servations has led the authors to the conclusion that the nocturnal periodicity of the larvæ is primarily dependent upon periodic variations in the arterial supply of larvæ to the cutaneous vessels. The periods of sleep and activity of the patient were reversed, and there resulted a gradual change in regard to the period of the cutaneous immigration of the larvæ. After four days the maximum concentration of the larvæ in the cutaneous vessels had been changed from midnight to 6 a.m., and after eleven days to midday. Graphs showing the number of larvæ per c.c. of blood passed in the urine reveal the existence of a regular periodicity corresponding with that of the larvæ in the cutaneous blood, with the difference that the time of maximum concentration of larvæ in the renal and vesical vessels was several hours later. Messrs. Malins Smith and Matthews give, in the same number of the Annals, further records of the occurrence of intestinal protozoa in non-dysenteric cases. Their results show that among the 200 returned soldiers examined in Liverpool *Entamoeba histolytica* was present in twelve of the 158 cases, with no previous history of dysentery.

Dr. N. A. Cobb, of the United States Department of Agriculture, has published (in *Nematology*, vol. iii., pp. 431–86) an account of the nematode genus Mononchus. The genus is of world-wide distribution, and some of the species are cosmopolitan Mononchs are regularly present in arable land of a sandy or loamy nature, and sometimes occur in great numbers; the author estimates that there were at least thirty millions per acre in the top six inches of a field of maize in New Jersey. Most mononchs are carnivorous; they have been found to feed on protozoa, on rotifers, and on other nematodes. One cosmopolitan species was found by the author in Florida feeding on the larvæ of *Heterodera radicicola*, a serious root-pest, and it is suggested that further investigations may reveal the possibility of utilising mononchs to reduce the enormous losses in crops due to plant-infesting nematodes. A description of the characters and anatomy of the genus is given, and it is stated that the females of many, probably of most, species are really hermaphrodite, the gonad producing also spermatozoa, which are so minute that they have apparently hitherto escaped notice. Males, if found at all, are nearly always rare, and of most of the species males are not known. A key is provided to the subgenera and to the fifty-seven species—including twenty-eight described as new in this memoir—and the text has seventy-five excellent figures.

RAINFALL DISTRIBUTION OVER FRANCE.[1]

THIS is the first portion of a contemplated large investigation into the rainfall distribution over France, and deals with the *régime* over the North-West Provinces. Other memoirs will contain a discussion of the data for the south-west, north-east, and south-east of the country for the fifty years 1851–1900. In the work under notice, which is an extract from the memoirs of the French Central Meteorological Office, full particulars are given of the data used in compiling the maps of average rainfall based on a fifty years' normal, by a comparison of short-period data with standard stations, affording records for the complete series. In some cases the standard stations seem to be at a considerable distance from the short-period record to be corrected to the fifty years' normal.

The variability of rainfall based on records for sixteen stations in France and adjacent countries during the second half of last century is discussed, from which it is shown that the departures of individual years from the normal are in accordance with the theory of probabilities. A list of the stations arranged in river basins is given by departments, along with the altitude and the period of observation. Monthly isohyetals are drawn at intervals of 10 mm. up to 100 mm., but at 120 mm. and 150 mm. thereafter, while on the annual maps the intervals extend to 100 mm. A summary of the leading features governing the rainfall distribution is given for each month and for the year.

In almost all the regions considered October is the wettest month, the rainfall exceeding 100 mm. in the country of Caux, the department of the Manche, the western part of Brittany, and the heights of Gâtine, the maximum being 151 mm. at Saussemesnil; while the driest areas in this month are the middle valley of the Seine, the basin of the Eure, and on the Beauce, where the rainfall is between 50 mm. and 60 mm., but not under the former value. The driest month is February, not only as regards the actual quantity, but also taking into consideration the shortness of the month.

For the whole year the driest regions are the basins of the Seine, the Loire, and the Oise, where the precipitation varies between 500 mm. and 600 mm. The stations where more than one metre of rain falls are extremely few, and are mostly located in mountainous areas, the maximum being 1181 mm. in the Monts d'Arrée. No detailed description appears of the methods of mapping the material utilised. Rivers are shown, but towns, railways, and departments are not indicated, nor are the orographical features shown. The maps clearly indicate the very patchy distribution of rainfall, and have evidently been drawn with much care. The originals were on a scale of 1 : 1,500,000, or twenty-two miles to an inch, and then reduced for publication on a scale of thirty-nine miles to an inch.

MINERAL PRODUCTION OF PERU AND THE PHILIPPINE ISLANDS.

THE official report upon the mineral production of the Philippine Islands for the year 1915 has recently been issued by the Division of Mines, Bureau of Science, of the Government of the Philippine Islands. The importance of the gold production far outweighs that of any other mineral; its value is returned as 2,633,526 pesos, say about 274,000*l*., being an increase of 12·1 per cent. above that of 1914. The gold bullion, of course, also carries a certain amount of silver, which is valued separately. The only other metallic product is iron, of which ninety-six tons appear to have been produced, this being only about one-half of the production of the previous year. This iron is all produced in small native furnaces, and is worked up into ploughshares or similar articles; the main reason in the falling off is the competition of inferior articles, made from scrap-iron. There is no production of native coal, none having been worked since 1912. The other minerals, of which returns are included, are salt, sand and gravel, clay products, stone, lime, and mineral waters. The total value of all these is estimated at rather less than the value of the gold output.

The mineral statistics of Peru for the year 1915 show a considerable increase in most of the products according to the report (No. 83) recently published in Lima. The total value is given as 5,930,000*l*., being an increase of 42 per cent. above that of 1914. This increase is due in part to the important rise in the value of mineral products, but it must be noted that this rise did not extend to the value of silver, and as

[1] "Etudes sur le Climat de la France. Régime des Pluies. Première Partie. Considérations générales: Région du nord-ouest." Par M. Alfred Angot. Pp. 128+13 plates.

silver ranks high amongst the mineral productions of Peru, the increase is less marked than it would otherwise have been. The leading products are copper, 34,727 metric tons; petroleum, 363,162 metric tons; silver, 294,425 kilos.; vanadium ore, 3145 metric tons; gold, 1690 kilos; coal, 290,743 metric tons. These are the only minerals the annual value of which exceeds 200,000*l.*; all the others are far less important. The production of copper, already very important, appears to be likely to increase still further. It is also noteworthy that of the total export of copper no less than 93·85 per cent. was in the form of bars, so that practically the whole of the copper ores produced in Peru are now smelted in that country. This effect is largely due to the heavy rise in freights; before the war these were about 30*s.* to 2*l.* per ton, whereas in 1915 they rose to 5*l.* to 6*l.* per ton without taking the increased cost of insurance into account, so that for any ore or matte containing under 40 per cent. of copper the rise in freights would outweigh a rise of 10*l.* in the price of the metal. This effect would be even more marked in the case of ores of a cheaper metal like lead, so that nowadays Peru exports few ores except those of such metals as vanadium, tungsten, molybdenum, etc., which, on account of their considerable intrinsic value, are proportionately less affected by a rise in freights. It is worth noting that the production of coal has only increased from 283,860 tons in 1914 to 290,743 tons in 1915, whilst the imports have fallen from 139,312 tons to 55,662 tons, in spite of the increased development of the metallurgical industry, as just pointed out, the reason being that the use of petroleum to replace coal as a fuel is on the increase, the output of oil having risen 43·7 per cent. above that in 1914.

NATIONAL LABORATORIES AND INDUSTRIAL DEVELOPMENT.[1]

II.

A NATIONAL PROVING HOUSE AND STANDARDISING LABORATORY.

CERTAIN general principles seem to me essential to success, namely:—

(1) Standardisation and testing must, if they are to be of value, depend upon research, and be closely connected with it.

(2) While there must be the closest union between the testing authority and the trade concerned with the production of the goods to be certified, the authority should not be dependent on the trade for financial support, and while the wishes of the trade as to the standards to be attained must be fully considered, the executive of the testing institution should be an independent authority.

Testing must go hand in hand with research. For, in the first place, research is necessary in order to set up the standards required. Take, for example, our standards of length. The yard or the metre is the distance between two marks on certain standard bars very carefully preserved. They are both arbitrary standards, it is true, and it is clearly of the greatest importance that they should be invariable. Do we know that this condition is secured, and, if so, how do we know it? Materials certainly alter their dimensions with changing temperatures, and possibly also with time; for standard work we must know the temperature at which we make our comparisons, and this need leads at once to the investigation of the methods of measuring temperature and of the amounts by which various materials change in size with changes of temperature. A wide field of investigation opens directly; temperatures are measured by thermometers. How are the various kinds of thermometer connected? Do a mercury thermometer and a gas thermometer give the same results? Is the glass of which an ordinary mercury thermometer is made of importance? Or, again: To what extent is the length of a yard measure of brass or steel dependent on the temperature? Can we find a material less sensitive to temperature changes than the platinum-iridium alloy of which the standard metre is made? And so on. The investigations necessary before we can standardise our yard measure have called for much research. But, again, what security have we that even if we keep the standard with the greatest care and make our comparisons under the most favourable conditions of temperature, its length is invariable? Is the metre the same length now as when it was first deposited at the Bureau des Poids et Mesures at Sèvres? To answer this question a research of great difficulty was carried out at Sèvres by Michelson when he compared the length of the metre with the wave-length of light under certain specified conditions. There are cogent reasons for supposing that to be an invariable quantity.

At the laboratory during the past two years we have tested vast numbers of gauges and the improvement in manufacture has been very marked; this has been reached only by careful investigation into each cause of error by attention to small details, and by research into methods of measurement with a view to their simplification so that they could be used in the workshop, and to improvement in accuracy so that the results obtained were not vitiated by errors in the method of obtaining them.

A visit to the gauge-testing-room of the National Physical Laboratory will show anyone how closely research and standardisation go together, how hopeless it would be to try to run a standardising laboratory apart from research. Or, again, to take an example from another department of science. Ohms and volts and amperes are nowadays familiar words; you measure the one with a Wheatstone bridge, or more probably with an ohmeter, you read off the others in a voltmeter or an ammeter. But the definitions of these quantities are highly technical and scientific.

Do you realise what research has been required before our present practical system of making electrical measurements was evolved, and how much you owe to that research? Compare the rate of advance of the electric motor and the steam engine.

The work of the Engineering Standards Committee has been of untold advantage to the country. At every step of that work the committee has kept in close touch with scientific principles, and researches of the most varied character have been carried out, and are being carried out now, with the view of determining what standards to set up and what tests to prescribe.

Nor is it enough to say that much of this has been done and need not be carried further; the principles on which ammeters and voltmeters are made have been thoroughly investigated, the optical laws with which telescopes and lenses must comply are well known; lay down your tests and specifications, and train observers, analysts, and testers to enforce them, and you have done all.

Stagnation and death, not life and progress, lie that way. It is not our object merely to apply with rigid fairness the laws laid down, and to be pleased rather than otherwise, like the mythical examiner, when we "plough" them every one. The standards set must be reasonable, but they must tend to raise the quality of the product tested. Recurring defects must be watched and investigated, and the tests modified to prevent

[1] Abridged from two lectures delivered at the Royal Institution on February 26 and March 5 by Sir R. T. Glazebrook, C.B., F.R.S. Continued from p. 77.