A General Stereospecific Annelation for the Synthesis of *trans*-Fused Polycyclic Ketones *via* Hydroboration–Carbonylation

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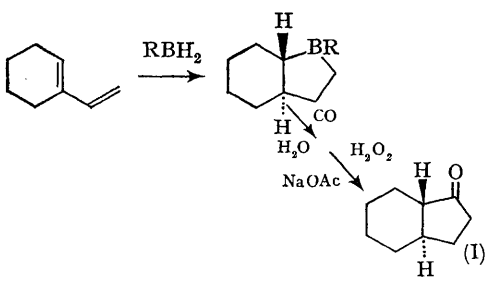
OUR recent investigations have established that thexylborane (2,3-dimethyl-2-butylborane) is a

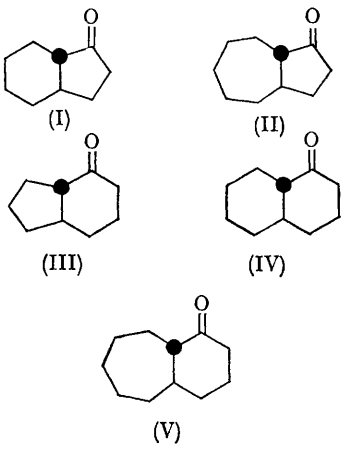


useful reagent for achieving the cyclic hydroboration of appropriate dienes.[1] Moreover, the thexyl group exhibits an unusually low aptitude for migration from boron to carbon in the carbonylation of thexyldialkylboranes.[2] Consequently, carbonylation–oxidation of thexylboracyclanes provides a new, highly promising procedure for the synthesis of ring ketones.[3] The possibilities of this new synthetic procedure were indicated by the stereospecific synthesis of the thermodynamically disfavoured *trans*-perhydro-1-indanone (1).[3]

We report that this new annelation reaction appears to possess considerable generality for the synthesis of *trans*-fused polycyclic ketones with a carbonyl group adjacent to the *trans*-ring junction (simply called *trans*-fused α-ketones hereinafter). The systems synthesized in the present study are shown below (I—V).

The hydroboration–carbonylation–oxidation procedure described previously[3] proved to be entirely satisfactory for the preparation of bicyclic

ketones (I—V). Hydroboration was carried out by adding slowly and simultaneously equimolar solutions of thexylborane and the diene to a well



Crude products with purities of 85—95% were readily obtained by simple distillation. Products with purities of greater than 99% were then obtained by recrystallization or by fractional distillation.

A noteworthy aspect of the present synthetic method is the formation of the *trans*-ketones with stereo-isomeric purities of nearly 100%. We believe that this is the first stereospecific synthesis of such ketones, applicable to such a wide range of structures.

Stereoisomeric purities were established by epimerization of the products in the presence of sodium methoxide, followed by g.l.p.c. analyses of the equilibrated mixtures, the isolated ketones, as well as of the concentrated reaction mixtures before isolation. In the case of one compound, perhydro-4-indanone, the *cis*- and *trans*-isomers were not adequately separated. Consequently, both the original ketone and the equilibrated mixture were reduced with $LiAlH_4$ which were analysed following the technique previously described.[5] In all cases the data revealed the absence of the *cis*-isomers.

trans-*Fused α-ketones prepared by the new annelation synthesis*

Product	Yield, % g.l.p.c.	Yield, % isolation	Stereo-isomeric purity %	B.p. (mm.) M.p.	Refractive index	M.p. of derivative, oxime	M.p. of derivative, semicarbazone
trans-Perhydro-1-indanone (I)[4a] ..	66	60	100	43° (0·5)	n^{20}D 1·4782	145—146°	
trans-Perhydro-1-azulenone (II)[4b]	71	67	100	68° (0·2)	n^{20}D 1·4865		229—230 decomp.
trans-Perhydro-4-indanone (III)[4c]	54	40	100	45° (0·5)	$n^{26.5}$D 1·4798	162—163°	192—193°
trans-1-Decalone (IV)[4d]	73	66	100	31—32°			229—230°
trans-Perhydro-1-benzocycloheptenone (V)[4e] ..	68	62	100	70—72° (0·6)	n^{20}D 1·4924		210—211°

stirred solution of tetrahydrofuran at 0° ("dilute solution technique"). The solution was then carbonylated in an autoclave with carbon monoxide at 70 atm. and 50°. The oxidation with alkaline hydrogen peroxide was carried out in the presence of sodium acetate, rather than the usual sodium hydroxide, to minimize epimerization of the ketonic product.

G.l.p.c. examination of the reaction mixtures revealed that in each case the major peak for the desired ketone accounted for 85—95% of all peaks other than the peak for thexyl alcohol.

The utility of the present annelation reaction is enhanced by the fact that the starting dienes are readily accessible by reaction of the parent ring ketones with either vinyl- or allyl-magnesium halides, followed by dehydration of the tertiary alcohols thus produced.

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