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Supporting Information

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Highly Regioselective Synthesis of Spriocyclic Compounds *via* Pd-catalyzed Intermolecular Tandem Reaction

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General Remarks:

Column chromatography was carried out on silica gel. ^{1}H NMR spectra were recorded on 300 MHz or 400 MHz in $CDCl_3$ and ^{13}C NMR spectra were recorded on 75 MHz or 100 MHz in $CDCl_3$ using TMS as internal standard. IR spectra were recorded on a FT-IR spectrometer and only major peaks are reported in cm^{-1}. Highresolution mass spectra (HRMS) were obtained by the ESI ionization sources. All products were further characterized by HRMS; copies of their ^{1}H NMR and ^{13}C NMR spectra are provided. Commercially available reagents and solvents were used without further purification.

Starting Materials:

2b,[1] **2c**,[2] **2d**,[2] **2e**,[2] **2f**,[2] **2g**,[1] **2h**,[1] and **2i**[1] were prepared following the published literature procedures. All other commercially available organic halides were used without further purification.

Diethyl 2-(2-(3-hydroxyprop-1-ynyl)benzyl)malonate was prepared according to the literature.[3]

Typical procedure for the preparation of propargylic compounds 1a-e. To a solution of propargylic alcohol (2.0 mmol), pyridine (0.63 g, 8.0 mmol), and DMAP (44.8 mg, 0.4 mmol) in CH_2Cl_2 (10 mL) was added at 0 °C ethyl chloroformate (0.87 g, 8.0 mmol). After stirring for 2 h at room temperature, the reaction mixture was diluted with CH_2Cl_2. The CH_2Cl_2 solution was washed with a saturated aqueous copper sulfate solution, water, dried over anhydrous sodium sulfate, and concentrated. The residue was purified by column chromatography on silica gel to afford the corresponding propargylic compounds.

1a: The **1a** was prepared by the above method, But employing diethyl 2-(2-(3-hydroxyprop-1-ynyl)benzyl)malonate (0.61 g, 2.0 mmol) and ethyl chloroformate (0.87 g, 8.0 mmol) afforded **1a** 0.68 g (90 %) as an oil: ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.45-7.42 (d, *J* = 6.9 Hz, 1H), 7.29-7.18 (m, 3H), 4.99 (s, 2H), 4.28-4.10 (m, 6H), 3.88-3.83 (t, *J* = 7.5 Hz, 1H), 3.36-3.34 (d, *J* = 7.8 Hz, 2H), 1.35-1.31 (m, 3H), 1.23-1.18 (t, *J* = 6.9 Hz, 6H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 168.7, 154.5, 140.2, 132.5, 129.7, 128.9, 126.7, 121.6, 87.1, 84.9, 64.3, 61.2, 55.8, 52.1, 33.4, 14.1, 13.9; IR (neat, cm^{-1}) 1750, 1256, 1153, 790, 762.

1b: The **1b** was prepared by the above method, But employing diethyl 2-(2-(3-hydroxyprop-1-ynyl)benzyl)malonate (0.61 g, 2.0 mmol) and methyl chloroformate (0.76 g, 8.0 mmol) afforded **1b** 0.67 g (92 %) as an oil: ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.45-7.42 (d, *J* = 7.8 Hz, 1H), 7.27-7.19 (m, 3H), 4.99 (s, 2H), 4.21-4.10 (m, 4H), 3.87-3.83 (m, 4H), 3.36-3.33 (d, *J* = 7.8 Hz, 2H), 1.23-1.18 (t, *J* = 7.8 Hz, 6H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 168.8, 155.2, 140.3, 132.6, 129.8, 128.9, 126.7, 121.7, 87.0, 85.1, 61.3, 56.1, 55.1, 52.1, 33.5, 13.9; IR (neat, cm^{-1}) 1754, 1727, 1446, 1372, 1266, 1153, 791, 763.

1c: The **1c** was prepared by the above method, But employing diethyl 2-(2-(3-hydroxyprop-1-ynyl)benzyl)malonate (0.61 g, 2.0 mmol), triethylamine (0.81, 8.0 mmol) and acetic anhydride (0.48 g, 4.0 mmol) afforded **1c** 0.66 g (96 %) as an oil: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45-7.43 (d, *J* = 7.2 Hz, 1H), 7.28-7.17 (m, 3H), 4.93 (s, 2H), 4.20-4.12 (m, 4H), 3.87-3.83 (t, *J* = 8.0 Hz, 1H), 3.36-3.34 (d, *J* = 8.0 Hz, 2H), 2.13 (s, 3H), 1.23-1.19 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.2, 168.8, 140.2, 132.5, 129.8, 128.8, 126.8, 121.8, 87.7, 84.3, 61.3, 52.7, 52.1, 33.5, 20.7, 14.0; IR (neat, cm^{-1}) 1748, 1224, 1029, 763.

1d: The **1d** was prepared by the above method, But employing diethyl 2-(2-(3-hydroxyprop-1-ynyl)benzyl)malonate (0.61 g, 2.0 mmol)，DCC (0.41 g, 2.0 mmol), DMAP (44.8 mg, 0.4 mmol) and benzoic acid (0.49 g, 4.0 mmol) afforded **1e** 0.69 g (84 %) as an oil: ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.12-8.09 (m, 2H) 7.61-7.55 (m, 1H), 7.48-7.44 (m, 3H), 7.27-7.16 (m, 3H), 5.19 (s, 2H), 4.18-4.07 (m, 4H), 3.93-3.88 (t, *J* = 7.5 Hz, 1H), 3.40-3.37 (d, *J* = 8.1 Hz, 2H), 1.20-1.15 (t, *J* = 7.2 Hz, 6H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 168.8, 165.8, 140.2, 133.2, 132.6, 129.8, 129.5, 128.8, 128.4, 126.8, 121.8, 87.8, 84.5, 61.3, 53.3, 52.1, 33.6, 13.9; IR (neat, cm^{-1}) 1728, 1268, 1102, 762, 714.

1e: The **1e** was prepared by the above method, But employing diethyl 2-(2-(3-hydroxyprop-1-ynyl)benzyl)malonate (0.61 g, 2.0 mmol) and diethyl phosphochloridate (0.69 g, 4.0 mmol) afforded **1e** 0.70 g (82 %) as an oil: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45-7.43 (d, *J* = 7.6 Hz, 1H), 7.27-7.19 (m, 3H), 4.95-4.92 (m, 2H), 4.22-4.11 (m, 8H), 3.87-3.83 (t, *J* = 8.0 Hz, 1H), 3.37-3.35 (d, *J* = 7.6 Hz, 2H), 1.38-1.35 (t, *J* = 7.2 Hz, 6H), 1.23-1.18 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.7, 140.1, 132.6, 129.7, 129.0, 126.8, 121.6, 87.6, 85.1, 64.0, 61.3, 55.6, 52.1, 33.4, 16.1, 13.9; IR (neat, cm^{-1}) 2984, 1733, 1274, 1029, 976, 763.

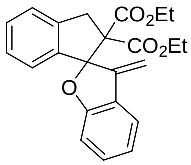
1f: The **1f** was prepared by the above method, But employing diethyl 2-(2-(3-hydroxyprop-1-ynyl)benzyl)malonate (0.61 g, 2.0 mmol) and 2-iodophenyl chloroformate (2.56 g, 8.0 mmol) afforded **1f** 0.88 g (80 %) as an oil: ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.84-7.81 (m, 1H), 7.48-7.45 (d, *J* = 7.8 Hz, 1H), 7.40-7.35 (m, 1H), 7.26-7.18 (m, 4H), 7.02-6.97 (m, 1H), 5.14 (s, 2H), 4.19-4.08 (m, 4H), 3.91-3.86 (t, *J* = 8.4 Hz, 1H), 3.39-3.37 (d, *J* = 8.1 Hz, 2H), 1.20-1.16 (t, *J* = 7.2 Hz, 6H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 168.7, 152.2, 151.0, 140.2, 139.4, 132.6, 129.7, 129.5, 129.0, 127.9, 126.7, 122.4, 121.4, 89.7, 86.3, 85.6, 61.3, 57.1, 52.1, 33.4, 13.9; IR (neat, cm^{-1}) 2982, 1771, 1730, 1467, 1371, 1213, 1153, 1035, 764.

1g: The **1g** was prepared by the above method, But employing diethyl 2-(2-(3-hydroxyprop-1-ynyl)benzyl)malonate (0.61 g, 2.0 mmol) and 2-bromophenyl chloroformate (1.87 g, 8.0 mmol) afforded **1g** 0.80 g (80 %) as an oil: ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.63-7.60 (m, 1H), 7.47-7.45 (d, *J* = 6.6 Hz, 1H), 7.35-7.12 (m, 6H), 5.14 (s, 2H), 4.18-4.09 (m, 4H), 3.90-3.85 (t, *J* = 7.5 Hz, 1H), 3.39-3.36 (d, *J* = 7.5 Hz, 2H), 1.21-1.16 (t, *J* = 7.2 Hz, 6H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 168.8, 152.2, 148.2, 140.3, 133.4, 132.7, 129.8, 129.1, 128.6, 127.7, 126.8, 123.2, 121.5, 115.9, 86.3, 85.7, 61.3, 57.2, 52.1, 33.5, 13.9; IR (neat, cm^{-1}) 2926, 1772, 1731, 1240, 1219, 1039, 764.

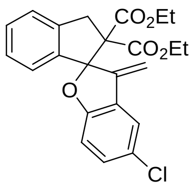
[1] K. J. Edgar, S. N. Falling, *J. Org. Chem.* **1990**, *55*, 5287.
[2] F. G. Schreiber, R. Stevenson, *J. Chem. Soc., Perkin Trans. 1* **1977**, 90.
[3] H. -P. Bi, L. -N. Guo, X. -H. Duan, F. -R. Gou, S. -H. Huang, X. -Y. Liu, Y. -M. Liang, *Org. Lett.* **2007**, *9*, 397.

General procedure for the preparation of spriocyclic compounds.

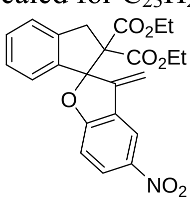
To a solution of Propargylic Compounds **1** (0.20 mmol) in DMF (2.0 mL) was added Cs_2CO_3 (130.4 mg, 0.40 mmol). The mixture was stirred for 5 min and $Pd(PPh_3)_4$ (11.5 mg, 0.01mmol, 5 mol %), and aryl halides **2** (0.30 mmol) were added. The resulting mixture was then heated under an argon atmosphere at 100°C. When the reaction was considered complete as determined by TLC analysis, the reaction mixture was allowed to cool to room temperature and quenched with a saturated aqueous solution of ammonium chloride, and the mixture was extracted with EtOAc. The combined organic extracts were washed with water and saturated brine. The organic layers were dried over Na_2SO_4, filtered. Solvents were evaporated under reduced pressure. The residue was purified by chromatography on silica gel to afford spriocyclic compounds **3**.



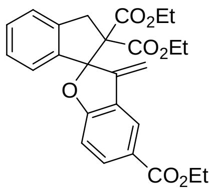
3a: The reaction mixture was chromatographed using 40:1 hexanes/EtOAc to afford 51.4 mg (68%) of the indicated compound as an oil: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43-7.41 (m, 1H), 7.34-7.33 (m, 2H), 7.26-7.22 (m, 2H), 7.11-7.09 (d, *J* = 7.2 Hz, 1H), 6.97-6.93 (t, *J* = 6.8 Hz, 1H), 6.85-6.83 (d, *J* = 8.0 Hz, 1H), 5.58 (s, 1H), 4.78 (s, 1H), 4.06-3.98 (m, 4H), 3.73-3.60 (q, *J* = 16.8 Hz, 2H), 0.96-0.92 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.9, 168.7, 160.9, 147.6, 143.4, 140.3, 130.5, 129.4, 127.6, 126.7, 124.5, 123.6, 120.9, 120.4, 110.1, 104.5, 99.4, 71.1, 61.3, 38.6, 13.4; IR (neat, cm^{-1}) 1735, 1465, 1284, 1251, 1177, 1096, 1014, 754; HRMS calcd for $C_{23}H_{23}O_5$ $[M+H]^+$ 379.1540, found 379.1543.



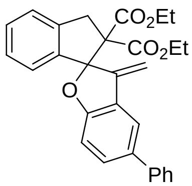
3b: The reaction mixture was chromatographed using 40:1 hexanes/EtOAc to afford 54.4 mg (66%) of the indicated compound as an oil: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39-7.34 (m, 3H), 7.26-7.24 (m, 1H), 7.20-7.18 (m, 1H), 7.09-7.07 (d, *J* = 8.0 Hz, 1H), 6.77-6.75 (d, *J* = 8.4 Hz, 1H), 5.59 (s, 1H), 4.85 (s, 1H), 4.06-3.99 (m, 4H), 3.73-3.57 (q, *J* = 16.4 Hz, 2H), 1.02-0.97 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.6, 168.4, 159.3, 146.5, 142.9, 140.5, 130.2, 129.7, 128.5, 127.6, 126.1, 124.6, 123.6, 120.4, 111.1, 106.2, 100.3, 71.1, 61.4, 38.7, 13.5; IR (neat, cm^{-1}) 1737, 1467, 1286, 1251, 1098, 763, 732; HRMS calcd for $C_{23}H_{22}ClO_5$ $[M+H]^+$ 413.1150, found 413.1154.



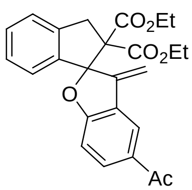
3c: The reaction mixture was chromatographed using 40:1 hexanes/EtOAc to afford 62.6 mg (74%) of the indicated compound as an oil: ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.35-8.34 (d, *J* = 2.4 Hz, 1H), 8.24-8.21 (m, 1H), 7.40-7.38 (m, 2H), 7.28-7.26 (m, 1H), 7.09-7.07 (m, 1H), 6.89-6.87 (d, *J* = 8.4 Hz, 1H), 5.83-5.82 (d, *J* = 0.8 Hz, 1H), 5.02-5.02 (d, *J* = 0.8 Hz, 1H), 4.08-4.00 (m, 4H), 3.78-3.58 (q, *J* = 16.8 Hz, 2H), 1.05-0.96 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.2, 165.0, 144.5, 142.4, 141.9, 140.8, 130.2, 128.3, 127.8, 127.1, 124.7, 123.7, 116.7, 110.1, 108.7, 102.0, 71.1, 61.6, 38.7, 13.6; IR (neat, cm^{-1}) 1735, 1522, 1468, 1340, 1273, 1251, 762, 739; HRMS calcd for $C_{23}H_{22}NO_7$ $[M+H]^+$ 424.1391, found 424.1389.



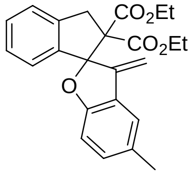
3d: The reaction mixture was chromatographed using 40:1 hexanes/EtOAc to afford 72.9 mg (81%) of the indicated compound as an oil: ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.14-8.14 (d, *J* = 1.8 Hz, 1H), 8.02-7.98 (m, 1H), 7.35-7.34 (m, 2H), 7.26-7.23 (m, 1H), 7.08-7.06 (d, *J* = 7.5 Hz, 1H), 6.86-6.83 (d, *J* = 8.7 Hz, 1H), 5.72 (s, 1H), 4.88 (s, 1H), 4.41-4.33 (m, 2H), 4.06-3.97 (m, 4H), 3.76-3.58 (q, *J* = 16.2 Hz, 2H), 1.43-1.35 (m, 3H), 1.00-0.92 (m, 6H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 168.5, 168.4, 166.3, 164.1, 145.9, 142.6, 140.5, 132.8, 129.7, 127.6, 127.3, 124.5, 123.6, 123.5, 122.3, 109.8, 106.3, 100.8, 71.0, 61.4, 60.8, 38.6, 14.3, 13.5; IR (neat, cm^{-1}) 1730, 1715, 1609, 1287, 1264, 1109, 1016, 761; HRMS calcd for $C_{26}H_{30}NO_7$ $[M+NH_4]^+$ 468.2017, found 468.2012.



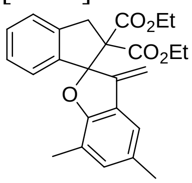
3e: The reaction mixture was chromatographed using 40:1 hexanes/EtOAc to afford 64.5 mg (71%) of the indicated compound as an oil: ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.62-7.62 (d, *J* = 1.5 Hz, 1H), 7.57-7.55 (m, 2H), 7.49-7.40 (m, 3H), 7.34-7.33 (m, 3H), 7.27-7.23 (m, 1H), 7.14-7.11 (d, *J* = 7.8 Hz, 1H), 6.91-6.88 (d, *J* = 8.4 Hz, 1H), 5.65-5.65 (d, *J* = 0.6 Hz, 1H), 4.83 (s, 1H), 4.08-3.98 (m, 4H), 3.76-3.59 (q, *J* = 16.2 Hz, 2H), 0.99-0.94 (m, 6H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 168.8, 168.7, 160.5, 147.4, 143.2, 141.1, 140.4, 134.6, 129.7, 129.5, 128.8, 127.6, 127.3, 126.8, 124.5, 123.7, 119.0, 110.3, 105.0, 100.1, 71.1, 61.4, 61.3, 38.7, 13.5, 13.4; IR (neat, cm^{-1}) 2925, 1735, 1472, 1283, 1255, 761; HRMS calcd for $C_{29}H_{30}NO_5$ $[M+NH_4]^+$ 472.2118, found 472.2123.



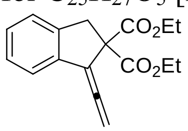
3f: The reaction mixture was chromatographed using 40:1 hexanes/EtOAc to afford 66.4 mg (79%) of the indicated compound as an oil: ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.09-8.09 (d, *J* = 1.8 Hz, 1H), 7.94-7.91 (m, 1H), 7.36-7.23 (m, 3H), 7.08-7.06 (d, *J* = 7.5 Hz, 1H), 6.88-6.85 (d, *J* = 8.1 Hz, 1H), 5.74 (s, 1H), 4.90 (s, 1H), 4.06-3.99 (m, 4H), 3.76-3.58 (q, *J* = 16.5 Hz, 2H), 2.60 (s, 3H), 1.00-0.93 (m, 6H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 196.5, 168.4, 168.3, 164.3, 145.8, 142.5, 140.6, 132.1, 131.0, 129.8, 127.6, 127.5, 124.6, 123.6, 121.0, 109.8, 106.6, 100.9, 71.0, 61.4, 38.6, 26.5, 13.5; IR (neat, cm^{-1}) 1735, 1677, 1605, 1261, 763, 730; HRMS calcd for $C_{25}H_{28}NO_6$ $[M+NH_4]^+$ 438.1911, found 438.1915.



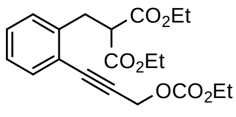
3g: The reaction mixture was chromatographed using 40:1 hexanes/EtOAc to afford 49.4 mg (63%) of the indicated compound as an oil: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33-7.32 (m, 2H), 7.26-7.20 (m, 2H), 7.10-7.03 (m, 2H), 6.74-6.72 (d, *J* = 8.4 Hz, 1H), 5.53 (s, 1H), 4.74 (s, 1H), 4.05-3.98 (m, 4H), 3.72-3.59 (q, *J* = 16.8 Hz, 2H), 0.99-0.94 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.9, 168.7, 159.1, 147.9, 143.6, 140.4, 131.2, 130.2, 129.3, 127.5, 126.6, 124.5, 123.6, 120.6, 109.7, 104.0, 99.6, 71.1, 61.2, 38.7, 20.8, 13.5; IR (neat, cm^{-1}) 1735, 1484, 1283, 1251, 1095, 810, 762; HRMS calcd for $C_{24}H_{25}O_5$ $[M+H]^+$ 393.1697, found 393.1702.



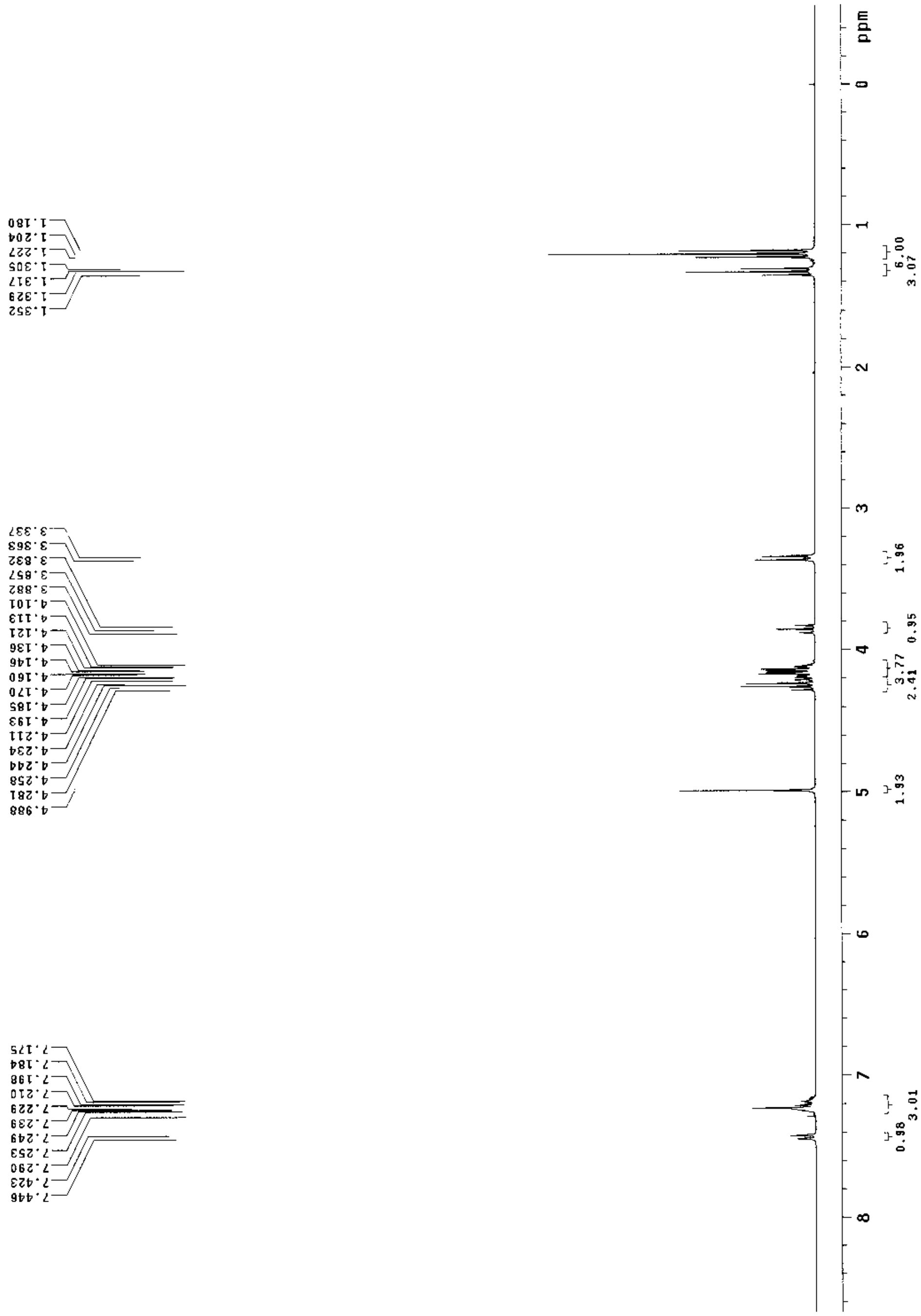
3h: The reaction mixture was chromatographed using 40:1 hexanes/EtOAc to afford 28.4 mg (35%) of the indicated compound as an oil: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33-7.32 (m, 2H), 7.24-7.21 (m, 1H), 7.09-7.05 (m, 2H), 6.87 (s, 1H), 5.49 (s, 1H), 4.71 (s, 1H), 4.07-3.91 (m, 4H), 3.76-3.55 (q, *J* = 16.4 Hz, 2H), 2.30 (s, 3H), 2.12 (s, 3H), 0.97-0.94 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.0, 168.8, 157.7, 148.6, 143.8, 140.7, 132.3, 130.1, 129.2, 127.4, 126.0, 124.3, 123.8, 119.7, 118.0, 103.8, 99.4, 71.4, 61.2, 61.1, 38.7, 20.8, 14.7, 13.5, 13.4; IR (neat, cm^{-1}) 1735, 1480, 1284, 1258, 1224, 762; HRMS calcd for $C_{25}H_{27}O_5$ $[M+H]^+$ 407.1853, found 407.1856.



4a: To a solution of 3-(2-(2,2-di(ethoxycarbonyl)ethyl)phenyl)prop-2-ynyl ethyl carbonate **1a** (75.2 mg, 0.20 mmol) in DMF (2.0 mL) was Cs_2CO_3 (130.4 mg, 0.40 mmol). The mixture was stirred for 5 min and $Pd(PPh_3)_4$ (11.5 mg, 0.01mmol, 5 mol %) was added. The resulting mixture was then heated under an argon atmosphere at 100°C. When the reaction was considered complete as determined by TLC analysis, the reaction mixture was allowed to cool to room temperature and quenched with a saturated aqueous solution of ammonium chloride, and the mixture was extracted with EtOAc. The combined organic extracts were washed with water and saturated brine. The organic layers were dried over Na_2SO_4, filtered. Solvents were evaporated under reduced pressure. The residue was purified by chromatography on silica gel to afford **4a** 52.1 mg (91%) as an oil: ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.25-7.19 (m, 4H), 5.38 (s, 2H), 4.26-4.20 (q, *J* = 6.9 Hz, 4H), 3.70 (s, 2H), 1.28-1.24 (t, *J* = 7.2 Hz, 6H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 206.1, 169.9, 139.4, 136.6, 128.1, 127.4, 124.5, 122.4, 82.5, 62.3, 61.9, 39.7, 14.1; IR (neat, cm^{-1}) 1734, 1247, 1179, 1057, 860, 764; HRMS calcd for $C_{17}H_{19}O_4$ $[M+H]^+$ 287.1278, found 287.1280.


CO2Et
CO2Et
OCO2Et

1a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1.305
1.317
1.329
1.352
3.337
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3.857
3.882
4.101
4.113
4.121
4.136
4.146
4.160
4.170
4.185
4.193
4.211
4.234
4.244
4.258
4.281
4.988
7.175
7.184
7.198
7.210
7.229
7.239
7.249
7.253
7.290
7.423
7.446
6.00
3.07
1.96
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2.41
1.93
0.98
3.01
ppm
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7
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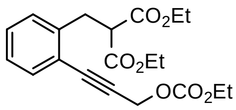
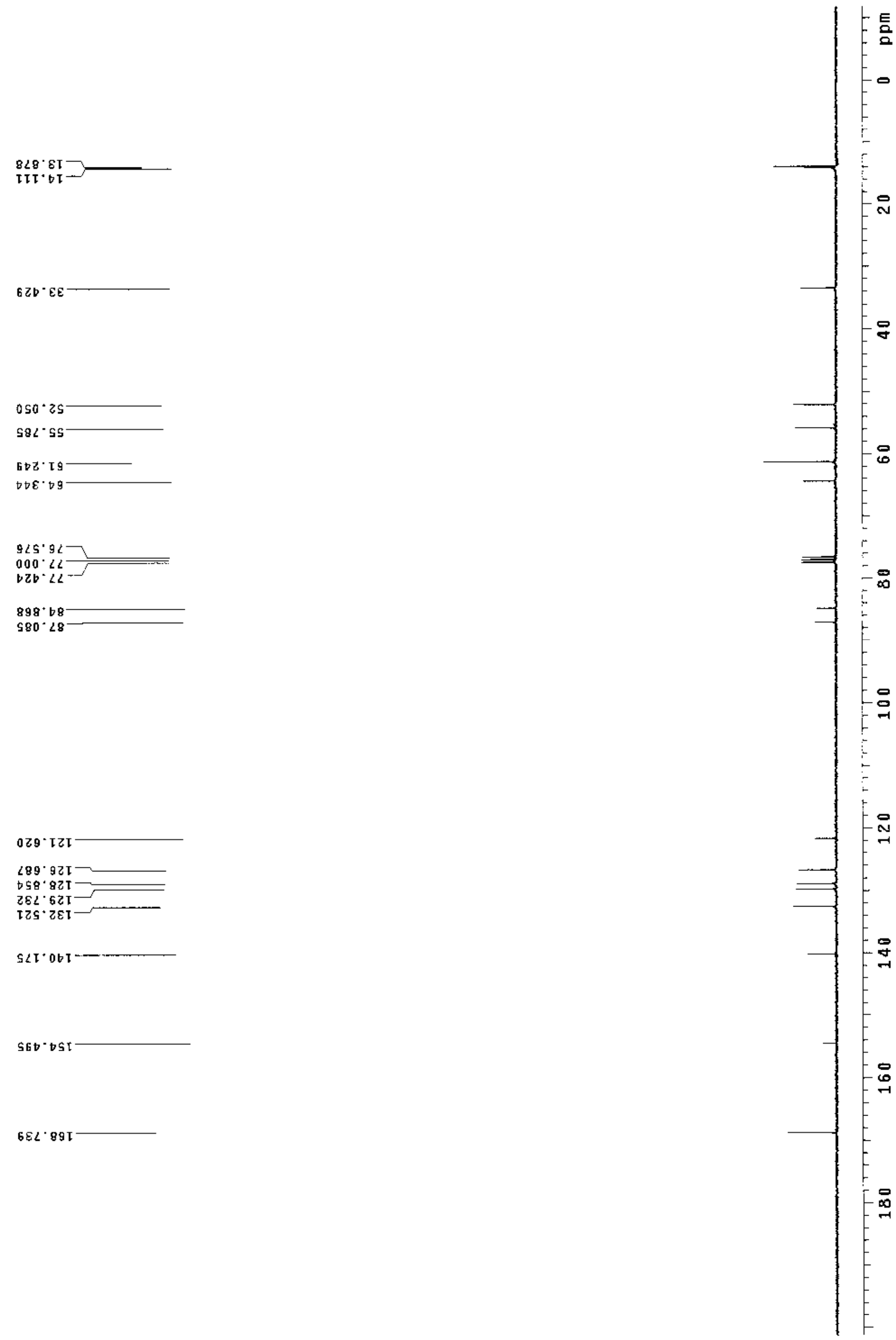

CO2Et
CO2Et
OCO2Et
1a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77.424
84.868
87.085
121.620
126.687
128.854
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140.175
154.495
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ppm
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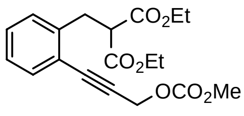

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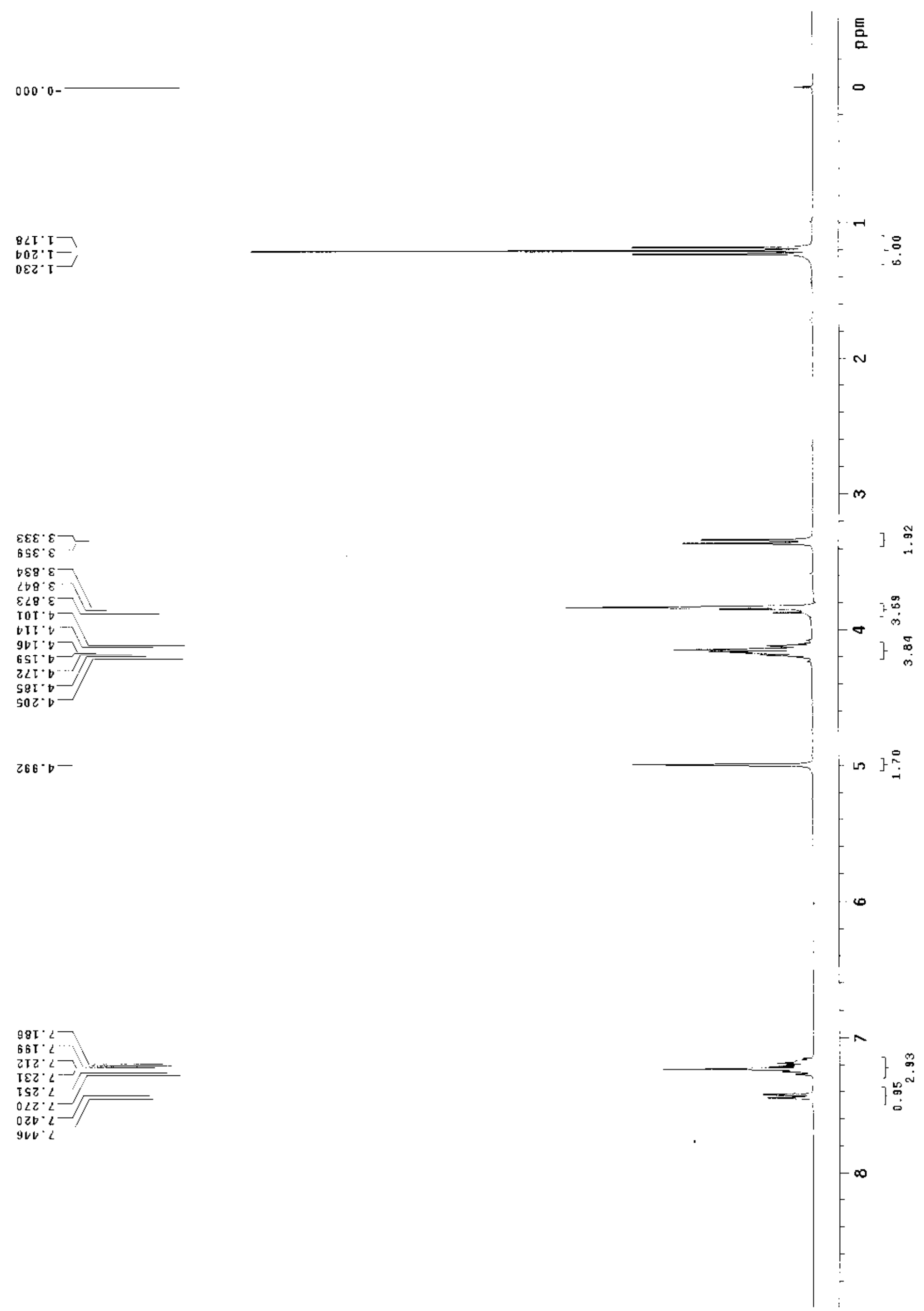
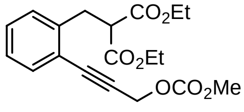
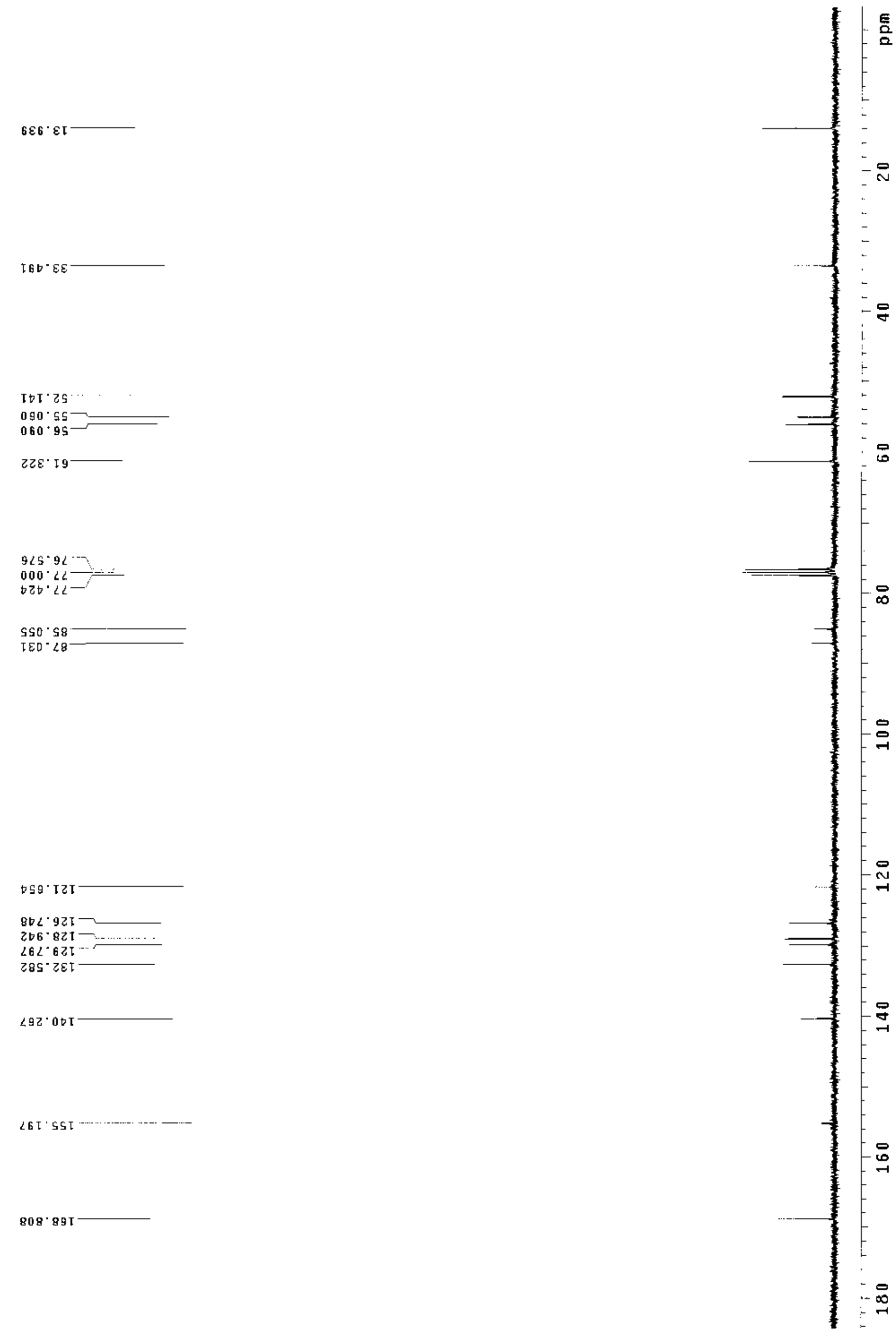



CO2Et
CO2Et
OCO2Me

1b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77.000
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85.055
87.031
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126.748
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140.267
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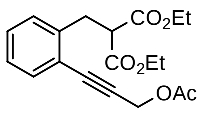

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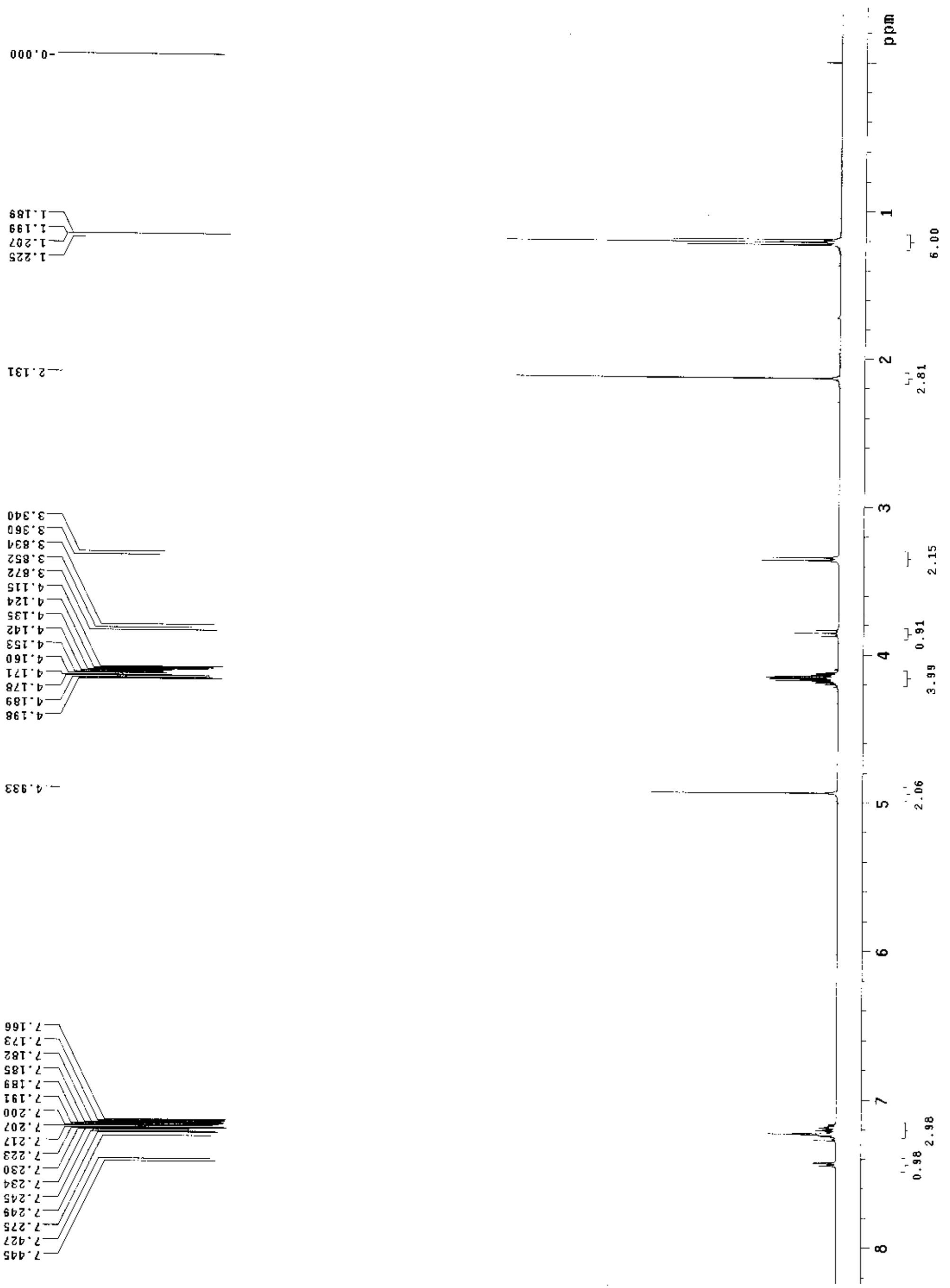
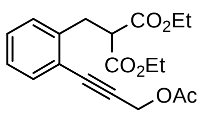
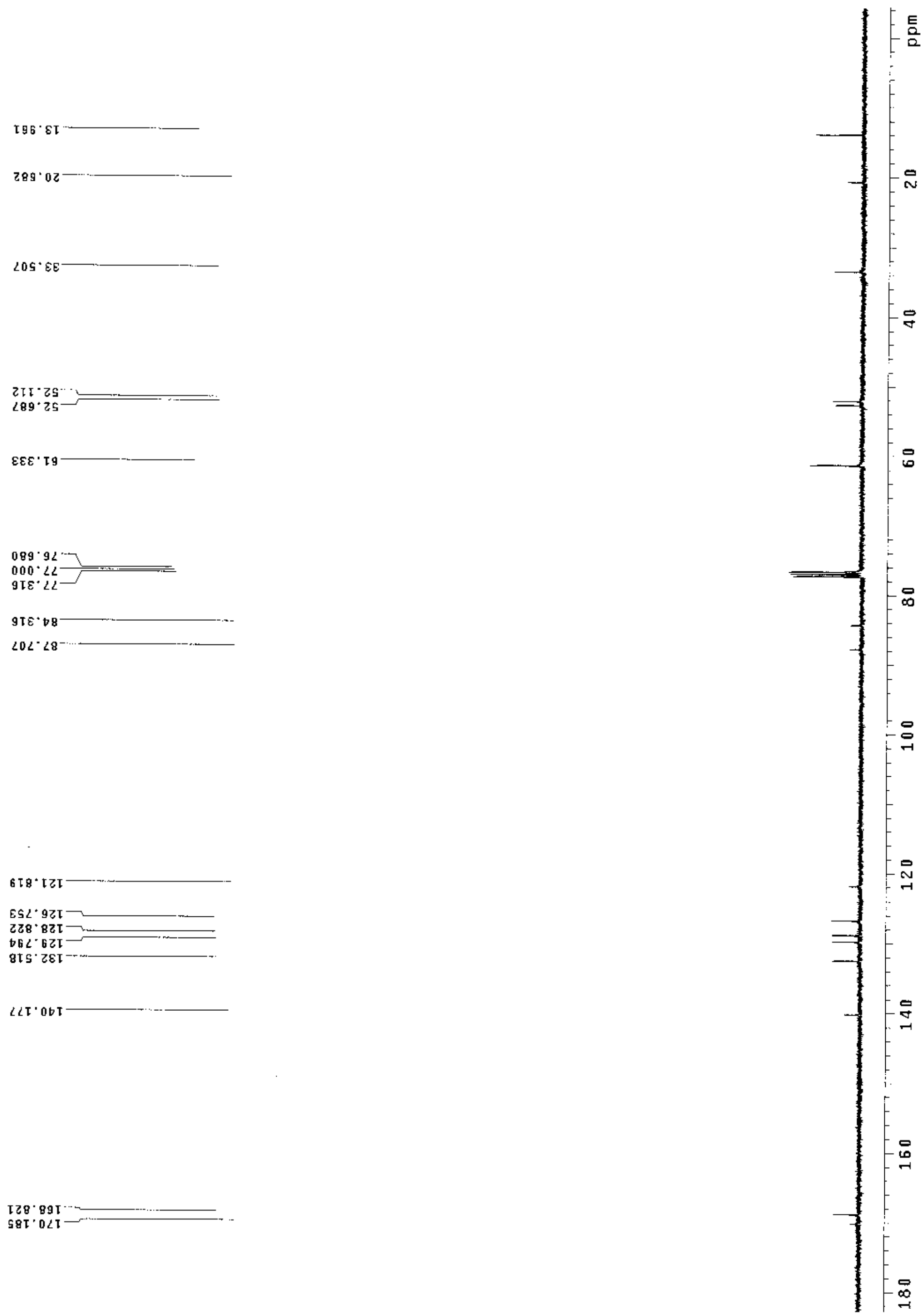



CO2Et
CO2Et
OAc
1c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87.707
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126.753
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170.185
ppm
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40
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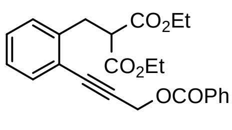
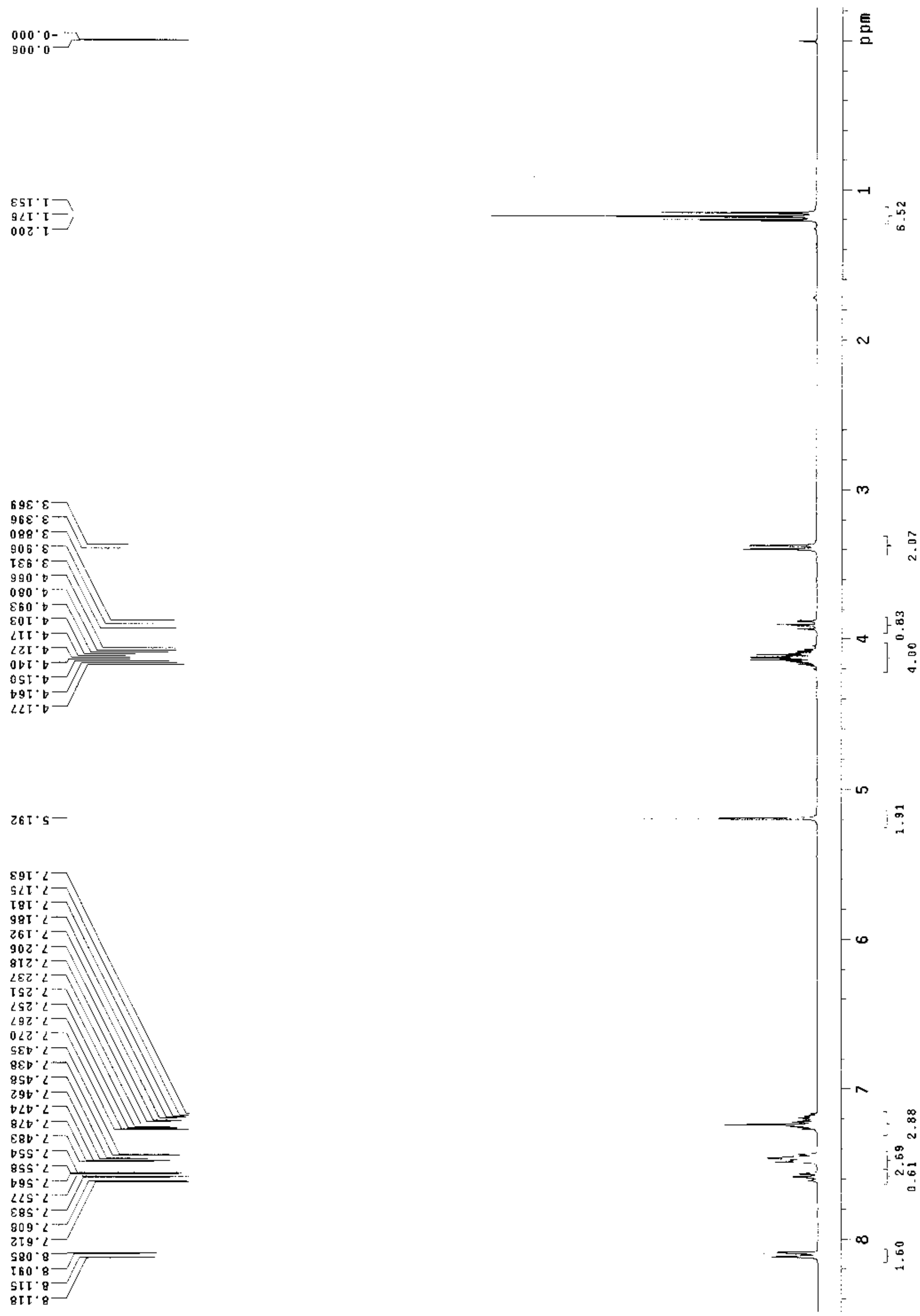
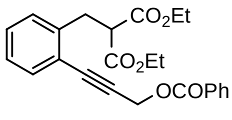
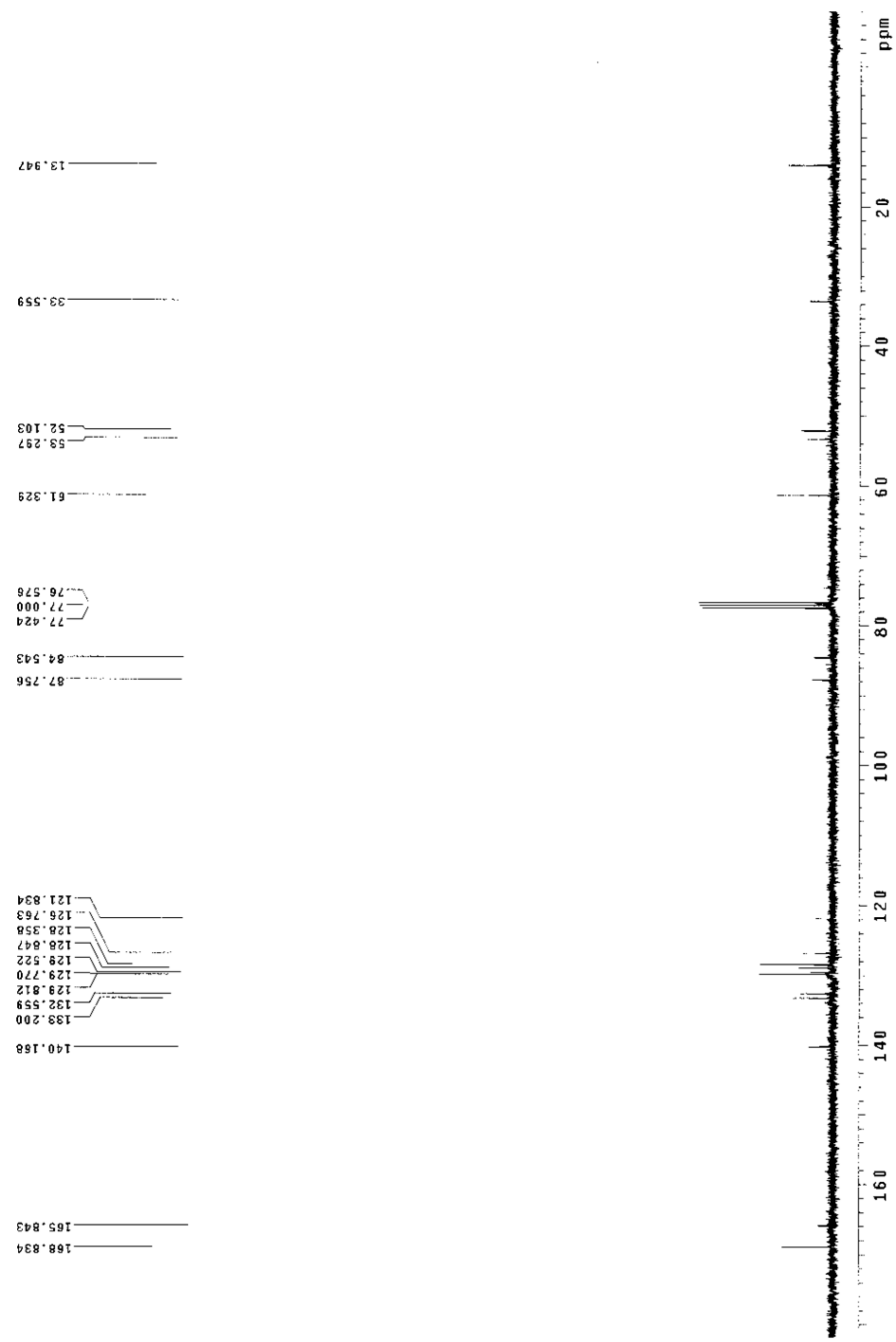


1d




CO$_2$Et
CO$_2$Et
OCOPh
1d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61.329
76.576
77.000
77.424
84.543
87.756
121.834
126.763
128.358
128.647
129.522
129.770
129.812
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133.200
140.168
165.843
168.834
ppm
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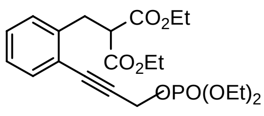
80
100
120
140
160



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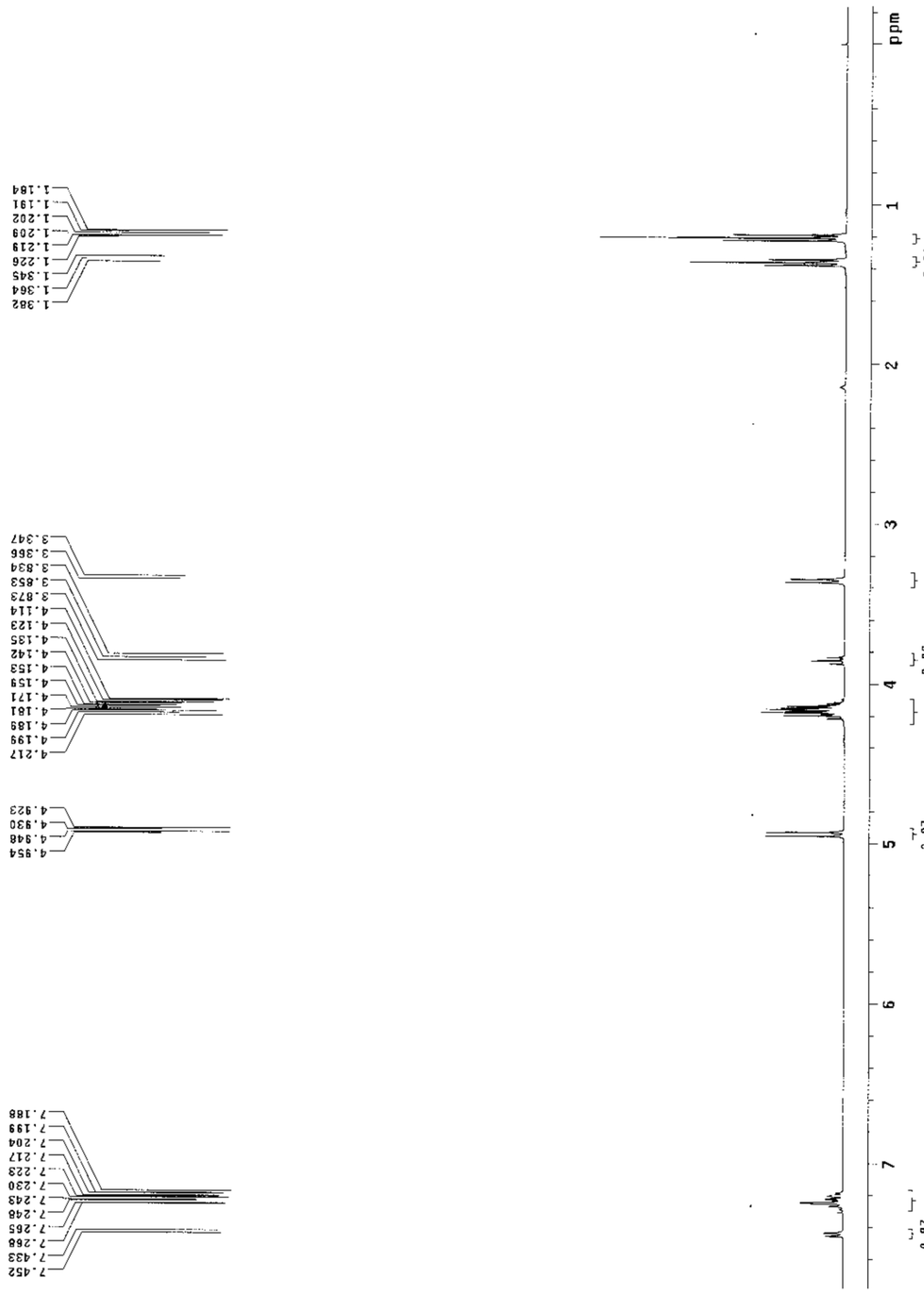
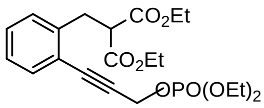
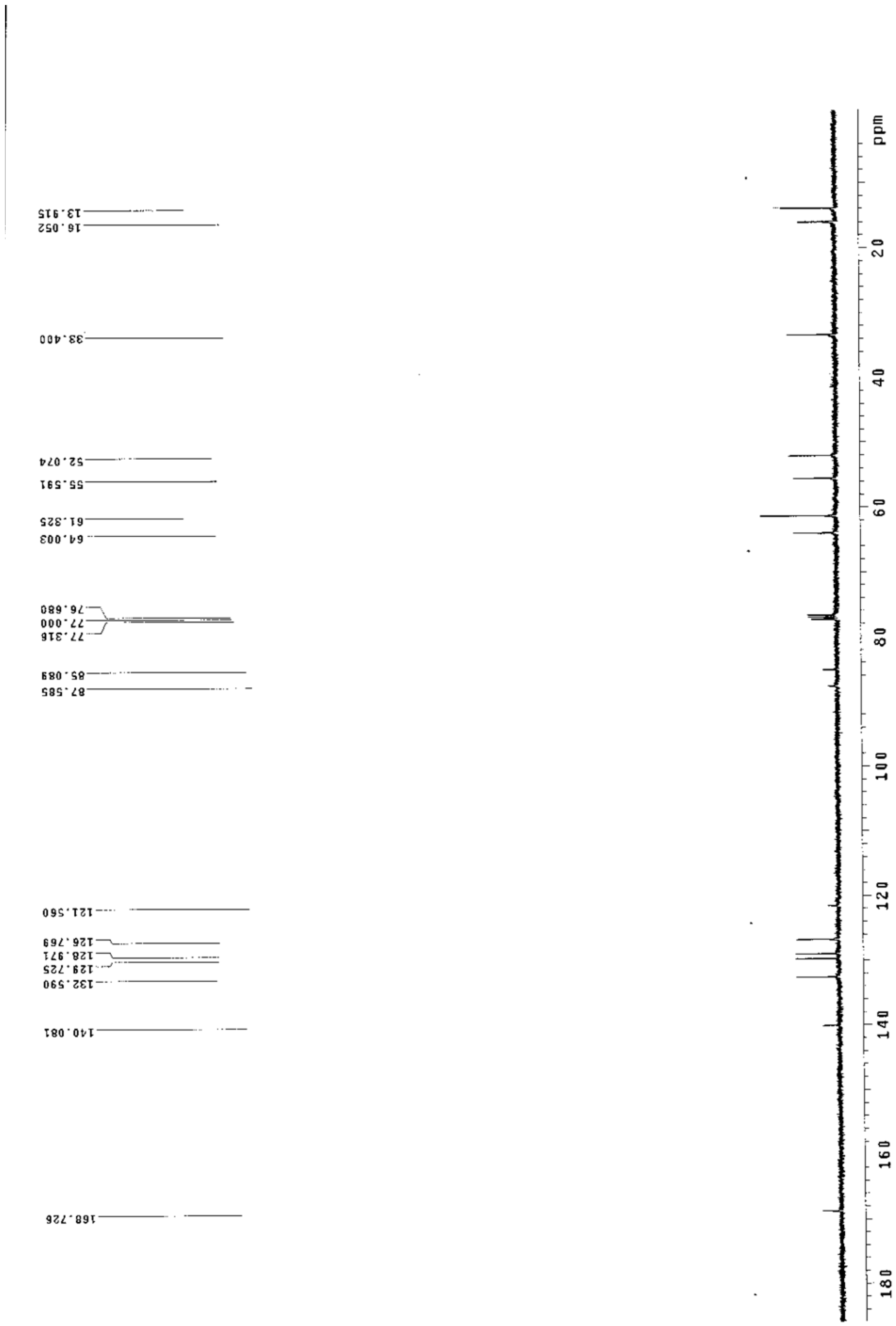



CO2Et
CO2Et
OPO(OEt)2

1e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64.003
76.680
77.000
77.316
85.089
87.585
121.560
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132.590
140.081
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ppm
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120
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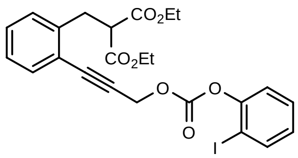
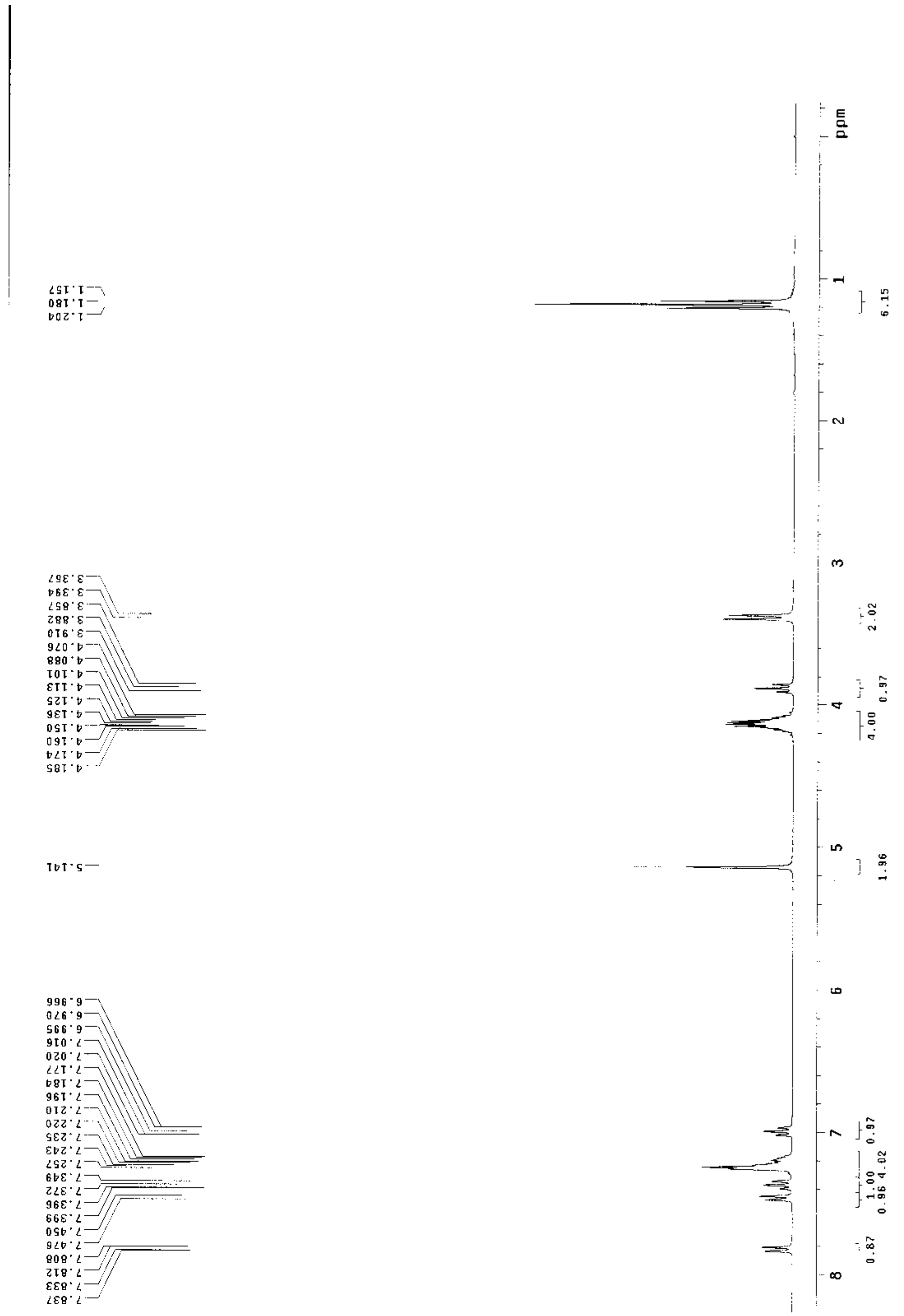
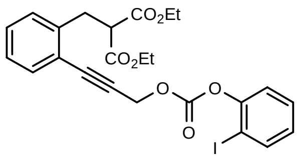
160
180

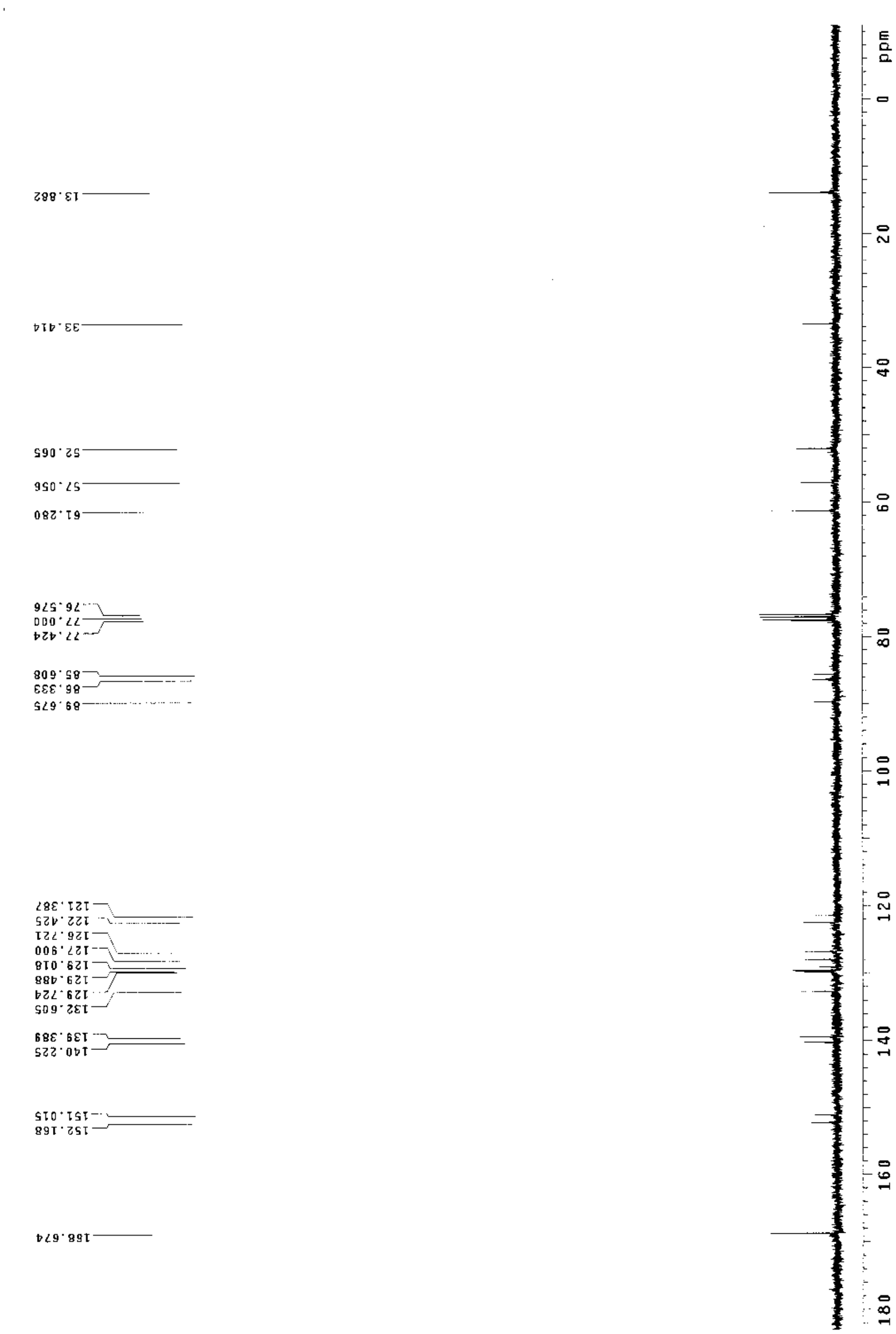


1f




CO2Et
CO2Et
O
O
O
O
I

1f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77.000
77.424
85.608
86.339
89.675
121.387
122.425
126.721
127.900
129.018
129.488
129.724
132.605
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151.015
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168.674
ppm
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40
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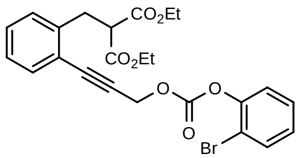
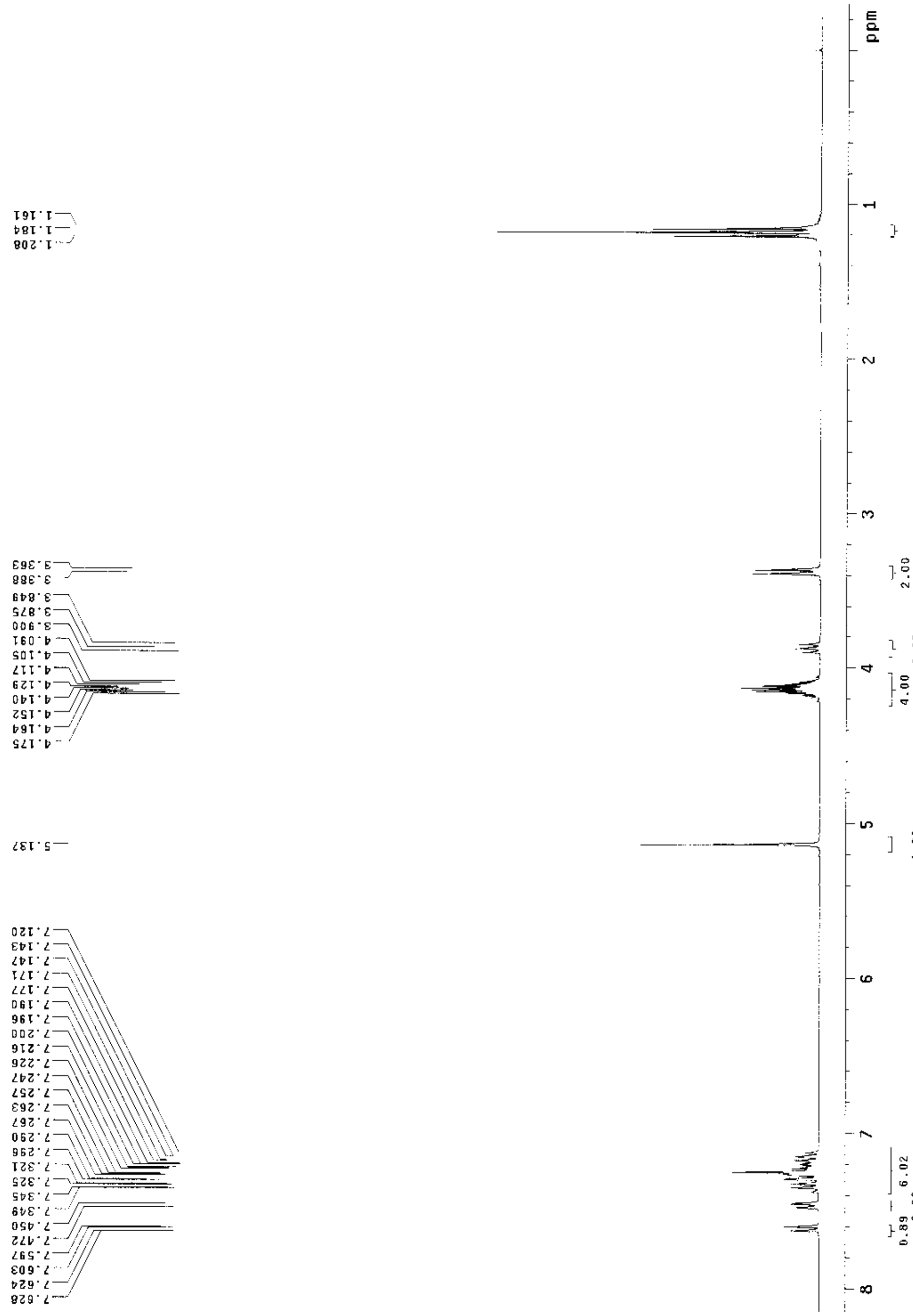
120
140
160
180



CO2Et
CO2Et
O
O
O
Br

1g



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3.875
3.900
4.091
4.105
4.117
4.129
4.140
4.152
4.164
4.175
5.137
7.120
7.143
7.147
7.171
7.177
7.190
7.196
7.200
7.216
7.226
7.247
7.257
7.263
7.267
7.290
7.296
7.321
7.325
7.345
7.349
7.450
7.472
7.597
7.603
7.624
7.628
ppm
1
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4.00
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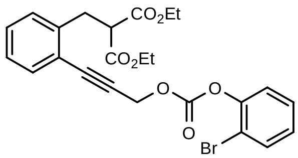
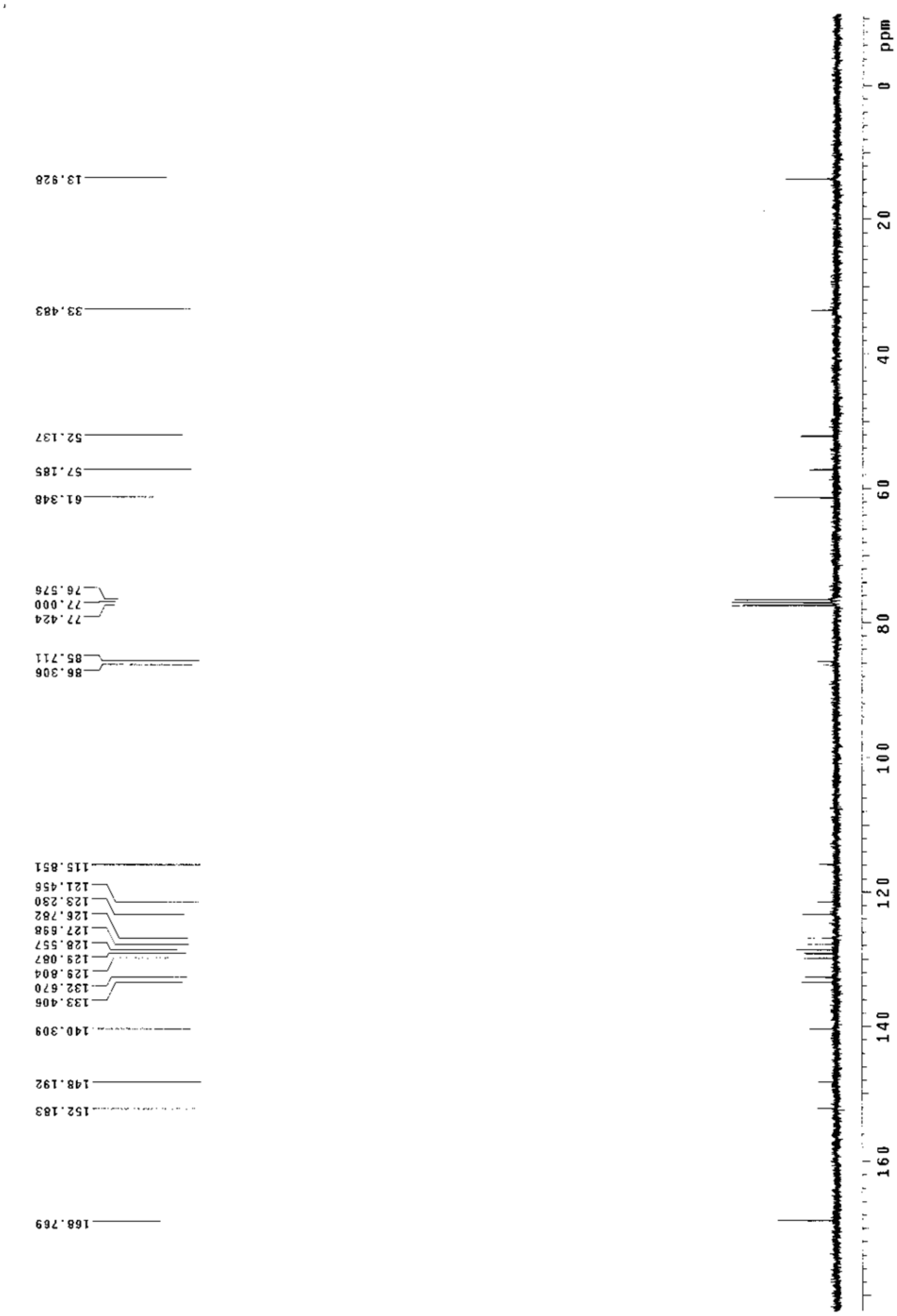
0.89
0.96


CO2Et
CO2Et
O
O
O
Br

1g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126.782
127.698
128.557
129.087
129.804
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ppm
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100
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140
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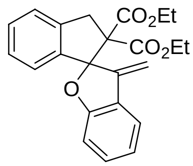
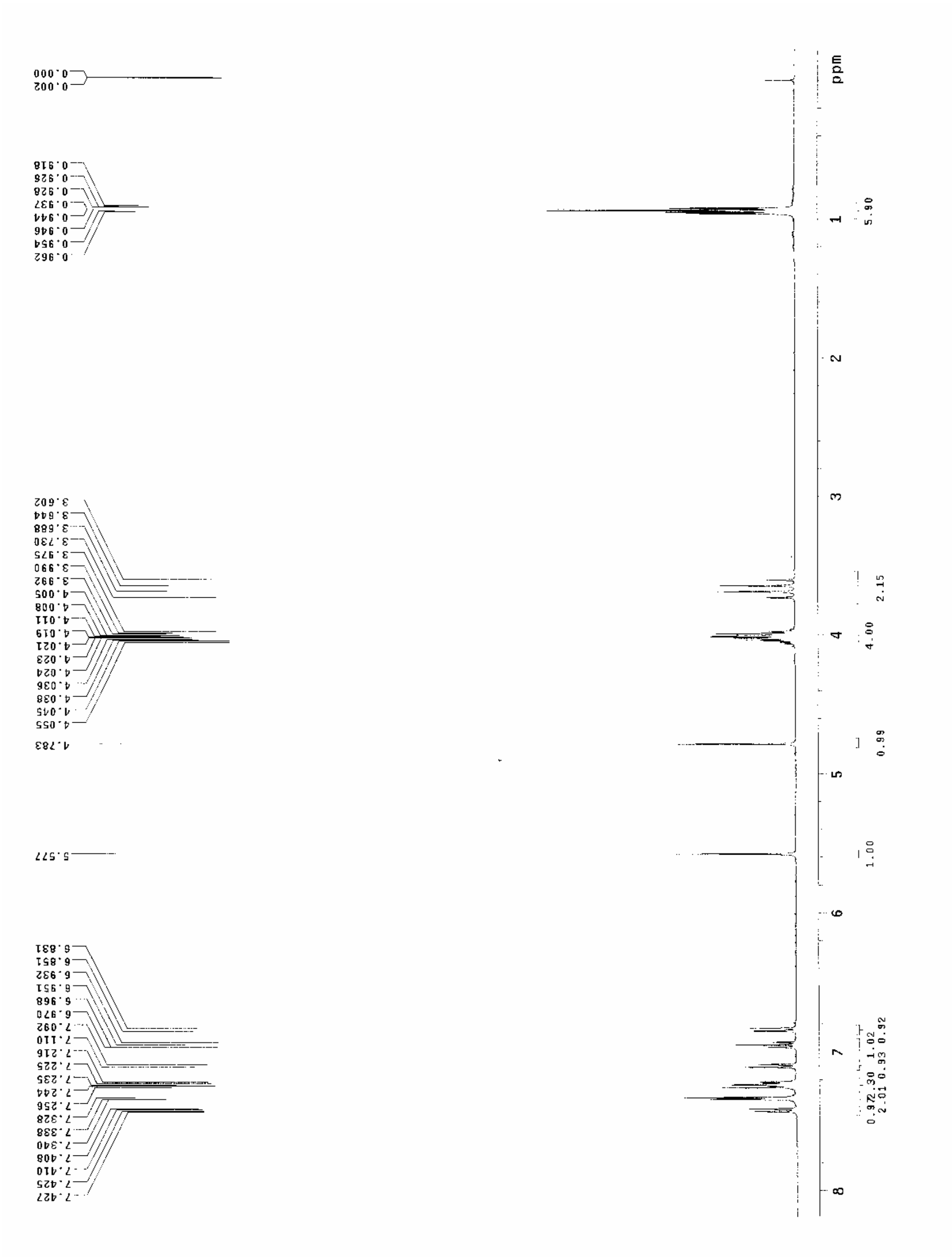
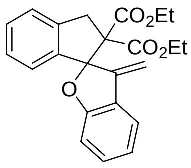


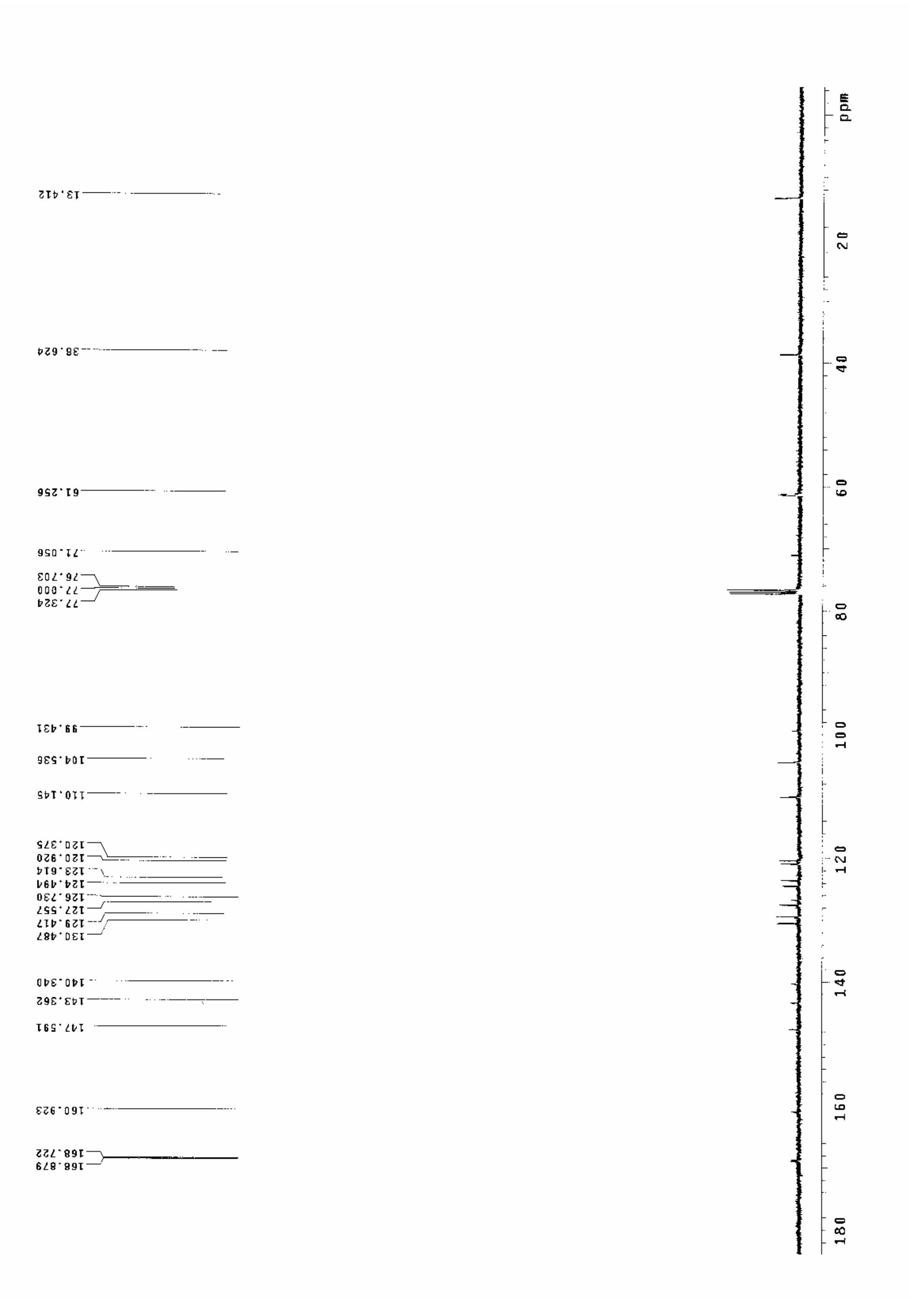
3a





CO_2Et
CO_2Et
O

3a



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123.614
124.494
126.230
127.557
129.417
130.487
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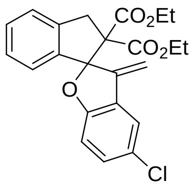
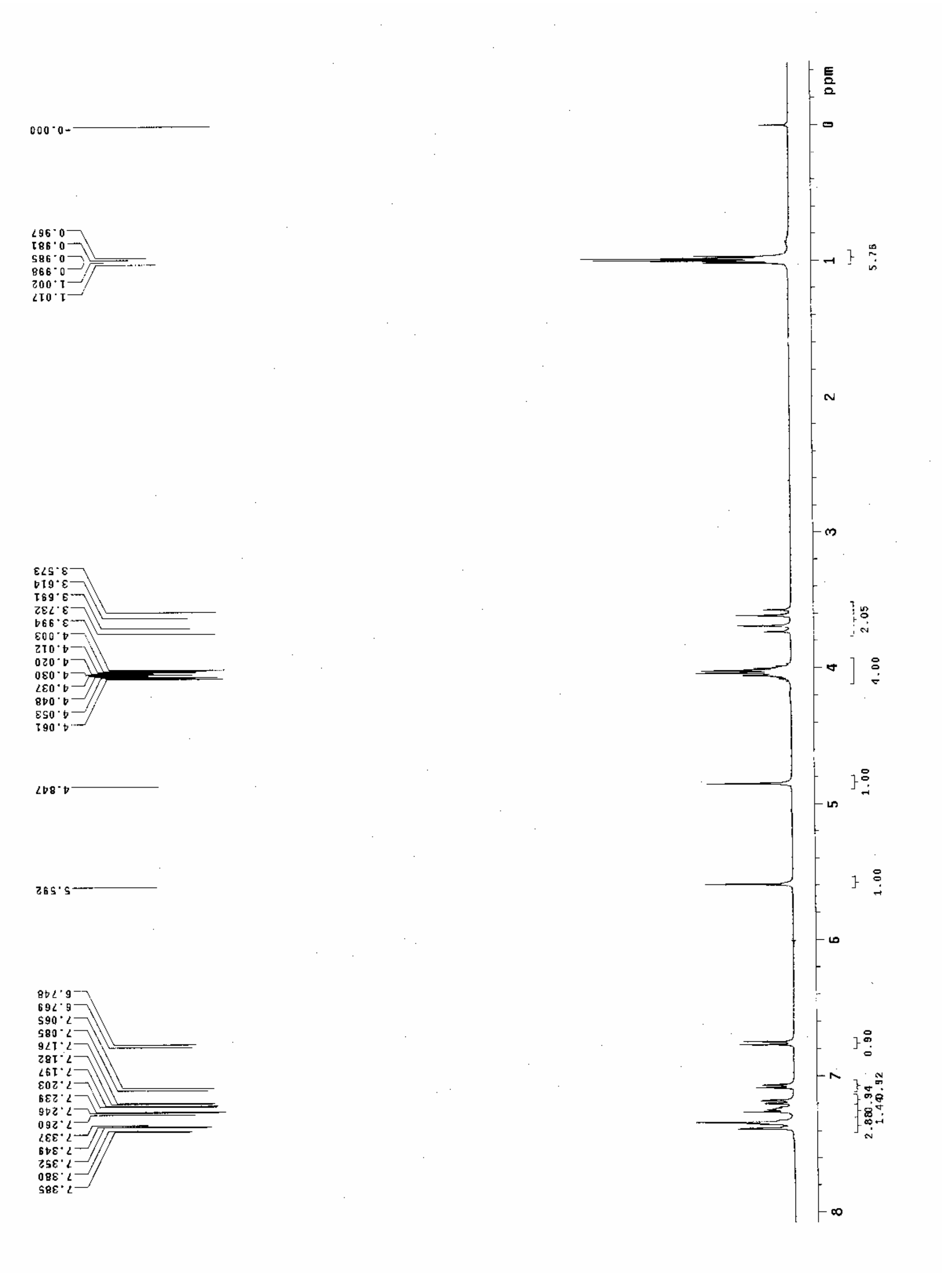
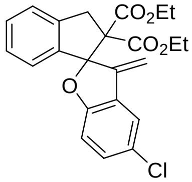


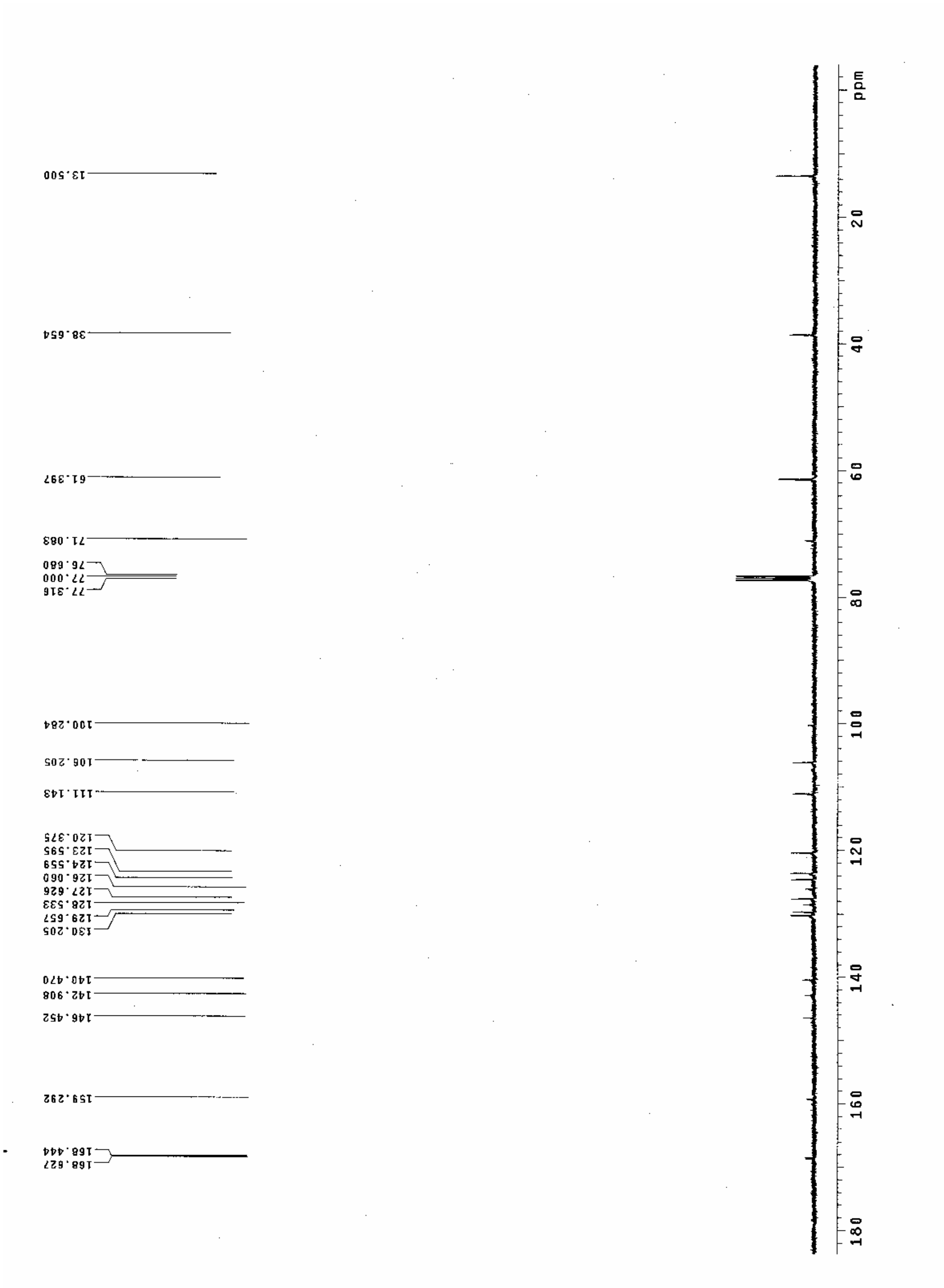
3b





CO2Et
CO2Et
O
Cl

3b



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120.375
123.595
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130.205
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ppm
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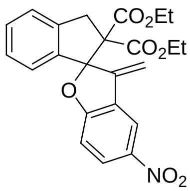
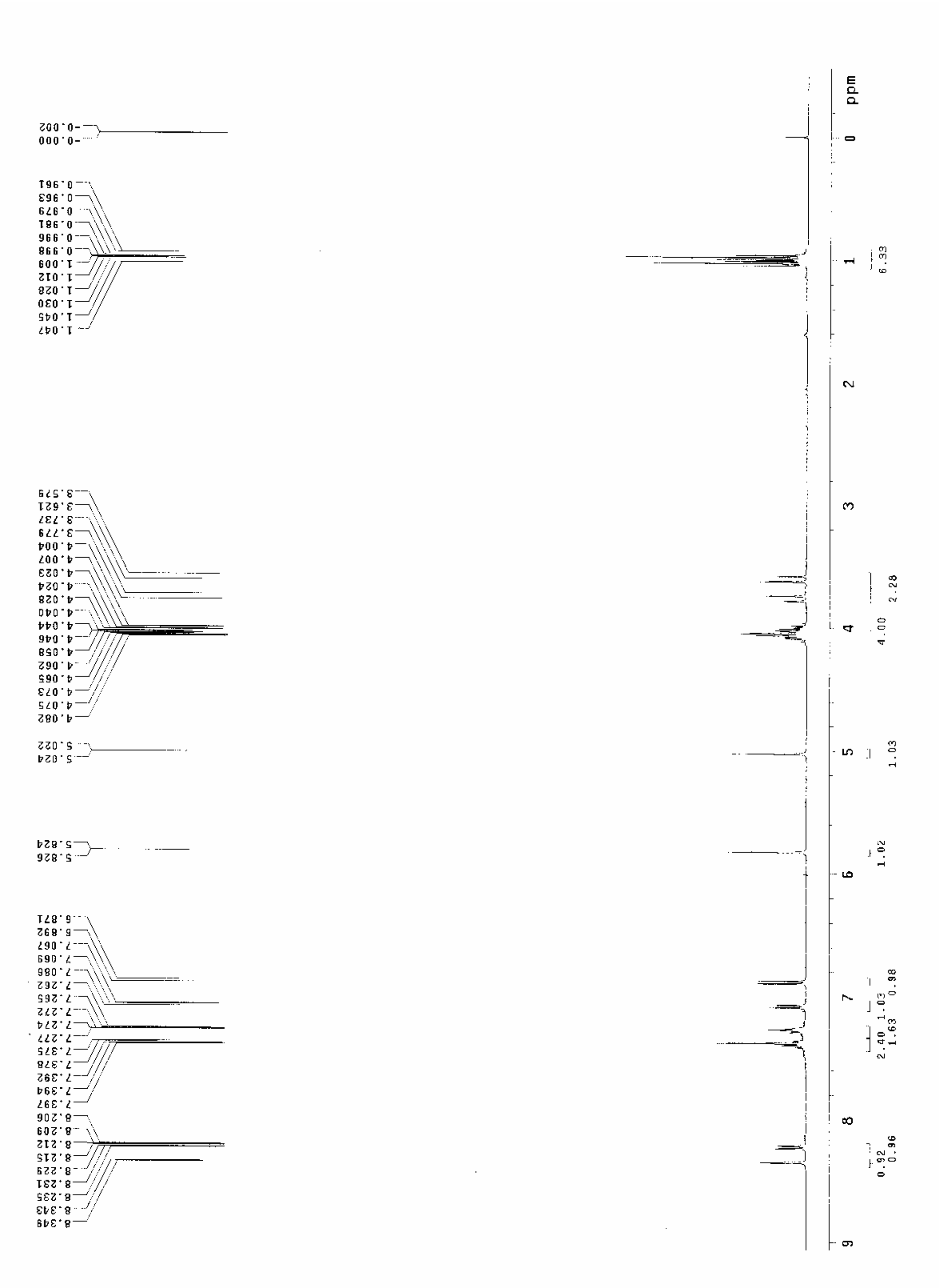
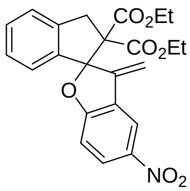
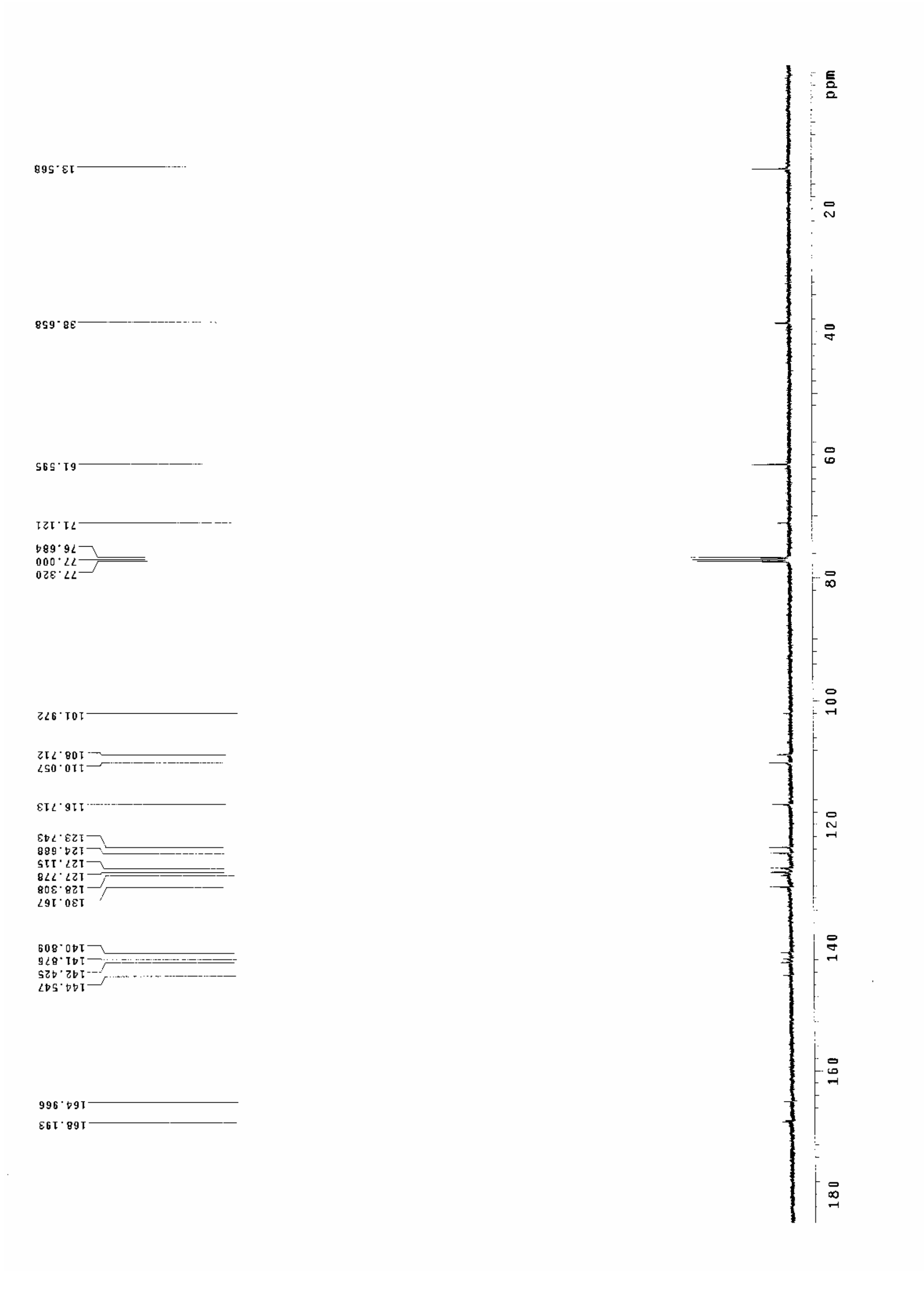


3c




CO2Et
CO2Et
O
NO2

3c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127.115
127.778
128.308
130.167
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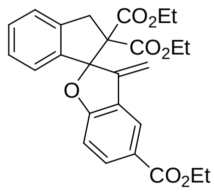
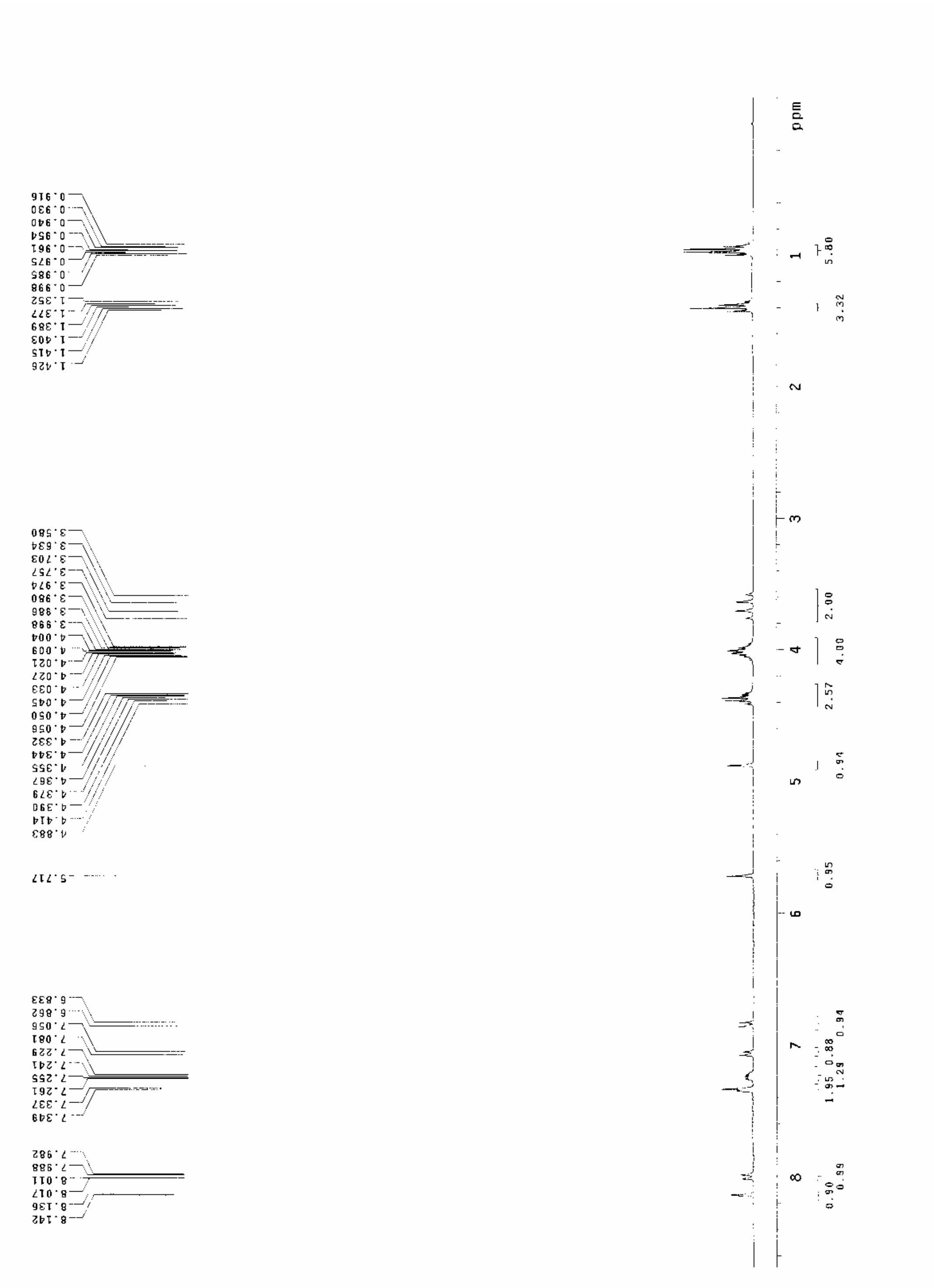
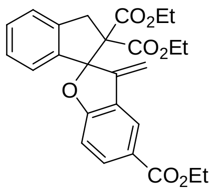


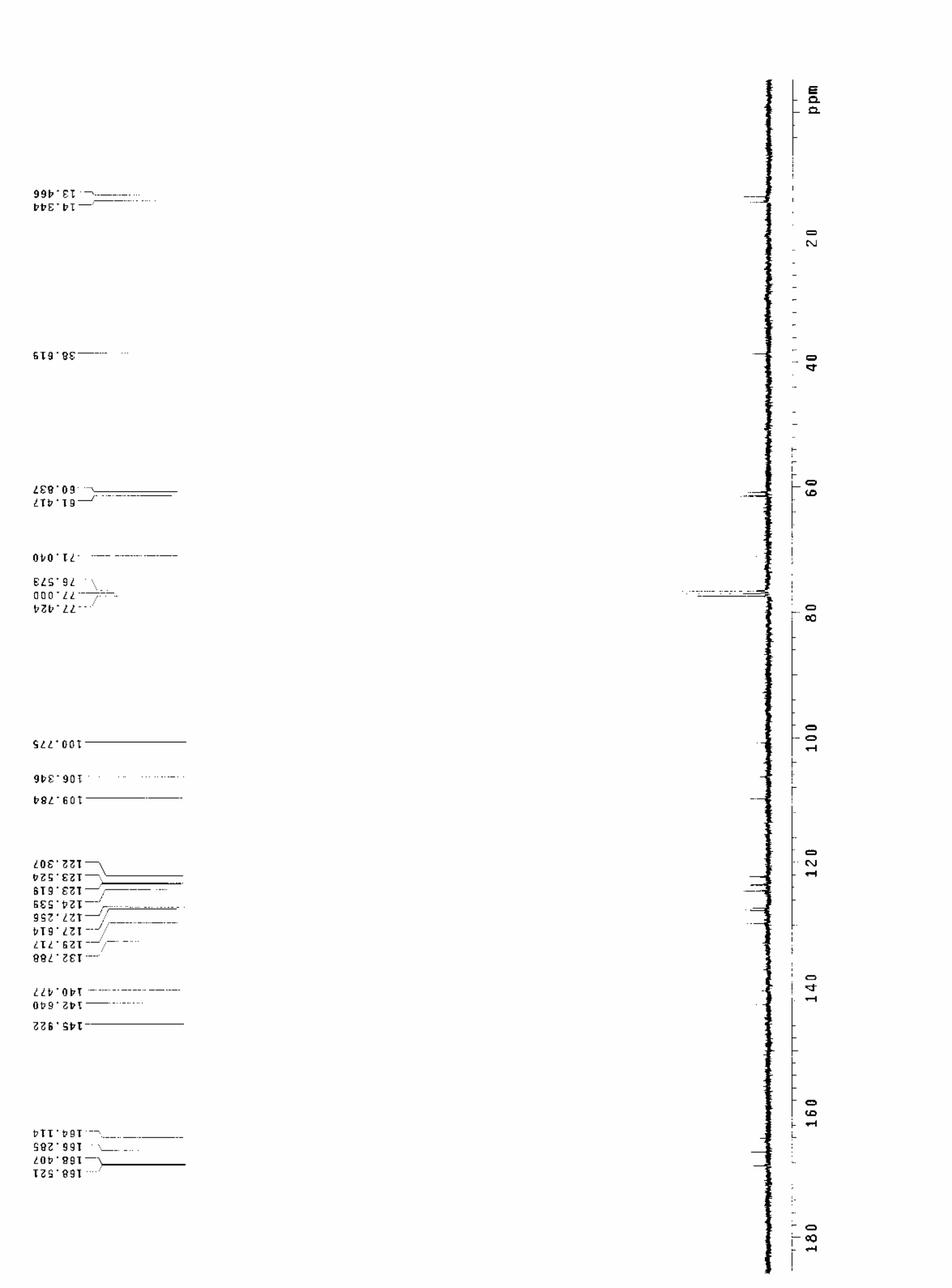
3d





CO_2Et
CO_2Et
O
CO_2Et

3d



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77.000
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100.775
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109.784
122.307
123.524
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124.539
127.256
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129.717
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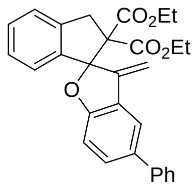
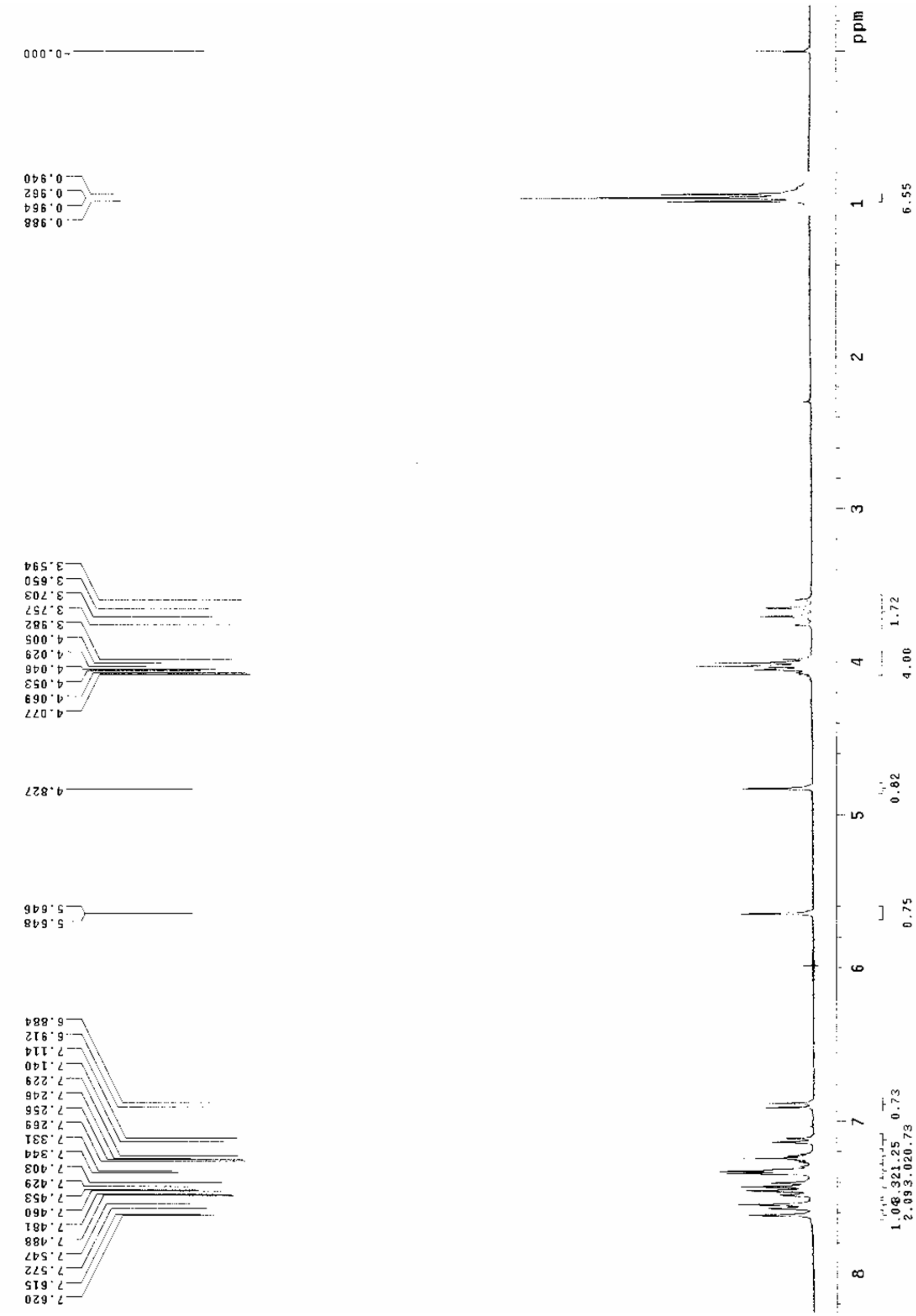
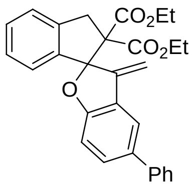
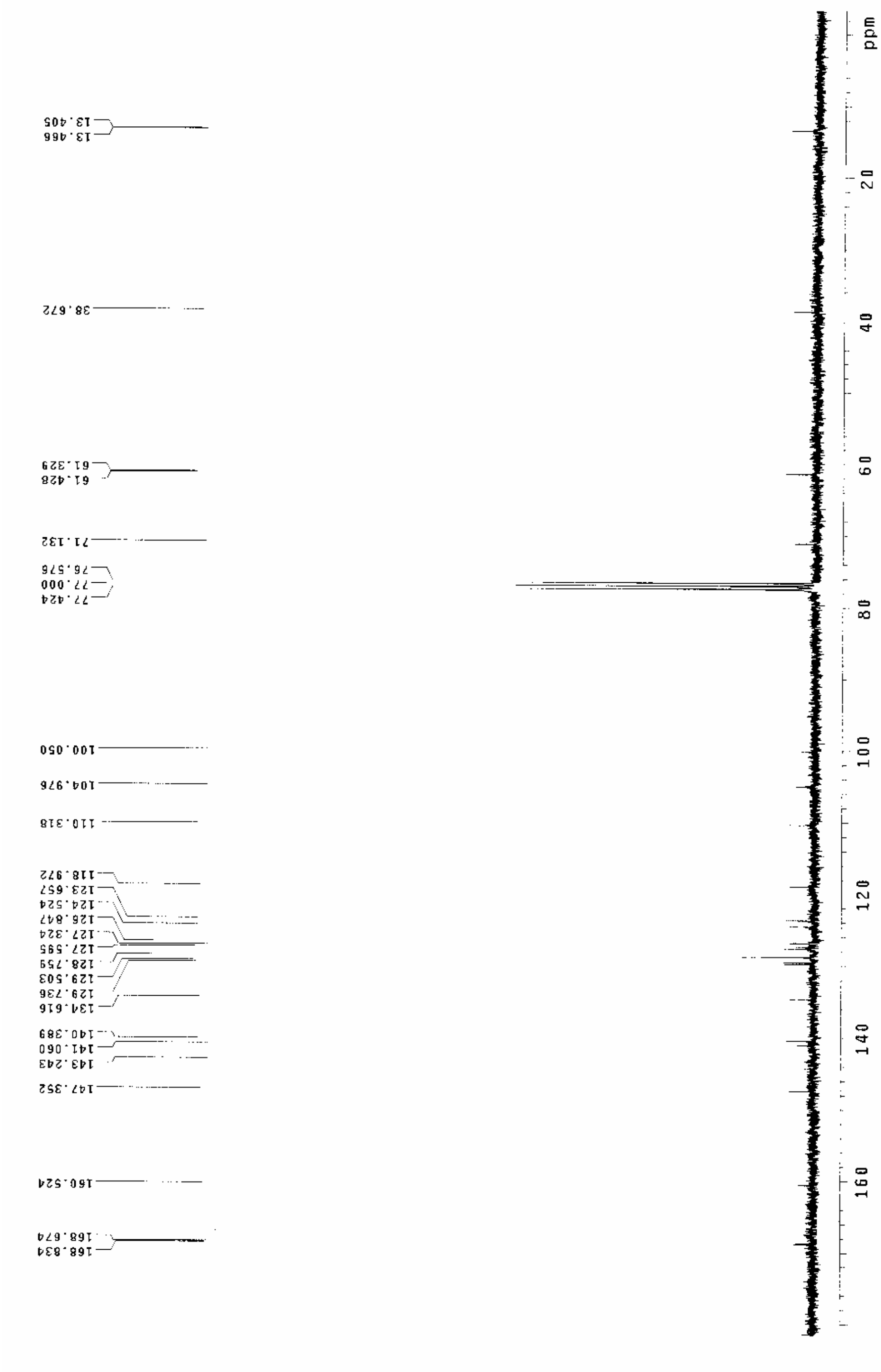


3e




CO2Et
CO2Et
O
Ph

3e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77.000
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100.050
104.976
110.318
118.972
123.657
124.524
126.847
127.324
127.595
128.759
129.503
129.736
134.616
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ppm
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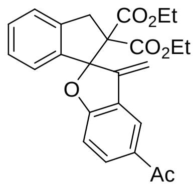
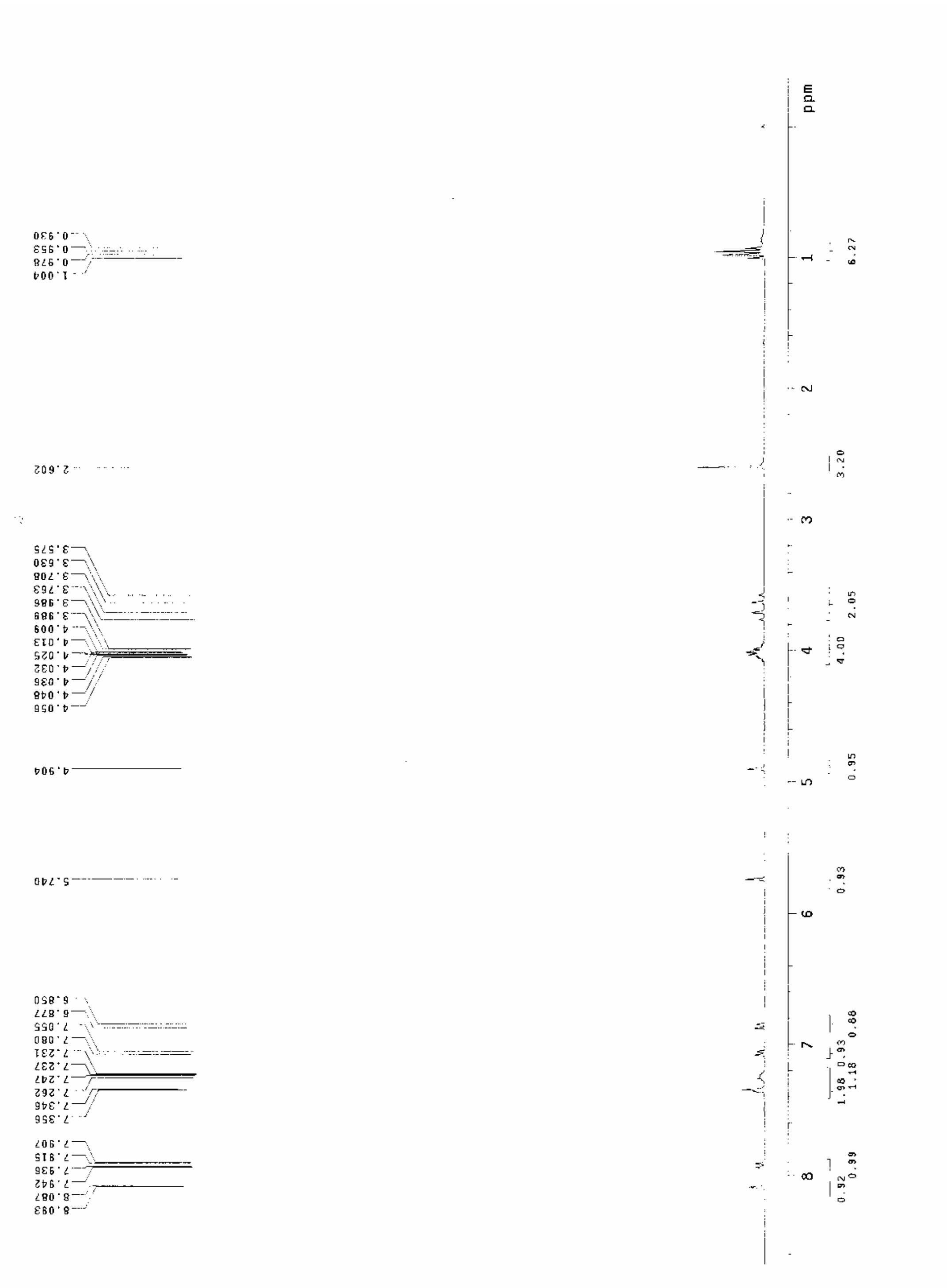

CO2Et
CO2Et
O
Ac

3f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3.986
3.989
4.009
4.013
4.025
4.032
4.036
4.048
4.056
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5.740
6.850
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7.247
7.262
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7.936
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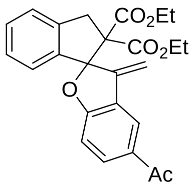
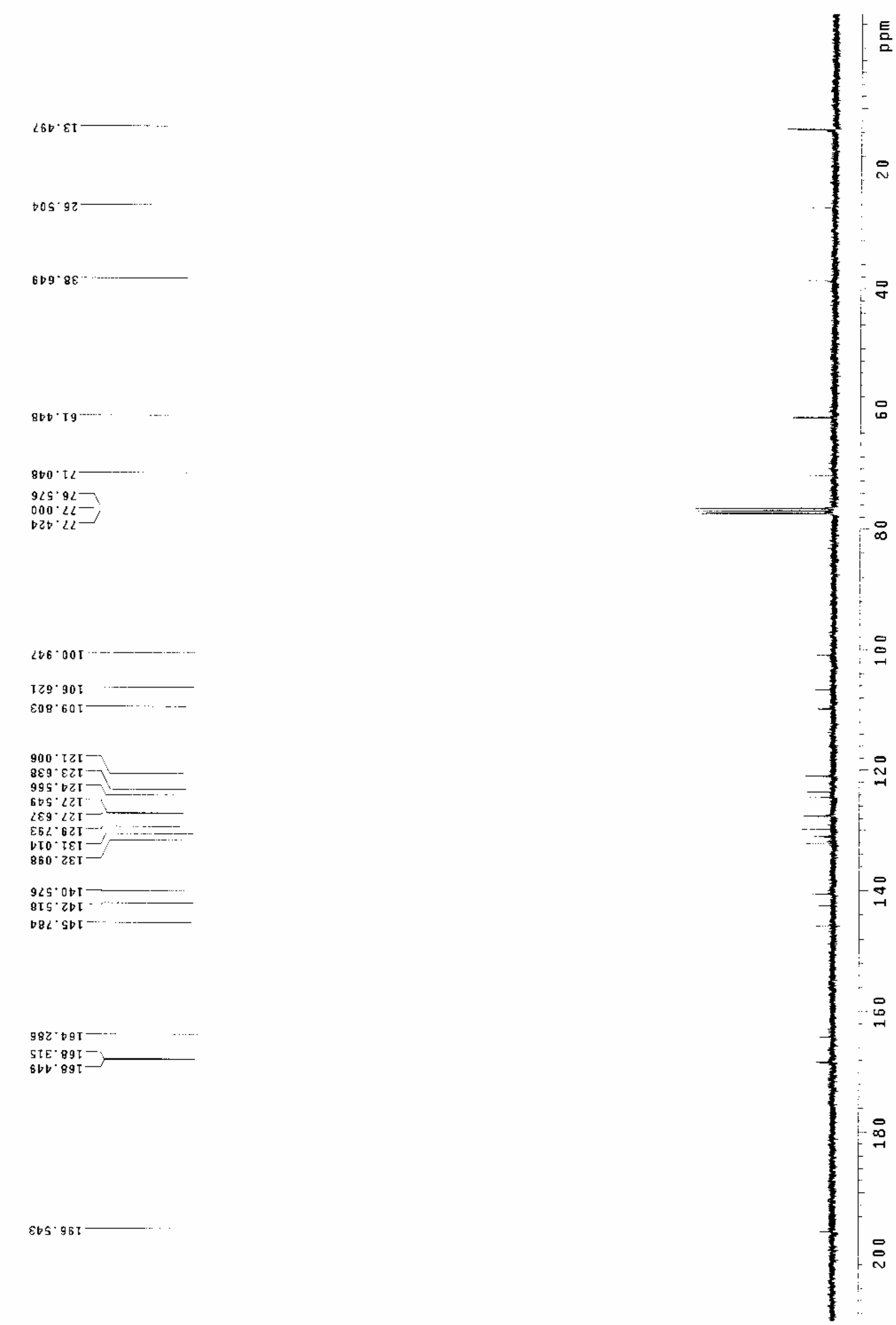

CO2Et
CO2Et
O
Ac

3f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26.504
38.649
61.448
71.048
76.576
77.000
77.424
100.947
106.621
109.803
121.006
123.638
124.566
127.549
127.637
129.793
131.014
132.098
140.576
142.518
145.784
164.286
168.315
168.449
196.543
ppm
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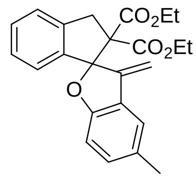
40
60
80
100
120
140
160
180
200



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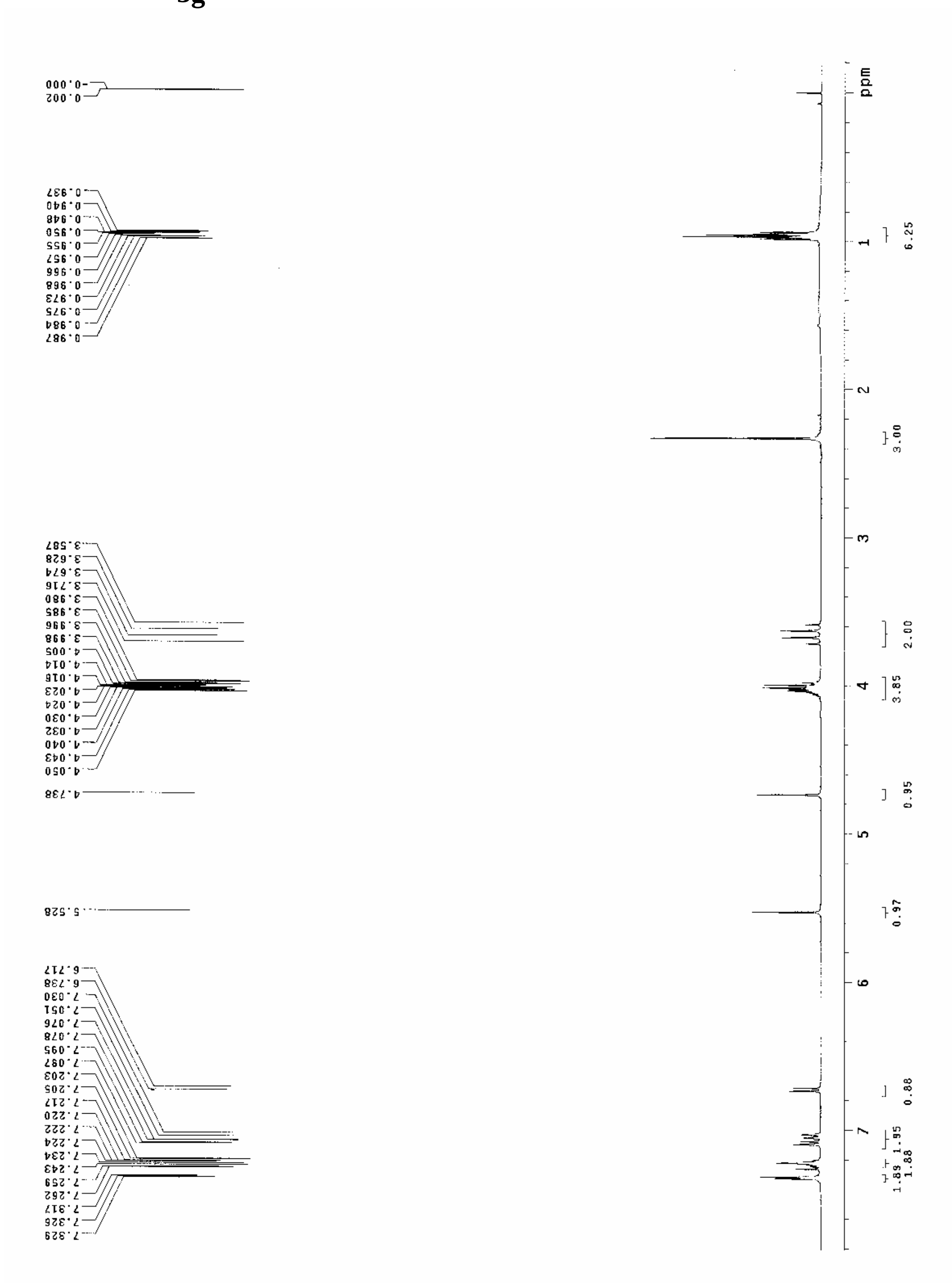
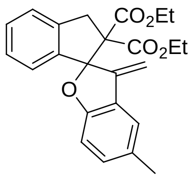
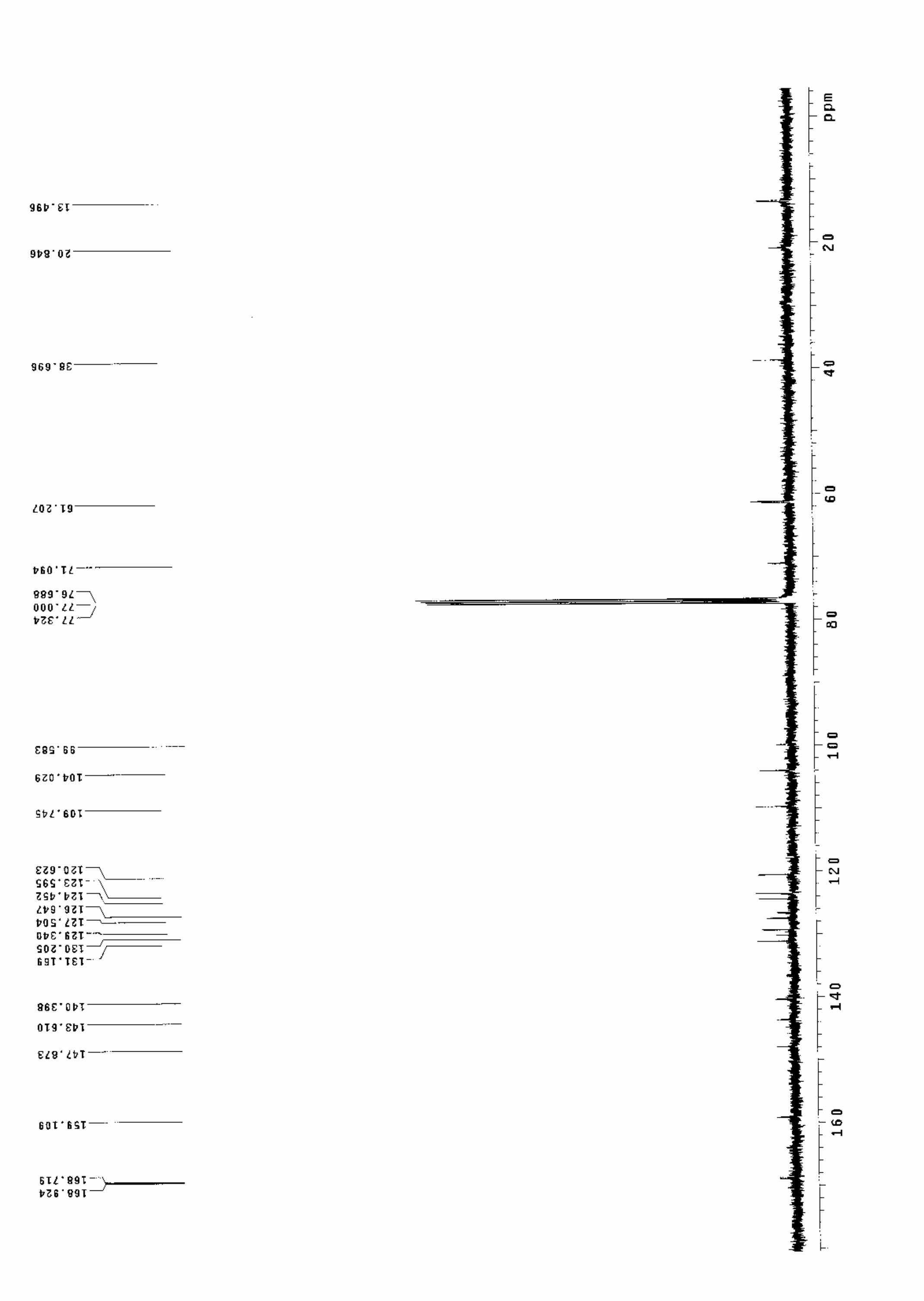



CO2Et
CO2Et
O

3g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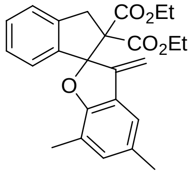
38.696
61.207
71.094
76.686
77.000
77.324
99.583
104.029
109.745
120.623
123.595
124.452
126.647
127.504
129.340
130.205
131.169
140.398
143.610
147.873
159.109
168.715
168.924
ppm
20
40
60
80
100
120
140
160



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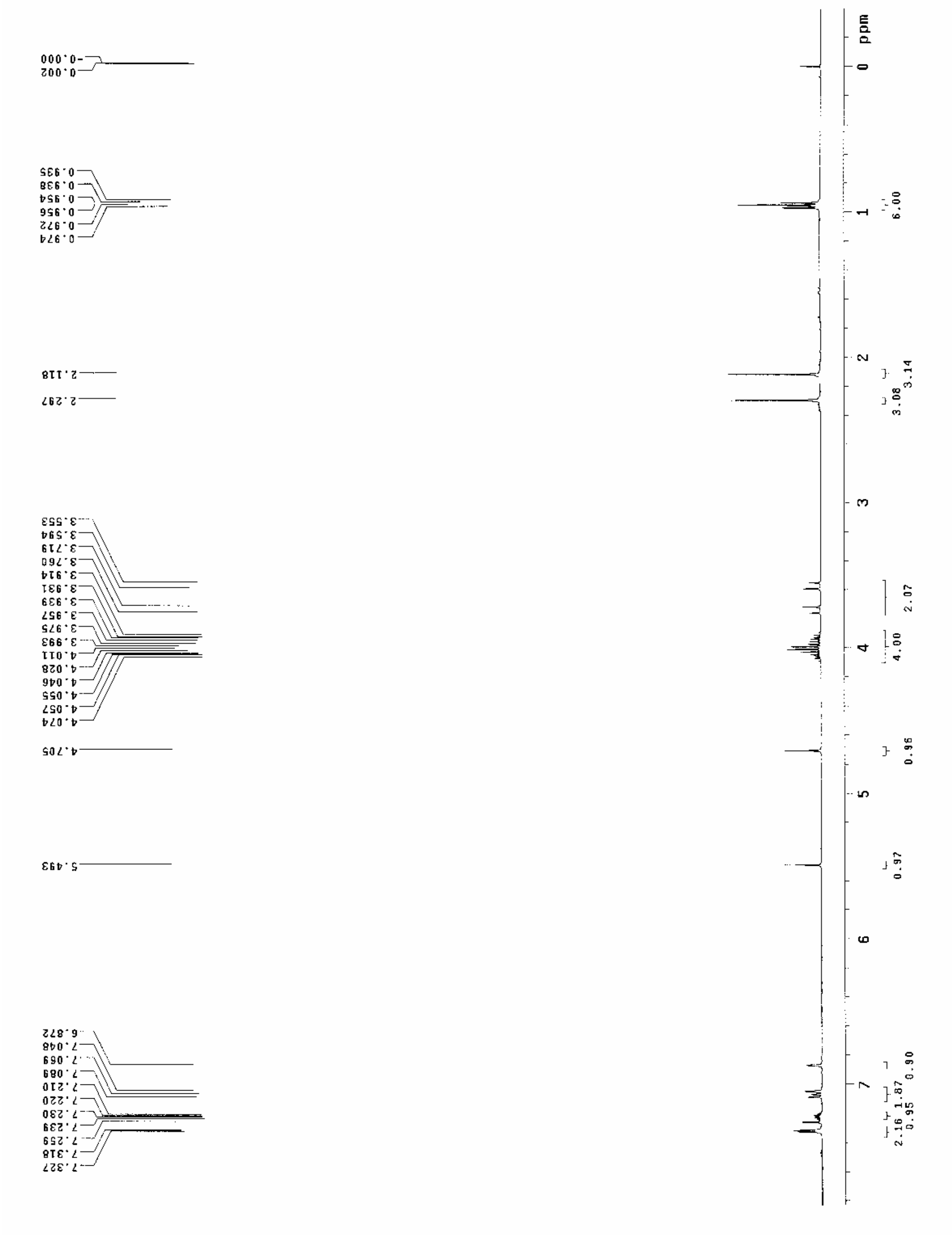
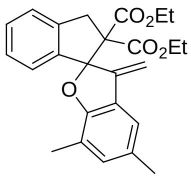
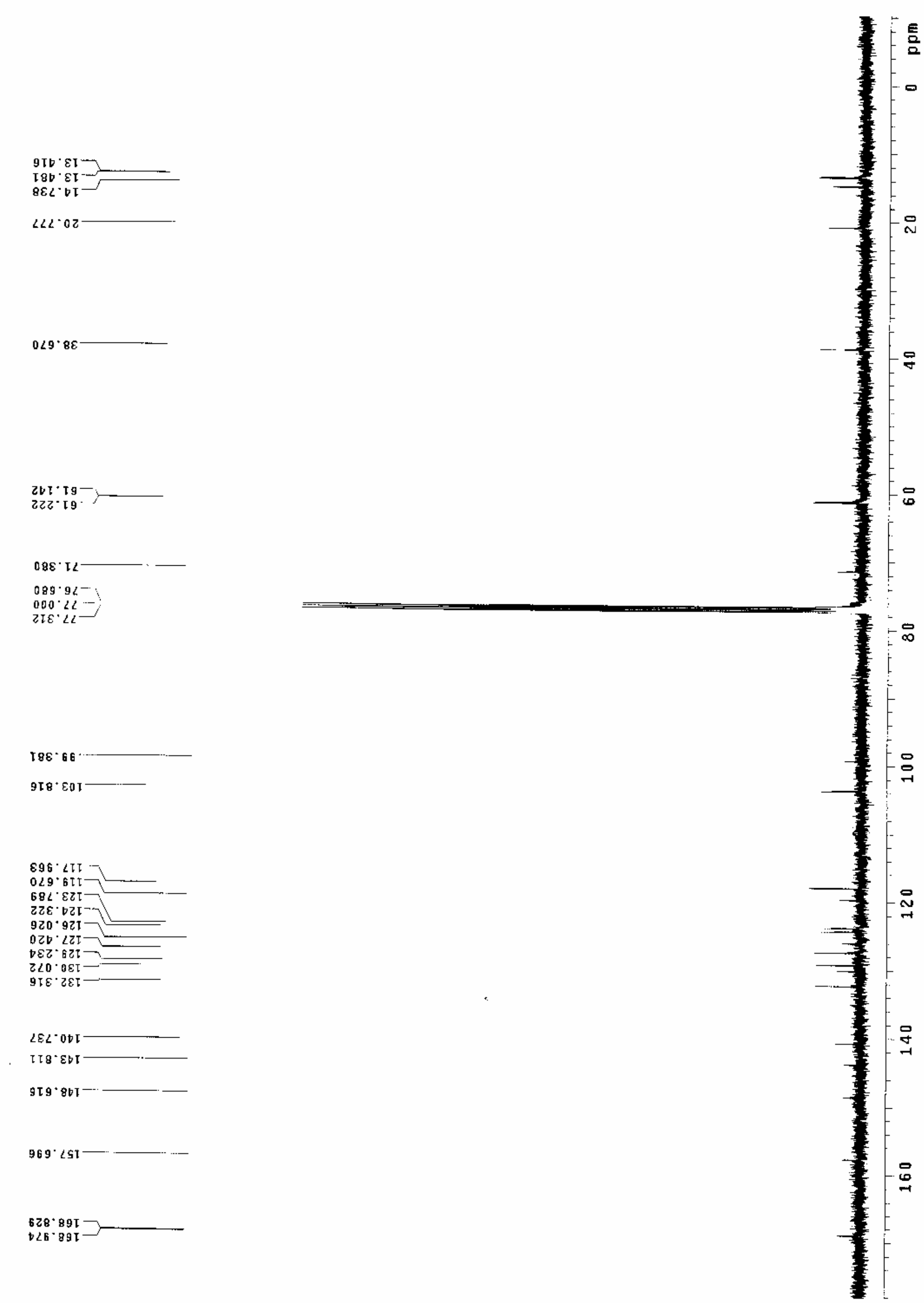



CO2Et
CO2Et
O

3h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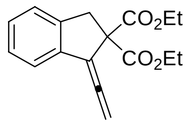
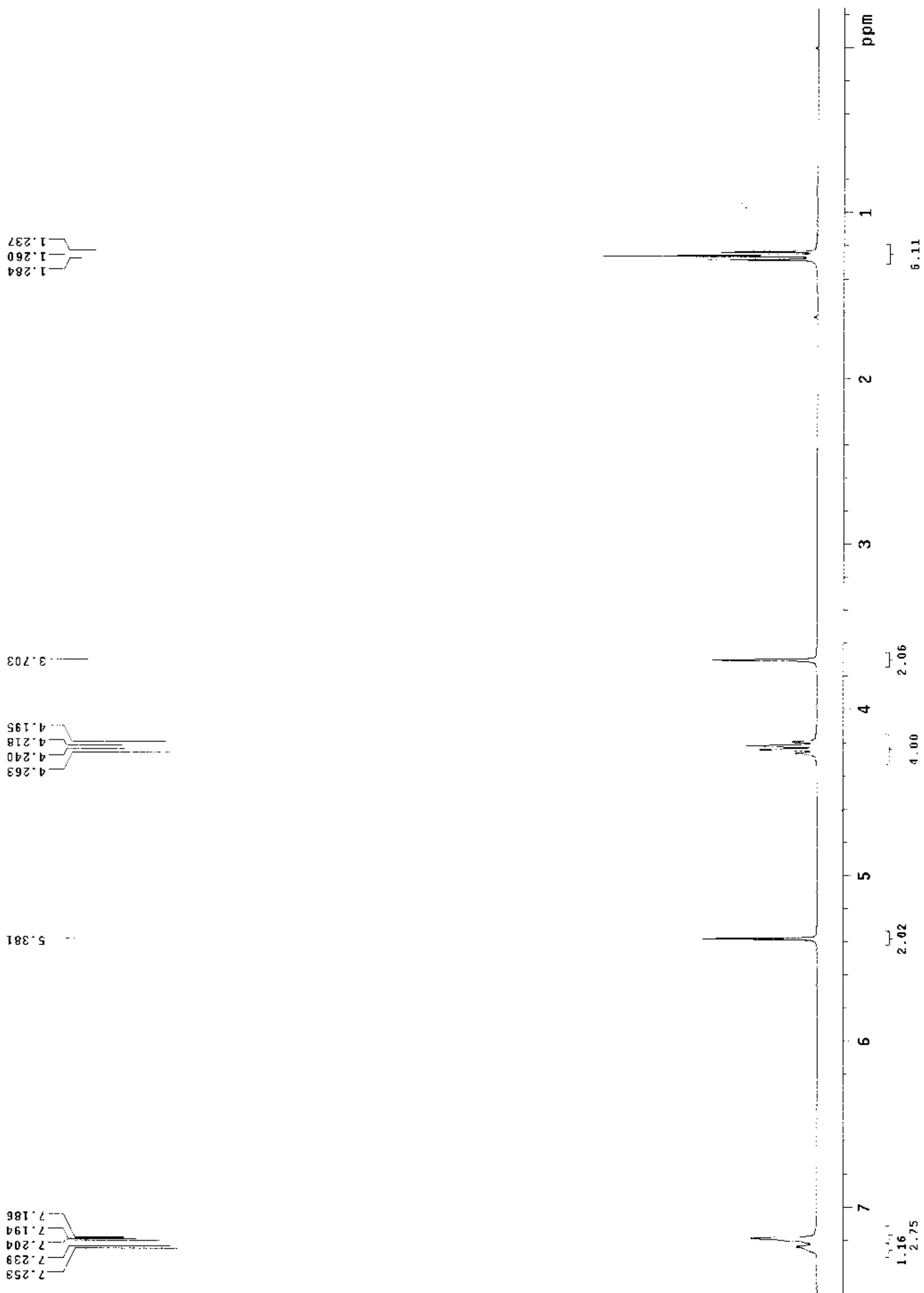
13.481
14.238
20.777
38.670
61.142
61.222
71.380
76.680
77.000
77.312
99.381
103.816
117.963
119.670
123.789
124.322
126.026
127.420
129.234
130.072
132.316
140.237
143.811
148.616
157.696
168.829
168.974
ppm
0
20
40
60
80
100
120
140
160


CO2Et
CO2Et

4a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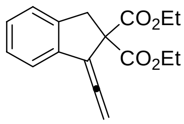
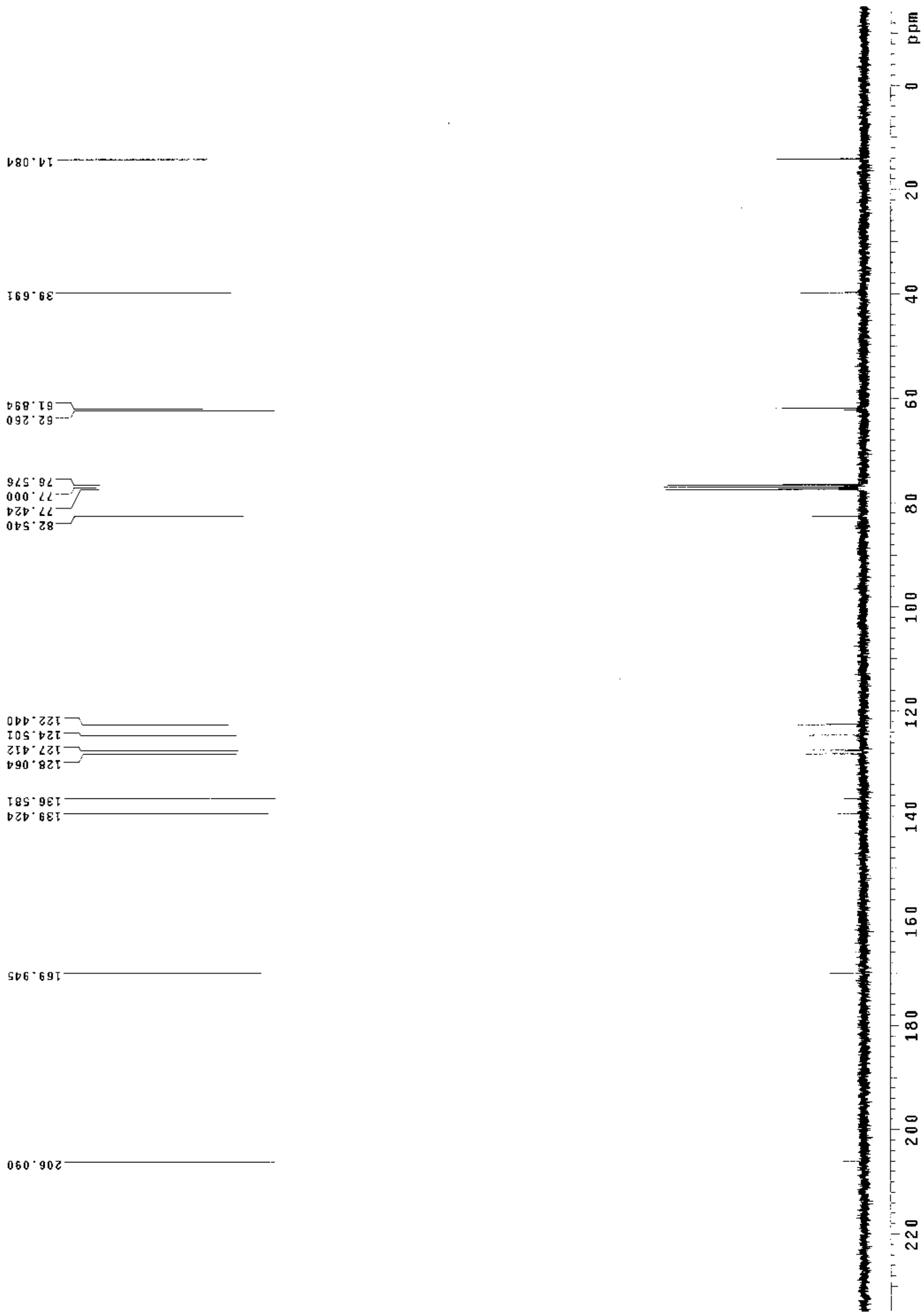
1.260
1.284
3.703
4.195
4.218
4.240
4.263
5.381
7.186
7.194
7.204
7.239
7.253
ppm
1
2
3
4
5
6
7
6.11
2.06
4.00
2.02
1.16
2.75


CO2Et
CO2Et

4a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61.894
62.260
76.576
77.000
77.424
82.540
122.440
124.501
127.412
128.064
136.581
139.424
169.945
206.090
ppm
0
20
40
60
80
100
120
140
160
180
200
220