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ON THE STEREOCHEMISTRY OF COLUMBIN

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THE elucidation of the structure of columbin (I) by Barton and Elad revealed that this diterpene possessed a rearranged sclareol skeleton; the reasonable suggestion was made that columbin may be regarded as derived from a normal diterpene precursor by appropriate methyl migrations which might have stereochemical implications.[1]

In view of our earlier interest in the columbin problem,[2] we wish to record our speculations concerning the stereochemistry of columbin as developed from the observed rotatory dispersion curve of octahydrodecarboxycolumbic acid (II).[1,2]

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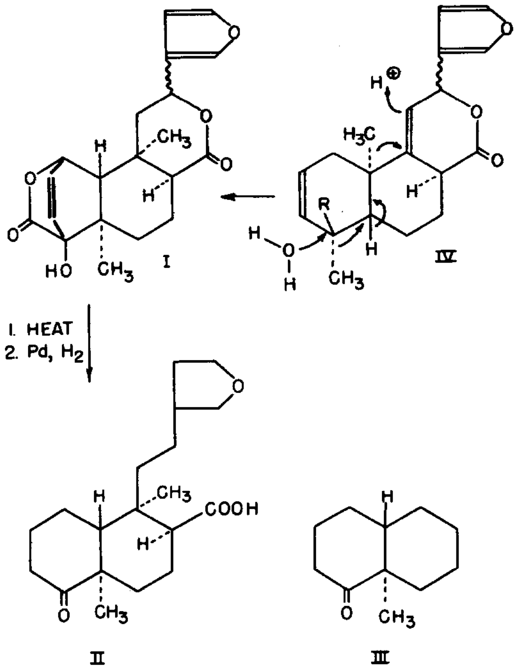
[1] D. H. R. Barton and D. Elad, J. Chem. Soc. 2085, 2090 (1956).

[2] M. P. Cava and E. J. Soboczenski, J. Amer. Chem. Soc. **78**, 5317 (1956).



I

IV

II

III

The observed R.D. values of the acid II in methanol (ca. 0.10) are: $[\alpha]_{320} + 470^{\circ}$, max $[\alpha]_{310} + 1440^{\circ}$, min $[\alpha]_{305} + 940^{\circ}$, max $[\alpha]_{320.5} + 1240^{\circ}$, min $[\alpha]_{270} - 1860^{\circ}$. These values, corrected for solvent effect (+ 7.5 for dioxane),[3] are very close to those recorded for the simple

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[3] C. Djerassi, R. Riniker and B. Riniker, J. Amer. Chem. Soc. **78**, 6377 (1956).

bicyclic model,[4] (+)-trans-9-methyldecalone-1 (III). This correlation establishes the absolute stereochemistry of the angular methyl group at the A/B ring fusion in the acid II, and also in columbin itself. The trans decalin junction is not rigorously proved by the above data, but is very likely on biogenetic grounds.

The shift of methyl groups postulated by Barton[1] to occur in the biogenesis of columbin from its hypothetical precursor of the general type IV recalls the biogenesis of friedelin from β-amyrin,[5] in which a concerted all-axial migration takes place. If a similar concerted shift occurs in the biogenesis of columbin, then the configuration of the second angular methyl group of columbin must necessarily be axial, i.e. alpha. The very ready base catalyzed isomerization of columbin to isocolumbin involves only an epimerization of the active hydrogen of the saturated lactone system.[1] It follows from these considerations that in the conversion of the lactone from cis to trans, an axial lactone carbonyl is being epimerized to the more stable equatorial position. This conformational change explains the remarkable shift of the lactone carbonyl frequency from 5.80 μ to 5.73 μ which occurs on passing from columbin to isocolumbin.[6]

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[4] C. Djerassi, R. Riniker and B. Riniker, J. Amer. Chem. Soc. 78, 6362 (1956).

[5] E. J. Corey and J. J. Ursprung, J. Amer. Chem. Soc. 77, 3668 (1955).

[6] The value of 5.80 μ was previously assigned to a β-γ-unsaturated lactone (cf. Ref. 2).

Concerning the unsaturated lactone ring: the observation that this lactone system does not open easily with base supports the placing of the ester bridge on the same side as the angular methyl group (carbonyl hindrance). The ethylenic bridge, which is readily reduced, is placed on the other, less hindered side of the molecule.

The absolute configuration of the β-furyl group cannot be surmised from the evidence now at hand.

Not the least interesting conclusion of the arguments presented here is that the hypothetical precursor of columbin (e.g. IV) must be a diterpene of the "wrong", or reversed, configuration. Indeed, the terpenoid lactones, iresin[7] and andrographolide,[8] which have this type of configuration may be closely related to this precursor.

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[7] C. Djerassi, W. Rittel, A. L. Nussbaum, F. W. Donovan and J. Herran, J. Amer. Chem. Soc. **76**, 6410 (1954).

[8] M. P. Cava and Boris Weinstein, Chem. & Ind. 851 (1959).