Exploration, Identification and Utilization of Barley Germplasm

Guoping Zhang, Chengdao Li *Editors*

In the face of the challenges to barley production caused by climate change, intensive agriculture, narrowing biodiversity and the use of marginal soils, ***Exploration, Identification and Utilization of Barley Germplasm***, presents recent advances in the exploitation and utilization of barley germplasm, for food and malt barley productivity and sustainability. The book's topics include: the identification and creation of elite genotypes and the utilization of novel germplasm to enhance crop breeding, genetics and evolution studies; the latest research on the mechanisms of barley abiotic stress tolerance, including responses to drought, salinity, and acid soil caused by aluminium toxicity, waterlogging and frost; and current advances in sequencing technologies and their potential applications, including improvement of yield and adaptation by the manipulation of phenology genes.

Key Features

- Describes special genotypes from wild barley, including Tibetan wild barley, which show wider genetic diversity and higher tolerance to abiotic stresses than cultivated barley;
- Focuses on the techniques for improvement of yield and adaptation by the manipulation of phenology genes.

About the Editors

Guoping Zhang is a Professor at the Agronomy Department of Zhejiang University, Hangzhou, China. He has been engaged in barley genetics and breeding for more than twenty years. In April 2012, Professor Zhang organized the 11th International Barley Genetics Symposium (IBGS) in Hangzhou, and was selected as the chairman of the IBGS (2012 – 2016).

Chengdao Li is a Professor at Murdoch University, Australia, and a guest professor at Zhejiang University, China. He has extensive international experience in barley breeding and molecular genetics. His research on barley germplasm development and breeding has resulted in the development and release of the new barley varieties "Baudin", and "Hamelin", as well as the identification and characterization of more than ten elite barley genotypes with high tolerance to abiotic stresses and high malt qualities.

上架建议：生命科学
ISBN 978-7-308-16576-1
9 787308 165761 >
定价：168.00元

Exploration, Identification and Utilization of Barley Germplasm
Guoping Zhang, Chengdao Li *Eds.*

浙江大学出版社
ZHEJIANG UNIVERSITY PRESS

Advances in China's Basic Research
Editor-in-Chief: YANG Wei

Exploration, Identification and Utilization of Barley Germplasm

Guoping Zhang, Chengdao Li *Editors*

ZHEJIANG UNIVERSITY PRESS
浙江大学出版社

ELSEVIER

Supported by the National Natural Science Foundation of China
(Nos.31330055 and 3161001022)

Exploration, Identification and Utilization of Barley Germplasm

Guoping Zhang, Chengdao Li
Editors

ZHEJIANG UNIVERSITY PRESS
浙江大学出版社

ELSEVIER

图书在版编目（CIP）数据

大麦种质资源创新与利用=Exploration, Identification and Utilization of Barley Germplasm: 英文 / 张国平，李承道编著. — 杭州：浙江大学出版社，2018.3
ISBN 978-7-308-16576-1

Ⅰ. ①大… Ⅱ. ①张… ②李… Ⅲ. ①大麦－种质资源－研究－英文 Ⅳ. ①S512.302.4

中国版本图书馆CIP数据核字（2017）第003324号

大麦种质资源创新与利用
张国平　李承道　编著

丛书统筹　国家自然科学基金委员会科学传播中心
策划编辑　徐有智　许佳颖
责任编辑　潘晶晶（panjingjing@zju.edu.cn）
责任校对　张凌静
封面设计　程　晨
出版发行　浙江大学出版社
（杭州市天目山路148号　邮政编码310007）
（网址：http://www.zjupress.com）
排　　版　杭州兴邦电子印务有限公司
印　　刷　浙江海虹彩色印务有限公司
开　　本　710mm×1000mm　1/16
印　　张　22.5
字　　数　600千
版 印 次　2018年3月第1版　2018年3月第1次印刷
书　　号　ISBN 978-7-308-16576-1
定　　价　168.00元

Advances in China's Basic Research
Editorial Board

Preface to the Series

As Lao Tzu said, "A huge tree grows from a tiny seedling; a nine-storey tower rises up from a mound of earth." Basic research is the fundamental approach to foster innovation-driven development, and its level becomes an important yardstick for measuring the overall scientific and national strength of a country. Since the beginning of the 21st century, China's overall strength in basic research has been increasing consistently. With respect to input and output, China's input in basic research has increased by 14.8 times from 5.22 billion *yuan* in 2001 to 82.29 billion *yuan* in 2016, with an average annual increase of 20.2%. In the same period, the number of China's scientific papers included in *Science Citation Index* (SCI) increased from less than 40,000 to 324,000; China rose from the 6th place to the 2nd place in global ranking in terms of the number of published papers. In regard to the quality of output, in 2016, China ranked No.2 in the world in terms of citation in 9 disciplines, among which Materials Science ranked No.1; in the past two years, China ranked No.3 in the world both in the number of top 1% most-cited international papers and the number of top 1‰ international hot papers with global share of 25.1%. In talent cultivation, in 2016, 175 scientists from China were included in the Thomson Reuters Highly-Cited Researchers List (136 of which from the Chinese Mainland), which ranked the fourth in the world and the first in Asia.

Meanwhile, we should also be keenly aware that China's basic research is still subject to great challenges. First, funding for basic research in China is still far less than that in developed countries — only about 5% of the R&D funds in China are used for basic research, a much lower percentage than the 15%–20% in developed countries. Second, competence for original innovation in China is insufficient. The major original science achievements that have global impact are still rare. Most of the scientific research projects are just a follow-up and imitation of the existing researches, rather than brand new novel or pioneering work. Third, the development of disciplines is not balanced, and China's research level in

some disciplines is noticeably lower than the international level — China's Field-Weighted Citation Impact (FWCI) in disciplines just reached 0.94 in 2016, lower than the world average of 1.0.

The Chinese government attaches great importance to basic research. In the "13th Five-Year Plan", China has confirmed scientific and technological innovation as a priority in all-round innovation, and has made strategic arrangements to strengthen basic research. General Secretary Xi Jinping put forward a grand blueprint of making China into a strong power in science and technology in his speech delivered at the National Conference on Scientific and Technological Innovation, and placed emphases on "targeting the world's advanced scientific and technological frontier, consolidating basic research to achieve major breakthroughs in forward-looking basic research and steering original achievements" at the 19th CPC National Congress on Oct.18, 2017. With more than 30 years of unremitting exploration, the National Natural Science Foundation of China (NSFC), one of the main channels for supporting basic research in China, has gradually shaped a funding pattern covering research, talents, tools and convergence, and has taken actions to vigorously promote basic frontier research and the growth of scientific research talents, reinforce the building of innovative research teams, deepen regional cooperation and exchanges, and push forward multidisciplinary convergence. As of 2016, nearly 70% of China's published scientific papers were funded by NSFC — accounted for 1/9 of the total number of published papers all over the world. Facing the new strategic target of building China into a strong country in science and technology, NSFC will conscientiously reinforce forward-looking planning, and enhance the efficiency of evaluation, so as to achieve the strategic goal of making China progressively share the same level with major innovative countries in research output, impact and original contribution by 2050.

The series of *Advances in China's Basic Research* and the series of *Reports of China's Basic Research* proposed and planned by NSFC emerge under such a background. Featuring of science, basics and advances, the two series are aimed to share innovative achievements, diffuse performances of basic research, and lead breakthroughs in key fields. They will closely follow the frontiers of basic research developments in China, and publish excellent innovation achievements funded by NSFC. The series of *Advances in China's Basic Research* will mainly present the important original achievements of the programs funded by NSFC

and display the breakthroughs and forward guidance of the key research fields, while the series of *Reports of China's Basic Research* will show the core contents of the final reports of the Major Programs and the Major Research Plans funded by NSFC to make a systematical summarization and strategic outlook of the achievements in the fields preferred to be funded by NSFC. We not only hope to comprehensively and systematically display the backgrounds, scientific significances, discipline layouts, frontier breakthroughs of the programs, as well as strategic outlooks of the subsequent research, but also expect to summarize the innovative ideas, enhance multidisciplinary convergence and promote the continuity of research in the fields concerned as well as original discoveries.

As an old saying in *Hsun Tzu* goes, "Where accumulated earth becomes a mountain, there prevails wind and rain. Where running waters gather widely and deeply, there gives birth to dragons." The series of *Advances in China's Basic Research* and the series of *Reports of China's Basic Research* are hoped to become the "historical records" of China's basic research, which will provide researchers with abundant scientific research materials and sources for innovation. It's believed that the series will certainly play an active role in making China's basic research prosper and in building China into a powerful nation of science and technology.

President of NSFC
Academician of Chinese Academy of Sciences
Dec. 2017, Beijing

Preface

Exploration and utilization of new germplasm has played a pivotal role in the increase of barley yield and improvement of malting quality in the 20th century. The *denso* gene from Triumph, *ari*-GP gene from Golden Promise, and *uze* gene from the Southeast Asian barley have become the cornerstones for modern barley breeding success in the world. Recently, success for deployment of the acid soil and boron toxicity tolerance genes in the Australian barley varieties have further demonstrated the high value of new germplasm in enhancing barley productivity and sustainability.

The consumption of barley keeps increasing with the growing population and the improvements in standards of living around the world. Barley is mainly used as raw material for feed and beer production. In recent years, use of barley as a functional food has been intensified due to its special chemical components, which are beneficial to human health. In this book, we present the advances in exploitation and utilization of barley germplasm for food and malt barley improvement. As a cereal crop, barley is often grown in the marginal soils. Climate irregularity has added new challenges to barley production. Understanding the mechanisms for barley's environmental stress tolerance is essential for future barley production. This book focuses on recent advances in barley abiotic stress tolerance, including drought, salinity, acidic soil (aluminum toxicity), waterlogging, and frost, with an emphasis on novel germplasm and technologies for germplasm exploration. The international community is still in the early stages of completing the barley genome sequence. However, recent advances in sequencing technology will have a dramatic impact on barley germplasm exploration and utilization. Thus, this book also includes one chapter on sequencing technologies and their potential applications.

The authors of each chapter in this book are researchers who are on the frontier in their specific research areas. We aim to cover the most recent

advances for barley quality and abiotic stress tolerance, with an emphasis on practical implementation. The book will provide a good reference both for barley genetics and breeding research.

This book can be read as a companion to *Genetic Improvement of Barley Malt Quality*. The malting quality chapter in this book is a supplementary of the previous book with an emphasis on the Canadian barley germplasm for malting quality improvement, as Canadian barley has been the international benchmark for malting quality.

Australia is the world's largest malting barley exporter and China is the largest malting barley importer. This interrelationship has fostered the two nations' long-term collaboration on barley abiotic stress tolerance. Many of the authors of this book have worked on these collaborative projects. Thus, this book can be seen as a summary of the collaborative research projects of Australia and China. In this regard, we would like to acknowledge the support from the National Natural Science Foundation of China（Nos. 31330055 and 3161001022）and the Australian Grain Research and Development Corporation.

Guoping Zhang and Chengdao Li

Contributors

Imrul Mosaddek Ahmed
Department of Agronomy, College of Agriculture and Biotechnology, Zijingang Campus, Zhejiang University, Hangzhou, China

Tefera Tolera Angessa
Western Barley Genetics Alliance, Murdoch University, Murdoch, Australia

Shengguan Cai
Department of Agronomy, College of Agriculture and Biotechnology, Zijingang Campus, Zhejiang University, Hangzhou, China

Stewart Coventry
University of Adelaide, Waite Campus, PMB, SA, Australia

Alfonso Cuesta-Marcos
Department of Crop and Soil Science, Oregon State University, Corvallis, OR, USA

Fei Dai
Department of Agronomy, College of Agriculture and Biotechnology, Zijingang Campus, Zhejiang University, Hangzhou, China

Jason Eglinton
University of Adelaide, Waite Campus, PMB, SA, Australia

Neil Fettell
Central West Farming Systems & University of New England, Condobolin, NSW, Australia

Scott Fisk
Department of Crop and Soil Science, Oregon State University, Corvallis, OR, USA

Patrick Hayes
Department of Crop and Soil Science, Oregon State University, Corvallis, OR, USA

Patricia Juskiw
Field Crop Development Centre, Alberta Agriculture and Forestry, Lacombe, Alberta, Canada

Chengdao Li
Western Barley Genetics Alliance, Murdoch University, Murdoch, Australia; Department of Agriculture and Food, Western Australia, South Perth, Australia

Yanling Ma
Tasmanian Institute for Agriculture and School of Land and Food, University of Tasmania, Australia

Brigid Meints
Department of Crop and Soil Science, Oregon State University, Corvallis, OR, USA

Umme Aktari Nadira
Department of Agronomy, College of Agriculture and Biotechnology, Zijingang Campus, Zhejiang University, Hangzhou, China

Kenton Porker
University of Adelaide, Waite Campus, PMB, SA, Australia

Andrew Ross
Department of Crop and Soil Science, Oregon State University, Corvallis, OR, USA

Sergey Shabala
Tasmanian Institute for Agriculture and School of Land and Food, University of Tasmania, Australia

Feibo Wu
Department of Agronomy, College of Agriculture and Biotechnology, Zijingang Campus, Zhejiang University, Hangzhou, China

Dezhi Wu
Department of Agronomy, College of Agriculture and Biotechnology, Zijingang Campus, Zhejiang University, Hangzhou, China

Jennifer Zantinge
Field Crop Development Centre, Alberta Agriculture and Forestry, Lacombe, Alberta, Canada

Guoping Zhang
Department of Agronomy, College of Agriculture and Biotechnology, Zijingang Campus, Zhejiang University, Hangzhou, China

Gaofeng Zhou
Western Barley Genetics Alliance, Murdoch University, Murdoch, Australia; Department of Agriculture and Food, Western Australia, South Perth, Australia

Meixue Zhou
Tasmanian Institute for Agriculture and School of Land and Food, University of Tasmania, Australia

Contents