Buckmaster and Gardner had shown that when a mixture of chloroform and air is inhaled, almost all the drug is held by the red corpuscles; in one case no less than 98·5 per cent. of the total chlorine in the blood was found associated with the red corpuscles after 2 per cent. of chloroform vapour had been inhaled for three-quarters of an hour. It would appear, therefore, highly probable that in chloroform narcosis the transport of chloroform from and to the lungs is a function of the red corpuscles, which are the chief vehicle for the drug. If this is the case, it is obvious that although the absolute quantity of chloroform in the blood of any individual would vary with the mass of blood, the percentage amount in a sample of blood would not vary, other conditions being constant, whether the total amount of blood in the body was augmented or diminished. A large number of experiments were therefore performed, in order to elucidate this point. The general aim of these was to vary the mass of blood either by bleeding or by introducing the greater part of the blood of one animal into another of the same species. The blood was directly transfused. In experiments where the asphyxial state was reached rapidly, the average percentage of chloroform in the blood was found to be practically identical before (0·043 gram) and after bleeding (0·045 gram). In cases where the asphyxial state occurred half an hour to an hour and a half after the commencement of chloroform-inhalation, the figures were 0·048 before and 0·051 after bleeding. The paper gives full details of fourteen experiments which have been made as to the percentage amounts of chloroform in blood before and after hæmorrhage, and these, together with other experiments in which comparisons were made with a normal, with an augmented, and with a diminished mass of blood in the same animal, show conclusively that the percentage of chloroform in the blood does not vary with differences in the mass of the circulating blood. The results of the experiments are therefore in complete accord with what would be the case if, as Buckmaster and Gardner suspected, the red corpuscles were the essential agents for the transport of chloroform.

The curves which illustrate the chloroform-content of the blood during the induction of anæsthesia with 2 per cent. or 3 per cent. of inhaled chloroform vapour are of much interest. At the present time these curves, constructed from data fully given in tabular form, possess great interest. Not only are they the only curves which exist that show clearly the rate at which the percentage of chloroform rises in the blood from the commencement of the administration of the anæsthetic, but the fact which is so well known, that deaths during anæsthesia not infrequently occur within two or three minutes after the patient commences to inhale, is easily understood, for the chloroform-content of the blood mounts up so rapidly at first as to constitute a veritable danger-point. The amount or tension of the drug in the blood rises in the initial stage of anæsthesia with great rapidity to a value which approaches a maximum. If the individual passes this stage naturally, then after a distinct fall in the chloroform-content of the blood, the amount of the drug quickly rises again towards a maximum value, and an equilibrium between the factors which determine the amount of chloroform in the blood is subsequently obtained, the processes of intake and output at the surface of the lung going on side by side. This period corresponds to the second stage of anæsthesia. It may last for one or more hours, and represents the state of surgical anæsthesia. But the condition of the individual is far from one of safety, for although this stage can be maintained with an amount of chloroform in the inspired air which could not have induced anæsthesia, throughout the whole of this time the difference between the amount of chloroform which is present in the blood and what is found at the lethal point is very minute. The authors have laid special stress on this point, and from a careful examination of their curves it would appear that their contention is a sound one.

In their third paper Buckmaster and Gardner have studied the rate of elimination of chloroform after anæsthesia. Five typical experiments, accompanied with full data and curves, are given. During recovery from chloroform small quantities of blood were in some cases taken at intervals from an artery; in other cases the blood was taken by a long canula from the venous system close to the right auricle of the heart, and one curve is constructed from data obtained by analysis of samples, taken simultaneously, of arterial and venous blood from the carotid artery and the neighbourhood of the right auricle. The authors find that the rate at which chloroform is eliminated at the surface of the lungs is at first comparatively rapid, though subsequently this becomes much slower. But the initial rates of elimination are much less rapid than the initial rates for absorption, and therefore, on the whole, elimination of the drug is a much slower process than the assumption. From Tissot's observations it would appear that during recovery from chloroform anæsthesia the amount of the drug in venous blood constantly exceeds the amount in arterial, and he suggests that a study of the chloroform-content of arterial blood should be made during the induction of anæsthesia, and of venous blood during the disappearance of this state. Buckmaster and Gardner do not confirm all the results obtained by Tissot, though they are in entire agreement with him on the important fact that at the moment when the inhalation of chloroform is stopped, arterial blood always contains an excess of the drug when compared with the amount in venous blood.

The salient points of these researches have now been indicated. The application of an exact method, and the performance of a large number of experiments which were carried out under precisely similar conditions in the physiological laboratory of the University of London, have enabled Dr. Buckmaster and Mr. J. A. Gardner to complete this portion of their work, and their results will probably afford a sure basis on which a full knowledge of the physiology of the anæsthetic process during the inhalation of chloroform may in the future be built up.

ARCHÆOLOGICAL REMAINS IN WALES AND THE MARCHES.

IN the sphere of archæology the University of Liverpool bids fair to surpass all other British homes of learning, ancient or modern. Backed by a number of wealthy citizens, more cultivated than the corresponding class in any other town of the Empire, it has lent generous aid to the excavator, and is able to boast, at the present time, of a vigorous archæological school directed by men whose names are pledges of efficiency in their several departments. So far, however, it has interested itself mainly in the elucidation of classical history, in the study of Greek art, and in exploration in Asia Minor and Egypt. Now for the first time its attention is being directed to regions nearer home; at the instance of many Celtic scholars, and numbers of influential Welshmen both in the city and the Principality, it is undertaking the supervision of no less a work than the survey and

systematic excavation of historic remains in Wales and the Marches. As a result of the meeting convened by the Lord Mayor of Liverpool (Dr. R. Caton)—an event already chronicled in these columns—a fund has been started and committees appointed—general, advisory, and financial—for the furthering of the scheme. The actual operations, needless to say, will be watched by the heads of the archæological school, Profs. Bosanquet, Garstang, Myres, and Newberry. Assistance has also been promised by Prof. Haverfield, of Oxford. The work will be carried out in cooperation with the University of Wales, with the Cambrian Archæological Association, with the district or county societies, and with such local committees as it may be found advisable to form from time to time. All these bodies are to be represented on the general committee, which is to include the names, not only of well-known scholars, such as Prof. Haverfield, Sir John Rhys, and Dr. Arthur J. Evans, but of patriotic Welshmen representing every interest and every shade of opinion.

The magnitude of the undertaking and its importance for the study of Welsh ethnology and history can hardly be exaggerated. Owing, it is suggested, to the absence of a capital where their records could be brought together and examined, the Welsh have unduly neglected the investigation of their past, so that the questions which beset the historian are unusually numerous and difficult. It has been the fashion hitherto to search for their solution in the national literature, the memoirs, so to speak, of the people themselves, taking them, in fact, at their own valuation. It cannot be denied that this method has its advantages, the facts which it supplies, when they can be shown to be facts indeed, stamping themselves on the mind with peculiar vividness. In this case, however, they have only too often ended as they began, mere autobiography, with little or no objective value, good material for history, it may be, but still not history. It can no longer be doubted that the study of the Welsh texts, if it is not to end in mere guess-work, must be supplemented for the early period, at any rate, by the study of evidence of another kind, the evidence, that is to say, of historic sites and monuments. That such is to be obtained has been shown by the sporadic excavations of recent years, but until last November it seemed useless to hope for a systematic archæological inquiry; now at last, under the direction of men who will not suffer a penny or the stroke of a pick to be spent in vain, the secrets of cromlech, camp and battlefield will be brought to light, and the story of the past reconstructed step by step.

There are several directions in which research seems particularly needed. It is important in the first place, through the exploring of Roman sites, to determine the relation of the mountaineers to the Roman army in possession, a subject which so far has remained shrouded in mystery. How excavation can help to increase our knowledge of the later Roman Empire may be seen from the work carried out in Germany and Austria, in North Africa and Asia Minor, where the Roman frontier defences have in each case been marked out and made available for comparison, or, looking nearer home, from the operations of the Society of Scottish Antiquaries and other learned bodies, during the past ten years, in Scotland. Though only nine or ten of the Scottish forts have been investigated, definite conclusions have already been formed. The scanty statements of civilians writing at a distance, which used to be our sole authorities for Roman Scotland, it has now been found possible to verify and amplify by means of the handiwork and personal belongings of the frontier guards themselves. At the present time there are ten Roman sites, most of them military posts, awaiting excavation in Wales and the Marches, and there is no reason to doubt that it will be as fruitful in their case as in any of those we have mentioned. We shall be disappointed indeed if it does not enable us to judge of the length of the Roman occupation of Wales, of their frontier policy, and the character and methods of their government. We need hardly point out that light shed on these subjects will be light, not only on the Silures, but on Roman Britain as a whole.

From the Roman remains the committee may proceed with advantage to the examination of the sites and monuments of early Christianity in Wales. Here also valuable data may be had for comparison from other countries, much having been done, both in Ireland and France, to preserve and record the memorials of the primitive church. Among Welsh ecclesiastical sites Bangor is y Coed in Flintshire, and Whitland (Ty Gwyn Ar Dav) in Carmarthenshire seem to promise the richest results. Again, the monasteries of Norman times might be explored with a view to the production of a Welsh Monasticon, the place and personal names in the charters to be corrected with such accuracy as to make these a help, not, as now, a stumbling-block to the student.

Other subjects for investigation will suggest themselves without doubt to all those interested in the early history of this island. The reader will have noticed that the researches specified above are mainly in the nature of digging out or clearing of the ground. We need scarcely remind him that valuable evidence may also be obtained through the observation of things on its surface. The materials for the early history of Wales, like that of other countries, must be sought with the theodolite no less than with the pick or shovel. That it will help us to fuller knowledge of the pre-Celtic inhabitants of the country has been made clear by Sir Norman Lockyer during his expeditions to South Wales. He has indicated the lines to be followed in this kind of inquiry, and the committee cannot do better than follow in his steps. It is occupied as yet with preliminary arrangements. Among the subjects which may be expected to engage its attention in the first instance are the following:—

(*a*) The preparation of an archæological map of Wales and the Marches, on which all known sites and individual finds shall be marked, together with a bibliography and index of all known information regarding them.

(*b*) The execution of an archæological survey of the whole area, to supplement the recorded material, and complete the archæological map, so far as surface evidence is required.

(*c*) The consideration of a scheme of successive excavations for the sites, which may be selected as of most crucial importance, for the solution of the questions of distribution and historical sequence, certain to be raised by the preliminary survey and mapping.

We will only remark, in conclusion, that great schemes cost money, and that those which we have been discussing are not likely to disprove the rule. The expense of surveying a county has been estimated at 150*l.*, that of excavating each of the Roman forts, together with the exploration of the adjacent roads and the subsequent publication of results, at not less than 1000*l.* Liverpool is proverbially generous, but even so there will be ample room for the liberality of sympathisers outside, both Welshmen and others. We sincerely hope that the appeal of the committee will not be made in vain; it would be regrettable indeed if its work were retarded or hampered through lack of the necessary funds.

We are given to understand that an illustrated

report of the work will be presented every year to subscribers of 2*l.* 2*s.* and upwards, and for five years to all donors of 10*l.* 10*s.* Cheques should be sent to the treasurer, Mr. T. Rowland Hughes (North and South Wales Bank, Liverpool), and requests for information addressed to the organising secretary Captain A. O. Vaughan (38 Bedford Street, North Liverpool).

DR. P. J. C. JANSSEN.

FRANCE is again called upon to mourn the loss of a veteran astronomer whose services have rendered him conspicuous among the many eminent men of science his country has given to the world. Jules Janssen, born in 1824, was first a painter, but for more than fifty years contributed to the scientific literature of his country and enriched many departments of physics by his untiring energy, his accurate observations, and his fertility of resource. He was a great traveller; his first scientific expedition was in 1857 to Peru, to study the magnetic equator. Ten years after he was studying the eruption of Santorin with Fouqué. It is not possible to do justice to his work within a small compass, but fortunately its salient features will long remain fresh in our memories.

Janssen's reputation will rest mainly upon his numerous and important researches on light spectra, and the methods he employed for pursuing his investigations. He early recognised the power of the spectroscope as an engine for research, and in its application to many problems connected with solar activity he was without rival among his own countrymen. In 1862, he published the first results of his celebrated researches on the origin of the telluric lines in the solar spectrum, and it is only necessary to recall the history of spectroscopy in the last half-century to make us appreciate the value of his pioneering services in this direction. The perseverance and ardour with which he pursued this subject was shown, first at La Villette, where he so arranged his experiments that the light the spectrum of which was to be examined passed through a tube, 37 metres long, containing steam under a pressure of seven atmospheres, and later, at Geneva, where in another series of experiments the light traversed several miles of atmosphere immediately overlying the lake. For many years the same problem in different aspects occupied his attention.

Long after the part played by water vapour in modifying the spectrum had been settled, Dr. Janssen had recourse to experiments of the same nature in order to decide the precise character of the spectrum effects due to oxygen. The pursuit of this question and his anxiety to vary as much as possible the conditions under which his observations were made, carried him to the top of Mont Blanc, where his experiments warranted him in asserting that there was no evidence of the presence of oxygen in the exterior and cooler parts of the solar atmosphere. To speak with equal confidence of the lower, and, consequently, hotter layers, it was necessary to examine the spectrum of oxygen when submitted to high temperatures and great pressure. By ingenious devices, Dr. Janssen succeeded in raising oxygen to a temperature of 800° or 900°, and in placing the gas under a pressure of 1000 atmospheres. As before, his observations pointed to the absence of oxygen in the sun's atmosphere. His researches on the effect of planetary atmospheres in modifying the spectrum of solar light were equally thorough and satisfactory.

The observations made on Mont Blanc firmly convinced Dr. Janssen of the advantages offered by high mountains for the conduct of certain inquiries, in which it was of importance to reduce as far as possible the thickness of the atmosphere, through which observations had to be made. In spite of increasing age and the inconvenience of lameness, he interested himself energetically in the construction of the Mont Blanc Observatory, and on more than one occasion personally made the ascent of the mountain to assure himself of the success of the enterprise. Under his auspices various physical inquiries have been successfully pursued in this elevated observatory.

As an observer of the sun at the time of total solar eclipse, Dr. Janssen was indefatigable. In 1868, he began that long series of observations which have so much enriched our knowledge of the sun's surroundings. For it was while observing this eclipse at Guntoor that he was impressed with the possibility of observing the prominence lines on the limb of an uneclipsed sun. How, without delay, he put his plan into operation and enjoyed the advantage of a prolonged eclipse is well known, as also the fact that the announcement of his discovery reached the Paris Academy of Sciences at the same time as a similar contribution from Mr. (afterwards Sir Norman) Lockyer informed that body of the successful results of his more prolonged researches. The claims of each have been fully admitted, and just as the names of Adams and Le Verrier are connected with a famous problem in gravitational astronomy, so those of Lockyer and Janssen are joined in the solution of a fundamental problem of physical astronomy. A medal containing effigies of the heads of the two astronomers side by side was struck by the French Government to commemorate this "Janssen-Lockyer Discovery." This is an oft-tale tale, and it would not be necessary to repeat it here but for one circumstance which is not so well known, and which it is desirable to emphasise. This is the generous recognition which Dr. Janssen ever expressed towards his English *confrère*, and his ready acknowledgment of the value of English work. Fortunately, the days of international jealousy in science have passed, but the loyal and hearty appreciation which Dr. Janssen exhibited stands out as a conspicuous example of unselfish and kindly interest, in which no unworthy considerations found a place. Needless to say that his warm-hearted sympathy and encouragement was highly valued and cordially reciprocated.

At Sir Norman Lockyer's suggestion, Janssen was invited to join the English Eclipse Expedition of 1870, and as he was then in besieged Paris, thanks to the exertions of the English Foreign Office the invitation reached him there by the hands of Bismarck, who accompanied it with a safe conduct. This he declined, and left the beleaguered city in a balloon. On that occasion he carried with him the essential parts of a reflector especially constructed to collect evidence about the solar corona. He repaired to Oran, and deserved better fortune than to find the sky completely obscured by clouds at the time of the eclipse. In 1871 and 1875 he was again in Asia, taking part in the observation of solar eclipses, while in 1883 he was one of that remarkable party of enthusiasts who repaired to the lonely coral reef in the Pacific known as Caroline Island. For this eclipse Dr. Janssen used telescopes of six and eight inches aperture, and on his photographs obtained an extension of the corona further than it could be traced in the field of the telescope, revealing a remarkable complexity of structure. Here, too, he confirmed his previous suspicions of the presence of reflected Fraunhofer lines in the spectrum of the corona. His passionate interest in solar phenomena never deserted him, and on the occasion of the eclipse in 1905, notwithstanding his advanced age, he was