Biocontrol of Sahara mustard: An update on exploration in the native range

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Collaborations

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Partners

Italy - Enrico deLillo

Israel - Alon Singer

Iran

Irkaya Farms-Qatar-Nazar Nawrani
• European Biological Control Laboratory

• Foreign exploration
• Host specificity of BCAs

• Ecology & Genetics of pests
• Quarantines

www.ars-ebcl.org
• So many weeds, so little time…
Classical biocontrol

- Target selection
- Foreign exploration
- Selection of candidate agents (BCAs)
- Host specificity testing
- Efficacy evaluation
- Regulatory approval
- Multiplication
- Release, establishment, distribution
- Impact assessment

1st year
- Literature search, TW taxonomy

2nd year
- Field surveys, CBCA selection, biology & taxonomy

3rd year
- Host specificity, impact & risk assessment tests, CBCA genetics

4th year

5th year
- US quarantine studies, submit petition

6th year
Overall perspective of a classical biocontrol program of weeds

Purpose of BC – no eradication of the target weed

Number of weeds vs. time

Equilibrium
Economic threshold

Pop. of the target
Purpose of BC

- No eradication of the target weed

Number

Time

Equilibrium

Agent(s) released

Economic threshold

New E

Pop. of the target
Schematic view of the costs and benefits associated with a successful biological control program (Briese 2000)
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Sahara mustard - *Brassica tournefortii*

- Brassicaceae
- Winter annual mustard
- Originating and widely distributed in Eurasia/North Africa/Middle East
- First collected in California (Coachella valley) in 1927 (with date palms?)
- Favors sandy soil, desert ecosystems
- Completing its life cycle during winter months
- Displacing wildflowers
- No classical Biocontrol management
Sahara Mustard Distribution
Based on herbarium records

- specimen in Br. Museum of NH
- specimen in Fr. Museum of NH
- specimens for DNA analysis

Map showing distribution of Sahara Mustard with symbols indicating different types of specimens.
Sahara mustard in Qatar
Sahara mustard in France

B. Bock
Current ★and historical records ○ for SM
Current ★ and historical records ○ for SM

Anza-Borrego SP
Invasion of SM in Anza-Borrego SP
Specific Goals of the Project

- EXPLORATION
- GENETICS, PHYLOGEOGRAPHY
- HERBARIUM DATA
- BIOCONTROL

Sahara mustard Project 2016-18
Specific Goals of the Project

- **EXPLORATION**
- **GENETICS, PHYLOGEOGRAPHY**
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- **BIOCONTROL**

**Sahara mustard Project 2016-18**
The purpose of visiting herbaria is to get locations and dates for preparing exploration.

The Paris Museum of Natural History
Observing all phenological stages
Data from the native range but...also from the introduced range
Specific Goals of the Project

- **EXPLORATION**
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**Sahara mustard Project 2016-18**
Why collecting?

1. Obtain voucher specimens for future morphological studies

2. Conduct genetic analyses of native and invasive populations

3. Find potential biocontrol agents
Where collecting?

- All native range (permits)
- Natural & agricultural ecosystems
- Roadsides
- National parks
- All year round
- Cooperation in hosted countries
- All kinds of BCAs (insects, mites, pathogens)

Collecting in Uzbekistan (Tamarix project)
Where have we been in 2016?

Foreign exploration in Europe & the Middle East:
- Morocco
- France
- Italy
- Turkey
- Israel
- Jordan
- Iran
- Qatar
- USDA-ARS France quarantine greenhouse
- Limited access to EBCL staff
- SOLID
- LIQUID
- AIR
Specific Goals of the Project

EXPLORATION

GENETICS, PHYLOGEOGRAPHY

HERBARIUM DATA

BIOCONTROL

Sahara mustard Project 2016-18
Phylogeography of Sahara mustard

• The goal is to determine which old world population(s) of Sahara mustard invaded North America

• In the U.S., the phylogeography study is conducted by Daniel Winkler (University of California, Irvine) (ddRAD-seq)

  ddRAD libraries for the weed in the old world need to be built as those in the U.S.
  • -> 15 populations sampled across the Mediterranean Basin
  • Sampling can be seeds: germination then extraction of the first pair of leaves
Sahara Mustard Distribution
Based on herbarium records

- ★ specimen in Br. Museum of NH
- ★★ specimen in Fr. Museum of NH
- ○ specimens for DNA analysis
Phylogeography of Sahara mustard

- Collected tissue samples from 2,061 plants from 70 unique locations in United States
- Collected seeds from 1,074 plants from 63 localities
Specific Goals of the Project

SAHARA MUSTARD PROJECT 2016-18

EXPLORATION

GENETICS, PHYLOGEOGRAPHY

HERBARIUM DATA

BIOCONTROL
Biocontrol agents?

Insects?

Mites?

Courtesy M. Cristofaro

18kV X650 20um

Courtesy M. Cristofaro
in the southeast of Italy, we found a flea beetle (*Psylloides* sp.?), and a root-galling insect (*Ceutorhynchus* sp.?)
Near Antalya, we found a stem mining larva (Lepidoptera or Chrysomelidae) and a seed feeder (potentially the adult from the chrysomelid larva).
Near Cesarea, we found phytophagous beetles, such as a Curculionidae Ceutorhynchini, a Chrysomelidae, and a possible stem-galling midge (Cecidomyidae).
We found typical symptoms of an Eryiophiid mite

• JORDAN (April)
Where will be going in 2017?

- Morocco
- France
- Italy
- Turkey
- Israel
- Jordan
- Armenia
- Iran
- Qatar

2016:
- Morocco
- France
- Italy
- Turkey
- Israel

2017:
- Jordan
- Armenia
- Iran
- Qatar
Next steps?

.1.

.2.

.3.

Centrifugal Phylogenetic Method

- Non-related
- Distant relatives
- Close relatives
  - Includes spp.
- Natives
- Econ. important

Target weed

Solutions from Nature
• When Insects go high, Weeds go low
• When Insects go high, Weeds go low

The present

Tamarix

Giant reed

The future

French broom

Medusahead

Sahara mustard
Thanks - Gracias - Merci

From the top of Half Dome