Tetrahedron Letters,Vol.23,No.43,pp 4489-4492,1982 0040-4039/82/434489-04$03.00/0
Printed in Great Britain

SYNTHESIS OF TETRACYCLIC HYDRAZONES, HYDRAZO- AND AZO- COMPOUNDS BY REACTION OF HYDRAZINE WITH 4,8-DIMETHYLBICYCLO[3,3,1]NONA-3,7-DIENE-2,6-DIONE

J.M. Mellor,* R.N. Pathirana and J.H.A. Stibbard
Department of Chemistry, The University, Southampton, SO9 5NH.

4,8-Dimethylbicyclo[3,3,1]nona-3,7-diene-2,6-dione with hydrazine gives a tetracyclic bishydrazone having two double bonds at bridgehead positions; the chemistry of hydrazo- and azo- compounds derived from this bishydrazone is described.

Attempts[1] to prepare bisazo compounds, capable of undergoing [2+2] photocycloaddition to give tetraazetidines have recently been described. As part of a programme designed to investigate the influence of stereoelectronic factors upon such cycloadditions the tetracyclic bisazo compound (1) was prepared but was found not to undergo a cycloaddition on irradiation. In contrast, evidence was presented for a [2+2] photocycloaddition on irradiation of a mixture of the mono-N-oxides of (1).

In studying the chemistry of 4,8-dimethylbicyclo[3,3,1]nona-3,7-diene-2,6-dione (2)[2] we have found a simple route to a tetracyclic analogue of (i) having proximate azo groups. We describe here the synthesis of (3) from (2) via the unusually strained bishydrazone (4) featuring two strained carbon-nitrogen double bonds at bridgehead positions, and the reactive bishydrazine (5).

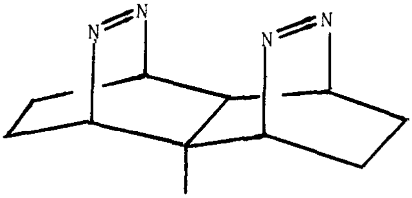
Condensation of 4,8-dimethylbicyclo[3,3,1]nona-3,7-diene-2,6-dione (2) with hydrazine gives the crystalline air-sensitive bishydrazone (4) in 90% yield. Unstable (4) was characterised as the stable crystalline diamide (6).[3] The bishydrazone (4) and the related (6) are the first bishydrazone members of a small group of compounds[4] characterised by having two double bonds at bridgehead positions. The containment of the two carbon-nitrogen double bonds within the framework of a bicyclo[5,2,1]decene leads to slight strain which may be observed spectroscopically [ν_{max} 1625cm^{-1} and λ_{max} 268nm for (4)].

Instead of formation of (4), an alternative mode of addition, which is well established with acyclic α,β-unsaturated ketones, might have given (7). However, such a bishydrazone has two double bonds at bridgehead positions contained within the framework of a bicyclo[3,2,1] octene. Dehydration to give (7) would, therefore, be much less favoured. Similarly an *exo* mode of Michael addition is less favoured, due to steric factors compared with the observed *endo* mode of addition.

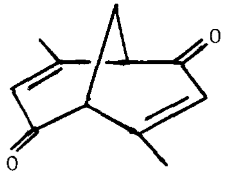
The bishydrazone (4) is unusually air-sensitive, and is rapidly decomposed by exposure to air. Cleavage of the tetracyclic (4) with aluminium chloride, or with lithium aluminium hydride gives tricyclic products,[5] but reduction of (4) with LiAlH$_4$/AlCl$_3$ (1:1), or by catalytic hydrogenation, gives the air-sensitive bishydrazine (5). This unstable bishydrazine was characterised as the stable crystalline tetraamide (8).[6] In related systems[7] a preference is observed for attack from an *exo* face, and the observed spectra for (5) and (8) confirm the *endo* stereochemistry of the four nitrogen substituents relative to the bicyclo [3,3,1]nonane moiety.

The potential of (5) as an intermediate in the synthesis of more highly caged systems is shown by reaction with benzaldehyde to give pentacyclic (9).[8]

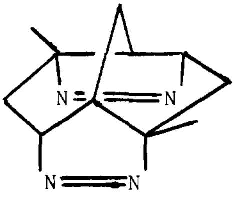
Exposure of (5) to air leads to rapid oxidation. Although oxidation of (5) to give (3) may be achieved with hydrogen peroxide in ethanol, or by stirring a suspension of palladium charcoal in a methanolic solution of (5) through which oxygen is bubbled, we find that optimum conversion of (5) to give (3)[9] (87% yield) is achieved by exposure of a chloroform solution of (5) to air.



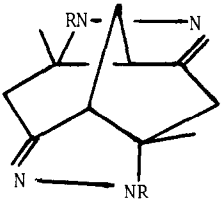
(1)



(2)

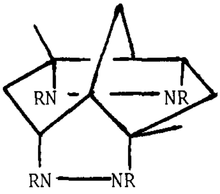


(3)



(4) R=H

(6) R=Ac

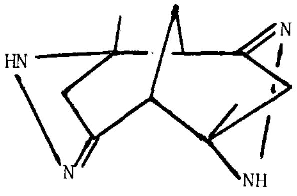


(5) R=H

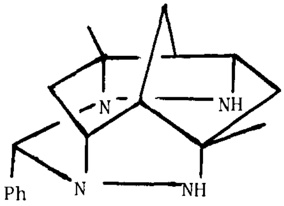
(8) R=Ac

The two azo chromophores, contained in five membered rings in (3), are held in close proximity if the bicyclo[3,3,1]nonane moiety adopts a double boat conformation. Flipping towards a double chair conformation increases the distance between the two chromophores. The neighbouring chromophores show no exceptional interaction. The spectrum of (3) [λ_{max} 335nm (ε=408)] shows the expected blue shift relative to (1) [λ_{max} 385nm (ε=240)][1] as containment of an azo chromophore in a strained five membered ring typically leads to a hypsochromic shift. Comparison with related monoazo and bisazo compounds reveals no unusual interaction in (3); (10) λ_{max} 355nm;[10] (11) λ_{max} 341.5nm[10] and (12) λ_{max} 325nm.[1] The structure (3) is further confirmed by catalytic hydrogenation to give (5), by acetylation in acetic acid/acetic anhydride to give (6) and by oxidation with m-chloroperbenzoic acid to give either mono-N-oxides or bis-N-oxides in a manner analogous[1] to (1).

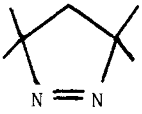
In view of the present interest[11] in the effect of chemical structure upon the thermal and photochemical properties of azo compounds, where containment of the azo chromophore in a five membered ring leads to marked differences from containment in a six membered ring, it will be profitable to investigate the properties of (3) and (12), the first bispyrazolines in which the two chromophores are held in a position capable of forming a tetraazetidine ring.



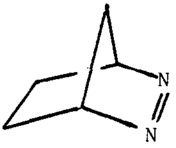
(7)



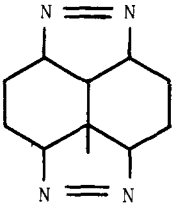
(9)



(10)



(11)



(12)

References and Notes

1. H. Prinzbach, G. Fischer, G. Rihs, G. Sedelmeier, E. Heilbronner and Yang Z., Tetrahedron Lett., 1982, 1251.
2. P.A. Knott and J.M. Mellor, J. Chem. Soc. C, 1971, 670.
3. Data for (6): m.p. 252-253°C; ^{1}H n.m.r. ($CDCl_3$) (τ) 6.06 (2H,t J 3Hz), 6.90 (2H,d J 14Hz) 7.74 (2H, d J 14Hz), 7.74 (6H,s), 8.06 (2H,t J 3Hz) and 8.10 (6H,s); ^{13}C n.m.r. ($CDCl_3$) (p.p.m.) 16.68, 23.59, 24.53, 33.36, 52.43, 75.05, 158.61 and 171.62.

4. J.R. Wiseman and J.J. Vanderbilt, *J. Am. Chem. Soc.*, 1978, **100**, 7730;
K.B. Wiberg, M. Matturro and R. Adams, *ibid*, **103**, 1600.

5. J.M. Mellor and R.N. Pathirana, following paper.

6. Data for (8): m.p. 284-286^{o}C; ^{1}H n.m.r. (pyridine-d^{5}) (τ) 5.49 (2H,m), 6.08 (2H,d J 17Hz), 7.65 (2H,m), 7.71 (6H,s), 7.81 (6H,s), 8.35 (2H,q J 17 and 8Hz), 8.40 (2H,t J 3Hz) and 8.48 (6H,s); ^{13}C n.m.r. (pyridine-d^{5}) (p.p.m.) 19.35, 21.79, 24.13, 28.32, 32.26, 42.24, 56.54, 62.74 and 169.11.

7. H. Tatemitsu, F. Ogura, Y. Nakagawa, M. Nakagawa, K. Neamura and M. Nakazaki, *Bull. Chem. Soc. Jpn.*, 1975, **48**, 2473.

8. Data for (9): m.p. 165-168^{o}C; ^{1}H n.m.r. (CDCl$_3$) (τ) 2.1-2.9 (5H), 4.76 (1H,s), 5.7 (2H, broad), 6.21 (1H,dt J,10,3 and 3Hz), 6.39 (1H,q, J 10 and 7Hz), 7.75-8.8 (8H, complex), 8.83 (3H,s) and 8.94 (3H,s); ^{13}C n.m.r. (CDCl$_3$) (p.p.m.) 21.92, 28.71, 29.82, 30.92, 40.66, 45.68, 46.87, 58.61, 60.44, 61.28, 86.77, 125.91, 127.04, 127.64 and 146.64.

9. Data for (3): m.p. 155-160^{o}C; ν_{max} (nujol) 1560cm^{-1} (weak); λ_{max} (EtOH) 335nm (ε,408); ^{1}H n.m.r. (CDCl$_3$) (τ) 5.00 (2H,m), 7.08 (2H, d J 17Hz), 8.28 (2H, dt J 12,3 and 3Hz), 8.4-8.5 (4H, complex) and 8.64 (6H,s); ^{13}C n.m.r. (CDCl$_3$) (p.p.m.) 16.85, 26.09, 27.97, 30.99, 86.97 and 89.81.

10. K.N. Houk, Y-M. Chang and P.S. Engel, *J. Am. Chem. Soc.*, 1975, **97**, 1824.

11. P.S. Engel, *Chem. Rev.*, 1980, **80**, 99.

(Received in UK 26 July 1982)