Tetrahedron Letters No.34, pp. 2893-2896, 1969. Pergamon Press. Printed in Great Britain.

A GRAPHICAL APPROACH TO CONFORMATIONAL STUDIES

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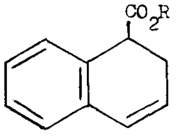
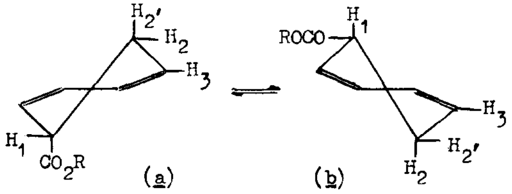
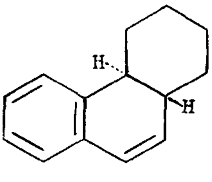
(Received in UK 6 June 1969; accepted for publication 20 June 1969)

The conformational equilibria of a number of conformationally mobile systems have been measured (1) by comparing a trans coupling constant between protons on adjacent methylene groups with values of J_{aa} and J_{ee} obtained from model compounds or estimated from the Karplus equation (2). In particular this approach, with modifications, has been applied to the 1-carbomethoxy and 1-carboxy substituted 1,2-dihydronaphthalenes (I and II), (3), a ring system which exists in the interconverting half-chair conformers a and b, (4).



I R = CH_3
II R = H





III

The measured coupling constants J_{12}, J_{23}, $J_{2'3}$ in both I and II are related to 'x', the fraction of the compound existing in conformer a by equations 1,2, and 3 respectively. Values of $1/2(J_{aa} + J_{ee})$ and $1/2(J_{2a3} + J_{2e3})$

$$J_{12} = xJ_{ee} + (1-x)J_{aa} = x(J_{ee} - J_{aa}) + J_{aa} \quad (1)$$

$$J_{23} = xJ_{2e3} + (1-x)J_{2a3} = x(J_{2e3} - J_{2a3}) + J_{2a3} \quad (2)$$

$$J_{2'3} = xJ_{2'a3} + (1-x)J_{2'e3} = x(J_{2'a3} - J_{2'e3}) + J_{2'e3} \quad (3)$$

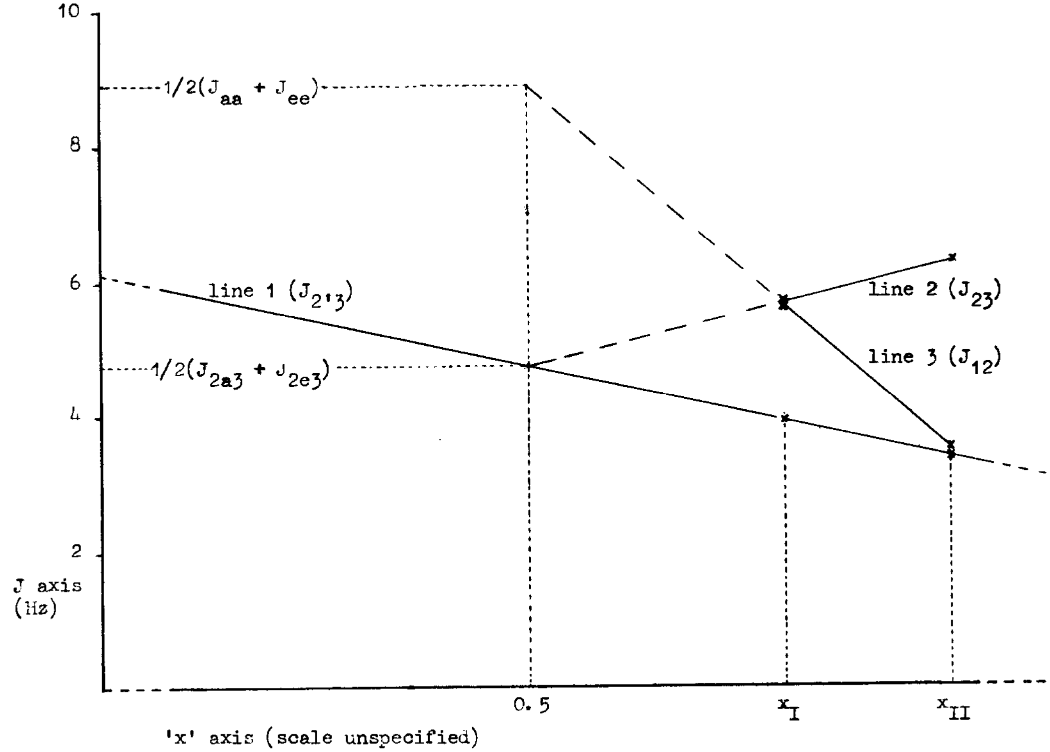
found in 1,2-dihydronaphthalene and 4-phenyl 1,2-dihydronaphthalene, and J_{2a3} found in the tricyclic compound (III) were used as a basis for estimating values of J_{aa}, J_{ee}, J_{2a3}, $J_{2'a3}$, J_{2e3}, and $J_{2'e3}$ in I and II; using these in equations 1-3 a value of x for both I and II were calculated.

In this paper a graphical procedure is presented which considerably simplifies this approach, and should also be applicable to a number of systems other than dihydronaphthalenes.

Coupling constants used here are taken from the literature (3); spectra were recorded in CCl_4 at 100 MHz. For I, $J_{12} = 5.62$; $J_{23} = 5.69$; $J_{2'3} = 3.92$ Hz and for II, $J_{12} = 3.47$; $J_{23} = 6.27$; $J_{2'3} = 3.36$ Hz. From these alone it is not clear whether the substituents at C-1 prefer the pseudo-axial or pseudo-equatorial position.

There are a number of assumptions inherently necessary when calculating conformational equilibria from coupling constant data and a number of these apply equally to this approach. In the present example J_{aa}, J_{ee}, J_{2a3}, $J_{2'a3}$, J_{2e3} and $J_{2'e3}$ are each assumed to be the same in both I and II, which is reasonable since the electronegativities of the substituent groups should be similar and the geometry of Ia and Ib should be the same as the geometry of IIa and IIb respectively. Secondly it is necessary to use the approximation that $J_{2a3} = J_{2'a3}$ and $J_{2e3} = J_{2'e3}$ which depends upon the assumption that the ring remains undistorted when the substituent group occupies either the pseudo-axial or pseudo-equatorial position, and further that the different configurations of the 2 and 2' protons with respect to the substituent group do not affect the coupling constants to these protons; an assumption which should be acceptable since the CO_2R groups are not highly electronegative (see ref. 5).

Bearing in mind the first assumption it can be seen from the form of the equations 1-3 that variations in each of J_{12}, J_{23} and $J_{2'3}$ are linearly related to x. Hence a straight line (line 1) drawn on a graph of Coupling Constant against x, where only the coupling constant scale is graduated, can represent a plot of the $J_{2'3}$ (or J_{23} or J_{12}) coupling constants in I and II against the x values of the compounds. On this line points are located corresponding to the values of $J_{2'3}$ in I and II and from these a different value of x, of unknown magnitude, is obtained for each compound (x_I and x_{II} on the graph). The values of J_{23} are now plotted against these relative x values and a straight line (line 2) drawn through the points and extrapolated to intersect line 1. The slopes of the lines are approximately equal but of opposite sign which is in accord with the approximation that $J_{2'e3}$ equals J_{2e3} and $J_{2'a3}$ equals J_{2a3}. Using this approximation the point of intersection is found to correspond to an x value of 0.5 and hence a value for $1/2(J_{2a3} + J_{2e3})$ is obtainable. A similar plot of J_{12} versus x (line 3), extrapolated to x = 0.5 gives a value for $1/2(J_{aa} + J_{ee})$. Since in I and II, J_{12} is less than $1/2(J_{aa} + J_{ee})$, and J_{aa} should be greater than J_{ee}, it becomes clear that x increases from left to right. The substituent group in both I and II is therefore found to prefer the pseudo-axial position, the preference being greater for the CO_2H group. The significance of this result is discussed elsewhere (3). If quantitative information about x_I and x_{II} is desired then the coupling constant data obtained could provide a basis for estimating J_{aa}, J_{ee}, J_{2a3} or J_{2e3}. With a knowledge of just one of these values one could



La *structure* de ces complexes est particulièrement intéressante. Leur stoechiométrie, leurs propriétés spectrales et les résultats des études de complexation nous conduisent à les considérer comme des composés d'inclusion dans lesquels le cation métallique est englobé dans la cavité moléculaire centrale du système macrobicyclique I*, les parois internes de la cavité contenant les sites de complexation (O et N).

Nous proposons le nom de **CRYPTATES** (grec κρύπτος: caché; latin crypta: cavité, grotte) pour cette nouvelle classe de complexes métalliques. Les constantes de stabilité très différentes obtenues pour les divers cations montrent que le composé I possède une *sélectivité de cavité* très marquée, qui fait intervenir sans doute à la fois des effets stériques, électriques et entropiques.

La conformation du ligand I dans les cryptates peut être du type *exo-exo* ou *endo-endo*. Un équilibre rapide entre ces formes, et éventuellement aussi avec la forme *exo-endo* est aussi en accord avec les données spectrales. Les résultats actuels ne permettent pas de préciser ce point. Il n'est pas non plus possible de déterminer quelles modifications conformationnelles se produisent dans la molécule I lors de la formation des cryptates, bien que les spectres de RMN semblent indiquer que de telles modifications ont effectivement lieu.

Le phénomène de *cryptation*, en plus de l'intérêt théorique qu'il présente en lui-même, peut conduire à un certain nombre d'applications dans d'autres domaines, par exemple:

- l'étude des *processus anioniques* (nucléophiles), puisqu'il est possible de préparer des solutions organiques de réactifs ioniques dans lesquelles les anions sont "nus" (d'où: augmentation de réactivité, modification de mécanismes, rupture de paires d'ions, etc...);
- l'étude des processus de *transport de cations*.

Des communications ultérieures décriront les propriétés physico-chimiques des cryptates et leur utilisation dans divers domaines.

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* L'inclusion d'anions halogénures dans la cavité centrale de sels d'amines macrobicycliques a aussi été signalée récemment (3).