Tetrahedron Letters No. 25, pp 2073 - 2076, 1975. Pergamon Press. Printed in Great Britain.

REACTION OF o-PHENYLENEDIAMINE WITH DIBENZOYLETHYLENE AND DIBENZOYLACETYLENE.

ISOLATION OF A REACTIVE INTERMEDIATE

R. G. Bass*, D. D. Crichton[1], Harriet K. Meetz and Ashby F. Johnson, Jr.[2]

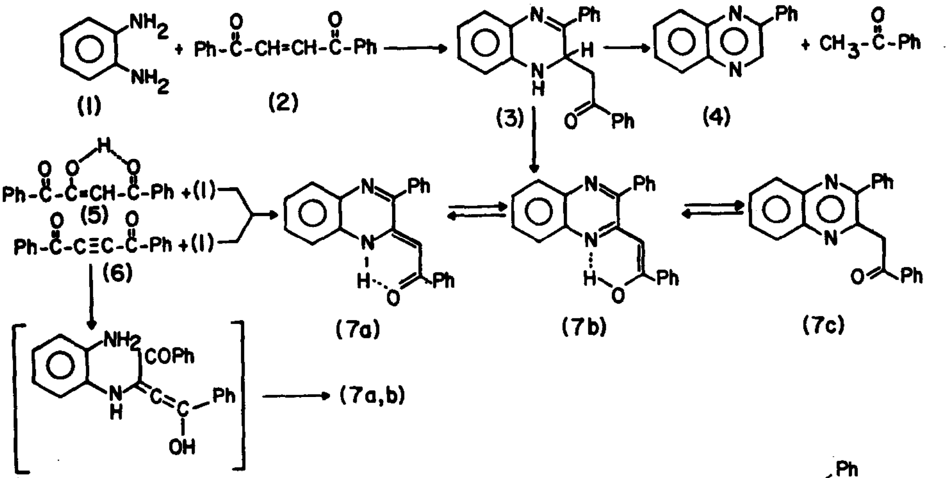
Department of Chemistry, Virginia Commonwealth University
Richmond, Virginia 23284

(Received in USA 19 March 1975; received in UK for publication 8 May 1975)

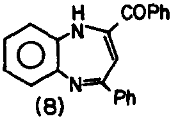
The recent publications of Bindra[3] and Perlmutter[4] concerning the condensation of o-phenylenediamine (1) with cis- and trans-dibenzoylethylene (2) have prompted us to report our findings[5] concerning the postulated reaction intermediate and to offer an alternative structure to that proposed[3] for one of the reaction products.

Refluxing equimolar amounts of (1) and (2) in acetic acid followed on cooling by dilution with water gives an orange solid (m.p. 169-171°) whose mass spectral and elemental analysis data show the compound to have the molecular formula $C_{22}H_{16}N_2O$; pmr ($CDCl_3$) δ 6.28 (1H,s,vinyl), δ 7.12-8.17 (14H,m,aromatic), δ 15.67-16.17 (1H,s,broad, NH or OH, replaceable by D_2O); ir (KBr) 1587 cm^{-1} (C=N or strongly hydrogen bonded C=O). The vinyl proton exchanges on deuteration but at a slower rate than NH or OH. The electronic spectrum shows absorption at λ235 nm (cyclohexane, ε = 28,650) and a broad band at λ408 nm (cyclohexane, ε = 17,620, reported[3] λmax 452 nm, ε = 35,000).

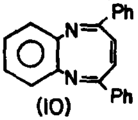
The orange material (m.p. 169°) reported by Bindra[3] to be 2-benzoyl-4-phenyl,(1H)1,5-benzodiazepine (8) proved to be identical with the product formed by reaction of (1) with dibenzoylethenol (5) which was characterized by Lutz and Stuart[6] as 2-phenacylquinoxaline (7c). Blomquist and LaLancette[7] questioned Lutz's structural assignment since this compound does not show a carbonyl absorption band in the usual 1700 cm^{-1} region but these workers[7] offered no alternative structure. We have formulated the structure of the orange compound (m.p. 169°) as 1-phenyl-2-(3-phenyl-1,2-dihydroquinoxaline-2-ylidene)ethanone (7a) or its tautomeric enol form (7b). Our data do not permit us to assign the structure unequivocally as (7a) or (7b). This type of enol-keto-tautomerism in side-chain derivatives of N-heterocycles is well known[8] and the chemical evidence is in agreement with the formulation as (7ab) rather than as 2-benzoyl-4-phenyl, (1H)1,5-benzodiazepine (8). The 25.2 MHz proton decoupled ^{13}C nmr ($CDCl_3$) of 7(ab) gives chemical shift values (ppm) at 90.77, 119.29, 125.48, 126.13, 128.28, 129.30, 130.32, 131.72, 136.83, 137.64, 147.16, 156.15 and 180.42. Although the ^{13}C spectrum does not unequivocally distinguish between (8) and (7ab) the *up field* shift of the carbonyl to 180.42 ppm is quite significant and gives support to (7ab) since the carbonyl carbon in (8) would not be expected to be as highly deshielded and should come at 195 ± 5 ppm.[9]



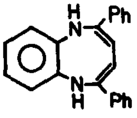
(9)



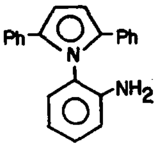
(8)



(10)



(11)



(12)

We have also found that (7ab) is formed (73% yield) on refluxing equimolar amounts of (1) and dibenzoylacetylene (6) in 95% ethanol possibly via an allene-ol intermediate (9).

Equimolar amounts of cis- or trans-dibenzoylethylene (2) and (1) react in refluxing ethanol to yield 2-phenylquinoxaline (4) and acetophenone.[3,4,5] Whereas combining equimolar amounts of (1) and (2) in 95% ethanol and warming (50°) to effect solution followed by cooling produces a new bright yellow substance (m.p. 124-125°); mass spectrum m/e (relative intensity) 326 (1), 324 (1), 307 (1), 296 (1), 219 (2), 206 (81), 179 (30), 152 (3), 120 (32), 105 (100), 77 (81), 51 (25); ir (KBr) 3350 cm^{-1} (NH), 1665 cm^{-1} (aromatic C=O); uv, λmax 243 nm (95% ethanol, ε = 33,600). Elemental analysis data and the value of 326 for the molecular ion showed this compound to have a molecular formula of $C_{22}H_{18}N_2O$. The 60 MHz pmr spectrum ($CDCl_3$) was complicated and showed an aromatic multiplet δ 6.35-8.17 (14H), a D_2O replaceable NH at δ 4.72 (1H), the X portion of an ABX pattern centered at δ 5.33 (1H, $|J_{AX}|$ = 10.3 Hz, $|J_{BX}|$ = 1.64 Hz), the four line A portion centered at δ 3.54 (1H, $|J_{AB}|$ = 18 Hz) and the four line B portion centered at δ 2.80 (1H). The proton decoupled ^{13}C nmr spectrum ($CDCl_3$) has signals (ppm) at 198.23, 157.50, 136.03, 135.70, 135.27, 133.50, 132.91, 130.38, 128.49, 126.61, 118.81, 114.07, 45.74, and 38.63. The signal at 198.23 ppm is typical for a carbonyl carbon.[9] Based on these data plus the ABX pattern in the nmr, the bright yellow substance was deduced to be 1-phenyl-2-(3-phenyl-1,2-dihydroquinoxaline-2-yl)ethanone (3), which is the proposed[3,4b,5] intermediate involved in the retroaldol reaction to give (4) and acetophenone. Compound (3) is quite sensitive and in refluxing 95% ethanol, it is converted quantitatively to (4) and acetophenone. The behavior is also evident in the mass spectrum by the significant fragments at m/e 206 and 120. On standing in a sample vial in the solid state for a period of approximately 4-6 weeks, (3) undergoes oxidation to produce (7ab). The ease of oxidation of (3) could account for the appearance of (7ab) along with other products on heating (1) and (2) briefly (1-5 minutes) in refluxing glacial acetic acid. Under similar conditions, Perlmutter[4] did not report the isolation of (7ab) however, he did report isolating a heterogeneous red-orange mixture which indicates some (7ab) was present. We have found it difficult to isolate (7ab) consistently.

The possibility that (3) is involved in the reduction of dibenzoylethylene (2) to 1,2-dibenzoylethane as reported[3,4] is under active investigation.

Bindra[3] and Perlmutter[4] isolated material (m.p. 203-206°) previously reported[11] to be 2,5-diphenyl-1,6-benzodiazocine (10). Bindra[3] assigned the structure as 2,5-diphenyl-1,6-dihydro-1,6-benzodiazocine (11) whereas Perlmutter[4] postulated that the compound was 1-(2-aminophenyl-

2,5-diphenylpyrrole (12). We also isolated this substance and are in agreement with Perlmutter's structural assignment. The proton decoupled ^{13}C nmr spectrum of ($CDCl_3$) (12) exhibits eleven signals (ppm) at 143.61, 135.38, 132.69, 130.11, 129.09, 127.63, 126.18, 124.78, 118.16, 115.69 and 109.82. This finding definitely eliminates (11) from consideration since (11) has a plane of symmetry and contains only nine different carbons.

Work is in progress to clarify these interesting reactions.

Acknowledgements: We appreciate the assistance of Dr. Jerry F. Whidby in obtaining and interpreting the ^{13}C nmr spectra and Mr. John Forehand for the mass spectra.

REFERENCES

(1) B. S. Thesis, VCU, David D. Crichton (1970).

(2) A. H. Robins Co., Inc., Richmond, Va. 23220.

(3) A. P. Bindra and E. LeGoff, Tetrahedron Lett., 1523 (1974).

(4) a) R. B. Trattner and H. D. Perlmutter, J. Heterocyclic Chem. 11, 89 (1974); b) H. D. Perlmutter and R. B. Trattner, ibid., 11, 847 (1974).

(5) Presented in part at the 22nd Southeastern Regional Meeting, ACS, New Orleans, La. (1970).

(6) R. E. Lutz and A. H. Stuart, J. Amer. Chem. Soc., 58, 1885 (1936).

(7) A. T. Blomquist and E. A. LaLancette, J. Amer. Chem. Soc., 84, 220 (1961).

(8) R. Mondelli and L. Merlini, Tetrahedron, 22, 3253 (1966); K. R. Wursthorn and E. H. Sund, J. Heterocyclic Chem., 9, 25 (1972).

(9) J. B. Stothers, "Carbon-13 NMR Spectroscopy", Academic Press, Inc., New York, N.Y., 1972, pp. 286-288.

(10) A number of related condensation reactions of dibenzoylacetylene have been actively studied and will be reported at a later date.

(11) M. I. Shevchuk, A. F. Tolochko and A. V. Dombrovskii, Zhur. Org. Khim. 6, 1108 (1970); J. Org. Chem. USSR, 6, 1110 (1970).