

Curricula Vitae

Larry L. Murdock

Purdue University

Department of Entomology

901 West State Street

West Lafayette, IN 47907-2089

Phone: (765) 494-4592; Fax: (765) 496-1219

E-mail: murdockl@purdue.edu

Education

Dates	Degree	Institution	Subject
1969	Ph.D.	Kansas State University	Entomology – Physiology
1966	M.S.	Kansas State University	Entomology – Toxicology
1964	B.A.	DePauw University	Chemistry

Appointments/Affiliations

Dates	Title	Organization
1984 – present	Professor	Purdue University, Dept. Entomology, West Lafayette, IN
1980 – 1984	Associate Professor	Purdue University, Dept. Entomology, West Lafayette, IN
1977 – 1980	Assistant Professor	Purdue University, Dept. Entomology, West Lafayette, IN
1975 – 1977	Research Associate	Univ. Wisconsin, Dept. Pediatrics, Madison, WI
1969 – 1975	Wissenschaft. Asst.	Univ. Konstanz, Fachbereich Biologie, West Germany
1968 – 1969	Research Associate	Kansas State Univ., Dept. Entomology, Manhattan, KS

Honors/Awards

1979	Vincennes University Alumni Citation
2001	Kansas State University Distinguished Alumnus in Entomology
2007	Purdue College of Agriculture Millionaire's Club Award
2007	Purdue University Seed of Excellence Award

Memberships

American Association for the Advancement of Science

Gamma Sigma Delta

Professional Service

Co-Founder & Co-Chair, Network for the Genetic Improvement of Cowpea for Africa (NGICA)

(www.entm.purdue.edu/NGICA/)

Bean/Cowpea Collaborative Research Support Program (CRSP) Technical Committee (Chair, 1991, 1994)

Research Interests

(1) physiological and biochemical systems in insects vulnerable to plant defense proteins, with especial focus on the use of new genomic tools; (2) application of molecular biology to identify new sources of insect resistance for crop plants; (3) genetic improvement of cowpea, particularly as regards insects that constrain cowpea production and utilization; (4) international agriculture, especially in Africa, focusing on the development and dissemination of simple, low-cost technologies for the post-harvest preservation of cowpea grain; (5) genomic and proteomic responses of the insect midgut to dietary challenges.

Career Accomplishments

1. Discovery, jointly with Bob Hollingworth, the octopaminergic mode of action of formamidine insecticides, using the firefly *Photinus pyralis*. Publication in Science (AAAS) with color cover page (Science 208: 74-76, 1980; paper has 107 citations)
2. Led the development of applications of quantitative behavioral pharmacology with insects, using the black blowfly, *Phormia regina*. Other scientists (e.g., John Stoffalano,

Wendell Roeloffs, Ted Hopkins) were influenced to take up the approach. Discovered anti-feeding and hyper-feeding drugs including the role of octopamine in stimulating feeding in blow flies. Published in the Proceedings of the National Academy of Science, with V. G. Dethier as sponsor (P.N.A.S. 80: 4149-4163. 1983; paper has 63 citations)

3. Pioneered the way to new understanding about insect digestive proteinases, namely that many insects, especially Coleoptera, using cysteine proteinases to digest their dietary protein. Until that time, the conventional wisdom was that most insects use serine proteinases (Comp. Biochem. Physiol. 87B: 783-787; paper has 156 citations)

4. Proved that insects, unlike mammals, inactivate aromatic biogenic amines by N-acetylation instead of monoamine oxidation (Insect Biochem. 11: 161-166, 1981; Comp. Biochem. Physiol. 58: 181-193, 1977; combined citations = 108)

5. With Dick Shade, developed an artificial seed system for bruchids and used it to characterize the effects of lectins (plant carbohydrate-binding proteins) on cowpea weevil. This paper called attention to the role lectins can play in plant protection (Phytochemistry 25: 85-89, 1990; paper has 92 citations).

6. Co-inventor, with Dick Shade and Eric Ferguson (Electrical Engineering) of a novel device for the detection of insects feeding in seeds, wood, and other hard materials by virtue of the ultrasonic emissions they produce during feeding (American Entomologist, Fall 1990, 231-234, citation numbers not available). Obtained U.S. Patent No. 4,809,554 for Ultrasonic Insect Detector. Dow Agro is using our device as part of its termite management package worldwide. Royalties from the patent paid by Dow Agro to the Department of Entomology amounted to in excess of \$21,000. The "biomonitor" enables detailed new insights into the life history of insects feeding hidden in dry materials, as well as early detection of infestations.

7. Invented and developed, with collaboration of Dick Shade, Laurie Kitch and Georges Ntougam, a simple, cheap, and effective solar technology for disinfecting insect-infested cowpea grain on low resource farms in sub-Saharan Africa. No chemical is involved. This technology is now being widely disseminated in Africa by the Bean/Cowpea CRSP, numerous NGO's including World Vision International, PEDUNE/PRONAF, and FAO, through technical bulletins, films, workshops, farmers field schools and village trainers.

8. Murdock, Shade Kitch and Ntougam also developed the use of triple-plastic bags as a way to store infested cowpea grain post-harvest and thereby arrest further damage by cowpea weevil. This technology is also being widely disseminated, as above. Again, no chemicals are involved. This technology is the basis for \$11.4 million of funding from the Bill and Melinda Gates Foundation to Purdue University to disseminate the triple bagging throughout the cowpea-growing area of West and Central Africa. The project seeks to reach 3.7 million farm families representing about 50 million individuals making up 30,000 villages in ten countries.

9. With Laurie Kitch working in Cameroon, I fostered a breeding program that produced two released cultivars of cowpea (CRSP Niebe and Lori Niebe) that are highly adapted to northern Cameroon, preferred by farmers, suited to the regional markets, and yet are storable in pod form for long periods of time without bruchid damage because they carry combined seed and pod wall resistance. We used farmer evaluations and inputs even in the early stages of the breeding work.

10. With T.J. Higgins, Maarten Chrispeels, Dick Shade and many others, created the first seeds genetically engineered for resistance to stored grain pests: garden peas expressing the alpha-amylase inhibitor from common bean. The original idea to do this, plus all of the entomological studies on both ends of the project, stemmed from Purdue.

Bio/Technology 12: 793-796, 1994; paper has 143 citations, and was the subject of a full page story in Science (265: 739, 1994). In collaboration with T.J. Higgins (work in progress) I have confirmed that cowpeas expressing the common bean alpha-amylase inhibitor gene are immune to cowpea weevil damage. I am also working with Jeff Ehlers (US Riverside) and T.J. Higgins to move the common bean alpha-amylase inhibitor gene in cowpea with the traditional TVu2027 resistance through the use of marker-assisted breeding. This concept, developed by Dick Shade and myself, is that a combination of two separate sources of insect resistance in cowpea will be both more effective in protecting the grain as well more durable vis-à-vis resistance development. Our work will be among the first to put this concept to practical use.

11. Currently developing a “sweet” trait in cowpea grain that was discovered in our CRSP breeding program in Cameroon. I arranged for analyses carried out that proved that the “sweet” flavor was due to elevated levels of sucrose and am currently working out the genetic basis of sweetness – a single pair of recessive genes appears to be responsible.

12. Co-founded and co-led NGICA, the Network for the Genetic Improvement of Cowpea for Africa, and serve as advisor to the African Agriculture Technology Foundation (AATF) on matters related to the development and deployment of Bt cowpea. Created the initiative in 1987 at Purdue that helped lead to the development of Bt cowpea. Current activities include a role in the development and management of the world’s first field trial of Bt cowpea during the late summer, 2008. Serve on the Project Advisory Committee of the African Agriculture Technology Foundation Bt cowpea project.

CURRENT GRANTS

Cowpea Hermetic Storage Technology Transfer in West and Central Africa – funded by the Bill and Melinda Gates Foundation. \$11.4 million. L.L.M. and colleagues created the original technology that is the foundation of the grant; I also drafted (as first author with Jess Lowenberg-DeBoer and Joan Fulton – see attachment) the concept note that was submitted to the Gates Foundation.

Genomic and Proteomic Responses to Dietary Toxins in a Stored Grain Insect Pest funded for \$900,000 over three years by the USDA/CSREES; Keyan Zhu-Salzman P.I., B.R. Pittendrigh and L.L. Murdock Co-PI's. Currently we are in the third year of the grant.

PUBLICATIONS (103 refereed papers, one edited book, two single authored books)

SCIENTIFIC CITATIONS

H-Index = 25 (see L.L. Murdock at ISI to verify)

Citations of my papers in 2008: 121, average last four years = 105 per year.

3 of my papers have >100 citations; 13 of them >50 citations

Recent Refereed Papers

Li, H.-M, V. Margam, W. Muir, L.L. Murdock, and B.R. Pittendrigh. 2007. Changes in *Drosophila melanogaster* midgut proteins in response to dietary Bowman-Birk inhibitor Insect Mol. Biol. 16: 539-549.

Tarver, M.R, R.E. Shade, R.H. Shukle, W.J. Moar, W.M. Muir, L.L. Murdock, and B.R. Pittendrigh. 2007. Pyramiding of insecticidal compounds for control of the cowpea bruchid (*Callosobruchus maculatus* F.). Pest Manag. Sci. 63:440-446.

Amirhusin, B., R.E. Shade, H. Koiwa, P.M. Hasegawa, R.A. Bressan, L.L. Murdock, K. Zhu-Salzman (2007) Protease inhibitors from several classes work synergistically against *Callosobruchus maculatus*. J. Insect Physiol. 53: 734-740.

Encyclopedia Entry

Zhu-Salzman, K. and L.L. Murdock (2006) Cowpea: insects, ecology and control. An invited article for the *Encyclopedia of Pest Management*, published by Marcel Dekker. pp1-3.

Book Chapter

Murdock, L.L., Coulibaly, O, Higgins, T.J.V., Huesing, J.E., Ishiyaku, M., Sithole-Niang, I. (2008) Cowpea. In *A Compendium of Transgenic Crop Plants* (ed. By C. Kole & T. Hall), Vol. 3, Legumes and Forages, Blackwell Publishing, Oxford, U.K.

Book Edited

Fishing in the Entomological Stream (2007) (ed. by Green, J., Heidel, T., and Murdock, L.), Lulu Press, 124 pp.

Books Authored

Why Did the Chicken Cross the Road? Subtitle: Essays on Antique Phrases and Midwest History (2007) L.L. Murdock, Lulu Press, xii + 201 pp.

Lyke Wandering Sheepe: Characters and Sketches from Other Places and Other Times (2008) Lulu Press, ix + 251 pp.

Selected Publications

- Murdock, L.L., Coulibaly, O., Higgins, T.J.V., Huesing, J.E., Ishiyaku, M., Sithole-Niang, I. (2008)** Cowpea. In *A Compendium of Transgenic Crop Plants* (ed. by C. Kole & T. Hall), Vol. 3, Legumes and Forages, Blackwell Publishing, Oxford, U.K.
- Tarver, MR, Shade, RE, Shukle, RH, Moar, WJ, Muir, WM, Murdock, LL, Pittendrigh BR (2007)** *Pyramiding of insecticidal compounds for control of the cowpea bruchid (Callosobruchus maculatus F)*. *Pest Management Sci.* 63: 440-446.
- Amirhusin B, Shade RE, Koiwa H, Hasegawa PM, Bressan RA, Murdock LL, Zhu-Salzman K (2007)** Protease inhibitors from several classes work synergistically against *Callosobruchus maculatus*. *J. Insect Physiol.* 53: 734-740.
- Li HM, Margam V, Muir WM, Murdock LL and Pittendrigh BR (2007)** Changes in *Drosophila melanogaster* midgut proteins in response to dietary Bowman-Birk inhibitor. *Insect Mol. Biol.* 16: 539-549
- Tarver, MR, Shade, RE, Tarver, RD, Liang, Y, Krishnamurthi, G, Pittendrigh, BR, Murdock, LL (2006)** Use of micro-CAT scans to understand cowpea seed resistance to *Callosobruchus maculatus*. *Entomol. Exp. Appl.* 118: 33-39.
- Zhu-Salzman, K.* and L.L. Murdock (2006)** Cowpea: insects, ecology and control. An invited article for the *Encyclopedia of Pest Management*, published by Marcel Dekker. pp1-3.
- Lalitha, S, Shade, RE, Murdock, LL, Hasegawa, PM, Bressan, RA, and Nielsen, SS (2005)** Comparison of chemical characteristics of three soybean cysteine proteinase inhibitors *J. Ag. Food Chem* 53: 1591-1597.
- Lalitha, S, Shade, RE, Murdock, LL, Bressan, RA, Hasegawa, PM, Nielsen, SS (2005)** Effectiveness of recombinant soybean cysteine proteinase inhibitors against selected crop pests. *Comp. Biochem. Physiol. C – Toxicol. & Pharmacol.* 140: 227-235.
- Liu, YL, Ahn, JE, Datta, S, Salzman, RA, Moon, J, Huyghues-Despointes, B, Pittendrigh, B, Murdock, LL, Koiwa, H, Zhu-Salzman, K (2005)** Arabidopsis vegetative storage protein is an anti-insect acid phosphatase. *Plant Physiol.* 130: 1545-1556.
- Amirhusin, B, Shade, RE, Koiwa, H, Hasegawa, PM, Bressan, RA, Murdock, LL, Zhu-Salzman, K (2004)** Soyacystatin N inhibits proteolysis of wheat alpha-amylase inhibitor and potentiates toxicity against cowpea weevil. *J. Econ. Entomol.* 97: 2095-2100.
- Pittendrigh, BR, Gaffney, PJ, Huesing, JE, Onstad, DW, Roush, RT, Murdock, LL (2004)** "Active" refuges can inhibit the evolution of resistance in insects towards transgenic insect-resistant plants. *J. Theoret. Biol.* 231: 461-474.
- Pedra, JHF, Brandt, A, Li, HM, Westerman, R, Romero-Severson, J, Pollack, RJ, Murdock, LL, Pittendrigh, BR (2003)** Transcriptome identification of putative genes involved in protein catabolism and innate immune response in human body louse (Pediculicidae : *Pediculus humanus*) *Insect Biochem. Mol. Biol* 33: 1135-1143.
- Pedra, JHF, Brandt, A, Westerman, R, Lobo, N, Li, HM, Romero-Severson, J, Murdock, LL, Pittendrigh, BR (2003)** Transcriptome analysis of the cowpea weevil bruchid: identification of putative proteinases and alpha-amylases associated with food breakdown. *Insect Mol. Biol.* 12: 405-412.
- Hall, AE, Cisse, N, Thiaw, S, Elawad, HOA, Ehlers, JD, Ismail, AM, Fery, RL, Roberts, PA, Kitch, LW, Murdock, LL, Boukar, O, Phillips, RD, McWatters, KH (2003)** Development of cowpea cultivars and germplasm by the Bean/Cowpea CRSP *Field Crops Res.* 82: 103-134.
- Murdock, LL, Seck, D, Ntougam, G, Kitch, L, Shade, RE (2003)** Preservation of cowpea grain in sub-Saharan Africa-Bean/Cowpea – CRSP contributions. *Field Crops Res.* 82: 169-178.
- Murdock, LL, Shade, RE (2002)** Lectins and protease inhibitors as plant defenses against insects. *J. Ag Food Chem*, 50: 6605-6611.

- Koiwa H, D'Urzo MP, Assfalg-Machleidt I, Zhu-Salzman K, Shade RE, An HJ, Murdock LL, Machleidt W, Bressan RA, Hasegawa PM (2001)** Phage display selection of hairpin loop soyacystatin variants that mediate high affinity inhibition of a cysteine proteinase. *Plant J.* 27, 393-391.
- Koiwa H, D'Urzo MP, Zhu-Salzman K, Ibeas JI, Shade RE, Murdock LL, Bressan RA, Hasegawa PM (2000)** An in-gel assay of a recombinant western corn rootworm (*Diabrotica virgifera virgifera*) cysteine proteinase expressed in yeast *Anal. Biochem* 282: 153-155.
- Pittendrigh BR, Gaffney P, Murdock LL (2000)** Deterministic modeling of negative cross-resistance strategies for use in transgenic host-plant resistance. *J Theoret. Biol.* 204: 135-150
- Koiwa H, Shade RE, Zhu-Salzman K, D'Urzo MP, Murdock LL, Bressan RA, Hasegawa PM (2000)** A plant defensive cystatin (soyacystatin) targets cathepsin L-like digestive cysteine proteinases (DvCALs) in the larval midgut of western corn rootworm (*Diabrotica virgifera virgifera*). *FEBS Lett.* 471: 67-70.
- Shade RE, Murdock LL, Kitch LW (2000)** Interactions between cowpea weevil (Coleoptera : Bruchidae) populations and Vigna (Leguminosae) species. *J Econ. Entomol.* 92: 740-745.
- Zhu-Salzman K, Salzman RA, Koiwa H, Murdock LL, Bressan RA, Hasegawa PM (1998)** Ethylene negatively regulates local expression of plant defense lectin genes. *Physiol. Plantarum* 104: 365-372.
- Zhu-Salzman K, Shade RE, Koiwa H, Salzman RA, Narasimhan M, Bressan RA, Hasegawa PM, Murdock LL (1998)** Carbohydrate binding and resistance to proteolysis control insecticidal activity of *Griffonia simplicifolia* lectin II. *Proc. Natl. Acad. Sci. USA* 95: 15123-15128.
- Kitch LW, Boukar O, Endondo C, Murdock, LL (1998)** Farmer acceptability criteria in breeding cowpea. *Exp. Agr.* 34: 475-486.
- Koiwa H, Shade RE, Zhu-Salzman K, Subramanian L, Murdock LL, Nielsen SS, Bressan RA, Hasegawa PM (1998)** Phage display selection can differentiate insecticidal activity of soybean cystatins. *Plant J.* 14: 371-379.
- Koiwa H, Subramanian L, Shade RE, Zhu KY, Nielsen SS, Murdock LL, Bressan RA, Hasegawa PM (1997)** Insecticidal activities of soybean cysteine proteinase inhibitors are correlated with their papain-binding affinities as phage-displayed proteins (1997) *Plant Physiol.* 114: 1115-1115 Suppl.
- Pittendrigh BR, Huesing JE, Shade RE, Murdock LL (1997)** Monitoring of rice weevil, *Sitophilus oryzae*, feeding behavior in maize seeds and the occurrence of supernumerary molts in low humidity conditions. *Entomol. Exp. Appl.* 83: 225-231.
- Ntoukam G, Kitch LW, Shade RE, Murdock LL (1997)** A novel method for conserving cowpea germplasm and breeding stocks using solar disinfestations. *J Stored Prod. Res.* 33: 175-179.
- Pittendrigh BR, Huesing JE, Shade RE, Murdock LL (1997)** Effects of lectins, CRY1A/CRY1B Bt delta-endotoxin, PAPA, protease and alpha-amylase inhibitors, on the development of the rice weevil, *Sitophilus oryzae*, using an artificial seed bioassay. *Entomol. Exp. Appl.* 82: 201-211.
- Shade RE, Kitch LW, Mentzer P, Murdock LL (1996)** Selection of a cowpea weevil (Coleoptera: Bruchidae) biotype virulent to cowpea weevil resistant landrace TVu 2027. *J. Econ. Entomol.* 89: 1325-1331.
- Zhu KY, Bressan RA, Hasegawa PM, Murdock LL (1996).** Identification of N-acetylglucosamine binding residues in *Griffonia simplicifolia* lectin II. *FEBS Lett.* 390: 271-274.
- Zhu KY, Huesing JE, Shade RE, Bressan RA, Hasegawa PM, Murdock LL. (1996)** An insecticidal N-acetylglucosamine-specific lectin gene from *Griffonia simplicifolia* (Leguminosae). *Plant Physiol.* 110: 195-202.
- Wolfson JL, Murdock LL (1995)** Potential use of protease inhibitors for host plant resistance – a test case. *Environ. Entomol.* 24: 52-57.
- Zhu KY, Huesing JE, Shade RE, Murdock LL. (1994)** Cowpea trypsin inhibitor and resistance to cowpea weevil (Coleoptera: Bruchidae) in cowpea variety Tvu 2027. *Environ. Entomol.* 23: 987-991.
- Shade RE, Schroeder HE, Pueyo JJ, Tabe LM, Murdock LL, Higgins TJV, Chrispeels MJ. (1994)** Transgenic pea seeds expressing the alpha amylase inhibitor of the common bean are resistant to bruchid beetles. *Bio/Technology* 12: 793-796.
- Book Chapters/Proceedings:
- Murdock, L.L. (2001)** The Dakar Symposium/Workshop on the Genetic Improvement of Cowpea. Proceedings Report.
- Murdock, L.L., Shade R.E., Kitch L.W., Ntoukam, G. Lowenberg-Deboer, J.**

- Huesing, J.E., Moar, W., Chambliss, O.L., Endondo, C., and Wolfson, J.L. (1997)** Postharvest storage of cowpea in sub-Saharan Africa. *In* B. B. Singh et al. [eds.] *Advances in Cowpea Research*. Co-publication of IITA and JIRCAS. IITA, Ibadan, Nigeria, pp. 302-312.
- Murdock, L.L. (1999)** Agricultural science (plant). *McGraw-Hill Yearbook of Science and Technology*, pp. 11-12.
- Monti, L.M., Murdock, L.L. and Thottappilly, G. (1997)** Opportunities for Biotechnology in Cowpea. *In* B. B. Singh et al. [eds.] *Advances in Cowpea Research*. Copublication of IITA and JIRCAS. IITA, Ibadan, Nigeria, pp. 302-312.
- Kononowicz, A.K., Cheah, M.L., Narasimhan, M.L., Murdock, L.L., Shade, R.E., Chrispeels, M.J., Filippone, E., Monti, L.M., Bressan, R.A., and Hasegawa, P.M. (1997)** Developing a transformation system for cowpea (*Vigna unguiculata* [L] Walp.). *In* B. B. Singh et al. [eds] *Advances in Cowpea Research*. Co-publication of IITA and JIRCAS. IITA, Ibadan, Nigeria, pp. 302-312.

TEACHING

ENT 595G Course entitled “Fishing in the Entomological Stream” 13 students, mostly graduate students; course designed to deal with issues important to careers in science (sources of ideas, importance of writing, bandwagons, scholarly management, dealing with distorted personalities, etc. – important things rarely or never taught in classes).

ENT 551 Insect Physiology and Biochemistry, 22 students in spring of 2008. Student evaluations: Professor 4.7; Class 4.6.