# The curious case of the ants in my plants friends

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Far in the remote rainforests of the Western Ghats of India, there's a tree with a tongue twisting name: *Humboldtia brunonis*. It is a small tree, about the height of a guava tree, and grows in clumps with its own kind. Known as Hasige maara in Kannada, this plant calls out to ants, enticing them with special food and safe shelter. The attractive food here is nectar droplets on the leaves! Each leaf has about 30-40 nectaries, producing up to 20 microlitres of nectar per leaf, everyday. The readymade ant shelters are also no less fascinating. The plant modifies some of the branch segments into long and swollen hollow structures called domatia (10-12cm long, 1cm wide), each with a small opening at one end that functions as the door. The ants reside here, establish their colonies, and drink the nectar meal. In return they patrol their host plant, which is now their home territory, and bite and chase away trespassing insects, especially caterpillars that come to eat the young leaves and flowers. The relationship seems like an ideal give and take protection in return for food and shelter except that it is not so. Of the 16 ant species found dwelling in the domatia of *H. brunonis*, only one ant species aggressively protects. So are the remaining ants freeloaders? To add to this mystery, many domatia are occupied by a peculiar tree earthworm that has never been found in soil, anywhere. What is its business here? Are all these ants and the earthworm just squatters, or are there new relationships waiting to be discovered here?

When I first heard about this ant-plant system, I immediately knew this was what I wanted to investigate for my PhD. There are many ant-plants in the world, mostly in tropical Southeast Asia, South America and Africa. In India, *H. brunonis* is the only ant-plant that has, so far, been

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discovered and studied. After years of theoretical understanding of ecology, this was my first chance to go out into the wild, and learn it first-hand. Following discussions with my supervisor, I charted out a plan; as field work could be done only during the dry season, October to March every year, and the remaining 6 months would be spent analyzing data. First, I would chart the distribution range of this plant in the Western Ghats. Then, I would find out if the plant provided the same rewards in all the places. I would also find out if that one protective ant species was present in the place where the plant is most vulnerable to herbivory. I also decided to see if nutrients derived from carcass or excreta of domatia-dwelling ants are absorbed by the host plant.

After much travelling and searching, I selected five sites across the range of *H. brunonis*, and 90 trees in each site, to study. A large number of samples and the randomising process made sure that what we observed was not just an individual characteristic, but that of the whole species at that site.

With each field season, the mystery started unfolding. We found that rewards provided by the plants, in the form of abundance of domatia, size and number of nectaries, and amount of nectar were higher in the southern than in northern sites. Further, nectar in the northern sites had mostly cheap sugars while in the southern sites it had expensive amino acids that are particularly preferred by the protective ant. In fact, the amino acid concentration was highest in the southern site most vulnerable to insect herbivory. This implied that the host plant can actually change its nectar composition, and invest in costly attractive nectar only when and where it needed protection!

The next problem was to see whether nutrients derived from domatia-dwellers were absorbed by the plant. In ants, it's known that the foraging workers take food back to their nest and feed their non-foraging nest-mates, and their excreta were dumped inside the nest. With this in mind, we conducted an experiment where we fed domatia-dwelling foraging worker ants with sugar solutions laced with a nitrogen stable isotope marker. After three weeks of feeding, we collected leaves and branches from various parts of each plant, to trace the course of the isotope if it was absorbed by the plant via domatia. Our results were positive! The nitrogen we fed the ants could be traced all the way to a branch far away from the experimental domatia! Our calculations showed that domatia-dwellers contributed significant amount of nitrogen to the host plant, (9% from the earthworms, and 17% from ants). This is important because rainforest soils are known to be nitrogen poor, and therefore the nitrogen that the plant received its domatia inhabitants would have been very welcome. We discovered a nutrient-based mutualism! Finally, to better understand waste decomposition and absorption in the domatia, I scrutinized the inner wall of domatia chambers under an electron microscope. The inner walls were lined with a mat of a fungus similar to those known to decompose waste into simpler absorbable products. I also observed that the plant cells lining the inner domatia wall has tiny holes through which the nutrients could pass into the plant's food channel.

To sum up: *H. brunonis* changes its rewards based on its need for protection, and it lures non-protective domatia- inhabitants for nutrient benefits. Nature is a network of interactions. A forest tree appears all tough on its own, but actually depends on its little friends, the ants and earthworms for protection and food. This novel finding contributes to our understanding of interactions in nature.