Scientific American.

ESTABLISHED 1845.

MUNN & CO., Editors and Proprietors.

PUBLISHED WEEKLY AT

No. 361 BROADWAY, NEW YORK.

O. D. MUNN. A. E. BEACH.

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NEW YORK, SATURDAY, JUNE 9, 1894.

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No. 962.

For the Week Ending June 9, 1894.

Price 10 cents. For sale by all newsdealers.

THE COAL STRIKE AND ITS LESSONS.

Some years ago, when natural gas was poured out of numberless wells in such quantities that manufacturers used it with reckless prodigality, a hope was entertained that although the supply might cease the lessons learned in its consumption would not be lost. These lessons were not of a very advanced kind; they simply went to show that gaseous fuel was superior to solid, that it was more manageable, and gave better products, but no lesson of economy of fuel was taught. Manufacturers went on in their usual way without a thought for the future.

The last six weeks have been occupied with occurrences which, grave in the social aspect, have brought the fuel question prominently forward in all its crudities. A strike among coal miners in fourteen States and two Territories has been in progress. The central Western region, included in a general way in the quadrangle defined by Chicago, Birmingham, Pittsburg and St. Louis, is the region most affected. The coal on hand approaching exhaustion, 175,000 men on strike, deeds of violence of frequent occurrence, the poor in cities paying three and four times the usual price for a bucket of coal, were features of the strike that made its seriousness evident. Large numbers of the miners are foreigners and of the most excitable nature, and liable to be carried almost any distance by their feelings.

The cause of the strike is one which brings into strong perspective the fuel question. The miners desire a uniform rate to be established to be paid them for coal as mined. This rate is 75 cents a ton. In some places the miners have received but 42 cents a ton in others 50 cents. Their request seems far from exorbitant. It is clear that the price asked by them is but little for the amount of combustible matter represented by the long ton of coal. So cheap a rate of extraction would imply a very good condition of things for the consumer. But it is not altogether so.

When the miner is paid for the coal which he has cut from the breast of his working, the smallest part of the cost of the coal is provided for. The coal has to go through preparation, more or less expensive, before delivery to the consumer, and it has to be transported from the mines to the furnace and factory. All this adds greatly to its cost. An addition of twenty-five cents to the ton would mean far more at the mine than it would two hundred miles distant. To the miner it means an increase of wages of fifty per cent; to the distant consumer it would mean an increase in price of ten per cent or less.

The improved regenerative and recuperative furnaces of the present day have effected economies of fifty per cent or more in coal consumption. Improved high pressure boilers working compound and triple expansion engines have brought about just as great economies in steam power. Electricity, by enabling the generation of energy to be concentrated in large plants, and to be delivered efficiently in small units, has opened up further possibilities in economy which the trolley street car system illustrates, for there is an unknown development awaiting us in the future.

But the coal strike, bringing out with its other features the fact that the extraction of coal represents so small an amount, and that with superadded transportation it reaches the consumer for so low a price, tells or implies a story of extravagance of coal consumption. With more rational methods of burning it, with more advanced engines for its utilization, with boilers working up to 200 pounds pressure instead of, perhaps, a tenth that amount, the fuel question could be made a much less important one, not only in question of cost but of absolute physical magnitude. For now the trouble is to supply tons enough of coal to keep wasteful furnaces and antiquated boilers and engines in operation, and to supply with fuel small isolated plants using six or eight pounds of coal to the horse power per hour. In a more enlightened and advanced state of society it is to be hoped that better social laws and principles may make strikes impossible and without cause or reason for existence. But outside of the social aspect, in the improvement of processes and in the consequent reduction of the great quantity of coal required lies one possibility of preventing these occurrences and of entitling the coal miner to better wages. If a manufacturer by substituting regenerative furnaces for his old fashioned reverberatories at one operation saves half his coal, he may feel able to pay a price for it that will justify the mine owner in paying the miner a higher rate.

It is in such possibilities as the above—perhaps they are hardly probabilities—that the scientists and inventors, the Siemens and the Bessemers, appear as the world's benefactors. It is in carrying out their processes that some of the highest wages are received by workmen. The Siemens furnace reduced coal consumption to one-half its former amount; the Bessemer converter, taking its fuel from the carbon and silicon of iron, almost abolished coal consumption for the production of soft steel. In advanced processes is always sooner or later to be found the amelioration of the condition of the workman as well as the general improvement of the condition of mankind. The present waste of coal is largely responsible for the low wages of the miners and for the consequent strikes and disturbances.

Cassava Meal and Tapioca.

Next to rice and sago, there are but few food products of a similar character that have such an extensive use as tapioca. And notwithstanding the enormous quantities that are produced, and the cheap rate at which it is sold in the English market, but little is generally known as to its origin and preparation.

Two distinct plants, though closely botanically allied, furnish tapioca; they are *Manihot utilissima, Pohl.*, known as bitter cassava, and *Manihot aipi, Pohl.*, the sweet cassava. The plants are natives of Brazil, where they are extensively cultivated, the bitter cassava especially, for the sake of the starch which is contained in the fleshy tuberous root, and which forms commercial tapioca. It is also largely grown in west tropical Africa, as well as in the Straits Settlements. It is a half shrubby perennial, with large leaves deeply divided into from three to seven segments. The tuberous root often grows to a very large size, weighing many pounds, and containing a poisonous milky juice. The plant is known under a great number of varieties, differing in the color of the stems and the division of the leaves. The roots of the bitter kind are said not to become soft by boiling or roasting, while those of the sweet cassava, though very tough in the center, become soft by the application of heat; so that after being roasted or boiled, they are eaten in a similar manner to potatoes.

Besides tapioca, the cassava root furnishes several other valuable food products, as cassava meal and cassareep. In one of the monthly numbers of the *Bulletin* of the Botanical Department of Jamaica these products and their uses are thus referred to. Cassava meal is prepared from both the sweet and bitter sorts, the root is grated, by which the cells containing the juice and starch grains are broken up, the grated material is placed under pressure, sometimes with water pouring through it. The pressure squeezes out all the juice, while a certain portion of the starch grains passes over with the liquor. The substance left under pressure consists chiefly of the cell walls broken up, but also of some starch grains. This is cassava meal, which is dried on hot plates and made into cassava cakes. The liquor which passes away under pressure being the pure juice only, or the juice mixed with water, which is allowed to stand for some time, when the starch settles to the bottom, and the liquor is poured off. The starch grains, as seen under a microscope, are muller shaped. This is cassava starch proper, as distinguished from cassava meal. Tapioca is prepared by heating moistened cassava starch on hot plates. This process alters the grains, which swell up, many bursting, and thus they agglomerate in small irregular masses.

Cassareep is the juice of the bitter cassava root, concentrated by heat, which also dissipates the volatile poisonous principle. The same is further flavored with aromatics. Boiled with peppers, and fish or meat, it forms the West Indian "pepper pot."

Cassareep is an article of import into England. It is a thick, black, treacly-looking substance, and forms a component part of most table sauces.

The following details for preparing cassareep, tapioca, and cassava cakes may be found useful: "Grate the cassava, and squeeze out the juice, which is to be put aside for about three days; add one part of fine salt to every twelve quarts, and then boil down, until it becomes like sirup. If it is intended for long keeping, it must be boiled thick. Put aside in jars till required for bottling."

To prepare tapioca, "grate the cassava, wash it, by putting in a cloth, and pouring clean water on it till settled, and the water at the top is quite clear. Decant the water, leaving the starch at the bottom; wash again with clean water, allow it to settle, and pour off the water. Take up the starch in lumps and put it to quail a little in the sun; then mash it up fine and sieve it. Put a large baking iron on the fire, and bake it in cakes, not too thick. The iron should not be too hot, as the cakes must not be baked brown. Then dry well in the sun, and beat in a mortar, coarse or fine, as required. If sieved, it will give two qualities, fine and coarse."

For making cassava cakes, the cassava should be grated, and well squeezed, but not washed. After squeezing, let the lumps dry very slightly in the sun. Beat on a mortar and sieve. Bake on the iron, thin or thick, according as the cakes are required.

A Macadamized Road through Swampy Land.

A Telford road recently built in Medford, Mass., by Street Commissioner John P. Prichard was constructed through low wet land, which had to be drained by a trench 4 feet deep, in which was a 6 inch pipe with open joints. The trench was then filled with stone up to the subgrade of the avenue, which was well wet and rolled. On this was the Telford foundation, 9 inches deep at the center and gradually decreasing in thickness to 5 inches at the curb line. This foundation was wedged and knapped, and then covered with 4 inches of 2½ inch stone unrolled, which was covered in turn by 3 inches of 2 inch stone, spread with a shovel from a cart, wet and rolled. The surface was next filled with enough half inch stone to fill out all the inequalities, more sprinkling was done and the surface again rolled to form a firm bed for a 2 inch course of 1 inch stone, well wet and rolled. This street, the *Engineering News* says, cost about $3 a linear foot, including the expense of grading, trenching, pipe laying, catch basins, and other incidentals.

The Periodical Cicada, *alias* Seventeen-Year Locust.

BY C. V. RILEY.

Few insects are more characteristically American than this, and few have been more written about or have attracted more popular attention. We become accustomed to the recurring seasons, and periodically recurring phenomena attract attention usually in proportion to the length of time elapsing between their recurrence. This in a measure explains the interest attaching to our periodical Cicada, for its term of life is exceptionally long and quite unique, nothing else of the kind being known among insects in any other part of the world. Most insects require but one year for their full life cycle, and few exceed for this purpose a period of three years. We are justified in indulging a little sentiment in connection with the recurring broods of this insect, since they enable us to go back in thought for centuries in the past and picture the woods in some particular locality, and in some particular year, resounding with its singular song. Thus Brood XII., which is now with us, has its largest distribution in New York and New Jersey, but reaches down to the national capital, and the ancestors of these very insects, six generations back, commemorated in their noisy way the founding of Washington in 1792, while the preceding generation, seventeen years before, made the woods vociferous during the battle of Bunker Hill.

SEVENTEEN-YEAR AND THIRTEEN-YEAR BROODS.

There are some twenty distinct broods pretty well established, each appearing at stated periods in some part or other of the eastern United States, and it often happens, as in the present year, that two of them appear simultaneously, but in different sections. There is, as a consequence, scarcely a year when in some part of the country some brood may not be heralded, and several may and do occur in the selfsame region at different periods. This fact gives rise to the idea that there are broods of shorter period, or say of seven or nine years. In reality, however, there are but two classes of broods, namely, the seventeen-year and the thirteen-year broods.

There are no specific differences between these broods, and so far as the insects themselves are concerned there is nothing to indicate whether they belong to the one or the other. Yet they must be considered as quite distinct races of one species, since they do not intermingle and have, in fact, an essentially different geographical range. The seventeen-year or *septendecim* race occupies the northernmost portion of the range of the species, extending farthest south along the Alleghany Mountains. The *tredecim* or thirteen year race occupies the southern portion of the range of the species. The first named is substantially confined to the transition zone, biologically speaking, extending rarely into the boreal, while the *tredecim* race is absolutely confined to the austro-riparian region, as defined by Dr. C. Hart Merriam.

THE BROODS OF THE PRESENT YEAR.

As shown by a circular issued from the Department of Agriculture, there are now occurring two rather extensive broods, one of each of the races. Below* are given the localities in which each of these broods may be expected, and I shall be glad to have any readers of the SCIENTIFIC AMERICAN corroborate or correct, from their own observations, any of the data thus given. I would especially like to have evidence, confirmatory or otherwise, in all cases where an interrogation point has been used.

TWO DISTINCT FORMS.

With both these races there are two distinct forms, the typical or larger form, originally characterized by Linnaeus as *Cicada septendecim*, measuring some three inches in wing expanse and about an inch and a half from the head to the tip of the closed wings. The inferior portion of the abdomen is more or less suffused with reddish-brown and the borders of the segments dorsally are marked with the same color. There is a smaller form, however, appearing somewhat later in the season and more completely black, which has been described as *Cicada cassinii* Fisher. Besides the differences in size and color, there are also some slight differences of structure, but the two forms intergrade, and the species should be classified as *Cicada septendecim* Linnaeus, race *tredecim* Riley, dimorphic variety *cassinii* Fisher. The long underground life of both the 13-year and 17-year races has been thoroughly established on chronological and historical data covering nearly two centuries. There is, however, chronic skepticism as to the facts, as they are so exceptional, and this is especially true among Europeans; whence the desirability of experimental proof. This I have obtained since 1868 by watching from year to year larvæ hatched from eggs placed under specially marked trees, and in the case of two distinct and different broods.

FOOD OF THE LARVA.

Many persons have insisted, and especially the late Dr. G. B. Smith, of Baltimore, that the larva during its underground life nourishes upon the moisture of the earth and takes no other food. He believed that this moisture was absorbed through capillary hairs at the tip of the proboscis. This is, of course, an entire misapprehension of the facts. These hairs in reality arise from the sheaths of the promuscis and have no connection with the true sucking mouth parts. There is, however, a good deal of evidence to indicate that, especially in early life, when the body covering is delicate, the young Cicada larva may, when necessary, nourish from the moisture of the soil, where this soil contains, as it almost always does, nutrient qualities. The nourishment in such case would be through the general surface of the body or by what might be called environmental assimilation. But while there is no special reason for denying the possibility of this mode of nourishment, it will always be difficult to prove, and the one thing that has been proved and which I have been able thoroughly to confirm is that, as in the case of all other sucking insects, the Cicada larva pierces the roots of plants and derives nourishment therefrom. Careful observation very soon determined this fact, and I have often seen even very young larvæ attached to fine roots, while the places where the roots have been punctured by them are also easily detected.

DEPTH OF THE LARVAL BURROW.

The larva rarely penetrates more than two feet below the surface of the soil, though exceptionally it has been found at much greater depths, there being authoritative records of its having come up through the bottoms of cellars and of its being found at depths of 10 to 12 feet.

METHOD OF BURROWING.

In burrowing the larva scratches away the walls of its cell with the claws of the femora and tibiae, very much as we would do with our hands. The loosened earth is pressed against the sides and ends of the cell, chiefly by the hind and middle legs. When burrowing downward the soil is first gathered into a little pellet and placed deftly on the front of the head, when the larva turns round with its little load and presses it against the upper portion of its burrow.

GALLERIES MADE BY THE PUPA.

In years of exit the pupa is found near the surface of the ground or on it, hiding under stones and logs. There is great uniformity in the issuing of the pupæ, which takes place in the latitude of Washington from the middle to the end of May, but earlier further south and later in its northernmost range. They issue in the same locality, after their long underground life, almost to a day. Frequently, and especially in low soil subject to overflow, or where the soil is particularly wet or covered with masses of wet leaves, the pupa extends the burrow in the shape of a tube from 4 to 6 inches above ground, this tube looking like a diminutive crawfish tube. The purpose of this extension of the tube is easily understood in such situations, but strangely enough we also find the same sort of funnel or tube thrown up on high ground; and the only explanation I can offer for this fact is that on high ground the tubes are thrown up by larvæ hatched from eggs laid by females which had themselves been reared on low ground, and which, as pupæ, had built such funnels themselves. The tubes are generally closed at the top, with an orifice at the surface of the ground, and the pupa awaits its approaching transformation in the top of the funnel, secure against heavy rains, and finally issues from the aperture above mentioned.

FINAL TRANSFORMATION.

It is most interesting to observe the unanimity with which all those pupæ which rise within a certain radius of a given tree crawl in a bee line for the trunk of that tree; and to see these pupæ, in such vast numbers that one cannot step on the ground without crushing several, swarming out of their subterranean holes, scrambling over the ground, all converging to one central point and then clambering up the trunk of the tree and diverging on to its branches, is an experience not readily forgotten and affording food for speculation on the nature of instinct. The phenomenon is most satisfactorily witnessed where there is a solitary or isolated tree. The pupæ begin to rise as soon as the sun is behind the horizon, and the majority of them have risen by about nine o'clock. They prefer to fasten in a horizontal position for the exclusion of the perfect insect or imago, though they transform in all positions. In about an hour after rising the skin splits down the middle of the thorax and the forming Cicada begins to issue. Its colors are first creamy white, with the exception of the red eyes and two strongly contrasting black patches on the prothorax, with certain other minor black marks upon the legs and an orange tinge at the base of the wings. There is a point when the emerging imago hangs by the tip of the abdomen, being held within the cast off exuvium in which position it remains for from ten to thirty minutes or more. During this period the wing pads separate and the front pair stretch at right angles from the body, when they gradually swell, and during all this time the legs are becoming firmer and assuming the ultimate position. Suddenly the insect bends upward with a good deal of effort, and clinging with its legs to the first object reached, whether leaf, twig or its own shell, withdraws entirely from the exuvium, and hangs for the first time with its head up. Now the wings perceptibly swell and expand, until they are fully stretched and hang flatly over the back, being transparent, with beautiful white veining. As they dry they assume the roof position, and during the night the natural colors of the species are gradually assumed. There are few more beautiful sights than to see these fresh forming Cicadas in their different positions, clinging and clustering in great numbers to the outside lower leaves and branches of a large tree. In the moonlight such a tree looks for all the world as though it were covered with beautiful white blossoms in various stages of expansion.

(*To be continued.*)

* BROOD XVIII.—*Tredecim*—(1881, 1894).

This is the largest thirteen-year brood and one of the best known of all recorded broods.

Alabama.—Blount County and adjacent districts; counties of Dallas, Perry, Lowndes, Montgomery, Russell; also reported from Mobile County.

Arkansas.—Northern and northwestern counties watered by White River and its tributaries; counties of Prairie, Pulaski, Conway and Garland in the central portion, and Sebastian County on the western line of the State.

Georgia.—Cherokee, Campbell and Walker Counties.

Illinois.—Most counties south of Adams County in the west and Jasper County in the east; especially abundant along the Mississippi and Ohio, but apparently not present in the counties adjacent to Wabash River. The following is a list of the counties reported to have been occupied by the Cicada in 1868 or 1881: Adams, Bond, Clinton, Champaign, Coles, Cumberland, Clay, Edwards (?), Franklin, Green, Hardin. Hamilton, Johnson, Jasper, Jersey, Jefferson, Lawrence, McLean, Macon, Madison, Marion, Massac, Monroe, Morgan, Pike, Perry, Piatt, Richland, Randolph, St. Clair, Saline, Sangamon, Union, Washington, Wayne and Williamson (?)

Indian Territory.—Near Muscogee P. O. (?)

Kentucky.—McCracken County and adjoining counties in the northwest corner of the State.

Louisiana.—Morehouse, Caddo, Claiborne, Washington and adjoining parishes.

Mississippi.—Madison County.

Missouri.—More or less throughout the whole State, with the exception of the northwest corner, bounded on the east by the Grand River, and on the south by the Missouri River. In the year 1881 or 1868 or at previous intervals of thirteen years the Cicadas have been reported from the following counties: Audrain, Bollinger, Benton, Clarke, Chariton, Callaway, Cooper, Cole, Franklin, Gasconade, Iron, Jefferson, Knox, Lewis, Marion, Macon, Morgan, Moniteau, Pike, Phelps, Pulaski, Polk, Pettis, Schuyler, Saint Charles, Saint Louis, Saint Francois, Saint Clair, Warren, Washington.

North Carolina.—Counties of Mecklenburg and Iredell, extending north and west into Wilkes and Caldwell Counties.

South Carolina.—County of Chester, extending westward to the Georgia line and northward to the North Carolina line; also counties of Anderson, Oconee and Pickens.

Texas.—The reported occurrence of this brood in the Rio Grande Valley south of El Paso is extremely doubtful.

Virginia.—Prince George County.

BROOD XII.—*Septendecim*—(1877, 1894).

This is also a well recorded brood of large extent, occurring chiefly along the eastern flank of the Alleghany Mountains. The isolated western localities are in need of confirmation.

Connecticut.—Near Meriden and New Haven, New Haven County.

District of Columbia.—This includes the adjacent portions of Virginia and Maryland.

Indiana.—Dearborn County (?)

Maryland.—The peninsula between the Potomac River and Chesapeake Bay, from Anne Arundel County to the northern part of St. Mary's County

Michigan.—At Kalamazoo (?)

New Jersey. The whole State, but more especially in the northeastern counties of Hudson, Bergen, Essex and Middlesex.

New York.—Within the city of New York (at least in former times, but in 1877 apparently exterminated by the sparrow); on Staten Island, western Long Island, along both sides of the Hudson River as far north as Troy.

North Carolina.—Rockingham, Stokes, Guilford, Rowan, Surry and adjoining counties.

Virginia.—From Fairfax County and southern portion of Loudoun County south to the North Carolina line.

The Electric Furnace and Artificial Diamonds.

At a recent conversazione of the Royal Society, an exhibit which attracted much attention was M. Moissan's electric furnace, and specimens of chemical elements obtained by means of it: vanadium, chromium, molybdenum, tungsten, uranium. The furnace consists of a parallelopiped of limestone having a cavity of similar shape cut in it. This cavity holds a small crucible, composed of a mixture of carbon and magnesia. The electrodes are made of hard carbon, and pass through holes cut on either side of the furnace, meeting within the cavity. For the purpose of certain experiments a carbon tube was fixed in the furnace at right angles to the electrodes, and so arranged as to be 10 mm. below the arc, and about the same distance from the bottom of the cavity. This tube contains the material to be heated, and by inclining it at an angle of about 30° the furnace may be made to work continuously, the material being introduced at one end of the tube and drawn off at the other. A temperature of about 3,500° C. is produced. The metals are reduced by heating a mixture of their oxides with finely divided carbon, and for this purpose a current of about 600 amperes and 60 volts is employed. M. Moissan has not only succeeded in reducing the most refractory metals, but has fused and volatilized both lime and magnesia. Nearly all the metals, including iron, manganese, and copper, have also been vaporized, while by fusing iron with an excess of carbon, and then quickly cooling the vessel containing the solution of carbon in molten iron by suddenly plunging it into cold water, or better in a bath of molten lead, he has been successful in producing small, colorless crystals of carbon, identical in their properties with natural diamonds.