

MEETING REPORT

Seed ecology III*

The International Society for Seed Science (ISSS) organizes two major meetings every three years on seed ecology and seed biology with an objective to foster and promote research, education and communication in the scientific understanding of seeds. In continuation with the two earlier seed ecology meetings held in Greece and Australia in 2004 and 2007 respectively, the third meeting was held in USA recently under the chairpersonship of Susan Meyer (US Forest Service Rocky Mountain Research Station, USA). The main theme of this meeting was the timely topic of 'seeds and change', with an agenda aimed at building bridges between seed ecology and plant conservation, restoration ecology and global change research.

About 109 researchers, with about a quarter being students, from 29 countries participated in the meeting. Six technical sessions occurred over three days, each starting with a plenary lecture to focus on timely research being conducted on the theme of the session. A session with 52 posters covered a substantial range of topics: dormancy, germination, dispersal, morphology, ecophysiology, ecological genetics, revegetation efforts, reproductive biology, fungal relations and soil seed-bank dynamics. A mid-conference field trip was organized to tour montane vegetation up to subalpine (2700 m elevation). The participants could have a glimpse of the seed industry in Utah in three phases: research propagation of wild plants for seed production, seed collection and cleaning facilities; large-scale seed storage (up to 600,000 pounds of seed), and land preparation and seedling equipment.

In the first session on 'Seed evolutionary ecology' chaired by Ken Thompson (University of Sheffield, UK), plenary speaker Kathleen Donohue (Duke University, USA) discussed the interface between evolutionary genetics and seed ecology emphasizing that the early life-

stages of plants have compounding effects into adulthood. The strong link between herbicide resistance and seed dormancy in *Lolium rigidum* was reported by Kathryn Steadman (University of Queensland, Australia). Molecular aspects of seed dormancy were discussed for *Arabidopsis* by Steven Footitt (University of Warwick, UK) and for rice by Xing-You Gu (South Dakota State University, USA). Robin Probert (Royal Botanic Gardens, Kew, UK) questioned the definition of dormancy in the light of seeds containing 'underdeveloped' embryos. The need for studies on inbreeding depression to consider dormancy status of seeds was highlighted by Jerry Baskin (University of Kentucky, USA). Our understanding of epicotyl dormancy, which occurs in all major groups of flowering plants as shown by Carol Baskin (University of Kentucky), has greatly expanded since its first description in the 1930s. A phylogenetic approach for interpreting evolution of embryo size in Apiaceae was described by Filip Vendelook (Katholieke Universiteit Leuven, Belgium). Seeds of the basal angiosperm, *Amborella trichopoda* were reported by Bruno Fogliani (Universite de la Nouvelle-Caledonie, New Caledonia) to have nondeep simple morphophysiological dormancy.

'Seed ecophysiology' was the second session, chaired by Carol Baskin. The plenary speaker Gehan Jayasuriya (University of Peradeniya, Sri Lanka) explained the model of sensitivity cycling in physically dormant seeds, similar to dormancy cycling in physiologically dormant seeds. Some papers in this session focused on seed germination in relation to seed dimorphism (Zhenying Huang, Chinese Academy of Sciences, China), seed storage (Ali El-Keblawy, UAE University, UAE), the presence of glumes (Hong-Yuan Ma, Chinese Academy of Sciences), and skotodormancy (Katerina Koutsovoulou, University of Athens, Greece). In *Convallaria kieskei* seeds, Tetsuya Kondo (Hokkaido University, Japan) showed that embryos did not grow until after radicle emergence, contrary to most species with underdeveloped embryos. Jan Kępczyński (Uni-

versity of Szczecin, Poland), Rowena Long (The University of Western Australia, Australia) and Jeffrey Walck (Middle Tennessee State University, USA) characterized the effects of smoke-derived compounds like karriginolide on germination of weedy and nonweedy species.

Rosemary Pendleton (U.S. Forest Service Rocky Mountain Research Station) was the chair and Larry Venable (University of Arizona, USA) was the plenary speaker in the third session entitled 'Seed dispersal in space and time'. Larry summarized a 28-year dataset on desert annuals to emphasize the importance of seeds in evolutionary processes, species coexistence, and diversity and community dynamics with climate change. The importance of the germination niche along hydrological gradients to allow species occurrence prediction was explained by Peter Poschlod (University of Regensburg, Germany). Kadri Koorem (University of Tartu, Estonia) showed how multiple factors determine regeneration patterns in an Estonian spruce forest. The role of soil seed banks in plant community dynamics and restoration was covered for a diversity of habitats: arid-region streams (Julie Stromberg, Arizona State University), Himalayan subtropical forest (Shyam Phartyal, H.N.B. Garhwal University, India), Mongolian sand dunes (Zhimin Liu, Chinese Academy of Sciences) and abandoned sheep corrals (Jaime Kigel, Hebrew University of Jerusalem, Israel). Marcelo Sternberg (Tel Aviv University, Israel) shared his finding that rainfall manipulations simulating climate-change scenarios did not impact soil seed banks in Israel. Lydia Guja (Curtin University of Technology, Australia) reported that ocean hydrochory can be an effective method of seed dispersal.

The fourth session on 'Climate, microclimate and seeds' was chaired by Costas Thanos (University of Athens). Roberto Benech-Arnold (University of Buenos Aires, Argentina) delivered a plenary lecture on the quantification and modeling of environmental factors that regulate dormancy status in the soil seed bank. A functional analysis of seed persistence in cereal weeds was presented

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by Arne Saatkamp (Université Paul Cézanne, France), whereas microenvironmental conditions that influence secondary dormancy in the highly invasive cheatgrass were illustrated by Phil Allen (Brigham Young University, USA). Germination ecology served as a factor to explain the distribution of species of Melastomataceae in neotropical montane savannas (Fernando Silveira, Universidade Federal de Minas Gerais, Brazil), a narrow endemic in Spain (Borja Jimenez-Alfaro, University of Oviedo, Spain) and an endemic eucalypt in Australia (Megan Hirst, Royal Botanic Gardens Melbourne, Australia). Hana Skálová (Czech Academy of Sciences, Czech Republic) reported that invasive *Impatiens* in Europe germinate earlier and have lower frost resistance as compared to native congeners.

The fifth session entitled 'Seed community ecology/consumer relations' chaired by Jerry Baskin included talks on dynamic relationships between seeds and dispersers, predators and pathogens. Peter Kotanen (University of Toronto, Canada) explored the impacts of fungal pathogens on soil seed-bank dynamics in his plenary lecture. Julie Beckstead (Gonzaga University, USA) reported that both the seed-bank pathogen and its host cheatgrass are well-adapted to frequent and low-intensity wildfires, allowing for post-fire cheatgrass expansion. While Bram D'hondt (Ghent University, Belgium) concluded that 'hardseededness' evolved in response to control dormancy and germination, Ken Thompson showed that it served as an anti-predator device,

i.e. dry seeds release few volatile chemicals making it difficult (or impossible) for predators to locate seeds by smell. During this session, we learned that rodents determine the distribution of blue fan palm (Elisabet Wehnecke, San Diego Natural History Museum, USA), earthworms are attracted to seeds as a food source (Emilie Regnier, Ohio State University, USA), terrestrial isopods are granivores as well as detritivores (Stanislava Koprdova, Crop Research Institute, Czech Republic) and nutcrackers play a pivotal role in dispersal of *Cembrae* pines (Eila Tillman-Sutela, Finnish Forest Research Institute, Finland). Carlos Carmona (Universidad Autónoma de Madrid, Spain) showed that germination and root growth of grazing increasers were unaffected by the presence of cow dung, whereas those of decreasers declined.

The last session entitled 'Restoration and conservation seed ecology' chaired by Phil Allen, showcased efforts of seed ecologists to restore damaged ecosystems and stem biodiversity loss. The plenary speaker David Merritt (Kings Park and Botanic Garden, Australia) spoke on managing seed resources to deliver large-scale biodiverse restoration projects, with examples drawn from Australia. In the light of climate change, Costas Thanos discussed its effect on germination in an alpine Cretan endemic and Andrea Mondoni (University of Pavia, Italy) highlighted *ex situ* seed banking for halting alpine biodiversity loss. The role of *ex situ* seed banking in Hawaiian rare plant reintroductions was covered by

Lauren Weisenberger (University of Hawaii, USA), whereas seedling production for restoration in the Brazilian cerrado region was discussed by Henk Hilhorst (Wageningen University, The Netherlands). Alvin Yoshinaga (University of Hawaii) spoke about the correlations between longevity of seeds in wet and dry storage and John Dickie (Royal Botanic Gardens, Kew) shared his model for predicting optimum germination conditions for wild species in the Millennium Seed Bank. Todd Erickson and Lucy Commander (Kings Park and Botanic Garden) characterized seed-germination strategies for arid-zone species and showed how this information can be used to restore mine sites in Australia.

The meeting concluded with an awards banquet, and closing remarks by Susan Meyer at the picturesque Red Butte Gardens and Arboretum. Student awards went to Jacqueline Betsch (Arizona State University) for best poster and Bram D'hondt (Ghent University) for best oral presentation. The next meeting in the series is tentatively planned to be held in China in 2013.

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MEETING REPORT

Air pollution and climate change effects on forest ecosystems*

Anthropogenic-driven elevated CO₂ levels in the atmosphere and consequent climate change are likely to affect the forest ecosystems. According to some studies,

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under elevated CO₂ conditions decomposition was more than the net primary production (NPP). Certain other studies predicted greater increase in NPP than decomposition, leading to carbon storage. Projecting to larger scales, the responses of forest ecosystems to elevated CO₂ may be highly variable temporally and globally. In areas where nitrogen is limiting, elevated CO₂ levels should not increase the growth of trees even

though there may be an increase in photosynthesis. Excess nitrogen deposition in forests is likely to increase productivity. On the other hand, increase in ambient ozone has negative effect on forest ecosystem, including foliar damage, decreased productivity and elevated sensitivity. Presentations and deliberations in the recently held International Union of Forest Research Organizations Conference were about these major issues, where the parti-