

貯存溫度與時間對岡崎釉小蜂 (*Closterocerus okazakii*) (膜翅目：釉小蜂科) 生育力與致死寄主能力之影響¹

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摘 要

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岡崎釉小蜂 [*Closterocerus okazakii* (Kamiyo)] 為台灣地區蔬菜斑潛蠅 (*Liriomyza sativae* Blanchard) 之優勢寄生蜂。為增進該蜂對蔬菜斑潛蠅生物防治之利用，本文探討貯存溫度與時間對其之影響。0 日齡蛹在 7°C 下經貯存 1–2 週後，轉移至 25°C，羽化率即下降為 83.1–90.4%，與對照組之 97.8% 呈顯著差異；而其若在 10°C 貯存 1–2 週，羽化率則與對照組無顯著差異。但 0 日齡蛹在 7 與 10°C 各貯存 1–3 與 1–4 週後，轉移至 25°C 定溫，待羽化成蜂後，每日供應寄主蔬菜斑潛蠅幼蟲與純蜂蜜，其中僅蜂蛹在 7°C 貯存 1–2 週者，其壽命、子代雌性比與對照組無顯著差異，僅子蜂數、致死寄主總數及寄生致死寄主與取食致死寄主之比值，顯著較對照組各減少 39.0–50.6、26.5–37.5 及 35.0%。其他不論蜂蛹在 7°C 貯存 3 週、或蜂蛹在 10°C 各貯存 1–4 週，各處理組間之雌蜂壽命、子蜂數及致死寄主總數雖均無顯著差異，但均較對照組各減少 29.4–42.2、65.8–72.7 及 42.1–60.6%。雌蜂在 15°C 貯存 10–20 日或在 25°C 貯存 10 日，其子蜂數與致死寄主總數均顯著較對照組各減少 60.6–68.0 與 26.0–36.2%。同時成蜂經貯存後，各處理組之日產卵與取食寄主型式與對照組不一。總之，岡崎釉小蜂之蛹與成蟲雖不適於長時間貯存，但在其繁殖過程中，若需要貯存時，本文建議其條件，依序為 0 日齡蛹在 7°C 貯存 1–2 週、其次為雌蜂在 15 與 25°C 餵食純蜂蜜各貯存 10–20 與 10 日。若釋放田間做為生物農藥使用時，其較適貯存蟲期與條件可放寬為 0 日齡蛹在 7 與 10°C 各貯存 1–2 與 1–4 週、或雌蜂在 15 與 25°C 餵食純蜂蜜各貯存 10–30 與 10 日。

關鍵詞：岡崎釉小蜂、蔬菜斑潛蠅、貯存、生育力、致死寄主能力。

前 言

岡崎釉小蜂 [*Closterocerus okazakii* (Kamiyo)] 分布於台灣 (Lin & Wang 1992; Chien & Ku

1998)、中國之福建省 (Huang *et al.* 2000; Chen & Ye 2002) 與廣東省 (Zeng *et al.* 1999) 及日本 (Arakaki & Kinjo 1998) 等地。在台灣瓜類、豆

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類及番茄上，該蜂不僅為蔬菜斑潛蠅 (*Liriomyza sativae* Blanchard) 田間本地種之優勢寄生蜂 (Chien & Chang unpublished data)，且由其生物特性亦顯示其為有效寄生蜂 (Chien & Chang 2009a, b)。進行害蟲生物防治時，為配合害蟲之發生，常需貯存天敵以備適時釋放，如此天敵之貯存蟲期與條件，即為害蟲生物防治成敗的關鍵之一。然岡崎釉小蜂貯存之相關資料闕如，僅知成蜂供應原蜜汁 (洋槐蜜) 或 20% 蜜水時均可顯著延長壽命 (Huang *et al.* 2000; Chen & Ye 2002)，另在 15 與 25°C 下，10 對岡崎釉小蜂成蜂於直徑 3 cm、高 10 cm 之玻璃管內，以純蜂蜜餵食時，成蜂壽命可各長達 39.5–48.0 與 24.1–31.9 日 (Chien & Chang 2009b)。為深入瞭解岡崎釉小蜂之最適貯存蟲期與條件，及貯存對雌蜂生育力與致死寄主能力之影響，乃進行本試驗，冀能提供該蜂貯存技術與保育措施之參考，進而增進岡崎釉小蜂對蔬菜斑潛蠅生物防治之利用。

材料與方法

供試蟲源

在雲林縣林內鄉菜豆 (*Phaseolus vulgaris* L.) 上採集被蔬菜斑潛蠅幼蟲為害之葉片，攜回 25°C 室內。攤開葉片，稍陰乾後，再分裝於有透氣孔之封口塑膠袋。待斑潛蠅成蠅與岡崎釉小蜂羽化，供做後續試驗飼育之蟲源。

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，與供試寄主蔬菜斑潛蠅之繁殖，係參照 Chien & Ku (1996) 之方法。岡崎釉小蜂之繁殖則參照 Chien & Ku (2001) 之方法，以帶有第三齡蔬菜斑潛蠅幼蟲潛食之罐插菜豆苗，繁殖岡崎釉小蜂。

寄生蜂寄生致死寄主與取食致死寄主之區分

本試驗中，區分寄主幼蟲被岡崎釉小蜂寄生、或取食後之致死徵狀，係依 Chien & Chang

(2009a) 所述。被寄生者體黃色、外形鬆馳拉長但仍保持原來之飽滿、消化管內無暗綠色之內容物、呈深度麻痺狀態；被取食者體黃褐色、外形伸長體扁且萎縮、消化管內仍殘留有暗綠色之內容物、傷口處留有乾涸之體液。

低溫貯存蜂蛹對蛹期發育之影響

先將在 25°C 繁殖之 0 日齡蜂蛹，每 30 個裝入直徑 1.5 cm、高 7 cm 之指形管內，然後將其分別移入 7 與 10°C、相對濕度 65–85% 之定溫箱內，各貯存 1、2、3、4、5、6 及 7 週，待各處理貯存期滿後，將內有蜂蛹之指形管取出，轉移至 25°C 定溫、相對濕度 65–85% 下，每日記錄各處理組蜂蛹之發育日數與存活率。另設一未經低溫貯存之對照組，其蟲源與處理方法如上述。各進行 4 重複。

低溫貯存蜂蛹對成蜂生育力 (fertility) 與致死寄主能力之影響

利用前述蜂蛹，經 7 與 10°C 低溫各貯存 1、2、3 週與 1、3、4、5 及 7 週後，於 25°C 正常羽化之成蜂為試材。在 25°C 定溫、相對濕度 65–85% 下，將 0 日齡成蜂，各取 1 對釋入直徑 12 cm、高 22 cm 之玻璃筒，每日早上 7 點，各處理除以細毛筆將未稀釋純蜂蜜塗於玻璃筒內壁餵食，另供應內有 40–50 隻第三齡寄主幼蟲潛食之 1 株罐插菜豆苗，直至雌蜂死亡為止。試驗期間，每日將各處理組所更換下內有被寄生寄主之菜豆苗，移至 25°C 飼育，直至子蜂羽化。記錄各處理 1 對成蜂之壽命，亦依 Chien & Ku (2001) 之方法，於接蜂後次晨，利用透光法計數雌蜂對寄主幼蟲之致死總數 (寄生致死數與取食致死數)，7 日後再分別記錄雌蜂對寄主幼蟲之寄生數 (寄生蜂蛹數) 與取食寄主數 (致死寄主總數 - 寄生蜂蛹數) 及寄生致死寄主與取食致死寄主之比值等；待寄生蜂羽化後，再記錄雌蜂與雄蜂數及雌性比。另設一對照組，其蟲源來自前項試驗未經低溫貯存之對照，處理方法如上述。每處理各進行 6–11 重複。

成蜂貯存對生育力與致死寄主能力之影響

將在 25°C 初羽化之成蜂，每 10 對釋入直徑 3 cm、高 10 cm 之玻璃管，再將玻璃管分別放置在 15 與 25°C 之定溫，15°C 時各貯存 10、20、30、40 及 50 日，25°C 時各貯存 10 與 15 日，期間每日以細毛筆將純蜂蜜塗於玻璃管內壁餵食。待各處理組成蜂貯存時間期滿後，轉移置 25°C 定溫，隨機取其中一對雌、雄蜂釋入直徑 12 cm、高 21 cm 之玻璃筒，各處理組每日如前項所述，供應純蜂蜜與內有 40–50 隻第三齡寄生幼蟲潛食之 1 株罐插菜豆苗，直至供試蜂死亡為止。試驗期間，每日將各處理組所更換下內有被寄生寄主之菜豆苗，移至 25°C 飼育，直至子蜂羽化，且依 Chien & Ku (2001) 之方法，記錄各處理成蜂之壽命、子蜂數、子代雌性比、致死寄主總數、及寄生致死寄主與取食致死寄主之比值等。亦設一未經貯存之對照組，其蟲源與處理方法如上述。各進行 5–19 重複。

統計分析

各項試驗資料除利用 SPSS (Statistical Products and Services Solutions) 10.0 版本軟體先進行變方分析，再以最小顯著差 (LSD) 法或 t 值測試法檢測，並採 $p < 0.05$ 顯著水準比較處理間之差異。另利用迴歸分析法，顯示寄生蜂之羽化率或蛹期 (y)，與貯存期 (x) 之關係，並採 $p < 0.01$ 之顯著水準進行迴歸之變異數分析。若二者之關係非線性迴歸時，則以二次曲線迴歸呈現。

結 果

低溫貯存蜂蛹對蛹期發育之影響

0 日齡蜂蛹在 7 與 10°C 貯存，二者之羽化率與其貯存期，各呈顯著之二次與線性迴歸關係 (圖 1)。蜂蛹不論在 7°C 貯存 1–7 週或 10°C 貯存 3–7 週後之羽化率，均顯著較對照組低；而相同貯存期中，二溫度處理間之羽化率，除貯存期在 3 週者二種處理間無顯著差異外，其餘 10°C 各處理組均顯著較 7°C 處理組高 (表 1)。

內含貯存時間之蛹期，不論在 7 或 10°C，均隨蜂蛹貯存期之延長而增加，二者均呈極顯著之線性迴歸關係 (圖 2A)；但若扣除貯存時間，在 7°C 時蛹期隨蜂蛹貯存期之延長而增加，呈極顯著之直線迴歸關係，10°C 時蛹期則維持不變，與貯存期無關 (表 1、圖 2B)。

低溫貯存蜂蛹對成蜂生育力與致死寄主能力之影響

蜂蛹在 7°C 貯存 1–2 週後，其壽命、取食致死寄主數及子代雌性比等雖與對照組無顯著差異，但子蜂數、致死寄主總數及寄生致死寄主與取食致死寄主之比值，各較對照組顯著降低 39.0–50.6、26.5–37.5 及 35.0%，且處理間無顯著差異 (表 2)；而蜂蛹在 7°C 貯存 3 週，不論壽命、子蜂數、致死寄主總數及寄生致死寄主與取食致死寄主之比值等，均顯著較對照組各減少 31.0–43.1、70.1、60.6 及 30.0% (表 2)。蜂蛹在 10°C 各貯存 1、3 及 4 週後，雌蜂壽命、子蜂數、致死寄主總數及寄生致死寄主與取食致死寄主之比值，均顯著較對照組各減少 29.4–42.2、65.8–72.7、42.1–46.9 及 50.0–55.0%，

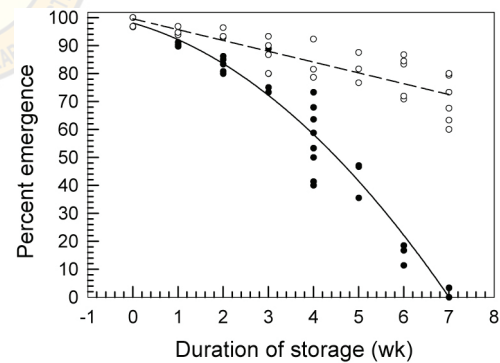


圖 1. 岡崎釉小蜂蜂蛹經 7 或 10°C 貯存 0 至 7 週後在 25°C 下之羽化率。

Fig. 1. Percent emergence of *Closterocerus okazakii* at 25°C after the pupae were stored at 7 or 10°C for 0 to 7 weeks. Regression lines are drawn for those relationships where $p < 0.01$. 7°C (●) $y = -1.347x^2 - 4.579x + 98.10$, $R^2 = 0.9608$; 10°C (○) $y = -3.868x + 99.54$, $R^2 = 0.7030$.

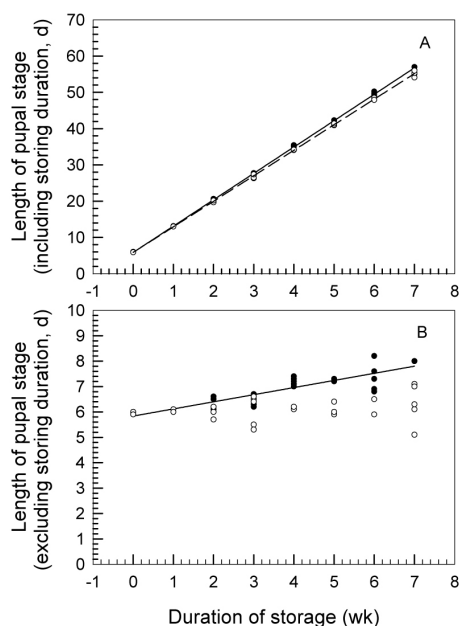


圖 2. 岡崎釉小蜂蜂蛹經 7 或 10°C 貯存 0 至 7 週後在 25°C 下之蛹期。

Fig. 2. Length of the pupal stage of *Closterocerus okazakii* at 25°C after the pupae were stored at 7 or 10°C for 0 to 7 weeks. Regression lines are drawn for those relationships where $p < 0.01$. A: 7°C (●) $y = 7.269x + 5.845$, $R^2 = 0.9993$; 10°C (○) $y = 7.041x + 5.899$, $R^2 = 0.9994$. B: 7°C (●) $y = 0.2806x + 5.838$, $R^2 = 0.7291$; 10°C (○) no regression relationship.

表 1. 岡崎釉小蜂蛹經 7 與 10°C 下貯存 0 至 7 週後在 25°C 下之羽化率與蛹期

Table 1. Percent emergence and length of the pupal stage ($\bar{x} \pm \text{SEM}$) of *Closterocerus okazakii* at 25°C after the pupae had been stored at 7 and 10°C for 0 to 7 weeks^{z, y}

Duration of storage (wk)	Percent emergence		Length of pupal stage (storage duration included, d)		Length of pupal stage (storage duration excluded, d)	
	7°C	10°C	7°C	10°C	7°C	10°C
0 (ck)	97.8 ± 1.1 Aa	97.8 ± 1.1 Aa	5.9 ± 0.1	5.9 ± 0.1	5.9 ± 0.1Ac	5.9 ± 0.1 Aa
1	90.4 ± 0.4 Bb	95.1 ± 0.9 Aa	13.1 ± 0.1	13.1 ± 0.1	6.1 ± 0.1 Ac	6.1 ± 0.1 Aa
2	83.1 ± 1.2 Bbc	94.0 ± 0.8 Aa	20.4 ± 0.2	20.0 ± 0.1	6.4 ± 0.2 Ac	6.0 ± 0.1 Aa
3	79.3 ± 3.5 Ac	86.0 ± 2.7 Ab	27.4 ± 0.1	26.9 ± 0.3	6.4 ± 0.1 Ac	6.1 ± 0.3 Aa
4	56.0 ± 4.3 Bd	84.1 ± 4.2 Abc	35.1 ± 0.1	34.2 ± 0.1	7.1 ± 0.1 Ab	6.2 ± 0.1 Ba
5	43.1 ± 3.8 Be	83.3 ± 2.6 Abc	42.2 ± 0.2	41.1 ± 0.2	7.2 ± 0.2 Aab	6.1 ± 0.2 Ba
6	15.5 ± 2.1 Bf	79.4 ± 3.3 Acd	49.4 ± 0.3	48.1 ± 0.2	7.4 ± 0.3 Aab	6.1 ± 0.2 Ba
7	1.7 ± 0.6 Bg	69.5 ± 3.1 Ad	56.8 ± 0.5	55.3 ± 0.3	7.8 ± 0.5 Aa	6.3 ± 0.3 Ba

^z With 30 pupae per treatment, four replicates.

^y Means within percent emergence and length of pupal stage (storage duration excluded, d) followed by the same uppercase letter are not significantly different between 7 and 10°C ($p < 0.05$, t -test). Means within each column followed by the same lowercase letter are not significantly different at $p < 0.05$ (LSD). Percentages of emergence were transformed to arcsine \sqrt{x} prior to the ANOVA test.

處理間無顯著差異 (表 2); 蜂蛹在 10°C 貯存 5 與 7 週後, 雌蜂壽命、雄蜂壽命、子蜂數、致死寄主總數及寄生致死寄主與取食致死寄主之比值, 更顯著較對照組減少 73.8–94.1、66.7–92.5、97.4–100、94.4–100 及 75.0%, 處理間除最後一項外均無顯著差異 (表 2)。

蜂蛹不論在 7°C 貯存 1–3 週或在 10°C 貯存 1、3、4、5 及 7 週時, 彼等日產卵型式或日取食寄主型式與對照組不一, 各處理組之產卵或取食前期雖均為 0 日, 但各處理之產卵或取食期不僅均縮短, 產卵或取食高峰期亦延後; 除在 7°C 貯存 1–3 週時, 每日產卵量明顯高於取食量外, 其餘各處理組每日取食量與產卵量近似或略高, 不若對照組每日產卵量明顯高於取食量 (圖 3)。

成蜂貯存對生育力與致死寄主能力之影響

雌蜂在 15°C 貯存 10–30 日者, 子代雌性比雖與對照組無顯著差異, 但壽命、子蜂數、產卵致死寄主數、致死寄主總數及寄生致死寄主與取食致死寄主之比值等, 各較對照組顯著降低 25.1–40.1、67.5–78.4、57.4–71.1、26.0–44.8 及 65.0–75.0%, 且處理間無顯著差異 (表 3);

表 2. 岡崎釉小蜂蛹經 7 或 10°C 貯存 0 至 7 週後在 25°C 下成蜂之壽命、生育力及致死寄主能力

Table 2. Longevity, fertility, and host-killing capability ($\bar{x} \pm \text{SEM}$) of *Closterocerus okazakii* adults at 25°C after the pupae had been stored at 10°C for 0 to 7 weeks^{z,y}

Duration of storage (wk)	n	Longevity (d)		No. progeny/female		No. hosts killed/female				
		Female	Male	No. adults	Female proportion	Parasitized	Feeding	Total	Parasitized/feeding	
7°C										
1	6	16.8 ± 1.7 Aab	14.0 ± 1.4 Aabc	141 ± 15 b	0.53 ± 0.07 a	152 ± 14 b	122 ± 15 a	274 ± 24 b	1.3 ± 0.2 bc	
2	8	16.8 ± 1.5 Aab	18.6 ± 1.7 Aa	114 ± 13 bc	0.56 ± 0.04 a	125 ± 13 bc	108 ± 12 a	233 ± 23 b	1.3 ± 0.1 b	
3	9	12.9 ± 1.2 Abc	9.9 ± 1.6 Acd	69 ± 13 d	0.53 ± 0.06 a	86 ± 15 c	61 ± 10 b	147 ± 24 c	1.4 ± 0.2 b	
10°C										
1	11	13.2 ± 1.5 Abc	14.7 ± 1.7 Aab	79 ± 10 cd	0.52 ± 0.03 a	92 ± 11 c	124 ± 17 a	216 ± 24 bc	0.9 ± 0.1 cd	
3	10	11.8 ± 1.5 Ac	11.1 ± 1.8 Abc	77 ± 11 d	0.52 ± 0.03 a	95 ± 14 c	103 ± 19 ab	198 ± 32 bc	1.0 ± 0.1 cd	
4	9	10.8 ± 1.3 Ac	9.1 ± 1.7 Acd	63 ± 11 d	0.60 ± 0.05 a	91 ± 15 c	108 ± 18 a	199 ± 32 bc	0.9 ± 0.1 de	
5	10	4.9 ± 1.2 Ad	5.8 ± 1.4 Ade	6 ± 2 e	0.02 ± 0.02 b	8 ± 3 d	13 ± 3 c	21 ± 6 d	0.5 ± 0.1 e	
7	9	1.1 ± 0.1 Ad	1.3 ± 0.3 Ae	0 e	—	0 d	0 c	0 d	—	
Control	9	18.7 ± 2.8 Aa	17.4 ± 1.7 Aa	231 ± 24 a	0.60 ± 0.03 a	242 ± 25 a	130 ± 21 a	373 ± 42 a	2.0 ± 0.2 a	

^z One pair of adults was provided with 40–50 third instars of *Liriomyza sativae* and honey daily under 25°C, 14L:10D, and 65–85% RH.

^y Means of longevity followed by the same uppercase letter denote that there are no significant differences between sexes ($p < 0.05$, t -test). Means in each column followed by the same letter are not significantly different at $p < 0.05$ (LSD).

表 3. 岡崎釉小蜂雌蜂經不同隔離寄主時間與二種溫度貯存後在 25°C 下之壽命、生育力及致死寄主能力

Table 3. Longevity, fertility, and host-killing capability ($\bar{x} \pm \text{SEM}$) of female *Closterocerus okazakii* at 25°C after the females had been stored and isolated from the hosts for various durations at 2 temperature regimes^{z,y}

Duration of storage (d)	n	Longevity (d)	No. progeny/female		No. hosts killed/female			
			No. adults	Female proportion	Parasitized	Feeding	Total	Parasitized/feeding
15°C								
10	12	12.8 ± 1.0 bc	75 ± 8 bc	0.68 ± 0.05 ab	97 ± 9 bc	142 ± 14 ab	239 ± 21 bc	0.7 ± 0.1 c
20	9	14.0 ± 1.6 bc	74 ± 12 bc	0.68 ± 0.04 ab	103 ± 18 bc	173 ± 26 a	276 ± 44 b	0.6 ± 0.1 cd
30	12	11.2 ± 1.4 cd	50 ± 9 cd	0.70 ± 0.10 a	70 ± 13 c	135 ± 21 ab	206 ± 32 bc	0.5 ± 0.1 cd
40	10	8.5 ± 1.5 d	23 ± 7 d	0.31 ± 0.14 c	28 ± 8 d	58 ± 15 c	86 ± 23 d	0.4 ± 0.1 de
50	5	8.0 ± 2.5 d	14 ± 11 d	0.44 ± 0.17 bc	18 ± 13 d	55 ± 25 c	73 ± 36 d	0.2 ± 0.1 e
25°C								
10	19	16.3 ± 0.9 ab	91 ± 7 b	0.53 ± 0.04 ab	113 ± 9 b	124 ± 9 b	238 ± 14 bc	1.0 ± 0.1 b
15	12	13.3 ± 1.0 bc	60 ± 7 c	0.21 ± 0.08 c	75 ± 10 c	117 ± 9 b	192 ± 18 c	0.6 ± 0.1 cd
Control	9	18.7 ± 2.8 a	231 ± 24 a	0.60 ± 0.03 ab	242 ± 25 a	130 ± 21 ab	373 ± 42 a	2.0 ± 0.2 a

^z Female wasp was provided with 40–50 third instars of *Liriomyza sativae* and honey daily under 25°C, 14L : 10D, and 65–85% RH.

^y Means in each column followed by the same letter are not significantly different at $p < 0.05$ (LSD).

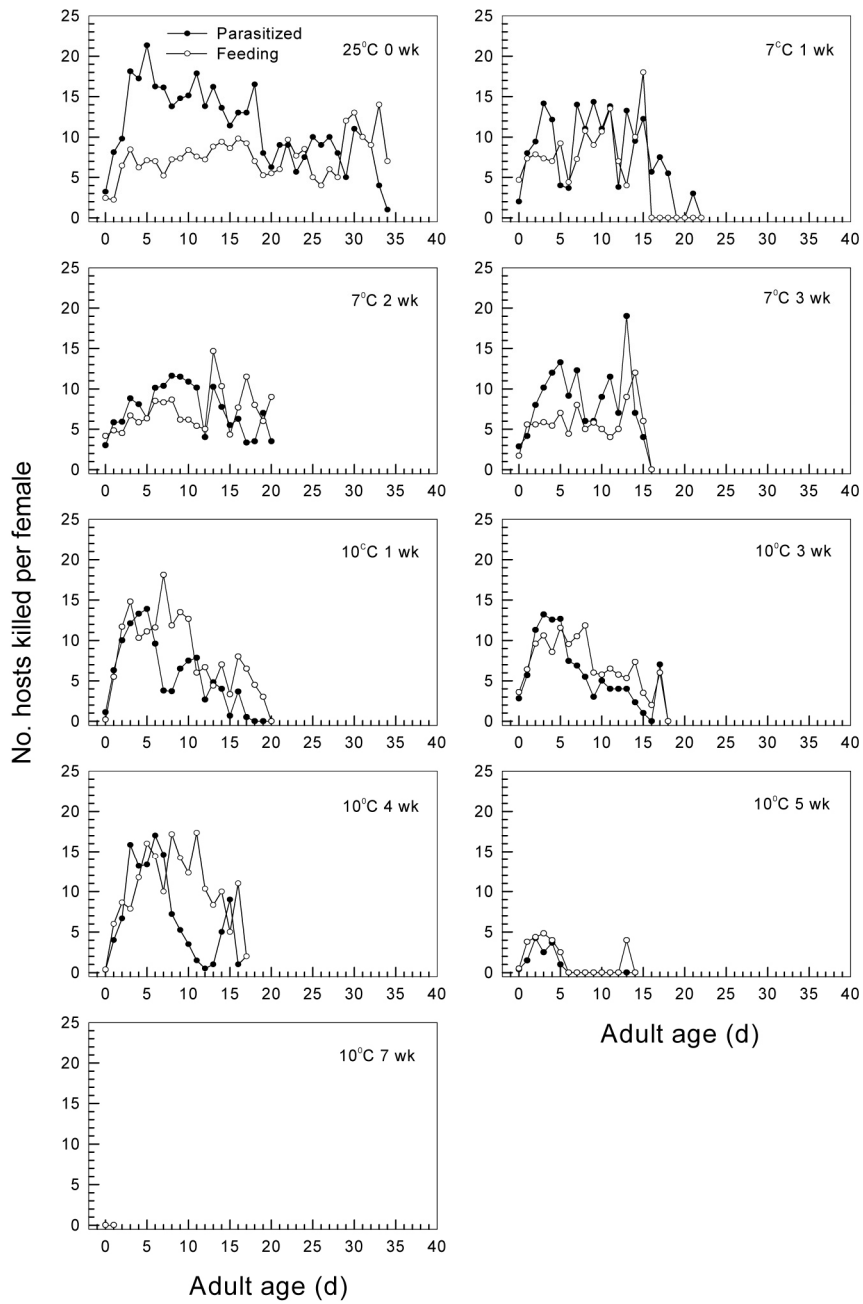


圖 3. 岡崎釉小蜂蛹經不同貯存時間與溫度處理後成蜂在 25°C 下之日產卵與取食寄主型式。

Fig. 3. Daily oviposition and host-feeding patterns of female *Closterocerus okazakii* at 25°C after the pupae had been stored for various durations at 2 temperature regimes.

雌蜂在 15°C 貯存 40 與 50 日者，壽命、子蜂數、產卵致死寄主數、致死寄主總數及寄生致死寄主與取食致死寄主之比值，較對照組各顯著大幅降低，各達 54.5–57.2、90.0–93.9、88.4–92.6、76.9–80.4 及 80.0–90.0% (表 3)。雌蜂在 25°C 貯存 10 與 15 日時，前者其壽命與子代雌性比雖與對照組無顯著差異，但二處理之子蜂數、產卵致死寄主數、致死寄主總數及寄生致死寄主與取食致死寄主比值等，均較對照組顯著降低，各達 60.6 與 74.0、53.3 與 69.0、36.2 與 48.5 及 50.0 與 70% (表 3)，二處理間除致死寄主總數無顯著差異外，其餘測試值處理間均呈顯著差異 (表 3)。

雌蜂不論在 15°C 貯存 10–50 日或在 25°C 貯存 10–15 日時，彼等日產卵型式或日取食寄主型式與對照組不一 (圖 4)。各處理之產卵或取食期均較對照組縮短。另除在 25°C 貯存 10 日處理組每日產卵量與取食量近似外，其餘各處理組每日取食量明顯高於產卵量，不若對照組每日產卵量明顯高於取食量 (圖 4)。

討 論

貯存之適當蟲期與條件

經本試驗測試岡崎釉小蜂蜂蛹與成蜂各經貯存後，對其羽化率、壽命、生育力、雌性比及致死寄主能力之影響，發現該蜂並不適宜長時間貯存。但若必須貯存時，其在室內繁殖時之較適貯存蟲期與條件，依序為 0 日齡蛹在 7°C 貯存 1–2 週、其次為雌蜂在 15 與 25°C 餵食純蜂蜜各貯存 10–20 與 10 日，此時前者與後者之子蜂數將各減少 39.0–50.6 與 60.6–68.0%；若釋放田間做為生物農藥使用時，其較適貯存蟲期與條件可放寬 0 日齡蛹在 7 與 10°C 各貯存 1–2 與 1–4 週、或雌蜂在 15 與 25°C 餵食純蜂蜜各貯存 10–30 與 10 日，此時其致死寄主總數將減少 26.0–46.9%。至於蜂蛹冷藏對成蜂之影響，其生理原因尚待探討。

產卵調節與保育

Bell & Bohm (1975) 認為採取應變式產卵 (synovigenic) (即非營養性胚胎膜型, anhydro-pic) 繁殖策略之寄生蜂，在不適繁衍環境下常以卵吸收 (oosorption) 之方式調節產卵時機，從而保存生殖資源並獲得與適齡寄主發生同律性 (synchronization) 之機會。岡崎釉小蜂依生物特性其卵形成之方式屬應變式產卵 (Chien & Ku 2001; Chien & Chang 2009a, b)。本試驗雖未探究該蜂在隔離寄主後是否有卵吸收現象，但研究結果顯示雌蜂僅餵食純蜂蜜在 15 或 25°C 定溫貯存 10–30 或 10–15 日後，遭遇寄主時，其寄生能力僅各達對照組之 28.9–46.7%，產子蜂數亦僅各達對照組之 21.6–39.4% (表 3)。由此推知岡崎釉小蜂當棲所環境不穩定，致使其與寄主同律性遭受破壞時，其產卵調節時間在 15°C 時雖較 25°C 延長，但為發揮岡崎釉小蜂對蔬菜斑潛蠅之抑制效果，建議田間防治蔬菜斑潛蠅時，除慎選對寄生蜂無毒或低毒之選擇性藥劑外，尚應注意藥劑之殘效期避免超過寄生蜂之產卵調節時限，及在田間供應寄生蜂蜜源以延長其壽命。

岡崎釉小蜂與底比斯釉小蜂產卵調節能力之比較

岡崎釉小蜂與底比斯釉小蜂 [*Chrysocharis pentheus* (Walker)] 同為台灣地區蔬菜斑潛蠅之有效寄生蜂 (Chien & Chang 2008a, b, 2009a, b)。但二種寄生蜂之雌蜂不論在 25°C 定溫各貯存 10 日、或岡崎釉小蜂在 15°C 定溫貯存 10–20 日、或底比斯釉小蜂在 15°C 定溫貯存 10–40 日，遭遇寄主時，岡崎釉小蜂與底比斯釉小蜂之寄生能力均各大幅下降 53.3–59.9 與 71.6–88.9%，顯見二蜂之產卵調節能力均不佳，但二蜂相較下以岡崎釉小蜂略強。

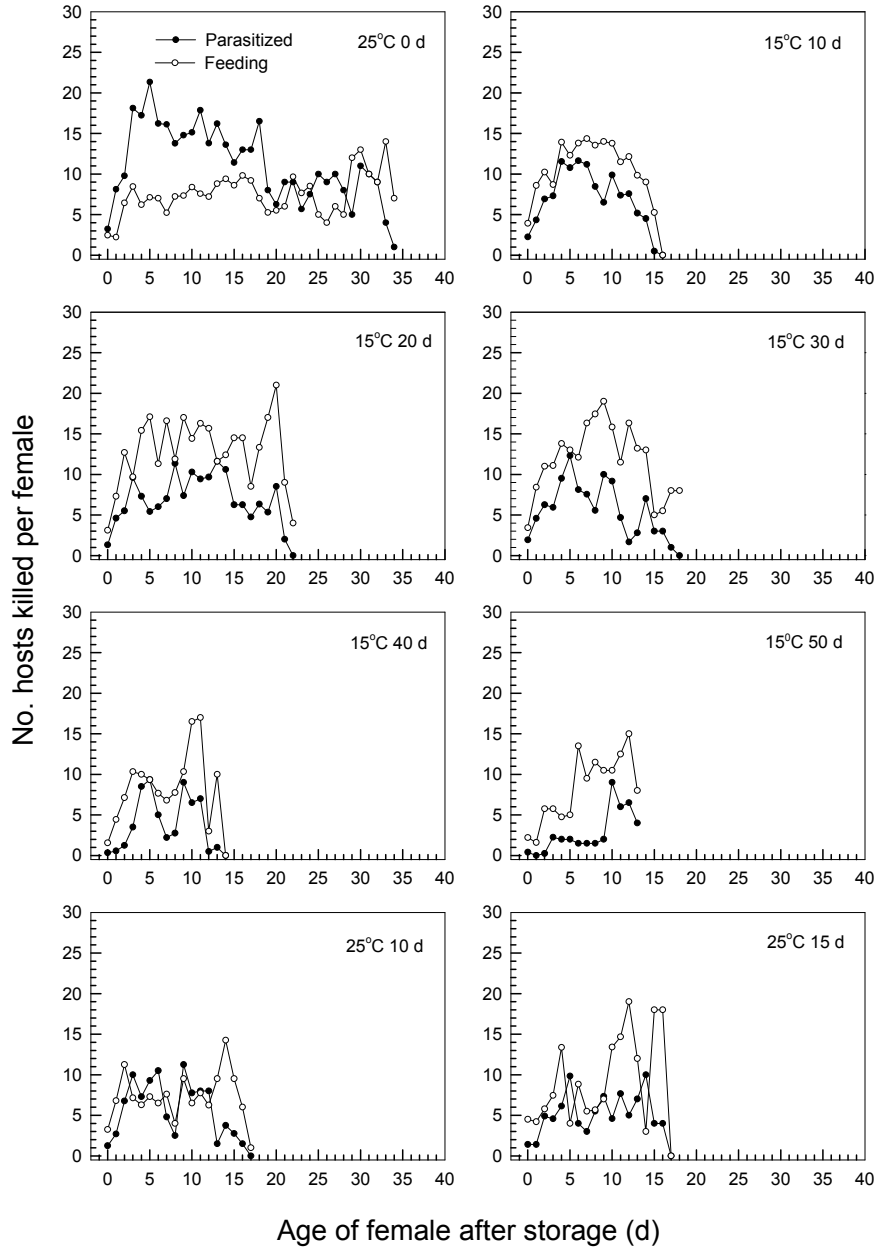


圖 4. 岡崎袖小蜂雌蜂經不同隔離寄主時間與溫度處理後在 25°C 下之日產卵與取食寄主型式。

Fig. 4. Daily oviposition and host-feeding patterns of female *Closterocerus okazakii* at 25°C after the females had been stored and isolated from the hosts for various durations at 2 temperature regimes.

引用文獻 (Literature cited)

- Arakaki, N. and K. Kinjo. 1998. Notes on the parasitoid fauna of the serpentine leafminer *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae) in Okinawa, southern Japan. *Appl. Entomol. Zool.* 33:577–581.
- Bell, W. J. and M. K. Bohm. 1975. Oosorption in insects. *Biol. Rev.* 50:373–396.
- Chen, Y. and Q. Ye. 2002. Studies on the biological characteristics of *Neochrysocharis okazakii* Kamijo (Hymenoptera: Braconidae). *Acta Entomol. Sin.* 45 (Suppl.):128–131. (in Chinese with English abstract)
- Chien, C. C. and S. C. Chang. 2008a. Morphology and life history of *Chrysocharis pentheus* (Walker) (Hymenoptera: Eulophidae). *Formosan Entomol.* 28:159–181. (in Chinese with English abstract)
- Chien, C. C. and S. C. Chang. 2008b. Influence of temperature on the population increase and host-killing capability of *Chrysocharis pentheus* (Walker) (Hymenoptera: Eulophidae). *Formosan Entomol.* 28:277–291. (in Chinese with English abstract)
- Chien, C. C. and S. C. Chang. 2008c. The influence of storage temperature and duration on *Chrysocharis pentheus* (Walker) (Hymenoptera: Eulophidae). *Formosan Entomol.* 28:293–304. (in Chinese with English abstract)
- Chien, C. C. and S. C. Chang. 2009a. Morphology and life history of *Closterocerus okazakii* (Kamijo) (Eulophidae). *Formosan Entomol.* 29:25–36. (in Chinese with English abstract)
- Chien, C. C. and S. C. Chang. 2009b. Influence of temperature on the life table and host-killing capability of *Closterocerus okazakii* (Kamijo) (Hymenoptera: Eulophidae). *Formosan Entomol.* 29:37–50. (in Chinese with English abstract)
- Chien, C. C. and S. C. Ku. 1996. Morphology, life history and reproductive ability of *Liriomyza trifolii*. *Jour. Agric. Res. China* 45:69–88. (in Chinese with English abstract)
- Chien, C. C. and S. C. Ku. 1998. The occurrence of *Liriomyza trifolii* (Diptera: Agromyzidae) and its parasitoids on fields of *Gerbera jamesonii*. *Chinese J. Entomol.* 18:187–197 (in Chinese with English abstract)
- Chien, C. C. and S. C. Ku. 2001. Instar preference of five species of parasitoids of *Liriomyza trifolii* (Hymenoptera: Eulophidae, Braconidae). *Formosan Entomol.* 21:89–97. (in Chinese with English abstract)
- Huang, J. C., Z. H. Lin, and J. H. Chen. 2000. Studies on biology of *Neochrysocharis okazakii* Kamijo (Hymenoptera: Eulophidae). *Entomol. J. East China* 9(2): 34–38. (in Chinese with English abstract)
- Lin, F. C. and C. L. Wang. 1992. The occurrence of parasitoids of *Liriomyza trifolii* (Burgess) in Taiwan. *Chinese J. Entomol.* 12:247–257. (in Chinese with English abstract)
- Zeng, L., J. J. Wu, and W. Q. Zhang. 1999. Preliminary studies on the parasitoids of *Liriomyza sativae* (Blanchard) (Diptera: Agromyzidae) in Guangdong. *Nat. Enemies Insects* 21:113–116. (in Chinese with English abstract)

The Influence of Storage Temperature and Duration on the Fertility and Host-Killing Capability of *Closterocerus okazakii* (Hymenoptera: Eulophidae)¹

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Abstract

Chien, C. C. and S. C. Chang. 2010. The influence of storage temperature and duration on the fertility and host-killing capability of *Closterocerus okazakii* (Hymenoptera: Eulophidae). J. Taiwan Agric. Res. 59:289–298.

Closterocerus okazakii (Kamijo) is one of the dominant species in the parasitoids of *Liriomyza sativae* Blanchard in Taiwan. In an attempt to increase the availability of the biological control agent of *C. okazakii*, the influence of storage temperature and duration on this wasp was investigated. The results of the investigation showed that there was a significant difference in the percent emergence between 0-day-old pupae stored at 7°C for 1–2 weeks (% emergences of 83.1–90.4%) and the control (% emergence of 97.8%). However, the percent emergence did not decrease if the 0-day-old pupae were stored at 10°C for 1–2 weeks. When the pupae were stored at 7°C for 1–2 weeks and the emergent wasps were reared at 25°C with honey and host (*L. sativae*), the longevity and female proportion were not significantly different from the control; but the offspring production, host-killing capability and proportion host parasitized per fed were significantly decreased by 39.0–50.6, 26.5–37.5 and 35.0%. When the pupae were stored at 7°C for 3 weeks or 10°C for 1–4 weeks, the female longevity, offspring production, and host-killing capability were significantly decreased by 29.4–42.2, 65.8–72.7 and 42.1–60.6%, respectively, compared to those of the control. Adults (0-day-old) were fed only with honey at 15 and 25°C for various periods for the study of storage conditions. After the end of the storage periods, wasps were kept at 25°C with both honey and hosts to evaluate their offspring production and host-killing capability. The results revealed that offspring production and host-killing capability of the wasps significantly decreased by 60.6–68.0 and 26.0–36.2% compared to those of the controls after the adults had been stored at 15°C for 10–20 days and 25°C for 10 days, respectively. Daily oviposition and host-feeding patterns of females after storage were different from the control. Long-term storage of pupae and adults of *C. okazakii* is not recommended. But if long-term storage is required, the best storage condition is maintaining the 0-day-old pupae at 7°C for 1–2 weeks, followed by female wasps fed with pure honey at 15 and 25°C for 10–20 and 10 days, respectively. The best storage conditions for wasp release as biopesticide are maintaining 0-day-old pupae at 7°C for 1–2 weeks or 10°C for 1–4 weeks; and female wasps fed with honey at 15°C for 10–30 days or 25°C for 10 days.

Key words: *Closterocerus okazakii*, *Liriomyza sativae*, Storage, Fertility, Host-killing capability.

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