

Supporting Information

Synthesis of Functionalized Alkyl Substituted Benzoquinones by Rh Catalyzed Additions of Boronic Acids

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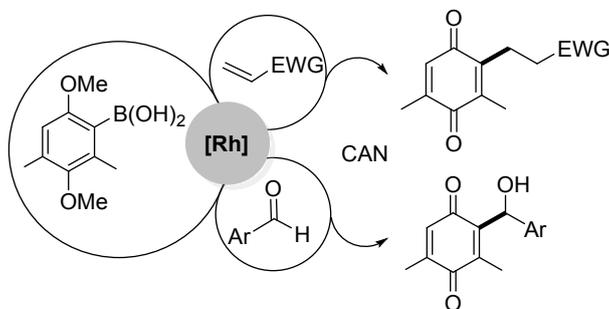


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General Synthetic Methods. Commercially available reagents were used without additional purification. Reagents were weighed on air. Subsequent work-up was performed on air. All reactions were monitored by TLC on commercially available precoated sheets (silica gel 60 F254, and flash column chromatography was done with silica gel 60 (230-400 mesh) of Merck. The reactions carried out in microwave tubes or vials were run under conventional conditions. For the preparation of starting materials which required anhydrous conditions, THF, CH₂Cl₂ and toluene (SDS, anhydrous, analytical grade), were dried by standing with activated 4Å molecular sieves for 7 days prior to use. Proton (¹H) and carbon (¹³C) NMR spectra were recorded on a Bruker AV-300 (at 300 MHz for ¹H, 75 MHz for ¹³C and 96 Hz for ¹¹B). CDCl₃ or acetone-d₆ were used as solvent. Chemical shifts are reported in ppm relative to CDCl₃ (δ 7.26 ppm) or acetone-d₆ (δ 2.1 ppm). The coupling constants (*J*) are reported in Hz. In the case of molecules containing boron, the α-carbon to the boron does not appear in ¹³C-NMR due to the quadrupolar moment of the boron nucleus. Mass spectra (FAB, EI and Electrospray (ESI)) were reported on a GCT

Walters spectrometer coupled to a chromatogram of gases (model 6890N of an Agilent technologies). Melting points were determined using a Buchi apparatus. Starting materials **1a** and **2a** were synthesized according to reported protocol.³⁰

General procedure A. Rhodium catalyzed conjugate addition of 2-benzoquinonyl boronic acid 1a with electron poor olefins.

An oven-dried 2-5 mL microwave tube was charged with benzoquinonyl boronic acid (**1a**) (1 equiv), the corresponding electron poor olefin (2-4 equiv), [Rh(COD)OH]₂ (0.04 equiv) and PCy₃ (0.16 equiv), capped with a rubber septum, and evacuated. After backfilling with Argon, this process was repeated twice more. To the microwave vial was added a mixture of *i*PrOH/Acetone/H₂O (6/3/1) (0.1 M). The mixture was stirred at 60 °C and time indicated in each case. After this time, the crude mixture was extracted with AcOEt, washed with water and a saturated solution of ammonium chloride. The organic phases were dried over anhydrous MgSO₄ and the solvent was removed under reduced pressure. Then, the crude residue was purified by flash column chromatography (eluent indicated in each case).

General Procedure B. Rhodium catalyzed conjugate addition of 1,4-dimethoxyaryl boronic acids with electron poor olefins. To a schlenk tube under argon atmosphere containing a solution of the corresponding aryl boronic acid (1 equiv), PCy₃ (0.3 equiv) and [Rh(COD)OH]₂ (0.04 equiv) in THF/H₂O 3:1 (0.1 M) was added the α,β -unsaturated carbonyl compound (1-4 equiv). The mixture was stirred at the temperature (T) and time indicated in each case. After this time the crude mixture was filtered through a short plug of silica. Then the crude mixture was extracted with Et₂O, washed with water and a saturated solution of brine. The organic phases were dried over anhydrous MgSO₄ and the solvent was removed under reduced pressure. Then, the crude residue was purified by flash column chromatography.

General Procedure C. One-pot Rh-catalyzed conjugate addition/CAN-oxidation of 1,4-dimethoxyaryl boronic acids with electron poor olefins. To a schlenk tube under argon atmosphere containing a solution of corresponding aryl boronic acid (1 equiv), PCy₃ (0.3 equiv) and [Rh(COD)OH]₂ (0.04 equiv) in THF/H₂O 3:1 (0.1 M) was added the corresponding α,β -unsaturated carbonyl compound (1-4 equiv). The mixture was stirred at the temperature (T) and time indicated in each case. Then, an aqueous solution of ammonium cerium (IV) nitrate (CAN) (3.4 equiv) was slowly added to the reaction mixture. After stirring for 30 min, the mixture was extracted with Et₂O (3x). The combined organic phases were washed with water (2x) and then finally brine (2x), dried over anhydrous MgSO₄, filtered and concentrated *in vacuo*. The crude product was purified by flash column chromatography using the eluent indicated in each case.

General procedure D. Rhodium catalyzed 1,2-addition of 1,4-dimethoxyaryl boronic acid 2 to aromatic aldehydes.

An oven-dried 2-5 mL microwave tube was charged with aryl boronic acid **2a** (1 equiv), KO^tBu¹ (1 equiv) and [Rh(COD)OH]₂ (0.04 equiv), capped with a rubber septum, and evacuated. After backfilling with Argon, this process was repeated twice more. To the microwave vial was added the corresponding aldehyde (2 equiv) and a mixture of CH₃CN/H₂O

¹ Et₃N was used as base in the case of cyclohexanecarboxaldehyde

1:1 (0.05 M). The mixture was stirred at 25° C and time indicated in each case. After this time, the crude mixture was extracted with AcOEt, washed with water and a saturated solution of NH₄Cl. The organic phases were dried over anhydrous MgSO₄ and the solvent was removed under reduced pressure. Then, the crude residue was purified by flash column chromatography.

General procedure E. Oxidative demethylation with CAN. To a stirred solution of the corresponding dimethoxyaryl derivative (1.0 equiv) in CH₃CN (0.07 M) was added an aqueous solution of CAN (2.4 equiv, 0.16 M) at room temperature. After stirring for 30 min, the organic solvent was evaporated and the mixture extracted with AcOEt (2 x 5 ml). The combined extracts were washed with water (2 x 5 ml), brine (2 x 5 ml) and dried over anhydrous magnesium sulfate, filtered and concentrated *in vacuo*.

General procedure F. One-pot rhodium catalyzed 1,2-addition/CAN-oxidation of 1,4-dimethoxyaryl boronic acid 1 with aromatic aldehydes.

An oven-dried 2-5 mL microwave tube was charged with aryl boronic acid **2a** (1 equiv), KO^tBu¹ (1 equiv) and [Rh(COD)OH]₂ (0.04 equiv), capped with a rubber septum, and evacuated. After backfilling with Argon, this process was repeated twice more. To the microwave vial was added the corresponding aldehyde (2 equiv) and a mixture of CH₃CN/H₂O 1:1 (0.05 M). The mixture was stirred at 25° C until boronic acid **2** was consumed. After the corresponding time, a CH₃CN/H₂O 1:1 (0.5 M) solution of CAN (2.4 equiv.) was added. After stirring for 30 min, the mixture was extracted with AcOEt (3x). The combined organic phases were washed with water and brine, dried over anhydrous MgSO₄, filtered and concentrated *in vacuo*. The crude product was purified by flash column chromatography using the eluent indicated in each case.

3,5-Dimethyl-2-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)cyclohexa-2,5-diene-1,4-dione (1b). The reaction of 2-(3,6-dimethoxy-2,4-dimethylphenyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (**2b**) (52 mg, 0.19 mmol) with CAN (234 mg, 0.43 mmol) in aqueous CH₃CN. After stirring for 30 min, the organic solvent was evaporated and the mixture extracted with AcOEt. The combined extracts were washed with water and brine, dried over anhydrous magnesium sulfate, filtered and concentrated *in vacuo* to give a 75/25 mixture of quinonyl boronic ester and boronic acid **1b/1a** as a yellow oil. The mixture was used without further purification in the Rh-catalyzed addition. ¹H-NMR (300 MHz, CDCl₃): δ = 6.53 (q, *J* = 1.5 Hz, 1H), 2.08 (s, 3H), 2.01 (d, *J* = 1.5 Hz, 3H), 1.36 (s, 12H). ¹³C-NMR (75 MHz, CDCl₃): δ = 190.8, 187.6, 150.8, 146.0, 133.7, 85.2, 24.6, 16.0, 15.9. ¹¹B-NMR (96 MHz, CDCl₃): δ = 28.3. MS (ESI) *m/z* (%): 263 (100) [M+1]⁺.

2-(3,6-Dimethoxy-2,4-dimethylphenyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (2b). To a stirred solution of aryl boronic acid **2a** (100 mg, 0.476 mmol) in pentane (1.06 ml) was added pinacol (61.9 mg, 0.524 mmol) under argon. The mixture was stirred at rt for 12 h and then the solvent was removed *in vacuo*. The crude product was purified by flash column chromatography (eluent Hexane/AcOEt 20:1) to obtain the 2-(3,6-dimethoxy-2,4-dimethylphenyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane **2b** as a white solid. Yield: 79%. M.p.: 62-64 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 6.44 (s, 1H), 3.67 (s, 3H) 3.60 (s, 3H), 2.26 (s, 3H) 2.23 (s, 3H), 1.35 (s, 12H). ¹³C-

NMR (75 MHz, CDCl₃): δ = 158.5, 150.9, 134.9, 132.5, 110.5, 83.7, 58.8, 55.9, 24.8, 16.6, 15.5. ¹¹B-NMR (96 MHz, CDCl₃): δ = 31.8. MS (ESI) *m/z* (%): 292 (100) [M]⁺, 225 (22), 167 (17).

Potassium (2,4-dimethyl-3,6-dioxocyclohexa-1,4-dien-1-yl)trifluoroborate (1c). To a solution of 2-quinonyl boronic acid **1a** (300 mg, 1.7 mmol) in MeOH (3.4 ml) was added KHF₂ (456 mg, 5.8 mmol) followed by the addition of H₂O (1.5 ml) over 15 min. The reaction was extracted with acetone and the combined organic extracts were concentrated and then held under high vacuum for 30 min. The resulting white solid was purified by dissolution in hot acetone and precipitating with ether affording **1c** as a yellow solid in a 43% yield. M.p.: > 280 °C. ¹H-NMR (300 MHz, D₂O): δ = 6.57 (d, *J* = 1.4 Hz, 1H), 2.13 (d, *J* = 1.1 Hz, 3H), 2.01 (d, *J* = 1.4 Hz, 3H). ¹³C-NMR (75 MHz, CDCl₃):² δ = 193.9, 190.7, 146.9, 142.8, 134.9, 58.6, 23.8, 19.6, 15.5, 13.5. ¹¹B-NMR (96 MHz, CDCl₃): δ = 2.0

2-(3,6-Dimethoxy-2,4-dimethylphenyl)-6-methyl-1,3,6,2-dioxazaborocane-4,8-dione (2d). A 500-mL, single-necked, round-bottomed flask equipped with a magnetic stir bar is charged with aryl boronic acid **2a** (266 mg, 1.27 mmol) and *N*-methyliminodiacetic acid (186 mg, 1.27 mmol). A freshly prepared 20% (v/v) solution of dimethyl sulfoxide in benzene (23 ml) is then added to afford a white solid suspended in a clear, colorless solution. The flask is then fitted with a toluene-filled Dean-Stark trap topped with a water-cooled condenser and the stirred reaction mixture is refluxed during 18 h. Then, the reaction is allowed to cool to 23 °C during 1 h. The reaction mixture is concentrated *in vacuo* to afford the crude product as a chunky solid. Acetone (10 ml) is then added and the flask is swirled vigorously to afford a white solid suspended in a clear tan solution. To this mixture, water is added causing the precipitation of additional white solid. The white solid is collected via vacuum filtration. The collected product is then washed with water (3 x 50 mL) and is allowed to dry under vacuum to give product **2c** as a white powder (49% yield). M.p.: 246-247 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 6.60 (s, 1H), 4.02 – 3.79 (m, 4H), 3.74 (s, 3H), 3.64 (s, 3H), 2.73 (s, 3H), 2.41 (s, 3H), 2.30 (s, 3H). ¹³C-NMR (75 MHz, Acetone d₆): 169.5, 160.2, 152.6, 138.2, 133.2, 112.2, 65.1, 60.0, 56.0, 48.7, 16.8, 15.4. ¹¹B-NMR 155 (96 MHz, Acetone d₆): δ = 12.3. MS (ESI) *m/z* (%): 322 (100) [M+1]⁺, 179 (39). HRMS Calcd for C₁₅H₂₁BNO₆ 322.1462, found 322.1463 [M+1]⁺.

2-(2,4-Dimethyl-3,6-dioxocyclohexa-1,4-dien-1-yl)-6-methyl-1,3,6,2-dioxazaborocane-4,8-dione (1d). The reaction of compound **2d** (200 mg, 0.62 mmol) with CAN (819 mg, 1.5 mmol) in aqueous CH₃CN. After stirring for 30 min, the organic solvent was evaporated and the mixture extracted with AcOEt. The combined extracts were washed with water and brine, dried over anhydrous magnesium sulfate, filtered and concentrated *in vacuo* to give compound **1c** as an orange solid. Yield: 83%. M.p.: Decompose over 170 °C. ¹H-NMR (300 MHz, CD₃CN): δ = 6.57 (s, 1H), 4.07 (s, 4H), 2.77 (s, 3H), 2.21 (s, 3H), 2.01 (s, 3H). ¹³C-NMR (75 MHz, CD₃CN): δ = 194.6, 189.2, 169.4, 154.1, 146.6, 135.1, 64.6, 48.6, 15.8, 14.5. ¹¹B-NMR (96 MHz, CD₃CN): δ = 11.9. MS (ESI) *m/z* (%): 292 (100) [M+1]⁺, 148 (47). HRMS Calcd for C₁₃H₁₅BNO₆ 292.0992, found 292.0986 [M+1]⁺.

3,5-Dimethyl-2-(3-oxobutyl)cyclohexa-2,5-diene-1,4-dione (3a). Following general procedure A, the reaction of **1a** (27 mg, 0.15 mmol) with but-3-en-2-one (49 μ l, 0.60 mmol), PCy₃ (6.7 mg,

² The product **1c** had to be derivatized to the corresponding tetrabutylammonium salt to improve the solubility in order to record the NMR spectra.

24 μmol) and $[\text{Rh}(\text{COD})\text{Cl}]_2$ (3.2 mg, 6 μmol) in $i\text{PrOH}/\text{Acetone}/\text{H}_2\text{O}$ (0.90 ml/0.45 ml/0.15 ml) gave compound **3a** as an orange solid (19 mg) after purification by flash column chromatography (eluent Hexane:AcOEt, 4:1). Reaction time: 30 min. Yield: 62%.

Following the general procedure C, the reaction of methyl vinyl ketone (23 μl , 0.29 mmol) with aryl boronic acid **2** (30 mg, 0.15 mmol), PCy_3 (12 mg, 0.04 mmol) and $[\text{Rh}(\text{COD})\text{OH}]_2$ (2.6 mg, 6 μmol) in $\text{THF}/\text{H}_2\text{O}$ (1.71 ml/0.36 ml) was stirred at 60 °C for 2 h gave the corresponding crude mixture. Then, CAN (266 mg, 0.49 mmol) was slowly added in water (0.48 ml) at rt. After purification by flash column chromatography (eluent Hexane/AcOEt 3:1) compound **3a** was obtained as an orange solid (25 mg). Yield: 85%.

Compound (3a): M. p.: 56-57 °C. $^1\text{H-NMR}$ (300 MHz, CDCl_3): δ = 6.53 (d, J = 1.3 Hz, 1H), 2.93 – 2.64 (m, 2H), 2.64 – 2.46 (m, 2H), 2.14 (s, 3H), 2.10 – 1.96 (m, 6H). $^{13}\text{C-NMR}$ (75 MHz, CDCl_3): δ = 206.9, 187.9, 187.2, 145.6, 143.1, 141.5, 133.2, 41.9, 29.7, 21.0, 16.0, 12.1. MS (EI) m/z (%): 206 (2) $[\text{M}]^+$, 190 (65) 189 (100), 175 (79), 164 (94). HRMS Calcd for $\text{C}_{12}\text{H}_{14}\text{O}_3$ 206.0943, found 206.0941 $[\text{M}]^+$.

Ethyl 3-(2,4-dimethylbenzoquinonyl)propanoate (3b) and (E)-ethyl 3-(2,4-dimethylbenzoquinonyl)acrylate (4b). Following general procedure A, the reaction of **1a** (27 mg, 0.15 mmol) with ethyl acrylate (66 μl , 0.60 mmol), PCy_3 (6.7 mg, 24 μmol) and $[\text{Rh}(\text{COD})\text{Cl}]_2$ (3.2 mg, 6 μmol) in $i\text{PrOH}/\text{Acetone}/\text{H}_2\text{O}$ (0.90 ml/0.45 ml/0.15 ml) gave an inseparable mixture of **3b** and **4b** (70/30, 19 mg) after flash column chromatography (eluent Hexane:AcOEt, 8:1). Reaction time: 3 h. Yield: 54%.

Following the general procedure C, the reaction of ethyl acrylate (18 μl , 0.17 mmol) with aryl boronic acid **2** (30 mg, 0.15 mmol), PCy_3 (12 mg, 0.04 mmol) and $[\text{Rh}(\text{COD})\text{OH}]_2$ (2.6 mg, 6 μmol) in $\text{THF}/\text{H}_2\text{O}$ (1.71 ml/0.36 ml) was stirred at 25 °C for 3 h. Then, CAN (266 mg, 0.49 mmol) was slowly added in water (0.48 ml) at rt. After purification by flash column chromatography (eluent Hexane/AcOEt 4:1) compound **3b** was obtained as a yellow solid (16 mg). Yield: 47%.

Compound (3b): M. p.: 45-47 °C. $^1\text{H-NMR}$ (300 MHz, CDCl_3): δ = 6.55 (d, J = 1.3 Hz, 1H), 4.12 (q, J = 7.1 Hz, 2H), 2.79 (t, J = 7.8 Hz, 2H), 2.44 (t, J = 7.8 Hz, 2H), 2.07 (s, 3H), 2.03 (d, J = 1.2 Hz, 3H). $^{13}\text{C-NMR}$ (75 MHz, CDCl_3): δ = 188.0, 187.0, 172.3, 145.5, 142.6, 141.7, 133.2, 60.6, 32.8, 22.1, 15.9, 14.2, 12. MS (EI) m/z (%): 236 (2) $[\text{M}]^+$, 192 (100). HRMS Calcd for $\text{C}_{13}\text{H}_{16}\text{O}_4$ 236.1049, found 236.1060 $[\text{M}]^+$.

Compound (4b): $^1\text{H-NMR}$ (300 MHz, CDCl_3): δ = 7.55 (d, J = 16.2 Hz, 1H), 6.76 (d, J = 16.2 Hz, 1H), 6.59 (s, 1H), 4.26 (q, J = 7.1 Hz, 2H), 2.20 (s, 3H), 2.07 (s, 3H), 1.33 (t, J = 7.1 Hz, 3H). $^{13}\text{C-NMR}$ (75 MHz, CDCl_3): δ = 187.5, 185.9, 166.3, 145.7, 143.8, 135.6, 134.7, 133.8, 129.3, 60.9, 15.9, 14.2, 13.0. MS (EI) m/z (%): 234 (1) $[\text{M}]^+$, 189 (11), 162 (100). HRMS Calcd for $\text{C}_{13}\text{H}_{14}\text{O}_4$ 234.08922, found 234.0891 $[\text{M}]^+$.

3-(2,4-Dimethylbenzoquinonyl)-N,N-dimethylpropanamide (3c). Following general procedure A, the reaction of **1a** (40 mg, 0.22 mmol) with *N,N*-dimethylacrylamide (46 μl , 0.44 mmol), PCy_3 (10 mg, 36 μmol) and $[\text{Rh}(\text{COD})\text{Cl}]_2$ (4.4 mg, 9 μmol) in $i\text{PrOH}/\text{Acetone}/\text{H}_2\text{O}$ (1.32 ml/0.66 ml/0.22 ml) afforded compound **3c** as a yellow solid (17 mg) after purification by flash column chromatography (eluent Hexane:AcOEt, 4:1). Reaction time: 3.5 h. Yield: 33%.

Following the general procedure C, the reaction of *N,N*-dimethylacrylamide (15 μl , 0.15 mmol) with aryl boronic acid **2** (61 mg, 0.29 mmol), PCy_3 (12 mg, 0.04 mmol) and $[\text{Rh}(\text{COD})\text{OH}]_2$ (2.7 mg, 6 μmol) in $\text{THF}/\text{H}_2\text{O}$ (1.1 ml/0.36 ml) was stirred at 60 °C for 2 h gave the corresponding crude mixture. Then, CAN (239 mg, 0.44 mmol) was slowly added in water (0.8 ml) at rt. After

purification by flash column chromatography (eluent Hexane/AcOEt 1:2) compound **3c** was obtained as a yellow solid (24 mg). Yield: 70%.

Compound (3c): M. p.: 69-71 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 6.54 (d, *J* = 1.3 Hz, 1H), 3.00 (s, 3H), 2.94 (s, 3H), 2.84 – 2.71 (m, 2H), 2.50 – 2.34 (m, 2H), 2.10 (s, 3H), 2.04 (d, *J* = 1.3 Hz, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 188.0, 187.5, 171.5, 145.6, 143.3, 141.7, 133.2, 37.2, 35.5, 32.1, 22.6, 15.9, 12.2. MS (EI) *m/z* (%): 235 (25) [M]⁺, 192 (42), 190 (48), 163 (100). HRMS Calcd for C₁₃H₁₇NO₃ 235.1208, found 235.1203 [M]⁺.

3-(2,4-Dimethylbenzoquinonyl)-1-phenylpyrrolidine-2,5-dione (3d). Following general procedure A, the reaction of **1a** (27 mg, 0.15 mmol) with *N*-phenyl maleimide (54 mg, 0.32 mmol), PCy₃ (6.7 mg, 24 μmol) and [Rh(COD)Cl]₂ (3.2 mg, 6 μmol) in *i*PrOH/Acetone/H₂O (0.90 ml/0.45 ml/0.15 ml) gave compound **3d** as an orange solid (20 mg) after purification by flash column chromatography (eluent Hexane:AcOEt, 4:1). Reaction time: 4 h. Yield: 43%.

Following the general procedure E, the reaction of **5d** (20 mg, 0.06 mmol) with CAN (78 mg, 0.14 mmol) in aqueous CH₃CN during 30 min gave compound **3d** as an orange solid after flash column chromatography (eluent Hexane/AcOEt 1:1). Yield: 88%.

Compound (3d): M.p.: 220-222 °C ¹H-NMR (300 MHz, CDCl₃): δ = 7.64 – 7.33 (m, 5H), 6.61 (d, *J* = 1.6 Hz, 1H), 4.10 (dd, *J* = 9.9 and 6.0 Hz, 1H), 3.17 (dd, *J* = 18.0 and 9.9 Hz, 1H), 2.75 (dd, *J* = 18.0 and 5.8 Hz, 1H), 2.20 (s, 3H), 2.09 (d, *J* = 1.6 Hz, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 186.1, 175.9, 174.6, 146.6, 144.6, 140.3, 133.0, 132.2, 129.3, 128.8, 126.7, 40.1, 35.1, 16.06, 12.8. MS (EI) *m/z* (%): 309 (100) [M]⁺, 190 (20), 162 (62). HRMS Calcd for C₁₈H₁₅NO 309.1001, found 309.0988 [M]⁺.

Benzyl 3-(2,4-dimethylbenzoquinonyl)propanoate (3e). Following the general procedure C, the reaction of benzyl acrylate (25.7 μl, 0.17 mmol) with aryl boronic acid **2** (30 mg, 0.15 mmol), PCy₃ (12 mg, 0.04 mmol) and [Rh(COD)OH]₂ (2.6 mg, 6 μmol) in THF/H₂O (1.71 ml/0.36 ml) was stirred at 60 °C for 2 h gave the corresponding crude mixture. Then, CAN (266 mg, 0.49 mmol) was slowly added in water (0.48 ml) at rt. After purification by flash column chromatography (eluent Hexane/AcOEt 4:1) compound **3e** was obtained as orange oil (33 mg). Yield: 73%. ¹H-NMR (300 MHz, CDCl₃): δ = 7.34 (s, 5H), 6.53 (d, *J* = 1.3 Hz, 1H), 5.11 (s, 2H), 2.82 (t, *J* = 7.7 Hz, 2H), 2.52 (t, *J* = 7.7 Hz, 2H), 2.04 (s, 3H), 2.03 (d, *J* = 1.3 Hz, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 187.9, 187.0, 172.2, 145.5, 142.4, 141.8, 135.7, 133.2, 128.6, 128.3, 66.5, 32.8, 22.2, 15.9, 12.2. MS (ESI) *m/z* (%): 321 (100) [M+Na]⁺, 299 (16) [M+1]⁺. HRMS Calcd for C₁₈H₁₈O₄ 299.1282, found 299.1282 [M+1]⁺.

3-(2,4-Dimethylbenzoquinonyl)propanenitrile (3f). Following the general procedure C, the reaction of acrylonitrile (1.63 μl, 0.19 mmol) with aryl boronic acid **2** (20 mg, 0.09 mmol), PCy₃ (8.0 mg, 0.03 mmol) and [Rh(COD)OH]₂ (1.7 mg, 3.8 μmol) in THF/H₂O (0.71 ml/0.23 ml) was stirred at 60 °C for 3 h gave the corresponding crude mixture. Then, CAN (209 mg, 0.38 mmol) was slowly added in water (0.48 ml) at rt. After purification by flash column chromatography (eluent Hexane/AcOEt 4:1) compound **3f** was obtained as a yellow solid (21 mg). Yield: 77%. M. p.: 54-56 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 6.59 (d, *J* = 1.4 Hz, 1H), 2.85 (t, *J* = 7.1 Hz, 2H), 2.57 (t, *J* = 7.1 Hz, 2H), 2.15 (s, 3H), 2.07 (d, *J* = 1.4 Hz, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 187.5, 186.7, 146.2, 143.4, 139.8, 133.0, 118.6, 22.7, 16.4, 16.0, 12.6. MS (EI) *m/z* (%): 189 (11) [M]⁺, 162 (100). HRMS Calcd for C₁₁H₁₁NO₂ 189.0790, found 189.0790 [M]⁺.

2-(2,2-Bis(phenylsulfonyl)ethyl)-3,5-dimethylbenzoquinone (3g). Following the general procedure C, the reaction of (1,1-bis(phenylsulfonyl) ethene (35 mg, 0.113 mmol) with aryl boronic acid **2** (47.7 mg, 0.23 mmol), PCy₃ (8.0 mg, 0.03 mmol) and [Rh(COD)OH]₂ (2.07 mg, 4.54 μmol) in THF/H₂O (0.85 ml/0.28 ml) was stirred at 60 °C for 3 h gave the corresponding crude mixture. Then, CAN (187 mg, 0.34 mmol) was slowly added in water (0.6 ml) at rt. After purification by flash column chromatography (eluent Hexane/AcOEt 3:1) compound **3g** was obtained as an orange solid (39 mg). Yield: 77%. M. p.: decomposes over 150 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 7.91 – 7.47 (m, 10H), 6.42 (d, *J* = 1.4 Hz, 1H), 5.34 (t, *J* = 7.3 Hz, 1H), 3.36 (d, *J* = 7.3 Hz, 2H), 2.14 (s, 4H), 2.00 (d, *J* = 1.3 Hz, 4H). ¹³C-NMR (75 MHz, CDCl₃): δ = 187.2, 187.1, 146.1, 143.8, 138.2, 137.8, 134.6, 133.0, 129.3, 129.2, 80.4, 24.5, 15.9, 12.7. MS (ESI) *m/z* (%): 467 (100) [M+Na]⁺, 445 (24) [M+1]⁺. HRMS Calcd for C₂₂H₂₀NaO₆S₂ 467.0599, found 467.0609 [M+Na]⁺.

Dimethyl 2-(2,4-dimethylbenzoquinonyl)succinate (3h). Following the general procedure C, the reaction of dimethyl fumarate (16.5 mg, 0.11 mmol) with aryl boronic acid **2** (20 mg, 0.09 mmol), PCy₃ (8.0 mg, 0.03 mmol) and [Rh(COD)OH]₂ (1.7 mg, 3.8 μmol) in THF/H₂O (0.71 ml/0.23 ml) was stirred at 60 °C for 2 h gave the corresponding crude mixture. Then, CAN (209 mg, 0.38 mmol) was slowly added in water (0.47 ml) at rt. After purification by flash column chromatography (eluent Hexane/AcOEt 7:1) compound **3h** was obtained as a yellow oil (23 mg). Yield: 86%. ¹H-NMR (300 MHz, CDCl₃): δ = 6.56 (d, *J* = 1.5 Hz, 1H), 4.22 (t, *J* = 6.9 Hz, 1H), 3.67 (d, *J* = 8.6 Hz, 7H), 3.27 (dd, *J* = 16.9 and 7.0 Hz, 1H), 2.51 (dd, *J* = 16.9 and 6.8 Hz, 1H), 2.14 (s, 3H), 2.06 (d, *J* = 1.5 Hz, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 187.6, 186.1, 171.9, 171.5, 145.9, 143.1, 141.1, 133.1, 52.5, 52.0, 40.1, 34.9, 15.9, 12.5. MS (EI) *m/z* (%): 280 (2) [M]⁺, 248 (45), 188 (100). HRMS Calcd for C₁₄H₁₆O₆ 280.0947, found 280.0938 [M]⁺.

4-(3,6-Dimethoxy-2,4-dimethylphenyl)butan-2-one (5a). Following the general procedure B, the reaction of methyl vinyl ketone (16 μL, 0.19 mmol) with 1,4-dimethoxy-3,5-dimethylphenyl boronic acid **2** (20 mg, 0.09 mmol), PCy₃ (8 mg, 0.03 mmol) and [Rh(COD)OH]₂ (1.7 mg, 3.4 μmol) in THF/H₂O 3:1 (0.71 ml/0.23 ml) gave 19 mg compound **5a** as a colorless oil after flash column chromatography (eluent Hex/AcOEt 6:1). Reaction time: 2 h. T: 60 °C. Yield: 84%. ¹H-NMR (300 MHz, CDCl₃): δ = 6.55 (s, 1H), 3.79 (s, 3H), 3.66 (s, 3H), 2.99 (t, *J* = 7.6 Hz, 2H), 2.52 (t, *J* = 7.6 Hz, 2H), 2.29 (d, *J* = 2.1 Hz, 6H). ¹³C-NMR (75 MHz, CDCl₃): δ = 152.4, 149.7, 129.4, 129.0, 122.6, 118.8, 109.3, 59.1, 54.5, 21.9, 15.6, 15.4, 11.2. MS (EI) *m/z* (%): 236 (100) [M]⁺, 179 (68), 163 (80). HRMS Calcd for C₁₄H₂₀O₃ 236.1412, found 236.1410 [M]⁺.

Ethyl 3-(3,6-dimethoxy-2,4-dimethylphenyl)propanoate (5b). Following the general procedure B, the reaction of ethyl acrylate (18 μL, 0.17 mmol) with 1,4-dimethoxy-3,5-dimethylphenyl boronic acid **2** (30 mg, 0.15 mmol), PCy₃ (12 mg, 0.04 mmol) and [Rh(COD)OH]₂ (2.6 mg, 6 μmol) in THF/H₂O 3:1 (1.07 ml/0.36 ml) gave 28 mg of compound **5b** as a colorless oil after flash column chromatography (eluent Hexane/AcOEt 9:1). Reaction time: 3 h. T: 25 °C. Yield: 74%. ¹H-NMR (300 MHz, CDCl₃): δ = 6.53 (s, 1H), 4.15 (q, *J* = 7.1 Hz, 2H), 3.78 (s, 3H), 3.66 (s, 3H), 3.00-2.88 (m, 2H), 2.52 – 2.40 (m, 2H), 2.29 (s, 3H), 2.26 (s, 3H), 1.27 (t, *J* = 7.1 Hz, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 173.5, 153.6, 150.6, 130.3, 128.8, 126.1, 110.2, 60.3, 60.1, 55.5, 33.7, 22.3, 16.4, 14.3, 12.0. MS (EI) *m/z* (%): 266 (100) [M]⁺, 179 (77), 163 (38). HRMS Calcd for C₁₅H₂₂O₄ 266.1518, found 266.1513 [M]⁺.

3-(3,6-Dimethoxy-2,4-dimethylphenyl)-N,N-dimethylpropanamide (5c). Following the general procedure B, the reaction of *N,N*-dimethylacrylamide (15 μ L, 0.15 mmol) with 1,4-dimethoxy-3,5-dimethyl phenyl boronic acid **2** (61 mg, 0.29 mmol), PCy₃ (12 mg, 0.04 mmol) and [Rh(COD)OH]₂ (3 mg, 6 μ mol) in THF/H₂O 3:1 (1.09 ml/0.36 ml) gave an inseparable mixture of 3-(3,6-dimethoxy-2,4-dimethylphenyl)-*N,N*-dimethylpropanamide **5c** and (*E*)-3-(3,6-dimethoxy-2,4-dimethylphenyl)-*N,N*-dimethylacrylamide **6c** as 36 mg (93% ratio 97:3) as yellow oil after flash column chromatography (eluent Hexane/AcOEt 9:1). Reaction time: 2 h. T: 60 °C. Yield: 93%. ¹H-NMR (300 MHz, CDCl₃): δ = 6.54 (s, 1H), 3.77 (s, 3H), 3.66 (s, 3H), 3.11-2.90 (m, 2H), 3.01 – 2.92 (m, 6H), 2.55 – 2.39 (m, 2H), 2.29 (s, 3H), 2.26 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 173.0, 153.6, 150.7, 130.4, 128.7, 126.8, 110.5, 110.2, 60.1, 55.6, 37.2, 35.4, 33.0, 22.7, 16.4, 12.1. MS (EI) *m/z* (%): 265 (100) [M]⁺, 234 (30), 179 (42). HRMS Calcd for C₁₅H₂₃NO₃ 265.1678, found 265.1684 [M]⁺.

3-(3,6-Dimethoxy-2,4-dimethylphenyl)-1-phenylpyrrolidine-2,5-dione (5d). Following the general procedure B, the reaction of *N*-phenyl maleimide (33 mg, 0.19 mmol) with aryl boronic acid **2** (20 mg, 0.09 mmol), PCy₃ (8 mg, 0.03 mmol) and [Rh(COD)OH]₂ (1.7 mg, 3.8 μ mol) in THF/H₂O 3:1 (0.71 ml/0.23 ml) gave 30 mg of the compound **5d** as a white solid after flash column chromatography (eluent Hex/AcOEt 4:1). Reaction time: 3 h. T: 60 °C. Yield: 93%. M. p.: 130-132 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 7.57 – 7.29 (m, 5H), 6.60 (s, 1H), 4.26 (dd, *J* = 9.7 and 5.6 Hz, 1H), 3.76 (s, 3H), 3.69 (s, 3H), 3.20 (dd, *J* = 18.1 and 9.8 Hz, 1H), 2.82 (dd, *J* = 18.1 and 5.6 Hz, 1H), 2.36 (s, 3H), 2.31 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 178.1, 175.9, 152.9, 150.9, 132.7, 131.1, 129.2, 128.4, 126.5, 123.7, 111.3, 60.2, 55.8, 40.2, 36.0, 16.5, 12.8. MS (EI) *m/z* (%): 339 (100) [M]⁺, 192 (14). HRMS Calcd for C₂₀H₂₁NO₄ 339.1471, found 339.1457 [M]⁺.

Benzyl 3-(3,6-dimethoxy-2,4-dimethylphenyl)propanoate (5e). Following the general procedure B, the reaction of benzyl acrylate (26 μ L, 0.17 mmol) with 1,4-dimethoxy-3,5-dimethylphenyl boronic acid **2** (30 mg, 0.14 mmol), PCy₃ (12 mg, 0.04 mmol) and [Rh(COD)OH]₂ (2.6 mg, 6 μ mol) in THF/H₂O 3:1 (1.07 ml/0.36 ml) gave compound **5e** (41 mg, 0.125 mmol) as a colorless oil after flash column chromatography (eluent Hexane/AcOEt 15:1). Reaction time: 2 h. T: 60 °C. Yield: 87%. ¹H-NMR (300 MHz, CDCl₃): δ = 7.37 (s, 5H), 6.54 (s, 1H), 5.15 (s, 2H), 3.77 (s, 3H), 3.66 (s, 3H), 2.99 (dd, *J* = 9.2 and 7.2 Hz, 2H), 2.55 (dd, *J* = 9.3 and 7.1 Hz, 2H), 2.30 (s, 3H), 2.26 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 173.4, 153.6, 150.6, 136.2, 130.3, 128.9, 128.5, 128.1, 126.0, 110.2, 66.1, 60.1, 55.5, 33.6, 22.3, 16.4, 12.1. MS (EI) *m/z* (%): 328 (41) [M]⁺, 219 (35), 91 (100). HRMS Calcd for C₂₀H₂₄O₄ 328.1675, found 328.1664[M]⁺.

3-(3,6-Dimethoxy-2,4-dimethylphenyl)propanenitrile (5f). Following the general procedure B, the reaction of acrylonitrile (1.6 μ L, 0.19 mmol) with 1,4-dimethoxy-3,5-dimethyl phenyl boronic acid **2** (20 mg, 0.09 mmol), PCy₃ (8 mg, 0.03 mmol) and [Rh(COD)OH]₂ (1.7 mg, 4 μ mol) in THF/H₂O 3:1 (0.71 ml/0.23 ml) gave 15 mg of compound **5f** as a colorless oil after purification by flash column chromatography (eluent Hexane/AcOEt 12:1). Reaction time: 3 h. T: 60 °C. Yield: 72%. ¹H-NMR (300 MHz, CDCl₃): δ = 6.55 (s, 1H), 3.79 (s, 3H), 3.66 (s, 3H), 3.00 (t, *J* = 7.6 Hz, 2H), 2.52 (t, *J* = 7.6 Hz, 2H), 2.30 (s, 3H), 2.28 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 152.4, 149.7, 129.4, 129.0, 122.6, 118.8, 109.3, 59.1, 54.5, 21.9, 15.6, 15.4, 11.2. MS (EI) *m/z* (%): 219 (62) [M]⁺, 204 (50), 179 (100). HRMS Calcd for C₁₃H₁₇NO₂ 219.1259, found 219.1268 [M]⁺.

(2-(2,2-Bis(phenylsulphonyl)ethyl)-3,6-dimethoxy-2,4-dimethylbenzene (**5g**). Following the general procedure B, the reaction of 1,1-bis(phenylsulphonyl)ethene (35 mg, 0.12 mmol) with aryl boronic acid **2** (20 mg, 0.09 mmol), PCy₃ (8 mg, 0.03 mmol) and [Rh(COD)OH]₂ (1.7 mg, 4 μmol) in THF/H₂O 3:1 (0.71 ml/0.23 ml) gave compound **5g** (47 mg) as a white solid after flash column chromatography (eluent Hexane/AcOEt 3:1). Reaction time: 2 h. T: 60 °C. Yield: 87%. M. p.: 122-123 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 7.81 – 7.67 (m, 4H), 7.60 (t, *J* = 7.4 Hz, 2H), 7.45 (t, *J* = 7.7 Hz, 4H), 6.06 (s, 1H), 5.56 (t, *J* = 7.3 Hz, 1H), 3.63 (s, 3H), 3.57 (d, *J* = 7.3 Hz, 2H), 3.45 (s, 3H), 2.35 (s, 3H), 2.17 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 153.2, 151.0, 139.4, 133.8, 132.1, 130.3, 128.7, 119.3, 109.7, 80.5, 60.0, 55.0, 25.0, 16.3, 12.6. MS (EI) *m/z* (%): 474 (7) [M]⁺, 332 (53), 192 (100), 177(68). HRMS Calcd for C₂₄H₂₆O₆S₂ 474.1171, found 474.1161 [M]⁺.

Dimethyl 2-(3,6-dimethoxy-2,4-dimethylphenyl)succinate (**5h**). Following the general procedure B, the reaction of dimethyl fumarate (16 mg, 0.12 mmol) with aryl boronic acid **2** (20 mg, 0.09 mmol), PCy₃ (8 mg, 0.03 mmol) and [Rh(COD)OH]₂ (1.7 mg, 4 μmol) in THF/H₂O 3:1 (0.71 ml/0.23 ml) gave 27 mg of compound **5h**, as a colorless oil after flash column chromatography (eluent Hex/AcOEt 7:1). Reaction time: 2 h. T: 60 °C. Yield: 91%. ¹H-NMR (300 MHz, CDCl₃): δ = 6.54 (s, 1H), 4.41 (dd, *J* = 8.9 and 4.8 Hz, 1H), 3.72 (s, 3H), 3.69 (s, 3H), 3.67 (s, 3H), 3.63 (s, 3H), 3.27 (dd, *J* = 16.5 and 9.1 Hz, 1H), 2.40 (dd, *J* = 16.5 and 4.9 Hz, 1H), 2.31 (s, 3H), 2.29 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 174.0, 172.9, 153.2, 150.8, 130.6, 130.3, 125.0, 110.9, 60.1, 55.5, 52.0, 51.7, 40.3, 35.2, 16.5, 12.4. MS (EI) *m/z* (%): 310 (89) [M]⁺, 250 (44), 235 (37), 219 (100). HRMS Calcd for C₁₆H₂₂O₆ 310.1416, found 310.1403 [M]⁺.

4-(2,5-Dimethoxyphenyl)butan-2-one (**9a**).³ Following the general procedure B, the reaction of methyl vinyl ketone (18 μl, 0.22 mmol) with aryl boronic acid **8** (20 mg, 0.11 mmol), PCy₃ (9 mg, 0.03 mmol) and [Rh(COD)OH]₂ (2 mg, 4.40 μmol) in THF/H₂O 3:1 (0.82 ml/0.27 ml) gave compound **9a** (19 mg) as a colorless oil after flash column chromatography (eluent Hexane/AcOEt 4:1). Reaction time: 2 h. T: 60 °C. Yield: 83%. ¹H-NMR (300 MHz, CDCl₃): δ = 6.83 – 6.59 (m, 5H), 3.77 (d, *J* = 6.9 Hz, 10H), 3.76 (s, 5H), 2.98–2.80 (m, 3H), 2.79 – 2.63 (m, 3H), 2.15 (s, 5H). ¹³C-NMR (75 MHz, CDCl₃): δ = 208.5, 153.5, 151.7, 130.5, 116.4, 111.4, 111.2, 55.8, 55.7, 43.7, 29.9, 25.1. MS (EI) *m/z* (%): 208 (100) [M]⁺, 165 (22), 151 (41). HRMS Calcd for C₁₂H₁₆O₃ 208.1099, found 208.1097 [M]⁺.

Ethyl 3-(2,5-dimethoxyphenyl)propanoate (**9b**).⁴ Following the general procedure B, the reaction of ethyl acrylate (21 μl, 0.2 mmol) with aryl boronic acid **8** (109 mg, 0.6 mmol), PCy₃ (17 mg, 0.06 mmol) and [Rh(COD)OH]₂ (3.6 mg, 8 μmol) in THF/H₂O 3:1 (1.5 ml/0.5 ml) gave compound **9b** (35 mg) as a colorless oil after flash column chromatography (Hexane/Et₂O 20:1). Reaction time: 3 h. T 60 °C. Yield: 73%. ¹H-NMR (300 MHz, CDCl₃): δ = 6.89 – 6.58 (m, 3H), 4.14 (q, *J* = 7.1 Hz, 2H), 3.79 (s, 3H), 3.76 (s, 3H), 3.08 – 2.74 (m, 2H), 2.70 – 2.49 (m, 2H), 1.25 (t, *J* = 7.1 Hz, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 173.3, 153.4, 151.8, 130.1, 116.3, 111.5, 111.1, 60.3, 55.8, 55.7, 34.3, 26.2, 14.2. MS (EI) *m/z* (%): 238 (100) [M]⁺, 164 (50), 151 (68). HRMS Calcd for C₁₃H₁₈O₄ 238.1205, found 238.1199 [M]⁺.

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Benzyl 3-(2,5-dimethoxyphenyl)propanoate (9c). Following the general procedure B, the reaction of benzyl acrylate (46 μ l, 0.29 mmol) with aryl boronic acid **8** (215 mg, 1.18 mmol), PCy₃ (24.9 mg, 0.09 mmol) and [Rh(COD)OH]₂ (5.4 mg, 0.01 mmol) in THF/H₂O 3:1 (2.2 ml/0.7 ml) gave compound **9c** (58 mg) as a colorless oil after flash column chromatography (eluent Hexane/Et₂O 15:1). Reaction time: 3 h. T: 60 °C. Yield: 65%. ¹H-NMR (300 MHz, CDCl₃): δ = 7.40 – 7.21 (m, 5H), 6.73 – 6.62 (m, 3H), 5.06 (s, 2H), 3.70 (s, 3H), 3.67 (s, 3H), 2.88 (t, J = 7.8 Hz, 2H), 2.60 (t, J = 7.7 Hz, 2H). ¹³C-NMR (75 MHz, CDCl₃): δ = 173.1, 153.5, 151.8, 136.1, 129.9, 128.5, 128.1, 116.3, 111.7, 111.2, 66.2, 55.8, 55.7, 34.2, 26.3. MS (EI) m/z (%): 300 (75) [M]⁺, 191 (61), 167 (69), 91 (100). HRMS Calcd for C₁₈H₂₀O₄ 300.1362, found 300.1350 [M]⁺.

2,5-dimethoxy-1-[(2,2-diphenylsulphonyl)ethyl]benzene (9d). Following the general procedure B, the reaction of 1,1-bis(phenylsulphonyl) ethene (50 mg, 0.16 mmol) with aryl boronic acid **8** (89 mg, 0.48 mmol), PCy₃ (13 mg, 0.05 mmol) and [Rh(COD)OH]₂ (3 mg, 6 μ mol) in THF/H₂O 3:1 (1.22 ml/0.40 ml) gave compound **9d** (71 mg) in 3 h as a white solid after flash column chromatography (Hexane/AcOEt 2:1). Reaction time: 3 h. T: 60 °C. Yield: 98%. M. p.: 134–136 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 7.82 (dd, J = 5.3 and 3.4 Hz, 4H), 7.68 – 7.56 (m, 2H), 7.48 (dd, J = 10.6 and 4.8 Hz, 4H), 6.72 (d, J = 3.0 Hz, 1H), 6.64 (dd, J = 8.9 and 3.1 Hz, 1H), 6.43 (d, J = 8.9 Hz, 1H), 5.37 (t, J = 6.9 Hz, 1H), 3.75 (s, 3H), 3.51 (s, 3H), 3.49 (d, J = 7.1 Hz, 2H). ¹³C-NMR (75 MHz, CDCl₃): δ = 153.4, 151.3, 139.0, 134.1, 129.1, 128.8, 123.3, 118.0, 113.4, 110.8, 81.4, 55.8, 55.4. MS (EI) m/z (%): 446 (5) [M]⁺, 304 (100), 164 (46), 162 (67). HRMS Calcd for C₂₂H₂₂O₆S₂ 446.0858, found 446.0838 [M]⁺.

3-(2,5-Dimethoxyphenyl)-1-phenylpyrrolidine-2,5-dione (9e). Following the general procedure B, the reaction of *N*-phenyl maleimide (34 mg, 0.2 mmol) with aryl boronic acid **8** (30 mg, 0.16 mmol), PCy₃ (14 mg, 0.05 mmol) and [Rh(COD)OH]₂ (3 mg, 6 μ mol) in THF/H₂O 3:1 (1.24 ml/0.41 ml) gave compound **9e** (43 mg) as a white solid after flash column chromatography (eluent Hexane/AcOEt: 2:1). Reaction time: 1 h. T: 60 °C. Yield: 84%. M. p.: 182–183 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 7.60 – 7.25 (m, 5H), 6.84 (s, 3H), 4.01 (dd, J = 9.8 and 5.2 Hz, 1H), 3.79 (s, 3H), 3.78 (s, 3H), 3.24 (dd, J = 18.2 and 9.8 Hz, 1H), 2.91 (dd, J = 18.2 and 5.2 Hz, 1H). ¹³C-NMR (75 MHz, CDCl₃): δ = 177.4, 175.7, 153.7, 151.0, 132.5, 129.2, 128.5, 127.0, 126.5, 117.7, 113.5, 112.1, 56.0, 55.8, 44.4, 36.5. MS (EI) m/z (%): 311 (100) [M]⁺, 164 (53), 149 (25). HRMS Calcd for C₁₈H₁₇NO₄ 311.1158, found 311.1165 [M]⁺.

3-(2,5-Dimethoxyphenyl)propanenitrile (9f). Following the general procedure B, the reaction of acrylonitrile (15 μ l, 0.22 mmol) with aryl boronic acid **8** (20 mg, 0.11 mmol), PCy₃ (9.25 mg, 0.03 mmol) and [Rh(COD)OH]₂ (2.0 mg, 4.40 μ mol) in THF/H₂O 3:1 (0.82 ml/0.27 ml) gave compound **9f** (18 mg) as a colorless oil after flash column chromatography (eluent Hex/AcOEt 6:1). Reaction time: 1.5 h. T: 60 °C. Yield: 86%. ¹H-NMR (300 MHz, CDCl₃): δ = 6.78 (dd, J = 5.3 and 2.2 Hz, 3H), 3.80 (s, 3H), 3.78 (s, 3H), 2.94 (t, J = 7.4 Hz, 2H), 2.63 (t, J = 7.4 Hz, 2H). ¹³C-NMR (75 MHz, CDCl₃): δ = 153.5, 151.5, 127.4, 119.6, 116.6, 112.6, 111.2, 55.8, 55.7, 27.3, 17.5. MS (EI) m/z (%): 191 (87) [M]⁺, 176 (22), 151 (100), 121 (36). HRMS Calcd for C₁₁H₁₃NO₂ 191.0946, found 191.0945 [M]⁺.

2-(3-Oxobutyl) benzoquinone (10a). To a suspension of **9a** (58 mg, 0.28 mmol) in H₂O (1.4 ml) was added PIFA (359 mg, 0.84 mmol). The mixture was stirred for 1 h at rt and then extracted with Et₂O (3x5 ml). The combined organic phases were washed with water (1x) and brine (1x),

and dried over anhydrous MgSO_4 , filtered and concentrated *in vacuo*. The crude mixture was purified by flash column chromatography (eluent Hexane/AcOEt 7:1) to provide compound **10a** as a yellow solid. Yield: 67%. M.p.: 90-91 °C. $^1\text{H-NMR}$ (300 MHz, CDCl_3): δ = 6.80 – 6.57 (m, 2H), 6.50 (d, J = 1.9 Hz, 1H), 2.63 (s, 4H), 2.10 (s, 3H). $^{13}\text{C-NMR}$ (75 MHz, CDCl_3): δ = 206.2, 187.4, 187.3, 148.0, 136.8, 136.4, 133.1, 41.2, 29.8, 23.5. MS (EI) m/z (%): 178 (10) $[\text{M}]^+$, 162 (24), 136 (100). HRMS Calcd for $\text{C}_{10}\text{H}_{10}\text{O}_3$ 178.0630, found 178.0638 $[\text{M}]^+$.

Benzyl 3-(benzoquinonyl)propanoate (10c). To a suspension of **9c** (57 mg, 0.19 mmol) in H_2O (0.95 ml) with MeOH (23 μl) was added PIFA (245 mg, 0.57 mmol). The mixture was stirred for 1h at rt. Then, the mixture was extracted con Et_2O (3x5 ml). The combined organic phases were washed with water (1x) and brine (2x), the organic phase was dried over anhydrous MgSO_4 , filtered and concentrated *in vacuo*. The crude mixture was purified by flash column chromatography (eluent Hexane/AcOEt 7:1) to provide compound **10c** (35 mg) as a yellow solid. Yield: 68%. M.p.: 76-79 °C. $^1\text{H-NMR}$ (300 MHz, CDCl_3): δ = 7.36 (m, 5H), 6.81–6.64 (m, 2H), 6.58 (s, 1H), 5.13 (s, 2H), 2.79 (t, J = 7.2 Hz, 2H), 2.63 (t, J = 7.0 Hz, 2H). $^{13}\text{C-NMR}$ (75 MHz, CDCl_3): δ = 187.3, 187.0, 171.7, 147.4, 136.7, 136.4, 135.6, 133.1, 128.6, 128.4, 128.4, 66.6, 32.1, 24.7. MS (ESI) m/z (%): 239 (100) $[\text{M}+\text{Na}]^+$, 238 (16). HRMS Calcd for $\text{C}_{16}\text{H}_{14}\text{NaO}_4$ 293.0790, found 293.0794 $[\text{M}+\text{Na}]^+$.

2-(2,2-Bis(phenylsulfonyl)ethyl)benzoquinone (10d). The reaction of compound **9d** (15 mg, 0.03 mmol) with CAN (44 mg, 0.08 mmol) in aqueous CH_3CN during 30 min gave compound **10d** as an orange solid without further purification. Yield: 86%. M.p.: Decomposes over 150 °C. $^1\text{H-NMR}$ (300 MHz, CDCl_3): δ = 7.90 (dd, J = 5.3 and 3.4 Hz, 4H), 7.76 – 7.66 (m, 2H), 7.57 (dd, J = 10.5 and 4.8 Hz, 4H), 6.69 (d, J = 1.9 Hz, 2H), 6.63 (d, J = 1.1 Hz, 1H), 5.27 (t, J = 7.2 Hz, 1H), 3.27 (dd, J = 7.2, and 1.2 Hz, 2H). $^{13}\text{C-NMR}$ (75 MHz, CDCl_3): δ = 187.0, 186.5, 142.5, 137.7, 136.6, 136.6, 135.3, 134.9, 129.5, 129.3, 80.5, 27.6. MS (EI) m/z (%): 161 (2) $[\text{M}]^+$, 434 $[\text{M}+\text{NH}_4]^+$, 439 (30) $[\text{M}+\text{Na}]^+$. HRMS Calcd for $\text{C}_{20}\text{H}_{17}\text{O}_6\text{S}_2$ 417.0467, found 417.0459 $[\text{M}+\text{H}]^+$.

3-(2-Benzoquinonyl)propanenitrile (10f). Following the general procedure C, the reaction of acrylonitrile (22 μl , 0.330 mmol) with (2,5-dimethoxyphenyl)boronic acid **8** (30 mg, 0.16 mmol), PCy_3 (14 mg, 0.05 mmol) and $[\text{Rh}(\text{COD})\text{OH}]_2$ (3 mg, 6 μmol) in THF/ H_2O (1.2 ml/0.41 ml) was stirred at 60 °C for 1.5 h gave the corresponding crude mixture. Then, CAN (289 mg, 0.53 mmol) was slowly added in water (0.8 ml) at rt. After purification by flash column chromatography (eluent Hexane/AcOEt 4:1) compound **10f** was obtained as an orange solid (20 mg). Yield: 75%. M. p.: 54-56 °C. $^1\text{H-NMR}$ (300 MHz, CDCl_3): δ = 6.80 (d, J = 2.0 Hz, 2H), 6.73 (d, J = 1.1 Hz, 1H), 2.95 – 2.74 (m, 2H), 2.66 (td, J = 6.7 and 1.1 Hz, 2H). $^{13}\text{C-NMR}$ (75 MHz, CDCl_3): δ = 186.7, 186.7, 144.5, 136.8, 136.6, 134.3, 118.0, 25.8, 16.29. MS (EI) m/z (%): 161 (2) $[\text{M}]^+$, 134 (100). HRMS Calcd for $\text{C}_9\text{H}_7\text{NO}_2$ 161.0467, found 161.0482 $[\text{M}]^+$.

(3,5-Dimethylbenzoquinonyl) (p-nitrophenyl)methanol (11a) To a microwave tube containing a mixture of benzoquinonyl boronic acid (**1a**) (27 mg, 0.15 mmol), K_2CO_3 (19.7 mg, 0.15 mmol), $[\text{Rh}(\text{COD})\text{OH}]_2$ (3.5 mg, 5.7 μmol), XPhos (10.9 mg, 11.9 μmol) and 4-nitrobenzaldehyde (43.2 mg, 0.30 mmol) was added dioxane (0.4 ml) and DME (0.1 ml) under an argon atmosphere. The mixture was stirred at 60° C during 18 h. After this time, the crude mixture was filtered throw a pad of celite. The filtrate was washed with a saturated solution of NH_4Cl , and extracted with AcOEt (x3). The organic phases were dried

over anhydrous MgSO₄ and the solvent was removed under reduced pressure. Then, the crude residue was purified by flash column chromatography (eluent Hexane/AcOEt 5:1) to afford 9.5 mg of compound **11a** as a yellow oil. Yield: 25%.

Following the general procedure E, the reaction of compound **12a** (32.5 mg, 0.10 mmol) with CAN (134.8 mg, 0.24 mmol) in aqueous CH₃CN gave compound **11a** as a yellow oil (30.5 mg) without further purification. Yield: 99%.

Following the general procedure F, the reaction of the reaction of 4-nitrobenzaldehyde (45.3 mg, 0.30 mmol) with aryl boronic acid **2** (32 mg, 0.15 mmol), KO^tBu (16.8 mg, 0.15 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μmol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml), followed by the addition of CAN (197.4 mg, 0.36 mmol) afforded compound **11a** (41.3 mg) after flash column chromatography (eluent Hexane/AcOEt 5:1). Reaction time (Catalyzed Addition): 1 h. Yield: 96%.

Compound (11a): ¹H-NMR (300 MHz, CDCl₃): δ = 8.19 (d, *J* = 8.9 Hz, 2H), 7.52 (d, *J* = 8.9 Hz, 2H), 6.54 (q, *J* = 1.6 Hz, 1H), 5.94 (d, *J* = 10.4 Hz, 1H), 4.07 (d, *J* = 10.5 Hz, 1H), 2.19 (s, 3H), 2.08 (d, *J* = 1.6 Hz, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 188.6, 187.6, 148.9, 147.3, 146.6, 142.7, 141.0, 133.3, 126.1, 123.8, 70.3, 16.0, 12.3. MS (EI) *m/z* (%): 287 (3) [M]⁺, 272 (100). HRMS Calcd for C₁₅H₁₃NO₅ 287.0794, found 287.0797 [M]⁺.

(3,5-Dimethylbenzoquinonyl) (p-(trifluoromethyl)phenyl)methanol (11b). Following the general procedure E, the reaction of compound **12b** (33.7 mg, 0.10 mmol) with CAN (134.8 mg, 0.24 mmol) in aqueous CH₃CN gave compound **11b** as a yellow oil (30.5 mg) without further purification. Yield: 99%.

Following the general procedure F, the reaction of the reaction of 4-trifluoromethylbenzaldehyde (40 μl, 0.30 mmol) with aryl boronic acid **2** (32 mg, 0.15 mmol), KO^tBu (16.8 mg, 0.15 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μmol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml), followed by the addition of CAN (197.4 mg, 0.36 mmol) afforded compound **11b** (44.3 mg) after flash column chromatography (eluent Hexane/AcOEt 4:1). Reaction time (Catalyzed Addition): 1 h. Yield: 95%.

Compound (11b): ¹H-NMR (300 MHz, CDCl₃): δ = 7.60 (d, *J* = 8.3 Hz, 2H), 7.46 (d, *J* = 8.7 Hz, 2H), 6.53 (q, *J* = 1.6 Hz, 1H), 5.90 (d, *J* = 10.5 Hz, 1H), 4.12 (d, *J* = 10.6 Hz, 1H), 2.18 (s, 3H), 2.08 (d, *J* = 1.6 Hz, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 188.9, 187.7, 146.4, 145.5, 142.3, 141.2, 133.4, 125.8, 125.6, 125.5 (q, ³*J*_{CF} = 3.9 Hz), 70.8, 16.0, 12.2. MS (EI) *m/z* (%): 295 (100) [M - 15]⁺, 279 (65), 225 (30). HRMS Calcd for C₁₆H₁₃F₃O₃ 309.0739, found 309.0744 [M - 1]⁺.

(3,5-Dimethylbenzoquinonyl) (p-methoxyphenyl) ketone (13). Following the general procedure E, the reaction of compound **12c** (10.2 mg, 0.03 mmol) with CAN (44.4 mg, 0.08 mmol) in aqueous CH₃CN gave compound **13** as a yellow oil (8.4 mg) without further purification. Yield: 92%.

Following the general procedure F, the reaction of 4-methoxybenzaldehyde (37 μl, 0.30 mmol) with aryl boronic acid **2** (30 mg, 0.15 mmol), KO^tBu (16.8 mg, 0.15 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μmol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml), followed by the addition of CAN (197.4 mg, 0.36 mmol) afforded compound **13** (41.3 mg) after flash column

chromatography (eluent Hexane/AcOEt 4:1). Reaction time (Catalyzed Addition): 2 h. Yield: 59%.

Compound (13): ¹H-NMR (300 MHz, CDCl₃): δ = 7.82 (d, *J* = 8.9 Hz, 2H), 6.95 (d, *J* = 8.9 Hz, 2H), 6.62 (q, *J* = 1.5 Hz, 1H), 3.88 (s, 3H), 2.13 (d, *J* = 1.4 Hz, 3H), 1.93 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 191.3, 187.7, 185.7, 164.7, 146.2, 142.3, 141.2, 132.8, 131.7, 129.0, 114.3, 55.6, 16.1, 13.2. MS (EI) *m/z* (%): 270 (100) [M]⁺, 227 (14), 135 (92). HRMS Calcd for C₁₆H₁₄O₄ 270.0892, found 270.0882 [M]⁺.

(3,5-Dimethylbenzoquinonyl) (p-tolyl)methanol (11d). Following the general procedure E, the reaction of compound **12d** (32.6 mg, 0.11 mmol) with CAN (150.0 mg, 0.28 mmol) in aqueous CH₃CN gave compound **11d** as a yellow oil (19.7 mg) without further purification. Yield: 67%.

Following the general procedure F, the reaction of the reaction of 4-methylbenzaldehyde (36.0 mg, 35 μL, 0.30 mmol) with aryl boronic acid **2** (30 mg, 0.15 mmol), KO^tBu (16.8 mg, 0.15 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μmol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml), followed by the addition of CAN (197.4 mg, 0.36 mmol) afforded compound **11d** (41.3 mg) after flash column chromatography (eluent Hexane/AcOEt 4:1). Reaction time (Catalyzed Addition): 1 h. Yield: 79%.

Compound (11d): ¹H-NMR (300 MHz, CDCl₃): δ = 7.22 (d, *J* = 8.1 Hz, 2H), 7.14 (d, *J* = 8.1 Hz, 2H), 6.51 (bd, *J* = 1.4 Hz, 1H), 5.81 (d, *J* = 10.8 Hz, 1H), 4.20 (d, *J* = 10.8 Hz, 1H), 2.33 (s, 3H), 2.14 (s, 3H), 2.06 (d, *J* = 1.4 Hz, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 189.1, 187.9, 145.9, 141.8, 141.6, 138.4, 137.2, 133.4, 129.2, 125.3, 71.1, 21.0, 15.8, 11.9. MS (EI) *m/z* (%): 256 (4) [M]⁺, 241 (100), 236 (70). HRMS Calcd for C₁₆H₁₆O₃ 256.1099, found 256.1092 [M]⁺.

(3,5-Dimethylbenzoquinonyl) (o-trifluoromethylphenyl)methanol (11e). Following the general procedure E, the reaction of compound **12e** (50.5 mg, 0.15 mmol) with CAN (194.7 mg, 0.35 mmol) in aqueous CH₃CN gave compound **11e** as a yellow oil (44.5 mg) without further purification. Yield: 96%.

Following the general procedure F, the reaction of 2-trifluoromethylbenzaldehyde (52.2 mg, 40 μL, 0.30 mmol) with aryl boronic acid **2** (30 mg, 0.15 mmol), KO^tBu (16.8 mg, 0.15 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μmol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml) followed by the addition of CAN (197.4 mg, 0.36 mmol) afforded compound **11e** (41.3 mg) after flash column chromatography (eluent Hexane/AcOEt 5:1). Reaction time (Catalyzed Addition): 1 h. Yield: 89%.

Compound (11e): ¹H-NMR (300 MHz, CDCl₃): δ = 7.71 (d, *J* = 7.7 Hz, 1H), 7.56 – 7.36 (m, 3H), 6.60 (bs, 1H), 6.20 (d, *J* = 9.5 Hz, 1H), 4.31 (d, *J* = 9.5 Hz, 1H), 2.08 (d, *J* = 1.3 Hz, 3H), 1.95 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 189.6, 187.6, 146.0, 143.1, 141.1, 139.7, 133.5, 132.1, 128.5, 128.3, 128.2 (q, ²*J*_{CF} = 30.4 Hz), 126.8 (q, ³*J*_{CF} = 6.0 Hz), 124.3 (q, ¹*J*_{CF} = 274.5 Hz), 68.55, 15.85, 11.84. MS (EI) *m/z* (%): 310 (1) [M]⁺, 223 (100), 195 (49). HRMS Calcd for C₁₆H₁₃O₃F₃ 310.0817, found 310.0829 [M]⁺.

(o-Bromophenyl) (3,5-dimethylbenzoquinonyl)methanol (11f). Following the general procedure E, the reaction of compound **12f** (350 mg, 0.76 mmol) with CAN (1 g, 0.24 mmol)

in aqueous CH₃CN gave compound **11f** as a yellow oil (232.6 mg) without further purification. Yield: 96%.

Following the general procedure F, the reaction of 2-bromobenzaldehyde (55.5 mg, 35 μ l, 0.30 mmol) with aryl boronic acid **2** (30 mg, 0.15 mmol), KO^tBu (16.8 mg, 0.15 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μ mol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml) followed by the addition of CAN (197.4 mg, 0.36 mmol) afforded compound **11f** (41.3 mg) after flash column chromatography (eluent Hexane/AcOEt 5:1). Reaction time (Catalyzed Addition): 0.5 h. Yield: 73%.

Compound (11f): ¹H-NMR (300 MHz, CDCl₃): δ = 7.56 (d, J = 8.0 Hz, 1H), 7.50 (d, J = 7.6 Hz, 1H), 7.32 (t, J = 8.0 Hz, 1H), 7.17 (t, J = 7.6 Hz, 1H), 6.58 (q, J = 1.6 Hz, 1H), 6.10 (d, J = 8.9 Hz, 1H), 3.95 (d, J = 9.2 Hz, 1H), 2.07 (d, J = 1.5 Hz, 3H), 2.01 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 189.0, 187.9, 146.0, 143.0, 141.00, 140.3, 133.4, 133.2, 129.4, 128.6, 127.6, 122.8, 70.8, 15.9, 12.4. MS (ESI) m/z (%): 345 (84), 343 (100) [M + 23]⁺. HRMS Calcd for C₁₅H₁₃O₃NaBr 342.9940, found 342.9925 [M + 23]⁺.

(3,5-Dimethylbenzoquinonyl) (2-thiophenyl)methanol (11g). Following the general procedure E, the reaction of compound **12g** (18.3 mg, 0.07 mmol) with CAN (87.7 g, 0.16 mmol) in aqueous CH₃CN gave compound **11g** as a dark yellow oil (11.3 mg) after flash column chromatography (eluent Hexane/AcOEt 6:1).

Following the general procedure F, the reaction of 2-thiophenecarboxaldehyde (33.6 mg, 28 μ l, 0.30 mmol) with aryl boronic acid **2** (30 mg, 0.15 mmol), KO^tBu (16.8 mg, 0.15 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μ mol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml) followed by the addition of CAN (197.4 mg, 0.36 mmol) afforded compound **11g** (41.3 mg) after flash column chromatography (eluent Hexane/AcOEt 5:1). Reaction time (Catalyzed Addition): 1 h. Yield: 38%.

Compound (11g): Yield: 69%. ¹H-NMR (300 MHz, CDCl₃): δ = 7.26 (dd, J = 4.9, 1.1 Hz, 1H), 6.94 (dd, J = 4.9, 3.6 Hz, 1H), 6.87 (m, 1H), 6.56 (q, J = 1.5 Hz, 1H), 5.98 (d, J = 10.8 Hz, 1H), 4.60 (d, J = 10.8 Hz, 1H), 2.14 (s, 3H), 2.07 (d, J = 1.5 Hz, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 189.2, 187.8, 146.2, 145.5, 141.3, 140.7, 133.5, 127.0, 125.5, 124.1, 68.7, 16.0, 11.7. MS (ESI) m/z (%): 271 (100) [M + 23]⁺. HRMS Calcd for C₁₃H₁₂O₃NaS 271.0399, found 271.0391 [M + 23]⁺.

(Cyclohexyl) (3,5-dimethylbenzoquinonyl)methanol (11i). Following the general procedure E, the reaction of compound **12i** (42.4 mg, 0.15 mmol) with CAN (197.4 g, 0.36 mmol) in aqueous CH₃CN gave compound **11i** as a yellow oil (31.0 mg) after flash column chromatography (eluent Heptane/AcOEt 6:1). Yield: 83%.

Following the general procedure F, the reaction of cyclohexanecarboxaldehyde (33.6 mg, 36 μ l, 0.30 mmol) with aryl boronic acid **2** (30 mg, 0.15 mmol), Et₃N (15.2 mg, 0.48 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μ mol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml) followed by the addition of CAN (197.4 mg, 0.36 mmol) afforded compound **11i** (7.4 mg) after flash column chromatography (eluent Hexane/AcOEt 5:1). Reaction time (Catalyzed Addition): 18 h. Yield: 20%.

Compound (11i): ¹H-NMR (300 MHz, CDCl₃): δ = 6.51 (s, 1H), 4.30 (dd, *J* = 10.8 and 9.2 Hz, 1H), 3.36 (d, *J* = 11.0 Hz, 1H), 2.05 (s, 6H), 1.85 – 1.61 (m, 5H), 1.39 (d, *J* = 11.2 Hz, 1H), 1.29 – 0.85 (m, 6H)¹³C-NMR (75 MHz, CDCl₃): δ = 189.6, 187.8, 145.8, 142.2, 141.8, 133.6, 75.0, 44.0, 29.9, 29.6, 26.3, 26.0, 25.8, 15.8, 12.2. MS (ESI) *m/z* (%): 271 (100) [M + Na]⁺. HRMS Calcd for C₁₅H₂₀O₃Na 271.1304, found 271.1295 [M + Na]⁺.

(3,6-Dimethoxy-2,4-dimethylphenyl)(*p*-nitrophenyl)methanol (12a). Following the general procedure D, the reaction of 4-nitrobenzaldehyde (45.3 mg, 0.30 mmol) with aryl boronic acid **2** (32 mg, 0.15 mmol), KO^tBu (16.8 mg, 0.15 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μmol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml) gave 46.2 mg of compound **12a** as a light-yellow oil after flash column chromatography (eluent Hexane/AcOEt 4:1). Reaction time: 1 h. Yield: 97%. ¹H-NMR (300 MHz, CDCl₃): δ = 8.13 (d, *J* = 8.8 Hz, 2H), 7.44 (d, *J* = 8.9 Hz, 2H), 6.61 (s, 1H), 6.06 (d, *J* = 10.2 Hz, 1H), 4.05 (d, *J* = 10.3 Hz, 1H), 3.69 (s, 3H), 3.62 (s, 3H), 2.32 (s, 3H), 2.31 (s, 3H). ¹³C NMR (75 MHz, CDCl₃): δ = 153.2, 152.1, 151.2, 146.8, 131.6, 130.2, 127.2, 126.4, 123.3, 111.8, 70.7, 60.2, 55.6, 16.6, 12.4. MS (EI) *m/z* (%): 317 (89) [M]⁺, 284 (100). HRMS Calcd for C₁₇H₁₉NO₅ 317.1263, found 317.1268 [M]⁺.

(3,6-Dimethoxy-2,4-dimethylphenyl)(*p*-trifluoromethylphenyl)methanol (12b). Following the general procedure D, the reaction of 4-trifluoromethylbenzaldehyde (40 μl, 0.30 mmol) with aryl boronic acid **2** (32 mg, 0.15 mmol), KO^tBu (16.8 mg, 0.15 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μmol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml) gave 40 mg of compound **12b** as a colorless oil after flash column chromatography (eluent Hexane/AcOEt 5:1). Reaction time: 1 h. Yield: 78%. ¹H-NMR (300 MHz, CDCl₃): δ = 7.53 (d, *J* = 8.2 Hz, 2H), 7.39 (d, *J* = 8.2 Hz, 2H), 6.61 (s, 1H), 6.04 (d, *J* = 10.6 Hz, 1H), 4.14 (d, *J* = 10.7 Hz, 1H), 3.68 (s, 3H), 3.63 (s, 3H), 2.32 (s, 3H), 2.29 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 153.4, 151.1, 148.4, 131.1, 130.1, 128.8 (q, ²*J*_{CF} = 32.2 Hz), 127.60, 125.95, 124.9 (q, ⁴*J*_{CF} = 3.8 Hz), 124.3 (q, ¹*J*_{CF} = 270 Hz), 111.80, 70.97, 60.20, 55.65, 16.51, 12.30. MS (EI) *m/z* (%): 340 (78) [M]⁺, 322 (21), 307 (100). HRMS Calcd for C₁₈H₁₉O₃F₃ 340.1286, found 340.1285 [M]⁺.

(3,6-Dimethoxy-2,4-dimethylphenyl)(4-methoxyphenyl)methanol (12c). Following the general procedure D, the reaction of 4-methoxybenzaldehyde (37 μl, 0.30 mmol) with aryl boronic acid **2** (30 mg, 0.15 mmol), KO^tBu (16.8 mg, 0.15 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μmol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml) gave 28.3 mg of compound **12c** as a colorless oil after flash column chromatography (eluent Hexane/AcOEt 5:1). Reaction time: 2 h. Yield: 62%. ¹H-NMR (300 MHz, CDCl₃): δ = 7.19 (d, *J* = 8.9 Hz, 2H), 6.82 (d, *J* = 8.8 Hz, 2H), 6.62 (s, 1H), 5.95 (d, *J* = 10.9 Hz, 1H), 4.28 (d, *J* = 10.9 Hz, 1H), 3.78 (s, 3H), 3.68 (s, 3H), 3.67 (s, 3H), 2.31 (s, 3H), 2.24 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 158.5, 153.6, 151.1, 136.2, 130.4, 129.9, 128.3, 127.2, 113.4, 111.91, 71.5, 60.2, 55.8, 55.2, 16.5, 12.2. MS (EI) *m/z* (%): 302 (35) [M]⁺, 299 (40), 286 (92), 269 (100). HRMS Calcd for C₁₈H₂₂O₄ 302.1518, found 302.1516 [M]⁺.

(3,6-Dimethoxy-2,4-dimethylphenyl)(*p*-tolyl)methanol (12d). Following the general procedure D, the reaction of 4-methylbenzaldehyde (36.0 mg, 35 μL, 0.30 mmol) with aryl boronic acid **2** (30 mg, 0.15 mmol), KO^tBu (16.8 mg, 0.15 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μmol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml) gave 32.6 mg of compound **12d** as a colorless oil after flash column chromatography (eluent Hexane/AcOEt 5:1). Reaction time: 1 h. Yield:

76%. ¹H-NMR (300 MHz, CDCl₃): δ = 7.17 (d, *J* = 8.1 Hz, 2H), 7.09 (d, *J* = 8.1 Hz, 2H), 6.62 (s, 1H), 5.98 (d, *J* = 7.4 Hz, 1H), 4.30 (d, *J* = 7.4 Hz, 1H), 3.67 (s, 3H), 3.67 (s, 3H), 2.32 (s, 3H), 2.31 (s, 3H), 2.26 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 153.6, 151.1, 141.1, 136.3, 130.4, 130.0, 128.8, 128.4, 125.9, 111.9, 71.7, 60.2, 55.8, 21.0, 16.5, 12.2. MS (EI) *m/z* (%): 286 (28) [M]⁺, 268 (99), 253 (100). HRMS Calcd for C₁₈H₂₂O₃ 286.1569, found 286.1580 [M]⁺.

(3,6-Dimethoxy-2,4-dimethylphenyl)(*o*-trifluoromethylphenyl)methanol (**12e**). Following the general procedure D, the reaction of 2-trifluoromethylbenzaldehyde (40 μl, 0.30 mmol) with aryl boronic acid **2** (30 mg, 0.15 mmol), KO^tBu (16.8 mg, 0.15 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μmol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml) gave 50.5 mg of compound **12e** as a light-yellow oil after flash column chromatography (eluent Hexane/AcOEt 5:1). Reaction time: 1 h. Yield: 70%. ¹H-NMR (300 MHz, CDCl₃): δ = 7.74 – 7.71 (m, 1H), 7.42 – 7.31 (m, 2H), 7.20 – 7.17 (m, 1H), 6.72 (s, 1H), 6.36 (d, *J* = 10.4 Hz, 1H), 4.91 (d, *J* = 10.4 Hz, 1H), 3.83 (s, 3H), 3.63 (s, 3H), 2.33 (s, 3H), 2.09 (s, 3H), 2.31 (s, 3H), 2.24 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 153.9, 151.4, 141.1, 131.6, 130.9, 130.28, 129.0, 128.9 (q, ²*J*_{CF} = 30.5 Hz), 127.62, 126.8 (q, ³*J*_{CF} = 6.1 Hz), 126.2, 124.7 (q, ¹*J*_{CF} = 274.3 Hz) 111.71, 70.0 (q, ⁴*J*_{CF} = 1.5 Hz), 60.13, 55.73, 16.47, 12.03. MS (EI) *m/z* (%): 340 (100) [M]⁺, 307 (52), 195 (76). HRMS Calcd for C₁₈H₁₉F₃O₃ 340.1286, found 340.1289 [M]⁺.

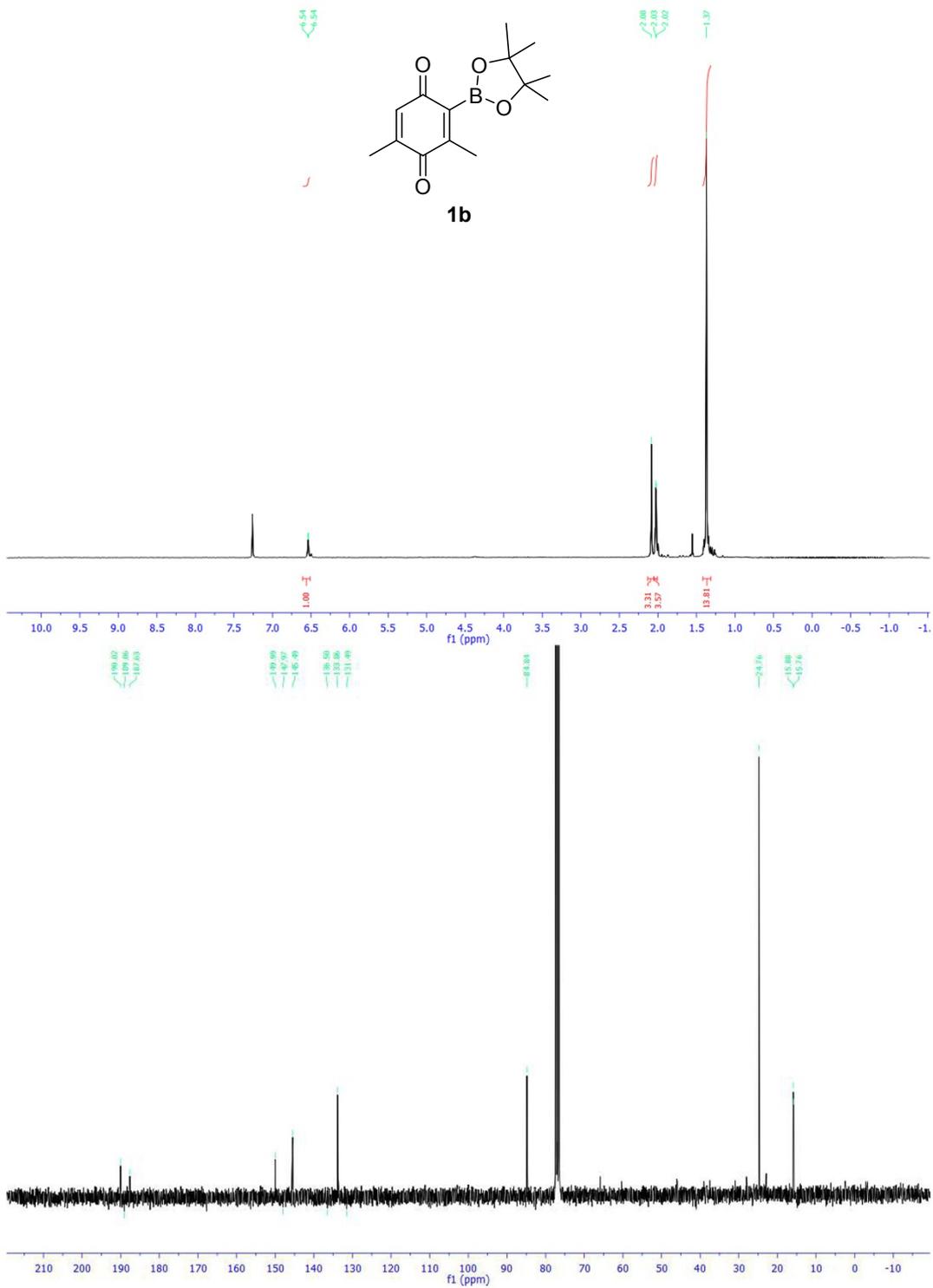
(*o*-Bromophenyl)(3,6-dimethoxy-2,4-dimethylphenyl)methanol (**12f**). Following the general procedure D, the reaction of 2-bromobenzaldehyde (176.1 mg, 111 μl, 0.95 mmol) with aryl boronic acid **2** (100 mg, 0.48 mmol), KO^tBu (53.4 mg, 0.48 mmol) and [Rh(COD)OH]₂ (8.7 mg, 0.02 mmol) in CH₃CN/H₂O, 1/1 (2.40 ml/2.40 ml) gave 163.6 mg of compound **12f** as a white solid after flash column chromatography (eluent Hexane/AcOEt 5:1). Reaction time: 30 min. Yield: 98%. M.p.: 77-78 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 7.59 (d, *J* = 7.7 Hz, 1H), 7.21 – 7.03 (m, 3H), 6.69 (s, 1H), 6.22 (d, *J* = 10.1 Hz, 1H), 4.56 (d, *J* = 10.1 Hz, 1H), 3.79 (s, 3H), 3.64 (s, 3H), 2.32 (s, 3H), 2.14 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 153.8, 151.4, 141.5, 133.2, 130.8, 130.5, 129.1, 129.0, 127.1, 126.2, 124.6, 111.7, 72.6, 60.2, 55.8, 16.5, 12.3. MS (EI) *m/z* (%): 350 (53) [M]⁺, 334 (66), 332 (52). HRMS Calcd for C₁₇H₁₉BrO₃ 350.0518, found 350.0505 [M]⁺.

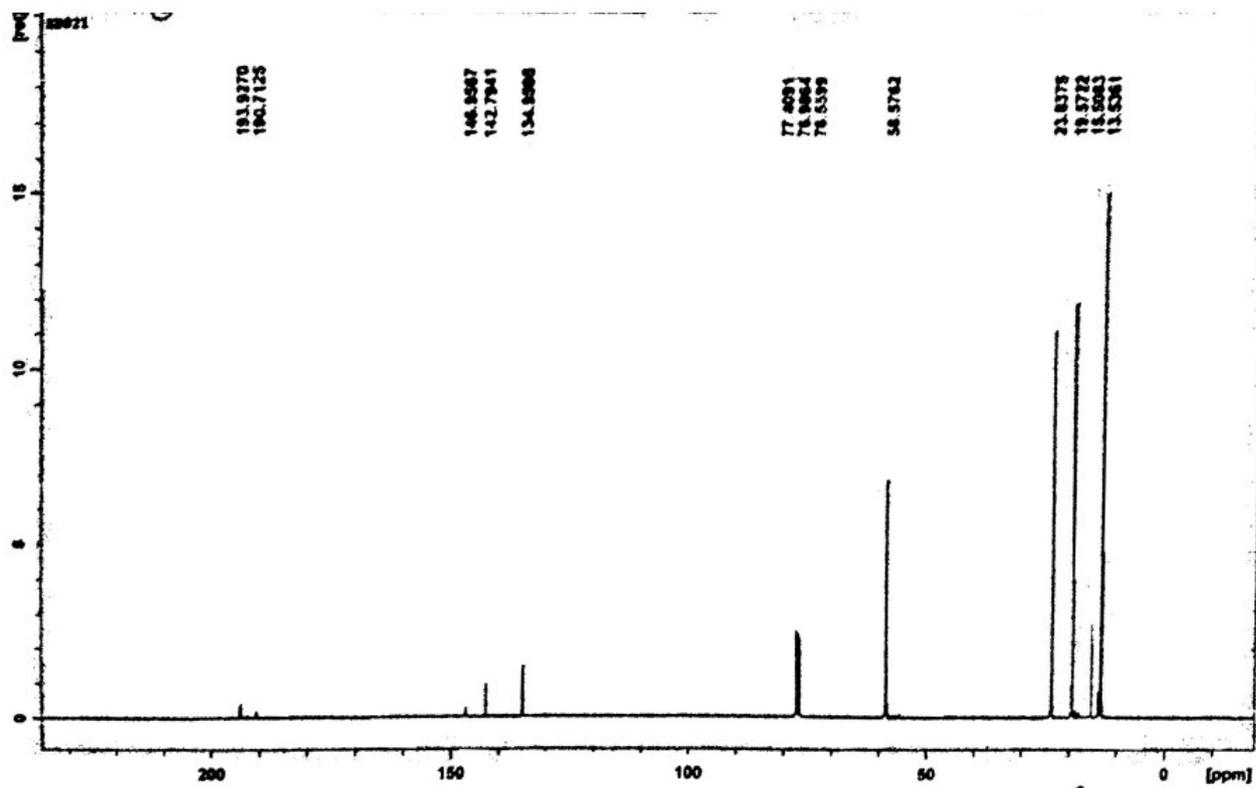
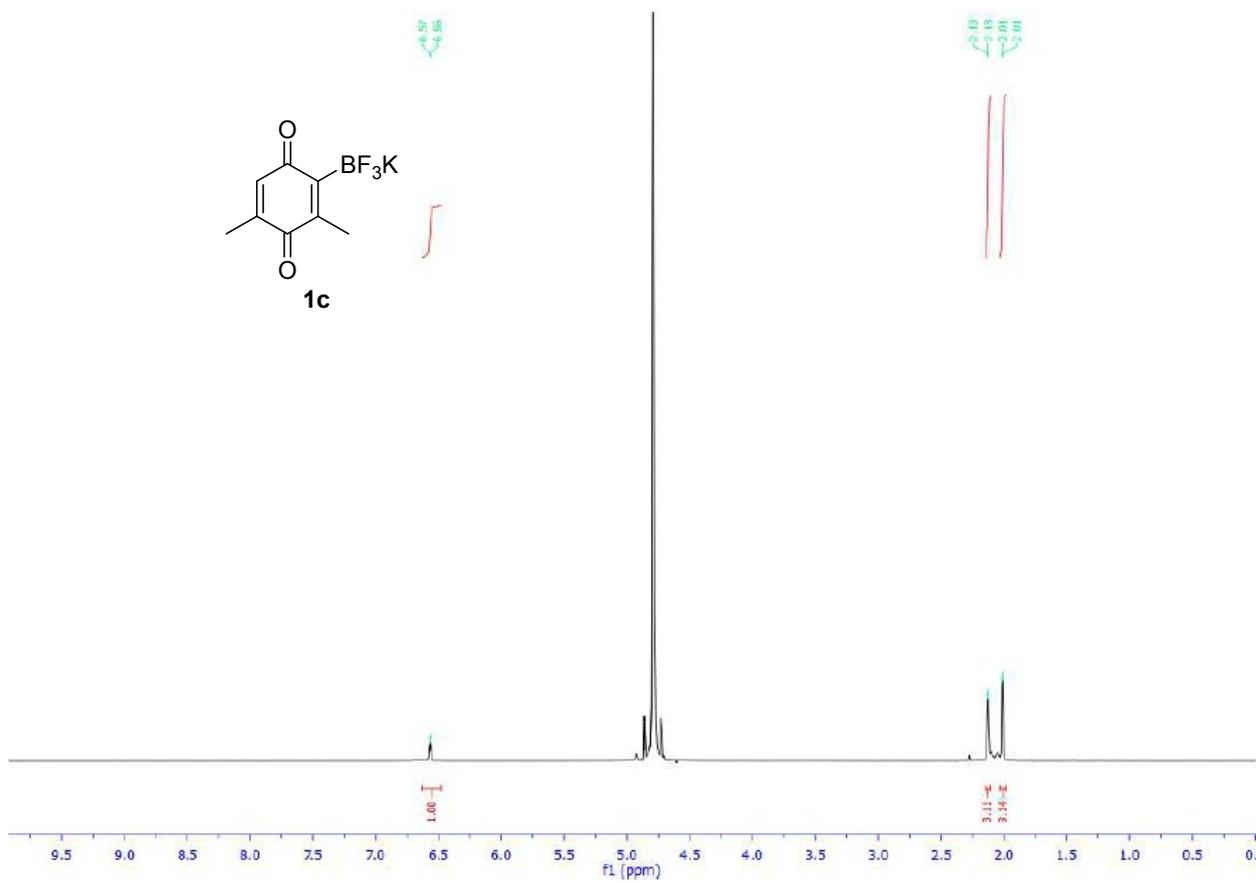
(3,6-Dimethoxy-2,4-dimethylphenyl)(thien-2-yl)methanol (**12g**). Following the general procedure D, the reaction of 2-thiophenecarboxaldehyde (33.6 mg, 28 μl, 0.30 mmol) with 2,5-dimethyl-3,6-dimethoxyphenyl boronic acid **2** (30 mg, 0.15 mmol), KO^tBu (16.8 mg, 0.15 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μmol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml) gave 23.6 mg of compound **12g** as a white solid after flash column chromatography (eluent Hexane/AcOEt 5:1). Reaction time: 1 h. Yield: 56%. M.p.: 92-93 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 7.20 (dd, *J* = 5.0, 1.0 Hz, 1H), 6.89 (dd, *J* = 5.0, 2.9 Hz, 1H), 6.69 (dd, *J* = 2.9, 1.0 Hz, 1H), 6.64 (s, 1H), 6.13 (d, *J* = 11.0 Hz, 1H), 4.73 (d, *J* = 11.0 Hz, 1H), 3.75 (s, 3H), 3.66 (s, 3H), 2.31 (s, 3H), 2.28 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 153.6, 151.0, 148.9, 130.8, 129.5, 127.8, 126.5, 124.6, 123.7, 111.9, 69.2, 60.2, 55.8, 16.5, 12.0. MS (ESI) *m/z* (%): 301 (100) [M + 23]⁺. HRMS Calcd for C₁₅H₁₈O₃NaS 301.0868, found 301.0870 [M + 23]⁺.

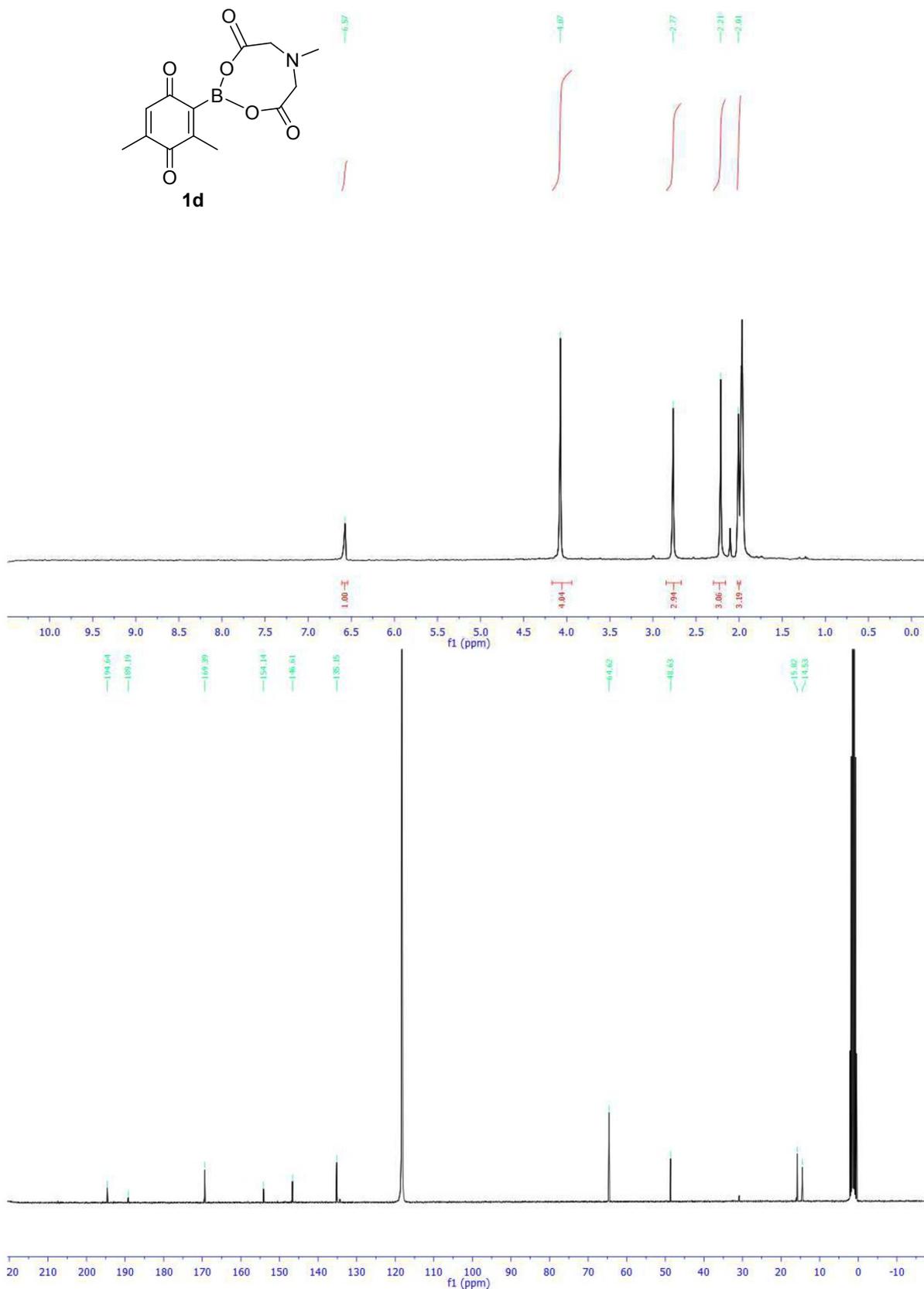
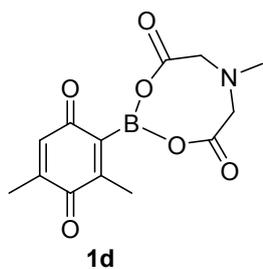
3,6-Dimethoxy-2,4-dimethylphenyl(*N*-methyl-1*H*-indol-2-yl)methanol (**12h**). Following the general procedure D, the reaction of *N*-methyl-2-carboxaldehyde (47.7 mg, 0.30 mmol) with aryl boronic acid **2** (30 mg, 0.15 mmol), KO^tBu (16.8 mg, 0.15 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μmol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml) gave 29.5 mg of compound **12h** as a

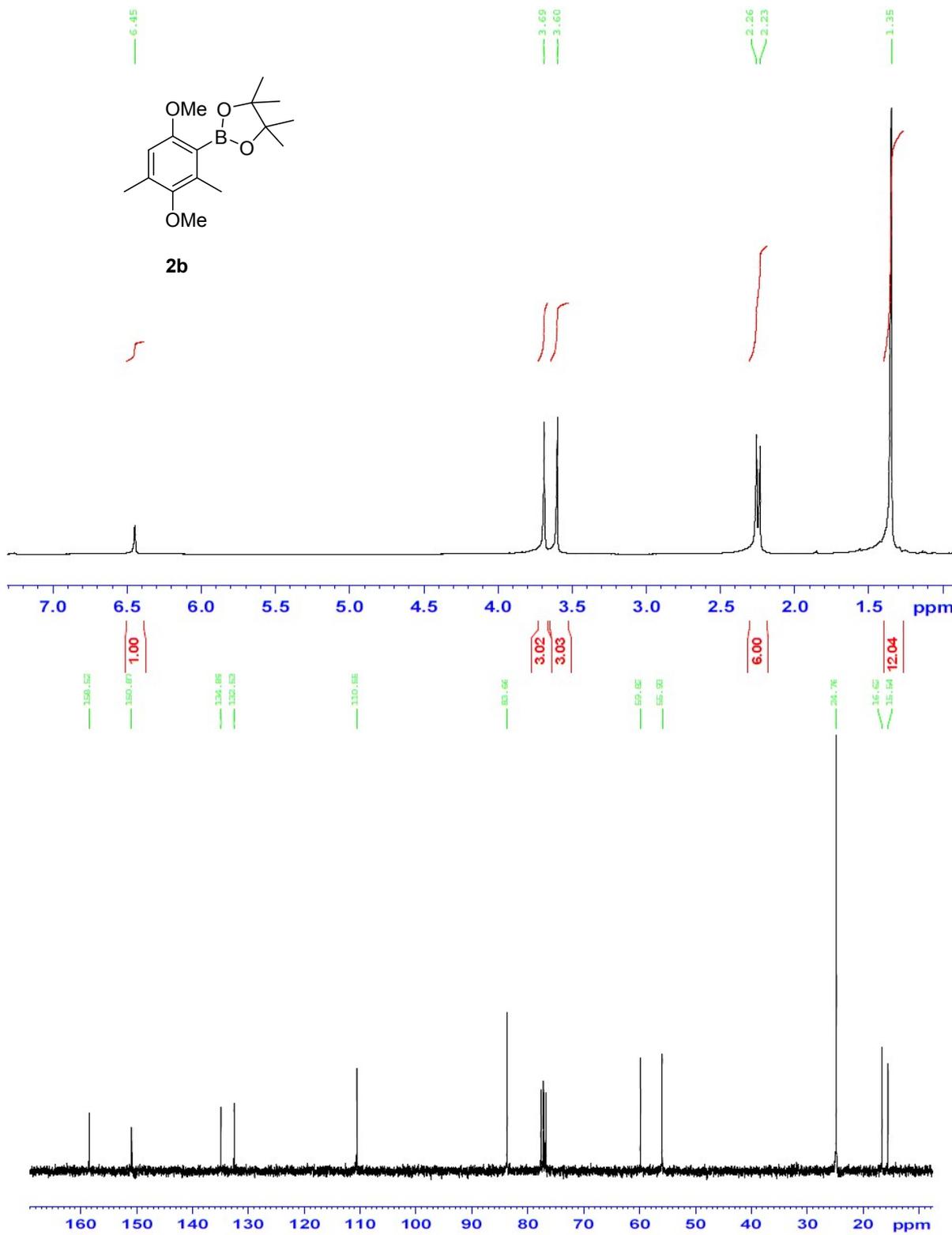
pale-pink solid after flash column chromatography (eluent Hexane/AcOEt 5:1). Reaction time: 2 h. Yield: 64%. M.p.: 163-164 °C. ¹H-NMR (300 MHz, CDCl₃): δ = 7.46 (d, *J* = 7.8 Hz, 1H), 7.36 (d, *J* = 8.2 Hz, 1H), 7.22 (t, *J* = 8.2 Hz, 1H), 7.06 (t, *J* = 7.8 Hz, 1H), 6.75 (s, 1H), 6.15 (d, *J* = 11.1 Hz, 1H), 5.86 (s, 1H), 4.72 (d, *J* = 11.1 Hz, 1H), 3.99 (s, 3H), 3.82 (s, 3H), 3.68 (s, 3H), 2.38 (s, 3H), 2.20 (s, 3H). ¹³C-NMR (75 MHz, CDCl₃): δ = 154.2, 151.1, 140.4, 138.3, 130.8, 129.7, 126.9, 126.0, 121.5, 120.6, 119.2, 111.9, 109.0, 100.9, 66.6, 60.2, 55.9, 30.3, 16.5, 11.9. MS (EI) *m/z* (%): 325 (26) [M]⁺, 309 (100), 292 (58), 278 (81). HRMS Calcd for C₂₀H₂₃O₃N 325.1678, found 325.1673 [M]⁺.

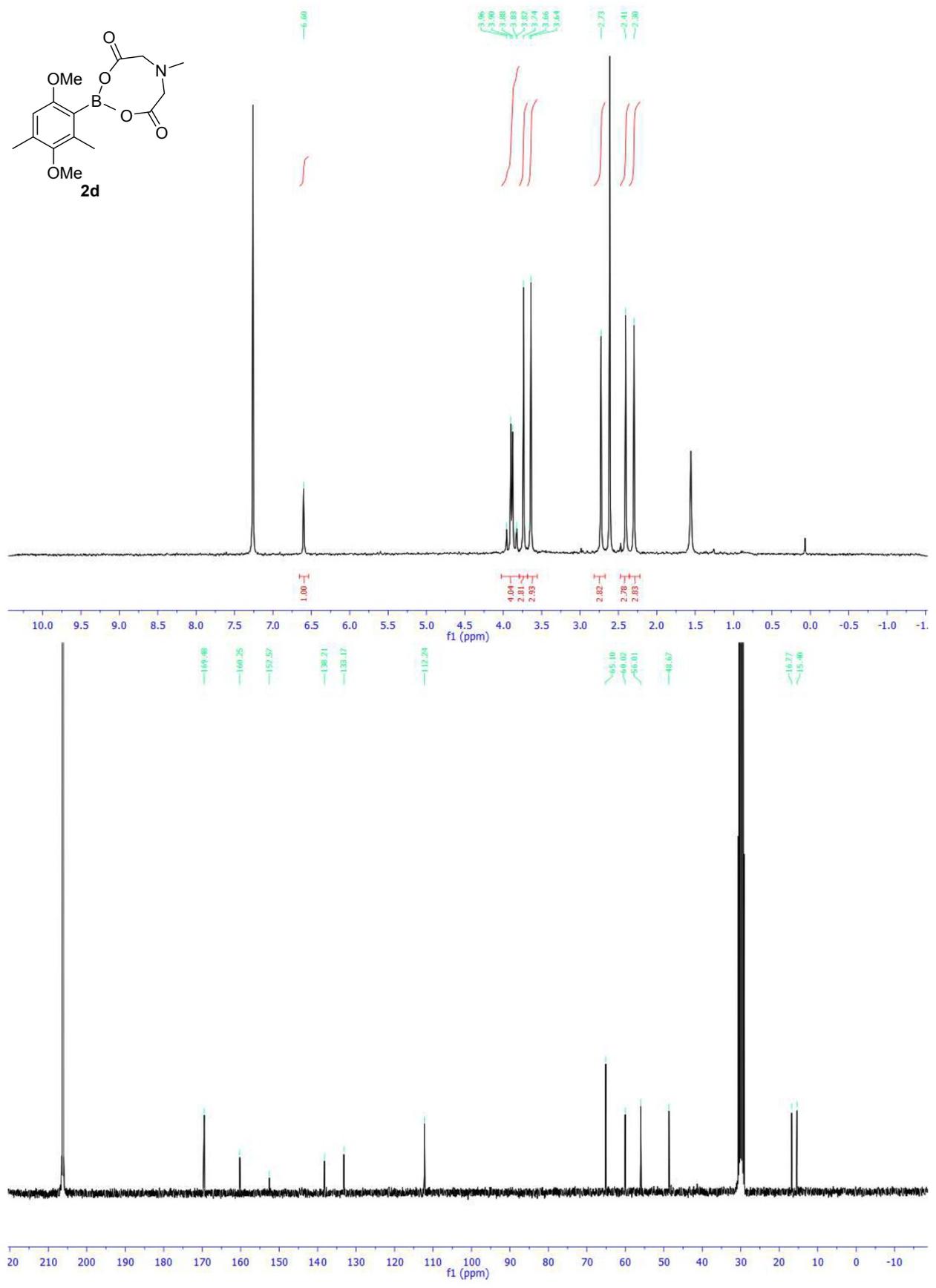
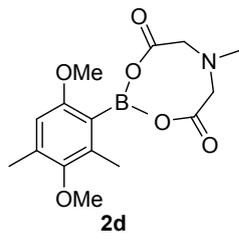
Cyclohexyl (3,6-dimethoxy-2,4-dimethylphenyl)methanol (12i). Following the general procedure D, the reaction of cyclohexanecarboxaldehyde (33.6 mg, 36 μl, 0.30 mmol) with aryl boronic acid **2** (30 mg, 0.15 mmol), Et₃N (15.2 mg, 21 μL, 0.48 mmol) and [Rh(COD)OH]₂ (2.7 mg, 6 μmol) in CH₃CN/H₂O, 1/1 (1.50 ml/1.50 ml) gave 10.0 mg of compound **12i** as a colorless oil after flash column chromatography (eluent Hexane/AcOEt 8:1). Reaction time: 18 h. Yield: 24%. ¹H-NMR (300 MHz, CDCl₃): δ = 6.58 (s, 1H), 4.47 (t, *J* = 9.7 Hz, 1H), 3.82 (s, 3H), 3.63 (s, 3H), 3.56 (d, *J* = 9.6 Hz, 1H), 2.27 (s, 3H), 2.23 (s, 3H), 1.87 – 1.75 (m, 2H), 1.61 (dd, *J* = 13.0, 3.7 Hz, 3H), 1.24 – 0.84 (m, 6H). ¹³C-NMR (75 MHz, CDCl₃): δ = 153.4, 150.9, 130.1, 129.6, 128.4, 111.1, 76.1, 60.0, 55.4, 44.1, 30.2, 29.9, 26.6, 26.4, 26.2, 16.4, 12.7. MS (ESI) *m/z* (%): 301 (100) [M+Na]⁺. HRMS Calcd for C₁₇H₂₆O₃Na 301.1774, found 301.1767 [M+Na]⁺.

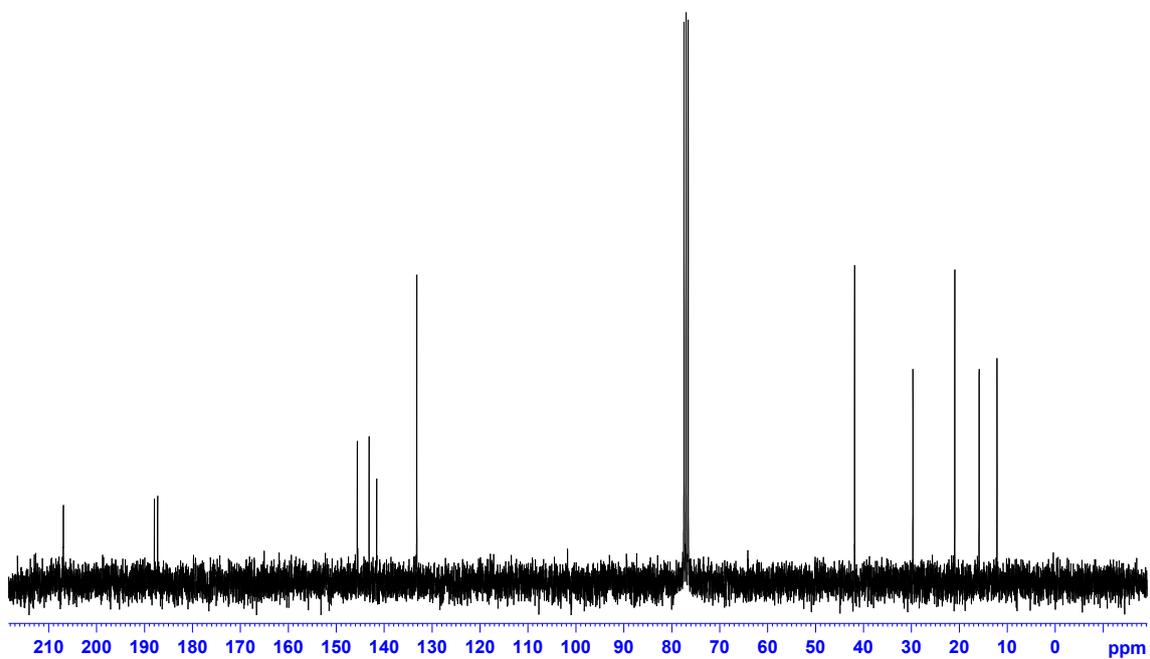
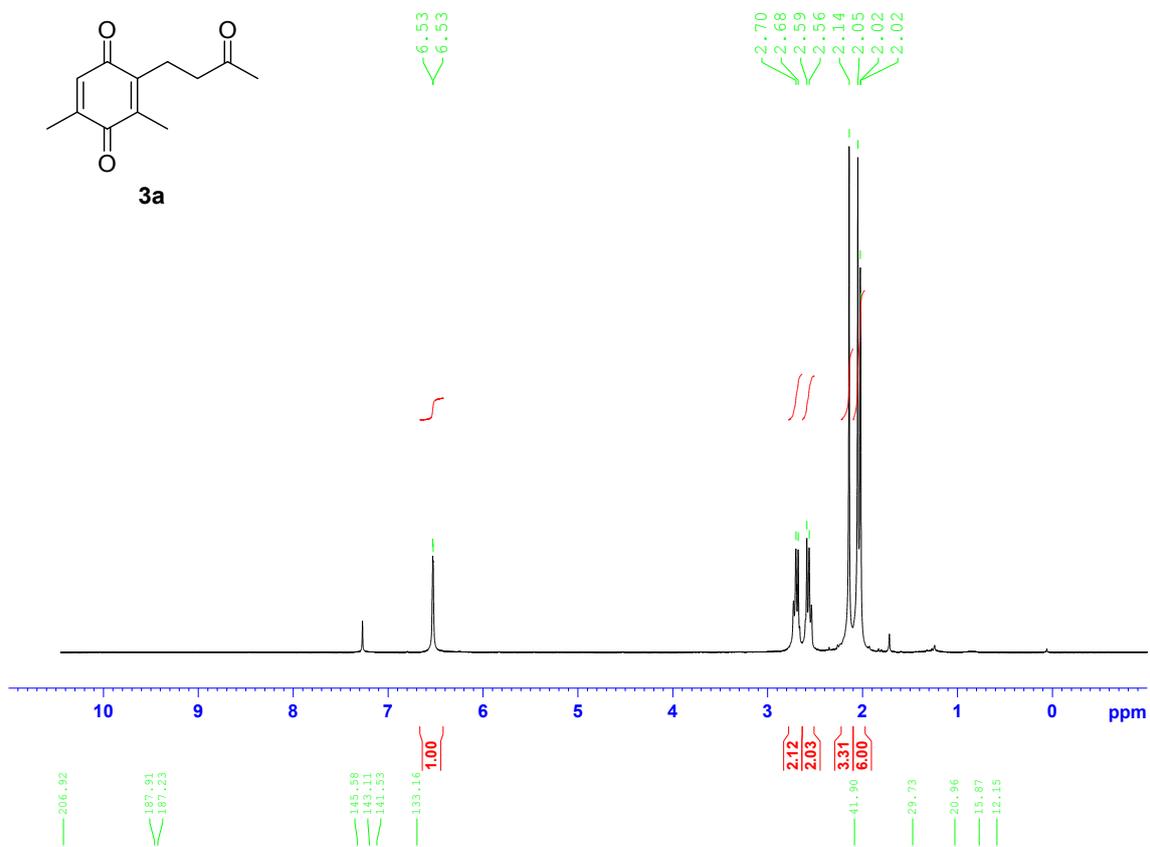
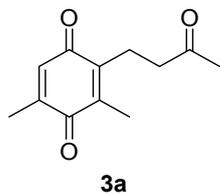


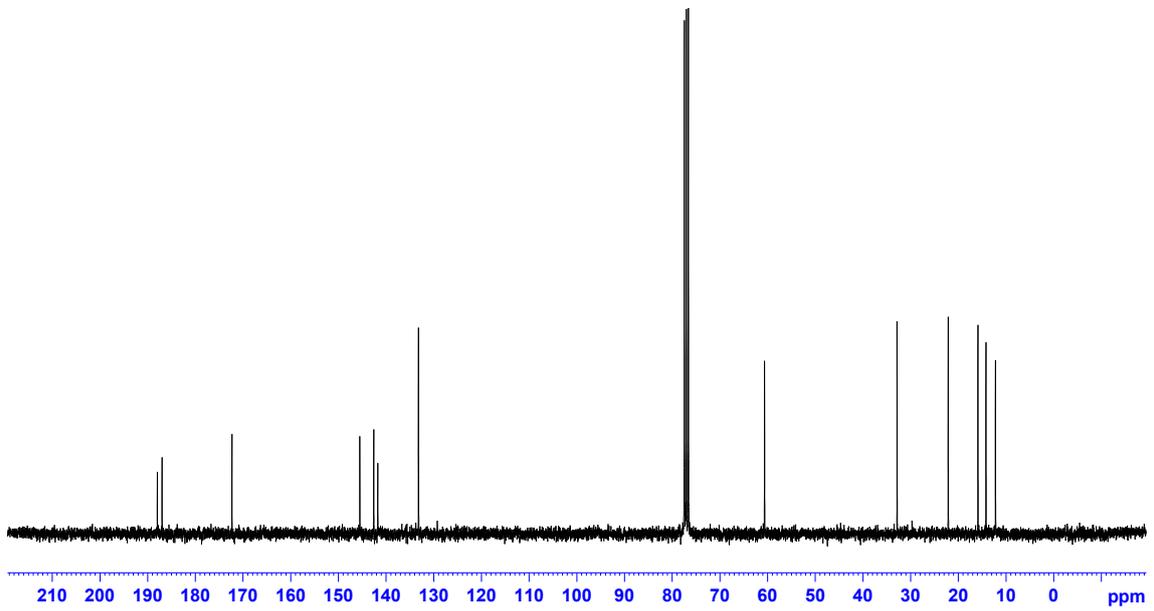
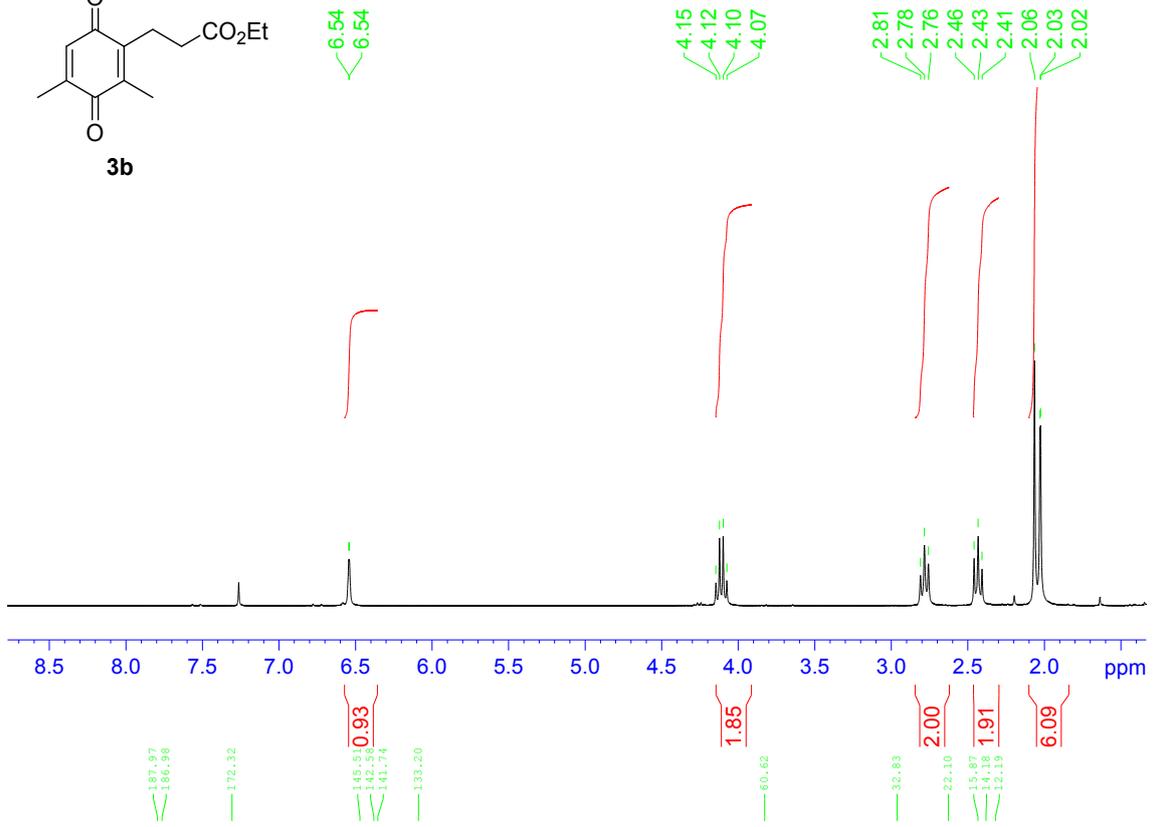
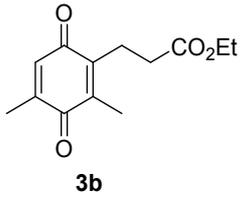


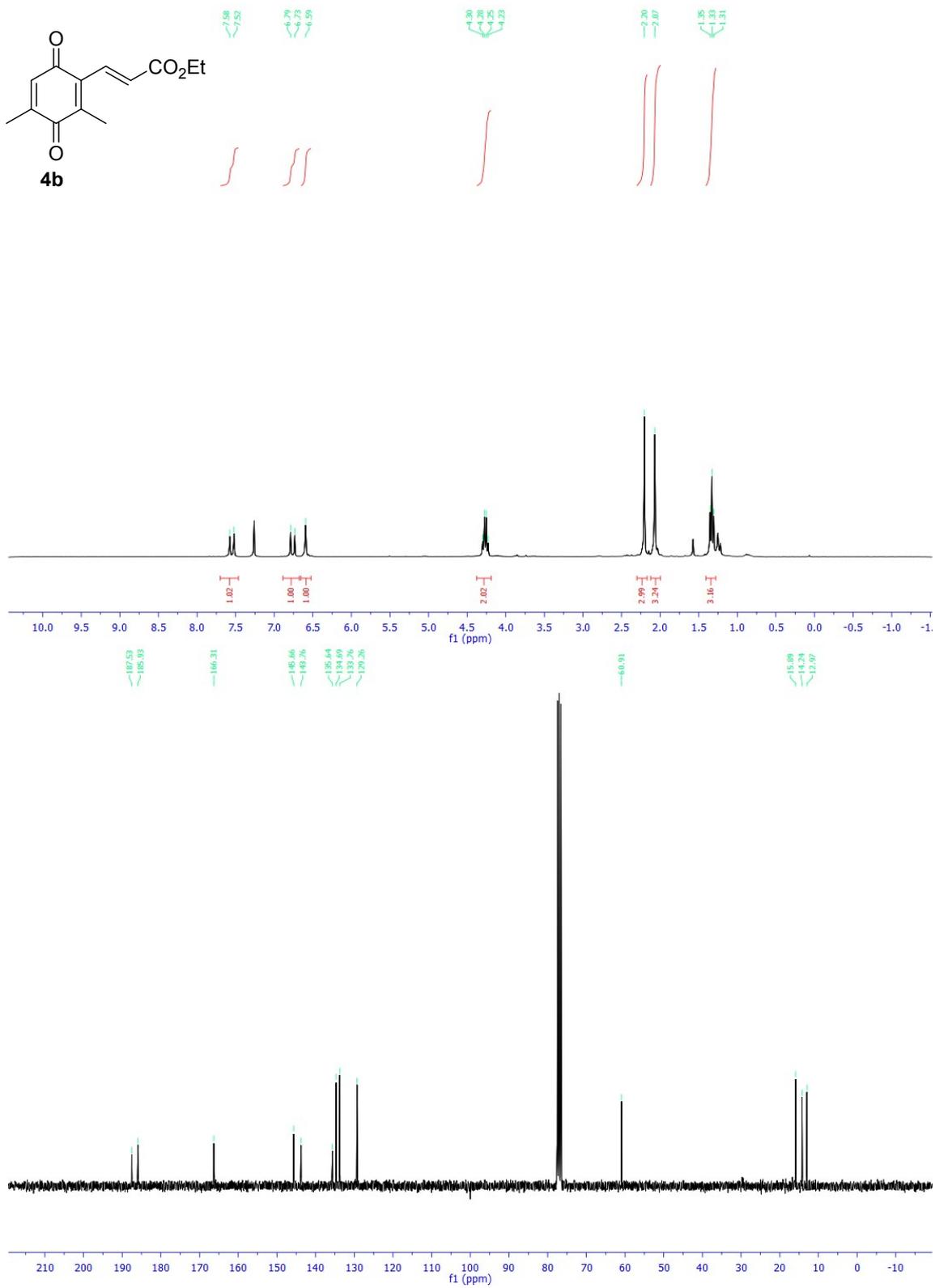


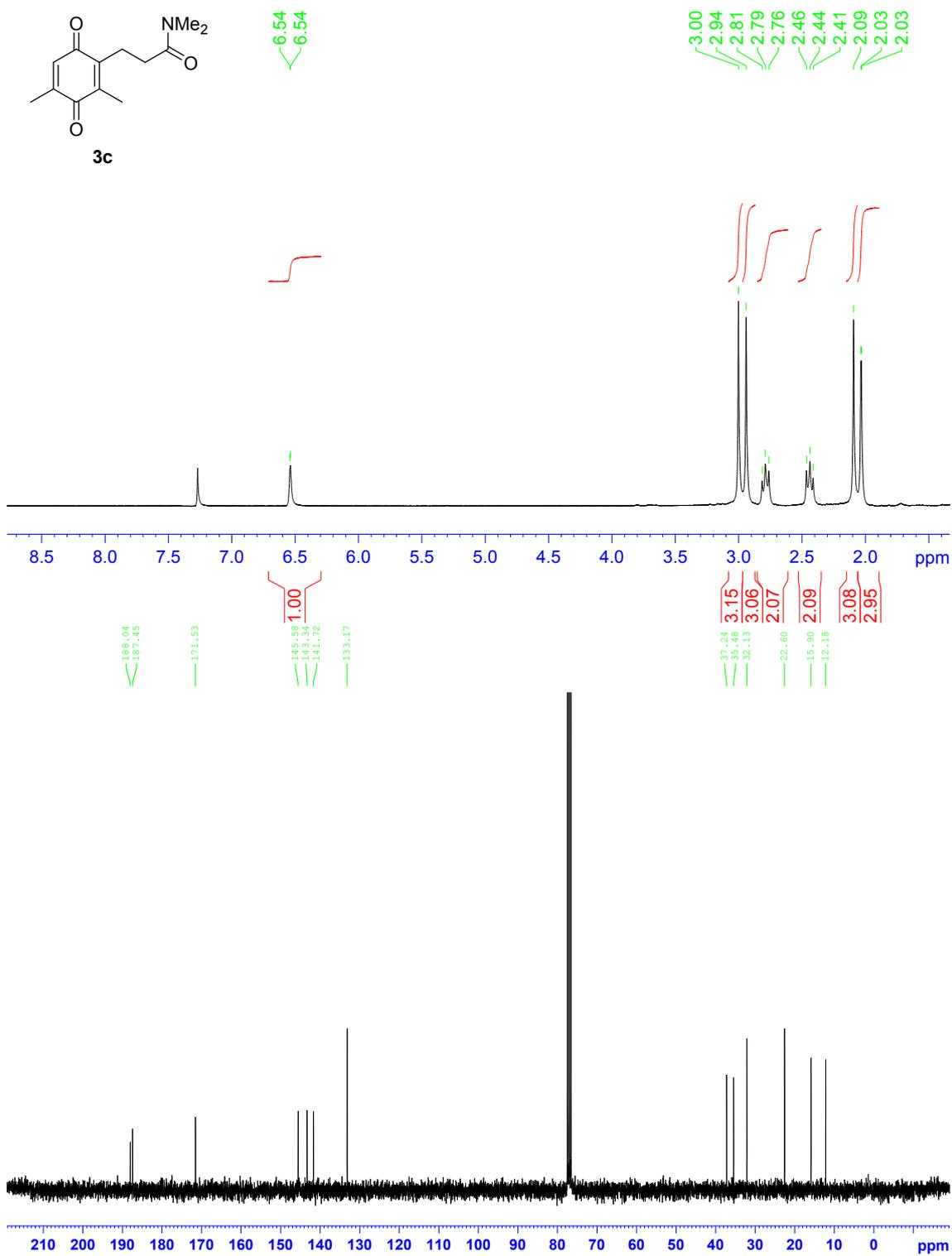
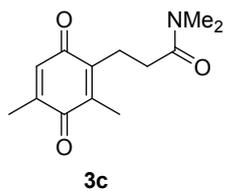


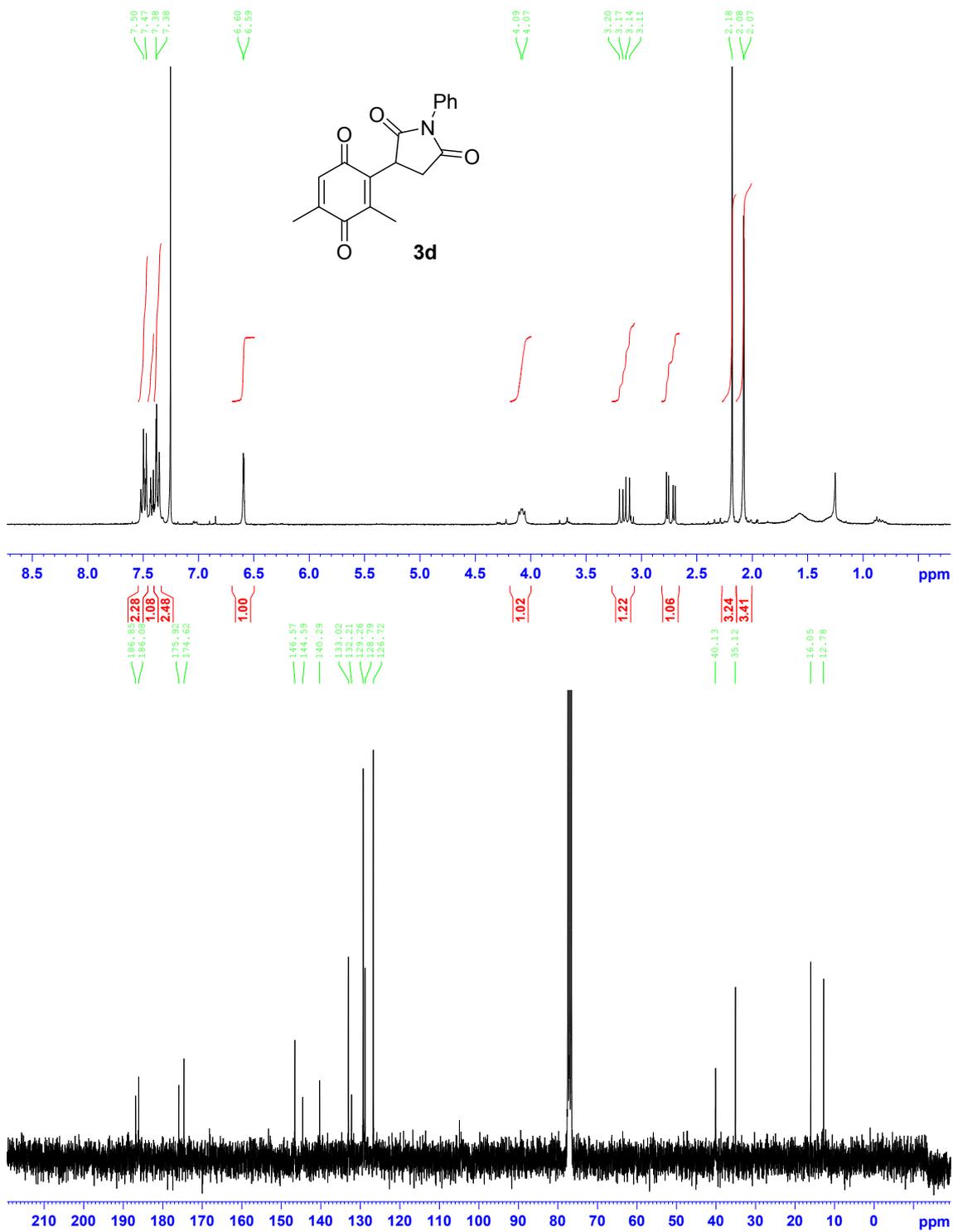


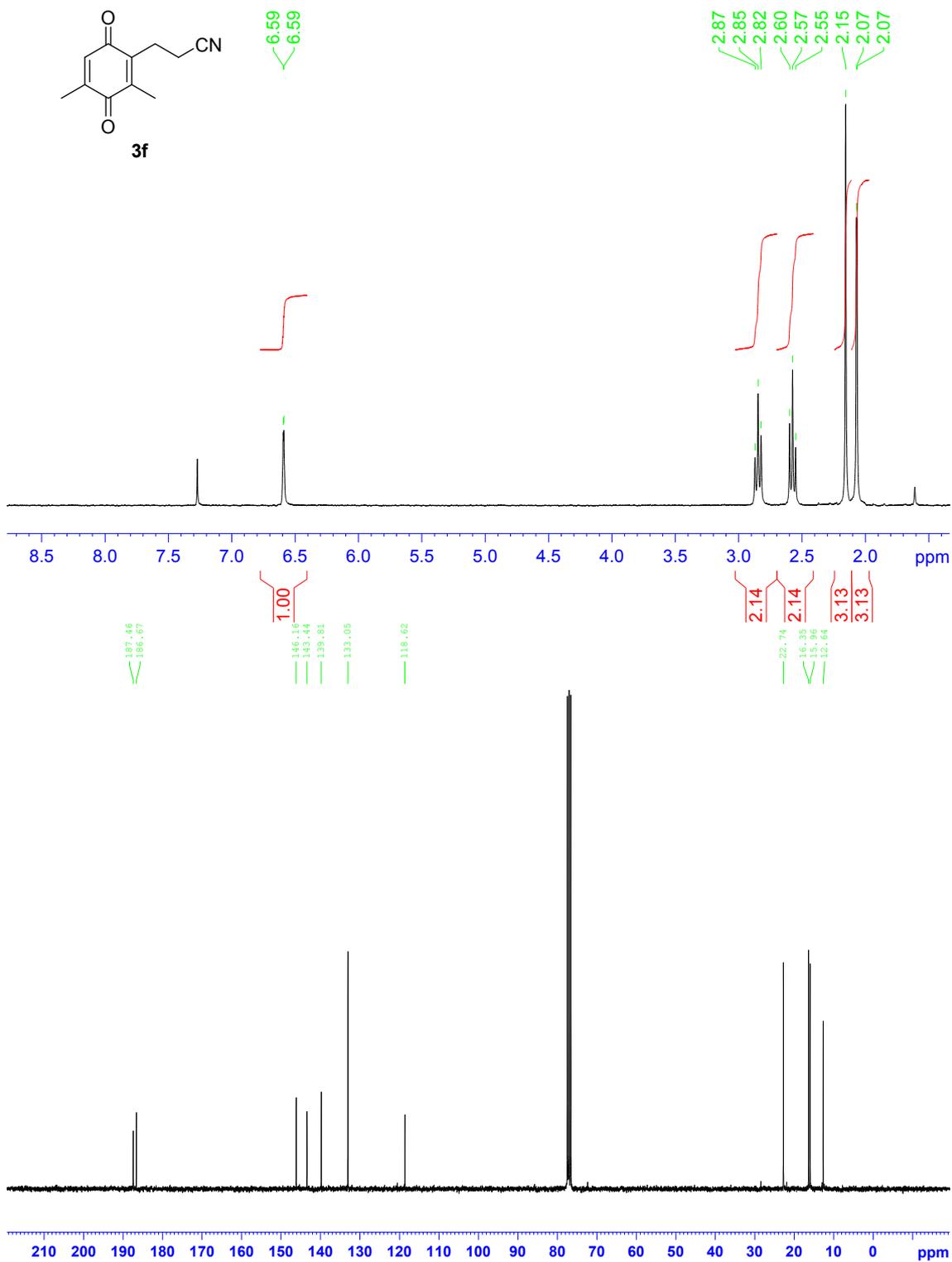


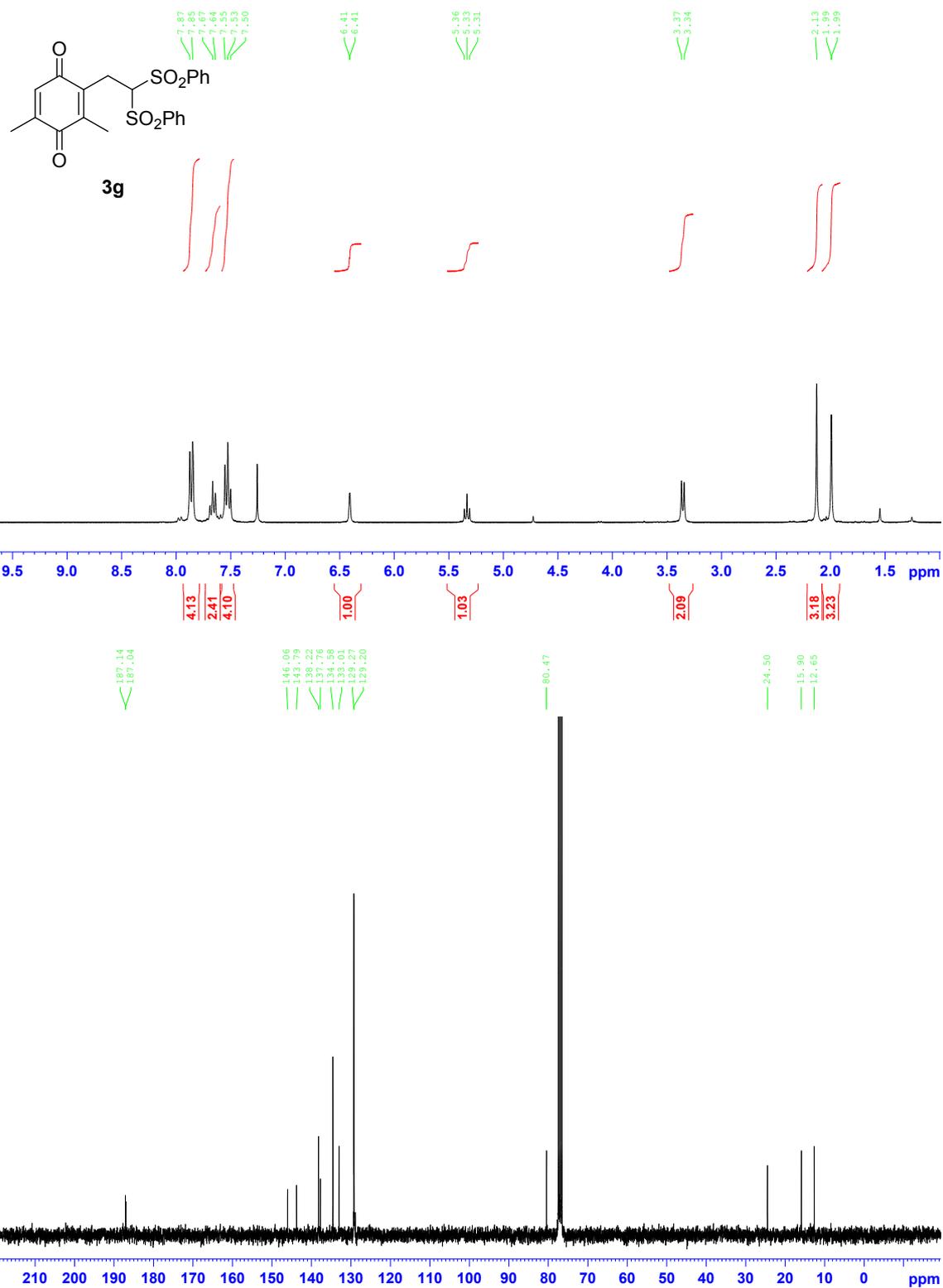


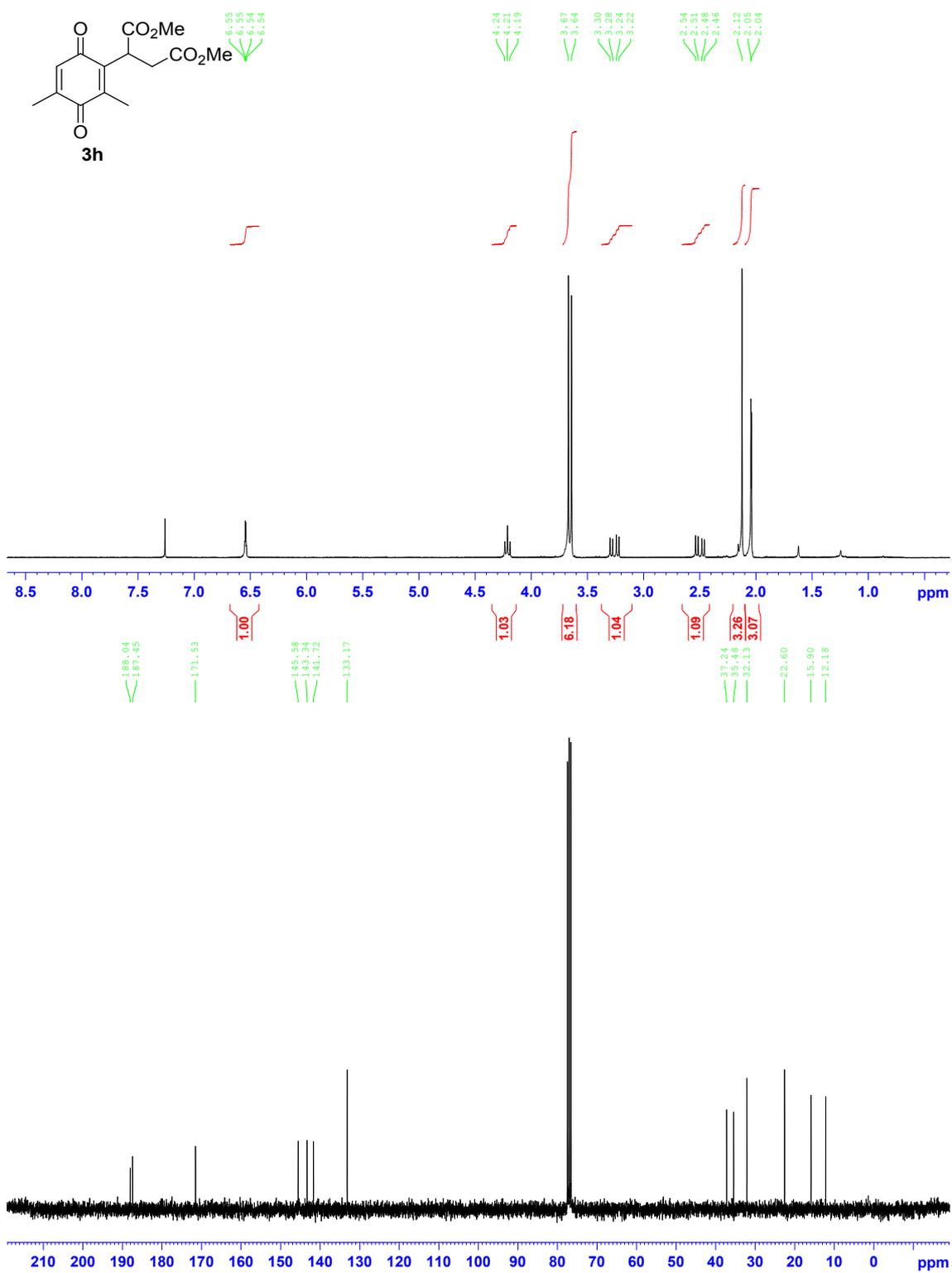


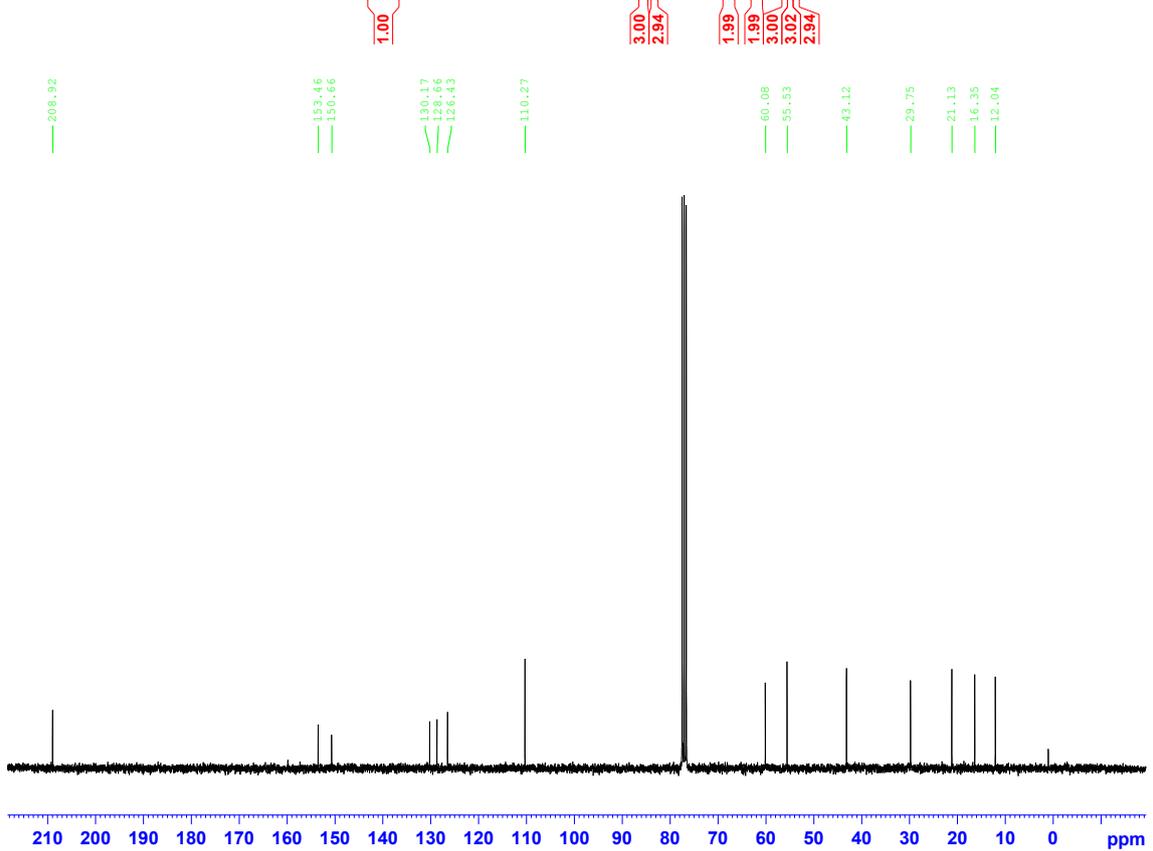
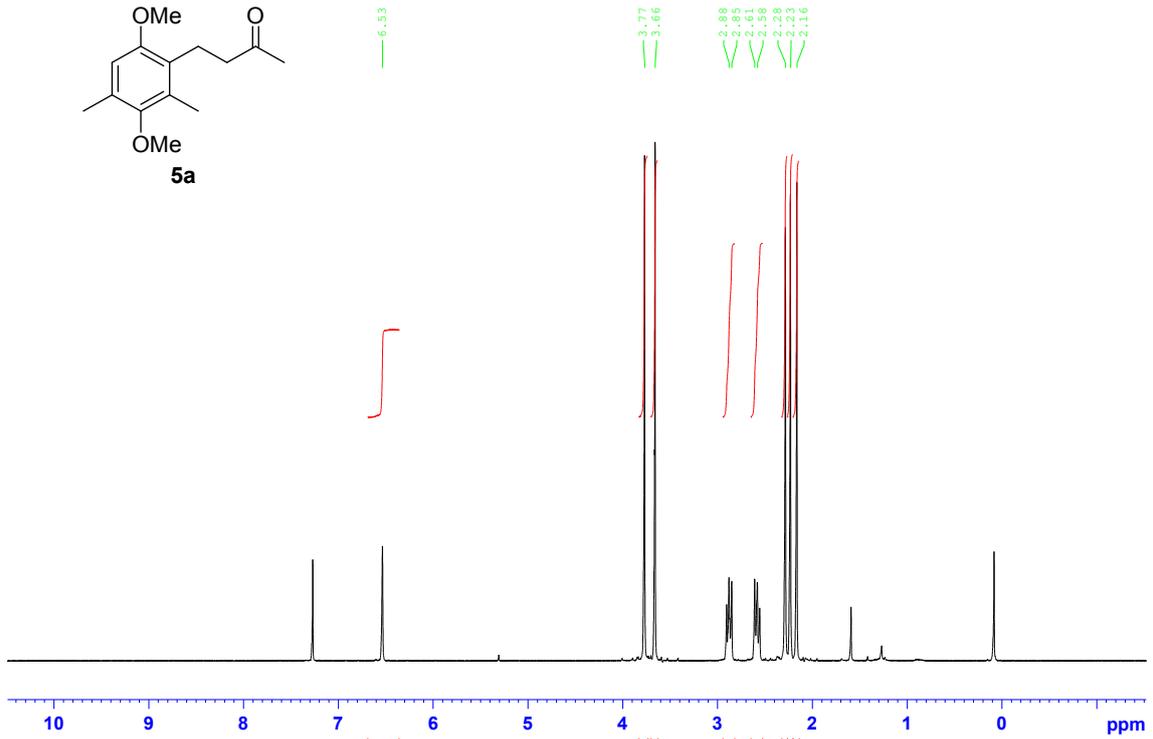
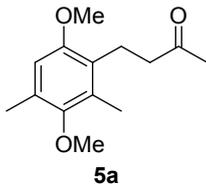


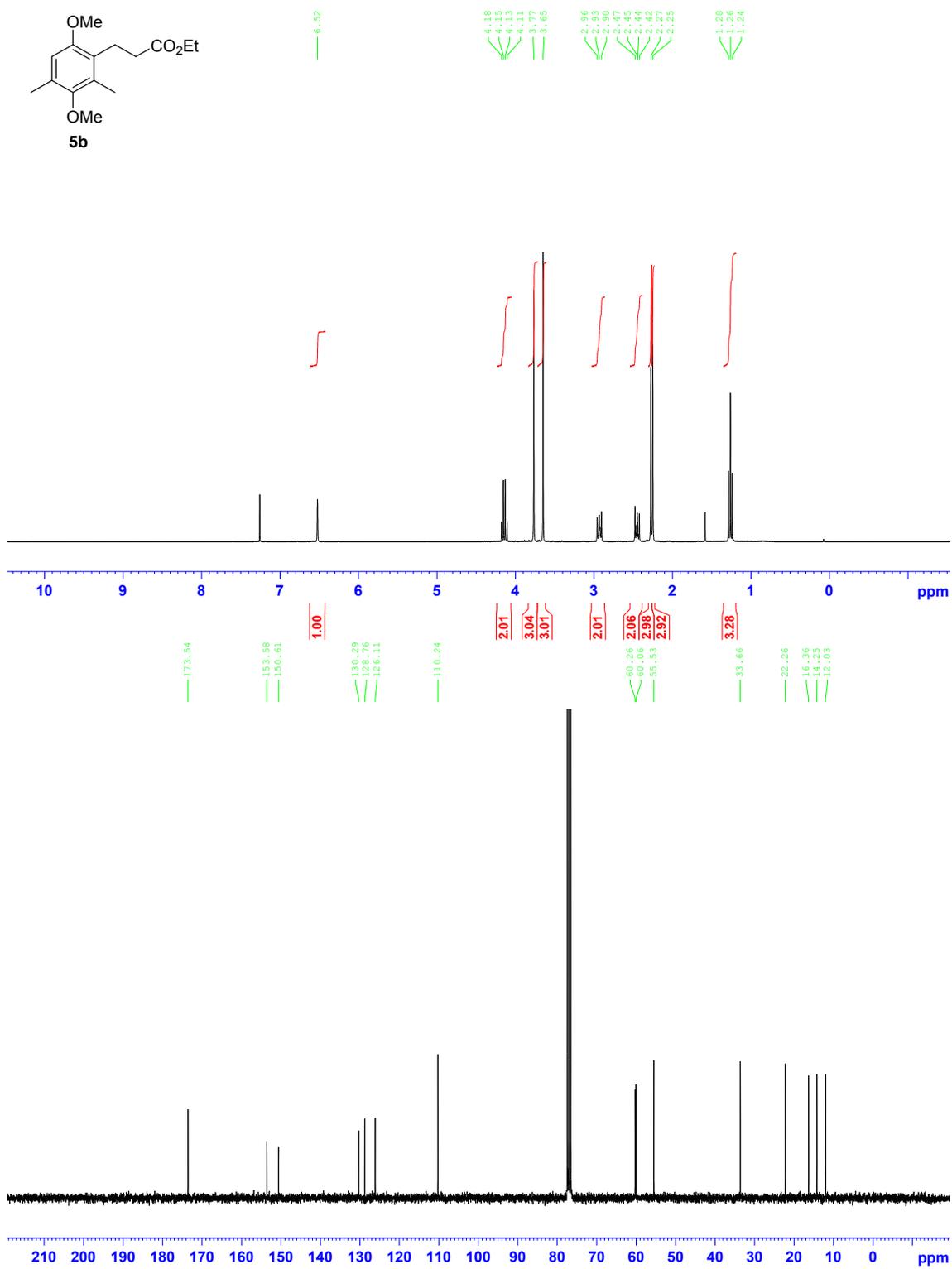
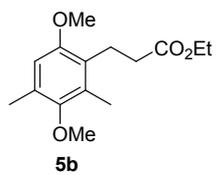


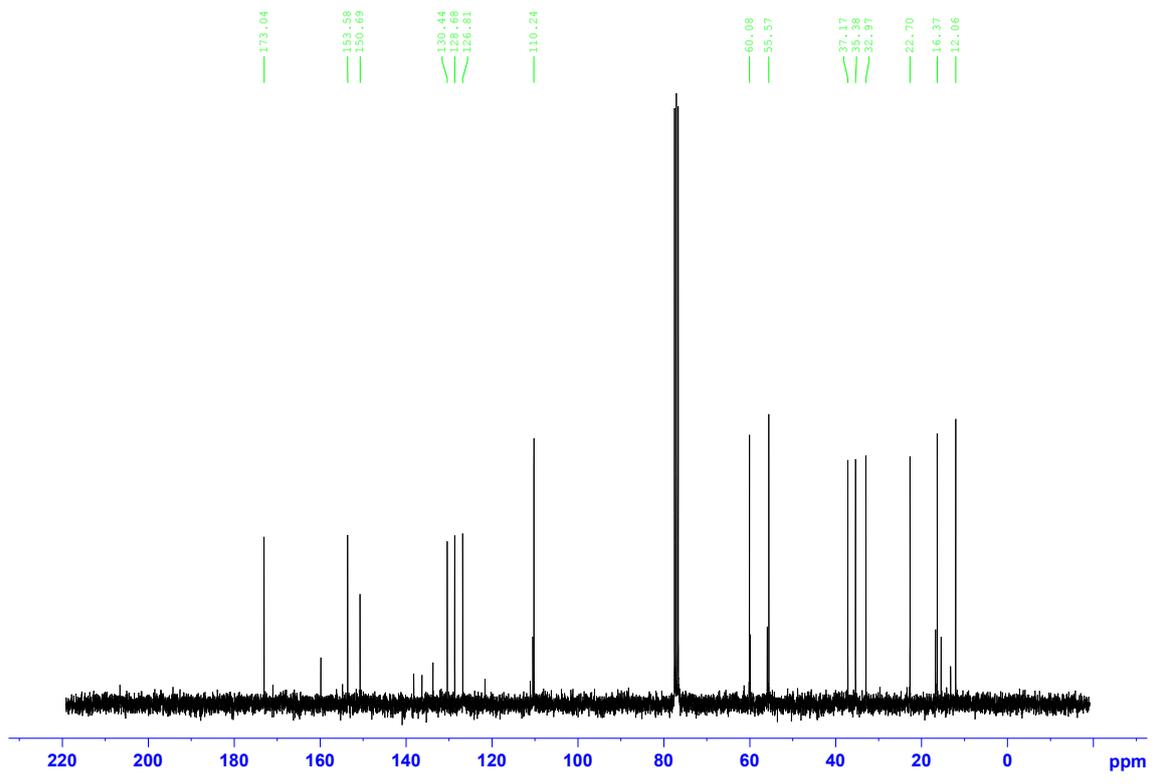
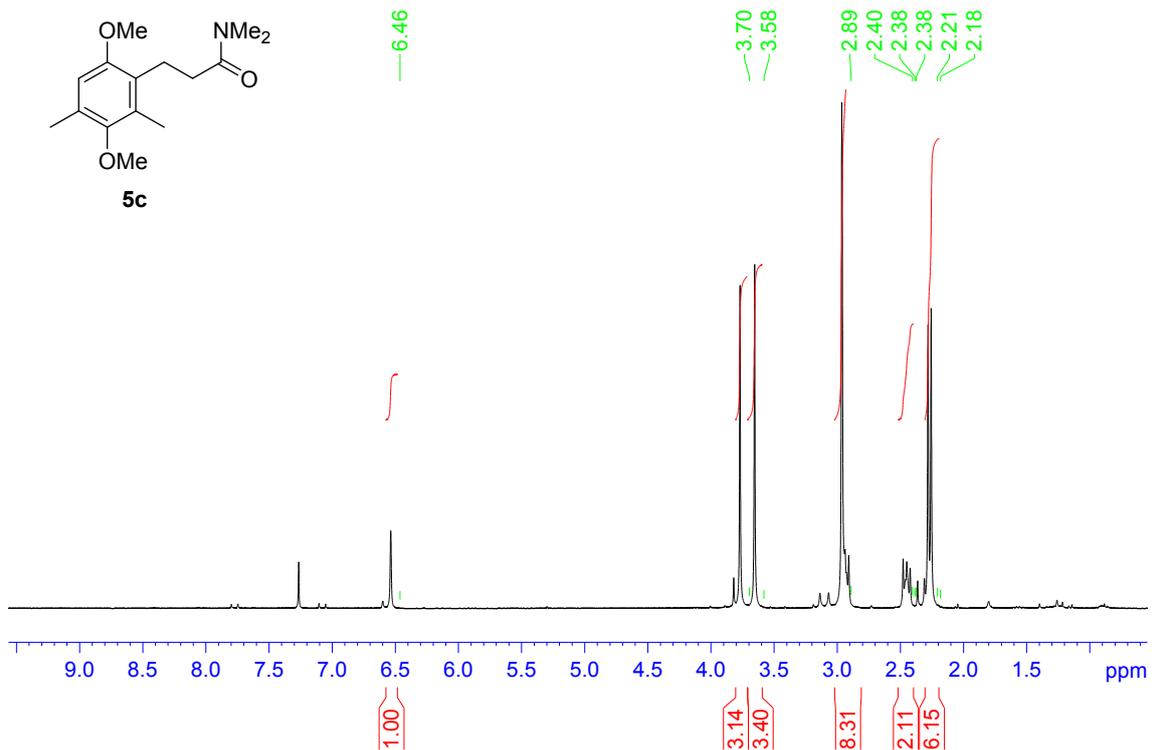
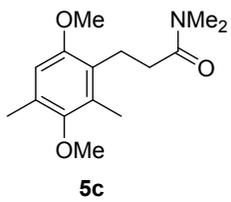


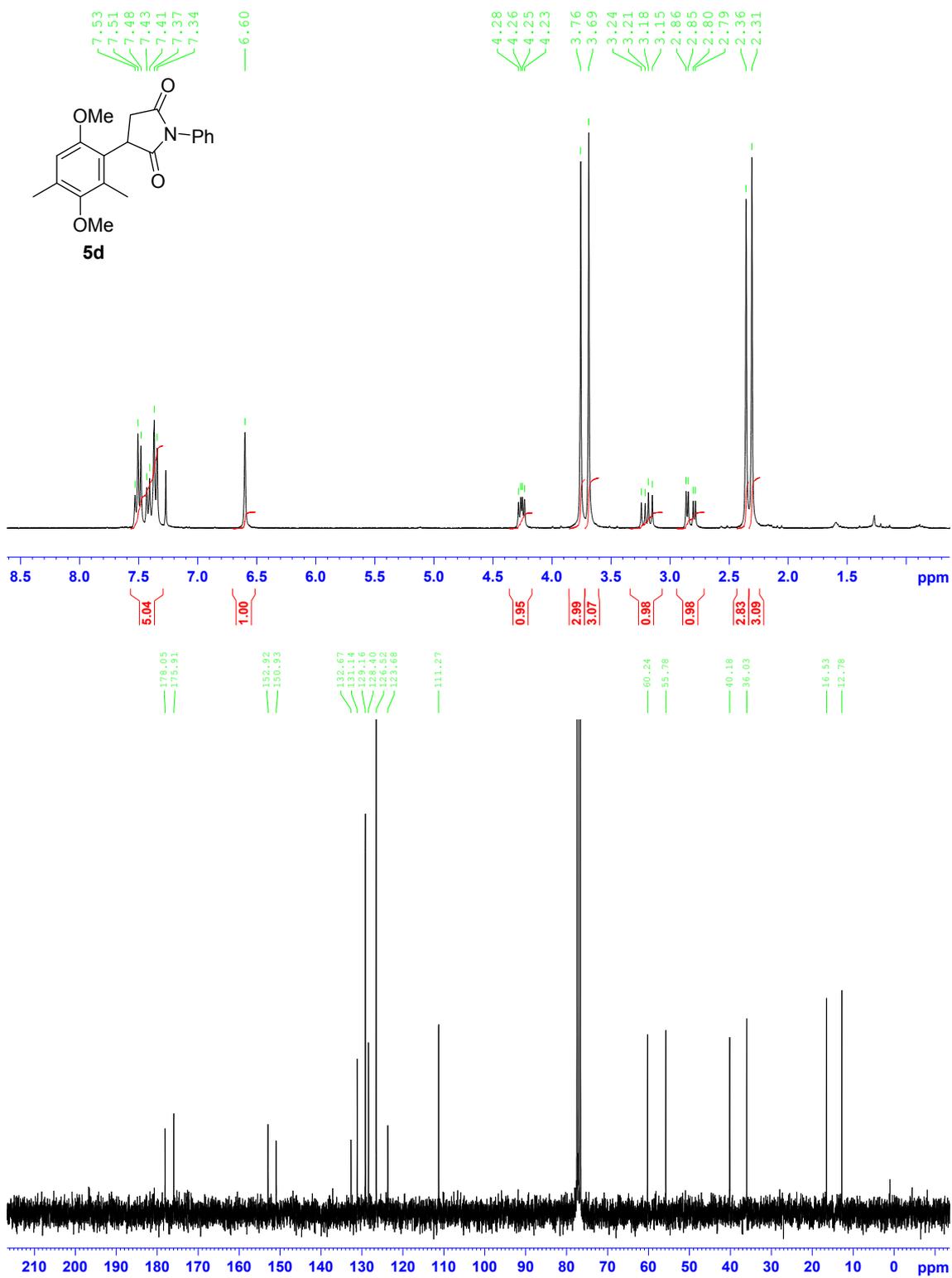


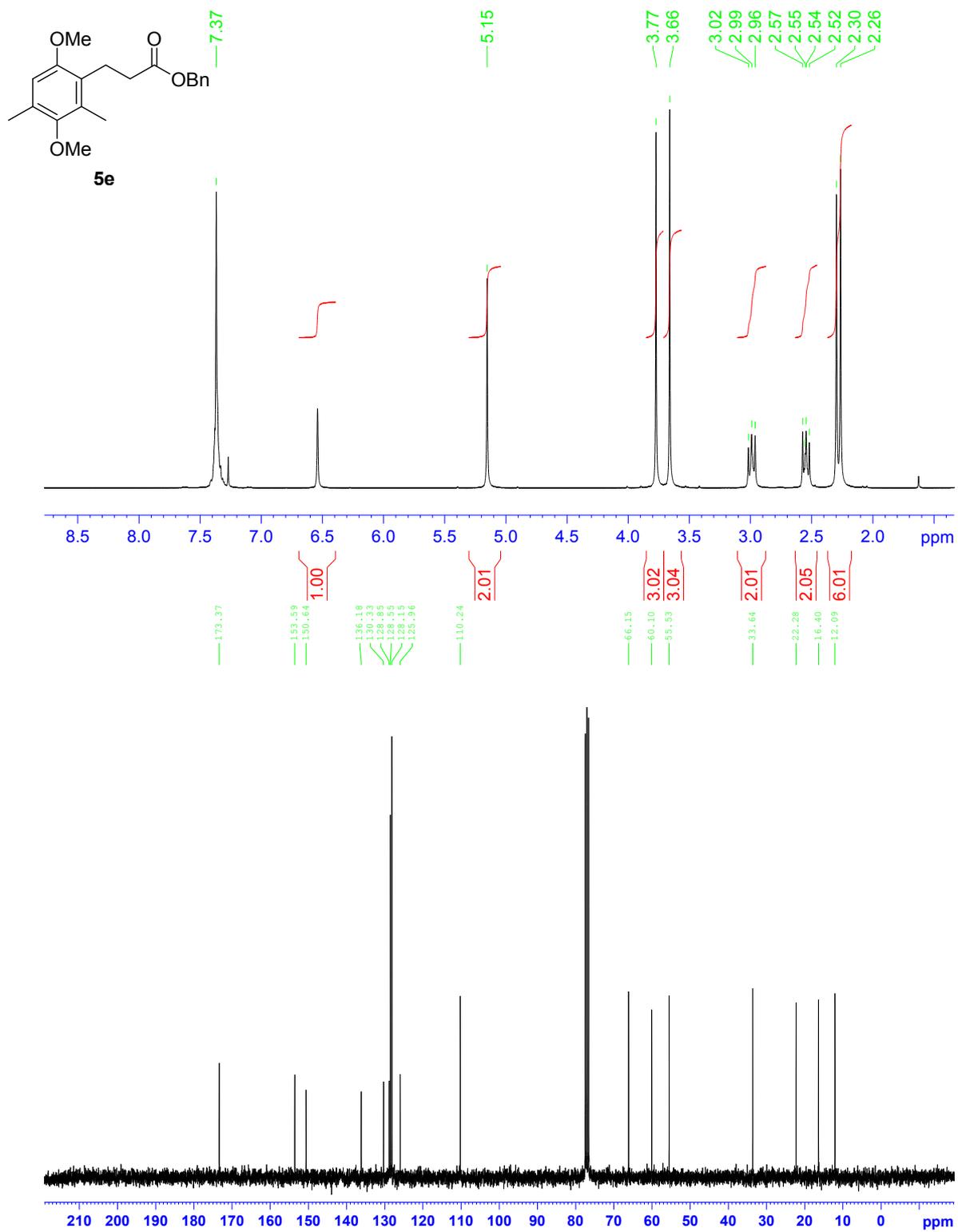


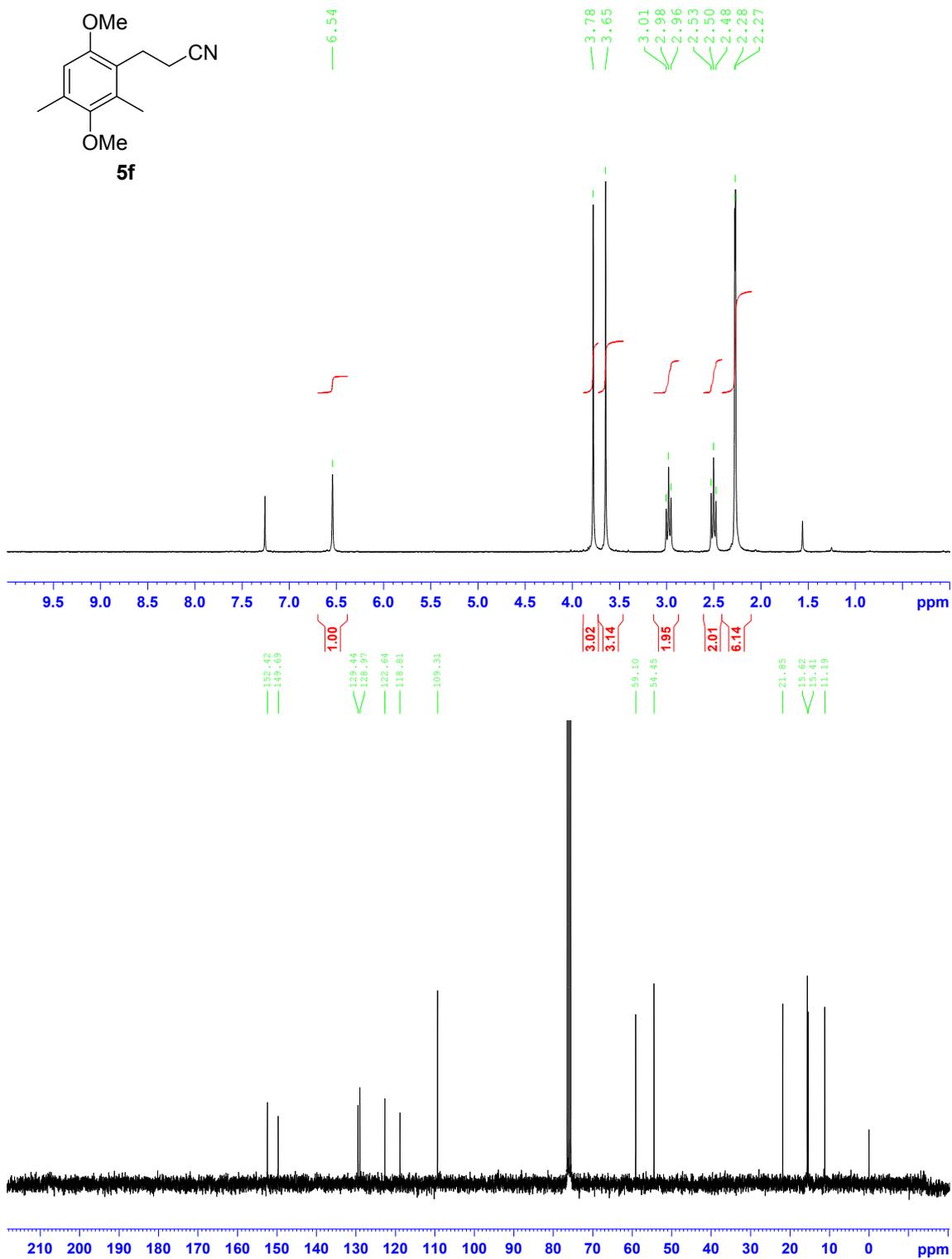
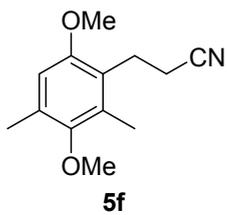


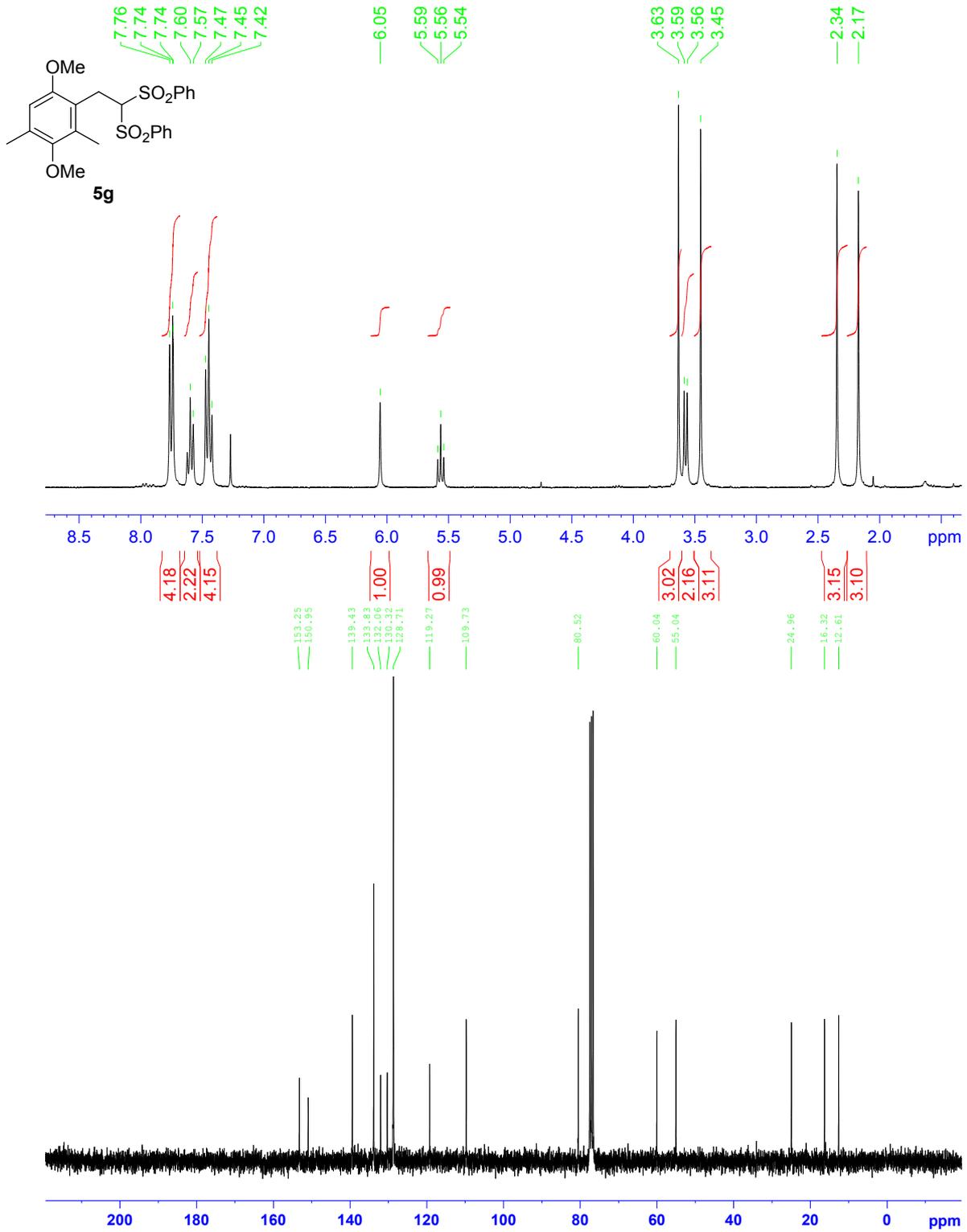


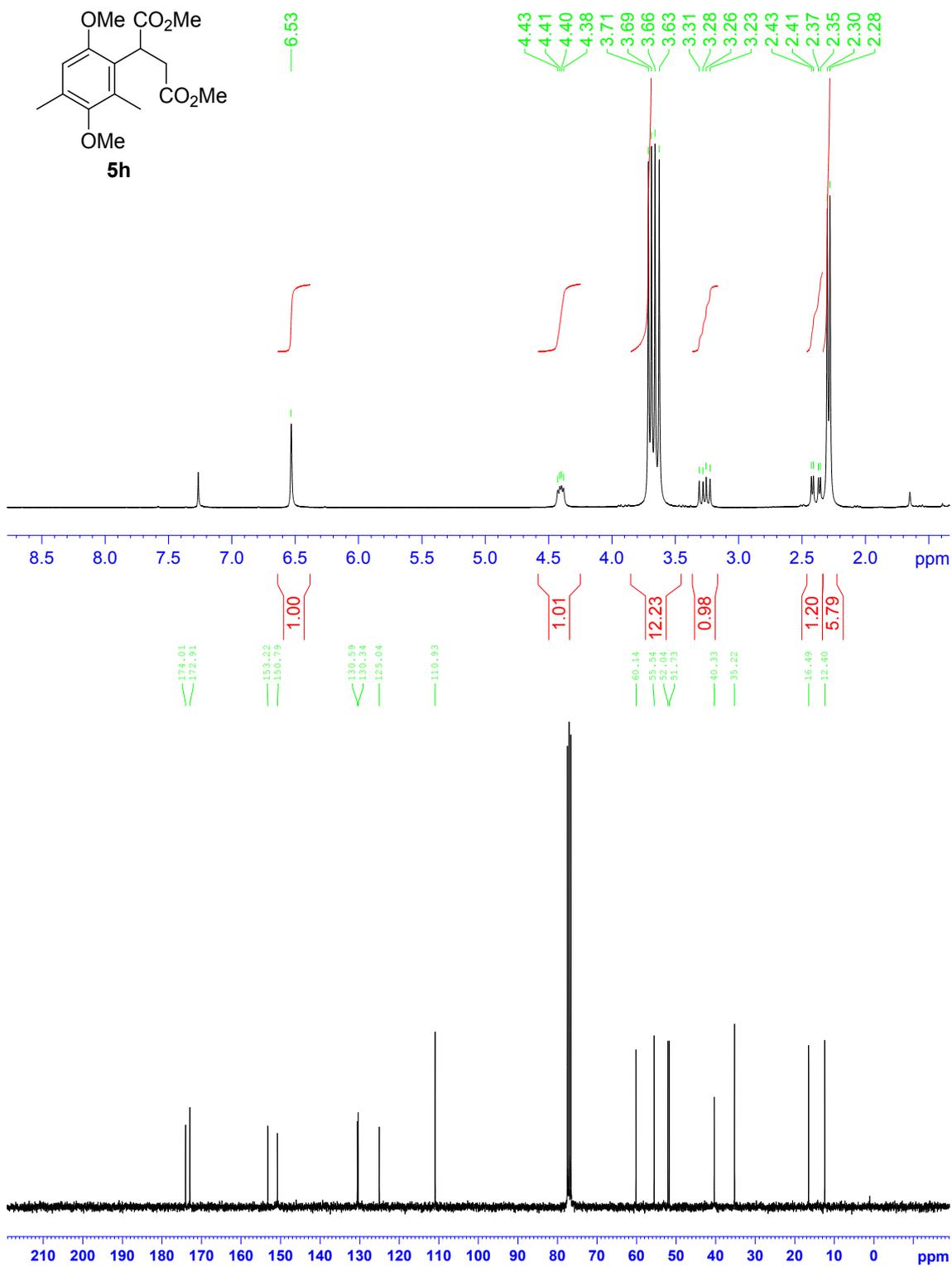


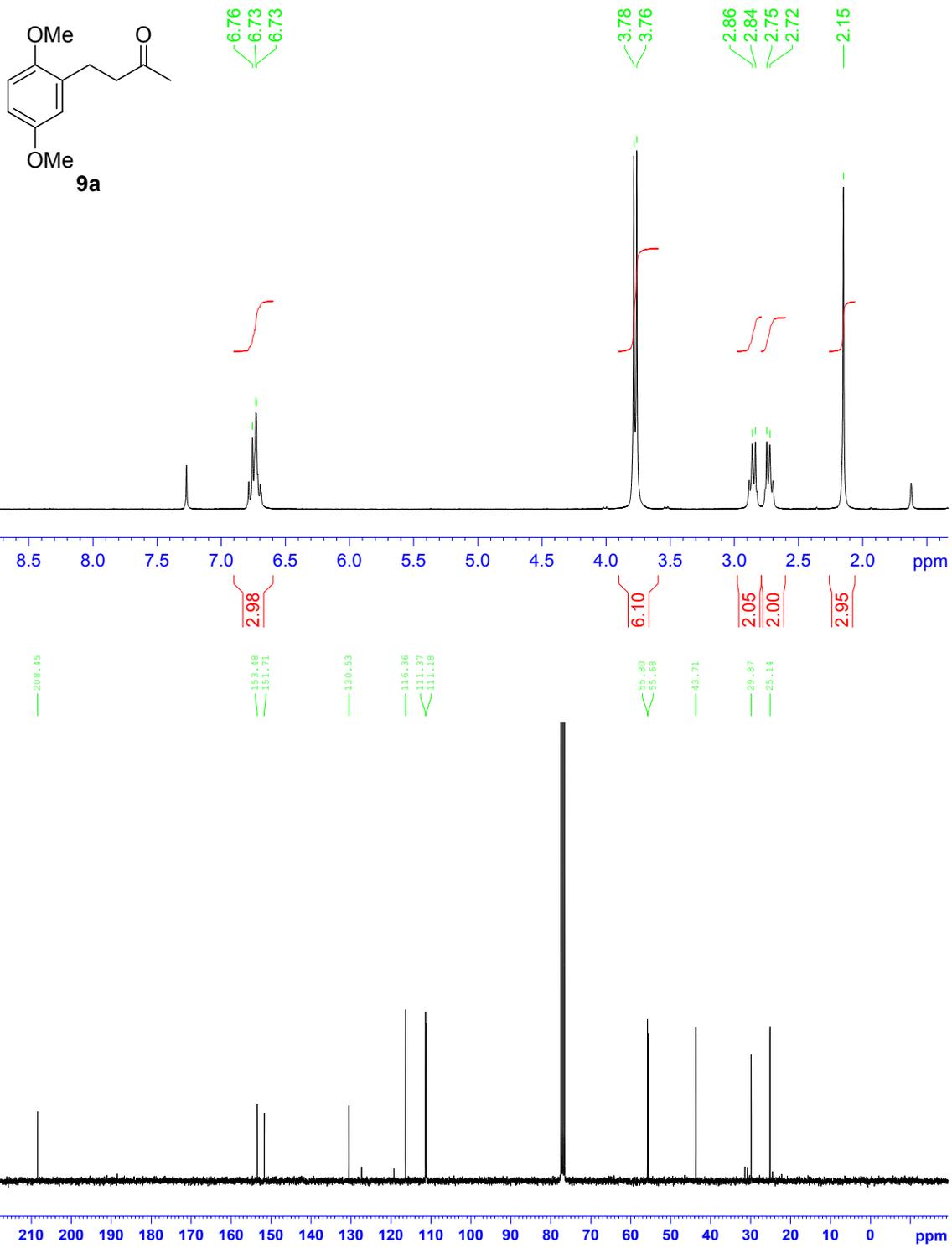


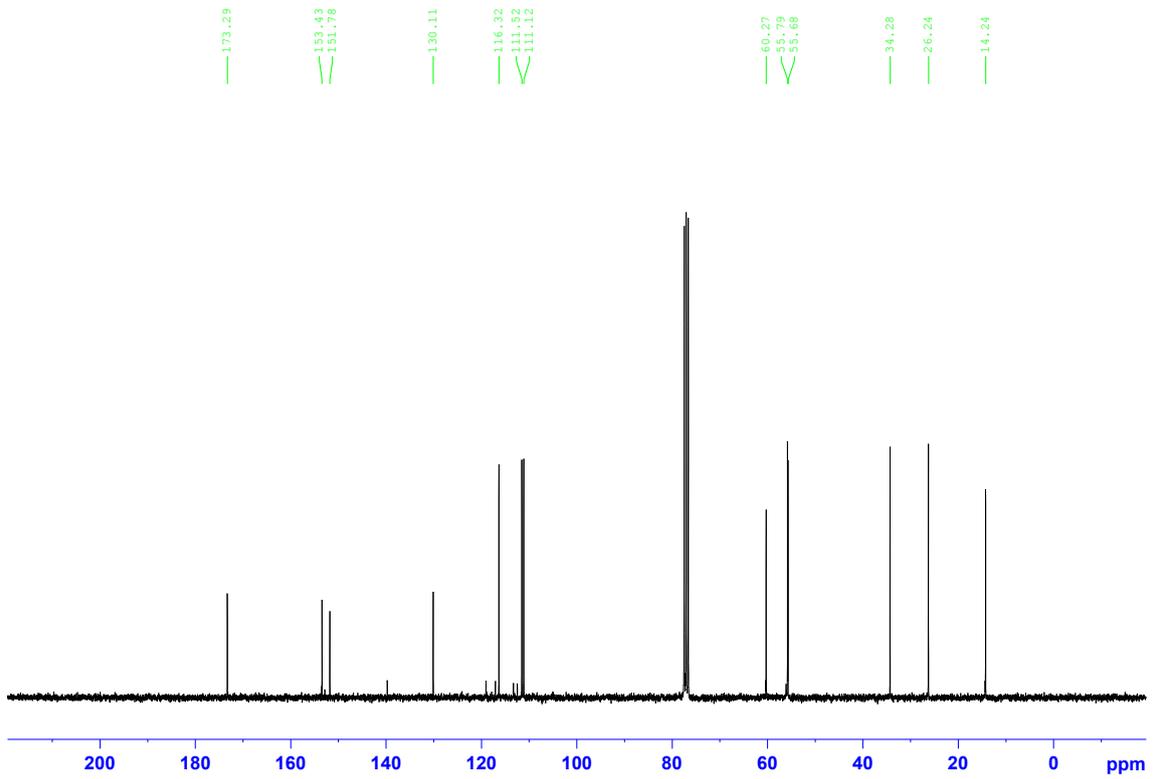
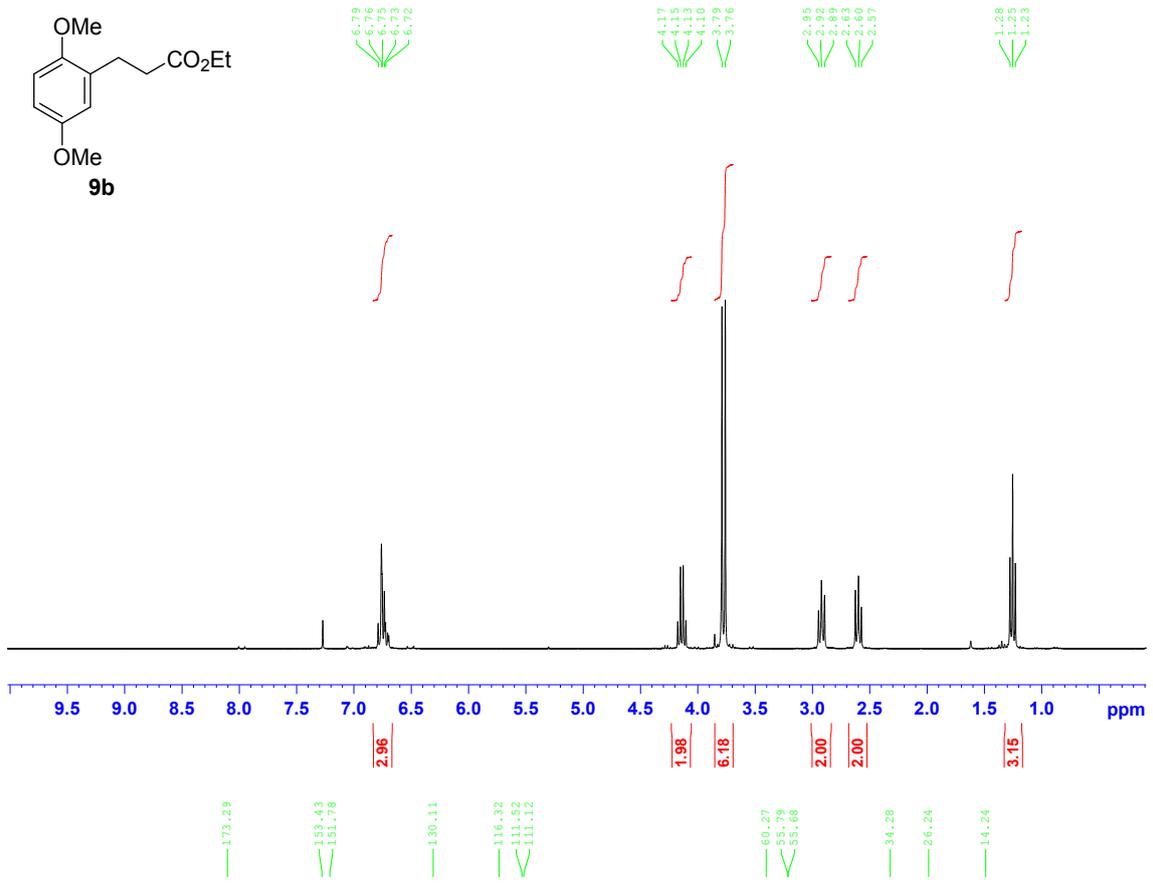
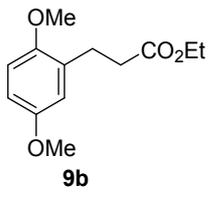


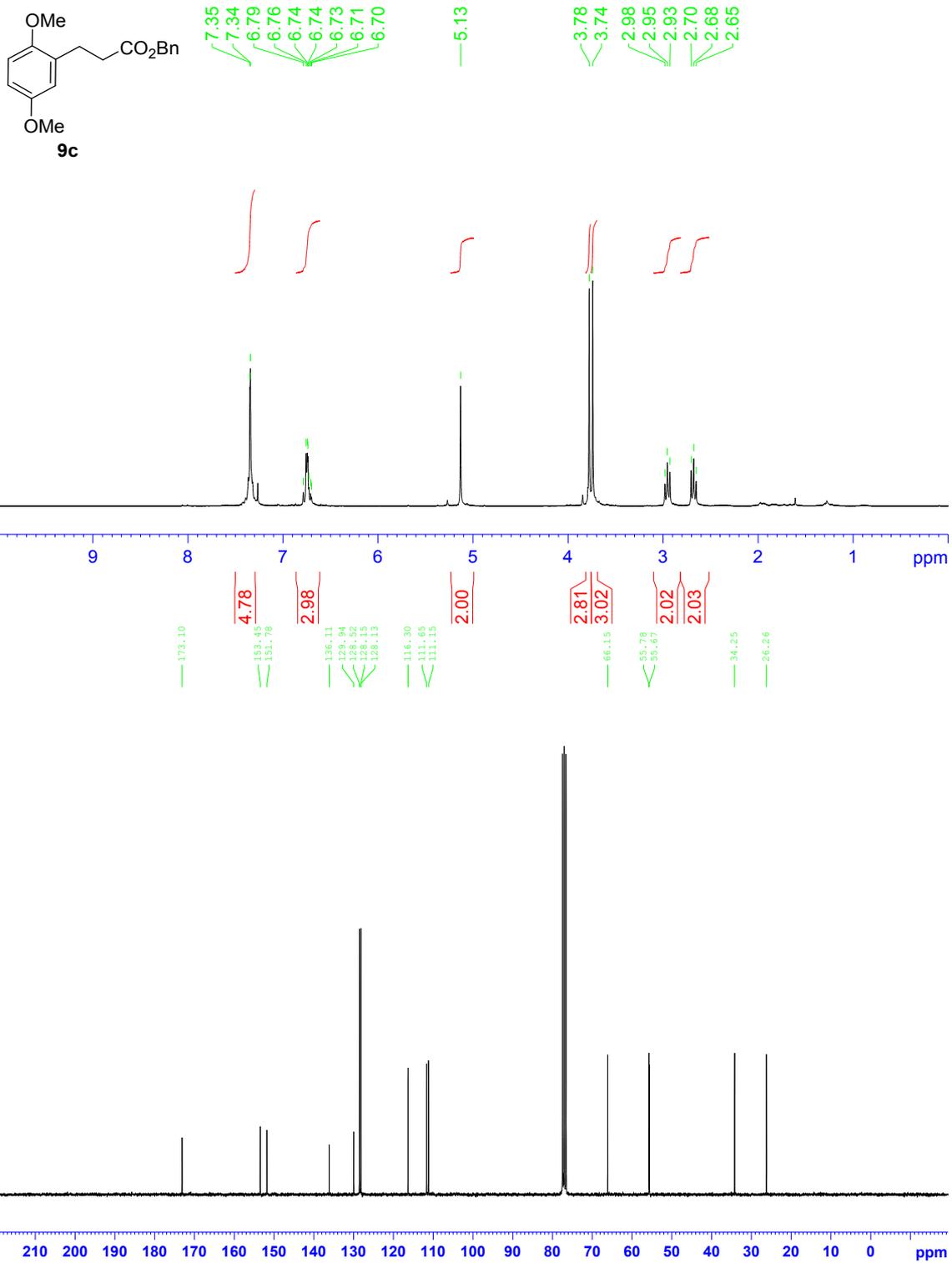


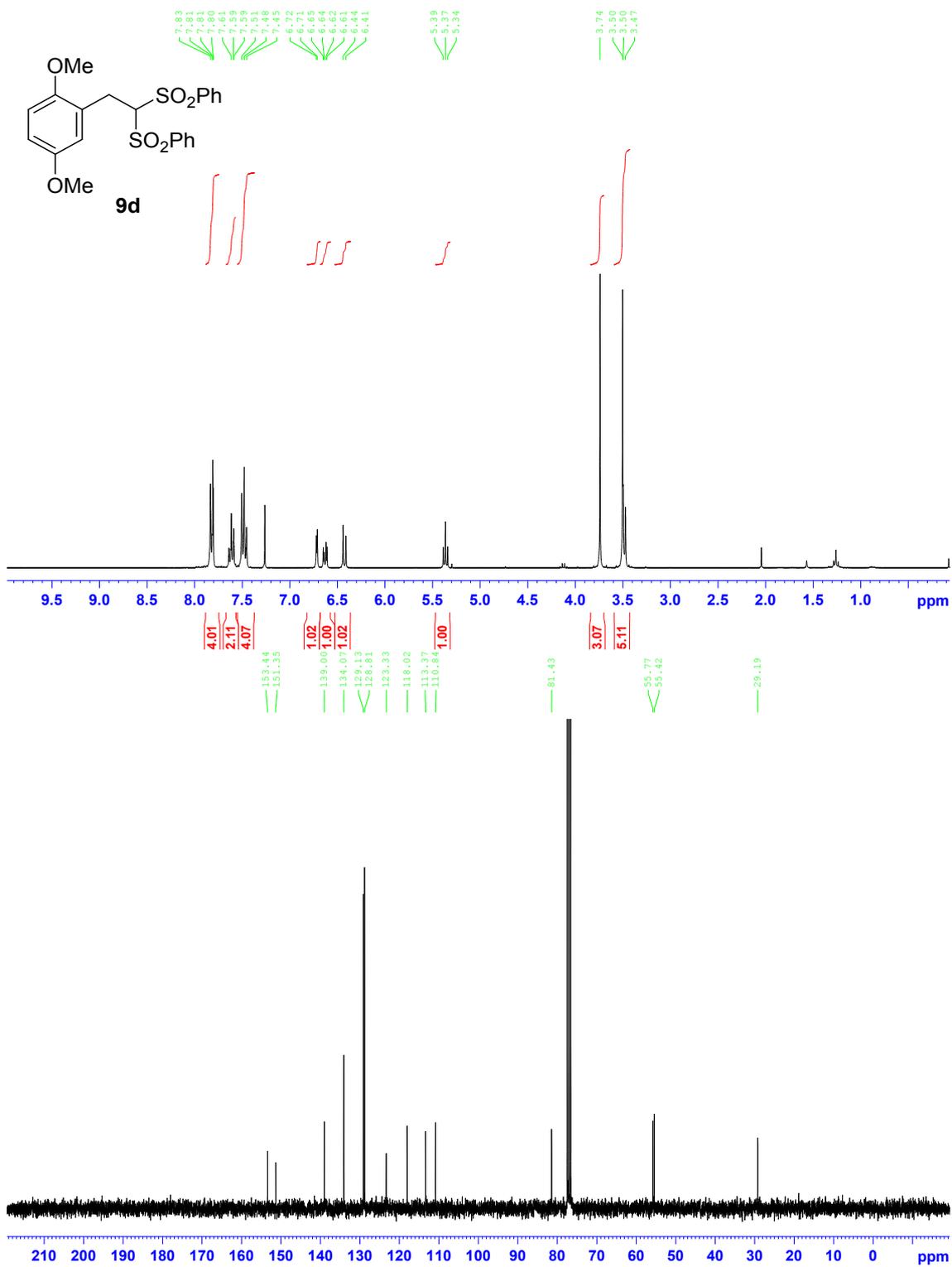


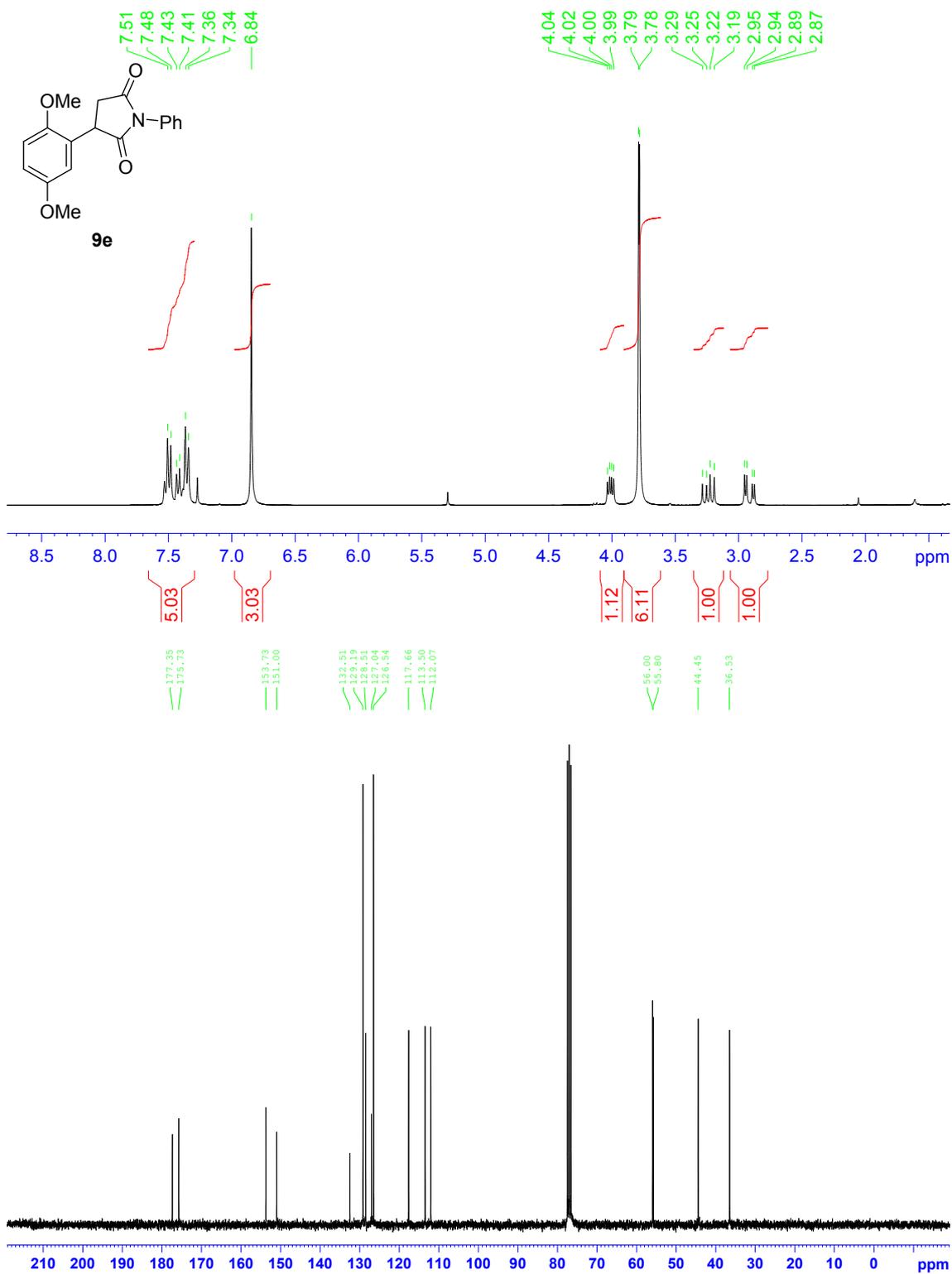


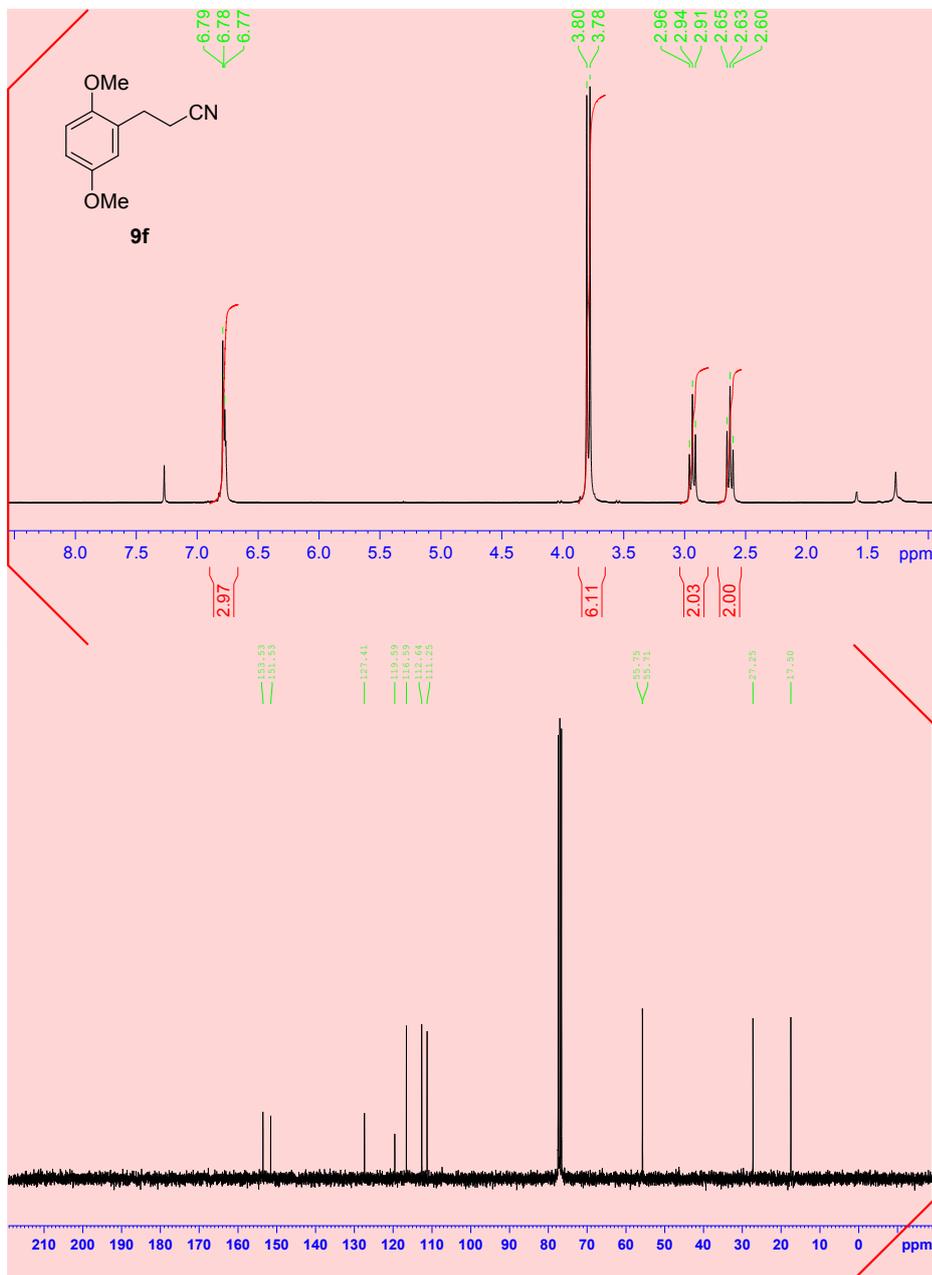












Comment [JRM]: No se comenta en la publi (solo el One-Pot)

