Ant colonies in Denver areas: Did they affected by extreme condition?

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Abstract. The basic debates in science since a few years ago related issues of environmental and climate changes. Global warming huge effects in the biodiversity around the world. The classical example, an extreme condition in summer season under the pressure of climate change has a big impact on environmental especially the presence of ant colonies in Denver Colorado, USA. We know well, ant as famous social insect, strongest organism in daily work and ability adaptable in all of the environmental changes. The purpose of the research is to study the presence of ant colonies species and the impact of the environmental in Denver areas. The research was conducted in summer season (June – July 2021) in sidewalks of student’s dorm at Denver Colorado USA. The observation focused to ant species that survived around the environment. The parameter of observations: ant colonies species and their anticipated adapted in the extreme condition. The first data observation showed the dominant ant colonies identified as Tetramorium sp. (Hymenoptera: Formicidae). In the simple case effect of the extreme condition increasing soil temperature and humidity affected movement to another place, protecting them from sunlight exposure. There is the “natural real fact” why the diversity of organisms decreasing when they are under the pressure of their habitat changes. The conclusion of field observation was showed: the pavement ant (Tetramorium sp.) as the dominant ant in Denver areas. The ant colonies activities are strongest affected by the temperature of soil, humidity, and food availability. There is a need for effort in the management of the environment in the summer condition, such as: preparing to plant more plant production nectar and seeds around a nest of ant colonies.

1. Introduction
In recent years, basic debates management of environmental strong related to the climate changes and their affecting an organism. Climate changes term climate refers to the general weather conditions of a place over many years. One example in the United States, Maine’s climate is cold and snowy in winter, while South Florida’s is tropical year-round [1]. In another words, climate change is a significant variation of average weather conditions such as: warmer, wetter, or drier. Global warming as the recent rise in the global average temperature near the earth surface. It means that global warming is just one aspect of climate change. Commonly climate-driven affected community structure and function are already apparent in natural systems. Identifying the mechanisms that underlie these shifts in communities in response to climate change is vital to understand relationship between organism and their environment [2,3].
Every species living in many environmental condition. They have different responses to climate change, especially in extreme condition. Famous example is comparison the presence population ant colonies in the forest and urban areas. This is resulting how to anticipating effects of climate change or extreme conditions on species interactions with their environment [4]. The transformation of the natural landscape to be urbanizing supporting erosion of biological diversity in worldwide. This is a common reality find in the urban areas because effect of urbanization affected biodiversity. The importance of ecosystem services (biotic and abiotic components) provides supporting organism such as: soil production, water purification, climate regulation and carbon sequestration [5].

The climate changes strong related to environment and all of organism activities especially for ant. The social insect such ant (Hymenoptera: Formicidae) has ability living in every environmental condition [6]. Commonly ant building the nest with the huge population. They are playing very important roles in ecosystem function, such as: water infiltration and soil modification with benefit providing ecosystem service of clean water and conserving soil [7]. Ant colonies have foraging behavior then carrying food to the nest. This useful activities controlling pest population because the colonies member has clear job description including specific structure in worker, soldier, male and queen [8]. Beside function as important agent of clean water and soil conserver, ant colonies also playing roles managing presence of pest insects in agroecosystem, for example, ant colonies have several advantages as potential predators for established through conservation and effective control of pests under climate change conditions [9].

As we know, the pavement ant, Tetramorium sp. (subfamily Myrmicinae), is ant species abundant in American urbanized and agricultural habitats [10,11]. Pavement ant workers perform random walks to search colony territory for foods contain high sugar and fat [12,13]. In order to secure territory boundaries, pavement ant workers organize conspicuous wars, involving thousands of ants, against neighboring colonies [14]. In these wars, fighting is ritualized and few ants die. Most workers fight in pairs then grasping mandibles or other body parts takes time to 12 hours. A worker is likely to fight a non-nestmate ant if it antennates the other ant, detects mismatches in nestmate chemical recognition cues, and has had a recent history of interaction with nestmate ants. The very interesting fact that other ants recruit workers from colonies to the war using pheromone trails and wars establish quickly, within about 30 minutes. Pavement ant wars are likely ritualized tournaments to display colony size at territorial boundaries [14,15]. Based the many reports previously, the purpose of the research is to study the presence of ant colonies species and impact of environment in Denver areas.

2. Methods

The research as field observation focused presence of ant colonies. There was conducted in summer season (June – July 2021) in sidewalks of student’s dorm at Denver, Colorado, United State of America. The observation conducted to ant species surviving around the urban environment.

2.1. Identification of ant colonies

The identification of ant species around sidewalks started to figure out the entrance of nest and the presence of ant on the surrounding observation areas. The measure of soil temperature was conducted near the ant colonies entrance [8]. The collected of workers from the different nests in sidewalks used an aspirator, then identified ant species [16].

2.2. Baits

After making sure the active ant colonies by the presence of their workers surrounding nest and sidewalks, then given the baits (corn snack pieces contain sugar and fat) to kept the colonies still living in areas of observation [12,17]. The observation of ant colonies was conducted five weeks started in the morning at 8 - 10 am with intervals seven days. Based on observation in the first week, the short periods (around five weeks) observation was conducted because the ant colonies were very mobile and sensitive to human presence on the sidewalks. Another fact face in the research, the potential losing of ant colonies observed because of lack of food and another supporting life (water and plant shades). These factors
caused ant colonies moving to another areas. Baits playing important roles in observation, its very helpfull to kept colonies still alive in the field.

The observation of ant colonies was focused on parameter including: identification of ant species in the urban areas, counting of workers found in baits, and measure of soil surrounding ant colonies. The dried soil and losing of flowering vegetation around the sidewalks as impacts of extreme conditions in summer. The workers of ant colonies in the research areas collected used plastic bottles that contained fresh grass and water, keeping humidity in dry areas. The different ant colonies used differently labeled plastic bottle avoiding fighting between other nest colonies [18,19].

3. Result and discussion
3.1. Identification and presence of ant colonies
The observation of ant colonies was conducted during summer time in Denver, Colorado. Based identification of workers, the result was showed in Figure 1 as *Tetramorium* sp. or pavement ant (Hymenoptera: Formicidae) [8,16,20]. Commonly pavement ants as the dominant species when conducted the observation. There are few nests and hard competition for food sources.

![Image](image.png)

**Figure 1.** Pavement ant (*Tetramorium* sp.) (Hymenoptera: Formicidae) and their habitat
[Source: Michael J. Greene, 2017 (left); Sri Nur Aminah, 2021 (right)]

Based on identification of the ant morphological characteristic, this is *Tetramorium* sp. living in the sidewalks as the observation areas. The pavement ant as the social insect has castes divided into a queen, soldiers, and workers. The ant workers have different color based the species and ages. Commonly workers who perform brown tend the darker color. In measurement, commonly, workers body differently than other castes. Their body measurements range from 2.75 to 3.2 mm. Specific characteristics showed in the head. Another characteristic at the thorax is sculptured with longitudinal, forming parallel or concentric fine ridges, clear pits with unique raised rims surrounding antennal insertions. The important element detector such as antennae has 12-segmented including three-segment forming club on the top, contain a single pair of spines propodeal and petiole [16].

The pavement ant *Tetramorium* sp. is the common, typical ant in the United States urban areas. Basic the history, the first introduction into the United States occurred from Europe at the beginning of the 19th century. This social insect has become well established in urban areas in the northern United States and little part of Canada [19,21]. Actually, *Tetramorium* sp. has a very broad native distribution in Europe as their origin areas. The pavement ant species found in the United States has a wide native range in Europe, reaching from Spain to Turkey and Germany to Greece [22]. In North America, the population of *Tetramorium* sp. as common animal soil found in urban areas in the northeastern United States, the Midwest, and the Pacific Northwest, also in urban areas in another states. In 2008, *Tetramorium* sp. have been spread well to 23 other states and Canada [23].

Commonly the pavement ant building their nest inside the soil and bring all of the food enter through the entrances. Related to the specific creating structure the nest of pavement ant, commonly in the tracks of workers marked by presence pieces of loam as road marker. In natural habitat, the nest of *Tetramorium* sp. found in different soil types such as sand to loam. The ant workers from *Tetramorium* sp. choosing building nest in the areas contain lower number of plant species such as in the urban habitat. The observation result diversity ant in the New York City showed, commonly the pavement ant found
in the dominant number and species (reaching 93% of samples observed) on the poor nutrition soil types with fewer plant varieties. Based on their behavior, commonly workers of *Tetramorium* sp. very careful considering build their nest position because sidewalks deserve as the supporting environment for the colonies. However, the research on the past remains terrible facts whether this animal has ability infest human environment and caused damaging condition. On another fact, the ant workers has potential become aesthetic pests when their presence in the residences. It means the population number huge and abundant in the sidewalks. The observation on the past also showed pavement ant has ability caused troublesome. In case, they has potential building the mutual relationship with agricultural pests such as aphids as producer of honey dew that colonies need. In contrast in the different situation, ant workers also playing important role as predator for soft-bodies insects that attacking agricultural plant. In fact on the field, it seems *Tetramorium* sp. less protective kept of aphids population than another ant species [24,25]. In Kentucky area of the United States, another pavement ant species, *Tetramorium caespitum* reported building the specific protecting structures from the soil near habitat the scale insects attacked Magnolia plant. Unfortunately, many of the activities of *T. casepitum* significantly decreasing number and avoiding scales insects parasitized by flies parasitoids. The condition showed negative impact increasing damage to the plants. Based the ecological knowledge, presence of *Tetramorium* sp. could be very competitively than another native ants from urban habitat [26].

Although we know pavement ant as the introduced insect species from another areas, in the other side, their presence has more benefit. The pavement ant has ability keep out more damage of another ant as the invaders in the habitat. In the laboratory experiments was showed, the pavement workers destroyed all the founded colonies of the red fire ant, *Solenopsis invicta*. This is a famous dangerous species that cause burn and heavy pain in the human skin and body [27]. *Tetramorium* sp. deserves decides as important ecosystem service provider, especially in the sidewalks or another urban environment. Beside their role as predator for agricultural pest, ant workers have ability as important seeds dispersing, creating the aeration of the soil and recycling waste product to be useful nutrients for another microorganism.

### 3.2. Baits

All of the ant colonies have a queen and building their nest near the source of food and facilities supporting their existence in nature. When observation around the sidewalks, three nests of ant separated by a distance about 10 – 25 m (Figure 2).

![Figure 2. The presence colonies of pavement ant (*Tetramorium* sp.) in Denver areas](image-url)
Based the results was showed in Figure 2, the highest pavement ant population prepared by the first nest near the vegetation. The second ant colonies lost during the second week and not seen again until the end of observation. The similar condition showed in third ant colonies. They are lost in third week. During the fourth to fifth weeks, all of the ant colonies moving from their original place. Commonly pavement ant in urban areas building nest near the plant or water sources to supporting their living. The presence of vegetation protected the ant colonies from exposure to sunlight. In general, the environment where the ant colonies living in dry conditions and lack of water source. In its introduced range in U.S, *Tetramorium* sp. reported living in human-modified environments. In surveys of urban environments where pavement ants are found, they generally account for most ants found at baits and around residences. These ants are also very resilient, being one of only a few species of ants found to recolonize an area after intensive human development, such as construction projects [28,29].

In general, Formicidae as social insect playing important role as the decomposer and water purification in the urban areas. In tropical countries, ant to be an important predator for several crops. Based proportion of ant abundance in the soil surface, especially in agroecosystem occupies the first rank. There are four species of ant in the dry season on Indonesian rice fields: *Solenopsis geminata*, *Dolichoderus thoracicus*, *Pheidolegeton diversus*, and *Anoplolepis gracilipes*. In the condition of climate change, ant population generally reduced because of drought and another extreme conditions [9].

An environmental condition such as: temperature and humidity playing important roles in the activities of ant colonies. Figure 3 was showed the soil temperature and humidity surrounding ant colonies in the summer time.

![Graph showing soil temperature and humidity surrounding ant colonies](image_url)

**Figure 3.** Soil temperature and humidity surrounding ant colonies in the summer time

Based Figure 3, the maximum and minimum temperature of soil near the entrance of ant colonies range between 26 – 35°C, then the humidity about 70-88%. All of the first workers starting surrounding on sidewalks around 8 in the morning. In the couple of time, sunlight has not yet exposed the soil surface near the entrance. The activities are increasing by time. Almost in the noon, the activities decreasing because environmental temperature increasing hot. This is a common condition in urban areas that poor with vegetation. The workers protecting themselves inside the nest in the situation are not supporting their activities. The workers are active again in the afternoon around 5 pm, however, is not similar in the morning.

In the other hand, every ant colonies need food to support energy building their colonies. They given baits very helpful the existence of ant colonies in their environment. Every ant colonies has its own territories. The marking and defending the areas by providing specific markers in the form of
pheromones that are different from one ant colony to another [30]. Environmental factors such as temperature and humidity very affected the ant colonies development. The inability to adapt to environmental conditions makes ant colonies moving into another place. This is a common condition found in urban areas [12,31].

4. Conclusion
The result of field observation showed: pavement ant (Tetramorium sp.) as the dominant ant in Denver areas. The ant colonies activities are strongest affected by the temperature of the soil, humidity, and food availability. There are need effort in management of environment in the summer condition, such as: preparing to plant more plant production nectar and seeds around nest of ant colonies.

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