茶角盲椿象 (*Helopeltis* spp.) 研究現況與未來研究展望

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摘 要

茶角盲椿象為茶樹一重要之刺吸式害蟲，不論其若蟲或成蟲皆會危害茶樹嫩芽葉，繼而造成嚴重茶菁產量損失。茶角盲椿象造成茶樹的危害不僅僅是刺吸茶樹嫩芽葉，更包含了產卵在茶樹幼嫩組織中，受傷部位形成癒傷組織而導致維管束的阻塞，最終影響植物生理反應及造成生長受阻。目前有數十種其他寄主植物可被茶角盲椿象危害，然而目前最普遍的管理方法仍為化學藥劑防治，為了避免茶葉農藥殘留及田間抗藥性產生，有必要整合各種管理方式以取代完全使用化學農藥。害物整合性管理策略包含了栽培防治、機械物理防治、生物防治、化學防治等，並藉由調整管理措施可望達到藥劑減量及提高防治效率效果，進而維持茶菁產量及安全。

關鍵字：害物整合性管理、抗藥性、生物防治、刺吸式害蟲

前 言

前人研究指出有數種與茶樹相關的椿象，其中以茶角盲椿象 (*Helopeltis theivora* Waterhouse (Heteroptera: Miridae)，或稱茶蚊子 (tea mosquito bug, TMB)) 為茶樹上最主要的椿象類害蟲 (Cranham, 1966b; Hazarika et al., 2009; Saha and Mukhapadhyay, 2013)，在臺灣，茶角盲椿象鑑定學名為 *H. fasciaticollis* Poppius (曾，2004)，需與其他國家之茶角盲椿象進行進一步比對方可確認兩者間之關係。本文整理之茶角盲椿象相關研究為針對 *Helopeltis theivora* 此一種進行論述。世界各地的學者專家們針對茶角盲椿象進行生理、生態研究，並研發合適此害蟲的管理方式，本篇綜合性論述並歸類現有的資訊，其中包括茶角盲椿象之生態、危害與評估及管理策略等，並思考與討論進一步研究未可行方向，以提供後續針對茶角盲椿象管理策略研究。

茶角盲椿象之生態

地理分布

茶角盲椿象在南半球及北半球皆有分佈，包括東南亞、非洲、澳洲北部等 (Stonedahl, 1991; CAB, 1992)，最早在 1847 年於爪哇被報導會危害茶樹 (Watt and Mann, 1903)，1968 年在印度察查

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縣 (Cachar region) 茶區首次被發現 (Rao, 1970)，此後續陸續證實，茶角盲椿象廣泛分佈於各個主要產茶國家，包括孟加拉 (Ahmed et al., 1992, 2005, 2013)、斯里蘭卡 (Cranham, 1966a, 1966b)、爪哇與蘇門答臘 (Koningsberger, 1908; Leefmans, 1916)、寮國 (Du Pasquier, 1932)、越南 (Du Pasquier, 1932)、西馬來西亞 (Lever, 1949; Corbett, 1930)、臺灣 (Liao, 1977)、巴布亞紐幾內亞 (Smith et al., 1985)、烏干達 (Hargreaves, 1936)、肯亞 (Rattan, 1992)及中國大陸 (Schuh, 1995)，此外，在海南島茶角盲椿象不僅為茶樹重要害蟲更為腰果重要害蟲之一 (Yong and Qi, 1985)。

生活史與生物學

茶角盲椿象可於單一寄主茶樹完成一整個生活史，其生活史長短會隨著不同季節之氣候因子而有差異，如自六月的 2 週至寒冷氣候下的 5-8 週不等 (Das, 1984)。各地重要茶區之茶角盲椿象生活史研究已被完整且持續的研究，包括 Gope and Handique (1991) 在阿薩姆茶區及 Roy 等人 (2009b) 在印度多爾茲茶區，皆有對該地區茶角盲椿象之生活史有完整的研究。一般來說，茶角盲椿象之世代有重疊現象，平均產卵率為 28.58 個卵，完成一個世代需要 22.05 天，其族群每週可擴增 2.9 倍。

族群發生季節及豐度

氣候環境因子如降雨及濕度直接影響茶角盲椿象的族群變動 (Swaine, 1959; Pillai et al., 1979; Giesberger, 1983; Muhamad and Chung, 1993; Karmawati et al., 1999)，茶角盲椿象主要活動期間為一天的清晨及傍晚 (Watson et al., 1975; Zeiss and Braber, 2001)。在印度西北部，Das (1957) 指出茶角盲椿象主要在雨季期間危害茶樹，自五月開始一直到九月為止；Muraleedharan (1992a, 1992b) 詳細指出在印度南部茶角盲椿象族群發生季節，主要族群發生高峰為七至十二月，低峰為一至六月，而此亦對應了茶菁生產時期；Kalita 與 Singh (1999) 指出在印度東北部茶角盲椿象主要發生時期為八至十月，其次為二至七月；Chakraborty 與 Chakraborty (2001) 的報告指出茶角盲椿象對茶樹的危害程度與氣溫、降雨及濕度呈正相關；根據 Zeiss 與 Braber (2001) 及 Damiri (2002) 的報告，在印尼及越南，茶角盲椿象在濕度高的月分及雨季對茶樹危害嚴重；在近期研究中，Roy 等人(2009) 指出茶角盲椿象在 sub-Himalayan Dooars 之茶區中全年發生。由此得知茶角盲椿象產卵前期、卵孵化期、若蟲期與晨間濕度有顯著的負相關性，產卵量、卵孵化率、成蟲羽化率、繁殖成功率、雌雄比等皆與溫度成正相關。

根據 Das (1965) 說法，影響茶角盲椿象族群豐度因子可包括有 1. 正常採收及剪枝 (移除特定長度的枝條)、2. 採收與剪枝時機、3. 剪枝程度、4. 採收茶菁長度、5. 遮陰程度、6. 中間寄主植物的有無、7. 施肥方式等，簡而言之，在茶菁生長期間若有持續的高濕氣候或間斷下雨伴隨著溫暖環境，都會提升茶角盲椿象對茶樹的危害程度。

行為和適應

茶角盲椿象喜涼爽氣候，尤其在多雲氣候環境下，茶角盲椿象容易在枝條莖頂上發現。其若蟲及成蟲若受到驚動，會向下快速移動至樹冠層中或掉落至地面。通常成蟲鮮少遷徙，除非受到驚動，雖然理論上成蟲可以飛行達 4 公里 (Cheramgoi, 2010)，但實際上茶角盲椿象主要藉風力進行遠距離傳播 (Das, 1965)。

危害與評估

寄主範圍

茶樹為茶角盲椿象最主要及最喜愛的寄主植物 (Mukhopadhyay and Roy, 2009; Roy et al., 2009d; Saha et al., 2012a)，除了茶樹之外，茶角盲椿象亦廣泛取食經濟作物，包括腰果、刺槐、可可、樟、胡椒等，且皆會造成以上經濟作物之嚴重損害，而茶角盲椿象亦會在主要寄主作物短缺或被施藥防治時，藉由非主要寄主植物繼續存活，此種行為有利於茶角盲椿象維持全年生育及殘存直至主要寄主植物再度大量出現為止 (Mukhopadhyay and Roy, 2009; Roy et al., 2009d)，此類在茶園或鄰近茶園之非主要寄主植物種類整理如表一，部分植物可作為茶角盲椿象中間寄主以完成其完整世代，如包瘡葉 (*Maesa indica*)(Sudhakaran and Selvasundaram, 2000; Sudhakaran and Muraleedharan, 2006)、小花蔓澤蘭 (*Mikania micrantha*)(Mukhopadhyay and Roy, 2009; Roy et al., 2009d; Saha et al., 2012a)、金露華 (*Duranta repens*)(Gogoi et al., 2012)、番石榴 (*Psidium guajava*)(Kalita et al., 2000)、梔子花 (*Gardenia jasminoides*)(Kalita et al., 2000)、閣浮樹 (*Eugenia jambolana*)(Kalita et al., 2000)、野牡丹 (*Melastoma malabathricum*)(Kalita et al., 2000) 及香澤蘭 (*Chromolaena odorata*)(Srikumar and Bhat, 2013) 等。雖然中間寄主可提供短暫性的繼代養分需求，茶角盲椿象在茶樹上的繁殖率與殘存率較在其他植物上高，顯示茶樹為茶角盲椿象最佳寄主植物。Saha 等人 (2012a) 認為三個主要異生解毒酶 (xenobiotic detoxifying enzymes) 包括一般酯酶 (the general esterases, GES)、穀胱甘肽 S-轉移酶 (Glutathione S-transferases, GSTs) 和細胞色素 P450 單加氧酶 (the cytochrome P450 monooxygenases, CYP）在不同寄主上之反應的差異，而影響茶角盲椿象對寄主對象的選擇，當寄主遭受 TMB 為害時，此三種酶的活性均顯著增強，而非主要寄主如小花蔓澤蘭與番石榴等當同樣遭受 TMB 為害時，其三種異生解毒酶的含量會顯著較高，由此可顯示茶樹對於 TMB 之為害會有較低的解毒反應，因此，茶樹較適當為 TMB 之寄主。

傷害特性

茶角盲椿象危害對茶葉的影響不僅為減少產量，亦會影響製茶風味。其若蟲及成蟲皆會取食茶芽葉之幼嫩組織，並於取食後造成紅褐色圓形明顯病斑，隨之茶芽葉捲曲、褐變及黑化，嚴重時容易落葉。而受危害之芽葉無法收穫且會影響下一季茶芽萌發，嚴重影響茶菁產量。此外，茶角盲椿象產卵行為會造成茶芽莖部產生裂縫與癒傷組織的形成，繼而影響茶芽生長甚至會造成該枝條梢枯 (dieback) 情形 (Das, 1965; Roy, 2008; Sudhakaran, 2000)。茶角盲椿象的危害通常是單點小面積開始發生，漸漸自鄰近茶樹開始傳播，顯示茶角盲椿象在茶園造成的危害為不均勻的發生 (Das, 1965)。因此，茶角盲椿象對茶樹造成的危害，包括直接降低可採收的茶芽及使茶芽衰弱甚至造成梢枯繼而影響萌芽，最終嚴重影響產量 (Rao, 1970)，而遭受 TMB 危害之茶菁所製之成茶，茶味苦澀且帶悶味，影響茶葉品質 (林等，2013)。

取食行為

茶角盲椿象的若蟲及成蟲皆利用其口針刺吸幼葉、芽及嫩莖之汁液。當刺吸時其有毒的唾液注射入植物體中，造成取食斑點周圍組織褐化，約取食後 2-3 小時，取食斑點周圍開始褐化，取食後 24 小時內，該取食斑點中央區域變成半透明的淺棕色，最終轉變為深褐色，且取食斑點呈凹陷和乾枯，受危害之葉片呈現變形捲曲 (圖一)(Roy et al., 2015)。

Sana 與 Haq (1974) 指出茶角盲椿象，在夜間取食的量較晝間多，且在全生活史中以五齡若蟲

取食量最多、斑點面積也最大 (Bhuyan and Bhattacharyya, 2006)，單一隻成蟲平均每天可造成 150 個取食斑點 (Hainsworth, 1952)，雌成蟲每日取食斑點面積可超過 412 平方公釐 (Kalita et al., 1995)，若受茶角盲椿象危害嚴重會影響茶葉品質，包括葉片外觀、茶湯活性及風味等 (Roy et al., 2015)。

TMB 引起茶樹之防禦反應方式可能為物理性傷害及生理生化反應。Cohen-Stuart (1922) 指出茶角盲椿象取食機制為利用口器刺入植物表皮組織，吸取汁液進而造成薄壁組織之崩壞；Tjallingii 與 Esch (1993) 認為茶角盲椿象口針短暫的刺入表皮、海綿組織、柵狀組織細胞可能引起植物的防禦反應。Leach (1935) 指出取食斑點可在茶角盲椿象停止取食前即被辨認，其原因為極端活躍的取食行為及具有毒性的唾液分泌進入植物組織中，此種取食斑點發展進程有助於植物受危害後的過敏性反應發生 (Fernandes, 1990) 及鄰近組織的壞死 (Klingler et al., 2005; Gao et al., 2008)，而限縮受害範圍。

受茶角盲椿象危害的葉片外觀會明顯改變，而 Chakraborty and Chakraborty (2001) 指出受茶角盲椿象攻擊後之生化物質的變化，包括有氧化酶類、黃酮及香氣成分等，其中過氧化酵素 (oxidative enzymes peroxidase)、抗壞血酸過氧化酵素 (ascorbate peroxidase) 及多酚氧化酵素 (polyphenol oxidase)等活性會因在受茶角盲椿象攻擊後升高。而苯丙胺酸氨裂解酶(phenylalanine ammonia-lyase)之活性則會下降。受茶角盲椿象危害之茶芽製成茶，其品質下降的原因為減少了重要的生化物質含量如總多元酚，及受害部位已進行氧化作用等 (Roy et al., 2015)。林等 (2013) 將受茶角盲椿象危害之青心烏龍茶菁製成包種茶，並與未受茶角盲椿象危害之茶菁（對照組）進行比較，結果顯示受危害之成茶滋味較對照組滋味苦澀，尤以苦味明顯提升。茶角盲椿象取食時分泌之唾液中所含的水解酵素與氧化還原酵素，可能與造成茶葉受危害時組織壞疽之反應有關 (Sarker and Mukhopadhyay, 2006)。Saikia 等人 (2011) 指出茶樹受茶角盲椿象危害時，植物荷爾蒙含量會明顯受影響，包括生長素 (auxin)、激勃素 (gibberellic acid) 及壓力荷爾蒙如離層酸 (abscisic acid) 等。

茶角盲椿象對茶樹造成的傷害不僅為取食汁液，其產卵在茶樹幼嫩組織更為重要危害之一。交尾後的雌蟲將卵單一的產在肉質的組織中，其產卵管當在刺入植物組織時即造成該處的破裂，繼而該處會形成癒傷組織導致維管束的阻塞，最終影響植物生理反應並造成生長受阻，更嚴重則使該枝條梢枯死亡 (Sundararaju, 1999; Rahman et al., 2006, 2007)。

在取食量及取食部位調查中，Kalita 等人 (1995) 及 Rahman 等人 (2007) 指出雌蟲取食量較雄蟲多；Roy 等人 (2009) 發現三齡、四齡若蟲及成蟲最喜歡取食茶樹枝條的第二葉，一齡及二齡若蟲則最喜歡停留在第一葉取食。Dhar 等人 (2001) 對於茶角盲椿象成蟲及若蟲之危害潛力進行評估，結果發現成蟲對芽的危害較若蟲高，若蟲因無法飛行限制了活動範圍，故若蟲常在同一嫩芽重複取食，單位時間及單點面積危害似乎較嚴重；而成蟲會在芽部產卵，雖不嚴重取食危害，其產卵後與孵化會造成族群的散佈，其影響更遠更廣。

對茶葉減產與傷害潛力之評估

茶角盲椿象為嚴重影響茶葉產量的害蟲之一，前人研究指出茶角盲椿象在非洲可使茶葉減產 55% (Rattan, 1992)、在亞洲可達 11-100%的茶葉損失 (Muraleedharan, 1992a, 1992b)。在 1950 年以前，茶葉受到茶角盲椿象危害，100%減產的情形是相當普遍的 (Rao, 1970; Muraleedharan, 1987; Muraleedharan, 1992a)。但自從化學農藥 DDT 問世以後，茶角盲椿象的問題可得到控制，但 DDT 若無連續使用，茶角盲椿象亦會重新回到茶樹上並造成嚴重危害 (Banerjee, 1983; Das, 1984)。一般來說，受茶角盲椿象危害通常會造成 25-50%的產量損失 (Prasad, 1992; Barbora and Singh, 1994)，但更早的報導指出可能會完全無法收穫，是因為茶角盲椿象大量發生且嚴重危害所致 (Rao and Murthy, 1976)。在印度已有超過 80 %的茶園遭受茶角盲椿象危害，其經常性產量損失在 10-50%間

(Bora and Gurusubramanian, 2007; Roy et al., 2008d; Roy and Gurusubramanian, 2013)；Ahmed (1996) 的報導指出在孟加拉每公頃茶園受茶角盲椿象危害後會減產 150 公斤茶菁，近年來孟加拉經常性受茶角盲椿象危害而減產約為 10-15%，亦有部分地區產量損失可達 100 % (Ahmed et al., 2011)。

茶角盲椿象的經濟閾值 (economic threshold level, ETL) 各國有其不同的定義，經濟閾值概念於 50 年代首先由 Stern 等 (1959) 正式提出，他把 ETL 定義為害蟲的某一密度，對此密度應採取防治措施，以防害蟲達到經濟危害水平 (economic injury level, EIL)，即引起經濟損失的最低蟲口密度。簡而言之，達到害蟲的某一密度時應採取措施，否則害蟲將引起等於這一措施期望代價的期望損失。在印度南部茶區認定若經濟危害水平達 5%即需要進行防治 (Muraleedharan and Selvasundaram, 2002)，在多爾茲 (Dooars) 茶區認為 10 個茶芽中有一對茶角盲椿象，即可能在 14 天內達經濟閾值，Sarmah 等人 (2011) 計算了阿薩姆茶區之茶芽損害的經濟閾值 (ETL) 及經濟危害水平 (EIL)，分別為 3.75%及 2.81%，孟加拉茶區則設定其經濟閾值為 5 % (Mamun and Ahmed, 2011)。然而 ETL 會隨著作物相、氣候狀況、防治成本、茶葉銷售價格等諸多因子而有不同。

取樣方法

適當之取樣方法對於防治掌握茶角盲椿象族群非常基礎也相當重要，然而取樣方法須以最經濟的方式下達到最貼近實際情形才能提供最有效率的資訊，目前推薦以下三種取樣方式以推估茶角盲椿象的族群：(1) 計算每嫩芽上的平均蟲口數；(2) 計算受茶角盲椿象危害之茶芽比例；(3) 計算採摘後籃中受危害茶芽之比率 (Muraleedharan and Selvasundaram, 2002)。在馬來西亞，已開發針對茶角盲椿象蟲口數調查之早期預警系統 (early warning system. EWS) 及經濟門檻反應系統 (threshold response system)(Wills, 1986; Wood and Chung, 1989)；在孟加拉，Ahmed 等人 (1992) 對茶角盲椿象族群變動開發了一套電腦演算模式。

管理策略

多年生、單一茶種、高密度、大面積栽種、高強度施用肥料與化學農藥的耕作方式，影響了茶角盲椿象的發生，可能有效的茶角盲椿象管理方法為早期偵測及立即施用適切管理方式如栽培防治、機械物理防治、生物防治、化學防治等 (Roy et al., 2015)，以下分別進行介紹。

栽培防治

作物栽培防治為一種古老且最基礎之防治方法，成功的栽培防治法需要有對作物與害物之詳細生態資訊方可成功應用。例如規律地採茶，此一耕作行為可移除茶角盲椿象之卵及嫩芽葉上之初齡若蟲 (Das, 1965)。強度採摘及枝條修剪等栽培管理手段，除了可直接降低茶角盲椿象族群密度外，亦可間接減少茶角盲椿象食物來源繼而降低其族群量 (Das, 1965; Muraleedharan and Selvasundaram, 2002; Rahman et al., 2006; Roy et al., 2010a)；規律採摘與配合使用化學藥劑可有效控制茶角盲椿象的發生 (Rahman et al., 2006)。移除茶園周圍及茶樹行間之中間寄主植物 (表一) 亦為一良好耕作防治手段 (Das, 1965; Roy et al., 2010a)。故在茶園與其他作物園或雜木林之間隔區中，應避免雜草等其他茶角盲椿象取食植物之生長，以減少當茶園施予化學藥劑防治時，茶角盲椿象遷徙移居期間而得以繼續生存繁殖。茶角盲椿象喜好濕度高及涼爽氣候，故此害蟲常在重度遮蔭的茶園中嚴重發生，故遮蔭管理也是栽培防治的重要方式。

機械和物理防治方法

茶角盲椿象以機械及物理防治通常較少，徒手抓蟲 (林，2014) 可在發生初期時進行，且最佳進行時機為早晨及傍晚 (Roy et al., 2015)。屏障施藥法 (barrier spraying) 為一種特殊施藥方法，其為先於受害茶園周圍 (約 8-10 茶行) 施藥，再向茶園中心施藥，此方法可以避免施藥時茶角盲椿象向施藥的反方向遷徙，Das (1965) 認為此一施藥方法可提升化學藥劑對茶角盲椿象防治之效果。利用茶角盲椿象對茶樹品種喜好性以誘捕之，亦為物理防治其中一種措施，Hazarika 等人 (2009) 指出茶樹品種 TV1 容易受茶角盲椿象危害，可作為誘捕品種。Andrews (1914, 1919, 1923) 及 Ballard (1921) 指出土壤中鉀元素較多時，茶樹受茶角盲椿象危害較輕微，土壤中磷鉀肥比例較高時，茶樹容易受茶角盲椿象危害。Borthakur 等人 (2011) 報導指出，超音波法可作為茶角盲椿象整合性管理中之重要一環，其為將茶園暴露在 20 KHz 之頻率下，每天分別處理 15、30 與 45 分鐘，易使茶角盲椿象若蟲死亡。邱等 (2012) 研究指出，利用不同波長之 LED 進行椿象誘引，結果顯示椿象對紫光及藍光有較高的偏好性，對於紅光、黃光及白光較不具偏好性。

生物防治

一、天敵

在傳統的生物防治觀念下為利用投入捕捉性或是寄生性天敵昆蟲，但目前尚無相關資訊，僅有少量的茶角盲椿象天然防治媒介曾被報導 (Simmonds, 1970; CIBC, 1983; Cadou, 1994)。Watt and Mann (1903) 及 Barthakur (2011) 指出一種獵椿 (Reduviid bug) 可以捕食茶角盲椿象；Ambika 等人 (1979) 指出一種螞蟻 *Crematogaster wrougtoni* Forel (Hymenoptera: Formicidae) 會捕食茶角盲椿象卵及初齡若蟲；Bhat and Srikumar (2013) 在可可上發現有兩種茶角盲椿象卵寄生蜂，分別為 *Telenomus* sp.及 *Chaetostricha* sp.；Bhat 等人 (2013) 在腰果植株上發現有 3 種獵椿可以有效捕食茶角盲椿象若蟲及成蟲，分別為 *Panthous bimaculatus* Dist、*Sycanus collaris* Fab 及 *Rihirbus trochantericus luteous* Stal；Somchowdhury 等人 (1993) 報導了一種草蛉 (*Chrysoperla* sp.) 在人造籠中會捕食茶角盲椿象，但其捕捉效率仍需加強。一種錫威特貓蛛 (*Oxyopes shweta* Tikader) 被報導為對茶角盲椿象若蟲及成蟲具有防治潛力之捕捉性天敵 (Mukhopadhyay and Sarker, 2007; Roy et al., 2006; Kumar and Mukhopadhyay, 2014)。在印度南部，一種寄生蜂 (*Erythmelus helopeltidis* Gahan) 會寄生茶角盲椿象的卵 (Sudhakaran and Muraleedharan, 1998, 2006)，實驗室環境下卵寄生成功率為 52-83%。在印度西北部則被報導有許多茶角盲椿象天敵，如草蛉 (*Chrysoperla carnea* Stephens, *Mallada* sp)、貓蛛 (*Oxyopes* sp)、條紋蠅虎蛛 (*Plexippus* sp.)、跳蛛 (*Phidippus* sp.、Marpissa sp)、黃帶犀獵椿 (Sycanus croceovittatus)、螳螂等 (Das et al., 2010; Barthakur, 2011; Borah et al., 2012)(圖二)。

昆蟲病原性真菌亦可於角盲椿象族群中發現，其特殊寄生能力為可穿透茶角盲椿象外表皮進而感染並致死 (圖三)，Gurusubramanian 等人 (2009) 報導指出，茶園每公頃施用白僵菌 *Beauveria bassiana* (Bals.-Criv.) 3 公斤，較對照組可降低茶角盲椿象 42-62%之危害率。Ghatak 等人 (2008) 在孟加拉西部茶區測試了白僵菌 (*B. bassiana)*、黑僵菌 (Metarrhizium anisopliae (Metchnikoff) Sorokin) 及臘蚧輪刺孢菌 (*Verticillium lecanii* (Zimmerman) Viegas) 對茶角盲椿象之防治效果，結果顯示白僵菌可以降低茶角盲椿象危害率 (88%) ，而其他測試真菌則無防治效果。Bordoloi 等人 (2011) 報告指出，有六種昆蟲病原真菌在印度阿薩姆茶區被發現可以感染茶角盲椿象，包括有鐮孢菌屬 (*Fusarium* sp.)、黃麴菌 (*Aspergillus flavus*)、芽枝黴菌屬 (*Cladosporium* sp.)、彎孢菌屬 (*Curvularia* sp.)、枝頂孢屬 (*Acremonium* sp.) 及木黴菌屬 (*Trichoderma* sp.)。此外 Mukerji 與 Roy Choudhuri (1965) 報導了一種六索線蟲會寄生茶角盲椿象，不過被寄生的茶角盲椿象不會有病徵表現，除非

檢查其內臟才會發現。林等 (2014) 指出白僵菌 *B. bassiana* 菌株 Bb011 在實驗室中對茶角盲椿象之感染及產孢效果佳，具有開發為防治資材之潛力 (圖四)。

二、植物源殺蟲劑

植物源殺蟲劑通常被視為生物可分解性、系統性、環境友善及對哺乳類動物無毒之安全防治資材 (Isman, 2006)，目前已有許多研究針對苦楝種子水萃取液對茶角盲椿象拒食作用進行評估。此外，苦楝種子水萃液更被指出具有降低卵孵化率與減短產卵與若蟲期 (Dutta et al., 2013)。Roy 等人 (2010a) 測試了不同的印楝素濃度對茶角盲椿象防治效果，結果顯示僅在印楝素施用濃度高達 250 ppm 時防治率可達 65%。究其原因，茶角盲椿象為利用口器刺吸取食植物汁液，而印楝素為非系統性資材，茶角盲椿象取食含有印楝素分布的部位機率相對低，故一般市售商品 (濃度不及 250 ppm) 常無法表現其防治效果，故印楝素施用濃度為防治茶角盲椿象是否成功之重要因子。除了苦楝外，尚有許多植物資材之萃取液被測試對茶角盲椿象的防治效果 (表二)，但大部分的研究仍在實驗室階段 (Hazarika et al., 2009)。在印度，已有部分化學農藥與印楝素合併製成單一製劑，如安殺番及第滅寧等 (Roy et al., 2010a)。

儘管植物源殺蟲劑為直接來自植物非人工合成，其使用原則與合成化學農藥相同，仍須遵照藥劑輪用概念，避免茶角盲椿象對相同防治資材產生抗性。

三、性費洛蒙

茶樹蟲害防治上常使用性費洛蒙誘殺法，Somchoudhury 等人 (1993) 及 Sudhakaran (2000) 認為利用茶角盲椿象的性費洛蒙活性誘引是可行的，Sachin 等人 (2008) 分析了茶角盲椿象雌性處女蟲體的胸椎部分之生物有效成分，發現有 2 種有效成分為 (Z)-3 hexenyl acetate 及 (E)-2-hexenol，在比例 1 : 5 時測試雄蟲會產生被誘引效果。

化學防治

在 1940 年代，茶角盲椿象的防治主要仰賴 DDT，而當時茶樹害蟲防治用藥有 10%氯丹粉劑 (chlordane)、50%滴滴涕 (DDT) 可濕性粉劑、20% Endrex 乳劑、50%六氯化苯 (Gammexane) 可濕性粉劑、5%蟲必死 (BHC) 粉劑、20%林丹 (lindane) 乳劑、阿特靈 (Aldrin)、地特靈 (dieldrin)、異狄氏劑 (endrin) 等 (Glover, 1955; Mukerjea, 1962)，在 Dooars 茶區自從導入安殺番 (endosulfan) 藥劑後，發現該藥劑為極具效果之防治藥劑，相當於 DDT 及地特靈 (Mukerjea, 1962)，適逢安殺番導入茶區後 DDT 被禁用，而在 1970 年代共有 8 種化學殺蟲劑可供使用於茶園中，包括安殺番 (endosulfan)、久效磷 (monocrotophos)、裕必松 (phosalone)、Shalimar Tar oil、大滅松 (dimethoate)、撲滅松 (fenitrothion)、蟲死蜱 (chlorpyriphos) 及拜裕松 (quinalphos) 等 (Banerjee, 1973)。合成除蟲菊類藥劑則是在 1982-1983 間引進印度東北部茶區使用 (Satyanarayana, 1982, 1983)。在 2001 年起有許多殺蟲劑出現，如安殺番、拜裕松、福賜米松 (phosphomidon) 、裕必松、歐殺松 (acephate)、大滅松、蟲死蜱、久效磷、滅多松 (oxydemeton methyl)、賽洛寧 (lamda-cyhalothrin)、貝他賽扶寧 (beta-cyfluthrin)、依芬寧 (etofenprox)、培丹 (cartap hydrochloride)、亞滅寧 (alphamethrin)、賽滅寧 (cypermethrin)、第滅寧 (deltamethrin)、佈飛松 (profenfos)、賽速安 (thiomethoxam)、益達胺 (imidacloprid) 及苦楝素製劑 (neem formulations) 等 (Anonymous, 2001)，然而目前僅有少量相對安全 (依據殘留容許量 maximum residue limits, MRL) 的化學藥劑可供使用，包括第滅寧、賽速安勃 (thiomethoxam)、畢芬寧 (bifenthrin)、佈飛松、拜裕松及賽果培 (thiacloprid) 等。廖 (1977) 報告指出納乃得具有良好防治茶角盲椿象效果；林等 (2014) 測試不同稀釋倍數之畢芬寧及賽扶寧對

茶角盲椿象防治之效果，結果顯示 2,000 倍稀釋之賽扶寧具有防治茶角盲椿象效果。

Rahman 等人 (2007) 及 Roy 等人 (2009a, 2010c) 針對不同殺蟲劑對茶角盲椿象之殺卵毒性進行研究，報導指出佈飛松、芬普寧 (fenpropathrin) 及賽洛寧具有殺卵毒性，但阿巴汀 (abamectin)、印楝素 (azadirachtin)、安殺番、亞特松 (oxydemeton methyl) 及畝殺松則對茶角盲椿象之卵無致死作用。

在藥效維持評估研究中，Roy 等人 (2008) 指出新菸鹼類 (neonicotinoids)、合成除蟲菊類 (synthetic pyrethroids) 及有機磷殺蟲劑 (monocrotophos) 在田間施用有效期約為 18-28 天，亞特松、安殺番、拜裕松在田間殘效較短，約為 7-11 天。

茶角盲椿象管理上若需要重複性的施藥，輪用不同作用機制之藥劑是必須的，Roy 等人 (2008 a, 2008b, 2009c, 2010b, 2013) 等報導即指出茶角盲椿象已對安殺番、拜裕松及第滅寧具有抗藥性，由於藥劑輪用概念的不足，大部分茶區出現以化學藥劑防治茶角盲椿象的挑戰。

未來防治管理展望

截至目前已有許多茶角盲椿象防治策略的研究，可供應用於茶園中防治此刺吸式口器害蟲。然而實務的防治仍以化學防治為主，而農民習慣以經常性的施藥及相同藥劑不輪用的方式進行害蟲管理，因而造成害蟲產生田間抗藥性、害蟲一再重複發生與農藥過量殘留等問題。最佳解決以上問題之方法為配合實際田間狀況並綜合應用所有防治策略，以達最有效的害蟲管理。

綜合諸多研究，茶角盲椿象之化學防治藥劑主要以新菸鹼類、合成除蟲菊類及有機磷劑等，但目前在臺灣尚無針對茶角盲椿象防治之核准登記使用藥劑，農友在進行化學藥劑選用時須特別注意，以提升茶品之飲用安全。

害物整合性管理 (Integrated Pest Management, IPM) 為一種以生態為基礎且長期性的害物管理策略，其中包含各種防治策略，包括栽培防治、機械與物理防治、生物防治、化學防治等，其中化學防治則需要參考基礎監測資料及遵守藥劑輪用等適當的操作守則；非化學農藥防治策略除了應加強該項技術本身之有效性外，提供正確的操作方式，方可提升防治效率，尤應配合害物發生生態及該茶園之氣候環境條件，並適當調整施用技術等；生物防治則需要找尋最佳的天敵昆蟲及病原微生物，除了繁衍容易外，提升天敵及病原微生物存活時間與強化其在茶園族群建立能力，更是重要課題之一。

結　語

茶角盲椿象的防治已為世界各地茶區重要課題之一，該如何適當利用現有知識及因應氣候環境進行防治策略的調整，實為所有為茶產業努力的專家、學者及茶農等應該著力的方向。除了開發更多新穎的防治技術外，確實落實整合性防治技術，方為茶角盲椿象防治之最重要途徑。

參考文獻

1. 林秀榮、曾信光、許飛霜、邱明賜、余錦安. 2014. 茶業改良場 103 年年報 pp. 96-101。
2. 林秀榮、戴佳如、劉天麟、黃思穎. 2013. 茶角盲椿象與其危害茶芽後之製茶品質. 茶業專訊 84: 11-13。
3. 林秀榮. 2014. 第一次抓蟲就上手--茶角盲椿象防治. 茶情雙月刊 71: 1-2。
4. 邱明賜、林秀榮、劉天麟. 2012. LED 燈應用於有機茶園農害防治. 有機農業研究團隊研發成果

研討會專刊. 行政院農業委員會花蓮區農業改良場出版. 花蓮. pp. 31-40。
5. 曾信光. 2004. 茶角盲椿象. 植物保護圖鑑系列 4-茶樹保護，第 52 頁. 防檢局.台北。
6. 廖增祿. 1977. 茶角盲椿象生活史調查及其藥劑防治試驗. 茶業改良場66年年報 pp. 148-149。
7. Ahmed, M. 1996. Relationship between infestation intensity and crop loss by *Helopeltis* in tea. Tea J Bangladesh. 32: 20-30.
8. Ahmed, M. 2005. Tea pest management. Dhaka: Evergreen Printing and Packaging. pp. 1-29.
9. Ahmed, M., Paul, S. K. and Mamun, M. S .A. 2011. Field performance and economic analysis of some commonly used insecticides against tea mosquito bug, *Helopeltis theivora* W. Bangladesh J Agri Res. 36: 449-454.
10. Ahmed, P., Bhagawati, P., Das, S. K., Kalita, M. C. and Das, S. 2013. Hypersensitive reaction and anatomical changes of young tea leaf (Camellia sinensis, clone TV1) during feeding by tea mosquito bug (Helopeltis theivora Waterhouse: Hemiptera: Miridae). Int. J. Curr. Micro. App. Sci. 2: 187-195.
11. Ambika, B. and Abraham, C. C. 1983. New record of *Helopeltis theivora* Waterhouse and an undetermined species of *Helopeltis* (Miridae: Hemipetra) as potential pests of cashew, Anacardium occidentale Linn. Indian J Entomol. 45: 183-184.
12. Ambika, B., Abraham, C. C. and Vidyadharan, K. K. 1979. Relative susceptibility of cashew types to infestation by *Helopeltis antonii* Sign. (Heteroptera: Miridae) In: Proceedings of PLACROSYM II; 26-29 June 1979; Ootacamund (India); pp. 513-516.
13. Andrews, E. A. 1914. A note on the relation between the tea mosquito (*Helopeltis theivora*) and the soil. Q J Indian Tea Assoc. 4: 31-35.
14. Andrews, E. A. 1919. A preliminary note on the present state of the mosquito-blight enquiry. Q J Indian Tea Assoc. 4: 119-129.
15. Andrews, E. A. 1923. Factors affecting the control of the tea mosquito bug (*Helopeltis theivora*, Waterh.). London: Worrall & Robey; p. 260.
16. Anonymous. 2001. TRA approved pesticides (as on 30th June, 2001). Two and a Bud. 48: 44-47.
17. Ballard, E. 1921. *Helopeltis* and its relatives. Planters' Chron. 16: 489-491.
18. Banerjee, B. 1973. List of Approved Pesticides. Two and a Bud. 20: 33-36.
19. Banerjee, B. 1983. Arthropod accumulation on tea in young and old habitats. Ecol Entomol. 8: 117-123.
20. Barbora, B. C. and Singh, K. 1994. All about *Helopeltis theivora*: a serious pest of tea. Two and a Bud. 41: 19-21.
21. Barthakur, B. K. 2011. Recent approach of Tocklai to plant protection in tea in North east India. Sci Culture. 77: 381-384.
22. Bhat, P. S. and Srikumar, K. K. 2013. Record of egg parasitoids *Telenomus* sp. laricis group (Hymenoptera: Platygastridae) and Chaetostricha sp. (Hym: Trichogrammatidae) from *Helopeltis theivora* Waterhouse (Heteroptera: Miridae) infesting cocoa. Int J Agric Sci. 3: 510-512.
23. Bhat, P. S., Srikumar, K. K., Raviprasad, T. N., Vanitha, K., Rebijith, K. B. and Asokan, R. 2013. Biology, behavior, functional response and molecular characterization of *Rihirbus trochantericus Sta*l var. *luteous* (Hemiptera: Reduviidae: Harpactorinae) a potential predator of *Helopeltis* spp. (Hemiptera: Miridae). Entomol News. 123: 264-277.

24. Bhuyan, M. and Bhattacharyya, P. R. 2006. Feeding and oviposition preference of *Helopeltis theivora* (Hemiptera: Miridae) on tea in Northeast India. Insect Sci. 13: 485-488.
25. Bora, S. and Gurusubramanian, G. 2007. Relative toxicity of some commonly used insecticides against adults of *Helopeltis theivora* Waterhouse (Miridae: Hemiptera) collected from Jorhat area tea plantations, South Assam, India. Resistant Pest Manag Newsl. 17: 8-12.
26. Borah, T., Rahman, A., Borthakur, M. and Barthakur, B. K. 2012. Biology and predatory potential of a newly recorded green lacewing, *Mallada* sp. (Neuroptera: Chrysopidae) on tea mosquito bug *Helopeltis theivora* (Waterhouse). Two and a Bud. 59: 60-62.
27. Bordoloi, M., Madhab, M., Dutta, P., Borah, T., Nair, S. C., Pukhan, I., Debnath, S. and Barthakur, B. K. 2011. Potential of entomopathogenic fungi for the management of *Helopeltis theivora* (Waterhouse). Abstract of World Tea Science Congress; Tocklai Experimental Station, Tea Research Association; Assam, India; p. 62.
28. Borthakur, S., Bhuyan, M., Bhattacharyya, P.R. and Rao, P.G. 2011. Ultrasound: a potential tool for management of tea mosquito bug, *Helopeltis theivora* Waterhouse (Miridae:Hemiptera). Sci Culture. 77:493-495.
29. CAB. 1992. Citation distribution maps of plant pests. Wallingford: CAB International; p. 530.
30. Cadou, J. 1994. Les miridae du cotonnier an Afrique et a Madagascar. Montpellier: CIRAD; p. 74.
31. Chakraborty, U. and Chakraborty, N. 2001. Impact of environmental factors on infestation of tea leaves by *Helopeltis theivora*, and associated changes in flavonoid flavor components and enzyme activities. Phytoparasitica. 33: 88-96.
32. Cheramgoi, E. 2010. Integrated management of tea mosquito bug (*Helopeltis schoute* Deni). TRFK Q. 15: 5-7.
33. CIBC (Commonwealth Institute of Biological Control). 1983. Possibility for the use of natural enemies in the control of *Helopeltis* spp. (Miridae). Biocontrol News Inf. 4: 7-11.
34. Cohen, S. C. P. 1922. Iets over den steek van *Helopeltis*. Meded Proefst Thee Buitenzorg. 81: 24-25.
35. Corbett, G. H. 1930. Entomological notes first quarter 1930. Malayan Agric J. 18: 212-214.
36. Cranham, J. E. 1966a. Tea pest and their control. Ann Rev Entomol. 11: 491-514.
37. Cranham, J. E. 1966b. Insect and mite pest of tea in Ceylon and their control. Monographs on tea production in Ceylon. Talawakelle: Tea Research Institute of Ceylon. No. 6; p. 122.
38. Damiri, B. V. 2002. Integrated pest management for controlling tea pests in Indonesia. [cited 2014 Apr. 10]. Available from: http://faculty.ksu.edu.sa/1882/Documents/502home08/Projects/Boy.doc
39. Das, G. M. 1957. Pests in relation to environment. Two and a Bud. 4: 14-16.
40. Das, G. M. 1965. Pest of tea in North-East India and there control (Memorandum No. 27). Jorhat Tocklai Experimental Station, Tea Research Association; p. 169-173.
41. Das, S., Roy, S. and Mukhopadhyay, A. 2010. Diversity of arthropod natural enemies in the tea plantations of North Bengal with emphasis on their association with tea pests. Curr Sci. 99: 1457-1463.
42. Das, S. C. 1984. Resurgence of tea mosquito bug *Helopeltis theivora* Waterhouse, a serious pest of tea. Two and a Bud. 31: 36-38.
43. Deka, M. K. and Saikia, G. K. 2011. Antifeedant and growth regulatory effects of *Clerodendron Inerme* (Linn.) Gaertn. and Lantana Camara L. extracts on tea mosquito bug, *Helopeltis Theivora*

Waterhouse (Hemiptera: Miridae). Pestic Res J. 23: 32-35.
44. Deka, M. K., Handique, R., Karan, S. and Hazarika, L. K. 1998. Effect of aqueous extracts on longevity and fecundity of tea mosquito bug. Crop Res. 16: 102-105.
45. Deka, M. K., Handique, R., Karan, S. and Hazarika, L. K. 1998. Effect of aqueous extracts on longevity and fecundity of tea mosquito bug. Crop Res. 16: 102-105.
46. Deka, M. K., Singh, K. and Handique, R. 2000. Field efficacy of different plant extracts in controlling tea mosquito bug, *Helopeltis theivora* Waterh. J Appl Zool Res. 11: 25-28.
47. Dhar, P. P., Samanta, A. K., Somchowdhury, A. K. and Roychoudhury, N. 2001. Distribution of tea mosquito bug, nymph and adult in different regions of light intensity in tea bushes in North east India. The Hort J. 14: 71-74.
48. Dolui, A. K. and Debnath, M. 2010. Antifeedant activity of plant extracts to an insect *Helopeltis theivora*. J Environ Biol. 31: 557-559.
49. Dolui, A. K., Debnath, M., De, B. and Kumar, A. 2012. Reproductive activities of *Heliotropium indicum* isolate against *Helopeltis theivora* and toxicity evaluation in mice. J Environ Biol. 33: 603-607.
50. Du Pasquier, R. H. 1932. Principales maladies parasitaires du théier et du caféier en Extréme-Orient. Bull Econ Indochine. 35: 367-415.
51. Dutta, P., Reddy, S. G. E. and Borthakur, B. K. 2013. Effect of neem kernel aqueous extract (nkae) in tea mosquito bug *Helopeltis theivora* (Waterhouse, 1886) (heteroptera: miridae). Munis Entomol Zool. 8: 213-218.
52. Fernandes, G. W. 1990. Hypersensitivity: a neglected plant-resistance mechanism against insect herbivores. Environmental Entomol. 19: 1173-1182.
53. Gao, L. L., Klingler, J. P., Anderson, J. P., Edwards, O. R. and Singh, K. B. 2008. Characterization of pea aphid resistance in Medicago truncatula. Plant Physiol. 146: 996-1009.
54. Ghatak, S. S., Reza, M. W. and Poi, S. C. 2008. Bio-efficacy of some biopesticides and modern synthetic pesticides against tea mosquito bug, *Helopeltis theivora* Waterhouse (Hemiptera: Miridae). Res Crops. 9: 165-171.
55. Giesberger, G. 1983. Biological control of the *Helopeltis* pest of cocoa in Java. In: Taxopeus H, Wessel PC, editors. Cocoa Research in Indonesia 1900-1950. American Cocoa Research Institute, International Office of Cocoa and Chocolate; pp. 91-181.
56. Gogoi B, Choudhury, K., Sharma, M, Rahman, A. and Borthakur, M. 2012. Studies on the host range of Helopeltis theivora. Two and a Bud. 59: 31-34.
57. Gope, B. and Handique, R. 1991. Bio-Ecological Studies on the Tea Mosquito Bug, *Helopeltis theivora* Waterhouse in North-East India. Two and a Bud. 38: 21-27.
58. Gurusubramanian, G. and Bora, S. 2008. Insecticidal resistance to tea mosquito bug, *Helopeltis theivora* Waterhouse (Miridae: Heteroptera) in North East India. J Environmental Res Dev. 2: 560-567.
59. Gurusubramanian, G., Rahman, A., Sarmah, M., Roy, S. and Bora, S. 2008a. Pesticide usage pattern in tea ecosystem, their retrospects and alternative measures. J Environ Biol. 29: 813-826.
60. Gurusubramanian, G., Senthil, N. K., Tamuli, A. K., Sarmah, M., Rahman, A., Bora, S. and Roy, S. 2009. Biointensive integrated management of tea pests for sustainable tea production in North East

India. Int J Tea Sci. 7: 45-59.
61. Gurusubramanian, G., Senthilkumar, N., Bora, S. and Roy, S. 2008b. Change in Susceptibility in male *Helopeltis theivora* Waterhouse (Jorhat Population, Assam, India) to different classes of insecticides. Resist Pest Manag Newsl. 18: 36-40.
62. Hainsworth, E. 1952. Tea pest and Disease and there control with special reference to North-East India. Cambridge: W. Heffer & Sons; p. 130.
63. Hargreaves, H. 1936. Report of the Government Entomologist for 1935. Annual Report of the Department of Agriculture; Uganda; 1935; pp. 8-11.
64. Hazarika, L. K., Bhuyan, M., Hazarika, B. N. 2009. Insect pests of tea and their management. Ann Rev Entomol. 54: 267-284.
65. Isman, M. B. 2006. Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. Annu Rev Entomol. 51: 45-66.
66. Kalita, H., Deka, M. K. and Singh, K. 2000. Diet breadth of tea mosquito bug, *Helopeltis theivora* Waterhouse (Hemiptera: Miridae). Crop Res. 19: 122-124.
67. Kalita, H. and Singh, K. 1999. Seasonal biology of tea mosquito bug, *Helopeltis theivora* Waterh. on tea. J App Zool Res. 10: 29-31.
68. Kalita, H., Handique, R., Singh, K. and Hazarika, L. K. 1995. Feeding behaviour of tea mosquito bug. Two and a Bud. 42: 34-35.
69. Karmawati, E., Savitri, T. H., Wahyono, T. E. and Laba, I. W. 1999. Dinamika populasi *Helopeltis antonii* Sign. pada tanaman jambu mente. Jurnal Penelitian Tanaman Industri. 4: 163-167.
70. Klingler, J., Creasy, R., Gao, L. L., Nair, R. M., Calix, A. S., Jacob, H. S., Edwards, O. R. and Singh, K. B. 2005. Aphid resistance in Medicago truncatula involves antixenosis and phloem-specific, inducible antibiosis, and maps to a single locus flanked by NBS-LRR resistance gene analogs. Plant Physiol. 137: 1445-1455.
71. Koningsberger, J. C. 1908. Tweede overzicht der schadelijke en nuttige insekten van Java. Mededeelingen uitgaande van het Departement van Landbouw. 6: 1-113.
72. Kumar, B. and Mukhopadhyay, A. 2014. Study on biological control potential of Lynx spider, *Oxyopes shweta* (Araenae: Oxyopidae) against tea mosquito bug, *Helopeltis theivora* (Heteroptera: Miridae). In: Souvenir and abstracts of AZRA silver jubilee international conference, “Probing biosciences for food security and environmental safety”; 16-18 February 2014; CRRI, Cuttack, India; pp. 30-31.
73. Leach, R. 1935. Insect injury stimulating fungal attack on plants: a stem canker, an angular leaf spot, a fruit scab and a fruit rot of mangoes caused by *Helopeltis bergrothi* Reuter (Capsidae). Ann Appl Biol. 22: 525-537.
74. Leefmans, S. 1916. Contributions to the Question of *Helopeltis* and Tea. Meded. v. h. Proefstation voor Thee. Buitenzorg L. 50: 214.
75. Lever, R. J. A. W. 1949. The tea mosquito bugs (*Helopeltis* spp.) in the Cameron Highlands. Malayan Agric J. 32: 91-108.
76. Mamun, M. S. A. and Ahmed M. 2011. Integrated pest management in tea: prospects and future strategies in Bangladesh. The J Plant Prot Sci. 3: 1-13.
77. Muhamad, R. and Chung, G. T. 1993. The relationship between population fluctuation of *Helopeltis*

theivora Waterhouse, availability of cocoa pods and rainfall pattern. Pertanika J Trop Agric Sci. 16: 81-86.

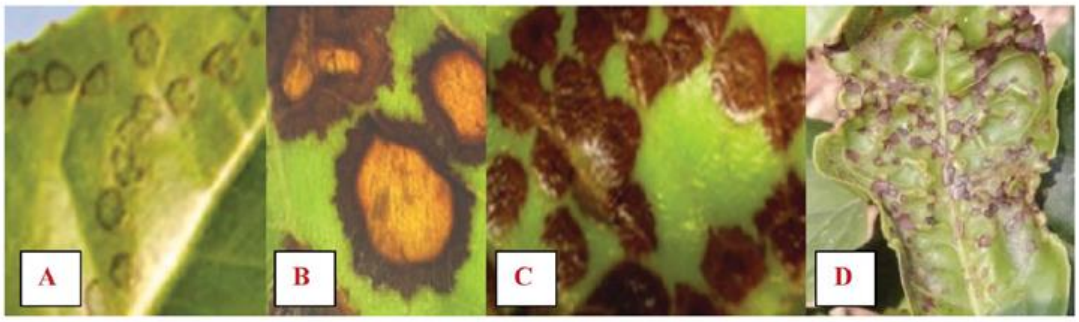
78. Mukerjea, T. D. 1962. Note on pesticides and weedicides. Two and a Bud. 9: 2223.
79. Mukhopadhyay, A. and Roy, S. 2009. Changing dimensions of IPM in the tea plantations of the North Eastern sub Himalayan region. In: Ramamurthy VV, Gupta GP, editors. Proceedings of National Symposium on IPM Strategies to Combat Emerging Pest in the Current Scenario of Climate change; 28-30 January; Arunachal Pradesh (India): Central Agricultural University Pasighat; pp. 290-302.
80. Mukhopadhyay, A. and Sarker, M. 2007. Natural enemies of some tea pests with special reference to Darjeeling, Terai and the Dooars. Kolkata: NTRF, Tea Board; pp. 7-49.
81. Muraleedharan, N. 1987. Entomological research in tea in southern India. J Coffee Res. 17: 80-83.
82. Muraleedharan, N. 1992a. Pest control in Asia. In: Wilson KC, Clifford MN, editors. Tea: cultivation to consumption. London: Chapman and Hall; pp. 375-412.
83. Muraleedharan, N. 1992b. Bioecology and management of tea pests in southern India. J Plantation Crops. 20: 1-21.
84. Muraleedharan, N. and Selvasundaram, R. 2002. An IPM package for tea in India. Planters' Chronicle. 4:107-124.
85. Pillai, G. B., Singh, V., Dubey, O. P. and Abraham, V. A. 1979. Seasonal abundance of tea mosquito *Helopeltis antonii* on cashew tree in relation to meteorological factors. In: Proceeding of The International Cashew Symposium; Cochin; pp. 103-110.
86. Prasad, S. 1992. Infestation of Helopeltis. Bombay: Tea times, Sandoz (India) Ltd.
87. Ragesh, G. 2013. New record of soapbush (*Clidemia hirta* (L.) Don, 1823) as a host and the biology of tea mosquito bug, *Helopeltis theivora* Waterhouse (Miridae: Hemiptera). Paper presented at: 2nd Global Conference on Entomology; Kuching, Sarawak, Malaysia.
88. Rahman, A., Sarmah, M., Phukan, A. K. and Gurusubramanian, G. 2007. Varietal preference and chemical control strategies for management of *Helopeltis theivora* Waterhouse. Uttar Pradesh J Zool. 27: 1-11.
89. Rahman, A., Sarmah. M., Phukan, A. K., Roy, S., Sannigrahi, S., Borthakur. M. and Gurusubramanian, G. 2006. Approaches for the management of tea mosquito bug, *Helopeltis theivora* Waterhouse (Miridae : Heteroptera). In: Proceedings of 34th Tocklai Conference-Strategies for Quality; 28-30 November 2005; Jorhat: Organized by Tocklai Experimental Station; Tea Research Association; pp. 146-161.
90. Rahman, I. and Nath, M. 2012. Properties and Potential of Natural Insecticides from Plants against *Helopeltis theivora* Waterhouse. Advances in Life Sci. 1: 29-31.
91. Rao, G. N. 1970. Helopeltis: A breakthrough in its control. UPASI Tea Sci Dept Bull. 28: 21-24.
92. Rao, G. N. and Murthy, R. L. N. 1976. Economics of tea pest control. In: Proceedings of the 22nd Scientific Conference Bulletin No. 33. Vol. 33. Tea Science Department; pp. 88-100.
93. Rattan, P. S. 1992. Pest and disease control in Africa. In: Wilson KC, Clifford MN, editors. Tea: Cultivation to Consumption. London: Chapman & Hall; pp. 331-352.
94. Roy, S., Talukdar, T., Saha, A. B., Banerjee, D. K., Sannigrahi, S. and Gurusubramanian, G. 2006. Species richness and seasonal abundance of spider and lady bird fauna in the tea eco-system of

North Bengal. In: Proceedings of 34th Tocklai Conference-Strategies for Quality; 28-30 November 2005; Organized by Tocklai Experimental Station, Tea Research Association; Jorhat; pp. 347-351.

95. Roy, S. 2008. Evaluation of the levels of insecticide susceptibility of *Helopeltis theivora* Waterhouse (Heteroptera: Miridae) and development of an efficacious strategy for management of the pest in Dooars tea plantation of North Bengal. Darjeeling, India: North Bengal University.
96. Roy, S. and Gurusubramanian, G. 2013. Comparison of life cycle traits of *Helopeltis theivora* Waterhouse (Heteroptera: Miridae) population infesting organic and conventional tea plantations, with emphasis on deltamethrin resistance. Arch Biol Sci. 65: 57-64.
97. Roy, S., Das, S., Mukhopadhyay, A. and Gurusubramanian, G. 2009. Screening of antiinsect properties of common botanicals isolated from plants of tea garden areas of North Bengal against the sucking pest, *Helopeltis theivora* (Het.: Miridae). In: Beniwal SPS, Choudhary SL, Nene YL, editors. Improving productivity and quality of tea through traditional agricultural practices. Secundrabad: Asian Agro- History Foundation
98. Roy, S., Gurusubramanian, G. and Mukhopadhyay, A. 2008. Insecticide persistence and residual toxicity monitoring in tea mosquito bug, *Helopeltis theivora* Waterhouse (Heteroptera: Hemiptera: Miridae) in Dooars, West Bengal. Resist Pest Manag Newsl. 17: 9-15.
99. Roy, S., Gurusubramanian, G. and Mukhopadhyay, A. 2010a. Neembased integrated approaches for the management of tea mosquito bug, *Helopeltis theivora* Waterhouse (Miridae: Heteroptera) in tea. J Pest Sci. 83: 143-148.
100. Roy, S., Mukhopadhyay, A. and Gurusubramanian, G. 2008a. Impact of pH (hydrogen ion concentration) of carrier water on the efficacy of commonly used insecticides against tea mosquito bug (*Helopeltis theivora* Waterhouse) in the Dooars tea plantation of North Bengal. Int J App Agric Res. 4: 25-28.
101. Roy, S., Mukhopadhyay, A. and Gurusubramanian, G. 2008b. Use Pattern of Insecticides in Tea Estates of the Dooars in North Bengal, India. North Bengal University. J Anim Sci. 2: 35-40.
102. Roy, S., Mukhopadhyay, A. and Gurusubramanian, G. 2008c. Antifeedant and insecticidal activity of Clerodendron infortunatum Gaertn. (Verbinaceae) extract tested on tea mosquito bug, *Helopeltis theivora* Waterhouse. (Hetoraptera: Miridae). Res Crops. 10: 152-158.
103. Roy, S., Mukhopadhyay, A. and Gurusubramanian, G. 2008e. Susceptibility status of *Helopeltis theivora* Waterhouse (Heteroptera: Miridae) to the commonly applied insecticides in the tea plantation of the Sub-Himalayan Dooars area of North Bengal. Resist Pest Manag Newsl. 18: 10-18.
104. Roy, S., Mukhopadhyay, A. and Gurusubramanian, G. 2009a. Ovicidal Toxicity of Chemical and Botanical Insecticides on the Eggs of Tea Mosquito Bug (*Helopeltis theivora* Waterhouse) in laboratory. Insect Environ. 14: 165-167.
105. Roy, S., Mukhopadhyay, A. and Gurusubramanian, G. 2009b. Biology of *Helopeltis theivora* (Heteroptera: Miridae) on tea (*Camellia sinensis*) in the sub Himalayan region. J Plantation Crops. 37: 226-228.
106. Roy, S., Mukhopadhyay, A. and Gurusubramanian, G. 2009c. Sensitivity of the tea mosquito bug (*Helopeltis theivora* Waterhouse), to commonly used insecticides in 2007 in Dooars tea plantations, India and implication for control. American-Eurasian J Agric Environ Sci. 6:244-251.

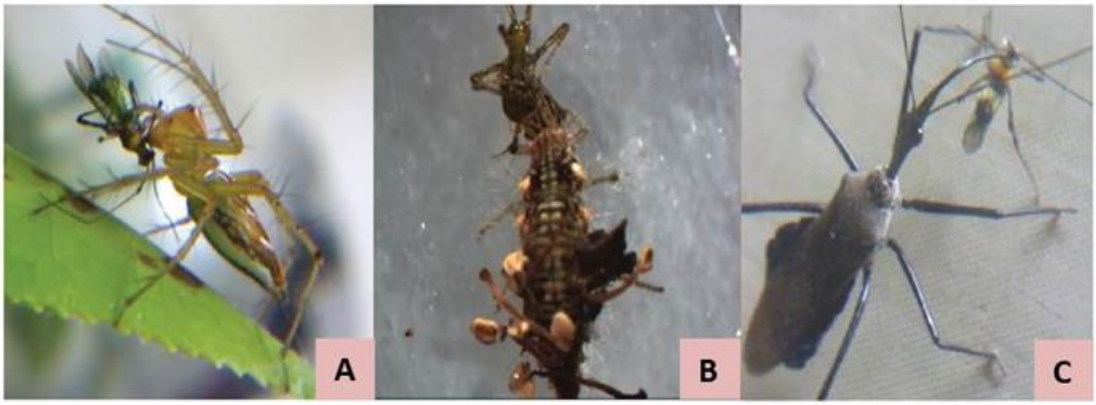
107. Roy, S., Mukhopadhyay, A. and Gurusubramanian, G. 2009d. Comparative lifecycle pattern of tea mosquito bug *Helopeltis theivora* (Miridae: Heteroptera) on tea (*Camellia sinensis*) and weed (*Mikania micrantha*). J Appl Zool Res. 20: 111-114.
108. Roy, S., Mukhopadhyay, A. and Gurusubramanian, G. 2010b. Fitness traits of insecticide resistant and susceptible strains of tea mosquito bug, *Helopeltis theivora* Waterhouse (Heteroptera: Miridae). Entomol Res. 40: 229-232.
109. Roy, S., Mukhopadhyay, A. and Gurusubramanian, G. 2010c. Relative susceptibility of tea mosquito bug, *Helopeltis theivora* Waterhouse and red spider mite, Oligonychus coffeae eggs to commonly used pesticides. J Plant Prot Res. 50: 271-276.
110. Roy, S., Muraleedharan, N., Mukhapadhyay, A. and Handique, G. 2015. The tea mosquito bug, *Helopeltis theivora* Waterhouse (Heteroptera: Miridae): its status, biology, ecology and management in tea plantations. Int. J. Pest. Mana. 61: 179-197.
111. Saha, D. and Mukhopadhyaya, A. 2013. Insecticide resistance mechanisms in three sucking insect pests of tea with reference to North-East India: an appraisal. Int. J. Trop. Insect. Sci. 33: 46-70.
112. Saha, D., Mukhopadhyay, A. and Bahadur, M. 2012a. Effect of host plants on fitness traits and detoxifying enzymes activity of *Helopeltis theivora*, a major sucking insect pest of tea. Phytoparasitica. 40: 433-444.
113. Saikia, J. K., Baruah, U., Barman, T. S., Saikia, H. and Bandyopadhyay. T. 2011. Impact of tea mosquito infestation on endogenous hormones of tea (*Camellia sinensis* L.). Sci Culture. 77: 412-415.
114. Sana, D. L. and Haq, M. I. 1974. Feeding intensity of tea mosquito bug during daily rhythm-I. Tea J Bangladesh. 10: 7-11.
115. Sarker, M. and Mukhopadhyay, A. 2006. Studies on salivary and midgut enzymes of a major sucking pest of tea, *Helopeltis theivora* (Heteroptera: Miridae) from Darjeeling Plains, India. J Ent Res Soc. 8: 27-36.
116. Sarmah, M. and Bhola, R. K. 2008. Antifeedant and repellent effects of aqueous plant extracts of *Azadirachta indica* and *Xanthium strumarium* on tea mosquito bug, *Helopeltis theivora* Waterhouse. Two and a Bud. 55: 36-40.
117. Sarmah, M. and Bhola, R. K. 2011. Effect of aqueous plant extracts on growth and development of tea mosquito bug, *Helopeltis theivora* Waterhouse. Indian J Entomol. 73: 258-262.
118. Sarmah, M., Phukan, A. K., Rahman, A. and Borthakur, M. 2011. Yield loss-infestation relationship and determination of economic injury level of tea mosquito bug. Two and a Bud. 58: 62-64.
119. Satyanarayana, G. 1982. Revised list of Approved Pesticides (as on December 1982). Two and a Bud. 19: 68-71.
120. Satyanarayana, G. 1983. Revised list of Approved Pesticides (as on December 1983). Two and a Bud. 30: 87-90.
121. Schuh, R.T. 1995. Plant bugs of the world (Insecta: Heteroptera: Miridae): systematic catalog, distributions, host list, and bibliography. New York (NY): The New York Entomological Society; pp. 475-516.
122. Simmonds, F. J. 1970. Commonwealth Institute of Biological Control report (Mimeograph). Oxford: CIBC; p. 7.

123. Smith, D., Brott, K. and Koki, G. 1985. Respiratory impairment in coffee factory-workers in the Asaro Valley of Papua-New-Guinea Br. J Ind Med. 42: 495-498.
124. Somchowdhury, A. K., Samanta, A. K. and Dhar, P. P. 1993. Approach to integrated control of tea mosquito bug. In: Proceedings of International Symposium of Tea Science and Human Health; 11–14 January; Kolkata (India): Tea Research Association; pp. 330-338.
125. Srikumar, K. K. and Bhat, P. S. 2013. Biology of the tea mosquito bug (*Helopeltis theivora* Waterhouse) on *Chromolaena odorata* (L.) R. M. King & H. Rob. Chilean J Agric Res. 73: 309-314.
126. Stern, V. M., Smith, R. F., van den Bosch, R. and Hagen, K. S. 1959. The integration of chemical and biological control of the spotted alfalfa aphid: The integrated control concept. Hilgardia 29(2): 81-101.
127. Stonedahal, G. M. 1991. Bull Entomol Res. 81: 465-490.
128. Sudhakaran, R. and Muraleedharan, N. 2006. Biology of *Helopeltis theivora* (Hemiptera: Miridae) infesting tea. Entomon. 31: 165-180.
129. Sudhakaran, R., Selvasundaram, R. 2000. Incidence of tea mosquito bug on Maesa indica. UPASI Tea Res Inst Newslett. 8: 3.
130. Sudhkaran, R. 2000. Studies in the Tea mosquito bug, *Helopeltis theivora* Waterhouse (Hemiptera: Miridae) infesting tea in Southern India. Coimbatore (India): Bharathiar University.
131. Sundararaju, D. and Sundarababu, P. C. 1999. *Helopeltis* sp. (Heteroptera: Miridae) and their management in plantation and horticultural crops of India. J Plantation Crops. 27: 155-174.
132. Swaine, G. 1959. A preliminary note on *Helopeltis* spp. damaging cashew in Tanganyika territory. Bull Entomol Res. 50: 171-181.
133. Thu, P. Q., Griffiths, M. W., Pegg, G. S., McDonald, J. M., Wylie, F. R., King, J. and Lawson, S. A. 2010. Healthy plantations: a field guide to pests and pathogens of Acacia and Eucalyptus in Vietnam. Brisbane: Queensland Department of Employment, Economic Development and Innovation.
134. Tjallingii, W. F. and Esch, T. H. 1993. Fine-structure of aphid stylet routes in plant-tissues in correlation with EPG signals. Physiol Entomol. 18: 317-328.
135. Watson, T. F., Moore, L. and Ware, G. W. 1975. Practical Insect Pest Management. A self-instruction manual. San Fransisco (CA): W. H. Freeman and Company.
136. Watt, G., Mann and H. N. 1903. The Pests and Blights of the Tea Plant. Calcutta: Government Printing Press; p. 429.
137. Wills, G. A. 1986. Use of an early warning system for the control of *Helopeltis theivora* theobromae in cocoa. In: Proceedings of Cocoa and Coconuts Conference: Progress and Outlook. Kuala Lumpur (Malaysia); pp. 241-253.
138. Wood, B. J and Chung, G. F. 1989. Integrated management of insect pests of cocoa in Malaysia. The Planter. 65: 389-418.
139. Yong, M. L. and Qi, A. J. 1985. Notes on two Helopeltis bugs in Hainan island. Chinese J Trop Crops. 5: 2.
140.Zeiss, M. R. and Braber, K. D. 2001. Tea: integrated pest management ecological guide. E-book. Vietnam: CIDSE; pp. 33-41.



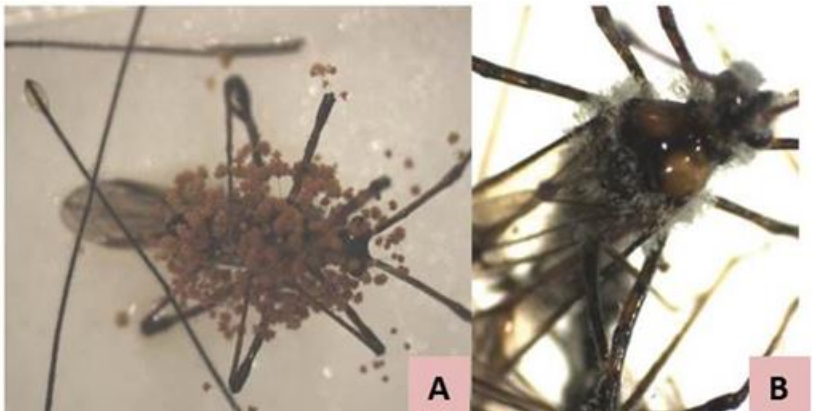
圖一、茶角盲椿象成蟲取食茶葉之取食斑點隨時間的變化。A. 取食後 2 小時，B. 取食後 3 小時，C. 取食後 24 小時，D. 取食後 5 天。(Roy 等人，2015)

Fig. 1. Feeding damage by adult TMB on tea: (A) after 2 h feeding, (B) after 3 h feeding, (C) after 24 h feeding, and (D) after 5 days feeding. (Roy et al., 2015)



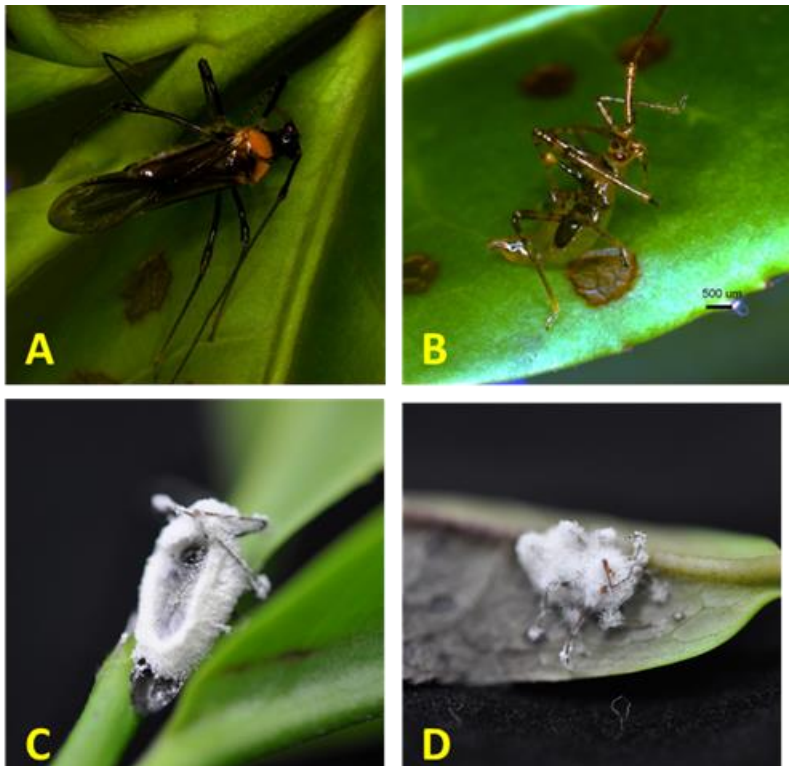
圖二、茶角盲椿象之天敵。A. 貓蛛捕食茶角盲椿象成蟲；B. 草蛉捕食茶角盲椿象若蟲；C. 黃帶犀獵椿象捕食茶角盲椿象成蟲。(Roy 等人，2015)

Fig. 2. Natural enemies of *Helopeltis Theivora*: (A) *Oxyopes* sp. feeding on adult TMB, (B) *Mallada* sp. feeding on nymph of TMB, and (C) *Sycanus croceovittatus* feeding on adult TMB. (Roy et al., 2015)



圖三、受昆蟲病原性真菌感染之茶角盲椿象成蟲。(Roy 等人，2015)

Fig. 3. Adult TMB infected by entomopathogenic fungi. (Roy et al., 2015)



圖四、茶角盲椿象受白僵菌菌株 Bb011 感染之情形。A 及 B 為感染初期蟲體僵直情形；C 及 D 為感染後期，白僵菌長出蟲體並大量產孢。

Fig. 4. TMB infected by *Beauveria bassiana* Bb011. A and B: the early infection period of TMB which showed the rigor bodies; C and D: the late infection period of TMB which showed numerous sporulation of *B. bassiana* Bb011 on TMB.

表一、茶角盲椿象之茶園周圍常見寄主植物整理 (Roy 等人，2015)

Table 1 List of hosts of *Helopeltis theivora* present in and around tea plantations (Roy et al., 2015)

寄主植物種類	學名	科別	文獻來源
直幹相思樹	*Acacia mangium* Willd.	豆科	Thu et al. (2010)
印度鐵莧	*Acalypha indica* L.	大戟科	Das (1965)
腰果	*Anacardium occidentale* L.	漆樹科	Ambika and Abraham (1983), Sundararaju (1993) and Das (1984)
牛心番荔枝	*Annona reticulata* L.	番荔枝科	Kalita et al. (2000)
卡鄧柏木	*Anthocephalus cadamba* (Roxb.) J. Bosser	茜草科	Saha and Mukhopadhyay (2013)
印度苦楝樹	*Azadirachta indica* A. Juss.	楝科	Sundararaju and Babu (1999)
大花咸豐草	*Bidens pilosa* L.	菊科	Saha and Mukhopadhyay (2013)
胭脂樹	*Bixa orellana* L.	胭脂樹科	Das (1984)
山茶花	*Camellia japonica* L.	山茶科	Sudhakaran and Muraleedharan (2006)
茶樹	*Camellia sinensis* (L.) Kuntze	山茶科	Das (1965)
大麻	*Cannabis sativa* L.	大麻科	Gogoi et al. (2012)
辣椒	*Capsicum* spp.	茄科	Anonymous (2007)
吉貝	*Ceiba pentandra* (L.) Gaertn.	錦葵科	Das (1984)
香澤蘭	*Chromolaena odorata* (L.) R.M. King & H. Rob	菊科	Srikumar and Bhat (2013)
金雞納樹	*Cinchona officinalis* L.	茜草科	Das (1984)
樟樹	*Cinnamomum camphora* (L.) J. Presl.	樟科	Das (1984)
毛野牡丹	*Clidemia hirta* (L.) Don	野牡丹科	Ragesh (2013)
金露華	*Duranta repens* L.	馬鞭草科	Gogoi et al. (2012)

厚殼樹	*Ehretia acuminata* R. Brown	紫草科	Barbora and Singh (1994)
蒲桃	*Eugenia jambolana*	桃金孃科	Kalita et al. (2000)
銳葉柃木	*Eurya acuminata* D.C.	山茶科	Das (1965)
垂葉榕	*Ficus benjamina* L.	桑科	Gogoi et al. (2012)
對葉榕	*Ficus hispida* L.f.	桑科	Saha and Mukhopadhyay (2013)
梔子花	*Gardenia jasminoides* Ellis	茜草科	Kalita et al. (2000)
紅仙丹花	*Ixora coccinea*	茜草科	Gogoi et al. (2012)
素馨	*Jasminum sandens* Vahl	木犀科	Das (1965)
包瘡葉	*Maesa indica* (Roxb.) DC.	紫金牛科	Sudhakaran and Muraleedharan (2006)
稱桿樹	*Maesa ramentacae* Wallich	紫金牛科	Das (1965)
基尖葉野牡丹	*Melastoma malabathricum* L.	野牡丹科	Das (1965)
小花蔓澤蘭	*Mikania micrantha* H.B. & K	菊科	Somchowdhury et al. (1993)
桑樹	*Morus alba* L.	桑科	Barbora and Singh (1994)
可因氏月橘	*Murraya koenigii*	芸香科	Gogoi et al. (2012)
台灣山酢漿草	*Oxalis acetosella* L.	酢漿草科	Barbora and Singh (1994)
鱷梨	*Persea bombycina* Kost	樟科	Gogoi et al. (2012)
火炭母草	*Persicaria chinensis* (L.) Nakai	蓼科	Saha and Mukhopadhyay (2013)
火焰木	*Phlogacanthus pubinervius* T. Anderson	爵床科	Somchowdhury et al. (1993)
火焰花	*Phlogacanthus thyrsiflorus* (Roxb.) Nees	爵床科	Gogoi et al. (2012)
胡椒	*Piper hamiltonii* C. DC.	胡椒科	Gogoi et al. (2012)
胡椒	*Piper nigrum* L.	胡椒科	Das (1984)

大葉豆腐柴	*Premna latifolia* Roxb.	馬鞭草科	Barbora and Singh (1994)
番石榴	*Psidium guajava* L.	桃金孃科	Saha et al. (2012)
蕨菜	*Pteridium aquilinum* (L.) Kuhn	碗蕨科	Saha and Mukhopadhyay (2013)
圓葉金午時花	*Sida cordifolia* L.	錦葵科	Gogoi et al. (2012)
烏蘇里山馬薯	*Smilax herbacea* L.	菝契科	Somchowdhury et al. (1993)
可可	*Theobroma cacao* L.	錦葵科	Anonymous (2007)

表二、具有防治茶角盲椿象潛力之植物種類整理 (Roy 等人，2015)

Table 2 Plants having anti-insect properties effective against *Helopeltis theivora* (Roy et al., 2015)

植物名稱及科別	使用部位	萃取基質	抗蟲作用機制	文獻來源
菖蒲 (菖蒲科)	葉片	水	殺卵、拒食	Sarmah and Bhola (2011)
鴨嘴花 (爵床科)	葉及肉質莖	水、氯仿、石油醚、甲醇	殺卵、拒食	Gurusubramanian et al. (2008a), , Roy et al. (2009)
藿香薊 (菊科)	全株	水	殺卵、拒食	Roy et al. (2009)
洋蔥 (百合科)	球莖	水	殺卵、拒食	Roy et al. (2009)
蒜 (百合科)	球莖	水	拒食	Roy et al. (2009)
香豆蔻 (薑科)	葉片	水	拒食	Roy et al. (2009)
釋迦 (番荔枝科)	葉及肉質莖	水	拒食	Gurusubramanian et al. (2008a) and Roy et al. (2009)
北艾 (菊科)	葉及肉質莖	水	殺卵、拒食	Roy et al. (2009)
印度苦楝 (楝科)	葉及肉質莖	水	拒食	Sarmah and Bhola (2008)
菊 (菊科)	乾花	水	拒食	Mamun and Ahmed (2011)
欠愉大青 (脣形科)	葉及肉質莖	水	殺卵、拒食、殺蟲	Gurusubramanian et al. (2008) and Roy et al. (2008c)
苦楮 (馬鞭草科)	葉及肉質莖	水	拒食、生長調節	Deka and Saikia (2011) and Deka et al. (2000); Gurusubramanian et al. (2008a)
白毛臭牡丹 (馬鞭草科)	葉及肉質莖	水	殺卵、拒食、殺蟲	Roy et al. (2010a)
白花曼陀羅 (茄科)	葉及肉質莖	水	殺卵、拒食、殺蟲	Mamun and Ahmed (2011), Roy et al. (2008c), and Roy et al. (2009)
小牙草 (茜草科)	葉片	水	拒食	Roy et al. (2009)
餘甘子 (大戟科)	葉片	水	拒食	Roy et al. (2009)
狗尾草 (紫草科)	葉及花	石油醚、乙酸乙酯、甲醇	拒食	Dolui and Debnath (2010) and Dolui et al. (2012)

馬櫻丹 (馬鞭草科)	葉及肉質莖	水、氯仿、石油醚、甲醇	拒食、殺蟲、生長調節	Deka and Saikia (2011), Deka et al. (1998), Gurusubramanian et al. (2008a), and Roy et al. (2009)
苦楝 (楝科)	種子及葉片	水	殺卵、拒食	Mamun and Ahmed (2011), Gurusubramanian et al. (2008)
苦瓜 (葫蘆科)	葉及肉質莖	水	拒食	Roy et al. (2009)
菸草 (茄科)	葉及肉質莖	水	殺卵、拒食、殺蟲	Roy et al. (2009)
短穗刺蕊草 (唇形科)	葉及肉質莖	水、氯仿	生長調節、降低繁殖	Gogoi et al. (2012), Rahman et al. (2007), Gurusubramanian et al. (2008a), Rahman and Nath (2012)
水蓼 (蓼科)	葉及肉質莖	水、氯仿、石油醚	拒食	Mamun and Ahmed (2011), Rahman and Nath (2012), and Sarmah and Bhola (2011)
紅蓼 (蓼科)	葉及肉質莖	水	生長調節、拒食	Deka and Singh (2005), Gurusubramanian et al. (2008a)
水黃皮 (豆科)	葉片	水	拒食	Gurusubramanian et al. (2008a)
水黃皮 (豆科)	種仁	水、氯仿、石油醚、甲醇	拒食、忌避	Deka et al. (1998), Deka et al. (2000), Mamun and Ahmed (2011), and Gurusubramanian et al. (2008b)
金鈕扣 (菊科)	葉及花	石油醚、乙酸乙酯、甲醇	拒食	Dolui and Debnath (2010)
桃花心木 (楝科)	種仁	水	殺蟲	Mamun and Ahmed (2011)
萬壽菊 (菊科)	全株	水	拒食	Roy et al. (2009)
黃荊 (唇形科)	葉片	水	拒食	Roy et al. (2009)
蒼耳 (菊科)	葉及肉質莖	水	殺卵、拒食、生長調節	Sarmah and Bhola (2008) and Sarmah and Bhola (2011)
薑 (薑科)	根部	水	殺卵、拒食	Roy et al. (2009)

The Review and Future Research Prospects of Tea Mosquito Bug, *Helopeltis* spp. (Heteroptera: Miridae)

Shiou-Ruei Lin[1]

Summary

Tea mosquito bug (*Helopeltis* spp. (Heteroptera: Miridae)) is one of the important piercing-stylet pest of tea in most tea-producing areas. Not only the nymphs but adults could damage the tea shoots and cause yield loss. The damage to tea by tea mosquito bug is not limit to the piercing-stylet sucking sap of young tea shoots. It is also including the oviposition which results in cracks and over-callusing that lead to blockages of the vascular bundles, which affects the physiology and causes stunted growth. So far, there are dozens of alternate host plants for tea mosquito bug. However, the most normally pest control is still using chemical pesticides. It is necessary for avoiding chemical residues and pesticide resistance by using integrated pest management instead of complete using chemical pesticides. Integrated pest management includes cultivation control, mechanical and physical control methods, bio-control and chemical control, etc. And with adjust management strategy, it might be possible to reduce the pesticides utilization and increase the control efficacy, and achieves the goal of maintaining the annual yield and free of chemical residue risks.

Key words: Integrated pest management, Pesticide resistance, Bio-control, Piercing-stylet pest

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