crystallography, which must at present, unfortunately, be regarded as a branch of mineralogy. And if they cannot acquire sound knowledge, how can they teach well? I feel quite sure that if the Science and Art Department would institute a summer course for teachers, where they would not have to waste their time over the merest rudiments, but could study practically the methods of crystal measurements, and the higher branches of mineralogical research, it would be largely taken advantage of by teachers and those who intend to become teachers. Failing this, I for one should be glad to know of any institution in this country or in Germany where such instruction could be obtained during the summer months. A TEACHER.

Glasgow, December 31, 1888.

Ventilating Bees.

I DO not know whether it is generally known that here, and I believe in other tropical countries, there are in every hive what one can only describe as "ventilating bees." I mean that during the hot season two or three bees post themselves, on their heads, at the entrance of the hive, and fan the interior with the incessant motion of their wings. They are relieved at intervals by fresh bees, who carry on the process. They are kept to their duty by a sort of patrol of bees to insure their incessant activity. This is a well-authenticated and known fact, and as such may interest your readers. EVA M. A. BEWSHER.

Mauritius, November 21.

Sonorous Sand at Botany Bay.

REFERRING to the correspondence with regard to the so-called "musical sands," which has appeared in your columns, it may be of interest to record the fact that sand with similar properties is found in Botany Bay, New South Wales, not far from the spot where Captain Cook first landed. When displaced by pressure from above, or disturbed with the hand or stick, this sand emits a musical sound, which appears to vary in intensity according to the degree of moisture which it contains. Should any of your correspondents wish for specimens, I shall be happy to forward a small quantity to them. A. SIDNEY OLLIFF.

Australian Museum, Sydney, November 16, 1888.

HOW RAIN IS FORMED.[1]

IN certain villages in the Indian Central Provinces, besides the village blacksmith, the village accountant, the village watchman, and the like, there is an official termed the *gápogári*, whose duty it is to make rain. So long as the seasons are good and the rain comes in due season, his office is no doubt a pleasant and lucrative one. It is not very laborious, and it is obviously the interest of all to keep him in good humour. But if, as sometimes happens, the hot dry weather of April and May is prolonged through June and July, and week after week the *ryot* sees his young sprouting crops withering beneath the pitiless hot winds, public feeling is wont to be roused against the peccant rain-maker, and he is led forth and periodically beaten until he mends his ways and brings down the much-needed showers.

You will hardly expect me, and I certainly cannot pretend, to impart to you the trade-secrets of the professional rain maker. Like some other branches of occult knowledge which Madam Blavatsky assures us are indigenous to India, this art of rain-making is perhaps not to be acquired by those who have been trained in European ideas; but we can at least watch and interrogate Nature, and learn something of her method of achieving the same end; and if her scale of operations is too large for our successful imitation, we shall find that not only is there much in it that may well challenge our interest, but it may enable us to some extent to exercise prevision of its results.

Stated in the most general terms, Nature's process of rain-making is extremely simple. We have its analogue in the working of the common still. First, we have steam or water vapour produced by heating and evaporating the water in the boiler; then the transfer of this vapour to a cooler; and finally we have it condensed by cooling, and reconverted into water. Heat is communicated to the water to convert it into vapour, and when that heat is withdrawn from it, the vapour returns to its original liquid state. Nature performs exactly the same process.

In the still, the water is heated until it boils; but this is not essential, for evaporation may take place at all temperatures, even from ice. A common little piece of apparatus, often to be seen in the window of the philosophical instrument maker, and known as Wollaston's cryophorus, is a still that works without any fire. It consists of a large glass tube with a bulb at each end, one of which is partly filled with water; and, all the air having been driven out of the tube by boiling the water, it is hermetically sealed and allowed to cool. It then contains nothing but water and water vapour, the greater part of which re-condenses when it cools. Now, when thus cold, if the empty bulb be surrounded by ice, or, better, a mixture of ice and salt, the water slowly distils over, and is condensed in the colder bulb, and this without any heat being applied to that which originally contained the water. And this shows us that all that is necessary to distillation is that the condenser be kept cooler than the evaporater.

Nevertheless, at whatever temperature it evaporates, water requires heat, and a large quantity of heat, merely to convert it into vapour; and this is the case with the cryophorus; for if the evaporating bulb be wrapped round with flannel, and so protected from sources of heat around, the water cools down until it freezes. That is to say, it gives up its own heat to form vapour. A simple experiment that anyone may try with a common thermometer affords another illustration of the same fact. If a thermometer bulb be covered with a piece of muslin, and dipped into water that has been standing long enough to have the same temperature as the air, it gives the same reading in the water as in the air. But if when thus wetted it be lifted out and exposed to the air, it begins to sink at once, owing to the evaporation of the water from the wet surface, and it sinks the lower the faster it dries. In India, when a hot wind is blowing, the wet bulb sometimes sinks 40° below the temperature of the air.

Now this is a very important fact in connection with the formation of rain, because it is owing to the fact that water vapour has absorbed a large quantity of heat—which is not sensible as heat, but must be taken away from it before it can be condensed and return to the liquid state—that vapour can be transported as such by the winds for thousands of miles, to be condensed as rain at some distant part of the earth's surface.

I have said that the quantity of absorbed heat is very large. It varies with the temperature of the water that is evaporating, and is the greater the lower that temperature. From water that is on the point of freezing it is such that one grain of water absorbs in evaporating as much heat as would raise nearly 5½ grains from the freezing to the boiling point. This is called the latent heat of water vapour. As I have said, it is quite insensible. The vapour is no warmer than the water that produced it, and this enormous quantity of heat has been employed simply in pulling the molecules of water asunder and setting them free in the form of vapour, which is merely water in the state of gas. All liquids absorb latent heat when they evaporate, but no other known liquid requires so much as water.

Many things familiar in everyone's experience find their explanation in this absorption of latent heat. For instance, we feel colder with a wet skin than with a dry one, and wet clothes are a fruitful source of chills when the body is in repose; although, so long as it is in active exercise and producing a large amount of heat, since the evaporation

[1] A Lecture delivered by H. F. Blanford, F.R.S., at the Hythe School of Musketry on November 13.