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# Evolutionary Forces and Tritrophic Interaction Between Microbes-Brassica-DBM

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**Introduction**

The Diamondback moth is the most destructive insect pest complex that attacks brassica plants in different regions of the world, which may be due to its flexible behaviour of adaptation in different environmental conditions. It was one of the first pest species that developed resistance against the *Bt* strains, and it has also developed resistance against many modern-day insecticides, That makes the entomologists think about the different other measures to control this pest. The microbial community that lives below ground and in the rhizosphere of plants decides the phenotypic characteristics of the plant, like productivity and resistance against some specific pests and diseases. As microbes have a much higher level of genetic diversity, relatively short generation times, and the capability to evolve at a much faster rate on ecological timescales, these types of characters may allow some fast changes in microbial community structure, which in turn may shape the way that plant populations respond to novel selective pressures in their environment.

## Natural selection and plant microbe interactions:

It is possible that the patterns of natural selection are directly affected by the microbial diversity present in the ecosystem. Plants will grow better in a more complex microbial community than in a simple microbial one. The microbe effect on selection may result from an indirect effect that will occur because microbial diversity can affect nutrient availability. Microbial diversity will also affect the selection of plant traits. Fungal diversity will also affect the functioning of the ecosystem. The diversity of the plants and the productivity of the plants might have some direct effects.

## Co-adaptation of plants and microbes to a local environment:

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It is interesting to know how both brassica species and the associated microbes like bacteria, fungus, and nematodes have developed mechanisms for co-adaptation in their local environment and how their interactions can increase the resistance against diamondback moth. Because the feedback between the above-ground parts of plants and the below-ground microbial communities is so well connected, both plants and microbes may come across similar environmental conditions. Plants and below-ground microbes could potentially co-adapt to soil moisture environments or other stresses. The emphasis is on how evolutionary interactions between Brassica plants and their rhizosphere community adapt to the local environmental and soil microbe community. What happened to the pre-existing microbial community in the soil, and whether or not it vanished or adapted to the plants that were growing? And how does soil affect the heritability of plant traits? For the high fitness of plants and microbes, mutualistic interactions are necessary, and without any interaction, plants and microbes can have better fitness. Genome epistatic interactions between plants and microbes can be common. As a result, plants and the microbes that live with them may need to be able to adapt to changes in the environment.

## Mechanisms used by soil microbes for selection of plant traits:

The well-studied interactions between plants and soil microbes are the exchange of resources between mycorrhizal fungi and rhizobia bacteria. These interactions can range from positive to negative, or mutualism to parasitism. The microbes involved in mutualism may prefer a plant trait that can increase plant products that are good for mutualism, such as carbon source allocation for mutual interaction. Another mechanism by which predators and parasitic strains of microbes may get plant resources without giving anything in return is through epistasis. In the case of brassica species, herbivory by diamondback moth and other related pests of brassica are important selective agents for brassica plant traits, and changes in the strengths of those interactions between the pest and plant are likely to affect how plant traits evolve. Maybe soil microbes associated with brassica plant species can affect the ability of plants to compete or mitigate competitive interactions. Some microbes can also interfere in the evolutionary process of plant traits by altering genetic variation, expression, heritability, or opportunity for selection. Let’s understand this with an example. In wet conditions, the variation in the traits makes it unsuitable to express the traits for drought tolerance. When microbes provide tolerance to drought to plants, it could change the amount of soil moisture at which plants perceive drought and thus alter the point at which genetic variation in drought-tolerant traits is expressed. Similarly, in brassica, there may be genetic traits that are involved in resistance or tolerance against diamondback moth that may be expressed in the presence of specific microbes. Diamondback moths are already a big problem all over the world, and knowing how they work and how to get rid of them will help a lot.

## Evolution of plant traits and its connection with microbes:

The soil microbial community can be affected by the variation in plant traits, suggesting a potential for plant trait evolution to affect soil microbes. Brassicas are seasonal crops in many parts of the world, so it is hard to know the evolutionary aspects of microbes. But those areas where brassica is grown all year round will be a great tool to study the evolutionary connection between plants and microbes. But some brassica plants have short generation times or long-term ecological research (LTER) sites may be useful systems for exploiting multigenerational exposure of plants to various ecological conditions to gain a better understanding of how the evolution of some plant traits can affect microbes.

## The interactions and their understanding between Brassica plants and microbes:

To better understand eco-evolutionary interactions between brassica plants and their microbial communities, we need to understand how specific brassica plant traits affect the rhizosphere microbial community associated with the plants in different environmental conditions, because brassica is grown all over the world in different environmental conditions. For example, increased relative growth rates or above-ground biomass can lead to increased soil nutrient inputs via leaf litter. This will surely affect the soil microbial community in return. Brassica plant root length, root surface, and other below-ground part traits will be good predictors of soil microbe abundance and composition, as well as microbial diversity. The C:N ratio of soil and plant matter also affects the decomposition of plant matter that is falling on the humus of soil. As a result, there can be a lot of different types of microbes in the soil, as well as different amounts of them.

## Eco-evolutionary dynamics in brassica plant and soil feedback:

Interactions between brassica plants and soil microbes are excellent candidates for examining eco-evolutionary interactions because interactions between organisms are tightly knit, with the potential for species with relatively short generation times to impose strong selection on one another. Organisms with very short generation times have the potential to evolve on much shorter timescales, but rapid evolutionary rates need not be limited to short-lived organisms. Strong selection, such as that which results from global change or biological invasions, can also increase rates of evolutionary change. Feedback between plants and soil microbes can have important consequences for the ecology of both plant and microbiological communities.

## The interactions and their understanding between Brassica plants and Diamond back moth:

The interaction between DBM and the brassica plant is a negative interaction as DBM feeds on the young leaves of the brassica and reduces the fitness of the plant. Herbivore species respond to different plant characters. Selection for multiple resistance traits occurs simultaneously. Plant-mediated interactions between herbivores that are dependent on plant genotype, as well as herbivory's non-additive effects on plant fitness, Sometimes multiple herbivores are present on a plant at the same time or may be one before the other, which makes feeding easy for the later coming herbivore. For example, the existence of the flea beetle and DBM The flea beetle makes it easy for the DBM to feed. Sometimes it also depends on how insects respond to prior feeding. They can respond positively or negatively to this. Sometimes individual brassica plants can be resistant or susceptible to DBM. The resistance can appear as a result of a plant-mediated response, or sometimes a non-additive effect can also be seen in the selection of a plant for resistance. The main compounds that attract the DBM to brassica plants are glucosinolate. It is very common in the brassica plant, and this compound attracts females to mate with it.