

## *2016 Curriculum vitae*



**NAME:** Charles E. Linn Jr.

**DEPARTMENT/UNIT:** Entomology

**TITLE:** Senior Research Associate

**CAMPUS ADDRESS:** Department of Entomology, Cornell University,  
NYSAES, 630 W. North St., Geneva, NY 14456

**PHONE:** 315-787-2319

**EMAIL:** cel1@cornell.edu

### **BACKGROUND**

#### **Education:**

Ph.D., University of California, Riverside, Riverside, CA, 1979. Major: Entomology

MS, California State University, Long Beach, Long Beach, CA, 1977. Major: Biology

BA/BS, California State University at Dominguez Hills, Dominguez Hills, CA, 1973.  
Major: Biology

**Military Experience:** U.S. Air Force, May 1966 to Sept. 1968. Honorable discharge with medical disability.

#### **Academic Rank:**

Senior Research Associate II: 1994 to present

#### **Professional Positions:**

Senior Research Associate II, Department of Entomology, New York State Agricultural Experiment Station, Cornell University, Geneva, NY. (1994 - Present).

Senior Research Associate I, Department of Entomology, New York State Agricultural Experiment Station, Cornell University, Geneva, NY. (1985 - 1994).

Research Associate III, Department of Entomology, New York State Agricultural Experiment Station, Cornell University, Geneva, NY. (1983 - 1985).

Postdoctoral Associate, Department of Entomology, New York State Agricultural Experiment Station, Cornell University, Geneva, NY. (1980 - 1983).

#### **Primary Departmental Program Area**

Insect Behavior and Chemical Communication Systems. In my position as Senior Research Associate I bring a level of expertise in Insect Behavior to the Entomology Department at Geneva. Our research program has both basic and applied aspects, studying basic processes involved in olfaction, and the development of monitoring and control tools for agriculture. In July 2008 my position was reclassified, with 80% research responsibilities and 20% technical service to the research community at Cornell in the area of chemical ecology. I have responsibility for all aspects of the Chemical Ecology program, along with expanded participation in department activities as a

member of faculty. As program leader I am involved in hiring of personnel, establishing collaborations within and outside the Experiment Station, and in mentoring undergraduate and graduate students.

### **Research Responsibilities**

Current projects include: **I)** testing a protocol for rapid identification of cryptic *Rhagoletis* flies infesting different host fruit in the western U.S. to determine whether *R. pomonella* is infesting domestic apples in that region (funded by USDA AFRI, in collaboration with Notre Dame and the USDA lab in Yakima, WA); **II)** identifying host plant volatiles used by specialist and generalist moth species, testing a model for host specialization (funded by USDA-AFRI, in collaboration with Greg Loeb); **III)** identifying volatiles from the surface of plant tissues (shoots and fruit) that are produced by microbial agents and contributing to the volatile profile used by insects for host location (funded by USDA, FFF); **IV)** identifying below ground volatiles and their sources that are involved in insect herbivory (USDA in collaboration with Kyle Wickings).

### **Areas of Expertise (keywords)**

Teaching Keywords: pheromones, host volatiles, host selection, chemical ecology, mating behavior, evolution

Research Keywords: chemical ecology, neuroethology, host location, odor discrimination, evolution, flight tunnel, pheromones, host volatiles, host selection.

Extension Keywords: K-12 education, insect diversity, insect development, insect behavior

### **Honors and Awards**

Sigma Xi, University of California, Riverside. (1979).

Graduate Research Assistantship, University of California, Riverside. (1977).

Biology Department Certificate of Recognition for Academic Excellence, Long Beach State University. (1976).

Phi Kappa Phi, Long Beach State University. (1975).

Who's Who Among Students in American Universities and Colleges, California State University, Dominguez Hills. (1973).

President's Honor List, Alpha Gamma Sigma. (1971).

## **CURRENT GRANT SUPPORT**

### **Grant**

Linn, Charles (Principal), "Chemical Communication Systems in Fruit, Vegetable and Urban/Turf Insects", Sponsored by Hatch, Federal, \$4,500.00. (October 1, 2012 - September 30, 2017).

Linn, Charles (Principal), Loeb, Greg (Co-Principal), "The Chemical Ecology of Eavesdropping: Olfactory-Based Host Location and Specialization in Phytophagous Insects", \$400,000.00, AFRI-USDA, Federal, Feb. 1, 2012 – February 28, 2017.

Linn, Charles (Principal), "Plants, Microbes, and Odorants Involved in Insect Host Plant Location: Who's Making the Message?" \$75,000.00, FFF initiative #2014-15-154, October 1, 2014 – September 30, 2017.

Linn, Charles (Co-Principal), Feder, Jeff (Principal), "Rapid Diagnostics for Cryptic Insect Pests: An Integrative Test Case Using the Apple Maggot Fly", \$22,079.00, USDA NIFA AFRI, January 1, 2015 – December 31, 2017.

Linn, Charles (Co-Principal), Wickings, Kyle (Principal), "Plants, Microbes And Chemical Signals Involved In Belowground Insect Herbivory: Who's Sending The Message?", \$90,195.00, USDA AFRI Exploratory Proposal, November 1, 2014 – October 31, 2015.

## **ACADEMIC RESPONSIBILITIES**

### **Graduate Field Membership**

Entomology

### **Advising Responsibilities**

#### **Past Postdoctoral Associates**

Robbins, Paul. (2007 - 2008)

Cha, Dong (2007 – 2012)

Nojima, Satoshi (2001-2007)

#### **Other Research Professionals Supervised**

Kathy Poole

Callie Musto

Karrie Catropia

Paula Fox

#### **Graduate Students**

Sara Hermann, M.S. program with Jennifer Thaler in 2013.

Michael Wolfen, 2012 beginning graduate program for Ph. D.

During the past year, as in the previous two years, I attended via polycom the weekly Plant Insect Group discussions. This involves exchanges and presentations of research ideas and plans by graduate students and post-docs, with input from faculty, including Jennifer Thaler, Andre Kessler, Rob Raguso, Anurag Agrawal, myself, and others. I consider this a valuable mentoring activity and contribution to the field.

### **Mentoring of Undergraduates**

During the summer months of 2015 Sara Volo, an undergraduate at Hobart and William Smith Colleges, worked in our program with graduate student Mike Wolfen to develop the sterilization

technique for use in exploring the role of plant surface microbes in producing volatiles that female grape berry moths are using to locate host plants.

In 2015 I also submitted a paper on responses of male European corn borer moths to cross-specific blends of European and Asian corn borer pheromones, work that had been done by undergraduates Nathan Martin and Kevin Moore, undergraduates at Hobart and William Smith Colleges. This paper was published online in December 2015 and in print in January 2016.

### **Mentoring of High School Students**

1. In 2015 I continued mentoring Thomas Nevins, a student at Greenwich High School, Greenwich, NY on a project titled “A Survey of Pumpkin Pollinators in Upstate Eastern New York”. His advisor at the school is Mrs. Nicole Dixon. Dr. Brian Nault is also involved as a technical advisor on the project. During the summer of 2015 Thomas completed a second year of monitoring 4 pumpkin fields field for the presence of pollinator bees as a function of time of day and season. He is preparing the complete report for presentation in a number of competitive programs and will continue the project in 2016.

2. In the summer of 2015 we began a plan to mentor a high school student during the upcoming school year. Ronnie Chilson is a student at Penn Yan Academy and in 2014 participated in a BOCES program in plant science. He also is an avid entomologist and the BOCES program was something that really inspired him and got him excited about academics and especially science. Unfortunately the program was being dropped, and in an effort to keep up the momentum Ronnie and his counselor, John Donoghue, along with his mother decided to approach the Experiment Station with the idea of serving as a BOCES substitute under the schools Work Experience Program. After meeting with Ronnie, his mom, and counselor, I said I would consider the idea. I then came up with the idea of a modular format such that Ronnie could spend time in my group, then with Kyle Wickings, who was very favorable to the idea, and then Greg Loeb. The program allows Ronnie two get credit toward graduation and he would spend mornings each day here at the station. His counselor would oversee the plan and progress and advise us.

During the Fall of 2015 Ronnie worked with my group and did an outstanding job continuing studies on the microbe volatile project that Sara Volo had worked on during the summer. Ronnie worked with Mike Wolfen and performed all his tasks with flying colors. Ronnie moved on to Kyle’s group in January 2016 and I am considering hiring him for the summer of 2016 before he enters Finger Lakes Community College.

### **Teaching**

In 2015, I presented five lectures on sex pheromone mediated behavior to the chemical ecology class on the Ithaca campus (BioEE, Entom, & BioNB 369). I also attended 30% of the lectures. I also presented a guest lecture in Linda Rayer’s Insect Behavior class in September 2015 on insect pheromones.

In May 2015, the Insect Physiology class, N Buchon instructor, visited the Experiment Station for a demonstration on the GC-EAD techniques and the sustained flight tunnel.

## **Extension/Outreach Responsibilities**

### **Extension/Outreach Workshops, Field Days, and Conferences**

In 2015 I continued as a member of the graduate student Extension and Outreach Activities committee, advising graduate students in this program on outreach activities and events. I still maintain a principle role in Empire Farm Days and Fun on the Farm, but the students now conduct all the outreach education programs.

## **OTHER CURRENT PROFESSIONAL ACTIVITIES**

### **Professional Service**

#### **Professional Societies**

Member, Entomological Society of America.  
Member, International Society of Chemical Ecology.

#### **Professional Honoraries**

Member, Sigma Xi. (1979 - Present).  
Member, Phi Kappa Phi. (1975 - Present).

### **College of Agriculture & Life Sciences Service**

#### **Committee Member**

Chemical Ecology Advisory Committee.  
Geneva Experiment Station Education and Outreach Committee. (2008 - Present).  
Geneva Experiment Station Library Committee. (2008 - Present).

### **Department Service**

#### **Coordinator**

Entomology Department Seminar Series. (1985 – 2009; 2013-2015).  
Extension and Outreach (2010-15).  
Mike Villani Graduate Student Fellowship (2003-2015).

## **OTHER CURRENT PROFESSIONAL CONTRIBUTIONS**

### **Presentations (2015)**

Charles Linn, presenter  
Entomology Department  
Penn State University, April,  
2015

Paradise Gained: Host fruit odors and host  
shifts in sympatry in *Rhagoletis pomonella*

Mike Wolfin, presenter  
Entomology Department  
Symposium Cornell University,  
Ithaca, NY 14853, January, 2015

Plants, microbes, and odorants involved in  
insect host location: Who's making the  
message?

Mike Wolfin, presenter  
Entomological Society of  
America Annual Meeting, PhD  
10- Minute Oral Paper  
Competition Minneapolis, MN,  
November 2015

Olfactory mediated responses to host and non-  
host plant volatiles by female grape berry  
moths (*Paralobesia viteana*)

Sara Volo, presenter  
Hobart and William Smith  
Colleges Undergraduate Research  
Poster Session, Geneva, NY  
14456, October 2015

Plants, microbes, and odorants involved in  
insect host location: Who's making the  
message?

Mike Wolfin, presenter  
Entomological Society of  
America Eastern Branch  
Meeting, PhD 10- Minutes Oral  
Paper Competition Rehoboth  
Beach, DE, March 2015

Olfactory mediated responses to host and non-  
host plant volatiles by female grape berry  
moths (*Paralobesia viteana*)

## EDITORIAL BOARDS

- I have continued (started in 2004) in my role as Subject Editor for the area of Chemical Ecology in the Journal Environmental Entomology. I was responsible for 19 manuscripts in 2015.

## PUBLICATIONS

### Published Intellectual Contributions – Journal Articles

Citation indices	All	Since 2010
Citations	3968	1282
h-index	36	18
i10-index	77	38

### Research

**2015** (the following were accepted in late 2015 but have publication dates in January 2016)

Lee, S-G., Poole, K., Linn Jr, C., and Vickers, N. 2016. Transplant antennae and host brain interact to shape odor space in male moths. *PLoS ONE* 11(1): e0147906.doi:10.1371/journal.pone.0147906.

Martin, N., Moore, K., Musto, C., and Linn Jr., C. 2016. Flight tunnel response of male European corn borer moths to cross-specific mixtures of European and Asian corn borer sex pheromones: Evidence supporting a critical stage in the evolution of a new communication system. *J. Chem. Ecol.* 42: 51-54.

## 2014

Yee, W. L., Nash, M. J., Goughner, R. B., Cha, D. H., Linn Jr., C. E., and Zalom, F. G. 2014. Ammonium Carbonate is more attractive than apple and hawthorn volatile lures to *Rhagoletis pomonella* (Diptera: Tephritidae) in Washington State. *Environ. Entomol.* 43: 957-968.

## 2013

Cha, D., Hesler, S. P., Linn Jr., C. E., Zhang, A., Teal, P. E. A., Knight, A., Roelofs, W. L., and Loeb, G. M. 2013. Influence of trap design on upwind flight behavior and capture of female grape berry moth (Lepidoptera: Tortricidae) with a kairomone lure. *Environ. Entomol.* 42(1): 150-157.

Mann, R. S., Rouseff, R. L., Smoot, J., Rao, C. N., Meyer, W. L., Lapointe, S. L., Robbins, P., Cha, D. H., Linn Jr., C., Webster, F., Tiwari, S., and Stelinsli, L. L. 2013. Chemical and behavioral analysis of the cuticular hydrocarbons from Asian Citrus Psyllid, *Diaphorina citri*. *Insect Science*, 20; 367-378.

## 2012

Droney, D., Musto, C., Mancuso, K., Roelofs, W., and Linn Jr., C. 2012. The response to selection for broad male response to female sex pheromone and its implications for divergence in close-range mating behavior in the European corn borer moth, *Ostrinia nubilalis*. *J. Chem. Ecol.* 38: 1504-1512.

Leary, G., Allen, J., Bunger, P., Luginbill, J., Linn, C., Maballister, I., Kavanaugh, M., and Wanner, K. 2012. A single mutation to a sex pheromone receptor provides adaptive specificity between closely related moth species. *PNAS*. 109: 14081-14086.

Cha, D. H., Yee, W., Goughnour, R., Sim, S., Powell, T., Feder, J. and Linn C. Jr. 2012. Identification of host fruit volatiles from domestic apple (*Malus domestica*), native black hawthorn (*Crataegus douglasii*) and introduced ornamental hawthorn (*C. monogyna*) attractive to *Rhagoletis pomonella* flies from the western United States. *J. Chem. Ecol.* 38: 319-329.

Sim, SB, M Mattsson, JL Feder, DH Cha, WL Lee, RB Goughnour, CE Linn Jr, and JL Feder. 2012. A field test for host odour discrimination and avoidance behavior for *Rhagoletis pomonella* flies in the western United States. *J. Evol. Biol.* 25: 961-971.

Powell, T., D Cha, C Linn Jr, and J Feder. 2012. On the scent of standing variation for speciation: Behavioral evidence for native sympatric host races of *Rhagoletis pomonella* (Diptera: Tephritidae) in the southern United States. *Evolution*. 66: 2739-2756.

Cha, D., T Powell, J Feder, and C Linn Jr. 2012. Geographic variation in fruit volatiles emitted by the hawthorn *Crataegus mollis* and its consequences for host race formation in the apple maggot fly, *Rhagoletis pomonella* (Diptera: Tephrotidae). *Entomol. Expt. et. Appl.* 143: 254-268.

- Linn CE, Jr., W Yee, S Sim, D Cha, T Powell, R Goughner, and J Feder. 2012. Behavioral evidence for fruit odor discrimination and sympatric host races of *Rhagoletis pomonella* flies in the western United States. *Entomol. Expt. et Appl.* 143: 254-268.
- Yee W, D Cha, C Linn Jr., M Klaus and R Goughnour. 2012. Abundance of apple maggot, *Rhagoletis pomonella*, across different areas in central Washington, with special reference to black-fruited hawthorns. *J. Insect Sci.* 12:124. Published online: <http://www.insectscience.org/12.124/i536-2442-12-124.pdf>

## 2011

- Cha D, T Powell, J Feder and C Linn Jr. 2011. Identification of host fruit volatiles from Mayhaw (*Crataegus* series *Aestivales*) attractive to Mayhaw-origin *Rhagoletis pomonella* flies. *J. Chem. Ecol.* 37: 961-973.
- Cha D, T Powell, J Feder and C Linn Jr. 2011. Identification of host fruit volatiles from two host plants, green hawthorn (*Crataegus viridis*) and blueberry hawthorn (*Crataegus brachyacantha*) attractive to different phenotypes of southern *Rhagoletis pomonella* flies. *J. Chem Ecol.* 37: 974-983.
- Loeb G, D Cha, S Hesler, C Linn, A Zhang, P Teal and W Roelofs. 2011. Monitoring grape berry moth (*Paralobesia vitianna*: Lepidoptera) in commercial vineyards using a host plant based synthetic lure. *Environ. Entomol.* 40(6): 1511-1522.
- Cha D, G Loeb, C Linn Jr., and W Roelofs. 2011. Electrophysiological and behavioral identification of a volatile blend involved in host location of female strawberry sap beetle, *Stelidota geminata*. *Entomologia experimentalis et applicata*, 140: 153-162.
- Cha, D.H., C.E. Linn, P.E.A. Teal, A. Zhang, W.L. Roelofs, and G.M. Loeb. 2011. Eavesdropping on plant volatiles by a specialist moth: significance of ratio and concentration. *PLoS ONE* 6(2), e17033.
- Robbins PS, Salsbury GA, Woodruff RE, Lapointe SL and Linn Jr. CE. 2011. Methyl 2-(methylthio) benzoate: a sex attractant for the June beetles, *Phyllophaga tristis* and *P. apicata*. *J. Insect Science.* 11:108 available online: [insectscience.org/11.108](http://insectscience.org/11.108).

## 2010

- Wanner KW, Nichols AS, Allen JE, Bunger PL, Garczynski SF, Linn Jr CE, Robertson HM, and Luetje CW. 2010. Sex Pheromone Receptor Specificity in the European Corn Borer Moth, *Ostrinia nubilalis*. *PLoS ONE* 5, e8685.
- Domingue MJ, Musto CJ, Linn CE Jr., Roelofs WL and TC Baker. 2010. Homology of olfactory receptor neuron response characteristics inferred from hybrids between Asian and European corn borer moths (Lepidoptera: Crambidae). *J. Insect Physiol.* 56: 73-80.

## 2009

- Olsson, S. B., Linn, C. E., Feder, J. L., Michel, A., Dambroski, H. R., Berlocher, S., Roelofs, W. L. (2009). Comparing peripheral olfactory coding with host preference in the *Rhagoletis* species complex. *Chemical Senses*, 34, 37-48.

## 2008

- Cha, D. H., Hesler, S., Moser, C., Nojima, S., Linn, C. E., Roelofs, W. L., Loeb, G. M. (2008). Flight tunnel responses of female grape berry moth (*Paralobesia viteanna*) to host plants. *Journal of Chemical Ecology*, 34, 622-627.



- Cha, D. H., Nojima, S., Hesler, S., Zhang, A., Linn, C. E., Roelofs, W. L., Loeb, G. M. (2008). Identification and field evaluation of grape shoot volatiles attractive to female grape berry moth (*Paralobesia viteana*). *Journal of Chemical Ecology*, *34*, 1180-1189.
- Olsson, S. B., Linn, C. E., Michel, A., Feder, J. L., Dambroski, H. R., Berlocher, S. H., Roelofs, W. L. (2008). Comparing Peripheral Olfactory Coding with Host Preference in the *Rhagoletis* Species Complex. *Chemical Senses*, *34* (1), 37-48.
- Domingue, M. J., Musto, C., Linn, C. E., Roelofs, W. L., Baker, T. C. (2008). Olfactory neuron responsiveness and pheromone blend preference in hybrids between *Ostrinia furnacalis* and *O. nubilalis* (Lepidoptera: Crambidae). *Journal of Insect Physiology*, *54*, 1261-1270.
- Robbins, P. S., Cash, D. B., Linn, C. E., Roelofs, W. L. (2008). Experimental evidence for three pheromone races of the scarab beetle *Phyllophaga anxius* (LeConte). *Journal of Chemical Ecology*, *34*, 205-214.

## 2007

- Domingue, M. J., Musto, C. J., Linn, C. E., Roelofs, W. L., Baker, T. C. (2007). Altered olfactory receptor neuron responsiveness in rare European corn borer males (*Ostrinia nubilalis*) attracted to Asian corn borer (*O. furnacalis*) pheromone blend. *Journal of Insect Physiology*, *53*, 1063-1071.
- Domingue, M. J., Musto, C., Linn, C. E., Roelofs, W. L., Baker, T. C. (2007). Evidence of olfactory antagonistic imposition as a facilitator of evolutionary shifts in pheromone blend usage in *Ostrinia* spp. (Lepidoptera: Crambidae). *Journal of Insect Physiology*, *53*, 488-496.
- Linn, C. E., Musto, C., Roelofs, W. L. (2007). More Rare Males in *Ostrinia*: Response of Asian Corn Borer Moths to the Sex Pheromone of the European Corn Borer. *Journal of Chemical Ecology*, *33*, 199-212.
- Linn, C. E., Domingue, M. J., Musto, C., Baker, T. C., Roelofs, W. L. (2007). Support for (Z)-11-hexadecanal as a pheromone antagonist in *Ostrinia nubilalis*: flight tunnel and single sensillum studies with a New York population. *Journal of Chemical Ecology*, *33*, 909-921.

## 2006

- Domingue, M. J., Roelofs, W. L., Linn, C. E., Baker, T. C. (2006). Effects of egg-to-adult development time and adult age on olfactory neuron response to semiochemicals in European corn borers. *Journal of Insect Physiology*, *52*, 975-983.
- Olsson, S. B., Linn, C. E., Michel, A., Dambroski, H. R., Berlocher, S. H., Feder, F. L., Roelofs, W. L. (2006). Receptor expression and sympatric speciation: unique olfactory receptor neuron responses in F1 hybrid *Rhagoletis* populations. *Journal of Experimental Biology*, *209*, 3729-3741.
- Robbins, P. S., Zhang, A., Averill, A. L., Linn, C. E., Roelofs, W. L., Sylvia, M. M., Villani, M. G. (2006). Sex pheromone of the cranberry root grub *Lichnanthe vulpine*. *Journal of Chemical Ecology*, *32*, 357.
- Olsson, S. B., Linn, C. E., Roelofs, W. L. (2006). The chemosensory basis for behavioral divergence involved in sympatric host shifts I. Characterizing olfactory receptor neuron classes responding to key host volatiles. *J. Comp. Physiol. A*, *192*, 279-288.
- Robbins, P. S., Alm, S. R., Armstrong, C. D., Averill, A. L., Baker, T. C., Bauernfiend, R. J., Baxendale, F. P., Braman, S. K., Brandenburg, R. L., Cash, D. B., Couch, G. J., Cowles, R. S., Crocker, R. L., DeLamar, Z. D., Dittl, T. G., Fitzpatrick, S. M., Flanders, K. L., Forgatsch, T., Gibb, T. J., Gill, B. D., Gilrein, D. O., Gorsuch, C. S., Hammond, A. M., Hastings, P. D., Held, D. W., Heller, P. R., Hiskes, R. T., Holliman, J. L., Hudson, W. G.,

Klein, M. G., Krischik, V. L., Lee, D. J., Linn, C. E., Luce, N. J., MacKenzie, K. E., Mannion, C. M., Polavarapu, S., Potter, D. A., Roelofs, W. L., Royals, B. M., Salsbury, G. A., Schiff, N. M., Shetlar, D. J., Skinner, M., Sparks, B. L., Sutschek, J. A., Sutschek, T. P., Swier, S. R., Sylvia, M. M., Vickers, N. J., Vittum, P. J., Weidman, R. B., Weber, D. C., Williamson, R. C., Villani, M. G. (2006). Trapping *Phyllophaga* spp. (Coleoptera: Scarabaeidae: Melolonthinae) with sex attractants in the United States and Canada. *Journal of Insect Science*, 6 (39). - available online: <http://www.insectscience.org/6.39/>