principles laid down in this incantation that I have read to you?

The example of the rulers is always of great importance for a people; and if we read the inscriptions of the Babylonian and Assyrian kings (who had a great many faults, and who were very vain and very ambitious and in some respects even cruel), we find that they emphasize over and over again the thought that they are placed on the throne for the purpose of seeing justice done in the land.

Perhaps there is no king of Babylonia with whom we are so apt to associate cruelty and injustice as Nebuchadnezzar; yet this same king has left on record some of the most beautiful prayers, in which he emphasizes the fact that he feels that his purpose in life is to promote justice. Let me read the prayer of Nebuchadnezzar (addressed to Marduk, the chief god of Babylonia), upon ascending the throne:

O Eternal Ruler! Lord of the Universe!
Grant that the name of the king whom thou lovest,
Whose name thou hast mentioned, may flourish as seems good to thee.

Guide him on the right path.
I am the ruler who obeys thee, the creation of thy hand.

It is thou who hast created me,
And thou hast intrusted to me sovereignty over mankind.

According to thy mercy, O Lord, which thou bestowest upon all,

Cause me to love thy supreme rule.

Implant the fear of thy divinity in my heart,
Grant to me whatsoever may seem good before thee.

Since it is thou that dost control my life.

A king who does not hesitate to say, in the same inscription, that he, in dealing with a vanquished enemy, burnt hundreds of children and carried thousands into captivity and murdered tens of thousands, yet who sets up a prayer of this kind, must have had, at least, a sense of right. And the Assyrian kings, who were much more cruel than the Babylonians, also boast, in their inscriptions, of their goodness and righteousness; and, for instance, one of them says, deliberately, that when he came to Babylonia, he restored the lands which had been taken away from their rightful owners. The king furnishing an example of that kind—boasting of righteousness—is an indication to us that there must have been a feeling in the world that it was the proper thing for him to do.

There is a further illustration of the practical force of ethical ideals in thousands of little clay tablets that have been found in the soil of Babylon, and which furnish us an insight into the private life. The temples were the great storehouses of the archives. The priests were not merely the officials of worship, but were also the judges of the court; and the records of the courts in those days were kept by the priests in the temples. These temple archives consisted of thousands and thousands of these little pieces of clay, on which are found the records of lawsuits, of quarrels, of judicial decisions, of wills, and testaments—all such public business as was carried on in the various cities where temples stood. These little tablets give us an insight into the private life. They are the court records. In these tablets we find records of the law, the commercial and legal transactions; when houses were sold, the people came before the courts; there was a record made on these little clay tablets: "So-and-so bought this house from so-and-so; and it was situated in such-and-such a place." That in itself is an indication that there must have been a high sense of right and justice in the country. The development of legal phraseology, of the legal niceties, shows us that there was a strong desire in the country to promote justice.

There is one point which may be taken as a safe indication of the fact that, in a general way, the Babylonians tolerably satisfied an ethical ideal of life—and that is, that woman was practically the equal of man before the law. That seems natural for us; but it was only a short time ago when in the Occident she could not have her rights protected by the court. A woman could hold property in those days, which is a most remarkable fact. A woman in those days could also dispose of her own property, which is another indication of the position she held. The way in which woman was protected by the divorce law is remarkable. A husband could not, in those days, divorce his wife except for sufficient reason; and the reasons had to be better than some of those furnished in the State of Illinois. The son owed obedience not only to his father, which is natural, but he owed it also to his mother. And among the series of so-called family laws, there is a direct stipulation that "A son who says to his mother, 'Thou art not my mother'" (that is to say, a son who wishes to set his mother aside) is, in the first place, fined to a certain extent, and then driven out of the city.

This position occupied by woman in Babylonia is a safe index and standard of morality, and we may, therefore, feel certain that, while they no doubt failed—as all nations and modern peoples do—in reaching up to their standard, the kings emphasized, whether in the south or in the north, their desire to carry out righteousness and justice. And the existence of the large number of clay tablets, bearing the records of the courts in the meting out of justice and the position of woman in Babylonia, show that they fairly satisfied the demands that could be made upon an ancient people.

A monster blast took place in the quarries of the Welsh Granite Company, Trevor, Carnarvonshire, on Wednesday, December 7. The reason for the blast was that the rock was getting very tight and extremely difficult to get at. The quarry is situated at 600 feet above sea level, and the bank to be operated on was 100 feet high. The plans of operations consisted in driving in a heading about 15 feet above the level of the bank. This heading was 53 feet long. Another heading, 23 feet long, was driven to the left of this, and a chamber formed there. A further tunnel was driven to the right, but nearer to the mouth of the first heading. This one was 29 feet long, and a chamber formed at the end. There was very little report, and by measurement it was found that about 80,000 tons of rock were displaced, and fell on the bank exactly as prepared to receive it. A further quantity of 20,000 tons has been loosened. There were 6¼ tons of powder used as an exploding charge, and a small

Siemens dynamo of 400 volts was used as the exploder. The operations were carried out under the superintendence of Mr. George Farren, M. Inst. C. E.

THE EVOLUTION OF A STRAWBERRY.

By L. H. BAILEY, Professor of General and Experimental Horticulture in Cornell University.

At one time I planted roots of wild strawberries which I received from Oregon. I gave them a warm and pleasant knoll in the back yard and they grew and thrived. I had photographed the plants before they were set, and had taken botanical specimens from them. I made similar records of the plants after they became established in their new quarters, and at the end of two years I found that the distinguishing ancestral marks had disappeared, and I had a new type of plant. This discovery so delighted me that I told my friend of it, and said that I believed that I had really produced a new species. The friend, however, at once became serious and said that such a remark is heresy and that I should straightway look to my conscience. This staggered me. I had not thought of it before as a matter of ethics or even of philosophy, but only as a matter of fact; and I was astonished, as I now thought of it, to see how sinful a simple fact might be.

I returned to the strawberries on the knoll, where they lay so innocently in the sun; and were it not for my friend's suggestion and for the bees fighting in the blossoms, I should have seen no morals in them. It became evident, however, as I reflected on the matter, that I had made a grievous fault in my terminology. I had used the word "species." If I had said "kind," I had made no offense.

It is about this technical word "species" that the battles of evolutionists and theologians have raged for the last quarter century and more. The ancients did not know this species-conception, because they knew and cared so little for the external creation that they gave little thought to the kinds of animals and plants. But with the restoration of knowledge, nature came to be more and more an intrinsic thing, and persons began to wonder whence and why organisms came. With the attempt to describe or to inventory natural objects, there arose the conception of the "species" as something fundamental, a real entity or originally created thing. There was little attempt or desire to look at the external world broadly and to discover its method and meaning. The mind rested upon the objects, and naturally exalted them, and their direct progeny, into units in the creation. As there was no knowledge of whence and how these units came, they were conceived to be the direct and immediate handiwork of the Creator; and there was, therefore, no occasion for speculation or inquiry. This human formula of species-units was projected into the Mosaic record, as if that record read, "Let the earth bring forth species of grass," and "species of winged fowl." The idea of the finished and completed species-product became indelibly associated with theological teaching, and was—and, in fact is—a genuine dogma. If this species-dogma had not become so intimately associated with theological and biological beliefs, the hypothesis of evolution, when it finally came into the world, would have had few combatants.

But are they not species, after all? Surely there are the red maple and the sugar maple, the rose and the cabbage, the horse and the dog. True enough; but we now conceive these to be the products of evolution, the result of the creation, not the beginning of it. The great Linné's definition is typical of the older mind: "We reckon as many species as there were forms created in the beginning." That is, there are as many trees in a garden as have been placed there. When, however, we are no longer justified in assuming origins, we must base our conclusions on evidence. We shall then count how many trees there are in the garden, and we may find more or fewer than were placed there.

But I must not forget my strawberry. A hundred and fifty years ago a strange strawberry made its appearance in the gardens of Europe. Some persons said that it came from South America, and others that it came from North America; but nobody knew its history. Botanists considered it to be a good species, and it was named *Fragaria grandiflora*. This *Fragaria grandiflora* is well known to have been the parent of our common garden strawberries, yet the botanists are discreetly silent as to the nativity of the plant. Now the truth is that my little strawberry, taken from the woods of Oregon, turned into *Fragaria grandiflora* in two years! In Oregon it is known to botanists as *Fragaria Chilensis*, for it grows in South America as well, and was named from Chilean specimens. If *Fragaria grandiflora* was a "good species" before my experiment, it was equally good afterward, and, as measured by the actual practice of botanists, I had caused a new species to be created from an old one. When I showed a botanist my results, he replied that the very fact that I had been a witness of this transformation is proof that the two plants are not true species. I replied that I was sorry that I had not closed my eyes when I passed the patch, and I also suggested that his species were founded upon ignorance of their origins; but he insisted, although himself an evolutionist, that my having caught the plant in the act was enough to excommunicate the form which had had the presumption to appear. My ethical friend had shown me the sinfulness of my little fact, and now the scientist had told me that observation is heresy; but the strawberry thrived.

It does not matter to the strawberry or to me whether it turned into a new species or not. It was a new thing or a new kind anyway; and this simple experiment on the sunny knoll has enabled me, as I verily believe, to reconstruct the genealogy of the garden strawberry. It is a modification of the Chilean strawberry, introduced into Europe by Capt. Frezier in 1712. The unnoticed modification of this strawberry under cultivation had added one more species to the infinitude of species; but my accidental discovery that the species was actually the result of modification has stricken that species from the lists; and thenceforth the backslider, if mentioned at all in reputable systematic botanies, must be only a variety or form of *Fragaria Chilensis*. All this means that species are not, in practice, founded on essential or intrinsic characters, but the word is applied to any group of animals or plants which is so distinct from other groups

that a name may be given it for convenience's sake. The name makes it possible for us to write and talk about the thing; but if we invest the name with assumptions of origins and genealogies, we are constructing for ourselves an idol which will enshackle us.

All this shows how personal a thing a species is, how much it is a matter of judgment of the man who makes it. Regel thinks that there are but two species of grapes in the northern hemisphere, whereas Munson considers that there are twenty-five species in the United States alone. Now the grapes are the same whether seen by Regel or Munson; but Regel is not Munson. In other words, species are matters of opinion rather than matters of fact.

It is so very important that the reader should understand the full meaning and consequences of the species-dogma that I illustrate it still further. Let us consider the exact methods of the naming of plants by an expert in any group. This group may be solidago, the goldenrods, and the botanist such an authority as Asa Gray. He has brought together all names and descriptions of goldenrods, has eliminated the duplicate or synonymous names, and has published a monograph of the American kinds, with the different species and varieties in definite and logical order. Nothing could be more precise than all this. The species are even contrasted, so that one stands against the other in the most clear-cut and emphatic way. Some one now sends him a dried specimen of goldenrod from the far West. Perhaps it can be referred at once to one of the given species or varieties, but the probability is that it will not fit any one of them. He first compares it with this species, then with that, and then with a third, and finally decides that it most closely matches a fourth. Another authority might have thought it most closely matched the second. The conclusion of the whole matter is that the description or conception of the species to which it is referred is modified to receive it. The naming of plants is a process of trying and fitting, and the descriptions are checked up by the plants, not the plants by the descriptions.

The reader may admit all this for the goldenrods or the grapes, to which he may have given little attention; but surely the red maple and the sugar maple are perfectly and clearly distinct. Perhaps; and yet I can bring specimens of each which I challenge the reader to name. The fact is that the layman generally sees—or notices—only the prevailing or type forms. He walks in the woods and makes a mental note, perhaps only half conscious, of a basswood, a beech, an elm, a bee, a black snake; but those individuals which have no designative or emphatic characters do not obtrude themselves on his attention. The naturalist, on the other hand, is trained to see the intermediates and the aberrant forms, and he, therefore, sees a different world than the layman does, even though both looked at the same things.

I must not be understood as saying that there are no distinct types in nature, or that it is an error to talk about species, or that there are always intermediate forms. My argument is that species are not original entities or things or starting points in the creation, but that the groups which, for convenience, we name as species are merely the present-time results of a long process of modification, and that these results have been produced by the contingencies through which the group has passed. Those types which are most pronounced and distinct are usually those in which evolution or change is most nearly completed; and those types which are unique are the ones in which has begun the slow decline that ends in extinction. The mastodon has perished, and the elephant is disappearing; the giant conifers of other ages are represented in the isolated groves of redwoods; the tulip-tree or whitewood, the sassafras, the ginkgo, all the ranks of cone-bearing trees; the scouring rushes are now a broken and ragged army slowly but surely marching to their doom. As they become less and less, as the changing environments and the inexorable grasp of time lop off the aberrant and sportive forms, these patriarchs become reduced to a single racial stem and, like the one remnant of a decaying family, perish at last into oblivion. What was once a chain becomes a series of detached and broken links; and the last and missing links comprise the proof that there was a chain.

But there is really no dispute among naturalists as to the fact of evolution. The controversy turns upon the means of evolution—the processes by which it has come about. Yet the reader—ye of little faith!—asks to see the process actually going on. I wish he could have seen my strawberries; but, then, he would not have believed his eyes if he had seen. Of course, the lifetime of a man is a short span in which to catch and to observe the movement of creation; but if my doubting reader will come with me into the fields, I will show him the process going forward. It is easy enough to see it, if one is ready to look and willing to believe what he sees. He will see it in the many intermediate and local differences in animals and plants. Here a plant grows stronger and there weaker, here erect and there decumbent, here it is small-leaved and there large-leaved, and so on through all grades of unlikenesses and combinations of unlikenesses.

Differences—or variations, as we technically call them—are the greatest facts in nature, but they are so common that, like the air and the sunshine, we have not discovered them until recent times. There are no two plants, nor even two animals, which are exactly alike; it must therefore follow, speaking broadly, that unlikenesses tend to perpetuate themselves. Now and then a strong variation, or sport, strikes off the main stem and we see it perpetuating itself year after year, a positive augmentation of differences which must in time arrive at that degree of difference which we are accustomed to regard as specific. In those groups in which progressive evolution is practically completed these new forms do not strike off freely. In fact, it is the lack of variation—the growing rigidity and inelasticity of the type—which has limited the group to extinction; for the moment that the organism refuses to adapt itself to new conditions, is that organism doomed. But sports are the exception. The creation has no doubt progressed slowly and steadily in the main, and it is still continuing.

There are numerous groups in which evolution is apparent to the close observer. These are the groups which are perplexing to the systematist. They refuse to fall into any scheme of classification, and rebel at

the paragraphing and versification into distinct categories (or species) to which, in an age of formalism, both the scriptures and the organic creation were submitted. Among common plants, some of these groups are the asters, brambles, goldenrods, cucurbitaceous plants, grapes, plums and their kin, and many of the sunflower-like groups.

An illustration of the making of a new species in the wilds may be taken from the genus *Vitis*, the grapes. In Texas and adjacent regions there is a grape known as *Vitis Longii*. There is evidence that it is a hybrid between two well known species, but it has spread itself more than two hundred miles beyond the ranges of its probable parents and often covers acres of ground as with a thicket. It has developed features which are unique, and it is probable that the intermediate or undefined forms are gradually being eliminated. It must, therefore, be regarded as a species. It is certainly a new type of grape, which is reaching out into unoccupied conditions. In my mind's eye I can see this type originating within the last century, and I can see its aberrations eliminated and its racial stem fixed into a close specific time within the next century.

The reader may be willing to accept all my remarks respecting the fact of variation, but he asks what proofs I bring that these varieties actually may be the beginnings of new species. In the first place, I must call attention to the fact that there is no difference between species and variety except one of degree. It is therefore a proper inference that the greater has come from the less. In the second place, we have the evidence of intergradient forms from very wide differences to very small ones.

Some of the best illustrations of the separating of two or more species from a parent stock are afforded by so-called geographical species. Let us turn again to the wild grapes. A certain species extends from the humid climate of the Atlantic seaboard to the arid country of Texas. It was first made known from eastern specimens and was named *Vitis æstivalis*. Later on, Texan specimens were described as *Vitis Linsecomii*. In these extremes the two grapes are perfectly well distinguished and have every merit to be ranked as distinct species. In the intermediate country, however, they merge and are indistinguishable. Therefore, for purposes of description and classification, one must be regarded as a variety of the other. If, however, a mountain chain or an ocean separated the two geographical regions, and thereby blotted out the intermediates, there could be no hesitation in awarding specific rank to each. This case is typical of the progress of creation; each geographical area has plants and animals peculiar to it, and in proportion as an area is disjoined and unlike others are its living forms peculiar and distinct. Scores of American plants are very like those of Europe, but the Atlantic Ocean so completely eliminates the possibility of intermediates that botanists regard the plants as geographical species. Thus we have another example of the fact that species may not be defined by intrinsic characters, but by personalities, and often in terms of mountains, plains and oceans.

But, to me, the best proof that small differences widen into great ones is the fact that I saw this result in my strawberry! I see it now as it grew on the sunny knoll—at first a squat, blue leaved, short trussed, densely hairy, bashful plant just brought into the East from the wilds of Oregon; then, the second year, a little more erect, the leaves thinner and more delicate, and a more confident and aspiring attitude; and the third year a tall growing, green leaved, high trussed, thinly hairy plant with ambitions to rival the garden strawberry. I began with *Fragaria Chiloensis*, but ended with *Fragaria grandiflora*; and I had the very same plants—the identical roots—to end with that I had to begin with, for I had sown no seeds and had not even transplanted the plants.

Fragaria grandiflora had already developed so far away from its parental species when it first began to be studied, a hundred years ago, that it could not be identified with that parent. Many garden plants and most domestic animals are further removed from their parental stems than the strawberry is, but history often supplies the connecting evidence and enables us to identify the offspring with the ancestry. But when history is silent, we may be able only to guess what the original form may have been, or we may say that the parental species is extinct. It is probable that very few of the original stems of our domestic plants are actually extinct, but the evolution has been so great that we can no longer trace it. It is a most significant fact that of very many of the common and long domesticated plants we do not positively know the wild originals. Of such plants are apple, peach, apricot, almond, orange, lemon, wheat, rye, barley, bean, wine grape, Indian corn, cotton, flax, sugar cane, tobacco, sweet potato, banana, pumpkin and squash, chrysanthemum, and a legion more.

I have now indicated in a most sketchy way a few of the evidences of evolution. I have chosen to speak of only the most familiar things, because they are seldom mentioned in contemporary writings, and because they seem to me to be the very best proofs of evolution. We have been looking so far into the past, have searched so diligently for great facts, have so urgently desired to see the missing links, and have so confounded ourselves with philosophy, that we have forgotten to go out and see the creation going on about us.

I cannot forbear to say a word about the missing links. Evolution is not a line; it is a genealogy. It is a tree of numberless branches, each branch forking again and again. The tip of one branch grows faster than its twin and thereby leaves the other behind; so that now we have in the world representatives of many of the stages of development. It is not unlikely that something very like the first forms of life still exist in the myxomycetes. The present groups of animals and plants are the tips of the branches in the multifold tree of creation. It is evident, then, that the missing links lie behind, not between. The genealogy is the missing link; and in many cases it is traceable. There are still many unfortunate persons who believe that Darwin taught that man came from the monkey. It is not to be wondered at that we sometimes think so. But the truth is, no doubt, that the two came off a single stem in ages past, and they now represent the tips of the branches of a letter Y; but I like to think that the human branch is a little longer than the monkey branch!—The Independent.

MYRMECOPHILOUS PLANTS.

It is a fact well known to everyone that ants have the habit (a disagreeable one in gardens) of running over the surface of plants in order to gather the nectar secreted by the leaves and flowers, or else to "milk" the plant lice that live thereon. After they have finished their work, these insects retire to their nest and leave the plants for a moment at rest. There are cases, however, in which things do not proceed in this way, for sometimes the plant contains cavities of greater or less irregularity in which the ants pass their entire existence, the plant then affording them both food and lodging. In exchange for these good offices, it is admitted that the ants prevent their host from being overrun by noxious insects. In this hypothesis the plant is the "friend" of the ant, and is called myrmecophilous.

From a biological standpoint, the existence of these myrmecophilous plants presents a great interest by reason of the problems that it raises. It may be asked, in fact, whether the cavities were created for the ants or by them. We shall revert to this question further along.

The most benign case of this nature that can be adduced is that of various palm trees in the spathe of which ants live, but without producing any distortion therein. For instance, these insects select, in certain species of *Dæmonorops*, a domicile among the spines, which, inclining toward each other in several longitudinal lines, form genuine covered galleries or a sort of elongated huts.

The case of the *Acacia cornigera* is still more inter-

Euphorbiad, the *Endospermum moluccanum*, which also is myrmecophilous. Its trunk contains cavities that are inhabited by ants, which feed upon the nectar secreted by the petioles. This plant is so beautiful that Rumphius named it the "Royal Tree." It seems that its large dimensions are due to the excitation produced by the presence of ants. In fact, when it is cultivated in tropical botanical gardens, it can be made to acquire only a moderate size, whatever be the care bestowed upon it.

The interior of the stalk of one of the Verbenaceæ, the *Clerodendron fistulosum*, is inhabited by ants. The internodes of the stalk are much inflated, and their interior communicates with the exterior through an orifice situated just beneath the insertion of the leaf. Is this orifice the work of the ants or is it natural? Beccari, who studied the question, seems to think that it is natural, while inclining to the opinion that the aperture was originally the work of ants, but has become hereditary. However this may be, in order to convince ourselves of the services that the ants render to the plant, it will suffice to gather one of the branches, when the insects will immediately make their exit, run over our hand and inflict a painful bite.

The habitation of ants in the *Nepenthes bicalcarata* is more singular; it is the petioles of those curious pitchers that are considered as being designed to capture insects. The petiole under consideration is now straight, now curved, spongy and inflated, and its cavity (which does not communicate with that of the pitcher) opens externally through an orifice. The ants live in its interior. We meet also with a few openings upon the axis of the inflorescence of which

FIG. 1.—MYRMECOPHILOUS PLANTS.

1. *Clerodendron fistulosum* (inflorescence). 2. Stalk of *Clerodendron*. 3. *Nepenthes bicalcarata*; a, orifice. 4. Longitudinal section of an ascidium of *Dischidia*. 5. Ascidium of *Dischidia*.

esting. The leaves of this tree are provided at their base, in lieu of stipules, with two strong spines, which are so bent as to have been compared to the horns of an ox. The interior of these spines is hollow and is occupied by ants, which effect an entrance thereto by making a small hole at the surface. The two cavities of the spines communicate with each other. The ants that dwell therein belong to the species of two genera; but these are never met with upon the same tree at the same time.

Upon certain trees the insect is the *Pseudomyrmex bicolor*, and upon others a *Crematogaster*. These two species gather the sweet substance secreted by the nectaries that dot the entire length of the principal petiole. Moreover, at the extremity of the leaflets, they meet with small buds that are at first compact but soon become succulent. When these sorts of little fruits are ripe, the ants cut them off and carry them into the spines in order to suck them at their leisure.

It is a fact curious to relate that, through culture (as Belt has ascertained), we obtain merely soft spines with pulpy contents, which no longer harden when they are invaded by certain kinds of ants. In order that they may acquire their full dimensions and hardness, the presence of the *Pseudomyrmex bicolor* or of a *Crematogaster* is indispensable. It will be seen that these two kinds of ants are useful to the *Acacia*, since, owing to them, the spines become formidable defenses against herbivora. The latter are, besides, repelled by the odor of the ants. In fact, the leaves of the *Acacia*, even when freed of their hosts, are not eaten by the herbivora on that account.

In the forests of Malasia we meet with a beautiful

the interior likewise is inhabited. It is curious to find that the ants select in the petiole the most dangerous place for them in the whole plant. If, in fact, they should venture upon the pitcher, there are many chances that they might slip into its interior and get drowned.

In the *Kibara formicarum* we meet with a relation of another kind. In this *Monimiaceæ* the internodes are filled with ants and coccinellæ. It is very probable that the latter are carried to this place by the ants, which derive a benefit therefrom by licking up the saccharine liquid that oozes out upon the surface of their bodies. It must be admitted that the presence of these coccinella "parks" in the interior of a stalk is very singular.

But one of the most curious myrmecophilous plants, and also one of the best studied, is certainly the *Myrmecodia echinata*. This epiphytal cinchonaceous shrub grows at a great height upon trees, to the branches of which it is attached by a few adventitious roots. It occurs in the form of large, irregular tubercles surmounted by a few leafy stalks.

These tubercles, which sometimes reach several inches in diameter, contain innumerable galleries, which all communicate with each other and open externally by several orifices. All of these cavities are inhabited by ants.

It would seem, a priori, as if these tubercles were pathological productions—galls produced by the irritating presence of ants. Such is not the case, however. According to the researches of Treub, the presence of the ants is very useful to the plant, which, so to speak, offers them a lodging of its own volition. If