Arizona ranks first in the United States in number of ant species.

Above, the Polyergus (slave-maker) queen attacks the queen of the Formica nest. Right, army ants attend their brood; close-up view of the formidable worker ant.

ARIZONA ANTS

By Robert A. Johnson, Ph. D.
Social Insect Research Group and Department of Botany, Arizona State University

Ants, which comprise one family of insects, are one of the most successful groups of organisms in the world. With an estimated 20,000 species (only about 9,000 currently known to scientists), these social insects manifest their success by their presence in all terrestrial habitats except polar areas. Nests may be out in the open and highly visible, in and under logs, in rock crevices and under rocks, in dead tree branches, or underground with whole colonies living entirely subterranean lives.

Ants establish a foundation of nutrient and energy production that flows upward through ecosystems to ultimately support mammals, birds, and other wildlife. They perform these functions through such vital activities as moving and aerating soil, decomposing organic matter, cycling soil nutrients, and dispersing seeds. Ant activities also increase soil moisture and contribute nutrients to areas near their nests. Plants located near nests demonstrate the benefit of this effect in several ways. In addition to growing larger than surrounding plants of the same species, they also produce more and bigger seeds. The local increase in soil moisture and nutrients also enhances biodiversity because some plant species grow solely in these microhabitats. In some instances, the connection between ants and wildlife is direct, as in the case of horned lizards, which eat seed-harvester ants almost exclusively.

The overall importance of ants stems from their vast numbers. In fact, it has been estimated that all ants together have a combined mass similar to that of all humans. Using the reasonable assumption that 10 percent of ants dig regularly, their importance for soil turnover and aeration is tantamount to the digging of 500 million humans. Even our hot Arizona deserts have on the order of one-half to one million ants per acre.

Arizona ranks first in the United States in number of ant species. It probably also ranks first in lack of knowledge regarding the ant fauna due to a combination of our extremely high diversity and an absence of systematic exploration. Thus, the list of species occurring in Arizona remains incomplete, but it continues to grow as we find species not previously recorded from Arizona and discover undescribed species, that is, species new to science that have never been described and given formal scientific names. Of the 42 genera and 261 species currently known from Arizona, one genus and 35 species (13%) are undescribed. A botanist friend, when hearing this state of affairs, lamented that this level of knowledge equates to what scientists knew about the distribution and abundance of plants 50 or more years ago. The situation is further illustrated by my recent move to Tempe, where I discovered an undescribed ant species in my backyard!

High numbers of ant species occur throughout most of Arizona, but are concentrated in mountain ranges and adjacent valleys. An intensive survey of the Chiricahua Mountains in southeastern Arizona found 158 (or 61%) of the 261 species known from the state. On a larger scale, this represents about 23 percent of the 670 species currently known from the United States. Such high species diversity is not limited to the Chiricahua Mountains, but rather appears to occur in most "sky island" mountain ranges of southern Arizona. This diversity is readily evident when collecting, as one can often find at least 20 to 30 ant species in a single location.

The ants of Arizona encompass numerous groups with interesting and unusual behaviors that are conveyed by common names such as leafcutter ant, honey ant, seed-harvester ant, trap jaw ant, thief ant, big-headed ant, slave-maker ant, and army ant.

Some of the most unusual and intriguing ants are the slave-makers and the social parasites. Slave-maker ants (genus *Polyergus*) are highly specialized morphologically, having sharply pointed, sickle-shaped mandibles that they use during raids on other ant colonies. Slave-makers have degenerated behaviorally in that they do not forage, do not feed their brood or their queen, and do not clean their nest, but rather depend upon slaves to perform these routine colony tasks.

Polyergus colonies are initiated by mated slave-maker females, which find and enter the colonies of *Formica,* a closely related ant genus. The *Polyergus* female launches a rapid, fatal attack on the host queen, repeatedly biting her with piercing mandibles. Typically, several defending workers are also killed during the attack. Following this execution, the *Polyergus* female licks the wounds of the dead queen to acquire her pheromones, i.e., the chemical cues that ants use to recognize their nest mates. She quickly takes on the unique colony odor, after which the *Formica* workers calm down and accept the invader as their new queen. The host workers then raise her initial brood of slave-makers. Henceforth, the slave force is maintained by *Polyergus* workers raiding nearby *Formica* nests previously located by individuals that function as scouts.

The honey ant stores more and more fluids, greatly distending the abdomen to many times its normal size.

Even more specialized are the social parasites, which comprise one of the most anomalous groups of ants, as they live inside the nest of another, closely related ant species, and, for the most part, they lack workers, i.e., they produce winged sexuals only. Thus they depend on their host colony for all activities including collecting and processing food and raising their brood. Most social parasites are very rare, as exemplified by one species recently located near Casa Grande for which only 10 colonies are known. This species is rare even at this site, as it only parasitizes about 1 percent of available host nests. In most ant species, both sexes fly from the nest to locate mates. In the social parasites, however, because of their rarity and consequent difficulty in locating mates away from their nest, most have evolved to mate with nest mates. Males remain in their natal nest and females fly off to locate and attempt to invade another host colony.

For our social parasite example, the seed-harvester ant *Pogonomyrmex colei,* mated females find and try to invade new host colonies by following chemical trails that host workers use to communicate food sources to nest mates. These social parasites have thus broken the chemical communication code of their hosts. Females follow the chemical trail to the nest entrance, all the while being harassed or often carried away by host workers that try to prevent her successful invasion. Success is not common, however, as researchers have found newly established colonies in only one of 600 previously unparasitized colonies.

Honey ants comprise a diverse genus that occurs throughout arid portions of western North America and Mexico. Workers collect dead insects, nectar and various plant juices, and honeydew, and then regurgitate the liquids to *repletes,* the caste for which these ants are most notable. As repletes store more and more fluids, their fully engorged crop (the storage chamber) greatly distends the abdomen to many times its normal size, to the extent that repletes become immobile and hang from the ceiling of nest chambers. Repletes thus serve as living food storage chambers for the colony, with these stored liquids being later regurgitated to nest mates. The rich, sugary nature of repletes is evidenced by native peoples who excavate nests to gather repletes for food.

Trap jaw ants are primarily tropical ants (one species in Arizona) that are truly amazing given their extraordinary mandibles and prey-capture technique. These ants have elongate mandibles with several teeth at the tip and a pair of long trigger hairs that extend forward from the mandible base. The mandibles lock open at 180 degrees until a prey item is located. The ant then jerks her head forward to touch the prey, causing the trigger hairs to close the mandibles and impale the insect on the distal teeth. Closure of fully open mandibles takes from one-third to

Left and clockwise, an army ant soldier attacks a cricket; cross-section view of a fungus garden; the entrance to a seed harvester ant nest

one millisecond (a millisecond is one-thousandth of a second). This equates to a speed of about 8.5 meters per second, and is the fastest movement thus far recorded for any anatomical structure in animals.

Leafcutter ants comprise a highly diverse group of primarily tropical ants. Several leafcutter ants occur in Arizona, though only the two species with massive nests and foraging trails traversed by thousands of individuals are easily located. As their name implies, leafcutter ants cut leaves of nearby plants and bring them back to the nest. These plant parts are chewed, softened by salivary juices, and attached to the colony's fungus garden to provide a medium upon which the fungus grows. The fungus in turn serves as food for the colony. The queen(s) (some species have more than one) lays her eggs on the fungus garden, which the larvae and pupae also eat. We know that this is a highly evolved system because each species of leafcutter ant grows a unique species of fungus. How is this fungus garden started? As females prepare for their mating flight, each individual takes a mouthful of fungus from the colony's fungus garden to serve as starter material for her incipient colony.

Army ants are another interesting group, so named because of their warlike raiding behavior. These blind to nearly blind ants (their eyes are extremely reduced or absent) conduct mostly nocturnal raids that involve tens of thousands of individuals progressing over a long column. Most insects and arthropods in the path of the column may become prey, with other ant colonies being frequent targets.

Related to their raiding behavior, a cycle has evolved in which colonies pass through alternating statary and migratory phases, each lasting two to three weeks. During the migratory phase, colonies conduct raids and move to a new nest or bivouac site daily. This tendency disappears and colonies remain at the same bivouac site during the statary phase. Phases appear linked to the reproductive cycle, as broods of workers are reared in periodic batches. Early in the statary phase the queen lays a pulse of thousands of eggs. A synchronous emergence of adults from the previous statary phase occurs about two weeks later. Thereafter, colony activity increases and the migratory phase begins with daily emigrations following each raid. As larvae from the previous statary phase pupate, raid intensity decreases and the colony returns to the statary phase to begin the cycle anew.

Eighteen species of army ants are known from Arizona. At least six of these species are undoubtedly completely subterranean, as they are known only from males captured during mating flights, while workers have never been seen.

Citronella ants (genus *Acanthomyops*) are yellowish, subterranean ants that emit citronella compounds as defensive chemicals when the colony is disturbed. This odor is very pronounced when a worker is crushed, and remains evident in specimens stored in alcohol. These ants are essentially farmers that tend root coccids and aphids as their "cattle." Root aphids and coccids suck sap from plant roots, and excrete honeydew, which largely consists of waste material and excess sap and sugars ingested by the insect. Honeydew then serves as the main, if not only, food source for the ants. Aphids and coccids benefit from this association, as removing honeydew decreases chances for its contamination by molds.

Overall, our Arizona ants are an extremely diverse group encompassing a wide range of natural histories and serving as cornerstones for the functioning of ecosystems. This brief overview discusses a very few of these species, with many stories left untold and many more yet to be discovered.