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Novel Metalloporphyrins Possessing Biomimetic Function

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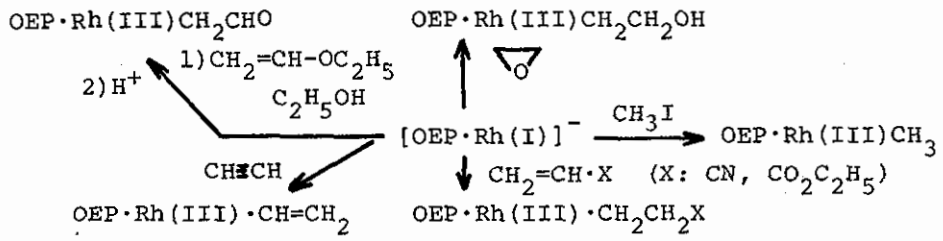
One of the most exciting area in heterocyclic chemistry seems to be bioorganic approach to naturally occurring porphyrins and related compounds for elucidation of the relationship between structure and function. In this Symposium, our investigation on model compounds for biological porphyrins and related compounds and novel syntheses of heterocyclic compounds related porphyrins will be presented.

1. Rhodium porphyrin complexes as a model of Vitamine B_{12}.

The complexes of octaethylporphyrin (OEP) with rhodium in its various oxidation state should be attractive model to elucidate the reaction behavior of vitamine B_{12} considering both sizes of metal and cavity in the tetrapyrrole ring. OEP was found to react with $[Rh(CO)_2Cl]_2$ to give at first $OEP[Rh_2(CO)_4Cl]$, then $OEP[Rh_2(CO)_4]$ and finally $OEP\cdot Rh(III)\cdot Cl\cdot OH_2$. The compound, $OEP\cdot Rh(III)\cdot Cl\cdot OH_2$ easily reacts with CH_3Li to give $OEP\cdot Rh(III)\cdot CH_3$ corresponding to methylcobalamine. It is to note that $OEP\cdot Rh(III)\cdot CH_3$ is obtained by the reaction of $N\text{-}CH_3OEP$ with $[Rh(CO)_2Cl]_2$ under the mild condition. When $OEP\cdot Rh(III)\cdot Cl\cdot OH_2$ is treated with $NaBH_4$ in alcoholic alkaline

solution, $[OEP\cdot Rh(I)]^-$ is readily formed, which is found to be very similar to Vitamine B_{12s} in its reaction behavior as shown in Scheme 1.



Scheme 1

Interestingly $[OEP\cdot Rh(I)]^-$ reacts with quadricyclane and [4.1.0.$0^{2,7}$]tricyclopentane in stereospecific manner.

2. Iron porphyrin complexes as hemoprotein models.

Very recently there have been independently reported the syntheses of the bridged porphyrins from Battersby's, Baldwin's and our laboratories as model ligands for the hemoproteins such as myoglobin and hemoglobin. Main purpose to construct the bridged structure is to prevent the irreversible oxidation of the oxygenated ferrous porphyrin due to dimeric interaction. Hydrophobic pocket in the hemoproteins of the vertebrates plays an important role in the reversible oxygenation during the respiratory cycle. We have synthesized cyclophane porphyrins possessing the various length of the bridge ($-CH_2CH_2CONH(CH_2)_n-NHCOCH_2CH_2-$) and investigated structure (effect of the size of the bridge) and function of their ferrous complexes.

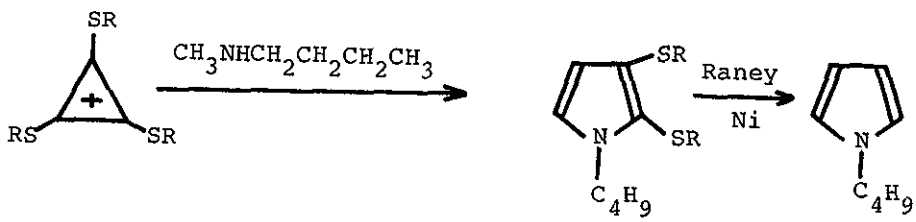
These bridged porphyrins have been prepared by adding

diamines ($H_2N(CH_2)_nNH_2$, n=6, 7, 8, 9, 10, 12) to a mixture of 1,2,5,6-tetraethyl-3,7-dimethyl-4,8-bis(2-carboxyethyl) porphin, isobutyl chroloformate and triethylamine using high dilution technique. The cobalt(II) complex of bridged porphyrin (n=12) in the presence of benzimidazole (axial ligand) showed reversible oxygen binding property at room temperature. The structure and properties related to oxygen binding of the ferrous complexes of bridged porphyrins will also be discussed. The iron porphyrin complexes as model for cytochrome P-450 and intermediate for biodehalogenation have been prepared and their properties have been investigated.

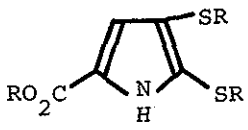
3. Novel syntheses of heterocyclic compounds (related porphyrins).

The key compounds in synthesis of porphyrin are pyrroles. We have been extensively investigated physical and chemical properties of our "hetero-substituted cyclopropenium ions". And very recently we succeeded in preparing various heterocycles including pyrroles from thiocyclopropenium ion.

For example trithiocyclopropenium ion reacted with secondary amine to give pyrrole derivative in good yield.



Even in the reaction with primary amine such as $H_2NCH_2CO_2R$, pyrrole derivative (1) was obtained. These pyrrole derivatives should be applied to porphyrin (especially ETIO type) synthesis. This ring expansion reaction of thiocyclopropenium ion can be successfully extended to one step synthesis of pyrazole-, isoxazole-, pyridine- and pyrimidine-rings.



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