ISSN 1070-4280, Russian Journal of Organic Chemistry, 2015, Vol. 51, No. 12, pp. 1820–1822. © Pleiades Publishing, Ltd., 2015.
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DISCUSSIONS

Intergenerational Continuity as a Key Factor for Efficient Development of Organic Chemistry and Metal Complex Catalysis in Russia

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Received May 3, 2015

DOI: 10.1134/S1070428015120350

Reading the article "The Reasons Organic Chemistry is Needed for in a Well Developed Country" by I.P. Beletskaya and V.P. Ananikov [1] has not left us, young scientists of one of the leading universities of Russia, indifferent to the problems raised by eminent experts in the field of organic synthesis and metal complex catalysis. This publication reflects the achievements of synthetic organic chemistry and its importance for Russian society and world civilization, as well as pressing problems hindering the active development of this scientific branch in Russia at the moment. The authors rightly point out that the prospects for the development of organic synthesis in our country are directly dependent on which of the current undergraduate and graduate students will work for the benefit of science and society and will continue the work initiated by A.M. Butlerov, N.D. Zelinskii, A.N. Nesmeyanov, and other outstanding Russian chemists. The authors [1] pay particular attention to the problems of young people in science, emphasizing their sincere concern for the fate of Russian chemistry and the urgent need for a strong effort to obtain positive results in the coming years. It is very important for us, young researchers working in the field of organic synthesis and wishing to continue our favorite and interesting work, to hear words of support from our teachers, the leading Russian synthetic chemists.

It is difficult to overestimate the role and place of organic chemistry in the modern world. The current civilization is inconceivable without the use of chemical products. Undoubtedly, there is a huge chasm between the synthesis of a new compound or discovery of new reactions and the creation of finished production technology, and construction of a bridge across that chasm requires joint efforts of chemists, engineers, and technologists. However, we should never forget what underlies the creation of things and objects that we use every day. Organic chemistry has provided foundation for the chemistry of organometallic compounds, polymer chemistry, materials science, and chemistry of physiologically active substances and medicines. In recent time, these directions have attracted more researchers' attention in comparison with the classical organic chemistry, primarily due to their proximity to the actual practical application. Nevertheless, one should not forget on what they are based and what lies in their origins. Of course, this is organic chemistry! Modern methods of macromolecular chemistry oriented to the preparation of polymeric materials with desired properties and characteristics are based on well-known organic reactions applied to the synthesis of macromolecules. These include a variety of coupling reactions [2], various click chemistry methods [3], metathesis [4], radical addition reactions [5], nucleophilic substitution, etc. These reactions underlie both building up of macromolecular skeleton and subsequent polymeranalogous reactions leading to the formation of desired products. All new innovative materials, which are frequently spoken about in recent years, made up of macromolecules prepared by the above described methods. As concerns modern biotechnologies and chemistry of physiologically active substances, they are also fully based on organic reactions. Metal complex catalysis underlying important industrial processes has grown from organic chemistry and is still inseparably linked with it. Metal complex catalysts allow various transformations of organic compounds to be performed with a high speed and quantitative yields. In turn, organic chemistry creates

new ligands for the development of more efficient catalysts. These processes and compounds had once been discovered by organic chemists and subsequently put into practice by them or their followers. Thus, the study of organic chemistry and the development of new methods and reactions are a kind of investment in the future, in new technologies and innovative materials.

Analysis of the history of world science shows that many discoveries that have received recognition in the form of later Nobel prizes and other prestigious awards were made by the authors at a young age, often at the beginning of their scientific career. It is no secret that the bulk of the research is done by hands of postgraduate students, undergraduates, and graduate students. It is clear that the effectiveness of the development of science is directly related to the activity of young researchers, as well as to their interest and motivation to engage in research and to continue working in the scientific field. Therefore, support for young synthetic chemists is a necessary condition for the further development of organic chemistry in our country.

It is obvious that one of the problems faced by young researchers is the lack of stable funding and material support of their research work. It should be noted that an appreciable shift to the better has recently appeared in this direction. First of all, it includes grants to young scientists in the framework of the Russian Foundation for Basic Research and the Russian Science Foundation, as well as projects sponsored by the Russian Ministry of Education and Science and by the Council for Grants at the President of the Russian Federation. At the same time, to obtain funding for these projects, the applicant should have a certain, usually quite significant scientific basis in the form of published articles and victories in various competitions. Synthetic research aimed at obtaining new compounds is a complex process that not always and not immediately leads to expected results. It may take a very long time to obtain data suitable for publication in high-impact journals. Obviously, under such circumstances, success of a young scientist will largely depend on the position of the supervisor, who often has to take care that the pupil had scientific articles early in his career.

Undoubtedly, publications and grants are a necessary condition for scientific growth of a young scientist and stimulation of research activity. However, even if someone wants to engage in some research and adequate funding is available, there are a number of infrastructure problems hindering active work on approved projects. The first of these is related to irregular flow of funds and the need to spend them within a calendar year. Because of the budget financing specificity, means to support the project often come closer to the middle of the year, but they should be spent and financial and scientific reports should be provided by the end of November. Therefore, the formal term of the project is reduced from one year to half, and it becomes even shorter taking into account that this half includes hot summer months when working with a number of organic substances is unsafe. Such a schedule of revenues impacts on the distribution of wages over months of the year, which is inconvenient from the standpoint of social protection of young people, which, of course, need to have regular and stable wages.

Another problem, which is constantly faced by researchers working in the field of synthetic organic chemistry, is the lack of necessary reagents and the complexity of their delivery. In Western countries, a required material is available from the manufacturer in a few days, whereas in Russian realities reagent supply at the best extends to several weeks or even months. The need for a variety of competitions, tenders, and auctions for the purchase makes this problem even more difficult. The above factors taken together constitute a very serious constraint to research works and delay their implementation or even force to abandon relevant experiments. Thus, the lack of efficient reagent supply in Russian universities and scientific organizations is also one of the reasons why active and talented young people often prefer to work abroad rather than continue to study in Russia.

One more infrastructure problem is related to poor availability of modern analytical equipment in Russian research centers. Nowadays, almost all analytical equipment used by synthetic chemists is manufactured abroad, and its cost is very high, especially in view of the recent sharp fall in ruble. For this reason, not all centers have necessary equipment, and not all researchers can use it to solve problems related to the synthetic process.

The lack of necessary reagents at proper time can often be compensated by synthesizing them with one's own hands. Sometimes, this process takes much less time than the long wait for delivery from abroad. However, the number of qualified professionals able to carry out complex multistep syntheses in our country decreases every year. We are talking about older synthetic professionals who began their formation and career during the Soviet years. Unfortunately, the

situation in Russia in 1990s resulted in the fact that the scientific community lost middle-aged specialists mastered the skills of synthetic work and able to pass them to the younger generation of chemists. Many Soviet synthetic schools, previously known worldwide, virtually ceased to exist. There is a large age gap between the older generation and young researchers in a number of laboratories due to the fact that young people did not continue working in the scientific sector in 1990s. It is obvious to organic chemists that success in carrying out a particular synthesis often relies on subtleties and nuances that are often not described in the experimental procedures. Organic synthesis is a great art that is inherited from teacher to student and can easily be lost if the connection between generations is interrupted. Therefore, it is essential for us, young researchers, to have time to learn from the invaluable wealth of experience in synthetic work from their mentors, save it, and multiply for the glory of the Russian chemical science.

The authors thank the Council for Grants at the President of the Russian Federation for support of research (project no. MK-7578.2015.3).

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