J. Chem. Research (S), 2001, 309–310
J. Chem. Research (M), 2001, 0835–0843

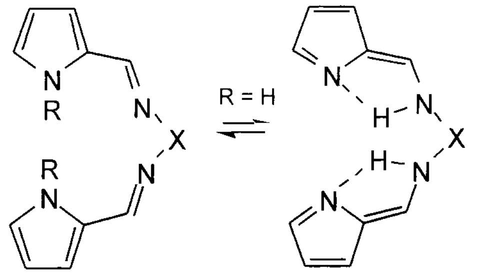
Pyrrole studies, Part 48.[1] ^{13}C NMR characterisation of imines and related compounds derived from pyrrole-2-carboxaldehydes and pyrrole-2,5-dicarboxaldehydes

R. Alan Jones*, Gloria Quintanilla-López, Orhan Öztürk, Sayed Ali Nagdi Taheri, Gülan Berber Karatepe and (in part) Richard O. Jones

School of Chemical Sciences, University of East Anglia, Norwich NR4 7TJ, UK

In contrast with the imines formed from monoaminoalkanes and α,ω-diaminoalkanes with pyrrole-3,4-dicarboxaldehydes, which exist in a tautomeric 3*H*-pyrrole form, pyrrole-2-carboxaldehydes and -2,5-dicarboxaldehydes react with amines to produce 1*H*-pyrrolyl-methylenimines. Pyrrole-2,5-dicarboxaldehydes with 1,2-diamino-ethane and with 1,3-diaminopropane yield symmetrical macrocyclic systems, contrary to earlier reports.

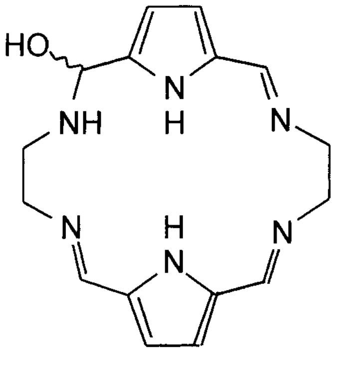
Keywords: pyrroles, imines, macrocycles, tautomerism



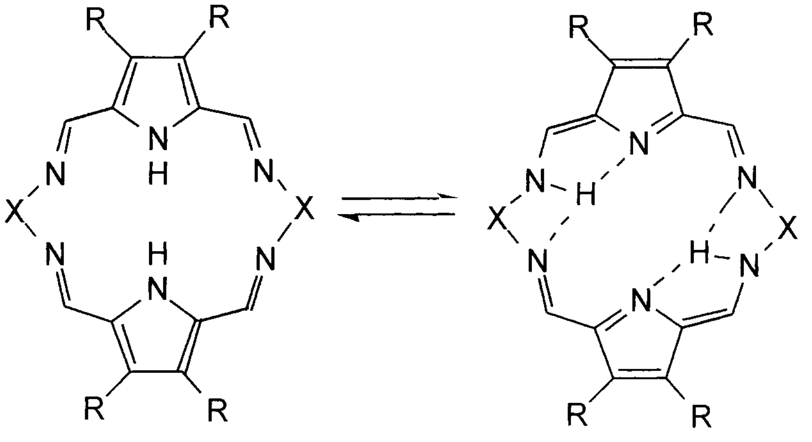
2

a R = H; X = $(CH_2)_2$ **b** R = H; X = $(CH_2)_3$
c R = H; X = $(CH_2)_5$ **d** R = H; X = $(CH_2)_6$
e R = H; X = $(CH_2)_{12}$
f R = H; X = $(CH_2)_2NH(CH_2)_2$
g R = Me; X = $(CH_2)_2$ **h** R = Ph; X = $(CH_2)_2$

In earlier publications[1,2] we established, using ^{13}C NMR spectroscopy, that pyrrole-3-carboxaldehyde reacted with aminoalkanes, α,ω-diaminoalkanes and aminoarenes to produce imines having the 1*H*-pyrrole system and not that of the alternative 3*H*-pyrrole tautomer. In contrast, the corresponding reactions with pyrrole-3,4-dicarboxaldehydes produced imines having the 3*H*-pyrrole system, which are stabilised by intramolecular H-bonding.[1,2] We now report the ^{13}C NMR spectra for the imines **2** and **5**, obtained from pyrrole-2-carboxaldehyde and pyrrole-2,5-dicarboxaldehyde (Table 1), which show that they exist predominantly as 1*H*-pyrroles and not as H-bonded 2*H*-pyrrole tautomers. The symmetry of the ^{13}C NMR spectra of **5** unequivocally identifies the products obtained from α,ω-diaminoalkanes with pyrrole-2,5-dicarboxaldehydes as macrocyclic tetraimine systems, which appear from infrared spectroscopic and elemental analysis to have a molecule of water occluded in the central cavity. This evidence conflicts with the previously reported[12] carbinolamine structure **4** for the macrocyclic systems. Analogous to



4



5

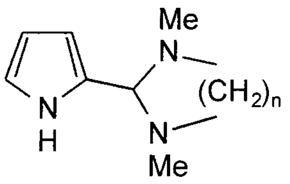
a R = H, X = $(CH_2)_2$ **c** R = Me, X = $(CH_2)_2$ **d** R = Me, X = $(CH_2)_3$

Table 1 Characteristic ^{13}C NMR signals for 1*H*-pyrrolylmethyleneimines and macrocycles

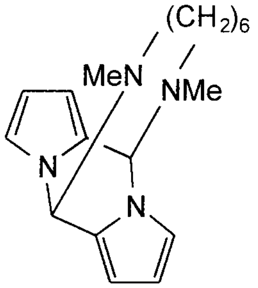
	α-pyrrolyl	α-pyrrolyl	β-pyrrolyl	β-pyrrolyl	CH=N-	N-CH_2-
2a–2f	130·0±0·1 (s)	123·3±3·3 (d)	109·1±0·4 (d)	113·8±0·7 (d)	152·1±0·4 (d)	60·2±1·2 (t)
2g, 2h	130·0±0·5 (s)	127·5±0·0 (d)	108·9±1·4 (d)	113·8±2·9 (d)	152·9±0·7 (d)	62·1±0·9 (t)
5a	132·7 (s)	132·7 (s)	114·2 (d)	114·2 (d)	152·4 (d)	61·9 (t)
5c	128·5 (s)	128·5 (s)	123·6 (s)	123·6 (s)	151·1 (d)	61·8 (t)
5d	128·5 (s)	128·5 (s)	123·1 (s)	123·1 (s)	149·8 (d)	58·9 (t)

---

* To receive any correspondence. E-mail: r.a.jones@uea.ac.uk



9 n= 2; **10** n = 3



11

the previously reported reaction of 1,3-diaminopropane with pyrrole-3,4-dicarboxaldehydes,[2] the corresponding reaction with pyrrole-2,5-dicarboxaldehyde leads to polymeric products. This observation reflects the lower N-O *cis*:*cis* conformational preference for the formyl groups of pyrrole-2,5-dicarboxaldehyde, compared with the 3,4-dimethyl derivative, which, combined with greater entropy factor for ring closure with the 1,3-diamine, compared with the 1,2-diamine (*cf*. ref. 12), inhibits the formation of the macrocyclic system **5**.

Dialkylamines react with pyrrole-2-carboxaldehyde to yield 5,10-bis(dialkylamino)dipyrrolo[1,2-*a*:1′2′*d*]pyrazines,[20,21] which are characterised *inter alia* by their ^{13}C NMR signal at δ 70.0 ± 2.6 assignable to the C2/C5 atoms of the pyrazine ring. In contrast, the products obtained from the reaction of *N*,*N*’-dimethyl-α,ω-diaminoalkanes with pyrrole-2-carboxaldehyde depend upon the alkane chain length. *N*,*N*′-Dimethyl-1,6-diaminohexane produces the dipyrrolopyrazine **11**, but a more favourable intramolecular ring closure of the intermediate iminium species obtained from *N*,*N*′-dimethyl-1,2-diaminoethane and from *N*,*N*′-dimethyl-1,3-diaminopropane leads to **9** and **10**, respectively, which are identified *inter alia* by a ^{13}C NMR signal at δ 85.0 ± 0.5 assignable to C2 of the reduced heterocyclic ring.

In all reactions of pyrrole-2-carboxaldehyde and the 2,5-dicarboxaldehydes with the α,ω-diamino-alkanes we found no evidence for the formation of condensation adducts analogous to **9** and **10** or **11**.

G.Q-L thanks the British Council and Fondo de Investigaciones Sanitarias for financial support and the Faculty of Pharmacy, University of Alcalá de Henares for leave of absence in 1983 and 1986 in order to undertake research at the University of East Anglia.

Techniques used: NMR (^{13}C and ^{1}H) and IR spectroscopy and mass spectrometry.

References: 26

Received 2 March 2001; accepted 30 May 2001
Paper 01/781

References cited in this synopsis

1 Part 47. R.A. Jones, G. Quintanilla-López, S.A.N. Taheri, M.M. Hania, O. Öztürk and H. Zuilhof, *ARKIVOC*, 2000, **1**, 382. (Paper 0044).
2 S.A.N. Taheri, R.A. Jones, S.S. Badesha and M.M. Hania, *Tetrahedron*, 1989, **45**, 7717.
12 H. Adams, N.A. Bailey, D.E. Fenton, S. Moss, C.O. Rodriguez de Barbarin and G. Jones, *J. Chem. Soc., Dalton Trans.*, 1987, 219.
20 M.A. Kira, A. Bruckner-Wilhelms, F. Ruff and J. Borsy, *Acta Chim. Acad. Sci. Hung.*, 1968, **56**, 189 (the dimeric product was incorrectly assigned the monomeric azafulvene structure).
21 see, *e.g.*, M. Watanabe, T. Kobayahi, S. Kajigaeshi and S. Kanemasa, *Chem. Lett.*, 1975, 607; S. Mori, M. Watanabe, S. Kajigaeshi and S. Kumemasa, *Heterocycles*, 1976, **4**, 957.