HEAT-WAVES IN ASIA: SUNSHINE AT TRIESTE.

DR. H. VON FICKER contributes to the *Sitzungsberichte d. K. Akad. der Wiss.*, of Vienna (vol. cxx., part vi., June, 1911), a comprehensive discussion of "heat-waves" travelling across northern Europe and Asia during the years 1898–1902. He deals with eleven cases in which the mean daily temperature increased by at least 10° C. in twenty-four hours, and the course of the change could be traced over a large area. The majority of the "heat-waves" occurred in winter, and three of these and the single summer-"wave" are discussed in detail. The mean values for the eleven cases are treated very fully, the synchronous conditions of wind, pressure, change of pressure, humidity, and cloud each receiving as full a consideration as the available data permitted.

In a previous investigation of cold waves in the same region, Dr. Ficker found that the wind in the cold area was roughly perpendicular to the wave-front, indicating that the change of temperature was produced by the horizontal transference of a mass of cold air. The result may be compared with the deductions of Lempfert and Corless from a detailed investigation of line squalls in this country. With heat-waves, however, the wave-front travels towards the east or south-east, while the wind is from south-west. The author concludes that there is a continuous south-west current which is lifted temporarily by the mass of cold air in the cold waves, and that in the general circulation of the atmosphere this warm south-west current is the medium through which air is carried polewards. He does not attempt to determine the motive power which pushes the cold air equatorwards. It may be the unexpended momentum of a south-west current which has crossed the polar regions, or it may be due to the effect of the earth's rotation on the south-west current in the rear of the cold wave.

In the northward progress of the warm current, the cooling is less than the warming which the cold wave experiences as it moves towards the equator, and this is attributed to the lifting of the warm current, which is thereby removed from the cooling effect of the earth. The latent heat of the vapour carried by the current ought also to be an important factor.

The maximum temperatures at different places in the "heat-wave" differ much less from one another than in the cold wave, and the increase of temperature is greatest in the coldest places. There are exceptional cases in Central Asia which are explained by the dynamic warming of descending air (Föhn).

The velocity of the wave-front is about 33 km. per hour, which agrees fairly well with the corresponding velocity found for cold waves. The latter would naturally expand laterally as they progressed, so that the actual velocity of the wave-front ought to be less in the case of heat-waves, for which no such lateral expansion is possible.

The relative humidity frequently increases with the advent of the "heat-wave," and the absolute humidity invariably does so. The amount of cloud also increases in general. The conclusion is drawn that the "heat-wave" cannot be attributed to descending air, but must be due to the horizontal flow of warmer and more humid air. It is difficult to reconcile this with the conclusions based upon the observations of wind, and it is possible that the surface wind does not provide a satisfactory basis for the theory developed by Dr. Ficker. It is now established that the upper wind, at moderate altitudes, deviates considerably from the wind at the surface, and has approximately the same direction as the surface isobars. Above the south-west winds found by Dr. Ficker, there would probably be a general current from west to east, or approximately in the direction of motion of the wave-front, and the general progress of the wave may be governed by this upper current.

The paper will contribute to the solution of the problem of scientific forecasting in its wider aspects, and the author is to be congratulated on the excellent use which he has made of the data contained in the publications of the Russian Central Observatory.

The same number contains a discussion by Dr. E. A. Kielhauser of nineteen years' records of the duration of sunshine at Trieste.

In the daily variation the maximum occurs at 1 p.m. in winter and at 2 p.m. in the other three seasons, but in summer there is a secondary maximum at 11 a.m. with nearly the same value as the principal maximum. At Kew the principal maximum in summer occurs at or before 11 a.m., and is considerably in excess of the secondary afternoon maximum.

The most interesting table is one giving the number of occasions in each month on which series of 1, 2, 3 . . . consecutive days without sunshine occurred. October had the greatest number of single days, and December of series of 2, 3, 4 days, but January had the greatest total number, and stands out as the month in which the longest sunless periods occur. No period, however, exceeded eleven days, so that Trieste is more favourably treated than London in this respect. At Westminster in January of the present year there were thirteen consecutive sunless days, at Kew fourteen. The difference in favour of Trieste is not sufficient, however, to justify its inclusion in the "sunny south."

In winter the chances are in favour of a sunless day being followed by a second sunless day, but the case is reversed in summer, and on no occasion did two consecutive sunless days occur in August, which had only ten such days in the nineteen years. July is the month with the greatest total duration, but August had the smallest number of sunless days.

E. GOLD.

THE TOTAL ECLIPSE OF THE SUN, APRIL, 1911, AS OBSERVED AT VAVAU, TONGA ISLANDS.[1]

OWING to very unfavourable weather, the eclipse of last year was observed in the presence of a large amount of cloud. The lecturer, while only being able to refer to the few results that were secured, took the opportunity of explaining why expeditions were sent out to observe eclipses, and how a large expedition is organised when it is known that the assistance of one of his Majesty's ships is available. Introducing the subject with a few words as to the conditions which cause total solar eclipses, their occurrence in families, &c., he then pointed out that the sum total of time spent in useful observation at all the eclipses which have been observed up to date is very short, and amounts probably to less than three hours, for an eclipse cannot last longer than eight minutes, and does not, as a rule, exceed three minutes.

The line of totality of last year's eclipse extended across the Pacific Ocean, commencing at New South Wales, Australia, and terminating in the ocean just to the west of Central America. The central portion of the track passed near the islands of Tofua, Vavau, Tau, Nassau, and Danger Islands. Tofua being an active volcano, and Tau, Nassau, and Danger Islands difficult of access, most of the expeditions located themselves on Vavau, where there was a very safe anchorage for ships and where stores were obtainable. All the parties settled close to Neiafu, the chief village

[1] Abstract of a discourse delivered at the Royal Institution on Friday March 1, by Dr. William J. S. Lockyer.

of Vavau, and there the duration of totality was computed to be three minutes thirty-seven seconds, or 217 seconds.

In the earlier days of eclipse expeditions those who took part in them had to be content with eye observations alone. The discovery of and rapid advance made in the sensitive photographic plate, and its successful application in 1860 to eclipse work, revolutionised eclipse programmes altogether, so that an abundance of facts may now be photographed in a brief interval of time, and these be examined at leisure at a less exciting moment.

It is well to remember that many inquiries, which in the earlier days formed part of eclipse programmes, need attention no longer. Thus, for example, the corona was first thought to be the illuminated lunar atmosphere until observations proved it to be a solar appendage. Further, during eclipses the corona was supposed to be either quickly rotating or pulsating

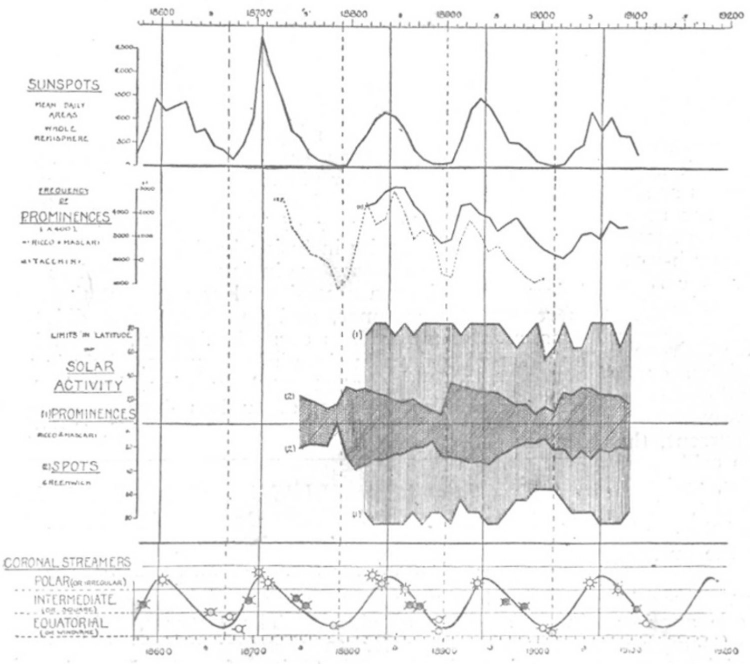

FIG. 1.—Curves to show that while the different forms of the corona exhibit a regular variation, corresponding in time to those of sun-spot areas and prominence frequency, it is the prominences (which, unlike the spots, are not limited to any latitude) that are responsible for the varying systematic changes of form of the corona.

visibly, but subsequent observations have shown that during those times it is apparently as rigid and stationary as an Indian order suspended in the sky.

The prominences, those ruddy, brilliant tree-like forms which appear during totality at the edge of the moon's limb, were also considered as belonging to our satellite, until observations in 1860 demonstrated them as belonging to the sun. While we know that they are solar, there is even now no necessity to waste time during eclipses on either the study of their forms, positions, or chemistry. The reasons for this are that in 1868 a method was devised by which they can be individually studied *visually* any day when the sun shines, and in 1891 a means was afforded of *photographing* in a few minutes, on one plate, all the prominences situated on the sun's limb.

The solution of these and other problems which might be mentioned are gradually reducing the importance of observing eclipses, and it is well within the bounds of possibility that in the near future all the main solar inquiries will be able to be conducted without waiting for their occurrence.

In recent years, among the most important work of eclipse expeditions, that of the study of the form and chemistry of the chromosphere and corona has taken first place.

Even now the research on the chemistry of the chromosphere is in process of being divorced from eclipse work. This is due to the magnificent work that is being carried on at the Mount Wilson Solar Observatory with large-scale instruments. At that observatory the chromospheric spectrum has been photographed in full sunlight. The method employed, while surpassing in accuracy of wave-length measures those made from eclipse spectra, may in time equal, or even possibly exceed, them in detail.

Thus the chemistry and form of the corona are practically the only large inquiries which are restricted to eclipses, and probably we may not have long to wait before even these form part of the daily routine of solar physics observatories situated in good observing localities.

Time will not permit me to tell you even briefly how the special results obtained during eclipses help the advancement of solar and celestial physics.

When it is remembered, however, that our sun has a temperature of about 7000° at its surface, and perhaps several hundreds of thousands of degrees at its centre—that the very sun-spots which appear to us as black spots on its surface are brighter than the brightest arc lamp—then the importance of the study of every attainable part of this very effective group of furnaces in and out of eclipse is imperative for the advancement of knowledge.

If one be permitted to refer briefly to the progress of our knowledge of the form, origin, and chemistry of the corona, you are well aware that its shape is not the same at every eclipse, but that there seems to be a systematic change going on, extending over several years (Fig. 1). A study of these forms has shown that the changes repeat themselves about every eleven years, and since the mean daily areas of sun-spots are known to have a periodicity of this length of time, their close association is generally conceded. It happens, however, that when the coronal streamers are most prominent in highest solar latitudes, and when at the same epochs the mean daily spotted area is at a maximum, the mean latitude of the spotted area is very low, being only about 15°. Thus there seems reason to question the conclusion that sun-spots at such a low latitude can originate coronal streamers so distant as the solar poles.

It must not be forgotten that a study of the frequency of solar prominences has disclosed the fact that not only have these phenomena a periodicity of about eleven years, synchronising exactly with the spotted area, but that when their frequency is at a maximum they are conspicuous at the highest solar latitudes. Thus there occur at the same time prominences and coronal streamers near the solar poles, a very possible and probable condition for cause and effect.

In the eclipses of 1901 and 1905 several striking photographs were secured illustrating intimate association between prominence and the overlying coronal material, thus affording further evidence of their close connection.

While, therefore, prominence activity is most likely responsible for providing and raising the material from the body of the sun in the various latitudes according to the different epochs of prominence activity, what action is it that organises and arranges the streamers which extend sometimes five or six millions of miles into space?

The close association between the occurrences of terrestrial magnetic storms and solar disturbances, and the results of the researches which were described in this institution in 1909, namely, the discovery of solar vortices and the presence of powerful magnetic fields which result from the revolution of the negatively charged particles, termed corpuscles, in them —these suggest strongly a cause, namely, electromagnetic action, to explain the effect.

So long, then, as the corona can only be observed during eclipses, the study of its general form and its structure in close proximity to prominences should be minutely recorded and discussed.

About the chemistry of the corona nothing is known. The spectroscope on many occasions has permitted observers to photograph the many radiations that it emits, and while numerous determinations of the wave-lengths of these radiations have been made, no terrestrial equivalents have yet been discovered. Thus its composition is still a mystery.

For the occasion of last year's eclipse the main work intended to be accomplished by the expedition of which I was in charge was a study on a large scale of the spectra of the chromosphere and corona, together with the form of the corona.

For the spectroscopic work, two instruments giving large dispersion were constructed, adjusted, and taken out, and several coronagraphs of different focal lengths were utilised for recording the form of the corona.

The large spectroscopes were of two kinds, one being of the "slit" type, employing a 10-ft. concave grating, while the other was of the "slitless" or prismatic camera type, in which the dispersion was secured by four 6-in. prisms of 45° angle.

The lecturer then referred to the various eclipse parties, namely, the two British official parties under himself and Father Cortie, a private party under Mr. Worthington, an Australian party under Prof. Baracchi, and two other observers who went out separately. The great assistance which the officers and men rendered to the lecturer's party can be gathered from the fact that 14 officers and 107 men took part in the observations.

Vavau was reached on April 2, and a camp was set up about a mile and a half up the harbour.

Work was commenced at once to clear the ground for the eclipse and living camps, to cut paths, and to erect landing-stages and steps. The various groups of volunteers confined themselves to their several duties, and general working parties were formed for fetching dead coral, sand, and water for the concrete pillars, for building the pillars, and putting together and covering the instrument-huts and dark-room.

FIG. 2.—A view of the eclipse camp (Solar Physics Observatory expedition).

The weather experienced for the first week was all that could be desired in the way of absence of rain, but the high humidity, coupled with a high temperature and the presence of millions of flies and thousands of mosquitoes, rendered the work of the camp formation extremely arduous. In the water we had other enemies in the form of sharks and sea-snakes.

At a later stage a rainy type of weather set in, and it was the exception to have a day free from it. Tropical downpours were very frequent, and special precautions had to be taken to have efficient coverings for every instrument and to trench the small compounds in which each instrument was enclosed.

By April 20 arrangements were sufficiently advanced to warrant the commencement of rehearsals, and on six days before the eclipse these rehearsals took place (Fig. 2).

During the period occupied in preparing the instruments for the eclipse, transit observations were being conducted for time and position, meteorological observations were being made at fixed times, and continuous records were being secured by a barograph, thermograph, and hygrograph.

In order to eliminate any doubt as to the possible inaccuracy of the computed times of the contacts of the limbs of the sun and moon, and also to give certain prescribed signals to those observers whose programmes necessitated them, a special telescope was set up (in conjunction with the siderostat of the 6-in. prismatic camera) to throw an image of the sun on a previously marked disc. The face of this disc was so graduated as to enable the observer to estimate the angle subtended at the centre of the dark moon by the remaining bright crescent of the uneclipsed portion of the sun; previous calculations had shown that when the crescent subtended angles of 90°, 45°, and 30°, there remained 42, 9, and 4 seconds respectively before totality began. This method only holds good when clouds do not obstruct the view of the sun.

In order to allow for the contingency of second contact not being seen on account of clouds, the observer was furnished with a deck-watch to give all the necessary signals at their computed times. The actual code of signals was as follows:—

10 minutes before totality (wind clocks, caps off, lamps lit)...	Bugle	"Rouse up"
5 minutes before totality ...	,,	"Alert"
42 seconds ,, ,, ...	3 blasts (whistle)	
9 ,, ,, ,, ...	2 ,, ,,	
4 ,, ,, ,, ...	1 ,, ,,	
Totality begins, "217" on eclipse clock	Voice	"Go"
Totality ends, "0" on eclipse clock	,,	"Stop"

Eclipse day, April 28, or, as we had not altered our date since we crossed the "date line," April 29, dawned. It was a cloudy morning, and too cloudy to make one believe that it would clear up for the eclipse.

The lecturer here referred in the main to the account of eclipse day which he gave previously in these columns (vol. lxxxvi., p. 567, June 22, 1911).

The following table shows the observed and calculated times, and it will be seen that second contact occurred about 23 seconds before the expected time, and the duration of totality was nearly five seconds shorter than was anticipated:—

—	Contacts		Duration
	Second h. m. s.	Third h. m. s.	m. s.
Calculated (Downing) ...	9 37 1·7	9 40 38·5	3 36·8
Observed (Lockyer)... ...	9 36 38·6	9 40 10·7	3 32·1
Difference	23·1	27·8	4·7

Large differences of time were experienced also by the Australian observers, whose time arrangements were quite independent of those of my party.

With the spectroscopic cameras of my party practically no results of any value were secured, while in the case of the coronagraphs nearly all the negatives displayed strong images of the clouds which marred the coronal streamers. Only two of the large number of plates exposed are of value, and these are restricted to the structure of the lower corona.

There is little doubt that the gradual fall of temperature during the eclipse, which was found to be 5° F., favoured the conditions of cloud formation in such a humid atmosphere, and thus prevented us from making satisfactory observations.

The work of all the other groups, such as those for sketching the corona, for the observation of the shadow bands, shadow phenomena, &c., was all for the main part spoilt by the presence of the clouds, in spite of the care taken in widely distributing the parties. Some interesting observations were, however, made by those who watched the behaviour of animals, &c.

While my party, together with that of Father Cortie, fared very badly, the Australian observers were more fortunate, and Mr. Worthington and his staff more fortunate still. With regard to the results secured by these parties, I can only show you in the

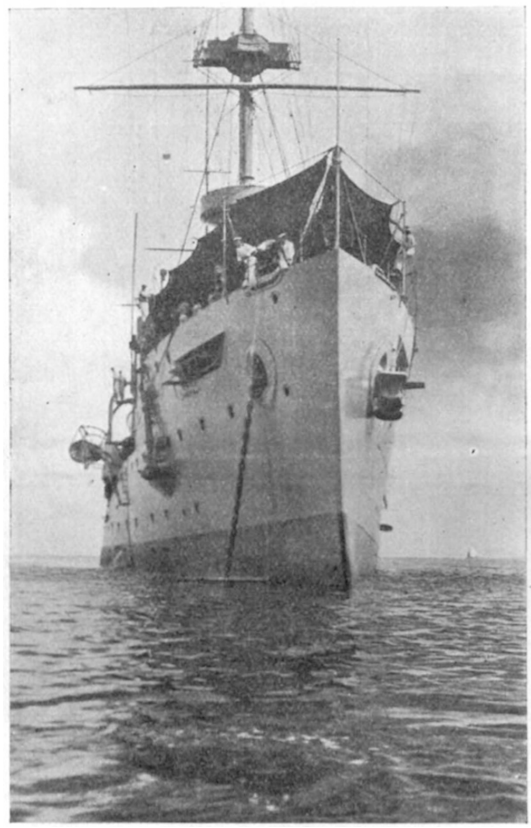

FIG. 3.—H.M.S. *Encounter* weighing anchor at Suva, Fiji, after landing the S.P.O. observing party.

case of the Australian observers a combined sketch carefully made from Mr. Dodwell's negatives and visual observations. This shows clearly the extensive equatorial streamers and the open spaces at the solar poles filled with the beautiful forms of the polar plumes. This corona is undoubtedly one of the "minimum" type, representing the wind-vane form. When this was compared with the sketch I made at the time of the eclipse, it was seen that both were in fair agreement in most of the main features.

Through the kindness of Mr. Worthington, I have been allowed to show you some of the beautiful results which he secured. Unfortunately, like us, he did not obtain any spectra, although he was equipped with a very fine instrument specially adapted for the ultraviolet region of the spectrum, but, unlike us, he was compensated by success on other lines. Both the long and short exposures with his coronagraphs met with success. Beautiful structure is displayed in the regions of the solar poles, and the equatorial streamers are extensive and full of detail. These photographs also exhibit a "minimum" type of corona, corroborating the observations of the other parties; they are of considerable value as records and for future study, and form the main contribution to solar physics which this eclipse has afforded.

Although the astronomical results of my party were chiefly negative, we managed to get together at odd moments a collection of specimens for the Natural History Museum at South Kensington, the Botanical Gardens at Kew, and the Physic Garden at Chelsea.

In concluding this account, I should like to place on record in this institution the fine way in which the volunteer observers of my party worked in sometimes very trying circumstances; the magnificent assistance rendered by the captain, officers, and men of H.M.S. *Encounter*; the great liberality of the Orient Steam Navigation Company in again transporting out and home all our instruments, baggage, &c., free of charge; and lastly, the assistance of many individuals who at various stages of our journey made matters as easy as possible for us.

THE RELATIONSHIP OF NEANDERTHAL MAN AND PITHECANTHROPUS TO MODERN MAN.[1]

THE more the remains of Neanderthal man are studied, the more it becomes apparent that Prof. Schwalbe is right in regarding this Pleistocene race as being totally distinct from all existing races of mankind. It is true that Neanderthal man in some characters, for instance, the teeth, shows a certain degree of specialisation, but in the vast majority he is infinitely more simian than any race now living. He serves in some degree to carry human history towards an ape stage. Those who believe that modern man has been evolved in a comparatively brief and recent geological period are inclined to accept the Neanderthal type as representative of mankind of a late stage of the Pleistocene epoch, and to suppose that modern man has been evolved from the more primitive type since that date.

Two lines of research have rendered such beliefs untenable. All the remains of Neanderthal man so far discovered in France and Belgium are referable to a limited and late part of the Pleistocene epoch. The flint implements and accessory evidence show that Neanderthal man flourished in Central Europe during the Mousterian and earlier part of the Aurignacian periods. All trace of this type then disappears; the races which immediately succeed it are of the modern type; the evidence points to an extermination of the ancient or Neanderthal type early in the Aurignacian period.

In those long stretches of the Pleistocene epoch—the Acheulean and Chellean—which precede the Mousterian period, and are characterised by flints of great beauty of workmanship, no trace of Neanderthal man has been found in Europe. The remains which have been discovered show that the Europeans of the Chellean and Acheulean periods were of the modern type. Lately, M. Rutot, of Brussels, has tabulated a list of the human remains which he regards as referable to pre-Mousterian periods, and in every case these belong to mankind of the modern type.

Prof. Keith reviewed the evidence relating to the human mandible found by Boucher de Perthes at Moulin Quinon in 1863, and came to the conclusion that it was an authentic document. Boucher de Perthes found it in a stratum containing implements of the Acheulean period. The mandible is peculiar in form, but is clearly of the non-Neanderthal type. No trace of Neanderthal man has been found in Italy, but human remains of the modern type have been found in Lombardy and Tuscany in strata which in point of formation long preceded the Mousterian period.

The most convincing evidence of the early existence of the modern type of man is to be found in England. The Galley Hill remains from the 100-ft. terrace of the Thames Valley are at least Chellean in date; according to M. Rutot they are much earlier. The fragmentary Bury St. Edmunds skull, of which Prof. Keith has lately made a minute examination, is of the modern type, and in point of date belongs to the Acheulean period. The human skeleton lately discovered by Mr. J. Reid Moir beneath a stratum of weathered chalky Boulder-clay near Ipswich is much older than the Galley Hill remains, yet in all its characters the Ipswich skeleton represents the modern type of man.

The only remains of man so far discovered in Europe which certainly antedate the Ipswich skeleton is the Heidelberg mandible, which must be assigned to the oldest part of the Pleistocene epoch. The Heidelberg jaw clearly formed part of the skeleton of a primitive form of Neanderthal man. On the evidence at present available, it must be inferred that two types of man were in existence in Europe during the Pleistocene epoch: (1) the Neanderthal type, represented by the Heidelberg mandible, near the beginning of that epoch, and by the various skeletons found in Belgium and France near its end; and (2) the modern type, represented by remains of many races belonging to the inferior, middle, and superior formations of the Pleistocene epoch. It is evident, too, that the point at which these two types of mankind emerged from a common stock must be assigned to an earlier date than most anthropologists are inclined to admit at present—probably to the older part of the Pliocene period.

That the modern type of man must be of great antiquity is evident from the degree of divergence which is to be seen amongst existing races of mankind. All the evidence at present at our disposal indicates that human races change very slowly in their physique; to produce the negro of Africa and the fair-haired European from a common stock clearly demands a very long period of time. Of all the races now existing in the world, the native Australian most nearly approaches the type which might serve as a common ancestor for African and European. He combines the characters of each, and at the same time has certain features which link him to the Neanderthal type. At least such a surmise serves as a convenient working hypothesis.

The structural differences between the Neanderthal and modern types of man are similar in nature, although somewhat less in degree, than those which separate the gorilla from the chimpanzee. Those two anthropoids are more nearly related structurally than is usually supposed. There is a similar differentiation among the modern gibbons of the Far East and among the extinct Miocene gibbons of Europe. The siamang and Paidopithex represent the gorilla or Neanderthal form; the gibbon and Pliopithecus correspond to the type represented by the chimpanzee and modern man. In all these groups of higher Primates the same process of evolution seems to be at work.

Although the results of more recent inquiries place

[1] From Hunterian Lectures delivered at the Royal College of Surgeons, England, on February 26 and 28, March 1, 4, 6, and 8, by Prof. Arthur Keith.