and gives the whole matter in a concise and useful shape.

In the first investigation 24 industries were compared; and the average of different modes of computation leads to the result that, in general, wages are 62% higher in Massachusetts than in Great Britain. In those cases where pay-rolls could be compared, the average weekly pay was $10.82 in Massachusetts, and $5.48 in Great Britain. We must remember, however, that the number of working hours is 12% greater in Massachusetts. The average wages per hour show a gain of 71% in favor of Massachusetts. Women's wages, as also those of young persons and children, show a gain of 59% in favor of Massachusetts. The next investigation covered 90 industries, and considers the wages of at least 1,250,000 of employés. The wages in Massachusetts are 77% higher than in Great Britain. Besides wages have increased since 1860 in Massachusetts by 28%, in Great Britain by 10% since 1872.

The other side of the question is represented by the cost of living. Our sources of information are prices and workingmen's budgets of expenditure. Prices are higher in Massachusetts (for everything except provisions) on an average of 43%. The average family in Great Britain is slightly larger, but a slightly larger proportion of the family are at work, thus making a direct comparison with the Massachusetts family perfectly fair. In Massachusetts the earnings per family are 55% higher than in Great Britain; the former saves 6%, and the latter 2%, of its income. The expenditures for 1883 of the two families are $754 and $508. If we consider the articles of expenditure, we shall find a remarkable harmony with an economic law demonstrated by Dr. Engel (Royal statistician at Berlin). This law says, 1. the greater the income, the smaller the relative percentage of outlay for subsistence; 2. the outlay for clothing remains uniform, as also; 3. does that for lodging, rent, fuel, light; 4. the outlay for 'sundries' becomes greater as the income increases. The agreement between the calculated and actual values for each item of the expense is very close, the average deviation being less than 3%. The table further teaches that the prices of articles entering into the cost of living were 17% higher in Massachusetts in 1883; of this 11% is due to higher rents in Massachusetts, leaving 6% as indicative of the higher cost of living in Massachusetts. As a final conclusion we have that the standard of living of Massachusetts workingmen to that of the workingmen of Great Britain is as 1.42 to 1. That is, while the cost of living is higher, the wages are still so much higher than those in Great Britain as to leave a margin for better living and even greater saving.

Another portion of the volume deals with the problem of Sunday labor. The questions are these: Has the Sabbath become a necessary element in modern industry, and is its abolition connected with serious evils or not? The departments in which Sunday labor is done are considered one by one. By far the greatest share of Sunday labor is done in connection with railroading. All the roads began without Sunday labor, but street cars and steam railways alike were forced to Sunday labor by public demand. The trains are run for convenience rather than for profit. While the employés generally declare that they would rather have the day of leisure than the additional wages, still the usual effects of overwork seldom occur. The important consideration is this: Sunday labor is not productive labor, but is labor for personal service, and such occupations do not call for constant exertion. If the weaver had to stand at his loom for seven days of the week, he would probably break down; but the car-conductor does it without physical deterioration. The proportion of Sunday laborers to the laboring community is probably larger than one would suppose, 32% of working females and 11% of males doing work on that day.

THE ASCENT OF POPOCATAPETL.[1]

DURING the conquest of Mexico by Cortez, some of his followers ascended this volcano to obtain sulphur with which to renew their exhausted supply of powder. The ascension of Popocatapetl, as compared with that of other great mountains of the world, presents no unusual difficulties, and in the course of the present century, many parties have accomplished it with entire safety, especially since the attention of the commercial world has been called to the great value of the sulphur deposits there.

The ascent is always undertaken from the northwest side of the mountain, starting from the town of Amecameca, which lies on the railroad from Mexico to Morelos. From here a horseback ride of three or four hours brings the traveller to the rancho Tlamacas, just below the snow-line, and from this point the ascent is continued on foot. The party is provided with alpenstocks, and a sort of primitive sandals called *guaraches*, drawn on over the boots to prevent slipping. A peon goes ahead and hews steps in the hard-frozen snow; the others follow in Indian file, pausing every now and then to rest, as the exertion in the extremely rarefied atmosphere is very exhausting.

After the summit is reached, the view, if the

[1] Condensed from an article by Carlos von Gagem, in the *Deutsche rundschau für geographie und statistik*,

weather is clear, amply compensates for all the difficulties of the ascent. At the feet of the spectator lies spread out like a map the beautiful plateau of Anahuac, over eighty miles long, with its four lakes, and more than 200 cities, villages and haciendas, including Mexico the capital, Puebla, Cholula, Atlixco and Tlaxcala, surrounded by snow-covered mountains, among which rise the peaks of Ixtaccihuatl, only eight miles distant, Malinche, and farther toward the east, Orizaba.

The view of the interior of the crater is always completely obscured by the sulphur vapor, which constantly rises from the openings in the bottom, called *respiraderos*. It is at first of a greenish color, then condenses and falls in yellow drops, and finally forms into beautiful crystals. The edge of the crater is composed of immense blocks of porphyry and basalt. To descend into the crater, one follows a path leading downwards from the summit among ice-covered rocks, till a huge block of basalt is reached, which serves as a support for the primitive machine, called *malacate*, which is used here, as in most of the mines of Mexico, for the perpendicular descent of the remaining distance. A strong beam projects a few feet horizontally over the abyss ; over a pulley in the end runs a long rope with a loop in the lower end. The person wishing to descend stands in the loop, holds the rope in one hand, and with the other manages a stick, to protect himself from injury by swinging against the rocks. Two peons let the rope run slowly out over the pulley, and in this way the descent is accomplished. The rope is over 250 feet long, and the descent occupies ten or fifteen minutes.

The crater has the form of a funnel. The bottom is composed of scoriæ, which glitter with various colors, and among which are the *respiraderos*. In one place is a stone so large that a man can stand upon it, which rises and falls as it feels the effect of the subterranean vapors. At the lowest point is a lake, the water of which has a sulphurous and also somewhat acid taste.

The descent of the mountain is, of course, very much easier and quicker than the ascent ; that of the snow-cone especially is accomplished in a very summary manner, familiar enough to a New Englander, to be sure, but rather startling in its novelty to inhabitants of the southern countries. An Indian sits on the forward end of a mat, holding a stick upright between his legs ; the traveller sits behind, clinging to the guide with hands and legs, and in less time than fifteen minutes the distance is traversed, which in the ascent occupied three or four hours.

According to the latest measurements, the height of Popocatapetl is 17,809 feet above the sea-level. The crater is about 2½ miles in circuit, and has a depth of 1,000 feet. Since the mountain has given out sulphurous vapors for centuries, and at the present time something like a ton of sulphur is deposited daily, the amount of the mineral existing there is almost beyond estimation. It would hardly be an exaggeration to say that the upper part of the mountain is an immense block of sulphur, enclosed in a shell of rock a few yards thick.

Three qualities of sulphur are obtained by the operations here. The best is almost chemically pure, obtained at the *respiraderos*, whence it issues in a liquid state and hardens as it cools. The other two qualities are known as rich and poor sulphur-ore. The former yields from 82 to 87 per cent of pure sulphur, the latter about 50.

The process used for the purification of the sulphur is that of Michel, with the apparatus improved by Lamy. The distillation takes place in six large cast-iron kettles, or half-cylinders, which take the place of retorts, and a large brick chamber which serves as the receiver.

Since the sulphur of Popocatapetl is much superior to the Sicilian, it is in greater demand in the American markets. The works at Tlamacas have control of enough water and fuel to increase their productiveness considerably. This would be in every respect advantageous ; aside from the consumption of Mexico, the United States use 200,000 tons annually, and even if every ton were sold 20 per cent below the usual price, there would still be, after allowing for freight and all other expenses, a clear profit of two dollars a ton. The expenses of production are very small. The workmen receive only about 75 cents per *arroba* (25 pounds), although their work is laborious, dangerous on account of the constantly falling rocks, and from breathing the sulphurous vapors very deleterious to the health, causing in a short time, among other inconvenience, the falling out of the teeth.

The principal source of the world's supply of sulphur at present is Sicily, which produces four-fifths of that consumed. The deposits of Popocatapetl are greater than those of Sicily, and, as already stated, of better quality. It seems incredible that they have not been more thoroughly worked, especially as this sulphur can be brought to market 25 per cent cheaper than the Sicilian, at least in the United States.

A plan is now on foot to lead a tunnel through the wall of the crater directly to the sulphur deposits, and connect its mouth by a narrow-gauge railroad with Amecameca, which is on one

of the main lines of the country. The capital is forthcoming, and it is quite likely that in a few years this mountain, which is of such great interest in geologic, topographic, and artistic respects, will have acquired an almost incalculable industrial importance.

NATURAL ENEMIES OF OYSTERS.

MAN in former times, and even at present in some localities, might be classed with the enemies of the oyster. But now, when he is introducing artificial means for their multiplication, instead of an enemy he becomes their protector. There are animals, harmless-looking and small, which do far more damage to this delicious shell-fish than man, and that, too, without giving anything in return. The many which are destroyed by human agency become few when compared to those killed by their smaller foes.

The oyster, although protected by a very hard shell that can be closed almost hermetically, is, on the whole, rather poorly defended, for there he lies right on the open bottom, exposed to everything that may chance to come along, without any power to move away and crawl into some crevice, but destined to remain motionless while attacked. Two kinds of animals do the most damage: one the common star-fish (Asterias Forbesii), the other a univalve spiral shell-fish, called by oystermen the 'drill' (Eurosalpinx cinerea).

A star-fish approaches its victim, slowly crawls upon it, and then bends its five arms around the shell. The mouth of a star fish is so small that an oyster a quarter of an inch long could not be taken into it. So what does it do, when its arms are encircled around the large oyster, but begin to project its stomach out of its mouth and surround the oyster with its stomach entirely outside of the body. Then the oyster gradually opens its shell, leaving the star-fish to do as it pleases. After a while the star-fish moves off, and we see that a large part of the oyster is gone. When the stomach is first protruded a liquid is excreted which seems to have the power of either killing or weakening the oyster. Just as soon as the shells are open digestion is begun by the star-fish, and after a short time the hunger of the star-fish is satisfied and the oyster is dead. Before long the star-fish feels like another meal, and he attacks another oyster, leaving the old one as prey to small crabs and shrimp. And so it goes on day after day, thousands operating in the same manner. At times they come in immense swarms from deeper water, in a single night entirely destroying a large bed. In brackish water they do not flourish, but in the almost pure ocean water found in some oyster-raising districts the destruction is immense, and there is no remedy.

If some shell-fish for which the star-fish have a preference could be introduced among the oysters, perhaps the devastation might be partially checked. Oystermen formerly had the stupid habit of tearing every star-fish that happened to come in their way into pieces, throwing the fragments overboard. They were not aware that each arm had the power of reproducing the remaining four arms and becoming a perfect star, so that each time one was torn into two or three pieces, two or three new individuals were formed.

The other enemy, the so-called 'drill,' is well named, for its peculiar operations are based upon its boring or drilling powers. Although seldom an inch long, it can bore a hole through the hard shell of an oyster with surprising speed. The hole is always smooth and about in the same place, a spot covering a vital part being the point attacked. Similar 'drills' operate on other species of shell-fish, and their deadly marks can be seen on the valves of the shells which are washed upon our beaches. In any collection of shells, and on any beach, numerous examples of the neatly-drilled hole can be found.

In the soft animal part of the 'drill' there is a little tube-like proboscis which encloses another proboscis. Over the end of the latter there runs a little ribbon which is covered with teeth. This ribbon, or odontophore, is attached at each end on the two opposite sides of the inner proboscis. By means of muscles at the base of each end of the ribbon it may be pulled back and forth over the end of the snout, with the teeth projecting outward. When the oyster is to be attacked, the end of the snout is pressed against that part of the shell to be bored, and the muscles begin to work the toothed strap. The teeth rasp away at the shell, each time removing particles of calcareous matter until a hole is bored. Then the rasp acts upon the flesh inside, and as the meat is removed it is drawn to the mouth and eaten.

The 'drill,' after eating a meal, leaves its victim, and later attacks another. By the time it has finished its meal the oyster is dead, and its shell flies open, leaving the rest to crabs and shrimp. Filing away upon the hard shell wears the teeth away rapidly, but this is remedied by nature, for one end of the strap is gradually absorbed, while from the other end a new supply of toothed ribbon is being formed. So, on one side of the proboscis, there are fresh unused teeth; on the other side, old worn ones; and on the end, teeth just being worn; and the whole gradually moving away to one end, to be absorbed while other fresh ones are being formed.

RALPH S. TARR.