

Coccoidea (Insecta: Hemiptera) Associated With Cactaceae in Argentina

Lucía E. Claps and María E. de Haro

Instituto Superior de Entomología “Dr. Abraham Willink” (INSUE)
Miguel Lillo 205, 4000 S. M. de Tucumán, Argentina
e-mail: instlillo@infovia.com.ar

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ABSTRACT

Coccoidea (Insecta: Hemiptera), commonly called “cochineal insects”, “mealybugs” or “scale insects”, show a marked sexual dimorphism and display a high degree of adaptation to the parasitic life. They have adapted to become a specialised group of small phytophagous insects no more than a few millimetres in length. This paper provides more information with regard to Coccoidea species and their hosts recorded on Argentinean cacti. Six species of Dactylopiidae: *Dactylopius austrinus* De Lotto, *Dactylopius ceylonicus* (Green), *Dactylopius confertus* De Lotto, *Dactylopius coccus* Costa, *Dactylopius salmianus* De Lotto, and *Dactylopius zimmermanni* De Lotto; four species of Diaspididae: *Abgrallaspis cyanophylli* Signoret, *Aonidomytilus albus* (Cockerell), *Diaspis boisduvalli* Signoret, *Diaspis echinocacti* (Bouché); and two species from Pseudococcidae: *Hypogeococcus festerianus* (Lizer y Trelles) and *Hypogeococcus pungens* Granara de Willink, are reviewed. The characterisation and importance of the three registered families are also provided.

Keywords: Dactylopiidae, Diaspididae, Pseudococcidae, Cactaceae

INTRODUCTION

The superfamily Coccoidea, commonly called “cochineal insects”, “mealybugs”, or “scale insects”, are hemipterous insects belonging to Sternorrhyncha. They constitute a homogenous and specialised group of small phytophagous insects a few millimetres in length, characterised by a high degree of adaptation to the parasitic life and showing extreme sexual dimorphism. According to different authors approximately 6000 to 8000 species from between 16 and 24 families can be identified worldwide (Claps, 1998). In general, the highest diversity of genera and species are found in the tropics, subtropics and in climates with high temperatures. They can be found in different parts of their hosts or even be restricted to a specific organ. Some species are cosmopolitan, whereas others are either present in specific environments or limited to specific geographical regions. Some species can have a wide host range including species from different plant families (polyphagous), be restricted to a few hosts (oligophagous) or can even be restricted to a single host (monophagous).

The Coccoidea are of particular importance because they include several prolific species that have become serious pests in crops, fruit, ornamentals and indigenous plants. On the other hand, some species are appreciated for their commercial use, both for the production of natural dyes and resins and also for their use in the biological control of weeds. This paper focuses on the cactus-associated Coccoidea species in Argentina. Several of these are of economic importance.

MORPHOLOGICAL AND BIOLOGICAL ASPECTS

The females are neotenic, i.e., they acquire sexual maturity but maintain juvenile characteristics and are always apterous. A cephalothorax and abdomen can be differentiated. Although legs can either be absent or rudimentary, most of them tend to lead a sedentary life as adults. Females and immatures of both sexes feed on plant saps by inserting their long stylets into their host plants. The body is globose, elongated or pyriform and may be protected by a waxy substance or by a lac resin produced by special glands. Such protective substances can be either pulverulent, in the form of thickish protective layers with diverse ornamentations and colourings, or in the form of scales. Males are generally smaller and less conspicuous than females and are active for only a short time after their final moult. Their mouthparts are nonfunctional and they have only one pair of wings, the second pair of wings being either absent or has developed into halteri.

Female development from the egg-stage until adulthood is slow and gradual (hemimetabolic). Males, however, develop through more conspicuous stages, especially in the final instars approaching a more complete metamorphosis characteristic of holometabolic insects. Before reaching its adult shape, the female typically undergoes two nymphal stages (for Pseudococcidae three) distinguished by the following phases: egg, first instar (ambulatory nymph or crawlers), second instar (fixed nymph), and third stage (adult). The male, in contrast, reaches the adult stage in a more evolved manner after passing through four nymphal stages; the first two instars being comparable to that of the female but the third and fourth are characterised by a prepupal and pupal stage.

MATERIALS AND METHODS

The insects that were studied are kept in the entomological collections of the following Institutions in Argentina: Instituto-Fundación Miguel Lillo, Tucumán (IMLA), and Colección Lizer y Trelles, deposited in the Instituto de Patología Vegetal del Instituto Nacional de Tecnología Agropecuaria (INTA) Castelar, Buenos Aires. The authors have also made extensive collections in different regions of Argentina, from La Quiaca, Jujuy (22° 06' S, 65° 35' W) as a northern limit to Las Lajas, Río Negro (38° 31' S, 70° 22' W) as a southern limit.

RESULTS

Three families are recognized within the superfamily Coccoidea, namely, Dactylopiidae, Diaspididae, and Pseudococcidae. The families' general characteristics are presented as well as a species list for cacti of Argentina.

Dactylopiidae

This family of Neotropical origin and commonly known as “carmine cochineals”, is found exclusively on cacti. They are sessile and female colonies are commonly found feeding externally on cladodes (modified cactus stems that function as leaves) (Photo 1), but they can also feed on the roots, flowers, and fruits. They are small, from 3 to 5 mm, and easily identified by the presence of a white cotton-type secretion that covers the red purple body (Photo 2).

The small family Dactylopiidae is unique in several ways: first, because it contains the commercial carmine cochineal, *Dactylopius coccus*, which is the basis of the cochineal dye industry and, second, because several species have been used successfully in the biological control of cactus weeds worldwide.

Native Americans have used the carmine cochineal as textile dyes, in medicines, and cosmetics. This insect acquired great commercial importance with the arrival of the Spanish Conquistadors, which promoted their cultivation in Mexico but also encouraged production in other regions, such as Guatemala, Honduras, and the Canary Islands. Likewise, England encouraged cultivation of the insects in Africa and India. At the end of the last century, the less expensive aniline synthetic dyes replaced carmine and production in Mexico and other countries ceased. At present, the global demand of carminic acid as a basic colourant in food, drink, and cosmetic products has increased notably as a result of the prohibition of the use of artificial dyes or synthetics in the United States of America and the European Community (Baranyovits, 1978). The few countries producing carmine commercially today are Perú, México, the Canary Islands and, more recently, Chile and Bolivia. All the carminic acid consumed in Argentina is imported.

The family Dactylopiidae consists of a single genus, *Dactylopius*, including nine species. Only *Dactylopius coccus* is reared for commercial purposes (Pérez Guerra and Kosztarab, 1992). Five species have been recorded in Argentina namely, *Dactylopius austrinus* De Lotto, *Dactylopius ceylonicus* (Green), *Dactylopius confertus* De Lotto, *Dactylopius salmianus* De Lotto, and *Dactylopius zimmermanni* De Lotto (de Haro and Claps, 1995). Of these, *D. salmianus* was studied from entomological collections in Argentina as it has not been collected by the present authors (de Haro and Claps, 1999). Collections of *D. coccus* were made from free-living populations found on naturalized *Opuntia ficus-indica* (L.) Mill. plants growing in Anillaco, La Rioja. *D. coccus* might have been introduced originally for commercial purposes but has subsequently naturalized and was able to survive unaided. The genus was reviewed by De Lotto (1974) and Pérez Guerra and Kosztarab (1992).

All the species in this family are restricted to *Opuntiae* with only a few exceptions where other cactus genera are used as hosts. The most common and abundant cochineal species found in Argentina is *D. ceylonicus*, commonly found in the Northwest.

Moran and Zimmermann (1984) and Zimmermann *et al.* (1979) have reviewed the cochineals (Dactylopiidae) as biological control agents for the control of cactus invaders in several countries outside the Americas. In their native countries, the cochineals are important in maintaining the equilibrium of many *Opuntia* species in their natural habitats.

***Dactylopius austrinus* De Lotto**

Hosts: *Opuntia aurantiaca* Lindley., *Opuntia anacantha* Speg. var. *anacantha* (Speg.) R. Kiesling, *Opuntia anacantha* Speg. var. *kiska-loro* (Speg.) R. Kiesling, *Opuntia anacantha* Speg. var. *retrorsa* (Speg.) R. Kiesling, *Opuntia sulphurea* Gillies ex Salm-Dick var. *pampeana* (Speg.) Backeb. (cited in Pérez Guerra & Kosztarab, 1992), *Opuntia sulphurea* Gillies ex Salm-Dyck.

D. austrinus was introduced to Australia and South Africa for the successful biocontrol of *O. aurantiaca*. (Julien and Griffiths, 1999; Moran and Zimmermann, 1984)

***Dactylopius ceylonicus* (Green)**

Hosts: *Opuntia discolor* Britton & Rose, *O. ficus-indica*, *Opuntia quimilo* K. Schum., *O. anacantha*. var. *retrorsa*, *O. sulphurea* (cited in Pérez Guerra and Kosztarab, 1992), *O. anacantha*. var. *anacantha*, *Opuntia longispina* Haw., *Opuntia soehrensii* Britton and Rose, *Opuntia salmiana* Parm.

This species has been widely used outside the Americas for the successful biological control of *Opuntia monacantha* Willdenow (*O. vulgaris*) (Moran and Zimmermann 1984).

***Dactylopius coccus* Costa**

Hosts: *O. ficus-indica*, *O. ficus-indica* (*uncultivated*) (cited in de Haro and Claps, 1999).

***Dactylopius confertus* De Lotto**

Hosts: *Cleistocactus baumannii* (Lem.) Lem., *Echinopsis leucantha* (Gillies ex Salm-Dyck) Walp., (cited in Pérez Guerra & Kosztarab, 1992), *Cereus aethiops* Haw., *Denmoza rhodocantha* (Salm-Dyck) Britton & Rose, *Gymnocalycium monvillei* (Lem.) Britton & Rose, *Harrisia tortuosa* (Forbes ex Otto & D. Dietr.) Britton & Rose, *Pilocereus* sp., *Trichocereus candicans* (Gillies ex Salm-Dyck) Britton & Rose.

***Dactylopius salmianus* De Lotto**

Host: *O. salmiana* Parm. ex Pfeiffer (cited in Pérez Guerra & Kosztarab, 1992).

***Dactylopius zimmermannii* De Lotto**

Hosts: *Maihueniopsis ovata* (Pfeiff.) R. Ritter (cited in Pérez Guerra & Kosztarab, 1992), *C aethiops*, *Maihuenia patagonica* (Phil.) Britton & Rose, *Maihueniopsis darwinii* (Hensl.) F. Ritter, *Opuntia* sp.

Diaspididae

The “armoured scales”, or Diaspididae, is the most important family in the Coccoidea, because of their numbers, abundance, and economic significance. About 2,650 species within nearly 400 genera are known (Gibson & Read, 1999). The insects are small, 1 to 3 mm in length, and are characterized by the presence of a protective shell (Photos 4 and 5). This bears nymphal exuviae and grows with each molt of the insect forming a protective scale that provides protection during the life of the adult insects. Another feature of the insect is the fusion of the distal abdominal segments to form a pygidium. In Argentina, 63 exotic species and 15 native species have been identified, of which the following were recorded on cacti.

***Abgrallaspis cyanophylli* (Signoret)**

Host: *Opuntia* sp.

***Aonidomytilus albus* (Cockerell)**

Host: *Harrisia* sp

***Diaspis boisduvalli* Signoret**

Host: *Harrisia* sp.

***Diaspis echinocacti* (Bouché)**

Hosts: *Austrocylindropuntia shaferei* (Britton & Rose) Backeb., *Cereus forbesi* Otto ex C.F. Först., *Cereus haenkeanus* F. A. C. Weber ex K. Schum., *Harrisia* sp., *Maihueniopsis boliviana* (Salm-Dyck) R. Kiesling, *O. quimilo*, *O. sulphurea*, *Opuntia* sp., *Pterocactus tuberosus* (Pfeiff.) Britton & Rose, *Trichocereus atacamensis* (Phil.) Backeb., *Trichocereus terscheckii* (Parm. ex Pfeiff.) Britton & Rose and *Trichocereus thelegonus* (F. A. C. Weber) Britton & Rose

Pseudococcidae

The Pseudococcidae are known as “mealybugs”, because of the more or less abundant wax on the body giving it a whitish look. They are cosmopolitan, nearly 200 genera and 2000 species are known. The recorded species on cacti are mainly associated with the roots of their hosts. Williams and Granara de Willink, 1992, mentioned the following for Argentina:

***Hypogeococcus festerianus* (Lizer y Trelles)**

Hosts: *Cereus* sp., *C. aethiops*, *Echinopsis* sp.

***Hypogeococcus pungens* Granara de Willink**

Hosts: *C. aethiops*, *Cereus forbesii* Otto ex C. F. Fört., *Cleistocactus* sp., *Cleistocactus baumannii* (Lem.) Lem., *Harrisia bonplandi* (Pfeiff.) Britton & Rose, *Harrisia martinii* (Labour.) Britton & Rose, *Parodia microsperma* (F. A. C. Weber) Speg.

DISCUSSION

Of the three families in Coccoidea associated with Cactaceae in Argentina, the Dactylopiidae are particularly interesting because they are endemic to the Neotropics and they have all co-evolved with their associated Cactaceae hosts. In addition, they are economically significant due to their ability to produce carminic acid and because they are well known as biological control agents. *D. coccus* is not native to Argentina and is the only species so far that has been commercialized. Attempts to start large commercial production in Argentina may be hampered by the presence of effective natural enemies that have co-evolved with native cochineals.

The species *Diaspis echinocacti* is the most abundant and frequent cactus-feeding Diaspididae in Northwest Argentina, and can produce serious damage resulting in death and desiccation of their hosts (Photo 3). This species shows a tendency to be associated with the upper parts of their hosts and are seldom found on the roots. It is now a cosmopolitan pest and is found wherever *Opuntia* spp. are cultivated. The mealybug, *Hypogeococcus festerianus*, of the family Pseudococcidae was introduced to Queensland, Australia and South Africa for the biological control of *Harrisia martinii*, *H. tortuosa* (Forbes) Britton & Rose, *H. bonplandii* (Parmentier) Britton & Rose and *Cereus jamacaru* de Candolle (Julien & Griffiths 1999). These species are not causing the same level of damage on their hosts in Argentina because they are attacked by a complex of effective natural enemies and predators in their native range.

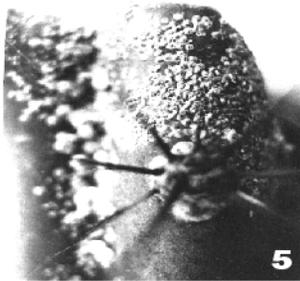
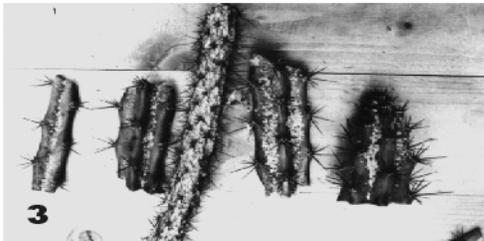
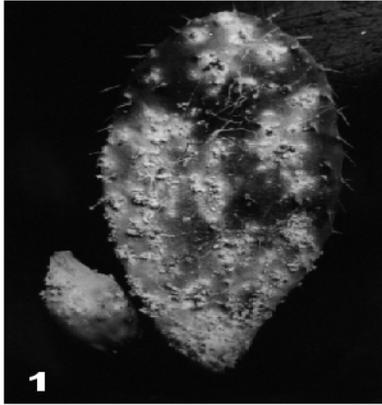


Photo 1. Infestation of cochineal scale, *Dactylopius coccus*, on *Opuntia ficus-indica*, from La Rioja, Argentina. Photo 2. Detail of a group of female adults of *Dactylopius ceylonicus* on *Opuntia* sp. Photo 3. General view of *Diaspis echinocacti* on *Harrisia* sp. showing different attack levels, until the eventual death of the plant. Photo 4. Detail of *Diaspis echinocacti* female scales. Photo 5. Detail of *Diaspis echinocacti* male scales

Photo 1. Infestation of Cochineal Scale, *Dactylopius coccus*, on *Opuntia ficus-indica*, from La Rioja, Argentina,

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Photo 3. General View of *Diaspis echinocacti* on *Harrisia* sp. Showing Different Attack Levels, Until the Eventual Death of the Plant,

Photo 4. Detail of *Diaspis echinocacti* Female Scales,

Photo 5. Detail of *Diaspis echinocacti* Male Scales

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