Natural Alternative Hosts of Eulophidae
(Hymenoptera: Chalcidoidea) Parasitoids of the Citrus Leafminer
*Phyllocnistis citrella* Stanton (Lepidoptera: Gracillariidae) in the
Mediterranean Basin

BRUNO MASSA, MARIA CONCETTA RIZZO, AND VIRGILIO CALECA

Istituto di Entomologia agraria, Università degli Studi di Palermo, Viale delle Scienze 13, 90128 Palermo, Italy. E-mail: zoolappl@unipa.it

Abstract.—The entomofauna linked to native flora in and around citrus groves was studied in Italy and Jordan in order to find alternative hosts of eulophid parasitoids of the Citrus Leafminer (CLM), *Phyllocnistis citrella* Stanton (Lepidoptera: Gracillariidae). Twenty new associations (12 in Italy, 8 in Jordan) among native and exotic CLM parasitoids and leafminers were found. Two new alternative hosts were recorded for *Citrostichus phyllocnistoides* (Narayanan) (an unidentified Nepticulidae on *Pistacia lentiscus* L. and *Stigmella* sp. on *Rubus ulmifolius* Schott, in Italy and Jordan respectively) and 1 for *Cirrospilus ingeniosus* Gahan (Agromyzidae on *Salix* sp., in Jordan). Five new alternative hosts were recorded for *Semielacher petiolatus* (Girault) (in Sicily *Liriomyza* sp. on *Mercurialis annua* L., *Chromatomyia horticola* (Goureau) on *Sonchus* spp., *Cosmosterix pulchrinella* Chambers on *Parietaria diffusa* M. et K., and *Stigmella aurella* (Fabr.) on *Rubus ulmifolius* Schott; in Jordan, *Dialectica scabriella* Zeller on *Echium* sp.). The other 12 new associations of CLM parasitoids with leafminers found in both countries include *Neochrysocharis formosa* (Westwood) (4 new hosts), *Cirrospilus variatus* (Masi) (5 new hosts), *Ratzeburgiola incompleta* Bouček (1 new host), *Ratzeburgiola cristata* (Ratzeburg) (1 new host), and *Ascedodes delucchii* (Bouček) (1 new host). Data reported here suggest that native vegetation harbours alternative hosts for both native and exotic parasitoids. They also underline that more attention should be paid to the understanding of ecology and biology of parasitoid species in order to use appropriate exotic enemies in biological control, preserving at the same time indigenous parasitoid communities.

The Citrus Leafminer (CLM), *Phyllocnis-
tis citrella* Stanton (Lepidoptera: Gracillari-
idae), is presently considered to be a ser-
ious threat to young citrus trees in the
Mediterranean region and other countries,
where it has expanded its range in the last
seven years. The CLM attacks new leaves
causing a loss of photosynthetic area. *Sen-
ielacher petiolatus* (Girault), *Citrostichus
phyllocnistoides* (Narayanan) and *Cirrospi-
lus ingeniosus* Gahan (Hymenoptera: Eulo-
phidae) are considered among dominant
natural enemies of CLM in its original
range (India and South Asia) and in Aus-
Eulophid parasitoids have been selected
for biological control programmes against
CLM in many countries and in some case
also have been recovered in neighbouring
countries (Schauff *et al.* 1998).

Native plants are an important source of
biological diversity in agroecosystems and
are known to harbour natural enemies of
phytophagous pests of cultivated plants,
supplying alternative food, refuges and
hosts (McMurtry and Johnson 1965, Powell
1986, Altieri 1991, Ragusa Di Chiara
1991). They provide a diverse source of
food for many species of polyphagous
natural enemies, which in turn may parasit-
ize phytophagous insects of cultivated
plants in seasons when they are abundant.

Studies of phytophagous insects are of-
ten directed at species attacking cultivated
plants and, less so, species feeding on native ones; thus our knowledge of the hosts of parasitoids on cultivated plants is extensive, whereas we have only scattered data on the alternative hosts available to these parasitoids on native plants. Preservation of these reservoirs of antagonists may prove valuable when parasitoids utilize hosts that are not pests of cultivated plants, and when biological control depends on multiple natural enemy species, as in the case of the CLM.

The present study is part of a research project examining the entomofauna of native flora carried out in 11 citrus orchards of Sicily (Italy), the results of which were partly published (Caleca et al. 1997, Mineo et al. 1997a, 1997b, Caleca 1998, Caleca et al. 1998, Mineo and Sinacori 1998, Rizzo et al. 1999, Massa and Rizzo 2000). Some new findings are presented that highlight interesting relationships between CLM parasitoids and their non-pest hosts exploiting native plants.

MATERIALS AND METHODS

Native floras associated with citrus groves in Sicily (Italy) have been studied in detail by Raimondo et al. (1979); they amount to about 200 species involving mainly herbs and shrubs. During the four years of our research project (1997–2000), we collected about 40 of the most common species belonging to this flora, and about 10 belonging to riverine flora sometimes occurring in the neighbouring areas of citrus orchards in Sicily. About 250 g of each plant species were collected monthly along at least two perpendicular transects inside 11 citrus groves and along their perimeter. Leaves infested by miners were placed in Petri dishes with wet paper at 25°C, 65% r.h. and L14:D10. All phytophagous species and parasitoids that emerged were mounted and identified. Further samples were gathered by the senior author during a research trip to Jordan between 21 and 29 May 1999 in the following localities: Al Bahhath (Amman), Aqaba and Dana Village.

RESULTS

In Sicily, 40 host-parasitoid associations involving phytophages of native plants and antagonists of CLM were already known (Caleca et al. 1997, Mineo et al. 1997a, 1997b, Caleca 1998, Caleca et al. 1998, Mineo and Sinacori 1998, Rizzo et al. 1999, Massa and Rizzo 2000). They are listed in Fig. 1 together with the 12 (Italy) and 8 (Jordan) associations, previously unnoticed, recorded in the present paper. Data for new records are reported in Table 1.

The parasitoids we found on indigenous leafminers belong to two quite different kinds: exotic CLM biological control agents (i.e., Semielacher petiolatus, Citrostichus phylocoenostoides and Cirsospilus ingenius), which possibly have switched over onto indigenous hosts after their introduction or immigration, and native parasitoids, which in turn have switched over onto the invading CLM. Among the latter, some (i.e., Neochrysocharis formosa (Westwood), Ratzeburgiola incompleta Bouček and Psigalio soennius (Walker)) are quite common on indigenous hosts in Sicily (Fig. 1a), while three of them (i.e., Dityplis isaea (Walker), Ratzeburgiola cristata (Ratzeburg) and Cirsospilus variegatus (Masi)) have not yet been recorded on CLM in the island, although they have been reported on this host in other countries (Schaff et al. 1998). It should be pointed out that, even if their parasitization does not always reach relevant values, most CLM parasitoids engage in host-feeding which contributes additional mortality. For example in Algeria Guenaoui and Dahniz (1997) attributed as much as 20–50% of CLM larval mortality to host-feeding and in Sicily it may approach 15% (pers. obs.).

Among the eight new host-parasitoid associations reported from Jordan (Fig. 1b), five concern eulophids (S. petiolatus, N. formosa, C. phylocoenostoides and C. ingenius)
known to attack CLM in the country (Schauff et al. 1998, Minoé et al. 1999). C. variegatus, R. incompleta and A. delucchii (Bouček) have been recorded as CLM parasites in other countries of the Mediterranean Basin, but until now have been found only on native plants in Jordan, although this may be due to the paucity of information on CLM in this country. Some details on the new findings are reported below.

**Semiulcher petiolatus** (Girault)

Originally described from Australia, *S. petiolatus* has also been reported from the Solomon Islands (Bouček 1988, Schauff et al. 1998). It was introduced to Oman, Syria, Israel, Egypt, Cyprus, Greece, Turkey, Tunisia and Morocco (Michelakis 1997, Argov and Rössler 1996, FAO 1996, Nia et al. 1997, Rössler and Argov 1997, Hamed et al. 1999); it spread spontaneously in Italy, Algeria and Jordan (Minoé et al. 1998, Schauff et al. 1998, Minoé 1999). Before being reared from *Agronemia littoralis* Becker (Diptera: Agromyzidae) (Massa and Rizzo 2000), the only host previously known for this species was the CLM (Schauff et al. 1998), and, from 1998 onwards, it became one of the most important parasitoids of

Fig. 1. Associations between eulophid parasitoids of *Phyllocnistis citrella* and other phytophagous insects exploiting native plants in citrus groves in Sicily, Italy (a) and Jordan (b).
this pest in Sicily (Caleca et al. 1998, Mineo and Mineo 1999a). The five new hosts listed in this paper (Table 1), comprising three Lepidoptera (Cosmopterigidae, Nep- ticulidae and Gracillariidae) and two Dipter- a (Agromyzidae), are widespread in the Mediterranean region.

It should be noted that this species appeared in Sicily on Chromatomyia horticola (Goureau) (Diptera: Agromyzidae) about one year after its release in 1996 in Tunisia (FAO 1996). The availability of alternative hosts that provide refuge and food for S. petiolatus during seasons of low CLM population density, could partly explain the quick spread and establishment of this species, both in countries where it has been released and in neighbouring sites (Caleca et al. 1998, Schaff et al. 1998, Mineo and Mineo 1999a).

Citrostichus phyllocnistoides (Narayanan)

This species is known from Afghanistan, China, India, Indonesia, Japan, Oman, Pakistan, Taiwan, Thailand, South Africa, Sudan, Swaziland (Bouček 1988, FAO 1996, Schaff et al. 1998), and has been introduced to Cyprus, Greece and Italy (Sicily) (Michelakis 1997, FAO 1996, Mineo and Mineo 1999b), and Australia and Israel (where it is not considered established) (Smith et al. 1997, Argov and Rössler 1996). It probably spread to Jordan from Israel (Mineo 1999). Although recorded as a parasitoid of the CLM (Bouček 1988, Ujiye and Adachi 1995, Wu and Lin 1998), it also has been reported to parasitize the nymphs of Triozia obsoleta Buckton (Homoptera: Psyllidae) a gall former on Diospyros melanoxylon (Roxb.) (Dash and Das 1997). Our records concern two additional Lepidoptera (Table 1); according to Nieukerken (pers. comm.) the mines on Rubus ulmifolius Schott found in Jordan belong to a Stigmella species (Nep- ticulidae), possibly Stigmella aurella (Fabr.), a previously unrecorded host for this parasitoid.

Cirrospilus ingenuus Gahan

Also known as its synonym C. quadris- triatus (Subba Rao and Ramamani), this species has been recorded from Australia, China, India, Indonesia, Japan, Malaysia, Oman, Taiwan, Thailand (Smith et al. 1997, Schaff et al. 1998), and introduced to Cyprus, Turkey, Israel, Syria, Egypt, Tunisia, Morocco, Florida and Mexico (Argov and Rössler 1996, FAO 1996, Perales-Gutierrez et al. 1996, Hamed et al. 1999, LaSalle et al. 1999). It has also spread to Jordan and North Egypt, probably from other countries of the Mediterranean Basin (Schaff et al. 1998). It is generally considered to be a dominant parasitoid of P. citrella (e.g., Thailand, Taiwan and Japan: Ujiye et al. 1996), but also has been recorded as a parasitoid of Rhynchachalnes mangiferae Marshall (Coleoptera: Curculionidae) in India (Peter and Balasubramanian 1984). Agromyzidae previously has not been recorded as a host for this parasitoid.

Cirrospilus variegatus (Masi)

Also known as its synonym Zagrammo- some variegatum, it occurs in the Mediter- ranean Region, North and East Africa, Central and South Asia, West Indies (Bar- bados), Australia and New Zealand (Bouček 1988; Yefremova 1996). This species was described from Italy by Masi (1907), as parasitoid of Metriochroa latifoliella (Mil- lière) (Lepidoptera: Gracillariidae). It is also known to parasitize many species of small leaf-mining Lepidoptera (Bouček 1988, Yefremova 1996) and the CLM in Libya, Spain and Turkey (Schaff et al. 1998). During this study it was found on two Nepoticulidae leafminers and on three Diptera (one Tephritidae and two Agro- myzidae) (Table 1), all previously unre- cognised as hosts.

Ratzeburgiola incompleta Bouček

Recorded from central Europe and many countries of the Mediterranean Ba-
Table 1. List of new host records for Eulophidae emerged from leafminers reared from native plants collected in Italy and Jordan.

<table>
<thead>
<tr>
<th>Eulophid</th>
<th>Host species</th>
<th>Host plant</th>
<th>Data</th>
<th>Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semielachys petiolatus</strong></td>
<td>Chromatomyia horticola</td>
<td>Souchus spp.</td>
<td>Italy, Parco d’Orléans (Palermo)</td>
<td>2♂</td>
</tr>
<tr>
<td>(Girault)</td>
<td>(Goureau) (Diptera: Agromyzidae)</td>
<td></td>
<td>3.V.97, 21.III.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Liriomyza sp. (Diptera: Agromyzidae)</td>
<td>Mercurialis annua L.</td>
<td>Italy, Borgo Molara (Palermo)</td>
<td>1♀</td>
</tr>
<tr>
<td></td>
<td>Cosmopterix pulcrinae (Chambers (Lepidoptera: Cosmopterigidae)</td>
<td>Parietaria diffusa M. and K.</td>
<td>29.XI.98</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stigmina aurelia (Fabr.) (Lepidoptera: Nepticulidae)</td>
<td>Rubus ulmifolius Schott</td>
<td>Borgo Molara 17.VIII.99, Parco d’Orléans 20.IX.99</td>
<td>1♀</td>
</tr>
<tr>
<td></td>
<td>Dialectica scalaricella Zeller (Lepidoptera: Gracillariidae)</td>
<td>Echium sp.</td>
<td>Jordan, Dana Village 25.V.99</td>
<td>1♀</td>
</tr>
<tr>
<td><strong>Citrostichus phyllocristoides</strong> (Narayanan)</td>
<td>Lepidoptera: Nepticulidae</td>
<td>Pistacia lentiscus L.</td>
<td>Zucco 4.IV.00</td>
<td>1♂, 1♀</td>
</tr>
<tr>
<td></td>
<td>Stigmella sp. (Lepidoptera: Nepticulidae)</td>
<td>R. ulmifolius</td>
<td>Jordan, Al Babhath (Amman) 23.V.99</td>
<td>1♂, 1♀</td>
</tr>
<tr>
<td><strong>Cirrospilus ingenuus</strong></td>
<td>Diptera: Agromyzidae</td>
<td>Salix sp.</td>
<td>Al Babhath 23.V.99</td>
<td>1♀</td>
</tr>
<tr>
<td>Gahan (Masi)</td>
<td>C. horticola</td>
<td>Reichardia picroides (L.)</td>
<td>Italy, Collesano (Palermo) 20.V.99</td>
<td>1♀</td>
</tr>
<tr>
<td></td>
<td>Liriomyza congesta (Becker) (Diptera: Agromyzidae)</td>
<td>Lathyrus pratensis L.</td>
<td>Collesano 20.V.99</td>
<td>1♀</td>
</tr>
<tr>
<td></td>
<td>Euclea heraclei (L.) (Diptera: Tephritidae)</td>
<td>Smyrnium perfoliatum (L.)</td>
<td>Italy, Petralia Sottana (Palermo) 6.VI.99</td>
<td>3♀</td>
</tr>
<tr>
<td></td>
<td>Lepidoptera: Nepticulidae</td>
<td>P. lentiscus</td>
<td>Zucco 27.VIII.99</td>
<td>1♂</td>
</tr>
<tr>
<td></td>
<td>Lepidoptera: Nepticulidae</td>
<td>Chrozophora tinctoria (L.)</td>
<td>Jordan, Aqaba 27.V.99</td>
<td>3♀, 4♀</td>
</tr>
<tr>
<td><strong>Ratzburgiola incompleta</strong></td>
<td>Diptera: Agromyzidae</td>
<td>Salix sp.</td>
<td>Al Babhath 23.V.99</td>
<td>1♂</td>
</tr>
<tr>
<td>Bouček (Ratzeburg)</td>
<td>L. congesta</td>
<td>L. pratensis</td>
<td>Collesano 20.V.99</td>
<td>2♀</td>
</tr>
<tr>
<td><strong>Ratzburgiola cristata</strong></td>
<td>D. scalaricella</td>
<td>Borago officinalis L.</td>
<td>Italy, Bagheria (Palermo) 20.XI.97</td>
<td>1♀</td>
</tr>
<tr>
<td>(Ratzeburg)</td>
<td>Leucoptera multifoliella (Costa (Lepidoptera: Gracillariidae)</td>
<td>Crataegus monogynia Jacq.</td>
<td>Zucco 7.VII.99</td>
<td>7♀</td>
</tr>
<tr>
<td><strong>Neochrysocharis formosa</strong></td>
<td>Liriomyza bryoniae (Kaltenbach)</td>
<td>Matthiola incana (L.)</td>
<td>Al Babhath 23.V.99</td>
<td>1♀, 2♂</td>
</tr>
<tr>
<td>(Westwood)</td>
<td>Lepidoptera: Nepticulidae</td>
<td>C. tinctoria</td>
<td>Aqaba 27.V.99</td>
<td>2♀, 1♀</td>
</tr>
<tr>
<td><strong>Asceodes delucchii</strong></td>
<td>Diptera: Agromyzidae</td>
<td>Salix sp.</td>
<td>Al Babhath 23.V.99</td>
<td>1♀</td>
</tr>
<tr>
<td>(Bouček)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
sin (Bouček 1969, 1970, Schauff et al. 1998), this species is known to parasitize Holo-
cacista rivilei Stainton (Lepidoptera: Hel-
liozelidae) (Bouček, 1969), Phyllonorycter 
corylifoliella Hübner (Lepidoptera: Gracil-
leriidae) (Mineo and Sinacori 1998), Cos-
mopterix pulchrinella Chambers (Lepidop-
tera: Cosmopterigidae) (Rizzo and Mineo 
1997), Liriomyza trifolii (Burgess) (Diptera: 
Agromyzidae) (Freidberg and Gijswijt 
1983), Liriomyza sp. (Diptera: Agromyzi-
dae) (Rizzo and Mineo 1997), and Agro-
myza hiemalis (Massa and Rizzo 2000). It 
is also recorded as CLM parasitoid (Azawi 
1997, Schauff et al. 1998), and as the most 
abundant native CLM parasitoid in Tur-
key (Uygun et al. 1997) and Israel (Rössler 
and Argov 1997).

**Ratzeburgiola cristata** (Ratzburg)

Known from the whole Europe (Bouček 
and Askew 1968, Rizzo and Mineo 1997, 
Schauff et al. 1998) parasitizing Phyllono-
rycter nigrescentella Logan (Lepidoptera: 
Gracillariidae) and Cosmia trapezina L. 
(Lepidoptera: Noctuidae) (Bouček and 
Askew 1968), Chrysoesthia sexguttella 
(Thunberg) (Lepidoptera: Gelechiidae), 
Cosmopterix pulchrinella and Stigmella au-
rella (Rizzo and Mineo 1997), and the CLM 
in Spain (Schauff et al. 1998). Agromyzidae 
previously has not been recorded as a host 
for this parasitoid.

**Neochrysocharis formosa** (Westwood)

This species is known from the Palearc-
tic, Asia and Africa (Bouček and Askew 
1968). It develops as a primary endopa-
rasitoid of larvae, and rarely eggs, of leaf-
miners (Hansson 1990), and is known as 
parasitoid of *P. citrella* in Cyprus, Greece, 
Israel, Italy, Japan, Jordan, Spain, Tunisia 
and Turkey (Caleca et al. 1996, FAO 1996, 

*Asecodes delucchii* (Bouček)

*Asecodes delucchii* (= *Telecopterus deluc-
chii*) is known throughout the Palearctic 
Region from England to Japan (J. LaSalle, 
pers. comm.), but has not been previously 
recorded in Jordan. It is known to attack 
*P. citrella* in Italy and Japan (Ujiye and 
1999), and has also been recorded as a par-
asitoid of *Caliroa cerasi* L. (Hymenoptera: 
Tenthredinidae) and *Phyllonorycter messan-
ella* (Zeller) (Lepidoptera: Gracillariidae) 
(J. LaSalle, pers. comm.). Agromyzidae 
previously has not been recorded as a host 
for this parasitoid.

**DISCUSSION**

The introduction of exotic polyphagous 
parasitoids could decrease native parasit-
oids competing for the same food resource 
(Bennett 1993, Duan et al. 1996); thus, due 
to the naturally low density of their pop-
ulations, native polyphagous parasitoids 
may undergo dramatic decrease to be-
come locally extinct (LaSalle 1993). For 
these reasons, to find the best control 
agent of a noxious insect before using it in 
biological control programs LaSalle (1993) 
suggested carrying out research on the bi-
ology and ecology of species of parasit-
oids that are considered antagonists of the 
host.

Since 1993, when *P. citrella* colonised 
Mediterranean citrus groves, endemic bi-
ological diversity represented the poten-
tial resource for biological control (cf. 
LaSalle 1993). A dozen native polypha-
gous eulophids were found to parasite it. 
These species constituted the parasitoid 
community living on leaf-miners of the 
native flora. Research carried out in Sicily 
listed a total of 47 associations involving 
native eulophids that parasitize the CLM 
(Caleca et al. 1997, Mineo et al. 1997a, 
1997b, Caleca 1998, Caleca et al. 1998, Mi-
neo and Sinacori 1998, Rizzo et al. 1999, 
Massa and Rizzo 2000, present study) (cf. 
Fig. 1a). Among CLM parasitoids, the ge-
rus *Cirrospilus* (Hymenoptera: Eulophi-
dae) played a dominant role, particularly 
*C. pictus* (Nees) in Sicily, Algeria and 
Spain (Caleca et al. 1998, Guenaoui and 
Dahlis 1997, Vercher et al. 1997). Due to
the spread of CLM, many researchers planned the introduction of its specific control agents; in the Mediterranean Basin today at least 6 exotic species, known as dominant parasitoids of P. citrella, have been introduced (Argov and Rössler 1996). Among them S. petiolatus spontaneously colonised Sicily (Mineo et al. 1998), probably from N Africa, where it had been introduced, while Ageniaspis citricola Logvinovskaya (Hymenoptera: Encyrtidae) and the eulophids Quadrastichus sp. and C. phyllocnistoides were here actively introduced (Siscaro et al. 1997, Mineo and Mineo 1999b).

Our research led us to find 5 alternative new native hosts of S. petiolatus and 2 of C. phyllocnistoides, as well as another new host of C. ingenuus, eulophids previously known as dominant or specialist CLM parasitoids. We believe that alternative hosts, leaf-miners of native flora, contributed to acclimatation of S. petiolatus and C. phyllocnistoides in Sicily, providing alternative food and shelter, mainly in winter and spring, when CLM populations decrease very much (Massa and Rizzo in press). As regards the interference determined on native CLM parasitoids by exotic ones, S. petiolatus in 1998 represented as much as 38% of all the parasitoids in an orange grove, with an average parasitization rate of 6.9%, peaking to 87.5% in September (Caleca et al. 1998), while in 1999 it represented 89% of all the parasitoids in a lemon grove, with a peak of parasitization rate of 69.6% (Mineo and Mineo 1999b), playing a dominant role in the CLM control. C. phyllocnistoides on the contrary seems to be still sporadic in Sicily (Mineo and Mineo 1999b).

Among native CLM parasitoids in Italy, in 1998 C. pectus reached 7.9% of parasitization rate, while all the other parasitoids did not exceed 2% (Caleca et al. 1998), values already known before the introduction of exotic parasitoids. As regards the parasitization on hosts of native flora, even if our data do not present a significant quantitative analysis, from the qualitative point of view it seems that the community structure of parasitoids did not change after the introduction of exotic species (Caleca et al. 1997, Mineo et al. 1997a, 1997b, Caleca 1998, Caleca et al. 1998, Mineo and Sinacori 1998, Rizzo et al. 1999, Massa and Rizzo 2000). The number of individuals of S. petiolatus and C. phyllocnistoides found parasitizing native hosts indeed is still low, compared with the whole number of parasitoids (564) obtained during our research (Massa and Rizzo in press).

Finally, our results point out that native flora within and at the edge of citrus groves strengthens the biological control of P. citrella, providing alternative hosts to its parasitoids, native as well exotic, mainly in the winter-spring seasons when P. citrella density is very low. Additionally, they stress the importance of knowledge of parasitoid biology and ecology to optimise their use in biological control programs, as well the conservation of native parasitoid communities.

ACKNOWLEDGMENTS

The authors thank Prof. Pietro Mazzola and Dr. Lorenzo Gianguzzi (Dipartimento di Scienze Botaniche, Palermo) for plant identification; Prof. Luciano Süß (Istituto di Entomologia agraria, Milan), Dr. Paolo Triberti (Museo di Storia Naturale, Verona), Dr. Erik Van Nieukerken (Rijksmuseum van Natuurlijke Historie, Leiden) and Dr. John LaSalle (CABI Bioscience UK Centre, Biology Dept., Ascot) for the identification of Agromyzidae, Gracillariidae, Nepticulidae and some Eulophidae, respectively; Prof. Ahmad Katbeh-Bader (Horticulture and Plant Protection Dept., Jordan Univ., Amman), Dr. Salvatore Blando, Rocco Lo Duca, Dr. Gabriella Lo Verde and Dr. Valentina Lo Verde (Istituto di Entomologia agraria, Palermo Univ.) for their help in the field; and Prof. Attilio Carapezza (Palermo University) for improving English. Paper funded by C.N.R. and M.U.R.S.T.

LITERATURE CITED

Argov, Y. and Y. Rössler. 1996. Introduction, release and recovery of several exotic natural enemies for biological control of the citrus leafminer Phyto-


VOLUME 10, NUMBER 1, 2001


