

Christel Anne Ross

Invasion Success by Plant Breeding

VIEWEG+TEUBNER RESEARCH

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Evolutionary Changes as a Critical Factor
for the Invasion of the Ornamental Plant
Mahonia aquifolium

With forewords by Prof. Dr. Helge Bruelheide
and Dr. Harald Auge

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Foreword

Christel has been intrigued by the phenomenon of invasions since her studies as an undergraduate student in botany at Goettingen University where she took several of my courses and where I supervised her diploma thesis. Her diploma thesis already addressed the possible impact of hybridization for the invasiveness of plant species. By using molecular markers, she studied North American and European *Rhododendron* species. We were also in close contact while she was working on her PhD thesis at the Department of Community Ecology at the Helmholtz-Centre for Environmental Research UFZ in Halle. Having been one of the reviewers of her PhD thesis, I readily agreed when she asked me to write a short preface to this publication.

While the main line of research on the role of evolutionary processes for plant invasions has mainly been on the response to a different natural selection pressures exerted by the abiotic and biotic site factors of the new environment, Christel has asked to which degree breeding efforts might have contributed to such pressures. She chose a very apt study object to address this topic, *Mahonia aquifolium*, a species native to North America and introduced to Europe as an ornamental plant, together with some other species of the same genus. Christel's basic question was whether invasive populations of *Mahonia aquifolium* in Europe originate from planted cultivars or from hybrids with *M. repens* und *M. pinnata*. She certainly deserves the credit to have studied this question with a broad methodological approach, using neutral genetic marker as well as common garden and transplant experiments, and with a remarkable personal devotion.

Although not all of her results confirmed her hypotheses, for which the reader has to refer to the nicely written articles and the summary in this booklet, Christel's work has delivered an important contribution to the field of invasion research. The reader will find answers to how the selection process influenced the genetic diversity of *Mahonia*, which traits of the species were affected and whether adaptation to local environmental conditions were involved. Certainly, not all questions have been given a final answer, which is to be expected even from such an excellent PhD thesis. The remaining open questions might be even more intriguing than the ones Christel started

with in her career. However, this is what science is actually about, and I hope that readers of her work will be as intrigued as she has been and become inspired to carry on with this topic.

Prof. Dr. Helge Bruelheide

Foreword

By human activities, such as international trade, tourism, horticulture as well as fur, food or timber production, exotic plants and animals have intentionally or unintentionally been transported across major biogeographic barriers. In part, these exotic species have been able to establish self-sustaining populations and have spread into the new area. This biogeographic process, triggered by human activity, is called a biological invasion; it takes place at unprecedented spatial and temporal scales and is unique in the number of species dispersing. Biological invasions may generate large economic costs and are one of the major threats to biodiversity. An improved understanding of the processes behind invasions will, therefore, allow us to predict future invasions, to assess their impact, and to develop management strategies. On the other hand, invasions can also be considered as grand but unplanned experiments that can contribute to our basic understanding of biogeographical, ecological, and evolutionary processes.

One important question in the study of biological invasion is: What makes a species a successful invader? Only during the past decade, awareness has been rising that evolutionary processes may greatly contribute to the success of invasive species. Since then, more and more evidence has accumulated that the ability for evolutionary adjustments to novel environments may play a key role for successful invasions. Research on evolutionary changes in invasive plants has primarily investigated the role of natural selection. However, the majority of plant invaders have been imported intentionally, mostly as ornamentals for landscaping and gardening. Therefore, the effect of plant breeding, including hybridization and artificial selection, has to be taken into account when studying evolutionary changes in invasive plants.

Christel Ross' publication significantly contributes to our knowledge on the evolutionary importance of horticulture for the invasion success of exotic plants. Based on a case study on a widely-used ornamental shrub, *Mahonia aquifolium*, the author investigates the genetic relationship between native populations, planted cultivars, and invasive populations. Combining molecular analyses and a common garden experiment, Christel Ross demonstrates a strong genetic differentiation between native and invasive

Mahonia populations, which is likely to be caused by plant breeding. Using reciprocal transplant experiments, she, finally, investigates to what extent local adaptation to habitat conditions within the introduced range may have contributed to the species' invasion success. Considered together, the results presented here show that humans have obviously produced a successful invader by themselves – which is probably not only true for *Mahonia* but also for many other invasive species that were originally introduced as ornamentals. The present case study is thus not only important for our understanding of the role of evolution in plant invasions but is also of high practical relevance. Therefore, I am convinced that this publication will be of great benefit to all ecologists who are interested in the mechanisms behind biological invasions.

Dr. Harald Auge

Preface

This PhD thesis was written at the Martin-Luther-University Halle-Wittenberg and the Helmholtz-Centre for Environmental Research – UFZ in Halle. I am very grateful for having been given the opportunity to complete my thesis at these excellent institutions and to work together with such great colleagues. My special thanks go to my supervisors and co-authors of a number of articles Dr. Harald Auge and Dr. Walter Durka, for their everyday support, and to Prof. Dr. Helge Bruehlheide for his guidance and encouragement.

This thesis is a cumulatively composed work. The contents of this thesis have been published in the following international journal articles.

Christel Roß & Walter Durka (2006) Isolation and characterization of microsatellite markers in the invasive shrub *Mahonia aquifolium* (Berberidaceae) and their applicability in related species. *Molecular Ecology Notes* 6, 948-950.

Christel A. Ross, Harald Auge & Walter Durka (2008) Genetic relationship among three native North-American *Mahonia* species, invasive *Mahonia* populations from Europe, and commercial cultivars. *Plant Systematics and Evolution* 275, 219-229.

Christel A. Ross & Harald Auge (2008) Invasive *Mahonia* populations outgrow their native relatives. *Plant Ecology* 199, 21-31.

Christel A. Ross, Daniela Faust & Harald Auge (2009) *Mahonia* invasions in different habitats: local adaptation or general-purpose genotypes? *Biological Invasions* DOI 10.1007/s10530-008-9261-y.

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