

Carbazole from *o*-Biphenylhydroxylamine and from 2-Nitrobiphenyl and Phenylmagnesium Bromide

Yul Yost

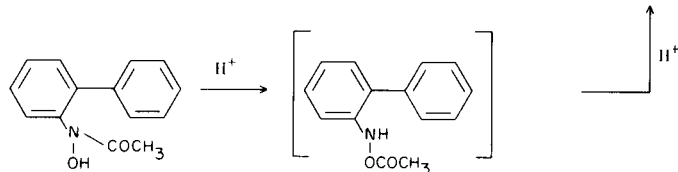
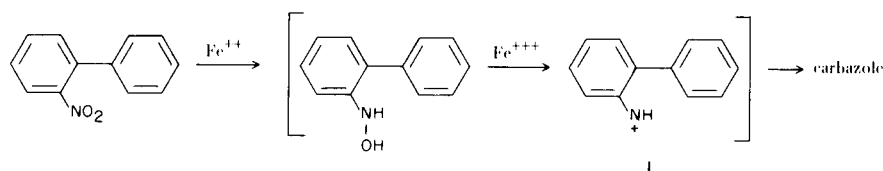
Laboratory for Cancer Research, Veterans Administration Hospital,
Minneapolis, Minnesota 55417

Received August 4, 1971

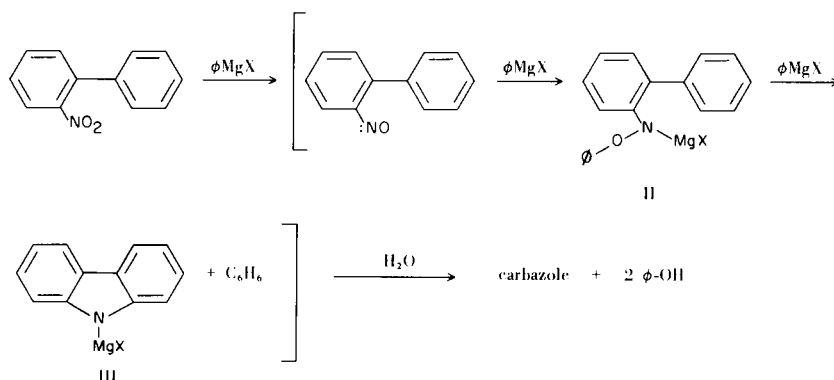
Two novel syntheses of carbazole have resulted as an outgrowth of our studies of hindered *N*-arylhydroxamic acids and of the reactions of Grignard reagents with various nitro- and nitroso-compounds (1,2). In one method, carbazole was obtained in quantitative yield upon treatment of *N*-(biphenyl-2-yl) acetohydroxamic acid (1) with sulfuric acid. The cyclization step of this reaction is probably similar to that of the reductive cyclization of 2-nitrobiphenyl with ferrous oxalate (3), in that both cyclizations may result from intermediacy of the nitrenium ion (1).

Carbazole was also obtained from 2-nitro- and 2-nitrosobiphenyl, albeit in low yields, *via* a procedure originally devised for preparation of *N,N*-diarylhydroxylamines (2). Treatment of either 2-nitro- or 2-nitrosobiphenyl with a large excess of phenylmagnesium bromide afforded complex mixtures from which carbazole was isolated in about 25% yield. The reaction sequence is presumed to proceed as follows. Reaction of the Grignard reagent with the hindered nitro group proceeds *via* attack on oxygen to afford the redox reaction products, phenolate and nitroso-compound. This reductive reaction occurs in preference to the usual 1,2-addition of Grignard reagents

SCHEME I



SCHEME II



to unhindered nitro-compounds, which affords *N,N*-disubstituted hydroxylamines or *N,N*-disubstituted amines (2,4). Further reaction of the hindered nitroso-compound with phenyl Grignard also occurs *via* attack on oxygen, affording II, in analogy with the reaction of nitroso-compounds with phenyllithium as reported by Buck and Köbrich (5). Elimination of phenolate and cyclization affords the carbazole derivative (III) and benzene.

2-Nitroso-, 2,2'-azoxy-, 2,2'-azobiphenyl, and 2-phenyldiphenylamine were also isolated from the reaction with 2-nitro and 2-nitrosobiphenyl. The 2,2'-azoxy- and 2,2'-azobiphenyl are envisioned as resulting from a redox reaction of the Grignard reagent with the dimer of 2-nitrosobiphenyl to form 2,2'-azoxybiphenyl, which is reduced further to form 2,2'-azobiphenyl. In a controlled reaction, 2,2'-azoxybiphenyl was converted to the azo-compound in 90% yield. The assumed intermediacy of the nitroso dimer *en route* to the azo-compound is suggested by evidence showing that 2-nitrosobiphenyl (6a) and other hindered nitroso-compounds exist in solution to a large extent as dimers (6b) (this is supported by our measurements of ϵ for 2-nitrosobiphenyl at 770 nm at varying concentrations), and the observation that the amount of azoxy- and azo-compounds obtained from 2-nitrobiphenyl (14%) was much larger than that isolated from the unhindered 2-nitrofluorene (*ca.* 1%) (2,7). The phenol from the reaction with phenyl Grignard and 2-nitrobiphenyl was isolated by extraction (2). The yield, 88%, was calculated on the basis of both oxygen atoms of the nitro group.

EXPERIMENTAL

The ir spectra were recorded with a Beckman IR-10 spectrophotometer. The uv spectra were taken with a Beckman DK-2 spectrophotometer.

Carbazole.

(a) *N*-(biphenyl-2-yl)acetohydroxamic acid (1), 100 mg. (0.44 mmole) was stirred in concentrated sulfuric acid (1.5 ml.) at 20° for 1 hour. Ice was added to the resulting blue solution, the color of which is characteristic of carbazole. The mixture was basified and extracted with chloroform. The organic phase was dried (magnesium sulfate) and the solvent evaporated off. The residue was carbazole in quantitative yield. It was identified by ir spectrum.

(b) 2-Nitrobiphenyl, 3.00 g. (15.0 mmoles) in anhydrous tetrahydrofuran (10 ml.) was poured into a cold (solid carbon dioxide-acetone) preparation of phenylmagnesium bromide (from 2.4 g. magnesium and 5.2 ml. of bromobenzene in diethyl ether, 150 ml.). The mixture was allowed to come to room temperature and then kept there for 30 minutes. Gentle stirring was applied throughout. Preparation of the phenylmagnesium bromide and other steps were performed under a nitrogen atmosphere. The reaction mixture was then, without stirring, treated with ice-cold water. Ether (100 ml.) was added and the organic phase was dried (magnesium sulfate), reduced in volume to *ca.* 18 ml. and then diluted with methylene chloride (3 ml.) and *n*-hexane (20

ml.). Carbazole was collected by filtration (21%) and identified by its ir spectrum. An aliquot of the filtrate was subjected to tlc (silica gel) and the chromatogram was developed with benzene. The chromatogram exhibited numerous bands of which six were prominent. The fastest band, R_f 0.9, gave the biphenyl. The second-fastest band gave 2-phenyl-diphenylamine (13% as determined spectrophotometrically at 290 nm); λ max (ethanol) 230 (log ϵ 4.11) and 290 (4.25) nm; ν max (neat) 3400 N-H cm^{-1} , m/e 245.

Anal. Calcd. for $\text{C}_{18}\text{H}_{15}\text{N}$: C, 88.15; H, 6.15; N, 5.71. Found: C, 87.63; H, 6.41; N, 5.38.

The third fastest, an orange band, gave 2,2'-azobiphenyl (~12%) followed by carbazole, R_f 0.6 (an additional 5% as determined spectrophotometrically at 293 nm, ϵ , 15,000). A trace of 2-nitrosobiphenyl and 2% of 2,2'-azoxybiphenyl were also isolated from bands that followed. The experiment was repeated. Attempts were made to isolate only the phenol. It was recovered in 88% yield (2). A few bands remained unidentified.

An experiment with 2-nitrosobiphenyl gave very similar results.

2,2'-Azobiphenyl.

2,2'-Azoxybiphenyl, 67 mg. (0.19 mmole) in anhydrous tetrahydrofuran (4 ml.) was added to phenyl Grignard [from magnesium 34 mg. (1.4 mmoles) and bromobenzene 0.10 ml. (0.95 mmole) in ether] which had been cooled to -5°. The mixture, which had turned to the color of the product (orange), was stirred and allowed to come to room temperature. It was then refluxed for 5 minutes and cooled. Cold water was slowly added. The organic phase was dried (magnesium sulfate) and the solvent was evaporated off. The product was isolated by tlc (silica gel - 25% *n*-hexane in benzene) in 90% yield as determined spectrophotometrically at 330 nm, log ϵ 4.23 (1).

Acknowledgment.

The author thanks Professor C. F. Koelsch for valuable discussion, Dr. H. R. Gutmann for help in the preparation of the manuscript, and Mrs. O. Hamerston for spectrophotometric analyses.

REFERENCES

- (1) Y. Yost and H. R. Gutmann, *J. Chem. Soc. (C)*, 2497 (1970).
- (2) Y. Yost, H. R. Gutmann and C. C. Muscoplat, *ibid.*, (C), 2119 (1971).
- (3) H. C. Waterman and D. L. Vivian, *J. Org. Chem.*, 14, 289 (1949).
- (4) M. S. Kharasch and O. Rheinmuth, in "Grignard Reactions of Nonmetallic Substances," Prentice Hall, New York, 1954, p. 1238.
- (5) P. Buck and G. Köbrich, *Tetrahedron Letters*, 1563 (1967).
- (6a) W. J. Mijs, S. E. Hoekstra, R. M. Ulmann and E. Havinga, *Rec. Trav. Chim.*, 77, 746 (1958); (b) V. von Keussler and W. Lüttke, *Z. Elektrochemi.*, 63, 614 (1959); R. Okazaki, T. Hosogai, E. Iwadare, M. Hashimoto and N. Inamoto, *Bull. Chem. Soc. Japan*, 42, 3611 (1969).
- (7) Grignard reagents often appear to attack oxygen when it is bound as an *N*-oxide. This is more evident when nitro-compounds are viewed as *N*-oxides of nitroso-compounds, and nitroso-dimers and azoxy-compounds as di-, and mono-*N*-oxides of the respective azo-compounds. See also structure 1 in ref. 2. However, under certain conditions Grignard reagent did not attack the oxygen of pentachloropyridine 1-oxide [F. Binns and H. Suschitzky, *Chem. Comm.*, 750 (1970)].