Supplementary Materials: Chemical Characteristics of Synthetic LWTX4 and Paralytic Shellfish Toxins under Standard Post–Column Oxidation (PCOX) and HILIC–MS/MS Conditions

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I. Experimental Procedure

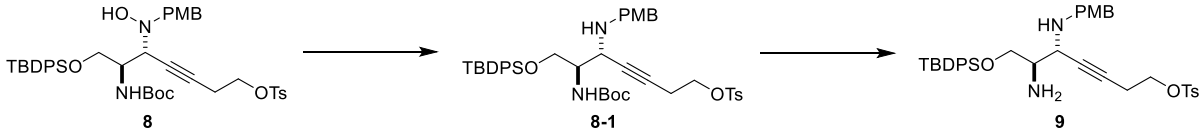
1) Synthesis of PSTs



(5*R*,6*R*)-6-((*tert*-Butoxycarbonyl)amino)-7-((*tert*-butyldiphenylsilyl)oxy)-5-(hydroxy(4-methoxybenzyl)amino)hept-3-yn-1-yl 4-methylbenzenesulfonate **8**

A solution of **6** (16.90 g, 75.34 mmol) in THF (168 mL) was cooled to -15 °C. To this solution was then added dropwise *i*-PrMgCl (2.0 M) (39 mL, 77.22 mmol). The flask was then cooled to -78 °C. A solution of **7** (10.60 g, 18.84 mmol) in THF (20 mL) was added dropwise to the reaction mixture. The reaction mixture was stirred for 5 h until the reaction was complete, as monitored by TLC. The reaction mixture was then quenched with saturated NH_4Cl (200 mL) then warmed to rt. The mixture was diluted with EtOAc (150 mL) and partitioned in a separatory funnel. The organic layer was separated, and the aqueous layer was extracted with EtOAc (150 mL). The organic layer was dried over $MgSO_4$ and concentrated under reduced pressure. The residue was purified via column chromatography over SiO_2 (Hexane/EtOAc = 5:1) to afford **8** as a clear oil (11.87 g, 80%). $[\alpha]^{20}_D$ = -60.0° (*c* = 0.5, $CHCl_3$);

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.78 (d, *J* = 8.1 Hz, 2H), 7.61 (dd, *J* = 16.7, 6.7 Hz, 4H), 7.45 – 7.28 (m, 8H), 6.84 (d, *J* = 8.2 Hz, 2H), 5.06 (d, *J* = 9.4 Hz, 1H), 4.04 (dt, *J* = 7.5, 4.6 Hz, 2H), 3.87 (t, *J* = 10.5 Hz, 3H), 3.79 (s, 3H), 3.68 (d, *J* = 12.7 Hz, 1H), 3.65 (s, 1H), 3.60 (dd, *J* = 10.0, 5.6 Hz, 1H), 2.59 – 2.54 (m, 2H), 2.40 (s, 3H), 1.45 (s, 9H), 0.97 (s, 9H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 158.7, 155.5, 144.9, 135.6, 135.5, 133.1, 133.0, 132.9, 131.7, 129.9, 129.8, 129.7, 129.6, 129.5, 127.7, 127.6, 113.7, 80.8, 79.6, 79.3, 67.6, 63.6, 55.2, 53.9, 50.6, 50.5, 28.4, 26.7, 21.6, 19.8, 19.1; IR (ATR) ν_{max} 2929, 2855, 1699, 1505, 1363, 1176 cm^{-1}; HRESIMS *m*/*z* 787.3425 $[M+H]^+$ (calcd for $C_{43}H_{54}N_2O_8SSi$, 787.3443)



(5*R*,6*R*)-6-((*tert*-Butoxycarbonyl)amino)-7-((*tert*-butyldiphenylsilyl)oxy)-5-((4-methoxybenzyl)amino)hept-3-yn-1-yl 4-methylbenzenesulfonate **8-1**

To a slurry of zinc dust (4.80 g, 73.50 mmol) in AcOH (53 mL) was added $Cu(OAc)_2$ (267 mg, 1.47 mmol). The contents were stirred for 15 min at rt. A solution of **8** (11.57 g, 14.70 mmol) in AcOH (24 mL) was then added to this slurry. H_2O (16 mL) was added. The contents of the flask were heated to 50 °C for 4 h. The flask was then cooled to rt, and solid Na_2EDTA (10.94 g, 27.40 mmol) was added. The mixture was stirred for 20 min, and the solution was basified (pH > 9) with 10% aqueous NaOH. The reaction mixture was diluted with EtOAc (50 mL) and then filtered through a pad of Celite. The filtrate was transferred to a separatory funnel, and the organic layer was separated. The aqueous layer was extracted with EtOAc (150 mL). The organic layer was dried over $MgSO_4$ and concentrated under reduced pressure. The residue was purified via column chromatography over SiO_2 (Hexane/EtOAc = 4:1) to afford **8-1** as a clear oil (7.18 g, 63%). $[\alpha]^{20}_D$ = -70.0° (*c* = 0.5, $CHCl_3$);

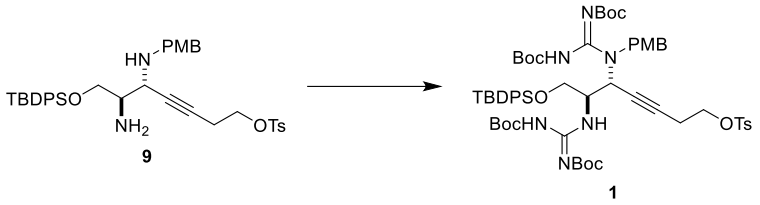
^{1}H NMR (600 MHz, $CDCl_3$) δ 7.77 (d, *J* = 7.9 Hz, 2H), 7.62 (dd, *J* = 11.1, 6.6 Hz, 4H), 7.45 – 7.34 (m, 7H), 7.28 (d, *J* = 8.8 Hz, 1H), 6.83 (d, *J* = 8.6 Hz, 2H), 4.75 (d, *J* = 10.0 Hz, 1H), 4.29 – 4.16 (m, 2H), 4.05 (m, 2H),

3.78 (s, 3H), 3.61 (dd, J = 10.1, 6.8 Hz, 1H), 2.58 (t, J = 6.7 Hz, 2H), 2.40 (s, 3H), 1.43 (s, 9H), 1.01 (s, 9H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 158.7, 156.7, 145.0, 135.6, 135.3, 133.1, 133.0, 132.9, 130.2, 129.9, 129.8, 129.8, 127.8, 127.7, 127.7, 113.5, 82.2, 79.8, 67.4, 63.2, 60.7, 60.1, 55.2, 52.8, 28.3, 26.8, 21.6, 19.9, 19.2; IR (ATR) ν_{max} 2933, 2855, 1717, 1509, 1173 cm^{-1}; HRESIMS m/z 771.3465 $[M+H]^+$ (calcd for $C_{43}H_{54}N_2O_7SSi$, 771.3494)

(5*R*,6*R*)-6-Amino-7-((*tert*-butyldiphenylsilyl)oxy)-5-((4-methoxybenzyl)amino)hept-3-yn-1-yl 4-methylbenzenesulfonate **9**

Trifluoroacetic acid (6.77 mL, 88.45 mmol) was added to a solution of **8-1** (6.82 g, 8.85 mmol) in CH_2Cl_2 (18 mL) at 0 °C. The reaction mixture was stirred for 12 h at rt and then quenched with saturated 10% NaOH (30 mL). The mixture was diluted with CH_2Cl_2 (40 mL) and partitioned in a separatory funnel. The organic layer was separated, and the aqueous layer was extracted with CH_2Cl_2 (150 mL). The organic layer was dried over $MgSO_4$ and concentrated under reduced pressure. The residue was purified via column chromatography over SiO_2 (CH_2Cl_2/MeOH = 98:2) to afford **9** as a clear oil (5.80 g, 98%). $[\alpha]^{20}_D$ = -80.0° (c = 0.5, $CHCl_3$);

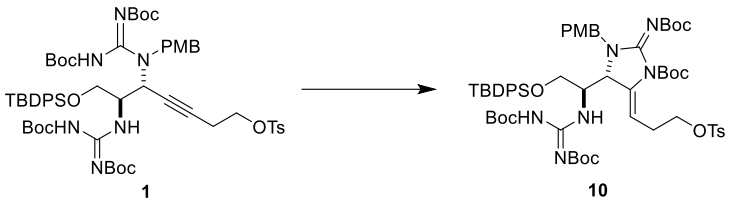
^{1}H NMR (600 MHz, $CDCl_3$) δ 7.78 (d, J = 8.4 Hz, 2H), 7.61 (d, J = 8.1 Hz, 5H), 7.43 – 7.29 (m, 10H), 7.25 (d, J = 8.5 Hz, 2H), 6.83 (d, J = 8.6 Hz, 2H), 4.06 (td, J = 7.0, 2.2 Hz, 2H), 3.91 (d, J = 14.1 Hz, 1H), 3.78 (s, 3H), 3.74 – 3.67 (m, 2H), 3.67 – 3.62 (m, 2H), 3.61 (m, 1H), 3.03 (s, 1H), 2.58 (td, J = 7.0, 2.0 Hz, 2H), 2.41 (s, 3H), 0.99 (s, 9H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 158.8, 145.1, 135.7, 135.7, 133.5, 133.5, 133.1, 132.0, 130.0, 129.8, 129.7, 128.9, 128.0, 128.0, 127.8, 127.8, 127.6, 126.1, 113.9, 81.2, 79.8, 67.9, 66.4, 56.1, 55.4, 55.4, 52.1, 51.0, 50.2, 27.0, 26.9, 26.9, 21.8, 21.4, 20.8, 20.0, 19.3, 19.3; IR (ATR) ν_{max} 2925, 1710, 1505, 1363, 1173 cm^{-1}; HRESIMS m/z 671.2965 $[M+H]^+$ (calcd for $C_{38}H_{46}N_2O_5SSi$, 671.2969)



(5*R*,6*R*)-5-((*E*)-2,3-bis(*tert*-Butoxycarbonyl)-1-(4-methoxybenzyl)guanidino)-6-((*E*)-2,3-bis(*tert*-butoxycarbonyl)guanidino)-7-((*tert*-butyldiphenylsilyl)oxy)hept-3-yn-1-yl 4-methylbenzenesulfonate **1**

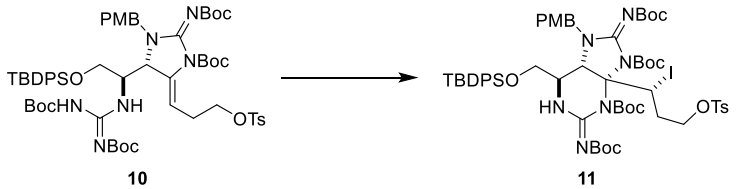
To a solution of **9** (5.80 g, 8.65 mmol) in CH_2Cl_2 (87 mL) were added *N*,*N*′-di-Boc-*S*-methylisothiourea (5.02 g, 17.29 mmol), Et_3N (3.01 mL, 21.61 mmol), and HgO (4.12 g, 19.02 mmol) at rt. The reaction mixture was stirred for 12 h. The contents of the flask were diluted with CH_2Cl_2 (100 mL) and filtered through a pad of Celite. The Celite bed was washed with an additional 50 mL of CH_2Cl_2. The combined filtrates were concentrated under reduced pressure. The residue was purified via column chromatography over SiO_2 (Hexane/EtOAc = 7:1) to afford **1** as a white solid (7.40 g, 74%). $[\alpha]^{20}_D$ = -50.0° (c = 0.5, $CHCl_3$);

^{1}H NMR (600 MHz, $CDCl_3$) δ 11.38 (s, 1H), 9.38 (m, 1H), 8.80 (d, J = 8.9 Hz, 1H), 7.72 (d, J = 8.4 Hz, 2H), 7.62 (dd, J = 25.6, 6.5 Hz, 4H), 7.40 – 7.29 (m, 7H), 7.11 (d, J = 8.2 Hz, 2H), 6.77 (d, J = 8.7 Hz, 2H), 6.03 (s, 1H), 4.67 – 4.57 (m, 2H), 4.51 (dtd, J = 8.8, 4.3, 2.1 Hz, 1H), 3.95 (t, J = 7.6 Hz, 2H), 3.79 (s, 3H), 3.59 (dd, J = 10.6, 4.3 Hz, 1H), 2.48 (t, J = 7.8 Hz, 2H), 2.42 (s, 3H), 1.46 (d, J = 15.2 Hz, 19H), 1.40 (d, J = 11.4 Hz, 19H), 1.04 (s, 9H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 163.5, 162.3, 158.8, 155.9, 154.8, 153.0, 150.0, 144.9, 135.8, 135.7, 133.1, 133.0, 130.0, 129.7, 129.6, 129.5, 128.3, 128.0, 127.7, 127.7, 113.9, 83.1, 81.8, 81.6, 79.4, 79.0, 78.3, 67.3, 61.9, 55.3, 54.2, 51.3, 49.8, 28.4, 28.3, 28.2, 28.1, 26.9, 21.7, 19.9, 19.2; IR (ATR) ν_{max} 2929, 1713, 1536, 1509, 1452 cm^{-1}; HRESIMS m/z 1155.5451 $[M+H]^+$ (calcd for $C_{60}H_{82}N_6O_{13}SSi$, 1155.5503)



tert-Butyl (*S*,2*E*,5*Z*)-4-((*R*,*E*)-8-((*tert*-butoxycarbonyl)amino)-2,2,12,12-tetramethyl-10-oxo-3,3-diphenyl-4,11-dioxa-7,9-diaza-3-silatridec-8-en-6-yl)-2-((*tert*-butoxycarbonyl)imino)-3-(4-methoxybenzyl)-5-(3-(tosyloxy)propylidene)imidazolidine-1-carboxylate **10**

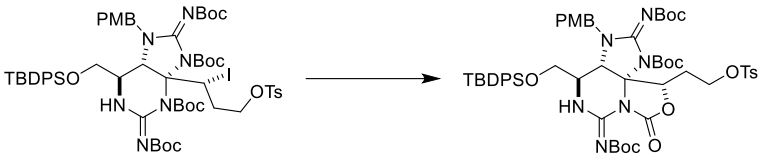
To a solution of **1** (6.59 g, 5.71 mmol) in CH_2Cl_2 (114 mL) was added AgOAc (953 mg, 5.71 mmol) at rt, and the resulting mixture was stirred for 5 h. The reaction was diluted with CH_2Cl_2 (100 mL) and filtered through a short pad of Celite. The filtrate was concentrated under reduced pressure, and the resulting residue was purified via column chromatography over SiO_2 (Hexane/EtOAc = 6:1) to afford **10** as a colorless oil (5.75 g, 87%). $[\alpha]^{20}_D$ = -21.3° (*c* = 0.5, $CHCl_3$);
^{1}H NMR (600 MHz, C_6D_6) δ 12.14 (s, 1H), 8.64 (d, *J* = 8.3 Hz, 1H), 7.79 (d, *J* = 7.9 Hz, 2H), 7.71 (d, *J* = 6.8 Hz, 2H), 7.66 (d, *J* = 7.2 Hz, 2H), 7.29 (m, 6H), 7.19 (d, *J* = 8.2 Hz, 2H), 6.78 (d, *J* = 7.9 Hz, 2H), 6.70 (d, *J* = 8.2 Hz, 2H), 5.30 (d, *J* = 15.2 Hz, 1H), 4.82 (t, *J* = 7.1 Hz, 1H), 4.62 (t, *J* = 6.7 Hz, 1H), 4.29 (d, *J* = 15.2 Hz, 1H), 4.13 (d, *J* = 5.1 Hz, 1H), 3.90 (q, *J* = 7.1 Hz, 2H), 3.86 (t, *J* = 6.6 Hz, 2H), 3.67 (dd, *J* = 11.0, 5.1 Hz, 1H), 3.59 (dd, *J* = 11.0, 5.8 Hz, 1H), 3.29 (s, 3H), 2.44 (m, 2H), 1.63 (s, 9H), 1.48 (s, 9H), 1.38 (s, 9H), 1.24 (s, 9H), 1.11 (s, 9H); ^{13}C NMR (150 MHz, C_6D_6) δ 164.1, 159.7, 159.4, 156.8, 153.4, 152.7, 149.5, 144.0, 136.1, 135.9, 134.5, 133.6, 133.2, 133.1, 130.3, 130.2, 129.8, 129.6, 128.4, 128.2, 128.2, 128.2, 114.5, 113.9, 83.7, 83.0, 78.8, 78.2, 69.2, 61.9, 58.5, 54.7, 54.2, 47.4, 29.0, 28.6, 28.3, 28.0, 27.8, 27.1, 21.2, 19.3; IR (ATR) ν_{max} 2975, 1749, 1685, 1511, 1455, 1293 cm^{-1}; HRESIMS *m*/*z* 1155.5490 $[M+H]^+$ (calcd for $C_{60}H_{82}N_6O_{13}SSi$, 1155.5503)



di-*tert*-Butyl (2*Z*,4*R*,5*S*,6*R*,8*E*)-2,8-bis((*tert*-butoxycarbonyl)imino)-6-(((*tert*-butyldiphenylsilyl)oxy)methyl)-4-((*R*)-1-iodo-3-(tosyloxy)propyl)-7-(4-methoxybenzyl)hexahydro-3*H*-purine-3,9(2*H*)-dicarboxylate **11**

Iodine (666 mg, 2.62 mmol) and AgOAc (438 mg, 2.62 mmol) were added to a solution of **10** (1.01 g, 0.87 mmol) in Et_2O (43.7 mL) at 0 °C. The reaction was warmed to rt, and two additional portions of iodine (666 mg, 2.62 mmol) were added at 2 h intervals. The reaction mixture was diluted with EtOAc (50 mL) and filtered through a pad of Celite. The filtrate was transferred to a separatory funnel and washed with 2.0 N *aq*.-$Na_2S_2O_3$ solution (100 mL). The organic layer was dried over $MgSO_4$ and concentrated under reduced pressure. The residue was purified via column chromatography over SiO_2 (Hexane/EtOAc = 6:1) to afford **11** as a clear oil (1.02 g, 92%). $[\alpha]^{20}_D$ = +108.0° (*c* = 0.5, $CHCl_3$);

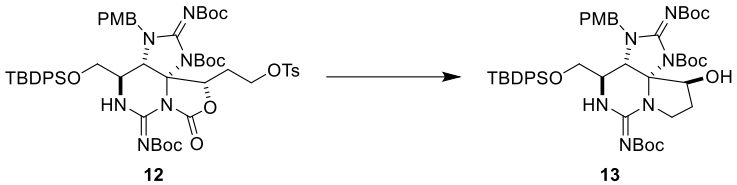
^{1}H NMR (600 MHz, C_6D_6) δ 9.49 (d, *J* = 5.6 Hz, 1H), 7.90 (d, *J* = 7.8 Hz, 2H), 7.60 (dd, *J* = 28.2, 6.1 Hz, 4H), 7.19 (m, 8H), 6.87 (d, *J* = 7.9 Hz, 2H), 6.62 (d, *J* = 8.2 Hz, 2H), 6.26 (d, *J* = 12.2 Hz, 1H), 4.78 (d, *J* = 14.8 Hz, 1H), 4.32 (s, 1H), 4.08 (dt, *J* = 9.2, 4.1 Hz, 2H), 3.97 (t, *J* = 9.4 Hz, 1H), 3.85 – 3.68 (m, 2H), 3.28 (s, 3H), 3.07 (q, *J* = 7.2 Hz, 1H), 2.71 – 2.45 (m, 1H), 1.89 (s, 3H), 1.75 (s, 9H), 1.64 (s, 9H), 1.41 (s, 18H), 1.12 (s, 9H), 0.92 (t, *J* = 7.2 Hz, 1H); ^{13}C NMR (150 MHz, C_6D_6) δ 163.8, 160.1, 159.9, 159.5, 151.1, 150.8, 148.8, 143.9, 136.1, 135.8, 134.1, 133.3, 133.3, 130.7, 130.3, 130.3, 130.0, 128.6, 128.6, 128.3, 114.5, 85.5, 82.4, 82.3, 78.6, 78.3, 68.9, 63.3, 61.2, 54.9, 53.7, 46.2, 36.7, 32.9, 28.8, 28.2, 28.2, 27.6, 27.2, 21.2; IR (ATR) ν_{max} 2929, 1752, 1653, 1540, 1458, 1286 cm^{-1}; HRESIMS *m*/*z* 1281.4409 $[M+H]^+$ (calcd for $C_{60}H_{81}IN_6O_{13}SSi$, 1281.4469)



tert-Butyl (2*E*,3a*S*,4*R*,6*Z*,10*S*,10a*R*)-2,6-bis((*tert*-butoxycarbonyl)imino)-4-(((*tert*-butyldiphenylsilyl)oxy)methyl)-3-(4-methoxybenzyl)-8-oxo-10-(2-(tosyloxy)ethyl)hexahydro-1*H*,8*H*,10*H*-oxazolo[3,4-*c*]purine-1-carboxylate **12**

To a solution of **11** (3.09 g, 2.41 mmol) in DMF (142 mL) was added silver trifluoroacetate (1.33 g, 6.03 mmol) at rt. The reaction was heated to 55 °C and stirred for 5 h to completion. The reaction mixture was cooled to rt, diluted with EtOAc (100 mL), and filtered through a small pad of Celite. The filtrate was mixed with toluene to form an azeotrope and concentrated under reduced pressure. The residue was purified via column chromatography over SiO_2 (Hexane/EtOAc = 3:1) to afford **12** (1.54 g, 58%) as a clear oil. $[\alpha]^{20}_D$ = +13.33° (*c* = 0.5, $CHCl_3$);

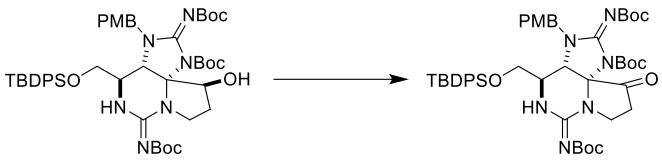
^{1}H NMR (600 MHz, $CDCl_3$) δ 9.31 (s, 1H), 7.74 (d, *J* = 7.8 Hz, 2H), 7.58 (d, *J* = 7.2 Hz, 2H), 7.49 (d, *J* = 7.3 Hz, 2H), 7.41 (m, 6H), 7.33 (d, *J* = 7.8 Hz, 2H), 7.09 (d, *J* = 8.1 Hz, 2H), 6.80 (d, *J* = 7.9 Hz, 2H), 4.73 (d, *J* = 15.3 Hz, 1H), 4.47 (s, 1H), 4.30 (d, *J* = 15.2 Hz, 1H), 4.06 (m, 3H), 3.91 (s, 1H), 3.80 (s, 3H), 3.54 (t, *J* = 8.6 Hz, 1H), 3.44 (t, *J* = 9.5 Hz, 1H), 3.34 (m, 1H), 2.43 (s, 3H), 2.24 (m, 1H), 2.00 (m, 1H), 1.48 (m, 18H), 1.41 (s, 9H), 1.04 (s, 9H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 163.3, 159.7, 159.1, 156.3, 152.7, 150.4, 148.6, 147.7, 145.3, 135.6, 135.5, 132.3, 132.0, 130.5, 130.3, 130.1, 129.5, 128.3, 128.2, 128.1, 126.9, 114.7, 87.4, 80.5, 80.4, 79.6, 78.7, 65.7, 63.3, 61.6, 55.3, 54.4, 46.8, 29.2, 28.3, 28.3, 28.1, 26.9, 21.7, 19.1; IR (ATR) ν_{max} 2959, 1815, 1754, 1658, 1533, 1393, 1250 cm^{-1}; HRESIMS *m*/*z* 1097.4720 $[M+H]^+$ (calcd for $C_{56}H_{72}N_6O_{13}SSi$, 1097.4717)



tert-Butyl (2*E*,3a*S*,4*R*,6*Z*,10*S*,10a*R*)-2,6-bis((*tert*-butoxycarbonyl)imino)-4-(((*tert*-butyldiphenylsilyl)oxy)methyl)-10-hydroxy-3-(4-methoxybenzyl)octahydro-1*H*,8*H*-pyrrolo[1,2-*c*]purine-1-carboxylate **13**

To a solution of **12** (1.04 g, 0.95 mmol) in EtOH (9.48 mL) was added Cs_2CO_3 (371 mg, 1.14 mmol) at 0 °C. The mixture was stirred for 3 h, diluted with EtOAc (10 mL), and filtered through a small pad of Celite. The filtrates were concentrated under reduced pressure, and the residue was purified via column chromatography over SiO_2 (Hexane/EtOAc = 2:1) to give **13** (782 mg, 92%) as an oil. $[\alpha]^{20}_D$ = +37.33° (*c* = 0.5, $CHCl_3$);

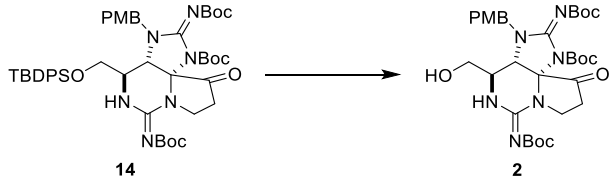
^{1}H NMR (600 MHz, $CDCl_3$) δ 9.92 (s, 1H), 7.65 (d, *J* = 7.2 Hz, 4H), 7.42 (m, 6H), 6.94 (d, *J* = 8.2 Hz, 2H), 6.67 (d, *J* = 8.2 Hz, 2H), 4.96 (d, *J* = 14.7 Hz, 1H), 4.01 (d, *J* = 3.8 Hz, 1H), 3.81 (t, *J* = 9.8 Hz, 1H), 3.72 (d, *J* = 14.9 Hz, 1H), 3.67 (m, 4H), 3.67 – 3.62 (m, 2H), 3.50 (d, *J* = 6.9 Hz, 1H), 3.46 – 3.41 (m, 1H), 3.41 – 3.35 (m, 1H), 2.64 (brs, 1H), 2.35 – 2.23 (m, 1H), 1.68 (dd, *J* = 13.5, 7.0 Hz, 1H), 1.47 (s, 9H), 1.45 (m, 18H), 1.05 (s, 9H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 163.9, 159.9, 159.4, 157.6, 151.9, 149.5, 135.7, 135.6, 132.5, 132.2, 130.1, 130.0, 129.8, 128.0, 127.9, 127.4, 114.2, 86.0, 84.1, 79.4, 78.6, 76.2, 64.2, 55.1, 54.2, 49.8, 47.9, 47.5, 29.1, 28.4, 28.3, 28.0, 26.7, 19.1; IR (ATR) ν_{max} 2966, 1736, 1686, 1640, 1590, 1390, 1250 cm^{-1}; HRESIMS *m*/*z* 899.4694 $[M+H]^+$ (calcd for $C_{48}H_{66}N_6O_9Si$, 899.4733)



tert-Butyl (2*E*,3a*S*,4*R*,6*Z*,10a*R*)-2,6-bis((*tert*-butoxycarbonyl)imino)-4-(((*tert*-butyldiphenylsilyl)oxy)methyl)-3-(4-methoxybenzyl)-10-oxooctahydro-1*H*,8*H*-pyrrolo[1,2-*c*]purine-1-carboxylate **14**

To a solution of **13** (539 mg, 0.60 mmol) in CH_2Cl_2 (6.0 mL) was added Dess-Martin periodinane (381 mg, 0.90 mmol) at rt, and the reaction was stirred for 3 h before being quenched with 2.0 N *aq*.-$Na_2S_2O_3$ solution (10 mL). The resulting layers were separated, and the organic layer was dried over $MgSO_4$ and filtered. The filtrate was concentrated under reduced pressure and purified via column chromatography over SiO_2 (Hexane/EtOAc = 2:1) to afford **14** (411 mg, 76%) as an oil. $[\alpha]^{20}_D$ = -6.67° (*c* = 0.5, $CHCl_3$);

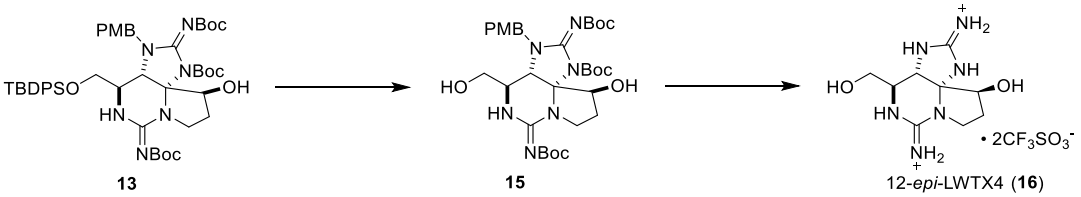
^{1}H NMR (600 MHz, $CDCl_3$) δ 9.21 (br s, 1H), 7.57 – 7.35 (m, 10H), 7.14 (d, *J* = 8.2 Hz, 2H), 6.80 (d, *J* = 8.1 Hz, 2H), 5.00 (d, *J* = 15.5 Hz, 1H), 4.12 (d, *J* = 15.2 Hz, 1H), 3.98 (d, *J* = 9.1 Hz, 1H), 3.83 (m, 1H), 3.76 (s, 3H), 3.65 (t, *J* = 10.1 Hz, 1H), 3.55 (d, *J* = 7.2 Hz, 1H), 3.28 (t, *J* = 9.0 Hz, 1H), 3.10 (t, *J* = 8.6 Hz, 1H), 2.62 (dd, *J* = 19.0, 7.2 Hz, 1H), 1.91 (dt, *J* = 18.3, 8.7 Hz, 1H), 1.47 (m, 27H), 0.92 (s, 9H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 205.5, 159.4, 158.0, 150.7, 149.9, 141.3, 135.5, 135.4, 132.2, 132.0, 131.1, 130.2, 130.1, 129.4, 128.1, 128.0, 127.9, 125.9, 114.4, 86.3, 79.1, 75.2, 63.1, 60.0, 55.2, 52.6, 46.6, 43.5, 34.5, 28.4, 28.3, 27.9, 26.6, 18.9; IR (ATR) ν_{max} 2929, 1738, 1596, 1511, 1458, 1246 cm^{-1}; HRESIMS *m*/*z* 897.4573 $[M+H]^+$ (calcd for $C_{48}H_{64}N_6O_9Si$, 897.4577)



tert-Butyl (2*E*,3a*S*,4*R*,6*Z*,10a*R*)-2,6-bis((*tert*-butoxycarbonyl)imino)-4-(hydroxymethyl)-3-(4-methoxybenzyl)-10-oxooctahydro-1*H*,8*H*-pyrrolo[1,2-*c*]purine-1-carboxylate **2**

AcOH (0.12 mL, 2.02 mmol) and TBAF (1.0 M in THF, 0.49 mL, 0.49 mmol) were successively added to a solution of **14** (363 mg, 0.41 mmol) in THF (8.0 mL) at 0 °C. The reaction mixture was warmed to rt and stirred for 2 h before being concentrated under reduced pressure. The residue was purified via column chromatography over SiO_2 (Hexane/EtOAc = 1:3) to give **2** (250 mg, 94%) as a clear oil. $[\alpha]^{20}_D$ = -50.67° (*c* = 0.5, $CHCl_3$);

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.78 (brs, 1H), 7.18 (d, *J* = 8.1 Hz, 2H), 6.83 (d, *J* = 8.1 Hz, 2H), 4.92 (d, *J* = 15.6 Hz, 1H), 4.18 (d, *J* = 15.4 Hz, 1H), 3.98 (q, *J* = 8.6 Hz, 1H), 3.87 (m, 1H), 3.76 (s, 3H), 3.43 (m, 1H), 3.39–3.25 (m, 1H), 2.69 (dd, *J* = 18.9, 7.5 Hz, 1H), 2.47 (dq, *J* = 18.3, 9.1, 8.6 Hz, 1H), 1.51–1.37 (m, 27H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 206.4, 163.7, 161.5, 159.4, 158.2, 151.0, 149.9, 129.5, 126.0, 114.4, 86.2, 79.6, 79.2, 75.6, 64.1, 61.0, 55.3, 52.4, 46.6, 44.3, 34.8, 28.4, 28.3, 27.9; IR (ATR) ν_{max} 2978, 1763, 1731, 1593, 1509, 1458, 1363, 1331, 1246 cm^{-1}; HRESIMS *m*/*z* 659.3381 $[M+H]^+$ (calcd for $C_{32}H_{46}N_6O_9$, 659.3399)



tert-Butyl (2*E*,3a*S*,4*R*,6*Z*,10*S*,10a*R*)-2,6-bis((*tert*-butoxycarbonyl)imino)-10-hydroxy-4-(hydroxymethyl)-3-(4-methoxybenzyl)octahydro-1*H*,8*H*-pyrrolo[1,2-*c*]purine-1-carboxylate **15**

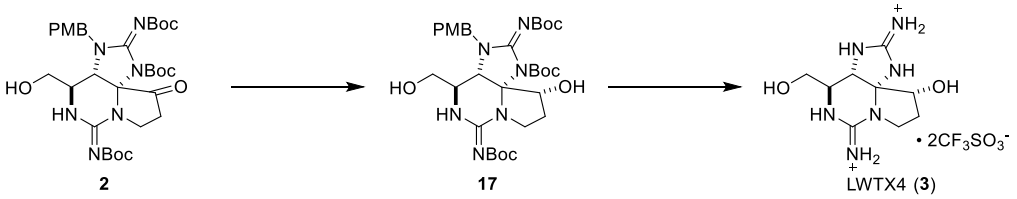
To a solution of **13** (147 mg, 0.164 mmol) in THF (3.3 mL) was added AcOH (0.05 mL, 0.823 mmol), followed by the dropwise addition of TBAF (0.2 mL, 0.180 mmol) at 15 °C. The reaction mixture was stirred for 2 h before being concentrated under reduced pressure. The residue was purified via column chromatography over SiO_2 (CH_2Cl_2/MeOH = 99:1) to give **15** (101 mg, 93%) as a clear oil. $[\alpha]^{20}_D$ = +66.00° (*c* = 0.5, $CHCl_3$);

^{1}H NMR (600 MHz, $CDCl_3$) δ 9.35 (s, 1H), 7.22 (d, *J* = 8.3 Hz, 2H), 6.77 (d, *J* = 8.2 Hz, 2H), 5.05 (d, *J* = 14.7 Hz, 1H), 4.31 (br s, 1H), 4.01 (d, *J* = 14.7 Hz, 1H), 3.94 (m, 1H), 3.78 – 3.70 (m, 2H), 3.68 (s, 3H), 3.64 (d, *J* = 7.7 Hz, 1H), 3.60 (m, 1H), 3.51 (dd, *J* = 11.6, 5.6 Hz, 1H), 3.30 (q, *J* = 5.4 Hz, 1H), 2.73 (br s, 1H), 2.22 (q, *J* = 10.8, 9.9 Hz, 1H), 1.70 (dd, *J* = 13.8, 7.0 Hz, 1H), 1.45 (s, 9H), 1.40 (s, 9H), 1.37 (s, 9H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 164.0, 160.0, 159.8, 158.0, 152.0, 149.7, 130.4, 128.2, 114.5, 86.3, 84.2, 79.6, 79.0, 76.3, 62.0, 55.4, 54.2, 48.5, 48.5, 47.8, 28.7, 28.5, 28.4, 28.1; IR (ATR) ν_{max} 2975, 1734, 1685, 1586, 1511, 1367, 1246 cm^{-1}; HRESIMS *m*/*z* 661.3533 $[M+H]^+$ (calcd for $C_{32}H_{48}N_6O_9$, 661.3556)

12-*epi*-LWTX4 (**16**)

Compound **15** (10 mg, 0.015 mmol) was dissolved in TFA (0.3 mL) at rt, and TfOH (4 μL, 0.045 mmol) was added dropwise. The reaction mixture was warmed to 70 °C and stirred for 15 h before being concentrated under reduced pressure. The residue was dissolved in a mixture of water (3.0 mL) and Et_2O (2.0 mL), and the aqueous layer was passed through a syringe filter (Sep-pak C18 cartridge). The filtrate was concentrated under reduced pressure to give **16** (3.0 mg, 70% by ^{1}H NMR) as an amorphous solid.

^{1}H NMR (600 MHz, D_2O) δ 4.71 (s, 1H), 4.30 (d, *J* = 4.2 Hz, 1H), 3.72 (t, *J* = 10.2 Hz, 1H), 3.68 – 3.50 (m, 4H), 2.37 (dtd, *J* = 14.5, 9.9, 4.4 Hz, 1H), 2.19 (dd, *J* = 14.9, 8.1 Hz, 1H); ^{13}C NMR (150 MHz, D_2O) δ 157.4, 155.7, 83.2, 74.5, 61.2, 57.3, 55.2, 43.7, 28.6; HRESIMS *m*/*z* 241.1407 $[M+H]^+$ (calcd for $C_9H_{16}N_6O_2$, 241.1408)



tert-Butyl (2*E*,3a*S*,4*R*,6*Z*,10*R*,10a*R*)-2,6-bis((*tert*-butoxycarbonyl)imino)-10-hydroxy-4-(hydroxymethyl)-3-(4-methoxybenzyl)octahydro-1*H*,8*H*-pyrrolo[1,2-*c*]purine-1-carboxylate **17**

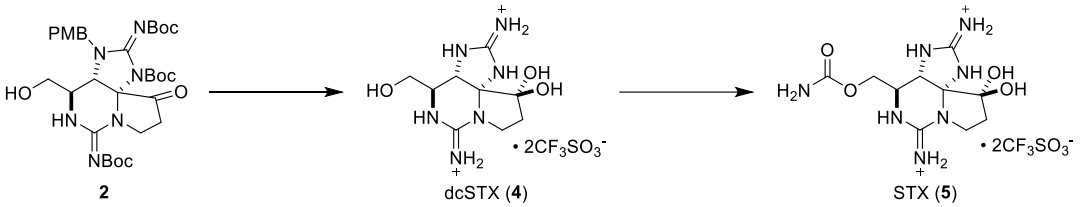
Compound **2** (7.2 mg, 0.011 mmol) was dissolved in MeOH (0.4 mL), and $NaBH_4$ (0.8 mg, 0.022 mmol) was added at 0 °C under N_2. The reaction mixture was stirred for 3 h under the same conditions until the reaction was complete, as monitored by TLC. A few drops of acetone were added to the reaction mixture, which was then filtered through a small pad of Celite. The filtrates were concentrated under reduced pressure, and the residue was purified via column chromatography over SiO_2 (Hexane/EtOAc = 3:1) to give **17** (5.6 mg, 77%) as an oil. $[\alpha]^{20}_D$ = +37.33° (*c* = 0.5, $CHCl_3$);

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.80 (s, 1H), 8.70 (s, 1H), 7.18 (d, *J* = 8.2 Hz, 2H), 6.84 (d, *J* = 8.1 Hz, 2H), 4.92 (d, *J* = 15.4 Hz, 1H), 4.86 (t, *J* = 8.2 Hz, 1H), 4.24 (d, *J* = 15.4 Hz, 1H), 4.15 (s, 1H), 3.79 (s, 3H), 3.67 (td, *J* = 10.6, 9.8, 5.0 Hz, 1H), 3.58 (dt, *J* = 11.8, 7.6 Hz, 1H), 3.51 – 3.40 (m, 3H), 2.35 (m, 1H), 1.97 (dt, *J* = 14.3, 7.5 Hz, 1H), 1.51 (s, 9H), 1.47 (d, *J* = 5.5 Hz, 18H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 163.6, 163.6, 161.1, 159.2, 159.1, 153.8, 129.7, 127.0, 114.1, 83.5, 79.2, 78.8, 78.3, 77.3, 62.6, 60.0, 55.1, 51.6, 45.3, 41.7, 28.3, 28.2, 27.6, 25.5; HRESIMS *m*/*z* 661.3542 $[M+H]^+$ (calcd for $C_{32}H_{48}N_6O_9$, 661.3556)

LWTX4 (**3**)

Compound **17** (5.6 mg, 0.0085 mmol) was dissolved in TFA (0.2 mL) at rt, and TfOH (2 μL, 0.025 mmol) was added dropwise. The reaction mixture was warmed to 70 °C and stirred for 15 h before being concentrated under reduced pressure. The residue was dissolved in a mixture of water (3.0 mL) and Et_2O (2.0 mL), and the aqueous layer was passed through a syringe filter (Sep-pak C18 cartridge). The filtrate was concentrated under reduced pressure to give **3** (1.4 mg, 67% by ^{1}H NMR) as an amorphous solid.

^{1}H NMR (600 MHz, D_2O) δ 4.47 (s, 1H), 4.23 (dd, J = 11.1, 7.6 Hz, 1H), 3.61 (t, J = 10.2 Hz, 1H), 3.58 – 3.51 (m, 3H), 3.37 (q, J = 9.4 Hz, 1H), 2.33 (dt, J = 14.6, 7.8 Hz, 1H), 1.84 (p, J = 21.1, 10.4 Hz, 1H); ^{13}C NMR (150 MHz, 4% acetic acid in D_2O) δ 158.2, 155.8, 80.0, 73.7, 61.9, 59.4, 55.0, 43.3, 27.0; HRESIMS m/z 241.1407 $[M+H]^+$ (calcd for $C_9H_{16}N_6O_2$, 241.1408)



Decarbamoyl saxitoxin (**4**)

Compound **2** (15 mg, 0.023 mmol) was dissolved in TFA (0.5 mL) at rt, and TfOH (10.2 mg, 0.068 mmol) was added dropwise. The reaction mixture was warmed to 70 °C and stirred for 15 h before being concentrated under reduced pressure. The residue was dissolved in a mixture of water (3.0 mL) and Et_2O (2.0 mL), and the aqueous layer was passed through a syringe filter (Sep-pak C18 cartridge). The filtrate was concentrated under reduced pressure to give **4** (4.5 mg, 77% by ^{1}H NMR) as an amorphous solid.

^{1}H NMR (600 MHz, D_2O) δ 4.72 (s, 1H), 3.78 (td, J = 10.1, 2.0 Hz, 1H), 3.69–3.58 (m, 3H), 3.55 (q, J = 9.8 Hz, 1H), 2.40 (ddd, J = 14.0, 8.2, 1.9 Hz, 1H), 2.33 (dt, J = 14.0, 9.9 Hz, 1H); ^{13}C NMR (150 MHz, D_2O) δ 157.7, 156.0, 98.7, 82.3, 61.3, 56.6, 55.6, 42.9, 32.9; HRESIMS m/z 257.1354 $[M+H]^+$ (calcd for $C_9H_{16}N_6O_3$, 257.1357)

Saxitoxin (**5**)

To a solution of **4** (3.73 mg, 0.0146 mmol) in acetonitrile (0.3 mL) was added chlorosulfonyl isocyanate (10.5 mg, 0.0741 mmol) dropwise at 0 °C, and the reaction was warmed to rt. The reaction progress was monitored by ^{1}H NMR (~3 h). Upon completion of the reaction, the mixture was concentrated under reduced pressure, and the residue was partitioned in a mixture of water (0.3 mL) and Et_2O (0.2 mL). The aqueous layer was passed through a syringe filter (Sep-pak C18 cartridge), and the filtrate was concentrated under reduced pressure to give **5** (2.36 mg, 54% by ^{1}H NMR) as an amorphous solid.

^{1}H NMR (600 MHz, D_2O) δ 4.74 (s, 1H), 4.29 – 4.21 (m, 1H), 4.03 (dd, J = 11.6, 5.3 Hz, 1H), 3.88 – 3.75 (m, 2H), 3.57 (q, J = 9.3 Hz, 1H), 2.42 (dd, J = 14.4, 8.0 Hz, 1H), 2.35 (dt, J = 14.1, 9.9 Hz, 1H); ^{13}C NMR (151 MHz, D_2O) δ 159.5, 158.3, 156.5, 99.1, 82.9, 63.8, 57.5, 53.5, 43.4, 33.4; HRESIMS m/z 300.1413 $[M+H]^+$ (calcd for $C_{10}H_{17}N_7O_4$, 300.1415)

2) Quantification of Synthetic STX and dcSTX by qNMR and HPLC–PCOX–FLD

2-1) Quantification by qNMR

Table S 1. Quantification of synthetic dcSTX (**4**) and STX (**5**) by quantitative ^{1}H NMR (qNMR).

	dcSTX	**STX**
Integration Ratio (DMF:Sample)	1.60:1	2.0:1
Amount of DMF (mmol)	0.0073	0.0073
Amount of Sample (mmol)	0.0045	0.0036
Molecular Weight (g/mol)	256.29	299.29
Calculated Mass (mg)	1.16	1.09

Note: DMF (26.53 mg) was dissolved in D_2O to prepare 10 mL of solution, and a 200 µL aliquot was used for quantitative ^{1}H NMR analysis. The amounts of dcSTX and STX were calculated from the integration ratios of their respective 1H signals to the DMF formyl proton (1H).

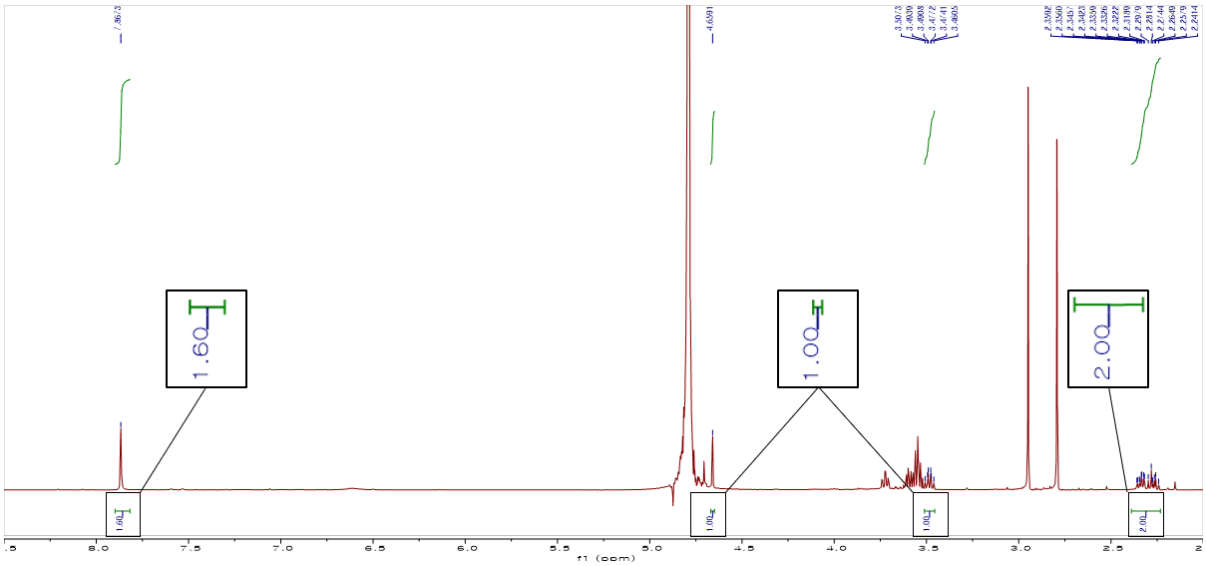


Figure S 1. Quantitative ^{1}H NMR spectrum of dcSTX (600 MHz, D_2O) using DMF as an internal standard.

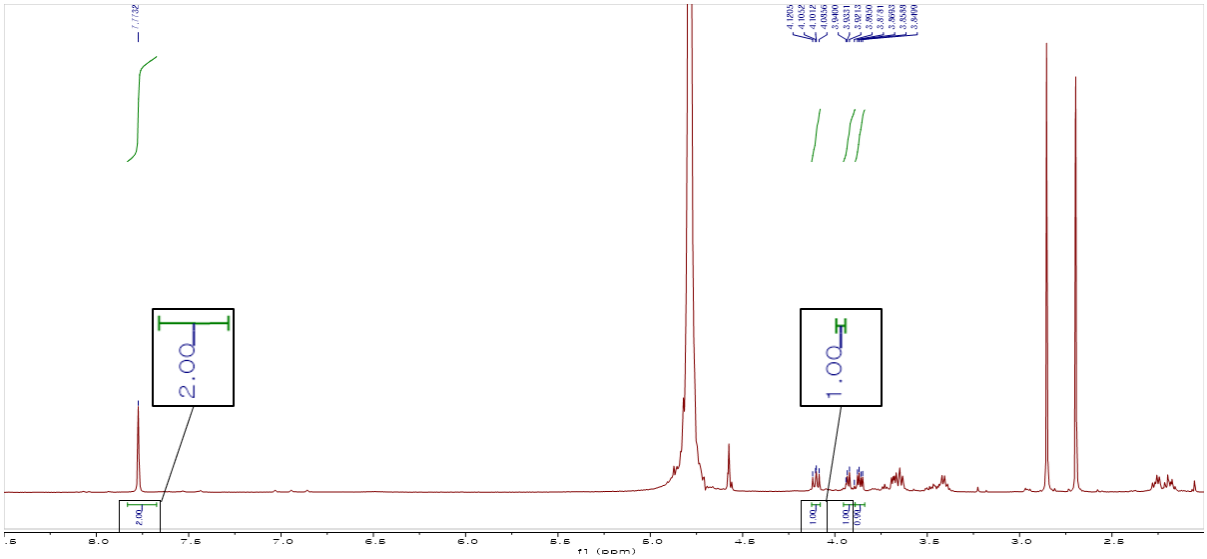


Figure S 2. Quantitative ^{1}H NMR spectrum of STX (600 MHz, D_2O) using DMF as an internal standard.

2-2) Quantification by HPLC–PCOX–FLD

Detailed analytical conditions are described in Section 3.

Table S 2. Calibration data for STX and dcSTX using HPLC–PCOX–FLD.

	dcSTX		**STX**	
Calibration level	Concentration (μM)	Peak area	Concentration (μM)	Peak area
1	2.04	16.48	1.92	20.40
2	3.27	29.73	3.07	31.40
3	4.08	31.94	3.84	40.30
4	8.16	65.85	7.68	77.95
5	16.33	113.45	15.35	171.78
Calibration curve	y = 6.7064x +6.0476 (R^2 = 0.9925)		y = 11.282x -3.5214 (R^2 = 0.9976)	

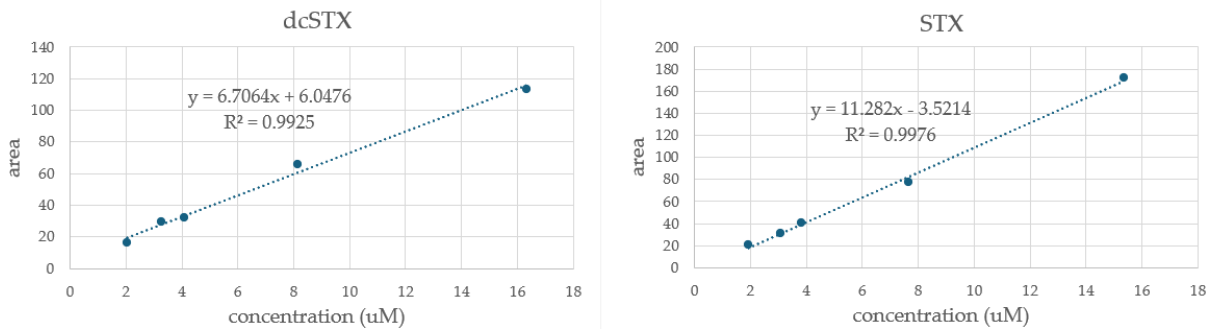


Figure S 3. Calibration curves for STX and dcSTX obtained by HPLC–PCOX–FLD using certified reference materials (CRMs).

3) Analysis of LWTX4, 12-*epi*-LWTX4, and PST on PCOX/FLD

PCOX-FLD analysis was performed using an Agilent 1260 Infinity HPLC system coupled to a Pinnacle PCX post–column derivatization system and a fluorescence detector. Chromatographic separation and post–column oxidation were conducted according to AOAC Official Method 2011.02 [31]. Detailed instrumental parameters are provided in Table S 2.

Table S 3. Instrumental conditions for AOAC 2011.02 PCOX-FLD analysis.

Parameter	Conditions
HPLC system	Agilent 1260 Infinity HPLC (Agilent Technologies, Santa Clara, CA, USA)
Post–column derivatization system	Pinnacle PCX (Pickering Laboratories, Mountain View, CA, USA)
Detector	Fluorescence (G7121B, Agilent)
Fluorescence wavelengths	Ex 330 nm/ Em 395 nm
Flow rate	0.8 mL/min (HPLC), 0.4 mL/min (PCOX)
Injection volume	10 μL
Reaction temperature	85 °C
Run time	24 min
	GTX, STX, and LWTX4 toxins
Column	Agilent Zorbax Bonus RP (3.5 μm, 4.6×150 mm)
solvent A	11 mM heptane sulfonate, 5.5 mM H_3PO_4, pH 7.1 (adjusted with 28-30% NH_4OH)
solvent B	11 mM heptane sulfonate, 16.5 mM H_3PO_4, 11.5% MeCN, pH 7.1 (adjusted with 28-30% NH_4OH)
Oxidant	100 mM H_3PO_4, 5 mM H_5IO_6, pH 7.8 (adjusted with 5N NaOH)
Acid	0.75 M Nitric acid
Column temperature	30 °C

4) Analysis of LWTX4, 12-*epi*-LWTX4, and PST on HILIC-MS/MS

HILIC-MS/MS analysis was performed based on a previously reported method [29]. Detailed instrumental parameters are provided in Table S 3.

Table S 4. Instrumental conditions for AOAC 2021 HILIC-MS/MS analysis.

Parameter	Conditions
HPLC system	ExionLC system (AB Sciex, Framingham, MA, USA)
MS system	Q-TOF X500R (AB Sciex, Framingham, MA, USA)
Flow rate	0.5 mL/min
Injection volume	1 μL
Run time	11 min
Column	Agilent HILIC-Z (2.7 μm, 2.1×150 mm)
Column temperature	30 °C
Solvent A	0.015% Formic acid, 0.06% of 25% NH_4OH, 100% water
Solvent B	0.01% Formic acid, 90% acetonitrile, 100% water
Ionization mode	ESI/positive
Ion source gas 1&2	50 psi
Curtain gas	25 psi
Temperature	temperature
CAD gas	6
Spray voltage	5500 V

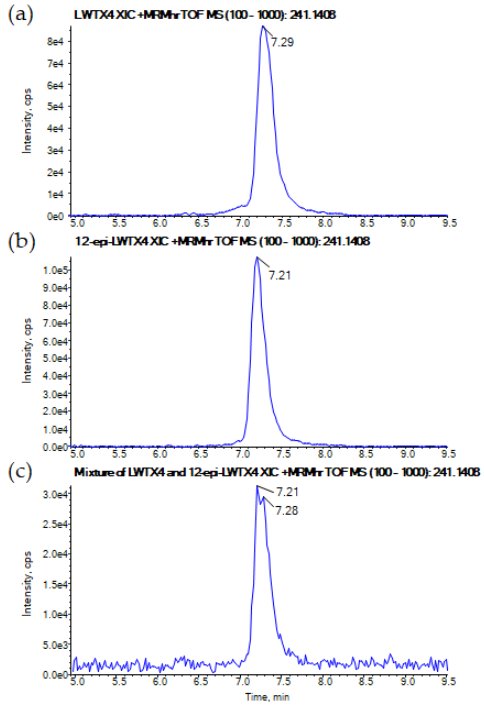


Figure S 4. Extracted ion chromatograms of (a) LWTX4, (b) 12-*epi*-LWTX4, and (c) mixture under AOAC 2021 HILIC–MS/MS conditions.

Table S 5. Retention-time variability, signal variability, and precursor mass accuracy of LWTX4 and 12-*epi*-LWTX4 under HILIC–MS/MS conditions.

Parameter	LWTX4	12-epi-LWTX4
Retention time (min)	7.29 ± 0.006	7.22 ± 0.012
RT RSD (%)	0.079	0.16
Peak area RSD (%)	4.82	4.17
Precursor mass error (ppm)	0.3	0.3

Note: Retention times are presented as mean ± SD from three replicate injections (n = 3). Relative standard deviations (RSDs) of retention times and precursor-ion extracted-ion chromatogram peak areas were calculated from the same replicate measurements.

Table S 6. Product-to-precursor ion ratios of the major product ions of LWTX4 and 12-*epi*-LWTX4 at different collision energies.

Collision energy (V)	LWTX4				12-*epi*-LWTX4			
	m/z 205.12	*m/z* 182.09	*m/z* 164.08	*m/z* 110.07	*m/z* 205.12	*m/z* 182.09	*m/z* 164.08	*m/z* 110.07
15	3.40 ± 0.55	7.00 ± 0.00	3.00 ± 0.00	2.20 ± 0.45	2.00 ± 0.00	4.80 ± 0.45	2.00 ± 0.00	2.00 ± 0.00
20	12.80 ± 0.45	25.00 ± 0.71	13.20 ± 0.84	10.60 ± 0.55	7.80 ± 0.45	18.20 ± 0.45	8.20 ± 0.45	8.60 ± 0.55
25	32.60 ± 0.55	71.60 ± 0.55	59.60 ± 0.55	46.40 ± 0.55	19.00 ± 0.00	48.80 ± 1.79	34.00 ± 0.00	35.00 ± 0.71
30	78.60 ± 3.78	208.00 ± 7.31	300.00 ± 10.79	285.00 ± 9.27	42.20 ± 1.64	131.60 ± 2.07	150.60 ± 2.30	185.80 ± 1.48

Note: Product-to-precursor ion ratios were calculated relative to the precursor ion at *m/z* 241.14, which was set to 100%. Values are presented as mean ± SD of five replicate injections (n = 5).

To assess whether MS/MS fragmentation could provide additional discrimination between the two epimers, their HRMS/MS fragmentation patterns were compared at collision energies of 15, 20, 25, and 30 V using five replicate injections. At all collision energies, both compounds produced the same major product ions at m/z 205.12, 182.09, 164.08, and 110.07, and no epimer-specific diagnostic product ion was observed. However, LWTX4 showed consistently higher product-to-precursor ion ratios for all four product ions than 12-*epi*-LWTX4, with the differences becoming more pronounced at 25 and 30 V (Table S6 and Figures S5–S8).

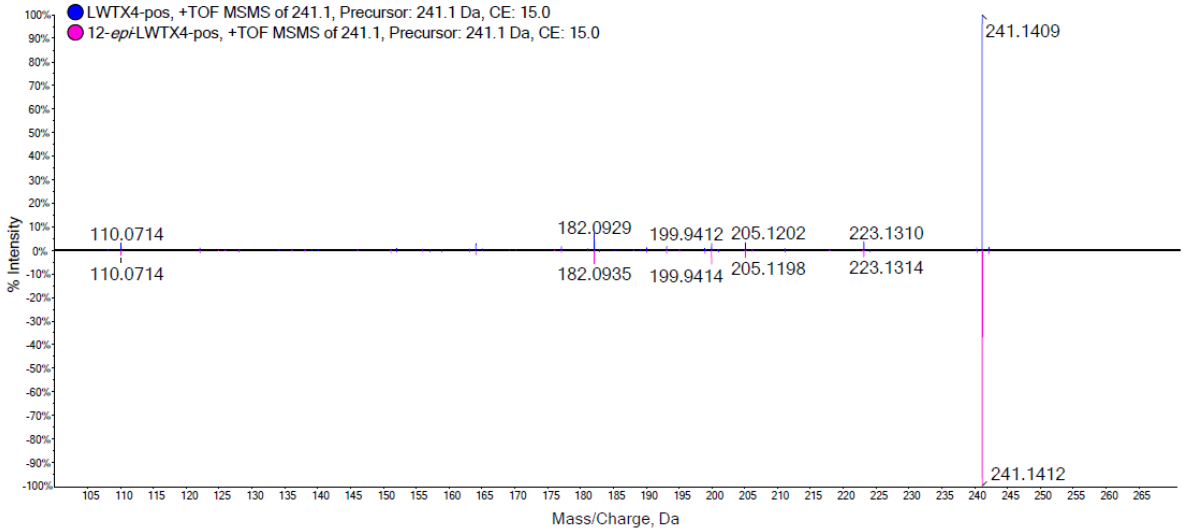


Figure S 5. Comparison of high-resolution MS/MS spectra of LWTX4 and 12-*epi*-LWTX4 at a collision energy of 15 V.

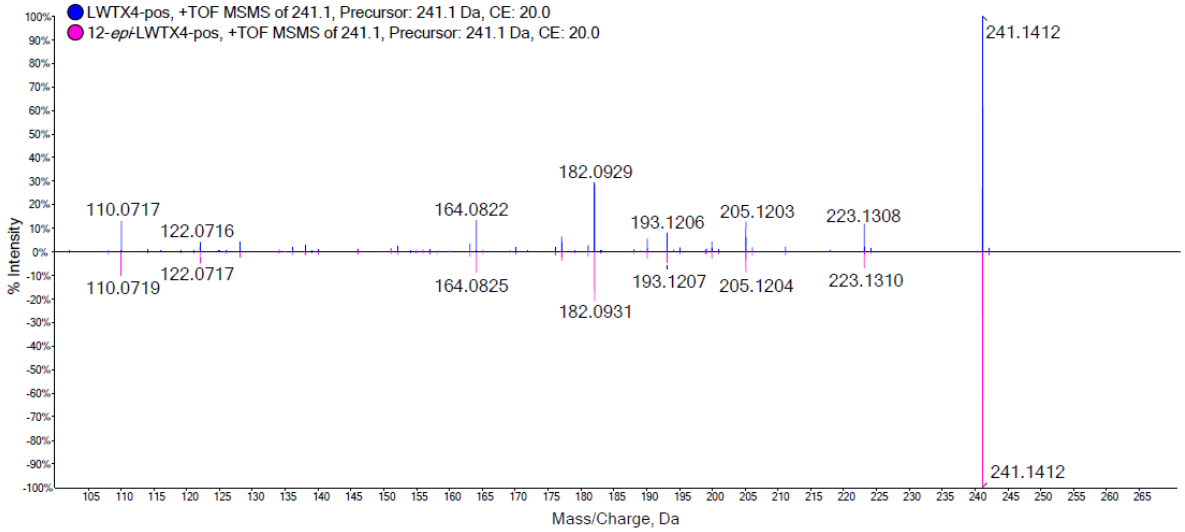


Figure S 6. Comparison of high-resolution MS/MS spectra of LWTX4 and 12-*epi*-LWTX4 at a collision energy of 20 V.

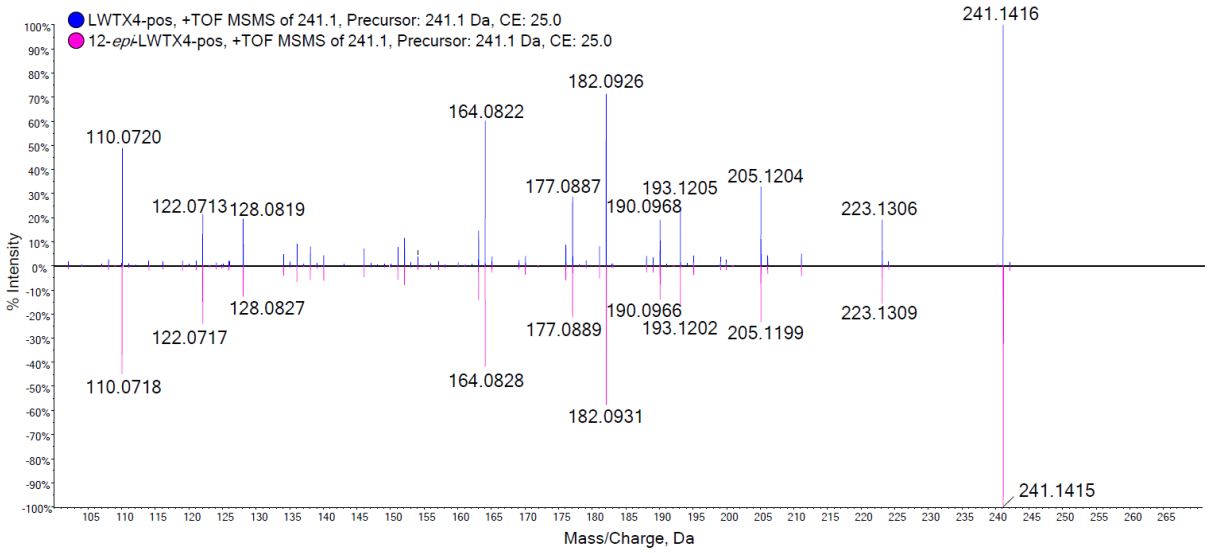


Figure S 7. Comparison of high-resolution MS/MS spectra of LWTX4 and 12-*epi*-LWTX4 at a collision energy of 25 V.

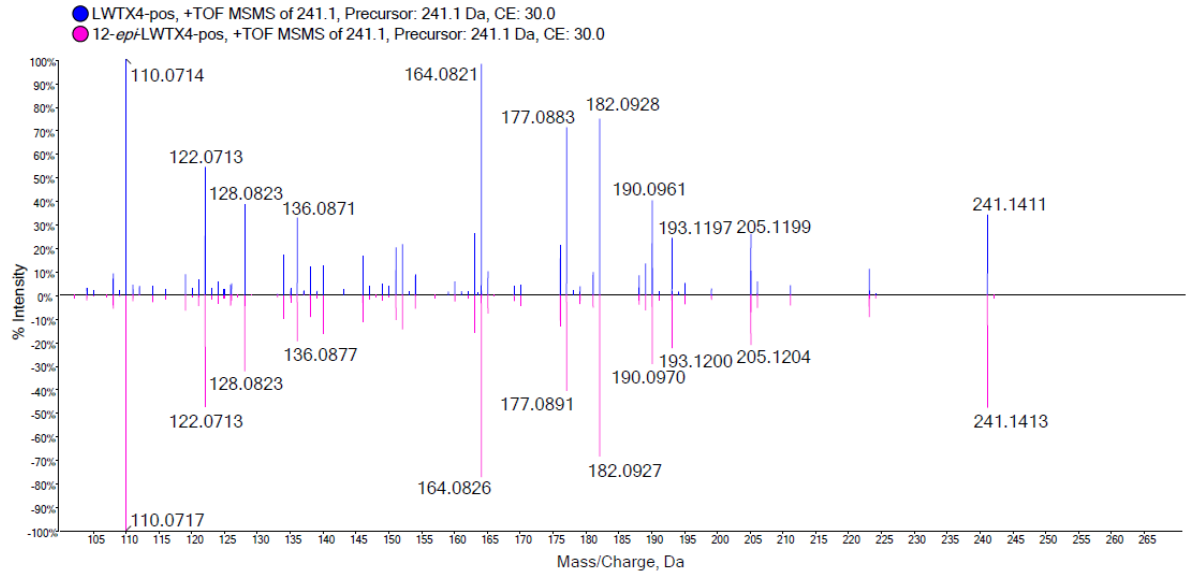


Figure S 8. Comparison of high-resolution MS/MS spectra of LWTX4 and 12-*epi*-LWTX4 at a collision energy of 30 V.

II. NMR spectra of synthetic compounds

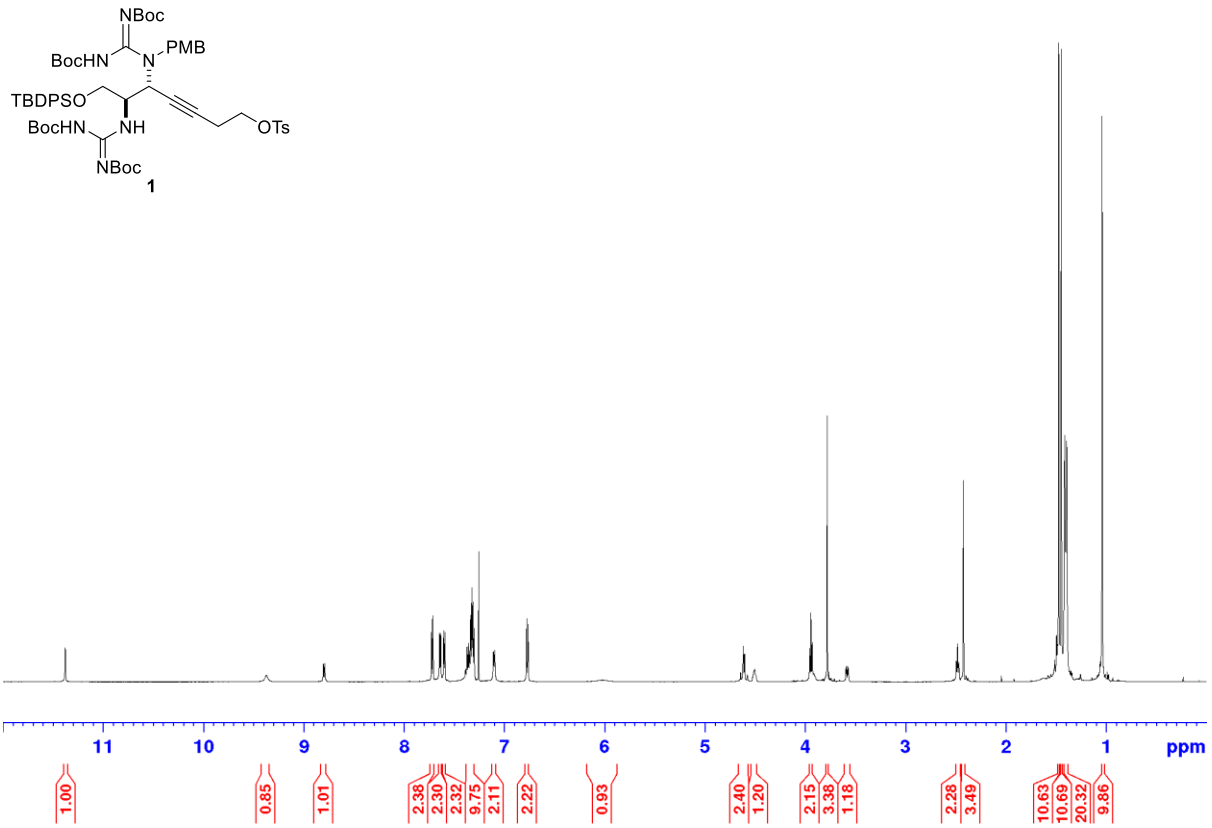


Figure S 9. ^{1}H NMR spectrum of **1** (600 MHz, $CDCl_3$).

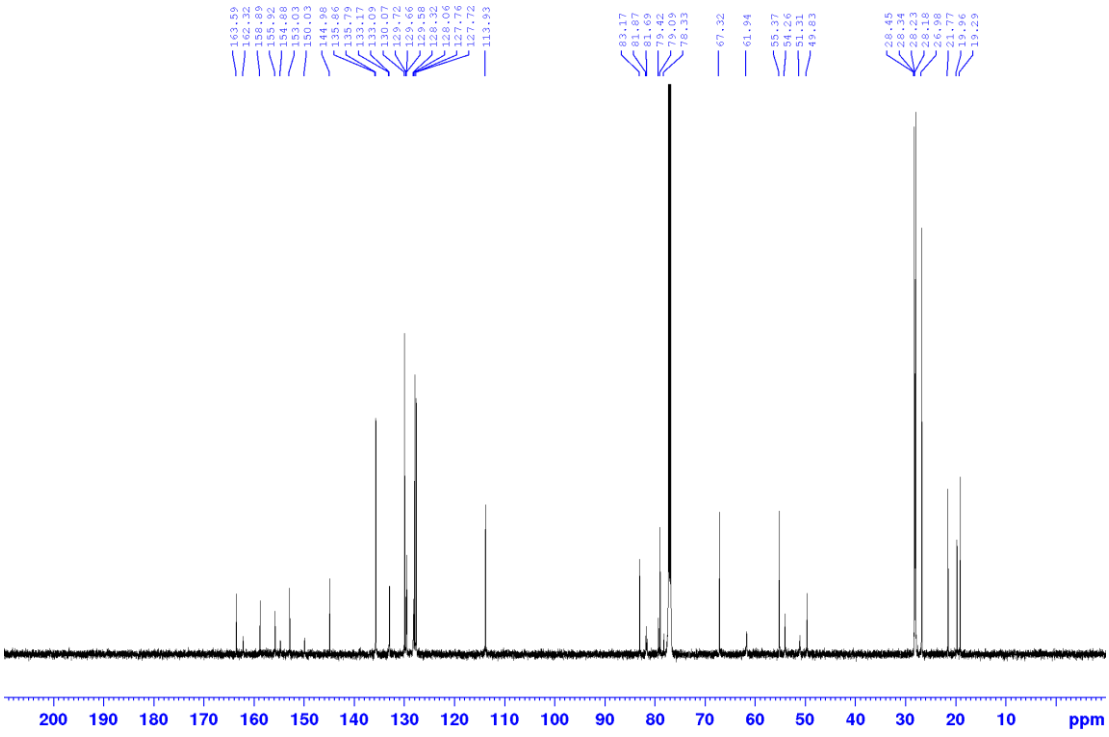


Figure S 10. ^{13}C NMR spectrum of **1** (150 MHz, $CDCl_3$).

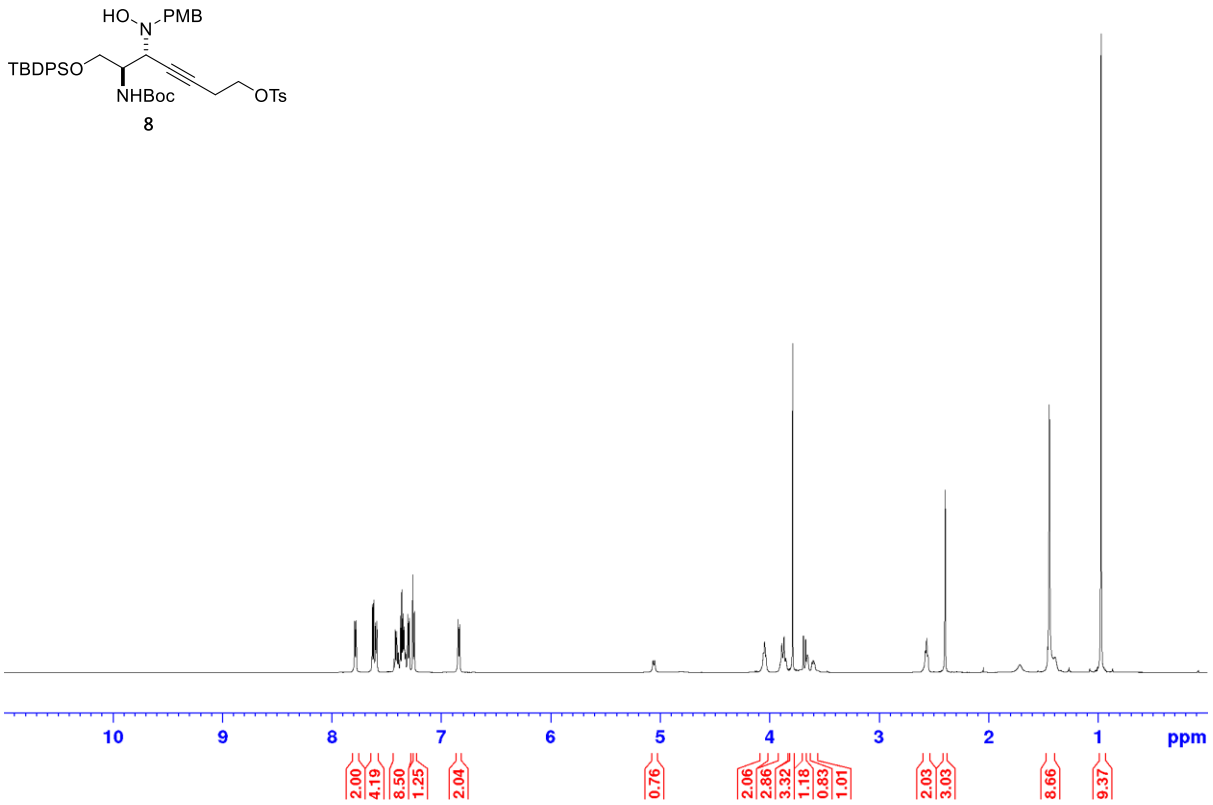


Figure S 11. ^{1}H NMR spectrum of **8** (600 MHz, $CDCl_3$).

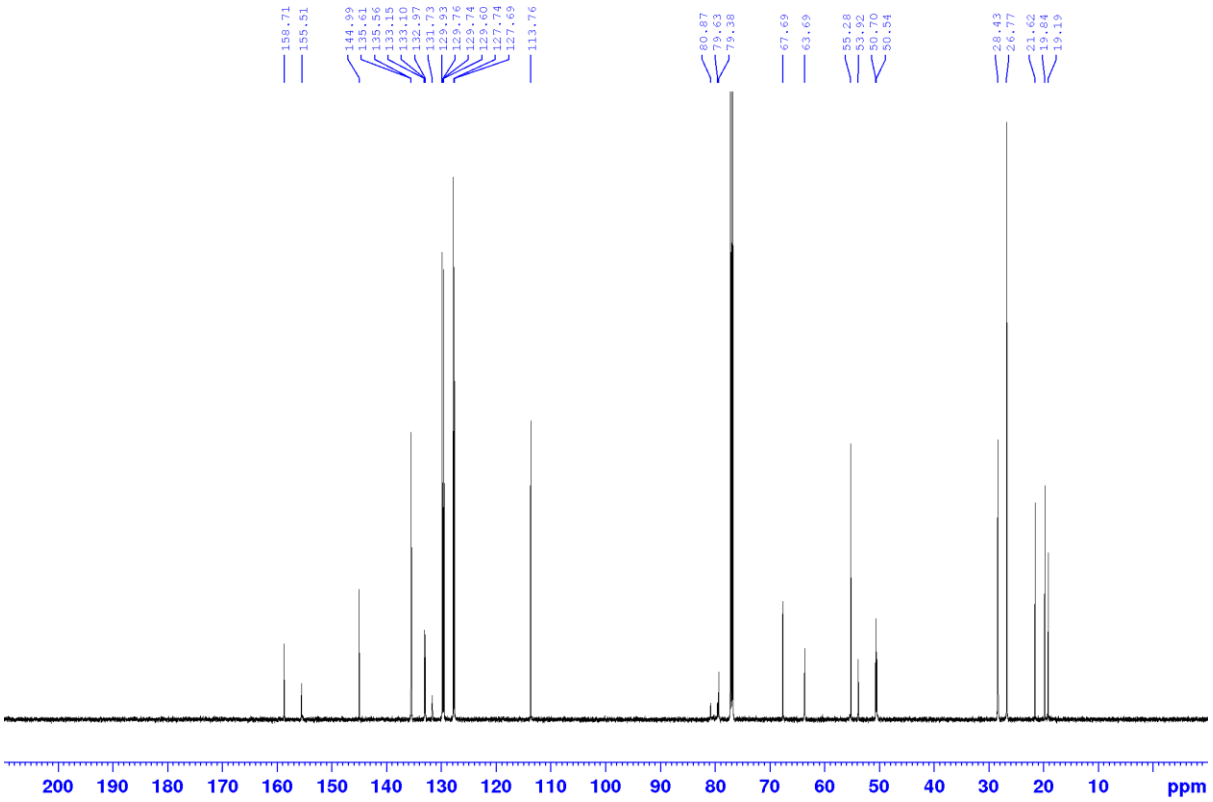


Figure S 12. ^{13}C NMR spectrum of **8** (150 MHz, $CDCl_3$).

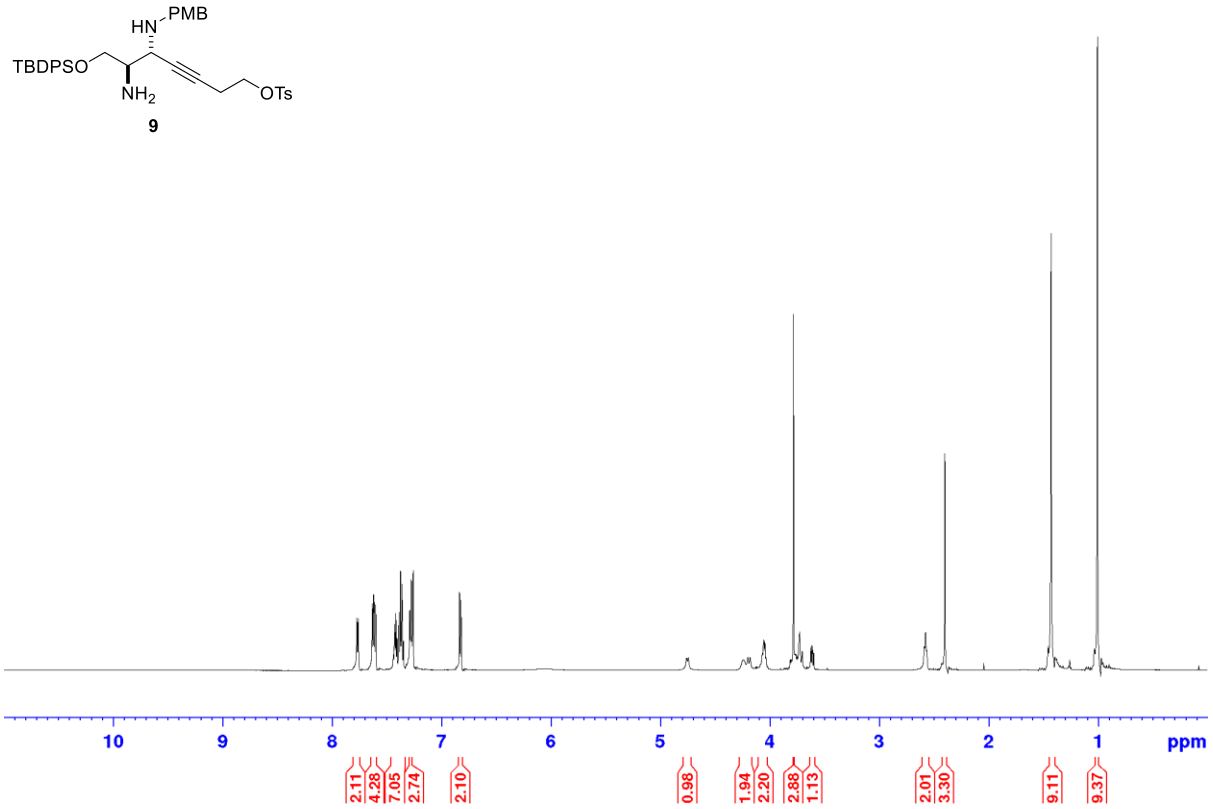


Figure S 13. ^{1}H NMR spectrum of **9** (600 MHz, $CDCl_3$).

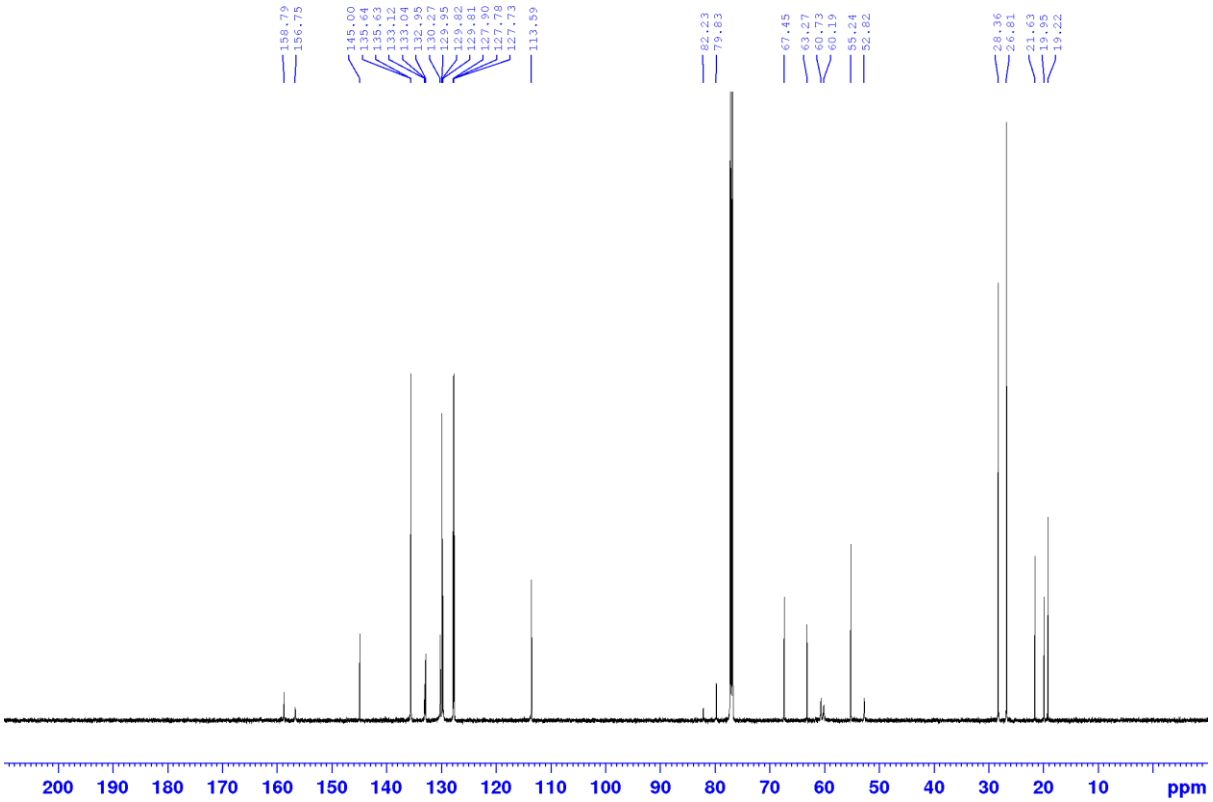


Figure S 14. ^{13}C NMR spectrum of **9** (150 MHz, $CDCl_3$).

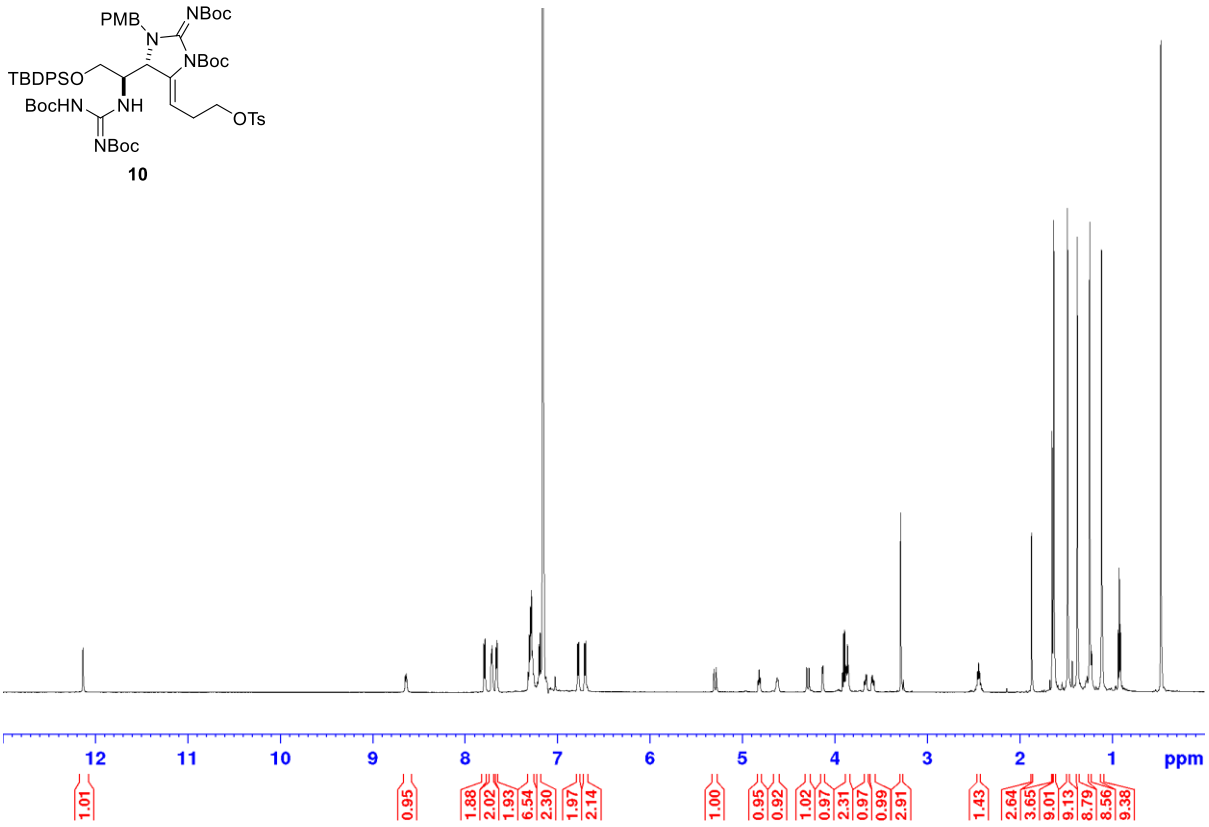


Figure S 15. ^{1}H NMR spectrum of **10** (600 MHz, C_6D_6).

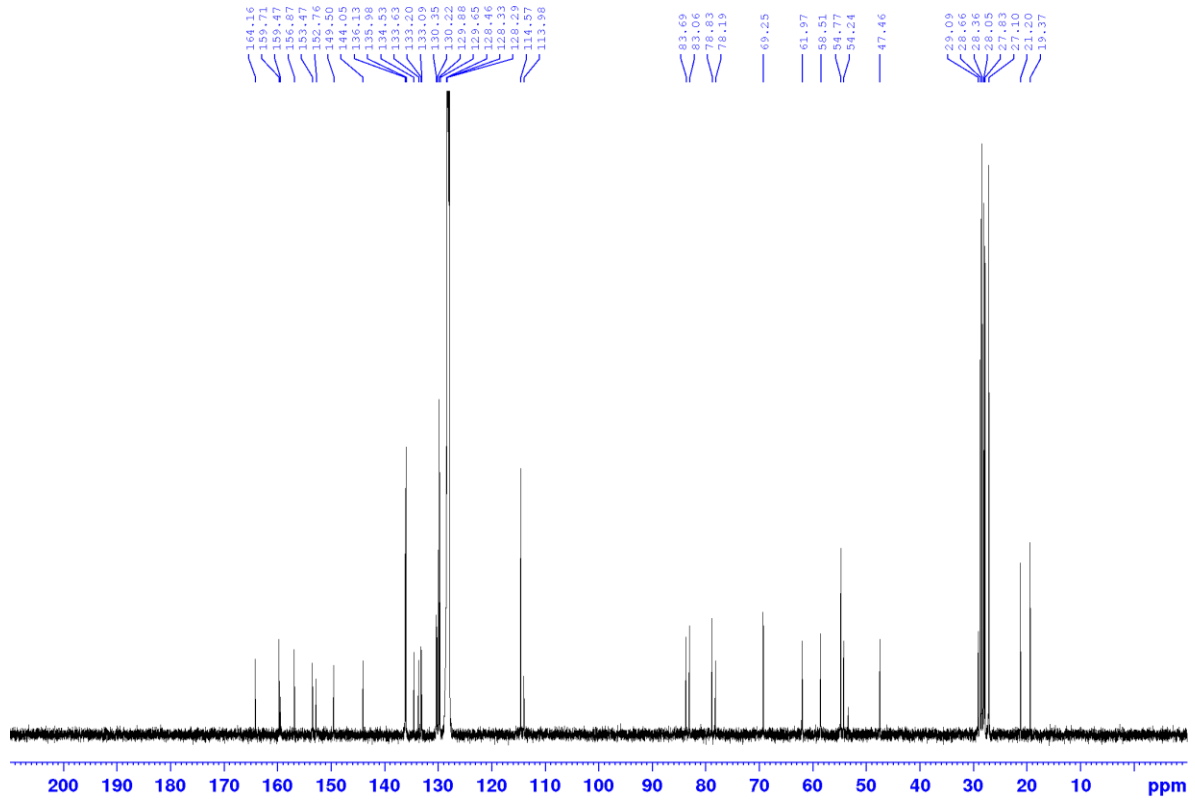


Figure S 16. ^{13}C NMR spectrum of **10** (150 MHz, C_6D_6).

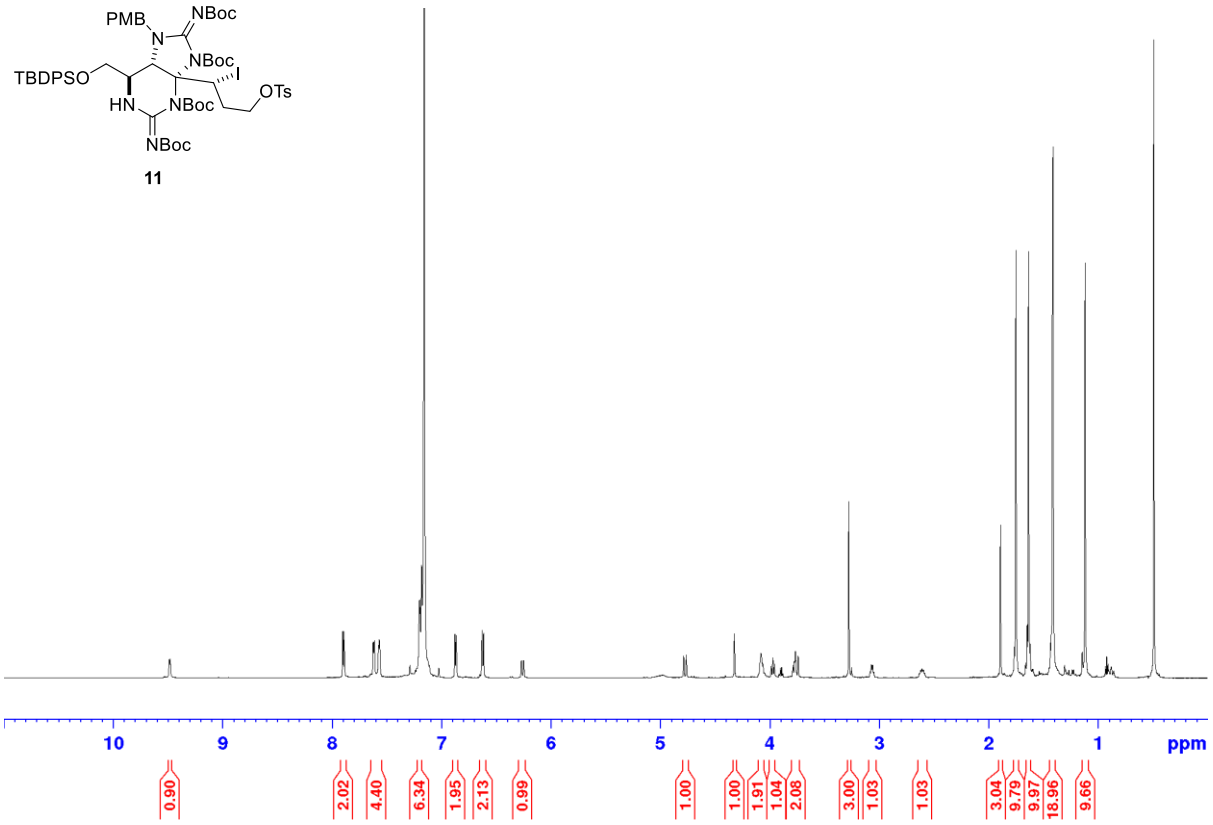


Figure S 17. ^{1}H NMR spectrum of **11** (600 MHz, C_6D_6).

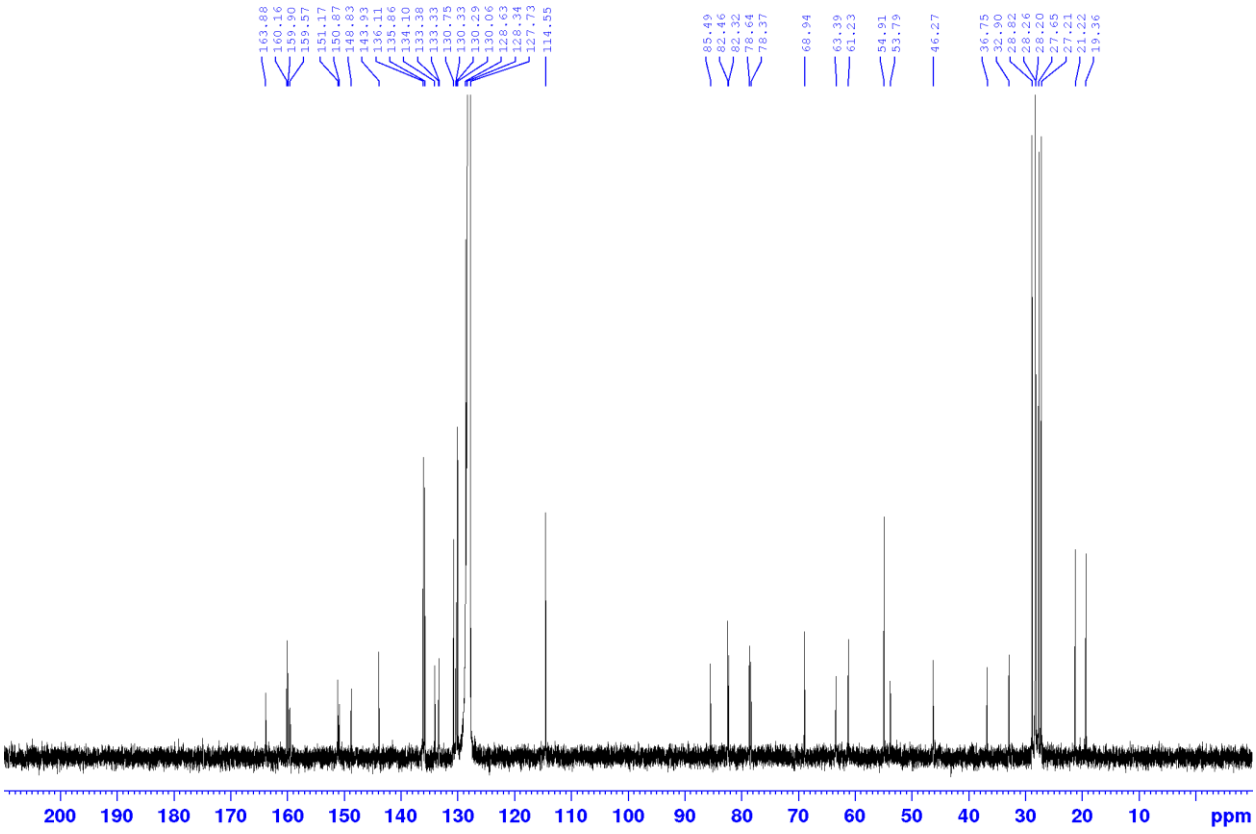


Figure S 18. ^{13}C NMR spectrum of **11** (150 MHz, C_6D_6).

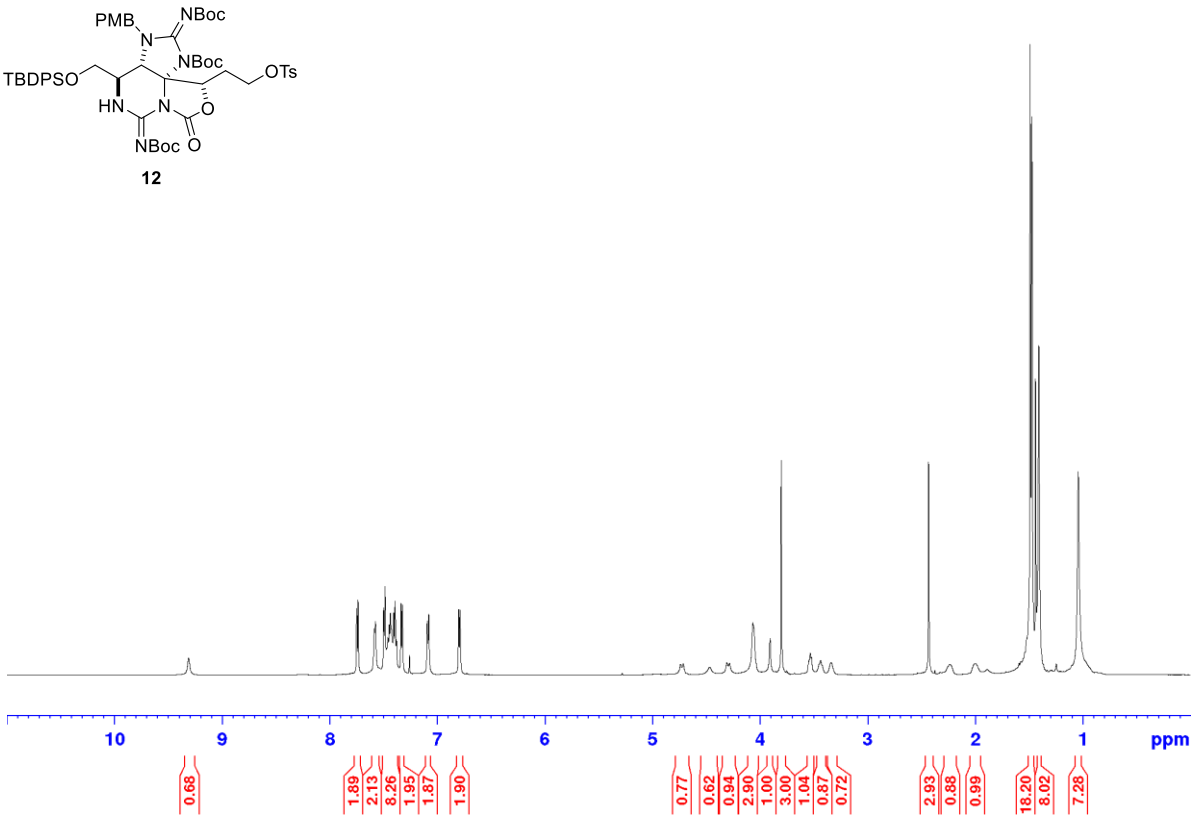


Figure S 19. ^{1}H NMR spectrum of **12** (600 MHz, $CDCl_3$).

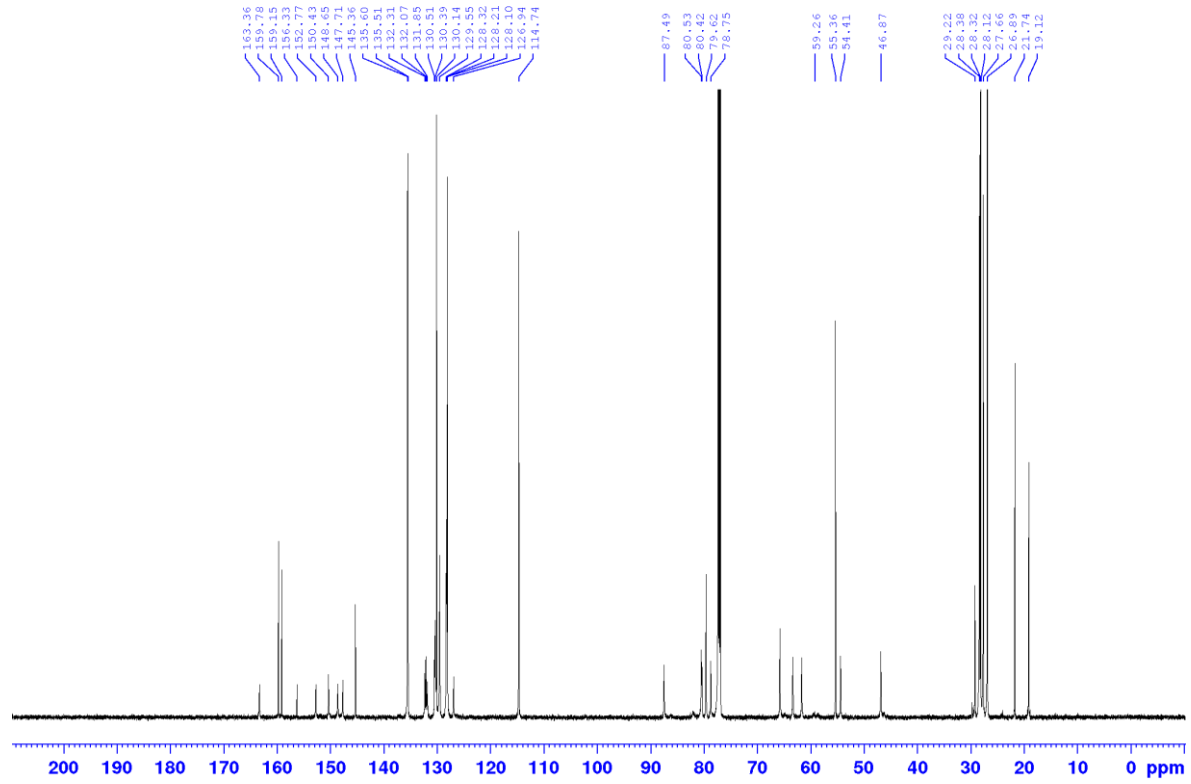


Figure S 20. ^{13}C NMR spectrum of **12** (150 MHz, $CDCl_3$).

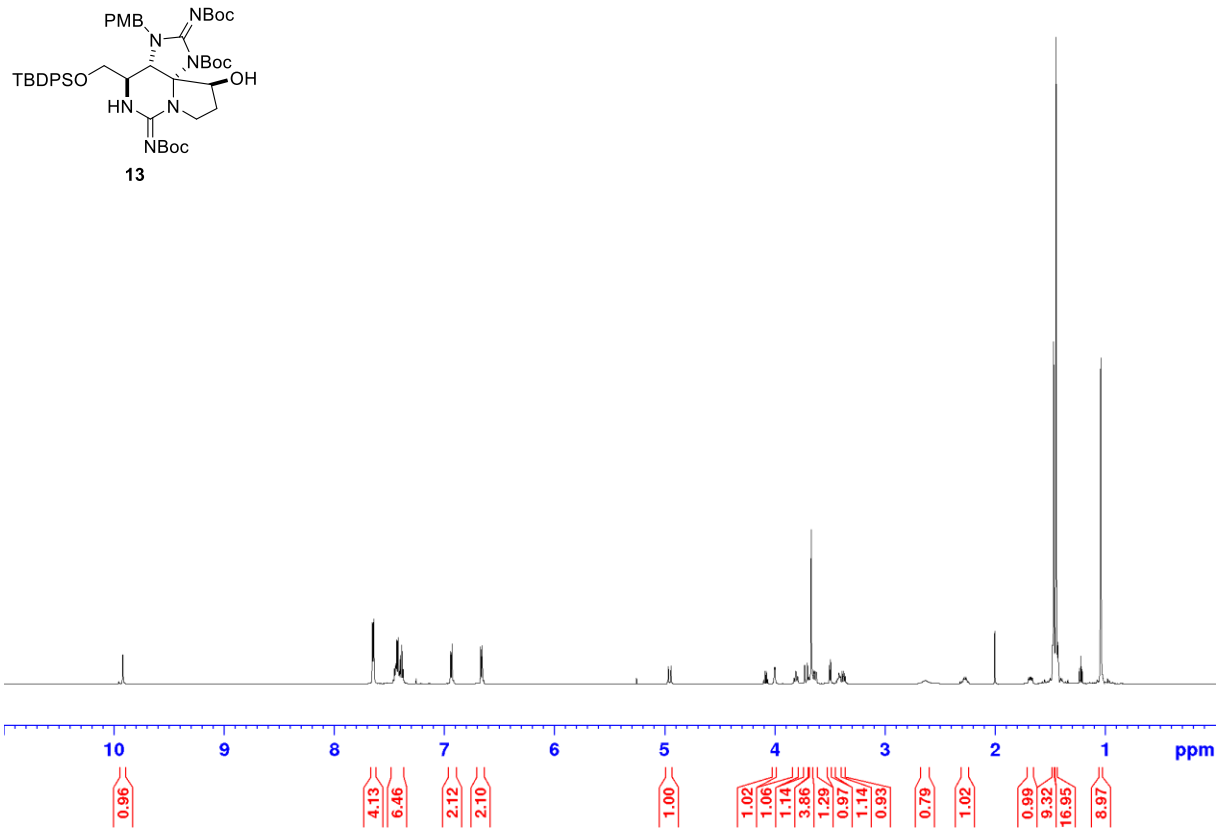


Figure S 21. ^{1}H NMR spectrum of **13** (600 MHz, $CDCl_3$).

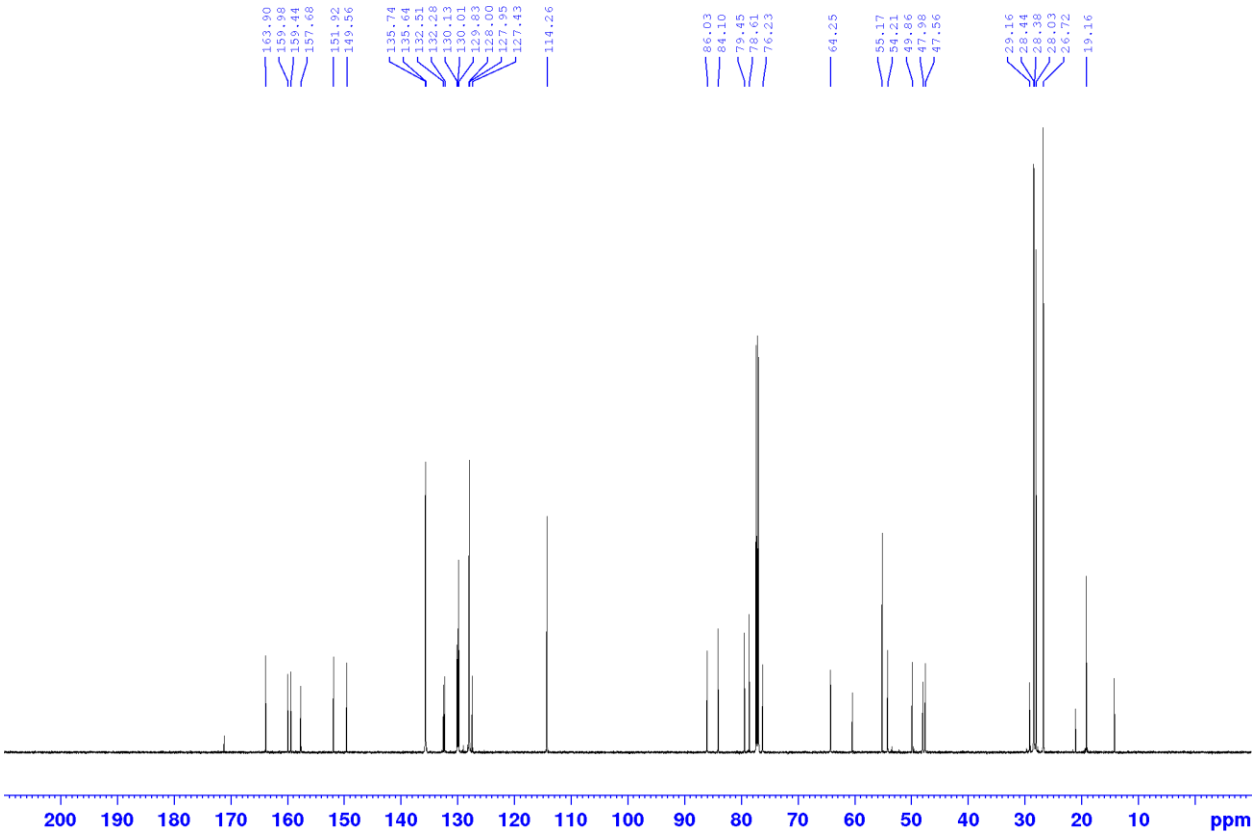


Figure S 22. ^{13}C NMR spectrum of **13** (150 MHz, $CDCl_3$).

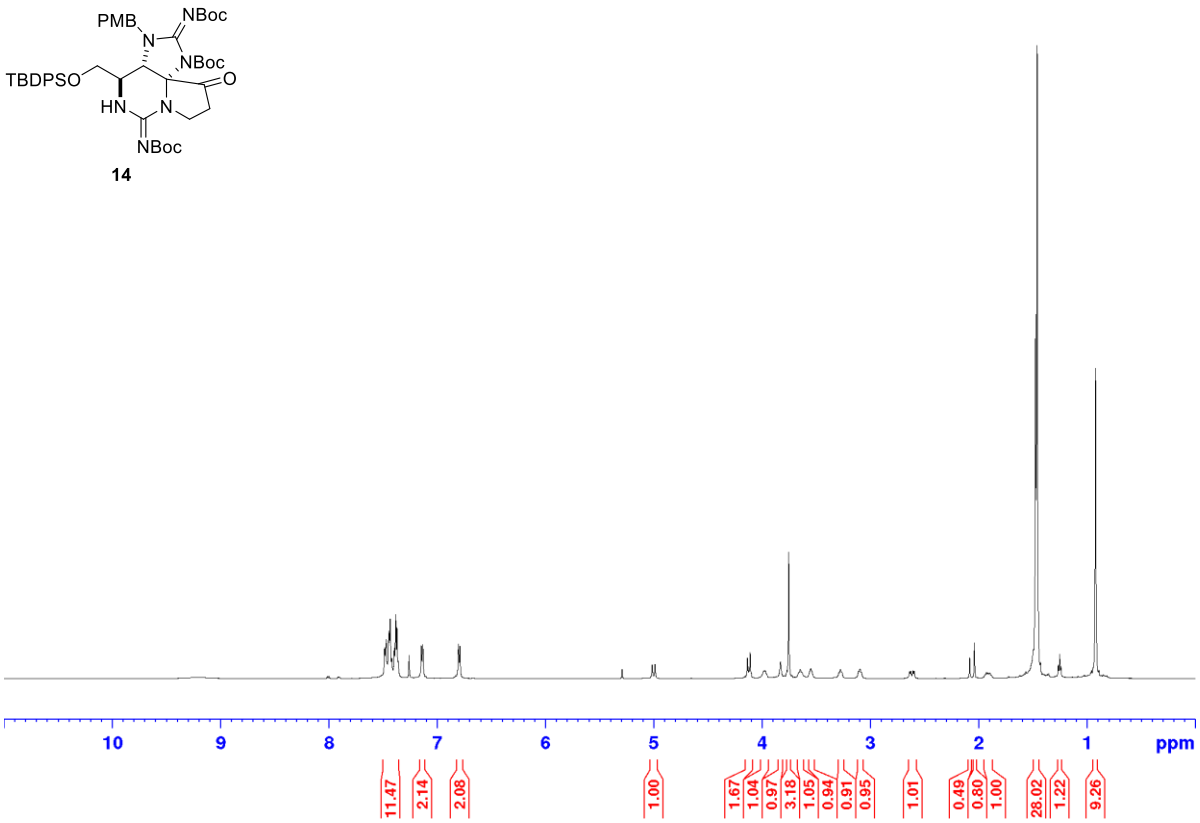


Figure S 23. ^{1}H NMR spectrum of **14** (600 MHz, $CDCl_3$).

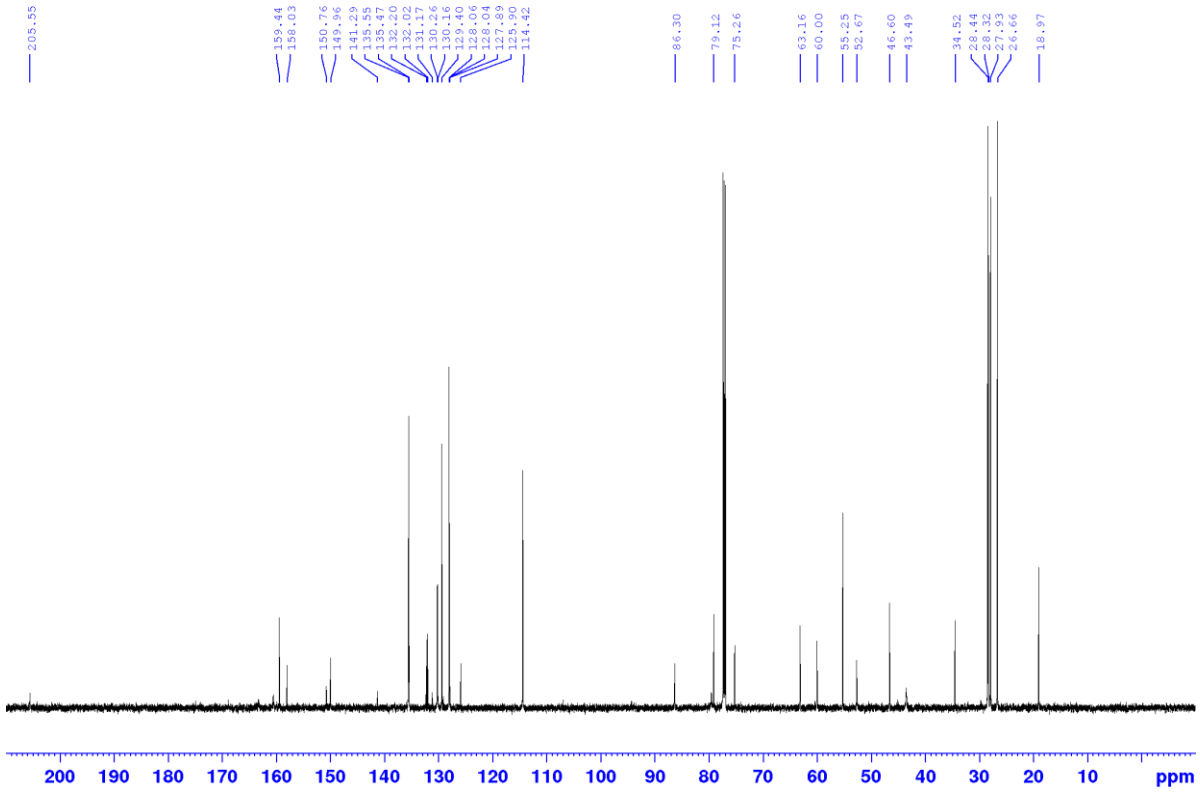


Figure S 24. ^{13}C NMR spectrum of **14** (150 MHz, $CDCl_3$).

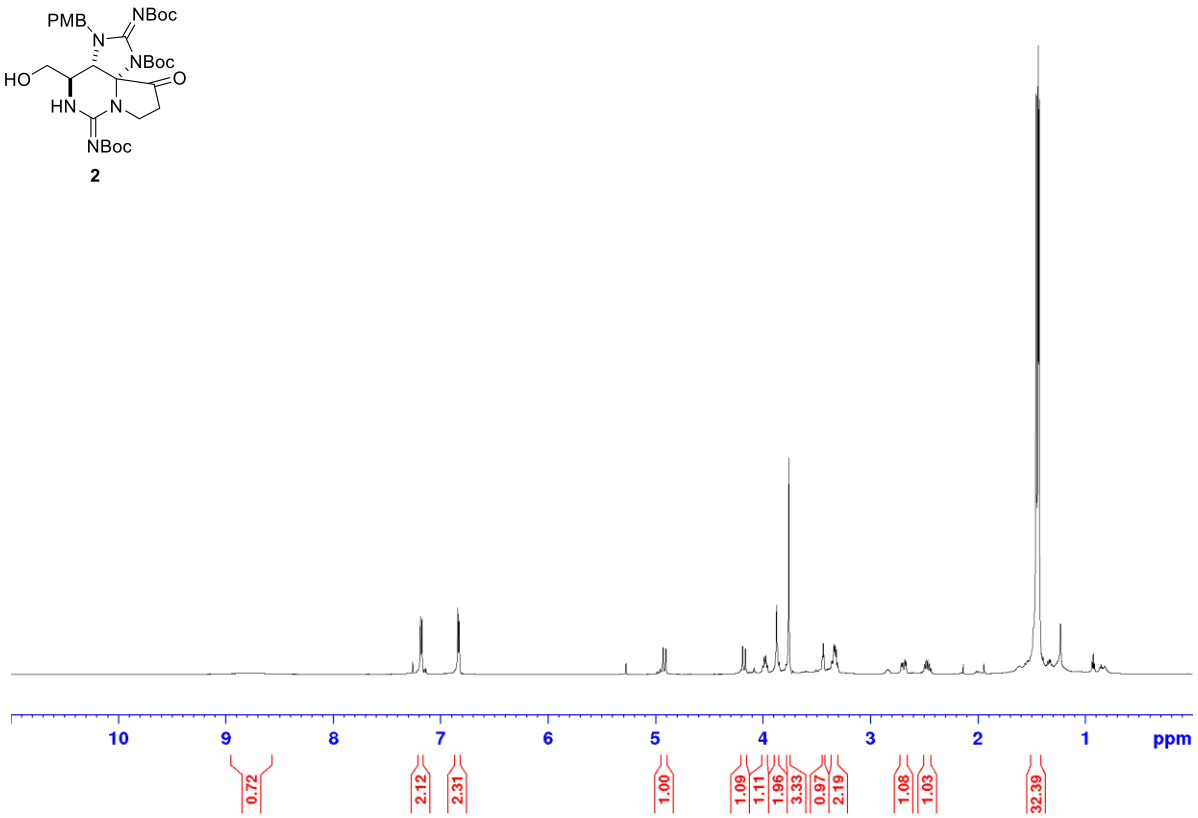


Figure S 25. ^{1}H NMR spectrum of **2** (600 MHz, $CDCl_3$).

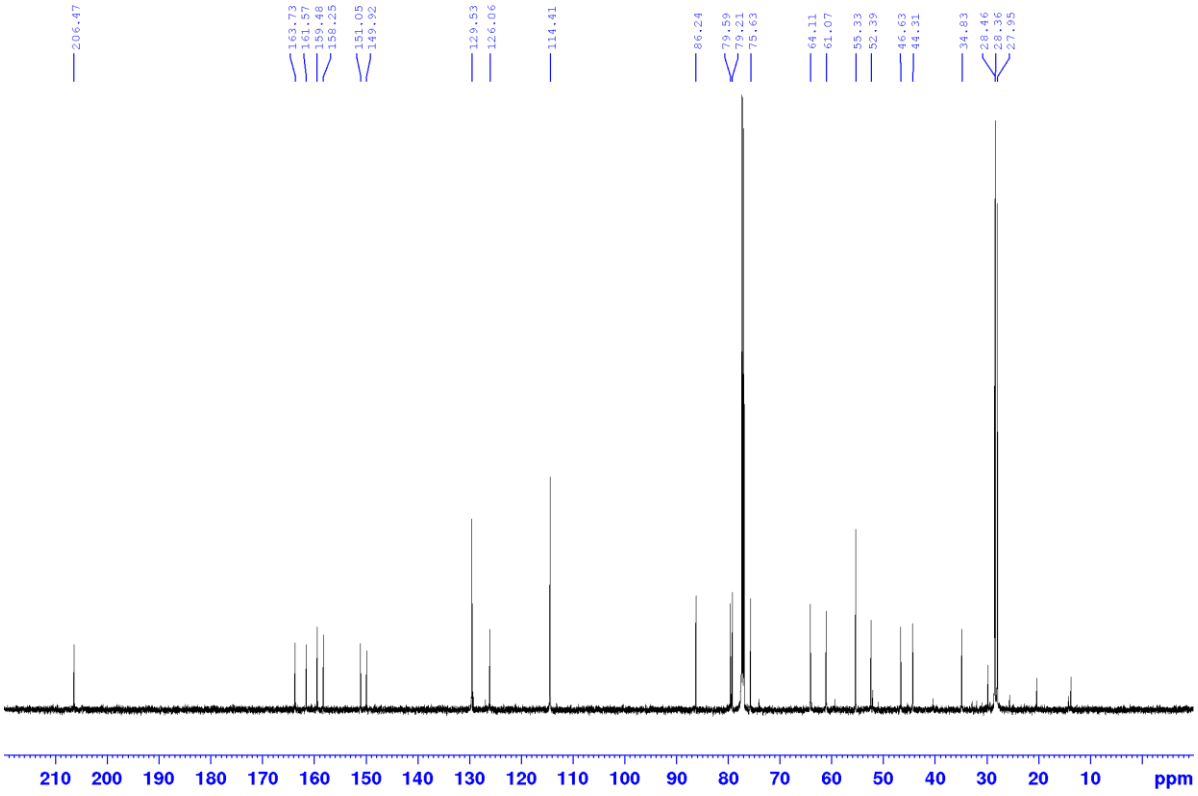


Figure S 26. ^{13}C NMR spectrum of **2** (150 MHz, $CDCl_3$).

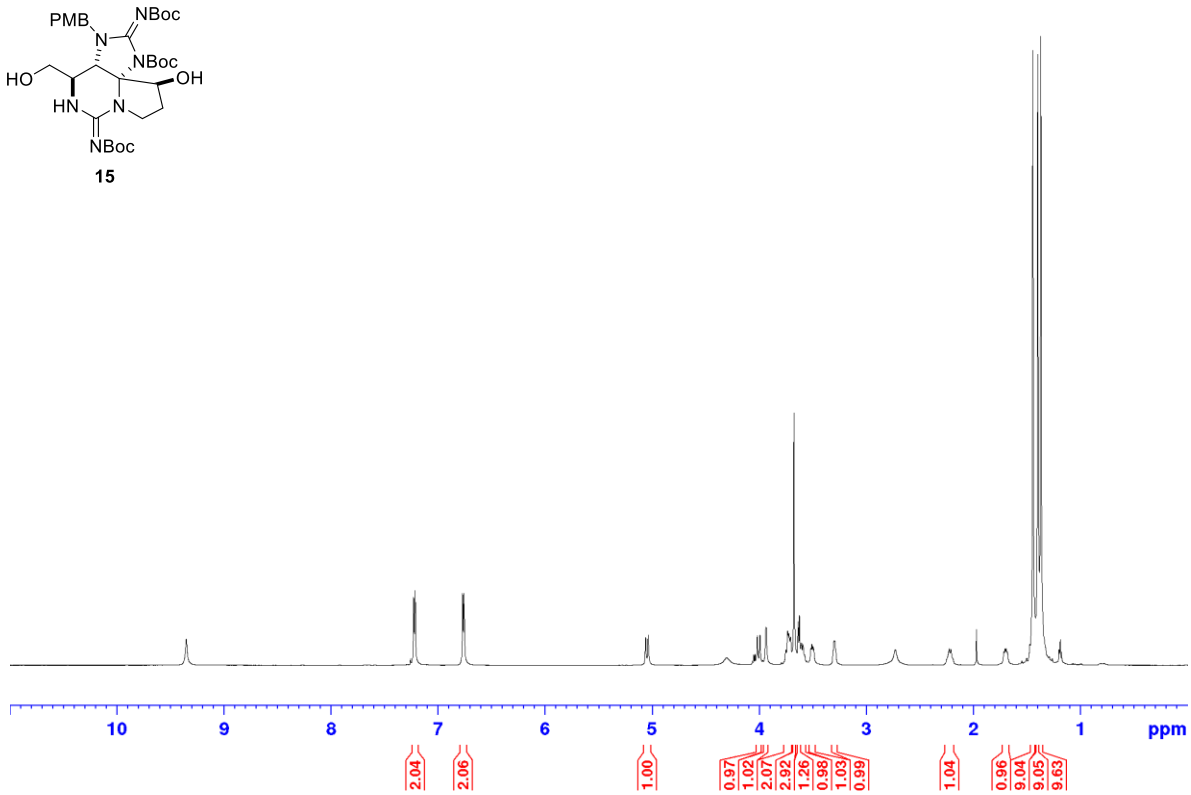


Figure S 27. ^{1}H NMR spectrum of **15** (600 MHz, $CDCl_3$).

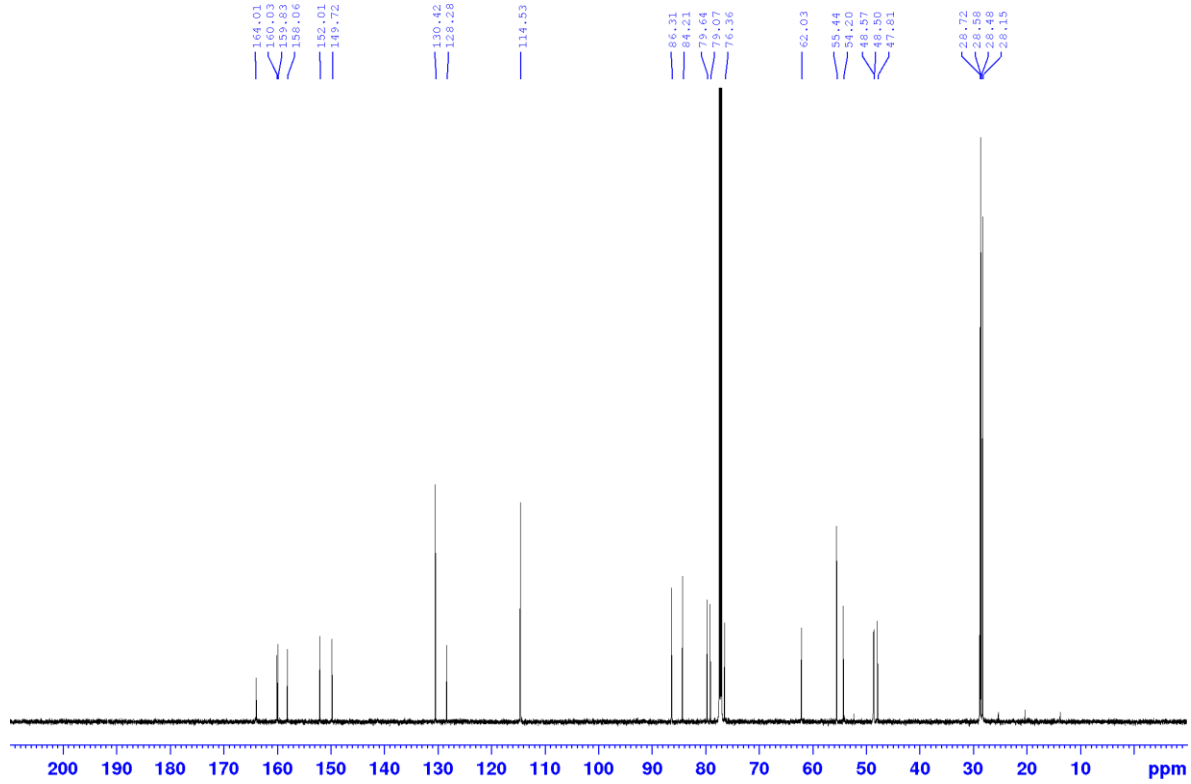


Figure S 28. ^{13}C NMR spectrum of **15** (150 MHz, $CDCl_3$).

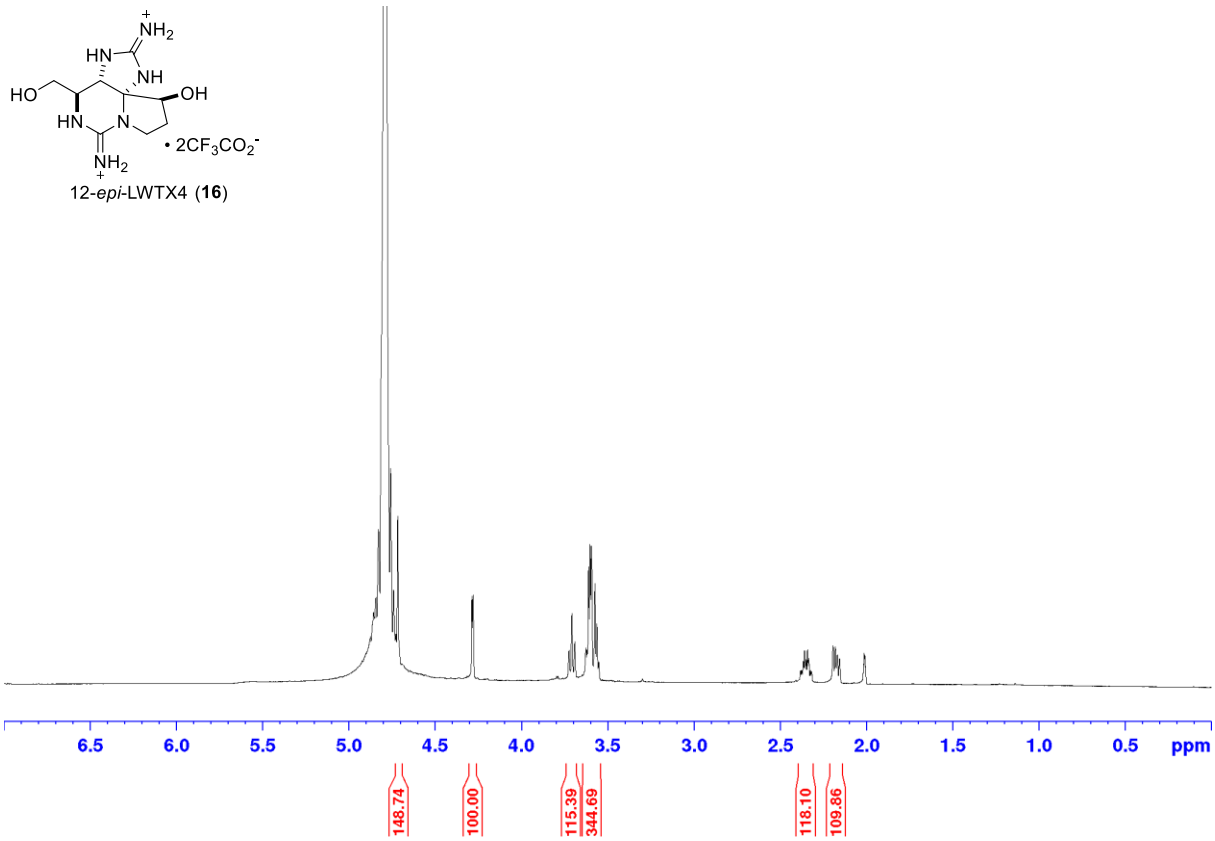


Figure S 29. ^{1}H NMR spectrum of 12-*epi*-LWTX4 (**16**) (600 MHz, 4 wt% acetic acid-d_4 in D_2O).

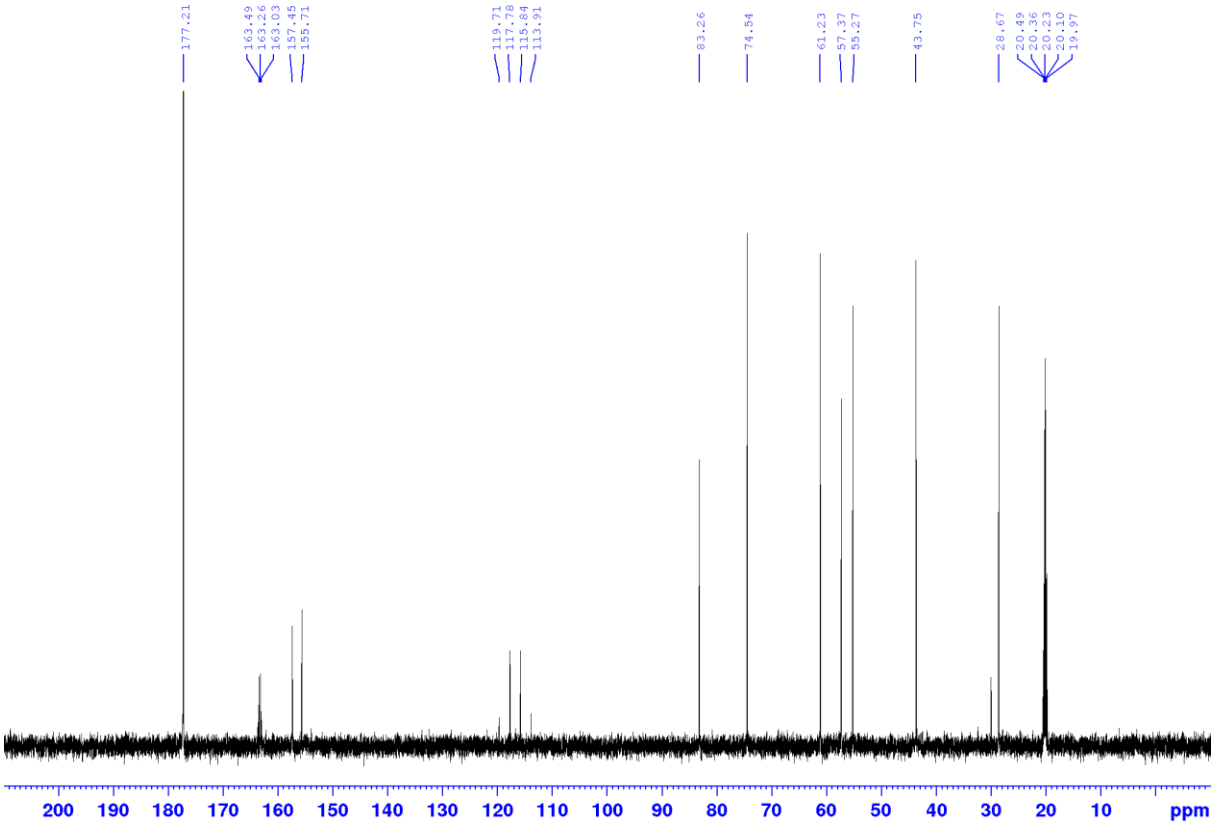


Figure S 30. ^{13}C NMR spectrum of 12-*epi*-LWTX4 (**16**) (150 MHz, 4 wt% acetic acid-d_4 in D_2O).

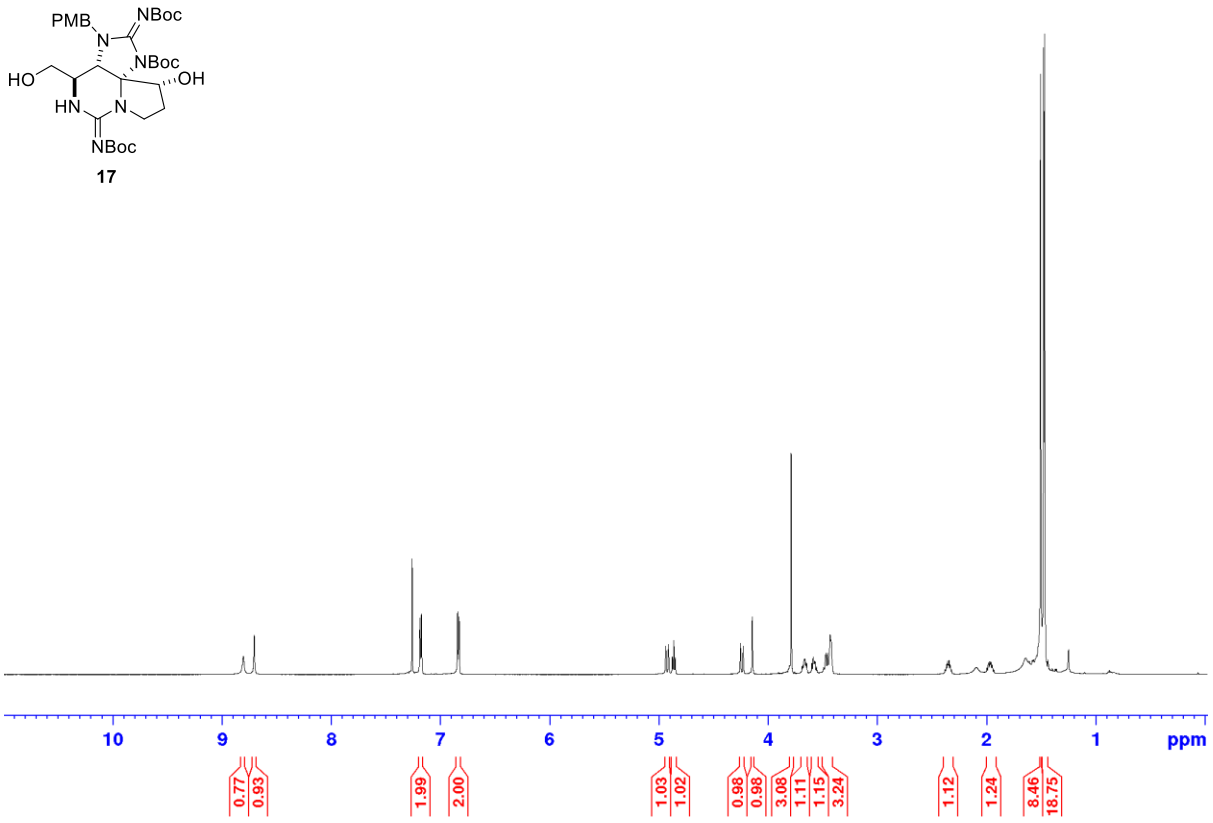


Figure S 31. ^{1}H NMR spectrum of **17** (600 MHz, $CDCl_3$).

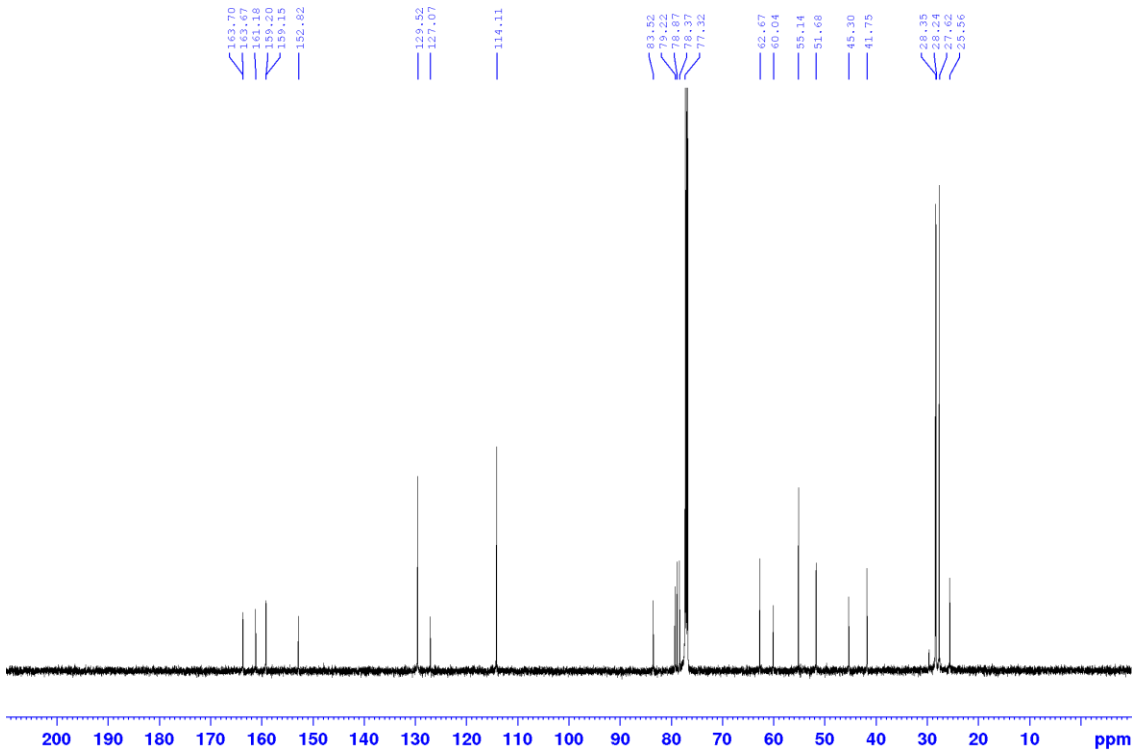


Figure S 32. ^{13}C NMR spectrum of **17** (150 MHz, $CDCl_3$).

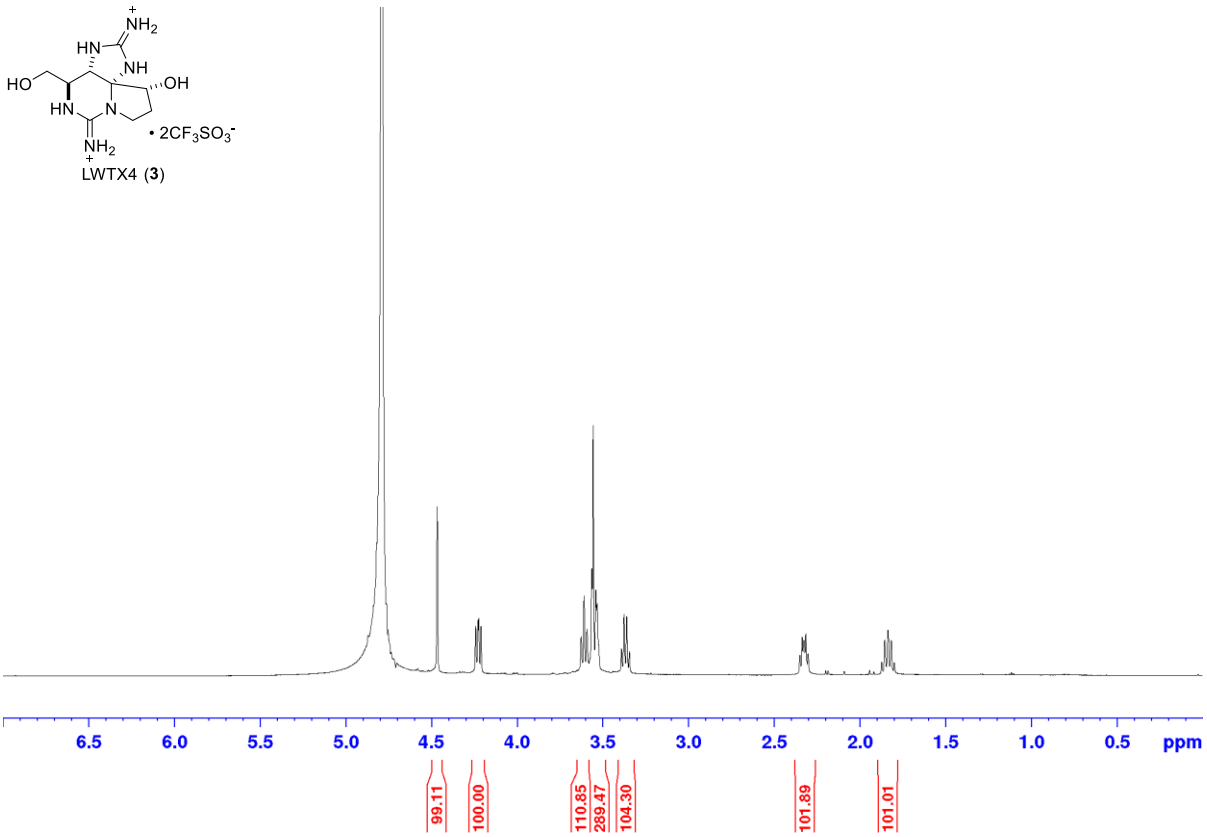


Figure S 33. ^{1}H NMR spectrum of LWTX4 (**3**) (600 MHz, D_2O).

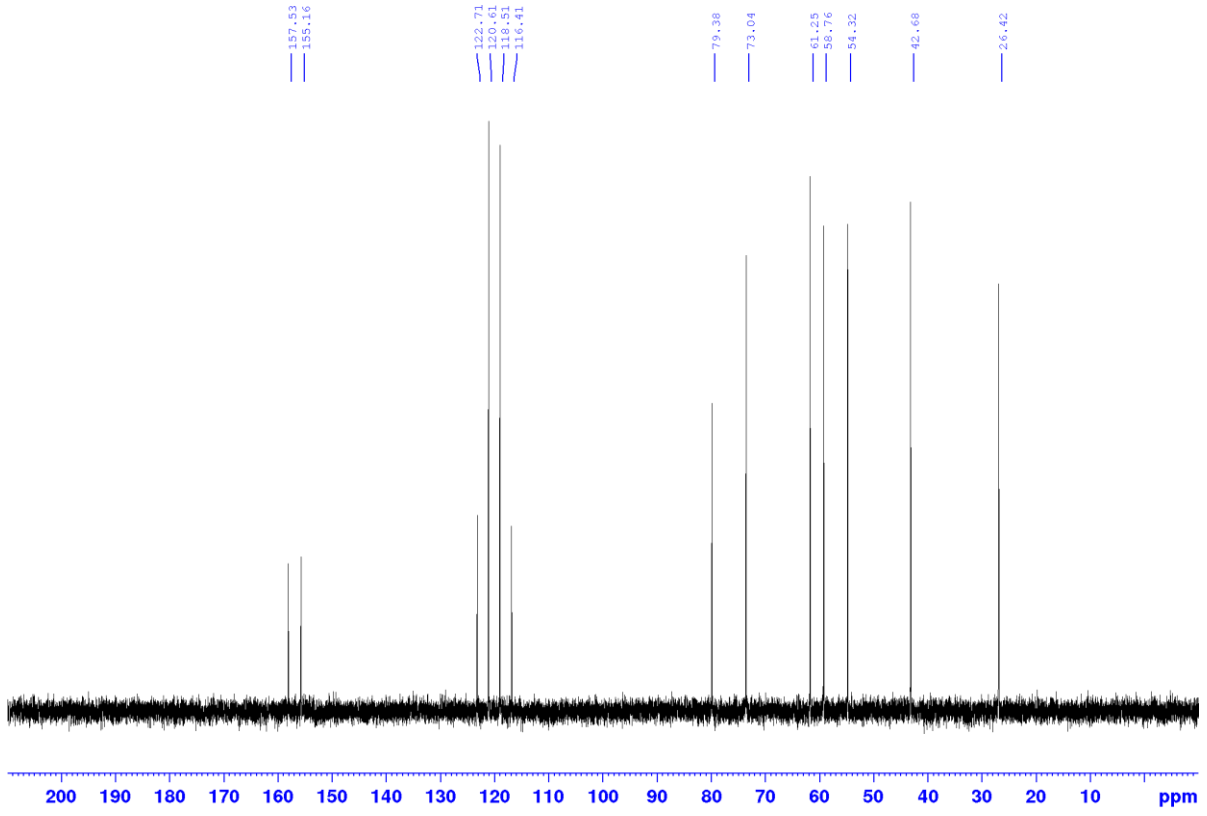


Figure S 34. ^{13}C NMR spectrum of LWTX (**3**) (150 MHz, 4 wt% acetic acid-d_4 in D_2O).

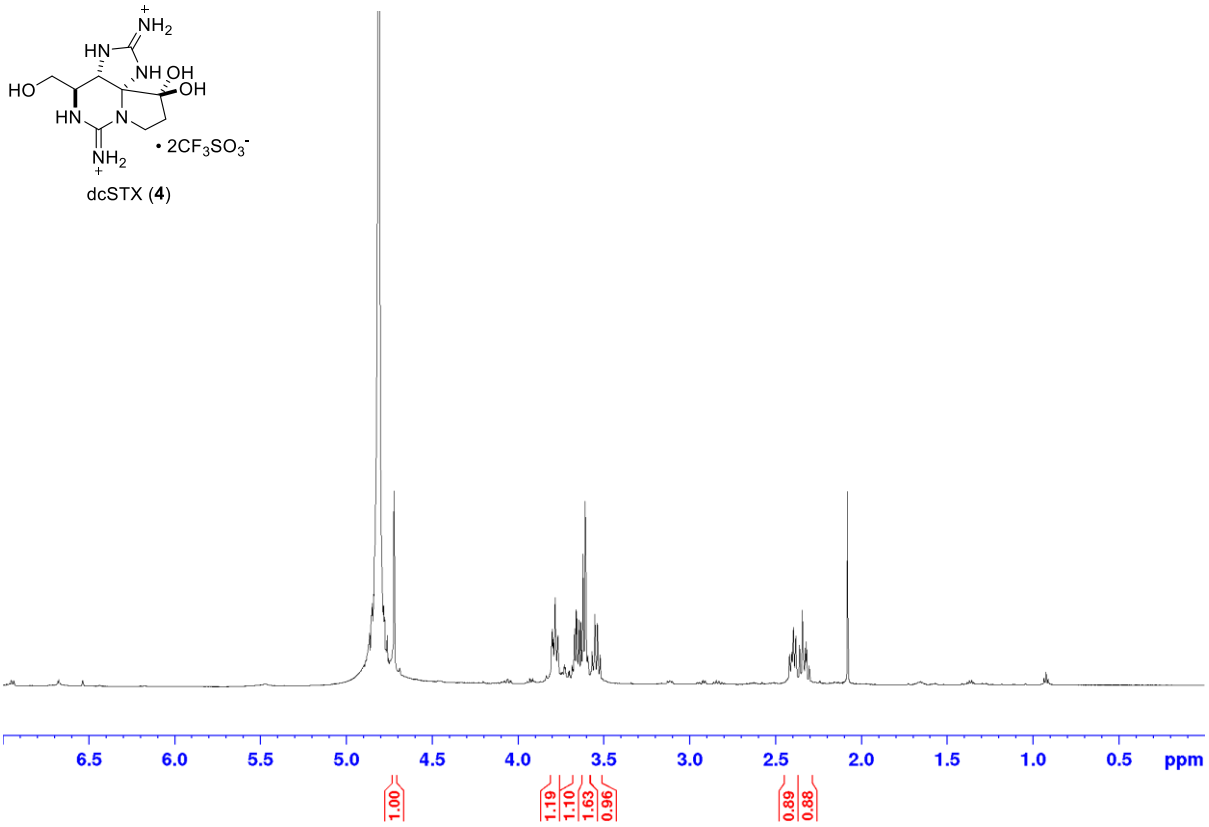


Figure S 35. ^{1}H NMR spectrum of dcSTX (**4**) (600 MHz, 4 wt% acetic acid-d_4 in D_2O).

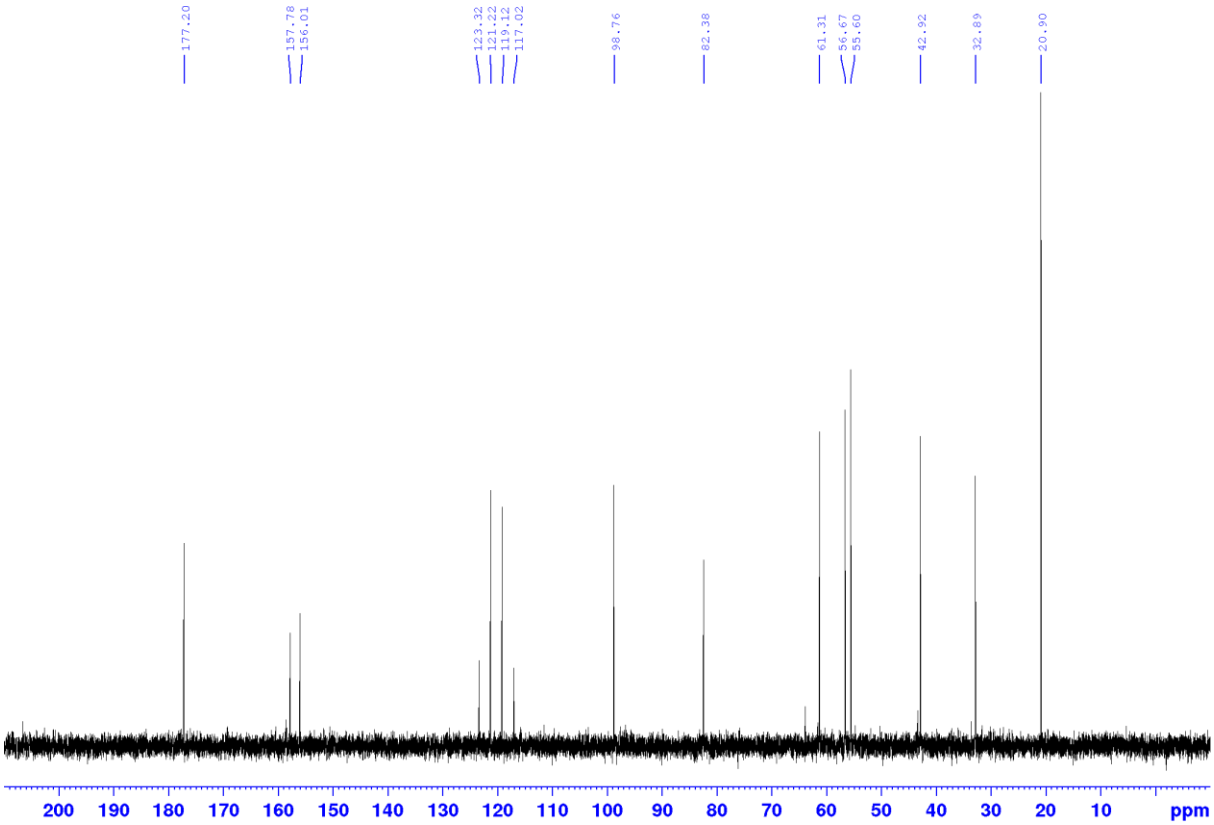


Figure S 36. ^{13}C NMR spectrum of dcSTX (**4**) (150 MHz, 4 wt% acetic acid-d_4 in D_2O).

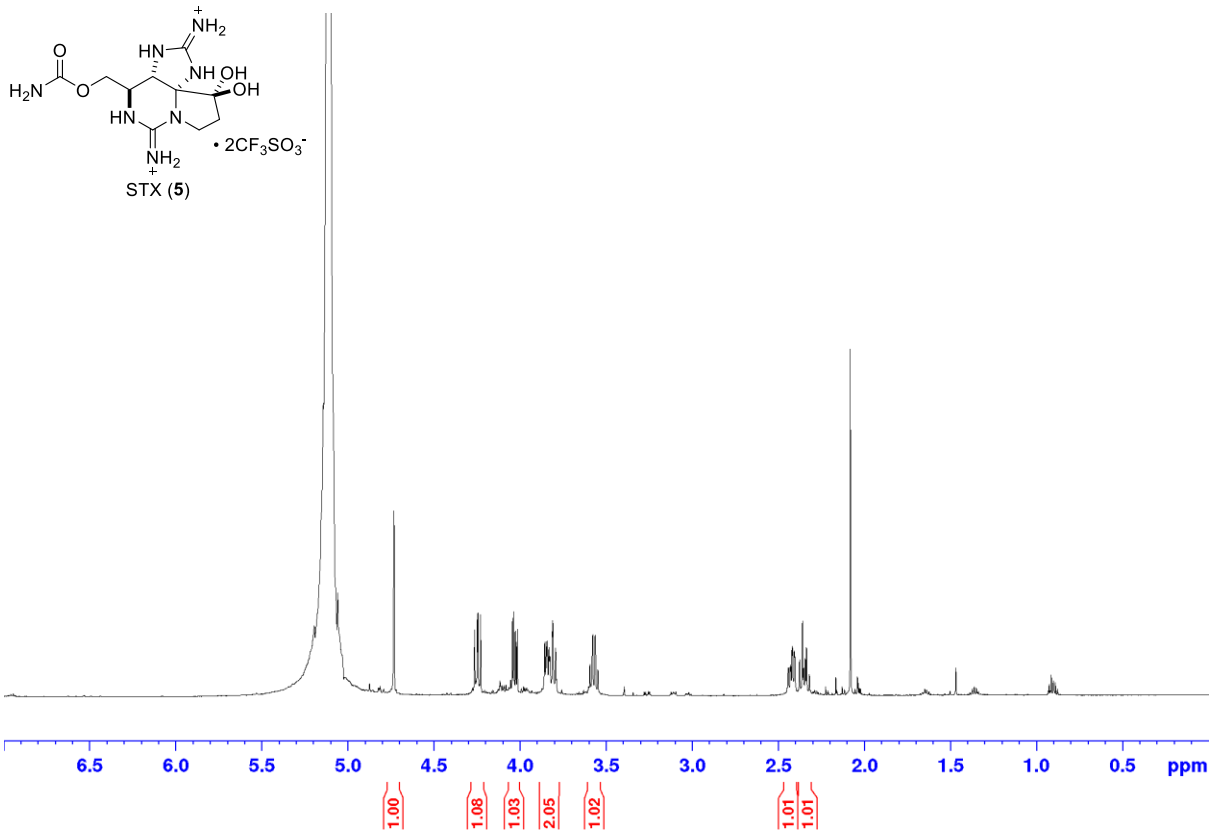


Figure S 37. ^{1}H NMR spectrum of saxitoxin (**5**) (600 MHz, 4 wt% acetic acid-d_4 in D_2O).

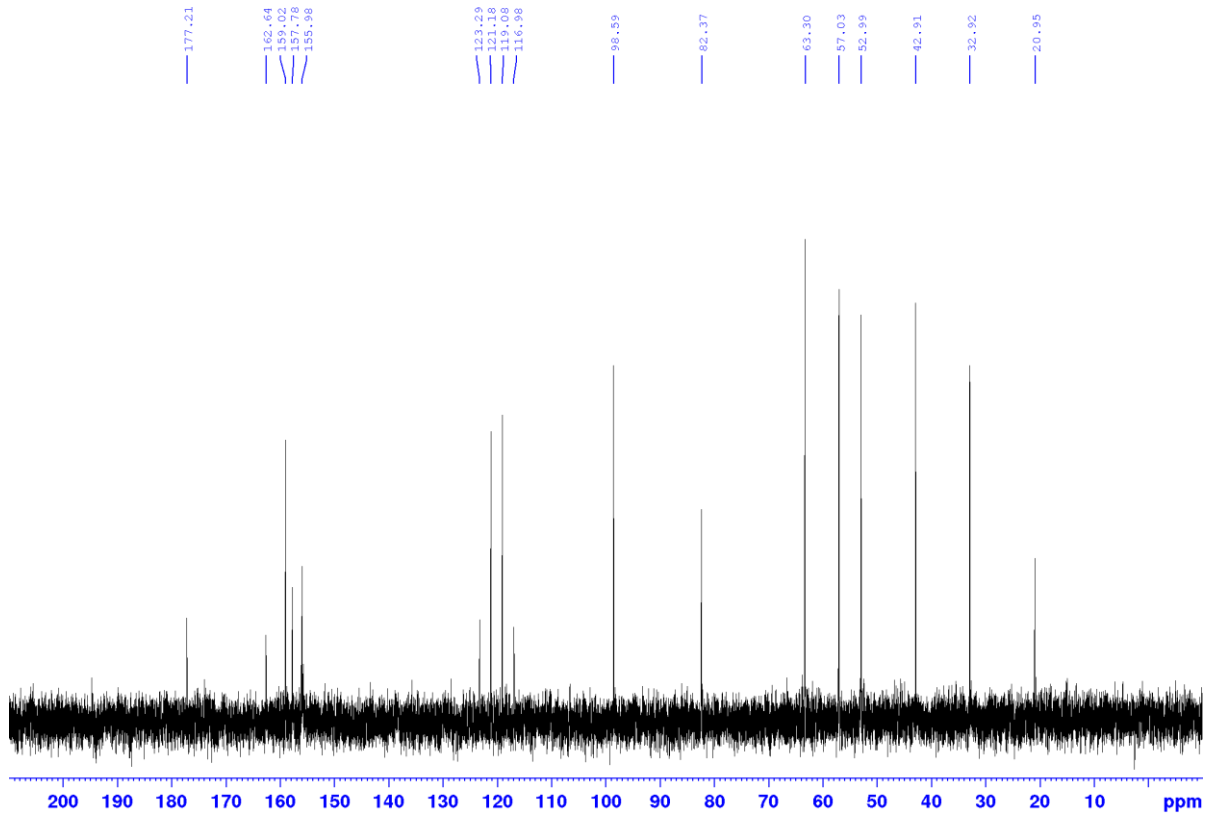


Figure S 38. ^{13}C NMR spectrum of saxitoxin (**5**) (150 MHz, 4 wt% acetic acid-d_4 in D_2O).

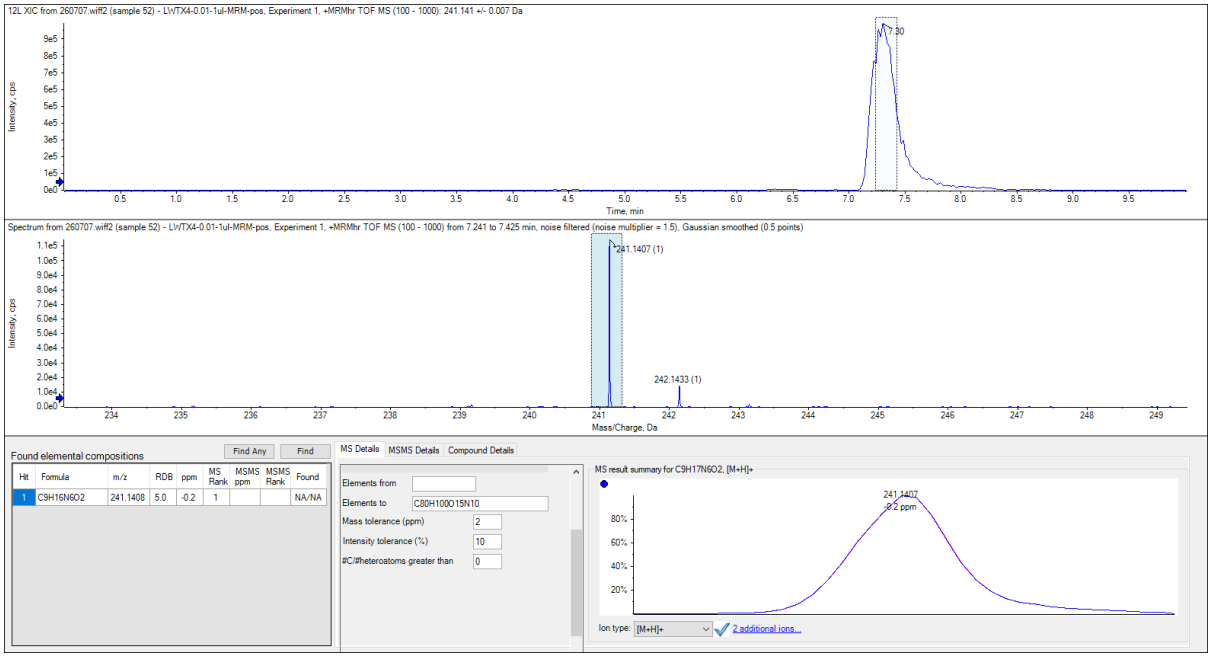


Figure S 39. HRMS spectrum of LWTX4 (**3**).

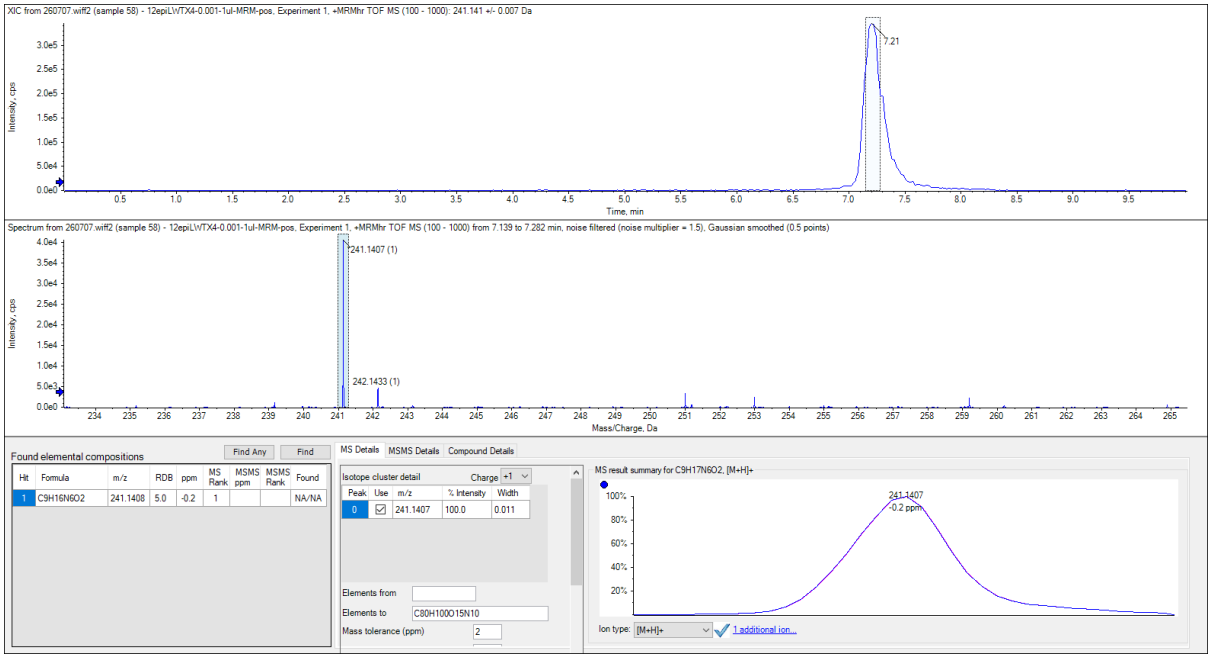


Figure S 40. HRMS spectrum of 12-*epi*-LWTX4 (**16**).