Allylic Tantalums as Highly Imine-selective Reagents

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1. Experimental

1-1 General

Materials. Allyl-, crotyl-tri-*n*-butyltin were prepared by the reaction of tri-*n*-butyltin chloride with the corresponding Grignard reagents.¹ Commercially available TaCl₅ was used. THF was freshly distilled from sodium benzophenone ketyl. All reactions were carried out under dry nitrogen.

1) Y. Naruta, Y. Nishigaichi, K. Maruyama, *Chem. Lett.* **1986**, 1857.

1-2 Sn-Ta exchange

GLC analysis of Generated *n*Bu₃SnCl: To a dry nitrogen-filled 10 mL round-bottomed flask containing TaCl₅ (0.358g, 1 mmol) in CH₂Cl₂ (1 mL) was added allyltri-*n*-butyltin (0.662 g, 2 mmol) at -78 °C. The resulting solution was measured by GLC analyses with SE-52. The peak of *n*Bu₃SnCl was detected at 2.5 min. Column temperature 180 °C, flow pressure: 1.5 kg/cm³, injector temp: 250 °C, detector temp: 250 °C.

NMR Measurement of Generated *n*Bu₃SnCl; Allyltri-*n*-butyltin (0.331 g, 1 mmol) and TaCl₅ (0.358 g, 1 mmol) were mixed at -78 °C for 0.5 h under dry N₂ in 0.75 mL of CH₂Cl₂. The resulting solution was transferred to a nitrogen-filled 5 mm ϕ NMR tube, and the tube was fixed into a 10 mm ϕ NMR tube containing CDCl₃ solution of Me₄Sn as external standard, and the 10 mm ϕ tube was set in the NMR instrument. Measurement was performed at -78 °C. *n*Bu₃SnCl was detected at 123 ppm, and starting allyltri-*n*-butyltin was not detected at all.

1-3 Allylation of Imines

Representative Procedure of Allylation to *N*-Aromatic Imines.

To a dry nitrogen-filled 10 mL round-bottomed flask containing TaCl₅ (0.358 g, 1 mmol) in CH₂Cl₂ (1 mL) was added allyltri-*n*-butyltin (0.662 g, 2 mmol) at -78 °C. TaCl₅ was partly insoluble. After stirring at -78 °C for 30 min, to the resulting solution was added benzylidenedianiline (**1a**) (0.181 g, 1 mmol). As the reaction proceeded, the mixture gradually turned homogeneous. During the reaction, the solution indicated a slight pale yellow color. After stirring the mixture at -78 °C for 2 h, the reaction mixture was quenched by saturated NaHCO₃ (2 mL). To the mixture were added saturated NH₄F (2 mL) and ether (10 mL). After stirring at rt for 30 min, the precipitated Bu₃SnF was filtered off and the filtrate was extracted with ether (15 mL x 3), dried over MgSO₄ and filtered. Volatiles were removed under reduced pressure. The residue was chromatographed on silica-gel column (FL100-DX (Fuji silysia)), eluting with hexane/EtOAc (99/1) to give homoallylamine **2a** (0.205 g, 92%).

Representative Procedure of One-pot Allylation using *N*-Aromatic Amines.

To a dry nitrogen-filled 10 mL round-bottomed flask containing TaCl₅ (0.358 g, 1 mmol) in THF (1 mL) was added allyltri-*n*-butyltin (0.331 g, 1 mmol) at -78 °C. After 30 min, aniline (0.093 g) and 3-Phenylpropionaldehyde (0.134 g, 1 mmol) were added and stirred the mixture at -78 °C for 3 h. The

reaction mixture was quenched by saturated NaHCO₃ (2 mL). To the mixture were added saturated NH₄F (2 mL) and ether (10 mL). After stirring at rt for 30 min, the precipitated Bu₃SnF was filtered off and the filtrate was extracted with ether (15 mL x 3), dried over MgSO₄ and filtered. Volatiles were removed under reduced pressure. The residue was chromatographed on silica-gel column (FL100-DX (Fuji silysia)) eluting with hexane/EtOAc (99/1) to give homoallylamine **2e** (0.249 g, 99%).

Representative Procedure of Allylation to *N*-Aliphatic Imines.

To a dry nitrogen-filled 10 mL round-bottomed flask containing TaCl₅ (0.358 g, 1 mmol) in CH₂Cl₂ (1 mL) were added MgO (0.201 g, 5 mmol) at rt and stirred for 1 h. The solution was cooled to -40 °C, and allyltri-*n*-butyltin (0.662 g, 2 mmol) was added. After stirring for 30 min, to the resulting solution was added benzylidene *N*-methylamine (0.119 g, 1 mmol). After stirring the mixture at -40 °C for 3 h, the reaction mixture was quenched by saturated NaHCO₃ (2 mL). To the mixture were added saturated NH₄F (2 mL) and ether (10 mL). After stirring at rt for 30 min, the precipitated Bu₃SnF was filtered off and the filtrate was extracted with ether (15 mL x 3). The organic layer was extracted with aqueous 0.5 M HCl (15 mL x 3), and products were transferred to a water layer as quaternary ammonium salts. To the water layer was added saturated NaHCO₃ (10 mL) slowly. The product was extracted with ether (20 mL x 3), dried over MgSO₄ and filtrated. Volatiles were removed under reduced pressure. The residue was purified by bulb-to-bulb distillation to give **2n** (0.127 g, 79%).

Representative Procedure of One-pot Allylation using *N*-Aliphatic Amines.

To a dry nitrogen-filled 10 mL round-bottomed flask containing *n*-propylamine (0.059 g, 1 mmol) and benzaldehyde (0.106 g, 1 mmol) was added MS4A (0.3 g). To prepare the corresponding imine *in situ*, the mixture was stirred at rt for 15 h. Allyltri-*n*-butyltin (0.662 g, 2 mmol) and MgO (0.201 g, 5 mmol) were added, and the solution was cooled to -40 °C. To the resulting solution was added TaCl₅ (0.358 g, 1 mmol). After stirring for 3 h, the reaction mixture was quenched by saturated NaHCO₃ (2 mL). Saturated NH₄F (2 mL) and ether (10 mL) were added. After stirring at rt for 30 min, the precipitated Bu₃SnF was filtered off, and the filtrate was extracted with ether (15 mL x 3). The organic layer was extracted with 0.5 M HCl (15 mL x 3) when products were transferred to water layer as quaternary ammonium salts. To the water layer was added saturated NaHCO₃ (10 mL) slowly. The product was extracted with ether (20 mL x 3), dried over MgSO₄ and filtered. Volatiles were removed under reduced pressure. The residue was purified by bulb-to bulb distillation to give **2p** (0.134 g, 71%).

2. Spectral data of products

(2a)

A. Studer, S. Amrein, *Synthesis* **2002**, 928.

colorless wax; IR (neat) 3409 cm^{-1} ; $^1\text{H-NMR}$ (CDCl_3) δ 2.41-2.64 (m, 2H), 4.13 (s, 1H), 4.37 (dt, $J=5.37, 7.81\text{ Hz}$, 1H), 5.13 (dd, $J=9.77$ and $<1\text{ Hz}$, 1H), 5.17 (dd, $J=17.09$ and $<1\text{ Hz}$, 1H), 5.75 (ddt, $J=17.09, 9.77, 7.32\text{ Hz}$, 1H), 6.48 (d, $J=7.33\text{ Hz}$, 2H), 6.63 (t, $J=7.33\text{ Hz}$, 1H), 7.01-7.38 (m, 7H). $^{13}\text{C-NMR}$ (CDCl_3) δ 43.3, 57.1, 113.4, 117.3, 118.2, 126.3, 128.5, 129.0, 126.9-134.6; HRMS calcd for $\text{C}_{16}\text{H}_{17}\text{N}$ 223.1361; Found 223.1364.

(2b)

colorless wax; IR (neat) $3424, 1596, 1227\text{ cm}^{-1}$; $^1\text{H-NMR}$ (CDCl_3) δ 2.49-2.63 (m, 2H), 3.87 (s, 3H), 4.37 (t, $J=7.33\text{ Hz}$, 1H), 4.79 (s, 1H), 5.11-5.21 (m, 2H), 5.70-5.86 (m, 1H), 6.29 (dd, $J=7.50, 1.46\text{ Hz}$, 2H), 6.56-6.77 (m, 3H), 7.19-7.37 (m, 5H). $^{13}\text{C-NMR}$ (CDCl_3) δ 43.3, 55.5, 57.2, 109.3, 111.1, 116.4, 118.0, 121.1, 126.3, 126.9, 128.5, 134.7, 137.2, 143.7, 146.8; HRMS calcd for $\text{C}_{17}\text{H}_{19}\text{NO}$ 253.1467; Found 253.1458.

(2c)

colorless wax; IR (neat) 3348 cm^{-1} ; $^1\text{H-NMR}$ (CDCl_3) δ 2.47-2.76 (m, 2H), 4.52 (dd, $J=5.37$ and 7.81 Hz , 1H), 4.87-4.97 (br, 1H), 5.16-5.29 (m, 2H), 5.64-5.83 (m, 1H), 6.44 (d, $J=9.28\text{ Hz}$, 2H), 7.20-7.41 (m, 5H), 7.99 (d, $J=9.18\text{ Hz}$, 2H). $^{13}\text{C-NMR}$ (CDCl_3) δ 42.8, 56.6, 112.1, 119.2, 126.0, 126.1, 127.6, 128.90, 133.6, 138.3, 141.4, 152.2; HRMS calcd for $\text{C}_{16}\text{H}_{16}\text{N}_2\text{O}_2$ 268.1212; Found 268.1211; Anal calcd for $\text{C}_{16}\text{H}_{16}\text{N}_2\text{O}_2$: C, 71.62; H, 6.01, N, 10.44; Found C, 71.80, H, 6.17, N, 10.33.

(2d)

K. Manabe, Y. Mori, S. Kobayashi, *Tetrahedron* **2001**, 57, 2537.

colorless wax; IR (neat) 3417cm^{-1} ; $^1\text{H-NMR}$ (CDCl_3) δ 2.40-2.68 (m, 2H), 4.10-4.22 (d, J = 4.89 Hz, 1H), 4.33 (dd, J = 4.89 and 7.08 Hz, 1H), 5.08-5.25 (m, 2H), 5.65-5.84 (m, 1H), 6.36-6.46 (m, 2H), 6.96-7.04 (m, 2H), 7.17-7.38 (m, 5H). $^{13}\text{C-NMR}$ (CDCl_3) δ 43.2, 57.1, 114.5, 118.5, 121.9, 126.2, 127.1, 128.6, 128.9, 134.4, 143.0, 145.8; HRMS calcd for $\text{C}_{16}\text{H}_{16}\text{ClN}$ 257.0971: Found 257.0962; Anal calcd for $\text{C}_{16}\text{H}_{16}\text{ClN}$: C, 74.45; H, 6.26, N, 5.43, Cl, 13.75: Found C, 74.40, H, 6.33, N, 5.41, Cl, 13.53.

(2e)

colorless wax; IR (neat) 3406cm^{-1} ; $^1\text{H-NMR}$ (CDCl_3) δ 1.64-1.93 (m, 2H), 2.28 (t, J = 6.35 Hz, 2H), 2.59-2.79 (m, 2H), 3.35-3.60 (m, 2H), 4.99-5.11 (m, 2H), 5.68-5.86 (m, 1H), 6.51 (d, J = 7.81 Hz, 2H), 6.65 (t, J = 7.32 Hz, 1H), 7.05-7.31(m, 7H). $^{13}\text{C-NMR}$ (CDCl_3) δ 32.2, 35.9, 38.4, 51.6, 113.3, 117.1, 117.7, 125.9, 128.4, 128.5, 129.3, 134.6, 1412.0, 147.6; HRMS calcd for $\text{C}_{18}\text{H}_{21}\text{N}$ 251.1674: Found 251.1683; Anal calcd for $\text{C}_{18}\text{H}_{21}\text{N}$: C, 86.01; H, 8.42, N, 5.57: Found C, 85.72, H, 8.53, N, 5.56.

(2g)

IR (neat) 3363 cm^{-1} ; $^1\text{H-NMR}$ (CDCl_3) δ 1.78-1.99 (m, 2H), 2.28-2.45 (m, 2H), 2.69-2.76 (m, 2H), 3.51-3.61 (m, 1H), 4.39-4.44 (m, 1H), 5.08-5.16 (m, 2H), 5.70-5.85 (m, 1H), 6.40-6.46 (m, 2H), 7.13-7.31 (m, 5H), 8.03-8.08 (m, 2H). $^{13}\text{C-NMR}$ (CDCl_3) 32.2, 35.8, 38.6, 51.5, 111.3, 118.6, 126.1, 126.4, 128.3, 128.5, 133.5, 137.6, 141.0, 152.7; HRMS calcd for $\text{C}_{18}\text{H}_{20}\text{N}_2\text{O}_2$ 296.1525: Found. 296.1530.

S. Kobayashi; S. Nagayama, *J. Am. Chem. Soc.* **1997**, *119*, 10049.

$^1\text{H-NMR}$ (CDCl_3) δ 0.84-1.85 (m, 11H), 2.14-2.39 (m, 2H), 3.24 (dd, J = 5.1, 6.9 Hz, 1H), 3.50 (brs, 1H), 5.00-5.08 (m, 2H), 5.72-5.87 (m, 1H), 6.53-6.65 (m, 3H), 7.10-7.19 (m, 2H). $^{13}\text{C-NMR}$ (CDCl_3) δ 26.3, 26.4, 26.5, 29.4, 35.8, 41.2, 57.2, 112.9, 116.5, 117.0, 129.2, 135.6, 148.3; HRMS calcd for $\text{C}_{18}\text{H}_{23}\text{N}$ 229.1877: Found 229.1854.

colorless wax; IR (neat) 3410 cm^{-1} ; $^1\text{H-NMR}$ (CDCl_3) δ 0.94 (d, J = 6.84 Hz, 3H), 0.97(d, J = 6.84Hz, 3H), 1.90 (dq, J = 13.64, 6.84Hz, 1H), 2.10-2.40 (m, 2H), 3.19-3.32 (m, 1H), 3.52 (brs, 1H), 4.99-5.13 (m, 2H), 5.71-5.90 (m, 1H), 6.49-6.68 (m, 3H), 7.08-7.19 (m, 2H). $^{13}\text{C-NMR}$ (CDCl_3) δ 18.3, 18.5, 30.7, 35.52, 57.8, 113.1, 116.7, 117.1, 129.4, 135.8, 148.4; HRMS calcd for $\text{C}_{18}\text{H}_{23}\text{N}$ 189.1517: Found 189.1512.

colorless wax; IR (neat) 3402 cm^{-1} ; $^1\text{H-NMR}$ (CDCl_3)(major isomer) δ 1.00 (d, 3H, J = 7.01 Hz), 1.42-1.71 (m, 1H), 1.77-2.00 (m, 1H), 2.49 (qdd, J = 7.01, 8.06 and 4.64 Hz, 1H), 2.56-2.87 (m, 2H), 3.22-3.42 (m, 1H), 3.51 (brs, 1H), 4.91-5.12 (m, 2H), 5.71 (ddd, J = 17.55, 10.37 and 8.06 Hz, 1H), 6.48-6.70 (m, 3H), 7.07-7.32 (m, 7H). $^{13}\text{C-NMR}$ (CDCl_3) (minor) δ 15.09, 32.75, 34.00, 40.27, 56.45, 112.97, 115.28, 116.71, 125.70, 128.24, 128.37, 129.20, 140.24, 141.99, 148.07 (major) δ 16.7, 32.8, 33.2, 41.5, 56.8, 112.4, 115.4, 116.9, 125.7, 128.2, 128.4, 129.2, 140.4, 142.1, 148.1; HRMS calcd for $\text{C}_{19}\text{H}_{23}\text{N}$ 265.1830: Found 265.1827; Anal calcd for $\text{C}_{19}\text{H}_{23}\text{N}$: C, 85.99, H, 8.74, N, 5.28. Found C, 85.72, H, 8.75, N, 5.01.

(2m)

colorless wax; IR (neat) 3410 cm^{-1} ; $^1\text{H-NMR}(\text{CDCl}_3)$ (major isomer) δ 0.78 (t, $J=7.57\text{ Hz}$, 3H), 1.05 (d, $J=6.84\text{ Hz}$, 3H), 1.16-1.68 (m, 9H), 3.21-3.32 (m, 1H), 3.50 (brs, 1H), 4.92-5.13 (m, 2H), 5.65-5.93 (m, 1H), 6.51-6.67 (m, 3H), 7.08-7.19 (m, 2H). $^{13}\text{C-NMR}(\text{CDCl}_3)$ (major) δ 14.1, 16.5, 22.6, 26.3, 31.5, 32.0, 41.4, 57.5, 113.12, 115.0, 116.6, 129.2, 140.8, 148.3; HRMS calcd for $\text{C}_{16}\text{H}_{25}\text{N}$ 231.1987; Found 231.1989.

(2n)

colorless wax; IR (neat) 3410 cm^{-1} ; $^1\text{H-NMR}(\text{CDCl}_3)$ (major isomer) δ 1.00 (d, $J=6.83\text{ Hz}$, 3H), 0.88-1.34 (m, 5H), 1.45-1.92 (m, 6H), 2.34-2.53 (m, 1H), 3.11 (t, $J=6.34\text{ Hz}$, 1H), 3.40 (br, 1H), 4.90-5.13 (m, 2H), 5.68-5.90 (m, 1H), 6.50-6.72 (m, 3H), 7.05-7.23 (m, 2H). $^{13}\text{C-NMR}(\text{CDCl}_3)$ (major) δ 16.4, 26.3-26.6 (3C), 27.8, 31.4, 41.3-41.4 (2C), 62.1, 112.5, 113.8, 116.1, 129.1, 142.7, 149.7; HRMS calcd for $\text{C}_{17}\text{H}_{25}\text{N}$ 243.1987; Found 243.1982.

(2o)

D-K. Wang, Y-G. Zhou, Y. Tang, X-L. Hou, L-X. Dai, *J. Org. Chem.* **1999**, *64*, 4233.

colorless wax; IR (neat) 3340 cm^{-1} ; $^1\text{H-NMR}(\text{CDCl}_3)$ δ 1.86 (s, 1H), 2.26 (s, 3H), 2.39-2.44 (m, 2H), 3.53 (t, $J=6.35\text{ Hz}$, 1H), 5.03-5.12 (m, 2H), 5.62-5.80 (m, 1H), 7.17-7.40 (m, 5H). $^{13}\text{C-NMR}(\text{CDCl}_3)$ δ 34.4, 42.7, 64.5, 117.4, 126.9, 127.0, 128.2, 135.3, 143.3; HRMS calcd for $\text{C}_{11}\text{H}_{15}\text{N}$ 161.1204; Found 162.1277 ($\text{Cl}(\text{M}^+)+1$).

S. Kobayashi; S. Nagayama, *J. Am. Chem. Soc.* **1997**, *119*, 10049.

colorless wax; $^1\text{H-NMR}$ (CDCl_3) δ 1.77 (brs, 1H), 2.41-2.46 (m, 3H), 3.53 (d, J = 13.4 Hz, 1H), 3.67 (d, J = 13.7 Hz, 1H), 5.02-5.11 (m, 2H), 5.65-5.75 (m, 1H), 7.20-7.37 (m, 10H). $^{13}\text{C-NMR}$ (CDCl_3) δ 43.1, 51.1, 61.6, 117.5, 126.8, 127.0, 127.3, 128.1, 128.2, 128.3, 135.4, 140.6, 143.8; HRMS calcd for $\text{C}_{17}\text{H}_{19}\text{N}$ 237.1499, Found 237.1483.

J. Wang, Y. Zhang, W. Bao, *Synth. Commun.* **1996**, *26*, 2473-2478.

colorless wax; IR (neat) 3325 cm^{-1} ; $^1\text{H-NMR}$ (CDCl_3) δ 0.85 (t, J = 7.32 Hz, 3H), 1.36-1.55 (m, 3H), 2.31-2.46 (m, 4H), 3.64 (t, J = 6.83 Hz, 1H), 5.01-5.14 (m, 2H), 5.62-5.82 (m, 1H), 7.16-7.40 (m, 5H). $^{13}\text{C-NMR}$ (CDCl_3) δ 11.8, 23.3, 43.1, 49.6, 62.6, 117.2, 126.8, 127.1, 128.2, 135.5, 144.2; HRMS calcd for $\text{C}_{13}\text{H}_{19}\text{N}$ 189.1517: Found 190.1594 ($\text{Cl}_2(\text{M}^+)+1$); Anal calcd for $\text{C}_{13}\text{H}_{19}\text{N}$: C, 82.48, H, 10.12, N, 7.20. Found C, 82.20, H, 10.00, N, 7.39.

G. Alvaroe, C. Boga, D. Savoia, A. Umani-Ronchi, *J. Chem. Soc. Perkin Trans. I.* **1996**, 875.

IR (neat) 3325 cm^{-1} ; $^1\text{H-NMR}$ (CDCl_3) (*syn*) δ 1.32 (d, J = 6.35 Hz, 1H), 1.65 (brs, 1H), 2.26-2.54 (2 H), 3.65-6.81 (m, 2H), 4.94-5.10 (m, 2H), 5.52-5.76 (m, 1H), 7.10-7.36 (m, 10H). (*anti*) δ 1.26 (d, J = 6.83 Hz, 1H), 1.65 (brs, 1H), 2.26-2.54 (2 H), 3.37 (t, J = 3.07 Hz, 1H), 3.48 (q, J = 6.60 Hz, 1H), 4.94-5.10 (m, 2H), 5.52-5.76 (m, 1H), 7.10-7.36 (m, 10H). $^{13}\text{C-NMR}$ (CDCl_3) (*syn*) δ 22.5, 42.1, 54.5, 59.6, 117.1, 126.5-128.3(6C), 135.3, 143.8, 146.0. (*anti*) 24.9, 43.3, 54.8, 58.97, 117.3, 126.5-128.3(6C), 135.6, 144.1, 145.6.; HRMS calcd for $\text{C}_{18}\text{H}_{21}\text{N}$ 251.1674: Found 252.1739($\text{Cl}_2(\text{M}^+)+1$).

(2s)

bp 50°C/ 1 mmHg; IR (neat) 3325 cm⁻¹; ¹H-NMR(CDCl₃) δ0.90 (t, *J*= 7.08 Hz, 3H), 0.84-1.84 (m, 13H), 1.98-2.13 (m, 1H), 2.46-2.58 (m, 2H), 2.52 (t, *J*= 7.08 Hz, 2H), 5.01-5.13 (m, 2H), 5.69-5.88 (m, 1H). ¹³C-NMR (CDCl₃) δ11.9, 23.6, 26.8(3H), 28.9, 29.5, 35.7, 40.9, 50.1, 62.1, 116.5, 137.0; HRMS calcd for C₁₃H₂₅N 195.1987; Found 196.2071(CI,(M⁺)+1).

(2t)

colorless wax; IR(neat) 3333 cm⁻¹; ¹H-NMR (CDCl₃) (major isomer) δ0.85 (t, *J*= 7.32 Hz, 3H), 0.98 (brs, 1H), 1.30 (d, *J*= 6.84 Hz, 3H), 1.21-1.52 (m, 2H), 1.85-2.00 (m, 1H), 2.05-2.20 (m, 1H), 2.40-2.60 (m, 2H), 2.60-2.75 (m, 1H), 2.80-2.90 (m, 1H), 5.01-5.14 (m, 2H), 5.62-5.82 (m, 1H), 7.16-7.40 (m, 5H). ¹³C-NMR (CDCl₃) δ11.8, 17.2, 23.5, 36.3, 42.8, 49.6, 62.8, 116.7, 126.0, 127.8, 128.1, 136.1, 145.3; HRMS calcd for C₁₅H₂₃N 217.1830; Found d217.1826; Anal calcd for C₁₅H₂₃N: C, 82.48, H, 10.12, N, 7.20. Found C, 82.20, H, 10.00, N, 7.39.

(2u)

bp 80°C/ 0.3 mmHg; IR(neat) 2931 cm⁻¹; ¹H-NMR (CDCl₃) δ0.86-0.93 (m, 6H), 1.29-1.54 (m, 11H), 2.05-2.28 (m, 2H), 2.48-2.57 (m, 3H), 5.04-5.10 (m, 2H), 5.70-5.86 (m, 1H); ¹³C-NMR (CDCl₃) δ12.4, 14.6, 23.1, 23.9, 26.0, 32.6, 34.5, 39.0, 49.6, 57.4, 117.4, 136.4; HRMS calcd for C₁₂H₂₅N 183.1987; Found. 184.2075 (CI,(M⁺)+1).

(2b)

3. ^{13}C NMR Chart

ppm
COMNT NC256
EXPCM "B"BCMA:Single.pulse.Complete.decoupling.IRRPW.IRATN

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15 peaks found in nc327c.gxd;1:import

peak	ppm	freq	amp
1	152.219	10340.77	381217.97
2	141.417	9606.93	288789.28
3	138.300	9395.18	208263.61
4	133.548	9072.37	851899.19
5	128.903	8756.83	1507323.12
6	127.620	8669.64	556107.62
7	126.138	8568.96	1336472.75
8	126.031	8561.70	1506999.25
9	119.232	8099.80	655518.31
10	112.066	7613.00	1307660.00
11	77.474	5263.05	4882748.50
12	77.000	5230.87	5290973.50
13	76.526	5198.69	5052560.50
14	56.587	3844.15	633179.31
15	42.759	2904.79	526051.50

(2c)

COMNT NC327C
EXPCM "B"BCMA:Single.pulse.Complete.decoupling.IRRPW.IRATN

(2g)

C:\Bec+12\Q&M-P\M2-1E\nc410.grd;1
NC410

(2k)

NC397T

(2m)

(2n)

(2S)

(2t)