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CONVERSION OF GURJUNENE TO 10-EPIZIERONE: STEREOCHEMISTRY OF ZIERONE

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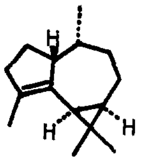
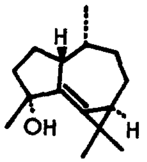
Previous investigations (1) by Birch and Barton on zierone, a sesquiterpene ketone from Zieria macrophylla, disclosed unique carbon skeleton (zierane) and π-electron system in the molecule. The stereochemistry is however still unknown. As compounds with the zierane skeleton were obtained in the course of our study (2) on the sensitized photooxygenation of gurjunene, a tricyclic sesquiterpene with the transoid α-vinylcyclopropane, we have attempted a partial synthesis of zierone in order to establish its stereochemistry. Since the configuration of our rearranged products is firmly established (2) and since zierone has only two asymmetric centers, derivation of zierone or even its stereoisomer from gurjunene should elucidate the stereochemistry of this unique sesquiterpene ketone.

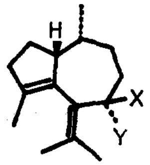
Sensitized photooxygenation of gurjunene (I) was performed essentially in the same way as described before (2), and the reaction mixture was reduced with $NaBH_4$ without isolation. Subsequent silica-gel chromatography afforded the allylic alcohol (II), unstable colorless oil [ν 3447 cm^{-1}, δ 1.09 (3H, d, J=7.2), 1.14 (3H, s), 1.36 (3H, s), 1.37 (3H, s), no olefinic hydrogen] in 47% yield (3). The treatment of II with oxalic acid in acetic anhydride-acetic acid at 0° for 30 min. induced the skeletal rearrangement to yield 10-epizieryl acetate (III), m.p. 67.5°, [$\lambda_{max}^{hex.}$ 243 nm (ϵ 1800 sh), ν 1731, 1242 cm^{-1}, δ 0.89 (3H, d, J=6.6), 1.49 (3H, dt, J=2, 1), 1.55 (3H, s), 1.83 (3H, s), 1.99 (3H, s), 5.93 (1H, dd, J=4.0, 3.4)] in 37% yield. $LiAlH_4$ removed the acetyl group of III to give 10-epizierol (IV), unstable colorless oil, [ν 3430 cm^{-1}, δ 0.88 (3H, d, J=6.9), 1.52 (3H, s), 1.60 (3H, dt, J=2.4, 1.0), 1.75 (3H, s), 4.70 (1H, m)], oxidation of which with chromium trioxide-pyridine complex furnished 10-epizierone (V), colorless oil [λ_{max} 245 nm (ϵ 4100), ν 1682 and 1600 cm^{-1}, δ_{CCl_4} 0.87 (3H, d, J=6.7), 1.56 (3H, dt, J=2.0, 1.0), 1.67 (3H, s),



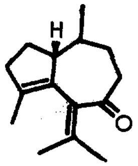
I



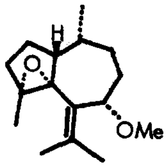
II



III: X=H, Y=OAc
IV: X=H, Y=OH
V: X, Y=O



VI



VII

2.10 (3H,s)] in 44% yield. The structures of these compounds are clear from the above spectral data.

Spectra of V are clearly different from those of zierone (VI), [λ_{max} 246 nm (ϵ 7400), δ_{CCl_4} 0.98 (3H, d, J=5.7), 1.51 (3H, br.s), 1.66 (3H, s), 2.02 (3H, s)], suggesting that they are a pair of stereoisomers. Since the sign of the Cotton effect in CD of V ($[\theta]_{348}$-2090, $[\theta]_{260}$+2810 (sh), $[\theta]_{220}$+13740! in dioxane) is the same with that for VI ($[\theta]_{332}$-11780, $[\theta]_{264}$+9300, $[\theta]_{220}$+27400! in dioxane), the chirality of the π-electron system, therefore the configuration at C_1, is the same in both compounds, showing them to be epimeric at C_{10} (4). Thence VI has 1R,10S-configuration.

Thus, although I with wrong stereochemistry was shown not to be the precursor of VI, our original proposal (2) for the biogenesis of VI which emphasizes the mode of formation of zierane carbon skeleton is still valid. Furthermore, our proposed mechanism for the skeletal rearrangement received experimental support from the isolation of II. The corresponding allylic hydroperoxide must be the intermediate to the allyl epoxide (VII) previously obtained (2).

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References and Footnotes

1) A.J. Birch, D.J. Collings, A.P. Penfold and J.P. Turnbull, J. Chem. Soc., 792 (1962). D.H.R. Barton and G.S. Gupta, Ibid., 1961 (1962).

2) S. Ito, H. Takeshita, M. Hirama and Y. Fukazawa, Tetrahedron Letters, 9 (1972).

3) Spectral data refer to the following conditions unless otherwise stated: UV; in methanol, IR; in CCl_4 for crystals, neat for liquid, NMR; in $CDCl_3$.

4) The large difference in [θ] can be attributed to the conformational difference between the epimers. Inspection of molecular model disclosed that, although VI can take a conformation in which methyl group at C_{10} occupies β-equatorial orientation without any large non-bonded interaction, V can not take such a stable conformation. Slight change in the conformation inevitably causes the conformational change in the whole π-system.