under consideration. Soapstone, mica, plumbago, asbestos, chromic iron, phosphate of lime, salt, pyrites, etc., had been noted in different localities. Among ornamental stones known to occur, might be mentioned the rare and beautiful mineral lazulite; also malachite, jade, agate, carnelian, chrysoprase, and others. Extensive beds of lignite were found in many places in the great tract of country occupied by the cretaceous and tertiary rocks in the Athabasca-Mackenzie valley and on the coasts and islands of the Arctic Sea; also in tertiary strata at Cumberland Bay, and in Greenland on the opposite side of Davis Strait. On the Moose River were considerable beds of lignite of post-tertiary age. Anthracite of a very pure quality had been found on Long Island in Hudson's Bay. Petroleum rising from the Devonian strata was found through a long stretch of country in the Athabasca-Mackenzie valley. Great quantities of asphalt, resulting from this petroleum, occurred along these rivers and on Great Slave Lake, as well as in various places in the interior. Of the metallic ores, those of iron were very abundant. Inexhaustible quantities of rich manganiferous ironstone exist on the Manitonink Islands, near the east coast of Hudson's Bay. The bedded ore formed the surface over hundreds of square miles, and it was broken up by the frost into pieces of a convenient size for shipping. Valuable deposits of magnetic iron had been found on Athabasca and Knee Lakes, and a thick bed of fine clay-ironstone on the Mattagami River. Capt. Dawson, R.A., had found a vein of crystalline specular iron on Great Slave Lake. Copper ore had been discovered on Hudson's Bay; and the native metal was known to occur in quantities on the Coppermine River, in rocks like those with which it is associated on Lake Superior. Galena was abundant in limestone from Little Whale River to Richmond Gulf, on the Eastmain coast. Zinc, molybdenum, and manganese had also been found on this coast, and antimony in the north. Gold and silver had likewise been detected in veins on the east coast; and alluvial gold had been washed out of the gravel and sand of different streams in the mountainous region west of the lower part of the Mackenzie River. For various reasons, Dr. Bell regarded this region as a highly promising one for the precious metals. The belt of auriferous drift, which crosses the North Saskatchewan at Edmonton, and from which the gold-dust is there washed, may have been brought from this region by ancient glaciers from the valleys of the upper branches of the Liard and Peace Rivers. A number of years ago, Dr. Bell had originated the theory that this gold might have been derived from Huronian rocks to the north-eastward of Edmonton; but he now thought it quite as likely to have had its source in the direction of Cassiar.

THE SCIENTIFIC ACTIVITY OF THE RUSSIAN UNIVERSITIES DURING THE LAST TWENTY-FIVE YEARS.[1]

No endeavor has as yet been made to properly estimate the scientific activity of our universities during the last quarter of a century; and this, I believe, mainly accounts for the sweeping condemnations which make their appearance from time to time, to the effect that our universities are declining, and that the high tide of their scientific activity was long ago passed. Submitting to the judgment of the reader a first feeble attempt of this kind with respect to the development of natural science, including the principles of medicine, I wish expressly to state that the material at my command, while not embracing all accomplished by the universities in the direction of natural science, nevertheless includes every thing essential to point out and prove the most prominent features of the results attained. This, indeed, is the object of the present article. My review excludes the universities at Dorpat and Helsingfors, as they, by their whole constitution, always distinguished themselves from their purely Russian brethren: it also fails to take into account the scientific activity of those members of our academy who are not connected with any Russian university. The material for this sketch has been brought together, not by myself, but by specialists in their respective branches of knowledge, — in physics, by Professor Petrushèfsky; in chemistry, by Professor Menshùtkin; in botany, by Professors Bekètoff, Borodìn, and Gobi; in zoölogy, by Professor Bogdànoff; in geology, by Professor Inostràntseff; in anatomy and physiology, by myself.

If we are to measure the scientific activity of an institution by the degree in which its members participate in the resolution of scientific questions, — and this seems to be the only correct standard, — then the activity of the Russian universities in natural science during the thirty years from 1830 to 1860 cannot be deemed great. Indeed, the number of university professors (with Russian names) engaged in scientific work was small; and these stood almost alone, as it were, hardly exerting any considerable influence over those around them.

There were, of course, many causes for this scarcity and isolation of working-forces; but the principal one, undoubtedly, is to be sought in the general conditions of university life. These conditions logically grew out of the view then accepted as to the object of university-work in regard to the intellectual

[1] Translated and abridged from the Russian of I. SÈCHENOFF, in the *Vestnik Evropy* (European herald) for November, 1883.

life of the country, — a view which, in our time, is no longer held. Even after the middle of this century, universities were looked upon in this country, merely as places for the dissemination of knowledge, where young people were instructed in the higher branches of science. To this end the entire activity of the universities was directed: indeed, the work of the university consisted simply in the delivery of lectures by professors, who undertook to acquaint their hearers with the last results of science, while the students were merely passive recipients. The professors were not required to do real scientific work, which at the present time alone constitutes true learning: such work was left to a select few, and it seldom emerged from the seclusion of the cabinet into close contact with the audience. It is characteristic of those times that such occupations were called the crude preparatory work. I myself have heard a learned man of that epoch (since dead) seriously call himself a 'laborer,' in contradistinction to the orator-professors.

The results obtained were such as might have been anticipated with this disposition of the public mind. Instruction by lectures was the chief aim: independent scientific work, although esteemed, was not obligatory, and was considered a matter to be left to personal predilection.

There were, of course, exceptions to this rule. Thus, for instance, the faculty of natural science at the St. Petersburg university showed some signs of organic scientific life, even during this period. This, however, was a consequence of the continuous close relations between the university and the neighboring academy, where science was practically cultivated, so to speak, by legal requirement. Some of the chairs of natural science in the university were occupied by academicians; others, by persons closely connected with the academy: for this reason we here find all the indications of a true scientific life. Besides the museums and the chemical laboratory, there were introduced into the university laboratories of some sort for other branches; some practical work in botany and zoölogy was required from the students; to a chosen few the physical laboratory of the academy of science was open; and even the old chemist Solovyòff himself superintended the practical exercises of the students. Tsenkòfsky's teacher, Shikhòfsky, with the aid of a single microscope, had to instruct his pupils in making microscopic observations; but he left behind him a pupil who has won a great reputation by his microscopic investigations.

We see, then, that, during the generation preceding our own, the whole condition of university life was any thing but favorable to the development of natural science. At that time, even Germany, whence our learning has been derived, probably had not yet fully awakened to the idea, that, to properly fulfil their purpose of disseminating knowledge, universities ought to be, not only institutions where science is rhetorically expounded, but also centres for developing and advancing scientific work. The old and simple belief that teaching, as well as learning, can be made successful only through real work, did not secure a broad, practical recognition in Germany before the sixth decade of the present century, when rich laboratories for natural science came to be considered indispensable attributes of a university. It is true that laboratories of some kind did exist in western Europe in former times; but their origin was due to local causes, accidental in character: they sprang up wherever a prominent worker in science had gathered pupils around him. The laboratories of our time have a much broader significance: as indispensable attributes of every university, they change the whole system of instruction; as institutions adapted to the practical working-out of scientific problems by many individual investigators, they superseded the closet of the student, and introduced to learners the very process of the building-up of science; as schools for practical instruction, laboratories materially raise the level of education among the masses; as working-centres where science is advanced, not by individual, but by united efforts, they materially increase the scientific productivity of the country. In Germany their importance is so fully recognized, that, even in universities of the second rank, hundreds of thousands of roubles are expended on the construction of laboratories in connection with the various chairs.

Hence it will readily be perceived what an immense service was rendered Russian science by the reform of our universities in the seventh decade of our century, when laboratories were established in connection with the faculties of medicine and of natural science, and provided with the necessary means, the staff of instructors being correspondingly increased. Another beneficent measure was the greater facility afforded private persons of leaving the country to study abroad, and the increased frequency with which the government sent young people abroad for the same purpose. This last measure, though long before in vogue by the universities for preparing their professors, at that time became even more necessary; for while, between 1848 and 1856, the ordering of students abroad had entirely ceased, by the new regulations the number of instructors was enlarged. I shall hardly err if I say that about one-half of the present professors in the faculties of medicine and of natural science have come from those young men who went abroad between 1856 and 1865.

The increase in the number of workers in natural science during the period under discussion appears most clearly from the formation of societies of naturalists at the universities. In the preceding period there were but two such societies in existence in Russia, — the mineralogical society at St. Petersburg, and the Moscow society of naturalists. At present there are, at the universities, seven societies of naturalists. Besides these, we have the Russian entomological society, and the societies at Yaroslàvl, Ekaterinbùrg, Tashkènt, and Tiflìs.

General confirmation of this opinion, respecting the increase in the number of workers in natural science, is found in our periodical congresses of naturalists. After the first congress, societies of naturalists organized at the universities; and the geological, zoölogi-

cal, and botanical sections of these societies began to send parties of investigators annually (usually for the summer) to all parts of Russia. Making the best of their limited means, they allowed a maximum of four hundred or five hundred roubles a person.[1]

At the instance of the same societies, larger expeditions, subsidized by the government, were sent out into Turkestàn (Fedchènko), into Khiva (Bogdànoff), into the Aralo-Caspian territory (Bogdànoff, Barbotte, Grimm, and Alenìtsyn), to the Murmàn coast (Bogdànoff, with seven students), to the White Sea (Tsenkòfsky and Wagner), among the Altai (Nikòlsky, Sokolòff, Polènoff, and Krasnòff).

Russian names occur in the foreign literature of natural science, even during the preceding period, though they are very rare, and not often important. But about 1860, that is, when Russian students began to throng to foreign universities (chiefly German), a rapid increase is perceptible in the number of Russian names appearing as contributors to foreign journals; and this number is steadily maintained at a figure previously unheard of. Even if the productions of these first years were often of an elementary character, they are nevertheless important as presenting a striking proof of a fact hitherto unprecedented in Russia; viz., that, in the very beginning of the period under discussion, a considerable number of young Russians passed through a very thorough course of study. The importance of this fact is enhanced when we recollect that our young laboratories drew their first supply of workers from those who, during this time, studied abroad.

Everybody who has ever been at the head of a newly established laboratory, will, I think, agree that it requires years, even in the case of an experienced director, to prepare two or three students for independent research. Now, in our case, in the seventh decade of the present century, the difficulty was enhanced by the fact that the management of laboratories was still a novelty, and the students were ill prepared. It is therefore not to be wondered at, that individual scientific activity only clearly manifested itself in our laboratories long after their foundation. This scientific activity, however, now exists in almost all laboratories of our country; and it shows itself in this, — that the working-out of scientific problems is not restricted to the professors alone, who may, perhaps, be said to derive their learning from western Europe. The students of the local Russian laboratories, also, now take part in this work. In former times it was impossible, with rare exceptions, for a Russian to become an independent scientific worker without going abroad to study: at present he can receive and complete his education at home.

It may not be amiss to present, in illustration of this change, some particularly striking figures.

Between 1830 and 1860, I do not recall a single special investigation in the branches of microscopic anatomy, physiology, and experimental pathology, made by a university professor of pure Russian name. During the present period, i.e., in the course of the twenty years from 1863 to 1882 inclusive, more than six hundred and fifty investigations in these branches, by authors of pure Russian name, were published in foreign periodicals. From this number are excluded all Dorpat professors, and foreigners like Professor Gruber; also, probably, a number of Russians by birth and education, but bearing foreign names.

The most remarkable showing, however, is made by our chemists. During the fourteen years from 1869 to 1882 inclusive, the journal of the Russian physico-chemical society published six hundred and seventy investigations, not including those relating to applications of chemistry to pharmacy, technology, and medicine.

Chemistry, having from the very outset of this period engaged the attention of such eminent workers as Zìnin, Bùtleroff, Mendelèyeff, N. Bekètoff, N. N. Sokolòff, and others, enjoyed a more rapid development than all other branches of natural science. For a long time it occupied among the sciences the first place; and this place it has succeeded in retaining. Just after the first congress of naturalists was held in 1867, the chemical (now physico-chemical) society was founded, with a journal for the publication of scientific researches; and this journal became the organ of Russian chemists. The investigations are thus first published in the Russian language; but the German, London, and Paris chemical societies regularly receive an account of them through special corresponding members, and they are also reported to the Italian chemical gazette. How completely the work of Russian chemists is recognized in western Europe, will appear from the statement of an eminent English man of science: Frankland said, that in chemistry there are more independent investigations published in Russia than in England. Our chemists, however, take the lead not by quantity alone: there are branches of chemistry in which they appear among the best specialists; and yet the principal representatives of Russian chemistry are engaged in researches extending over the entire domain of chemical knowledge.

The development of physics, from the very nature of things, could not keep pace with this rapid progress, especially as there were hardly any well-trained scientific men at work in this branch at the beginning of our period. At present, physics numbers, among its independent leading workers, Petrushèfsky, Lenz, Stolètoff, Avenarius, Shvèdoff, and others.

The scientific activity of our botanists proved exceedingly fertile. At the beginning of our period, Tsenkòfsky stands out eminent indeed, but alone: in the course of twenty-five years, his intellectual offspring has become a family of seventy-five workers; and of this number we may certainly assume that three-quarters grew up in the Russian school. During the preceding period, Russian botanists were almost exclusively engaged in the study of local floras: at present, the study of botany has been specialized into the branches of anatomy, physiology, development of plants, and botanical geography. In

[1] Each of these societies has a government subsidy of twenty-five hundred roubles (about fifteen hundred dollars), apart from the contributions of the members, the physico-chemical society alone receiving no subsidy.

anatomy, eighty-seven original researches appeared during this period; in physiology, a hundred and fifty-two. The number of special investigations in botanical geography during the last twenty years amounts to twenty, while the articles relating to local floras number about a hundred.

During this period, zoölogy developed in two directions: on the one hand, investigations of faunas, increasing considerably in quantity and quality, form a continuation of the preceding period; and, on the other hand, a new phase of zoölogical research is inaugurated by workers in the field of comparative anatomy, of animal histology, and of embryology. At the head of this last movement, fortunately, we find such exceedingly talented men and energetic workers as Kovalèfsky and Mèchnikoff, who enjoy in Europe a reputation not less honorable than that of the principal representatives of our chemical school. This is the reason why the new movement not only soon extended over Russia generally, but gained a strong foothold; so that at present it has representatives in every university, and unites the body of common workers into a Russian zoölogical school.

A review of the development of mineralogy and geology in the universities during the last twenty-five years is embarrassed with two difficulties. In three of the six universities to which this article refers, the scientific workers of the previous epoch continue their activity into the present period. On the other hand, the mining-engineers, *pari passu* with the university-workers, begin to work zealously, and their common labors appear in the same publications. An over-nice discrimination of the work of the mining-engineers from the work done by the universities, will, however, be superfluous, when we reflect that the stimulation of scientific activity among the mining-engineers is primarily due to the same causes that infused new life into the universities themselves. These causes were the reforms in the mining-corps (now become a mining-institution) which were in the same direction as the new system of instruction in the natural science faculties. The increased activity among the mining-engineers, being a product of the same cause, merely fortifies by additional proof the leading idea of this article. From this point of view, the activity in mineralogy and geology will appear to have increased very considerably. Since 1869 the St. Petersburg mineralogical society has published thirteen volumes of 'Materials for the geology of Russia' (in Russian). In the St. Petersburg society of naturalists alone, there were received two hundred and ten original communications from 1868 to 1882 inclusive; and, in the 'Index to Russian literature in mathematics and pure and applied science' (in Russian), we find enumerated two hundred and seventy-four works (pamphlets and books) on mineralogy and geology for the period 1873 to 1879. In addition, it should be mentioned that our present university geologists, by practical work, have transplanted to Russian soil the problem of prehistoric man, and the application of microscopy to the investigation of mineral species.

Finally, as above mentioned, the sciences of microscopic anatomy and physiology began to be cultivated in Russia between 1860 and 1870. The first to introduce them were the Dorpat professors, the late Yakubòvich and Ovsiànnikoff. They were followed by a succession of Russian specialists who had studied abroad between 1855 and 1865. The following data will show to what extent these young sciences took root and thrived in Russia. When in Germany, between 1870 and 1880, the composition of histological and physiological text-books was undertaken by collaboration, our scientific men, being recognized as specialists, were asked to write certain parts of these works. Some of them complied with this request; as, for instance, Babùkhin and the late Ivànoff. There are even names to which the honor belongs of having established new and important methods of research: to Khronshchèfsky, for instance, is due the method of transfusion. At the present day, there is hardly a branch of these two sciences that has not been more or less successfully attacked by Russian investigators; and a large proportion of their work has been done at home.

Such is a general outline of the results obtained by our universities in natural science, thanks to the reforms introduced in the seventh decade of our century. In reality they are even greater than here represented, since the data at my disposition do not include every thing actually accomplished. Is not this ample evidence that the naturalists of our universities have commendably improved their opportunity, and honorably fulfilled the task imposed on them? Not to speak of the industrial and other material advantages always following the development of natural science in a country, the mere fact that this development exists is of great importance from an intellectual point of view, especially for novices in civilization, like ourselves.

The appearance of science always marks the culminating-point in intellectual development: it is always and everywhere the surest touchstone of the capacity of a race for the highest culture. When a race has successfully undergone this test, it at once takes its place among civilized nations. When recently we mourned Turgièneff, it was justly pointed out as one of his merits, that his work had fostered the intellectual commerce of Russians with the west. Did not our naturalists do the same?

It must, however, be confessed, that, in spite of all this, we are still novices in science, and our young plantations require assiduous care. The experience of twenty-five years has demonstrated that the conditions favorable to development are to be sought in the establishment of laboratories, and in the increase of the staff of instructors. These conditions of progress, therefore, must be extended in the future, as is done in western Europe, or they must at least be maintained.

RECENT LINGUISTIC RESEARCHES.

'TOPONOMASTICS,' or the analysis of geographic names, is a branch of linguistics, which, on account of the large material and numerous publications accu-