North-Eastern Tasmanian Field Naturalists Club Inc.

The North Eastern Naturalist

Newsletter of the NE Tasmanian Field Naturalists Club

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MISSION STATEMENT: It is the mission of this club to encourage the study, appreciation and preservation of our natural and cultural environment, the animals, plants, geology and landforms, including those of the coastal and marine areas in the North East region of Tasmania.

From the Editor: This is the Christmas supplement to the December 2020 issue of the North Eastern Naturalist.

As usual, it consists of material that is unrelated, or only indirectly related to our monthly activities, but may be of interest to members.

The first article, by Ross Coad, should appeal to members with an interest in mathematics: Ross examines the relationship between spirals (which are mathematical concepts) and natural specimens he found around his house.

The second article is by Mike Douglas and describes some quirks of the orchids he has discovered in his extensive garden. (An article describing Mike's garden in detail is in The North Eastern Naturalist issue number 205, published in June 2019.)

I hope everyone enjoys a relaxing Christmas and New Year, and that 2021 turns out to be better than 2020. I also look forward to seeing many of you at our first outing for 2021, which will be in February (details to be sent by email later).

MATHEMATICS AND NATURE — IN A BIT OF A SPIN

Article by Ross Coad; illustrations by Ross Coad and from Wikipedia

In this article I introduce the topic of spirals in nature and take a closer look at one specific type of spiral, using some natural examples I found around my home.

In mathematics a spiral is a curve that emanates from a point, moving farther away as it revolves around the point. There are four types of spiral I will mention. The first two are the Archimedean spiral (Figure 1) and the logarithmic spiral (Figure 2).

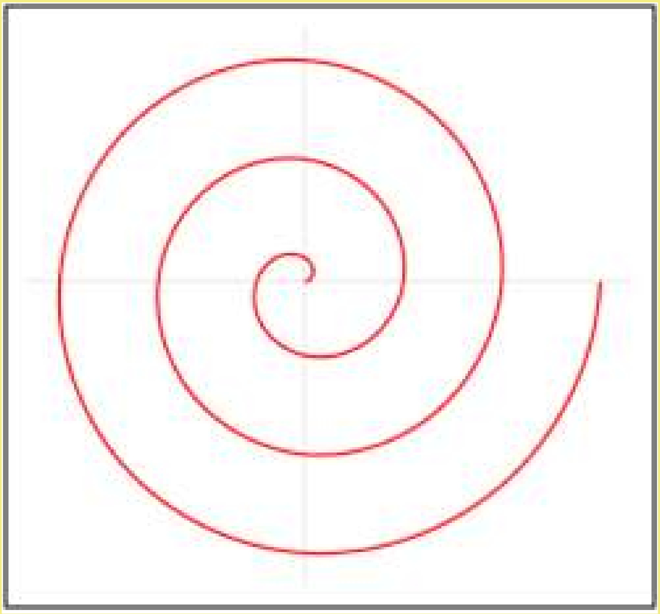

Figure 1. The Archimedean spiral [image downloaded from https://en.wikipedia.org/wiki/Spiral]

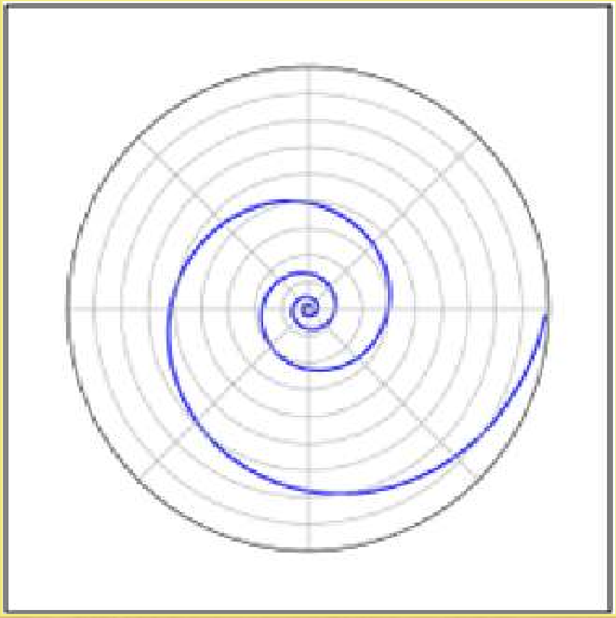

Figure 2. The logarithmic spiral [image downloaded from https://en.wikipedia.org/wiki/Spiral].

You will notice that the Archimedean spiral differs from the logarithmic spiral in general appearance. The difference can be explained in terms of the separation distance between successive turns of the spiral. The separation distance of the Archimedean spiral is constant—an arithmetic progression—whereas logarithmic spirals are characterised by separation distances that increase such that successive turns in the sequence have the same ratio—a geometric progression.

The focus of this article is on spirals that are found in nature. The Archimedean spiral has applications in the engineering world and is present in some natural phenomena, but not commonly in nature more generally. However, there are some examples, such as the coiled up millipedes I found in my backyard.

Logarithmic spirals are more plentiful in nature, but are not always obvious, as the spiral may be hidden in the detail, for example in a flower head. The logarithmic spiral has the interesting and unique property of self-similarity, whereby as the size of the spiral increases the shape remains unaltered. This property is also displayed by some organisms, for example the nautilus, a marine mollusc that grows larger inside a shell that also grows larger, but doesn't alter its shape.

The third and fourth spirals I will mention are special cases of the logarithmic spiral—the golden spiral, and the Fibonacci spiral, which is an approximation of the golden spiral (Figure 3).

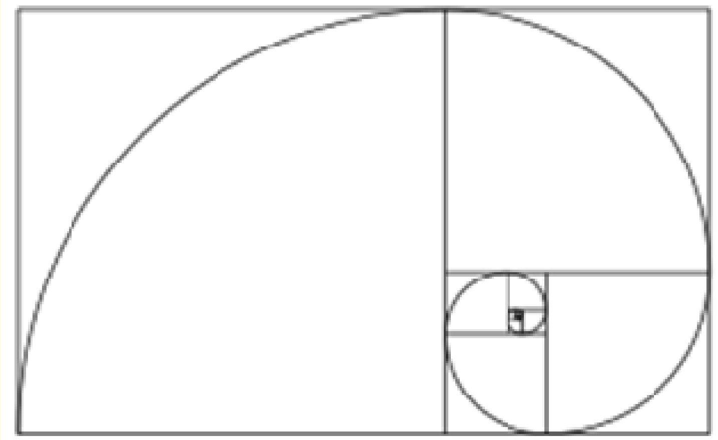

Figure 3. The Fibonacci spiral, which closely approximates a golden spiral [image downloaded from https://en.wikipedia.org/wiki/Spiral]

The Fibonacci spiral and the underlying Fibonacci series are relevant to the topic of mathematics and nature. I intend to return to this topic—Fibonacci numbers and nature—in a future article. In the remainder of the current article I will focus most closely on the golden spiral.

The golden spiral is a special case of the logarithmic spiral where the separation distance is a factor of the golden ratio. Two quantities are in the golden ratio when their ratio is the same as the ratio of their sum to the larger of the two quantities (Wikipedia). The value of the golden ratio is $(1+\sqrt{5})/2$, which is approximately 1.618. A golden spiral increases in size by a factor of the golden ratio for each quarter turn, or 90 degrees of rotation.

The golden ratio has been used in the design of many buildings of architectural significance, both ancient and modern. This ratio also figures prominently in art, notably in some famous paintings. There are also examples in nature, such as spiral cacti, spiral galaxies, sunflowers, pinecones, sea shells and so on—or so I have read. Is it true or is it just nice to think that nature is so 'perfect'? I decided to do some field work to see whether any examples of the golden ratio would emerge.

I obtained some specimens from around the house to check how their dimensions mapped to those of various spirals. Making accurate measurements on relatively small objects can be difficult without specialised equipment; I needed to scale up my specimens so I could make accurate measurements. I took photographs, viewed them on my computer and measured dimensions directly on the computer screen. This was sufficient for my purposes as the actual dimensions did not matter greatly, rather the relationships between measurements were more important; recall that it is the relationship between successive turns of a spiral that is of interest.

To test my measurement technique, I obtained an image of a golden spiral and made measurements as I planned to do with images of collected specimens. I measured the distance from the centre to the spiral at four locations separated by 90 degrees of rotation. Then I calculated the ratio of the second distance to the first distance, the third distance to the second and the fourth distance to the third. I repeated this process at another two sets of locations. Finally, I resized the image and conducted a series of eight measurements moving outwards around the spiral 90 degrees at a time, and calculated the ratios.

The lowest result I obtained was 1.622 (average of 3 ratios) and the highest was 1.644 (average of 8 ratios). Ideally, I would have obtained a result of 1.618. The fact that I didn't suggests the measurement technique may have been imperfect (although minor errors in individual measurements should have cancelled out) or the figure was not as divinely proportioned as expected. I measured the overall dimensions of the golden spiral and calculated the ratio of the long side to the short side and found it was 1.621, a close approximation of the golden ratio, or proportion.

My first locally acquired specimen was a young fern frond just starting to unfurl. I have several ferns in my garden, and if I recall correctly I used the frond of a mother shield fern, *Polystichum proliferum*, for these measurements.

The frond was quite hairy, which made estimating the centre and the edges difficult, but not so difficult that the task could not be completed. I found I was able to take more successive measurements on the frond than I could on the drawing of a golden spiral. This was possible because the frond had more revolutions than my golden spiral image.

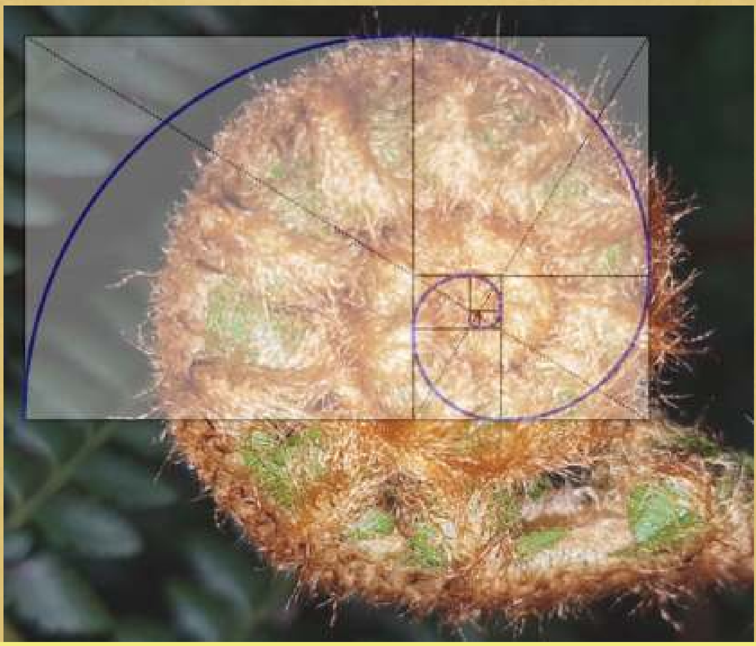

Figure 4. Frond of a mother shield fern (*Polystichum proliferum*) overlaid with a golden spiral [frond image by Ross Coad]

I obtained a series of 12 successive measurements on the frond and calculated a growth factor of 1.27 with a standard deviation of 0.15. I recalculated, dropping the outermost measurement because at this location the frond was starting to open up and flatten out, giving me a growth factor of 1.30 and a standard deviation of 0.12. As the growth factor was lower than that of a golden spiral, it indicates that the fern frond was more tightly coiled than a golden spiral.

I also measured the distance across the whole frond at two locations 90 degrees apart and calculated the ratio of the two measurements. I rotated about 45 degrees and repeated the process, then averaged the two ratios. This gave me an average ratio of 1.11, less than the calculated growth factor and much lower than the golden ratio. Figure 4 (previous page) presents an overlay of a golden spiral onto an image of the fern frond, clearly showing the difference in shape.

My second locally-acquired specimen was the shell of a common garden snail, *Helix aspersa*. Although native to Great Britain and parts of continental Europe, it has spread to the Americas, southern Africa, and Australia and New Zealand. Snail shells display the property of chirality, or handedness, meaning the shell is coiled or spirals in a particular direction. Most snails are dextral—that is they coil to the right—rather than sinistral, or coiling to the left. *Helix aspersa* is a dextral snail. The spiral may be dextral, but is it golden?

My measurements on the snail shell were conducted on a photograph, which meant that I was collecting data from a 2-dimensional image to tell me something about a 3-dimensional surface. However, as sequential measurements were separated by only 90 degrees, the error between measurements due to curvature would have been small. I made 17 measurements and calculated a growth factor of 1.25 with a standard deviation of 0.18.

Figure 5 shows a garden snail shell overlaid by a golden spiral. I had to flip my golden spiral image so it spiralled in the same direction as the snail shell. Although the spirals are broadly similar in shape, the snail shell is obviously rounder. I measured its overall dimensions and calculated the ratio of the sides to be 1.19, numerically similar to the growth factor.

Finally, my third locally acquired specimen was the eggcase of a species of octopus, known as the knobby argonaut (*Argonauta nodosa*), or paper nautilus, after the paper-thin eggcase that wraps around the octopus resembling the nautilus mollusc in its shell. (I mentioned this mollusc earlier in the discussion on logarithmic spirals.) The delicate eggcase was found washed up on a beach on Cape Barren Island a few years ago, and was carefully transported to my home in Scottsdale where it now sits on a mantel piece.

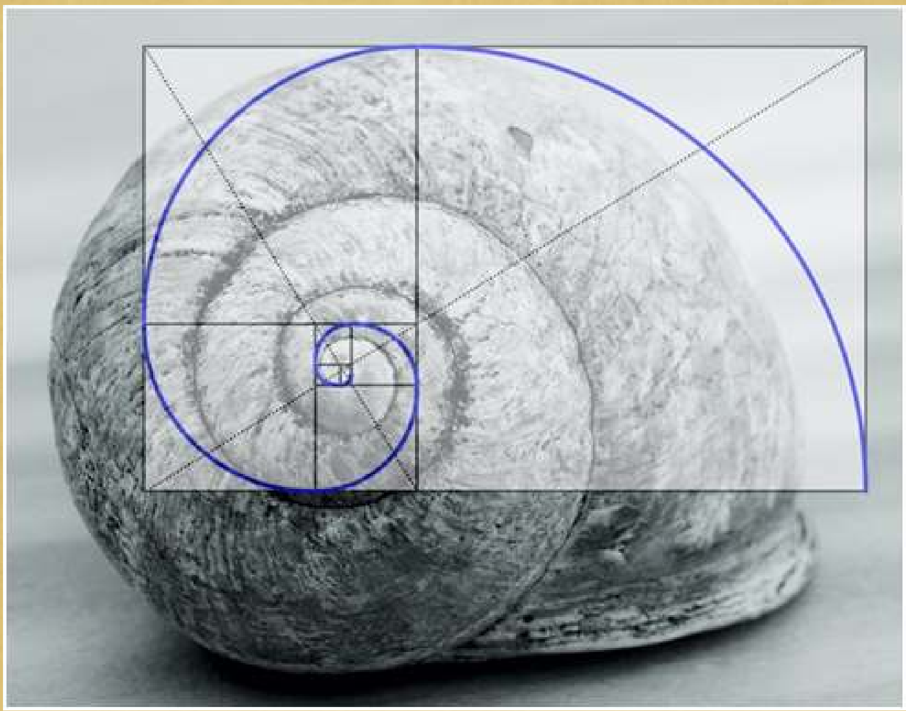

Figure 5. Shell of a common garden snail (*Helix aspersa*) overlaid with a golden spiral [shell image by Ross Coad]

Inclusion of the argonaut eggcase as an example of a spiral is open to challenge. Does it spiral? I couldn't conduct any measurements on successive turns of the spiral, because I couldn't identify any turns radiating out from the centre. However, it undoubtedly has the overall form of a logarithmic spiral, and not just any logarithmic spiral—it has the form of a golden spiral!

Figure 6 shows an image of my argonaut eggcase overlaid with a golden spiral, and it is a very close fit, a much better fit than the snail shell or fern frond.

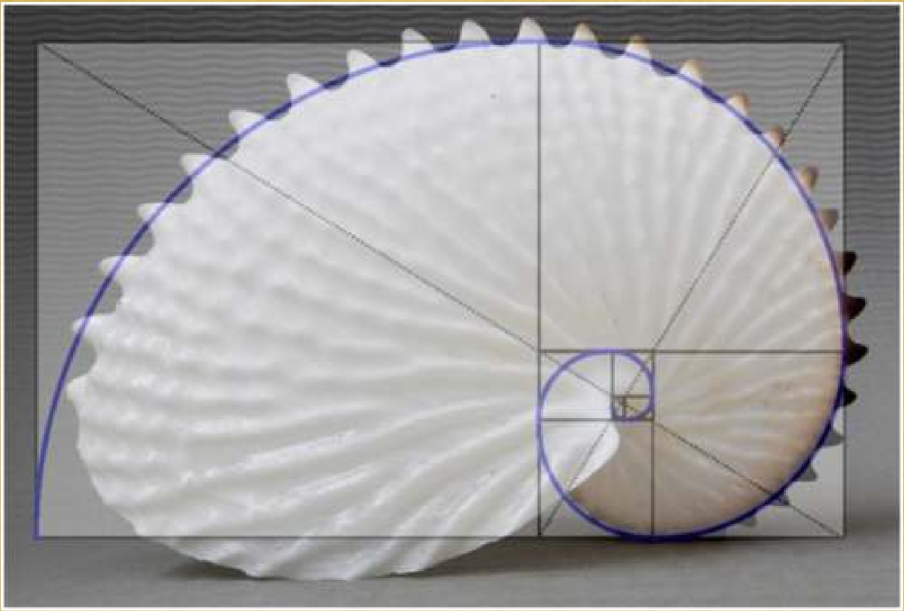
Figure 6. Eggcase of *Argonauta nodosa* overlaid with a golden spiral [eggcase image by Ross Coad]

I found it interesting that both the snail shell and the fern frond had similar growth factors. Neither displayed the divine proportions of the golden spiral, but both were pleasing to the eye. However, I think most people would find the argonaut, or paper nautilus eggcase particularly pleasing in its proportions.

MY CAPRICIOUS ORCHIDS

Article by Mike Douglas; photos by Lou Brooker and Mike Douglas

It's hard to predict the behaviour of the orchids in my garden at Bridport.

I have colonies of autumn bird orchids (*Chiloglottis reflexa*). These flowered in April 2015, then disappeared, probably remaining underground as dormant tubers.


Autumn bird orchid (*Chiloglottis reflexa*) - photo by Lou Brooker

This year they reappeared, no doubt due to vegetative reproduction, as two crowded colonies containing hundreds of plants. The orchid reference book by Jones et al. gives the flowering period as February to May, but my colonies were in full flower in mid-August.

One of my lawns is patchy due to various grubs and caterpillars chomping on the grass roots. The resident bandicoots, which hide within clumps of sags, emerge after dark to feast on these pests, tearing up the lawn in the process.

Dozens of orchids have come up in this 'lawn', and although not yet in flower, the leaves reveal their identity as slender sun orchids (*Thelmytrita pauciflora*) and onion orchids (*Microtis* sp.), probably the yellow sun orchid (*Microtis atrata*). These, I suspect, grew from seeds dispersed from a few plants in the other parts of the garden.

Potato orchid (*Gastrodia sesamoides*) – photo by Mike Douglas

I am also blessed with potato orchids (*Gastrodia sesamoides*). These arrived, seemingly out of the ether, three years ago. They have since appeared early each summer, as a clump of plants bearing brown and white bell-shaped flowers on tall scapes.

Since they are leafless saprophytes there is nothing currently visible (*Editorial note: 'currently' refers to August 2020*) to indicate their presence, but I'm hoping for another display in December.

Years ago, tiger orchids (*Diuris sulphurea*) grew in the part of my garden across the road, near the play school/girl guide centre. Unfortunately, they seem to have vanished, but like Dr Pangloss* I'm always hopeful, and continue to search for them.

*Pangloss, fictional character, the pedantic and unfailingly optimistic tutor of Candide, the protagonist of Voltaire's novel Candide (1759), a satire on philosophical optimism. The name Pangloss—from the Greek elements pan-, "all," and glōssa, "tongue"—suggests glibness and garrulousness. (Ref: Wikipedia).

FURTHER READING

Members may enjoy reading a recent article from Science News about a likely comeback by the Tasmanian devil. Reference: https://www.sciencenews.org/article/tasmanian-devils-highly-contagious-face-cancer-endemic

Tasmanian devils were supposed to be extinct by now. With a deadly, highly contagious face cancer tearing through devil populations, forecasts over the past decade or so spelled imminent doom for the iconic marsupial.

Only 25,000 or so devils (*Sarcophilus harrisii*) remain, down from about 150,000 in the 1990s, but a new analysis offers hope. Devil facial tumor disease has become far less transmissible since the peak of the epidemic, suggesting it won't wipe out the species, researchers report in the Dec. 11 issue of Science.

Instead, the disease may stick around at lower levels, or "the tumor itself might eventually go extinct," says Andrew Storfer, an evolutionary geneticist at Washington State University in Pullman.

Storfer and his colleagues reconstructed the history of the tumor's spread by analyzing changes in tumor genes that evolve in a regular, clocklike manner. Samples from 51 tumors dating back to 2003 helped calibrate this timeline.

Though the disease was discovered in 1996 (SN: 3/11/13), the study found that it probably originated years earlier, in the '80s, slowly circulating at first. At its peak in the late '90s, each afflicted devil was infecting 3.5 other devils, on average, usually through biting. Recently, that number has fallen to one, suggesting the epidemic may peter out.

The slowdown may stem from population decline — fewer devils means fewer transmission opportunities for a disease that spreads fastest within dense groups. Additionally, the tumor itself might have become less transmissible; the researchers identified some genes that could underlie this shift. Finally, the devils themselves seem to have evolved resistance to the disease (SN: 8/30/16).

But devils are still endangered, and some experts want to introduce captive-bred animals to boost numbers. That could backfire, Storfer says, by allowing the disease to take off again. "It sounds boring, but doing nothing might be the best option for the devils."