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論文宣讀摘要

01 東方果實蠅棲群生態資料收集自動化的研究現況——無線感測器網路技術之應用
Automatic acquisition of ecological information of oriental fruit fly population—
Application of wireless sensor network

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東方果實蠅 (*Bactrocera dorsalis* (Handel)) 為台灣果樹重要害蟲。目前無論政府與農民皆倚賴人工計算由誘捕器捕獲之果實蠅數量判斷危害情況與決定化學防治的時機。本研究藉無線感測器網路技術 (Wireless Sensor Network, WSN) 實地進行區域性的果實蠅棲群監測。不同於傳統人工計數方式，本研究改良市售果實蠅誘捕器以結合無線通信模組研製出東方果實蠅專用的無線感測器節點。同時，本研究亦開發出搭載 GSM 簡訊模組之田間閘道器。所開發的無線感測器節點可自動計數所誘捕到之果實蠅數目，並定時將捕獲數及各環境參數傳至閘道器，再以簡訊方式回傳至資料庫彙整。於室內進行偵測準確率可達 95.71% (N = 140)；於野外持續 25 天的測試結果亦達 93.98%。此外，我們於農試所嘉義分所亦佈建三套網路進行長期的果園監測試驗。為期 99 天的實驗結果經線性回歸分析後發現所有佈建節點的平均判定係數 (R^2 值) 皆大於 0.86，線性方程式誤差量皆小於 9.6；顯示用以分析的各蟲數數值與此線性方程式關聯性高。利用本系統所建立的長期監測資料庫，可進行各種與東方果實蠅棲群生態相關的分析。由長期監測資料發現，果實蠅出沒密度大都集中在剛日出及日落的時候，顯示出雙峰現象且與溫度相關。未來的研究方向將著重在區域性棲群生態分析，對東方果實蠅棲群遷移或變異情況做更深入的瞭解。

關鍵詞：生態監測、東方果實蠅、棲群遷移、無線感測器網路

The Oriental fruit fly (OFF), *Bactrocera dorsalis* (Hendel) is one of the major insect pests in Taiwan. Currently both the government and farmers rely on the manually counted quantity of trapped flies to estimate the population size in the field and the best timing for chemical control. The present study aimed to monitor the area-wide population of OFF using wireless sensor network (WSN) technology. Different from the traditional approach, we reformed the trapping tube from the commercial style and combined the wireless communication device to develop a wireless sensor node for OFF monitoring. Meanwhile, the field gateway embarking GSM short message module was also developed. The sensor node counted the number of trapped flies when entering the modified trapping tube, and returned the captured number with the environmental parameters to the gateway on schedule. The information being collected was transmitted to a database in form of short message via the gateway. To examine the detection accuracy, the modified trapping tube was firstly installed indoor, and the average rate of detection accuracy was 95.71% (N = 140). The result of field testing for 25 days gave a average detection accuracy up to 93.98%. Another three long-term monitoring networks were also deployed at the Chia-Yi Agricultural Experiment

Station (CAES). With a 99 day-long record employing linear regression analysis, the average squared correlation (R^2) for all of the deployed nodes was greater than 0.86 with the error less than 9.6, suggesting high correlation between the number of trapped flies and the linear equation. With the aid of this system, various analyses involving population ecology of OFF become feasible. The long-term monitoring data also reveals a correlation between temperature and activities of OFF. More OFFs were trapped during sunrise and sunset, suggesting two peaks in the daily inquiry chart. With the help of this powerful tool, future studies, for both regional and area-wide, will focus on the population ecology, including migration and variation issues.

Key words: ecological monitoring, oriental fruit fly, population migration, wireless sensor network

02 形態與功能——探索生存適應的物理
Form and function: Exploring life from a physical perspective

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生物學研究的主要課題之一，在於探討生物體的形態與功能之間的關係，從而瞭解生物生存的機制。功能形態學的研究，一般能以歷史和物理的觀點切入。其中，生物學家較為熟悉的歷史或親緣分析，有助於確定生物在演化過程中，結構和功能變化的順序。而生物力學或生物物理學的分析，則有助於闡明環境與生物的交互作用，使我們瞭解生物形態的物理限制，協助我們提出力學或數學模式，來解釋生物體運作的機制，以進一步探討生物體在面對不同的環境時，是如何以有限的物理定律，發展出不同的形態與結構，進而解決生存的問題。在這場演講中，我首先將簡介「比較生物力學」這個領域，以及其所探討的研究課題，例如，生物是如何透過短時間內行為或形狀的改變，以及長時間材料與結構的變化，來因應來自環境的作用力。我將以多類生物為例（包含昆蟲、以及其他脊椎與無脊椎動物），來廣泛探討的生物形態、功能、或行為（包含感覺、攝食、交配、運動等系統）。此外，我將以昆蟲為主，概述生物力學的研究現況。最後，我將分享在國內學習與教授生物力學、以及進行跨領域研究的經驗與面臨的挑戰。

關鍵詞：功能形態學、生物力學、生物物理

One of the key problems biologists attempt to solve is to examine the relation between organismal form and function, and subsequently to understand the mechanisms of their living. Historical and physical approaches have been applied to solve such problem. More familiar to biologists, historical or phylogenetic analysis allows the determination of the evolutionary sequences of structural and functional change in organisms through time. On the other hand, biomechanical or biophysical analysis helps elucidate the relation between physical, environmental constraints and the design of morphological systems. Such analyses contribute an understanding of the design constraints on organismal form, explicitly propose mechanical or mathematical models of organismal function, and ultimately make it possible to determine the extent to which organismal design matches environmental demands. In this talk, I will first introduce the field of “comparative biomechanics,” which addresses questions like how organisms response to forces imposed by the environment through changing shapes and behaviors over physiological time, or modifying materials and structures over evolutionary times. Examples cover diverse organisms, including insects, and various invertebrates and vertebrates, and a broad realm of forms, functions, or behaviors, including sensory, feeding, mating, and locomotory systems. Furthermore, I will overview the current status of biomechanical research focusing on insects. Lastly, I will share my experiences and challenges of learning and teaching biomechanics, as well as conducting interdisciplinary research in Taiwan.

Key words: functional morphology, biomechanics, biophysics

03 太平洋偽葉蟎在蝴蝶蘭上之生活史
Life history of *Tenuipalpus pacificus* reared on *Phalaenopsis* sp.

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太平洋偽葉蟎於蝴蝶蘭上以 20、24、28、32、36°C 等 5 種定溫、相對濕度 80%、光週期 12:12 (L:D) 之條件下進行生活史觀察。卵於 20°C 下需時 27.5 天方能孵化，在 36°C 時僅需 6.7 天。幼蟎之發育期介於 24°C 之 13.4 天與 36°C 之 3.7 天之間，前若蟎則介於 20°C 之 10.9 天與 32°C 之 3.9 天之間，後若蟎之發育期介於 14.1 與 4.1 天之間。整個幼期發育所需時間，於 20°C 時需 66.5 天，24°C 時需 49.6 天，而 28、32 及 36°C 時則分別需時 31.7、22.6 與 19.4 天。卵之發育臨界低溫為 16.19°C、幼蟎為 14.81°C、前若蟎為 14.52°C、而後若蟎則為 16.07°C。卵、幼蟎、前若蟎與後若蟎之發育總積溫依序分別為 144.09、85.11、70.47 與 66.23 日度。幼期之發育臨界低溫與發育總積溫分別為 14.60°C 及 411.52 日度。雄成蟎之壽命介於 42.7 與 14.0 天之間，而雌成蟎則介於 42.9 與 21.2 天之間，在 20、24、28、32 與 36°C 下平均每隻雌蟎分別產下 4.0、10.6、31.3、35.9 與 6.2 粒卵。將生活史資料進行兩性生命表分析，其內在增殖率 (r) 在 20、24、28、32、36°C 下分別為 -0.0012、0.0195、0.0531、0.0578、0.0411 (1/day)。淨增殖率 (R_0) 以 28°C 時為最高 ($R_0=13.89$)，而於 20°C 時為低 ($R_0=0.90$)。平均世代所需時間 (T) 依序為 87.71、65.81、49.53、36.87 與 27.72 天。

關鍵詞：太平洋偽葉蟎、蝴蝶蘭、溫度、生活史、族群介量

The life history of *Tenuipalpus pacificus* on *Phalaenopsis* sp. were studied at 20, 24, 28, 32, 36°C, 70 ± 5% RH and a photoperiod of 12:12 (L:D) h under laboratory conditions. Developmental time of egg stage was 27.5 d at 20°C, and only 6.7 d at 36°C respectively. The developmental time of larva stage was ranged from 13.4 d at 24°C to 3.7 d at 36°C. The developmental time of protonymph stage was between 10.9 d at 20°C to 3.9 d at 32°C. At deutonymph the developmental time was between 14.1 d to 4.1 d. The developmental times of the immature stage was 66.5 d at 20°C, 49.6 d at 24°C, and 31.7, 22.6, 19.4 d at 28, 32, and 36°C, respectively. Low temperature threshold of the egg, larva, protonymph, and deutonymph were 16.19, 14.81, 14.52, and 16.07°C, respectively, and the thermal summation of each stage were 144.09, 85.11, 70.47, and 66.23 degree-day, respectively. The low temperature threshold and thermal summation of the immature stage were 14.60°C and 411.52 degree-day. The longevity of the male and female stage was between 42.7 to 14.0 d and 42.9 to 21.2 d, respectively. The average fecundity was 4.0, 10.6, 31.3, 35.9 and 6.2 eggs/female at 20, 24, 28, 32, 36°C, respectively. The intrinsic rate of increase (r) was -0.0012, 0.0195, 0.0531, 0.0578, and 0.0411 d⁻¹ at 20, 24, 28, 32, 36°C, respectively. The net reproduction rate (R_0) was highest at 28°C ($R_0 = 13.89$), and lowest at 20 °C ($R_0 = 0.90$). The mean generation time (T) was 87.71, 65.81, 49.53, 36.87 and 27.72 d at 20, 24, 28, 32, 36°C, respectively.

Key words: *Tenuipalpus pacificus*, *Phalaenopsis* sp., temperature, life history, population parameter

04 台灣銜蠓 *Forcipomyia taiwana* (Shiraki) 的產卵習性、棲群動態與對昆蟲生長調節劑感受性之研究
Studies on the oviposition, population dynamics and the susceptibility to insect growth regulators of
biting midge, *Forcipomyia taiwana* (Shiraki) (Diptera: Ceratopogonidae)

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台灣銜蠓 *Forcipomyia (Lasiohelea) taiwana* (Shiraki) 雌蟲產卵受幼蟲食物存在與否、溫度及光度之影響。吸血雌蟲於 15°C、20°C、25°C、30°C 與 35°C 下皆可完成生殖營養週期，卵發育速率隨著溫度的升高而增加。在 25°C 與 30°C 下雌蟲之產卵率明顯高於其他溫度，其中 25°C 下以 12:00 至 15:00 與 15:00 至 18:00 兩時段之產卵量最多，顯示台灣銜蠓雌蟲具產卵日律動。懷卵雌蟲選擇將卵產於具有光照或幼蟲食物的地方，其中光之影響明顯高於幼蟲食物。測試幼蟲對昆蟲生長調節劑 (Insect growth regulators, IGRs) 之感受性，結果顯示二齡幼蟲對百利普芬、氟芬隆及克福隆之感受性均高於四齡，其中以百利普芬之藥效最佳。台灣銜蠓全省分布調查結果顯示，其於台灣之危害已有 13 縣 125 個鄉鎮地區，分布最高海拔為 900 公尺之南投魚池地區。自 2005 年 5 月至 2006 年 5 月，以人體誘集法於南投地區竹山秀林里及鹿谷秀峰村進行台灣銜蠓田間棲群動態調查，調查結果指出其發生具有季節性，以 7、8 月為最高峰，介於 12 月至隔年 4 月間密度最低。根據相關性及複迴歸統計分析，台灣銜蠓棲群密度之變動與調查日之前兩週之溫度、相對濕度與降雨日數間具有較高的相關性，其中以溫度之影響最為重要。

關鍵詞：台灣銜蠓、產卵習性、棲群動態、昆蟲生長調節劑、分布

The gonotrophic cycle of the blood-feeding females of *Forcipomyia taiwana* (Shiraki) were complete at 15°C, 20°C, 25°C, 30°C, and 35°C. Egg developmental rate in the gravid female is increase with temperature rising, and the oviposition rate of gravid female is significantly high at 25°C and 30°C. Normally, there are circadian rhythm phenomenon in the oviposition of gravid female under 25°C, the higher peak of eggs laid are located at 12:00 to 18:00. The oviposition of gravid female *F. taiwana* is effected by the temperature, light, and the food of larva, and the light factor is most important that affects the oviposition. Pyriproxyfen is the effectiveness insect growth regulator (IGR) on the susceptibility of 2nd and 4th larva of *F. taiwana* among the three tested IGRs, Pyriproxyfen, Flufenoxuron, and Chlorofluazuron. There are 125 village or towns in 13 counties occurs *F. taiwana* under the distribution investigation during August to October, 2006. A highest collected record is at the 900 meters high upper sea in Nantou area. Seasonal dynamic of the population of *F. taiwana* was surveyed at two countries area, Shioufeng in Lugu village and Hsiolin in Jhushan township during May, 2005 to May 2007. These investigations show the low population density of *F. taiwana* in winter and early spring seasons, and the density were increasing with temperature higher, than the highest population density was located at summer seasons, in July and August. The dynamic of *F. taiwana* population density were affected by climate fluctuation. By using the correlation and multiple regression analysis, the temperature, relative humidity, and raining period are the most correlation meteorological factors with population density of *F. taiwana*, especially two weeks before the midge collected.

Key words: *Forcipomyia taiwana*, oviposition, population dynamics, insect growth regulators, distribution

05 外銷番茄成熟度與果實蠅為害相關性探討及網室番茄園內果實蠅發生監測
Relationships between tomato ripeness and fruit fly infestation and monitoring of the fruit flies occurred
in tomato field under screenhouse cultivation

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於室內測試1、5、10及20對四種密度下瓜實蠅及東方果實蠅分別對(1)綠轉粉紅果(6分熟)、(2)淡紅果(7分熟)、(3)微紅果(8分熟)及(4)紅果(9分熟)4種不同成熟度紅番與紅美玲牛番茄產卵為害情形並進行網室番茄園內果實蠅發生監測。試驗結果顯示,於紅美玲牛番茄,在1、5、10及20對瓜、果實蠅密度處理下,四種供試成熟度番茄均會被瓜實蠅及東方果實蠅產卵為害。於紅番牛番茄,在5、10及20對瓜、果實蠅密度處理下,四種供試成熟度番茄均會被瓜實蠅及東方果實蠅產卵為害;1對瓜實蠅密度處理下,供試四種成熟度紅番牛番茄未被瓜實蠅產卵為害,但1對東方果實蠅密度處理下,供試四種成熟度紅番牛番茄均會被東方果實蠅產卵為害。瓜、果實蠅雌蟲會將卵產於果實萼片下,雖然大部份孵化的幼蟲會死亡,但仍有少部份幼蟲可由果蒂處鑽入果肉內存活。果實較紅番與紅美玲牛番茄小的紅慧番茄,其萼片面積明顯小於紅番與紅美玲牛番茄。在20對瓜、果實蠅密度試驗下,紅慧番茄在萼片下與被產卵的次數與量明顯較紅番與紅美玲牛番茄少。在網室番茄園內監測果實蠅,並未發現有果實蠅侵入,顯示設計良好的網室可有效阻隔果實蠅為害。

關鍵詞: 果實蠅、番茄、番茄成熟度、族群、監測

Relationship between ripeness of tomato (*Lycopersicon lycopersicum* L.) and infestations of the oriental fruit fly (*Bactrocera dorsalis* (Hendel)) and the melon fly (*Bactrocera cucurbitae* (Coquillett)) were determined in the laboratory. Tests were done with four levels of fruit ripeness, 60, 70, 80 and 90% ripe, two tomato varieties, 'Hong Fan' and 'Hong Mei Ling', and four fruit fly density treatments, 1, 5, 10, and 20 pairs. Fruit ripeness levels were distinguished by the fruits' reddish color development, i.e., green-pink- 60% ripe, slightly red- 70% ripe, lightly red- 80% ripe, and red- 90% ripe. Results indicated that both the oriental fruit fly and the melon fly at all four density treatments laid eggs in 'Hong Mei Ling' beef tomatoes of all tested ripeness levels. For 'Hong Fan' beef tomatoes, both fruit flies laid eggs in tomatoes of various tested ripeness levels at the three higher fly density treatments, but at the 1-pair treatment, only the oriental fruit fly, but not the melon fly, laid eggs in the tomatoes. The fruit flies laid eggs in fruit calyx. Although most of the hatching larvae died, a few of them penetrated into the fruit flesh and survived. 'Hong-huei' is another tomato variety with significantly smaller fruit and calyx area than the 'Hong Fan' and the 'Hong Mei Ling' beef tomato. We compared the fly's ovipositional behavior among these three tomato varieties with both fruit flies at the 20-pair treatment. It showed that the frequency and the amount of egg laid in the Hong-huei tomato were significantly less than in the Hong Fan and in the Hong Mei Ling beef tomato. Besides, no fruit flies were found in the tomato screenhouse during our monitoring. This indicates that well-designed screenhouses would avoid the invasion of fruit flies.

Key words: fruit fly, tomato, tomato ripeness, oviposition, monitoring

06 關渡紅樹林保留區內斑星天牛群聚模式的動態觀察

Dynamic study on aggregation pattern of *Anoplophora macularia* (Thomson) (Coleoptera: Cerambycidae) in the Reservoir of mangrove forest, GUAN-DOU

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自 1999 到 2008 年間，吾人作了台北關渡紅樹林中，斑星天牛的飛遷、交配、取食，和爭鬥群聚模式的動態觀察。結果顯示，成蟲約在三月末四月初出現，出現的早晚視一年的積溫而定。族群出現的高峰在五月間，第二高峰在六月初。然而，2003 及 2008 的兩群不見第二高峰。通常一天內會有百隻個體出沒，少於此數時，會有互殘行為。日間飛遷活動，以日出後一個小時後為最高：以 45 隻計，半小時，飛遷 136 次。日落前一小時再創飛遷高峰。交配高峰通常與飛遷高峰重疊。以捕捉、標記，再捕捉，來看棲群在取食/交配區的滯留時段，可知 2003 年者在標記後十二小時內，有 75% 者飛離，而 2008 年者有 56%。群聚模式的飛遷在 1999 年經 30 天時段呈高原型，以後呈較短期的諸峰型，到 2008 年時只有單峰。總交配率則由前數年的 21% 降到 2008 年的 13.5%。增溫的長期及短期效應，影響群聚模式的改變將在此討論。

關鍵詞：斑星天牛、動態觀察、群聚模式、年積溫、增溫效應

Dynamic study on aggregation pattern of *Anoplophora macularia* (Thomson) among mangrove forest and feeding areas in the Guan-Du Natural Reservoir was monitored during 1999 to 2008. Copulation, fighting, feeding and flocking of this insect were recorded. Adult was initially found during late March or early April, depending on the annually accumulating temperature. High peak(s) of adult moving to feeding areas occurred during May. Usually, one hundred or more individuals could be observed in a feeding area within a day. Slash activity, somehow, was observed when a population was on the decrease. Daily rhythmic migration of this beetle among mangrove forest and feeding areas showed that the movement reached its peak (136 flight/30 min/45 beetles) one hour after sunrise, or one hour before sundown. Data on catching, marking, and re-catching of the beetle in feeding areas showed that the average rate of the marked ones moving into mangrove forest were of 75% in 2003 and 56% in 2008 in a period of 12 hours. The aggregation pattern of adult flocking of 1999 is in plateau form with interval of 30 days. The pattern shifted to multiple-peak form with shorter interval and then, to single peak form by 2008. The total mating rate sampled during 2000-2004 was around 21% in average. It dropped to 13.5% by 2008. Variation on aggregation pattern caused by climate warming, either in short-term effect or in long-term effect will be discussed.

Key words: *Anoplophora macularia*, dynamic study, aggregation pattern, annual accumulated-temperature, climate-impact

07 東方果實蠅膏狀餌劑田間誘效評估

Field evaluation on the trapping efficacy of a paste formulation of methyl eugenol for the oriental fruit fly

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本研究於中、南、東地區擇點進行田間試驗，比較朝陽科技大學研發之新型含毒甲基丁香油膏劑配方與甲基丁香油誘殺板誘殺東方果實蠅的效果，並於室內比較雄蠅取食此二誘餌及死亡情形。結果顯示 1~3 及 5~7 日齡未交尾雄蟲在膏劑上之取食時間均顯著短於在誘殺板上者。9~11、13~15、17~19 日齡雄蟲，不論或是否已交尾，於膏劑上的取食時間亦均顯著短於誘殺板處理組。21~23 日齡已交尾雄蟲在兩種誘餌上的平均取食時間無顯著差異。1~3 及 5~7 日齡雄蟲無論在那一種誘餌上之取食時間，僅約為其他日齡蟲之二分之一。在兩種處理中，只要雄蠅停留取食不論時間長短均會死亡。比較不同日齡及交尾狀態雄蟲取食兩種誘餌後之死亡時間，不論是否已交尾，取食膏劑後至死亡時間均顯著長於誘殺板處理組。果實蠅在膏劑上取食的時間顯著隨日齡增加而增長；在誘殺板上取食的時間無顯著隨日齡增加增加之趨勢。在膏劑或誘殺板上取食後至死亡的時間，均顯著隨日齡增加而縮短。比較甲基丁香油膏劑與誘殺板二者懸掛距離在 5 m 或 30~50 m 的情況下誘殺的效果，結果顯示農業試驗所、農試所鳳山分所、高雄改良場及花蓮改良場所分別進行 13、12、18 及 10 次的調查中，此二種誘餌平均捕獲蟲數間均無顯著差異。然若將膏劑直接塗抹於多種果樹枝條上時，塗抹部位均產生藥害，在葡萄上更造成枝條枯死。

關鍵詞：東方果實蠅、甲基丁香油乃力松膏劑、誘效、取食時間、取食後至死亡時間

This study compared the attract-and-kill efficacy for the oriental fruit fly between a new paste formulation of toxicant-added methyl eugenol (ME), developed by CUT, and the ME fiberboard in the fields located in the central, southern, and eastern Taiwan. The feeding time and the time to death after feeding of male flies on the two ME baits in door were also compared. Results showed that the feeding times of 1-3 and 5-7 days old unmated males were significantly shorter when feeding on paste bait than on ME fiberboard. Same results were also found for the mated and unmated 9-11, 13-15, and 17-19 days old males. However, no significant difference in feeding time was found for the 21-23 days old mated flies between the two baits. The durations of feeding on either lure for the 1-3 and 5-7 days old flies were only half of those for the flies at other ages. All the flies feeding on either lure died despite feeding times. The time to death after feeding was longer when feeding on the paste regardless of age and mating status. The duration of feeding on the paste was significantly increased as the age increased; however, this was not the case for the flies feeding on the fiberboard. The times to death after feeding on either lure significantly decreased with increasing fly age. There were no significant differences in the capture number between the two baits for either treatment of hanging height or various field investigations conducted by TARI, TARI-Fengshan Branch, Kaohsiung DARES, and Hualien DARES, respectively. Phytotoxicities on various fruit species were detected and led to death of grape vines.

Key words: oriental fruit fly, methyl eugenol-naled paste formulation, trapping efficacy, feeding time, time to death after feeding

08 X 光影像技術在果實內部病蟲害偵測之應用
The application of X-ray imaging technology to detect fruit pest and pathogen infestations

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以肉眼檢視水果病蟲害為主要的檢疫方法之一，然而人眼是無法透視水果內部病蟲危害狀況。本研究藉由 X 光影像偵測出水果內部因病蟲害所造成的不均質現象以判斷水果是否遭受危害，並與肉眼檢視的結果做比較，評估兩種方法孰優孰劣。受測水果分別先以人工植卵與東方果實蠅自然產卵兩種方式處理，之後再接受 X 光影像偵測系統與檢疫人員的檢視。人工植卵處理方面，在蘋果、芒果、油桃和柳橙等，水果在 4 至 5 天即可由 X 光影像檢測出植卵處的影像差異。在果實蠅自然產卵處理方面，人工檢視與 X 光影像檢測的檢出能力比較結果發現，X 光影像方法在整體正確率 (accuracy) 與鑑別度 (specificity) 的表現優於人工檢視，而靈敏度 (sensitivity) 則是以人工檢視較佳。

關鍵詞：X 光影像技術、檢疫檢查、東方果實蠅、水果、檢出率

The naked-eye inspection for checking insect pest and pathogen inside the fruits is one of main methods in quarantine inspection. However, it is impossible for human eye to see into the inside of fruits. In this study, X-ray imaging technology was employed to detect interior heterogeneous composition of fruit caused by insect pest and pathogen and to determine the fruits were infested or not. The results were then compared with those results obtained from routine naked-eye inspection to evaluate the accuracy, specificity and sensitivity of the two methods. For simulating fruits infested by the oriental fruit fly, all the fruits used for inspection were treated either with artificial egg implantation or normal egg deposition by the female flies. The treated fruits were then inspected by the X-ray imaging system and quarantine inspectors. The X-ray imaging system was able to detect the infested portions of apples, mangos, oranges and peach. The evaluation of the two inspection methods showed that the X-ray imaging system had a better performance in accuracy and specificity than naked-eye inspection, though the naked-eye inspection had a better performance in sensitivity.

Key words: X-ray imaging technology, quarantine inspection, *Bactrocera dorsalis*, fruit, detectable rate

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本研究自 2007 年 9 月起到 2008 年 3 月底止，在嘉義縣六腳鄉、永賢村、蒜頭村、崩山村、更寮村、六腳村、潭墘村、竹本村和雙涵村，逢機選取相鄰兩塊田為樣區，試驗樣區之作物有玉米、水稻、太陽麻、田菁及牛蒡，每個月以掃網方式調查一次，試驗期間每樣區總計各採樣七次，採得昆蟲共計 13 目 109 科 28372 隻。以 Species richness index, Simpson's index, Shannon-Wiener's index, Pielous's evenness index 四種多樣性指數分析，結果顯示鄰田間的生物多樣性會彼此影響，且隨著作物生長，昆蟲數量呈累積增加的趨勢，其生物多樣性指數也會隨之變動，不同作物出現之昆蟲相不同，再經 Sorensen 相似度指數分析，發現除裸地外，鄰田間昆蟲相都有共同昆蟲物種存在，且當鄰田一塊為裸地時，昆蟲則會聚集到另一塊作物田，而農藥的噴灑也會將害蟲逼到鄰近田地，而休耕地的綠肥更是容易形成害蟲躲藏的棲地，因此如何有效的管理休耕地減少蟲害，應可作為害蟲綜合管理的方法之一。

關鍵詞：昆蟲相、生物多樣性、昆蟲演替、棲地

Insect survey was conducted from September, 2007 to March, 2008. Seven fields with two adjacent fields in Yongsian village, Suantou village, Bengshan village, Gengliao village, Lioujiao village, Tancian village, Jhuben village and Shuanghan village were randomly selected. The crop planted in the experimental field were *Zea mays*, *Oryza sativa*, *Crotalaria juncea*, *Sesbania cannabiana* and *Arctium lappa* L. Insect seasonality was surveyed monthly by sweeping. In a total of seven surveys were taken during the study period. Total numbers of insects of 13 orders, 109 families, and 28372 insects have collected. Species richness index, Simpson's index, Shannon-Wiener's index, Pielous's evenness index were employed to analyze the insect diversity. The data has indicated that diversity could be influenced by adjacent field by each other. The biodiversity index was increased as the crop growing and different crop has different insect fauna. Furthermore, using Sorensen similarity index to analyze the diversity, some species were shown in both field except the bare field. When one of the adjacent fields was bare field, the insects would aggregate in another field. Spraying pesticide would make pests move to another field. Meanwhile, the *Sesbania* field has become a shelter for the insect pest. Therefore, effectively control the fallow field insect pest is considered to be a measure of Insect pest management.

Key words: insect fauna, biodiversity, insect succession, Habitat

10 96 槽微孔盤於進口農作上之薊馬檢測應用
Microplate application to identify thrips in imported agricultural products

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DNA 分子鑑定已是害蟲檢疫的重要方法之一，但在面對大量樣品受檢時，要如何快速的進行檢測，則需配合現有設備及技術，建立適當的檢測方法或流程。本研究應用 96 槽微孔盤，可同時操作 96 個樣本，應用於薊馬 DNA 資料之建立，並針對進口農作上常見的檢疫害蟲西方花薊馬和蔥薊馬進行檢測。在防檢局新竹分局所提供的近千個薊馬標本中，我們應用 96 槽微孔盤及全自動毛細管電泳設備，進行薊馬 DNA 的複製及 PCR 產物的確認；另利用兩組專一性引子從大量的樣本數中篩檢西方花薊馬及蔥薊馬。在定序的部份，分析了三盤共 288 個樣本，定序出 158 個樣本，內有 84 隻蔥薊馬、48 隻西方花薊馬，以及少量的澳洲疫薊馬 5 個、台灣花薊馬 5 個、小黃花薊馬 2 個等；另有 130 個樣本在複製或定序上未成功。在快速鑑定西方花薊馬及蔥薊馬的部份，無論是單一專一性引子或兩組 multiplex 專一性引子的測試結果，均有很高的正確率，在分析的八盤 768 樣本當中，西方花薊馬及蔥薊馬分別有 125 及 333 個個體，也發現 33 個樣本兩者均呈正反應，需進一步設計更專一性的引子解決此問題；此外，也有 277 個樣本未有 PCR 複製產物，可能是標本保存狀況較不理想或屬其它薊馬。

關鍵詞：微孔盤、分子鑑定、薊馬

Molecular identification is an important method to examine the quarantine pest. It is necessary, however, to establish an appropriate process to conduct a large amount of samples. In this study, microtiter plate with 96 samples operation was applied to establish thrips DNA information. Moreover, thrips concealed in the imported agricultural products such as *Thrips tabaci* and the quarantine *Frankliniella occidentalis* was determined via microplate application. The 96 microplate and full-automatic capillary electrophoresis equipment were carry out for DNA extraction and PCR product examination of 1000 thrips individuals provide by Hsinchu Branch of BAPHIQ. Further more, two specific paired primers were used to examine the *F. occidentalis* and *T. tabaci* of these samples. In DNA sequence determination, 288 samples within three microplates were analyzed; and 158 sequences were definitely, including 84 *T. tabaci*, 48 *F. occidentalis*, and that of 5 *T. imaginis*, 5 *F. intonsa*, 2 *Scirtothrips dorsalis*. However, about 130 samples were amplified or sequenced unsuccessfully. In the identification of *F. occidentalis* and *T. tabaci*, either examined by one- or two-specific paired primers, the identified validity is high within analyzed 768 samples of 8 macroplates. The examined result showed that 125 *F. occidentalis* and 333 *T. tabaci* was found, but 33 samples revealed amplified products of both thrips. Moreover, 277 samples did not yield PCR products, which might be caused by nonoptimal specimen preservation or different thrip species.

Key words: microplate, molecular identification, thrips

11 利用 PCR-RFLP 鑑定西方花薊馬 (*Frankliniella occidentalis* (Pergande)) (縷翅目：薊馬科)
之技術改進
Improvement of the identification of *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae)
by PCR-RFLP analysis

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西方花薊馬 (*Frankliniella occidentalis* (Pergande)) 為全球分佈的重大農作物害蟲，台灣為少數尚未發現此害蟲存在的地區之一。然而，在進口的農產品上常檢測出此害蟲，入侵台灣的機會相當高，因此已被列為我國檢疫害蟲的名單中。薊馬之鑑定以雌成蟲的形態特徵為主，但檢出的害蟲多為幼蟲期，無法明確鑑定至種。藉由分子形質的開發，可有效且快速解決形態無法解決的鑑定問題。本研究以核糖體DNA (rDNA) 之ITS + 5.8S區域為標的區段，利用18S下游及28S上游保守區段解碼的核酸序列，設計可增幅西方花薊馬的引子對SD18S-5/SD28S-5，可擴增出約1.5 Kb標的區段DNA，進一步利用核酸內切限制酶進行RFLP技術分析，已建立西方花薊馬*AluI*、*HaeIII*、*MspI*和*TaqI* 4種限制酶的酶切DNA片段圖譜，可準確鑑定西方花薊馬。以往西方花薊馬的分子鑑定由於引子的專一性不高，或再現性差，使得鑑定的可靠性受到質疑。本研究針對西方花薊馬設計的引子對SD18S-5/SD28S-5，具有專一性及靈敏度，可準確的增幅標的DNA，並具有可靠的再現性，符合要求快速、簡便的檢疫鑑定。

關鍵詞：鑑定、西方花薊馬、核糖體 DNA、ITS 區段、PCR-RFLP

The western flower thrips, *Frankliniella occidentalis* (Pergande), is an agricultural pest causes serious damage to economic plants in the world. Taiwan is one of the few areas where this pest has not been found. This pest has frequently been intercepted with agricultural products imported, hence the chance of it to invade Taiwan is considered quite high. The morphological identification of the thrips is relied on characteristics of female adults, but individuals encountered are often larval stage, and it is difficult to identify them to species. By the development of the molecular characters, the identification problem can be solved. In this study, we have explored one molecular marker. Utilization of the self-designed PCR primer pair (SD18S-5/SD28S-5), a rDNA-ITS region of approximately 1.5 Kb was amplified, and then using restriction enzymes to carry on RFLP technological analysis. We have already set up DNA digesting fragment map atlas of 4 kinds of restriction enzymes (includ *AluI*、*HaeIII*、*MspI* and *TaqI*) of *F. occidentalis*, for the accurate identification. Primer pair (SD18S-5/SD28S-5) designed for *F. occidentalis* in this research, have higher specificity and sensitivity, than those primer pairs developed before. This method has reliable results and can be used for quarantine inspection.

Key words: identification, *Frankliniella occidentalis*, rDNA, ITS region, PCR-RFLP

12 金馬地區鼠類之斑點熱病媒及病原體監測

Surveillance on the vectors and pathogens of spotted fever on murine-like animals in Kinmen and Matsu areas

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2006年6月至2008年3月於金門縣和連江縣進行5次野鼠捕捉及野鼠體外節肢動物採集，共計捕獲野鼠275隻，採集之野鼠血清以2種斑點熱立克次體抗原玻片 (*Rickettsia rickettsii* 和 *R. conorii*) 行血清學檢測。金門縣3次調查結果小黃腹鼠之 *R. rickettsii* 抗體陽性率為87.5~100.0%，連江縣2次調查結果小黃腹鼠 *R. rickettsii* 抗體陽性率為80.0~82.5%，顯示金門縣及連江縣野外主要鼠種小黃腹鼠感染斑點熱立克次體情形非常嚴重。為探究野鼠本身是否帶有斑點熱立克次體，取其內臟檢體，以120~135 kDa surface antigen (*ompB*) 及 citrate synthase (*gltA*) 為基因標的進行 nested-PCR 檢測。金門縣野鼠脾臟、肝臟及腎臟的 PCR 陽性率分別為 57.0、27.0 及 13.0%；連江縣的野鼠 PCR 陽性率則為 6.6、33.0 及 43.0%。顯示兩地野鼠可能扮演斑點熱立克次體傳染窩 (reservoir) 的角色。為瞭解野鼠是透過何種管道感染斑點熱立克次體，由其體外節肢動物以 *ompB* 及 *gltA* 為基因標的進行 nested-PCR 檢測，結果發現採自金門縣的鐮形扇頭蜱 (*Rhipicephalus haemaphysaloides*)、粒形硬蜱 (*Ixodes granulatus*)、地里恙蟎 (*Leptotrombidium deliense*)、小板恙蟎 (*L. scutellare*)、優勝病蚤 (*Nosopsyllus nicanus*) 及厲蟎 (*Laelaps* spp.) 的陽性率分別為 48.8、7.5、13.0、15.0、10.0 及 40.0%；採自連江縣的粒形硬蜱、地里恙蟎、蒼白恙蟎 (*Leptotrombidium pallidum*)、優勝病蚤及厲蟎的陽性率分別為 21.9、20.0、63.0、80.0 及 60.0%，顯示斑點熱立克次體透過這些野鼠體外節肢動物在鼠類間循環，甚至可能傳給人類。所有檢測出之斑點熱立克次體菌株序列進行親緣關係分析，詳細結果將於報告中發表。

關鍵詞：斑點熱、鼠類、間接免疫螢光反應、聚合酶連鎖反應、金馬地區

Rodent trapping and ectoparasite collection were conducted five times from June 2006 to March 2008 in Kinmen and Matsu. A total of 275 rodents were collected, with their sera challenged to detect IgG against *Rickettsia rickettsii* and *R. conorii* antigens with immunofluorescent antibody test (IFA). The seropositive rates of *Rattus losea* for *R. rickettsii* were 87.5-100.0% and 80.0-82.5% in Kinmen and Matsu, respectively, revealing *R. losea*, the dominant wild rodent species in these areas, was severely infected with spotted fever rickettsia. To be aware of pathogen infections in rodents, spleens, livers and kidneys were checked by nested-PCR with 120-135 kDa surface antigens (*ompB*) and citrate synthase (*gltA*) as gene targets. PCR positive rates for spleens, livers and kidneys were 6.6%, 33.0%, 43.0% in Kinmen, and 6.6%, 33.0%, 43.0% in Matsu, suggesting rodents might be the reservoirs of spotted fever rickettsia in these two areas. To realize possible transmission routes among rodents, ectoparasites of rodents were tested by nested-PCR. PCR positive rates for *ompB* and *gltA* were 48.8%, 7.5%, 13.0%, 15.0%, 10.0%, 40.0% in *Rhipicephalus haemaphysaloides*, *Ixodes granulatus*, *Leptotrombidium deliense*, *L. scutellare*, *Nosopsyllus nicanus*, *Laelaps* spp. in Kinmen, and 21.9%, 20.0%, 63.0%, 80.0%, 60.0% in *I. granulatus*, *L. deliense*, *L. pallidum*, *N. nicanus*, *Laelaps* spp. in Matsu. These results suggested that spotted fever rickettsia were transmitted among rodents by ectoparasites, and humans might also be infected. All PCR positive samples were also sequenced and their phylogenetic relations will also be reported.

Key words: spotted fever, rodent, IFA, PCR, Kinmen and Matsu

13 台灣之貓蚤媒介立克次體病
Flea-borne rickettsiosis in Taiwan

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貓蚤 (*Ctenocephalides felis*) 為貓蚤立克次體 (*Rickettsia felis*) 的主要病媒，近來各國陸續發現人類感染貓蚤立克次體病的案例。感染貓蚤立克次體病的病徵包括發燒、頭痛、肌肉酸痛、紅疹與肝功能不正常等，由於臨床表徵與其他立克次體疾病類似，因此不易區分診斷。本研究以聚合酶鏈反應 (PCR) 分析野外貓蚤族群之貓蚤立克次體感染率，結果顯示：單隻貓蚤平均感染率為 18.8% (13/69)，而混合採樣的平均最低感染率為 8.2% (8/97)，分析其 pRF 和 17-kDa 片段基因序列顯示與 *R. felis* URRWXC_{al2} 標準株相同。以免疫螢光抗體試驗 (Immunofluorescence antibody test; IFA) 分析二隻貓蚤 (已感染貓蚤立克次體) 寄生的野貓血清，結果顯示抗貓蚤立克次體的 IgG 抗體效價皆為 1:320。此外，本研究也報導台灣第一例人類感染貓蚤立克次體的確定病例。

關鍵詞：貓蚤、貓蚤立克次體、立克次體病

Rickettsia felis, the etiologic agent of flea-borne spotted fever, is carried by fleas worldwide. In the last decade, several human cases of *R. felis* infection have been reported around the world. Clinical symptoms and biological data for *R. felis* infections are similar to those of murine typhus and other rickettsial diseases, making it difficult in clinical diagnosis. Patients with *R. felis* infections may present common clinical manifestations, such as fever, headache, myalgia, macular rash, and elevated liver enzymes. In this study, natural infections of *R. felis* in cat fleas (*Ctenocephalides felis*) were isolated and confirmed using polymerase chain reaction and an immunofluorescence assay. The infection rate in individual flea and the minimum infection rate (MIR) in pooled fleas detected by the PCR method were found to be 18.8% (13/69) and 8.2% (8/97), respectively. Partial sequences of the plasmid pRF, 17-kDa antigen, and outer membrane protein A genes obtained from the samples are identical to those of *R. felis* URRWXC_{al2}. Serological studies confirmed *R. felis* infection in two stray cats, as demonstrated by the presence of serum IgG antibodies against *R. felis* with an IFA titer of 1:320. In addition, we report the first indigenous human case of *R. felis* infection in Taiwan.

Key words: cat flea, *Ctenocephalides felis*, *Rickettsia felis*, rickettsiosis

14 台北縣貢寮鄉住民感染斑點熱立克次體之血清流行病學研究
Seroepidemiologic study on human spotted fever group rickettsiae in Gong-Liao Township, Taipei County,
northeastern Taiwan

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台灣已列通報的立克次體疾病包括恙蟲病 (由恙蟲所媒介, 病原為 *Orientia tsutsugamushi*)、流行性斑疹傷寒 (由蝨所媒介, 病原為 *Rickettsia prowazekii*) 和 地方性斑疹傷寒 (由蚤所媒介, 病原為 *R. typhi*) 等, 尚未包括斑點熱 (由蜱所媒介, 病原為 *Rickettsia* spp.)。雖然台灣疾病管制局已經發表一例跳蚤媒介的斑點熱立克次體人類病例; 然而, 由病媒蜱或蝨所媒介的立克次體病則尚未有官方確認的病例報告。近來, 本實驗室陸續在貓蚤和病媒蜱族群中分離出新的斑點熱立克次體菌株, 證實斑點熱立克次體存在於台灣; 同時也揭發國人感染斑點熱立克次體的可能性。為了進一步探討東北部民眾對不同立克次體的感染率, 本研究於 2008 年 5 月和台北縣澳底群體醫療中心合辦居民年度健康檢查, 共收得貢寮地區當地住民有效血清檢體 259 支, 經實驗室免疫螢光抗原抗體分析後 (抗原為 *R. rickettsii*、*R. conorii*、*R. typhi* 和 *O. tsutsugamushi*) 發現: 當地住民血清中斑點熱、地方性斑疹傷寒和恙蟲病的 IgG 抗體盛行率分別為 3.09% (8/259)、1.54% (4/259) 和 14.67% (38/259); 利用全球定位系統將上述血清 IgG 抗體陽性的民眾居住地予以標記, 結果顯示恙蟲病和斑點熱立克次體感染在澳底有群集的現象, 該現象是否與該區農耕生活形式有關則尚待後續研究。

關鍵詞: 斑點熱、地方性斑疹傷寒、恙蟲病、血清流行病學

Reportable rickettsioses in Taiwan include scrub typhus (STG; caused by *Orientia tsutsugamushi*), epidemic typhus (TG; caused by *Rickettsia prowazekii*) and murine typhus (TG; caused by *R. typhi*). Except for a human case of flea-borne rickettsiosis (caused by *R. felis*), there are no human cases of infections caused by tick-borne spotted fever group (SFG) rickettsiae and louse-borne typhus rickettsia in Taiwan. In addition, novel strains of SFG have been isolated from ticks and fleas from Taiwan as recently described. In this study, a number of 259 volunteer local residents from Gong-liao Village, Taipei County, northeastern Taiwan were determined in May 2008. Serum was analyzed by immunofluorescent antibody test (IFA) to detect IgG against *R. rickettsii*, *R. conorii*, *R. typhi*, and *O. tsutsugamushi* antigens. The seropositivity rate for SFG, TG, and STG were 3.09% (8/259), 1.54% (4/259) and 14.67% (38/259), respectively. Based on these serologic evidence of infection with SFG, TG, and STG, the spotted fever rickettsioses in Taiwan should be confirmed. Cluster infections of STG and SFG rickettsiae were analyzed using global positioning system (GPS). Whether the cluster is related to the activities of agro-culture will be discussed in further studies.

Key words: spotted fever, murine typhus, scrub typhus, seroepidemiologic

15 臺灣地區農地休耕政策對於恙蟲病之影響
Agricultural policies can influence susceptibility to scrub typhus

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農業發展經常造成自然環境極大的改變，可能導致病媒數量產生變化，進而影響到人類感染病媒傳播疾病的可能。恙蟲病為感染恙蟲病立克次體 (*Orientia tsutsugamushi*) 的恙蟲幼蟲叮咬所導致的致命疾病，恙蟲幼蟲主要寄生於鼠類，若蟲和成蟲階段則行自由生活，以土壤中節肢動物為食，恙蟲數量因此會相當程度受到環境改變所影響。台灣於 2002 年加入世界貿易組織後，鼓勵農民進行農地休耕以減輕國外低價競爭壓力，並補助農民每年翻耕兩次以降低鼠類與病蟲害對於鄰近農作物的危害，然而由於龐大的補貼支出，近年來政府考慮取消翻耕補貼政策。為了得知翻耕與否是否會影響到恙蟲數量與人類感染恙蟲病的可能，我們於 2007 年 8 月至 2008 年 3 月於恙蟲病盛行的花蓮縣壽豐鄉與鳳林鎮，選擇經常性翻耕和長久未翻耕的田地，進行連續 3 晚鼠類捕捉，利用鼠類寄生恙蟲數量與恙蟲病感染情況，來代表並比較在翻耕和未翻耕的狀況下，人類感染恙蟲病的可能。由於赤背條鼠 (*Apodemus agrarius*) 在多數樣區都有出現，加上赤背條鼠個體間被寄生的恙蟲數量有相當大的變異，因此選擇該鼠種作為比較對象，且僅採用至少捕捉到 5 隻赤背條鼠個體的樣區。17 個翻耕樣區和 16 個未翻耕樣區共捕獲 463 隻赤背條鼠個體，資料顯示未翻耕樣區赤背條鼠平均寄生恙蟲數量 (146 隻) 約為翻耕樣區 (51 隻) 的 3 倍，由於兩類樣區間赤背條鼠的密度相近 (翻耕 vs. 未翻耕: 0.13 vs. 0.11 隻/捕捉籠夜)，代表未翻耕樣區的恙蟲總數的確較翻耕樣區來得高。利用恙蟲病抗原玻片檢測 243 隻赤背條鼠血清，亦以未翻耕樣區的陽性率 (92.8%) 較翻耕樣區 (78.8%) 高。所鑑定約 10,800 隻恙蟲幼蟲中，兩類型樣區均以會叮咬人類的英帕恙蟲 (*Leptotrombidium imphalum*) 為主 (翻耕, 未翻耕: 85.1%, 79.1%)。本結果顯示休耕政策可能會影響恙蟲病的發生，休耕地若無經過適當的管理，可能導致當地恙蟲病例的增加。

關鍵詞：環境變遷、農業、休耕、疾病、恙蟲病

Agricultural development has dramatically altered the environment, which can affect the numbers of disease vectors, thus humans' susceptibility to vector-borne diseases. Scrub typhus is a lethal human disease transmitted by larval trombiculid mites (i.e. chiggers) harboring the pathogen *Orientia tsutsugamushi*. Chiggers primarily parasitize rodents, while nymphs and adults are free-living in the soils, feeding on arthropods. Trombiculid mites are therefore susceptible to environmental change. Taiwan's joining WTO in 2002 has led to intense price competition from abroad. Many farms have thus been abandoned, but are subsidized to plow twice a year to suppress rodents and agricultural pests. The subsidy policy, however, may be abolished due to its great economic costs. To evaluate how a change in agricultural policy may influence scrub typhus incidence, we trapped rodents for 3 consecutive nights in scrub typhus endemic Hua-lien County from August 2007 to March 2008, and compared chiggers infested in and seroprevalence of rodents in plots with versus without plow. *Apodemus agrarius* was selected for comparison due to this rodent's frequent occurrence in many plots, and a high variability in chigger loads (we discarded plots with less than five *A. agrarius* trapped). 463 *A. agrarius* from 16 non-plowed and 17 plowed plots revealed a nearly three times of average chigger loads in the former than in the latter (146 vs. 51 chiggers), and this was not due to chiggers' been diluted by a much higher *A. agrarius* density in plowed plots (plowed, non-plowed: 0.13, 0.11 rodent/trap night). Sera of 243 *A. agrarius* against *O. tsutsugamushi* with immunofluorescent antibody test (IFA) also disclosed a higher positive rate in

non-plowed (92.8%) compared with plowed (78.8%) plots. Among 10,800 chiggers keyed, *Leptotrombidium imphalum* that can parasitize humans dominated in both types of plots (plowed, non-plowed: 85.1%, 79.1%). It is concluded that a surge in scrub typhus human cases could occur without proper management of abandoned fields.

Key words: environmental change, agriculture, fallow, disease, scrub typhus

16 自發性翅膀發育異常的東方果實蠅 (雙翅目：果實蠅科) 之生殖研究
The study of reproduction of the spontaneously wing-defective *Bactrocera dorsalis* (Diptera: Tephritidae)

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本實驗目的，在探討東方果實蠅的子代出現自發性翅膀發育異常的情形，並分析此種突變型東方果實蠅的生殖能力。統計約 3200 多個東方果實蠅的蛹，發現羽化後出現翅膀殘缺的機率約為 $1.8 \pm 0.05\%$ 。並將突變型東方果實蠅進行交配後，發現其所產出的卵，無法孵化成幼蟲。將突變型與野生型東方果實蠅予以配對交配，則可產出約 500 顆卵，其中約有 200 個卵順利孵化為幼蟲，經培養後，有 130 隻幼蟲化蛹。利用 RT-PCR 分析東方果實蠅 PP1 基因的表現情形，發現野生型東方果實蠅的 PP1 表現量高於突變型東方果實蠅，這個結果暗示著 PP1 的表現量多寡，具有影響東方果實蠅翅膀是否正常發育的可能性。

關鍵詞：東方果實蠅、翅膀、發育、第一型蛋白質去磷酸酶

The aim of this study was to investigate spontaneous wing defects of *Bactrocera dorsalis* in a laboratory culture condition. Total 3200 pupae of *B. dorsalis* were analyzed, and the mutation rate of wing defect was $1.8 \pm 0.05\%$. The eggs of mutants mated with each other did not hatch, while 200 larvae hatched out from 500 fertilized eggs of mutants mated with wild type *B. dorsalis*. Among these 200 larvae, 130 larvae became pupae successfully. The expression of protein phosphatase 1 (PP1) was analyzed in wild type and mutant *B. dorsalis*. A lower level of PP1 mRNA was observed in mutant, suggesting that PP1 may play an important role in wing development.

Key words: *Bactrocera dorsalis*, wing, development, protein phosphatases type 1

17 東方果實蠅（雙翅目：果實蠅科）翅表蛋白質與化合物之分析
Analysis of the proteins and compounds on the wings of *Bactrocera dorsalis* (Diptera: Tephritidae)

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本試驗藉由聚丙烯酰胺電泳 (SDS-PAGE)，分析東方果實蠅雌、雄成蟲其翅膀表面蛋白及化合物的差異，結果顯示雌成蟲翅表具有 1 個特異的蛋白質，經液相層析串連式質譜儀 (LC/MS/MS) 鑑定此蛋白質身分，證實為卵黃蛋白之前驅物 (vitellogenin 1 precursor)；除此，藉由高效能液相層析儀 (HPLC) 分析翅之化合物，發現雄蟲有 3 種獨特的化學物質，雌蟲則有 1 種獨特的化學物質。由以上結果，推測不同性別的東方果實蠅，會將不同的物質塗抹在翅膀上 (或身體其他部位)，至於這些物質是否具有身分辨識或雌雄間相互吸引的功能，尚須進一步的研究證實。

關鍵詞：東方果實蠅、卵黃蛋白、高效能液相層析儀、液相層析串連式質譜儀

In this study, the proteins coated on the wings of male and female Oriental fruit fly, *Bactrocera dorsalis* were analyzed by SDS-PAGE. The result showed that there was a unique protein only present on the female wings. Subsequently, this protein was identified as a vitellogenin 1 precursor by LC/MS/MS. The extracts of male and female wings were also analyzed by HPLC. The results demonstrated that there were three specific compounds on male wings and one on female wings, respectively. Since these proteins and compounds are sexually specific, it may be interesting to know whether these materials are involved in identification and/or attraction between male and female Oriental fruit fly.

Key words: *Bactrocera dorsalis*; vitellogenin; HPLC; LC/MS/MS

18 熱衝擊對豌豆蚜 (半翅目：常蚜科) 族群之影響
Effects of heat-shock treatment on *Acyrtosiphon pisum* (Hemiptera: Aphididae) population

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以豌豆 (*Pisum sativum*) 飼育豌豆蚜 (*Acyrtosiphon pisum*)，於實驗室中分別觀察六個不同溫度熱衝擊 (25°C、30°C、35°C、37°C、38°C及 40°C) 四小時後對蚜蟲生活史特性如生存、壽命、繁殖及族群介量之影響。結果顯示 37°C、38°C、40°C 熱衝擊後的成蚜皆無法存活。過去研究 30°C 已經是豌豆蚜能完成發育之溫度上限，此外成蚜在 30°C 和 35°C 不能繁殖。30°C 和 35°C 熱衝擊四小時後的成蚜能存活並產下子代，但 35°C 熱衝擊後的成蚜產下高達 43% 的不正常胚胎。25°C~35°C 熱衝擊後之族群早期皆為 100% 存活，可存活 39、44、45 天與對照組 20°C 可 46 天相較之下，熱衝擊對豌豆蚜壽命並無顯著影響。族群 50% 自然死亡時間在 20°C 為 31 天，25°C~35°C 熱衝擊後之族群 50% 自然死亡時間分別為 36、32、28 天。25°C 熱衝擊後之繁殖率最高，每一母蚜可產超過 108 子代。族群介量方面，終極增長率及內在增殖率在不同熱衝擊下，皆隨熱衝擊溫度上升到 30°C，到 35°C 時再下降。淨增殖率於熱衝擊 25°C 時達到最大，35°C 時最低。平均世代時間隨熱衝擊溫度提高而縮短。

關鍵詞：豌豆蚜、熱衝擊、不正常胚胎、族群介量

Heat-shock effect on the life history traits of pea aphid *Acyrtosiphon pisum* (Harris), reared on pea plant *Pisum sativum* Linn. at 20°C, was evaluated by treating the aphids for 4-hr treatments at 25, 30, 35, 37, 38, and 40°C and then returning the aphids to 20°C under laboratory conditions. Above 37°C, all pea aphids failed to survive. Rearing temperatures of 30°C and 35°C have been considered in the past far beyond the upper limits for *A. pisum* development, and adult aphids thus reared fail to reproduce. After 4-hr heat shock treatment at 30°C and 35°C, *A. pisum* survived and produced offspring, with 43% of the embryos being abnormal at 35°C. On early phase after heat-shock at 25°C to 35°C, 100% of the populations survived for 39, 44 and 45 days, respectively. Adult longevity of *A. pisum* was affected not significantly by heat-shock temperature. The time of a 50% population natural mortality at control 20°C was 31 days, whereas that at heat-shock 25°C to 35°C was 36, 32, 28 days, respectively. Adults of *A. pisum* at heat-shock 25°C showed the maximal average reproductive capability, with each adult producing more than 108 nymphs. Demographic parameters of the finite rate of increase (λ) and the intrinsic rate of increase (r) were increased as heat-shock temperature increased up to 30°C, and then decreased at heat-shock 35°C. At heat-shock 25°C the highest net reproductive rate (R_0) was observed, while the lowest was observed at heat-shock 35°C. The mean generation time (T) shortened as the heat-shock temperature increased.

Key words : *Acyrtosiphon pisum*, heat-shock, abnormal embryo, demographic parameters

19 東方果實蠅成蟲脂肪體之轉型作用
Fat body transition in the adult of the oriental fruit fly *Bactrocera dorsalis* (Hendel)

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脂肪體 (fat body) 於昆蟲體內負責儲存營養、提供能量及代謝物質。由解剖與組織切片結果顯示，東方果實蠅 (*Bactrocera dorsalis*) 成蟲腹部具有兩種形式之脂肪體，一為白色團狀的幼蟲脂肪體 (larval fat body)，另一為扁平片狀的成蟲脂肪體 (adult fat body)。隨著成蟲的成長，幼蟲脂肪體所佔比例逐漸遞減，而成蟲脂肪體則逐日增加。利用 cDNA 篩減法 (cDNA subtraction) 篩檢第 0 日齡及第 9 日齡成蟲腹部脂肪體各自專一表現之基因，用以進一步於分子層次觀測脂肪體轉型作用 (transition)。第 0 日齡成蟲腹部脂肪體表現之基因中，以芳基蛋白受器基因 (arylphorin receptor gene, *ArR*) 所佔比例最高，達 15%；而第 9 日齡者，則以卵黃原蛋白基因 1 (yolk protein gene 1, *YPI*) 最多。以 RT-PCR 分析，*ArR* 大量表現於幼蟲脂肪體，成蟲脂肪體僅見少量表現；相對地，*YPI* 則只表現於成蟲脂肪體。此兩基因之表現變化形式與切片觀察之結果大致相符，亦即東方果實蠅成蟲體內脂肪體功能的轉型作用係由新生成的成蟲脂肪體完全取代原有的幼蟲脂肪體所致。

關鍵詞：幼蟲脂肪體、成蟲脂肪體、cDNA 篩減、芳基蛋白受器基因、卵黃原蛋白基因 1

Insect fat body is responsible for storing nutrients, providing energy and metabolizing materials. Dissection and histological observation revealed that there were two forms of fat body in the adult abdomen of *Bactrocera dorsalis*, i.e., white nodule-like “larval fat body” and thin sheet-like “adult fat body”. The amount of larval fat body was decreasing while adult fat body was increasing following adult development. To observe the transition of adult fat body on molecular level, we further attempted to screen stage specific-expressed genes from the abdominal fat body of day-0 and day-9 adults using cDNA subtraction. The subtracted results showed that arylphorin receptor (*ArR*) gene was expressed most abundantly in the 0-day-old adult fat body, about 15%; yet yolk protein gene 1 (*YPI*) was the major gene in 9-day-old adult fat body. RT-PCR analysis demonstrated that *ArR* was expressed greatly in larval fat body, but only very weak expression was observed in adult fat body; in contrast, *YPI* gene was specifically expressed in adult fat body. The expression profiles of *ArR* and *YPI* coincided with transition of the fat body observed in histology. In conclusion, these results demonstrate that functional transition of fat body in adult of *B. dorsalis* is due to complete replacement of the old larval fat body by new adult fat body during the development.

Key words: larval fat body, adult fat body, cDNA subtraction, arylphorin receptor gene, yolk protein gene

20 衣蛾 (*Phereoeca uterella*) 生物學與造巢取材之偏好性分析 (鱗翅目：蕈蛾科)
Biology of clothes moth (*Phereoeca uterella* Walsingham (Lepidoptera: Tineidae) and the preference
analysis of their case-making materials

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“Clothes Moths”是指蕈蛾科中所含之數個不同的屬，例如 *Tineola*、*Phereoeca*、*Praeacedes*、*Sphecioses* 等，而其中幾個種類會利用本身所吐的絲與收集的碎屑製作可攜式的巢，因此又稱之為 Household casebearer 或是 Plaster bagworm。*Phereoeca uterella* 是台灣居家環境中常見的衣蛾，在台灣各地設點進行採集調查後發現台灣室內至少有兩種衣蛾，室外則有另一種，且均具有相似的造巢習性，但巢的外形則有所不同。因不同齡期的幼蟲口器大小不同，造巢所取用的材料顆粒大小也應有所差異；幼蟲隨著成長而增大其巢，因此巢的外觀會有同心圓的現象發生，而此特性也記錄了環境的變化。本研究即對於衣蛾的造巢行為與取用材料做深入的探討；不同環境所提供的材料不同，幼蟲也應能使用不同材料來造巢，因此分析採集所獲得衣蛾巢使用的材料，以及使用幼蟲和數種不同材料進行實驗，以證明衣蛾對於巢材的取用是否具有偏好性。而為了解此種類之生物學，本研究調查衣蛾所存在的環境溫濕度、照度、風速和海拔，對其外部形態、雄蟲外生殖器以及造巢的過程進行描述，並討論衣蛾的天敵。雖然在自然狀態，沙粒是最普遍被使用的材料，但若環境提供不同的原料，例如木屑、蟲糞等，牠們能隨機的使用並當成造巢的材料。在哺乳動物屍體上之昆蟲相消長紀錄中，最後的分解階段出現的蛾類即為蕈蛾科 (Tineidae)，牠們能在乾燥的屍體上進行最後殘餘物的分解；將衣蛾造巢的生物特性與法醫昆蟲學相互連結，預期此造巢行為之特性可以提供連結犯罪現場的證據。

關鍵詞：衣蛾、蕈蛾科、生物學、造巢行為、法醫昆蟲學

The name of “Clothes Moths” is generally referred to several different genera in the family Tineidae, such as *Tineola*, *Phereoeca*, *Praeacedes* and *Sphecioses*. Some of them can use their silk and the materials which they collected to build a portable case, and we usually called them the household casebearer or plaster bagworm. *Phereoeca uterella* is the most common household clothes moth species in Taiwan. According to our general survey around Taiwan, we found there are at least three clothes moth species. They have similar behavior of building the portable cases, but their case shapes are obviously different. Due to the fact that the different instar larvae have different size of mouthpart, the particle of the materials for building their cases are also different. Their cases will be enlarged when the larvae grow, and the morphology of their cases will appear the phenomenon of concentric circles. We believe this phenomenon could also record the changes of the circumstances the larvae lived. In this study, we focus on the clothes moth's case-making behavior and the materials which collected by the larvae from their surroundings. We found different environments could cause the larvae choosing different case-making materials. To analyze the preference of their case-making materials, randomly selected materials were supplied for the larvae. To understand the biology and case-making behavior of clothes moths, the related environmental parameters, such as humidity, illumination, wind velocity and elevation in the collecting sites were also recorded. In addition, their case shapes, male genitalia, case-building behavior and the nature enemies were also described for further references. Although sand is the most common material the clothes moth adopted for their casing, yet if different material offered in their living environment, such as saw dust or feces, they could also use them randomly as their case-making materials. So far, we know the larvae can use many different kinds of materials to build their cases. Previous studies have recorded some Tineidae larvae found on mammal's corpses at the late dry decay stages. Thus, connecting the previously mentioned case-making behavior of clothes moth to the forensic entomology may be a possible way to provide some evidences in further describing the environment of the crime scene.

Key words: clothes moth, Tineidae, biology, case-making behavior, forensic entomology

21 台灣的新紀錄屬及新種：厚潔方鐵甲蟲；並描述其幼生期及生物學
(鞘翅目：金花蟲科：龜金花蟲亞科：瘤鐵甲族)

Prionispa houjayi, a newly recorded genus and a new species from Taiwan, with description of immature stages and notes on its bionomy (Coleoptera: Chrysomelidae: Cassidinae: Oncocephalini)

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瘤鐵甲族 Oncocephalini 共有三個屬：瘤鐵甲屬 *Oncocephala*、方鐵甲屬 *Prionispa* 及殘鐵甲屬 *Chaeridiona*，台灣舊紀錄只有一種，*Oncocephala formosana* Chujo；而在幼生期研究方面，只有殘鐵甲屬及瘤鐵甲屬，因此厚潔方鐵甲蟲的發現，不僅是一個新種，也是台灣新紀錄屬，在幼生期的研究更是重要；經過一年的調查，本種似乎只侷限於烏來一帶，幼蟲及成蟲均以百合科 Liliaceae 的台灣寶鐸花 *Disporum kawakamii* Hayata，幼蟲為潛葉性，老熟的幼蟲會離開原本的取食坑道，在接近主脈及基部的部份，潛入葉片中做成蛹室，尾部朝外，腹部第八節的氣孔特別發達，為主要的呼吸器孔；一年一世代，五月開始觀察到雌蟲產卵，幼生期約一個月，蛹期九天，成蟲壽命很長，有些個體長達一年。

關鍵詞：瘤鐵甲族、厚潔方鐵甲蟲、新種、幼生期、生物學

The tribe Oncocephalini Weise contains three genera: *Prionispa* Chapuis, *Oncocephala* Agassiz, and *Chaeridiona* Baly. So far, only one member of this tribe had been described: *Oncocephala formosana* Chujo. Immature stages of two of these genera had been described: *Oncocephala* Agassiz and *Chaeridiona* Baly. Only those of *Prionispa* remained unknown. In the present study, immature stages of a new species belonging to this genus are described and possible autapomorphies of the genus are proposed. The population was found in the Wulai district (Northern Taiwan, Taipei County), in a deciduous forest at an altitude of 120-500 m. The larvae of *P. houjayi* were found mining in the leaves of *Disporum kawakamii* Hayata. Mature larvae left their own feeding canal and walked toward stem and underside of the leaves. Subsequently, they bored into the leaves with the head oriented towards the stem. The pupae were usually hiding in their pupal chamber, but the apical part of the abdomen could be seen at the entrance of the pupal chamber. The well developed spiracles on the abdominal segment VIII should be responsible for most of respiration. The life history is univoltine by field observation. Most of the eggs were found in May inside the leaf of the host plant. The larval stage lasts about one month, and the pupal stage lasts about nine days. Adults are long-lived, sometimes living up to one year in the laboratory.

Key words: Oncocephalini, *Prionispa houjayi*, new species, immature stages, bionomy.

22 紹德春蜓 *Leptogomphus sauteri* (蜻蛉目：春蜓科) 分類學研究
Taxonomy of the Sauter's clubtail (*Leptogomphus sauteri*) (Odonata: Gomphidae)

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紹德春蜓為台灣特有種，包括恆春亞種 (*Leptogomphus sauteri sauteri* Ris) 與嘉義亞種 (*L. s. formosanus* Matsumura) 2 亞種。本研究通過環島標本採集，比較分析各地樣本之體表斑紋與雄性性器等外部形質。初步結果顯示本種形態特徵變異頗大，亞種間的鑑定特徵不易定義。此外，在分子資料方面，本研究以通用引子對增幅紹德春蜓 2 亞種的粒腺體細胞色素氧化酶 I (mtCOI) 片段，並輔以本島產其他春蜓種類與日本八重山群島產之姬細春蜓 (*L. yayeyamensis* Matsumura) 之 mtCOI 序列，分別以鄰接法 (Neighbor-joining methods) 及最大儉約法 (Maximum parsimony methods) 建構類緣關係樹。結果顯示本島產之紹德春蜓可分為南部、中北東部 2 群，且 2 群的地理分布與 2 亞種歷史分布紀錄頗為相符，惟鑑定特徵仍待檢視更多樣本後再行探討。

關鍵詞：紹德春蜓、春蜓科、分類學、特有種、台灣

The Sauter's clubtail (*Leptogomphus sauteri*) is endemic to Taiwan and it includes two geographical subspecies (*L. s. sauteri* Ris and *L. s. formosanus* Matsumura). In order to compare both morphological and molecular difference between two subspecies, we collected the specimens around the Taiwan Island. The preliminary results indicate that there were relatively morphological variations in the body color and male genitalia. The diagnostic characters of these two subspecies can not easily be defined. Furthermore, the mitochondrial cytochrome oxidase I gene (mtCOI) was amplified using universal primers for these two subspecies. The other clubtail species from Taiwan and the Himaehosoi clubtail (*L. yayeyamensis* Matsumura) from Yaeyama Islands, Japan, were also amplified. Then, these molecular data were combined for analysis. The phylogenetic trees among mtDNA sequences were constructed using neighbor-joining methods and maximum parsimony methods. The results suggest that Sauter's clubtail would be divided into the Southern Taiwan group and the Central-Northern-Eastern Taiwan group. The geographical distributional limit of these two groups is relatively fit for the previous specimen records, but we still need more specimens to assess the diagnostic characters.

Key words: *Leptogomphus sauteri*, Gomphidae, taxonomy, endemic species, Taiwan

23 臺灣產葉蟬科分類研究之回顧與現況
A review and the present status on the taxonomy of Cicadellidae
(Hemiptera: Cicadomorpha: Membracoidea) of Taiwan

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葉蟬的口器為刺吸式，以吸食植物木質部、或韌皮部或葉肉細胞的汁液為生。絕多數的葉蟬為農業經濟害蟲，這與葉蟬具有傳播植物病原性細菌、菌質體及病毒的能力有關，因此詳盡的分類學研究更顯重要。全世界的葉蟬科昆蟲約有 25000 種，其中臺灣已知約有 374 種。在西元 1940 年之前，臺灣產葉蟬的主要分類學者為松村松年博士，其餘尚有日本的加藤正世與德國的索瑪裘氏，然而學者在這段時間所建立新分類群的依據，卻僅有少數的形態特徵與顏色型式，且缺乏與具名種類作全面性的橫向比較，這些新分類群的原始描述過於簡單、或某些如加藤正世的模式已經不存在等等問題，造成現今臺灣或東亞地區葉蟬分類研究的諸多困擾。1941 年以後，歷經 30 年，才有少數的本土及國外學者研究臺灣產葉蟬科的分類工作。目前臺灣產葉蟬科的分類修訂工作，主要著重在雄蟲生殖器以及若干新特徵（如觸角感覺器、塗抹與梳洗行為）。除此，未來研究重點包括建立亞科或屬級層次的診斷特徵，並建立具農業經濟重要性葉蟬的物種鑑定資料。

關鍵詞：葉蟬科、農業害蟲、分類、行為、臺灣

Leafhoppers have piercing sucking mouthparts, and they feed on plant sap from xylem, or phloem, or mesophyll. Most leafhoppers are agricultural pests due to they can transmit plant-infecting bacteria, phytoplasma, and virus. Thus, the taxonomy on Cicadellidae is extremely important. There are 25000 species of leafhopper in the world, of which 374 are recorded from Taiwan. Before 1940, Shonen Matsumura had described most of the Taiwanese leafhoppers. The rest of species were mostly done by Masayo Kato and F. Schumacher. At that time, taxonomists established new taxa usually based on few morphological characters and coloration patterns, and the resultant unclear species delimitations due to no comparisons with allied species. Furthermore, the type deposition of Kato's type specimens is still unknown. Most of taxonomic problems above have a great effect upon the subsequent taxonomy on leafhoppers of Taiwan and eastern Asia. After 1941, the silence on the taxonomy of Cicadellidae of Taiwan lasted 30 years. Taxonomy of Cicadellidae emerged again by some taxonomists after 1970, for example, C. C. Chiang, K. W. Huang, H. T. Shih, and a few foreign taxonomists. The Cicadellidae of Taiwan is revised taxonomically based on the male genitalia and some new characters (e.g. antennal sensory organs, anointing and grooming behaviors); in addition, the diagnostic characters on subfamilial or generic category and identifications of agriculturally economic species will also be done in near future.

Key words: Cicadellidae, agricultural pest, taxonomy, behavior, Taiwan

24 台灣椿象 (半翅目：異翅亞目) 分類研究現況
Taxonomic status of true bugs (Hemiptera: Heteroptera) in Taiwan

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異翅亞目或椿象，全世界已知約有 85 科 40,000 種。此類群為一個單系群，受到數個共同衍徵支持，如成蟲後胸腹板及若蟲腹部背板 3~7 節的臭腺結構 (但某些類群二次消失)、下唇自頭部前端伸出、幕狀骨退化及具有咽片等。椿象的形態與習性非常多樣，從陸生、水生甚至到海生環境都有他們的蹤跡；食性方面囊括了植食性、肉食性與吸血性。有關台灣最早的椿象分類記述始於 1868 年，由英籍動物學家 Francis Walker 描述了 5 種椿科；日據時期是椿象分類研究的活躍期，以農業害蟲與蟲相調查為主，加上德籍昆蟲採集家 Hans Sauter 來台從事貿易及採集活動，將大量標本寄回德國昆蟲蒐藏所並捐贈或轉賣至歐洲許多博物館供歐洲學者研究描述，經江崎整理首次發表台灣椿種名錄，計有 36 科 326 種；二次大戰期間分類研究趨緩，直到 1960 年代中期因日籍昆蟲學者在台的採集活動而使得椿種紀錄又開始增加。1990 年代物種累計漸緩，到最近十年間，才又開始注入一股新活力。儘管如此，有關台灣椿種的紀錄仍相當貧乏，僅記錄 44 科 766 種；然而此種數只佔真正物種多樣性的一小部分。目前台灣椿象分類面臨的問題歸納有 1) 過去有許多例子因未以東方區系的觀點來檢視台灣異翅亞目相，以致有許多同物異名，及複雜的分類問題需待修訂才能釐清；2) 過去紀錄有誤且持續引用；3) 模式標本取得不便，阻礙比對工作；4) 過去未針對椿象特性密集進行採集，以致科級種類蒐藏數量甚少。目前台灣有六個主要的椿象蒐藏所，而從事椿象研究有四個單位。這些研究人員的研究主題涵蓋多個層面，從形態、分類描述、親緣關係、地區性昆蟲相調查至生態學方面等議題。我們目前正持續編撰台灣椿象名錄與收集書目文獻，並以此為基礎，選擇某些常見陸生類群進行分類修訂。

關鍵詞：台灣、異翅亞目、歷史回顧、分類、名錄

Heteroptera or true bugs contains about 40,000 described species in 85 families. This group is defined as a monophyly by presence of a scent gland system located on metathorax in adults and on abdominal tergites 3-7th in nymphs (secondarily lost in several groups), the labium inserted anteriorly on head, reduced tentorium and presence of gula. Their morphology and life habits are diverse, occupying most niches ranging from ground-dwelling to aquatic or even marine habitats, and utilize a wide variety of food sources, comprising phytophagy, predation, and even feeding on vertebrate blood. The first study on Taiwanese Heteroptera was initiated in 1868 by the British zoologist Francis Walker who described five pentatomid species, and underwent an active period during Japanese occupation, mainly on agricultural pests and faunistic surveys. More extensively collecting activity was carried out by the Germany merchant and insect collector, Hans Sauter, who gathered a huge amount of insect materials and sent back to entomological institutes in Germany or sold to various European museums. Many of them were later described as new taxa by European entomologists. Esaki published the first checklist, recording 326 species. During and after the Second World War, the study slackened, except a relatively active period in the mid of 1960's, mainly achieved by Japanese entomologists. After that, the research continued with a moderate pace until the 1990's, however, in the last ten years, it got a new impulse. Despite of this, true bugs are still poorly known in Taiwan. Only 766 species in 44 families have been reported so far, which is far from the real diversity. The current difficulties are concluded as 1) the study of Taiwanese fauna was in many cases not conducted in Oriental perspective, which usually caused many synonyms and

taxonomic problems; 2) previously unreliable records are still in use; 3) clarification of several taxa are rendered as problematic due to the limited availability of type materials; 4) poor collections are available in several families due to lack of specialized collectings. Currently there are six major collections in Taiwan housing several thousands of bugs, and four main institutions are focusing on various topics from morphology and phylogeny through descriptive taxonomy, faunistic survey to ecology. We are currently undertaking the compilation of a checklist and bibliography of Heteroptera and revisions of selected groups of common terrestrial true bugs.

Key words: Taiwan, Heteroptera, historical review, taxonomy, checklist

25 臺灣產晏蜓科 (蜻蛉目) 稚蟲分類研究
Taxonomic study of the larval stage of Aeshnidae (Odonata) in Taiwan

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台灣蜻蛉目晏蜓科 (第二大科) 成蟲共有 9 屬 23 種, 本研究針對台灣所採的 8 屬 17 種的晏蜓科稚蟲進行分類研究, 研究中有依據相關文獻報告及採集結果進行柱缺晏蜓、李斯晏蜓、陽明晏蜓、泰雅晏蜓、朱黛晏蜓、描金晏蜓、碧翠晏蜓、烏基晏蜓、烏帶晏蜓、麻斑晏蜓、綠胸晏蜓、倭缺晏蜓、琉球晏蜓等 13 種稚蟲之重新描述; 而源垓晏蜓、日清晏蜓、石垣晏蜓、喙缺晏蜓等 4 種晏蜓稚蟲之外部形態特徵則是首次被描述。此外, 並針對上述 17 種晏蜓稚蟲製作屬種的分類檢索表, 作為日後相關分類研究之參考。

關鍵詞: 臺灣、晏蜓科、稚蟲、分類、檢索表

The Aeshnidae is the second largest family of Odonata in Taiwan, with some 23 species now assigned to 9 genera. Seventeen species of larval aeshnids from 8 genera collected in Taiwan were taxonomically studied. Based on literature records and examination of an extensive collection, a redescription of the larva of *Periaeschna magdalena* Martin, 1909, *Planaeschna risi risi* Asahina, 1964, *Planaeschna taiwana* Asahina, 1951, *Aeshna petalura taiyal* Asahina, 1938, *Polycanthagyna erythromelas* (McLachlan, 1896), *Polycanthagyna melanictera* (Selys, 1883), *Anaciaeschna jaspidea* (Burmeister, 1839), *Anaciaeschna martini* Selys, 1897, *Anax nigrofasciatus nigrofasciatus* Oguma, 1915, *Anax panybeus* Hagen, 1867, *Anax parthenope julius* Brauer, 1865, *Gynacantha japonica* Bartenef, 1909, *Gynacantha ryukyuensis* Asahina, 1962 is provided. Morphological characteristics of the larva of *Sarasaeschna pyanan* (Asahina, 1951), *Sarasaeschna lienii* (Yeh & Chen, 2000), *Planaeschna ishigakiana flavostria* Yeh, 1996, *Polycanthagyna ornithocephala* (McLachlan, 1896) is described and illustrated for the first time. In addition, all 17 larval aeshnids are keyed for reference in future research.

Key words: Taiwan, Aeshnidae, larva, taxonomy, taxonomic key

26 台北市立動物園的鐵線蟲及其寄主螳螂的分類
Taxonomy of horsehair worms (Nematomorpha) and their mantis hosts (Mantodea) in Taipei Zoo

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鐵線蟲隸屬於線形動物門 (Nematomorpha)，在台灣是常見的節肢動物寄生蟲；全世界現生的種類被分成 21 屬 300 餘種，其中 20 屬在淡水中生活。鐵線蟲成體必須在水中交配及產卵，但大多數卻必須在陸生節肢動物體內成熟，橫跨水陸環境的生活史及引起寄主跳水的現象，使鐵線蟲在寄生蟲及寄主交互關係中受到注目。本研究於 2007 年 4 月到 2008 年 2 月之間，在台北市立動物園蝴蝶公園（現名蟲蟲探索谷）中藉由目視和掃網採集螳螂，並加以解剖。期間發現一種 *Chordodes* 屬的鐵線蟲，同時也在搖蚊幼蟲體內發現鐵線蟲的幼蟲，顯示其能在該區完成生活史。受感染的螳螂以台灣斧螳 (*Hierodula formosana*) 為最大宗，寬腹螳螂 (*Hierodula patellifera*) 次之，但未在該區所採集到的其他 5 種螳螂體內發現。對所採集的台灣斧螳的形態測量結果顯示，受感染的台灣斧螳雄蟲前、後翅長，及全長均小於未受感染的個體 ($p < 0.05$)；雌蟲則未有顯著的差異；且在電子顯微鏡的觀察之下，雄蟲觸角各鞭節的平均長度及單位面積內感覺毛的數量均變小。該現象顯示鐵線蟲的感染可能造成寄主的形態改變。

關鍵詞：台灣斧螳、寬腹螳螂、鐵線蟲、形態改變

About 300 extant species in 21 genera of the horsehair worms (Nematomorpha) are known to date. Among these 21 genera, there are 20 genera living in the fresh water and one genus in the ocean. However, most of their definitive hosts are terrestrial arthropods. The life cycle including aquatic and terrestrial environments and the capability to manipulate the water seeking behavior of their terrestrial hosts let them be famous in the issue of host-parasite interaction. The investigation of horsehair worms and their mantis hosts in Taipei Zoo was done from April 2007 to February 2008. We found one morphospecies of Nematomorpha which belongs to the genus *Chordodes*. Its adults infected with two of the seven mantises found in Taipei Zoo, *Hierodula formosana* and *Hierodula patellifera*, and occurred most in the former. It seems that they can complete their life cycles in Taipei Zoo especially one horsehair worm larva was found infected with a midge larva. Infected male *Hierodula formosana* had reduced body, length, wing length ($p < 0.05$), lengths of each segments of flagella and numbers of sensilla on their surfaces. These phenomena suggest that infection of horsehair worms can cause the morphological change in their hosts.

Key words: *Hierodula formosana*, *Hierodula patellifera*, horsehair worm, morphological change

27 輸入植物或植物產品檢測出介殼蟲存證標本之數位化

The Digital archives of scale voucher specimens (Homoptera: Sternorrhyncha: Coccoidea) from imported plants and plant products

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以 2002 年至 2008 年由動植物防檢疫局各分局由輸入植物或植物產品檢測出之介殼蟲，經行政院農業委員會農業試驗所 (TARI) 鑑定的存證標本為數位化對象。建立的數位化資料庫和查詢系統，除保存上述存證標本外，未來亦可逐年提供由輸入植物或植物產品檢測出之介殼蟲之相關資訊以供參考。

關鍵詞：數位化、檢疫、介殼蟲存證標本、介殼蟲總科、查詢系統

The Digital archives of scale insects (Homoptera: Coccoidea) intercepted on imported plants and agricultural products at the plant quarantine stations of Taiwan, from 2002 to 2008, is given. To set up the digital archives and query system not only protect of these voucher specimens indentified by TARI, and support useful information of scale insects intercepted on imported plants and agricultural products in the future.

Key words: digital archives, quarantine, scale voucher specimens, Coccoidea, query system

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本研究以澳洲棘冠幽靈竹節蟲 (*Extatosoma tiaratum* MacLeay) 當日孵化的幼蟲，置於 25°C，相對溼度 70~75%RH，12L:12D 之生長箱內單隻飼養，以桃金娘科 (Myrtaceae) 之番石榴葉 (*Psidium guajava* Linn) 飼養，每日觀察及記錄其若蟲發育所需時間、頭殼寬度、頭殼長度、體長及外部形態描述；並比較此蟲孤雌生殖繁殖力及有性生殖繁殖力。得知雄蟲為五齡型若蟲，雌蟲則為六至七齡期。若蟲頭殼寬、頭殼長及體長皆隨齡期增長；而發育所需時間除一齡較二齡長 1 天左右，其餘亦隨齡期增長而增加；且有性生殖之產卵數明顯高於孤雌生殖。

關鍵詞：棘冠幽靈竹節蟲、生活史、外部形態

The single-rearing *Extatosoma tiaratum* MacLeay nymph was placed in 25°C RH 70-75%, 12L:12D in growth chamber, and fed on guava leaf (*Psidium guajava* Linn, Myrtaceae). The parameters, developing duration, head width, head length, body length and external morphological characters were recorded, and comparing the fecundity of parthenogenesis and sexual reproduction. The results show the male nymph have five instars and female are six to seven. The head width, head length and body length all increase each nymphal stage. The developing duration also increase, except the first instar is one day longer than the second instar. And the egg number of sexual reproduction is obviously higher than parthenogenesis.

Key words: *Extatosoma tiaratum*, life history, morphology

29 台灣家白蟻 (等翅目：鼻白蟻科) 隧道構築中土壤之位移
Soil displacement during tunnel excavation by the Formosan subterranean termite
(Isoptera: Rhinotermitidae)

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根據過去在田間針對台灣家白蟻 (*Coptotermes formosanus* Shiraki) 巢穴的挖掘報告指出，其地底隧道總長可達 580 公尺，總隧道空間可超過 34,800 立方公分。由於台灣家白蟻並無將土壤堆置地表構築蟻丘的習性，故以往學者認為其隧道空間乃由工蟻以頭部擠壓土壤顆粒產生，即所謂“土壤擠壓假說”。本研究透過錄影檢視白蟻隧道挖掘過程發現，工蟻並無在隧道末端表現出推擠沙子的行為。而透過顯微攝影，將隧道挖掘前後的照片重疊，隧道末端沙子顆粒的在時間序列上的相對位置也並未改變，證實其隧道空間並非由白蟻直接將沙子往隧道兩側推擠所產生。因此修改土壤擠壓假說為：台灣家白蟻可能藉由將挖掘的土壤搬移至其他地方並將之壓實以產生隧道空間。然而實驗證明，被移動後的土壤密度反而降低，因此修改後的假說也遭否決。於是我們提出第三個假說是所謂木材消耗假說，認為白蟻可藉由消耗遭遇的木材而產生隧道空間。當白蟻置放在木片上 30 日後，木片減少的體積顯著多於排泄物的總體積，其所增加空間的淨值為 50% 的木材消耗量。因此我們推論台灣家白蟻在隧道構築過程中是透過土壤的搬移，加上取食遭遇木材增加的空間，轉換成隧道的空間。本研究的行為觀察與實驗結果均支持台灣家白蟻隧道構築的主要機制是透過土壤的位移而非土壤的壓縮。

關鍵詞：台灣家白蟻、地下白蟻、隧道構築、挖掘行為、木材消耗量

Previous field excavations of nest structure of *Coptotermes formosanus* Shiraki, the Formosan subterranean termite, indicated that the total length of the gallery system ranged up to 580 meters and its total volume was over 34,800 cm³. Because Formosan subterranean termites do not build mounds, a “soil-compaction hypothesis” was developed suggesting that subterranean termites compress sand particles with their heads to build the tunnel. Examination of video recordings of tunnel excavation showed that sand was not compacted. Microscopic photographs of tunnel tips taken before and after excavation were superimposed, and sand particles surrounding tunnel tips remained in place demonstrating that termites did not press sand to either side. A “modified” soil-compaction model hypothesized that Formosan subterranean termites removed soil to another site and compacted it to increase space during tunnel excavation. However, the deposited sand had less density than the unexcavated sand in all replications, and thus the modified hypothesis was rejected. A third wood-consumption hypothesis suggested that termites gain tunnel space as a result of consuming wood. When termites were placed with wood pieces for 30 days, the decreased volume of wood was significantly higher than the increased volume of fecal material. The net increased space was approximately 50% of the volume of consumed wood. We speculate that the space created by wood consumption could be transformed into tunnel space during soil displacement. Observations and experiments indicate that soil particle displacement is the major mechanism for subterranean termites to build tunnels rather than soil particle compaction.

Key words: *Coptotermes formosanus*, subterranean termite, tunnel architecture, excavating behavior, wood consumption

30 輻射照射對太平洋臀紋粉介殼蟲之影響
Effects of irradiation on Pacific mealybugs (*Planococcus minor*)

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全世界貿易的流通增加了未感染地區害蟲爆發的危險。由於很多檢疫方法對環境是不安全性，且在平衡害蟲撲殺和減低對寄主商品的不良影響中有著極大的阻礙存在，所以已被認可的輻射照射法可能是現今檢疫方法之外的另一個選擇。本試驗利用鈷60 (5種劑量：50、100、150、200、250 Gy) 分別照射3種不同階段的太平洋臀紋粉介殼蟲 (卵、一齡若蟲、成蟲)，用以瞭解其忍受性最佳之階段與最適之防治劑量。結果顯示，輻射照射能顯著降低3種階段介殼蟲之最終存活率、生殖率、產卵量和孵化率。而在死亡率與孵化率上，成蟲期為忍受性最高之時期。另外，所有經輻射照射的介殼蟲皆可產卵，但劑量在150到250 Gy的實驗組皆無法成功孵化。因此，所有出口商品都能利用劑量為150到250 Gy的輻射照射檢疫太平洋臀紋粉介殼蟲。

關鍵詞：太平洋臀紋粉介殼蟲、輻射照射、檢疫

The increasing trade worldwide also increases the risk of pest outbreak in many uninfested areas. Many quarantine treatments are environmentally unsound and has obstacles in finding a balance to kill insect pests and minimizing adverse effects on the host commodities. Irradiation has been recognized and endorsed as a potential phytosanitary measure that could be an alternative to current quarantine treatments. A dosage of 50, 100, 150, 200 and 250 Gy (Grays) were used to irradiate three different life stages (eggs, crawlers and adult life stages) of *Planococcus minor*; with an aim to find the most tolerant stage and the most optimum dosage to control *P. minor*. Cobalt 60 was the source of irradiation used. Irradiation has a significant effect on all life stages of *P. minor*; decreasing its' survival, fecundity, oviposition and hatch rate. The adult was the most tolerant life stage in both mortality and hatch rate. All the different irradiated target life stage groups oviposited eggs but none of the eggs hatched at the most optimum dosage, 150 to 250 Gy. In this study, a dosage of 150-250 Gy could provide quarantine security for *P. minor* on all exported commodities.

Key words: *Planococcus minor*, ionizing radiation, quarantine

31 T-餌劑：在潮溼地區防治火蟻的新工具

T-bait: a new tool to control fire ant (Hymenoptera: Formicidae) in humid regions

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由於潮濕的氣候和經常下雨，目前使用的以玉米渣為基質的火蟻餌劑無法在台灣及世界其他潮溼地區有效地防治野外的火蟻。為了在台灣及世界其他潮溼地區有效對付此破壞性極大的火蟻，抗水性的火蟻餌劑是正確的工具。因此，為了符合抗水性火蟻餌劑的強大需求，乃進行本地載體的系列篩選試驗。在篩選的載體中，T-載體和毒劑 (0.045% 因得克) 及誘引劑相容，並在很廣的環境逆壓下皆能作用。T-載體和毒劑及誘引劑混合後評估其對火蟻工蟻的效力，結果顯示以 T-載體為基質的火蟻餌劑 (T-餌劑) 殺火蟻工蟻的效力和市面上販售的以玉米渣為基質的 0.045% 因得克火蟻餌劑 (I-餌劑) 相同，而且其抗潮溼條件比 I-餌劑佳。在正常條件下，T-餌劑的殺火蟻工蟻的速率和 I-餌劑幾乎完全相同；在潮溼及環境逆壓條件下，T-餌劑的殺火蟻工蟻的速率幾乎為 I-餌劑的二倍。基於火蟻的偏好性、對潮濕的抗性、保持誘引劑的能力、與毒劑相容性及在很廣的環境逆壓範圍下皆能作用，T-餌劑可視為有效的火蟻餌劑產品。

關鍵詞：I-餌劑、T-餌劑、因得克、火蟻工蟻

Due to the humid climates and frequent rains, the current corn grit based fire ant baits cannot control field fire ants effectively in Taiwan and other humid areas around the world. To combat with those devastating fire ants effectively in Taiwan and other humid areas around the world, water resistant fire ant bait could be a right tool. Therefore, to satisfy that powerful demand of water resistant fire ant bait, series of screening of local carriers were conducted in Taiwan. Among screened carriers, T-carrier was found compatible with toxicant (0.045% indoxacarb) and attractants and was also active with wide range of environmental stresses. T-carrier blended with toxicant and attractants was evaluated for its' efficacy against fire ant workers. The T-carrier based fire ant bait (T-bait) not only killed the fire ant workers as the commercial indoxacarb (0.045%) based corn grit bait (I-bait) did, but also resisted humid conditions better than I-bait. The speed efficacy of T-bait against fire ant workers in normal condition was almost identical with commercial I-bait. In humid and environmentally stressed conditions, the speed efficacy of T-bait against fire ant workers was almost double than the I-bait. Based on the fire ants' preference, its humidity resistance, attractants holding abilities, compatibility with toxicant and activeness in wide range of environmental stresses observed in this study, T-bait could be considered as an effective fire ant bait product.

Key words: I-bait, T-bait, indoxacarb, fire ant workers

32 利用感染率評估病毒防治入侵紅火蟻之可行性

Could viruses be potential agents for suppress of the red imported fire ant in Taiwan? Perspective from prevalence data

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兩種正股核糖核酸病毒已於入侵紅火蟻 (*Solenopsis invicta*) 體內發現，並證實存在於美國及南美洲之火蟻族群內。此二病毒分別被命名為 SINV-1 (*Solenopsis invicta* virus, SINV) 與 SINV-2。前人研究指出，SINV 感染之蟻巢無明顯病徵，故此病毒是否對火蟻適存值造成影響仍無定論。在沒有文獻精確描述前，本研究試圖以當前各火蟻發生區域之感染盛行率，初步推測 SINV 於火蟻族群生活史中扮演之角色。利用 SINV 專一性之 two-step RT-PCR，針對澳洲、中國大陸、香港與台灣等新入侵地之火蟻巢樣本進行檢測。由於這些入侵地區之火蟻族群遭受瓶頸效應與藥劑防治之影響，病毒盛行率可能為感染蟻巢之感受性於選汰壓力下之平衡狀態。結果顯示除澳洲外，其餘地區皆受到 SINV 感染，且兩種病毒卻呈現不同之感染率 (SINV-1: 41.5~55.6%；SINV-2: 16%，僅出現於台灣樣本中)。由此不同之感染結果可推測，受 SINV-2 感染之蟻巢對環境壓力之感受性可能較強。而 SINV-1 於新入侵地之高感染率，則與部份感染昆蟲之正股核糖核酸病毒的高度感染性與隱性病徵相符，且需伴隨其他病原共同感染引發病狀等特性。在台灣，此二病毒雙重感染並不普遍 (7.8%)，更提高了後者推測的可能性。直接試驗資料已著手進行評估病毒對於火蟻適存值之影響，除檢驗上述假設外，並期使火蟻病毒能進一步應用於我國火蟻整合性生物防治上。

關鍵詞：入侵種、火蟻、病毒、感染率、防治

Two positive-strain RNA virus species, designated as SINV-1 (*Solenopsis invicta* virus, SINV) and SINV-2, have recently been discovered to infect the red imported fire ant, *Solenopsis invicta*, in either the US or its home range, South America. Imperceptible symptom among infected field nests leads uncertainty of impact of SINVs infection on fitness of *S. invicta*. Since no available literature describes this issue, the present study aims to infer what magnitude the SINVs involve in life history of its host by surveying the prevalence in field fire ant populations. Species-specific two-step RT-PCRs were employed to survey the presence of SINVs in *S. invicta* nests collected from Australia, mainland China, Hong Kong, and Taiwan where an array of selective pressures may be imposed by recent bottleneck effect accompanied introductions and/or intensive bait broadcasting. SINVs were found to infect sampled nests from all infested areas except Australia, with notably different field prevalence registered by each virus (SINV-1: 41.5-55.6%; SINV-2: 16% and only detected in Taiwan). Distinct prevalence patterns may provide a provisional hypothesis that the susceptibility to environmental stress of SINV-2-infected nests is relatively stronger. High prevalence of SINV-1 is consistent to general characters of insect-infecting positive-strain RNA virus in terms of high level persistence in the populations with inapparent symptom and requirement of presence of additional pathogen(s) to induce pathogenesis. The latter character is further evident given the extremely low prevalence of dual infection (nests infected by both viruses: 7.8%) found in Taiwan. Additional experiments directly estimate the fitness impacts of SINVs on *S. invicta* are underway to confirm the hypothesis and to gain more support for integrating multiple pathogens in suppressing fire ants.

Key words: invasive species, fire ant, virus, prevalence, control

33 台灣利用外來寵物昆蟲現況及風險評估
Alien pet insects: approach to utilization and risk assessment

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由 1999 至 2003 年，日本政府合法開放外來種甲蟲以寵物昆蟲之名義輸入日本，共有 436 種外來種甲蟲被許可進口；而四年間，計有 41 起野外發現外來種甲蟲個體的案例；這些外來種甲蟲有些身上帶有寄生蟲或其他病原，這些寄生蟲或病原的傳染造成了日本本土種甲蟲死亡的案例；甚至有些外來種甲蟲與本地同種甲蟲雜交，造成基因污染問題。在台灣，隨著網路的發達及普及，越來越多不屬於傳統寵物規範的寵物昆蟲受到廣大的喜愛；從寵物昆蟲專賣店數量增加可以看出寵物昆蟲市場的擴大；2002 年時台北僅有 5 家寵物昆蟲專賣店，到現在共有 25 家以上的寵物昆蟲專賣店。而其他水族店或是傳統寵物店，甚至是在街邊的攤販，都可發現販賣寵物昆蟲。另外，除了實體店面販售之外，網路上的交易活動也日漸活躍；面對此情形，目前卻沒有相對應的管理辦法，其衍生出的問題都令人擔憂。本研究對台北縣市內的店家做整合調查及建立外來寵物昆蟲名錄，並以現有名錄中寵物昆蟲的生物學特性，測試防檢局及文獻所收集之外來物種風險評估系統，評估目前引入台灣之外來寵物昆蟲之風險等級，以提供未來風險評估之依據和評估寵物昆蟲潛在威脅，並作為法規防治之基礎。同時，本研究並對目前台灣寵物昆蟲發展現況及問題提出討論，也參考日本的前車之鑑，設想可能有效的解決方式。

關鍵詞：寵物昆蟲、甲蟲、外來種、入侵、風險評估

From 1999 to 2003, Japan Government legally opened alien species of beetles to introduce to Japan for pets, and 436 species of beetles were recorded. Therefore during 1999 to 2003, a total of 41 cases of alien beetles were found in the wild in Japan. Some of them carried parasites of beetles, and caused the death of local species of beetles. Even some hybrids have been occurred in Japan. Pet insects' market in Taiwan now is expanding, more and more alien pet insects has been imported to Taiwan by illegal ways. From 2000 to now, the rapid development of alien pet insects is even more alarming. In 2002, there are only 5 insect stores in Taipei, up to now it increases to 20. In many aquarium shops or traditional pet shops, or even in the streets of vendors, the sale of pet insects can be found easily. In this paper, based on quarantine pest risk analysis to assess the potential risks of alien insects, and that it will serve as a viable basis for effective management approach.

Key words: pet insect, beetles, alien species, invasive species, risk assessment

34 刺桐紬小蜂 (膜翅目：紬小蜂科) 顏色偏好之研究
Study on color preference of erythrina gall wasp (Hymenoptera, Eulophidae)

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入侵物種刺桐紬小蜂 (*Quadrastichus erythrinae* Kim) 於 2003 年首次在台灣發現時，對台灣的刺桐屬 (*Erythrina*) 植物 (主要為刺桐及黃脈刺桐) 已經造成嚴重的危害。刺桐紬小蜂在刺桐屬植物上造瘿危害，造成受感染的植株葉片組織膨大增生、捲曲脫落，甚至死亡的狀況發生。前人研究發現，市售黃色黏蟲紙對刺桐紬小蜂具有良好的誘引效果，且不同廠商印製之黃色黏蟲紙誘引的效果也有所不同，故推測刺桐紬小蜂可能對特定的波長具有偏好性。本研究首先以光譜儀測量出市售色票之反射光譜，選定反射波長落在大多數昆蟲可見的 300~700 nm 之間的八組色票印製試驗用之色紙，再以此八種色紙進行顏色偏好的行為測試與野外誘集試驗。顏色偏好行為測試發現刺桐紬小蜂雌雄蟲對於 WRR 色紙 (wide range reflectance, 光譜涵蓋不同長波長範圍) 皆不具顯著之偏好性，然而以 NBR 色紙 (narrow bandwidth reflectance, 光譜具有明顯單一波長峰值) 進行測試時，結果顯示雄蟲之偏好波長範圍落在 414~534 nm 及 578~658 nm 兩段光譜範圍，以 578~658 nm 範圍之誘引效果較佳，但兩者無統計上之差異，而雌蟲偏好之波長範圍則落在 410~534 nm 之間。另一方面，以上膠之色紙進行野外誘集試驗之結果發現，刺桐紬小蜂對波長範圍 508~578nm 有較顯著之偏好，且誘引結果以雄蟲佔絕大多數，各色紙黏附雄蟲數占總蟲數之 79% 以上，而雌蟲僅有零星黏附數據。以上結果顯示，刺桐紬小蜂屬於偏好光譜範圍小 (narrow band) 的昆蟲，有利於未來研發新式刺桐紬小蜂視覺誘引設備之參考。由於野外試驗結果顯示雌蟲無特定反射波長的偏好性，建議未來研究應著重在雌蟲之化學誘引。

關鍵詞：刺桐紬小蜂、顏色偏好、反射光譜、波長、有色黏紙

In 2003, erythrina gall wasp (*Quadrastichus erythrinae* Kim) was first recorded in Taiwan that in the capacity of newly invasive species. It has induced galls in tissues and caused serious damages on various species belong to *Erythrina* (Fabaceae). Obvious swelling can be seen on infected tissue parts, and severe infestations cause curling of young shoots, defoliation, and death of the tree. Previous study indicated that yellow sticky paper trap was effective to catch the wasps, and therefore we supposed that *Q. erythrina* should have preference to specific wavelengths. We tested the wavelength preference with customized color papers, and the results showed that both males and females had not performed preference at WRR (wide range reflectance) color papers but NBR (narrow bandwidth reflectance) ones. The male wasps preferred the wavelength ranges within 414-534 nm and 578-658 nm, however the females preferred the range within 410-534 nm. When surveying in the field, the color papers with reflective spectral range within 508-578 nm significantly attracted more erythrina gall wasps than other colors. Our study also found that the female wasps performed no significant preference to any of the color papers in the field, indicating that the females do not have specific color preference. Study on chemical attractant for trapping the female wasps should be emphasized in the future.

Key words: *Quadrastichus erythrinae*, color preference, spectral reflectance, wavelength, sticky color paper

35 台灣產蟲生線蟲 (*Steinernema abbasi*) 共生細菌之鑑定
The bacterium associated with the entomopathogenic nematode, *Steinernema abbasi*
(Nematoda: Steinernematidae), isolated from Taiwan

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台灣產之蟲生線蟲 (*Steinernema abbasi*) 於 1998 年在花蓮縣甘藷田中採集土壤，經斜紋夜蛾 (*Spodoptera litura*) 幼蟲誘釣而得，其腸道內所含之共生菌經細胞型態、培養特性、生理生化特性，測定結果應屬於 *Xenorhabdus* 屬的共生菌；在 16S rDNA 部分序列所構建之系統發生樹，顯示台灣產之蟲生線蟲共生菌種之鑑定應為 *Xenorhabdus indica*。

關鍵詞：蟲生線蟲、共生菌、系統發生樹、16S rDNA、*Xenorhabdus*

A symbiotic bacterium of the entomopathogenic nematode, *Steinernema abbasi*, isolated from Taiwan, determined to be a species of *Xenorhabdus* based on its physiological and biochemical characteristics has been determined to be similar to *Xenorhabdus indica* of *S. abbasi* Oman isolate as based on sequence analyses of 16S rDNA.

Key words: entomopathogenic nematode, symbiotic bacterium, phylogenetic tree, 16S rDNA, *Xenorhabdus*

36 吉悌細顎針蟻 (膜翅目：蟻科) 的聲學溝通機制
The mechanism of acoustical communication of *Leptogenys kitteli* (Hymenoptera: Formicidae)

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螞蟻是一種社會性昆蟲，而其溝通機制是表現社會行為的重要關鍵。過往研究螞蟻溝通方式著重於費洛蒙的化學溝通，甚少討論聲學振動溝通方式，但從生態上推測和一些實驗證據顯示，此方式對易遭土石掩埋的土棲性螞蟻為一重要溝通管道。本實驗物種，吉悌細顎針蟻 (*Leptogenys kitteli*) 主要分佈於台灣平地林緣至中海拔山區，當其在獵食或受干擾時，會摩擦錘腹上的體節發出聲響做溝通。此實驗主要在觀察吉悌細顎針蟻在給予不同振動頻率刺激下，蟻巢內的群體行為反應，及日週律動中，何時刻對振動刺激最敏感。發現約在 700 Hz 的振動刺激下，蟻巢內受刺激移動的個體數量最多，速率也最快，並且有工蟻攜帶幼蟲亂竄或逃出蟻巢，可判定為受干擾的行為表現。且早上行為反應，比下午和傍晚還要強烈。令人意外的是，接收振動刺激的主要頻率範圍與前次研究所獲得螞蟻發出的聲音頻率範圍 (4000~14000 Hz) 相左，值得再做深入探討。

關鍵詞：螞蟻、社會行為、聲學溝通機制、振動、影像處理

Mechanisms of communication of ants as social insects play an important role in social behavior. Most studies about ants' communication concentrate on chemical communication by pheromone, and few researches study the acoustical communication by vibration. But from ecological inference and some experimental evidence, we expect the acoustical communication is a critical role of communication in those ants which dwell under ground and are easier buried in soil. The species of experiment, *Leptogenys kitteli*, distributes from lowland forest to medium elevation in Taiwan. When *L. kitteli* prey or are disturbed, they will communicate by stridulating two segments at gaster. In this study, we observe the response of group behavior in nest to external vibration of different frequencies and when the ants are sensitive to vibrational signal in circadian rhythm. At about 700 Hz stimuli, the group of inner nest move more actively and even take larvae out from nest. In addition, they respond stronger in the morning than in afternoon and evening. The range of frequency of vibration which *L. kitteli* are sensitive is different from the range of frequency of sound they produce as we recorded previously.

Key words: ant, social behavior, mechanism of acoustical communication, vibration, image processing

37 台灣黑翅螢 (鞘翅目：螢科) 之交尾行為及性擇
The mating behavior and sex selection of the black-winged firefly,
Luciola cerata Olivier (Coleoptera: Lampyridae) in Taiwan

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黑翅螢 (*Luciola cerata* Olivier) 是台灣常見且數量較多之螢火蟲，為雌雄雙態：雄蟲兩節發光器，雌蟲一節發光器；根據第二發光節之型態，可將雄蟲區分成五角形及半橢圓形兩種；在不受干擾之環境下，五角形雄蟲之發光為兩節發光器皆發光，而半橢圓形雄蟲僅第一節發光器發光；除型態差異外，此二類雄蟲之閃光模式及交尾行為亦有不同，五角形雄蟲之閃光速率較半橢圓形為快；五角形雄蟲間的競爭主要為吸引力競爭，而半橢圓形雄蟲則為替代性策略，從室內實驗結果得知，當雄蟲數量多於雌蟲時，雌蟲偏好與五角形雄蟲交尾，但當雌蟲數量多於雄蟲時，雌蟲回應半橢圓形雄蟲閃光之「雌蟲回應時間」會縮短，故可推測當雄蟲數量多於雌蟲時，黑翅螢之性擇機制為雄蟲競爭及雌蟲選擇，但當雌蟲數量多於雄蟲時，則雌蟲競爭程度增加。

關鍵詞：黑翅螢、交尾行為、性擇、螢火蟲、螢科

The black-winged firefly *Luciola cerata* Olivier is endemic to Taiwan and the most common species in the island. The morphology of flash segment in male *L. cerata* have two types: two-flash segments male, large one with pentagonal 2nd light segment and the other is one-flash segment male, small one with semi-oval 2nd light segment, beside morphology different, the flash patterns and mating behavior are also difference, pentagonal males have rapid flash rate than semi-oval males; and the male competition of pentagonal male is attractiveness competition, pentagonal males compete to be most attractive to females but semi-oval males is alternative tactics, it has more chance to mate when mate competition increasing. Female prefer mating with pentagonal male in male-biased ratio, but female responses delay time for semi-oval male shorten in female-biased ratio. Male competition and female choice are the main mechanism of *L. cerata* in male-biased ratio, but female competition will increase in female-biased ratio

Key words: *Luciola cerata*, mating behavior, sexual selection, firefly, Lampyridae

38 大頭金蠅 (*Chrysomya megacephala*) 之產卵偏好 (雙翅目：麗蠅科)
Oviposition preference of oriental latrine flies (*Chrysomya megacephala*) (Diptera: Calliphoridae)

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在法醫昆蟲學領域中，最常探討的問題就是如何以昆蟲資料來估算死者的死後間隔時間 (post-mortem interval, PMI)。由於雙翅目麗蠅科 (Diptera: Calliphoridae) 中許多食腐性種類會於死亡發生後極短時間內，即在屍體上產卵。因此藉著估算屍體上麗蠅幼蟲的日齡，能夠提供相當具準確性之死後間隔時間數據。在此前提下，麗蠅對屍體之產卵偏好，即成為十分重要之議題。前人研究結果顯示，不同種類的麗蠅不論對不同大小之屍體、屍體部位、死亡時間或其他因素，都有不同的產卵偏好表現。本研究以台灣地區最具優勢之麗蠅種類，大頭金蠅 (*Chrysomya megacephala*) 作為對象，進行產卵偏好選擇實驗。在溫度固定為 $28 \pm 0.5^\circ\text{C}$ ，光週期 D:L=12:12 之條件下，以二選擇之 Y 型管試驗其妊娠之雌成蟲在不同條件之產卵基質間之選擇情形。實驗初步結果經統計檢定顯示，在產卵基質上有紅顏金蠅 (*Chrysomya rufifacies*) 三齡幼蟲 50 隻，與不具幼蟲之產卵基質選擇上，大頭金蠅對無幼蟲基質具有顯著之產卵偏好 ($P = 0.0061$)，而其對基質上具同種幼蟲及無幼蟲基質之產卵選擇中，則無顯著偏好 ($P = 0.0948$)。在產卵基質上具胖葉帶綠蠅 (*Hemipyrellia pulchra*) 幼蟲及無幼蟲的產卵選擇中亦無顯著差異 ($P = 0.3750$)。推測此結果可能是為躲避具捕食性的紅顏金蠅幼蟲所導致。另外在產卵基質其他條件不同時的選擇亦進行試驗，如暴露天數等，期能藉此研究更深入了解大頭金蠅產卵之偏好性，進而能對更精確以昆蟲發育時間估算 PMI 有所貢獻。

關鍵詞：法醫昆蟲學、死後間隔時間、麗蠅科、大頭金蠅、產卵偏好

One of the most typical questions in forensic entomology is about to estimate the post-mortem interval, PMI. Some sarcophagous or necrophagous species of blow flies (Diptera: Calliphoridae) can provide information relating to the accurate estimation of PMI, because blow flies oviposit eggs on carrions within minutes after death and the thermal history of the developing fly larvae can be determined. Therefore, what kind of carcass blow flies prefer to lay eggs is an important issue in forensic entomology. In recent studies, different species of blow flies show divergent behaviors of their oviposition preference, regardless of the carrion size, position, time or other factors. In this study, a dual-choice Y-shape tunnel was used to allow the female adults, *Chrysomya megacephala* (Fabricius), the most dominant blow fly species in Taiwan, to choose their oviposition site at $28 \pm 0.5^\circ\text{C}$, and photoperiod D:L=12:12. Preliminary results show that *C. megacephala* have higher preference for laying eggs on the pork liver without third instar larvae of *C. rufifacies* when compared to the pork liver which have 50 larvae on it ($P = 0.0061$). However, *C. megacephala* shows no preference ($P = 0.0948$) between the pork liver with and without larvae of *C. megacephala*. Similar results also displayed ($P = 0.3750$) when the larvae on the chosen pork liver were changed into the species of *Hemipyrellia pulchra*. We presumed that the oviposition preference that *Chrysomya megacephala* showed is to avoid the predation from species *C. rufifacies*. Additionally, other experiments such as the choice between different exposure times of pork liver were conducted to find out more about the oviposition preference of blow flies. We believe the series of this study on oviposition preference could provide more useful information for a more accurate PMI estimation in the near future.

Key words: forensic entomology, post-mortem interval, Calliphoridae, *Chrysomya megacephala*, oviposition preference

39 繡眼畫眉 (*Alcippe morrisonia*) 繁殖活動與鱗翅目幼蟲數量之季節性關係初探
A preliminary study on the breeding activity of Grey-cheeked Fulvetta *Alcippe morrisonia* in relation to caterpillar seasonality

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鱗翅目幼蟲為食蟲性鳥類—繡眼畫眉 (*Alcippe morrisonia*) 繁殖季主要的育雛食物來源，因此其繁殖活動很可能反應其所在環境鱗翅目幼蟲的豐度變化。本研究以育雛期鳥巢數為食物需求量的指標，先於2006~2007年在雲林縣東北側丘陵尋找繡眼畫眉鳥巢，且定期監測其繁殖過程；後在2008年於同一丘陵地區的8個1ha樣區中設置32條25 m穿越線，並於4~8月每月沿線調查鱗翅目幼蟲的數量及種類。調查發現繡眼畫眉以3~6月時的育雛期鳥巢數為最多，在6月之後鳥巢數明顯減少；另鱗翅目調查共記錄蛾類幼蟲10總科，其中以夜蛾總科數量最多 (58.4%)，螟蛾科次之 (25.4%)，數量則以4~6月為最多，7~8月明顯減少。本研究顯示繡眼畫眉的繁殖活動確實與鱗翅目幼蟲數量的季節性變化趨勢一致，但兩者是否僅為季節性變動的巧合或的確交互影響，則仍待進一步的研究證實。

關鍵詞：繡眼畫眉、繁殖、鱗翅目幼蟲、季節性、豐度

Caterpillars are the main food item that grey-cheeked fulvettas (*Alcippe morrisonia*) provide for their nestlings. Thus, their breeding activity probably responds to the caterpillar abundance in their breeding area. In order to relate the breeding activity of grey-cheeked fulvetta and the caterpillar abundance, we first found and then monitored fulvettas nests in a hilly area in north-eastern Yunlin County during the 2006 and 2007 breeding seasons, and then counted the numbers of caterpillars along 32 transects which were 25 m in length and were located in eight 1ha plots in the same hilly area once a month from April to August 2008. The number of fulvetta nests during the nestling period increased steadily from March and then decreased sharply after June. Of the ten caterpillar families recorded, Noctuoidea was the dominant family (58.4%), following by Pyralidoidea (25.4%). Additionally, caterpillar abundance was higher between April and June and decreased after June. The results show that the breeding activities of Grey-cheeked Fulvettas were consistent with caterpillar abundance. However, further studies are needed to prove that the results were not the coincidence of seasonality in general.

Key words: grey-cheeked fulvetta, *Alcippe morrisonia*, breeding, caterpillar, seasonality, abundance

40 黃緣步行蟲 (*Epomis nigricans*) 對蛙類的掠食行為
Predation on anura by *Epomis nigricans* (Coleoptera: Carabidae)

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蛙類的昆蟲天敵多屬捕食蛙卵、蝌蚪或變態中小蛙的水棲性種類；然而，陸棲的黃緣步行蟲 (*Epomis nigricans*) 成蟲及幼蟲均可捕食陸域環境中已變態之蛙類，且可利用大於本身體長之獵物。2007 年夏季在馬祖地區進行兩棲類相調查期間，於黑眶蟾蜍腹部、貢德氏赤蛙腿部及地面上共發現三隻黃緣步行蟲的幼蟲，經由累代繁殖瞭解其初步生活史，以及成蟲與幼蟲的掠食偏好及取食行為。成蟲食性廣泛，蛙類、魚類或其他無脊椎動物屍體皆為其可利用的食物來源，但僅對活蛙展現明確掠食行為。幼蟲可附著於數種蛙類體表吸食體液，轉齡前需脫離至地面等待蛻皮，共經三個齡期，故至少須獵食三隻次蛙類方可完成發育；取食期間若蛙類死亡，其食性則轉為腐食，且隨著齡期增加，腐食行為越為明顯；幼蟲取食過程中，常造成蛙體傷口潰爛、組織缺損或殘肢，甚至死亡。於室溫 26~30°C 飼育下，卵發育至成蟲約 26.4 ± 1.1 天。黃緣步行蟲雖亦分佈於台灣本島，但目前為止尚未有其掠食蛙類行為的文獻記載，對台灣蛙類族群的影響值得深入探討。

關鍵詞：黃緣步行蟲、無尾目、掠食、生活史、取食行為

Most predatory insects on amphibians are aquatic. They prey on eggs, tadpoles, and the just metamorphosed young frogs in water. However, adults and larvae of the terrestrial beetle *Epomis nigricans* preyed on juveniles and adults of frogs on the ground, whose sizes were usually bigger than the beetles themselves. In summer 2007 when we surveyed the amphibian fauna of the Matsu islands off the coast of mainland China, we observed three larvae of *E. nigricans*: one on the abdominal body wall of *Bufo melanostictus*, one on the tarsal skin of *Rana guentheri*, and the third one on the ground. These three larvae were brought back to the laboratory, bred in captivity, and their predatory preference, feeding behaviors and life cycle were investigated. The results showed that adults of *E. nigricans* ate wide varieties of animal carcasses, such as frogs, fishes, and invertebrates, but they preyed only on live frogs. The larvae had 3 instar stages. At each stage, the larva attached on a live frog for feeding, left it for ecdysis on the ground, and then found another frog as a prey for the next instar stage. In other words, a larva of *E. nigricans* required a consumption of at least three frogs to develop to adulthood. In the predation, a larva usually attached on frog's skin with its mandibles and sucked the prey's body fluids. When the prey died, the larva became necrophagous, eating up the prey's carcass. The necrophagous ability of the larvae was higher at the later instar stages. The regions of the frogs where the larvae attached became lesion, fester, and even loss of tissues or legs, resulting in death for critically injured frogs. The larvae took 26.4 ± 1.1 days at room temperatures (26-30°C) to develop from eggs to adults. *E. nigricans* has been also found on the island of Taiwan, but its predation on frogs has not been reported. It is required for a future investigation.

Key words: *Epomis nigricans*, anura, predation, life cycle, feeding behavior

41 小菜蛾幾丁質酶基因之選殖

Molecular cloning of the major chitinase from the diamondback moth (*Plutella xylostella*)

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幾丁質是一種 N-乙醯葡萄糖胺聚合成之多醣體，也是形成昆蟲表皮和圍食膜的重要物質。昆蟲成長發育期間，表皮和圍食膜必須週期性的降解及重新形成以使昆蟲能正常生長成熟。幾丁質酶在昆蟲脫皮及圍食膜的降解扮演重要的角色，因此具有成為防治蟲害的標的潛力。昆蟲幾丁質酶屬於醣水解酶家族十八的一員，許多鱗翅目，包括煙草夜蛾 (*Manduca sexta*)、家蠶 (*Bombyx mori*)、斜紋夜蛾 (*Spodoptera litura*)、甜菜夜蛾 (*Spodoptera frugiperda*) 的幾丁質酶基因已被選殖出來。小菜蛾 (*Plutella xylostella*) 為世界性的十字花科作物重要害蟲，其幾丁質酶基因序列目前仍未被解析；因此本篇研究目的在於利用 RACE-PCR 技術來選殖小菜蛾之幾丁質酶基因序列全長。首先以小菜蛾 RNA 為模版，反轉錄得到其 cDNA 後，在以鱗翅目昆蟲已知的幾丁質酶基因兩段保守的區域 DLDWEYP 及 WAIDMDDF 來設計退化性引子，進行 RACE-PCR，成功的增幅出一段 707bp 之產物，此基因序列經比對與其他鱗翅目昆蟲幾丁質酶有高度的相似性。進而根據此序列來設計專一性引子，成功的利用 5'RACE-PCR 來得到 5'端序列。而 3'端序列目前正在建構中。

關鍵詞：幾丁質酶基因、幾丁質、小菜蛾、圍食膜、鱗翅目

Chitin, a linear polysaccharide of β (1-4)-N-acetylglucosamine residues (GlcNAc), is a major component of the cuticle and peritrophic membrane (PM) lining the midgut epithelium in many insects. During insect growth and development, both the cuticle and PM must be degraded periodically and replaced to allow for growth, maturation and repair. Chitinolytic enzymes play important roles in shedding of the old cuticle and turnover of the PM and can be the potential target for bio-control of insects. Chitinase genes belong to family 18 of glycohydrolase superfamily from many insects have been characterized, including Lepidopteran species such as *Manduca sexta*, *Bombyx mori*, *Spodoptera litura*, *Spodoptera frugiperda*. These studies aimed to clone full length cDNA of the major chitinase from the diamondback moth (*Plutella xylostella*) which is a worldwide pest of cruciferous crops by using the RACE-PCR strategy. A degenerated PCR was performed based on a pair of degenerate primers corresponding to two conserved regions DLDWEYP and WAIDMDDF found in other insect's chitinase. We have successfully characterized an amplified fragment (707 bp) from *P. xylostella* which has shown high homology with other major chitinases from Lepidopteran species. According to this partial chitinase sequence, a gene specific primers were further employed to successfully reach the 5'-end of chitinase cDNA by 5' RACE-PCR. The RACE-PCR of 3'-end of chitinase cDNA was currently under construction.

Key words: chitinase, chitin, peritrophic membrane, *plutella xylostella*, Lepidoptera

42 白腹叢蚊抗菌胜肽 cecropin 之選殖及表現特性
The expression and cloning of antimicrobial peptides, cecropin, of *Armigeres subalbatus*

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抗菌胜肽為昆蟲先天性免疫反應中體液性免疫之重要成員，其中 cecropin 最早於 1981 年在 *Hyalophora cecropia* 體內被分離出來；至今雙翅目、鱗翅目、鞘翅目、膜翅目等昆蟲均發現 cecropin 的存在。本研究利用經大腸桿菌 (*Escherichia coli*) 免疫刺激之白腹叢蚊之表現標誌序列 (expression sequence tag, EST) 之資訊成功選殖出五條 cecropin 基因，並分別命名為 *cecropin A1*, *cecropin A2*, *cecropin B1*, *cecropin B2*, *cecropin N*。以北方墨點法探討經免疫刺激之白腹叢蚊體內不同時間點的 cecropin 表現量變化，結果顯示免疫刺激後九十六小時內 cecropin 基因則會有不同的表現模式，其中 *cecropin B2* 於免疫刺激前已呈現表現，且並不隨免疫刺激增加其表現量。為了解各 cecropin 基因之表現調控，故選殖五條 cecropin 之 DNA 基因結構及其上游之啟動子區域，再以生物資訊學之方法描繪免疫相關之轉錄因子 NF- κ B, R1, GATA 之核酸結合位分佈，作為往後進行 cecropin 基因表現調節研究之基石。

關鍵詞：先天性免疫、體液性免疫、抗菌胜肽、免疫刺激、白腹叢蚊

Innate immunity was relied on protecting insects against microbial invaders. One of vital members is antimicrobial peptides in humoral immune responses. At 1981, first insect antimicrobial peptide, cecropin, was isolated and identified from *Hyalophora cecropia* with immune challenge by *Escherichia coli*. Up to data, four orders of insects as diptera, lepidoptera, coleoptera, and hymenoptera, were also isolated cecropin genes. We depended on information of expression sequence tag (EST) to successfully clone five cecropin genes from *Ar. subalbatus* with immune challenge of *E. coil* and denominate them, *cecropin A1*, *cecropin A2*, *cecropin B1*, *cecropin B2*, and *cecropin N*, respectively. There were observed different expression patterns by the result of northern blotting within 96 hours after immune challenge. Interesting, the result of northern blotting also revealed *cecropin B2* constitutively expresses and can not be obviously up-regulated by immune challenge. Subsequence in order to investigate the regulation of cecropin genes, we cloned encoding regions and promoters of five cecropin genes on genomic DNA and mapped distributions of DNA binding motifs of immune-related transcription factors, NF- κ B, R1, and GATA, by bioinformatics.

Key words: innate immunity, humoral immune response, antimicrobial peptide, immune challenge, *Armigeres subalbatus*

43 單隻存證蟎體的 DNA 純化複製

Vouchering DNA-amplification mites: a non-homogenized extraction method for single individual mites

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蟎類大多體型微小，需製作成玻片於顯微鏡下觀察與鑑定，或經由電子顯微鏡的應用才得以描述區辨。雖說目前可應用 DNA 特徵達到鑑定的目的，但是純化過程蟎體已被研磨，存證標本不復見，或用於研磨的多隻蟎體，混有別種蟎類，均是難以克服的現況。本研究結合形態觀測與 DNA 分析的優點，利用單隻蟎體進行 DNA 萃取並將蟎體外殼同時完成玻片製作。萃取之蟎體 DNA 進行 Nested-PCR 的複製，再進一步定序確認 DNA 序列。不戳洞的蟎體殘骸所製成的玻片標本，在拍攝的特徵較完整，目前應用於兩種根蟎的 DNA 複製及定序；而戳洞方式的玻片標本雖較不完整，但此種方式可萃取葉蟎、水蟎、根蟎、甲蟎、蜂蟹蟎單隻樣本的 DNA，並得以複製定序。本研究唯引子專一性不足，偶爾會複製到真菌的 DNA，未來需進一步克服。

關鍵詞：根蟎、葉蟎、水蟎、存證標本、巢式 PCR

Taxonomic recognition of mites must be slide mounted or use SEM treatment prior to identification. Many kinds of DNA markers can be used in mite identification, however, the mite specimens used in DNA extraction have already been homogenized. It is possible to extract DNA and make the slide voucher of mite in the same time. In this study, we combine the utility of slide-mounting and the DNA extraction in mite identification. Slide-mounting of single mites was conducted after DNA extraction. Then, the extracted DNA was carried out via Nested-PCR methods to obtain the sequences. The non-homogenized mites of two bulb mite species can be successfully mounted and the following DNA amplified and sequenced. The non-homogenized with a pierced pole of spider mite, water mite, bulb mite, oribatid mite, varroa mite also can be successfully mounted but some characters might be destroyed. The sequence results showed the primers used in the study are too conserved, which would carry out fungal DNA in some treatments. It is necessary to design the specific primers to avoid the non-target DNA amplification.

Key words: bulb mite, spider mite, water mite, voucher specimens, nested-PCR

44 光桿菌毒蛋白 TcaA 和 TcaC 之基因選殖、表現及殺蟲活性測試
Molecular cloning, expression and insecticidal activity of TcaA and TcaC toxin proteins from
Photorhabdus luminescens

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光桿菌 (*Photorhabdus luminescens*) 屬於腸內桿菌科 (*Enterobacteriaceae*)，為革蘭氏陰性菌，可和昆蟲病原線蟲共生，在隨著線蟲侵染過程進入昆蟲宿主的血腔時期，會分泌出高分子量蛋白複合物 (high-molecular-weight toxin complexes)，光桿菌會在宿主体內繁殖且在 24 到 48 小時內殺死宿主。本研究係進一步探討單一毒蛋白的殺蟲效果，從光桿菌分別選殖出 *tcaA* 和 *tcaC* 單一基因，並成功地將其表現於大腸桿菌 (*Escherichia coli*) 中。光桿菌的 *tcaA* 基因含有 3,243 核苷酸和 1,081 個胺基酸，*tcaC* 基因含有 4,458 核苷酸和 1,486 個胺基酸。利用 His-Binding column 分別純化 TcaA 和 TcaC 毒蛋白，其分子量分別約為 120kDa 和 160kDa。將 TcaA 和 TcaC 分別注射至七齡初大蠟蛾，發現注射 TcaA 的殺蟲活性和生長抑制率都比 TcaC 高。

關鍵詞：光桿菌、基因表現、毒蛋白、殺蟲活性、生長抑制

Photorhabdus luminescens is a gram-negative bacterium belonging to the *Enterobacteriaceae* which is mutualistic with entomopathogenic nematodes and which secretes high-molecular-weight toxin complexes following its release into the insect hemocoel upon nematode invasion. The bacteria multiply and kill the host within 24 to 48 hours. In order to further investigate toxin protein gene, we successfully cloned the complete *tcaA* and *tcaC* ORF (open reading frame) from *P. luminescens*, expressed then in *Escherichia coli*. Sequence analysis of the *tcaA* gene showed an open reading frame of 3,243 nucleotides encoding 1,081 amino acids and the *tcaC* gene showed an open reading frame of 4,458 nucleotides encoding 1,486 amino acids. Purified toxin proteins TcaA and TcaC by one-step purification were achieved with His-Binding column. The molecular mass of the TcaA and TcaC was determined to be approximately 120 kDa and 160 kDa, respectively. Bioassay of *P. luminescens* purified toxin protein against *Galleria mellonella* by injection showed that the insecticidal activity and the growth inhibition of TcaA were both higher than that of TcaC.

Key words: *Photorhabdus luminescens*, gene expression, toxin protein, insecticidal activity, growth inhibition

45 利用核糖體去氧核糖核酸之內轉錄區間鑑定昆蟲細胞株和細胞株的交互污染
Identification of insect cell lines and cell line cross-contamination (CLCC) by internal transcribed spacer
region of ribosomal DNA

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昆蟲細胞株 (insect cell lines) 為研究工業化之體外 (*in vitro*) 增殖病毒或生產重組蛋白的有效工具，特別適用於昆蟲桿狀病毒表現載體 (baculovirus expression vector system, BEVS)。就多數的細胞培養研究室而言，昆蟲細胞被經常性的使用、操作和維持時，需要定期的偵測和鑑定，以避免發生細胞株交互污染 (cell line cross-contamination, CLCC) 的事件。因此我們利用分子標示法，針對核糖體去氧核糖核酸 (ribosomal DNA, rDNA; or nuclear rDNA) 之內轉錄區間 (internal transcribed spacer, ITS)，進行昆蟲細胞株 (NTU-LY, NTU-PN, IPLB-LD-652Y, and Sf9 cell lines) 之種源鑑定和細胞株交互污染 (Cell line cross-contamination, CLCC) 的檢測。係以增幅的 ITS 加上 5.8S 區間，若蟲體與其同源細胞株的序列相似度 (identity) 高達 95 至 99% 者，如此這些被增幅的複製子序列 (amplicon's sequences)，可用於證實該細胞株的物種來源。根據這些增幅的複製子序列，配合兩種限制酶，*Pst*I 和 *Hind*III 的篩選，利用聚合酶連鎖反應—限制酶片段長度多態型 (PCR-restriction fragment length polymorphism, PCR-RFLP) 的技術，建立一套快速鑑定昆蟲細胞株的方法。同時，也透過 DNA 隨機增幅多態型聚合酶連鎖反應 (random amplified polymorphic DNA-PCR, RAPD-PCR) 的分析，利用隨機的核苷酸引子—OPU-10，進行本研究之細胞株的篩選和分析。另外，設計了各別的專一性引子對：*Ly-ITS1/ Ly-ITS2*、*ITS1-1/ Ld-ITS1* 及 *Sf9-F2/ ITS4*，分別針對 LY、LD 及 Sf9 等三細胞株，進行種特异性聚合酶連鎖反應 (species-specific polymerase chain reaction, SS-PCR) 的鑑定。上述的三個分子標示法：PCR-RFLP、RAPD-PCR 和 SS-PCR 的技術輔助確認，可鑑別細胞種源和避免發生細胞株交互污染。

關鍵詞：昆蟲細胞株、內轉錄區間、核糖體去氧核糖核酸、細胞株交互污染、種特异性聚合酶連鎖反應

Insect cell lines are useful tools in the study of virus basic biology and production of recombinant proteins, especially by baculovirus expression vector system (BEVS). In most cell culture laboratories, several different cell lines are routinely used, maintained, or handled, these cell lines should be regularly monitored to avoid cell line cross-contamination (CLCC). We developed a technique for identification of species origin and CLCC detection for insect cell lines (NTU-LY, NTU-PN, IPLB-LD652Y, and Sf9 cell lines) based on the sequence of internal transcribed spacer (ITS) of ribosomal DNA (rDNA). The identity of the amplicon's sequences between insect and its homologous cell line was up to 95 % ~ 99 %, thus these amplicon's sequences could be used to confirm the species origin of a cell line. Two endonucleases, *Pst*I and *Hind*III based on these sequences of amplicons, were selected for rapid identification of insect cell lines by PCR-RFLP (PCR-restriction fragment length polymorphism). The homologous cell lines could be examined by RAPD-PCR (random amplified polymorphic DNA – PCR) method with a selected oligonucleotide primer, OPU-10. Three species-specific primer sets, *Ly-ITS1/ Ly-ITS2*, *ITS1-1/ Ld-ITS1*, and *Sf9-F2/ ITS4*, were then designated for identification of LY, LD, and Sf9 cells, respectively, by SS-PCR (species-specific PCR). Therefore three methods, RFLP-PCR, RAPD and SS-PCR, can be used to define cell origin and avoid CLCC.

Key words: insect cell lines, internal transcribed spacer (ITS), ribosomal DNA (rDNA), cell line cross-contamination (CLCC), species-specific polymerase chain reaction (SS-PCR)

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自 2003 年 6 月起至 2006 年 12 月止調查阿里山地區螢火蟲，共計錄 2 科 11 屬 42 種，並依據調查成蟲出現的季節種類規劃賞螢活動；春季為黑翅螢 (*Luciola cerata*)、大端黑螢 (*L. anceyi*)、夏季為端黑螢 (*L. praeusta*)、三節熠螢 (*L. trilucida*)；秋季為山窗螢 (*Pyocoelia praetexta*)、橙螢 (*Diaphanes citrinus*)；冬季為神木螢 (*D. nubilus*)、鋸角雪螢 (*D. lamproides*)。本研究並深入阿里山地區協助社區講授螢火蟲相關課程，引導居民從觀察螢火蟲、體驗、瞭解到螢火蟲棲地保護之重要性；目前賞螢已成為阿里山地區重要生態旅遊特色。為了瞭解當地民宿業者對於賞螢活動規劃行程及所帶來的產值，建立當地民宿業者資料，自 2007 年 6 月至 2008 年 2 月止，以問卷方式，逢機調查成功地訪問了 31 家旅遊業者（不含阿里山國家森林遊樂區），業者經營賞螢活動時間平均 7.5 年，以春、夏季為主；導覽解說賞螢時段在晚上 6~9 點間，每晚一場。根據結果推估阿里山地區旅遊活動年營收約 9 億 3 千 1 百萬元（不包含農特產品）。賞螢季（4 月至 6 月）業者總營收約 52,654,560 元，約占全年營收之 28.67%；非賞螢季（7 月至次年 3 月）業者總營收 131,011,920 元，約占全年營收之 71.33%，賞螢季的月營收約 17,551,520 元（54%），也明顯高於非賞螢季之月營收 14,556,880 元（46%），證實賞螢活動對於民宿業者所帶來的收益甚高。本文也建議對於螢火蟲生態產業中增加產值、經營管理與競爭力的方法，以提升阿里山成為國際級的賞螢區。

關鍵詞：螢火蟲、生態旅遊、生態產業、賞螢、阿里山

The firefly surveying works conducted from June, 2003 to Dec, 2006. Totally two families eleven genus and 42 species of firefly were recorded. The results indicated that the adult occurrence in each season were category and planned for the firefly watching, included: *Luciola cerata* and *L. anceyi* in spring, *L. praeusta* and *L. trilucida* in summer, *Pyocoelia praetexta* and *Diaphanes citrinus* in autumn and *D. nubilus* and *D. lamproides* in winter. Firefly specialist helps the community's people to find and observe them. Relative curriculum of community was arranged for the understanding, explosion, the importance for habitat protection. By guidance of biodiversity concept, firefly watching as new vital items of ecotourism were created and prompted by the government. Gradually fireflies watching in Mt. Ali area are characteristic and famous in Taiwan. Production value for firefly watching managed by home stays in Mt. Ali area are realized and evaluated by questionnaire and establishment local home stay database from Jun, 2007 to Feb, 2008 randomly. Successfully we visited and get 31 sets of home stays data (no included Mt. Ali nation forest recreation Area). As results, operators manage the firefly watching for 7.5 years in average during spring and summer respectively. Duration of firefly watching was one hour in average at 6-9:00 p.m. and no charge once per night. As results, the production values of traveling business in Mt. Ali area evaluate income of 931,000,000 NT of home stays annually (not included agricultural product). Income of home stays in firefly watching seasons (from Apr. to Jun.) and in non firefly watching seasons (Jul. to next year Mar.) was 52,654,560 NT (28.67%) and 131,011,920 NT (71.33%) annually. As comparison with monthly income between firefly watching and non firefly watching show 17,551,520 NT (54%) higher than 14,556,880 NT (46%). Results improve that firefly watching in Mt. Ali area was beneficial to the home stay operator. This paper also suggests that the approaches were increasing production values, management and competition of firefly ecological industry in Mt. Ali area as well as promotion to the international class scenic area in the world.

Key words: firefly, ecotourism, ecological industry, firefly watching, Mt. Ali.

47 三用捕捉網與傳統型馬氏網於原始林中攔截昆蟲之效果比較
Comparing insect interception between SLAM and traditional Malaise trap in natural forest

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相較於傳統型馬氏網，新型馬氏網（三用捕捉網）能更簡易地組裝並架設，且也具有更多的應用性與功能。在利用新型馬氏網做許多生態調查時，這些潛力似乎能提高昆蟲蒐集的能力。基於如此多的優點，設計出了改良的馬氏網。我們想比較於森林地表與樹冠層中，三用捕捉網所蒐集到的昆蟲資料在傳統型（對照組）與不同顏色（黑色與白色）的三用捕捉網間差異。這項調查在台灣中部蓮華池的低地天然林中（海拔 774 公尺）進行五天的樣本蒐集。飛行昆蟲能被傳統型馬氏網與兩種不同的三用捕捉網所攔截，並加以分析。陷阱在不同的設置地點與其不同的組成顏色或許都會影響其昆蟲的捕抓能力，因此，這個測驗為了比較新型陷阱於不同地點間差異，同時將黑色三用捕捉網架設在樣區地表與其上方 3 到 4 公尺高之樹冠層中；而在同一地點，為了檢驗不同顏色的影響及與傳統型間差異，在距前二黑色陷阱 4 到 5 公尺處，分別放置另一個白色三用捕捉網與一個傳統型馬氏網。這樣的設置在天然林中不同地點重複五次。我們的結果顯示黑色三用捕捉網與傳統型馬氏網在白天與夜間地表的昆蟲捕抓數據沒有顯著差異（Bray-Curtis 相似度分析黑夜， $p = 0.397$ ；白晝， $p = 0.175$ ），但在地表與樹冠層中的兩黑色三用捕捉網間，是有顯著差異的（Bray-Curtis 相似度分析黑夜， $p^* = 0.008$ ；白晝， $p^* = 0.008$ ）；然而，由於黑色與白色三用捕捉網只有在白天時，地表的昆蟲捕抓數據有顯著差異，所以僅在白天時，陷阱的顏色才有明顯地影響（Bray-Curtis 相似度分析白晝， $p^* = 0.016$ ；黑夜， $p = 0.302$ ）且黑色三用捕捉網所攔截昆蟲的能力似乎優於白色的三用捕捉網（黑色，Mean \pm S.D = 173 ± 59.86 ；白色，Mean \pm S.D = 100 ± 17.58 ）。

關鍵詞：馬氏網、三用捕捉網、蓮華池、樹冠層、Bray-Curtis 相似度分析

The new Malaise trap, named “SLAM” trap is easier to set up and more versatile than the traditional one. It is likely to facilitate insect collection in many ecological investigations. Having more benefit than traditional, an improved version of the Malaise trap was designed. We are in an attempt to compare the insect-collection data of the SLAM trap between the traditional (control) one and another SLAM trap with different color (black and white) at both forest strata ground and canopy. This investigation was conducted in a five-day sampling in a lowland natural forest (774 m in elevation) at Lien-Hua-Chih of central Taiwan. Flying insects were intercepted for analysis by a traditional and two kinds of SLAM traps. Both different setting locations and color components of the traps may affect the ability of insect capturing. Therefore, contrasted the new traps in different locations, this test put a black SLAM trap on a stratum ground while another one was suspended 3-4 m directly above it. On the same place, an additional new white and a traditional trap were set space 4-5 m apart from two black former traps as examination of different color effect and a control test respectively. These setups were duplicated five times at different areas in the natural forest. Our results showed that there was no significant difference in capture data between the black SLAM trap and traditional one in both night and day time collection on strata ground (Bray-Curtis *ANOSIM* Night, $p = 0.397$; Day, $p = 0.175$), but between the black SLAM traps in canopy and strata (Bray-Curtis *ANOSIM* Night, $p^* = 0.008$; Day, $p^* = 0.008$). However, differing from night, the color effect was obviously detected only in the day-time collection, as there was significant difference for insect data between the white and the black SLAM traps (Bray-Curtis *ANOSIM* Day, $p^* = 0.016$; Night, $p = 0.302$), and the intercepted ability of black SLAM trap seemed better than the white one (Black, Mean \pm S.D = 173 ± 59.86 ; White, Mean \pm S.D = 100 ± 17.58).

Key words: Malaise trap, SLAM trap, Lien-Hua-Chih, canopy, Bray-Curtis *ANOSIM*

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颱風年年襲台灣，不同強度的風雨，如何影響宜蘭蘭陽溪各水域中水生昆蟲棲群，會是吾人瞭解水蟲棲群恢復能力之所據。本監測每月在七個採樣點行之，所採的蟲種 (S)、種之數量 (N)、種之質量 (E)、及其空間/時間的多樣性 (H) 皆以 EXCEL 程式整合。再以多變因子統計程式 (PRIME 6) 分析之。結果顯示，年間七棲群在空間分佈上有明顯區別：R = 0.39，三年間三主流棲群總分佈 2-D stress 得值 0.12，顯示三個年度分佈亦屬明顯區分。如以三主流棲群總分佈依逐月份分佈，在 2-D stress 得值 0.11，顯示月份間區分更顯著。其中 2004/2005 者棲群由始而盛而衰，順時鐘循春/夏/秋/冬 迴旋；而 2006 者，反是。四支流棲群分佈所得值則是依地勢標高而下，分別得 0.1；0.1；0.12；0.17。這暗示著高地水域昆蟲棲群可能較不易在暴風侵襲 之後復原：雖然諸年月份分佈之迴旋皆依順時鐘方向而行。諸迴旋對棲群恢復所呈的義意將探討之。

關鍵詞：蘭陽溪、水生昆蟲、颱風、監測、復原

Taiwan experienced typhoons every year. Comparative study on how the stormy rain effecting to the insect communities in different channels of the Lan-Yang River in the Yi-Lan County may reveal the restoration capability of the original insect pool of the inhabitant. Would the insect pool as a reservoir source be the most potential base for restoration? The survey was conducted monthly at seven sampling sites along the watershed of the river: from upstream to downstream. Data of number of aquatic insect species (S), number of each species (N), biomass of each species (E), temporary and spatial distribution of insect group (H) were listed in form of EXCEL (Windows). Data were then analyzed according to PRIMER 6, the software. Value for spatial distribution of insect had a Global R: 0.34 for year of 2005 and 0.39 for 2006 indicating that the insect communities varied from place to place. MDS analysis on yearly distribution of insect sampled at three sites in the mainstream had a lower 2D-Stress of 0.12 hinted that each years' count were separated from one another. Further MDS analysis on monthly distribution of pooled insect communities at the three sites in three years showed that a lower 2-D Stress of 0.11. MDS figure showed that the difference between 2004/2005 and 2006 was mainly laid in the attendance of cycling swirl: a clock-wise circle for monthly distribution of 2006 and a count-clock-wise cycle for monthly distribution of 2004/2005. Significance of the swirl of the sampled insect of both mainstream and tributaries in MDS will be discussed in aspect of insect community restoration.

Key words: Lan-Yang River, aquatic insect, typhoon, monitoring, restoration

49 水棲昆蟲在固床工程上之次級演替
Secondary succession of aquatic insects on the consolidation work

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台灣在溪流上做了許多工程來防範水患與防止土石崩塌，而這些工程設施通常都會干擾河床；在施工期間干擾所及的範圍內，流失相當數量的泥沙和水生生物。在施工後，產生了新的棲地，隨後各種水棲生物會在新棲地再拓殖。在溪流中水棲昆蟲是主要的無脊椎動物，牠們能夠非常快速地拓殖新的棲地；而群聚結構將隨著拓殖的時間而改變。本研究的目的是檢視水棲昆蟲群聚結構在工程前後的差異，和在工程後的次級演替。在桶后溪上設置兩個樣站，樣站 2 就在固床工程上，樣站 2' 則是在工程的上游。在急瀨型棲地上使用蘇伯式水網作隨機取樣，並且定期紀錄環境的理化資料，在演替初期，四節蜉蝣科、搖蚊科和蚋科為主要的類群；至於固床工程對水棲昆蟲的影響，則仍持續蒐集資料分析中。

關鍵詞：水棲昆蟲、群聚結構、工程、次級演替、拓殖

There are a lot of projects for flood control and conducted in the streams in Taiwan. These engineering constructions usually cause disturbance on the riverbed. A considerable amount of sediment as well as aquatic organisms were lost from the disturbed reaches during the construction. New patches are created after construction and subsequently recolonised by various aquatic organisms. Aquatic insects are one of the major invertebrate groups in streams. They could colonize to a new patch very fast. Changes in community composition in a new patch are affected by the colonization time. The objectives of the study is to exam the differences in the community structures of aquatic insect between before and after the construction and their secondary succession on the consolidation work. Two sites were set up in the Tonghou Stream; one site (Site 2) was on the consolidation work and the other site (Site 2') in the upstream of the construction site. Aquatic insects were randomly sampled in riffle habitats by Suber net sampler and environmental variables are also recorded. Baetidae, Chironomidae and Simuliidae were the major group of taxa at the Site 2 in the early stage of succession. As for the impact of the consolidation work on the aquatic insects, still continuing to gather information to analysis.

Key words: aquatic insects, community struture, engineering, secondary succession, colinization

50 蓮華池試驗林樹棲螞蟻 (膜翅目：蟻科) 群聚結構之研究
Study of the arboreal ant (Hymenoptera: Formicidae) community structure in Lien-Hua-Chih
experimental forest

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指標生物 (bioindicators) 是指任何一個生物物種或一群生物其功能、族群或狀態可以用來監測一環境或生態系的健康。理想的指標生物必須符合一些基本標準或特性，像是容易被採集、量化、相對數量多和歧異度高、對環境改變反應敏感等。近年來，有更多的研究著重在陸域生態系，很多昆蟲有潛力可以成為指標生物而被利用，其中螞蟻就是一個最好的例子。螞蟻已經廣泛被用來監測生物多樣性 (biodiversity) 和環境擾動 (disturbances)，像是農業和森林管理措施。不同種類的螞蟻還可以依據牠們對棲所的要求和種間競爭交互作用被分類成數個生態功能群 (functional groups)，各別生態功能群和棲地狀況之間的相互關係非常重要，隨著棲地擾動嚴重程度增加，生態功能群的相對數量 (relative abundance) 也隨之改變，所以在環境擾動和生物多樣性監測上提供可預測性 (predictable) 的資訊。本研究以蓮華池樹棲螞蟻相調查為重點，選定兩種類型樣區 (天然林和人工林)，利用兩種不同型式 (枝條型與樹幹型) 的樹型掉落式陷阱 (tree pitfall traps) 進行每個月份的調查工作，並將其中指標重要性類群螞蟻進行分析，比較此區域之種類豐度與歧異度、群聚結構及人為干擾度間之關係。在 2008 年 3 月至 8 月的調查中，共採獲樹棲螞蟻共 41 種，隸屬於 5 個亞科 (山蟻亞科、針蟻亞科、家蟻亞科、擬家蟻亞科、琉璃蟻亞科)、23 個屬。在不同類型樣區的樹棲螞蟻種類與數量變化上，兩樣區皆隨月份逐漸增加，而天然林較人工林明顯，顯示其有較高的生物多樣性。兩種不同型式的樹型掉落式陷阱的比較上，則以樹幹型有較佳的採集率。

關鍵詞：指標生物、生態功能群、生物多樣性、蟻科、掉落式陷阱

Bioindicators are any biological species or group of species whose function, population, or status can be used to monitor the health of an environment or ecosystem. Ideal bioindicators should meet some basic criteria, like easily sampled, quantifiable, relatively abundant and diverse and sensitive for response to environmental change, etc. Recently, more interest focus on terrestrial ecosystem and various insects are potential used as bioindicators, ants scored highest. Ants have widely used to monitor biodiversity and many disturbances such as agriculture and forest management practices. Ant species were classified into functional groups according to their habitat requirements and competitive interactions. Interaction among individual functional groups and treatment condition was important, as disturbance severity increase, the relative abundance of functional groups will changes, so can provide predictable information in monitor environmental disturbances and biodiversity. The study was conducted two different type areas (nature forest and artificial forest) in Lien-Hua-Chih experimental forest, we focus on the survey of the arboreal ant fauna every month, use two type tree pitfall traps (stick-type and trunk-type). We analyze the important indicator ant groups, and compare the species richness, diversity, community structure and disturbances between two areas. In 2008, from March to August, we collected all 41 species from 5 subfamilies (Formicinae, Ponerinae, Myrmicinae, Pseudomyrmecinae, Dolichoderinae), 23 genera. The arboreal ant species and abundance all increase with month at the two areas, but the nature forest is more significant than artificial forest, indicating its' higher biodiversity. The comparasion between two different types of tree pitfall traps shows that trunk-type pitfall trap has better sampling effort.

Key words: bioindicator, functional group, biodiversity, Formicidae, pitfall trap

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陽明山國家公園的青斑蝶，每年五、六月間，在大屯山及七星山一帶，族群量會遽增，大量聚集蜜源植物上覓食；根據本研究調查，島田氏澤蘭及臺灣澤蘭分別為陽明山國家公園造訪蝴蝶種類及數量第二及第三多的蜜源植物。在島田氏澤蘭盛開期間，大屯山車道沿途有盛開的虎葛 (*Cayratia aponica*)、臭黃荊 (*Premna microphylla*) 及狹瓣八仙 (*Hydrangea angustipetala*) 等重要蜜源植物，但蝴蝶喜好情形並不如島田氏澤蘭，顯示大屯山區蝴蝶偏好島田氏澤蘭。本研究自 2008 年 5 月起，每周一次沿大屯山主峰車道進行調查，調查的時間於晴天上午 8 時至下午 1 時之間，沿步道調查島田氏澤蘭與臺灣澤蘭的發育情形，記錄是否有花苞、開花或凋謝，以及訪花蝴蝶種類與數量。大屯山車道的島田氏澤蘭自 5 月份開始產生花苞，發育先後順序有由低海拔向高海拔的現象，到 6 月底後各路段的島田氏澤蘭多數已枯萎，僅剩大屯山頂尚有島田氏澤蘭開花，因此尚未擴散離開的青斑蝶幾乎都集中在山頂附近。到 7 月底為止大屯山頂的島田氏澤蘭也多數枯萎，僅殘存少數尚未枯萎供應斑蝶吸食，不過此時臺灣澤蘭已盛開，成為蝴蝶造訪頻率最高的蜜源植物。臺灣澤蘭的分布，多數與島田氏澤蘭的棲息環境相同，於 6 月底開始產生花苞，到 8 月中開始有枯萎的現象產生，其發育期與島田氏澤蘭錯開但有短期銜接連續。島田氏澤蘭與臺灣澤蘭在大屯山區的分布，主要在有擋土牆的位置，在非擋土牆部份，則面臨五節芒、包籜矢竹、野當歸、刺莓、大花咸豐草及虎葛等其他植物的競爭，因此島田氏澤蘭與臺灣澤蘭未來經營管理的方向，應以擋土牆為重點，且適當的經營管理將可避免澤蘭被其他物種所取代。

關鍵詞：青斑蝶、島田氏澤蘭、臺灣澤蘭、陽明山國家公園、大屯山

The Chestnut Tiger is outbreak every May and June, in the Mt. Datun and Mt. Cising of Yang Ming Shan National Park, population will increase in a large amount, and Chestnut Tigers were assembled on the nectar plants. According to investigate, *Eupatorium shimadae* and *Eupatorium formosanum* attract butterfly kind and quantity to rank the nectar plant of the second and the third. At time when *Eupatorium shimadae* is in bloom, there are important nectar plants such as *Cayratia aponica*, *Premna microphylla* and *Hydrangea angustipetala* in bloom, etc. on the way in the Mt. Datun, but the butterfly is preferring the *Eupatorium shimadae* to the others. Reveal the butterfly of Mt. Datun has a partiality for *Eupatorium shimadae*. This research since May of 2008, go on the investigation along the lane of Mt. Datun while being weekly. Investigate the development of *Eupatorium shimadae* and *Eupatorium formosanum*, record it was have buds, bloom or wither, and visit butterfly kind and quantity. *Eupatorium shimadae* on the Mt. Datun begins to produce flower buds since May. It development order have from low altitude to the high altitude. Most of the *Eupatorium shimadae* have been already withered on June, only the mountaintops of Datun that still has *Eupatorium shimadae* to bloom. So most Chestnut Tigers were all assemble near the mountaintop. *Eupatorium formosanum* was in full bloom at the end of July, become the most liked nectar plant by the butterfly. The *Eupatorium formosanum*'s habit environment is nearly the same as *Eupatorium shimadae*. It has the flower bud on the end of June, and withered in August. *Eupatorium shimadae* and *Eupatorium formosanum* are mainly distributed in the position with the retaining wall. There are the competitions of other plants such as *Miscanthus flavidus*, *Pseudosasa usawai*, *Angelica dahurica*, *Rubus croceacanthus*, *Bidens pilosa* and *Cayratia aponica* in the other places. So the *Eupatorium shimadae* and the *Eupatorium formosanum* future management should take retaining wall as the focal point.

Key words: Chestnut Tiger, *Eupatorium shimadae*, *Eupatorium formosanum*, Yang Ming Shan National Park, Mt. Datun

52 玉山國家公園塔塔加地區蝴蝶活動日週性研究
Studies on daily rhythms of butterfly at Tataka area in Yushan National Park

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塔塔加地區位於玉山國家公園西北方，海拔高度 2580 公尺，屬於中高海拔的氣候，孕育著豐富的自然景觀與生物多樣性。本研究係以塔塔加鞍部（座標：N23°28'39.1"、120°53'30.5"）為樣區，調查蝴蝶每日活動情形與氣溫及相對濕度之間的關係。每兩週調查一次，每次調查時間從上午 6 時至下午 6 時之間，並視塔塔加鞍部氣候狀況至蝴蝶停止活動為止。調查時間以每小時為一單位記錄出現蝴蝶的種類、數量及當時的溫濕度。自 2007 年 7 至 2008 年 9 月，共完成 41 次有效資料。根據調查結果顯示，塔塔加鞍部蝴蝶活動日週性受太陽日照溫度之影響，氣溫平均在上午 9 時明顯回溫，蝴蝶開始活動，而蝶種於上午 10 時至 11 時有大幅增加的趨勢；蝴蝶數量以紫斑蝶類最多，其次分別有青斑蝶類、玉山蔭蝶及阿里山琉璃小灰蝶、高山粉蝶等種類。在氣候方面，因塔塔加鞍部中午過後，相對濕度明顯上升，常有雲霧籠罩，使當地氣溫逐漸下降，偶有降雨發生，使蝴蝶活動上有明顯減少並消失的情形。塔塔加地區為中高海拔環境，常有雲霧產生籠罩整個地區，進而影響當地的蝴蝶活動；塔塔加鞍部位於玉山山脈與阿里山山脈交接處鞍部，除了原本活動於中高海拔的蝴蝶之外，許多在低海拔常見的蝶種也在此出現。

關鍵詞：玉山國家公園、塔塔加地區、蝴蝶、日週活動、蝶相調查

Tataka area 2580 meters above sea level, located in the North West of Yushan National Park is in the high altitude climate, pregnant with the natural landscape and biodiversity. In this study, Tataka Saddle (coordinates: N23°28'39.1", 120°53'30.5") for the kind of area to investigate the situation and the Butterfly daily rhythms with temperature and relative humidity. Once every two weeks to survey, from time to investigate each 6:00 to 6:00 p.m., if weather conditions change, resulting in reducing the activities of the butterflies to disappear, then the end of the day of investigation time per hour for the emergence of a unit record Butterfly the variety and quantity at the time of temperature and humidity. Survey period is from July 2007 to September 2008, and a total of 41 data are effective. According to the report, Tataka Saddle Butterfly daily rhythms of sunshine temperature by the sun's influence, the average temperature at 9:00 to the beginning of Butterfly apparent, butterfly species at 10 o'clock to 11 o'clock there is the sharp increase; the most number of butterflies is *Euploea* spp., followed by the respective categories *Danaia* spp., *Zophoessa niitakana*, *Celastrina oreas arisana*, and *Aporia agathon moltrechtii*. In the climate, as a result of Tataka Saddle afternoon, a marked increase in relative humidity, clouds hung over often so that the local temperature gradually decreased, occasional rain occurred, so that the butterflies have decreased activity and disappeared. Tataka in the region for the high-altitude environment, often have a cloud over the entire region which in turn will affect the activities of the Butterfly; Tataka is a saddle between Alishan mountain chain and Yushan mountain chain, in addition to the original activity at high altitude in the butterfly, in many low-lying Common species of butterflies are also the emergence of future for this part of the in-depth inquiry.

Key words: Yushan National Park, Tataka area, butterfly, daily rhythms, butterfly fauna survey

53 蚜蟲內共生菌 *Buchnera aphidicola* 支鏈型胺基酸 leucine 合成酵素 LeuA 表現、
純化與酵素特性分析

Expression, purification, and characterization of branched chain amino acid leucine synthesis enzyme
LeuA of *Buchnera aphidicola*

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蚜蟲是一種利用刺吸式口器以植物韌皮部汁液為食的昆蟲，為農業害蟲，然而植物韌皮部組織缺乏部分必需胺基酸，因此體內含有內共生菌 *Buchnera aphidicola* 補足其生長需求。*B. aphidicola* 分類上屬於 γ -Proteobacteria 且與 *Escherichia coli* 關係相近，並生長在蚜蟲腹腔的 mycetocyte (懷菌器) 中。與蚜蟲共生關係中，*B. aphidicola* 提供宿主必須胺基酸 (如 leucine、isoleucine)，以補充植物汁液中含氮養分的不足，而宿主蚜蟲則提供其生長環境，兩者屬於絕對的互利共生。 α -isopropylmalate synthase，簡稱 α -IPMS，EC number 為 2.3.3.13，為支鏈型胺基酸 leucine 合成路徑中一個重要的調節酵素，此調節酵素的基因為 *leuA*；在 *B. aphidicola* 中，*leuA* 是以質體方式存在，可能因其必須大量表現以供給 leucine 合成。 α -IPMS 在各種物種中已經有不少研究，而在 2004 年也解出第一個 crystal structure (from *Mycobacterium tuberculosis*)，但是 *Buchnera* 的 α -IPMS 尚未有相關的酵素活性研究。因此，本實驗將選殖 *B. aphidicola leuA* 並使用 *E. coli* 菌株 BL21 (DE3)，進行大量表現，然後利用鹽析法 (硫酸銨沉澱) 以及親和性層析法 (Ni sepharoseTM High Performance) 進行純化。純化完成後，便進行酵素動力學分析，以了解其調節特性。未來，便可進一步建立一篩選平台，進行抑制物的篩選，對於蚜蟲的防治是相當好的方向。

關鍵詞：蚜蟲、內共生菌、*Buchnera*、leucine、 α -isopropylmalate synthase、*leuA*

Aphids feed on plant phloem, a diet deficient in essential amino acids. Aphids have developed the specialized cell bacteriocyte (mycetocyte) to house the endosymbiont *Buchnera aphidicola*. The major role of *B. aphidicola* in the symbiosis is the provision of essential amino acids, including isoleucine, leucine, threonine, lysine, and valine. The first committed step in L-leucine biosynthesis, catalyzed by the enzyme α -isopropylmalate synthase (α -IPMS, EC number is 2.3.3.13) is the condensation of acetyl-coenzyme A (AcCoA) with α -ketoisovalerate (α -KIV) and the subsequent hydrolysis of α -isopropylmalyl-CoA to generate the products CoA and α -isopropylmalate (α -IPM). The gene *leuA* encodes α -IPMS. In *B. aphidicola*, *leuA* is not on the chromosome but on a plasmid, suggesting that *B. aphidicola* needs to overexpress α -IPMS to provide leucine. To determine the kinetic and regulatory properties of α -IPMS, we used *E. coli* to overexpress this protein and purified the enzyme by ammonium sulfate precipitation and immobilized metal affinity chromatography.

Key words: aphids, endosymbiont, *Buchnera*, leucine, α -isopropylmalate synthase, *leuA*

54 利用大腸桿菌系統表現及純化蚜蟲內共生菌*Buchnera*之N-acetylglutamate synthase
Expression, purification, and characterization of the N-acetylglutamate synthase of *Buchnera aphidicola*
in an *E. coli* system

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蚜蟲是常見的農業害蟲，以吸食植物韌皮部汁液維生。其生長繁殖有賴於體內內共生菌 *Buchnera aphidicola* 提供必需胺基酸以補充植物汁液中含氮養分的不足。因此 *Buchnera* 的必需胺基酸合成酵素可以作為安全而理想的藥物作用目標。N-acetylglutamate synthase，簡稱 NAGS，為 arginine 合成路徑中的重要酵素，此酵素的基因為 *argA*。雖然 *Buchnera* 無法在蚜蟲體外進行一般細菌培養實驗，但 *Buchnera* 與大腸桿菌同樣屬於腸內細菌科 (Enterobacteriaceae)，親源關係十分接近。因此可透過建立大腸桿菌表現系統，來研究 *Buchnera* NAGS 酵素功能及回饋調控。本研究選殖並建構含有 *Buchnera argA* 的質體，轉型進入大腸桿菌 *argA* 缺陷株 NK5992，發現在 20°C、26°C 時可以補償缺陷，37°C 時無法補償缺陷。再將含有 *Buchnera argA* 質體轉型進入大腸桿菌 BL21 (DE3) 菌株大量表現 *Buchnera argA*，並以 20~40%飽和濃度硫酸銨沈澱 *Buchnera* NAGS 後再用金屬螯合層析法純化蛋白質，以 DTNB 呈色法進行細胞外的酵素活性測定。

關鍵詞：蚜蟲、內共生菌、*Buchnera*、*argA*、NAGS

Aphid is an important agricultural pest insect feeding on the phloem sap of plants. As phloem sap lacks of nitrogenous compounds, the growth of aphid relies on the endosymbiont *Buchnera aphidicola* for providing essential amino acids. Thus, the *Buchnera* enzymes for biosynthesis of the essential amino acids are ideal and safe targets for pesticides. N-acetylglutamate synthase (NAGS, encoded by *argA*), is a good target that plays an important role in the arginine biosynthesis pathway. *Buchnera* can not be cultivated *in vitro*. The relationship between *Buchnera* and *E. coli* is close since both belong to the Enterobacteriaceae family. Therefore, expression of *Buchnera* NAGS in an *E. coli* system is a good avenue to study the function of *Buchnera* NAGS and its feedback inhibition mechanism. In this study, we constructed a plasmid that contains *Buchnera argA*, and transformed the plasmid into the *E. coli argA* mutant NK5992 for complementation test. Our results demonstrated that the *Buchnera argA* complemented for arginine auxotroph at 20°C, 26°C, but not at 37°C. *Buchnera* NAGS was detected in transformed *E. coli* BL21 (DE3) cells by SDS-PAGE. The enzyme was precipitated with 20-40% saturation of ammonium sulfate, and purified by metal-chelating affinity chromatography. Its activity was measured using a DTNB-based method.

Key words: aphid, endosymbiont, *Buchnera*, *argA*, NAGS

55 利用大腸桿菌系統表現及純化蚜蟲內共生菌 *Buchnera* 之芳香族胺基酸合成酵素 DAHPS
Expression, purification, and characterization of the aromatic amino-acid synthesis enzyme DAHPS of
Buchnera aphidicola in an *E. coli* system

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蚜蟲以刺吸式口器吸取植物汁液，造成植株枯萎，為重要的農業害蟲。蚜蟲體內有多種內共生菌，其中 *Buchnera* 為主要的內共生菌。*Buchnera* 與蚜蟲間為絕對互利共生，*Buchnera* 會提供胺基酸給蚜蟲使用，所以研究 *Buchnera* 之胺基酸合成酵素的特性不僅可瞭解其共同演化的關係，也可作為防制蚜蟲的作用標的。因為 *Buchnera* 無法單獨體外培養，所以利用與 *Buchnera* 同為腸內細菌科 (Enterobacteriaceae) 的大腸桿菌作為表現平台，將 *Buchnera* 之基因放到質體上，再送入大腸桿菌大量表現，本實驗研究 Shikimate pathway 中的第一個酵素，DAHPS (3-deoxy-D-arabino-2-heptulosonate 7-phosphate synthetase, EC 2.5.1.54) 之生化特性，建立大量表現之方法後，再以親和性層析法純化的蛋白質，以純化後的 *Buchnera* DAHPS 進行活性測定，及探討其是否受到最終產物 tryptophan、phenylalanine 與 tyrosine 的回饋抑制。未來可利用此系統，篩選可抑制其活性的化合物，作為防治蚜蟲的基礎。

關鍵詞：蚜蟲、內共生菌、*Buchnera*、DAHPS、*aroH*

Aphids use their piercing mouthparts to suck plant sap from the phloem, and in doing so cause physical damage to plant tissues and distribute diseases. Therefore many species of aphids are well-known pest insects in agriculture. Aphids have lots of endosymbiont, including the essential primary endosymbiont *Buchnera*. The symbiotic relationship between *Buchnera* and aphids is an obligate mutualism in which *Buchnera* supplies essential amino acids to aphids. Examination of the *Buchnera* enzymes involved in amino acids biosynthesis pathway can not only provide a better understanding of the co-evolution between *Buchnera* and aphids, but also form a basis for developing new pesticides by using these enzymes as targets. *Buchnera* cannot be cultivated without aphids. Since both *E. coli* and *Buchnera* belong to the Enterobacteriaceae family, we used *E. coli* as an expression host to synthesize enzymes of *Buchnera*. In this experiment, we study the biochemical characteristics of 3-deoxy-D-arabino-2-heptulosonate 7-phosphate synthetase (DAHPS, EC 2.5.1.54), the first enzyme of the shikimate pathway. We cloned the enzyme gene, *aroH*, and transformed it into *E. coli* with a plasmid. We overexpressed the gene and purified the enzyme using Ni-chelating affinity chromatography. The purified enzyme was used to study enzyme activity and feedback inhibition by tryptophan, phenylalanine, and tyrosine. In the future, this system can be used to screen chemical compounds for enzyme inhibitors that can be further modified into new pesticides.

Key words: aphid, endosymbiont, *Buchnera*, DAHPS, *aroH*

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雷帕黴素標靶蛋白 (target of rapamycin, TOR) 為一種高度保守的絲氨酸/蘇氨酸蛋白質酶 (serine/threonine protein kinase)，主要具調節細胞生長與增殖及基因表現與蛋白質合成等等之功能。本研究報導：1. 我們自東方果實蠅 (*Bactrocera dorsalis* (Hendel)) 分離得一個 TOR cDNA，命名為 *BdTOR*，其開放讀架 (open reading frame) 衍生之蛋白質具 2460 氨基酸；2. 正常情況下，*BdTOR* 在第一批卵發育的雌成蟲 (羽化後至第 10 天間) 脂肪體與卵巢內有明顯的表現；目前，我們正在進行關於飢餓、雷帕黴素與青春激素 (juvenile hormone, JH) 等處理對 *BdTOR* 以及卵黃原蛋白基因 (yolk protein gene, *BdYp*) 表現的影響，藉以瞭解它們彼此間的調控關係；3. 我們同時亦將進行降低 (knock down) *BdTOR* 的表現量，以探究對其下游基因，如 *BdYp* 表現之影響。期望藉此瞭解 *BdTOR* 於調控 *BdYp* 表現的細胞內訊息傳遞 (intracellular signal transduction) 機制。

關鍵詞：東方果實蠅，雷帕黴素，雷帕黴素標靶蛋白，細胞內訊息傳遞，基因表現

Target of rapamycin (TOR) is a highly conserved serine/threonine protein kinase regulating cell growth, cell proliferation, transcription and protein synthesis, etc. Here we report: 1. The characterization of full length amino acid sequence of *Bactrocera dorsalis* TOR (*BdTOR*) which has 2460 amino acid sequence; 2. *BdTOR* expression profile of normally fed whose mRNA are expressed at higher levels in ovary than fat body during the first phase of egg development (through out 10 days after eclosion); further, *BdTOR* expression during starvation, rapamycin and juvenile hormone treated, in fat body and ovary is understudy. These results would be compared to see how *BdYp* (yolk protein) expression gets affected; 3. Knock down of *BdTOR* and its impact on *BdYp* expression is also understudy. These studies help to explore the signal transduction of *BdTOR* for yolk protein expression.

Key words: *Bactrocera dorsalis*, rapamycin, target of rapamycin (TOR), intracellular signal transduction, gene expression

57 東方果實蠅卵黃原蛋白基因啟動子調控外源基因之表現
Regulation of expression of an exogenous gene by the promoter of *Bactrocera dorsalis* yolk protein 1
(*Bdyp1*) gene

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卵黃原蛋白 (vitellogenin or yolk protein) 由昆蟲脂肪體和/或卵泡細胞 (follicular cell) 合成，經醯基化和磷酸化等轉譯後修飾作用後分泌至血體腔中，再經由發育中的卵細胞藉由受器媒介之內吞作用 (receptor-mediated endocytosis)，將卵黃蛋白吸收至卵中做為胚胎發育所需養分。前期研究，我們已證實東方果實蠅 (*Bactrocera dorsalis* Hendel) 的卵黃原蛋白基因僅表現於雌成蟲脂肪體和卵巢。本研究中，我們進一步構築東方果實蠅卵黃原蛋白基因 1 (*Bdyp1*) 之 5' 端上游 2.4 kb 的 DNA 片段結合綠色螢光蛋白 (green fluorescence protein, EGFP) 報導基因，並藉轉基因子 *piggyBac* 為載體，轉殖並建立得一東方果實蠅轉基因品系，pBac{Bdyp2.4-EGFP/PUB-DsRed}，其轉殖效率為 2.8%。利用南方墨點法 (Southern blot) 和 DNA 轉位 (DNA transposition) 分析得知，此重組 DNA 片段確實循 *piggyBac* 以“cut and paste”的作用機制進行轉位，將此外源蛋白嵌入染色體內。此外，螢光顯微鏡觀察和免疫標定偵測結果皆顯示，此 EGFP 之表現模式與卵黃原蛋白相符，顯示卵黃原蛋白基因上游 2.4 kb 的 DNA 具調控基因表現組織 (脂肪體) 專一性功能。

關鍵詞：東方果實蠅，卵黃原蛋白基因啟動子，基因轉殖，組織專一性，綠色螢光蛋白

In most insects, vitellogenin or yolk protein are synthesized in fat body and/or follicular cells, secreted into haemolymph following post-translational modification, absorbed into the developing oocytes via receptor-mediated endocytosis; and finally used as nutrients for embryonic development. In the previous study, we have reported that the yolk protein gene, namely *Bdyp1*, in the oriental fruit fly *Bactrocera dorsalis* is expressed in the adult female fat body and ovary. Here, in this study, we report that a transgenic construct, pBac{Bdyp2.4-EGFP/PUB-DsRed}, which recombined the 2.4-kb *Bdyp1* 5'-flanking fragment with a reporter gene, *i.e.*, green fluorescence protein (EGFP), and inserted to a *piggyBac* transposon. This recombined transposon was successfully transformed into *B. dorsalis* with 2.8% transformation frequency; and a transgenic line has been established. The results of southern blot and transposition assay showed that the exogenous DNA frame was integrated into *B. dorsalis* genome by “cut and paste” mechanism of *piggyBac*. Finally, the EGFP expression was only detected in the fat body by UV-illumination and immunohistochemical staining, implying that the upstream 2.4-kb region of *Bdyp1* is responsible for regulating the tissue-specific expression of genes.

Key words: *Bactrocera dorsalis*, yolk protein gene promoter, transgenesis, tissue-specificity, green fluorescence protein

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卵生昆蟲中，卵的發育受到營養條件、內分泌激素和類胰島素受器 (insulin-like receptor, InLR) 媒介的訊息傳遞路徑共同調控。本研究，我們利用簡併引子及 5'和 3'端快速放大法 (5' and 3'-rapid amplification cDNA ends, RACE) 分離得東方果實蠅 (*Bactrocera dorsalis*) 之類胰島素受器基因 (*BdInLR*) 部份序列。該序列與黃果蠅 (*Drosophila melanogaster*) 與埃及斑蚊 (*Aedes aegypti*) 等物種之酪胺酸激酶 (tyrosine kinase) 區域之胺基酸序列相似性達 70% 以上，故可判定所增幅之基因應屬於類胰島素受器類群。RT-PCR 的分析結果，顯示此基因於雌雄成蟲初羽化後第一至第三日齡表現皆逐日下降，於第五日齡表現達一高峰，並持續至第九日齡。另外，RNA 干擾 (RNA interference, RNAi) 試驗中，將第四日齡雌成蟲微注射 *BdInLR* 之雙股 RNA，於五日齡時可見卵巢發育明顯受到抑制，並持續至十日齡。上述結果顯示 *BdInLR* 於東方果實蠅卵發育過程中，應扮演著重要地調控角色。

關鍵詞：卵黃生成、東方果實蠅、類胰島素受器、雙股 RNA 干擾

In oviparous insects, egg development is controlled by nutritional condition, hormones and insulin-like receptor (InLR)-mediated signaling pathway. In this study, we report that a partial sequence of putative *InLR*, named *BdInLR*, was identified in *Bactrocera dorsalis*. The deduced tyrosine kinase domain of *BdInLR* shows over 70% identity in comparison with the InLRs of *Drosophila melanogaster* and *Aedes aegypti*. RT-PCR analysis of *BdInLR* expression revealed that *BdInLR* transcript was progressively decreased in day-1 to day-3 male and female adults and elevated again afterward; the greatest expression was reached in day 5 and sustained to end of the observation (day 9). Microinjection of double strand RNA of *BdInLR*, *i.e.*, RNA interference (RNAi), into 4-day-old female adults significantly blocked the ovary development after 24 h and continued to the end of the observation (day 10). These results indicate that the insulin-like receptor might play an important role in regulation of egg development in *B. dorsalis*.

Key words: vitellogenesis, *Bactrocera dorsalis*, insulin-like receptor, double strand RNA interference

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生命條碼 (DNA Barcode) 是目前頗具爭議的熱門話題之一，國際生命條碼組織 (CBOL) 聲稱在 2010 年要收集到五百萬筆資料，而目前為止僅有四十八萬筆，如何在不到 2 年的時間內完成如此多筆的資料，勢必要有更快速更大量的操作技術加以輔佐。在醫學上應用微孔盤來進行大量樣本的操作已經十分盛行，若應用此方法在 DNA 萃取及後續 PCR 複製定序等實驗上，應可加快 DNA Barcode 資料累積的速度。在此，本研究使用自然科學博物館保存的冷凍遺傳物質進行測試。其共蒐藏了 688 種分屬 14 目 108 科的昆蟲標本，以鱗翅目為最大宗有 35 科，其次是鞘翅目有 16 科。大量操作之前先使用 6 個樣本測試不同的純化方式及複製條件；結果顯示，萃取 DNA 時浸泡至隔夜並配合 50°C 的黏合溫度複製效果最佳。目前操作的四盤共 380 個樣本中，主要以夜蛾總科 (157)、蠶蛾總科 (60) 及尺蛾總科 (54) 數量最多，其他尚有螟蛾總科及鳳蝶總科等約 100 餘種。結果顯示目前使用的引子可成功複製出多數鱗翅目的 *coxI* 序列，定序分析顯示科間序列差異大多數坐落在 0.10 到 0.19 之間，且大多數種內沒有差異。

關鍵詞：生命條碼、微孔盤、大量操作、鱗翅目、*coxI*

DNA Barcode is one of the most popular subjects and causes some contentions recently. The Consortium for the Barcode of Life (CBOL) would accumulate five million data in 2010, herein, only 480 thousand data was kept in the database. It is necessary to have more effective technique to collect so many data within less than two years. In medicine field, using the microtiter plate to handle a great deal of samples has been very popular. If we use this method on DNA extraction, PCR amplification, and sequencing, it would be helpful to accumulate the DNA barcodes. The work herein, the insect material stored in National Museum of Natural Science (NMNS) was used to make a microtiter plate application in DNA barcodes. NMNS has stored 688 species of insect belong to 14 orders and 108 families; most of them is Lepidopteran (35 families), and the following is Coleopteran (16 families). Firstly, six samples were used to test the different conditions of DNA extraction and amplification, and result shown that DNA extraction overnight and 50°C annealing temperature will obtain the best amplified efficiency. The optimal condition was undertaken in 380 samples via 4 microtiter plate, and most of them are Noctuoidea (157), Bombycoidea (60), Geometroidea (54), and the others are Pyraloidea, Papilionoidea etc. about hundred species. The result shows that the primers used currently could amplify most of the Lepidoptera *coxI* fragments; sequence divergences among families were ranging from 0.10 to 0.19, and no variation was found among species.

Key words: DNA barcode, microtiter plate, high throughput, Lepidoptera, *coxI*

60 翅痣對蜻蜓 (蜻蛉目：蜻蜓科) 翅膀力學特性之影響
The role of pterostigma in wing mechanics of dragonflies (Odonata, Libellulidae)

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翅痣為昆蟲翅上一增厚且顏色較深的特殊構造，通常位於翅前緣接近末端的部分，因其大小、形態、和相對位置具有種間差異，故通常作為分類依據。時值今日，唯一以翅痣為主題，探討其力學功能的研究指出：以蜻蜓為例，翅痣改變了翅的質量分佈，故可能影響翅的振動特性及昆蟲飛行；然而此說仍無直接數據支持以描述其作用機制。本研究的目的是在於探討翅痣是如何影響蜻蜓翅膀的力學特性。我們以常見的薄翅蜻蜓 (*Pantala flavescens*) 為材料，首先運用掃描式電子顯微鏡觀察翅的剖面，以比較翅痣與翅室厚度之差異。翅痣質量與面積的量測顯示，翅痣僅佔全翅面積的 0.5%，但卻達全翅質量的 2.5%，亦即其面密度為翅平均的五倍之多。為探討翅痣的力學效應，我們比較移除翅痣前後翅膀的振動特性。我們將取下的翅膀膠著於振盪器上，以不同的振盪頻率振動翅膀，並用高速攝影機拍攝翅的振動行為，進而量化其形變量。初步結果顯示，翅痣的有無顯著地影響了蜻蜓翅膀振動的震幅及波形，推測其可能進一步影響了蜻蜓的飛行。

關鍵詞：翅痣、蜻蜓、翅膀振動、高速攝影術、生物力學

Pterostigma is a thickened and darkened region on an insect wing, located distally from the wing base and near the leading edge. Because of interspecific variation in its size, morphology, and related position, pterostigma is often used as a trait for classification. To date, the only study that examined its mechanical function indicates that, in dragonflies, the pterostigma changes the distribution of wing mass, which may change the vibration characteristics of wings and consequently the flight performance. However, no direct empirical evidence has been reported to explain how it works. In this study, we aimed to examine how pterostigma affects the dynamic characteristics of wings in *Pantala flavescens*, a species commonly found in Taiwan. Scanning electron micrographs were taken in order to compare the thickness of pterostigma and wing cell. Direct measurements of pterostigma showed that it accounted for only 0.5% of the wing area, yet more than 2.5% of the wing mass. That is, the pterostigma is five times heavier than the rest of the wing. To examine the effects of pterostigma, we compared the vibration characteristics of complete wings with those without this structure. To this end, each wing sample was cut off from the thorax and glued onto an oscillator that provided different frequencies to vibrate the wing. High-speed videocamera was used to record the behavior of the vibrating wing, from which we could quantify its deformation. Preliminary results reveal that the existence of pterostigma changes the wave amplitudes and shapes of a flapping wing, which implies a functional consequence in dragonfly flight.

Key words: pterostigma, dragonfly, high-speed videography, wing vibration, biomechanics

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豆莢螟屬於鱗翅目螟蛾科 (Lepidoptera:pyralidae)，是嚴重危害豆科植物的主要害蟲。豆莢螟核多角體病毒 (*Maruca vitrata* multiple nucleopolyhedrovirus, MaviNPV) 是由罹病的豆莢螟幼蟲分離而得，與加州苜蓿夜蛾核多角體病毒 (AcMNPV) 在基因體有極高度的相似性，且部份同源性基因相似度達100%。本研究主要探討MaviNPV經過繼代培養後，在宿主細胞 (NTU-MV) 與非宿主細胞 (Sf9) 中感染能力的變化；另外探討AcMNPV是否會輔助MaviNPV感染Sf9細胞。初步比較第一代病毒與第五代病毒感染宿主與非宿主細胞中所產生的封埋體數量。結果顯示在宿主細胞第一代產生封埋體為6.28個/cell，第五代病毒產生封埋體為6.64個/cell，而在非宿主細胞第一代產生封埋體為0.06個/cell，第五代病毒產生的封埋體為2.22個/cell，證實多次繼代培養後在宿主細胞的封埋體產量無顯著差異，但在非宿主細胞中則明顯上升。本研究亦發現少量AcMNPV可輔助MaviNPV感染Sf9細胞，AcMNPV在低效價 (m.o.i. = 0.1) 與MaviNPV共同感染Sf9細胞，會輔助第一代MaviNPV在Sf9細胞產生封埋體1.12個/cell，但當效價提高到m.o.i. = 1時，封埋體數量反而下降至0.35個/cell；同樣條件下，在第五代MaviNPV試驗結果，AcMNPV之m.o.i. = 0.1時輔助MaviNPV在Sf9細胞產生封埋體數量為15.63個/cell，m. o. i.提高到1時，封埋體數量反而下降至4.12個/cell。

關鍵詞：豆莢螟、豆莢螟核多角體病毒、加州苜蓿夜蛾核多角體病毒、封埋體、繼代效應

Legume pod borer (LPB), *Maruca vitrata* (syn.*M.testulalis*) (Lepidoptera: Pyralidae) is the most serious insect pest of legume crops. A nucleopolyhedrovirus, *Maruca vitrate* multiple nucleopolyhedrovirus (MaviMNPV), was isolated from diseased larvae of LPB. The genomic profile of MaviNPV have the highest similar to that of *Autographa californica* multiple nucleopolyhedrovirus (AcMNPV). The similarity of several homologous genes shared by both MaviNPV and AcMNPV appeared to be 100%. In this study, we examined the passage effect on infective efficiency of MaviNPV in permissive cell (NTU-MV) and non-permissive cell (Sf9). In addition, we suspected that some component of AcMNPV facilitated the infection of MaviNPV on Sf9 cells. The comparison of occlusion bodies (OBs) production generated by 1st passage and 5th passage of MaviNPV was conducted on both NTU-MV and Sf-9 cells. The results showed that OBs yield by 1st generation of MaviNPV was 6.28 OBs / cell while it was 6.64 OBs / cell produced by 5th generation in NTU-MV cells. In the Sf-9 cells, OBs yield by 1st passage of MaviNPV was 0.06 OBs / cell while it increased to 2.22 OBs / cell produced by 5th passage of MaviNPV. These data indicated that the yield of OBs generated by 1st and 5th passage of MaviNPV on NTU-MV cells was not significant, however, the OBs generated by 5th passage virus was more than 1st passage of MaviNPV when these viruses infected Sf9 cells. In this study, we also demonstrated that low titer of AcMNPV could assist the infection of MaviNPV on Sf9 cells. MaviNPV and AcMNPV (m.o.i. of 0.1) co-infection on Sf9 cells resulted in producing 1.12 OBs / cell, although the OBs yield decreased to 0.35 OBs / cell with AcMNPV at m.o.i. of 1.0 by 1st passage of MaviNPV. Upon the similar condition instead of using 5th passage of MaviNPV, the OBs yield increased to 15.63 OBs / cell with AcMNPV (m.o.i. of 0.1) co-infection, and only increased to 4.12 OBs / cell with AcMNPV (m.o.i. of 0.1) co-infection.

Key words: Legume pod borer (LPB), MaviNPV, AcMNPV, occlusion body, passage effect

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雙翅目瘿蚋科為主要的造瘿昆蟲，台灣常見的壺狀蟲癭即是由雙翅目瘿蚋科所誘發的植物瘿，著生於寄主植物葉背，可發現於香楠、日本槿楠、霧社槿楠三種樟科槿楠屬植物上，蟲癭綠色，表面被覆一層白色臘狀物質，壺身具有數條縱走之稜突，壺口內陷，蟲癭基部有一短柄和葉片連接，蟲癭內部具有單一蟲室，內有瘿蚋幼蟲一隻。壺狀造瘿瘿蚋生活史為一年一代，成蟲羽化時間集中於三~四月，交配後於寄主植物嫩芽產卵，一齡幼蟲孵化後鑽進葉肉組織進入休眠，於九月時開始快速發育，同時刺激寄主植物葉肉組織形成蟲癭，三齡老熟幼蟲於蟲癭內化蛹，於隔年三~四月羽化。由於幼蟲飼育難度高以及成蟲不易獲得，分類研究迄今闕如，僅有幼蟲以及蛹之形態描述。造瘿瘿蚋具有高度寄主專一性，曾被利用為植物分類之依據，而著生於上述三種槿楠屬植物之壺狀蟲癭，瘿體形態近似，造瘿瘿蚋尚未有完整描述與鑑定，本研究擬於台灣各地區採集香楠、日本槿楠、霧社槿楠之壺狀蟲癭，藉由比較蟲癭以及造瘿瘿蚋形態特徵，探討 (1) 在三種寄主植物上造瘿瘿蚋是否為不同種？(2) 香楠與霧社槿楠較近緣，其上的瘿蚋是否也反映相似的親緣關係？目前由三種槿楠屬寄主植物之壺狀蟲癭已飼育出成蟲，經初步比較蟲癭形態後，結果顯示三種寄主植物之壺狀蟲癭互有差異，是否亦反映在成蟲形態差異上，為本研究探討的主題。

關鍵詞：瘿蚋、壺狀蟲癭、槿楠屬植物、寄主專一

The gall midge (Diptera: Cecidomyiidae) is one of the major galling groups. The urn-shaped gall induced by gall midges on *M. zuihoensis* var. *zuihoensis*, *M. japonica* var. *japonica* and *M. zuihoensis* var. *mushaensis* (Laurance: *Machilus*) are common in Taiwan. The urn-shaped galls grow on the under side of leaf which have several longitudinal ridges. The gall surface is smooth the color is green in general, and covered with a layer of whitish wax. A short stalk connects the gall to the leaf of host plant. A single cylindrical larval cavity with one larva inside the gall could be found. The life history of urn-shaped gall-inducing insect is univoltine. The short adult life span and the difficulty in obtaining adults by rearing larvae may explain the reason why little taxonomic work has been done for the group. Galling midges reveal an extremely high host specificity and sometimes used for host identification. The morphology of galls on the above-mentioned three *Machilus* species is similar but the midge has not been examined. The aims of this study are (1) Do urn-shaped galls on different plants, i.e. *M. zuihoensis* var. *zuihoensis*, *M. japonica* var. *japonica* and *M. zuihoensis* var. *mushaensis* represent different species? (2) *M. zuihoensis* var. *zuihoensis* and *M. zuihoensis* var. *mushaensis* is relatively close. Do urn-shaped galls on those two plants are more similar to each other than to the other host? We have successfully reared the adult gall midges from the three *Machilus* plants. A comparison of the gall morphology on the three hosts shows differences among them. Whether the morphology of the gall midge also reveals the same pattern of differences is the theme of current study.

Key words: gall midges, urn-shaped gall, *Machilus*, host specificity

63 取食地上與地下部植食昆蟲間的交互作用：

黃條葉蚤取食後之蘿蔔對斜紋夜盜蛾生長表現的影響

Interactions between above- and below-ground insect herbivores: Performance of *Spodoptera litura* on radish plants previously fed by *Phyllotreta striolata*

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本研究探討植物的不同部位被植食昆蟲取食後，造成植物體內的化學成分改變，進而影響後續取食的植食昆蟲之生長表現。以蘿蔔 (*Raphanus sativus* L.) 為實驗植物，使用黃條葉蚤 (*Phyllotreta striolata*) 分別或同時取食蘿蔔的地上 (葉) 與地下 (根) 部分，共分成四種處理組：(1) 地上部傷害 (2) 地下部傷害 (3) 地上及地下部均傷害 (4) 無傷害組。分別取各組蘿蔔葉片餵食斜紋夜盜蛾 (*Spodoptera litura*) 三齡幼蟲，分析其生長表現。結果顯示，不論傷害處理部位為何，取食有傷害處理的葉片，均會使幼蟲的消耗食物轉換率 (ECI) 顯著低於無傷害組。地下部傷害組之幼蟲的相對生長速率 (RGR)，為四組處理中最低。至於幼蟲的消化效率 (AD)、消化食物轉換率 (ECD)、總消耗量 (TC) 及相對消耗速率 (RCR)，於四組處理間均無顯著差異。同時分析各處理組葉片的營養與防禦性化學物質含量，營養物質的結果顯示，地下部傷害處理的葉片，其含水量顯著低於無傷害組。有傷害處理的葉片，不論傷害處理部位為何，其蛋白質含量均顯著低於無傷害組。可溶性碳水化合物含量於四組間無顯著差異。至於防禦性物質的結果顯示，在地上或地下部傷害組葉片的黑芥籽油 (sinigrin) 含量，顯著高於其他兩組；但多酚氧化酵素 (polyphenol oxidase) 含量於四組間無顯著差異。整體而言，本研究指出植食性昆蟲對植物造成不同部位的傷害，會改變植物體內營養與防禦性化學物質的含量，進而影響後續取食該植物的植食昆蟲之生長表現。此種交互作用推測應與植物的能量分配與利用有關。

關鍵詞：地上與地下部植食作用、植物誘導反應、蘿蔔、黃條葉蚤、斜紋夜盜蛾

This study investigates the effects of different feeding ways on plants' induced chemical contents, and on performance of subsequent insect herbivore which fed on these plants. Radish, *Raphanus sativus* L., was used as the test plant, and flea beetles, *Phyllotreta striolata*, were fed on leaves (above-) and/or roots (below-ground) of the radish. There were four treatments in our design, (1) above-ground injury, (2) below-ground injury, (3) above- and below-ground injury, (4) no injury. Analyzing the growth performance of third-instar *Spodoptera litura* fed with the leaves of the four treatments, respectively. The efficiency of conversion of ingested food of *S. litura* fed with injury treatment leaves were significantly lower than no injury, no matter where the injury was. The relative growth rate of *S. litura* with below-ground injury treatment was the lowest in all treatments. However, the approximate digestibility, efficiency of conversion of digested food, total consumption, and relative consumption rate of *S. litura* were not different among treatments. We also analyzed the nutritional and defensive chemical contents of leaves of all treatments. The water content of leaves with below-ground injury treatment was significantly lower than that of no injury. The protein content of leaves with injury treatment was significantly lower than that of no injury, no matter where the injury was. However, the content of soluble carbohydrates was not different in all treatments. The sinigrin content of leaves with above- or below-ground injury treatment were significantly higher than those of other treatments. However, the content of polyphenol oxidase was not different in all treatments. Overall, this study indicated that plants damaged by different insect herbivores fed on various sites will change the nutritional and defensive chemical contents of plants, and host plant chemistry will affect the growth performance of the later insect herbivore. We predicted this interaction may relate to the energy allocation and utilization of the plants.

Key words: above- and below-ground herbivory, induced plant chemistry, *Raphanus sativus* L., *Phyllotreta striolata*, *Spodoptera litura*

64 源自鱗翅目最小的核多角體病毒—豆莢螟核多角體病毒上的一個新穎基因 (*orf74*)
A novel gene (*orf74*) found in the smallest lepidopteran nucleopolyhedrovirus, *Maruca vitrata*
nucleopolyhedrovirus

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於2007年從罹病的豆莢螟幼蟲上分離出的核多角體病毒，命名為豆莢螟核多角體病毒 (*Maruca vitrata* nucleopolyhedrovirus, MaviNPV)，此病毒的基因體大小僅有111,953 bp其中包含126個開放譯讀區 (open reading frame)，是現今發現源自鱗翅目最小的核多角體病毒。豆莢螟核多角體病毒上除了第74個開放譯讀區 (*orf74*) 外，其餘的125個開放譯讀區皆可在加州首蓓夜蛾核多角體病毒 (*Autographa californica* multiple NPV, AcMNPV) 找到同源的基因，且其同源基因的相似度皆很高。此基因 (*orf74*) 雖在AcMNPV上無同源基因，但利用網路上序列比對系統發現和 *Chrysodeixis chalcites* NPV的*orf34*、*Orgyia pseudotsugata* MNPV的*orf98*及*Mamestra configurata* NPV-A的*orf28*為同源，但胺基酸的相似度也僅有21~26%。尤於*orf74*基因在基因庫內的同源基因少而且功能未知，值得去探究其在病毒中所扮演的角色。*orf74*長度為675個核苷酸，可轉譯出224個胺基酸，五端的未轉錄區 (5' UTR) 段有61個核苷酸，三端的未轉錄區段 (3' UTR) 有27個核苷酸；以即時定量聚合酶連鎖反應 (real time PCR) 可得知，RNA在病毒感染後第二小時即有微量表現，但在感染後第72小時表現達最高量；蛋白質則是在病毒感染第48小時後才能以自製的ORF74抗體偵測到，感染後第72小時亦達最高量；利用ORF74和多角體蛋白抗體同時以免疫螢光偵測，可發現ORF74 主要分佈在細胞質蛋白質，尤其位在核膜邊緣；有時亦發現ORF74與多角體蛋白表現處重疊。其確切的機能需進一步將此基因剔除或大量表現之後才能確定。

關鍵詞：豆莢螟核多角體病毒、新穎基因、*orf74*

A new virus was isolated from the infected *Maruca vitrata* larvae with nucleopolyhedrovirus and named *M. vitrata* nucleopolyhedrovirus (MaviNPV). MaviNPV is the smallest lepidopteran NPV, its size is 111,953 bp and consists of 126 open reading frames (ORF) only. MaviNPV has 125 homologous genes found in *Autographa californica* multiple NPV (AcMNPV), except *orf74*. However, *orf74* is homologous to *orf34*, *orf98* and *orf28* in *Chrysodeixis chalcites* NPV, *Orgyia pseudotsugata* MNPV, and *Mamestra configurata* NPV-A, respectively. Whereas the identities in the amino acid sequences of these viral genes are only around 21 to 26%. In addition, a few homologous gene of *orf74* in GenBank are found and the function of *orf74* is still unknown. The main purpose of this study is to analyze the role of *orf74* in MaviNPV. The *orf74* consists of 675 base pairs, and encodes a protein with 224 amino acids. The 5' and 3' untranslated regions (5' and 3'UTR) contain 61 and 27 base pairs, respectively. The transcription of *orf74* was first detected at 2 hours postinfection (hpi) and the highest amount at 72 hpi. The ORF74 was detected at 48 hpi and the highest amount at 72 hpi by the prepared ORF74 antibody. By the indirect fluorescent immunoassay with ORF74 and POLHEDRIN antibodies, the location of ORF74 in the infected cells was found mainly in cytoplasm, especially around the nuclear membrane, also overlapped occasionally with the expression site of POLHEDRIN. The function of ORF74 needs to be confirmed by the methods of gene silencing and overexpression in the future.

Key words: *Maruca vitrata* nucleopolyhedrovirus, MaviNPV, novel gene, *orf74*

65 西藏翠蛺蝶複合群之系統分類研究
Systematics and phylogeny of *Euthalia thibetana* species complex (Lepidoptera: Nymphalidae)

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西藏翠蛺蝶複合群 (*Euthalia thibetana* complex) 為蛺蝶科 (Nymphalidae) 翠蛺蝶屬 (*Euthalia*) 之中大型蝶種，包括西藏翠蛺蝶 (*E. thibetana*)、台灣翠蛺蝶 (*E. formosana*)、鋸帶翠蛺蝶 (*E. alpherakyi*)、波紋翠蛺蝶 (*E. undosa*) 與窄帶翠蛺蝶 (*E. insulae*)。此複合群種間鑑定常以翅紋等外部形態進行辨識，但初步研究發現翅紋變異極大，難以作為可靠的辨識依據，因此造成此複合群種類辨識混亂。本研究期以粒線體 DNA COI 及 COII 序列資料為初步分群基礎，再加入雄蝶交尾器形態特徵，以重建此複合群種間親緣關係。目前分子序列的初步結果顯示此複合群可分為六群，未來擬加入交尾器的形態比較，進一步釐清此六群間的關係。

關鍵詞：西藏翠蛺蝶、複合群、親緣關係、翠蛺蝶族、粒線體 DNA

The members of *Euthalia thibetana* complex, including *E. thibetana*, *E. formosana*, *E. alpherakyi*, *E. undosa*, and *E. insulae*, are often identified using wing pattern. However, after examining a good series of specimens, it turns out that the wing pattern shows high degree of variation, making the identification of specimens unreliable. The present study attempts to solve the problem by reconstructing phylogeny of *Euthalia thibetana* complex based on sequence data of COI and CO II gene. Morphological characters of male genitalia will also be added to the dataset for a combined analysis. Preliminary result of molecular sequences shows that 6 groups may be recognized in this species complex. Future work would involve adding the morphological characters of male genitalia to clarify the relationship of the 6 groups.

Key words: *Euthalia thibetana*, species complex, phylogeny, Euthaliini, mitochondrial DNA

66 雙翅目瘿蚋科 *Daphnephila* 屬 ambrosia 瘿於樟科槲楠屬植物之發育與生態學
Development and biology of *Daphnephila* spp. (Diptera, Cecidomyiidae) in the ambrosia galls of
Machilus plants (Lauraceae)

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蟲瘿是造瘿昆蟲誘發植物所導致的變形產物，它提供造瘿昆蟲幼期保護的避難所及獲取營養的空間。有些蟲瘿內長有真菌，且造瘿昆蟲以真菌為食而非瘿組織，此類蟲瘿被稱為 ambrosia 瘿。而造瘿昆蟲、真菌和寄主植物形成三個營養層的交互作用。在台灣近年來發現，瘿蚋在紅楠所造的蟲瘿為 ambrosia 瘿，其中有五種不同形態的蟲瘿，分別為鼠狀、鳥頭狀、棒狀、倒卵形和砲彈狀，且每一類蟲瘿的造瘿者皆為 *Daphnephila* 屬的不同種瘿蚋。由 *D. ornithocephala* 所形成的鳥頭狀蟲瘿內之真菌首先被確認為 *Botryosphaeria dothidea* (Ascomycotina: Botryosphaeriales: Botryosphaeriaceae)。進一步分析發現，這五種形態不同的蟲瘿中的真菌均屬於同一種真菌。如果蟲瘿類型是造瘿昆蟲表型的延伸，那麼根據瘿蚋的系統發生，紅楠 *Daphnephila* 蟲瘿類型可分為 1) 原始型-*D. truncicola* (砲彈狀)，2) 中間型-*D. taiwanensis* (鼠狀) 和 3) 衍生型-*D. sueyanae* (倒卵形)、*D. ornithocephala* (鳥頭狀) 和 *D. stenocalia* (棒狀)。由於營養利用為蟲瘿適應假說中最被接受的想法，則蟲瘿的演化程度可能反映其營養利用，我們藉由蟲瘿的能量分析，探討其能量的分布是否與其演化類型一致。結果顯示，棒狀蟲瘿的卡洛里值相對於其他形狀的蟲瘿較高，顯示後期演化出來的蟲瘿結構組織較原始的蟲瘿含有較高的能量。進一步探討各類型蟲瘿組織的差異，藉由連續石蠟切片可以瞭解此五種形態的蟲瘿是否在組織結構有所差異。此外，本研究擬進一步探討的問題尚有：真菌與 *Daphnephila* 之間的關係究竟為何？瘿蚋與真菌之間為絕對或偶發的關係？此類瘿蚋在營養階層上扮演何種角色？是以真菌為食或瘿組織為食？*Daphnephila* 是否具有具有 mycangia (攜帶孢子的特殊結構)，以利將孢子帶入蟲瘿內？若有，其構造和功能為何？

關鍵詞： ambrosia gall、瘿蚋科、槲楠屬、蟲瘿組織、能量

Insect-induced galls are the deformation of plants initiated by insects providing shelters for immature insects to acquire nutrition and protection to develop. In some cases, fungi are involved in the play and the gall inducing-insects feed on the fungi rather than gall tissue. These galls are called ambrosia galls, and the galling insect, fungus and host plant form a tritrophic interaction. In Taiwan, the midge galls on *Machilus thunbergii* were diagnosed as ambrosia galls recently and represented by five different types: such as ovoid, swan-shaped, banana-shaped, obovate and spindle-shaped galls and each represents different species of *Daphnephila*. The fungal taxon associated with the swan-shaped galls induced by *D. ornithocephala* has been determined as *Botryosphaeria dothidea* (Ascomycotina: Botryosphaeriales: Botryosphaeriaceae). Further analyses suggest that the fungi associated with the five different galls on *M. thunbergii* are belonging to the same species. If the type of gall is an extension of galling-insects' phenotype, three clades could be identified according to their phylogeny of *Daphnephila* 1) the primitive-*D. truncicola* (spindle-shaped gall), 2) the mediate- *D. taiwanensis* (ovoid gall) and 3) the derived- *D. sueyanae* (obovate gall), *D. ornithocephala* (swan-shaped gall) and *D. stenocalia* (banana-shaped gall). Since nutrition hypothesis is the most plausible one, the degree of evolution may reflect the utilization of nutrition. We analyze the energy of different types of galls to understand whether there is a concordant pattern of evolution in their energy use. The data show that the energy of banana-shaped gall is relatively higher than others. It indicates that the gall of derived groups contains higher energy than the other two. Further examination of gall tissue by paraffin sectioning will answer the question whether the structure of different galls have various differentiation. Other questions could be addressed including: What are the

relationships between the ambrosia fungus and the *Daphnephila* galls? Are they obligate or facultative? What is the role in nutritional level of *Daphnephila*? Whether the gall midges feed on fungus or gall tissue? Are there micangia, a specific structure carrying spores, in *Daphnephila* to carry the spores? If so, what are their structure and function?

Key words: ambrosia gall, cecidomyiidae, *Machilus* spp., gall tissue, energy

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抗氧化功能被廣泛認為是蜂膠的眾多藥理作用之一，在世界各地及台灣各類蜂膠萃取物同樣也展現抗氧化的能力。例如咖啡酸衍生物 caffeic acid phenethyl ester (CAPE) 無論在細胞培養或活體實驗中，其均可降低細胞因自由基過載所導致的氧化傷害。不過我們卻發現 CAPE 本身除了抗氧化功能外，亦會促使自由基的產生。如此蜂膠的主成分卻具有抗氧化及促氧化傷害細胞的特性，這使得蜂膠的使用在保健或醫療上可能潛藏隱憂。為了剖析 CAPE 對於自由基調控的正體，我們觀察不同劑量的 CAPE 對於人類細胞株各個時間點胞內自由基量的變化，在 CAPE 處理下自由基隨著時間經過會逐漸下降，但在 2 小時後又會使自由基量上升而最後產生氧化傷害，結果顯示 CAPE 在早期具有抗氧化的功能；在晚期則會反轉為促氧化的角色，而這樣的現象跟處理劑量沒有太大的關聯，反而處理時間才是關鍵的因子。進一步釐清其中的機制，我們發現 CAPE 會誘發抗氧化蛋白 heme-oxygenase 1 (HO-1) 的表現，此可解釋 CAPE 抗氧化的現象，但在晚期，CAPE 所引起 HO-1 的表現則呈現過量狀態，而促使細胞鐵離子濃度失衡，過多的游離鐵離子易與過氧化氫作用而生成具有高度破壞性的氫氧自由基，進而造成氧化壓力與細胞凋亡。當 HO-1 的活性被專一拮抗劑抑制後，我們不僅發現 CAPE 在晚期所造成細胞毒性與細胞凋亡減低，其同時也遮蔽了 CAPE 抗氧化及促氧化的雙重效應，由此可見 HO-1 確實在 CAPE 對於細胞自由基的載覆性扮演重要的角色。鑑於上述諸果，在利用蜂膠於研究或保健上的抗氧化應用應更行謹慎。

關鍵詞：蜂膠、自由基、抗氧化、促氧化、細胞凋亡

Propolis has been used as a folk medicine for centuries and as a health-care food recently. Antioxidant nature of propolis is considered as one of many well-known bioactivities. Many flavonoids including caffeic acid phenethyl ester (CAPE) isolated from propolis exhibit antioxidant ability. However, our preliminary observations have found that CAPE may be also a pro-oxidant, which stands opposite to what people think it used to be as an antioxidant. In this communication, we uncover that CAPE can possess both anti- and pro-oxidant effects. CAPE acted as an antioxidant to lower down intracellular reactive oxygen species (ROS) level in an acute treatment, whereas it shifted to a pro-oxidant during chronic treatment afterward and induced oxidative stress, in which the concentration of CAPE dose was independent to the transformation of dual roles. Time-dependent expression of heme-oxygenase 1 (HO-1) induced by CAPE played a key role in double-edged effect of CAPE. In acute treatment, appropriate HO-1 behaved as antioxidant to maintain low background of intracellular ROS level; in chronic condition, a disorder highly-expressed HO-1 caused intracellular iron overloading, which led to formation of hydroxyl radicals and caused severe cytotoxicity. While activity of HO-1 was arrested, CAPE-induced ROS alteration and cytotoxicity were both buffered. This communication shows the major ingredient of propolis, CAPE, behaving as not only an antioxidant but also a pro-oxidant. Based on the complicated effects on ROS regulation, it should be punctilious in usage of propolis.

Key words: propolis, caffeic acid phenethyl ester, antioxidant, reactive oxygen species, heme-oxygenase

1

68 華夏粗針蟻運用成體搬運行為形成最佳化覓食策略之研究
Application of adult transport to optimal feeding strategy of the Asian needle ant,
Pachycondyla chinensis

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華夏粗針蟻 (*Pachycondyla chinensis*) 屬於針蟻亞科 (Ponerinae) 粗針蟻屬 (*Pachycondyla*)，其聚落偏好分佈於陰暗、潮濕且具大量落葉層及腐植質之地表土壤環境。經由行為譜 (ethogram) 的分析得知，華夏粗針蟻之有后聚落 (queenright colony) 職蟻間分工嚴謹，且部分亞階級具有成體搬運行為 (adult transport)，並將此行為應用於覓食過程中，產生一特殊角色—搬運者 (porter)。結果顯示，當巢外食物量較少，產生成體搬運行為比例降低。在聚落處於飢餓的情況下，搬運者數量增加，且被搬運者 (portee) 成為搬運者之機率亦提升，說明其單態型職蟻之角色可迅速轉換。另外，當食物與蟻巢距離超過 25 公分，搬運者產生之機率亦隨之下降。若將搬運者於覓食過程中移除，其覓食職蟻數量減少，取食效率亦隨之降低。藉由公式的推算，模擬其成體搬運行為，可縮短總體覓食距離，減少聚落總能量的消耗，以利其達成最佳化覓食。

關鍵詞：華夏粗針蟻、成體搬運行為、搬運者

The Asian needle ant, *Pachycondyla chinensis*, belongs to genus *Pachycondyla* of subfamily Ponerinae, and its colony usually exists in dark and damp surface soil with decayed defoliation. Analyzing the behavior of *P. chinensis* with the ethogram, we knew *P. chinensis* expressed strict division of labor in the queenright colony, and some subcaste workers showed adult transport applied for feeding. As the result, a special character, porter, produced. The study shows that the less food outside the colony is, the lower proportion of adult transport will have. In starvation condition, with the increasing of porters, the proportion that portees change into porters will rise, which explains unitary roles of workers can be changed fast. Moreover, when the food is more than 25 cm away from the nest, the proportion of producing porters will reduce. If we move porters away from the process of feeding, the efficiency of getting food will decrease as well. We simulated adult transport expressed or non-expressed by the formula, discovering they could shorten all distances of feeding, and reduced the consumption of energy of the colony, which is beneficial to achieve optimal feeding strategy.

Key words: *Pachycondyla chinensis*, adult transport, porter

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襉翅目為半行變態之水棲昆蟲，俗稱石蠅。稚蟲為乾淨溪流的指標生物，多棲息於低水溫、高溶氧、流速快的水域中。然而，尚無相關研究針對目級以下各分類群的微棲地利用做一探討。本研究期以排序技術分析石蠅稚蟲群聚與微棲地因子的相關性。在太魯閣國家公園境內的砂卡礑溪以微棲地尺度進行稚蟲採集，並測量各項環境因子（水文條件、水質、底質組成等共 17 項變因），調查期間從 2008 年 3 月到同年 8 月，所採石蠅稚蟲個體鑑定出 4 科 6 屬共計 1132 隻。資料分析先以降趨對應分析檢視第一軸軸長梯度後，再採用典型對應分析探討各分類群的棲地利用。分析結果中，前兩軸組成與非穩固大型底質（受水流沖刷移動，粒徑 > 256 mm 的底質）、凋落物乾重（取 > 15 mm 葉片）、穩固大型底質（岩床，粒徑 > 256 mm 的底質）、中型底質（64~16 mm）、流速、小型底質（16~2 mm）等等棲地因子有較高的相關性。表示這些因子為影響各分類群的棲地利用與群聚結構的重要因子。而排序圖則顯示，短尾石蠅科的球尾石蠅屬、頸鰓石蠅屬豐量與非穩固大型底質、凋落物乾重有高度的正相關。扁石蠅科的端刺石蠅屬豐量與穩固大型底質、底質露出水面比例有高度正相關。石蠅科的新石蠅屬、節石蠅屬、刺石蠅科的刺石蠅屬豐量則與中、小型底質（64~16 mm, 16~2 mm）有高度正相關。本研究初步結果顯示在同科級內的分類群中，對於環境棲地的利用較為一致，不同科級間對於棲地條件的利用則不同，但仍需更長時間的調查資料，以呈現較完整的趨勢。

關鍵詞：砂卡礑溪、水棲昆蟲、襉翅目、微棲地、排序技術

Plecoptera, commonly called as stoneflies, is a hemimetamorphic order of aquatic insects whose nymphal stage lives in cold, fast-flowing waters with high dissolved oxygen content. Related study on the patterns of various microhabitat uses by stonefly assemblage of the taxonomic hierarchy below the Order have not been documented and further research is needed. The present study aims to find out the relationship between stonefly taxa and environmental variables in Shakadang Stream by employing ordination techniques. Micro-habitat scales were used in the study process and environmental factors in each plots (17 variables, such as water regime, water quality and substrate structure, etc.) were monitored. Surveying periods started from Mar to Aug in 2008 and 1132 sampling individuals from 6 genera in 4 families were identified. After checking the data by DCA, CCA was used to analyze the habitat uses of the stonefly taxa. The results of the first two axes of CCA showed that the change of stonefly structure correlated with environmental variables such as: unstable large-size substrate (unmovable, size > 256 mm), leaf litters, stable larger-size substrate (movable by current, size > 256 mm), middle-size substrate, current velocity and small-size substrate, etc. In the ordination graph, the abundances of *Spheronemoura* and *Amphinemura* (Nemouridae) were found having a positive correlation to stable larger-size substrate and leaf litters. Abundance of the *Cryptoperla* (Peltoperlidae) are positively correlated with stable larger-sized substrate and area of exposed substrate. Abundances of *Neoperla*, *Paragnetina* (Perlidae) and *Cerconychia* (Styloperlidae) are positively correlated with middle- and small-size substrates. The results show that stonefly assemblage within the same family has similar habitat uses while nymphs of different families have distinct habitat uses. But supportive data from a long-term survey is still needed to reveal a fuller picture.

Key words: Shakadang Stream, aquatic insects, Plecoptera, habitat use, ordination techniques

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熱帶火蟻 (*Solenopsis geminate*) 是多年前便已進入台灣的外來種，和近年來的入侵紅火蟻 (*Solenopsis invicta*) 都為目前重大有害入侵物種，對於經濟和生物多樣性破壞甚大。熱帶火蟻和入侵紅火蟻族群數量多，有著密實的巢穴構造，常使用毒液於防禦、捕捉獵物和消滅巢內的細菌、微生物，其毒液是自毒囊到螫針分泌而出。本試驗利用細胞核染色及組織切片，觀察熱帶紅火蟻以及入侵紅火蟻的毒囊構造。發現這兩種火蟻的毒囊形狀非常相似，皆為橢圓形的球體外型，且均分為兩個部份，其一為位於毒囊內部一側的圓形黃色囊狀構造，其二為位於毒囊外的兩根小管構造，並發現兩根小管末端有插入於螫針肌肉組織的現象。另外，利用 DAPI 進行毒囊構造細胞核染色，可觀察到細胞核隨機地分佈於毒囊表面、毒腺、以及與毒腺相連的細管內，其中毒腺有著密實的膜細胞包覆，使得 DAPI 無法進入，在冷凍切片後才得以染色。聚丙烯胺膠體電泳顯示，螫針所分泌的毒液蛋白質與毒囊內液體的蛋白質相似，證實了毒液蛋白質確實儲存在毒囊內。

關鍵詞：火蟻、毒腺系統、SDS-PAGE 蛋白質電泳分析、毒液蛋白質

The tropical fire ant (*Solenopsis geminate*) was many years ago then entered Taiwan's invasive alien species, with the recent years red imported fire ant (*Solenopsis invicta*) all for the important invasive insect species. It seriously impacts the economy and biodiversity. The tropical fire ant and red imported fire ant are many quantities of group, and has the dense nest structure, often uses the venom to defend, capture and to eliminate nest bacterium, the microorganism. The venom is from the poison sac to the sting secretion. This experiment use dyeing cell nucleus and tissue slice, observe both of the fire ant are similar in the poison gland system, with the spheroid outlook, and divides two parts. One is yellow round shape to located one side in the poison sac interior. Another is two tubes located outside the poison sac, and discovered two tube terminal have insertion in the sting muscular tissue. The poison gland system is using DAPI to dye cell nucleus, and observe the cell nucleus to distribute stochastically in the poison sac surface, the poison gland, as well as with the poison gland connected narrow tube. The poison gland has the dense cell membrane, causes DAPI to be unable to enter, only to dye after the freezing slice. The SDS-polyacrylamide gel electrophoresis displayed the protein is similar between sting to secrete venom and poison sac liquid. In this test to prove the venom protein stored up in the poison sac.

Key words: fire ant, poison gland system, SDS-polyacrylamide gel electrophoresis, venom Protein

71 本土白殭菌 (*Beauveria bassiana*) 耐高溫及紫外光菌株之生理特性
Physiological characters of high temperatures and ultraviolet light tolerant strain of *Beauveria bassiana*

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本研究探討蟲生真菌白殭菌 (*Beauveria bassiana*) 耐高溫及紫外光之菌系的生理特性。本實驗選用五株白殭菌菌株 (1×10^8 conidia/ml)，取 10 ml 孢子懸浮液先置於溫度 30°C 下，爾後每 24 hr 升溫 5°C 至 50°C 止，每個溫度皆取出 100 μ l 之孢子懸浮液，培養於 SDA 固體培養基中 7 天，進行耐溫試驗。結果顯示於 35°C 以下皆會生長但非 50°C，45°C 下僅菌株編號 35547 及 Ho212 會生長，產孢量分別為 1.8×10^6 及 1.0×10^6 conidia/ml，表示菌株編號 35547 及 Ho212 在不良溫度條件下較具耐受性。將之經紫外光 (UV-C) 照射，以 1% 存活率進行誘變，篩選可耐高溫 (35°C) 之菌落，並長期培養於 35°C 恆溫箱中，比較未誘變及誘變之菌株其生理特性之差異性，並初步以隨機複製多型性 (Random Amplified Polymorphic DNA, RAPD) 技術，觀察經紫外光誘變的菌株孢子染色體 DNA 是否具自行修復能力。結果顯示發芽率在第 8 及 16 hr 時，誘變株較非誘變株提早發芽，且發芽率具顯著差異；但 24 hr 後，發芽率皆達 99%，並無顯著差異。在幾丁酶酵素活性檢測上，未誘變及誘變株在第 4 天後皆可觀察到作用圈，Ho212 菌株誘變較非誘變之作用圈大，培養至第 12 天測得之作用圈皆無顯著差異；在 API ZYM 測試上，未誘變及誘變之菌株均未測到胰蛋白酶 (Trypsin)、 β -葡萄糖醛酸酶 (β -Glucuronidase)、 α -葡萄糖苷酶 (α -Glucosidase) 及 α -甘露糖苷酶 (α -Mannosidase)，Ho212 皆無測得 α -胰凝乳蛋白酶 (α -Chymotrypsin)，而其他酵素活性則有反應，只是活性呈現強弱差異；在 SDA 培養於 6 種溫度測試上，25°C 生長速率及產孢量最佳，其中誘變之 Ho212 較非誘變之菌株及 35547 菌株為佳，且四者均有顯著差異；在糙米太空包培養於 25°C 恆溫箱內 30 天，測試結果未誘變及誘變之菌株皆可達 1.0×10^8 spores/g，無顯著差異；經紫外光誘變處理下所取得之菌株，其染色體 DNA 以 9 組引子進行 RAPD 反應之帶型，與未經誘變處理者相同，顯示菌株編號 35547 及 Ho212 皆可自行將受損之染色體 DNA 修復之能力。

關鍵詞：白殭菌 (*Beauveria bassiana*)、耐高溫、耐紫外光、生理特性

These studies were to investigate the physiological characters of high temperature and ultraviolet tolerant strain of *Beauveria bassiana*. Ten ml of five isolates of *B. bassiana* (1×10^8 conidia/ml) were placed at 30°C for incubation, 5°C was increased 24 hr later, to 50°C. One hundred μ l spore suspension were taken out and plated on SDA medium plates for incubation for 7 days. Data have indicated that all five isolated were able to grow below 35°C not 50°C. At 45°C, only isolates 35547 and Ho212 were able to grow and its sporulation were 1.8×10^6 and 1.0×10^6 conidia/ml, respectively. The above data have suggested that isolates 35547 and Ho212 were high temperature tolerated. Thereafter, isolates 35547 and Ho212 were treated with UV-C and took the 1% survival culture for the following experiment. Physiological charters were compared between UV-induced mutant and wild type. The DNA reparation was tested with RAPD, the data have indicated that UV-induced mutant sporulated significant earlier than wild type at 8 and 16 hr. However, no significant difference was shown at 24 hr and all reached 99%. For the chitinase assay, both culture had clear zone on day 4, and Ho212 has larger clear zone. All of them had no significant difference when culture for 12 days. In API ZYM test, no Trypsin, β -Glucuronidase, α -Glucosidase and α -Mannosidase were presence for all culture, and Ho212 has shown no reaction to α -Chymotrypsin. Various degrees of activity have exhibited for the rest of substrates. At 25°C, both UV-induced mutant and wild type have the optimum growth and sporulation, and Ho212 is better than others culture. No significant difference was found among both UV-induced mutant and wild type when cultured at 25°C for 30 days, the sporulation were 1.0×10^8 spores/g with rice medium. Both 35547 and Ho212 has the ability of DNA reparation.

Key words: *Beauveria bassiana*, high temperature tolerance, UV tolerance, physiological characters

72 蜜蜂腦內一氧化氮合成酶之日齡依變表現
Age-related expression of nitric oxide synthase in the brain of honeybee, *Apis mellifera* L.

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由生物體內所生成的一氧化氮 (nitric oxide, NO) 可直接穿過細胞膜，並以立體輻射擴散方式影響周圍細胞，因此推測 NO 可能具有調控昆蟲周邊視覺系統的光適應機制及協調控制區域性神經增生等功能。本研究以 NADPH diaphorase 染色技術，觀察一氧化氮合成酶 (nitric oxide synthase, NOS) 在不同日齡工蜂腦內的表現狀況，以推測蜜蜂腦內運用一氧化氮進行經訊息傳導及調控的情形。結果顯示蜜蜂視葉中除 lobula 外，其餘的視神經節及內外視神經交叉區均可發現 NOS 的表現；此外在觸角葉、腦內 anterior optic tubercle 以及蕈狀體部分區域及其 α -lobe 周邊也發現 NOS 的表現。分析蜜蜂發育狀況及分工日齡的關係後發現，工蜂羽化初期的視葉 lamina 與腦內有較高的 NOS 表現量，顯示 NO 在這些區域的作用與神經增生調控有關。在其它視葉神經節中，NOS 則是在工蜂較常接觸巢外環境的時期才有較高的表現量，推測其功能與調控視覺光適應機制相關。由於 NO 調控系統的發展與蜜蜂分工行為的調控時程可能相關，有待未來結合生理與行為試驗進行更深入的研究。

關鍵詞：一氧化氮、一氧化氮合成酶、光適應、分工、蜜蜂

The endogenous nitric oxide (NO) can permeate through cell membranes and diffuse three-dimensionally to act on multiple nearby targets. NO has been considered as a systemic neurotransmitter and/or neuromodulator to rectify the light adaptation mechanism in the peripheral visual system and to regulate the regional neurodevelopment. In this study, NADPH diaphorase histochemistry technique was applied to investigate the nitric oxide synthase (NOS) expression in adult honeybee worker's brain. The NOS expression was observed in both the outer and inner chiasmata as well as the visual ganglions, except the lobula. The NOS expression was also observed in the antennal lobe, anterior optic tubercle (AOTu), parts of mushroom body, and the surrounding of the mushroom body α -lobe. Comparison of the variation of NOS expression among the labor division phases shows that NOS expression are higher in the lamina and the central brain of newly emerged workers, but in the inner and outer chiasmata and the medulla, of older workers. These results indicate that NO may primarily regulate the neurodevelopment when the workers are newly emerged and staying in the dark hive. Whereas, NO may modulate the light adaptation when the workers getting older and foraging in the outside lightened environments. We herein propose that NO signaling is related to the time course regulation of honeybee labor division.

Key words: nitric oxide, nitric oxide synthase, light adaptation, labor division, honeybee

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日本紋白蝶 (*Pieris rapae crucivora* Boisduval) 為十字花科重要害蟲，在冬季栽培十字花科蔬菜時，若不以化學藥劑加以防治，所造成的危害相當嚴重。但近年來，隨著有機栽培的觀念盛行，非化學藥劑的防治方式逐漸受到重視。菜蝶絨繭蜂 (*Cotesia glomerata* (Linnaeus)) 為日本紋白蝶幼蟲之寄生性天敵，屬於內寄生多元性之寄生蜂，寄主範圍專一，僅以數種粉蝶屬之幼蟲為寄主，極適合開發防治日本紋白蝶。本研究目的在於測試最適合菜蝶絨繭蜂發育之寄主齡期，以便簡化飼養繁殖之程序。結果顯示，菜蝶絨繭蜂若以二齡的日本紋白蝶幼蟲為寄主，可獲得較多的繭數，平均繭數為 36.92 ± 2.70 個；而菜蝶絨繭蜂之幼蟲期及蛹期所需發育日數亦較短，幼蟲期平均日數為 16.92 ± 0.31 日，蛹期平均日數為 8.58 ± 0.10 日；在另一方面，其防禦行為較不易對菜蝶絨繭蜂造成嚴重傷害。利用菜蝶絨繭蜂成功防治日本紋白蝶的可能性很高，然而如何在全年穩定的提供健康且適合的日本紋白蝶幼蟲作為菜蝶絨繭蜂之寄主，則成為大量飼養繁殖菜蝶絨繭蜂的重要關鍵。因此，未來應加強簡化日本紋白蝶的飼養過程，以利於菜蝶絨繭蜂之大量飼養繁殖，並將研究結果實際應用於害蟲綜合管理及有機作物栽培上。

關鍵詞：菜蝶絨繭蜂、搜尋行為、日本紋白蝶、十字花科蔬菜、生長發育

Pieris rapae crucivora (Boisduval) is an important pest of Brassicaceae crop. If farmer didn't use chemical pesticide to control cabbageworm in the winter season, *P. rapae crucivora* will seriously harm the crop. The non-chemical control is becoming valuable because organic crop is in vogue recently. *Cotesia glomerata* is one kind of the parasitical enemies for *P. rapae crucivora* larva. *C. glomerata* is an endo-parasitoid, and its host range is especially in *Pieris* genus. Therefore, it can be a suitable nature enemy to control *P. rapae crucivora*. The purposes of this study were to identify the optimal host age of *C. glomerata*. The results indicated that the second instar larvae could be the optimal host age for *C. glomerata* because the second instar larvae could breed more cocoons and the larval or pupae developmental time were shorter for *C. glomerata*. Therefore, the second instar is a low risk host age for *C. glomerata*. The results indicate that use of *C. glomerata* to control the pest is a quite promising way. Therefore, identify the proper ways to provide hosts for the wasp year round will become the very important step for future development.

Key words: *Cotesia glomerat*, oviposition preference, *Pieris rapae*, Brassicaceae, development

74 近年來斑衣蠟蟬由中國至朝鮮半島之引入
Recent Introduction of *Lycorma delicatula* from China to Korea (Hemiptera: Auchenorrhyncha:
Fulgoridae)

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曾經被錯誤地記載於朝鮮半島的斑衣蠟蟬近年突然因偶然來自中國的引入與拓殖在韓國西部大量出現。本研究回顧了這個外來物種以及另一個韓國固有種蠟蟬—艾米利俄諾夫麗蠟蟬於韓國出現的報導以及命名變遷。斑衣蠟蟬首先於 76 年由日本研究者土居氏所報導。雖然當時這個物種於韓國記錄的錯誤隨即在該期刊的下一期所更正，然而這個錯誤的記錄卻一直延用至今。然而就在它在韓國的記錄被確認為誤記後，此物種又突然可能因為來自中國的引入成為韓國的常見物種。我們在此倡議將此昆蟲的韓名定為“ggot-mae-mi”而不是“ju-hong-nahl-gae-ggot-mae-mi”以反映其廣被使用的俗名。至於艾米利俄諾夫麗蠟蟬—另一個韓國蠟蟬科物種，於近年被拼寫為 *L. emeljanovi*，然而我們發現根據國際動物命名規約 32.5.1 條款其原拼法應是正確的。由於 LCO-HCO 這個由 Folmer 所發展之生命條碼引子僅對艾米利俄諾夫麗蠟蟬有效，而對斑衣蠟蟬失效，因此我們在此設計了一組新的引子以對其生命條碼區增幅。

關鍵詞：斑衣蠟蟬、艾米利俄諾夫麗蠟蟬、韓國、中國、COI、DNA 條碼

Lycorma delicatula, spot clothing wax cicada, once mistakenly reported its occurrence in Korea, is now suddenly common in western Korea, due to its recent arrival from China and their subsequent settlement. A history of the occurrence reports and name changes in this exotic fulgorid species, *Lycorma delicatula*, together with *Limois emelianovi*, the only other Korean fulgorid species, is reviewed. *Lycorma* sp. was first reported in Korea 76 years ago by a Japanese researcher, Doi. Although it was misidentified and the misidentification was noted in the subsequent issue of the journal, its erroneous record had been unfortunately maintained until recently. However, soon after it was finally confirmed that it has never been occurred in Korea, it became all of a sudden very common in Korea, due to its presumable introduction from China. We now propose its Korean common name as “ggot-mae-mi” instead of “ju-hong-nahl-gae-ggot-mae-mi”, reflecting its original common name used for the species. The other fulgorid species in Korea, *L. emelianovi* was recently spelled differently as *L. emeljanovi* but found the original spelling is right according to the ICZN code 32.5.1. A new primer set was developed for amplifying its barcoding region as the Folmer’s original primer pair for barcoding, LCO-HCO, only worked for *L. emelianovi* but not for *L. delicatula*.

Key words: *Lycorma delicatula*, *Limois emelianovi*, Korea, China, COI, DNA barcode

75 台灣海灘蟋蟀 (直翅目：地蟋蟀科) 發育期與各部位生長速率之分析
The analysis of development time and growth rate in body parts in *Taiwanemobius formosanus* Yang et Chang, 1996 (Orthoptera: Nemobiidae)

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台灣海灘蟋蟀 (*Taiwanemobius formosanus* Yang et Chang, 1996) 由楊正澤及張玉玲於 1996 年發表為單模屬 (monotypic genus) 後，1997 年初 Oshiro 及 Ichikawa 發表另一種採自沖繩，命名為 *Taiwanemobius ryukyuensis* Oshiro et Ichikawa, 1997；*Taiwanemobius* 相近的屬分別有 *Apteronemobius*、*Caconemobius* 兩屬，皆分布於太平洋沿岸地區，因此太平洋區海灘蟋蟀共 3 屬 10 種，分別是 *Taiwanemobius* 屬的 *Taiwanemobius formosanus* Yang et Chang, 1996 及 *T. ryukyuensis* Oshiro et Ichikawa, 1997；*Apteronemobius* 屬的 *Apteronemobius longipes* Chopard, 1929 及 *A. darwini* Otte et Alexander, 1983；*Caconemobius* 屬的 *Caconemobius sazanami* (Furukawa, 1970)、*C. daitoensis* (Oshiro, 1986)、*C. akusekiensis* (Oshiro, 1990)、*C. takarai* (Oshiro, 1990)、*C. nihoensis* (Otte, 1994) 及 *C. sandwichensis* (Otte, 1994)，以上各種分別分布在台灣、琉球、夏威夷及澳洲。台灣海灘蟋蟀成蟲無翅，身體具有黑白大理石斑紋，和棲地的砂石背景形成保護色，雄蟲體長約 9~10 mm，雌蟲 10~11 mm，棲息於大小鵝卵石所組成的礫石砂灘。其棲地分布在台灣東海岸，南界原為安朔，最近調查發現，最南界為屏東縣旭海，最北達宜蘭縣東澳粉鳥林，外島蘭嶼之八代灣及東清灣有採集紀錄。野外採回的蟋蟀飼養於光週期 (L/D) = 12/12、恆溫 25°C 之生長箱，以室內飼養之第一代，測量各齡期的頭殼寬、前胸背板長、後足腿脛節長、生殖下片、產卵管長度等部位之長度，建立各齡期不同部位之生長速率，探討台灣海灘蟋蟀之生長模式，提供給研究人員進行野外蟋蟀之齡期判斷及保育評估之參考。

關鍵詞：台灣海灘蟋蟀、東部礫石海灘、發育速率

Since previous workers published the Taiwan beach cricket, *Taiwanemobius formosanus* Yang et Chang for monotypic genus in 1996, Oshiro and Ichikawa publish a new species, *Taiwanemobius ryukyuensis* Oshiro et Ichikawa in 1997. There are two genus, *Apteronemobius* and *Caconemobius*, are similar to genus *Taiwanemobius*. Both of them distribute in pacific rim. There are 10 species, include *Taiwanemobius formosanus*, *T. ryukyuensis*, *Apteronemobius longipes*, *A. darwini*, *Caconemobius sazanami*, *C. daitoensis*, *C. akusekiensis*, *C. takarai*, *C. nihoensis*, *C. sandwichensis*, distribute in Taiwan, Ryukyu, Hawaii and Australia. *Taiwanemobius formosanus* are wingless. When they live in sandy pebble beach, marble-like coloration will protect them to avoid predator. The body length is 9 to 10 mm in male, 10 to 11 mm in female. The northern limit distribution in Taiwan is Fenniaolin, Ilien county, and the southern limit distribution is Syuhai, Pingtung county. Not only in Taiwan, but also in off-shore island, Lanyu, has collecting record in Dongching Bay and Badai Bay. We collect crickets from the field and rear them in growth chamber (12L:12D, 25°C). We reared the first generation of the beach cricket and measured their body parts of each instar nymph, like head width, pronotum length, hind femur length, subgenital plate and ovipositor length. We analysed the data to find the proportion of head width to the other body parts for determining the instar by measurement in the field survey. This is also the basic research for the model of growth rate in the future.

Key words: Taiwan beach cricket, eastern sandy beach, development rate

76 COI 基因無法鑑識台灣特有的兩種杜鵑斑蛾——到底是 COI 資訊不足或我們需要更多的基因？
COI sequence data fails to tell two Taiwan endemic *Rhodopsona* species apart – is COI useless or we need more genes?

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分子標記已廣泛地使用於系統分類學研究，其中粒線體細胞色素氧化第一次單元 (COI) 的 DNA 片段更被許多動物學者認為可作為物種鑑別的「基因條碼」。然而目前系統分類學者對此依賴單一 DNA 短片段鑑別物種的概念仍有許多歧見與辯證。在本研究中我們採用一個具有複雜分類歷史以及形態特徵的台灣特有杜鵑斑蛾屬 (*Rhodopsona*) 複合種群做為測試 COI 這個 DNA 條碼效能的案例。我們於台灣島內的 13 個地點獲得 93 隻成蟲杜鵑樣本，分析長度為 801 鹼基對的序列資訊後得到 41 個對偶基因，再使用 neighbor-joining, maximum parsimony 以及 Bayesian inference 三種方法進行對偶基因的親緣關係推測。結果顯示過去依極為少量的標本檢查所定義的兩個「種」—*Rhodopsona marginata* 以及 *R. rutila* 的成蟲外部形態 (包含發香器結構與生殖器)、幼蟲的寄主利用以及分布海拔區隔在以 COI 序列所獲得的分析結果中並不被支持。我們因此將朝向採用對核 DNA 片段的分析以評估母系遺傳的粒腺體 DNA 在某些情況下是否缺乏對種的鑑別度，或者過去依據形態特徵的分類處理是否低估了表型的多樣性與可塑性。

關鍵詞：DNA 條碼、杜鵑斑蛾、COI、物種界限、特有物種

Molecular markers have widely been used in systematic biology research for decades. Recently, a short DNA fragment of mitochondrial cytochrome *c* oxidase I (COI) was proposed to be the “DNA barcode” for species delimitation, though the suggestion is still under debate among scientists. In the present study, we used a Taiwan endemic species complex of the genus *Rhodopsona*, which has complex taxonomic history and morphological characters, to address the utility of COI barcode gene fragment. In total 41 haplotypes of 801 base pairs of COI DNA sequence were obtained from 93 *Rhodopsona* samples collected at 13 localities in Taiwan. Phylogenetic analysis using neighbour-joining, maximum parsimony and Bayesian inference showed that the separation of the two species” *Rhodopsona marginata* and *R. rutila*, based on morphological characters (including androconial organ and genitalia), larval host utilizations and distribution altitudes was not corroborated by the analysis of COI sequence data. We therefore will turn to investigate the nuclear DNA sequence to assess if mitochondrial DNA sequence data may fail to distinguish species under some circumstances, or, alternatively, if the phenotypic diversity and morphological plasticity were overlooked in the morphology-based taxonomic practice.

Key words: DNA barcode, *Rhodopsona*, COI, species delimitation, endemic species

77 由幼蟲所提取之 *COI* 序列鑑識台灣產蓑蛾 (鱗翅目: 蓑蛾總科)
Species delimitation of Taiwanese Psychidae based on *COI* gene obtained from larval material

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精確並快速的鑑定物種是生物學研究的關鍵步驟，而大多數昆蟲類群之分類特徵建立在成蟲形態與生態資訊上，當資訊不易取得或成蟲特徵在親緣關係上十分保守時，這些方法往往難以有效應用，因此使用粒線體 DNA 序列 *COI* 條碼解決幼生期物種鑑定及歸類問題，往往成為較有潛力而可行的工具。避債蛾為鱗翅目昆蟲中唯一高比例呈現雌雄二型性的類群，雄蟲具翅但壽命短暫，雌蟲則依種類為有翅、短翅、附肢退化、或完全蠕蟲狀。成蟲少有趨光性導致採用成蟲形態資訊鑑定困難，更無法做進一步研究。而幼蟲期生活史長，具有多種造巢習性並採用許多的材質，其巢式專一性可能作為種類鑑定快速且精確之依據，惟需累積足夠幼蟲造巢生態習性、人工飼養以獲得雄蟲成體形態資訊、並以 DNA 條碼三者相互佐證。本實驗使用了 30 隻避債蛾樣本，包含 5 隻成蟲及 25 隻幼蟲，獲得 441bps 長度的 *COI* 序列資料來測試我們的想法，以鄰近相連法 (neighbor joining, NJ) 建構遺傳距離樹，結果顯示可區別為 8 個種，並以蛹期巢式、成蟲形態、以及生態資訊嘗試佐證。初步結果暗示隨著樣本數的增加以及更多樣分子特徵的分析，將可以鑑別出更多的隱蔽種 (cryptic species)。

關鍵詞：DNA 條碼、無翅性、性雙型性、隱藏種、物種界限

Reliable and rapid species identifications are critical to most research areas of biology. In most insect taxa, identifications mostly rely upon the morphological and ecological information of the adult stage, but this approach may not be practical when adult material is not easily accessible and identifiable and the characters of adult stage are phylogenetically conservative. Thus using the *COI*-based DNA barcode to distinguish species delimitation and attribute species membership based on larval material becomes potential and necessary. The bagworm moths show extreme sexual dimorphism in most of the members, of which males are usually winged and female can be fully winged, brachypterous, apterous with appendages vestigial or completely vermiform. The adults are usually not attracted by light traps and the immature stages last for a long period, which makes rapid identification based on adults infeasible and any further research based on correct identification impossible. When undergoing a population genetics research on bagworm moths, we found that larval case style seems to be diagnostic for species identification regardless the material being used for case construction, but this approach still requires corroboration from molecular data. We tested our idea by analysing 441 bps of the *COI* sequence data obtained from 30 bagworm specimens, including 5 adults and 25 larvae. The result based on a NJ analysis reveals 8 recognizable species, of which the larval case style, adult characters and ecological features are distinguishable from each other. This preliminary result also suggests that some more cryptic species are to be identified in future study when material sampling and amplified sequence length are expanded.

Key words: DNA barcode, aptery, sexual dimorphism, cryptic species, species delimitation

78 大鈎蛾亞科與鈎蛾總科 (鱗翅目) 內部親緣關係之重新評估
Reassessment of internal phylogenies of Cyclidiinae and Drepanoidea

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大鈎蛾亞科為大鱗翅類中一個規模較小的分類群，分佈於東方區，有 2 屬被描述，即 *Cyclidia* Guenée, 1857 以及 *Mimozethes* Warren, 1901，目前已知共有 13 種。本亞科之幼蟲對山茱萸科八角楓屬植物具有專一性，並具有醒目色的體表斑紋，其功能推測與警戒有關。由於學者對於大鈎蛾科級分類地位有不同看法，本亞科過去曾被處理為獨立於鈎蛾科外之科級分類群，後又被降為亞科，與鈎蛾亞科、波紋蛾亞科及特產於澳洲亞科地位不明的 *Hypsidia* 屬共同組成鈎蛾科。位於可見腹節第一節之鼓膜聽器被認為是代表鈎蛾科單系性之共有衍徵，然而無論是大鈎蛾亞科、鈎蛾科及鈎蛾總科之單系性假說，皆未曾被以系統分析方法進行測試。本研究目的是解決大鈎蛾亞科之系統發生，並對其他鈎蛾總科及尺蛾總科下之亞科系統發生位置之重新檢視，再以重建之系統親緣關係進行幼蟲聚集行為演化方向之推測。本研究選取大鈎蛾亞科 15 個分類群 (12 種及 3 亞種) 作為內群，並由鈎蛾總科中之鳳蛾科、鈎蛾亞科、波紋蛾亞科、*Hypsidia* 屬及尺蛾總科中之燕蛾亞科、微點燕蛾亞科、雙尾蛾亞科、波尺蛾亞科及偽燕蛾科中，選取具有代表性種類共 12 種作為外群，以重建大鈎蛾亞科與其他相關類群之科級親緣關係。結果顯示 1. 大鈎蛾亞科為一單系群，並且是鈎蛾亞科加上波紋蛾之姐妹群。2. 此親緣關係顯示鈎蛾科中幼蟲之聚集性 (無發聲領域行為並且具有警戒色外表)，是由獨居性 (具發聲領域行為及隱蔽色外表) 所演化而來。3. 鳳蛾科與偽燕蛾科形成之支系並不支持過去鈎蛾總科包含鈎蛾科與鳳蛾科之假說。

關鍵詞：大鱗翅群、鈎蛾總科、鈎蛾科、鼓膜器、發香毛

The Cyclidiinae is a small macrolepidopteran group endemic to the Oriental region, comprising species in 2 genera, *Cyclidia* Guenée, 1857 and *Mimozethes* Warren, 1901. The larvae of the entire subfamily are specialists on *Alangium* (Cornaceae) and exhibit conspicuous colouration that possibly functions as a warning signal. Historically this subfamily was inconsistently treated as either a separate family from Drepanidae, or lumped as a subordination of Drepanidae with Thyatirinae and Hypsidia, a bizarre genus endemic to Australia. The presence of a paired tympanal organ in the 2nd abdominal sternite is the only putative synapomorphic character supporting the monophyly of Drepanidae. However, the monophyly of either the superfamily Drepanoidea, Drepanidae, or Cyclidiinae has never been tested using modern methods. In the present study we investigated the phylogenetic relationships of Cyclidiinae based on morphological characters obtained from all the cyclidine species and using representatives of Drepaninae, Thyatirinae, Sematuridae and Epicopeiidae as the outgroup taxa. Our analysis shows that: 1. *Cyclidia* and *Mimozethes* constitute a monophyletic clade, which is the sistergroup of (Drepaninae + Thyatirinae). 2. This phylogenetic pattern suggests an evolutionary trend that cryptic solitary larvae with sound-producing defensive behaviour are evolved from aposematic gregarious larvae without sound producing behaviour. 3. The monophyly of Drepanoidea, comprising Drepanidae and Epicopeiidae, however, is rejected because the geometroid Sematuridae and drepanoid Epicopeiidae were nested within the relationships.

Key words: Macrolepidoptera, Drepanoidea, Drepanidae, tympanal organ, androconial organ

79 跳蛛何以不攻擊小蛾？被騙？被嚇到？或只是無動於衷？

Why does not jumping spider attack micromoth? Being perceived? scared? or simply ignoring?

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掠食者擬態是貝氏擬態中的一個特例，意指獵物藉著展示與掠食者相似的訊息以躲避捕食，例如某些小鱗翅類已知可藉展示與跳蛛相似的斑紋或行為降低跳蛛的追捕或爭取逃跑時間。此種對跳蛛的掠食者擬態現象很早以前就被觀察到，但直到最近才有一些簡單的行為試驗證實跳蛛對擬態小蛾具較低的捕食率。然在對於捕食者的知覺與捕食行為的瞭解不足時，僅就捕食率的簡單估算佐證此種擬態的存在是具有風險的。若小蛾的翅紋與行為真的欺瞞了跳蛛，那麼跳蛛對小蛾所展現的行為理論上應近於跳蛛於種內或種間展示的行為，而非對可食獵物的行為。為瞭解跳蛛對同種異性的跳蛛、異種跳蛛、具擬態及非擬態小蛾之行為組成，我們使用了十三個行為作為鑑別分析之依變項，比較 *Ptocasius strupiter* (蜘蛛目：蠅虎科) 對 *Eugauria albidentata* (鱗翅目：草螟科) 的行為分佈。結果顯示第一個區別函數對整體影響為 63%，也就是說雄性的展示行為可作為區別蜘蛛對獵物及對同類之行為依據，且跳蛛對螟蛾的行為展示較接近對於異種跳蛛的反應，而非對可食獵物之反應。

關鍵詞：視覺溝通、領域展示、求偶展示、恐嚇假說、掠食者知覺

Predator mimicry refers to a peculiar scenario of Batesian mimicry that the predator is mimicked by the prey and perceptually confused by the signals exhibited by the prey. For example some microlepidopteran species are known for displaying the wing pattern and/or behaviour that is similar to that of jumping spider to decrease chasing from spider or to strive for extra time to escape. This phenomenon has been described for long, but it was not tested using experimental ethological methods until recently, and the results showed significantly lower predation rate of jumping spider on mimicking moths. However, using predation rate alone cannot entirely interpret why micromoths receive fewer attacks from jumping spiders. We investigated both inter- and intraspecific communications, including male-male and male-female interactions, in *Ptocasius strupiter* and behaviours between jumping spider, mimicking and non-mimicking preys. A mimicking moth, *Eugauria albidentata* was used as a defended prey in the experiment. Thirteen behaviour variables plus the grouping variable were subjected to discriminant analysis. The first discriminant accounted for 63% of the common variance. Thus, the result suggests that the display behaviour of male spiders contains reliable information for distinguishing conspecific behaviour from predatory one, that is, the response of jumping spider to mimicking moth is closer to that towards heterospecific jumping spider, but not the palatable and undefended prey.

Key words: visual communication, territorial display, courtship display, intimidation hypothesis, predator perception

80 黃毒蛾族 (鱗翅目：毒蛾科) 之親緣關係重建及其翅紋之趨同演化
Phylogenetic reconstruction of the Nygmiini tussock moths (Lepidoptera: Lymantriidae) and the
convergent evolution of wing patterns

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毒蛾科分布全球且包含近 2700 個物種。牠們的幼蟲通常具有一對翻縮腺並且經常被視為木本植物的廣食性害蟲，並因其令人刺癢剛毛所引發的過敏反應被視為衛生害蟲。本研究著重於黃毒蛾族主要支系親緣關係的解析以及系統分類的建構。黃毒蛾族的混亂分類歷史肇因於白毒蛾屬 (*Euproctis* Hübner, 1819) 這個根據歐洲產模式種 *Phalaena chrysorrhoea* Linnaeus, 1758 所建立的屬以及其後所加入的近 650 個合法名。Holloway 曾經試圖根據馬來亞-印度澳太區的物種解決此族的屬級分類難題，然而許多「非白毒蛾屬」物種，即始具有農業與生物多樣性研究的重要性，仍未被置入任何適當的屬中。因此我們需要一個親緣關係假說用以解決系統分類上的紊亂。我們的研究主要將回答兩個問題：(1) 黃毒蛾族是否為單系群？以及 (2) 黃毒蛾族內的親緣關係架構為何？我們使用超過 100 種代表全球所有族與主要支系的毒蛾成蟲與幼期形態特徵重建其親緣關係。初步結果顯示黃毒蛾族僅分布於舊世界，且其共有衍徵由雌性與幼期特徵所提供。我們也發現性雙型性以及多態性於黃毒蛾族中十分常見而這樣的現象也已誤導了系統分類處理。

關鍵詞：夜蛾總科、毒蛾科、焮毛、趨同演化、多系群

The Lymantriidae comprises about 2700 species distributed globally. Their larvae are characterised by having a pair of funnel wart, and often considered to be polyphagous pests of woody plants and sanitary pests due to the urticating setae that cause various allergic syndromes. In the present study we focus on the phylogeny and systematics of the major lineages of the tribe Nygmiini. The taxonomic chaos of the tribe involve a polyphyletic genus *Euproctis* Hübner, 1819, which is initially established upon the European *Phalaena chrysorrhoea* Linnaeus, 1758 and so far comprising more than 650 available names. Holloway attempted to resolve the generic systematics the tribe for the Malayan-Indoaustralian region, but many “non-*Euproctis*” species, even with importance in agriculture and biodiversity research, have not been assigned to any appropriate genus. Therefore a phylogenetic hypothesis to be based to resolve the systematic chaos becomes needed. Our research is to address two main questions: 1) is the tribe Nygmiini monophyletic? and 2) what are the internal relationships of the Nygmiini? We used more than 100 lymantriid species representing all the tribes and major lineages to reconstruct a phylogeny based on adult and immature morphology. The preliminary result shows that the Nygmiini is confined to the Old World and the synapomorphies are better provided by the female and larval characters. We also found that sexual dimorphism and polymorphism are very common in this tribe and thus the current taxonomy is very misleading.

Key words: Noctuoidea, Lymantriidae, stinging hairs, convergent evolution, polyphyletic group

81 防檢疫重要性捲蛾科昆蟲於台灣果園之非疫狀態

The pest-free status of the tortricid moths with importance in animal and plant quarantine and inspection in the orchards of Taiwan

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本研究目的在於確認東方果實蛾以及相關物種於台灣果園中之非疫狀態。我們首先追溯台灣之東方果實蛾記錄來源與引證標本存放地點，其次以燈光誘集，費洛蒙誘引，以及搜尋桃，梨與蘋果園中的幼蟲以確認台灣是否存在東方果實蛾之族群。此外我們並蒐集各國東方果實蛾之文獻與樣本確認所謂東方果實蛾的分類身份。我們已確認早期有關台灣產東方果實蛾的報導皆未根據證據標本引述，但近期的記錄因證據標本的保存而得以被確認。我們比較了存放於華盛頓的 OFM 模式標本、近年侵入澳洲的個體、以及來自被認為是起源地的中國的標本，台灣產個體與上述地區個體並無明顯差異。我們目前已掌握東方果實蛾之形態變異，確認正確的鑑定流程，並確認東方果實蛾的有效學名為 *Grapholita molesta* 而非 *Cydia molesta*。

關鍵詞：薔薇科果樹、捲蛾科、*Cydia* 屬、*Grapholita* 屬、非疫狀態

Occurrence of Oriental fruit moth (OFM), *Grapholita molesta*, was recently confirmed from the central and northern Taiwan through an overall survey based on collection records using pheromone lures and examination of institution specimens. The project goal in 2007 is aimed to investigate the distribution of OFM along altitude, and thus the horizontal and longitudinal distributions of OFM could be confirmed allowing further actions of pest control to be planned and proposed. Unlike the populations of Japan, Korean peninsula and China, the OFM in Taiwan is multivoltine and confined to the peach estates in northern and central lowland. Essay of host specificity reveals that this species only attacked cultivated rosacean fruits in Taiwan, but the feeding marks have never seen from any native *Prunus* or *Malus* species.

Key words: rosacean fruit trees, Tortricidae, *Cydia*, *Grapholita*, pest-free status

82 近年於進口薔薇科鮮果所檢出鱗翅目樣本之鑑識
Identification of the lepidopteran samples recently found in the imported rosacean fruits

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卷蛾科的 *Grapholita* 與旋蛾科的 *Anarsia* 兩者皆具有大量被視為薔薇科果園害蟲的種類。牠們也同時具有不少在國際防檢疫工作上相當重要的物種。然而，由於與其它分類群於歷史上的混淆以及標本認證上的問題，它們的鑑定通常被認為極為困難。本研究具有多重目的：(1) 釐清涉及此兩屬物種之分類資訊；(2) 對於有害物種的鑑別特徵價值進行認證；(3) 提供實用的檢索表以及高品質的影像資料庫以理正確鑑定。本研究結果期待可解覺此兩屬小型且色彩暗淡蛾類長期以來的鑑定困難。

關鍵詞：薔薇科果樹、捲蛾科、旋蛾科、草螟科、蛀果性種類

The tortricid genus *Grapholita* and the gelechiid genus *Anarsia* both harbor a great number of species that are considered as severe pests in rosaceous fruit orchards. Identification of these two genera, however, is usually considered difficult due to historical confusion with other taxa in literature and specimen verification. The aims of the present research proposal are multi-folded: (1) to elucidate the taxonomic information of the species involved in these two genera; (2) verifying the diagnostic utilities of the characters which are often used for identifying pest species; (3) providing a promising key to and high quality image database of these two genera for correct identification. The research result is expected to resolve the long term difficulty in identifying the moths of these two genera, which are usually small and dull-coloured.

Key words: rosacean fruit trees, Tortricidae, Gelechiidae, Crambidae, fruit-borer

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鱗翅目昆蟲 (Lepidoptera) 為昆蟲綱之第二大目，也是各型植被與生態系中最重要之植食性昆蟲 (herbivorous insects) 之一，無論在博物典藏、科普教育、生態保育與生物多樣性研究上皆有舉足輕重的角色。根據最新之研究結果，臺灣產鱗翅類昆蟲至少有近 5000 種。由於大鱗翅群 (Macrolepidoptera) 佔該目昆蟲在臺灣約 60% 的種數，也是各項生物資源、博物館收藏以及公眾展示中的要角，因此我們選擇這個類群進行其模式標本與原始文獻之數位化工作，以協助以上諸多工作的進行。並藉由網際網路的便利性與科技達到維護收藏品質、促進科學研究以及普及大眾科學教育的目的。我們已於 2006 至 2007 年分別完成蠶蛾總科 (Bombycoidea)、尺蠖總科 (Geometroidea) 與鉤蛾總科 (Drepanoidea) 模式標本數位化工作。於 2008 至 2009 年我們將進行台灣產大鱗翅類中多樣性最高的夜蛾總科 (Noctuoidea) 模式標本與文獻數位化資料庫。並且藉由這個多樣性極高的類群所具有的更多文獻與標本認證案例，改進資料庫的邏輯架構。我們期待這三年的計畫中數位化約 80% 合法名之模式標本以及標籤資訊，並訓練更多具有生物分類、生物標本典藏管理、典藏數位化以及資料庫設計與管理人力。

關鍵詞：大鱗翅群、模式標本、自然史典藏、生物多樣性資料庫、分類學

The Lepidoptera represents the second largest insect order and the most significant herbivores in every vegetation types and ecosystems. This insect order also plays an important role in museum collection, popular science, conservation and biodiversity research. According to the most current study, about 5000 lepidopteran species are recognized from Taiwan. The Macrolepidoptera occupies about 60% of the Taiwan Lepidoptera diversity and represents a major character in bioresources, museum collection and public exhibitions, we therefore selected this taxon to carry out this digital archive project for type specimens and original literature to promote the above works and to sustain collection quality via the ease and technology of internet. From 2006 to 2007, we have already completed digitization of the type specimens, construction and testing of the database for Bombycoidea, Geometroidea and Drepanoidea. In the 3rd year project, we aim to complete the part of Noctuoidea, which harbours the largest diversity in the Lepidoptera (more than 70000 species in 700 genera). Up to date there are 1450 species in 603 genera of Noctuoidea, placed in 6 to 14 different families, being recognized from Taiwan. The Noctuoidea does not only have high diversity, but also have significant role in agriculture, forestry and public health. Identification of Noctuoidea has been regarded difficult for years due to lacking of complete image and comprehensive terminology. The present study will attempt to enrich our database by including more literature records and specimen verification cases. Apart from digitizing about 800-10000 specimens of valid taxa, we will also train more human powers for database curation, interpretation of nomenclature codes, collection digitization and database design. We also start including non-museum specimen images and the voucher specimens in this project.

Key words: Macrolepidoptera, type specimen, natural history collection, biodiversity database, taxonomy