

A NEW SESQUITERPENE, BICYCLOGERMACRENE

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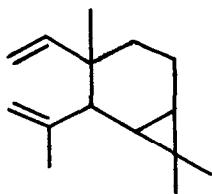
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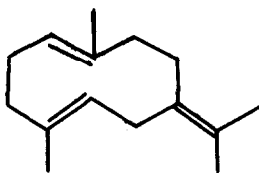
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In our recent work,¹⁾ bicycloelemene (I),²⁾ which was first found in the peppermint oil of Burgarian origin, was isolated from the sesquiterpene hydrocarbon fraction of the cold-pressed peel oil of Citrus junos together with 14 hydrocarbons.

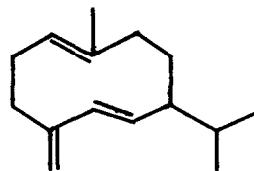
When the isolation of sesquiterpene hydrocarbons was carried out with careful treatment, there was found no bicycloelemene but a new hydrocarbon named bicyclogermacrene as a second principal component together with germacrene B (II)³⁾ and germacrene D (III).⁴⁾



(I)



(II)



(III)

Bicyclogermacrene (IV), $C_{15}H_{24}$, $[\alpha]_D + 61^\circ$ (in acetone), exhibited two signals of gem-dimethyl group at 1.02 and 1.11 ppm, a pair of doublet signals of two methyl groups on double bonds at 1.46 ppm ($J = 1.3$ cps) and 1.63 ppm ($J = 1.3$ cps), a doublet signal with fine splitting of a proton on trisubstituted double bond carrying a methyl group at 4.28 ppm, a multiplet signal of another proton on trisubstituted double bond centered at 4.79 ppm and a multiplet signal of two methine proton on cyclopropane ring at 0.50 to 0.90 ppm in n.m.r. spectrum.

On hydrogenation with platinum oxide in ethanol, IV afforded a mixture of a dihydro-compound (V) (δ $\overset{CCl_4}{\text{ppm}}$ 0.77 (3H, d, $J = 6.6$ cps, $\text{CH}_3\text{-CH-}$), 1.05 and 1.12 (each 3H, s, $(\text{CH}_3)_2\text{C}^<$), 1.66

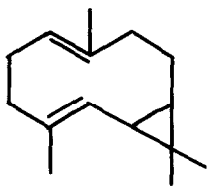
(3H, broad s, $\text{CH}_3-\overset{\text{C}}{\underset{|}{\text{C}}}=\text{CH}-$), 4.89 (1H, d, $J=9.6$ cps, $-\text{CH}=\overset{\text{C}}{\underset{|}{\text{C}}}$), M^+ ion m/e 206 and base peak m/e 107) and a tetrahydro-compound (VI) ($\delta_{\text{ppm}}^{\text{CCl}_4}$ 0.77 and 0.97 (each 3H, two s, $(\text{CH}_3)_2\overset{\text{C}}{\underset{|}{\text{C}}}$), 0.80 and 0.89 (each 3H, broad s, $\text{CH}_3-\overset{\text{C}}{\underset{|}{\text{C}}}$), 0.20~0.60 (2H, m, methine protons on cyclopropane ring), M^+ ion m/e 208 and base peak m/e 55). V yielded VI on further hydrogenation with platinum oxide in acetic acid.

On ozonolysis followed by methylation with diazomethane, IV afforded a mixture of methyl esters from which methyl levulinate (VII) and a ketoester (VIII) of M. W. 198 were obtained as the main products. VIII disclosed the signals in n.m.r. spectrum at 1.16 and 1.23 ppm (6H, two s, gem-dimethyl), 2.13 ppm (3H, s, CH_3-CO), 3.62 ppm (3H, s, CH_3OCO), 1.44 ppm (1H, d, $J=9.4$ cps, a cyclopropane methine proton adjacent to carbomethoxy group) and at 1.26~0.90 ppm (1H, broad m, a methine proton on a cyclopropane ring). The mass spectrum of VIII showed the predominant fragments at m/e 43 (100 %, CH_3CO^+), 198 (0.2 %, M^+), 183 (3 %, M^+-CH_3), 166 (6 %, $\text{M}^+-\text{CH}_3\text{OH}$), 140 (41 %, $\text{M}^+-\text{CH}_3\text{COCH}_3$). These spectral properties support the structure VIII.

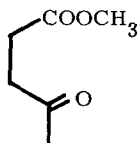
By heating at 200°C in a sealed tube, IV afforded a mixture of I, IV and isobicyclogermacrene (IX) ($\delta_{\text{ppm}}^{\text{CCl}_4}$ 1.00 and 1.06 (each 3H, s, $(\text{CH}_3)_2\overset{\text{C}}{\underset{|}{\text{C}}}$), 1.39 and 1.70 (each 3H, two d, $J=1.2$ cps, $\text{CH}_3-\overset{\text{C}}{\underset{|}{\text{C}}}=\text{CH}-$), 0.20~1.09 (2H, unresolved m, methine protons on cyclopropane ring), 4.84 and 4.97 (each 1H, two unresolved m, $-\text{CH}=\overset{\text{C}}{\underset{|}{\text{C}}}$), M^+ ion m/e 204 and base peak m/e 121), in a ratio of 4 : 5 : 1 after first 30 minutes which changed to 1 : 1 : 8, respectively, after 2 hours heating. (I) behaved in a similar manner as IV under the same condition yielding a mixture of I, IV and IX in a ratio of 4 : 3 : 3 after 30 minutes and 1 : 1 : 8 after 2 hours.

On the other hand IX is quite stable on thermal treatment suggesting that isomerization of I occurred into two directions, namely, to IV and to IX. IV and I are possibly interconvertible while IX are produced irreversibly. IX afforded the same products with those from IV on catalytic hydrogenation and on ozonolysis.

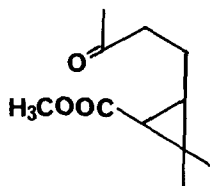
These spectral and chemical data of IV and IX well accord with the formula IV in which the double bonds of bicyclogermacrene are arranged trans-trans and those of isobicyclogermacrene are cis-trans or, more probably, cis-cis.



(IV)



(VII)

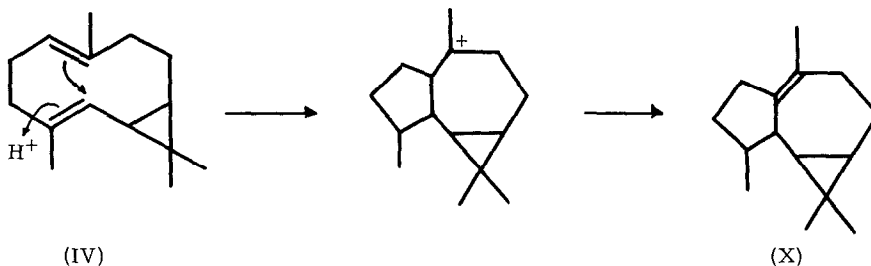


(VIII)

On treatment with 0.1 N sulphuric acid in 80 % aqueous dioxane at room temperature for 24 hrs, IV was isomerized into ledrene (X) and δ -cadinene (XI) as the main products. X was identified by comparing i. r. and m. s. spectra and retention time with those of authentic sample obtained by dehydration of ledol.

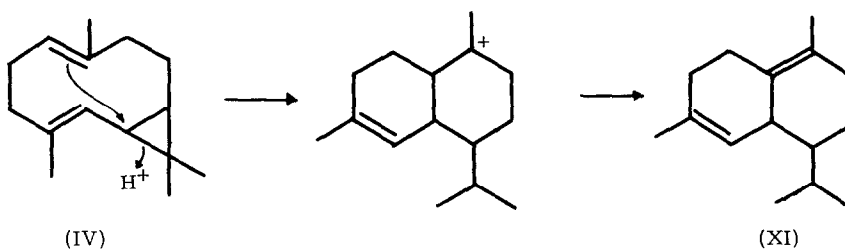
Isomerization of IV by heat or acid suggest strongly that IV is not only a precursor of bicyclic elemene but a key intermediate of aromadendrene and allo-aromadendrene derivatives⁵⁾ such as globulol, ledol, spatulenol and related hydrocarbons.

Indeed, this is the first unique example of forming 5, 7-membered bicyclic system by a simple catalytic action of dilute mineral acid on a sesquiterpene hydrocarbon.



(IV)

(X)



(IV)

(XI)

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References

1. N. Shinoda, M. Shiga and K. Nishimura, in manuscript.
2. V. Herout, I. Ognyanov and R. Vlahov, Coll. Czech. Chem. Comm., 32, 808 (1967).
I. Ognyanov and R. Vlahov, Riechstoff u. Aromen, 17 [8], 315 (1967).
3. Germacrene B was first prepared from germacrone by Brown and his co-workers (Chem. Comm., 1967, 111). There have been no literature of its being found in natural source. For its nomenclature, see K. Morikawa and Y. Hirose, Tetrahedron Letters, No. 22, 1799 (1969).
4. K. Yoshihara, Y. Ohta, T. Sakai and Y. Hirose, Tetrahedron Letters, No. 27, in press.
5. Among these compounds, spatulenol and globulol were isolated from the oil of Citrus junos as the predominant components of the sesquiterpene alcohol fraction by us.