mits in itself no other mathematical comparison than that of equality and inequality, and no other mathematical treatment than simple increase or decrease, and in consequence it does not admit directly of ordinary mathematical investigation. Number and extended magnitude, such as length, duration, &c., admits of comparison by ratio, and of addition, subtraction, multiplication, division, &c. Magnitudes of degree are only brought under mathematical processes by means of conventional measurement. That is to say, some number or extended magnitude, which is found by experience to vary with the magnitude of degree, is adopted eventually as the measure of that magnitude, and mathematical processes are applied to the measure. It is incorrect, however, to say that we take an extended magnitude which varies in direct proportion with the magnitude of degree, as its measure, because direct proportion of magnitudes which vary together involves inequality of ratio of corresponding value, and, as already stated, the proportion of ratio does not really subsist between different values of a magnitude of degree, though from the intimate mental connection between certain magnitudes of degree and their measures, we often think it does.

When, for instance, we say that the brightness of two equal lights is double that of either, the statement is quite incapable of proof by experiment, and is certainly not intuitional; it is simply conventional. If we agreed that the brightness of a number of equal lights should be measured by the square root of the number, we should have to consider that the brightness of light varies inversely as its distance instead of as the square of its distance from its origin,—a result against which nothing could be urged but its practical inconvenience. Or, to take the example of a magnitude of degree whose conventional movement is somewhat less familiar to our minds: when we say that our expectation of an event which happens on an average three out of four times is double of our expectation of an event which happens once out of four times, we are clearly using words in a conventional way. The one belief is not really double of the other, but the average by which we agree to measure it is double.

Now with respect to force and mass, both magnitudes of degree, it so happens that there are two almost equally natural methods of measuring them consistent with, but nevertheless independent of, each other. Each of these may be conventionally adopted, but in either case its consistence with the other can only be demonstrated by experiment.

If you agree to measure force as directly proportionate to the acceleration it produces on a given mass, and mass as inversely proportionate to the acceleration produced by a given force, then, to that extent, the second law of motion, and the law which is sometimes adopted in place of Newton's third, are the results neither of experience nor intuition, but simply of convention; but then, on the other hand, it must be held that it is by experience we come to the conclusion that the mass of two bodies, *as above measured*, is the sum of their two masses, and the weight of two bodies the sum of their weights. If, on the other hand, you conventionally measure forces by the number of equal weights which will produce the same effect, and masses by the number of bodies of equal mass which make them up, then clearly the truth of the above portion of the laws of motion can only be proved by experience.

The mistake made by some mathematicians is that while ostensibly assuming the one conventional measure of force and mass they tacitly assume the other, and then illogically profess to demonstrate the necessary consequences of their own conventions by reference to experience founded on the other. They agree to measure force by the acceleration it produces in its own direction on a given mass, and then profess to prove forces do produce such proportionate acceleration by reference to experience, on the assumption that forces are to be measured by the number of equal weights or other forces which will produce the same effect.

In the case of the first law of motion, mathematicians often commit an error even more flagrant. To define force as that which affects motion, and then to profess that it is proved by experience that a body acted on by no force will remain at rest or move uniform, is on the face of it absurd. As well might Euclid, after defining a circle, have appealed to experience to show that a figure, every point of whose circumference is not equally distant from the centre, is not a circle. Or as well might a doctor begin by defining intoxication to be a state produced by taking alcohol, and then appeal to the experience of the Good Templars to prove that in the absence of alcohol there is no intoxication.

Herbert Spencer seems to me to be wrong, therefore, in concluding that our belief in the laws of motion is in the true sense (if it has any true sense) intuitive; but his error is the more excusable on account of the confusion of ideas involved in most mathematical explanations of these laws.

F. GUTHRIE

Graaff Reinet College, Cape of Good Hope, June 21

ORGANISATION OF THE FRENCH METEOROLOGICAL SERVICE

THE measures we alluded to in NATURE, vol. x. p. 294, with respect to the French Meteorological Service, have been partially adopted, and will be shortly followed by others. The Meteorological Service has been divided between two astronomers—M. Rayet, who has under his special care the magnetical map of France, the official observations taken at the observatory, and the several French stations; and M. Froat, who has been appointed to investigate the great disturbances of the atmosphere, to send warnings to the principal French seaports, to publish the atlas, and correspond with the several departmental commissions which have been already appointed. These departmental commissions are appointed by the prefect of each department, and funds are granted to them out of the departmental budget and voted by the Council-General of each department.

M. Leverrier issued, on August 5, a circular to these general commissions, informing them that the printing of the storm-maps, which had been stopped owing to the country's calamities, was to be resumed.

Special mention is made in this circular of the hail-storms which have been studied most carefully by MM. Becquerel, father and son. Nothing has been done yet to increase the efficiency of lightning conductors.

The several departmental commissions, numbering about ninety, including Algiers, have been grouped into six natural regions. M. Ch. Sainte-Clair Deville has been sent to Algiers to organise the meteorology of that country, from the sea to the remotest parts of the French possessions in the desert. He has not finished his tour yet. He is General Inspector for Meteorology, and had issued an order for altering the hours of observation, which order was cancelled by the Ministry.

Some arrangements have yet to be made with the navy for the storm warnings. Very likely French seaports will continue to receive warnings from England, which are very popular, as well as warnings from their own observatory.

NOTES

MR. BRIAN HODGSON, F.Z.S., has presented to the library of the Zoological Society a large collection of original drawings of Himalayan Mammals, made during his residence in Nepaul. They are of much scientific value, as being in many cases taken from the types on which his species are founded.

M. MAREY has recently published the results of experiments undertaken to determine by the graphic method what is the true movement of the legs in walking. His results prove convincingly that the brothers Weber were wrong in assuming that the oscillation of the leg which is not in contact with the ground is the same as that of a pendulum; for when it is represented on a uniformly moving plane, the line drawn is a straight and not a curved one. The movement of the suspended foot is therefore uniform, depending on muscular action, in combination with that of gravity.

DR. MORRISON WATSON, Senior Demonstrator of Anatomy in the University of Edinburgh, has been appointed Professor of Anatomy in the Owens College, Manchester.