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THE STRENGTH OF INSECTS.

It is said that he is a philosopher who can accept the inevitable without repining. There are times in our lives when the most unpleasant things are forced upon our attention, and we fail with our best efforts to rid ourselves of them. As warm weather advances, we need no argument to convince us that the insects which destroy our vegetation, offend us with their presence, and even without permission cause our own blood to course through their veins, are among the inevitables. To accept these without complaint or repining would surely give us undisputed title to the name of philosophers; and if we could find anything of pleasure instead of annoyance in our involuntary contemplation of them, we would be doubly worthy of the appellation. That they all serve some useful purpose, cannot be denied; and if we knew their whole history we should doubtless be fully convinced of this. Some of our greatest pests, as flies and mosquitoes, have already been shown quite clearly to be our friends rather than our enemies.

Besides their practical benefit, there is no little interest in noticing the great physical force which they exert. We call a man, a horse, a lion, or an elephant strong; but it is very easy to see that, proportionally, insects are the strongest animals that live. They manifest their strength in running, leaping, flying, and sometimes in other ways. Some insects have been known to run so rapidly that, if a man of ordinary size should make as good time, proportionally, he would run more than twenty miles per minute, or sixty times the ordinary rate of a railroad train. A locust with the aid of its wings will leap 200 times its own length; to equal which, a man would need to leap nearly a quarter of a mile. A flea, without wings, will leap the same relative distance; and it has been estimated that, if a horse should jump as far in proportion to its weight, it would scale the Rocky Mountains in a single leap. Most insects jump by means of their hind legs and the latter part of the hind body; but one family of beetles—the *elateridæ* or spring beetles—leap vertically when on their backs, by use of a spine on the hinder part of the thorax which fits into a cavity behind it, and which, when forcibly closed and acting like a spring, throws the beetle several inches into the air. While in the very act of writing this, one of this family pays me a visit, and shows its power by making several springs at least six inches in hight, which is about twelve times its own length. Some dragon flies are among the strongest on the wing. They can be seen flying about pools of water after smaller insects for hours at a time, turning, wheeling, going sideways, and in nearly every conceivable direction, and never seem to think of being tired. And, what is very remarkable, they have the power of changing at right angles the direction of their flight, and so suddenly that one can hardly ever be quick enough to hit or capture them. The *Entomological Magazine* speaks of one of these that flew on a vessel at sea when the nearest land was the coast of Africa, 500 miles away. A humble bee has been seen to follow a rail car going twenty miles per hour, against a strong wind, for a considerable distance; and it even went faster than the car, as it flew to and fro and in various zigzags around the vehicle. Some beetles have a flight swifter, considering their size, than any bird; and Linnæus mentions a butterfly that sometimes travels more than a hundred miles on the wing at one flight; he also says that an elephant having the force of a horn beetle would be able to move a mountain. All have doubtless seen a beetle move a candlestick or lamp in his efforts to escape from underneath it; and he has been compared to a prisoner in Newgate shaking the building with his back. Pliny said, long ago, that, if we compare the loads of ants with the size of their bodies, "it must be allowed that no other animal is endowed with such strength in proportion."

Some interesting and ingenious experiments for measuring the strength of insects have lately been made by a Belgian naturalist named Plateau. He first tested their power of raising weights while walking on a level surface. His novel method of doing this was to harness the insect by a horizontal thread running over an easily-moving pulley, at the other end of which was attached a scale pan for holding sand. To keep the insect in a straight direction, he fenced it in between two parallel strips of glass; and to keep it from slipping, he covered its track with coarse muslin. As the insect moved forward, it pulled the thread over the pulley and raised the pan, and the experimenter poured sand into it until the insect could move no longer. The insect and the sand it had raised were then weighed, and the relation between the weight of the two was obtained. He found that the insect could raise forty times its own weight; while by a similar method a man could raise only five sixths of his weight, and a horse only one half or two thirds of his. By repeating each experiment three times and employing a vast number of insects of various sizes, and comparing his results, he came to the conclusion that the smaller insects in the same group invariably raise the greater weight in proportion to their own weight.

He then tried their leaping power, by fastening the wings and elytra, and by suspending under the thorax (by a thread) bits of lead set in wax. He increased the weight till the insect could no longer raise it. Then, by his determinations as before, he found that, while the largest crickets could raise in this way only about one and a half times their own weight, the smaller ones could raise three or four times theirs.

To test the pushing power of insects, he placed some of them in a long cardboard tube blackened on the inside and admitting light only by a transparent glass at one end. To this glass was attached a lever which drew the scale pan over the pulley, as in the first experiment. The insect, in its endeavors to escape, pushed against the glass, moved the lever, and thus raised the weight. As results of these experiments, he found that, in inverse ratio to their weight, the pushing power varied from three or four to eighty or ninety times the insect's weight.

The power of flight possessed by insects was tested by fixing weights to the body in the same way as in leaping. He found that they employ much less force in flying than in other efforts of strength; perhaps this is because, unlike birds, they are not intended to carry weights through the air. Beetles raise in flight from one sixth to twice their weight; flies, three times their weight. A drone weighs four times as much as a bee, and drags less than fifteen times its weight, while the bee drags twenty-three or twenty-four times her weight. But in flying, the bee raises nearly her own weight, while the drone raises a weight equal to only half its own.

By these experiments, he found that his law applies equally well, whether the strength is exerted in walking, leaping, pushing, or flying. He finds that it also applies, in a measure, to the entire class of insects taken together, as well as to the same group of insects taken by themselves. There are some exceptions to this, however, which are probably due to differences of structure. By dividing all the insects into three groups—lightest, medium, and heaviest—he finds that the law holds good. Then the relative force is represented by the numbers 26, 19, and 9 respectively. The fact seems to be that the strength of an insect increases with the surface of a section, and not with the volume of its muscles. This would make the weight increase faster than the motive power, and be consistent with the law that the smallest are strongest. It takes but a moment's reflection to see the wisdom of this arrangement. Of course the hardness of the soil, the weight of the grains of sand, and all the resistance to be overcome are equally great to the small as to the large insects, and it needs greater relative strength to give the small ones a fair chance in the "struggle for existence" with their larger associates.

But these facts and conclusions give rise to other questions which are not so easily answered. Since insects are stronger than other animals, on what food do these small Cæsars feed that they are grown so strong? Is their physical organization formed on different mechanical principles? Have they power of creating or utilizing greater force from the food they eat? Their food, being animal and vegetable, does not seem to differ materially from the food of other animals; and they seem to use the same mechanical powers in their motions. They are, in the perfect state (in which state they manifest their great strength), as a rule, very small feeders, and some eat even nothing. As their strength must come from the food they eat, the question as to how so much can come from so little is as interesting as it is difficult. So far as we know, no attempt has ever been made to determine the laws of the relations between the amount of food consumed and the strength which it generates. The difficulties are perhaps not insurmountable; but one great disturbing element would probably appear in the fact that insects may store up force in their earlier stages which they use in the perfect state.

RAPID TRANSIT IN NEW YORK.

A commission, appointed by virtue of a recent law of the State legislature, is now holding sessions in this city to determine upon the best plans for city steam railways. Formerly it was considered that the underground method was by far the best for a narrow and crowded city like New York, as it occupies no portion of the street surface, is out of sight, occasions no disturbance by its operation, and furnishes the most abundant accommodations for speed and the largest traffic. In those days the proud New Yorker had determined to have the best and most substantial railway works that could be built. But that was prior to the Tweed and other robberies, before the debt of the city had been swelled to over a hundred millions of dollars. Cheaper structures, it is now supposed, will answer, and on this account the elevated plan has come to be looked upon with special favor.

At a recent sitting of the Commissioners, no less than thirty different plans for rapid transit were presented, all of which were for elevated tracks except one, the latter being for a canal railway between the buildings, with bridges or tunnels for the street crossings.

All of these elevated plans involve the placing of bridge structures of some sort, in several of the principal streets; and there appears to be a peculiar unanimity among the citizens on the subject. Nearly every person is in favor of such roads, but no one wants it to run in his street or in front of his store or dwelling. The Sixth avenue people think that an elevated railway is greatly needed, and will do their share toward its construction, provided it is erected on Seventh avenue. The Seventh avenue people are equally in favor of the bridge, but are ready to rise in arms if their magnificent thoroughfare is disfigured with it; they are clearly of opinion, however, that Eighth avenue is the proper place for it.

The road must also cross the town somewhere, and those who reside on 42d, a fine broad street, are in its favor, provided it is erected on their neighbors' premises, a quarter of a mile distant, say, on 37th street; and they are of opinion that the constant passing of cars and locomotives in front of the second story windows of their friends down there will improve their prospects and healths, which now suffer by reason of too much quietude and seclusion.

To satisfy the public will be an apparently difficult task for the new Commissioners; but we wish them success. They will doubtless find out, before their labors are finished, that the building and equipping a first class substantial railway for rapid transit, capacities being equal, is just as expensive on the elevated as on the underground plan.

In the neighboring city of Brooklyn, the projected elevated street railway is also accepted with pleasure by the people. "But when the route of the proposed road is mentioned there is," says the New York *Herald*, "at once a persistent and screeching dissent Property holders on Myrtle avenue come forward and scream against building the road on that avenue."

A CITY ONE HUNDRED AND EIGHTY THOUSAND YEARS OLD.

In the current number of the *Overland*, a Californian geologist reviews the geological evidence of the antiquity of a human settlement near the present town of Cherokee in that State, and estimates the age of that most ancient of discovered towns to be not less than 180,000 years!

The data for all such calculations are necessarily uncertain, as they are derived from the present motions of the continents and present rates of erosion: still, from the changes that have taken place since the pioneers of prehistoric California left their traces on its ancient sea shore, there can be no doubt that thousands of centuries must have come and gone.

The traces in question are numerous stone mortars, found in undisturbed white and yellow gravel of a subaqueous formation, not fluviatile, underlying the vast sheets of volcanic rock of which Table Mountain is a part. In one instance a mortar was found standing upright, with the pestle in it, apparently just as it had been left by its owner. In some cases the mortars have been found at the depth of forty feet from the surface of the gravel underlying Table Mountain. The distribution of the mortars is such as to indicate with great positiveness the former existence of a human settlement on that ancient beach when the water stood near the level at which they occur: a time anterior to the volcanic outpouring which Table Mountain records, and anterior to the glacial epoch.

The recent geological history of that region may be briefly summed as follows:

Previous to the placing of the mortars in the position in which they have been found, the early and middle tertiary sea level had receded to the position of the coal beds underlying Table Mountain, fully one thousand feet below the level of Cherokee. Subsequently, in the pliocene period, there was a further subsidence of about fifteen hundred feet, something like six hundred feet occurring after the mortars had been abandoned. All this, as has been noticed, took place before the volcanic outflows which covered up all the ancient *detritus* of the region, including that of the ancient rivers (whose gravels have furnished so much of the gold of California). The geological age of the river period was determined by Lesquereux from specimens of vegetation, now extinct, collected in the survey of the ancient rivers: specimens indicating a flora of the pliocene age, retaining some characteristic miocene forms

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