COLOUR CHANGING FLOWERS AND CHOOSEY POLLINATORS

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Flowers come in a spectrum of colours of reds, blues, yellows and so on. Did you know that some flowers can change colours over time? Or that flowers use colours to communicate with insects that visit them for nectar?

Flowers act as billboards. Just like large advertising boards that tell potential customers where to go to obtain lucrative gifts, flowers advertise the nectar hidden in them to pollinators (see **Box 1**). Through their size, shape, scent, texture and colour, flowers attract insects, birds, and even mammals to their nectarine reward. Reward for carrying pollen from one flower to the other, thereby pollinating it, and aiding the plant in making seeds (see **Fig. 1**).

In typical flowering plants, flowers bloom in a particular colour that fades as they become older and wither away. Interestingly, in some plant species, flowers bloom in one colour and, almost magically, change to another colour well before they start ageing! These flowers use colour to convey messages to pollinators and influence pollinator behaviour in order to increase their chances of pollination.

There are more than 450 species of plants whose flowers are known to undergo colour change. These changes involve a wide spectrum of colours in different parts of the flower.[1] This phenomenon is seen in species spread over several families of the plant kingdom, and is believed to have evolved multiple times through evolutionary history.[2] We find several of these floral colour changing plant species in India (see **Fig. 2**).

Box 1. Anatomy of a flower:

Each flower has a stalk (pedicel), colourful petals, male (anther with pollen grains) and female (ovary) parts, and nectaries that store sugary nectar.

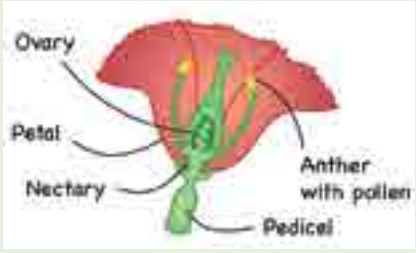

Fig. 1. Where is nectar present in a flower?

Credits: Mariana Ruiz LadyofHats, Wikimedia Commons. URL: https://commons.wikimedia.org/wiki/File:Mature_flower_diagram.svg. License: Public Domain.

Fig. 2. Some common examples of colour changing flowers in India

2a. The peacock flower *(Caesalpinia pulcherrima)*, a common ornamental plant, changes from yellow to red.

Credits: Jim Evans, Wikimedia commons. URL: https://commons.wikimedia.org/wiki/File:Peacock_Flower_or_Pride-of-Barbados_--_Caesalpinia_pulcherrima.jpg. License: CC-BY-SA.

2b. Flowers of Mountain pomegranate *(Catunaregam spinosa)*, found in deciduous forests throughout India, change from white to yellow.

Credits: J. M. Garg, Wikimedia commons. URL: https://commons.wikimedia.org/wiki/File:Catunaregam_spinosa_(Mountain_Pomegranate)_W_IMG_9381.jpg. License: CC-BY.

2c. Flowers of the Chinese honeysuckle *(Quisqualis indica)*, a climber native to Asia, are white when they open at night, and turn red the next morning.

Credits: Tatiana Gerus from Brisbane, Australia, Wikimedia commons. URL: https://commons.wikimedia.org/wiki/File:Quisqualis_indica_1.jpg. License: CC-BY-SA.

2d. Only the centers of flowers of Woolly Rock Jasmine *(Androsace lanuginose)*, a plant native to the Himalayas, change from yellow to red.

Credits: David Short, Wikimedia commons. URL: https://commons.wikimedia.org/wiki/File:Androsace_lanuginosa.jpg. License: CC-BY.

2e. The flowers of a variety of *Lantana camara*, one of the most notorious invasive plants found across India, change from yellow to orange to red/pink.

Credits: J. M. Garg, Wikimedia commons. URL: https://commons.wikimedia.org/wiki/File:Catunaregam_spinosa_(Mountain_Pomegranate)_W_IMG_9381.jpg. License: CC-BY.

Box 2. Colour pigments in plants:

We know that leaves are green because of the pigment chlorophyll. Similarly, colours in flowers and fruits are produced due to different types of colour pigments. Carrots get their colour from a class of pigments called carotenoids, which produce yellow and orange shades. The red of hibiscus flowers comes from anthocyanin pigments, which produce blue, purple and red colouration. Beetroots get their colour from betalain pigments, which produce shades of red.

How does colour change happen?

Colour change in flowers is believed to occur due to the accumulation, depletion, or change in the composition of colour pigments (see **Box 2**). It may also happen when a pigment changes colour due to changes in pH or temperature. For example, the pigment anthocyanin is red in an acidic cellular medium, but changes to blue as the medium becomes basic.

These physiological changes are in turn triggered by factors like a flower's age, its sexual maturity, or its day/night cycle etc. Interestingly, in some plants, colour change is triggered and hastened once an animal pollinates its flowers.

Why do flowers change colours?

A plant has to expend energy for its flowers to change colour. In many plant species, change in flower colour is also coupled with a loss of nectar and pollen (but see **Box 3**). Hence, after colour change, flowers don't serve the purpose of aiding pollination. So, why do plants still spend energy in changing colour and maintaining these seemingly useless flowers? What purpose does this change serve?

The size of a floral display is important in attracting pollinators at long distances, while the colour of the flowers in a display 'arrests' pollinators at short distances. Scientists suggest that colour changing flowers may help in both:

a. Long-distance attraction:

Maintaining flowers after colour change, even if they are not reproductively viable, increases the size of the overall floral display of the plant. This is particularly effective in plants like *Lantana camara* where individual flowers are very small and are bunched together in an inflorescence. Larger floral displays make flower signals, saying "come to me", more noticeable to a pollinator flying at a distance. These signals can, hence, be seen by and attract more pollinators. Scientists have shown that pollinators prefer larger inflorescences, and visit them more than smaller ones.[3]

b. Short-distance arrestation:

When you are picking a mango to eat, you know by experience that yellow ones are likely to be sweet, and green ones sour. Similarly, the different colours in colour changing flowers often signal differences in the quality and quantity of the nectar they offer to pollinators. Pollinators can use this information to forage more efficiently by selectively visiting flowers of colours associated with more nectar. Since flowers of colours associated with more nectar have more mature pollen, the targeted visits of pollinators to mature flowers is also beneficial to the plant (see **Box 4**).

Box 3. Colour change in Chinese honeysuckle:

Unlike many colour changing plants, colour change in flowers of the Chinese Honeysuckle *(Quisqualis indica)* is not accompanied by a loss in pollen or nectar. Instead, it is coupled with a change in the intensity of their smell — the white flowers that bloom at night are more fragrant than the red ones they turn to the next morning. But why?

In this fascinating plant, colour change helps attract different types of pollinators at different times of the day! Moths are nocturnal, and rely more on odour than visual cues to find food. Also, white coloured flowers are more visible at night, and are known to be preferred by moths. On the other hand, bees and butterflies are diurnal, and use visual cues to forage. Hence they are more likely to be attracted to the distinctive red colour of these flowers in day light.

Box 4. Colour change in *Lantana camara* flowers:

The flowers of one of the more common varieties of *Lantana camara* are yellow to start with, and change to pink after two days (use **Activity Sheet I** to encourage your students to observe the nature of colour change in *Lantana* flowers). This change in colour takes about four hours, with the pink flowers in the inflorescence withering away in a couple of days. Not all varieties of *Lantana* show such dramatic colour change. Some have all-yellow flowers, some all-white, while some have lavender flowers (see **Fig. 3**).

Fig. 3. Different varieties of *Lantana*: some colour changes are dramatic **(a)**, while others are more subtle **(b)**.

We, and other researchers, have found that yellow *Lantana* flowers have more nectar with higher sucrose (sugar) concentrations than pink flowers (use **Activity Sheet II** to encourage your students to compare the quantity of nectar in differently coloured *Lantana* flowers). We've also found that insects like butterflies and bees prefer yellow flowers over pink ones (see **Fig. 4**). Not only do they spend more time drinking nectar from yellow flowers, they also visit yellow flowers more frequently than pink ones (use **Activity Sheet III** to encourage students to test this out for themselves). Associating flower colour with nectar and pollen availability is a strategy common to many colour changing plants.

How do insects choose some flowers over others?

A pollinator like a butterfly or a bee, flying over a meadow, often encounters flowers of different colours, shapes, and sizes. How do you think pollinators choose which flowers to forage from? More specifically, how do you think butterflies and bees know that visiting yellow *Lantana* flowers is likely to be more rewarding than visiting pink ones?

Fig. 4. Some common butterfly pollinators of *Lantana*:

(a) Common emigrant

Credits: Charles J Sharp, Wikimedia Commons. URL: https://commons.wikimedia.org/wiki/File:Common_emigrant_(Catopsilia_pomona)_male_crocale_underside.jpg. License: CC-BY-SA.

(b) Common Mormon

Credits: Dr. Raju Kasambe, Wikimedia Commons. URL: https://commons.wikimedia.org/wiki/File:Common_Mormon_Papilio_polytes_from_stichius_Kerala_by_Dr._Raju_Kasambe_DSC_8444_(3).jpg. License: CC-BY-SA.

(c) Pioneer

Credits: Anagha devi, Wikimedia Commons. URL: https://commons.wikimedia.org/wiki/File:Belenois_aurota-Pioneer_butterfly.jpg. License: CC-BY-SA.

(d) Common rose

Credits: Yathin S Krishnappa, Wikimedia Commons. URL: https://commons.wikimedia.org/wiki/File:2005-common-rose.jpg. License: CC-BY-SA.

(e) Common crow

Credits: © 2010 Jee & Rani Nature Photography, Wikimedia Commons. URL: https://commons.wikimedia.org/wiki/File:Euploea_core_by_kadavoor.jpg. License: CC-BY-SA.

(f) Common leopard

Credits: Anton Croos, Wikimedia Commons. URL: https://commons.wikimedia.org/wiki/File:Common_Leopard_(Phalanta_phalantha).jpg. License: CC-BY-SA.

Box 5. Innate floral preferences in insects:

A newborn insect has certain inherent or hardwired preferences in floral features like size, colour, pattern, and symmetry. These preferences help it choose flowers to feed from. However, these initial preferences can rapidly change based on floral rewards that change over space and time.

They learn! Like us, they can learn to associate flower colours with pollen and nectar rewards. This is called associative learning. Insects have innate preferences — that is, naïve insects (which are just born, and have no experience) have some biases and preferences to different colours (see **Box 5**). But, depending on what is available in their environment, they can often learn to change their innate preference. So, if a butterfly innately prefers red, it would initially go to red flowers. But, if it finds out that yellow is more rewarding than red, it learns to prefer yellow over red, and forages more frequently on yellow flowers. The ability to learn helps insects forage more efficiently from flowers of different colours and forms, and several floral colour changing plant species have evolved to take advantage of this ability to direct pollinators to mature flowers!

Parting thoughts

The natural world is full of captivating wonders. You only have to be curious and observant to discover them. Plants are thought to be passive, and relatively less dynamic than animals, because of their stationary lifestyles. But, if you observe them carefully, you will see that they constantly change, and communicate with the world around them. One doesn't have to go far to find this. You can, in fact, observe the dynamic dialogues between plants and animals, like that of colour changing flowers and their choosey pollinators, right in your own backyard! The next time you spot a bunch of flowers, observe them carefully. If you see differently coloured flowers on the same plant, go back the next day to see if any of its flowers have changed colours. If they have, you'd have discovered a plant that has colour changing flowers!

Key takeaways

- Flowers of certain plant species change colour over time.
- A change in flower colour occurs as a result of the accumulation or depletion of pigments and changes in pH triggered by the age of the flower, its sexual maturity or the day/night cycle etc.
- Older flowers in altered colours help increase the size of the floral displays of colour changing plant species and, thereby, attract more pollinators.
- Flowers of colour changing plants also use colour to signal information about the quality and quantity of nectar they contain.
- While insect pollinators have innate colour preferences, they can readily learn to forage from novel flower colours associated with better/more nectar rewards.
- Insects can benefit from the information provided by colour changing flowers to selectively pollinate flowers of colours associated with better/more nectar. The plant also benefits from this selective foraging, as flowers with nectar tend to contain more viable pollen.

Note: Source of the image used in the background of the article title: https://www.needpix.com/photo/662473/lantana-butterfly-nature-garden-insect-wings-flowers-floral-yellow. Credits: cosmicart (pixabay.com). License: CC-BY.

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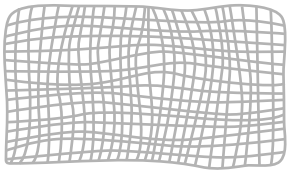
Life in Your Backyard

ACTIVITY SHEET 1: COLOUR CHANGE IN LANTANA

Aim:

To study colour change in a *Lantana camara* inflorescence.

You will need:



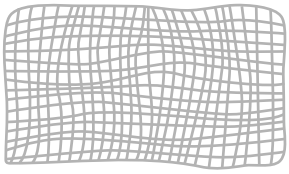
Mosquito net/ Muslin cloth

Notebook

Pencil

What to do:

- Make small bags out of mosquito net. Bags can also be made from thin tracing paper.
- Locate an unopened Lantana inflorescence, and cover the buds with the bag.
- A day later, open the bag and choose around four flowers that have opened. Note down their colours (typically yellow).
- Bag the inflorescence again.
- Visit the inflorescence every day for a week in the morning, afternoon, and evening, and note down the colour of the chosen flowers.



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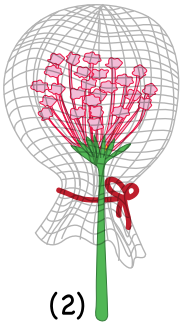

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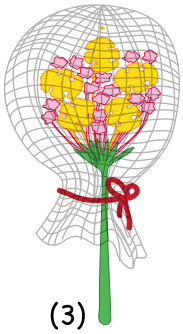

(3)

Discuss:

- Does the same flower change color over time?

- Do flowers change color at a particular time of the day?

- Why do you think we bag inflorescences?

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ACTIVITY SHEET II: NECTAR IN LANTANA

Aim:

Observing if floral colour indicates differences in relative quantities of nectar.

You will need:

Filter paper

Scale

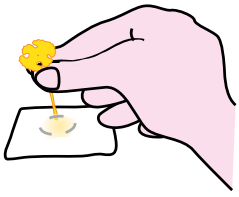
Pencil

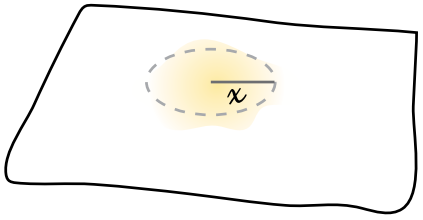
Notebook

What to do:

- Gently pluck a few yellow and pink flowers from a few fully bloomed *Lantana camara* inflorescences.
- Squeeze the nectar from the stalk of each flower onto a filter paper, and let the drop spread on the paper. Expect a tiny drop of liquid – this is likely to be the nectar.
- Do this for the yellow flowers and pink flowers separately.

(1) Squeeze





(2) Measure x for pink and yellow flowers

Observe:

Before the nectar drop dries up, mark its spread, and measure the diameter of the spread using a scale.

Discuss:

- Is the quantity of nectar different in yellow and pink flowers?

- If you were an insect looking for sweet nectar, which colour flower would you find it more rewarding to go to?

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ACTIVITY SHEET III: CHOOSEY BUTTERFLIES

Aim:

Observing if number of pollinator visits varies with floral colour.

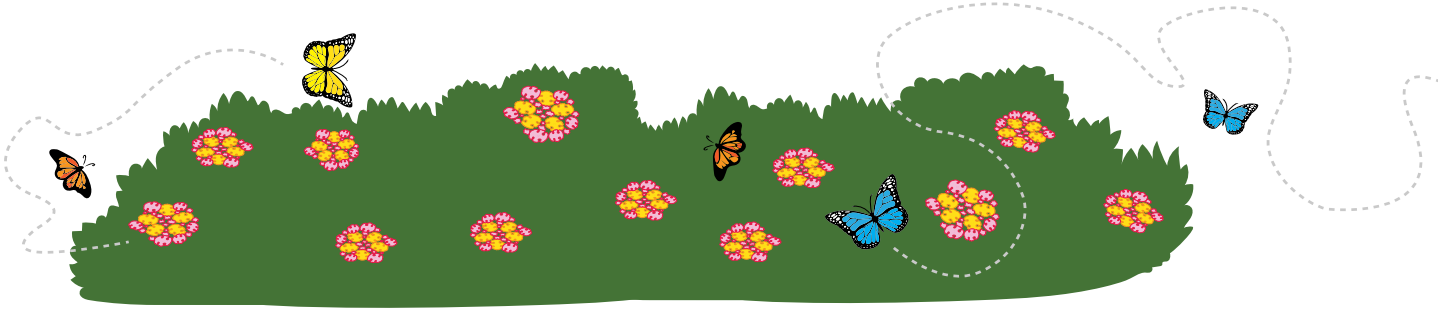
You will need:

Pencil

Notebook

What to do:

- Locate a *Lantana camara* bush that has a lot of flowers blooming.
- On a sunny day, position yourself near one or a few inflorescences such that you can observe butterflies feeding on the Lantana flowers.
- Observe which flowers are visited most.



Discuss:

- Does the butterfly land on yellow or pink/red flowers? Count the number of times it visits yellow or pink/red flowers.

- Which of these flowers (yellow/pink) do you observe it feeding from more often?

- Repeat the same activity with other butterflies in the area. Do you find that they prefer one flower colour over the other? If so, why do you think this happens?

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