Martin Heil – Curriculum vitae

Departamento de Ingeniería Genética,
CINVESTAV - Irapuato
Km. 9.6 Libramiento Norte,
Irapuato, Guanajuato, Mexico, CP 36821
e-mail: mheil@ira.cinvestav.mx
phone: +52 462 623 96 57

Personal information

Born 5.5.1968 in Hanau, Hessen, Germany
Parents: Heinz Werner Heil and Karin Ilse Carla Heil

Research Interests

Indirect plant defence
Costs of induced resistance of plants to pathogens
Mutualistic and antagonistic interactions among different trophic levels
Evolutionary stability of mutualism
Plant-plant communication

Professional experience

Since April 2007	Researcher and Lecturer at CINVESTAV (Centro de Investigacion y de Estudios Avancados) in Irapuato, México
Oct. 2004 - Aug 2007	Head of Dept. of General Botany – Plant Ecology and Director of the Botanical Garden of University Duisburg-Essen, Germany
Dec. 2001 – Sept. 2004:	Head of a junior group at the Max-Planck-Institute for Chemical Ecology (Dept. of Bioorganic Chemistry) in Jena, Germany
Jan 2000 – Nov. 2001	Postdoctoral Fellowship at CEFE-CNRS, Montpellier, France
Jan 1998 – Dec. 1999	Postdoctoral Fellowship at University of Würzburg, Germany

Education

May 2003	**Habilitation in Ecology** at University of Würzburg, Germany. Thesis on „Costs of plant defences as a concept to understand the evolution of genetic variability and phenotypic plasticity in defence traits" Public lecture on "Molecular ecology – chances, risks and limits"
Dec. 1997	**Ph.D. in Ecology** at University of Würzburg, Germany Doctoral thesis on „Quantitative cost-benefit analysis in various ant-plant mutualisms in the genus *Macaranga*". Graded "*summa cum laude*" Honors: The doctoral thesis won the annual price for the best thesis by the „Unterfränkische Gedenkjahresstiftung für die Wissenschaft"
March 1993	**Diploma in Geobotany** at University of Würzburg, Germany Diploma thesis on "Differentations and dynamics in the greenland vegetation of the Hafenlohrtal (Spessart, Germany)".
1987 – 1993	**Studies in Biology and Philosophy** at University of Würzburg, Germany

Languages

German (mother tongue),
English (fluent in conversation, writing and reading),
Spanish (adequate conversation, writing and reading),
French (beginner's level)

Grants and Fellowships

Since 1.12.2007 **Project 160379 del CONACYT "Specificity and stabilising factors in defensive ant-plant mutualisms"**
Portable GC (Z-Nose), funds for travelling, consumables for field investigation and plant cultivation, consumables for laboratory studies on enzyme activities, quantification of volatile compounds (GC-columns) etc.
Overall volume 1.800.000 Mexican Pesos (180.000 US-$) for three years.

since 1.10.2005 **Project He 3169/4-2 "Coevolutionary stabilisation of specific mutualisms with special emphasis on ant-plant symbiosis"**
2 positions for PhD students
One thermocycler for realtime-PCR, one plate-reader photometer.
Funds for material, travelling and field work (molecular phylogeny and physiological and behavioural adaptations of *Pseudomyrmex* ants, biodiversity of endosymbiotic bacteria of ants inhabiting *Acacia* as mutualists or parasites, nutrient fluxes between ant and plant, chemical adaptations of nectar, control of nectar secretion)
Overall volume ca. 470.000 € for three years.

1.3.2003 – 30.9.2005 Project He 3169/3-1 "Evolution of the inducibility of an indirect defence trait in myrmecophilic and myrmecophytic *Acacia* species"
Funds for material and field work (field work in Mexico, enzymatic assays, chemical analytics, working with molecular markers and sequencing to establish a molecular phylogeny of *Acacia* species) for 18 months
Overall volume ca. 100.000 €

1.12.2001 – 30.9.2005 Emmy-Noether-grant (He 3169/2-1,2,3,4) "Ecological aspects of induced plant defence to pathogens and herbivores"
1 position for group leader, 2 positions for doctoral students, 1 for an assistant
Funds for student helpers in Germany and Mexico, material, travelling and field work (field work in Malaysia und Mexico, enzymatic assays, chemical analytics etc.)
Equipment for the quantification of plant gas exchange.
Overall volume ca. 600.000 €

1.1.2000 – 30.11.2001 Projects He 3169/1-1 to 1-4
Grant for studies over 23 months in Montpellier, France and field work in Malaysia and Mexico
Funds for local helpers in Mexico, for material, travelling and field work
Overall volume ca. 110.000 €

1.1.1998 – 31.12.1999 TP C8 of SFB 251
Own postdoc position for two years
Funds for material, travelling and field work in Malaysia, clima measuring equipment
Overall volume ca. 90.000 €

Further scientific contributions

Referee for international journals

1998 Acta Oecologica

2000 Annals of Botany, Functional Ecology (2x), Biological Systematics and Evolution

2001 Journal of Ecology, Ecology, Basic and Applied Ecology, Functional Ecology, Journal of Chemical Ecology (2x), Oecologia

2002 Functional Ecology, Acta Oecologica, Ecoscience
Book chapter for “Plant-provided food and plant-carnivore interactions", Cambridge

2003 Trends in Plant Science, Functional Ecology, Journal of Tropical Ecology, Oikos, Physiologia Plantarum

2004 Acta Oecologica, Oecologia, Journal of Tropical Ecology, Journal of Phytopathology Ecological Applications

2005 Oecologia, Naturwissenschaften, Physiological and Molecular Plant Pathology, Pesticide Biochemistry and Physiology, Oikos, Journal of Chemical Ecology, Ecology Letters, Canadian Journal of Botany, Ecology Letters (2x), Journal of Tropical Ecology

2006 Acta Oecologica (2x), Biology Letters (3x), Canadian Journal of Botany, Ecology Letters, Functional Ecology, Journal of Ecology, Journal of Chemical Ecology (2x), Journal of Tropical Ecology, New Phytologist (2x), Oecologia, Oikos, Plant, Cell & Environment, Plant Journal, Proceedings of the Royal Society of London B, Tree Physiology

2007 Am Naturalist, Ann Bot (2x), Behav Ecol Sociobiol (2x), Ecology (2x), Ecol Entomol, Ecol Lett (2x), Ecol Research, Entomol Exp Applic, Environ Pollution, Eur J Plant Pathol, Evol Ecol, J Appl Entomol (4x), J Chem Ecol (2x), J Ins Physiol, J Plant Interactions, Oecologia, Naturwissenschaften (2x), New Phytol (3x), Plant Journal, Plant Physiol, Plant Science, PNAS, Proc Roy Soc London B (3x), Sciencia Agricola, Science (2x)

2008 Acta Oecol, Ann Bot, Behav Ecol Sociobiol, Evol Ecol, Biol Control, Biol Reviews (2x), Biotropica, Curr Biol, Ecology (2x), Ecol Lett, Ecol Research, Entomol Exp Appl, Evol Ecol, Funct Ecol (2x), J Ecol (2x), J Exp Botany, J Trop Ecol, Mol Ecol, Myrmecological News, Naturwissenschaften (2x), New Phytol (3x), Oikos, Plant Cell & Environ, Plant Journal, Plant Physiol (2x), Plant & Soil, Proc Natl Acad Sci USA, Proc Roy Soc London B, Trends Plant Sci

since 1/2005: Member of the editorial board of ***Journal of Ecology***
since 1/2007: Member of the editorial board of ***The Plant Pathology Journal***
since 9/2007: Member of the editorial board of ***Communicative and Integrative Biology***
since 8/2008: Councilllor of the ***International Society of Chemical Ecology***

Referee for grants
Since 2001 five proposals reviewed for „Netherlands Organisation for Scientific Research“ Dept. „Earth and Life Sciences“.
2007 one review for a research proposal submitted to British Ecological Society
2007 one review for a project proposal submitted to U.S. National Science Foundation (NSF)
2008 one review for a project proposal submitted to the DFG (German Research Foundation)
2008 one review for a project proposal submitted to U.S. National Science Foundation (NSF)

Committee member for foreign PhD theses
March 2008: Megha Shenoy, Bangalore, India
May 2008: Sarah Gomez, Nijmegen, The Netherlands
May 2008: Rieta Gols, Wageningen, The Netherlands

Teaching

Practical field courses for graduate students (6-8 weeks of field research):

W. Scholtz (1997) On the effect of food body production on structure and development of ant colonies in *Macaranga.*

B. Baumann (1998) Effects of abiotic and biotic site factors on secretion of extrafloral nectar by *Macaranga tanarius*.

A. Brunschweiger (1998) The importance of scale insects as a third partner in the mutualisms among *Crematogaster* ants and the myrmecophytes, *Macaranga triloba* und *M. hypoleuca*.

A. Muth (1999) Site preferences of myrmecophytic and myrmecophilic *Macaranga* species.

Diploma and Master students

P. Menke (1996) Food body production by ant-plants of the genus *Macaranga* (Euphorbiaceae). University of Frankfurt/Main.

G. Eck (2001) Anti-herbivore protection in ant-plants of the genus *Macaranga*: chemical and biological strategies. University of Würzburg.

D. Feil (2002) Relations among soil nutrient content, size of ant colony, and anti-herbivore protection, in the ant plant, *Macaranga bancana*. University of Würzburg.

S. Greiner (2004) Rapid evolution of inducibility of the secretion of extrafloral nectar by Mexican *Acacia* species. University of Würzburg/MPI for Chemical Ecology Jena

S. Mantheij (2004) Phylogenetic analysis of Central American Ant-Acacias using ITS sequences. University of Jena/MPI for Chemical Ecology Jena.

L. Clement (2005) Biology of the parasitic ant *Pseudomyrmex gracilis*. University of Jena/MPI for Chemical Ecology Jena.

J. Sickinger (2006) Floristic and biogeographic investigations in the two valleys Rumbachtal and Forstbachtal: implications for conservational strategies. University of Duisburg-Essen

S. Kautz (2006) Invertase activity and molecular phylogeny of plant-inhabiting *Pseudomyrmex* ants. Thesis in English. University of Duisburg-Essen.

A. Ellwanger (2006) Enzymatic activities during induced systemic resistance (ISR) to pathogens and their effect on the nodulation of *Glycine max*.

M. Hermes (2006) Responses of herbivorous beetles to herbivore-induced plant volatiles of Lima bean, *Phaseolus lunatus*. University of Duisburg-Essen.

S. Köppen (2006) How do herbivores localise ant-free *Acacia*-ant plants? Olfactory strategies to select enemy-free space. Thesis in English. University of Duisburg-Essen.

J. Preuß (2007) Release of volatiles and secretion of extrafloral nectar by *Pteridium aquilinum* – an induced defence? University of Duisburg-Essen.

A. Ellwanger (2007) Inhibition of root nodule development in Soybean by chemical induction of plant resistance to pathogens. University of Duisburg-Essen.

E. Mendoza (2008) “Evaluación de las estrategias de defensa indirecta del frijol lima (*Phaseolus lunatus*) y frijol común (*Phaseolus vulgaris*)” Tesis de Licenciatura, Universidad del Mar, Puerto Escondido, Oax., Mex.

PhD. Students

C. Kost (2006) Herbivore-induced indirect plant defences of Lima bean (*Phaseolus lunatus*, Fabaceae). Thesis in English. University of Jena/MPI for Chemical Ecology Jena.

N. Wirtz (2006) Phylogeny and phylogeography of antarctic and bipolar lichens of the genus *Usnea, Neuropogon*. University of Duisburg-Essen.

Courses taught include Seminars on “Biology and Epistemology”, “Chemical Ecology”, “Chemical Ecology of plant-animal interactions”, “Scientific Writing”, “Theory of Science”, “Epistemology”, practical courses on “Plant Determination”, “Animal Determination”, “Microscopy for Beginners”, and lectures on “General Botany”, “Biology of Crop Plants”, “Evolution”, “Biodiversity”, “Tropical Ecology”

Current working group

Postdocs

Dr. Daniel Ballhorn. Teaching courses in plant determination, microscopy, field ecology, introduction to ecological methods, expression of three defensive traits of Lima bean (cyanogenesis, extrafloral nectar secretion, volatile release) in genetically different genotypes under different environmental conditions.

Dr. Miriam de Roman (Humboldt-grant for 2.0 years, started 1.10.06). Effect of BION-induced systemic pathogen resistance of wheat plants on AM mycorrhiza.

PhD. Students

S. Eilmus (started Feb. 2006) Diversity of bacteria involved as soil-bacteria or as endosymbionts in the *Acacia-Pseudomyrmex*-mutualism as derived from t-RFLP studies

J. Kley (started March 2006) The proteome in chloroplasts of *Arabidopsis* in response to chemical elicitation of induced systemic resistance to pathogens. Thesis in cooperation with MPI for Chemical Ecology, Jena.

Radhika V. (started May 2006) Biochemical mechanisms underlying the nectar secretion in taxonomically unrelated plants. Thesis in cooperation with MPI for Chemical Ecology, Jena.

S. Kautz (started June 2006) Behavioural and biochemical adaptations in food use and digestive tracts of obligate ant-plants of the genus *Pseudomyrmex*.

M. González-Teuber (started Oct. 2006) The chemical ecology of extrafloral nectar of myrmecophytic and non-myrmecophytic *Acacia* species

Co-worker

Domancar Orona. Contract for one year for the investigation of the proteome of *Acacia* food bodies.

Technical assistant

Rosa Maria Adame Alvarez. Enzymatic assays, DNA and mRNA extraction, plant cultivation, help with field work

Publications

1. Heil, M. (1995) Differenzierungen und Dynamik in der Grünlandvegetation des Hafenlohrtals (Spessart): Nutzung als dominierender Standortfaktor. (Differentations and dynamics in the greenland vegetation of the Hafenlohrtal (Spessart, Germany). Land use as dominant site factor). **Tuexenia 15**: 295-327

2. Heil, M., Fiala, B., Linsenmair, K.E., Zotz, G., Menke, P. & Maschwitz, U. (1997) Food body production in *Macaranga triloba* (Euphorbiaceae): a plant investment in anti-herbivore defence via symbiotic ant partners. **J. Ecol 85**: 847-861

3. Heil, M., Fiala, B., Kaiser, W. & Linsenmair, K.E. (1998) Chemical contents of *Macaranga* food bodies: adaptations to their role in ant attraction and nutrition. **Funct. Ecol. 12**: 117-122

4. Heil, M. (1999) Systemic acquired resistance: available information and open ecological questions. **J. Ecol. 87**: 341-346

5. Heil, M., Fiala, B., Boller, T. & Linsenmair, K.E. (1999) Reduced chitinase activities in ant plants of the genus *Macaranga*. **Naturwissenschaften 86**: 146-149

6. Heil, M (2000) Different strategies for studying ecological aspects of systemic acquired resistance (SAR). **J. Ecol. 88**: 707-708

7. Heil, M., Fiala, B., Baumann, B. & Linsenmair, K.E. (2000) Temporal, spatial and biotic variation in extrafloral nectar secretion by *Macaranga tanarius.* **Funct. Ecol. 14**: 749-757

8. Heil, M., Hilpert, A., Kaiser, W. & Linsenmair, K.E (2000) Reduced growth and seed set following chemical induction of pathogen defence: does systemic acquired resistance (SAR) incur allocation costs? **J. Ecol. 88**: 645-654

9. Heil, M., Staehelin, C. & McKey D. (2000) Low chitinase activity in *Acacia* myrmecophytes: a potential trade-off between biotic and chemical defences? **Naturwissenschaften 87**: 555-558

10. Heil, M. (2001) The ecological concept of costs of induced systemic resistance (ISR) **Eur. J. Plant Pathol. 107**: 137-146

11. Heil, M. (2001) Induced systemic resistance (ISR) against pathogens – a promising field for ecological research. **Perspect. Plant Ecol. Evol. Syst. 4**: 65-79

12. Heil, M., Koch, T., Hilpert, A., Fiala, B., Boland, W. & Linsenmair, K.E. (2001) Extrafloral nectar production of the ant-associated plant, *Macaranga tanarius*, is an induced, indirect, defensive response elicited by jasmonic acid. **Proc. Natl. Acad. Sci. USA 98**: 1083-1088

13. Heil, M., Fiala, B., Maschwitz, U. & Linsenmair, K.E. (2001) On benefits of indirect defence: short- and long-term studies of antiherbivore protection via mutualistic ants. **Oecologia 126**: 395-403

14. Heil, M., Hilpert, A., Fiala, B., Linsenmair, KE (2001) Nutrient availability and indirect (biotic) defence in a Malaysian ant-plant. **Oecologia 126**: 404-408

15. Linsenmair, K.E., Heil, M., Kaiser, W.M., Fiala, B., Koch, T.& Boland, W. (2001) Adaptations to biotic and abiotic stress: *Macaranga*-ant plants optimise investment in biotic defence. **J. Exp. Bot. 52**: 2057-2065

16. Heil, M. (2002) Ecological costs of induced resistance. **Curr. Opin. Plant Biol. 5**: 345-350

17. Heil, M. & Baldwin, I. (2002) Costs of induced resistance: emerging experimental support for a slippery concept. **Trends Plant Sci. 7**: 61-67

18. Heil, M. & Bostock, R. (2002) Induced systemic resistance (ISR) against pathogens in the context of induced plant defences. **Ann. Bot. 89**: 503-512

19. Heil, M., Hilpert, A., Fiala, B., bin Hashim, R., Strohm, E., Zotz, G. & Linsenmair, K.E. (2002) Nutrient allocation of *Macaranga triloba* ant plants to growth, photosynthesis, and indirect defence. **Funct. Ecol. 16**: 475-483

20. Heil, M., Delsinne, T., Hilpert, A., Schürkens, S., Andary, C., Linsenmair, K.E., Sousa, M.S. & McKey, D. (2002) Reduced chemical defence in ant-plants? A critical re-evaluation of a widely accepted hypothesis. **Oikos 99**: 457-468

21. Heil, M., Baumann, B., Andary, C., Linsenmair, K.E., McKey, D. (2002) Extraction and quantification of “condensed tannins“ as valuable measure of plant anti-herbivore defence? Revisiting an old problem. **Naturwissenschaften 89**: 519-524

22. Heil, M. & McKey, D. (2003) Protective ant-plant interactions as model systems in ecological and evolutionary research. **Annu. Rev. Ecol. Evol. Syst. 34**, 425-453

23. Heil, M. (2004) Induction of two indirect defences benefits Lima bean (*Phaseolus lunatus*) in nature. **J. Ecol. 92**, 527-536

24. Heil, M. (2004) Direct defense or ecological costs?? Responses of herbivorous beetles to volatiles released by wild Lima bean (*Phaseolus lunatus*). **J. Chem. Ecol. 30,** 1289-1295

25. Heil, M., Greiner, S., Meimberg, H., Krüger, R., Heubl., G. Noyer, J.-L., Linsenmair, K.E. & Boland, W. (2004) Evolutionary change from induced to constitutive expression of an indirect plant resistance. **Nature 430**, 205-208

26. Heil, M., Hilpert, A., Krüger, R. & Linsenmair, K.E. (2004) Competition among visitors to extrafloral nectaries as a source of ecological costs of an indirect defence. **J. Trop. Ecol. 20**, 201-208

27. Heil, M., Feil, D., Hilpert, A. & Linsenmair, K.E. (2004) Spatio-temporal patterns in indirect defence of a South-East Asian ant-plant support the optimal defence hypothesis. **J. Trop. Ecol. 20**, 573-580

28. Heil, M., Baumann, B., Krüger, R. & Linsenmair, K.E. (2004) Main nutrient compounds in food bodies of Mexican *Acacia* ant-plants. **Chemoecol. 14**, 45-52

29. Dietrich, R., Ploß, K. & Heil, M. (2004) Constitutive and induced resistance to pathogens in *Arabidopsis thaliana* depend on nitrogen supply. **Plant Cell Environ. 27**, 896-906

30. Kost, C. & Heil, M. (2005) Increased availability of extrafloral nectar reduces herbivory in Lima bean plants (*Phaseolus lunatus*). **Basic Appl. Ecol. 6**, 237-248

31. Dietrich, R., Ploss, K., & Heil, M. (2005) Growth responses and fitness costs after induction of pathogen resistance depend on environmental conditions. **Plant Cell Environ. 28**, 211-222

32. Heil, M., Büchler, R. & Boland, M. (2005) Quantification of invertase activity in ants under field conditions. **J. Chem. Ecol. 31**, 431-437

33. Heil, M., Rattke, J., Boland, W. (2005) Post-secretory hydrolysis of nectar sucrose and specialization in ant/plant mutualism. **Science 308** (5721), 560-563

34. Kost, C. & Heil, M. (2006) Herbivore-induced plant volatiles induce an indirect defence in neighbouring plants. **J. Ecol. 94**, 619-628

35. Ballhorn, D.J., Heil, M. & Lieberei, R. (2006) Phenotypic plasticity of cyanogenesis in lima bean *Phaseolus lunatus* - activity and activation of *β*-glucosidase. **J. Chem. Ecol. 32**: 261-275.

36. Heil, M. & Kost, C. (2006) Priming of indirect defences. **Ecol. Lett. 9:** 813-817.

37. Heil, M. & Ploss, K (2006) Induced resistance enzymes in wild plants – do 'early birds' escape from pathogen attack? **Naturwissenschaften 93:** 455-460.

38. Heil, M. & Silva Bueno, J.C. (2007) Within-plant signalling by volatiles leads to induction and priming of an indirect plant defence in nature. **Proc. Natl. Acad. Sci. USA 104:** 5467-5472.

39. Heil, M. & Silva Bueno, J.C. (2007) Herbivore-induced volatiles as rapid signals in systemic plant responses. **Plant Signal. Behav. 2**, 191-193

40. Walters, D. & Heil, M. (2007) Costs and trade-offs associated with induced resistance. **Physiol. Mol. Plant Pathol. 71,** 3-17

41. Ballhorn, D., Heil, M., Pietrowski, A., Lieberei, R. (2007) Quantitative effects of cyanogenesis on an adapted herbivore. **J. Chem. Ecol. 33,** 2195-2208

42. Kost, C. & Heil, M. (2008) The defensive role of volatile emission and extrafloral nectar secretion for Lima bean in nature. **J Chem. Ecol**. **34**, 2-13

43. Clement, L., Köppen, S.C.W., Brand, W.A., & Heil, M. (2008) Strategies of a parasite of the ant-*Acacia* mutualism. **Behav. Ecol. Sociobiol. 62,** 953-962.

44. Heil, M. (2008) Indirect defence via tritrophic interactions. **New Phytologist 178,** 41-61

45. Heil, M. (2008) Ants and plants – a world of interactions. **Trends Ecol. Evol. 23**, 253-254. (invited book review).

46. Heil, M., Lion, U. & Boland, W. (2008) Defence-inducing volatiles – in search for the active motif. **J. Chem. Ecol. 34**, 601-604

47. Heil, M. & Ton, J. (2008) Long-distance signalling in plant defence. **Trends Plant Sci. 13**, 264-272

48. Heil, M. (2008) Rico-Gray, V. & Oliveira, P.S. 2007: The ecology and evolution of ant-plant interactions. **Myrmecol. News 11**: 78 (invited book review).

49. Ballhorn D.J., Kautz S., Lion U. & Heil, M. (2008) Trade-offs between direct and indirect defences of lima bean (*Phaseolus lunatus*). **J. Ecol 96,** 971-980

50. Radhika, V., Kost, S., Bartram, S., Heil, M. & Boland, W. (2008) Testing the optimal defence hypothesis for two indirect defences: secretion of extrafloral nectar and emission of volatile organic compounds. **Planta 228**, 449-457

51. Ballhorn D.J., Schiwy S., Jensen M. & Heil M. (2008) Quantitative variability of direct chemical defense in primary and secondary leaves of lima bean (*Phaseolus lunatus*) and consequences for a natural herbivore. **J Chem Ecol 34**, 1298-1301

52. Ballhorn D.J., Kautz S., Lion U. & Heil, M. (2008) Qualitative variability of lima bean's VOC bouquets and its putative consequences on plant-plant communication **Plant Signal. Behav. 3**, 1005-1007

53. Kautz S., Lumbsch TH, Ward PS & Heil M (2009) How to prevent cheating: digestive specialization ties mutualistic plant-ants to their ant-plant partners. **Evolution**, in press.

54. Kautz S, Schmid VS, Trindl A, Heinze J, Ballhorn DJ & Heil M (2009) Isolation and characterization of microsatellite loci in the plant-ant *Pseudomyrmex ferrugineus* (Formicidae: Pseudomyrmecinae) and cross-testing for two congeneric species'. **Mol. Ecol. Res.**, in press

55. González-Teuber M., Eilmus S., Muck A., Svatos A. & Heil M. (2009) Pathogenesis-related proteins protect extrafloral nectar from microbial infections. **Plant Journal**, in press

Articles submitted :

González-Teuber M. & Heil M. The role of extrafloral nectar amino acids for the preferences of facultative and obligate ant mutualists. subm. to J. Chem Ecol.

Heil M. Damaged-self recognition in plant herbivore defence. subm. to Trends in Plant Sciences

Heil M. & Karban R. Airborne plant-plant communication. subm. to Trends in Ecology and Evolution

Heil M. & Walters D. Ecological consequences of plant defence signalling (invited book chapter for 'Plant Innate Immunity', ed. L.C. van Loon, Elsevier)

Manuscripts in Preparation

Heil M. & Ton J. Systemic resistance induction by vascular and airborne signalling (invited book chapter for 'Progress in Botany' eds Lüttge & Beyschlag, Springer)

Book

Heil, M. (1998) Quantitative Kosten-Nutzen-Analyse verschiedener Ameisen-Pflanzen-Assoziationen innerhalb der Gattung *Macaranga*. Wissenschaft & Technik Verlag, Berlin.

Book chapters

McKey, D., Gaume, L., Brouat, C., di Giusto, B., Pascal, L., Debout, G., Dalecky, A., Heil, M. (2005) The trophic structure of tropical ant-plant-herbivore interactions: community consequences and coevolutionary dynamics. pp 386-413 in: Burslem, D., Pinard, M., Hartley, S. (eds.) Biotic Interactions in the tropics: Their Role in the Maintenance of Species Diversity. Cambridge University Press

Heil, M. (2005) Plant protection by induced systemic resistance (ISR) - chances and potential risks. pp 1254-1275 In: Dris, R. (ed.) Crops: Growth, quality and biotechnology. WFL publisher, Helsinki.

Heil, M. (2007) Trade-offs associated with induced resistance. pp 157-177 In: Walters, D., Newton, C.A., Lyon, G.D. (eds) Induced Resistance for Plant Defence: a sustainable approach to crop protection. Blackwell, Oxford, U.K, 258 pp.

Heil, M. (2008) Indirect defence – recent developments and open questions. pp 360-395 In: Lüttke, U., Beyschlag, W., Murata, J. (eds.) Progress in Botany Vol. 69. Springer, Berlin. 479 pp.

Heil, M. (2009) Airborne induction and priming of defences. Chapter 8 In: Baluška, F. (ed.) Plant – Environment Interactions. Springer, Berlin. in press

Talks and Posters at congresses

1. Heil, M., Fiala, B. & Linsenmair, K.E. (1997) Rentiert sich eine Ameisen-Schutzarmee? Quantitative Bilanzierung des Herbivorie-Schutzes bei *Macaranga*. 10. meeting of the German Society for Tropical Ecology (Deutsche Gesellschaft für Tropenökologie, GTÖ), 14.-16.2 1997, Leipzig.

2. Heil, M. Hilpert, A., Fiala, B. & Linsenmair, K.E. (1999) Herbivorenverteidigung, Ameisennahrung und Standortfaktoren: Hängen die Standortansprüche verschiedener *Macaranga*-Arten von ihrer Symbiose mit Ameisen ab? 12. meeting of the German Society

for Tropical Ecology (Deutsche Gesellschaft für Tropenökologie, GTÖ), 17.-19.2.1999 Ulm. Meeting Abstracts: P26.

3. Heil, M. (1999) On the cost of plant defence against pathogens: hints from studies in wheat, bean, and tropical ant plants. International Society of Chemical Ecology, 16th annual meeting, 13.-17.11.1999 Marseille, France. Meeting Abstracts: P50

4. Heil, M. (2000a) SAR in the context of ecological questions and theories. Talk at 1st Internat. Symp. Induced resistance to plant diseases. 22.-27.2000, Corfu, Greece. Meeting Abstracts: P18.

5. Heil, M. (2000b) On the costs of chemically induced resistance against pathogens. Poster at 1st Internat. Symp. Induced resistance to plant diseases. 22.-27.5.2000, Corfu, Greece. Meeting Abstracts: P83.

6. Heil, M. (2001) Costs of induced resistance – what do we know and what can they explain? (Talk at 1st IOBC Conference on Induced resitance in plants against insects and diseases. 26.-28.4.2001, Wageningen, The Netherlands)
In Baldwin, I., Dicke, M., Haukioja, E., Mauch-Manie, B., Schmitt, A. (eds) Induced Resistance in Plants against Insects and Diseases. IOBC/wprs Bulletin 26: 89-94.

7. Heil, M., Koch, T., Hilpert, A., Fiala, B., Boland, W. & Linsenmair, K.E. (2001) Extrafloral nectar produced by *Macaranga tanarius* is an induced, indirect defence against herbivores. (Poster at 1st IOBC Conference on Induced resistance in plants against insects and diseases. 26.-28.4.2001, Wageningen, The Netherlands)
In Baldwin, I., Dicke, M., Haukioja, E., Mauch-Mani, B., Schmitt, A. (eds) Induced Resistance in Plants against Insects and Diseases. IOBC/wprs Bulletin 26: 177-182.

8. Heil, M. (2002a) Indirect defence by ant-plants – a successful strategy on secondary sites in the tropics. (Poster at GFÖ meeting 2002). In Verhandlungen der Gesellschaft für Ökologie Bd. 32: 281.

9. Heil, M. (2002b) Costs of induced resistance – new evidence for an old question (Talk at GFÖ meeting 2002). In Verhandlungen der Gesellschaft für Ökologie Bd. 32: 276.

10. Baumann, B., Heil, M. (2002) Indirect defence in lima bean – ontogenetic variation in volatile production of *Phaseolus lunatus*. (Poster at GFÖ meeting 2002). In Verhandlungen der Gesellschaft für Ökologie Bd. 32: 279.

11. Heil, M. (2002c) Indirect defence by ant-plants – regulatory processes in defensive ant-plants interactions. (Talk held at Botanikertagung 2002, Freiburg i. Brsg.)

12. Heil, M. (2004a) Responses of herbivorous beetles to volatiles released by wild Lima bean (*Phaseolus lunatus*) (Talk held at 12th Symposium on Insect-Plant relationships 2004, Berlin)

13. Heil, M. (2004b) Chemical composition of ant food produced by *Acacia* myrmecophytes (Talk held at Botanikertagung 2004, Braunschweig)

14. Heil, M. Ploss, K., Dietrich, R. (2004) Growth and fitness of *Arabidopsis* after chemical induction of pathogen resistance (Poster presented at Botanikertagung 2004, Braunschweig)

15. Kost, C. & Heil, M. (2004) Two induced indirect defences benefit lima bean plants in nature. (Poster presented at 12th Symposium on Insect-Plant relationships 2004, Berlin)

16. Heil, M. (2005a) Physiological and molecular adaptations stabilizing symbiotic ant-plant mutualisms. (Talk held at 21st Annual meeting of the International Society of Chemical Ecology, 2005, Washington DC, USA)

17. Kost, C. & Heil, M. (2005) Lima bean neighbourhood watch – herbivore-induced volatiles induce an indirect defence in neighbouring plants. (Poster presented at 21st Annual meeting of the International Society of Chemical Ecology, 2005, Washington DC, USA)

18. Heil, M. (2005b) Coevolutionary adaptations stabilizing obligate ant-plant mutualism. (Talk held at 90th Annual meeting of the Ecological Society of America (ESA), Montréal, Quebec, Canada).

19. Heil, M. (2006) Plant talk - but to whom? Talk held at 22nd Annual meeting of the International Society of Chemical Ecology, Barcelona, Spain

20. Heil, M., Silva Bueno, J.C. & Kost, C. (2007) Induction and priming of an indirect plant defence in nature. Talk held at congress on 'PR proteins and induced resistance against pathogens and insects' in Doorn, The Netherlands.

21. Heil, M. & Clement, L. (2007) Investment pays off - resource provisioning of myrmecophytic *Acacia* species to mutualistic and parasitic ants. Talk held on 2nd August at SIP 13 (13th Symposium on Insect-Plant Relationships) in Uppsala, Sweden.

22. Silva Bueno, J.C., Kost, C., Heil, M. (2007) Ecological and physiological functions of herbivore-induced volatiles in nature. Poster presented at SIP 13 (13th Symposium on Insect-Plant Relationships) in Uppsala, Sweden.

23. Heil M. (2008) Plant-plant signalling by volatiles – mechanisms and evolutionary implications. Poster presented at the annual meeting of the American Society of Plant Biologists (ASPB) in Mérida, México.

24. Eilmus S. & Heil, M. (2008) The unexplored diversity of bacteria in arboreal ants of the genus *Pseudomyrmex* and their putative role in nitrogen fixation. Poster presented at at 25th Annual meeting of the International Society of Chemical Ecology. August 17th – 22nd, State College, Pennsylvania, USA.

25. González-Teuber M. & Heil, M. (2008) Components of extrafloral nectar (EFN): functions in ant attraction and pathogen defence. Talk held at 25th Annual meeting of the International Society of Chemical Ecology. August 17th – 22nd, State College, Pennsylvania, USA.

26. Orona-Tamayo, D. & Heil, M. (2008) Análisis proteomico de granulos nutrititivos para hormigas protectoras de *Acacia hindsii*. Poster presented at XXVII Congreso Nacional de la Sociedad Mexicana de Bioquímica. November 16th – 21st, Mérida, Yucatán, México.

Invited speaker at international congresses

1. Floral and extrafloral nectar - the same or not the same? Talk presented on 25th June 2007 at 9th International Pollination Symposium at Iowa State University, Ames, Iowa, USA

2. Induced indirect defences of plants against natural enemies. Talk presented on 11th July 2007 at KCIST-2007 International Symposium on Molecular Host-Parasite Interactions: New Horizon for Interface Biology. Jeju, S. Korea.

3. Lima bean: Multiple interactions among direct and indirect defences. Talk at 23rd Annual meeting of the International Society of Chemical Ecology. July 22nd - 26th 2007. Jena, Germany

4. Ecological and physiological roles of herbivore-induced plant volatiles. Talk held at Gordon Conference on Plant Volatiles. Oct. 12-17th 2007. Les Diablerets, Switzerland.

5. *Acacia* and *Pseudomyrmex*: Coevolutionary stabilisation of an obligate mutualism. Keynote lecture held at the biannual Workshop “Multitrophic interactions”, in Goettingen, Germany, from 6th to 7th March, 2008.

6. Parasites of a mutualism: strategies and phylogenetic histories in the *Acacia-Pseudomyrmex* system. Talk at 25th Annual meeting of the International Society of Chemical Ecology. 17th – 22nd August 2008, State College, Pennsylvania, USA.

7. Indirect defence achieved by facultative and obligate plant-carnivore mutualisms. Talk held at International workshop "Plant Interactions with the Environment". 3rd – 5th September 2008, Neuchâtel, Switzerland

8. Plant resistance induced by airborne signalling. Talk held at 2008 KSPP International Symposium (Korean Society of Plant Pathology). 23rd-24th October 2008, Muju, Korea.

9. Chemical communication and coevolution in ant ant-plant mutualism. Talk held at International Symposium of the Fondation Jean-Marie Delwart on "Chemical communication within, among and around plants", 7th-9th November, Genval, Belgium.

Invited talks at institutes

1. Heil, M. (1999) What are the costs of systemic acquired resistance? SAR from an ecologist's point of view. Talk held on 25 March 1999 at the Botanical Institute (AG Prof. Boller), University of Basel, Switzerland.

2. Heil, M., Fiala, B., Rosli, H. & Linsenmair, K.E. (1999) Do the growing sites of different *Macaranga* species depend on their respective form of ant-plant mutualism? Poster presented at the Meeting at the Department of Zoology, University of Malaya, Kuala Lumpur, Malaysia (30 March 1999).

3. Heil, M. (2000) Ecological aspects of systemic acquired resistance (SAR) – findings and perspectives. Talk held at 1st. Postdoc conference, 26th-28th April 2000, John Innes Centre, Norwich, UK.

4. Heil, M. (2001) Kosten induzierter Pathogenabwehr: Ergebnisse aus dem Freiland und theoretische Hintergründe. (Costs of induced pathogen defence. Results from field studies and theoretical background). Talk held on 11.2 2001 at the Phytopathology Institute, University of Hohenheim, Stuttgart-Hohenheim, Germany

5. Heil, M. (2003a) Costs of induced resistance to pathogens – new empirical evidence for an evolutionary concept. Talk held on 23.7.2003 at the Max-Planck-Institute for Plant Breeding in Köln, Germany

6. Heil, M. (2003b) Defensas activadas e indirectas de las plantas - Estudias en sitios naturales en México. Talk held on 27.11.2003 at the Universidad del Mar in Puerto Escondido, Oaxaca, Mexico

7. Heil, M. (2005a) Comparative Approaches in Contemporary Ecology - Lessons from the Insect-Plant-Interface. Talk held at “Symposium on new directions in the study of plant-insect interactions” in Feb. 2005 at MPI of Chemical Ecology, Jena, Germany

8. Heil, M. (2005b) Indirect plant defences – costs and benefits. Talk held during symposium on “Above- and belowground interactions of plants” held in May 2005 at the Forschungszentrum Jülich, Jülich, Germany.

9. Heil, M. (2005c) How comparative approaches help to understand evolutionary processes. Talk held on 4.8.2005 in the group of Prof. Dr. P. Barbosa, University of Maryland, Maryland, USA.

10. Heil, M. (2005d) Defensas activadas e indirectas de las plantas - Costos y beneficios de diferentes estrategias. Talk held on 15.8.2005 at CINVESTAV – IPN, Irapuato, Guanajuato, México.

11. Heil, M. (2006a) Indirect defence - costs, consequences and co-occurring strategies. Talk held on 15.2.2006 in the group of Prof. Dr. R. Medina at Texas A & M University, College Station, TX, USA

12. Heil, M. (2006b) El costo de las relaciones permanentes: adaptaciones y gastos en las interacciones de las plantas con insectos y patógenos. Talk held on 3.2.2006 at CINVESTAV – IPN, Irapuato, Guanajuato, México.

13. Heil, M. (2006c) The difficult partnerships. Stability and specificity in defensive ant-plant interactions. Talk held on 11.12.2006 in the group of Dr. Ted Turlings, University of Neuchatel, Switzerland

14. Heil, M. (2006d) The difficult partnerships. Stability and specificity in defensive ant-plant interactions. Talk held on 13.13.2006 at the Institute of Ecology and Evolution, University of Lausanne, Switzerland.

15. Heil, M. (2007a) La communicación dificil: Estabilidad y especifidad en interaciones defensivas entre plantas y hormigas. Talk held on 14.3.2007 at Universidad del Mar, Campus Puerto Escondido. Pto. Escondido, Oaxaca, México.

16. Heil, M. (2007b) Costs of defence. Talk held on 9th July in the group of Dr. Choong-Min Ryu, Systems Microbiology Research Center KRIBB, Daejeon, S. Korea.

17. Heil, M. (2008a) Indirect defences in facultative and obligate plant-carnivore mutualisms - field studies in México. Talk held on March 23th in the group of Prof. Dr. Marcel Dicke at the University of Wageningen, The Netherlands

18. Heil, M. (2008b) Indirect defences in facultative and obligate plant-carnivore mutualisms - field studies in México. Talk held on March 24th in the group of Prof. Dr. Corné Pieterse at the University of Utrecht, The Netherlands

19. Heil, M. (2008c) Plant volatiles carry both private and public messages - communication within and among lima beans. Talk held on March 27th in the group of Prof. Dr. Hans de Kroon at the University of Nijmegen, The Netherlands