

Supporting Information

'On-water' synthesis of chromeno-isoxazoles mediated by [hydroxy(tosyloxy)iodo]benzene (HTIB)

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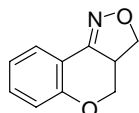
Experimental section

General methods

All reactions were performed at room temperature and the chemicals used in the reactions were not dried. Analytical thin-layer chromatography was performed with E. Merck silica gel 60F glass plates and flash chromatography used E. Merck silica gel 60 (230–400 mesh). MS were measured using a JEOL JMS-HX110 spectrometer. ¹H and ¹³C NMR spectra were recorded with a Bruker Avance EX 400 instrument. All substrates were prepared using previously reported procedures.^{1,2}

Spectral data

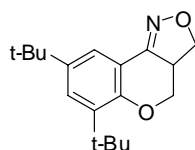
(1) **3a,4-Dihydro-3H-chromeno[4,3-c]isoxazole (1a)**^{11g, h, i, k, 10e, h}:



Colorless solid, mp: 60-61 °C (60-61 °C)

¹H NMR (400 MHz, CDCl₃) δ 7.79 (d, *J* = 7.7 Hz, 1H), 7.33 (t, *J* = 7.8 Hz, 1H), 6.99 (t, *J* = 7.4 Hz, 1H), 6.95 (d, *J* = 8.3 Hz, 1H), 4.69 (m, 2H), 4.11-4.03 (m, 1H), 3.99-3.87 (m, 2H); ¹³C NMR (100 MHz, CDCl₃): δ 155.8, 152.9, 132.6, 125.9, 122.0, 117.6, 113.2, 70.8, 69.4, 46.1; MS *m/z* (relative intensity): 176 (M⁺+1, 18), 175 (M⁺, 100), 145 (24), 117 (5), 91 (4). HRMS calcd for C₁₀H₉NO₂ (M⁺) 175.0628, found 175.0636.

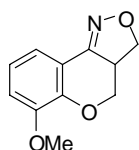
(2) **6,8-di-tert-butyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (2a)**:



Colorless Solid; mp :185-187 °C

^1H NMR (400 MHz, CDCl_3) δ 7.70 (d, $J = 2.4$ Hz, 1H), 7.40 (d, $J = 2.4$ Hz, 1H), 4.75-4.71 (m, 1H), 4.71-4.67 (m, 1H), 4.07-4.01 (m, 1H), 3.95-3.89 (m, 2H), 1.37 (s, 9H), 1.31 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3) δ 154.3, 152.6, 144.1, 138.2, 127.5, 120.1, 112.9, 70.9, 68.9, 46.2, 35.4, 34.7, 31.6, 29.9; MS m/z (relative intensity): 288 ($\text{M}^+ + 1$, 30), 287 (M^+ , 100), 272 (86), 200 (11). HRMS calcd for $\text{C}_{18}\text{H}_{25}\text{NO}_2$ (M^+) 287.1880, found 287.1888.

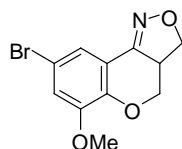
(3) 6-Methoxy-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (3a)^{10f}:



Colorless Solid; mp : 95-96 °C (reported 92-93 °C)

^1H NMR (400 MHz, CDCl_3): δ 7.40 (dd, $J = 7.2, 2.0$ Hz, 1H), 6.98-6.92 (m, 2H), 4.84-4.81 (m, 1H), 4.73-4.69 (m, 1H), 4.15-4.09 (m, 1H), 4.01-3.93 (m, 2H), 3.90 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 152.8, 148.9, 145.5, 121.8, 117.5, 113.9, 113.8, 70.9, 69.9, 56.3, 45.9; MS m/z (relative intensity): 205 (M^+ , 100), 175 (17), 148 (10), 106 (9), 77 (11). HRMS calcd for $\text{C}_{11}\text{H}_{11}\text{NO}_3$ (M^+) 205.0733, found 205.0738.

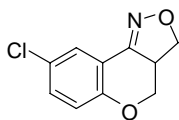
(4) 8-Bromo-6-methoxy-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (4a)



Colorless Solid; mp: 147-149 °C

^1H NMR (400 MHz, CDCl_3): δ 7.54 (t, $J = 2.1$ Hz, 1H), 7.01 (d, $J = 1.5$ Hz, 1H), 4.84-4.80 (m, 1H), 4.74-4.72 (m, 1H), 4.12-4.06 (m, 1H), 3.97-3.90 (m, 2H), 3.89 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 151.6, 149.4, 144.4, 119.5, 116.9, 114.8, 113.8, 70.9, 69.8, 56.4, 45.4; MS m/z (relative intensity): 285 ($\text{M}^+ + 2$, 100), 253 (21), 226 (9), 159 (10). HRMS calcd for $\text{C}_{11}\text{H}_{10}\text{Br}^{79}\text{NO}_3$ (M^+) 282.9839, found 282.9848. $\text{C}_{11}\text{H}_{10}\text{Br}^{81}\text{NO}_3$ ($\text{M}^+ + 2$) 284.9818, found 284.9832.

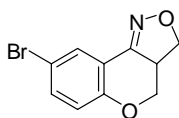
(5) 8-Chloro-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (5a)^{11g,h} :



Colorless Solid; mp 129-130 °C (reported 130-131 °C)

^1H NMR (400 MHz, CDCl_3): δ 7.74 (d, $J = 2.4$ Hz, 1H), 7.27 (dd, $J = 6.4, 2.4$ Hz, 1H), 6.89 (d, $J = 8.8$ Hz, 1H), 4.76-4.71 (m, 1H), 4.70-4.67 (m, 1H), 4.11-4.01 (m, 1H), 3.97-3.85 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ 154.2, 152.1, 132.5, 127.1, 125.2, 119.1, 114.4, 71.0, 69.5, 45.6; MS m/z (relative intensity): 209 (M^+ , 100), 208 (32), 179 (44), 125 (17), 115 (18). HRMS calcd for $\text{C}_{10}\text{H}_8\text{ClNO}_2$ (M^+) 209.0238, found 209.0238.

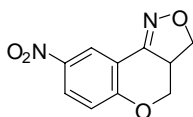
(6) 8-Bromo-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole(6a)^{11c, g, h} :



Colorless Solid; mp 125-127 °C (reported 127-128 °C)

^1H NMR (400 MHz, CDCl_3): δ 7.92 (d, $J = 2.4$ Hz, 1H), 7.41 (dd, $J = 8.9, 2.4$ Hz, 1H), 6.84 (d, $J = 8.9$ Hz, 1H), 4.76-4.71 (m, 1H), 4.70-4.61 (m, 1H), 4.09-4.01 (m, 1H), 3.97-3.85 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ 154.7, 151.9, 135.4, 128.2, 119.5, 114.9, 114.4, 71.1, 69.6, 45.6; MS m/z (relative intensity): 255 ($\text{M}^+ + 2$, 93), 253 (M^+ , 100), 225 (12), 223 (17), 144 (7). HRMS calcd for $\text{C}_{10}\text{H}_8\text{NO}_2\text{Br}$ (M^+) 252.9733, found 252.9740.

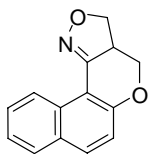
(7) 8-Nitro-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole(7a)



Colorless Solid; mp : 215-217 °C

^1H NMR (400 MHz, CDCl_3): δ 8.70 (d, $J = 2.8$ Hz, 1H), 8.20 (dd, $J = 9.2, 2.8$ Hz, 1H), 7.07 (d, $J = 9.2$ Hz, 1H), 4.86-4.83 (m, 1H), 4.82-4.77 (m, 1H), 4.24-4.13 (m, 1H), 4.04-3.91 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ 159.9, 151.1, 142.5, 127.5, 122.1, 118.6, 113.6, 71.4, 70.1, 45.0. MS m/z (relative intensity) 220 (M^+ , 78), 205 (100), 190 (48), 173 (10), 165 (30), 144 (19). HRMS calcd for $\text{C}_{10}\text{H}_8\text{N}_2\text{O}_4$ (M^+) 220.0479, found 220.0485.

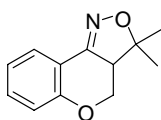
(8) 3a,4-Dihydro-3H-benzo[5,6]chromeno[4,3-c]isoxazole (8a)^{10a}



Colorless Solid; mp : 78-80 °C (reported 72-73 °C)

^1H NMR (400 MHz, CDCl_3): δ 9.01 (d, $J = 8.4$ Hz, 1H), 7.75 (t, $J = 8.2$ Hz, 2H), 7.60-7.56 (m, 1H), 7.43-7.38 (m, 1H), 7.06 (d, $J = 8.4$ Hz, 1H), 4.73 (dd, $J = 10.2, 5.44$ Hz, 1H), 4.67 (dd, $J = 9.5, 7.9$ Hz, 1H), 4.19 (dd, $J = 12.5, 10.2$ Hz, 1H), 4.11-4.00 (m, 1H), 3.90 (dd, $J = 12.8, 8.0$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ 155.8, 153.3, 133.6, 130.7, 129.5, 128.6, 128.5, 126.7, 124.9, 118.4, 106.3, 69.6, 69.4, 47.1; MS m/z (relative intensity): 227 ($\text{M}^+ + 2$, 2), 225 (M^+ , 100), 194 (12), 167 (22), 140 (24), 114 (12). HRMS calcd for $\text{C}_{14}\text{H}_{11}\text{NO}_2$ (M^+) 225.0784, found 225.0788.

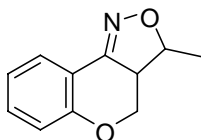
(9) 3,3-Dimethyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole(9a)^{11g}



Colorless Solid; mp : 76-78 °C (reported 76-78 °C)

^1H NMR (400 MHz, CDCl_3): δ 7.84 (dd, $J = 7.8, 1.5$ Hz, 1H), 7.34-7.29 (m, 1H), 7.02-6.98 (m, 1H), 6.97-6.94 (m, 1H), 4.48 (dd, $J = 10.4, 5.6$ Hz, 1H), 4.05 (dd, $J = 13.2, 10.4$ Hz, 1H), 3.42 (dd, $J = 13.0, 5.6$ Hz, 1H), 1.63 (s, 3H), 1.21 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 155.6, 152.4, 132.2, 125.5, 122.0, 117.6, 114.5, 86.2, 66.6, 52.6, 27.0, 22.3; MS m/z (relative intensity): 205 ($\text{M}^+ + 2$, 1), 203 (M^+ , 100), 186 (20), 146 (4), 145 (8), 117 (4). HRMS calcd for $\text{C}_{12}\text{H}_{13}\text{NO}_2$ (M^+) 203.0941, found 203.0947.

(10) 3-Methyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (10a)

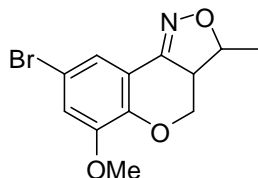


Colorless Solid; mp : 100-102 °C

^1H NMR (400 MHz, CDCl_3): δ 7.78 (dd, $J = 7.8, 1.5$ Hz, 1H), 7.33-7.29 (m, 1H), 7.00-6.96 (m, 1H), 6.92 (d, $J = 8.4$ Hz, 1H), 4.58 (dd, $J = 10.4, 5.8$ Hz, 1H), 4.44-4.36 (m, 1H), 4.07 (dd, $J = 12.5, 10.4$ Hz, 1H), 3.52-3.44 (m, 1H), 1.60 (d, $J = 6.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 155.7, 153.9, 132.5, 125.6, 122.0, 117.6, 113.6, 80.4, 69.1, 51.8,

18.5; MS m/z (relative intensity) 190 ($M^+ + 1$, 8), 189 (M^+ , 100), 174 (18). HRMS calcd for $C_{11}H_{11}NO_2$ (M^+) 189.0784, found 189.0780.

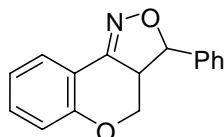
(11) 8-bromo-6-methoxy-3-methyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (11a)



Colorless Solid; mp : 158-160 °C

1H NMR (400 MHz, $CDCl_3$): δ 7.53 (d, $J = 1$ Hz, 1H), 6.99 (d, $J = 1$ Hz, 1H), 4.72 (dd, $J = 10.4, 5.8$ Hz, 1H), 4.46 – 4.41 (m, 1H), 4.08 (dd, $J = 12.5, 10.5$ Hz, 1H), 3.88 (s, 3H), 3.51-3.43 (m, 1H), 1.60 (d, $J = 6.1$ Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.8, 149.6, 144.5, 119.4, 116.9, 115.4, 113.9, 80.9, 69.7, 56.5, 51.3, 18.5; MS m/z (relative intensity) 299 ($M^+ + 2$, 57), 297 (M^+ , 100), 254 (38), 226 (53), 188 (28), 175 (24), 159 (21), 119 (14). HRMS calcd for $C_{12}H_{12}Br^{79}NO_3$ (M^+) 296.9995, found 296.9999. $C_{12}H_{12}Br^{81}NO_3$ ($M^+ + 2$) 298.9975, found 298.9984.

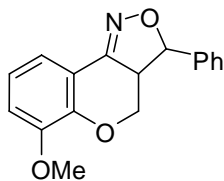
(12) 3-Phenyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (12a) ^{10a, 10d}



Colorless Solid; mp : 156-158 (reported 162-163)°C

1H NMR (400 MHz, $CDCl_3$): δ 7.85 (dd, $J = 7.7, 1.6$ Hz, 1H), 7.47-7.39 (m, 5H), 7.37-7.32 (m, 1H), 7.03 (t, $J = 7.6$ Hz, 1H), 6.95 (d, $J = 8.3$ Hz, 1H), 5.25 (d, $J = 12.6$ Hz, 1H), 4.65 (dd, $J = 10.3, 5.6$ Hz, 1H), 4.25 (dd, $J = 12.2, 10.4$ Hz, 1H), 3.94-3.87 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 155.8, 153.5, 137.5, 132.7, 129.1, 129.0, 126.8, 125.7, 122.1, 117.6, 113.4, 85.9, 69.2, 53.1; MS m/z (relative intensity) 253 ($M^+ + 2$, 2), 251 (M^+ , 100), 145 (15), 117 (9). HRMS calcd for $C_{16}H_{13}NO_2$ (M^+) 251.0941, found 251.0952.

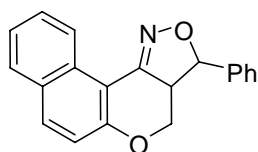
(13) 6-Methoxy-3-phenyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (13a)



Colorless Solid; mp :130-132°C

^1H NMR (400 MHz, CDCl_3): δ 7.47-7.36 (m, 6H), 6.99-6.92 (m, 2H), 5.28 (d, $J = 12.6$ Hz, 1H), 4.77 (dd, $J = 10.3, 5.6$ Hz, 1H), 4.27 (dd, $J = 12.5, 10.4$ Hz, 1H), 3.93 (dd, $J = 12.6, 5.8$ Hz, 1H), 3.88 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 153.4, 148.9, 145.5, 137.3, 129.2, 126.9, 121.9, 117.3, 114.0, 113.9, 86.1, 69.7, 56.3, 52.8; MS m/z (relative intensity) 283 ($\text{M}^+ + 2$, 2), 281 (M^+ , 100), 117 (46). HRMS calcd for $\text{C}_{17}\text{H}_{15}\text{NO}_3$ (M^+) 281.1046, found 281.1051.

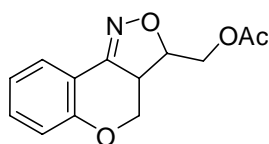
(14) 3-Phenyl-3a,4-Dihydro-3H-benzo[5,6]chromeno[4,3-c]isoxazole (14a)^{10b}



Colorless Solid; mp : 215-217 °C

^1H NMR (400 MHz, CDCl_3) δ 9.09 (d, $J = 8.5$ Hz, 1H), 7.77 (t, $J = 7.8$ Hz, 2H), 7.64-7.60 (m, 1H), 7.49-7.36 (m, 6H), 7.07 (d, $J = 8.9$ Hz, 1H), 5.24 (d, $J = 12.4$, 1H), 4.71 (dd, $J = 10.2, 5.7$ Hz, 1H), 4.37 (dd, $J = 12.4, 10.4$ Hz, 1H), 4.07-3.99 (m, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ 155.9, 154.1, 137.8, 133.7, 130.8, 129.6, 129.2, 129.1, 128.8, 128.6, 126.9, 124.9, 118.4, 115.2, 106.4, 84.7, 69.2, 54.4; MS m/z (relative intensity): 302 ($\text{M}^+ + 1$, 3), 301 (M^+ , 100), 117 (9); HRMS calcd for $\text{C}_{20}\text{H}_{15}\text{NO}_2$ (M^+) 301.1097, found 301.1107.

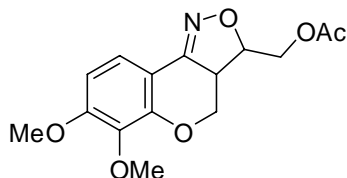
(15) (3a,4-Dihydro-3H-chromeno[4,3-c]isoxazol-3-yl)methyl acetate(15a)



Colorless Solid; mp : 113-115 °C

^1H NMR (400 MHz, CDCl_3): δ 7.84 (dd, $J = 7.8, 1.5$ Hz, 1H), 7.37-7.33 (m, 1H), 7.04-7.00 (m, 1H), 6.97 (d, $J = 8.4$ Hz, 1H), 5.05-4.98 (m, 1H), 4.66 (dd, $J = 10.4, 5.4$ Hz, 1H), 4.13 (dd, $J = 13.1, 10.4$ Hz, 1H), 4.07 (d, $J = 6.2$ Hz, 2H), 3.99-3.95 (m, 1H), 2.08 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 170.4, 155.7, 151.7, 132.7, 125.9, 122.2, 117.6, 113.3, 78.2, 65.9, 61.8, 46.9, 20.9; MS m/z (relative intensity): 247 (M^+ , 100), 205 (20), 187 (76), 174 (23), 146 (20), 145 (10); HRMS calcd for $\text{C}_{13}\text{H}_{13}\text{NO}_4$ (M^+) 247.0839, found 247.0847.

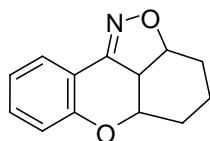
(16) (6,7-Dimethoxy-3a,4-dihydro-3H-chromeno[4,3-c]isoxazol-3-yl)methyl acetate (16a)



Colorless Solid; mp : 123-125 °C

^1H NMR (400 MHz, CDCl_3): δ 7.58 (d, $J = 8.8$ Hz, 1H), 6.66 (d, $J = 8.8$ Hz, 1H), 5.03-4.98 (m, 1H), 4.78 (dd, $J = 10.4, 5.4$ Hz, 1H), 4.12 (dd, $J = 13.1, 10.4$ Hz, 1H), 4.07 (dd, $J = 6.3, 3.1$ Hz, 2H), 3.97-3.93 (m, 1H), 3.91 (s, 3H), 3.86 (s, 3H), 2.08 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 170.5, 156.1, 151.5, 149.8, 137.8, 121.2, 107.7, 106.7, 77.9, 66.5, 61.8, 61.3, 56.4, 47.1, 20.9; MS m/z (relative intensity): 309 ($\text{M}^+ + 2$, 2), 307 (M^+ , 100), 265 (12), 247 (5), 218 (8); HRMS calcd for $\text{C}_{15}\text{H}_{17}\text{NO}_6$ (M^+) 307.1050, found 307.1065.

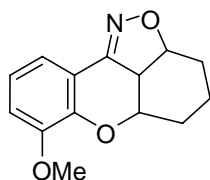
(17) 2a,2a1,3,4,5,5a-Hexahydroxantheno[9,1-cd]isoxazole (17a) ¹¹ⁱ



Colorless Solid; mp : 103-104 °C (103-104 °C)

^1H NMR (400 MHz, CDCl_3): δ 7.84 (dd, $J = 7.8, 1.3$ Hz, 1H), 7.35-7.31 (m, 1H), 6.97 (t, $J = 7.6$ Hz, 1H), 6.93 (d, $J = 8.4$ Hz, 1H), 4.93 (dd, $J = 16.8, 8.4$ Hz, 1H), 4.76-4.69 (m, 1H), 3.83 (t, $J = 7.7$ Hz, 1H), 2.04-1.98 (m, 2H), 1.65-1.56 (m, 1H), 1.45-1.34 (m, 1H), 1.33-1.25 (m, 1H), 1.12-1.00 (m, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ 153.4, 150.4, 132.6, 125.2, 121.3, 117.9, 112.7, 80.2, 74.7, 47.2, 27.6, 27.0, 17.1; MS m/z (relative intensity): 216 ($\text{M}^+ + 1$, 22), 215 (M^+ , 100), 200 (15), 159 (10), 138 (9), 120 (10). HRMS calcd for $\text{C}_{13}\text{H}_{13}\text{NO}_2$ (M^+) 215.0941, found 215.0949.

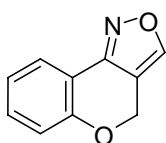
(18) 7-Methoxy-2a,2a1,3,4,5,5a-hexahydroxantheno[9,1-cd]isoxazole (18a)



Colorless Solid; mp : 121-123 °C

^1H NMR (400 MHz, CDCl_3): δ 7.46 (t, $J = 4.7$ Hz, 1H), 6.94 (d, $J = 4.8$ Hz, 2H), 4.96 (dd, $J = 16.8, 9$ Hz, 1H), 4.86 (dd, $J = 12.3, 6$ Hz, 1H), 3.89 (s, 3H), 3.85 (t, $J = 7.7$ Hz, 1H), 2.07-1.99 (m, 2H), 1.65-1.59 (m, 1H), 1.47- 1.36 (m, 1H), 1.35-1.25 (m, 1H), 1.13-1.01 (m, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ 150.5, 149.3, 143.2, 121.1, 116.9, 113.9, 113.3, 80.5, 75.3, 56.2, 47.2, 27.8, 27.0, 17.2; MS m/z (relative intensity): 246 ($\text{M}^+ + 1$, 14), 245 (M^+ , 100), 204 (11), 150 (12). HRMS calcd for $\text{C}_{14}\text{H}_{15}\text{NO}_3$ (M^+) 245.1046, found 245.1059.

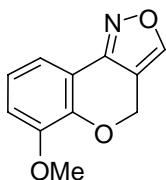
(19) 4H-chromeno[4,3-c]isoxazole (19a)^{10a}



Gummy liquid

^1H NMR (400 MHz, CDCl_3): δ 8.21 (t, $J = 1$ Hz, 1H), 7.87 (dd, $J = 7.6, 1.5$ Hz, 1H), 7.37-7.33 (m, 1H), 7.09-7.05 (m, 1H), 7.01 (d, $J = 8.2$ Hz, 1H), 5.23 (d, $J = 1.1$ Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ 155.1, 153.9, 150.8, 132.3, 124.8, 122.6, 118.1, 114.2, 111.4, 61.6; MS m/z (relative intensity) 173 (M^+ , 100), 146 (5), 145 (44), 117 (4), 90 (2). HRMS calcd for $\text{C}_{10}\text{H}_7\text{NO}_2$ (M^+) 173.0471, found 173.0480.

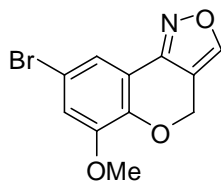
(20) 6-methoxy-4H-chromeno[4,3-c]isoxazole(20a)^{10g}



Colorless Solid; mp : 126-128 °C(114-116 °C)

^1H NMR (400 MHz, CDCl_3): δ 8.22 (s, 1H), 7.50 (dd, $J = 7.6, 1.1$ Hz, 1H), 7.04 (t, $J = 7.8$ Hz, 1H), 6.97 (d, $J = 8.4$ Hz, 1H), 5.32 (s, 2H), 3.91 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 153.8, 150.8, 149.3, 144.5, 122.4, 116.5, 114.9, 114.2, 111.3, 61.9, 56.3; MS m/z (relative intensity) 205 ($\text{M}^+ + 2$, 2), 203 (M^+ , 100), 175 (13), 174 (10), 146 (15). HRMS calcd for $\text{C}_{11}\text{H}_9\text{NO}_3$ (M^+) 203.0577, found 203.0586.

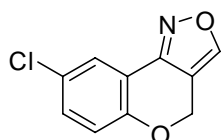
(21) 8-bromo-6-methoxy-4H-chromeno[4,3-c]isoxazole(21a):



Colorless Solid; mp : 144-146 °C

^1H NMR (400 MHz, CDCl_3): δ 8.23 (t, $J = 1$ Hz, 1H), 7.63 (d, $J = 2.2$ Hz, 1H), 7.07 (d, $J = 2.2$ Hz, 1H), 5.32 (d, $J = 1.1$ Hz, 2H), 3.91 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 152.7, 151.0, 149.9, 143.4, 118.8, 117.2, 115.8, 114.4, 110.9, 61.9, 56.4; MS m/z (relative intensity) 283 ($\text{M}^+ + 2$, 71), 281 (M^+ , 100), 253 (54), 238 (23), 226 (19), 210 (17), 185 (32), 159 (27), 93 (31). HRMS calcd for $\text{C}_{11}\text{H}_8\text{Br}^{79}\text{NO}_3$ (M^+) 280.9682, found 280.9706. $\text{C}_{11}\text{H}_8\text{Br}^{81}\text{NO}_3$ ($\text{M}^+ + 2$) 282.9662, found 282.9693.

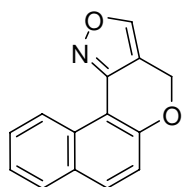
(22) 8-chloro-4H-chromeno [4,3-c]isoxazole(22a)



Colorless Solid; mp : 140-142 °C

^1H NMR (400 MHz, CDCl_3): δ 8.23 (s, 1H), 7.84 (d, $J = 2.3$ Hz, 1H), 7.29 (dd, $J = 8.4$, 2.4 Hz, 1H), 6.96 (d, $J = 8.5$ Hz, 1H), 5.24 (s, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ 153.5, 153.1, 151.2, 132.2, 127.7, 124.4, 119.5, 115.3, 111.4, 61.7; MS m/z (relative intensity) 209 ($\text{M}^+ + 2$, 34), 207 (M^+ , 100), 179 (54), 153 (15), 125 (15), 116 (8), 98 (14), 63 (49). HRMS calcd for $\text{C}_{10}\text{H}_6\text{Cl}^{35}\text{NO}_2$ (M^+) 207.0082, found 207.0090. for $\text{C}_{10}\text{H}_6\text{Cl}^{37}\text{NO}_2$ ($\text{M}^+ + 2$) 209.0052, found 209.0079.

(23) 3H-benzo[5,6]chromeno[4,3-c]isoxazole (23a) ^{10b}

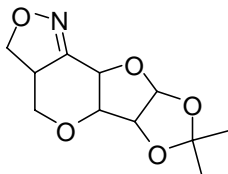


Colorless Solid; mp : 178-180 °C (reported 181-182 °C)

^1H NMR (400 MHz, CDCl_3): δ 9.04 (d, $J = 8.4$ Hz, 1H), 8.26 (s, 1H), 7.83 (d, $J = 8.9$ Hz, 1H), 7.80 (d, $J = 8.2$ Hz, 1H), 7.67-7.62 (m, 1H), 7.48-7.43 (m, 1H), 7.18 (d, $J = 8.3$ Hz, 1H), 5.32 (d, $J = 1$ Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ 154.9, 154.6, 149.7, 133.0,

130.3, 129.9, 128.6, 128.5, 126.6, 125.0, 118.8, 111.9, 108.1, 61.5; MS m/z (relative intensity) 224 ($M^+ + 1$, 26), 223 (M^+ , 100), 195 (61), 166 (18), 140 (34), 114 (49). HRMS calcd for $C_{14}H_9NO_2$ (M^+) 223.0628, found 223.0635.

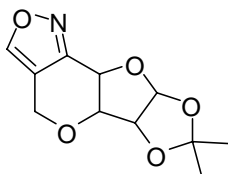
(24) Glucose-isoxazoline (24a) ^{11g, 20a}:



Colorless Solid; mp : 107-109 °C (107-109 °C)

1H NMR (400 MHz, $CDCl_3$): δ 5.99 (d, $J = 3.6$ Hz, 1H), 4.99 (d, $J = 1.9$ Hz, 1H), 4.59 (d, $J = 3.6$ Hz, 1H), 4.55-4.50 (dd, $J = 10.8, 8.5$ Hz, 1H), 4.20 (dd, $J = 10.8, 6.3$ Hz, 1H), 4.00 (d, $J = 2.0$ Hz, 1H), 3.87 (dd, $J = 9.2, 8.8$ Hz, 1H), 3.70-3.60 (m, 1H), 3.31 (t, $J = 11.0$ Hz, 1H), 1.54 (s, 3H), 1.34 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.3, 112.7, 106.3, 83.5, 82.7, 71.5, 70.9, 70.1, 44.1, 26.9, 26.4; MS m/z (relative intensity) 242 ($M^+ + 1$, 5), 241 (M^+ , 18), 226 (100), 184 (30), 166 (31), 71 (25). HRMS calcd for $C_{11}H_{15}NO_5$ (M^+) 241.0945, found 241.0950.

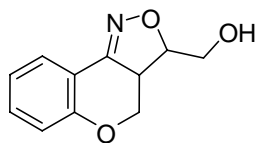
(25) (5aS, 6R, 7R, 8aR)-5a,6,7,8a-Tetrahydro-6,7-isopropylidenedioxy-4H-furo[2',3':5,6]pyrano[4,3-c]isoxazole (25a) ^{11j}



Colorless Solid; mp : 140-142 °C (144-146 °C)

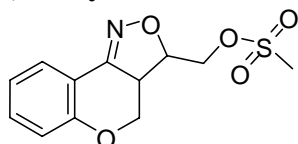
1H NMR (400 MHz, $CDCl_3$): δ 8.24 (s, 1H), 6.01 (d, $J = 3.6$ Hz, 1H), 5.22 (d, $J = 2.2$ Hz, 1H), 4.91 (d, $J = 14.4$ Hz, 1H), 4.70 (d, $J = 3.6$ Hz, 1H), 4.53 (dd, $J = 14.2, 1.3$ Hz, 1H), 4.13 (d, $J = 2.2$ Hz, 1H), 1.58 (s, 3H), 1.37 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.9, 151.5, 112.7, 112.6, 106.3, 83.7, 80.7, 68.7, 60.7, 27.1, 26.5; MS m/z (relative intensity) 240 ($M^+ + 1$, 2), 224 (100), 182 (32).

(26) (3a,4-dihydro-3H-chromeno[4,3-c]isoxazol-3-yl)methanol (15b)



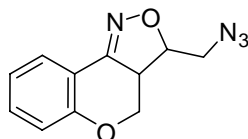
^1H NMR (400 MHz, CDCl_3): δ 7.80 (dd, $J = 7.8, 1.6$ Hz, 1H), 7.36-7.31 (m, 1H), 7.01 (dd, $J = 7.4, 1.0$ Hz, 1H), 6.96 (d, $J = 8.1$ Hz, 1H), 4.89-4.83 (m, 1H), 4.65 (dd, $J = 10.5, 5.7$ Hz, 1H), 4.35 (dd, $J = 13.0, 10.5$ Hz, 1H), 3.94-3.86 (m, 1H), 3.69 (dd, $J = 12.2, 4.5$ Hz, 1H), 3.59 (dd, $J = 12.2, 4.8$ Hz, 1H), 2.27 (brs, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 155.7, 152.4, 132.5, 125.7, 121.9, 117.5, 113.2, 81.1, 65.9, 61.3, 46.3. MS m/z (relative intensity) 205 (M^+ , 100), 174 (39), 174 (12), 158 (4), 146 (34), 119 (8).

(27) (3a,4-dihydro-3H-chromeno[4,3-c]isoxazol-3-yl)methyl methanesulfonate (15c)



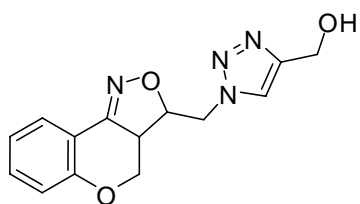
^1H NMR (400 MHz, CDCl_3): δ 7.80 (dd, $J = 7.8, 1.6$ Hz, 1H), 7.39-7.35 (m, 1H), 7.05-7.01 (m, 1H), 6.98 (dd, $J = 8.4, 1$ Hz, 1H), 5.08-5.03 (m, 1H), 4.69 (dd, $J = 10.4, 5.5$ Hz, 1H), 4.25-4.18 (m, 3H), 4.04-3.97 (m, 1H), 3.09 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 155.8, 152.1, 133.0, 125.9, 122.2, 117.8, 112.9, 77.7, 66.7, 65.7, 46.9, 37.9; MS m/z (relative intensity) 285 ($\text{M}^+ + 2$, 8), 284 ($\text{M}^+ + 1$, 14), 283 (M^+ , 65), 187 (12), 174 (100), 158 (8), 146 (12), 131 (5).

(28) 3-(azidomethyl)-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (15d)



^1H NMR (400 MHz, CDCl_3): δ 7.84 (dd, $J = 7.8, 1.6$ Hz, 1H), 7.38-7.34 (m, 1H), 7.05-7.01 (m, 1H), 6.98 (d, $J = 8.4$ Hz, 1H), 4.96-4.91 (m, 1H), 4.65 (dd, $J = 10.5, 5.6$ Hz, 1H), 4.20 (dd, $J = 13.1, 10.4$ Hz, 1H), 3.97-3.89 (m, 1H), 3.34 (d, $J = 5.7$ Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 155.8, 151.9, 132.8, 126.0, 122.2, 117.7, 113.3, 79.2, 65.9, 50.4, 47.0; MS m/z (relative intensity) 231 ($\text{M}^+ + 1$, 24.2), 230 (M^+ , 100), 201 (1), 185 (8), 174 (20), 156 (17), 146 (25), 145 (8), 129 (4), 91 (5), 68 (11).

(29) 1-((3a,4-dihydro-3H-chromeno[4,3-c]isoxazol-3-yl)methyl)-1H-1,2,3-triazol-4-yl)methanol (15e)

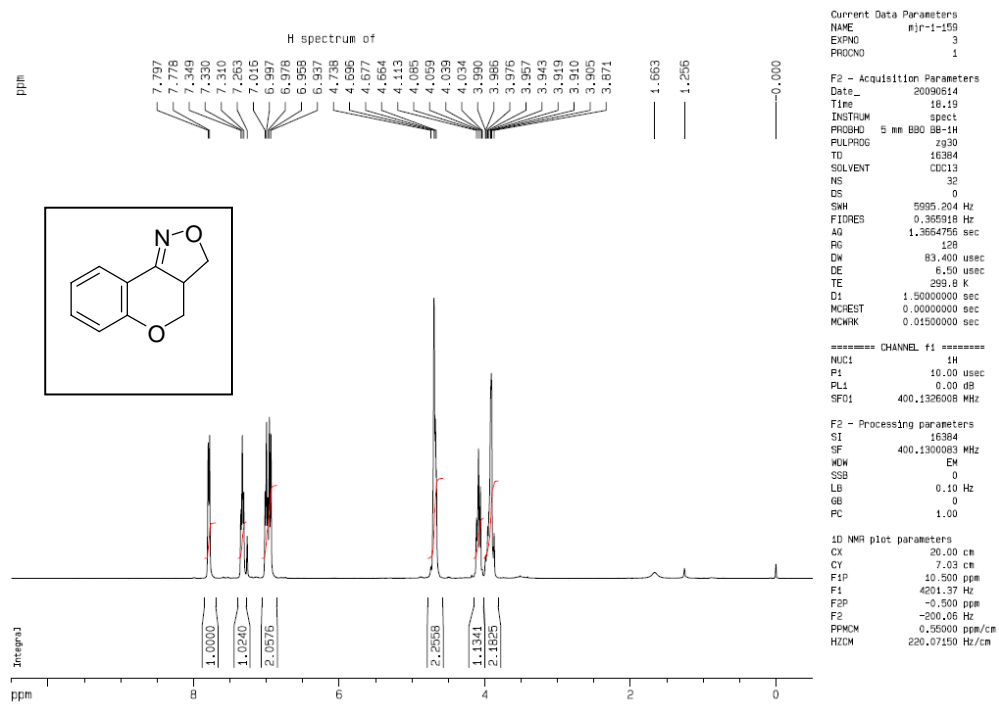


Colorless Solid; mp : 181-183 °C

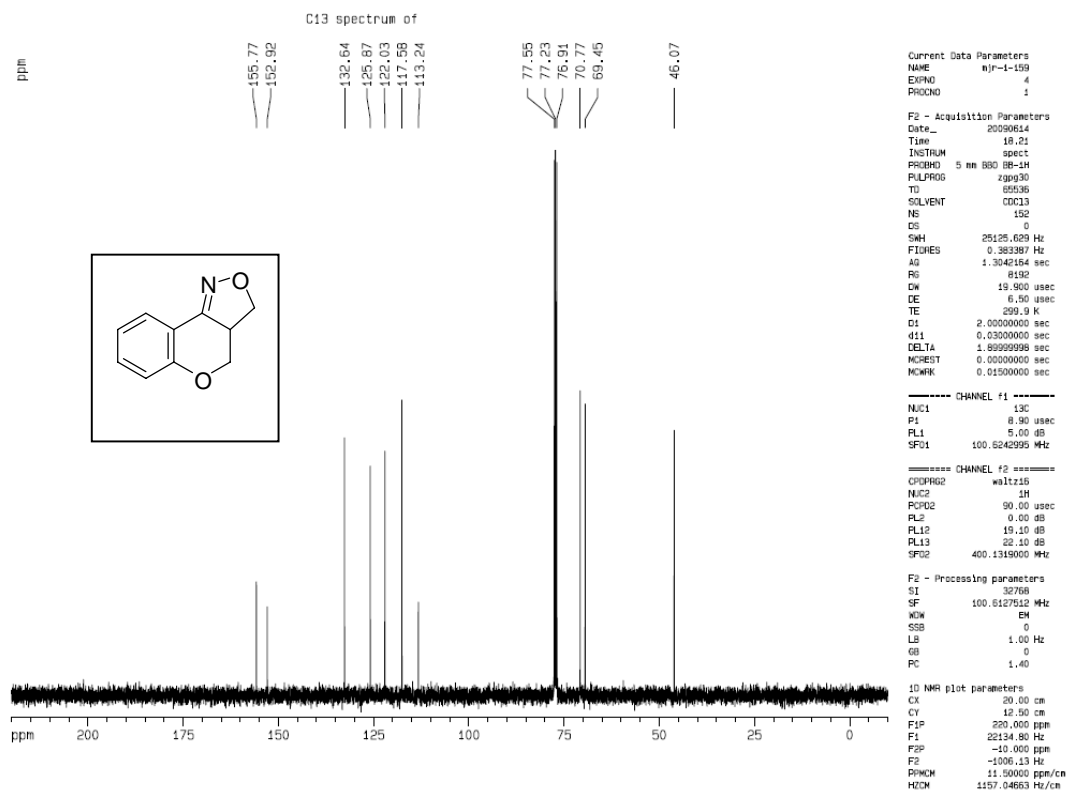
^1H NMR (400 MHz, $\text{dms}\text{-d}_6$): δ 7.94 (s, 1H), 7.73 (dd, $J = 7.8, 1.4$ Hz, 1H), 7.45-7.40 (m, 1H), 7.08-7.04 (m, 2H), 5.25-5.18 (m, 1H), 4.71 (dd, $J = 10.3, 5.7$ Hz, 1H), 4.57-4.51 (m, 3H), 4.37 (dd, $J = 14.2, 3.8$ Hz, 1H), 4.31 (dd, $J = 13.1, 10.4$ Hz, 1H), 4.18-3.92 (m, 1H), 3.75 (brs, 1H); ^{13}C NMR (100 MHz, $\text{dms}\text{-d}_6$) δ 155.3, 151.9, 148.0, 132.6, 125.1, 123.4, 121.7, 117.4, 113.1, 79.3, 65.3, 65.9, 54.9, 48.9, 46.1; MS m/z (relative intensity) 286 (M^+ , 80), 269 (2), 211 (4), 184 (8), 174 (11), 146 (100), 113 (11), 84 (5), 68 (7). HRMS calcd for $\text{C}_{14}\text{H}_{14}\text{N}_4\text{O}_3$ (M^+) 286.1066, found 286.1063.

^1H NMR and ^{13}C NMR Spectra Copies

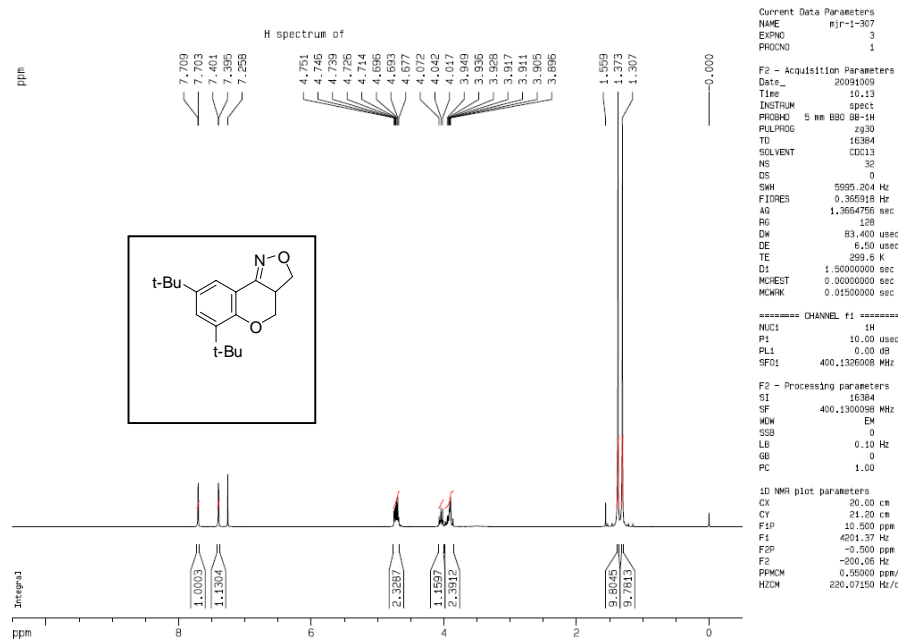
3a,4-Dihydro-3H-chromeno[4,3-c]isoxazole (1a): ¹H NMR (400 MHz, CDCl₃)



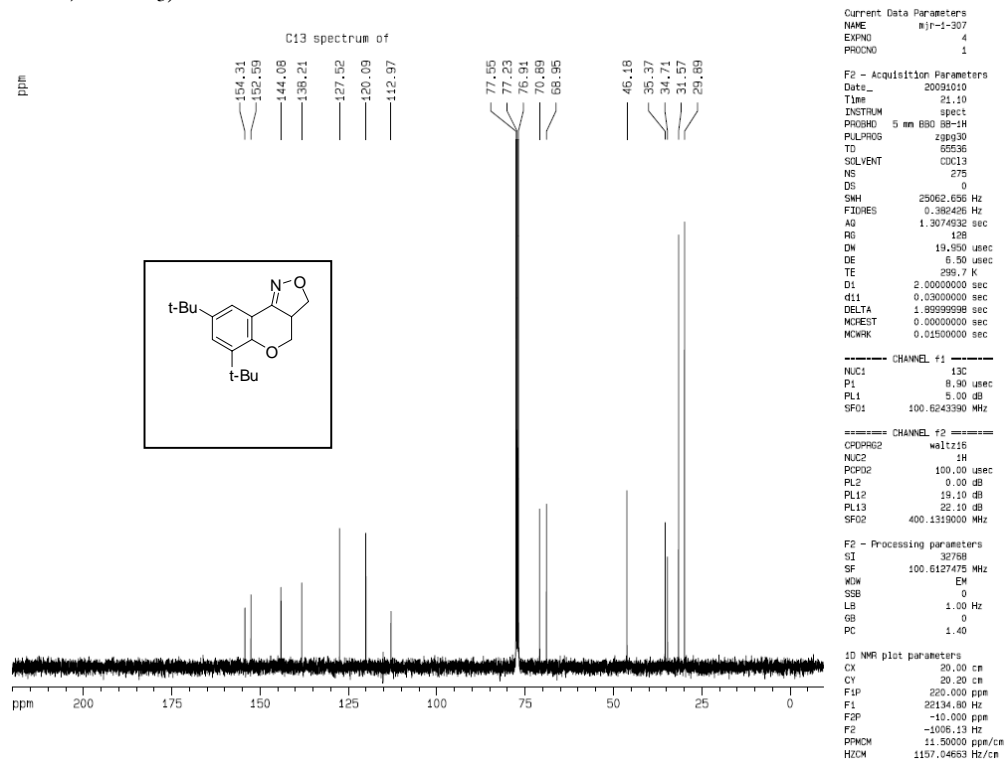
3a,4-Dihydro-3H-chromeno[4,3-c]isoxazole (1a): ¹³C NMR (100 MHz, CDCl₃)



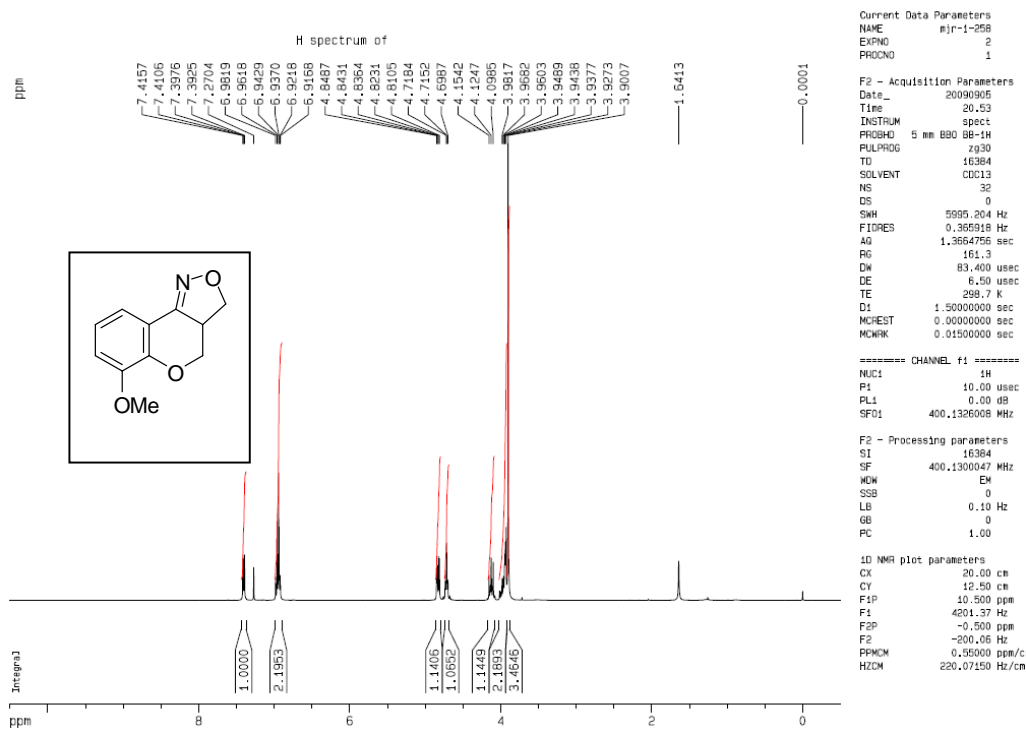
6,8-di-tert-butyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (2a): ¹H NMR (400 MHz, CDCl₃)



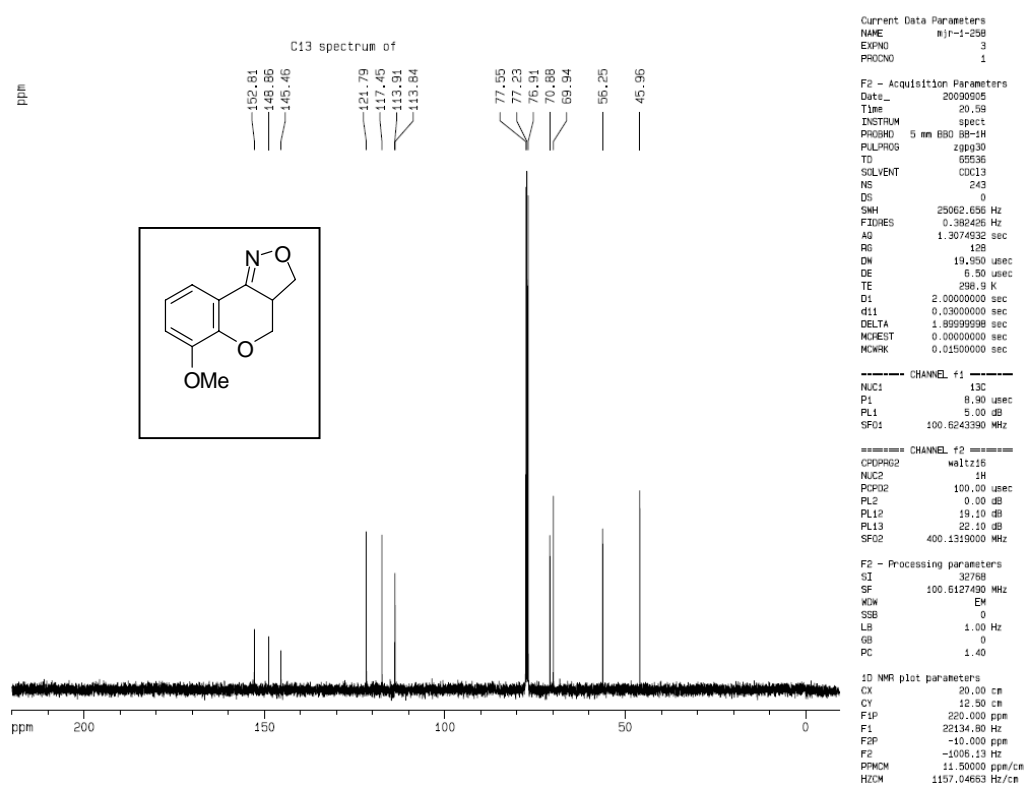
6,8-di-tert-butyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (2a): ¹³C NMR (100 MHz, CDCl₃)



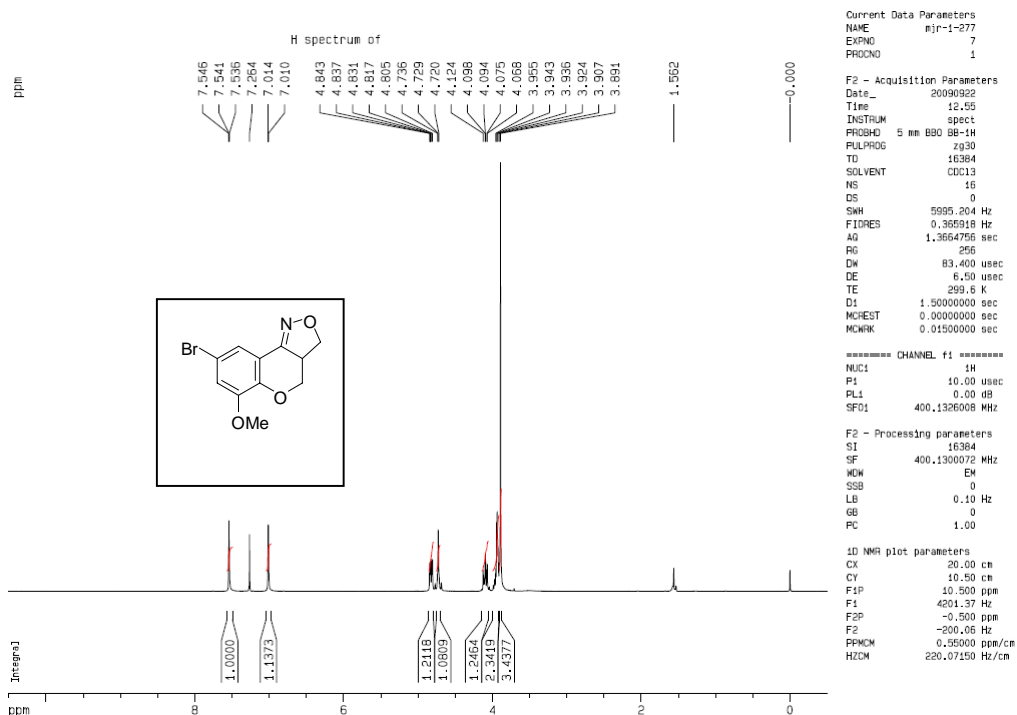
6-Methoxy-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (3a): ^1H NMR (400 MHz, CDCl_3)



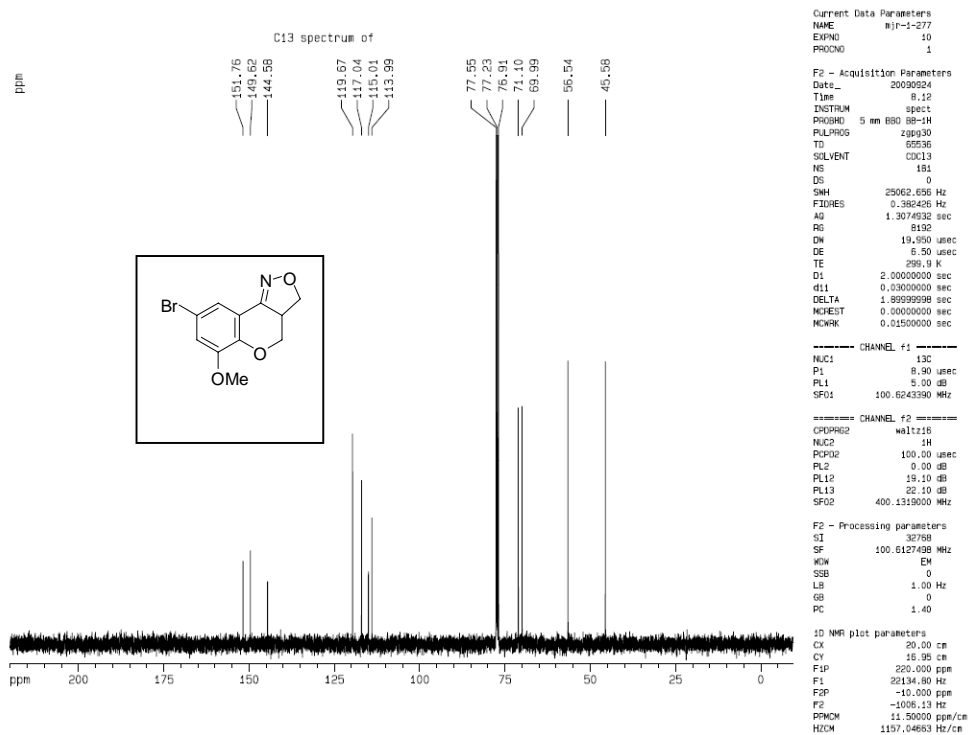
6-Methoxy-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (3a): ^{13}C NMR (100 MHz, CDCl_3)



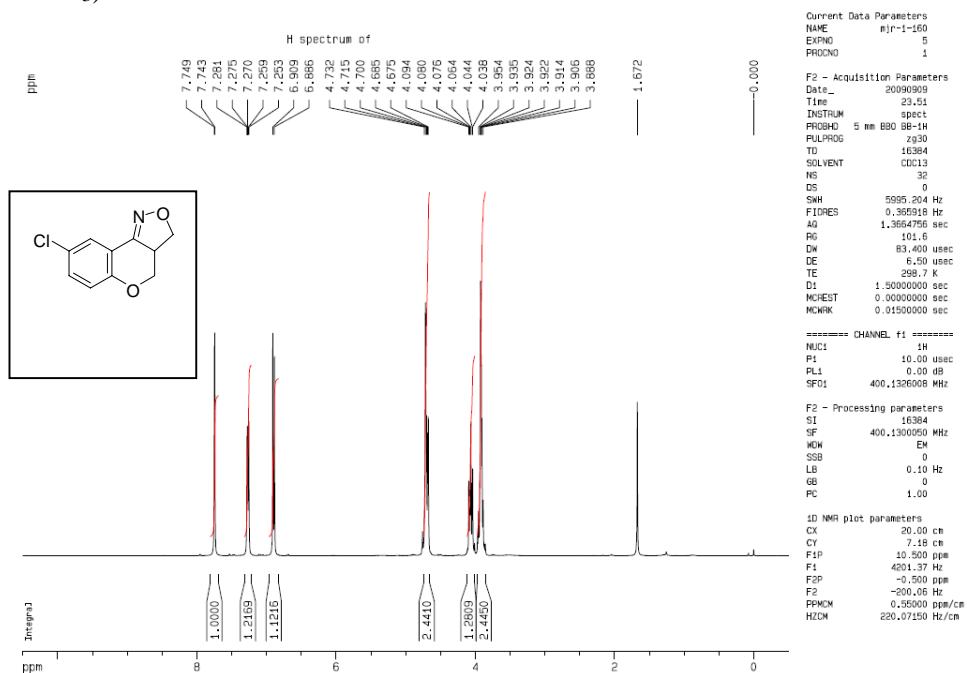
8-Bromo-6-methoxy-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (4a) ¹H NMR (400 MHz, CDCl₃)



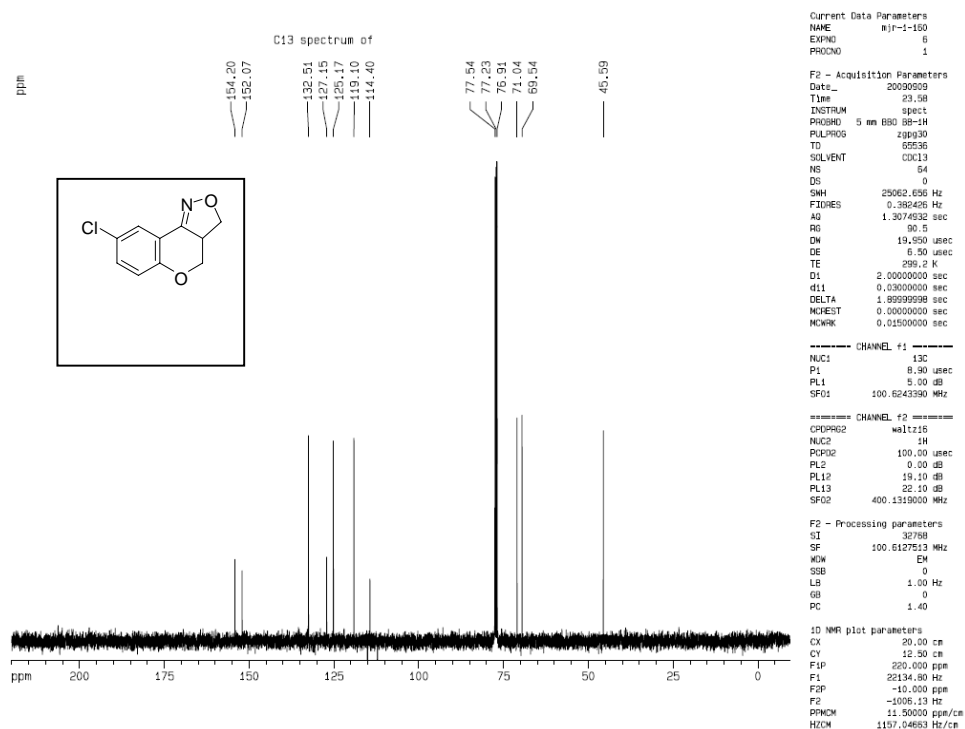
8-Bromo-6-methoxy-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (4a) ¹³C NMR (100 MHz, CDCl₃)



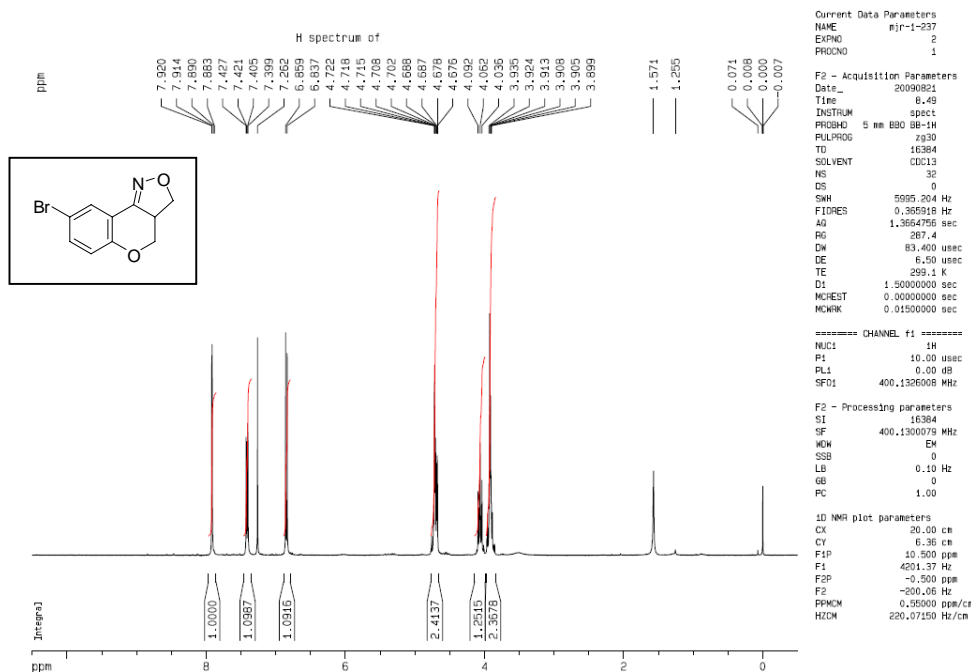
8-Chloro-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (5a): ¹H NMR (400 MHz, CDCl₃):



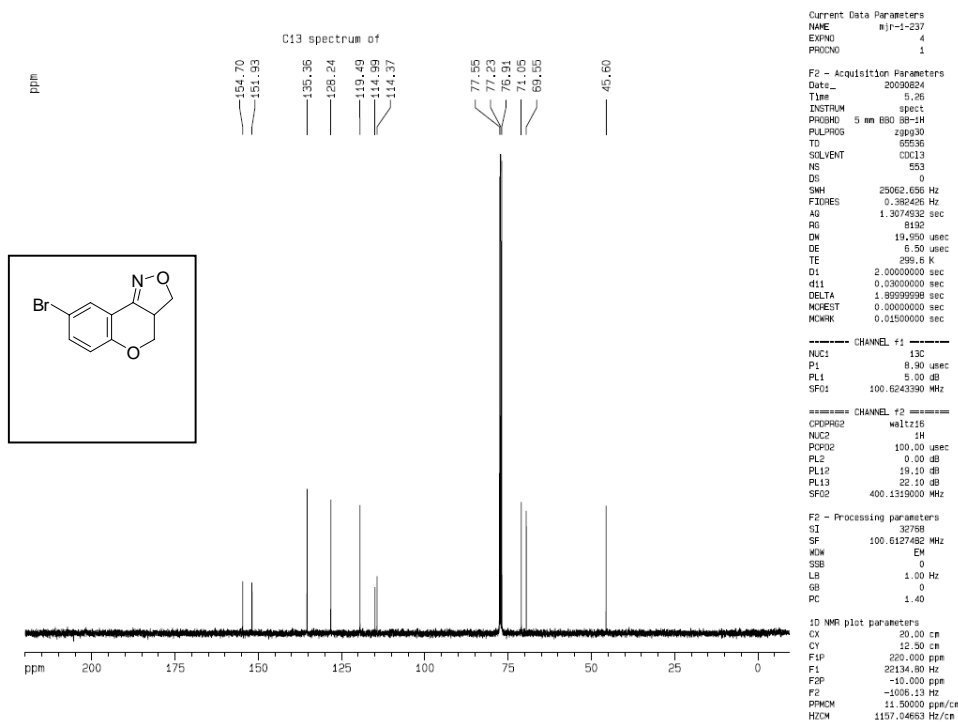
8-Chloro-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (5a): ¹³C NMR (100 MHz, CDCl₃):



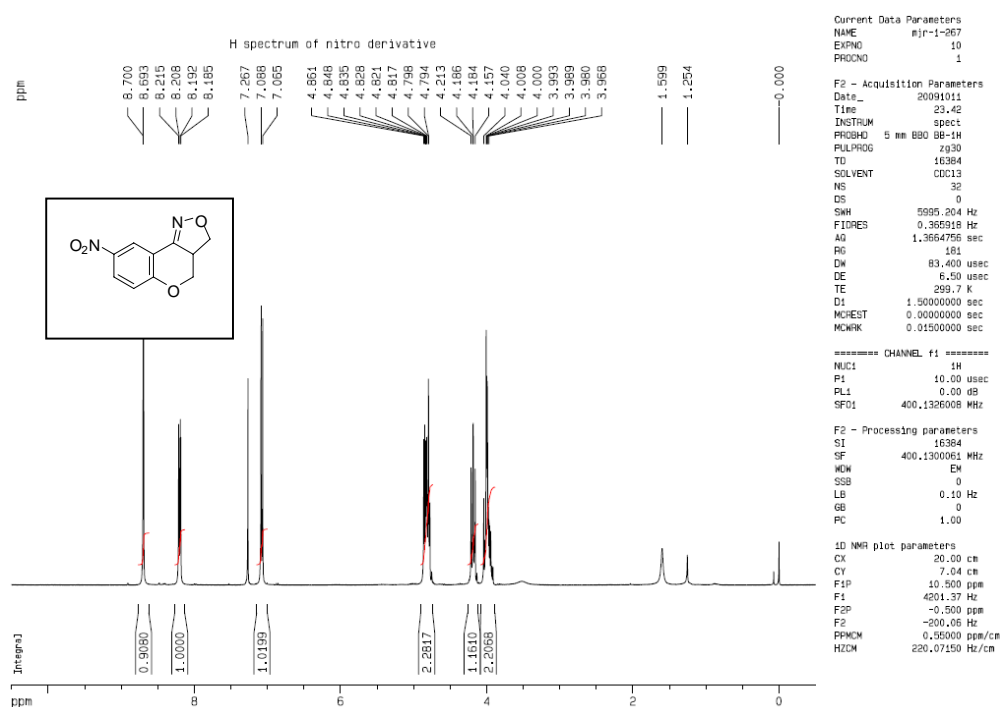
8-Bromo-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (6a): ^1H NMR (400 MHz, CDCl_3)



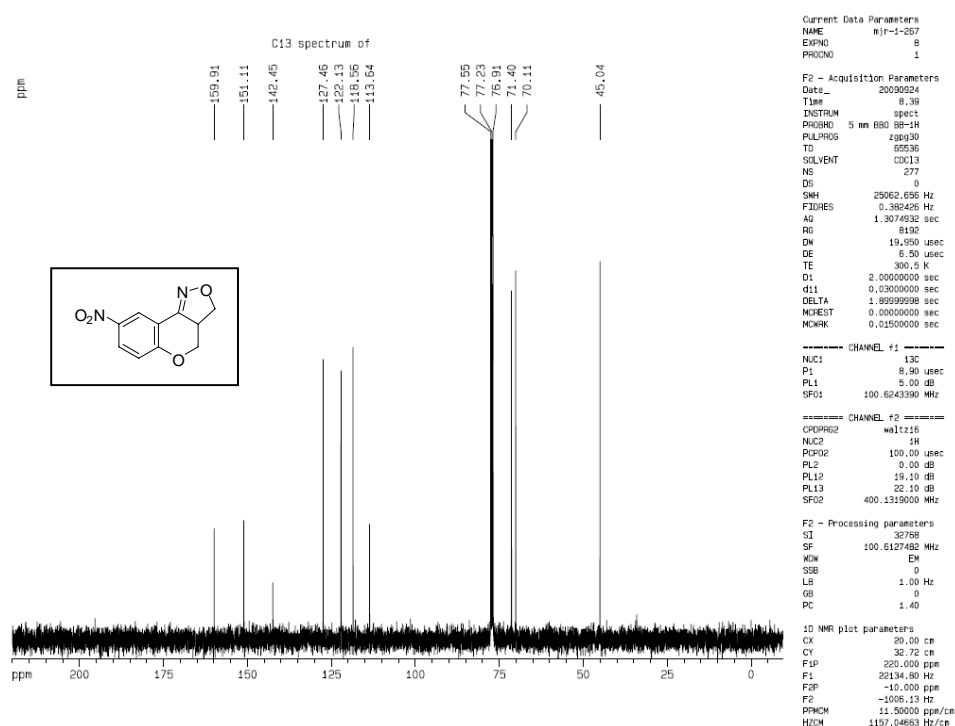
8-Bromo-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (6a): ^{13}C NMR (100 MHz, CDCl_3)



8-Nitro-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole(7a): ¹H NMR (400 MHz, CDCl₃)

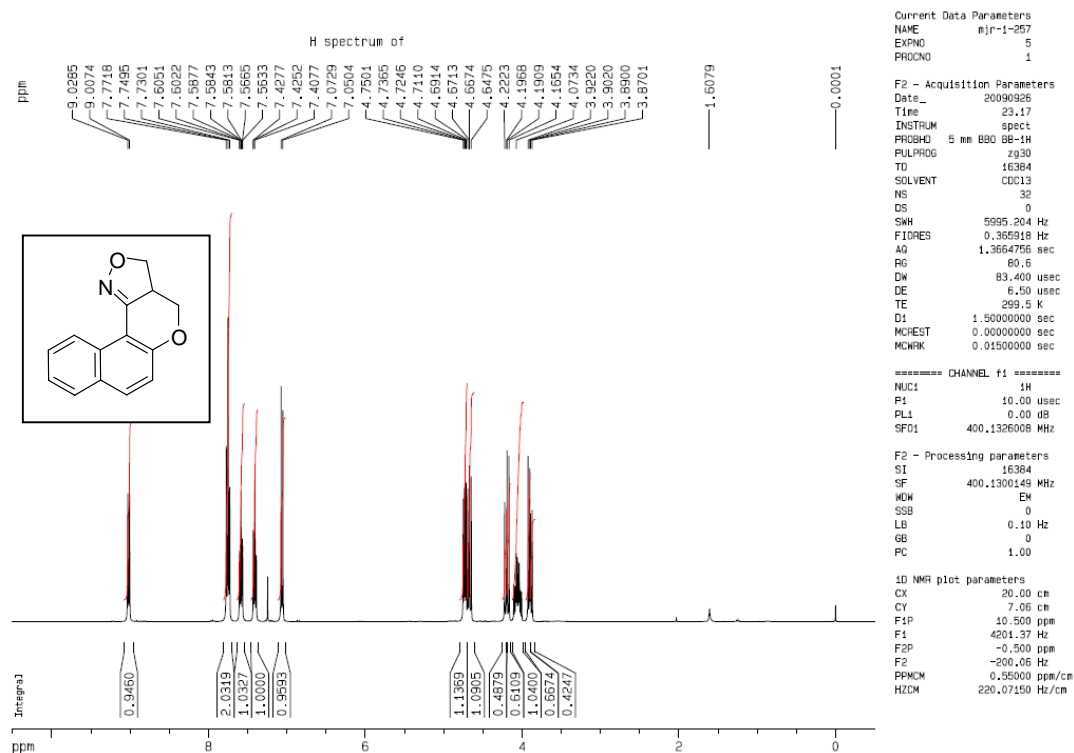


8-Nitro-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole(7a): ¹³C NMR (100 MHz, CDCl₃)

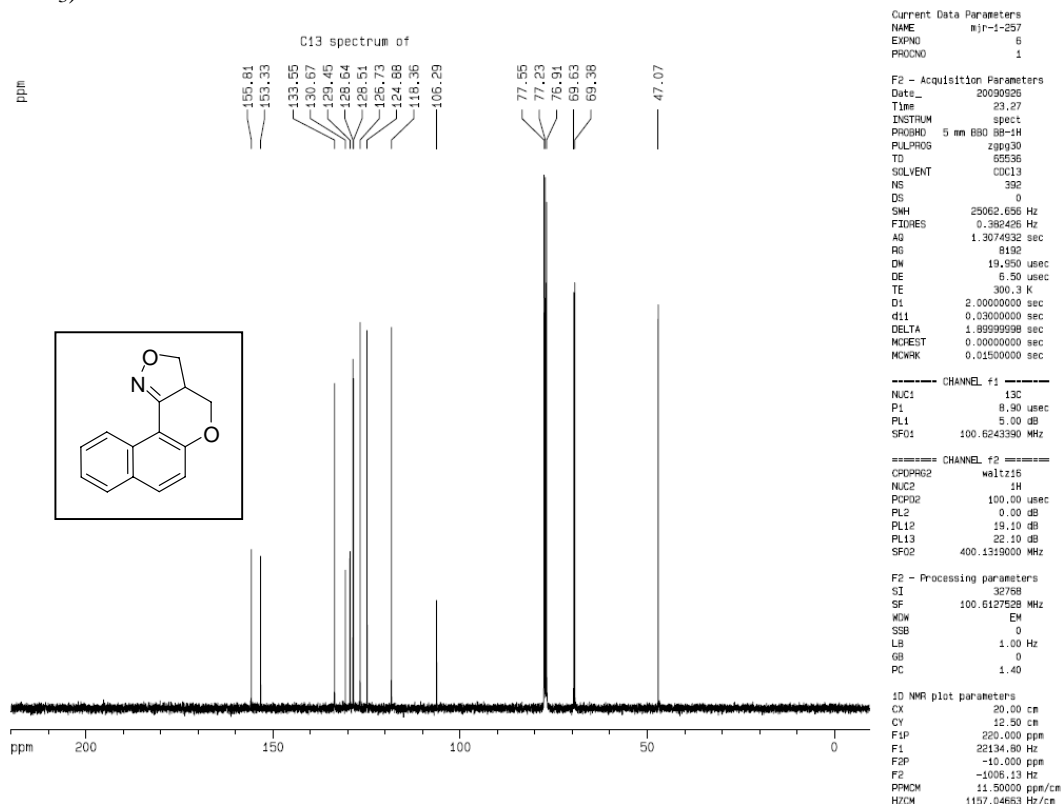


3a,4-Dihydro-3H-benzo[5,6]chromeno[4,3-c]isoxazole (8a) ¹H NMR (400 MHz, CDCl₃):

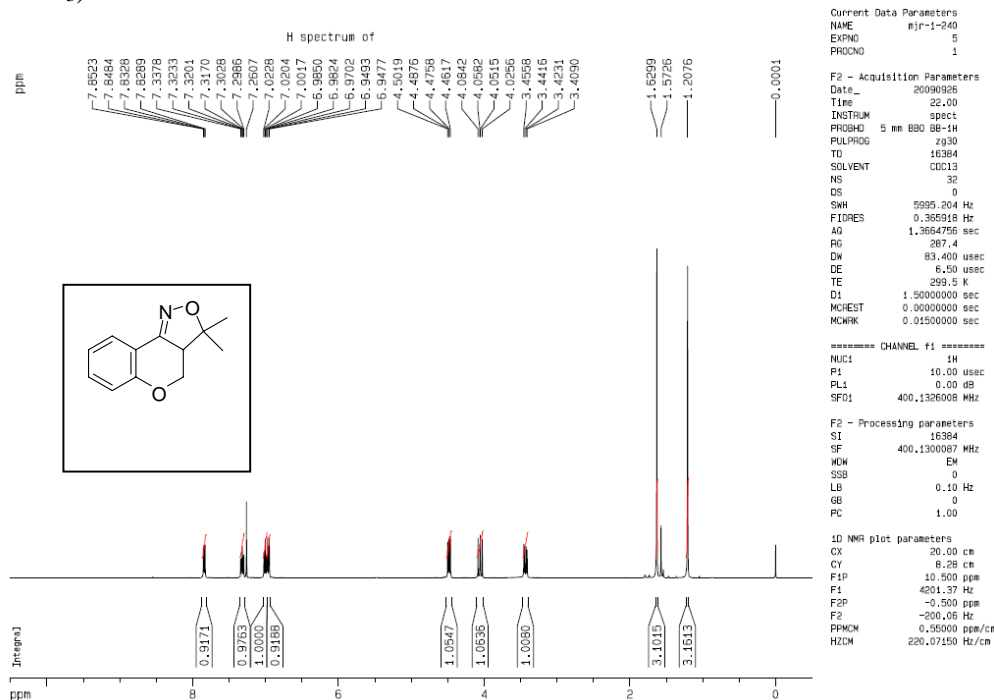
Supplementary Material (ESI) for Green Chemistry
This journal is © The Royal Society of Chemistry 2010



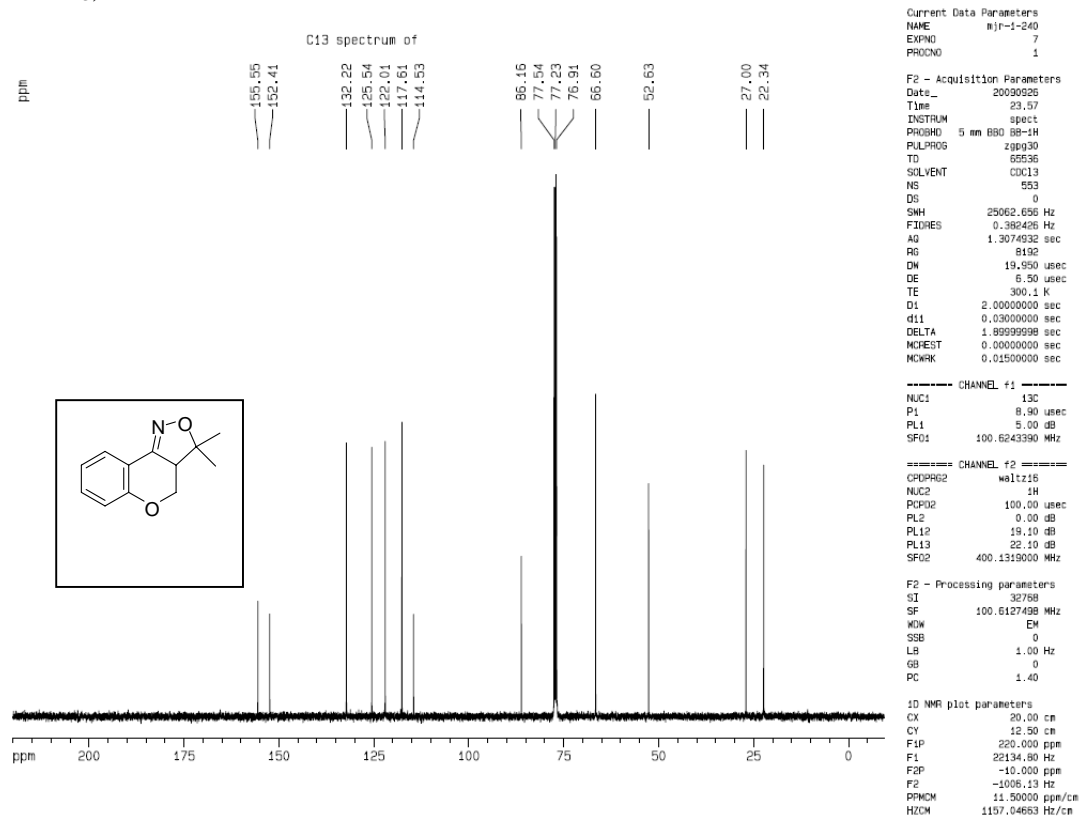
3a,4-Dihydro-3H-benzo[5,6]chromeno[4,3-c]isoxazole (8a) ¹³C NMR (100 MHz, CDCl₃):



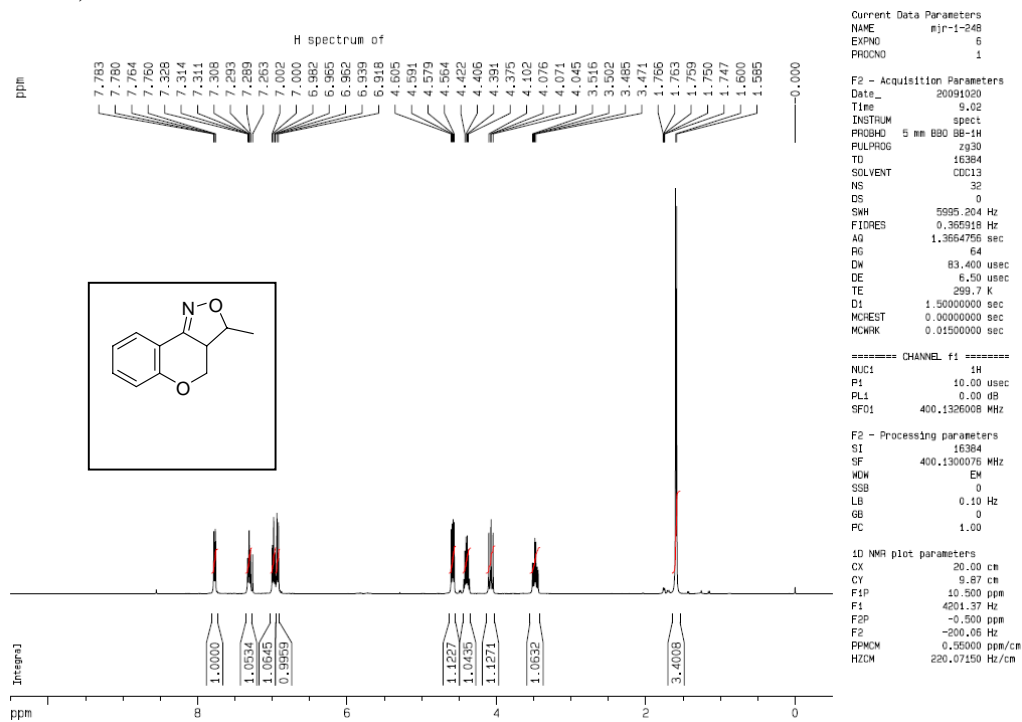
3,3-Dimethyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole(9a): ^1H NMR (400 MHz, CDCl_3):



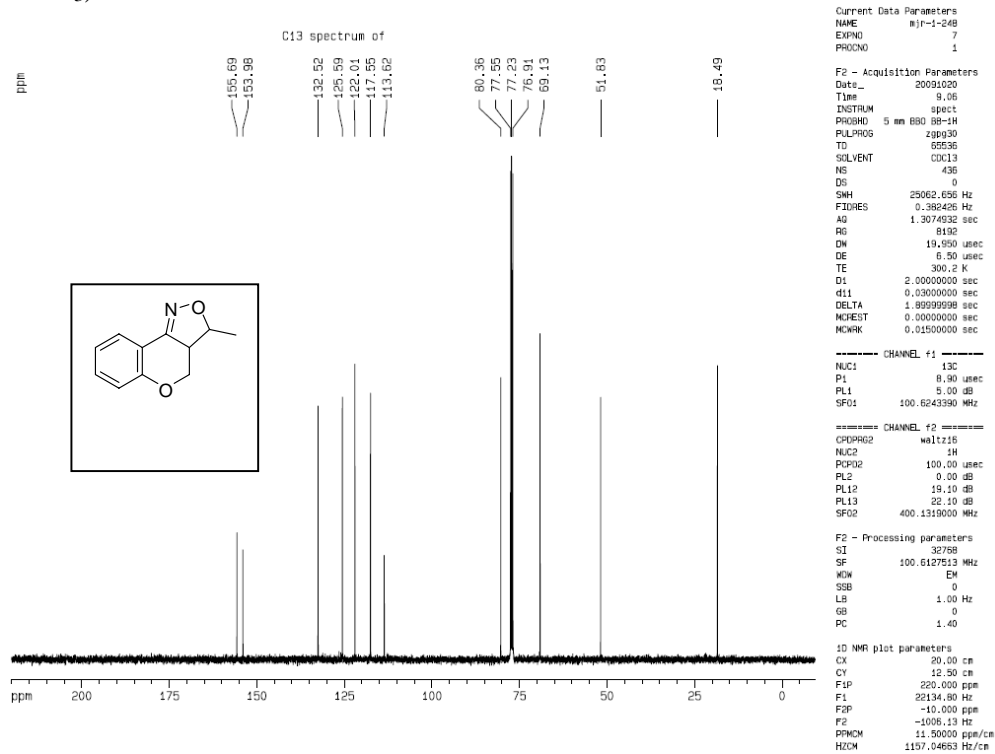
3,3-Dimethyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole(9a): ^{13}C NMR (100 MHz, CDCl_3):



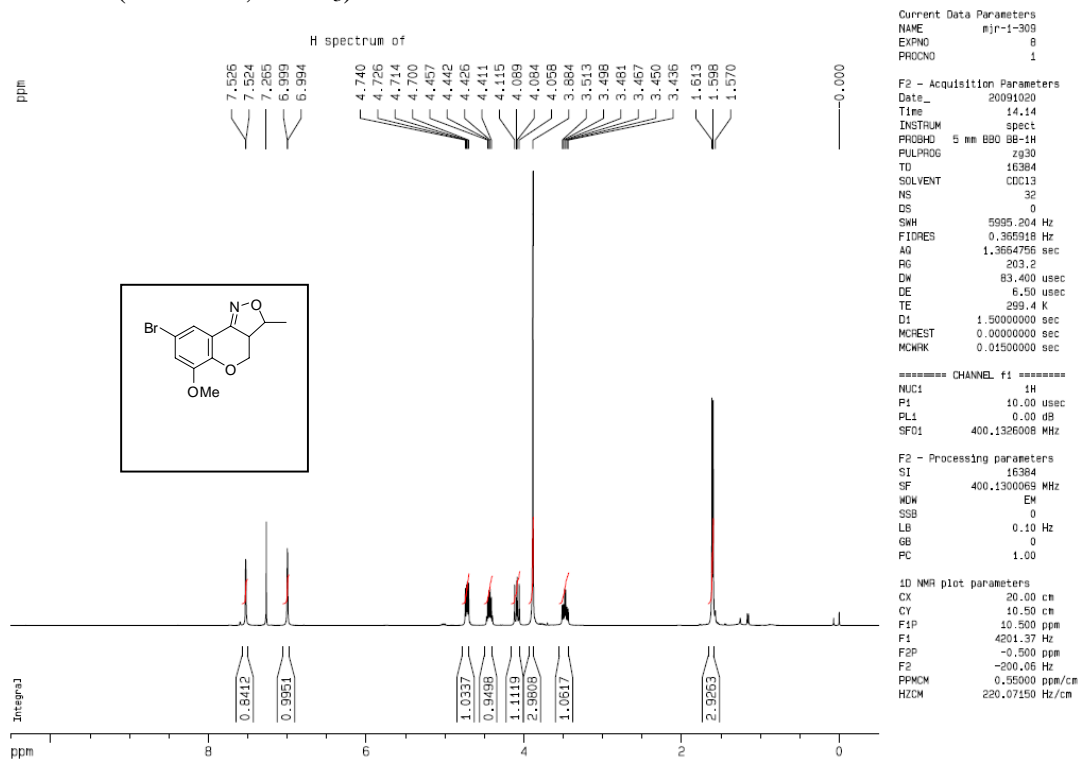
3-Methyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (10a): ¹H NMR (400 MHz, CDCl₃):



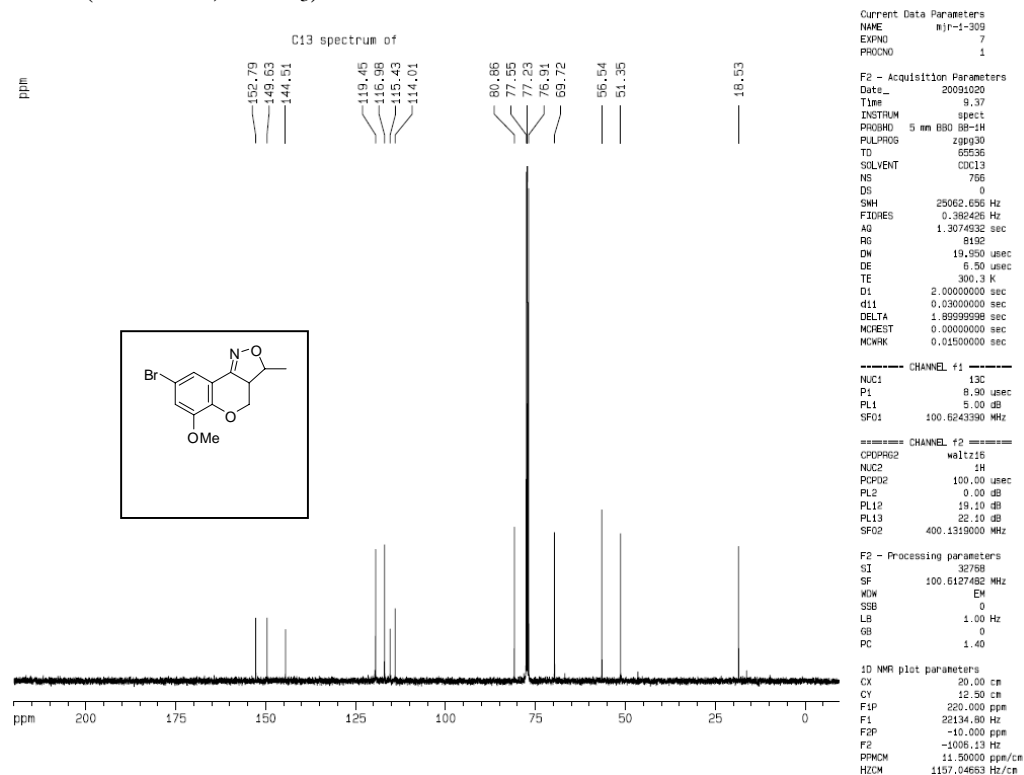
3-Methyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (10a): ¹³C NMR (100 MHz, CDCl₃):



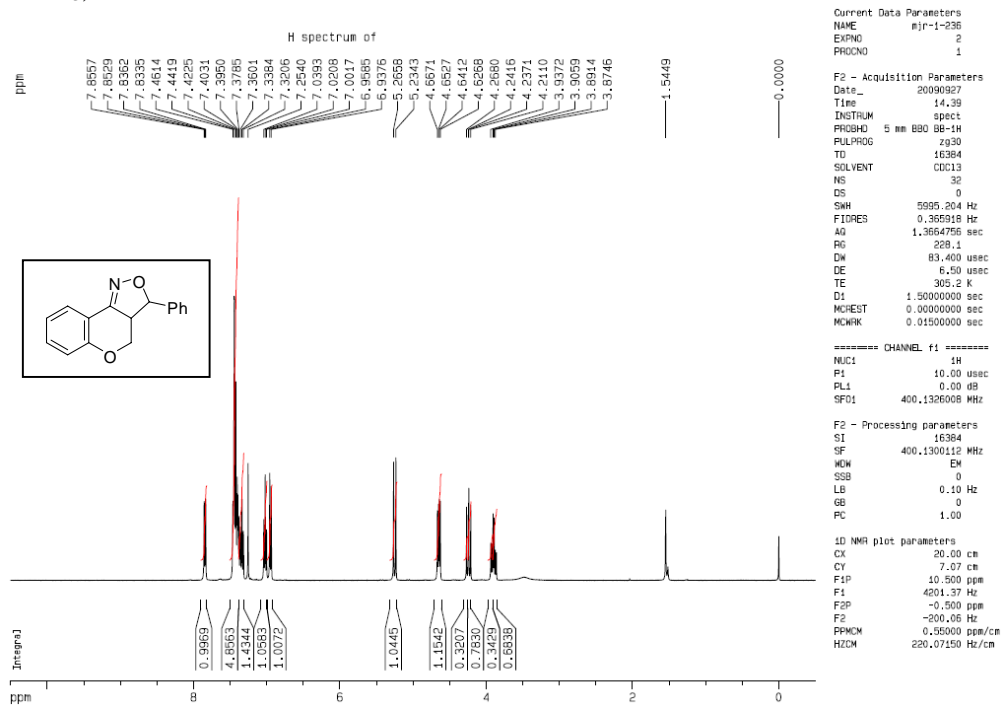
8-bromo-6-methoxy-3-methyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (11a)
¹H NMR (400 MHz, CDCl₃):



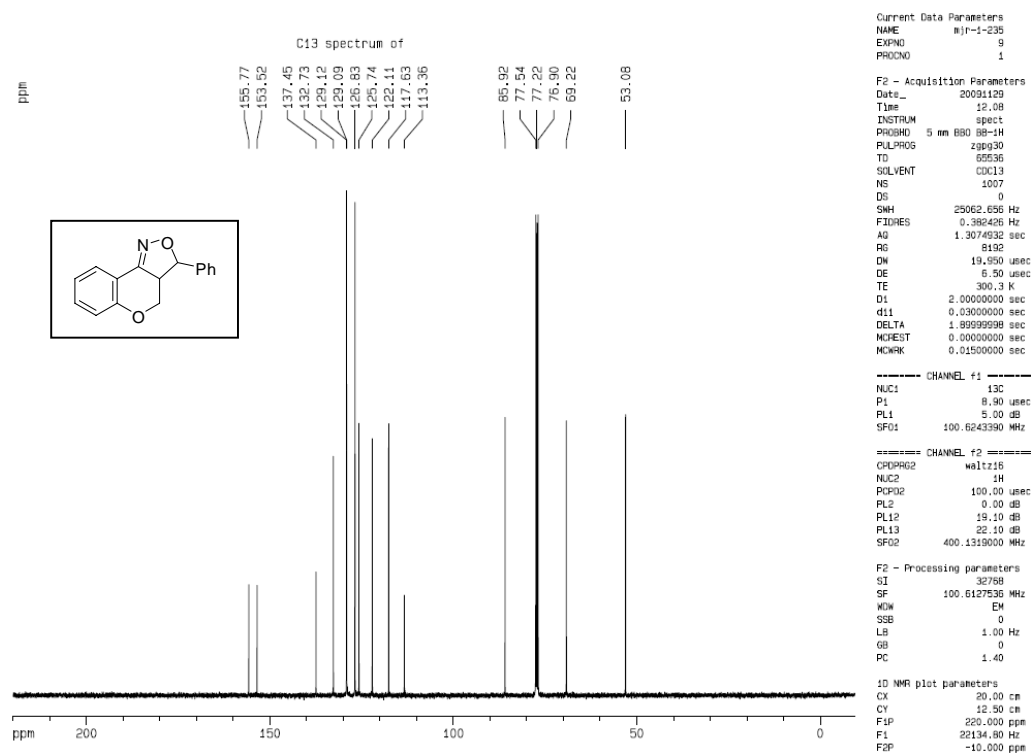
8-bromo-6-methoxy-3-methyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (11a) ¹³C
NMR (100 MHz, CDCl₃):



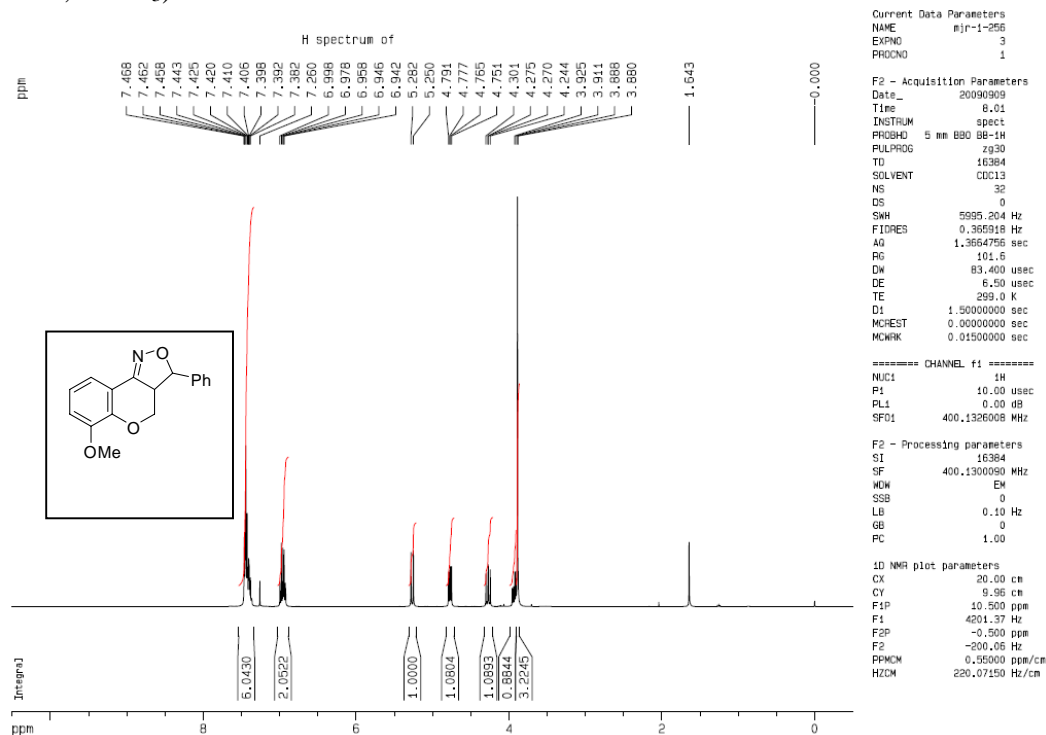
3-Phenyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (12a): ¹H NMR (400 MHz, CDCl₃):



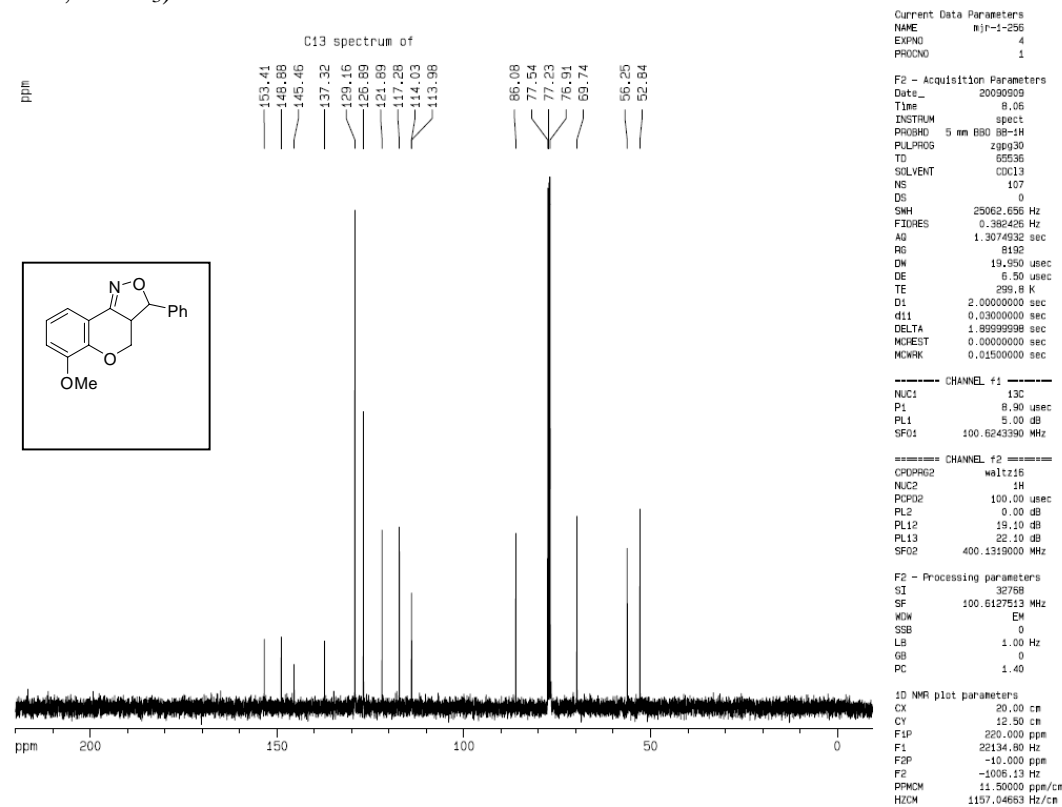
3-Phenyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (12a): ¹³C NMR (100 MHz, CDCl₃):



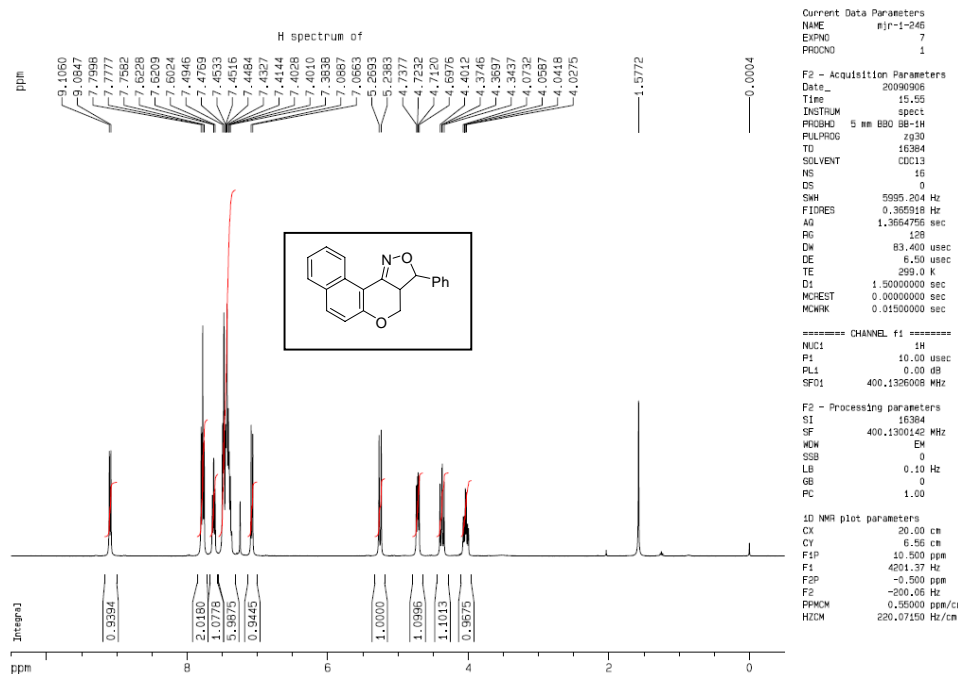
6-Methoxy-3-phenyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (13a) ¹H NMR (400 MHz, CDCl₃):



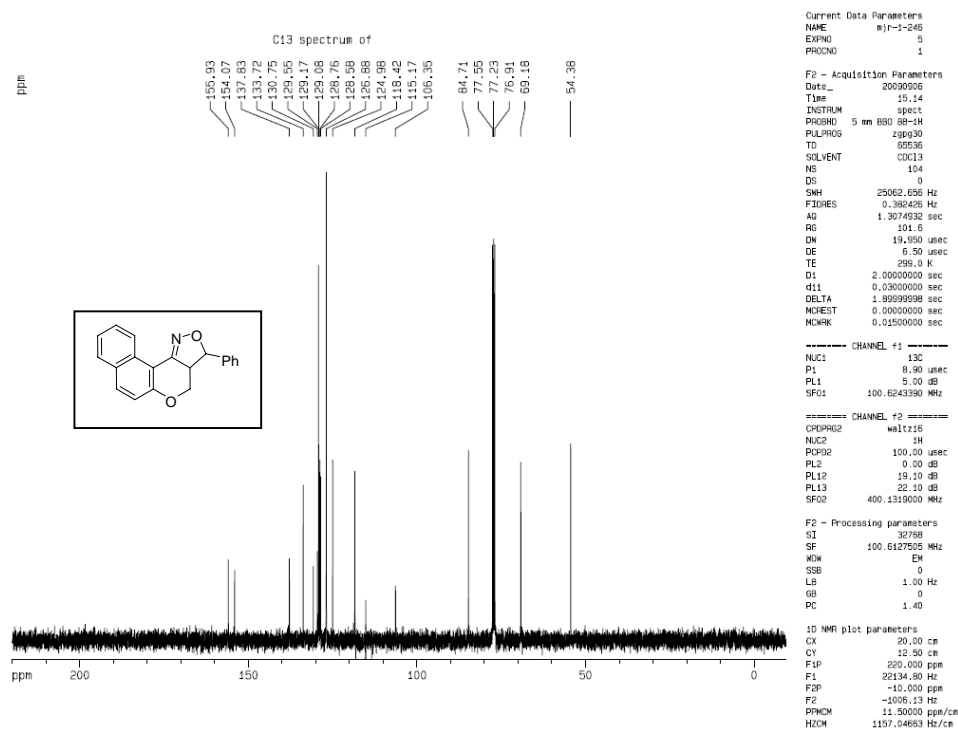
6-Methoxy-3-phenyl-3a,4-dihydro-3H-chromeno[4,3-c]isoxazole (13a) ¹³C NMR (100 MHz, CDCl₃):



3-Phenyl-3a,4-Dihydro-3H-benzo[5,6]chromeno[4,3-c]isoxazole (14a) ¹H NMR (400 MHz, CDCl₃):

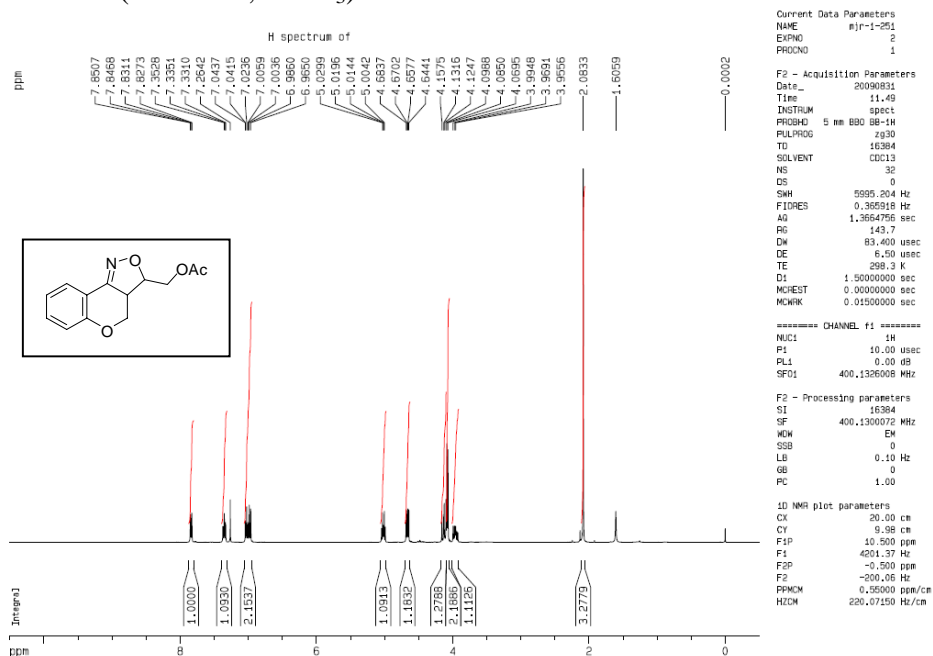


3-Phenyl-3a,4-Dihydro-3H-benzo[5,6]chromeno[4,3-c]isoxazole (14a) ¹³C NMR (100 MHz, CDCl₃):



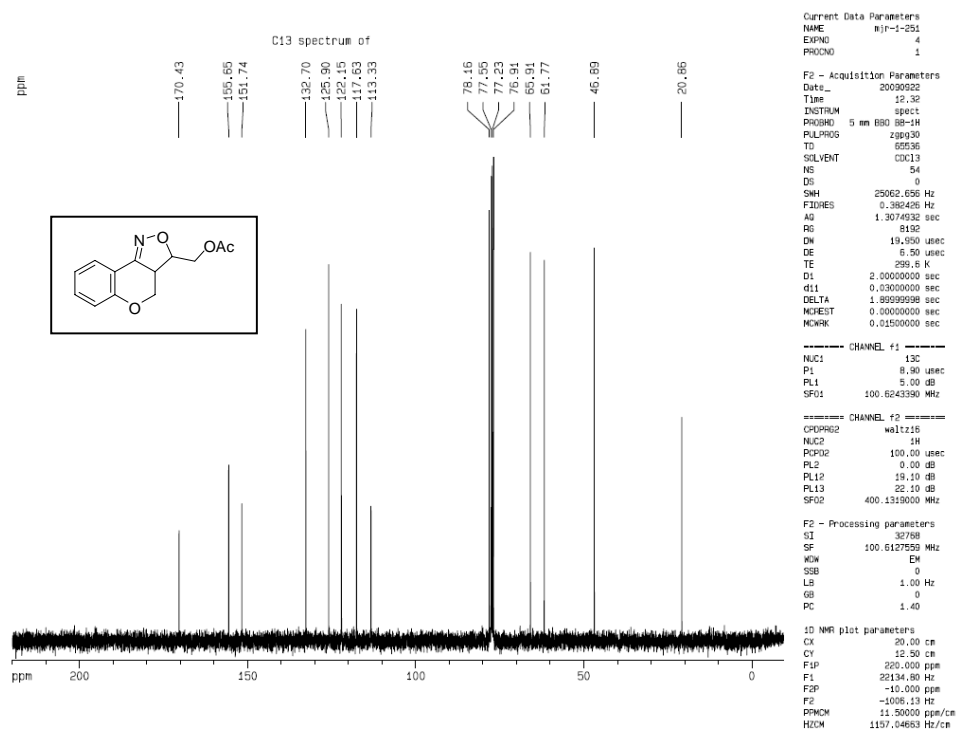
(3a,4-Dihydro-3H-chromeno[4,3-c]isoxazol-3-yl)methyl acetate(15a)

¹H NMR (400 MHz, CDCl₃):

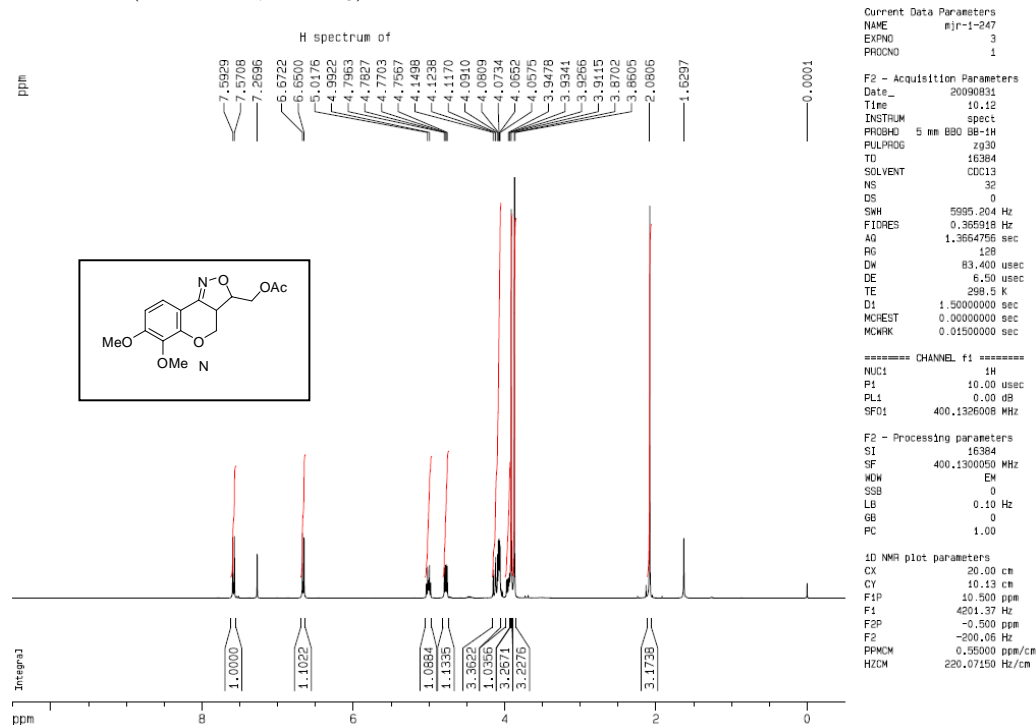


(3a,4-Dihydro-3H-chromeno[4,3-c]isoxazol-3-yl)methyl acetate(15a)

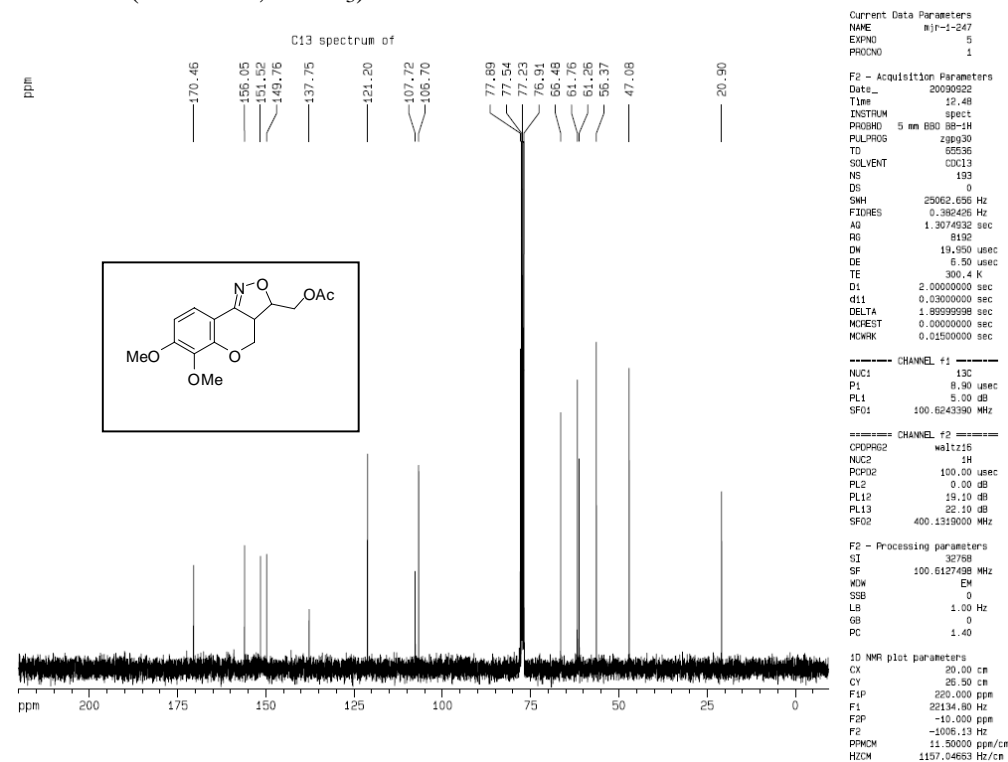
¹³C NMR (100 MHz, CDCl₃):



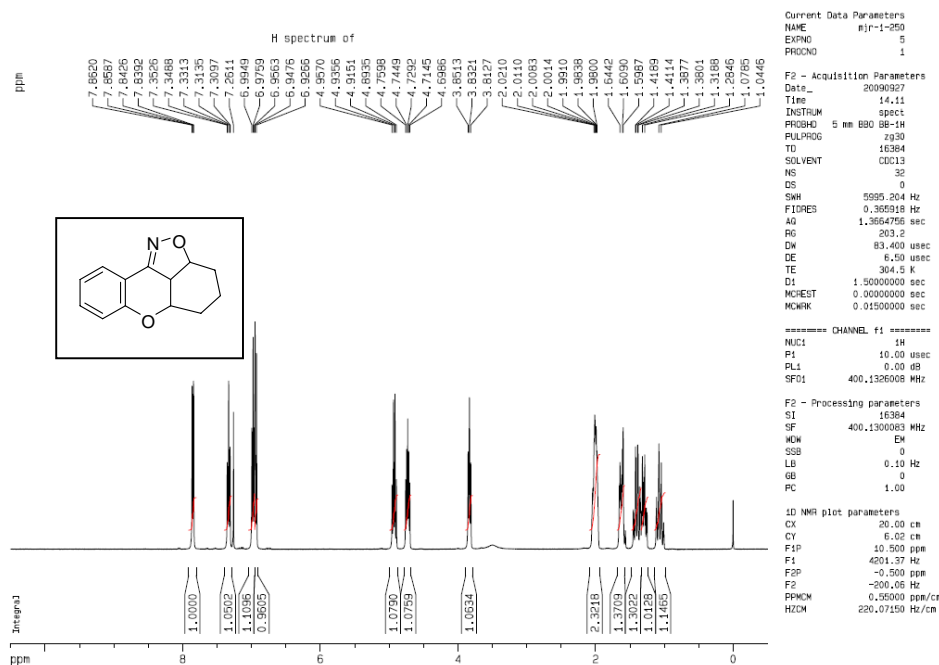
(6,7-Dimethoxy-3a,4-dihydro-3H-chromeno[4,3-c]isoxazol-3-yl)methyl acetate (16a)
¹H NMR (400 MHz, CDCl₃):



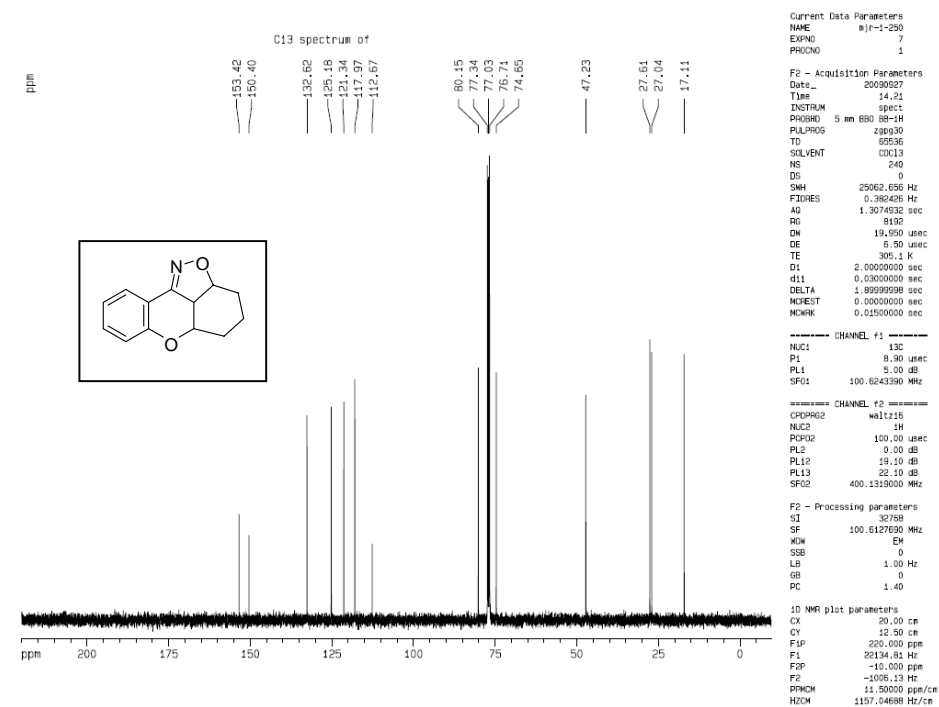
(6,7-Dimethoxy-3a,4-dihydro-3H-chromeno[4,3-c]isoxazol-3-yl)methyl acetate (16a)
¹³C NMR (100 MHz, CDCl₃):



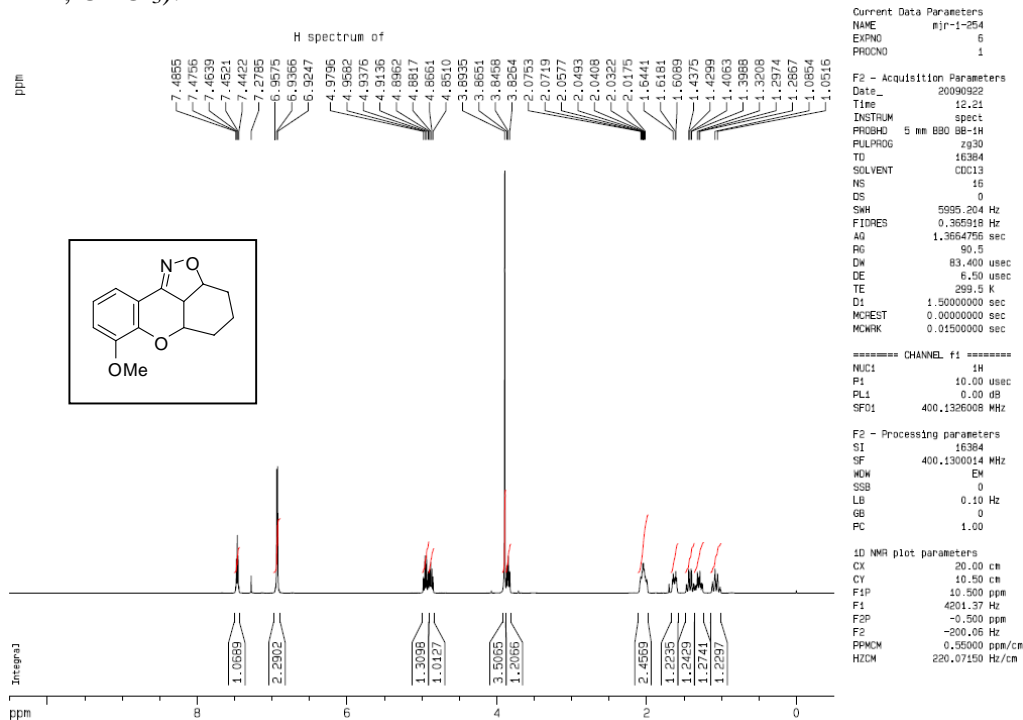
2a,2a1,3,4,5,5a-Hexahydroxantheno[9,1-cd]isoxazole (17a) ^1H NMR (400 MHz, CDCl_3):



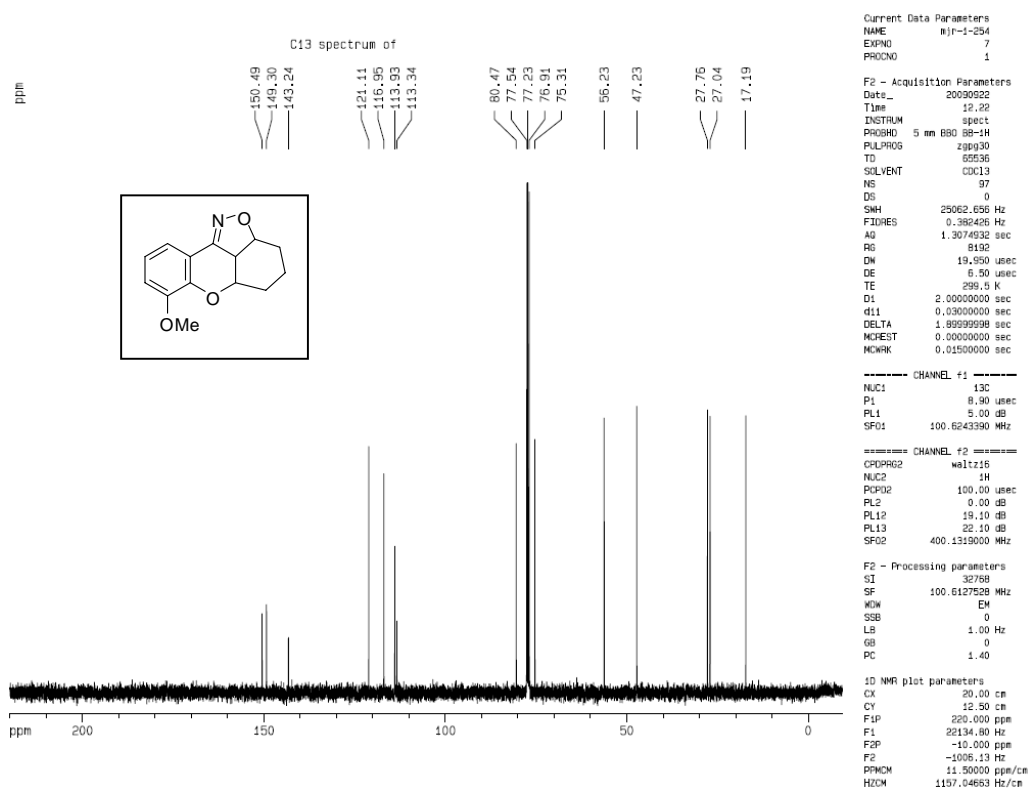
2a,2a1,3,4,5,5a-Hexahydroxantheno[9,1-cd]isoxazole (17a) ^{13}C NMR (100 MHz, CDCl_3):



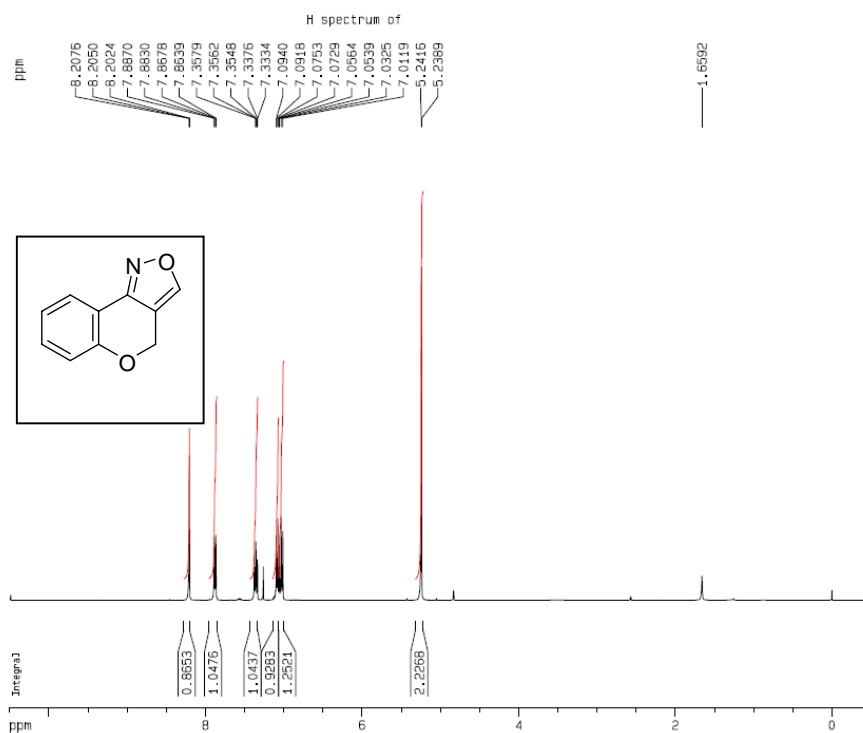
7-Methoxy-2a,2a1,3,4,5,5a-hexahydroxantheno[9,1-cd]isoxazole (18a) ¹H NMR (400 MHz, CDCl₃):



7-Methoxy-2a,2a1,3,4,5,5a-hexahydroxantheno[9,1-cd]isoxazole (18a) ¹³C NMR (100 MHz, CDCl₃):



4H-chromeno[4,3-c]isoxazole (19a) ¹H NMR (400 MHz, CDCl₃):



```
Current Data Parameters
NAME      mjr-1-239
EXPNO    3
PROCNO   1

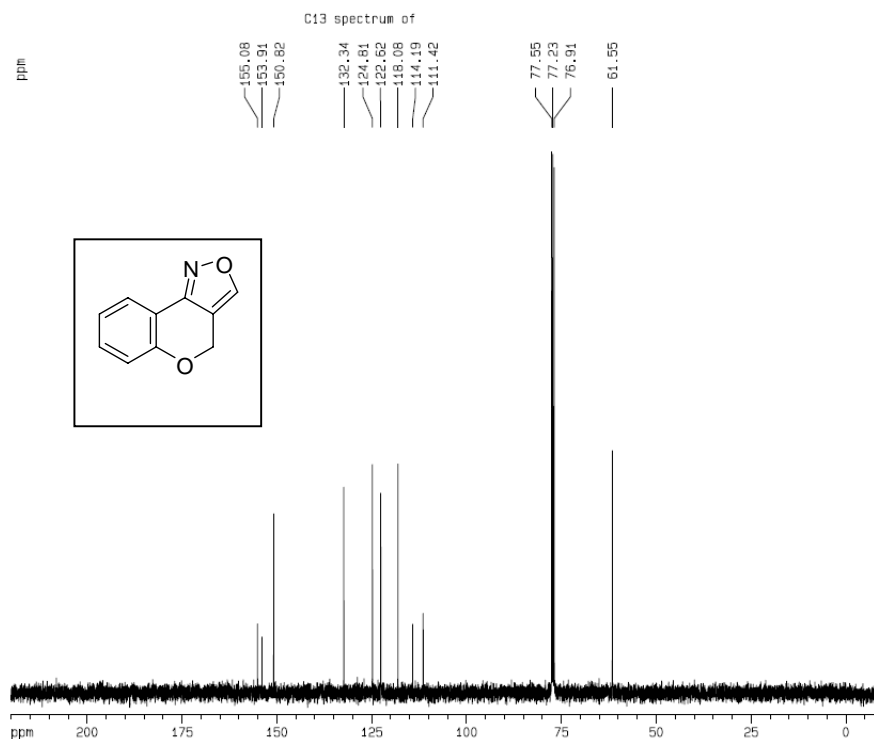
F2 - Acquisition Parameters
Date_    20090824
Time     2.19
INSTRUM  spect
PROBHD   5 mm BBO BB-1H
PULPROG  zg30
TD        16384
SOLVENT  CDCl3
NS        32
DS        0
SWH       5995.204 Hz
FIDRES   0.365918 Hz
AQ        1.3664756 sec
RG         161.3
DW        83.400 usec
DE         6.50 usec
TE        298.9 K
D1        1.5000000 sec
MCHST     0.0000000 sec
MCWRK    0.0150000 sec

----- CHANNEL f1 -----
NUC1      1H
P1        10.00 usec
PL1       0.00 dB
SFO1     400.1326008 MHz

F2 - Processing parameters
SI        16384
SF        400.1300083 MHz
WDW       EM
SSB       0
LB        0.10 Hz
GB        0
PC        1.00

1D NMR plot parameters
CX        20.00 cm
CY        7.93 cm
F1P       10.500 ppm
F1        4201.37 Hz
F2P       -0.500 ppm
F2        -200.06 Hz
PRMCM    0.55000 ppm/cm
HZCM     220.07150 Hz/cm
```

4H-chromeno[4,3-c]isoxazole (19a) ¹³C NMR (100 MHz, CDCl₃):



```
Current Data Parameters
NAME      mjr-1-239
EXPNO    4
PROCNO   1

F2 - Acquisition Parameters
Date_    20090824
Time     2.26
INSTRUM  spect
PROBHD   5 mm BBO BB-1H
PULPROG  zgpg30
TD        65536
SOLVENT  CDCl3
NS        97
DS        0
SWH       25062.656 Hz
FIDRES   0.394226 Hz
AQ        1.3074932 sec
RG         8192
DW        19.950 usec
DE         6.50 usec
TE        299.4 K
D1        2.0000000 sec
d11       0.0000000 sec
DELTA    1.80999998 sec
MCHST     0.0000000 sec
MCWRK    0.0150000 sec

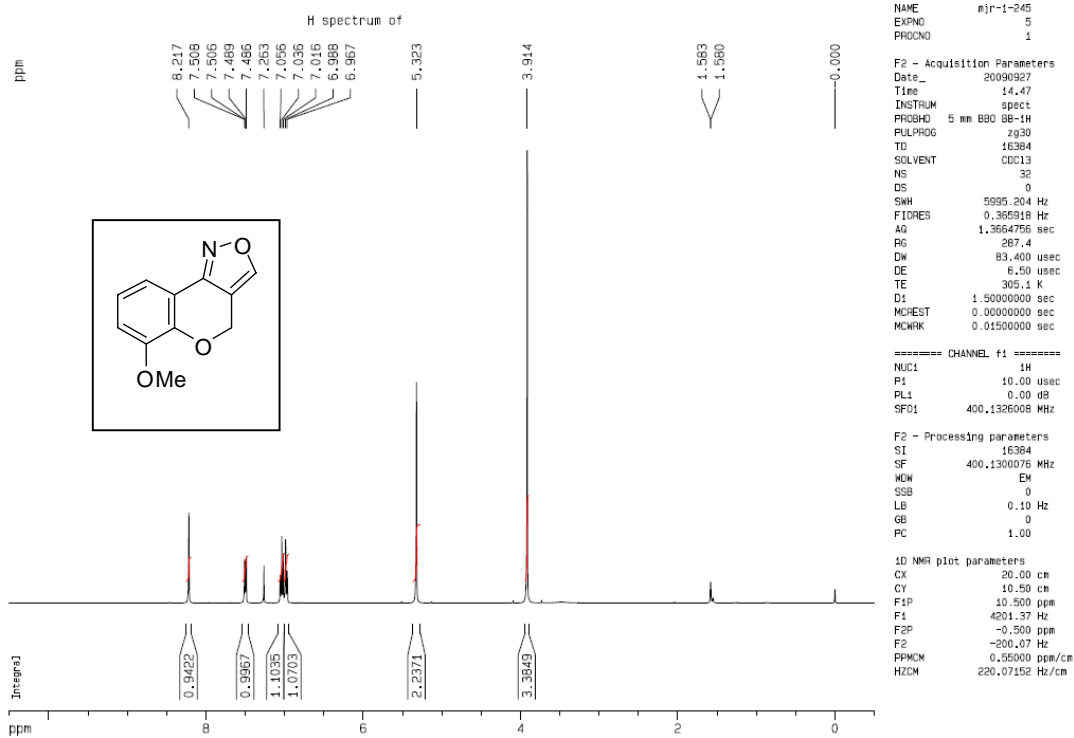
----- CHANNEL f1 -----
NUC1      13C
P1         8.90 usec
PL1        5.00 dB
SFO1     100.6243390 MHz

----- CHANNEL f2 -----
CPDPRG2  waltz16
NUC2      1H
PCPD2    100.00 usec
PL2       0.00 dB
PL12     19.10 dB
PL13     22.10 dB
SFO2     400.1315000 MHz

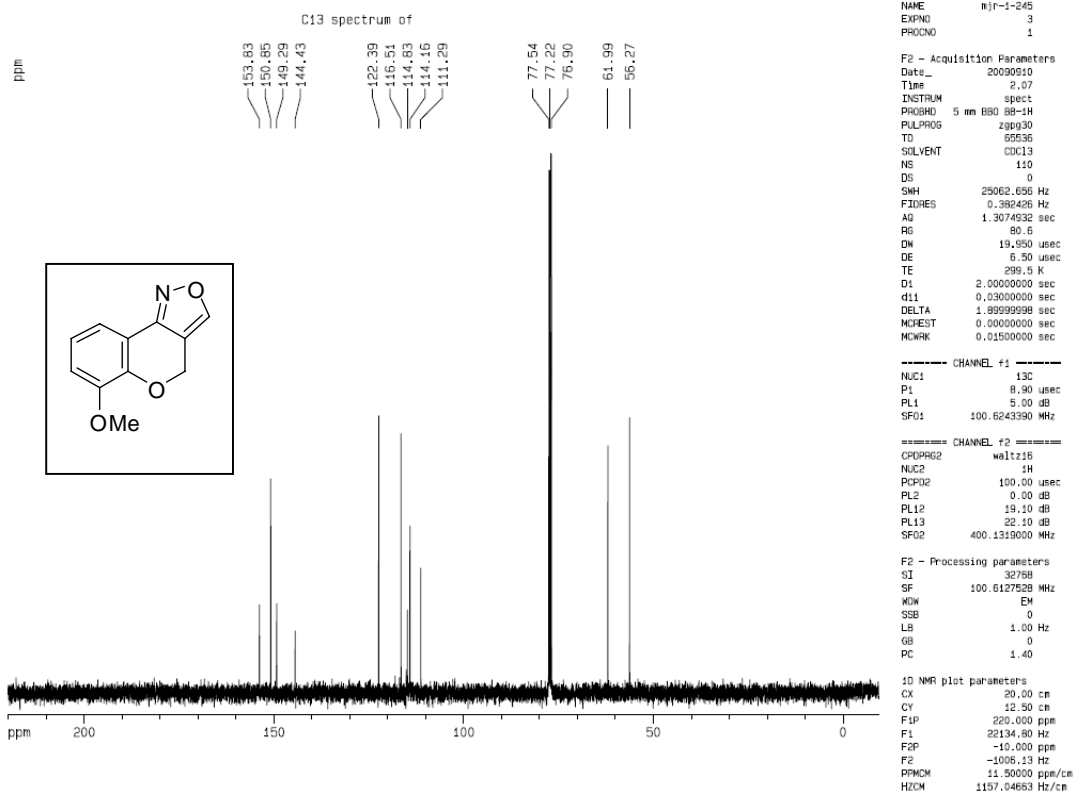
F2 - Processing parameters
SI        32768
SF        100.6127498 MHz
WDW       EM
SSB       0
LB        1.00 Hz
GB        0
PC        1.40

1D NMR plot parameters
CX        20.00 cm
CY        12.50 cm
F1P       220.000 ppm
F1        22134.80 Hz
F2P       -45.000 ppm
F2        -1006.13 Hz
PRMCM    11.50000 ppm/cm
HZCM     1157.04653 Hz/cm
```

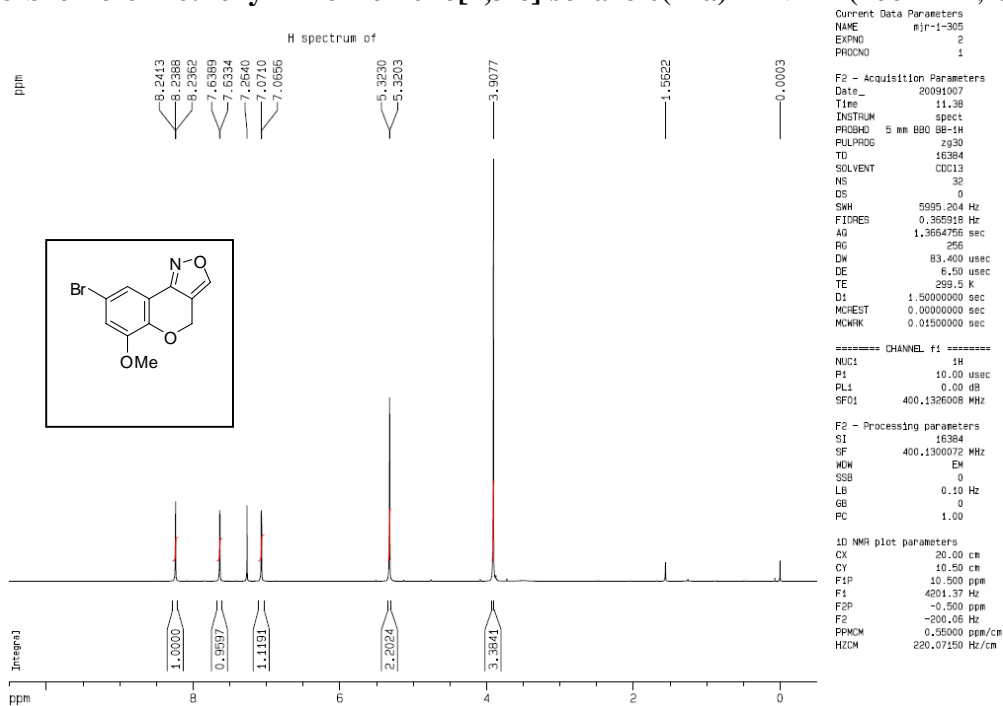
6-methoxy-4H-chromeno[4,3-c]isoxazole(20a) ¹H NMR (400 MHz, CDCl₃):



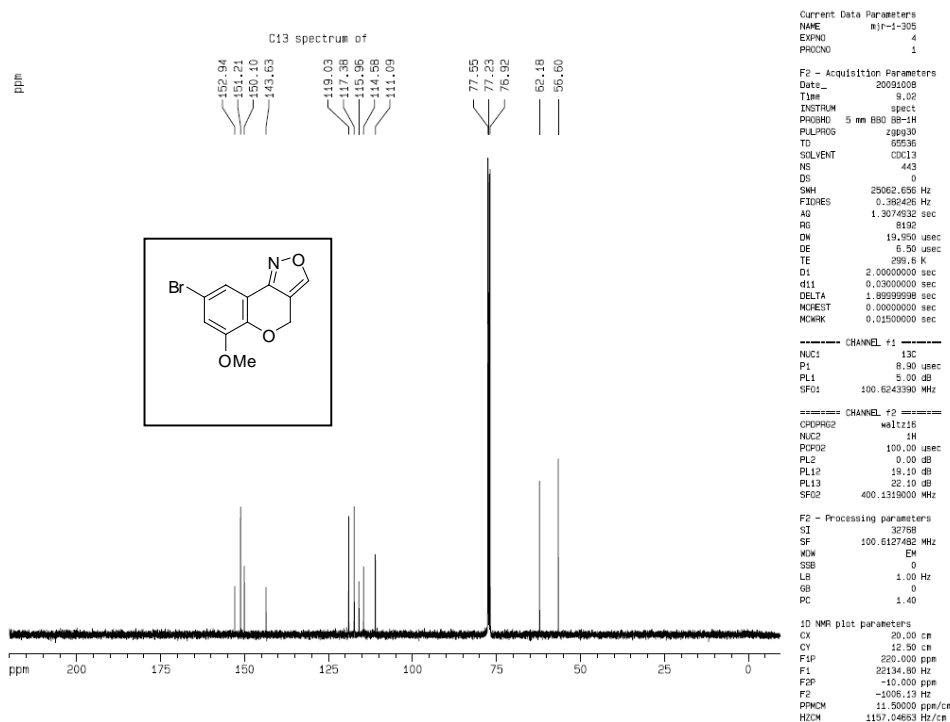
6-methoxy-4H-chromeno[4,3-c]isoxazole(20a) ¹³C NMR (100 MHz, CDCl₃)



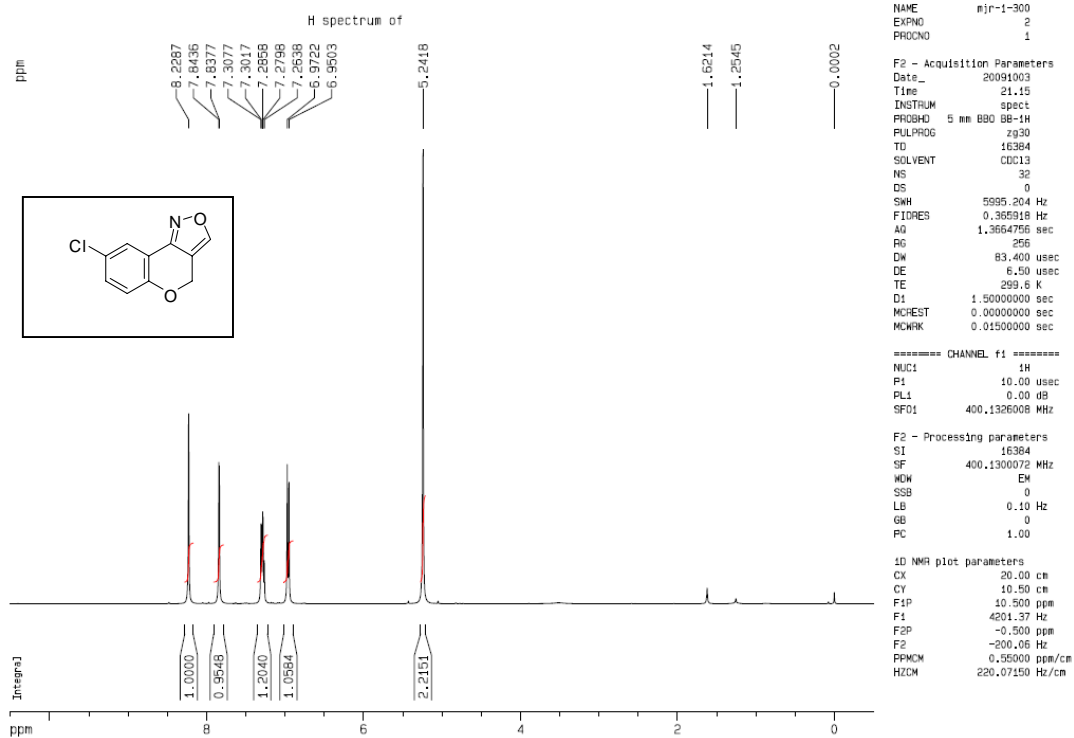
8-bromo-6-methoxy-4H-chromeno[4,3-c]isoxazole(21a)¹H NMR (400 MHz, CDCl₃):



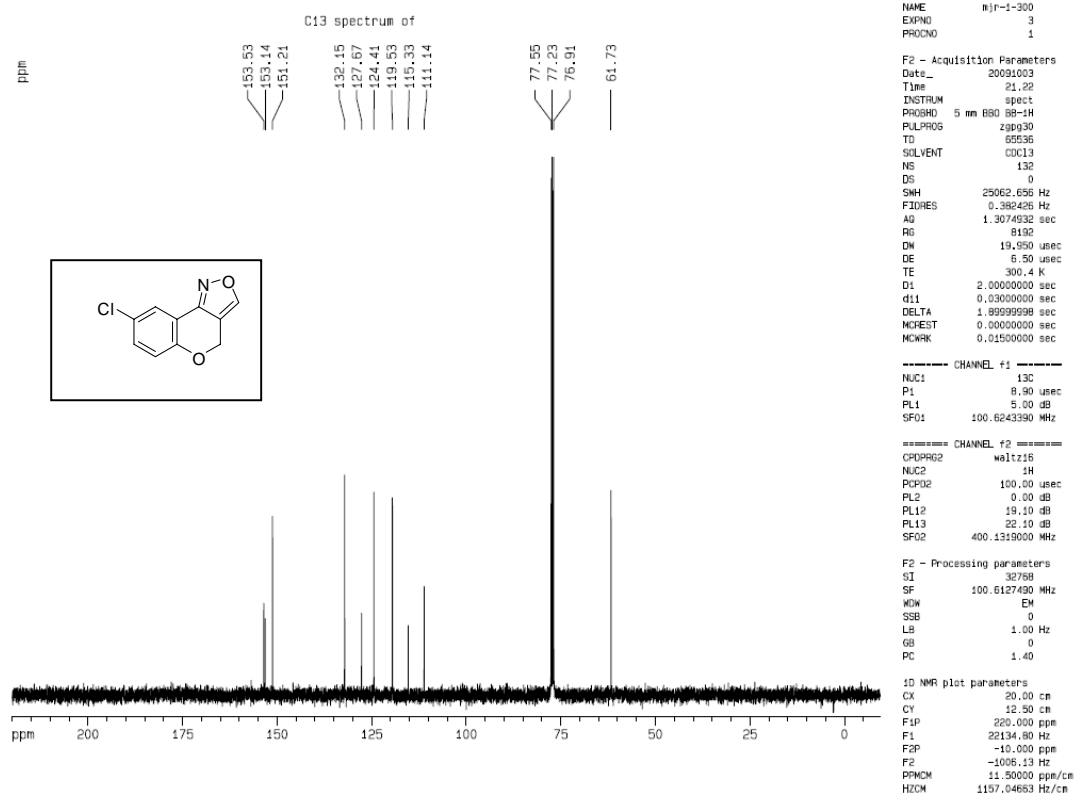
8-bromo-6-methoxy-4H-chromeno[4,3-c]isoxazole(21a)¹³C NMR (400 MHz, CDCl₃):



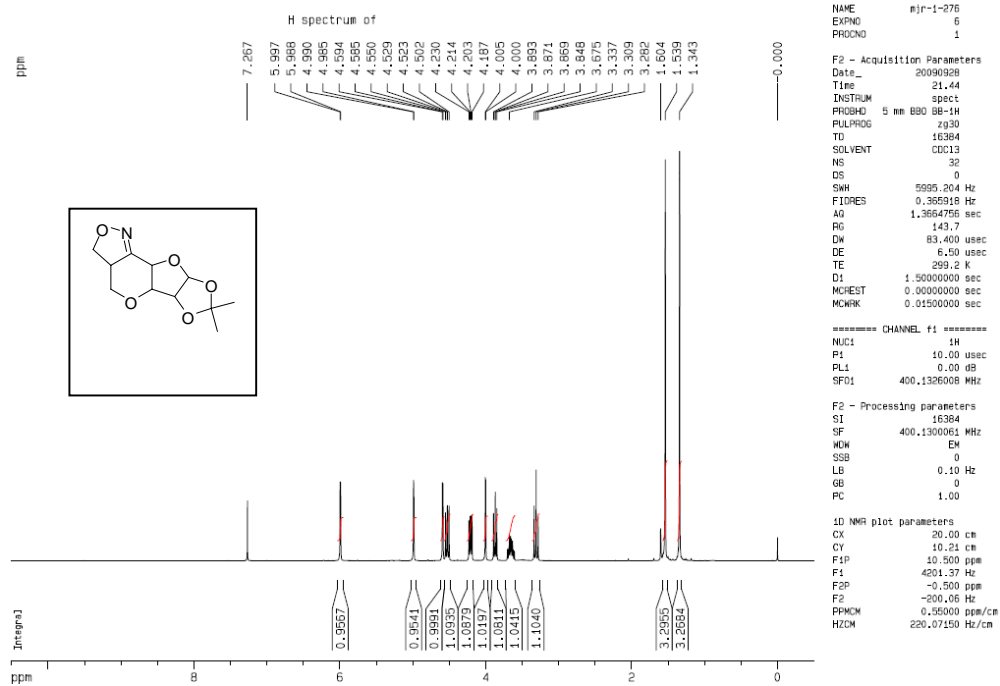
8-chloro-4*H*-chromeno[4,3-*c*]isoxazole(22a)



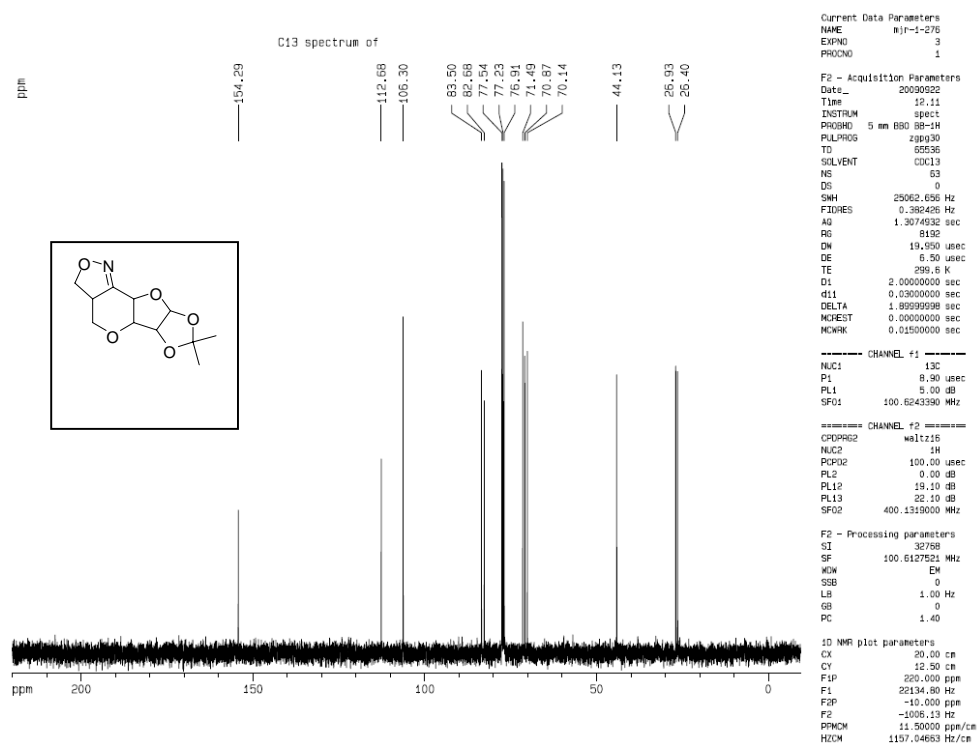
8-chloro-4*H*-chromeno[4,3-*c*]isoxazole(22a)



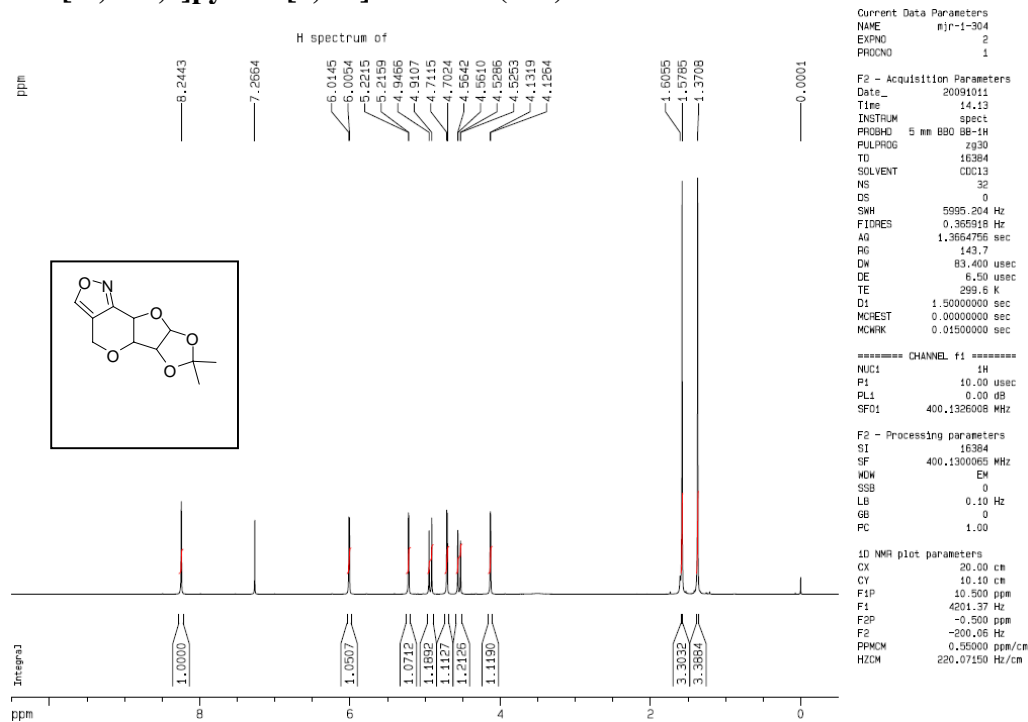
Glucose-isoxazoline (24a):



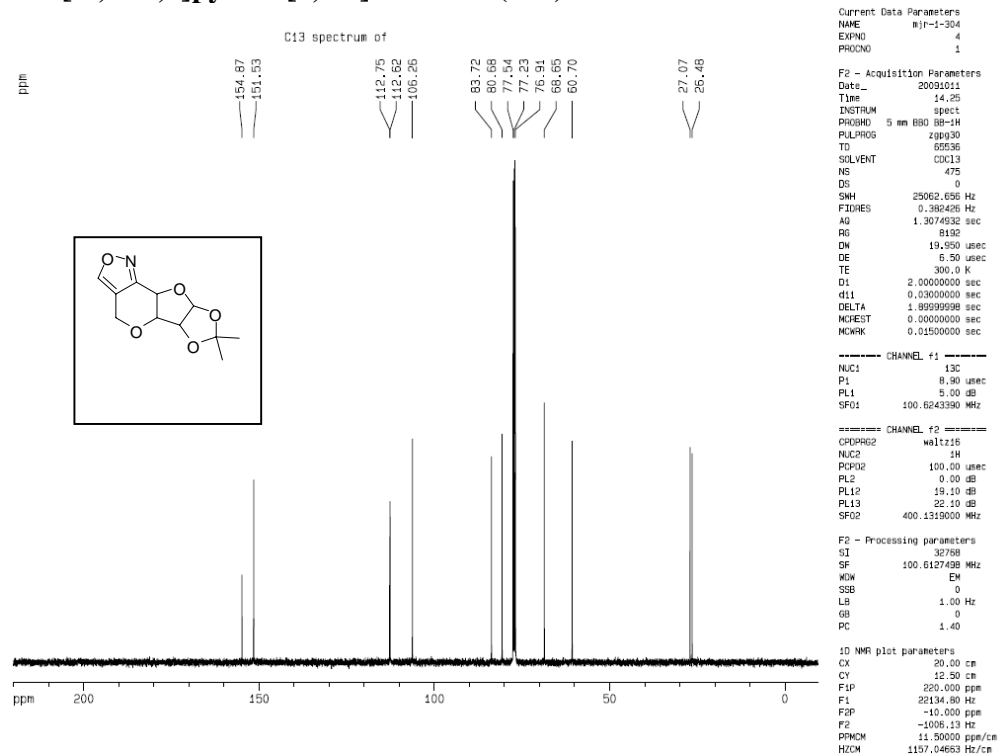
Glucose-isoxazoline (24a):



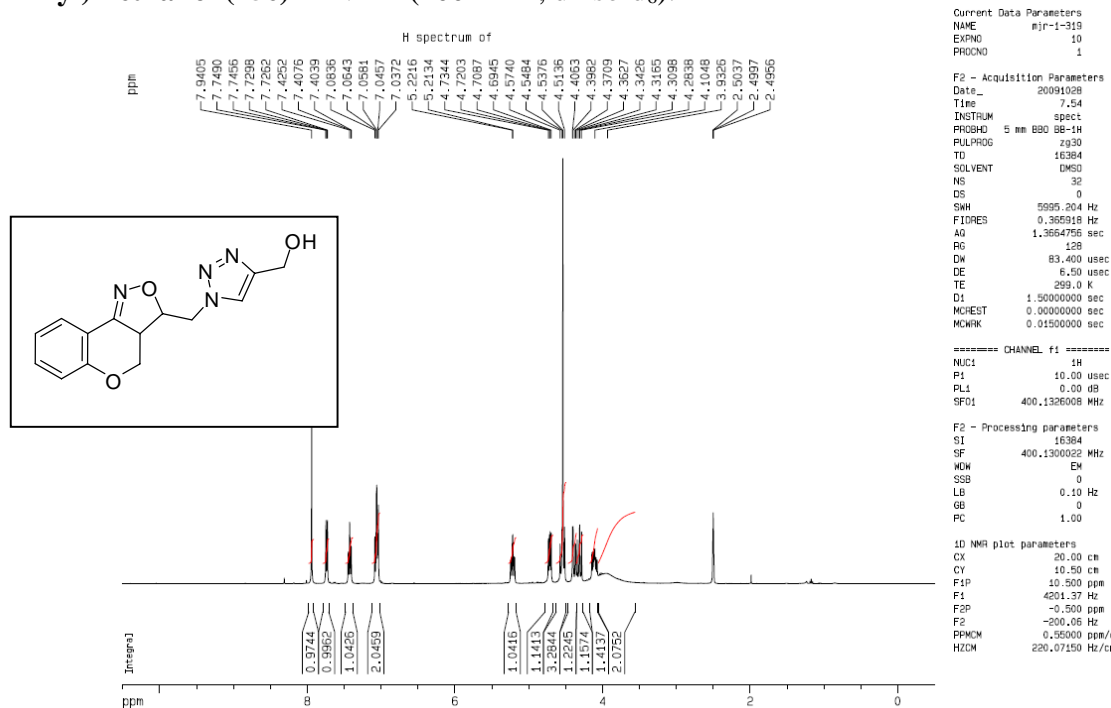
(5a*S*, 6*R*, 7*R*, 8*aR*)-5a,6,7,8a-Tetrahydro-6,7-isopropylidenedioxy-4*H*-furo[2',3':5,6]pyrano[4,3-*c*]isoxazole (25a)



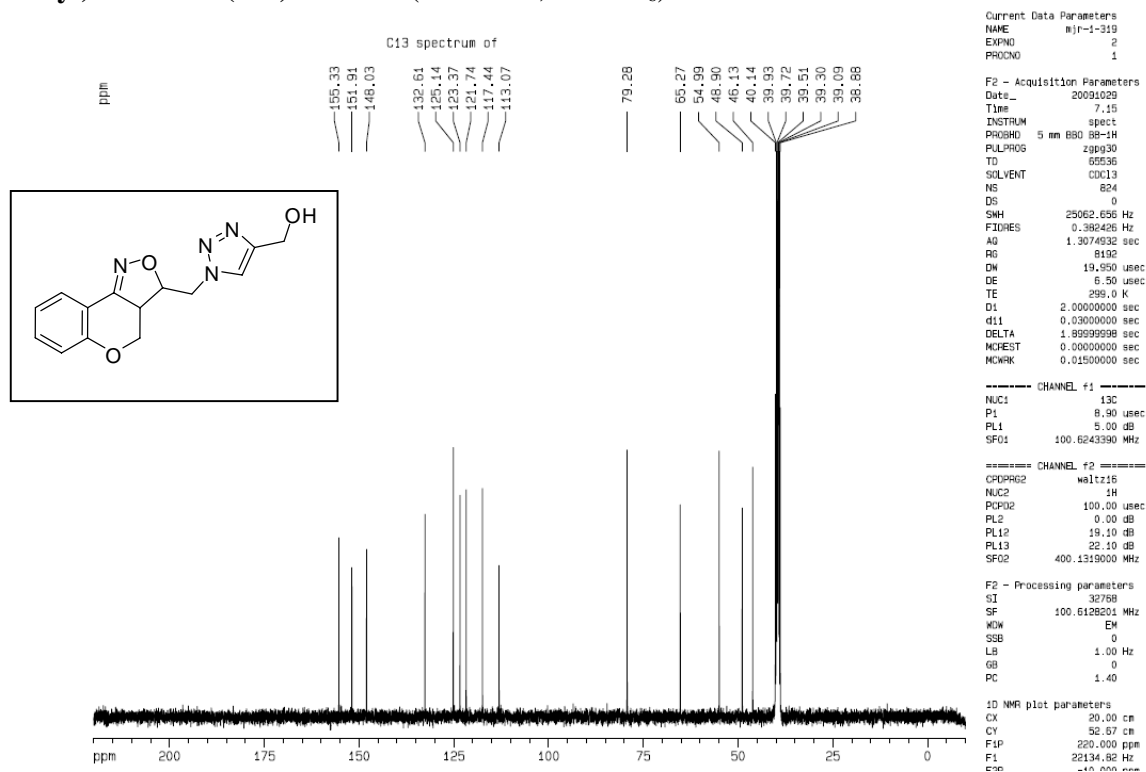
(5a*S*, 6*R*, 7*R*, 8*aR*)-5a,6,7,8a-Tetrahydro-6,7-isopropylidenedioxy-4*H*-furo[2',3':5,6]pyrano[4,3-*c*]isoxazole (25a)



(1-((3a,4-dihydro-3H-chromeno[4,3-c]isoxazol-3-yl)methyl)-1H-1,2,3-triazol-4-yl)methanol (15e) ¹HNMR (400 MHz, dmsO-d₆):



(1-((3a,4-dihydro-3H-chromeno[4,3-c]isoxazol-3-yl)methyl)-1H-1,2,3-triazol-4-yl)methanol (15e) ¹³CNMR (100 MHz, dmsO-d₆):



CCDC number of the crystals,

(14a) 751947

(16a) 751948

(18a) 751949

(25a) 757190

References :

- (1) (a) **Z. Huang, H. Lai, Y. Qin**, *J. Org. Chem.*, 2007, **72**, 1373 (b) **B. Gabriele, R. Mancuso, G. Salerno, M. Costa**, *Adv. Synth. & Cat.*, 2006, **348**, 1101. (O-allylation and Propagation)
- (2) (a) **M. L. Bennesar, T. Roca, M. Monerri, D. Garcia-Diaz**, *J. Org. Chem.*, **2006**, 71, 7028. (oxime preparation)