MOST plant species bear flowers and fruits towards the outer side on their branches in the canopy. But nature encourages diversity! There are some species in which flowers and subsequent fruits abruptly grow from the main wooded trunk or major branches rather than twigs and smaller branches and the finer branches usually remain vegetative. This phenomenon is known as ‘cauliflory’ (from the Latin words for ‘stem’ and ‘flower’) and the plant species exhibiting it are called ‘cauliflorous’.

Examples of cauliflorous species are more common in the tropical rain forests. More than 100 plant species, belonging to some 15 families, exhibit this unique feature of cauliflory including jackfruit (Artocarpus heterophyllus), figs (Ficus), cocoa or chocolate tree (Theobroma cacao), bilimbi (Averrhoa bilimbi), jaboticaba (Myrciaria cauliflora), calabash tree (Crescentia alata), cannonball tree (Couroupita guianensis) and so on.

Some plant scientists classified cauliflory into a few subtypes. For example, when the flowers are borne on the main stem and branches as well as on the twigs, it is called simple cauliflory as in Theobroma cacao and species of Diospyros, Drypetes and many other genera. When flowers develop on the larger branches and not usually on the twigs or main trunk, it is a case of ramiflory as in Polyalthia insignis.

Evolution and Cauliflory

What may be the evolutionary significance or why did cauliflory evolve in certain tree species? There are several opinions that try to explain evolution of cauliflory. For example, according to Wallace (1878), a tree species of a dense tropical forest producing cauliflorous flowers can utilize the services provided by terrestrial animals for its own perpetuation. Cauliflorous flowers could be pollinated by a variety of animals that are distributed in forests at various heights including different crawling and flying shade-loving insect species living near the ground level.

Another view is that cauliflory makes the fruits readily accessible to a wide range of animals such as marsupials, rodents, bats and certain perching bird species that are adapted to feed on the fruits developing from tree trunks. In this way, these animal species facilitate seed dispersal.
According to plant physiologists, however, cauliflower allows individuals of a plant species to utilize existing resources more efficiently. For instance, flowers and fruits will receive abundant water and nutrients if they grow from the stem or near the ground.

Another obvious question is how cauliflower came into existence? One of the possible ways by which cauliflower may have evolved could be the relatively longer dormancy period of floral buds on the primary stem. During growth, dormant buds got buried under secondary tissues and later when they became active they pushed their way through the bark. Most of the cauliflorous species seem to have larger fruits that, some workers argue, were heavy enough and could not be supported by delicate branches and, during evolution, shifted to the main trunk.

The opposite of this might also be true: since fruits started to grow from the trunk, they tended to become larger and heavier. Whatever may be the case, the evolution of cauliflory is still a matter of conjecture. It is an underemphasized area of research. The reason may be that there are few or no experimental evidences for the different speculations.

**Cauliflower Tree**

One of the most striking examples of cauliflory is *Couroupita guianensis*. It belongs to the family Lecythidaceae. The species was given its name in 1775 by the famous botanist J.F. Aublet. It is also known as the 'cannonball tree' since the size and shape of its fruits resemble a cannonball. Although native of South America, the species finds habitat in almost all tropical and sub-tropical regions of the world with abundance in the Amazonian basin. In India also, it is grown as an ornamental species.

According to some ecologists, the presence of *Couroupita* is an indicator of good health of an ecosystem where it plays a significant role in maintaining ecosystem services. Since long, the species has attracted botanists due to its remarkable morphological features.

**Cannonball Tree**

The tree of *C. guianensis* is eye-catching in its flowering and fruiting stage. A typical mature tree attains a height of about 25 meters with dense crown having leaves clustered at the tip of the branches. Trees bloom and bear fruits simultaneously. Buds, flowers and fruits originate from the main trunk with about 1 meter-long thick, tangled branches covering the trunk completely. These flowers and fruit-bearing branches are easily distinguishable from the leaf-bearing branches.

**Flowers:** The flowering season for *C. guianensis* is from March to September. Flowers, having a diameter of 7-8 cm, look very fascinating due to a blending of pale yellow, white and pinkish-red colours. A flower remains attached to the tree only for 10 to 12 hours, and then falls down. The flower has six thick petals that are bowl-shaped and orange-red to white in colour on the upper side and pale-yellow on the lower side.

**Different tree parts have been shown to possess strong antibiotic and antifungal properties too.**

*Couroupita guianensis* is an example of cauliflory where flowers and subsequent fruits develop from the main trunk of the tree.

*Couroupita guianensis* in the splendid flowering and fruiting stage. A typical mature tree goes up to about 25 meters in height (photo taken by author at IISc campus, Bangalore)
When cross-pollination fails, the pattern of arrangement of the two types of stamens in the flower allows self-pollination to occur though at a lesser degree.

**Pollination:** C. guianensis has a wide range of visitors including a number of insect species but honeybees and carpenter bees are known to be the most important pollinators. The floral shape, colour and fragrance collectively act as attractants for these pollinators. Since flowers of C. guianensis do not contain nectar, pollinators that visit the flowers in search of food usually get hood pollens as a reward. In the process, they transfer fertile pollens present on the staminal disc to the next flower thus making cross-pollination effective. When cross-pollination fails, the pattern of arrangement of the two types of stamens in the flower allows self-pollination to occur though at a lesser degree.

In addition to colourful petals, white coloured-hood and yellow-coloured apices of stamens also entice pollinators since they are known to reflect ultraviolet light.

**Fruits:** Fruits of C. guianensis are also very attractive. The tree species got its common name ‘cannonball tree’ based on the rusty appearance of the fruits. Moreover, because of the shape of fruits, this species is popular regionally as ‘ayahuma’ meaning ‘Heads of spirits’. Light brown-coloured, spherical fruits are about 20 centimeters in diameter and take about 12 months to mature and turn soft on ripening. The number of fruits per plant may vary from 50 to 150 while a single fruit may contain up to 300 small seeds suspended in a very unpleasant pale yellow pulp having a toxic nature.

Plant tissues have several unusual physical and chemical properties. For example, when the pulp of the fruits and floral tissues get exposed to air, they oxidize and turn bluish-green in colour. Contrary to flowers that are rich in fragrance, the fruits emit a repulsive odour (for humans) though these fruits are a part of the diet of some animals including monkeys, peccaries and bats. These animals disperse the seeds to long distances.

At the end of the fruiting season, the tree sheds leaves but the leafless stage is very short. After about a week, new leaves start to reappear. Because of the heavy fruits similar to coconut (Cocos nucifera), wood apple (Limonia acidissima) and bel (Aegle marmelos), it is not advisable to grow C. guianensis in gardens, parking places, along the roadsides etc.

Different parts of the tree such as flowers, leaves, bark and fruits are used in appropriate dosages to treat various health problems such as colds, stomachaches, and even malaria. Juice from the leaves is often used in treatment of skin diseases. Different tree parts have been shown to possess strong antibiotic and antifungal properties too. Although not exploited economically yet, the chemicals responsible for floral fragrance can be utilized in perfume manufacturing and cosmetic industries.

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**Feature Article**

Reduced ovary is found in the centre of the flower that is surrounded by a staminal disc. The staminal disc extends up as a hood-like projection called androecial hood that arches protectively over the ovary. The interesting feature of C. guianensis flower is the presence of two types of stamens. Credit for the discovery of the two types of stamens in Couroupita goes to the French botanist Pierre Antoine Poiteau who made the discovery in 1825. Stamens that are found on the staminal disc are fertile and arranged in groups. These stamens have about 450 fertile pollen grains per anther with the ability to germinate and are responsible for most of the fruit set. On the other hand, stamens that are positioned on the androecial hood have unviable pollen grains whose number may be about 3000 per anther.

Flowers of C. guianensis have very intense fragrance that could be sensed from a distance of 15-20 meters. The fragrance is actually a mixture of certain volatile chemical compounds found in the buds. The ready-to open buds have relatively higher temperature inside them, which allows the volatile compounds (mainly monoterpenes hydrocarbons) to disperse readily on opening. Some important terpenoids identified in the extract of flowers from C. guianensis include geraniol, farnesol, linalool, eugenol and nerol.

**Fruits:**

Couroupita guianensis got its common name ‘cannonball tree’ due to the shape and size of its fruits, which are about 20 cm in diameter. The fruits contain a very unpleasant pale yellow pulp that is toxic in nature (photo by author).