tric supply. A similar sliding contact carried by the main train connects a point opposite this train with the negative terminal.

In the event of an obstacle being present on the track the engineer of the car in advance would stop and such action would notify the engineer in charge of the following main train of danger ahead so that he could bring his train to a standstill. If, however, the engineer of the advance car did not happen to see the obstacle, the resulting accident would usually affect his car only, and, therefore, but a small fraction of the passengers on that section instead of a whole trainful.

THE VOLCANO OF COLIMA.*

By CHARLES RICHARDS DODGE.

THIS old fire mountain, in Mexico, which has been the subject of recent press dispatches on account of

the towns we passed through. Tonila was especially marked in this particular. The Mexican Central Railway is extending its line from Tuxpan to the City of Colima, following as nearly as possible, considering the deep cañons, or barrancas, of the region, the line of the old Spanish mule trail. On account of the recent activity of Mt. Colima a change in a portion of the route has been necessitated. The scenery of this entire region is wild and picturesque—the cañons formidable—that known as the Grand Barranca of Beltran being the most interesting. Here the sides seem to drop perpendicularly a thousand feet, the stone paved, zig-zag, mule trail which passes down and up—constructed in the days of Spanish occupancy with heavy retaining walls—showing engineering skill of high order, especially in an earthquake country, for the masonry seems as solid as when built in Cortes's time. One picture shows one of the many sharp turns in the trail, some of which have inclines so steep in

MT. COLIMA FROM CITY OF TONILA.

its alarming activity, is situated about 150 miles south of Guadalajara, and less than 40 miles from the Pacific coast. It has been "smoking" for nearly twenty-five years, though until this year it has not been regarded as menacing to the surrounding country. It is said by the scientists to be in the Mt. Pelé chain, and it is worthy of note that the first evidences of activity approaching violence were observed only a few days after the first Mt. Pelé outbreak. It soon returned to its normal condition, however, attracting no further attention until its recent violence called it again into public notice, and sent the denizens of the farms and near towns of the locality fleeing for their lives. The latest eruption occurred on August 2, which covered the mountain with lava and dense smoke, and was accompanied by loud detonations and rumblings.

Tuxpan is the present terminus of the railway line which extends southward from Guadalajara, distant from the last-named city about 120 miles. To reach the volcano from Tuxpan the old Spanish mule trail from Zapotlan, via Tonila, must be followed, the volcano lying northerly from Tonila, within about fifteen miles, across country, from this busy town. Both Tuxpan and Tonila were mentioned in the press dispatches, the latter city reported as having been abandoned. The city of Colima, which lies to the westward of Tonila about 20 miles, also felt the effects of the disturbance.

The writer spent three days in 1902 at the Hacienda La Joya, which lies just at the foot of Mt. Colima, and was afforded opportunity to climb the mountain, as far, at least, as was possible with safety. The mountain peak, as it rises above the timber line, is very precipitous, and is seamed and gullied from the erosion of ages, some of the seams being in reality deep valleys. The peak is difficult of ascent, and absolutely dangerous on account of the volleys of red-hot rock, weighing tons, which ever and anon are thrown from its crater, and which crash down the mountain side like an avalanche, and with the roar of a limited express train.

In normal times the eruptions occur at irregular intervals of thirty minutes to two hours. First is heard a dull rumbling sound which steadily increases in volume, while the crater is seen to send forth a cloud of smoke and steam. Then the masses of rock and loose stones rush down the paths of erosion, stirring up the dust on the way, these dust clouds appearing as a series of lesser eruptions as point after point is reached in the fall.

Mt. Colima is about the same elevation above sea level as Pike's Peak, or about 14,300 feet, the main peak of Colima rising above the surrounding country some 3,890 meters. The peak is absolutely bare of vegetation, appearing glistening white in the sunshine, against a deep blue sky, and on this account is a difficult subject for the camera. Our illustrations show the mountain with its chain of peaks, as seen from Tonila fifteen miles away, and from a point near the higher peak, two miles from timber line, the latter picture having been made during a slight eruption. To reach this point from Tonila we described nearly one-half of the arc of a circle.

There is no regular trail up the mountain. It is very steep in portions of the way, and is so rough a journey that the novice, on a mule, is liable frequently to find himself in hair-raising situations. But as a Colima mule can always be relied upon to "find a way," there is little danger in making the journey up to the timber line.

This is a region of earthquakes, and evidences of seismic disturbances in past time were noted in all

places that the term "break-neck" is most applicable. Yet for centuries all of the merchandise, and the travel as well, that goes into this section of Mexico, is transported over this terrible trail upon the backs of pack animals, or horses. When the railroad is finished this trail will become a less important thoroughfare, and Mt. Colima will be more readily accessible to tourists.

[Continued from SUPPLEMENT No. 1440, page 23078.]

VEGETABLE PHYSIOLOGY.*

By Prof. J. REYNOLDS GREEN, M. A., Sc. D., F. R. S.

ANOTHER worker of great eminence who has found similar conditions to exist in normal vegetation is Berthelot. He put blades of wheat and leaves of the hazel in flasks, displaced the air by hydrogen, and distilled. In the case of the wheat he heated the flask to 94 deg. C., in that of hazel he conducted the distillation by passing steam through the flask. In both he found the distillate contained alcohol. The quantity was not large, but still measurable; from 10 kilos of leaves he obtained 10 grammes of alcohol.

Mazé claims to have found alcohol under normal conditions in the stems and leaves of the vine.

We may inquire further how far the evidence points to the probability that the molecule of sugar is split up in that way into alcohol and carbon dioxide, and that the alcohol is the nutritive part of the sugar molecule. Certainly Mazé's experiments on the submerged seeds with the plumule exposed above the water are not inconsistent with that view. Duclaux has spoken more definitely still on this point, and has said that the alcohol formed becomes a true reserve material to be used for nutriment.

We have, however, further evidence that to some plants, at all events, alcohol is a food. Laborde has published some researches conducted upon a fungus, *Eurotiosis gayoni*, which point unmistakably to this conclusion. He cultivated it in a solution containing only the mineral constituents of Rawlin's fluid and a certain percentage of alcohol, usually from 4 to 5 per cent. The plant grew well, forming little circular patches of mycelium, which enlarged radially as the growth progressed. The mycelium became very dense in the center of the patches, and the fungus evidently thrived well. As it grew, the alcohol slowly disappeared, the rate being about equal to that of sugar in a similar culture in which this substance replaced the alcohol. The mycelium in some experiments was cultivated quite from the spores. *Eurotiosis* is a fungus which has the power of setting up alcoholic fermentation in saccharine solutions. When cultivated in these alcohol is accordingly produced, and subsequently used, but the growth of the mold is not so easy under these conditions as when the alcohol is supplied to it at the outset.

Duclaux has shown that in the case of another fungus, the well-known *Aspergillus niger*, though alcohol kills it while it is in course of germination from the spore, it can utilize for nutrition 6.8 per cent when it becomes adult, continuing to grow and putting out aerial hyphae. *Eurotiosis* is more pronounced in its liking for alcohol, for it thrives in a mixture containing 10 per cent; even if submerged entirely it continues to grow and flourish in an 8 per cent solution. The peculiarity relates only to ethyl alcohol; methyl alcohol will serve as a nutritive medium for only a little time, sufficient only for the commencing development of the spores into a mycelium and disappearing very slowly from the culture fluid. The higher alcohols, propyl, butyl, and amyl, not only give no nourishment, but are poisonous to spores. A very small trace of any of them can be used by the adult mold.

Laborde claims to have established as the result of his investigations that *Eurotiosis* normally makes alcohol from the sugar to nourish itself with it, just as yeast makes invert sugar from cane sugar because it is the nutritive material it likes best. The enzyme-ase is present in the fungus and plays the part of an alimentary enzyme. Its consumption lasts twice as long as that of a corresponding weight of glucose; it can serve twice as long for the nutrition of the same weight of plant.

These remarkable results lead us to the consideration of the mode in which the carbohydrates, and particularly the sugars, are assimilated by the plant. We have held the view that the sugar molecule is capable of entering with little if any alteration into that of protoplasm. We have found no direct evidence bearing upon its fate. It is possible to detect sugar in the axis of a plant till quite near its growing point. Then the reaction ceases to be obtainable, and we know that assimilation is taking place. But we have still to investigate the steps, no very easy problem to undertake. May it possibly be that it is the alcohol moiety of the sugar which the protoplasm takes up, part of the carbon dioxide evolved by the growing organ being an expression, not of respiration, but of a fermentation preliminary to assimilation?

But I feel I have dealt at sufficient length with this question. I pass, therefore, to consider briefly another nutrition problem of a rather different kind. The

MT. COLIMA, NORTHERLY PEAK FROM HACIENDA LA JOYA.

Mazé finds, further, that the weight of a seedling of maize approximates at any moment during the early stages of germination to half that lost by the reserve store in the endosperm.

From his experiments, and those of the other authors alluded to, he concludes that alcohol is formed in the living cells of seeds at the expense of grape sugar by virtue of a normal diastasic process, which makes them approach yeast cells more closely than has been suggested by any of the experiments hitherto published.

germination of seeds is a question that might be thought to have been fairly settled by the investigations of the latter half of the last century. We have come to the conception of the seed as fundamentally a young embryo lying quiescent within its testa, and provided with a store of nourishment deposited either within its own substance or lying round it in the tissues vaguely named endosperm or perisperm. The nourishment has been held to be practically ready for its use, needing only a certain amount of enzyme action to be applied to it to convert the food store from the reserve to the nutritive condition. We have recognized here starch,

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

* Read before the British Association for the Advancement of Science.