

GRADUATE AND POSTDOCTORAL STUDIES

MCGILL UNIVERSITY



FINAL ORAL EXAMINATION
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

OF

CHAEHO BYUN
DEPARTMENT OF PLANT SCIENCE
DETERMINANTS OF BIOTIC RESISTANCE TO INVASION
IN PLANT COMMUNITY ASSEMBLY

March 30, 2015
8:00

Graduate and Post-Doctoral Studies, Room 400, James Building
McGill University

COMMITTEE:

Dr. L. Nilson, Pro-Dean (Biology)
Dr. M. Stromvik, Chair (Plant Science)
Dr. S. de Blois, Supervisor (Plant Science and MSE)
Dr. B. Leung, Internal Examiner (Biology and MSE)
Dr. M. Lechowicz, External member (Biology)
Dr. Jacques Brisson, Member (IRBV, UDM)

Dr. Martin Kreiswirth, Dean of Graduate and Postdoctoral Studies
Members of the Faculty and Graduate Students
are invited to attend

ABSTRACT

Biotic resistance refers to the ability of species in a resident community to restrict invasion. Biotic resistance's principles are relevant to the restoration of communities and/or the management of invasive species, but fundamental ecological mechanisms regulating biotic resistance are not fully understood. This research investigates determinants of biotic resistance to invasion. It aims to identify the characteristics of species and communities making them more or less resistant to species invasion and to quantify the contribution of biotic and abiotic factors to the regulation of biotic resistance.

An introduced lineage of *Phragmites australis* was used as a model invasive species to test biotic resistance. I conducted a series of rigorous community assembly experiments both in pots and in wetland to simulate a situation where *P. australis* seeds land on bare soil along with other wetland species, a common occurrence after disturbances or wetland restoration. Biotic resistance was estimated by comparing *P. australis* emergence in experimental treatments and control group. I used advanced statistical approaches based on diversity-interaction models to disentangle species interaction mechanisms underlying diversity effect and structural equation models to estimate effect of flooding on invasion.

Short fast-growing annual plants consistently showed strong resistance to invasion across several experiments, suggesting priority effect as a mechanism regulating biotic resistance. Regarding the diversity-invasibility relationship in community assembly, combining certain functional groups in specific ratio led to complementarity diversity effect, which strengthened biotic resistance. This result implies species interactions between functional groups generate diversity effect. Structural equation model supported a partial mediation hypothesis in which both direct flooding effect on *P. australis* and indirect flooding effect on wetland plants determined invasion success. Abiotic constraint and biotic resistance worked synergistically or antagonistically in controlling invasion depending on the fitness of the wetlands species involved. Finally, propagule pressure increased invasion success up to a threshold beyond which additional *P. australis* seeds did not increase invasion proportionally. This threshold was controlled by the species recruitment rate (i.e., seed density) of wetland plants, decreasing with increased density of wetland plants.

By embracing complex invasion processes and multiple drivers, my research advances our comprehension of early community assembly and response to invasion. This study can be an important step toward predicting invasion risk and impact as well as designing native community assembly for invasive plant management.

CURRICULUM VITAE

UNIVERSITY EDUCATION

Ph.D. candidate, Plant Ecology, Department of Plant Science, McGill University

2007 Master of Civil Planning, Environmental Management, Graduate School of Environmental Studies, Seoul National University

2005 B.Sc., Biological Science major, Geography minor, School of Biological Science, Seoul National University

EMPLOYMENT

2013. Research Assistant, Ecology Lab, Department of Plant Science, McGill University. Project: Tools for assessing the risks of biological invasion under climate change.

2010-13 Teaching Assistant, Plant Ecology, McGill University

2005,2008. Research Assistant, Environmental Planning Institute, Seoul

PUBLICATIONS

Byun, C, S. de Blois S, J. Brisson. 2014. Interactions between abiotic constraint, propagule pressure, and biotic resistance regulate species invasion. *Oecologia*: doi: 10.1007/s00442-014-3188-z

Bae, J., C. Byun, A. Watson, D. Benoit. 2014. Ground cover species selection to manage common ragweed (*Ambrosia artemisiifolia* L.) in roadside edge of highway. *Plant Ecology* doi: 10.1007/s11258-014-0433-9

Byun C., S. de Blois, J. Brisson. 2013. Plant functional group identity and diversity determine biotic resistance to invasion by an exotic grass. *Journal of Ecology* 101 (1): 128-139 DOI:10.1111/1365-2745.12016

Byun, C., G. Kwon, D. Lee, J. Wojdak, and J. Kim. 2008. Ecological assessment of plant succession and water quality in abandoned rice fields. *Journal of Ecology and Field Biology* 31 (3): 213-223 DOI:10.5141/JEFB.2008.31.3.213

Kwon G., B. Lee, **C. Byun**, J. Nam, and J. Kim. 2006. The optimal environmental ranges for wetland plants: I. *Zizania latifolia* and *Typha angustifolia*. *Journal of the Korean Society for Environmental Restoration and Revegetation Technology*. 9(1): 72-88. ISSN: 1229-3032

Scientific reports

de Blois, S., L. Boisvert-Marsh, R. Schmucki, C. Lovat, **C. Byun**, P. Gomez-Garcia, E. Groeneveld, C. Lavoie, 2013, Tools for assessing the risk of biological invasion under climate change 89 p.

Kim, J., **C. Byun**, *et al.* 2007. Environmental characterization of wetland plants for wetland restoration and management. Ministry of Science & Technology.

Kim, J., **C. Byun**, *et al.* 2006. Management strategies for natural conservation areas, Green City Department. Seoul

Lee, D., **C. Byun**, *et al.* 2005. Ecological guideline for village forest restoration. Environmental Planning Institute.

Conference presentations (selected international meetings)

Byun, C., S. de Blois, and J. Brisson, 2013, Functional group interaction drives negative diversity-invasibility relationship in experimental plant community assembly, 98th Annual Meeting of Ecological Society of America, Minneapolis, MN, USA, Oral presentation

Byun, C., S. de Blois, and J. Brisson, 2012, Functional group composition in restored plant communities determines biotic resistance to invasion by introduced common reed (*Phragmites australis*) in North America, 2012. Annual Symposium of the International Association for Vegetation Science (IAVS), Mokpo, South Korea, Oral presentation

Byun, C., S. de Blois, and J. Brisson, 2011, Can functional trait and community assembly predict biological resistance to invasion? An experiment with common reed, Annual Meeting of Ecological Society of America, Austin, TX, USA, Oral presentation

Byun, C., S. de Blois, and J. Brisson, 2011, Restoration of wetland plant cover to control early invasion of common reed. Annual Meeting of Society of Wetland Scientist, Praha, Czech Republic. Oral presentation

Byun, C., G. Kwon, J. Nam, and J. Kim. 2007. Ecological assessment of abandoned rice fields for water quality and wildlife habitat improvement, Annual meeting of Society of Wetland Scientists, Sacramento, California, USA, Poster presentation