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OUTLINE OF THE DEVELOPMENT OF POLISH SCIENCE

One may not speak of Polish science until the twelfth century. There appeared in Poland, at that time, the first historians-annalists, and a certain number of Poles were studying in Italian and French universities. In the thirteenth century, the most outstanding of them remained there as lecturers. So, for instance, Nicolas of Poland, the author of two treatises opposing the official medicine of that time, lived in Montpellier for a good many years, and in Italy a great glory was won by the Silesian Witelo owing to his works in the domain of astronomy, mathematics, and chiefly optics.

A crucial event for the development of Polish science was the foundation of a university in Cracow. It was the second university — after Prague — in Central Europe, since its foundation had been initiated by King Casimir the Great in 1364. After a period of neglect, the Cracow University was renovated in 1400 by King Ladislaus Jagiello, thence its present name: the Jagiellonian University. In the second half of the fifteenth century, it became an important scientific center, especially in the field of astronomy and mathematics, and attracted scores of students from Bohemia, Hungary, Germany and from other countries, so that by the end of the fifteenth century nearly half the students in Cracow originated from outside Poland. The Polish scientists of that time maintained close contacts with foreign universities, and many of them were entrusted with chairs in those universities. Thus, for instance, between 1448 and 1480 the astronomy chair in Bologna University was entrusted to Polish professors seven times. One of them was Marcin Bylica, later on an astrologer of Pope Paul II and organizer of the Hungarian university in Bratislava.

Many Poles were studying abroad, too. So, for instance, Nicolas Copernicus started his studies in Cracow at the close of the fifteenth century and pursued them in some Italian universities. On his return

home, Copernicus worked in solitude in Warmia, the northern province of Poland, mainly in Frombork, away from the major cultural centers, but he maintained regular contacts with the Cracow Academy. In the second half of the sixteenth century, that school was one of those few where lectures based upon the heliocentric theory were conducted for some years (1578—1580), and the astronomical tables of Copernicus had been in use some twenty five years before.

At the turn of the fifteenth and sixteenth centuries, Cracow was also one of the lively centers of humanist thought. It was in Cracow that lived scholars who animated the scientific-literary circles: among others, Philip Buonacorsi-Kallimach, formerly connected with the Roman Academy of Pomponius Letus, and the German humanist Konrad Celtis. In the sixteenth century, the Polish religious reformers, e.g. Jan Łaski, played an important role in the West; the works of Polish humanists, as for instance *De Republica emendanda* by Andrzej Frycz Modrzewski, were translated into various languages; the works of orientalists and geographers were an important source of information about Russia and the Near East; and a keen interest was also aroused by the work of Józef Struśko on the pulse.

But if in the initial period of Renaissance the social, political and cultural development of Poland went on similar lines as that of other European countries, from the middle of the sixteenth century the direction was changed. The Polish bourgeoisie was not as strong as the Western one. It was the gentry which was in power, and it hampered the economic development, directing Poland on the road backward — from Renaissance, humanism and science — back to feudalism, counter-reformation and scholasticism. The Cracow Academy was losing its role as an important scientific center despite the valuable works of some professors. The number of students also decreased. Attempts to organize other universities were unsuccessful; it was only in Zamość that there appeared by the end of the sixteenth century, owing to the patronage of the chancellor Jan Zamoyski, a higher school rallying a group of scholars connected with humanist thought, mainly philologists. After Zamoyski's death, however, this school rapidly declined.

The flood of scholasticism and counter-reformation met with the opposition of Protestant schools and centers for some time. They were active in the rich, mainly German-speaking Pomeranian towns, as Gdańsk and Toruń, as well as under the patronage of wealthy heterodox noblemen and magnates in minor localities. So, for instance, in Leszno, Greater Poland, under the protection of Leszczyńskis (ancestors of Stanisław Leszczyński, King of Poland in the eighteenth century, and later on duke of Lorraine) refuge was found by the Czech Brethren exiled from Bohemia, and among them by the well-known pedagogue Jan Amos Komensky (Comenius). Raków, Little Poland, was the concentra-

tion place of Socinians (Arians, Polish Brethren). Those two centers died away toward the middle of the seventeenth century, and the Socinians, exiled from Poland after the war with Sweden, settled in England and Holland where they played — just as Komensky did — an important role in the formation of social ideas of Locke and of other philosophers in England.

In spite of the general regression, some other scholars active in Poland made a substantial contribution to world science in the seventeenth century. In the thirties and forties of that century, a rather lively scientific center arose in Warsaw around the court of King Władysław the Fourth. Valeriano Magni repeated there the experiments of Torricelli and was first to publish their results, and Titus Livius Burattini constructed models of flying machines and worked out the conception of his friend, professor in Cracow University, Stanisław Pudłowski, noted for his contacts with Galileo, concerning the unification of measures of length on the basis of the length of the second pendulum.

The Gdańsk astronomer Jan Hevelius made such important observations that Halley was sent by the Royal Society to work with him. In military engineering the books by Adam Freytag on fortifications and the *Artis Magnae Artilleriae* by Kazimierz Siemienowicz (published in Amsterdam in 1650) were well known and translated into some Western languages. (Recently the part on rockets of Siemienowicz's book is often quoted as it is there that for the first time the principle and construction of multi-stage rockets was described).

In the eighteenth century, however, the cultural downfall in Poland — just as the economic and political one — became so great that for some first decades of that century Polish science did not practically play any role at all.

A progressive improvement did not begin until the middle of that century, and became more and more marked with the economic development and the attempts at social and political reforms. Warsaw, being the capital of the Polish state since the very end of the sixteenth century, became the main cultural center. A school of Lyceum type, the Collegium Nobilium, founded there in 1740 by Piarists, in opposition to the Jesuits, became a center of interest for natural sciences, wholly neglected at that time in Poland. It was in Warsaw that the magnate family of Załuskis established a library which, after having gathered about four hundred thousand volumes, became one of the greatest in Europe. The literary-scientific circles and periodicals, appearing in that city, popularize the German, English and French ideas of the Age of Enlightenment.

The cultural revival gained momentum after Stanisław August Poniatowski, one of the most cultivated men of his time, ascended the throne in 1764. He prepared the reform of education and of higher

school system realized by the Commission for National Education called to life in 1773. The said Commission may be regarded as the first ministry of education in Europe. Its delegate, the public man and philosopher of great fame, Hugo Kołłątaj, transformed the Cracow Academy, retarded and sticking to scholasticism, into a university of modern type, by reconstructing and developing first of all its departments of exact sciences. At the same time, the Jesuit school existing in Vilna since the end of the sixteenth century was transformed into another scientific center. Only then did Newtonian science begin to be taught in Polish universities.

Polish science, whose contribution to world science was not yet considerable enough, began to gain importance in this country — according to the then popular conception of “useful science”, bound up with economic and social needs. The scientists were thus engaged in exploring the natural resources of Poland, in developing metallurgy; they were writing textbooks, preparing projects of political or juridical reforms, and so on.

The progressive social and cultural movements were, however, too weak and could not prevent Poland from losing its independence in 1795. At first, that fact did not considerably hamper the development of science. The national danger even provided for the unity of efforts towards promoting that development and creating new organizational forms of science.

It was then already in 1800 that the Warsaw Society of Friends of Science came into being. It became — especially under the chairmanship of the illustrious thinker, scientist and public man Stanisław Staszic — an important scientific institution both in the field of social and natural sciences.

The Cracow University had by this time lost its importance, but there flourished the Vilna University whose rector was for good many years the well-known mathematician and astronomer Jan Śniadecki. There arose, as well, higher schools in Warsaw: in 1818 the University, and in 1826, on Staszic's initiative, the Preparatory School to the Polytechnic Institute, the first Polish higher technical educational establishment. In the twenties of the nineteenth century, Warsaw was abundant, too, in periodical literature with scientific trend.

In those three first decades of the nineteenth century, comparatively prosperous despite the loss of independence, Polish science began again, after more than a century, to make its contribution to world science both in the field of natural and social sciences. Thus, for instance, Jędrzej Śniadecki is to be regarded as one of the precursors of present-day biochemistry, and his elder brother, Jan Śniadecki, became famous through his observations of minor planets, just discovered. Within the Slavonic philology, of great importance was the *Dictionary of Polish*

Language by Samuel Bogumił Linde and the philosophical and historical-philosophical works of Kołłątaj and Staszic were creatively developing the ideas of French Enlightenment.

This scientific life, developing rather luxuriantly, was dealt a great blow after the November Insurrection had fallen in 1831. The Tsarist reprisals struck then with full force against the organizational foundations of Polish science. The higher schools of Warsaw and the Vilna University were closed, and the Warsaw Society of Friends of Science dissolved.

At the same time, the only remaining institution of higher learning — the University of Cracow — was vegetating, at first accessible solely to the young students from the miniature Free City of Cracow, and was for some time exposed to Germanization in the fifties of the nineteenth century after Cracow had been annexed by Austria.

A partial revival of scientific centers took place only in the sixties and seventies. As early as 1857, there arose in Warsaw the Medical-Surgical Academy included five years later in a new school of university standing called the Main School. This school did not represent, indeed, a creative research center of great importance, but played a considerable role in the formation of the scientific world outlook, by becoming the cradle of a progressive-liberal trend, subsequently called "Warsaw positivism". The Main School was, however, active just seven years, being transformed in 1869 into a Russian university. A Russian school, as well, was the Polytechnic Institute founded in Warsaw in 1898.

At the end of the nineteenth and at the beginning of the twentieth century, the Polish higher schools existed in the Austrian Partition only. In the seventies, the universities of Cracow and Lvov, as well as the Lvov Institute of Technology were re-polonized. There arose in Cracow, at the same time, the Academy of Learning, a scientific society grouping the Polish scholars from all the Partitions, and thus representing the totality of Polish science. Scientific societies came into being also in other towns: in Poznań, Toruń, and after the 1905 revolution in Warsaw, too. All these institutions had limited possibilities of action, enjoying no assistance on the part of the State and drawing their financial means upon public generosity only. It is after the same manner that was acting in Paris the Polish Society to Exact Sciences in the seventies, and in Warsaw since 1881 the Mianowski Office for Scientific Aid, founded in order to commemorate the rector of the Main School. Both these institutions conducted — in addition to the Academy of Learning — a lively publishing activity, owing to which the Polish scholars were in a position to publish their works, and quite a number of scientific textbooks were, at the same time, edited or translated. There appeared

also, at that time, scientific periodicals and specialistic societies within the particular branches of science.

However, absence or the insufficient number of higher schools, and the political persecutions, resulted in that many thousands of Polish young people were yearly studying in foreign schools — in Russia, France, Switzerland, Belgium, Germany and Austria. Thus, for instance, in one of the outstanding colleges of Petersburg — the Transport Institute — in the seventies, up to forty per cent of the students were Polish. In consequence, among engineers building the Great Siberian Railway one third were Poles. Many Polish scientists, besides, were active in foreign scientific centers, be it because they had no possibility of doing research work in their country, be it because they had emigrated or had been deported after the insurrections of 1830 and 1863.

Many of the scientists in question made an important contribution both to Polish science and to that of the country in which they lived, and many a time to world science, too. Many of them rendered great services about the organization of science in various countries or became famous as civic leaders.

Thus, for instance, the eminent historian Joachim Lelewel, member of the insurrectional government in 1830 and 1831, got fame during his thirty-years' stay in Brussels as a champion of national and social liberation, highly esteemed, among others, by Marx and Engels. Ignacy Domeyko, Adam Mickiewicz's friend since their common studies at the University of Vilna, was chancellor of Santiago University and co-organizer of Chilean science, education and mining. A group of Polish engineers constructed, in the second half of the nineteenth century, the Peruvian network of transport. The chair of chemistry at the University of Bern and that of hydrotechnics at the Zürich Institute of Technology were held by Polish scientists, and the University of Bonn was proud of the scientific center for cytology and morphology of plants, founded by Edward Strasburger. Maria Curie, born Skłodowska, twice the winner of the Nobel prize, organized the Radium Institute in Paris and the French service of radiology during the First World War. Many Poles were professors, and even rectors of universities and other higher schools in Petersburg, Moscow, Kazan or Kharkov. Another group (consisting, among others, of Aleksander Czekanowski, Jan Czerski, Benedykt Dybowski), deported by the Tsarist authorities to the East Siberia after the 1863 insurrection, contributed in a great measure to the exploration of natural resources and of fauna of that region, previously not much explored.

In spite of unfavourable conditions, important research work was being done by Polish scientists in their own country, as well. The University of Cracow became famous in exact sciences owing to the

works of Zygmunt Wróblewski and Karol Olszewski on the liquefaction of gases and to those of Marian Smoluchowski concerning the statistical interpretation of the second principle of thermodynamics and the Brownian movement. One of the principal hypotheses in applied mechanics is named the hypothesis of Huber-Hencky-Miseses, after the names of three professors, of whom the first, Maksymilian Huber, worked in the Lvov Institute of Technology. The professor of that school, Maksymilian Thullie, made a great contribution to the theory of reinforced concrete. Of great importance for the social life of Poland was the research work on history, carried on in Warsaw, Cracow and Lvov. On the international scene, however, a rather great fame was won by the works of Polish linguists in the field of general Indo-European linguistics as well as of Polish dialects. Some of the Polish sociologists (Róża Luksemburg, Ludwik Krzywicki) developed Marxist theory, others — for instance Florian Znamiecki or Bronisław Malinowski who stayed a long time in the United States or England, and Ludwik Gumpłowicz who lectured in Graz — contributed to the formation of modern Anglo-Saxon and German sociology.

All these achievements were subsequently developed in the inter-war period. The return of a great majority of Polish scientists from foreign universities to the already independent country made possible a considerable extension of higher schools in Poland. In Warsaw, during the very war, in 1915, the University was re-established, an Institute of Technology and two other higher schools, an agricultural and a commercial one, were founded. The University of Vilna was revived, there came to life a new school of university standing in Poznań, as well as the Catholic University in Lublin. Cracow received another higher school, next to the University: the Academy of Mining. There arose, too, more than ten scientific institutes — apart from the higher schools. The Cracow Academy of Learning continued its existence as the central scientific institution in Poland; next to it, the Academy of Applied Sciences came into being and a network of specialistic scientific societies, of technical and medical associations became more and more extended.

The material conditions of the development of science were, however, all this time modest. Public assistance to this end was manifestly insufficient, and the industry controlled in a great measure by foreign capital had no interest in creating institutes and industrial laboratories in Poland.

In some domains, first of all in the theoretical ones, Poland's contribution to world science was, for all that, very considerable. The question is here, in particular of mathematics where a Polish school (Zygmunt Janiszewski, Waclaw Sierpiński, Stefan Banach and many others), creatively developing new research trends — the theory of functionals, the theory of sets, topology — came into being. An import-

ant contribution to the foundations of mathematics and mathematical logic was made, among others, by Alfred Tarski. The applied sciences were developing, an important research work was conducted in some divisions of biology, physics and chemistry. The linguists, slavists and sociologists pursued their previous investigations.

This development was brutally interrupted by the war and the Nazi occupation. All the higher schools were closed, a great part of scientists (as, for instance, the totality of professors of the Jagiellonian University) found themselves in concentration camps, and some — among them the most distinguished — were shot.

The research work was, however, continued not only by the scientists who found themselves in exile. Also those remaining in Poland continued their research in their homes and gave conspiratory university courses and seminars.

During the retreat of German troops, all the higher schools of Warsaw and a great part of the remaining ones were completely destroyed, the rest — despoiled. Out of 603 scientific centers existing prior to the war, only three remained intact, 357 were, on the contrary, utterly demolished. Moreover, a great part of archives and libraries were burnt down.

The first years after the liberation were devoted to the reconstruction of the destroyed scientific institutions and to the higher education, discontinued during the war, for the needs of national economy and culture. From the very beginning, however, the reconstruction was connected with the development, which may be evidenced by the fact that the first higher schools put in service still during the hostilities, when only a small part of the country had been liberated, were: the new university in Lublin, next to the Catholic one, and the Warsaw Institute of Technology with a provisional seat in Lublin.

As a result, already in the first academic year after the liberation of the whole country the number of higher schools was superior to that of the prewar period and amounts, now, to 74 with 350 faculties — against 28 schools with 93 faculties in the year 1937/1938. Main emphasis was, moreover, laid on the extension of technological, medical and agricultural schools. Thus, for instance, in place of 6 universities existing before the war, there exist 8 universities at present, and in place of 3 higher technological schools — 16. The number of scientific workers of higher schools rose from 3400 to 17 500, and the number of students from 48 000 to 213 000, that is from 14 to 69 students per 10 000 inhabitants.

In addition to that, a big network of scientific institutes and other centers was created. There exist, now, in Poland 22 institutes and 59 minor scientific centers dependent on the Polish Academy of Science and concerned chiefly with fundamental research, as well as 110 in-

stitutes dependent on various ministries and institutions — these are mainly for industrial, agricultural and medical research. There exists, as well, a large network of scientific societies: 17 general regional and 87 special ones, as well as 19 technical associations grouped in the Main Technical Organization. It may be stated, that, on the whole, the research staff is at least eight times bigger than in the interwar period.

Apart from a further extension of the scientific centers existing before, especially of Warsaw, Cracow and Poznań, there arose new centers of Polish science. Among them, Wrocław got ahead, but in addition to that, new higher schools and scientific institutes came into being in such industrial and seaport towns as, for instance, Łódź, Gdańsk, Szczecin, Gliwice, Częstochowa, Opole, and others.

An important event for Polish science was the Congress of Science in 1951. It determined the tasks and organizational foundations of science; its resolutions, in particular, underlay the creation of the Polish Academy of Sciences in 1952. This institution is not solely an association grouping the most outstanding scholars; it simultaneously directs, as mentioned above, the network of scientific centers and co-ordinates, through the scientific committees active within the particular disciplines, the whole of research work in this country; it does this in collaboration with the Committee of Science and Technology at the Presidium of the Council of Ministers, called into life in 1963 and acting under the chairmanship of a vice-premier.

The great extension of scientific centers and of higher schools could not find its direct expression in an equally great increase of scientific production, both because of difficulties in procuring modern and expensive laboratory equipment, and of the scientific cadres being rather young and in some cases incompletely prepared. Nevertheless, Polish science achieved, after the liberation, excellent results in many domains. With that, its general character was changed. If the even remarkable theoretical accomplishments of the interwar period came to be applied in practice to a slight degree only, one of the most fundamental features of the present-day development of science is the linking of the basic theoretical investigations with those having a direct bearing upon the technological, medicinal or social practice.

Thus, in mathematics, the abstract problems developed in the interwar period (for instance, the topology dealt with by Kazimierz Kuratowski, among others) are being linked with divisions having a direct bearing upon physical and applied sciences. Also in progress are the applications of mathematics, especially in the scientific school of Hugo Steinhaus in Wrocław. The theory and design of electronic computers is well advanced, the evidence of which is the general-purpose computer which was been put in operation in 1958, the first in the socialist countries outside the U.S.S.R.

In physics, apart from theoretical problems, as for instance the general field theory being dealt with by Einstein's collaborator, Leopold Infeld, and his disciples, there develops the experimental physics, in particular nuclear physics, which already in 1958 commanded a cyclotron in Cracow and a reactor in Świerk near Warsaw. The Polish physicists take part, too, in the activities of the United Nuclear Research Institute and are welcome to use its excellent equipment in Dubna, U.S.S.R. On the basis of the investigations in the field of theoretical electronics, there are proceeding technological works on semiconductors, underlying the production of transistor apparatus. The above works are carried on under the guidance of the President of the Polish Academy of Sciences Janusz Groszkowski.

In biological sciences, the botanical and palaeobotanical works of Władysław Szafer are directly bound up with his activities devoted to the protection of nature and of natural resources of Poland. Of great practical importance have also been the works on the groups of blood, conducted in Wrocław by Ludwik Hirszfild (deceased ten years ago).

A leading representative of the Polish philosophy, for some decades, has been Tadeusz Kotarbiński, concentrating, of late years, his particular attention on the problems of praxeology, that is, of the science which is a theoretical basis for the organization of labour. The Marxist trend in philosophy is chiefly represented by Adam Schaff. For some years past, sociology has widely developed, setting itself the task of supplying scientific bases for the solution of practical social problems occurring in the period of socialist construction. Analogous tasks are confronting the economic sciences whose chief representative is Oskar Lange, a planned-economy theoretician of world fame.

Historical sciences have taken a serious step towards a materialist view of the history of Poland; the respective works have found their recapitulation in the voluminous, not yet finished publication *History of Poland*. Great are the achievements of archaeology. The Polish archaeologists conduct their research work in many countries: in Egypt, Syria and Sudan (Kazimierz Michałowski), in the Crimea, in Italy, in Bulgaria, yet the most fruitful excavation works have been, of course, carried out in Poland. They have led to far-reaching changes in the approach to the Slav prehistory, particularly as regards material culture in the Polish territory during prehistoric times, and the rudiments of the formation of Polish statehood. In progress, too, is the formerly neglected history of science and technology.

In recent years, the Polish Academy of Sciences has also made fruitful attempts of complex research requiring the co-operation among specialists of various domains of science. Of such a character have been the works concerning the water resources and the electrification of the

country, the problems of developing the Industrial District of Upper Silesia, the socio-economic problems of regions formerly underdeveloped and now being objects of investment, the complex approach to the problems of contemporary culture, and — lately — the problems relative to science of science. Thus, the complexity of research becomes, apart from its connection with practical problems, another distinctive feature of the present-day Polish science. Both these very features constitute the premises of its further and even more brilliant development.