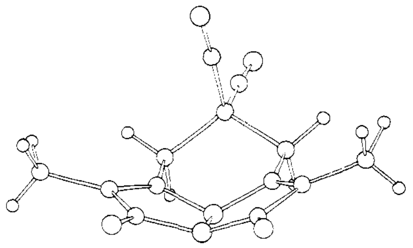

Figure 2. Structure of μ-($(CN)_2C$)-*syn*-(CH_2,CH_3)B (bridged "dicyanomethylene-*syn*-methylene, methylbimane").

= 7.394 Å, c = 16.969 Å, β = 100.11°, $P2_1/c$, Z = 4. Anisotropic refinement converged smoothly to R = 0.047.

Individual five-membered rings are not quite planar, and the two of them form a dihedral angle of 139.3°. The six-membered ring is in the chair conformation. Strain in the molecule is reflected in some of the bond angles and most notably in the long CH_2-$C(CN)_2$ bonds (1.568 Å). The structure is illustrated in Figure 2.

It is remarkable that the coplanarity of the two five-membered rings has little influence on the position or quantum yield of fluorescence. In dioxane, emission maxima and quantum yield for *syn*-(CH_3,CH_3)B and the bridged dicyano compound are 420 (0.72) and 426 nm (0.73), respectively. Substitution shifts the emission maximum for *syn*-(C_6H_5,Cl)B to 457 nm but affects the quantum yield only slightly (0.62). The implications of this combination of structural and photophysical information concerning the nature of the emitting state will be further examined.

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Received August 18, 1978

Rigidity, Lipophilicity, and Henry's Constant

Sir:

Aranow and Witten[1] described a model for the influence of aliphatic chains on water solubility. In their model, solvent molecules interact with these chains, thus restricting internal rotation. Restriction is proportional to the energy of interaction and is thus much greater in water than in commonly applied organic solvents. Because of this interaction, there is much less gain of entropy when dissolving a compound in water than in most organic solvents.

Some applications of the model for physicochemical phenomena are given. We report two further applications of the model. When, owing to restricted internal rotation, solubility in water is lower than that in other solvents, it is obvious that compounds with a structurally restricted rotation will not display such a decrease in water solubility. This must also be reflected in their partition behavior.

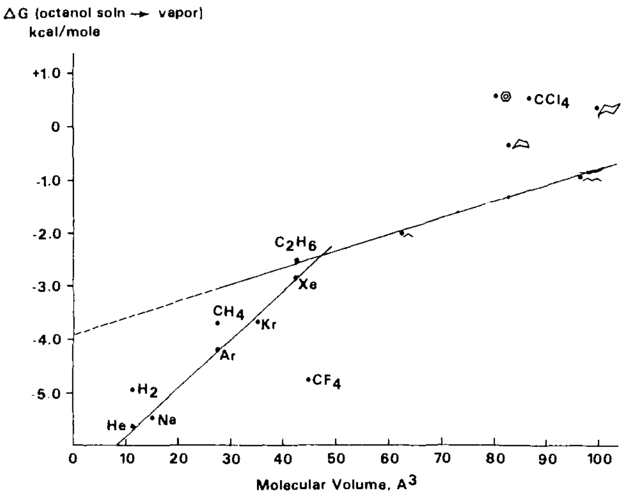

Figure 1.

Table I. Lipophilicity in Water/Octanol

compd	expt	calcd	diff
progesterone	3.87	5.61	1.74
11-deoxy-17-hydroxycorticosterone	2.46	3.52	1.06
deoxycorticosterone	2.88	4.52	1.64
testosterone	3.32	5.12	1.80
mean difference			1.56

The first application is concerned with lipophilicity. Lipophilicity is the decimal logarithm of the partition coefficient, and can be calculated by adding together the appropriate values assigned to the fragments of which the compounds are composed. These values are calculated from usually small, flexible compounds.[2] This means that, if the ideas of Aranow and Witten are correct, rigid molecules will have a lower experimental lipophilicity than calculated. This is well brought out by steroids, which possess an extremely rigid skeleton. Therefore, a few steroids were selected from the Hansch file, and their lipophilicity was calculated on the basis of Rekker's fragmental constants.[2] Table I compares the values obtained. The absence of restricted rotation provides a possible explanation of the difference in lipophilicity. If this explanation is correct, it would imply that (a) a rigidity factor should be included in the prediction systems for lipophilicity; (b) as this factor is entropy related and thus temperature dependent, the partition coefficient is also temperature dependent. Thus, if in a series of compounds the rigidity changes significantly, this would also have influence on the temperature dependence of the lipophilicity. Therefore, it is recommended that the partition coefficient at 310 K be measured if one wishes to correlate biological properties with lipophilicity. However, many other factors may be implicated, and even counterbalance one another. These include change of mutual solubility of the two solvents and changes in the degree of dissociation of the solute.

The second application lies in a related field, namely that of Henry's law, according to which the concentration of a solute and the pressure of its vapor have a constant as a quotient. This constant is a measure of the free energy necessary to bring a compound from the solvent to the vapor phase or vice versa.

Cramer[3] studied ΔG (solution-vapor) in relation to the molecular volume of the compounds. For water and octanol he obtained two separate plots, which are reproduced in Figures 1 and 2. From these figures it is readily apparent that all rigid molecules are on one line (for example, those of the noble gases, methane and benzene), while the flexible ones are on separate lines. The cycloalkanes occupy an intermediate position. This is in excellent agreement with the view that restricted rotation is an important factor. It can also be seen that

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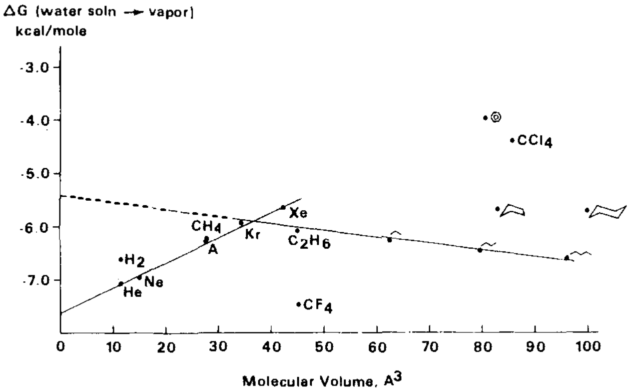

Figure 2.

this factor plays a role both in water and in octanol. In the latter case, however, it is less significant.

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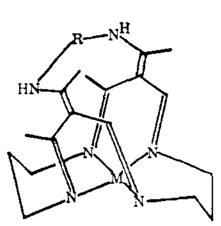
Received July 11, 1978

Totally Synthetic Heme Protein Models Based on Complexes with Superstructure Ligands

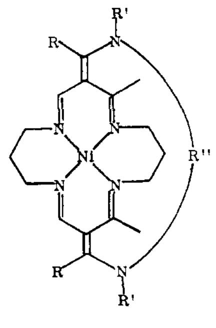
Sir:

Heme proteins perform many functions and yet all contain an iron porphyrin prosthetic group. The main part of the ligand field varies only slightly from species to species while the function varies greatly. Thus the protein is of similar importance to the heme in determining the specific function of the heme protein. We are concerned with the design and synthesis of complexes whose ligands have appropriate superstructures[1] to facilitate their emulation of various protein complexes.

Structure I summarizes a new family of superstructure complexes containing bicyclic ligands,[2] which might facilitate a variety of functions. However, we concentrate here on providing a single protected site, a "dry cave", near one of the metal coordination positions (structure II). Many different bridge groups can be built into the structure, including $-(CH_2)_n$ (n = 3-7), m- and p-xylyl, durenyl, substituted anthracenes, and groups containing heteroatoms. The bridge group is most important in determining the size and shape of the cavity. The groups R bracket the entrance to the dry cave and influence both its size and accessibility. To date R can be H-, CH_3-, $CH_3(CH_2)_n$-, i-C_3H_7-, or C_6H_5-. The group R′ affects the electron density at the metal ion.



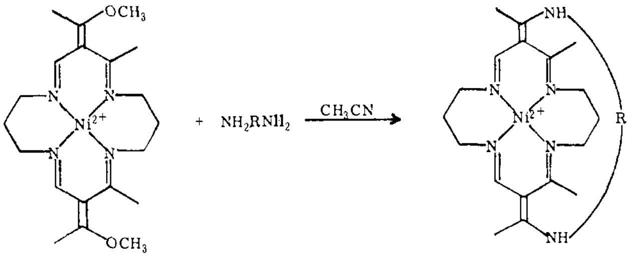
(II)



(I)

These studies are inspired by the elegant porphyrin chemistry of Professors Baldwin,[3] Collman,[4] Traylor,[5] and Battersby[6] and their associates. We see two advantages to the new substances reported here. Since these totally synthetic species involve ligand structures that are different from the porphyrins, the reproducing of natural function with them cannot be construed as deriving from the natural prosthetic group. Also, it is quite easy to vary components of these new structures so that the effects of a range of structural parameters are readily studied.

The synthetic strategy for the preparation of I is based on an unusual intermediate (structure III, eq 1). The vinyl carbon atom to which the methoxy group is attached readily undergoes addition–elimination reactions; the functional group is closely analogous to an ester group. Amines are excellent nucleophiles for this reagent and the stable products resemble carboxylic amides in their chemical properties. From the crystal structure,[7] III has a saddle shape (similar to structure II) and the two vinyl functions react with diamines under conditions of modest dilution forming I in high yield, usually >60%.



(III) (1)

The preparation of 2,11,20,26-tetramethyl-3,10,14,-18,21,25-hexaazatricyclo[10.7.7.$2^{5,8}$]octacosa-1,5,7,11,-13,18,20,25,27-nonaene(N_4)nickel(II) hexafluorophosphate, {Ni[p-xylyl(NHEthi)$_2$Me$_2$[16]tetraeneN$_4$]}$(PF_6)_2$, proceeded as indicated in eq 1. α,α'-Diamino-p-xylene was prepared by the Gabriel synthesis.[8] The diamine (1.1 g, 8.1 mmol) dissolved in 500 mL of acetonitrile was added dropwise to 5.72 g (8.1 mmol) of {Ni[(MeOEthi)$_2$Me$_2$[16]tetraeneN$_4$]}$(PF_6)_2$ (III) dissolved in 500 mL of acetonitrile. The color changed from yellow–green to orange upon addition of the diamine. The solution was reduced in volume to 30 mL and then passed through a column (4-cm diameter, 15-cm length) packed with alumina under acetonitrile. The solvent was evaporated and methanol (200 ml) was added. The yellow crystalline product was isolated by filtration: yield, 3.6 g (57%). Anal. Calcd for $NiC_{26}H_{36}N_6P_2F_{12}$: C, 39.97; H, 4.65; N, 10.76. Found: C, 39.74; H, 4.70; N, 10.64.

The nickel(II) complex having a p-xylyl bridging group (R″) (R = CH_3 and R′ = H), $(NiN_6C_{26}H_{36})(PF_6)_2$, was subjected to complete X-ray structure determination: space group, $Pmn2_1$; $a = 11.621$ (5), $b = 8.471$ (2), $c = 16.117$ (4) Å; $\alpha = \beta = \gamma = 90.00°$; $Z = 2$; $\lambda_{MoK\bar{\alpha}} = 0.71069$ Å; $T = 20$ (1) °C; $\mu = 10.78\ cm^{-1}$; $\rho_{obsd} = 1.61$ (2), $\rho_{calcd} = 1.63$; $\omega = 2\theta$ scan technique for all reflections of positive hkl having $2\theta \leqslant 65°$; 2505 independent reflections of which 2255 had intensities $>3\sigma(F)$ above background. The solution was by the heavy-atom Patterson technique and standard Fourier and least-squares methods were used in refinement. The disorder in one PF_6^- ion was satisfactorily treated by refining the coordinates, orientations, and occupancy factors of three rigid, partial-occupancy PF_6^- groups. Hydrogen atom contributions were included in the least-squares calculations. The final disagreement indices are $R = 0.055$, $R_w = 0.099$, and GOF = 3.2.

The most striking features relate to the configuration and

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