vated — the last for the making of sugar. Cattle, pigs, and other domestic animals are kept in small numbers, but little attention is bestowed upon them. The Government has set up mills and sugar and hemp factories. At present they have not been remarkably active, owing either to the deficiency of raw material, or to the absence of a demand for the finished article. Fishing is a far more important industry. The annual value of the products of the sea is about £833,000, and it is on them exclusively that the taxes are levied. Herrings, salmon, and trout are extraordinarily plentiful on the northern and western coasts of the island, and cod is caught in the deep water. The native fishermen number about 60,000, and in the season these are reinforced by hired men from the island of Nipon. There are in the whole island about 17,000 Ainos, but their number is decreasing owing to the effects of disease and, more than all, intermarriage with the Japanese. In the north-east they are still in a state of degradation, but along the shores of Volcano Bay they are beginning to occupy themselves in agriculture. They are well treated by the Government, and enjoy the same rights as Japanese. Where it is possible, their children attend the Japanese schools.

PROFESSOR PICTET'S LABORATORY AT BERLIN.[1]

IT has often been remarked that purely scientific research frequently bears fruit of practical value. A fresh illustration of this fact is afforded by the work of Professor Pictet, the eminent man of science of Geneva, who is turning to practical account the apparatus by which, in 1877, he first reduced hydrogen and oxygen to the liquid state. At Berlin, where he now resides, he has established, on the scale of a small factory, what he terms a "laboratoire à basses températures." The following account of the work carried on and the results obtained is taken from papers read by the professor before different scientific societies of Berlin.

The refrigerating machinery, driven by several powerful steam-engines, is intended to withdraw heat from the objects under observation, and to keep them at any temperature between —20° and —200° C. as long as may be required. Professor Pictet's experience has led him to the conclusion that among the refrigerating agents known, such as rarefaction of gases, dissolution of salts, evaporation of liquids, the latter is to be preferred. A long course of research has further enabled him to choose the most convenient from amongst the great number of suitable liquids. In order to avoid the great pressure required in handling the highly evaporative substances of lowest boiling-point which serve to produce extreme cold, it is necessary to divide the difference of temperature into several stages. Each stage is fitted with especial apparatus consisting of an air-pump worked by steam, which drains off the vapors of the liquid from the refrigerator, and forces them into a condenser, whence, reduced to the liquid state, they are again offered for evaporation in the refrigerator. Thus the liquid, without any loss beyond leakage, passes through a continuous circuit, and the operations can be carried on for any length of time. The liquid made use of for the first stage is the mixture of sulphurous acid and a small percentage of carbonic acid called "liquide Pictet." It is condensed at a pressure of about two atmospheres in a spiral tube merely cooled by running water. Oxide of nitrogen (laughing gas) is the liquid chosen for the second stage. Its vapors are condensed in the same way at a pressure about five or six times as great in a tube maintained at about —80° by the action of the first circuit. As medium for a third stage, in which, however, continuous circulation has not yet been attempted, atmospheric air is employed, which passes into the liquid state at a pressure of no more than about 75 atmospheres, provided the condenser is kept at —135° by the first two circuits. The evaporation of the liquefied air causes the thermometer to fall below —200°.

[1] From Nature.

By this combination quite new conditions for investigating the properties of matter are realized. In various branches of science new and surprising facts have already been brought to light. Many laws and observations will have to be re-examined and altered with regard to changes at an extremely low temperature.

For instance, a remarkable difference was noted in the radiation of heat. Material considered a non-conductor of heat does not appear to affect much the passage of heat into a body cooled down to below —100°. Or, to state the fact according to Professor Pictet's view: "The slow oscillations of matter, which constitute the lowest degrees of heat, pass more readily through the obstruction of a so-called non-conductor than those corresponding to a higher temperature, just as the less intense undulations of the red light are better able to penetrate clouds of dust or vapor than those of the blue." If the natural rise of temperature in the refrigerator, starting from —135°, is noted in a tracing, and afterwards the same refrigerator carefully packed in a covering of cotton-wool of more than half a yard in thickness, and cooled down afresh, and the rise of temperature again marked, on comparing the tracings hardly any difference will be found in the two curves up to —100°, and only a very slight deviation even up to —50°. On this ground it is clear that the utmost limit of cold that can possibly be attained is not much lower than that reached in the famous experiment of liquefaction of hydrogen. The quantity of warmth which hourly floods a cylinder 1,250 millimetres high by 210 millimetres wide (the size of the refrigerator) at —80°, is no less than 600 calories, and no packing will keep it out. At a lower temperature, the radiation being even greater, the power of the machinery intended to draw off still more heat would have to be enormous. And as —273° is absolute zero, the utmost Professor Pictet judges to be attainable is about —255°.

As an example of the surprising methods which the refrigerating machine permits the investigator to employ, it may be mentioned that, in order to measure the elasticity of mercury, Professor Paalzow had the metal cast into the shape of a tuning-fork, and frozen hard enough for the purpose in view. On this occasion it appeared that quicksilver can be shown in a crystallized state, the crystals being of a beautiful fern-like appearance.

Glycerine was likewise made to crystallize; and cognac, after having been frozen, was found to possess that peculiar mellowness commonly only attained by long keeping.

But the most important application of the refrigerating machinery has been the purification of chloroform, undertaken by Professor Pictet, at the instance of Professor Liebreich of the Pharmacological Institute, Berlin. Chloroform has hitherto been considered a most unstable and easily defiled substance. The action of sunlight, the slight impurities retained from the different processes of manufacture, perhaps the mere settling down during protracted storage, have invariably resulted in a more or less marked decomposition. By the simple process of crystallization this unstableness is got rid of, and a practically unchangeable liquid is produced. The crystals begin to form at —68°, first covering the bottom of the vessel, and gradually filling it up to within one-fifth of the whole volume. This residue being drained off, the frozen part is allowed to melt under cover, so as to exclude the atmospheric moisture. Chloroform thus refined has, by way of testing its durability, remained exposed on the roof in a light brown bottle from November till June without the slightest sign of decomposition.

Professor Pictet has already taken steps to introduce his process into manufacture, and proposes to apply the principle to various other chemical and technical objects. Sulphurous ether, for instance, has by a similar process been produced in a hitherto unknown degree of purity. At the same time, the professor continues eagerly to pursue the various purely scientific inquiries with which he started.

R. DU BOIS-REYMOND.

LETTERS TO THE EDITOR.

*** *Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

Dr. Hann and the Fohn.

IN the good old meteorological times — before the advent of Dr. Hann and his fatal misapplication of the mechanical theory of heat to the phenomena of the atmosphere — it was generally considered that the hot winds of Switzerland, the so-called Föhn, had their birthplace in the Desert of Sahara. The good folks thought, in their simplicity, that the warm air which suddenly came upon them must have come from a hot place. They noticed that it always came from a more or less southerly direction, and judged that the sand-dust it carried with it must have come from some sandy region. They felt the sand-dust smart in their eyes, and saw how it discolored the snow white face of the mountains; but the sand-dust did not obstruct their vision further but they could judge that the dust must have got into the air from somewhere, and so they fixed upon the Sahara as the nearest and most likely locality.

It seems, indeed, marvellous that Dr. Hann's opposing theory could have made headway against such glaring and incontestible facts, as it should be much easier to convince the world of a simple and tangible truth than to convert it to the opposite theory, which has nothing whatever of observations of natural phenomena to support it; but when I here propose to maintain the old theory, by taking away the basis of Dr. Hann's, it may not seem unbecoming in me to say a few words in apology for such seemingly reckless behavior.

It is now nearly two years ago I published, through these columns, the rudiments of a theory of the atmosphere which is more or less diametrically opposite to the prevailing ideas on the subject. Rain was supposed to be due to expansion of moist air, and I found by experiments that it must be due to compression, etc. As far as I could ascertain, meteorologists had no objection to urge against my theory, but on further investigation it became clear to me that they possessed a high-priest, or *Dalai Lama*, in Dr. Hann, without whose sanction no new theory could be seriously considered by reputable meteorologists of any standing, and as he refrained from expressing himself directly on the subject, the matter was put aside for the time being. Dr. Hann, however, gave indirectly vent to his opinion; a few weeks after the publication of my theory Dr. Hann handed in to the Vienna Academy of Science a paper wherein he held forth that the established theories on the atmosphere required considerable modifications, and the modifications he proposed were all an approach towards the views which had immediately before been set forth by the present writer. This paper caused considerable discussion, but nobody seemed to consider the high-level observations on which he proposed to base these modifications of any real value. Any further approach to my views would undoubtedly have led Dr. Hann to upset his own theory of the Föhn, — a theory which has brought its author no inconsiderable renown during the past years, — and that any man should upset his own reputation as a philosopher could hardly be expected; and there is so far nothing to be said against his silence, as all is fair in war and love, and to gain time is the great object in all cases of emergency.

There is, however, a time for every thing, and as nearly two years have elapsed since I published what, in my humble opinion, is the true theory of the atmosphere, it may be about time for me, and my duty also, to endeavor to upset the chief obstacle against its adoption, which I consider Dr. Hann's Föhn theory to be.

I take occasion from an article by Mr. Rotch, on "Mountain Meteorology," in *American Meteorological Journal* (August, 1891), wherein this staunch upholder of Dr. Hann's views has very ably tried to systematize the aspects of the prevailing meteorological theories from this particular point of view. It is always a laudable endeavor, of any author, to try systematically to combine into a collected whole the varying theories concerning any particular branch of this science, as it enables the critic to mark out the weak point. The most consistent or systematic treatise on the atmosphere as a whole, which the present writer is acquainted with, is the "Elementary Meteorology," by Mr. R. H. Scott, and the remarkable candidness of its author made it a comparatively easy task for the present writer to point out, that, according to the causes of rain given there, we should not get any rain at all if we were to believe the gentlemen who had the atmosphere "in charge," so to speak. As I on that occasion dealt extensively with the question of the effect on the humidity of the air caused by ascent or descent of the air, I may at present confine myself to discuss exclusively the question of change in temperature caused by ascent or descent.

Mr. Rotch says, on page 154: "It has been shown by Dr. Hann that the Föhn owes its extreme warmth, as well as its dryness, to the descent from the ridges on the north side of the Alps, and that it does not bring it from further south. The warmth of the Föhn is explained by the fact that a mass of air sinking into one of higher pressure is warmed at a rate of one degree for each 300 feet of descent, and a rapidly sinking stream of air, which is so quickly heated, must be relatively very dry." And a few lines above we read: "The cool night wind (from the mountains) is caused by the sinking of the cold air into the bottom lands, and is most intense in narrow valleys, where there is great difference between the temperature of the valley and the plain," and again, during Föhn the temperature "rises sometimes 60° F. above the normal."

The unbiased reader cannot help noticing the anomaly that the mere descent of air is (1) in case of Föhn accused of causing a considerable rise in the temperature above the normal, and (2) in case of the night wind an equally considerable lowering of the temperature below the normal.

This contrast becomes even more drastic when Mr. Rotch says, page 151, "Slowly descending currents of cold air fill the valleys like rivers, while the summits receive the air warmed dynamically by descending from a greater height; and it seems obvious that the author has a little private theory of his own that it makes a great difference whether the air is descending slowly or not, whereby he tries to patch over the glaring discrepancy.

We may now set to work to put these contradictory theories to their proper test, thereby confining ourselves to statements contained in the article itself. It is thus truly mentioned that the air is warmed at the rate of 1° F. for each 300 feet of descent and cooled at the rate of 1° F. for each 300 feet of ascent, but we also find mentioned another fact, equally true, that, on an average, or under normal conditions, the temperature of the atmosphere decreases at the rate of 1° F. for each 300 feet rise; and this fact throws a peculiarly instructive light on the whole subject. It shows that under normal conditions air rising to any height will during the ascent be cooled by expansion at such a rate that wherever it goes it meets with air having a temperature exactly equal to its own, and also that air descending to any level will for a similar reason meet with air having a temperature exactly equal to its own, wherever it goes. In other words, for air arriving at any particular place to have an abnormally high or low temperature it must have had an equally abnormally high or low temperature at the locality where it started from.