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SUPPLEMENTARY MATERIAL FOR:

A Novel Synthesis of Ikarugamycin. The Carbocyclic Portion.

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Mass spectral and elemental analysis data for diol 7S:

MS 167(14), 166(100), 148(16), 139(13), 137(12), 125(15), 124(38), 122(12), 121(18), 120(19), 119(10), 110(30), 106(10), 105(23); HRMS Calcd for $C_{10}H_{14}O_4$: 198.0892. Found 198.0897; too hygroscopic for combustion analysis.

Mass spectral and elemental analysis data for diol 6S:

MS 195(11), 182(12), 181(30), 180(10), 179(16), 167(24), 166(37), 165(100), 164(12), 163(18), 162(12), 154(25), 153(22), 152(18), 151(25), 150(12), 149(20), 148(17), 147(34), 140(16), 139(26), 138(20), 137(31), 136(62), 135(42), 134(25), 127(17), 126(20), 125(45), 124(52), 123(28), 122(29), 121(30), 120(24), 119(28), 118(11), 116(11), 113(10), 111(26), 110(47), 109(56), 108(40), 107(36), 106(13), 105(34), 104(15), 103(13); HRMS Calcd for $C_{10}H_{14}O_4$: 198.0892. Found 198.0897; too hygroscopic for combustion analysis.

Methyl (4R)-cis-5-(2-Hydroxyethyl)-4-(hydroxymethyl)-1-cyclopentene-1-carboxylate (8).

To a stirred solution of 13.5 g (68.1 mmol) of the mixture of diols **6R** and **7R** in 225 mL of methanol cooled in a room temperature water bath was added a solution of 16.0 g (74.9 mmol, 1.1 eq) of sodium periodate in 300 mL of water. After 45 min methanol was removed on the rotary evaporator and the resulting aqueous suspension was saturated with salt and extracted four times with ethyl acetate.

Removal of solvent left 15.1 g (97%) of crude dialdehyde as a mixture of cyclic methyl hemiacetals.

To a stirred solution of the crude "dialdehyde" in 275 mL of methanol cooled to -78 °C was added all at once 5.00 g (132.5 mmol) of dry, free-flowing sodium borohydride. The gently foaming reaction was left for 30 min at -78 °C and then 30 min more at 0 °C. The solution was made barely acidic (pH 6) with anhydrous HCl in methanol and then evaporated to dryness. The residue was partioned between brine and ethyl acetate, after which the aqueous layer was extracted three times more with ethyl acetate. Concentration of the organic layers at room temperature gave 11.6 g (87%) of diol **8** as a viscous yellow oil. NMR analysis of the product showed that approximately 10% had lactonized. The use of "damp", clumped sodium borohydride and over or under acidification in workup results in a larger proportion of lactone. The lactone can be opened, however, by stirring for 1 h at room temperature with 0.2 eq of sodium dissolved in methanol, followed by the above careful workup.

Diol **8**: ^{1}HMR(360 MHz) 6.83 (t, 1 H, J = 2.5, C2-H), 3.80 (dd, 1 H, J = 9, 11, C6-H), 3.75 (s, 3 H, OCH_3), ca. 3.7p (br m, 3 H, C8-H + 2 x OH), 3.65 (dd, 1 H, J = 8, 11, C6-H), 3.58 (ddd, 1 H, J = 4.5, 9.5, 11, C8-H), 3.10 (ca. qd, 1 H, J = 2, ca. 7, C5-H), 2.65 (m, 1 H, C4-H), 2.45 (ddd, 1 H, J = 3.5, 8, 18, C3-H), 2.21 (ddt, 1 H, J = 2, 10.5, 18, C3-H), 1.89 (ddt, 1 H, J = 5.5, 9, 14, C7-H), 1.44 (ddt, 1 H, J = 4.5, 7.5, 14, C7-H); ^{13}CMR(20 MHz) 166.2 (CO), 143.6 (C2), 140.8 (C1), 61.9 (C6 or C8), 61.2 (C8 or C6), 51.5 (OCH_3), 45.8 (C4), 41.4 (C5), 34.6 (C3), 31.0 (C7).

Lactone derived from **8**: ^{1}HMR(360 MHz) 6.95 (q, 1 H, J = 3, C2-H), 4.49 (ddd, 1 H, J = 2, 4.5, 11.5, C8-H), 4.28 (ddd, 1 H, J = 2.5,

11.5, 12.4, C8-H), ca. 3.70 (br m, 2 H, C6-H + OH), 3.47 (dd, 1 H, J = 7, 12, C6-H), 3.15 (m, 1 H, C5-H), 2.74 (br pentet, 1 H, J = ca. 7.5, C4-H), ca. 2.62 (m, 1 H, C3-H), 2.39 (dtd, 1 H, J = 1, 3, 18.5, C3-H), 2.05 (dddd, 1 H, J = 2, 2, 4.5, 13.5, C7-H), 1.87 (qd, 1 H, J = 4.5, 13.5, C7-H);

^{13}CMR(20 MHz) 164.2 (CO), 144.5 (C2), 133.4 (C1), 70.3 (C8), 62.4 (C6), 44.1 (C4 or C5), 43.1 (C5 or C4), 35.5 (C3), 25.5 (C7).

Methyl (4R)-cis-5-(2-Mesyloxyethyl)-4-(mesyloxymethyl)-1-cyclopentene-1-carboxylate (9).

Methanesulfonyl chloride (9.9 mL, 127 mmol, 2.2 eq) was added dropwise over 15 min to a stirred, ice-cold solution of 11.6 g (58 mmol) of crude diol **8** and 24.2 mL (170 mmol, 3 eq) of triethylamine in 330 mL of dichloromethane. After stirring at 0 °C for 3 h, the mixture was poured into ice water. The organic layer was washed with cold 2 N HCl, water, and 1 N sodium bicarbonate. Concentration provided 20.2 g (100%) of dimesylate **9** as a viscous orange oil, which contained some of the corresponding monomesylate - lactone.

^{1}HMR(360 MHz) 6.84 (br s, 1 H, C2-H), 4.38 (dd, 1 H, J = 8, 10, C6-H), 4.33 (dd, 1 H, J = 7, 10, C6-H), ca. 4.3 (m, 1 H, C8-H), 4.27 (dt, 1 H, J = 6.5, 18, C8-H), 3.75 (s, 3 H, OCH_3), 3.17 (br q, 1 H, J = ca. 7.5, C5-H), 3.07 (s, 3 H, SO_2CH_3), 3.03 (s, 3 H, SO_2CH_3), 2.87 (br sextet, 1 H, J = ca. 8, C4-H), 2.58 (ddd, 1 H, J = 3, 8, 18, C3-H), 2.37 (ddt, 1 H, J = 2, 9.5, 18, C3-H), 2.04 (dq, 1 H, J = 7, 14, C7-H), 1.91 (dq, 1 H, J = 7, 14, C7-H).

Mass spectral and elemental analysis data for ester 10:

MS 168(12), 139(27), 137(12), 111(18), 109(42), 108(28), 107(38);

HRMS Calcd for $C_{10}H_{16}O_2$: 168.1150. Found: 168.1155; Anal. Calcd for $C_{10}H_{16}O_2$: C, 71.39; H, 9.59. Found: C, 71.17; 1 H, 9.59.

(4R)-(-)-cis-5-Ethyl-4-methyl-1-cyclopentene-1-methanol (11).

Diisobutylaluminum hydride (135 mL of 0.65M solution in hexane, 88 mmol, 2.1 eq) was added dropwise over 2.75 h to a stirred solution of 7 g (42 mmol) of crude **10** in 130 mL of Skelly B cooled to -78 °C. After 5 min more the solution was warmed to 0° and quenched by careful dropwise addition of 140 mL of cold 10% sulfuric acid. The layers were separated and the aqueous phase was washed with ether. The combined organic layers were washed with water, 1 N sodium bicarbonate, and brine. Concentration provided 5.9 g (100%) of crude allylic alcohol as a pale yellow oil. A colorless analytical sample of **11** was molecularly distilled at 40 °C, 0.03-0.04 mmHg. $[a]^{23}_D$ -1.6° (c 1.0, abs EtOH); IR 3610, 2930, 1450, 1375, 1020, 975; ^{1}HMR(360 MHz) 5.62 (narrow m, 1 H, C2-H), 4.18 (br d, 1 H, J = 14, C6-H), 4.12 (br d, 1 H, J = 14, C6-H), 2.50 (br m, 1 H, C5-H), 2.45 (m, 1 H, C4-H), 2.37 (ddm, 1 H, J = 7.5, 15.5, C3-H), 1.95 (br, 1 H, OH), 1.90 (dm, 1 H J = 15.5, C3-H), 1.50 (dqd, 1 H, J = 4.5, 7.5, 14, C8-H), 1.41 (m, 1 H, J = 7.5, C8-H), 0.94 (d, 3 H, J = 6.5, C7-H), 0.89 (t, 3 H, J = 7.5, C9-H); ^{13}CMR(20 MHz) 147.0 (s, C1), 125.1 (d, C2), 61.4 (t, C6), 49.1 (d, C5), 39.6 (t, C3), 36.4 (d, C4), 20.6 (t, C8), 15.3 (q, C7), 12.5 (q, C9); MS 140(28), 111(72), 110(12), 109(100), 107(24); HRMS Calcd for $C_9H_{16}O$: 140.1201. Found 140.1203; Anal. Calcd for $C_9H_{16}O$: C, 77.09; H, 11.50. Found: C, 76.89; H, 11.38.

(4R)-cis-1-(Bromomethyl)-5-ethyl-4-methylcyclopentene (12).

Phosphorus tribromide (2.6 mL, 28 mmol) was added dropwise over 15 min to a mechanically stirred solution of 5.4 g (38 mmol) of the crude allylic alcohol **11** and 0.77 mL (9.5 mmol) of pyridine in 30 mL of pentane cooled to -40 °C. After 15 min more the thick mixture was warmed to 0 °C and stirred an additional 45 min. Ice water was added dropwise, the layers were separated, and the aqueous phase was washed twice more with pentane. The combined organic layers were washed with cold 1 N sodium bicarbonate, dried and concentrated leaving 5.9 g (77%) of allylic bromide **12** as a fluid yellow oil which was used immediately in the next step.

^{1}HMR(360 MHz) 5.82 (br s, 1 H, C2-H), 4.11 (d, 1 H, J = 10, C6-H), 4.00 (dm, 1 H, J = 10, C6-H), 2.65 (m, 1 H, C5-H), 2.48 (md, 1 H, J = 4.5, 7, C4-H), 2.42 (ddm, 1 H, J = 7.5, 16, C3-H), 1.90 (dm, 1 H, J = 16, C3-H), 1.58 (dqd, 1 H, J = 4, 7.5, 14, C8-H), 1.38 (dqd, 1 H, J = 7.5, 9, 14, C8-H), 0.92 (t, 3 H, J = 7.5, C9-H), 0.92 (d, 3 H, J = 7, C7-H);

^{13}CMR(20 MHz) 142.8 (s, C1), 130.7 (d, C2), 48.8 (d, C5), 39.8 (t, C3), 35.8 (d, C4), 30.5 (t, C6), 20.0 (t, C8), 15.3 (q, C7), 12.3 (q, C9); MS 204(14), 202(18), 175(28), 173(27), 124(17), 123(100), 121(18), 109(23), 107(10); HRMS Calcd for $C_9H_{15}{}^{79}Br$: 202.0358. Found 202.0363.

(4R)-(-)-[(cis-5-Ethyl-4-methyl-1-cyclopenten-1-yl)methyl]-triphenylphosphonium bromide (13).

The crude allylic bromide **12** (5.9 g, 29 mmol) was added neat dropwise over 20 min to an ice-cold, mechanically stirred solution of 8.4 g (32 mmol, 1.1 eq) of triphenylphosphine in 15 mL f benzene. After addition was complete the solution was warmed to room

temperature and stirred for two weeks. The precipitated salt was collected by vacuum filtration, washed well with benzene, dried under a stream of nitrogen, and stored in a desicator over Drierite. There were obtained 12.5 g (92%) of beige solid, mp 154.5-155.5 °C. $[a]^{23}_{D}$ -2.0° (c 1.0, abs EtOH); ^{1}HMR(360 MHz) 7.87 (d, 1 H, J = 8, p-Ar-H), 7.83 (br t, 2 H, J = ca.8.5, o-Ar-H), 7.22 (td, 2 H, J = 3.5, 7.5, m-Ar-H), 5.68 (br s, 1 H, C2-H), 4.90 (t, 1 H, J = 15.5, C6-H), 4.23 (t, 1 H, J = 15.5, C6-H), 2.21 (m, 2 H, C5-H & C3-H or C4-H), ca. 1.86 (m, 1 H, C3-H or C4-H), 1.80 (m, 1 H, C4-H or C3-H), ca 1.35 (m, 2 H, C8-H), 0.87 (d, 3 H, J = 6.5, C7-H), 0.73 (t, 3 H, J = 7.5, C9-H);
^{13}CMR(20 MHz) 135.3 (d, J_{PC} = 10.0, C2), 135.1 (d, J_{PC} = 3.1, p-Ar), 133.9 (d, J_{PC} = 9.8, o-Ar), 132.9 (d, J_{PC} = 9.7, C1), 130.4 (d, J_{PC} = 12.6, m-Ar), 118.4 (d, J_{PC} = 85.4, i-Ar), 51.1 (d, J_{PC} = 3.0, C5), 39.8 (d, J_{PC} = 2.4, C3), 35.9 (s, C4), 25.2 (d, J_{PC} = 50.0, C6), 20.0 (d, J_{PC} = 1.4, C8), 15.1 (s, C7), 12.1 (s, C9); MS 263(36), 262(100), 261(27), 185(13), 184(17), 183(68), 122(21), 121(11), 108(34), 107(48).

Mass spectral and elemental analysis data for ester 14:
MS 243(21), 242(100), 156(36), 142(14), 124(11);
HRMS Calcd for $C_{17}H_{26}O_4$: 294.1831. Found: 294.1837;
Anal. Calcd for $C_{17}H_{26}O_4$: C, 69.36; H, 8.90. Found: C, 69.35; H, 8.82.

(1S)-(+)-cis,endo-6,7-Dihydroxy-cis-bicyclo[3.3.0]oct-2-ene-2-methanol diisopropylketal (15).

Diisobutylaluminum hydride (105 mL of 1 M solution in hexane, 105 mmol, 2.2 eq) was added dropwise over 1.75 h to a stirred

solution of 14.1 g (48 mmol) of crude **14** in 165 mL of dichloromethane cooled to -78 °C. The solution was stirred 45 min more at -78 °C and then 75 min at 0 °C. Methanol (3.6 mL) was added dropwise, stirring at 0 °C was continued 15 min, and then 36 mL of 10% KOH was added. Stirring was continued at room temperature another 10 min until all precipitate had redissolved. The mixture was distributed between ether and brine, and the aqueous layer was extracted twice more with ether. The combined organic layers were washed with brine and concentrated leaving 13 g (100%) of **15** as a pale yellow oil which partially solidified to a mush. A viscous, colorless analytical sample was obtained by molecular distillation at 100 °C, 0.05 mmHg. $[a]^{22}_{D}$ +0.9 ° (c 0.97, abs EtOH);
IR 3610, 3470, 2940, 1465, 1380, 1220, 1185, 1065, 1020, 980, 945, 825; ^{1}HMR(360 MHz) 5.51 (br s, 1 H, C3-H), 4.74 (td, 1 H, J = 4.5, 6, C7-H), 4.61 (dd, 1 H, J = 6.5, 7, C6-H), 4.16 (br s, 2 H, CH_2OH), 3.20 (m, 1 H, C1-H), ca. 2.75 (m, 2 H, C4-H_{endo} & C5-H), 2.34 (ddt, 1 H, J = 2, 9.5, 17, C4-H_{exo}), 2.10 (septet, 1 H, J = 7, endo-^{i}Pr CH), ca. 2.0 (m, 2 H, C8-H), 1.99 (septet, 1 H, J = 7, exo-^{i}Pr CH), 1.89 (br s, 1 H, OH), 0.96 (d, 6 H, J = 7, endo-^{i}Pr CH_3), 0.92 (d, 6 H, J = 7, exo-^{i}Pr CH_3); ^{13}CMR(20 MHz) 144.8 (s, C2), 126.3 (d, C3), 117.9 (s, $(^{i}Pr)_2CO_2$), 84.6 (d, c6 or C7), 83.2 (d, C7 or C6), 60.8 (t, CH_2OH), 51.6 (d, C1), 45.7 (d, C5), 34.9 (t, C8), 34.2 (d, ^{i}Pr CH), 34.0 (d, ^{i}Pr CH), 31.2 (t, C4), 18.6 (q, ^{i}Pr CH_3), 18.5 (q, ^{i}Pr CH_3); MS 265(10), 224(19), 223(100), 221(46), 135(21), 133(27), 117(55), 115(13), 107(21), 105(38), 103(11); Anal. Calcd for $C_{16}H_{26}O_3$: C, 72.14; H, 9.84. Found: C, 71.98; H, 10.04.

(1S)-(+)-cis,endo-6,7-Dihydroxy-cis-bicyclo[3.3.0]oct-2-ene-2-carboxaldehyde diisopropylketal (16).

Pyridinium dichromate[24] (24.1 g, 64 mmol, 1.5 eq) was added rapidly to a solution of 11.3 g (42.5 mmol) of **15** in 70 mL of dichloromethane with stirring and cooling in a room temperature water bath. After 24 h the mixture was filtered through Florisil with ether. Concentration and prolonged high vacuum drying to remove pyridine provided 10 g (89%) of **16** as a pale yellow liquid. An analytical sample was obtained by molecular distillation at 80 °C, 0.04 mmHg.

$[a]^{22}_{D}$ +9.0 ° (c 1.0, abs EtOH);

IR 2940, 2290, 1675, 1610, 1545, 1420, 1060, 1020, 965, 935;

^{1}HMR(360 MHz) 9.74 (s, 1 H, CHO), 6.75 (q, 1 H, J = 2.5, C3-H), 4.76 (ddd, 1 H, J = 4, 6.5, 7.5, C7-H), 4.63 (dd, 1 H, J = 6.5, 7.5, C6-H), 3.39 (m, 1 H, C1-H), 3.08 (dq, 1 H, J = 3, 19.5, C4-H_{endo}), 2.90 (dddd, 1 H, J = 3.5, 7.5, 9, 9.5, C5-H), 2.58 (ddt, 1 H, J = 2, 9.5, 19.5, C4-H_{exo}), 2.25 (ddd, 1 H, J = 7.5, 9.5, 15, C8-H_{exo}), 2.09 (septet, 1 H, J = 7, endo-^{i}Pr CH), 2.00 (dt, 1 H, J = 4.5, 15, C8-H_{endo}), 1.94 (septet, 1 H, J = 7, exo-^{i}Pr CH), 0.95 (d, 3 H, J = 7, endo-^{i}Pr CH_3), 0.94 (d, 3 H, J = 7, endo-^{i}Pr CH_3), 0.89 (d, 3 H, J = 7, exo-^{i}Pr CH_3), 0.87 (d, 3 H, J = 7, exo-^{i}Pr CH_3);

^{13}CMR(20 MHz) 189.3 (d, CHO), 152.6 (d, C3), 149.2 (narrow d, C2), 117.9 (s, $(^{i}Pr)_2CO_2$), 84.3 (d, C6 or C7), 83.0 (d, C7 or C6), 48.7 (d, C1), 45.4 (d, C5), 35.7 (t, C8), 34.1 (d, ^{i}Pr CH), 33.5 (d, ^{i}Pr CH), 33.0 (t, C4), 18.7 (q, ^{i}Pr CH_3), 18.6 (q, ^{i}Pr Ch_3), 18.5 (q, ^{i}Pr CH_3), 18.3 (q, ^{i}Pr CH_3); MS 239(13), 237(49), 222(43), 221(100), 149(13), 134(10), 133(59), 121(24), 105(47), 103(12);

HRMS Calcd for $C_{16}H_{24}O_3$: 264.1725. Found 264.1732.

Spectral data for a 4:1 mixture of diene ketals 18 and 19:

UV 276; ^{1}HMR(80 MHz) 5.68 (m, 2 H, C7-H & C8-H), 4.68 (m, 2 H, C3-H & C17-H), 3.3-0.8 (m, remaining protons); ^{13}CMR (20 MHz) major diastereomer (**18**) 150.8 (C9), 149.0 (C6), 118.2 ($(^{i}Pr)_2CO_2$), 116.3 (C7 or C8), 116.2 (C8 or C7), 84.6 (C17 or C3), 84.3 (C3 or C17), 48.0 (C5 or C16), 47.8 (C16 or C5), 47.2 (C14 or C13), 47.1 (C13 or C14), 46.8 (C10), 39.2 (C4), 37.6 (C12 or C11), 37.4 (C11 or C12), 34.1 (^{i}Pr CH), 33.8 (^{i}Pr CH), 31.4 (C15), 21.8 (CH_2 of Et), several peaks ca. 18.5 (^{i}Pr CH_3), 15.4 (CH_3 at C11), 12.2 (CH_3 of Et); minor diastereomer (**19**) 149.1 (C9), 148.0 (C6), 120.2 ($(^{i}Pr)_2$CO%2), 116.4 (C7 or C8), 115.8 (C8 or C7), 84.0 (C17 or C3), 82.6 (C3 or C17), 48.8 (C13), 48.1 (C5), 47.6 (C14), 46.1 (C16), 44.9 (C10), 38.7 (C4 or C12), 38.3 (C12 or C4), 35.1 (C11 or ^{i}Pr CH), 34.9 (^{i}Pr CH or C11), 33.6 (^{i}Pr CH), 31.8 (C15), 21.1 (CH_2 of Et), several peaks ca. 18.5 (^{i}Pr CH_3), 14.6 (CH_3 at C11), 12.8 (CH_3 of Et).

Byproducts from the hydrolysis of ketals 18 and 19 to form diols 20 and 21:

Aromatized diol: ^{1}HMR(360 MHz) 7.00 (d, 1 H, J = 7.5, C7-H or C8-H), 6.94 (d, 1 H, J = 7.5, C7-H or C8-H), ca. 4.1 (m, 2 H, C3-H & C17-H), 3.64 (td, 1 H, J = 6.5, 9, C5-H), 3.2-1.2 (m, remaining protons except Me), 0.99 (t, 3 H, J = 7.5, CH_3 of Et), 0.97 (d, 3 H, J = 6.5, CH_3 at C11); ^{13}CMR(90 MHz) 145.5 (s, C9 or C6), 145.1 (s, C6 or C9), 139.2 (s, C13 or C14), 139.0 (s, C14 or C13), 122.6 (d, C7 or C8), 121.2 (d, C8 or C7), 75.9 (d, C17 or C3), 75.4 (d, C3 or C17), 49.7 (d, C10), 46.6 (d, C5), 44.2 (d, C16), 38.2 (t, C12 or C4), 38.0 (t, C4 or C12), 37.7 (d, C11), 30.1 (t, C15), 21.7 (t, CH_2 of Et), 15.0 (q, CH_3 at C11), 12.4 (q, CH_3 of Et).

Unknown diol: ^{1}HMR(360 MHz) 5.95 (d, 1 H, J = 12.5, C7-H or C8-H), 5.86 (d, 1 H, J = 12.5, C7-H or C8-H), ca. 5.65 (m, 1 H), 5.56 (narrow m, 1 H), 4.17-3.99 (m, 2 H, C3-H & C17-H), 3.32 (m, 1 H, C5-H), 3.0-1.2 (m, remaining protons except Me), 0.97 (d, 3 H, J = 6.5, CH_3 at C11), 0.88 (t, 3 H, J = 7.5, CH_3 of Et); ^{13}CMR(90 MHz) 144.2, 131.3, 131.3, 129.7, 126.2, 124.5, 75.6 (C17 or C3), 75.2 (C3 or C17), 51.0, 47.8, 43.2, 40.0, 36.3, 35.5, 31.5 (C15), 20.6 (CH_2 of Et), 15.2 (CH_3 at C11), 12.5 (CH_3 of Et).

Mass spectral and elemental analysis data for enediol 22:

MS 276(27), 258(11), 248(16), 247(100), 240(10), 230(18), 229(80), 211(36), 202(10), 201(43), 185(16), 174(17), 173(15), 171(24), 169(16), 163(10), 157(11), 155(11), 147(16), 145(22), 143(11), 136(11), 135(10), 131(22), 130(11), 129(16), 128(11), 122(13), 121(10), 119(13), 117(25), 115(12), 109(21), 107(30), 105(21); HRMS Calcd for $C_{18}H_{28}O_2$: 276.20892. Found 276.20836.

Byproducts from the reduction of diene 20 to form enediol 22:

Minor 1,2-reduced diol: ^{1}HMR(360 MHz) 5.39 (br s, 1 H, C7-H), 3.95 (m, 2 H, C3-H & C17-H), 2.81 (br q, 1 H, J = 9, C5-H), 2.72 (br, 2 H, OH), 2.47 (qd, 1 H, J = 6, 9.5, C16-H), 2.25-0.8 (m, remaining protons except Me), 0.91 (t, 3 H, J = 7.5, CH_3 of Et), 0.86 (d, 3 H, J = 7, CH_3 at C11);
^{13}CMR(90 MHz) 149.5 (s, C6), 117.6 (d, C7), 75.5 (d, C17 or C3), 75.0 (d, C3 or C17), 49.9 (d), 48.8 (d), 46.9 (d), 45.8 (d), 44.2 (d), 43.7 (d), 39.4 (t, C12 or C4), 38.9 (t, C4 or C12), 33.8 (d, C11), 31.8 (t, C8 or C15), 31.7 (t, C15 or C8), 22.0 (t, CH_2 of Et), 17.8 (q, CH_3 at C11), 13.3 (q, CH_3 of Et).

MS 258(40), 240(26), 231(13), 230(64), 226(11), 223(18), 214(22), 213(100), 199(12), 198(11), 196(15), 195(57), 187(16), 186(43), 184(16), 177(13), 172(12), 170(21), 168(10), 163(11), 162(50), 161(30), 160(31), 159(28), 157(25), 156(10), 155(18), 149(15), 147(13), 145(19), 144(21), 142(16), 136(11), 135(11), 134(37), 133(11), 132(39), 131(12), 130(24), 128(14), 124(13), 123(22), 121(21), 120(15), 119(39), 118(16), 117(43), 116(17), 111(34), 110(48), 109(24), 108(11), 107(23), 106(13), 105(51), 104(13), 104(26);

HRMS Calcd for $C_{18}H_{28}O_2$: 276.2089. Found: 276.2073.

1,4-Reduced diol: ^{1}HMR(360 MHz) 5.57 (dt, 1 H, J = 2, 10.5, C7-H or C8-H), 5.40 (br d, 1 H, J = 10.5, C7-H or C8-H), 3.93 (m, 2 H, C3-H & C17-H), 3.15 (br, 1 H, OH), 2.91 (br, 1 H, OH), 2.46 (br q, 1 H, J = 9, C16-H), 2.40 (m, 1 H), 2.27-2.01 (m, 8 H), 1.82 (dd, 1 H, J = 7, 14.5), 1.52-1.32 (m, 4 H, CH_2 of Et & ?), 1.04 (m, 1 H), 0.94 (t, 3 H, J = 7.5, CH_3 of Et), 0.80 (d, 3 H, J = 7, CH_3 at C11); ^{13}CMR(90 MHz) 130.9 (d, C7), 126.6 (d, C8), 75.2 (d, C17), 74.6 (d, C3), 48.3 (d, C5), 46.2 (d, C16), 43.6 (d, C10), 42.7 (d, C6), 41.2 (d, C9), 39.4 (t, C12), 38.9 (d, C14 or C13), 38.6 (d, C13 or C14), 37.9 (t, C4), 33.9 (d, C11), 30.1 (t, C15), 20.0 (t, CH_2 of Et), 18.6 (q, CH_3 at C11), 13.6 (q, CH_3 of Et); MS 258(20), 241(16), 231(10), 230(41), 223(19), 213(54), q95(24), 187(13), 186(41), 170(12), 161(11), 160(16), 159(12), 157(14), 156(16), 155(14), 144(12), 143(20), 142(18), 134(16), 132(22), 130(16), 129(10), 128(11), 124(10), 123(17), 121(14), 119(27), 118(15), 117(39), 116(26), 111(11), 110(21), 109(14), 107(15), 106(15), 105(54), 105(14), 104(24); HRMS Calcd for $C_{18}H_{28}O_2$: 276.20892. Found: 276.20810.

(2R)-cis,anti,cis,cis-2,3,5,5a,5b,6,7,8,8a,9,9a,9b-Dodecahydro-3-ethyl-2-methyl-1H-cyclopent[b]-as-indacene-cis,endo-7,8-diol acetonide (23).

A solution of 0.22 g (0.8 mmol) of the major 1,2-reduced diol **22** and a few crystals of p-toluenesulfonic acid monohydrate in 20 mL of acetone and 2 mL of THF was stirred overnight at room temperature. After 14 h solid sodium bicarbonate was added and stirring was continued for 1 h. After stripping the solvents, the residue was filtered through a plug of silica gel using 2:1 Skelly B : ethyl acetate. Concentration provided 0.26 g (100%) of the acetonide **23** as a yellow oil.

^{1}HMR(360 MHz) 5.37 (m, 1 H, J = 3, 5, C8-H), 4.74 (dt, 1 H, J = 2.5, 6, C3-H), 4.52 (dd, 1 H, J = 6, 7.5, C17-H), 2.49 (qd, 1 H, J = 4.5, 8.5, C16-H), 2.33 (dm, 1 H, J = 2, ?, 19, C7-H), 2.25-2.00 (m, 7 H), 1.94-1.74 (m, 4 H), 1.6-1.37 (m, 2 H), 1.46 (s, 3 H, acetonide endo CH_3), 1.30 (m+s, 4 H, CH_2 of Et & acetonide exo CH_3), 1.04 (m, 1 H, C12-H), 0.92 (t, 3 H, J = 7.5, CH_3 of Et), 0.73 (d, 3 H, J = 7, CH_3 at C11); ^{13}CMR(90 MHz) 147.9 (s, C9), 115.6 (d, C8), 110.4 (s, Me_2CO_2), 84.2 (d, C17), 82.5 (d, C3), 51.8 (d, C5), 48.5 (d, C10 or C16), 47.9 (d, C16 or C10), 46.3 (d, C13), 43.2 (d, C14), 41.5 (d, C6), 37.9 (t, C12), 35.0 (d, C11), 33.9 (t, C4), 30.6 (t, C15), 28.0 (t, C7), 26.6 (q, acetonide exo CH_3), 24.1 (q, acetonide endo CH_3), 20.8 (t, CH_2 of Et), 15.8 (q, CH_3 at C11), 12.5 (q, CH_3 of Et); MS 317(28), 316(97), 302(16), 301(61), 287(39), 259(20), 258(26), 255(10), 241(31), 240(22), 230(30), 229(100), 225(10), 213(11), 212(13), 211(60), 209(19), 202(12), 201(51), 199(14), 185(21), 178(14), 176(12), 175(19), 174(21), 173(21), 171(21), 170(12), 169(19), 161(12), 159(14), 157(21), 155(13), 147(27), 145(29),

143(22), 142(12), 141(11), 136(27), 135(13), 133(17), 131(29), 130(11), 129(37), 128(16), 123(16), 122(17), 121(28), 119(21), 117(37), 116(10), 115(19), 109(54), 108(15), 107(60), 106(15), 105(58), 104(12), 103(11);

HRMS Calcd for $C_{21}H_{32}O_2$: 316.24022. Found: 316.24088.

(2R)-cis,cis,anti,cis,cis-Tetradecahydro-3-ethyl-2-methyl-1H-cyclopent[b]-as-indacene-4,cis,endo-7,8-triol acetonide (24).

Cold borane-THF (2.4 mL of 1 M solution, 2.4 mmol, 3 eq) was added dropwise over 4 min to a stirred, ice-cold solution of 0.26 g (0.8 mmol) of crude **23** in 3.5 mL of THF. The solution was stirred 15 min more at 0 °C and then 1 hr at room temperaturen The reaction was again cooled in ice and quenched by careful dropwise addition of 0.25 mL of water followed by 0.6 mL (2.4 mmol, 3 eq) of 4 M sodium hydroxide and 0.55 mL (5.3 mmol, 6.6 eq) of 30% hydrogen peroxide. The mixture was heated at 55 °C for 1 h, then cooled and acidified with 6 N HCl until only weakly basic. The mixture was saturated with sodium chloride and extracted thrice with ether. Concentration gave 0.34 g of crude product which was purified by semi-preparative HPLC using 3:1 Skelly B : ethyl acetate. There was obtained 0.21 g (77%) of the equatorial alcohol **24** as a colorless, viscous oil. If care is not exercised in excluding air during the oxidation, a small quantity of the corresponding axial alcohol may be obtained. (This alcohol can also be oxidized in the next step without incident.)

Equatorial alcohol **24**:

^{1}HMR(360 MHz) 4.57-4.48 (m, 2 H, C3-H & C17-H), 3.71 (ddd, 1 H, J = 4, 10, 11.5, C8-H), 2.53 (br q, 1 H, J = ca. 8, C16-H), 2.20 (qd, 1 H, J = 3, 8), 2.11 (br q (?), 1 H, J = 7.5), 2.08-1.91 (m, 6 H),

1.89-1.70 (m, 3 H), 1.60-1.40 (m, 5 H), 1.48 (s, 3 H, acetonide endo CH_3), 1.30 (s, 3 H, acetonide exo CH_3), 1.04 (q, 1 H, J = 12, C12-H), 0.99 (d, 3 H, J = 7, CH_3 at C11), 0.98 (t, 3 H, J = 7.5, CH_3 of Et), 0.95-0.88 (m, 1 H);

^{13}CMR(90MHz) 110.9 (s, Me_2CO_2), 8s.1 (d, C17 or C3), 82.9 (d, C3 or C17), 69.9 (d, C8), 52.1 (d, C5), 49.2 (d, C9 or C16), 48.3 (d, C16 or C9), 43.9 (d, C13), 42.5 (d, C10 or C6 or C14), 42.0 (d, C6 or C10 or C14), 41.8 (d, C14 or C6 or C10), 40.1 (t, C12), 38.8 (t, C7 or C4), 37.0 (t, C4 or C7), 34.2 (d, C11), 30.3 (t, C15), 27.4 (q, acetonide exo CH_3), 24.9 (q, acetonide endo CH_3), 20.5 (t, CH_2 of Et), 18.4 (q, CH_3 at C11), 14.6 (q, CH_3 of Et);

MS 335(10), 334(38), 321(18), 320(75), 319(100), 317(15), 316(41), 277(16), 260(13), 259(49), 258(30), 242(22), 241(63), 240(29), 229(33), 219(12), 215(23), 214(39), 213(12), 211(25), 202(11), 201(40), 199(13), 185(20), 175(19), 174(10), 173(14), 171(13), 161(25), 159(13), 157(17), 147(11), 145(13), 135(10), 133(14), 131(14), 129(10), 123(10), 121(16), 119(16), 117(19), 109(25), 107(15), 105(23);

HRMS Calcd for $C_{21}H_{34}O_3$: 334.25078. Found: 334.25010.

Axial alcohol:

^{1}HMR(360 MHz) 4.50 (m, 2 H, C3-H & C17-H), 3.97 (br s, 1 H, C8-H), 2.56 (br q, 1 H, J = ca. 8, C16-H), 2.32-1.83 (m, 10 H), 1.60-1.23 (m, 7 H), 1.51 (s, 3 H, acetonide endo CH_3), 1.31 (s, 3 H, acetonide exo CH_3), 1.10 (br s, 1 H, OH), 0.95 (t, 3 H, J = 7.5, CH_3 of Et), 0.94 (d, 3 H, J = 7, CH_3 at C11);

^{13}CMR(90 MHz) 111.3 (s, Me_2CO_2), 83.1 (d, C17 or C3), 83.0 (d, C3 or C17), 66.6 (d, C8), 51.3 (d, C5), 46.6 (d, C16), 42.9 (t, C12), 42.4

(d, C10 or C9), 41.9 (d, C9 or C10), 40.3 (d, C13), 39.3 (d, C14), 38.1 (t, C4), 35.7 (d + t, C6 & C7), 32.9 (d, C11), 30.2 (t, C15), 28.0 (q, acetonide exo CH_3), 25.6 (q, acetonide endo CH_3), 19.9 (CH_2 of Et), 16.1 (q, CH_3 at C11), 14.5 (q, CH_3 of Et);
MS 320(21), 319(100), 317(13), 316(27), 259(17), 258(13), 241(42), 240(24), 229(11), 215(10), 214(18), 211(13), 201(33), 185(13), 175(15), 173(11), 161(10), 159(11), 157(16), 149(11), 147(12), 145(15), 135(10), 133(17), 131(19), 129(13), 123(13), 121(23), 119(21), 117(23), 115(10), 109(35), 107(21), 105(31);
HRMS Calcd for $C_{21}H_{34}O_3$: 334.25078. Found: 334.25162.

(2R)-cis,cis,anti,cis,cis-Tetradecahydro-3-ethyl-2-methyl-1H-cyclopent[b]-as-indacene-cis,endo-7,8-diol-4-one acetonide (25).

A mixture of 0.21 g (0.6 mmol) of **24**, 0.35 g (0.93 mmol, 1.5 eq) of pyridinium dichromate, and 48 mg (0.25 mmol, 0.4 eq) of pyridinium trifluoroacetate[24] in 2.5 mL of dichloromethane was stirred at room temperature. After 3.5 hr ether was added and the mixture was filtered through silica gel with ether. Concentration of the filtrate gave 0.18 g (90%) of the ketone **25** as a yellow oil.
^{1}HNMR(360 MHz) 4.63 (td, 1 H, J = 3.5, 6.5, C3-H), 4.52 (t, 1 H, J = 6.5, C17-H), 2.66 (dd, 1 H, J = 6.5, 8, C9-H), 2.56 (br q, 1 H, J = ca. 8, C16-H), 2.38-2.29 (m, 2 H), 2.25-2.09 (m, 6 H), 2.08-1.88 (m, 3 H), 1.63 (m, 1 H), 1.55-1.35 (m, 3 H), 1.45 (s, 3 H, acetonide endo CH_3), 1.29 (s, 3 H, acetonide exo CH_3), 1.06 (dt, 1 H, J = 9.5, 12.5, C12-H), 0.96 (d, 3 H, J = 7, CH_3 at C11), 0.90 (t, 3 H, J = 7.5, CH_3 of Et);
^{13}CMR(90 MHz) 214.5 (s, C8), 110.7 (s, Me_2CO_2), 83.3 (d, C17), 82.6 (d, C3), 54.4 (d, C9), 53.1 (d, C5), 47.6 (d, C16), 45.6 (d, C10),

44.9 (t + d, C7 & C6 or C13 or C14), 44.5 (d, C13 or C14 or C6), 44.4 (d, C14 or C13 or C6), 40.5 (t, C12), 35.8 (t, c4), 35.5 (d, C11), 31.4 (t, C15), 26.9 (q, acetonide exo CH_3), 24.4 (q, acetonide endo CH_3), 19.8 (t, CH_2 of Et), 17.0 (q, CH_3 at C11), 14.8 (q, CH_3 of Et); MS 333(10), 332(33), 319(11), 318(18), 317(75), 274(12), 257(29), 256(13), 239(10), 217(18), 215(12), 191(24), 175(14), 173(14), 161(10), 137(12), 135(12), 133(14), 131(11), 129(10), 121(17), 119(16), 117(19), 109(27), 107(21), 105(21);
HRMS Calcd for $C_{21}H_{32}O_3$: 332.2351. Found: 332.2363.

(2R)-cis,trans,anti,cis,cis-Tetradecahydro-3-ethyl-2-methyl-1H-cyclopent[b]-as-indacene-cis,endo-7,8-diol-4-one acetonide (26).

Pentane-washed sodium metal (10 mg, 0.45 mmol, 1 eq) was added to a stirred solution of 0.15 g (0.45 mmol) of crude ketone **25** in 5 mL of methanol. After 15 min at room temperature the solution was heated at 60 °C for 2.5 h. After cooling the solution was neutralized with 0.08 mL (0.48 mmol) of 6 N HCl and the methanol was stripped off. The residue was partitioned between ether and water, and the aqueous layer was washed twice more with ether. The combined organic layers were washed with brine and concentrated leaving 0.15 g (100%) of the epimerized ketone **26** as an off-white crystalline solid. X-ray quality crystals were grown from ethyl acetate as colorless flat plates, mp 152-2.5 °C. The X-ray structure determination[11] confirmed the configuration of all stereochemical centers to be as shown.

^{1}HMR(360 MHz) 4.72 (td, 1 H, J = 1.5, 6, C3-H), 4.48 (dd, 1 H, J = 6, 7.5, C17-H), 2.59-2.46 (m, 3 H, C9-H, C16-H, & ?), 2.30-2.00 (m, 9 H), 1.88 (ddd, 1 H, J = 6.5, 8, 15, C4-H_{exo}), 1.77 (br d, 1 H, J =

15, C4-H_{endo}), 1.65-1.51 (m, 2 H), 1.48 (s, 3 H, acetonide endo CH_3), 1.38-1.25 (m, 2 H), 1.30 (s, 3 H, acetonide exo CH_3), 0.90 (d, 3 H, J = 6.5, CH_3 at C11), 0.83 (t, 3 H, J = 7.5, CH_3 of Et); ^{13}CMR(90 MHz) 212.0 (s, C8), 110.4 (s, Me_2CO_2), 84.1 (d, C17), 82.3 (d, C3), 60.6 (d, C9), 50.1 (d, C5), 49.4 (d, C13 or C14 or C16), 48.7 (d, C14 or C13 or C16), 48.6 (d, C16 or C14 or C13), 46.1 (d, C10), 43.4 (t, C7), 40.8 (d, C6), 40.6 (t, C12), 33.3 (t, C4), 33.3 (d, C11), 28.3 (t, C15), 26.7 (q, acetonide exo CH_3), 24.1 (q, acetonide endo CH_3), 22.9 (t, CH_2 of Et), 17.0 (q, CH_3 at C11), 12.7 (q, CH_3 of Et); MS 332(27), 318(24), 317(100), 257(26), 239(12), 217(22), 214(13), 173(10), 137(19), 109(14); HRMS Calcd for $C_{21}H_{32}O_3$: 332.23513. Found: 332.23599.

(2R)-cis,trans,anti,cis,cis-2,3,3a,5a,5b,6,7,8,8a,9,9a,9b-Dodecahydro-3-ethyl-2-methyl-1H-cyclopent[b]-as-indacene-cis,endo-7,8-diol acetonide (28).

n-Butyllithium (0.17 mL of 4.2 M solution in hexane, 0.72 mmol, 3.6 eq) was added dropwise to a stirred solution of 0.10 mL (0.72 mmol, 3.6 eq) of diisopropylamine in 2 mL of THF cooled to -78 °C. The solution was warmed briefly to 0 °C to ensure complete deprotonation, then recooled to -78 °C and treated dropwise with a solution of 67 mg (0.2 mmol) of recrystallized ketone **26** in 1 mL of THF. After 5 min more at -78 °C the solution was warmed to 0 °C and 0.5 mL of HMPA was added followed by 0.3 mL (2.0 mmol, 10 eq) of bis(dimethylamino)phosphorochloridate (Aldrich)[25]. The orange solution was stirred 20 min at 0 °C and then 2 hr at room temperature. Sodium bicarbonate (2 mL of 1 N solution) was added and stirring was continued 30 min more. The mixture was diluted with

water and extracted three times with ether. The combined ether layers were washed with water and brine and concentrated leaving 95 mg (100%) of the intermediate enol phosphorodiamidate **27** as an orange oil.

A stirred solution of **27** (95 mg, 0.2 mmol) in 2.5 mL of THF was cooled to -78 °C and ammonia (ca. 3 mL) was redistilled from a blue solution with lithium wire into the flask until precipitation of the enol derivative began. A solution of 0.08 mL (0.8 mmol, 4 eq) of tert-butanol in 0.5 mL of THF was then added followed by 4 very small pieces of pentane-washed lithium wire. The mixture, which slowly turned blue, was stirred at -78 °C for 2 hr and then left to slowly warm to room temperature overnight. The resulting mixture was cooled in ice and quenched by careful dropwise addition of methanol and then water. After acidification with conc HCl the mixture was extracted three times with ether. The combined organic layers were washed with water, 1 N sodium bicarbonate, and brine. Concentration gave 56 mg (88%) of acetonide **28** as a colorless oil.

^{1}HMR(360 MHz) 5.80 (dt, 1 H, J = 1.5, 10, C8-H), 5.71 (dt, 1 H, J = 3, 10, C7-H), 4.72 (td, 1 H, J = 2, 6, C3-H), 4.50 (t, 1 H, J = 6.5, C17-H), 2.62 (m, 1 H), 2.41 (qd, 1 H, J = 3, 8, C16-H), 2.24 (br pentet, 1 H, J = 7.5), 2.19 (dd, 1 H, J = 3, 8.5), 2.17-2.06 (m, 3 H), 1.92 (dt, 1 H, J = 2, 14.5, C4-H_{exo}), 1.86 (dd, 1 H, J = 7, 14.4, C4-H_{endo}), 1.58-1.42 (m, 3 H), 1.46 (s, 3 H, acetonide endo CH_3), 1.40-1.25 (m, 2 H), 1.29 (s, 3 H, acetonide exo CH_3), 1.12 (qd, 1 H, J = 7, 11.5), 0.93 (t, 3 H, J = 7, CH_3 of Et), 0.87 (d, 3 H, J = 7, CH_3 at C11), 0.69 (td, 1 H, J = 7, 12, C12-H); ^{13}CMR(90 MHz) 129.7 (d, C8), 128.0 (d, C7), 109.3 (s, Me_2CO_2), 82.7 (d, C17), 81.8 (d, C3), 51.5 (d, C5), 46.8, 46.4, 46.3, 46.2, 46.1, 45.5 (all d, C6, C9,

C10, C13, C14, C16), 37.7 (t, C12), 33.6 (t, C4), 32.2 (d, C11), 28.8 (t, C15), 25.5 (q, acetonide <u>exo</u> CH_3), 22.7 (q, acetonide <u>endo</u> CH_3), 20.7 (t, CH_2 of Et), 16.7 (q, CH_3 at C11), 12.3 (q, CH_3 of Et); MS 317(21), 316(78), 301(15), 258(12), 241(12), 240(32), 229(18), 211(280, 202(10), 201(68), 191(31), 188(10), 178(29), 174(14), 173(18), 170(19), 169(17), 159(11), 157(13), 155(14), 149(18), 145(16), 143(11), 131(19), 130(10), 129(26), 128(10), 119(11), 117(17), 115(10), 110(10), 109(100), 108(11), 107(15), 105(26); HRMS Calcd for $C_{21}H_{32}O_2$: 316.24022. Found: 316.23936.

Mass spectral and elemental analysis data for diol 2:

MS 277(33), 276(77), 261(21), 259(19), 258(58), 248(54), 247(100), 243(18), 241(34), 240(70), 230(38), 229(72), 225(12), 215(17), 214(12), 213(19), 212(30), 211(67), 203(13), 202(56), 201(84), 200(13), 199(21), 193(18), 192(36), 191(47), 189(10), 188(32), 187(25), 185(27), 183(12), 179(12), 178(48), 177(16), 176(31), 175(41), 174(50), 173(51), 172(15), 171(42), 170(47), 169(43), 163(23), 161(19), 160(11), 159(36), 157(40), 156(41), 155(40), 149(31), 148(11), 147(41), 146(13), 145(48), 144(14), 143(34), 142(18), 141(24), 136(38), 135(40), 134(14), 133(35), 132(15), 131(49), 130(29), 129(49), 128(39), 127(10), 123(25), 122(44), 121(35), 120(14), 119(36), 118(23), 117(50), 116(24), 115(37), 110(35), 109(70), 108(47), 107(49), 106(18), 105(45), 104(27), 103(15);

HRMS Calcd for $C_{18}H_{28}O_2$: 276.20892. Found: 276.20810; too hygroscopic for combustion analysis.

endo-4-Methyl-cis-bicyclo[3.2.0]heptane-1-methanol (36).

p-Toluenesulfonyl chloride (0.84 g, 4.4 mmol, 2.2 eq) was added all at once to a stirred, ice-cold solution of 0.39 g (2 mmol) of crude diol **8** in 7 mL of pyridine. After 30 min the reaction was sealed under nitrogen and placed in a refrigerator at 3 °C overnight. After 18 hr more the reaction mixture was poured into 25 g of ice and 5 mL of water and extracted three times with ether. The combined organic layers were washed with 6 M HCl followed by 2 M HCl. The combined acid layers were back extracted once with ether, and then the combined ether layers were washed with water, 1 N sodium bicarbonate, and brine. Concentration gave 0.78 g (77%) of the crude ditosylate as a light yellow solid which was used without further purification.

^{1}HMR(90 MHz) 7.77 (d, 2 H, J = 8.5, o-Ar-H), 7.73 (d, 2 H, J = 8.5, o-Ar-H), 7.34 (d, 4 H, J = 8.5, m-Ar-H), 6.67 (br t, 1 H, J = ca. 2.5, C2-H), 4.00 (m, 4 H, C6-H & C8-H), 3.64 (s, 3 H, OCH_3), 2.43 (s, 6 H, p-$ArCH_3$), 3.46-1.56 (br m, remaining protons); ^{13}CMR(20 MHz) 164.6 (CO), 145.1 (p-Ar), 144.8 (p-Ar), 143.1 (C2), 139.0 (C1), 133.2 (i-Ar), 132.9 (i-Ar), 130.1 (m-Ar), 129.9 (m-Ar), 127.9 (2C, o-Ar), 69.7 (C6 or C8), 69.1 (C8 or C6), 51.4 (OCH_3), 41.8 (C4), 41.2 (C5), 34.2 (C3), 27.8 (C7), 21.5 (2C, p-$ArCH_3$).

A stirred suspension of 0.17 g (4.5 mmole) of lithium aluminum hydride in 20 mL of ether was refluxed for 30 min and then cooled to 0 °C and treated dropwise over 25 min with a solution of 0.78 g (1.5 mmole) of the ditosylate of **8** in 25 mL of THF. After addition was complete the mixture was warmed to room temperature for 1.5 hr and finally refluxed for 1.5 hr. After again cooling to 0 °C the reaction was quenched by careful dropwise addition of 0.17 mL of

water, 0.17 mL of 4 N sodium hydroxide, and 0.68 mL of water. The milky mixture was vacuum filtered through Celite and the solids were washed well with ether. The combined filtrates were washed with brine and concentrated leaving 0.26 g of cloudy yellow oil, which was filtered through silica gel with 1:1 Skelly B : ethyl acetate and purified by semi-preparative HPLC using 2.3:1 Skelly B : ethyl acetate. There were obtained 85 mg (40%) of **36** as a pale yellow oil. The use of sodium bis(2-methoxyethoxy)aluminum hydride (Red-Al) in benzene as the reducing agent gave a lower yield of less pure product.

IR 3630, 2960, 2880, 1455, 1380, 1025; ^{1}HMR(100 MHz) 3.58 (s, 2 H, CH_2OH), 2.56-2.20 (m, 1 H, C5-H), 2.51 (s, 1 H, OH, disappears with D_2O), 2.20-1.15 (m, 9 H), 0.92 (d, 3 H, J = 6, CH_3); ^{13}CMR(20 MHz) 69.4 (t, C8), 50.6 (d, C1), 43.7 (d, C5), 37.7 (d, C4), 35.6 (t, C2), 33.3 (t, C3), 26.3 (t, C7), 14.5 (t, C6), 13.7 (q, C9).

Additional References

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