Natural enemies associated with *Dactylopius opuntiae* (Cockerell) (Hemiptera: Dactylopiidae) in Morocco and their population fluctuations

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Abstract

*Dactylopius opuntiae* (Cockerell) (Hemiptera: Dactylopiidae) is the most important pest of prickly pear cactus *Opuntia ficus-indica* in Morocco in recent years. In order to identify the natural enemies associated with this pest, and determine their population fluctuations, samplings were carried out at two distinct areas, sampling area 1- Zemamra in the Sidi Bennour region (120 km north-west of Marrakech), Morocco and sampling area 2-Gharbia in the same region. 15 species were found and identified: *Episyrphus balteatus* de Geer, *Eupeodes corollae* Fabricius (Diptera: Syrphidae), *Hyperaspis campestris* (Herbst, 1783), *Scymnus interruptus* (Goeze), *Scymnus loewii*, *Nephus redtenbacheri* (Mulsant, 1846), *Scymnus latemaculatus*, *Scymnus guttulatus* LeConte, *Exochomus nigripennis* (Erichson, 1843), *Coccinella septempunctata* (Linnaeus, 1758), *Hippodamia convergens*, *Chilocorus bipustulatus* (Linnaeus, 1758), and *Chilocorus politus* (Mulsant, 1850). (Coleoptera: Coccinellidae) and *Emmelina Monodactyla* (Lepidoptera: Pterophoridae). *Hyperaspis campestris* was found to be the most important species associated with *D. opuntiae* in study area-1 and *Chilocorus bipustulatus* in study area-2.

Keywords: *Dactylopius opuntiae*, *Hyperaspis campestris*, *Chilocorus bipustulatus*, biocontrol

Résumé

**Mots-clés:** *Dactylopius opuntiae, Hyperaspis campestris, Chilocorus bipustulatus*, biocontrôle

**Introduction**

As a result of drought, the cactus cultivation in Morocco has evolved significantly in the past two decades, from 50,000 ha in 1998 to > 120,000 ha at present. The region of Guelmin-Sidi Ifni accounts for over 50% (> 50000 ha) of the national surface area, followed by Haouz-El Kelaa of the Sraghnas with 30% (about 33,000 ha). Khourigba is in third place (12000 ha), and Doukkala fourth (about 1500 ha) (Anonymous, 2009). The cactus is represented in the Moroccan rural landscape in anarchic plantations in almost all villages and douars, in hedges limiting cultivated lands, orchards or trails. Cactus has become widely appreciated by a large majority of farmers for its fruit and forage production. Also, a considerable effort to support the planting and valorization of the cactus has been deployed by the Ministry of Agriculture of Maritime Fisheries, Rural Development and Waters and Forests in different regions of the Kingdom. Through investment by the MAPMDREF and the farmers’ commitment to cultivate the cactus, the target of reaching an area of 160,000 ha planned for 2020 has already been achieved (MAPMDREF, 2016). Unfortunately, the sustainability of this extremely resilient ecosystem has become seriously threatened by the appearance of an invasive and devastating pest of the cactus, *Dactylopius opuntiae*. This cochineal which is specific to cacti (Bouharroud et al., 2016), was introduced in Morocco in 2014. Since its appearance in Sidi Bennour-Doukkala-Morocco, it has caused enormous damage in several areas of the cactus. The spread of the infestation by this pest is fast and unpredictable, and consequently, the destruction of large areas planted with cactus in several regions of Morocco, in particular in Doukkala, Rhamna, Bengrir, Abda, Azilal, Benimellal, Taourirt, Haouz and Chaouia where tens of thousands hectares of cactus are totally destroyed, causing enormous socio-economic and environmental losses. Similar cases have been reported by Lopes et al. in 2009, when *D. opuntiae* attacked a fodder species of cactus, *Opuntia ficus indica*, in Brazil where 100,000 ha were damaged, estimated at about $25 million.

Given the urgency of the cochineal, and in order to prevent further spread of the pest, the Ministry of Agriculture, Maritime Fisheries, Rural Development and Water and Forests, has put in place a major emergency plan for the control of this pest in 2016. This plan also included a research program covering the most important management components (host plan resistance, biopesticides and beneficial insects). Features of *D. opuntiae*, such as soft body, slow movement and most importantly, feeding in groups, make these pests easy preys by natural enemies (Ebling, 1959). The aim of this study was to identify the natural enemies of *D. opuntiae* and their activity periods in Morocco.

**Material and Methods**

After the first record of *D. opuntiae*, surveys have been conducted in different production areas of cactus in order to find natural enemies with potential as a biological control agent during 2017-2018. The collection, sampling, stretching, pinning, labeling and preservation methods for the study of adult, larvae, and pupa stages of natural enemies were made according to Gullan and Cranston, 2004 and 2010. The identification of the specimens was done by the following keys: Canepari et al. (1985), Fursch (1992), Brunetti (1923), Vockeroth (1969), Stubbs and Falk (1996), Van Veen (2004), Speight (2005), DeGroot and Govedic (2008), and (Gielis, 1990).

To determine the population fluctuation of natural enemies associated with *D. opuntiae*, samplings were carried out at two distinct areas, about 15 kilometers apart: sampling area 1-Zemamra locality in the Sidi Bennour region (120 km North-West of Marrakech), Morocco.
Sampling area 2 - Gharbia locality in the same region. In each sampling date, 2500 m² of infested plants were checked, and the natural enemies collected were transferred to the laboratory in test tube containing 95% ethanol (Alizadeh et al., 2013). Then they were identified to species and counted. Voucher specimens of natural enemies identified were labeled and deposited at the laboratory of entomology at National Institute of Agronomic Research (INRA-Agadir).

**Results and discussion**

In this study, a total of 14 species belonging to three orders and three families of natural enemies associated with *D. opuntiae* were identified: *Episyrphus balteatus* de Geer, *Eupeodes corollae* Fabricius (Diptera: Syrphidae), *Hyperaspis campestris* (Herbst, 1783), *Scymnus interruptus* (Goeze). *Scymnus loewii*, *Nephus redtenbacheri* (Mulsant, 1846), *Scymnus latemaculatus*, *Scymnus guttulatus* LeConte, *Exochomus nigripennis* (Erichson, 1843), *Coccinella septempunctata* (Linnaeus, 1758), *Hippodamia convergens*, *Chilocorus bipustulatus* (Linnaeus, 1758), and *Chilocorus politus* (Mulsant, 1850). (Coleoptera: Coccinellidae), and *Emmelina Monodactyla* (Lepidoptera: Pterophoridae) (Table 1; Fig 1).

**Table 1.** Field and laboratory observations about the feeding of predators of *D. opuntiae*.

<table>
<thead>
<tr>
<th>Natural enemies</th>
<th>Development stages of <em>Dactylopius opuntiae</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st instar nymphs</td>
</tr>
<tr>
<td><em>Episyrphus balteatus</em> larvae</td>
<td>+</td>
</tr>
<tr>
<td><em>Eupeodes corollae</em> larvae</td>
<td>+</td>
</tr>
<tr>
<td><em>Hyperaspis campestris</em> adults</td>
<td>+</td>
</tr>
<tr>
<td><em>Scymnus interruptus</em> adults</td>
<td>+</td>
</tr>
<tr>
<td><em>Nephus redtenbacheri</em> adults</td>
<td>+</td>
</tr>
<tr>
<td><em>Exochomus nigripennis</em> adults</td>
<td>+</td>
</tr>
<tr>
<td><em>Chilocorus bipustulatus</em> adults</td>
<td>+</td>
</tr>
<tr>
<td><em>Emmelina Monodactyla</em> adults</td>
<td>–</td>
</tr>
<tr>
<td><em>Coccinella septempunctata</em> (larvae and adults)</td>
<td>–</td>
</tr>
<tr>
<td><em>Emmelina Monodactyla</em> larvae</td>
<td>+</td>
</tr>
<tr>
<td><em>Scymnus latemaculatus</em> adults</td>
<td>+</td>
</tr>
<tr>
<td><em>Scymnus guttulatus</em> adults</td>
<td>+</td>
</tr>
<tr>
<td><em>Hippodamia convergens</em> adults</td>
<td>+</td>
</tr>
<tr>
<td><em>Chilocorus politus</em> adults</td>
<td>+</td>
</tr>
<tr>
<td><em>Scymnus loewii</em> adults</td>
<td>+</td>
</tr>
</tbody>
</table>

+= They feed. – = They do not feed.
Fig 1. natural enemies associated with *D. opuntiae* in two study areas in Morocco.
Many natural enemies were found associated with *D. opuntiae* around the world, among them are immature stages of Lepidoptera, Coleoptera, Diptera and Neuroptera (Vanegas Rico *et al.*, 2010, Grissell, 2004). The main natural enemies of *D. opuntiae* reported in the literature have been found in Mexico. In this study, the coccinellid *H. campestris* was found to be the most important specie associated with *D. opuntiae* in study area-1, and *C. bipustulatus* in study area-2. Other species were also observed, but with low populations and during a short period of time (Fig 2 and Fig 3).

**Fig 2.** Population fluctuations of natural enemies of *D. opuntiae* in 2017-2018, at sampling area 1 in Morocco.

**Fig 3.** Population fluctuations of natural enemies of *D. opuntiae* in 2017-2018, at sampling area 2 in Morocco.
We have observed that adults of *H. campestris* and *C. bipustulatus* feed on both first and second instar nymphs of *D. opuntiae*. Other species of *Hyperaspidis* and *Chilocus* have been reported feeding on *D. opuntiae*. *Hyperaspidis trifurcata* is a highly specific predator on the *Dactylopius* genus (Gilreath and Smith, 1988). Vanegas-Rico *et al.* (2010) have reported that *H. trifurcata* preys on all developmental stages of *Dactylopiidae*. Also, *Chilocus cacti* and *H. trifurcata* are the most abundant natural enemies associated with the genus *Dactylopius* in Mexico and USA (Vanegas-Rico *et al.*, 2016). All-natural enemies identified started to build up activity from end of March (Figs 2 and 3). During winter, no natural enemies were found in the samples. In May 2018, *E. balteatus* de Geer, *E. corollae* Fabricius (Diptera: Syrphidae), *S. interruptus* (Goeze), *N. redienbacheri* (Mulsant, 1846), *E. nigripennis* (Erichson, 1843), *C. bipustulatus* (Linnaeus, 1758) (Coleoptera: Coccinellidae), and *E. Monodactyla* were observed together and in high populations (Figs 2 and 3). Also, from early May, 2018, a high number of *E. Monodactyla* pupa and larvae were observed in infested cladodes in study area-2. Populations of *E. balteatus* de Geer, *E. corollae* Fabricius (Diptera: Syrphidae) and *E. Monodactyla* were lower at study area-1 compared to study area-2. In contrast, the population of *E. nigripennis* was lower in study area-2. In brazil, several groups of predators of which *Exochomus* sp, *Chilocus* sp, *Cryptolaemus* sp, *Hyperaspidis* sp, and *Scymnus* sp have been consistently observed associated with colonies of *D. opuntiae* (Baskaran *et al.*, 1999; Adalma-Aguilera *et al.*, 2005; Vanegas-Rico *et al.*, 2010; Barbosa *et al.*, 2014). The *C. septempunctata* (Linnaeus, 1758) larvae and adults were also observed associated with *D. opuntiae* in the field in the two study areas, but they do were not observed feeding. A few number of *H. convergens*, *C. politus*, *S. latemaculatus*, *S. gattulatus*, and *S. loewii* adults were also found actively feeding on *D. opuntiae* nymphs in the field in study area-1 (Table 1, Fig 1). It is good to note that many abiotic and biotic factors can affect the presence and the distribution of naturals enemies. The presence of other crops around the cactus crop also can play a role in change of natural enemies feeding preference. All the predators found in Morocco may contribute to the control of *D. opuntiae*. However, because *H. campestris* and *Chilocus bipustulatus* sp. were found in high populations during longer periods of activity could be more effective than the other natural enemies and could be mass produced for biocontrol of this mealybug.

References


