a description of the arrow used, should be carefully preserved.

As soon as possible, I shall publish an account of the bows and arrows in the national museum, and shall be more than pleased to collate and preserve the results of careful experiments as a basis of comparison with the archery of savages. It is generally conceded that the archery clubs, with their much better artillery, achieve higher averages in shooting than could be attained by the aboriginal bowmen.

O. T. MASON,
Curator of Dept. of ethnology.

Smithsonian institution,
March 31.

Underground rivers.

In an article in *Nature* (Jan. 14, p. 246) entitled 'Curious phenomena in Cephalonia,' a former pupil of Ledger writes, "The sea runs into the land in a strong stream, turning a water-wheel on the way, and disappears in the earth about a hundred yards from the entrance. . . . I imagine that this water must be converted into steam, which comes out either at Naples or at Stromboli." Prof. Henry S. Williams of this university called my attention to this quotation, and to its indirect connection with what follows. The writer, while passing through Yucatan, Mexico, in 1870, saw a large stream running with torrential speed within a natural tunnel not far from the seashore, and probably over one hundred feet below the surface of the ocean. These underground rivers, which are said to be numerous in the neighborhood of the city of Merida, are called *zanates* (Thah-n'ah-tess) by the inhabitants of Yucatan. I had time to visit only one of these remarkable subterranean rivers. Its shaft-like entrance was adorned by a picturesque old Spanish well-curb of stone, furnished with standards of fancifully forged iron-work. Nothing on the surface indicated the existence of the vast cavern under the monotonous and flat lowlands of the peninsula of Yucatan; and, though not a breath of air stirred, the deafening roar of the torrent under our feet could not be perceived until we were fully inside of the cave. A rapid descent brought us to the level of the pumps used for irrigating a very extensive *ixtle* plantation; and from here we could see, by the light of our torches, the yellow foam of the waters upon the undefined background of the chasm below. Descending still farther, the full stream could be seen through a wide fissure in the limestone of the cave. It had the rounded appearance of a stream flowing horizontally under great pressure, ten or twelve feet in diameter, and looking like a gigantic black icicle lying on its side. This large volume of water plunged with great swiftness into an unexplored and dark chamber with terrific roar, and producing noises which resembled the hollow echoes of heavy explosions heard now and then above the perpetual rumbling of the rushing water. A visit to this cave cannot fail to produce a very deep impression, and not unlike the feeling which renders so imposing the unpleasant experience of an earthquake.

The manager of the plantation informed me that the mouth or entrance of this *zanate* was only twenty-eight feet above the Gulf of Mexico; and since my barometer indicated a descent of a hundred and forty feet, if the information was correct, this stream was delivering, within forty miles from the seashore, a volume of fresh water about a hundred and twelve feet below the level of the sea. The temperature of the water was 52° F., and is said to remain constant throughout the year. Only a small portion of the stream was visible; and the direction of the current was N. 60° W. I could obtain very little additional information in reference to the other *zanates*, of which the natives speak with almost religious reverence as "great miracles which have always been as they are now."

Since the velocity of the water, as well as the form of its cross-section, can leave no doubt that the delivery takes place under a considerable head, it would be quite important to ascertain the location of its source, and learn why this cave does not fill up to within twenty-eight feet from the surface, if the stream communicates with the sea. This latter circumstance seems to prove that the elevation given by the manager of the plantation may be incorrect; but, besides the fact that the belief in the great depth of these *zanates* below the ocean is current among the cultivated people of Merida, the manager of the plantation insisted on the correctness of his figures, which were obtained by the instrumental surveys connected with the irrigation of his large estate, the waste water from which runs into the sea. It would seem desirable, therefore, to ascertain through the columns of *Science* if any one else has visited these *zanates*, and has satisfactory data bearing upon this question.

A study of the soundings made by the U. S. coast and geodetic survey upon the Bay of North America; the erosions showed by the stereographic model of the Caribbean Sea, made by Capt. J. R. Bartlett, U. S. N.; the gravimetric work conducted by Professor Peirce of the coast survey; and the hydraulic problems connected with the delta of the Mississippi River,— seem to involve problems related to the Gulf Stream which make desirable a better knowledge of these truly remarkable subterranean rivers.

E. A. FUERTES.

Ithaca, N.Y., March 30.

Note on the nocturnal cooling of bodies.

An interesting application to this subject may be made, by way of supplement, of the principles and expressions contained in my letter on the temperature of the moon (*Science*, vi. No. 150). According to these, the rate with which a body radiates heat is to that with which it receives and absorbs heat from a complete enclosure as μ^θ is to $\mu^{\theta'}$, in which $\mu = 1.0077$, and θ and θ' are the temperatures of the body and of the enclosure respectively on the centigrade scale. In this case we necessarily have for the static temperature of the body, that of the enclosure remaining constant, $\theta = \theta'$; but, in the case of an incomplete enclosure, the body, at the same temperature, radiates more heat than it receives and absorbs from the enclosure, and consequently its static temperature is less than that of the enclosure, since it cools down until the rate with which it radiates heat is equal to the rate with which it absorbs heat received from the enclosure.

In the case of a thermometer exposed near the surface of an earth without an atmosphere, the earth's surface would form the half of a complete enclosure, since it would subtend a solid angle equal to that of a hemisphere. In this case the thermometer would receive no heat from the enclosure by reflection, but only the radiated heat; and the rate with which the bulb, if spherical, would radiate heat, would be to that with which it would receive and absorb heat as μ^θ to $\frac{1}{2} r' \mu^{\theta'}$, in which r' is the relative radiating power of the earth's surface. Hence for the static temperature of the thermometer, that of the earth's surface being supposed to be stationary, we should have

$$\mu^\theta = \tfrac{1}{2} r' \mu^{\theta'}, \text{ or } \theta - \theta' = 300 \log \tfrac{1}{2} r'.$$

In case of a maximum radiating power of the earth's surface, in which case $r' = 1$, we have

$$\theta' - \theta = - 300 \log \tfrac{1}{2} = 300 \times 0.301 = 90° \text{ C.}$$

for the difference between the temperature of the earth's surface and that of the exposed thermometer, the latter being the less. It is seen that the difference is the same, whatever the temperature of the earth's surface. According to this result, if the temperature of the earth's surface were maintained at 0° C., that of the thermometer would be −90° C., if the law of Dulong and Petit can be extended to so low a temperature.

If the earth's surface were polished silver, and of the ordinary temperature, the temperature of the thermometer would be nearly that of absolute zero. If we suppose that the earth's atmosphere, when clear, radiates and reflects back to the body four-fifths as much heat as the body radiates into it, then the enclosure, comprising the earth's surface on the one side, and the atmosphere on the other, lacks one-tenth of completeness, and we then have from the preceding expression,

$$\theta' - \theta = - 300 \log 0.9 = 300 \times 0.046 = 13.8° \text{ C.}$$

for the difference between the temperature of the earth's surface and that of the thermometer, in case the thermometer received no heat by convection and conduction from the surrounding warmer air. In the case of Melloni's cups, the former of these is prevented, and hence the thermometer in these stands at a lower temperature than one does suspended in the open air, where the colder air immediately in contact with the thermometer-bulb falls down, and warmer air takes its place.

Supposing the atmosphere and the earth's surface to furnish nine-tenths of a complete enclosure to a body near the surface, then, at an altitude which leaves one-half of the atmosphere below it, they would furnish something more than 0.7 of a complete enclosure; for the amount of heat escaping into space is not quite proportional to the mass passed through, especially in the case of dark heat. We should have, in this case,

$$\theta' - \theta < - 300 \log 0.7, \text{ or } 46.5° \text{ C.},$$

in case of no convection and conduction; but these, of course, would diminish the difference very much. This result, in comparison with the preceding one, explains the low temperatures of bodies at night, when exposed in the air on high mountains a little above the earth's surface, so as to receive no heat from contact with the surface.

The greater the altitude, the more nearly would the difference approximate to 90° C., and would sensibly reach it at a point leaving no sensible portion of atmosphere above it, and even surpass it if the point were so high as to sensibly diminish the subtending solid angle.

The whole of the earth's surface, of course, cools considerably during a clear night; but this only continues until a temperature gradient is formed by which heat is conducted from the lower strata to the surface as fast as it is radiated into the atmosphere. This state, however, can be only approximately reached, and, if the night were continued, the cooling would still go on; but the rate of cooling becomes very small in the latter part of an ordinary night, and much less in that of a polar night. Bodies exposed in the open air, of course, receive no sensible amount of heat by conduction of heat through the air up to the bodies, and so their temperatures fall much lower than that of the earth's surface, and the differences are given by the preceding conditions. WM. FERREL.

Maori poetry.

An example of Maori poetry may be interesting to some of your readers. The first is a modern Maori love-song composed by a young native and sent to his sweetheart. I am indebted to Mr. C. O. Davis of Auckland, New Zealand, for the translations.

At eventide I lay me down to rest,
As winds from the great ocean pierce my frame.
Come, ye soft northern airs, hasten your speed,
With messengers of love to me. O maiden!
Send me thy epistle to cheer this heart
Of mine, — to dry the tears which freely flow
For thee, O Rosa, absent from thee so long.
When darkness has set in, I rest alone,
The while I fancy thou art present,
And all my thoughts are fettered by thy love.

A maiden's lament on account of the desertion of her lover.

Retire, O sun! and leave the night to me,
While tears, like water, from these eyes are flowing.
The sound of footsteps is no longer heard,
O Taratu! thou comest not again
By way of Waishipa's headlands; still
The sea-fowl show their breasts at Mitiwai,
But my lover lingers in the north,
Binding thyself to thy own landscapes there.
Ah! shall my days of weeping never cease?

C. F. HOLDER.

Pasadena, Los Angeles county, Cal., March 21.

Names of the Canadian Rocky Mountain peaks.

As to the naming of the Canadian Rocky Mountain peaks, Mr. Ingersoll may withdraw his correction made upon the authority of Dr. George M. Dawson. Here is an extract from Douglas's journal, under date of May 1, 1827, printed in companion to *Botanical magazine*, ii. 136, in 1836.

"This peak, the highest yet known in the northern continent of America, I felt a sincere pleasure in naming 'Mount Brown' in honor of Robert Brown, Esq., the illustrious botanist, a man no less distinguished by the amiable qualities of his mind than by his scientific attainments. A little to the southward is one of nearly the same height, rising to a sharper point: this I named 'Mount Hooker' in honor of my early patron the professor of botany in the University of Glasgow."

Dr. Hector, "who in 1857–59 was attached to Captain Palliser's expedition," may indeed have named 'Mount Balfour,' curiously sandwiched between the names of Hooker and Brown. Douglas could not well do that, the worthy Edinburgh professor so honored being at that time a lad of nineteen. A. G.