Challenge of *in situ* conservation for wild relative species
— A case study in rice

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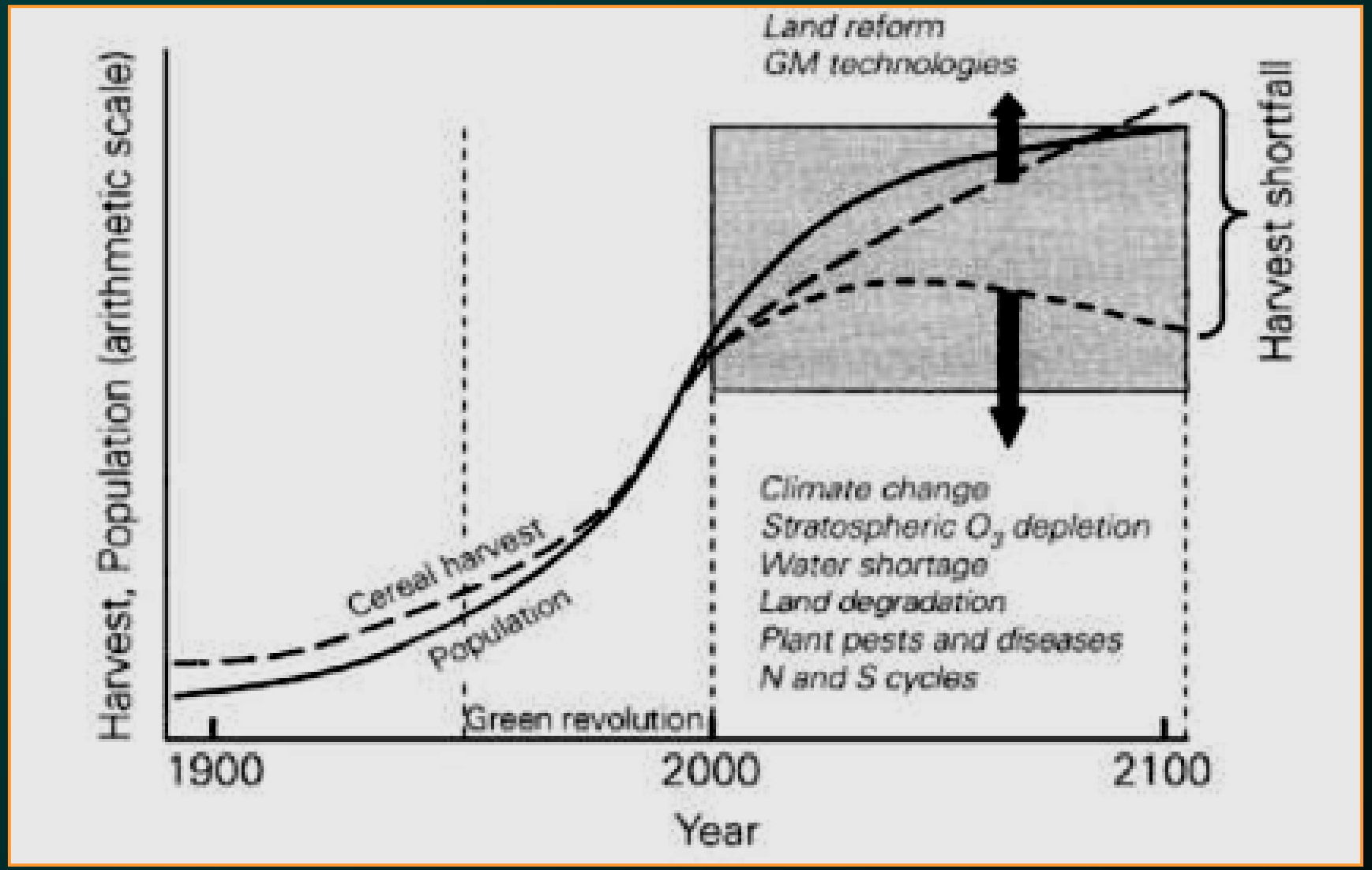
Why need crop wild relatives ?

Challenge of the world's food security




Global climate change

Enhance crop productivity

- **Effective use of genetic resources provides more opportunities**
  - **Crop species**
  - **Crop wild relative species**

Father of hybrid rice

MS gene

Yield increase 20~40%

1700 mh/y in China

In situ conservation is an important strategy for wild relatives

The genus *Oryza*

- Classified in the tribe *Oryzeae* of the grass family (*Poaceae*)
- **Containing 2 cultivated & more than 22 wild species widely distributed in pan-tropics**
- The Sect. *Oryzae* is the most important germplasm in the genus for rice breeding

Close wild relatives with A genome

- ***O. rufipogon* complex**
- ***O. barthii*, *O. longistaminata***
- ***O. meridionalis***
- ***O. glumaepatula***

  (weedy rice)

Wild *Oryza* species in China

Oryza rufipogon

Oryza officinalis

Oryza granulata

Extinction of *O. rufipogon* populations

- **Ca. 80% *O. rufipogon* populations recorded in China (1970s) were extinct**
- **Size of many survived populations was significantly reduced**

Reasons of extinction

- **Habitat deterioration**
- **Human disturbance**
  - **Agricultural land**
  - **Water drainage**
  - **Animal grazing**

- **Introgression of crop alleles?**

Evol Ecol (2006) 20:501–522
DOI 10.1007/s10682-006-9113-0

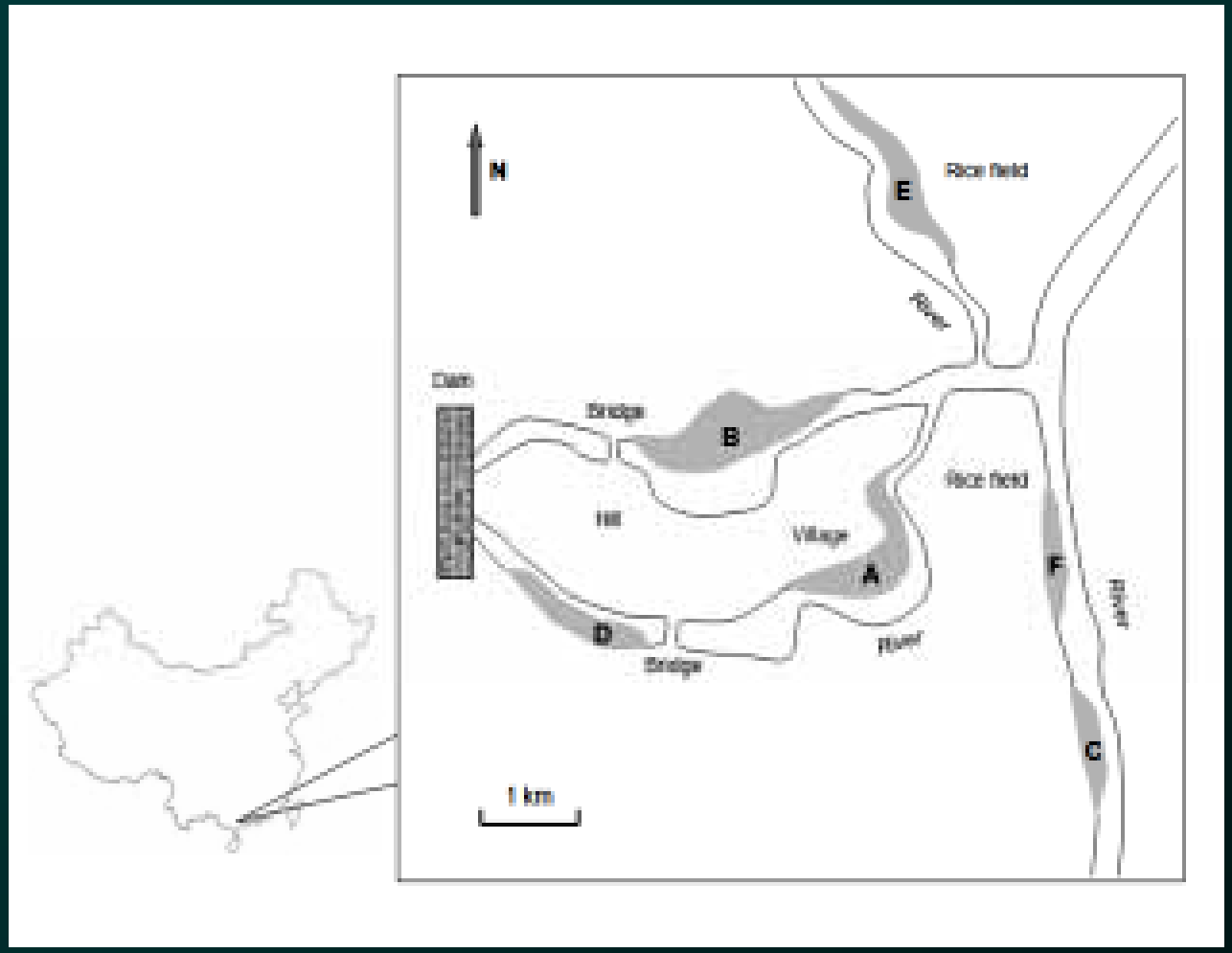
ORIGINAL PAPER

Evidences of introgression from cultivated rice to *Oryza rufipogon* (Poaceae) populations based on SSR fingerprinting: implications for wild rice differentiation and conservation

Zhiping Song · Weiyue Zhu · Jun Rong · Xian Xu · Jiakuan Chen · Bao-Rong Lu

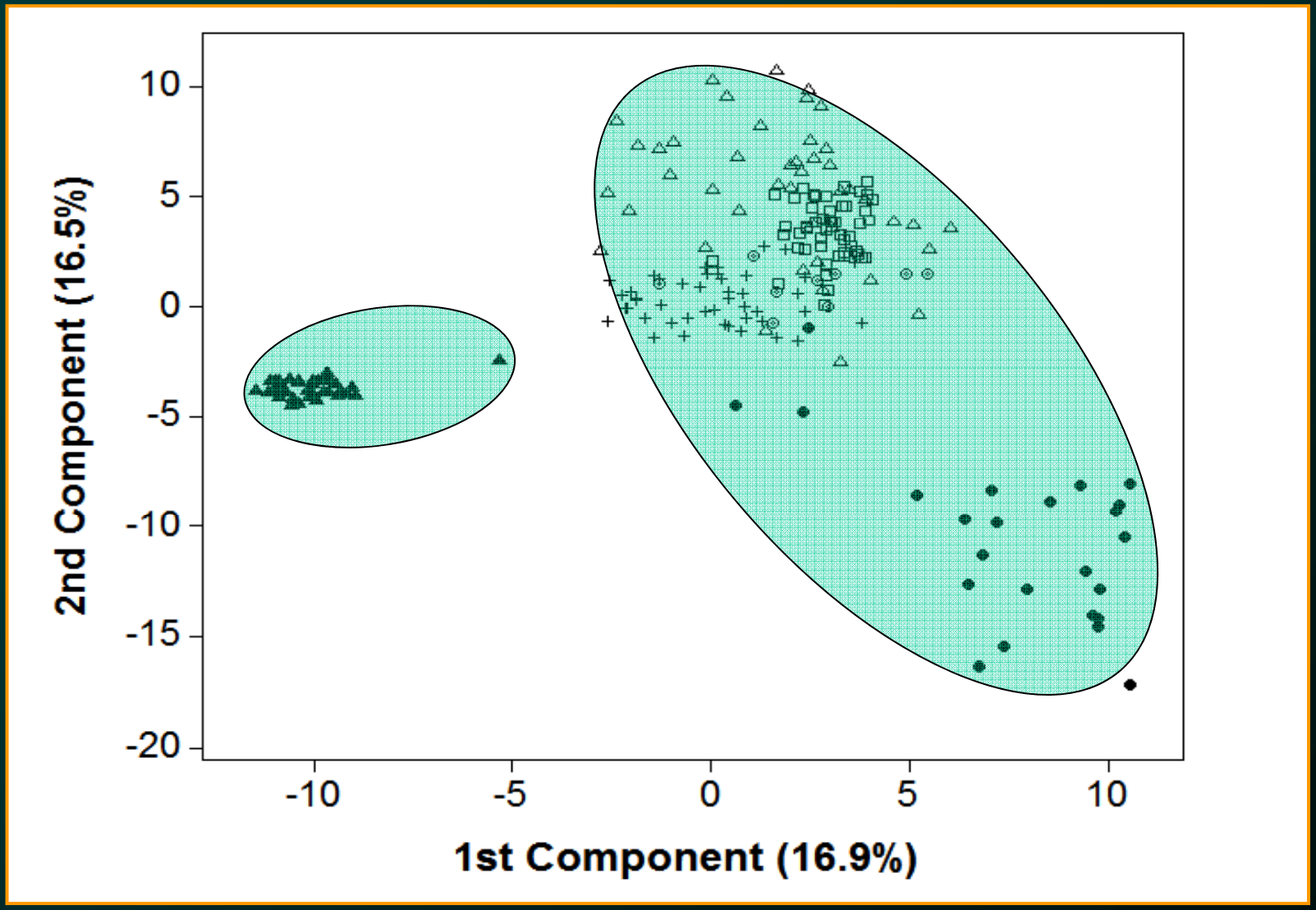
- **Substantial gene flow from rice crop to wild *O. rufipogon***
- **Introgressed populations have higher genetic diversity**
- **Introgression from crop affects *in situ* conservation of wild rice**

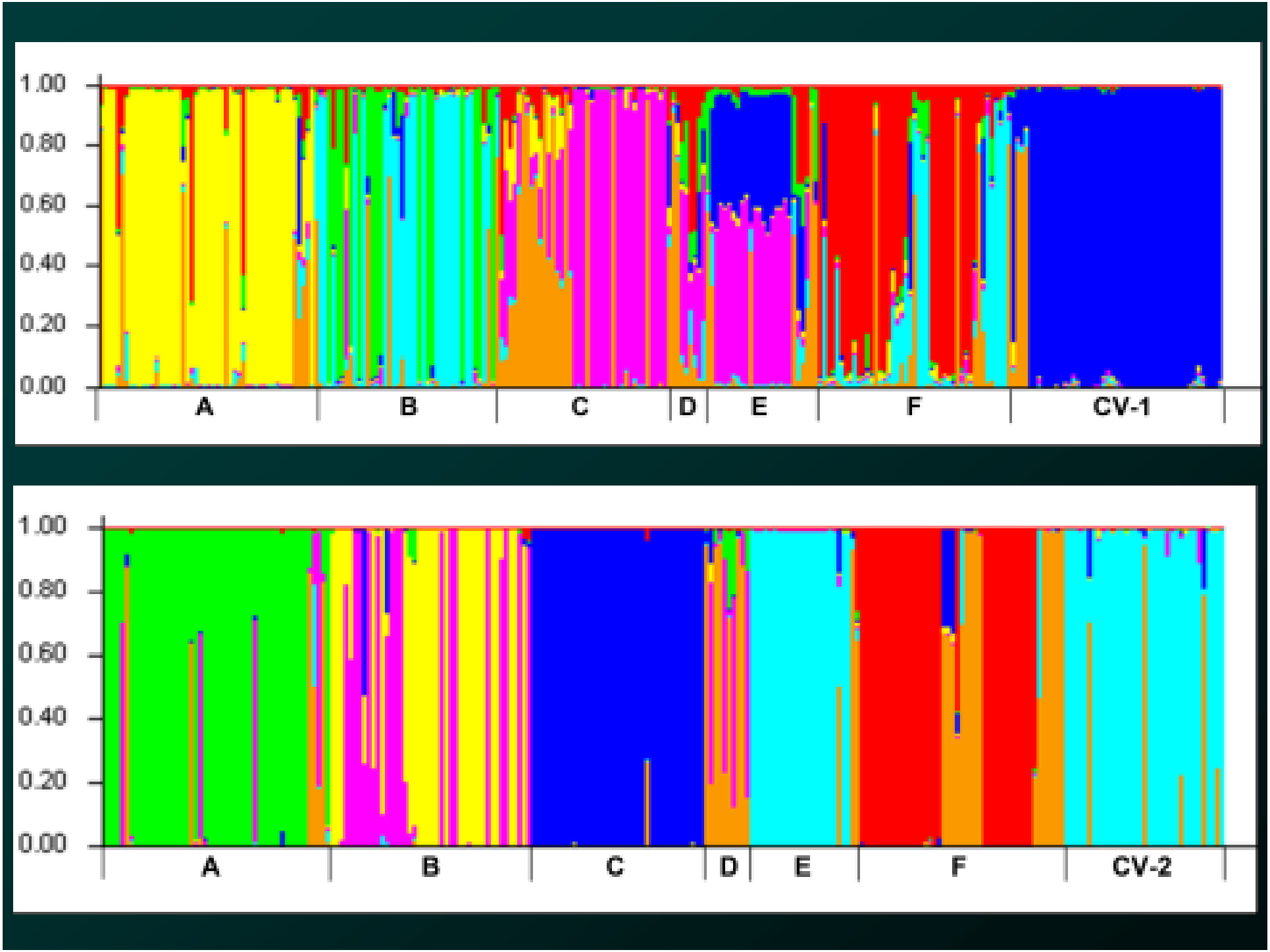
Introgression from crop affects genetic structure of wild rice



PCA plot of wild rice by SSRs

□=A, △=B, ▲=C, =D, ●=E, +=F subpopulation




1.00
0.80
0.60
0.40
0.20
0.00
A
B
C
D
E
F
CV-1
1.00
0.80
0.60
0.40
0.20
0.00
A
B
C
D
E
F
CV-2

Genetic diversity of wild population

Wild pop. code	*A*	A_e	H_o	Nei' gene diversity	*I*	Total no. of alleles	No. of population specific alleles
A	4.06	1.66	0.45	0.34	0.61	138	13
B	4.09	2.60	0.59	0.56	1.00	139	8
C	2.12	1.64	0.58	0.31	0.46	72	3
D	3.26	2.60	0.64	0.57	0.98	110	3
E	3.41	2.05	0.81	0.48	0.79	116	11
F	4.24	2.11	0.50	0.45	0.82	142	18
Over all	7.47	3.22	0.56	0.65	1.32	254	105

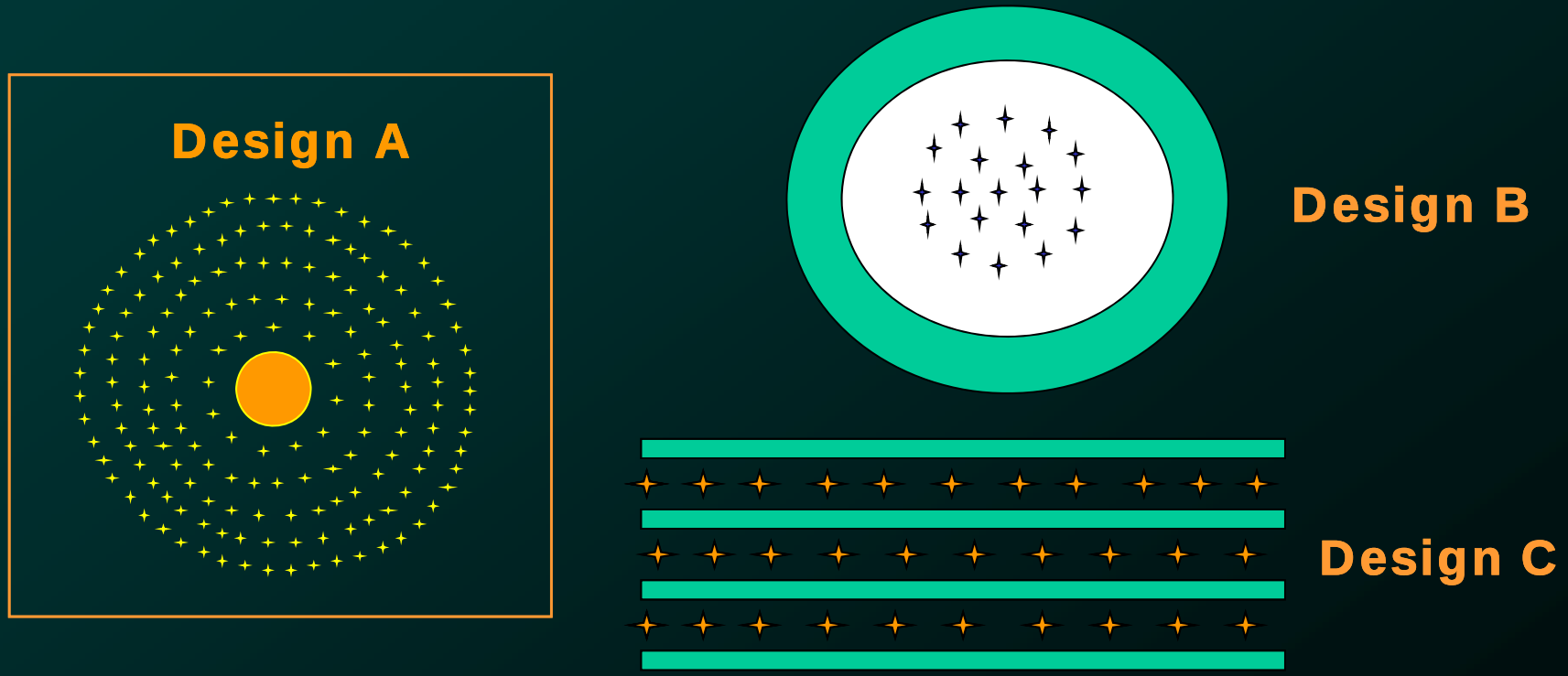
New Phytologist

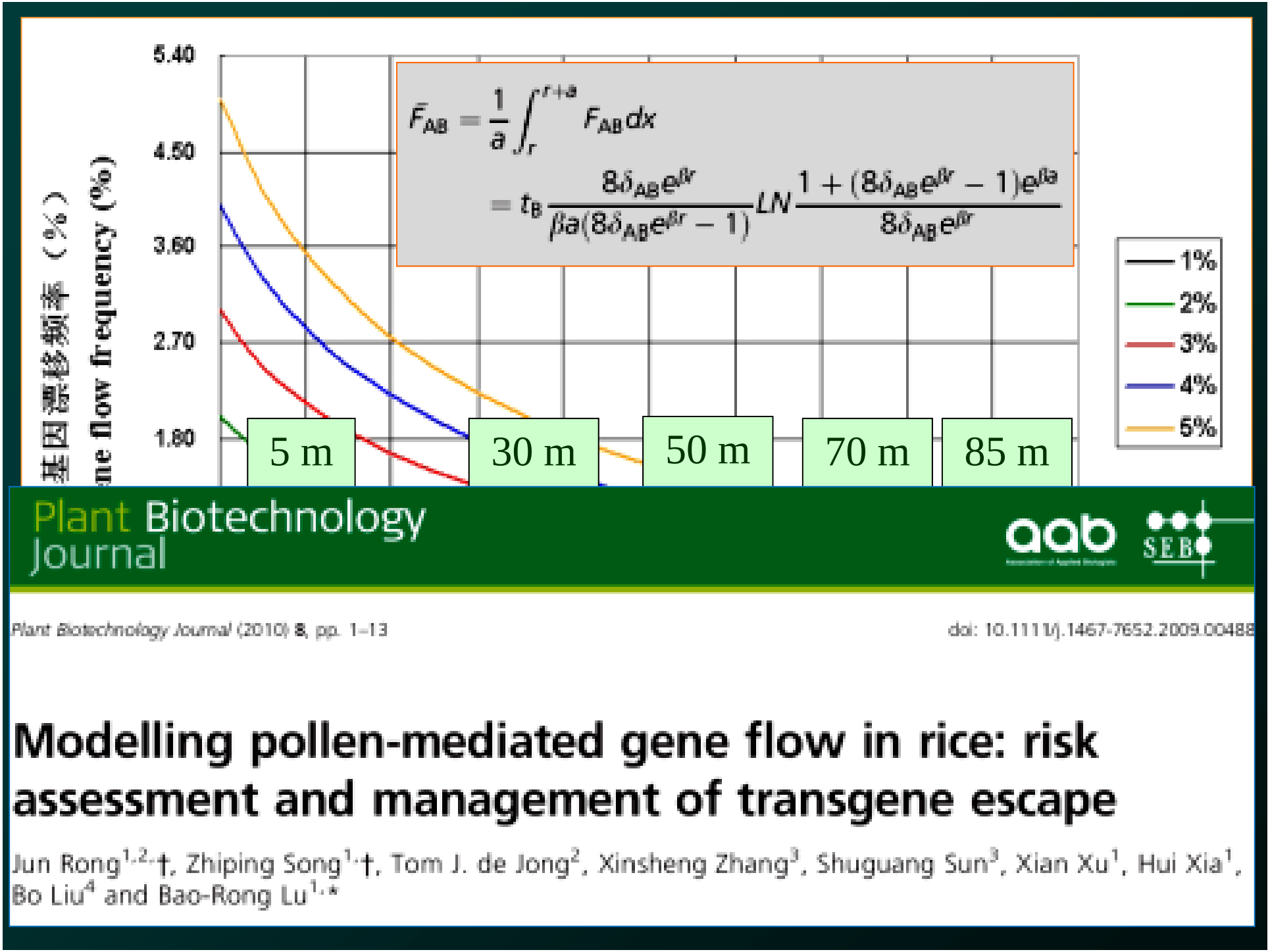
Research

Gene flow from cultivated rice to the wild species *Oryza rufipogon* under experimental field conditions

Zhi Ping Song[1,2], Bao-Rong Lu[1], Ying Guo Zhu[2] and Jia Kuan Chen[1]

[1]Ministry of Education Key Laboratory for Biodiversity Science and Ecological Engineering, Institute of Biodiversity Science, Fudan University, Shanghai 200433, China; [2]School of Life Sciences, Wuhan University, Wuhan 430072, China





Plant Biotechnology Journal

Plant Biotechnology Journal (2010) **8**, pp. 1–13

doi: 10.1111/j.1467-7652.2009.00488

Modelling pollen-mediated gene flow in rice: risk assessment and management of transgene escape

Jun Rong[1,2,†], Zhiping Song[1,†], Tom J. de Jong[2], Xinsheng Zhang[3], Shuguang Sun[3], Xian Xu[1], Hui Xia[1], Bo Liu[4] and Bao-Rong Lu[1,*]

Annals of Botany **93**: 311–316, 2004
doi:10.1093/aob/mch036, available online at www.aob.oupjournals.org

Fitness Estimation through Performance Comparison of F_1 Hybrids with their Parental Species *Oryza rufipogon* and *O. sativa*

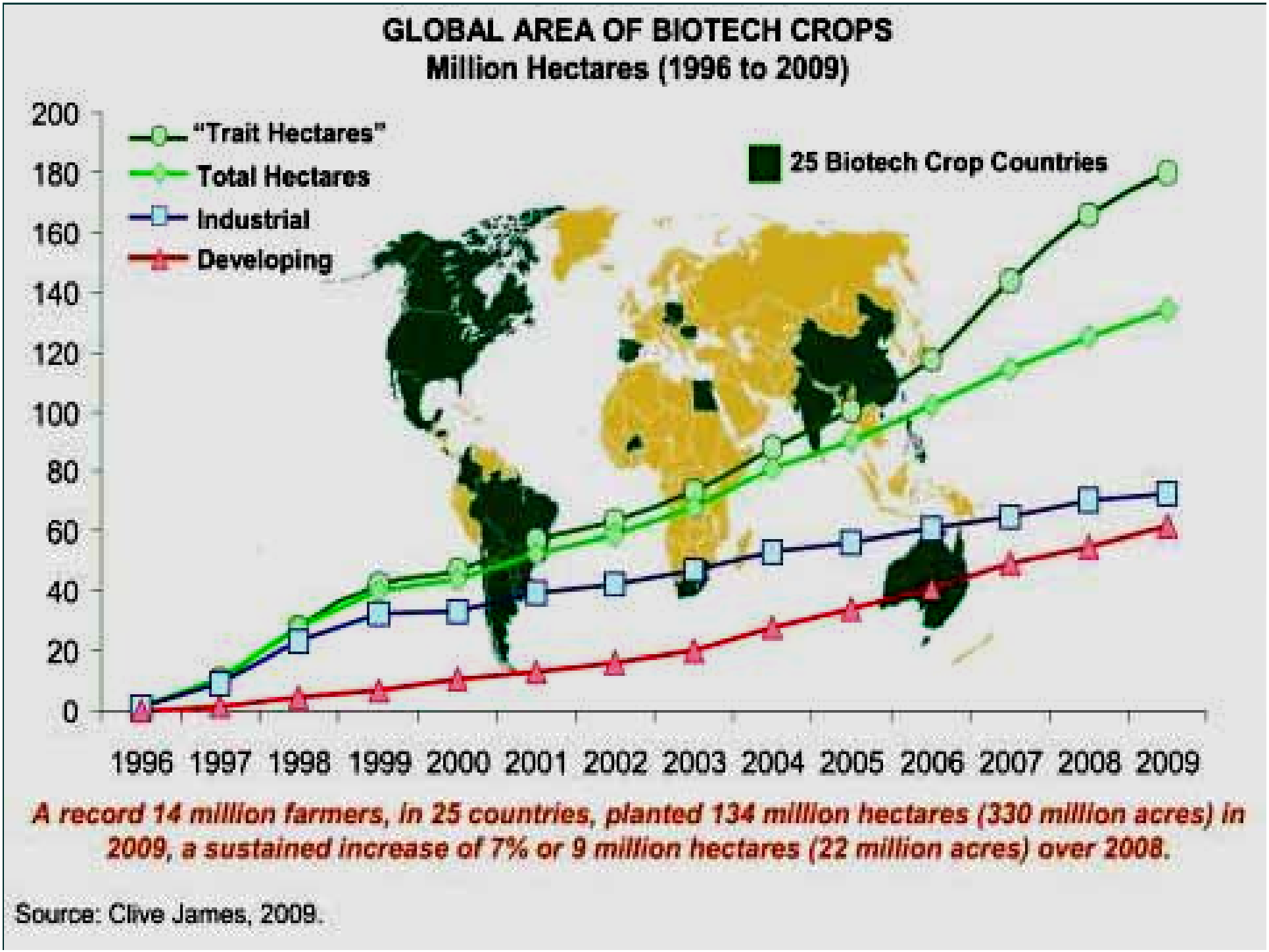
ZHI PING SONG, BAO-RONG LU, BIN WANG and JIA KUAN CHEN*

Ministry of Education Key Laboratory for Biodiversity Science and Ecological Engineering, Institute of Biodiversity Science, Fudan University, Shanghai 200433, China

- **Hybrid vigor, poor sexual reproduction**
- **No significant differences in composite fitness across whole life-history**

Results:

- **Rice genes may persist in wild populations *via* vegetative & sexual reproduction**


GLOBAL AREA OF BIOTECH CROPS
Million Hectares (1996 to 2009)
"Trait Hectares"
Total Hectares
Industrial
Developing
25 Biotech Crop Countries
200
180
160
140
120
100
80
60
40
20
0
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
A record 14 million farmers, in 25 countries, planted 134 million hectares (330 million acres) in 2009, a sustained increase of 7% or 9 million hectares (22 million acres) over 2008.
Source: Clive James, 2009.

Contents lists available at ScienceDirect

Biotechnology Advances

journal homepage: www.elsevier.com/locate/biotechadv

Research review paper

Gene flow from genetically modified rice to its wild relatives: Assessing potential ecological consequences

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ARTICLE INFO

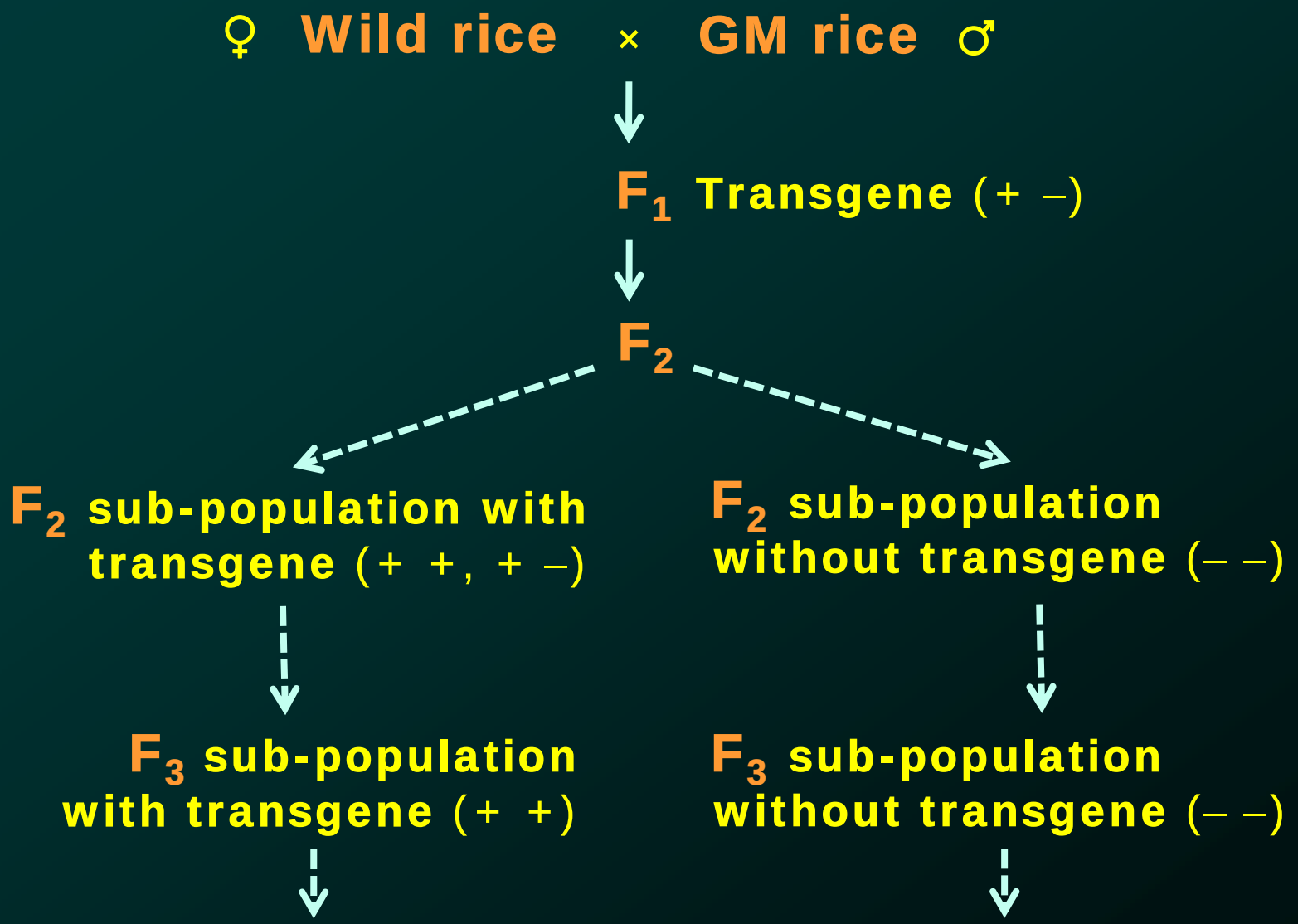
Available online xxxx

Keywords:
Oryza
Transgenic rice
Wild rice
Environmental biosafety
Outcrossing
Introgression
Fitness

ABSTRACT

Pollen-mediated gene flow is the major pathway for transgene escape from GM rice to its wild relatives. Transgene escape to wild Oryza species having AA-genome will occur if GM rice is released to environments with these wild Oryza species. Transgenes may persist to and spread in wild populations after gene flow, resulting unwanted ecological consequences. For assessing the potential consequences caused by transgene escape, it is important to understand the actual gene flow frequencies from GM rice to wild relatives, transgene expression and inheritance in the wild relatives, as well as fitness changes that brought to wild relatives by the transgenes. This article reviews studies on transgene escape from rice to its wild relatives via gene flow and its ecological consequences. A framework for assessing potential ecological consequences caused by transgene escape from GM rice to its wild relatives is discussed based on studies of gene flow and fitness changes.

Fitness study of GM – weedy rice hybrids



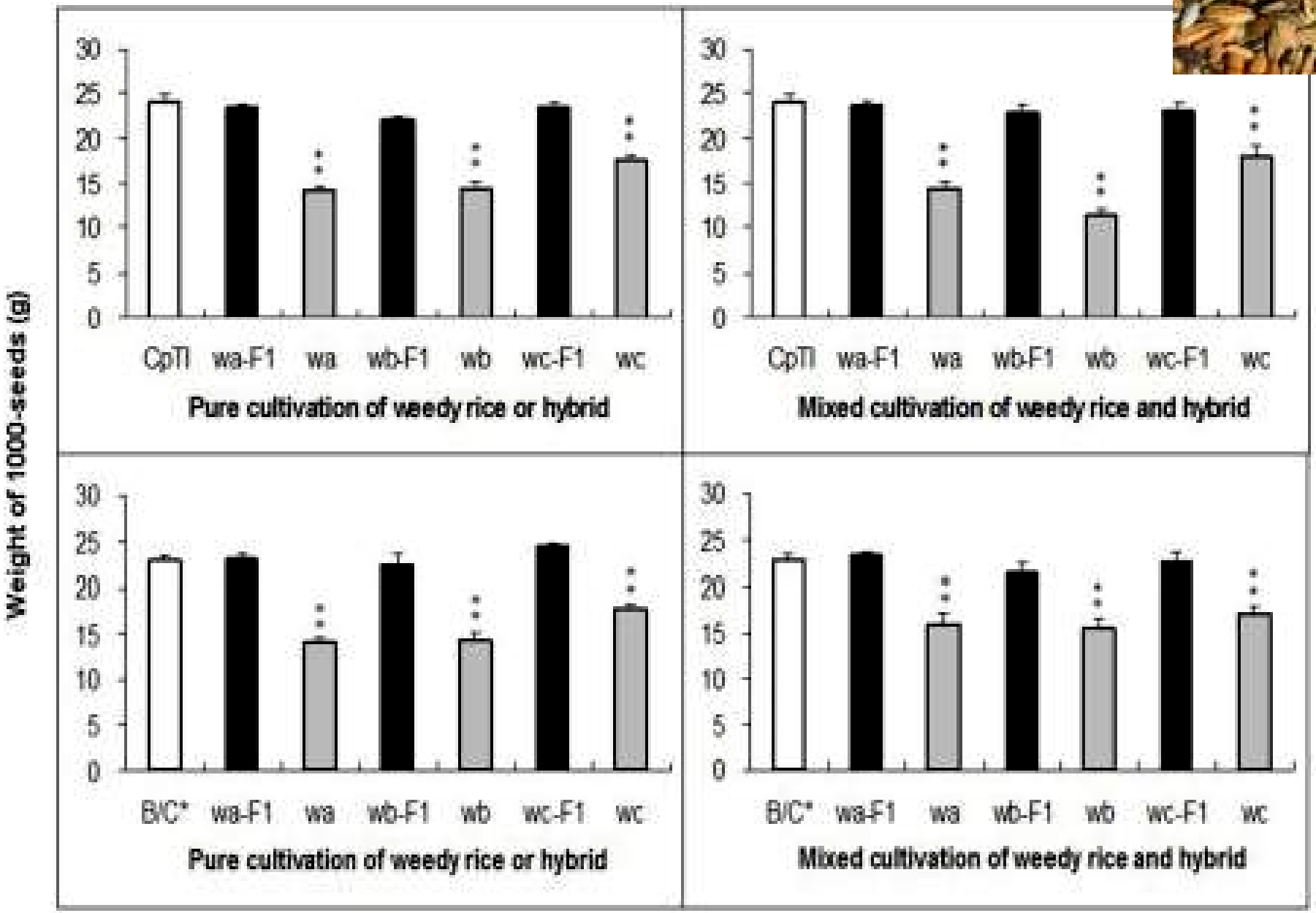
Journal of Integrative Plant Biology 2009, **51** (12): 1138–1148

Performance of Hybrids between Weedy Rice and Insect-resistant Transgenic Rice under Field Experiments: Implication for Environmental Biosafety Assessment

Qian-Jin Cao†, Hui Xia†, Xiao Yang and Bao-Rong Lu*

(*Ministry of Education Key Laboratory for Biodiversity Science and Ecological Engineering, Institute of Biodiversity Science, Fudan University,* Shanghai 200433, China)

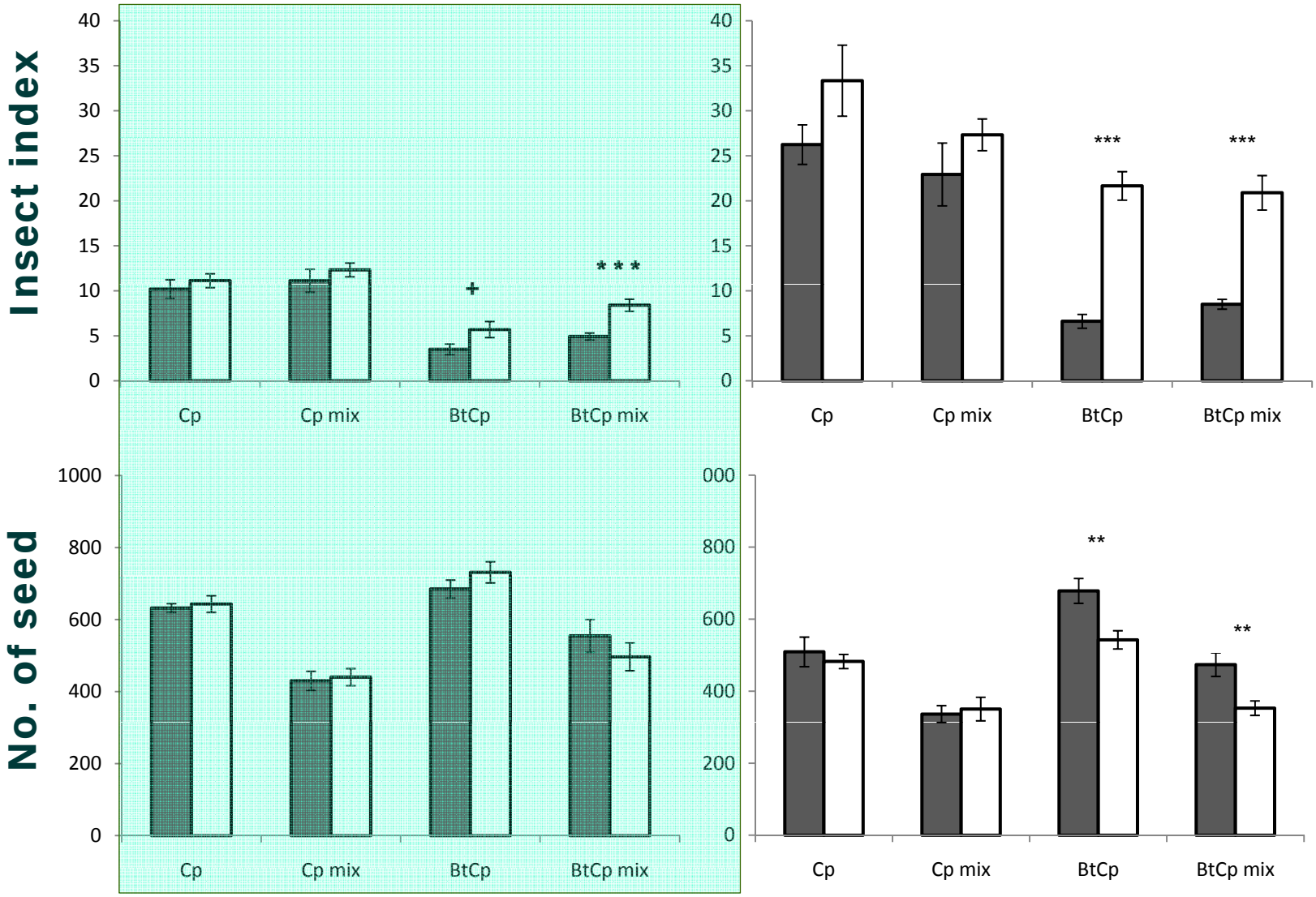
- **Hybrids (weedy-crop)**
- **GM rice lines (*CpTI* or *Bt*/*CpTI*)**
- **Weedy rice parents**
- **Pure or mixed planting**


Weight of 1000-seeds (g)
30
25
20
15
10
5
0
CpTl
wa-F1
wa
wb-F1
wb
wc-F1
wc
Pure cultivation of weedy rice or hybrid
Mixed cultivation of weedy rice and hybrid
B/C*
Pure cultivation of weedy rice or hybrid
Mixed cultivation of weedy rice and hybrid

Fitness study of F_2 & F_3 populations

- **With transgenes**: ***CpTI*** **(++ or +–) & *Bt/CpTI* (++ or +–)**
- **Without transgenes**: ***CpTI*** **(––) & *Bt/CpTI* (––)**
- **Normal or low insect pressure**
- **Pure or mixed cultivation**

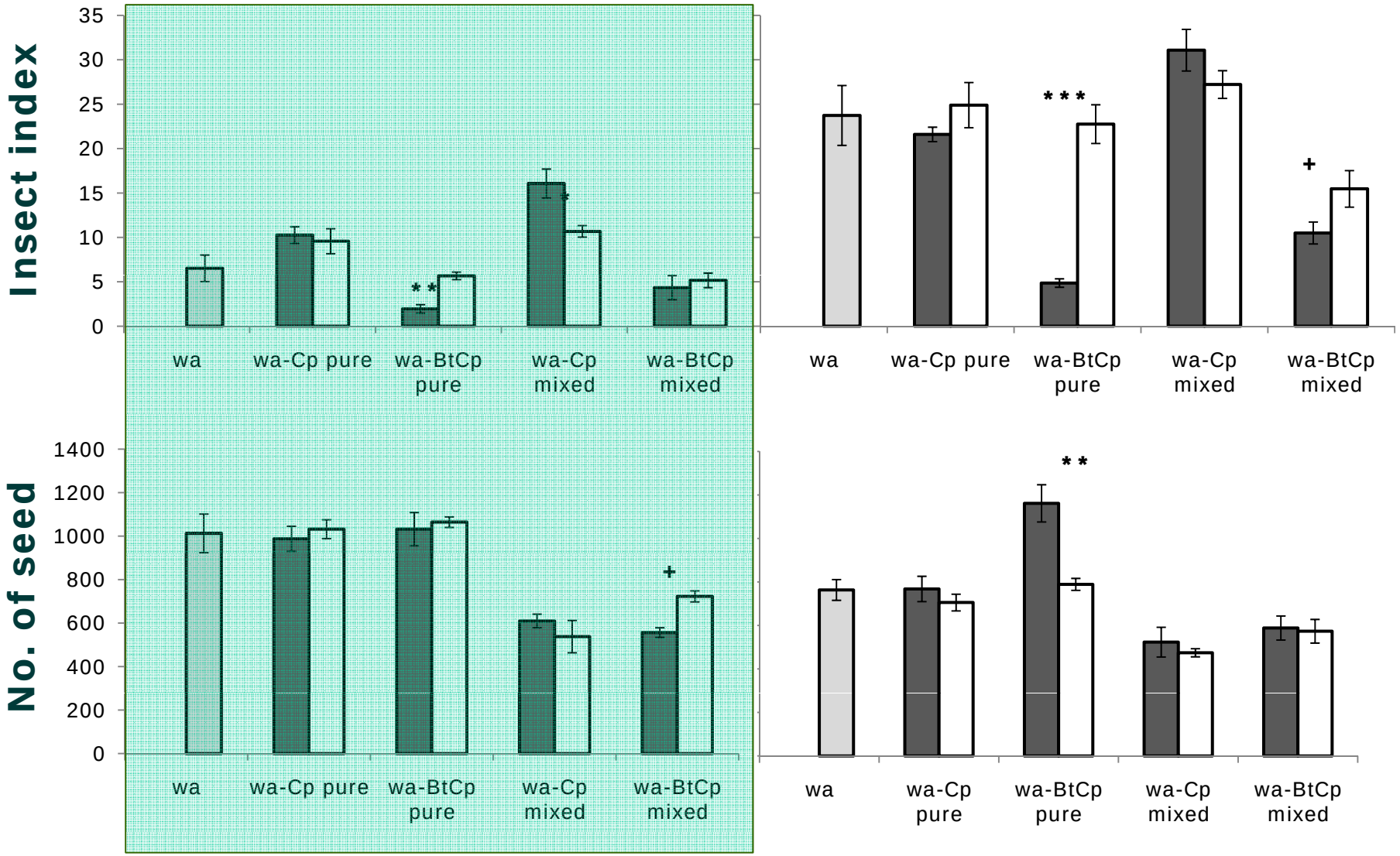
Insect index & seed production of F_2



Low insect pressure

Natural insect pressure

Insect index & seed production of F_3



Conclusion:

- **Rice & its wild relatives co-exist worldwide**
- **Crop-to-wild / weedy (trans)gene flow occurs**
- **Introgressed (trans)genes may change fitness & impact evolution of wild rice**
- **New challenge of *in situ* conservation of wild relatives**

Fudan University


Thank you !