Colony Collapse Disorder and Pollinator Decline

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and

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Committee on Agriculture

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Good morning, Mr. Chairman and members of the Subcommittee; thank you for the opportunity to talk to you about colony collapse disorder and related issues affecting American agriculture. My name is May Berenbaum and I am Swanlund Professor and Head of the Department of Entomology at the University of Illinois at Urbana-Champaign. I recently served as chair of the National Research Council Committee on the Status of Pollinators in North America; I also currently serve on the Council of the National Academy of Sciences and am former chair of the NRC Board on Agriculture and Natural Resources.

Background to Colony Collapse Disorder—Committee on the Status of Pollinators in North America

The principal focus of this hearing is the sudden inexplicable disappearance of millions of honey bees across the nation, a phenomenon called, for want of an identified cause, colony collapse disorder (CCD). To understand the magnitude and potential impacts of this problem, however, it is important to place it into the broader context of pollinator decline in general. Pollination is the process by which pollen grains are transferred to receptive female floral parts to bring about fertilization. Because they are for the most part firmly rooted in the ground, approximately 3/4 of the 250,000 + species of flowering plants on the planet rely on mobile animal partners—pollinators—to carry out this vital process. Over the past two decades, concern has grown around the world about apparent reductions in the abundance of pollinators of all descriptions, with declines reported on no fewer than four continents. During this same time

period in the U.S., the western honey bee *Apis mellifera*, the world's premier managed pollinator species, experienced dramatic population declines, primarily as a result of the accidental introduction in the 1980s of two bloodsucking parasitic mites. Between 1947 and 2005, colony numbers nationwide declined by over 40%, from 5.9 million to 2.4 million. These losses have occurred as demand for pollination services has soared for a number of fruit, nut and vegetable crops, most notably for almonds. The NRC, the research arm of the National Academies of Science, is chartered to provide independent objective analysis and advice on scientific matters of national importance. Thus, with funding from the US Department of Agriculture, the US Geological Survey, and The National Academy of Sciences itself, the National Research Council's Board on Life Sciences and Board on Agriculture and Natural Resources jointly convened an ad hoc committee to document the status of pollinating animals in North America.

The committee was charged with determining whether, and to what degree, pollinators are experiencing significant declines, identifying causes of such declines, and detailing the consequences of pollinator declines in both agricultural and natural ecosystems. The committee was also asked to make recommendations on research and monitoring needs and on conservation or restoration steps to prevent, slow, or reverse potential decline. The committee addressed their charge by compiling and analyzing published literature and evaluating expert testimony to determine the current state of knowledge on pollinator status, to identify knowledge gaps, and to establish priorities for closing these gaps.

The Committee, comprising a group of 15 members from the U.S., Canada, and Mexico with expertise encompassing ecology, population biology, ethology, genetics, botany, entomology, systematics, agricultural economics, apiculture and conservation biology, quickly ascertained that there is an extraordinary paucity of reliable data on pollinator populations. This

dearth surprisingly applies even to the honey bee, a species that has been semi-domesticated and managed for thousands of years. Honey bees are in effect six-legged livestock that both manufacture agricultural commodities—honey and wax—and, more importantly, contribute agricultural services—pollination. Close to 100 crop species in the U.S. rely to some degree on pollination services provided by this one species—collectively, these crops make up approximately 1/3 of the U.S. diet, including the majority of high-value crops that contribute to healthy diets. Although economists differ in calculating the exact dollar value of honey bee pollination to American agriculture, virtually all estimates are in the range of billions of dollars. It is difficult in fact to think of any other multi-billion-dollar agricultural enterprise that is so casually monitored.

Despite the enormous importance of the honey bee, methods for estimating the availability of bees for pollination services are outdated and disturbingly inadequate. Since 1947, the National Agricultural Statistics Service has conducted an annual survey of honey bees, but the focus of data collection has been honey production and not pollination services; moreover, this assessment excludes hobbyist beekeepers with fewer than five colonies, does not take into account colony movement between states, and does not include assessments of the general health and vigor of the bees. Every 5 years, NASS conducts a census that covers all farming operations with honey bees, including the 30% that do not produce honey, but this census also does not assess pollination activities or colony health. Thus, the magnitude of decline in honey bee abundance and efficacy, despite six decades of data collection, is difficult to assess with precision.

That colony health is not regularly assessed is a serious deficiency. Bees in America have been beset of late; colony collapse disorder is just the most recent of a seemingly unrelenting

series of devastating problems for the beekeeping industry. Introduced pests and parasites, microbial diseases, pesticide drift, and competition with Africanized bees have all contributed to reductions in colony numbers since NASS assessments began. Exacerbating the shortages created by the decline in numbers is the steadily increasing demand for pollination services. Shortages were sufficiently acute that, in 2005, for the first time since passage of the Honeybee Act of 1922, honey bees were imported from outside the U.S., primarily to meet the needs of the $2 billion almond crop. Importing bees, although necessary to meet the demand for pollination, is an inherently risky enterprise in that it increases the chances of introducing new pests and parasites. Even before CCD came to light, our committee estimated that, if honey bee numbers continue to decline at the rates documented from 1989 to 1996, managed honey bees will cease to exist by 2035. Historically, feral, or "wild," honey bees have provided pollination services to both natural and managed plant communities but no system is in place for monitoring their numbers. Some evidence suggests that parasite infestations have all but eliminated feral colonies in some areas, yet in the absence of systematic monitoring there is no certainty as to their distribution or abundance.

Potential impacts of pollinator decline on U.S. agriculture

Why should reductions in the availability of one species of insect (one that can inflict a painful sting to boot) be a concern of Congress? Even the complete disappearance of honey bees would not fundamentally jeopardize food supplies in terms of calories because grains—the world's primary sources of dietary energy—do not depend upon animal pollinators. However, supplies of animal-pollinated foods—most fruit, vegetable, and nut crops, which provide the bulk of vitamins and other necessary nutrients in our diets—may well be dramatically affected. Among the most conspicuous demonstrable consequences of honey bee declines in agriculture

are the rising costs of producing bees and hence rising costs for honey bee rentals, contributing in turn to rising prices for crops and reductions in consumer welfare. Honey bee declines can reduce crop quality as well as yield. Rising production costs combined with declining yields may lead economically marginal producers to switch to crops independent of pollinators or to leave the industry altogether. Even before the advent of CCD, financial impacts of honey bee shortages have materialized; varroa mites are estimated to have increased honey bee colony rental fees by $30 million annually. Because bee pollination contributes to so many different sectors of the agricultural economy, including the beef and dairy industries (via pollination of clover and other hay and forage crops), disruption of the honey bee supply will likely reverberate across the entire country. Free markets work well only when good information is available and, without information on how to manage CCD, beekeepers will not be able to keep their bees alive. If honey bees die in numbers large enough to compromise pollination, markets will respond, but may do so in ways that are detrimental to the overall economy. Possible outcomes include greater imports of bees from abroad (with associated risks of importing new pests), higher prices of nuts, fruits and vegetables, reduced exports of major commodities, and increased imports of cheaper fruits and vegetables from foreign markets where CCD is not a problem, all of which will likely exacerbate the record U.S. trade deficit.

Short-term and long-term recommendations for honey bees

To address the problems in assessing honey bee decline, our committee recommended changes in data collection methodologies to take into account colony use (i.e., honey production or pollination) and colony seasonal losses. Moreover, our report recommended increased investment to encourage innovative approaches to protecting honey bee health and improving

genetic stocks of bees. Investment in honey bee research has hardly been commensurate with the economic importance of this species. Certain elements of contemporary apiculture have remained essentially unchanged for the past century; in part, the lack of innovation reflects the relatively low priority accorded to honey bee research in the agricultural sector. Appropriate investment requires minimally restoring lost positions in ARS for bee scientists.

The Committee concluded its deliberations before Colony Collapse Disorder came to light. That honey bees are experiencing losses on an unprecedented scale, however, was essentially predicted by the report—over-reliance on one managed non-native species is inherently unstable. CCD has accelerated the rate of colony loss, and beekeepers as well as growers need immediate relief. In view of the urgency of this new problem, support in the form of new extramural funds would have the desirable effect of rapidly expanding the now limited pool of investigators addressing the gaps in knowledge of honey bee biology. Competitive funds offered through the USDA National Research Initiative (NRI) provide an ideal mechanism for bringing new methods, new approaches, and new investigators into bee biology. In particular, completion of the honey bee genome in October 2006 provides extraordinarily powerful new tools for diagnosing problems, including CCD, and developing new management strategies. At the moment, many investigators in the Colony Collapse Disorder working group are donating their own time and money to solve this problem; such altruism, although befitting the social behavior of the honey bee, is not sustainable long-term.

The 2002 Farm Bill is set to expire September 30 2007 and proposed 2007 legislation identifies specialty crops as a high priority for research; many, if not most, of these specialty crops depend heavily upon insect pollination, and pollinator sustainability

should be a conspicuous component of such research. At present NRI represents a tiny fraction of research funding within USDA; in comparison with the proposed $1.38 billion intramural ARS budget, only $180 million is assigned to the Cooperative State Research, Education and Extension Service (CSREES) for competitive grants through NRI. Altogether, only 10% of USDA funding is competitive. No fewer than three NRC reports attest to the value of competitive programs such as NRI in generating high-quality basic and mission-oriented research (the 1989 study proposing the creation of NRI, *Investing in the National Research Initiative: A Proposal to Strengthen the Agricultural, Food and Environmental System*, the 1994 study *Investing in the National Research Initiative: An Update of the Competitive Grants Program of the U.S. Department of Agriculture* and the 2000 report *National Research Initiative: A Vital Competitive Grants Program in Food, Fiber, and Natural Resources Research*). As well, a permanent surveillance program for parasites and diseases of the honey bee is clearly in the best interests of the nation; such a survey could prevent the introduction of new pests and bring the U.S. into compliance with international trade agreements. The request from APHIS for a National Honey Bee Pest Survey, declined last year, is well worth reconsidering in the light of CCD.

Wild pollinators—putting pollen in more than one basket

It is an unfortunate consequence of benign indifference to the precarious nature of an overwhelming reliance on a single species that few alternative actively managed species are currently available for use. And despite evidence of their efficacy as crop pollinators, wild species are not being exploited to any significant extent. While efforts to monitor honey bees are inadequate, efforts to monitor the status of wild pollinators in North America are essentially nonexistent. Wild pollinators contribute in important ways to crop pollination; in fact, pollination

by native bees was recently estimated to be worth 3 billion dollars annually in the US. In the Central Valley of California, for example, a wide variety of native bees meet part or all of the crop pollination requirements for the region. Collectively, native bees are more versatile than the honey bee; some species, including mason bees and bumble bees, are active when conditions are unsuitable for honey bees, and others are capable of buzz-pollination—vibrating the flower to induce it to release pollen—and thereby can service crops such as tomatoes, cranberries and tomatoes more efficiently. Yet the status of wild pollinators is essentially undocumented for all but the most charismatic species. There is reliable evidence that some North American pollinator species have gone extinct, become locally extirpated, or have declined in number. At least two bumble bee species, one of which is a crop pollinator, could face imminent extinction, and several other pollinators have declined significantly. For some species, there is no evidence of population decline because their populations have never been monitored over time; there is seldom a historical baseline with which contemporary data can be compared.

The committee noted that, while systematic, thorough monitoring programs in Europe have revealed dramatic declines in native pollinator abundance and diversity, there are no comparable North American programs. The European experience demonstrates that monitoring is needed to document changes in pollinator status. Additional recommendations for long-term pollination sustainability include discovery surveys supported by the U.S. Geological Survey, the Fish and Wildlife Service, and other agencies responsible for natural resource protection, to identify potential new pollinators. As well, because of the importance of pollination as an ecosystem service in both agricultural and natural ecosystems, federal funding agencies should recognize pollination as a cross-cutting theme in their competitive grant programs and work

together to integrate research that ranges from the genomics of honey bees and the systematics and ecology of wild pollinators.

Conserving America's pollinators will require economic incentives. Upcoming discussions of the Farm Bill provide an opportunity to address this need. Through the Farm Bill, the federal government has an opportunity to encourage state-level Natural Resources Conservation Service (NRCS) offices to promote scientifically tested and approved pollinator-friendly practices for farmers participating in USDA cost share programs (the Wildlife Habitat Incentives Program and the Environmental Quality Incentives Program) and land retirement programs (the Conservation Reserve Program (CRP), the Conservation Reserve Enhancement Program, and the Conservation Security Program (CSP)). CRP should explicitly incorporate pollinator habitat in the environmental-benefits index used to evaluate land parcel proposals and CSP should incorporate the value of pollinator habitat development into its determination of the stewardship tiers that are the basis for federal payments. USDA cost-sharing, land retirement, and production stewardship programs should be available to producers of all commodities that depend on pollinators. The Xerces Society For Invertebrate Conservation (of which I am President) has been working with the Natural Resource Conservation Service to incorporate native pollinators into Farm Bill programs at both the National and State level and offers its time and expertise to congressional staffers on language for the Farm Bill and its programs to accomplish this goal.

Pollination reserves and the American quality of life

Insuring the safety and security of our national food supply is an explicit national priority. Although it is generally discussed in the context of vulnerability to attack and disruption from beyond our borders, food security may well face a greater threat from within our

borders--the overly optimistic deep-seated conviction that pollination resources will always be available. The honey bee was critical to the success of the earliest European colonists of the New World--English immigrant William Blackstone's efforts to grow apple trees in New England in 1623, e.g., were unsuccessful until honey bees were also brought over to provide the necessary pollination. Four centuries later, American farmers remain dependent upon this insect to produce their crops. Beyond agriculture, pollinators are crucial to maintaining the quality of American life. They serve as keystone species in most terrestrial ecosystems in that the services they provide allow most plants to reproduce and maintain genetic diversity. These plants in turn provide food and shelter for animals; fruits and seeds produced by insect pollination are a major part of the diet of approximately 25 percent of birds and of mammals ranging from red-backed voles to grizzly bears. In some areas, pollinator-supported plant communities prevent erosion by binding the soil—thereby conserving an important resource and keeping creeks clean for aquatic life.

Phalanxes of economists devote many hours to estimating and calculating our energy reserves but there has been no comparable effort to calculate our pollination reserves. Human technological innovation has not, in most cases, replaced or even improved upon animal pollinators and is unlikely to do so in the immediate future. "The birds and the bees" remain an essential fact of life; as long as plants depend on pollinators, so will people and it behooves us to shepherd them wisely.

Reference

National Academy of Sciences, 2006. Status of Pollinators in North America. Washington (DC): National Academies Press.

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B.S. Yale University 1975 (*summa cum laude,* honors in biology)
Ph.D. Cornell University 1980 (Ecology and Evolutionary Biology)

Positions Held:
1980 Assistant Professor, Department of Entomology, UIUC
1985 Associate Professor, Department of Entomology, UIUC
1990 Professor, Department of Entomology, UIUC: joint appointment, Department of Plant Biology,UIUC; Affiliate Center for Biodiversity and Ecological Entomology, Illinois Natural History Survey
1992 Head, Department of Entomology, UIUC

Selected Awards and Honors
Elected Member, National Academy of Sciences; Founder's Award, Entomological Society of America; Fellow, American Academy of Arts and Sciences; Fellow, American Philosophical Society; Fellow, American Academy of Arts and Sciences; E. O. Wilson Naturalist Award, American Society of Naturalists; Silverstein-Simeone Award, International Society for Chemical Ecology; University of Illinois Chancellor's Award for Distinguished Public Service; Fellow, Entomological Society of America; Robert MacArthur Award, Ecological Society of America; Women and Science Award, Weizmann Institute; inclusion on the UIUC Incomplete List of Teachers Rated Excellent by their Students >20 semesters (courses include IB109/Ent105, IB444/Ent315, IB445/Bio324); 2006 Entomological Society of America Distinguished Teaching Award

Publications
Refereed journal publications > 180
Book chapters > 30
Books written 4 (99 Gnats, Nits and Nibblers; 99 More Maggots Mites and Munchers; Bugs in the System: Insects and their Impact on Human Affairs; Buzzwords: A Scientist Muses on Bugs, Sex, and Rock 'n' Roll)
Books and special journal issues edited 3
Popular articles >110

External funding
Total funding as principal or co-principal investigator > $9,000,000 (primarily NSF, USDA, DOE)

Advising
Doctoral students 20; Master's students 19; Undergraduate honors students 8; Postdoctoral associates 6

Service (past 7 years)
Editorial work (Editor, Annual Review of Entomology, Associate Editor, J. Chem. Ecology, Chemoecology, Proceedings of the National Academy of Sciences), reviewing for journals and federal, international and private funding agencies, and service on boards, panels and committees (member, Board on Agriculture and Natural Resources-NRC, member, Office for Public Understanding of Science-NAS, Board of Directors, Xerces Society (president 2007), Chair, NRC Committee on the Future Role of Pesticides In Agriculture, National Awards Committee, Entomological Society of America, National Academy of Sciences Nominating Committee 2000, Chair, Section 27, National Academy of Sciences, 2001-2004, Chair, Board on Agriculture and Natural Resources, 2003-2005, Elected Member, Council, National Academy of Sciences, Chair, NRC Committee on Pollinator Status 2005-2006, National Research Council Report Review Committee, Advisory Board for NAS Koshland Museum, Advisory Board Joseph Henry Press, National Science Foundation Ecological and Evolutionary Physiology panel 2006, Reviewer--draft chapter 4.1 of the USDA/APHIS - Biotechnology Regulatory Services (BRS) Draft Programmatic Environmental Impact Statement for the revision of its CFR Part 340 regulations, External Advisory Committees for programs at North Carolina State University Raleigh, University of Pennsylvania, University of California Berkeley, University of Nevada Reno, Columbia University, Cornell University)

Committee on Agriculture

U.S. House of Representatives
Required Witness Disclosure Form

House Rules* require nongovernmental witnesses to disclose the amount and source of Federal grants received since October 1, 2004.

Name: May Berenbaum

Address: Dept Entomology, 320 Morrill Hall University of Illinois, 505 S. Goodwin, Urbana, IL 61801-3795

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Organization you represent (if any): National Academy of Sciences (NRC Committee on the Status of Pollinators

1. Please list any federal grants or contracts (including subgrants and subcontracts) you have received since October 1, 2004, as well as the source and the amount of each grant or contract. House Rules do NOT require disclosure of federal payments to individuals, such as Social Security or Medicare benefits, farm program payments, or assistance to agricultural producers:

Source: NSFIBN-SGER	Amount: $97,418
Source: NSFDEB OPUS	Amount: $108,000
Source: NSFDEB-SGER	Amount $17,838
Source: DOE (co-PI with 5 others, E DeLucia PI	Amount: $2.984,356

2. If you are appearing on behalf of an organization, please list any federal grants or contracts (including subgrants and subcontracts) the organization has received since October 1, 2004, as well as the source and the amount of each grant or contract:

Source: _____ Amount: _____

Source: _____ Amount: _____

Please check here if this form is NOT applicable to you: _____

Signature: May R. Berenbaum

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PLEASE ATTACH DISCLOSURE FORM TO EACH COPY OF TESTIMONY.