Metallated Nitriles: Organolithium, -Magnesium, and -Copper Exchange of α -Halonitriles

Fraser F. Fleming,* Zhiyu Zhang, Wang Liu and Paul Knochel.**

Department of Chemistry and Biochemistry, Duquesne University, Pittsburgh, Pennsylvania 15282-1530 and
Department Chemie, Ludwig-Maximilians-Universität, Butenandtstrasse 5-13, 81377, München, Germany.

flemingf@duq.edu

Compound	Procedure	Reference	¹ H NMR	¹³ C NMR
12a	S2	3	S12	S13
12b	S2		S14	S15
12e	S2		S16	S17
12f	S3		S18	S19
15a	S4	5	S20	S21
15b	S4		S22	S23
15c	S4(S8)		S24	S25
15d	S5		S26	S27
15e	S5		S28	S29
15f	S5		S30	S31
15g	S6		S32	S33
15h	S6(S8)		S34	S35
15i	S7		S36	S37
15j	S7		S38	S39
i	S7		S40	S41
15k	S8		S42	S43
15l	S9		S44	S45
15m	S10		S46	S47
15n	S10		S48	S49
15o	S10		S50	S51
15p	S11		S52	S53
16(dl)	S11	6	S54	S55
16(meso)	S11	6	S56	S57
17	S11	7	S58	S59
References		S60		

Experimental¹

General nitrile bromination procedure.² Neat bromine and nitrile were sequentially added to ice-cooled PBr₃. After the addition, the ice bath was removed and the reaction was heated at 60 °C. After 5 h the mixture was poured onto ice, extracted with ether (3x), and then the crude extracts were washed with NaHCO₃ (3x), and water, and then dried (MgSO₄). Concentration and purification of the crude product by radial chromatography afforded analytically pure material.

2-Bromo-2-phenyl-propionitrile (12a): The general procedure was employed with 2-phenyl-propionitrile (3.60 g, 27.5 mmol), Br₂ (4.48 g, 28 mmol) and PBr₃ (7.56 g, 28 mmol) to afford, after purification by radial chromatography (1: 60 to 1: 30 EtOAc/hexanes), 4.85 g of **12a** (84%) as an oil, spectrally identical with previous characterized material.³

1-Bromocyclohexanecarbonitrile (12b): The general procedure was employed with **20** (3 g, 27.5 mmol), Br₂ (4.48 g, 28 mmol) and PBr₃ (7.56 g, 28 mmol) to afford, after purification by radial chromatography (1: 48 to 1:24 EtOAc/hexanes), 4.7 g (90%) of **12b** as an oil: IR (film) 2240, 802 cm⁻¹; ¹H NMR: d 1.37 – 1.44 (m, 1H), 1.66-1.82 (m, 4H), 2.06 – 2.15 (m, 3H), 2.34 – 2.39 (m, 2H); ¹³C NMR: d 24.5, 24.5, 41.5, 46.3, 120.4.

1-Chlorocyclohexanecarbonitrile (12e): Neat **20** (2.91 g, 26.7 mmol) was added to a CH₃Cl solution (60 mL) of PCl₅ (8.32 g, 40 mmol) and pyridine (4.22 g, 53.4 mmol).⁴ The reaction was heated to reflux and after 16 h the mixture was poured onto ice and extracted with CH₂Cl₂ (2x). The combined organic extract was washed sequentially with brine, and 10% aqueous Na₂CO₃, and then dried (MgSO₄) and concentrated to afford, after purification by radial chromatography

(1:48 to 1:24 EtOAc/hexanes), 4.38 g (81%) of **12e** as an oil: IR (film) 2243, 815 cm^{-1} ; ^1H NMR: d 1.29 – 1.42 (m, 1H), 1.56 – 2.01 (m, 7H), 2.26 – 2.31 (m, 2H); ^{13}C NMR: d 22.9, 23.7, 40.0, 57.2, 119.1. HRMS(EI) calcd for (M^+), $\text{C}_7\text{H}_{10}\text{ClN}^+$ 143.0496, found 143.0533.

2-bromooctanenitrile (12f): The general procedure was employed with octanenitrile (3.44 g, 27.5 mmol), Br_2 (4.48 g, 28 mmol) and PBr_3 (7.56 g, 28 mmol) to afford, after purification by radial chromatography (1: 20 to 1: 10 EtOAc/hexanes), 3.09 g of **12f** (55%) as an oil: IR (film) 2244, 800 cm^{-1} ; ^1H NMR: d 0.88 – 1.60 (m, 11H), 2.06 - 2.13 (m, 2H), 4.29 (t, 1H); ^{13}C NMR: d 13.9, 22.4, 26.9, 27.1, 28.1. 31.3, 36.5, 117.4.

General alkylation procedure A: A THF solution of *i*-PrMgBr (1.05 equiv) was added to a -78 $^\circ\text{C}$, THF solution of the bromonitrile (1.0 equiv) and after 1 minute the electrophile (1.05 equiv) was added neat. After 2 h saturated, aqueous NH_4Cl solution was added, the crude product was extracted with EtOAc, dried (MgSO_4), concentrated, and purified by radial chromatography to afford analytically pure material.

General *in situ* alkylation procedure B: A THF solution of *i*-PrMgBr (1.05 equiv) was added to a -78 $^\circ\text{C}$, THF solution of the bromonitrile (1.0 equiv) and the electrophile (1.05 equiv). After 2 h saturated, aqueous NH_4Cl solution was added, the crude product was extracted with EtOAc, dried (MgSO_4), concentrated, and purified by radial chromatography to afford analytically pure material.

2-Methyl-2-phenyl-pent-4-enenitrile (15a): The standard procedure A was employed with **12a** (195 mg, 0.93 mmol) to afford, after purification by radial chromatography (1:60 to 1:30 EtOAc/hexanes), 115 mg (72%) of **15a**, spectrally identical with previously characterized material.⁵

2-(1-Hydroxy-cyclohexyl)-2-phenyl-propionitrile (15b): The standard procedure B was employed with **12a** (195 mg, 0.93 mmol) to afford, after purification by radial chromatography (1:10 to 1:5 EtOAc/hexanes), 151 mg (71%) of **15b** as an oil: IR (film) 3479, 2235 cm^{-1} ; ^1H NMR d 1.08 – 1.97 (m, 11H), 1.81 (s, 3H), 7.27 – 7.52 (m, 5H); ^{13}C NMR d 20.3, 21.5, 21.7, 25.0, 32.2, 33.0, 51.9, 74.5, 123.4, 127.9, 128.0, 128.2, 136.9; HRMS(EI) calcd for $(\text{M}+\text{Na}^+)$, $\text{C}_{15}\text{H}_{19}\text{NONa}^+$ 252.135882, found 252.13678.

1-Allylcyclohexanecarbonitrile (15c): The standard procedure A was employed with **12b** (45 mg, 0.24 mmol) to afford, after purification by radial chromatography (1:39 to 1:19 EtOAc/hexanes), 22 mg (62%) of **15c** as an oil: IR (film) 3075, 2224, 1635 cm^{-1} ; ^1H NMR: d 1.02 (d, $J = 6.5$ Hz, 1H), 1.13-1.26 (m, 3H), 1.53 - 1.72 (m, 4H), 1.93 (d, $J = 13.1$ Hz, 1H), 2.05-2.50 (m, 2H), 2.15 (d, $J = 10.9$ Hz, 1H), 5.11 - 5.19 (m, 2H), 5.79 – 5.94 (m, 1H); ^{13}C NMR: d 22.8, 25.1, 35.2, 38.7, 44.4, 119.4, 123.1, 131.8; HRMS(EI) calcd for (M^+) , $\text{C}_{10}\text{H}_{15}\text{N}^+$ 149.1199, found 149.1182. The standard procedure B was employed with **12b** (175 mg, 0.93 mmol) to afford, after purification by radial chromatography (1:39 to 1:19 EtOAc/hexanes), 113 mg (82%) of **15c** as an oil. Alkylation of **12e** (40 mg, 0.28 mmol), following general procedure A, but substituting *n*-BuLi for *i*-PrMgBr, afforded 29 mg (72%) of **15c**.

Methyl 1-cyanocyclohexanecarboxylate (15d): The standard procedure A was employed with **12b** (50 mg, 0.26 mmol) and methyl cyanoformate (44 mg, 0.52 mmol) to afford, after purification by radial chromatography (stepped gradient 1:19, 1:9 EtOAc/hexanes), 25 mg (58%) of **15d** as an oil: IR (film) 2239, 1736 cm^{-1} ; ^1H NMR: d 1.13-1.25 (m, 1H), 1.52-1.73 (m, 7H), 1.99 (d, $J = 13.3$ Hz, 2H), 3.69 (s, 3H); ^{13}C NMR: d 22.1, 24.5, 32.9, 45.2, 53.3, 119.0, 169.8; HRMS(EI) calcd for (M^+), $\text{C}_9\text{H}_{13}\text{NO}_2^+$ 167.0941, found 167.0938. The standard procedure B was employed with **12b** (190 mg, 1.01 mmol) and methyl cyanoformate (94 mg, 1.1 mmol) to afford 122 mg (72%) of **15d**.

1-(2,2-Dimethylpropanoyl)cyclohexanecarbonitrile (15e): The standard procedure A was employed with **12b** (50 mg, 0.26 mmol) and pivaloyl chloride (122 mg, 0.52 mmol), to afford, after purification by radial chromatography (stepped gradient 1:39, 1:19 EtOAc/hexanes), 26 mg (52%) of **15e** as a white solid (m.p. 58-59 $^\circ\text{C}$): IR (film) 2229, 1703 cm^{-1} ; ^1H NMR: d 1.23-1.30 (m, 2H), 1.37 (s, 9H), 1.72-1.85 (m, 6H), 1.91-1.94 (m, 2H); ^{13}C NMR: d 21.9, 24.6, 26.5, 34.2, 46.3, 48.0, 121.6, 208.5; HRMS(ESI) calcd for ($\text{M}+\text{Na}^+$), $\text{C}_{12}\text{H}_{19}\text{NONa}^+$ 216.1359, found 216.1364. The standard procedure B was employed with **12b** (185 mg, 0.98 mmol) and pivaloyl chloride (120 mg, 1 mmol) to afford, 130 mg (70%) of **15e**. Alkylation of **12e** (76 mg, 0.53 mmol) with pivaloyl chloride (140 mg, 1.16 mmol), following general procedure A, but substituting *n*-BuLi for *i*-PrMgBr, afforded 55 mg (54%) of **15e**.

1-(1-hydroxyhexyl)cyclohexanecarbonitrile (15f): The standard procedure B was employed with **12b** (188 mg, 1.03 mmol) and hexanal (109 mg, 1.09 mmol) to afford, after purification by radial chromatography (stepped gradient 1:9, 3:17, 1:4 EtOAc/hexanes), 140 mg (65%) of **15f** as

an oil: IR (film) 3457, 2234 cm^{-1} ; ^1H NMR: d 0.84-0.99 (m, 3H), 1.07-1.88 (m, 17H), 2.15 (d, J = 11.8 Hz, 2H), 3.36-3.41 (m, 1H); ^{13}C NMR: d 13.9, 22.5, 22.8, 22.9, 25.2, 25.8, 31.4, 31.5, 31.7, 32.1, 45.6, 76.4, 122.4; HRMS(ESI) calcd for $(\text{M}+\text{Na}^+)$, $\text{C}_{13}\text{H}_{23}\text{NONa}^+$ 232.1672, found 232.1687.

1'-hydroxy-1,1'-bi(cyclohexyl)-1-carbonitrile (15g): The standard procedure B was employed with **12b** (50 mg, 0.27 mmol) and cyclohexanone (26 mg, 0.27 mmol) to afford, after purification by radial chromatography (stepped gradient 1:9, 3:17, 1:4 EtOAc/hexanes), 40 mg (73%) of **15g** as a colorless solid (m.p. 112-113 $^{\circ}\text{C}$): IR (film) 3491, 2222 cm^{-1} ; ^1H NMR: d 1.05-1.15 (m, 1H), 1.35-1.76 (m, 19H), 1.96 (d, J = 8.2 Hz, 1H); ^{13}C NMR: d 21.5, 23.3, 25.2, 25.4, 28.8, 31.8, 49.7, 73.7, 123.0; HRMS(ESI) calcd for $(\text{M}+\text{Na}^+)$, $\text{C}_{13}\text{H}_{21}\text{NONa}^+$ 230.1515, found 230.1522.

1-[(2E)-3-phenylprop-2-enyl]cyclohexanecarbonitrile (15h): The standard procedure B was employed with **12b** (148 mg, 0.79 mmol) and cinnamyl bromide (158 mg, 0.80 mmol) to afford, after purification by radial chromatography (stepped gradient 1:49, 1:24, 3:47 EtOAc/hexanes), 125 mg (70%) of **15h** as a white solid (m.p. 62-63 $^{\circ}\text{C}$): IR (film) 3055, 2226, 1597 cm^{-1} ; ^1H NMR: d 1.13-1.34 (m, 3H), 1.58-1.77 (m, 5H), 2.01 (d, J = 11.8 Hz, 2H), 2.45 (d, J = 7.4 Hz, 2H), 6.24-6.35 (m, 1H), 6.51 (d, J = 16.1 Hz, 1H), 7.22-7.41 (m, 5H); ^{13}C NMR: d 23.0, 25.3, 35.4, 39.2, 43.8, 123.4, 126.3, 127.5, 128.5, 134.5, 136.8; HRMS(EI) calcd for (M^+) , $\text{C}_{16}\text{H}_{19}\text{N}^+$ 225.1512, found 225.1494.

1-Ethynyl-cyclohexanecarbonitrile (15i): The standard procedure B was employed with **12b** (148 mg, 0.79 mmol) and propargyl bromide (95.2 mg, 0.80 mmol) to afford, after purification by radial chromatography (1:50 EtOAc/hexanes), 73.2 mg (63%) of **15i** as an oil: IR (film) 3289, 2234, 2123 cm^{-1} ; ^1H NMR d 1.12 – 2.07 (m, 10H), 2.17 (t, $J = 3.0$ Hz, 1H), 2.48 (d, $J = 3.0$ Hz, 2H); ^{13}C NMR d 22.9, 25.0, 30.3, 34.7, 38.7, 72.3, 78.1, 122.6; HRMS(EI) calcd for (M-H), $\text{C}_{10}\text{H}_{12}\text{N}^+$ 146.0963, found 146.0987. Preparation of **15i** by deprotonation of **20**: Neat **20** (1 mmol, 109 mg) was added to a 0 °C, THF solution (8 mL) of LDA, generated from butyllithium (1.05 mmol) and diisopropylamine (1.10 mmol). After 30 min at 0 °C, propargyl bromide (155 mg, 1.30 mmol) was added, and after a further 2 h at 0 °C, saturated, aqueous NH_4Cl solution was added. The mixture was extracted with EtOAc, and the extracts were then dried (MgSO_4) and concentrated, and then purified by radial chromatography (1:100 to 1:50 EtOAc/hexane) to afford 106 mg (72%) of **15i** as an oil.

(1-Hydroxycyclohexyl)acetonitrile (15j): The standard procedure B was employed with iodoacetonitrile (322 mg, 1.93 mmol) and cyclohexanone (200 mg, 2.03 mmol) to afford, after purification by radial chromatography (stepped gradient 1:4, 3:7, 1:1 EtOAc/hexanes), 208 mg (79%) of **15j** as an oil: IR (film) 3416, 2251 cm^{-1} ; ^1H NMR: d 1.20 - 1.34 (m, 2H), 1.52 - 1.74 (m, 9H), 2.51 (s, 2H); ^{13}C NMR: d 21.5, 24.8, 31.4, 36.5, 69.7, 117.7; HRMS(EI) calcd for (M^+), $\text{C}_8\text{H}_{13}\text{NO}^+$ 139.0992, found 139.0987. The standard procedure A was employed with iodoacetonitrile (194 mg, 1.16 mmol) and cyclohexanone (125 mg, 1.25 mmol), but substituting $n\text{-BuLi}$ for $i\text{-PrMgBr}$, to afford 82.2 mg (51%) of **15j**. The standard general procedure B was employed with bromoacetonitrile (57.6 mg, 0.48 mmol) and cyclohexanone (49.0 mg, 0.50 mmol) to afford 40.0 mg (60%) of **15j** and 10.5mg (6%) of bromo-(1-hydroxy-cyclohexyl)-

acetonitrile (**i**) as an oil: IR (film) 3395, 2234 cm^{-1} ; ^1H NMR: d 1.16 - 1.22 (m, 1H), 1.56 - 1.77 (m, 4H) 2.01 – 2.04 (m, 1H), 2.68 (s, 1H), 3.61 (s, 1H); ^{13}C NMR: d 21.4, 21.5, 24.9, 35.9, 38.8, 53.2, 74.9, 119.5.

General Bromine-Copper exchange Procedure: A THF solution of the bromonitrile was added to a 0 °C, ether solution of Me_2CuLi [generated by adding methyllithium (2.2 equiv) to copper iodide (1.2 equiv)]. After 1h, the electrophile (1.30 equiv) was added neat and, after a further 2 h at 0 °C, saturated, aqueous NH_4Cl solution was then added. The mixture was stirred vigorously with exposure to air for 30 min, and the crude product was extracted with ethyl ether and dried (MgSO_4). Concentration of the crude product and purification by radial chromatography afforded analytically pure material.

1-Allyl-cyclohexanecarbonitrile (15c): The standard procedure was employed with **12b** (188 mg, 1.00 mmol) and allyl bromide (157 mg, 1.30 mmol) to afford, after purification by radial chromatography (1:39 to 1:19 EtOAc/hexanes) 103 mg (69%) of **15c**.

1-(3-Phenyl-allyl)-cyclohexanecarbonitrile (15h): The standard procedure was employed with **12b** (188 mg, 1.00 mmol) and (3-bromo-propenyl)-benzene (256 mg, 1.30 mmol) to afford, after purification by radial chromatography (stepped gradient 1:49, 1:24, 3:47 EtOAc/hexanes) 122 mg (54%) of **15h**.

2-(1-Cyano-cyclohexylmethyl)-acrylic acid ethyl ester (15k): The standard procedure was employed with **12b** (188 mg, 1.00 mmol) and 2-bromomethyl-acrylic acid ethyl ester (251 mg,

1.30 mmol) to afford, after purification by radial chromatography (1:20 to 1:10 EtOAc/hexanes), 155 mg (70%) of **15k** as an oil: IR (film) 2231, 1718, 1629 cm^{-1} ; ^1H NMR d 1.08 – 1.89 (m, 10H), 1.30 (t, $J = 7.4$ Hz, 3H), 2.58 (s, 2H), 4.18 – 4.25 (m, 2H), 5.85 (s, 1H), 6.40 (s, 1H); ^{13}C NMR d 14.1, 23.0, 25.1, 35.3, 40.3, 40.6, 61.1, 122.8, 129.7, 135.2, 167.0; HRMS(EI) calcd for ($\text{M}+\text{Na}^+$), $\text{C}_{13}\text{H}_{19}\text{NO}_2\text{Na}^+$ 244.130797, found 244.13032.

1-Propa-1,2-dienyl-cyclohexanecarbonitrile (15l): The standard procedure was employed with **12b** (188 mg, 1.00 mmol) and propargyl bromide (155 mg, 1.30 mmol) to afford, after purification by radial chromatography (1:100 to 1:50 EtOAc/hexanes), 107 mg (73%) of **15l** as an oil: IR (film) 2236, 1956 cm^{-1} ; ^1H NMR d 1.10 – 2.05 (m, 10H), 4.95 (d, $J = 5.8$ Hz, 2H), 5.10 – 5.20 (m, 1H); ^{13}C NMR d 22.8, 24.9, 36.0, 38.1, 79.5, 94.4, 122.3, 206.9; HRMS(EI) calcd for (M^+), $\text{C}_{10}\text{H}_{13}\text{N}^+$ 147.10425, found 147.1032. Preparation of **15l** by transmetallation of the lithiated nitrile with MeCu: Neat **20** (1 mmol, 109 mg) was added to a 0 °C, THF solution (8 mL) of LDA, generated from butyllithium (1.05 mmol) and diisopropylamine (1.10 mmol). After 30 min at 0 °C, an ether solution (5 mL) of MeCu [prepared from methyl lithium (1.2 mmol) and copper iodide (1.25 mmol)] was added and after a further 1 h at 0 °C, propargyl bromide (155 mg, 1.30 mmol) was added. After two hours at 0 °C, saturated, aqueous NH_4Cl was added. The mixture was stirred vigorously with exposure to air for 30 min, and then the crude product was extracted with ethyl ether, and dried (MgSO_4). The crude product was concentrated and purified by radial chromatography (1:100 to 1:50 EtOAc/hexanes) to afford 103 mg (70%) of **15l**.

2-Allyl-octanenitrile (15m): The standard procedure was employed with **12f** (81.6 mg, 0.40 mmol) and allyl bromide (62.9 mg, 0.52 mmol) to afford, after purification by radial

chromatography (1:80 to 1:40 EtOAc/hexanes), 56.1 mg (85%) of **15m** as an oil: IR (film) 3082, 2238, 1645 cm^{-1} ; ^1H NMR d 0.86 – 0.89 (m, 3H), 1.29 – 1.66 (m, 10H), 2.32 – 2.37 (m, 2H), 2.54 – 2.63 (m, 1H), 5.16 – 5.22 (m, 2H), 5.75 – 5.89 (m, 1H); ^{13}C NMR d 14.0, 22.5, 27.0, 28.7, 31.5, 31.6, 36.3, 118.7, 121.8, 133.2; HRMS(EI) calcd for (M+H), $\text{C}_{11}\text{H}_{20}\text{N}^+$ 166.1600, found 166.1667.

2-Propa-1,2-dienyl-octanenitrile (15n): The standard procedure was employed with **12f** (81.6 mg, 0.40 mmol) and propargyl bromide (61.9 mg, 0.52 mmol) to afford, after purification by radial chromatography (1:100 to 1:50 EtOAc/hexanes), 50.2 mg (77%) of **15n** as an oil: IR (film) 2241, 1959 cm^{-1} ; ^1H NMR d 0.85 – 0.88 (m, 3H), 1.29 – 1.76 (m, 10H), 3.20 – 3.25 (m, 1H), 4.94 – 4.96 (m, 2H), 5.12 (dd, $J = 7.4$ Hz, 5.9 Hz, 1H); ^{13}C NMR d 13.9, 22.4, 26.7, 28.5, 31.0, 31.4, 32.7, 78.7, 87.3, 120.2, 208.1; HRMS(EI) calcd for (M-H), $\text{C}_{11}\text{H}_{16}\text{N}^+$ 162.12761, found 162.1368.

4-Cyano-2-methylene-decanoic acid ethyl ester (15o): The standard procedure was employed with **12f** (81.6 mg, 0.40 mmol) and 2-bromomethyl-acrylic acid ethyl ester (100 mg, 0.52 mmol) to afford, after purification by radial chromatography (1:30 to 1:15 EtOAc/hexanes), 73.9 mg (78%) of **15o** as an oil: IR (film) 3106, 2238, 1712, 1631 cm^{-1} ; ^1H NMR d 0.86 – 0.88 (m, 3H), 1.29 – 1.67 (m, 13H), 2.44 – 2.52 (m, 1H), 2.59 – 2.66 (m, 1H), 2.82 – 2.92 (m, 1H), 4.19 – 4.26 (m, 2H), 5.78 (s, 1H), 6.35 (s, 1H); ^{13}C NMR d 14.0, 14.1, 22.4, 26.9, 28.7, 31.3, 31.5, 32.1, 35.2, 61.0, 121.6, 128.7, 136.1, 166.2; HRMS(EI) calcd for (M+Na $^+$), $\text{C}_{14}\text{H}_{23}\text{NO}_2\text{Na}^+$ 260.162097, found 260.16224.

2-Cyano-octanoic acid methyl ester (15p): The standard procedure was employed with **12f** (81.6 mg, 0.40 mmol) and methyl cyanoformate (44.2 mg, 0.52 mmol) to afford, after purification by radial chromatography (1:32 to 1:16 EtOAc/hexanes), 63.9 mg (87%) of **15p** as an oil: IR (film) 2251, 1751 cm^{-1} ; ^1H NMR d 0.88 (br t, $J = 6.6$ Hz, 3H), 1.29 – 1.59 (m, 10H), 2.15 – 2.20 (m, 1H), 3.87 (s, 3H); ^{13}C NMR d 13.9, 22.3, 25.0, 28.6, 31.2, 34.3, 54.3, 55.1, 114.8, 164.1; HRMS(EI) calcd for $(\text{M}+\text{Na}^+)$, $\text{C}_{10}\text{H}_{17}\text{NO}_2\text{Na}^+$ 206.115147, found 206.11506.

2,3-Dimethyl-2,3-diphenyl-succinonitrile (16) and 2-Methyl-2-phenyl-propionitrile (17):

The general bromine-copper exchange procedure was employed at -78°C with **12a** (210mg, 1.0 mmol) and methyl cyanoformate (128mg, 1.5 mmol) for 1.5 h to afford, after purification by radial chromatography (stepped gradient 1:100, 1:50, 1:1 EtOAc/hexane), 93.6 mg (36%) of **16** (dl and meso)⁶ and 60.9 mg (42%) of **17**⁷, spectrally identical with previous characterized material. Performing the standard procedure at -78°C with **12a** (210 mg, 1.0 mmol) and methyl cyanoformate (128mg, 1.5mmol) with MeCu [generated from MeLi (1.2 mmol) and CuI (1.25 mmol)] rather than Me_2CuLi , afforded, after purification by radial chromatography (stepped gradient 1:100, 1:50, 1:1 EtOAc/hexane), 161 mg (62%) of **16**.

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F2 - Processing parameters
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 F2 -1089.50 Hz
 PPMCK 11.85214 ppm/cm
 HZCM 894.45435 Hz/cm

Current Data Parameters
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 NAME zho5_501
 EXPNO 2
 PROCNO 1

F2 - Acquisition Parameters
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 NUCLEUS 13C

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1D NMR plot parameters
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 F1 18140.87 Hz
 F2P -14.442 ppm
 F2 -1089.90 Hz
 PPMCM 11.85214 ppm/cm
 HZCM 894.45435 Hz/cm

Chloroform-d
 -7.25

PPM

FFZY123.102
DATE 25-10-3

SF 75.469
SY 75.0
O1 6147.202
SI 16384
TD 16384
SM 17857.143
HZ/PT 2.180
PM 4.0
RD 3.000
AG 459
RG 200
NS 16620
TE 297
FW 22400
O2 4004.452
DP 20H BB
LB 0.0
GB 0.0
CX 25.00
CY 4.00
F1 220.033P
F2 .024P
HZ/CM 664.150
PPM/CM 8.800
SR -1401.20

136.760
134.505
128.517
127.544
126.273
123.360

77.429
76.999
76.568

43.784
39.248
35.437

25.269
22.988

~~BROOKER~~

BRIAN32.001
DATE 16-1-99
TIME 12:33

SOLVENT CDCl3
SF 300.133
SY 210.0
O1 4800.000
SI 16384
TD 16384
SN 4504.505
HZ/PT .550

PM 5.0
RD 2.500
AQ 1.819
RG 1
NS 8
TE 297

FM 5700
O2 5684.205
DP 4L P0

LB 0.0
GB 0.0
CX 25.00
CY 1.25
F1 10.001P
F2 -.198P
HZ/CM 122.444
PPM/CM .408
SR 3367.75

PPM

117.559

77.434
76.999
76.989
69.999

38.734
31.706
24.950
21.685

SOLVENT	CDCl3	
SF	75.469	
SY	75.0	
O1	6147.202	
SI	16384	
TD	16384	
SM	17857.143	
HZ/PT	2.180	
PM	4.0	
RD	3.000	
AG	.459	
R6	200	
NS	613	
TE	297	
FM	22400	
O2	4004.452	
DP	20H BB	
LB	.200	
GB	0.0	
CX	25.00	
CY	.50	
F1	220.004P	
F2	-5.001P	
HZ/CM	679.234	
PPM/CM	9.000	
SR	-1396.84

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