Tetrahedron Letters No. 49, pp 4521 - 4524, 1976. Pergamon Press. Printed in Great Britain.

THE SYNTHESIS OF 2,2,8-TRIMETHYLTRICYCLO[6,2,2,$0^{1,6}$]DODEC-5-ENE; A REARRANGEMENT PRODUCT OF THUJOPSENE

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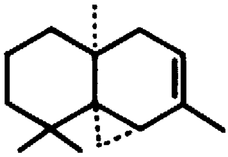
(Received in UK 17 September 1976; accepted for publication 18 October 1976)

Treatment of the hydrocarbon fraction of American cedarwood oil, which largely consists of (-)-cedrene and (-)-thujopsene (1), with acetic anhydride and polyphosphoric acid produces a ketonic mixture which possesses a strong woody-musk-ambergis odour of value to the fragrance industry. A study[1] of the components of this mixture has revealed that the tricyclic ketone (2, R = $COCH_3$) is largely responsible for this odour. The genesis of (2, R = $COCH_3$) is directly related to the fact that (-)-thujopsene itself undergoes a variety of deep-seated acid-catalysed rearrangements to produce a number of hydrocarbons of which (2, R = H) is the predominant isomer under non-aqueous conditions[2]. The olefin (2, R = H) has been converted into the ketone (2, R = $COCH_3$) both by direct acetylation[3] and by the sequence of hydroboration/oxidation to the ketone (3), followed by treatment with lithium acetylide and Rupe rearrangement of the derived ethynyl alcohol.



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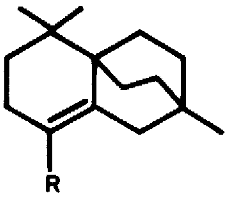

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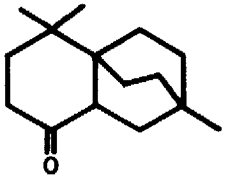

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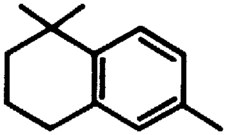

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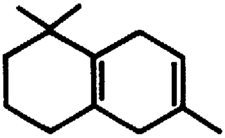
We wish to describe a short synthesis of (2, R = H) starting from the readily available 1,1,6-trimethyl-1,2,3,4-tetrahydronaphthalene (ionene) (4) which can be obtained[4] in high yield by cyclodehydration of the commercial ionones. Birch reduction of ionene under modified conditions[5] yielded the dihydro derivative (5)[6] [$\delta(CDCl_3)$5.35(1H,m), 2.45(4H,m), 1.6(3H,bs), and

1.00(6H,s)] in 93% yield which, upon treatment with potassium t-butoxide in DMSO, produced a quantitative yield of the two conjugated dienes (6) and (7) in the ratio of approximately 6:1[7] whose u.v. spectrum was anomalous [λ_{max}(obs.) 267 nm ($\varepsilon \sim$7000), λ_{max}(calc.) 278 nm]. However, treatment of this hydrocarbon mixture with maleic anhydride in o-xylene under reflux produced two adducts (8) and (9), the major one of which could be separated by column chromatography to yield (20%) a pure sample of (8), m.p. 117°C. The n.m.r. spectrum δ($CDCl_3$) 5.69(1H,t,J=2.2Hz), 3.33(1H,d,J=9Hz), 2.86(1H,d,J=9Hz), 1.5(3H,s), 1.34(3H,s), and 1.1(3H,s) was completely in accord with its assigned structure thus providing convincing evidence for structure (6) of the major bicyclic diene. The 6-isopropyl analogue of (6) has an even more anomalous u.v. spectrum [λ_{max} 250 nm (ε 6100)].[8]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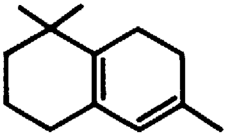
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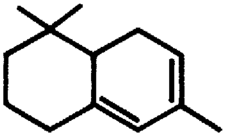
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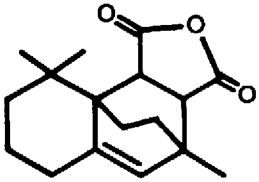
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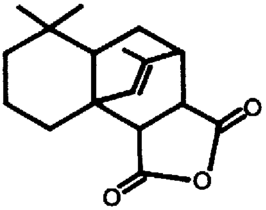
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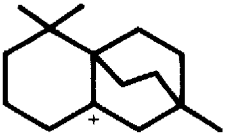
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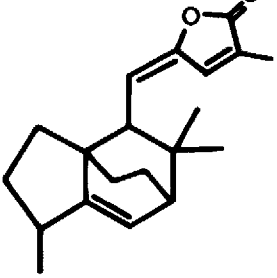
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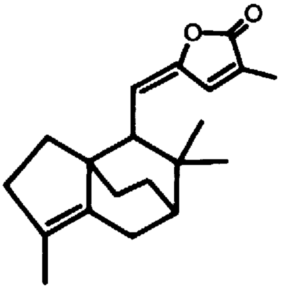
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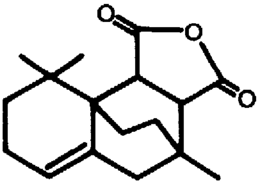
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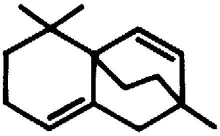
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One of the underlying principles of this synthesis was the consideration that, under appropriate conditions, the double bond in (8) could be induced to migrate from the endocyclic to the exocyclic position with respect to the basic bicyclo(2,2,2)octyl system thus relieving the inherent angle strain. This consideration was based largely on two factors: (a) the presumed carbonium ion percursor (10) of (2, R = H) appears to deprotonate exclusively at the C-5 position[1,2] and (b) under acidic conditions, eremolactone (11) can be converted into isoeremolactone (12)[9]. In the event, brief treatment of (8) with trifluoroacetic acid gave the isomeric anhydride (13) m.p. 104°C, $\delta(CDCl_3)$ 5.55(1H,bs,$w_{\frac{1}{2}h}$=8Hz), 3.20(1H,d,J=9Hz), 2.90(1H,d,J=9Hz), 1.22(6H,s), and 0.85 (3H,s) in 87% yield after chromatographic purification. To allay any fears that a skeletal rearrangement had occurred in this step a single crystal of (13) was subjected to X-ray analysis by direct methods[10] which completely substantiated its structure. Hydrolysis of (13) to the corresponding di-acid was followed by lead tetra-acetate bis-decarboxylation[11] to give the tricyclic diene (14) in 28% yield[12]. Selective hydrogenation of (14) to give (2, R = H) was accomplished in 75% yield using 10% Pd/C[13] and it was shown to be identical to an authentic sample[14] by g.l.c., t.l.c., m.s., i.r., and n.m.r. comparisons.

Achnowledgement

We wish to acknowledge the support of an S.R.C. CASE award in collaboration with Bush Boake Allen Ltd.

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5. H. Kwart and R.A. Conley, J.Org.Chem., 1973, 38, 2011.
6. With the exception of (5) - (7) which were not purified, all other new compounds were characterised by i.r., n.m.r., and m.s. spectral data and by satisfactory elemental analyses.

7. The n.m.r. spectrum of the mixture of (6) and (7) showed the virtual absence of di-allylic protons at 2.45ppm but a marked increase at 2ppm for allylic protons. [A small amount of (4) and (5) was also present]. The ratio of isomers was indirectly determined from the ratio of (8):(9) which may not necessarily reflect the true composition of (6) and (7) from the isomerisation step.
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12. Attempted conversion of (13) $\rightarrow$ (2,R=H) using $Ni(CO)_2(PPh_3)_2$ failed, see B.M. Trost and F. Chen, *Tetrahedron Letters*, 1971, 2603; W.G. Dauben, G.T. Rivers, R.J. Twieg, and W.T. Zimmerman, *J.Org.Chem.*, 1976, *41*, 887.
13. We had previously established that (2, R = H) does not hydrogenate readily under these conditions.
14. We wish to thank Dr. A.R. Hochstetler of Givaudan Corporation for a generous sample of (2, R = H) and Professor S. Itô for i.r. and n.m.r. spectra of (2, R = H).