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Soil insects associated with lucumo (*Pouteria lucuma* L.) trees in La Molina, Lima, Peru

Insectos de suelo asociados con árboles de lúcumo (*Pouteria lucuma* L.) en La Molina, Lima, Perú

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Abstract

This study aimed to determine the composition and relative abundance of soil insects associated with lucumo (*Pouteria lucuma* L.) trees growing in the agricultural fields of the Universidad Nacional Agraria La Molina in Lima, Peru. In total, 12 pitfall traps were installed in a 5-ha lucumo field and samples were collected on a weekly basis for approximately 4 months (March–June). Insects in each sample were separated into morphotypes, and the number of individuals in each morphotype and date of collection were recorded. The collected insects were then identified at the Entomology Museum laboratory in Lima through comparison with museum samples and with the help of identification keys. Individuals in the orders Orthoptera (families Acrididae and Gryllidae), Dermaptera (Anisolabididae), Coleoptera (Carabidae, Staphylinidae, Tenebrionidae, Scarabaeidae and Elateridae), Blattodea (Blatellidae) and Hymenoptera (Formicidae) were identified. Among the Coleoptera, *Tetracha chilensis* (Laporte, 1834) (Carabidae) was the most abundant species; furthermore, Staphylinidae of the subfamily Oxytelinae and the families Elateridae (*Conoderus* spp.), Tenebrionidae (*Epitragopsis* sp.) and Scarabaeidae (*Ataenius* sp.) were identified. Additional taxa identified were as follow: *Gryllus assimilis* (Fabricius, 1775) (Gryllidae) in Orthoptera, *Euborellia annulipes* (Lucas, 1847) (Anisolabididae) in Dermaptera and *Linepithema* spp. in Hymenoptera.

Keywords: Insect, Soil, Lucumo, Peru

Resumen

Con la finalidad de determinar la composición y abundancia relativa de los insectos de suelo en el cultivo de lúcumo en el área agrícola de la Universidad Nacional Agraria La Molina, se instalaron 12 trampas de caída en un campo de lúcumo (Banco de Germoplasma de Lúcumo del Programa de Investigación en Árboles Frutales), de 5 Has. Se realizaron evaluaciones semanales durante aproximadamente 4 meses (marzo-junio). Las muestras colectadas se procesaron separando los individuos por morfotipos, registrando la cantidad y fecha de colección. Finalmente, se identificaron los individuos en el Laboratorio del Museo de Entomología comparando con las muestras del museo y con ayuda de llaves de identificación. Se identificaron individuos de las órdenes Orthoptera (Fam. Acrididae y Gryllidae); Dermaptera (Fam. Anisolabididae); Coleoptera (Fam. Carabidae, Staphylinidae, Tenebrionidae, Scarabaeidae y Elateridae); Blattodea (Fam. Blatellidae); e Hymenoptera (Fam. Formicidae). Del Orden Coleoptera, se identificaron a las familias: Carabidae teniendo como especie más abundante a *Tetracha chilensis* (Laporte, 1834); Staphylinidae, los individuos de la subfamilia Oxytelinae; Elateridae, *Conoderus* sp.; Tenebrionidae, *Epitragopsis* sp.; y Scarabaeidae, *Ataenius* sp. De Coleoptera, la especie más abundante fue *Tetracha chilensis* (Carabidae). Del orden Orthoptera, *Gryllus assimilis* Fabricios (Gryllidae). Dermaptera, *Euborellia annulipes* Lucas (Anisolabididae). Del Orden Hymenoptera, el género *Linepithema* sp. fue el más abundante.

Palabras clave: Insectos, Suelo, Lúcumo, Perú.

Introduction

Various perennial crops, primarily fruit trees, are grown in Peru, particularly along the coast. One such tree is the lucumo (*Pouteria lucuma* L.), which is very important in this region, although it is not sown at a large scale on the coast. Peru is considered to be the primary producer of lucuma in the international market, with Lima, Piura, Cajamarca, La Libertad, Ica and Ayacucho being the regions with the highest production (Lavado, Yenque, &

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Robles, 2012). Of these, the valleys of Cañete, Huaral and Huacho of the Lima Region and the Chincha valley of the Ica Region produce higher quality fruits for export purposes (SIICEX 2015).

Studies have been conducted on insects that affect this crop; these insects are mostly found in the canopy of trees. These studies have enabled the determination of many pests that are known today. On the contrary, limited information is available regarding the insects that inhabit the soils in which this crop is grown; Among these, potential pests, or beneficial insects can be found to the crop.

Five orders of insects are believed to use soils as their main habitat: Blattodea, Dermaptera, Orthoptera, Coleoptera and Hymenoptera.

Within the order Blattodea, the families Blattidae, Blatellidae and Blaberidae are found most frequently in soil.

In Dermaptera, members of the families Anisolabididae and Labiduridae inhabit soil. Among these, the species *Euborellia annulipes* (Lucas, 1847) (Anisolabididae) is considered as a predator species, particularly of eggs and larval stages of some insects. However, Rondón (1999) analysed the stomach content of the aforementioned species and determined that these may primarily be phytophagous species and may secondarily feed on some soil arthropods; these findings suggest that *E. annulipes* is not a predator species.

Most soil-dwelling Orthoptera belong to the family Acrididae, with approximately 84 species recorded in Peru (Lieberman, 1963, as cited by Beingolea, 1990). However, Gryllidae have been recorded in soil, including *Gryllus assimilis* (Fabricius, 1775), which is considered to be a potential pest of several crops (Sánchez & Vergara, 2014).

Among the Coleoptera, members of the family Carabidae are generally considered to use soil as their main habitat. This family comprises >40,000 species worldwide (Lovëi & Sunderland, 1996); most of these are generalist predators, and some are important in the natural control of agricultural pests (Vélez-Azañero & Lizárraga, 2013). For example, *Blennidus peruvianus* (Dejean, 1828), which is one of the most abundant soil predators in fields of various crops, including sweet potato, asparagus, beans, corn, potato and tomato (Vergara & Amaya de Guerra, 1978; Velapatiño, 1997; Schuller & Sánchez, 2003; Rondón & Vergara, 2004), along with *Tetracha chilensis* (Laporte, 1834). However, other species in this family, such as *Notiobia peruviana* Dejean, are phytophagous and prefer to eat seeds (Lietti, Montero, Faccini, & Nisensohn, 2000, as cited by Castañeda, Sánchez, & Arellano, 2007). Similarly, although most members of the family Staphylinidae are predators of insects and other invertebrates, some species feed on fungi or decomposing organic matter (Arnett & Thomas, 2001).

The order Coleoptera includes the family Scarabaeidae, including some species of economic importance because they can cause considerable damage by defoliation as adults or feeding on the roots as larvae (Arnett & Thomas, 2002). Within this family, *Anomala testaceipennis* (Blanchard, 1850) and *Paranomala undulata* (Melsheimer, 1845) are particularly important pests of various crops, such as potato, strawberry, cotton, sugar cane, beans, lima beans, asparagus and corn (Alata, 1973, as cited by Gonzales-Bustamente, 1994; Vergara & Amaya de Guerra, 1978; Raven, 1988). Some species in the family Elateridae are pests of crops, with adults feeding on nectar, pollen, floral parts, fungi and extrafloral nectaries, with most insects being diurnal and some, particularly in the neotropics, being crepuscular or nocturnal (Johnson & Quartone, 2004, as cited by Aguirre-Tapiero, 2009). In contrast, members of the family Tenebrionidae are mainly scavengers (Van et al., 2000) that can additionally feed on wood, although they often emerge nocturnally to feed on lichens, fungi or some other plant material.

Finally, in the Hymenoptera, members of the family Formicidae mainly inhabit the soil.

Therefore, the objective of this research was to determine the composition and relative abundance of insects inhabiting the soils in which lucumo trees are grown in La Molina, Lima, Peru.

Materials and Methods

Weekly evaluations of the soil invertebrate fauna in a field of the Germplasm Bank of Lucumo of the Research Program in Fruit Trees at the Universidad Nacional Agraria La Molina in Lima, Peru, were conducted between 9th March and 8th June 2013 (n = 13 samples). Lucumo trees were planted over 5 ha in these fields, and soil insects were collected using pitfall traps.

Field work

Installation of pitfall traps

Quadrat sampling was used to distribute the pitfall traps as uniformly as possible across the lucumo field. The field was divided into three sectors, each of which had an irregular shape, rendering it impossible to determine the specific area. Therefore, the relative size of each sector was used to determine the distribution of pitfall traps, resulting in the installation of 3, 4 and 5 pitfall traps in the first, second and third sectors, respectively, with 12 traps installed in total.

The pitfall traps were poly-wrap polyethylene

containers that were 15 cm in height and 10 cm in diameter. They were filled with 250 mL of a solution that was approximately 9 parts water to 1 part formaldehyde with 4–5 g of detergent. The formaldehyde was added to prevent the decomposition of the collected insects, whereas the detergent was used to break the surface tension of the solution.

To install the pitfall traps, a hole was dug in the ground using a small hoe such that the mouth of the container was flush with the surface of the soil, and the soil was then flattened to create a uniform surface. The pitfall traps were randomly distributed through the lucumo field to cover the largest possible area. Lucumo trees were planted at a spacing of 4 m × 4 m, and the pitfall traps were placed between the trees at a distance of 2 m from each tree and the edge of the irrigation channel. A brightly coloured stake was then placed alongside each trap to enable easy identification. No pitfall traps were installed within 10 m of the ends of the field to avoid any edge effects.

Sample collection

The pitfall traps were removed on a weekly basis and their contents were poured into hermetically sealed polyethylene cups, 7 cm in height and 5 cm in diameter, marked with the trap number and date of evaluation using indelible ink. The pitfall trap containers were washed, cleaned, refilled with 250 mL of solution (as mentioned above) and reinstalled.

Sample processing in the laboratory

The collected samples were transported to the Research Laboratory of the Entomology Museum of the Universidad Nacional Agraria La Molina for processing.

Each sample was sieved through an organza cloth strainer and rinsed with running water until it was clean and free from formalin odours. The sieved sample was then returned to the original polyethylene cup, which was washed and filled with clean water to facilitate the separation of the captured insects and prevent them from being damaged.

The samples were placed in Petri dishes and separated and grouped into morphotypes based on their morphological characteristics (Oliver & Beattie, 1993, 1996a, b) using knife and fine forceps. Further, the number of individuals in each morphotype was counted, and the invertebrates were placed in small 10-mL bottles containing 70% alcohol. These bottles were labelled with a code that consisted of the first letter of the crop, the first three letters of the order to which the invertebrates belonged and the morphotype number, for example, lucumo and order Hymenoptera samples were coded as 'LHYM1', 'LHYM2' and 'LHYM3'.

A sample of each species that was collected during the evaluation was mounted on entomological pins and/or placed in alcohol, labelled and registered in the Entomology Museum of the Universidad Nacional Agraria La Molina.

Taxonomic identification

The collected individuals were identified by specialists in the laboratory of the Klaus Raven Büller Entomology Museum of the Universidad Nacional Agraria La Molina using identification keys and comparing them with samples in the museum collection.

Results

In total, 66,901 insects were collected during the study period, with 96.6% of these species developing in and mainly inhabiting the soil. These soil insects included members of the Orthoptera, Blattodea, Dermaptera, Coleoptera and Hymenoptera (Fig. 1).

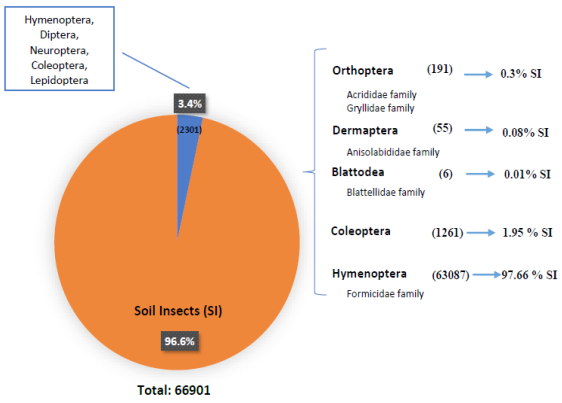

Figure 1. Insects that were captured in pitfall traps installed in a field of lucumo (*Pouteria lucuma* L.) in La Molina, Lima, Peru between March and June 2013.

The order Hymenoptera was the most predominant, comprising 97.66% of the total soil insects collected (63,087 individuals), followed by the orders Coleoptera (1.95%, 1,261 individuals), Orthoptera (0.30%, 191 individuals), Dermaptera (0.08%, 55 individuals) and Blattodea (0.01%, 6 individuals).

On the first collection date (16 March 2013), 19,881 insects were captured, most of which belonged to the family Formicidae (Fig. 2). An overall decrease in the number of insects was observed until 13th April, when 719 individuals were captured, with a slight increase recorded on 6th April (2,573 individuals) because a large number of ants were captured in one of the traps. The second highest number of insects was captured on 20th April (18,649 individuals), with 3,000–9,000 individuals of the Formicidae family recorded in three pitfall traps.

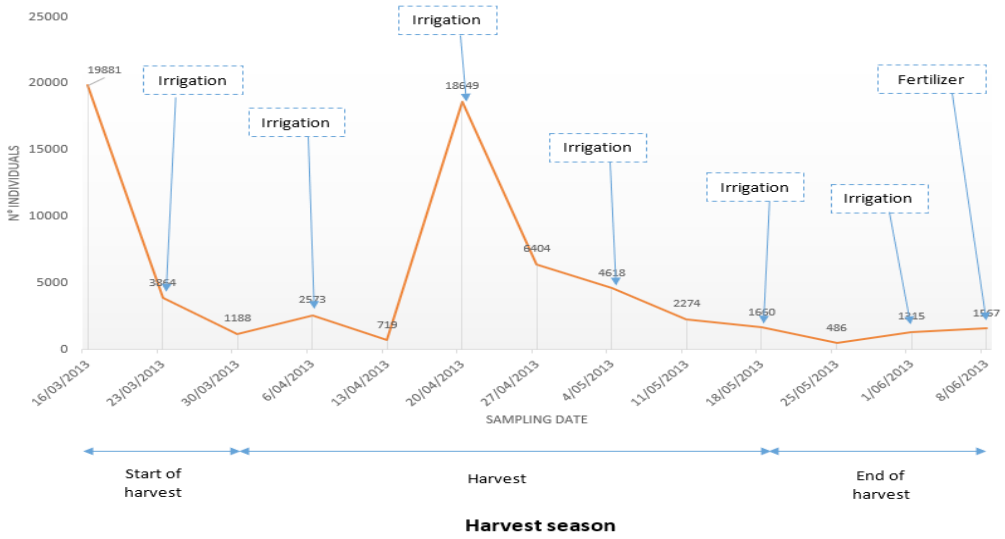

Figure 2. Changes in the number of soil insects captured in pitfall traps installed in a field of lucumo (*Pouteria lucuma* L.) in La Molina, Lima, Peru between March and June 2013.

However, the number then decreased again from 27th April to 25th May, when the lowest number of insects was captured throughout the entire study period (486 individuals). A slight increase in the number was observed in the last two evaluations (1,315 individuals on 1st June and 1,567 individuals on 8th June).

Order Orthoptera

Members of the families Acrididae and Gryllidae were recorded in the samples.

A low abundance of Acrididae was observed among the samples, with only two individuals in the nymphal stage being identified as 'Gen sp1'. Generally, adults of this family are found to be feeding on the leaves of plants. However, most nymphs are found in the ground, which explains why only this stage was captured in the pitfall traps. The family Grylidae was represented by *Gryllus assimilis* (Fabricius, 1775), with 189 individuals captured in total. Particularly high numbers of this species were captured on 16th March (24 individuals), 6th April (25 individuals) and 18th May (19 individuals; Fig. 3).

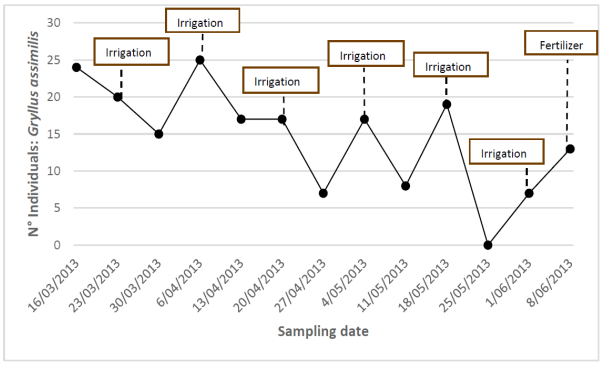

Figure 3. Incidence of *Gryllus assimilis* (Fabricius, 1775) in pitfall traps installed in a field of lucumo (*Pouteria lucuma* L.) in La Molina, Lima, Peru in March–June 2013.

Order Dermaptera

Euborellia annulipes (Lucas, 1847) in the family Anisolabididae was the only representative of the order Dermaptera that was recorded in the samples. In total, 55 individuals were collected, with high numbers occurring on 16th March (7 individuals), 23th March (8 individuals), 27th April (8 individuals), 4th May (7 individuals) and 11th May (7 individuals; Fig. 4).

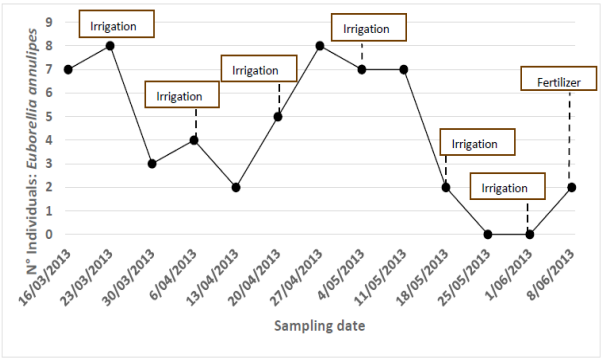

Figure 4. Incidence of *Euborellia annulipes* (Lucas, HF, 1847) in pitfall traps installed in a field of lucumo (*Pouteria lucuma* L.) in La Molina, Lima, Peru in March–June 2013.

Order Blattodea

Six individuals belonging to the family Blatellidae were collected; however, they could not be identified and were recorded as Gen sp1.

Order Coleoptera

Five families were recorded in the order Coleoptera: Carabidae, Staphylinidae, Scarabaeidae, Elateridae and Tenebrionidae. Among these, members of the family Carabidae were most abundant (76.6%, 966 individuals),

followed by Tenebrionidae (11.82%, 149 individuals), Elateridae (9.99%, 126 individuals), Staphylinidae (1.1%, 14 individuals) and Scarabaeidae (0.5%, 6 individuals; Fig. 5). Although insects belonging to other families were identified, these were not included in this study because they are not considered to be soil invertebrates.

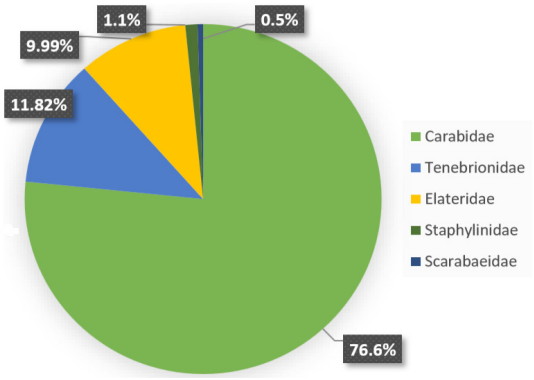

Figure 5. Families of soil insects in the order Coleoptera that were captured in pitfall traps in a field of lucumo (*Pouteria lucuma* L.) in La Molina, Lima, Peru in March–June 2013.

Family Carabidae

Five species of Carabidae were recorded: *Tetracha chilensis* (Laporte, 1834) (653 individuals), *Blennidus peruvianus* (Dejean, 1828) (293 individuals), *Notiobia peruviana* (Dejean, 1829) (15 individuals), *Tetragonoderus* sp. (3 individuals) and Gen sp. (Harpalini) (2 individuals).

The two individuals of Gen sp. were captured on 20th April and 4th May, whereas *Tetragonoderus* sp. was only collected on 25th May. In contrast, *N. peruviana* was collected on 10 of the 13 collection dates, with a maximum of three individuals recorded in a collection. Similarly, *B. peruvianus* was captured throughout the study period, with a maximum of 80 individuals captured on 25th May and a minimum of 10 individuals captured on 24th April (Fig. 6).

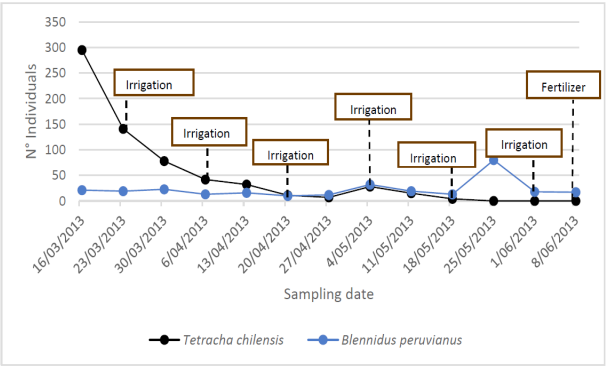

Figure 6. Incidences of *Tetracha chilensis* (Laporte, 1834) and *Blennidus peruvianus* (Dejean, 1828) in pitfall traps installed in a field of lucumo (*Pouteria lucuma* L.) in La Molina, Lima, Peru in March–June 2013.

Finally, a high number of *Tetracha chilensis* was captured on 16th March (295 individuals), 23th March (141 individuals) and 30th March (78 individuals). However, the population subsequently decreased, with no individuals captured on the last three collection dates (Fig. 6).

Family Staphylinidae

In the family Staphylinidae, two individuals of the species *Platydracus notatus* (Solsky, 1872), two morphotypes of the subfamily Oxytelinae recorded as Gen sp1. (1 individual) and Gen sp2. (8 individuals), two morphotypes of the subfamily Aleocharinae recorded as Gen sp3. (1 individual) and Gen sp4. (1 individual) and one morphotype of the subfamily Staphylininae recorded as Gen sp5. (1 individual) were collected.

Family Scarabaeidae

Two species of Scarabaeidae were collected: *Paranomala undulata* (Melsheimer, 1845) (2 individuals) and *Ataenius* sp. (4 individuals). *Paranomala undulata* was collected on 23th March and 20th March, whereas *Ataenius* sp. was recorded on 30th March, 11th May, 25th May and 1st June (1 individual on each date).

Family Elateridae

Two species of Elateridae were collected: *Conoderus* sp. (116 individuals) and *Horistonotus* sp. (10 individuals). *Horistonotus* sp. was collected on five dates: 16th March (4 individuals), 23th March (2 individuals), 6th April (1 individual), 20th April (2 individuals) and 18th May (1 individual). In contrast, *Conoderus* sp. had a more constant presence, although the highest numbers were recorded at the beginning of the study period on 16th March (25 individuals) and 23th March (24 individuals), with numbers gradually decreasing until no individuals were recorded on 25th May (Fig. 7).

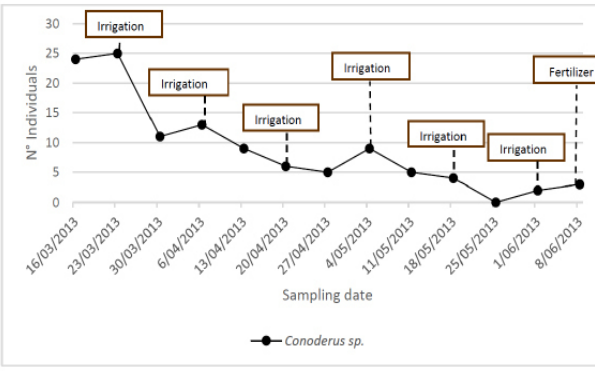

Figure 7. Incidence of *Conoderus* sp. in pitfall traps installed in a field of lucumo (*Pouteria lucuma* L.) in La Molina, Lima, Peruin March–June 2013.

Family Tenebrionidae

Four species of Tenebrionidae were recorded: *Epitragopsis*

sp. (74 individuals), *Gondwanocrypticus* sp. (24 individuals), *Blapstinus holosericius* (Laporte, 1840) (50 individuals) and *Hipalmus costatus* (Guérin-Méneville, 1831) (1 individual).

The largest number of *Epitragopsis* sp. was recorded on the first collection date (16th March), with 16 individuals captured (Fig. 8). Subsequently, the population decreased, with no individuals recorded on two occasions. High numbers of *Gondwanocrypticus* sp. were recorded on the second collection date (8 individuals), following which few or no individuals were collected in the subsequent evaluations (Fig. 8). *Blapstinus holosericius* showed peaks on 20th April (8 individuals) and 27th April (7 individuals) and was not recorded on 16th March (Fig. 8). Finally, one individual of *Hipalmus costatus* was recorded on 20th April.

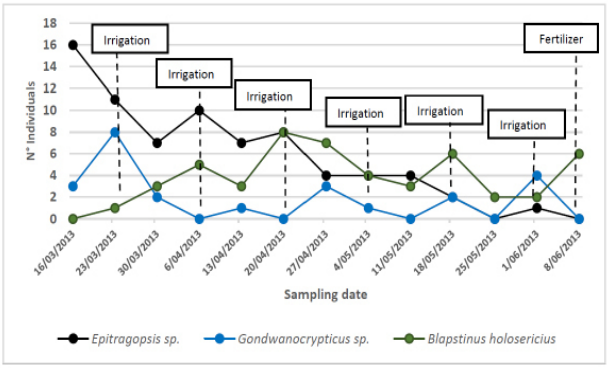

Figure 8. Incidences of *Epitragopsis* sp., *Gondwanocrypticus* sp. and *Blapstinus holosericius* (Laporte, 1840) in pitfall traps installed in a field of lucumo (*Pouteria lucuma* L.) in La Molina, Lima, Peru in March–June 2013.

Order Hymenoptera

Several taxa in the family Formicidae were recorded during the study period, including *Linepithema* sp. (60,342 individuals), *Tetramorium* sp. (1,185 individuals), *Brachymyrmex* sp. (1,377 individuals), *Brachymyrmex* sp1. (9 individuals), three morphotypes of the subfamily Formicinae recorded as Gen sp1. (25 individuals), Gen sp2. (138 individuals) and Gen sp3. (5 individuals) and two taxa recorded only as Gen sp4. and Gen sp5.

Linepithema sp. was the most abundant taxon, with 19,130 individuals recorded on the first collection date, following which the population decreased remarkably (Fig. 9). Further, a second peak was recorded on 20th April (18,463 individuals), whereas the lowest collection was recorded on 25th May (384 individuals).

The highest number of *Tetramorium* sp. was obtained on the first collection date (173 individuals), following which the number of individuals gradually decreased, approaching the lowest record of only 2 individuals on 25th May (Fig. 10). In contrast, the highest number of *Brachymyrmex* sp. was collected on the last collection date (633 individuals), whereas only 6 individuals were collected on 25th May (Fig. 10).

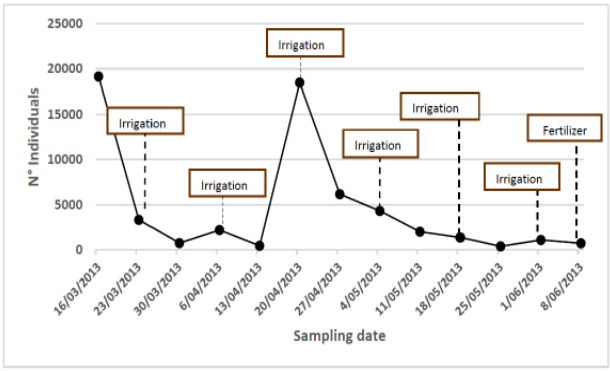

Figure 9. Incidence of *Linepithema* sp. in pitfall traps installed in a field of lucumo (*Pouteria lucuma* L.) in La Molina, Lima, Peru in March–June 2013.

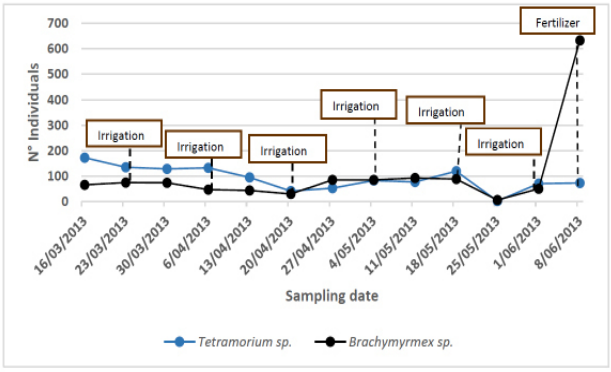

Figure 10. Incidences of *Tetramorium* sp. and *Brachymyrmex* sp. in pitfall traps installed in a field of lucumo (*Pouteria lucuma* L.) in La Molina, Lima, Peru, in March–June 2013.

Discussion

Orthoptera

The number of *G. assimilis* captured generally increased on the dates when irrigation occurred (Fig. 3). The abundance of litter on the field beneath the lucumo trees provided a refuge for these insects, with individuals being captured in the pitfall traps while they were moving. Unlike Acrididae adults, Gryllidae adults are not very commonly found on trees, resulting in the traps collecting both first stage and adult individuals. This species is considered to be a potential pest of crops such as corn (Sánchez & Vergara, 2014).

Dermaptera

Low numbers of individuals were captured between the third and fifth collection dates and during the final collection. This may have occurred because of irrigation during the study period, which displaced individuals that were present in the irrigation furrows. On the dates with

no risks, individuals may have accidentally fallen into the pitfall traps.

Blattodea

Members of the order Blattodea are known to be omnivores; therefore, their presence may have been supported by the refuge areas and diverse food sources that were available.

Coleoptera

Among the members of the family Carabidae, *Tetracha chilensis* and *Blennidus peruvianus* were the most abundant. A high abundance of the former species can be explained by the large number of refuge areas that were observed in lucumo fields; as a result, a wide variety of arthropods were available in the soil as a food source for this species. *B. peruvianus* has been reported to be one of the most abundant soil predators in the fields of several crops such as sweet potato, asparagus, bean, potato and tomato (Vergara & Amaya de Guerra, 1978; Velapatiño, 1997; Schuller & Sánchez, 2003; Rondón & Vergara, 2004). Among the least abundant species, *Notiobia peruviana* is considered to be a highly polyphagous species; however, it appears to primarily feed on the seeds of various plants (Nisensohn, Faccini, Montero, & Lietti, 1999; Lietti, et al., 2000; Arndt & Kirmse, 2002, as cited by Yábar, Castro, Melo, & Gianoli, 2006).

Staphylinidae

Staphylinidae is the family that showed the highest diversity of species with regard to the others families. Most Staphylinidae are predators of insects and other invertebrates; however, some feed on fungi or decomposing organic matter and most live among the leaf litter of forests and mosses (Arnett & Thomas, 2001), which resembles the habitat observed in lucumo fields.

Scarabaidae

Members of this family are usually found in places with abundant decomposing organic matter. Consequently, fruit fields, particularly perennial crops, represent a favourable agro-ecosystem for these insects because of the large number of leaves and fruits that fall on the ground.

Elateridae

The decrease in the number of the members of this family during the last evaluations coincided with the end of the harvest period in the field. Probably, conditions in this period were not favorable these insects. Moreover, Rondón & Vergara (2004) identified *Conoderus* sp. in a sweet potato field in Cañete, Lima, supporting its presence in this region.

Tenebrionidae

No specific information could be obtained regarding the behaviours or characteristics of *Gondwanocrypticus* sp., *B. holosericius* and *H. costatus*. However, *Epitragopsis olivaceus* (Erichson, 1847) was previously recorded in a sweet potato field in Cañete (Rondón & Vergara, 2004), although this may have been a different species from that observed here. Tenebrionidae are known to be saprophagous and generally feed on a various decaying plants and fungi (Van et al., 2000). Therefore, these insects may have fallen into the traps while searching for shelter and/or food because these conditions are common in lucumo fields.

Hymenoptera

Formicidae are known to inhabit the soil and litter (Fernández, 2003), which commonly occurs in lucumo fields. Furthermore, the large distance between plants enabled these insects to establish their nests throughout the entire field. Several nests were located on the edges of the water channels and were disturbed by the irrigation, which may have displaced the ants and resulted in their capture.

Conclusions

Soil insects belonging to the orders Orthoptera, Dermaptera, Blattodea, Coleoptera and Hymenoptera were captured in pitfall traps installed in a lucumo field in Lima, Peru between March and June 2013. Members of the order Hymenoptera were most abundant, followed by Coleoptera, Orthoptera, Dermaptera and Blattodea.

In the order Orthoptera, members of the family Gryllidae were identified, with *Gryllus assimilis* (Fabricius, 1775) being the most abundant. In the order Dermaptera, *Euborellia annulipes* (Lucas, 1847) in the family Anisolabididae was recorded, whereas in the order Blattodea, members of the family Blatellidae were collected. Four families in the order Coleoptera were recorded, among which Carabidae was the most abundant, with *Tetracha chilensis* (Laporte, 1834) being predominant. In the family Staphylinidae, the subfamily Oxytelinae was the most abundant, whereas *Ataenius* sp. (Scarabaeidae), *Conoderus* sp. (Elateridae) and *Epitragopsis* sp. (Tenebrionidae) were additionally present. Finally, three species were identified in the order Hymenoptera, belonging to the family Formicidae: *Linepithema* sp., *Tetramorium* sp. and *Brachymyrmex* sp.; *Linepithema* sp. was found to be the most abundant.

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