A survey was conducted of the beneficial insects occurring in a sustainable estate mango orchard in Miami-Dade County, FL. The orchard was planted in 2014 and consists of a half-acre of the new and high quality cultivars grown in a sustainable system and destined for marketing in specialty outlets in South Florida. Since inception, the orchard has been managed without the use of herbicides, insecticides, or chemical fertilizers. The current study was conducted to demonstrate the diversity of predators and other beneficial organisms that are found in this orchard and to discuss their effectiveness in control and their long term survival. Several species of spiders, lacewings, ladybugs, mealy-bug destroyer, assassin bugs, paper wasps, and native and non-native lizards were sampled over the one-year of study in the orchard. The role of each of these organisms and their effectiveness will be discussed.

**Materials and Methods**

A survey of predators and beneficial organisms was conducted within the BA Campbell Estate orchard located in Miami-Dade County, FL. (Campbell and Campbell, 2015). Planting within the orchard began in 2014 and there have not been any applications of herbicides, insecticides, or chemical fertilizers. Pruning and selective removal of foliage and twigs have been used to control pests in the first year of the orchard. There are no mango orchards within 1/2 mile of the BA Campbell Estate and there is no known herbicide or insecticide use within 500 m of the orchard. Aerial spraying for mosquito control is conducted by Miami-Dade County during the rainy season.

Opportunities are increasing in South Florida for estate mango orchards. South Florida contains a large, diverse population of residents from mango growing and consuming countries which offers a unique local marketing opportunity for high quality fresh mangos. Small-scale estate orchard systems offer many advantages and some important challenges over large-scale conventional mango production systems that have developed over the past 50 years in South Florida. A sustainable system that embraces many of the tenets of traditional Caribbean mango growing techniques and organic production, along with the latest and best genetic material that offers dwarfing, disease tolerance and quality, is achievable in South Florida.

The objective of the current paper is to conduct a survey of predators and other beneficial organisms in an estate orchard in order to establish a baseline of information for estate orchards in South Florida and to foster a better understanding of the feasibility of sustainable mango production.

**Observations were made in the orchard weekly to document the beneficial organisms within the orchard for a time period of close to one year. Observations were made of the effectiveness of the beneficial organisms within the orchard in controlling the various pests.**

**Beneficial Organisms Identified**

**Lady Bird Beetle.** Lady Bird beetles (ladybugs) can consume 50–60 aphids per day, although they also eat a variety of other insects, such as scales, mealybugs, leaf hoppers, and mites (Planet Natural, <www.planetnatural.com>). It has been demonstrated that a single ladybug may consume nearly 5000 aphids in its lifetime. Many species of ladybugs are present in North America and are common across the country and across crops. One larva will eat about 400 medium-sized aphids during its development to the pupal stage. An adult can eat an average of 300 medium-sized aphids before laying eggs. They will feed on other pests but are best known for eating aphids. They are also considered one of the most active predators, feeding from dawn to dusk. These were among the most common predators found in the orchard throughout the study. Both adults and larvae were found, but the adults were most numerous. In order to be attractive to ladybugs, a source of pollen for food and specific plants are needed. The most popular plants include fennel, dill, cilantro, caraway, coreopsis, dandelions, and scented geraniums. Another way to promote ladybug populations is to eliminate the use of insecticides. They are sensitive to insecticides and the insecticides eliminate their food source. Allowing aphids to live on certain plants is necessary to ensure there is enough food for ladybugs. When the ants were controlled within the orchard with physical barriers, populations of ladybugs increased dramatically.

**Lacewing.** Green Lacewings, from the family Chrysopidae, are an excellent addition to any pest management program. While the adults feed only on nectar, pollen, and aphid honeydew, the
larvae are active predators. Green Lacewings are voracious predators of the eggs and immature stages of many soft bodied insect pests. This includes leafhoppers, thrips, whitefly, spider mites, aphids, mealybugs, eggs of pest moths, and some beetle larvae. The larva’s life cycle consists of feeding for 2–3 weeks, then spinning a cocoon and emerging as an adult 10–14 d later. They are a wonderful and cost effective addition to any pest control program and work with beneficial insects. Larvae of several species were found, providing excellent pest management, particularly when ants were controlled within the orchard (Arkico organics, <www.arkico-organics.com>). 

**Mealybug Destroyer.** Cryptolaemus montrouzieri is a small, reddish-brown beetle with dark brown wing covers. Often called “crypts,” they also eat other prey (such as soft scales and aphids), which is why they are ideal in greenhouses, interior plantscapes, orchards, and ornamental gardens (Planet natural, <www.planetnatural.com>). Within our orchard study, these are the most impactful of the predators—when their populations exploded, the pest populations crashed in the following few weeks. Pest populations do need to achieve significant populations to allow for the growth of the predators to occur. The mealybug destroyer is large and often mistaken for a pest itself, leading to the application of unnecessary and destructive pesticides.

Adult female mealybug destroyers lay yellow eggs in the cottony egg sacks of mealybugs. Eggs hatch in about 5 d, based on the temperature. There are three larval stages that last from 12–17 d, during which time the larvae feed on young crawlers, eggs and the sugary liquid excrement. Pupation typically occurs on sheltered plant stems. After 7–10 d, adults emerge and live for approximately two months. There are an average of 4 generations each year. They are best released in early spring when pests are first observed. They are most active at 70 °F or higher. The release rate should be 0.5 per sq. ft. of planted area. They are a wonderful and cost effective addition to any pest control program and work with beneficial insects. Larvae of several species were found, providing excellent pest management, particularly when ants were controlled within the orchard (Arkico organics, <www.arkico-organics.com>).

**Assassin Bug.** Several of the species have widely known common names. With the experimental orchard we had Zelus longipes, the Milkweed Assassin Bug. Milkweed Assassin Bugs are highly beneficial insects (Planet natural, <www.planetnatural.com>). They eat several insects, such as houseflies, armymyrmoids, stinkbugs, aphids, etc. Assassin bugs have a bright red-colored bodies with black wings, long black antennae, and long black legs. Common throughout the orchard they eat a host of large chewing insects in the orchard.

The assassin bug often waits in hiding and ambushes its prey. The eyes tend to be large and set at the middle or rear of the head with a neck-like area behind. The antennae have four segments. Like all true bugs, assassin bugs have sucking-piercing mouthparts (called a beak) used to remove body fluids from their prey. The beak has three segments and rests in a groove between the legs when not in use. Once the prey is captured, salivary secretions are pumped inside the piercing/sucking mouthpart. The salivary secretions not only immobilize prey, but also dissolve the internal tissues of the prey. This makes it easier for the bug to withdraw the bodily contents of its prey. In warm months, the females lay eggs which stick in clusters to leaves and stems.

**Paper wasps.** Paper wasps feed on caterpillars and other insects that could be damaging within the orchard (Planet natural, <www.planetnatural.com>). The wasps carry caterpillars back to their nests, feeding them to the developing larvae. They feed on a variety of worms, including armyworms, corn earworms, hornworms, and loopers. They also feed their young beetle larvae, flies, and scales.

Adult paper wasps primarily feed on nectar or other sugary solutions, such as honeydew, and will feed on the juices of ripe fruits being mistaken for pests. Within our experimental orchard the paper wasp is an efficient predator of large soft scales such as croton scale. The adults pry the adult scale up, turn it over and eat the soft-bodied insect. They alone are not able to keep scales under control, but were effective in association with other predators in the orchard.

**Spiders.** Spiders are an abundant and widespread natural controller of insect pests (James, 2014 ). While web building spiders ensnare their prey in their web, other spiders hunt and actively search for their food. Spiders are arachnids, not insects, although both are considered arthropods. Spiders lay their eggs in a silken, egg-shaped sac. Many of the several hundred newly born spiders climb to the top of a nearby object, producing long filaments of silk and get carried by the wind. This method of dispersal is known as ballooning.

Jumping spiders were found to be the most effective predators among the spiders within the orchard. These ambush predators are highly colored and active in the spring, causing alarm among the inexperienced orchardist. They prey upon large and small chewing and sucking pests and had a large positive impact in our orchard. Common in gardens, jumping spiders do not make webs, and instead use a silk string to tether themselves to vegetation in case they do not make a jump. Spiders tend to hunt for their prey, which includes aphids, mites, caterpillars, wasps, beetles, wasps, grasshoppers, moths, butterflies, etc. The spiders, as well as serving as beneficial predators in the garden, also serve as food for certain predators, such as parasitic wasps. Having spiders in your garden is essential, with them serving as both predators and prey in the garden.

**Lizards.** Anoles are often called chameleons because they change color from green to brown and vice versa. These changing colors depend on hormones and are triggered by temperature, background color, or mood. They are adept at climbing trees, shrubs, fences, and walls (Texas A&M University, <www.agegie-horticulture.tamu.edu>). The experimental orchard had many adult and immature anoles on a routine basis. They controlled flies (including fruitflies), grasshoppers and other foliage feeders. Seeing these lizards in the orchard is a good thing, meaning that you are probably not using pesticides that could harm them. These lizards are beneficial, feeding on many different small insects such as crickets, cockroaches, moths, grubs, beetles, flies, and grasshoppers. With birds being a major enemy, anoles are often seen with missing tails and body wounds, including holes in their sides. The tails can be re-grown, but the new tail lacks bones, is often deformed, and tends to remain a constant grayish brown color.

**Conclusions**

Within the BA Campbell estate orchards we found a good range and number of predators that, throughout the observational interval of the study, successfully managed the pests within the orchard. The fruit from this orchard was sold through local farmers’ markets and by mail order with considerable success. Damage due to insect pests was not a major hindrance for the orchard, given the way the fruit were marketed and the orchard
and harvested managed. The authors feel it is possible to control the orchard pests of mango through a healthy and diverse predator population for estate growing here in South Florida.

**Literature Cited**


