

A CONVENIENT REDUCTION OF  $\alpha,\beta$ -UNSATURATED NITROALKENES TO  
ALKYLAMINES USING BORON HYDRIDES

M. Soubel Mourad, Rajender S. Varma, George W. Kabalka\*

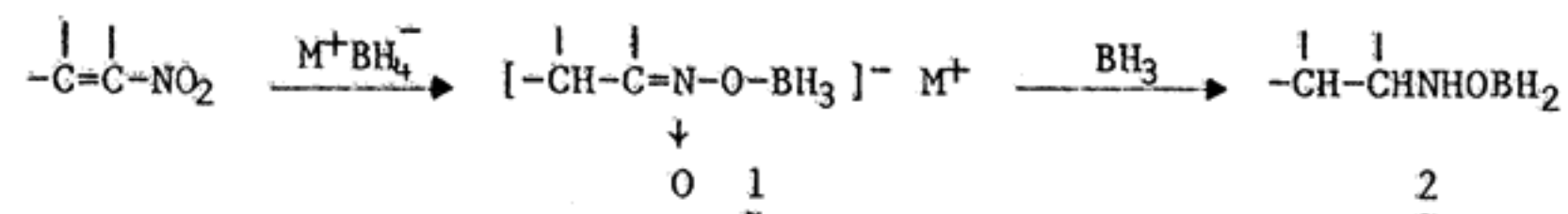
Department of Chemistry  
University of Tennessee  
Knoxville, Tennessee 37996-1600

$\alpha,\beta$ -Unsaturated nitroalkenes are reduced to  
alkylamines in good yields by excess of borane-  
THF in presence of catalytic amount of sodium  
borohydride.

In connection with our ongoing program directed toward the  
synthesis of radiolabeled amphetamine derivatives<sup>1</sup>, we required a  
convenient procedure for synthesis of amines from  $\alpha,\beta$ -unsaturated  
nitroalkenes. The reduction of conjugated nitroalkenes to alkyl-  
amines is conventionally accomplished using lithium aluminum  
hydride.<sup>2-5</sup> Generally, mixtures of products are obtained and  
yields are modest. Catalytic hydrogenation<sup>6</sup> has also been used on  
rare occasions with limited success.

We recently reported<sup>7</sup> a sodium borohydride catalyzed reaction  
of borane complexes with  $\alpha,\beta$ -unsaturated nitroalkenes.

The reaction presumably proceeds via a nitronate intermediate, 1, which is then reduced to a hydroxylamine ester 2 by borane.



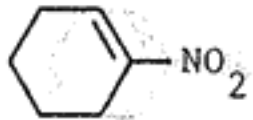
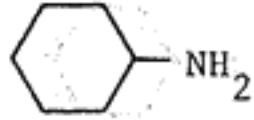
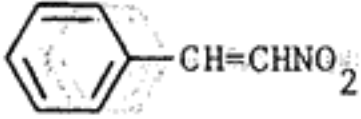
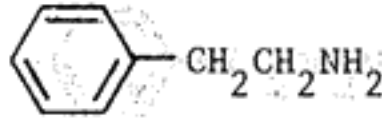
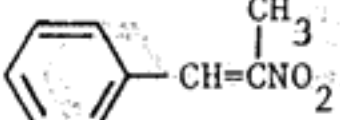
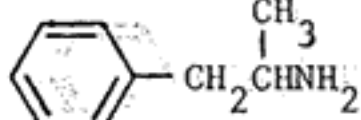
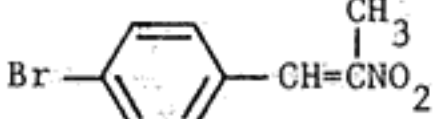
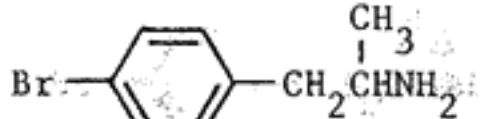
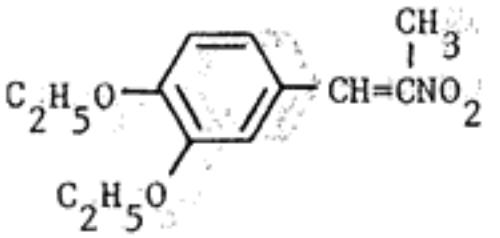
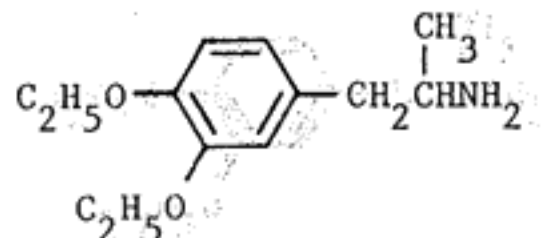
Since earlier studies<sup>8</sup> demonstrate that hydroxylamines as well as their precursor oxime derivatives are reduced by diborane to amines at elevated temperature (105–110°C), we decided to investigate the reduction of the boron esters of hydroxylamines, 2, to amines.

We wish to report that the borohydride catalyzed reduction of  $\alpha,\beta$ -unsaturated nitroalkenes to alkylamines can be carried out in good yields at room temperature using an excess of borane-THF. Our results are summarized in Table I.

### EXPERIMENTAL

All glassware was thoroughly dried in an oven and cooled under dry nitrogen just before using. THF was dried over  $\text{CaH}_2$ , distilled from  $\text{LiAlH}_4$  and stored under dry nitrogen. The  $\text{BH}_3$ -THF solution was prepared and standardized according to the published procedure.<sup>13</sup> Commercially available samples of 1-nitro-1-cyclohexene and  $\beta$ -nitrostyrene (Aldrich) were used as received. Other nitroalkenes were prepared via published procedures.<sup>5,12,14</sup> Amine hydrochloride salts were prepared in a usual manner according to standard procedure<sup>3</sup> by bubbling anhydrous hydrogen chloride through a solution of the amine in absolute ether and recrystal-

Table I. Reduction of  $\alpha,\beta$ -Unsaturated Nitroalkenes with  $\text{BH}_3 \cdot \text{THF}$  and Sodium borohydride (catalytic amount).

Nitroalkene	Product	Yield <sup>b</sup> (%)	M.p. <sup>c</sup> (°C)	Ref.
		89(84)	207 <sup>d</sup>	9,15
		88(82)	215–16 <sup>e</sup>	10,16
		91(86)	146–47 <sup>f</sup>	3,17
		85(79)	202–3 <sup>g</sup>	11
		87(82)	139–40	12

a. All products were characterized by their physical properties and spectral characteristics ( $^1\text{H-NMR}$ ,  $^{13}\text{C-NMR}$  etc.). b. Yields in parentheses are for the hydrochloride salts. c. Melting points (hydrochloride salts) are uncorrected. d. (Lit.<sup>9</sup> 209–10); e. (Lit.<sup>10</sup> 218–19); f. (Lit.<sup>3</sup> 147–48); g. (Lit.<sup>11</sup> 204–6).

lized from ethanol-ether.

### Synthesis of Alkylamines. General Procedure

The synthesis of  $\beta$ -phenylethylamine is representative of the procedure employed. A flame-dried, nitrogen-flushed, 100 mL flask, equipped with a septum inlet, magnetic stirring bar and reflux condenser was cooled to 0°C. A  $\text{BH}_3$ -THF solution (16 mmol, 9.5 mL of

1.7M) was injected into the reaction flask via a syringe, followed by the slow addition of a solution of  $\beta$ -nitrostyrene in THF (4 mmol, 0.6g in 6 mL THF). After the addition, the ice-bath was removed and a catalytic amount (~40 mg) of  $\text{NaBH}_4$  was added to the stirred reaction mixture by means of a spatula. A moderately exothermic reaction ensued. The reaction was then allowed to proceed for 6 days at 25°C. The reaction mixture was poured on to ice-water mixture (50 mL), acidified with 10% HCl (~20 mL) and then stirred at 60-65°C for 2h. After cooling to room temperature, the acidic layer was washed with ether (2x50 mL), and then the  $\beta$ -phenylethylamine was liberated via the addition of aqueous sodium hydroxide. Solid NaCl was added and the product extracted into ether (3x50 mL). The combined ethereal extracts were dried over anhydrous  $\text{MgSO}_4$  and the solvent removed under reduced pressure to yield 0.43 g (88%) of  $\beta$ -phenylethylamine. The product exhibited physical properties<sup>10</sup> and spectral characteristics<sup>16</sup> in accord with an authentic sample.

### References

1. G. W. Kabalka, *Acct. Chem. Res.*, 17, 215 (1984).
2. F. A. Ramirez and A. Burger, *J. Am. Chem. Soc.*, 72, 2781 (1950).
3. R. T. Gilsdorf and F. F. Nord, *J. Am. Chem. Soc.* 74, 1837 (1952).
4. A. T. Shulgin, *J. Med. Chem.* 9, 445 (1966).
5. B. T. Ho, W. M. McIsaac, R. An, L. W. Tansey, K. E. Walker, L. F. Englert, Jr. and M. B. Noel, *J. Med. Chem.* 13, 26 (1970).
6. R. T. Coutts and J. L. Malicky, *Can. J. Chem.*, 52, 395 (1974).
7. M. S. Mourad, R. S. Varma, G. W. Kabalka, *J. Org. Chem.* (in press).
8. H. Feuer and D. M. Braunstein, *J. Org. Chem.* 34, 1817 (1969).
9. J. H. Boyer and S. E. Ellzey, Jr., *J. Am. Chem. Soc.* 82, 2525 (1960).
10. J. C. Robinson, Jr., and H. R. Snyder, *Organic Synthesis*, 23, 71 (1943).
11. T. M. Patrick, Jr., E. T. McBee and H. B. Hass, *J. Am. Chem. Soc.* 68, 1009 (1946).
12. E. R. Shepard, J. F. Noth, H. D. Porter and C. K. Simmans, *J. Am. Chem. Soc.*, 74, 4611 (1952).
13. H. C. Brown, "Organic Synthesis via Boranes", p 18 and 241 Wiley, N.Y. 1975.
14. H. B. Hass, A. G. Susie and R. L. Heider, *J. Org. Chem.* 15, 8 (1950).

15. Standard Spectra Collection, Sadtler Research Labor., 6937M  
(1969) and 1833C (1977).
16. *ibid*, 35M (1966) and 68C (1976).
17. *ibid*, 5824M (1968).