Cross Metathesis as a General Strategy for the Synthesis of Prostacyclin and Prostaglandin Analogues – Supporting Information

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General Experimental

All reactions were carried out in oven or flame-dried glassware under an argon atmosphere, unless otherwise stated. Anhydrous tetrahydrofuran (THF) and diethyl ether (Et₂O) were freshly distilled from sodium / benzophenone under argon. All other solvents were HPLC grade. Reactions were magnetically stirred and monitored by thin layer chromatography (TLC) with E. Merck silica gel 60-F254 plates. Flash column chromatography was performed with Merck silica gel (0.04-0.63 μ m, 240-400 mesh) under high pressure. Yields refer to chromatographically and spectroscopically pure compounds, unless otherwise stated. NMR spectra were recorded on either a Bruker Avance DPX 400 MHz or 600 MHz spectrometer. Unless otherwise stated, all NMR spectra were measured in CDCl₃ solutions and referenced to the residual CHCl₃ signal (¹H, δ = 7.26; ¹³C, δ = 77.0). All ¹H and ¹³C NMR shifts are given in ppm (for ¹H NMR: s = singlet, d = doublet, t = triplet, q = quadruplet, m = multiplet; br s = broad signal; for ¹³C NMR: p = primary, s = secondary, t = tertiary, q = quaternary). Coupling constants *J* are given in Hz; assignments of proton resonances were confirmed, when possible, by selective homonuclear decoupling experiments or by correlated spectroscopy.

Reference [7h] in full: T. Maruyama, S.-I. Kuwabe, Y. Kawanaka, T. Shiraishi, Y. Shinagawa, K. Sakata, A. Seki, Y. Kishida, H. Yoshida, T. Maruyama, *Bioorg. Med. Chem.* **2002**, *10*, 2103-2110.

(S)-tert-butylldimethyl(oct-1-en-3-yloxy)silane 9

9

C₁₄H₃₀OSi

M_r = 242.47

¹H NMR (400 MHz, CDCl₃) 5.80 (1H, ddd, *J* 17.2, 10.4, 6.1, H₂C=CH), 5.13 (1H, ddd, *J* 17.2, 1.9, 1.3, HHC=CH), 5.01 (1H, ddd, *J* 10.4, 1.9, 1.1, HHC=CH), 4.08 (1H, dddd, *J* 12.1, 6.1, 1.2, 1.2, CHOTBS), 1.57-1.41 (2H, m, TBSOCHCH₂), 1.41-1.20 (6H, m, CH₂CH₂CH₂CH₃), 0.93-0.85 (3H, m, CH₃), 0.90 (9H, s, SiC(CH₃)₃), 0.06 (3H, s, SiCH₃), 0.04 (3H, s, SiCH₃)

¹³C-NMR (100 MHz, CDCl₃) 141.9 (t), 113.3 (s), 73.9 (t), 38.1 (s), 31.8 (s), 25.9 (p), 24.8 (s), 22.6 (s), 18.2 (q), 14.0 (p), -4.4 (p), -4.8 (p)

IR (Si, Film) $\tilde{\nu}_{\max}$ = 2957, 2930, 2858, 1472, 1252, 1081, 920, 836

HRMS (70 °C 70 eV): *m/z* calcd for C₁₄H₃₀OSi: 242.2066; found 242.2059

Optical Rotation: [α]_D²⁰ = + 6.5 (c = 1.09, acetone)

R_f (10:1 Hex/EtOAc) = 0.68

(R)-tert-butylldimethyl(1-*m*-tolylbut-3-en-2-yloxy)silane 12

12

C₁₇H₂₈O₂Si

M_r = 276.49

¹H NMR (400 MHz, CDCl₃) 7.17 (1H, dd, *J* 7.8, 7.8, ArH), 7.05-6.97 (3H, m, ArH), 5.88 (1H, ddd, *J* 17.2, 10.3, 5.8, H₂C=CH), 5.18 (1H, ddd, *J* 17.2, 1.6, 1.6, HHC=CH) 5.05 (1H, ddd, *J* 10.3, 1.6, 1.6, HHC=CH), (1H, dddd, *J* 6.1, 5.8, 1.2, 1.2, CHOTBS), 2.74 (2H, d, *J* 6.8,

CH_2ArCH_3), 2.34 (3H, s, ArCH_3), 0.86 (9H, s, $\text{SiC}(\text{CH}_3)_3$), -0.08 (3H, s, SiCH_3), -0.20 (3H, s, SiCH_3)

^{13}C -NMR (100 MHz, CDCl_3) 141.3 (t), 138.6 (q), 137.4 (q), 130.9 (t), 127.9 (t), 126.8 (t), 126.8 (t), 113.6 (s), 75.1 (t), 45.0 (s), 25.8 (p), 21.3 (p), 18.2 (q), -4.8 (p), -5.3 (p)

IR (Si, Film) $\tilde{\nu}_{\text{max}}$ = 3024, 2956, 2928, 2857, 1644, 1610, 1472, 1462, 1124, 1078, 1034

HRMS (70 °C 70 eV): m/z calcd for $\text{C}_{17}\text{H}_{28}\text{OSi}$: 276.1909; found 276.1900

Optical Rotation: $[\alpha]_{\text{D}}^{20} = +3.5$ ($c = 1.12$, acetone)

R_f (10:1 Hex/EtOAc) = 0.68

tert-butyl((2R,3R,3aS,6aS)-5-(5-(4-methoxybenzyloxy)pentyl)-3-vinyl-1,2,3,3a,4,6a-hexahydropentalen-2-yloxy)dimethylsilane 16a

$\text{C}_{29}\text{H}_{46}\text{O}_3\text{Si}$ $M_r = 470.76$

^1H NMR (400 MHz, CDCl_3) 7.26 (2H, d, J 8.6, ArH), 6.88 (2H, d, J 8.6, ArH), 5.71 (1H, ddd, J 17.2, 10.1, 7.8, $\text{H}_2\text{C}=\text{CH}$), 5.24 (1H, d, J 1.5, vinylic in ring), 5.10-4.98 (2H, m, $\text{H}_2\text{C}=\text{CH}$). 4.43 (2H, s, OCH_2Ar), 3.80 (3H, s, ArOCH_3), 3.74 (1H, ddd, J 9.6, 9.6, 6.8, CHOTBS), 3.44 (2H, dd, J 6.7, 6.7, alkyl CH_2), 2.94 (1H, pseudo q, J 9.0, $\text{CHCH}_2\text{CHOTBS}$), 2.42 (1H, dd, J 16.3, 8.7, $\text{HC}=\text{CCHH}$), 2.28 (1H, dddd, J 9.5, 9.5, 8.8, 1.7, $\text{H}_2\text{C}=\text{CHCHCH}$), 2.19 (1H, ddd, J 12.1, 8.8, 7.1, CHHCHOTBS), 2.05-1.93 (4H, m, CHCHOTBS , $\text{HC}=\text{CCHH}$, alkyl CH_2), 1.66-1.56 (2H, m, alkyl CH_2), 1.48-1.22 (7H, m, CHHCHOTBS , 3 x alkyl CH_2), 0.87 (9H, s, $\text{SiC}(\text{CH}_3)_3$), 0.02 (6H, s, $\text{Si}(\text{CH}_3)_2$)

¹³C-NMR (100 MHz, CDCl₃) 159.1 (q), 141.8 (q), 140.4 (t), 130.8 (q), 129.2 (t), 127.8 (t), 115.3 (s), 113.7 (t), 77.7 (t), 72.5 (s), 70.1 (s), 58.9 (t), 55.2 (p), 45.4 (s), 43.0 (s), 40.7 (s), 40.0 (s), 31.0 (s), 29.6 (s), 27.6 (s), 26.1 (s), 25.8 (p), 18.1 (q), -4.5 (p), -4.6 (p)

IR (Si, Film) $\tilde{\nu}_{\max}$ = 2929, 2855, 1640, 1613, 1585, 1512, 1462, 1360, 1248, 1171, 1039

HRMS (100 °C 70 eV): *m/z* calcd for C₂₉H₄₆O₃Si: 470.3216; found 470.3229

Optical Rotation: $[\alpha]_{\text{D}}^{20} = -16.3$ (c = 0.83, acetone)

R_f (3:1 Hex/EtOAc) = 0.58

(3*aR*,4*R*,5*R*,6*aS*)-5-(*tert*-butyldimethylsilyloxy)-4-vinylhexahydro-2*H*-cyclopenta[*b*]furan-2-one, 22a

C₁₅H₂₆O₃Si **M_r** = 282.45

¹H NMR (400 MHz, CDCl₃) 5.62 (1H, ddd, *J* 16.7, 10.8, 7.6, H₂C=CH), 5.12-5.10 (1H, m, HHC=CH), 5.07 (1H, ddd, *J* 8.1, 1.3, 1.3, HHC=CH), 4.93 (1H, ddd, *J* 7.1, 7.1, 2.5, HCOC=O), 3.98 (1H, ddd, *J* 6.1, 5.9, 5.8, CHOTBS), 2.75 (1H, dd, *J* 17.4, 10.1, OC=OCHH), 2.70-2.62 (1H, m, H₂C=CHCHCH), 2.49 (1H, dd, *J* 17.7, 2.3, OC=OCHH), 2.42 (1H, dd, *J* 13.4, 6.8, H₂C=CHCH), 2.29 (1H, ddd, *J* 14.6, 7.1, 6.1, CHHCHOTBS), 1.97 (1H, ddd, *J* 14.7, 5.7, 2.6, CHHCHOTBS), 0.87 (9H, s, SiC(CH₃)₃), 0.04 (3H, s, SiCH₃), 0.04 (3H, s, SiCH₃)

¹³C-NMR (100 MHz, CDCl₃) 177.0 (q), 137.6 (t), 116.7 (s), 83.1 (t), 77.7 (t), 58.0 (t), 41.7 (t), 40.6 (s), 34.8 (s), 25.7 (p), 18.0 (q), -4.8 (p), -4.9 (p)

IR (Si, Film) $\tilde{\nu}_{\max}$ = 2930, 2857, 1760, 1644, 1471, 1360, 1258, 1168, 1127, 1036, 980

HRMS (100 °C 70 eV): m/z calcd for $C_{15}H_{26}O_3Si$: 282.1651; found 282.1649

Optical Rotation: $[\alpha]_D^{20} = -23.5$ ($c = 0.31$, acetone)

R_f (1:2 Hex/EtOAc) = 0.65

(3*aS*,4*R*,5*R*,6*aR*)-5-(*tert*-butyldimethylsilyloxy)-4-vinylhexahydropentalen-2(1*H*)-one, 23

$C_{16}H_{28}O_2Si$ **$M_r = 280.48$**

1H NMR (400 MHz, $CDCl_3$) 5.67 (1H, ddd, J 17.7, 9.6, 8.1, $H_2C=CH$), 5.09-5.05 (1H, m, $HHC=CH$), 5.05-5.02 (1H, m, $HHC=CH$), 3.94 (1H, ddd, J 7.3, 7.1, 7.1, $CHOTBS$), 2.76-2.65 (1H, m, $CHCH_2CHOTBS$), 2.56 (1H, ddd, J 19.0, 10.4, 1.3, $O=CCHHCHCH$), 2.52-2.42 (2H, m, $CHCHCH=CH_2$, $O=CCHHCHCH_2$), 2.34 (1H, ddd, J 13.1, 6.3, 1.6, $CHHCHOTBS$), 2.26-2.11 (3H, m, $CHCHOTBS$, $O=CCHHCHCH$, $O=CCHHCHCH_2$), 1.47 (1H, ddd, J 13.2, 7.0, 6.9, $CHHCHOTBS$), 0.86 (9H, s, $SiC(CH_3)_3$), 0.03 (6H, s, $Si(CH_3)_2$)

^{13}C -NMR (100 MHz, $CDCl_3$) 220.1 (q), 139.1 (t), 116.1 (s), 78.9 (t), 59.2 (t), 45.9 (s), 43.1 (s), 42.4 (t), 42.3 (s), 35.5 (t), 25.8 (p), 18.1 (q), -4.7 (p)

IR (Si, Film) $\tilde{\nu}_{max} = 2955, 2930, 2857, 1742, 1641, 1472, 1407, 1257, 1122, 1004$

HRMS (100 °C 70 eV): m/z calcd for $C_{16}H_{28}O_2Si$: 280.1859; found 280.1848

Optical Rotation: $[\alpha]_D^{20} = -30.7$ ($c = 0.5$, acetone)

R_f (3:1 Hex/EtOAc) = 0.46

General Procedure for Cross Metathesis (CM) for Isocarbacyclin Derivatives

Table 1 Isocarbacyclin Derivative Cross Metathesis (Yields Not Optimized)^a

entry	bicyclic olefin	ω -side chain olefin R ^b	PG ₁	product	<i>E</i> : <i>Z</i>	yield (%) ^[c]
1	16a		TBS	17a	15:1	82
2	16a		TBS	17b	11:1	61 ^d
3	16b		H	17c	13:1	74
4	16a		TBS	17d	19:1	90
5	16a		TBS	17e	16:1	66 ^d

^a All reactions were carried out in CH₂Cl₂ at 40 °C. ^b 2 equivalents of ω -side chain used. ^c Isolated yields. ^d 30-35% homodimerized ω -side chain recovered.

The following procedure for the preparation of *tert*-butyl((2*R*,3*R*,3*aS*,6*aS*)-3-((*R,E*)-3-(*tert*-butyldimethylsilyloxy)-4-*m*-tolylbut-1-enyl)-5-(5-(4-methoxybenzyloxy)pentyl)-1,2,3,3*a*,4,6*a*-hexahydropentalen-2-yloxy)dimethylsilane, **17d**, is representative.

To a solution of bicyclic olefin **16a** (0.250 g, 0.53 mmol) and ω -side chain olefin **12** (0.293 g, 1.06 mmol) in degassed CH₂Cl₂ or degassed C₆H₆Me* (30 mL) was added a solution of Grubbs II (6 mol %, 0.027 g, 0.032 mmol) in degassed CH₂Cl₂ or degassed C₆H₆Me (7 mL) *via* syringe pump (over 8 hr.) at 40 or 80°C (see Table 1). After the reaction was complete (monitored by TLC), air was bubbled through the solution to destroy the catalyst. The mixture was concentrated *in vacuo* and purified by flash column chromatography using a

hexanes:ethyl acetate mixture as the mobile phase to afford the corresponding cross metathesis product.

* Degassing of CH₂Cl₂ and C₆H₆Me was achieved by carrying out 4 cycles of the pump and freeze technique.

tert-butyl((S,E)-1-((1R,2R,3aS,6aS)-2-(tert-butyltrimethylsilyloxy)-5-(5-(4-methoxybenzyloxy)pentyl)-1,2,3,3a,6,6a-hexahydropentalen-1-yl)oct-1-en-3-yloxy)dimethylsilane, 17a

17a

C₄₁H₇₂O₄Si₂

M_r = 685.18

¹H NMR (600 MHz, CDCl₃) 7.26 (2H, d, *J* 8.5, *ArH*), 6.88 (2H, d, *J* 8.5, *ArH*), 5.52-5.44 (1H, overlapping dd, *J* 15.4, *HC=CH*), 5.52-5.44 (1H, overlapping dd, *J* 15.4, *HC=CH*), 5.23 (1H, d, *J* 1.5, vinylic in ring), 4.43 (2H, s, OCH₂Ar), 4.06 (1H, ddd, *J* 6.2, 6.2, 4.7, HC=CHCHOTBS), 3.80 (3H, s, ArOCH₃), 3.74 (1H, ddd, *J* 9.4, 7.0, 7.0, CHOTBS), 3.44 (2H, dd, *J* 6.8, 6.6, alkyl CH₂), 2.97-2.88 (1H, m, CHCH₂CHOTBS), 2.39 (1H, dd, *J* 16.3, 8.6, HC=CCHH), 2.23 (1H, dddd, *J* 9.4, 9.4, 8.8, 1.7, HCHCHC=CH), 2.18 (1H, ddd, *J* 12.2, 8.8, 6.9, CHHCHOTBS), 2.04-1.93 (4H, m, HCHC=CH, HC=CCHH, alkyl CH₂), 1.61 (2H, dddd, *J* 7.5, 7.3, 6.8, 6.8, alkyl CH₂), 1.53-1.38 (4H, m, 2 x alkyl CH₂), 1.38-1.22 (9H, 4 x CH₂, CHHCHOTBS), 0.90-0.88 (3H, m, alkyl CH₃), 0.89 (9H, s, SiC(CH₃)₃), 0.86 (9H, s, SiC(CH₃)₃), 0.04 (3H, s, SiCH₃), 0.02 (9H, s, SiCH₃, Si(CH₃)₂)

¹³C-NMR (100 MHz, CDCl₃) 159.6 (q), 141.8 (q), 134.3 (t), 130.9 (t), 130.8 (q), 129.2 (t), 127.8 (t), 113.7 (t), 78.0 (t), 73.3 (t), 72.5 (s), 70.2 (s), 57.0 (t), 55.3 (p), 45.3 (t), 43.3 (t), 40.8 (s), 40.0 (s), 38.7 (s), 31.8 (s), 31.0 (s), 29.6 (s), 27.6 (s), 26.1 (s), 25.9 (p), 25.9 (p), 25.2 (s), 22.6 (s), 18.3 (q), 18.1 (q), 14.0 (p), -4.2 (p), -4.5 (p), -4.6 (p), -4.7 (p)

IR (Si, Film) $\tilde{\nu}_{\max}$ = 2930, 2857, 1608, 1514, 1462, 1255, 1113, 835, 775

HRMS (150 °C 60 eV): m/z calcd for $C_{41}H_{72}O_4Si_2$: 684.4969; found 684.4957

Optical Rotation: $[\alpha]_D^{20} = -1.1$ ($c = 0.3$, acetone)

R_f (10:1 Hex/EtOAc) = 0.52

(S,E)-1-((1R,2R,3aS,6aS)-2-(tert-butyltrimethylsilyloxy)-5-(5-(4-methoxybenzyloxy)pentyl)-1,2,3,3a,6,6a-hexahdropentalen-1-yl)oct-1-en-3-ol, 17b

$C_{35}H_{58}O_4Si$ $M_r = 570.92$

1H NMR (400 MHz, $CDCl_3$) 7.26 (2H, d, J 8.6, ArH), 6.88 (2H, d, J 8.6, ArH), 5.59-5.48 (1H, overlapping dd, J 15.4, 4.3, HC=CH), 5.59-5.48 (1H, overlapping dd, J 15.4, 5.3, HC=CH), 5.24 (1H, d, J 1.3, vinylic in ring), 4.43 (2H, s, OCH_2Ar), 4.10-4.03 (1H, m, HC=CHCHOH), 3.80 (3H, s, $ArOCH_3$), 3.73 (1H, ddd, J 9.8, 9.5, 6.8, CHOTBS), 3.43 (2H, dd, J 6.8, 6.6, alkyl CH_2), 2.94 (1H, dddd, J 8.6, 8.6, 8.5, 1.8, $CHCH_2CHOTBS$), 2.40 (1H, dd, J 16.6, 9.0, HC=CCHH), 2.25 (1H, dddd, J 9.5, 9.5, 8.9, 1.8, $HCHCHC=CH$), 2.18 (1H, ddd, J 12.2, 8.8, 7.0, $CHHCHOTBS$), 2.04-1.93 (4H, m, $HCHC=CH$, $HC=CCHH$, alkyl CH_2), 1.61 (2H, dddd, J 7.3, 7.1, 6.8, 6.8, alkyl CH_2), 1.59-1.57 (1H, m, OH), 1.56-1.24 (15H, m, 7 x alkyl CH_2 , $CHHCHOTBS$), 0.93-0.84 (3H, m, alkyl CH_3), 0.86 (9H, s, $Si(CH_3)_3$), 0.02 (9H, s, $Si(CH_3)_2$)

^{13}C -NMR (100 MHz, $CDCl_3$) 159.1 (q), 141.8 (q), 134.1 (t), 133.1 (t), 130.8 (q), 129.2 (t), 127.8 (t), 113.8 (t), 77.8 (t), 73.1 (t), 72.5 (s), 70.1 (s), 57.3 (t), 55.3 (p), 45.4 (t), 43.2 (t),

40.7 (s), 39.9 (s), 37.3 (s), 31.8 (s), 31.0 (s), 29.6 (s), 27.6 (s), 26.1 (s), 25.9 (p), 25.3 (p), 22.6 (s), 18.1 (q), 14.0 (p), -4.4 (p), -4.6 (p)

IR (Si, Film) $\tilde{\nu}_{\max}$ = 3437, 2930, 2857, 1613, 1587, 1513, 1463, 1360, 1302, 1249, 1172

HRMS (140 °C 50 eV): m/z calcd for $C_{35}H_{58}O_4Si$: 570.4104; found 570.4394

Optical Rotation: $[\alpha]_D^{20} = -3.3$ ($c = 0.48$, acetone)

R_f (3:1 Hex/EtOAc) = 0.37

tert-butyl((2*R*,3*R*,3*aS*,6*aS*)-3-((*R*,*E*)-3-(*tert*-butyldimethylsilyloxy)-4-*m*-tolylbut-1-enyl)-5-(5-(4-methoxybenzyloxy)pentyl)-1,2,3,3*a*,4,6*a*-hexahydropentalen-2-yloxy)dimethylsilane, 17d

$C_{44}H_{70}O_4Si_2$

$M_r = 719.20$

1H NMR (400 MHz, $CDCl_3$) 7.26 (2H, d, J 8.6; ArH), 7.14 (1H, dd, J 7.6, 7.3, ArH), 7.02-6.95 (3H, m, ArH), 6.88 (2H, d, J 8.6, ArH), 5.56-5.42 (1H, overlapping dd, J 15.3, 6.3, $HC=CH$), 5.56-5.42 (1H, overlapping dd, J 15.3, 6.9, $HC=CH$), 5.23 (1H, d, J 1.3, vinylic in ring), 4.43 (2H, s, OCH_2Ar), 4.22 (1H, ddd, J 7.6, 5.9, 5.4, $HC=CHCHOTBS$), 3.80 (3H, s, $ArOCH_3$), 3.72 (1H, ddd, J 9.6, 9.5, 6.8, $CHOTBS$), 3.44 (2H, J 6.8, 6.6, alkyl CH_2), 3.01-2.88 (1H, m, $CHCH_2CHOTBS$), 2.77-2.64 (1H, overlapping dd, J 13.1, 4.5, $HHCArCH_3$), 2.77-2.64 (1H, overlapping dd, J 13.0, 7.7, $HHCArCH_3$), 2.39 (1H, dd, J 15.7, 8.8, $HC=CCHH$), 2.31 (3H, s, $ArCH_3$), 2.25 (1H, dddd, J 9.1, 8.8, 8.5, 2.0, $HCHCHC=CH$), 2.20-2.14 (1H, m, $CHHCHOTBS$), 2.05-1.91 (4H, m, $HCHC=CH$, $HC=CCHH$, alkyl CH_2), 1.61 (2H, dddd, J 7.3, 7.3, 6.8, 6.6, alkyl CH_2), 1.48-1.29 (6H, m, 3 x alkyl CH_2), 1.29-1.22 (1H,

m, CHHCHOTBS), 0.86 (9H, s, SiC(CH₃)₃), 0.80 (9H, s, SiC(CH₃)₃), 0.02 (6H, s, Si(CH₃)₂), -0.14 (3H, s, SiCH₃), -0.22 (3H, s, SiCH₃)

¹³C-NMR (100 MHz, CDCl₃) 159.1 (q), 141.9 (q), 139.0 (q), 137.3 (q), 134.4 (t), 131.9 (t), 130.9 (t), 130.8 (q), 129.2 (t), 127.8 (t), 127.8 (t), 126.9 (t), 126.6 (t), 113.8 (t), 77.8 (t), 75.3 (t), 72.5 (s), 70.2 (s), 57.3 (t), 55.3 (p), 45.4 (t), 45.3 (s), 43.2 (t), 40.8 (s), 40.1 (s), 31.0 (s), 29.6 (s), 27.6 (s), 26.1 (s), 25.9 (p), 25.8 (p), 21.3 (p), 18.2 (q), 18.1 (q), -4.4 (p), -4.6 (p), -4.6 (p), -5.1 (p)

IR (Si, Film) $\tilde{\nu}_{\max}$ = 2929, 2856, 1714, 1610, 1513, 1462, 1360, 1249, 1112, 835

HRMS (160 °C 70 eV): *m/z* calcd for C₄₄H₇₀O₄Si₂: 718.4813; found 718.4801

Optical Rotation: $[\alpha]_{\text{D}}^{20}$ = + 1.4 (c = 0.66, acetone)

R_f (10:1 Hex/EtOAc) = 0.39

(*R,E*)-4-((1*R*,2*R*,3*aS*,6*aS*)-2-(*tert*-butyldimethylsilyloxy)-5-(5-(4-methoxybenzyloxy)pentyl)-1,2,3,3*a*,6,6*a*-hexahydropentalen-1-yl)-1-*m*-tolylbut-3-en-2-ol,

17e

C₃₈H₅₆O₄Si

M_r = 604.93

¹H NMR (400 MHz, CDCl₃) 7.26 (2H, d, *J* 8.6, Ar*H*), 7.18 (1H, dd, *J* 7.6, 7.4, Ar*H*), 7.08-7.01 (3H, m, Ar*H*), 6.88 (2H, d, *J* 8.6, Ar*H*), 5.65-5.54 (1H, overlapping dd, *J* 15.3, HC=CH), 5.65-5.54 (1H, overlapping dd, *J* 15.3, HC=CH), 5.24 (1H, d, *J* 1.3, vinylic in ring), 4.43 (2H, s, OCH₂Ar), 4.37-4.30 (1H, m, HC=CHCHOH), 3.80 (3H, s, ArOCH₃), 3.74 (1H, ddd, *J* 9.6, 9.6, 7.1, CHOTBS), 3.44 (2H, dd, *J* 6.8, 6.8, alkyl CH₂), 2.98-2.90 (1H, m,

CHCH₂CHOTBS), 2.85 (1H, ddd, *J* 13.3, 13.3, 4.4, CHOHCHHArCH₃), 2.71 (1H, dd, *J* 13.3, 8.3, CHOHCHHArCH₃), 2.47-2.36 (1H, m, HC=CCHH), 2.34m(3H, s, ArCH₃), 2.29 (1H, ddd, *J* 8.8, 8.8, 8.7, HCHCHC=CH), 2.18 (1H, ddd, *J* 12.3, 8.8, 7.0, CHHCHOTBS), 2.06-1.93 (4H, m, HCHC=CH, HC=CCHH, alkyl CH₂), 1.61 (2H, dddd, *J* 7.3, 7.1, 6.8, 6.6, alkyl CH₂), 1.47-1.23 (8H, m, 3 x alkyl CH₂, CHHCHOTBS, OH), 0.86 (9H, s, SiC(CH₃)₃), 0.02 (6H, s, Si(CH₃)₂)

HRMS (150 °C 70 eV): *m/z* calcd for C₃₈H₅₆O₄Si: 604.3948; found 604.3957

R_f (3:1 Hex/EtOAc) = 0.38

tert-butyl((2*R*,3*R*,3*aS*,6*aS*)-5-(5-(4-methoxybenzyloxy)pentyl)-3-((*E*)-4-*m*-tolylbut-1-enyl)-1,2,3,3*a*,4,6*a*-hexahydropentalen-2-yloxy)dimethylsilane, 17f

C₃₈H₅₆O₃Si

M_r = 588.93

¹H NMR (400 MHz, CDCl₃) 7.25 (2H, d, *J* 8.8, Ar*H*), 7.15 (1H, dd, *J* 7.8, 7.3, Ar*H*), 7.03-6.96 (3H, m, Ar*H*), 6.86 (2H, d, *J* 8.8, Ar*H*), 5.51 (1H, ddd, *J* 15.1, 6.6, 6.6, vinylic in chain), 5.31 (1H, ddd, *J* 15.1, 8.5, 1.3, vinylic in chain), 5.23 (1H, dd, *J* 3.5, 2.0, vinylic in ring), 4.44 (2H, s, OCH₂Ar), 3.81 (3H, s, OCH₃), 3.70 (1H, ddd, *J* 9.6, 9.6, 7.0, CHOTBS), 3.44 (2H, t, *J* 6.6, alkyl CH₂), 2.92 (1H, dd, *J* 8.8, 8.1, CHCH₂CHOTBS), 2.72-2.58 (2H, m, benzylic CH₂), 2.39 (1H, dd, *J* 16.2, 8.6, HC=CCHH), 2.36-2.28 (2H, m, HC=CHCH₂), 2.33 (3H, s, CH₃), 2.21 (1H, ddd, *J* 9.7, 8.8, 8.6, CHCHCHOTBS), 2.17 (1H, ddd, *J* 12.3, 8.8, 7.0, CHHCHOTBS), 2.05-1.96 (3H, m, HC=CCHH, alkyl CH₂), 1.91 (1H, ddd, *J* 9.7, 9.6, 8.5, CHCHOTBS), 1.62 (2H, dddd, *J* 7.1, 7.1, 6.8, 6.8, alkyl CH₂), 1.48-1.31 (4H, m, 2 x alkyl CH₂), 1.26 (1H, ddd, *J* 12.3, 9.6, 8.1, CHHCHOTBS), 0.87 (9H, s, SiC(CH₃)₃), 0.02 (6H, s, Si(CH₃)₂)

^{13}C -NMR (100 MHz, CDCl_3) 159.3 (q), 142.4 (q), 142.0 (q), 137.9 (q), 132.7 (t), 131.0 (q), 131.0 (t), 129.4 (t), 129.3 (t), 128.3 (t), 128.0 (t), 126.6 (t), 125.6 (t), 113.9 (t), 78.1 (t), 72.7 (s), 70.3 (s), 58.0 (t), 55.4 (t), 45.4 (t), 43.6 (t), 40.8 (s), 40.1 (s), 36.2 (s), 35.0 (s), 31.2 (s), 29.8 (s), 27.8 (s), 26.2 (s), 26.0 (p), 21.6 (p), 18.4 (q), -4.4 (p), -4.4 (p)

IR (Si, Film) $\tilde{\nu}_{\text{max}}$ = 2928, 2855, 1612, 1513, 1172, 1113, 1039, 1005, 908, 836, 700

HRMS (160 °C 70 eV): m/z calcd for $\text{C}_{38}\text{H}_{56}\text{O}_3\text{Si}$: 588.3999; found 588.3984

Optical Rotation: $[\alpha]_{\text{D}}^{20} = +0.5$ ($c = 1.05$, CHCl_3)

R_f (3:1 Hex/EtOAc) = 0.48

General Procedure for Cross Metathesis (CM) for Corey Lactone and Carbacyclin

Derivatives

Table 2 Prostaglandin/Carbacyclin Cross Metathesis (Yields Not Optimized)^a

entry	bicyclic olefin	PG ₁	ω-side chain olefin R ^b	product	<i>E</i> : <i>Z</i>	yield (%) ^c
1	22a	TBS		24a	6:1	76
2^d	22a	TBS		24a	12:1	68
3^e	22a	TBS		24a	17:1	84
4	22a	TBS		24b	12:1	60 ^f
5	22b	H		24c	14:1	70
6	23	TBS		25	7:1	69
7^g	23	TBS		25	10:1	65
8^e	23	TBS		25	10:1	86

^a All reactions were carried out in CH₂Cl₂ at 40 °C. ^b 2 equivalents of ω-side chain used. ^c

Isolated yields. ^d Product described in entry 1 was re-exposed to Grubbs' II for 12 h at 40 °C.

^e Catalyst added over 12 hrs at 40 °C. ^f 30% homodimerized ω-side chain was recovered. ^g

Product described in entry 6 was re-exposed to Grubbs' II for 12 h at 40 °C.

A representative procedure for the cross metathesis reaction is as previously described (*vide supra*).

(3*aR*,4*R*,5*R*,6*aS*)-5-(*tert*-butyldimethylsilyloxy)-4-((*S,E*)-3-(*tert*-butyldimethylsilyloxy)oct-1-enyl)hexahydro-2*H*-cyclopenta[*b*]furan-2-one, 24a

24a

C₂₇H₅₂O₄Si₂ **M_r = 496.87**

¹H NMR (600 MHz, CDCl₃) 5.50 (1H, ddd, *J* 15.4, 5.8, 1.0, HC=CH), 5.37 (1H, ddd, *J* 15.4, 7.7, 1.0, HC=CH), 4.94 (1H, ddd, *J* 7.1, 7.1, 2.1, HCOC=O), 4.04 (1H, ddd, *J* 5.9, 5.7, 5.7, C=CHCHOTBS), 3.98 (1H, ddd, *J* 5.3, 5.3, 5.3, CHOTBS), 2.75 (1H, dd, *J* 18.1, 10.4, OC=OCHH), 2.67-2.61 (1H, m, HC=CHCHCH), 2.49 (1H, dd, *J* 18.1, 2.8, OC=OCHH), 2.44 (dd, *J* 12.9, 6.0, H₂C=CHCH), 2.24 (1H, ddd, *J* 14.8, 7.0, 5.8, CHHCHOTBS), 1.98 (1H, ddd, *J* 14.8, 4.9, 1.9, CHHCHOTBS), 1.51-1.44 (1H, m, CHOTBSCHH), 1.44-1.37 (1H, m, CHOTBSCHH), 1.34-1.20 (6H, m, 3 x alkyl CH₂), 0.90-0.88 (3H, m, alkyl CH₃), 0.88 (9H, s, SiC(CH₃)₃), 0.87 (9H, s, SiC(CH₃)₃), 0.05 (3H, s, SiCH₃), 0.04 (3H, s, SiCH₃), 0.03 (3H, s, SiCH₃), 0.00 (3H, s, SiCH₃)

¹³C-NMR (150 MHz, CDCl₃) 177.0 (q), 135.8 (t), 128.4 (t), 83.4 (t), 79.0 (t), 72.9 (t), 56.1 (t), 42.3 (t), 40.7 (s), 38.4 (s), 35.0 (s), 31.8 (s), 25.9 (p), 25.7 (p), 25.0 (s), 22.6 (s), 18.2 (q), 18.0 (q), 14.0 (p), -4.3 (p), -4.7 (p), -4.8 (p), -4.9 (p)

IR (Si, Film) $\tilde{\nu}_{\text{max}}$ = 2930, 2857, 2362, 1752, 1472, 1249, 1165, 1119, 974

HRMS (160 °C 70 eV): *m/z* calcd for C₂₇H₅₂O₄Si₂: 496.3404; found 496.3395

Optical Rotation: $[\alpha]_{\text{D}}^{20} = -19.2$ (c = 0.43, acetone)

R_f (1:1 Hex/EtOAc) = 0.64

(3aR,4R,5R,6aS)-4-((S,E)-3-(tert-butyl dimethylsilyloxy)oct-1-enyl)-5-hydroxyhexahydro-2H-cyclopenta[b]furan-2-one, 24c

24c

C₂₁H₃₈O₄Si **M_r = 382.61**

¹H NMR (400 MHz, CDCl₃) 5.60 (1H, dd, *J* 15.3, 5.7, HC=CH), 5.41 (1H, dd, *J* 15.3, 9.0, HC=CH), 4.97-4.86 (1H, m, HCOC=O), 4.13-3.95 (2H, m, CHOH, CHOTBS), 2.85-2.30 (5H, m, OC=OCH₂CH, HCHC=CH, CH₂CHOH, OC=OCHH), 2.01 (1H, ddd, *J* 15.0, 6.9, 2.8, OC=OCHH), 1.55-1.41 (2H, m, alkyl CH₂) 1.39-1.21 (6H, m, 3 x alkyl CH₂), 0.89 (9H, s, SiC(CH₃)₃), 0.92-0.85 (3H, m, alkyl CH₃), 0.05 (3H, s, SiCH₃), 0.03 (3H, s, SiCH₃)

¹³C-NMR (100 MHz, CDCl₃) 176.6 (q), 137.6 (t), 127.5 (t), 82.6 (t), 76.8 (t), 72.3 (t), 56.1 (t), 42.6 (t), 39.8 (s), 38.2 (s), 34.3 (s), 31.6 (s), 24.8 (s), 22.5 (s), 25.8 (p), 18.1 (q), 13.9 (p), -4.4 (p), -4.8 (p)

IR (Si, Film) $\tilde{\nu}_{\text{max}}$ = 3396, 2925, 2840, 1761, 1168

HRMS (150 °C 70 eV): *m/z* calcd for C₂₁H₃₈O₄Si: 382.2539; found 382.2547

Optical Rotation: $[\alpha]_{\text{D}}^{20} = -14.7$ (c = 0.48, CH₂Cl₂)

R_f (1:1 Hex/EtOAc) = 0.35

(3*aS*,4*R*,5*R*,6*aR*)-5-(*tert*-butyldimethylsilyloxy)-4-((*S,E*)-3-(*tert*-butyldimethylsilyloxy)oct-1-enyl)hexahydropentalen-2(1*H*)-one, 25

25

C₂₈H₅₄O₃Si₂ **M_r = 494.90**

¹H NMR (600 MHz, CDCl₃) 5.51-5.41 (1H, overlapping dd, *J* 15.5, 5.0, HC=CH), 5.51-5.41 (1H, overlapping dd, *J* 15.5, 7.2, HC=CH), 4.05 (1H, ddd, *J* 6.1, 5.9, 5.5, HC=CHCHOTBS), 3.95 (1H, ddd, *J* 6.8, 6.8, 6.8, CHOTBS), 2.75-2.67 (1H, m, CHCH₂CHOTBS), 2.56 (1H, ddd, *J* 18.7, 10.5, 1.3, O=CCHHCHCH), 2.47-2.37 (1H, overlapping dd, *J* 9.3, 2.7, O=CHHCHCH₂), 2.47-2.37 (1H, overlapping dd, *J* 9.6, 1.3, HCHCHC=CH), 2.33 (1H, ddd, *J* 13.4, 8.6, 6.8 CHHCHOTBS), 2.25-2.20 (1H, m, O=CHHCHCH₂), 2.20-2.14 (2H, m, CHCHOTBS, O=CCHHCHCH), 1.51-1.44 (2H, m, CHHCHOTBS, HC=CHCHOTBSCHH), 1.44-1.37 (1H, m, HC=CHCHOTBSCHH), 1.36-1.21 (6H, m, 3 x alkyl CH₂), 0.90-0.87 (3H, m, alkyl CH₃), 0.87 (9H, s, SiC(CH₃)₃), 0.86 (9H, s, SiC(CH₃)₃), 0.04 (3H, s, SiCH₃), 0.03 (3H, s, SiCH₃), 0.03 (3H, s, SiCH₃), 0.01 (3H, s, SiCH₃)

¹³C-NMR (100 MHz, CDCl₃) 220.3 (q), 135.1 (t), 129.7 (t), 79.3 (t), 73.0 (t), 57.5 (t), 46.0 (s), 43.2 (s), 43.0 (t), 42.4 (s), 38.5 (s), 31.8 (s), 25.9 (p), 25.8 (p), 25.1 (s), 22.6 (s), 18.2 (q), 18.0 (q), 14.0 (p), -4.2 (p), -4.6 (p), -4.7 (p), -4.7 (p)

IR (Si, Film) $\tilde{\nu}_{\max}$ = 2956, 2930, 2857, 1742, 1472, 1361, 1256, 1121, 1005, 837, 776

HRMS (160 °C 70 eV): *m/z* calcd for C₂₈H₅₄O₃Si₂: 494.3611; found 494.3601

Optical Rotation: $[\alpha]_{\text{D}}^{20} = -14.2$ (c = 0.72, acetone)

R_f (5:1 Hex/EtOAc) = 0.48

5-((3*aS*,5*R*,6*R*,6*aS*)-5-hydroxy-6-((*S,E*)-3-hydroxyoct-1-enyl)-1,3*a*,4,5,6,6*a*-hexahydropentalen-2-yl)pentanoic acid (Isocarbacyclin), 1

Isocarbacyclin (1)

C₂₁H₃₄O₄

M_r = 350.25

¹H NMR (600 MHz, CDCl₃) 5.56 (1H, dd, *J* 15.3, 7.2, vinylic in chain), 5.50 (1H, dd, *J* 15.3, 8.4, vinylic in chain), 5.29 (1H, d, *J* 1.4, vinylic in ring), 5.23-3.26 (1H, broad s, COOH), 4.06 (1H, ddd, *J* 6.9, 6.7, 6.7, HC=CHC(OH)H), 3.76 (1H, ddd, *J* 9.6, 7.2, 7.1, HCOH), 3.00 (1H, ddd, *J* 8.8, 8.6, 2.1, CHCH₂CHOH), 2.42-2.25 (5H, m, alkyl CH₂, CHCHCHOH, CHHCHCH, CHHCHOH), 2.06 (2H, dd, *J* 7.2, 6.9, alkyl CH₂), 1.99 (1H, bd, *J* 15.7, CHHCHCH), 1.92 (1H, ddd, *J* 9.5, 9.2, 8.8, CHCHOH), 1.70-1.54 (3H, m, alkyl CH₂, HC=CHC(OH)HCHH), 1.52-1.44 (3H, m, alkyl CH₂, HC=CHC(OH)HCHH), 1.40-1.23 (7H, m, 3 x alkyl CH₂, CHHCHOH), 0.89 (3H, t, *J* 7.0, CH₃)

¹³C-NMR (100 MHz, CDCl₃) 178.1 (q), 141.1 (q), 135.6 (t), 133.0 (t), 128.9 (t), 77.3 (t), 73.3 (t), 58.0 (t), 45.6 (t), 44.3 (t), 39.5 (s), 39.2 (s), 37.0 (s), 33.7 (s), 31.7 (s), 30.3 (s), 26.9 (s), 25.2 (s), 24.3 (s), 22.6 (s), 14.0 (p)

IR (Si, Film) $\tilde{\nu}_{\max}$ = 3369, 2927, 2857, 1707, 1653, 1560, 1540, 1507, 1457, 1261, 1088, 970

HRMS (170 °C 70 eV): *m/z* calcd for C₂₁H₃₄O₄: 350.2457; found 350.2432

Optical Rotation: $[\alpha]_{\text{D}}^{20} = +11.8$ (c = 0.46, CH₂Cl₂)

R_f (EtOAc/1% AcOH) = 0.33

¹H, ¹³C NMR and optical rotation were concurrent with literature values for Isocarbacyclin. See T. Ishikawa; H. Ishii; K. Shimizu; H. Nakao; J. Urano; T. Kudo; S. Saito, *J. Org. Chem.* **2004**, *69*, 8133.

5-((3*aS*,5*R*,6*aS*)-5-hydroxy-6-((*R,E*)-3-hydroxy-4-*m*-tolylbut-1-enyl)-1,3*a*,4,5,6,6*a*-hexahydropentalen-2-yl)pentanoic acid (15*R*-TIC), 2

15*R*-TIC (2)

C₂₄H₃₂O₄

M_r = 384.23

¹H NMR (600 MHz, CDCl₃) 7.20 (1H, dd, *J* 7.6, 7.5, Ar*H*), 7.05 (1H, d, *J* 7.6, Ar*H*), 7.02 (1H, s, Ar*H*), 7.00 (1H, d, *J* 7.5, Ar*H*), 5.61 (1H, ddd, *J* 15.4, 6.7, 0.7, vinylic in chain), 5.44 (1H, ddd, *J* 15.4, 8.7, 0.7, vinylic in chain), 5.28 (1H, d, *J* 3.3, vinylic in ring), 4.35 (1H, ddd, *J* 6.6, 6.5, 6.4, HC=CHC(OH)*H*), 3.63 (1H, ddd, *J* 9.5, 7.0, 6.9, HCOH), 2.98 (1H, ddd, *J* 9.0, 8.9, 8.9, CHCH₂CHOH), 2.86 (1H, dd, *J* 13.3, 7.2, CHHAr), 2.79 (1H, dd, *J* 13.3, 6.3, CHHAr), 2.42-2.34 (2H, m, CH₂COOH), 2.33 (3H, s, CH₃), 2.31-2.27 (2H, m, CHCHCHOH, CHHCHCH), 2.26 (1H, ddd, *J* 12.5, 8.8, 7.1, CHHCHOH), 2.08-1.94 (3H, m, alkyl CH₂, CHHCHCH), 1.89 (1H, ddd, *J* 9.4, 9.3, 9.2, CHCHOH), 1.70-1.58 (2H, m, alkyl CH₂), 1.54-1.45 (2H, m, alkyl CH₂), 1.39-1.18 (3H, CHHCHOH, HC=CHCOH)

¹³C-NMR (100 MHz, CDCl₃) 178.3 (q), 141.3 (q), 138.2 (q), 137.8 (q), 134.3 (t), 132.9 (t), 130.4 (t), 128.5 (t), 128.3 (t), 127.4 (t), 126.6 (t), 76.9 (s), 73.7 (t), 58.1 (t), 45.6 (t), 44.3 (t), 44.3 (t), 39.5 (s), 39.3 (s), 33.5 (s), 30.5 (s), 27.0 (s), 24.4 (s), 21.4 (p)

IR (Si, Film) $\tilde{\nu}_{\text{max}}$ = 3401, 2917, 2849, 1701, 1653, 1560, 1540, 1507, 1457, 1261, 1092, 1020

HRMS (170 °C 70 eV): *m/z* calcd for C₂₄H₃₂O₄: 384.2301; found 384.2287

R_f (EtOAc/1% AcOH) = 0.52

¹H, ¹³C NMR and optical rotation were concurrent with literature values for 15*R*-TIC. See M. Suzuki; K. Kato; R. Noyori; Y. Watanabe; H. Takechi,; K. Matsumura; B. Långström; Y. Watanabe, *Angew. Chem. Int. Ed. Engl.* **1996**, 35, 334.

(Z)-7-((1R,2R,3R,5S)-3,5-dihydroxy-2-((S,E)-3-hydroxyoct-1-enyl)cyclopentyl)hept-5-enoic acid (PGF_{2α}), 4

C₂₀H₃₄O₅

M_r = 354.24

¹H NMR (600 MHz, CDCl₃) 5.88-4.45 (1H, bs, COOH), 5.58 (1H, dd, *J* 15.3, 6.4, vinylic in chain), 5.51 (1H, dd, *J* 15.3, 8.6, vinylic in chain), 5.50-5.44 (1H, m, vinylic in chain), 5.41-5.33 (1H, m, vinylic in chain), 4.19 (1H, t, *J* 4.4, CHOH), 4.11 (1H, q, *J* 6.6, HC=CHCHOH), 3.98-3.94 (1H, m, CHOH), 2.34 (2H, dd, *J* 7.1, 6.7, alkyl CH₂), 2.34-2.30 (1H, m, CHCHOH), 2.26-2.10 (5H, m CHHCHOH, 2 x alkyl CH₂), 1.77 (1H, dd, *J* 15.1, 2.7, CHHCHOH), 1.74-1.62 (2H, m, alkyl CH₂), 1.62-1.54 (1H, m, HC=CHC(OH)HCHH), 1.53-1.44 (2H, m, CHCH₂CH=CH, HC=CHC(OH)HCHH), 1.43-1.29 (6H, 3 x alkyl CH₂), 0.88 (3H, t, *J* 6.9, CH₃)

¹³C-NMR (100 MHz, CDCl₃) 177.6 (q), 134.6 (t), 132.7 (t), 129.6 (t), 129.1 (t), 77.9 (t), 73.0 (t), 72.8 (t), 55.6 (t), 50.6 (t), 42.8 (s), 37.0 (s), 32.9 (s), 31.7 (s), 26.3 (s), 25.3 (s), 25.2 (s), 24.5 (s), 22.6 (s), 14.0 (p)

IR (Si, Film) $\tilde{\nu}_{\text{max}}$ = 3369, 2927, 2857, 1706, 1558, 1456, 1261, 1020, 971, 875, 870, 860

HRMS (150 °C 70 eV): *m/z* calcd for C₂₀H₃₄O₅: 350.2457; found 350.2444

Optical Rotation: $[\alpha]_{\text{D}}^{20} = +24.9$ (*c* = 0.57, THF)

R_f (EtOAc) = 0.18

¹H, ¹³C NMR and optical rotation were concurrent with literature values for PGF_{2α}. See (a) Y. Sato; M. Takimoto; M. Mori, *Chem. Pharm. Bull.*, 2000, 48, 1753. (b) E. J. Corey; N. M. Weinshenker; T. K. Schaaf; W. Huber, *J. Am. Chem. Soc.*, 1969, 91, 5675.

(E)-5-((3aS,5R,6R,6aS)-5-hydroxy-6-((S,E)-3-hydroxyoct-1-enyl)-hexahydropentalen-2(1H)-ylidene)pentanoic acid (Carbacyclin), 6

Carbacyclin (6)

C₂₁H₃₄O₄

M_r = 350.25

¹H NMR (600 MHz, CDCl₃) 4.90-6.49 (1H, bs, COOH), 5.52 (1H, dd, *J* 15.3, 7.0, vinylic in chain), 5.47 (1H, dd, *J* 15.3 8.3, vinylic in chain), 5.22 (1H, t, *J* 6.7, C=CH), 4.05 (1H, ddd, *J* 6.9, 6.9, 6.6, HC=CHC(OH)H), 3.69 (1H, ddd, *J* 9.6, 9.6, 6.9, HCOH), 2.50-2.40 (1H, m, CHCH₂CHOH), 2.40-2.25 (4H, m, alkyl CH₂, CHHCHCH, CHHCHCH₂CHOH), 2.18-1.99 (5H, m, alkyl CH₂, CHHCHCH, CHCHCHOH), 1.97 (1H, bd, *J* 14.5, CHHCHCH₂CHOH), 1.82-1.73 (2H, m, alkyl CH₂), 1.72-1.64 (1H, m, CHCHOH), 1.62-1.53 (1H, m, C(OH)HCHH), 1.51-1.43 (1H, m, C(OH)HCHH), 1.40-1.22 (6H, m, 3 x alkyl CH₂), 1.16 (1H, ddd, *J* 12.3, 9.6, 8.0, CHHCHCH), 0.89 (3H, t, *J* 6.8, CH₃)

¹³C-NMR (100 MHz, CDCl₃) 177.8 (q), 142.7 (q), 135.3 (t), 133.5 (t), 120.9 (t), 77.2 (t), 73.4 (t), 56.9 (t), 45.1 (t), 41.5 (s), 38.1 (s), 37.4 (t), 36.9 (s), 35.8 (s), 32.5 (s), 31.7 (s), 28.4 (s), 25.2 (s), 24.5 (s), 22.6 (s), 14.0 (p)

IR (Si, Film) $\tilde{\nu}_{\text{max}}$ = 3306, 2928, 2858, 1717, 1684, 1653, 1558, 1540, 1507, 1457, 1033, 971

HRMS (170 °C 70 eV): *m/z* calcd for C₂₁H₃₄O₄: 350.2457; found 350.2439

Optical Rotation: $[\alpha]_{\text{D}}^{20} = +91.4$ (c = 0.64, CH₃OH)

R_f (EtOAc/1% AcOH) = 0.33

¹H, ¹³C NMR and optical rotation were concurrent with literature values for Carbacyclin. See a) D. R. Morton, Jr.; F. C. Brokaw, *J. Org. Chem.* **1979**, *44*, 2880; b) S. Okamoto; K. Subburaj; F. Sato, *J. Am. Chem. Soc.* **2000**, *122*, 11244.

C=CC[C@H](C1=CC=C(C)C=C1)OSi(C)(C)CCCC
(R)-*tert*-butyldimethyl(1-*m*-tolylbut-3-en-2-yloxy)silane, **12**

(3aR,4R,5R,6aS)-5-(*tert*-butyldimethylsilyloxy)-4-vinyl-hexahydrocyclopenta[b]furan-2-one, **22a**

tert-butyl((1*R*,2*R*,3*aS*,6*aS*)-1-((*R*,*E*)-3-(*tert*-butyldimethylsilyloxy)-4-*m*-tolylbut-1-enyl)-5-(5-(4-methoxybenzyloxy)pentyl)-1,2,3,3*a*,6,6*a*-hexahydropentalen-2-yloxy)dimethylsilane, **17d**

(*R,E*)-4-((1*R*,2*R*,3*aS*,6*aS*)-2-(*tert*-butyl(dimethylsilyloxy)-5-(5-(4-methoxybenzyloxy)pentyl)-1,2,3,3*a*,6,6*a*-hexahydropentalen-1-yl)-1-*m*-tolylbut-3-en-2-ol, **17e**

Comparison of Saito *et al.* spectral data with our spectral data for Isocarbaeyclin (**1**) δH for Isocarbacyclin (**1**)

¹ H NMR															
Saito (400 MHz)	0.88	1.21- 1.39	1.39- 1.52	1.52- 1.68	1.89	1.96	2.04	2.21- 2.41	2.97	3.73	4.02	4.6-5.8 (acid)	5.29	5.44	5.52
Mulzer (600 MHz)	0.89	1.23- 1.40	1.44- 1.52	1.54- 1.70	1.92	1.99	2.06	2.25- 2.42	3.00	3.76	4.06	3.26-5.23 (acid)	5.29	5.50	5.56

 δC for Isocarbacyclin (1)

¹³ C																					
NMR																					
Saito (126 MHz)	14.0	22.6	24.3	25.2	26.6	30.3	31.7	33.9	36.8	39.1	39.3	44.2	45.4	57.9	73.5	77.1	128.8	133.5	135.6	141.0	178.4
Mulzer (100 MHz)	14.0	22.6	24.6	25.2	26.9	30.3	31.7	33.7	37.0	39.2	39.5	44.3	45.6	58.0	73.3	77.2	128.9	133.0	135.6	141.1	178.1

T. Ishikawa; H. Ishii; K. Shimizu; H. Nakao; J. Urano; T. Kudo; S. Saito, *J. Org. Chem.* **2004**, *69*, 8133.

Comparison of Mori *et al.* and Parve *et al.* spectral data with our spectral data for PGF_{2α} (**4**)

δH for PGF_{2α} (**4**)

¹ H NMR																
Mori (250 MHz)	0.88	1.20-1.78					1.88-2.37			3.90	4.02	4.14	5.29-5.50		5.52	
Mulzer (600 MHz)	0.88	1.29- 1.43	1.44- 1.53	1.54- 1.62	1.62- 1.74	1.77	2.10- 2.26	2.30- 2.34	3.94- 3.98	4.11	4.19	5.33- 5.41	5.44- 5.50	5.51	5.58	4.45- 5.88 (acid)

δC for PGF_{2α} (**4**)

¹³ C NMR																				
Parve (125 MHz)	14.0	22.5	24.6	25.1	25.2	26.3	31.7	33.3	36.8	42.6	49.9	55.1	72.2	73.2	77.3	129.1	129.4	132.8	135.1	177.4
Mulzer (100 MHz)	14.0	22.6	24.5	25.2	25.3	26.3	31.7	32.9	37.0	42.8	50.6	55.6	72.8	73.0	77.9	129.1	129.6	132.7	134.6	177.6

¹H NMR: Y. Sato, M. Takimoto; M. Mori, *Chem. Pharm. Bull.*, **2000**, 48, 1753.

¹³C NMR: O. Parve, I. Jarving, I. Martin, A. Metsala, I. Vallikivi, M. Aidnik, T. Pehk, N. Samel, *Bioorg. Med. Chem. Lett.* **1999**, 9, 1853.

Comparison of Sato *et al.* spectral data with our spectral data for Carbacyclin (**6**)

δ H for Carbacyclin (**6**)

¹ H NMR																	
Sato (300 MHz)	0.88	1.10-1.95					1.93-2.15		2.29	2.46	3.68	4.03	3.5 (acid)	5.21	5.45	5.52	
Mulzer (600 MHz)	0.89	1.16	1.22- 1.40	1.43- 1.51	1.53- 1.62	1.64- 1.72	1.73- 1.82	1.97	1.99- 2.18	2.25- 2.40	2.40- 2.50	3.69	4.05	4.90-6.49 (acid)	5.22	5.47	5.52

δ C for Carbacyclin (**6**)

¹³ C NMR																					
Sato (75 MHz)	13.9	22.5	24.3	25.1	28.0	31.6	32.9	35.8	36.8	37.2	38.0	41.4	44.9	56.8	73.5	77.2	121.0	133.6	135.5	142.7	177.6
Mulzer (100 MHz)	14.0	22.6	24.5	25.2	28.4	31.7	32.5	35.8	36.9	37.4	38.1	41.5	45.1	56.9	73.4	77.2	120.9	133.5	135.3	142.7	177.8

S. Okamoto; K. Subburaj; F. Sato, *J. Am. Chem. Soc.* **2000**, *122*, 11244.