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Supporting information for

"Visible-light photoredox catalysis: direct synthesis of fused β-carbolines through oxidation/[3+2] cycloaddition/oxidative aromatization reaction cascade in batch and flow microreactors"

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Materials and methods

All the reagents, chemicals, solvents were purchased from commercial suppliers and used without further any purification. The 11 W white light LED bulb commonly used for domestic lighting was used for our study. The syringe pumps, visible light transparent capillaries (PFA capillaries, id = 500µm), and fittings were obtained from commercial suppliers. The reactions were monitored using thin layer chromatography (TLC) visualised under UV irradiation and iodine. All the new compounds were characterized by their ^{1}H, ^{13}C NMR, IR, MS/HRMS spectra obtained from the central instrumental facility of the institute.

Synthetic procedures

General experimental procedures for the synthesis of N-alkylated of tetrahydro-β-carbolines ***1a-f***: In a 25 mL round bottom flask, tryptoline (86 mg, 0.5 mmol), α-halo carbonyls (0.5 mmol), Et_3N (50 mg, 0.5 mmol) and CH_2Cl_2 (5 mL) was taken and the reaction mixture was stirred at ambient temperature for 2 h. Next the reaction mixture was diluted with CH_2Cl_2 (15 mL) and washed with water. The organic layer was dried over anhydrous Na_2SO_4 and evaporated to yield a crude product which was purified by silica-gel column chromatography using ethyl acetate/hexane in increasing polarity to yield compounds **1a-f**.

General experimental procedures for the visible light photoredox catalyzed coupling of N-alkylated of tetrahydro-β-carbolines ***1a-f*** *with dipolarophiles* ***2a-g*** *under batch conditions:* In a 25 mL round bottom flask, tetrahydro-β-carbolines **1a-f** (0.1 mmol), dipolarophiles **2a-g** (0.1 mmol), $[Ru(bpy)_3Cl_2]\cdot 6H_2O$ (0.5 mol%) and MeCN (5 mL) was taken. The reaction vessel was kept at a distance of 10 cm (approx.) from a visible light source (11W white LED bulb) and the reaction mixture was stirred in open air condition until the reaction was complete (TLC). Next the reaction mixture was concentrated to give a crude product which was purified

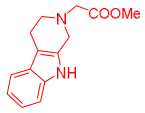
by silica-gel column chromatography using ethyl acetate/hexane in increasing polarity to yield compounds **3a-n**.

*General experimental procedures for the visible light photoredox catalyzed coupling of N-alkylated of tetrahydro-β-carbolines **1a** with dipolarophiles **2a** in flow microreactors:*

A solution of tetrahydro-β-carboline **1a** (0.2 mmol) and dipolarophile **2a** (0.2 mmol) in MeCN (5 mL) was kept in one syringe and the solutions of photocatalyst $[Ru(bpy)_3Cl_2]\cdot 6H_2O$ (0.001 mmol in 5 mL MeCN) and t-BuOOH (2 mmol in 2 mL MeCN) were taken in two separate syringes. All the three solutions were pumped via two syringe pumps and mixed on an X-junction and flown through the capillary microreactor wrapped over a visible light source (11W white LED bulb). Under stable conditions, exactly 6 mL of the reaction mixture was collected, concentrated to yield a crude product which was purified by silica-gel column chromatography using ethyl acetate/hexane in increasing polarity to yield compounds **3a**.

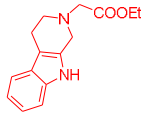
Characterization data for the synthesized compounds:

Methyl 2-(1,3,4,9-tetrahydro-2*H*-pyrido[3,4-*b*]indol-2-yl)acetate **1a:**



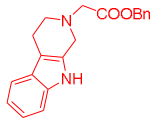
From 0.5 mmol of tryptoline, 97 mg (80%) of **1a** was obtained as a pale yellow solid. Mp. 140-143 ^{0}C (Lit.[1] 141-144 ^{0}C). Spectral data was found in accordance with literature.[1]

Ethyl 2-(1,3,4,9-tetrahydro-2*H*-pyrido[3,4-*b*]indol-2-yl)acetate **1b**:



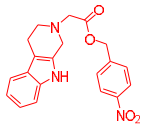
From 1.0 mmol of tryptoline, 198 mg (77%) of **1b** was obtained as a pale yellow solid. Mp. 140-142 ^{0}C. R_f = 0.74 (EtOAc/Hexane = 1:1). IR (KBr, cm^{-1}): 3066, 2899, 1735, 1451, 1414, 1297. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.94 (s, 1H), 7.46 (d, *J* = 7.7 Hz, 1H), 7.30 (d, *J* = 7.9 Hz, 1H), 7.17 – 7.02 (m, 2H), 4.22 (q, *J* = 7.1 Hz, 2H), 3.92 (s, 2H), 3.50 (s, 2H), 3.05 (t, *J* = 5.8 Hz, 2H), 2.84 (t, *J* = 5.7 Hz, 2H), 1.29 (t, *J* = 7.1 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.81, 136.13, 131.40, 127.19, 121.32, 119.28, 117.94, 110.93, 107.81, 60.77, 58.05, 50.69, 49.58, 21.01, 14.34. HRMS calcd. for $C_{15}H_{19}N_2O_2$ (M+H): 259.14465; found: 259.14375.

Benzyl 2-(1,3,4,9-tetrahydro-2*H*-pyrido[3,4-*b*]indol-2-yl)acetate **1c**:



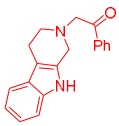
From 1.0 mmol of tryptoline, 250 mg (78%) of **1c** was obtained as a pale yellow solid. Mp. 168-170 ^{0}C. R_f = 0.75 (EtOAc/Hexane = 1:1). IR (KBr, cm^{-1}): 3061, 2898, 1736, 1451, 1346, 1297. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.72 (s, 1H), 7.46 (d, *J* = 7.7 Hz, 1H), 7.40 – 7.30 (m, 5H), 7.28 (dd, *J* = 7.9, 2.7 Hz, 1H), 7.12 (dd, *J* = 11.0, 4.0 Hz, 1H), 7.08 (td, *J* = 7.5, 1.1 Hz, 1H), 5.20 (s, 2H), 3.88 (s, 2H), 3.55 (s, 2H), 3.03 (t, *J* = 5.7 Hz, 2H), 2.83 (t, *J* = 5.7 Hz, 2H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 170.58, 136.01, 135.66, 131.13, 128.66, 128.45, 127.20, 121.44, 119.38, 117.99, 110.75, 108.07, 66.50, 58.00, 50.73, 49.65, 20.93. HRMS calcd. for $C_{20}H_{21}N_2O_2$ (M+H): 321.16030; found: 321.16007.

4-Nitrobenzyl 2-(1,3,4,9-tetrahydro-2*H*-pyrido[3,4-*b*]indol-2-yl)acetate **1d**:



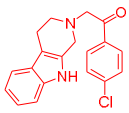
From 0.5 mmol of tryptoline, 135 mg (74%) of **1d** was obtained as a yellow solid; Mp. 200-202 ^{0}C; R_f = 0.77 (EtOAc/Hexane = 1:1); IR (KBr, cm^{-1}): 2848, 1736, 1519, 1347, 1165. ^{1}H NMR (300 MHz, $CDCl_3$+DMSO) δ 10.35 (s, 1H), 8.22 (d, *J* = 8.6 Hz, 2H), 7.61 (d, *J* = 8.6 Hz, 2H), 7.37 (d, *J* = 7.5 Hz, 1H), 7.28 (d, *J* = 7.8 Hz, 1H), 7.05-6.93 (m, 2H), 5.30 (s, 2H), 3.87 (s, 2H), 3.61 (s, 2H), 3.00 (t, *J* = 5.5 Hz, 2H), 2.80 (t, *J* = 5.5 Hz, 2H). ^{13}C NMR (75 MHz, $CDCl_3$+DMSO-d6) δ 175.08, 152.31, 148.69, 141.08, 137.23, 133.58, 131.84, 128.58, 125.45, 123.38, 122.40, 115.97, 111.29, 69.45, 62.87, 55.47, 54.51, 26.26. HRMS calcd for $C_{20}H_{20}N_3O_4$ (M+H): 366.14538; found: 366.14384.

1-Phenyl-2-(1,3,4,9-tetrahydro-2*H*-pyrido[3,4-*b*]indol-2-yl)ethan-1-one **1e**:



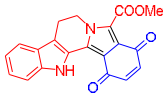
From 0.5 mmol of tryptoline, 109 mg (75%) of **1e** was obtained as a yellow solid. Mp. 75-77 ^{0}C (Lit.[2] 78 ^{0}C). Spectral data was found in accordance with literature.[2]

1-(4-chlorophenyl)-2-(1,3,4,9-tetrahydro-2*H*-pyrido[3,4-*b*]indol-2-yl)ethan-1-one **1f**:



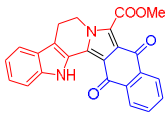
From 0.5 mmol of tryptoline, 125 mg (77%) of **1f** was obtained as a light brown solid. Mp. 168-170 ^{0}C; R_f = 0.40 (EtOAc/Hexane = 1:1). IR (KBr, cm^{-1}): 3056, 2851, 1692, 1586, 1450, 1204. ^{1}H NMR (300 MHz, $CDCl_3$+DMSO) δ 10.55 (s, 1H), 8.05 (d, *J* = 7.6 Hz, 2H), 7.51 (dd, *J* = 8.5, 1.8 Hz, 2H), 7.35 (d, *J* = 7.5 Hz, 1H), 7.26 (d, *J* = 7.7 Hz, 1H), 7.03-6.91 (m, 2H), 4.09 (s, 2H), 3.81 (s, 2H), 2.96 (t, *J* = 5.6 Hz, 3H), 2.76 (t, *J* = 5.1 Hz, 2H). ^{13}C NMR (75 MHz, $CDCl_3$+DMSO) δ 194.18, 136.79, 134.19, 132.53, 130.24, 129.26, 128.23, 126.85, 126.70, 124.95, 118.61, 116.53, 115.53, 109.10, 104.46, 61.51, 49.08, 48.21, 19.18. HRMS calcd. for $C_{19}H_{18}ClN_2O$ (M+H): 325.11077; found: 325.11002.

Methyl 1,4-dioxo-1,7,8,13-tetrahydro-4*H*-benzo[1,2]indolizino[8,7-*b*]indole-5-carboxylate **3a**:



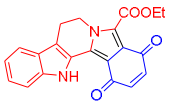
Following the batch synthesis, on 0.1 mmol scale reaction, 24 mg (69%) of **3a** was obtained as a blue solid. Mp. 190-192 ^{0}C. R_f = 0.79 (EtOAc/Hexane = 2:3). IR (KBr, cm^{-1}): 3194, 2924, 2853, 1729, 1637, 1517, 1466, 1282, 1259. ^{1}H NMR (500 MHz, $CDCl_3$) δ 11.03 (s, 1H), 7.60 (d, *J* = 8.0 Hz, 1H), 7.53 (d, *J* = 8.3 Hz, 1H), 7.34-7.30 (m, 1H), 7.18 (t, *J* = 7.5 Hz, 1H), 6.81 (d, *J* = 10.3 Hz, 1H), 6.76 (d, *J* = 10.3 Hz, 1H), 4.58 (t, *J* = 7.4 Hz, 2H), 4.04 (s, 3H), 3.31 (t, *J* = 7.4 Hz, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 182.17, 180.23, 161.11, 140.68, 138.74, 136.69, 136.55, 131.77, 125.94, 125.54, 124.70, 121.22, 120.60, 119.18, 114.44, 112.46, 111.49, 52.93, 44.59, 20.54. HRMS calcd. for $C_{20}H_{15}N_2O_4$ (M+H): 347.10318; found: 347.10208.

Methyl 9,14-dioxo-5,9,14,15-tetrahydro-6*H*-naphtho[2',3':1,2]indolizino[8,7-*b*]indole-8-carboxylate **3b**:



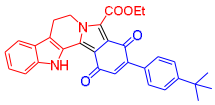
Following the batch synthesis, on 0.1 mmol scale reaction, 27 mg (68%) of **3b** was obtained as a brown solid. Mp. 196-198 ^{0}C. R_f = 0.74 (EtOAc/Hexane = 2:3). IR (KBr, cm^{-1}): 3299, 2923, 1711, 1656, 1592, 1570, 1481, 1433, 1273, 1221. ^{1}H NMR (500 MHz, $CDCl_3$) δ 11.32 (s, 1H), 8.34 – 8.29 (m, 1H), 8.27 – 8.22 (m, 1H), 7.79 – 7.70 (m, 2H), 7.60 (d, *J* = 8.0 Hz, 1H), 7.55 (d, *J* = 8.2 Hz, 1H), 7.32 (t, *J* = 7.6 Hz, 1H), 7.18 (d, *J* = 7.7 Hz, 1H), 4.56 (t, *J* = 7.4 Hz, 2H), 4.10 (s, 3H), 3.33 (t, *J* = 7.4 Hz, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 180.53, 178.71, 161.54, 136.62, 135.63, 134.65, 133.52, 133.24, 132.06, 127.30, 126.72, 126.52, 125.58, 124.94, 124.43, 122.47, 120.45, 119.08, 115.57, 112.44, 110.97, 53.03, 44.71, 20.49. HRMS calcd. for $C_{24}H_{17}N_2O_4$ (M+H): 397.11883; found: 397.11756.

Ethyl 1,4-dioxo-1,7,8,13-tetrahydro-4*H*-benzo[1,2]indolizino[8,7-*b*]indole-5-carboxylate **3c**:



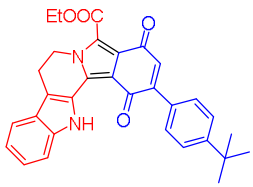
Following the batch synthesis, on 0.1 mmol scale reaction, 25 mg (69%) of **3c** was obtained as a brown solid. Mp. 210-212 ^{0}C. R_f = 0.70 (EtOAc/Hexane = 2:3). IR (KBr, cm^{-1}): 3448, 2921, 1707, 1654, 1648, 1578, 1476, 1419, 1281. ^{1}H NMR (500 MHz, $CDCl_3$) δ 11.03 (s, 1H), 7.59 (dd, *J* = 8.0, 0.8 Hz, 1H), 7.52 (d, *J* = 8.3 Hz, 1H), 7.32 (ddd, *J* = 8.2, 7.0, 1.1 Hz, 1H), 7.18 (ddd, *J* = 7.9, 7.1, 0.9 Hz, 1H), 6.80 (d, *J* = 10.3 Hz, 1H), 6.75 (d, *J* = 10.3 Hz, 1H), 4.57 (t, *J* = 7.4 Hz, 2H), 4.51 (q, *J* = 7.1 Hz, 2H), 3.31 (t, *J* = 7.4 Hz, 2H), 1.49 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 179.77, 178.51, 160.61, 145.03, 139.17, 136.79, 132.14, 126.23, 125.42, 124.53, 121.15, 120.56, 120.45, 119.02, 114.17, 112.63, 111.40, 62.32, 44.50, 20.44, 14.00. HRMS calcd for $C_{21}H_{17}N_2O_4$ (M+H): 361.11883; found: 361.11702.

Ethyl 3-(4-(tert-butyl)phenyl)-1,4-dioxo-1,7,8,13-tetrahydro-4*H*-benzo[1,2]indolizino[8,7-*b*]indole-5-carboxylate **3d**:



Following the batch synthesis, on 0.1 mmol scale reaction, 14 mg (28%) of **3d** was obtained as a brown solid. Mp. 210-212 ^{0}C. R_f = 0.84 (EtOAc/Hexane = 2:3). IR (KBr, cm^{-1}): 3452, 2924, 1711, 1658, 1641, 1599, 1485, 1263. ^{1}H NMR (500 MHz, $CDCl_3$) δ 11.05 (s, 1H), 7.59 (d, *J* = 8.0 Hz, 1H), 7.55 – 7.45 (m, 5H), 7.31 (t, *J* = 7.3 Hz, 1H), 7.18 (t, *J* = 7.5 Hz, 1H), 6.91 (s, 1H), 4.56-4.49 (m, 4H), 3.32 (t, *J* = 7.4 Hz, 2H), 1.48 (t, *J* = 7.2 Hz, 3H), 1.36 (s, 9H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 182.25, 179.66, 161.00, 153.03, 150.14, 136.72, 135.61, 131.26, 130.75, 129.28, 129.11, 127.27, 125.66, 125.39, 124.94, 124.53, 121.68, 120.53, 119.11, 114.81, 112.47, 111.05, 62.44, 44.54, 34.82, 31.24, 20.64, 14.04. HRMS calcd. for $C_{31}H_{29}N_2O_4$ (M+H): 493.21273; found: 493.21180.

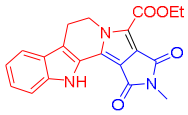
Ethyl 2-(4-(tert-butyl)phenyl)-1,4-dioxo-1,7,8,13-tetrahydro-4*H*-benzo[1,2]indolizino[8,7-*b*]indole-5-carboxylate **3d'**:



Following the batch synthesis, on 0.1 mmol scale reaction, 15 mg (30%) of **3d'** was obtained as a brown solid. Mp. 213-214 ^{0}C. R_f = 0.82 (EtOAc/Hexane = 2:3). IR (KBr, cm^{-1}): 3439, 2924, 1709,

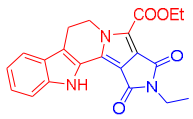
1654, 1642, 1618, 1577, 1236. ^{1}H NMR (500 MHz, $CDCl_3$) δ 11.18 (s, 1H), 7.59 (d, *J* = 8.0 Hz, 1H), 7.52 (s, 4H), 7.47 (d, *J* = 8.3 Hz, 1H), 7.33 – 7.27 (m, 1H), 7.20 – 7.15 (m, 1H), 6.83 (s, 1H), 4.59 (t, *J* = 7.4 Hz, 2H), 4.53 (q, *J* = 7.1 Hz, 2H), 3.32 (t, *J* = 7.4 Hz, 2H), 1.51 (t, *J* = 7.2 Hz, 3H), 1.38 (s, 9H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 181.83, 180.34, 160.83, 152.96, 148.34, 137.67, 136.64, 132.31, 131.01, 129.11, 125.94, 125.57, 125.47, 124.94, 124.61, 121.70, 120.53, 119.14, 115.14, 112.42, 111.54, 62.37, 44.62, 34.84, 31.26, 20.59, 14.01. HRMS calcd. for $C_{31}H_{29}N_2O_4$ (M+H): 493.21273; found: 493.21152.

Ethyl 2-methyl-1,3-dioxo-1,2,3,6,7,12-hexahydropyrrolo[3',4':1,2]indolizino[8,7-*b*]indole-4-carboxylate **3e**:



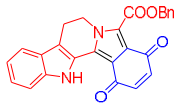
Following the batch synthesis, on 0.1 mmol scale reaction, 22 mg (61%) of **3e** was obtained as a yellow solid. Mp. 196-198 ^{0}C. R_f = 0.72 (EtOAc/Hexane = 2:3). IR (KBr, cm^{-1}): 3411, 2923, 1753, 1693, 1643, 1425, 1270. ^{1}H NMR (300 MHz, $CDCl_3$) δ 9.02 (s, 1H), 7.59 (d, *J* = 7.8 Hz, 1H), 7.48 (d, *J* = 8.2 Hz, 1H), 7.38 – 7.28 (m, 1H), 7.19 (t, *J* = 7.5 Hz, 1H), 4.84 (t, *J* = 7.4 Hz, 2H), 4.44 (q, *J* = 7.1 Hz, 2H), 3.29 (t, *J* = 7.4 Hz, 2H), 3.14 (s, 3H), 1.49 (t, *J* = 7.1 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 164.54, 162.70, 159.52, 137.52, 126.36, 125.57, 124.66, 124.46, 124.22, 120.73, 119.52, 119.29, 114.28, 112.01, 110.91, 61.55, 44.59, 24.19, 20.78, 14.18. HRMS calcd. for $C_{20}H_{18}N_3O_4$ (M+H): 364.12973; found: 364.12882.

Ethyl 2-ethyl-1,3-dioxo-1,2,3,6,7,12-hexahydropyrrolo[3',4':1,2]indolizino[8,7-*b*]indole-4-carboxylate **3f**:



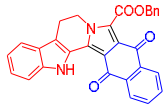
Following the batch synthesis, on 0.1 mmol scale reaction, 25 mg (66%) of **3f** was obtained as a yellow solid. Mp. 202-204 ^{0}C. R_f = 0.75 (EtOAc/Hexane = 2:3). IR (KBr, cm^{-1}): 3420, 1759, 1698, 1651, 1273. ^{1}H NMR (500 MHz, $CDCl_3$) δ 9.01 (s, 1H), 7.58 (d, *J* = 7.9 Hz, 1H), 7.45 (d, *J* = 8.2 Hz, 1H), 7.35 – 7.24 (m, 1H), 7.20 – 7.07 (m, 1H), 4.83 (t, *J* = 7.4 Hz, 2H), 4.44 (q, *J* = 7.1 Hz, 2H), 3.69 (q, *J* = 7.2 Hz, 2H), 3.28 (t, *J* = 7.4 Hz, 2H), 1.49 (t, *J* = 7.1 Hz, 3H), 1.27 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 164.44, 162.53, 159.59, 137.47, 126.41, 125.56, 124.43, 124.30, 120.70, 119.45, 119.32, 114.37, 112.00, 110.89, 61.60, 44.63, 33.10, 20.84, 14.21, 14.10. HRMS calcd. for $C_{21}H_{20}N_3O_4$ (M+H): 378.14538; found: 378.14434.

Benzyl 1,4-dioxo-1,7,8,13-tetrahydro-4*H*-benzo[1,2]indolizino[8,7-*b*]indole-5-carboxylate **3g**:



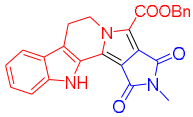
Following the batch synthesis, on 0.1 mmol scale reaction, 30 mg (71%) of **3g** was obtained as a blue solid. Mp. 207-208 ^{0}C. R_f = 0.70 (EtOAc/Hexane = 2:3). IR (KBr, cm^{-1}): 3322, 2852, 1730, 1638, 1464, 1284. ^{1}H NMR (500 MHz, $CDCl_3$) δ 11.03 (s, 1H), 7.59-7.56 (m, 3H), 7.52 (d, *J* = 8.3 Hz, 1H), 7.42 (t, *J* = 7.3 Hz, 2H), 7.37 (t, *J* = 7.3 Hz, 1H), 7.32 (t, *J* = 7.6 Hz, 1H), 7.18 (t, *J* = 7.5 Hz, 1H), 6.81 (d, *J* = 10.3 Hz, 1H), 6.77 (d, *J* = 10.3 Hz, 1H), 5.47 (s, 2H), 4.55 (t, *J* = 7.4 Hz, 2H), 3.29 (t, *J* = 7.4 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 182.13, 180.06, 160.55, 140.64, 138.62, 136.61, 134.84, 131.72, 128.77, 128.64, 125.86, 125.47, 124.63, 121.24, 120.53, 119.12, 116.12, 114.40, 112.41, 111.44, 68.22, 44.55, 20.48. HRMS calcd. for $C_{26}H_{19}N_2O_4$ (M+H): 423.13448; found: 423.13350.

Benzyl 9,14-dioxo-5,9,14,15-tetrahydro-6*H*-naphtho[2',3':1,2]indolizino[8,7-*b*]indole-8-carboxylate **3h**:



Following the batch synthesis, on 0.1 mmol scale reaction, 29 mg (61%) of **3h** was obtained as a light red solid. Mp. 210-212 ^{0}C. R_f = 0.75 (EtOAc/Hexane = 2:3). IR (KBr, cm^{-1}): 3449, 1706, 1666, 1594, 1584, 1479, 1270. ^{1}H NMR (500 MHz, $CDCl_3$) δ 11.32 (s, 1H), 8.32-8.27 (m, 2H), 7.82 – 7.71 (m, 2H), 7.59 (d, *J* = 7.7 Hz, 3H), 7.55 (d, *J* = 8.2 Hz, 1H), 7.43 (t, *J* = 7.3 Hz, 2H), 7.37 (t, *J* = 7.3 Hz, 1H), 7.31 (t, *J* = 7.2 Hz, 1H), 7.18 (t, *J* = 7.5 Hz, 1H), 5.53 (s, 2H), 4.52 (t, *J* = 7.4 Hz, 2H), 3.30 (t, *J* = 7.4 Hz, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 180.55, 178.54, 160.94, 136.59, 135.67, 135.04, 134.63, 133.49, 133.18, 132.00, 128.71, 128.66, 128.58, 127.35, 126.69, 126.50, 125.57, 124.94, 124.40, 122.59, 115.59, 112.42, 110.91, 68.26, 44.69, 20.46. HRMS calcd for $C_{30}H_{21}N_2O_4$ (M+H): 473.15013; found: 473.14868.

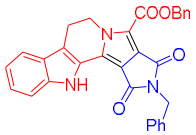
Benzyl 2-methyl-1,3-dioxo-1,2,3,6,7,12-hexahydropyrrolo[3',4':1,2]indolizino[8,7-*b*]indole-4-carboxylate **3i**:



Following the batch synthesis, on 0.1 mmol scale reaction, 27 mg (64%) of **3i** was obtained as a yellow solid. Mp. 202-204 ^{0}C. R_f = 0.80 (EtOAc/Hexane = 2:3). IR (KBr, cm^{-1}): 3408, 2923, 1752, 1691, 1497, 1428, 1383, 1348, 1326, 1268. ^{1}H NMR (500 MHz, $CDCl_3$) δ 9.00 (s, 1H), 7.60 (d, *J* = 7.4 Hz, 2H), 7.57 (d, *J* = 8.0 Hz, 1H), 7.46 (d, *J* = 8.3 Hz, 1H), 7.41 (t, *J* = 7.5 Hz, 2H), 7.34 (t, *J* = 7.3 Hz, 1H), 7.29 (t, *J* = 7.6 Hz, 1H), 7.18 (t, *J* = 7.5 Hz, 1H), 5.44 (s, 2H), 4.82 (t, *J* = 7.4 Hz, 2H),

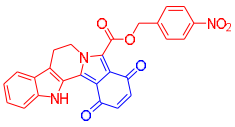
3.27 (t, J = 7.4 Hz, 2H), 3.13 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.57, 162.65, 159.32, 137.50, 135.44, 128.56, 128.30, 128.23, 126.60, 125.54, 124.93, 124.50, 124.18, 120.74, 119.34, 119.06, 114.44, 112.03, 111.02, 66.98, 44.70, 24.31, 20.80. HRMS calcd. for $C_{25}H_{20}N_3O_4$ (M+H): 426.14538; found: 426.14451.

Benzyl 2-benzyl-1,3-dioxo-1,2,3,6,7,12-hexahydropyrrolo[3',4':1,2]indolizino[8,7-*b*]indole-4-carboxylate **3j**:



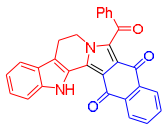
Following the batch synthesis, on 0.1 mmol scale reaction, 31 mg (62%) of **3j** was obtained as a yellow solid. Mp. 208-210 ^{0}C. R_f = 0.79 (EtOAc/Hexane = 2:3). IR (KBr, cm^{-1}): 3404, 2923, 2853, 1743, 1704, 1647, 1268, 1175. ^{1}H NMR (300 MHz, $CDCl_3$) δ 9.00 (s, 1H), 7.73 – 7.52 (m, 3H), 7.51 – 7.23 (m, 10H), 7.16 (t, J = 7.3 Hz, 1H), 5.45 (s, 2H), 4.88 – 4.70 (m, 4H), 3.25 (t, J = 7.4 Hz, 2H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 164.36, 162.14, 159.31, 137.55, 136.96, 135.55, 128.62, 128.57, 128.36, 128.28, 128.25, 127.61, 126.82, 125.54, 124.82, 124.55, 124.16, 120.75, 119.35**,** 119.28, 114.28, 111.99, 111.07, 66.98, 44.77, 41.90, 20.82. HRMS calcd. for $C_{31}H_{24}N_3O_4$ (M+H): 502.17668; found: 502.17579.

4-Nitrobenzyl 1,4-dioxo-1,7,8,13-tetrahydro-4*H*-benzo[1,2]indolizino[8,7-*b*]indole-5-carboxylate **3k**:



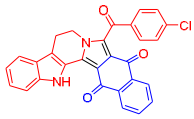
Following the batch synthesis, on 0.1 mmol scale reaction, 32 mg (68%) of **3k** was obtained as a brown solid. Mp. 212-214 ^{0}C. R_f = 0.71 (EtOAc/Hexane = 2:3). IR (KBr, cm^{-1}): 3444, 2920, 1712, 1650, 1597, 1482, 1463, 1454, 1265.^{1}H NMR (400 MHz, $CDCl_3$) δ 11.05 (s, 1H), 8.29 (d, J = 8.8 Hz, 2H), 7.79 (d, J = 8.8 Hz, 2H), 7.60 (d, J = 8.0 Hz, 1H), 7.53 (d, J = 8.3 Hz, 1H), 7.34 (dd, J = 11.2, 4.1 Hz, 1H), 7.19 (t, J = 7.2 Hz, 1H), 6.84 (d, J = 10.3 Hz, 1H), 6.79 (d, J = 10.3 Hz, 1H), 5.54 (s, 2H), 4.61 (t, J = 7.4 Hz, 3H), 3.32 (t, J = 7.4 Hz, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 182.17, 180.27, 160.50, 142,14, 140.74, 138.83, 136.77, 132.40, 128.96, 125.49, 124.86, 124.82, 124.56, 123.88, 121.86, 120.68, 119.24, 116.18, 114.66, 112.50, 111.76, 66.60, 44.72, 20.60. HRMS calcd. for $C_{26}H_{18}N_3O_6$ (M+H): 468.11956; found: 468.11850.

8-Benzoyl-5,15-dihydro-6*H*-naphtho[2',3':1,2]indolizino[8,7-*b*]indole-9,14-dione **3l**:



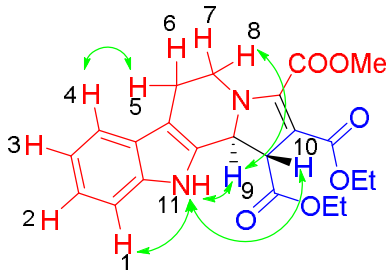
Following the batch synthesis, on 0.1 mmol scale reaction, 30 mg (68%) of **3l** was obtained as a red solid. Mp. 280-282 ^{0}C. R_f = 0.60 (EtOAc/Hexane = 3:7). IR (KBr, cm^{-1}): 3317, 2920, 1664, 1596, 1584, 1566, 1480, 1449, 1420, 1397, 1270. ^{1}H NMR (400 MHz, $CDCl_3$) δ 11.29 (s, 1H), 8.35 (d, *J* = 7.6 Hz, 1H), 8.10 (d, *J* = 7.8 Hz, 1H), 8.03 (d, *J* = 7.6 Hz, 2H), 7.76-7.68 (m, 3H), 7.59 (t, *J* = 7.7 Hz, 2H), 7.51 (t, *J* = 7.6 Hz, 2H), 7.34 (t, *J* = 7.5 Hz, 1H), 7.19 (t, *J* = 7.5 Hz, 1H), 4.38 (t, *J* = 7.4 Hz, 2H), 3.32 (t, *J* = 7.4 Hz, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 188.78, 180.66, 178.85, 137.18, 136.75, 135.33, 135.11, 134.31, 133.47, 133.38, 133.35, 132.16, 129.63, 128.86, 127.31, 126.89, 125.73, 125.12, 124.48, 122.29, 120.52, 119.12, 115.03, 112.46, 110.95, 44.49, 20.64. HRMS calcd. for $C_{29}H_{19}N_2O_3$ (M+H): 443.13957; found: 443.13887.

8-(4-Chlorobenzoyl)-5,15-dihydro-6*H*-naphtho[2',3':1,2]indolizino[8,7-*b*]indole-9,14-dione **3m**:



Following the batch synthesis, on 0.1 mmol scale reaction, 32 mg (67%) of **3m** was obtained as a red solid. Mp. 298-300 ^{0}C. R_f = 0.68 (EtOAc/Hexane = 2:3). IR (KBr, cm^{-1}): 3422, 2923, 1657, 1587, 1482, 1267. ^{1}H NMR (500 MHz, $CDCl_3$) δ 11.27 (s, 1H), 8.33 (d, *J* = 7.0 Hz, 1H), 8.08 (d, *J* = 6.9 Hz, 1H), 7.97 (d, *J* = 8.6 Hz, 2H), 7.76 (t, *J* = 6.9 Hz, 1H), 7.70 (dd, *J* = 10.7, 4.2 Hz, 1H), 7.58 (dd, *J* = 10.9, 8.3 Hz, 2H), 7.47 (d, *J* = 8.6 Hz, 2H), 7.33 (t, *J* = 7.3 Hz, 1H), 7.19 (t, *J* = 7.4 Hz, 1H), 4.38 (t, *J* = 7.4 Hz, 2H), 3.31 (t, *J* = 7.4 Hz, 2H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 187.45, 180.56, 178.94, 140.80, 136.74, 135.65, 135.16, 135.00, 133.53, 132.60, 132.50, 130.93, 129.21, 127.29, 126.91, 125.66, 124.95, 124.57, 122.56, 120.54, 119.16, 112.47, 111.11, 44.51, 20.61 HRMS calcd. for $C_{29}H_{18}ClN_2O_3$ (M+H): 477.10060; found: 477.10001.

1,2-diethyl 3-methyl 5,6,11,11b-tetrahydro-1*H*-indolizino[8,7-*b*]indole-1,2,3-tricarboxylate **3n**:

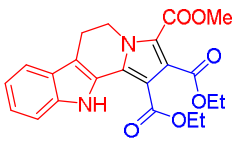


(Key NOEs of compound **3n**)

Following the batch synthesis, on 0.1 mmol scale reaction, 27 mg (65%) of **3n** was obtained as a white solid. Mp. 170-172 ^{0}C. R_f = 0.55 (EtOAc/Hexane = 2:3). IR (KBr, cm^{-1}): 3301, 2987, 1744, 1647, 1571, 1560, 1491, 1339, 1244. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.06 (bs, 1H, H11), 7.45(dd, J_{H4-}

$_{H3}$ = 8.0 Hz, J_{H4-H2} = 1.0 Hz, 1H, H4), 7.29(td, J_{H1-H2} = 8.0 Hz, J_{H1-H3} = 1.0 Hz, J_{H1-H4} = 1.0 Hz, 1H, H1), 7.16(td, J_{H1-H2} = 8.0 Hz, J_{H3-H2} = 8.0, J_{H4-H2} = 1.0 Hz, 1H, H2), 7.09(td, J_{H3-H2} = 8.0 Hz, J_{H3-H4} = 8.0 Hz, J_{H1-H3} = 1.0 Hz, 1H, H3), 5.55(dt, J_{H10-H9} = 12.5 Hz, J_{H9-H5} = 2.0, J_{H9-H6} = 2.0 Hz, 1H, H9), 4.37 (d, J_{H10-H9} = 12.5 Hz, 1H, H10), 4.10(m, 2H, -OCH_2-), 3.98(s, 3H, OMe), 3.81(m, 2H, -OCH_2-), 3.65(ddd, J_{H7-H8} = 13.8 Hz, J_{H7-H6} = 5.3, J_{H7-H5} = 1.0 Hz, 1H, H7), 3.24(ddd, J_{H7-H8} = 13.8, J_{H5-H8} = 11.8, J_{H6-H8} = 4.0 Hz, 1H, H8), 2.95(m, 1H, H6), 2.77(m, 1H, H5), 1.19(t, J = 7.1 Hz, 3H, -OCH_2-C$\underline{H}_3$), 0.78(t, J = 7.1 Hz, 3H, -OCH_2-C$\underline{H}_3$) (All proton resonances were assigned using 2D-DQFCOSY, NOESY and HSQC experiments). ^{13}C NMR (125 MHz, $CDCl_3$) δ 170.58, 163.97, 163.23, 152.96, 136.29, 128.39, 126.36, 122.51, 119.76, 118.25, 110.95, 110.57, 100.26, 61.20, 60.69, 59.61, 53.10, 51.42, 43.49, 21.75, 14.33, 13.60. HRMS calcd. for $C_{22}H_{24}N_2NaO_6$ (M+Na): 435.15321; found: 435.15266.

1,2-diethyl 3-methyl 6,11-dihydro-5H-indolizino[8,7-b]indole-1,2,3-tricarboxylate **3o**:

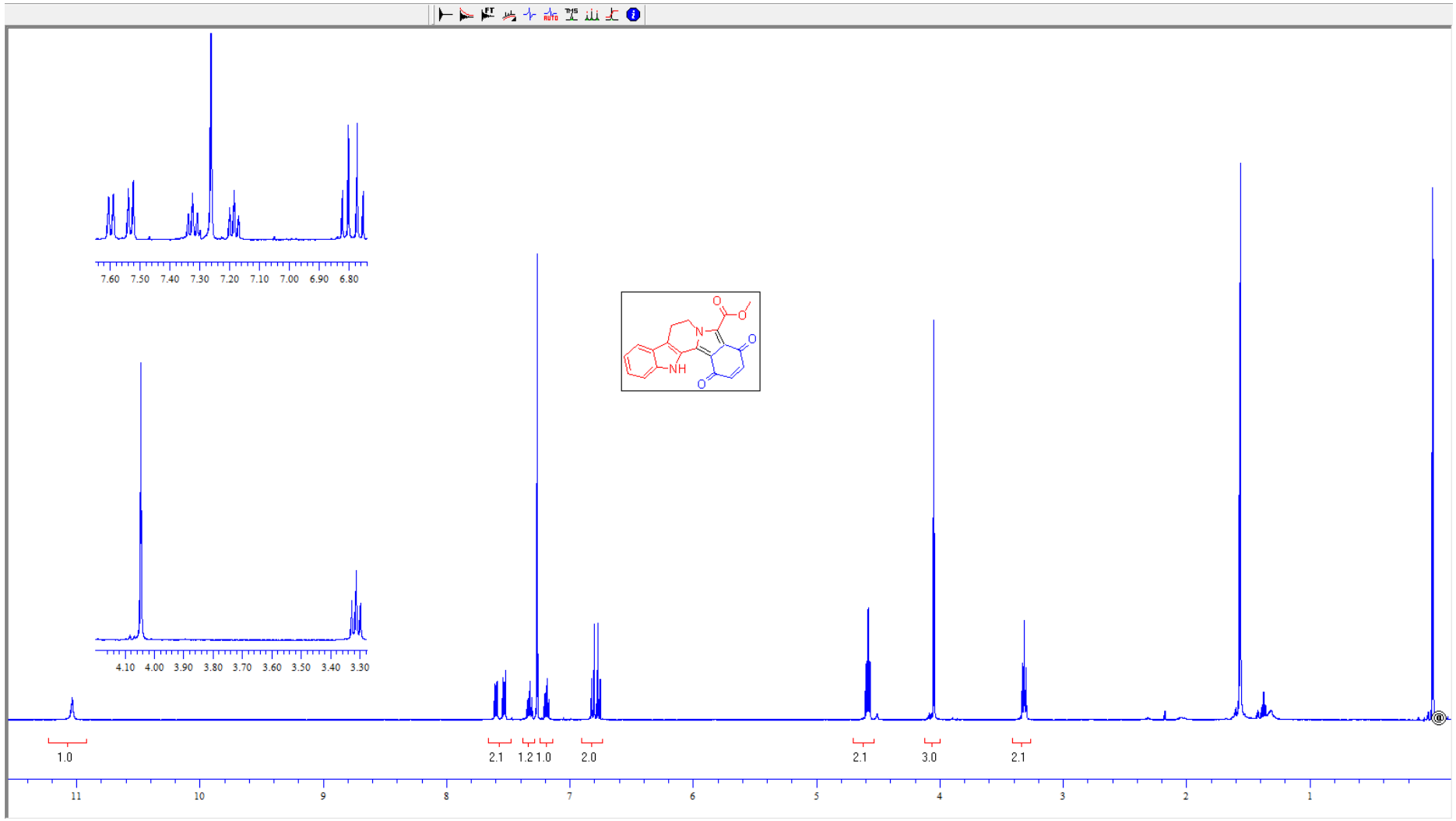


Following the batch synthesis, on 0.1 mmol scale reaction, 33 mg (80%) of **3o** was obtained as a white solid. Mp. 160-162 ^{0}C. R_f = 0.56 (EtOAc/Hexane = 1:3). IR (KBr, cm^{-1}): 3342, 2980, 1740, 1682, 1529, 1515, 1474, 1438, 1418, 1382. ^{1}H NMR (500 MHz, $CDCl_3$) δ 11.03 (s, 1H), 7.57 (d, J = 8.0 Hz, 1H), 7.46 (d, J = 8.2 Hz, 1H), 7.31 – 7.21 (m, 1H), 7.20 – 7.04 (m, 1H), 4.76 (t, J = 7.5 Hz, 2H), 4.41-4.33 (m, 4H), 3.21 (t, J = 7.5 Hz, 2H), 1.41-4.36 (m, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.96, 164.48, 160.25, 136.55, 134.26, 126.61, 125.35, 125.03, 123.81, 120.17, 120.04, 118.96, 112.19, 110.83, 107.72, 61.57, 61.22, 51.93, 44.41, 20.48, 14.29, 14.08. HRMS calcd. for $C_{22}H_{23}N_2O_6$ (M+H): 411.15561; found: 411.15446.

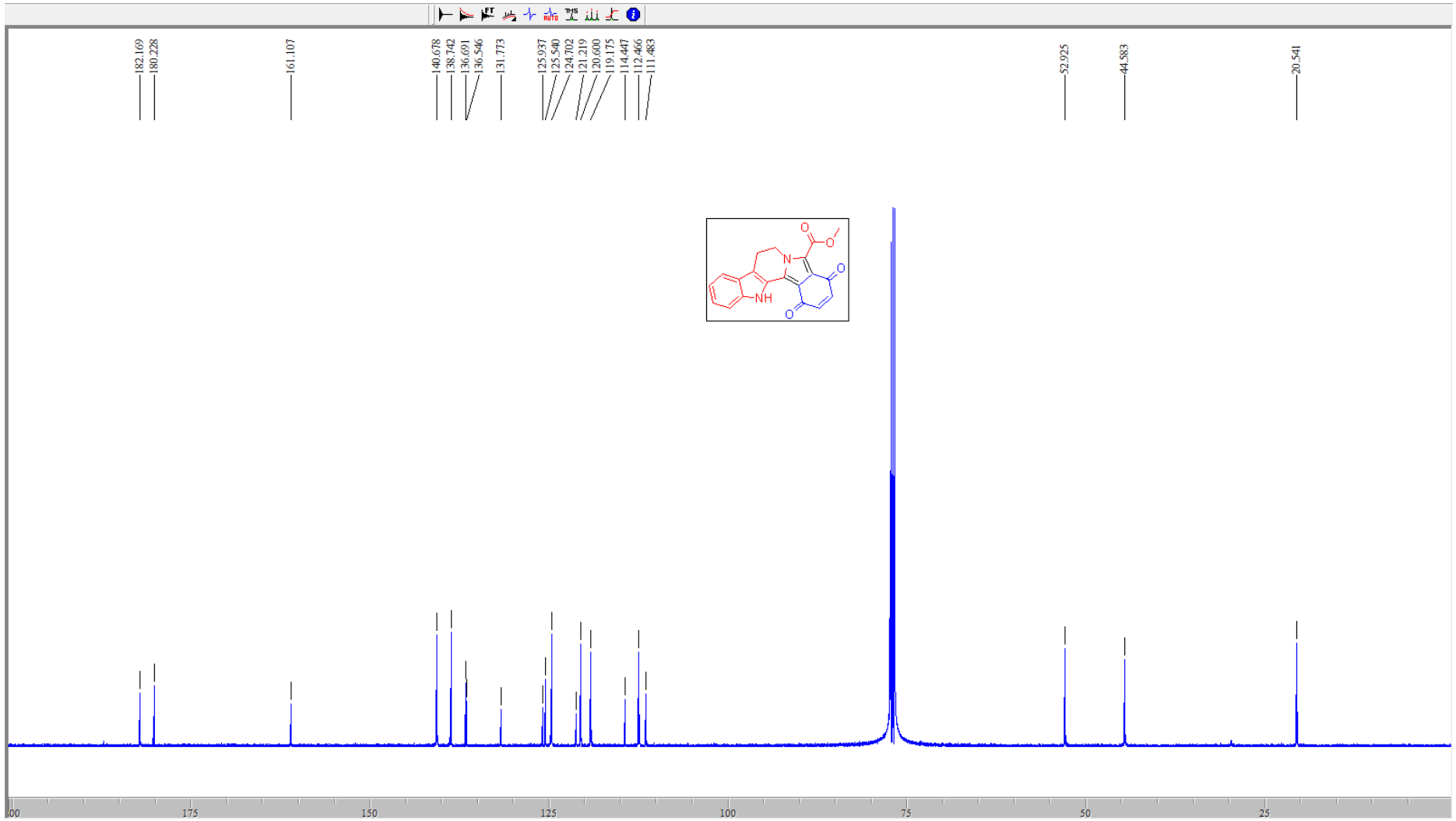
References:

1. I. Kadas, G. Szanto, L. Toke, A. Simon, G. Toth, *J. Heterocyclic Chem.*, 2007, **44**, 1373.
2. C. Aubry, A. J. Wilson, P. R. Jenkins, S. Mahale, B. Chaudhuri, J.-D. Marechal, M. J. Sutcliffe, *Org. Biomol. Chem.*, 2006, **4**, 787.

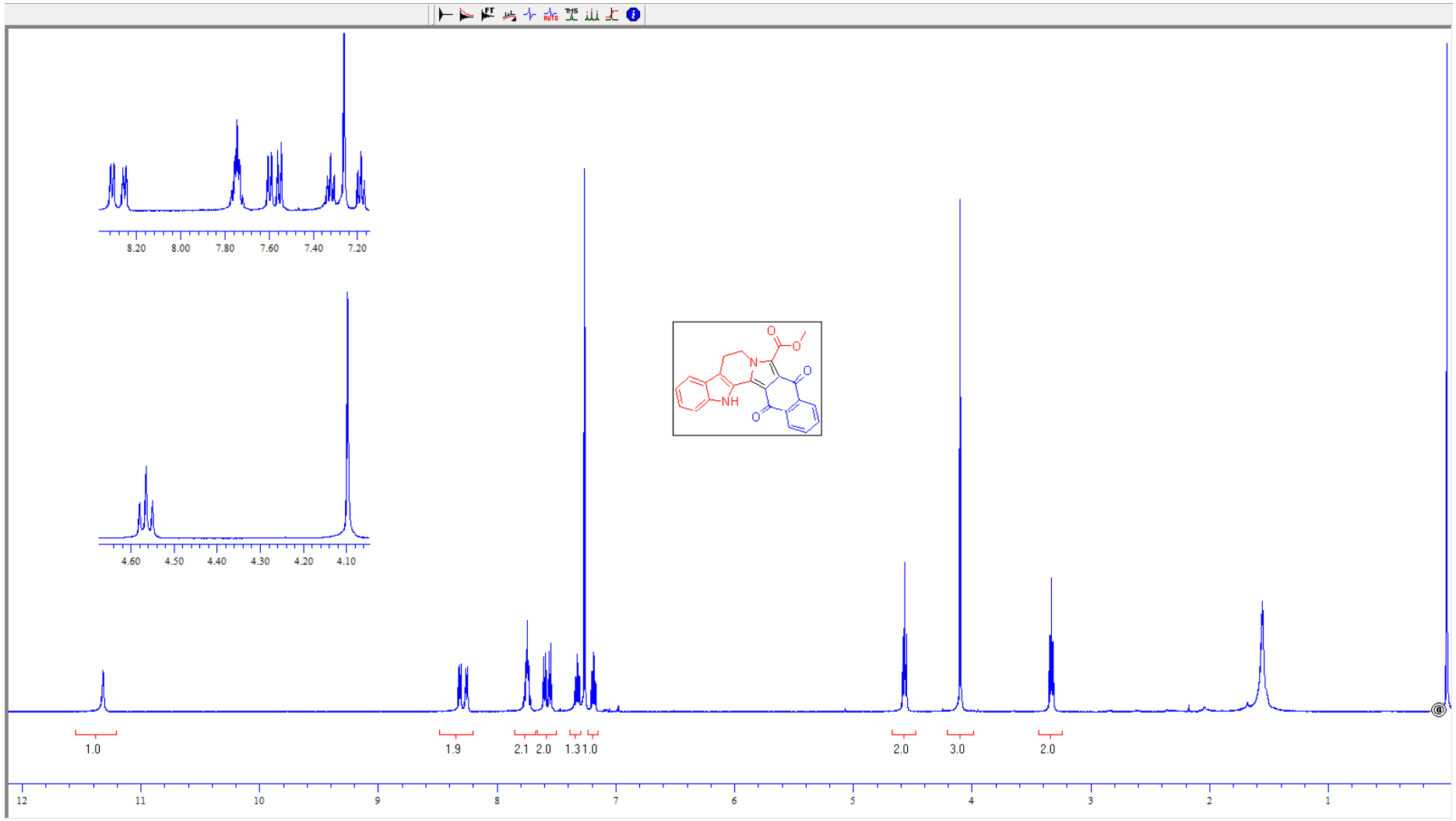
^{1}H NMR Spectrum of **3a**:



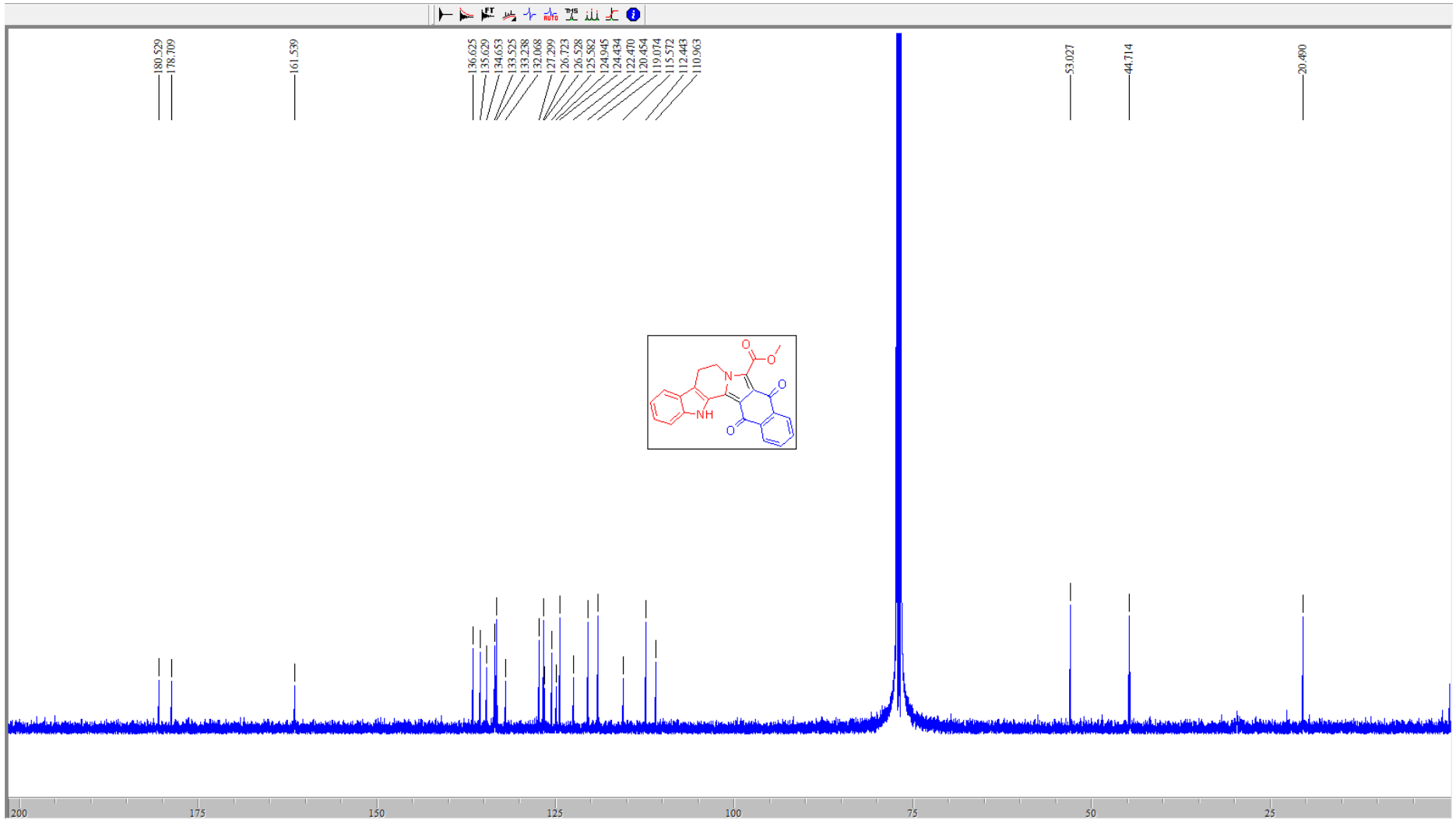
^{13}C NMR Spectrum of **3a**:



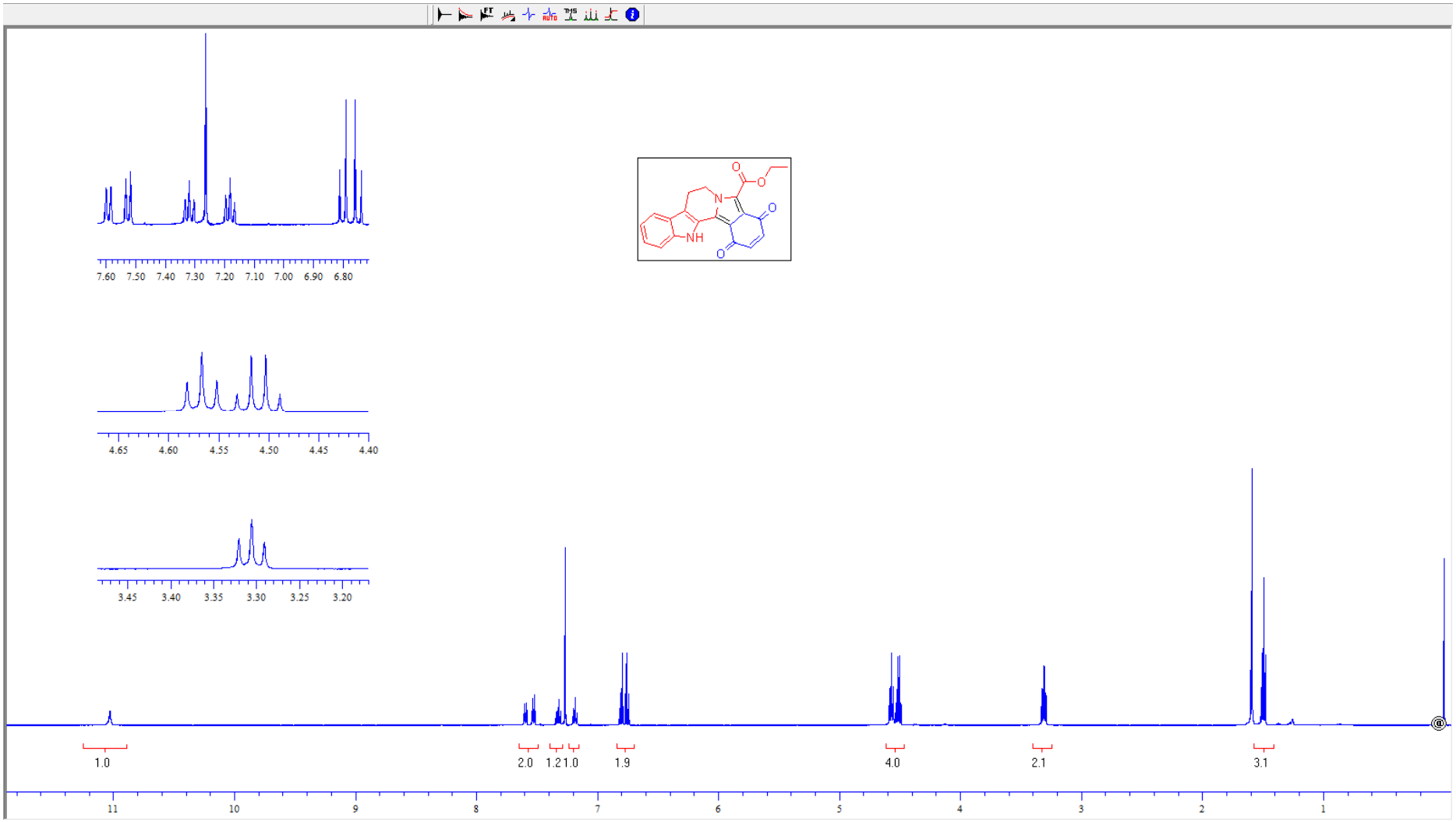
^{1}H NMR Spectrum of **3b**:



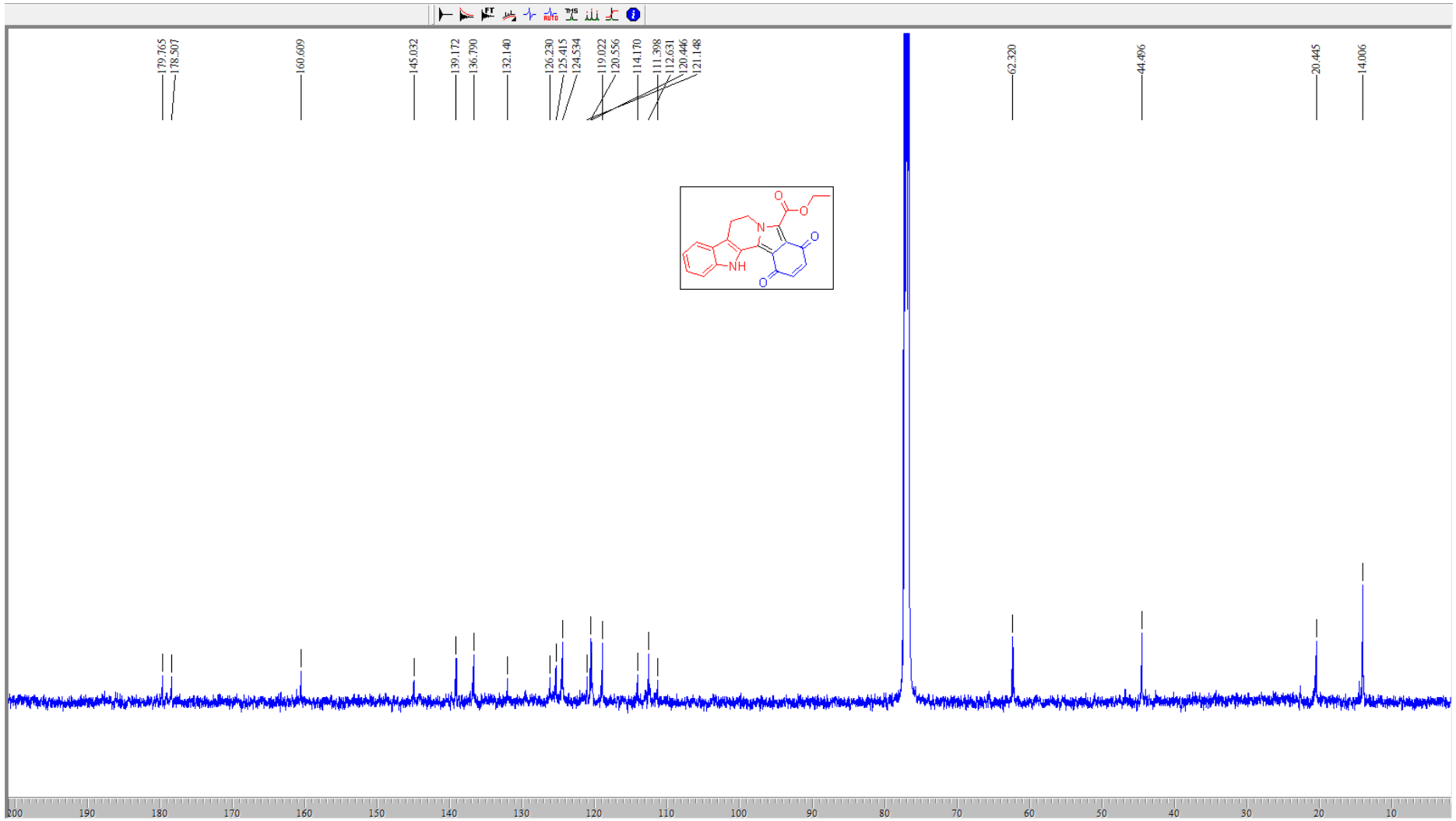
^{13}C NMR Spectrum of **3b**:



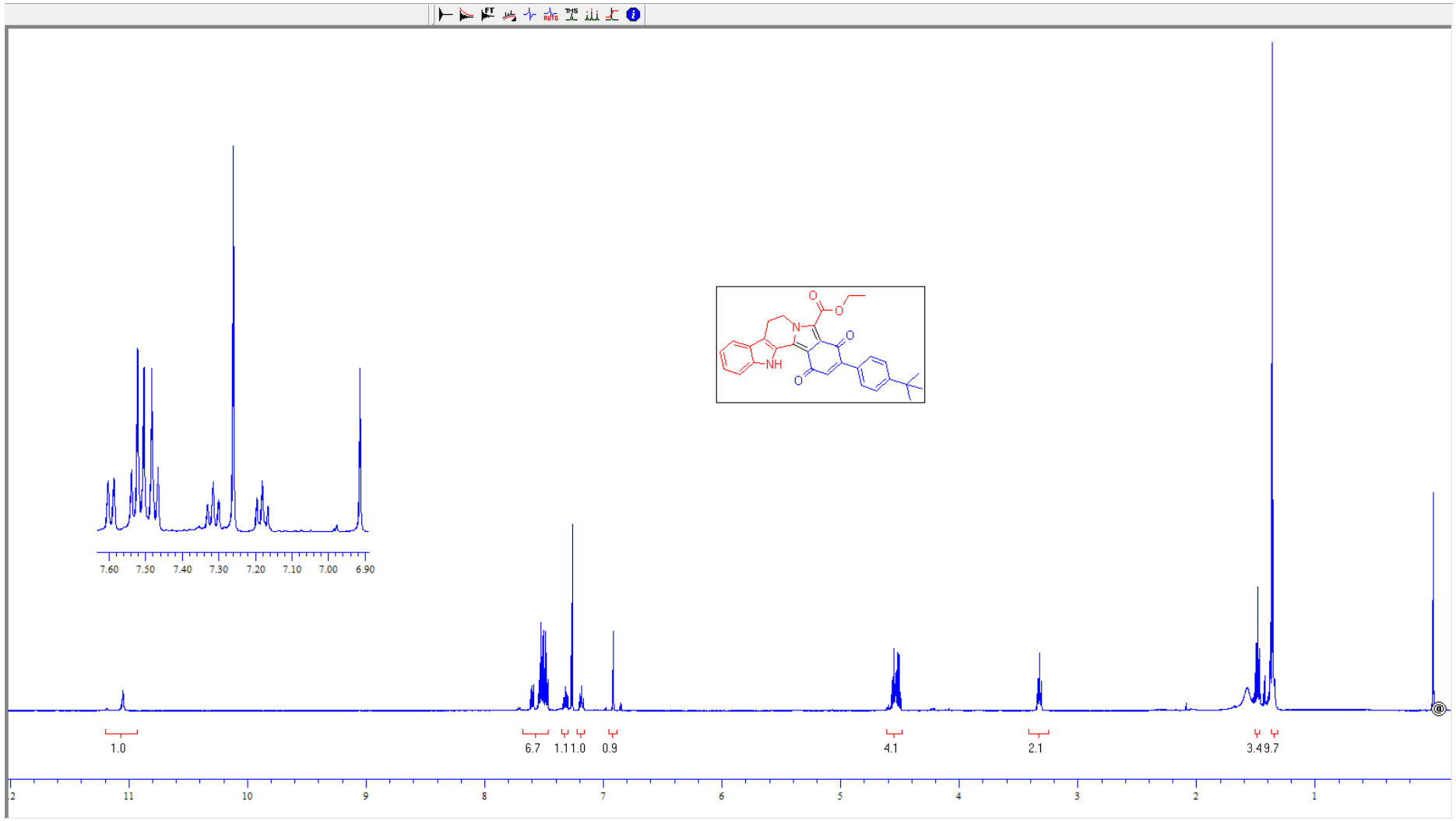
^{1}H NMR Spectrum of **3c**:



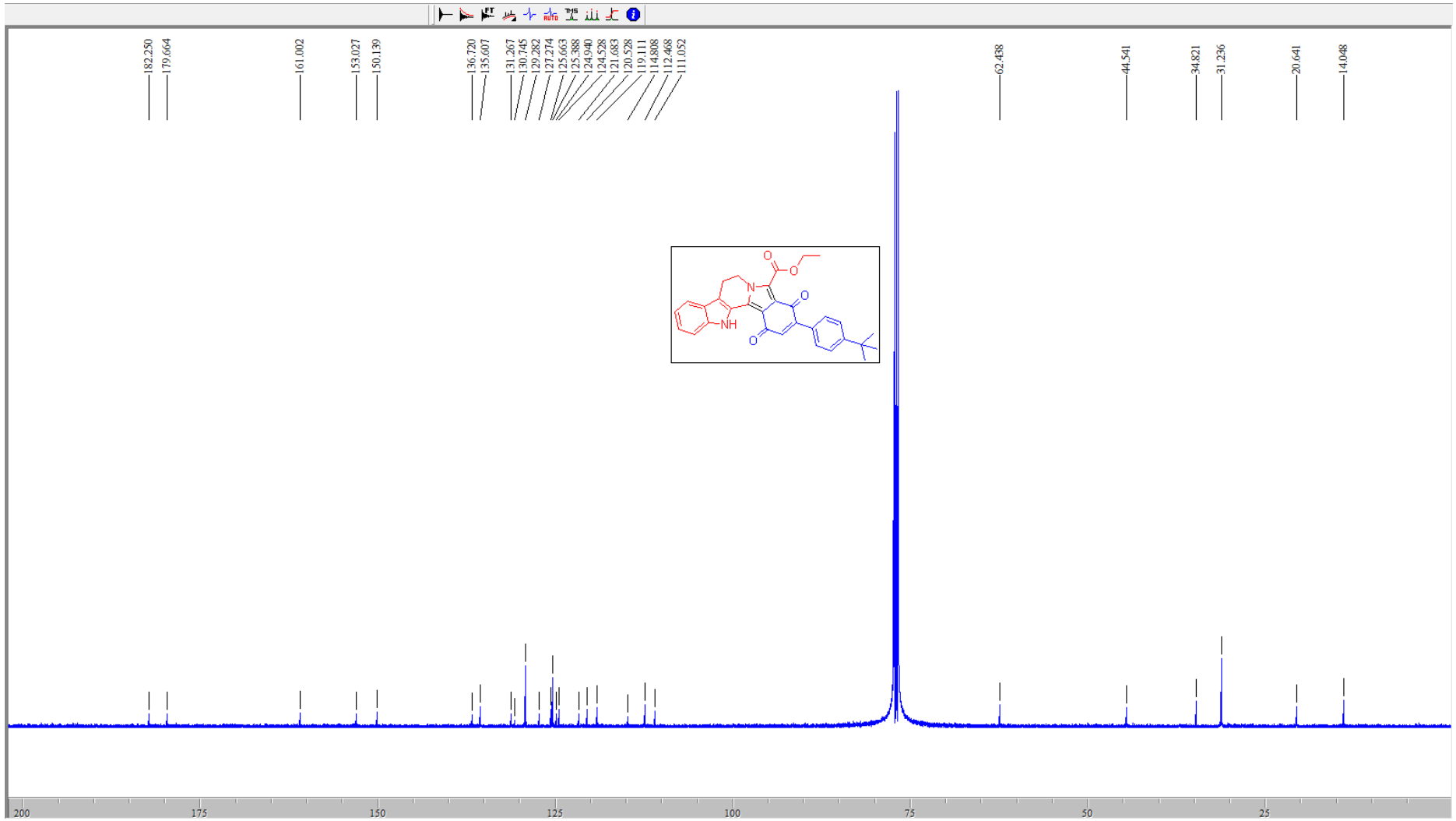
^{13}C NMR Spectrum of **3c**:



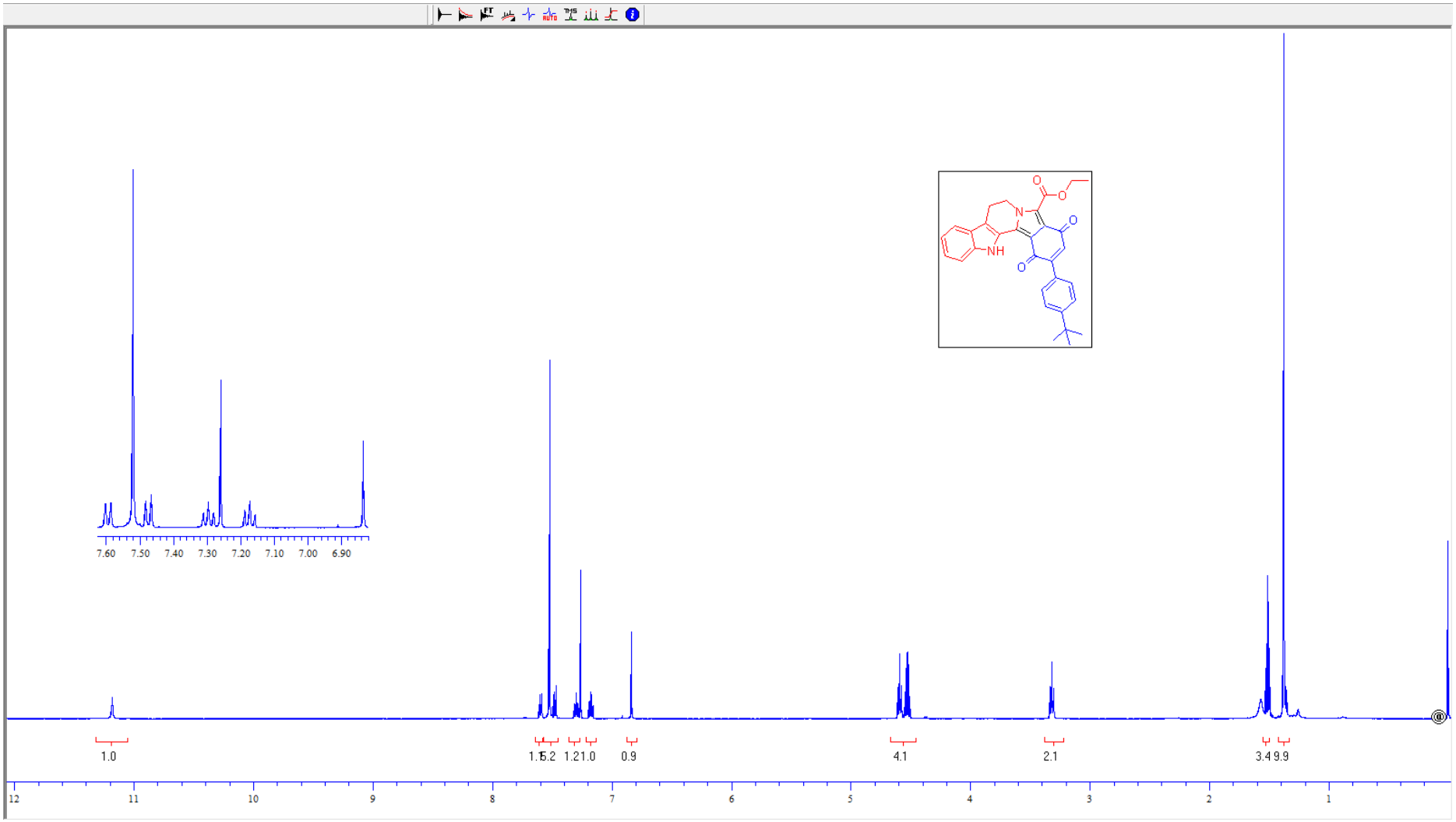
^{1}H NMR Spectrum of **3d**:



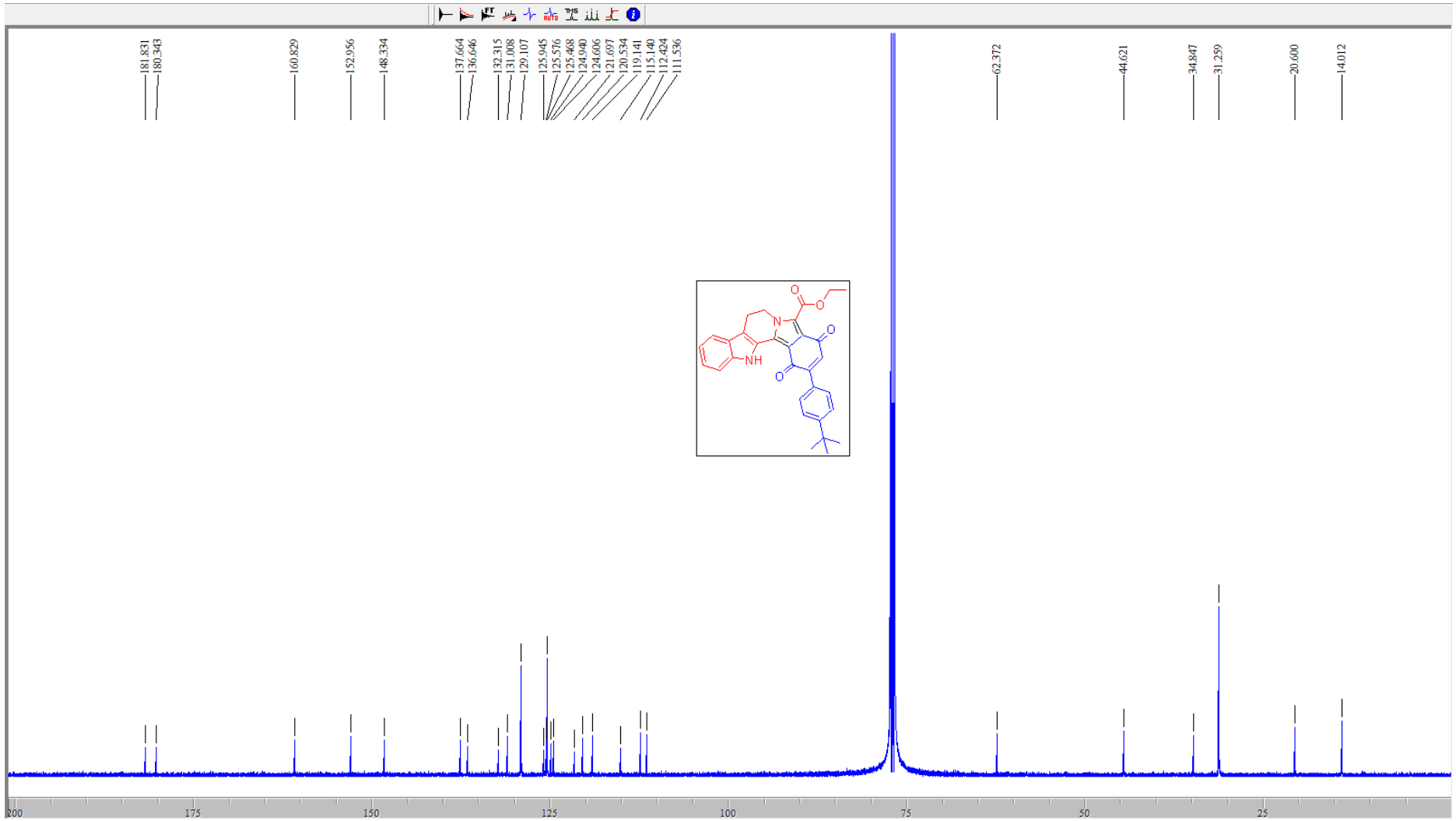
^{13}C NMR Spectrum of **3d**:



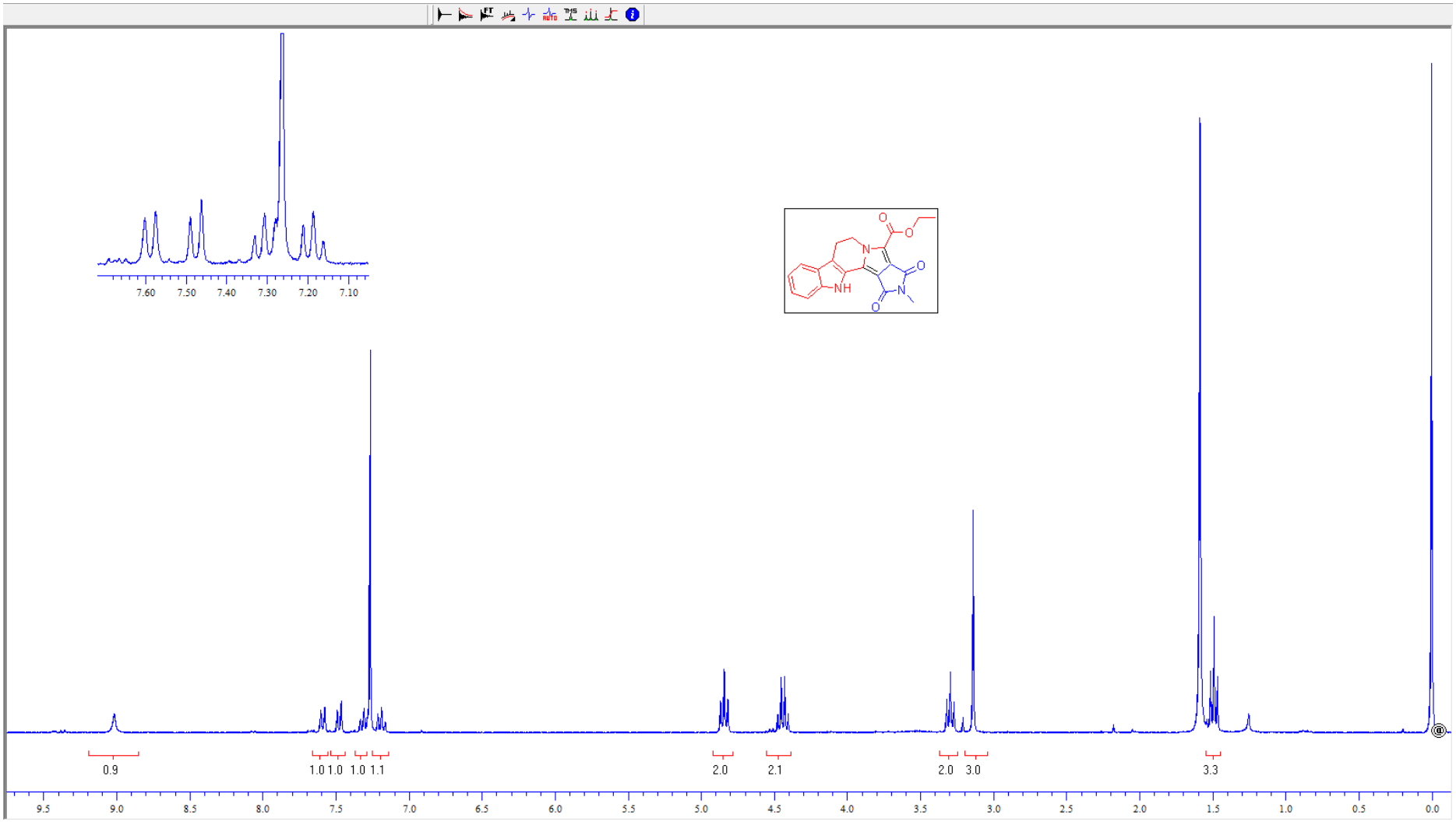
^{1}H NMR Spectrum of **3d'**:



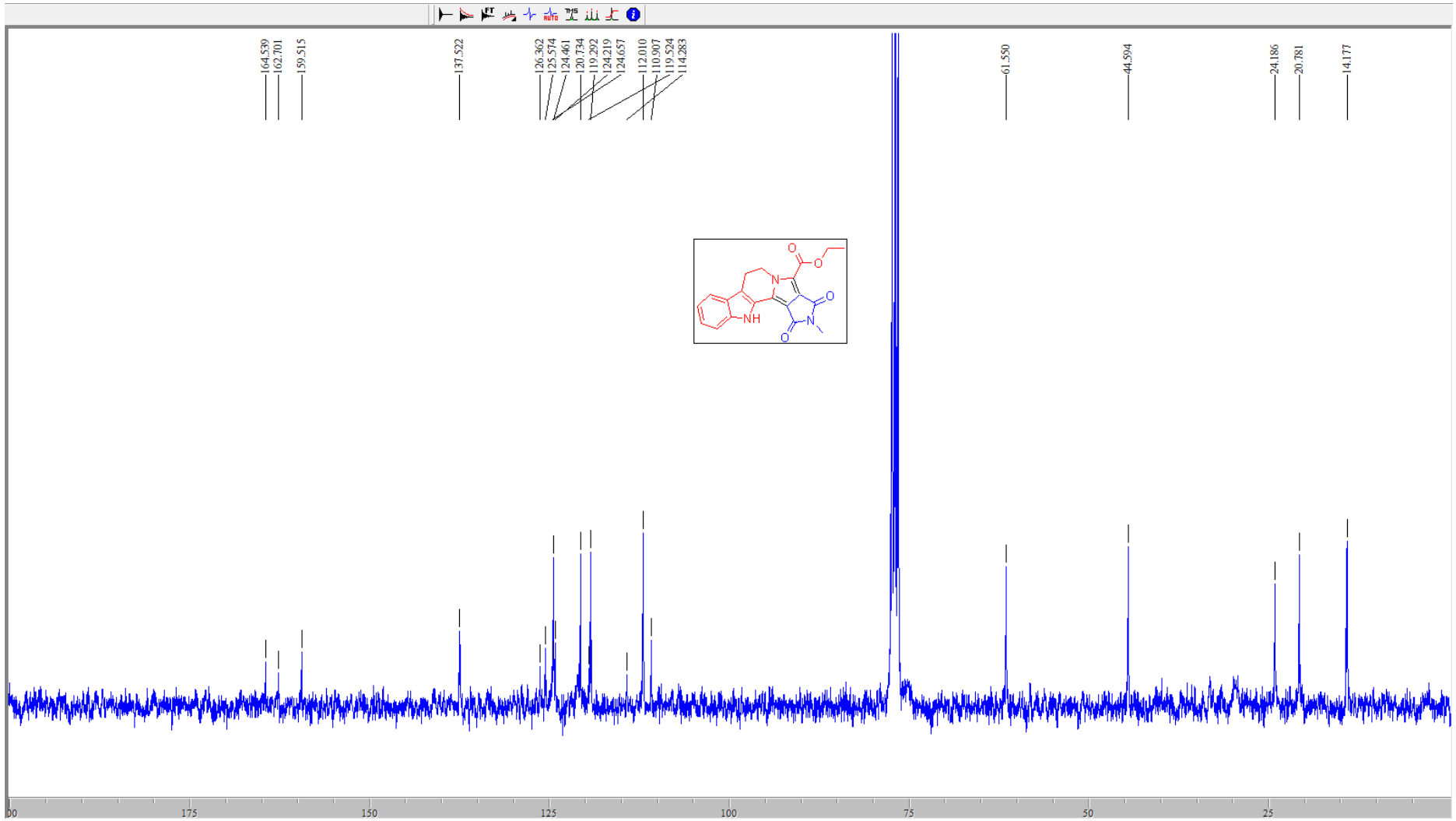
^{13}C NMR Spectrum of **3d'**:



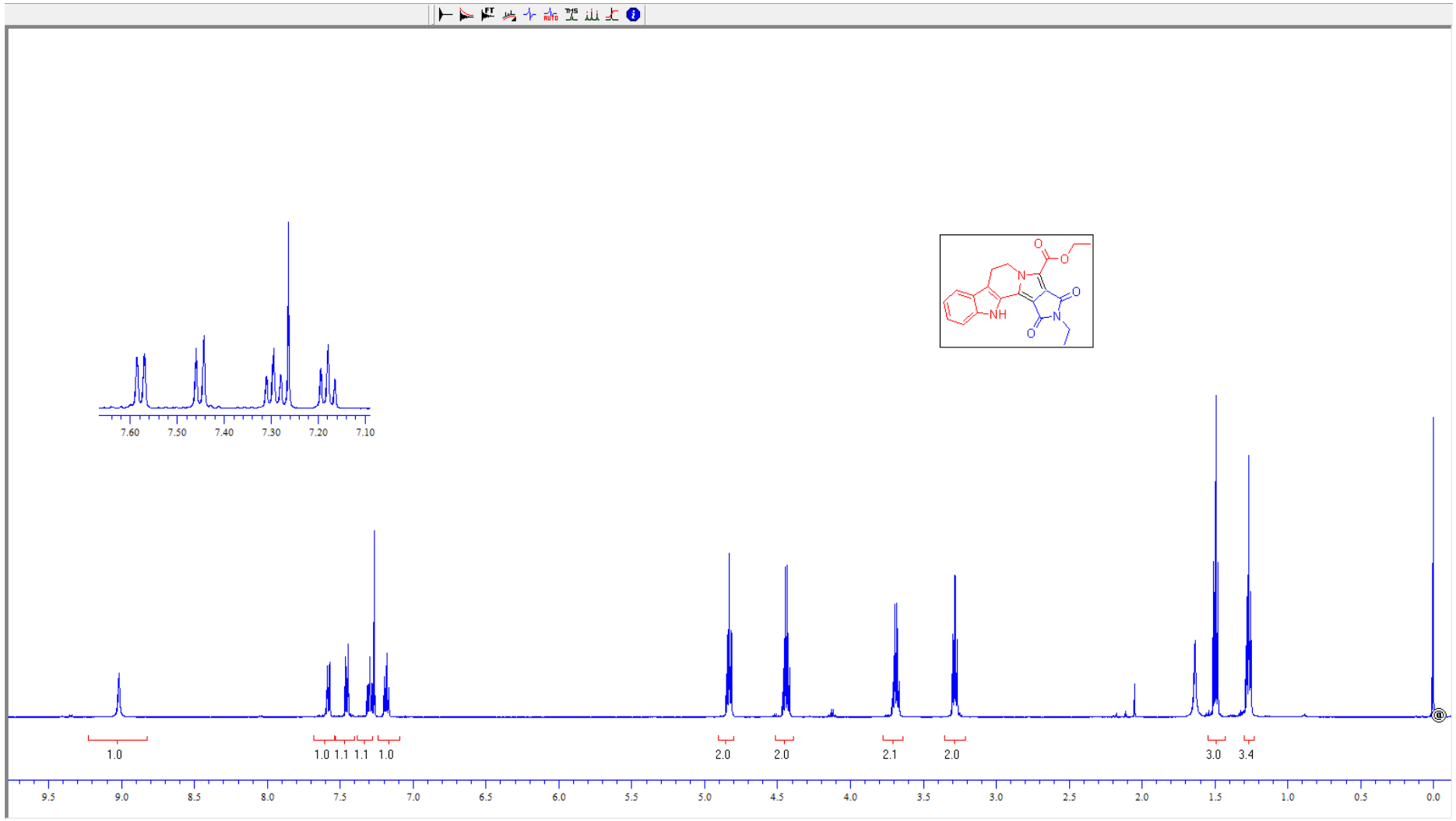
^{1}H NMR Spectrum of **3e**:



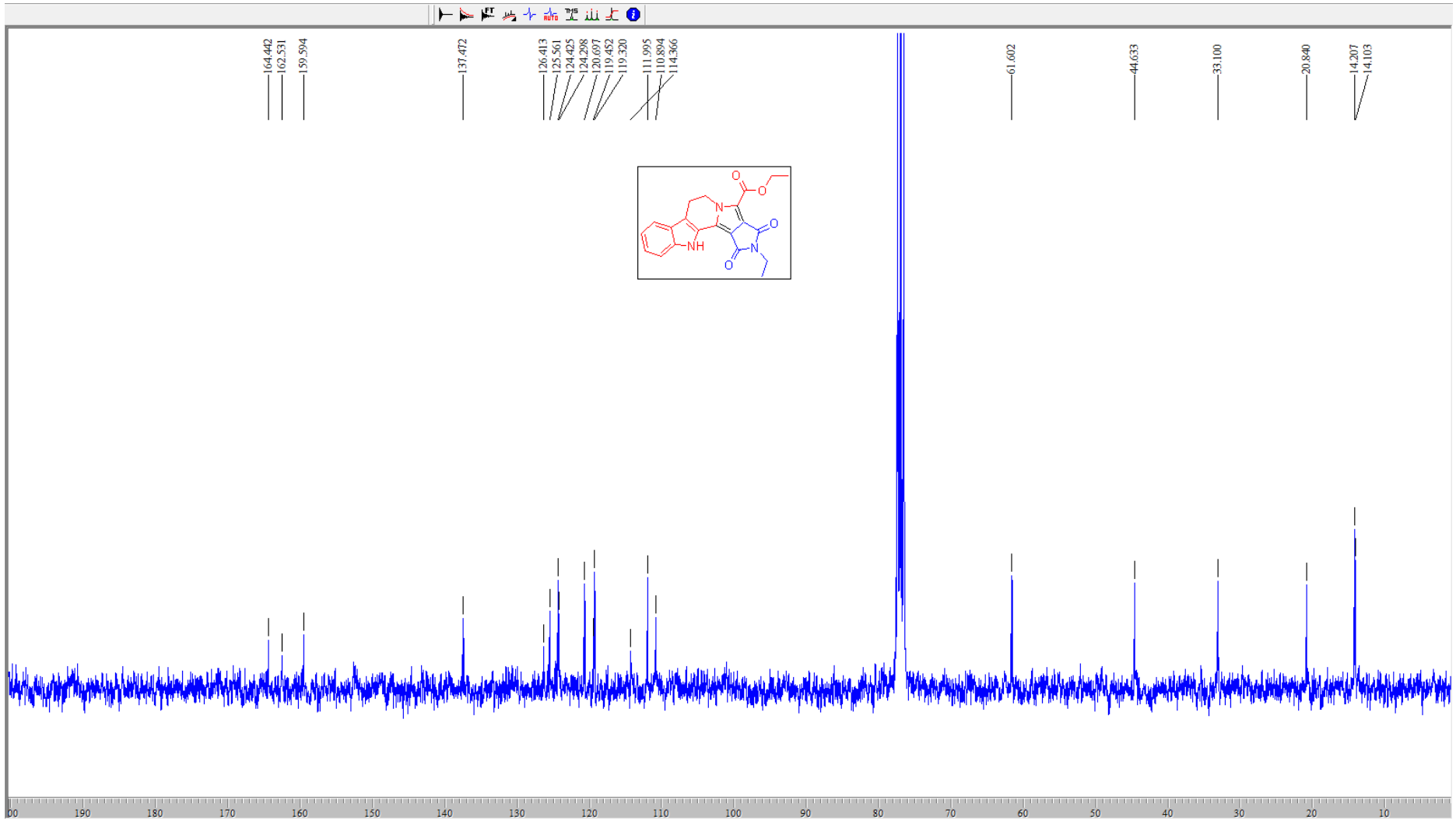
^{13}C NMR Spectrum of **3e**:



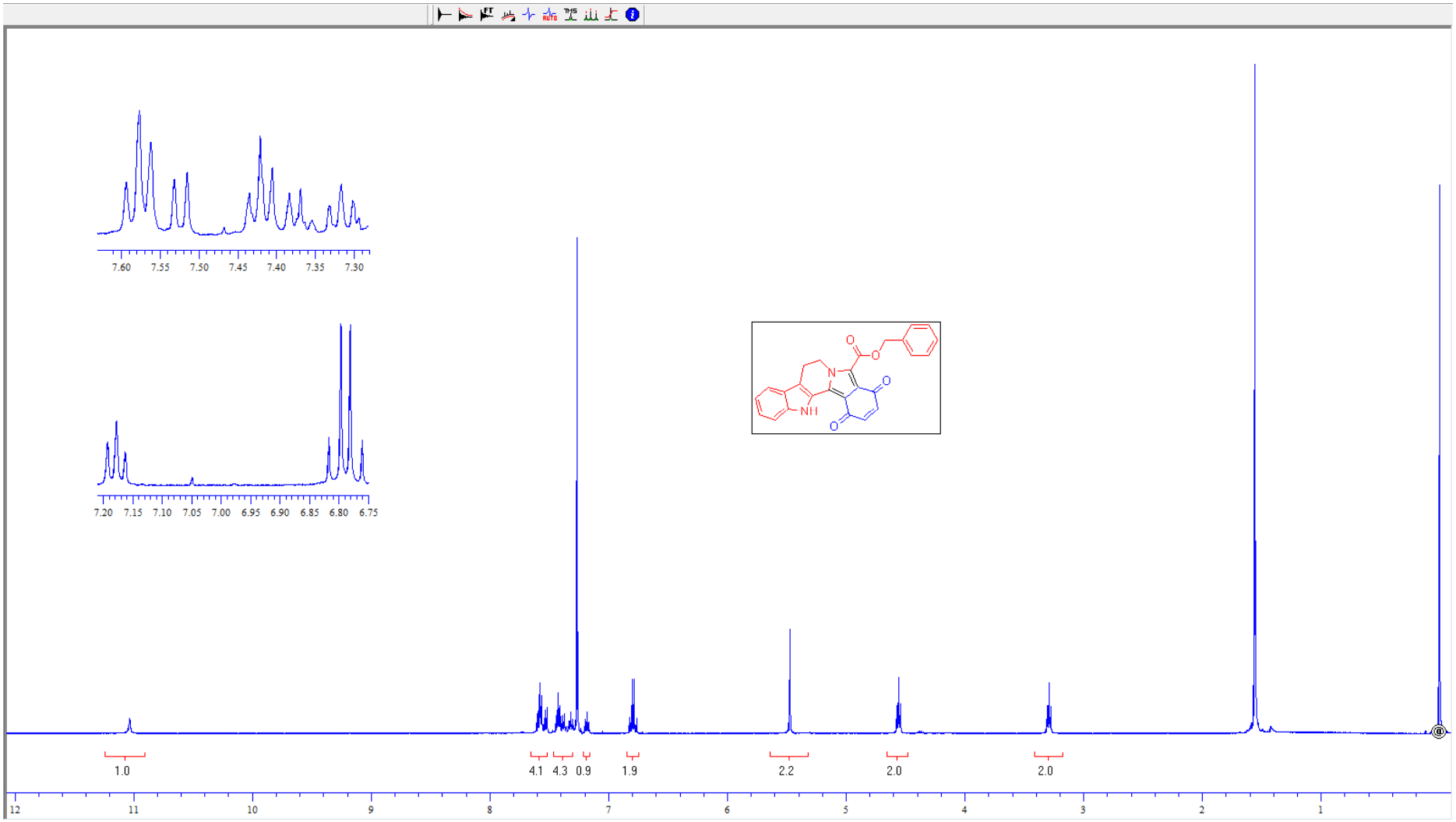
^{1}H NMR Spectrum of **3f**:



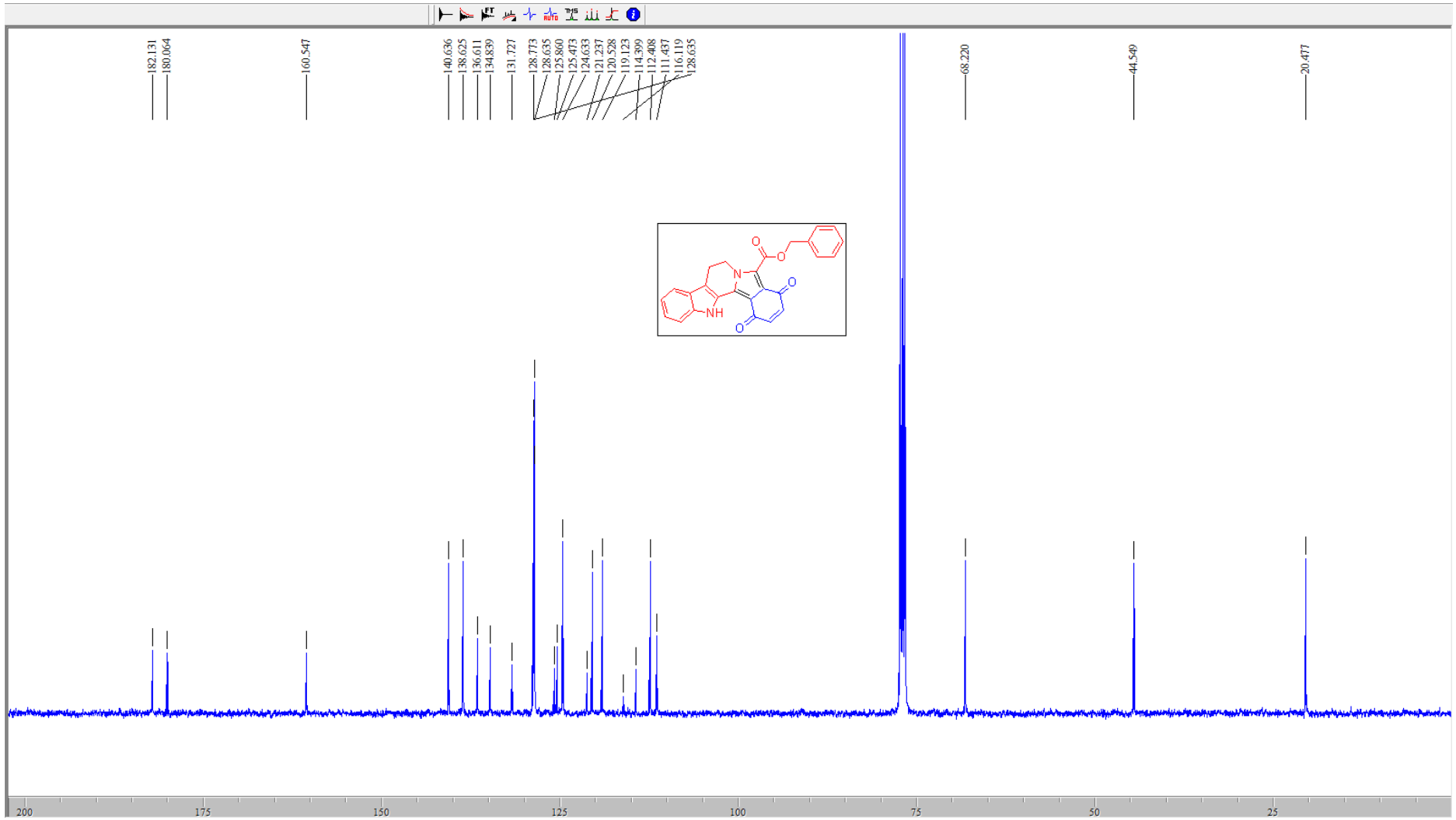
^{13}C NMR Spectrum of **3f**:



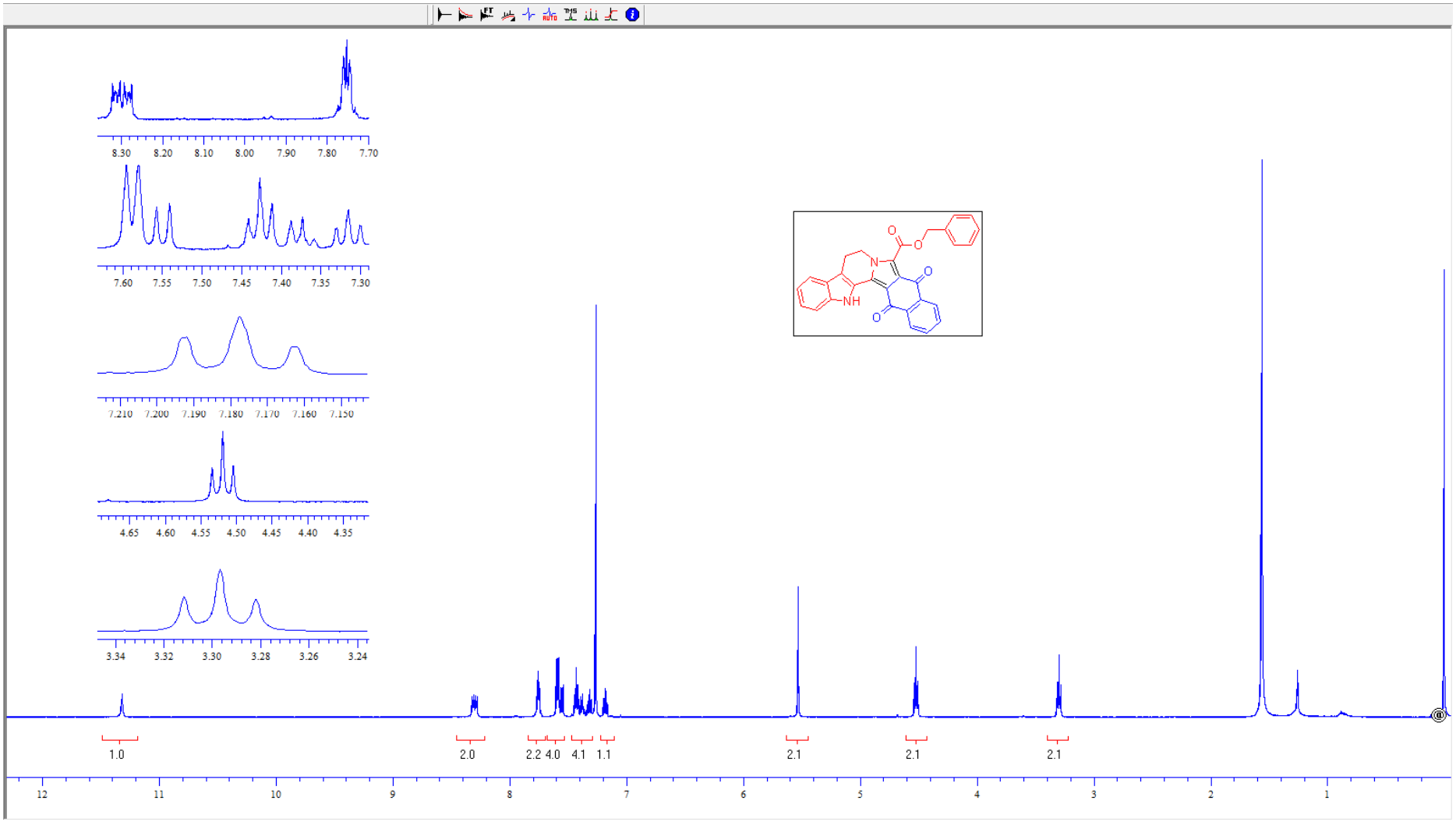
^{1}H NMR Spectrum of **3g**:



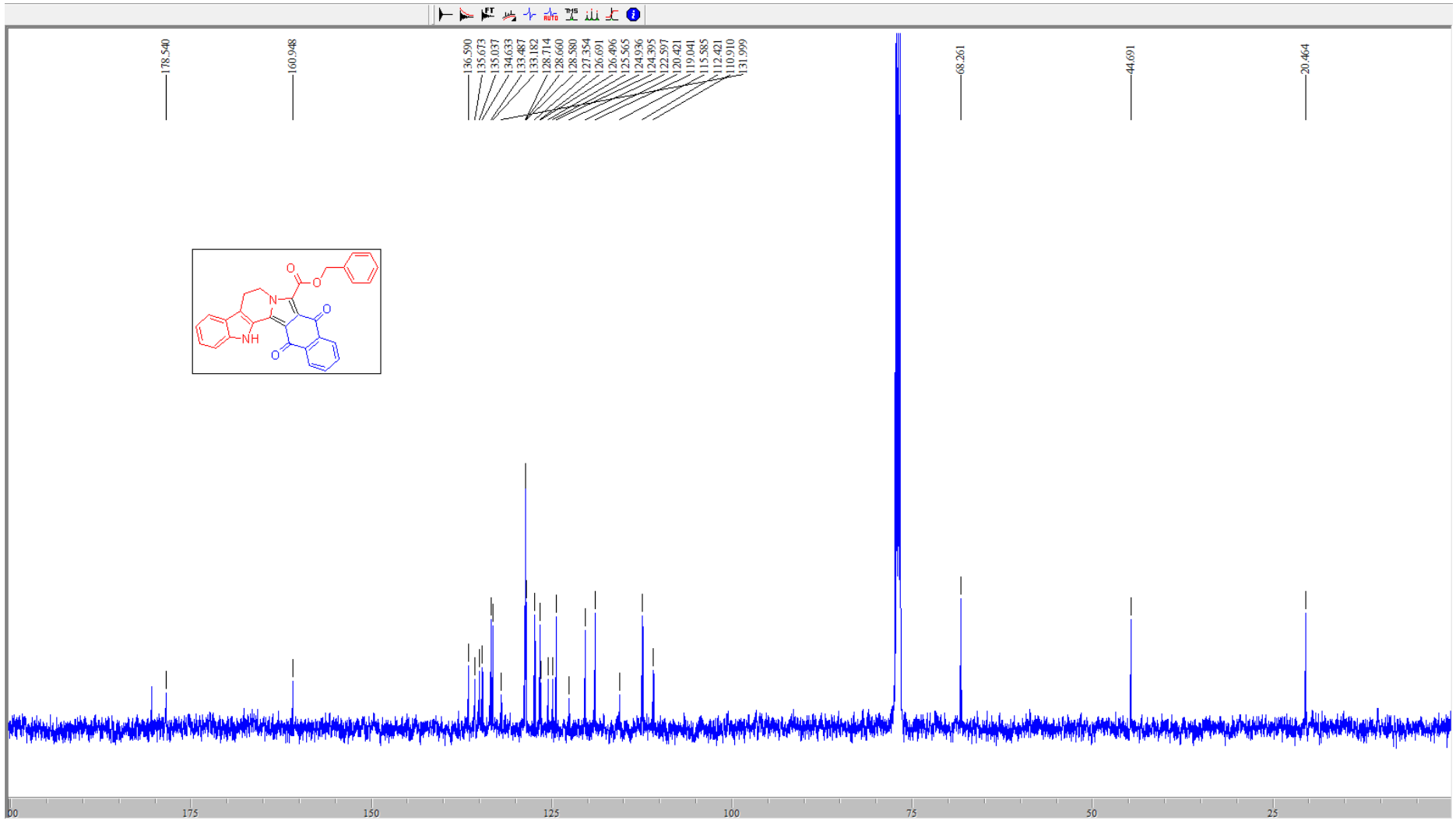
^{13}C NMR Spectrum of **3g**:



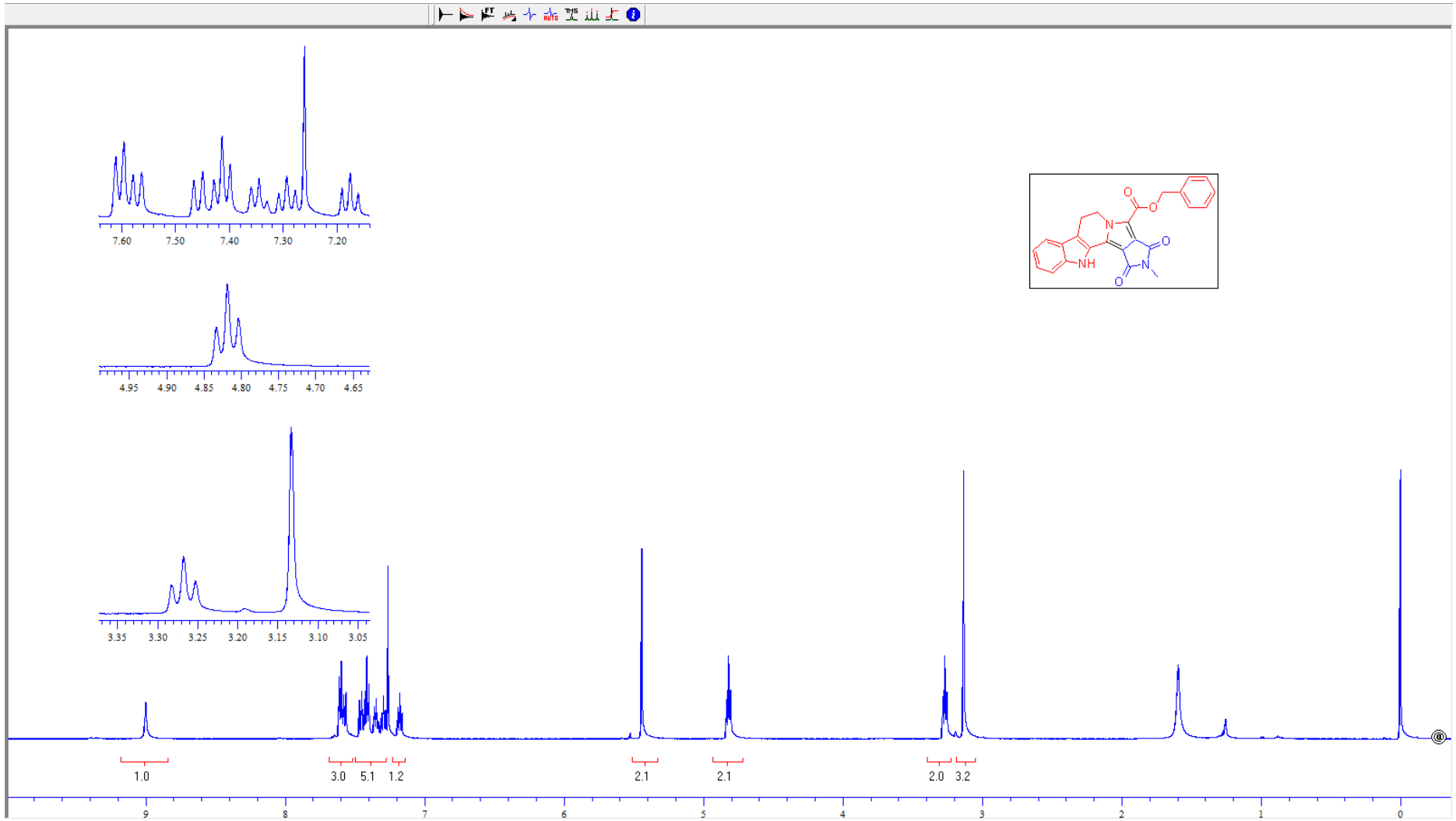
^{1}H NMR Spectrum of **3h**:



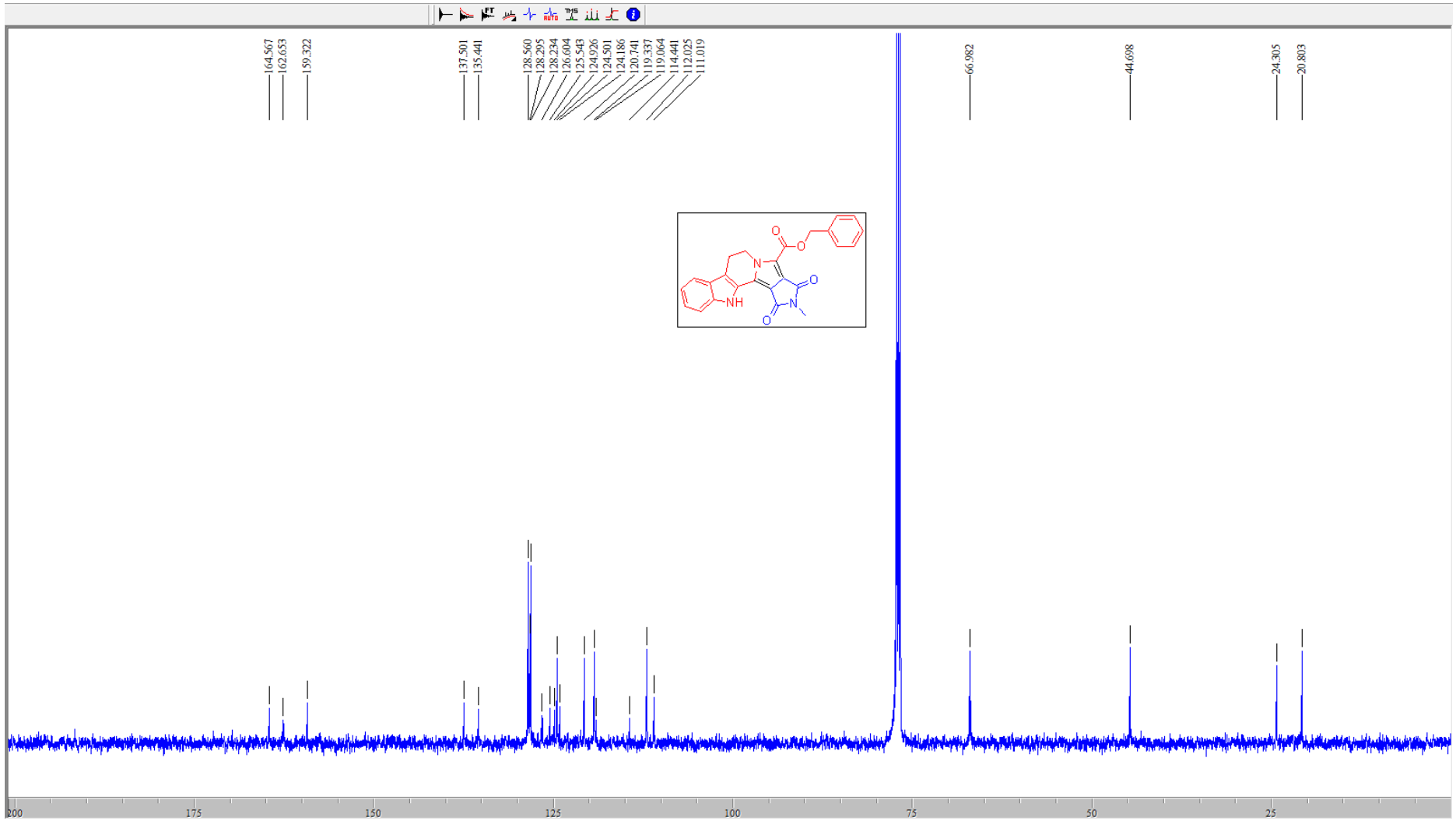
^{13}C NMR Spectrum of **3h**:



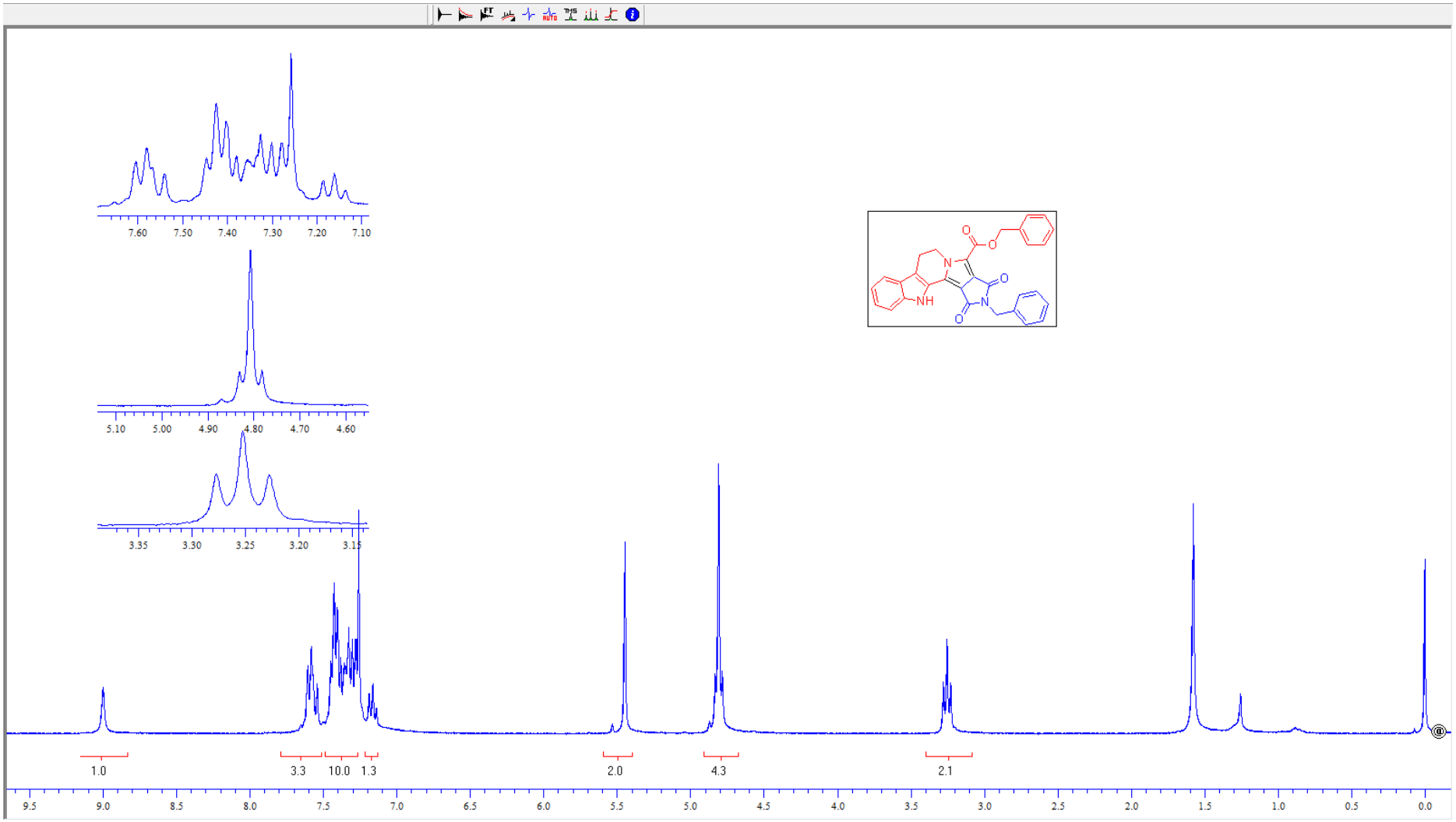
^{1}H NMR Spectrum of **3i**:



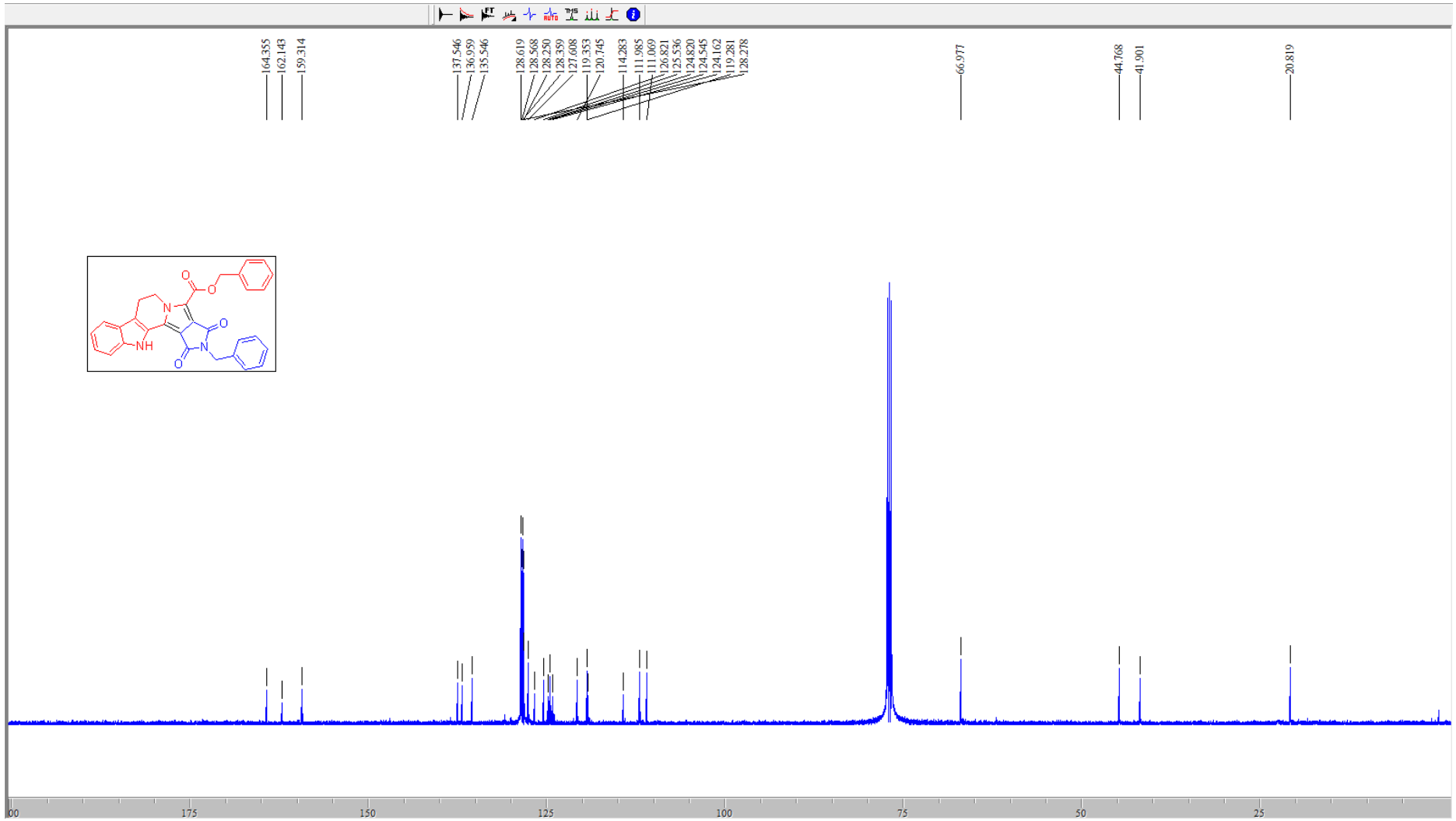
^{13}C NMR Spectrum of **3i**:



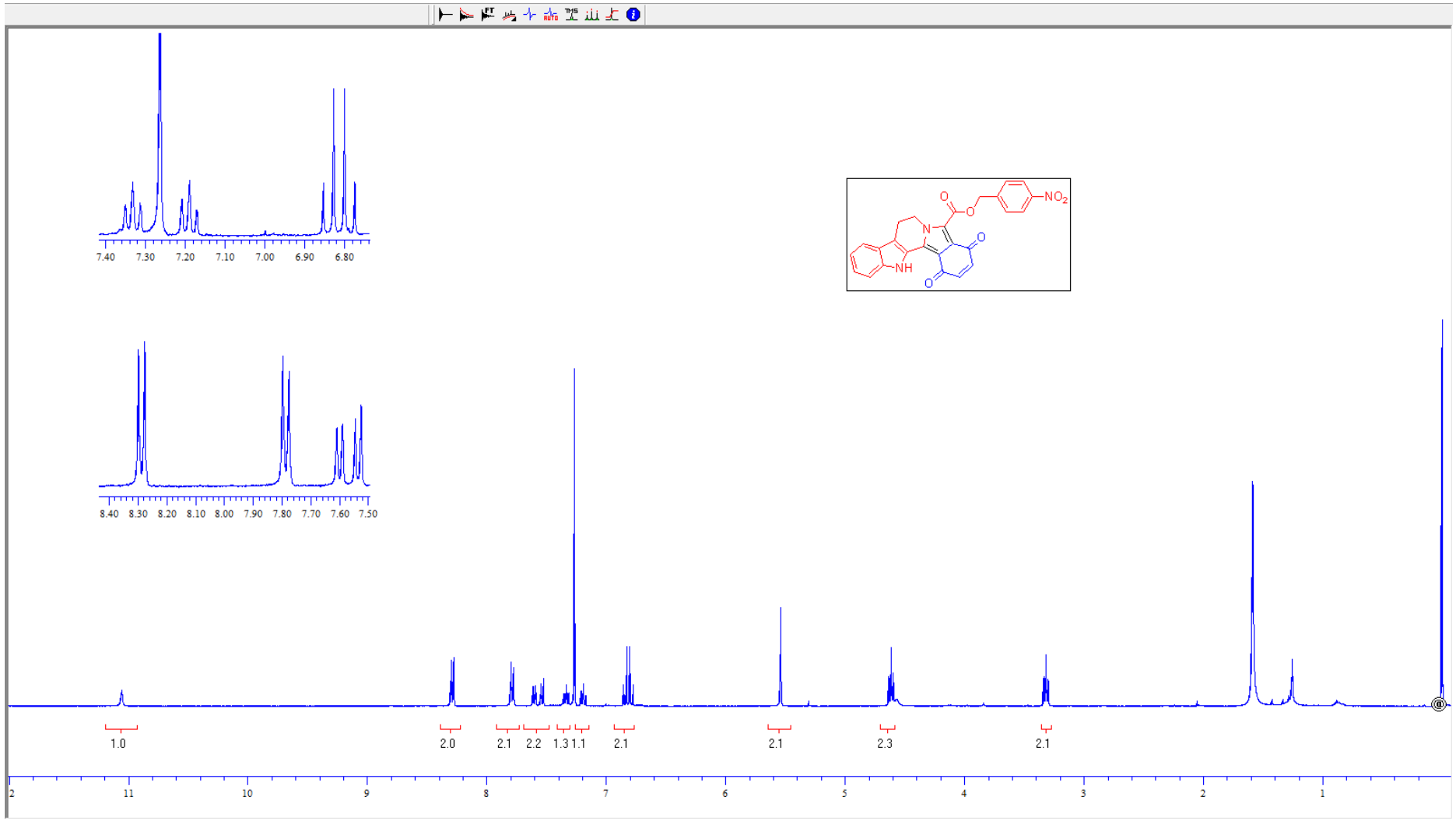
^{1}H NMR Spectrum of **3j**:



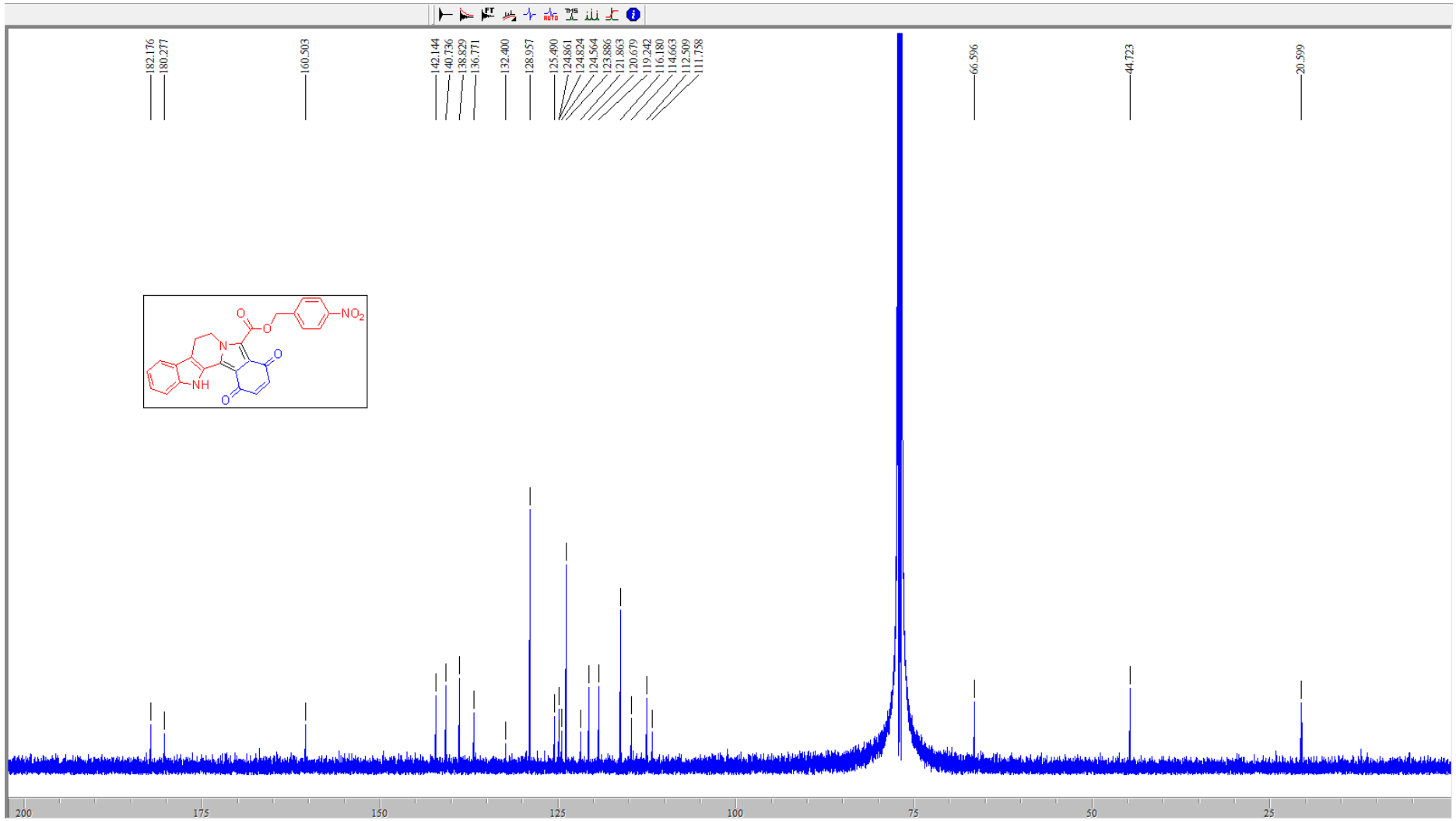
^{13}C NMR Spectrum of **3j**:



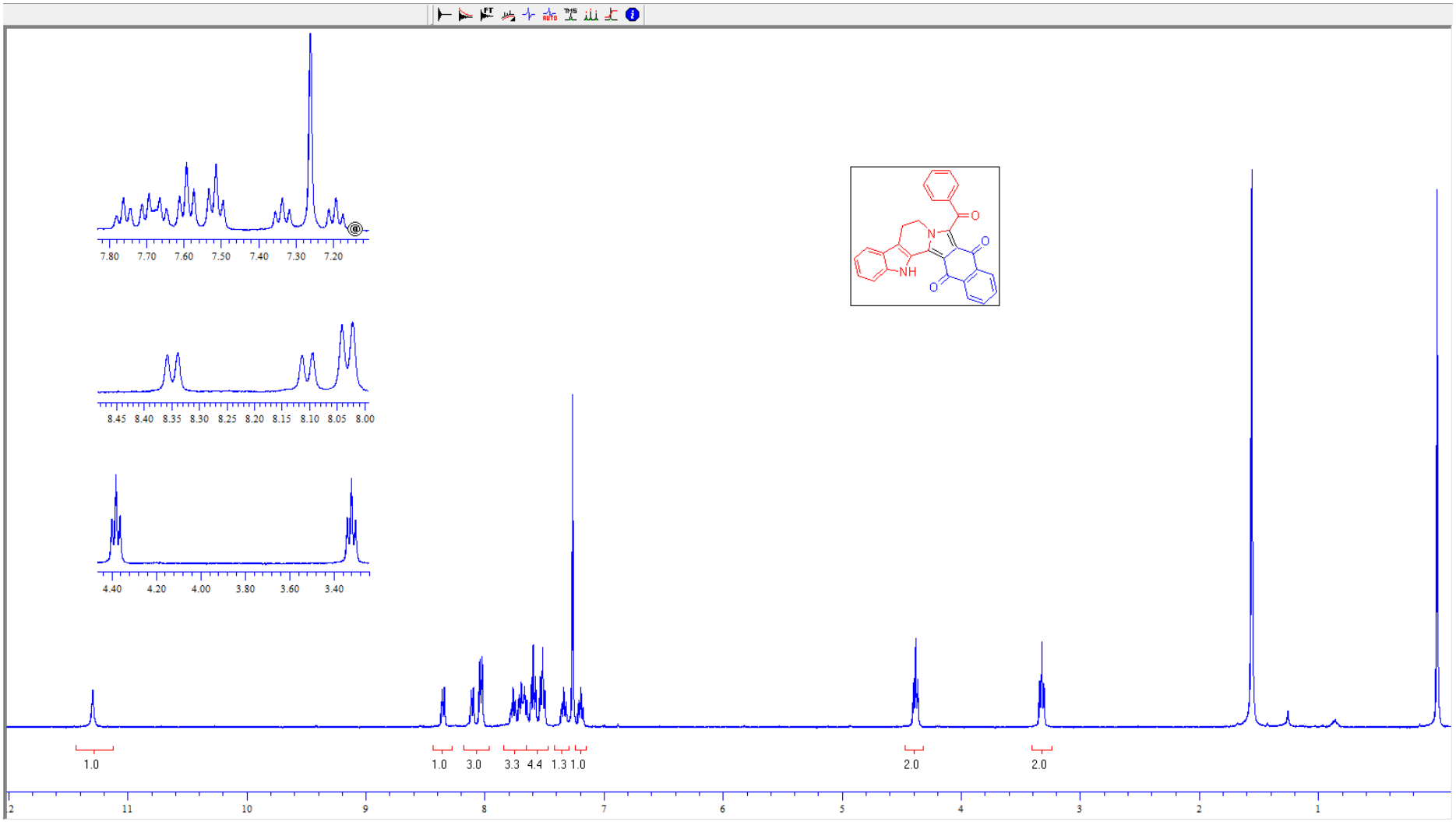
^{1}H NMR Spectrum of **3k**:



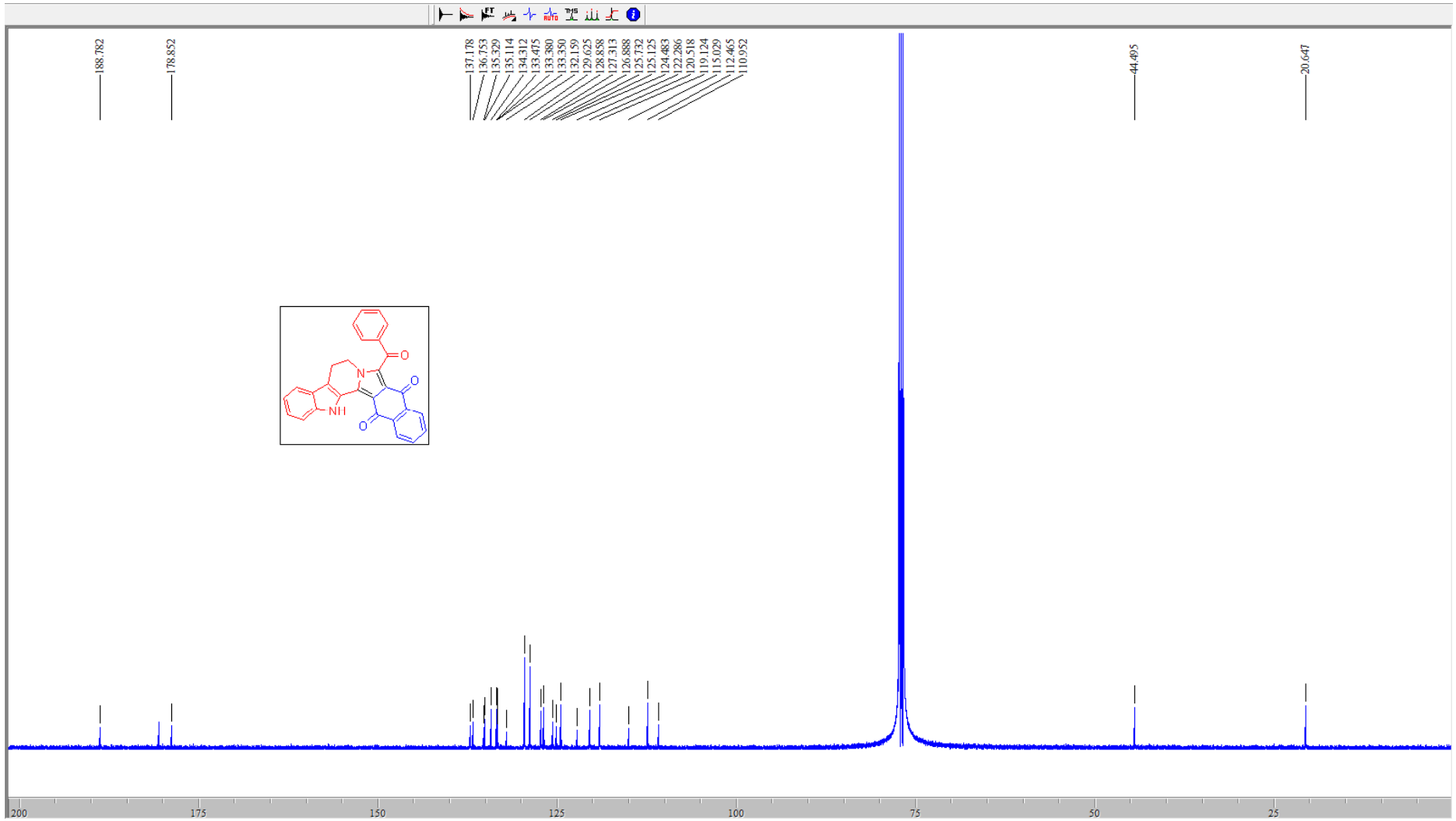
^{13}C NMR Spectrum of **3k**:



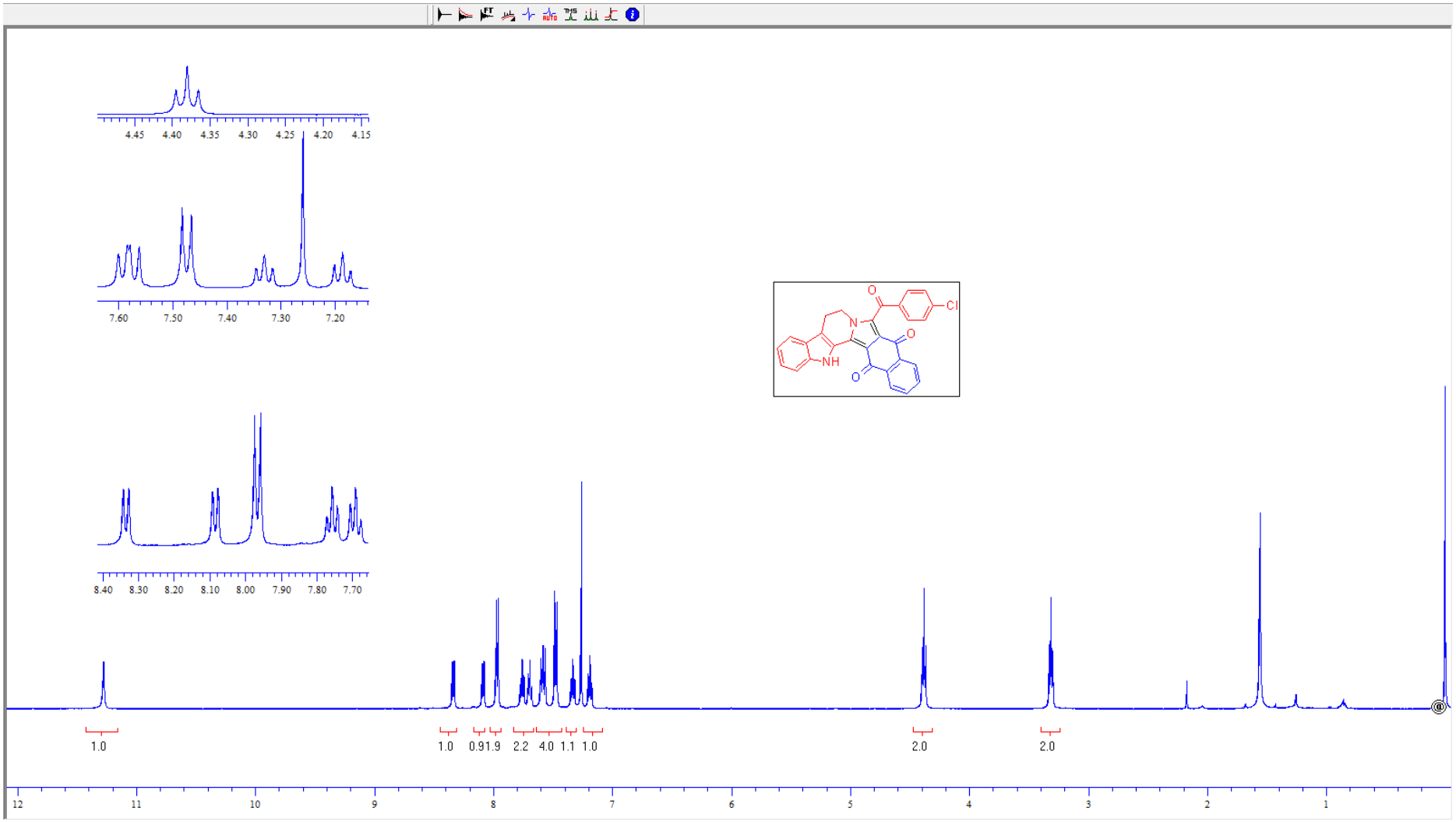
^{1}H NMR Spectrum of **3l**:



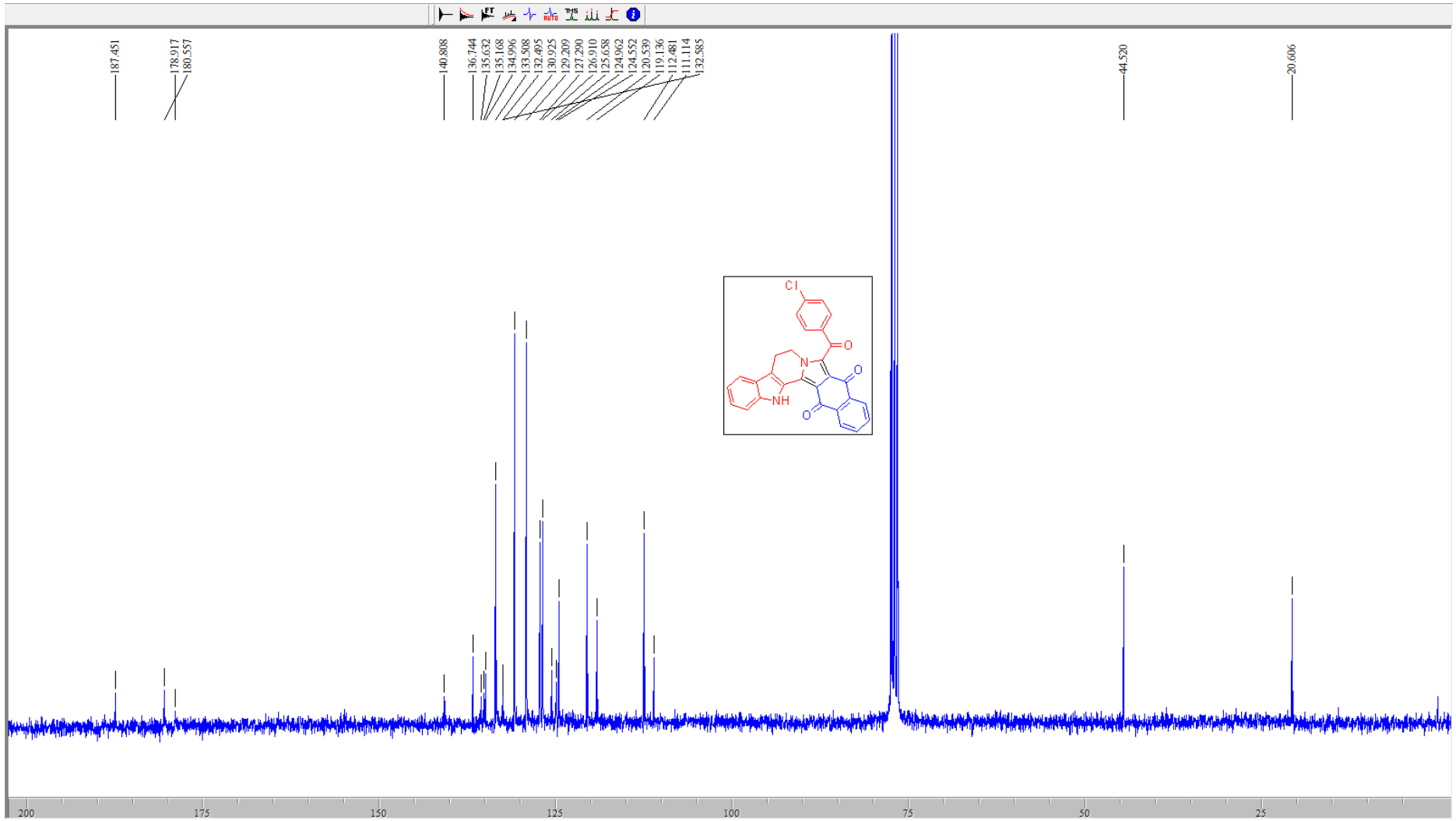
^{13}C NMR Spectrum of **3l**:



^{1}H NMR Spectrum of **3m**:

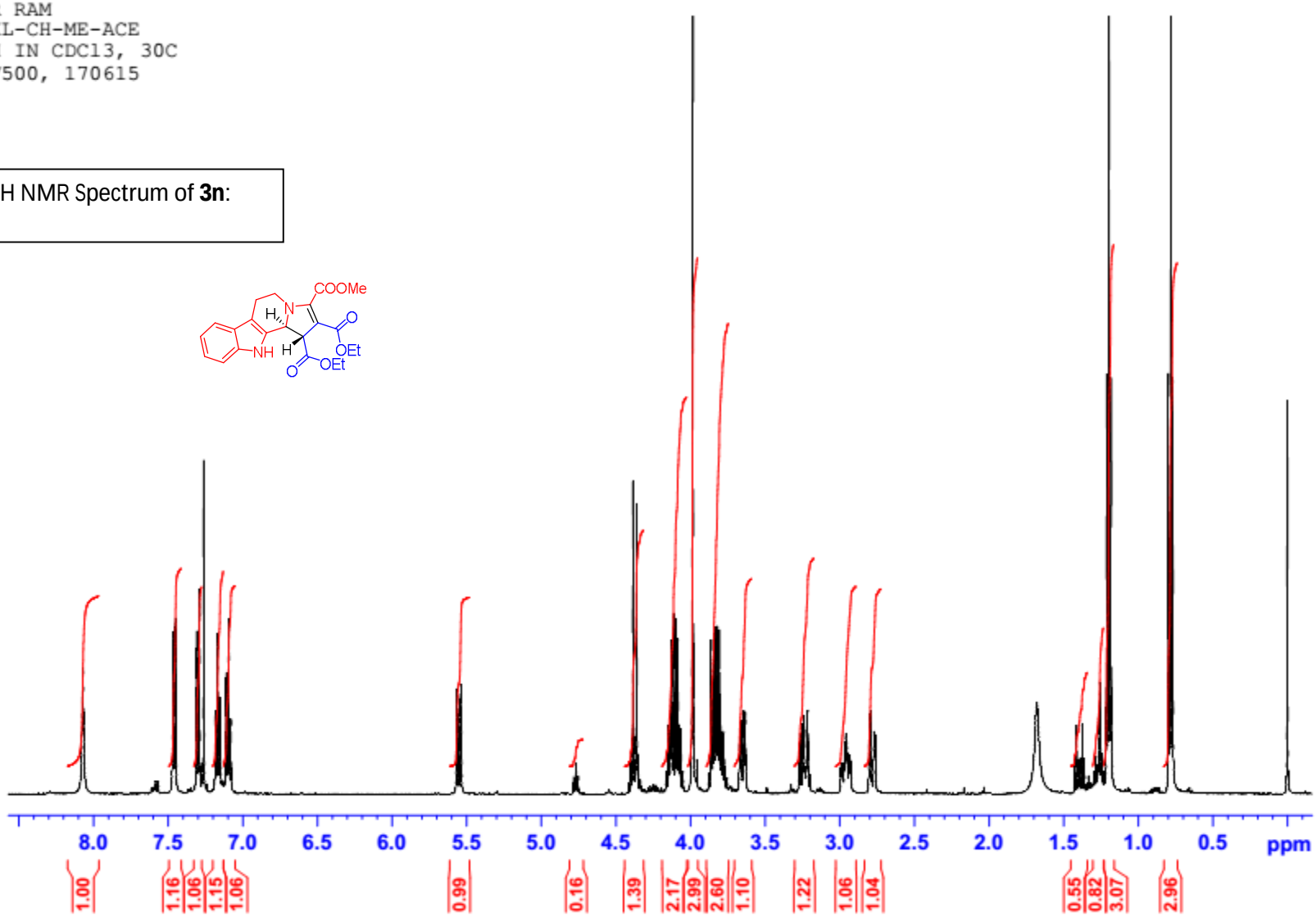


^{13}C NMR Spectrum of **3m**:



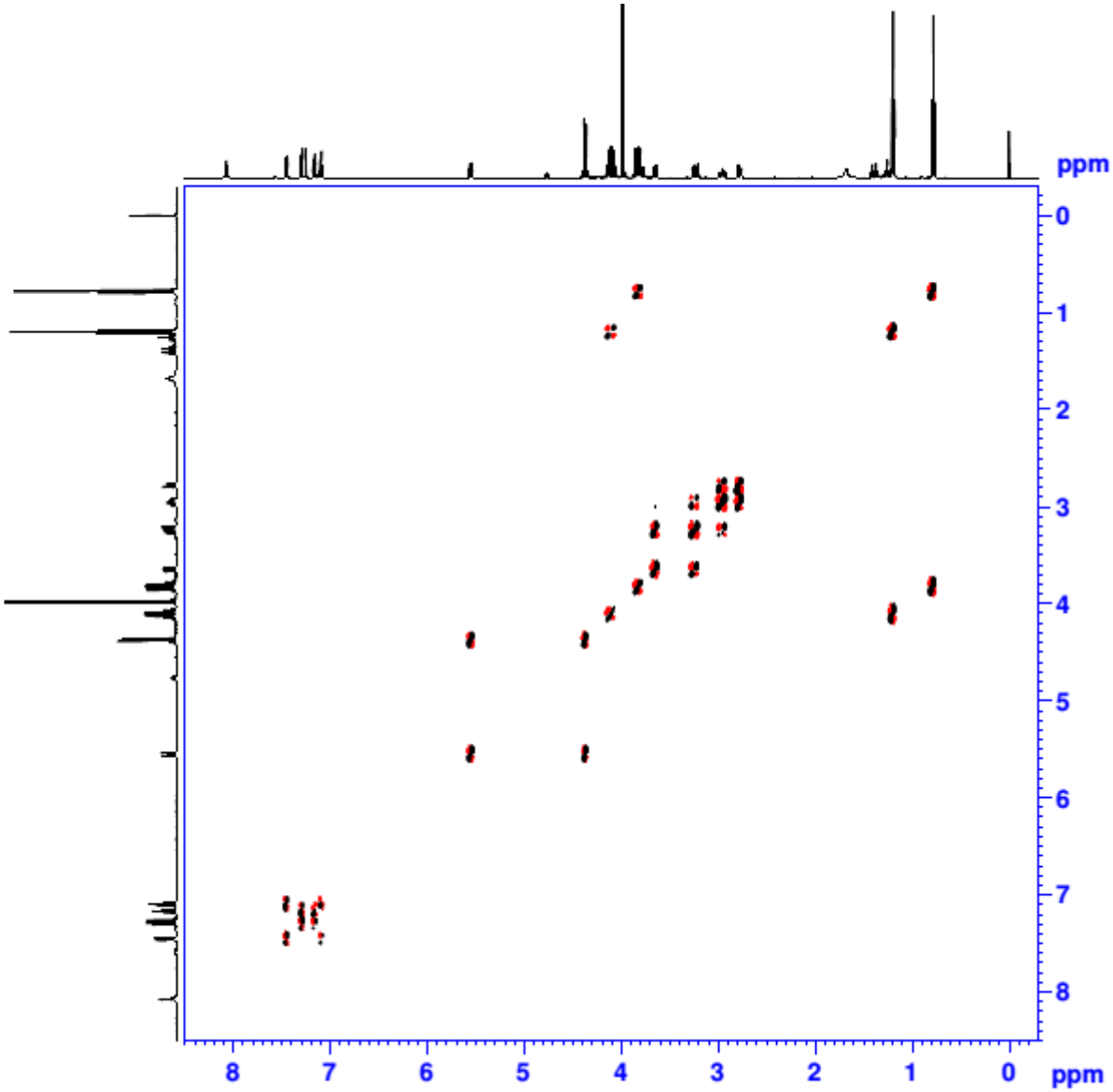
DR RAM
AKL-CH-ME-ACE
1H IN CDCl3, 30C
AV500, 170615

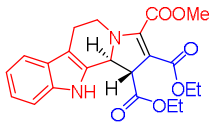
^{1}H NMR Spectrum of **3n**:



DR RAM
AKL-CH-ME-ACE
gDQFCOSY IN CDCl3, 30C
AV500, 170615

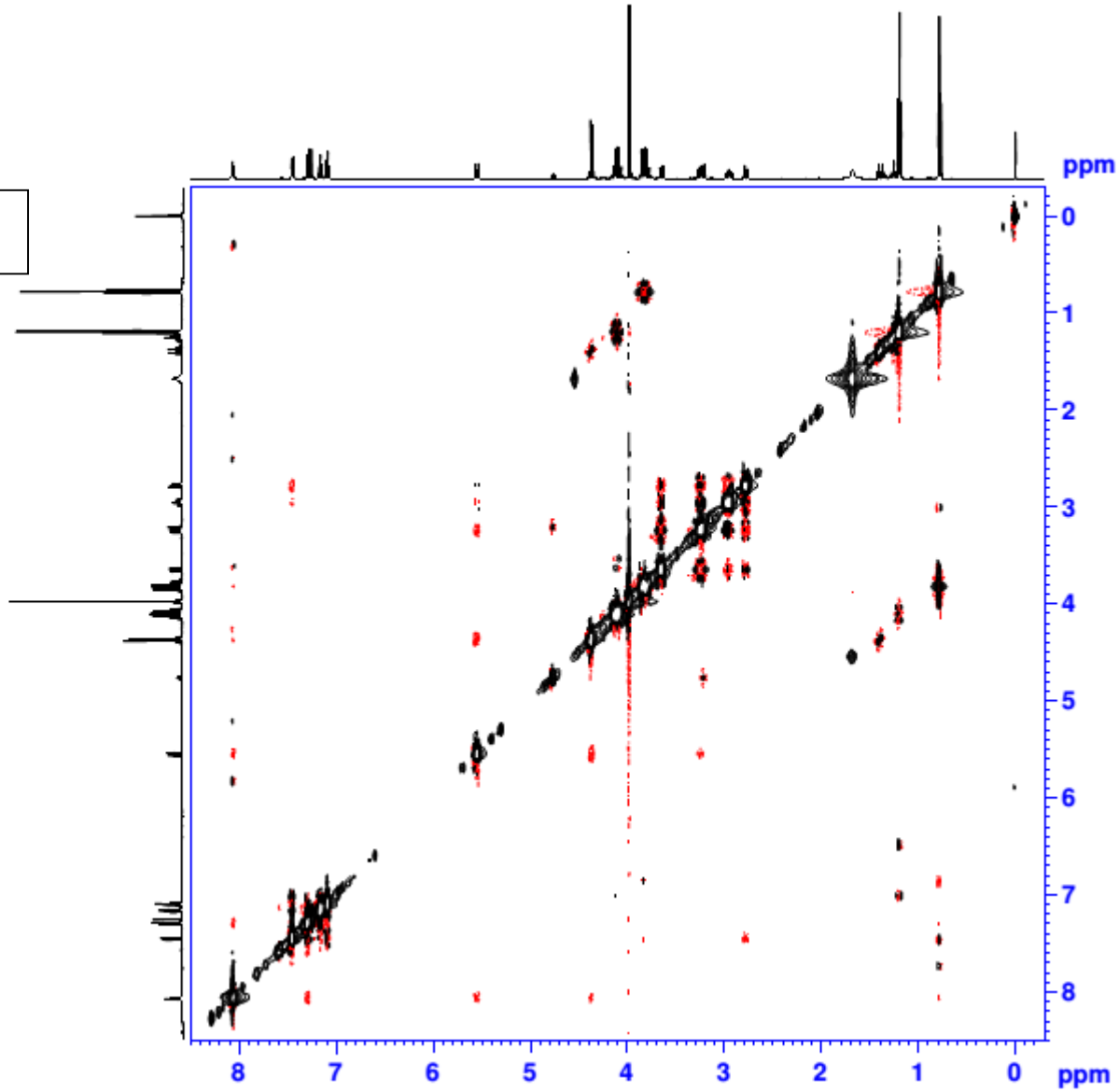
DQFCOSY Spectrum of **3n**:

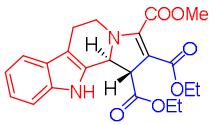




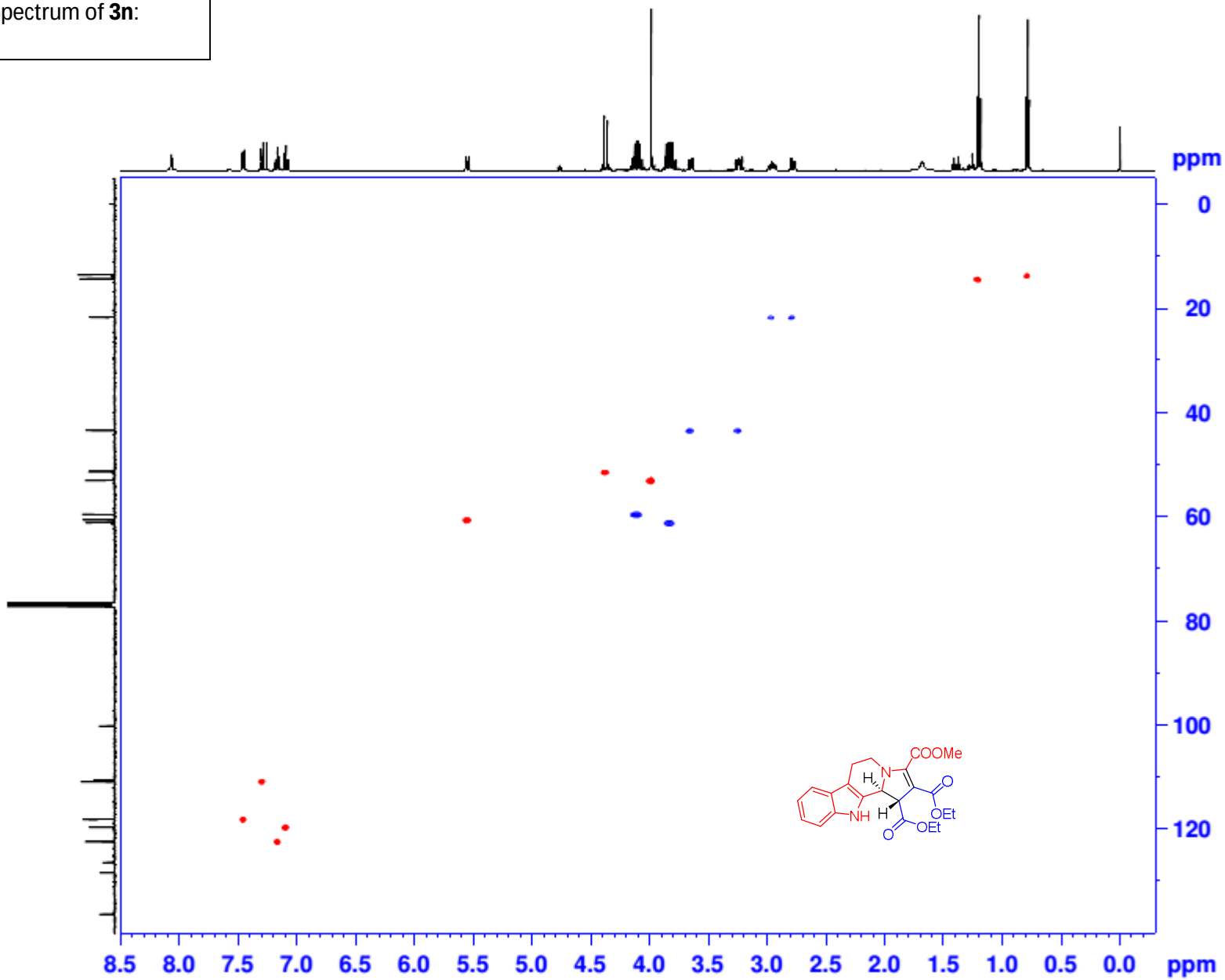
DR RAM
AKL-CH-ME-ACE
1H NOESY IN CDC13, 30C
AV500, 170615

NOESY Spectrum of **3n**:

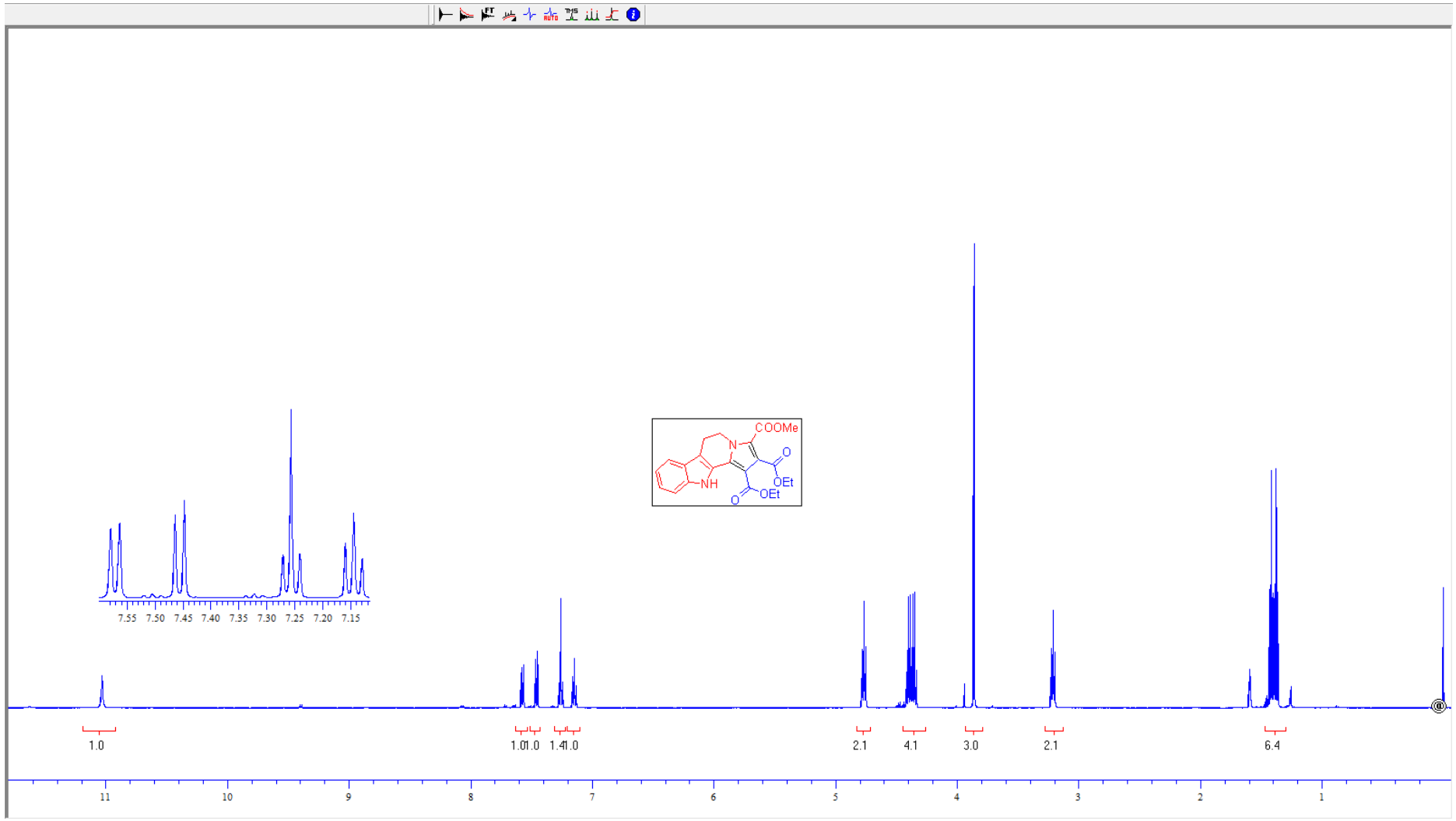
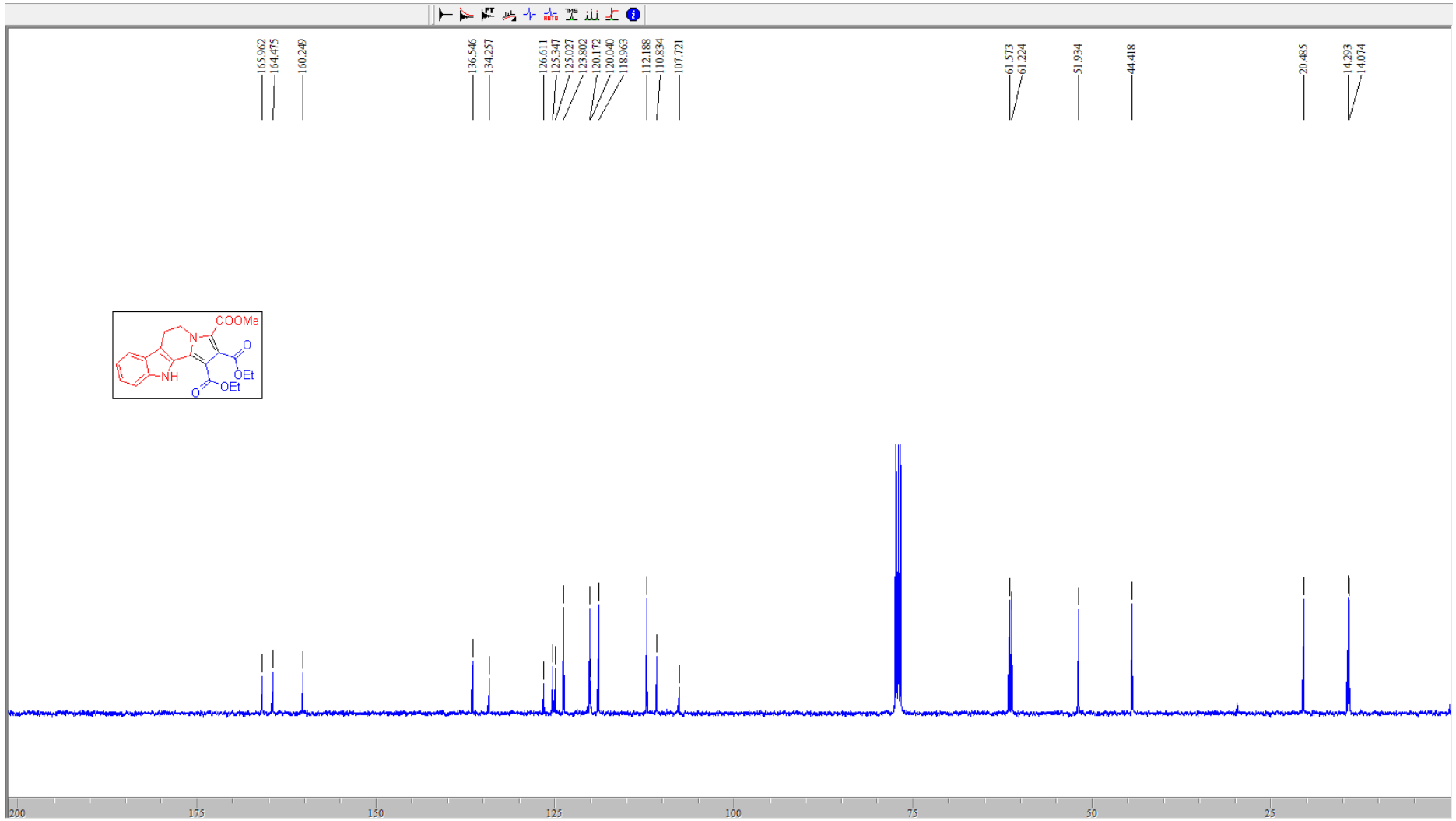




HSQC Spectrum of **3n**:



^{1}H NMR Spectrum of **3o**:



^{13}C NMR Spectrum of **3o**: