

Jun-Bo Luan

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Academic Record

2005.9-2008.7 PhD Zhejiang University, China

2002.9-2005.7 MS Shenyang Agriculture University, China

1998.9-2002.7 BS Shenyang Agriculture University, China

Professional Positions

2016.8.1-present **Research associate** at Cornell University (PI-Dr. Angela E. Douglas)

Research field: Whitefly symbiosis and functional genomics

2013.8.1-2016.7.31 **Postdoctoral associate** at Cornell University (PI-Dr. Angela E. Douglas)

Research field: Whitefly symbiosis and functional genomics

2011.11-2012.11 **Postdoctoral fellow** at The Hebrew University of Jerusalem, Israel (PI-Dr. Henryk Czosnek)

Research field: RNAi in whiteflies

2008.7-2011.11 **Postdoctoral associate** at Zhejiang University, China (PI-Dr. Shu-Sheng Liu and Xue-Ping Zhou)

Research field: Whitefly-begomovirus-plant interactions

Professional Overview

My long-term efforts are to understand Insect Biology and Ecology, especially Insect-Microbe-Plant Interactions, and to use such knowledge for better management of pest insects. I have studied molecular, cellular and metabolic mechanisms underlying insect interactions with endosymbionts and plant viruses through integrating multidisciplinary approaches. The five research topics have been investigated:

Cellular and molecular remodeling of bacteriocytes for vertical transmission of symbionts.

Various insects require intracellular bacteria that are restricted to specialized cells (bacteriocytes) and are transmitted vertically via the female ovary, but the transmission mechanisms are obscure. I demonstrate dramatic remodeling of bacteriocytes at the developmental transition from nymph to adulthood in whiteflies involves the loss of cell-cell adhesion, high division rates to constant cell size and onset of cell mobility, enabling the bacteriocytes to crawl to the ovaries. These changes are accompanied by cytoskeleton reorganization and changes in gene expression: genes functioning in cell-cell adhesion display reduced expression, and genes involved in cell division, cell motility and endocytosis/exocytosis have elevated expression in adult bacteriocytes, relative to nymph bacteriocytes. This study demonstrates, for the first time, how

developmentally-orchestrated remodeling of gene expression and correlated changes in cell behavior underpin the capacity of bacteriocytes to mediate the vertical transmission and persistence of the symbiotic bacteria on which the insect host depends (Luan et al. 2016, *Proceedings of the Royal Society of London B: Biological Sciences*).

Metabolic coevolution in the bacterial symbiosis of whiteflies. Two bacteria (*Portiera aleyrodidarum* and *Hamiltonella defensa*) are cohoused in each host cell of the whitefly *Bemisia tabaci*. I investigated whether the decay of *Portiera* metabolism genes is complemented by host and *Hamiltonella* genes. Parallel genomic and transcriptomic analysis revealed that the host genes of insect origin and bacterial origin contributes multiple metabolic reactions that complement or duplicate *Portiera* function, and that *Hamiltonella* may contribute multiple cofactors and one essential amino acid, lysine (Luan et al. 2015, *Genome Biology and Evolution*).

Silencing the ecdysone synthesis and signaling pathway genes disrupts nymphal development in the whitefly. A lack of efficient gene silencing methods allowing functional genetic analyses has been the obstruction to study sap-sucking insect biology. I developed a new and high throughput method to silence whitefly genes using a leaf-mediated dsRNA feeding method. Then I applied this method to explore the roles of genes within the molting hormone-ecdysone (synthesis and signaling) pathway for the survival, reproduction and development of whiteflies. The results suggest that the silencing method developed provides a useful tool for functional gene discovery studies of sap-sucking insects, and further indicate the potential of regulating the ecdysone pathway in whitefly control (Luan et al. 2013, *Insect Biochemistry and Molecular Biology*).

Plant-mediated whitefly–begomovirus interactions. Vectors often perform better on plants infected with pathogens, and this promotes the spread of pathogens. Although tobacco plants are relatively poor host plants for the whitefly *B. tabaci*, tobacco’s suitability to the whitefly was substantially increased when infected by the begomovirus. By integrating ecological, mechanistic, molecular and metabolomic approaches, I demonstrated that virus infection depleted the jasmonic acid and terpenoid-mediated plant defence against whiteflies, thereby favouring vector–virus mutualism (Zhang and Luan et al. 2012, *Molecular Ecology*; Luan et al. 2013, *Ecology Letters*). Furthermore, I found that reduced detoxification activity in whiteflies feeding on virus-infected plants is likely to attenuate energy costs, which enhances the performance of whiteflies on virus-infected plants (Luan et al. 2013, *Insect Molecular Biology*). Overall, these studies reveal the complex mechanisms underlying interactions between plant viruses and their insect vectors (Luan et al. 2014, *Bulletin of Entomological Research*).

Immune response of the whitefly to begomovirus. The begomoviruses are the largest and most economically important group of plant viruses transmitted exclusively by the whitefly *B. tabaci* in

a circulative, persistent manner. I investigated the transcriptional response of the invasive *B. tabaci* species to *Tomato yellow leaf curl China virus* (TYLCCNV). I found that TYLCCNV can activate cellular and humoral immune responses, such as autophagy and antimicrobial peptide production. Virus also suppressed Toll-like signaling and mitogen-activated protein kinase pathways. These results reveal the relationship of coevolved adaptations between begomoviruses and whiteflies (Luan et al. 2011, *Journal of Virology*).

Publication

- Luan JB**, Shan HW, Isermann P, Huang JH, Lammerding J, Liu SS, Douglas AE. 2016. Cellular and molecular remodeling of a host cell for vertical transmission of bacterial symbionts. *Proceedings of the Royal Society of London B: Biological Sciences*. 283, 20160580.
- Jing X, White TA, **Luan JB**, Jiao C, Fei Z, Douglas AE. 2016. Evolutionary conservation of candidate osmoregulation genes in plant phloem sap-feeding insects. *Insect Molecular Biology*, 25, 251-258.
- Luan JB**, Chen WB, Hasegawa DK, Simmons AM, Wintermantel WM, Ling KS, Fei ZJ, Liu SS, Douglas AE. 2015. Metabolic coevolution in the bacterial symbiosis of whiteflies and related plant sap-feeding insects. *Genome Biology and Evolution*, 7, 2635–2647.
- Luan JB**, Wang XW, Colvin J, Liu SS. 2014. Plant-mediated whitefly-begomovirus interactions: research progress and future prospects. *Bulletin of Entomological Research*, 104, 267–276. **Invited review.**
- Luan JB**, Wang YL, Wang J, Wang XW, Liu SS. 2013. Detoxification activity and energy cost is attenuated in the whiteflies feeding on *Tomato yellow leaf curl China virus*-infected tobacco plants. *Insect Molecular Biology*, 22, 597–607.
- Luan JB**, Ghanim M, Liu SS, Czosnek H. 2013. Silencing the ecdysone synthesis and signaling pathway genes disrupts nymphal development in the whitefly. *Insect Biochemistry and Molecular Biology*, 43, 740–746.
- Luan JB**, Yao DM, Zhang T, Walling LL, Yang M, Wang YJ, Liu SS. 2013. Suppression of terpenoid synthesis in plants by a virus promotes its mutualism with vectors. *Ecology Letters*, 16, 390–398.
- Wang YL, Wang YJ, **Luan JB**, Yan GH, Liu SS, Wang XW. 2013. Analysis of the transcriptional differences between indigenous and invasive whiteflies reveals possible mechanisms of whitefly invasion. *PLoS ONE*, 8, e62176.
- Zhang T*, **Luan JB***, Qi JF, Huang CJ, Li M, Zhou XP, Liu SS. 2012. Begomovirus-whitefly mutualism is achieved through repression of plant defenses by a virus pathogenicity factor. *Molecular Ecology*, 21, 1294–1304. * **First co-authors. Equal contribution.**
- Luan JB**, De Barro PJ, Ruan YM, Liu SS. 2012. Distinct behavioural strategies underlying asymmetric mating interactions between invasive and indigenous whiteflies. *Entomologia Experimentalis et Applicata*, 146, 186–194.
- Luan JB**, Xu J, Lin KK, Zalucki MP, Liu SS. 2012. Species exclusion between an invasive and an indigenous whitefly on host plants with differential levels of suitability. *Journal of*

- Integrative Agriculture*, 11, 101–105.
- Wang XX, Zhao QY, **Luan JB**, Wang YJ, Yan GH, Liu SS. 2012. Analysis of a native whitefly transcriptome and its sequence divergence with two invasive whitefly species. *BMC Genomics*, 13, 529.
- Su YL, Li JM, Li M, **Luan JB**, Ye XD, Wang XW, Liu SS. 2012. Transcriptomic analysis of the salivary glands of an invasive whitefly. *PLoS ONE*, 7, e39303.
- Luan JB**, Li JM, Varela N, Wang YL, Li FF, Bao YY, Zhang CX, Liu SS, Wang XW. 2011. Global analysis of the transcriptional response of whitefly to *Tomato yellow leaf curl China virus* reveals their relationship of coevolved adaptations. *Journal of Virology*, 85, 3330–3340. (appeared on journal cover).
- Luan JB**, Liu SS. 2011. Differences in mating behavior lead to asymmetric mating interactions and consequential changes in sex ratio between an invasive and an indigenous whitefly. *Integrative Zoology*, 7, 1–15.
- Wang XW*, **Luan JB***, Li JM, Su YL, Xia J, Liu SS. 2011. Transcriptome analysis and comparison reveal divergence between two invasive whitefly cryptic species. *BMC Genomics*, 12, 458. * **First co-authors. Equal contribution.**
- Sun DB, Xu J, **Luan JB**, Liu SS. 2011. Reproductive incompatibility between the B and Q biotypes of the whitefly *Bemisia tabaci* in China: genetic and behavioural evidence. *Bulletin of Entomological Research*, 101, 211–220.
- Sun DB, **Luan JB**, Liu SS. 2011. Leaf substrates determine oviposition and in turn frequency of copulation in the whitefly *Bemisia tabaci*. *Entomologia Experimentalis et Applicata*, 139, 180–185.
- Wang XW, **Luan JB**, Li JM, Bao YY, Zhang CX, Liu SS. 2010. De novo characterization and comparison of the whitefly transcriptomes reveals genes associated with development and insecticide resistance. *BMC Genomics*, 11, 400.
- Luan JB**, Ruan YM, Zhang L, De Barro PJ, Liu SS. 2008. Pre-copulation intervals, copulation frequencies, and initial progeny sex ratios in two biotypes of whitefly, *Bemisia tabaci*. *Entomologia Experimentalis et Applicata*, 129, 316–324.
- Liu SS, De Barro PJ, Xu J, **Luan JB**, Zang LS, Ruan YM, Wan FH. 2007. Asymmetric mating interactions between closely related organisms drive widespread invasion and displacement. *Science*, 318, 1769–1772.
- Ruan YM, **Luan JB**, Zang LS, Liu SS. 2007. Observing and recording copulation events of whiteflies on plants using a video camera. *Entomologia Experimentalis et Applicata*, 124, 229–233.
- Luan JB**, Cong B, Wang H, Li W, Zhang WW, Wang HY. 2004. Distribution of entomopathogenic nematodes in Liaoning province of China. *Chinese Journal of Biological Control*, 20 (Suppl.), 97–100. (in Chinese with English summary).

Grants

National Natural Science Foundation of China (NSFC)-Israel Science Foundation (ISF) joint research program (2013-2016)

Project No. C140204

Blocking begomovirus transmission to plants by silencing genes of their whitefly vector

Special Science Foundation of China Post-doctor (2010-2012)

Project No. 201003739

Mechanisms of plant mediated whitefly-begomovirus mutualism

National Natural Science Foundation of China (2009-2012)

Project No. 30900164

Roles of cuticular hydrocarbons in mating interactions of whiteflies

Oral presentation

2016 XXV International Congress of Entomology (ICE 2016), Orlando, Florida, USA

–The molecular basis of nutrient exchange in the whitefly symbiosis with two intracellular bacteria

2014 The 2014 Annual Meeting of the Entomological Society of America, Portland, Oregon, USA

–Mechanisms underlying plant-mediated whitefly-begomovirus interactions

2014 The 2014 Patton Symposium, Cornell University, USA

–The molecular basis of nutrient exchange in the whitefly symbiosis with two intracellular bacteria

2011 14th Symposium on Insect-Plant Interactions, The Netherlands

–Comparison of global transcriptional response of plants to a begomovirus and whitefly

2009 5th International *Bemisia* Workshop, China

–Competitive displacement between the invasive B and indigenous ZHJ2 biotypes of *Bemisia tabaci* in the laboratory

Poster presentation

2015 Ninth Annual Arthropod Genomics Symposium, Kansas State University, Manhattan, Kansas, USA

–Host cell compensation for genomic deterioration of an intracellular bacterial symbiont

2008 “Fifty years of invasion ecology—the legacy of Charles Elton”, South Africa

–Behavioral mechanisms in animal invasions

Honors

Distinguished Young Scientist Award, The Entomological Society of China (2011)

The Hebrew University of Jerusalem–China Scholarship Council Joint Scholarship (2011)

Teaching Activity

I have taught an undergraduate-level course on Biological Control of Pest Insects in 2004. I was also the teacher assistant for an undergraduate-level course on Agricultural Entomology in 2002-2005 and an undergraduate-level course on Urban Entomology and Resource Entomology in 2006.

I have assisted my supervisors in supervising 8 B.Sc., 6 M.Sc. and 3 Ph.D students with their research (designing projects, performing experiments and writing papers) since 2002.

Other academic activities

Invited reviewer for the Discovery Grants of the Natural Science and Engineering Research Council of Canada;

Peer reviewer for *Insect Molecular Biology*, *Entomologia Experimentalis et Applicata*, *Arthropod-Plant Interactions*, *Scientific reports*, *PLOS ONE*.

References

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