The Structure of Tamaulipin-B, a New Germacranolide, and the Thermal Conversion of a *trans*-1,2-Divinylcyclohexane Derivative into a Cyclodeca-1,5-diene System

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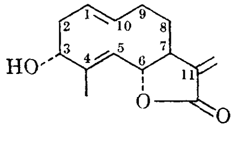
HERE we report (i) the isolation and structure determination of a new germacranolide (a sesquiterpene lactone which contains a ten-membered carbocyclic unit) from *Ambrosia confertiflora* DC. (Compositae), and (ii) the first example of the thermal conversion of a *trans*-1,2-divinylcyclohexane derivative into a cyclodeca-1,5-diene system.

Chloroform extraction of dried leaves of *Ambrosia confertiflora* from near Cd. Victoria, Tamaulipas, Mexico, yielded after silica-gel chromatography a number of sesquiterpene lactones including tamaulipin-B (0·5% yield), (I), $C_{15}H_{20}O_3$,† m.p. 140—142°, $[\alpha]_D^{24°}$ + 99°; λ_{max} (MeOH) 207 nm., (ϵ 19,400); infrared: ν_{max} (Nujol) 3500 (hydroxyl), 1745 ($\alpha\beta'$-unsaturated δ-lactone), 1660 cm.$^{-1}$ (double bonds); n.m.r.‡: 1·44 (d, J = 1 c./sec.) and 1·63 (d, J = 1·2) for two vinyl methyls; 4·50 (tr, J = 3) for the allylic proton on the carbon atom bearing the hydroxyl group; 4·65 (dd, J = 10 and 8) for the C-6 lactonic proton; 5·25 (m) for the two vinyl protons and 5·55 and 6·25 (two d, J = 3·2 and 3·5, respectively) for the two C-11 exocyclic methylene protons. Tamaulipin-B was further characterized by the preparation of an acetate, $C_{17}H_{22}O_4$, m.p. 155—156°, $[\alpha]_D^{24}$ + 128°; λ_{max} (MeOH) 209 nm. (ϵ 19,100); ν_{max} (Nujol) 1745 (γ-lactone and acetate) and 1660 cm.$^{-1}$ (double bonds).

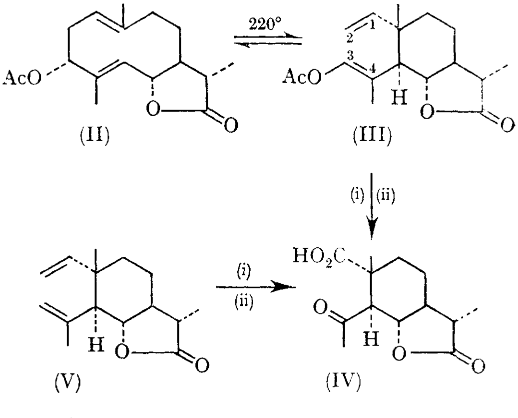
Hydrogenation of (I) with Pd–C as catalyst yielded dihydrotamaulipin-B, $C_{15}H_{22}O_3$, which crystallized from benzene with one mole of benzene solvate, m.p. 73—80°. The dihydro-product was converted into dihydrotamaulipin-B acetate (II), $C_{17}H_{24}O_4$, m.p. 140°, $[\alpha]_D^{24}$ + 136°; λ_{max} (MeOH) 205 nm. (ϵ 9500); ν_{max} (Nujol) 1760 (γ-lactone), 1740 and 1238 (acetate), and 1660 cm.$^{-1}$ (double bonds); n.m.r.: 1·26 (d, J = 6·5 c./sec.) for C-11 methyl; 1·45 (d, J = 1) and 1·71 (d, J = 1·5) C-4 and C-10 vinyl methyls; 5·33 (tr, J = 3) for the allylic proton on the carbon atom bearing the acetate function, and 4·60 (dd, J = 8 and 10) for the C-6 lactonic proton.

The structure of (II) and thus tamaulipin-B (with the exception of the stereochemistry at C-3 in both substances) was provided by the conversion of (II) into the keto-acid (IV), a product also derived by ozonolysis and oxidation of saussurea lactone (V), a sesquiterpene lactone of known absolute structure.[1]

Pyrolysis of (II) in a nitrogen at 220° for 3 min. yielded a 2 : 3 mixture of starting material and the Cope product (III), $C_{17}H_{24}O_4$, m.p. 102—104°, $[\alpha]_D^{24}$ + 24°; ν_{max} (Nujol) 1765 (γ-lactone), 1748 and 1230 (enol acetate), and 1665 cm.$^{-1}$ (double bonds); n.m.r.: 1·25 (d, J = 6·5 c./sec.) for the C-11 methyl, 1·09 for the C-10 methyl, 1·73 (d, J = 1·5) for C-4 vinyl methyl, 7·02 (q, J = 1·5) for the C-3 proton, 5·84 (dd, J = 10 and 18) for the C-1 olefinic proton, 4·90 and 4·91 (two dd, J = 10 and 1 and J = 18 and 1, respectively) for the two C-2 protons. Ozonolysis of (III) as well as saussurea lactone (V) at −40° in EtOAc followed by $KMnO_4$ oxidation in aqueous dioxan gave the keto-acid (IV), $C_{13}H_{18}O_5$, m.p. 167—169°; ν_{max} (KBr) 1774 (γ-lactone), 1736 (carboxyl) and 1712 cm.$^{-1}$ (keto).



(I)



Reagents: (i) O_3–EtOAc; (ii) $KMnO_4$.

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† Satisfactory elemental analyses were obtained for all new compounds reported herein.

‡ The n.m.r. were recorded in $CDCl_3$ and the chemical shifts are reported in p.p.m. (δ-scale) and coupling constants (J values) are in c./sec.: d = doublet, dd = double doublet, tr = triplet, q = quartet, and m = multiplet.

The stereochemistry at C-3 in (I) is tentatively assigned an α-orientation on the basis of the recovery of dextrorotatory α-phenylbutyric acid in 77% optical yield by the Horeau technique.[2] Therefore, on the evidence described above, we suggest structure (I) for tamaulipin-B.

When pure (III) was heated under the same conditions in which it was formed originally from (II), a 2:3 mixture of (II) and (III) was again obtained. This represents the first report of the formation of a cyclodeca-1,5-diene system from a *trans*-1,2-divinylcyclohexane derivative; moreover, these data establish that the Cope transformation of either (II) or (III) under the conditions mentioned above yield an equilibrium mixture of the two compounds.§

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§ The scope of these equilibrium reactions is under investigation.

[1] A. S. Rao, A. P. Sadgopal, and S. C. Bhattacharyya, *Tetrahedron*, 1961, **13**, 319.

[2] A. Horeau, *Tetrahedron Letters*, 1961, 506; 1962, 965; T. J. Mabry, W. Ranold, H. E. Miller, and H. B. Kagan, *J. Org. Chem.*, 1966, **31**, 681; N. H. Fischer and T. J. Mabry, *Tetrahedron*, 1967, **23**, 2529.