Conversion of a Pimarane Diterpene into the Cleistanthane Ring System

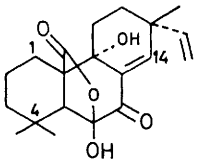
By GEORGE A. ELLESTAD,* MARTIN P. KUNSTMANN, and GEORGE O. MORTON
(*Lederle Laboratories, A Division of American Cyanamid Company, Pearl River, New York* 10965)

Summary The acid-catalysed migration of the C-13 vinylidene grouping to C-14 in a pimarane diterpene is reported.

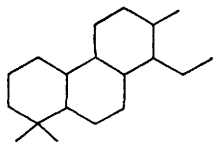
IN connection with the chemistry of the diterpene antibiotic LL-S491β (**1**),[1] we observed an interesting acid-catalysed migration of the C-13 vinylidene grouping to C-14. To our knowledge such a 1,2-migration has not been reported previously. However, it has been suggested by McGarry *et al.*[2] that the carbon skeleton for the cleistanthane diterpenes (**2**) is derived biogenetically from a pimarane involving a 1,2-migration of the C-13 vinylidene fragment. Our observations provide a chemical model for this postulate.

Treatment of (**1**) with acetic anhydride and a catalytic amount of toluene-*p*-sulphonic acid at room temperature gave, after partition chromatography, the cleistanthanes (**3**) and (**4**) in yields of 20 and 6%, respectively. In addition, the pimarane (**5**) was obtained in 6% yield. The structures and stereochemistry (as known) were elucidated primarily by n.m.r. spectroscopy along with spin decoupling experiments. The n.m.r. spectrum ($CDCl_3$) of the least polar material (**3**) includes signals at δ 1·66 (d, J 1 Hz, 13-Me), 2·99 (m, 11-H), 3·69 (m, 14-H), 5·44br (s, 12-H) and 5·00—5·80 (complex, $HC{=}CH_2$). The essentially zero coupling between the allylic 12- and 14-H suggests the latter is in the pseudoaxial conformation.[3] Irradiation of

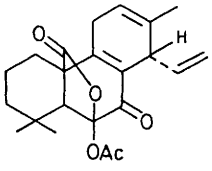
14-H collapsed the 11-H pattern to a broad singlet ($w_{\frac{1}{2}}$ 8 Hz) and reduced the adjacent ethylidene signals to a pattern similar to that in the spectrum of (**1**). Signals due to the remaining protons in (**3**) and also in (**4**) and (**5**) are essentially the same as the corresponding ones in the spectrum of the 6-monoacetate of (**1**).



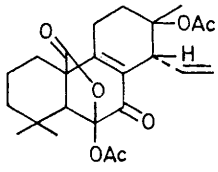
(1)



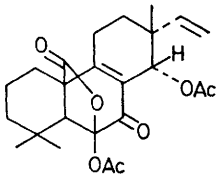
(2)



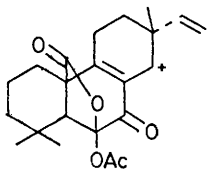
(3)



(4)



(5)



(6)

The diacetate (**4**)† was eluted next, which shows sharp 3H singlets at δ 1·53 and 1·85 due to the C-13 methyl and C-13 acetate methyl groups. The ethylidene protons show a pattern between δ 5·04 and 5·59 similar to that in the spectrum of (**3**).

The pimarane (**5**) was eluted last and exhibits the 14-H methine signal at δ 5·60 as a 1H singlet ($w_{\frac{1}{2}}$ 3 Hz). The C-13 ethylidene pattern is similar to that in the n.m.r. spectrum of (**1**).

The C-7 ketone absorption in (**3**) (1700 cm^{-1}), (**4**) (1700 cm^{-1}), and (**5**) (1710 cm^{-1}) is again unusually high for an $\alpha\beta$-unsaturated carbonyl grouping but can be explained by the influence of the neighbouring oxygen functions.[1] The u.v. maximum at 260—265 nm is also higher than expected,[4] probably owing to the proximity of the rigid axial C-10 carbonyl group to the $\alpha\beta$-unsaturated ketone system thus permitting a certain amount of orbital overlap. The c.d. of such an inherently dissymmetric chromophore is characterised by two strong Cotton effects of opposite sign in the 210—250 nm region where the sign of the long-wavelength transition can be related to the helicity of the $\beta\gamma$-unsaturated ester portion.[5] The c.d. of (**5**) shows two bands at 262 ($\Delta\epsilon$ +32·7) and 230 nm ($\Delta\epsilon$ −41·7) consistent with the previously assigned stereochemistry of C-10.[1] The n–π^* band of the C-7 ketone is observed at 345 nm ($\Delta\epsilon$ −1·43).

It seems reasonable to assume the intermediacy of ion (**6**) in the conversion into the cleistanthane skeleton. Migration of the vinylidene fragment (bicyclobutonium ion?) followed by elimination of a proton at C-12 or capture of acetic acid to neutralize the resulting C-13 positive centre would account for (**3**) and (**4**). Allylic rearrangement of the C-9 acetoxy-group‡ which is presumably formed would provide (**5**).

We thank W. F. Fulmor and L. Brancone and associates for spectral and analytical data, Dr. G. Van Lear for the mass spectra (direct inlet MS9 AEI) and Miss P. Mullen of the Stamford Laboratories for the c.d. spectrum.

(*Received*, 19*th February* 1973; *Com.* 222.)

† Satisfactory analyses (high-resolution mass spectral) were obtained for all compounds reported.

‡ Acylating conditions are necessary as substitution of acetic acid for the anhydride resulted in the recovery of starting material.

[1] G. A. Ellestad, M. P. Kunstmann, P. Mirando, and G. O. Morton, *J. Amer. Chem. Soc.*, 1972, **94**, 6204.
[2] E. J. McGarry, K. H. Pegel, L. Phillips, and E. S. Waight, *J. Chem. Soc.* (*C*), 1971, 904.
[3] E. W. Garbisch, *J. Amer. Chem. Soc.*, 1964, **86**, 5561.
[4] Certain diterpenes containing the 8(9)-ene-7-one chromophore and a C-10 methyl group have u.v. maxima at 247—248 nm: W. Herz and J. J. Schmid, *J. Org. Chem.*, 1969, **34**, 3464.
[5] J. D. Bu'Lock, D. J. Austin, G. Snatzke, and L. Hruban, *Chem. Comm.*, 1970, 255; G. Snatzke and K. Schaffner, *Helv. Chim. Acta*, 1968, **51**, 986.