The book does not give any of the scientific results of the expedition, which will no doubt prove to be valuable from an observer of such wide arctic experience as Captain Mikkelsen. The book is illustrated by many instructive photographs, which are arranged haphazard, and by a map which is the most inconveniently placed that we remember to have seen.

CORONÆ, GLORIES, AND HEILIGENSCHEIN.

DURING May and June, 1912, several correspondents described a number of optical phenomena, principally solar haloes, which they had observed just before the commencement of the remarkable haze which covered the sky in the northern hemisphere during the summer months of last year, and a short article dealing with the simpler haloes and mock suns appeared in NATURE (vol. lxxxix., p. 377). Recently attention has been directed to certain less generally known and less majestic phenomena (possibly also less ominous), which are described as (1) coronæ, (2) glories, Ulloa's rings, anthelia, or Brocken spectres; (3) haloes, or more strictly Heiligenschein or dew glories, and a note on these may supplement the earlier article.

Coronæ are luminous rings around the sun or moon, usually, although not necessarily, smaller than the smallest halo properly so called, which has a radius of 22°. The order of their colours is opposite to that of haloes, red being outside and blue inside for each ring. Inside the first ring is the aureole of a peculiar pale-tinted blue near the luminary, with brownish-red next to it. Sometimes the aureole alone is visible.

Coronæ are produced by diffraction either by small drops of water or possibly by ice-needles, although Dr. Simpson, from observations in the Antarctic with a party led by Captain Scott in September, 1911, and from theoretical considerations, concluded that coronæ there were not produced by ice-crystals, but by super-cooled drops of water, and drew the very important deduction that "liquid" water exists in the atmosphere at temperatures far below the ordinary freezing point. The more uniform the size of the drops in the cloud producing a corona, the more brilliant is the phenomenon. The angular radius θ of a coronal ring is proportional to the wave-length λ of the colour of the ring and inversely proportional to r, the radius of the drops, but a small correction is necessary on account of the fact that the sun or moon is not a point-source of light, but has a definite diameter. Observed radii θ must be diminished by 16′ before they are used in the formula $\sin\theta = c\lambda/r$, where c is roughly 0·8, 1·3, 1·9 for the first, second, and third rings. The intensity of the light in the rings is of the order of 1/100 of the intensity of the direct light from the source. The diameter of the drops in clouds producing coronæ varies from about 0·01 to 0·04 millimetres.

Glories are luminous rings seen around the head of the shadow of the observer upon a cloud. They are specially frequent upon mountains, hence the name Brocken-spectre. Antonio de Ulloa, the Spanish captain who took the French scientific expedition to Peru in 1735 and explored the Andes with Bouguer and Condamine, shares with Bouguer the honour of having first given a precise description of the phenomenon which is sometimes associated with his name. Scoresby, the arctic explorer, observed glories frequently in polar regions, with clouds rising from the sea, by climbing the mast of his ship. On one occasion he saw as many as four coloured rings.

Accounts of glories occur on almost every page of the logbook kept by the observers on Ben Nevis, and on one occasion, November 23, 1884, they saw as many as five together, varying in radius from less than 2° to more than 10°. According to Pernter, glories are coronæ produced by reflected light. They are consequently much less intense than direct coronæ, and are usually seen by sunlight. Out of nearly 200 glories described by the Ben Nevis observers, only three were seen by moonlight. Mascart, however, attributes glories to diffraction of the incident light in the same way as if it were travelling in the opposite direction, and against this explanation the objections which Miss A. Everett quotes (January 23) from Prof. Richarz would not hold.

Haloes or glories around the shadow of the head thrown on dewy grass in early morning or evening have been called "Heiligenschein" to distinguish them from haloes of the ordinary type. The "Heiligenschein" is a real phenomenon which can be photographed, and it extends some distance from the edge of the shadow. It is not to be confused with the apparent brightness around the shadow thrown on a flat surface, which is a purely subjective phenomenon. This latter may explain the brightness along the shadow of an overhead tram-wire mentioned by Mr. Merrick in a letter. The Heiligenschein is most clearly seen in meadows where the grass is more or less uniform in length and orientation, and is covered with small drops of dew. The height of the sun should be such that the length of the shadow is 40 ft. or more. The phenomenon is attributed to the light reflected from the spherical dew-drops both directly and after two refractions and one or more internal reflections. These effects give a maximum intensity in the direction of the incident light, the intensity falling off continuously without alternation of colour. It is, therefore, quite distinct from haloes, coronæ, and glories.

The halo on ruffled water described by Prof. Worthington in NATURE of February 13 (p. 647) appears to be akin to Heiligenschein, although the condition of slight turbidity which he postulates suggests that the turbid constituents may act in a similar way to fog particles.

In addition to the letters already published in NATURE, several others have been received. Mr. T. S. Patterson, of Glasgow University, refers to Benvenuto Cellini and the consolation which

golfers may gain by contemplating the Heiligenschein when they are searching in the lengthening shadows for a missing ball; Mr. G. A. Shakespeare, of Birmingham University, also refers to Cellini and to the subjective effect at the edge of a shadow, and to the peculiar effectiveness of the leaves of the white pink in producing Heiligenschein; Mr. G. Merrick, of Newcastle, states that he has observed Heiligenschein around the head of a person 4 ft. from him—an unusual occurrence—and along the shadow of an overhead tram-wire; Mr. G. M. Davies, of Croydon, describes an observation of a "glory" on Snowdon at 3 p.m. in September, 1905; Mr. Howard Fox, of Falmouth, relates an experience in Cornwall forty years ago as he was driving along the road, when he saw a glory on a low fog, followed later by a white "fog-bow." A note has also been received of a "halo" of about 15° diameter seen on the surface of Lake Suwa in Central Japan by Viscount Tanaka. In this case the phenomenon might be attributed to diffraction by minute water-drops condensed in the air just above the surface of the lake, but such an explanation would fail if, as stated, the colour-bands were radial. The phenomenon is discussed in an article (in Japanese) in the Journal of the Meteorological Society of Japan (December, 1912).

"H. V. G." refers to the radial appearance of dust on the surface of a mirror owing to the particles of dust and their images presenting to the eye the appearance of short straight lines.

E. G.

THE OIL-SHALES OF THE LOTHIANS.[1]

THE memoir on the oil-shales of the Lothians published by the Geological Survey of Scotland in 1906 contained so much valuable information that the first edition was exhausted in 1911, and the second edition, brought thoroughly to date, has now been issued, and forms a most welcome and valuable addition to our knowledge at a time when the Scotch shale-oil industry is exciting so much interest as a possible asset to the Empire in the supply of fuel oil.

Nearly the whole of the industry is confined to a belt of land some six miles in breadth, which stretches from near Dalmeny on the Firth of Forth in a southward direction to the moorlands around Cobbinshaw and Tarbrax. The first portion of the memoir is devoted to the geology of this shale-oil field, the survey of which was commenced by Sir Archibald Geikie in 1857, carried on by Mr. H. M. Cadell and the late Mr. James S. Grant Wilson, and is now brought up to date by Mr. R. G. Carruthers. The second part deals with the methods of working the oil-shales, and has been entrusted to Mr. W. Caldwell, whose wide experience as mining engineer to the Pumpherston district makes this section of special value: whilst in the third and concluding portion of the work Mr. D. R. Steuart describes the treatment of the shale from the time it leaves the mine until its products are ready for marketing.

The history of the shale-oil industry is one that always appeals strongly to the imagination as an illustration of how every obstacle can be surmounted by dogged perseverance and determination, and the fact that to-day the industry still holds its own after a forty years' war with the powerful oil combines of America and the East is one of which every British subject should be proud.

The late Lord Playfair often declared that he was the founder of the Scotch shale-oil industry, and certainly it was he who in 1847 directed the attention of James Young to a trickle of oil from the shale in the Riddings Colliery, near Alfreton. On distilling this oil Young produced an excellent lubricant, the demand for which soon exhausted the supply, and imbued with the idea that the oil had been formed by a low temperature distillation of the coal, he experimented with many varieties and found that boghead cannel from West Lothian was best suited for his purpose. In 1850 the Bathgate works were started by Messrs. Young, Meldrum and Binny, and for twelve years the boghead coal, or Torbanehill mineral as it was often called, yielded an ample supply of oil for illuminating and lubricating purposes, as much as 120 gallons of crude oil per ton being obtained from it.

The supply of this material becoming exhausted, in 1862 shale was used in its place, but yielded only a third of the volume of crude oil; in spite of this, the expiry of Young's patent in 1864 led to a rapid expansion of the shale-oil industry, which, however, received a severe check soon after. In 1859 Drake had discovered how to obtain natural oil in enormous volumes by boring in Pennsylvania, and by 1864 it began to be imported into England in large quantities, with the result that lamp oil, which during the existence of Young's patent had varied from 3*s.* 6*d.* to 2*s.* 6*d.* per gallon, fell to 1*s.* 5*d.* to 1*s.*, whilst, to make matters worse, the Americans began to import into this country lubricating oils and paraffin wax, which before had been practically a monopoly with the Scotch distillers.

In 1873 the Russian fields also entered into the competition, and for a time it appeared as if the Scotch industry must succumb, but by amalgamating the small works with the larger, by organisation, the adoption of labour-saving appliances, and the introduction of every form of economy the crisis was survived, and the manufacture of sulphate of ammonia from the nitrogen in the shale helped the Scotch oil industry to hold its own in spite of the overwhelming odds.

In 1871 there were fifty-one works in Scotland, producing 25,000,000 gallons of crude oil per year, but in 1894 these had been reduced to thirteen oil companies, and at the present time there are only seven, but the production of crude oil has risen to 70,000,000 gallons.

[1] Memoirs of the Geological Survey, Scotland. The Oil-shales of the Lothians. Part I., The Geology of the Oil-shale Fields. By R. G. Carruthers, based on the work of H. M. Cadell and J. S. Grant Wilson. Part II., Methods of Working the Oil-shales By W. Caldwell. Part III., The Chemistry of the Oil-shales. By D. R. Steuart. Second Edition. (Edinburgh: Morrison and Gibb, Ltd., 1912.) Price 2*s.* 6*d.*