

We generally think of nature as being free from all mathematical exactness and regular arrangement— that nature never places herself in straight lines and exact angles. We feel that she is free from squares and circles and of all things suggestive of mathematical government; that she is careless and easy and restricted to no such stiff ways as those ^{of} man, but picturesque in her irregularity, and purposeless in the promiscuous scattering of her elements over land and sea and sky. Such is the impression of the casual observer. But when we come to study nature more carefully, we find that it is not a miscellaneous collection of things without definite laws or regulations.

We find these elements disposed in circles, pentagons, ellipses and other geometrical forms. But nature, like an artistic builder, conceals the rough and angular framework of construction beneath pleasing decorative substances and seeming irregularity of arrangement. And it is only by scientific penetration that the workings and real machinery of nature are to

be seen and understood. Do not think that the whole of nature is laid out after a hit or miss pattern.

Let us accompany the Botanist and allow him to show us some of the mathematics of plant life.

Of all things with which we associate that of plant life, we are less likely to think of as having fixed regularities; yet they are abundant in every plant. As we walk through the grass and wild flowers of a meadow, or through a shady forest, the swaying of branches and flutter and murmur of leaves, holds our attention and we forget all things so like study as searching for the fundamental plans of plants; and enjoy only these gentle influences of field and forest. The contrast wild nature with the squares, hearts and horse-shoes, symmetrically arranged in our flower gardens, and the parallel rows of shade trees in our yards. But the precision of nature's mark is in the structure of the plant itself, rather than in the more obvious placement. On some trees the arrangement of the buds and leaves on the

stem is alternate and in some opposite. The bases of the leaves are of various shapes and make different shaped scars on the stem oval, triangular, semicircular etc. The pith may be round, pentagonal, solid or diaphragmed. The leaves are of various shapes, each species having peculiarly shaped leaves. Plants are distinguished and classified by these and other peculiar regularities. Trees, in their growth form year to year, form a circle in their wood which records each year's growth. In this simple way nature makes a record at times and in places where men could not, and which may be kept for hundreds of years, hidden in the hearts of trees, then to be read and studied by man. Many of the things about us are but little appreciated because we cannot see, at a glance, their beauty of structure. But when we look at them through a powerful microscope, we are as in a new and beautiful world. What man calls the most useless of plants are made with as much care and exactness as the useful ones.

Leaving the field of the Botanist we now focus our attention on the more life-

less part of nature.

Here we find the geologist and mineralogist working, not among masses of shapeless substances, as one might first suppose, but among beautiful crystals with smooth faces and exact angles of various geometrical forms. As we pursue this study we are made to think that crystallization shows to us, nature at her foundation work and illustrates its mathematical character; for we find that minerals of every kind are made up of crystals of various sizes. Each mineral, with few exceptions, has its definite forms of crystals, by which it may be distinguished. There are specific forms for each species of inorganic matter as there are in life for each living species. These crystals may be cubes, prisms, octahedrons, or other exact forms.

Look where we may, and we find only few exceptions in the inorganic world where the substance is not made up of masses of crystalline grains, or else exists in distinct crystals. Granite mountains are of crystals. The lava, as it is thrown out from the

interior of the earth and cooled, becomes a mass of crystalline grains. The rocks are often found in large regular forms which they have taken on cooling. The glittering diamonds and other precious gems are crystals. In fact the whole earth may be said to have a crystalline foundation; and, though their beauty is not always apparent on the exterior, from the constant wearing of the surface, it always is from the interior. When the cold of winter settles over the earth, it is a signal for crystallization of vapor and water. The air is filled with crystal flakes when it snows; the streams become covered with little crystals which are called ice; crystal is added to crystal and makes beautiful feathery pictures on our windows — Jack Frost's work being to make beautiful crystals.

The rainbow is another one of nature's mathematical forms. As we step into the bright open air which has just been cooled and freshened by a shower, we may notice the magnificent arch painted in colors of unequalled splendor, which may

rest against the most somber cloud in the heavens, like hope rising from the darkest discouragement. The sun produces this beautiful bow by the reflection of light coming at certain angles, through the scattering drops of water falling through the air. The seven colors which we see in the bow are produced by the separation of the rays of white light coming in contact with the drop. It is refracted, driven through to the other side, reflected back, and again refracted at the emergence from the drop, and then conveyed to the observer; every step showing mathematical exactness.

As the sun disappears and twilight grows deeper and deeper and merges into darkness, there is opened to our view a field far more beautiful and extensive than any we have explored before. The stars begin to appear one by one, as if shy at first, then more rapidly until the heavens are nearly filled with the sparkling bodies, scarcely seeming to afford room for another one. But by aid of the telescope thousands of others can be seen. As our view is thus extended, we begin to realize

the vastness of space; and feel how very insignificant is each individual on this little earth of ours. But man does not moulder long. He begins, as he has done before, to study the mathematics of the solar system. With the heavens spread before him as his book, he begins to study the true laws of the heavenly bodies. He observes, records, matches and waits until he has learned the motion of the various spheres, calculated their distance, and studied the forces which govern them. He sees how the planets move in circles about a great luminous body, a mother planet so to speak, called the sun. And how our earth makes this journey in an exact length of time, to which man has applied the term year, making a basis for calculating all time. He matches the moon move about the earth at a certain rate, dividing the year into twelve equal parts. How the earth revolves on its axis regularly, giving to us darkness and light, a time for man to rest and to work. He observes the reliable motion which brings to us the seasons — summer and winter, seedtime and harvest; sees the regular ebb

and flow of the tides and studies the forces which causes them; and tries to realize the rapid rate at which we are flying through space, yet keeping our relative position with the other planets. He looks as far into space as his telescope will enable him, and he can see nothing but harmony and regularity of motion with all the members of the heavenly family. He discovers worlds and systems of worlds, all working, so to speak, together in one vast field. Yet all moving as smoothly as one great well regulated machine.

What is there more beautiful and interesting to study than the natural phenomena among which the creator has placed us? The more we learn of nature the more we want to know.

There is something fascinating about the study, and it invites us on and on in gathering up the fragments of truth. Time may come and go, but as far as the intellect of man can penetrate, the plant will follow its individual law of growth, the minerals will crystalize by their special forces, the

rosy fingers of morning will still draw
the curtain in the east, each time to
be closed by the chilling hand of night,
the rainbow will still extend its promises
for the future, and all things continue
to move in harmony and in obedience
to nature's governing laws.

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