Olycella aff. junctolineella (Lepidoptera: Pyralidae) florivory on Opuntia microdasys, a Chihuahuan Desert endemic cactus

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ARTICLE INFO

Article history:
Received 23 July 2008
Received in revised form 15 January 2010
Accepted 25 January 2010
Available online xxx

Keywords:
Arid environments
Biological interactions
Floral biology
Resource addition experiments
Watering

ABSTRACT

The object of this study was to provide the first data on the natural history of the little known plant–florivore interaction between Opuntia microdasys and Olycella aff. junctolineella larvae and to study interindividual variability in the number of reproductive structures attacked as a function of plant resource availability.

Field observations of larval activity and a quantification of the damages produced were done at the Southern Chihuahuan Desert, Mexico. To quantify the interindividual variation of florivory damage as a function of resource availability (water and nutrients), a resource addition experiment was carried out. Larvae caused 21% of buds and 7% of flowers to abort. Adding resources (water and nutrients) to plants had no effect on bud production, although more buds developed into flowers and fruits in fertilized plants, suggesting a selective abortion against ill-nourished reproductive structures. The number of buds and flowers attacked by larvae were higher for non-fertilized than for fertilized plants, indicating that reproductive structures of plants under abiotic stress become more suitable as food for florivores. The number of structures attacked was a non-linear function of the number of buds originally produced, suggesting a florivore satiation threshold.

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1. Introduction

Although the effect of tissue herbivory on plant fitness has been extensively studied, little research has focused on florivory (i.e., bud or flower consumption prior to the formation of the seed coat, Krupnick and Weis, 1999; Krupnick et al., 1999; McCall and Irwin, 2006) even though the evidence indicates that florivory is a very specialized (Fernández et al., 2008; Mann, 1969) and old interaction (Frame, 2003). In particular, Lepidoptera larvae have been recognized as major consumers of reproductive structures (i.e., flowers, fruits, or seeds) in certain families of plants (Ehlers and Olesen, 2003; Pratt and Pierce, 2001; Winotai et al., 2005). Mutualistic relationships have also been documented, in which larvae consume reproductive structures, either partially or entirely, and adults are pollinators (Addicott, 1986; Petterson, 1991; Udovic and Acker, 1981). The scarce literature on florivory is generally devoted to estimating either the direct or indirect trophic effects of florivory (McCall and Irwin, 2006). Direct effects occur because of a reduction in the amount of buds, flowers, fruits, or seeds produced by attacked plants (Oguro and Sakai, 2009). Indirect effects occur because of changes in pollinator behavior due to a reduction in floral rewards or modification of floral structure and/or floral displays caused by florivory (Cascante-Marín et al., 2009; Krupnick et al., 1999; Malo et al., 2001) affecting male and/or female floral functions (Krupnick and Weis, 1999). Both direct and indirect effects have been shown to decrease population performance (Kelly and Dyer, 2002; Leee and Wolfe, 2002; Louda and Potvin, 1995).

The amount of resources available to a plant determines the energetic allocation toward the production of reproductive structures and floral rewards (Roach and Wulff, 1987; Stephenson, 1981) but can also indirectly influence herbivory (Bazzaz et al., 1987; Dempster and Pollard, 1981; Price, 1991; Tobler et al., 2006; Trumble et al., 1993). This is particularly important in environments such as deserts, with marked inter-annual fluctuations in resource availability (Noy-Meir, 1973; Schlesinger et al., 1990). Herbivore populations respond to an increase in plant resources in vastly different ways (Jones and Coleman, 1991). Traditionally it was thought that plants under abiotic stress become more suitable as food for herbivorous insects. However, the responses can be positive (concentrating attack on vigorous plants: Price, 1991), negative (concentrating attack on weak or stressed plants: White, 1984), or neutral (reviewed by Larsson, 1989, see also Lejeune et al., 2005 and Schowalter et al., 1999). However, there is no
information on the response of florivores to the level of plant resource availability.

For Cactaceae, little research has been done to assess damage to reproductive structures caused by lepidopterans or insects in general (Badii and Flores, 2001; Pimienta-Barrios, 1990). Zimmerman and Granata (2002) report that 75% of the insects that affect cacti are “internal feeders,” 3% “external feeders,” 12% sap suckers, and 1% leaf miners; only 6% consume fruit, with no insects observed to consume flowers. Within the known community of insects that feed on cacti, the family Pyralidae (Lepidoptera) that mostly consume vegetative parts, is the most diverse, with 58 species (Longo and Rapisarda, 1995; Zimmerman and Granata, 2002). There are only a few reports of flower or fruit predation by their larvae (e.g., Pemberton and Cordo, 2001; Mann, 1969; McIntosh, 2002a,b), while mutualistic relationships have been reported for Lophocereus schottii and Upiga virens (Pyralidae, Gephyriinae; Holland and Fleming, 1999).

For the genus Opuntia (the prickly pears, with over 200 species), attacks by several phytophagous insects have been reported (Badii and Flores, 2001; Pimienta-Barrios, 1990). Two species of lepidopterans stand out as consumers of cladodes and stalks: Olycella nephelepsa Dyar (zebra worm, Pyralidae) and Luniferia cyclades Dreux (white worm, Pyralidae). Badii and Flores, 2001; Lummis and Wanberg, 1981; Ueckert, 1998). Another lepidopteran, of South American origin, that affects the vegetative structures of Opuntia (29 known hosts) is Cactoblastis cactorum (Pyralidae), which is considered a threat to cacti populations in Mexico and the United States (Golubov et al., 2001; Pemberton and Cordo, 2001). To our knowledge, no studies of lepidopterans that consume only Opuntia flowers have been performed.

In this study we describe the natural history of the Opuntia-Olycella interaction, experimentally assess whether or not Olycella prefers to attack plants that receive additional resources, and measure the effect of Olycella on reproductive success. In particular, we studied interindividual variability in the production of flower buds and damage from florivory (in this case, causing the total destruction, or abortion, of reproductive structures) as a function of experimentally adding resources to plants. Given the marked limiting conditions of resources (water and nutrients) in desert settings, we expected that plants provided with additional resources would produce more flower buds than those given no such supplement. We also expected a positive response of florivores to changes in the quality and/or quantity of floral resources produced – i.e., plants receiving resource supplementation would be attacked more than those that did not.

2. Methods

2.1. Plant and study site

Research was conducted at the Mapimí Biosphere Reserve (Chihuahuan Desert, Mexico, 26°41’N, 103°45’W, 1150 m asl, 264 mm annual precipitation, 20.8 °C mean annual temperature; Montaña, 1990). This study was carried out in an area of approximately 3500 ha, in a “bajada” (gentle sloping terrain, slope: 3–16%, that connects piedmonts to the bottom of endorheic basins). Vegetation (Montaña, 1990) consists of scrubs growing in sandy-clay soils dominated by Larrea tridentata (DC.) Cov. (Zygophyllaceae), Opuntia rastrera (Weber) Britton and Rose, Opuntia microdasys, Jatropha dioica Cerv. (Euphorbiaceae), and Fouqueria splendens Engelmann (Fouquieraceae). O. microdasys is a cactus endemic to the Chihuahuan Desert (commonly known as nopal cedador or bunny-ears prickly pear). It blooms from March to May more or less synchronously. Flowers produce abundant nectar (>30 μL/flower), last for a single day, and lose the anther a few days following anthesis (Pina et al., 2007). Flower production and fruit set are limited by nutrient availability (Pina et al., 2007). The main pollinator is the oligolectic bee, Diadasia sp., and the fruit and seed set has been shown to be limited by pollen (Pina et al., 2007).

Seedling recruitment is very rare (Palleiro et al., 2006), but clonal propagation is more common and occurs through plantlets stemming from cladodes and roots produced in areoles from the pericarpe of aborted fruits (Palleiro et al., 2006; Mandujano, Montaña and Golubov, unpublished data). Opuntia spp. has a very shallow root system that allows water uptake even after very low rainfall spells. Moreover, a few hours after it has rained, they produce new fine roots (“rain roots,” Gibson and Noble, 1986) that enable a very efficient water uptake process (Noble, 1995).

2.2. Larval activity

Detailed field observations of larval activity were done during the blooming period (April–May 2002). In order to provide a detailed description of the damage caused by larvae, we dissected 50 flower buds and 50 flowers from 15 plants that showed typical signs of florivory during the blooming peak (April 2002). On each structure, data on larval position and evidence of damage were recorded. Observations of parasitoids and predators of larvae were also made.

2.3. Quantification of damage to reproductive structures

We quantified the type of tissue damage (i.e., attacks at the perianth and ovarian level) on aborted flowers at the blooming peak (April 2002) by analyzing all aborted structures on 40 randomly selected plants. For that purpose, we visited the 40 selected plants every other day and collected all aborted structures. In order to determine if larvae also attack fruits, 20 recently aborted reproductive structures in each of 20 randomly selected plants were examined after the blooming season had ended (late May 2002).

2.4. Effect of resource availability on flower bud production and florivory

To quantify variation in flower bud production and the intensity of florivore damage (number of aborted structures) as a function of water and nutrient availability, a resource addition experiment was carried out during the 2002 blooming season. We used 60 randomly selected plants that had been given a combination of two treatments, also random (addition of 300 L of water per plant or no addition of water) and two types of fertilization (addition of a mixture of 350 g of ammonium sulfate, 300 g of simple calcium superphosphate, 200 g of potassium chloride, and no fertilizer addition). The amounts of fertilizer used met the reproductive needs of cultivated Opuntia spp. (Pimienta-Barrios, 1990). The addition of fertilizer was done on two occasions immediately prior to the watering dates, with 425 g delivered at a time. Watering was done in circular plots of 7 m² delimited by a soil border, so that upon watering, moisture was retained and could filter into the soil that surrounded the plant. This plot size was sufficient to water a surface larger than the area of influence for the root system of O. rastrera (6.61 m², Briones et al., 1998), a sister species of the same lifeform and very similar to O. microdasys in morphology and phenology. Watering was done on two occasions before flowering (September 2001 and March 2002, 150 L each time, the equivalent to a 20 mm rain). These dates were chosen in order to ensure that the resources would be available to the plants before blooming (which starts in early March and ends in May, with the first rainfalls. De la Barrera et al. (2009) (see also Pimienta-Barrios, 1990) mention that floral differentiation for various species of Opuntia...
occurs in late winter, during a relatively short period of time in the same year that the fruit develop.

On each plant, we counted the number of flower buds produced (most begin developing simultaneously, before the first flower opens) as well as the number or aborted reproductive structures. Abortion caused by Olycella aff. junctolineella larval predation occurs in flower buds and flowers. During the transition from flower to fruit (i.e., when fruit have different degrees of development), further abortions occur, in all likelihood due to self-incompatibility (Piña et al., 2007). For this reason, during the blooming period daily counts were taken of the number of aborted buds and flowers. There were always clear signs of larval attack—consumption of floral rewards, visible damage to the flower’s sexual or ovarian structures, necrosis, and/or the presence of excreta. Furthermore, it is noteworthy that unattacked flower buds and flowers remain firmly attached to the cladode and develop normally. It is thus fairly easy to recognize attacked structures, as they detach from the plant under slight pressure. Piña et al. (2007) provides additional methodological data and results concerning flower, fruit, and seed production as well as fruit abortion due to causes other than O. aff. junctolineella attacks.

We analyzed the effect of water and nutrient addition on the total production of flower buds using two-way deviance analyses with a Poisson error (ANODEV. Crawley, 1993). Factors (and their interactions) considered were watering and nutrient addition, both on two levels. The number of cladodes (an indicator of plant size—they were counted before the experiment began) was used as a covariable in order to control the possible effect of plant size on response variables. Abortion due to the attack by O. aff. junctoline ella larvae was analyzed by fitting a log-linear model with binomial probability distribution to the proportion of aborted O. microdasys structures (buds + flowers) as a function of watering and fertilization treatments. The total number of buds produced per plant was used as the reference to calculate the proportion of aborted structures. Preliminary analyses showed that plant size (number of cladodes) had no effect on the number of reproductive structures attacked – and was eliminated from further study. Analyses were done using the GLIM program (Generalized Linear Interactive Modeling, ver. 4, Francis et al., 1993). To account for overdispersion, we rescaled the scalar parameter by dividing the residual variance by the residual degrees of freedom (Crawley, 1993). To ascertain the probable existence of a satiation effect in the number of attacked structures, we conducted regressions for second-degree polynomial and square root fits between the number of buds and flowers attacked and the number of buds produced by the plants.

3. Results

3.1. Larval activity

O. junctolineella larvae have a cryptic coloration closely resembling petal colors (i.e., yellow with a reddish banding) and reach a maximum size of 30 mm. Only one larva was found on each damaged flower, and no gregarious larval behavior was recorded inside or outside of the attacked reproductive structures. The first instar (~3 mm) was found only inside the style of buds attacked at the perianth, suggesting that this is where oviposition and hatching occur. After consuming the entire style, the larva consumes floral rewards (nectar and pollen) and other floral structures (i.e., stamens and the perianth). When resources run out, the larva moves across the surface of the plant, helped by silk threads, in search of a new flower bud. The larva enters it in one of two ways: 1) at the perianth or 2) at the flower base (near the insertion of the bud and cladode). It is unknown how many buds are attacked before the pupa is formed, presumably on the ground. Larval entry and/or presence are detected through observation of a characteristic frass surrounding the opening that larvae make when entering. Regardless of the point of entry, the final result is the abortion of the bud. No other florivore was recorded on reproductive structures throughout the reproductive season. Larvae were attacked by at least two species of parasitoids (one ichneumonid and one braconid), both of which surround flower buds and were apparently able to determine the location of the larva inside the floral structures.

While moving from one bud to another, larvae sometimes fell to the ground, where they were eaten by the lizards Cnemidophorus texanus (Teiidea) and Phrynosoma modestum (Iguanidae).

3.2. Quantification of damage to reproductive structures

An average of 27.5 ± 4.1 (mean ± SE) aborted reproductive structures was recorded on the 40 plants monitored during the peak of the blooming period. Almost 85% (23.3 ± 3.4 aborted structures) consisted of flower buds and flowers aborted by larval attack, while the remaining 15% (4.1 ± 1.0 aborted structures) corresponded to developing fruits that showed no larval damage – and most probably were caused by resource limitation or incompatibility problems reported for this species (Palleiro et al., 2006; Piña et al., 2007). Seventy-six percent of damaged buds were attacked through the perianth, while the other 24% were attacked through the basal region of the reproductive structure.

No attacked fruits were recorded on the reproductive structures analyzed at the end of the reproductive period (20 aborted structures on each of 20 plants). 9.8 ± 3.0 of aborted structures corresponded to buds or flowers that exhibited damage by O. aff. junctolineella, indicating that the phenomenon persisted throughout the blooming season. The remaining aborted structures were developing fruits that showed no larval damage and may have aborted due to incompatibility problems or resource limitation; 58.3 ± 7.1 corresponded to fruits with seeds that had not developed completely, while 32% ± 6.1 were seedless fruits.

3.3. The effect of resource availability on flower bud production and florivory

Neither the main factors (watering \( \chi^2 = 0.223, P = 0.64 \), fertilization \( \chi^2 = 2.453, P = 0.12 \)), the covariable (number of cladodes \( \chi^2 = 0.263, P = 0.61 \)), or their interactions affected flower bud production. The mean number of buds per plant was 187.4 ± 16.0 SE (range 27–587 buds per plant). Plant size varied between 71 and 284 cladodes (average size 149.5 ± 6.0 SE). Florivory (number of buds and flowers aborted due to larval attack) did not vary with watering, but it did with fertilization (Table 1). The abortion of seedless fruits.

Table 1

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>( \chi^2 )</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watering (W)</td>
<td>1</td>
<td>0.001</td>
<td>0.97</td>
</tr>
<tr>
<td>Fertilization (F)</td>
<td>1</td>
<td>8.538</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>W × F</td>
<td>1</td>
<td>0.252</td>
<td>0.62</td>
</tr>
<tr>
<td>Error</td>
<td>56</td>
<td>55.813</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>59</td>
<td>64.604</td>
<td></td>
</tr>
</tbody>
</table>

reproductive structures was lower for fertilized plants (24% ± 3 SE) than for control plants (35% ± 4 SE). The numbers of attacks recorded at each stage of development of the reproductive structures is shown in Table 2. Regression analyses of the relationship between the number of aborted structures (number of buds + flowers attacked) and the number of buds on the plant showed significant regressions for linear, second-degree polynomial, and square root fits. The best fit (highest $r^2$) was shown to be that of the square root function ($r^2 = 0.80$, $P < 0.0001$, Fig. 1).

4. Discussion

4.1. Characteristics of larval florivory

The Olycella-Opuntia interaction showed a high degree of specialization. There is an apparent mimetism between larva colors and perianth segments: larvae consume various floral structures and use two different entrance points to the bud (through the perianth or ovary), only feed on floral resources, and do not attack developing or mature fruits. At the study site, where O. rastrera, Opuntia macrocentra, and O. microdasys cohabit and have overlapping blooming periods, Olycella aff. junctolineella larvae mainly attack O. microdasys. Other host plants of O. junctolineella are Grusonia bracteata flowers in the Cuatrociénegas region (M.C. Mandujano, pers. obs.) and O. stricta populations at sea level in Veracruz, Mexico (H. Piña, pers. obs.). The Olycella-Opuntia interaction may be complicated by the presence of parasitoids, of which several have been recorded to attack Olycella (Pemberton and Cordo, 2001). The overall effect of the consumption of O. microdasys reproductive structures measured in the experiment is decreasing fruit set by ca. 30% (as a proportion of the buds produced).

Florivory was observed throughout the blooming period, in contrast to other species for which it occurs mainly during a particular part of the period (e.g. during early blooming; Crawley, 1983; McIntosh, 2002a; Thomson, 1981). Although existing data are scarce, florivory in O. microdasys has been observed in different years, both before and after this study, as well as in other species—namely, Ferocactus cylindraceus and F. wislizenii (McIntosh, 2002b) by a lepidopteran, and in Echinocactus platycanthus and Ariocarpus fissuratus (M. Mandujano pers. obs.) involving other insect orders.

4.2. The effect of resource availability on flower bud production and florivory

The number of flower buds produced by O. microdasys did not change with resource supplementation. This suggests that the resources added were assigned to other metabolic functions (storage, growth, fruit set, etc.) or to other reproductive structures (Nobel, 1995; Roach and Wulff, 1987). Indeed, more buds developed into flowers and fruits in the plants receiving nutrient addition (Piña et al., 2007), as could be expected due to the importance of nitrogen for the development of these structures (Pimienta-Barrios, 1990). The watering treatments did not affect bud production, flower production, or fruit set. It cannot be said whether higher levels of watering might exercise an effect on reproductive success, but the reported ability of cultivated Opuntias to produce viable fruit crops under extreme conditions of dryness (Inglese et al., 2009) would also suggest that increasing watering beyond the maximum levels used in this study may not have a very significant impact on the reproductive success of O. microdasys. There was no relationship between the number of buds and plant size. Piña et al. (2007) also found that the number of flowers and the fruit set did not vary with plant size. Fruit production for the 312 O. microdasys plants (sizes ranging from 5 to ca. 700 cladodes) recorded by Palleiro et al. (2006) in three populations on the Mapimí Biosphere Reserve increases with plant size. But the variance explained by the regression model used to study this relationship is only 21%, suggesting that other factors beside plant size determine fruit set. Taking these results into account, it can be concluded that our random sample of only 60 plants (sizes ranging from 71 to 284 cladodes) is probably insufficient to make a strong inference about the relationship between numbers of reproductive structures and plant size. Moreover, our objective when recording plant size was to use it as a covariable and not to measure its statistical relationship with the production of reproductive structures. Another experimental design would have been more appropriate for that purpose.

Even if fertilization does not promote the production of more buds, its benefits for O. microdasys are twofold because it prevents the shedding of otherwise damaged as well as undamaged reproductive structures. On the one hand, less buds and flowers are attacked by florivores—leading to less abortion and subsequent loss; on the other, more buds and flowers develop into fruits, preventing the loss of undamaged aborted structures. This last point suggests a possible parent plant selective abortion between the stages of floral buds (selective abortion hypothesis; Stephenson, 1981) and fruit set – i.e., that ill-nourished developing reproductive structures would be eliminated unless more resources were available for the plant. Alternatively, a control of floral buds that is unrelated to current environmental factors – such as previous year cladode production (i.e., the resource-matching hypothesis; Kelly and Sork, 2002) – could be responsible for the independence between bud production and nutrient addition. Even the existence of genotypes with different potential reproductive success independent of plant size cannot be discarded in this species, which

### Table 2

Number of reproductive structures produced by Opuntia microdasys. The percentage of bud and flower abortion shown is due to attack by Olycella aff. juncuolineella larvae, while fruit abortion is due to incompatibility problems or resource shortages. Means and SE on a per plant basis are shown. Data are from 60 plants studied during the 2002 blooming season in the Southern Chihuahuan Desert.

<table>
<thead>
<tr>
<th>Reproductive structure</th>
<th>Number produced</th>
<th>Number aborted</th>
<th>% of abortion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buds</td>
<td>167.43 ± 15.94</td>
<td>40.01 ± 4.48</td>
<td>21.35</td>
</tr>
<tr>
<td>Flowers</td>
<td>147.42 ± 14.98</td>
<td>10.07 ± 1.41</td>
<td>6.83</td>
</tr>
<tr>
<td>Initiated Fruits</td>
<td>137.35 ± 14.34</td>
<td>71.01 ± 6.86</td>
<td>51.7</td>
</tr>
<tr>
<td>Mature Fruits</td>
<td>66.3 ± 8.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1. Relationship between the number of aborted reproductive structures (buds and flowers) due to Olycella aff. juncuolineella attacks and the number of initiated buds in Opuntia microdasys plants ($n = 60$ plants). Data are from the 2002 flowering season in the Southern Chihuahuan Desert.
tends to reproduce clonally and where some aborted structures (probably those due to incompatibility or nutritional problems) are propagules able to root and produce new plants with the same genotype as the mother (Piña et al., 2007).

Contrary to our hypothesis, Olycella attacked non-fertilized plants more intensely. Thus, the response in the Opuntia-Olycella interaction regarding fertilizer supplementation and florivory was negative (sensu Lejeune et al., 2005; Schowalter et al., 1999). Sickerman and Wangberg (1983) documented a higher level of attack by insects on weakened prickly pears subject to prescribed burns than on strengthened plants. However, other lepidoptera had the opposite response; for example, the control of prickly pears by the cactus moth (C. cactorum) improved only when soil fertility and plant conditions were improved (Dodd, 1940), and larger plants tended to be more susceptible to attack (Myers et al., 1981).

The number of reproductive structures attacked increases non-linearly with number of buds produced by the plant suggesting a progressive satiation of florivores. The rate of attacks on buds and flowers increases quickly in plants with less than 100 buds, and then increases more gradually in those that produce over 100 buds. This may be due to an abundance of resources for oviposition, which could lead to shorter travel distances and thus less energetic expenditure for larvae (Dempster and Pollard, 1981; Schowalter et al., 1999). Furthermore, an apparent floral excess (in this case, more than 100 flower buds) is advantageous to plants because it mitigates damage from predation and allows them to increase reproductive success (Stephenson, 1981).

Florivory caused by Olycella aff. junctolineella to O. microdasys buds and flowers meant a substantial decrease in reproductive success, as approximately 30% of their costly reproductive structures are destroyed. In addition, all studied plants showed a significant degree of larval attack, which was 11% for stressed plants than for fertilized plants. Olycella florivory has direct effects on plant fitness because of a reduction in the amount of buds, flowers, fruits, and seeds. Decreased plant fitness in attacked plants (Oguo and Sakai, 2009) as well as decreases in population performance has been shown (Kelly and Dyer, 2002; Leech and Wolfe 2002; Louda and Potvin, 1995) in several species. In particular, the level of predation found in O. microdasys is comparable to maximum levels recorded for other interactions between plants and lepidopterans that affect reproductive structures (e.g. Addicott, 1986; Pettersson, 1991). In F. cylindraceus (Cactaceae), Pseudoschinia eluata (Lepidoptera: Crambidae) larval predation of flower buds causes a 23–29% loss of such structures, while for F. wislizeni, the loss is only 1% (Mcintosh, 2002b). In Lophocereus schottii (Cactaceae), U. virescens (Lepidoptera: Pyralidae) larvae have been reported to consume fruits and seeds, causing 21% of fruits to abort (Holland and Fleming, 1999). Clearly, florivory is a neglected side of herbivory that seems to be more widespread in Cactaceae than previously thought. For O. microdasys, the toll of florivory is twofold as it limits sexual reproduction as well as clonal reproduction.

Acknowledgments

The authors are grateful for the logistic support of personnel from INEOLS Desert Laboratory, K. Herrera, G. Murz, J. Sánchez, O. Montenegro, and R. Lara collaborated enthusiastically on fieldwork. J. Rull and M. Aluja provided very useful comments and suggestions on the ms. J. Golubov corrected a previous version of the ms. The taxonomic determination of larvae was carried out by MCM and collaborators. This study is part of Hugo Piña’s doctoral research at the Instituto de Ecología, A.C. under the supervision of CM and MCM. The research was funded by CONACyT Project 4126P-N0608 to C M and IN205007 PAPIIT-DGAPA-UNAM to MCM; the participation of Hugo Piña was funded by a CONACYT graduate scholarship.

References


Dodd, A.P., 1940. The Biological Campaign Against Prickly Pear. Commonwealth Prickly Pear Board, Brisbane.


Please cite this article in press as: Piña, H.H., et al., Olycella aff. junctolineella (Lepidoptera:... Journal of Arid Environments (2010), doi:10.1016/j.jaridenv.2010.01.008


