Plant and Insect Symbiotics: An Unlikely Relationship

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Symbiotic relationships occur when two organisms interact in a way that provides benefits for at least one of the organisms. Complex relationships like these are an important part of ecosystems and are prime examples of what biodiversity can mean. There are three types of symbiotic relationships: mutualistic, which is where both benefit, commensalism, where only one benefits but no damage is done to the host, and parasitism, where only one benefits and the host is harmed. It is very common in nature to see these relationships among plants and insects. Many instances of this can affect the plant’s nitrogen intake or pollination; both are important parts of what keeps the plant alive and allows it to reproduce. In this paper, I plan to examine three studies, all of which will cover symbiotic relationships that relate to one of these areas of plant function. The first, done by Scharmann et al. (2013), deals with commensalism, the second, by Morales and Aizen (2006), deals with mutualism, and the third, by Katayama et al. (2014), deals with parasitism.

Scharmann et al. (2013) conducted a study that measured the difference in the amounts of soil-derived nitrogen and insect-derived nitrogen for *Nepenthes bicalcarata*, a carnivorous pitcher plant and *Camponotus schmitzi*, an ant which is the only type of insect not killed by the plant. In this study, they estimated the amount of insect-derived nitrogen taken in from the pitcher plants by comparing the amount of soil-derived nitrogen of the pitcher plants to that of seven non-carnivorous plants. They then went on to test if the *N. bicalcarata* could absorb the nitrogen produced by the ant colonies, and where this may be possible on the plant’s surface. In order to do this, nitrogen tracers were used in solution on the ants and the plants. The nitrogen levels were sampled before the tracers were applied. After fourteen days, the nitrogen levels were sampled again, twice in both the leaves and in the ants. The ant colonies of five separate pitchers (all on the same plant) were given the sugar tracer. Feeders containing the solution were placed inside the pitchers and each was covered to prevent rainfall and other insects from causing issues. The nitrogen left by the ants was sampled on all of the plants’ leaves after fourteen days. Next, Sharmann et al. tested which parts of the pitcher plant could absorb the nitrogen by applying the water tracer to two rosettes on one plant and injecting it into three tendrils of another. They also tested to see if the ants could transfer nitrogen in other places than the pitcher. This was done by severing the connection between the pitcher and the rest of the plant, but keeping it affixed so the ants would move about naturally to the other locations. Once again the ants were given feeders filled with sugar tracer and the plant was sampled after seven days. Lastly, they analyzed the ants to see their nitrogen makeup.

In addition to the previous experiment, Scharmann et al. also tested the predation rates of the ants on the pupae that develop in the pitcher plant. As a control mechanism, they first removed the pitcher plants’ fluid and replaced it with water, then introduced twenty mosquito pupae and then covered the pitcher with what they dubbed an “emergence trap,” which was a modified clear plastic bottle. This was done for nine colonized plants and ten uncolonized plants, and after the pupae were no longer present, the surviving adult mosquitos were counted.

Scharmann et al. found that the amount of nitrogen was significantly greater when the pitcher plants were colonized by the ants. Between the two types they experimented on, the rosettes had greater nitrogen levels than the climbers. Their tests to see if the pitcher plant could absorb nitrogen from the ants in places other than on the pitcher also yielded positive results, as there was nitrogen absorption after the pitcher had been cut off. The number of pupae that reached adulthood was lessened in pitchers that were colonized, giving evidence that the ants do, in fact, help to prevent other insects from harming the pitcher plant.

Morales and Aizen (2006) analyzed the mutualistic relationship between invasive species and native insects in a study conducted in Patagonia, Argentina, a temperate rainforest. For the study, two contiguous sampling plots were chosen, both of which contained undisturbed areas and disturbed areas, meaning that the canopy was no longer intact due to fires or clear cutting. Within these land selections, thirteen alien and fifteen native plant species were identified. It was noted that there were more alien plants in the undisturbed habitat, although both types of habitat had large amounts of both plant origin types. During the blooming period for each species, the number of diurnal flower visitors were counted and identified over a time period of fifteen minutes. Throughout each week, each site was sampled at least once and sites were alternated everyday between disturbed and undisturbed habitats. Over the course of seventy-three days and 1,639 samples, one hundred-ten insect species were identified, including a small number of alien species. Some of the insects were not identifiable down to the species, but all were known to at least genus. Using the plant species (both native and alien) which were found to have more than one hundred visits, Morales and Aizen made estimates on how many plant species would be visited by each insect species every one hundred visits. After analysis, it was found that there was no significant difference between the number of insects that visited the alien plants and those that visited the native plants. It was found, however, that there was a smaller diversity in the types of insects that visited the alien plants than the natives. Alien plants were also visited more often by alien insects.

This study shows that even among populations of invasive species, mutualism between plants and insects is commonplace. For flowering plants, such as the ones in this study, being visited by pollinators is essential to the continuation of the species’ existence, so this mutualism is almost certain to occur in any environment that has both pollinators and flowering plants. In the study, it is mentioned that previous to this experiment it was thought that alien plants would have a significantly lower number of insect visitors than the native plants. Because this was proven otherwise, it shows that these invasive species were able to continue to exist and evolve in a new environment successfully, meeting the same capacity to attract visitors as their native competition.

Katayama et al. (2014) explore parasitism in their study about *Glycine max* (soybeans) and soybean aphids (*Aphis glycines*). The purpose of the study was to analyze how the aphids affect the nitrogen levels in the soil when they live on a soybean plant. They began by cultivating the aphids, raising them in incubated and covered environments and maintaining them for two years. For the first part of the experiment, ten soybean plants similar in size were chosen, five of which remained aphid-free and five that were populated with one thousand aphids each. These plants were covered by a nylon net and the number of aphids was monitored and kept constant. Pots were rearranged regularly in order to prevent the formation of microhabitats. At two and four weeks, an aluminum disc was placed five centimeters above the soil in order to catch the aphids’ honeydew. The honeydew was then collected and analyzed for each time interval. After one month, the top five centimeters was removed from each of the plants and tested to see what nitrogen types and amounts were present. They found that there was roughly seven times more inorganic nitrogen when aphids were not present, although the total nitrogen amounts did not change.

The second study used twenty soybean plants, also similar in size, and placed one thousand aphids on ten of them. One month into the study, the plants were cut five centimeters above soil level and the severed end was covered with cotton wool to collect the xylem sap coming from the cut. This was used to test the amount of nitrogen absorbed by the plant. It was found that aphid presence did not affect the flow of sap but it did decrease the amount of nitrogen that was taken in by the plant. In particular, amino acid-N uptake was lessened. This decrease in nitrogen absorption was contributed to the aphids’ effect on the rhizobia in the soil. These microbes are an important part of bringing nitrogen to the soil and the large amount of honeydew immobilized them, therefore decreasing the amount of nitrogen the plant was able to absorb from the soil. Overall, it is clear that the aphids had a parasitic and negative effect on the soybeans.

These three experiments give clear examples of what effects the different types of symbiotic relationships can have in the world of plants and insects. Scharmann et al. (2013) studied an example of commensalism where only one species of ants could survive on a plant but other insects were unable to. Morales and Aizen (2006) showed that mutualistic interactions are powerful enough to perpetuate the existence of an alien plant species through native and alien pollinators, despite the competitive presence of other native plants. Finally, Katayama et al. (2014) gave evidence of the negative and harmful impact a parasitic insect species can have on its host plant, basically taking away and depleting the essential nutrients it needs to survive, without providing any services in return. These three forms of symbiosis have great and sometimes devastating effects on an ecosystem, and understanding and evaluating these relationships is all the more important because of this.

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