THE HINDU

Coffee and the selfish gene

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Tempting:Caffeine in nectar hooks bees.— photo: AFP

How did coffee become more popular in south India and tea in the north? History appears to give the reason. Legend has it that in the late 16{+t}{+h}century while Haji Baba Budan was returning from Haj through Yemen, he found people boiling coffee beans in water and enjoying the “decoction”. He then smuggled a handful of the (forbidden to export) beans with him and planted them on the Chikamagalur hills in Karnataka and the locals took to it with elan. Soon, coffee plantations appeared in Kodagu and the Nilgiris, and we all were hooked on to the morning coffee. Tea, on the other hand, was introduced later (early 19{+t}{+h}century) by the colonial British who copied it from the Chinese and planted it in Assam and Darjeeling. This colonial drink soon became popular among the subjects in the plains as well. Coffee and tea are thus external entrants into the Indian taste buds.

But why are we hooked on to coffee and tea? The answer comes from science, which tells us that they both contain the mood- altering and addictive drug caffeine. While this is a proximal answer, the ultimate question is why at all do these plants go to the trouble of making the molecule in the first place. After all, it takes metabolic energy to do so. The answer appears to be “to deter herbivores”, or as a defence chemical. Note that the raw bean or leaf is bitter to taste, and the animal would shy away, leaving the plant alone to grow and flourish.

Recent findings add another dimension to the tale. It has been found the caffeine is found not only in the bean or the leaves but also in the nectar that the plant produces and packs a drop or two in its flowers. And why it would do so and what this stored caffeine does in the flower nectar has been investigated by a group of researchers from U.K. and published in the March 8, 2013 issue of *Science* .

They note that while plant-derived drugs like caffeine and nicotine (the drug in the tobacco plant) are lethal in high doses, they do generate pleasant effects when taken in very low doses. But then why in the floral nectar? Is it in order to “hook on” bees and other pollinating insects? To understand this, the researchers first measured the levels of caffeine in the nectar of three plants, *Coffee arabica* , *C. liberica* and *C. canephora* , to which bees make a bee-line for (pardon the pun), and found the amounts to be less than a thousand-fold that of the sugar present in the bean — just a teasing touch.

They hypothesised that the caffeine in the nectar could affect the learning and memory of the foraging pollinators. Could it be that they would come to these flowers, enjoy the nectar and in the process take

away and dispense the pollen, thus breeding these plants in preference to those that do not store caffeine in their nectar? In order to test this, the researchers took the trouble of training individual bees to associate a floral scent with sugar reward. In one set the bees would go to the containers with sugar solution, and in another set the sugar solution spiked with a bit of caffeine. And they found that the bees would consistently return to the caffeine sugar scent even three days later. In other words, caffeine acted as a memory enhancer. The bees were hooked onto caffeine.

The researchers went further ahead and investigated the biological mechanisms behind the mode of action of the caffeine. The bee brain contains what are called projection neurons or nerve cells that have a protein surface (a receptor) that normally binds to the molecule adenosine. When these nerve cells are adenosine-bound, the behaviour of the bee is one of quiet and calm. However when caffeine is brought in, it kicks out the adenosine and attaches itself to the receptors at the end of the sensory neurons. The effect is to stimulate the neurons, increase memory, and wake up and excite the insect.

In effect then, caffeine has two roles in the plant. One is defence against the predator goats and cows, while the other is to entice the pollinating insect by drugging it and tweaking its memory so that it pollinates this plant in preference to other pants that do not pack the drug in their nectar. The researchers conclude by stating that “our experiments suggest that by affecting a pollinator’s memory, plants reap the reproductive benefits arising from enhanced pollinator fidelity”.In plainer English, one can say that the trick the coffee plants play is another example of the ‘selfish gene’ idea, namely, use any ruse to help propagate my genes over other competitors, and do so for generations; and if it takes caffeine to entice and tweak the memory of the pollinator, so be it.