

Supporting Information

Triphenylphosphine Oxide-Catalyzed Stereoselective Poly- and Dibromination of Unsaturated Compounds

Tian-Yang Yu, Yao Wang, Xiu-Qin Hu and Peng-Fei Xu*

State Key Laboratory of Applied Organic Chemistry, College of Chemistry and Chemical

Engineering, Lanzhou University, Lanzhou 730000, P. R. China

Fax: (+86) 931-8915557, E-mail: xupf@lzu.edu.cn

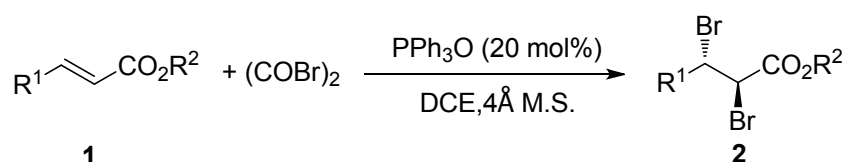
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1. General Information

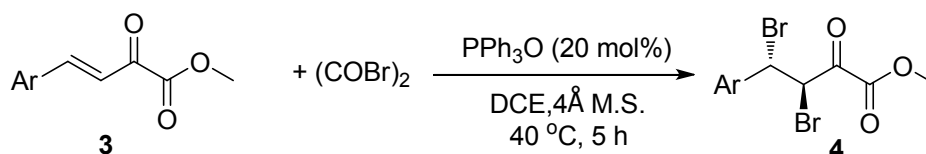
Chemicals and solvents were either purchased from commercial suppliers or purified by standard procedures as specified in *Purification of Laboratory Chemicals*, 4th Ed (Armarego, W. L. F.; Perrin, D. D. Butterworth Heinemann: 1997). Analytical thin-layer chromatography (TLC) was performed on silica gel plates with F-254 indicator and compounds were visualized by irradiation with UV light. Flash column chromatography was carried out using silica gel (200–300 mesh) at increased pressure. ^1H NMR, ^{13}C NMR spectra were recorded on a Bruker AM-400 spectrometer (400 MHz ^1H , 100 MHz ^{13}C). The spectra were recorded in CDCl_3 as the solvent at room temperature. ^1H and ^{13}C chemical shifts are reported in ppm relative to either the residual solvent peak (^{13}C) or TMS (^1H) as an internal standard. IR spectra were recorded using Nicolet NEXUS 670 FT-IR instrument. HRMS were performed on Thermo ORBITRAP ELITE (ESI). GC-MS (EI) was performed on SHIMADZU GCMS-QP2010. The substrates were prepared according to the literature procedures.¹⁻⁵

2. General Procedure for the Preparation of Compounds 2a-2o



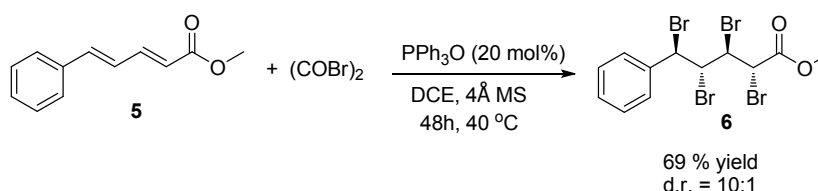
α,β -unsaturated ester **1** (0.10 mmol), Ph_3PO (5.6 mg, 0.02 mmol) and 4Å molecular sieve (40.0 mg) were added to a flame-dried Schlenk tube. The vessel was placed under vacuum and the atmosphere was exchanged with argon three times before adding dry DCE (0.5 ml). Then oxalyl bromide (29 μL , 0.3 mmol) was added to the stirred reaction mixture. The reaction mixture was stirred at a proper temperature for 24h or 36h. After the reaction was complete, the reaction mixture was purified by flash column chromatography using petroleum ether/EtOAc (70:1) to obtain the desired product **2**.

3. General Procedure for the Preparation of Compounds 4a-4g

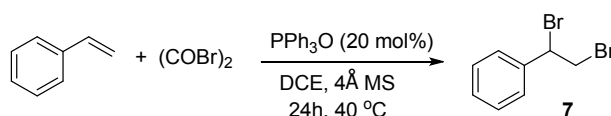


β,γ -unsaturated α -ketoester **3** (0.10 mmol), Ph₃PO (5.6 mg, 0.02 mmol) and 4Å molecular sieve (40.0 mg) were added to a flame-dried Schlenk tube. The vessel was placed under vacuum and the atmosphere was exchanged with argon three times before adding dry DCE (0.5 ml). Then oxalyl bromide (29 μ L, 0.3 mmol) was added to the stirred reaction mixture. The reaction mixture was stirred at 40 °C for 5h. After the reaction was complete, the reaction mixture was purified by flash column chromatography using petroleum ether/EtOAc (30:1) to obtain the desired product **4**.

4. Preparation of Compounds 6-7

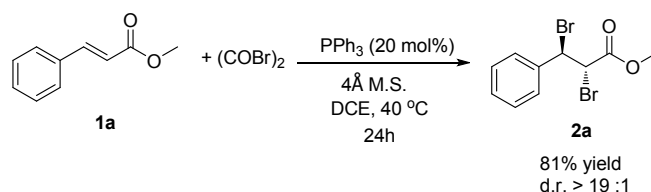


5 (18.8 mg, 0.10 mmol), Ph₃PO (5.6 mg, 0.02 mmol) and 4Å molecular sieve (40.0 mg) were added to a flame-dried Schlenk tube. The vessel was placed under vacuum and the atmosphere was exchanged with argon three times before adding dry DCE (0.5 ml). Then oxalyl bromide (29 μ L, 0.3 mmol) was added to the stirred reaction mixture. The reaction mixture was stirred at 40 °C for 48h. After the reaction was complete, the reaction mixture was purified by flash column chromatography using petroleum ether/EtOAc (30:1) to obtain the desired product **6**, the yield was 69% and d.r. = 10:1.



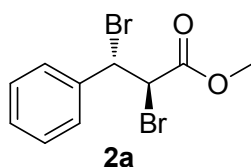
Styrene (11.5 μ L, 0.10 mmol), Ph₃PO (5.6 mg, 0.02 mmol) and 4Å molecular sieve (40.0 mg) were added to a flame-dried Schlenk tube. The vessel was placed under vacuum and the atmosphere was exchanged with argon three times before adding dry DCE (0.5 ml). Then oxalyl bromide (29 μ L, 0.3 mmol) was added to the stirred reaction mixture. The reaction mixture was stirred at 40 °C for 24h. The reaction mixture was purified by flash column chromatography using petroleum ether to obtain the desired product **7**, the yield was 49%.

5. Control experiment



1a (16.2 mg, 0.10 mmol), Ph_3P (5.2 mg, 0.02 mmol) and 4Å molecular sieve (40.0 mg) were added to a flame-dried Schlenk tube. The vessel was placed under vacuum and the atmosphere was exchanged with argon three times before adding dry DCE (0.5 ml). Then oxalyl bromide (29 μL , 0.3 mmol) was added to the stirred reaction mixture. The reaction mixture was stirred at 40 $^\circ\text{C}$ for 24h. The reaction mixture was purified by flash column chromatography using petroleum ether/EtOAc (30:1) to obtain the desired product **2a**, the yield was 81% and d.r. >19:1.

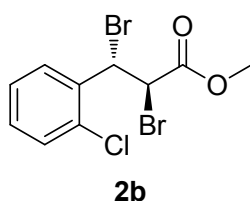
6. Analytical data



(trans)-methyl 2,3-dibromo-3-phenylpropanoate (2a): a white solid

(29.0 mg, 90%, d.r. >19 :1), m.p. 108-109 $^\circ\text{C}$; ^1H NMR(400 MHz, CDCl_3): δ 3.90 (s, 3H), 4.85 (d, J = 11.6 Hz, 1H), 5.34 (d, J = 11.6 Hz, 1H), 7.36-7.42 (m, 5H); ^{13}C NMR (100 MHz, CDCl_3): δ 168.4, 137.5,

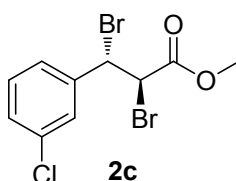
129.4, 128.9, 128.0, 53.4, 50.6, 46.7; IR (KBr): 3456, 3064, 3009, 2950, 2847, 1961, 1737, 1497, 1454, 1434, 1380, 1273, 1219, 1149, 981, 699, 587 cm^{-1} ; HRMS (ESI $^+$) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{10}\text{H}_{10}\text{Br}_2\text{NaO}_2$) requires m/z 342.8940, found m/z 342.8944.



(trans)-methyl 2,3-dibromo-3-(2-chlorophenyl)propanoate (2b): a

white solid (32.4mg, 91%, d.r. > 19:1), m.p. 80-81 $^\circ\text{C}$; ^1H NMR(400 MHz, CDCl_3): δ 3.91 (s, 3H), 4.93 (s, 1H), 5.92 (s, 1H), 7.26-7.48 (m, 4H); ^{13}C NMR (100 MHz, CDCl_3): δ 168.0, 135.1, 134.0, 130.3, 130.2,

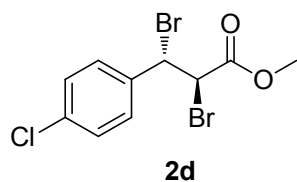
128.8, 127.6, 53.5, 45.4; IR (KBr): 3448, 3026, 3006, 2325, 1737, 1591, 1480, 1433, 1288, 1276, 1230, 1036, 1013, 764, 735, 604, 487 cm^{-1} ; HRMS (ESI $^+$) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{10}\text{H}_9\text{Br}_2\text{ClNaO}_2$) requires m/z 376.8550, found m/z 376.8557.



(trans)-methyl 2,3-dibromo-3-(3-chlorophenyl)propanoate (2c): a

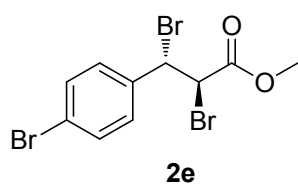
white solid (34.2 mg, 96%, d.r. > 19:1), m.p. 61-62 $^\circ\text{C}$; ^1H NMR(400 MHz, CDCl_3): δ 3.90 (s, 3H), 4.78 (d, J = 12.0 Hz, 1H), 5.28 (d, J = 12.0 Hz, 1H), 7.27-7.35 (m, 3H), 7.40 (s, 1H); ^{13}C NMR (100 MHz,

CDCl₃): δ 168.1, 139.5, 134.7, 130.1, 129.6, 128.2, 126.3, 53.5, 49.2, 46.3; IR (KBr): 3463, 3101, 3021, 2064, 1743, 1595, 1574, 1480, 1435, 1370, 1303, 1268, 1214, 1155, 1141, 1079, 978, 921, 891, 795, 700, 684, 608, 576, 482 cm⁻¹; HRMS (ESI⁺) exact mass calculated for [M+Na]⁺ (C₁₀H₉Br₂ClNaO₂) requires m/z 376.8550, found m/z 376.8556.



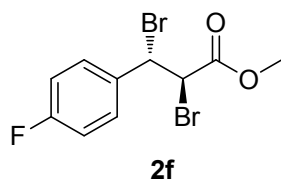
(trans)-methyl 2,3-dibromo-3-(4-chlorophenyl)propanoate (2d):

a white solid (32.8 mg, 92%, d.r. > 19:1), m.p. 96-97 °C; ¹H NMR(400 MHz, CDCl₃): δ 3.90 (s, 1H), 4.79 (d, J = 12.0 Hz, 1H), 5.31 (d, J = 11.6 Hz, 1H), 7.34 (d, J = 8.4 Hz, 2H), 7.37 (d, J = 8.8 Hz, 2H); ¹³C NMR (100 MHz, CDCl₃): δ 168.1, 136.1, 135.2, 129.4, 129.2, 53.5, 49.5, 46.4; IR (KBr): 3454, 3089, 3049, 3009, 2359, 1920, 1745, 1593, 1494, 1439, 1414, 1279, 1231, 1152, 1012, 838, 726, 713, 590, 511 cm⁻¹; HRMS (ESI⁺) exact mass calculated for [M+Na]⁺ (C₁₀H₉Br₂ClNaO₂) requires m/z 376.8550, found m/z 376.8557.



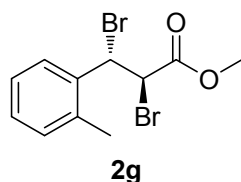
(trans)-methyl 2,3-dibromo-3-(4-bromophenyl)propanoate (2e) :

a white solid (37.0 mg, 92%, d.r. > 19:1), m.p. 105-106 °C; ¹H NMR(400 MHz, CDCl₃): δ 3.90 (s, 3H), 4.78 (d, J = 11.6 Hz, 1H), 5.30 (d, J = 11.6 Hz, 1H), 7.28 (d, J = 8.8 Hz, 2H), 7.53 (d, J = 8.4 Hz, 2H); ¹³C NMR (100 MHz, CDCl₃): δ 168.1, 136.6, 132.1, 129.6, 123.4, 53.5, 49.5, 46.3; IR (KBr): 3452, 3008, 2591, 1744, 1590, 1491, 1438, 1277, 1231, 1152, 1072, 1010, 835, 587, 509 cm⁻¹; HRMS (ESI⁺) exact mass calculated for [M+Na]⁺ (C₁₀H₉Br₃NaO₂) requires m/z 420.8045, found m/z 420.8054.



(trans)-methyl 2,3-dibromo-3-(4-fluorophenyl)propanoate (2f):

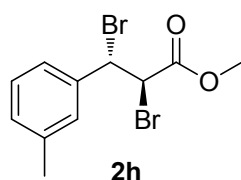
a white solid (31.0 mg, 91%, d.r. > 19 :1), m.p. 61-63 °C; ¹H NMR(400 MHz, CDCl₃): δ 3.90 (s, 3H), 4.80 (d, J = 12 Hz, 1H), 5.34 (d, J = 11.6 Hz, 1H), 7.09 (t, J = 8.4 Hz, 2H), 7.39 (dd, J = 5.4 Hz, 8.0 Hz, 2H); ¹³C NMR (100 MHz, CDCl₃): δ 168.2, 162.9 (d, J = 249.0 Hz), 133.5 (d, J = 3.0 Hz), 129.9 (d, J = 8.0 Hz), 116.0 (d, J = 22.0 Hz), 53.5, 49.7, 46.8; IR (KBr): 3451, 3014, 2958, 2452, 1739, 1602, 1511, 1436, 1276, 1229, 1157, 1011, 861, 841, 591, 510 cm⁻¹; HRMS (ESI⁺) exact mass calculated for [M+Na]⁺ (C₁₀H₉Br₂FNaO₂) requires m/z 360.8846, found m/z 360.8852.



(trans)-methyl 2,3-dibromo-3-(o-tolyl)propanoate (2g):

a white solid (30.9 mg, 92%, d.r. > 19 :1), m.p. 81-82 °C; ¹H NMR(400 MHz, CDCl₃):

δ 2.45 (s, 3H), 3.91 (s, 3H), 4.93 (d, J = 11.6 Hz, 1H), 5.65 (d, J = 12.0 Hz, 1H), 7.18-7.29 (m, 3H), 7.40-7.41 (m, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ 168.5, 136.5, 135.6, 130.8, 129.2, 126.9, 126.7, 53.5, 46.2, 19.4; IR (KBr): 3454, 3022, 2848, 2349, 1735, 1464, 1436, 1382, 1313, 1274, 1210, 1145, 982, 918, 771, 729, 600, 498 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{11}\text{H}_{12}\text{Br}_2\text{NaO}_2$) requires m/z 356.9096, found m/z 356.9099.

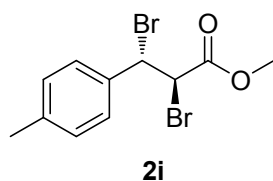


(trans)-methyl 2,3-dibromo-3-(m-tolyl)propanoate (2h): a white solid

(28.0 mg, 83%, d.r. > 19:1), m.p. 68-69 °C; ^1H NMR(400 MHz, CDCl_3):

δ 2.38 (s, 3H), 3.90 (s, 3H), 4.85 (d, J = 12.0 Hz, 1H), 5.31 (d, J = 11.6 Hz, 1H), 7.16-7.30 (m, 4H); ^{13}C NMR (100 MHz, CDCl_3): δ 168.4,

138.7, 137.4, 130.2, 128.8, 128.6, 125.1, 53.4, 50.8, 46.6, 21.4; IR (KBr): 3463, 3018, 2948, 1739, 1605, 1436, 1373, 1306, 1248, 1198, 1148, 978, 799, 701, 615, 579, 483 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{11}\text{H}_{12}\text{Br}_2\text{NaO}_2$) requires m/z 356.9096, found m/z 356.9098.

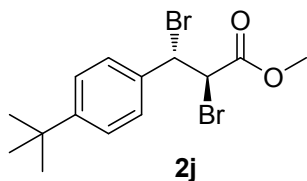


(trans)-methyl 2,3-dibromo-3-(p-tolyl)propanoate (2i): a white

solid (32.0 mg, 95%, d.r. > 19:1), m.p. 96-98 °C; ^1H NMR(400 MHz,

CDCl_3): δ 2.36 (s, 3H), 3.90 (s, 3H), 4.85 (d, J = 12.0 Hz, 1H), 5.34 (d, J = 12.0 Hz, 1H), 7.20 (d, J = 8.0 Hz, 2H), 7.29 (d, J = 8.0 Hz,

2H); ^{13}C NMR (100 MHz, CDCl_3): δ 168.4, 139.5, 134.6, 129.6, 127.9, 53.4, 50.8, 46.8, 21.3; IR (KBr): 3469, 3007, 2919, 2308, 1746, 1610, 1514, 1434, 1374, 1322, 1266, 1187, 1141, 1009, 979, 700, 512 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{11}\text{H}_{12}\text{Br}_2\text{NaO}_2$) requires m/z 356.9096, found m/z 356.9100.

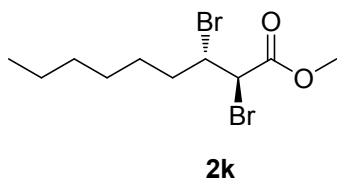


(trans)-methyl 2,3-dibromo-3-(4-(tert-butyl)phenyl)propanoate

(2j): a white solid (35.9mg, 95%, d.r. > 19:1), m.p. 105-106 °C; ^1H

NMR(400 MHz, CDCl_3): δ 1.32 (s, 9H), 3.89 (s, 3H), 4.86 (d, J = 12.0 Hz, 1H), 5.35 (d, J = 12.0 Hz, 1H), 7.32 (d, J = 8.8 Hz, 2H),

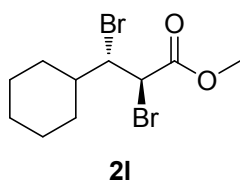
7.40 (d, J = 8.4 Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ 168.4, 152.6, 134.4, 127.7, 125.8, 53.4, 50.8, 46.7, 34.7, 31.2; IR (KBr): 3468, 3001, 2954, 2867, 1917, 1747, 1609, 1436, 1365, 1275, 1145, 1020, 834, 654, 589 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{14}\text{H}_{18}\text{Br}_2\text{NaO}_2$) requires m/z 398.9566, found m/z 398.9574.



(trans)-methyl 2,3-dibromononanoate (2k) : a colorless oil

(30.2 mg, 91%, d.r. > 19:1); ^1H NMR (400 MHz, CDCl_3): δ 0.9 (t,

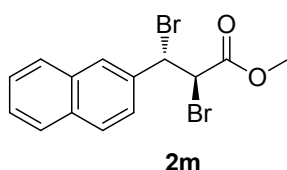
$J = 6.4$ Hz, 3H), 1.32-1.60 (m, 8H), 1.77-1.86 (m, 1H), 2.20-2.28 (m, 1H), 3.83 (s, 3H), 4.35-4.43 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ 168.4, 53.2, 52.8, 47.7, 35.0, 31.5, 28.4, 26.2, 22.5, 14.0; IR (KBr): 3381, 3052, 2956, 2923, 2857, 2309, 1750, 1458, 1438, 1266, 1150, 1022, 740, 565 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{10}\text{H}_{18}\text{Br}_2\text{NaO}_2$) requires m/z 350.9566, found m/z 350.9574.



(trans)-methyl 2,3-dibromo-3-cyclohexylpropanoate (2l): a colorless

oil (31.0 mg, 95%, d.r. = 11:1); ^1H NMR(400 MHz, CDCl_3): δ 1.10-1.60 (m, 7H), 1.70 (d, $J = 12.8$ Hz, 1H), 1.79-1.82 (m, 2H), 1.95-2.02 (m, 1H), 3.83 (s, 3H), 4.39 (dd, $J = 2.0$ Hz, 11.6 Hz, 1H), 4.50 (d, $J = 12.0$ Hz, 1H);

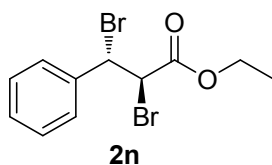
^{13}C NMR (100 MHz, CDCl_3): δ 168.7, 59.9, 53.2, 45.4, 39.0, 32.1, 25.9, 25.9, 25.5, 25.4; IR (KBr): 3482, 3007, 2929, 2855, 1752, 1449, 1437, 1369, 1301, 1276, 1214, 1158, 1018, 988, 569 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{10}\text{H}_{16}\text{Br}_2\text{NaO}_2$) requires m/z 348.9409, found m/z 348.9420.



(trans)-methyl 2,3-dibromo-3-(naphthalen-2-yl)propanoate (2m):

a white solid (36.5 mg, 98%, d.r. > 19 : 1), m.p. 92-93 $^{\circ}\text{C}$; ^1H NMR(400 MHz, CDCl_3): δ 3.92 (s, 3H), 4.98 (d, $J = 11.6$ Hz, 1H), 5.54 (d, $J = 11.6$ Hz, 1H), 7.48-7.54 (m, 3H), 7.83-7.90 (m, 4H); ^{13}C

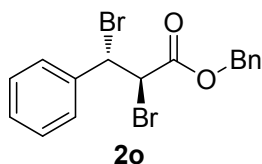
NMR (100 MHz, CDCl_3): δ 168.4, 134.5, 133.5, 132.8, 129.2, 128.2, 128.0, 127.8, 127.1, 126.8, 124.3, 53.5, 51.2, 46.5; IR (KBr): 3467, 3050, 3003, 2849, 1747, 1599, 1437, 1377, 1280, 1267, 1197, 1145, 1024, 747, 575, 476 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{14}\text{H}_{12}\text{Br}_2\text{NaO}_2$) requires m/z 392.9096, found m/z 392.9097.



(trans)-ethyl 2,3-dibromo-3-phenylpropanoate (2n): a white solid

(29.5 mg, 88%, d.r. > 19 :1), m.p. 71-72 $^{\circ}\text{C}$; ^1H NMR(400 MHz, CDCl_3): δ 1.38 (t, $J = 7.2$ Hz, 3H), 4.36 (q, $J = 7.2$ Hz, 2H), 4.83 (d, $J =$

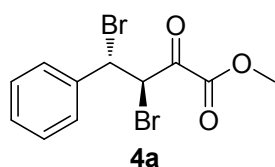
11.6 Hz, 1H), 5.35 (d, $J = 12.0$ Hz, 1H), 7.35-7.41 (m, 5H); ^{13}C NMR (100 MHz, CDCl_3): δ 167.8, 137.6, 129.4, 128.9, 128.0, 62.6, 50.7, 47.0, 13.9; IR (KBr): 3455, 3007, 2988, 2939, 2902, 1974, 1739, 1455, 1394, 1274, 1217, 1149, 1018, 772, 694, 620, 605, 560 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{11}\text{H}_{12}\text{Br}_2\text{NaO}_2$) requires m/z 356.9096, found m/z 356.9104.



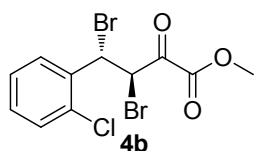
(trans)-benzyl 2,3-dibromo-3-phenylpropanoate (2o): a white solid

(34.7 mg, 87%, d.r. > 19 :1) 95-96 $^{\circ}\text{C}$; ^1H NMR(400 MHz, CDCl_3): δ

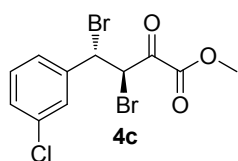
4.89 (d, $J = 12.0$ Hz, 1H), 5.31 (d, $J = 4.0$ Hz, 2H), 5.35 (d, $J = 12.0$ Hz, 1H), 7.36-7.45 (m, 10H); ^{13}C NMR (100 MHz, CDCl_3): δ 167.7, 137.5, 134.7, 129.4, 128.9, 128.6, 128.4, 128.0, 68.2, 50.6, 46.9; IR (KBr): 3469, 3061, 3011, 2348, 1954, 1746, 1584, 1495, 1454, 1438, 1387, 1212, 1143, 981, 732, 694, 732, 694, 609, 592 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{16}\text{H}_{14}\text{Br}_2\text{NaO}_2$) requires m/z 418.9253, found m/z 418.9259.



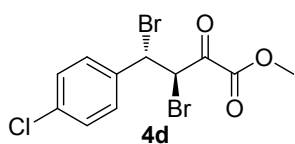
(trans)-methyl 3,4-dibromo-2-oxo-4-phenylbutanoate (4a): a white solid (32.2 mg, 92%, d.r. = 8:1), m.p. 109-110 $^{\circ}\text{C}$; ^1H NMR(400 MHz, CDCl_3): δ 4.00 (s, 3H), 5.48 (d, $J = 12.0$ Hz, 1H), 5.77 (d, $J = 11.6$ Hz, 1H), 7.38-7.48 (m, 5H); ^{13}C NMR (100 MHz, CDCl_3): δ 182.4, 159.4, 137.3, 129.6, 129.0, 128.2, 53.9, 48.1, 47.5; IR (KBr): 3458, 3062, 3015, 2850, 1962, 1733, 1689, 1453, 1438, 1310, 1293, 1239, 1208, 1146, 918, 732, 698, 595, 572, 471 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{11}\text{H}_{10}\text{Br}_2\text{NaO}_3$) requires m/z 370.8889, found m/z 370.8895.



(trans)-methyl 3,4-dibromo-4-(2-chlorophenyl)-2-oxobutanoate (4b): a white solid (31.1 mg, 81%, d.r. = 7:1), m.p. 70-71 $^{\circ}\text{C}$; ^1H NMR(400 MHz, CDCl_3): δ 4.01 (s, 3H), 5.88 (s, 1H), 6.06 (s, 1H), 7.30-7.44 (m, 3H), 7.57-7.59 (m, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ 182.0, 159.5, 134.9, 134.0, 130.5, 130.2, 129.3, 127.7, 53.9, 46.1, 43.2; IR (KBr): 3449, 3005, 2991, 1727, 1695, 1479, 1441, 1321, 1286, 1239, 1207, 1139, 1086, 1063, 1037, 763, 731, 678, 589, 450 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{11}\text{H}_9\text{Br}_2\text{ClNaO}_3$) requires m/z 404.8499, found m/z 404.8503.

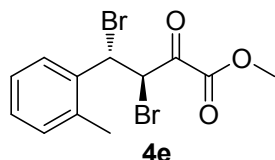


(trans)-methyl 3,4-dibromo-4-(3-chlorophenyl)-2-oxobutanoate (4c) : a white solid (36.2 mg, 94%, d.r. = 11:1), m.p. 95-96 $^{\circ}\text{C}$; ^1H NMR(400 MHz, CDCl_3): δ 4.00 (s, 3H), 5.42 (d, $J = 12.0$ Hz, 1H), 5.71 (d, $J = 11.6$ Hz, 1H), 7.34-7.37 (m, 3H), 7.46 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ 182.1, 159.3, 139.3, 134.8, 130.2, 129.7, 128.3, 126.4, 53.9, 47.1, 46.7; IR (KBr): 3458, 3029, 3007, 2949, 1736, 1597, 1572, 1479, 1447, 1435, 1312, 1281, 1245, 1204, 1145, 1043, 847, 798, 699, 686, 583, 447 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{11}\text{H}_9\text{Br}_2\text{ClNaO}_3$) requires m/z 404.8499, found m/z 404.8504.



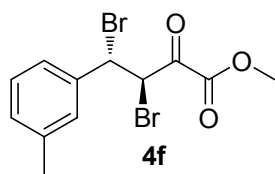
(trans)-methyl 3,4-dibromo-4-(4-chlorophenyl)-2-oxobutanoate (4d): a white solid (36.9 mg, 96%, d.r. = 9:1), m.p. 94-96 $^{\circ}\text{C}$; ^1H NMR(400 MHz, CDCl_3): δ 4.00 (s, 3H), 5.45 (d, $J = 11.6$ Hz, 1H),

5.72 (d, $J = 12.0$ Hz, 1H), 7.38-7.43 (m, 4H); ^{13}C NMR (100 MHz, CDCl_3): δ 182.1, 159.3, 135.9, 135.4, 129.5, 129.2, 53.9, 47.1, 47.0; IR (KBr): 3458, 2997, 2953, 1732, 1686, 1592, 1492, 1439, 1413, 1375, 1318, 1300, 1279, 1242, 1205, 1092, 1041, 832, 746, 563 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{11}\text{H}_9\text{Br}_2\text{ClNaO}_3$) requires m/z 404.8499, found m/z 404.8503.



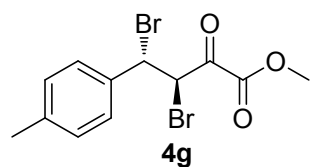
(trans)-methyl 3,4-dibromo-2-oxo-4-(o-tolyl)butanoate (4e): a white solid (30.0 mg, 82%, d.r.= 7:1), m.p. 61-62 °C; ^1H NMR(400 MHz, CDCl_3): δ 2.46 (s, 3H), 4.00 (s, 3H), 5.81 (d, $J = 11.6$ Hz, 1H), 5.86 (d, $J = 11.6$ Hz, 1H), 7.19-7.33 (m, 3H), 7.52-7.53 (m, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ 182.4,

159.5, 136.5, 135.4, 130.9, 129.3, 127.2, 127.0, 53.9, 46.9, 43.8, 19.4; IR (KBr): 3452, 3015, 3000, 2952, 1734, 1604, 1493, 1463, 1449, 1434, 1322, 1288, 1239, 1191, 1163, 1145, 1079, 1042, 789, 770, 725, 599 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{12}\text{H}_{12}\text{Br}_2\text{NaO}_3$) requires m/z 384.9045, found m/z 384.9053.



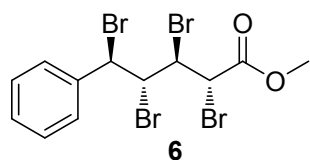
(trans)-methyl 3,4-dibromo-2-oxo-4-(m-tolyl)butanoate (4f): a white solid (33.3 mg, 92%, d.r. = 12:1), m.p. 106-108 °C; ^1H NMR(400 MHz, CDCl_3): δ 2.39 (s, 3H), 4.00 (s, 3H), 5.45 (d, $J = 11.6$ Hz, 1H), 5.77 (d, $J = 12.0$ Hz, 1H), 7.19 (d, $J = 7.2$ Hz, 1H), 7.25-7.32 (m, 3H); ^{13}C

NMR (100 MHz, CDCl_3): δ 182.4, 159.4, 138.8, 137.1, 130.4, 128.8, 128.7, 125.2, 53.9, 48.2, 47.4, 21.4; IR (KBr): 3453, 3017, 3000, 2952, 2923, 1734, 1691, 1602, 1590, 1487, 1435, 1287, 1231, 1055, 800, 704, 590 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{12}\text{H}_{12}\text{Br}_2\text{NaO}_3$) requires m/z 384.9045, found m/z 384.9052.



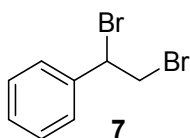
(trans)-methyl 3,4-dibromo-2-oxo-4-(p-tolyl)butanoate (4g): a white solid (33.9 mg, 93%, d.r. = 9:1), m.p. 81-82 °C; ^1H NMR(400 MHz, CDCl_3): δ 2.38 (s, 3H), 4.00 (s, 3H), 5.48 (d, $J = 11.6$ Hz, 1H), 5.77 (d, $J = 11.6$ Hz, 1H), 7.22 (d, $J = 8.0$ Hz, 2H), 7.36 (d, $J = 8.0$ Hz, 2H); ^{13}C NMR (100

MHz, CDCl_3): δ 182.4, 159.4, 139.7, 134.4, 129.7, 128.0, 53.8, 48.3, 47.5, 21.3; IR (KBr): 3445, 3015, 2955, 2927, 1915, 1727, 1685, 1610, 1513, 1450, 1306, 1288, 1241, 1213, 1187, 1036, 820, 718, 601, 501 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{12}\text{H}_{12}\text{Br}_2\text{NaO}_3$) requires m/z 384.9045, found m/z 384.9052.



(anti)-methyl 2,3,4,5-tetrabromo-5-phenylpentanoate (6), white solid (35.0 mg, 69%, d.r. = 10 :1), m.p. 145-146 °C; ^1H NMR(400 MHz, CDCl_3): δ 2.38 (s, 3H), 4.00 (s, 3H), 5.48 (d, $J = 11.6$ Hz, 1H), 5.77 (d, $J = 11.6$ Hz, 1H), 7.22 (d, $J = 8.0$ Hz, 2H), 7.36 (d, $J = 8.0$ Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ 182.4, 159.4, 139.7, 134.4, 129.7, 128.0, 53.8, 48.3, 47.5, 21.3; IR (KBr): 3445, 3015, 2955, 2927, 1915, 1727, 1685, 1610, 1513, 1450, 1306, 1288, 1241, 1213, 1187, 1036, 820, 718, 601, 501 cm^{-1} ; HRMS (ESI+) exact mass calculated for $[\text{M}+\text{Na}]^+$ ($\text{C}_{12}\text{H}_{12}\text{Br}_2\text{NaO}_3$) requires m/z 384.9045, found m/z 384.9052.

MHz, CDCl₃): δ 3.89 (s, 3H), 4.72 (d, J = 10.8 Hz, 1H), 5.06 (d, J = 10.8 Hz, 1H), 5.23 (d, J = 11.2 Hz, 1H), 5.31 (d, J = 11.2 Hz, 1H), 7.38-7.41 (m, 5H); ¹³C NMR (100 MHz, CDCl₃): δ 167.7, 139.0, 129.3, 128.9, 128.1, 57.0, 55.0, 54.7, 53.6, 47.2; IR (KBr): 3470, 3001, 2952, 2290, 2126, 1957, 1878, 1749, 1435, 1269, 1144, 1023, 691, 603, 509 cm⁻¹; HRMS (ESI+) exact mass calculated for [M+Na]⁺ (C₁₂H₁₂Br₄NaO₂) requires m/z 526.7463, found m/z 526.7463.

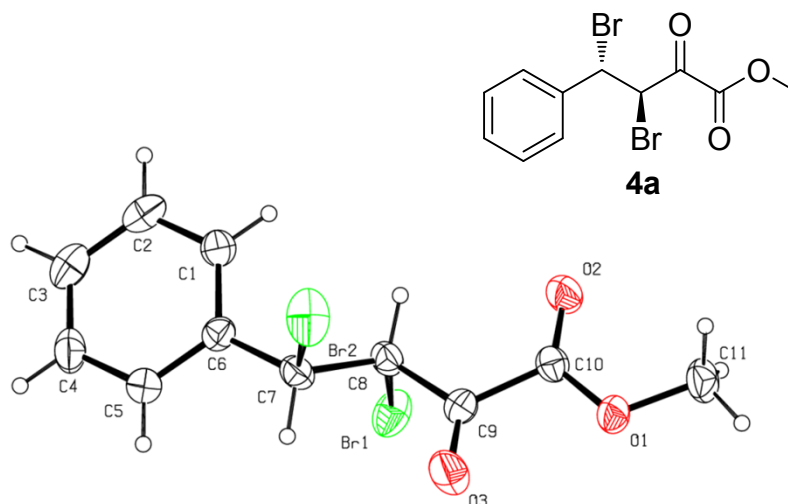


(1,2-dibromoethyl)benzene (7), white solid (13.0 mg, 49%), m.p. 69-71 °C;

¹H NMR(400 MHz, CDCl₃): δ 4.02 (t, J = 10.4 Hz, 1H), 4.08 (dd, J = 5.6, 10.2 Hz, 1H), 5.14 (dd, J = 5.2, 10.6 Hz, 1H), 7.33-7.42 (m, 5H); ¹³C NMR

(100 MHz, CDCl₃): δ 138.6, 129.2, 128.9, 127.7, 50.9, 35.0; IR (KBr):3365, 3032, 2923, 2854, 1455, 1433, 1265, 1134, 908, 769, 739, 693, 591 cm⁻¹; GC/MS m/z (rel. intensity): 104 (100), 183 (48), 185 (46), 262 (0.9), 264 (1.8), 266 (0.9).

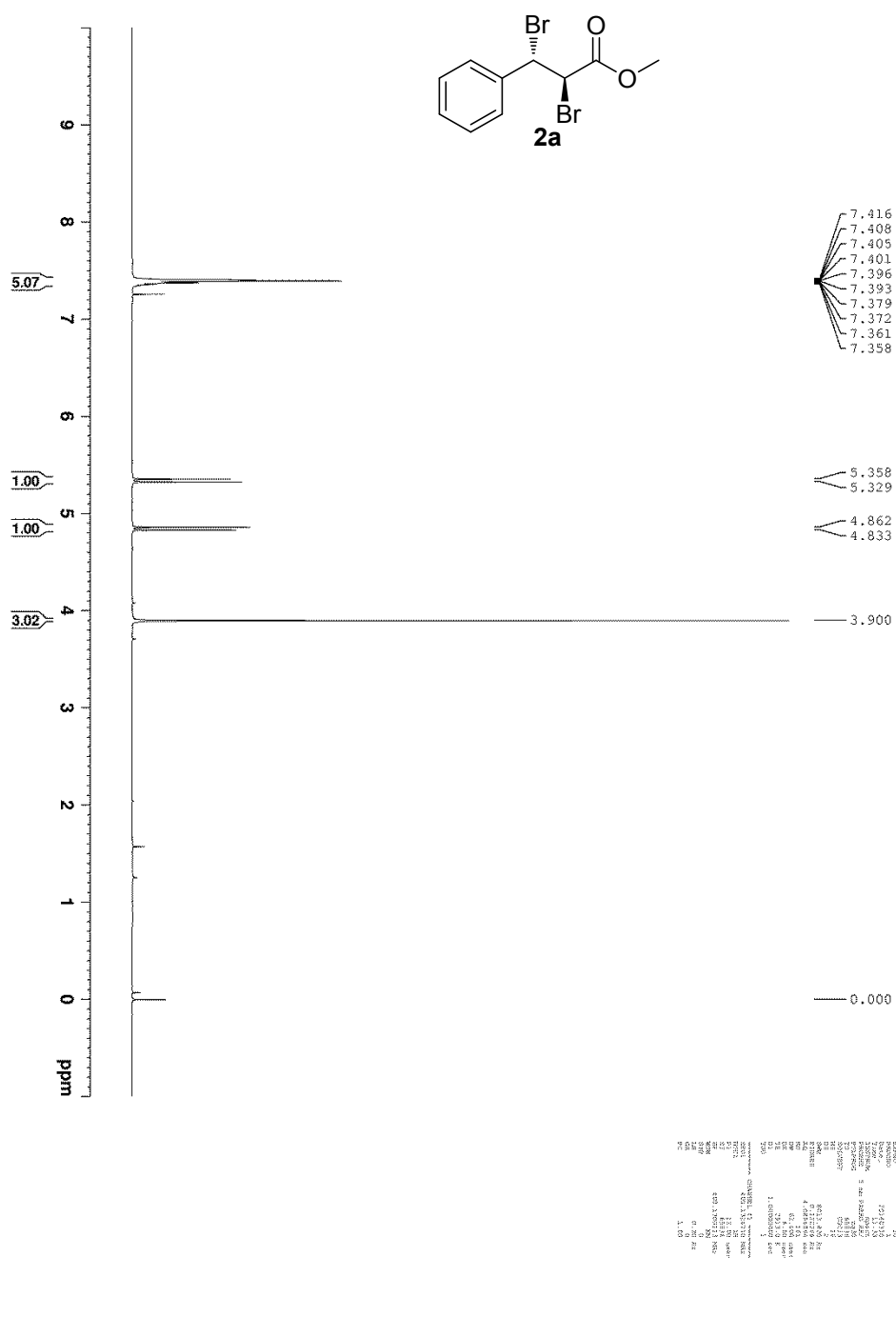
7. X-Ray structure of 4a



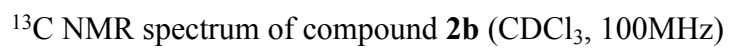
CCDC 992325 (**4a**) contains the supplementary crystallographic data for this paper. These data can be obtained free of charge from the Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk/data_request/cif.

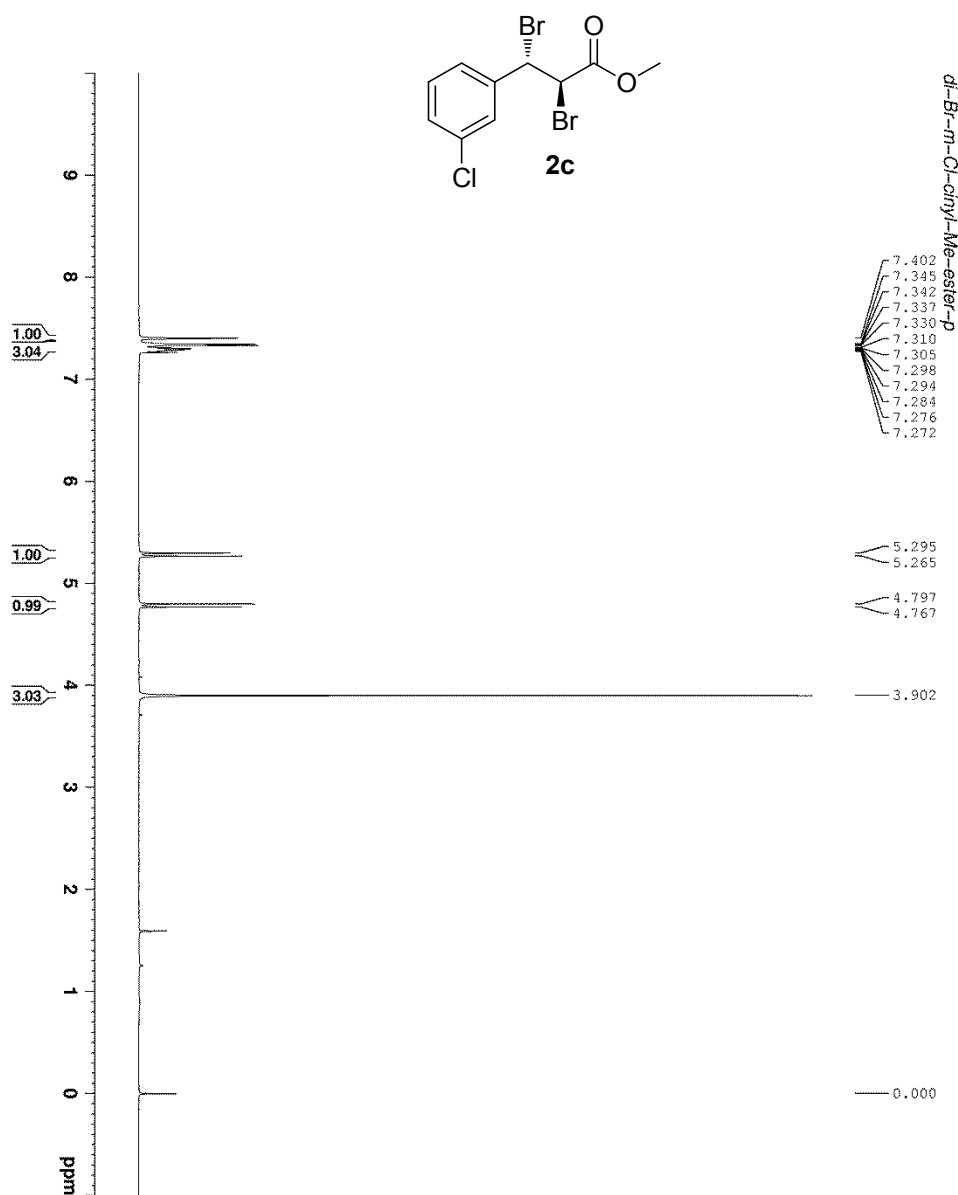
8. NMR Spectra

¹H NMR spectrum of compound **2a** (CDCl₃, 400MHz)



¹³C NMR spectrum of compound **2a** (CDCl₃, 100MHz)



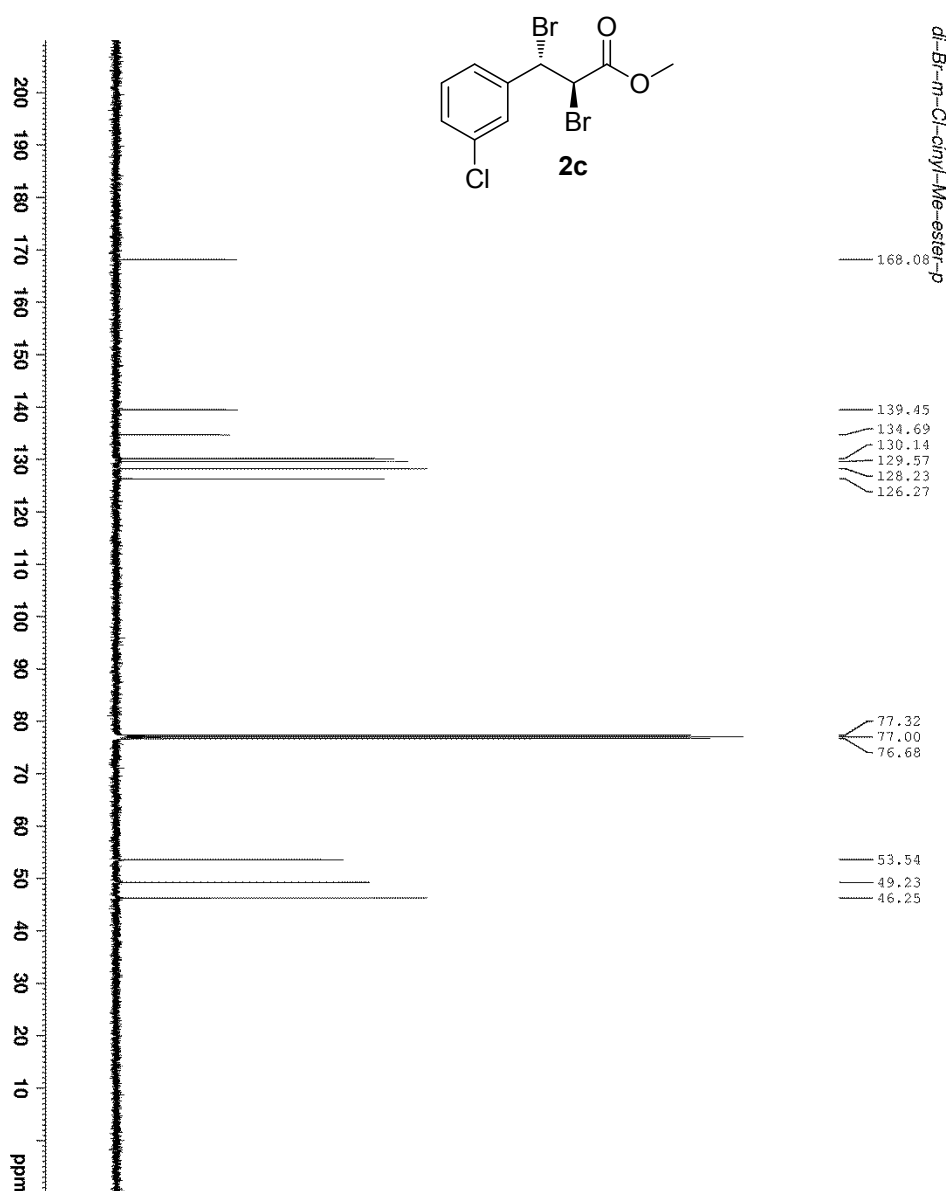


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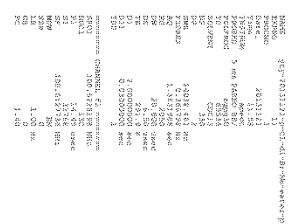
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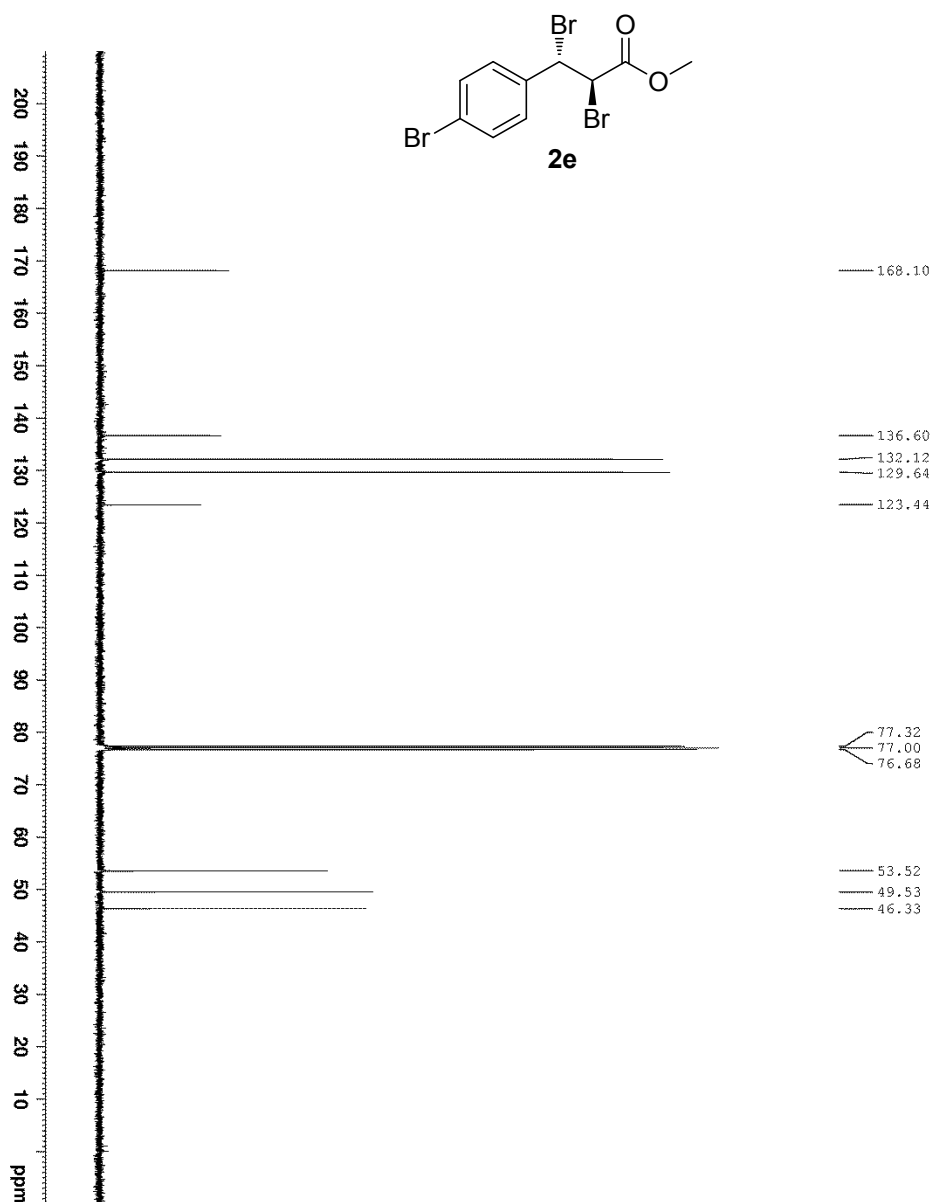
¹³C NMR spectrum of compound **2c** (CDCl₃, 100MHz)



1H NMR (400 MHz, CDCl₃) δ 7.72 (t, 3H, J = 7.8 Hz), 7.22 (m, 4H), 6.82 (m, 4H), 5.42 (s, 2H), 4.92 (s, 2H), 4.62 (s, 2H).
 13C NMR (100 MHz, CDCl₃) δ 168.08, 139.45, 134.69, 130.14, 129.57, 128.23, 126.27, 77.32, 77.00, 76.68, 53.54, 49.23, 46.25.

¹H NMR spectrum of compound **2d** (CDCl₃, 400 MHz)



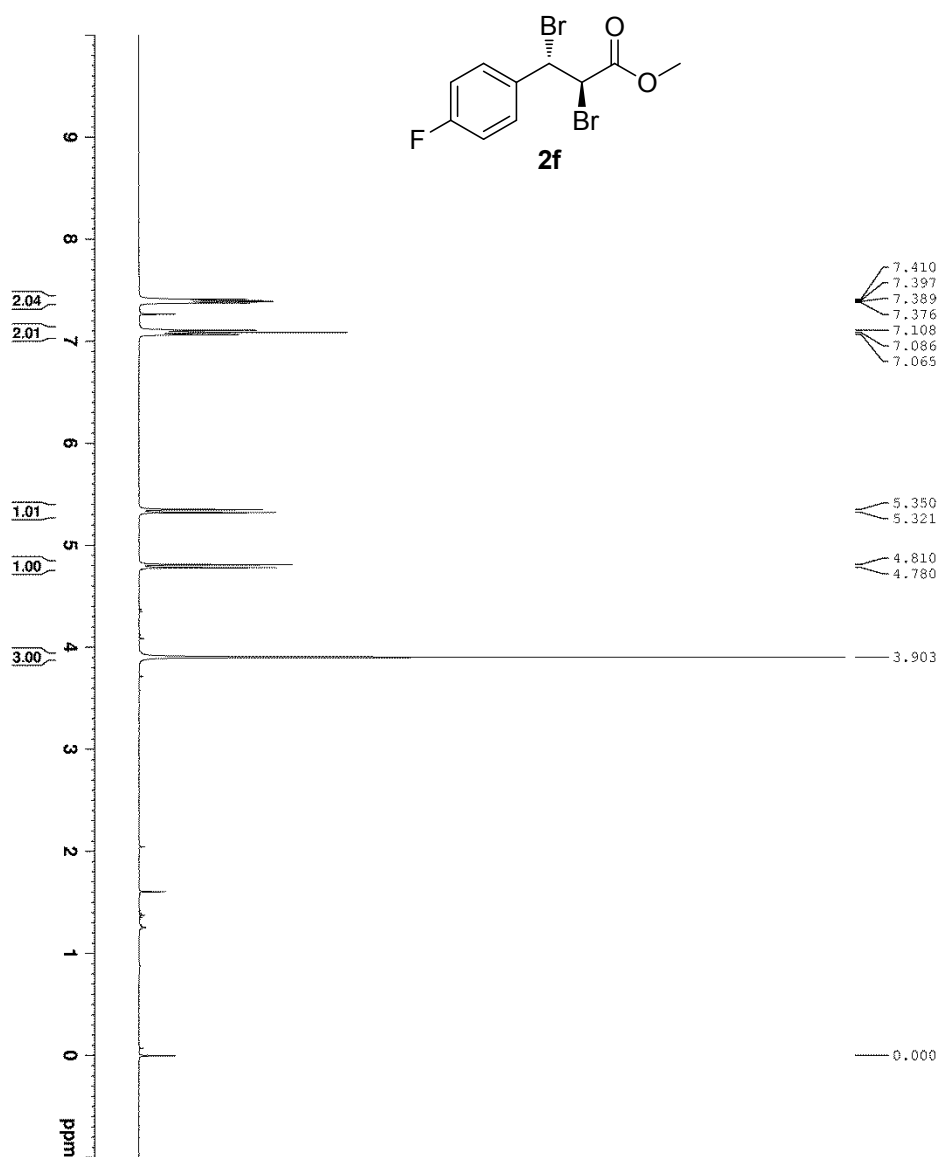


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PROCNO: 1
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RG: 2.00
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DE: 0.000000
TE: 300.2
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1H: 400.146

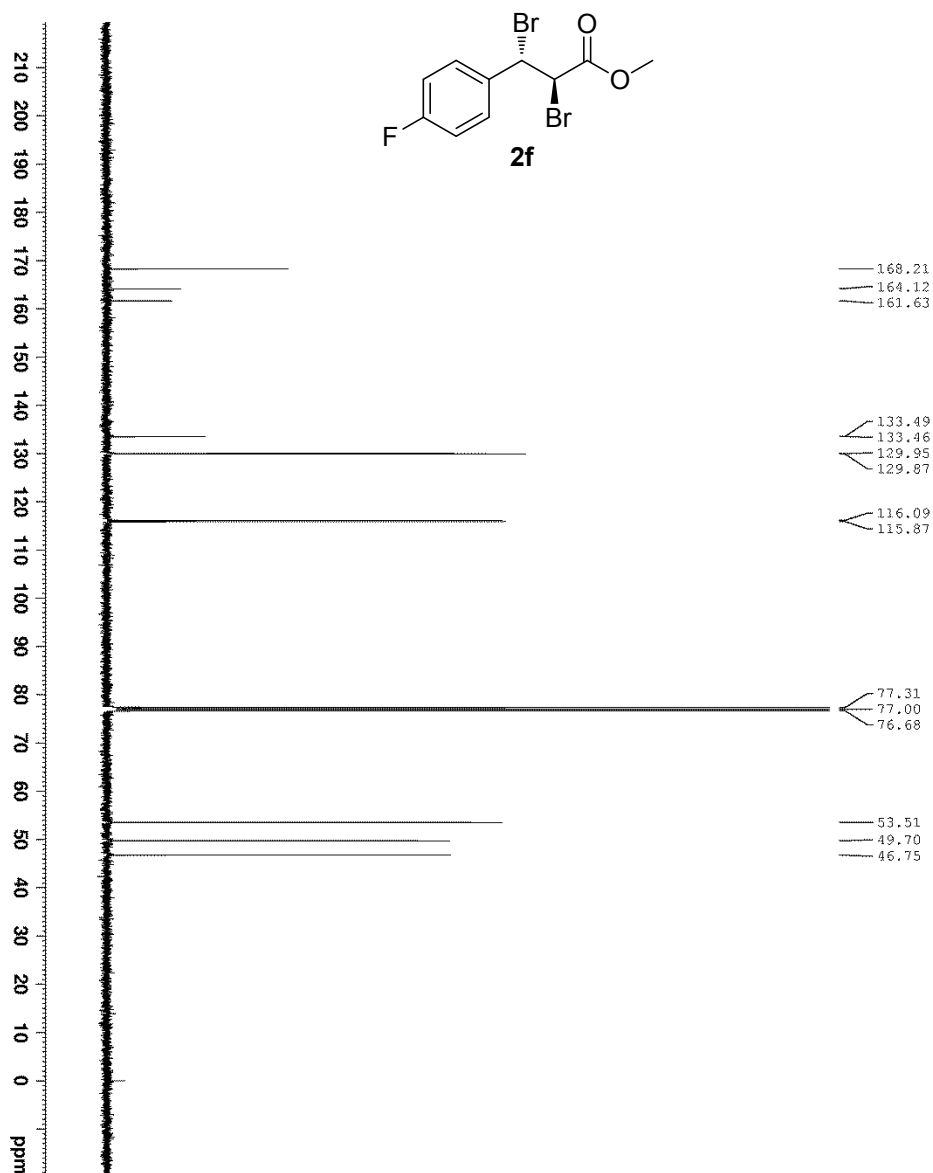
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¹H NMR spectrum of compound **2f** (CDCl₃, 400 MHz)



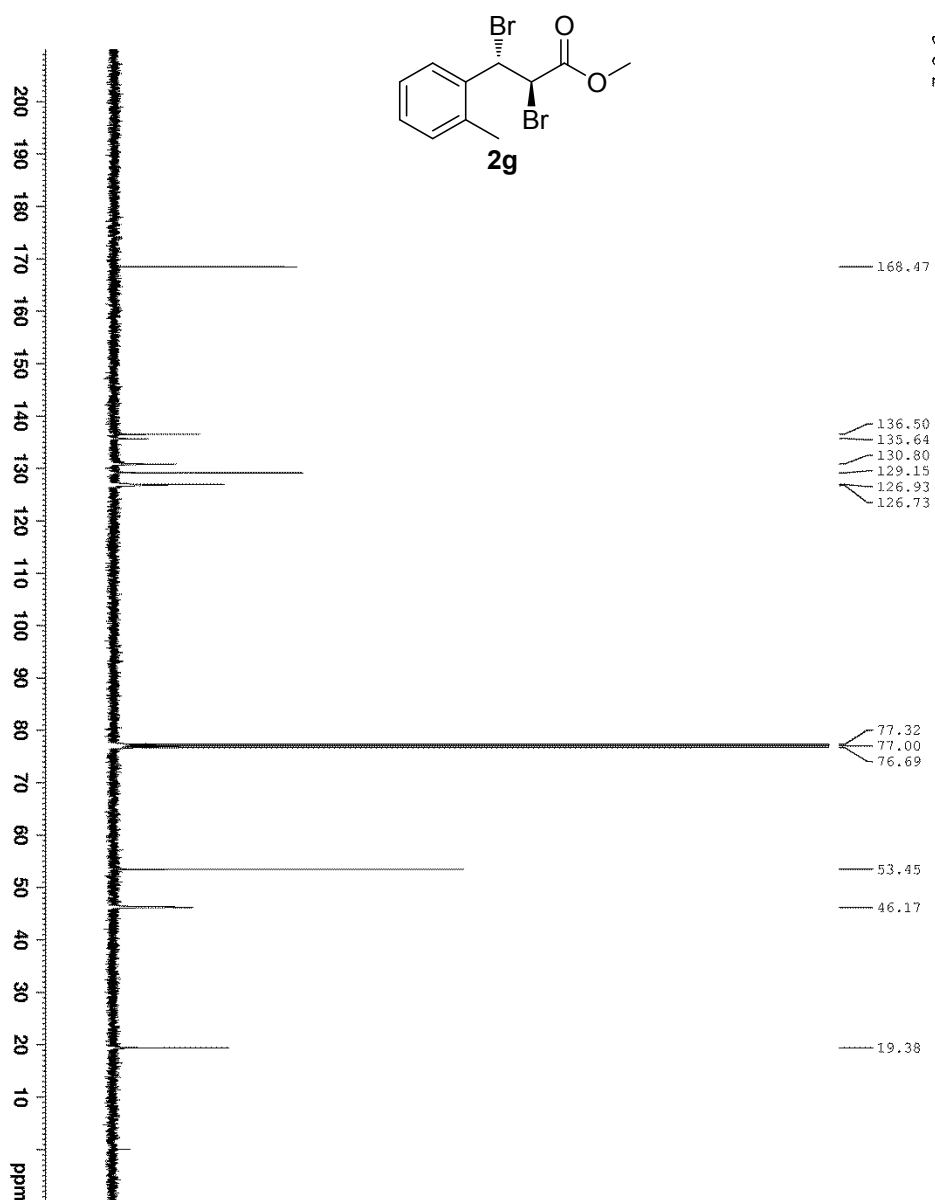
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¹³C NMR spectrum of compound **2f** (CDCl₃, 100 MHz)



^1H NMR spectrum of compound **2g** (CDCl_3 , 400 MHz)



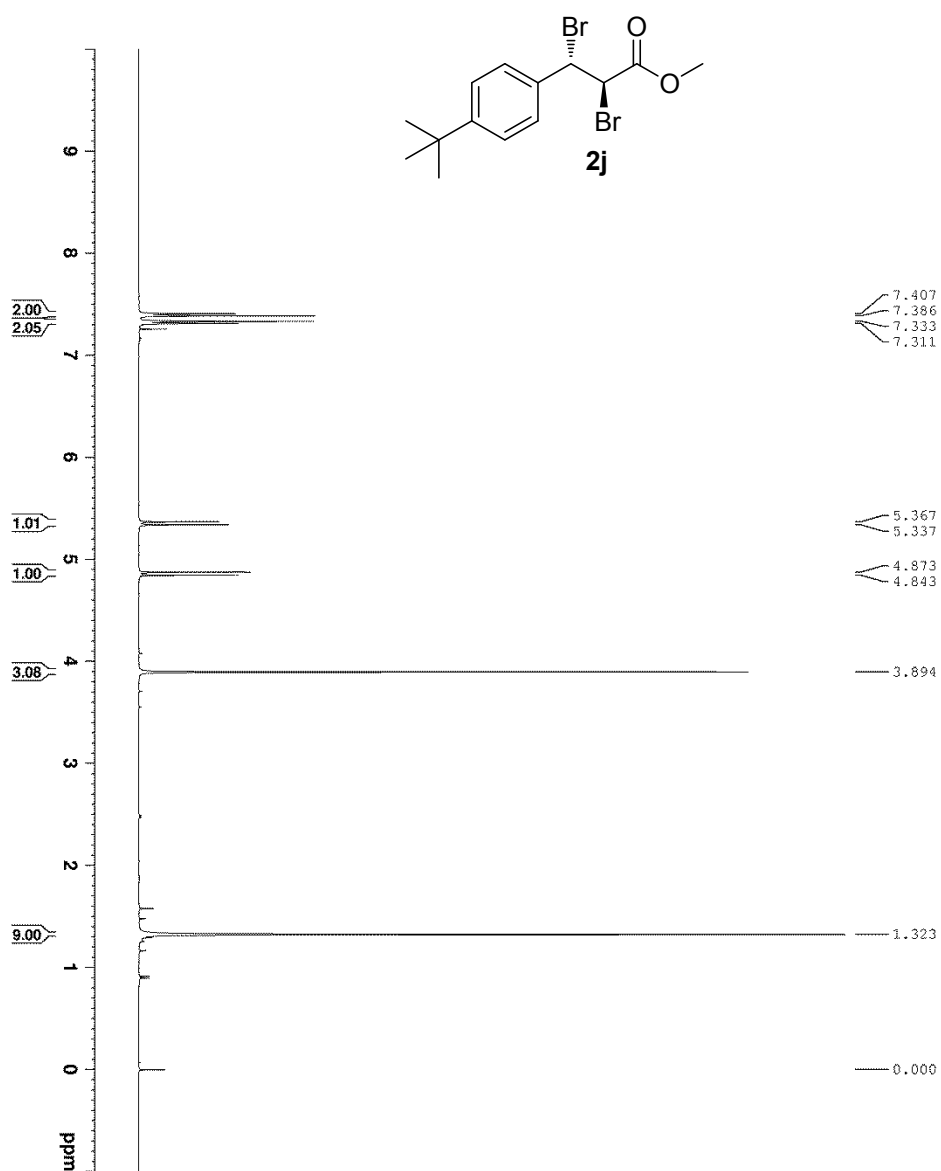


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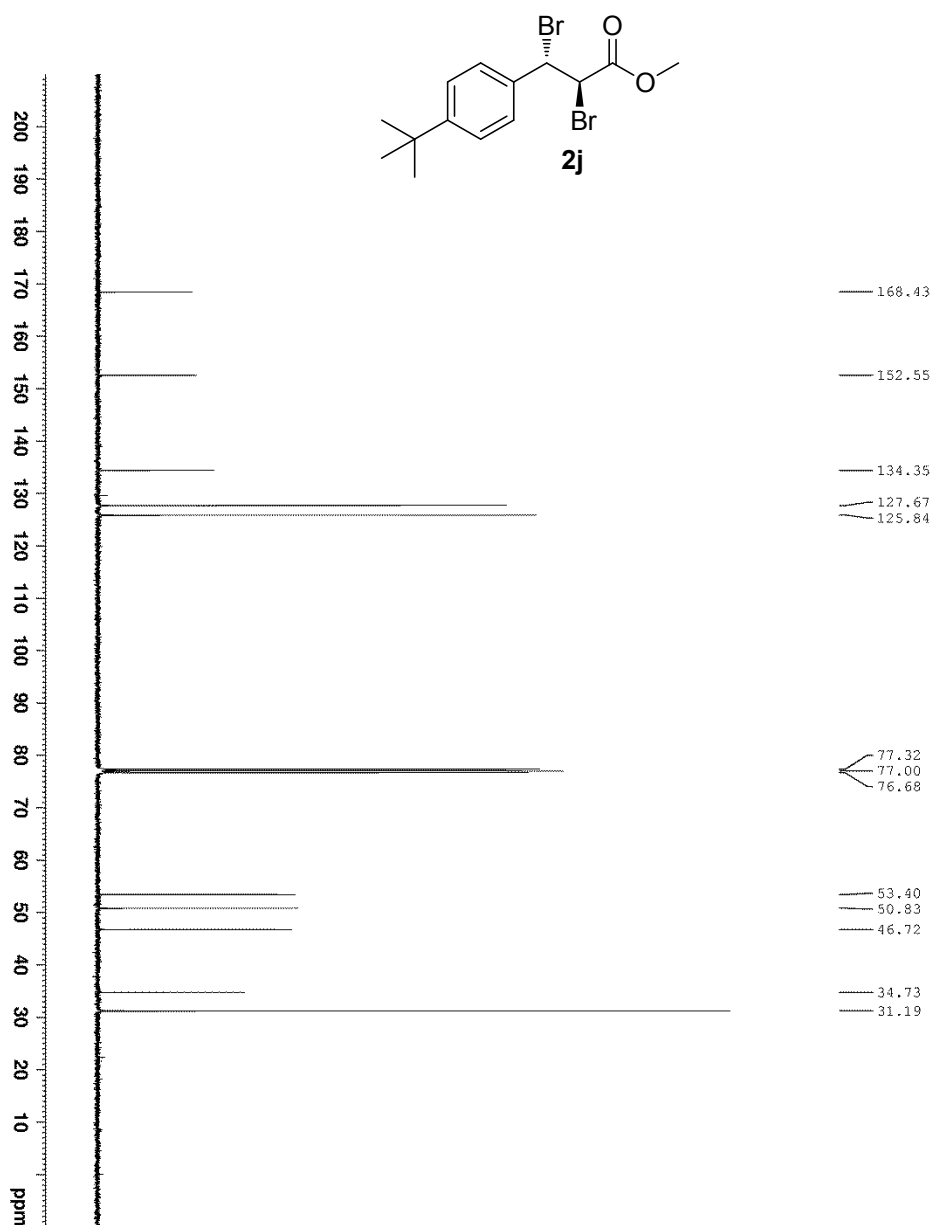
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¹H NMR spectrum of compound **2h** (CDCl₃, 400 MHz)



13C NMR spectrum of compound **2j** in CDCl₃. The spectrum shows peaks at 7.407, 7.386, 7.333, 7.311, 5.367, 5.337, 4.873, 4.843, 3.894, 1.323, and 0.000 ppm. The integrations are 2.00, 2.05, 1.01, 1.00, 3.08, and 9.00 respectively.

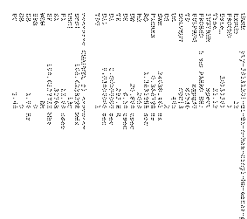
¹³C NMR spectrum of compound **2j** (CDCl₃, 100 MHz)



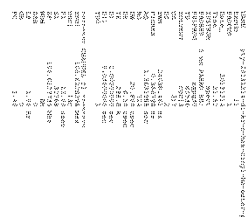
13C NMR (400 MHz, CDCl₃) δ: 168.43, 152.55, 134.35, 127.67, 125.84, 77.32, 77.00, 76.68, 53.40, 50.83, 46.72, 34.73, 31.19.

¹H NMR spectrum of compound **2k** (CDCl₃, 400 MHz)

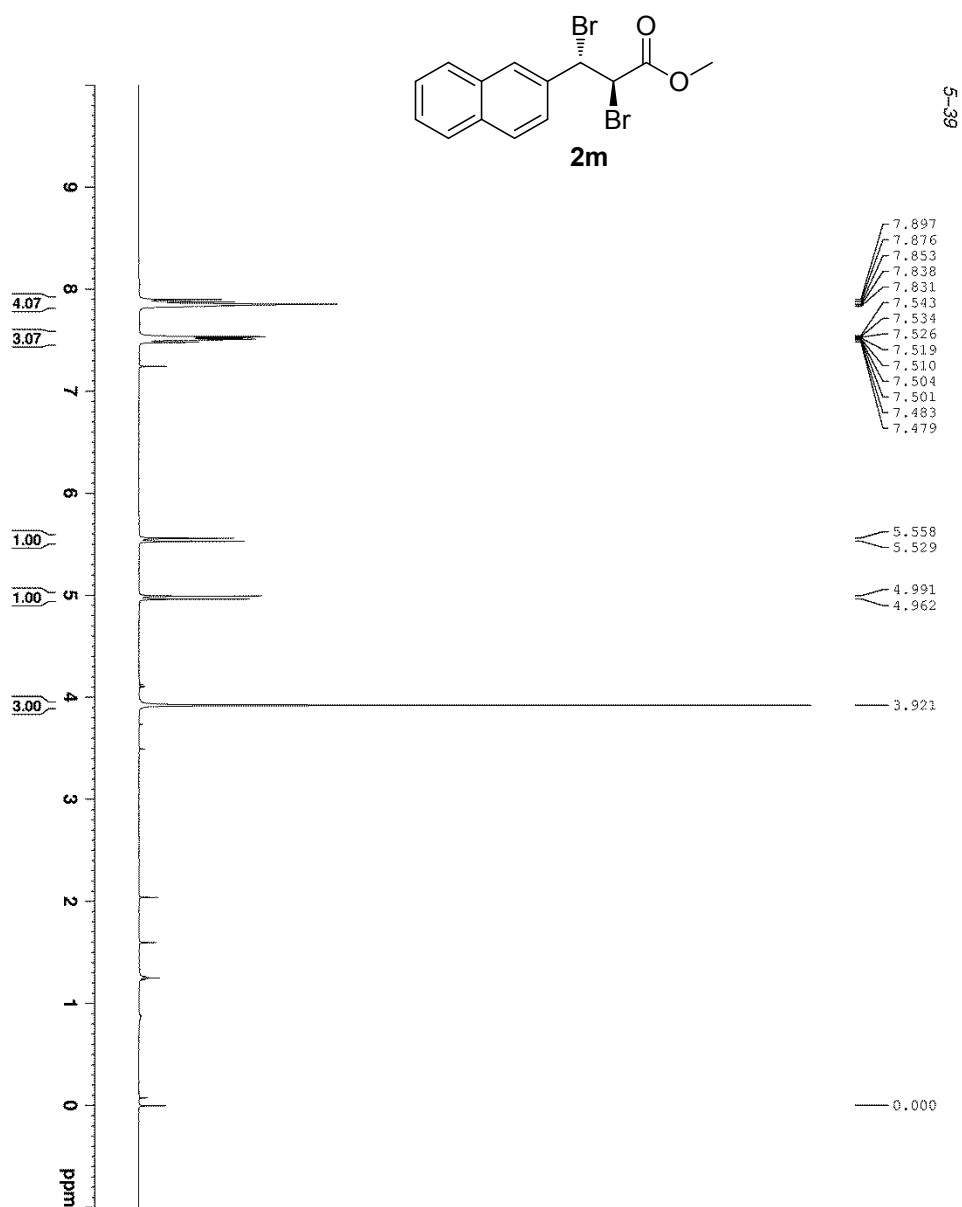




S32

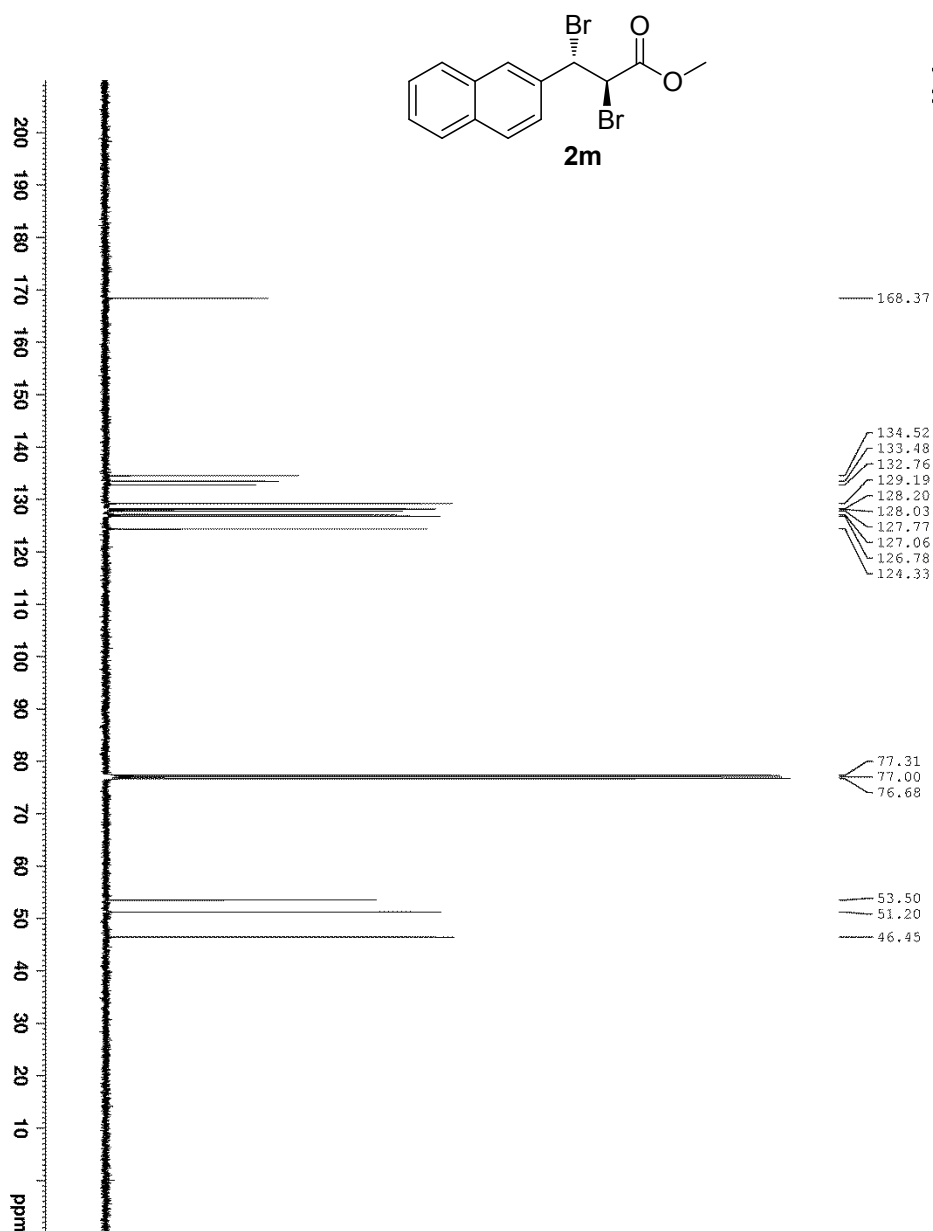


S34



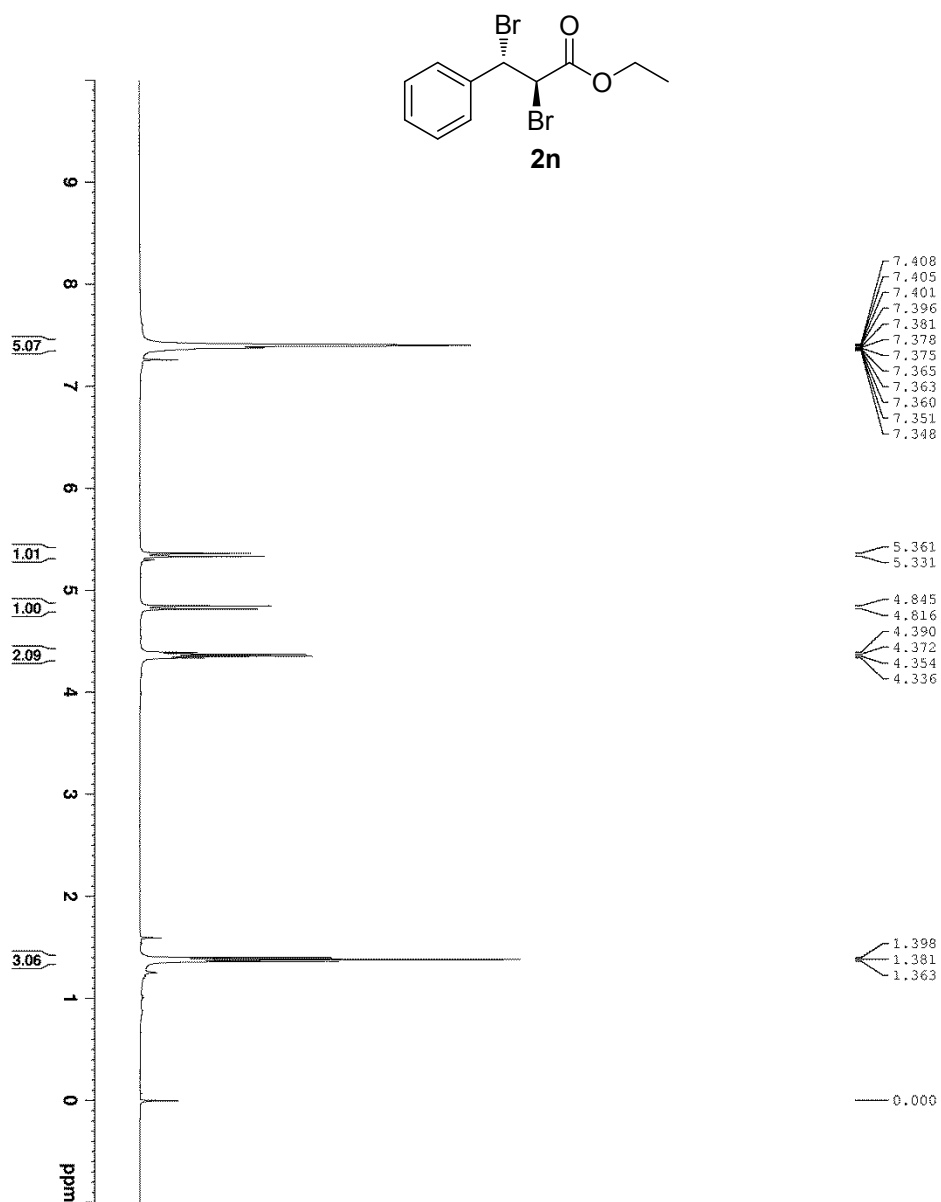
13C NMR (100 MHz, CDCl₃)
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¹³C NMR spectrum of compound **2m** (CDCl₃, 100 MHz)



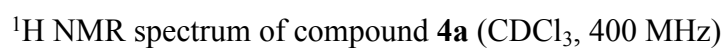
13C NMR (400 MHz, CDCl₃)
 168.37, 134.52, 133.48, 132.76, 129.19, 128.20, 128.03, 127.77, 127.06, 126.78, 124.33, 77.31, 77.00, 76.68, 53.50, 51.20, 46.45

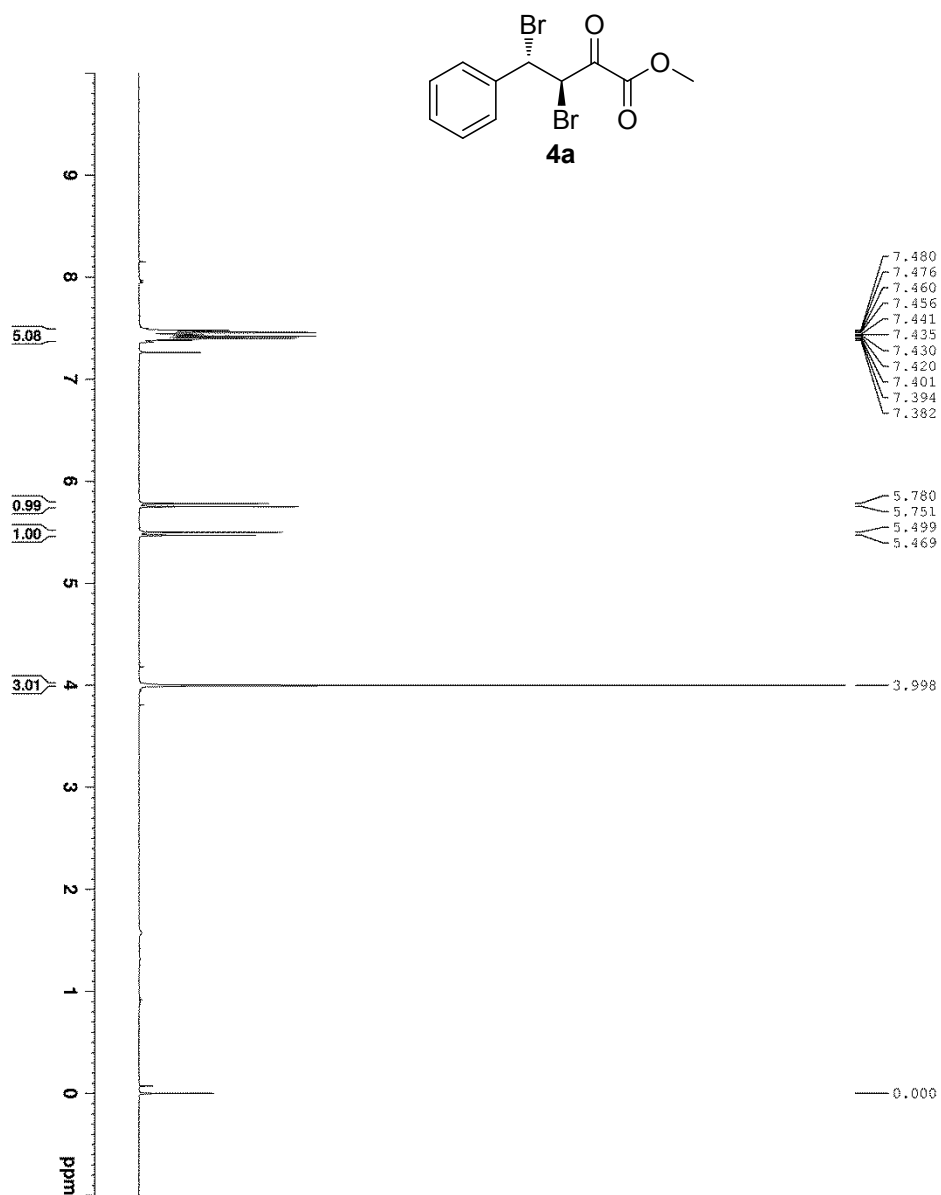
¹H NMR spectrum of compound **2n** (CDCl₃, 400 MHz)



13C NMR (100 MHz, CDCl₃) δ : 7.35-7.41 (m, 5H), 5.36 (d, 1H), 5.33 (d, 1H), 4.85 (d, 1H), 4.82 (d, 1H), 4.37-4.40 (m, 2H), 1.37-1.40 (t, 3H).
 1H NMR (400 MHz, CDCl₃) δ : 7.35-7.41 (m, 5H), 5.36 (d, 1H), 5.33 (d, 1H), 4.85 (d, 1H), 4.82 (d, 1H), 4.37-4.40 (m, 2H), 1.37-1.40 (t, 3H).
 13C NMR (100 MHz, CDCl₃) δ : 171.2, 138.2, 137.8, 137.5, 137.2, 136.9, 136.6, 136.3, 136.0, 135.7, 135.4, 135.1, 134.8, 134.5, 134.2, 133.9, 133.6, 133.3, 133.0, 132.7, 132.4, 132.1, 131.8, 131.5, 131.2, 130.9, 130.6, 130.3, 130.0, 129.7, 129.4, 129.1, 128.8, 128.5, 128.2, 127.9, 127.6, 127.3, 127.0, 126.7, 126.4, 126.1, 125.8, 125.5, 125.2, 124.9, 124.6, 124.3, 124.0, 123.7, 123.4, 123.1, 122.8, 122.5, 122.2, 121.9, 121.6, 121.3, 121.0, 120.7, 120.4, 120.1, 119.8, 119.5, 119.2, 118.9, 118.6, 118.3, 118.0, 117.7, 117.4, 117.1, 116.8, 116.5, 116.2, 115.9, 115.6, 115.3, 115.0, 114.7, 114.4, 114.1, 113.8, 113.5, 113.2, 112.9, 112.6, 112.3, 112.0, 111.7, 111.4, 111.1, 110.8, 110.5, 110.2, 109.9, 109.6, 109.3, 109.0, 108.7, 108.4, 108.1, 107.8, 107.5, 107.2, 106.9, 106.6, 106.3, 106.0, 105.7, 105.4, 105.1, 104.8, 104.5, 104.2, 103.9, 103.6, 103.3, 103.0, 102.7, 102.4, 102.1, 101.8, 101.5, 101.2, 100.9, 100.6, 100.3, 100.0, 99.7, 99.4, 99.1, 98.8, 98.5, 98.2, 97.9, 97.6, 97.3, 97.0, 96.7, 96.4, 96.1, 95.8, 95.5, 95.2, 94.9, 94.6, 94.3, 94.0, 93.7, 93.4, 93.1, 92.8, 92.5, 92.2, 91.9, 91.6, 91.3, 91.0, 90.7, 90.4, 90.1, 89.8, 89.5, 89.2, 88.9, 88.6, 88.3, 88.0, 87.7, 87.4, 87.1, 86.8, 86.5, 86.2, 85.9, 85.6, 85.3, 85.0, 84.7, 84.4, 84.1, 83.8, 83.5, 83.2, 82.9, 82.6, 82.3, 82.0, 81.7, 81.4, 81.1, 80.8, 80.5, 80.2, 79.9, 79.6, 79.3, 79.0, 78.7, 78.4, 78.1, 77.8, 77.5, 77.2, 76.9, 76.6, 76.3, 76.0, 75.7, 75.4, 75.1, 74.8, 74.5, 74.2, 73.9, 73.6, 73.3, 73.0, 72.7, 72.4, 72.1, 71.8, 71.5, 71.2, 70.9, 70.6, 70.3, 70.0, 69.7, 69.4, 69.1, 68.8, 68.5, 68.2, 67.9, 67.6, 67.3, 67.0, 66.7, 66.4, 66.1, 65.8, 65.5, 65.2, 64.9, 64.6, 64.3, 64.0, 63.7, 63.4, 63.1, 62.8, 62.5, 62.2, 61.9, 61.6, 61.3, 61.0, 60.7, 60.4, 60.1, 59.8, 59.5, 59.2, 58.9, 58.6, 58.3, 58.0, 57.7, 57.4, 57.1, 56.8, 56.5, 56.2, 55.9, 55.6, 55.3, 55.0, 54.7, 54.4, 54.1, 53.8, 53.5, 53.2, 52.9, 52.6, 52.3, 52.0, 51.7, 51.4, 51.1, 50.8, 50.5, 50.2, 49.9, 49.6, 49.3, 49.0, 48.7, 48.4, 48.1, 47.8, 47.5, 47.2, 46.9, 46.6, 46.3, 46.0, 45.7, 45.4, 45.1, 44.8, 44.5, 44.2, 43.9, 43.6, 43.3, 43.0, 42.7, 42.4, 42.1, 41.8, 41.5, 41.2, 40.9, 40.6, 40.3, 40.0, 39.7, 39.4, 39.1, 38.8, 38.5, 38.2, 37.9, 37.6, 37.3, 37.0, 36.7, 36.4, 36.1, 35.8, 35.5, 35.2, 34.9, 34.6, 34.3, 34.0, 33.7, 33.4, 33.1, 32.8, 32.5, 32.2, 31.9, 31.6, 31.3, 31.0, 30.7, 30.4, 30.1, 29.8, 29.5, 29.2, 28.9, 28.6, 28.3, 28.0, 27.7, 27.4, 27.1, 26.8, 26.5, 26.2, 25.9, 25.6, 25.3, 25.0, 24.7, 24.4, 24.1, 23.8, 23.5, 23.2, 22.9, 22.6, 22.3, 22.0, 21.7, 21.4, 21.1, 20.8, 20.5, 20.2, 19.9, 19.6, 19.3, 19.0, 18.7, 18.4, 18.1, 17.8, 17.5, 17.2, 16.9, 16.6, 16.3, 16.0, 15.7, 15.4, 15.1, 14.8, 14.5, 14.2, 13.9, 13.6, 13.3, 13.0, 12.7, 12.4, 12.1, 11.8, 11.5, 11.2, 10.9, 10.6, 10.3, 10.0, 9.7, 9.4, 9.1, 8.8, 8.5, 8.2, 7.9, 7.6, 7.3, 7.0, 6.7, 6.4, 6.1, 5.8, 5.5, 5.2, 4.9, 4.6, 4.3, 4.0, 3.7, 3.4, 3.1, 2.8, 2.5, 2.2, 1.9, 1.6, 1.3, 1.0, 0.7, 0.4, 0.1.

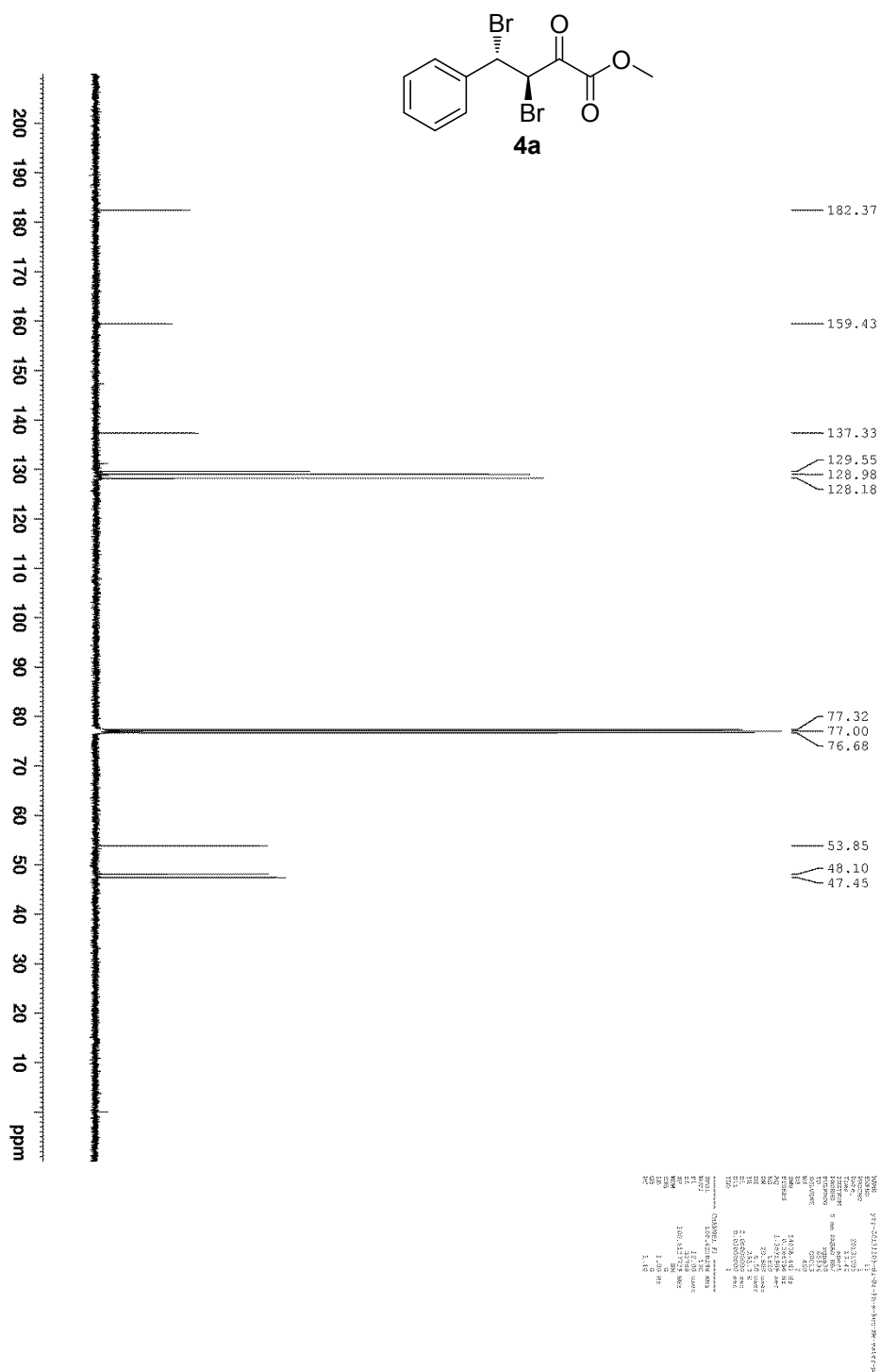
¹³C NMR spectrum of compound **2n** (CDCl₃, 100 MHz)



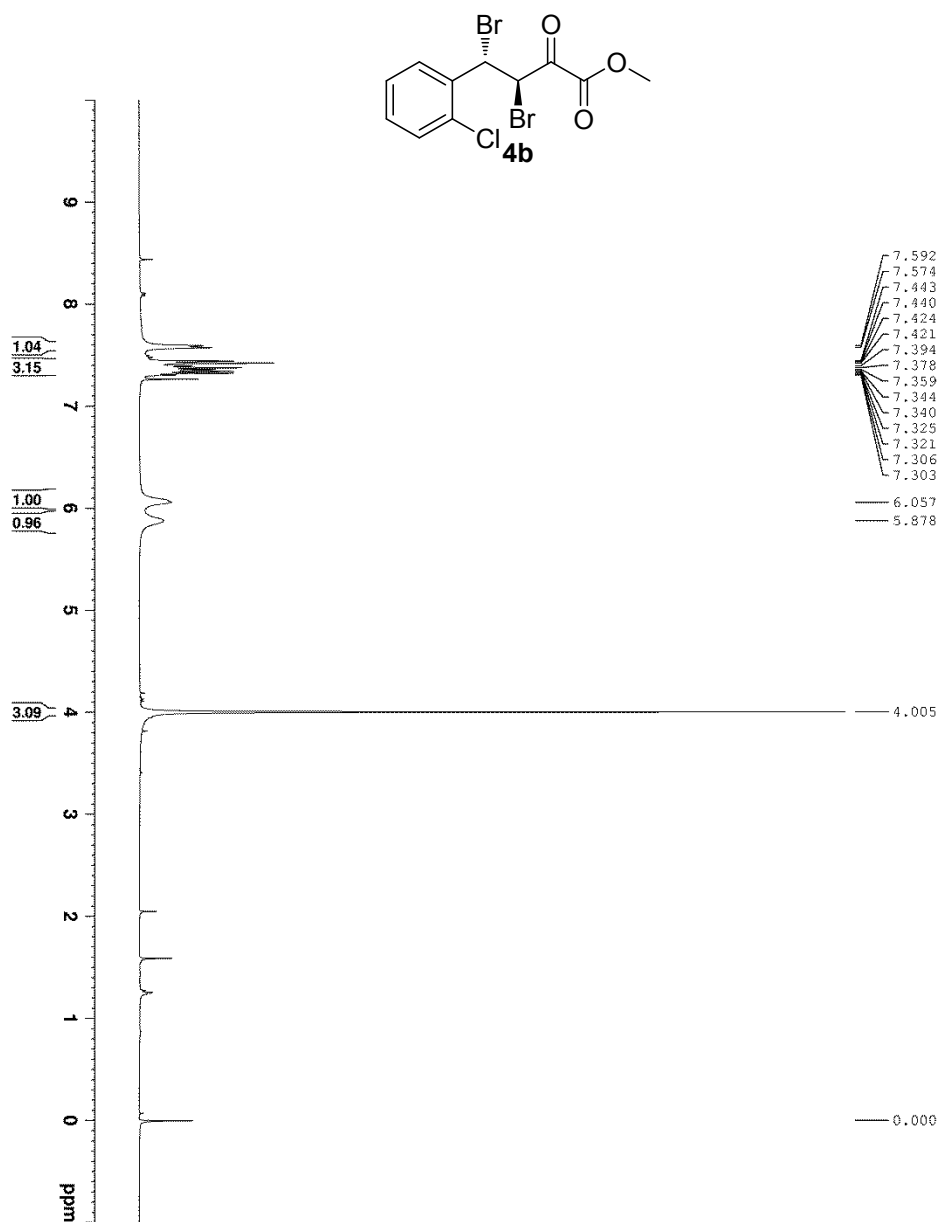


13C NMR spectrum (CDCl₃, 100 MHz) of compound 4a. The spectrum shows peaks at 7.480, 7.476, 7.460, 7.456, 7.441, 7.435, 7.430, 7.420, 7.401, 7.394, 7.382, 5.780, 5.751, 5.499, 5.469, 3.998, and 0.000 ppm. The integration values are 5.08, 0.99, 1.00, and 3.01.

¹³C NMR spectrum of compound **4a** (CDCl₃, 100 MHz)

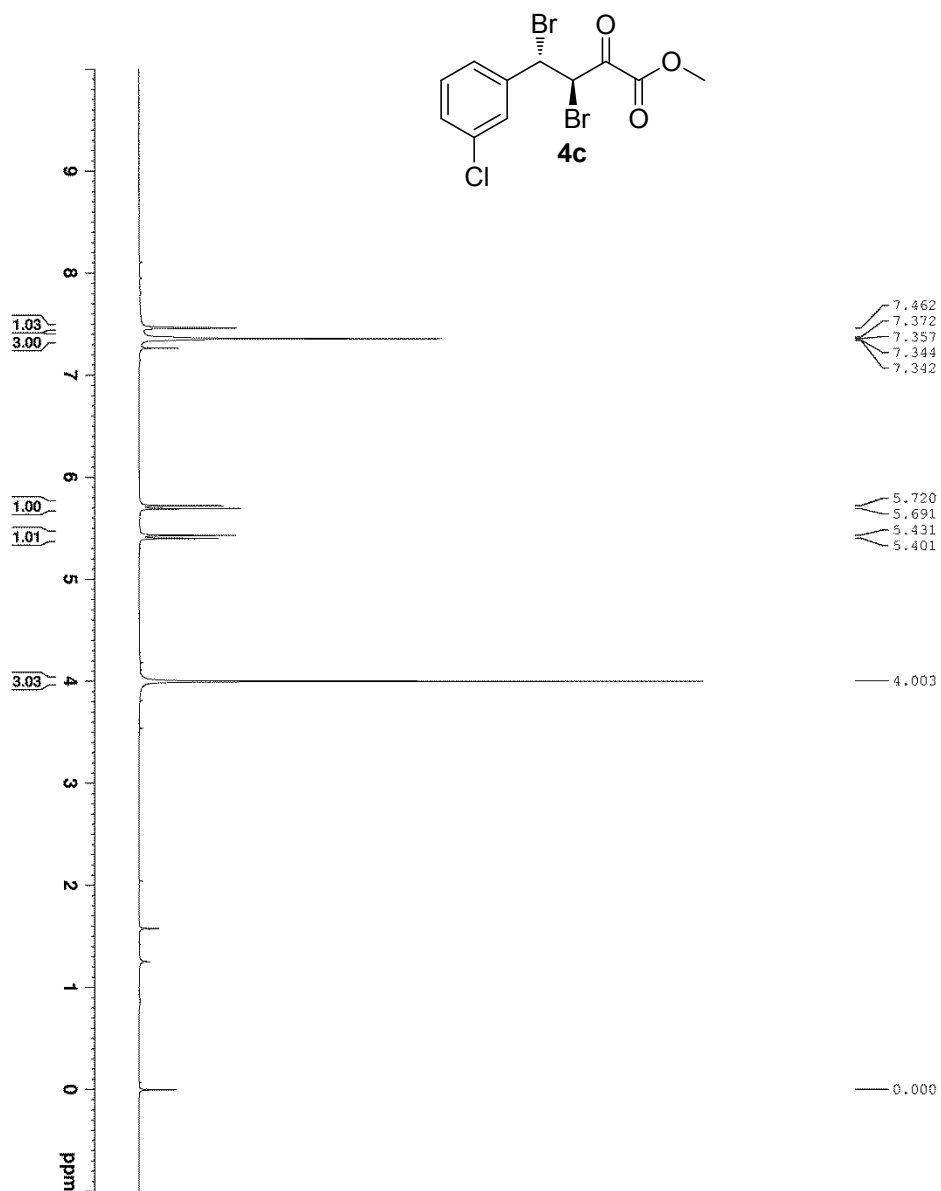


¹H NMR spectrum of compound **4b** (CDCl₃, 400 MHz)



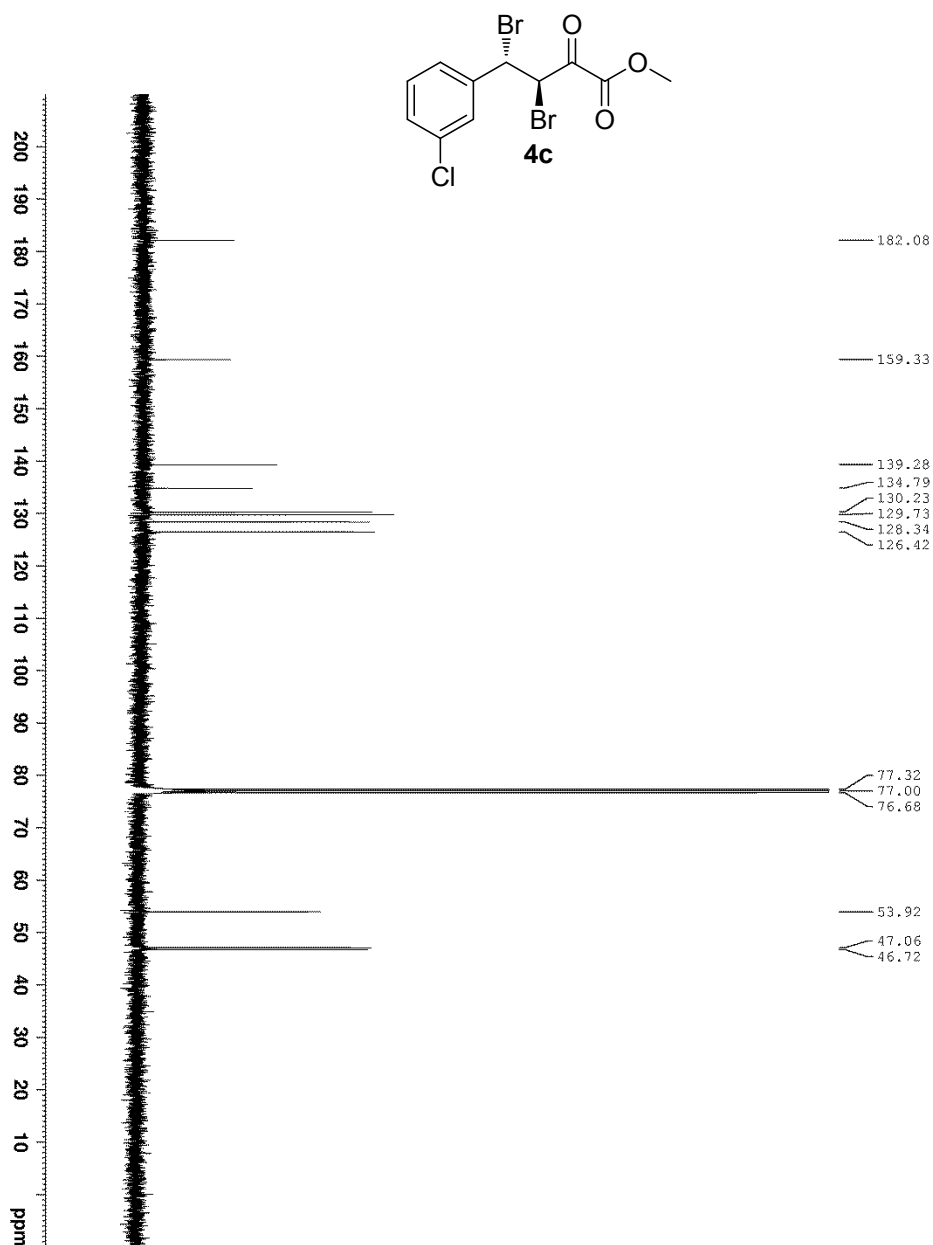
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Formula	C ₁₁ H ₉ BrClO ₂
Weight	291.04
SMILES	COC(=O)C(Br)C(Br)c1cc(Cl)ccc1Br
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Index	98
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Index	100

¹³C NMR spectrum of compound **4b** (CDCl₃, 100 MHz)

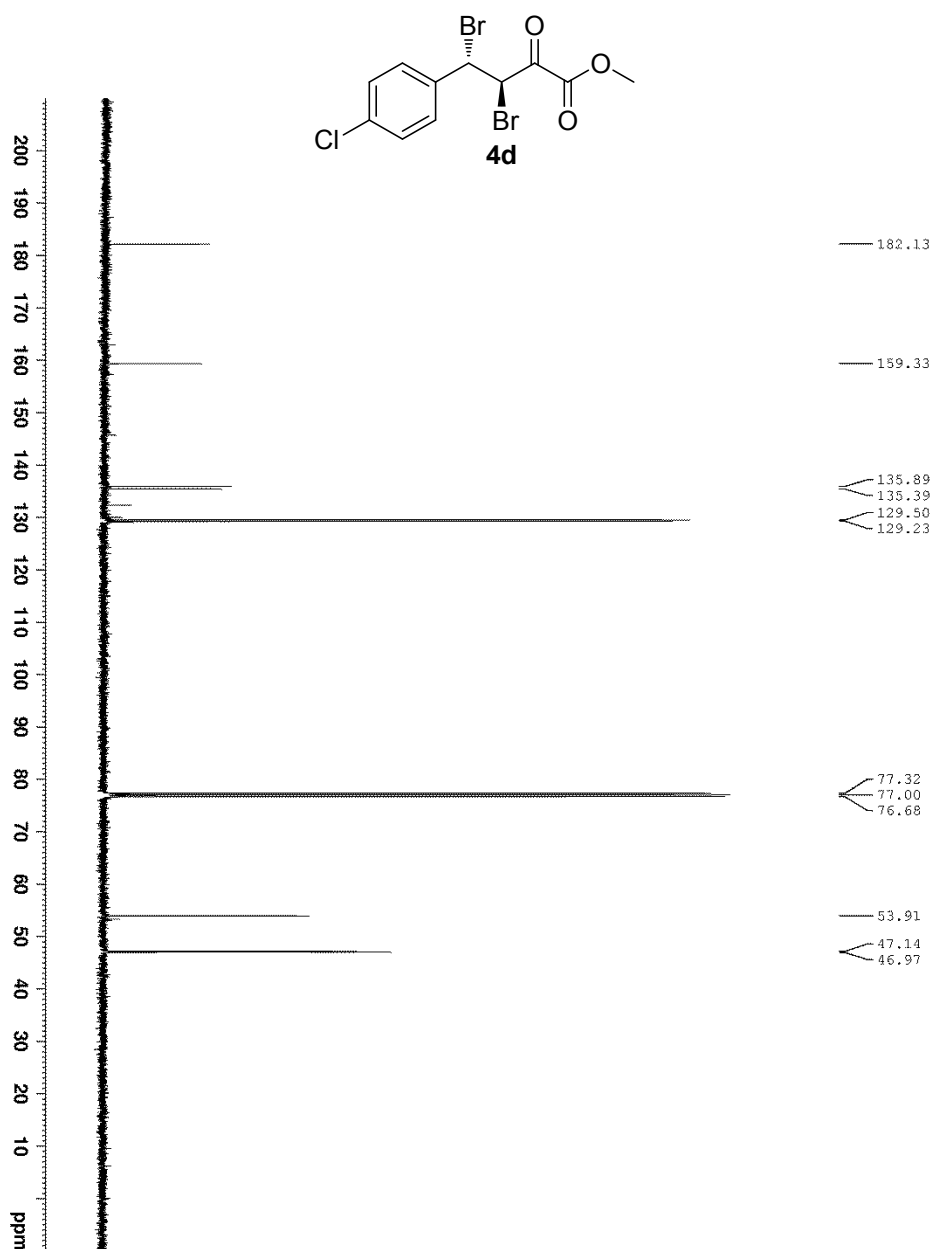


13C NMR (100 MHz, CDCl₃) δ: 168.1 (C=O), 155.1 (C=O), 134.1 (C=C), 133.1 (C=C), 132.1 (C=C), 131.1 (C=C), 130.1 (C=C), 129.1 (C=C), 128.1 (C=C), 127.1 (C=C), 126.1 (C=C), 125.1 (C=C), 124.1 (C=C), 123.1 (C=C), 122.1 (C=C), 121.1 (C=C), 120.1 (C=C), 119.1 (C=C), 118.1 (C=C), 117.1 (C=C), 116.1 (C=C), 115.1 (C=C), 114.1 (C=C), 113.1 (C=C), 112.1 (C=C), 111.1 (C=C), 110.1 (C=C), 109.1 (C=C), 108.1 (C=C), 107.1 (C=C), 106.1 (C=C), 105.1 (C=C), 104.1 (C=C), 103.1 (C=C), 102.1 (C=C), 101.1 (C=C), 100.1 (C=C), 99.1 (C=C), 98.1 (C=C), 97.1 (C=C), 96.1 (C=C), 95.1 (C=C), 94.1 (C=C), 93.1 (C=C), 92.1 (C=C), 91.1 (C=C), 90.1 (C=C), 89.1 (C=C), 88.1 (C=C), 87.1 (C=C), 86.1 (C=C), 85.1 (C=C), 84.1 (C=C), 83.1 (C=C), 82.1 (C=C), 81.1 (C=C), 80.1 (C=C), 79.1 (C=C), 78.1 (C=C), 77.1 (C=C), 76.1 (C=C), 75.1 (C=C), 74.1 (C=C), 73.1 (C=C), 72.1 (C=C), 71.1 (C=C), 70.1 (C=C), 69.1 (C=C), 68.1 (C=C), 67.1 (C=C), 66.1 (C=C), 65.1 (C=C), 64.1 (C=C), 63.1 (C=C), 62.1 (C=C), 61.1 (C=C), 60.1 (C=C), 59.1 (C=C), 58.1 (C=C), 57.1 (C=C), 56.1 (C=C), 55.1 (C=C), 54.1 (C=C), 53.1 (C=C), 52.1 (C=C), 51.1 (C=C), 50.1 (C=C), 49.1 (C=C), 48.1 (C=C), 47.1 (C=C), 46.1 (C=C), 45.1 (C=C), 44.1 (C=C), 43.1 (C=C), 42.1 (C=C), 41.1 (C=C), 40.1 (C=C), 39.1 (C=C), 38.1 (C=C), 37.1 (C=C), 36.1 (C=C), 35.1 (C=C), 34.1 (C=C), 33.1 (C=C), 32.1 (C=C), 31.1 (C=C), 30.1 (C=C), 29.1 (C=C), 28.1 (C=C), 27.1 (C=C), 26.1 (C=C), 25.1 (C=C), 24.1 (C=C), 23.1 (C=C), 22.1 (C=C), 21.1 (C=C), 20.1 (C=C), 19.1 (C=C), 18.1 (C=C), 17.1 (C=C), 16.1 (C=C), 15.1 (C=C), 14.1 (C=C), 13.1 (C=C), 12.1 (C=C), 11.1 (C=C), 10.1 (C=C), 9.1 (C=C), 8.1 (C=C), 7.1 (C=C), 6.1 (C=C), 5.1 (C=C), 4.1 (C=C), 3.1 (C=C), 2.1 (C=C), 1.1 (C=C), 0.1 (C=C).

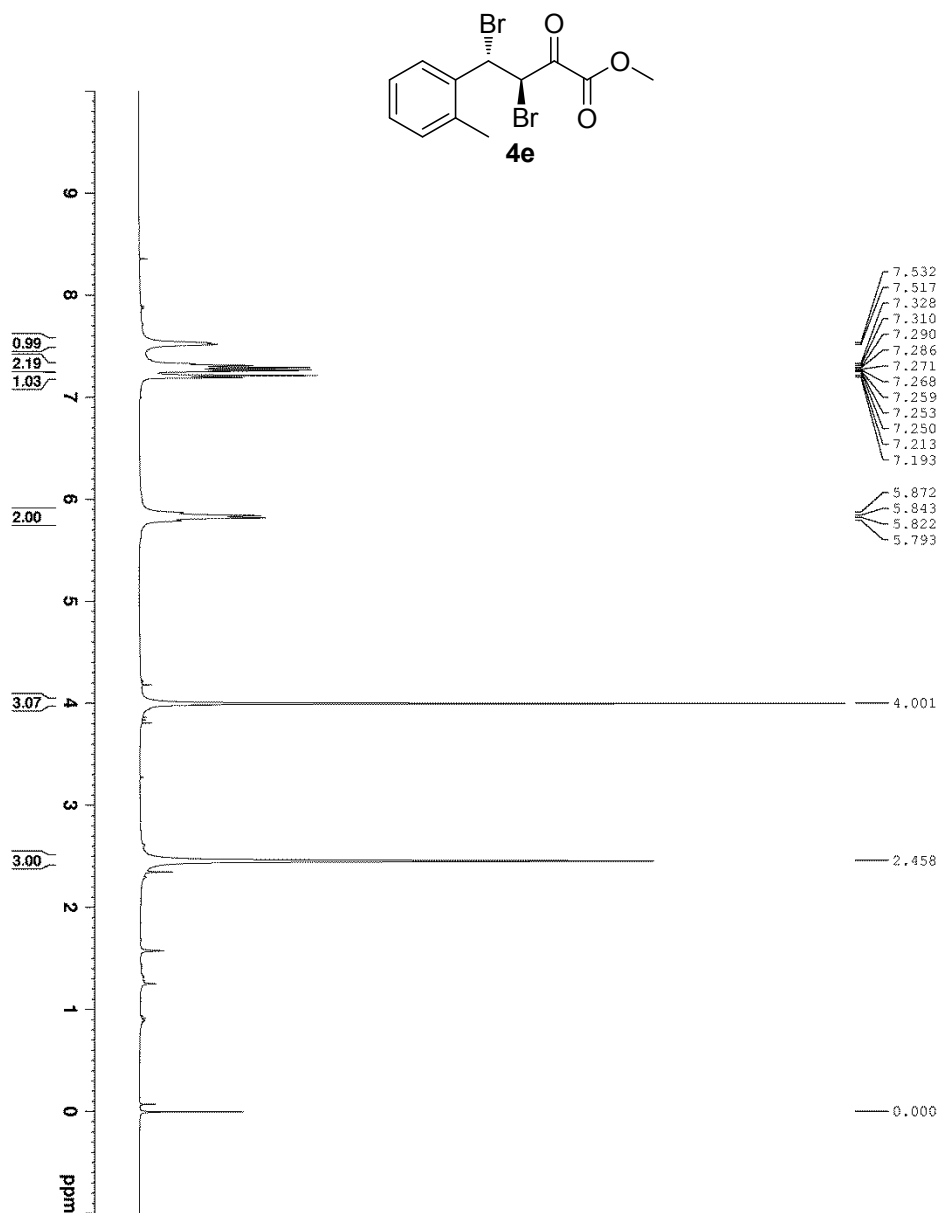
¹³C NMR spectrum of compound **4c** (CDCl₃, 100 MHz)



¹H NMR spectrum of compound **4d** (CDCl₃, 400 MHz)

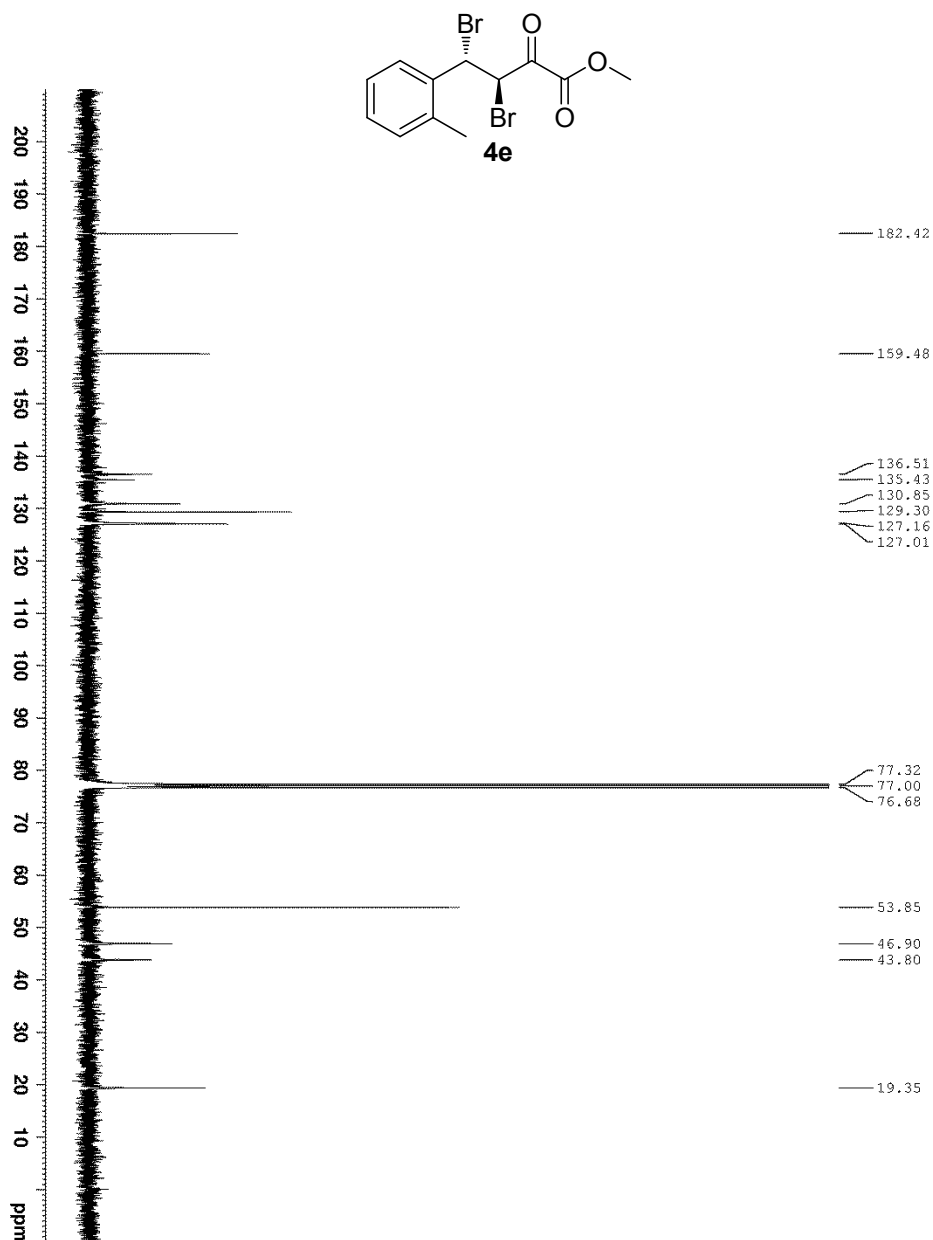


^1H NMR spectrum of compound **4e** (CDCl_3 , 400 MHz)



13C NMR spectrum of compound **4e** (CDCl₃, 100 MHz). The spectrum shows several peaks in the aromatic region (7.1-7.6 ppm), a triplet in the methine region (5.8 ppm), a singlet in the methoxy region (4.0 ppm), and a singlet in the methyl region (2.5 ppm). The integration values are 0.99, 2.19, 1.03, 2.00, 3.07, and 3.00.

¹³C NMR spectrum of compound **4e** (CDCl₃, 100 MHz)

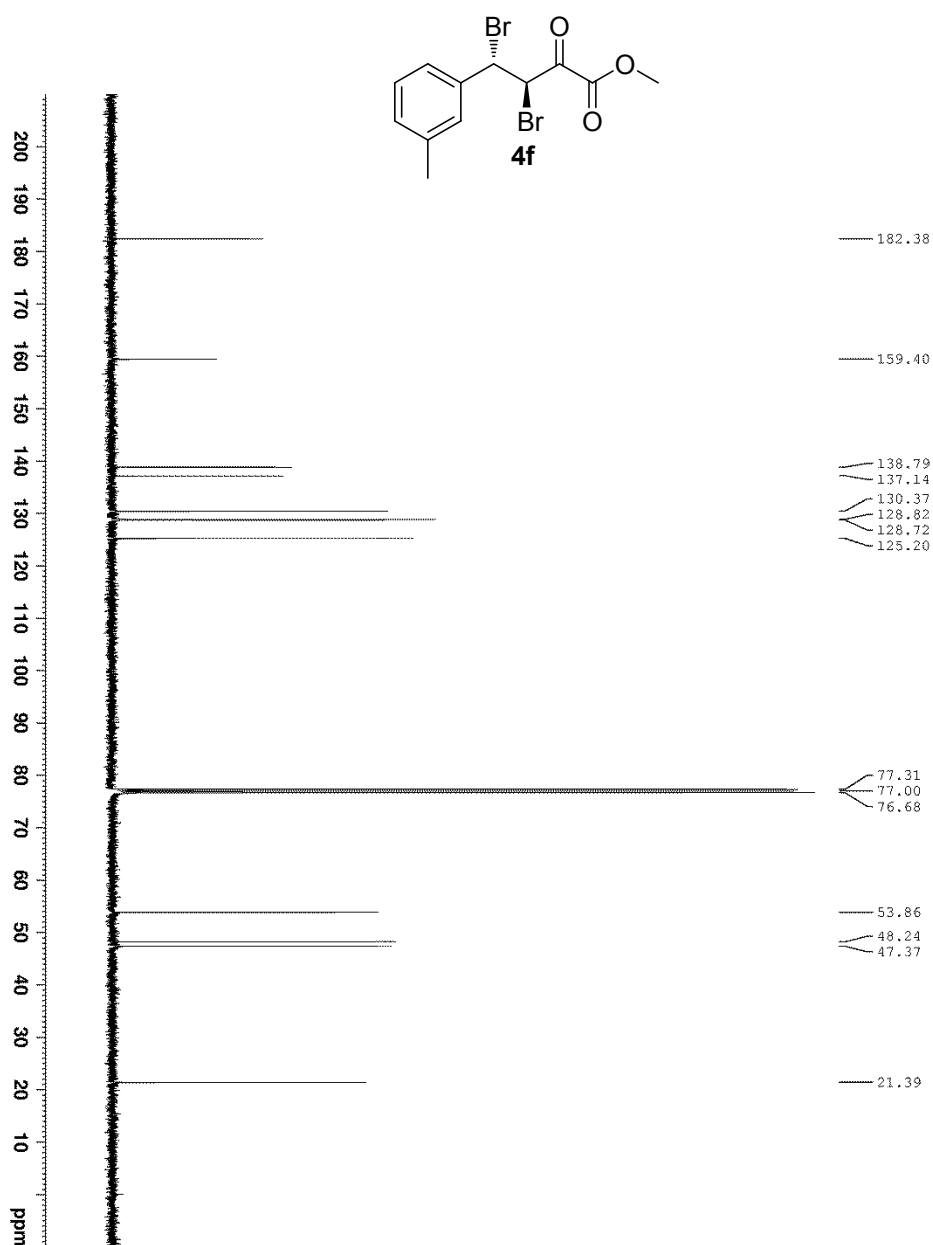


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PROCNO: 1
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F3: 101.624
SOLVENT: CDCl3
NS: 2048
DS: 4
AQ: 0.025
RG: 327.5
RT: 1.00
TE: 300.2
DE: 0.00000000
AQ: 0.025
RG: 327.5
RT: 1.00
TE: 300.2
DE: 0.00000000
NAME: 4e
EXPNO: 1
PROCNO: 1
F2: 101.624
F3: 101.624
SOLVENT: CDCl3
NS: 2048
DS: 4
AQ: 0.025
RG: 327.5
RT: 1.00
TE: 300.2
DE: 0.00000000

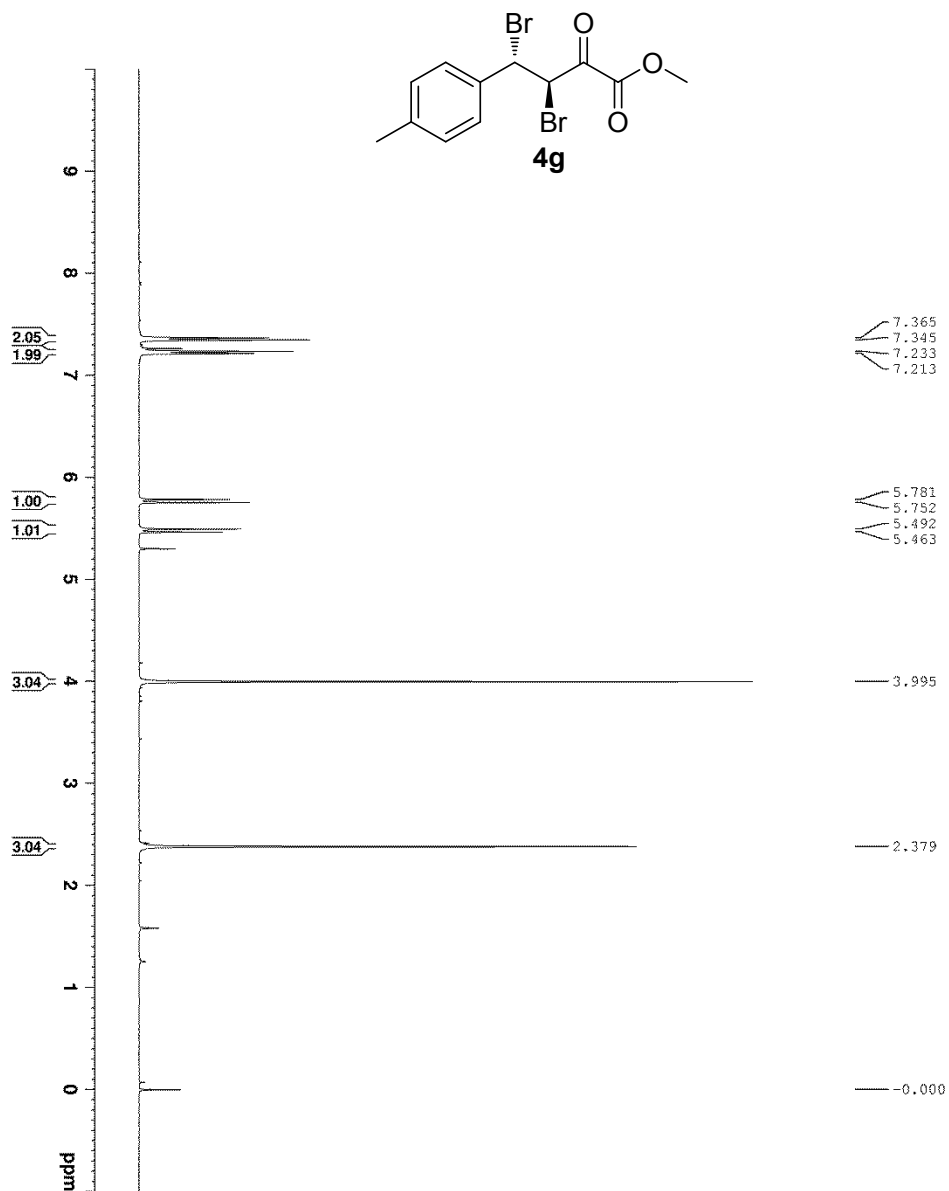
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¹H NMR spectrum of compound **4f** (CDCl₃, 400 MHz)



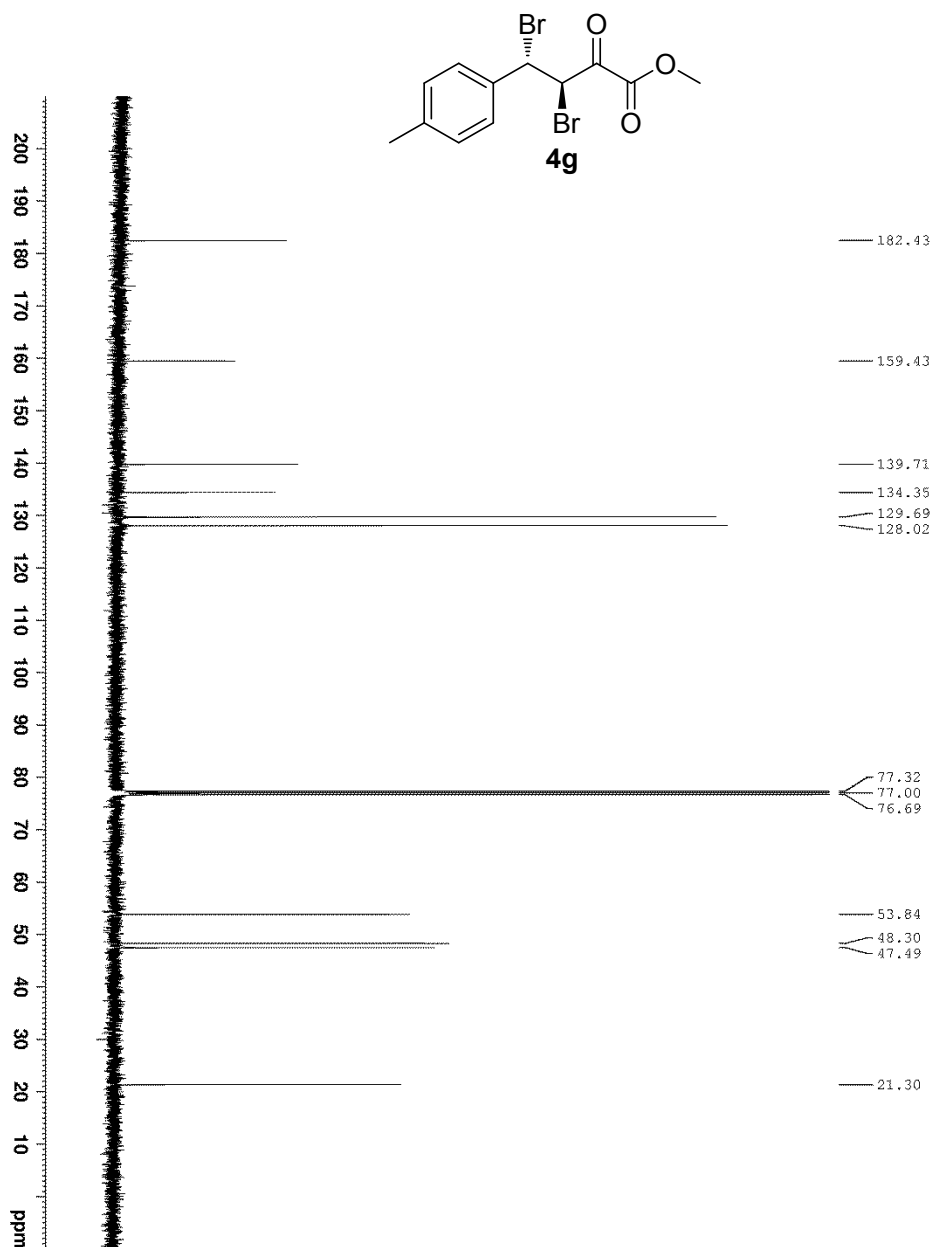
1H NMR (400 MHz, CDCl₃) δ 7.73 (d, 2H, H_A), 7.68 (d, 2H, H_B), 5.39 (s, 1H, H_C), 4.82 (s, 1H, H_D), 4.74 (s, 1H, H_E), 2.14 (s, 3H, H_F).
 13C NMR (100 MHz, CDCl₃) δ 182.38, 159.40, 138.79, 137.14, 130.37, 128.82, 128.72, 125.20, 77.31, 77.00, 76.68, 53.86, 48.24, 47.37, 21.39.

¹H NMR spectrum of compound **4g** (CDCl₃, 400 MHz)



13C NMR (100 MHz, CDCl₃)
 7.365, 7.345, 7.233, 7.213, 5.781, 5.752, 5.492, 5.463, 3.995, 2.379, -0.000
 2.05, 1.99, 1.00, 1.01, 3.04, 3.04

¹³C NMR spectrum of compound **4g** (CDCl₃, 100 MHz)

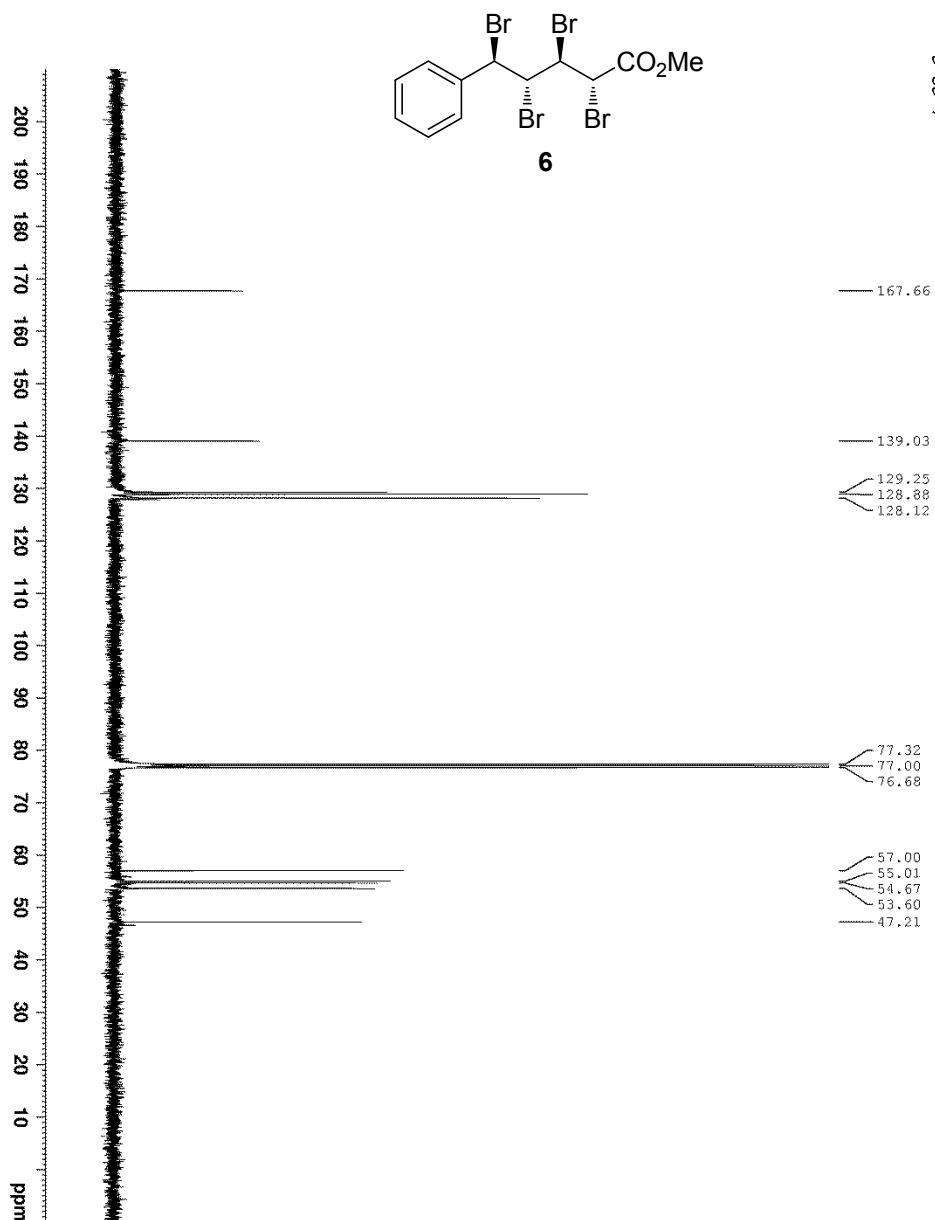


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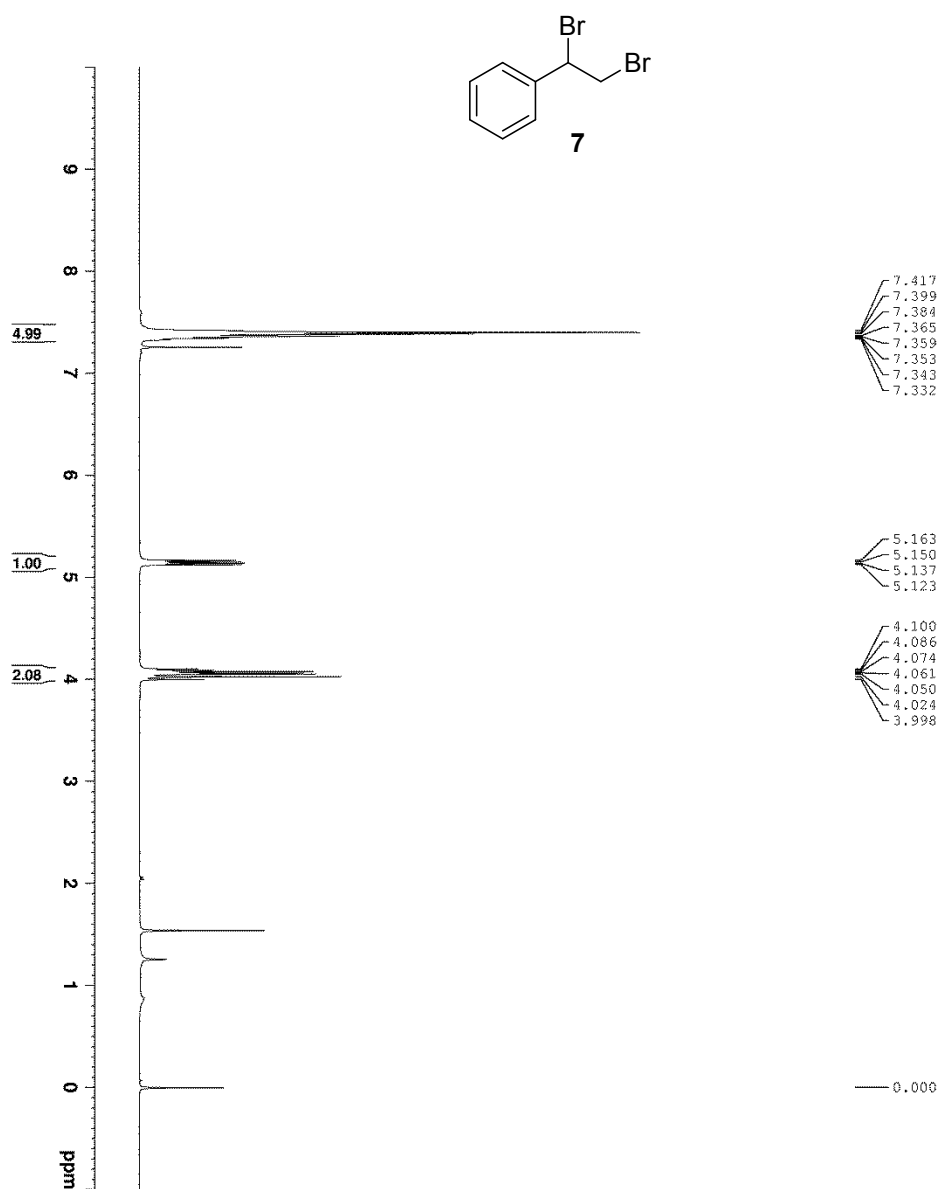
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F100 -> 1

```

¹H NMR spectrum of compound **6** (CDCl₃, 400 MHz)



¹H NMR spectrum of compound **7** (CDCl₃, 400 MHz)

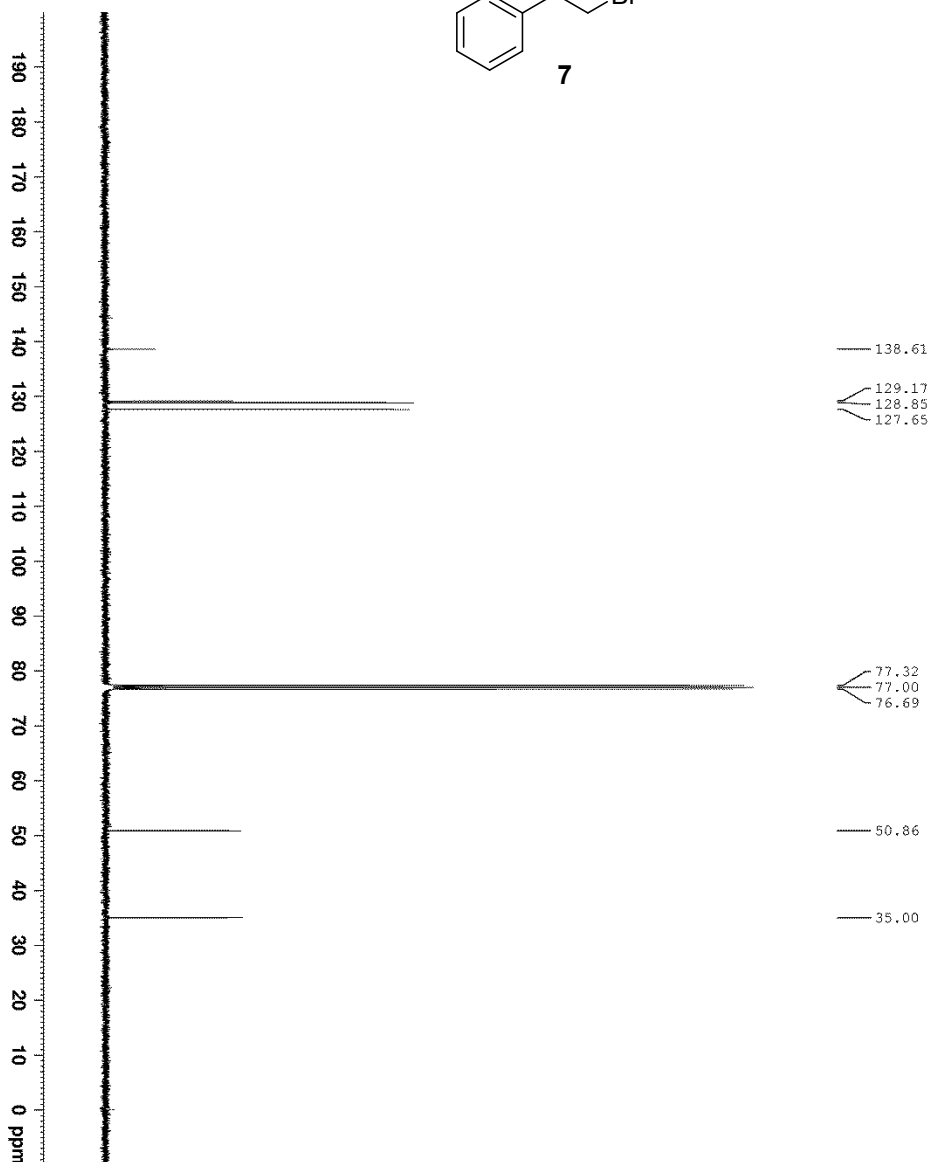
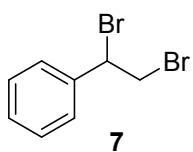


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PROCNO        10
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TD            65536
SOLVENT       CDCl3
NS            14
DS            2
SWH           8012.820 Hz
F2           400.130118 MHz
AQ           62.400 usec
RG           4.0891986 sec
RG2          62.400 usec
RG3          293.7 X
RG4          1.0000000 sec
RG5          1
RG6          1
RG7          1
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RG9          1
RG10         1
RG11         1
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RG98         1
RG99         1
RG100        1

```

^{13}C NMR spectrum of compound **7** (CDCl_3 , 100 MHz)



NAME Y-Y-20140510-5-128-1
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EXPNO 1
PROCNO 1
Date_ 20140510
Time 21.26
INSTRUM spect
PROBHD 5 mm HANCO
PULPROG zgpg30
TD 65536
FIDRES 0.3536
SOLVENT CDCl3
DS 2
AQ 4.00
F2 24036.461 Hz
FIDRES 0.3536 Hz
RG 1.561175
AQ 575 sec
DM 20.800 usec
DE 6.50 usec
TE 300.2 K
D1 2.000000 sec
D11 0.030000 sec
ID0 1
ID6 1
===== CHANNEL f1 =====
STO1 100.628298 MHz
NUC1 13C
P1 120.00 usec
PL1 0.00 dB
SI 32768
SE 100.612714 MHz
WDW EN
SSB 0
GB 1.00 Hz
PC 1.40

9. Reference

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