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RING INVERSION IN POLYCYCLIC TETRAAMINES

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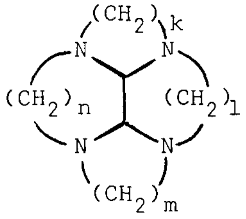
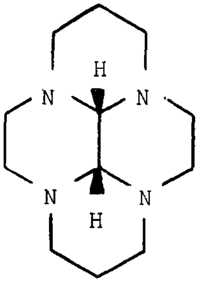
ABSTRACT: Inversion barriers for four polycyclic tetraamines are reported.

Kolinski and Choinski,[1] and Weisman et al[2] have reported the synthesis of some tetracyclic tetraamines of general formula (1) and Fuchs and Ellenzweig[3] that of the tricyclic tetraamine (4).



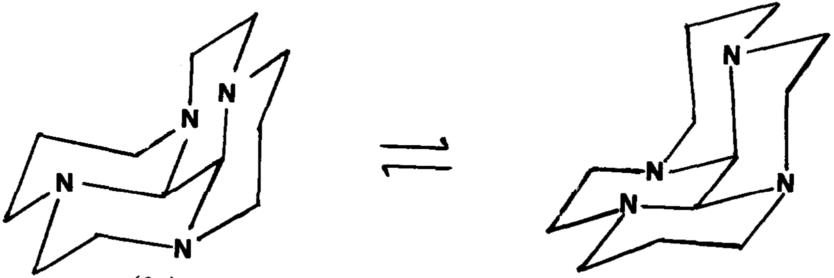
(1)



(2)

k,l,m,n = 2 or 3

In particular, Weisman et al noted that cis-perhydrotetraazapyrene (2) showed a temperature dependent ^{13}C nmr spectrum. These spectral changes can be associated with the inversion process 2a $\rightleftharpoons$ 2b which involves (finally) the inversion of all four nitrogen atoms and both of the piperazine rings. The hexahydropyrimidine rings remain in the same state of inversion after the process as they had before it.[4]

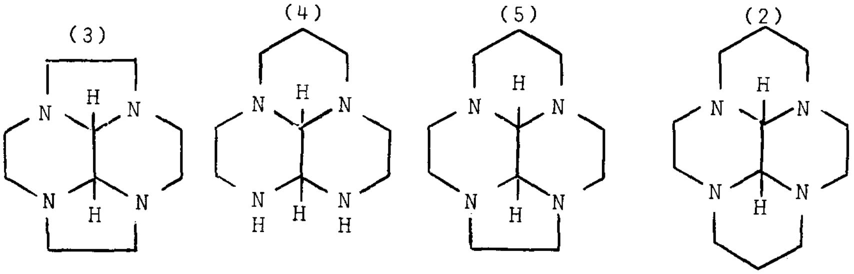


(2a) (2b)

Their result confirmed the cis stereochemistry of the two central methine hydrogens,[5] since this process is not possible with the trans stereochemistry

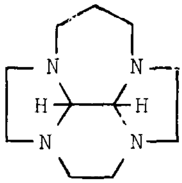
We now wish to report that several other polycyclic tetraamines also show a similar inversion process. Our results for free energies of activation are presented in Scheme 1 and the spectral details recorded in Table 1.

Scheme One

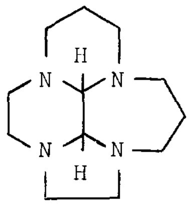


$\Delta G^{\ddagger}_{C}$ kcal mole^{-1}	11.44±0.2 (CD_2Cl_2)	13.14±0.2 ($CDCl_3$)	13.89±0.2 ($CDCl_3$)	15.57±0.2 ($CDCl_3$) 15.85±0.2 (toluene d_8) 15.36±0.2 (DMSO d_6?)[2]

Our free energies of activation for the inversion process in (2) are somewhat higher than the result presented by Weisman[2] but both sets of results probably agree within experimental error when changes in solvent are allowed for. Compound (5) was studied in the presence of a small amount of an isomeric compound (probably 6) which showed no evidence of a coalescence over the temperature range studied. Compound (7) was also studied down to -100° (CD_2Cl_2 solution) but showed no evidence of any kinetic line broadening. This is consistent with either a very rapid inversion process ($\Delta G^{\ddagger}_{c}$ < 9 kcal mole^{-1}), or a very biased conformational equilibrium (ΔG^{o} >2.5 kcal mole^{-1}) or a trans stereochemistry in the centre



(6)



(7)

of the molecule.

The overall trend of the results is clear. As successive bridges are placed between the nitrogens on the cis fused piperazine rings the barrier to the inversion increases. Three carbon bridges have a greater effect than two carbon bridges.

Our results on compound (2) together with a detailed examination of the mechanism of this remarkable molecular inversion will be presented in full shortly.[4]

Table * ^{13}C COALESCENCE DATA

Compound (solvent)	M.P.°	Coalescing Resonances /ppm (temp/K)		Tc/K	$\Delta G^{\ddagger}_{c}$ kcal mole^{-1}
2 (CDCl$_3$)		56.16	52.53	320.5±5	15.55±0.3
	82-84	54.43	44.77	334.5±5	15.57±0.3
		(273K)			
2 (toluene d$_8$)		56.54	53.08	325.5±5	15.83±0.3
		54.86	45.37	340.5±5	15.90±0.3
		(273K)			
3 (CD$_2$Cl$_2$)		52.25	49.92	235 ± 3	11.44±0.2
	87-90.5†	51.59	49.10		
		(204K)			
4 (CDCl$_3$)		55.80	52.31	272 ± 5	13.02±0.3
	98-99	54.49	44.76	285 ± 5	13.20±0.3
		44.76	39.08	279 ± 5	13.20±0.3
		(247K)			
5 (CDCl$_3$)		54.74	51.62	285 ± 5	13.84±0.3
	oil	53.16	45.53	295 ± 5	13.82±0.3
		51.62	49.25	285 ± 5	14.00±0.3
		(263K)			

* Data recorded at 20.15 MHz on a Bruker WP80 instrument.

† Very hygroscopic

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2. G R Weisman, S C H Ho and V Johnson, Tetrahedron Letters, 1980, 335.
3. B Fuchs and A Ellenzweig, Rec.Trav.Chim., 1979, 98, 326.
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5. The *cis*-structure of compound (2) has been confirmed by an X-ray structure determination, P Gluzinski and J W Krajewski, private communication.

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