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exo- AND endo-7-PHENYLNORCARANE

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Recently, Hodgkins and co-workers (1) reported the preparation of the two isomeric 7-phenylnorcaranes and assigned structures to them. The separation procedure was tedious and not entirely satisfactory. In connection with other studies, convenient syntheses of these compounds have been devised and structural assignments reinvestigated. The results are interpreted to indicate a structural assignment the reverse of that given by Hodgkins and co-workers. In the discussion given below, the structural representations are those obtained in the work presented here.

Following the procedure of the previous workers, 7-chloro-7-phenylnorcarane was obtained from benzal chloride, excess cyclohexene and potassium t-butoxide. Our experience with this compound has been that it is much less thermally stable than indicated by these workers. By purifying the material by distillation at 80-85°/0.15 mm rather than 170-173°/33 mm (1) the yield was found to be raised from 27% to 65%.

This mixture of epimeric chloro compounds was reduced by Hodgkins and co-workers utilizing a number of reagents, but in

no instance was the reduction highly selective. Their structural assignments were made by comparing the expected stereochemistry for the reductions with the isomer distributions of the chloro epimers and the product hydrocarbons, and also from the NMR spectral data. In our opinion, the stereochemical courses assigned to the reduction processes are speculative and not supported by analogy or rigid mechanistic considerations. The NMR spectral data, which is discussed below, is interpreted by us to indicate the opposite assignment.

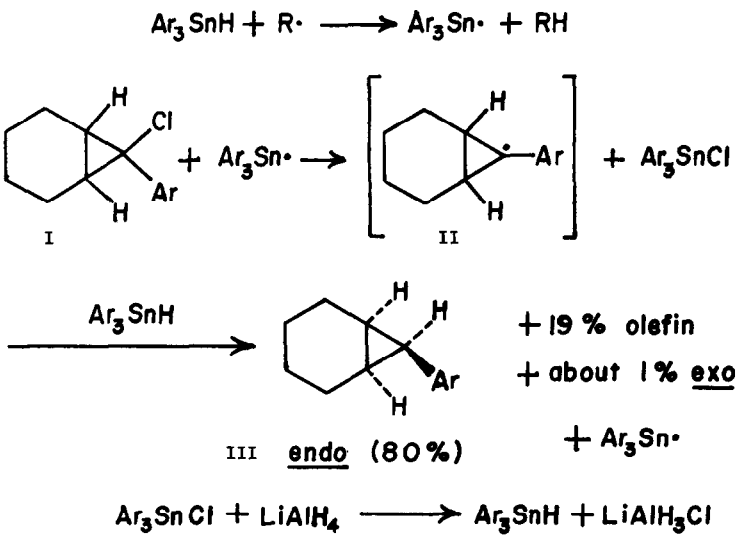
Triphenyltin hydride has been found to very selectively reduce the mixed chloro compounds to yield, by vpc, 80% endo-7-phenylnorcarane, ca. 1% of the exo-isomer, and about 19% of an isomeric olefin (Fig. 1). This olefin is readily removed by ozonization (1). This distribution of products is obtained by carrying out the reduction in refluxing glyme for 90 minutes (longer times give more exo) utilizing 300 mol % lithium aluminum hydride and 10 mol % triphenyltin chloride. This reduction procedure utilizing the organotin halide as the hydrogen carrier is adapted from the method of Kuivila and Menapace (2).

After working-up the reaction mixture and subjecting the products to ozonolysis in acetic acid, endo-7-phenylnorcarane, b.p. 68-70°/0.2 mm and n_D^{20} 1.5496 is obtained in 50-60% yield from the mixed chloro compounds.

The exo-7-phenylnorcarane (Fig. 2) is obtained in about 99% yield by heating the endo-isomer in DMSO solvent containing 10 mol % potassium t-butoxide at 80° in a sealed ampoule for 48 hours (3). This material has a b.p. slightly greater than

FIG. 1

Stereoselective Reduction of 7-Chloro-7-phenylnorcarane by Triphenyltin Hydride (Ar=C_6H_5).

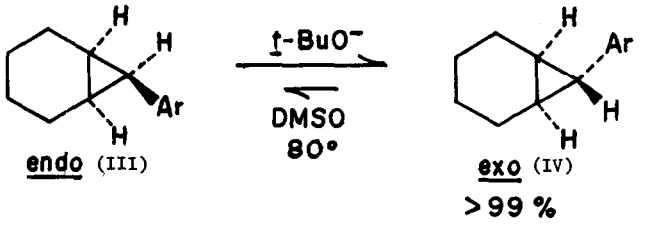


that of the endo-isomer, and has n_D^{20} 1.5506. Both isomers yield the correct C and H analyses and the correct non-aromatic to aromatic NMR proton ratios of 2.2.

The stereochemical assignments are based on the expected stereochemical course of the reduction (Fig. 1), the equilibration studies (Fig. 2) and the NMR spectral data. Considerable evidence has accumulated which indicates these alkyl halide reductions occur through free-radical intermediates (2,4). The intermediate radical (Structure II of Fig. 1) is expected to abstract a hydrogen atom from the tin moiety on its less hindered exo-side to yield the endo-isomer (III) because of the

FIG. 2

Base-Catalyzed Equilibration of the 7-Phenylnorcaranes.



large steric requirements of the triphenyltin group. Consistent with this assignment, by steric considerations (3) the exo-epimer (IV) is expected to be the thermodynamically more stable isomer (Fig. 2).

The NMR spectra (taken on the Varian A-60 spectrometer) and structural assignments are in accord with the generalization of Closs and co-workers (5,6). The aromatic hydrogen resonances of the endo-epimer (III) consist of a narrow band with a half-width of 4 cps centered at τ 2.8 (neat). The exo-isomer (IV) exhibits broad, highly split aromatic hydrogen resonances extending from about τ 2.6-3.3 (neat). In this latter compound, the conformation in which one of the ortho-protons of the aromatic ring is above the cyclopropane ring is expected to be preferred (5,6). As a result, the ortho-protons should experience a net shielding and the aromatic hydrogen signals should appear over a field range. In the endo-compound, the aromatic ring is expected to face the cyclopropane ring. As a result, the aromatic protons are not expected to exhibit greatly different chemical shifts (5,6).

Nefedov and co-workers (7) obtained a mixture of exo- and endo-7-phenylnorcarane by reacting phenyllithium and methylene chloride with cyclohexene. Samples of the product mixture were analyzed by vpc and the isomer obtained in larger amount was thought to be the endo-isomer by analogy with results obtained by other workers in similar systems (5). Their assignment is in agreement with that presented in this paper.

gem-Dihalocyclopropanes, including 7,7-dibromo-, 7-chloro-7-bromo- and 7,7-dichloronorcarane have been reduced to monohalocyclopropanes with tri-n-butyltin hydride by Seyferth and co-workers but stereoselectivity of the order reported here is not observed (8).

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