# Advances in Heterocyclic Chemistry

## Volume 102

# *Advances in*
# HETEROCYCLIC CHEMISTRY

VOLUME **102**

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# PREFACE TO VOLUME 102

Volume 102 of our Advances commences with the next of our continuing surveys of the "The Literature of Heterocyclic Chemistry, Part X, 2005–2007" this one covering reviews published in the period 2005–2007, again authored by Professor L.I. Belen'kii and his colleagues V.N. Gramenitskaya and Yu.B. Evdokimenkova all affiliated with the Zelinsky Institute of Organic Chemistry.

A comprehensive treatment of the "Friedländer Annulation in the Synthesis of Azaheterocyclic Compounds" has been provided by M. Shiri and Z. Tanbakouchian (Alzahra University, Tehran, Iran), M.A. Zolfigol (Bu-Ali Sina University, Hamedan, Iran), and H.G. Kruger (University of KwaZulu-Natal, Durban, South Africa); it details the wide variety of heterocyclic systems available with this methodology.

This volume closes with another contribution by A.P. Sadimenko (University of Fort Hare, Alice, South Africa) in his ongoing series covering "Organometallic Complexes of Heterocycles." The present chapter deals with "Organometallic Complexes of Aminopyridines" of which a very large number have been described with highly diverse structures and important applications in a variety of areas.

Alan R. Katritzky
Gainesville, Florida

# CONTENTS

CHAPTER 1

# The Literature of Heterocyclic Chemistry, Part X, 2005–2007

**L.I. Belen'kii[a], V.N. Gramenitskaya[a] and Yu.B. Evdokimenkova[b]**

Contents



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## 1. INTRODUCTION

This survey is a sequel to nine already published survey's in *Advances in Heterocyclic Chemistry* (66AHC(7)225, 79AHC(25)303, 88AHC(44)269, 92AHC(55)31, 98AHC(71)291, 99AHC(73)295, 01AHC(79)199, 04AHC (87)1, 06AHC(92)145). It includes monographs and reviews published during the period 2005–2007 as well as some published earlier but omitted in Part IX.

Like Parts III–IX, this survey is based partly on bibliographic papers published by the authors in *Khimiya Geterotsiklicheskikh Soedinenii* since 2006 (09KGS466, 09KGS939, 09KGS1107). Sources not only in English but also in Russian, Japanese, Chinese, Czech, and other languages are surveyed and classified. This feature of the survey should cause no problem because some of the sources are available in English translations and practically all others have informative English abstracts as well as quite understandable and useful schemes and lists of references. As before, carbohydrates are not covered. Such compounds are mentioned only in general cases (e.g., anomeric effect) as well as when carbohydrates serve as starting compounds for the synthesis of other heterocycles or they are present as fragments of a complex system including another heterocyclic moiety such as nucleosides.

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# 2. GENERAL SOURCES AND TOPICS

## 2.1 General books and reviews

### 2.1.1 Textbooks and handbooks

Synthesis and properties of heteroaromatic compounds: 05MI1.

### 2.1.2 Annual reports

#### 2.1.2.1 Comprehensive reports

07PHC1, 08PHC1, 09PHC1.

#### 2.1.2.2 Specialized reports devoted to basic series of heterocycles

Three-membered heterocycles: 07PHC55, 07PHC81, 08PHC70, 09PHC47.
Four-membered heterocycles: 07PHC106, 08PHC92, 09PHC74.
Pyrrole and its benzo derivatives: 07PHC150, 08PHC135, 09PHC122.
Furan and its benzo derivatives: 07PHC187, 08PHC176, 09PHC152.
Thiophenes, selenophenes, and tellurophenes: 07PHC126, 08PHC112, 09PHC94.
Five-membered heterocycles with more than one N atom: 07PHC218, 08PHC208, 09PHC190.
Five-membered heterocycles with N and S (Se) atoms: 07PHC247, 08PHC242, 09PHC220.
Five-membered heterocycles with O and S (Se, Te) atoms: 07PHC276, 08PHC277, 09PHC253.
Five-membered heterocycles with O and N atoms: 07PHC288, 08PHC288, 09PHC265.
Pyridine and its benzo derivatives: 07PHC310, 08PHC314, 09PHC289.
Diazines and their benzo derivatives: 08PHC353, 08PHC383, 09PHC333.
Triazines, tetrazines, and fused polyaza-systems: 07PHC371, 08PHC414, 05PHC337.
Six-membered heterocycles with O and/or S atoms: 07PHC376, 09PHC365, 09PHC399.
Seven-membered heterocycles: 07PHC402, 08PHC437, 09PHC432.
Heterocycles with eight-membered and large rings: 07PHC430, 08PHC465, 09PHC459.

#### 2.1.2.3 Reports devoted to individual problems

Annual survey of organometallic metal cluster chemistry for the year 2003: 05CCR(249)2763.
Transition metals in organic synthesis, highlights for the year 2003: 06CCR(250)300.
Transition metals in organic synthesis, highlights for the year 2004: 06CCR(250)2411.
Bioinspired organic chemistry: 06AR(B)377.
Catalysis (particularly, the use of ionic liquids in catalysis): 06AR(B)325.
Chemical genetics: 06AR(B)138.
Computational organic chemistry: 06AR(B)219.

Heterocyclic chemistry: 06AR(B)81.
Highlights of natural product synthesis (2004, 2005): 06AR(B)98.
Marine natural products: 06AR(B)123.
Mechanisms of radical and radical ion reactions: 06AR(B)247.
*N*-Heterocyclic carbenes in transition metal and organic catalysis: 06AR(B)168.
Oxidation and reduction methods: 06AR(B)34.
Recent developments in palladium-catalyzed heterocycle synthesis and functionalization: 05COC625.
Supramolecular chemistry (molecular recognition, structure and assembly, and functional systems): 06AR(B)148.
TEMPO (2,2,6,6-tetramethylpiperidine-*N*-oxyl) as an important reagent in alcohol oxidation and its application in synthesis of natural products between 2000 and 2004: 06MRO155.

### 2.1.3 Nomenclature

IUPAC nomenclature (general monograph): 04MI1.

### 2.1.4 History of heterocyclic chemistry, biographies

Heterocyclic chemistry in Moscow State University: 05KGS31.
History of aromaticity (heteroaromaticity) concept: 05CRV3436.
The history of Woodward–Doering/Rabe–Kindler total synthesis of quinine: 07AG(E)1378.
Input of Prof. K. C. Nicolaou in chemical biology and medicinal chemistry: 05JMC5613.

### 2.1.5 Bibliography of monographs and reviews

The literature of heterocyclic chemistry, 2002–2004: 06AHC(92)145.
Specialized surveys: 09KGS466, 09KGS939, 09KGS1107.

## 2.2 General topics by reaction type

We have classified the many reviews dealing with these materials under the following headings:

1. *General Sources and Topics.*
2. *Structure and Stereochemistry (it is self-subdivided into Theoretical Aspects, Stereochemical Aspects, Betaines and Other Unusual Structures, Miscellaneous Substituted Heterocycles).*
3. *Reactivity (General Topics: Reactions with Electrophiles and Oxidants, Reactions with Nucleophiles and Reducing Agents, Reactions Toward Free Radicals, Carbenes, etc., Reactions with Cyclic Transition State, Reactivity of Substituents, Heterocycles as Intermediates in Organic Synthesis).*
4. *Syntheses (General Topics and Nonconventional Synthetic Methodologies, Synthetic Strategies and Individual Methods, Versatile Synthons and Specific*

*Reagents, Ring Synthesis from Nonheterocyclic Compounds, Syntheses by Transformation of Heterocycles).*

5. *Properties and Applications (Dyes and Intermediates, Substances with Luminescent and Related Properties, Organic Conductors, Coordination Compounds, Polymers, Ionic Liquids, Miscellaneous).*

### 2.2.1 General sources and topics

All-metal aromaticity and antiaromaticity of inorganic heterocycles: 05CRV3716.

Anion receptors: 05H(66)689.

Conjugated polymers (particularly, polythiophene, polypyrrole, and polyfuran) and aromaticity: 05CRV3448.

Estimating aromatic stabilization energies, particularly, in heterocycles: 05CRV3773.

From macrocyclic oligo-acetylenes to aromatic ring carbomers, pericyclynes and hetero-pericyclynes: 06CRV5317.

The influence of different main group elements on relative stability of valence isomers: 07BCJ1241.

Interactions C–F. . .H, F. . .F, C–F. . .$\pi$ in crystalline compounds including fluorine heterocycles: 05CSR22.

Intervalence charge transfer in trinuclear and tetranuclear Fe, Ru, and Os complexes with heterocyclic ligands: 06CRV2270.

Liquid chromatography – mass spectrometry: 03MI1.

Locking self-assembly of supramolecular structures possessing heterocyclic fragments: 07CSR856.

Memory of chirality and asymmetric synthesis: 05S1.

Modern HPLC: 06MI8.

Molecular recognition of oxoanions based on guanidinium receptors: 07CSR198.

Nucleus-independent chemical shifts (NICS) as an aromaticity (heteroaromaticity) criterion: 05CRV3842.

Palladium-catalyzed dynamic kinetic asymmetric allylic alkylation with the DPPBA ligands: 07AA59.

Principles of environmental chemistry (general monograph): 05MI9.

Recent advances in heterolytic nucleofugal, particularly, heterocyclic leaving groups: 07T5103.

Recent progress in stable radical chemistry (including heterocyclic radicals and radicals with heterocyclic substituents): 07OBS1321.

Tautomeric equilibria in relation to $\pi$-electron delocalization (particularly, tautomerism of heteroaromatic compounds): 05CRV3561.

Spherical aromaticity of fullerenes, polyhedral boranes, and related structures including heterofullerenes: 05CRV3613.

## 2.2.2 Structure and stereochemistry

### 2.2.2.1 Theoretical aspects

H-Bond-assembled supramolecular architectures of fullerenes functionalized by various heterocyclic fragments: 07CJO153.

Planar tetracoordinate carbon and fenestranes, in particular, azafenestranes: 06CRV4787.

Supramolecular chemistry in water (noncovalent interactions with participation of heterocycles): 07AG(E)2366.

Supramolecular species bearing quaternary azaaromatic moieties: 06H (68)1467.

### 2.2.2.2 Molecular dimensions

Atomic resolution crystallography of proteins and X-ray absorption fine structure studies of metalloproteins: 05CCR197.

Bioactive conformations, and structure–activity relationship of taxol and its analogs: 05ZOR329. Configuration, conformation, reactivity, and applications of hexahydropyrrolo[2,3-b]indoles in synthesis: 07ACR151.

Conformationally constrained peptide nucleic acid (PNA) analogs and DNA/RNA binding selectivity: 05ACR404.

Conformationally locked nucleotides and their analogs: 06Y681.

Coordination modes of 5-pyrazolones (X-ray diffraction data): 07CCR1561.

Effect of preferential conformations on base properties and thermodynamics of conformation conversion along with type of ring fusion on *cis–trans* conversion of bicycle in pyrrolizidines: 06KGS1443.

Metalloproteins three-dimensional structure determination using multiple-scattering analysis of X-ray absorption fine structure: 05CCR(249)141.

Rules to predict the conformational behavior of saturated seven-membered heterocycles: 05ARK(6)88.

Structural (X-ray) properties of homoleptic, mononuclear transition metal complexes of 1,2-dioxolenes: 06CCR(250)2000.

X-ray structural chemistry of cobalamins: 06CCR(250)1332.

### 2.2.2.3 Stereochemical aspects

Asymmetric domino reactions based on the use of chiral auxiliaries: 06T1619.

Asymmetric domino reactions based on the use of chiral catalysts and biocatalysts: 06T2143.

Asymmetric organocatalysis (general monograph): 05MI13.

Asymmetric organocatalysis of Diels–Alder, [3 + 2] and [4 + 3] cycloaddition reactions: 05Y464.

Asymmetric catalysis by chiral hydrogen-bond donors, particularly, by proline and alkaloids: 06AG(E)1520.

Asymmetric heterogeneous catalysis (heterocycles as catalysts, starting compounds and products): 06AG(E)4732.
Catalytic enantioselective construction of all-carbon quaternary stereocenters: 06S369.
Crystallization-induced diastereomer transformations: 06CRV2711.
Dynamic stereochemical rearrangements in chiral organometallic complexes with heterocyclic ligands: 07CSR551.
Efficiency in nonenzymatic kinetic resolution of chiral heterocycles: 05AG (E)3974.
Enantioselective organocatalysis (general monograph): 07MI3.
Exciting supramolecular architectures: Light-induced processes and synthetic transformations in noncovalent assemblies: 05EJO4041.
Lewis acid–base bifunctional asymmetric catalysis, particularly, in the Reissert reaction: 05SL1491.
One-pot synthesis of fused aromatics, particularly, those with diazapentaphene skeleton possessing helical chirality and assignment of absolute configuration assisted by theoretical circular dichroism: 05Y798.
Principles and recent applications of chiral auxiliaries: 06S1899.
Structure of fullerenes and fullereno-annulated heterocycles; problem of fullerene chirality: 06CRV5049.
Synthesis and the potential of thiaheterohelicenes: 06OBC2518.
Use of chiral sulfoxides as chiral auxiliaries in asymmetric synthesis of bioactive products: 06T5559.

#### 2.2.2.4 Betaines and other unusual structures

Azafulvenium methides chemistry: 06ARK(7)89.
The chemistry of functionalized *N*-heterocyclic carbenes: 07CSR592.
Development of organic photochromic radical compounds: 07CJO696.
Formation of [5,6]- and [6,6]-open fulleroide structures, particularly, fullerenoheterocycles: 07UK768.
Synthesis and properties of cationic $\pi$-conjugated systems stabilized by bicyclo[2.2.2]octene units including annulated silatropilium ion, thiophene, 1,2-dithiine, 1,4-dithiine, and oligothiophenes: 05SL187.
Synthesis and properties of molecular rods containing heterocyclic fragments: 05CRV1197.

#### 2.2.2.5 Miscellaneous substituted heterocycles

Chemistry of arene- and hetarene-based hydrazonoalkanenitriles: 07H(71)2545.
Fluorinated ethers, thioethers, and amines, derivatives of heterocycles: 05CRV827.
Heterofullerenes: 06CRV5191.
Persulfurated aromatic compounds including hetarenes: 06AG(E)1686.
Products of [2 + 3] cycloaddition to [60] fullerene: 05CJO159.

### 2.2.3 Reactivity

#### 2.2.3.1 General topics

Activation of heteroaromatics by metal sulfonate catalysts in C–C bond forming reactions: 06Y752.

Alkynylation of chiral alkoxy-, amino-, and thio-substituted hetarencarbaldehydes: 06CRV2355.

Anion binding involving π-acidic heteroaromatic rings: 07ACR435.

Baylis–Hillman reactions in nontraditional media (water, ionic liquids, supercritical $CO_2$): 07CJO322.

Baylis–Hillman reaction in synthetic chemistry (particularly, cyclic amines as catalysts): 07CSR1581.

Carbonylation of heterocycles by homogeneous catalysts: 07CC657.

Chemistry of *N*-(1-haloalkyl)azinium halides: 07ARK(3)96.

Cycloacylation of thioamides and their derivatives by compounds with activated multiple bond: 07KGS1283.

Homologation of heterocycles by a sequential reductive opening lithiation–electrophilic substitution–cyclization: 06AHC(91)135.

Electrochemical fluorination of heterocyclic compounds: 06AHC(90)239.

Microwave irradiation for accelerating reactions of three- to five-membered heterocycles: 05AHC(88)1.

Microwave acceleration of reactions of six-, seven-membered, spiro and fused heterocycles: 06AHC(90)1.

Modern Pummerer-type reactions including those concerning heterocycles: 06T5003.

Proton-coupled electron transfer: 07CRV5004.

Recent advances in intermolecular direct arylation reactions of heterocycles and arenes: 07AA35.

Some aspects of the Willgerodt–Kindler reaction and connected reactions: 05H(65)411.

Templated photoreactions (including reactions of heterocycles) in homogeneous solutions: 06CRV5413.

Water as a reagent in regio- and stereoselective reactions including syntheses of heterocycles and ring opening of epoxides: 05Y18.

#### 2.2.3.2 Reactions with electrophiles and oxidants

Advances in singlet oxygen chemistry including photooxidation of five-membered heteroaromatics with one and two heteroatoms: 05T6665.

Electrophilic reactions of aromatic and heteroaromatic compounds in ionic liquids: 06ZOR1761.

Photooxygenation of heterocycles: 05COC109.

Use of solid catalysts in Friedel–Crafts acylation reactions, particularly, in acylation of heterocycles: 06CRV1077.

Uses of sodium chlorite and sodium bromate in oxidation of heterocycles, particularly, to give lactones: 06OPP177.

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