Tetrahedron Letters No. 40, pp 4111 - 4112, 1972. Pergamon Press. Printed in Great Britain.

BRIDGEHEAD ENOLISATION IN ent-17-norKAURAN-16-ONE

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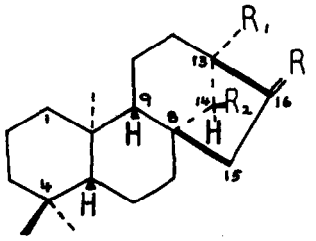
(Received in UK 16 August 1972; accepted for publication 4 September 1972)

Turnbull et al.[1] have recently demonstrated that copacamphor and longicamphor incorporate deuterium at the bridgehead position under basic conditions. We have independently demonstrated bridgehead enolisation in ent-17-norkauran-16-one (1) as follows.

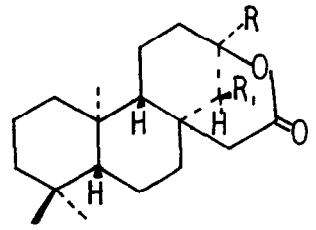
The ketone (2) with 36-47%-$[^2H_1]$ and 50-60%-$[^2H_2]$ was prepared as described later. Virtually complete deuteration at C-13 was demonstrated by Baeyer-Villiger oxidation to the lactone (4)[2] the n.m.r. spectrum of which contained no detectable 13-H multiplet at τ5.22. After treatment with KO^tBu and HO^tBu at 172° for 72 hr. in a sealed tube, the ketone contained 52%-$[^2H_1]$ and 4%-$[^2H_2]$. Loss of deuterium from C-13 was shown by the presence of the 13-H multiplet at τ5.22 in the n.m.r. spectrum of the derived lactone (5).

The deuterated ketone (2) was prepared as follows. ent-Beyer-15-ene (6), prepared from ent-kaur-16-ene (3) with iodine in boiling xylene, was hydroboronated to give a mixture of the ent-beyeran-15- and -16-ols. This mixture was directly oxidised to the corresponding ketones (8) and (9), separated by preparative t.l.c. The 16-one (8) was distinguished from the 15-one (9) by n.m.r.[3] and by the ready formation of the benzenesulphonyl hydrazone (10) (cf. Ref. 4). Decomposition of the hydrazone (10) by heating with MeONa and MeOD gave ent-kaur-16-ene, ent-kaur-15-ene, ent-16-methoxykaurane, ent-beyer-15-ene, and two methoxy derivatives of (as yet) undetermined structure. By combined gas chromatography-mass spectrometry, the ent-kaurane derivatives contained 36-47%-$[^2H_1]$ and 50-60%$[^2H_2]$; these measurements of deuterium content are subject to considerable statistical variations.[5] Oxidation of the ent-kaur-16-ene gave the norketone (2) with the same deuterium content. Evidence for almost complete deuteration at C-13 was presented above; n.m.r. evidence for the location of the second deuterium atom at the 14β-position in these ent-kaurene derivatives will be presented in the full paper. The ent-beyer-15-ene, obtained from the benzenesulphonyl hydrazone (10) contained 67-79%-$[^2H_1]$ and 2-12%-$[^2H_2]$. The deuterium was located at C-16 by conversion of the ent-beyer-15-ene into the 16- (8) and 15- (9) ketones with loss of deuterium in the former and retention of deuterium in the latter.

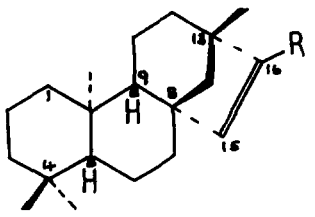
The incorporation of a second deuterium into the ent-kauranes suggests an equilibrium between the hydrazone (10) and the enamine (7). The absence of ent-15-[^{2}H]-beyer-15-ene and of 14,14-dideuterated ent-kauranes from the reaction indicates that de-protonation - protonation (de-deuteration - deuteration) at C-15 in the hydrazone (10) and enamine (7) is stereospecific. This stereospecificity supports our previous suggestion that 15,16-hydride transfer in the ent-kaurane 16-carbonium ion,[6] and that enolisation of 13β- and ent-kauran-15-ones,[7] are under stereo-electronic control.



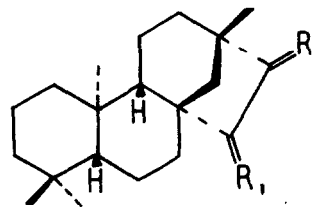
1. R = O, R_1 = R_2 = H
2. R = O, R_1 = R_2 = D
3. R = CH_2, R_1 = R_2 = H



4. R = R_1 = D
5. R = H, R_1 = D



6. R = H
7. R = -NHNHSO$_2$Ph



8. R = O, R_1 = H_2
9. R = H_2, R_1 = O
10. R = =NNHSO$_2$Ph, R_1 = H_2

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