Fibonacci in Nature

I have become more curious about Fibonacci and his life, and how he found his amazing discoveries involving mathematics, and especially how those numbers are involved in so many things in nature. Fibonacci is amazing for his mathematics and contributions to the numbers in nature's plant system. (TJOP 2013) My testable question is, "What percentage of nature that I come across daily has the Fibonacci Sequence in it?"

Leonardo of Pisa, more commonly known as Fibonacci, contributed to the mathematical world in numerous ways, but he is most famous for the sequence of numbers that bears his name, the "Fibonacci Sequence". These series of numbers are found everywhere in our world; in flowers, in sculptures, buildings, even art. When the numbers are studied and moved around, patterns seem to evolve. The list is extensive, and continues to grow, as more scientists are discovering the relationship between things in our, world and the numbers contained in the Fibonacci Sequence. (Grigas 2013)

Leonardo de Pisa refers to the city of Pisa in Italy. Although it is not known specifically where, it is believed that Leonardo Pisano, Leonardo de Pisa, was born somewhere near the city of Pisa in Italy in or around 1170. "Fibonacci" means "of the house of Bonacci". Leonardo's father was Guielmo Bonacci, and he was a merchant in the city of Pisa. At that time, Pisa, Italy was a very important city for the world of trade. (Grigas 2013)

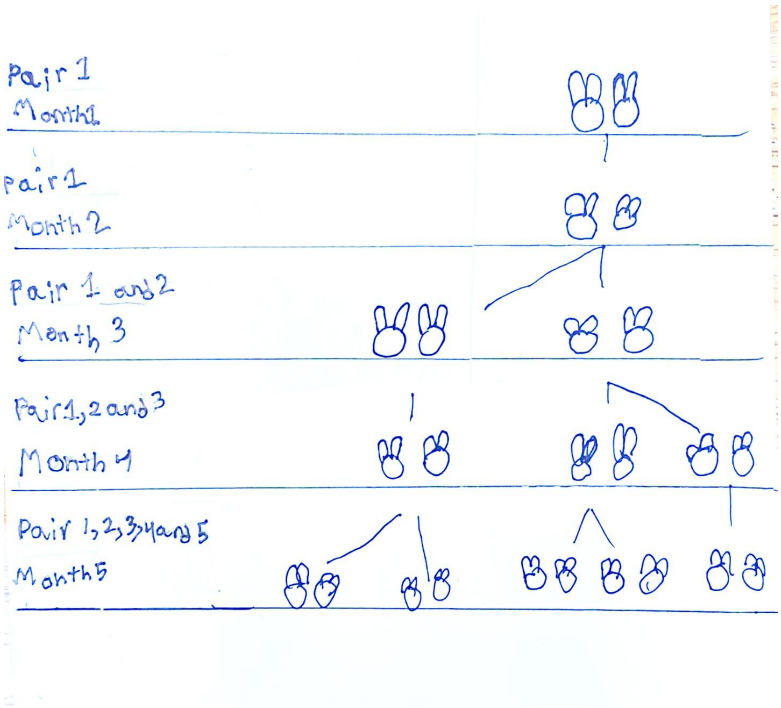
Leonardo grew up in the middle of all the busy trading and commerce, and he was exposed to mathematical numbers on a daily basis. His father had to measure goods, set prices for them, and deal with money involved in trading. Since young boys then assisted their fathers, Leonardo was also doing mathematics at an early age. (Boyd 2013)

When Leonardo was a teenager, his father was appointed to represent the Pisan Italian merchants in Borgia, a port on the coast of North Africa. (Grigas 2013). Leonardo then traveled through North Africa with his father, where he learned about the Hindu-Arabic number system: Europeons were still using Roman numerals (I, II, III). (Boyd 2013). Hindu-Arabic numerals were much more simple and robust, meaning that you would not get lost counting large numbers.

Once Leonardo came home to Italy, he continued studying mathematics, geometry, trigonometry using his newly found Arabic number system. As an adult, he became a well-known mathematician, due to his continuous work with numbers and publishing his findings in several books. People started calling him Fibonacci, and he began writing the book **Liber Abaci** in 1202 (hand-written in Latin), using the Arabic numerals. This is a very important book that has influenced Western knowledge in math, patterns, and his now-famous "Fibonacci Sequence" in nature. (Shields 2012)

His "Rabbit Study", which he used to help develop the Fibonacci Sequence of numbers, started out with his question: Starting with one pair of rabbits (one male and one female), how many pairs of rabbits would there be at the end of an entire year? Fibonacci's rabbit experiment went something like this: asume no rabbits die; there is one pair of newborn rabbits to start; all rabbits become mature after one month; the new pair of rabbits have one male rabbit and one female rabbit; they can reproduce at one month of age. At month 1, the first pair of rabbits are newborns and need time to mature (1 month=1 pair). At month 2, rabbit pair #1 are the only ones and have matured so they can reproduce. At month 3, there are 2 pairs of rabbits, the original and the new pair. However, rabbit pair #2 cannot have another pair of rabbits until month 4. At month 4, there are now 3 pairs of rabbits, BUT, rabbit pair #3 can't have a pair of rabbits until

month 5, there are the original 2 and the new pair. In month 5, there are now 8 pairs of rabbits (The original 3 and the 5 new pairs). This can keep happening until you reach 1 full year. At the end of one full year, there will be 144 rabbits. (Marshal 2010)



Month	1	2	3	4	5
# of Pairs	1	1	2	3	5

Image from: (Marshal 2010)

The Fibonacci sequence is that each number is the sum of the 2 preceding ones, starting from 0 and 1.

Start at 0 and 1

0+1=1

1+1=2

1+2=3

2+3=5

3+5=8

5+8=13

8+13=21

13+21=34

21+34=55

34+55=89

89+55=144

89+144=233

144+233=377

233+377=610

377+610=987

610+987=1597

1589+987=2584

2584+1589=4182

2584+4182=6766

6766+4182=10948

This keeps happening until you want to stop.

The Fibonacci numbers thus far are:

1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987, 1597, 2584, 4182, 6766, 10948…

(Benjamin 2013)

Another fascinating thing about Fibonacci's number sequence is almost "magical": it is called the Golden Ratio. Each of the numbers is approximately 1.618 times greater than the preceding number. For example:

1/1=1

2/1=2

3/2=1.5

5/3= 1.6667

8/5=1.6

13/8=1.625

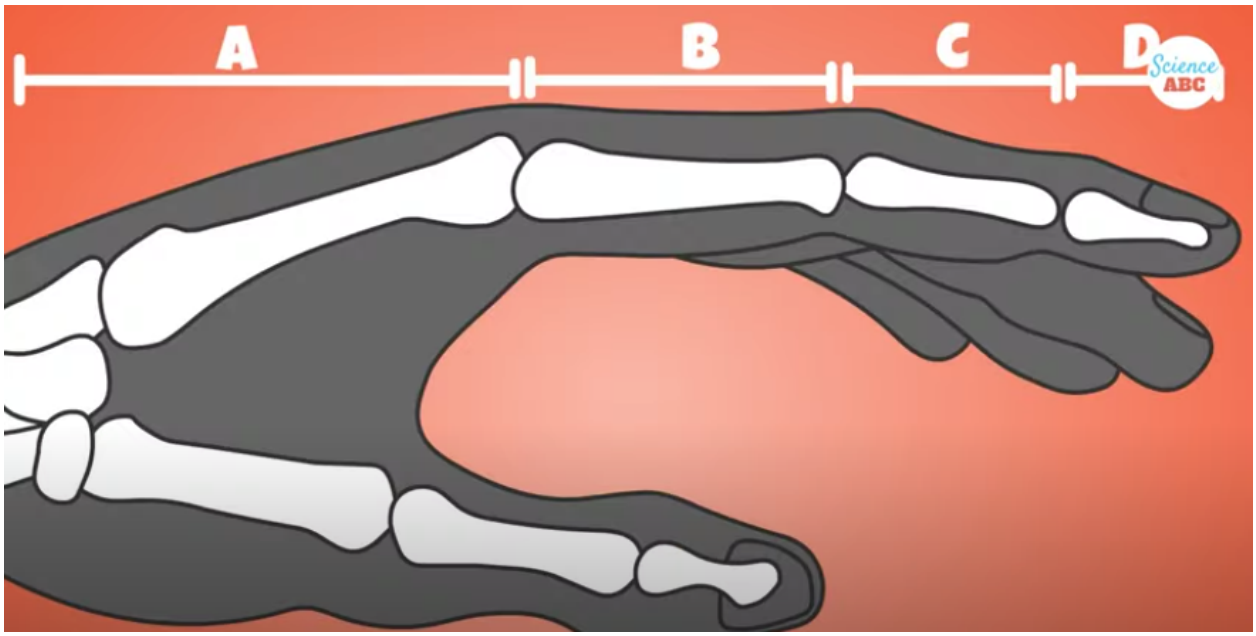
21/13=1.61538461538

34/21=1.61904761905

The ratio is settling down to one particular value, which is called The Golden Ratio (PHI=1.618). The Golden Ratio is also known as The Divine Proportion. (Benjamin 2013). Nature uses the Golden Ratio to maintain balance. The Golden Ratio seems to have an important role in nature, astronomy, music, architecture and painting. Salvador Dali used the Golden Ratio in his famous painting, "The Sacrament of The Last Supper". (Tiwari 2021)

Hundreds of years after Fibonacci's death, the Renaissance happened. People became more aware of the beauty of nature, humans, animals, plants, architecture, music and art. As they studied these things, they found that the Fibonacci number patterns appeared. "One place where Fibonacci numbers consistently appear is in the leaf arrangement on plants. As leaves go up a plant stem, they follow a spiral arrangement." (Grigas 2013)

Sometimes flowers with all petals intact are Fibonacci numbers with 3, 5, 8, 13, 21 or more petals. Sunflower seeds and cacti leaves are both arranged in left and right spirals. We have 2 hands with 5 fingers, the fingers are divided into 3 parts; all Fibonacci numbers. The length of the bones in our hands are divided into 3 parts with 3 separate lengths which are Fibonacci numbers. (Tiwalri 2021)



Picture from: (Tiwari 2021)

More Fibonacci sequence numbers and spirals can be found on or in snail shells, cacti, pinecones, pineapples and sweet peppers.

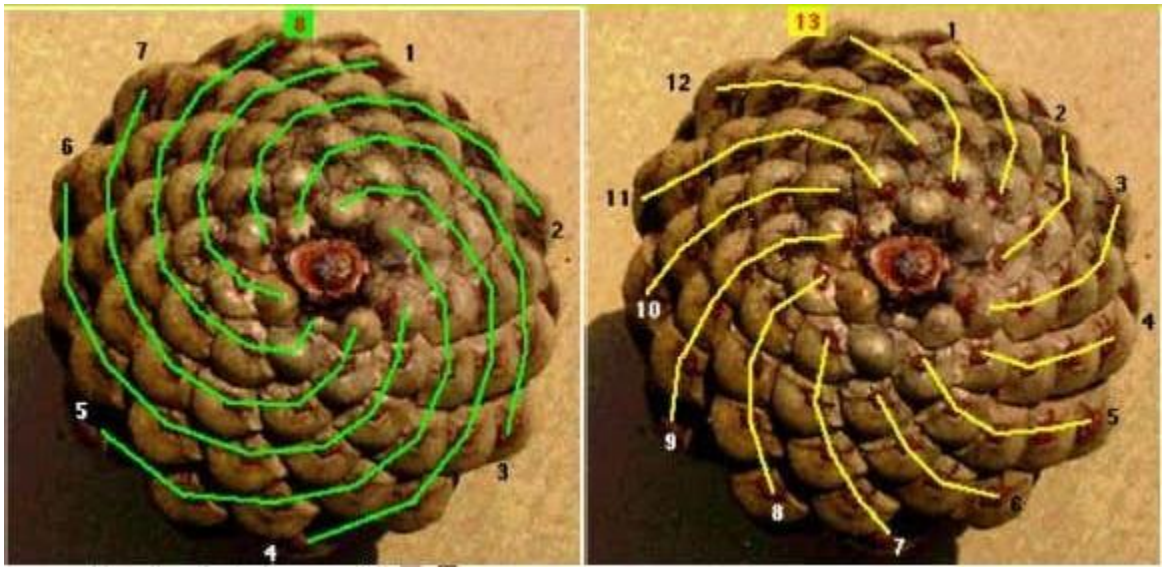


Image from: (Razkova 2014, Page 11)

There are other things in nature than plants and flowers that contain the Fibonacci spiral; ocean waves, hurricanes, shells and spider webs naturally have the spiral. The Golden Ratio is sometimes called “The Divine Proportion”. (Tiwari 2021) It is impossible to list all items that have the Golden Ratio.

Do all plants have the Fibonacci Spiral or numbers? No, they do not. You might be able to find an elusive 4-leaved clover in a field. Sometimes sweet peppers can have not only 3, but 4 chambers inside them. You can find flowers with 6 petals. “So it is clear that not all plants show the Fibonacci numbers!” (Knott 2016) However, the number of plants that do not have the Fibonacci numbers in them are so outnumbered that it is an irregularity. You will probably find these abnormalities in all the other natural objects that do follow the Fibonacci patterns.

Image from: (Knott 2016, Page)

In conclusion, I found that Leonardo of Pisa (Fibonacci) is the man who has invented the sequence of numbers that has his name. His work in numbers and mathematics has left us humans amazed at how nature seems to revolve around his numbers. The Fibonacci sequence is found throughout the world, in buildings, art, people, animals and music. His unusual string of numbers contains all sorts of intriguing properties, by utilizing various mathematical functions to the numbers in the sequence. Scientists and mathematicians are often astonished, and sometimes

perplexed, at the beauty of the numbers and patterns that are contained in this world. The list gets very extensive and will keep growing as we find new things to add to the list of items in our world. (Grigas 2013)

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