SCIENCE

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MOUNT ORIZABA OR CITLALTEPETL.

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THE central portion of Mexico is a plateau from 3,000 to 8,000 feet in elevation. About 19° north of the equator a broad belt of this plateau is composed of volcanic formations, which culminate in the snow-clad peaks of Citlaltepetl, Popocatepetl, and Ixtaccihuatl.

Citlaltepetl stands on the eastern margin of the plateau, about 80 miles from the coast, its eastern slope rising from the Gulf, the others from the plateau.

Orizaba, the name of a city on the eastern slope, is the name by which the mountain is best known to foreigners, but seen from a distance, rising far above all surrounding peaks, with its crown of glistening snow, the Indian name of Citlaltepetl, star mountain, seems singularly appropriate.

Popocatepetl, smoking mountain, and Ixtaccihuatl, woman in white, rise from the plateau about 100 miles west of Citlaltepetl. These old volcanoes, with Mount St. Elias in Alaska, are the culminating points of North America.

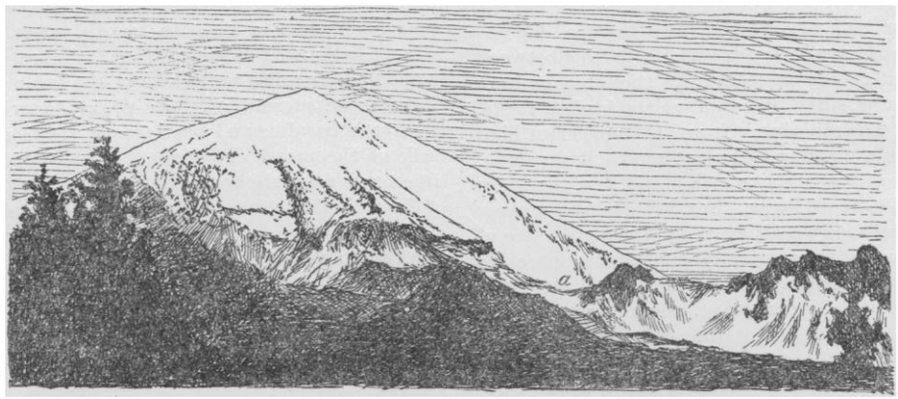


FIG. 1.—Southwestern slope of Citlaltepetl, taken Aug. 3, 1891, from the 13,800 ft. level. *a*. The 16,000 ft. level where the horses are left. See moraine just above and to the left of *a*. Tree in foreground is just above the cave.

Citlaltepetl, situated just within the northern boundary of the torrid zone, rising from tropical waters to polar snows, presents within narrow limits an epitome of the earth. On the slopes of this mountain may be found every variety of surface and every kind of climate, they produce all classes of vegetation and afford a congenial home for all sorts of animal life. This region, with its wonderful variety of scenery and its myriad forms of life, is of special interest to the student of science, whatever his department.

In July, 1891, a party consisting of W. S. Blatchley of Terre Haute, Ind., entomologist; Henry E. Seaton, now of Cambridge, Mass., botanist; A. J. Woolman of South Bend, Ind., icthyologist; U. O. Cox of Mankato, Minn., ornithologist; and the writer, visited the eastern slope of Citlaltepetl, making interesting collections of the varied forms of life which abound in that region. We found some forms new to science, found some familiar forms in unexpected localities, saw many interesting things, making the trip an interesting and valuable one to us. The different members of the party have published, or are preparing to publish, accounts of the work done in their several departments.

There is considerable discrepancy among observers as to the elevation of these Mexican mountains, until recently Popocatepetl has been considered the highest elevation, but determinations made within the last three or four years show that Citlaltepetl rises considerably higher than its rivals further west. Dr. Franz Kaska, using mercurial barometers, made the elevation 18,270 feet. Professor A. Heilprin, using an aneroid barometer, adjusted by a mercurial, and estimating his station as 120 feet below the true summit, made the elevation 18,205 feet. My aneroid made the elevation estimated at 120 feet only 86 feet. Making this correction, the elevation would be 18,171 feet. Mr. O. G. Bunsen, C.E., of the University of Texas, and the writer, using railway levels to 8,313 feet, carried a line of spirit levels up to 14,000 feet, then using our aneroid barometer, made the elevation 18,179 feet. In April, 1892, by triangulation from the 13,000 feet level of Bunsen and Scovell, I made the total elevation 18,314 feet. These results, arrived at by different methods, seem closely confirmatory. Popocatepetl is about 700 feet lower than Citlaltepetl, and Ixtaccihuatl is about 700 feet lower than Popocatepetl. In a paper before the National Geographical Society, Dr. Mendenhall gave the elevation of Mt. St. Elias as 18,010 ft., so that Mt. Orizaba seems to be the highest elevation in North America.

Climate of Glaciers.

In this region the summer is a wet season and the winter a dry one. In the sunshine it is generally hot, summer or winter, even on the upper slopes, but in the shade or at night it is usually cool and pleasant, anywhere between 4,000 feet and 10,000 feet. In summer the northeasterly winds seem to prevail, as shown by the fact that a tract of country, about 50 miles wide, to the southwest of Citlaltepetl, was dry and dusty, receiving only an occasional shower, while on either side of this region it rained almost every afternoon. The explanation seems to be that the winds from the northeast, losing their moisture on the mountain, flow over the region to the southwest as dry winds. Above the elevation of 12,500 feet, there were evidences of westerly winds, as leaning trees, drifting sands, more abundant vegetation on the eastern side of rocks, etc. But the winds most noticeable, summer and winter, were cold winds down the mountain at night, and warmer winds up the mountain by day. There is in general no rainfall during the winter, during the summer it is scanty from the coast up to 1,500 feet, then plenty of moisture to the summit, except on the southwest above 8,000 feet. The rains on the lower slopes are represented by snows on the upper slopes, but, while it rains almost every afternoon below, the snows above are less frequent, sometimes eight or ten days passing without a storm. But snow falls often enough during the summer to keep the peak covered down to about the 14,000 feet level, forming a distinct snow-line. If for a few days no snow falls, the old snow melts, and the snow-line rises, while an exceptional storm may carry the snow down to 11,000 feet or below, but 14,000 feet seems to

be about the average level of the snow-line. As the dry season comes on, the snowfall gradually ceases, and the snow that has accumulated during the summer rapidly disappears under the heat of a tropical sun; rocky ridges and loose sands appear on the south and east, while an extensive glacier is disclosed on the north and west. (See Figs. 1 and 5 for summer views and 2 and 4 for winter views.) The glacier on the southwest extends downward to about 16,250 feet, narrow tongues of ice reaching 400 or 500 feet further downward, while on the north the main body descends nearly to 15,000 feet. In April, 1892, near the close of

FIG. 2.—The Peak from the 13,000 ft. level on the southwest. Sierra Colorado on the left.

the dry season, the snow had disappeared and the ice had retreated some distance, leaving a valley or series of basins between the glacier and the crest of the moraine. In these basins were streams and ponds of water, small bodies of ice and broken rocks. (See Fig. 2 and Fig. 3.) The moraine is from 100 to 300 feet high on its outer face, and from nothing to 15 feet on its inner slope. The moraine is as steep as loose rocks will stand, but the rocks composing it are by no means loose, they are bound together with ice. The ice is continually melting from the outer face of the moraine, but the mass is practically constant, apparently supplied by water from the melting glacier above. Water from the glacier sinks slowly into the moraine, becoming ice again, later it melts from the face of the moraine and is absorbed by the rocks and sands below, without forming streams. I only saw one instance of a stream across the moraine, and it soon disappeared in the porous rocks. Dry drainage channels indicate that sometimes there is water enough to form streams, but, in general, there are no streams above 12,000 feet, and those below are few and small, on account of scanty rainfall and porous rocks. While it snows frequently during the summer, the total amount does not seem to be very great. The slope on the north is more gradual, so that the glacier on the north, measured along the slope, is about five miles long, while on the west it is not more than two miles in length (see Fig. 6). The width is from eight to ten miles, and the thickness or depth from 10 feet to 50 feet. I found no polished bowlders or striated rocks, the only evidences of motion were occasional crevasses, and the interval between the moraine and the ice. During the summer the glacier probably advances to the moraine, and both are generally covered with snow, but, on a photograph of the peak (Fig 1), taken from an elevation of about 13,700 feet, Aug. 2, 1891, after eight days without snow, the moraine can be seen as a sort of terrace across the slope of the mountain, while on July 28 and 29 it was entirely hidden by snow. The fact of the glacier on the west and north seems to indicate that more snow falls on those slopes, and that the moisture from which it is formed comes from the west. But the moisture might come from the Gulf, and the snow formed on the east be carried to the western slopes by the wind. From the storms I saw, I judged that the snow was somewhat equally distributed over the mountain, whether the storm was westerly or easterly, and that the glacier on the north, and the naked rocks and sands on the south, were due to the fact that more snow melted on the south, rather than that more snow fell on the north.

At first I felt sure that the glacier had its source in the Pacific Ocean, but the more I investigated the matter the more I inclined to the view that much of it might have come from the Gulf. These glaciers are not very extensive as glaciers go, but they present many interesting features for study, and they are easily accessible, one can ride to the foot of the moraine with little danger or fatigue. And there is little or no danger attending the exploration of the glacier, beyond the physiological effects of the great elevation. From January to the middle of April the glacier may be seen at its best. No danger from snow-slides or avalanches, and crevasses are not numerous or extensive, and can be easily avoided. In summer, there are occasional snow-slides on the western slope, and after 10 A.M. on a clear day there might be some danger from snow-covered crevasses, but earlier the frozen snow forms a safe bridge over any crevasse there may be in the glaciers of the Star Mountain.

Ice is quarried from the glacier for domestic use in the surrounding towns. The ice is taken out and dragged to the foot of the moraine and there loaded on burros or horses for transportation to the lower slopes.

Geology.

Citlaltepetl, Sierra Negra, and Sierra Colorado are the culminating domes of a great mass of volcanic rocks, which forms part of the eastern boundary of the famous valley of Mexico. This mass, about 50 miles in diameter, at the 8,000 feet level, rises by gentle slopes to the 13,000 feet level, above which rise the peaks mentioned. Citlaltepetl, the highest, is somewhat cone-shaped, but Sierra Colorado and Sierra Negra are ridges trending east and west, each about a mile in length. Sierra Negra is about five miles, a little west of south, from Citlaltepetl, and Sierra Colorado is about three miles southwest of the same peak.

From the summit of these peaks down to the 8,000 feet level trachytes, basalts, and scoriaceous rocks seem to make up the bulk of the mass. Then there are 200 or 300 feet of Cretaceous limestone in nearly horizontal strata, then from 800 to 1,000 feet of Jurassic limestone, whose crumpled and folded strata remind one of the folded rocks of Arkansas, thence down to about 4,000 feet there are several alternations of basaltic rocks and Carboniferous limestones. Near the city of Orizaba the limestone is thick-bedded and associated with beds of quite good marble and beds of the famous Mexican onyx. Below the city there are Devonian limestones, then Carboniferous strata to about 2,500 feet, then Cretaceous to the coast sands, about 25 miles from the Gulf. I noticed the succession of rocks, but did not attempt to identify the limestones, I name them as identified by Mr. Hugo Finck of Cordoba.

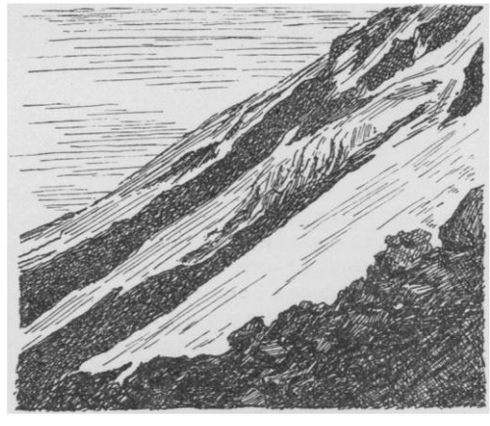


FIG. 3.—Detail at the foot of the glacier seen in Fig. 2.

According to Mr. Finck, the different phazes of the Glacial, Champlain, and Terrace periods are well marked in this portion of Mexico. The valleys of Orizaba and Cordoba were occupied by glacial lakes, over whose beds were deposited several hundred

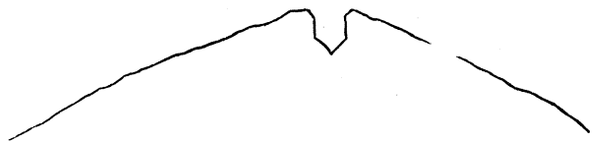
feet of drift materials, and the bowlder-strewn region below the valley of Cordoba seems to indicate glacial or iceberg action.

The interstratification of volcanic and carboniferous rocks seems to indicate that this region has been a centre of volcanic energy for several geological ages, and that the limestones mentioned occupy a comparatively narrow space along the slopes of a great core of volcanic materials.

Of the peaks mentioned, Sierra Colorado has an elevation of about 14,000 feet, has a smooth, uniform outline, and the greater portions of its outcropping rocks are of a reddish color. I saw no indications of a crater. Sierra Negra has an elevation of about 15,000 feet, with a uniform surface, broken only on the south, where the old crater was situated. The southern or outer wall of the crater has been broken away, leaving the inner or northern wall as an abrupt and rugged section of the otherwise uniform slopes of the mountain (see Fig. 4). The outcropping rocks are dark basalts.

Seen from a distance, especially when covered with snow, Citlaltepetl seems quite symmetrical, but in winter, or on careful inspection in summer, great ridges of rock may be seen leading up, like giant ribs, from all directions quite to the summit, giving the peak a rugged, restless appearance, so different from the restful outlines of its less elevated neighbors.

The crater of Citlaltepetl occupies the whole summit. It is somewhat elliptical in form, measuring about 800 feet from north to south by 600 feet from east to west, with a depth of between 400 and 500 feet. The rim is nearly horizontal, the difference in level between the highest and lowest points being about 80 feet. The peak is a little steeper on the south than on the north, the slope being between 30° and 35° on the south, increasing toward the summit. Inside the crater, for 30 or 40 feet, the slope is about the same as outside, then about 200 feet of vertical walls, then a sharp talus to the centre, as shown in the annexed cross-section.



The hot sunshine by day and the intense cold at night, with plenty of moisture during a large part of the year, result in rapid disintegration of the crater walls, cutting down the rim, and filling up at the bottom with fragments from the crumbling walls, so that, geologically speaking, the crater can exist but a short time. The ruggedness of the slopes and the fact of a crater seem to indicate that the peak is of recent formation. Citlaltepetl has a hot top, at least great areas of the rim of the crater are hot, giving off steam and gases, and large quantities of rocky material in the summit are the product of this fumarole action. Sulphur is found in considerable quantities in the rim of the crater, but I had no evidence of sulphur gases, or anything to indicate that Sulphur is being deposited at the present time. While there are many evidences of the recent formation of this cone, there is no evidence of an eruption of lava within historic times.

Between 8,000 and 12,000 feet we saw no rocks, the mountain was covered with a thick mantle of finely pulverized volcanic material, in some cases a black sand, then a sand of lighter color, again it is clay, that frequently appears like rock, called by the Mexicans tepetate. This deposit rises to about the same elevation on Popocatepetl, and to a height of 10,000 feet on the Toluca Mountains west of the City of Mexico, and in some places it constitutes the rim of the valley of Mexico. The proposed tunnel for the drainage of the City and valley of Mexico is deing dug through the tepetate, where it is at least 300 feet deep. The material was evidently deposited from water. It seems to indicate a more extensive lake system than now exists, and possibly more rapid erosion. The presence of this deposit at such high elevations seems to indicate an upheaval of some 3,000 or 4,000 feet within comparatively recent times. The geology of this region may not be very complicated, but fossils are not abundant, and there will doubtless be many conflicting opinions among geologists in regard to many of the geological features, yet the geologist who works up the region carefully will find an immense amount of very interesting geological material within a very limited area.

Life on Citlaltepetl.

With its base in the torrid zone and its summit in the region of perpetual snow, the eastern slope of Citlaltepetl produces almost every variety of vegetable and animal life. From the coast up to the 1,500 feet level, the country is practically a steppe; rainfall limited, soil sterile, vegetation scanty except along the streams; birds, insects, lizards, etc., abundant with but few mammals.

FIG. 4.—The Peak, seen over Sierra Negra, looking north from Esperanza during the dry season.

The region between 1,500 and 6,000 feet is the life-centre of this slope, the rainfall is abundant, and the soil, composed of the debris of volcanic and limestone rocks, is exceptionally fertile, producing a vegetation of great variety and luxuriance. The forest trees are seldom large but they exist in great variety, bearing ferns, orchids, bromelias, and other plants in great profusion on their trunks and branches; and every spot not shaded by the forest is crowded with a rank growth of herbaceous plants.

While in Cordoba, at an elevation of about 3,000 feet, I met a man from New York, who was buying Mexican lumber for the inside finish of his house, and went with him out to a little sawmill, where there was not more than 2,000 feet of lumber in stock. From this small quantity 65 pieces were selected, and, on counting, the man found he had 41 different kinds, all valuable as finishing lumber. It is said that there are as many as 100 different kinds of trees on the slopes of Orizaba that are valuable for lumber, besides many that furnish valuable dyes, oils, or gums.

This region is also famous for its orchids and ferns. I saw in Cordoba a collection of 70 species of native orchids, and was told that the collection did not contain nearly all the species of the region. Mr. Hugo Finck has sent to the Kew gardens from this

region more than 50 species of ferns that were new to science. In this region are cultivated cotton, sugar-cane, coffee, pineapples, bananas, oranges, lemons, wheat, corn, potatoes, and many other interesting and valuable plants. The markets of Orizaba, at an elevation of 4,000 feet, displayed the most extensive variety of vegetables and fruits I ever saw in one collection. In this region there were many beautiful birds with some mammals and reptiles, but after plants insects were perhaps the most interesting zoölogical features of the locality. Professor Blatchley, in eleven days' collecting, took 160 species of moths, 145 of butterflies, 125 of coleoptera, 60 of hemiptera, and 40 of orthoptera. Other kinds of insects were numerous, but no collections were made of them. (See *Entomological News*, May, 1892.) From 6,000 feet upward the character of the different kinds of life changes rapidly, and the numbers of individuals and the variety of species are greatly diminished. In two days' collecting at 8,000 feet, Professor Blatchley only took about a dozen species of butterflies and beetles, and other forms of life seem to diminish in numbers quite as rapidly as the insects. Birds were an exception, for they were as numerous and varied at 8,000 feet as below.

Above 7,000 feet the different forms of life were more like those of the northern zones. There were oaks and elders, mustards, plantains, chickweeds, dock, violets, and familiar ferns; sparrows, meadow-larks, blackbirds, crows, woodpeckers and humming-birds were common along with many unfamiliar forms. But while vegetation was abundant, there were no forests similar to those so common in the temperate zone.

FIG. 5.—Same as Fig. 4, but taken during the wet season.

Pines are common from 6,000 feet upward, but the forests of pine and spruce begin at about 9,000 feet, thinning out above 12,000 feet, so that the forest scarcely reaches 13,000 feet, although in some localities trees are found up to the 14,000 feet level. Above 13,000 feet a species of juniper spreads out over the rocks so that at a distance it appeared like moss. Along the slopes above 13,000 feet there were mustards, compositæ, castelleias, and a few other plants with two grasses, but no ranunculaceæ, claytonias, willows, or other water-loving vegetation so common on the high slopes of the Rocky Mountains in Colorado. The distribution is different in the two localities, on Orizaba individuals of the same species are seldom in groups, while on the other mountains great areas are often covered by one species. Near the 14,000 feet level, at the foot of a cliff looking east and south, where there was an indication of moisture, we found 14 or 15 species of plants, some of which had not been seen elsewhere above 12,000 feet. Only four species extended to any distance above this cliff, they were a castelleia and a draba, both nearly stemless, and scattering bunches of two grasses, probably an agrostis and a bromus, and these were passed at about 15,500 feet. The oaks stopped abruptly just above 9,000 feet. The ylite tree, whose thick bark furnishes a valuable dye, stopped as abruptly just above the 11,000 feet level.

A thistle, with a large white blossom, was seen only above 13,000 feet. Others again, as the castelleia, had a wide range, gradually diminishing in size as the elevation increased. Between 8,000 and 9,000 feet there were nearly as many flowers in April as in July, while above 9,000 feet in July we found nearly 75 species, but in April scarcely a half-dozen were found, of which the castelleia and draba were two. In the regions below, flowers were much more abundant in the summer, though more orchids and some other plants bloom in the dry season. So that whether one visits Citlaltepetl in summer or winter he will find the plant-life interesting and well worthy of consideration. Insects were found up to the 14,000 feet level, and I saw two white butterflies at the summit, but the number of species found above 9,000 feet were very few. Between 8,000 and 9,000 feet there were some familiar birds, but above and below these levels most of the birds were peculiar to the locality. There seemed to be several species of humming-birds and many others with highly colored plumage, but we heard no songs more beautiful than we hear in temperate zones.

Sparrows were common up to 14,000 feet, and I heard one while on the summit, but whether he made his home there or was only a visitor like myself, I could not tell. Woodpeckers were busy about the trees between 13,000 and 14,000 feet, and several other birds were seen and heard at that elevation.

The rainy season was not favorable for collecting birds, but Professor Cox secured some very interesting specimens. Among reptiles, lizards were the most common, and they seemed just as lively near the 14,000 feet level as on the coast sands. Salamanders were found near the 14,000 feet level and at other localities on the slope, toads and tree-toads were seen, and collections of snakes were seen, but no live ones were taken by the party. Lizards are much more abundant in the dry season. I took more in three hours one day in April than the whole party saw in fifteen days in July. We saw rabbits, had mice in camp at 12,000 feet, saw evidences of moles, ground squirrels, and other burrowing animals. Saw tracks of antelope and coyotes above 14,000 feet, but mammalian life did not seem to be abundant. Fish are abundant in the streams of the dry season, but during the wet season the streams are muddy torrents, containing but few fish and it is almost impossible to do successful fishing in such rapid streams, so that but few species were taken. Those taken were interesting, some of which are probably new to science. The predominant forms of life were plants, insects, and birds.

Professor Seaton collected over 500 species of shrubs and herbs between the 3,000 feet and 14,000 feet levels, and made many interesting observations as to the distribution of plant-life within those limits and the families and genera most abundantly represented by the flora of Orizaba (see Proceedings Indiana Academy of Science, 1891). The vegetation, insect-life, and birds were all we expected, but serpents, tarantulas, scorpions, centipedes, and the like, so common in pictures of tropical life, were seldom seen. We found the zoölogical altitude zones somewhat like the latitude zones, but with interesting variations, the details of which will be brought out fully in the reports from the different members of the party.

The Ascent.

The ascent of Citlaltepetl is neither difficult nor dangerous. Leaving Vera Cruz or the City of Mexico by the morning train, one reaches San Andres early in the afternoon, then by tramwas about six miles, to Chalchicomula, a little town of some 3,000 people situated on the western slope of the mountain at an eleva tion of about 8,300 feet. At this place, guides and horses rom be engaged and other preparations made for continuing the

ascent next day. A ride of six or seven hours over a steep but fairly good road for horses takes one to a cave, at an elevation of about 13,700 feet, where camp is usually made for the second night. The work of the third day is severe, and preparations should be made for a good breakfast and an early start. These items must be looked after by the tourist himself, as the guides are in no hurry, and an ordinary Mexican breakfast would not do for an American or Englishman who has a day of hard work before him. Starting early on the third morning, one rides to the foot of the moraine, near the 16,000 feet level, above which the slope is too steep for horses and the real work of the ascent begins. (See *A*, Fig. 1.)

The ascent from this point is made along a ridge which forms the eastern boundary of the glacier. In the dry season the tourist climbs slowly upward over rock and ice without danger, except such as may arise from severe exertion in the rarified air of such great elevations.

In the wet season the rocks and ice are more or less thickly covered with snow, which necessitates precautions not called for during the dry season. The eyes should be protected by colored glasses, and the face by a thick veil from the heat and light reflected from the snow, and the feet should be wrapped in coarse cloth to protect them from cold and to prevent slipping on the crusted snow. The chief guide leads the party, cutting steps in the snow for himself and followers. One might miss his footing and slide to his death on the rocks below, but the danger is not great if the instructions and example of the guide are followed carefully. It requires considerable exertion to climb steep slopes at low elevations, but when the elevation is so great that nearly or quite half the air is below, the least exertion is exhausting.

FIG. 6.—The Peak from the west at the 10,000 ft. level.

The lungs can get oxygen enough to supply the system when at rest, and one may ride from the sea-level to the 16,000 feet level without discomfort from light air. Above 16,000 feet, one not accustomed to the air of such elevations can climb but a few feet before sinking down in utter exhaustion, gasping for breath, with palpitating heart, oppressed brain, and possibly a qualmy stomach. After a brief rest the unpleasant symptoms pass away, then a little climb, then a rest, and so upward, the climbs getting shorter and the rests longer till at length the summit is reached. Some can climb faster than others; a good rule is to climb so far as possible without opening the mouth to breathe, then rest. On the average, one does well to climb 500 feet an hour.

Edward Whymper speaks of a "mountain sickness" which affected him and his assistants while exploring among the high Andes. Some of us had a little nausea, but we did not attribute it to the rarified air, and Mr. Bunsen had a severe headache while on the summit, which passed away soon after the descent began, but none of the party was affected with the mountain sickness of Whymper. No other locality on the globe affords such a full and comprehensive panoramic view as does the eastern slope of Citlaltepetl, whether seen from shipboard some 20 or 30 miles at sea, or from the summit of the mountain. The view from the summit is clearest during the forenoons of the wet season when the air is free from dust and usually clear. During the dry season a dust or haze pervades the air to an elevation of 9,000 or 10,000 feet so that objects below that elevation cannot be distinctly seen.

The descent is made to the cave or to Chalchicomula for the night, and Vera Cruz may be reached on the fourth day; thus practically making a journey from the tropical to the polar region and return in four days. Nowhere else on the earth can this be done as easily, quickly, and safely as on the eastern slope of Citlaltepetl, the Star Mountain of North America.

NOTES AND NEWS.

IN October, 1891, Thomas George Hodgkins, Esq., of Setauket, New York, made a donation to the Smithsonian Institution, the income from a part of which was to be devoted "to the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man." With the intent of furthering the donor's wishes, the Smithsonian Institution now announces the following prizes to be awarded on or after July 1, 1894, should satisfactory papers be offered in competition: 1. A prize of $10,000 for a treatise embodying some new and important discovery in regard to the nature or properties of atmospheric air. These properties may be considered in their bearing upon any or all of the sciences — e.g., not only in regard to meteorology, but in connection with hygiene, or with any department whatever of biological or physical knowledge. 2. A prize of $2,000 for the most satisfactory essay upon (*a*) The known properties of atmospheric air considered in their relationships to research in every department of natural science, and the importance of a study of the atmosphere considered in view of these relationships. (*b*) The proper direction of future research in connection with the imperfections of our knowledge of atmospheric air, and of the connections of that knowledge with other sciences. The essay, as a whole, should tend to indicate the path best calculated to lead to worthy results in connection with the future administration of the Hodgkins foundation. 3. A prize of $1,000 for the best popular treatise upon atmospheric air, its properties and relationships (including those to hygiene, physical and mental). This essay need not exceed 20,000 words in length; it should be written in simple language, and be suitable for publication for popular instruction. 4. A medal will be established, under the name of the Hodgkins Medal of the Smithsonian Institution, which will be awarded annually or biennially, for important contributions to our knowledge of the nature and properties of atmospheric air, or for practical applications of our existing knowledge of them to the welfare of mankind. This medal will be of gold, and will be accompanied by a duplicate impression in silver or bronze. The treatises may be written in English, French, German, or Italian, and should be sent to the Secretary of the Smithsonian Institution, Washington, before July 1, 1894, except those in competition for the first prize, the sending of which may be delayed until Dec. 31, 1894. A principal motive for offering these prizes is to call attention to the Hodgkins Fund, and the purposes for which it exists. Suggestions and recommendations in regard to the most effective application of this fund are invited. It is probable that special grants of money may be made to specialists engaged in original investigation upon atmospheric air and its properties. Applications for grants of this nature should have the indorsement of some recognized academy of sciences, or other institution of learning, and should be accompanied by evidences of the capacity of the applicant, in the form of at least one memoir already published by him, based upon original investigation. To prevent misapprehension of the founder's wishes, it is repeated that the discoveries or applications proper to be brought to the consideration of the committee of award, may be in the field of any science or any art without restriction; provided only that they have to do with "the nature and properties of atmospheric air in connection with the welfare of man." Information of any kind desired by persons intending to become competitors will be furnished on application. All communications in regard to the Hodgkins Fund, the Hodgkins Prizes, the Hodgkins Medals, and the Hodgkins Fund publications, or applications for grants of money, should be addressed to S. P. Langley, Secretary of the Smithsonian Institution, Washington, U.S.A.