

桉樹枝癭釉小蜂對台灣桉屬植物之造癭偏好性

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摘 要

桃金娘科(Myrtaceae)桉屬(*Eucalyptus*)植物，因其生長快速之特性和高經濟價值，在世界各地皆有廣泛造林。桉樹枝癭釉小蜂(*Leptocybe invasa* Fisher & La Salle)，源起於澳洲，屬膜翅目小蜂總科(Hymenoptera: Eulophidae)，是一種危害桉樹植物的植食性造癭蜂，於2000年於以色列造林地首次發現。主要危害桉樹的幼嫩枝條、葉柄及葉脈，嚴重感染時會影響植株的生長甚至死亡。而在不同植物寄主上造癭數量、密度、蟲總數和植物受損情形有所差異，本研究檢視台灣所種植14種桉樹，發現其中山藍桉、赤桉、檸檬桉、白桉、玫瑰桉、斑桉、小果灰桉、大葉桉、雪梨藍桉、細葉桉等10種桉樹會受到桉樹枝癭釉小蜂不同程度的感染，而又以赤桉、玫瑰桉與雪梨藍桉造成的感染最為嚴重。又由於桉樹本身具有不同程度之抗性，本研究對於7個具造林潛力的桉屬植物雜交株進行感性試驗(susceptibility tests)，並以最小顯著差異測驗法(Fisher's Least Significant Difference, LSD)進行差異性測驗，檢測不同品系間平均感染率的差異。結果發現感染率高的品系多為玫瑰桉或赤桉的雜交品種，而感染率低的品系皆為GUT5品系及L151品系雜交後裔，此一研究結果有助於桉樹種植時的選擇，以降低此一外來入侵種造成的經濟損害與影響。

關鍵詞：桉樹、蟲癭、桉樹枝癭釉小蜂、感性試驗、寄主偏好。

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Research note

Susceptibility Tests of Various *Eucalyptus* Host Species to *Leptocybe invasa* in Taiwan

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【 Summary 】

Eucalyptus trees are the collective name of the genus *Eucalyptus* which is in the family Myrtaceae. These are globally well-known species with fast-growing characteristics and economic value. *Leptocybe invasa* Fisher & La Salle (Hymenoptera: Eulophidae), the gall wasp of eucalyptus trees, originated in Australia. In 2000, the gall wasp was discovered in Israel. It causes damage to young eucalyptus branches, petioles and veins. It can affect the growth of plants and cause serious infections and even death. The gall quantity, density, and plants damaged varied among various host species. In this study, we found that 10 eucalyptus species were affected by *L. invasa*, but with different extents of infection: *E. amplifolia*, *E. camaldulensis*, *E. citriodora*, *E. dunii*, *E. grandis*, *E. maculata*, *E. propinqua*, *E. robusta*, *E. saligna*, and *E. tereticornis*. Among them, *E. camaldulensis*, *E. grandis*, and *E. saligna* were the 3 most vulnerable ones. Because of variable degrees of resistance of these species of eucalyptus, we carried out susceptibility tests on 7 different known strains of eucalyptus using Fisher's least significant difference (LSD) test. We found that most of hybrid strains from *E. grandis* and *E. camaldulensis* had higher infection rates by *L. invasa* than did the other strains. On the contrary, hybrids from strains GUT5 and L151 had lower infection rates. The results can help us choose suitable strains to protect against *L. invasa*.

Key words: eucalyptus, gall, *Leptocybe invasa*, susceptibility tests, host preferences

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緒言

原生長於澳洲的桉樹，為世界三大類生長快速樹種之一，纖維適宜製漿，具高經濟價值(Rejmánek and Richardson 2011)，在世界各地廣為種植，是重要的商用樹種之一，在世界各地大面積造林，直到2012年，已經有96個國家引進栽植(Anon 2013)。早期桉樹的蟲害不多，然而近年來，造癭的袖小蜂科肆虐歐洲以及各大陸，危害桉樹幼嫩枝條，葉柄及葉脈，嚴重感染時會影響植株的生長甚至死亡，造成許多國家的重大經濟損失。全世界已知有4000多種已經被描述的袖小蜂科昆蟲，原先出現在澳

洲，自1987年紐西蘭就記錄到桉樹葉片上的袖小蜂(Raman and Withers 2003)，直到2000年，中東、南歐與北非的桉樹造林被袖小蜂科昆蟲嚴重侵害，造成許多桉樹林死亡，製漿產量大減(Aytar 2006, Branco et al. 2006, Costa et al. 2008, Nyeko and Nakabonge 2008, Wiley and Skelley 2008, Nyeko et al. 2009, Wu et al. 2009, Kulkarni 2010)。

台灣於2010年在臺北與雲林發現桉樹上有蟲害病徵(Tung and La Salle 2010)，經由鑑定確定其為2004年所發表的*Leptocybe invasa*

(Hymenoptera: Eulophidae)，中文定名為桉樹枝癭小蜂。其寄主植物範圍涵蓋三個亞屬(*Exsertaria*、*Latoangulata*、*Maidenaria*)及其雜交種，已記錄寄主包括鹽風桉(*Eucalyptus botryoides*)、蘋果桉(*E. bridgesiana*)、赤桉(*E. camaldulensis*)、藍桉(*E. globulus*)、雪桉(*E. gunii*)、玫瑰桉(*E. grandis*)、大葉桉(*E. robusta*)、雪梨藍桉(*E. saligna*)、細葉桉(*E. tereticornis*)、多枝桉(*E. viminalis*)與直幹桉(*E. maidenii*)等，其中以赤桉受桉樹枝癭小蜂的危害最為嚴重。雜交種中，玫瑰桉與赤桉的雜交種(*E. grandis*×*E. camaldulensis*)亦被感染，中國廣西的尾葉桉與細葉桉的雜交種(*E. urophylla*×*E. tereticornis*)亦於2007年受到危害(Mendel et al. 2004, Jacob et al. 2007)。

桉樹枝癭小蜂的分佈於亞洲地區的中國、越南、泰國、印度、土耳其、伊朗、以色列、約旦、敘利亞；非洲地區的阿爾及利亞、衣索比亞、肯亞、摩洛哥、坦尚尼亞、烏干達、南非；歐洲地區的希臘、義大利、西班牙、葡萄牙以及澳洲等地皆有其分佈(Mendel et al. 2004, Branco et al. 2005, Aytar 2006, Jacob et al. 2007, Anagnou-Veroniki et al. 2008)，台灣地區則自受害報導後(Tung and La Salle 2010)，全台危害現況尚須進一步確認。

而桉樹枝癭小蜂在不同寄主植物上造癭數量、密度、總蟲數和植物受損情形有所差異，顯示其具有不同程度之抗性(Thu et al. 2009, Basavanagoud et al. 2010, Javaregowda and Prabhu 2010, Jhala et al. 2010, Kumari et al. 2010, Nyeko et al. 2010)。因此對於台灣現有不同寄主植物應有不同的評估感染程度基準，以便決定該植株的防治處理方式並判斷野外的感染入侵情形，達到有效監控管理桉樹枝癭小蜂入侵的目標。

材料與方法

一、桉樹枝癭小蜂在台灣分布及寄主種類

自2010年開始在全台各地桉樹苗圃、造林地、行道樹與綠地植栽，檢視桉樹是否受到桉

樹枝癭小蜂感染，若有感染情況，記錄桉樹種類與定位座標。另外由文獻及資料庫收集桉樹枝癭小蜂在全球的分布位置。

二、桉樹屬寄主植物對桉樹枝癭小蜂的感性試驗

本試驗利用具有造林潛力的品系，分別為赤桉(*Eucalyptus camaldulensis*)、玫瑰桉(*E. grandis*)、細葉桉(*E. tereticornis*)與尾葉桉(*E. urophylla*)之雜交種，共選取7個雜交品系進行桉樹屬寄主植物對桉樹枝癭小蜂的感性試驗，分別為：品系1. CG43 - *E. camaldulensis*×*E. grandis*；品系2. GU×LH303 - (*E. grandis*×*E. urophylla*)×(*E. grandis*×*E. urophylla*)；品系3. L151×L151 - *E. camaldulensis*×*E. camaldulensis*；品系4. L151×L151 - (*E. tereticornis*×*E. grandis*)×*E. camaldulensis*；品系5. L151×LH303 - *E. camaldulensis*×(*E. grandis*×*E. urophylla*)；品系6. TG47×LH303 - (*E. tereticornis*×*E. grandis*)×(*E. grandis*×*E. urophylla*)；品系7. GUT5 - *E. grandis*×*E. urophylla*。每品系各10株，苗高約1 m。待確定植株無任何桉樹枝癭小蜂之危害後，為避免其他昆蟲之干擾，每株植株分別套入網袋，於各網袋中放入桉樹癭小蜂雌、雄蟲各5隻，於8週後拆除網袋，並計數各植株桉樹癭小蜂感染狀況。以全株的葉片數為分母，感染蟲癭的葉片數為分子，計算每株的感染率。以單因子變異數分析(one-way ANOVA)其是否有顯著差異，再進一步以最小顯著差異測驗法(Fisher's Least Significant Difference, LSD)進行差異性測驗，檢測不同品系間平均感染率的差異。

結果與討論

一、桉樹枝癭小蜂在台灣分布及寄主種類

目前檢視台灣地區所種植之14種桉樹，其中以山藍桉、赤桉、檸檬桉、白桉、玫瑰桉、斑桉、小果灰桉、大葉桉、雪梨藍桉、細葉桉等10種桉樹會受到桉樹枝癭小蜂不同程度的

感染；脂桉、樹膠桉、灰桉和尾葉桉等4種桉樹未發現感染(Table 1)。而這些桉樹種類在台灣主要用於造林(Chen et al. 1995)或做為無尾熊的食草。

在台灣各地檢視桉樹的結果，目前在台北(木柵動物園、淡水苗圃、林試所苗圃)、雲林(古坑行道樹)、嘉義(苗圃)及金門(植物園苗圃)(Fig. 1)發現桉樹上有蟲害病徵，大部分為桉樹苗或新種植株遭感染，周圍的長期造林地或植栽大部分未發現感染。近期在金門及古坑亦發現栽種較久的行道樹或造林地開始感染，雖然桉樹枝癭袖小蜂主要危害年輕的苗木，大樹較不易受蟲癭影響其生理及生長，但仍須持續監控大樹是否受蟲癭影響生長，並針對大樹尋求有效的防治方式。此外，當務之急為減緩新造林地的蟲害，並避免繼續擴散，以及有效控管苗圃的新生苗。

二、桉樹屬寄主植物對桉樹枝癭袖小蜂的感性試驗

桉樹枝癭袖小蜂對7個桉樹品系的感染率顯著不同(one-way ANOVA, $F_{6,63} = 7.037$, $p < 0.001$)，最小顯著差異測驗法(Fisher's Least Significant Difference, LSD) 檢測不同品系間平均感染率的差異，結果品系1、品系2、品系4及

品系6的感染率顯著高於品系3及品系7，而品系5則介於中間(Fig. 2, $LSD = 0.079$)。被感染率高的品系多為包含玫瑰桉或赤桉的雜交品種，而感染率低的品系為品系GUT5及品系L151的再雜交種。

低感性的品系如脂桉、樹膠桉、灰桉與尾葉桉等，仍需控制其蟲量，避免成為感染源，而影響其他高感性的寄主植物種類。

結論

在台灣目前已知桉樹枝癭袖小蜂會在10種桉樹上造癭，感性實驗顯示偏好玫瑰桉、赤桉的雜交品系，在野外則發現對玫瑰桉、赤桉及雪梨藍桉會造成較嚴重的感染，一旦在這些種類發現病徵，必須立即處理，以避免樹木嚴重感染，並降低感染源。

未來育林人員可以依照試驗結果，選擇非感性植株選育抗蟲雜交品系，並避免在田間繼續種植高感性品系。

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Table 1. Survey of damage levels of *Leptocybe invasa* on 14 *Eucalyptus* species in Taiwan

No.	Scientific name	Infection type	Utility
1	<i>E. amplifolia</i>	infected	reforestation/koala's diet
2	<i>E. camaldulensis</i>	severely infected	reforestation/koala's diet
3	<i>E. citriodora</i>	moderately infected	reforestation
4	<i>E. dunii</i>	infected	reforestation/koala's diet
5	<i>E. grandis</i>	severely infected	reforestation/koala's diet
6	<i>E. maculata</i>	infected	reforestation/koala's diet
7	<i>E. propinqua</i>	infected	reforestation/koala's diet
8	<i>E. robusta</i>	infected	reforestation/koala's diet
9	<i>E. saligna</i>	severely infected	reforestation/koala's diet
10	<i>E. tereticornis</i>	infected	reforestation/koala's diet
11	<i>E. microcorys</i>	non-infected	reforestation/koala's diet
12	<i>E. resinifera</i>	non-infected	reforestation/koala's diet
13	<i>E. punctata</i>	non-infected	reforestation/koala's diet
14	<i>E. urophylla</i>	non-infected	reforestation

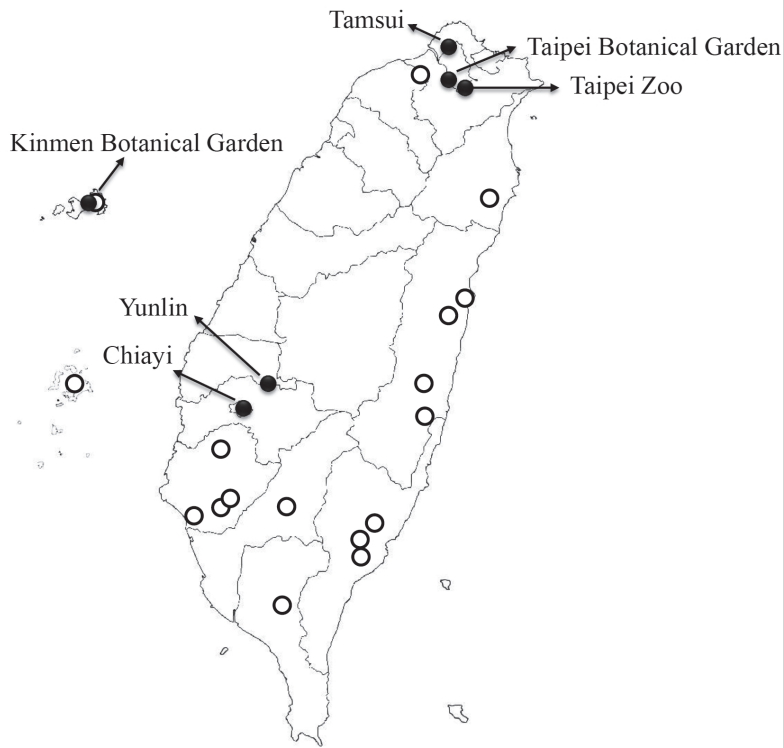


Fig. 1. Surveys of damage levels of *Leptocybe invasa* in Taiwan. Solid and empty circles indicated serious infected and non-infected levels, respectively.

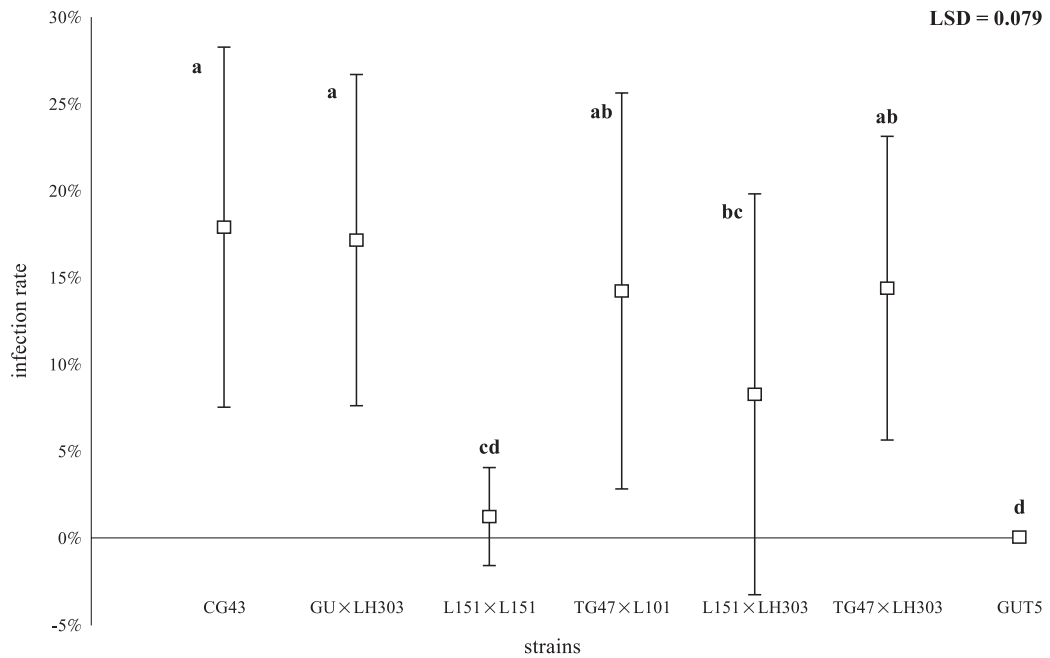


Fig. 2. Susceptibility tests of *Eucalyptus* species to *Leptocybe invasa*.

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