

¹H-NMR SPECTRAL EVIDENCES FOR THE DOUBLE-CHAIR
CONFORMATION OF THE 9-AZABICYCLO[3.3.1]NONANE-
3,7-DIONE SYSTEM

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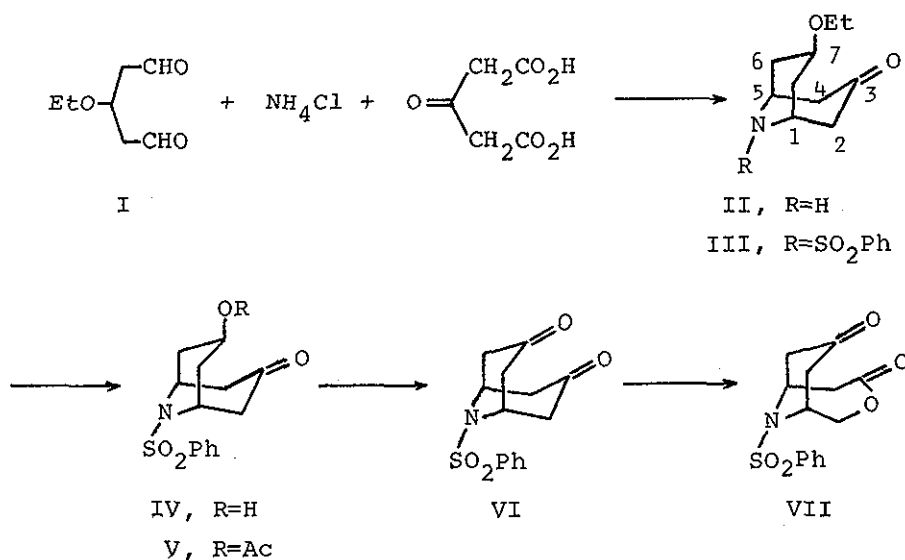
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N-Benzenesulfonyl-9-azabicyclo[3.3.1]nonane-3,7-dione was synthesized, and its conformation was shown to be of a double-chair form by ¹H-nmr spectrum evidences.

Of the conformation of bicyclo[3.3.1]nonanes, a chair-boat as well as twin-chair form are known today. In general, the 9-azabicyclo[3.3.1]nonan-3-one system is known¹ to exist in the double-chair conformation, but the carbocyclic bicyclo[3.3.1]nonan-3-one has been shown to undergo 'chair'-'boat' isomerization in the cyclohexanone ring as evidenced by the nuclear magnetic resonance (nmr)² and electron spin resonance study.³ The bicyclo[3.3.1]nonane-3,7-dione system has been reported to be in the double-chair conformation from the nmr spectrum evidence by Dreiding et al.⁴ and from the ir spectrum evidence by Eglinton et al.,⁵ but 9,10-benzobicyclo[3.3.2]dec-9-ene-3,7-dione was reported⁶ to be in equilibrium between a double-chair and double-boat form.⁷

As for 9-azabicyclo[3.3.1]nonane-3,7-dione, there have been no reports describing its conformation. In the present paper, we describe the ^1H -nmr evidence for the double-chair conformation of 9-azabicyclo[3.3.1]nonane-3,7-dione.

N-Benzenesulfonyl-9-azabicyclo[3.3.1]nonane-3,7-dione (VI), which was needed for some of our works concerning the structure-reactivity relationships of the bicyclo[3.3.1]nonane-3,7-dione system,⁸ was synthesized as follows.



The Robinson-Schöpf condensation of β -ethoxyglutaraldehyde (I) with ammonium chloride and acetonedicarboxylic acid gave an amino ketone (II),⁹ which was converted to a sulfonamide (III), m.p. 131-133°; IR (KCl): 1715, 1350, 1165 cm^{-1} . The ketol (IV), m.p. 181-183°; IR (KCl): 3400 cm^{-1} , was obtained in 78% yield upon treatment of III with boron tribromide. Its acetate (V), m.p. 136-137°; IR (KCl): 1750, 1710 cm^{-1} , displays an ^1H -nmr signal¹⁰ due to the C₇-H as a nine-line multiplet ($W_{\frac{1}{2}}=22\text{Hz}$) at δ 4.91ppm,

the feature of which suggests an equatorial orientation for the C_7 -substituent in II-V. Oxidation of IV with chromium trioxide-pyridine gave the diketone (VI), m.p. 161-162°; IR ($CHCl_3$): 1730 cm^{-1} ; MS: m/e 293 (M^+ , 6%), in 80% yield. In the 1H -nmr spectrum of VI (Fig. 1), the signal for the axial hydrogens at C_2 , C_4 , C_6 , C_8 appears as a double-doublet ($J=16Hz$, 6Hz) at δ 2.71ppm, and that for the equatorial counterparts as a doublet ($J=16Hz$) at δ 2.38ppm. In addition, the bridgehead hydrogens at C_1 and C_5 positions appear as a pseudo-triplet centered at δ 4.93ppm with half-width of 10Hz and base-width of 22Hz.¹¹ These results indicate that VI exists in the double-chair conformation despite the dipolar repulsion resulting from the two facing ketone carbonyls.

Peracid oxidation of VI with *m*-chloroperbenzoic acid in boiling methylene chloride gave a keto lactone (VII) [m.p. 165-167°; IR (KCl): 1750, 1720 cm^{-1} ; 68% yield] possibly via the through-space participation⁸ of the facing carbonyls.

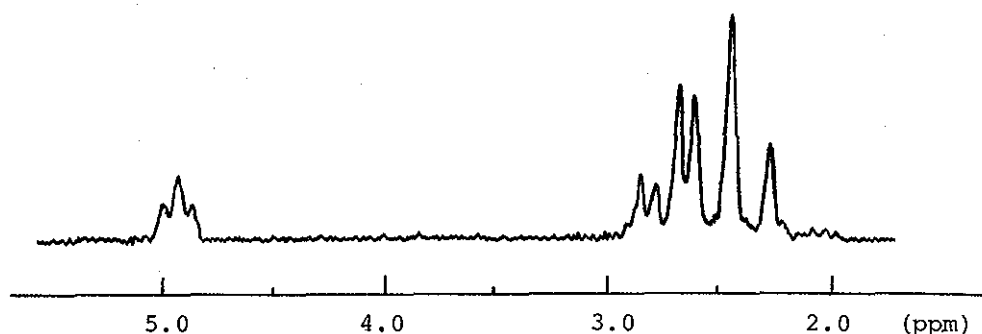


Fig. 1 The nmr spectrum of compound VI

NOTES AND REFERENCES

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2. M. R. Vegar and R. J. Wells, ibid., 1971, 2847.
3. A. Caragheorgheopol, U. Gräfe, M. Hartmann, V. E. Sahini, and K. Wermann, ibid., 1970, 3035.
4. I. A. McDonald and A. S. Dreiding, Helv. Chim. Acta, 1973, 56, 2523.
5. Eglinton and co-workers have ascribed its carbonyl absorption (1729 cm^{-1}) in the anomalously high frequency region to the dipolar interaction between two facing carbonyls in the double-chair conformation; G. Eglinton, J. Martin, and W. Parker, J. Chem. Soc., 1965, 1243.
6. B. Föhlisch, V. Dukek, I. Graessle, B. Novotny, E. Schupp, G. Schwaiger, and E. Widmann, Liebigs Ann. Chem., 1973, 1839.
7. Dreiding et al., in contrast to the result of Föhlisch et al.,⁶ have shown that 9,10-benzobicyclo[3.3.2]dec-9-ene-3,7-dione is in the double-chair conformation; C. B. Chapleo and A. S. Dreiding, Helv. Chim. Acta, 1974, 57, 2420.
8. See, for example, T. Momose, S. Atarashi, and O. Muraoka, Tetrahedron Letters, 1974, 3697.
9. The N-methyl derivative of II was prepared by Stetter et al.; H. Stetter and R. Mehren, Liebigs Ann. Chem., 1967, 709, 170.
10. ¹H-nmr spectra were measured for the CDCl₃ solution with TMS as an internal standard on a Hitachi R-22 spectrometer operating at 90MHz.
11. In the tropane system in which the piperidine ring is in a chair form, the half-width and the base-width of the two bridgehead protons are reported to be 9.5-10.2Hz and 17.5-21Hz, respectively: see C.-Y. Chen and R. J. W. Le Fèvre, J. Chem. Soc., 1965, 3473.

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