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Journal of Organometallic Chemistry 656 (2002) 305–306

**Journal
of Organo
metallic
Chemistry**

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Book review

Phosphorus–Carbon Heterocyclic Chemistry: The Rise of A New Domain

Edited by F. Mathey, Elsevier, Amsterdam, 2001. ISBN 0-08-043952-7; pp. x+846; Euro 290.00; US\$ 290.00 (hbk.)

Following the Elsevier publication of *Comprehensive Heterocyclic Chemistry II* about 5 years ago, it became apparent that important advances in the field of phosphorus heterocyclic chemistry warranted their extensive updating and collecting within a single volume. This has now been achieved by the appearance of the above text under the editorship of François Mathey, himself a major contributor to the rapid development of this area of chemistry. He has assembled an impressive array of reviewers who are themselves active practitioners and authorities in the field, and the result is a very pleasing and informative overview of this fascinating area of phosphorus chemistry. The literature is covered up to 1999.

The book consists of seven sections. Following an introduction by the editor entitled ‘The birth of a new domain’, which succinctly highlights some of the topics to be developed, there are discussions of 3-, 4-, 5- and 6-membered ring systems followed by macro-, poly- and spiro-heterocycles and the application of phosphorus heterocycles in homogeneous catalysis.

François Mathey and Manfred Regitz give an authoritative account of phosphiranes and phosphirenes, with a detailed coverage of synthetic, reactivity, structural and theoretical aspects of these remarkable 3-membered ring compounds. The phosphirenium cation, which is the simplest aromatic 2π -system, is also discussed. The coverage of the structurally related diphosphiranes and diphosphirenes by Guita Etemad-Moghadam and Max Koenig, shows how much the field has progressed since the seminal work of Marianne Baudler on diphosphiranes. A variety of synthetic approaches now provide access to these types of compound, whose chemical reactivity is dominated by a ring-opening reaction involving P–P bond breaking.

Following an introductory chapter by Angela Marinetti and Duncan Carmichael on the early studies of the 4-membered phosphetane ring system in the period up to 1982, Takayuki Kawashima and Renji Okazaki give a detailed account of 4-membered rings containing one phosphorus atom, i.e. phosphetanes, phosphetenes and phosphetes (phosphacyclobutadienes). Here the empha-

sis is on synthesis, structural, theoretical, thermodynamics, reactivity and coordination aspects, including much useful tabulated data.

The extension of these types of 4-membered ring system to those containing two phosphorus atoms typified by diphosphetanes, dihydrodiphosphetes and diphosphetes is discussed by Martin Hofmann and Ulrich Zenneck. The useful role of phospho-alkynes in the generation of some of these types of compound is evident from the detailed coverage presented, as is the variety of their ligating behaviour towards transition metals.

5-Membered phospholane and phospholene ring systems are described by Terry Kee, with particular emphasis not just on their synthesis and reactivity, but also on their optically active derivatives and their application in catalysis. Useful tabulations of data from these types of reaction are presented and structural features are also discussed.

The vast area of phosphole chemistry warrants two separate chapters. The first, by Louis Quin, covers the earlier published work, from 1953 to 1994, and in the second Louis and his wife Gyöngyi Quin cover the literature to mid-1999. These chapters are, as is to be expected, written in an authoritative manner, by authors with a deep knowledge of their subject. Other relevant articles in this important area of heterocyclic phosphorus chemistry are also cited and the tabulated data are very useful alongside the descriptive text. Metal complexes of the corresponding phospholide anions are also included in the discussion.

The chapter on heterophospholes, by Alfred Schmidpeter, which is also extremely well written, shows the wide variety of novel ring systems that result by the incorporation of one, two, three or four or more heteroatoms into the phosphole ring system and the resulting effect on their chemistry. Topics covered include aza-, oxa-, thia-, seleno- and telluro-derivatives. The chapter also discusses diphospholes and triphospholes with one or two additional heteroatoms and finally oligophospholes, diphospho-arsoles and diphospho-stiboles. The coverage also embraces the corresponding anionic ring systems and their metal complexes and gives an excellent insight into this fast growing area.

6-Membered ring systems are dealt with in three separate contributions by Michael Gallagher (phosphinanes, dihydro- and tetrahydro-phosphinines); (Pascal le Floch (phosphinines) and Gottfried Märkl and Peter Kreitmeyer (6-membered rings with two or more het-

eroatoms with at least one or two P atoms). Compounds containing P^{III} or P^V oxidation states are discussed together in Gallagher's chapter, the emphasis being on synthesis, reactivity, structure and stereochemistry. The progress in phosphinine chemistry since the landmark publication by Märkl in 1966, can be well judged by the excellent chapter by le Floch. Following a detailed discussion of the theoretical aspects of these novel ring systems and structural and thermodynamic aspects, there are sections on synthetic and reactivity studies and future developments are pointed to in the description of polydentate and macrocyclic derivatives. The recently established catalytic potential of phosphinine rhodium complexes, for example in the hydroformylation of alkenes, is also covered. Aza-phosphinines, diaza-phosphinines, triaza-phosphinines, diphosphinines, aza-diphosphinines, triaza-diphosphinines, triphosphinines, diaza-triphosphinines, tetra-phosphinines, oxa-phosphinines, dioxa-phosphinines, and their structural and aromatic character, are highlighted in the article by Märkl and Kreitmeier, the former being a major contributor to this area. The variety of synthetic strategies in the development of this area and the obvious potential for further exciting developments are particularly well described.

A number of interesting topics are well-presented in the Chapter entitled 'Macro- and Spiro-heterocycles' by Michael Pabel and Bruce Wild, which addresses (a) 6- 7- and 8-membered rings containing phosphorus, (b) a variety of rings with two or more heteroatoms and (c) bicyclic systems with a bridgehead phosphorus, typified by calixarene phosphites and related compounds and phosphatranes. The article gives a good summary of the huge variety of cyclic compounds of unusual structural types in which phosphorus can participate.

In his two Chapters concerned with 'Bi-cyclic and poly-cyclic systems', John Tebby addresses the role of phosphorus at a ring junction, and discusses 'Com-

pounds with phosphorus at the spiro position'. He gives an in depth account of the wide range of structural types of compound that are now available and the role of spectroscopic techniques used in their structural elucidation.

In the final chapter of the book, the editor, François Mathey, gives an important summary of the applications of phosphorus heterocycles in homogeneous catalysis. In addition to the use of phosphiranes, phosphetanes, phospholanes, phospholenes, phospholes and polycyclic and macrocyclic phosphines, he draws attention to very promising recent developments involving di-coordinate phosphorus heterocycles such as phosphinines and phospho-metallocenes, where recent publications strongly suggest the likelihood of new exciting developments.

Both the editor and the publishers of *Phosphorus-Carbon Heterocyclic Chemistry: The Rise of A New Domain*, are to be congratulated on an attractively produced, timely and well-written account of an important area of contemporary phosphorus chemistry. The chronological listing of the individual references makes it easy to get an historical perspective of the development of the subject. The book is sure to be the standard reference for several years. However, the price of almost 300 Euros will perhaps make it more likely to be purchased by libraries than by individuals.

On a lighter note, the computer-generated author index can give rise to some curious entries, the most striking being those for U. Bergsträsser who makes no fewer than five separate appearances!

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