cent. the lowest figures being those found in Lorn, Sonachan, Dalmally, Arrochar and Tarbet.

The Mediterranean race is much less important as a factor in the population. In the great bulk of the country it accounts for no more than about 15 per cent., the percentage falling specially low in the border counties where it ranges from 9 to 12. In certain localities it seems to maintain, however, a pretty firm hold. In Portree, in Skye and in the region of Glencoe, Onich, Ballachulish, Lorn and Arrochar with an extension into Breadalbane the average is 30 per cent. In parts of the great glen also proportions rose to about 25 per cent. and in central Perthshire, Comrie to Callander the same amount is preserved. In the southern lowlands the only place which has any high percentage is Stranraer and that is obviously due to Irish immigration, the percentage of Irish born in that town being considerable. With regard to the medium haired race the variations are not so interesting. The percentage falls lowest in Midlothian and the Merse. In some parts of the great glen again it is somewhat difficient falling as low as 30 per cent., and in Breadalbane the proportion is just under that figure. Elsewhere it ranges commonly from 35 to 45 and only rises higher than this in one instance in the town of Brechin where the figures are specially untrustworthy. It may be taken to range in the great bulk of instances from 34 to 44 and thus to show a much less departure from the average than the other tnree races. The main results of this investigations are to show that the amount of Teutonic blood in Scotland is considerably higher than is generally believed. That the amount of Mediterranean blood is less than that assumed by some anthropologists and that the medium haired or Alpine race is very uniformly distributed from one end of the country to the other.

HYGROMETERS AND HUMIDITY.

BY W. J. MILLAR, C.E.

[Read 26th November, 1912].

When speaking or writing about the weather we use the terms dry and wet to express certain conditions which occur from time to time, and we also make reference to the readings of the barometer and of the thermometer, whose records tell us of the pressure of the atmosphere, and of the temperature of the air at the time.

The atmosphere consists mainly of two gases, oxygen and nitrogen, with a proportion of watery vapour. The gases are invisible to us but we can readily distinguish the presence of the vapour by noticing the formation of cloud, fog or mist. The formation of mist quite suddenly may be noticed sometimes when on a mountain top, where, standing on some isolated rocky peak, with a clear view all around, all at once a cap of mist envelopes the rocks beside us and soon extends over the summit.

This phenomenon shows at once that, in the apparently dry and clear air through which we saw the landscape spread out before us, there lay concealed a proportion of watery vapour, which by some cooling process was rendered visible to us in the form of haze or mist.

Again, on fine evenings with a clear sky, heat radiates readily from the earth's surface and we find that the vegetation at the same time has now received a damp and watery coating and which we know as dew, being the condensed watery vapour existing at the time in the atmosphere. The same action can be observed in a room where the atmosphere is warm and moist, when the surface of a glass of water brought into the room becomes coated over with small drops of water. What is known as the Dew-point is thus defined by Glaisher: "If a mass of air be gradually cooled, it will descend to a degree of temperature at which it will be saturated by the quantity of vapour then mixed with it. This temperature is called the Dew-point." Hence we may readily determine this point by noting the temperature at which deposition of the moisture in the form of drops of water, and in the water and tumbler experiment, takes place.

Humidity is a condition of the air, such as when we say the air is moist, and involves the relation between any particular moist condition and a condition of complete saturation. Thus, if saturation be represented by 100, then some other condition of weight of vapour may be represented by say 75, we have the ratio $\frac{75}{100}$ as the humidity, or relative humidity, as it is called.

Another expression for the relative humidity is

$$\frac{\text{Actual Vapour pressure}}{\text{Possible Vapour pressure}} = \text{Relative humidity.}$$

In speaking of "The degree of humidity in the air," Glaisher says :—"The degree of humidity is the ratio of the quantity of vapour present in any volume of the air to the quantity which would have been present in the same volume had the air been completely saturated, or, which is the same thing, the ratio of the elastic force of vapour at the temperature of the dew-point to the elastic force of vapour at the temperature of the air, as found in Table III." of Glaisher's Tables

Glaisher's Tables contain, amongst other matters, the elastic force of vapour at various temperatures, dew-point temperatures, and relative humidities.

The variation of the elastic force of vapour at various temperatures may be best shown by a diagram, where the

horizontal ordinates are temperatures, and the vertical ordinates are pressures.

In such a diagram the temperatures are taken in degrees Fahrenheit, and the pressures are in inches of Mercury. Joining the tops of the pressure ordinates we get an approximately curved line, and therefore get the relation existing between the temperature and pressure at any point.

In determining humidities we have to note the temperature of the air at the time, and to find the temperature of the dew-point, then find the elastic force of vapour at each of these temperatures, and finally dividing the pressure corresponding to the dew-point by the pressure of saturation corresponding to the temperature of the air, we have the ratio already referred to.

Representing this by an equation we have

$$\frac{\text{Actual Vapour Pressure.}}{\text{Possible Vapour Pressure.}} = \text{Relative humidity.}$$

The actual vapour pressure is the pressure at the dew-point of the air at the time, and the possible vapour pressure is that corresponding to the temperature of the air.

Various instruments have been devised to determine the humidity of the atmosphere. Glaisher's form of dry and wet bulb thermometer, taking precedence in this country. One of these instruments, now exhibited, shows two thermometers placed together in a frame ; these are both graduated alike. One of them has a piece of linen fastened round the bulb and a loop of cotton wick passes from this linen wrapper into a vessel containing water. Before the addition of the water the thermometers register the same temperature, but when water is added the linen becomes damp by the water passing to it through the wick, and the mercury in the attached thermometer falls. After a little no further drop in the temperature is noticeable. This change has taken place through the cooling action due to evaporation from the surface of the wet bulb.

The difference between the height of the mercury in the two thermometers varies with the state of the atmosphere ; thus, when the air is dry, the difference may be several degrees, but when damp, only one or two. So that when the air is saturated with moisture, the two thermometers stand at the same figure.

These differences are used for calculating the dew-point, and thereafter the relative humidity. When the dry bulb thermometer registers 53°F., and the wet bulb some degrees lower, then the dew-point is as much lower again as the difference. Thus we may have the dry bulb at 53° and the wet bulb at 50°, the difference being 3°, the dew point is 47°.

Now as the vapour pressure at 47° is ·323 inch, and the vapour pressure at 53° is ·403 inch, we have, by the rule already given $\frac{\cdot 323}{403} = \cdot 80$ or $\frac{80}{100}$ths as the relative humidity. So that, as complete saturation may be called 100, the humidity may be stated as 80 per cent.

For temperature, some degrees away from 53°, we have to use the tables provided for calculating the position of the dew-point.

In the absence of Tables, an approximation may be made by using certain factors. Thus, if the depression of the wet bulb thermometer below the dry bulb be represented by $t^0 - t^{01}$ = and c a factor, we have $c\ (t - t^1) =$ position of dew point. At 53° dry bulb, the factor is 2, hence the position of dew point below 53° is $c\ (t - t^1)$, and assuming, as in foregoing example, the wet bulb is 50°, then $2\ (53° - 50°) = 6°$, hence, as before, the dew point is at 47°. These factors vary :— thus at 53° we have 2 as a multiplier of the difference between the dry and wet bulb. At a temperature of 45° in dry bulb, the factor is 2·16, and at 40° it is 2·29. Then with rising temperatures we have, when dry bulb reads 60°, the factor becomes 1·88, and at 70° it is 1·77.

These latter remarks refer to the finding of the dew point. To find the vapour pressure there the following

formula was early established :— $p = p^1 - (t - t^1)\ \cdot 011$ where p = pressure of the aqueous vapour at the dew point, and p^1 the vapour pressure corresponding to the temperature of the wet bulb thermometer ; t = temperature of dry bulb, and t^1 = temperature of wet bulb ; ·011 is a constant determined from experiment. To give an example of the working of this rule we may take the figures already given, viz. :—

Pressure at wet bulb temperature of 50° p^1 =	·361 inch.
Temperature of dry bulb, - - - -	53°
,, wet bulb, - - - -	50°

Then since $p = p^1 - (t - t^1) \times \cdot 011$ we have—

$$p = \cdot 361 - (53° - 50°)\ \cdot 011, \text{ or } p = \cdot 361 - \cdot 033, = \cdot 328 \text{ inch},$$

as the vapour pressure at the dew point.

The value of the results obtained from observations of the Dry and Wet bulb thermometer instrument depends on various circumstances, thus, it should be placed in an open space, about four feet above the ground and in the shade. The water supplied to the small cistern should be rain or distilled water, and the muslin wrapper round the wet bulb thermometer as well as the wick should be changed at times. The reading of the mercury in each thermometer requires careful and accurate attention.

When the temperature falls to the freezing point the limit of its working is practically reached. The instrument does not in itself show what the humidity is ; this result having to be worked out by the help of tables, already referred to.

To enable humidities to be determined directly various forms of hygrometer have been devised, one form used largely on the Continent and in America depends on the variations in the length of a hair to which a pointer is attached ; hair, cat-gut, cordage and other materials are readily affected in length by changes in the moisture in the atmosphere. Hair and cat-gut lengthen with damp and shorten with dryness, cordage acts in the opposite way ; advantage can therefore be taken of this property to form an instrument having a pointer which can indicate these movements on a scale, gratuated from 100, representing complete saturation, round to any required point of dryness fixed upon.

Such instruments have a distinct advantage over the wet and dry bulb thermometers, as the humidity is obtained at a glance, and readings are not affected by low temperatures in frosty weather.

Some years ago, when studying the varying conditions of the weather, I made some experiments with various substances susceptible to moisture, amongst these I found that catgut as used for a 2nd violin string was most efficient, and a piece of this suspended from a fixed point and having a light weight with an attached pointer at the opposite end readily responded to variations in the condition of the moisture in the air and moved backwards and forwards for wet and dry conditions. Later on I arranged an instrument (as shown) in which the catgut fibre was arranged in a twist; one end was fixed to a wire support and the other end, which carried a pointer moving in a vertical plane, was attached to a vertical support by means of a silk thread. The contractions and extensions in the twisted catgut, due to variations in the moisture of the air, were then found to be well shown by movements of the pointer, and, as the latter moved over a dial plate, degrees of moisture could be readily noted. Thinking that this motion might register the humidity of the atmosphere, I graduated the scale from 100, for complete saturation, to from 50 or 60 for dry weather conditions, and after a large number of experiments, made simultaneously with this instrument and the ordinary wet and dry bulb instrument, I finally fixed the relation of the pointer and scale, so that the percentage of humidity shown by the position of the pointer became fairly well in accordance with those obtained by calculation from the wet and dry bulb instrument. The testing of these relations took some time, and I append in table form a few of them to show the close approximation of the results between the two instruments.

DATE.	Humidity by Fibre or Direct Hygrometer	Humidity calculated from Wet and Dry Bulb Readings.	Dry Bulb.	Wet Bulb.
1912.	Per Cent.	Per Cent.	F.	F.
September 6,	78	78	58°	54°
	79	82	55½	52½
	79	82	56	53
	80	82	56	53
	78	76	54	50
	78	78	53½	50
	6 | 472	478		
	78	79		
September 7,	83	88	55½°	53½°
	82	85	56	53½
	82	82	55	52
	84	91	53½	52
	92	97	52½	52
	100	100	52½	52½
	89	84	60	57
	87	89	58½	56½
	86	89	59	57
	9 | 785	805		
	87	89		
September 8,	86	83	59	56
	86	89	58	56
	85	86	58	55½
	85	86	58⅓	56
	85	84	60	57
	5 | 427	428		
	85	85		

Taking a week's observations, numbering 50, the average came out as 77 by direct hygrometer to 79 by dry and wet bulb instruments.

I am much indebted to Dr Hall for his loan of the dry and wet bulb instrument; also to Dr Marshall and Mr Andrew Watt for loan of Tables; and to Mr Duncan Penney for practical assistance in recording some additional observations of relative readings.