Tetrahedron Letters,Vol.23,No.9,pp 991-994,1982 0040-4039/82/090991-04$03.00/0
Printed in Great Britain

BIOGENETICALLY PATTERNED SYNTHESIS OF $\Delta^{8(9)}$-CAPNELLENE

Alan M. Birch and Gerald Pattenden

Department of Chemistry, The University,
Nottingham, NG7 2RD.

Summary In a biogenetically patterned synthesis, treatment of the cycloocta-1,5-diene (3b) or its *exo*-methylene isomer (4), with boron trifluoride etherate is shown to lead to $\Delta^{8(9)}$-capnellene (8).

Capnellane is the generic name applied to the group of tricyclic sesquiterpene alcohols (1a - e) and the hydrocarbon (2), isolated from the soft coral *Capnella imbricata*.[1,2] $\Delta^{(9,12)}$-Capnellene (2) is the presumed biosynthetic precursor of the capnellenols (1). Although the biosynthetic origin of the parent hydrocarbon (2) is not known, it is almost certain that like the corresponding 'hirsutane' carbon framework it is derived ultimately from humulene by a series of transannular reactions possibly involving a fused 5,8-membered carbocyclic system as a key intermediate.[3] Compelling support for this proposal came with the isolation, in 1979 of a second sesquiterpene hydrocarbon from *C. imbricata* which was isomeric with (2) and given the novel structure (3).[4] We recently described the total synthesis of this novel hydrocarbon by a route which at the same time established its relative stereochemistry as shown in (3a)[5] We now report the transannular cyclisation of synthetic (3b), and of its *exo*-methylene isomer (4), to the capnellene carbon framework, which gives added support to the biosynthetic speculation discussed above.[†]

[†] This work was first reported at the Seventh International Symposium on *Synthesis in Organic Chemistry*, Oxford, July 1981.

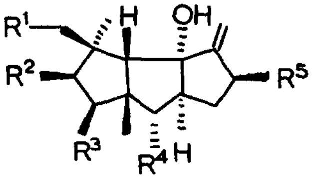
Treatment of either of the hydrocarbons (3*b*) and (4) with boron trifluoride etherate in benzene under reflux for 1 hr. resulted in clean transannular cyclisation to one major new hydrocarbon (> 50%) accompanied by two minor isomeric hydrocarbon products.[6] The major product was separated and purified by chromatography on silica gel impregnated with silver nitrate (15% w/w; petroleum ether eluant) and identified as the $\Delta^{8(9)}$-capnellene (8) from its n.m.r. spectral data, δ 0.94 (Me), 1.03 (Me), 1.1 (Me), 1.67 (:CMe), 5.13 (:C$\underline{H}$), $\delta_{(carbon)}$ 15.1 q, 25.6 q, 29.7 t, 30.7 q, 31.3 q, 39.4 t, 40.3 t, 41.8, 43.6 d, 51.0 t, 52.8, 56.9 d, 64.6 d, 122.0 d, 143.1 p.p.m. The minor hydrocarbon products were not completely resolved in chromatography, but spectral data on partly separated materials (> 75% resolved) established that they were the $\Delta^{6(10)}$-[δ 0.83 (Me), 0.97 (d, *J* 7, CH*Me*, 1.02 (Me), 1.15 (Me)] and and $\Delta^{9(10)}$-[δ 0.81 (Me), 1.09 (Me), 1.17 (Me), 1.61 (:CMe)] isomers, (6) and (7) respectively of (8). We were unable to detect the presence of $\Delta^{9(12)}$-capnellene (2) in any of the hydrocarbon mixtures resulting from treatment of (3b) or (4) with boron trifluoride.[7]

We assume that the isomeric capnellenes (6), (7) and (8) result from the same carbocation intermediate (*viz* 5) produced from transannular cyclisation of (3*b*) and (4), and that the major [$\Delta^{8(9)}$] capnellene product (8) arises as a result of isomerisation (*in situ*, and partly during chromatography) of the bridgehead capnellene (7). The *cis*, *anti*, *cis* stereochemistry assigned to (8) follows largely from comparison of proton and carbon n.m.r. shift data with those reported for natural $\Delta^{9(12)}$-capnellene.

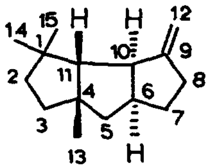
Further work is in hand to extend these transannular studies to related fused ring terpenoids.

Acknowledgement

We thank Professor Djerassi for providing spectra of natural $\Delta^{9(12)}$-capnellene, the S.E.R.C. for a fellowship (to A.M.B.) and the Royal Society for an equipment grant.



(1)



(2)

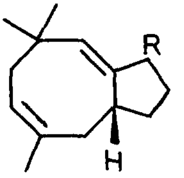
a $R^2=R^5=OH$, $R^1=R^3=R^4=H$

b $R^3=R^5=OH$, $R^1=R^2=R^4=H$

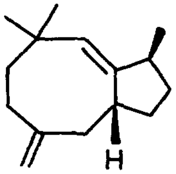
c $R^4=R^5=OH$, $R^1=R^2=R^3=H$

d $R^1=R^3=H$, $R^2=R^4=R^5=OH$

e $R^2=R^4=H$, $R^1=R^3=R^5=OH$

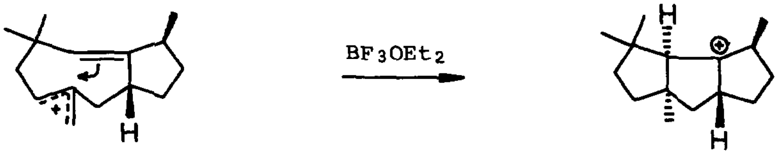


(3)

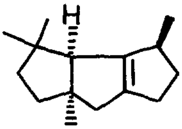


(4)

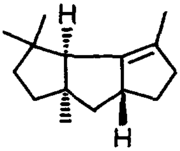
a R = ⁞Me; b R = ▬Me



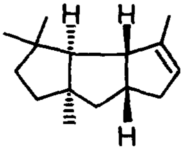
(5)



(6)



(7)



(8)

References

1. Y.M. Sheikh, G. Singy, M. Kaisin, H. Eggert, C. Djerassi, B. Tursh, D. Daloze and J.C. Braekman, Tetrahedron Lett., 1978, 1671.

2. E. Ayanoglu, T. Gebreyesus, C.M. Beecham, C. Djerassi and M. Kaisin, Tetrahedron Lett., 1978, 1671.

3. For bibliography and relevant recent work see: K. Hayano, Y. Ohfune, H. Shirahama and T. Matsumoto, Helv. Chim. Acta. 1981, 64, 1347.

4. E. Ayanoglu, T. Gebreyesus, C.M. Beecham, and G. Djerassi, Tetrahedron, 1979, **35**, 1035.

5. A.M. Birch and G. Pattenden, J. Chem. Soc., Chem. Commun., 1980, 1195.

6. For examples of the synthesis of bicyclooctanes by transannular reactions involving cycloocta-1,5-dienes, see: L. Paquette, Fortschr. Chem. Forsch, 1979, **79**, 43.

7. For recent total syntheses of $\Delta^{9(12)}$-capnellene see: (a) R.D. Little and G.L. Carroll, Tetrahedron Letters, 1981, 4389, and (b) K.E. Stevens and L.A. Paquette, ibid., 1981, 4393.

(Received in UK 7 December 1981)