

# Synthesis and Stereochemical Assignment of *endo*-7-Phenyl-2,5-dioxabicyclo[4.1.0]heptane

Gregory D. Hobbs, James D. Woodyard\* and John R. Curtis

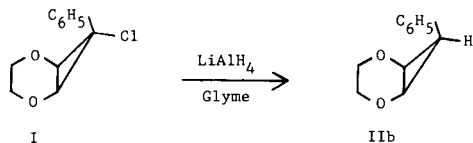
Department of Chemistry and Killgore Research Center, West Texas State University,  
Canyon, Texas 79016  
Received July 16, 1982

The synthesis and stereochemical assignment of *endo*-7-phenyl-2,5-dioxabicyclo[4.1.0]heptane is reported. The stereochemical assignment was made based on both spectral and chemical data.

*J. Heterocyclic Chem.*, **20**, 251 (1983).

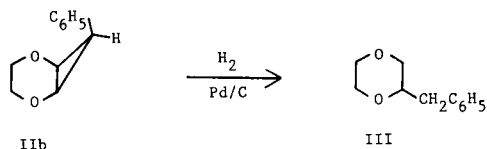
The reduction of *exo*-7-chloro-*endo*-7-phenyl-2,5-dioxabicyclo[4.1.0]heptane, I, (1) with activated zinc dust in a 5% solution of sodium ethoxide has been shown to produce *exo*-7-phenyl-2,5-dioxabicyclo[4.1.0]heptane, IIa, as the major product (2). We have observed that the reduction of compounds structurally related to I with lithium aluminum hydride has been stereoselective, producing only the *endo* isomer (3-5). As a part of our continuing nmr study of derivatives of bicyclo[4.1.0]heptane, we now wish to extend this reaction to the reduction of I to produce pure *endo*-7-phenyl-2,5-dioxabicyclo[4.1.0]heptane, IIb.

Synthesis of the title compound was accomplished by the reduction of I with four equivalents of lithium aluminum hydride in dry glyme for 17 hours at 25°. This reduction furnished only one compound, *endo*-7-phenyl-2,5-dioxabicyclo[4.1.0]heptane (IIb), 99% pure. The gross struc-



ture of IIb was established by a correct elemental analysis for  $C_{11}H_{12}O_2$ , ultraviolet absorption bands at 207 nm ( $\epsilon$  7263) and 220 nm ( $\epsilon$  4895), the latter of which is characteristic of phenyl substituted cyclopropanes (1,4-7), and nmr absorptions at  $\delta$  7.0-7.6 (5H, multiplet), 2.8-3.7 (6H, multiplet) and 1.4-1.8 (1H, triplet;  $J = 6.8$ ). These data are in agreement with the assigned structure for IIb.

Additional evidence supporting the gross structure of IIb was obtained from catalytic hydrogenation. Although the ir spectrum revealed no olefinic linkage, IIb absorbed one equivalent of hydrogen, which is consistent with the



presence of a cyclopropane moiety. The hydrogenation product, 2-benzylidioxane (III) was identified on the basis of a correct elemental analysis for  $C_{11}H_{14}O_2$  and an nmr spectrum consistent with the assigned structure.

The stereochemical assignment for IIb could be made based on spectral as well as chemical data. No coalescence in the phenyl absorption in the nmr spectrum of IIb was observed as a function of temperature, whereas a coalescence of the phenyl absorption in the nmr spectrum of the *exo* isomer, IIa, has been observed as the temperature was increased from 25° to 180° (2). This data is in agreement with results previously obtained for the 7-phenylnorcaradienes (8), the 7-phenyl-2-oxabicyclo[4.1.0]heptanes (4), and the 7-phenyl-3-oxabicyclo[4.1.0]heptanes (5). Additionally, Closs (9) has studied the nmr spectra of several arylcyclopropanes where the vicinal cyclopropyl hydrogens were *cis* and *trans* to the benzylic hydrogen and observed that the benzylic hydrogen absorbed at a higher field and furnished a larger coupling constant when the vicinal cyclopropyl hydrogens were in the *cis* orientation. For the benzylic hydrogen of IIa and IIb, the positions of the absorptions ( $\delta$  2.3 and 1.7, respectively) and the coupling constants (7.0 and 15.0 Hz, respectively) are in agreement with the findings of Closs.

Chemical evidence supporting this stereochemical assignment for IIb was obtained from its base equilibration to the more thermodynamically stable *exo* isomer. This equilibration is possible only if IIb has the *endo* configuration (10). Also, the lithium aluminum hydride reduction of structurally related compounds has been shown to produce only the *endo* isomer (3-5).

## EXPERIMENTAL

An F and M gas chromatograph, Model 810, was employed for all gas chromatographic analyses. Infrared spectra were obtained using a Beckman Model 10 grating infrared spectrophotometer with potassium bromide cells. Nmr spectra were recorded in carbon tetrachloride with a Varian A-60 spectrometer employing tetramethylsilane as an internal reference. Ultraviolet spectra were recorded in cyclohexane with a Bausch and Lomb Model 505 spectrophotometer. Elemental analyses were performed by M-H-W Laboratories, Garden City, Michigan. Boiling points are uncorrected.

*endo*-7-Phenyl-2,5-dioxabicyclo[4.1.0]heptane (IIb).

Lithium aluminum hydride (0.37 g, 0.00975 mole) was added to 10 ml of dry glyme in a 25 ml round bottomed flask equipped with a mechanical stirrer and a calcium chloride drying tube. Compound I (0.5 g, 0.00237 mole) was then added and the reaction allowed to proceed for 17 hours at 25°. The excess lithium aluminum hydride was destroyed by the sequential dropwise addition of 0.37 ml of water, 0.37 ml of 15% sodium

hydroxide solution and 1.1 ml of water (11). The reaction mixture was then filtered, the filtrate taken up in ether, washed with water and dried over magnesium sulfate. The ether was evaporated and the residue distilled *in vacuo* to give 0.29 g (69% yield) of pure IIb, bp 81-82°/1 mm; nmr (carbon tetrachloride):  $\delta$  7.0-7.6 (5H, multiplet), 2.8-3.7 (6H, multiplet) and 1.4-1.8 (1H, triplet; J = 6.8); uv (cyclohexane):  $\lambda$  max 207 nm ( $\epsilon$  7263) and 220 nm ( $\epsilon$  4895).

*Anal.* Calcd. for  $C_{11}H_{12}O_2$ : C, 74.98; H, 6.86; O, 18.16; Found: C, 74.78; H, 7.05; O, 18.31.

Hydrogenation of *endo*-7-Phenyl-2,5-dioxabicyclo[4.1.0]heptane (IIb).

Hydrogenation of 1.0 g (0.00568 mole) of IIb was carried out in 50 ml of absolute ethanol and 0.1 g of 5% Palladium on charcoal in a Parr reaction apparatus (48 psi) for 48 hours. The solution was filtered, the alcohol evaporated and the residue distilled *in vacuo* to yield 0.92 g (91% yield) of III, bp 107°/2 mm; nmr (carbon tetrachloride):  $\delta$  7.2 (5H, singlet), 3.1-3.9 (7H, multiplet) and 2.5-2.8 (2H, triplet; J = 7).

*Anal.* Calcd. for  $C_{11}H_{14}O_2$ : C, 74.13; H, 7.92; O, 17.95. Found: C, 74.08; H, 7.96; O, 17.96.

*exo*-7-Phenyl-2,5-dioxabicyclo[4.1.0]heptane (IIa).

To a solution 114 ml of dry dimethyl sulfoxide and 23.4 g of potassium *tert*-butoxide (6.9), 15.64 g (0.0888 mole) of IIb was added. The reaction was heated under a nitrogen atmosphere at 100° for 30 hours, then 100 ml of water added, the organic layer extracted with ether, washed with water, a saturated sodium chloride solution and dried over magnesium sulfate. The ether was evaporated and the residue distilled *in vacuo* to give 11.89 g (76% yield) of IIa, bp 96-97°/1 mm; nmr (carbon tetra-

chloride):  $\delta$  6.7-7.4 (5H, multiplet), 3.7 (6H, singlet) and 2.2-2.4 (1H, triplet, J = 3.3).

*Anal.* Calcd. for  $C_{11}H_{12}O_2$ : C, 74.98; H, 6.86; O, 18.16. Found: C, 74.92; H, 6.97; O, 18.29.

Acknowledgement.

The authors wish to acknowledge the financial support (Grant AE-361) of The Robert A. Welch Foundation.

#### REFERENCES AND NOTES

- (1) J. D. Oliver, J. D. Woodyard, P. E. Rush, and J. R. Curtis, *J. Heterocyclic Chem.*, **11**, 1125 (1974).
- (2) G. D. Hobbs, J. D. Woodyard, and J. R. Curtis, *ibid.*, **18**, 1637 (1981).
- (3) J. D. Woodyard and P. R. Morris, *Org. Prep. Proced. Int.*, **5**, 273 (1973).
- (4) G. D. Hobbs, J. D. Woodyard, and J. R. Curtis, *ibid.*, **13**, 356 (1981).
- (5) D. H. Corbin, G. D. Hobbs, and J. D. Woodyard, *J. Heterocyclic Chem.*, **18**, 643 (1981).
- (6) M. T. Rogers, *J. Am. Chem. Soc.*, **69**, 2544 (1947).
- (7) J. E. Hodgkins, J. D. Woodyard, and D. L. Stevenson, *ibid.*, **86**, 4080 (1964).
- (8) Unpublished results.
- (9) G. L. Closs and R. A. Moss, *J. Am. Chem. Soc.*, **86**, 4042 (1964).
- (10) G. L. Closs and J. J. Coyle, *J. Org. Chem.*, **31**, 2759 (1966).
- (11) V. M. Mičović and M. L. Mihailović, *ibid.*, **31**, 2759 (1953).