Russian Thermophysiology Today

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The deep political, economical, and social reforms taking place in the former USSR, the collapse of the communist regime, and the sudden fall of the Russian Empire, occupying one-sixth of the surface of the Earth, are attracting the attention of people all over the world. In addition to general curiosity about current events in the new Commonwealth, the international scientific community has manifested a keen interest in specific information concerning Russian science and Russian scientists [see, for example, the recent publications in *Science* and *Nature* (1, 3, 4, 12, 15, 19, 23)]. There are several reasons for such a particular interest.

1. After they became no longer insulated from the rest of the world, Russian laboratories opened to cooperation. Their special features—scientific (recognized expertise of Russian scientists in some field, e.g., laser physics, nonlinear dynamic mathematics, and cosmic exploration; good experience in the study of some unique subjects, such as endemic diseases or rare species of animals; accumulated experimental data still unpublished for various reasons in the international scientific literature); geographic (location of the laboratories in different climatic zones, at different altitudes, etc.); economic (access to a wide spectrum of natural compound, cheap labor)—are attractive potentials for foreign investigators interested in working in Russian laboratories. However, to use these facilities, foreign scientists need to be informed about them.

2. The scientific community has already faced the fact of a rapid increase in the number of Russian researchers who are working or wishing to work in foreign laboratories. This kind of cooperation might result in significant contributions to the investigations carried out in these laboratories but also—what is even more important—helps to keep a large number of young Russian scientists in research during this critical period in their native country, thus preparing qualified people to conduct investigations in Russia in the future. Better knowledge of the real situation in this or that scientific field in Russia (list of top-rated laboratories, names of the experts, areas of expertise, etc.) could improve the efficiency of this form of cooperation to mutual advantage.

3. The disintegration of the former political, economical, and other institutions in the former USSR has led to critical situations in many fields of social life, including science. Russian science needs help now, and a lot of state and private foundations, scientific institutions, and individuals in Western countries are ready to help (see, e.g., refs. 3, 4, 8, 10, 11, 15, 19). But for this help to be totally effective, Western colleagues should possess much fuller information about Russian science.

The duty of the Soviet scientists now is to provide this information. The situation in neuroscience in the Republic of Georgia was described in a recent issue of *Trends in Neurosciences* (9). "Special Feature" of a recent *Trends in Pharmacological Science* is devoted to some of the contributions of Soviet scientists to pharmacology and toxicology (18). The aim of the present article is to give some ideas about the situation in one field of Soviet physiology, thermophysiology, which may appeal to foreign scientists thinking about helping or cooperating with Russian colleagues.

There are about three dozen laboratories in the Commonwealth in which thermophysiology is the only, or major, field of investigation (it is hardly possible to give a more precise figure because of the confused present political and administrative map of the country, as well as continual reorganizations of scientific institutions). The highest concentration of thermophysiological laboratories is within the European part of the country (St. Petersburg, Moscow, Minsk). Among Asian centers, the best known laboratories are those in Novosibirsk and in the capitals of the three Middle Asian Republics: Kazakhstan, Kirgizstan, and Turkmenistan. Most of the laboratories belong to so-called scientific research institutes included in a system of one or another Academy of Sciences (in former days, they were the academy of Sciences of the USSR, the Academy of Medical Sciences of the USSR, the Academies of Sciences of each Republic of the Soviet Union); the rest belong to universities and institutes (colleges) of various USSR or Republic Ministries. The scientists working in the latter are burdened by a tremendous teaching load of up to 30 hours per week, while in the former, the researchers are usually completely exempt from teaching. During the previous years, scientists working in both scientific research institutes and universities received financial support for their research predominantly (or, more often, exclusively) from the government. Now this centralized system of constant financing is being revised, and it is hardly possible to predict how it will develop in the future.

The scientific staff of Russian thermophysiological centers consists of approximately 300 physiologists, yet only a

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few names are included in the international Directory of Thermal Biologists (21). Among the better internationally known thermophysiologists are V. N. Gourine (Minsk), co-organizer of and active participant in the Regional Thermoregulatory Group (RTG); K. P. Ivanov (St. Petersburg), contributor to the second edition of Glossary of Terms for Thermal Physiology (2) and former member of the Commission for Thermal Physiology of the International Union of Physiological Sciences (IUPS Thermal Physiology Commission); V. S. Koshcheev (Moscow), Yu. V. Lupandin (Petrozavodsk), Yu. F. Pastukhov (St. Petersburg), and V. I. Sobolev (Donetsk). In the field of comparative and ecological thermophysiology, the studies of N. I. Kalabukhov (Astrakhan) and A. D. Slonim (deceased; Novoskibirsk) are familiar to Western colleagues. Slonim was also a member of the IUPS Thermal Physiology Commission and consultant for the first edition of Glossary of Terms for Thermal Physiology (6). A notable presentation of Russian thermophysiology in the international arena was made at the 5th Regular Meeting of the RTG (May 1990, Beichlingen, GDR), in which 18 scientists from the USSR participated. The reports presented at the meeting are summarized in the review (14). The recent national scientific meetings at which the problems of temperature regulation were discussed are reviewed in *Thermophysiology* (24, 25).

During the last four years, research projects carried out in thermophysiological laboratories of the USSR were united in the framework of the program Physiological Mechanisms of Thermoregulation, supervised by both the Academy of Sciences and the Academy of Medical Sciences of the USSR (24). Apart from the coordination of the investigations, the activities of the program included the organization of annual scientific meetings, publication of the bulletin *Thermophysiology*, and others. The head institution of the program Physiological Mechanisms of Thermoregulation is the Institute Physiology of the Byelorussian Academy of Sciences (Minsk), directed by V. N. Gourine. The main research areas of the institute are the role of the autonomic nervous system in temperature regulation and the mechanisms of fever and antipyresis. International connections of the institute include those with thermophysiological centers in Canada, Czechoslovakia, Germany, Hungary, and the United States. In 1988, the institute organized an international symposium on thermoregulation and published its proceedings (13). Three employees of the institute are working now in American and German laboratories.

The entrance of Russian researchers in the competition for positions in Western universities raises certain questions about their general and professional education and expertise. The scientific community of the former Soviet Union, a huge country comprising more than 100 ethnic groups—big and small, speaking different languages, having different cultural traditions, religious beliefs, economic levels, and living standards—is not homogenous. Many of the Soviet scientists who were educated and worked within the communist system have obvious shortcomings well-known to Western colleagues; some of these have already been mentioned (23). However, the image of Russian science is determined by its achievements and its best representatives rather than by its shortcomings and mediocre scientists. "There are some areas of science where the old Soviet Union was a world leader," said L. R. Graham, an expert on Russian science at the Massachusetts Institute of Technology. "There were centers of excellence. If those dry up and disappear, it is a loss not just for Russia and former Soviet republics, but for world civilization" (8). In this paper, we shall use thermophysiology as an example to describe the characteristic features of the best Russian scientists.

Traditionally, education in Russia gives students a good basic knowledge in a wide range of disciplines rather than a narrow specialization. Most thermophysiologists in the USSR have received a medical education that consists of five years of general medical courses (identical for all students), a final year of undergraduate specialization in one of the three primary branches of medicine (internal medicine, surgery, or obstetrics and gynecology), and, usually, three years of postgraduate training in a narrower professional subfield. Substantial parts of the physiological education of Russian researchers today are Pavlov's nervism, Anokhin's functional system theory, and the general adaptation syndrome theory of Selye (whose books have all been translated into Russian and are well known to Russian scientists).

As one of the results of such an education, Russian physiologists have paid much more attention to the whole "forest" rather than to a particular "tree": understanding of the biological and medical meanings of experimental phenomena is considered to be of great importance. It was in Russia that, for example, the ancient idea of the beneficial role of fever was reborn in the 1880s (7), during the time when the "fathers" of thermophysiology—German physicians and physiologists (Liebermeister, Meyer, Brandt)—were united in the opinion of the harmfulness of the febrile process. It is not surprising, therefore, that some of the roots of today's important thermophysiological concepts (e.g., the difference between fever and hyperthermia) may be found in the works of Russian investigators of the previous century (5). The modern Russian handbook on thermoregulation (17) convinces one that these traditions are alive; the basic categories (temperature homeostasis, temperature regulation, homeothermy) and fundamental questions, such as what is regulated and how, are presented at great length.

Another advantage of a "broad" versus "deep" education is the progress achieved by Russian scientists in the border areas between orthodoxically subdivided scientific disciplines. A recent example of such investigations connected with thermophysiology is the work by E. A. Korneva (St. Petersburg), who is internationally recognized as one of the pioneers in neuroimmunomodulation. The traditional thermophysiological studies of endogenous pyrogen in her department evolved into complex investigations of the roles of cy-

tokines in host-defense reactions and the analysis of neuronal and hormonal mechanisms of their regulation. The development of interdisciplinary sciences in the former Soviet Union is also demonstrated by the list of specialities in which PhDs are awarded in Russia but have not yet been identified by US markets (see ref. 16 for examples of these disciplines).

Aside from specialities of education and training, the expertise of Russian thermophysiologists is strongly influenced by the conditions under which scientific work was carried out in the former Soviet Union. Trying to produce reliable scientific results despite poor organization of the work, restricted access to information, and severe lack of supplies and equipment, many researchers had to become true "jacks-of-all-trades" in experimental routine. The 1981 Nobel laureate in chemistry, R. Hoffmann, introducing Soviet scientists immigrated to the United States, advised their potential employers, " . . . [A]sk them to suggest innovations, to invent" (16).

The absence of modern—sophisticated and expensive —tools often forces Russian researchers to look for important scientific questions that might be solved by relatively simple experiments. Such an approach, very similar to that of Selye, allows one (by taking daring steps) if not to obtain the exact answer, at lease to determine the prospective area for further study. The possibility of making a successful scientific analysis of the results obtained by simple methods is a characteristic trait of Russian scientists. It was enough for A. L. Polenov (St. Petersburg), having observed the presence in the organism of large stores of neurosecretory materials, to propose in the early 1960s the hypothesis of the participation of the neurosecretion of the posterior hypophysis in the regulation of a wide spectrum of physiological functions other than diuresis (20). The thermophysiological application of this hypothesis—the discovery of the antipyretic properties of arginine vasopressin—was made 20 years later by Canadian scientists.

Though working under unfavorable conditions, the best Soviet thermophysiologists were able to create highly productive research groups. One of them was P. N. Veselkin (deceased; Leningrad), the author of a fundamental monograph of fever (27). It was in his department that I. S. Repin and A. V. Sorokin (both deceased) worked. The latter is the author of one of the first Soviet books on pyrogens (26). The former is known for investigations on fever mechanisms that were carried out by his group in the 1960s. His article, which describes fever produced by intracentrally injected endogenous pyrogen (22), is one of the most cited, in the West, papers of Soviet thermophysiolgists. As a recognition of his successes, Repin was invited in 1970 to participate in the Ciba Foundation Symposium on Pyrogens and Fever in London. However, as often happened at that time, he was not able to leave the USSR.

Another specific feature of Russian laboratories is that, in the best of them, the traditions, ethical norms, and spirit of Russian intelligence of the 19th century managed to survive. Let me give on example. Preparing to retire, N. I. Kalabukhov, who had, for decades, collected literature on thermoregulation, distributed among Soviet thermophysiologists the catalog of his collection, asking them to mark items of their particular interest. He managed to prolong the active scientific life of his library by sending to dozens of active scientists rare and unique books of their choice.

To complete the portrait of Soviet thermophysiologists, it is, unfortunately, necessary to add that the activities of many of them reflected the shortcomings of the imperfect system of the organization of science under the communist regime rather than the high traditions of Russian researchers. However, the best Russian scientists working in different fields, whether before or after the October coup of 1917, possess the positive features described here. These features are made concrete by Mendeleev's periodic table and Lobachevsky's geometry; the discovery of phygocytosis by Mechnikov and Pavlov's theory of conditioned and unconditioned relaxes; the understanding by Russian physicians of the 1880s of the biological value of fever and the ideas of Russian mathematicians who, in the 1930s, anticipated the theory of chaos; the launching of the first Sputnik and the development of holography; the invention of the surgical staple; and the placing of a human into space for a year. These features give the hope that the "goose" of cooperation with Russian laboratories will some day lay the "golden egg." It is very important now to allow this "golden" hope to materialize.

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The pathophysiological mechanisms proper underlie the development of pathological processes, diseases, and functional disorders. However, the tasks of pathophysiology and clinical physiology intertwine. Therefore cooperation between pathophysiology and clinical physiology is quite natural, important and fruitful.

Presently an ever increasing number of pathophysiological studies are being carried out by specialists of different profiles in various field of biomedical sciences. This trend and an increase in the number of pathophysiological studies are understandable in view of the final goal of biomedical sciences, viz., maintenance and restoration of human health. In this case, all the scientists concerned—the biochemists, biophysicists, physiologists, and others—as well as the clinicians, while studying the disorders of normal processes and trying to correct them, do not suspect that they are becoming pathophysiologists, too.

Paradoxically, pathophysiology of the organs and systems, comprising all the fields of medicine and penetrating into the studies of various profile, seems to merge with and dissolve in them. But this peculiarity only underlines the growing importance of pathophysiology for medicine.

Another phenomenon, characteristic of the development of every science, is clearly seen in modern pathophysiology: differentiation and emergence of new fields and branches—space pathophysiology, ecology and environment pathophysiology, extreme-event pathophysiology, pathophysiology of work and sport, adaption pathophysiology, etc. The misfortunes afflicting the humanity pose before medicine new, ever more serious and urgent problems. Pathophysiology is to play an important role in solving these problems.

In these conditions, of paramount importance become consolidation and unification of the efforts of scientists of various profile throughout the world who are concerned with a wide range of pathophysiological problems.

Therefore, the past Constituent Congress of the International Society for Pathophysiology (ISP) (May 28–June 1, 1991 in Moscow) was of special importance. Discussed at its numerious sections (about 20) and symposia (about 60) were the problems of pathophysiology of cells, organs, and systems, united by one main characteristic of pathophysiology topic: "Dysregulation and Its Correction." The Congress constituted the ISP, which is a society not only of pathophysiologists; it is a society for pathophysiology. This means that it is open to specialists of any profile, experimentalists and clinicians, to all concerned with pathophysiological problems. The Society sections will interact with the corresponding international scientific associations. Such cooperative activities of the Society reflect the peculiaritites of modern pathophysiology as an integrative biomedical science. The International Union of Physiological Sciences (IUPS) has set up and approved in its framework a commission for pathophysiology; the ISP is expected to become an associate member of the IUPS. The ISP will publish the journal *Pathphysiology*. The next congresses will be held in Japan, Finland, and Hungary.

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