

DRAGO GRDENIĆ

The third Recipient of the Božo Težak Medal of the Croatian Chemical Society



At the age of eighteen, after finishing secondary school (1937), Drago Grdenić enrolled in the Faculty of Philosophy of the University of Zagreb. He chose chemistry and physics as major courses and, together with these, also mathematics, physical chemistry, mineralogy and meteorology with climatology, which at that time were compulsory subjects for the education of secondary – school teachers. The extensive programme of physics concurred with his aspiration for a more complete picture of material world, for knowledge of chemical as well as physical properties of matter. This desire guided him during his studies as well as in his scientific and teaching activity. However, Grdenić's chemistry was never physical chemistry. Chemistry and physics were for him two aspects of matter; applied together they provide a better, more complete picture of matter. Very often, he told us this idea in several ways.

From this point of view and with such an approach, he wrote his *Molecules and Crystals – an introduction to structural chemistry* (1973), a book accepted by students of all Yugoslav universities, which recently appeared in its fourth edition (1989). In the chapters on atomic radii, interatomic distances, crystal structure and molecular stereochemistry, he put forward his own long experience not only as a teacher, but also as a scientist. X-ray diffraction on crystals prompted him to measure interatomic distances, to determine – together with his numerous co-workers – the crystal structure of a number of, predominantly, mercury compounds.

Chances often play a decisive role in a man's life. Mercury played such a role in Grdenić's life under the extraordinary war-time circumstances. In the early 1942, Professor Tomislav Pinter (1899–1980) from the Chemistry Department of the Faculty of Medicine in Zagreb proposed to him to investigate how mercury was bonded in mercury acetamide. Diazomethane, the first reagent chosen by Grdenić for that purpose, made free acetamide and bound itself with mercury into an unknown yellow compound, extremely explosive at the slightest touch. Soon afterwards, Grdenić left Zagreb to join Tito's partisans. It was only after the war that he determined the composition of this, his first compound, as HgCN_2 and assumed polymeric mercurated diazomethane, $-\text{Hg}-\text{C}(\text{N}_2)-$, since at that time he was already aware that the mercury-carbon double bond was to be ruled out. He still keeps a tentative version of a paper about this finding that he has never published. Prepared from mercury acetate at the University of Marburg (1971), this compound was described in the same way. However, as far as the structure of mercury acetamide is concerned, we determined it together (1969) by establishing its symmetrical molecule.

After the war, Grdenić had an opportunity of continuing his study in Moscow. It was then that mercury again played its crucial role: he was kindly invited by Professor A. N. Nesmeyanov, the world-known organo-mercuric chemist and Director of the Institute of Organic Chemistry

of the Academy of Sciences, at the time one of the best equipped Soviet scientific institutions, to join his research group. The two academic years (1946–48) of study and research were decisive for Grdenić's scientific career. His desire to work on molecular structure using physical methods was promptly met by Professor Nesmeyanov; so Grdenić became a co-worker to Professor A. I. Kitaigorodsky, head of the X-Ray Laboratory.

The first two scientific papers on the crystal structure of diphenyl mercury and alkyl mercury halogenides can hardly be a measure of all the knowledge and experience that Grdenić brought with him and laid into the foundations of our X-ray structure analysis. After his return to Zagreb, as early as New Year's Eve 1948, Grdenić made the first X-ray photograph of a rotating crystal in this country. In two years, the first crystal structure was solved by the Fourier electron density projection calculated by using Beevers-Lipson strips: mercury diethylene oxide got a new formula and Grdenić his Ph. D. degree (1951) at the University of Zagreb. This very first molecular structure solved in this country by X-ray analysis was determined by the heavy atom method. Only a year later, D. Grdenić together with A. Bezjak, using the Patterson synthesis solved the structure of phthalyl urea, $C_9H_6O_3$, a compound composed only of light atoms. Unfortunately, at that time, our organic chemists did not pay due attention to such achievements and did not show any interest in modern methods of structure determination.

At the Ruder Bošković Institute (RBI), in the foundation of which he took part, Grdenić could realize his plans of modern inorganic chemistry in this country. The first Weissenberg goniometer, "Acta Crystallographica" from its first volume, new books, accessories and chemicals, young and enthusiastic co-workers — all that contributed to the speedy attainment of the European scientific level in the field then unknown in Croatia. And, moreover, access to the science of the West was opened.

In Paris, he attended the IIIrd Congress of the International Union for Crystallography (1954); it was the first Congress in which Grdenić participated. Afterwards, he spent a short but fruitful period for postdoctoral research in Oxford (1955–56) with Professor Dorothy C. Hodgkin (Nobel prize for chemistry in 1964).

There, he was engaged in attempts to solve the structure of bacterial pigment feroverdin, got acquainted with outstanding British scientists, their laboratories and methods of research. He brought the newly acquired knowledge and experience to Zagreb, to his department of Structural and Inorganic Chemistry at the RBI and to his Laboratory of General and Inorganic Chemistry at the Faculty of Science, which he had founded (1952) and conducted for thirty years, as Assistant Professor (1952), Associate Professor (1956) and Full Professor (1960).

As one of Grdenić's co-workers at the RBI since 1956, I also had the opportunity to spend two years (1964/65 and 1971/72) in the Oxford Laboratory of Dorothy C. Hodgkin. That was the time when new techniques and computational methods in structural analysis were introduced and when it was no longer possible to do any research without the use of computers. In his endeavour to organize research at European scientific level, Grdenić succeeded in providing (1972) a four-circle automatic diffractometer for the University Institute of Inorganic and Analytical Chemistry, at that time a successful institution established by three Zagreb faculties. Grdenić founded and headed that Institute from the beginning to its forced suspension. We, younger co-workers kept contacts with foreign crystallographic centres, provided new software, introduced direct methods for solving crystal structure and, under Grdenić's guidance, determined quite a number of crystal and molecular structures.

In his endeavour to keep up with the European level and maintain a fruitful scientific collaboration with foreign scientists, Grdenić together with us younger crystallographers founded the Yugoslav Centre of Crystallography (1966) under the auspices of the Yugoslav Academy of Sciences and Arts in Zagreb. He had been its President until this year, when he resigned and was elected Honorary President.

In the extensive issue of *Croatica Chemica Acta* 57 (1984), No. 4, which I edited as guest editor on the occasion of Grdenić's 65th birthday and which contained contributions of a num-

ber of scientists from eleven countries, Dorothy C. Hodgkin presented Grdenić's activity and, among other tributes, said the following: "... he has built up a flourishing department of Inorganic chemistry in Zagreb, specialising in crystallography and in solution of many problems in the stereochemistry of metals, and particularly, of mercury Zagreb has been a scientific home for crystallographers from all over the world through his presence."

Of the numerous Grdenić's scientific results published in his eighty papers, let me point out some of permanent value. In mercury chemistry these are: (i) discovery of the alkylmercury oxonium (1957) and sulphonium (1958) ions, species to be considered later by the scientists investigating bacterial methylation of mercury; (ii) rules for the effective coordination of mercury in mercury compounds, based on its characteristic coordination, covalent and van der Waals radii. These results were published in the review *The Structural Chemistry of Mercury*, *Quart. Rev.* **19** (1965), and are frequently cited in the literature; then, in the section on the crystal chemistry of mercury of the *Handbook of Geochemistry*, II, 1 (1969), and in another contribution entitled *Connections in the Crystal Structures of Mercury Compounds* (1981) in the book dedicated to Dorothy C. Hodgkin; (iii) the discovery of permercurated methane, such as tetrakis(acetatomercurio)methane and its derivatives (1974), to which I also contributed. In this exciting investigation we determined permercurated methane, that is, four mercury atoms bonded to one carbon atom; (iv) permercurated acetaldehyde and acetic acid and the actual formula of their derivatives, such as mercuretine (1982–87).

In non-mercury chemistry: (v) Archimedean antiprism as a coordination polyhedron in the acetylacetonates of zirconium, cerium, thorium and uranium (1958); (vi) confirmation of the Sidgwick-Powell rule in the structure of tin(II) compounds, which was my first structural investigation with Grdenić (1960–61). The same rule was confirmed for antimony in the structure of stibnite, in collaboration with S. Ščavničar (1960).

Grdenić is still actively engaged in mercury chemistry and may take us by surprise with some additional discovery. He has returned to synthetic chemistry, which he always considered to be the basis of chemistry, since — as he used to say jokingly — chemistry appeared when the man made a matter that had not existed in nature before.

For over 30 years, Grdenić has lectured a one-semester fourth-year course on the History of Chemistry. At the beginning, it was his hobby but later on it became his second speciality, as he often likes to say. His contributions to the history of chemical education at the University of Zagreb, in particular his fairly extensive paper on the *Chemical Education at Universities in the Nineteenth Century* (1977) shows that he is an excellent connoisseur of the development of chemistry at the University. A real masterpiece is the critical edition of an old chemical work from the phlogiston period — the *Physical Treatise on the Genesis, Nature, and Utility of Factitious Air* written in Latin by the Zagreb citizen J. F. Domin (1784), which Grdenić prepared with a splendid and extensive commentary. Today, retired (1985) he uses his free time to write a book on the history of chemistry.

Let me also mention two additional, less known Grdenić's contributions: a review article (in Croatian) entitled *Origin of the Organic Matter and Life on the Earth* on the basis of which he had once intended to undertake some experiments. The other contribution is *Joseph Needham as Historian of Science and Sinologue*, a preface to the Croatian edition (1984) of Needham's book *The Grand Titration, Science and Society in East and West*. In this preface Grdenić acquainted the Yugoslav reader with Needham's capital work on science in China, to which he frequently refers in studying the history of protochemistry.

Grdenić's scientific and teaching activities were recognized by many awards and prizes. Among these, the Republican Prize Ruder Bošković (1961), which he most appreciates, and the Republican Prize for Life Achievement (1985). He is a member of the following Yugoslav Academies of Sciences and Arts: the Yugoslav Academy in Zagreb (1973), the Academy of Bosnia and Herzegovina in Sarajevo (1975), the Slovene Academy in Ljubljana (1977), the Serbian Academy in Belgrade (1985). He has been Rector of the University of Zagreb (1976–79),

President of the Croatian Chemical Society (1970–72), and honorary member of the Croatian Society for Natural Sciences and an honorary senior advisor of the Ruder Bošković Institute (1980).

The Croatian Chemical Society Božo Težak Medal, the recent recognition awarded to D. Grdenić, was a good opportunity and occasion for me to write about Drago Grdenić. In the ceremonial part of the annual meeting, held on 28 June 1990, after receiving the Medal from Professor Z. Maksić, President of the Society, D. Grdenić gave a lecture antititled *Why Mercury?* Unfortunately, I did not attend the lecture because I was away as a Visiting Professor at Massey University, Palmerston North, in New Zealand, but I was told that the lecture had been enthusiastically received.

After Linus Pauling (1988) and Vladimir Prelog (1989), Drago Grdenić is the third recipient of this high award. He has deserved it in recognition for his merits and his devoted service to chemical science.

B. KAMENAR

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