mountains. Sometimes they are manufactured articles, stones or blocks of wood cut into some shape which has a meaning either obvious or traditional.

The universality of this tendency to connect some material objects with religious worship, and the immense variety of modes in which this tendency has been manifested, is a fact which receives a full and adequate explanation in our natural disposition to conceive of all Personal Agencies as living in some form and in some place, or as having some other special connection with particular things in Nature. Nor is it difficult to understand how the embodiments, or the symbols, or the abodes, which may be imagined and devised by men, will vary according as their mental condition has been developed in a good or in a wrong direction. And as these imaginings and devices are never, as we see them now among savages, the work of any one generation of men, but are the accumulated inheritance of many generations, all existing systems of worship among them must be regarded as presumably very wide departures from the conceptions which were primeval. And this presumption gains additional force when we observe the distinction which exists between the fundamental conceptions of religious belief and the forms of worship which have come to be the expression and embodiment of these. In the Religion of the highest and best races, in Christianity itself, we know the wide difference which obtains between the theology of the Church and the popular superstitions which have been developed under it. These superstitions may be, and often are, of the grossest kind. They may be indeed, and in many cases are known to be, vestiges of Pagan worship which have survived all religious revolutions and reforms; but in other cases they are the natural and legitimate development of some erroneous belief accepted as part of the Christian creed. Here, as elsewhere, Reason working on false data has been, as under such conditions it must always be, the great agent in degradation and decay.

METEOROLOGICAL ELECTRICITY.

Ciel et Terre gives a description of a cyclone which passed over Japan on the night of the 3d or 4th of October, 1880. At Tokio a rapidity of 45 metres per second has been observed, but this had only a rapidity of 10 metres; its diameter was not very considerable, 240 kilometres. The fall of the barometer, though rapid, was far from being as prompt as that occurring eight days before on the coasts of the Island of Formosa, where a depression of 73 millimetres in 4 hours, or 18 millimetres per hour, was observed. These indicate that the old theory of whirlwinds is perfectly useless to account for meteorological phenomena.

THE APERTURE OF MICROSCOPE-OBJECTIVES.

The last number of the *Journal* of the Royal Microscopical Society is largely occupied with a discussion of this question by Prof. E. Abbe, of Jena, and Mr. Frank Crisp, one of the secretaries of the Society.

The subject appears to have been again brought up by a paper by Mr. G. Shadbolt (President of the Society in 1856), who claimed to have "demonstrated beyond dispute that no objective could have an aperture of any kind in excess of 180° angular in air." The grounds on which Mr. Shadbolt rested his demonstration are disposed of in detail in the papers now published; but with this aspect of the matter we do not propose to deal, confining ourselves to the more general consideration of the subject, apart from any controversial matter.

The proper definition of the aperture of a microscope-objective was, for a long time, as is well known, a very vexed one among microscopists. The astronomer has always a ready definition for the telescope, the aperture of which was simply estimated by the absolute diameter of the object-glass. No such absolute measure is, however, possible in the case of the microscope-objective, as the lenses of which it is composed vary in diameter within considerable limits, and the larger lens is by no means the larger aperture, as is readily seen by the comparison of the large lenses of the low powers with the small lenses of the high powers, which yet much exceed the former in aperture.

In consequence of this difficulty, the angle of the pencil, as it emanates from the object, and prior to its transmission through the objective to the image, came to be very generally considered as the proper measure of the aperture of the objective. This was at a time when dry or air objectives were generally known, immersion objectives not having been brought into ordinary use.

But even with air objectives the angle of the radiant pencil did not afford a true comparison, which could only be made by the *sines* of the angles; but when immersion objectives were originated—that is, objectives in which water or oil replaced the air in front of the objective—the use of the angles became very misleading, for now three angles might all have the same number of degrees and yet denote very different values, according as they are in air, water, or oil.

It therefore became necessary to find a substitute for the angles in the comparison of apertures; for although it was no doubt possible to bear in mind that 82° in air was less aperture than 82° in water, and the latter less than 82° in oil, yet the use of the same figures inevitably tended to produce confusion in the minds of microscopists—so much so that it was stoutly maintained by one party that the apertures in the three cases we have referred to were identical because the angles were the same.

A solution of the difficulty was discovered by Professor Abbe, who pointed out that the true definition of aperture (in its legitimate meaning of "opening") was obtained when we compared the diameter of the pencil emerging from the objective with the focal length of the objective.

It will be desirable to explain somewhat more in detail how this conclusion is arrived at—as given in Prof. Abbe's paper.

Taking in the first case a *single*-lens microscope, the number of rays admitted within one meridional plane of the lens evidently increases as the diameter of the lens (all other circumstances remaining the same), for in the microscope we have at the back of the lens the same circumstances as are in front in the case of the telescope. The larger or smaller number of emergent rays will, therefore, be properly measured by the clear diameter; and as no rays can *emerge* that have not first been *admitted*, this must also give the measure of the admitted rays.

Suppose now that the focal lengths of the lenses compared are not the same,—what then is the proper measure of the rays admitted?

If the two lenses have equal openings but different focal lengths, they transmit the same number of rays to equal areas of an image at a definite distance, because they would admit the same number if an object were substituted for the image—that is, if the lens were used as a telescope-objective. But as the focal lengths are different the amplification of the images is different also, and equal areas of these images correspond to different areas of the object from which the rays are collected. Therefore, the higher-power lens, with the same opening as the lower power, will admit a *greater* number of rays in all from the same object because it admits the *same* number as the latter from a *smaller* portion of the object. Thus if the focal lengths of the two lenses are as 2:1, and the first amplifies N diameters, the second will amplify 2 N with the same distance of the image, so that the rays which are collected *to* a given field of 1 mm. diameter of