made for the crucible furnace stand, as a rule, exceedingly well; but with alterations in form great difficulties are introduced, more especially with muffles, which, as at present made, will not stand any sudden heat, nor will they hold their shape at any temperature approaching whiteness. The burner alone will be useful in heating many substances in the open, but, owing to the broad and diffused flame, it is of little practical value for blow-pipe work.

The special advantages of the apparatus are that it is entirely self-acting, requires no attendance, and that it greatly increases the range of temperatures which can be obtained by any simple apparatus. The largest size at present made takes crucibles not exceeding three inches high.—*Nature*.

THE ACTION OF MEDICINE.

By E. M. McPHERON, M.D.

A KNOWLEDGE of the *modus operandi* of medicine when introduced into the organism is the most essential element of therapeutics. In order that the physician may make a rational application of remedial agents for the cure of disease or alleviation of pain, it is necessary that he be possessed of a knowledge, to some degree, of the method of action, when introduced into the body, of the agents which he is using; and the more he knows of such action, the more rational will be their application and the more successful will be his practice.

We will admit that the manner of action of many therapeutic agents in the organism is obscure, and in some instances impossible of detection and apparently inconsistent, as is instanced in the action of carbo-veg. It is an admitted fact, among those who have specially experimented with this agent, that it is incapable of absorption when introduced into the organism in the natural way, regardless of the amount introduced or the high degree of subdivision; still it is a well-known fact that this is an agent used extensively by the best physicians of our school and of other schools to overcome passive hemorrhagic conditions of organs of the body remote from the alimentary canal, prominent among which is the uterus.

In Scudder's "Diseases of Women," page 461, in treating of menorrhagia, the author says: "In passive uterine hemorrhage I have placed more dependence upon carbo-veg., 2d dec. trituration, than upon any other remedy, though of course it is not adapted to all cases. I give it in grain doses, every one to four hours, and usually follow it with the tincture of cuprum as a blood maker."

There are other agents which are almost insoluble, such as subnitrate of bismuth, sulphur, calomel, etc., but it is probable that these substances undergo decomposition in some of the fluids of the body, being rendered partially soluble thereby. According to Headland, calomel is rendered soluble, to some degree, by the action of the biliary secretion upon it; and, aside from this, that it is absolutely insoluble and incapable of absorption in the animal organism; but no experimenter has ever discovered a solvent for carbo-veg., hence we cannot account for its probable action in such a manner. A number of propositions, as formulated by Headland, will serve as a basis of what we shall say upon this subject.

The first proposition affirms that "the great majority of medicines must obtain entry into the blood or internal fluids of the body before their action can be manifested;" that mechanical contact with the parietes of the stomach is not sufficient, in general, to produce a systemic effect. The only exceptions to this rule may be cited those agents having a mere local action on the mucous membrane, simple contact being necessary, such as irritant emetics, irritant cathartics, superficial stimulants, sedatives, astringents, etc. Medicines do not have to enter the blood directly to reach distant parts. For example, when chloroform, cocaine, aconite, or opium—fluid preparations—are rubbed upon the skin or mucous membranes, they are directly absorbed by the intestinal fluids, acting upon the minute nervous ramifications in the superficial tissues before being taken into the blood. Such is the action of belladonna, atropine, and eserine when dropped into the eye of an animal. They are directly absorbed by the intestinal fluids of the cornea, sclerotics, and iris, and exert their action upon the tissues of the parts before entry into the blood. From the foregoing, it might be inferred that these medicines may never reach the blood, but this is pretty conclusively disproved by the fact that a drop of hydrocyanic acid, dropped into the eye of a dog, has been known to produce speedy death; and the more conclusive does this seem to be, since it has been positively demonstrated that nervous connection alone is wholly insufficient for the transmission of the action of medicines in the organism. To substantiate our proposition, we will make the following affirmations:

1st. That a medicine introduced into the organism elsewhere acts in the same way as when introduced into the stomach. Many proofs of this may be shown. Tartar emetic, ipecac, apomorphia, etc., injected into the tissues, will produce emesis, and even more rapidly than when taken into the stomach. A moistened leaf of tobacco, placed over the radial artery at the wrist, has been known to provoke vomiting. Sulphate of magnesia, when injected into the veins, will act on the bowels; and, in like manner, rhubarb or senna, injected into the thorax, will produce purging. Croton oil, liquid jalap, rhubarb or gamboge, rubbed upon the abdomen sufficiently long, will produce purging. Injections of nux are rapidly followed by toxic symptoms, similar to those following its internal administration, etc.

2d. The continuity of nerve is not necessary for the propagation of remedial effects; but vascular connection is necessary. This affirmation is proved by the experiments of Magendie. He introduced some urari poison into the limb of a dog, which was only connected to the trunk by means of quills uniting the divided ends to the main vessels. It rapidly took effect. Having divided all the nerves and lymphatics in the intestine of another dog, he introduced into it some nuxvom. beyond the division. It quickly acted, and must have done so through the vessels. Sir B. Brodie cut all the nerves of the anterior extremity of a rabbit near the axilla, and introduced urari into the foot. It quickly acted. Sufficiently tight ligaturing of an extremity will prevent systemic toxic influence. Sir B. Brodie also ex-

perimented upon parts connected with the body only by nerve continuity carefully dissected out, and found nervous structure incapable of transmitting toxic action. Other experimenters, as Emmer, Robinson, etc., have confirmed this latter experiment with the most violent of poisons, prominent among which is prussic acid.

3d. The circulation of the blood is sufficiently quick to account even for the operation of those poisons which act most rapidly by influencing the nerve centers. Experiments have proved that a substance will traverse the whole circulation of a dog in nine seconds, and of a horse in twenty seconds, while in an adult man the time required is 65.76 seconds. This is sufficient to account for the mode of action of that most rapid and fatal of all poisons, viz., prussic acid. Besides, if a medicine acted by nervous transmission, it would act as soon as it touched the stomach or injected into the tissues. Animals will sometimes live for thirty minutes after being poisoned with cyanide of potassium.

4th. The great majority of medicines have been detected in the blood or the secretions formed from it. We have proved that poisons act when introduced into the organism at any point; that vascular connection is required for this action; that nervous connection is wholly insufficient; and that the circulation is sufficiently rapid to account for the action of the most rapid of poisons. Now, if our last affirmation can be proved, we will have carried our first proposition close to certainty. In 1847, Mr. Allen detected daturia in the urine of a man poisoned by stramonium. In 1824, M. Runge discovered the principles of henbane and belladonna in urine. Kletzinsky finds that if the throat be gargled for five minutes with a solution of any soluble mineral salt, its presence may be detected in the urine next evacuated. Chloroform has often been detected in the blood. Indigo, logwood, and many other substances have been found in the urine. Alcohol, prussic acid, etc., have been found in the blood of persons dying shortly after the ingestion of such substances. Sulphur has been detected in the perspiration, and mercury in the saliva of persons who have taken these substances. Arsenic, mercury, antimony, and other poisons may be detected in various parts of the body after death. Blood passing from the veins of a poisoned animal into the circulation of another animal causes its death. Flesh of poisoned animals is poisonous to those who eat it.

Thus, from these four considerations, we seem to be justified in concluding that a medicine must pass from the stomach into the blood before its distinct action can be manifested.

Some exceptions may be taken to this as follows: Suppose a cantharides plaster be applied to the surface of the chest, in a case of pericarditis, so as to blister the skin, absorption of the fluid in the pericardium may follow the application. In our proposition, we have reference to the special or peculiar action of a remedy. In this last case, any irritant would have done the same thing; so we cannot attribute the absorption to the special or peculiar action of the cantharides.

Some medicines have a marked local action on the mucous surfaces of the stomach and bowels. These may, without entry into the blood, produce an effect in parts of the organism remote from the alimentary canal, by counter-irritation or revulsion. Thus we use irritant emetics or cathartics to arrest incipient inflammatory action, as in disease of the eye, ear, brain, etc. This action may be carried to that extent that it will produce death, as when powerful corrosive poisons are taken into the stomach; but, as before stated, this is not the special action of such agents, and does not invalidate our proposition.

Our second proposition is as follows: That the great majority of medicines are capable of solution in the gastric or intestinal secretions, and pass without material change, by a process of absorption, through the coats of the stomach and intestines, to enter the capillaries of the portal system of veins.

In order that the substances may gain entrance into the blood after ingestion, it is necessary that they pass through the coats of the stomach and intestines, and also penetrate the capillary coat.

This process is called absorption or endosmosis. The basement membrane, supporting all mucous membranes, is a structureless or homogeneous tissue; hence no substance can pass through this membrane except it be in a state of solution. Outside the mucous membrane, and in juxtaposition to it, is a network of very small veins with thin walls, and the same forces which cause the fluids to penetrate the mucous membrane also cause the same to pass through the walls of the capillaries and smaller veins.

We will consider this subject in three parts: 1st. What is the nature and function of the gastric juice? 2d. The laws of the process of endosmosis. 3d. The mode by which medicines are reduced to a state of solution.

Stomach digestion is pretty thoroughly understood at the present time. We will not attempt a treatise on gastric digestion, but will recount some of the more salient points having a relation to the thought we are pressing. Whenever a substance is introduced into the stomach there is a copious outpouring of the gastric juice, the secretion of the glandular apparatus of the mucous membrane of the stomach. The amount of this secretion depends, to some extent, on the kind and mode of introduction of substances introduced into the stomach. This secretion is highly acid, owing to its admixture with hydrochloric or lactic acid, and contains, as one of its essential constituents, an organic principle known as pepsine, or *gasterase*. The result of this secretion is the solution of those substances soluble in a fluid of this chemical nature, reducing them to a thin, watery pulp capable of being absorbed. Medicinal substances which are soluble in the gastric secretion are directly taken up by the coats of the stomach and passed into the blood, and from thence to that part or parts of the organism upon which they have an affinity for action; while those that are insoluble in this *menstruum* are passed on into the intestines; and if non-soluble in the intestinal fluid, are excreted in the form in which they were ingested, without producing any special or peculiar effect on any part of the organism remote from the alimentary canal. The intestinal and buccal fluids are alkaline in reaction, from the presence of carbonate of soda, and the gastric juice, as before stated, is acid; so that if any substance is insoluble in the one, it will likely be reduced to solution

in the other. We need say nothing about the possibility of stomache and intestinal absorption, as that fact is well established. The mucous membrane of the small intestines is covered by small projections, called villi, the function of which is the absorption of fatty substances which have been taken into the alimentary canal and reduced to a state of emulsion by the action of the pancreatic juice. According to Bernard, and others, the villi of the small intestines never absorb medicinal substances not of an oily or fatty nature, but that substances reduced to solution in the intestines are absorbed directly into the blood. Magendie demonstrated that a ligature placed around the thoracic duct will not affect or prevent the toxic influence of poisons introduced into the body. Experiments have been made to discover the presence of medicinal substances in the chyle ducts, but so far they have failed; so that we may reasonably conclude that medicines are not absorbed in this way.

The process by which fluids pass and repass through animal membranes is known as *endosmosis* and *exosmosis*, according as the current tends inward or outward. There are fluids on both sides of the membrane, so the following laws regulate the direction of its passage: 1st. The densities of the liquids. The lighter of the two tends to pass through the heavier, other things being equal. 2d. Their attraction for the intervening membrane. The one passing the more rapidly having the greater affinity for the membrane. 3d. The affinity of the fluids for each other. That one passing through more rapidly which is readily taken up and dissolved by that on the opposite side. 4th. The motion of the fluid on one side prevents the passage from the other. 5th. Pressure of the fluid on one side tends to hasten its passage to the other.

All soluble mineral substances are absorbed in the stomach and intestines. Precipitations and re-solutions occur between some of the minerals and the salts of the digestive fluids, but in no case is there absolute fixation of the foreign agent, from its chemical incompatibility with animal fluids. Mineral acids, salts of metals, alum, and the tannic principles of vegetables must be precipitated to some extent by the albumen and pepsine of the gastric juice, but are redissolved by the intestinal fluids, which are alkaline. The inorganic alkaline salts are not precipitated by any of the animal fluids, but tend to render them more solvent. Some have thought that the soluble salts of mercury, silver, and lead might be precipitated by the chloride of soda in the gastric juice; but this can hardly be, since this fluid only contains 25 per cent. of the salt; besides, a small dose is more efficient than a large one of these salts, which could not be if precipitation took place. The intestinal secretions contain alkaline carbonates, which would precipitate the oxides of many metals, from solution of their salts; but if the metallic salt is not absorbed in the stomach, it descends into the intestines as an albuminate, and, instead of being precipitated, is rendered more soluble by the alkaline secretion.

Thus it appears that all soluble substances, organic or inorganic, given either as food or medicine, and in whatever way rendered soluble, whether by acids or alkalis or by digestion, are absorbed by the stomach or intestines. All, except fatty matters, pass directly into the blood, through the portal vein into the liver, to the heart, and thence to the various parts of the body. They are mostly absorbed without change. Some, however, may be absorbed as an albuminate. The stomach acid is too weak to displace mineral acids. It does displace a few vegetable acids, prominent among which is prussic acid. When cyanide of potassium is administered, the acid of the gastric juice, being a stronger base than that of hydrocyanic acid, immediately displaces the latter, setting free the prussic acid in the stomach; hence the rapidity of its action.—*Amer. Med. Jour.*

ON THE USE OF STEAM IN SPECTRUM ANALYSIS.

By JOHN TROWBRIDGE and W. C. SABINE.

AMONG the difficulties with which the investigator in spectrum analysis must contend is that of obtaining a source of light which is free from constituents other than those which are under examination, and at the same time sufficiently powerful to enable him to photograph the spectra of the latter. The voltaic arc gives a sufficiently strong light to enable one to photograph throughout the visible spectrum; the electric carbons, however, are full of impurities, and it is difficult to interpret the spectra obtained by these means. Moreover, it is not easy to employ the arc spectrum for researches in the ultra-violet portion of the spectrum. On the other hand, the spark from a Ruhmkorff coil taken between terminals of metals, the spectrum of which we wish to examine, gives us in general spectra comparatively free from impurities, but its light is very feeble compared with that of the electric arc, and even when the spark is obtained by means of a powerful coil which is excited by an alternating dynamo machine an hour is necessary to obtain with a concave grating of 21 feet radius of curvature, on the most sensitive dry plate, a photograph of the ultra-violet spectra of copper at the wave length 2100.

It becomes an important question then to ascertain whether the time of exposure of the sensitive plate can be shortened by any process; for the outlay in obtaining one photograph in the ultra-violet by the means hitherto at our command is very large, involving as we have said the running of an engine of at least two horse power for an hour. In our experiments with a jet of steam we find that the time of exposure of the sensitive plate can be shortened to at least one-third.

We were led to employ steam for the purpose of obtaining the spectra of oxygen and hydrogen with a more powerful electrical excitation than is possible in Geissler tubes. During the winter of 1886, when engaged upon the subject of oxygen in the sun, one of us in connection with Mr. C. C. Hutchins tried to obtain a powerful electric spark in an atmosphere of steam, but the experiments were unsatisfactory. The difficulties were chiefly in the way of proper insulation. Experiments showed that no containing vessel could be employed for the sides of the vessel conducting the electricity from one terminal of the Ruhmkorff coil to the other. No spark could be obtained, and the experiments were abandoned. During the present winter the experiments were renewed. The containing vessel was abandoned, and the jet of steam was allowed to

impinge directly upon the spark. No effect could be perceived when there were no condensers in the secondary circuit, and with the introduction of small condensers the effect was not marked; but when the number of Leyden jar condensers was increased to four, the effect of the jet of steam upon the electric spark was surprising. Its light immediately became comparable with that of the electric arc, enabling us to see the metallic spectra with the naked eye upon the ground glass of the photographic camera without the use of an eye piece. The chamber in which the spark and steam jet were placed became rosy red from the hydrogen arising from the dissociation of the steam. The hydrogen and oxygen lines in the air spectra became very much strengthened, a continuous spectrum showed itself in the neighborhood of the C line and also in the yellow, and a photograph of the air line and metallic line of the terminals employed could be taken in a third of the time which was necessary when the steam jet was not employed.

The apparatus consists merely of a tin box which is placed opposite the slit of the spectroscopic. Steam enters at one side and is blown across the terminals of the Ruhmkorff coil, which are placed in the box opposite the slit; an outlet on the side opposite from the place of entrance of the steam allows the waste steam to escape into the outer air.

The change of color of the spark is undoubtedly due to hydrogen. The light filling the box above referred to is decidedly red, and the hydrogen line, C, flashes out with great brilliancy in the midst of a continuous band of red in the spectrum. The metallic line from the terminals is greatly strengthened. The light from iron terminals is especially brilliant. Without the steam the spark between iron terminals seemed to consist of a single line of discharge. When the steam was turned on, a great bundle of sparks appeared in the midst of a flaring light, and the noise of the spark was greatly increased. This effect can undoubtedly be traced to increased conduction of the air space between the terminals of the Ruhmkorff coil.

The appearance of the spectra led us to examine the question of the spectrum of the aurora borealis and its connection with that of aqueous vapor. We believe that the theory that the shifting nature of the northern lights may be due to electrical discharges following strata of air more or less laden with aqueous vapor has been advocated. The appearance of the spectra of the electric spark in steam certainly leads one at first to favor this hypothesis. We have spoken of the marked brilliancy of the hydrogen line and of a continuous red band near this line. The continuous spectrum in the yellow is no less prominent. The observations which have been made on the northern lights do not enable one to make exact comparisons. The lines given by different observers, however, do not appear to coincide with the prominent lines and bands observed in the air spectrum heightened by steam.

Other observers, among them Professors Liveing and Dewar, have employed steam to obtain steam lines, but we have been unable to find any reference to the remarkable economy in time and in waste of apparatus which results in the use of a jet of steam in spectrum analysis, when the spark method of obtaining the spectra of metals is employed.—*Amer. Jour. of Science.*

[NATURE]

N. M. PRJEVALSKY.

A TELEGRAM from Vyernyi—one of those small Russian towns which have grown of late in the outspurs of the Tian-Shan Mountains—announces the death of Prjevalsky, the bold and indefatigable explorer of the wildernesses of Central Asia. In September last, immediately after having terminated the work which embodied the results of his fourth great journey to Central Asia, he started on a new journey, the fifth, thus prosecuting again what has been the aim of his life during the last twelve years—that of reaching Lhasa in Tibet, and opening to science the lofty plateaus and highlands which separate East Turkestan from India. This time he proposed to start from Russian Turkestan, and his expedition had to be equipped at Vyernyi, on the north of Lake Issyk-kul. He arrived at Tashkend in October, and had left it on October 13 (old style) on his way to Vyernyi, but he seems not to have reached that town, and must have died on the route, as far as we can judge from the telegram. The new expedition, which promised to be even richer in scientific results than all those which preceded it, was thus prevented. But Prjevalsky has left, in the traveling companions who remained so true to him in his adventurous journeys, a staff of young men who will certainly continue his work, and sooner or later open to science the dreary highlands which have baffled so many a bold explorer.

N. M. Prjevalsky was only in his fiftieth year, and usually enjoyed robust health. He belonged to a noble family, and was born in 1839, in the government of Smolensk. At the age of seven he lost his father. During the early years of his life he was trained by his mother (whose maiden name was Karetnikoff), a teacher who stayed in their house, and a brother of his mother. He soon became an eager hunter, and spent all his holidays in hunting in the Smolensk forests with his uncle. This taste he retained during the rest of his life, and he frankly admitted that his first journeys in Central Asia were due as much to his passionate longing for rich hunting grounds as to his desire to conquer for science the unknown wildernesses. Scientific interest developed more and more during and after his first Central Asian journey, when, accompanied only by three men, and possessing ridiculously small pecuniary means, he crossed the Gobi, reached Pekin, and, pushing westward and southwestward from the Chinese capital, explored the Ordos and the Ala-shan, and reached the Kuku-nor as well as the upper parts of the Yang-tse-kiang—the mysterious Dy-tchu of the Chinese geographers. And yet, when we saw him on his return from that wonderful journey, his eyes glittered and his face radiated chiefly when he was telling us of his achievements as a hunter and a discoverer of the ancestors of our domesticated animals—much more than when he was talking of his geographical discoveries, about which he always was, in fact, remarkably modest.

He received his first school education in the Smolensk Gymnasium, but he soon left this institution, and entered in 1855 an infantry regiment as a subaltern. Next year he became an officer, and five years later he

entered the Academy of the General Staff. His love for geographical exploration had been to some extent developed by that time, and the dissertation he wrote on leaving the Academy was upon the Amur region, which was much spoken of in Russia. But he had not yet the means of satisfying his desire for travel, and he was compelled to return to his regiment and take part in the suppression of the Polish insurrection. He soon withdrew from active military service, and accepted the position of teacher of geography at a Warsaw Gymnasium, devoting his leisure hours to studies in natural history. It was only in 1867 that he was admitted into the General Staff and sent to Irkutsk, whence he immediately started for the exploration of the very little known highlands on the banks of the Usuri—the great southern tributary of the Amur. Here he found a wide field for exploration and hunting, and wrote a book on the Usuri region (published in 1869), partly of an ethnographical character. The Geographical Society awarded him for this book only a small silver medal; and, when Prjevalsky applied for means to enable him to explore Southern Mongolia, the society was anything but generous in its response. Had it not been for his own small economies—he always lived a very simple life—and for the help he received from the then Russian Ambassador at Pekin (M. Vianigalli), himself an explorer of Mongolia, Prjevalsky could hardly have started on that remarkable journey. When he began the exploration of the land of the Tangutes, he possessed only 178 rubles (about £25); and when he reached, with his three companions, the sources of the Yang-tse-kiang, after having crossed the province of Hân-su, the Tsaidam, and part of Northern Tibet, he had only ten rubles left, and his camels were quite exhausted. The whole expedition, which lasted thirty-four months (November, 1870, to September, 1873), had cost only 6,000 rubles; yet this undoubtedly was the most remarkable journey that had been made in Asia in the nineteenth century. Prjevalsky proved that, for resolute and enduring men, traveling on the Central Asian plateaus was much easier than had been supposed. He twice crossed the Gobi, reached the Kuku-nor, penetrated as far southwest as the spot where the Yang-tse-kiang rises from the confluence of the Mur-usu and the Nantchitai River, and returned with exceedingly rich zoological and botanical collections, after having traveled no less than 7,320 miles across formerly quite unknown deserts and highlands. The work in which he embodied the results of that wonderful journey, "Mongolia and the Land of the Tangutes," was immediately translated into all civilized languages. The Russian Geographical Society hastened to present him with its great Constantine medal, and most of the geographical societies all over Europe congratulated him on his discoveries, and awarded him medals, honorary diplomas, and the like.

Prjevalsky, in the meantime, was trying to find the means for continuing his explorations; but it was only in 1876 that he succeeded in obtaining from the Ministry of War the 25,000 rubles which were necessary to enable him to push as far as Lob-nor. His aim was not only to rediscover the basin of the Tarim and the great lake of East Turkestan, which had not been visited by any European from the time of Marco Polo; he desired to cross East Turkestan and the northern plateaus of Tibet, and to reach Lhasa. This time he started from Turkestan, and, following the upper part of the Ili River (the Kunges), he reached Kurla in East Turkestan, whence he crossed the desert and reached the Lob-nor. The great lake was thus rediscovered. But it was impossible to reach Lhasa by this route, and Prjevalsky returned to Kulja, and thence to the Russian post Zaisan. His aim was to penetrate into Tibet *via* Hami, the Tsaidam, and the sources of the Blue River. So he started again, from Zaisan to Gutchen. Unhappily, the skin disease of the steppes (*pruritis scroti*) overtook him, and he was compelled to return from Gutchen. Still, next March, he was again on his way to Lhasa, when the frontier authorities ordered him to postpone his expedition. He then returned to St. Petersburg.

The Lob-nor journey was made in 1877, and although only eleven years have elapsed since, it is almost impossible now to realize the imperfection of our knowledge of Central Asia at that time. When it became known that Prjevalsky had visited the Lob-nor, Baron Richthofen contested the fact, and maintained that the lake which receives the Tarim must be situated further north and due east from the mouth of the Ughen-daria; while now Lob-nor is perfectly well known. As to the natural history collections which were brought in from this second journey, they were even more valuable than those gathered during the first journey. They gave us a clear insight into the flora and fauna of those parts of East Turkestan; while the barometrical measurements enabled us to form, for the first time, a correct idea as to the characters of the Tarim depression of the great Central Asian plateau. It was also from this journey that Prjevalsky brought the wild camel—the ancestor of the domesticated species.

As soon as he was back at St. Petersburg, Prjevalsky hastened to prepare for a new journey; and after having written a short account of his Lob-nor journey, "From Kulja, across the Tian-shan, to Lob-nor," he left the Russian capital for Zaisan, and began his third journey, the most remarkable of all. He soon reached Barkul and Hami, the two Turkestan oases which were almost less known than some parts of the moon. He crossed the Western Gobi, and reached a spot, Dzun-zasak, in South Tsaidam, at the foot of the highlands which separate Mongolia from Tibet. Thence he went south, in order to reach the longed-for Tibetan city of Lhasa. The journey in the highlands which border the great plateau on the northeast was exceedingly difficult. Ridges, 16,000 feet high in their lowest parts (one of them was named after Marco Polo), separated from one another by deep valleys, the bottoms of which are 13,000 and 15,000 feet above the level of the sea, had to be crossed; and when the expedition reached the upper parts of the Blue River, it was brought by the guide to quite impracticable highlands, and had to find its way amid the barren mountains, peopled by Tangutes, whose attacks had to be repulsed by force. Nevertheless, Prjevalsky crossed the highlands, and had already reached, under the 32d degree of latitude, the great valley of the Tibetan river Khara-usu, whence the route to Lhasa was relatively easy; but here a new obstacle rose before him. The Dalai-lama had sent officials who declared to Prjevalsky that the Tibetan

nation would not allow Russians to enter the capital of the great chief of the Buddhist religion. The expedition was thus compelled to return; and so it did, recrossing the same highlands in the midst of the winter. Having returned to the Ala-shan town Sinin, Prjevalsky did not like to go back to Russia without having visited the Hoang-ho, which makes a great bend to the north in the neighborhood of Kuku-nor. He reached, in fact, the great river of China at Guidui, crossed it, and explored it for some 200 miles, and only then returned to Kiakhta, after having traveled about 14,700 miles, half of which stretch was surveyed, and bringing in more than 4,500 specimens of mammals, birds, and fishes, 6,000 insects, and many thousands of plants. The most remarkable "find" was, however, the wild horse—the ancestor of our present horse—which inhabited Russia and Poland some two hundred years ago, and has been described by the late I. Polyakoff under the name of *Equus przewalskii* (*Izvestia Russ. Geog. Soc.*, 1881). It is hardly necessary to say that this remarkable journey produced the greatest impression on the scientific world. The Russian Geographical Society elected Prjevalsky an honorary member, the city of St. Petersburg offered him its honorary citizenship, and many scientific bodies bestowed on him all kinds of distinctions. The general results of this journey were embodied in a work entitled "Third Journey to Central Asia," which also has been translated into many European languages.

As soon as the publication of this work was ready, Prjevalsky started again, in November, 1883, on a new journey, again proposing to visit Tibet. This time he started from Kiakhta, crossed the Gobi in the winter, and soon reached the spot, Dzun-zasak, whence he intended to start for the exploration of the highlands of northeastern Tibet. But all kinds of misfortunes attended him. The expedition, freely provided with money, already numbered twenty-one men, and so it could not move with less than fifty camels and several horses. It was found very difficult to obtain such a number of animals from the poverty-stricken populations of South Tsaidam; and Prjevalsky, usually so mild in his relations with the natives, resorted to violence. The animals he thus secured proved to be quite unfit for journeys across the high ridges which fill up the space in the south of Dzun-zasak; and it seems most probable that by taking a route due south from that point, instead of proceeding southwestward as he did during his third journey, Prjevalsky committed an error. Not taking into account the northeastern direction of the ridges, he had to cross the numerous ridges of the Upper Hoang-ho, instead of availing himself of the depressions having a southwestern direction, which permitted him to reach the Khara-usu in 1880 without serious difficulty.

It is true, that by taking a southern direction, he reached the two great lakes Jirin and Orin, through which the Upper Hoang-ho flows, and that he thus solved one of the problems of the geography of Asia. But when he went further south, he had to cross such a succession of wild highlands of an Alpine character that his camels were soon disabled; and when he reached the Dy-tchu, or Upper Yang-tse-kiang, some 120 miles to the east of the spot he visited in 1872, he found it impossible either to cross it or to follow the river downward. He was obliged to return, and on his way back he even could not fully explore the Jakes Jirin and Orin, because the Tangutes, gathering in hundreds, violently attacked the caravan, and were repulsed only after having lost a great number of their warriors.

Having returned to Dzun-zasak, Prjevalsky went northwestward along the foot of the ridges which separate Mongolia from Tibet, and, when at the lake Gas, he made a winter excursion into the highlands. This excursion enabled him to get a clear idea as to the series of parallel ridges which separate the Tsaidam from the higher terrace of plateaus of Northeastern Tibet. Moreover, instead of returning from Lob-nor by his usual route, he pushed westward into East Turkestan, as far as Khotan, and returned to Russian Turkestan *via* Aksu, thus covering nearly the same ground as that visited at the same time by Mr. Carey.

Years and years will pass before all the specimens of plants and animals brought in from his four journeys can be fully described. Maximowicz's description of Central Asian plants, now being printed by instalments in the Bulletin of the Moscow Society of Naturalists, already gives some idea of the richness of Prjevalsky's collections, which represent a total of 700 specimens of mammals, 5,000 of birds, 1,200 of reptiles and amphibians, 800 of fishes, 2,000 mollusks, 10,000 insects, and from 15,000 to 16,000 plants. All the zoological specimens are in the St. Petersburg Academy of Sciences, the botanical specimens at the St. Petersburg Botanical Garden, the geological collections at the St. Petersburg University, and special funds have been granted by the government for the publication of the scientific results of these journeys as soon as the necessary work has been done by the specialists.

The volume embodying the general results of Prjevalsky's fourth journey, and entitled "From Kiakhta to the Sources of the Yellow River, Northern Tibet, and the Journey from Lob-nor through the Basin of the Tarim," reached London only a few weeks ago, and the present writer was preparing an account of it when the sad news reached us from Vyernyi. Although less striking than his previous books, so far as geographical discovery is concerned, this work may be even more important for the light it throws on the nature of a wide, unknown country. It presents also the clearest view of the traveler himself, and affords a clew to the causes of his success.

In a chapter devoted to the ways and means of traveling in Central Asia, Prjevalsky gives detailed instructions as to how an expedition ought to be organized, and when speaking of the traveler himself he writes: "As to the person who will have before him the beautiful task of scientifically exploring new regions, his task will not be easy. The explorer will have to pay for the smallest discoveries by plenty of suffering, physical and moral. He must be strong physically and morally. Flourishing health, strong muscles, and still better an athletic complexion, on the one side, and strong character, energy, and resoluteness on the other—such are the features which best guarantee success." And, after mentioning the necessity of general scientific knowledge, and of special knowledge in, at least, some one branch, as well as the necessity of a real passion for traveling, Prjevalsky adds: "Moreover, he must be an excellent shooter, and, still better, a passionate hunter."