

Wild Sunflower Species as a Genetic Resource for Resistance to Sunflower Broomrape

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Outline

- Broomrape History
- Genetic diversity of wild species
- Broomrape resistance sources
- Future prospective





Broomrape History

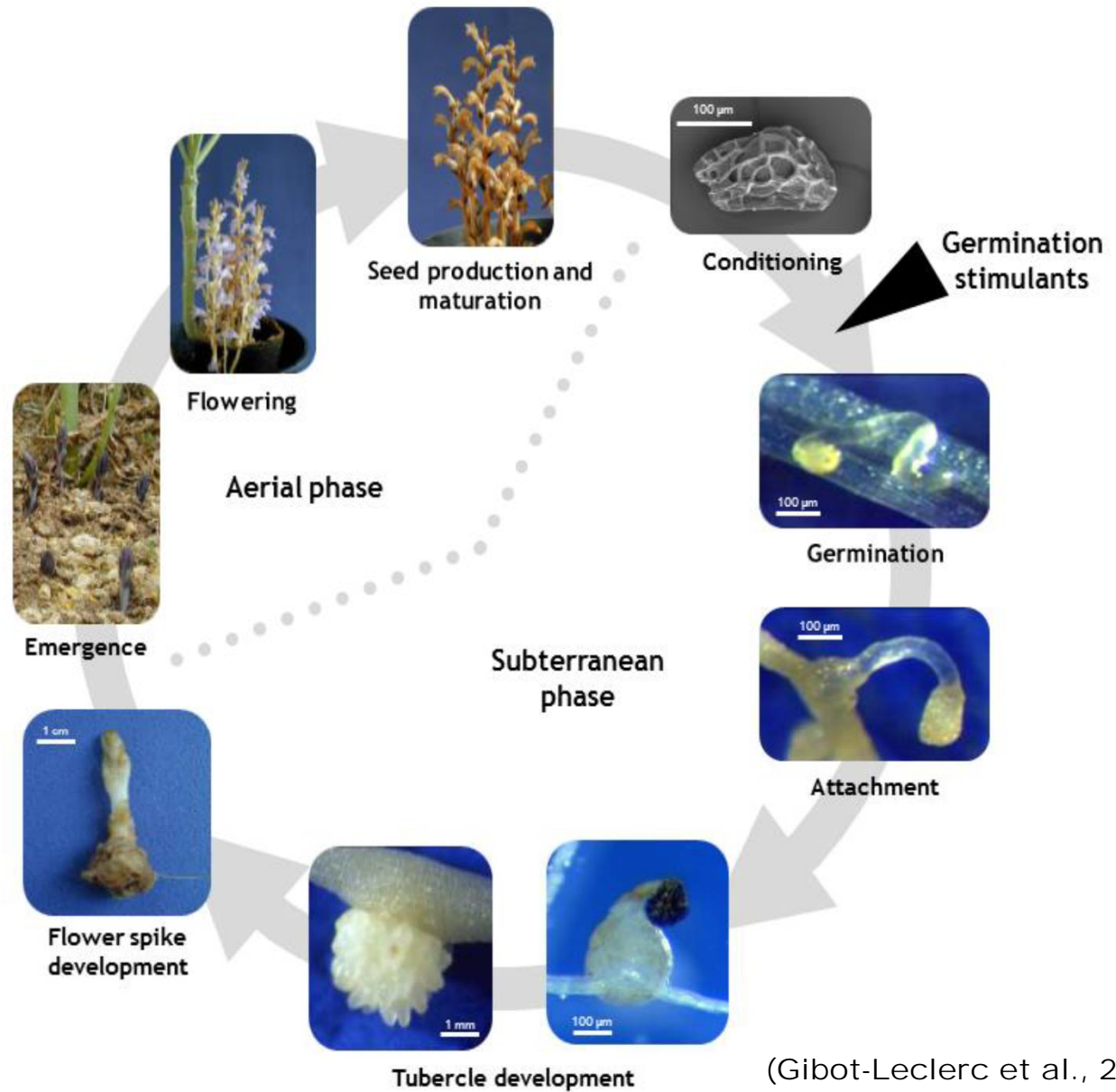
- *Orobanchaceae* family is composed of 2060 species distributed in 90 heterotrophic genera
- Only about 20 species considered as harmful parasitic weeds in important crops
- First reports on sunflower from Saratov Oblast in Russia in the 1890s
- Distribution on sunflower in Russia, Ukraine, Romania, Bulgaria, Turkey, Spain, Serbia, Hungary, Moldova, Greece, Tunisia, Israel, Iran, Kazakhstan, China, Mongolia, and France



Broomrape History

- *Orobanche cumana and cernua*
- Races A-E controlled by Or_1 - Or_5 genes
- Race F appeared in Spain in the mid 1990s
 Or_6 Or_7
- Races G and H appeared in Spain and Turkey recently
- Race identification is complicated because broomrape was thought to be only self-pollinated, but occasionally outcrosses

Broomrape Life Cycle



(Gibot-Leclerc et al., 2012)

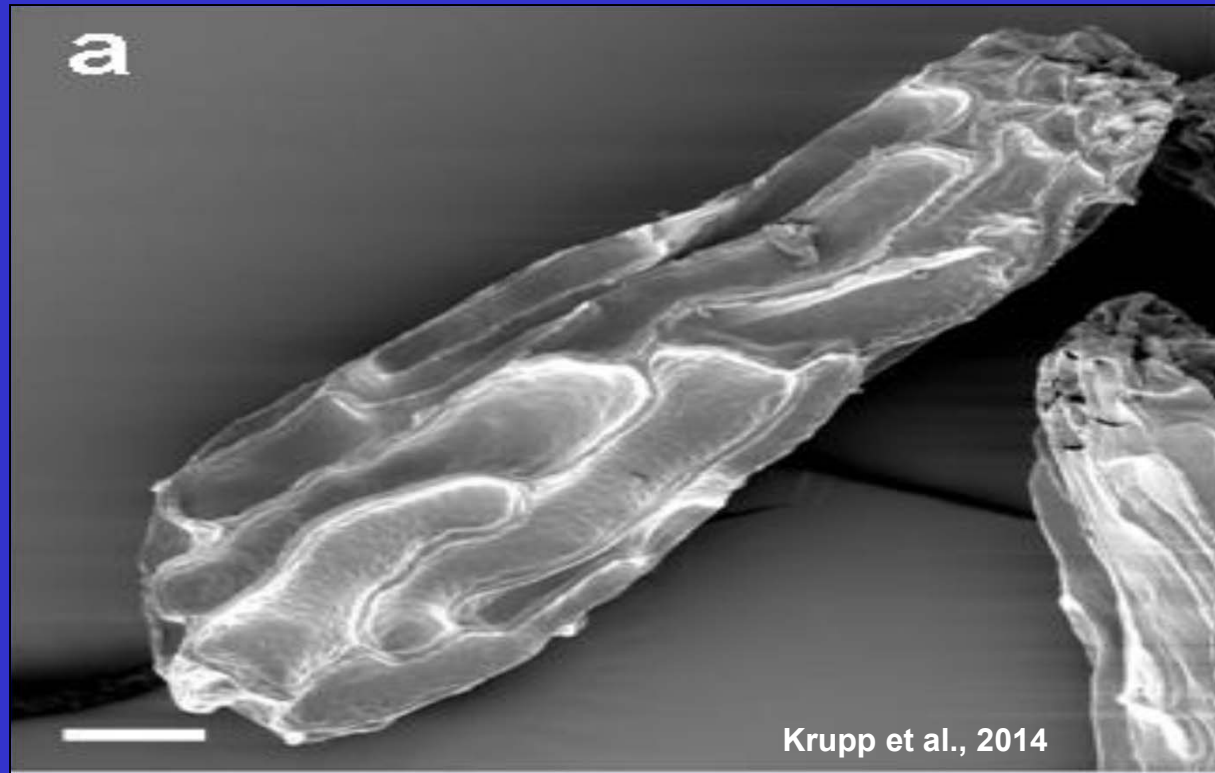


Fig. 1. Scanning electron micrographs showing the typical forms of dry seeds of *O. cumana*; Scale bar, 50 μm .

Seed=39.320 X 10⁻⁶ Inches; 1000 seed weight =0.0029g



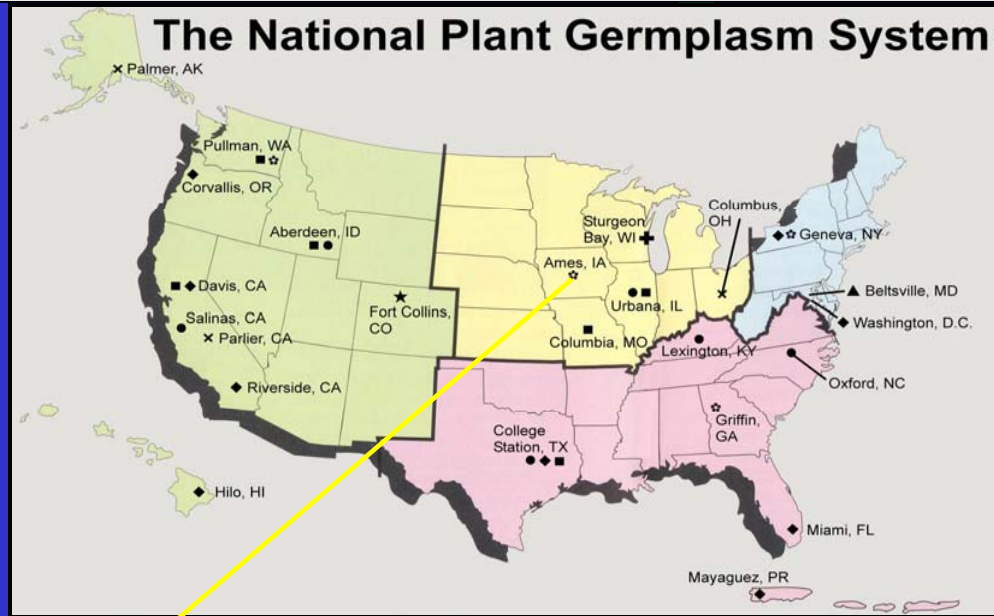
Broomrape Resistance

Helianthus species constitute a substantial reservoir of genes conferring resistance to new broomrape virulence races

(Fernández-Martínez et al., 2000, 2010; Nikolova et al., 2000; Bervillé, 2002; Škorić and Pacureanu-Joita, 2011; Christov, 2013; Antonova et al., 2011; Terzic et al., 2010)



USDA, ARS, North Central Regional Plant Introduction Station and Iowa State University, Ames, Iowa



Laura Marek, Curator



Seed increase, Ames, IA

Wild Sunflower Species

Cultivated ($2n=2x=34$)

14 wild annuals ($2x=34$)

29 **wild diploids** ($2x=34$)

4 **wild tetraploids** ($4x=68$)

6 **wild hexaploids** ($6x=102$)

- All wild species can be hybridized with cultivated sunflower except *H. agrestis*
- F_1 abortion (embryo rescue)
- F_1 sterility (colchicine treatment)



Accessions in the USDA-ARS Sunflower Collections



H. debilis, Florida



H. pumilus, Colorado



H. niveus, California

Type	Number	Available %
Cultivated	1886	92
Wild species	2201	87
Annual	1359	95
Perennial	842	70
Total	4087	88

Wild *Helianthus* sources of resistance for diseases

Disease	Wild species		Total
	Annual	Perennial	
Rust	3	5	8
Downy mildew	10	15	25
Sclerotinia	7	18	25
Phomopsis	7	18	25
Alternaria	3	9	12
Powdery mildew	3	9	12
Rhizopus	0	4	4
Phoma	2	8	10
Charcoal rot	0	5	5
Broomrape	8	29	37
Verticillium	4	3	7



BROOMRAPE

Races A-E (Or_1 - Or_5)

<u>Species</u>	<u>Introduction</u>	<u>Germplasm</u>
<i>H. anomalus</i>	PI 468644	ANO-1509-2
<i>H. tuberosus</i>	PI 430541	Progress
<i>H. tuberosus</i>	PI 430538	Novinka
<i>H. deserticola</i>	PI 468701	DES-1474-1



H. anomalus, Utah



H. tuberosus, Indiana

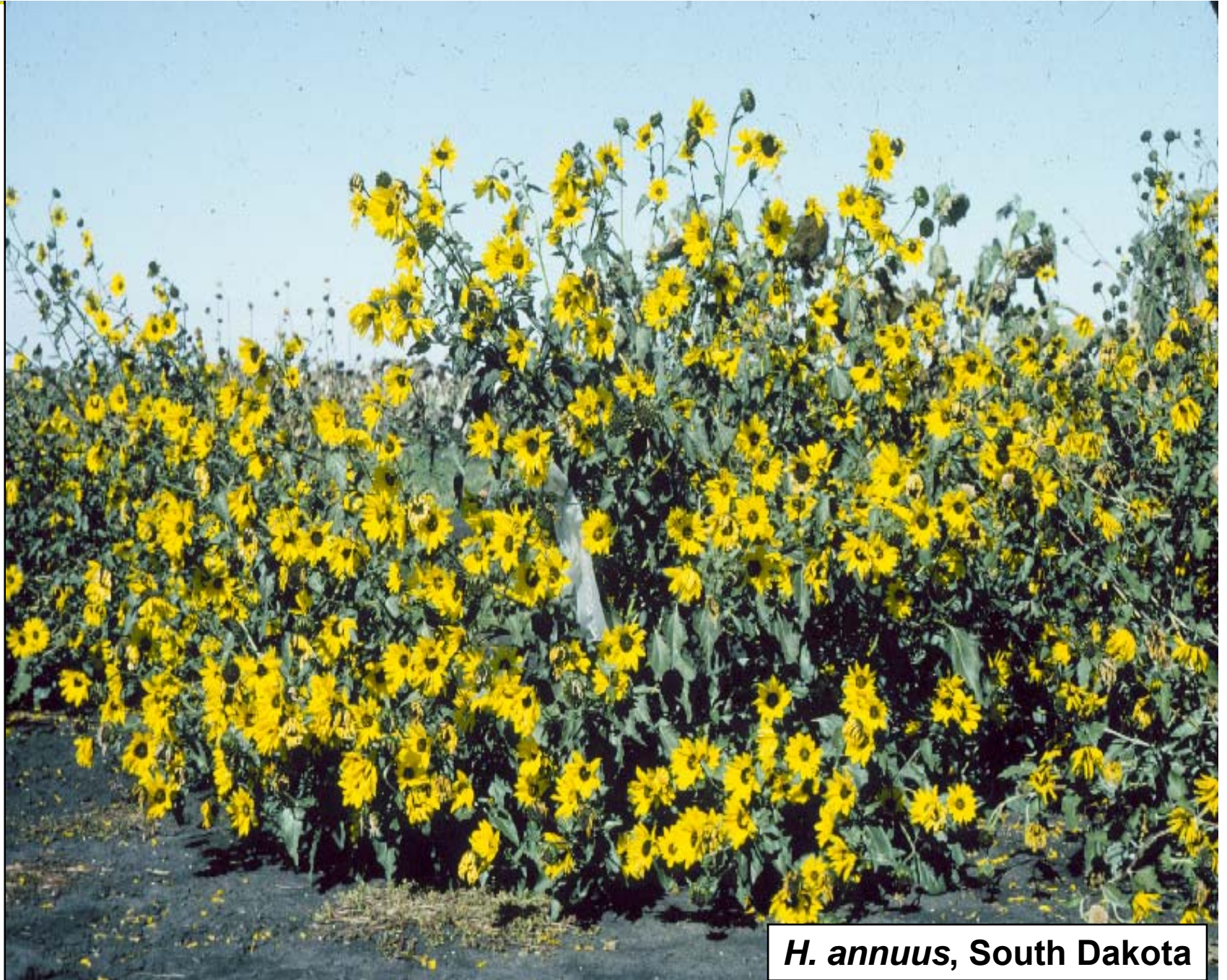


H. deserticola, Arizona



Wild annual species

Species	Race(s)
<i>annuus</i>	E
<i>anomalus</i>	E-F
<i>argophyllus</i>	F
<i>debilis</i> ssp. <i>tardiflorus</i>	G
<i>deserticola</i>	E-F
<i>exilis</i>	E-F
<i>petiolaris</i>	A-G
<i>praecox</i>	A-G



H. annuus, South Dakota



1980

H. argophyllus, Daytona Beach, FL

2006



H. petiolaris, Texas



H. exilis, California

Broomrape (Races E-F)

29 species of **perennial** sunflower have
resistance

Only *H. nuttallii* had 33% incidence





BROOMRAPE

Race F

<u>Species</u>	<u>Introduction</u>	<u>Germplasm</u>
<i>H. grosseserratus</i>	PI 617026	BR1
<i>H. maximiliani</i>	PI 617027	BR2
<i>H. divaricatus</i>	PI 617028	BR3
<i>H. divaricatus</i>	PI 617029	BR4



H. maximiliani, Manitoba, Canada



BROOMRAPE

Race G

Species

Source

H. debilis subsp. *tardiflorus* PI 468691



H. debilis ssp. *tardiflorus*, Florida



Future Perspective

- **Genetics resources are available, but will require some effort to use**
- **Opportunity to move exotic genes with more precision and efficiency**
- **Additional molecular tools are becoming available to mine the genetic diversity**
- **Need a good breeding strategy and global cooperation**

Thank You



H. niveus ssp. *tephrodes*- California