SKELETON FLOWERS

A magnificent disappearing act

Albert Scholz

EVERYWHERE YOU look, nature is filled with awe-inspiring designs. One of the most striking is the ability of certain organisms to change their colour. You can see this across the animal kingdom in such creatures as chameleons, cephalopods, reed frogs, and crab spiders. Animals are not the only organisms capable of changing colour, however. Some plant species can do it too.

The skeleton flower (*Diphylleia grayi*) is one of these species. Unlike what its name might suggest, this unique plant is beautiful to behold, not morbid or frightening. The skeleton flower is a small perennial plant that grows in the damp undergrowth of Japan's forests. It can reach a height of 25–90 cm (10–35 in) and is decked with broad serrated leaves. The plant stores its seeds inside small blue berries. What makes skeleton flowers unique, however, are their small white petals.[1]

At first sight, these flowers might look like any other white blossom. However, when walking through the forest after a light rain shower, an amazing sight will meet your eyes. Upon becoming wet, the flowers are robbed of all their colour and turn completely transparent. This reveals the internal veins of the petals, hence the plant's name. In a matter of seconds, the once white petals assume the appearance of fine delicate crystal.

Achieving transparency

The skeleton flower performs this mind-boggling change through the clever use of the reflective and refractive properties of light. The petals of most white flowers contain a pigment that reflects all the sunlight falling onto the flower. Your eyes interpret this reflected light as white. But the petals of the skeleton flower are different. The cells within the petals contain no pigment to reflect the light; they are transparent.

Why, then, do the petals appear white when dry? The secret lies in the large intercellular spaces surrounding the cells of the petals. The cells are structurally arranged into layers so that light is internally reflected and scattered within the surrounding air pockets. As with pigmented flowers, the scattered light is interpreted as white by your eyes.[2]

When it rains, the air within the intercellular spaces is replaced with water. The water allows the light to pass through the plant cells without being reflected. The petals no longer block the light from passing through and therefore appear transparent. When the petals dry out, the cells again internally reflect and scatter the light, and the flower regains its white colour. (For more details, see 'Reflection vs refraction', p. 17.)

Practical applications

The flower has no control over the colour change of its petals. The change is passive, and depends only on its wetness. This is different from the active mechanisms which some animals use to modify their pigmentation.

It is the simplicity of the skeleton flower's colour-changing ability that makes it so attractive to engineers. This ingenious mechanism has been incorporated into multiple designs, developed for a variety of applications.[3] Designs inspired by the flowers include transparent and oil-resistant surfaces for use under water,[2] 'smart' windows,[4] and anticounterfeiting materials.[5] Other designs involve materials that can alter their colour according to the surrounding temperature[6] and, in some cases, even regulate the

temperature.[7] The skeleton flower has even served as inspiration for a new, improved biochemical tool (an ELISA assay) used in detecting tumour markers.[8]

Evolution or creation?

Unfortunately, as is often the case, the origin of this wonderful colour-changing mechanism has been attributed to evolution over millions of years. One paper stated:

> With billions of years of evolution, creatures have developed almost perfect structures and have exhibited various functions. Nature is the best school for human beings and inspires us to design advanced materials and to use new technology.[2]

Interestingly, evolutionists have no idea how this colour-changing mechanism could have evolved.[9] So far, scientists have found no adaptive advantage, past or present, for this mechanism. This does not necessarily mean that the mechanism confers no benefit to the organism. But, until such a benefit is found, the lack of any known advantage is a serious problem for evolutionists. Without an adaptive advantage, natural selection cannot be used to explain this mechanism's origin and spread. Evolutionists therefore must conclude that the mechanism developed and spread by pure chance. However, the likelihood that such a complex feature arose by chance alone stretches credulity.

By contrast, the lack of an adaptive purpose for the skeleton flower's colour-changing ability is not a problem from a creationist perspective. According to Genesis 1:26–27, God created humans in His image and likeness. It is common for human engineers to design elements with no other function than to improve the aesthetics of the designs. Also, when we consider the works of artists, their designs may likewise on occasion have no other function than to be pleasing to their audience. How much more should we expect to see such artistic quality in the work of the divine Artist? We should not be surprised to find designs in nature intended just to delight and inspire us.

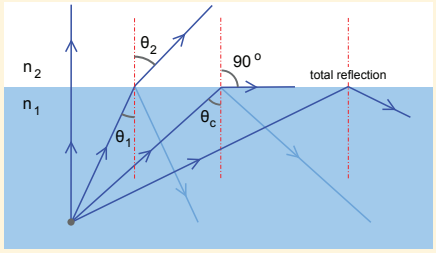
And, even if, someday, someone does discover a specific function served by this amazing mechanism, that discovery will only further reveal the ingenuity of our Lord.

According to Psalm 148, all creation praises the Lord. When we consider that the skeleton flower's colour-changing ability might be designed purely for us to marvel at and enjoy, how can we do anything else but praise its Designer, our great and glorious God?

Reflection vs refraction

The colour displayed by the petals of the skeleton flower relies solely on the properties of light. Light consists of multiple waves that can pass through a vacuum and transparent media, such as air, water, and glass alike. In a vacuum, light travels at a speed of about 3 $\times 10^8$ m/s. When light crosses into another medium, the speed of light decreases according to the density of the medium. The ratio of the speed of light in a medium to the speed of light in a vacuum is known as the *refractive index*.[10]

When light travels from one transparent medium to another, the change in speed causes the light to bend. This phenomenon, known as *refraction*, is what you see when you put a straw into a glass of water. The angle of bending depends on the ratio of the refractive indexes of the two media and the angle of the incoming light. This incoming angle is measured as the angle between the incoming light ray and the *normal* (a line perpendicular to the surface between the two media).[10]



There is however a maximum angle beyond which light cannot bend when it passes from a denser medium to a less dense medium. The incoming angle at which light has the maximum bend angle is known as the *critical angle*. When the incoming angle is larger than the critical angle, the light is no longer refracted. Instead, the light is reflected back into the denser medium.[10]

Light falling onto the dry skeleton flower enters the petals' cells. There is a large difference between the refractive indexes of the plant cells and the air in the surrounding intercellular spaces. The light trying to leave the cells has an incoming angle larger than the critical angle and is internally reflected. During the reflection, the light scatters and is perceived by our eyes as white.[10]

After a rain shower, the intercellular spaces of the petals are filled with water. The plant cells have nearly the same refractive index as water. Since the light detects no change, it behaves as if there is no boundary, and goes straight through. The light exits the petals in the same direction it entered. This results in the petals becoming transparent.[10]

The cornea in your eyes is transparent by the same principle. It has finely organized fibres plus pumps to ensure the right water content.[11]

References and notes

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