THE GYMNOTUS ELECTRICUS, OR ELECTRIC EEL.

For two months of the present year, an electric eel was kept in one of the aquaria at Eugene Blackford's establishment in Fulton Market, where it was the source of much amusement, as well as of a certain amount of distress, by the shocks it gave to those of an investigating or curious mind. Toward the end of its captivity the writer received one of its shocks. It was

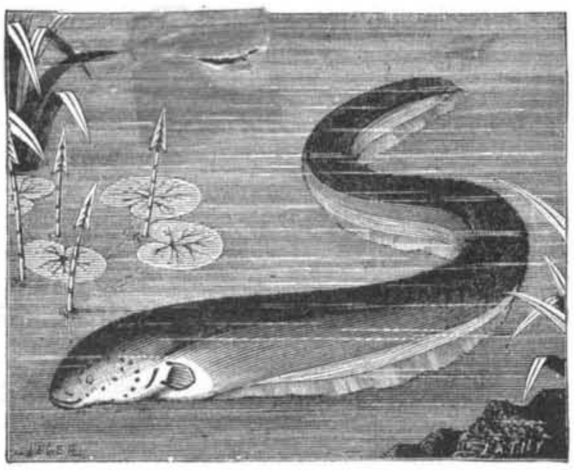


Fig. 1.—THE GYMNOTUS ELECTRICUS.

but a feeble one—comparable to that from a pint Leyden jar. The fish was then growing weak, and shortly afterward it died. Thus the shock could only be considered an indication of what it might do if in good health. A snapping turtle which was in the same compartment with it was once so badly shocked that for ten minutes it floated upon the surface of the tank senseless.

By the kind permission of Mr. Blackford, the eel was dissected. This was an operation of much interest, as the eel was the largest one he had ever had possession of.

Its general external appearance is exceedingly well represented in the cut. On cutting it open, the first thing that impressed one was the disproportionate size of the electric organ. The fish was 34 inches long and weighed 3½ pounds, and one-seventh of this weight was represented by its battery. The abdominal regions were confined to the forward part of the body, next to the head. The rest was all muscle, bone, and electric organ. The cut, Fig. 2, shows this organ as nearly as possible in its position in the body

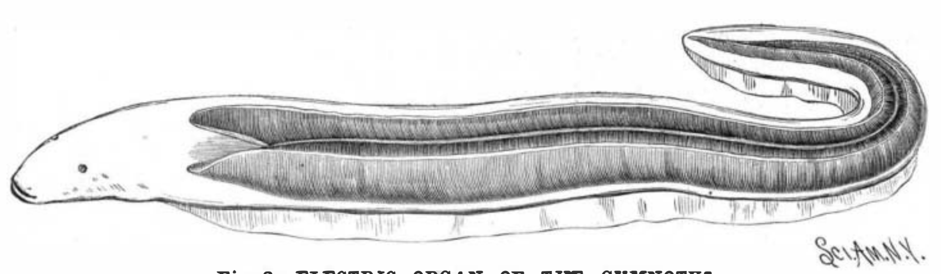


Fig. 2.—ELECTRIC ORGAN OF THE GYMNOTUS.

of the eel. It was sketched from the actual organ, and is a most interesting study. In Fig. 3 is shown a general section of the body, in which the parts marked E are the main body of the organ, while subsidiary divisions of the same are seen at *n* E and *e*. The microscopic section of the cellular tissue of the organ given in Fig. 4 shows what an immense active surface may be contained. Though this fish was an unusually fine one, a length of five or six feet is often attained. Its exact place in the kingdom of fishes is not satisfactorily settled, as it differs in many respects from the true eels. Its fins, confined to pectoral and anal, are covered with a thick skin. It has no dorsal, ventral, or caudal fins. Its vent is very far forward, just back of the jaw.

Michael Faraday's researches in the matter of the electricity of the Gymnotus are classic. His paper detailing the result of his experiments was read before the Royal Society on December 6, 1838. It may be consulted in the collection of his "Experimental Researches in Electricity," published by Quaritch in 1844, and recently reprinted in fac-simile.

He collected electricity under different circumstances, and tried many experiments with it. He used two kinds of collectors. In one of them, a copper disk, one and a half inches in diameter, was brazed to a copper rod fifteen inches long, with a copper cylinder for handle, the rod being insulated with a thick India rubber tube. In the other, a plate of copper, eight inches long by two and a half wide, was bent into a saddle shape, and its outer surface covered with caoutchouc. A wire was brazed to it and insulated by a rubber coating. With the first kind of conductors, the handles being wet, shocks were obtained when one collector was held in each hand and applied to different parts of the fish. The saddle collectors, properly applied, gave current enough to deflect a galvanometer that was not very sensitive. With a helix of twenty-two feet of fine silk-covered wire wound on a quill and placed in the circuit, a wire was magnetized, and its polarity indicated a direction of current from the anterior to the posterior parts of the animals. Iodide of potassium was readily decomposed, iodine appearing at the end of the wire connected to the fore part of the Gymnotus. By carrying out this line of experimentation, he ascertained that "within certain limits the condition of the fish externally at the time of the shock appears to be such that any given part is negative to other parts anterior to it, and positive to such as are behind it."

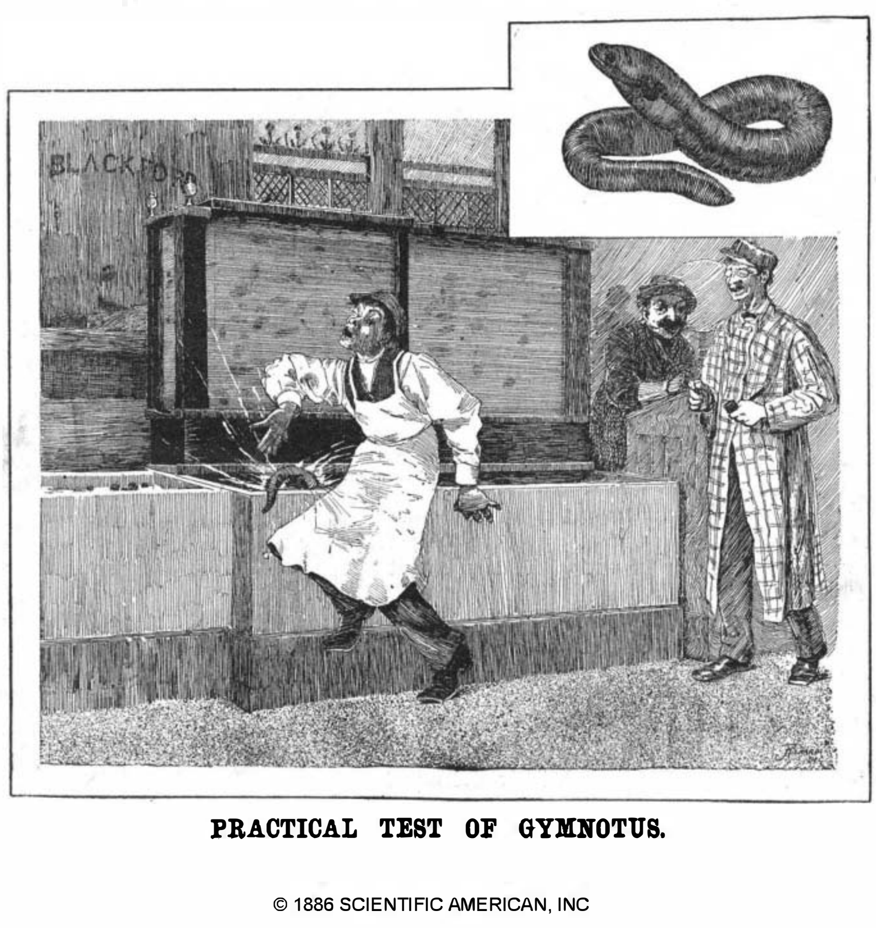
He repeatedly obtained the spark by placing a spark coil in the circuit, with files as circuit breakers. Subsequently a revolving steel plate, cut file fashion on its face, with a wire to bear on the roughened surface, was used. Connecting one piece to one saddle collector, and the other to the second one, applying them to the fish's body, and exciting it while moving one electrode over the rough surface of the other, a spark was repeatedly obtained. His object in this experiment was to secure a break in the current while it was passing.

By a rough comparison with Leyden jars, he concluded that a single medium discharge was equal to the electricity of fifteen Leyden jars with 3,500 square inches of glass, coated on both sides, and charged to its highest degree.

His general theory of the action of the fish is that a current is discharged from the head to the tail through the water as conductor. If any sensitive object, as the human hand, is placed in an intermediate part of the water, it will receive a slight shock. If the hand grasps the fish, it will also be a portion of the connecting conductor, and will be shocked up to the point of immersion. If both hands grasp it, the shock is received in great intensity, as the body all comes into the circuit. The farther apart the points of the body thus grasped were, the worse was the shock.

By bending into an arc, the fish can send a current across the chord with much force. Faraday saw it stun a fish in this manner before devouring it, coiling in a partial circle around its victim before discharging its battery. A curious feature in its disposition to discharge itself was that it would only do so repeatedly when touched by a sensitive object. Disturbed by a glass rod, it would give a few shocks, and desist; but on touching it with the hand, it would again discharge itself. This Faraday attributes to the recognition obtained by the fish from the convulsive movements of the hand of a sensitive organism. When this movement was not perceived, the fish soon desisted from shocking.

When Mr. Blackford's eel was in full vigor, many persons were shocked by merely putting their hands in the water. It was also remarked that the shock from contact with a single hand was not necessarily confined to the immersed portion.



PRACTICAL TEST OF GYMNOTUS.

Ant-Inhabited Plants.

Hernandez, about the middle of the seventeenth century, described the stipular thorns of *Acacia cornigera* of Central America, into which certain ants eat, feed upon the pulpy interior, and live in the dwelling

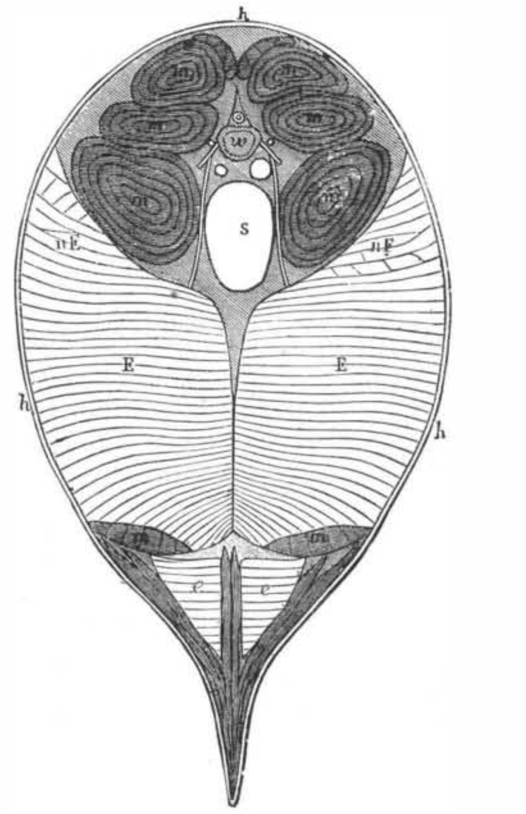


Fig. 3.—SECTION OF BODY OF GYMNOTUS.

thus made. Such inhabited thorns grow larger and distorted, and the ants seem to pay for this hospitality by protecting the tree from other marauding insects. Two woody *Rubiaceæ* of Sumatra were described in 1750 by Rumphius as inhabited by ants. They are both epiphytic and attached to the host

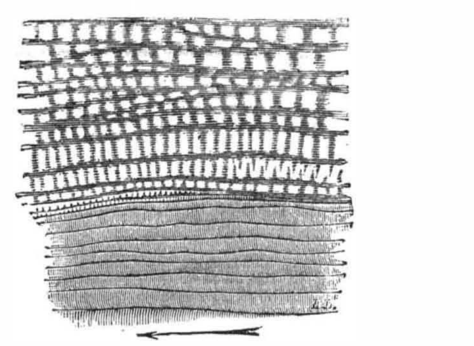


Fig. 4.—MICROSCOPIC VIEW OF CELLS OF ORGAN.

tree by a large tuberous base, which is cavernous and occupied by ants. The ants, by their irritating presence, cause the tuberous growth to enlarge, but the enlargement begins during germination, before the ants attack it—an instance of a plant preparing beforehand for expected guests. It is said that seedling plants which fail to become inhabited perish. Dr. Gray, in a review, says that "it is most supposable that this extraordinary formation was acquired gradually; that the normally fleshy caulicle of the ancestral plant, made a nidus for an insect, developed under the disturbing stimulus somewhat as a gall develops, until at length the tendency became hereditary, and the singular adaptation of plant to insect was established."—*Botan. Gazette.*

IN the SCIENTIFIC AMERICAN, not long ago, was published the record of Baldwin locomotive No. 165, which made 119,360 miles without undergoing general repairs. Locomotive No. 61, on the Northern and Northwestern R. R., Canada, and built at the Brooks Locomotive Works, at Dunkirk, N. Y., has made the wonderful aggregate mileage of 190,554 without general repairs, not even by changing a pin, brass, or driving brass, or having a flue taken out. After running 45,179 miles, with a view to changing her from a freight to a passenger locomotive, she was taken off her wheels and had her tires turned. After that she was run 145,375 miles without being lifted from her wheels. Her engineer is Robert Pearson, who has been on the road for over thirty years. No. 61 has cylinders 17 × 24 and 5 ft. drivers.

Blast Furnaces in the United States.

The number of anthracite furnaces in blast in the United States at the commencement of October, 1886, was 114, their aggregate productive capacity being 35,819 tons per week. The corresponding number of anthracite furnaces in blast at the commencement of July, 1886, was 117, their aggregate productive capacity being 36,762 tons per week. The number of bituminous or coke furnaces in blast in the United States at the commencement of October, 1886, was 136, their aggregate productive capacity being 70,802 tons per week. The corresponding number of furnaces in blast at the commencement of July, 1886, was 132, their aggregate productive capacity being 71,316 tons per week. The number of charcoal furnaces in blast at the commencement of October, 1886, was 68, their aggregate productive capacity being 10,232 tons per week. The corresponding number of charcoal furnaces in blast at the commencement of July, 1886, was 61, their aggregate productive capacity being 9,885 tons per week. It follows that the number of furnaces of all descriptions in blast at the commencement of October, 1886, was 318, their aggregate productive capacity being 116,853 tons per week. The corresponding aggregate number of furnaces in blast at the commencement of July, 1886, was 310, their aggregate productive capacity being 117,963 tons per week.

CENTRIFUGAL TOP.

BY GEO. M. HOPKINS.

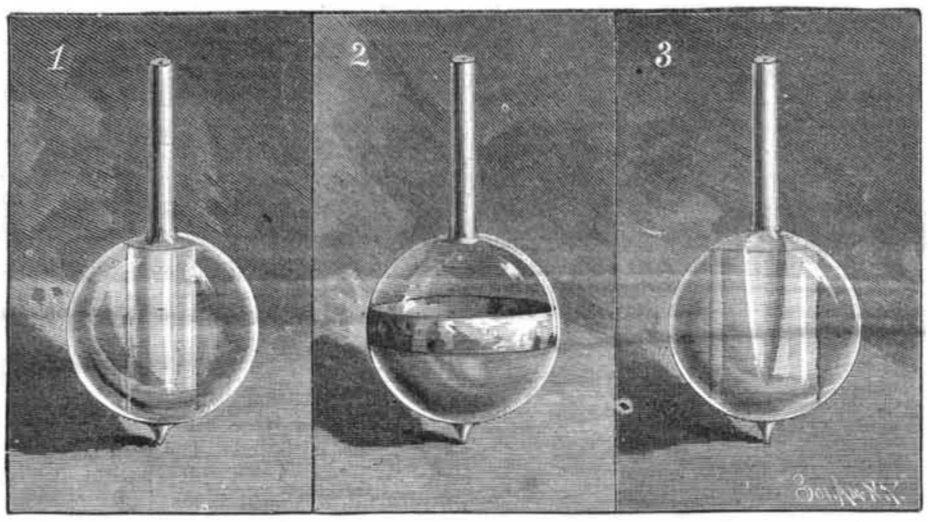
The annexed engraving shows a very simple but effective device for exhibiting centrifugal action on liquids. It is a hollow glass top of spherical form, having a tubular stem and a point on which to spin.

These tops are filled with various liquids, some of them containing two or more. The one shown in Fig. 1 is filled partly with water and partly with air. When the top is spun, the water flies as far from the center as possible, leaving in the center of the sphere an air space, which at first is almost perfectly cylindrical, but which gradually assumes the form of a parabola as the velocity of the top diminishes.

In Fig. 2 is shown a top having a filling consisting of air, water, and a small quantity of mercury. The water acts as above described, and the mercury forms a bright band at the equator of the sphere.

In Fig. 3 is shown a top containing water and oil (kerosene). The water, being the heavier liquid, takes the outside position, the oil forming a hollow cylinder with a core of air.

The top, after being filled, is corked and sealed. It is spun by the hands alone or with a string and the ordinary handle. The diameter of the top is 1½ inches. It is made of considerable thickness, to give it the required weight and strength.



TOP FOR SHOWING CENTRIFUGAL ACTION ON LIQUIDS.

Modern Cameo Cutting.

The substance of which a modern cameo is made is a piece of sea shell. Every one must have noticed that, while the outside of many shells is rough and unseemly, the interior is perfectly polished, and often of a brilliant color. If the shell be broken, the way in which the two layers lie upon and pass into each other may be clearly seen. The species used by the trade will be described farther on, but we may here premise that they are chosen on account of the thickness and hardness of the layers, of the contrast of color between them, and the presence of knobs on the exterior surface, which render it possible to work in relief.

When a cameo is begun, a piece of the shell, rather larger than the ornament is intended to be, is cut out and affixed to a wooden holder by means of a substance which looks like a coarse kind of sealing wax, and seems to the touch as firm as stone, but at once yields to any high degree of heat. The inner surface of the shell is of course the lowest, and on the gray outside the master draws a rough outline of the design, and places the work in the hands of an apprentice, who reduces the knob by means of a file to the requisite height, and with the same instrument removes all the gray matter that lies outside the boundary lines, and dresses the whole of the irregular surface. In this condition a cameo looks like an irregular piece of chalk rising out of a small plate of colored glass. It is now returned to the master, who again draws the design in pencil upon it, but more carefully this time, as the places in which the dark background has to be seen through the white mass must be indicated; and from him it passes to another apprentice or workman, who has already learned the use of the *bulino* or burin. This is an instrument which is present in at least twenty forms in every workshop of importance—the coarser almost resembling a stone cutter's tool; the finer are nearly as delicate as those used by an engraver. Thus, from the beginning to the end, the work is always submitted to the master's eye, and always passes into more skillful hands, until he himself adds the finishing touches.

It has of late years become the fashion to have cameo portraits taken. This form of art is chiefly patronized by the Americans. When such a portrait is made, the whole work, except the mere filing down, is usually done by the master's own hand. The likeness may be taken from a photograph, but the cameo cutter greatly prefers a study from life. As a rule, he demands three sittings, of about a quarter of an hour each. In the first, he makes a general outline of the face; in the second, he adds dignity, loveliness, and expression; in the third, he adds or corrects details. It must be confessed that these likenesses are often striking, always clever, and generally abominable. All the resources of the master's art somehow fail to make Brother Jonathan look like a Greek hero; and as the cutter has some classical hero always in his mind, his work is apt to become an unconscious satire. We speak of Brother Jonathan, but must confess that John Bull and his wife are not free from the same vanity. The British matron considers such portraits exquisite; they are for her the criterion of all art, the *ne plus ultra* of truth and beauty, the touchstone by which to test good taste; but we cannot defer to her opinion.

The great fault of most modern cameos is an excessive fondness for detail. The more labor that is spent upon a piece, the more valuable it becomes. Besides this, the master takes a pleasure in the exercise of his skill; he is proud of showing his work through a lens and pointing out the fineness of the single lines, and the perfection of the whole execution. This exactly suits the taste of many of his best customers, and so the general purpose of a design is often hidden under a crowd of minute felicities. It is because the Neapolitan workmen are comparatively free from this fault that their work ranks so highly as it does; but even they fall into it at times, especially in their portraits, the cheapest of which are usually also the best.

The shells used by the cameo cutter are of three kinds. The most valuable, *Casis tuberosa*, is known in the trade as *Conchiglia serpentina*. When the shell is perfect, the external layer is of a spotless white, while the lower one seems at the first glance to be black. It is, in fact, of a dark gray tint, something like unpolished steel, with brown reflections. But such specimens are exceedingly rare, as much as twenty-five francs being sometimes paid for a single one. In imperfect examples, the white layer is either too thin or is spoiled by yellowish spots, while the black one is wanting in thickness and hardness. These shells are bought by the hundred at the price of from six to eight hundred francs. About a third of the number are worthless, while only single parts of many of the rest can be used, and then only for inferior articles.—*London Saturday Review.*

The American Shipping Convention at Pensacola.

A convention in the interest of American shipping assembled at Pensacola, Fla., on the 10th, 11th, and 12th of November. It was called at the instance of the committee of the Gulf Shipping League. Without attempting anything like an account of the meeting, it will be of interest to cite some of the sentiments uttered. The decay of American shipping naturally formed one of the topics. Mexico and Spanish America generally buy annually $520,000,000 worth of goods, yet of this amount but 18 per cent comes from her near neighbor, America, and of the 18 per cent but one-third is carried in American ships.

In 1885, but 20 American ships, aggregating 3,102 tons, entered the port of New Orleans from Mexico, against 38 foreign vessels, aggregating 45,526 tons. During the same year one American ship, of 1,113 tons, entered the port from Brazil, against 41 foreign vessels, of 44,092 tons. Of 330,000 sacks of coffee imported from Brazil through New Orleans, less than 30,000 came in American bottoms. In the fiscal year ending June 30, 1884, 616 steamships entered at and cleared from Rio de Janeiro, and of these but 17 carried the American flag. The convention was naturally very desirous of seeing this state of things remedied, and a series of resolutions containing the sense of the meeting were adopted. They included indorsement of the bounty bill subsidizing American ships and suggestions for the regulation of port charges.

But one of the most striking features of the meeting was its approval of the Eads ship railroad across the Isthmus. The prediction was made that if this project were carried out, the peninsula of Florida would soon be covered with a similar one. Two resolutions were adopted indorsing the Tehuantepec ship railroad, and declaring that it would take its place in history with the Mississippi jetties of the same engineer.

The indorsement by this representative body of Col. Eads' plans is of much force. The Gulf States are deeply interested in Isthmus transit, and any means looking to its improvement are closely watched by them. The representatives of no region can less afford to approve a possible failure.

Much enthusiasm was evoked by the success of the meeting, and, after a due amount of excursions and enjoyments, it adjourned to meet at Washington, D. C., January next, at the call and under the auspices of the American Shipping and Industrial League.

Hints for Lithographers.

1. When a stone has been printed and is intended to be preserved for future use, it is not enough to have it rolled up or inked in and then well gummed. In former times the drawing or engraving was inked in or rolled up with what was called a "conservation ink." This may yet very properly be done, but very few firms indeed keep now such an ink in stock, or know even of its properties. To avoid trouble, or from want of knowledge, in the absence of this especial kind of ink, the transferer or printer, when done with the stone, uses the ordinary ink for inking in or rolling up. By and by, when the stone is again needed, this ink, it is found, has become dry, and can only be removed from the stone with damage to what may be a valuable engraving or drawing.

In our experience, we have found that the easiest, quickest, and best way of preserving a stone for future wants is the use of finely powdered resin. We have found that, even after years' delay, the ink on which the resin has been used removes freely by washing out, and shows the stone to have been excellently preserved. This should never be forgotten, since resin is not only inexpensive, but is always at hand when needed.

2. When a crayon drawing, after etching and preparing by rolling up, shows white spots—which may result from saliva, gum, sweat, or other causes—the artist is usually called to redraw such places on the stone, after the places have been counter-prepared by using acetic acid, lemon juice, etc. Although correct, this method has the fault that such counter-prepared and redrawn places always appear uneven and in varying shades, darker or lighter than the original design. This defect is caused by the fact that it is always impossible to keep the counter preparation within its proper limits.

We have found that the best way is to have the stone washed clean from all gum, etc., then fan entirely dry, and redraw the special places upon the stone without any counter preparation; then put the stone in a hand press, cover the drawing with a slightly dampened sheet, and pull through the press but once; then take off the sheet, again fan the dry stone, and afterward gum over. It will then be found that the crayon will hold as well as on an unprepared stone. The reason is obvious, since the alkali from the stone so acts upon the gum preparation that the soap in the crayon can penetrate the gum layer. Lithographers who understand the chemical actions made use of in their art will readily understand this matter.—*American Lithographer.*

Sleep a Preventive of Headache.

A scientific writer says: "Sleep, if taken at the right moment, will prevent an attack of nervous headache. If the subjects of such headaches will watch the symptoms of its coming, they can notice that it begins with a feeling of weariness or heaviness. This is the time a sleep of an hour, or even two, as nature guides, will effectually prevent the headache. If not taken just then, it will be too late, for, after the attack is fairly under way, it is impossible to get sleep till far into the night, perhaps. It is so common in these days for doctors to forbid having their patients waked to take medicine if they are asleep when the hour comes round, that the people have learned the lesson pretty well, and they generally know that sleep is better for the sick than medicine. But it is not so well known that sleep is a wonderful preventive of disease—better than tonic regulators and stimulants."