Based-catalysed Enolization of Copacamphor and Longicamphor

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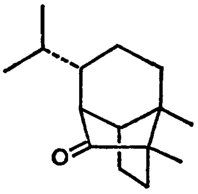
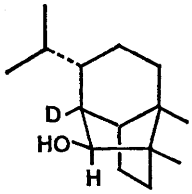
Summary Under basic conditions both copacamphor (**1**) and longicamphor (**3**) undergo bridgehead enolization, whereas only the latter can be induced to homoenolize.

In connection with the preparation of a labelled sample of copacamphor (**1**),[1] which was needed for the biosynthetic studies reported in the following communication,[2] we investigated the possibility of incorporating hydrogen isotopes into this compound by homoenolization.[3] Treatment of (**1**) with Bu^tOK in Bu^tOD (sealed tube; 48 h; 185°) resulted only in mono-deuteriation (75% $^2H_1$, 25% $^2H_0$ by mass spectrometry). The strongly reduced intensity of the signal at δ 2·2 p.p.m. in the n.m.r. spectrum of the exchanged material suggested that, contrary to expectation, exchange had occurred exclusively at the bridgehead position adjacent to the carbonyl group. This was confirmed by reduction of $[^2H_1]$-(**1**) with $LiAlH_4$ to $[^2H_1]$copaisoborneol (**2**),[1] showing at δ 3·64 a triplet (*J* 1 Hz) rather than the normal doublet (*J* 8 Hz) for the carbinol proton.



(1)



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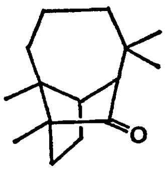

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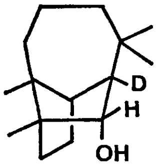

(4)

Under the same exchange conditions longicamphor (**3**)[4] was shown to incorporate up to 3 equiv. of deuterium (*ca.* 70% recovery of a material with 28·4% $^2H_1$, 42·2% $^2H_2$, and 21·5% $^2H_3$), part of which must have been introduced by a homoenolization process, akin to the one reported for the related longicamphenilone.[5] In contrast, a milder treatment of (**3**) with NaOEt in EtOD at reflux for 48 h produced exclusively monodeuteriated material (91% $^2H_1$), the n.m.r. spectrum of which lacked the singlet at δ 1·6 p.p.m. assigned to the proton adjacent to the carbonyl group. Reduction of the deuteriated ketone with sodium in propanol led to $[^2H_1]$longiborneol (**4**); the n.m.r. signal of the carbinol proton at δ 3·67, normally a doublet (*J* 5 Hz) had collapsed to a broad singlet, thus confirming the location of deuterium at the bridgehead position.

The different behaviour of (**1**) and (**3**) under strongly basic conditions indicates that lack of homoenolization in (**1**) is a consequence of the additional strain imposed by the three-membered bridge on the [2,2,1]bicyloheptane system. While the anti-Bredt intermediate required for the introduction of deuterium into longicamphor (**3**) seems unexceptional in view of the isolation of [4,2,1]bicyclonon-1(8)-ene,[6] the successful labelling of copacamphor (**1**) lends further support to the suggestion[7] that a double bond can also be accommodated at the bridgehead position of a [3,2,1]bicyclo-octane system.† An even more startling exception to Bredt's rule involving a [2,2,1]bicycloheptane system has been reported recently.[8]

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† Alternative but less likely explanations involving stabilization of the relevant anion by purely electrostatic or other factors cannot be entirely ruled out for the time being.

[1] M. Kolbe and L. Westfelt, *Acta Chem. Scand.*, 1967, **21**, 585; 1970, **24**, 1623.

[2] K. W. Turnbull, W. Acklin, D. Arigoni, A. Corbella, P. Gariboldi, and G. Jommi, following communication.

[3] A. Nickon, J. L. Lambert, S. J., and J. E. Oliver, *J. Amer. Chem. Soc.*, 1966, **88**, 2787, and references cited therein.

[4] P. Naffa and G. Ourisson, *Bull. Soc. chim. France*, 1954, 1410.

[5] R. M. Coates and J. P. Chen, *Chem. Comm.*, 1970, 1481.

[6] J. R. Wiesman, H.-F. Chan, and C. J. Ahola, *J. Amer. Chem. Soc.*, 1969, **91**, 2812.

[7] J. P. Ferris and N. C. Miller, *J. Amer. Chem. Soc.*, 1966, **88**, 3522. See also: J. O. Reed and W. Lwowski, *J. Org. Chem.*, 1971, **36**, 2864; M. Toda, H. Niwa, K. Ienaga, and Y. Hirata, *Tetrahedron Letters*, 1972, 336.

[8] R. Keese and E.-P. Krebs, *Angew. Chem. Internat. Edn.*, 1971, **10**, 262.