[Chem. Pharm. Bull. 18(7)1497–1499(1970)] UDC 547.852.7.04: 547.559.04

The Reaction of Cinnoline 2-Oxides with Phenylmagnesium Bromide

We have already reported[1] that the reactions of pyridazine N-oxides with organometallic compounds such as Grignard reagents and phenyllithium afforded different products compared with those of other aromatic amine N-oxides.[2]
Namely, the 1,3-addition of the reagent took place at first, and the fission of the pyridazine ring occurred, followed by the elimination of nitrogen. The reaction then proceeded through two paths to form two kinds of hydrocarbons, butadienes and vinylacetylenes.

This observation prompted us to investigate the reactions of other 1,2-diazines with these reagents, and we obtained some interesting results.

Thus, the reaction of cinnoline 2-oxides (I) with phenylmagnesium bromide afforded three kinds of hydrocarbons, phenanthrenes (II), *trans*-stilbenes (III), their *cis*-isomers (IV), and also two kinds of nitrogen–containing compounds, 2,3-diphenyl-1,2-dihydrocinnolines (V), 2-styrylazobenzenes (VI).

To a solution of cinnoline 2-oxide (Ia)[3] in benzene, an etheral solution of 2 moles equivalents PhMgBr was added under stirring at room temperature. To a reaction mixture, ice was added and worked up as usual. The crude was then purified by column chromatography on alumina. Phenanthrene (IIa, *ca.* 10%),[4] *trans*-stilbene (IIIa, 7—10%),[4] and *cis*-stilbene (IVa, 1—2%)[4] were eluted with *n*-hexane.

2,3-Diphenyl-1,2-dihydrocinnoline (Va, 10%), mp 166°; IR ($CHCl_3$): 3380 cm^{-1}; UV λ_{max} (MeOH): 245, 300 mμ, NMR (CCl_4) δ: 6.5—8.0 unassigned m. (15H), and 2-styrylazobenzene (VIa, 10%); UV λ_{max} (MeOH): 297, 389 mμ, NMR (CCl_4) δ: 7.0—8.0 m. (15H), were eluted with benzene.

The reaction of 4-methylcinnoline 2-oxide (Ib)[3] with this reagent similarly afforded 9-methylphenanthrene (IIb, *ca.* 15%),[5] *trans*-α-methylstilbene (IIIb, 4—5%),[6] its *cis*-isomer (IVb, 1—2%),[6] 4-methyl-2,3-diphenyl-1,2-dihydrocinnoline (Vb, 10—15%), mp 147°, UV λ_{max} (MeOH): 235, 297 mμ, IR (KBr): 3390 cm^{-1}, NMR (CCl_4) δ: 2.29 (s. 3H), 6.01 (broad s. 1H), 6.23 (q. 7.0 and 1.2 cps, 2H), 6.5—7.6 (m. 12H), and 2-(α-methylstyryl)-azobenzene (VIb, *ca.* 10%), UV λ_{max} (MeOH): 284, 399 mμ, NMR (CCl_4) δ: 1.69 (s. 3H), 6.63 (s. 1H), 6.7—7.5 (m. 14H).

The structures of the hydrocarbons (II, III and IV) were confirmed by mixture melting point with authentic samples, and those of Va and Vb were also confirmed by elemental analyses and molecular weight determination by mass spectrometry.

Infrared (IR) spectra of Va and Vb exhibited sharp peaks at 3400 cm^{-1} and nuclear magnetic resonance (NMR) spectrum of Vb showed a broad signal (1H) at 6.01 δ, which was erased by addition of D_2O, indicating the presence of N–H functional group. The doublet signal (2H) at 6.23 δ was assigned to H(2)- and H(6)-protons of the 2-phenyl group, and this value of chemical shift was well coincident with that of aminobenzene.[7]

VIa and VIb were obtained as syrup of GL- and TL-chromatographycal purity, and have maximum absorbance at 400 mμ. NMR spectrum of VIb exhibited a singlet (1H)

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1) *a*) H. Igeta, T. Tsuchiya, and T. Nakai, *Tetrahedron Letters*, **1969**, 2267; *b*) G. Okusa, M. Kumagai, and T. Itai, *Chem. Comm.*, **1969**, 710; *idem*, *Chem. Pharm. Bull.* (Tokyo), **17**, 2502 (1969).
2) E. Ochiai, "Aromatic Amine Oxides," Elsevier, Amsterdam (1967), and references cited therein.
3) M. Ogata, H. Kano, and K. Tori, *Chem. Pharm. Bull.* (Tokyo), **10**, 1123 (1962).
4) These authentic samples were obtained from Tokyo Chemical Industry Co. Ltd. (Tokyo).
5) C.K. Bradsher and S.T. Amore, *J. Am. Chem. Soc.*, **65**, 2016 (1943).
6) D.J. Cram and F.A.A. Elhafez, *J. Am. Chem. Soc.*, **74**, 5828 (1952); H. Ley, *Ber.*, **50**, 249 (1917); E. Ellingboe and R.C. Fuson, *J. Am. Chem. Soc.*, **55**, 2964 (1933).
7) P.L. Corio and B.P. Dailey, *J. Am. Chem. Soc.*, **78**, 3043 (1956).

at 6.63 δ due to a proton of methylene, and m. singnals (14H) at 6.7—7.5 δ due to phenyl protons. Somewhat higher field shift of methyl protons (1.69 δ) was probably due to a twist of phenyl groups of the stilbene moiety and subsequently, to a decrease of anisotropic effect of them.

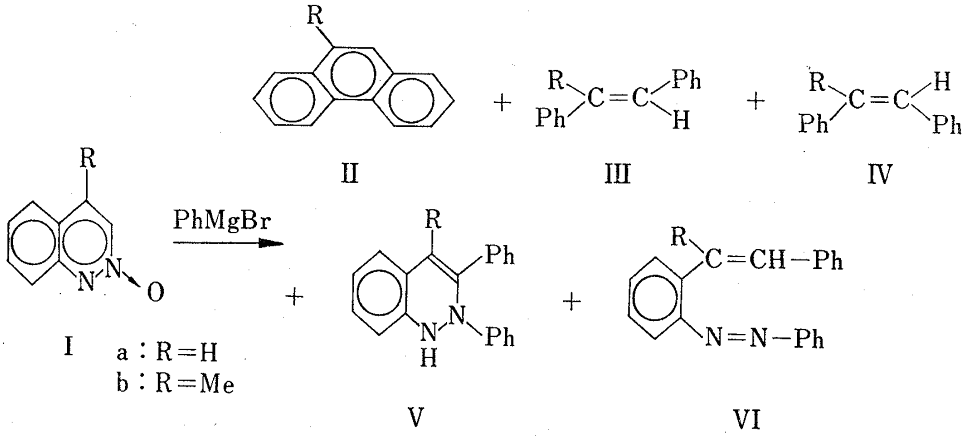

Chart 1

Both VIa and VIb afforded aniline by hydrogenation with Pd-charcoal. From these findings, we proposed the structures tentatively for them. The definite and detailed stereochemistry of them are now being investigated.

The following mechanism can be proposed as the most reasonable one for the formation of II—IV from I. The 2,3-dihydro compounds (VII) lead to the ring-opened intermediates (VIII), which then give rise to the diazonium ions (IX). The *cis*-forms of IX are cyclized by denitrogenation to form phenanthrenes (II).

When R is Me, the yield of II is increased, suggesting that the methyl group makes the cyclization easier.

Dediazoniation[8] of IX affords stilbenes (III and IV). Addition of phenyl anion to IX forms azobenzenes (VI). The formation of dihydrocinnolines (V) are presumably due to the cyclization of VI.

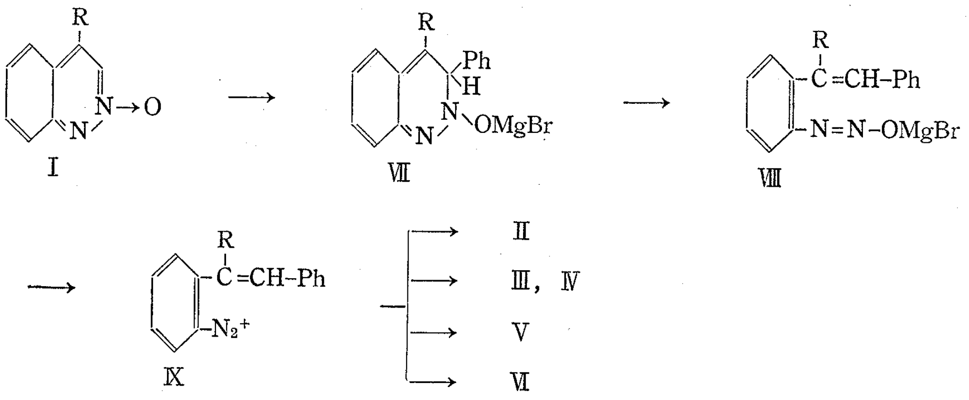

Chart 2

Excess amounts of the reagents, or the increasement of the concentration of the reactants, led to the better yields of V and VI, which might support the validity of the mechanism.

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[8] J.F. Bunnett and H. Takayama, *J. Am. Chem. Soc.*, **90**, 5173 (1968).

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Received April 23, 1970