in the upper half, so that a line of print can be easily read if the lower halves of the letters are covered, but is illegible if the upper halves are covered.

The eye is not only automatically adjustable to distances, but also its sensitivity is automatically adjusted to the amount of light entering it. The sensitivity of the retina increases enormously in dark adaptation, and scotopic or twilight vision differs in many respects from photopic vision. Evidence derived from physiological and pathological observations supports the view that the rods are responsible for scotopic, the cones chiefly for photopic vision. This is the so-called duplicity theory. Thus, the rod-free area of the macula is night-blind, as was long ago discovered by astronomers, and it is generally held that the Purkinje phenomenon is absent at the fovea. Further, the rate at which the eyes become adapted to dim light varies somewhat in normal people, and there are diseased conditions in which it is very slow or almost absent. Such people are night-blind. They are practically incapacitated in dull lights, and cannot get about after dark. In one rare group the eyes appear to be otherwise normal and the disease is transmitted from one generation to another. The most famous and most extensive pedigree of any diseased condition is that of some congenitally night-blind people in the Montpellier district in the south of France. The pedigree was started by Cunier in 1838 and brought up-to-date in 1907 by Nettleship. It consists of ten generations of 2121 persons, 135 of whom were night-blind. Much commoner is the night-blindness associated with the disease of the retina called retinitis pigmentosa.

An interesting antithesis to night-blindness is found in the rare cases of congenital total colour-blindness. For the normal sighted the colourless grey spectrum of scotopic vision becomes suffused with all the colours of the rainbow as the intensity of the light is increased. For the totally colour-blind, although the brightness increases under these conditions, no colours are seen. Moreover, there is no shift of the maximum brightness from the green to the yellow region of the spectrum, such as occurs in the normal.

On the duplicity theory, the congenital night-blind may be regarded as having only cone vision, and the totally colour-blind only rod vision. There are, however, difficulties in accepting this simple explanation.

The discovery of the visual purple indicates forcibly that the first stage in the energetics of the retina is photo-chemical. It is associated with electrical changes of great complexity; and whereas Adrian has shown that the electrical changes in the optic nerve are in all respects like those in an ordinary nerve under excitation, the correlation of these changes with those of the more complex retina has yet to be elucidated.

Stimulation of the retina by an instantaneous flash of light elicits two facts—the persistence of the visual impression for an appreciable time beyond that of stimulation, and the recurrence of vision. The latter is due to the pulsatile nature of the sensory response. It accounts for such peculiar phenomena as 'Bidwell's ghost,' Charpentier's bands, and so on. One of the most striking phenomena is the production of a colour sensation by pure black and white stimulation, as in Benham's top; and this has recently been partially explained by Piéron on the same principle.

The relations of these scientific observations on light and sight to such practical problems as the illuminations of rooms, factories, art galleries, etc., and the hygiene of vision in relation to flickering lights, the cinema, etc., is full of interest, but also often very obscure. The investigation of such problems is the chief work of the Physiology of Vision Committee of the Medical Research Council.

The Second Danish-Icelandic Expedition to Iceland, 1927.

By Dr. NIELS NIELSEN, Copenhagen.

OUR knowledge of the interior of Iceland is of quite recent date and still in part very incomplete, even to the point that there are districts which may be said to be utterly unknown to science. This applies both to topography and to geographical and geological conditions. The reason is that it is very difficult to push into the highlands of the interior, because different difficulties, each of which requires to be met by a special technique on the part of the traveller, combine to present obstacles to his passage as well as to his closer scientific investigation of the country.

In a purely practical way the coast districts have been known ever since the country was first inhabited, that is, for about a thousand years, and similarly certain tracks through the inner highlands, which one may suppose were considerably better known seven or eight hundred years ago than they were in the eighteenth and nineteenth centuries. Meanwhile, the last fifty years have made great changes in our knowledge of this region, inasmuch as a great advance has been made in the scientific investigation of the highlands, and at the same time in a practical knowledge of the country. This advance is due to a considerable number of able and energetic men of science and travellers, among whom one may name Winkler (1858), Preyer and Zirkel (1860), Keilhack (1883), Watts's various expeditions in the 'seventies, and Biziker (1900). Above all, one must mention the great work carried out by the distinguished Icelandic investigator, Thorvaldur Thoroddsen, who in the last two decades of the nineteenth century travelled over a very great extent both of the highlands and of the coast districts, and published numerous papers on the geography and geology of Iceland. We further owe to Thoroddsen a number of excellent handbooks which are among the most important aids in Icelandic exploration. Since 1898, when Thoroddsen's journeys ended, the work has been continued by

German, British, Icelandic, and Danish men of science, who have all contributed to our knowledge of the peculiar natural conditions of the interior of Iceland. During the War, Icelandic investigation came almost to a complete standstill, but since then a number of investigators have made journeys into the country, and the results are beginning to appear in various journals.

One link in the series of these resumed investigations of Iceland is contributed by the journeys accomplished in the years 1924 and 1927 under the name of the First and Second Danish-Icelandic Expeditions, under the leadership of the author of this article and the Icelander Palmi Hannesson. The costs of these expeditions were provided by the Danish-Icelandic Confederation Fund and the Danish Carlsberg Fund. With regard to the expedition of 1924, the reader may be referred to the articles already published,[1] but in what now follows a short synopsis will be given of the work accomplished in the expedition of 1927.

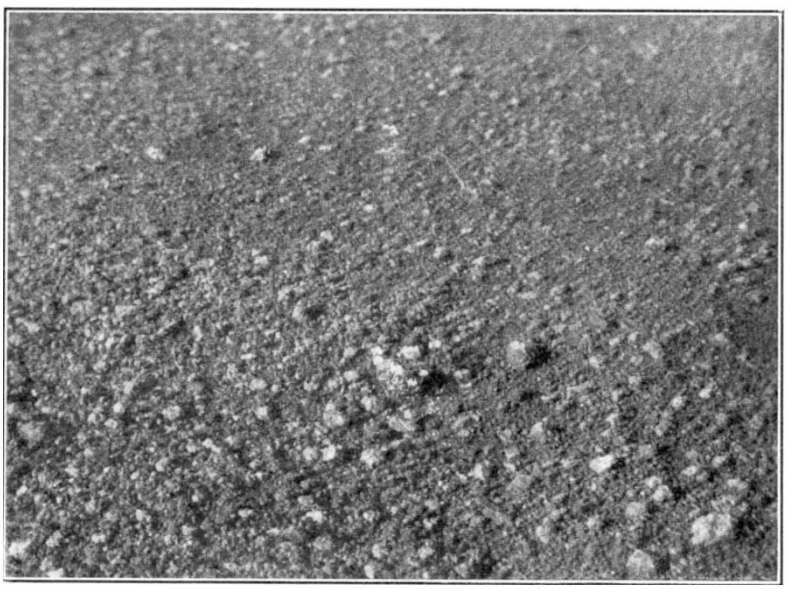

FIG. 1.—Surface of lava-gravel near Fiskivötn, Iceland. The storms, joined with the great porosity of the surface, make vegetation very scarce. In the foreground may be seen a little stunted Armeria.

The main lines of the plan were to push from the district near Hecla towards the western part of the great ice-field of Vatnajökull and to make investigations in the ice-free country west of the ice-field and its western part, the intention being to explore westward until contact was established with the districts south of Hofsjökull explored in 1924.[2] That has now been done, and the plan proved on the whole to be workable with the means and the man-power which were at our disposal.

The participators in the scientific work were Steinthor Sigurdsson, Palmi Hannesson, and Niels Nielsen. They were accompanied by a non-scientific colleague, an Icelandic schoolmaster, Sigurdur Jonsson. The work lasted from the beginning of July until the middle of September, and from July 18 to Sept. 3 the expedition was cut off from all connexion with the inhabited district except that the Danish minister in Iceland, Fr. de Fontenay, was from July 30 to Aug. 5 the guest of the expedition and took part in the work.

By far the greatest part of the highlands of Iceland is extremely deficient in vegetation and may be described as desert; but this differs very much, as great parts are covered with ice the whole year through, especially the higher altitudes of the plateaux, which embrace most of the country and in many places extend right down to the coast. The parts of the highlands which are free from snow in summer are for the most part very sparingly overgrown, and it is only at long intervals that one comes upon oases. These conditions completely govern the technique of travel in Iceland, which is based on the use of Icelandic ponies, because it is only with their help that one is able to overcome the obstacles presented by ice-fields, lava-fields, barren stretches of sand and gravel, and, not least, the great number of rivers springing from the margins of the ice-fields.

On long journeys in country free from snow it is impossible to transport fodder for the horses,[3] because a horse can only carry fodder for himself to last about ten days, so that one must depend on the few and scattered oases already mentioned. The explorations of 1927 set out from two such oases near Fiskivötn and Illugaver, both known before. On these spots we established a base whence the work was carried on, partly on horseback, partly on foot, partly by the setting up of small intermediate stations in the desert tracts around.

The equipment consisted of tents, with watertight floors, sleeping-bags of lamb-skin, and vegetable provisions for nine weeks: on the other hand, the supply of meat was quite small, the intention being to furnish the expedition with animal food by hunting and fishing. We succeeded, thanks especially to our catches of trout, in getting what we needed. For transport of men and goods, seventeen horses were employed, of which, however, immediately after our arrival at Base No. 1, four had to be sent back to the inhabited district, because there was not grass to feed them all. So the number of our horses was properly thirteen. The scientific equipment consisted, *inter alia*, of a complete outfit for mapping and astronomical determination of position (wireless receivers for

[1] *Geografisk Tidsskrift*, Copenhagen, 1924; Niels Nielsen: "Der Vulkanismus am Hvitárvatn und Hofsjökull auf Island." Meddelser fra Dansk Geologisk Forening, Copenhagen, 1927.

[2] Niels Nielsen: "Plan til en Ekspedition til den vestlige Del af Vatnajökull og tilgrænsende Egne i Centralisland." *Geografisk Tidsskrift*, Copenhagen, 1927.

[3] Conditions are quite different when one has to do with ice-tracts and can employ sledges drawn by horses; cf. J. P. Koch's journey over the inland ice of Greenland with Icelandic horses, 1912–13.

determining time and for meteorological intelligence), apparatus for meteorological observations, and a set of instruments for limnological work. We carried, besides, a good photographic equipment, both the usual plates and cinema-films.

Those who took part in the scientific work worked to some extent collectively and to some extent singly. Thus the cartographical work was mainly carried out by Sigurdsson, the limnological, as also the zoological and botanical investigations, were made by Hannesson, while I mainly occupied myself with geomorphological inquiries, especially concerning the morphology of vulcanism and tectonics. But collective work was much needed both for practical and for scientific reasons.

The results of the investigation can naturally not appear in their completed form until later, and then will probably be published as articles in journals in a widely used language, but a short survey of the materials collected can be given at once.

1. The results obtained give a series of new lights on topographical facts in the country west of Vatnajökull and the western part of that ice-mass; and on the basis of the triangulation carried out for the whole district and the detailed measurements carried out in certain cases, it will be possible to make a general survey map of the whole district and a map to smaller scale of different areas of especial geographical or geological interest. The working sketches already made show that the chief topographical lines, mountains, rivers, ice-margins, seashores, run essentially otherwise than has been hitherto supposed, and of a great part of the district it is certain that it was never before travelled in, far less mapped out.

2. The biological, and more especially the limnological, material will probably contribute to an understanding of the rigorous conditions under which animals and plants subsist in these regions, which may be described as the border-regions of the diffusion of life on the earth. A special investigation has been taken in hand of some peculiar lakes in the neighbourhood of ice-margins, which are marked by an extraordinarily rich fauna and flora, though its richness relates only to the number of individuals, not of species. Only two species of fish are found, namely, one of stickleback and one of trout, but by way of compensation the fish were very well-grown and fat; the trout weighed up to 4 kilograms. Another special research has been made into the peculiar plant-world which is found at times in the immediate vicinity of the ice-margin, and here forms such large and continuous oases that one can feed a small number of horses there for some days, a plant-world existing amid a number of concurring circumstances of a remarkable kind.

3. The geographical-geological material is very extensive and various in character. Of the topographical part, mention has already been made. In addition, there are numerous observations concerning volcanic action, which has been very violent and varied, in this part of the country. One finds, for example, typical fissure-eruptions with a great production of lava which has formed lava-fields covering many hundreds of kilometres. Again, we have single volcanoes with a mixed formation of the same type as Vesuvius, while the excrescences found at fissure-eruptions a e so slight that they are difficult to find. In one of the volcanic zones the explosive activity has been very great and has led to the formation of a number of craters or 'Maarer' of many different types. The volcanic activity can be followed from the later period of the ice age down to the present day—the last outbreak which can be dated with certainty took place in 1913. Consequent on the volcanic phenomena, many fumaroles and hot springs are found.

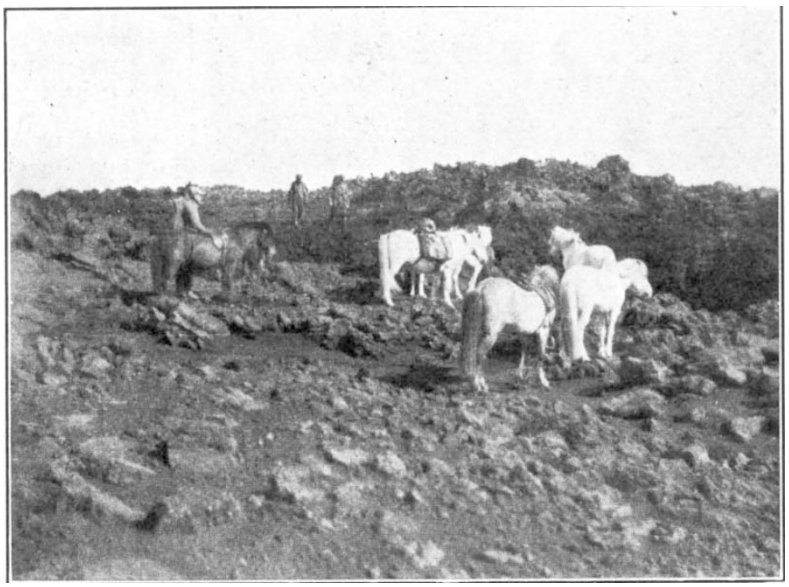

FIG. 2.—In the lava-fields immediately west of Vatnajökull. The horses are standing on an old lava-stream of somewhat loose sand, while the two men behind are walking on quite recent lava which is very difficult to cross. The demarcation of the two streams is seen quite clearly.

The country west of Vatnajökull is further remarkable for being a very disturbed country in a tectonic sense. A great part of the region is broken up by earthquakes. The displacements have especially taken place along lines running in the direction S.W.—N.E. and have divided the country into a number of ridges with intervening depressions. Some of these displacements go back to the ice age, while others are quite recent, in any case not more than some few thousand years old.

As a third factor in landscape-formation one may mention the ice, which has many times spread from the neighbouring Vatnajökull over the whole country, and the effect of which, both in earlier times and in modern times, has been the subject of study.

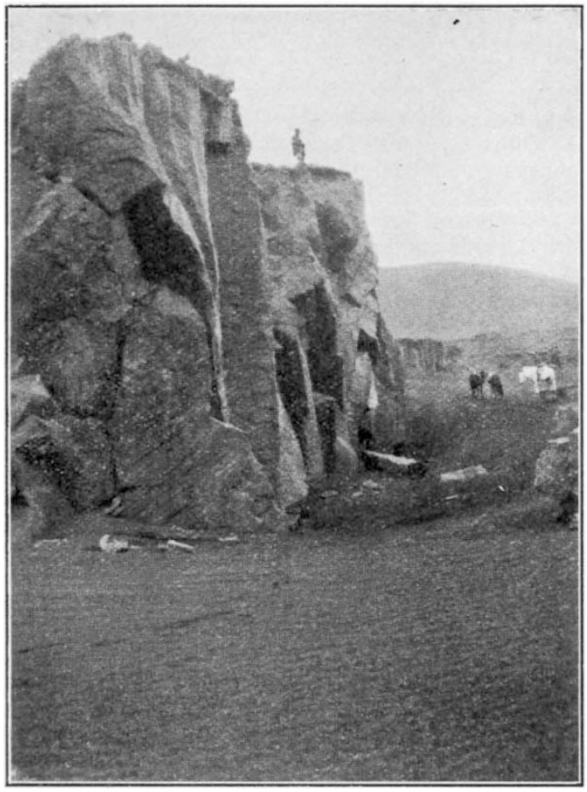

FIG. 3.—An earthquake-rift in the lava-fields west of Vatnajökull.

In this landscape, the origin of which, as has been stated, must be referred to three different sets of factors, a whole series of transforming forces are at work at this moment, and some of these have been specially investigated, because the conditions here in certain respects are abnormal. A very special rôle, for example, is played by the wind, the erosive power of which is very violent and is the cause of production of frightful sandstorms, which in their strength remind one of those that take place in the great desert regions of Asia and Africa. Another very real factor in erosion is the snow, which, together with the masses of water set free by its melting, greatly contributes to the transformation of the landscape. The reason why the above-mentioned factors play so great a part in this work, and can be studied with comparative ease, is that nearly the whole district is deficient in surface streams. Apart from the great rivers of melted ice, one finds only a few short streams, since the whole surface consists of very porous kinds of rock which absorb water with avidity and carry it underground a great distance until it emerges as springs of surprising abundance.

The expedition has met with great kindness and support on many sides both in Iceland and in Denmark, the conditions of work have on the whole been good, and the work has been carried out without serious misfortune to man or beast.

Obituary.

PROF. P. H. VON GROTH, FOR. MEM. R.S.

GEHEIMRAT PAUL HEINRICH RITTER VON GROTH, who died on Dec. 2, 1927, was born on June 23, 1843, at Magdeburg. His father was a portrait painter. His early academic studies were pursued first at the Bergakademie at Freiberg (1862–65) and then at the University of Berlin (1865–67), where he obtained his Ph.D. degree in 1868. He was successively assistant in the Department of Physics in the University (1868–70), reader of mineralogy and geology at the Bergakademie in Berlin (1870–72), and in 1872 was appointed professor in the newly constituted University of Strasbourg, where he remained for eleven years until his promotion to the chair at Munich. It was during Groth's tenure of office at Munich that the most important work of his life was accomplished. In 1874 he published his "Tabellarische Übersicht der einfachen Mineralien"—a comprehensive list of the mineral kingdom, containing not only a systematic classification of species, but also a critical survey of views on their chemical composition; subsequent editions with much new material appeared in 1882, 1889, 1898, and were followed in 1921 by a new survey, "Mineralogische Tabellen," in conjunction with Mieleitner. In 1876 he published his famous "Physikalische Krystallographie," a most readable and suggestive treatise which was for many generations of teachers and students an attractive introduction to a science that had previously been presented in a very unattractive form. Sir Lazarus Fletcher has recorded the fact that he was led to take up the study of the subject by happening to see a copy of the book in that year. Subsequent enlarged and revised editions appeared in 1885, 1895, 1905.

In 1877, Groth started the first volume of the *Zeitschrift für Krystallographie und Mineralogie*, which became universally known as Groth's *Zeitschrift*. This he edited with great skill for thirty-nine years, enlisting the co-operation of a large number of mineralogists from all countries; it was conspicuous for its international character and for the value not only of the original papers, but also of the abstracts which it contained. In a memoir which appeared shortly before his death in the *Zeitschrift*, he gave an account of its inception and a history of its progress during the period of his editorship. The fiftieth volume (1923) was a

(*Continued on p.* 107.)