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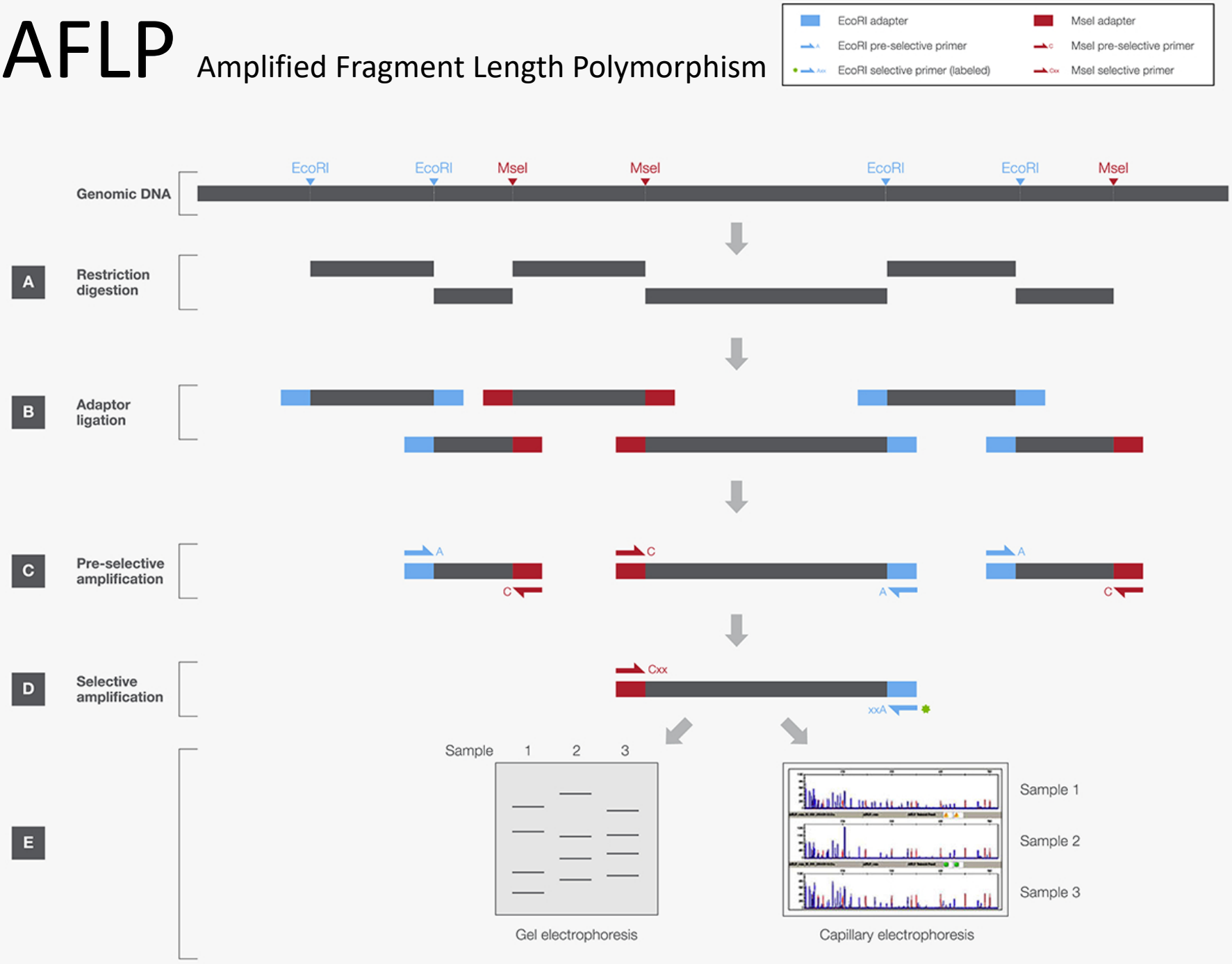
University of Connecticut
Storrs, CT

Latest *Aronia* Research

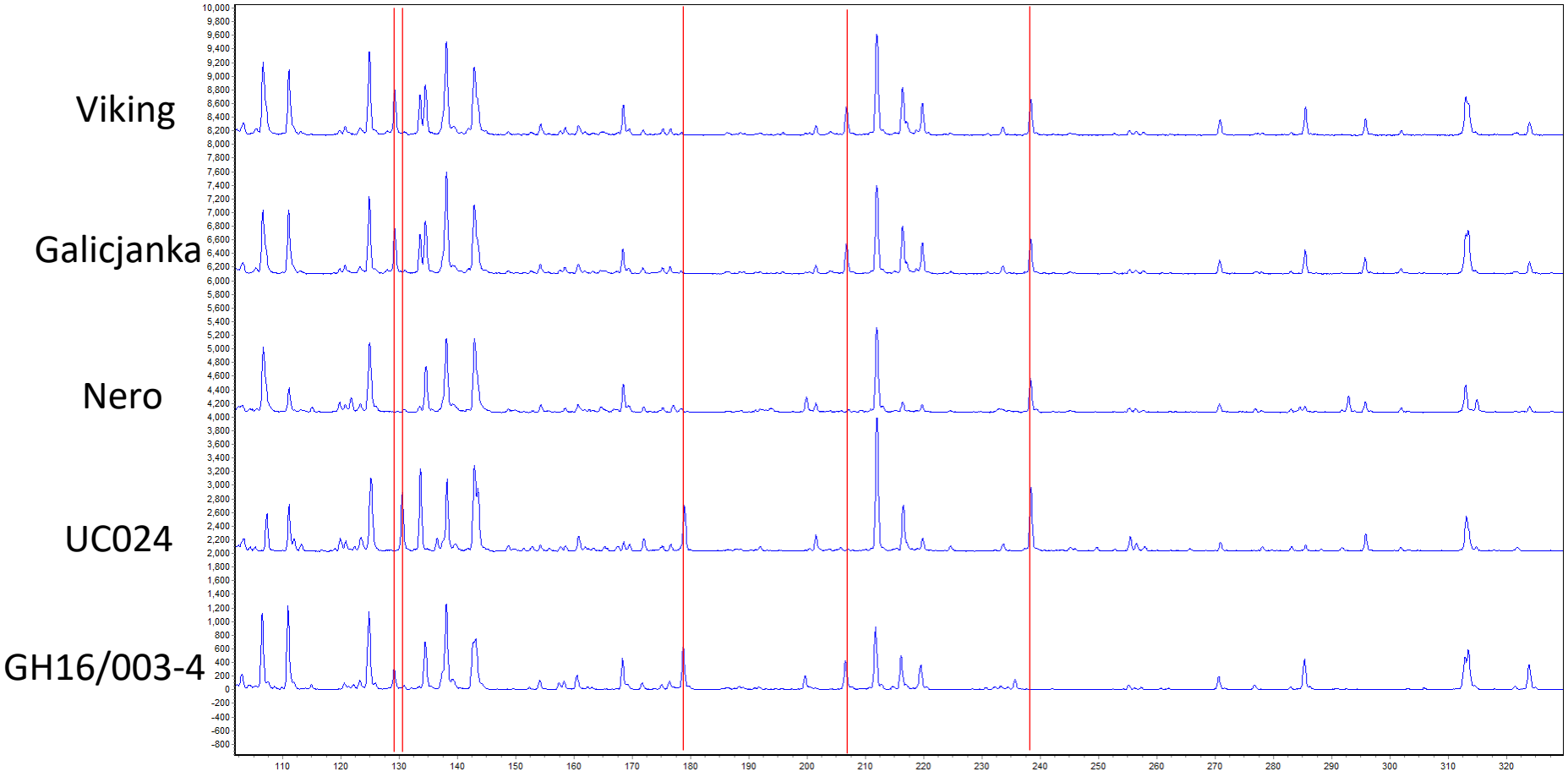
UCONN | COLLEGE OF AGRICULTURE, HEALTH AND NATURAL RESOURCES

Wild *Aronia* and speciation

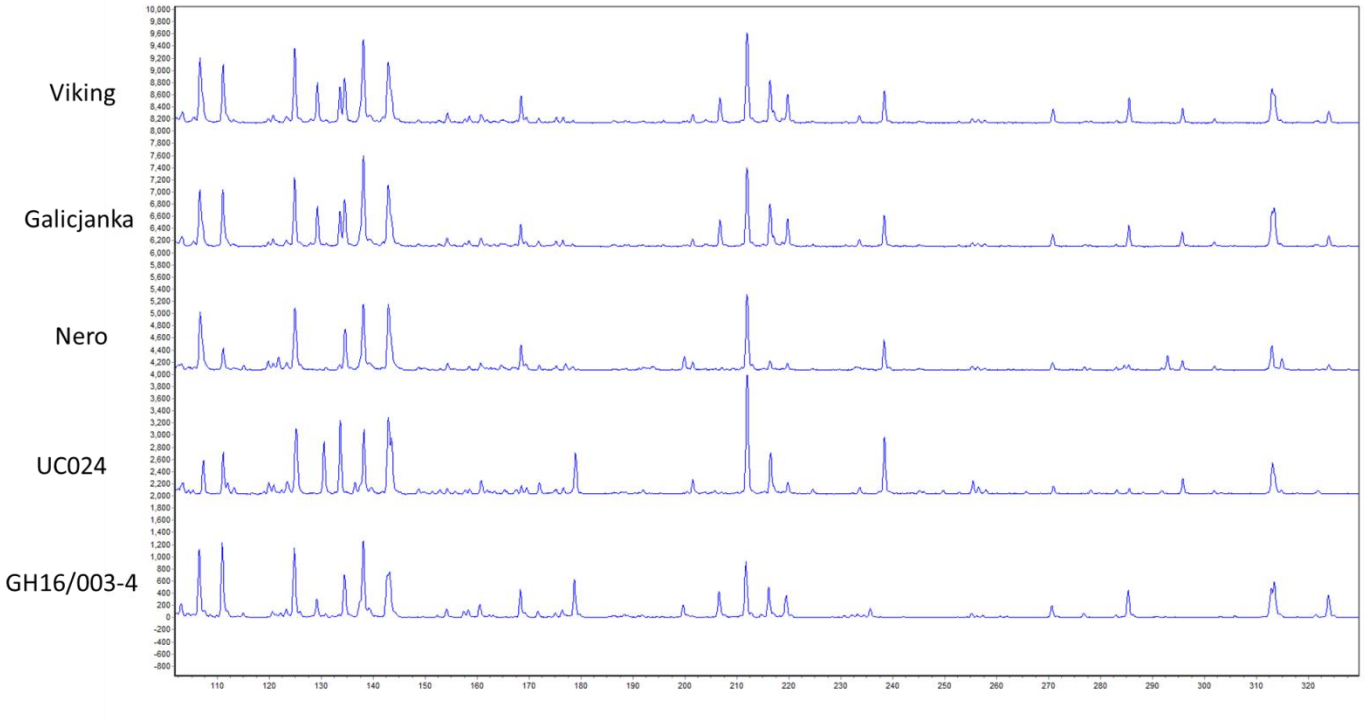
AFLP Amplified Fragment Length Polymorphism



AFLP Amplified Fragment Length Polymorphism



Create Binary Matrix



GeneMarker®
The Biologist Friendly Software

Accession	a1	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	.... a400
Viking	1	1	1	1	1	1	0	1	1	1	1	1	1	0
Galicjanka	1	1	1	1	1	1	0	1	1	1	1	1	1	0
Nero	1	0	1	1	0	1	1	1	1	1	0	1	1	1
UC024	1	1	0	1	0	1	1	1	1	1	1	1	0	1
GH16/003-4	1	1	1	1	0	1	1	1	1	1	1	1	1	0

How many wild *Aronia* species are there?

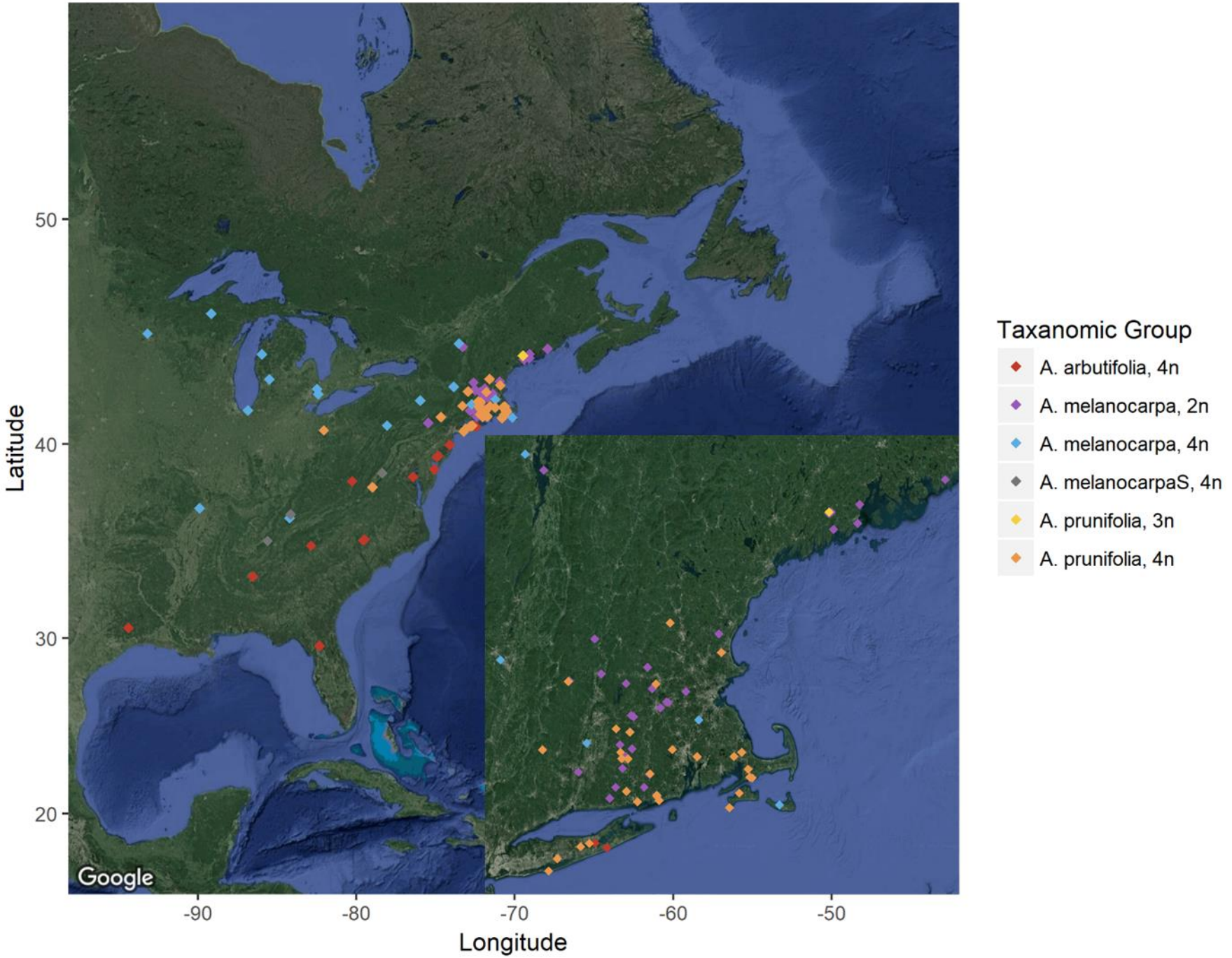
The Genus *Aronia* - wild species

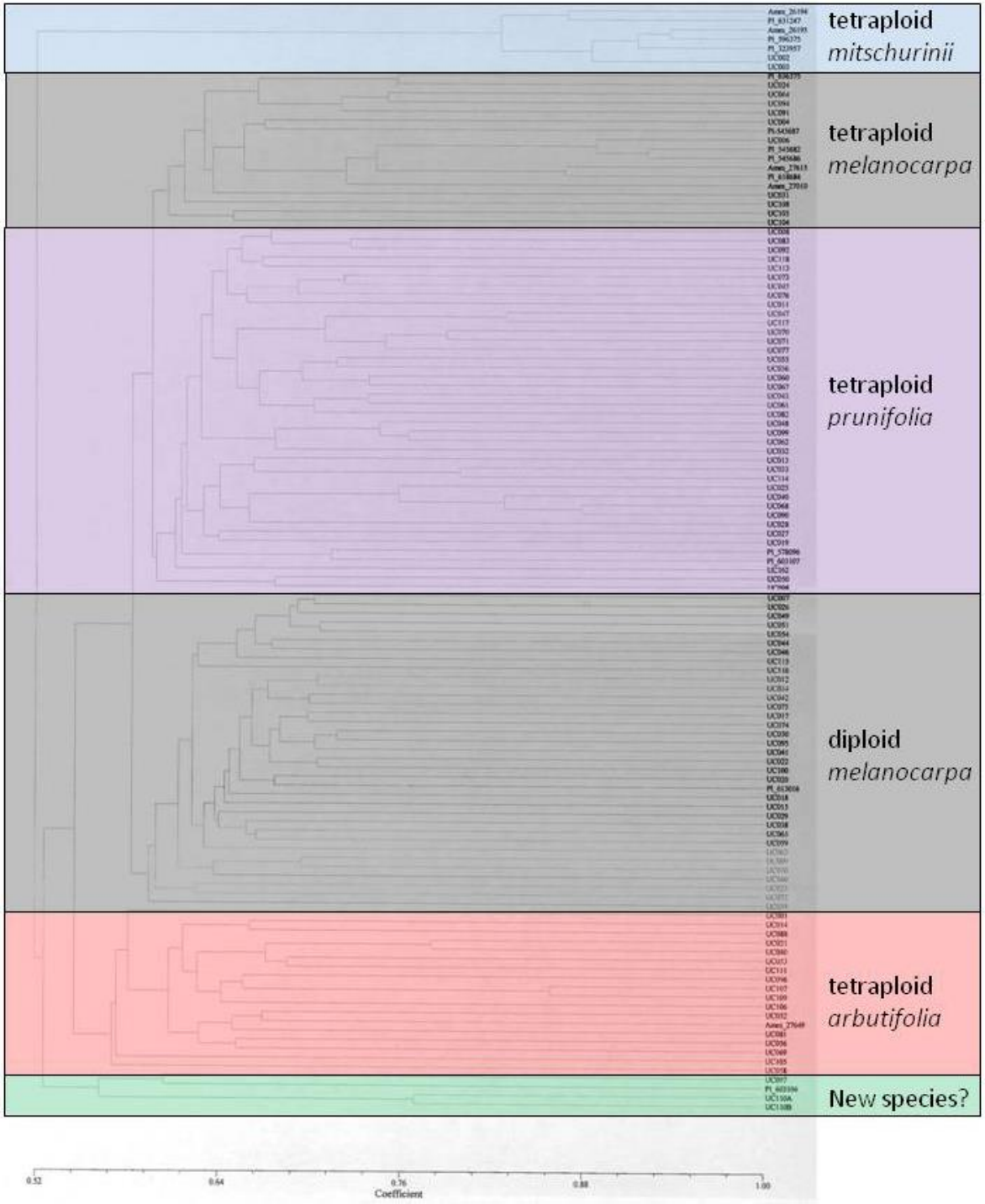
Aronia arbutifolia – red chokeberry
Aronia prunifolia – purple chokeberry
Aronia melanocarpa (diploid) – black chokeberry
Aronia melanocarpa (tetraploid) – black chokeberry

Aronia melanocarpa (tetraploid Southern)
NEW SPECIES?!

Largest wild *Aronia* germplasm collection in the world

120 different accessions from 25 states


Latitude
50
40
30
20
Google
-90
-80
-70
-60
-50
Longitude
Taxanomic Group
A. arbutifolia, 4n
A. melanocarpa, 2n
A. melanocarpa, 4n
A. melanocarpaS, 4n
A. prunifolia, 3n
A. prunifolia, 4n


tetraploid
mitschurinii
tetraploid
melanocarpa
tetraploid
prunifolia
diploid
melanocarpa
tetraploid
arbutifolia
New species?
0.52
0.64
0.76
0.88
1.00
Coefficient

What *Aronia* are farmers growing?

What's the best cultivar?

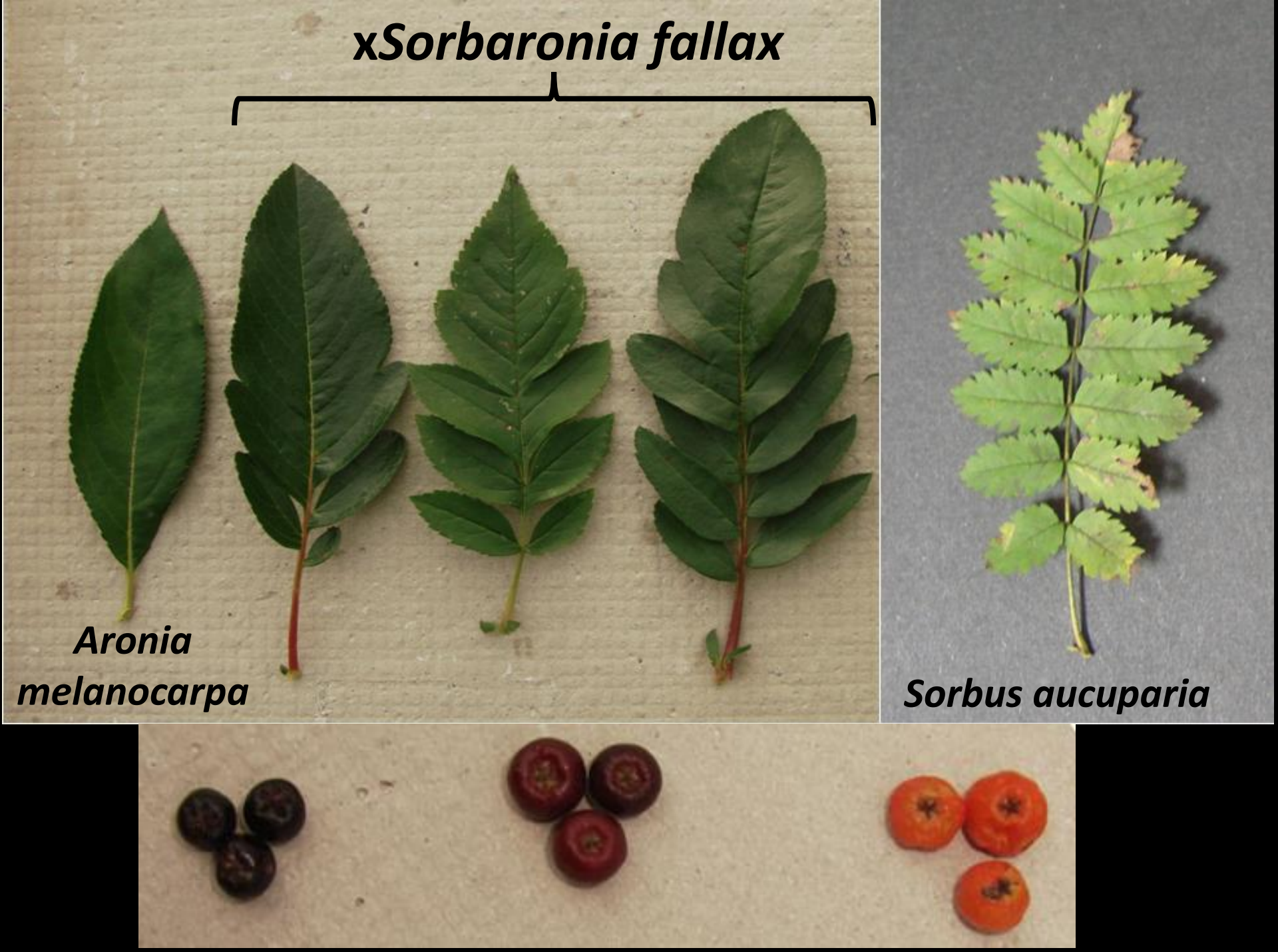
Tetraploid *melanocarpa*

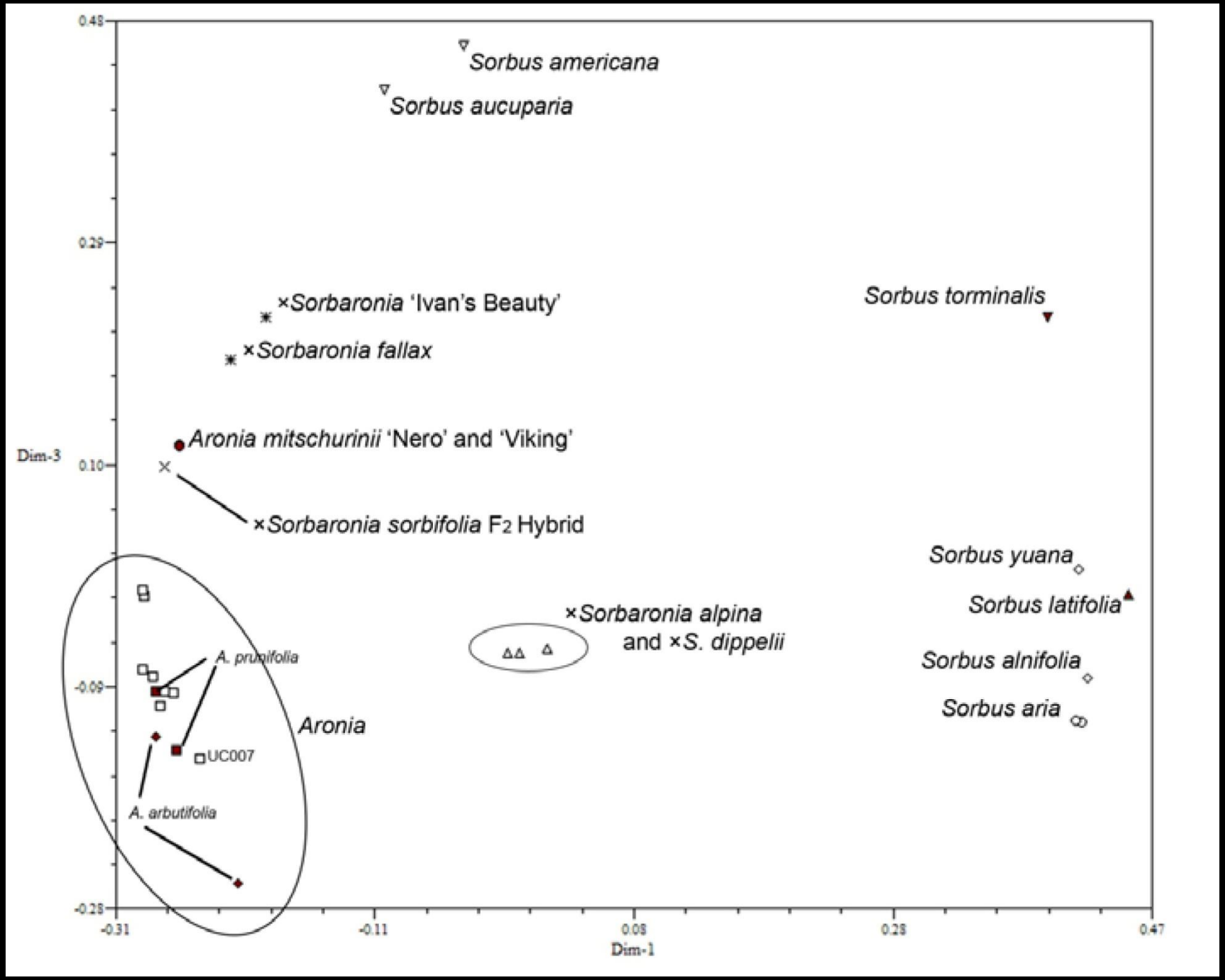
Tetraploid *mitschurinii* 'Viking'

Tetraploid *melanocarpa*

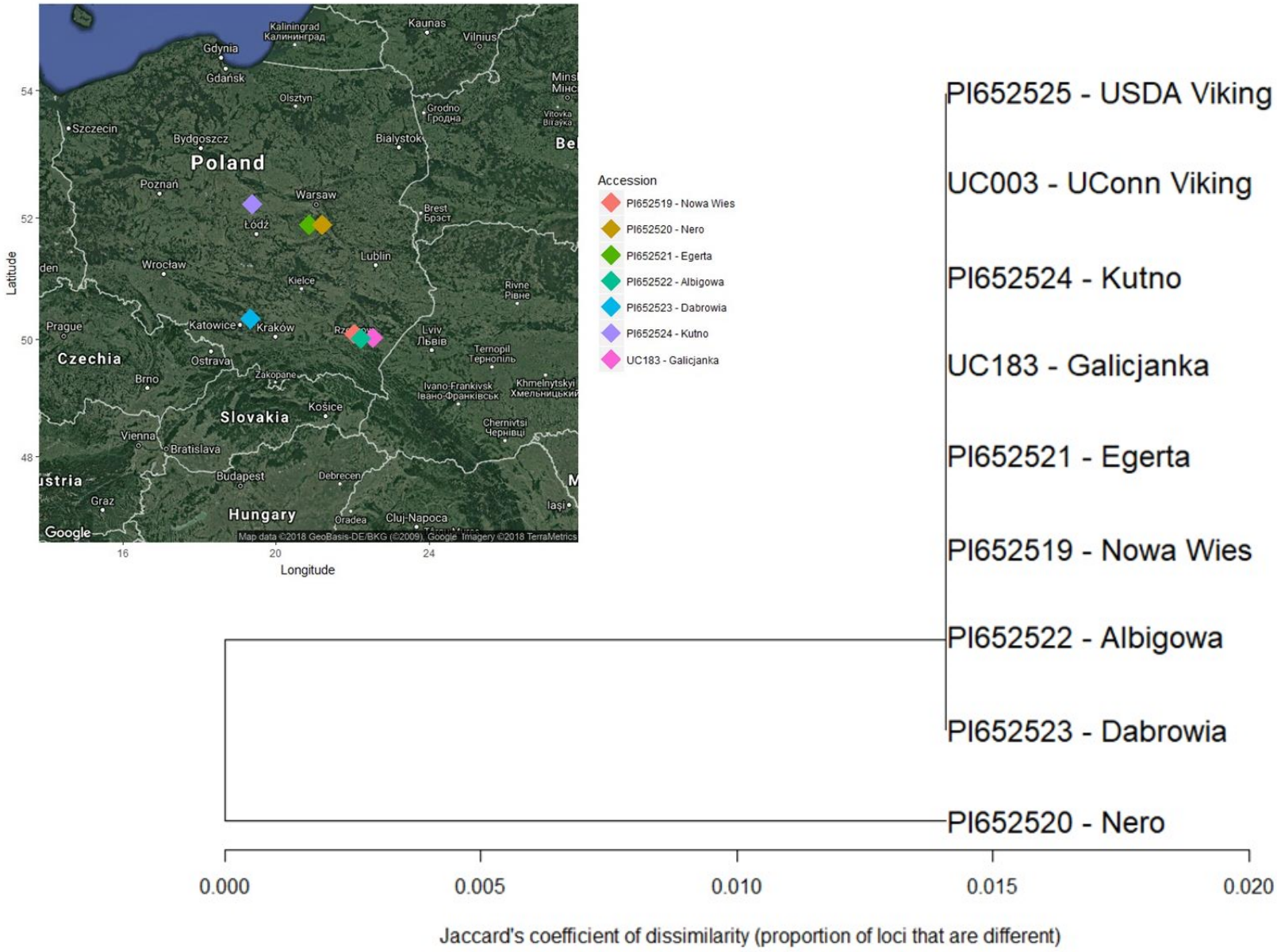
Tetraploid *mitschurinii* 'Viking'

- Fruit forms are hybrids with *Sorbus* (mountain ash)
- *Aronia mitschurinii*


xSorbaronia fallax
Aronia melanocarpa
Sorbus aucuparia


0.48
0.29
0.10
-0.09
-0.28
Dim-3
-0.31
-0.11
0.08
0.28
0.47
Dim-1
Sorbus americana
Sorbus aucuparia
×Sorbaronia 'Ivan's Beauty'
×Sorbaronia fallax
Sorbus torminalis
Aronia mitschurinii 'Nero' and 'Viking'
×Sorbaronia sorbifolia F2 Hybrid
Sorbus yuana
Sorbus latifolia
×Sorbaronia alpina
and ×S. dippelii
Sorbus alnifolia
Sorbus aria
A. prunifolia
Aronia
UC007
A. arbutifolia


ALBERTA
ALBERTA
ALBERTA


Kaliningrad
Калининград
Kaunas
Vilnius
Gdynia
Gdańsk
Olsztyn
Grodno
Гродна
Vitovka
Віцебск
Szczecin
Bydgoszcz
Białystok
Poland
Poznań
Warsaw
Łódź
Brest
Брэст
Wrocław
Lublin
Kielce
Rivne
Рівне
Prague
Katowice
Kraków
Lviv
Львів
Ternopil
Тернопіль
Czechia
Ostrava
Zakopane
Brno
Ivano-Frankivsk
Івано-Франківськ
Khmelnytskyi
Хмельницький
Košice
Slovakia
Chernivtsi
Чернівці
Vienna
Bratislava
Budapest
Debrecen
Graz
Hungary
Oradea
Cluj-Napoca
Iași
Google
Map data ©2018 GeoBasis-DE/BKG (©2009), Google Imagery ©2018 TerraMetrics
54
52
50
48
16
20
24
Latitude
Longitude
Accession
PI652519 - Nowa Wies
PI652520 - Nero
PI652521 - Egerta
PI652522 - Albigowa
PI652523 - Dabrowia
PI652524 - Kutno
UC183 - Galicjanka
PI652525 - USDA Viking
UC003 - UConn Viking
PI652524 - Kutno
UC183 - Galicjanka
PI652521 - Egerta
PI652519 - Nowa Wies
PI652522 - Albigowa
PI652523 - Dabrowia
PI652520 - Nero
0.000
0.005
0.010
0.015
0.020
Jaccard's coefficient of dissimilarity (proportion of loci that are different)

Genotype x Environment = Phenotype (plant appearance & performance)

Performance of Chokeberry (*Aronia melanocarpa*) in Oregon, USA

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Corvallis,OR 97331
USA

(2003) Acta Horticulturae 626: 439-443.

Table 1. Yield, berry weight and percent soluble solids of chokeberry (*Aronia melanocarpa*) in 1999-2001 from a planting established in 1997 (from rooted, one-year-old cuttings). N=4

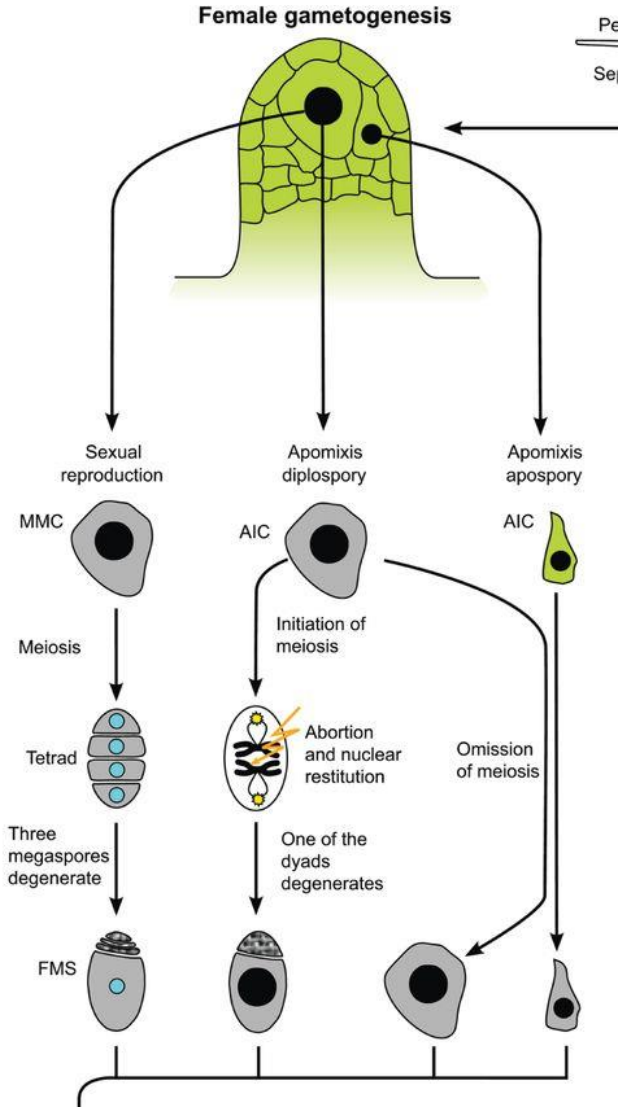
Cultivar	Yield (kg/plant)			Berry weight (g)			Soluble solids (%)		
	1999	2000	2001	1999	2000	2001	1999	2000	2001
Nero	12.4 a[z]	17.9 ab	24.1 a	1.13 b	1.03 c	2.62 c	13.0	19.5 a	15.8
Nowa Wies	11.1 a	21.6 a	15.9 bc	1.13 b	1.13 bc	2.69 bc	13.2	16.4 b	17.8
Albigowa	10.4 a	21.6 a	20.5 ab	1.22 a	1.25 a	2.79 ab	12.8	17.5 ab	17.5
Kutno	10.0 a	22.1 a	17.3 bc	1.19 ab	1.09 bc	2.72 abc	13.0	16.6 b	18.3
Dabrowice	4.8 b	13.9 bc	16.5 bc	1.25 a	1.16 ab	2.69 bc	13.5	16.5 b	16.8
Egerta	4.4 b	13.0 c	13.1 c	1.22 a	1.15 ab	2.82 a	13.4	16.6 b	16.7
LSD	2.4	4.4	6.4	0.09	0.10	0.12	1.1	2.1	1.9
Significance	0.0001	0.0008	0.0347	0.0283	0.0067	0.0200	0.8123	0.0500	0.1562

[z] Means followed by the same letter are not significantly different using a protected LSD (P>0.05)

How does *Aronia* make seeds?

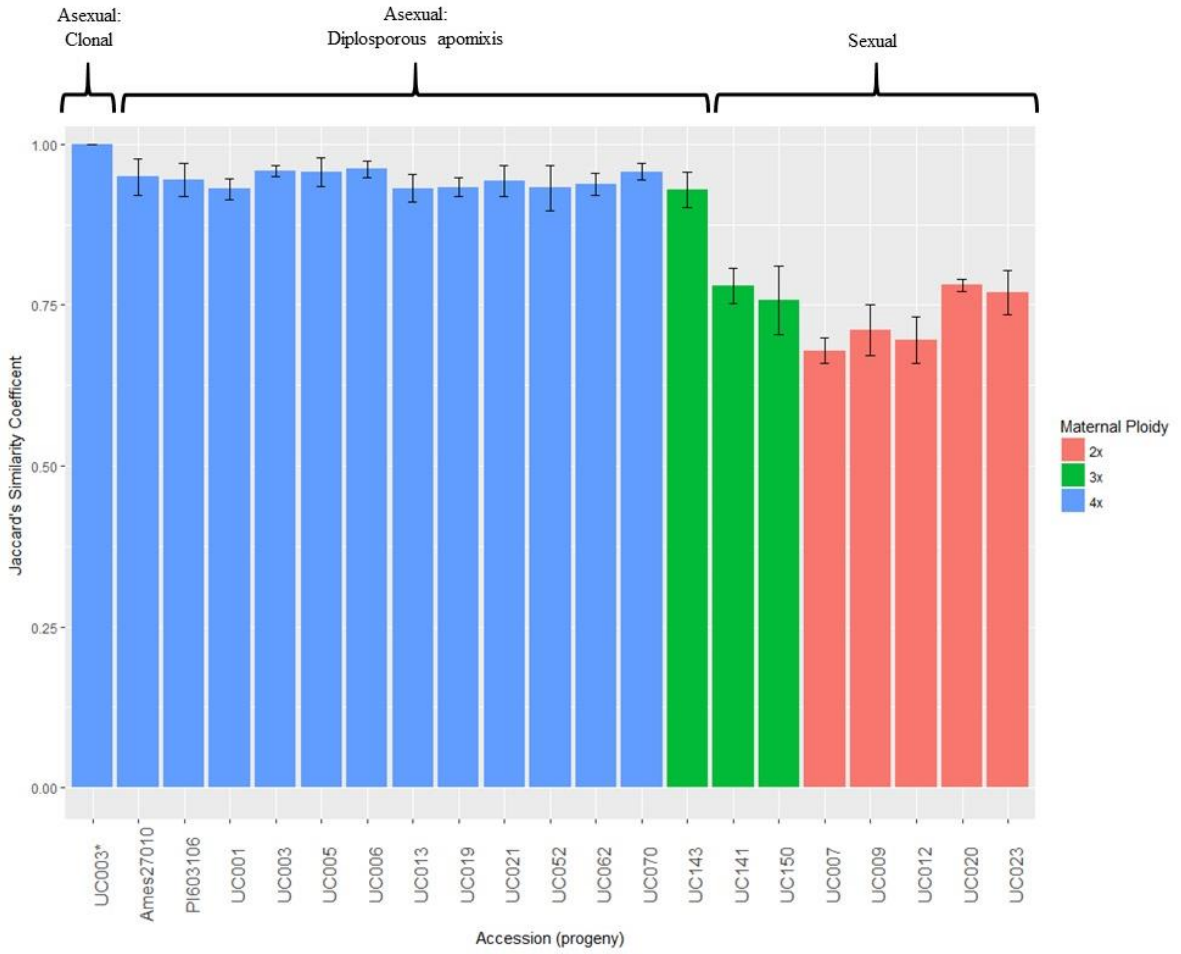
Sexual or Asexual?

Schmidt et al. 2015. *Development 142* 229-241.



60-80% *90-98%* *100%* *100%*

Jaccard's Similarity Coefficient (open pollinated)



APOMICTIC

Pollen parent only

- *Aronia arbutifolia*
- *Aronia prunifolia* (tetraploid)
- *Aronia melanocarpa* (tetraploid)
- *Aronia mitschurinii*

SEXUAL

Pollen or seed parent

- *Aronia melanocarpa* (diploid)

APOMICTIC or SEXUAL

Pollen or seed parent

- *Aronia prunifolia* (triploid)

Grafting onto tree rootstocks

Grafting – Why bother?

- Raise canopy: a) facilitate mechanical harvesting
  b) facilitate weed control

- Shorten time until first fruit harvest?
- Change fruit ripening date?
- Change fruit biochemical content?

- Cost of grafted plant vs. cutting?

Pyrinae tree rootstocks

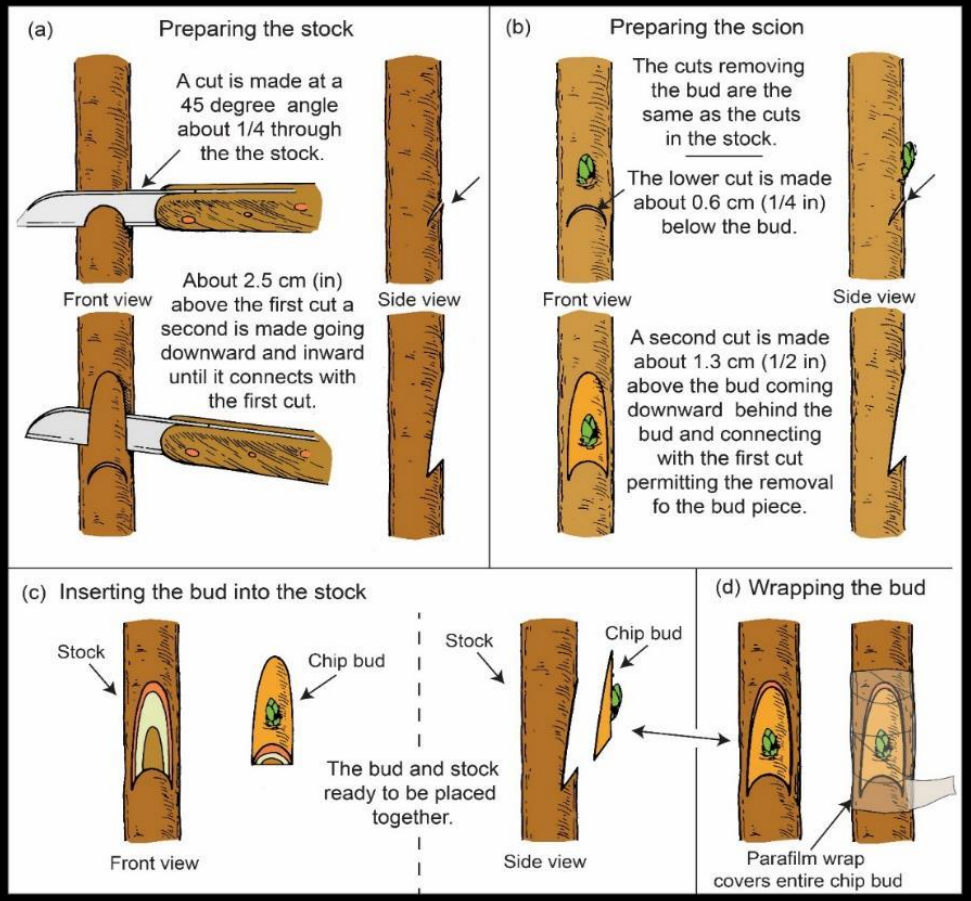
Sorbus aucuparia
European Mountain Ash


Sorbus alnifolia
Korean Mountain Ash


Crataegus laevigata
English Hawthorn


Pyrus communis
Common Pear


Chip bud grafting



End of first growing season

End of second growing season

Scion – *Aronia mitschurinii* 'Viking'
Bench grafting in April; chip-bud; bare root rootstocks

ROOTSTOCK SPECIES	SUCCESSFUL UNIONS	FIRST SEASON SHOOT GROWTH (CM)	TWO YEAR SURVIVAL
Crataegus laevigata – 6"	33%	9.8	85%
Pyrus communis – 6"	53%	22.4	86%
Sorbus alnifolia – 6"	50%	23.4	100%
Sorbus aucuparia – 6"	84%	47.2	100%
Sorbus aucuparia – 24"	88%	41.7	100%
Own root (6" cutting)	96%	15.6	100%


own root
S. aucuparia S
S. aucuparia T
S. alnifolia
Pyrus
Crataegus

Aronia mitschurinii ‘Viking’ on *Sorbus aucuparia* rootstock 24” graft

Aronia mitschurinii ‘Viking’ on *Sorbus aucuparia* rootstock 6” graft

Own root *Aronia mitschurinii* ‘Viking’

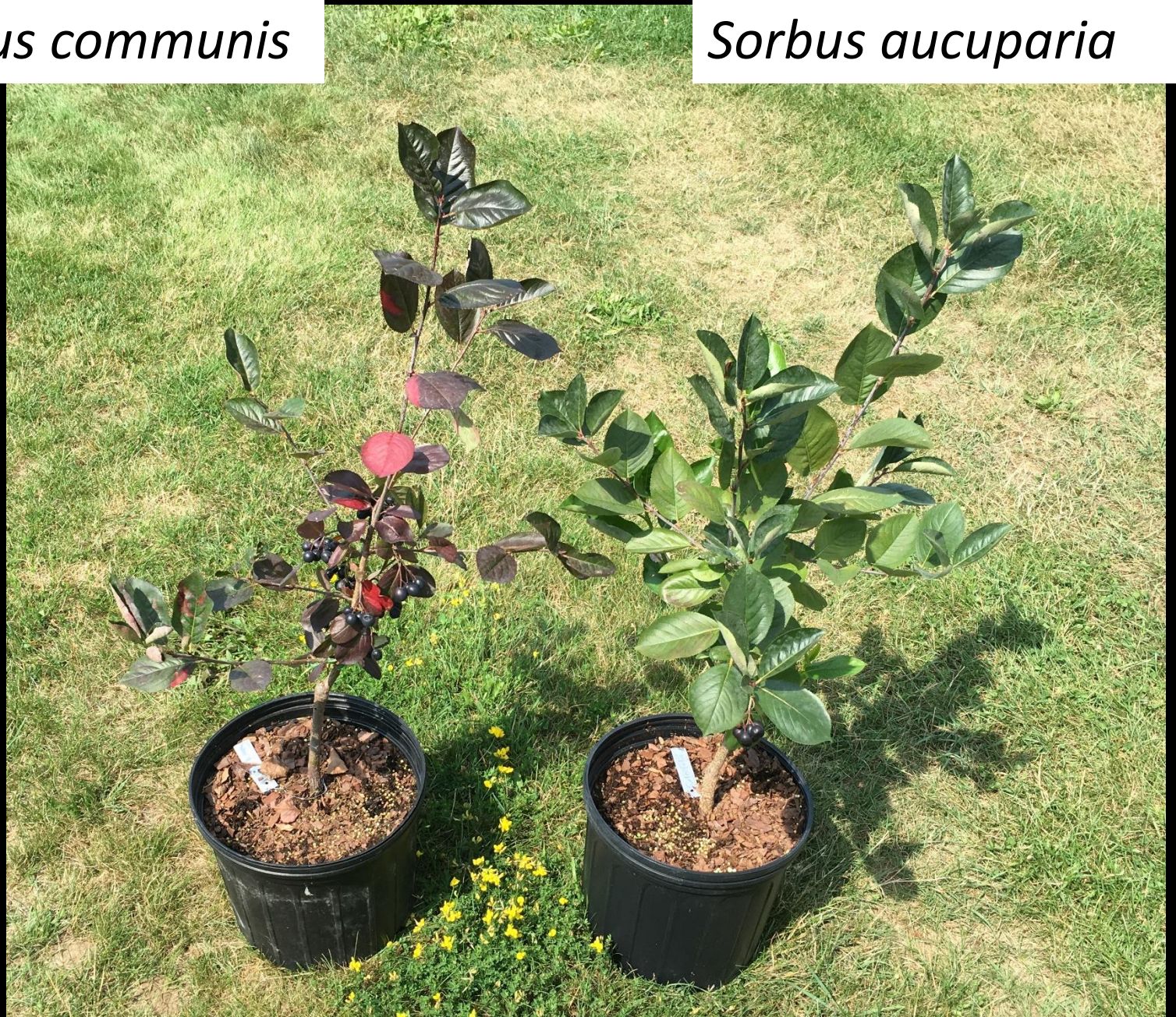
End of third growing season

Aronia mitschurinii ‘Viking’ on *Sorbus aucuparia* rootstock 24” graft

Aronia mitschurinii ‘Viking’ on *Sorbus aucuparia* rootstock 6” graft

‘Viking’ on:
Pyrus communis

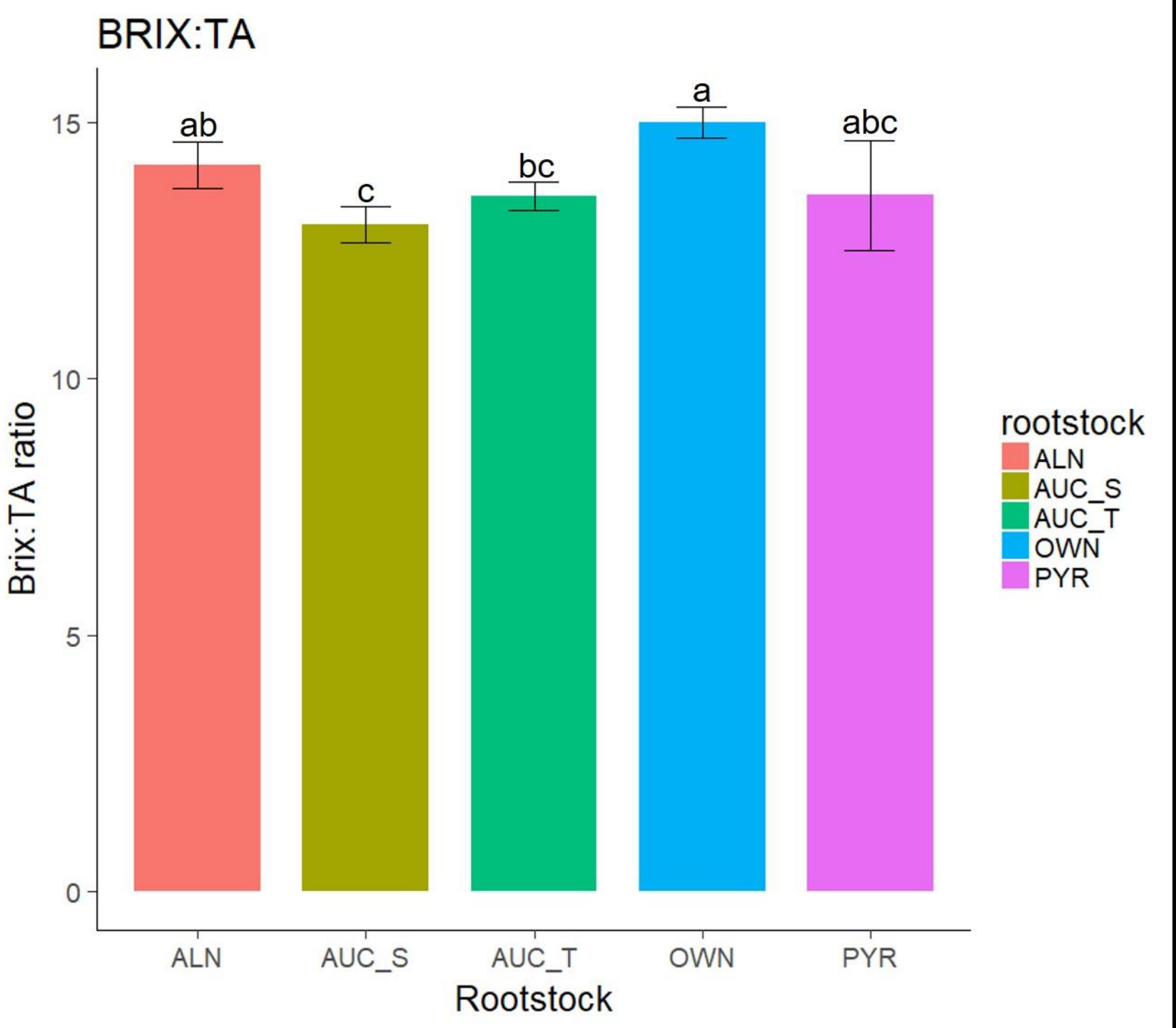
‘Viking’ on:
Sorbus aucuparia



Growth by end of second growing season

Rootstock	Height (cm)	Number of shoots	Total shoot length (cm)	Average shoot length (cm)
Sorbus alnifolia	68.6	10.4	295.6	28.6
Sorbus aucuparia S	99.3	18.2	622.8	34.1
Sorbus aucuparia T	131.2	16.9	482.0	28.5
Crataegus laevigata	43.4	2.8	62.4	22.3
own root	81.1	4.0	193.3	48.3
Pyrus communis	71.5	8.0	224.4	28.0

Rootstock species	flower clusters per plant	total fruit per plant (g)	fresh weight 100 fruits (g)	dry weight 100 fruit (g)
Sorbus alnifolia	57	579.9	77.4	12.3
Sorbus aucuparia S	72	898.1	81.2	12.2
Sorbus aucuparia T	73	814.7	86.0	13.3
Crataegus laevigata	9	86.8	51.3	11.6
Own-root	22	287.1	80.4	12.2
Pyrus communis	45	322.7	59.7	8.3


BRIX:TA
ab
c
bc
a
abc
15
10
5
0
Brix:TA ratio
ALN
AUC_S
AUC_T
OWN
PYR
Rootstock
rootstock
ALN
AUC_S
AUC_T
OWN
PYR


UCONN

Aronia Breeding

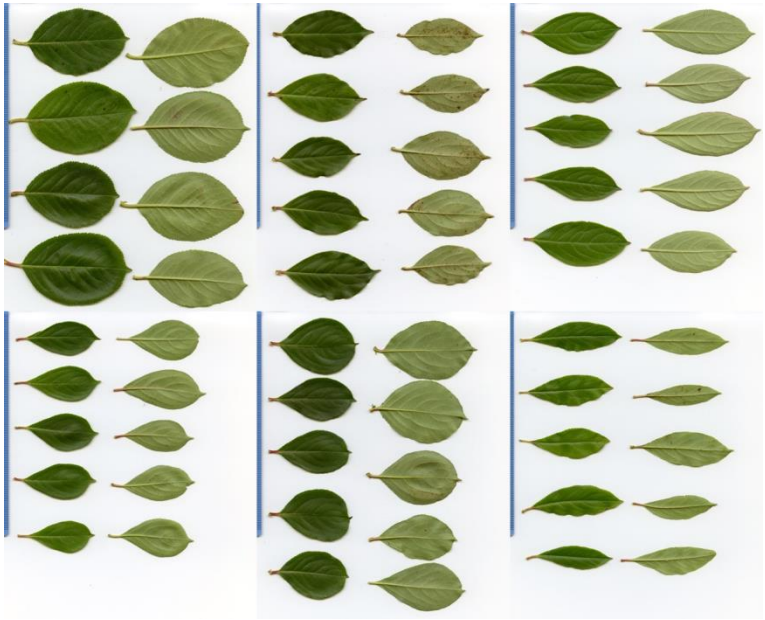
Diploid *melanocarpa* from New England

prostrate

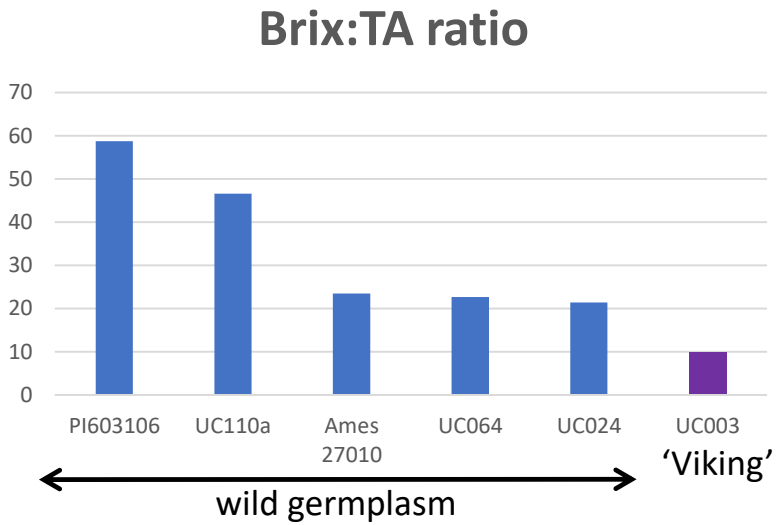
upright

Wild aronia diversity!!

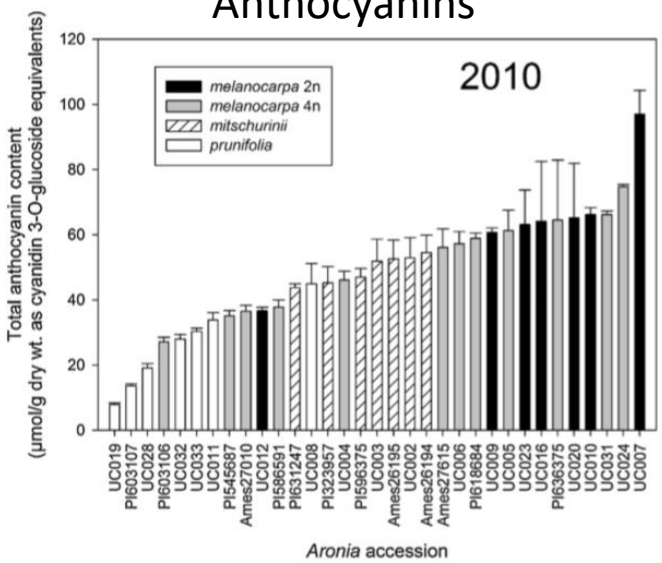
Leaf morphology



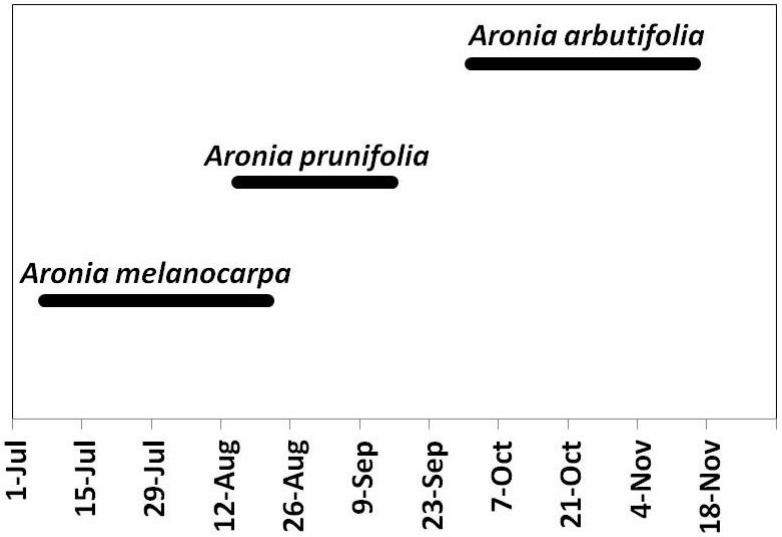
Brix:TA ratio



Anthocyanins



Fruit ripening date

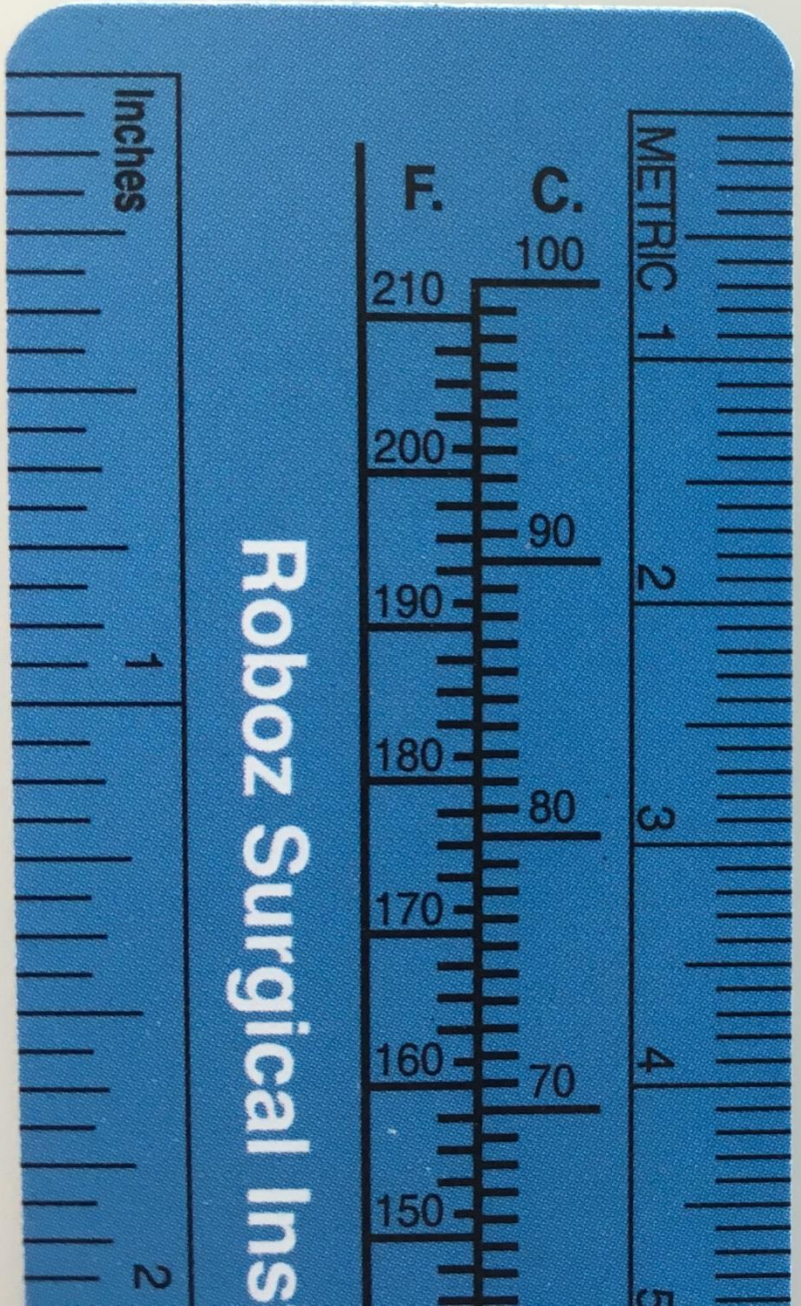


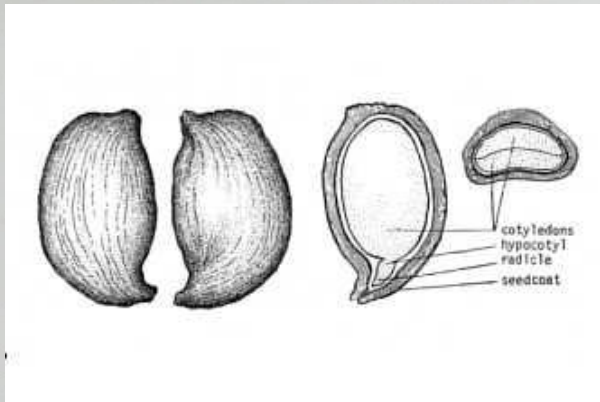
Dark-fruited *Aronia* (chokeberry) taxonomic groups

melanocarpa 2n	*melanocarpa* 4n	*prunifolia*	*mitschurinii*
			
highest $ORAC_{FL}$ highest anthocyanins low phenolics	medium anthocyanins medium phenolics	lowest anthocyanins highest phenolics	lowest $ORAC_{FL}$ highest moisture low phenolics

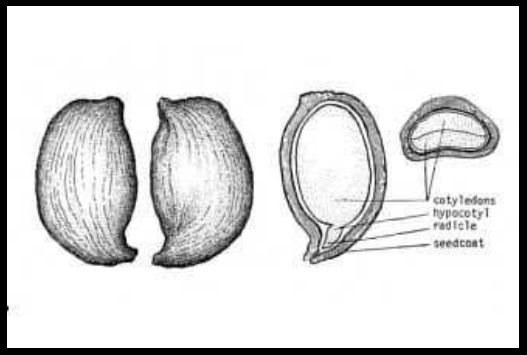
Controlled pollinations:
Intergeneric hybridization and sexual polyploidization

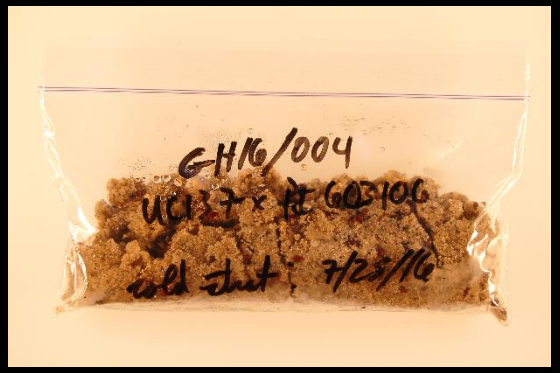
Seed


Inches
METRIC
F.
C.
Roboz Surgical Ins

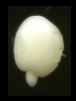

cotyledons
hypocotyl
radicle
seedcoat

~3 months





~4 months



Pathway to *Aronia mitschurinii*

AA

Sorbus aucuparia (2x)

×

BBBB

Aronia melanocarpa (4x)

ABB

×*Sorbaronia fallax* (3x)

×

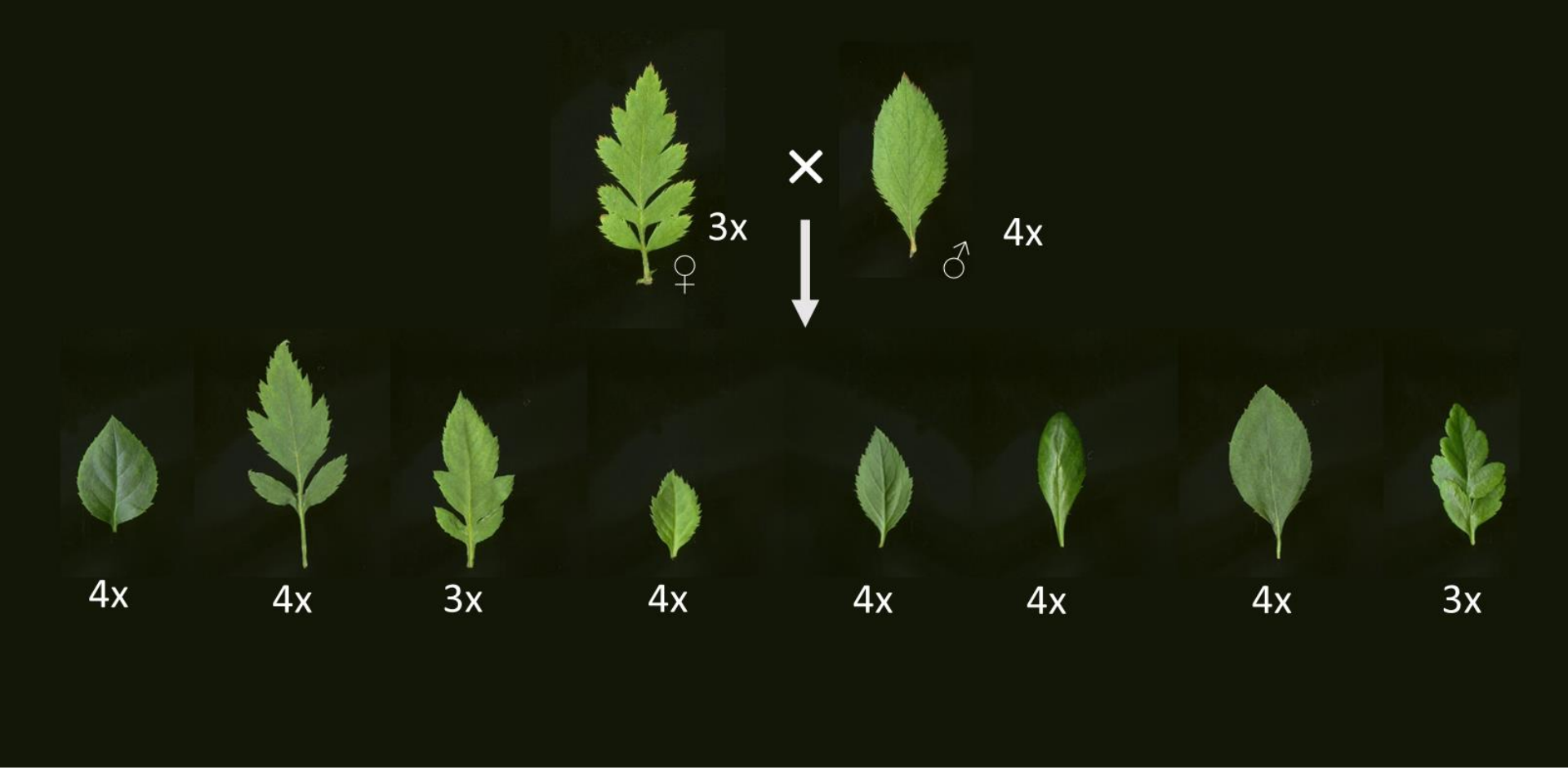
BBBB

Aronia melanocarpa (4x)

ABBB

Aronia mitschurinii (4x)

Paternal Genotypes:
Aronia melanocarpa tetraploids



~100 putative *Aronia mitschurinii* genotypes under evaluation

Timeline for Introduction

Evaluation in containers (3-5 yrs):

- Growth performance
- Fruit yield
- Fruit quality
- Disease resistance

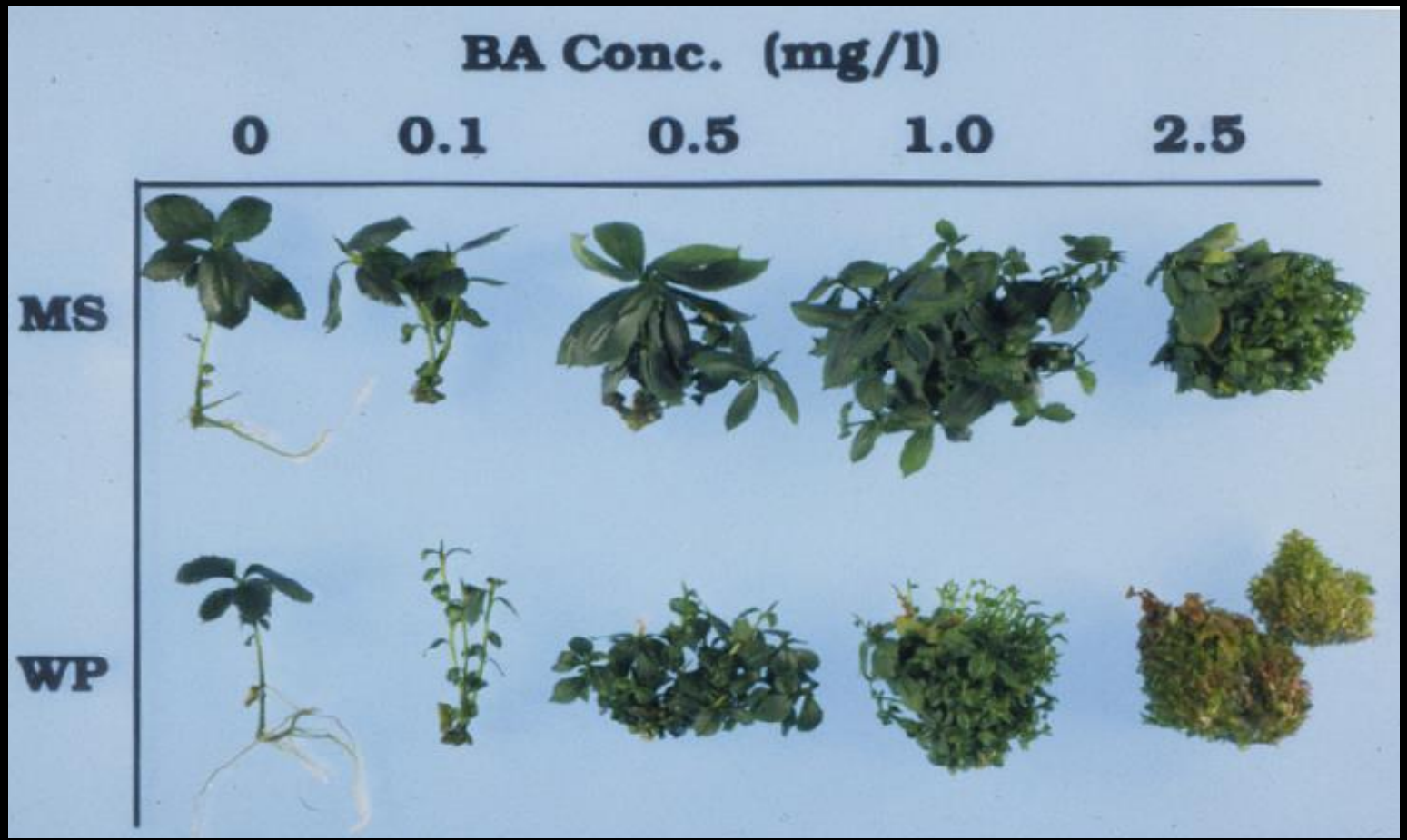
Evaluation in field (3-5 yrs):

- Same as above
- Multiple locations

Make final selections:

- Patent & license
- Propagate rapidly

Murashige and Skoog salts and vitamins
Sucrose (20-30 g/l)
pH 5.7
Agar (7-8 g/l)
Subculture frequency (6-8 weeks)
Culture storage – Refrigerated xfer 8-12 months



1 week after acclimation

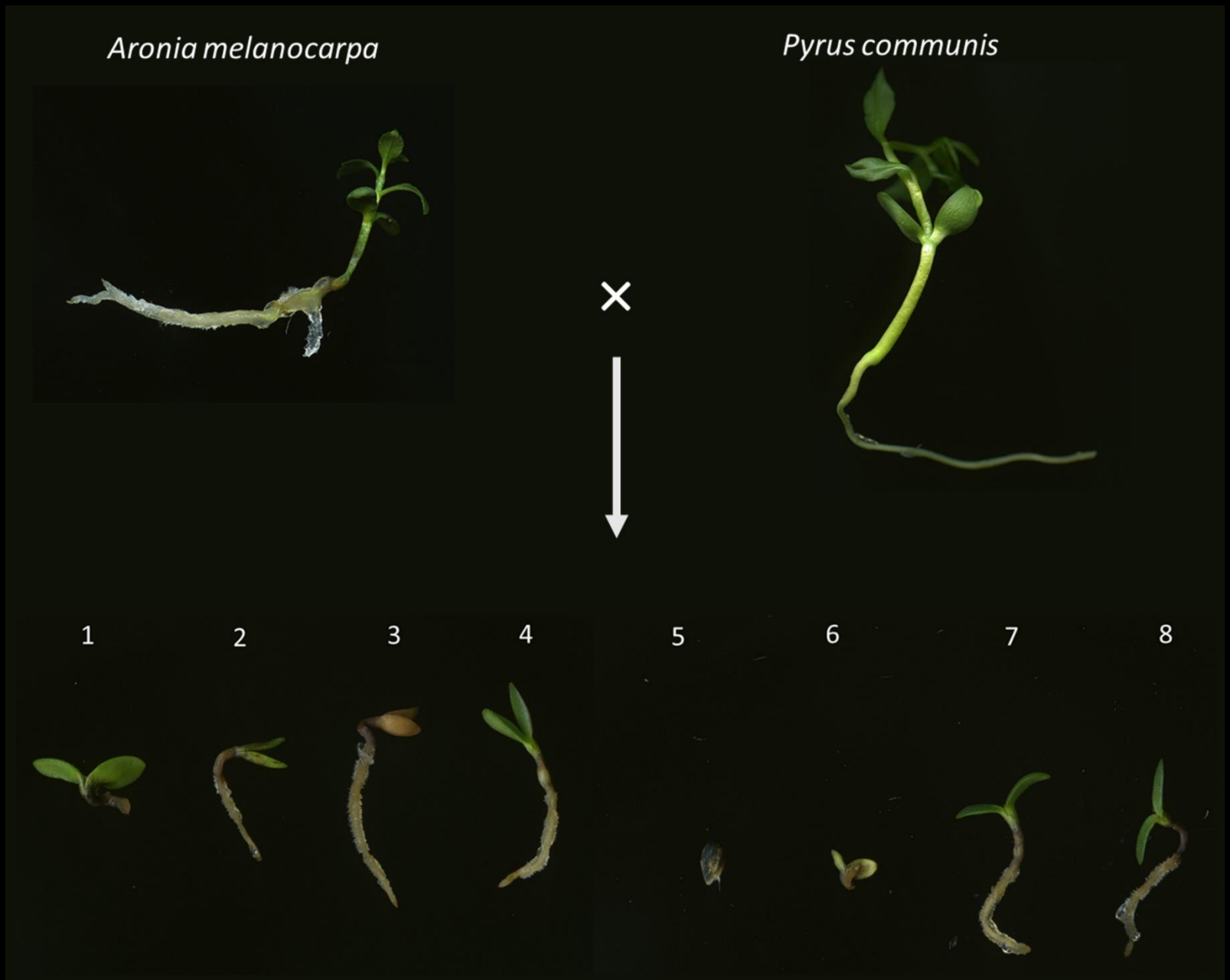
3 week after acclimation

Aronia-Pear hybrid

×

=

Hybrid Necrosis (2015, 2016, 2017)



x*Sorbaronia dippelii* – Pear hybrid

(*Sorbus aria* x *Aronia melanocarpa*) (*Pyrus communis*)

F1 Hybrid
(AA15/002)

Pyrus communis
(Pear)

7 d

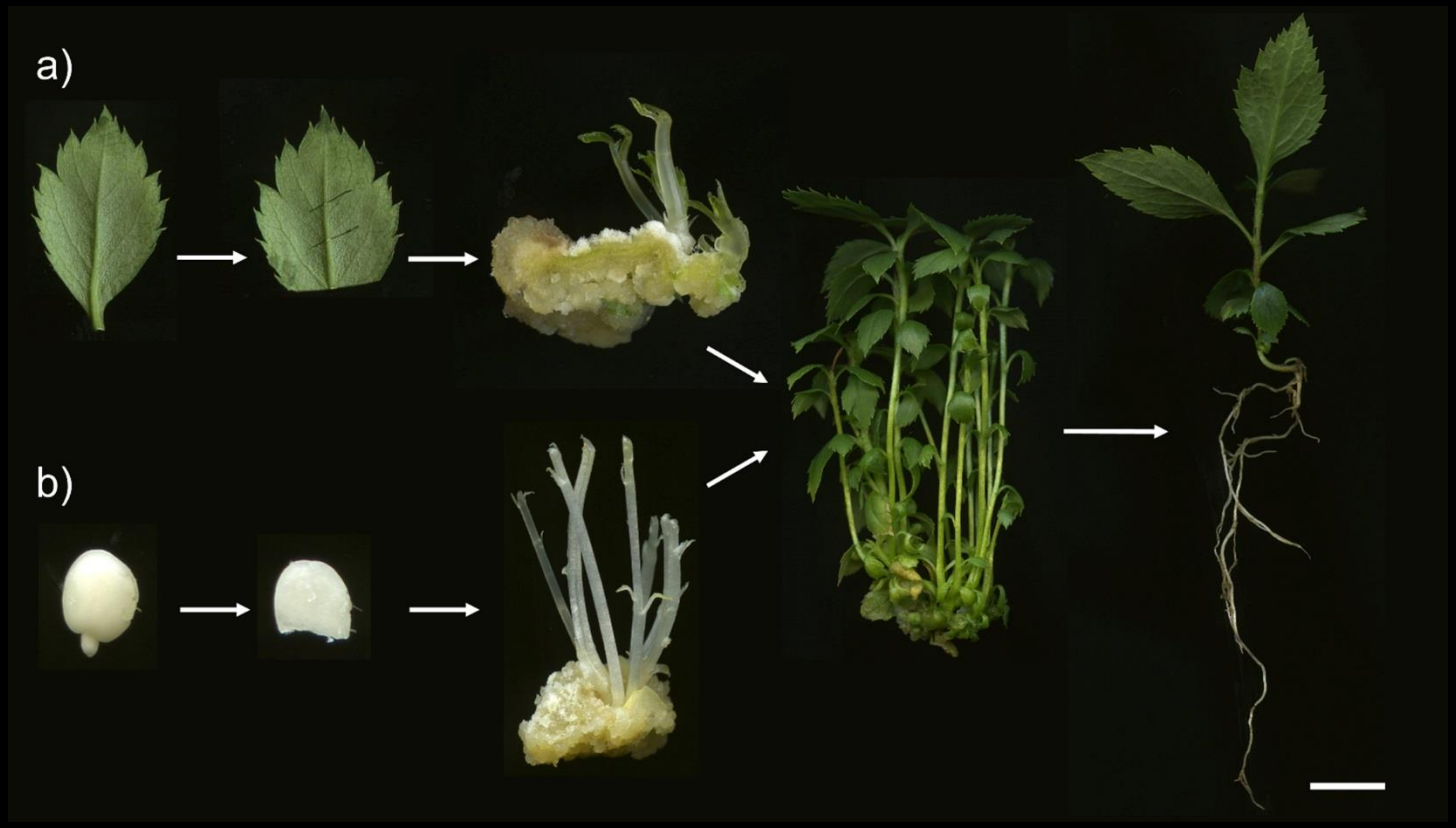
14 d

28 d

Aronia – Sorbus – Pyrus Hybrids

Other *Aronia* activities

Aronia shoot organogenesis techniques
Future transgenic or gene editing crop improvement

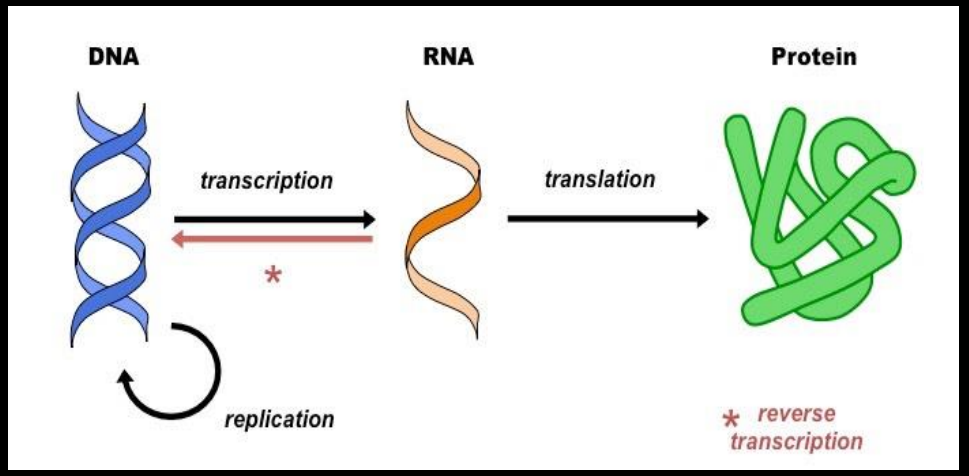


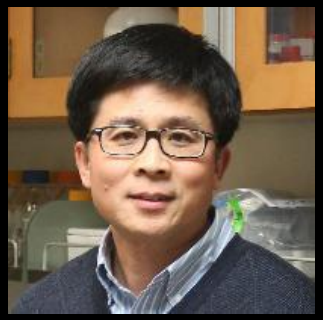
Micrografting in vitro

1 acre, 700 plant ‘Viking’ pilot orchard
2018 will be 8th growing season

fertility, irrigation, pruning studies – need $$$

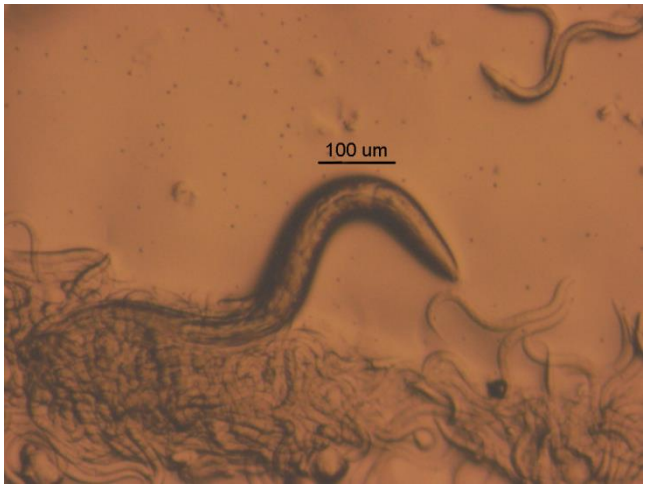
What genes control *Aronia* polyphenol biosynthesis: RNA-sequencing

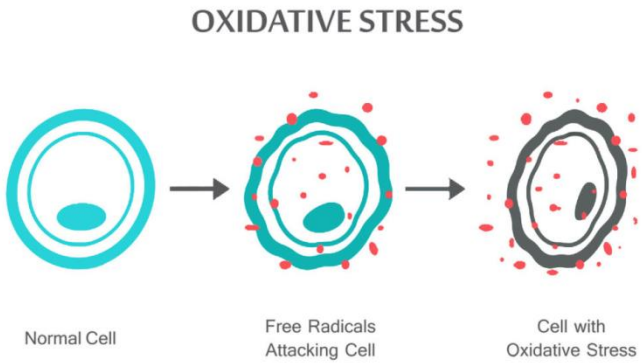


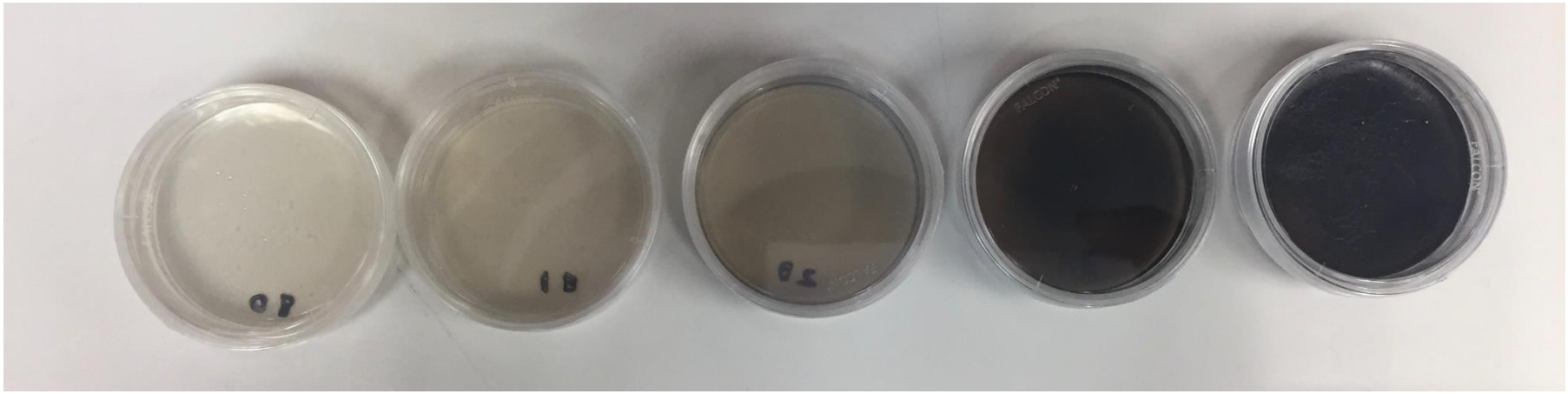


Collaboration with: Dr. Huanzhong Wang, Plant Science

Caenorhabditis elegans, roundworm nematode
Model system to study health protective properties of aronia extracts







Collaboration with: **Dr. Elaine Choung-Hee Lee, Kinesiology**

Aronia parfait

Aronia yogurt

Collaboration with: **Dr. Dennis D'Amico, Animal Science**

Jon Mahoney, PhD candidate