withdrawal of light. But, in the present state of our knowledge, we become painfully aware that we are lacking sufficient data to group even our most important forest-trees in a series according to light-requirements. This is not so, however, in Europe. Some forty years ago German foresters made observations along this line, formulating them and elaborating rules for the management of the various species, especially in thinning, mixing, and cutting for reproduction; and, although these rules have been practised for so long a time based on empirical knowledge, it is only now that Dr. Kienitz offers a physiological explanation of the difference in the behavior of trees under changing light-conditions. He found that on the same branch those leaves which are developed under the full influence of the sunlight are not only, as was known before, often larger and always tougher in texture, and thicker, but they have a larger number of stomata (or 'breathing-pores'), than those formed under less exposure to sunlight. The same, of course, was observed in individual trees grown under shade and in full enjoyment of light. If, then, the trees which have their foliage formed under the shade of outgrowing neighbors are suddenly placed in different light-conditions, the foliage is not adapted to perform its function as energetically as the stronger light necessitates. The buds which are formed in deficient light, show also in their leaves a deficiency in the number of stomata; and in consequence the favorable influence upon wood-formation, due to increased light, for which the thinnings and interlucations are made, become in fact noticeable only the second year, when new buds, developed under the increased light-influence, have formed leaves adapted to the changed conditions. In conifers, which hold their leaves for several years, this adaptation naturally takes a much longer time; and under unfavorable conditions, if moved too suddenly from the shade into the light, they often lose their old foliage, and even die before the new foliage adapted to the light-influence is sufficiently developed to sustain the increased demand of respiration, transpiration, and assimilation.

"The importance of this knowledge becomes apparent when we attempt to formulate the rules for thinnings, etc. There is hardly any line of investigation, observation, and experiment more fruitful, and more needed for the practical purposes of forest planting and management, than to establish this relation of our timber-trees to light-conditions. The rational compositions and form of our plantations, their management and reproduction, are based upon this knowledge, and the proper application of it may be well termed 'the essence of forestry.'

"Observations and experiments, therefore, in regard to the dependence of our important timber-trees upon light-conditions, are among the first to be undertaken by the experiment-stations in the forest and in the nursery.

"Hand in hand with these experiments, will go, of course, the inquiries into the rate of growth and yield before alluded to. If there are old growths at hand, the influence upon the yield of thinning with consequent 'undergrowing' may be ascertained."

ETHNOLOGY.

The Prehistoric Race of Spain.

MESSRS. H. AND L. SIRET have published the results of their interesting archæological researches in south-eastern Spain, and from their finds trace the history of the primitive people inhabiting that country. The most ancient remains show this people living in the neolithic period; later on, copper and bronze were used. Thus the researches of the authors give interesting confirmation of the recently established fact, that a copper age preceded the bronze age in most parts of Europe. At the close of the bronze age, silver is first used, and fortified villages occur. At the same time the methods of manufacturing bronze are improved. No iron was found in any of the stations of this people. There were two modes of burial: the dead were buried in large clay vessels, or the corpses were burnt. Weapons, ornaments, tools, food, and earthenware are always found in the graves, of which about a hundred were explored. The latter have been studied by Jaques. The results of the latter are summarized by Kollmann as follows. First of all, the principal result is of great value: various races occurred among these early inhabitants. No history mentions the name of this people. Since the neolithic period it has remained in the same locality. The impression is, that its culture developed continuously without any breaks. Its origin and descent are unknown, but one fact is shown by the forms of the skulls: it was a European people, consisting of European types, the same as live at present in Europe, and which lived at a still earlier period in the caves of Estremadura and at the kitchen-middens of Mugem, or later on in the dolmens near Lisbon. A series of dolichocephalic skulls has been found with an average cranial index of 73.8, and long face. The nose is long and the orbit high. This is the exact counterpart of the long skull of the northern inhabitants of Europe. Besides these, Jaques found a short-headed race, also with long faces, high noses and orbits. Their type also occurs frequently in northern Europe. A third race is also brachycephalic, but its characteristics are a broad, flat face, and strong prognathism. Broca considers this type mongoloid. Nevertheless, from a study of the photographs contained in the work, we assume that this race also is of exactly the same type as the European broad-faced, short-headed races, and does not resemble the Mongols. Besides this, a race with broad faces and long heads, the Cro-Magnon race of French writers was found. The fundamental conclusion from these facts is, that in this early period the shores of the Mediterranean were inhabited by several European races. Kollmann considers this result a confirmation of his theory that the migrating European tribes spread early over the whole continent, and that all European peoples consist of a mixture of these earliest inhabitants.

THE EVOLUTION OF ORNAMENTS. — There are few branches of ethnology in which the usefulness of extensive collections becomes more evident than in the study of the development of ornament. It is only in collections of this kind that incidental ornaments can be distinguished from characteristic ones. Since Holmes's admirable study of American ornaments, a number of essays have been published, most of which refer to the islands of the Pacific Ocean. Some time ago we mentioned Dr. L. Serrurier's study of arrows from New Guinea, which was published in the *International Ethnographical Archive*. The May number of the *Journal of the Anthropological Institute* contains another paper on a similar subject. Mr. Henry Balfour has studied a collection of arrows from the Solomon Islands, which are on exhibition in the Pitt Rivers Museum at Oxford. The ornamental design of these arrows is invariably found immediately above the joints of the reed of which the shaft is made. It usually consists of a number of incised straight lines, blackened, and running parallel to the shaft, so as to form a band round it. Balfour shows that this design originated in the necessary smoothing-off of the joints. When this is done, the fibrous nature of the substance of the reed causes narrow strips to peel away along the length of the shaft. To prevent this peeling extending far, cross-notches were cut. This was the origin of the ornament, which was later on retained, even when other methods of smoothing off the joints were used. Balfour compares this ornament with those of reed arrows from other countries, and shows that it is probably confined to the Solomon Islands, other methods of ornamentation and of smoothing the joint being used by other peoples. He mentions only a single arrow from South America of a similar description.

HEALTH MATTERS.

Diagnosis of Human Blood.

THE diagnosis of human blood is discussed by Dr. Henry Formad in the *Journal of Comparative Medicine*. Especial attention is given to the methods of examining blood-stains and measuring the blood-corpuscles.

For testing the question whether a certain substance is blood or not, the spectroscope and chemical re-agents come into play; but for the recognition of human blood the microscope alone is of any value, and the sole method yet found available with this instrument is that of measurement of the corpuscular elements. The differentiation of mammalian blood from that of lower orders of animals is made easy by the fact that in mammals alone is the cell round and non-nucleated. The differentiation between the blood of man and that of lower mammals depends entirely upon the micrometer.

Only the following animals have corpuscles larger than man, i.e., larger than $\frac{1}{3200}$ of an inch; viz., the elephant, great ant-eater, walrus, sloth, platypus, whale, capibara, and (according to Wormley) opossum. Animals the corpuscles of which are slightly below man in size, i.e., having corpuscles from $\frac{1}{3500}$ to $\frac{1}{3200}$ of an inch average diameter, are the seal, beaver, musk-rat, porcupine, monkey, kangaroo, wolf, and guinea-pig. None of these are domestic animals. All other animals, including all domestic animals, have blood-corpuscles of a mean diameter less than $\frac{1}{3500}$ of an inch; and, in fact, those animals which, as a rule, are blamed for blood-stains found on the clothing and apparel of criminals (ox, pig, horse, sheep, and goat), have corpuscles with an average diameter less than $\frac{1}{4000}$ of an inch. He summarizes the facts as follows: —

1. The blood-corpuscles of birds, fishes, and reptiles, being oval and nucleated, can never be mistaken for human blood.

2. Fresh human blood cannot be mistaken, under the microscope, for the blood of any animal the corpuscles of which have a mean diameter of less than $\frac{1}{4000}$, or even $\frac{1}{3600}$, of an inch.

3. (*a*) If the average diameter of blood-corpuscles in fresh blood is less than $\frac{1}{4000}$, then it cannot possibly be human blood; (*b*) if the diameter is more than $\frac{1}{3500}$, then it may be human blood; (*c*) if the blood-corpuscles, after exhaustive measurement, give a mean diameter of more than $\frac{1}{3300}$, then it *is* human blood (provided it is not the blood of one of the wild beasts referred to).

The foregoing applies especially to the diagnosis of fresh blood. With regard to dried blood, it is claimed that this can be recognized just as readily, provided it has dried quickly. Blood that has dried slowly undergoes decomposition, and its morphology cannot be made out. A good liquid for remoistening blood is Müller's fluid; but perhaps the best is Virchow's solution, composed of thirty parts caustic potash and seventy parts water. At least five hundred measurements should be made in order to establish the average diameter of the cells.

If the corpuscles are spheroidal from absorption of moisture, or crenated from drying, they may still be diagnosed, because such changes are the same in the corpuscles of all animals, and have really their proportionate and corresponding ratio of alteration in form and diminution in size, the range or scale of diminution being always alike in the same animal.

The red blood-corpuscles that have become spherical from imbibition of liquid have thus presented in Dr. Formad's experiments the following average diameters in the various animals: 1. Man, $\frac{1}{4300}$ inch; 2. guinea-pig, $\frac{1}{4500}$ inch; 3. Wolf, $\frac{1}{4600}$ inch; 4. Dog, $\frac{1}{4800}$ inch; 5. Rabbit, $\frac{1}{4900}$ inch; 6. Ox, $\frac{1}{5600}$ inch; 7. Sheep, $\frac{1}{6700}$ inch; 8. Goat, $\frac{1}{8100}$ inch.

These figures show that the diameter of the artificially spherical corpuscles in each animal is just about one-third less than that of the normal bi-concave or disk-like corpuscles of the same animals.

The question has long been a mooted one, as to whether the microscope can be depended on to determine positively, or not, that a given specimen of blood is that of a human being. Dr. Formad believes that this can be done, while other microscopists of equal eminence deny the possibility.

VACCINATION. — That small-pox has greatly declined in England during the past fifty years is apparent from figures which have been published by Dr. Henry Thorne. From 1838 to 1842 the deaths from small-pox in England amounted to 57.2 per 100,000; in 1880–84 the death-rate was 6.5 per 100,000. He thinks that vaccination has not only a direct influence in causing this reduction in the number of victims to small-pox, but that it has also a tendency to decrease the liability to the disease of children of vaccinated parents. In this connection it is interesting to note that *The Medical Press* states, that, out of the five thousand children born every month in Paris, only a thousand are vaccinated by the medical officers appointed for that purpose. The remaining four thousand infants are therefore either vaccinated by private practitioners, or not at all. Seeing, however, that more than half the population apply for and receive gratuitous medical attendance, and that half the burials are gratuitous, it is very unlikely that all of the four thousand are vaccinated at the cost of the parents. It may fairly be assumed that a large proportion are not vaccinated at all, and that is why small-pox exists as an endemic disease at Paris, and does not disappear, as it has done, to a great extent, in Germany.

ELECTRICAL SCIENCE.

Experiments in Proof of the Electro-magnetic Theory of Light.

IN his presidential address before the mathematical and physical section of the British Association, Prof. G. F. Fitzgerald dwelt at length on the recent experiments of Hertz in Germany on the propagation of electro-magnetic disturbances. These experiments are of so much importance, and go so far toward confirming the electro-magnetic theory of light, that a brief *résumé* of the subject will not be untimely.

There have been for years two theories with respect to the action upon each other of quantities of electricity, and of elements of electric current. One held that the various phenomena were caused by direct action at a distance; the other, that they were due to the action of the intervening medium. With respect to the electrostatic phenomena, Faraday's discovery that the capacity of a condenser varied with different dielectrics between the conducting coatings, made the theory of direct action extremely improbable; and his work, with that of Maxwell, has put the theory of an action of the dielectric on a firm foundation.

With respect to electro-magnetic phenomena, however, the case is different. Maxwell, in his magnificent work on electricity and magnetism, developed the idea that electro-magnetic actions are dependent on the surrounding medium, and one of the results is the electro-magnetic theory of light. But there has been no direct and unquestioned proof that there really is such an action in the dielectric as Maxwell has supposed. To illustrate the fundamental ideas involved, suppose we have a condenser made of two sheets of tinfoil with glass between; and suppose, further, that we have a battery whose poles may be connected to the coatings of the condenser. If we suddenly connect the poles to the coatings, there will be a momentary current, which will last only long enough to charge the condenser, probably for only a small fraction of a second. Now, the general idea was, that there was a current in the battery, and in the wires used to connect it with the condenser; and the result was to charge the two coatings, one with plus, the other with minus, electricity; and there the action stopped. Maxwell's idea was, that the current, so long as it lasted, was perfectly continuous, but that in the glass plate the action consisted of a 'displacement' of electricity; that is, considering a number of planes drawn through the conductors and through the glass, perpendicular to the direction of current, the amount of electricity crossing any plane was the same at the same instant, but that in the glass the result was a state of strain, exactly as if a spring were bent. The amount of 'displacement' depends on the displacing force, — the electro-motive force of the battery. When the proper displacement has taken place, all further action ceases, unless the strain is too great, in which case the dielectric breaks down, and we have the well-known phenomenon of disruptive discharge. The amount of displacement determines the charge of the condenser. When the electro-motive force is removed and the coatings joined, the strain in the dielectric relieves itself, producing the discharge.

If we charge the condenser with an alternating current, we have in the glass continuous displacement currents, first in one direction, then in the other.

From this fundamental idea of looking to the dielectric for the really important part of the phenomena, Maxwell was led to consider the laws by which the vibration of electricity on a small conductor would be propagated in the surrounding medium. He found that the equations governing the propagation were essentially the same as those deduced from the elastic solid theory of light; and he found that the velocity of propagation of such a disturbance was equal to a certain electrical constant which has several times been determined, and which agrees, within the limit of experimental error, with the value of the velocity of light. He also showed a relation between the specific inductive capacity and index of refraction of substances, which has not been completely proved, but which is suggestively close.

Here the matter dropped for a while. The theory has been extended, notably by Rowland and Fitzgerald, to account for other phenomena of light, but no experimental evidence of a conclusive nature has been produced.