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DRAGO GRDENIĆ – *Curriculum Vitae*

Professor Drago Grdenić was born in Križevci on August 31, 1919 to his father Radovan, an agronomist, and his mother Marinka née Zuber. Križevci is a town 60 km northeast of Zagreb that played a significant role in Croatian history. In 1944 Grdenić married Milka née Buljević. They have three daughters (Branka, Nevenka and Mira), five granddaughters and one grandson. Drago Grdenić had a younger brother Vlado (1921–2001), an economist with a passionate hobby of fruit-growing, while Drago Grdenić is very proud of their small garden and orchard surrounding their cottage in Baška on the island Krk. As a county agronomist, Drago's father was often shifted from one place to another, so that Drago Grdenić attended primary and secondary schools in many different places, such as Ludbreg, Lepoglava, Varaždin, Velika Gorica, Gospić and Zagreb.

As the past cannot be changed, this Grdenić's CV is only slightly extended and updated in comparison to the one I published on the occasion when he was awarded the "Božo Težak" Medal of the Croatian Chemical Society (*Croat. Chem. Acta*, **63** (1990) C19–C26).

Finishing secondary school at the age of eighteen (1937), Drago Grdenić enrolled in the Faculty of Philosophy of the University of Zagreb, choosing chemistry and physics as his majors together with courses in mathematics, mineralogy, and meteorology with climatology. The extensive programme of physics and the lectures given by Professor Stanko Hondl (1873–1971) concurred with his aspiration for a more complete picture of the material world, for knowledge of the chemical as well as physical properties of matter. This desire guided him during his studies as well as in his scientific and teaching activities. However, Grdenić's chemistry was never physical chemistry. Chemistry and physics were for him two aspects of matter, and applied together they provide a better, more complete picture of matter. Very often, he presented 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 read by students at all universities in the former Yugoslavia. Its fifth renewed and completed edition appeared in 2005. In the chapters on atomic radii, interatomic distances, crystal structure and molecular stereochemistry, he put forth his long experience not only as a teacher, but also as a scientist. X-ray diffraction prompted him to measure interatomic distances, to determine – together with his numerous co-workers – the crystal structure of a number of predominantly mercury compounds.

Chance often plays a decisive role in a man's life. Mercury played such a role in Grdenić's life under extraordinary war-time circumstances. In early 1942, Professor Tomislav Pinter (1899–1980) from the Chemistry Department of the Faculty of Medicine in Zagreb proposed that he 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, -Hg-C(N_2)-, since 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, we determined it together (1969) by establishing its symmetrical molecule.

After the Second World War, Grdenić had an opportunity of continuing his studies 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. These 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 approved 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 Beevers-Lipson strips: mercury diethylene oxide received 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 phtalyl 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 Ruđer 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 a 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 3rd Congress of the International Union of Crystallography (1954); it was the first Congress in which Grdenić participated. Afterwards, he spent a short but fruitful period of 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 the bacterial pigment ferroverdin, became 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 headed for thirty years, as Assistant Professor (1952), Associate Professor (1956) and Full Professor (1960).

As one of Grdenić's co-worker 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 structure 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 a 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 in contact 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 maintain a European level and maintain a fruitful scientific collaboration with foreign scientists, Grdenić together with us younger crystallographers in 1966 founded the Yugoslav Centre of Crystallography (today the Croatian Crystallographic Association) under the auspices of the Yugoslav (today Croatian) Academy of Sciences and Arts in Zagreb. He was its President until 1990, 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 by a number of scientists from eleven countries, Dorothy C. Hodgkin outlined 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 scientific results in his eighty papers, let me point out some of permanent value. In mercury chemistry these are: (i) the 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, that is, four mercury atoms bonded to one carbon atom; (iv) permercurated acetal-

dehyde 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. Šćavničar (1960). The validity of this rule was proven by us also in the structure of racemic *Tartar emetic* – potassium antimonyl tartrate (1970).

Drago Grdenić was in love with crystallography but always passionately engaged in preparing new, sometimes surprising, compounds. Synthetic chemistry he always considered to be the basis of chemistry, since – as he used to say jokingly – chemistry appeared when man made a matter that had not existed in nature before. I think this is the reason for his persistency in writing a new book on *Inorganic Chemistry*.

For over 30 years, Grdenić has lectured a one-semester fourth-year course on the History of Chemistry. At the beginning, it was a 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 *Chemical Education at Universities in the Nineteenth Century* (1977), show that he is an excellent connoisseur of the development of chemistry at the University. One real masterpiece is the critical edition of an early 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. His interest in the history of chemistry was finally crowned by a monumental piece of work – a book on the *History of Chemistry* (2001). As far as I know this book is one of the best ever written on this subject. It has been translated in Slovenian (2007) and I hope its English edition will appear in the near future.

Let me also mention two additional, less known contributions by Grdenić: a review article (in Croatian) entitled *Origin of Organic Matter and Life on Earth* (1966), on the basis of which he had once intended to undertake some experiments. The other contribution is *Joseph Needham as a 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 our readers with Needham's capital work on science in China, to which he frequently refers in studying the history of protochemistry.

Also, for many years Grdenić often surprised us with articles popularizing scientific topics of general interest. They were usually published in a popular Croatian journal, *Priroda*, of which Grdenić was once Editor-in-Chief (1945 and 1949–1958).

Grdenić's scientific and teaching activities were recognized by many awards and prizes, the Croatian Prize "Ruđer Bošković" (1961), which he most appreciates, the Croatian Prize for Life Achievement (1985), Federal Prize AVNOJ (1988), and the "Božo Težak" Medal of the Croatian Chemical Society. He is a member of the following Academies of Sciences and Arts: the Croatian Academy in Zagreb (1973), the Academy of Bosnia and Herzegovina in Sarajevo (1975), the Slovene Academy in Ljubljana (1977). He has been Rector of the University of Zagreb (1976–79), President of the Croatian Chemical Society (1970–72), and an honorary member of the Croatian Society for Natural Sciences, and an honorary senior advisor of the Ruđer Bošković Institute (1980).

Boris Kamenar