



Host plant cultivar of the grapevine moth *Lobesia botrana* affects the life history traits of an egg parasitoid

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ABSTRACT

The quality and susceptibility of insect eggs for egg parasitoids may be affected by the diet experienced by the females that produce the host eggs. We tested the hypothesis that the host plant fed upon by an herbivore during the larval stages will determine the quality of the eggs laid by the adult for an egg parasitoid. We used the tritrophic system comprising five grape cultivars, the European grapevine moth, *Lobesia botrana* and the parasitoid *Trichogramma evanescens*. Parasitoid performance in host eggs of different sizes and originating from five grape cultivars was determined. Overall, egg parasitism was higher on cultivars on which *L. botrana* laid larger eggs, which resulted in higher larval survival and faster development time of the wasps. One exception was found for the cultivar Pinot. *Trichogramma* wasps parasitized fewer eggs originating from females that fed on the Pinot cultivar as larvae despite good progeny performance (high survival and fast development time). The poor motivation of the parasitoid to oviposit in “Pinot” eggs could be a result of deterrence due to plant compounds ingested by the moth as a larva and transferred to the eggs, or lack of plant-derived compounds that stimulate oviposition in the parasitoid. Interestingly, within a cultivar, *Trichogramma* larval survivorship was higher in younger, smaller eggs than in older, larger ones. This effect however is confounded by the effect of the plant cultivar, since the host egg size varies among grape varieties. Overall, the results of this study support the hypothesis that an herbivore's host plant can influence the performance of its egg parasitoids.

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1. Introduction

The genus *Trichogramma* contains more than 100 species of egg parasitoids with a wide geographical distribution. Many of these species have been used in inundative biological control programs in a variety of crops against numerous pests (Morrison, 1985; Van Lenteren, 2000; Reda Abd el-Monsef, 2004). Parasitism efficiency in *Trichogramma* parasitoids is influenced by environmental factors such as, humidity, light and temperature and also by intrinsic factors of the host such as, egg size and suitability (Salt, 1940; Martson and Ertle, 1973; Stinner et al., 1974; Navarajan Paul et al., 1975; Kazmer and Luck, 1991; Calvin et al., 1984). Thus, the acceptance of a host and the subsequent development of the parasitoid larvae are dependent on the ability of female wasps to recognize the quality of the host as a suitable resource for its progeny (Pak and Jong, 1987). Several egg characteristics have been identified to play a role during the process of host acceptance in *Trichogramma* parasitoids. Among these: age, size and shape, sur-

face odour, chorion thickness and hardness, as well as, chemical cues from the internal contents of the egg (Schmidt, 1994).

Research on the host acceptance behaviour in egg parasitoids often neglects the role of plant the host feeds (Salt, 1935; Van Dijken et al., 1986; Pak and Jong, 1987). For *Trichogramma*, the influence of the egg content on the acceptance and suitability has almost exclusively been studied within the context of developing artificial host eggs for mass rearing of these parasitoids (Grenier, 1994 for an example). Under natural conditions, the host plant fed upon the herbivore during the larval stages might influence the quality of the egg laid by the adult and as a consequence its suitability for a parasitoid. For example, plant compounds that are ingested by a phytophagous insect might be passed onto its eggs, serving as eggs protectants (Blum and Hilker, 2002) and can potentially affect egg parasitoids. Indeed, the host's food plant can affect several parasitoid life history traits including development rate, size, longevity and fecundity (Navarajan Paul et al., 1975; Altahtawy et al., 1976).

The European grapevine moth, *Lobesia botrana* (Denis and Schiffmüller) (Lepidoptera: Tortricidae) is a major pest of grapevines in the palearctic region and it can develop on ca. 30 host plants belonging to different plant families like rosemary, olive trees,

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sea squill or the flax-leaved daphne (Thiéry, 2005). Eggs and larvae of this moth can be parasitized by several species of parasitoids, including over 15 species of *Trichogramma* (Thiéry, 2008). To understand the factors driving and maintaining polyphagy in *L. botrana*, previous studies have examined the influence of the larval food plant on different life history traits. These demonstrate that the larval food quality is important for the reproductive performance of adult moths (number and size of eggs laid) (Thiéry and Moreau, 2005; Moreau et al., 2006a,b). Egg size is a key factor for adult fertility since larger eggs often contain more nutritional provisions than smaller ones (Berrigan, 1991; Fox and Czesak, 2000). Egg size may also be a key factor for the fitness of egg parasitoids; larger eggs being often more apparent to the searching females and more suitable for the subsequent development of their progeny (Van Huis and De Rooy, 1998). The goal of the present study was to determine the effect of host plant cultivar on a range of life history traits of the egg parasitoid *Trichogramma evanescens* Westwood (Hymenoptera: Trichogrammatidae). The study was conducted with natural populations of *L. botrana* collected as larvae from grape bunches and a strain of *T. evanescens* raised on the factious host *Ephesia kuehniella* Zeller (Lepidoptera: Pyralidae). *T. evanescens* was selected because this species occurs naturally in several European vineyards (Barnay et al., 2001; Reda Abd el-Monsef, 2004; Thiéry, 2008).

2. Materials and methods

2.1. Sampling of *L. botrana* individuals

In Europe, depending on the region, *L. botrana* completes 2–4 broods. The first overwintering adults appear at the beginning of the spring generally when the vine bears few leaves. The duration of a generation varies from 1 to 2 months depending on the region. Adults of *L. botrana* are mainly active at night, mating begins at nightfall and egg laying starts 2–3 days after the first mating. The first generation of eggs is laid on the flower bud, sometimes on the bracts, the vine-shoots or the leaves, those of later generations on the grapes. The first instars larvae present a “strolling stage” of only few hours, and then bore into the flower bud (called glomerulae). The caterpillar completes its development at the time of flowering. The second generation emerges at the end of June–July and the third generation occurs between mid-August and the end of September. Each generation cause damages to the bunches either by quantitative but also qualitative losses especially by facilitating the infection of pathogenic fungi like the grey mold disease (Roehrich and Boller, 1991) or black mold *Aspergillus* sp. (Thiéry, 2008).

Fourth and 5th instar larvae nesting in glomerulae were collected in June 2004 in different vineyards of five grape varieties: *Vitis vinifera* cv “Chardonnay”, “Chasselas”, “Grenache”, “Pinot”, and “Syrah”. At each site, larval nests were extensively gathered without size discrimination. Larvae of *L. botrana* generally complete their development within one single grape bunch (Torres-Vila et al., 1997), therefore each larva was considered as having accomplished its whole development on this bunch. Larvae were maintained in small boxes with fresh parts of bunches collected from the same location (same cultivar of origin), and fed *ad libitum* until the end of their development. Larval populations were daily checked until pupation, upon which, pupae were gently removed from the flowers buds, weighed to the nearest 0.1 mg and placed individually in glass tubes (70 × 9 mm diameter) closed with cotton plugs, labelled and stored in the room at 23 °C and under natural a photoperiod. Adults were sexed immediately after emerging. Newly emerged adults resulting from the grape varieties were used to obtain eggs for the parasitism experiments.

2.2. Mating and oviposition by *L. botrana*

To obtain host eggs, newly-emerged females (less than 1-day-old), originating from a given grape cultivar were confined in large tubes (length 9.5 cm, diam 1.5 cm), serving as mating chambers and in which females could subsequently oviposit on the glass wall. Water was provided *ad libitum* through a soaked cotton dental wick. One virgin male (1-day-old) from the same cultivar was randomly assigned to each female before dusk. Every morning, the eggs laid on the glass tubes were counted and labelled on the outside of the tube with a specific colour marker pen. Pairs were maintained in these tubes until the females laid eggs during 3 nights (day 1, day 2, and day 3). Adults were removed from the tubes and the eggs were offered to *T. evanescens* females (see below). Five eggs per oviposition day were randomly assigned to measurement using a binocular micrometer. Their surface (fit as an elliptic surface, $S = \pi \times a \times b$ (mm²), where a and b are the ellipse semiaxes) was used as an index of egg size. Hence, this experimental design enabled us to calculate the mean egg size according for each day of oviposition (day 1, 2, and 3).

2.3. Parasitism by *Trichogramma*

2.3.1. Insect culture

Experiments were done with a strain of *T. evanescens* producing males and females collected in Egypt in 2000 and maintained at INRA Antibes on *E. kuehniella* eggs. The *E. kuehniella* larvae were reared at 25 ± 1 °C on wheat flour. *Trichogramma* parasitoids were reared in culture tubes (10 × 1 cm) plugged with cotton at 25 ± 1 °C, 16:8 LD and 75% RH in a climatic chamber. A droplet of honey was added into the tube to feed emerged wasps. One-day-old wasps were provided with a piece of cardboard (1 × 6 cm) with host eggs (<24 h old). About 2000 *E. kuehniella* eggs were provided for 200 *T. evanescens* females. This important number of females parasitoid ensure that almost all *E. kuehniella* eggs were parasitized. After 5 days of exposure, the egg card was transferred to a clean culture tube at 25 ± 1 °C, 16:8 LD and 75% RH in an environmental chamber until adult wasps emerged.

2.3.2. Parasitism procedure

For each cultivar, we selected tubes containing at least 40 eggs of *L. botrana*, spread over the three days of oviposition, in order to limit the experimental variation in host density. This number of 40 eggs was preliminary determined as the maximum number of egg which one *T. evanescens* female can parasitize in 6 h (unpublished observations). Among active *T. evanescens* females (less than 4 h-old), one young *T. evanescens* female was selected and introduced at 11.00 a.m. inside a tube containing eggs of *L. botrana* and the tube was then closed with cotton. Each *T. evanescens* female was removed 6 h later using a thin paint brush. No food was provided during the experiment. Tubes containing dead or inactive *T. evanescens* females at the end of the experiment were discarded. Tubes were then stored in an environmental chamber during 20 days with the following conditions: temperature: 25 ± 1 °C, relative humidity: 70 ± 5%, photoperiod: L16:D8. Tubes were checked daily and eggs turning grey (parasitized) were counted. During this period of 20 days, emergence of *L. botrana* larvae occurred from the non-parasitized eggs. In the absence of food, young *L. botrana* larvae died within a very short time. In order to minimize any disturbance inside the tubes, we did not remove the dead larvae until the end of the experiment. A sample of five parasitized eggs per egg-laying-day (day 1, day 2, and day 3), were randomly selected and measured as described above. The length of development of *Trichogramma* larvae (i.e. parasitoid development time) was measured by counting the number of emerged parasitoids twice a day (at 11 a.m. and 5 p.m.). Parasitoid larval mortality could be calculated

from the number of parasitoids emerging from the grey eggs. Some *T. evanescens* females oviposited more than once in eggs when the host's eggs were sufficiently large. The few tubes containing eggs with dual oviposition were discarded from the statistical analysis. We recorded: (1) the number of eggs parasitized for the period of 6 h (=an estimate of fecundity of *T. evanescens* females), (2) the proportion of parasitized eggs that hatched (=larval survivorship) as the difference between the number of *L. botrana* eggs that turned grey and the number of eggs that hatched and (3) parasitoid development time (from the beginning of the oviposition (11.00 a.m) to the emergence of the adult parasitoid). Since egg laying of *L. botrana* was separated and labelled by day, we were able to assess the effect of oviposition day on the recorded life history traits of the parasitoids. The number of replicates (in number of tubes) available for the statistical analysis was the following: Chardonnay (20), Chasselas (20), Grenache (25), Pinot (20), and Syrah (18).

2.4. Fitness of the *Trichogramma* offspring emerged from *L. botrana* eggs obtained from different cultivars

The fitness of *T. evanescens* females emerging from the *L. botrana* eggs obtained from different cultivars was determined using the following procedure. Four mated females (less than 6 h-old), of *T. evanescens* were chosen randomly from each tube of parasitized eggs where males and females emerged at the same time. Each mated female was immediately offered *ad libitum* fresh eggs of *L. botrana*. Tubes containing at least 100 fresh eggs were obtained by placing five female moths from our mass rearing (without plant material in their diet) in the tube for one night (Thiéry and Moreau, 2005). This procedure assured a sufficient number of host eggs, as well as genetic variability among the eggs offered to the different *T. evanescens* females. All host eggs had almost identical size (results not shown). Each wasp was allowed to parasitize eggs until she died. No food was provided to the parasitoids during the experiment.

We recorded: (1) the longevity of mated females by checking tubes twice daily (at 11 a.m. and 5 p.m.), (2) the number of eggs they parasitized (same methods as described above) and (3) the proportion of parasitized eggs that hatched. The number of replicates (in number of tubes) available for the statistical analysis was the following: Chardonnay (19), Chasselas (11), Grenache (19), Pinot (18), and Syrah (17).

2.5. Statistical analysis

All statistical tests were done using the JMP software (Version 3.2.2, SAS institute Inc.). A stepwise analysis (backward procedure) was used to remove non-significant ($P > 0.05$) effects and interactions (SAS Institute, 1995). Only the resulting models are presented here. Tests of residuals for normality (Shapiro–Wilk) and homoscedasticity of variances (Levene's test) were used to check the validity of the model. Kruskal–Wallis or Wilcoxon Rank Sum non-parametric tests were used when data did not meet assumptions on normality or homogeneity. Two-tailed tests of significance were used throughout.

3. Results

Regardless of the cultivar of origin, the proportion of eggs laid by *L. botrana* females during the three oviposition days was not significantly different (Anova with repeated measures, effect of cultivar on number of eggs laid $F_{1,223} = 15,06$, $P > 0.05$). However, the size of the eggs decreased significantly over 3 days of oviposition. Moreover, the cultivar on which *L. botrana* females were reared as larvae also affected the size of the eggs they laid (Fig. 1a) (2-

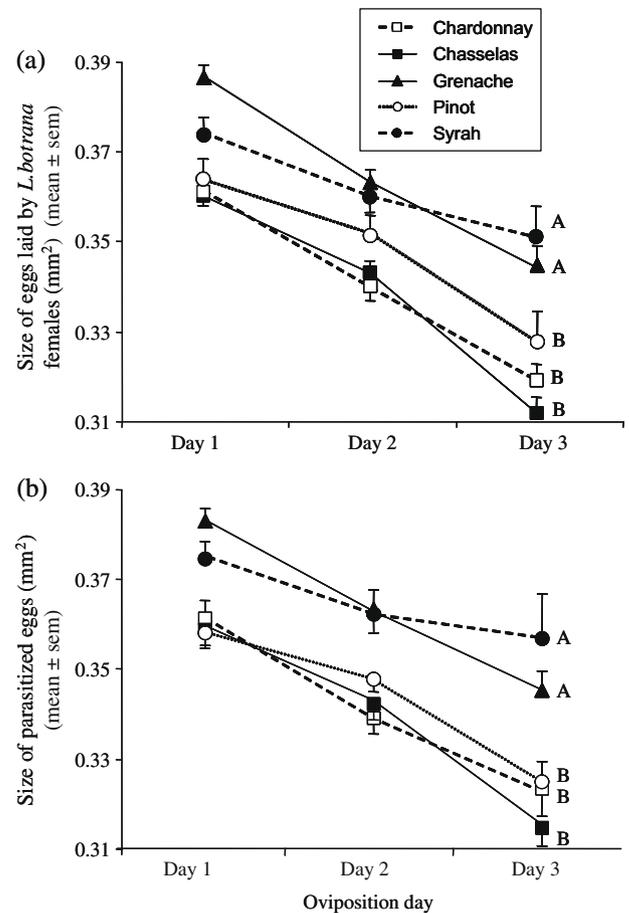


Fig. 1. Relationship between the size of the eggs (a) laid by *Lobesia botrana* females and (b) parasitized by *Trichogramma evanescens* and oviposition day of *L. botrana* on different grape cultivars. Points with the same capital letter are not significantly different ($P > 0.05$) after a parametric PLSD test.

ways Anova: General model: $F_{14,393} = 18.42$, $P < 0.0001$; effect of cultivar: $F_{4,393} = 6.05$, $P < 0.0001$; effect of oviposition day: $F_{2,393} = 80.53$, $P < 0.0001$; effect of their interaction: $F_{8,393} = 0.90$, $P = 0.51$). Females reared on Grenache and Syrah laid larger eggs than females reared on Chasselas, Chardonnay and Pinot. The same pattern was found for the size of eggs that were parasitized (Fig. 1b) (2-way Anova: General model: $F_{14,433} = 14.77$, $P < 0.0001$; effect of cultivar: $F_{4,433} = 2.87$, $P < 0.05$; effect of oviposition day: $F_{2,433} = 72.71$, $P < 0.0001$; effect of their interaction: $F_{8,433} = 1.31$, $P = 0.24$).

The total number of eggs parasitized also depended on the *L. botrana* origin (Kruskal–Wallis test, $\chi^2_4 = 12.19$, $P = 0.016$) (Fig. 2). The number of eggs parasitized was higher on egg batches obtained from Grenache and Syrah, and lower on eggs from Pinot. The proportion of parasitized eggs that hatched increased with the oviposition day independent of the cultivar of origin (2-ways Nominal Logistic: General model: $F_{14,265} = 7.07$, $P < 0.0001$; effect of cultivar: $F_{4,265} = 9.28$, $P < 0.0001$; effect of oviposition day: $F_{2,265} = 19.73$, $P < 0.0001$; effect of their interaction: $F_{8,265} = 0.89$, $P = 0.52$) (Fig. 3). For all cultivars, the proportion of parasitized eggs that hatched was higher on eggs laid on day 3, followed by eggs from the second day and was lowest on eggs laid on the first day of oviposition. In addition, the cultivars on which *L. botrana* larvae were reared had a significant effect on the proportion of parasitized eggs that hatched (Fig. 3). Independently of when the eggs were laid, a higher proportion of eggs were parasitized on Grenache, Pinot, and Syrah than on Chardonnay and Chasselas.

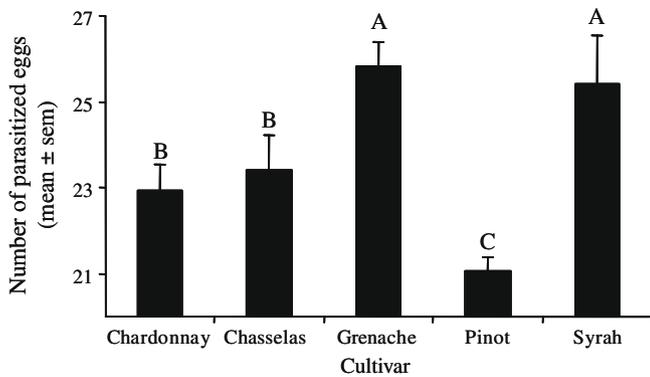


Fig. 2. Number of parasitized eggs of *Lobesia botrana* reared on different grape cultivars. Bars with the same capital letter are not significantly different ($P > 0.05$) after a non-parametric PLSD test.

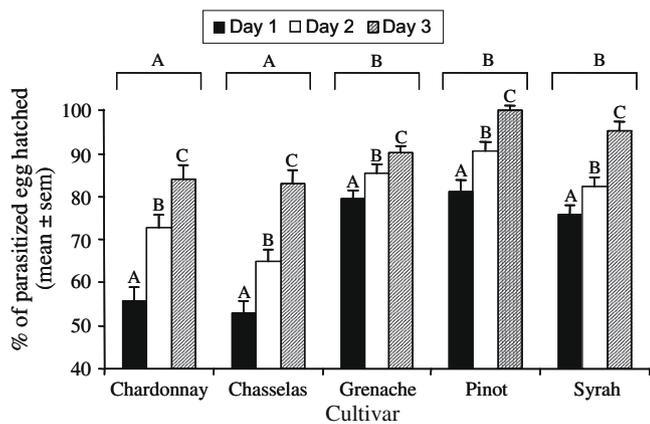


Fig. 3. Percentage of parasitized eggs by *Trichogramma evanescens* that hatched according to the oviposition day of *L. botrana* and to the cultivar on which the larvae developed. Inside cultivar, bars with the same capital letter are not significantly different ($P > 0.05$) after a parametric PLSD test. Cultivars with the same capital letter are not significantly different ($P > 0.05$) after a parametric PLSD test.

Parasitoid development time was similarly influenced by the cultivar of origin but not by the oviposition day (2-ways Anova: General model: $F_{6,265} = 4.20$, $P < 0.0001$; effect of cultivar: $F_{4,265} = 4.76$, $P < 0.0001$; effect of oviposition day: $F_{2,265} = 1.86$, $P = 0.09$) (Fig. 4). *Trichogramma* reared on eggs from Pinot, Gre-

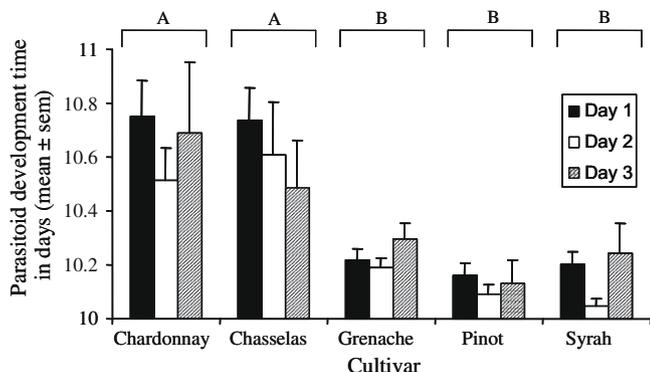


Fig. 4. Parasitoid development time of *Trichogramma evanescens* according to the oviposition day of *L. botrana* and to the cultivar on which the larvae developed. Bars with the same capital letter are not significantly different ($P > 0.05$) after a parametric PLSD test.

nache, and Syrah had a shorter development time than on eggs from Chardonnay and Chasselas.

We measured several fitness parameters of *T. evanescens* females emerging from eggs of *L. botrana* obtained from different cultivars (Table 1). No significant difference was observed for the number of eggs parasitized by the *T. evanescens* females of different origins nor in the longevity of mated females that emerged from *L. botrana* eggs from different cultivars. However, the proportion of parasitized eggs that hatched varied according to the origin of *T. evanescens* females. Eggs parasitized by females originating from eggs of *L. botrana* fed on Chardonnay, Chasselas and Pinot had a higher probability to hatch than those parasitized by females that emerged from eggs from Grenache and Syrah.

4. Discussion

This study shows that several fitness components of *T. evanescens* are influenced by the grape cultivar on which the females that had produced their host eggs have been feeding as larvae. Overall, the number of eggs parasitized was significantly higher for females originating from Grenache and Syrah than for those that came from the three other cultivars. These results are similar to those obtained from a previous study in which female moths were raised on artificial diet to which we had added plant material from different cultivars (Thiéry et al., unpublished data). In that study, parasitism rates by *Trichogramma cacoeciae* also varied depending on the host plant consumed by the moths during the larval stages.

Host acceptance is the process by which a female evaluates the host for oviposition (Arthur, 1981). In egg parasitoids, this process depends mainly on physical and chemical factors associated with the host (Schmidt, 1994; Boo and Yang, 2000). Grape cultivars on which larvae fed significantly influenced the mean egg size laid by females of *L. botrana* (see also Moreau et al., 2006a,b). Female wasps parasitized more eggs from *L. botrana* females reared on the two cultivars on which they produced the largest eggs. The importance of egg size for parasitism has already been suggested by others (e.g. Roriz et al., 2006). Foraging females detected larger host eggs and larger eggs may produce more attractive kairomones than smaller ones (Pak et al., 1991; Bruines et al., 1994). Several compounds have been identified from *L. botrana* eggs (Gabel and Thiéry, 1992), of which long chain fatty acids might attract or arrest *Trichogramma brassicae* (Frenoy et al., 1992). In addition, the two cultivars for which we find the larger host eggs, also had a higher proportion of parasitized eggs that successfully hatched, indicating that larger eggs are of superior quality for developing parasitoids than smaller eggs (see, Kazmer and Luck, 1991; Bai et al., 1992).

For the Pinot cultivar, we find an interesting pattern in the number of eggs parasitized and the proportion of parasitized eggs that successfully hatched. Although, *Trichogramma* females parasitized much less on *L. botrana* from Pinot cultivar (in comparison to others), the proportion of parasitized eggs that hatched was not significantly different from that found for host eggs from Grenache and Syrah. Thus, the question remains why *Trichogramma* females do not oviposit more on eggs from Pinot, given that they showed a good survivorship and fast development. Insect eggs can be victim to different kinds of enemies that can be highly specialized and able to find them even when they are well hidden. The eggs may have evolved to produce chemical repellents or protectants against their enemies (Hilker and Meiners, 2002). Plant compounds that are ingested by an herbivore might be passed onto insect eggs and provoke or interfere with the process of host acceptance by the parasitoid (Blum and Hilker, 2002; Hilker and Meiners, 2002). Some studies have shown that certain compounds may reduce host-egg acceptance by *Trichogramma* spp. during the exter-

Table 1

Life history traits of *Trichogramma evanescens* offspring reared as larvae on eggs of *L. botrana* females fed on as larvae on different cultivars. Values are presented with mean \pm SEM. Columns with the same capital letter are not significantly different ($P > 0.05$) after a non-parametric PLSD test.

Cultivar on which the <i>L. botrana</i> larvae developed	<i>n</i>	Number standard eggs of <i>L. botrana</i> parasitized	Proportion of parasitized eggs from which <i>T. evanescens</i> hatched	Longevity of mated females of <i>T. evanescens</i>
Chardonnay	19	22.72 \pm 1.00	0.96 \pm 0.01 A	2.51 \pm 0.14
Chasselas	11	22.89 \pm 0.97	0.95 \pm 0.02 A	2.51 \pm 0.13
Grenache	19	22.05 \pm 0.99	0.85 \pm 0.03 B	2.44 \pm 0.10
Pinot	18	23.27 \pm 1.11	0.96 \pm 0.01 A	2.12 \pm 0.15
Syrah	17	23.04 \pm 1.01	0.84 \pm 0.03 B	2.45 \pm 0.22
Kruskal–Wallis Test	χ^2	$\chi^2_4 = 3.47$	$\chi^2_4 = 19.14$	$\chi^2_4 = 5.26$
	<i>P</i>	0.48	0.0007	0.26

nal examination phase, even if eggs do not differ in their suitability for parasitoid development (Song et al., 1997; Babendreier et al., 2003). In this context, we hypothesize that the motivation to oviposit in Pinot eggs was either decreased because of plant compounds ingested by the *L. botrana* larvae and incorporated into the eggs were repellent or because some compounds that the wasps normally use for egg recognition and/or acceptance were absent. The more than adequate development of the parasitoids on host eggs from Pinot supports this idea. The development of *Trichogramma* wasps in *L. botrana* eggs from Pinot is not significantly different than that the development in superior eggs from Syrah and Grenache for which we found high parasitism rates.

Interestingly, within a cultivar, we found a strong effect of the oviposition day on larval parasitoid survivorship. A higher proportion of parasitoids emerged from the host eggs laid on day 3, followed by eggs laid on day 2 and finally by eggs laid on day 1. However, there was no effect of the oviposition day on parasitoid development time. Because the eggs laid on the first day of oviposition (day 1) are larger than eggs laid on day 2 and day 3, there appears to be a negative relationship between the host's egg size and parasitoid survival: the smaller the host's egg, the higher the probability to hatch. This is a puzzling result since we showed that the two cultivars that produced larger host eggs, also resulted in a higher survival of parasitoids, which is in accordance with the general theory that proposes that larger eggs contain more nutritional provisions for developing larvae (Berrigan, 1991; Fox and Czesak, 2000), and thus increase the probability for an egg parasitoid to hatch. A more parsimonious explanation for the inverse relationship between oviposition day and parasitoid survival could be the difference in age of the host egg. The lower survival of wasp progeny in eggs from day 1 may simply be due to more advanced developed *L. botrana* larvae which reduced the probability of a successful parasitoid development. It is known that parasitoid survival decreases with host age (Pak, 1986; Strand, 1986; Hintz and Andow, 1990; Reznik and Umarova, 1990; Ruberson and Kring, 1993; Godin and Boivin, 2000). Host stage effects may be associated with the inability of the venom injected into the host to digest the sclerotized host embryo (Strand, 1986) and/or to provide fewer resources with increasing age as nutrients are metabolized into substances that presumably cannot be assimilated (Strand, 1986; Ruberson et al., 1987).

The longevity and fecundity of *T. evanescens* females emerging from different cultivars and exposed to control eggs of *L. botrana*, (eggs laid by moths reared on an artificial diet), was not influenced by their origin. All females of *T. evanescens* exposed to host eggs with no food died within 3 days after their emergence. Similar results have been reported by previous studies with the same species and other *Trichogramma* species (Hoffman et al., 2001; Tunçbilek and Ayvaz, 2003). Generally, adult lifespan in *Trichogramma* is very short in the absence of a sugar source, and high reproductive effort early in life results in decreased longevity due to the existence of a gametic–somatic trade-off (Hohmann and Luck, 2004). Our results

show that the ability of *T. evanescens* to parasitize eggs of *L. botrana* is not influenced by the diet of the females that produced the eggs from which they emerged or by the host egg size. This finding is surprising since numerous authors have reported that *Trichogramma* reared on smaller hosts have lower fecundity than those reared on larger host eggs (e.g. Kazmer and Luck, 1991; Bai et al., 1992). Additional factors not tested in this study such as, nutritional contents of the host egg (see Barrett and Schmidt, 1991 for an example) may account for the fecundity of *Trichogramma* females. The only life history trait that was affected by the origin of eggs from which *T. evanescens* females emerged was the proportion of parasitized eggs that successfully hatched into adult parasitoids. Surprisingly, the two cultivars that resulted in the highest performance of *Trichogramma* (Grenache and Syrah) yielded the lowest offspring survival in the next generation. Further experiments are needed to elucidate this counterintuitive correlation.

In conclusion, we found support for the hypothesis that the first trophic level, in this case, the grapevine cultivar, can greatly influence the performance and fitness of the egg parasitoid *T. evanescens*, the third trophic level. The choice of oviposition made by individual moths can affect the subsequent fitness and population dynamics of its associated parasitoids, via an extended longevity and increased fecundity. These results should be taken into consideration in the successful implementation of pest management programs aimed to control the European grapevine moth.

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