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# Breeding and Biotechnology of Tea and its Wild Species

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Tapan Kumar Mondal

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 Springer

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*Dedicated to  
my beloved parents*

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## Preface

Tea is an important industrial crop that supports the life of several million plantation workers working globally. It is the morning drink of several million people worldwide. Interestingly, several wild species such as *C. japonica* are important due to its elegant flower colour. Because of its perennial nature with a life span of more than 100 years, breeding of tea and its wild species to improve the cultivars is difficult and limited to only few aspects. During the past 2 decades, as a student, teacher and humble science worker, I was, am, and surely will remain fascinated by this beautiful plant whose not only taste but also scenic beauty of plantation always refreshes my mind. While working with this plant, at various tea research institutes in the last 2 decades, I have experienced the present practices, gaps and scope of varietal improvement works and felt the need of *in vitro* culture, molecular breeding, and genomics to supplement the conventional breeding works. With the initiation of cell culture technique in 1968, a significant amount of work on various aspects of breeding and biotechnology of tea and its wild relatives has been done. Although several topical reviews and scientific articles have been published on tea and *Camellia* species, yet they are not codified in a single document.

I am deeply indebted to my teachers who blessed me to learn about this crop and plant biotechnology as a whole. Therefore, I sincerely acknowledge my thanks to my beloved teachers of Assam Agricultural University, Prof. P. S. Ahuja, Director and other Scientists of Institute of Himalayan Bioresource Technology, India, Prof. P. K. Chand of Utkal University, Scientists of UPASI, Tamil Nadu, Tocklai Experimental Station, Assam and Prof. P. C. Deka, Vice Chancellor, Sir Padampat Singhanian University, Udaipur. Few people also inspired me to work further on tea breeding and they are Prof. N. K. Jain, Mr P. Haridas, and some of my planter friends of Southern India, Dooars, West Bengal as well as Assam.

I would also like to thank my wife, Dr. Bipasa Sarkar who helped me to improve the manuscript in several ways. Lastly, my son, Vaibhav, my younger sister, Tia and her family, elder brother, Prof. Swapan Kumar Mondal and his family, Kaku and his family are also gratefully acknowledged. I am also thankful to Profs. C. R. Park of USA, A. M. Vieitez of Spain, S. Matsumoto of Japan, Z. Apostolides of South Africa, Z. Chen of China, I. D. Singh of Sri Lanka, S. C. Das, T.R. Sharma, and L. M. S. Palni, India for my personal interactions with them since my student days. I apologize for those works, if any, which did not appear in this book despite a detail search worldwide.

I am also grateful to my PhD students Dr. Pranay, Olivia, Akan, Pratap, Mainaak and Showkat as I was enriched with knowledge while working with them. It is my sincere belief that this book will serve the requirement of students, scientists and industries involved in studies, teaching, research on breeding and biotechnology of tea and other *Camellia* species with an intension of serving science and society.

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New Delhi, India

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## About the Author



Dr. Tapan Kumar Mondal joined at Institute of Himalayan Bioresource Technology (CSIR), Himachal Pradesh, India, for his Ph.D degree which he completed in 1998. After that, he served as Deputy Manager, Research and Development Department, Tata Tatley Ltd, Munnar, Kerala till March, 2002. Since then up to 2010, he further served as Assistant Professor at North Bengal Agricultural University, Cooch Behar, West Bengal. Later in February 2010, he joined as Senior Scientist (Plant Biotechnology) at National Bureau of Plant Genetic Resource (ICAR), New Delhi. He carried out his Post Doctoral training with Prof. J. K. Zhu of University of California, Riverside, USA, on 'Regulation of small RNA under cold stress of Arabidopsis' and later worked at University of Illinois, Urbana-Champaign, USA, on 'Identification of nitrogen use efficient genes of maize by RNAseq'.

Dr. Mondal has significantly contributed in various areas of biotechnology and genetic resource management of tea. His work leads to develop the first transgenic tea plants. He has also submitted several gene sequences of tea at NCBI and also published more than 60 publications in this area. He was PI of various projects of tea biotechnology funded by DBT, DST, ICAR and Tea Board, India.

He is the recipient of University merit scholarship, scholarship from Indian Tea association, ICAR JRF, DBT fellowship, CSIR fellowship and life member of several professional societies. He also bagged 'Young scientist award' by Korean Society of Tea Science in 2003 and Japan Tea Science Society in 2004.

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## Abbreviations

ABA	Abscisic acid
AS	Acetosyringone
BAC	Bacterial artificial chromosome
ANN	Artificial neural network
6-BAP	6-Benzylaminopurine
cM	Centimorgan
CTAB	Cetyl trimethyl ammonium bromide
cv	Cultivar
°C	Degree celsius
CM	Coconut milk
2,4-D	2,4-Dichlorophenoxy acetic acid
DMSO	Dimethyl sulfoxide
d	Day(s)
g	Gram(s)
g/l	Gram(s) per litre
GA3	Gibberellic acid
GUS	$\beta$ -glucuronidase
<i>gus</i>	$\beta$ -glucuronidase gene
<i>gusint</i>	$\beta$ -glucuronidase gene with an intron
h	Hour(s)
ha	Hectare(s)
<i>hpt</i>	Hygromycin phosphotransferase gene
HPLC	High performance liquid chromatography
IAA	Indole-3-acetic acid
IBA	Indole-3-butyric acid
Kn	Kinetin
KPa	Kilo pascal
kb	Kilo base pair
M	Molar
min	Minute(s)
m	Meter(s)
ml	Millilitre(s)
mM	Micromolar
MS	Murashige and Skoog's (1962) medium
$\mu$ l	Microlitre
NAA	Napthalene acetic acid
NCBI	National Centre for Biotechnology Information

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nM	Nano mole
<i>npt-II</i>	Neomycin phosphotransferase gene
O.D.	Optical density
PCR	Polymerase chain reaction
PVP	Polyvinyl pyrrolidone
pM	Pico mole
%	Percent
QTL	Quantitative trait loci
Q-PCR	Quantitative-PCR
rpm	Revolution per minute
RAPD	Random amplified polymorphic DNA
RFLP	Restriction fragment length polymorphism
ROS	Reactive oxygen species
sdH <sub>2</sub> O	Sterile distilled water
Sec	Second(s)
SE	Somatic embryogenesis
SSR	Suppression subtractive hybridization
SSH	Simple sequence repeat
SNP	Single nucleotide polymorphism
t	Tonnes
<i>Taq</i> Pol.	<i>Taq</i> DNA polymerase
TBA	Tertiary butyl alcohol
TBE	Tris borate EDTA
TES	Tocklai experimental station
TDZ	Thidiazuron
TE	Tris-EDTA
UV	Ultra-violet
UPGMA	Unweighted pair group method with arithmetic mean
UPASI	United Planter Association of South-India
v/v	Volume by volume
WPM	Woody plant medium of Lloyd and McCown (1982)
w/v	Weight by volume
mg	Micro gram
ng	Nano gram
YE	Yeast extracts
YMB	Yeast mannitol broth