Supporting information for

Synthesis of 2,4-Diiodoquinolines via the Photochemical Cyclization of *o*-Alkynylaryl Isocyanides with Iodine

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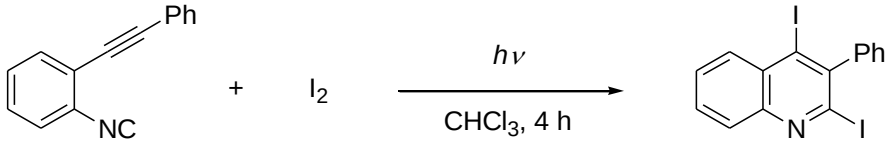
Contents

General Comments.

^{1}H NMR spectra were recorded at 300 MHz or 400 MHz using $CDCl_3$ as the solvent with tetramethylsilane (TMS) as the internal standard. ^{13}C NMR spectra were obtained at 75 MHz or 100 MHz using $CDCl_3$ as the solvent. Chemical shifts in ^{13}C NMR were measured relative to $CDCl_3$ by using δ 77.0 ppm. Infrared spectra were recorded with a FT-IR spectrometer. Melting points were determined on a micro melting point apparatus. Conventional mass spectra were recorded with a gas chromatograph mass spectrometer (EI). High resolution mass spectra were obtained on a mass spectrometer (FAB). The preparation of *o*-alkynylaryl isocyanides[S1] and terminal acetylenes such as 4-methylphenylacetylene,[S2] 4-methoxyphenylacetylene,[S2] 4-chlorophenylacetylene,[S2] and 4-nitrophenylacetylene[S3] was prepared according to the literature. Other reagents were commercially available and used without further purification.

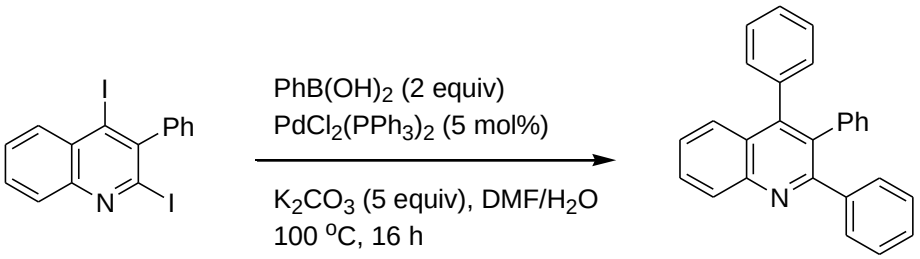
Experimental and Analytical Data.

General Procedure for the Photochemical Iodocyclization of *o*-Alkynylaryl Isocyanide.



In an NMR tube (ϕ = 5 mm, length = 180 mm), 2-(phenylethynyl)phenyl isocyanide (**1a**, 20 mg, 0.10 mmol), iodine (25.4 mg, 0.20 mmol, 1.0 equiv), and $CHCl_3$ (0.50 mL) were taken under ambient atmosphere, and the reaction was carried out for 4 h; the reaction was irradiated with a high-pressure Hg lamp through a Pyrex filter ($h\upsilon$ > 300 nm). After the photoirradiation, the resulting mixture was concentrated in vacuo and purified by PTLC (Hex; AcOEt = 9:1) to give 2,4-diiodo-3-phenylquinoline (**2a**, 30.6 mg, 0.067 mmol, 67%) as a white solid.

Procedure for Suzuki-Miyaura Cross-Coupling Reaction of 2,4-Diiodoquinoline 2a.

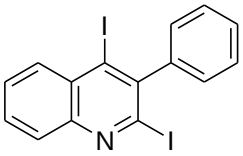


A mixture of 2,4-diiodo-3-phenylquinoline (**2a**, 46 mg, 0.10 mmol), phenylboronic acid (24 mg, 0.20 mmol), $PdCl_2(PPh_3)_2$ (3.5 mg, 5 mol%), and K_2CO_3 (69 mg, 0.50 mmol) in DMF (4 mL) and H_2O (1 mL) was heated at 100 °C for 16 h in a nitrogen atmosphere. To the resulting mixture, H_2O was added, and the organic portion was extracted with ethyl acetate. The organic phase was dried over anhydrous $MgSO_4$, filtrated, and removed in vacuo. The resulting crude oil was purified by PTLC (eluted with hexane; AcOEt = 9:1) to give

2,3,4-triphenylquinoline (**5a**, 30 mg, 0.083 mmol, 83%) as a white solid.

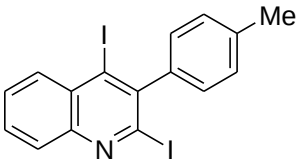
Spectral and Analytical Data.

2,4-Diiodo-3-phenylquinoline (2a):



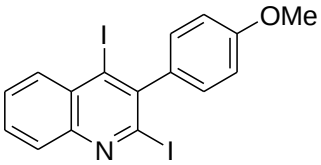
White solid; mp 183–184 ^{o}C; ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 7.15–7.23 (m, 1H), 7.42–7.56 (m, 4H), 7.59–7.79 (m, 2H), 8.00–8.13 (m, 2H); ^{13}C NMR (75 MHz, $CDCl_3$, ppm) δ 121.6, 127.3, 127.5, 128.3, 128.5, 128.9, 129.0, 129.2, 129.4, 130.7, 133.2, 145.8, 147.1; IR (NaCl, cm^{-1}) 3043, 3022, 1545, 1470, 1442, 1375, 1329, 1281, 1136, 1088, 1072, 1028, 961, 874, 758, 696; HRMS (FAB) calcd for $C_{15}H_{10}I_2N$ $[M+H]^+$ 457.8903, found 457.8884.

2,4-Diiodo-3-(4-methylphenyl)quinoline (2b):



White solid; mp 143–145 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 2.48 (s, 3H), 7.16 (d, *J* = 7.8 Hz, 2H), 7.34 (d, *J* = 7.8 Hz, 2H), 7.66 (ddd, *J* = 1.4, 6.9, 7.3 Hz, 1H), 7.78 (ddd, *J* = 1.4, 6.9, 7.3 Hz, 1H), 8.02 (dd, *J* = 0.9, 8.2 Hz, 1H), 8.13 (dd, *J* = 0.9, 8.2 Hz, 1H); ^{13}C NMR (75 MHz, $CDCl_3$, ppm) δ 21.6, 119.9, 127.2, 128.7, 128.8, 129.1, 129.2, 130.0, 130.9, 133.1, 138.6, 139.5, 140.7, 146.3; IR (NaCl, cm^{-1}) 3058, 3021, 2977, 2874, 1549, 1474, 1379, 1335, 1288, 1142, 1105, 1022, 887, 772, 725, 696; HRMS (FAB) calcd for $C_{16}H_{12}I_2N$ $[M+H]^+$ 471.9059, found 471.9072.

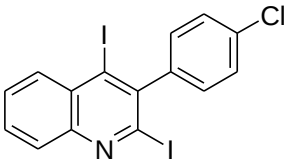
2,4-Diiodo-3-(4-methoxyphenyl)quinoline (2c):



White solid; mp 165–167 ^{o}C; ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 3.91 (s, 3H), 7.04 (d, *J* = 8.9 Hz, 2H), 7.19 (d, *J* = 8.9 Hz, 2H), 7.65 (ddd, *J* = 1.4, 6.8, 6.9 Hz, 1H), 7.76 (ddd, *J* = 1.4, 6.8, 6.9 Hz, 1H), 8.01 (dd, *J* = 0.8, 8.2 Hz, 1H), 8.12 (dd, *J* = 0.8, 8.2 Hz, 1H); ^{13}C NMR (75 MHz, $CDCl_3$, ppm) δ 55.3, 113.8, 127.2, 127.4, 128.9, 129.1, 130.6, 130.9, 133.3, 138.6, 139.9, 146.7, 147.9, 159.9; IR (NaCl, cm^{-1}) 3058, 3023, 2958, 2923, 2830, 1545, 1508, 1468, 1325, 1281, 1244, 1178, 1090, 1030, 876, 827, 766, 681; HRMS (FAB) calcd for

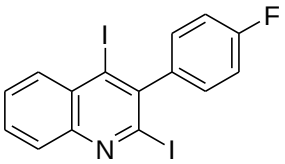
$C_{16}H_{12}I_2NO$ $[M+H]^+$ 487.9008, found 487.9015.

2,4-Diiodo-3-(4-chlorophenyl)quinoline (2d):



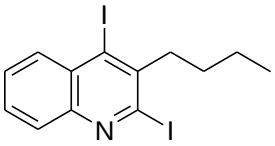
White solid; mp 164–165 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 7.16 (d, *J* = 8.7 Hz, 2H), 7.52 (d, *J* = 8.7 Hz, 2H), 7.67 (ddd, *J* = 1.4, 7.2, 8.2 Hz, 1H), 7.75 (ddd, *J* = 1.4, 7.2, 8.2 Hz, 1H), 8.05 (dd, *J* = 1.4, 8.2 Hz, 1H), 8.09 (dd, *J* = 1.4, 8.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 121.1, 127.4, 127.9, 128.5, 128.9, 129.1, 130.8, 130.9, 133.2, 135.0, 144.6, 145.3, 148.0; IR (NaCl, cm^{-1}) 3058, 3025, 1541, 1489, 1470, 1325, 1283, 1219, 1134, 1094, 1016, 878, 826, 772, 719, 665; HRMS (FAB) calcd for $C_{15}H_9ClI_2N$ $[M+H]^+$ 491.8513, found 491.8539.

2,4-Diiodo-3-(4-fluorophenyl)quinoline (2e):



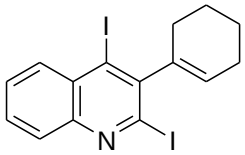
White solid; mp 189–191 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 7.17–7.26 (m, 4H), 7.67 (ddd, *J* = 1.4, 6.9, 8.4 Hz, 1H), 7.74 (ddd, *J* = 1.4, 6.9, 8.4 Hz, 1H), 8.05 (dd, *J* = 1.4, 8.4 Hz, 1H), 8.09 (dd, *J* = 1.4, 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 115.6 (d, J_{CF} = 21.0 Hz), 128.9 (d, J_{CF} = 3.8 Hz), 129.1 (d, J_{CF} = 3.8 Hz), 130.9, 131.2, 131.2, 131.3, 133.1, 133.2, 143.0, 144.8, 148.0, 162.7 (d, J_{CF} = 232.5 Hz); IR (NaCl, cm^{-1}) 3058, 3028, 1545, 1506, 1472, 1327, 1283, 1219, 1157, 1136, 1088, 1016, 880, 833, 772, 729, 683; HRMS (FAB) calcd for $C_{15}H_9FI_2N$ $[M+H]^+$ 475.8809, found 475.8796.

2,4-Diiodo-3-*n*-butylquinoline (2g):



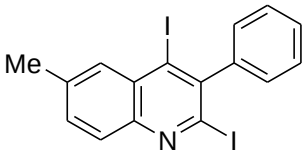
White solid; mp 85–87 °C; ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 1.04 (t, *J* = 6.9 Hz, 3H), 1.48–1.72 (m, 4H), 3.28 (t, *J* = 8.1 Hz, 2H), 7.54–7.71 (m, 2H), 7.94 (dd, *J* = 1.2, 7.8 Hz, 1H), 8.02 (dd, *J* = 1.2, 7.8 Hz, 1H); ^{13}C NMR (75 MHz, $CDCl_3$, ppm) δ 13.8, 22.9, 30.5, 45.9, 115.3, 123.3, 128.7, 128.9, 129.8, 130.5, 132.7, 142.2, 147.5; IR (NaCl, cm^{-1}) 3058, 3028, 2955, 2926, 2856, 1541, 1472, 1454, 1369, 1342, 1290, 1275, 1238, 1182, 1142, 1080, 1026, 1007, 988, 901, 860, 754, 682; HRMS (FAB) calcd for $C_{13}H_{14}I_2N$ $[M+H]^+$ 437.9216, found 437.9191.

2,4-Diiodo-3-(1-cyclohexenyl)quinoline (2h):



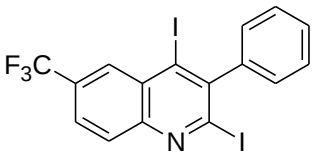
Slight yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 1.73–1.82 (m, 2H), 1.85–1.94 (m, 2H), 2.25–2.34 (m, 4H), 5.62–5.72 (m, 1H), 7.60 (ddd, *J* = 1.2, 6.9, 8.2 Hz, 1H), 7.67 (ddd, *J* = 1.2, 6.9, 8.2 Hz, 1H), 7.97 (dd, *J* = 1.2, 8.2 Hz, 1H), 8.06 (dd, *J* = 1.2, 8.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 21.6, 22.7, 25.3, 28.1, 121.8, 127.2, 128.6, 128.9, 130.0, 130.1, 130.4, 130.8, 132.8, 144.4, 147.5; IR (NaCl, cm^{-1}) 3055, 3029, 2930, 2883, 2829, 1584, 1541, 1472, 1458, 1325, 1281, 1219, 1134, 1078, 1042, 913, 873, 772, 759, 694; HRMS (FAB) calcd for $C_{15}H_{14}I_2N$ $[M+H]^+$ 461.9216, found 461.9226.

2,4-Diiodo-3-phenyl-6-methylquinoline (2i):



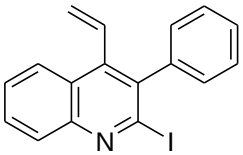
White solid; mp 113–114 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 2.59 (s, 3H), 7.12–7.22 (m, 2H), 7.49–7.58 (m, 4H), 7.85 (s, 1H), 7.94 (d, *J* = 8.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 22.0, 114.9, 120.2, 128.2, 128.8, 128.9, 129.3, 129.9, 132.0, 132.9, 139.4, 145.5, 146.6, 147.2; IR (NaCl, cm^{-1}) 3056, 3021, 2918, 2849, 1545, 1487, 1443, 1375, 1339, 1315, 1279, 1177, 1151, 1090, 1030, 926, 822, 770, 754, 696; HRMS (FAB) calcd for $C_{16}H_{12}I_2N$ $[M+H]^+$ 471.9059, found 471.9035.

2,4-Diiodo-3-phenyl-6-trifluoromethylquinoline (2j):



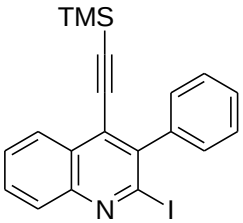
White solid; mp 137–138 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 7.18–7.23 (m, 2H), 7.52–7.57 (m, 3H), 7.90 (dd, *J* = 1.8, 8.9 Hz, 1H), 8.18 (d, *J* = 8.9 Hz), 8.43 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 116.0, 123.6 (J_{CF} = 272.4 Hz), 124.6, 126.5 (J_{CF} = 3.8 Hz), 128.4, 128.6, 129.1, 129.3 (J_{CF} = 30.5 Hz), 129.5, 130.5, 131.4 (J_{CF} = 5.7 Hz), 146.6, 147.4, 148.7; IR (NaCl, cm^{-1}) 3058, 3024, 1541, 1495, 1444, 1383, 1352, 1304, 1265, 1234, 1205, 1167, 1128, 1092, 1069, 1030, 920, 895, 835, 766, 696; HRMS (FAB) calcd for $C_{16}H_9F_3I_2N$ $[M+H]^+$ 525.8777, found 525.8777.

4-Ethenyl-2-iodo-3-phenylquinoline (3a):



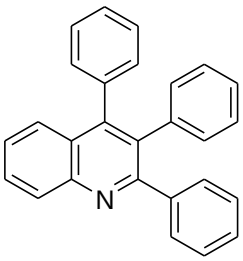
White solid; mp 102–103 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 5.45 (dd, *J* = 1.4, 17.9 Hz, 1H), 5.64 (dd, *J* = 0.9, 12.4 Hz, 1H), 6.60 (dd, *J* = 11.4, 17.9 Hz, 1H), 7.23–7.29 (m, 2H), 7.40–7.49 (m, 3H), 7.57 (t, *J* = 8.4 Hz, 1H), 7.74 (t, *J* = 8.4 Hz, 1H), 8.07 (d, *J* = 8.4 Hz, 1H), 8.19 (d, *J* = 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 124.1, 125.4, 125.8, 127.0, 127.9, 128.2, 128.9, 130.1, 130.2, 131.8, 132.1, 136.8, 146.0, 147.3, 150.6; IR (NaCl, cm^{-1}) 3063, 3023, 1732, 1634, 1558, 1543, 1489, 1473, 1387, 1331, 1298, 1259, 1169, 1111, 1063, 1032, 986, 907, 778, 756, 700, 675; HRMS (FAB) calcd for $C_{17}H_{13}IN$ $[M+H]^+$ 358.0093, found 358.0080.

2-Iodo-3-phenyl-4-trimethylsilylethynylquinoline (4a):



Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 0.10 (s, 9H), 7.40–7.49 (m, 5H), 7.64 (ddd, *J* = 1.4, 6.8, 8.2 Hz, 1H), 7.77 (ddd, *J* = 1.4, 6.8, 8.2 Hz, 1H), 8.05 (dd, *J* = 1.4, 8.2 Hz, 1H), 8.27 (dd, *J* = 1.4, 8.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ -0.5, 99.0, 110.2, 126.5, 126.7, 127.7, 127.9, 128.2, 128.6, 129.9, 130.6, 136.7, 137.0, 146.5, 150.0, 156.9; IR (NaCl, cm^{-1}) 3055, 3028, 2959, 2926, 2853, 2148, 1543, 1489, 1448, 1389, 1364, 1339, 1250, 1219, 1169, 1111, 1059, 1028, 926, 880, 847, 772, 698; HRMS (FAB) calcd for $C_{20}H_{19}NSiI$ $[M+H]^+$ 428.0331, found 428.0341.

2,3,4-Triphenylquinoline (5a):[S4]



White solid; mp 199–201 °C (lit. 190–191 °C); ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 6.85–6.92 (m, 2H), 6.97–7.03 (m, 3H), 7.10–7.16 (m, 2H), 7.18–7.23 (m, 3H) 7.24–7.31 (m, 3H), 7.34–7.40 (m, 2H), 7.45 (ddd, *J* = 1.2, 6.8, 8.2 Hz, 1H), 7.58 (dd, *J* = 1.2, 8.2 Hz, 1H), 7.73 (ddd, *J* = 1.2, 6.8, 8.2 Hz, 1H), 8.26 (d, *J* = 8.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$,

ppm) δ 126.3, 126.5, 126.6, 126.6, 127.2, 127.3, 127.6, 127.6, 127.7, 129.3, 129.7, 129.9, 130.3, 131.3, 132.9, 136.9, 138.3, 141.1, 147.3, 147.6, 159.0; MS (EI) *m/z* 357 (M^+, 100).

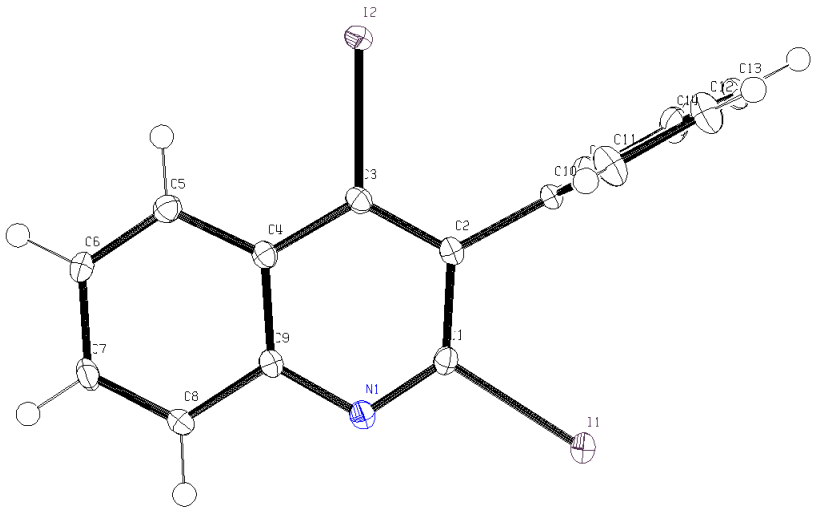


FIGURE S1. ORTEP Diagram of 2a.

References and Notes for Supporting Information

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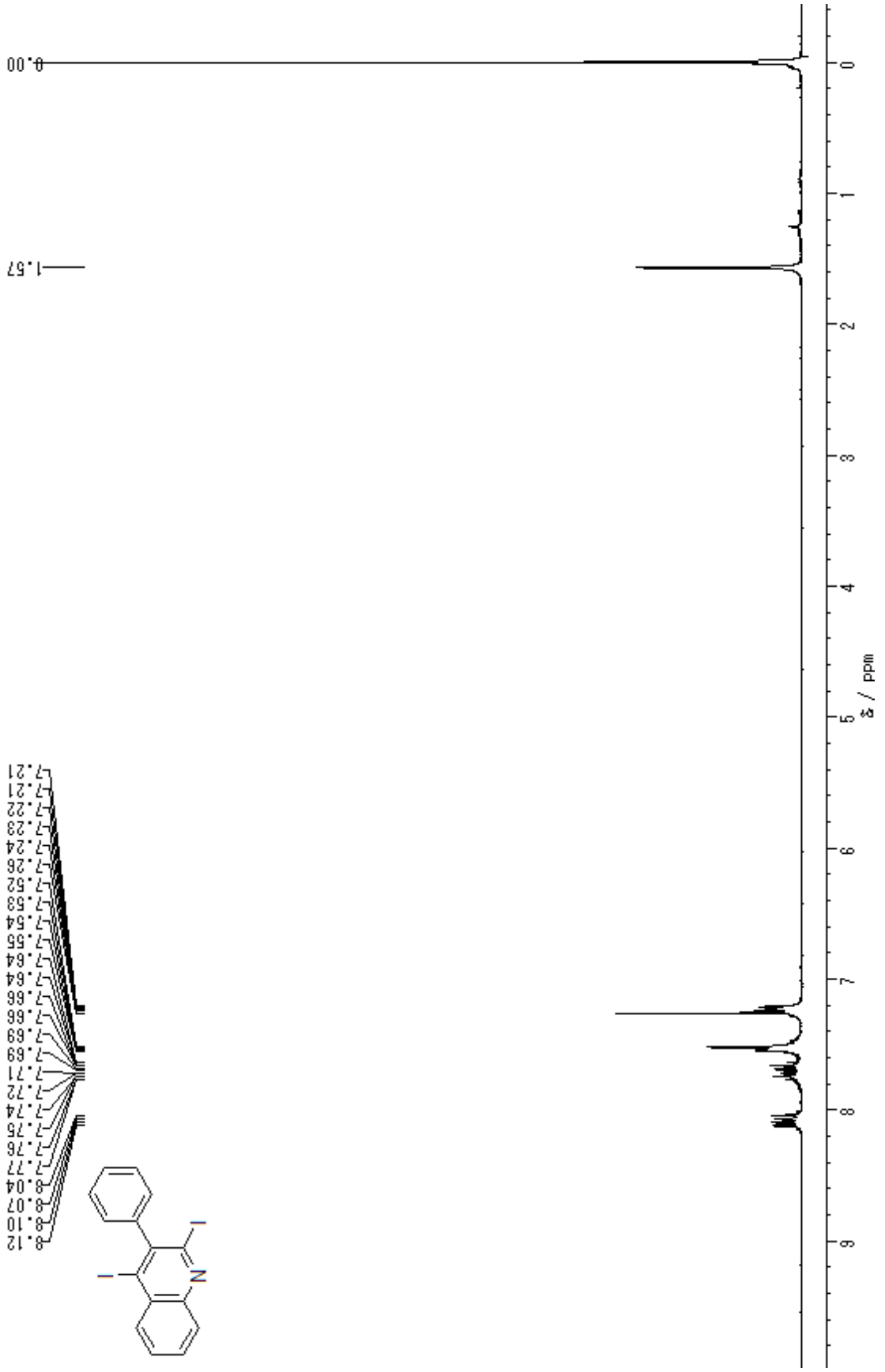
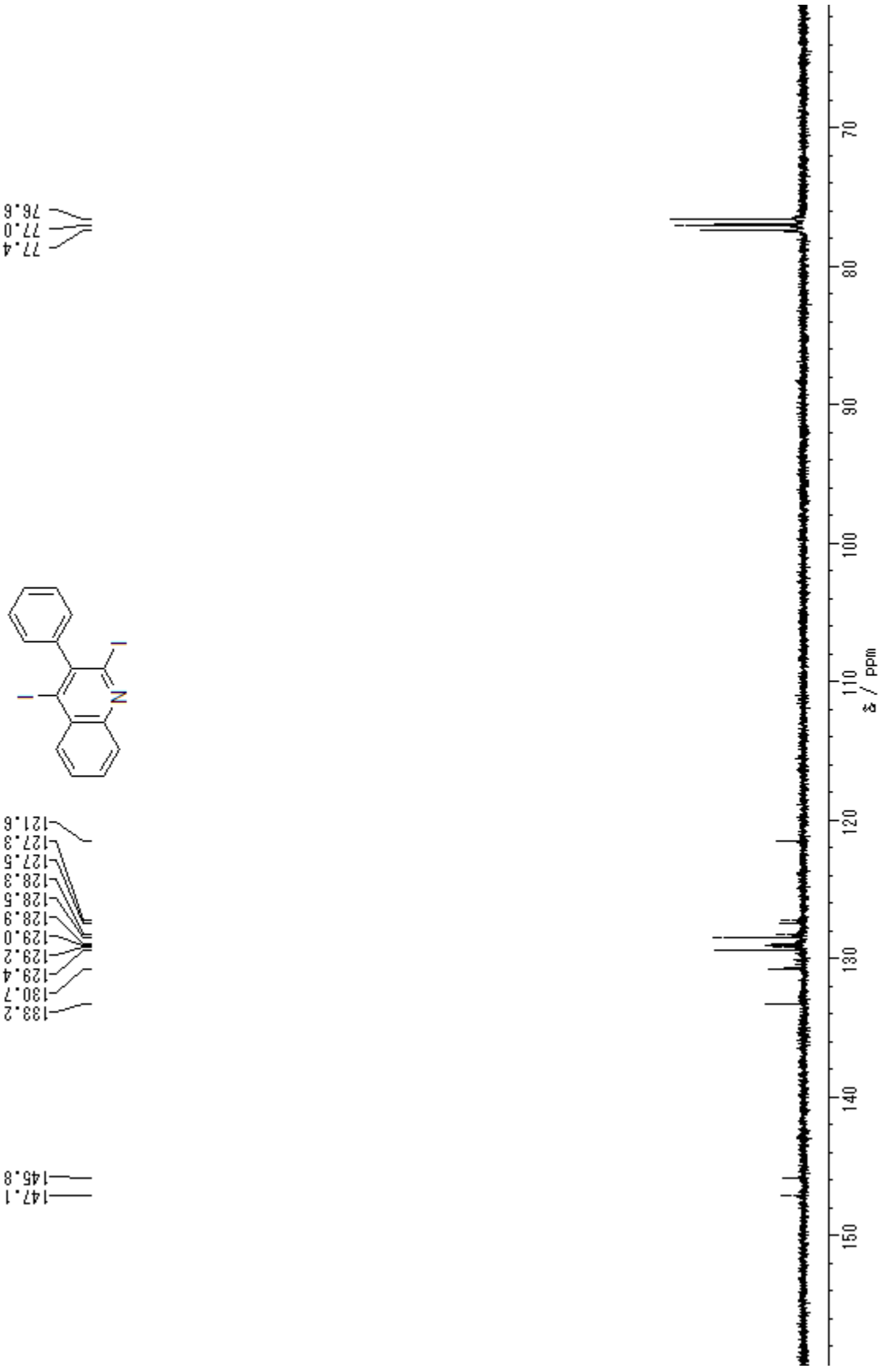
S3. Blackburn, B. K.; Lee, A.; Baier, M.; Kohl, B.; Olivero, A. G.; Matamoros, R.; Robarge, K. D.; McDowell, R. S. *J. Med. Chem.* **1997**, *40*, 717.

S4. Hou, L.-S.; Wu, J.-L.; Cheng, H.-T.; Xie, Y.-T.; Chen, L.-C. *J. Chinese Chem. Soc*. **2008**, *55*, 915.

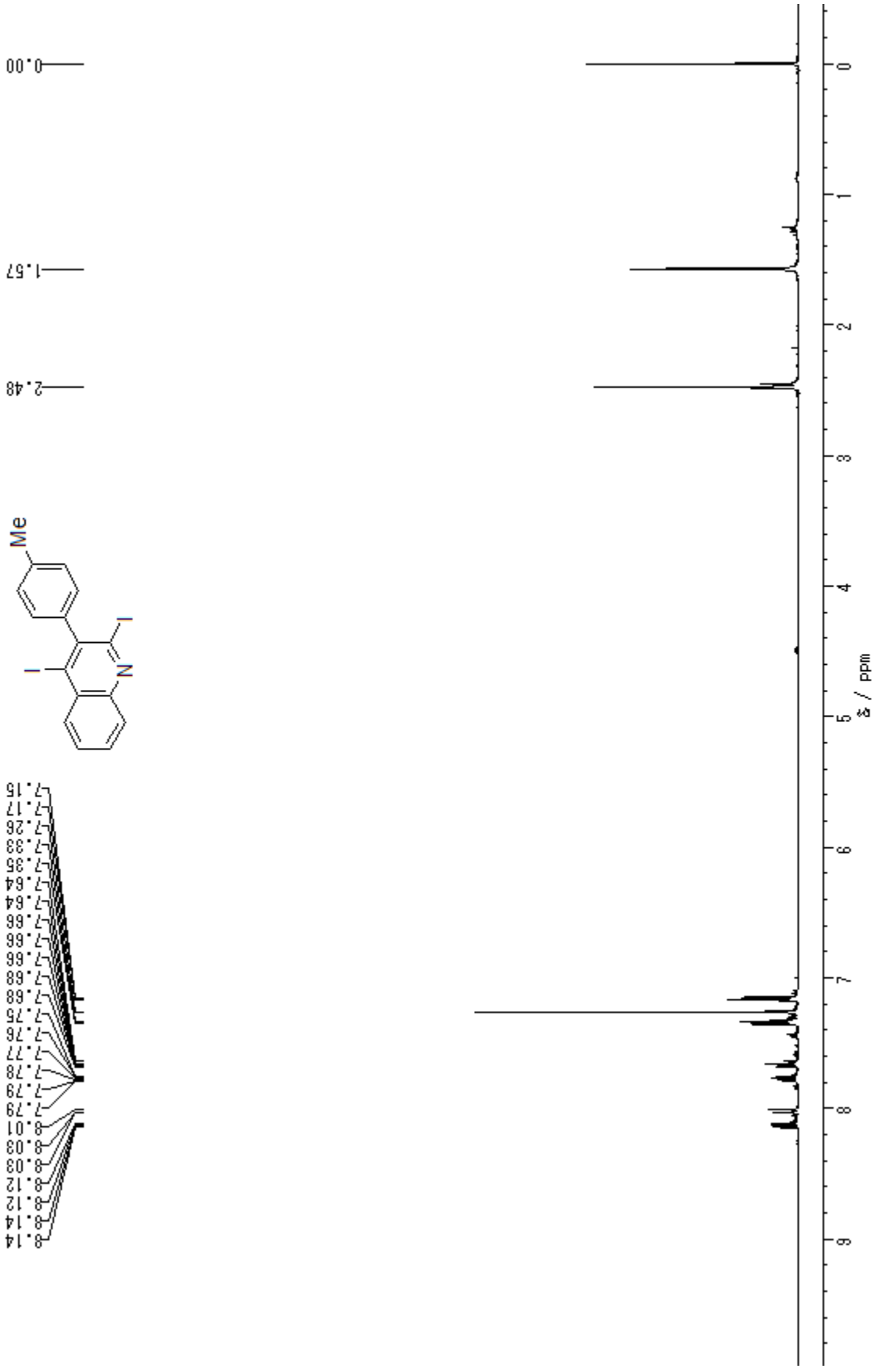
2,4-Diiodo-3-phenylquinoline (2a)



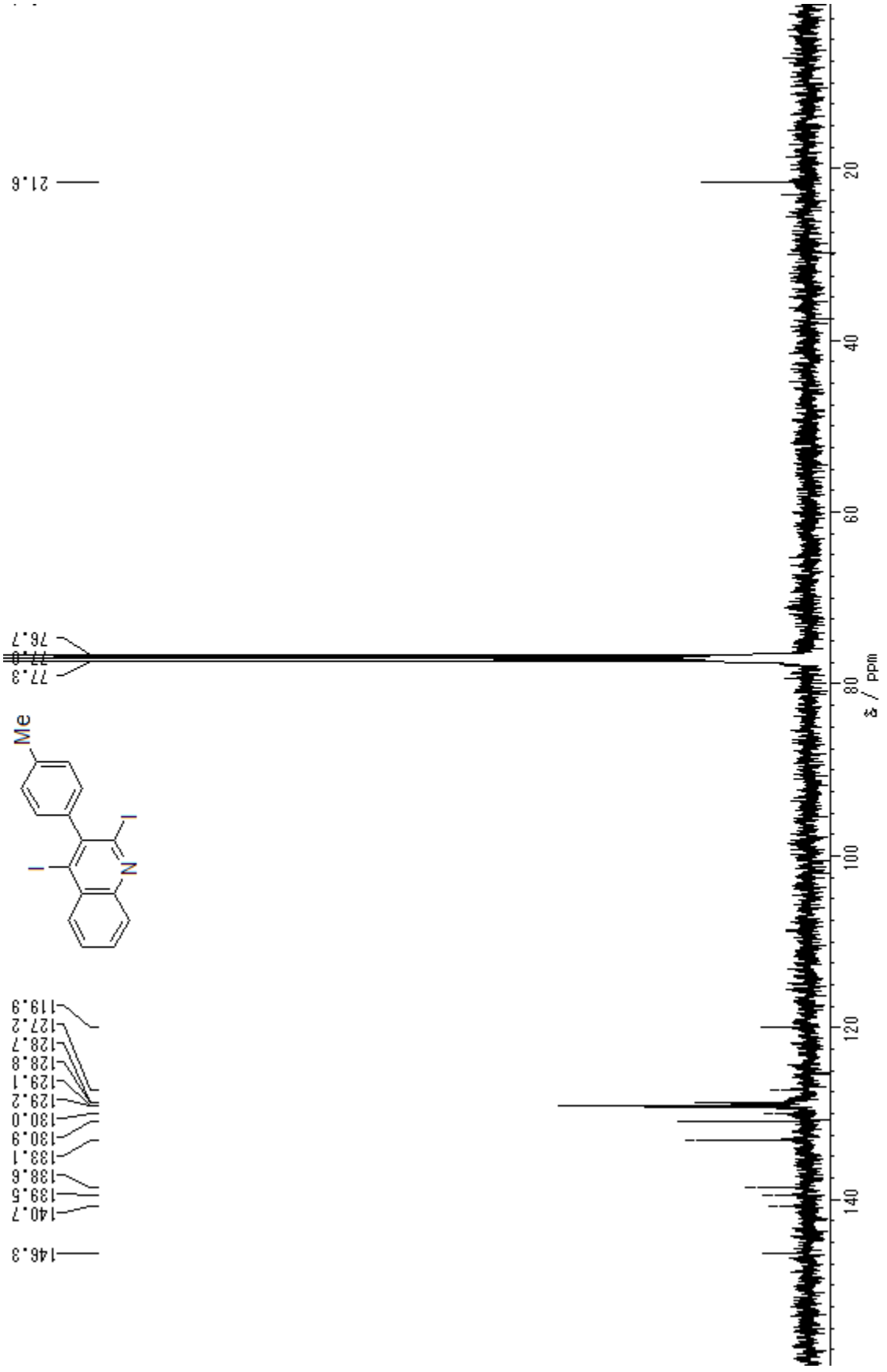
2,4-Diiodo-3-phenylquinoline (2a)



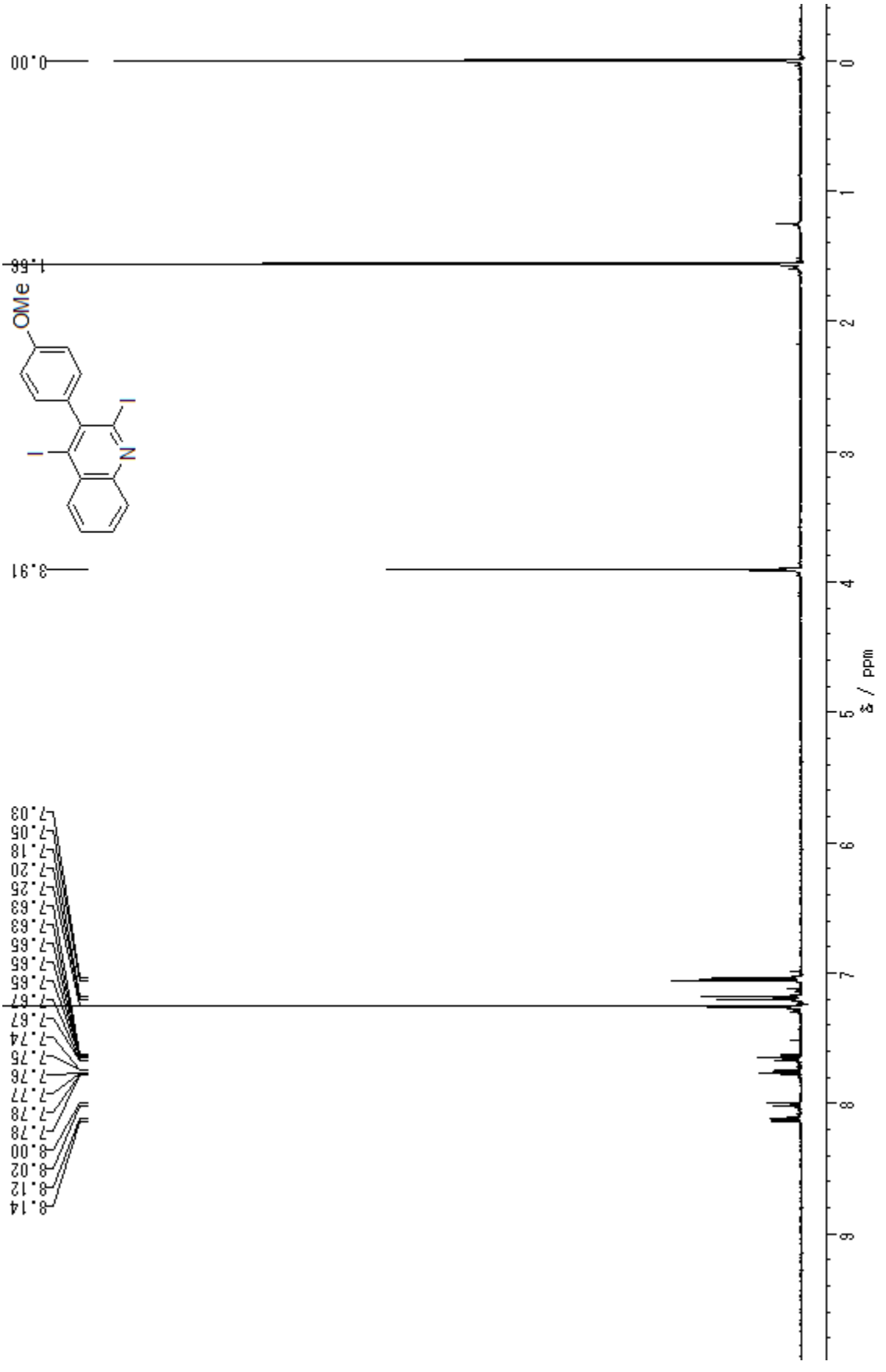
2,4-Diiodo-3-(4-methylphenyl)quinoline (2b)



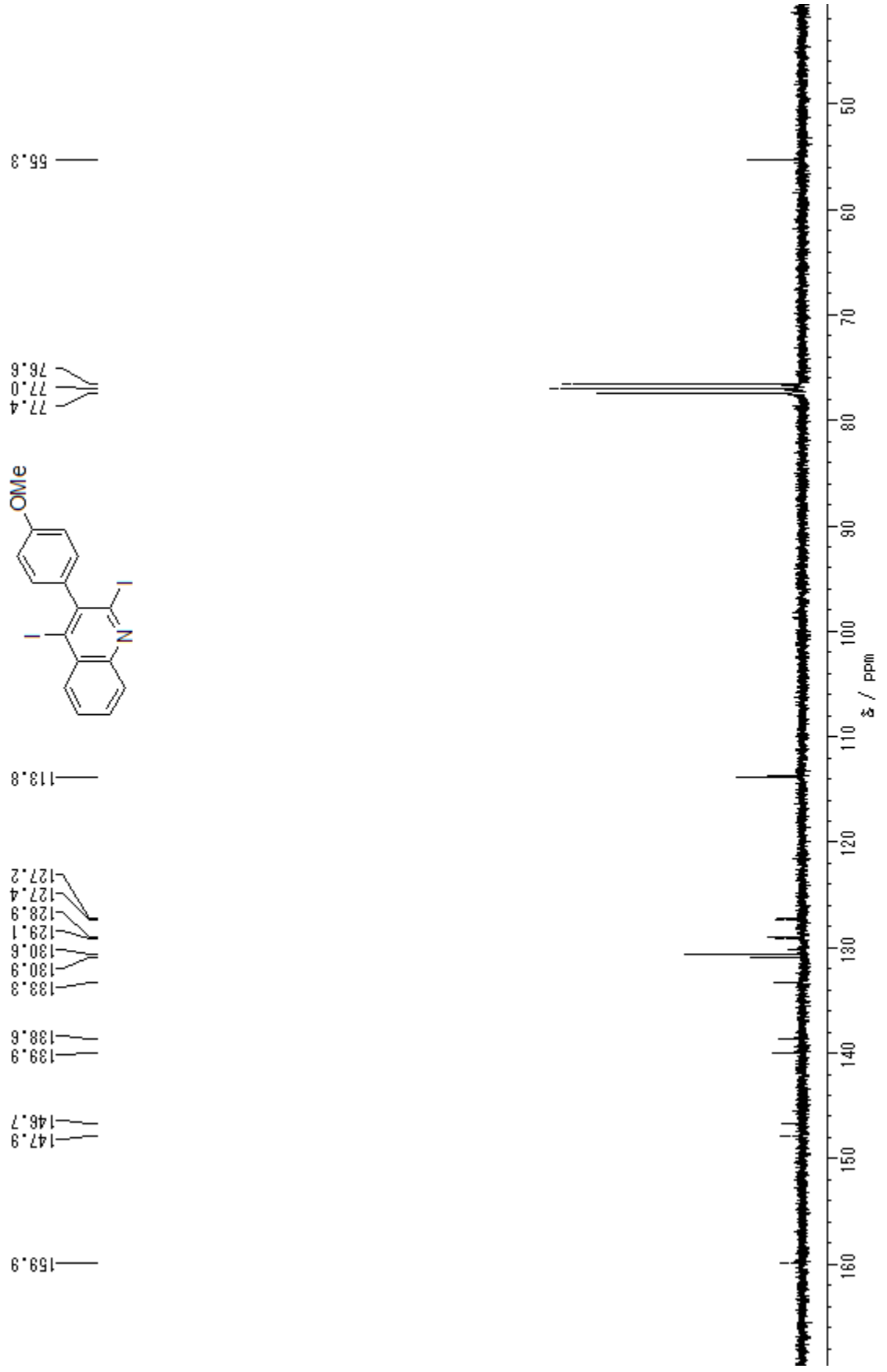
2,4-Diiodo-3-(4-methylphenyl)quinoline (2b)



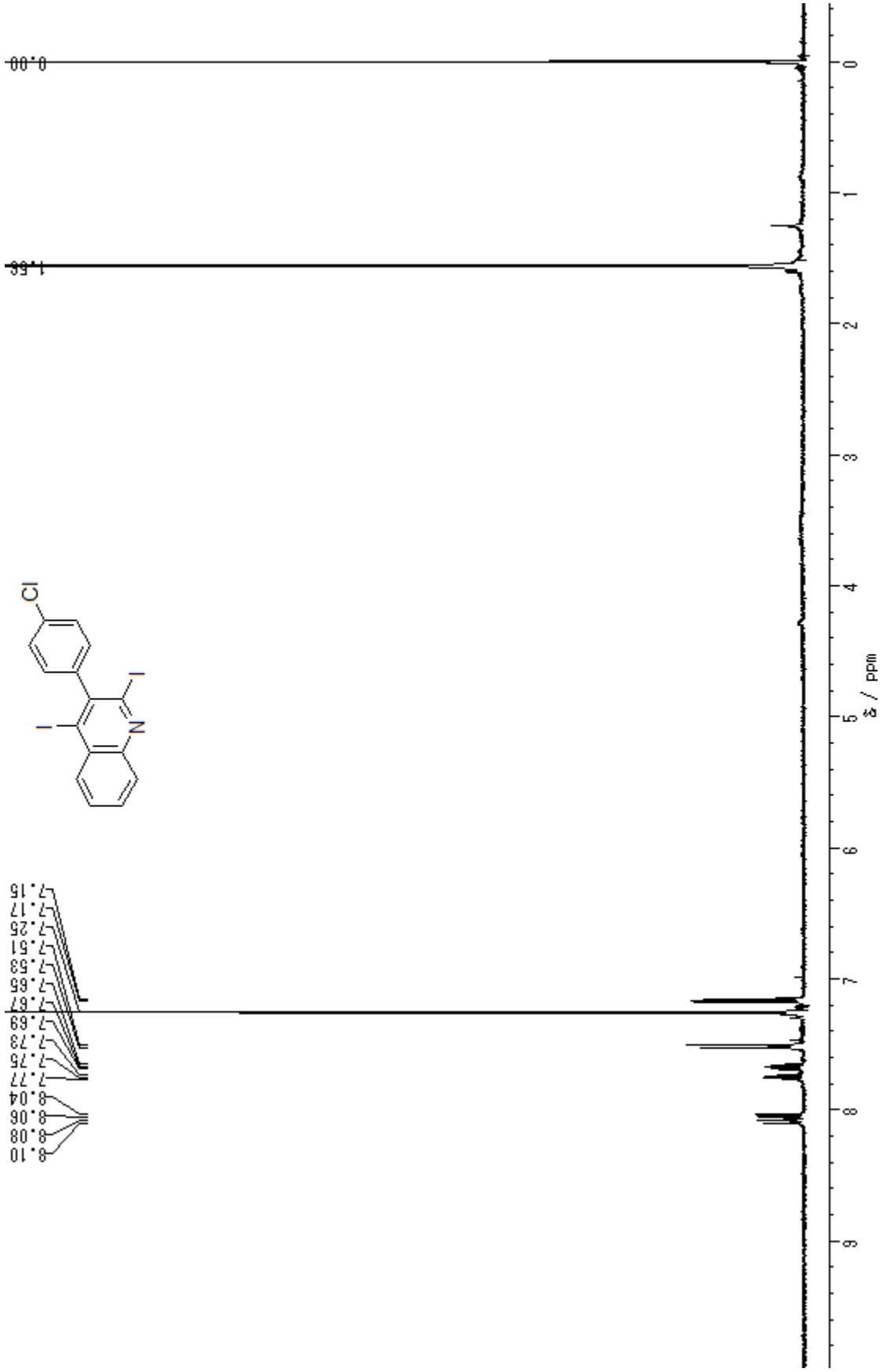
2,4-Diiodo-3-(4-methoxyphenyl)quinoline (2c)



2,4-Diiodo-3-(4-methoxyphenyl)quinoline (2c)



2,4-Diiodo-3-(4-chlorophenyl)quinoline (2d)



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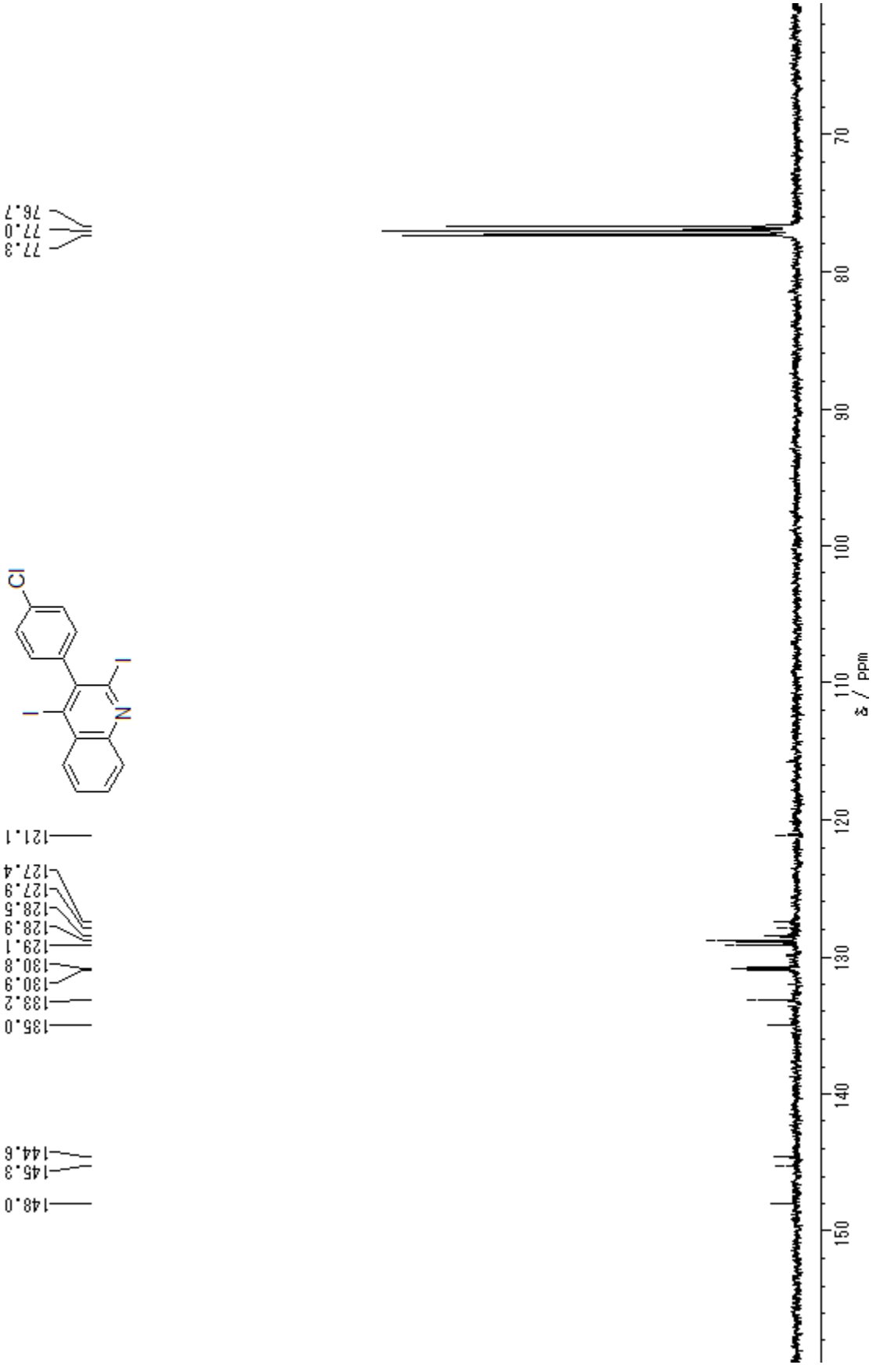

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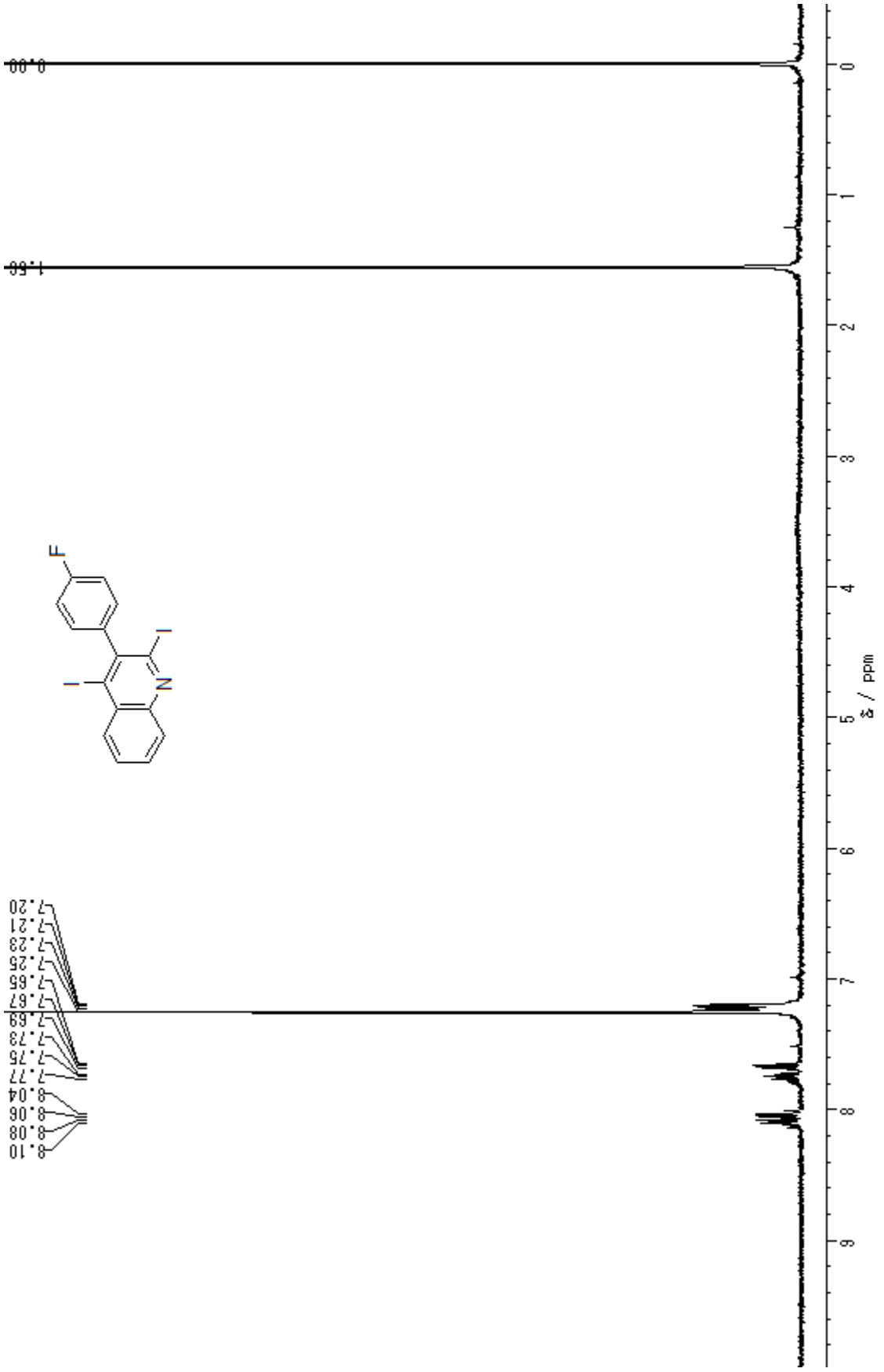

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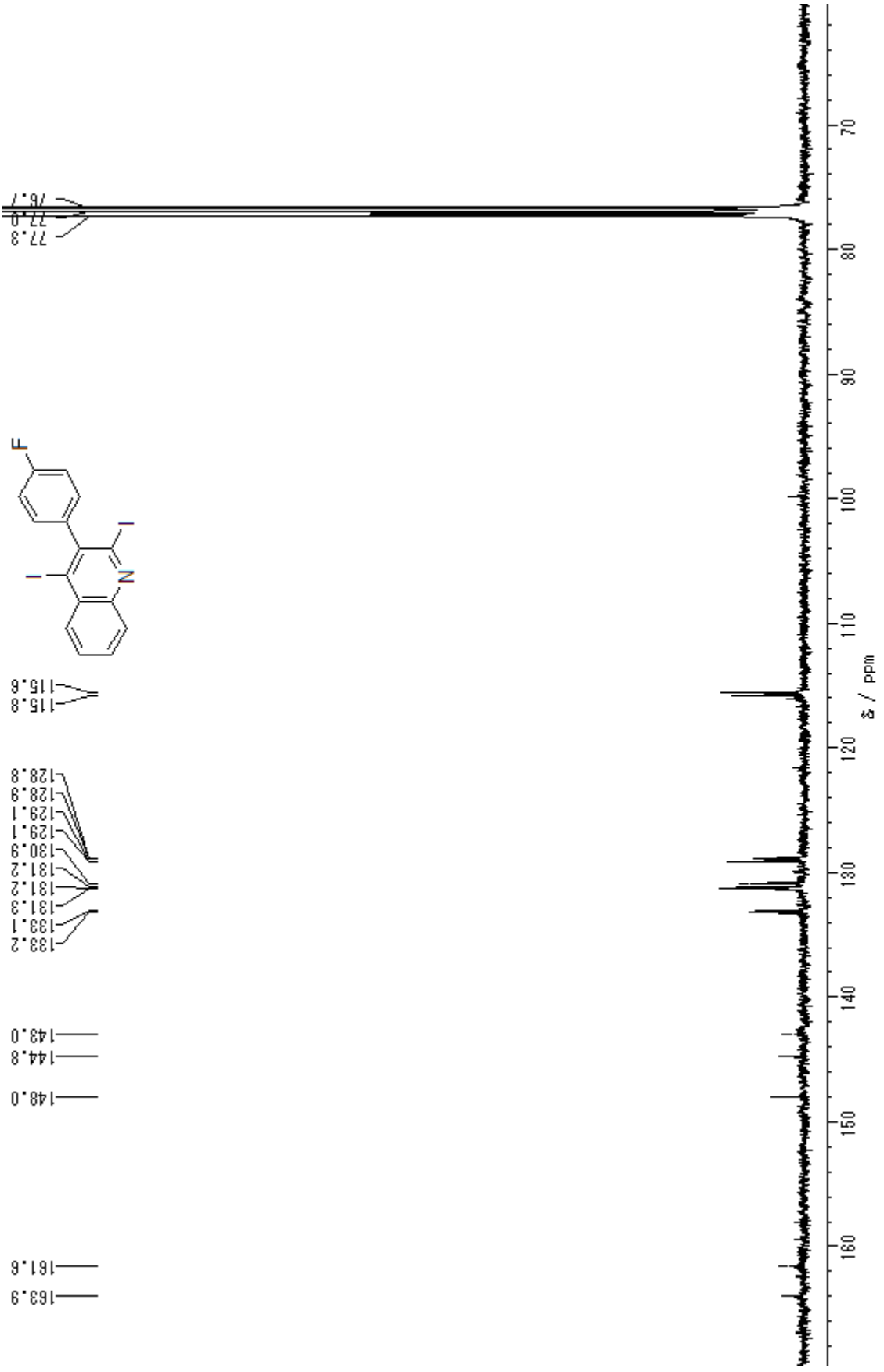
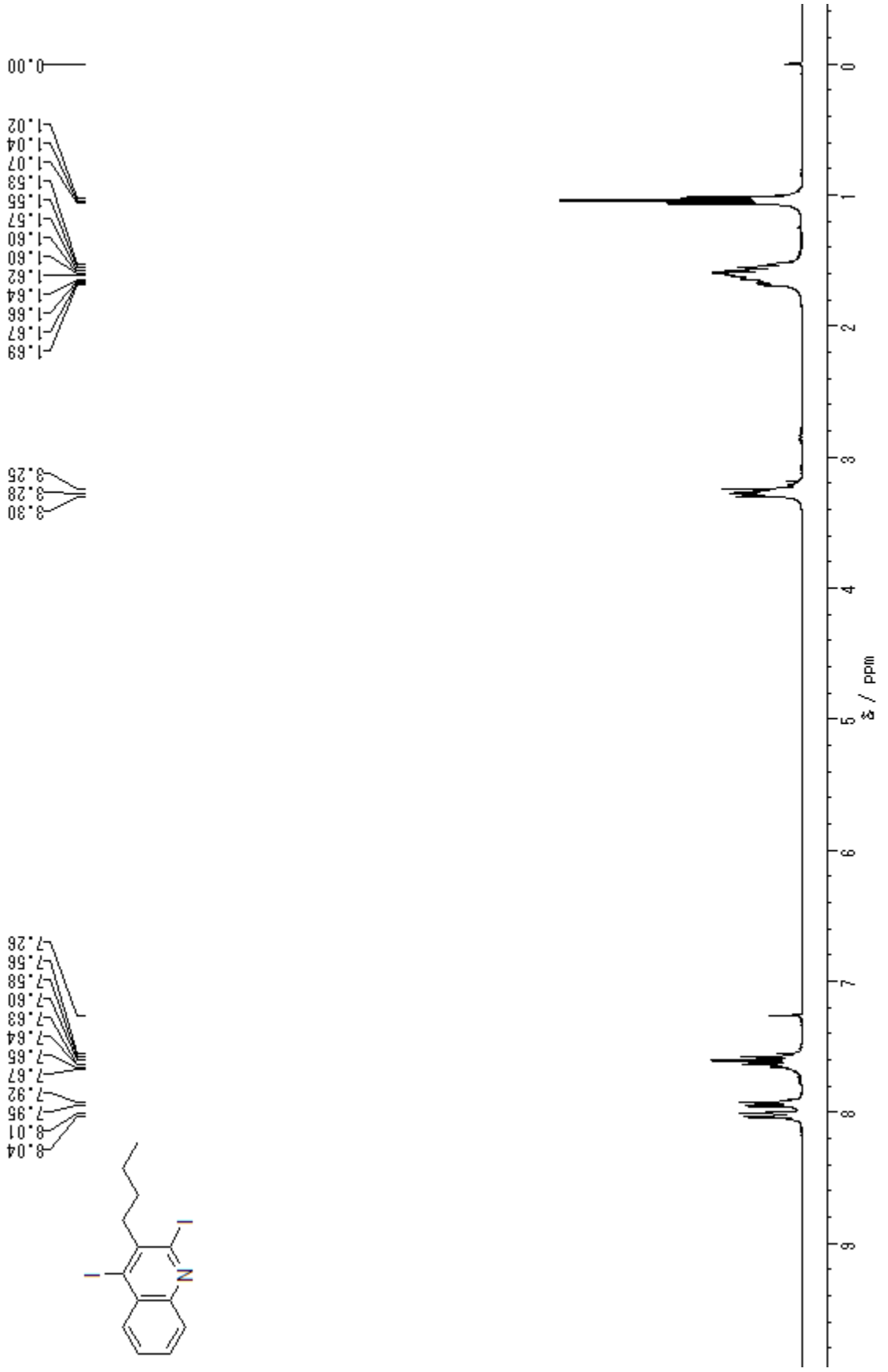


2,4-Diiodo-3-*n*-butylquinoline (2g)



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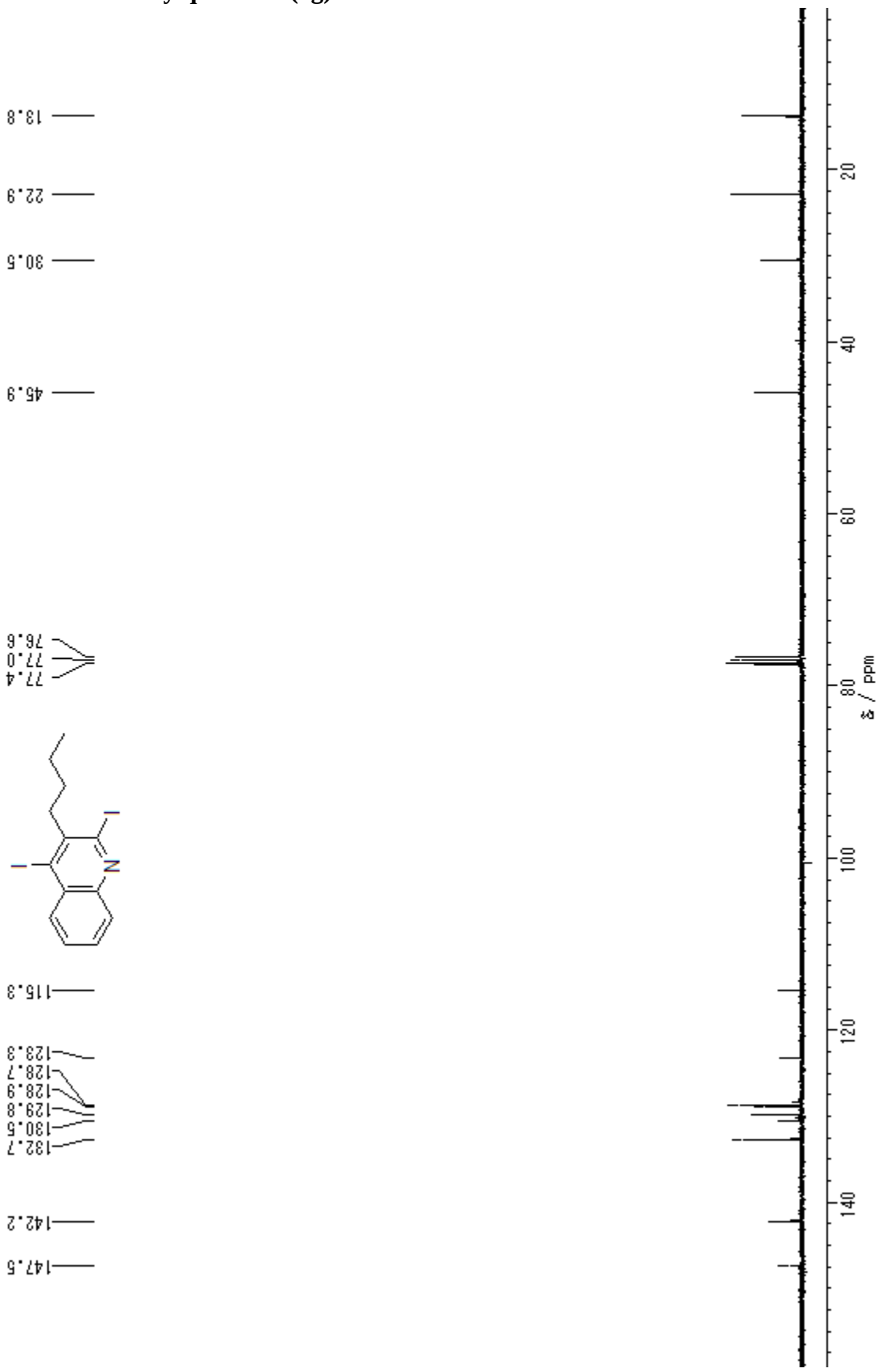
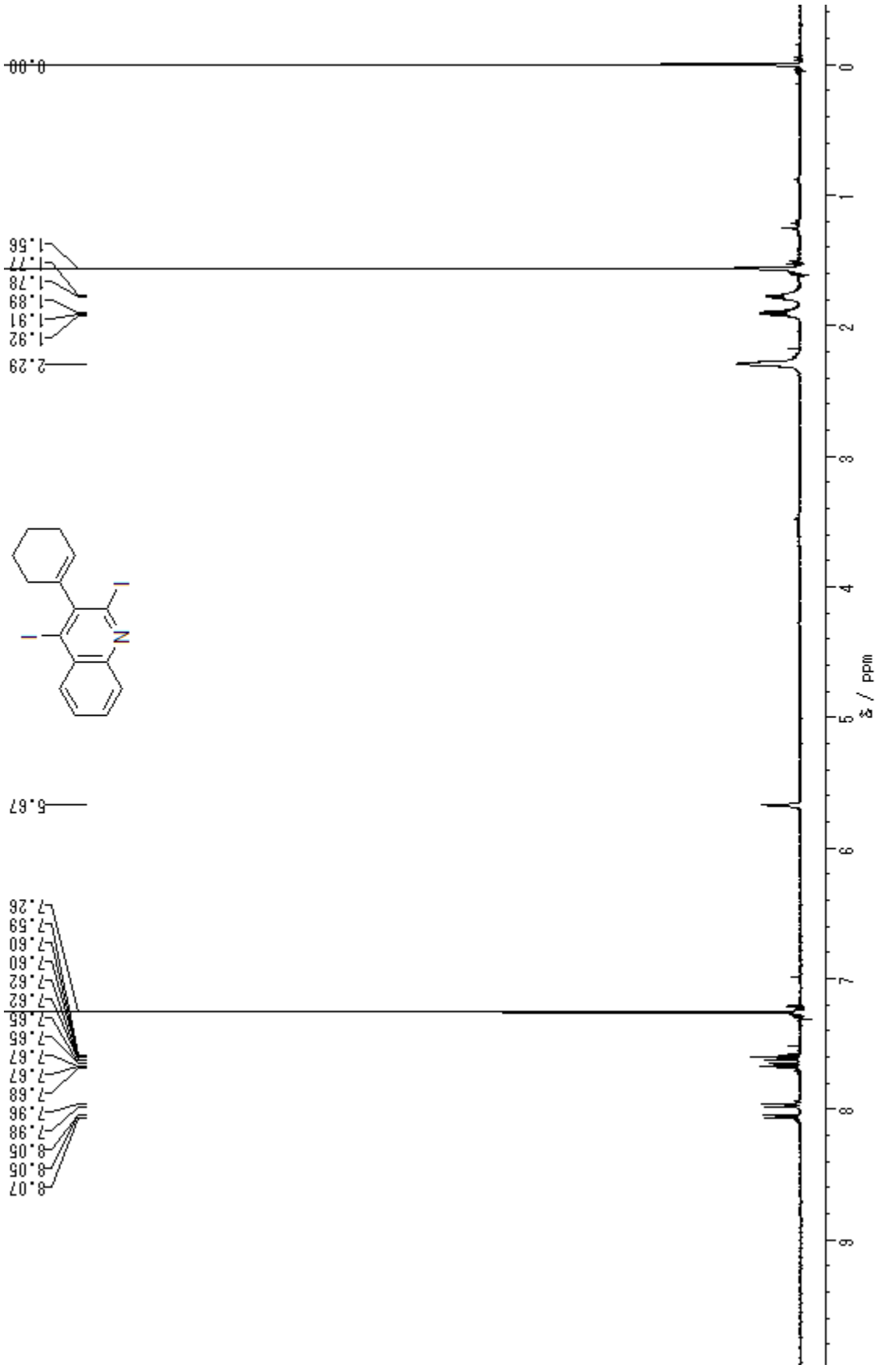
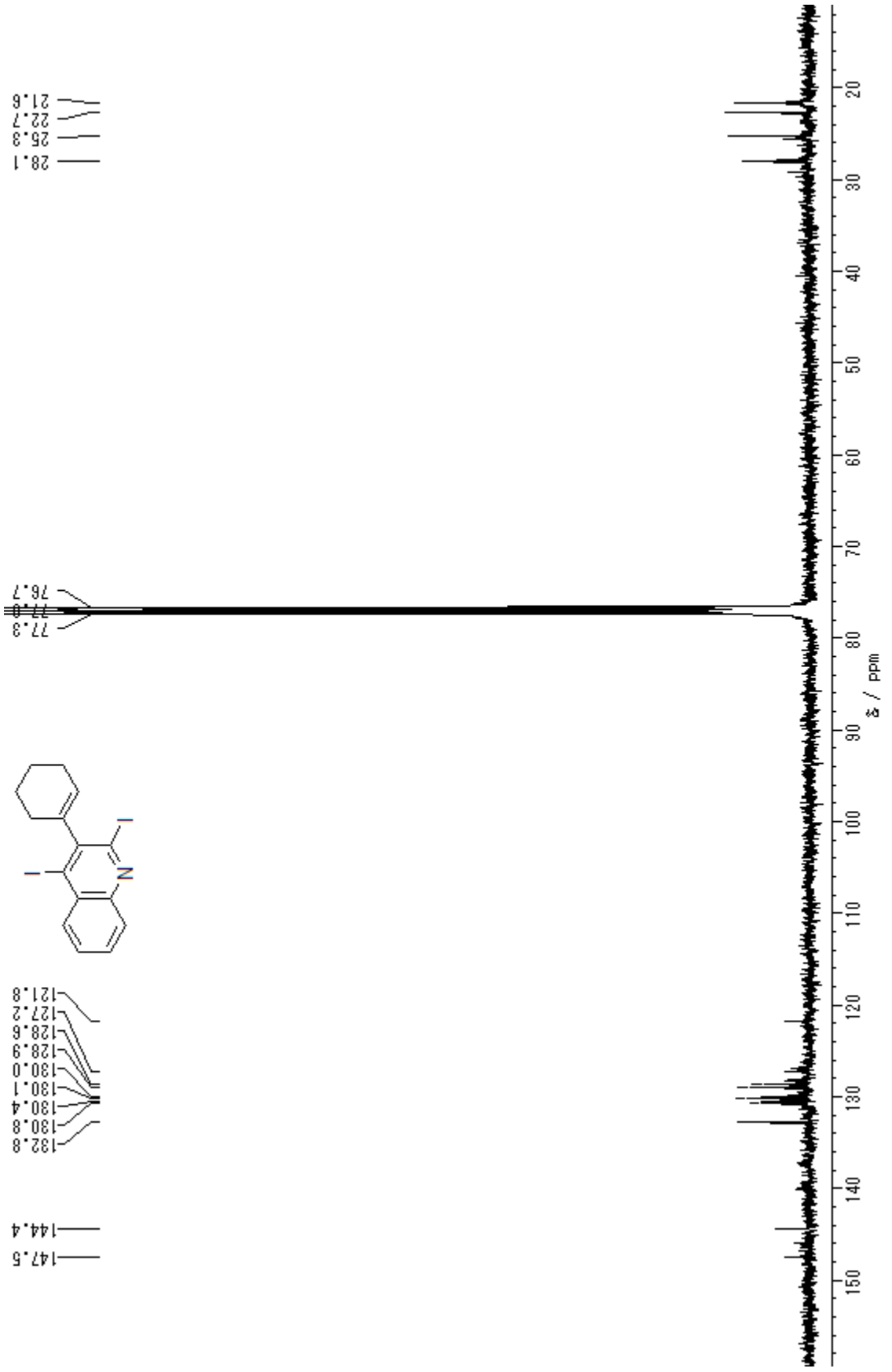


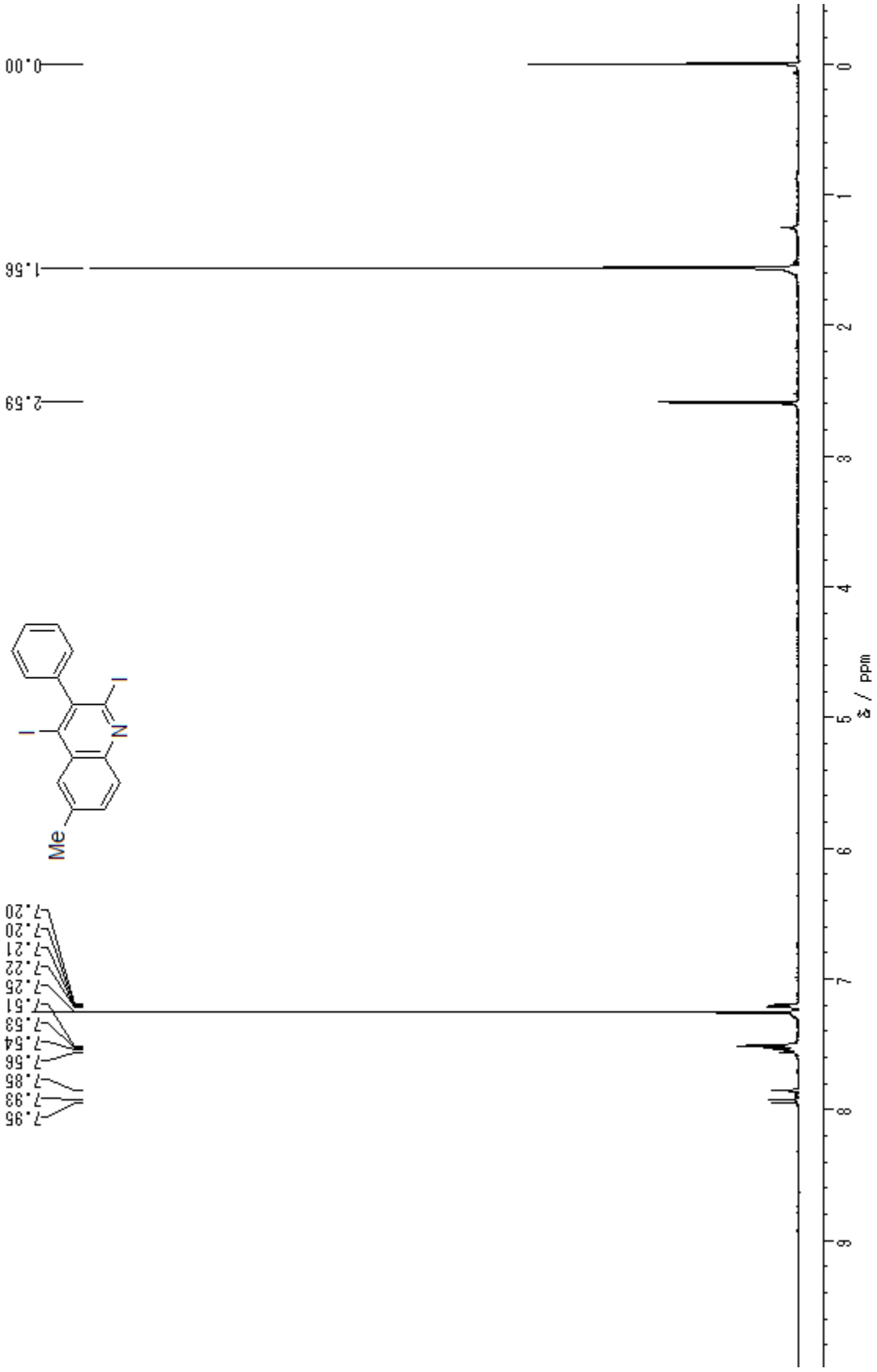
2,4-Diiodo-3-(1-cyclohexenyl)quinoline (2h)



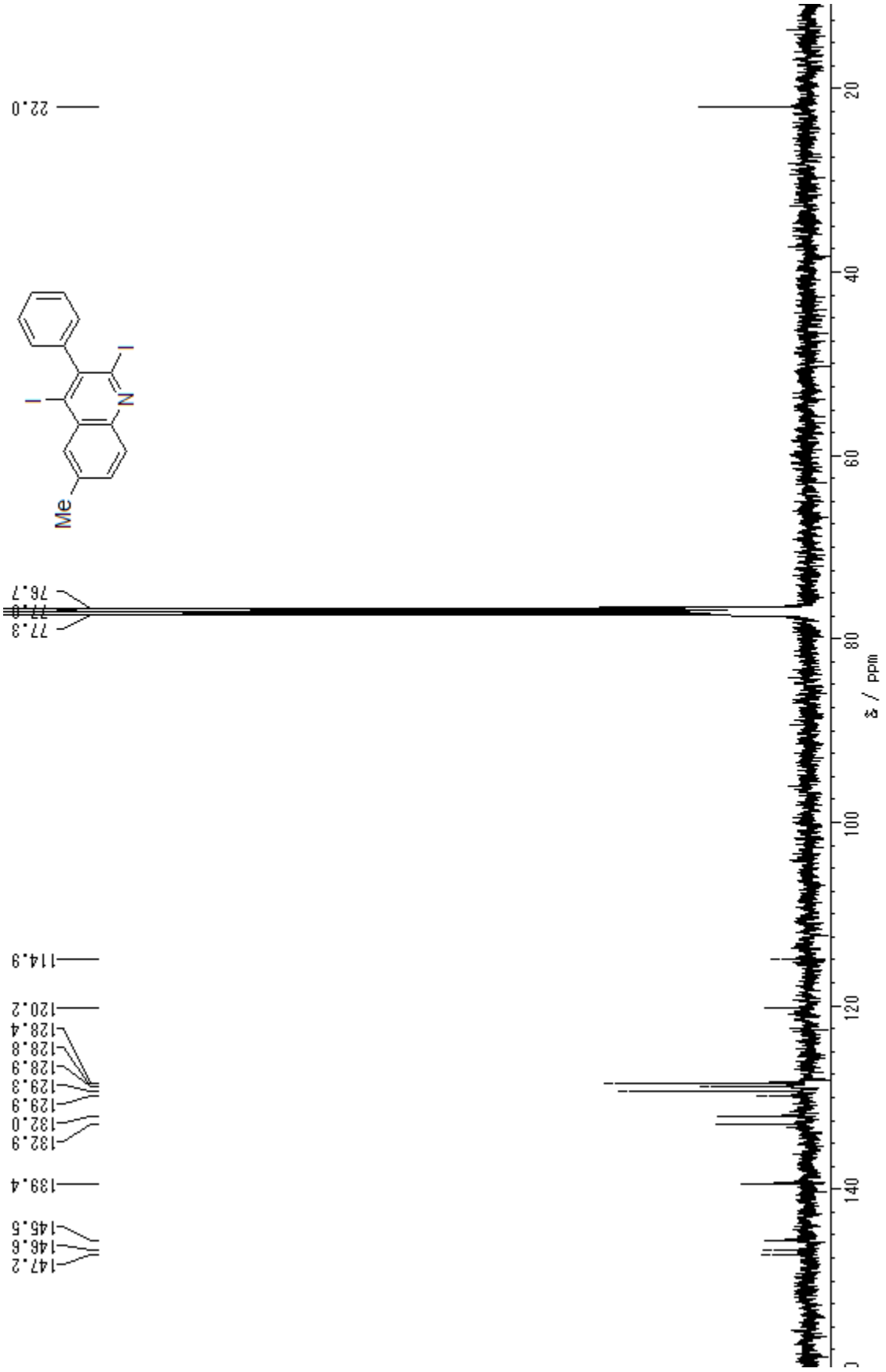
2,4-Diiodo-3-(1-cyclohexenyl)quinoline (2h)



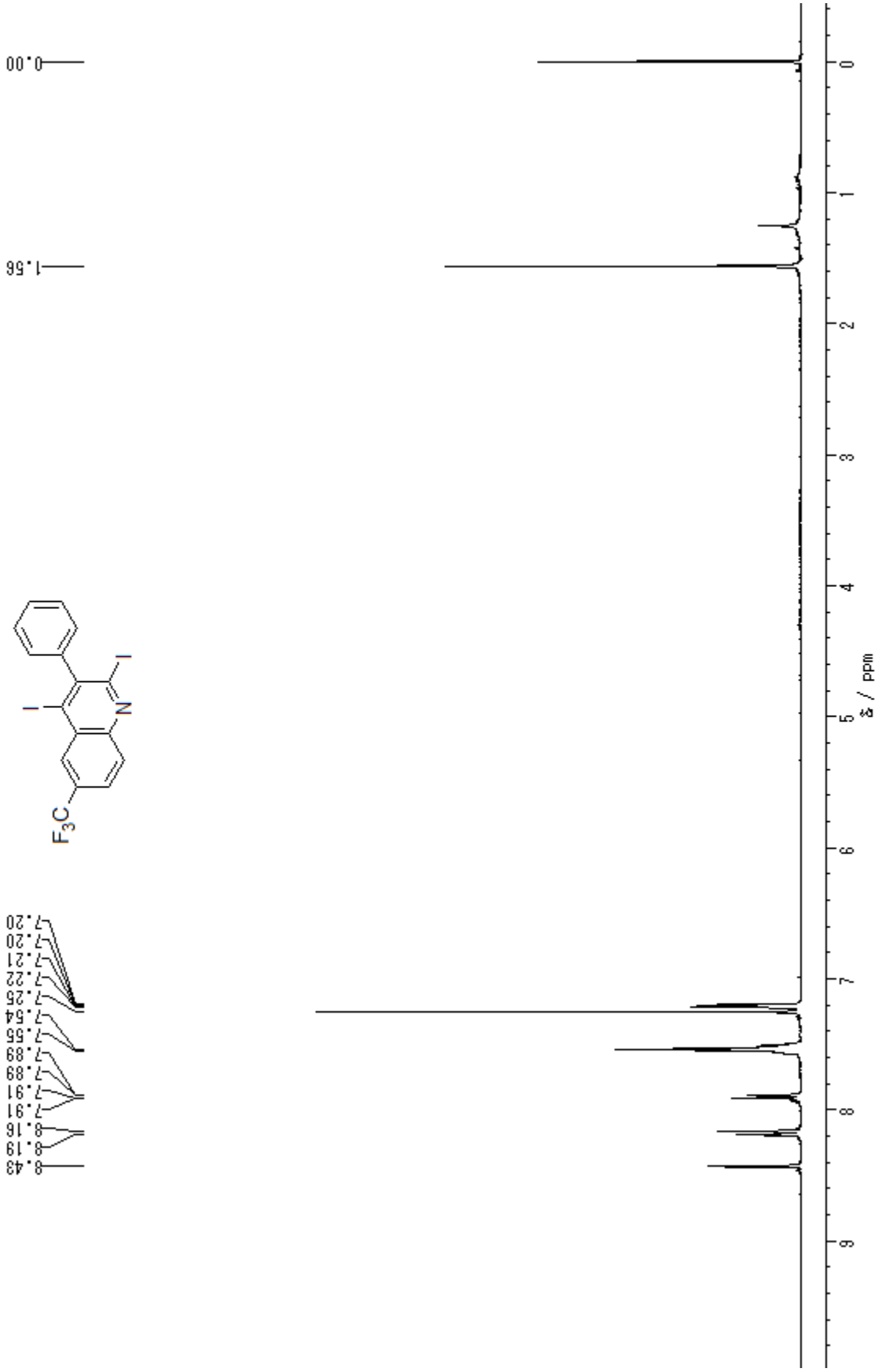
2,4-Diiodo-3-phenyl-6-methylquinoline (2i)



2,4-Diiodo-3-phenyl-6-methylquinoline (2i)



2,4-Diiodo-3-phenyl-6-trifluoromethylquinoline (2j)



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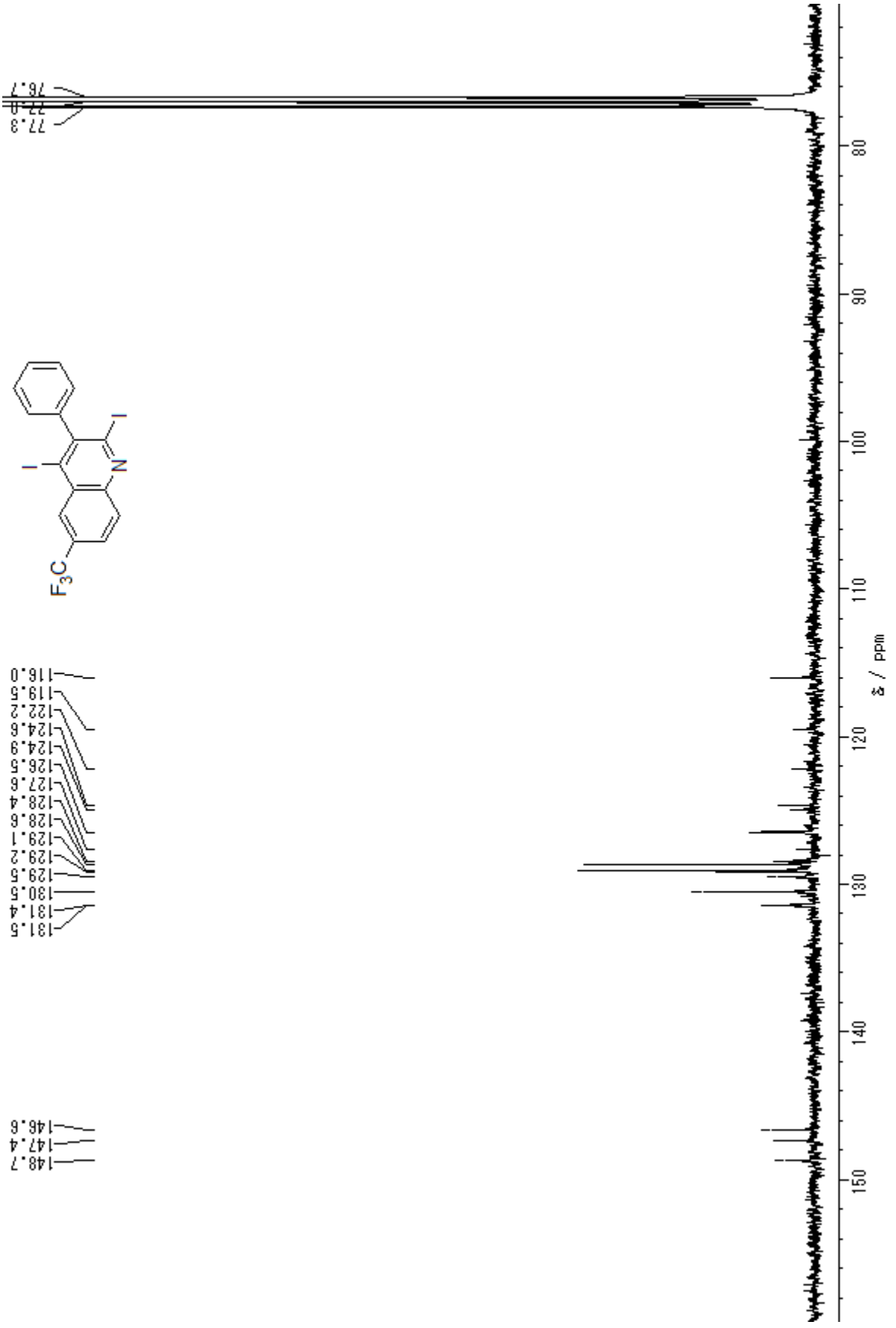
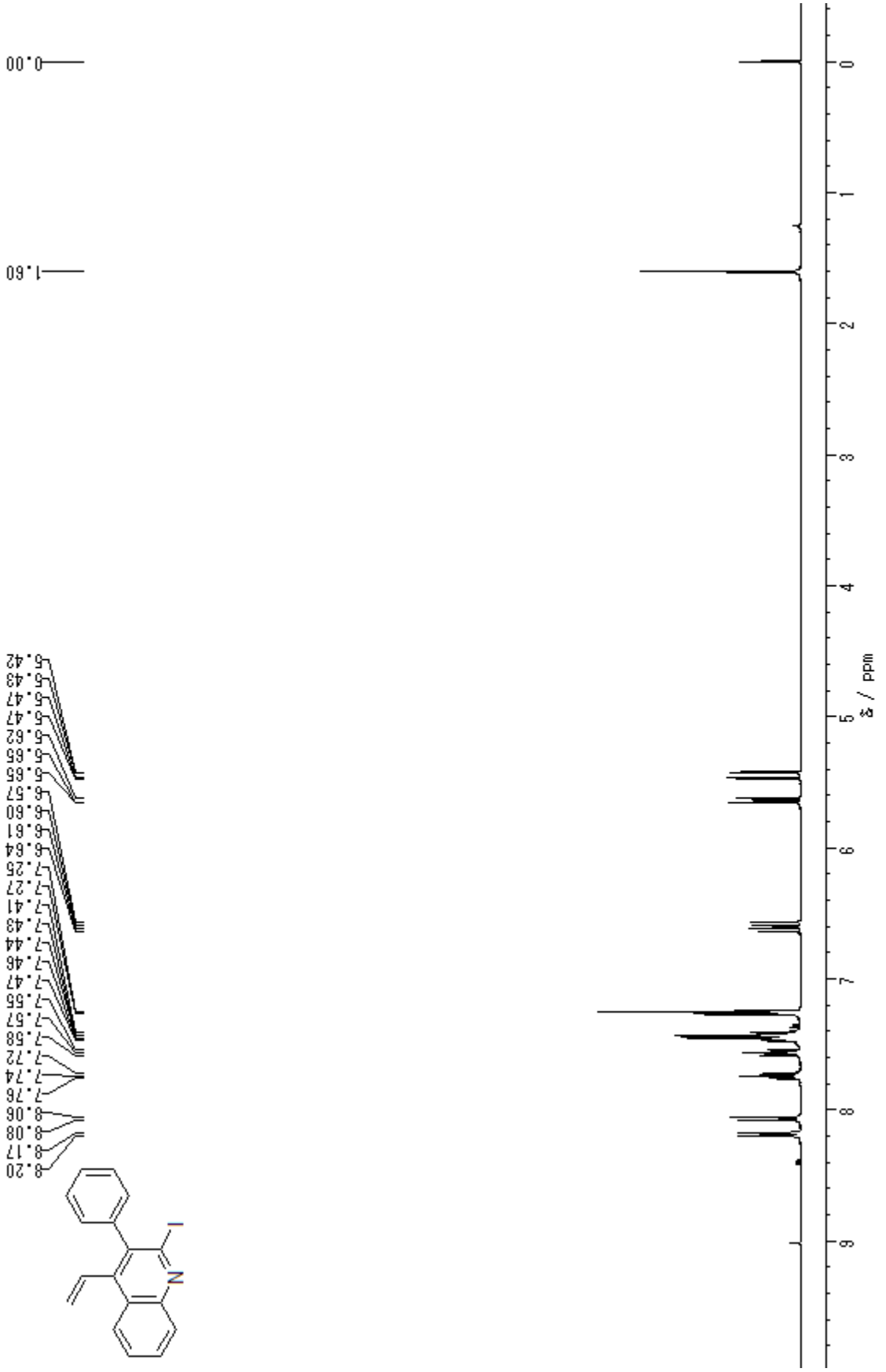
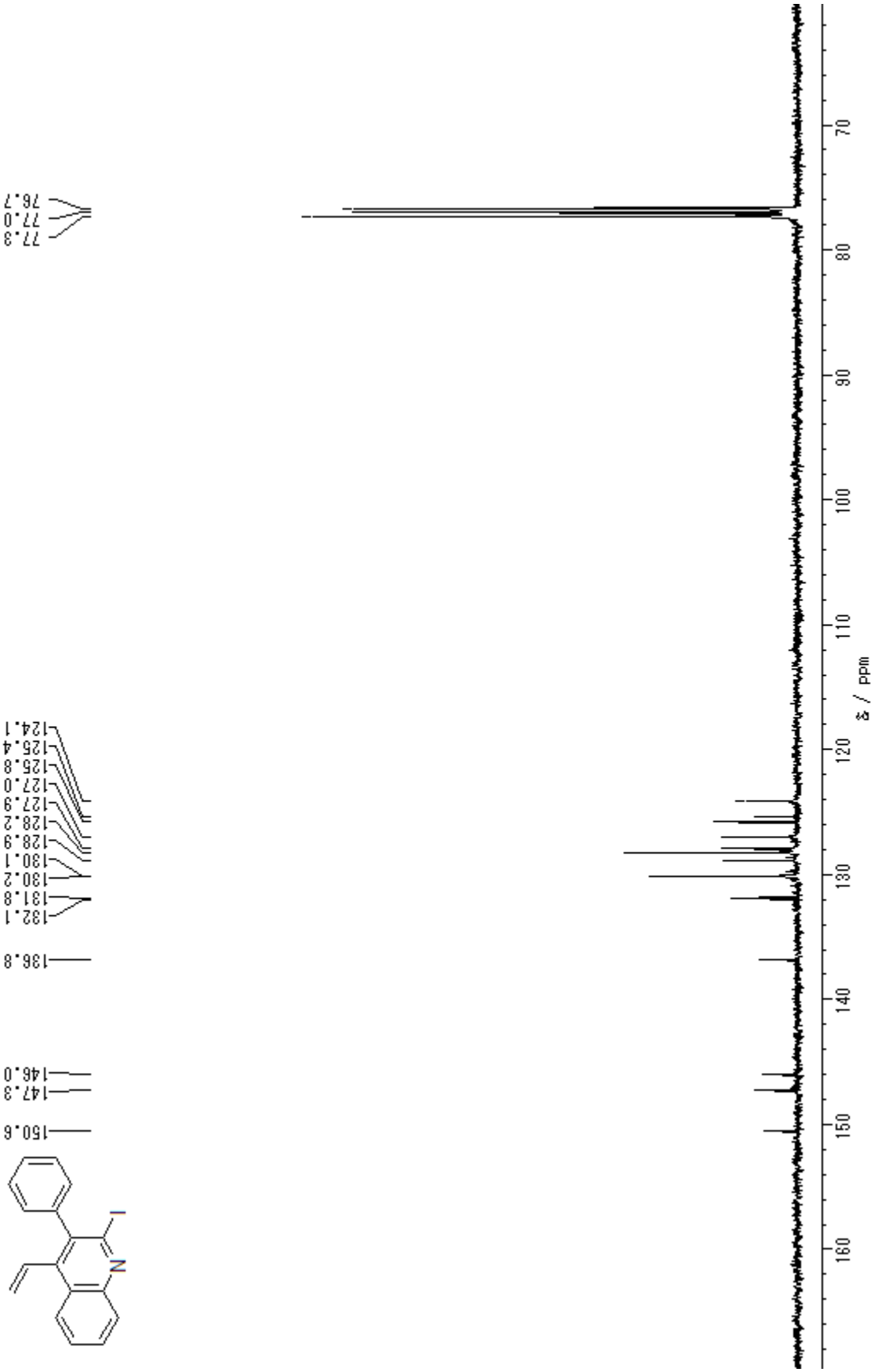


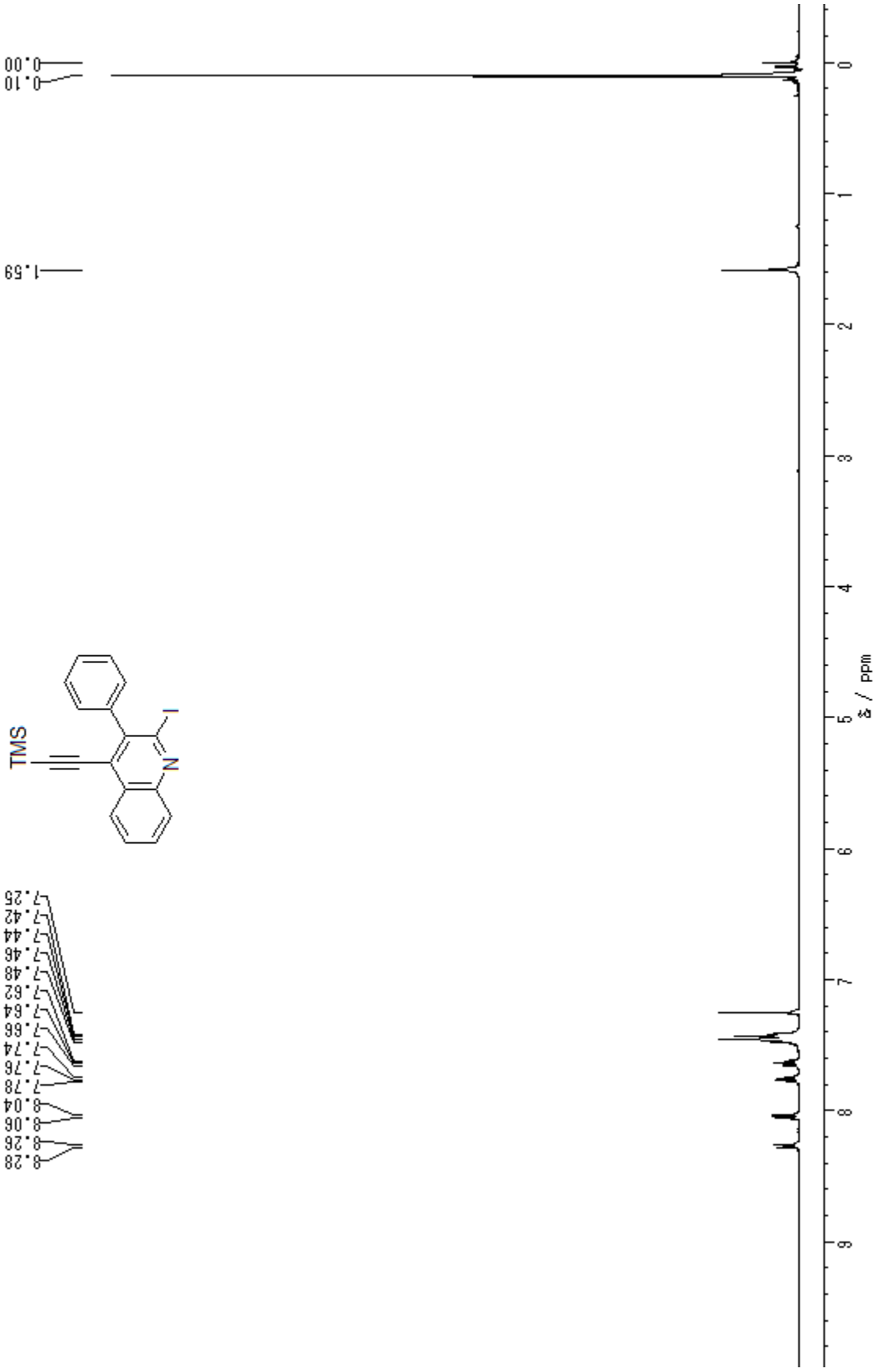
4-Ethenyl-2-iodo-3-phenylquinoline (3a)



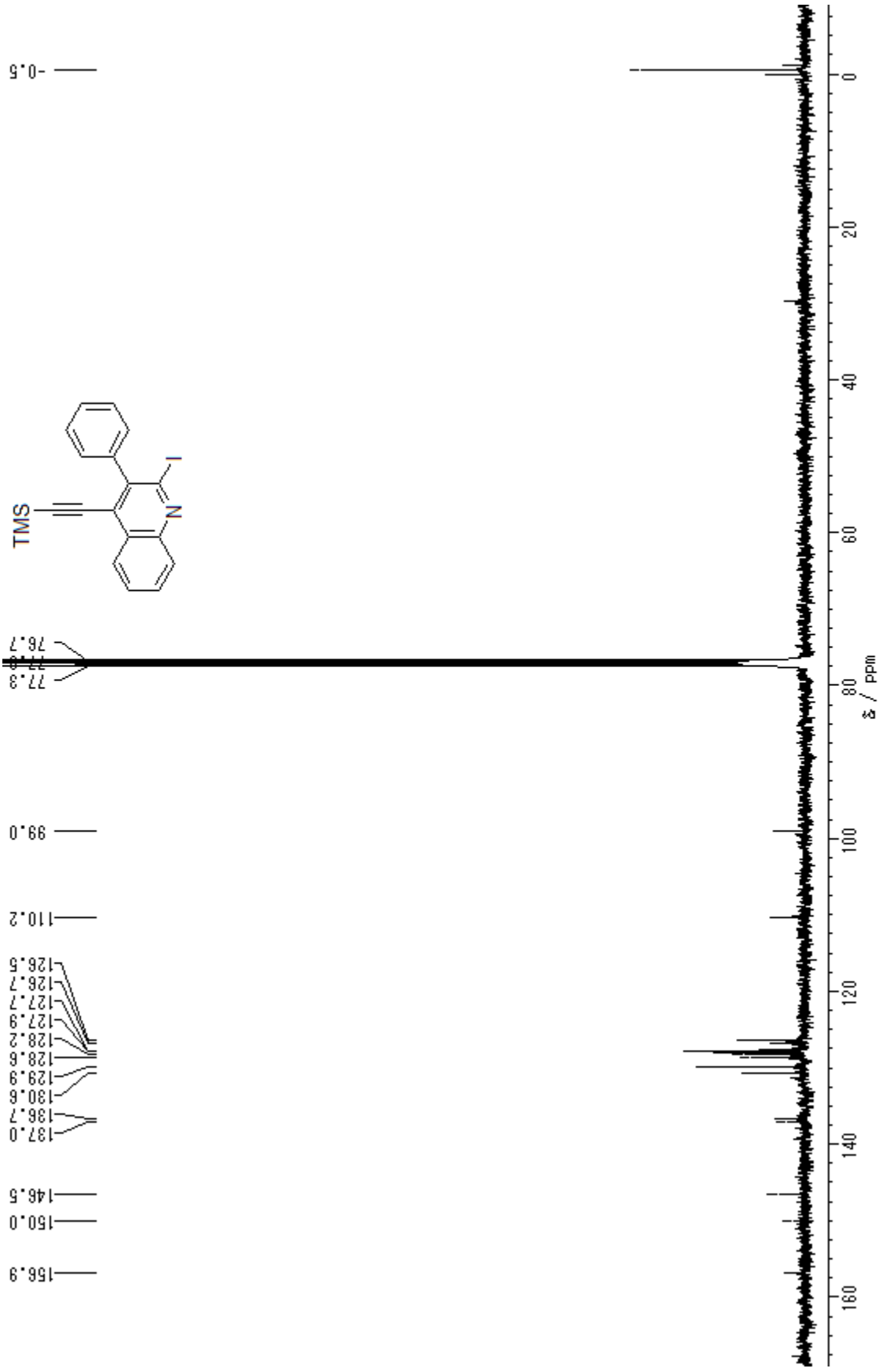
4-Ethenyl-2-iodo-3-phenylquinoline (3a)



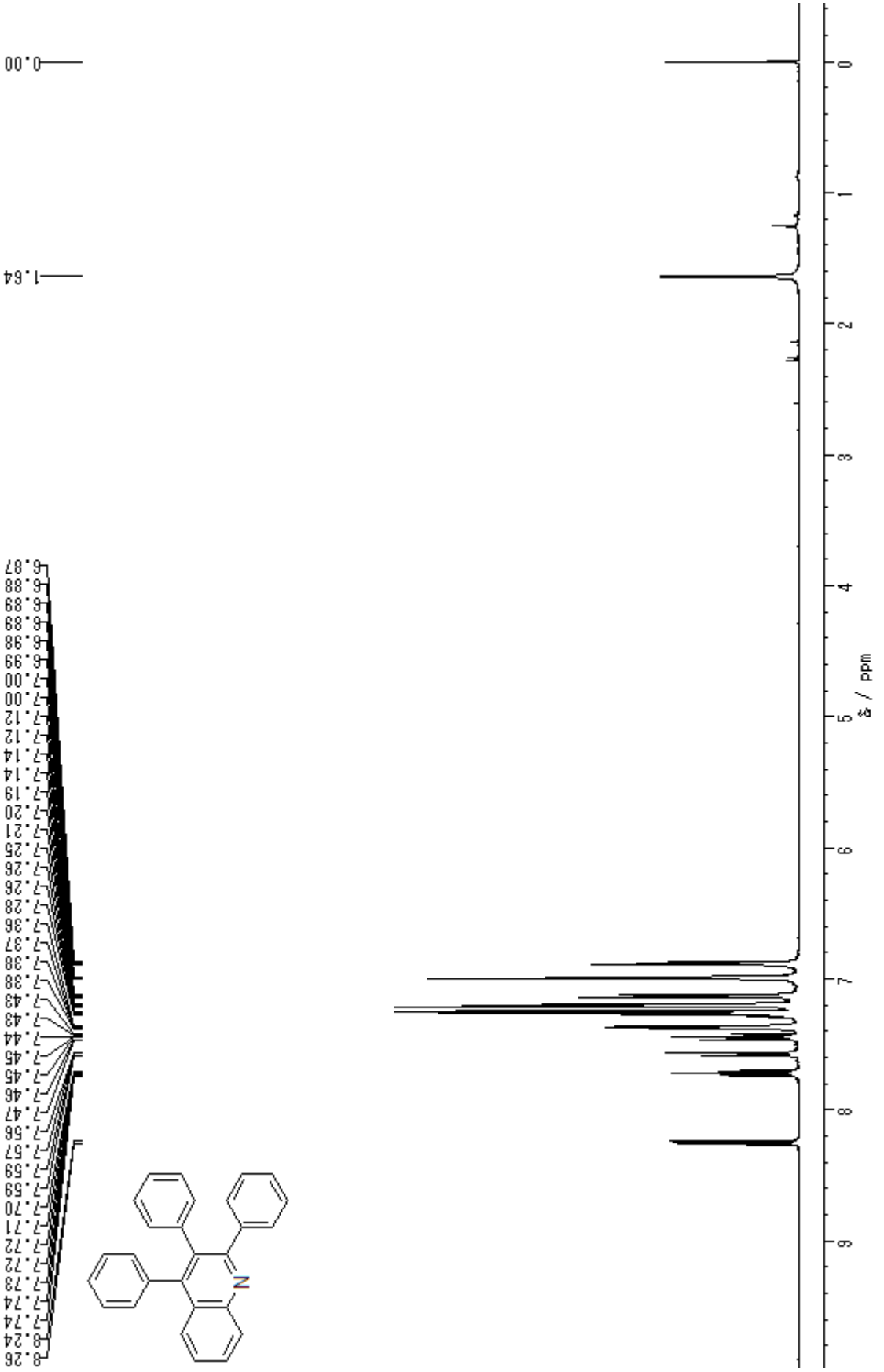
2-Iodo-3-phenyl-4-trimethylsilylethynylquinoline (4a)



2-Iodo-3-phenyl-4-trimethylsilylethynylquinoline (4a)



2,3,4-Triphenylquinoline (5a)



2,3,4-Triphenylquinoline (5a)