Preparation and Some Reactions of 2-Oxatricyclo[3.3.0.0^{4,6}]oct-7-en-3-one: Synthesis of 9-Deoxa-9,10-dehydroprostaglandin D$_2$

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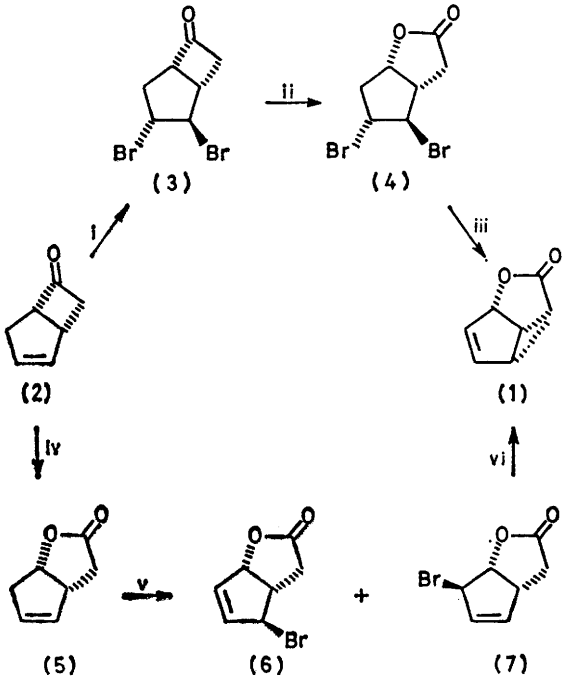
The tricyclic lactone (1) was prepared by two methods. Reaction of (1) with electrophilic reagents occurred on the more exposed *exo*-face of the alkene unit resulting in the formation of the epoxylactone (8) on peracid oxidation and the bromolactones (9)—(11) on bromination in the appropriate solvent. Thiophenoxide ion reacted with (1) in S_N2 fashion to give the acid (13) while deuteriation studies suggested that lithium dibutylcuprate reacted with (1) through the S_N' pathway preferentially to give the acid (15). The cuprate reagent (20) reacted with the lactone (1) to form the acid (21) which was converted into the prostanoid (29) in a standard fashion.

THE tricyclic lactone (1) may be prepared from the readily available ketone (2) in two ways (Scheme 1), the route *via* the dibromoketone (3) and the dibromolactone (4) [1] being preferred to the alternative route *via* the lactone (5) and the allyl bromides (6) and (7).[2,3]

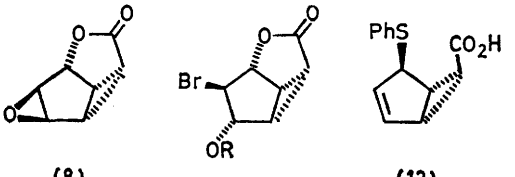


SCHEME 1 *Reagents:* i, Br_2, CCl_4, $NaHCO_3$; ii, $ClC_6H_4CO_3H$; iii, DBU; iv, CH_3CO_3H, CH_3CO_2H; v, NBS, CCl_4, $h\nu$; vi, KOBu^t, HOBu^t

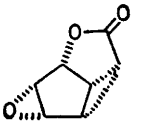
While stable for long periods in chloroform solution at −20 °C, the lactone (1) formed a white insoluble powder on being warmed to *ca.* 60 °C. Electrophilic attack at the alkene unit took place from the more exposed *exo*-face of the molecule specifically. Thus reaction of the lactone (1) with *m*-chloroperoxybenzoic acid furnished the *exo*-epoxide (8) (88%). N.m.r. spectroscopy and in particular the high-field shift of H-5 due to the epoxide ring-current effect [4] aided the determination of the structure of (8).

Treatment of the lactone (1) with *N*-bromoacetamide (NBA) in water, methanol, or acetic acid gave only the bromohydrin (9), the bromoether (10), and the bromoacetate (11) respectively. The configurations of the substituents within the compounds (9)—(11) were elucidated by study of the n.m.r. spectra. The signal due to the proton-CHBr appeared as a singlet at δ 4.25—4.20 while the proton adjacent to the newly introduced oxygen function-CHOR appeared as a multiplet and spin-spin coupling to the proton H-6 was demonstrated for the ether (10) and the ester (11).[5] Furthermore, treatment of the bromohydrin (9) with base gave the *endo*-epoxide (12).

The lactone (1) reacted with thiophenoxide ion to give the acid (13) in high yield. Reaction of the lactone (1) with alkenyl or alkyl cuprate reagents also takes place through displacement of the activated acyloxy-unit. Thus reaction of (1) with the cuprate reagent (14) gave



(8) (9) R = H (10) R = Me (11) R = Ac (13)



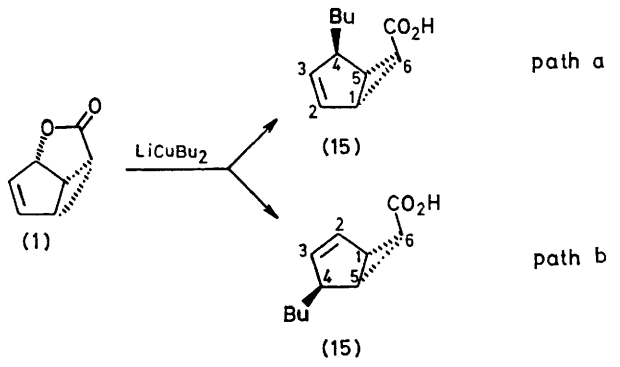
(12)

$LiCuR_2$
(14) R = Bu
(20) R = CH:CHCH(OSiMeBu^t)C_5H_{11}

$Ph_3\overset{+}{P}\overset{-}{C}H(CH_2)_3CO_2^-$
(26)

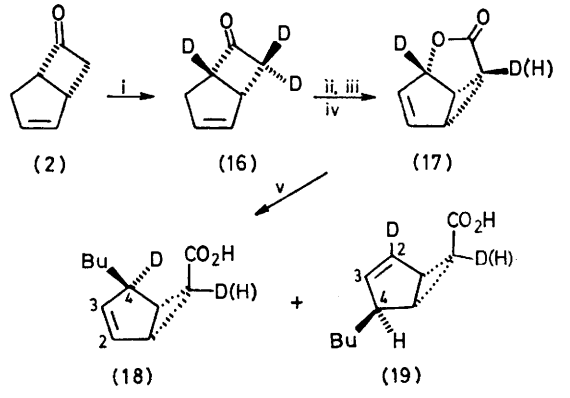
rise to the cyclopropylcarboxylic acid (15) in 68% yield. In view of our previous experience regarding the proclivity of cuprate reagents to perform S_N' reactions [6] we decided to investigate whether the reaction of (1) with (14) involved a straightforward S_N2 displacement (Scheme 2—path a) or an S_N' pathway (Scheme 2—path b).

To this end the ketone (2) was dissolved in methylene chloride and stirred with NaOD in D_2O in the presence of a phase-transfer catalyst to give the trideuteriated compound (16) (Scheme 3). The ketone (16) was converted into the lactone (17) [deuteriated at C-1: partially (*ca.* 50%) deuteriated at C-4] using the bromination–dehydrobromination procedure. Reaction of the butyl cuprate reagent (14) with the deuteriolactone (17) gave the acids (18) and (19) in the ratio 1 : 6 demonstrating once again the extraordinary tendency for cuprate reagents to undergo S_N' reactions with cycloalkenyl acylates. The ratio of the deuteriated acids (18) and (19) was assessed by integration of the AA′ signal due to H(D)-2 and H-3 and the signal at δ 2.8 due to H(D)-4 in the n.m.r. spectrum of the mixture of acids.



SCHEME 2

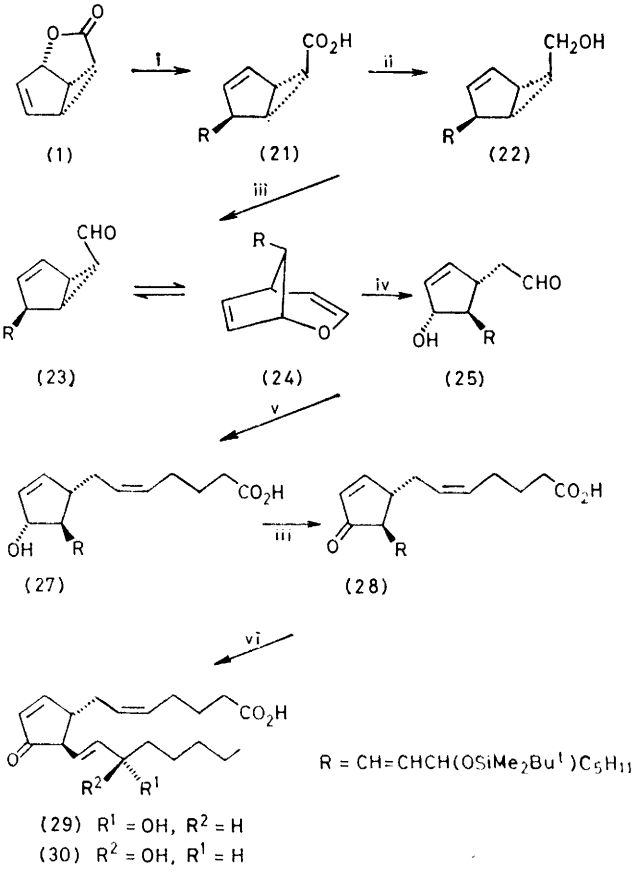
The non-selectivity of the cuprate reaction was of no consequence in the synthesis of racemic 9-deoxa-9,10-dehydroprostaglandin D_2 (29) from racemic lactone (1),* The lactone (1) reacted smoothly with the cuprate reagent (20) in ether solution at −78 °C to give the cyclopropanecarboxylic acid (21) in 65% yield after chromatography (Scheme 4).



SCHEME 3 *Reagents:* i, $PhCH_2\overset{+}{N}(Et)_3\bar{C}l$, NaOD, D_2O, $MeCl_2$; ii, Br_2, CCl_4, $NaHCO_3$; iii, $ClC_6H_4CO_3H$; iv, DBU; v, reagent (14)

Lithium aluminium hydride reduction of the acid (21) produced the alcohol (22) (78%) which was oxidised by Collins reagent to the required aldehyde (23) (70%). N.m.r. spectroscopy showed that in chloroform solution at room temperature the aldehyde (23) was in equilibrium with the enol-ether (24). The ratio of the isomers (23): (24) (which are interconverted by a Cope rearrangement) was *ca.* 4 : 1. Other workers have reported related Cope rearrangements of simple bicyclo[3.1.0]hex-2-ene-6-carbaldehydes,[7] and Dreiding *et al.* have shown in one case that the enol-ether component is readily hydrolysed by aqueous acid.[8]

Indeed, we found that hydrolysis of the enol-ether (24) could be effected in 92% yield by vigorously stirring a chloroform solution of the compound with 4N-hydrochloric acid. The resulting hydroxy-aldehyde (25) was stable to further acid treatment [9] and reacted readily with the ylide (26) to give the alcohol (27), a system similar to that previously reported by Gandolfi.[10]



SCHEME 4 *Reagents:* i, Reagent (20), −78 °C, ether; ii, $LiAlH_4$; iii, CrO_3, pyridine; iv, H^+; v, reagent (26); vi, HF, H_2O, MeCN.

The hydroxy-acid (27) was oxidized using chromium trioxide in pyridine to give the cyclopentenone derivative (28) which, on treatment with aqueous hydrofluoric acid in acetonitrile [11] and rapid chromatography over silica, gave 9-deoxa-9,10-dehydroprostaglandin D_2 (29) and the diastereoisomer (30). The former compound, which was identical (u.v., n.m.r., and t.l.c.) with an authentic sample prepared from prostaglandin $F_{2\alpha}$ using the recommended

* Only one enantiomer of the racemate is illustrated in the diagrams. For a preliminary report of this synthesis see ref. 2.

procedure,[12] was unstable to prolonged chromatography and to treatment with base.[13]

EXPERIMENTAL

N.m.r. spectra were obtained with a Varian EM-360 or Perkin-Elmer R-32 spectrometer ($CDCl_3$). I.r. spectra were recorded with a Perkin-Elmer 257 spectrometer for neat films unless otherwise stated. M.p.s. were taken by the capillary tube method. Distillations were accomplished by using the Buchi Kügelrohr (bulb-to-bulb) system and the b.p.s. reported are oven temperatures at distillation. Anhydrous sodium sulphate was used as a drying agent for solutions in organic solvents. Precoated plates with silica gel GF by Anachem were used for t.l.c.

5,7,7-Trideuteriobicyclo[3.2.0]*hept-2-en-6-one* (16).—A solution of bicyclo[3.2.0]hept-2-en-6-one (2) (4.0 g) in methylene chloride (15 ml) containing triethylbenzylammonium chloride (1.5 g) was stirred with a 40% solution of sodium deuterioxide in D_2O (20 ml) for 3 days. The aqueous layer was separated and washed with methylene chloride (3 × 50 ml). The combined organic fractions were washed with water, dried, and evaporated to give a brown oil which was distilled to give the *trideuterioketone* (16) (50%).

2-Oxatricyclo[3.3.0.$0^{4,6}$]*hept-7-en-2-one* (1).—(*a*) To the dibromoketone (3) [5] (4.2 g) in glacial acetic acid (20 ml) was added an aqueous solution of hydrogen peroxide (20 ml, 30%) in glacial acetic acid (20 ml) and the reaction mixture was kept at room temperature for 16 h. Water (60 ml) was added to the reaction mixture which was then shaken with chloroform (100 ml). The chloroform extract was separated, washed with water (3 × 40 ml) and a saturated aqueous solution of sodium hydrogen carbonate (2 × 40 ml), dried, and the solvent evaporated. Crystallisation from diethyl ether yielded the lactone (4) as colourless cubes (4.2 g, 95%), m.p. 71—72 °C, $\nu_{max.}$ (Nujol) 2 950, 1 760, 1 460, 1 180, and 1 010 cm^{-1}; δ 5.3 (1 H, dt, *J* 7, 2 Hz, H-1), 4.5 (2 H, m, H-6 and H-7), and 3.8—2.6 (5 H, m, 2 × H-4, 2 × H-8 and H-5) (Found: M^+ 281.889 1. $C_7H_8Br_2O_2$ requires *M* 281.889 2).

To a solution of the above dibromolactone (4) (2.8 g) in acetonitrile (30 ml) was added a solution of DBU (3.2 g) in acetonitrile (5 ml), dropwise with stirring at 0 °C. After 1 h at 0 °C, the reaction mixture was stirred at room temperature for 16 h. The residue was extracted with ether (70 ml) and the ether extract was washed with water (4 × 20 ml) and dried. Evaporation of the solvent yielded the required *tricyclic lactone* (1) as a colourless oil (1.0 g, 85%); $\nu_{max.}$ 1 760, 1 340, 1 180, 960, 940, and 820 cm^{-1}; δ 6.3br (1 H, d, *J* 5 Hz, H-7 or H-8), 6.0br (1 H, d, *J* 5 Hz, H-7 or H-8), 5.25 (1 H, m, H-1), 3.3 (1 H, ddd, *J* 5.5, 5.5, 5.5 Hz, H-5), and 2.6 (2 H, m, H-4 and H-6) (Found: M^+ 122.036 3. $C_7H_6O_2$ requires *M* 122.036 8).

(*b*) To freshly prepared potassium t-butoxide (0.84 g) in dry benzene (25 ml) and t-butyl alcohol (2 ml) was added a mixture of 6-*exo*-bromo-2-oxabicyclo[3.3.0]oct-7-en-3-one (6) and 8-*exo*-bromo-2-oxabicyclo[3.3.0]oct-6-en-3-one (7) [3] (10 g) in dry benzene (5 ml) at 0 °C, with stirring. The reaction mixture was then stirred at room temperature for 60 h after which diethyl ether (50 ml) was added to it; it was then filtered through Hyflo. Evaporation of the solvent yielded the tricyclic lactone (1) as a colourless oil (0.39 g, 65%).

1-Deuterio-2-oxatricyclo[3.3.0.$0^{4,6}$]*oct-7-en-3-one* (17) was prepared from the ketone (16) using Method (*a*) above.

Reactions of 2-Oxatricyclo[3.3.0.$0^{4,6}$]*oct-7-en-3-one* (1)

(*a*) *With* m-*Chloroperoxybenzoic Acid.*—To a solution of the tricycle (1) (0.7 g) in chloroform (30 ml) were added *m*-chloroperoxybenzoic acid (1.0 g) and sodium hydrogen carbonate (1.0 g) and the reaction mixture was stirred at room temperature for 4 days. After work-up the *exo-epoxytricycle* (8) was obtained as a colourless oil (0.7 g, 88%), b.p. 110 °C at 0.01 mmHg; $\nu_{max.}$ 1 760, 1 330, 1 180, 1 000, 980, and 960 cm^{-1}; δ 5.2br (1 H, d, *J* 4 Hz, H-1), 3.75br (1 H, s, H-7 or H-8), 3.5br (1 H, s, H-7 or H-8), and 2.8—2.2 (3 H, m, H-4, H-5, and H-6) (Found: M^+ 138.031 7. $C_7H_6O_3$ requires *M* 138.031 7).

(*b*) *With* N-*Bromoacetamide.*—(i) *In the presence of water.* To a solution of the tricycle (1) (0.8 g) in acetone (15 ml) and water (10 ml) was added *N*-bromoacetamide (0.95 g) and the reaction mixture was left at room temperature overnight. The solvents were evaporated, and the residue was washed with hydrochloric acid (2N; 15 ml) and crystallised from acetone–chloroform to yield 8-exo-*bromo*-7-endo-*hydroxy*-2-*oxatricyclo*[3.3.0.$0^{4,6}$]*octan*-3-*one* (9), m.p. 170—172 °C, $\nu_{max.}$ (Nujol) 3 400, 1 760, and 1 200 cm^{-1}; δ [$(CD_3)_2CO$] 5.1 (2 H, m, H-1 and H-7), 4.2 (1 H, s, H-8), 3.5 (1 H, m, H-5), and 3.0—2.0 (3 H, m, H-4, H-6, and −OH) (Found: M^+ 271.957 8. $C_7H_7BrO_3$ requires *M* 217.957 7).

To a solution of the above bromohydrin (9) (0.5 g) in dimethyl sulphoxide (3 ml), was added potassium t-butoxide (0.26 g) at room temperature. After 2 h water (15 ml) was added and the reaction mixture was extracted with chloroform (4 × 15 ml). The combined chloroform extracts were washed with water (2 × 15 ml), dried, and the solvent evaporated. Purification by t.l.c. ($CHCl_3$) and crystallisation from diethyl ether yielded the endo-*epoxide* (12) as colourless needles (0.194 g, 60%), m.p. 105—107 °C, $\nu_{max.}$ (Nujol), 1 770, 1 320, and 1 200 cm^{-1}; δ 4.9 (1 H, m, H-1), 4.1 (1 H, t, *J* 3 Hz, H-7), 3.95 (1 H, m, H-8), 3.7 (1 H, m H-5), and 2.2 (2 H, m, H-4 and H-6).

(ii) *In the presence of methanol.* To a solution of the tricycle (1) (0.2 g) in methanol (10 ml) was added *N*-bromoacetamide (0.21 g) and the reaction mixture was left at room temperature for 16 h. After work-up, t.l.c. ($CHCl_3$) purification, and crystallisation from diethyl ether, 8-exo-*bromo*-7-endo-*methoxy*-2-*oxatricyclo*[3.3.0.$0^{4,6}$]*octan*-3-*one* (10) was obtained as colourless needles (0.35 g, 92%), m.p. 91—92 °C, $\nu_{max.}$ (Nujol) 2 920, 1 760, 1 460, 1 190, and 1 085 cm^{-1}; δ 5.0 (1 H, dd, *J* 4, 2 Hz, H-1), 4.6 (1 H, dd, *J* 5, 2 Hz, H-7), 4.2 (1 H, s, H-8), (3 H, s, OCH_3), 3.3 (1 H, m, H-5), and 2.4 (2 H, m, H-4 and H-6) (Found: C, 41.4; H, 4.0. $C_8H_9BrO_3$ requires C, 41.2; H, 3.8%).

(iii) *In the presence of acetic acid.* To a solution of the tricycle (0.1 g) in glacial acetic acid (5 ml) was added *N*-bromoacetamide (0.115 g) and the reaction mixture was left at room temperature for 16 h. Removal of acetic acid followed by purification by t.l.c. ($CHCl_3$) and crystallisation [chloroform–light petroleum (b.p. 60—80 °C] yielded 7-endo-*acetoxy*-8-exo-*bromo*-2-*oxatricyclo*[3.3.0.$0^{4,6}$]*octan*-3-*one* (11) as colourless needles (0.19 g, 90%), m.p. 108—109 °C, $\nu_{max.}$ (Nujol), 1 780, 1 730, 1 230, 1 180, and 1 030 cm^{-1}; δ 5.7 (1 H, dd, *J* 6, 2 Hz, H-7), 5.0 (1 H, dd, *J* 4, 2 Hz, H-1), 4.25 (1 H, s, H-8), 3.5 (1 H, ddd, *J* 6, 6, 4 Hz, H-5), 2.7 (1 H, m, H-6), 2.35 (1 H, m, H-4), and 2.01 (3 H, s, O−$COCH_3$) (Found: M^+ 259.968 3. $C_9H_9BrO_4$ requires *M* 259.968 4) (Found: C, 41.6; H, 3.6. $C_9H_9BrO_4$ requires C, 41.4; H, 3.5%).

(*c*) *With Potassium Thiophenoxide.*—The lactone (1) wa

treated with an equimolar quantity of potassium thiophenoxide in tetrahydrofuran at room temperature for 16 h. After work-up and chromatography was isolated the *acid* (13) (59%), m.p. 116—118 °C, $\nu_{max.}$ (Nujol) 1 690, 1 585, and 1 235 cm^{-1}; δ 10.6br (1 H, s, CO_2H), 7.38 (5 H, m, C_6H_5 5.78 (2 H, m, H-2 and H-3), 4.43 (1 H, d, *J* 2 Hz, H-4), and *2.70—1.75* (3 H, m, H-1, H-5, and H-6) (Found: C, 67.1, H, 5.4. $C_{13}H_{12}O_2S$ requires C, 67.2; H, 5.2%).

(*d*) *With Cuprate Reagents.*—(i) 4-exo-*Butylbicyclo*[3.1.0]-*hex*-2-*ene*-6-*carboxylic acid* (15). To butyl-lithium in diethyl ether (80 ml) was added a solution of CuBr–Me_2S complex (2.25 g) in dimethyl sulphide–diethyl ether (30 ml; 2 : 1) dropwise with stirring at −78 °C. After 15 min a solution of the tricycle (1) (1.0 g) in diethyl ether (20 ml) was added and the reaction mixture was stirred at −78 °C for 6 h. The reaction was quenched with an aqueous solution of ammonium chloride. The organic phase was separated and washed with sulphuric acid (2N; 50 ml) and water (3 × 50 ml), and then dried. Evaporation of the solvent, followed by purification by t.l.c. yielded the acid (15) as a colourless thick oil which solidified on cooling, m.p. 54—59 °C (1.0 g, 68%), $\nu_{max.}$ (Nujol), 3 600, 1 690, 1 610, 1 260, and 820 cm^{-1}; δ 11.2 (1 H, s, CO_2H), 5.61 (2 H, m, H-2 and H-3), 2.8br (1 H, s, H-4), 2.36 (1 H, m, H-6), 1.73 (2 H, m, H-1 and H-5), 1.3 (6 H, m, 3 × CH_2), and 0.85 (3 H, m, CH_3) (Found: M^+ 180.114 5. $C_{11}H_{16}O_2$ requires *M* 180.114 9).

The deuteriolactone (17) was treated with lithium dibutylcuprate in the manner described above to give a mixture of 2- (19), δ (*inter alia*) 5.61 (1 H, m, H-3) and 2.8 (1 H, m, H-4), and 4-deuteriobicyclohexene-6-carboxylic acid (18), δ (*inter alia*) 5.61 (2 H, m, H-2 and H-3), in the ratio 6 : 1.

(ii) 4-exo-(3′-t-*Butyldimethylsilyloxyoct*-1′-*enyl*)*bicyclo*-[3.1.0]*hex*-2-*ene*-6-*carboxylic acid* (21).—n-Butyl-lithium (1.15 g) was added to 3-(t-butyldimethylsilyloxy)oct-1-enyl iodide (7 g) in diethyl ether (80 ml) at −78 °C under an atmosphere of argon. After the mixture had been stirred for 30 min a solution of copper(I) bromide–dimethyl sulphide complex (2.0 g) in dimethyl sulphide and diethyl ether (30 ml; 2 : 1) was added dropwise. After 15 min a solution of 2-oxatricyclo[3.3.0.$0^{4,6}$]hept-7-en-3-one (1) (0.9 g) in diethyl ether (15 ml) was added dropwise and the reaction mixture was stirred at −78 °C for 6 h. The reaction was quenched with saturated ammonium chloride solution. The organic phase was washed with sulphuric acid (2N; 50 ml) and water (2 × 30 ml) and dried. Evaporation of the solvent followed by purification by t.l.c. ($CHCl_3$) yielded the *acid* (21) as a colourless oil (1.73 g, 65%), $\nu_{max.}$ 1 700, 1 300, 860, and 770 cm^{-1}; δ 8.5br (1 H, s, $-CO_2H$), 6.0—5.1 (4 H, m, H-2, H-3, H-1′ and H-2′), 4.3 (1 H, m, H-3′), 3.8 (1 H, m, H-4), 2.7 (1 H, m, H-1), 2.1 (2 H, m, H-5 and H-6), 1.6 (8 H, m, 4 × CH_2), 1.2 (12 H, m, 4 × CH_3), and 0.2 [6 H, s, $Si(CH_3)_2$] (Found: M^+ 364.241 3. $C_{21}H_{36}O_3Si$ requires *M* 364.243 1).

4-exo-(3′-*t*-*Butyldimethylsilyloxyoct*-1′-*enyl*)-6-endo-*hydroxymethylbicyclo*[3.1.0]*hex*-2-*ene* (22).—A solution of the bicyclic acid (21) (1.0 g) in diethyl ether (30 ml) was added dropwise to $LiAlH_4$ (0.4 g) in diethyl ether (50 ml) at 0 °C with stirring. After the addition was complete the reaction mixture was stirred for 3 h. Water (2 ml) was added to the mixture followed by hydrochloric acid (10%, 30 ml). The ether layer was separated and the aqueous layer was extracted with ether (2 × 30 ml). The combined ether extracts were washed with water (2 × 30 ml), dried, and the solvent evaporated. Purification by t.l.c. ($CHCl_3$) yielded the *bicyclic alcohol* (22) as a colourless oil (0.75 g, 78%), $\nu_{max.}$ 3 350, 2.975, 2 950, 1 470, 1 260, 820, and 780 cm^{-1}; δ 6.0—5.5 (4 H, m, H-2, H-3, H-1′ and H-2′), 4.2 (1 H, m, H-3′), 3.5 (2 H, d, *J* 7 Hz, CH_2O), 3.0 (1 H, m, H-4), 2.6 (1 H, s, O*H*), 2.3 (1 H, m, H-6), 1.7 (2 H, m, H-1 and H-5), 1.5 (8 H, m, 4 × CH_2), 1.0 (12 H, m, 4 × CH_3), and 0.1 [6 H, s, $Si(CH_3)_2$] (Found: M^+ 350.263 6. $C_{21}H_{38}O_2Si$ requires *M* 350.263 9).

4-exo-(3′-*t*-*Butyldimethylsilyloxyoct*-1′-*enyl*)*bicyclo*[3.1.0]-*hex*-2-*ene*-6-endo-*carbaldehyde* (23).—A solution of the bicyclic alcohol (22) (13.0 g) in dry dichloromethane (10 ml) was added to a solution of Collins reagent (6.5 g) in dry dichloromethane (150 ml) at room temperature with stirring. After 15 min the dichloromethane solution was decanted off and the residue was washed with dichloromethane (50 ml). The combined dichloromethane solutions were quickly shaken with hydrochloric acid (2N; 80 ml), washed with water (3 × 50 ml), and dried. Evaporation of the solvent and purification by t.l.c. ($CHCl_3$) yielded the required *bicyclic aldehyde* (23) as a colourless oil (1.0 g, 70%), $\nu_{max.}$ 2 930, 2 860, 1 700, 1 460, 1 250, 1 070, 835, and 770 cm^{-1}; δ 9.45 (1 H, d, *J* 6 Hz, CHO), 6.1—5.5 (4 H, m, H-2, H-3, H-1′ and H-2′), 4.2 (1 H, m, H-3′), 3.5 (1 H, m, H-4), 3.0—1.8 (3 H, m, H-1, H-5 and H-6), 1.4 (8 H, m, 4 × CH_2), 0.9 (12 H, m, 4 × CH_3), and 0.1 [6 H, s, $Si(CH_3)_2$].

2-[4′-endo-*Hydroxy*-5′-exo-(3″-*t*-*butyldimethylsilyloxyoct*-1″-*enyl*)*cyclopent*-2′-*enyl*]*acetaldehyde* (25).—A solution of the bicyclic aldehyde (23) (0.7 g) in dichloromethane (60 ml) was stirred with hydrochloric acid (2N; 30 ml) at room temperature for 90 min. The organic layer was washed with water (3 × 20 ml), dried, and the solvent was evaporated. Purification by t.l.c. ($CHCl_3$) yielded the hydroxy-aldehyde (25) as a colourless oil (0.644 g, 92%), $\nu_{max.}$ 3 400, 2 950, 2 850, 1 720, 1 260, 820, and 780 cm^{-1}; δ 10.0br (1 H, s, CHO), 6.0 (2 H, s, H-2′ and H-3′), 5.7 (2 H, m, H-1″ and H-2″), 4.65 (1 H, m, H-4′), 4.2 (1 H, m, H-3″), 3.0—2.0 (5 H, m, 2 × H-2, H-1′, H-5′ and OH), 1.5 (8 H, m, 4 × CH_2), 1.0 (12 H, m, 4 × CH_3), and 0.1 [6 H, s, $Si(CH_3)_2$] (Found: M^+, 366.258 8. $C_{21}H_{38}O_3Si$ requires *M* 366.258 8).

9-*Deoxa*-9,10-*dehydro*-15-*t*-*butyldimethylsilyloxyprostaglanding* $F_2\alpha$ (27).—To a stirred solution of 4-carboxybutyltriphenylphosphonium bromide (5 g) in dry tetrahydrofuran (THF) (50 ml) was added potassium t-butoxide (2.5 g) with stirring at room temperature. After 15 min a solution of the hydroxyaldehyde (25) (0.9 g) in tetrahydrofuran (15 ml) was added dropwise and the reaction mixture was stirred for 2 h. Water (100 ml) and sulphuric acid (2N; 100 ml) were added to the reaction mixture which was then extracted with diethyl ether (3 × 100 ml). The combined ether extracts were washed with sulphuric acid (2N; 100 ml) and water (2 × 100 ml) and then dried. Evaporation of the solvent followed by purification by t.l.c. [ethyl acetate–petroleum ether (40 : 60)] gave the required *acid* (27) as a pale yellow oil (0.83 g, 75%), $\nu_{max.}$ 3 050 and 1 710 cm^{-1}; δ 6.95—6.7 (2 H, m, O*H* and CO_2H), 5.85 (2 H, s, H-9 and H-10), 5.75—5.3 (4 H, m, H-5, H-6, H-13, and H-14), 4.6 (1 H, m, H-11), 4.2 (1 H, m, H-15), 2.8—1.1 (18 H, m, 8 × CH_2, H-8 and H-12), 0.9 (12 H, m, 4 × CH_3), and 0.1 [6 H, s, $Si(CH_3)_2$] (Found: M^+ 468.355 0. $C_{26}H_{46}O_4SiNH_4$ requires *M* 468.350 9).

9-*Deoxy*-9,10-*dehydro*-15-*t*-*butyldimethylsilyloxyprostaglandin* D_2 (28).—To a stirred solution of the Collins reagent (2.87 g) in dry dichloromethane (60 ml) was added a solution of the allylic alcohol (27) (0.83 g) in dry dichloromethane (15 ml) with stirring at 0 °C. After 15 min the dichloromethane solution was decanted off and the residue was washed with

dichloromethane (2 × 30 ml) The combined organic solutions were washed with hydrochloric acid (2N; 100 ml), dried, and the solvent was evaporated. Purification by t.l.c. [ethyl acetate–petroleum ether (40 : 60)] yielded the product (28) as an oil (0.47 g, 55%), $\nu_{max.}$ 1 700 and 1 660 cm^{-1}; δ 10.7 (1 H, m, COOH), 7.7 (1 H, m, H-9), 6.3 (1 H, m, H-10), 5.8—5.5 (4 H, m, H-5, H-6, H-13 and H-14), 4.2 (1 H, m, H-15), 2.8—1.1 (18 H, m, 8 × CH_2, H-8 and H-12), 0.9 (12 H, m, 4 × CH_3), and 0.1 [6 H, s, $Si(CH_3)_2$].

9-Deoxa-9,10-dehydroprostaglandin D_2.—A 10% solution of 40% aqueous hydrofluoric acid in acetonitrile was added to the enone (28) (0.42 g) and the reaction mixture was left at room temperature for 20 min. Chloroform (50 ml) was then added to the mixture which was then washed with water (3 × 75 ml) and dried. Evaporation of the solvent yielded the two epimers (29) and (30) (0.3 g, 100%). A small sample (0.1 g) was separated by chromatography over Kieselgel 7 729 with ethyl acetate–petroleum ether–acetic acid (40 : 59 : 1) as eluant to give the desired prostanoid (29) (0.006 g), δ 7.6 (1 H, dd, *J* 6, 1.5 Hz, H-9), 6.15 (1 H, dd, H-6, 1.5 Hz, H-10), 5.7—5.3 (4 H, m, H-5, H-6, H-13 and H-14), 4.1 (1 H, m, H-15), 3.0—1.0 (18 H, m, H-8, H-12, 8 × CH_2), and 0.9 (3 H, m, Me) [Found (c.i.m.s. NH_3) : $(M + NH_4)^+$, 352.253 7. $C_{20}H_{30}O_4$ requires $(M + NH_4)$ 352.248 8] and the C-15 epimer (30) (0.007 g) δ 7.62 (1 H, dd, *J* 6, 1.5 Hz, H-9), 6.15 (1 H, dd, *J* 6, 1.5 Hz), H-10), 5.8—5.3 (4 H, m, H-5, H-6, H-13 and H-14), 4.08 (1 H, m, H-15), 2.7—1.0 (18 H, m, H-8, H-12, 8 × CH_2), and 0.9 (3 H, m, Me) [Found (c.i.m.s. NH_3) : $(M + NH_4)^+$ 352.252 8. $C_{20}H_{30}O_4$ requires $(M + NH_4)$ 352.248 8].

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