Argentine Ant Invasion

Megan Crapo
Department of Biology
Lake Forest College
Lake Forest, Illinois 60045

Over time, the Argentine ant species, *Linephithema humile*, has invaded and displaced native ant species from their habitats. This phenomenon led Kathleen G. Human, Stuart Weiss, Andrew Weiss, Bennet Sandler, and Deborah M. Gordon of the Department of Biological Sciences at Stanford University to wonder why the Argentine species has invaded. The scientists constructed multiple bait experiments and recorded different observations to try to understand the Argentine ant species and their invasion behaviors. Their goal was to discover the abiotic and biotic conditions of the area, what type of native ant species was present, and behavioral interactions that affected the movement and interaction of the Argentine ant species (*Linepithema humile*).

For their first set of experiments, the researchers looked into how the physical conditions of the area and the animal or other animal colonies conditions of northern California affect the Argentine ant invasive patterns and distribution. In this experiment, they related the local distributions of the Argentine ant to four abiotic factors: time of day, soil temperature, air temperature, and relative humidity of the Jasper Ridge Biological Preserve in northern California. They also looked at the different animal and ant species present in each area. To conclude, the researchers determined whether these four conditions or the species present in each area could limit the invasion of the Argentine ant. The scientists hypothesized that the daily activity patterns of ant colonies would depend more on abiotic factors such as soil temperature, air temperature, and relative humidity rather than the other species.

To test the researchers' hypothesis, they started with a survey of the area to understand the distributions of the different ant species. They took a map of the entire Jasper Ridge Biological Preserve and divided this area into different sections. Then, they recorded what type of ant species were in the area and whether or not there were Argentine ants present. If there were no ants found in the area, then the researchers planted honey and came back to check on the spot 24 hours later. After that, they took notes on the geological features of different regions of the preserve. These records included the elevation of the area, distance to the edge of the park, distance to the water, the slope, and the isolation of the area. Overall, they found that the Argentine ants appear to have invaded the preserve around the areas that are near water, including the edge. They also found that the Argentine ants were present at lower elevation levels, closer to the water, and areas of higher isolations. However, there was no variation between the slope of the land and the location of Argentine and native ants,which means that the ants have no preference of how steep the land is. With all of the data that the researchers collected, they noticed that of the seven native species that are present within the reserve, the *P. impairs* is the most similar species to the Argentine ants.

After determining the different areas in which the various species were found, the researchers looked into the different activity patterns of the native ant species and the Argentine ants. During this observation, the four-native species that were observed were the *Camponotus semitestaceus Snelling*, *Formica subpolita Mayr*, *Messer Andrei Mayr*, and *Pheidole californica Mayr*. The researchers noted six colonies of each different species each day. While observing, the researchers recorded the number of ants that entered and exited the colonies. They also recorded the soil surface temperature, relative humidity, and air temperature. The results of these observations showed that the temperature and humidity recorded had a significant relation to the distribution of ant genera. The Argentine ants were more likely to be active within the higher soil and air temperature. However, the humidity affects all of the ant species. With a higher humidity, almost all of the ant species were going to be inactive.

The results show that, because of where the Argentine ants are located and because of their ability to forage longer due environmental factors, the Argentine ants can feed longer than the different native ant species. Human and Gordon now know that the environmental factors and the different ant species factors affect the foraging patterns of the Argentine ant. However, they then did not know if there were a foraging difference between the native ant species and the Argentine ant.

To start, Human and Gordon already knew that the Argentine ants were better than the native ants at finding food, recruiting higher numbers, and recruiting more consistently. With this being said, Human and Gordon began by asking three different questions to conclude how the different native ant species interacted with the aggressive Argentine ants. The first question that they considered was whether the Argentine ant affected the foraging of the native ant species, which then led them to wonder whether specific interactions caused that result. Finally, the researchers were left with the final question of how the native ant species responds during encounters with the Argentine ants.

For the first question, Human and Gordon predicted that the Argentine ants would affect the foraging success of the native species. To test their prediction, Human and Gordon used baiting experiments. They started out by having 75 different bait stations throughout three different grassland baiting areas. They conducted ten separate baiting experiments between June 1st and August 29th of 1993. During each observation of the bating sessions, they recorded the duration of time spent at the bait and the maximum number of ants that recruited to the bait. After the initial three baiting experiments, Human and Gordon continued at a slower pace from September of 1993 to November of 1994. While Human and Gordon were recording their data, they separated their bait stations into three different categories: bait that attracted only native ant species, bait that just drew Argentine ant species, andbait that attracted both invasive and native ant species. After all of the baiting experimentsconcluded, Human and Gordon pilled together everything that they recorded and found that their results supported their prediction. They found that the presence of the Argentine ants made the recruitment and foraging of the native ants less than these behaviors would have been without the presence of the Argentine ants. It also showed that the native ants were more likely to be found recruiting to the baits at which there were no Argentine ants than at the baits with the Argentine ants. This allowed the researchersto conclude that the presence of the Argentine ants hurts the foraging success of the native ant species. The same goes for the Argentine ants. The presence of the native ant species had a negative impact on the Argentine ants' foraging rates.

With the results that were brought forth from the bait experiments, Human and Gordon hypothesized that there wa some interaction that led to these results. They tested this through observations of the different ant colonies. They observed and recorded the number of ants going into and out of the different nest entrances and the different foraging times that were available to the native ant species and Argentine ant species. The researchers recorded the daily foraging patterns of the *C. semitestaceus*, *Formica subpolita*, *L. humile* (Argentine ant), *M. Andrei*, and *P. California*. The results showed that the Argentine ants foraged for longer and foraged in higher numbers than any of the native ant species that were observed. With these observations supplementingthe results of the bait experiments, Human and Gordon were able to test their final question of how the different native ant species respond during encounters with the Argentine ant species.

To answer this question, Human and Gordon used Argentine ant introduction experiments. In the field, Human and Gordon set up semi-artificial introduction experiments. The seven Argentine ant colonies that were used were field-caught from the Stanford University campus. In 1993 and 1994, Human and Gordon tested three colonies three different times. In 1993, they introduced the native ant species to the bait first before giving the Argentine ants access. In 1994, they gave the Argentine ant access to the bait first before giving the native ant access. The experiment ended when one of the species was away from the bait for 15 minutes. While the experiments were taking place, Human and Gordon recorded the frequency of persistence at the baits with the native ant species despite the presence of the Argentine ant foragers. The results that were found from these introductions showed that the different species varied in responses to the Argentine ants. However, in all but one of the introduction experiments, one ant species took control over the baits being shown. For the 1993 experiments, the *P. California* were pushed out by the Argentine ants every time, whereas with Messer Andrei were only excluded half of the time by the Argentine ants. However, there were some species like the *C. semitestaceus*, that were only sometimes pushed out by the Argentine ants. Then for the 1994 experiments, the *P. California* was always excluded from the baits. Then, the *M. Andrei* was more likely to be excluded from the baits. This is a significant change

from the 1993 experiments in which this species was only excluded half of the time. Then the *C. semitestaceus* always excluded the Argentine ants. Overall, even though each native species had different reactions to the Argentine ants' aggression, it is safe to say that each of the native species always recruited less than the Argentine ants to the experimental baits.

Through all three of these experiments, Human and Gordon were able to come up with conclusions that support their predictions. They were able to conclude that the Argentine ants and the native ants affect each other, whether it is the aggression or the different behaviors that are performed by the different species of ants. This discovery led Human and Gordon to the last set of experiments being discussed. After seeing their results for the Argentine ants and the differences between the species, Human and Gordon decided to see if the behavior of the encounters between the native species and Argentine ants affected the food resources. They came up with an overall hypothesis that the behavioral interactions of the native ants and the Argentine ants do contribute to the success of the Argentine ant as an invader. For these experiments, the researchers used the same set up as in the previousexperiments. They set up two different bait experiments and recorded the number of various ant species and the behavioral interactions between the native and Argentine ants.

For both of the baiting experiments, the researchers used the same baits as in the previous experiments; honey, cookie crumbs, and tuna. They also used the same number of sites set out in the same grid pattern. Human and Gordon compared the same three species as in the previous experiments, *C. semitestaceus*, *P. California*, and *M. Andrei*. In the first baiting experiment, Human and Gordon did not manipulate the presence of the Argentine ant or the native species. They recorded and observed the natural interactions with the baits. Then, in the second set of bait experiments, Human and Gordon introduced the Argentine ant colony to a lure near the nesting colony of a native ant species. However, these indigenous ant nest colonies had not been infested with Argentine ants yet. The researchers allowed the native ants to roam and recruit to the baits before they dropped the Argentine ants into the territories. They observed the baits for 30 seconds at a time for every five minutes. The experiment was classified as over when one species was left at the bait for over 15 minutes. Human and Gordon organized each of the experiment results into three different groups; either the native ant species persisted, the Argentine ant species endured, or both of them persisted. They also classified the interactions into three distinct categories: aggressive, retreat, and neutral. For Human and Gordon to compare the behavior of the Argentine ants and the native species, they calculated the proportion of the acts that were aggressive. Then, to determine whether the native species or the Argentine ants started more interactions, the researchers compared the percentages of all the interactions that were initiated by the native species using Chi-squared tests. When observing the behaviors of the initial interaction acts, they were either classified as aggressive or neutral. Then, the reaction could either be classified as fight retreat or neutral. However, the neutral response rarely ever occurred. A G-test was used to compare the numbers of interactions initiated by each species.

The results of the two different baiting sessions showed that both the native species and the Argentine ants recruited simultaneously to the baits and encountered each other. The frequency of the aggressive behavior was different for every species. Human and Gordon observed that, during the baiting sessions, the Argentine ant behaved aggressively more frequently than the native ants. This interaction occurred during the introduction experiments as well. The Argentine ants were more likely to act aggressively than the native species. The persistence of the baits by the Argentine ants was only somewhat associated with aggressive behavior. When the Argentine ant persisted, the majority of the behavior was aggressive; when it did not continue, still, a majority of the behavior was aggressive. This showed that there was no significant association between the aggressive behavior and whether or not the ant was persistent at baiting. When the native species persisted against the Argentine ant, the results showed that they were no more aggressive than when they were displaced. The final result revealed showed that the Argentine ants initiated the majority of the interactions. The observations showed that the native ants rarely approached the Argentine ant even when they were close to them. Human's and Gordon's observations also showed that most of the behavioral responses depended on the behavior that the opposing ant initiated. For example, if the Argentine ant started an aggressive interaction, it was found that most often the native ant was going to respond aggressively back. The results also showed that ants were more likely to retreat when they were approached neutrally.

The overall results found demonstrated that there was no relation between the frequency of aggressive behavior and the outcome of interactions between species as food sources. It showed that when one ant initiates an encounter, it is most likely that the approached ant will retreat; thus, the ant that initiates more encounters is most likely going to be able to invade more often. This proves that, since the Argentine ant is more likely to initiate an encounter with the native species, then it is more likely to recruit more and take over more bait.

All of these experiments done by Human and Gordon show that the habitat, the native species, and the aggressiveness of the Argentine ants allow it to invade the habitats of the native species. To continue researching, some other questions that could be asked would be whetherthere were two different Argentine ant colonies present, would they still be as aggressive as they are with the native ant species?