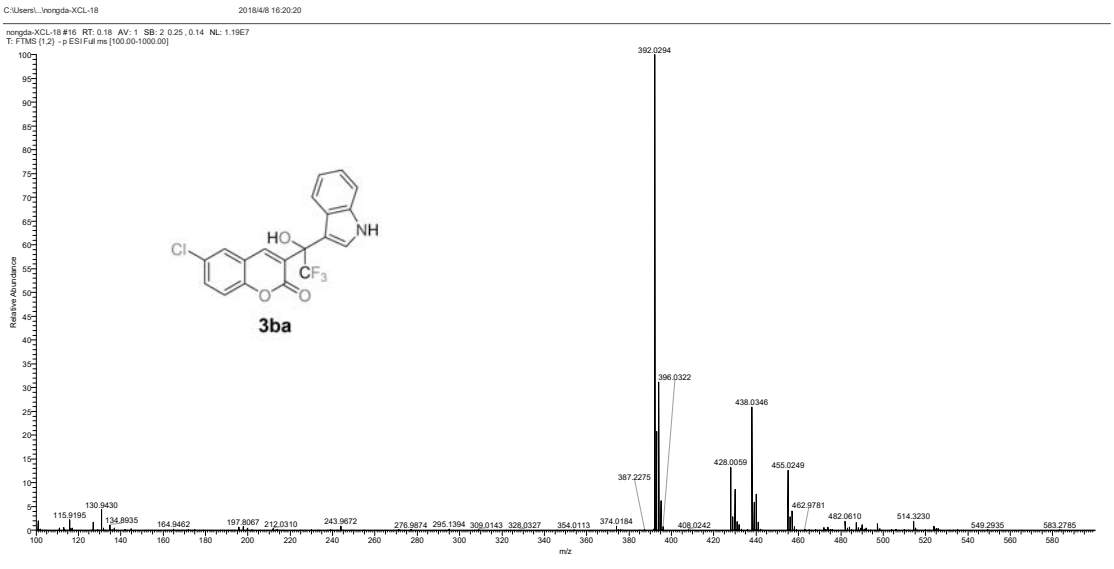
HRMS *m/z* calcd for $C_{19}H_{11}ClF_3NNaO_3$: 416.0277 $[M+Na]^+$; found:416.0273.

Figure S66. HRMS of 3ag



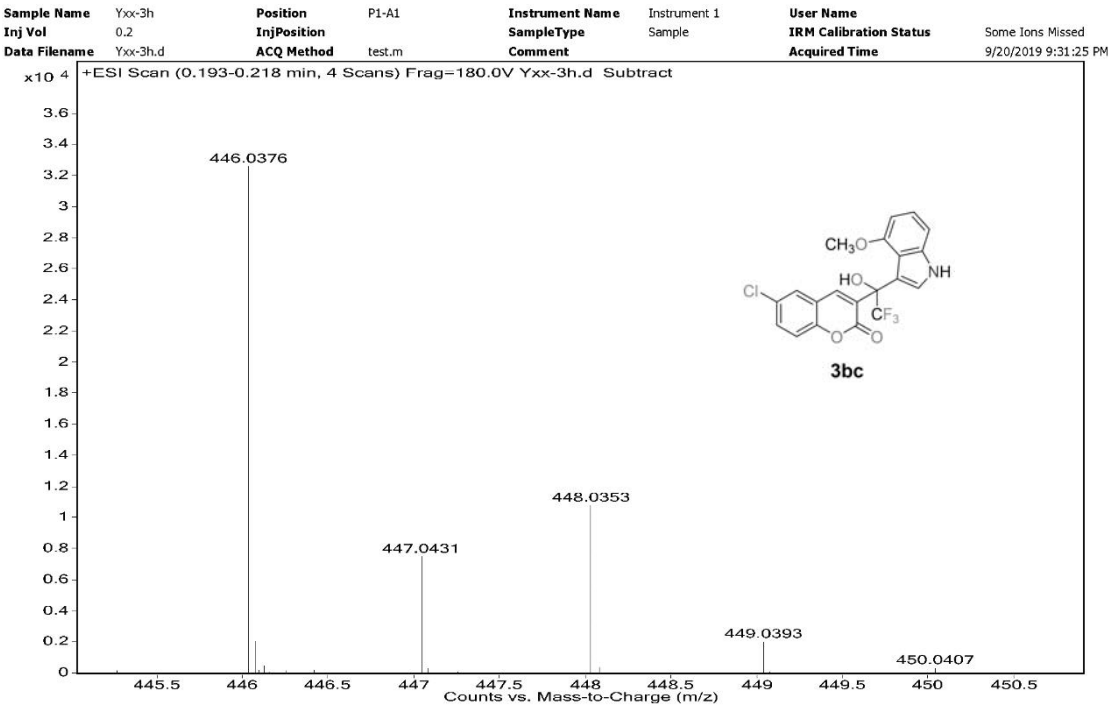
HRMS *m/z* calcd for $C_{19}H_{11}BrF_3NNaO_3$: 459.9772 $[M+Na]^+$; found:459.9770.

Figure S67. HRMS of **3ah**



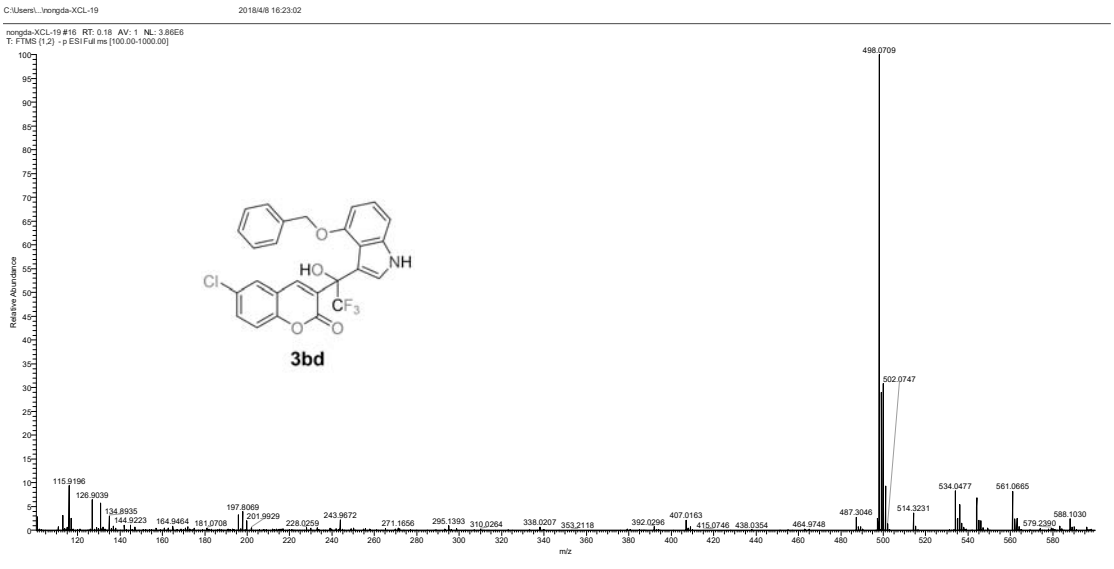
HRMS *m/z* calcd for $C_{19}H_{10}ClF_3NO_3$: 392.0301 $[M-H]^+$; found: 392.0294.

Figure S68. HRMS of 3ba



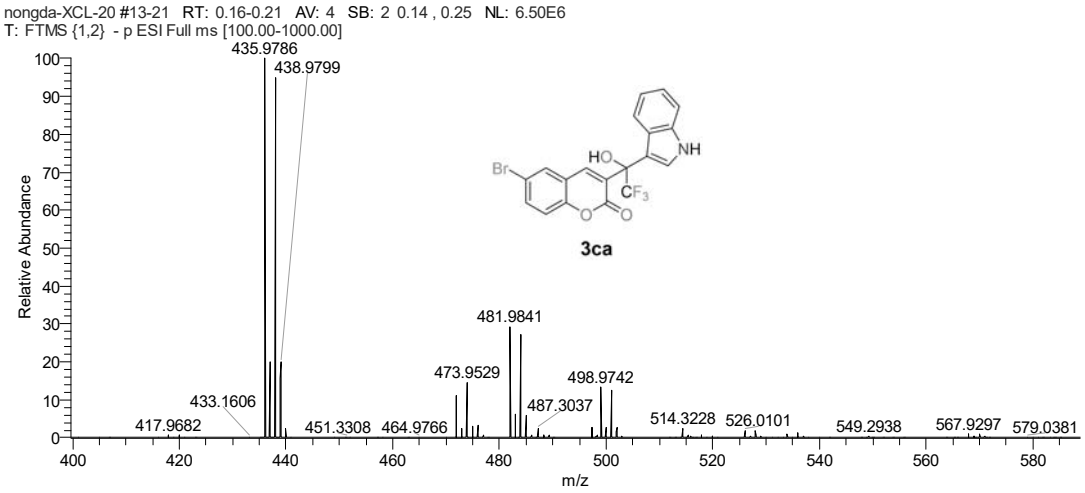
HRMS *m/z* calcd for $C_{20}H_{13}ClF_3NNaO_4$: 446.0383 $[M+Na]^+$; found: 446.0376.

Figure S69. HRMS of 3bc



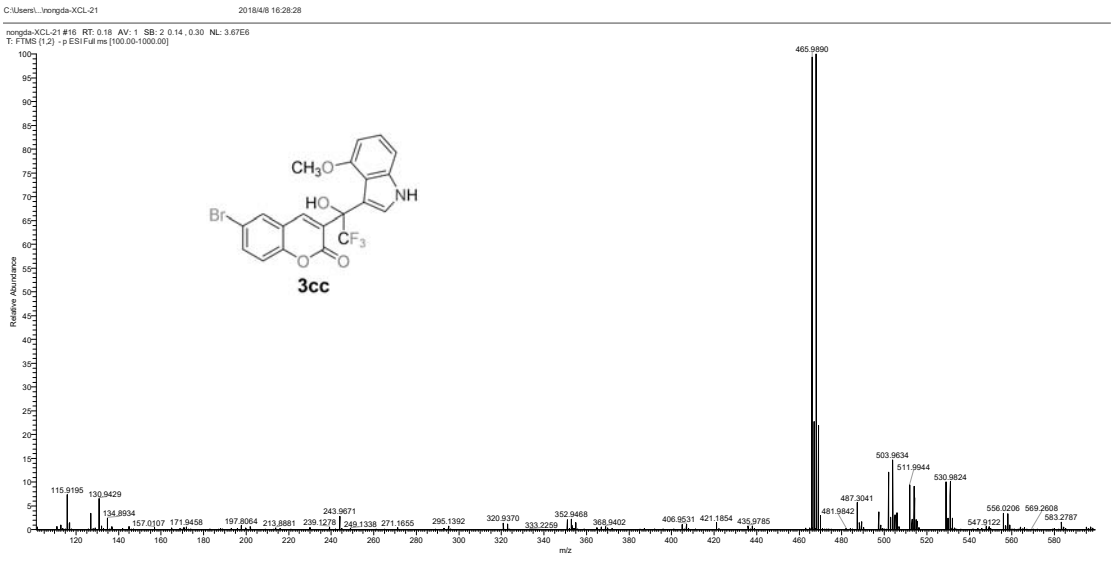
HRMS *m/z* calcd for $C_{26}H_{16}ClF_3NO_4$: 498.0720 $[M-H]^+$; found: 498.0709.

Figure S70. HRMS of 3bd



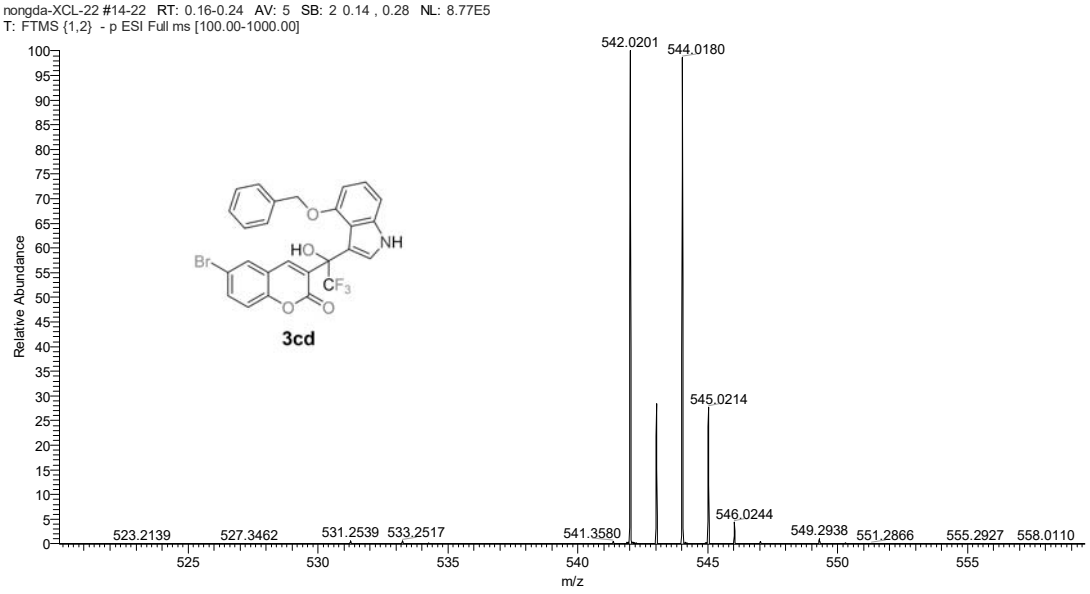
HRMS *m/z* calcd for $C_{19}H_{10}BrF_3NO_3$: 435.9796 $[M-H]^+$; found: 435.9786

Figure S71. HRMS of 3ca



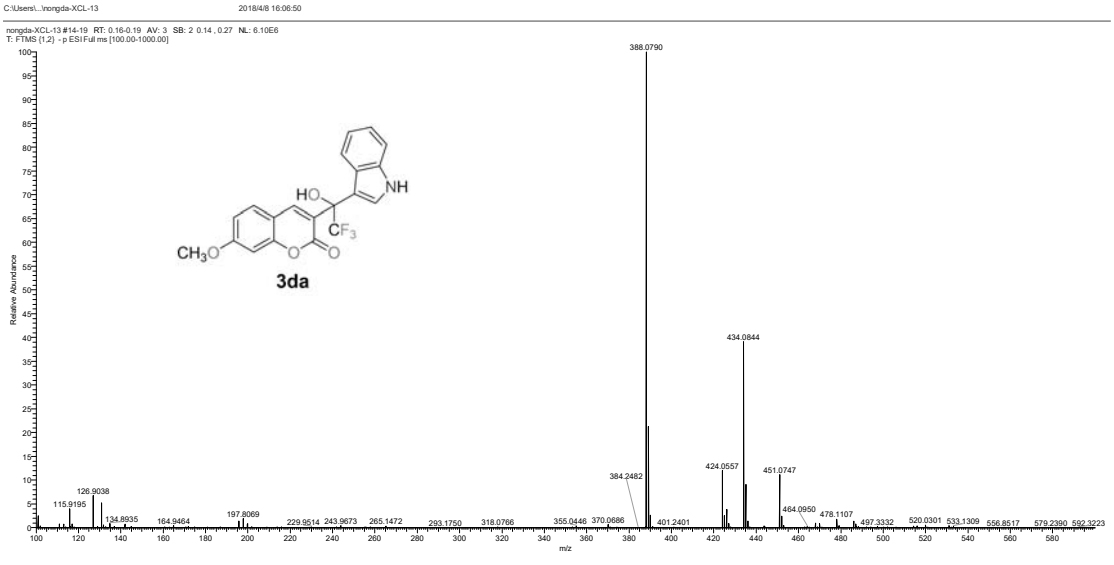
HRMS *m/z* calcd for $C_{20}H_{12}BrF_3NO_4$: 465.9902 $[M-H]^+$; found: 465.9890.

Figure S72. HRMS of 3cc



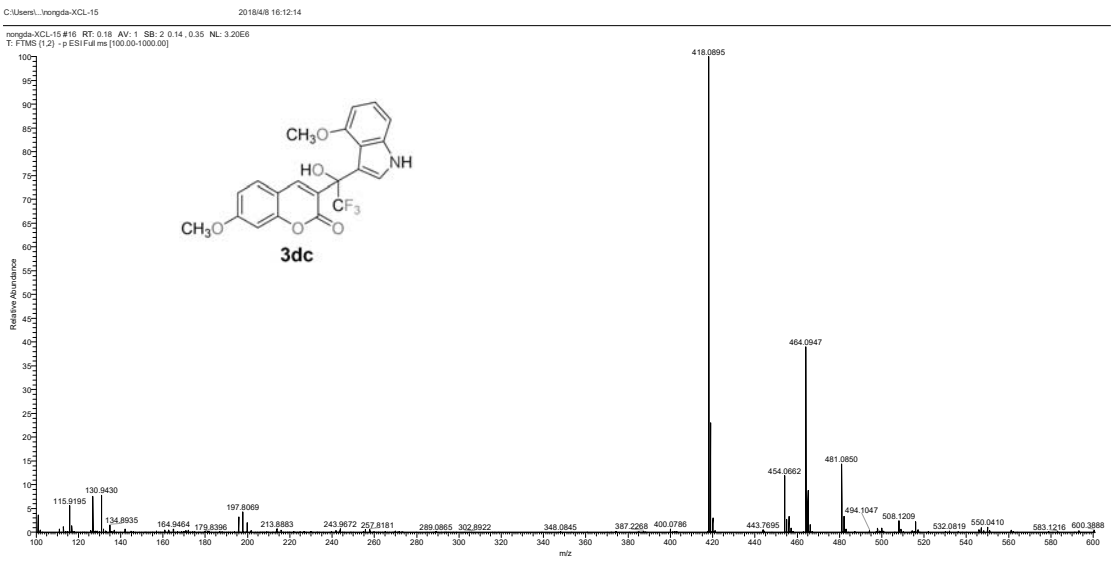
HRMS *m/z* calcd for $C_{26}H_{16}BrF_3NO_4$: 542.0215 $[M-H]^+$; found: 542.0201.

Figure S73. HRMS of 3cd



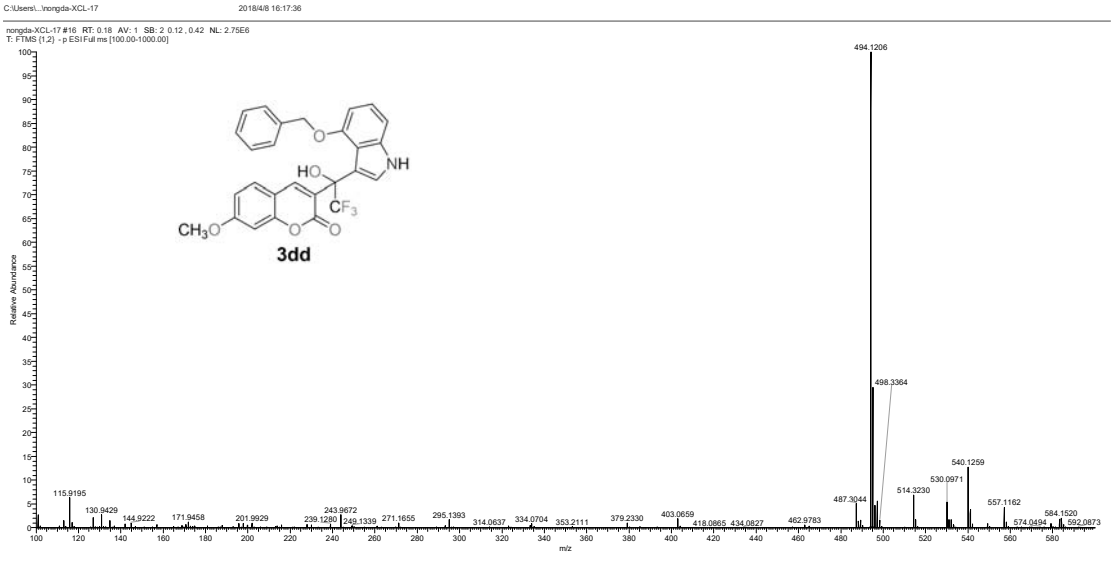
HRMS: *m/z* calcd for $C_{20}H_{13}F_3NO_4$: 388.0797 $[M-H]^+$; found: 388.0790.

Figure S74. HRMS of 3da



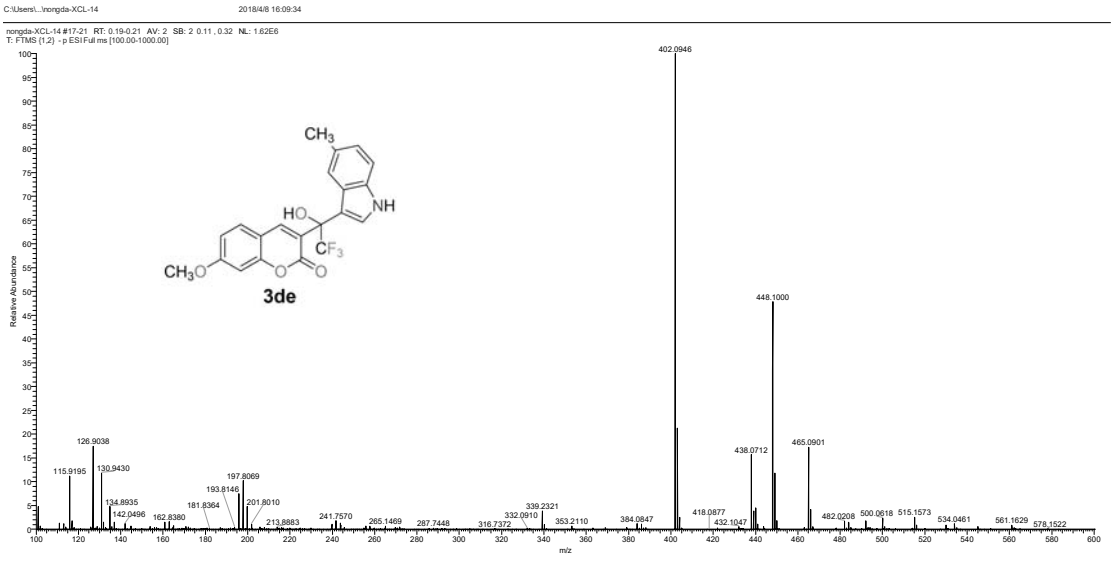
HRMS: *m/z* calcd for $C_{21}H_{15}F_3NO_5$: 418.0902 $[M-H]^+$; found: 418.0895.

Figure S75. HRMS of 3dc



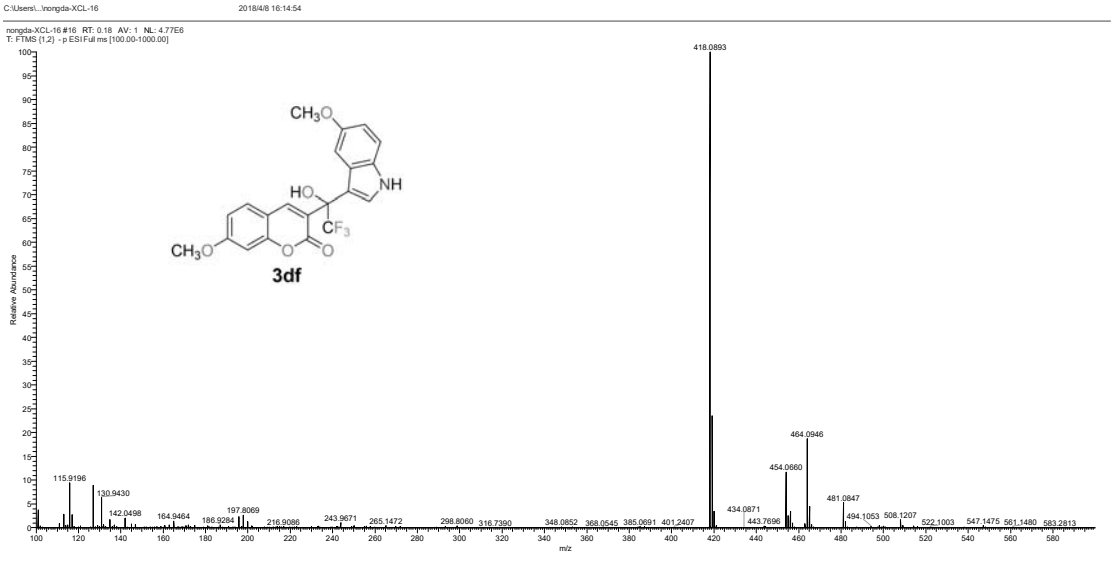
HRMS: *m/z* calcd for $C_{27}H_{19}F_3NO_5$: 494.1215 $[M-H]^+$; found: 494.1206.

Figure S76. HRMS of 3dd



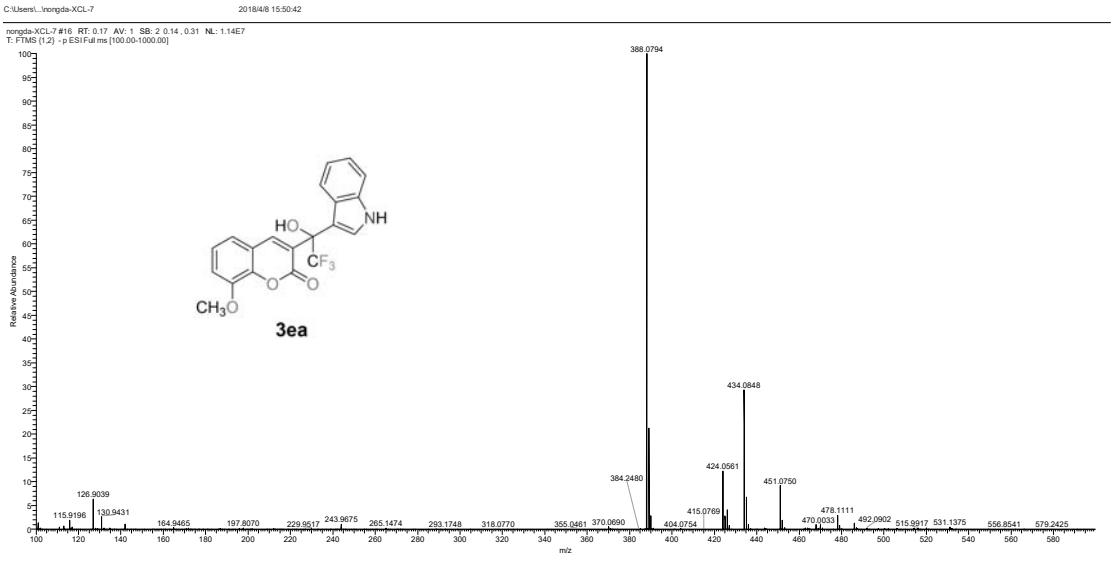
HRMS: *m/z* calcd for $C_{21}H_{15}F_3NO_4$: 402.0953 $[M-H]^+$; found: 402.0946.

Figure S77. HRMS of 3de



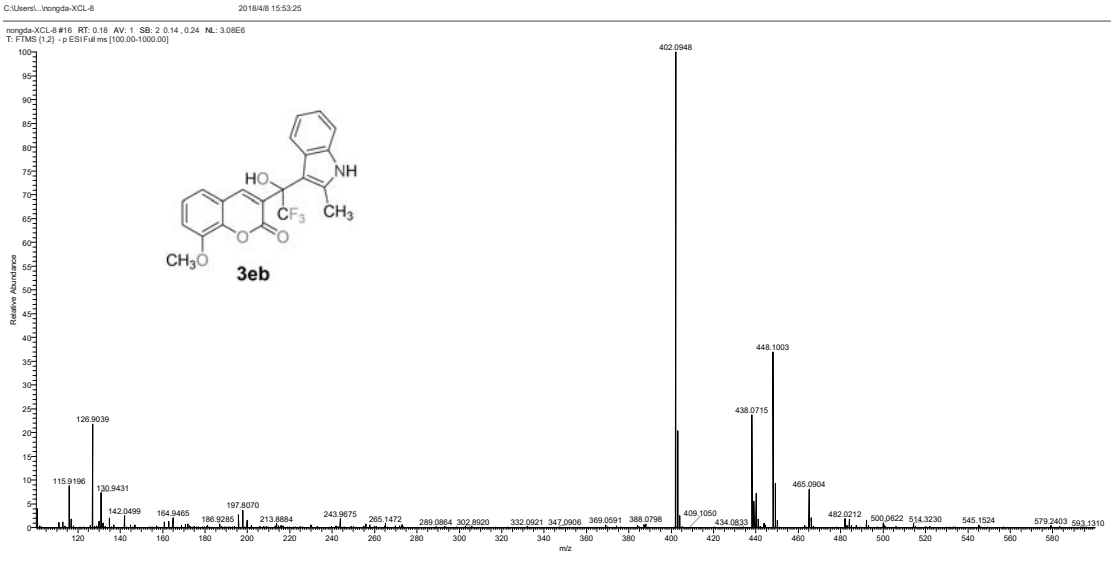
HRMS: *m/z* calcd for $C_{21}H_{15}F_3NO_5$: 418.0902 $[M-H]^+$; found: 418.0893.

Figure S78. HRMS of 3df



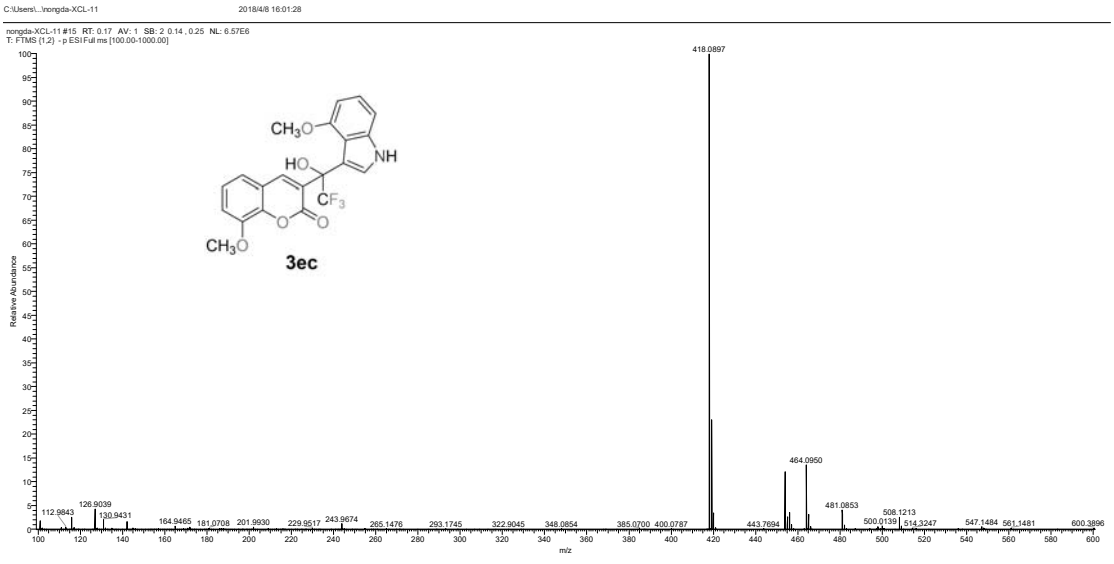
HRMS: *m/z* calcd for $C_{20}H_{13}F_3NO_4$: 388.0797 $[M-H]^+$; found: 388.0794.

Figure S79. HRMS of 3ea



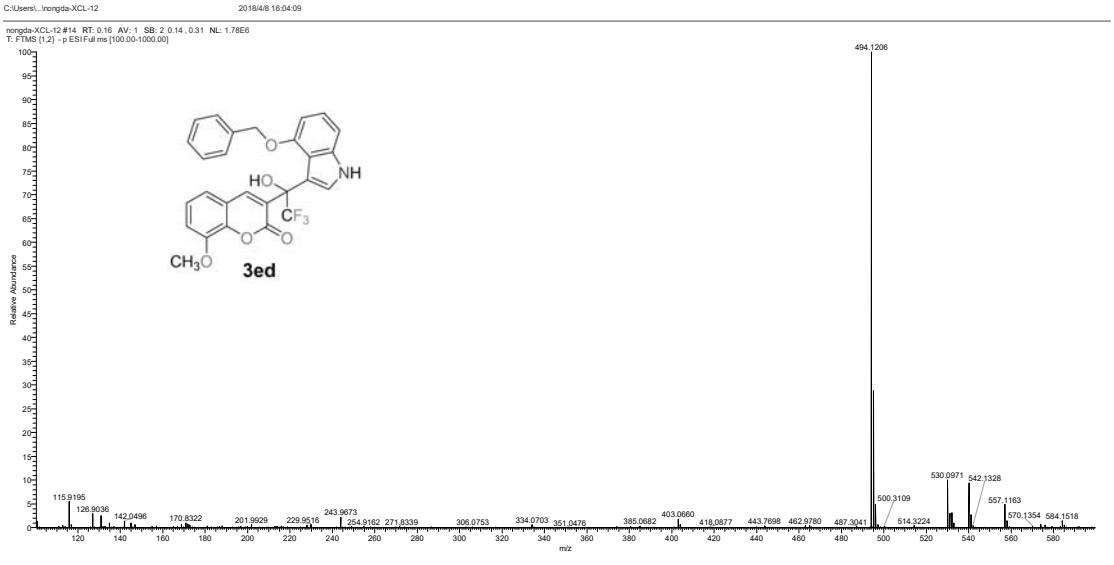
HRMS: *m/z* calcd for $C_{21}H_{15}F_3NO_4$: 402.0953 $[M-H]^+$; found: 402.0948.

Figure S80. HRMS of 3eb



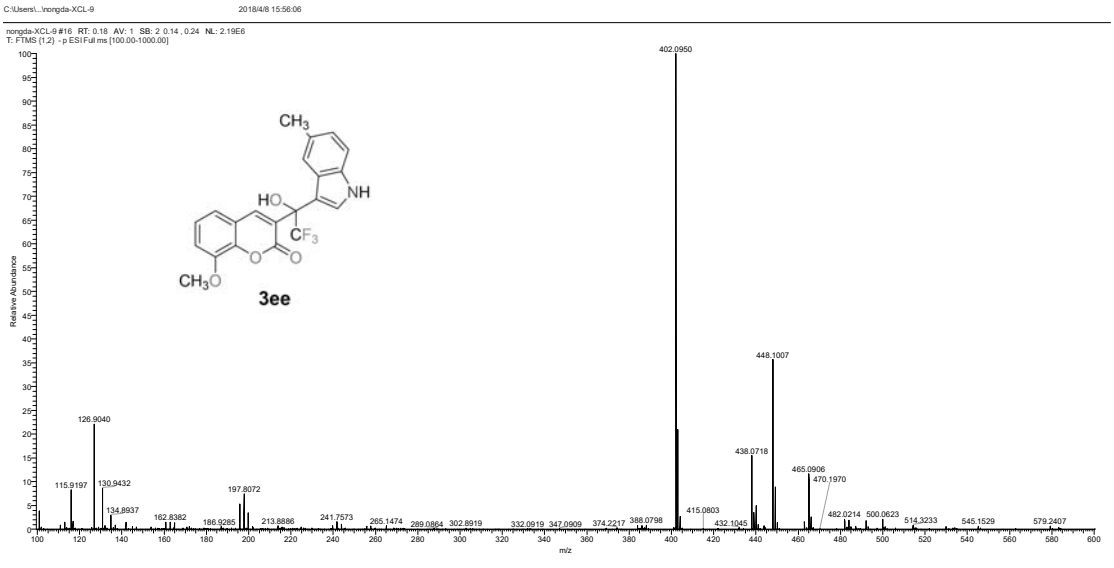
HRMS: *m/z* calcd for $C_{21}H_{15}F_3NO_5$: 418.0902 $[M-H]^+$; found: 418.0897.

Figure S81. HRMS of 3ec



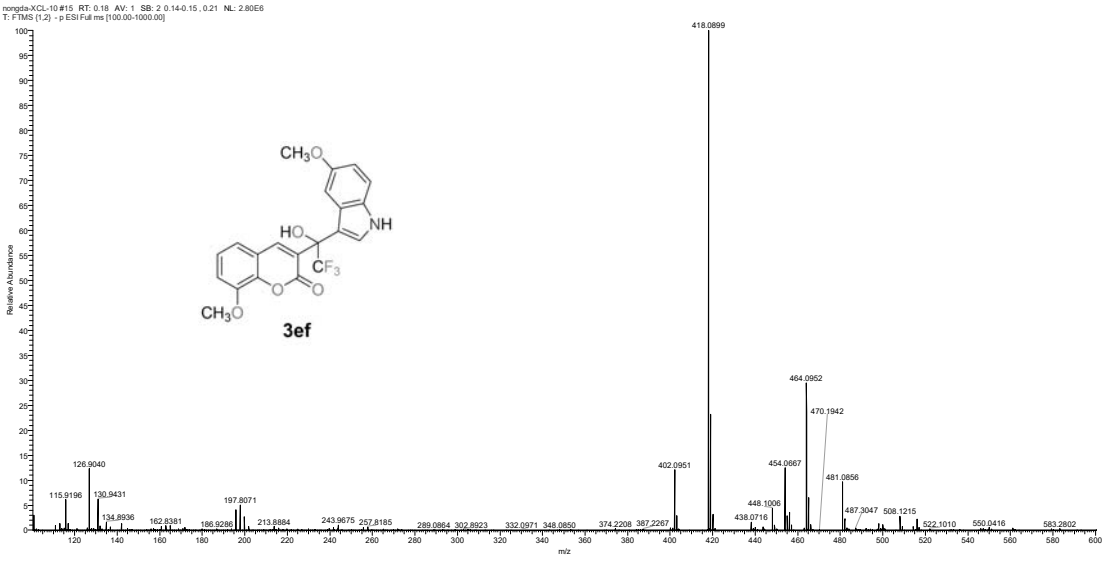
HRMS: *m/z* calcd for $C_{27}H_{19}F_3NO_5$: 494.1215 $[M-H]^+$; found: 494.1206.

Figure S82. HRMS of 3ed



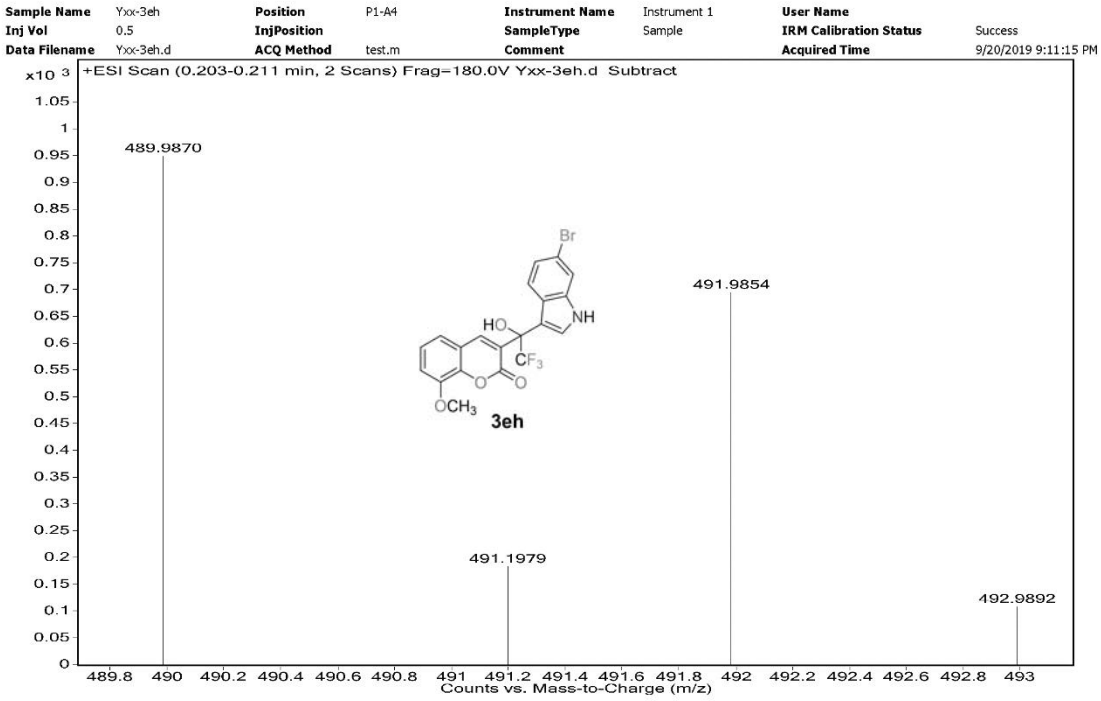
HRMS: *m/z* calcd for $C_{21}H_{15}F_3NO_4$: 402.0953 $[M-H]^+$; found: 402.0950.

Figure S83. HRMS of 3ee



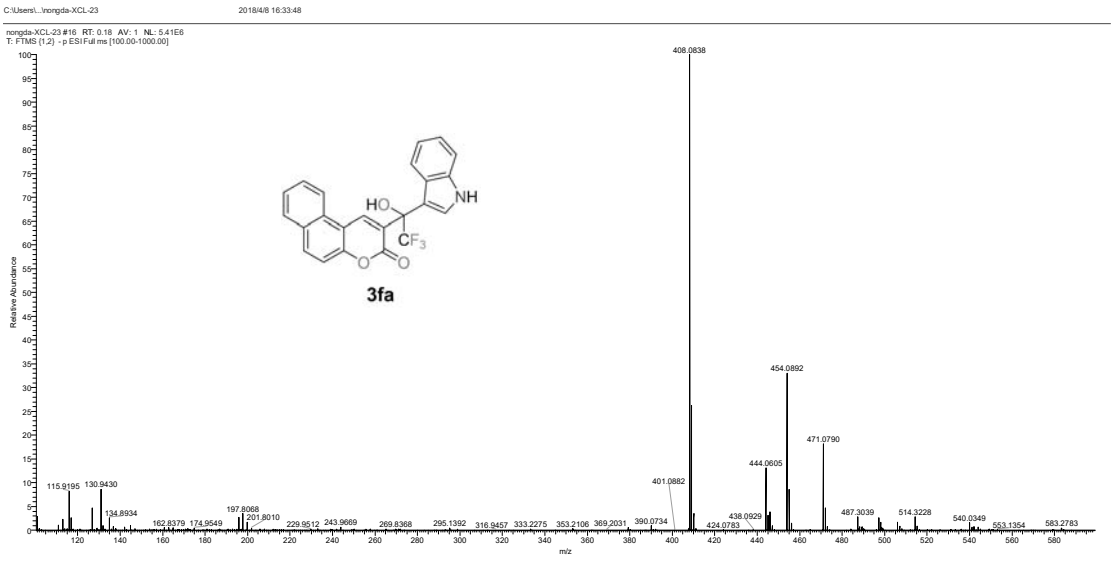
HRMS: *m/z* calcd for $C_{21}H_{15}F_3NO_5$: 418.0902 $[M-H]^+$; found: 418.0899.

Figure S84. HRMS of 3ef



HRMS: *m/z* calcd for $C_{20}H_{13}BrF_3NNaO_4$: 489.9878 $[M+Na]^+$; found: 489.9870.

Figure S85. HRMS of 3eh



HRMS: *m/z* calcd for $C_{23}H_{13}F_3NO_3$: 408.0848 $[M-H]^+$; found: 408.0838.

Figure S86. HRMS of 3fa

4. Crystal data for 3aa and 3dd

Contents of Crystal data

Table S2. Crystal data and structure refinement for **3aa** and **3dd**

	3aa	**3dd**
Empirical formula	$C_{19}H_{12}F_3NO_3$	$C_{27}H_{20}F_3NO_5$
Formula weight	359.30	495.44
Temperature/K	293(2)	293(2)
Crystal system	monoclinic	Monoclinic
Space group	$P2_1/c$	C2/c
a/Å	5.8958(2)	22.1710(10)
b/Å	15.5043(9)	8.6836(3)
c/Å	17.1980(6)	32.4701(14)
α/°	90	90
β/°	99.277(4)	111.054(5)
γ/°	90	90
Volume/Å^3	1551.49(13)	5833.9(5)
Z	4	8
ρ_{calc} /(g/cm^{-3})	1.538	1.128
μ/mm^{-1}	1.107	0.772
F(000)	736.0	2048.0
Crystal size/mm^3	0.2×0.18×0.15	0.24×0.17×0.14
Radiation	CuKα (λ = 1.54184)	CuKα (λ = 1.54184)
2Θ range for data collection/°	7.724 to 134.112	8.442 to 134.128
Index ranges	-4 ≤ h ≤ 7, -18 ≤ k ≤ 18, -20 ≤ l ≤ 20	-25 ≤ h ≤ 26, -10 ≤ k ≤ 10, -38 ≤ l ≤ 29

Reflections collected	5737	13558
Independent reflections	2762 [R_{int} = 0.0347, R_{sigma} = 0.0533]	5220 [R_{int} = 0.0221, R_{sigma} = 0.0222]
Data/restraints/parameters	2762/0/237	5220/0/327
Goodness-of-fit on F^2	1.002	1.051
Final R indexes [I>=2σ (I)]	R_1 = 0.0522, wR_2 = 0.1273	R_1 = 0.0731, wR_2 = 0.2181
Final R indexes [all data]	R_1 = 0.0725, wR_2 = 0.1504	R_1 = 0.0850, wR_2 = 0.2350
Largest diff. peak/hole / e $Å^{-3}$	0.21/-0.20	0.18/-0.34

Table S3. Fractional Atomic Coordinates (×10^4) and Equivalent Isotropic Displacement Parameters (Å^2×10^3) for 3aa.

U_{eq} is defined as 1/3 of of the trace of the orthogonalised U_{IJ}tensor.

Atom	*x*	*y*	*z*	U(eq)
C1	2663(4)	3077.3(17)	4049.8(14)	48.0(6)
C2	1822(5)	3981.0(19)	4219.5(15)	57.6(7)
C3	-675(4)	2962.0(19)	2870.6(14)	55.1(7)
C4	1431(4)	2736.8(18)	3272.8(13)	47.6(6)
C5	2290(4)	2060.0(17)	2834.2(13)	47.8(6)
C6	621(4)	1916.9(18)	2164.9(14)	52.6(6)
C7	879(5)	1300(2)	1599.4(14)	63.3(8)
C8	2851(5)	825(2)	1711.5(17)	69.4(8)
C9	4564(5)	952(2)	2366.5(16)	66.5(8)
C10	4304(4)	1563.0(19)	2925.8(15)	57.0(7)
C11	4128(4)	2438.5(19)	5432.6(14)	52.0(6)
C12	2350(4)	2465.3(17)	4730.2(13)	46.1(6)
C13	498(4)	1957.3(18)	4698.9(14)	51.0(6)
C14	200(4)	1383.3(18)	5330.4(14)	52.4(6)
C15	1900(5)	1365.1(18)	5983.1(14)	55.4(6)
C16	1777(6)	823(2)	6616.5(16)	70.9(8)
C17	-102(6)	298(2)	6593.0(18)	78.1(9)
C18	-1848(6)	303(2)	5949(2)	76.9(9)
C19	-1703(5)	842(2)	5320.6(17)	67.8(8)
F1	1961(3)	4528.0(12)	3630.9(10)	80.4(6)
F2	-368(3)	3984.0(12)	4340.8(10)	73.7(5)
F3	3068(3)	4322.8(12)	4863.4(10)	76.4(5)
N1	-1157(3)	2473.5(17)	2206.7(12)	58.9(6)
O1	5026(3)	3165.6(15)	3971.8(10)	61.7(6)
O2	5890(3)	2851.6(14)	5539.2(11)	65.6(6)
O3	3812(3)	1883.1(13)	6023.1(10)	58.9(5)

Table S4. Anisotropic Displacement Parameters ($Å^2×10^3$) for 3aa.

The Anisotropic displacement factor exponent takes the form:
$-2\pi^2[h^2a^{*2}U_{11}+2hka^*b^*U_{12}+\ldots]$.

Atom	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
C1	35.8(11)	63.4(15)	43.3(12)	0.3(11)	2.2(9)	-3.3(10)
C2	62.5(16)	60.3(17)	48.6(13)	3.0(12)	4.7(11)	-6.0(13)
C3	45.2(13)	71.4(18)	46.8(13)	4.4(12)	1.4(10)	-0.2(12)
C4	41.3(11)	62.3(15)	38.0(11)	7.4(11)	2.4(9)	-4.7(11)
C5	45.0(12)	60.4(15)	36.6(11)	5.9(11)	2.4(9)	-9.9(11)
C6	50.0(13)	64.6(16)	40.6(12)	10.0(11)	-0.4(10)	-9.1(12)
C7	73.3(18)	70.5(19)	42.2(13)	0.7(13)	-2.6(12)	-19.0(15)
C8	88(2)	64.5(18)	54.9(15)	-3.7(14)	10.1(14)	-7.8(16)
C9	69.2(18)	64.7(18)	65.3(17)	2.5(15)	9.9(13)	5.2(15)
C10	53.5(14)	65.5(17)	48.3(13)	5.1(13)	-2.4(10)	-0.7(13)
C11	49.2(13)	61.3(16)	41.6(12)	-5.6(12)	-3.9(10)	7.6(12)
C12	38.8(11)	58.2(15)	39.1(11)	-3.0(11)	0.2(9)	3.2(11)
C13	43.6(12)	64.5(16)	42.2(12)	3.7(11)	-1.2(9)	0.0(11)
C14	53.3(14)	57.2(15)	47.9(13)	1.8(12)	11.8(10)	3.2(12)
C15	63.7(15)	60.2(16)	42.9(12)	1.3(12)	10.5(11)	13.5(13)
C16	88(2)	76(2)	48.9(15)	10.5(15)	10.5(13)	19.1(18)
C17	104(2)	72(2)	63.7(18)	19.3(16)	30.2(17)	12(2)
C18	87(2)	68(2)	82(2)	10.4(17)	32.6(18)	-2.5(17)
C19	62.7(17)	76(2)	65.2(17)	7.0(16)	11.7(13)	-1.5(15)
F1	105.7(14)	66.1(11)	68.5(10)	13.6(9)	11.1(10)	-6.7(10)
F2	64.9(10)	72.0(11)	85.5(12)	-0.3(10)	16.2(8)	10.6(9)
F3	89.1(12)	70.9(11)	63.7(10)	-11.6(9)	-3.8(8)	-6.7(10)
N1	45.7(11)	80.4(16)	44.8(11)	7.1(11)	-10.4(8)	-4.0(11)
O1	39.4(9)	94.6(15)	50(1)	-7.6(10)	4.0(7)	-12.7(9)
O2	50.2(10)	81.7(14)	57.4(11)	-3.7(10)	-14.7(8)	-6.1(10)
O3	58.9(10)	71.4(12)	41.4(9)	3.0(9)	-6.7(7)	8.6(9)

Table S5. Bond Lengths for 3aa.

Atom	Atom	Length/Å	Atom	Atom	Length/Å
C1	C2	1.530(4)	C8	C9	1.400(4)
C1	C4	1.510(3)	C9	C10	1.376(4)
C1	C12	1.541(3)	C11	C12	1.467(3)
C1	O1	1.428(3)	C11	O2	1.209(3)
C2	F1	1.333(3)	C11	O3	1.367(3)
C2	F2	1.340(3)	C12	C13	1.341(3)
C2	F3	1.336(3)	C13	C14	1.437(3)
C3	C4	1.366(3)	C14	C15	1.379(3)
C3	N1	1.361(3)	C14	C19	1.399(4)
C4	C5	1.432(4)	C15	C16	1.387(4)
C5	C6	1.406(3)	C15	O3	1.377(3)
C5	C10	1.403(4)	C16	C17	1.370(5)
C6	C7	1.390(4)	C17	C18	1.385(5)
C6	N1	1.369(4)	C18	C19	1.380(4)
C7	C8	1.363(4)			

Table S6. Bond Angles for 3aa.

Atom	Atom	Atom	Angle/°	Atom	Atom	Atom	Angle/°
C2	C1	C12	109.7(2)	C7	C8	C9	121.8(3)
C4	C1	C2	111.4(2)	C10	C9	C8	120.8(3)
C4	C1	C12	111.0(2)	C9	C10	C5	119.2(2)
O1	C1	C2	106.3(2)	O2	C11	C12	126.3(3)
O1	C1	C4	106.73(19)	O2	C11	O3	115.9(2)
O1	C1	C12	111.62(19)	O3	C11	C12	117.7(2)
F1	C2	C1	112.1(2)	C11	C12	C1	119.1(2)
F1	C2	F2	107.1(2)	C13	C12	C1	121.9(2)
F1	C2	F3	106.5(2)	C13	C12	C11	119.1(2)
F2	C2	C1	112.5(2)	C12	C13	C14	122.1(2)
F3	C2	C1	111.7(2)	C15	C14	C13	117.8(2)
F3	C2	F2	106.5(2)	C15	C14	C19	118.3(3)
N1	C3	C4	109.4(2)	C19	C14	C13	123.9(2)
C3	C4	C1	128.8(2)	C14	C15	C16	121.9(3)
C3	C4	C5	106.9(2)	O3	C15	C14	120.7(2)
C5	C4	C1	124.2(2)	O3	C15	C16	117.4(3)
C6	C5	C4	106.7(2)	C17	C16	C15	118.7(3)
C10	C5	C4	135.1(2)	C16	C17	C18	120.9(3)
C10	C5	C6	118.2(2)	C19	C18	C17	119.8(3)
C7	C6	C5	122.7(3)	C18	C19	C14	120.3(3)
N1	C6	C5	107.4(2)	C3	N1	C6	109.7(2)
N1	C6	C7	129.9(2)	C11	O3	C15	122.59(19)
C8	C7	C6	117.4(2)				

Table S7. Hydrogen Bonds for 3aa.

D	H	A	d(D-H)/Å	d(H-A)/Å	d(D-A)/Å	D-H-A/°
N1	H1	O2[1]	0.86	2.41	3.146(3)	144.3
N1	H1	O3[1]	0.86	2.64	3.462(3)	161.5
O1	H1A	O2	0.82	2.02	2.705(3)	141.3

[1]-1+X,1/2-Y,-1/2+Z

Table S8. Hydrogen Atom Coordinates (Å×10^4) and Isotropic Displacement Parameters (Å^2×10^3) for 3aa.

Atom	*x*	*y*	*z*	U(eq)
H3	-1632	3383	3026	66
H7	-249	1214	1162	76
H8	3064	406	1343	83
H9	5893	619	2424	80
H10	5449	1645	3359	68
H13	-631	1977	4254	61
H16	2949	816	7049	85
H17	-207	-66	7015	94
H18	-3115	-57	5941	92
H19	-2876	845	4888	81
H1	-2392	2509	1865	71
H1A	5805	3217	4410	93

Table S9. Fractional Atomic Coordinates (×10^4) and Equivalent Isotropic Displacement Parameters (Å^2×10^3) for 3dd.

U_{eq} is defined as 1/3 of of the trace of the orthogonalised U_{IJ} tensor.

Atom	*x*	*y*	*z*	U(eq)
C1	3002.7(13)	1578(3)	3492.8(8)	75.5(6)
C2	3979.7(14)	911(4)	4194.0(8)	81.7(7)
C3	3662.2(12)	1993(3)	3844.9(7)	71.4(6)
C4	3944.5(12)	3357(3)	3838.4(8)	74.2(6)
C5	4543.2(13)	3780(3)	4167.6(8)	78.0(6)
C6	4840.8(13)	2736(3)	4501.2(8)	77.5(6)
C7	5417.3(13)	3029(4)	4841.1(9)	84.3(7)
C8	5711.9(14)	4423(4)	4843.8(10)	91.1(8)
C9	5428.3(17)	5505(4)	4513.4(11)	102.7(10)
C10	4853.7(16)	5186(4)	4180.6(10)	95.4(9)
C11	2471.5(15)	2255(4)	3638.6(9)	90.5(8)
C12	2497.1(12)	3131(3)	2768.6(8)	76.1(6)
C13	2943.1(11)	2152(3)	3039.2(7)	68.2(6)
C14	3340.6(11)	1646(3)	2797.6(8)	67.5(5)
C15	3099.2(12)	2369(3)	2384.7(8)	73.9(6)
C16	3358.3(16)	2168(4)	2057.5(10)	89.7(8)
C17	3878.7(16)	1213(4)	2155.9(10)	94.9(9)
C18	4147.4(15)	470(4)	2570.1(11)	91.5(8)
C19	3882.9(12)	695(3)	2888.3(8)	75.1(6)
C20	4735.5(14)	-694(4)	3437.7(10)	88.9(8)
C21	4712.4(13)	-2288(3)	3252.4(9)	80.8(7)
C22	4144.6(16)	-3084(4)	3071.4(11)	95.4(9)
C23	4132(2)	-4556(5)	2918.6(13)	113.4(11)
C24	4696(3)	-5252(5)	2947.8(15)	130.1(14)
C25	5273(2)	-4462(5)	3122.7(15)	124.5(13)
C26	5280.0(16)	-2976(4)	3275.2(12)	98.2(9)
C27	6613.8(18)	3787(5)	5483.4(12)	120.0(13)
F1	1885.7(8)	1875(3)	3373.6(7)	112.1(7)
F2	2495.1(9)	3802(2)	3659.5(6)	103.7(6)
F3	2536.2(10)	1770(3)	4041.8(6)	116.9(7)
N1	2586.5(11)	3266(3)	2378.8(7)	79.3(6)
O1	2883.9(10)	-33(2)	3461.3(6)	83.3(5)
O2	3793.6(12)	-368(3)	4235.5(7)	107.3(7)
O3	4554.5(9)	1330(2)	4506.8(6)	87.0(5)
O4	6280.0(11)	4870(3)	5151.7(8)	109.9(7)
O5	4117.8(9)	56(2)	3299.4(6)	86.2(5)

Table S10. Anisotropic Displacement Parameters ($Å^2 \times 10^3$) for 3dd.

The Anisotropic displacement factor exponent takes the form:

$-2\pi^2[h^2a^{*2}U_{11}+2hka^*b^*U_{12}+\ldots]$.

Atom	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
C1	72.5(14)	82.9(16)	65.2(13)	-3.2(11)	17.6(11)	-12.8(12)
C2	82.8(16)	90.0(18)	62.6(13)	3.0(12)	14.3(11)	-14.0(13)
C3	67.8(13)	84.7(15)	56.9(12)	1.7(10)	16.8(10)	-7.8(11)
C4	72.4(14)	82.8(15)	58.4(12)	5.0(11)	12.7(10)	-4.8(12)
C5	74.1(14)	87.6(16)	65.8(13)	-0.5(12)	17.3(11)	-12.3(12)
C6	75.5(14)	87.0(16)	63.5(13)	0.1(12)	17.1(11)	-9.5(12)
C7	74.6(15)	99(2)	67.7(14)	0.3(13)	11.9(12)	-4.5(14)
C8	74.9(16)	107(2)	77.5(16)	-9.6(15)	10.5(13)	-16.9(15)
C9	94(2)	105(2)	93(2)	1.0(17)	15.2(16)	-30.3(17)
C10	97(2)	94(2)	82.0(17)	9.2(14)	15.7(15)	-20.2(16)
C11	79.3(17)	117(2)	74.3(16)	-9.1(15)	26.8(13)	-13.5(16)
C12	65.6(13)	88.2(16)	68.0(13)	-4.9(12)	16.0(11)	-2.2(11)
C13	61.2(12)	74.6(14)	60.0(12)	-2.8(10)	11.2(9)	-6.8(10)
C14	65.8(12)	67.6(13)	62.5(12)	2(1)	14.9(10)	-7.3(10)
C15	75.6(14)	74.0(14)	65.2(13)	4.2(11)	16.9(11)	-2.9(11)
C16	101(2)	95.2(19)	72.1(15)	16.9(14)	30.7(14)	5.5(16)
C17	106(2)	106(2)	84.8(18)	15.8(16)	49.7(17)	13.1(17)
C18	89.4(18)	89.2(18)	106(2)	15.0(15)	47.5(16)	15.4(14)
C19	73.4(14)	73.4(14)	74.2(14)	9.3(11)	21.3(11)	-1.1(11)
C20	72.4(15)	91.3(18)	88.6(17)	7.6(14)	11.6(13)	1.3(13)
C21	68.8(14)	85.5(16)	79.7(15)	18.4(13)	16.5(11)	0.2(12)
C22	81.0(17)	97(2)	95.6(19)	19.0(16)	16.5(15)	-6.8(15)
C23	124(3)	99(2)	107(2)	1.0(19)	29(2)	-27(2)
C24	175(5)	90(2)	127(3)	-8(2)	56(3)	-8(3)
C25	126(3)	116(3)	137(3)	-5(2)	55(3)	27(3)
C26	78.2(17)	108(2)	105(2)	3.9(17)	28.8(16)	3.2(16)
C27	87(2)	129(3)	105(2)	-13(2)	-12.4(18)	-10(2)
F1	69.6(10)	159.7(19)	104.8(13)	-13.8(12)	28.8(9)	-18.8(10)
F2	93.4(11)	118.5(14)	98.2(11)	-19.9(10)	33.3(9)	2.6(10)
F3	108.1(13)	168(2)	84.2(11)	1.9(11)	46.1(10)	-10.7(13)
N1	73.9(12)	85.7(14)	67.2(11)	10.1(10)	11.9(9)	8.2(10)
O1	86.2(12)	85.4(12)	68(1)	1.6(8)	15.2(8)	-22.0(9)
O2	112.9(16)	97.8(15)	82.3(12)	21.5(11)	0.2(11)	-30.8(13)
O3	84.4(11)	89.1(12)	69(1)	11.0(9)	5.1(8)	-11.1(9)
O4	84.6(13)	117.2(17)	101.0(15)	-5.6(13)	0.7(11)	-25.9(12)

O5	81.5(11)	94.4(13)	77.2(11)	18.9(9)	21.9(9)	16.2(9)

Table S11. Bond Lengths for 3dd.

Atom	Atom	Length/Å	Atom	Atom	Length/Å
C1	C3	1.541(3)	C12	C13	1.360(4)
C1	C11	1.536(4)	C12	N1	1.355(3)
C1	C13	1.515(3)	C13	C14	1.443(3)
C1	O1	1.420(3)	C14	C15	1.401(3)
C2	C3	1.445(4)	C14	C19	1.400(4)
C2	O2	1.209(3)	C15	C16	1.389(4)
C2	O3	1.363(3)	C15	N1	1.372(3)
C3	C4	1.344(4)	C16	C17	1.362(4)
C4	C5	1.421(3)	C17	C18	1.416(4)
C5	C6	1.385(4)	C18	C19	1.373(4)
C5	C10	1.394(4)	C19	O5	1.364(3)
C6	C7	1.379(4)	C20	C21	1.502(4)
C6	O3	1.379(3)	C20	O5	1.435(3)
C7	C8	1.373(4)	C21	C22	1.370(4)
C8	C9	1.395(5)	C21	C26	1.371(4)
C8	O4	1.354(3)	C22	C23	1.368(5)
C9	C10	1.370(4)	C23	C24	1.362(7)
C11	F1	1.317(3)	C24	C25	1.380(6)
C11	F2	1.344(4)	C25	C26	1.380(5)
C11	F3	1.333(4)	C27	O4	1.421(4)

Table S12. Bond Angles for 3dd.

Atom	Atom	Atom	Angle/°	Atom	Atom	Atom	Angle/°
C11	C1	C3	108.1(2)	F3	C11	F2	106.1(2)
C13	C1	C3	111.9(2)	N1	C12	C13	109.9(2)
C13	C1	C11	111.4(2)	C12	C13	C1	128.6(2)
O1	C1	C3	112.7(2)	C12	C13	C14	106.5(2)
O1	C1	C11	104.9(2)	C14	C13	C1	124.9(2)
O1	C1	C13	107.8(2)	C15	C14	C13	106.6(2)
O2	C2	C3	126.5(3)	C19	C14	C13	135.3(2)
O2	C2	O3	115.3(2)	C19	C14	C15	118.0(2)
O3	C2	C3	118.2(2)	C16	C15	C14	123.7(3)
C2	C3	C1	119.7(2)	N1	C15	C14	107.3(2)
C4	C3	C1	121.2(2)	N1	C15	C16	129.0(2)
C4	C3	C2	119.1(2)	C17	C16	C15	116.5(3)
C3	C4	C5	122.0(2)	C16	C17	C18	122.1(3)
C6	C5	C4	118.2(3)	C19	C18	C17	120.2(3)
C6	C5	C10	117.3(3)	C18	C19	C14	119.5(2)
C10	C5	C4	124.5(3)	O5	C19	C14	116.3(2)
C7	C6	C5	123.3(3)	O5	C19	C18	124.2(2)
O3	C6	C5	119.8(2)	O5	C20	C21	113.7(2)
O3	C6	C7	116.8(2)	C22	C21	C20	122.0(3)
C8	C7	C6	118.0(3)	C22	C21	C26	119.2(3)
C7	C8	C9	120.4(3)	C26	C21	C20	118.8(3)
O4	C8	C7	124.9(3)	C23	C22	C21	121.5(4)
O4	C8	C9	114.7(3)	C24	C23	C22	119.4(4)
C10	C9	C8	120.3(3)	C23	C24	C25	120.0(4)
C9	C10	C5	120.7(3)	C26	C25	C24	120.1(4)
F1	C11	C1	112.8(2)	C21	C26	C25	119.8(3)
F1	C11	F2	107.2(3)	C12	N1	C15	109.7(2)
F1	C11	F3	107.2(2)	C2	O3	C6	122.6(2)
F2	C11	C1	112.2(2)	C8	O4	C27	117.6(3)
F3	C11	C1	111.0(3)	C19	O5	C20	118.5(2)

Table S13. Hydrogen Bonds for 3dd.

D	H	A	d(D-H)/Å	d(H-A)/Å	d(D-A)/Å	D-H-A/°
N1	H1	O1[1]	0.86	2.14	2.944(3)	156.0
O1	H1A	O2	0.82	1.87	2.613(3)	150.6

[1]1/2-X,1/2+Y,1/2-Z

Table S14. Hydrogen Atom Coordinates (Å×10^4) and Isotropic Displacement Parameters (Å^2×10^3) for 3dd.

Atom	*x*	*y*	*z*	U(eq)
H4	3742	4045	3611	89
H7	5601	2305	5062	101
H9	5630	6448	4519	123
H10	4669	5914	3961	115
H12	2178	3634	2841	91
H16	3186	2659	1786	108
H17	4063	1043	1944	114
H18	4504	-171	2627	110
H20A	4907	-754	3757	107
H20B	5030	-72	3348	107
H22	3759	-2612	3052	114
H23	3742	-5077	2796	136
H24	4693	-6260	2850	156
H25	5657	-4932	3138	149
H26	5668	-2444	3393	118
H27A	7011	4233	5676	180
H27B	6706	2880	5348	180
H27C	6350	3517	5651	180
H1	2357	3828	2161	95
H1A	3126	-457	3686	125

Table S15. Solvent masks information for 3dd.

Number	X	Y	Z	Volume	Electron count	Content
1	0.250	0.006	0.000	359	97	
2	0.750	-0.051	0.000	359	97	
3	0.750	0.006	0.500	359	97	
4	0.250	-0.101	0.500	359	97	
5	0.191	0.156	0.151	9	0	
6	0.809	0.156	0.349	10	0	
7	0.691	0.343	0.651	9	0	
8	0.309	0.343	0.849	10	0	
9	0.691	0.656	0.151	9	0	
10	0.309	0.656	0.349	10	0	
11	0.191	0.843	0.651	9	0	
12	0.809	0.843	0.849	10	0	

5. Method of DFT

Our first-principles calculations were performed by using the Vienna ab initio simulation package known as the VASP code.[1-3] The electronic-ion interaction is described by projector augmented wave method (PAW).[4, 5] The energy cut off of the plane waves was set to 450 eV. The electron exchange–correlation function was treated using a generalized gradient approximation (GGA) in the form proposed by Perdew, Burke, and Ernzerhof (PBE).[6] Both atomic positions and lattice vectors were fully optimized using the conjugate gradient (CG) algorithm until the maximum atomic forces were less than 0.01 eV/Å with an energy precision of 10^{-5} eV. A Vacuum about 20 Å at each direction is adapted to eliminate the interaction of two molecular. Sigle Gamma (0, 0, 0) point is used for k sample at Brillouin zone (BZ). The van der Waals interaction is including by DFT-D3 method of Grimme.[7]

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Figure S87. Charge computation of **1a** by DFT