A REVIEW ARTICLE ON SYMMETRY IN NATURE

Gayathri Shanmugam*

*Department of Mathematics, Vel Tech Ranga Sanku Arts College,

42, Vel Tech Road, Avadi, Chennai,

Tamilnadu, India -600062

Abstract:

Mathematics is all around us. As we discover more and more about our environment and our surroundings we see that nature can be described mathematically. The beauty of a flower, the majesty of a tree, even the rocks upon which we walk can exhibit nature's sense of symmetry. Although there are other examples to be found in crystallography or even at a microscopic level of nature, we have chosen representations within objects in our field of view that exhibit many different types of symmetry. This review article showcases various inspiring symmetries by nature.

Keywords: Symmetry, Bilateral, Radial, Mirror, Spiral, Fibonacci series

Introduction

Mathematics is an extremely powerful tool both in its ability to describe the world and as the starting point for many innovations and novel technologies[1]. The scientific method relies heavily on mathematics which is used to quantify the phenomena in the world. The literal meaning of mathematics is "things which can be counted" now you can think that counting has vital role in our daily life. Imagine that there were no mathematics at all, how would it be possible for us to count members of the family, number of students in the class, rupees in the pocket, and runs in a cricket match, days in a week or in a months or years. On a basic level you need to be able to count, add, subtract, multiply, and divide. At a psychological level, exposure to mathematics helps in developing an analytic mind and assists in better organization of ideas and accurate expression of thoughts. At a more general level, far away from dealing with the higher mathematical concepts, the importance of mathematics for a common man underpinned

A common man is being increasingly dependent upon the application of science and technology in the day-to-day activities of life, the role of mathematics has undoubtedly been redefined. Mathematics is around us. It is present in different forms; Right from getting up in early hours of the day to the ringing of an alarm, reading time on a watch, rounding a date on a calendar, picking up the phone, preparing a recipe in the kitchen, to wait for the counts of whistles of the cooker, manage the money, travel to some place, to exchange currency at a ticket outlet while availing a public conveyance or checking up the mileage of your car, halting at the filling station, attending to a roll call at school, getting scores in the class exams, even meet new friends the list is just endless if one goes on to note down the situations when our computational skill, or more specifically, simple mathematics comes to play a role, almost every next moment we do the simple calculations at the back of our mind. Of course these are all done pretty unconsciously without a thought being spared for the use of mathematics on all such occasions.

Mathematics helps the man to give exact interpretation to his ideas and conclusions. It is the numerical and calculation part of man's life and knowledge. It plays a predominant role in our everyday life and it has become an indispensable factor for the progress of our present day world. Even nature also embraces mathematics completely. We see so much of symmetry-around us and have a deep sense of awareness and appreciation of patterns. Observe any natural thing and find out symmetry or pattern in it. Change of day into night, summer into winter etc. The sun rises and sets at specified moment. The stars appear at fixed time. Mathematics runs in the veins of natural sciences like Physics and Astronomy. This subject is inextricably incorporated with world and the natural phenomena. Importance of mathematics can be understood by the definition given by Galileo. He defined mathematics as '*a language in which God has written the world'*.

In this article, discussed in details there are innumerable examples of symmetry, shapes, patterns which are inseparable with mathematics. Such examples exist in animals, in objects, in pictures and other things.

1.1 Fibonacci Spiral Pattern

When you sit in a garden and look around, you can easily recognise several natural designs. You see bees buzzing around flowers with neatly arranged petals, trees whose trunks are surrounded by pinecones with their distinctly patterned bracts, and maybe a little snail with a spirally shelled house on its back. But what exactly makes these designs look the way they do? It may sound weird, but it is actually a mathematical sequence, called the "*Fibonacci series*" which can explain this phenomenon. Actually, this sequence of numbers, which seems to mysteriously pop up everywhere, is not as weird as you may think.

Fibonacci was an *Italian* man who studied maths and theories back in the eleventh century. He discovered a pattern called the *Fibonacci sequence*.[1] It's a series of numbers that starts with 0 and 1, and each number after is found by adding the two previous numbers (0, 1, 1, 2, 3, 5, 8, 13, 21 34, 55...) The sequence just keeps going on and on. This pattern repeats itself as seen below:

0 + 1 = 1

1 + 1 = 2

1 + 2 = 3

2 + 3 = 5

3 + 5 = 8

5 + 8 = 13

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89 …

Pinecones have seed pods that arrange in a spiral pattern. They consist of a pair of spirals, each one twisting upwards in opposing directions.

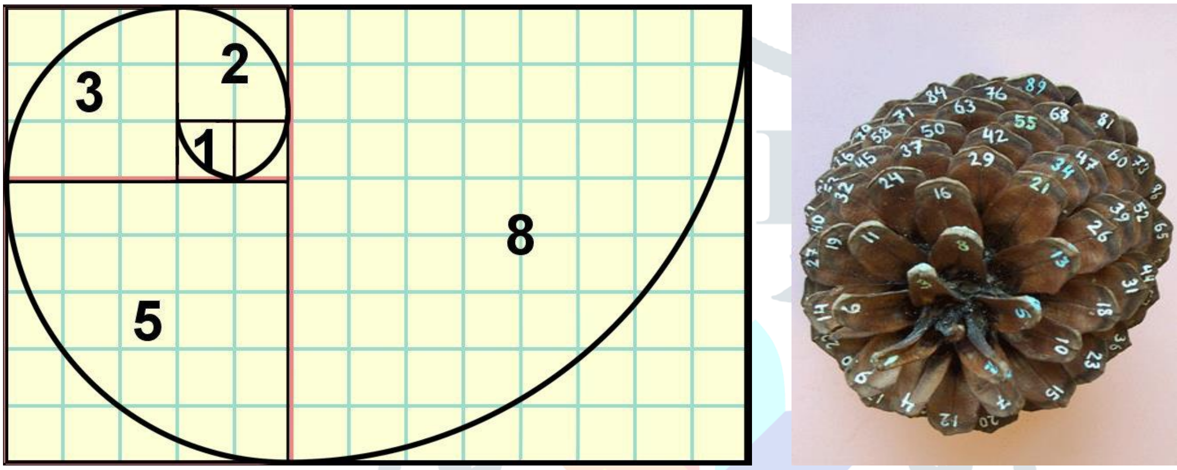

Fig1: Illustration of Fibonacci sequence/spiral in Pinecones

1.2 Honeycomb

The beauty of honeycombs is an example of wallpaper symmetry as shown in *Fig 2*. It is believed bees build these hexagonal constructions because it is the shape most efficient for storing the largest possible amount of honey while using the least amount of wax[1]. Shapes like circles would leave gaps between the cells because they don't fit perfectly together.

Fig 2: Honeycombs - Wallpaper Symmetry

1.3 Milky Way

Symmetry and mathematical patterns seem to exist everywhere on Earth[2]. Recently, a new section on the edges of the Milky Way Galaxy was discovered, and, by studying this, astronomers now believe the galaxy is a near-perfect mirror image of itself as shown in *Fig 3*.

Using this new information, scientists have become more confident in their theory that the galaxy has only two major arms: the Scutum-Centaurus and the Perseus. As well as having mirror symmetry, the Milky Way has another amazing design. Like nautilus shells and sunflowers, each 'arm' of the galaxy symbolises a logarithmic spiral that begins at the galaxy's centre and expands outwards.

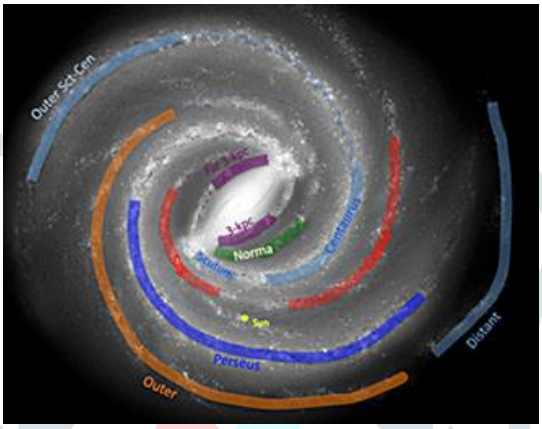

Fig 3: Milky way - Mirror Symmetry

1.4 Human Faces

The body plans of most animals, including humans, exhibit mirror symmetry, also called bilateral symmetry as shown in *Fig 4*. They are symmetric about a plane running from head to tail (or toe). Bilateral symmetry is so prevalent in the animal kingdom that many scientists think that it can't be a coincidence. After all, there are infinitely more ways to construct an asymmetrical body than a symmetrical one. And yet, fossilized evidence shows that bilateral symmetry had already taken hold in animals as early as 500 million years ago. Bilateral symmetry must have evolved for a reason, the thinking goes. And over the years, scientists have come up with a number of hypotheses about what that reason might be. According to one, a body that is bilaterally symmetrical is easier for the brain to recognize while in different orientations and positions, thus making visual perception easier[3]. Another popular hypothesis is that symmetry evolved to help with mate selection.

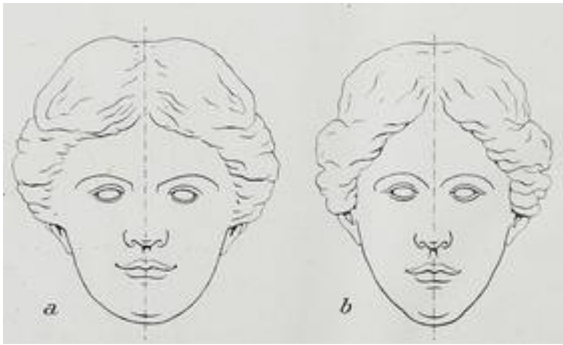

Fig 4: Human Face – Bilateral Symmetry

The beautiful dragonfly, presented in *Fig 5*, is an excellent example for bilateral symmetry. The more flowers are formed by radial symmetry in *Fig 6 (A & B)*. Snowflakes are other model of radial symmetry show spiral symmetry in nature in *Fig* 7 (*A, B & C)*[4].

Fig 5: Dragonfly

A *B*

Fig 6 (A&B): Radial Symmetry in nature

A B C

Fig 7 (A, B & C): Spiral Symmetry in nature

1.5 Spider Web

Spider webs illustrate a beautiful geometric pattern as shown in *Fig 8*. All of them create near perfect circular webs that have near-equal-distanced radial supports coming out of the middle and a spiral that is woven to catch prey. Studies[4] have shown that orbed webs are no better at catching prey than irregularly shaped webs. Some scientists theorise that orb webs are built for strength, with radial symmetry helping to evenly distribute the force of impact when a spider's prey makes contact with the web. This would mean there'd be less rips in the thread. But if this is a better web design, why aren't all spiders utilising it? Some spiders have the capacity to produce orb webs, but don't seem bothered. It's a case that requires further study.

Fig 8: Spider Web

Conclusion

Few things are as pleasing to the eye or ear as symmetry. Whether it is a flower, a bird or another human being, almost nothing excites our attention and quickens our interest as much as a symmetrical appearance. Our left and right halves are not exactly identical, each petal on a flower does not match the others perfectly and the segments of an earthworm can be told apart (with some effort). Developmental biologists have been engaged on the question of what brings about a symmetric form in an animal or plant; evolutionary biologists want to know why symmetry should be there at all. It appears that symmetries are good for us in an evolutionary sense. The pleasing quality of symmetrical objects, and our aesthetic preference for beauty, may have distant evolutionary antecedents.

References

1. Einstein, A., B. Podolsky, and N. Rosen, 1935. "Can Quantum-Mechanical Description of Physical Reality be Considered Complete?" *Physical Review Journals* 2; 47, 777-780.

2. John Sappington and Richard Topolski, 2005. "Maths performance as A Function of Sex, Laterality, and Age of Pubertal Onset, *Laterality*. 10; 4, 369-379.

3. Bernstein D, 2013. Giant Gravitons: A Collective Coordinate Approach. *Physical Review Journals*. 10; 87, 126-127.

4. Ferguson H, Ferguson C. Celebrating Mathematics in Stone and Bronze, 2010. *Notices of the AMS*. 3; 57, 840-850.