are near land or shallow water, and apparently follow the trend of such upheaved parts of the earth's crust.

The positions of the soundings are :—

Lat. S.	Long. W.	Depth. Fms.	Depth. Feet.	Nature of bottom.
23° 39′	175·04	5022	30,132	(Wire broke.)
28° 44′	176·04	5147	30,882	Red clay.
30° 28′	176·39	5155	30,930	Red clay.

The attached chart shows their general position, the Kermadec Islands being 500 miles north-east of Auckland in New Zealand.

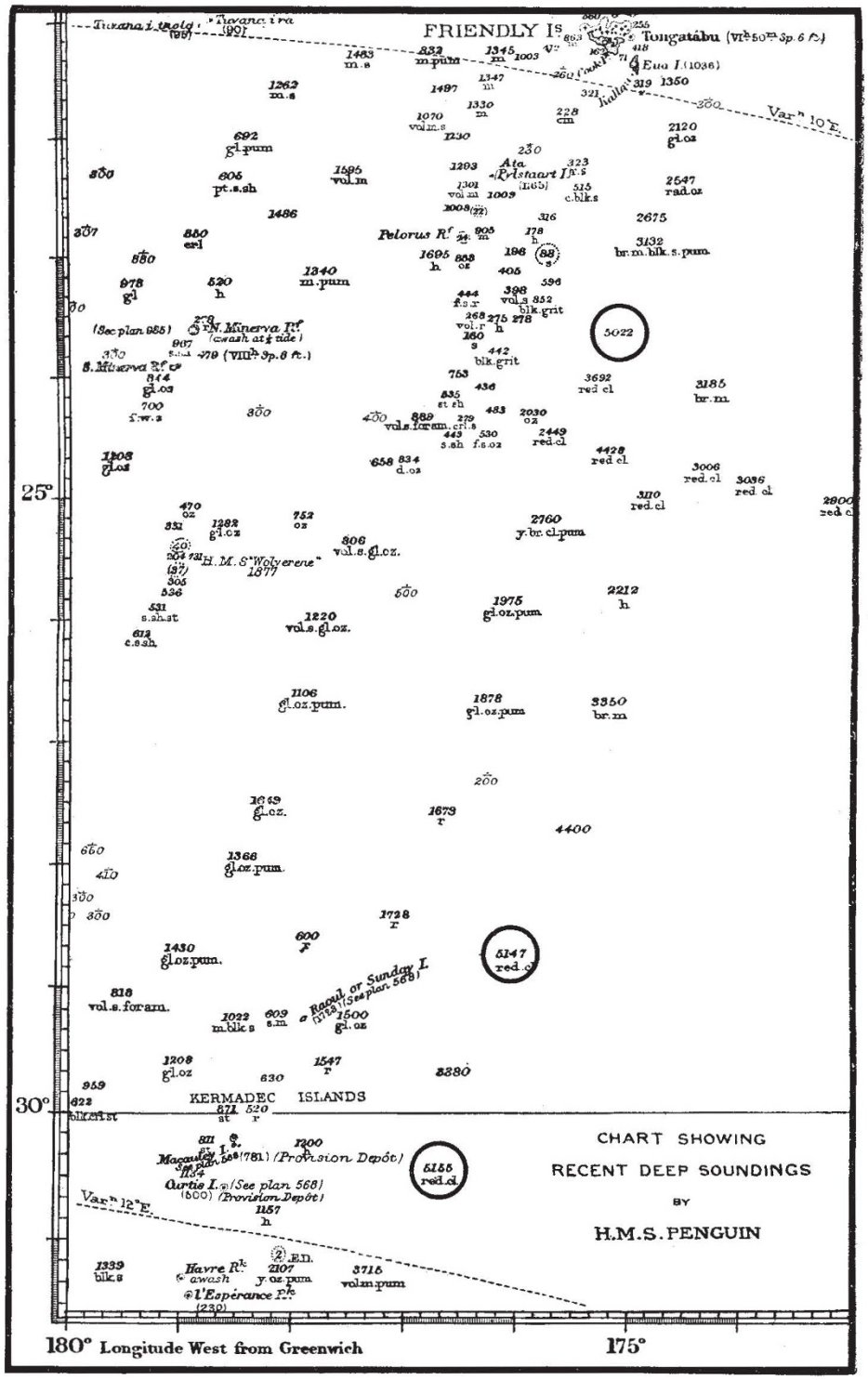
W. J. L. WHARTON.

THE DESTRUCTION OF TREES BY LIGHTNING.

IN an article[1] by Dr. Carl Müller, on the probable causes which induce lightning to strike certain kinds of trees and not others, the writer brings together some very interesting information, which has from time to time been gleaned from experiments and observations. In Germany, where the study of forestry is considerable, and where any experiments for procuring the welfare and preservation of trees are treated with great importance, the investigations on the point now under consideration have a very practical object, for great damage must be yearly done by the storms which occur there during the summer months. The work to which reference is here chiefly made is that of Dimitrie Jonescu,[2] and his observations are based on close observation in the field and experiments in the laboratory. The knowledge that we thus obtain contrasts strikingly with that previously attained, which was founded, for the most part, on conjecture and hearsay.

It has long been known that lightning seemed to have a special fascination for certain kinds of trees, and therefore preferred to strike these rather than others. We have been informed, for instance, that the laurel was seldom if ever struck; while the oak, on the other hand, was the tree which, above all others, was signalled out for this purpose. We do not mean to say, however, that other trees are never damaged in this way, for all are to a more or less extent; but it seems that, in consequence of an unknown reason, preference is given to some more than to others.

A study of this question therefore, if it is to be



[1] *Himmel und Erde* for Jan. 1896.

[2] "Uber die Ursachen der Blitzschläge in Bäume" in "Jahresheft des Vereins für Vaterländ. Naturkunde in Württemberg," 1893, S. 32-62.

thoroughly well undertaken, must not be restricted simply to the species of tree, but should include the conditions of their position and surroundings, such as soil, moisture, &c., as these may play an important part.

The only operations, as far as we know, that seem to have been systematically carried out on these lines, are those which since the year 1874 have been made by the fürstlich Lippe-Detmoldschen Forstdirektion.

The statistics show that from 1879 to 1890 lightning had struck 56 oaks, 3 or 4 pines, 20 or 21 firs, but not a single instance of a beech tree was recorded. These facts will be seen to be of importance when it is stated that the relations between the numbers of different kinds of trees in the region under observation were such that, out of 100 trees, about 70 were beech, 11 oaks, 13 pines, and 6 were firs. The numbers show at a glance that beech trees seemed to have been entirely free from attack, although they were twice as numerous as all the other trees put together. A practical hint can at once be deduced from this; for protection against lightning, when one is in, perhaps, a wood, can be apparently secured, provided of course there are beech trees there!

In the investigation of the underlying causes, it was considered unnecessary to take into account the nature of the soil, for observation showed that trees situated on wet ground were very often struck, thus contradicting the generally conceded idea that this only occurred when they were on soil which contained a very small amount of water. Further, it was also difficult to trace any connection between the different depths to which the roots of trees extended, since this is a subject about which very little is known, and no statistics are at hand for trees that have been thus damaged.

The next step was to consider the species of tree, and investigate whether any facts here might be brought to light. With this point well in mind it was necessary, first, to determine the degree of conductivity of the different kinds of wood. Experiments in this direction have previously been made by Du Moncel, but his observations, for many reasons, gave very variable values, so variable in fact that he himself could not lay any weight on them.

One fact known, with regard to the conductivity of different species of wood by the help of the electric spark, is that electricity is conducted better in the direction of the grain than in the direction perpendicular to it. Further, Caspary has shown, in the case of lime- and dry pine-wood, that conductivity varies according as the direction is longitudinal, radial, or tangential.

Notwithstanding the results just mentioned, Jonescu[1] undertook the work afresh, and made independent observations, employing the electric spark throughout, and taking into consideration the anatomical, chemical, and physiological properties of the different kinds of wood.

It will be sufficient for us to deal simply with the results of these investigations, without entering into the method of experiment adopted.

The first experiments with oak and beech indicated that the former was a very much better conductor than the latter, just as appeared to be the case from the statistics given above, if conductivity be assumed to play the most prominent part. Similar experiments were made with black-poplar and willow. With living wood—that is, wood just cut, and therefore containing moisture—the percentage of the latter being, according to Schübler and R. Hartig, for black-poplar 51·8, beech 39·7, oak 35·4, and willow 26·0, experiments led to the result that conductivity of wood in this state is independent of the amount of moisture inside.

[1] Berichten der Deutschen Botanischen Gesellschaft. Bd. xii., 1894, S. 129-136.

Extending the observations over a far wider range, and employing numerous different kinds of woods containing varying quantities of fatty materials, such as oil and resin, it was discovered that the wood cut from living trees was in every case a worse conductor of electricity the more oil or resin they contained. The fresh wood of trees, on the other hand, which are rich in starch but poor with regard to fatty matter, conducted electricity very well, although no large difference for the various kinds of wood was noticed.

It will thus be seen that the question under consideration seems to reduce itself to the finding out the qualities of the juicy matters in the wood of the trees, as these seem to play an important, if not the whole, *rôle* in the proceedings.

As regards the distribution of the fatty materials and the starch in the wood of trees, we have to apply to Fisher and Suroz, who, from their investigations on these points, have shown that the quantity of oil and starch varies with the time of year; they have, further, classified trees according to their richness in these materials.

According to these facts then, assuming in the case of Germany that it is during the summer months that thunderstorms are most frequent, those trees rich in fatty materials (Fettbäume), and which during the summer contain much of them, are to a great extent protected against lightning. Those, on the other hand, that are poor in oil during the period of thunder-storms, and especially such trees which contain much starch (Stärkbäume), are more liable to be struck.

One very interesting example to which reference is made is the wood-pine. This tree, during the summer months in Germany, is, comparatively speaking, very often damaged, while in countries where the thunderstorms occur in the winter months (Ireland and Norway) it is usually untouched. To explain this according to the deductions of Jonescu's observations, it must be shown that in winter the tree is richer in oil than in summer. A microscopic examination of samples at both these periods of the year has proved conclusively that this is really the case, the oil disappearing in April, to have its place taken by glucose and starch. Employing the apparatus previously referred to, Jonescu found that for the winter wood of this tree double the amount of potential energy was required for sparking purposes than was required when operating with the summer wood.

As a check on his own results, Jonescu took the wood of typical trees rich in fatty materials (Fettbäume), beech and walnut, and found that when deprived of their oil by means of ether, their degrees of conductivity were increased and became practically the same as those of the wood of typical trees rich in starch (Stärkebäume).

The above explanation of the causes which render some trees more than others liable to the destructive power of a lightning flash, helps certainly to explain other points of less importance. Experiment showed that for both kinds of trees, namely, those rich in fatty materials and starch respectively, the wood in the living state is a far worse conductor than when dead. This leads to the deduction that trees with dead branches on them are more likely to be struck than those without any, so that they should be avoided if possible. Jonescu's hypothesis also explains why it is that lightning does not as a rule strike the highest part of a tree, but generally the trunk, either inside or underneath the crown.

In conclusion, it is to be hoped that these investigations of Jonescu, to which only brief reference here has been made, will be followed by observations and statistics from other sources, for this question is one that is of very general interest. It is sad to think, however, that the oak, a tree which we cherish so much, is such a friend to flashes of lightning in the way of conduction, that it in this way brings on its own destruction. D.