

NEW BOOKS

W. L. F. Armarego

STEREOCHEMISTRY OF HETEROCYCLIC COMPOUNDS.

PART 1. NITROGEN HETEROCYCLES*

Reviewed by A. N. Kost

The methods of conformational analysis have already become classical for carbocycles, but they cannot always be applied to heterocyclic models, in which the unshared pairs of p electrons of the heteroatoms make a substantial contribution, the angles between the atoms are somewhat different, and inversion occurs with a different energy barrier. The most valuable pathways for the development of the modern stereochemistry of organic substances today are found precisely in the chemistry of heterocyclic compounds, which have richer and more diverse possibilities than the analogous carbocyclic models.

The Australian chemist W. L. F. Armarego, who is a specialist in the application of nuclear magnetic resonance, has directed primary attention in his book to the *cis-trans* isomerism and conformations of heterocyclic molecules. Problems involving the optical activity of the compounds are dealt with only where necessary. The book is intended for synthetic chemists and is constructed with respect to the classes of organic compounds. The author does not make excessive use of his knowledge of NMR spectroscopy. On the contrary, he perhaps does not use it enough, in that he allows himself only to say something regarding the fact that a given model was established by an NMR method. However, anyone who wishes to doubt the substantiality of the conclusions can readily find the original paper, which the author cites, to examine the experimental details and the accuracy of the calculations.

The material discussed directly in the book pertains to publications over the period 1960-1974, although individual papers published in 1975 are also used. The author has selected material that is most important to organic chemistry and therefore has used virtually no examples from the chemistry of natural compounds.

The first 130 pages of the text deal with three-, four-, and five-membered structures with one or two nitrogen atoms in the ring (the bibliography contains 696 citations). In this and subsequent chapters the author initially presents general data on synthetic methods (mainly ring-formation reactions); he then successively examines the configurations and conformations, after which he turns to ring-opening reactions and ring-substitution reactions. Consequently, in the case of aziridones we find the stereochemistry of the addition of nitrenes to carbon-carbon double bonds, the synthesis of aziridines from oximes by the action of a Grignard reagent or lithium aluminum hydride or by thermolysis of triazolines, and photochemical transformations that lead to the formation of a three-membered ring. The section on configurations and conformations concentrates on the problem of restriction of free inversion at the nitrogen atom of 1-substituted aziridines. The author here cites S. J. Brois and R. G. Kostyanovskii but does not cite S. A. Giller.

The material on reactions with opening of a three-membered ring, including reactions with ring expansion, was well selected. Diazirines are also discussed briefly. Azetidines, i.e., four-membered rings, have been relatively adequately studied in connection with the chemistry of penicillin; in this research primarily lactams were studied. Lactams are discussed briefly but effectively in the book. There is also a small section on structures with two nitrogen atoms. A significantly larger amount of space has been allocated to five-membered rings; here the reader will find the stereochemistry of the formation of the pyrrolidine ring in the Löffler or Michael synthesis, as well as various skeletal rearrangements leading to the formation of the pyrrolidine ring. The sections on spiropyrrolodines, chiral pyrroles (dipyrrolyls with restricted mutual rotation of the rings because of ortho, ortho substitution), and other analogs of diphenic acids) are interesting. Material on per-

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hydroindoles, perhydroisoindoles, the conformations of substituted indoles, dihydroindoles (including thermochromic spirans of the indole type), carbazoles, etc., is presented in the same chapter. The stereochemistry of pyrazolines and pyrazolidines, which has been studied intensively in recent years in connection with the fact that violations of the Huisgen concept of the specificity of cycloaddition have been observed in this sector and Woodward's concepts regarding the retention of molecular orbitals have been successfully realized, is singled out in an independent paragraph.

The major portion of the book (with a bibliography of 820 citations) deals with the stereochemistry of six-membered rings. Principal attention in it is, of course, directed to the stereochemistry of piperidines. The material on the stereospecific synthesis of rings was rather successfully chosen. The author states the problems involved in chirality, particularly optical activity; however, he does not deal in detail with the problems involved in the induction of optical activity. This section is of value for Soviet readers in view of the fact that the high school of students and co-workers of I. N. Nazarov have been for many years engaged in research on the chemistry of piperidols and piperidones.

The sections on hydrogenated pyrazines and pyrimidines are brief but sufficiently informative, although the exposition here is in the nature of a formal enumeration of data from individual papers. Perhydropyrindines are given even shorter shrift, although the problem of the stereochemistry of the fusion of a five-membered ring with a six-membered ring has become an extremely nonstandard problem in recent years and deserves more serious attention. The section on tetrahydroquinolines appears to be a set of examples of compounds whose side chains have an asymmetric carbon atom. The subsection on perhydroquinolines, in which the problems involved in the stereospecificity of ring closing, configurations, and conformations are examined logically, is considerably more successful. Similar material is given for hydrogenated isoquinolines; an interesting paragraph is devoted to the stereospecificity of ring opening and other chemical transformations of stereoisomeric substances. In the same chapter the reader will find information on the stereochemistry of azatwistanes (this is important in view of the growing interest of chemists in carcass structures), hydrogenated naphthyridines, the corresponding phthalazines, quinazolines, quinoxalines, and some other nitrogen heterorings, for example, perhydrophenanthridines. The photochemistry of six-membered rings, including the formation of skeletons of the "bird cage" type on the basis of an olefinic bond, is singled out.

The stereochemistry of compounds in which the heteroring is a completely aromatic structure is touched upon only in individual cases, primarily analogs of diphenic acids and some substances with a side chain having an asymmetric carbon atom.

The last chapter on compounds with seven or more atoms in the ring (with a bibliography containing 571 citations) includes not only azepines, diazepines, azocines, and diazocines but also azacyclophanes and, with some violation of the general logic of the construction of the book, bicyclic compounds with a bridged nitrogen atom. This chapter deals with pyrrolizidines, indolizidines, quinolizidines, and other azabicycloalkanes, including tropanes. The reader will also find a brief reference to the stereochemistry of Tröger's base, propellanes, and carcass structures of the azabullvalene type and molecules similar to it. The author examines the stereochemistry of the seven- and eight-membered rings primarily from the point of view of the conformations of azepines or azocines, while paying less attention to their hydrogenated analogs. The brief summary of azacyclophanes is interesting.

The reader will not find data on the stereochemistry of complexes, including charge-transfer complexes or heteroatomic analogs of ferrocene, in this book; however, the book is interesting and useful within the limits selected by the author. It may be a valuable manual for many chemists engaged in research involving the synthesis or establishment of the structures of organic substances.