



Dimorphic fruits, seeds/seedlings as adaptation mechanisms to abiotic stress in unpredictable environments

(Short) project outline and preliminary results:
biomechanics and microscopy

K. Mummenhoff | Osnabrück University | on behalf of the SeedAdapt team



ERA-CAPS

ERA-NET for Coordinating
Action in Plant Sciences





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Royal Holloway University of London, UK



ERA-NET for Coordinating
Action in Plant Sciences

SeedAdapt Project Overview

- First ERA-CAPS call
- 36 months duration
- Themes: Adaptation to climate change
 1. Biotic/ abiotic stress
 2. Food security
- Objectives:
 - ‘Dimorphic fruits, seeds and seedlings as adaptation mechanisms to abiotic stress in unpredictable environments’
 - (Aethionema arabicum has 2 distinct types of diaspores)...*

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1. Royal Holloway University of London

Prof. Gerhard Leubner's lab



2. Friedrich Schiller University of Jena

Prof. Günter Theißen's lab



3. Wageningen University

Prof. Eric Schranz's lab



4. University of Osnabrück

Prof. Klaus Mummenhoff's lab



5. GMI Molecular Plant Biology

Prof. Ortrun Mittelsten-Scheid's lab



6. Philipps-University Marburg

Stefan Rensing's lab

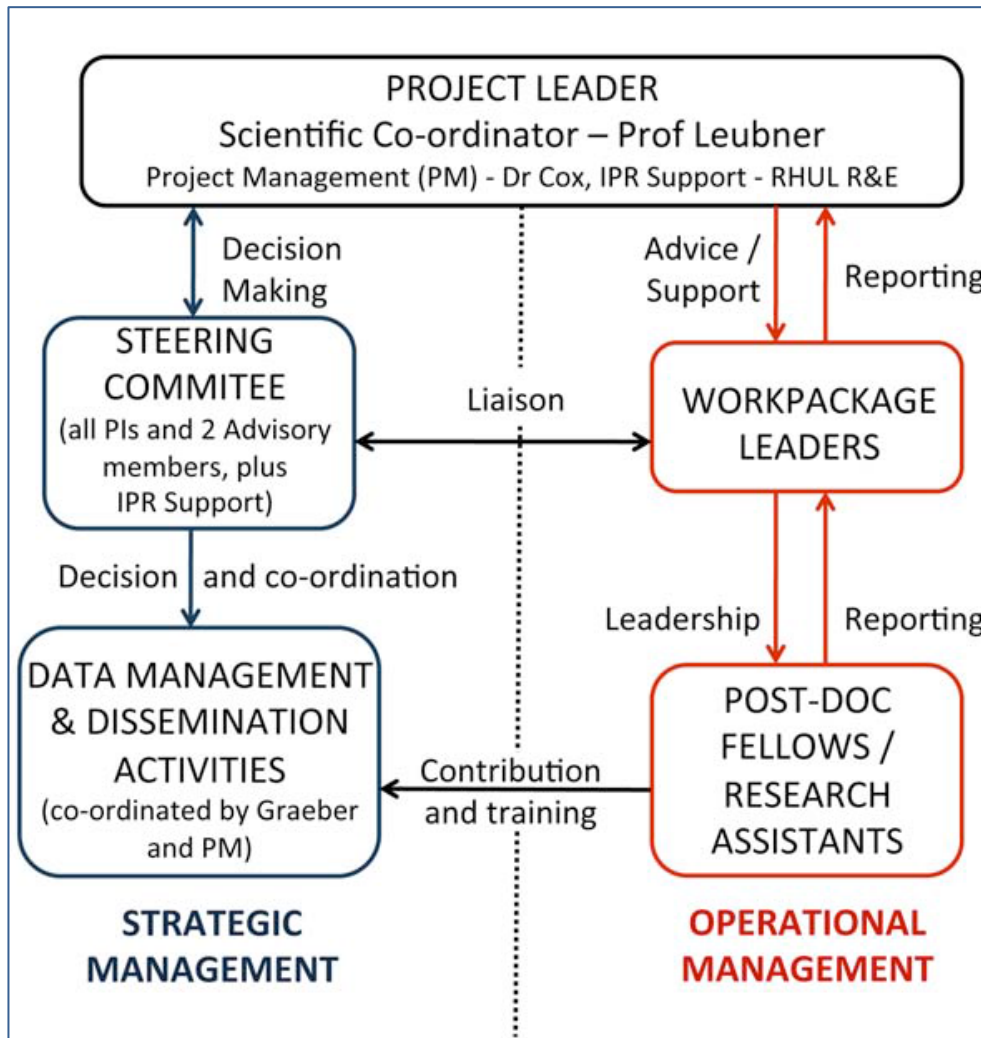


7. Palacky University, Olomouc

Miroslav Strnad's lab



Project Organisation and Reporting



- Project organisation chart
- Monthly Skype meetings
- Biannual Consortium meetings

Project Organisation and Reporting



May 2014



November 2014



Data Management and Dissemination

www.seedadapt.eu

<https://www.seedadapt.eu>



[Home](#) [About](#) [Team](#) [Publications](#) [Links](#)





Welcome to the website of the EU-funded ERA-CAPS project SeedAdapt which aims to investigate dimorphic fruits, seeds and seedlings as adaptation mechanisms to abiotic stress in unpredictable environments.



The aim of the SeedAdapt project is to elucidate the molecular mechanisms of fruit/seed-related early-life history traits that evolved in annual plant species as adaptations to abiotic stresses. Higher plant dispersal units - diaspores, *here*: fruits and seeds - support the distribution and early life history of the progeny. Our project will use a comparative approach to understand the dimorphic diaspore (fruit/seed) syndromes produced on the same plant of annual *Aethionema* species (sister of all core Brassicaceae, cabbage family) and provide distinct adaptations as a dormancy bet-hedging strategy. The availability of the *Aethionema arabicum* genome will facilitate our comparative investigation of the epigenomes, homonomes and transcriptomes in relation to abiotic stress during sensitive developmental processes. We propose that investigating the regulatory basis of fruit, seed, and seedling trait diversity is ideal for integrating new technologies and complementary expertise in order to study a field with utmost importance in ecology, evolution, seed industry and crop breeding.

SeedAdapt members

 ravenhill



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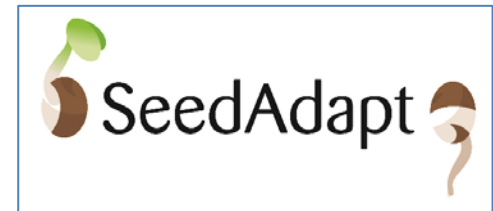
[Forum](#) [Index](#)

[Mark all topics read](#) [Board Categories](#) [Go](#)

SeedAdapt Forum
Welcome to the SeedAdapt forum for discussions and interactions related to our collaborative ERA-CAPS project.

	Experiments Post question or comments on future experiments here and discuss obtained experimental results.	1 Topics	0 Replies	Last Post: Germination conditio ... by admin 8 months 1 week ago
	Literature Post and discuss interesting papers.	2 Topics	2 Replies	Last Post: new paper on epigene ... by graeber

www.seedadapt.eu



Hypothesis

Dimorphic fruits, seeds as adaptation to abiotic stress in unpredictable environments

Objective

Regulatory basis of fruit and seed diversity

Methods

Comparative analysis of epigenome, hormonome, transcriptome, glucosinolates, evo-devo, germination essays, microscopy, etc.

Study Group

Aethionema arabicum, Brassicaceae, two distinct types of diaspores

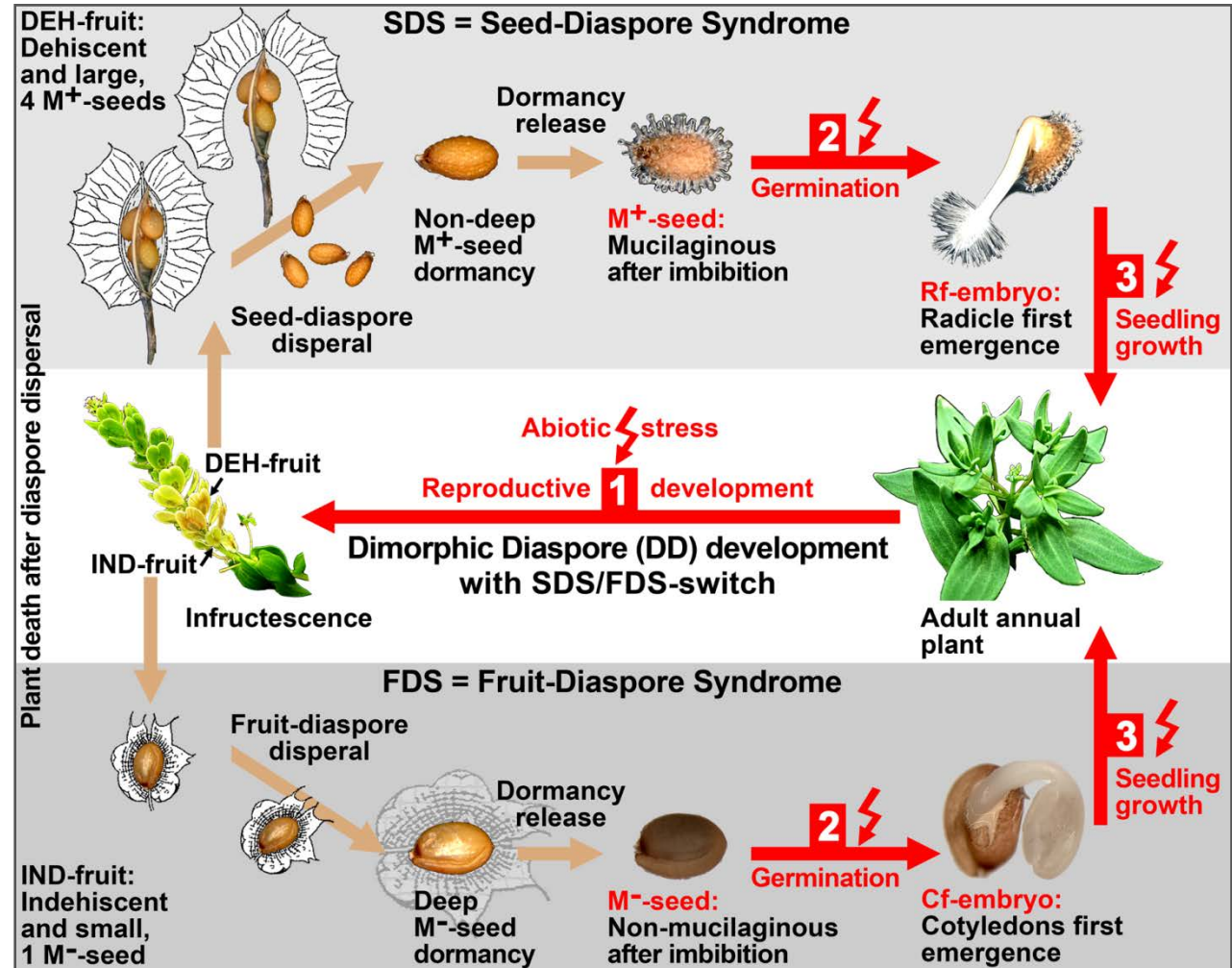
Consortium with multiple expertise

Six synergistic work packages

DEH fruit_ M⁺ seed
high dispersal / low dormancy
escape in space

Fruit/seed heteromorphism:
Bet-hedging strategy in
environmentally fluctuating
(unpredictable) habitats;
Reduces risk of failure
under temporal environ-
mental uncertainty

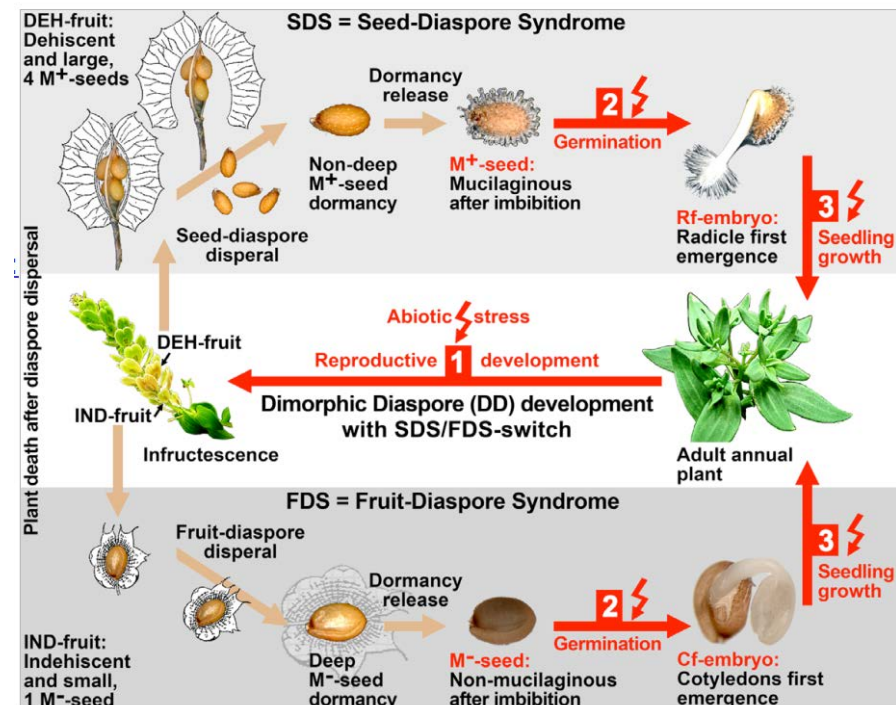
low dispersal / high dormancy
escape in time
IND fruit_ M⁻ seed



The aim of the SeedAdapt project is to elucidate the molecular mechanisms of heterocarpic fruit/seed-related life history traits that evolved in annual plant species as adaptations to abiotic stresses.

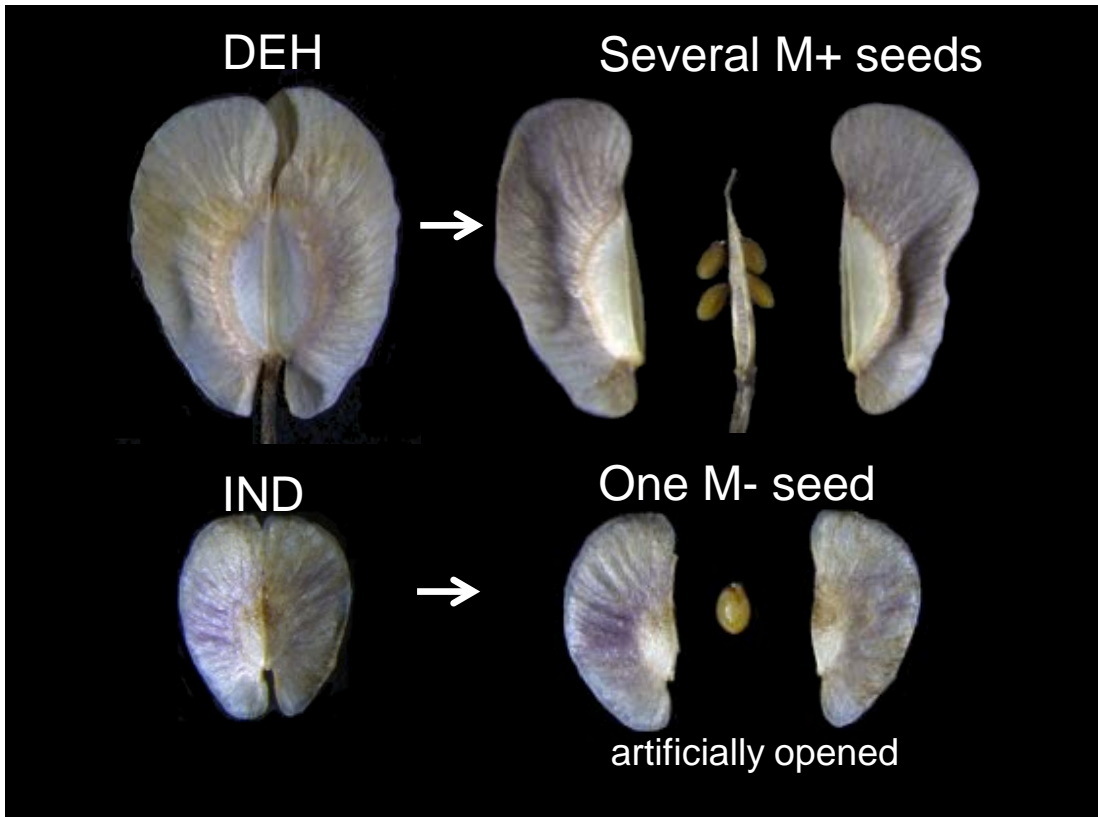
Core experiment:

Investigate the influence of abiotic stress (heat) on epigenomes, hormones and transcriptomes during reproductive development (1), seed germination (2), and seedling establishment (3) of *Aeth. arabicum*.



> Six work packages contribute to the core experiment

Dimorphic diaspore syndromes in *Aethionema arabicum*



dry



imbibed



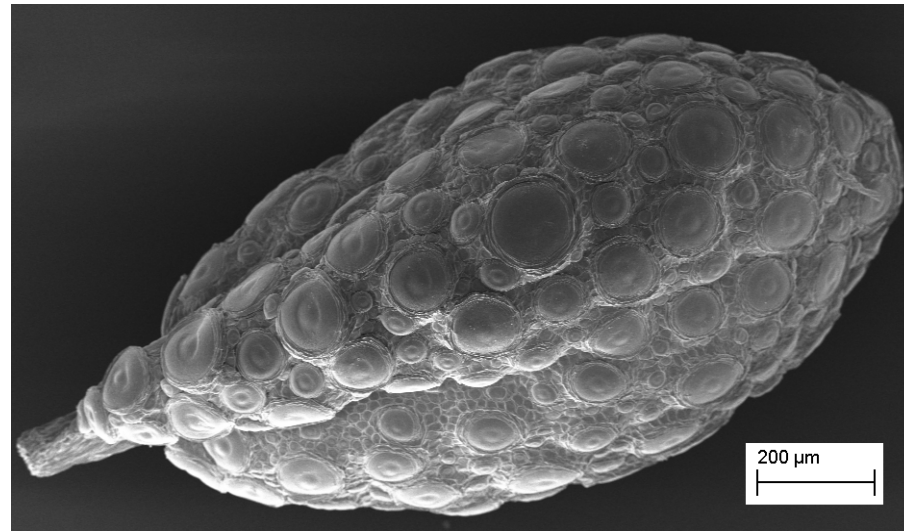
Two different fruit / seed types

DEH_M⁺
IND_M⁻

Two different ecotypes

Tur
Cyp

Surface structures on DEH_M+ seeds

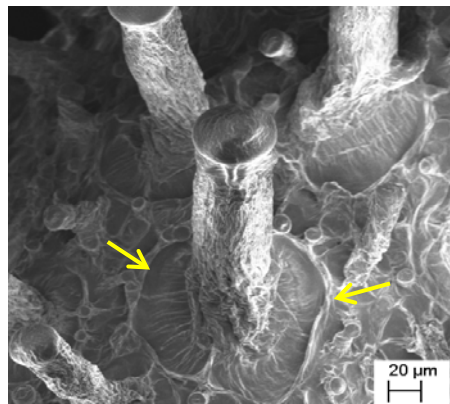
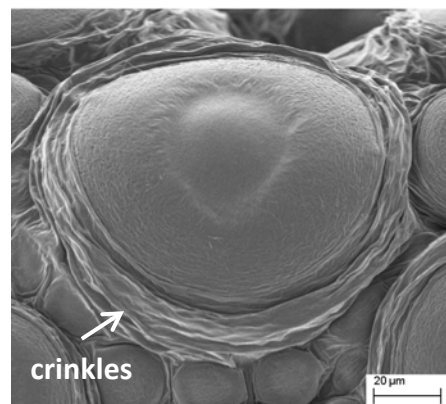
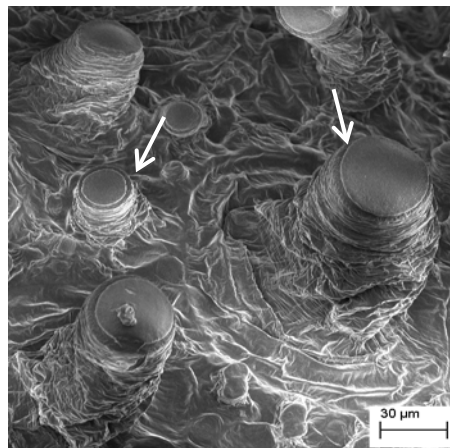
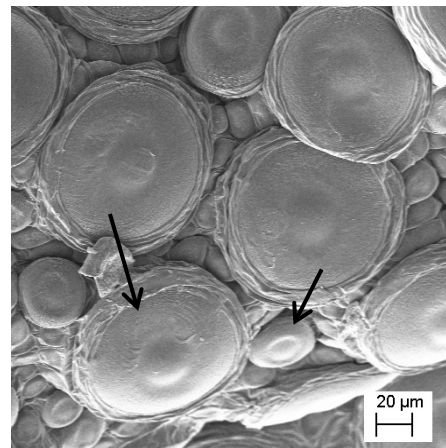


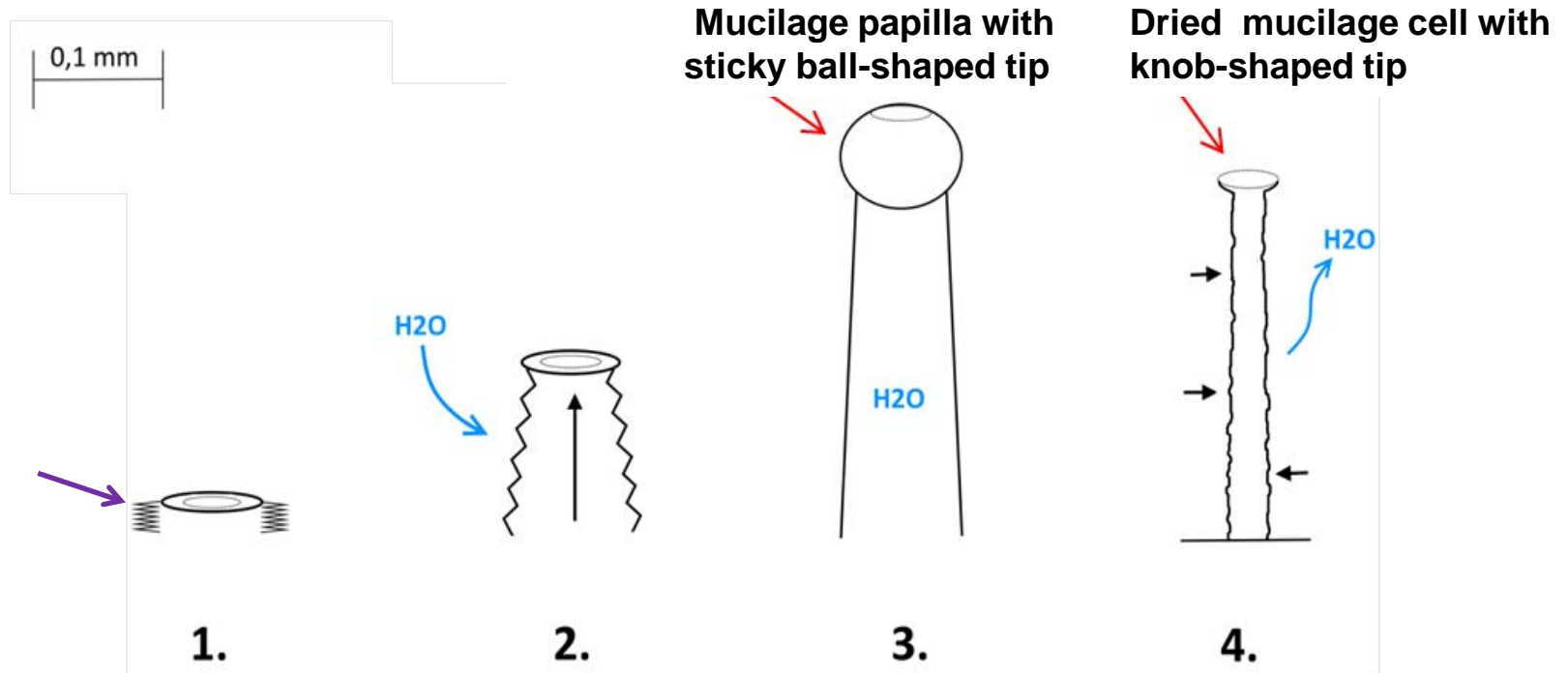
SEM analysis

Wart like mucilage cells

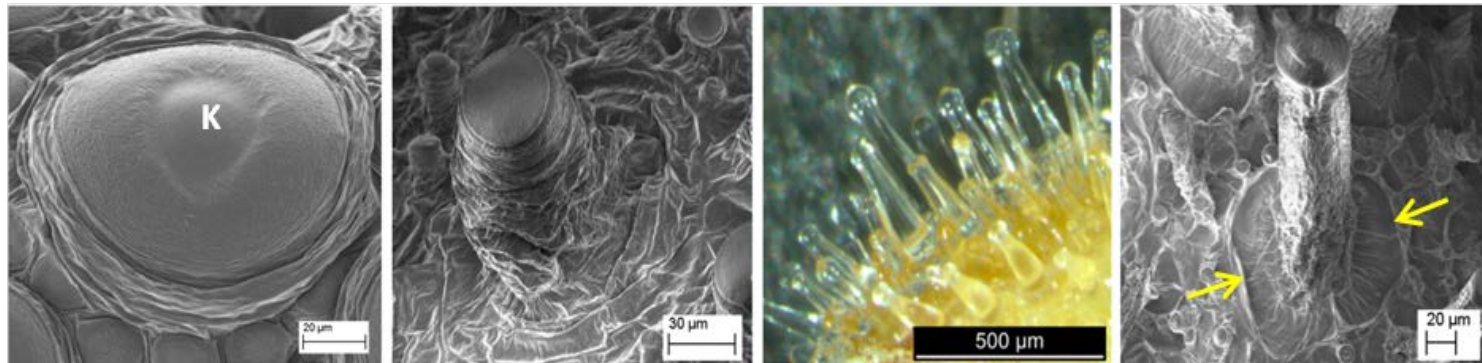
Developing mucilage papillae upon wetting

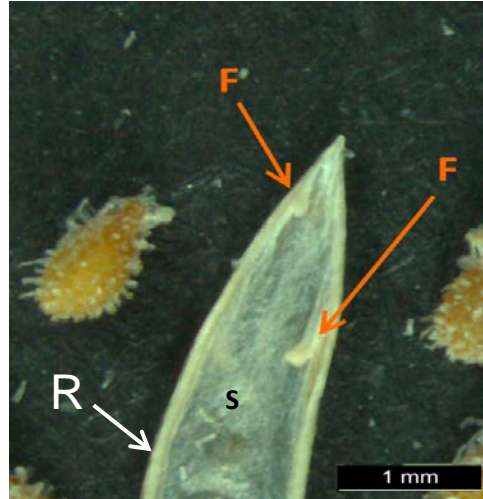
Wetted and subsequently dried mucilage papillae with knob-shaped tip





Mucilage cell with crinkles Expanding mucilage papilla

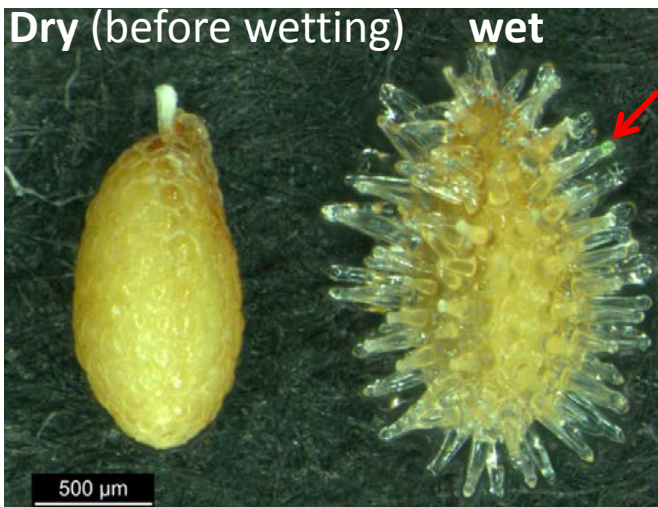




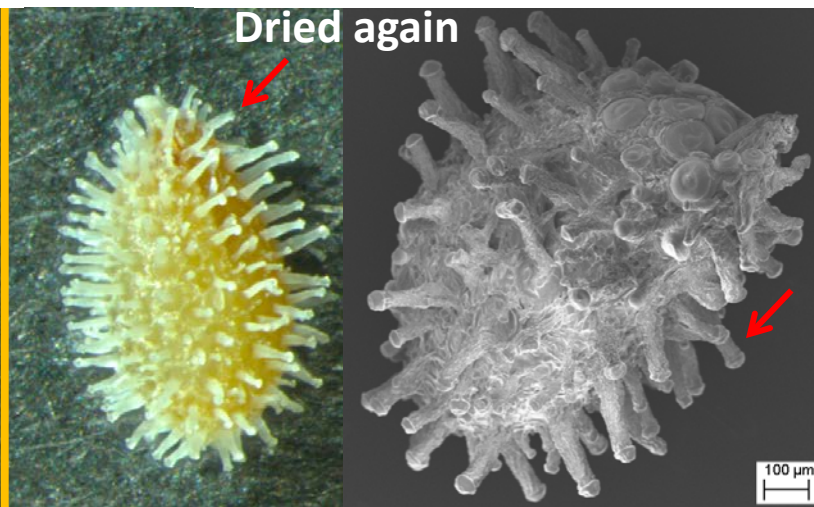
F = Funiculus
S = Septum
R = Replum (frame where seeds are attached)

Long distance dispersal !

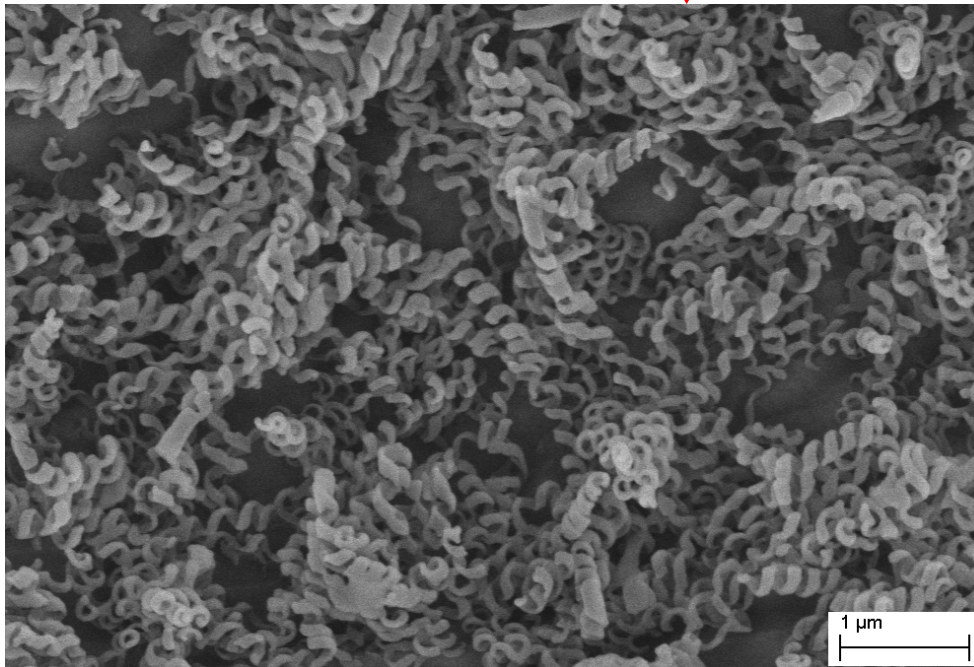
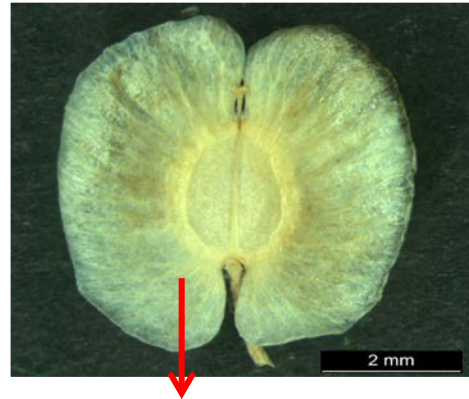
Mucilage papilla with sticky ball-shaped tip



Mucilage cell with knob-shaped tip



Surface structures on fruits



Epicuticular wax spirals?

Relevance for IND??

Hydrophobic effects:

Microbiotic colonization reduced?

Mechanical dormancy prolonged?

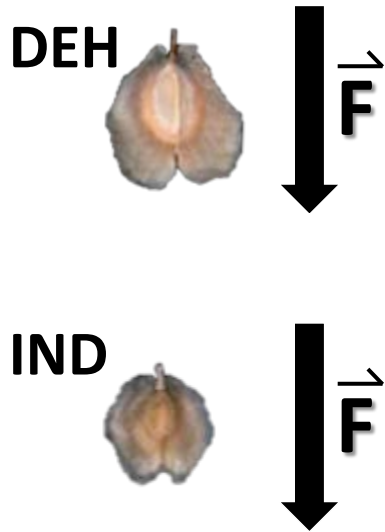
Physical dormancy???

Escape in time, soil seed bank?

Determination of the force needed to detach:

- Indehiscent (IND)
- Dehiscent (DEH)

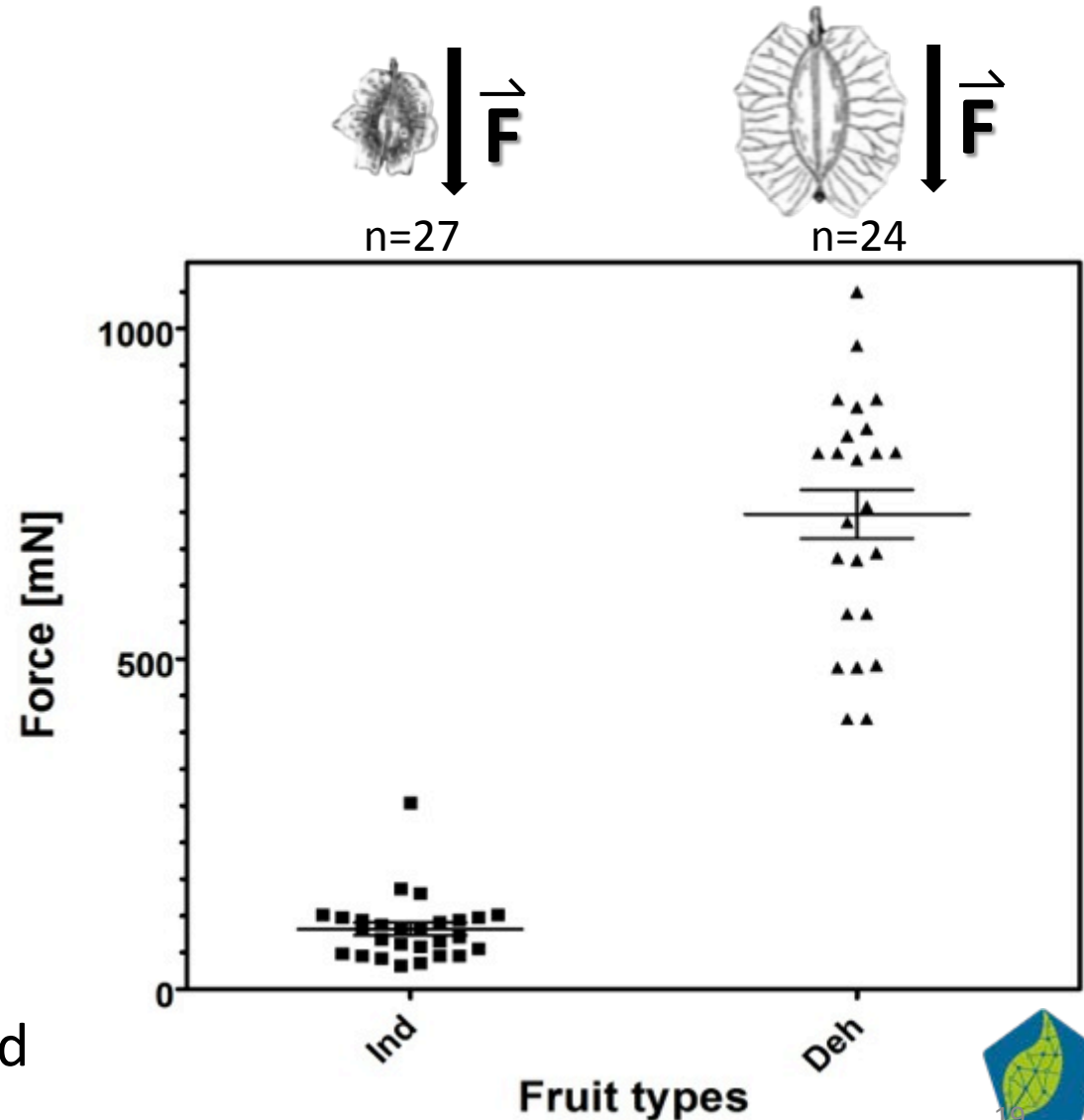




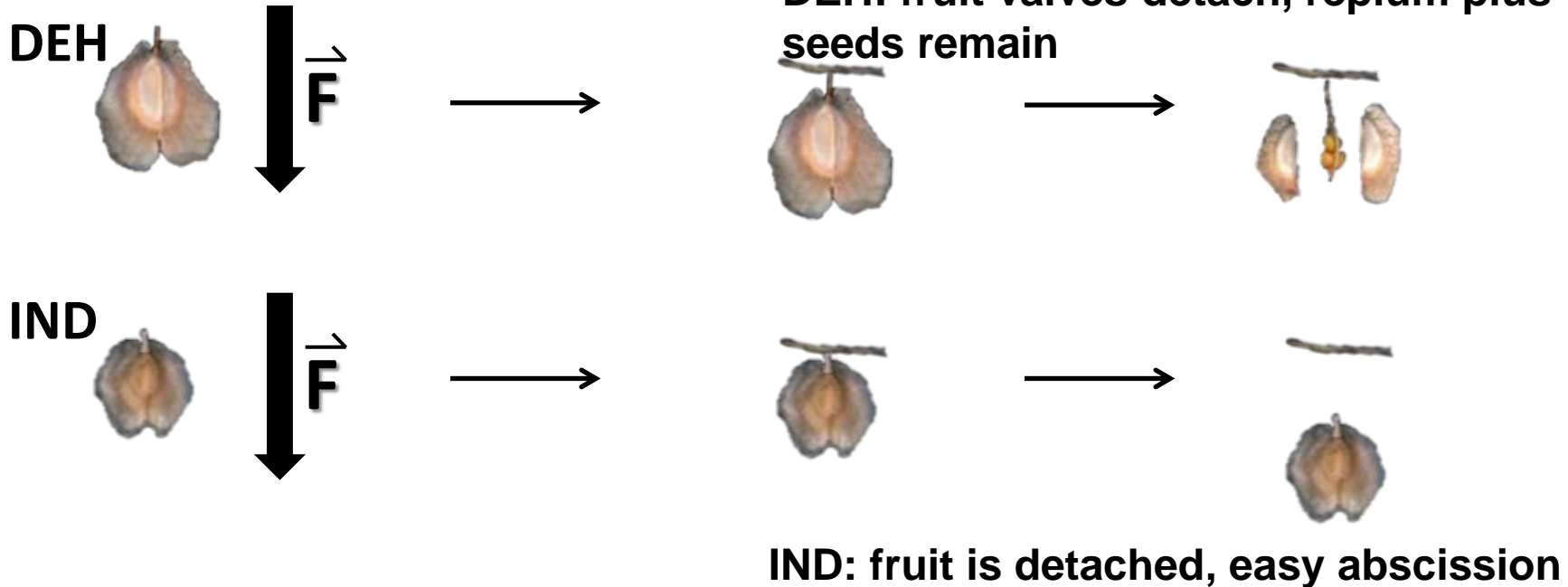
IND fruits: 91 ± 49 mN

DEH fruits: 719 ± 180 mN

~ 8 folds higher force needed



Two different „detaching patterns“

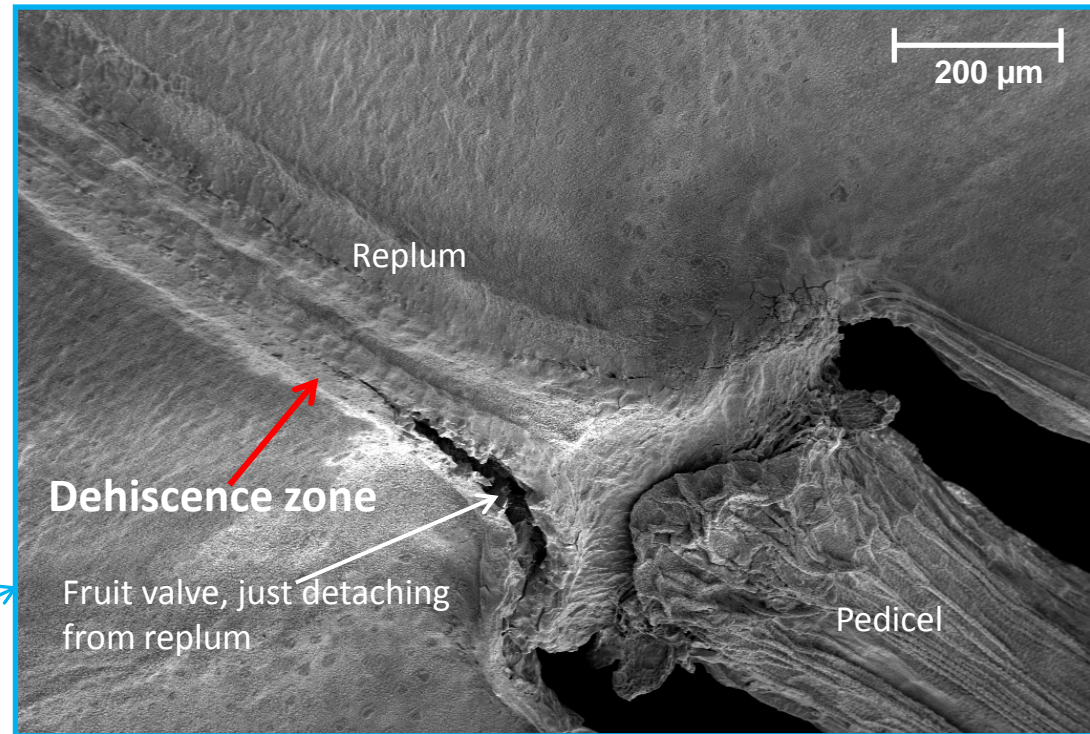
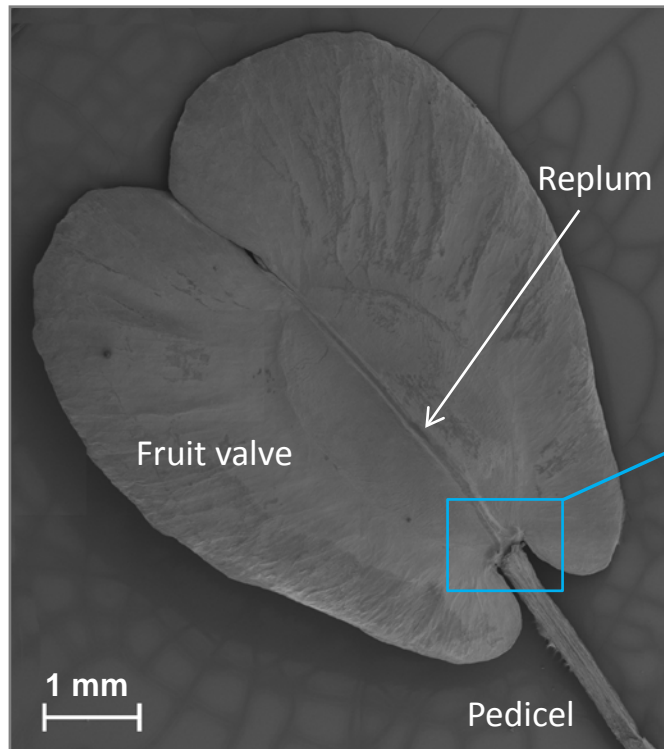


IND fruits: 91 ± 49 mN

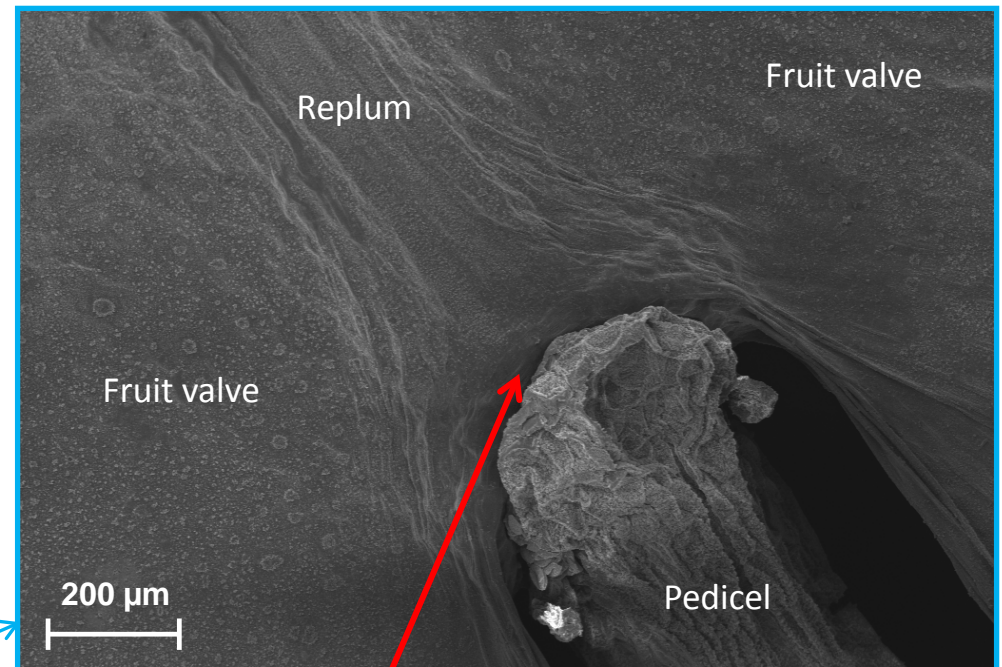
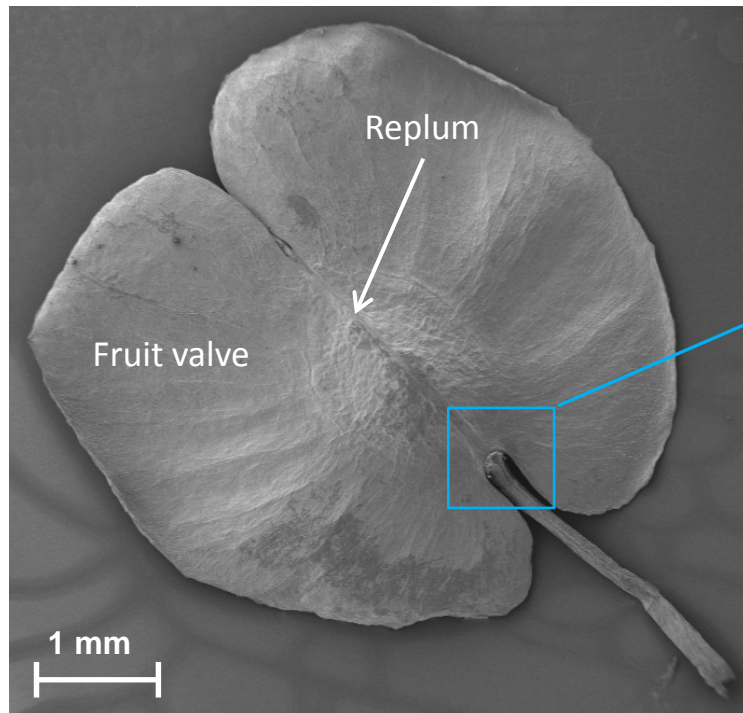
DEH fruits: 719 ± 180 mN

~ 8 folds higher force needed

Opening of DEH fruits: fruit valves detach from replum

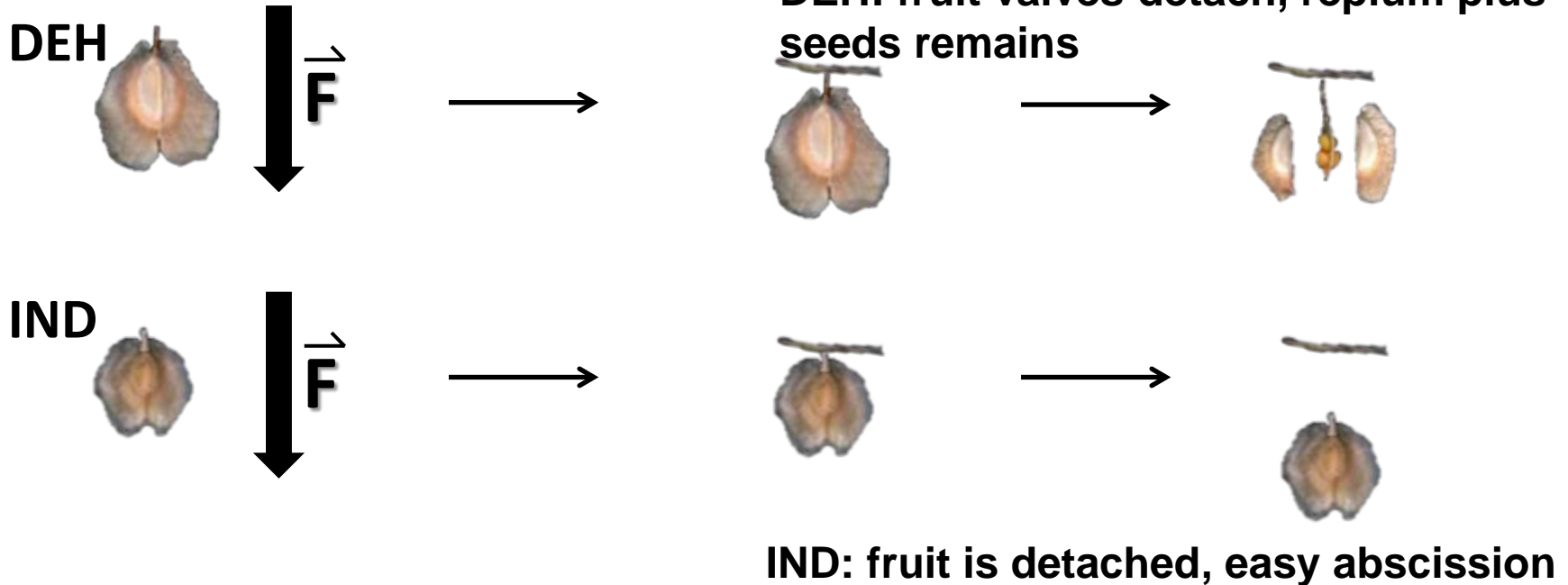


Abscission of IND fruits



Putative abscission zone at
replum - pedicel interface

Two different „detaching patterns“

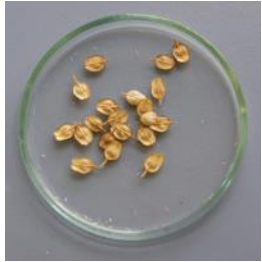


IND fruits: 91 ± 49 mN

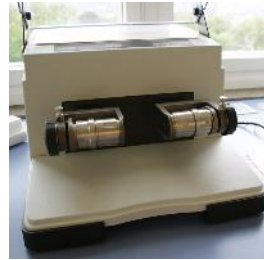
DEH fruits: 719 ± 180 mN

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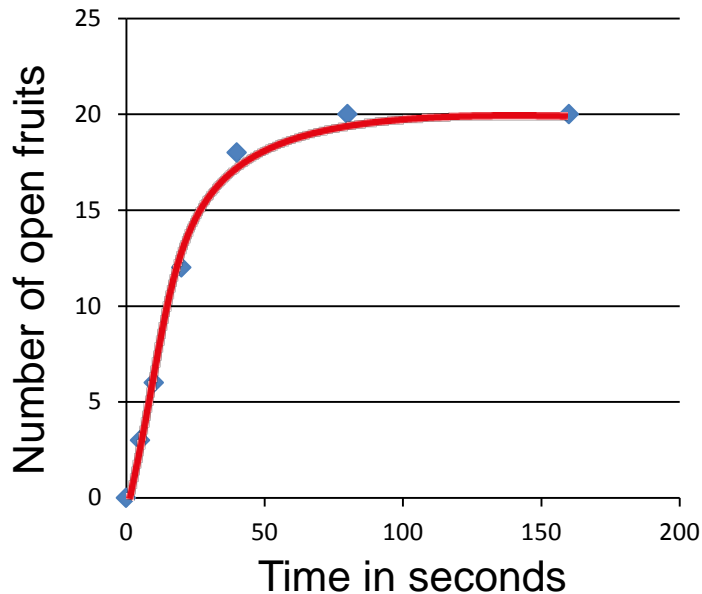
Measuring fruit dehiscence (fruit valves detach from replum) via random impact test



20 fruits



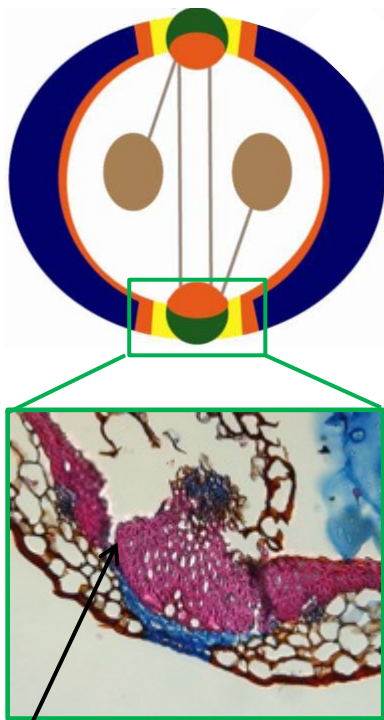
5, 10, 20, 40, 80, 160 sec.



➔ Calculating dehiscence half-life

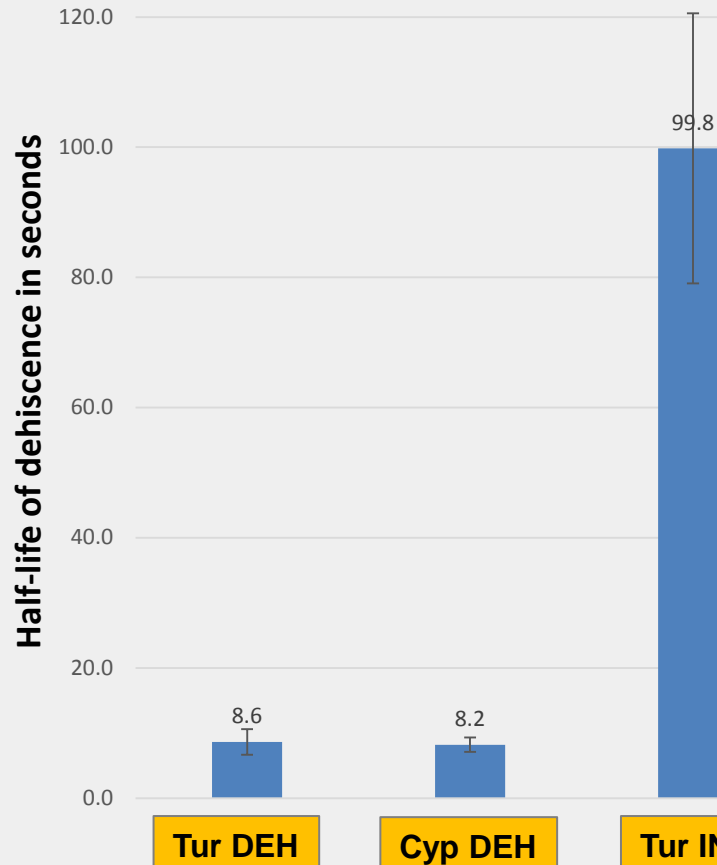
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DEH

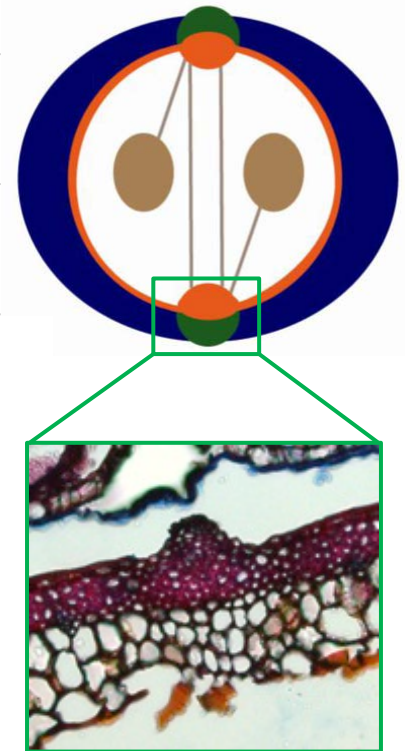


Dehiscence zone
Non-lignified cells

Quantification of dehiscence in *Aethionema arabicum*

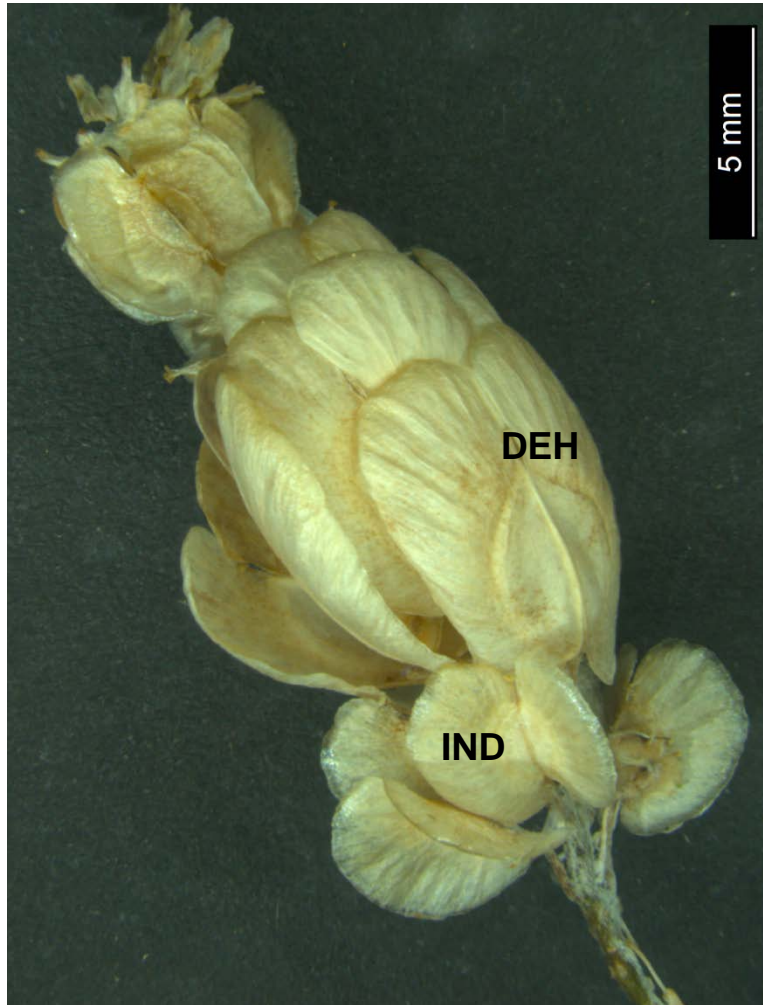


IND



No Dehiscence zone
Lignified cells

Hygrochasy – Pedicels of DEH bend outwards in mature infructescence



1. Open – close (dry conditions)
5 min. between pictures

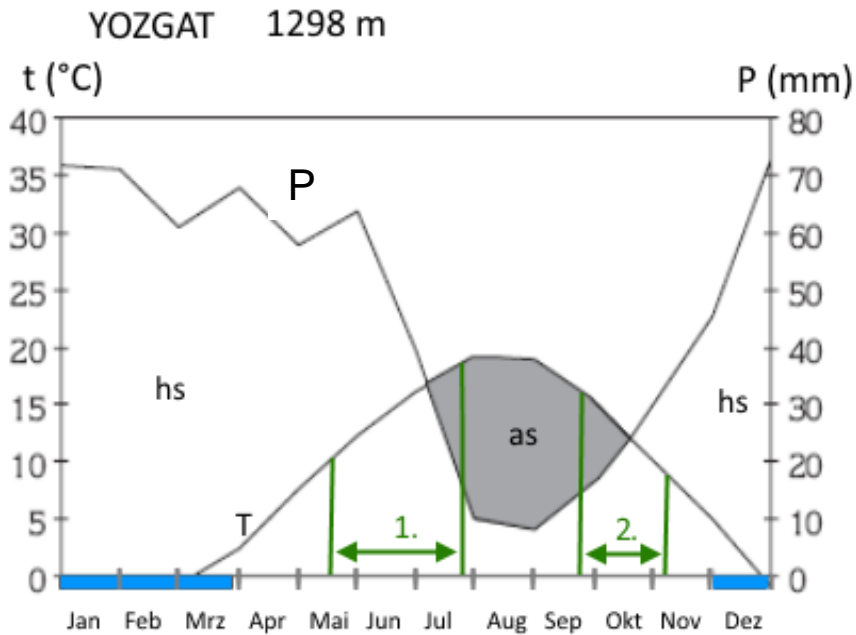
2. Close – open (moist conditions)
30 sec. between pictures



Time lapse *Aethionema arabicum*_DEH.m4v

Climate of a typical habitat of *Aethionema arabicum*

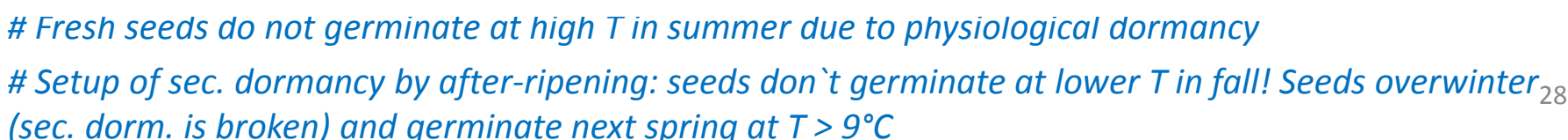
Two potential time windows for germination



P: precipitation
 T: temperature
 hs: humid season
 as: arid season
 Frost possible
 Germination possible

Climate diagramme of Yozgat (Turkey, Central Anatolia).
 Erinc 1988, modified





Risk seen while submitting the proposal

Uncontrolled growth conditions (e.g., failure of phytochambers) during *Aethionema* fruit/seed production

Failure of genetic transformation in *Aethionema* accessions

Loss of data sets due to server breakdowns

Current situation

Successful seed production during 2013 in Wageningen and Osnabrück

Selection experiments, marker genes and transformation protocols need to be established, though first results are encouraging.

Data will be stored on servers with regular back-ups at distinct locations, i.e., RHUL GMI, Wageningen, Marburg

Website (www.seedadapt.eu) online: Forum, downloads (methods and manuals, datasets, literature)



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Figures and data from various
members of the SeedAdapt
consortium