CHAPTER 2

REVIEW OF RELATED LITERATURE

2.1 Ants

2.1.1 Brief Explanation

Ants are social insects of the family Formicidae (Clark and Holbrook, 2009). Ants belong to the insect order Hymenoptera which also include the bees and waps. Ants are familier insects that are easily recognized, especially in their common wingless adult forms, known as workers (Pest Notes, 2014).

2.1.2 Taxonomy of Ants in General

Ants belong to the insect order of the Hymenoptera and close relatives to bees and wasps. It belongs to the phylum Arthropoda and family Formicidae and subfamily Myrmicinae (IT IS, 2014).

2.1.3 Taxonomy of the *Solenopsis sp.* (Fire Ants)

The taxonomical classification used in the study is as follow:

Kingdom : Animalia

Phylum : Arthropoda

Subphylum : Hexapoda

Class : Insecta

Subclass : Pterygorta

Order : Hymenoptera

Suborder : Apocrita

Family : Formicidae

Sub family : Myrmicinae

Tribe : Solenopsidini

Genus : *Solenopsis sp*. (ITIS, 2014)

2.1.4 Morphology of an Ant

Ant undergo complete metamorphosis and they pass through egg, larval, pupal and adult stages. Larvae are immobile, wormlike and do not resemble their adults. Ants, like many other hymenopterans such as bees and wasps, are social insects with duties divided among different types or castes of adults. Queens conduct the reproductive functions of a colony and are larger than other ants. They lay eggs and sometimes participate in feeding and grooming larvae. The sterile female workers gather food, feed and care for larvae, build tunnels and defend the colony; these workers make up the bulk of the colony. Males do not participate in colony activities; their sole purpose is to mate with the queens. Workers feed and care for males, which are few in number (Pest Notes, 2014).

2.1.4.1 Egg

Egg is the first stage of the ant's life. Ants eggs are soft, oval and tiny. Not all eggs are destinated to become become adults but some of them are eaten by natemates for extra nourishment (Clark and Holbrook, 2009).

Figure 2.1 A Worker Ant delicately handles A freshly- laid egg (Alex Wild, 2014)

2.1.4.2 Larva

Ant larvae are small and white grub-like creatures that are helpless for the most part of immobile. During this stage of development, larva are totally dependent upon their caretakers for food. They are fed by trophallixis, the regulation of liquid food stored in the stomach (crop) of an adult, and or given solid food items brought back to the nest by foraging workers. On occasion, caretaker worker ants (which are female) lay non-viable eggs for larvae to eat. This is the only time during an ants' life which it consumes solid food. Adults subsist entirely on liquid nourishment, either by direct consumption (i.e plant nectars) or socially, by trophallixis. Females with higher nutrition intake will become queens instead of workers. After a series of molts (approximately three weeks) the larvae enter the pupal stage (Pararas-Carayannis, 2008).

Late stage fire ant larva. Note the head at the lower left side.

Figure 2.2 Fire Ant Larvae (Layton, 2014)

2.1.4.3 Pupa

Pupa formation is hormone- dependent. During this stage the larval anatomy of the ant is broken down and adult structures that are formed. Pupae are incased in a hard protective coating and form the outside. It appear immobile for the duration of time they spend in this state. Like larva, pupae are protected and cared for by caretaker worker ants. Pupae require constant temperatures to ensures proper development and are moved by their caretakers to the best chamber available for this purpose. This stage of development lasts for a few weeks. After shedding its hard encasement the individual emerges as a young adult ant, its position within the complex social system of the colony (Pararas-Carayannis, 2008).

2.1.4.4 Morphology of Adult Ant

Ant are divided into three major regions (the head, thorax and abdomen), a pair of antennae, and a hard exoskeleton (Clark and Holbrook, 2009).

a. Head

The ant's head have two compound eyes, mandibles and two pair of antennae and ect. The structure of an ant head corresponds to its function (Clark and Holbrook, 2009).

b. Eyes

Ants have two compounds eyes and it can contain hundred of lenses or corneas that combine to form a single image in the ant's brain. Some of the ants have three simple eyes that are called ocelli to detect light and shadow (Clark and Holbrook, 2009).

c. Antennae

Ants have two jointed antennae and they are always moving back and forth, touching, tasting and smelling everything. And, they are also sensory appendages attached to the head. Each antenna of ant is blent in the middle like the elbow of a human arm- this is another distinct part of the ants (Clark and Holbrook, 2009).

d. Thorax

The thorax is the second body segment of the ant (mesosoma). The mesosoma is packed full with muscles that power is three pairs of legs and it can very fast by using their legs. The thorax contain the muscles which make the legs move. At the end of each leg contain a hooked claw that is used to climb and hang on to things (Clark and Holbrook, 2009).

e. Abdomen

The abdomen of the ant is the segmented tail area of an ant. It also contains the vital organs and reproductive parts. The abdomen contains the heart that is a long tube and pumps colorless blood from the head throughout the body and back up to the head again. Ant has a petiole that connects the thorax to the abdomen (Clark and Holbrook, 2009).

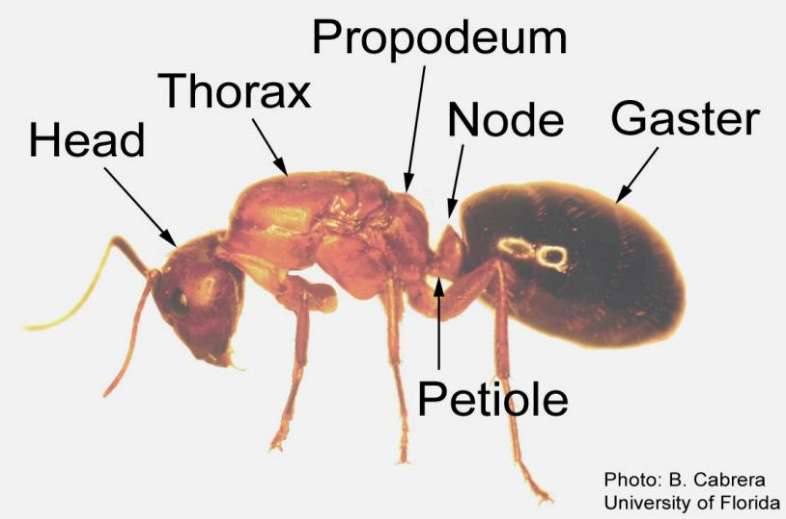

Figure 2.3 The Parts of An Ant (Cabrera, 2014)

2.1.5 Life cycle

Ants life cycle go through the same process to reach adulthood. Every ant colony has one or more queens. The worker ants are female and the queen is the only ant that can lay eggs. The queen searches for mate places especially tall trees, large shrubs or hill tops. At this stage, the queen reduces her activities to egg laying and the workers assume all other tasks in the nest. The queen lays the eggs and the hatch into larva. The queen is still essential for normal colony

life because she produces to control the activities of all workers in the nest. The male ants produce a much simpler controlling mechanism and females (queens and workers) are diploid. They have two copies of chromosome. Males, are haploid and have only a single copy of each chromosome. The queen lays the eggs and hatch into larva. The life of an ant start from an egg. After a new ant emerge, they remain in the nest waiting for environment triggers to initate leaving the nest. The new ant workers will get food for their new larvae and pupae. Ant life colonies has begun. Afterthat, the queen will lay eggs again and that will develop into new queens and males and will start new colonies (Shattuck and Barnett, 2014).

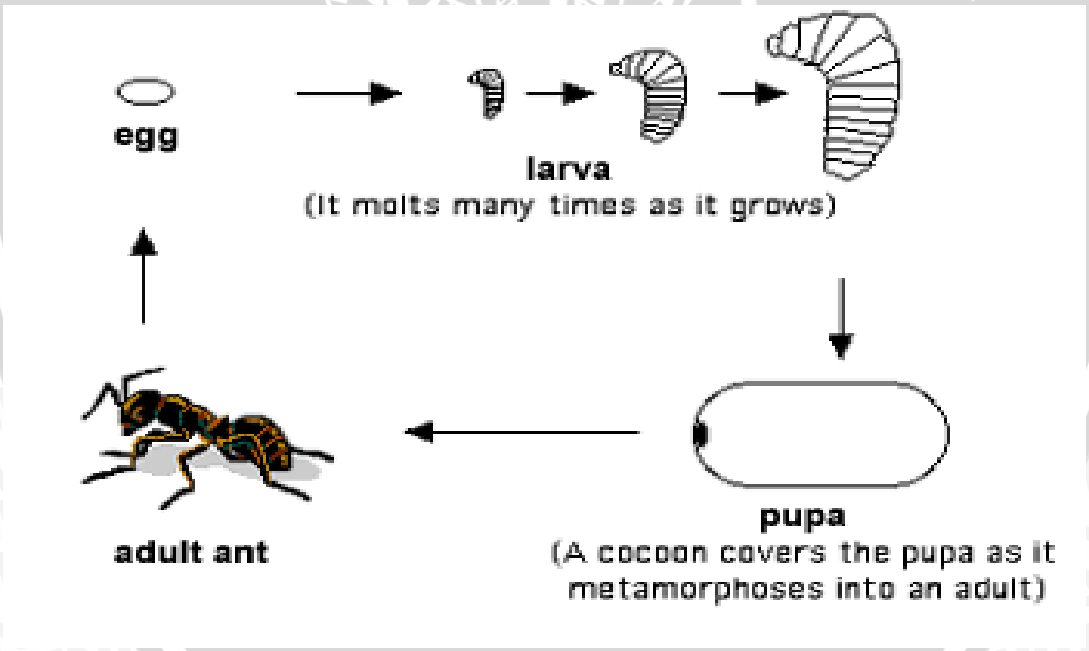

Figure 2.4 Life Cycle of Ant (Animal Corner, 2010)

2.1.6 Habitat

In general, *Solenopsis sp*. can be found areas surrounding houses provide a number of ideal homes for ants, including wood and soil, in old trees,

rock or leaves, on the ships and tall buildings, and open spaces such as fields, parks and lawns. Ants will burrow into wood or soil and create tunnels where their colonies live (Shaw, 2011).

2.1.7 Medical Importance of Fire Ants (*Solenopsis sp*)

Fire ants are the most common red coloured insects which sting and deliver a harmful substances called venom (Heller, 2013). Fire ants stings are the most notorious and they respond rapidly and aggressively to any disturbance of the colony or to a food source. The venom is produced in a poison gland and stored in a venom reservoir (Lockley, 2013). This reservoir opens into a poison bulb located at the base of the stinger (Bledsoe, 2004). The fire ants venom contains a chemical called piperidine. After the ants bite within 24- 48 hours, the white pustule is formed and these pustules can become sites of the secondary infection (Lockley, 2013).

Figure 2.5 Diagram of Fire Ants Stings (Bledsoe, 2004)

2.1.7.1 Reaction to Fire Ants Stings

There are three main types of reactions to fire ant stings.

a. Local reaction – The most common reaction to fire ant stings is immediate intense burning, continued by itching, redness and raised red welt on the skin at the sting site. These symptoms are to resolve over four to six hours. After that day, there is usually a sterile pustule at the sting site, which is best described as a small bump with a white blister on top. The pustule resolves over a week or unless it is scratched off. Scratching is not recommended because it can allow an infection to develop in the skin.

b. Large local reaction – A small percentage of people who are stung develop a large local reaction. The signs include extreme itching and a large raised red welt at the site of the sting. Over 6 to 12 hours, the swelling and intense itching increases and evolves into a large area of painful swelling. These reactions reach maximum size at 24 to 48 hour, when they are hot, itchy and painful. Fortunately, large local reactions do not cause a body- wide allergic reaction (anaphylaxis).

c. Anaphylaxis – Between 0.6 and 16 percent of people who are stung by a fire ant have a sever, whole- body allergic reaction called anaphylaxis. This type of reaction is more common in people who have previously been stung or had an allergic reaction to a wasp (yellow jacket) sting. Anaphylatic reactions are very serious and usually develop within 30 minutes of being stung. If left untreated, this reaction can be life threatening. Signs of

anaphylaxis include body- wide itching, welts, difficulty breathing or swallowing weakness or fainting (Deshazo *et al,* 2014).

Figure 2.6 Fire Ant Sting Pustules (Extension, 2014)

2.1.7.2 Venom and Allergic Reaction

One of the proteins in fire ant venom can cause a severe allergic reaction or anaphylaxis. Anaphylaxis can cause a particular substance called an allergen. Following exposure to a particular allergen, large quantities of IgE antibodies are released. When the allergen binds to IgE attached to the basophiles and mast cells, these cells release histamine, heparin and other substances into the surrounding tissues. The process of releasing these substances from the cells is called degranulation. This release results in an allergic reaction which can range from very mild to very severe of an allergic reaction is histamine. Histamine is a potent substance that causes bronchoconstriction, increased intestinal motility, vasodilation and increased vascular permeability. A common manifestation of severe allergic reactions and anaphylaxis is angioneurotic edema. Anaphylaxis

usually occurs when a specific allergen is injected directly into the circulation. When the allergen enters the circulation, it is distributed widely throughout the body. The principal body systems affected by anaphylaxis are the cardiovascular system, the respiratory system, the gastrointestinal system and the skin. The signs and symptoms of anaphylaxis usually begin within 30–60 seconds following exposure to the allergen (Bledsoe, 2004).

2.1.7.3 Common Symptoms of Fire Ant Bite

Symptom may include:

1. Swelling, redness, itching and pain around the site of bite
2. Pus-filled blisters that last 3 – 8 days
3. Possible scah at the area of the bite that lasts 3 – 10 days
4. Difficulty breathing
5. Rapid heart rate
6. Throat swelling (The New York Times, 2014)

2.2 Bay Leaf (*Laurus nobilis*)

2.2.1 Description

The trade name of the *Laurus nobilis* is sweet bay leaf, bay laural, true, Roman or Turkish Laurel. Laural is an evergreen tree and family Lauraceae. Most people are familiar with Laurel on their kitchen where it is known as bay leaf. It is hardy multibranched tree with smooth bark. It grows to about 10m high. It has alternate, narrowly oblong- lanceolate leaves and the flowers are small and four lobed that the males has 8 to 12 starnens and female has 2 to 4 staminodes. The fruit is 10 to 15 mm, ovoid and black when ripe 3 (Patrakar *et al*, 2012).

The plant have aromatic and fragrant effect and it contains volatile oil as well camphor. It is a plant of industrial importance. Therefore, it sis used in foods, drugs and cosmetics. The bay leaves contain an essential oil of aromatic, spicy, odour and flavour. The dried bay leaves and essential oils are used in the food, soups and fishes. It is used in food industry for food preservations. The food contains volatile oil that are used in soap making. The volatile oil is sometimes used in perfume. The oil is a valuable adjunct in the flavouring of all kinds of products, meats, sausages, canned soups, baked goods, confectionery, ect. (Patrakar *et al*, 2012).

Figure 2.7 Bay Leaf (*Laurus nobilis*) Plant (Patrakar *et al*, 2012)

2.2.2 Taxonomy of Bay Leaf

The taxonomical classification of bay leaf is as follow:

Kingdom : Plantae

Division : Magnolids

Order : Laurales

Family : Lauraceae

Genus : *Laurus*

Species : *Laurus nobilis* (Patrakar *et al*, 2012)

2.2.3 Morphology

2.2.3.1 Flower

Most flowers are unisexual which are small with white petals and males with yellow stamens lending an overall creamy white to yellow – white color to the flower clusters; the flowers are hidden in the foliage and are generally inconspicuous (Arnoid, 2004).

2.2.3.2 Fruit

Bay fruits are roundish black berries approximately half centimeter in diameter which mature in as fall. They are not particulary ornamental (Arnoid, 2004).

2.2.3.3 Stem / Bark

The stems are medium to stout, bright green and remain so for an extended time, eventually becoming splotched with gray and maturing to a gray-brown color; angled at first. There is strong apical dominance on vigorous stems. The buds are divergent; pointed to conical; prominently stalked; initially green, then maturing to a light to medium brown. The colour of the bark is gray- brown (Arnoid, 2004).

2.2.3.4 Leaves

The leaves are alternate, narrowly parallel – sided, lance – shaped, pinched at both ends, 5 to 10 x 2 to 7.5 cm, smooth, margins undulate, glossy dark green above (Tucker, 2009).

Figure 2.8 Bay Leaf *(Laurus nobilis*) (Anhr, 2013)

2.2.4 Composition of Bay Leaf, *Laurus nobilis*

Bay leaf contains essential oil such as 1,8-cineol (50.3%), dihydrocarvone (5%), α-terpinenyl acetate (11.4%), sabinene (9.2%), spathulenol (3.4 %), α-pinene (3.2%) and eugenol and geraniol. They are the most abundant components in *Laurus nobilis* essential oil (Ghanem *et al*, 2012). It also contains various lactones such as 10-epigazaniolide, Gazaniolide, spirafolide, costunolide, Reynosin and santamarine (Patrakar *et al*, 2012).

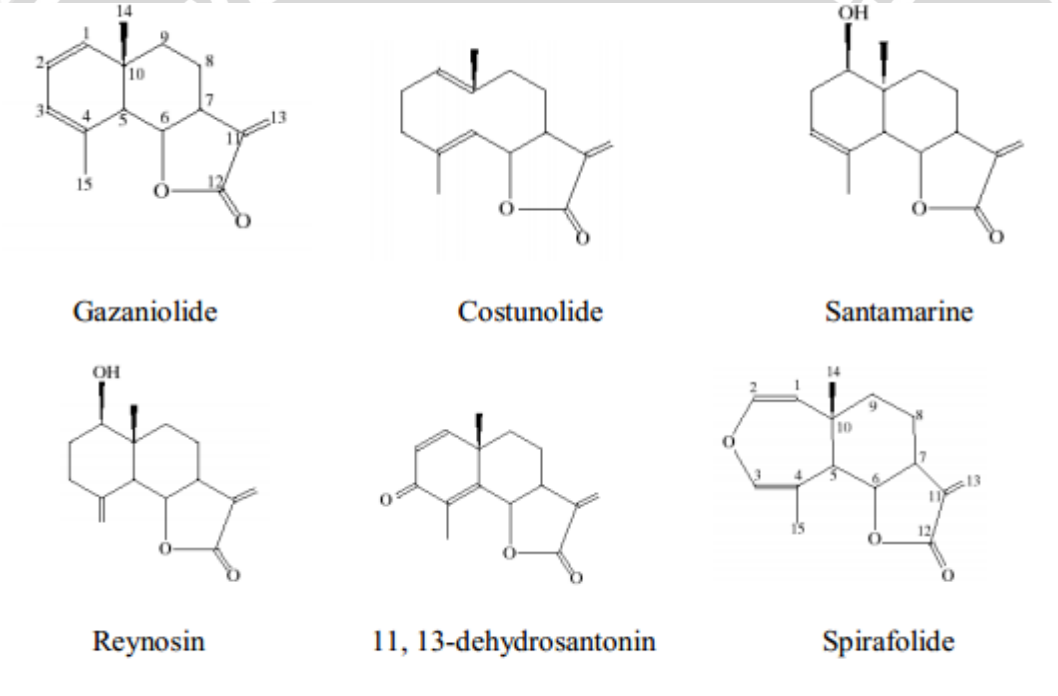

Figure 2.9 Structures of Some Phytochemicals (lactones) Isolated from *Laurus nobilis* (Patrakar, Mansuriya and Patil, 2012)

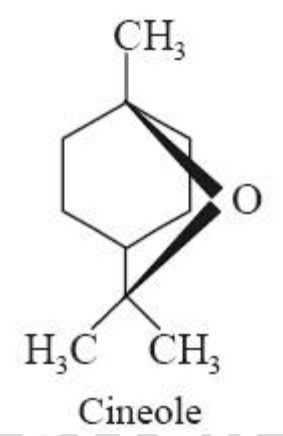

Figure 2.10 Structure of Cineole (Pharmacognosy, 2012)

2.2.5 Common Uses of Bay Leaf (*Laurus nobilis*)

2.2.5.1 Culinary Uses

Bay leaves are spices used in cooking due to their flavouring capacity and aroma. Moreover, the aromatic leaves are used as fresh or dried leaves. For cooking purposes, bay leaves are used almost exclusively as flavor agents during the food preparation stage; even when cooked (Moghtader and Salari, 2012).

2.2.5.2 Medicinal Uses

Bay leaves are used for antimicrobial, antiviral, antifungal, antibacterial and insect repellent activity. Traditionally, it is used in rheumatism and dermatitis and gastrointestinal problems. The aqueous extract is used in Turkish folk medicine as an anti-hemorrhoidal, anti-rheumatic, diuretic, an antidote in snakebites and for the treatment of stomachache diuretic. Recently it is used in treating diabetes and preventing migraine (Patrakar, Mansuriya and Patil, 2012). Moreover, it is used to treat the symptoms of: Acne, Aging skin, Angina

pectoris, Arthritis, Asthma, Bacterial infections, Common cold, Dry skin,Ear aches, Eczema, Hypertension (high blood pressure), Influenza (flu), Psoriasis, Rosacea, Rashes, Rheumatism, Tinea (fungal) infections, Viral infections, Wounds, Wrinkles (Wholesome, 2013).

2.2.5.3 Insect Repellent Activity

L. nobilis could be used as botanical biopesticide in postharvest crop protection. *L. nobilis* essential oil has a repellent action, reduces fecundity, decreases egg hatchability, increases larval mortality and adversely influences offspring to female of bean weevil and the rust-red flour beetle. In addition, *L.nobilis* essential oil have repellency against *Sitophilus zeamais*, *Cryptolestes ferrugineus*, and *Tenebrio molitor*. On the other hand, *L.nobilis* have fumigant toxic activities and acaricidal activity which against the carmine spider mite (Jemâa *et al,* 2011).

2.2.5.4 Mechanism of Action of Bay Leaf (*Laurus nobilis*) As a Repellent

Repellent are generally considered as nontoxic, non-irritating and non-allergenic to humans and other animals. Non-chemical method of control is as effective and convenient as a chemical alternative to prevent form fire ants stings. Most of the chemical repellents that consist of a lot of different side effects on human body. Moreover, repellent should be obtained from the substances like natural plants and vegetables to reduce side effects and it will become a lot of helpful to our society.

Bay leaf extract contains essential oil of aromatic and spicy odour which is disliked by insects. It contains volatile components especially 1,8 cineol, eugenol and geraniol which can produce unpleasant smell to fire ants. Essential

oils are lipophilic in nature and interefer with basic metabolic, biochemical and physiological and behavioural functions of insects. The repellent molecule interact with fire ants olfactory receptors and blocking the sense of smell. This strong smell of bay leaf prevent pests from reaching the food source or move it away once it is there. Therefore, it is well known that bay leaf has a high repellent effect on other insects (Tripathi *et al*, 2009).