Synthesis of (±)-aklavinone and (±)-auramycinone *via* electron-deficient *o*-quinonoid pyrones

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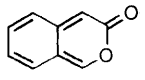
Dehydration of the formyl acid **3** (R = H) with acetic anhydride in benzene at 80 °C generates the quinonoid pyrone **4** which can be trapped with norbornadiene, *N*-phenylmaleimide and enol silyl ethers; the adduct **6** (R = Me, P = TES) and its 9-epimer **10** from 2-(triethylsilyloxy)propene are readily transformed into (±)-auramycinone **2** (R = Me) whilst those [**6** (R = vinyl, P = TES) and its 9-epimer] from 2-(triethylsilyloxy)buta-1,3-diene are readily converted into the methyl ethers **24**, **25**, **33** and **34** of which **24**, **33** and **34** are known to be readily converted into (±)-aklavinone **2** (R = Et).

Derivatives of 2-benzopyran-3-one **1** are reactive Diels–Alder dienes which are useful building blocks for the assembly of



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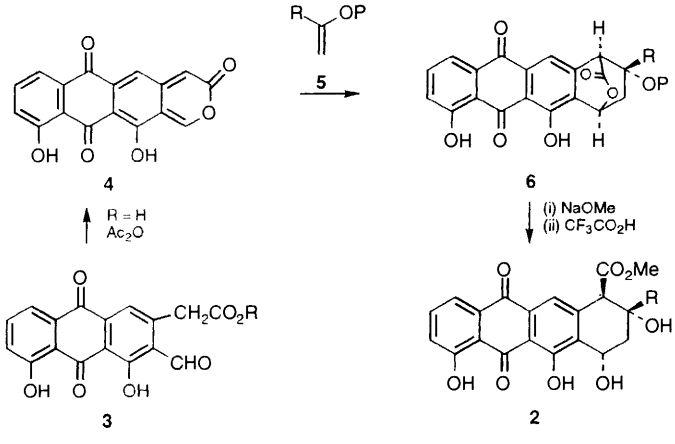
aromatic steroids[1] and lignans like podophyllotoxin.[2] In addition Jung and his collaborators[3] have used the parent pyrone **1** to prepare AB-ring analogues of anthracyclinones. Like these workers we have long cherished the view that anthracyclinones such as aklavinone **2** (R = Et) and auramycinone **2** (R = Me) could be prepared from the potentially tautomeric pyrone **4** along the lines outlined in Scheme 1. We now describe the reduction of this plan to practice.[4]



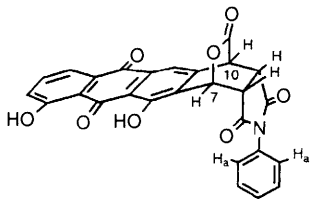
Scheme 1

The acid **3** (R = H) was prepared by acid-catalysed hydrolysis of the methyl ester **3** (R = Me), in turn available from 3-furoic acid and bromojuglone in six steps.[5] Attempts to generate and trap the pyrone **4** using our usual method (boiling acetic anhydride) were abortive. However reducing the reaction temperature to *ca.* 80 °C by treating **3** (R = H) with boiling benzene–acetic anhydride (ratio 2:1) gave a modest yield of the *N*-phenylmaleimide adduct **7**.

The *endo*-configuration of **7** is indicated by the appearance of signals for two aromatic protons at δ 6.67–6.70; the signals of the *o*-protons of the phenyl ring (H_a in **7**) are shielded by the *syn*-anthraquinone moiety. In addition the vicinal coupling constants associated with 7-H (4.9 Hz) and 10-H (3.8 Hz) are characteristic of *endo*-adducts.[6] Similar trapping of **4** with norbornadiene gave the *endo*-adduct **8** (45%) and the *exo*-adduct **9** (22%) which were readily distinguished by the strongly shielded signals of the methylene protons in the former (δ_{Ha} 0.08, δ_{Hb} 0.84) compared with the latter (δ 1.53 and 2.13, not necessarily respectively). The improved adduct yield with the more electron rich dienophile suggests **4** behaves as an electron deficient diene. This was confirmed by the efficient trapping of **4** with enol silyl ethers. Thus, with **5** (R = Me, P = TES) the *endo*-OTES adduct **6** (R = Me, P = TES) and its *exo* isomer **10** were obtained in a ratio of 2:1 and in 50% yield together with a *ca.* 1:1 mixture of the adducts **13** (18% yield). Once again the greater shielding of *endo*-orientated groups was used to assign *endo-exo* stereochemistry (see Experimental section). The structures of the unexpected adducts **13** are consistent with the NMR spectra; part of the data for the chromatographically more polar isomer is appended to formula **13**. The presence of an isolated AB-spin system, an ABX-spin system, and only one chelated hydroxy group is most easily accommodated by this structure. The compounds **13** are most simply regarded as arising from the quinone methide tautomer **14** of the pyrone **4**.

However, formation of **13** in other ways cannot be excluded (Scheme 2). Both the pseudo-acid anhydride **15** and the cation **16** produced from it by loss of acetate ion are intermediates of a type that are likely to be involved in acetic anhydride induced dehydration of *o*-formylphenylacetic acids.[1] It is possible that **16** could be captured by enol silyl ether to give intermediate **17** (Scheme 2) which could give **13** by proton loss (arrows in **17**). Alternatively loss of a phenolic proton in **16** could give the quinone methide **14** directly. This could then give **6** and **10** only after tautomerisation to **4**. As described in the sequel trapping **4** with the more electron rich (higher HOMO) dienol silyl ether **5** (R = vinyl, P = TES) gives adducts of type **6** and **10** in good yield but no detectable products of type **13**. This suggests the pyrone **4** is the first formed trappable intermediate. It is only with the less efficient enol silyl ether traps *e.g.* **5** (R = Me, R = TES) that some **4** escapes trapping and tautomerises to **14** which then gives the adducts **13**.

Model experiments using the 4,6-dideoxy congener of **4** and the ether **5** (R = Et, P = TBDMS) gave adducts derived from the *Z*- and *E*-forms **18** of the double bond shift isomer of the starting alkene. Our planned route to aklavinone was therefore modified to involve adduction of **4** with the dienol ether **5** (R = vinyl, P = TES). Trapping was more efficient with the dienol ether and the *endo*-adduct **6** (R = vinyl, P = TES) and its *exo*-isomer **11** were obtained in a 1:1 ratio and 75% yield. The adducts could be separated by crystallisation and fully



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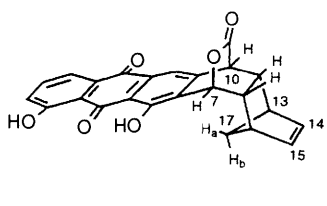

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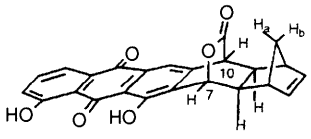

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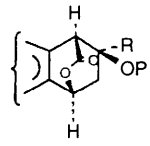
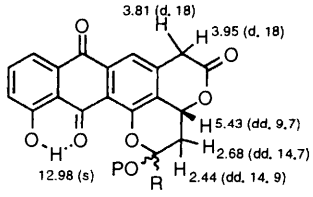
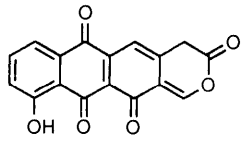


10; R = Me, P = TES
11; R = vinyl, P = TES
12; R = Et, P = TES



13; R = Me, P = TES



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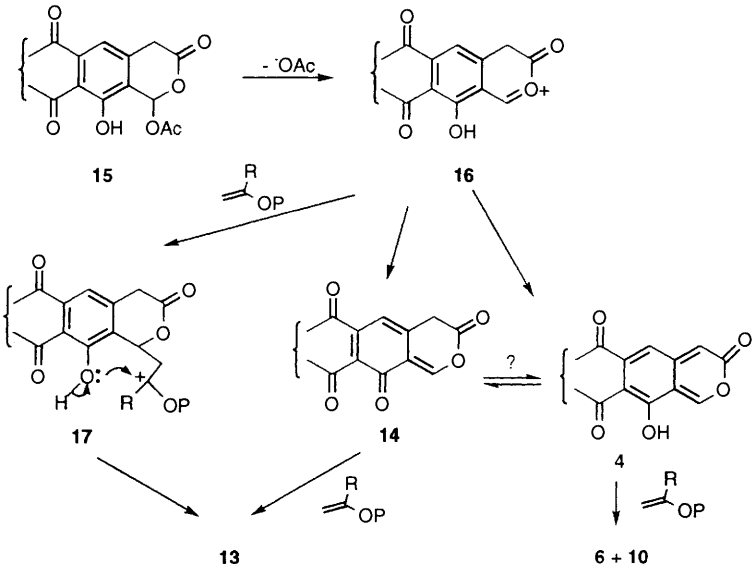
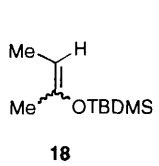


Scheme 2

characterised. Again the preferred shielding of *endo*-orientated groups allowed easy assignment of stereochemistry. The adducts were individually reduced using hydrogen and Wilkinson's catalyst to avoid benzylic hydrogenolysis and reduction of ring-D; **6** (R = Et, P = TES) and its C-9 epimer **12** were obtained in excellent yield.

Our model studies using the *endo*-OMe adduct **19** showed it underwent smooth lactone ring opening with sodium methoxide. The resulting 7β-hydroxy derivative was expected to epimerise to the natural 7α-stereochemistry upon treatment with either BF_3–diethyl ether[5] or CF_3CO_2H[7]. In contrast the *exo*-OMe isomer of **19** reacted slowly with NaOMe–MeOH to give only the naphthacene derivative **20** (X = H, R = Et) by elimination of both methanol and water. In this case the hydroxy ester formed upon opening the lactone ring has a *trans*-periplanar relationship between 10-H and the methoxy at C-9 so that an E2 reaction (with E1cB character) results in rapid loss of methanol, to be followed by water loss giving **20** (X = H, R = Et).

Fortunately, the lactone ring opening took a different mechanistic course with the C-6 hydroxy intermediates involved in the actual synthesis. With a large excess of sodium methoxide (26 mol equiv.) in a MeOH–CH_2Cl_2 solution **6** (R = Et, P = TES) gave, after a work-up involving brief treatment with diazomethane, a mixture of **21** (49%) and **22** (9%) as well as 6% of the $\Delta^{7,8}$ alkene **39** (X = Et, Y = OTES),



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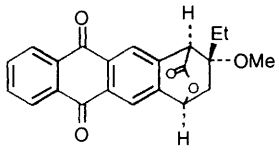

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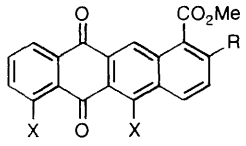

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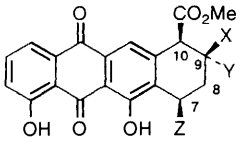
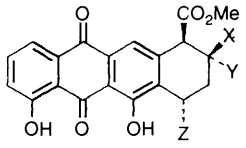
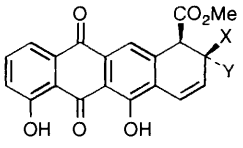


21: X = Et, Y = OTES, Z = OMe
22; X = Et, Y = OTES, Z = OH
23; X = OTES, Y = Et, Z = OMe
24; X = Et, Y = OH, Z = OMe
25; X = OH, Y = Et, Z = OMe
26; X = Me, Y = OTES, Z = OMe
27; X = OTES, Y = Me, Z = OMe
28; X = Me, Y = OH, Z = OMe
29; X = OH, Y = Me, Z = OMe
30; X = Me, Y = OTES, Z = OH



31; X = OTES, Y = Et, Z = OMe
32; X = Et, Y = OTES, Z = OMe
33; X = OH, Y = Et, Z = OMe
34; X = Et, Y = OH, Z = OMe
35; X = OTES, Y = Me, Z = OMe
36; X = Me, Y = OTES, Z = OMe
37; X = OH, Y = Me, Z = OMe
38; X = Me, Y = OH, Z = OMe



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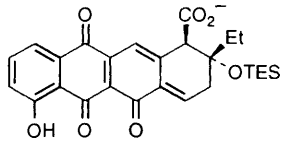

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and traces of the fully aromatic product **20** (R = Et, X = OH). Whilst the hydroxy ester **22** arises *via* the usual acyl–oxygen fission of the lactone, the methoxy ester **21** is most likely formed by elimination to the quinone methide carboxylate **40** which then adds methoxide to the less hindered β-face. Similar treatment of the C-9 epimer **12**, expected on the basis of our model experiments to be problematic, actually proceeded smoothly *via* the quinone methide mechanism to give **23** (13%) and **31** (49%) as well as alkenic product (8%).

In marked contrast to the related *tert*-butyldimethylsilyl ether which only loses the protecting group under conditions which also cause extensive aromatisation of ring-A, the TES ether **21** was smoothly deprotected (6% $HF–H_2O$ in 2:1 $MeCN–CH_2Cl_2$, 20 °C, 2 h) to give the alcohol **24** in quantitative yield. Replacement of the C-7 β-methoxy group by an α-hydroxy group was accomplished using trifluoroacetic acid [7] to give (±)-aklavinone in 87% yield. For preparative purposes it is simplest to treat the mixture of hydrogenated adduct **6** (R = Et, P = TES) and its C-9 epimer **12** with sodium methoxide to give four products separated by chromatography into two pairs; **21** and **23** forming one pair (45%, ratio 6:1) and **31** and **32** forming the second pair (26%, ratio 6:1). Desilylation of the first pair ($HF–H_2O–MeCN–CH_2Cl_2$) gave **24** (70%) and **25** (21%). Desilylation of the second pair gave **33** (86%) and **34** (12%). Since **24**, **33** and **34** are readily converted [5] into (±)-aklavinone **2** (R = Et) this route constitutes an efficient total synthesis of aklavinone.

The synthesis of (±)-auramycinone proceeded along the same lines. The adducts **6** (R = Me, P = TES) and **10** prepared as described above were separated by crystallisation but the process was inefficient and lactone ring opening was carried out, at first on partially separated adduct mixtures to trace which methoxy ester arose from which adduct. Subsequently the unrecrystallised adduct mixture was submitted to ring opening. The 2:1 mixture of *endo*-OTES adduct **6** (R = Me, P = TES) and *exo*-TES adduct **10** gave after ring opening and chromatography a least polar fraction (25%) containing **35** (2.7 parts) and **36** (1 part). The more polar fraction (49%) consisted of the β-methoxy ester **26** and its C-9 epimer **27** (ratio 8.7:1). Both mixtures were desilylated cleanly ($HF–H_2O–MeCN–CH_2Cl_2$) and the individual alcohols separated by chromatography. With trifluoroacetic acid the alcohol **28** from the major product **26** gave (±)-auramycinone in 80% yield. In the same way α-methoxy isomer **38** gave (±)-auramycinone in 91% yield. Conversion of the less abundant alcohols **37** and **29** into (±)-auramycinone requires epimerisation at C-10 for **29** and at both C-10 and C-7 for **37**. Our preliminary attempts to epimerise **37** and **29** at C-7 using BF_3–diethyl ether gave mainly **20** (R = Me, X = OH). Nevertheless even without utilising **37** and **29** the auramycinone synthesis is quite efficient giving a 19% yield in four steps from the acid **3** (R = H).

In summary, we have shown that the novel pyrone **4** can be generated and trapped efficiently despite its possible tautomerism, *e.g.* with **14**. Its additions to dienol silyl ethers are highly chemo- and regio-selective, but there is little *endo*-preference shown between the silyloxy and vinyl (or alkyl) groups of the dienophile. The adducts **6** (R = alkyl, P = TES) undergo smooth ring opening with sodium methoxide probably *via* quinone methide intermediates rather than by acyl–oxygen fission as originally conceived and investigated in model experiments both by ourselves and Jung.[3] This is important as the C-9 epimers of the adducts **6** lacking a C-6 hydroxy group fail to undergo clean lactone ring opening with sodium methoxide. The availability of the quinone methide mechanism therefore allows utilisation of both *endo*- and *exo*-OTES compounds [**6** (R = Et, P = TES) and its C-9 epimer].

Experimental

Mps were determined with a Kofler hot-stage apparatus and are uncorrected. Unless otherwise stated infrared spectra were recorded as Nujol mulls on a Philips PU 8706 infrared spectrophotometer, and referenced to a peak at 1601 cm^{-1} of polystyrene. ^1H NMR spectra were determined in $CDCl_3$, with tetramethylsilane as internal standard with a JEOL FX 90Q instrument (90 MHz spectra) and a General Electric QE 300 instrument (300 MHz spectra). *J* Values are given in Hz. Mass spectra were obtained on an A.E.I. MS902 instrument. Chromatography on silica refers to short-column chromatography over Kieselgel G60 (Merck).[8] Ether refers to diethyl ether and light petroleum (petroleum) to the fraction bp 60–80 °C.

Preparation of 3-formyl-4,5-dihydroxy-9,10-dioxo-2-anthrylacetic acid 3 (R = H)

A solution of the corresponding methyl ester[5,7] (150 mg) in a mixture of tetrahydrofuran (THF) (100 cm^3) and hydrochloric acid (12 mol dm^{-3}; 10 cm^3) was stirred at room temperature. After 18 h water was added and the resulting suspension was extracted with dichloromethane and the extracts washed with water, dried ($MgSO_4$) and evaporated. The residue was suspended in a small volume of boiling dichloromethane and the filtered solid dried *in vacuo* to give the *title compound* **3** (R = H) as an orange crystalline solid (95 mg, 66%), mp 197–202 °C (Found: C, 62.55; H, 3.15. $C_{17}H_{10}O_7$ requires C, 62.6; H, 3.1%); ν_{max}/cm^{-1} 3500–2600, 1705, 1680 and 1620; δ(300 MHz, [$^2H_8$]THF) 4.12 (2 H, s, $ArCH_2CO_2R$), 7.35 (1 H, dd, *J* 6.7, 2.8), 7.77–7.79 (2 H, m), 7.91 (1 H, s), 10.67 (1 H, s), 10.88 (1 H, s), 11.85 (1 H, s, ArOH) and 12.78 (1 H, s, ArOH); *m/z* 282 ($M^+ - CO_2$, 52.3%) and 254 ($M^+ - CO_2$ and CO, 100).

Preparation of *N*-phenylmaleimide adduct 7

A mixture of formyl acid **3** (R = H) (25 mg, 0.077 mmol), *N*-phenylmaleimide (200 mg, 1.15 mmol), benzene (2 cm^3) and acetic anhydride (0.6 cm^3) was boiled under reflux. After 2.75 h the solvent was removed under reduced pressure and the residue chromatographed on silica gel (3:17, ether–dichloromethane) to give N-*phenylmaleimide adduct* **7** (4.5 mg, 12%) as a yellow crystalline solid, mp 284–288 °C (decomp.) (benzene) (Found: C, 67.35; H, 3.1; N, 2.8. $C_{27}H_{15}NO_8$ requires C, 67.4; H, 3.1; N, 2.9%); ν_{max}/cm^{-1} 1785, 1710, 1680 and 1625; δ(300 MHz) 3.81 (1 H, dd, *J* 8.6, 3.8, 9-H), 4.14 (1 H, dd, *J* 8.6, 4.9, 8-H), 4.68 (1 H, d, *J* 3.8, 10-H), 6.62 (1 H, d, *J* 4.9, 7-H), 6.67–6.70 (2 H, m, 2 × *o*-PhH), 7.36 (1 H, dd, *J* 8.0, 0.9), 7.75 (1 H, t, *J* 8.0), 7.86–7.89 (3 H, m), 11.84 (1 H, s, ArOH) and 12.35 (1 H, s, ArOH); *m/z* 439 (M − NCO, 15.6%).

Preparation of *endo* and *exo*-norbornadiene adducts 8 and 9

A mixture of formyl acid **3** (R = H) (45 mg, 0.14 mmol), norbornadiene (0.14 cm^3, 1.3 mmol), benzene (3.6 cm^3) and acetic anhydride (0.9 cm^3) was boiled under reflux. After 30 min the solvent was removed under reduced pressure to leave a yellow solid (54 mg). A portion of the crude product (44 mg) was chromatographed on silica in dichloromethane to give first the exo-*adduct* **9** (10 mg, 22%) as a yellow crystalline solid, mp 254–270 °C (decomp.) (ethanol) (Found: C, 71.9; H, 3.9. $C_{24}H_{16}O_6$ requires C, 72.0; H, 4.0%); ν_{max}/cm^{-1} 1767, 1674 and 1629; δ(300 MHz) 1.53 (1 H, d, *J* 10.7, 17-H), 1.98–2.07 (2 H, m, 8- and 9-H), 2.13 (1 H, d, *J* 10.7, 17-H), 2.95 (1 H, s, 13- or 16-H), 3.05 (1 H, s, 13- or 16-H), 4.00 (1 H, d, *J* 2.4, 10-H), 6.11 (1 H, br s, 7-H), 6.27 (1 H, m, olefinic H), 6.35 (1 H, m, olefinic H), 7.32 (1 H, dd, *J* 8.0, 0.8), 7.70 (1 H, t, *J* 8.0), 7.76 (1 H, s), 7.83 (1 H, dd, *J* 8.0, 0.8), 11.97 (1 H, s, ArOH) and 12.24 (1 H, s, ArOH); *m/z* 400 (M^+, 3.1%), 372 ($M^+ - CO$, 4.9), 356 ($M^+ - CO_2$, 1.3) and 290 ($M^+ - CO_2$ and C_5H_6, 73.8).

Further elution of the column gave the endo-*adduct* **8** (20 mg, 45%) as orange–yellow needles, mp 207–209.5 °C (ethanol) (Found: C, 71.8; H, 3.95%); ν_{max}/cm^{-1} 1763, 1670, 1630 and 1617 cm^{-1}; δ(300 MHz) 0.08 (1 H, d, *J* 10.0, 17-H), 0.84 (1 H, d, *J* 10.0, 17-H), 2.38 (1 H, dd, *J* 8.3, 3.0, 9-H), 2.65 (1 H, s, 13- or 16-H), 2.71 (1 H, s, 13- or 16-H), 2.74 (1 H, dd, *J* 8.3, 4.3, 8-H), 4.1 (1 H, d, *J* 3.0, 10-H), 6.11 (1 H, d, *J* 4.3, 7-H), 6.25 (1 H, m, olefinic H), 6.28 (1 H, m, olefinic H), 7.34 (1 H, dd, *J* 8.0, 0.9), 7.73 (1 H, t, *J* 8.0), 7.79 (1 H, s), 7.86 (1 H, dd, *J* 8.0, 0.9), 11.98 (1 H, s, ArOH) and 12.24 (1 H, s, ArOH); *m/z* 290 ($M^+ - CO_2$ and C_5H_6, 100).

Preparation of 2-(triethylsilyloxy)buta-1,3-diene 5 (R = vinyl, P = TES)

Methyl vinyl ketone (2.1 g, 30.0 mmol) was added dropwise over 10 min to a stirred solution of lithium diisopropylamide [from butyllithium (1.6 mol dm^{-3} in hexane; 32 mmol) and diisopropylamine (32.8 mmol) in THF (60 cm^3) and 1,3-dimethyl-3,4,5,6-tetrahydro-2(1*H*)-pyrimidone (DMPU) (1.7 cm^3] at −78 °C. After 5 min a solution of triethylsilyl chloride (5.1 g, 33.8 mmol) in THF (22 cm^3) was added dropwise to the reaction mixture. The mixture was allowed to warm to room temperature over 1.25 h and then poured into a mixture of 1 mol dm^{-3} acetic acid and light petroleum (bp 40–60 °C). The layers were separated and the aqueous layer extracted with light petroleum (bp 40–60 °C). The combined extracts were washed with water, saturated aqueous sodium hydrogen carbonate, water (2 ×) and finally brine. The solution was dried ($MgSO_4$) and the solvent removed under reduced pressure. Filtration of the residue through silica gel using light petroleum (bp 40–60 °C) as eluent gave 2-(triethylsilyloxy)buta-1,3-diene (4.02 g, 82%) as a colourless liquid; δ(300 MHz) 0.73 (6 H, q, *J* 8.0, 3 × $SiCH_2Me$), 1.00 (9 H, t, *J* 8.0, 3 × $SiCH_2CH_3$), 4.29 (1 H, s), 4.33 (1 H, s), 5.06 (1 H, d, *J* 10.5), 5.51 (1 H, dd, *J* 16.9, 1.7) and 6.18 (1 H, dd, *J* 16.9, 10.5).

Preparation of adducts 6 (R = vinyl, P = TES) and 11

A mixture of formyl acid **3** (R = H) (326 mg, 1.0 mmol), 2-(triethylsilyloxy)buta-1,3-diene (3.67 g, 20 mmol), benzene (13 cm^3) and acetic anhydride (6.5 cm^3) was stirred and boiled under reflux. After 35 min the mixture was cooled and the solvent removed under reduced pressure. Silica gel chromatography (1:49, ethyl acetate–benzene) gave an orange solid (390 mg, 79%). ^1H NMR showed this to consist of a mixture of *endo* and *exo* adducts in the ratio 1:1. Fractional crystallisation from dichloromethane–benzene gave the exo-*adduct* **11** (120 mg, 24%) as a yellow crystalline solid, mp 230 °C (decomp.) (ethanol) (Found: C, 66.0; H, 5.75. $C_{27}H_{28}O_7Si$ requires C, 65.85; H, 5.75%); ν_{max}/cm^{-1} 1770, 1680, 1635 and 1623; δ(300 MHz) 0.65 (6 H, q, *J* 7.8, 3 × $SiCH_2Me$), 0.97 (9 H, t, *J* 7.8, 3 × $SiCH_2CH_3$), 2.27 (1 H, dd, *J* 14.4, 1.2, 8-H), 2.58 (1 H, dd, *J* 14.4, 4.0, 8-H), 4.04 (1 H, s, 10-H), 4.77 (1 H, d, *J* 17.3, olefinic H), 4.99 (1 H, d, *J* 10.7, olefinic H), 5.77 (1 H, dd, *J* 17.3, 10.7, olefinic H), 6.18–6.19 (1 H, m, 7-H), 7.33 (1 H, dd, *J* 8.0, 0.9), 7.7 (1 H, s), 7.71 (1 H, t, *J* 8.0), 7.84 (1 H, dd, *J* 8.0, 0.9), 11.97 (1 H, s, ArOH) and 12.29 (1 H, s, ArOH); *m/z* 492 (M^+, 10.3%), 463 (M^+ − Et, 20.6), 419 ($M^+ - CO_2$ and Et, 100) and 308 [$M^+ - CH_2C(OSiEt_3)CHCH_2$, 81.0].

Recrystallisation of the mother liquors from benzene gave the endo-*adduct* **6** (R = vinyl, P = TES) (122 mg, 25%) as yellow needles, mp 193–196 °C [benzene–light petroleum (bp 80–100 °C)] (Found: C, 66.05; H, 5.75%); ν_{max}/cm^{-1} 1774, 1680 and 1628; δ(300 MHz) 0.40 (6 H, m, 3 × $SiCH_2Me$), 0.70 (9 H, t, *J* 7.9, 3 × $SiCH_2CH_3$), 1.91 (1 H, dd, *J* 14.6, 1.3, 8-H), 2.89 (1 H, dd, *J* 14.6, 3.8, 8-H), 4.11 (1 H, s, 10-H), 5.36 (1 H, d, *J* 10.8, olefinic H), 5.45 (1 H, d, *J* 17.4, olefinic H), 6.12 (1 H, dd, *J* 17.4, 10.8, olefinic H), 6.19 (1 H, m, 7-H), 7.33 (1 H, dd, *J* 8.0, 0.9), 7.72 (1 H, t, *J* 8.0), 7.82 (1 H, s), 7.86 (1 H, dd, *J* 8.0, 0.9), 12.00 (1 H, s, ArOH) and 12.33 (1 H, s, ArOH); *m/z* 492 (M^+, 6.6%),

448 ($M^+ - CO_2$, 9.6), 419 ($M^+ - CO_2$ and Et, 14.0) and 316 ($M^+ - Et_3SiOH$ and CO_2, 100).

Tris(triphenylphosphine)rhodium(I) chloride catalysed hydrogenation of adduct 6 (R = vinyl, P = TES)

Adduct **6** (R = vinyl, P = TES) (118 mg, 0.24 mmol) and $[Rh(PPh_3)_3Cl]$ (50 mg) in dichloromethane (20 cm^3) were shaken at 20 °C under hydrogen at a pressure of 1 atm. After 36 h the solvent was removed under reduced pressure and the residue chromatographed on silica gel (dichloromethane) to give a yellow solid (107 mg). ^1H NMR analysis indicated that the reduction was only 60% complete. The partially hydrogenated material (107 mg) and $[Rh(PPh_3)_3Cl]$ (50 mg) in dichloromethane (20 cm^3) were shaken at 20 °C under hydrogen at a pressure of 1 atm. After 26 h the solvent was removed under reduced pressure and the residue chromatographed on silica (dichloromethane) to give the *lactone* **6** (R = Et, P = TES) (91.5 mg, 77%) as yellow needles, mp 212–216 °C (ethanol) (Found: C, 65.6; H, 6.15. $C_{27}H_{30}O_7Si$ requires C, 65.55; H, 6.1%); ν_{max}/cm^{-1} 1768, 1675 and 1624; δ(300 MHz) 0.25–0.42 (6 H, m, 3 × $SiCH_2Me$), 0.68 (9 H, t, *J* 7.9, 3 × $SiCH_2CH_3$), 1.12 (3 H, t, *J* 7.5, CH_3), 1.76 (1 H, dq, *J* 14.3, 7.5, R-*H*CHMe), 1.93 (1 H, dq, *J* 14.3, 7.5, R-HC*H*Me), 1.96 (1 H, br d, *J* 14.4, 8-H), 2.49 (1 H, dd, *J* 14.4, 3.7, 8-H), 4.22 (1 H, s, 10-H), 6.12–6.14 (1 H, m, 7-H), 7.33 (1 H, dd, *J* 8.0, 0.8), 7.72 (1 H, t, *J* 8.0), 7.81 (1 H, s), 7.86 (1 H, dd, *J* 8.0, 1.0), 12.01 (1 H, s, ArOH) and 12.32 (1 H, s, ArOH); *m/z* 494 (M^+, 11.9%), 465 ($M^+ - Et$, 17.3), 421 ($M^+ - CO_2$ and Et, 28.9) and 318 ($M^+ - Et_3SiOH$ and CO_2, 100).

Tris(triphenylphosphine)rhodium(I) chloride catalysed hydrogenation of adduct 11

Adduct **11** (120 mg, 0.24 mmol) and $[Rh(PPh_3)_3Cl]$ (50 mg) in dichloromethane (45 cm^3) were shaken at 20 °C under hydrogen at a pressure of 1 atm. After 24 h the solvent was removed under reduced pressure. ^1H NMR analysis indicated that the reduction was only 50% complete. The partially hydrogenated residue and $[Rh(PPh_3)_3Cl]$ (50 mg) in dichloromethane (30 cm^3) were shaken at 20 °C under hydrogen at a pressure of 1 atm. After 24 h the solvent was removed under reduced pressure and the residue chromatographed on silica gel (dichloromethane) to give a yellow solid (91 mg). ^1H NMR analysis indicated that the reduction was only 64% complete. The partially hydrogenated material (91 mg) and $[Rh(PPh_3)_3Cl]$ (50 mg) in dichloromethane (30 cm^3) were shaken at 20 °C under hydrogen at a pressure of 1 atm. After 24 h the solvent was removed under reduced pressure and the residue chromatographed on silica gel (dichloromethane) to give the *lactone* **12** (73 mg, 61%) as yellow needles, mp 240 °C (decomp.) (ethanol) (Found: C, 65.7; H, 6.25. $C_{27}H_{30}O_7Si$ requires C, 65.55; H, 6.1%); ν_{max}/cm^{-1} 1770, 1715, 1669 and 1610; δ(300 MHz) 0.68 (6 H, t, *J* 7.8, 3 × $SiCH_2Me$), 0.93 (3 H, t, *J* 7.1, CH_3), 1.00 (9 H, t, *J* 7.8, 3 × $SiCH_2CH_3$), 1.06 (1 H, dq, *J* 14.4, 7.1, R-*H*CHMe), 1.50 (1 H, dq, *J* 14.4, 7.1, R-HC*H*Me), 1.84 (1 H, dd, *J* 14.1, 1.1, 8-H), 2.60 (1 H, dd, *J* 14.1, 4.3, 8-H), 4.14 (1 H, s, 10-H), 6.12–6.13 (1 H, m, 7-H), 7.32 (1 H, dd, *J* 8.0, 1.0), 7.71 (1 H, t, *J* 8.0), 7.78 (1 H, s), 7.84 (1 H, dd, *J* 8.0, 1.2), 11.95 (1 H, s, ArOH) and 12.27 (1 H, s, ArOH); *m/z* 494 (M^+, 2.7%), 465 ($M^+ - Et$, 11.8), 421 ($M^+ - CO_2$ and Et, 30.3) and 318 ($M^+ - Et_3SiOH$ and CO_2, 100).

Tris(triphenylphosphine)rhodium(I) chloride catalysed hydrogenation of the adduct mixture 6 (R = vinyl, P = TES) and 11

A mixture of the adducts (ratio 1:1) (410 mg, 0.83 mmol) and $[Rh(PPh_3)_3Cl]$ (100 mg) in dichloromethane (20 cm^3) was shaken at 20 °C under hydrogen at a pressure of 1 atm. After 44 h the solvent was removed under reduced pressure and the residue chromatographed on silica gel (dichloromethane) to give a yellow crystalline solid (336 mg, 82%), ^1H NMR analysis of which showed that it consisted of a mixture of the lactones **6** (R = Et, P = TES) and **12** (ratio 1:1).

Treatment of lactone 12 with sodium methoxide

A solution of sodium methoxide in methanol (0.65 mol dm^{-3}; 3.1 cm^3, 2.0 mmol) was added to a stirred solution of the lactone **12** (41 mg, 0.083 mmol) in dichloromethane (20 cm^3) at room temperature. After 3 h the mixture was acidified with hydrochloric acid (2 mol dm^{-3}) and extracted with dichloromethane. The combined extracts were evaporated under reduced pressure and the residue taken up in dichloromethane and treated with an excess of ethereal diazomethane. Removal of the solvent under reduced pressure followed by silica gel chromatography (1:49, ethyl acetate–benzene) gave an orange solid (3.5 mg, 8%) tentatively identified from its ^1H NMR as methyl 9-ethyl-4,6-dihydroxy-5,12-dioxo-9-(triethylsilyloxy)-5,9,10,12-tetrahydrotetracene-10-carboxylate **39**† (X = OTES, Y = Et); δ(300 MHz) 0.63 (6 H, q, *J* 7.9, 3 × $SiCH_2Me$), 0.86 (3 H, t, *J* 7.0, CH_3), 0.95 (9 H, t, *J* 7.9, 3 × $SiCH_2CH_3$), 1.63 (1 H, dq, *J* 14.1, 7.0, R-*H*CHMe), 1.75 (1 H, dq, *J* 14.1, 7.0, R-HC*H*Me), 3.65 (3 H, s, CO_2CH_3), 4.05 (1 H, s, 10-H), 6.05 (1 H, d, *J* 10.4, 8-H), 6.97 (1 H, d, *J* 10.4, 7-H), 7.30 (1 H, dd, *J* 8.0, 0.9), 7.64 (1 H, s), 7.68 (1 H, t, *J* 8.0), 7.83 (1 H, dd, *J* 8.0, 1.0), 12.06 (1 H, s, ArOH) and 12.41 (1 H, s, ArOH).

Further elution gave the *α-methoxy ester* **31** (22 mg, 49%) as orange needles, mp 146–149 °C (ethanol) (Found: C, 64.3; H, 6.6. $C_{29}H_{36}O_8Si$ requires C, 64.4; H, 6.7%); ν_{max}/cm^{-1} 1739, 1677 and 1619 cm^{-1}; δ(300 MHz) 0.65 (6 H, t, *J* 7.8, 3 × $SiCH_2Me$), 0.91–1.02 (12 H, m, 3 × $SiCH_2CH_3$ and CH_3), 1.56 (1 H, dq, *J* 14.9, 7.5, R-*H*CHMe), 1.88 (1 H, dq, *J* 14.9, 7.5, R-HC*H*Me), 2.20 (1 H, d, *J* 14.0, 8-H), 2.73 (1 H, dd, *J* 14.0, 4.8, 8-H), 3.57 (3 H, s, OCH_3), 3.67 (3 H, s, CO_2CH_3), 4.17 (1 H, s, 10-H), 4.77 (1 H, d, *J* 4.8, 7-H), 7.28 (1 H, dd, *J* 8.0, 0.9), 7.57 (1 H, s), 7.66 (1 H, t, *J* 8.0), 7.80 (1 H, dd, *J* 7.5, 0.9), 12.05 (1 H, s, ArOH) and 12.65 (1 H, s, ArOH); *m/z* 511 (M^+ – Et, 100%) and 479 (M^+ – MeOH and Et, 46.7).

Elution of the column with 1:19 ethyl acetate–benzene gave a yellow crystalline solid (6 mg, 13%) identified from its ^1H NMR as methyl 9-ethyl-4,6-dihydroxy-7-methoxy-5,12-dioxo-9-(triethylsilyloxy)-5,7,8,9,10,12-hexahydrotetracene-10-carboxylate **23**; δ(300 MHz) 0.65 (6 H, t, *J* 7.5, 3 × $SiCH_2Me$), 0.86 (3 H, t, *J* 7.5, CH_3), 0.99 (9 H, t, *J* 7.9, 3 × $SiCH_2CH_3$), 1.30 (1 H, dq, *J* 14.2, 7.2, R-*H*CHMe), 1.45 (1 H, dq, *J* 14.2, 7.2, R-HC*H*Me), 2.34 (1 H, ddd, *J* 12.6, 8.5, 1.8, 8-H), 2.88 (1 H, dd, *J* 12.6, 8.5, 8-H), 3.52 (3 H, s, OCH_3), 3.72 (3 H, s, CO_2CH_3), 4.03 (1 H, d, *J* 1.4, 10-H), 4.77 (1 H, t, *J* 8.5, 7-H), 7.31 (1 H, dd, *J* 8.0, 0.8), 7.60 (1 H, s), 7.68 (1 H, t, *J* 8.0), 7.82 (1 H, dd, *J* 8.0, 0.9), 12.06 (1 H, s, ArOH) and 12.76 (1 H, s, ArOH).

Treatment of lactone 6 (R = Et, P = TES) with sodium methoxide

A solution of sodium methoxide in methanol (0.52 mol dm^{-3}; 6.3 cm^3, 3.3 mmol) was added to a stirred solution of the lactone **6** (R = Et, P = TES) (65 mg, 0.13 mmol) in dichloromethane (14 cm^3) at room temperature. After 80 min the mixture was acidified with hydrochloric acid (2 mol dm^{-3}) and extracted with dichloromethane. The combined extracts were evaporated under reduced pressure and the residue taken up in dichloromethane and treated with an excess of ethereal diazometh-

† For consistency the same numbering system has been used for all compounds although in some instances this means that the principal group does not have the lowest possible locant.

ane. Removal of the solvent under reduced pressure followed by silica gel chromatography (1:49, ethyl acetate–benzene) gave an orange solid (4 mg, 6%) whose ^{1}H NMR spectrum was consistent with the $\Delta^{7,8}$ olefin **39** (X = Et, Y = OTES); δ(300 MHz) 0.40–0.50 (6 H, m, 3 × SiCH_2Me), 0.77 (9 H, t, J 7.8, 3 × SiCH$_2$CH_3), 1.06 (3 H, t, J 7.4, CH$_3$), 1.70 (1 H, dq, J 14.4, 7.4, R-HCHMe), 1.85 (1 H, dq, J 14.4, 7.4, R-HCHMe), 3.65 (3 H, s, CO$_2$CH$_3$), 4.14 (1 H, s, 10-H), 6.12 (1 H, d, J 9.8, 8-H), 7.10 (1 H, d, J 9.8, 7-H), 7.30 (1 H, dd, J 7.9, 0.9), 7.70 (1 H, t, J 7.9), 7.73 (1 H, s), 7.84 (1 H, dd, J 7.9, 0.8), 12.08 (1 H, s, ArOH) and 12.43 (1 H, s, ArOH).

Further elution with 1:19 ethyl acetate–benzene gave a yellow solid (13.5 mg) shown by ^{1}H NMR to consist of a complex mixture of compounds including starting material and aromatic ester **20** (R = Et, X = OH). Further elution gave the β-*methoxy ester* **21** (34.5 mg, 49%) as yellow needles, mp 154–156 °C (ethanol) (Found: C, 64.45; H, 6.8. $C_{29}H_{36}O_8Si$ requires C, 64.4; H, 6.7%); ν_{max}/cm^{-1} 1736, 1679 and 1624; δ(300 MHz) 0.40–0.50 (6 H, m, 3 × SiCH_2Me), 0.76 (9 H, t, J 7.8, 3 × SiCH$_2$CH$_3$), 1.02 (3 H, t, J 7.2, CH$_3$), 1.65 (1 H, dq, J 14.2, 7.2, R-HCHMe), 1.75 (1 H, dq, J 14.2, 7.2, R-HCHMe), 2.35–2.45 (2 H, m, 8-H), 3.53 (3 H, s, OCH$_3$), 3.72 (3 H, s, CO$_2$CH$_3$), 3.91 (1 H, br s, 10-H), 4.85 (1 H, t, J 7.6, 7-H), 7.30 (1 H, dd, J 8.0, 0.9), 7.63 (1 H, s), 7.68 (1 H, t, J 8.0), 7.83 (1 H, dd, J 7.2, 0.8), 12.11 (1 H, s, ArOH) and 12.71 (1 H, s, ArOH); m/z 511 (M$^+$ − Et, 79.8%), 479 (M$^+$ − MeOH and Et, 87.3) and 408 (M$^+$ − Et$_3$SiOH, 97.3).

Finally elution with 1:4 ethyl acetate–benzene gave *methyl 9-ethyl-4,6,7-trihydroxy-5,12-dioxo-9-(triethylsilyloxy)-5,7,8,-9,10,12-hexahydrotetracene-10-carboxylate* **22** (6.5 mg, 9%) as orange needles, mp 192–193.5 °C (ethanol) (Found: C, 64.2; H, 6.65. $C_{28}H_{34}O_8Si$ requires C, 63.85; H, 6.5%); ν_{max}/cm^{-1} 3600, 1744, 1678 and 1626; δ(300 MHz) 0.40–0.50 (6 H, m, 3 × SiCH_2Me), 0.75 (9 H, t, J 7.9, 3 × SiCH$_2$CH_3), 1.03 (3 H, t, J 7.4, CH$_3$), 1.65 (2 H, m, CH_2Me), 2.30 (1 H, dd, J 13.5, 8.5, 8-H), 2.47 (1 H, ddd, J 13.5, 8.5, 1.9, 8-H), 3.72 (3 H, s, CO$_2$CH$_3$), 3.94 (1 H, d, J 1.5, 10-H), 4.02 (1 H, d, J 2.4, OH), 5.27 (1 H, br t, J 8.5, 7-H), 7.32 (1 H, dd, J 8.0, 0.7), 7.68 (1 H, s), 7.71 (1 H, t, J 8.0), 7.85 (1 H, br d, J 8.0), 12.0 (1 H, s, ArOH) and 12.93 (1 H, s, ArOH); m/z 497 (M$^+$ − Et, 21.7%), 479 (M$^+$ − H$_2$O and Et, 76.6), 394 (M$^+$ − Et$_3$SiOH, 80.8) and 376 (M$^+$ − Et$_3$SiOH and H$_2$O, 63.4).

Preparation of 7-*epi*-alkavinone 7-methyl ether 24

Hydrofluoric acid (40% aqueous; 0.5 cm^3) was added to a stirred solution of β-methoxy ester **21** (12 mg, 0.022 mmol) in dichloromethane (2.5 cm^3) and acetonitrile (5 cm^3) at room temperature. After 2 h saturated aqueous sodium hydrogen carbonate was added and the resulting mixture extracted with dichloromethane. The combined extracts were washed with saturated aqueous sodium hydrogen carbonate and dried (MgSO$_4$). The solvent was removed under reduced pressure and the crude product recrystallised from ethanol to give 7-*epi*-aklavinone 7-methyl ether **24** (9 mg, 95%) as yellow needles, mp 202–203 °C (ethanol); δ(300 MHz) 1.05 (3 H, t, J 7.4, CH$_3$), 1.65 (1 H, m, HCHMe), 1.75 (1 H, dq, J 14.4, 7.4, HCHMe), 2.25 (1 H, ddd, J 14.2, 6.6, 1.2, 8-H), 2.50 (1 H, dd, J 14.2, 6.6, 8-H), 3.54 (3 H, s, OCH$_3$), 3.76 (3 H, s, CO$_2$CH$_3$), 3.92 (1 H, br s, 10-H), 4.84 (1 H, t, J 6.6, 7-H), 7.31 (1 H, dd, J 8.0, 0.9), 7.65 (1 H, s), 7.68 (1 H, t, J 8.0), 7.82 (1 H, dd, J 8.0, 0.9), 12.07 (1 H, s, ArOH) and 12.69 (1 H, s, ArOH).

Treatment of a mixture of lactone 6 (R = Et, P = TES) and its C-9 epimer 12 with sodium methoxide

A solution of sodium methoxide in methanol (1.4 mol dm^{-3}; 10 cm^3, 14.0 mmol) was added to a stirred solution of the lactones **6** (R = Et, P = TES) and **12** (1:1 ratio) (336 mg, 0.68 mmol) in dichloromethane (50 cm^3) at room temperature. After 2 h the mixture was acidified with hydrochloric acid (2 mol dm^{-3}) and extracted with dichloromethane. The combined extracts were evaporated under reduced pressure and the residue taken up in dichloromethane and treated with an excess of ethereal diazomethane. Removal of the solvent under reduced pressure followed by silica gel chromatography (benzene then 1:49, ethyl acetate–benzene) gave a yellow crystalline solid (96.5 mg, 26%) which ^{1}H NMR showed consisted of the methoxy esters **31** and **32** (6:1 ratio). The ^{1}H NMR data for the minor isomer **32** is as follows (*NB* aromatic signals obscured by major isomer): δ(300 MHz) 0.52 (6 H, q, J 7.5, SiCH_2Me), 0.83 (9 H, t, J 7.5, SiCH$_2$CH_3), 1.44 (1 H, m, R-HCHMe), 1.73 (1 H, m, R-HCHMe), 2.28 (2 H, m, 8-H), 3.54 (3 H, s, OCH$_3$), 3.71 (3 H, CO$_2$CH$_3$), 4.08 (1 H, s, 10-H), 4.69 (1 H, m, 7-H), 12.10 (1 H, s, ArOH) and 12.69 (1 H, s, ArOH).

Elution of the column with 1:9 ethyl acetate–benzene gave a yellow crystalline solid (166 mg, 45%) which ^{1}H NMR showed consisted of the methoxy esters **22** and **23** (6:1 ratio). Finally elution of the column with 1:4 ethyl acetate–benzene gave a yellow solid (12.5 mg, 3.5%) which ^{1}H NMR showed to be the hydroxy ester **22**.

Preparation of methyl 9-ethyl-4,6,9-trihydroxy-7-methoxy-5,12-dioxo-5,7,8,9,10,12-hexahydrotetracene-10-carboxylates 33 and 34

Hydrofluoric acid (40% aqueous; 3 cm^3) was added to a stirred solution of the silyl ethers **31** and **32** (ratio 6:1 by ^{1}H NMR) (96 mg, 0.18 mmol) in dichloromethane (16 cm^3) and acetonitrile (32 cm^3) at room temperature. After 1.5 h saturated aqueous sodium hydrogen carbonate was added and the resulting mixture partitioned between saturated aqueous sodium hydrogen carbonate and dichloromethane. The organic layer was separated and the aqueous layer extracted with dichloromethane. The combined extracts were washed with saturated aqueous sodium hydrogen carbonate and dried (MgSO$_4$). The solvent was removed under reduced pressure and the crude product chromatographed on silica gel. Elution with 1:9 then 1:4 ethyl acetate–benzene gave aklavinone 7-methyl ether **34** (9 mg, 12%) as orange needles, mp 190–193 °C (ethanol) (lit.,[5] 193–199 °C); δ(300 MHz) 1.10 (3 H, t, J 7.4, CH$_2$CH_3), 1.55 (1 H, dq, J 14.2, 7.4, R-HCHMe), 1.70 (1 H, dq, J 14.2, 7.4, R-HCHMe), 2.35–2.5 (2 H, m, 8-H), 3.63 (3 H, s, OCH$_3$), 3.69 (3 H, s, CO$_2$CH$_3$), 4.15 (1 H, s, 10-H), 4.79 (1 H, s, OH), 4.91 (1 H, t, J 2.9, 7-H), 7.31 (1 H, dd, J 8.3, 0.9), 7.66–7.72 (2 H, m), 7.83 (1 H, dd, J 7.6, 0.9), 12.05 (1 H, s, ArOH) and 12.69 (1 H, s, ArOH).

Elution of the column with 3:7 ethyl acetate–benzene gave 9-*epi*-aklavinone 7-methyl ether **33** (65.5 mg, 86.5%) as a yellow crystalline solid, mp 185–188 °C (ethanol) (lit.,[5] 191–192 °C); δ(300 MHz) 1.00 (3 H, t, J 7.3, CH$_2$CH_3), 1.60–1.80 (2 H, m, CH_2Me), 2.23 (1 H, dd, J 14.5, 2.5, 8-H), 2.37 (1 H, dd, J 14.5, 5.6, 8-H), 2.68 (1 H, s, OH), 3.52 (3 H, s, OCH$_3$), 3.81 (3 H, s, CO$_2$CH$_3$), 4.07 (1 H, s, 10-H), 4.85 (1 H, dd, J 5.6, 2.5, 7-H), 7.31 (1 H, dd, J 8.0, 0.8), 7.58 (1 H, s), 7.69 (1 H, t, J 8.0), 7.82 (1 H, dd, J 8.0, 0.8), 12.05 (1 H, s, ArOH) and 12.61 (1 H, s, ArOH).

Preparation of methyl 9-ethyl-4,6,9-trihydroxy-7-methoxy-5,12-dioxo-5,7,8,9,10,12-hexahydrotetracene-10-carboxylates 24 and 25

Hydrofluoric acid (40% aqueous; 3.75 cm^3) was added to a stirred solution of the silyl ethers **21** and **23** (ratio 6:1 by ^{1}H NMR) (166 mg, 0.31 mmol) in dichloromethane (20 cm^3) and acetonitrile (40 cm^3) at room temperature. After 2 h saturated aqueous sodium hydrogen carbonate was added and the resulting mixture partitioned between saturated aqueous sodium hydrogen carbonate and dichloromethane. The organic layer was separated and the aqueous layer extracted with

dichloromethane. The combined extracts were washed with saturated aqueous sodium hydrogen carbonate and dried ($MgSO_4$). The solvent was removed under reduced pressure and the crude material chromatographed on silica gel (1:9, ethyl acetate–benzene) to give 10-*epi*-aklavinone 7-methyl ether **25** (28 mg, 21%) as a yellow crystalline solid, mp 179–184 °C (ethanol) (lit.,[5] 184–187 °C); δ(300 MHz) 1.01 (3 H, t, *J* 7.5, CH_2CH_3), 1.50–1.77 (1 H, m, R-*H*CHMe), 1.75 (1 H, dd, *J* 14.6, 3.5, 8-H), 1.90 (1 H, dq, *J* 14.5, 7.2, R-HC*H*Me), 2.49 (1 H, dd, *J* 14.6, 3.5, 8-H), 3.56 (3 H, s, OCH_3), 3.78 (3 H, s, CO_2CH_3), 4.02 (1 H, s, 10-H), 4.80 (1 H, s, OH), 5.0 (1 H, t, *J* 3.5, 7-H), 7.32 (1 H, dd, *J* 8.0, 0.9), 7.58 (1 H, s), 7.70 (1 H, t, *J* 8.0), 7.84 (1 H, dd, *J* 8.0, 0.9), 12.05 (1 H, s, ArOH) and 12.67 (1 H, s, ArOH).

Further elution gave 7-*epi*-aklavinone 7-methyl ether **24** (92 mg, 70%) as a yellow crystalline solid (identified by ^1H NMR).

Conversion of methoxy ester 24 into aklavinone

Trifluoroacetic acid (3.5 cm^3) was added to methoxy ester **24** (45 mg, 0.1 mmol) at −78 °C (bath temperature) and the mixture was allowed to warm to 10 °C over 30 min with stirring. The mixture was stirred at room temperature for 1.5 h before being concentrated *in vacuo*. The residue was dissolved in acetone (7 cm^3) and saturated aqueous sodium hydrogen carbonate (3 cm^3) added with stirring. After 45 min water was added and the mixture extracted with dichloromethane. The combined extracts were dried (Na_2SO_4) and the solvent removed under reduced pressure. Silica gel chromatography of the residue using 1:4, ethyl acetate–benzene then 2:3, ethyl acetate–benzene gave a yellow crystalline solid (38 mg, 87%) with ^1H NMR signals identical with those reported for aklavinone.[9]

Synthesis of auramycinone

Preparation of 2-(triethylsilyloxy)propene 5 (R = Me, P = TES)

Acetone (1.74 g, 30 mmol) was added dropwise to a stirred solution of lithium diisopropylamide [from butyllithium (1.6 mol dm^{-3} in hexane; 32 mmol) and diisopropylamine (31.5 mmol)] in THF (60 cm^3) at −78 °C. After 10 min 1,3-dimethyl-3,4,5,6-tetrahydro-2(1*H*)-pyrimidone (DMPU) (17 cm^3) was added followed immediately by the dropwise addition of a solution of triethylsilyl chloride (5 g, 33 mmol) in THF (22 cm^3). The mixture was allowed to warm to room temperature over 2 h and poured into a mixture of acetic acid (1 mol dm^{-3}) and light petroleum (bp 40–60 °C). The layers were separated and the aqueous layer extracted with light petroleum (bp 40–60 °C). The combined organic extracts were washed with water, saturated aqueous sodium hydrogen carbonate, water (2 ×) and finally brine. The solution was dried ($MgSO_4$) and the solvent removed under removed pressure. Filtration through a short column of silica gel [light petroleum (bp 40–60 °C) as eluent] gave 2-(triethylsilyloxy)propene **5** (R = Me, P = TES) (2.26 g, 43%) as a colourless liquid; δ(300 MHz) 0.69 (6 H, q, *J* 7.8, $SiCH_2Me$), 0.98 (9 H, t, *J* 7.8, 3 × $SiCH_2CH_3$), 1.79 (3 H, s, CH_3) and 4.04 (2 H, m, olefinic H).

Preparation of adducts 6 (R = Me, P = TES), 10 and 13 (R = Me, P = TES)

A mixture of formyl acid **3** (R = H) (220 mg, 0.67 mmol), 2-(triethylsilyloxy)propene (2.1 g, 12.2 mmol), benzene (9 cm^3) and acetic anhydride (4.5 cm^3) was boiled under reflux for 30 min. The solvent was removed under reduced pressure and the residue chromatographed on silica gel (1:49, ethyl acetate–benzene) to give a yellow–orange solid (170 mg, 52%) which ^1H NMR showed consisted of a mixture of adducts **6** (R = Me, P = TES) and **10** in the ratio 2:1 respectively. Fractional crystallisation from benzene gave the exo-*adduct* **10** (38.5 mg, 12%) as yellow plates, mp 237–241 °C (ethanol) (Found: C, 65.2; H, 5.95. $C_{26}H_{28}O_7Si$ requires C, 65.0; H, 5.9%); ν_{max}/cm^{-1} 1770, 1676 and 1662; δ(300 MHz) 0.67 (6 H, q, *J* 7.8, $SiCH_2Me$), 1.00 (9 H, t, *J* 7.8, $SiCH_2CH_3$), 1.18 (3 H, s, CH_3), 1.85 (1 H, dd, *J* 14.0, 1.1, 8-H), 2.61 (1 H, dd, *J* 14.0, 4.2, 8-H), 3.95 (1 H, s, 10-H), 6.11–6.12 (1 H, m, 7-H), 7.32 (1 H, dd, *J* 8.0, 1.0), 7.71 (1 H, t, *J* 8.0), 7.78 (1 H, s), 7.84 (1 H, dd, *J* 8.0, 0.9), 11.94 (1 H s, ArOH) and 12.26 (1 H, s, ArOH); *m/z* 480 (M^+, 7.3%), 451 (M − Et, 38.2), 407 (M^+ − Et and CO_2, 47.7), 308 [M^+ − $CH_2C(OSiEt_3)Me$, 40.3] and 304 (M^+ − Et_3SiOH and CO_2, 100).

Recrystallisation of the mother liquors from benzene gave the endo-*adduct* **6** (R = Me, P = TES) (50 mg, 15%) as orange plates, mp 213–230 °C (ethanol) (Found: C, 64.7; H, 5.75%); ν_{max}/cm^{-1} 1770, 1678 and 1627; δ(300 MHz) 0.42 (6 H, q, *J* 7.8, $SiCH_2Me$), 0.72 (9 H, t, *J* 7.8, $SiCH_2CH_3$), 1.66 (3 H, s, CH_3), 1.94 (1 H, dd, *J* 14.3, 1.2, 8-H), 2.51 (1 H, dd, *J* 14.3, 7.2, 8-H), 4.03 (1 H, s, 10-H), 6.11–6.13 (1 H, m, 7-H), 7.32 (1 H, dd, *J* 8.0, 0.8), 7.71 (1 H, t, *J* 8.0), 7.79 (1 H, s), 7.85 (1 H, dd, *J* 8.0, 0.8), 12.00 (1 H, s, ArOH) and 12.31 (1 H, s, ArOH); *m/z* 480 (M^+, 9.9%), 451 (M^+ − Et, 17.8), 308 [M^+ − $CH_2C(OSiEt_3)Me$, 47.8] and 304 (M^+ − Et_3SiOH and CO_2, 100).

Further elution of the column gave one stereoisomer of lactone **13** (R = Me, P = TES) (31 mg, 9.5%) as yellow needles, mp 228.5–230 °C (ethanol) (Found: C, 65.15; H, 5.9%); ν_{max}/cm^{-1} 1768, 1670, 1635 and 1600; δ(300 MHz) 0.59 (6 H, q, *J* 7.5, $SiCH_2Me$), 0.80 (9 H, t, *J* 7.5, $SiCH_2CH_3$), 1.89 (3 H, s, CH_3), 2.13 (1 H, t, *J* 12.0, 18-H), 2.78 (1 H, dd, *J* 12.0, 6.8, 18-H), 3.79 (1 H, d, *J* 18.1, 9-H), 3.94 (1 H, d, *J* 18.1, 9-H), 5.69 (1 H, dd, *J* 12.0, 6.8, 7-H), 7.31 (1 H, dd, *J* 8.3, 1.0), 7.64 (1 H, t, *J* 7.9), 7.78 (1 H, dd, *J* 7.6, 1.0), 7.81 (1 H, s) and 12.99 (1 H, s, ArOH); *m/z* 451 (M^+ − Et, 100).

Further elution gave the epimeric lactone **13** (R = Me, P = TES) (28 mg, 8.5%) as a yellow crystalline solid, mp 173–177 °C (diethyl ether) (Found: C, 64.75; H, 5.7%); ν_{max}/cm^{-1} 1744, 1672, 1641 and 1596; δ(300 MHz) 0.73 (6 H, q, *J* 7.6, $SiCH_2Me$), 0.93 (9 H, t, *J* 8.0, $SiCH_2CH_3$), 1.69 (3 H, s, CH_3), 2.44 (1 H, dd, *J* 14.0, 8.0, 18-H), 2.68 (1 H, dd, *J* 14.0, 8.0, 18-H), 3.81 (1 H, d, *J* 18.0, 9-H), 3.95 (1 H, d, *J* 18.0, 9-H), 5.43 (1 H, t, *J* 8.0, 7-H), 7.32 (1 H, dd, *J* 8.0, 0.9), 7.64 (1 H, t, *J* 8.0), 7.78 (1 H, dd, *J* 8.0, 0.9), 7.81 (1 H, s) and 12.98 (1 H, s, ArOH); *m/z* 451 (M^+ − Et, 100%).

Preparation of methyl 4,6-dihydroxy-7-methoxy-9-methyl-5,12-dioxo-9-(triethylsilyloxy)-5,7,8,9,10,12-hexahydrotetracene-10-carboxylate 35

A solution of sodium methoxide in methanol (0.48 mol dm^{-3}; 5 cm^3, 2.4 mmol) was added to a stirred solution of the *adducts* **6** (R = Me, P = TES) and **10** (ratio 2:23) (38.5 mg, 0.08 mmol) in dichloromethane (10 cm^3) at room temperature. After 2 h the mixture was acidified with hydrochloric acid (2 mol dm^{-3}) and extracted with dichloromethane. The combined extracts were evaporated under reduced pressure and the residue taken up in dichloromethane and treated with an excess of ethereal diazomethane. Removal of the solvent under reduced pressure followed by silica gel chromatography (benzene then 1:49 ethyl acetate–benzene) gave an orange solid which was recrystallised from ethanol to give the *methoxy ester* **35** (15.5 mg, 37%) as orange plates, mp 164–167 °C (ethanol) (Found: C, 63.7; H, 6.4. $C_{28}H_{34}O_8Si$ requires C, 63.85; H, 6.5%); ν_{max}/cm^{-1} 1732, 1670 and 1614; δ(300 MHz) 0.65 (6 H, q, *J* 7.8, $SiCH_2Me$), 0.99 (9 H, t, *J* 7.9, $SiCH_2CH_3$), 1.46 (3 H, s, CH_3), 2.20 (1 H, d, *J* 14.2, 8-H), 2.66 (1 H, dd, *J* 14.2, 5.0, 8-H), 3.57 (3 H, s, OCH_3), 3.66 (3 H, s, CO_2CH_3), 3.99 (1 H, s, 10-H), 4.78 (1 H, dd, *J* 5.0, 1.0, 7-H), 7.29 (1 H, dd, *J* 8.0, 0.8), 7.58 (1 H, s), 7.67 (1 H, t, *J* 8.0), 7.81 (1 H, dd, *J* 8.0, 0.8), 12.05 (1 H, s, ArOH) and 12.67 (1 H, s, ArOH); *m/z* 497 (M^+ − Et, 100%) and 465 (M^+ − Et and MeOH, 13.7).

Further elution of the column gave a yellow crystalline solid (5.5 mg) which ^{1}H NMR indicated consisted of a mixture of the methoxy ester **27** and its C-9 epimer **26** (ratio 2.5:1). For the major isomer **27** the ^{1}H NMR data is as follows: δ(300 MHz) 0.65 (6 H, q, *J* 7.7, SiC*H*$_2$Me), 0.98 (9 H, t, *J* 7.7, SiCH$_2$C*H*$_3$), 1.2 (3 H, s, CH$_3$), 2.30 (1 H, m, 8-H), 2.80 (1 H, dd, *J* 11.5, 8.5, 8-H), 3.52 (3 H, s, OCH$_3$), 3.71 (3 H, s, CO$_2$CH$_3$), 3.85 (1 H, s, 10-H), 5.73 (1 H, t, *J* 8.5, 7-H), 7.31 (1 H, dd, *J* 8.0, < 1), 7.60 (1 H, s), 7.88 (1 H, t, *J* 8.0), 7.82 (1 H, dd, *J* 8.0, < 1), 12.06 (1 H, s, ArOH) and 12.78 (1 H, s, ArOH).

Preparation of methyl 4,6-dihydroxy-7-methoxy-9-methyl-5,12-dioxo-9-(triethylsilyloxy)-5,7,8,9,10,12-hexahydrotetracene-10-carboxylate 36 and methyl 4,6,7-trihydroxy-9-methyl-5,12-dioxo-9-(triethylsilyloxy)-5,7,8,9,10,12-hexahydrotetracene-10-carboxylate 30

A solution of sodium methoxide in methanol (0.91 mol dm^{-3}; 5 cm^3, 4.5 mmol) was added to a stirred solution of the adducts **6** (R = Me, P = TES) and **10** (ratio 3.8:1) (75 mg, 0.16 mmol) in dichloromethane (16 cm^3) at room temperature. After 2 h the mixture was acidified with hydrochloric acid (2 mol dm^{-3}) and extracted with dichloromethane. The combined extracts were evaporated under reduced pressure and the residue taken up in dichloromethane and treated with an excess of ethereal diazomethane. Removal of the solvent under reduced pressure followed by silica gel chromatography (benzene then 1:49 ethyl acetate–benzene) gave a yellow solid (15 mg, 18%) which ^{1}H NMR showed consisted of a mixture of the methoxy ester **36** and its C-9 epimer **35** (ratio 1.8:1). For the minor isomer **35** the ^{1}H NMR is as follows: δ(300 MHz) 0.58 (6 H, m, SiC*H*$_2$Me), 0.88 (9 H, t, *J* 8.0, SiCH$_2$C*H*$_3$), 1.36 (3 H, s, CH$_3$), 2.35 (2 H, m, 8-H), 3.50 (3 H, s, OCH$_3$), 3.71 (3 H, s, CO$_2$CH$_3$), 4.04 (1 H, s, 10-H), 4.68 (1 H, m, 7-H), 7.29 (1 H, m), 7.58 (1 H, s), 7.65 (1 H, m), 7.81 (1 H, m), 12.1 (1 H, s, ArOH) and 12.67 (1 H, s, ArOH). Further elution gave a yellow solid (1 mg, 2%) which ^{1}H NMR showed to be aromatic ester **20** (R = Me, X = OH). Elution of the column with 1:19, ethyl acetate–benzene gave the β-*methoxy ester* **26** (24 mg, 29%) as a yellow crystalline solid, mp 130–133.5 °C (ethanol) (Found: C, 63.85; H, 6.55. C$_{28}$H$_{34}$O$_8$Si requires C, 63.85; H, 6.5%); ν_{max}/cm^{-1} 3400, 1743, 1677, 1623 and 1605; δ(300 MHz) 0.45–0.55 (6 H, m, SiC*H*$_2$Me), 0.80 (9 H, t, *J* 7.8, SiCH$_2$C*H*$_3$), 1.47 (3 H, s, CH$_3$), 2.30–2.50 (2 H, m, 8-H), 3.52 (3 H, s, OCH$_3$), 3.74 (3 H, s, CO$_2$CH$_3$), 3.86 (1 H, s, 10-H), 4.83 (1 H, t, *J* 7.2, 7-H), 7.30 (1 H, dd, *J* 8.0, 0.9), 7.58 (1 H, s), 7.67 (1 H, t, *J* 8.0), 7.82 (1 H, dd, *J* 8.0, 0.9), 12.10 (1 H, s, ArOH) and 12.69 (1 H, s, ArOH); *m*/*z* 497 (M$^+$ − Et, 72.9%), 465 (M$^+$ − Et and MeOH, 40.2), 394 (M$^+$ − Et$_3$SiOH, 85.1), 363 (M$^+$ − Et$_3$SiOH and OMe, 52.6) and 335 (M$^+$ − R$_3$SiOH and CO$_2$Me, 100).

Elution of the column with 1:4 ethyl acetate–benzene gave the *hydroxy ester* **30** as a yellow crystalline solid (16 mg, 20%), mp 200–203 °C (ethanol) (Found: C, 63.05; H, 6.15. C$_{27}$H$_{32}$O$_8$Si requires C, 63.3; H, 6.3%); ν_{max}/cm^{-1} 3500, 1748, 1670 and 1627; δ(300 MHz) 0.45–0.57 (6 H, m, SiC*H*$_2$Me), 0.79 (9 H, t, *J* 7.8, SiCH$_2$C*H*$_3$), 1.46 (3 H, s, CH$_3$), 2.35–2.38 (2 H, m, 8-H), 3.73 (3 H, s, CO$_2$CH$_3$), 3.89 (1 H, s, 10-H), 4.02 (1 H, d, *J* 2.0, OH), 5.28 (1 H, dt, *J* 8.0, 2.0, 7-H), 7.30 (1 H, d, *J* 8.0), 7.65 (1 H, s), 7.70 (1 H, t, *J* 8.0), 7.84 (1 H, d, *J* 8.0), 11.99 (1 H, s, ArOH) and 12.93 (1 H, s, ArOH); *m*/*z* 483 (M$^+$ − Et and H$_2$O, 22.1%), 380 (M$^+$ − Et$_3$SiOH, 74.1) and 321 (M$^+$ − Et$_3$SiOH and CO$_2$Me, 100).

Treatment of a mixture of 6 (R = Me, P = TES) and its C-9 epimer 10 with sodium methoxide

A solution of sodium methoxide in methanol (1.9 mol dm^{-3}; 10 cm^3, 19.0 mmol) was added to a stirred solution of the title lactones (2:1 ratio) (400 mg, 0.83 mmol) in dichloromethane (60 cm^3) at room temperature. After 1.5 h the mixture was acidified with hydrochloric acid (2 mol dm^{-3}) and extracted with dichloromethane. The combined extracts were evaporated under reduced pressure and the residue taken up in dichloromethane and treated with an excess of ethereal diazomethane. Removal of the solvent under reduced pressure followed by silica gel chromatography (benzene then 1:49 ethyl acetate–benzene) gave, a yellow crystalline solid (108 mg, 25%) which ^{1}H NMR showed consisted of the methoxy esters **35** and **36** (2.7:1 ratio). Further elution gave a yellow crystalline solid (215 mg, 49%) which ^{1}H NMR showed consisted of the methoxy esters **26** and **27** (8.7:1 ratio).

Preparation of methyl 4,6,9-trihydroxy-7-methoxy-9-methyl-5,12-dioxo-5,7,8,9,10,12-hexahydrotetracene-10-carboxylates 37 and 38

Hydrofluoric acid (40% aqueous; 3 cm^3) was added to a stirred solution of the silyl ethers **35** and **36** (ratio 2.7:1 by ^{1}H NMR) (108 mg, 0.21 mmol) in dichloromethane (16 cm^3) and acetonitrile (32 cm^3) at room temperature. After 1.5 h saturated aqueous sodium hydrogen carbonate was added and the resulting mixture partitioned between saturated aqueous sodium hydrogen carbonate and dichloromethane. The organic layer was separated and the aqueous layer extracted with dichloromethane. The combined extracts were washed with water and dried (MgSO$_4$). The solvent was removed under reduced pressure and the crude product chromatographed on silica gel (1:4, ethyl acetate–benzene) to give *auramycinone 7-methyl ether* **38** (23.5 mg, 28%) as orange plates, mp 202–207 °C (ethanol) (Found: C, 64.2; H, 5.15. C$_{22}$H$_{20}$O$_8$ requires C, 64.05; H, 4.9%); ν_{max}/cm^{-1} 3510, 1735, 1674, 1621 and 1606; δ(300 MHz) 1.39 (3 H, s, CH$_3$), 2.30 (1 H, dm, *J* 15.0, 8-H), 2.44 (1 H, dd, *J* 15.0, 3.9, 8-H), 3.63 (3 H, s, OCH$_3$), 3.70 (3 H, s, CO$_2$CH$_3$), 4.11 (1 H, br s, 10-H), 4.91 (1 H, dd, *J* 3.9, 1.9, 7-H), 4.95 (1 H, br s, OH), 7.31 (1 H, dd, *J* 8.0, 0.9), 7.67 (1 H, s), 7.69 (1 H, t, *J* 8.0), 7.83 (1 H, dd, *J* 8.0, 1.1), 12.04 (1 H, s, ArOH) and 12.70 (1 H, s, ArOH); *m*/*z* 412 (M$^+$, 26.6%), 394 (M$^+$ − H$_2$O, 76.6), 380 (M$^+$ − MeOH, 43.9), 362 (M$^+$ − H$_2$O and MeOH, 50.7) and 335 (M$^+$ − H$_2$O and CO$_2$Me, 100).

Further elution gave 9-*epi*-auramycinone 7-methyl ether **37** (59.5 mg, 70%) as a yellow crystalline solid, mp 200–204 °C (Found: C, 64.3; H, 5.05. C$_{22}$H$_{20}$O$_8$ requires C, 64.05; H, 4.9%); δ(300 MHz) 1.46 (3 H, s, Me), 2.18 (1 H, dd, *J* 14.5 and 2.6, 8-H), 2.51 (1 H, dd, *J* 14.5, 5.7, 8-H), 2.82 (1 H, br m, OH), 3.51 (3 H, s, OMe), 3.81 (3 H, s, CO$_2$Me), 4.04 (1 H, br s, 10-H), 4.88 (1 H, dd, *J* 5.7, 2.6, 7-H), 7.31 (1 H, dd, *J* 8.0, 1.0), 7.60 (1 H, s), 7.69 (1 H, t, *J* 8.0), 7.83 (1 H, dd, *J* 8.0, 1.0), 12.05 (1 H, s, ArOH) and 12.63 (1 H, s, ArOH); *m*/*z* 412 (M$^+$, 2.6%), 394 (M$^+$ − H$_2$O, 50.1), 380 (M$^+$ − MeOH, 15.2), 362 (M$^+$ − H$_2$O and MeOH, 20.3) and 335 (M$^+$ − H$_2$O and CO$_2$Me, 100).

Preparation of methyl 4,6,9-trihydroxy-7-methoxy-9-methyl-5,12-dioxo-5,7,8,9,10,12-hexahydrotetracene-10-carboxylates 28 and 29

Hydrofluoric acid (40% aqueous; 4.5 cm^3) was added to a stirred solution of the silyl ethers **26** and **27** (ratio 8.7:1 by ^{1}H NMR) (215 mg, 0.41 mmol) in dichloromethane (52 cm^3) and acetonitrile (36 cm^3) at room temperature. After 1.5 h saturated aqueous sodium hydrogen carbonate was added and the mixture partitioned between saturated aqueous sodium hydrogen carbonate and dichloromethane. The organic layer was separated and the aqueous layer extracted with dichloromethane. The combined extracts were washed with water and dried (MgSO$_4$). The solvent was removed under reduced pressure and the crude product chromatographed on silica gel (1:4, ethyl acetate–benzene) to give 10-epi-*auramycinone 7-methyl ether* **29** (15.5 mg, 9%) as yellow needles, mp 176–180 °C (ethanol) (Found: C, 63.8; H, 4.9. C$_{22}$H$_{20}$O$_8$ requires C, 64.05; H, 4.9%); ν_{max}/cm^{-1} 3440, 1737, 1676 and 1620 cm^{-1};

δ(300 MHz) 1.52 (3 H, s, CH_3), 1.81 (1 H, dd, *J* 14.7, 3.0, 8-H), 2.54 (1 H, dd, *J* 14.7, 3.0, 8-H), 3.57 (3 H, s, OCH_3), 3.81 (3 H, s, CO_2CH_3), 3.97 (1 H, br s, 10-H), 4.83 (1 H, br m, OH), 4.96 (1 H, t, *J* 3.0, 7-H), 7.32 (1 H, dd, *J* 8.3, 0.9), 7.56 (1 H, s), 7.70 (1 H, t, *J* 8.0), 7.84 (1 H, dd, *J* 7.5, 0.9), 12.04 (1 H, s, ArOH) and 12.68 (1 H, s, ArOH); *m/z* 380 (M^+ − MeOH, 35.6%) and 362 (M^+ − H_2O and MeOH, 44.7).

Further elution gave 7-epi-*auramycinone* 7-*methyl ether* **28** (127 mg, 75%) as yellow needles, mp 211–213.5 °C (ethanol) (Found: C, 64.25; H, 4.85%); ν_{max}/cm^{-1} 3427, 1735, 1672, 1618 and 1600; δ(300 MHz) 1.45 (3 H, s, CH_3), 2.19 (1 H, dd, *J* 14.2, 6.5, 8-H), 2.50 (1 H, dd, *J* 14.2, 5.1, 8-H), 3.54 (3 H, s, OCH_3), 3.80 (3 H, s, CO_2CH_3), 3.89 (1 H, br s, 10-H), 4.83 (1 H, t, *J* 5.7, 7-H), 7.31 (1 H, dd, *J* 8.7, 1.0), 7.62 (1 H, s), 7.68 (1 H, t, *J* 8.0), 7.82 (1 H, dd, *J* 7.3, 1.0), 12.06 (1 H, s, ArOH) and 12.69 (1 H, s, ArOH), one OH resonance undetected; *m/z* 412 (M^+, 10.5%), 394 (M^+ − H_2O, 16.0), 380 (M^+ − MeOH, 5.8), 362 (M^+ − H_2O and MeOH, 100) and 335 (M^+ − H_2O and CO_2Me, 65.7).

Preparation of auramycinone from 7-*epi*-auramycinone 7-methyl ether 28

Trifluoroacetic acid (1 cm^3) was added to the methoxy ester **28** (9 mg, 0.02 mmol) at −15 °C (bath temperature). The stirred mixture was allowed to warm to room temperature over 30 min. After a further 1.5 h the mixture was concentrated *in vacuo* and acetone (7 cm^3) and saturated aqueous sodium hydrogen carbonate (3 cm^3) added with stirring. After 45 min water was added and the mixture extracted with dichloromethane. The combined extracts were dried (Na_2SO_4) and the solvent removed under reduced pressure. Silica gel chromatography of the residue gave auramycinone (7 mg, 80%) as a yellow crystalline solid with ^1H NMR signals identical with those reported in the literature:[9] δ(300 MHz) 1.43 (3 H, s, CH_3), 2.24 (1 H, d, *J* 15.0, 8-H), 2.63 (1 H, dd, *J* 15.0, 5.0, 8-H), 3.37 (1 H, br s, collapses with D_2O, OH), 3.72 (3 H, s, CO_2CH_3), 4.04 (1 H, s, collapses with D_2O, OH), 4.06 (1 H, s, 10-H), 5.4 (1 H, br m, d, *J* 5.0 with D_2O, 7-H), 7.33 (1 H, dd, *J* 8.4, 0.9), 7.69–7.74 (2 H, m), 7.85 (1 H, dd, *J* 7.6, 0.9), 11.98 (1 H, s, ArOH) and 12.75 (1 H, s, ArOH).

Preparation of auramycinone from auramycinone 7-methyl ether 38

Trifluoroacetic acid (1 cm^3) was added to the methoxy ester **38** (6 mg, 0.015 mmol) at −15 °C (bath temperature). The stirred mixture was allowed to warm to room temperature over 30 min. After a further 1.5 h the mixture was concentrated *in vacuo* and acetone (7 cm^3) and solid sodium hydrogen carbonate were added with stirring. After ~5 min water was added and the mixture extracted with dichloromethane. The combined extracts were dried (Na_2SO_4) and the solvent removed under reduced pressure. Recrystallisation of the residue gave auramycinone (5.3 mg, 91%) as a yellow crystalline solid with ^1H NMR signals identical with those reported.[9]

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