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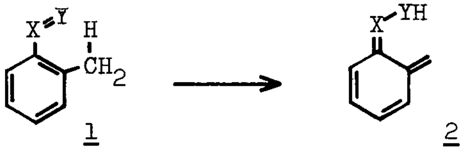
UNUSUALLY FACILE 1,5-HYDROGEN SHIFT INVOLVING A NITROSO GROUP. FORMATION OF BENZISOXAZOLE FROM o-ALKYLNITROSOBENZENES.

Renji Okazaki, Masako Watanabe, Yoshio Inagaki, and Naoki Inamoto
Department of Chemistry, Faculty of Science,
The University of Tokyo, Hongo, Tokyo 113, Japan

Although thermal [1,5] sigmatropic hydrogen migration has been investigated extensively in recent years and is probably the most widely known of all the sigmatropic processes,1) examples of a thermal 1,5-hydrogen shift between a benzylic hydrogen and an adjacent functional group as represented in the following equation seem very scarce.2) This is in marked contrast to well documented photochemical formation, via excited triplet states, of conjugated enols (2: X=R-C; Y=O)3) or alkenes (2: X=Ar-C; Y=CH_2)4) from o-substituted aryl ketones or 1,1-diarylethylenes (1).

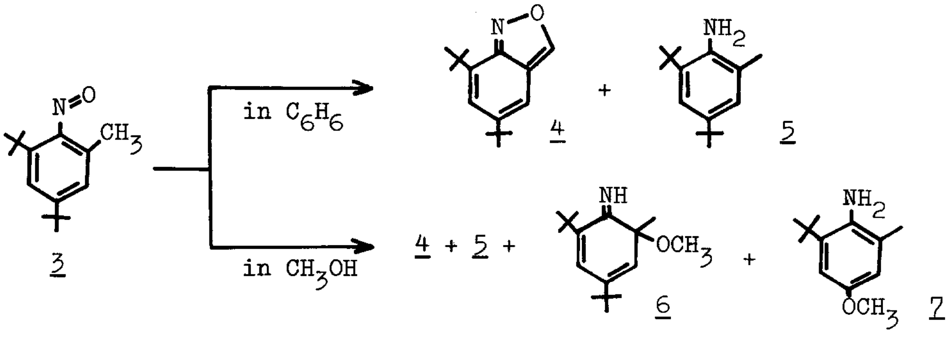


We wish here to report an unusually facile thermal 1,5-hydrogen shift found for a nitrosoarene with o-benzylic hydrogens.

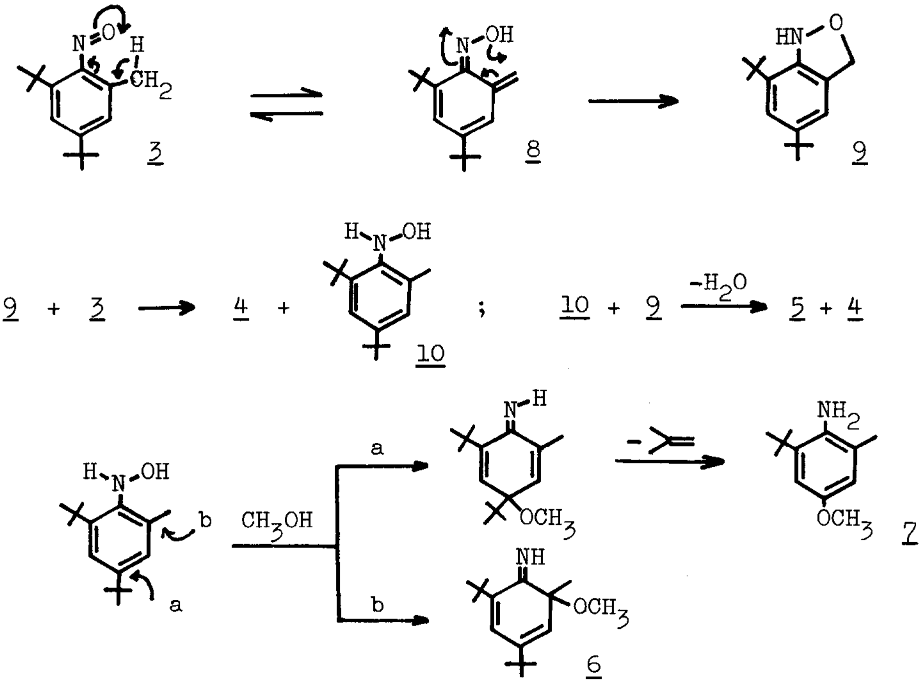
Thermolysis of 2,4-di-t-butyl-6-methylnitrosobenzene (3)5) in benzene under reflux for 35 hr resulted in the formation of 5,7-di-t-butyl-2,1-benzisoxazole (4, 50%) and 2,4-di-t-butyl-6-methylaniline (5, 25%).6) When the thermolysis was conducted in methanol (reflux, 7 hr), imine (6, 16%) and aniline (7, 18%) were formed in addition to 4 (48%) and 5 (8%) (Scheme 1).

Formation of these seemingly unusual products can be explained in terms of Scheme 2 beginning with 1,5-hydrogen shift from the 6-methyl to the nitroso oxygen on the basis of the following observations and considerations.

Scheme 1.



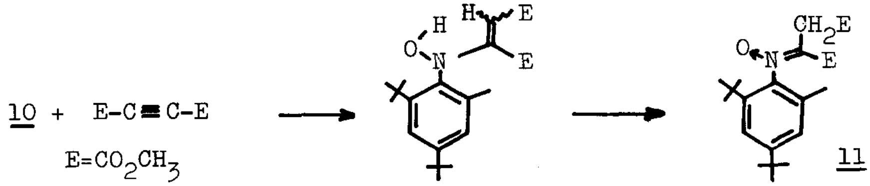
Scheme 2.



1) Benzisoxazole (4) and recovered nitrosobenzene (3) obtained from the thermolysis in methanol-[OD] contained 8% (at 3-position on the isoxazole ring) and about 30% deuterium (at 6-methyl) respectively (by NMR and MS). This is most easily accomodated by the assumption that there exists an equilibrium between 3 and 8, and deuterium incorporation occurs on the OH group of 8.[7]

2) Upon refluxing in benzene in the presence of dimethyl acetylenedicarboxylate,

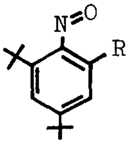
3 afforded 4 (48%) and 11 (46%) at the expence of aniline (5). The formation of 11 can be rationalized by the reaction of hydroxylamine (10) with dimethyl acetylenedicarboxylate,[8] thus providing evidence for the intermediacy of 10.



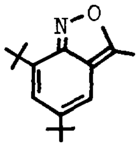
3) Hindered N-arylhydroxylamines (e.g., 2,6-dimethylphenyl- and 2,4,6-trimethylphenylhydroxylamine) have been reported to be attacked by neutral water.[9] Thus, the formation of 6 and 7 can be accounted for by nucleophilic attack of methanol at the ortho- and para-positions of hydroxylamine (10), respectively. 4) The yields of the products are in line with the stoichiometry required by Scheme 2 (i.e., a) Y(4)/Y(5)=2 in benzene; b) Y(4)=2Y(5)+Y(6)+Y(7) in methanol; Y denotes a yield).

The ease with which 3 undergoes 1,5-hydrogen shift is noteworthy because 2,4-di-t-butyl-6-methylnitrobenzene was recovered unchanged even after heating (sealed tube) in methanol at 100-110 °C for about nine days.

The [1,5] sigmatropic shift seems to occur much faster in the cases of more crowded nitrosobenzenes, 12 and 13. Thus, oxidation (m-chloroperbenzoic acid in dichloromethane at -40 °C) of aniline (15) followed by chromatographic purification at -78 °C gave a green oil, indicating the formation of 12, but it decomposed even at 5 °C to afford 14 (59%) and 15 (14%). Similar oxidation of aniline (16) led to 13 but it was also unstable above 0 °C and decomposed to give a complex mixture of intractable products.



12 R=C_2H_5
13 R=$CH(CH_3)_2$



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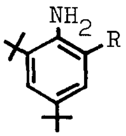
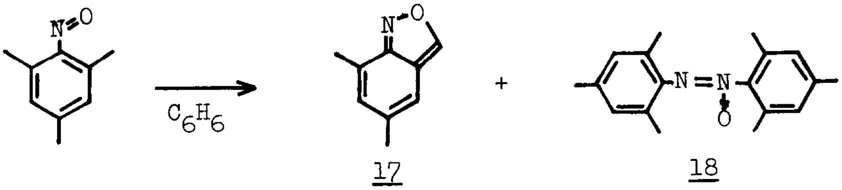


15 R=C_2H_5
16 R=$CH(CH_3)_2$

This disproportionation reaction involving 1,5-hydrogen shift is not only characteristic of t-butyl-substituted nitrosobenzenes but occurs also for other nitrosobenzenes with o-methyl group; 2,4,6-trimethylnitrosobenzene on heating in benzene for 45 min afforded 17 (10%) and 18 (18%) along with recovered starting material (19%).



References and Notes

1) C.W. Spangler, Chem. Rev., 76, 187 (1976).
2) As far as we are aware, the only unequivocal example is that of o-substituted allenylbenzenes, which undergo [1,5] H migration at 170 °C in decane. H. Heimgartner, J. Zsindely, H.-J. Hansen, and H. Schmid, Helv. Chim. Acta, 56, 2924 (1973). See also R. Wehrli, H. Heimgartner, H. Schmid, and H-J. Hansen, ibid., 60, 2034 (1977).
3) P.G. Sammes, Tetrahedron, 32, 405 (1976) and references cited therein.
4) F. Scully and H. Morrison, J. Chem. Soc. Chem. Commun., 529 (1973); A.L. Pratt, ibid., 183 (1974); J.M. Hornback, Tetrahedron Lett., 3389 (1976).
5) R. Okazaki, T. Hosogai, E. Iwadare, M. Hashimoto, and N. Inamoto, Bull. Chem. Soc. Jpn., 42, 3611 (1969).
6) We previously reported the thermal decomposition of 3 in benzene in connection with the radical reaction of 3 without any consideration on the mechanism. T. Hosogai, N. Inamoto, and R. Okazaki, J. Chem. Soc. (C), 3389 (1971).
7) Compound (4) underwent no deuterium incorporation under the reaction conditions, eliminating the possibility that the incorporation occurred after the formation of 4. The possibility of direct incorporation of deuterium into the methyl of 3 without the intermediacy of 8 because of electron-withdrawing ability of the nitroso group, can be ruled out by the fact that p-nitrosotoluene was recovered with no deuterium incorporation under comparable reaction conditions.
8) The reaction of a hydroxylamine with dimethyl acetylenedicarboxylate is known to give such a nitrone as 11 as an initial product. E. Winterfeldt, W. Krohn, and H-U. Stracke, Chem. Ber., 102, 2346 (1969).
9) E. Bamberger, Ber., 33, 3600, 3623 (1900).

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