

寄主與齡期對臺潛蠅繭蜂 (*Opius caricivorae*) (膜翅目：小繭蜂科) 發育與產卵之影響¹

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摘要

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臺潛蠅繭蜂 (*Opius caricivorae* Fischer) 為南美斑潛蠅 [*Liriomyza huidobrensis* (Blanchard)]、蔬菜斑潛蠅 [*Liriomyza sativae* Blanchard) 及非洲菊斑潛蠅 [*Liriomyza trifolii* (Burgess)] 之幼蟲至蛹內寄生蜂。為建立寄生蜂繁殖方法及對寄主防治潛能之評估，本試驗於室內 25°C 下進行上述三種寄主與齡期對臺潛蠅繭蜂發育、子蜂數及子代雌性比之影響。結果得知寄主種類對該蜂之發育期與存活率均無顯著影響。在寄主齡期無選擇性或有選擇性試驗時，雌蜂雖均可在寄主三種不同齡期上產卵，但均顯著偏好產卵於寄主第二與三齡幼蟲，且此二處理間無顯著差異。成蜂體型大小雖不受寄主齡期影響，但子蜂數與子代雌性比卻受寄主齡期影響。寄生第一齡寄主者其子蜂數顯著較寄生第二、三齡寄主者減少 24.4–32.8%，子代雌性比顯著較寄生第二、三齡寄主者減少 19.6–35.2%。顯示臺潛蠅繭蜂較適宜在斑潛蠅第二與三齡幼蟲上繁殖。

關鍵詞：臺潛蠅繭蜂、南美斑潛蠅、蔬菜斑潛蠅、非洲菊斑潛蠅、齡期偏好。

前言

臺潛蠅繭蜂 (*Opius caricivorae* Fischer) 屬膜翅目 (Hymenoptera)、小繭蜂科 (Braconidae)、蠅繭蜂屬 (*Opius*)，於 1964 年被定名 (Yu *et al.* 2009)。中文異名為黃腹蠅繭蜂 (Yin *et al.* 2003; Wan *et al.* 2005; Xu *et al.* 2007a, 2007b)，英文異名為 *Opius labradorensis* Fischer (Yu *et al.* 2009)。

該蜂分布於西舊北區、歐洲、東舊北區

及東方等地 (Yu *et al.* 2009)。該蜂為多食性，寄主範圍包括雙翅目潛蠅 15 種 (Lin & Wang 1992; Chien & Ku 1998; Chen *et al.* 2003; Yu *et al.* 2009; Chien & Chang 2012a)。臺潛蠅繭蜂在中國浙江省杭州地區為蔬菜斑潛蠅 (*Liriomyza sativae* Blanchard) 重要的寄生蜂 (Chen *et al.* 2003)，在台灣該蜂亦寄生蔬菜斑潛蠅、南美斑潛蠅 [*Liriomyza huidobrensis* (Blanchard)] (Chien & Chang unpublished data) 及非洲菊斑

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潛蠅 [*Liriomyza trifolii* (Burgess)] (Lin & Wang 1992; Chien & Ku 1998)。

Chien & Chang (2012a) 已報導該蜂形態與部分生活史，為進一步瞭解臺灣潛蠅繭蜂對台灣三種斑潛蠅之抑制能力，本研究以南美斑潛蠅、蔬菜斑潛蠅及非洲菊斑潛蠅為寄主，觀察寄主與齡期對臺灣潛蠅繭蜂發育與繁殖之影響，藉以提供該蜂繁殖方法與生物防治時評估寄生蜂對寄主防治潛能之參考。

材料與方法

供試蟲源

在雲林縣林內鄉菜豆 (*Phaseolus vulgaris* L.) 及在彰化縣永靖鄉非洲菊 (*Gerbera jamesonii* Bolus ex Hook. f.) 上，分別採集被南美斑潛蠅、蔬菜斑潛蠅及非洲菊斑潛蠅幼蟲危害之葉片，並攜回室內。攤開葉片置放在塑膠盤內，待斑潛蠅老熟幼蟲鑽出化蛹後，收集蠅蛹於玻璃皿內。待成蠅與臺灣潛蠅繭蜂羽化，供做飼育之蟲源。

供試寄主植物、寄主害蟲及寄生蜂之繁殖

本試驗所用之寄主植物菜豆苗 (*P. vulgaris* var. *communis* Aeschers) 之栽培，及供試寄主南美斑潛蠅、蔬菜斑潛蠅及非洲菊斑潛蠅之繁殖，係參照 Chien & Ku (1996) 之方法。臺灣潛蠅繭蜂之繁殖，則參照 Chien & Ku (2001) 之方法，以帶有寄主第三齡幼蟲潛食之罐插菜豆苗，繁殖臺灣潛蠅繭蜂。

三種寄主對臺灣潛蠅繭蜂發育之影響

在 25°C 下，參照 Chien & Ku (2001) 之方法，將各內有 120 隻第三齡上述三種供試寄主幼蟲 (產卵後第六日) 潛食之罐插菜豆苗 (每葉 30 隻)，放入直徑 20 cm、高 25 cm 之壓克力筒，各供 30 隻臺灣潛蠅繭蜂雌蜂產卵 2 小時 (上午 8 點至 10 點間)，然後將罐插菜豆苗移出。繼之，在溫度 25°C、相對濕度 65–85% 及光週期 14L:10D (上午 5 點至下午 7 點間照光)

下，依 Chien & Chang (2012a) 之方法，每日觀察臺灣潛蠅繭蜂各蟲期在三種不同斑潛蠅第三齡幼蟲上之存活率與發育日數。其中存活率試驗，27–32 粒卵為一組，計 4 重複；發育期試驗各觀察 17–42 隻不等。

寄主齡期對臺灣潛蠅繭蜂產卵偏好性之影響

參照 Chien & Ku (2001) 之方法，試驗分無選擇性試驗 (no-choice test) 與選擇性試驗 (free-choice test) 二種方式進行。寄主有南美斑潛蠅、蔬菜斑潛蠅及非洲菊斑潛蠅三種。無選擇性試驗時，先準備各帶有 20 隻第一、二、或三齡寄主幼蟲之 1 片罐插菜豆葉片，將其各置入直徑 12 cm、高 22 cm 之玻璃筒內。而選擇性試驗時，則先準備各帶有 10 隻第一齡、10 隻第二齡及 10 隻第三齡寄主幼蟲之 3 片罐插菜豆葉片，將其置入上述相同大小之玻璃筒內。然後在 25°C 定溫下，釋入第五日齡已有產卵經驗之雌蜂 1 隻，任其產卵。各處理雌蜂產卵時段，為上午 9 點至下午 1 點之 4 小時。15 日後，記錄羽化之雌與雄蜂數。無選擇性試驗，每一處理組做 8–29 重複；選擇性試驗，每一處理組做 19–29 重複。

寄主與齡期對臺灣潛蠅繭蜂子蜂數、雌性比及體型大小之影響

測試不同寄主 (南美斑潛蠅、蔬菜斑潛蠅及非洲菊斑潛蠅) 與齡期，對臺灣潛蠅繭蜂子代數、雌性比及體型大小之影響。將內有 200 隻第一齡、或第二齡、或第三齡寄主幼蟲潛食之罐插菜豆葉片 (每葉 20–30 隻)，將它各置入上述相同大小之壓克力筒內。然後在 25°C 定溫下，引入第五日齡已有產卵經驗之雌蜂 10 隻，任其產卵 4 小時 (上午 9 點至下午 1 點間)，然後將罐插菜豆苗移出。15 日後，記錄羽化之雌與雄蜂數、子代雌性比 [$\frac{\text{♀}}{\text{♀} + \text{♂}}$] 及成蜂大小，各做 3–5 重複。

統計分析

各項處理之試驗資料利用 SAS-EG (SAS

Enterprise Guide) 4.1 版本統計分析軟體先進行變方分析 (analysis of variance, ANOVA), 再以最小顯著差異性 (least significant difference, LSD) 測驗, 在 5% 顯著水準下比較處理間平均值之差異。若遇百分率時, 資料先進行角度轉換 (arcsine transformation), 再進行分析。

結 果

三種寄主對臺潛蠅繭蜂發育之影響

臺潛蠅繭蜂不論寄生在南美斑潛蠅、或蔬菜斑潛蠅、或非洲菊斑潛蠅寄主上, 其卵至蛹期之發育期為 15.0–15.5 日 (表 1), 存活率為 79.2–89.0% (表 2), 各處理間均無顯著差異, 顯示寄主種類對臺潛蠅繭蜂之發育期與存活率均無顯著影響。

寄主齡期對臺潛蠅繭蜂產卵偏好性之影響

臺潛蠅繭蜂在寄主齡期無選擇性試驗, 雌蜂在寄主第一、二及三齡幼蟲之產卵數,

當寄主為南美斑潛蠅時各為 10.9、13.9 及 14.3 粒, 蔬菜斑潛蠅時各為 11.2、14.3 及 13.8 粒, 非洲菊斑潛蠅時各為 11.6、14.6 及 14.3 粒, 顯示臺潛蠅繭蜂不論寄主種類, 雌蜂產卵時均顯著偏好寄主第二與三齡幼蟲, 且此二處理間無顯著差異 (表 3)。在寄主齡期選擇性試驗中, 當寄主為南美斑潛蠅、蔬菜斑潛蠅及非洲菊斑潛蠅時, 雌蜂在第二或三齡幼蟲上之產卵數間雖無顯著差異, 但均顯著較第一齡幼蟲上之產卵數各增多 3.1–3.6、1.5–2.1 及 3.4–3.9 倍 (表 3)。

寄主與齡期對臺潛蠅繭蜂子蜂數、雌性比及體型大小之影響

臺潛蠅繭蜂在寄主齡期無選擇性下, 不論寄生在寄主第一、二及三齡幼蟲, 在當寄主為南美斑潛蠅、蔬菜斑潛蠅及非洲菊斑潛蠅時, 其子代雌蜂體長各為 1.782–1.815、1.724–1.728 及 1.811–1.815 mm, 體寬各為 0.362–0.366、

表 1. 寄主種類對臺潛蠅繭蜂卵、幼蟲、前蛹、蛹及卵至蛹期發育之影響

Table 1. Effect of host species on duration (d) of egg, larval, prepupal, pupal and egg to pupal stages of *Opius caricivora*^z

| Host species | Duration (d) of the stages of <i>Opius caricivora</i> | | | | | | | | | |
|-------------------------------|---|-------------------------|-------|-------------|---------|-------------|------|-------------|----------|--------------|
| | Egg | | Larva | | Prepupa | | Pupa | | Egg-pupa | |
| | n | Mean ± SEM ^y | n | Mean ± SEM | n | Mean ± SEM | n | Mean ± SEM | n | Mean ± SEM |
| <i>Liriomyza huidobrensis</i> | 33 | 2.2 ± 0.0 a | 26 | 5.0 ± 0.3 a | 26 | 1.9 ± 0.3 a | 26 | 6.4 ± 0.2 a | 26 | 15.5 ± 0.2 a |
| <i>Liriomyza sativae</i> | 20 | 2.2 ± 0.0 a | 17 | 5.0 ± 0.1 a | 17 | 1.7 ± 0.1 a | 17 | 6.1 ± 0.2 a | 17 | 15.0 ± 0.2 a |
| <i>Liriomyza trifolii</i> | 42 | 2.2 ± 0.0 a | 37 | 4.9 ± 0.1 a | 37 | 1.8 ± 0.1 a | 37 | 6.1 ± 0.2 a | 37 | 15.0 ± 0.3 a |

^z The experiment was conducted at 25°C.

^y SEM: standard error of mean. Means within each column followed by the same letter are not significantly different at 5% level by LSD test.

表 2. 寄主種類對臺潛蠅繭蜂卵、幼蟲、前蛹、蛹及卵至蛹期存活率之影響

Table 2. Effect of host species on survival (%) of egg, larval, prepupal, pupal, and egg to pupal stages of *Opius caricivora*^z

| Host species | Survival (%) of the stages of <i>Opius caricivora</i> | | | | |
|-------------------------------|---|--------------|---------------|---------------|--------------|
| | Egg | Larva | Prepupa | Pupa | Egg to pupa |
| <i>Liriomyza huidobrensis</i> | 100.0 ± 0.0 a ^y | 79.2 ± 2.1 a | 100.0 ± 0.0 a | 100.0 ± 0.0 a | 79.2 ± 2.1 a |
| <i>Liriomyza sativae</i> | 100.0 ± 0.0 a | 89.0 ± 3.6 a | 100.0 ± 0.0 a | 100.0 ± 0.0 a | 89.0 ± 3.6 a |
| <i>Liriomyza trifolii</i> | 100.0 ± 0.0 a | 87.5 ± 1.8 a | 100.0 ± 0.0 a | 100.0 ± 0.0 a | 87.5 ± 1.8 a |

^z The experiment was conducted with four replicates at 25°C, 27–32 eggs/treatment.

^y Mean (Y) ± standard error. Means within each column followed by the same letter are not significantly different at 5% level by LSD test. Data were arcsine-square-root (1-Y) transformed prior to analysis.

表 3. 臺灣蠅繭蜂對三種斑潛蠅幼蟲不同齡期之偏好性

Table 3. Preference of *Opius caricivora* on different instars of three leafminer species

| Instars of leafminer | No-choice test ^z | | Free-choice test ^y | |
|-------------------------------|-----------------------------|---------------------------|-------------------------------|-------------------|
| | <i>n</i> | No. wasps emerged | <i>n</i> | No. wasps emerged |
| <i>Liriomyza huidobrensis</i> | | | | |
| 1st | 18 | 10.9 ± 0.6 b ^x | 21 | 1.6 ± 0.3 b |
| 2nd | 18 | 13.9 ± 1.1 a | 21 | 7.4 ± 0.3 a |
| 3rd | 18 | 14.3 ± 0.7 a | 21 | 6.5 ± 0.5 a |
| <i>Liriomyza sativae</i> | | | | |
| 1st | 22 | 11.2 ± 0.6 b | 12 | 2.2 ± 0.2 b |
| 2nd | 21 | 14.3 ± 0.9 a | 12 | 5.5 ± 0.4 a |
| 3rd | 23 | 13.8 ± 0.7 a | 12 | 6.8 ± 0.4 a |
| <i>Liriomyza trifolii</i> | | | | |
| 1st | 17 | 11.6 ± 0.7 b | 20 | 1.5 ± 0.3 b |
| 2nd | 20 | 14.6 ± 0.7 a | 20 | 6.6 ± 0.4 a |
| 3rd | 24 | 14.3 ± 0.6 a | 20 | 7.4 ± 0.5 a |

^z Each 5-day-old female wasp with egg-laying experience was provided with 20 larvae of leafminer during 9:00–13:00 in an acrylic cylinder (20 cm diameter × 25 cm height) at 25°C, 65–85% RH and a photoperiod of 14L:10D.

^y Each 5-day-old female wasp with egg-laying experience was provided with 30 larvae of leafminer (10 1st-instar, 10 2nd-instar and 10 3rd-instar) during 9:00–13:00 in an acrylic cylinder (20 cm diameter × 25 cm height) at 25°C, 65–85% RH and a photoperiod of 14L:10D.

^x Mean ± standard error. Means within each column of *L. huidobrensis*, *L. sativae* and *L. trifolii*, followed by the same letter(s) are not significantly different at 5% level by LSD test.

0.348–0.356 及 0.367 mm；雄蜂體長各為 1.797–1.802、1.648–1.655 及 1.800–1.811 mm，體寬各為 0.358–0.359、0.338–0.345 及 0.359–0.363 mm，顯示不論寄主種類，臺灣蠅繭蜂成蜂大小均不受寄主齡期影響，處理間無顯著差異 (表 4)。但子蜂數與子代雌性比卻受寄主齡期影響，不論寄主種類，寄生第一齡寄主者其子蜂數顯著較寄生第二、三齡寄主者減少 24.4–32.8%，其子代雌性比亦顯著較寄生第二、三齡寄主者減少 19.6–35.2%，顯示臺灣蠅繭蜂較偏好在斑潛蠅第二與三齡幼蟲上繁殖 (表 4)。

討 論

臺灣蠅繭蜂寄主範圍包括雙翅目潛蠅 15 種 (Lin & Wang 1992; Chien & Ku 1998; Chen *et al.* 2003; Yu *et al.* 2009; Chien & Chang 2012a)。在台灣亦可發現該蜂寄生在三種主要農作物斑潛蠅，即南美斑潛蠅、蔬菜斑潛蠅 (Chien &

Chang unpublished data) 及非洲菊斑潛蠅 (Lin & Wang 1992; Chien & Ku 1998)。本文證實不論寄主為南美斑潛蠅、蔬菜斑潛蠅、或非洲菊斑潛蠅，臺灣蠅繭蜂之發育期 (15.0–15.5 日) 與存活率 (79.2–89.0%) 均不受寄主種類之影響。

寄生蜂與寄主在長期共同演化中，行內寄生生活方式之寄生蜂常需發展對抗寄主包埋其卵之包囊 (encapsulation) 反應，或藉對寄主較低齡期之偏好性以免遭受寄主之防禦反應 (Chien 1997)。臺灣蠅繭蜂行單員幼蟲至蛹內寄生，其產卵方式屬共育寄生 (koinobiont) (Chien & Ku 2001)。有關該蜂對抗寄主防禦反應之策略，Wan *et al.* (2005) 藉由臺灣蠅繭蜂寄生因子對寄主生理效應之觀察，推測係雌蜂毒腺分泌之毒液抑制了寄主對其蜂卵的包囊作用。本文則藉寄生蜂產卵對寄主齡期之偏好性試驗，證實臺灣蠅繭蜂並非以對寄主較低齡期

表 4. 薑潛蠅繭蜂寄生在三種斑潛蠅幼蟲不同齡期後之子蜂數、雌性比及成蜂大小

Table 4. Number of adult progeny, female proportion and body size of *Opius caricivorae* on different instars of three leafminer species

| Instars of leafminer | No. progeny produced/10 ♀ ^z | | Female wasp ^y | | Male wasp ^y | |
|-------------------------------|--|-------------------|--------------------------|-----------------|------------------------|-----------------|
| | No. wasps | Female proportion | Body length (mm) | Body width (mm) | Body length (mm) | Body width (mm) |
| <i>Liriomyza huidobrensis</i> | | | | | | |
| 1st | 68 ± 7 b ^x | 0.37 ± 0.01 b | 1.808 ± 0.003 a | 0.362 ± 0.001 a | 1.797 ± 0.004 a | 0.358 ± 0.003 a |
| 2nd | 91 ± 6 a | 0.46 ± 0.01 a | 1.782 ± 0.003 a | 0.364 ± 0.001 a | 1.799 ± 0.003 a | 0.359 ± 0.002 a |
| 3rd | 90 ± 4 a | 0.50 ± 0.02 a | 1.815 ± 0.003 a | 0.366 ± 0.003 a | 1.802 ± 0.004 a | 0.358 ± 0.003 a |
| <i>Liriomyza sativae</i> | | | | | | |
| 1st | 82 ± 7 b | 0.39 ± 0.02 b | 1.724 ± 0.003 a | 0.348 ± 0.003 a | 1.648 ± 0.003 a | 0.338 ± 0.003 a |
| 2nd | 117 ± 8 a | 0.49 ± 0.02 a | 1.728 ± 0.003 a | 0.356 ± 0.003 a | 1.648 ± 0.003 a | 0.341 ± 0.003 a |
| 3rd | 122 ± 12 a | 0.57 ± 0.04 a | 1.728 ± 0.003 a | 0.356 ± 0.003 a | 1.655 ± 0.003 a | 0.345 ± 0.003 a |
| <i>Liriomyza trifolii</i> | | | | | | |
| 1st | 87 ± 5 b | 0.35 ± 0.02 b | 1.811 ± 0.003 a | 0.367 ± 0.003 a | 1.800 ± 0.003 a | 0.359 ± 0.003 a |
| 2nd | 127 ± 4 a | 0.53 ± 0.03 a | 1.815 ± 0.003 a | 0.367 ± 0.003 a | 1.811 ± 0.003 a | 0.363 ± 0.003 a |
| 3rd | 123 ± 8 a | 0.54 ± 0.02 a | 1.811 ± 0.003 a | 0.367 ± 0.003 a | 1.804 ± 0.003 a | 0.359 ± 0.003 a |

^z In each treatment, 200 larvae of leafminer were provided for ten 5-day-old female wasps with egg-laying experience during 9:00–13:00 in an acrylic cylinder (20 cm diameter × 25 cm height) and kept at 25°C.

^y In each treatment 20 wasps were sampled.

^x Mean ± standard error ($n = 3-7$). Means within each column of *L. huidobrensis*, *L. sativae* and *L. trifolii*, followed by the same letter(s) are not significantly different at 5% level by LSD test.

之偏好性對抗寄主之防禦反應，因該蜂不僅在寄主斑潛蠅三種不同齡期上均可產卵，且顯著偏好產卵在寄主第二與三齡幼蟲。

一般行非共育寄生 (idiobiont) 之寄生蜂，為達子代營養需求與適應值 (體型大小、產卵量、雌性比等) 之提升，產卵時偏好選擇較大齡期之寄主，如寄生非洲菊斑潛蠅之異角袖小蜂 [*Hemiptarsenus varicornis* (Girault)]、華袖小蜂 [*Neochrysocharis formosa* (Westwood)]、底比斯袖小蜂 [*Chrysocharis pentheus* (Walker)] 及岡琦袖小蜂 [*Closterocerus okazakii* (Westwood)]，產卵時均偏好寄主第三齡幼蟲 (Chien & Ku 2001)。薑潛蠅繭蜂產卵方式屬共育寄生 (Chien & Ku 2001)，本文證實因其與寄主共育寄生之特性，子代營養需求不受限，致使寄主齡期不影響寄生蜂子代發育與子蜂體型大小，但子蜂數與雌性比卻仍顯著受寄主齡期影響，寄生第一齡寄主者其子蜂數與雌性比較寄

生第二、三齡寄主者，各減少 24.4–32.8% 與 19.6–35.2%。

薑潛蠅繭蜂在 15–25°C 時對南美斑潛蠅、15–30°C 時對蔬菜斑潛蠅族群均具有強勢至相當之抑制力，為二者之有效寄生蜂 (Chien & Chang 2012b)。為發揮寄生蜂對寄主之抑制能力，有關薑潛蠅繭蜂之接蜂方法、寄主植物、生活史、接蜂空間、寄生蜂與寄主之適當繁殖比例及溫度等已有報導 (Chien & Chang 2012a, 2012b)。今藉本試驗觀察寄主與齡期對薑潛蠅繭蜂發育與繁殖之結果，更可供該蜂繁殖方法與生物防治效益評估時之參考。

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Effect of Host and Instar Preference on the Development and Oviposition of the Endoparasitoid *Opius caricivora* (Hymenoptera: Braconidae)¹

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Abstract

Chien, C. C. and S. C. Chang. 2012. Effect of host and instar preference on the development and oviposition of the endoparasitoid *Opius caricivora* (Hymenoptera: Braconidae). J. Taiwan Agric. Res. 61:165–171.

Opius caricivora Fischer is a larval-pupal endoparasitoid of the three leafminer species, *Liriomyza huidobrensis* (Blanchard), *Liriomyza sativae* Blanchard and *Liriomyza trifolii* (Burgess), in Taiwan. This study was conducted to determine biological control potential and mass-rearing method of this wasp by investigating effects of host species and different instars of hosts (*L. huidobrensis*, *L. sativae*, and *L. trifolii*) on the development, number of progeny and female proportion of *O. caricivora* at 25°C. Results showed that there were no significant ($P < 0.05$) effect among the three species of leafminer on survival and development of the wasp. Although female wasps could oviposit on larvae of all the three different instars of the three species of leafminers, the female wasps preferred to oviposit on the second and third instars in both experiments of no-choice and free-choice of instars. Also, effect of instars of leafminer was significant ($P < 0.05$) on number of progeny and female proportion of wasps, but was no significant ($P < 0.05$) on body size of wasps. The number of progeny from the parasitized, first instar leafminer decreased by 24.4–32.8% compared to the second and third instar leafminer. The proportion of female wasps from the parasitized, first instar leafminer decreased by 19.6–35.2% compared to the second and third instar leafminer. This study indicates that the second and third instar larvae of leafminer are suitably provided for rearing of *O. caricivora*.

Key words: *Opius caricivora*, *Liriomyza huidobrensis*, *Liriomyza sativae*, *Liriomyza trifolii*, Instars preference.

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