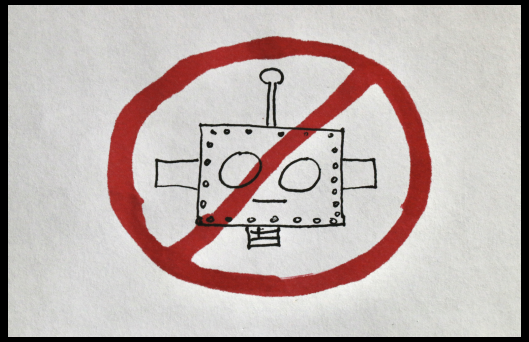
The mysterious genetics of the controversial Del Mar Manzanita: a brief history of its taxonomy, an explanation of current genomic results, and suggestions for identification in light of this data.

Tito Abbo

This is a 100% human-made presentation: All content, data, research, coding, and analysis was generated or carried out to the best of my knowledge **without AI assistance**





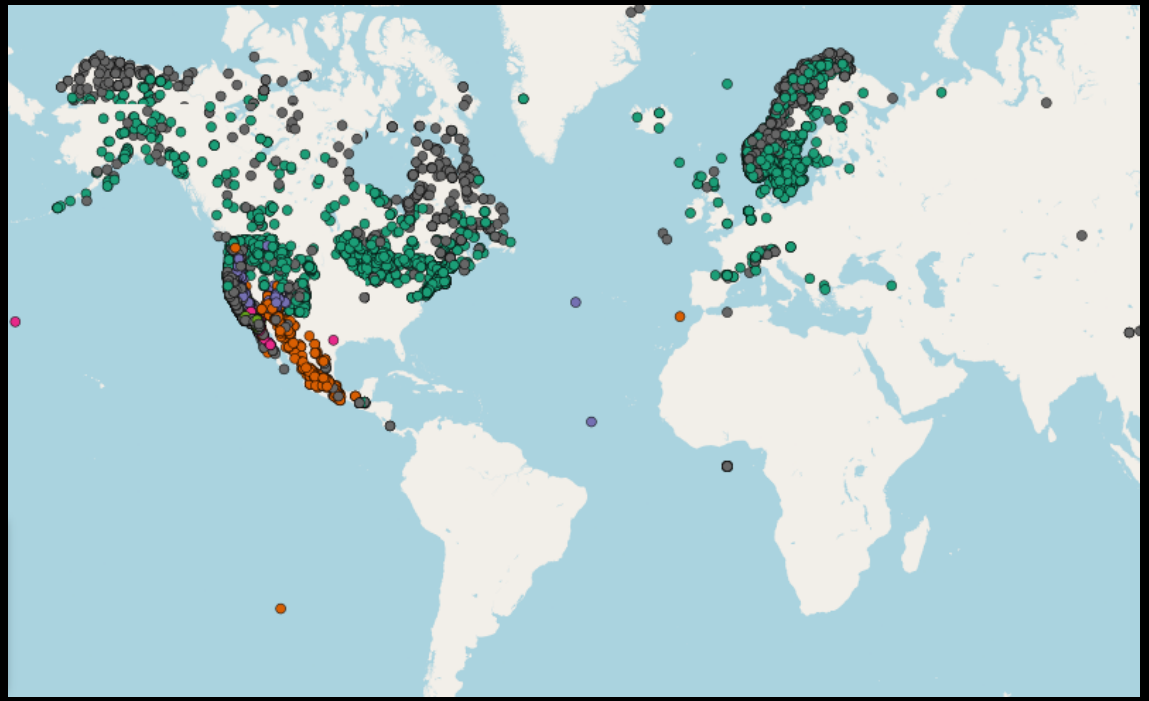
This is your brain and this is your brain on AI



Photos:
Morgan A.
Stickrod



Manzanitas (*Arctostaphylos*) Ericaceae



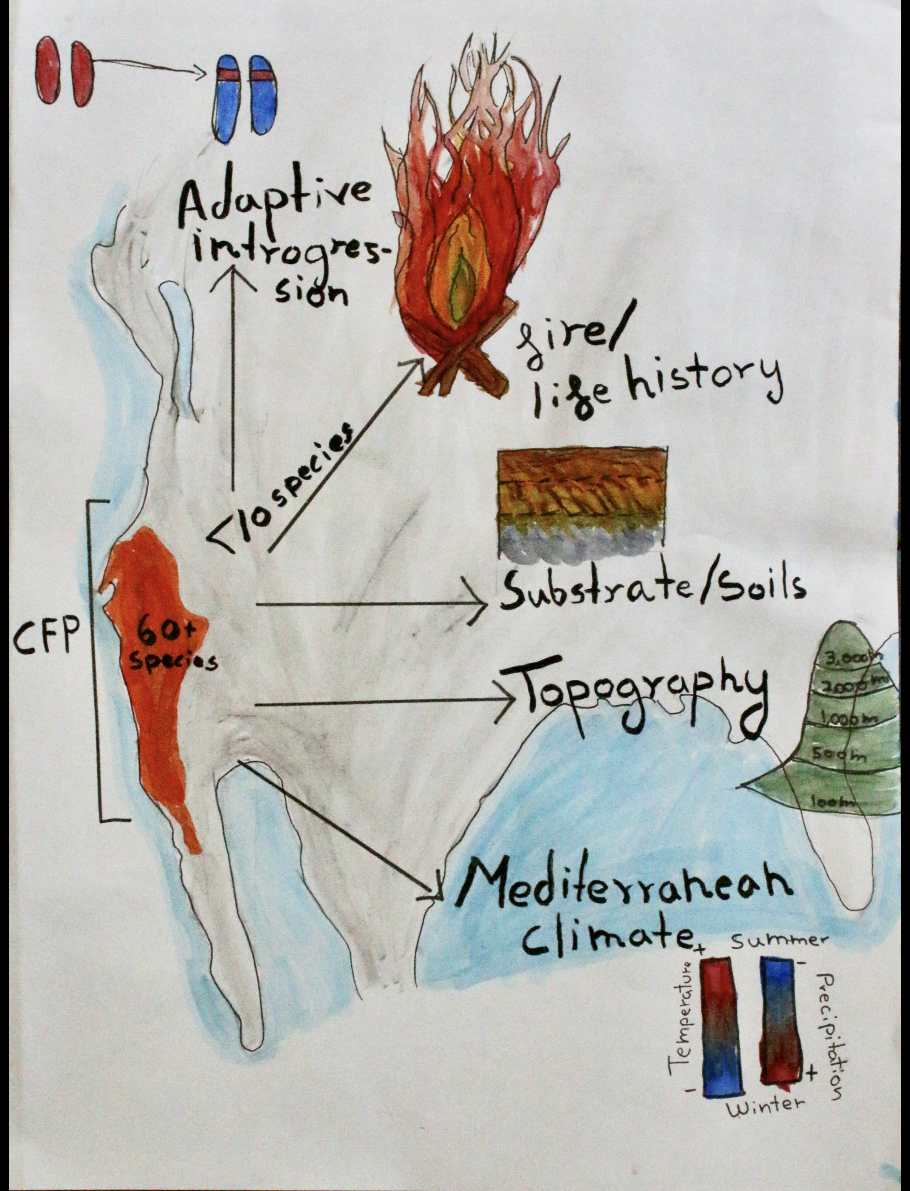
Map credit:
portal.idigbio.org





Photos:
Morgan A.
Stickrod

Why so many in the CFP?










Images:
Morgan A.
Stickrod

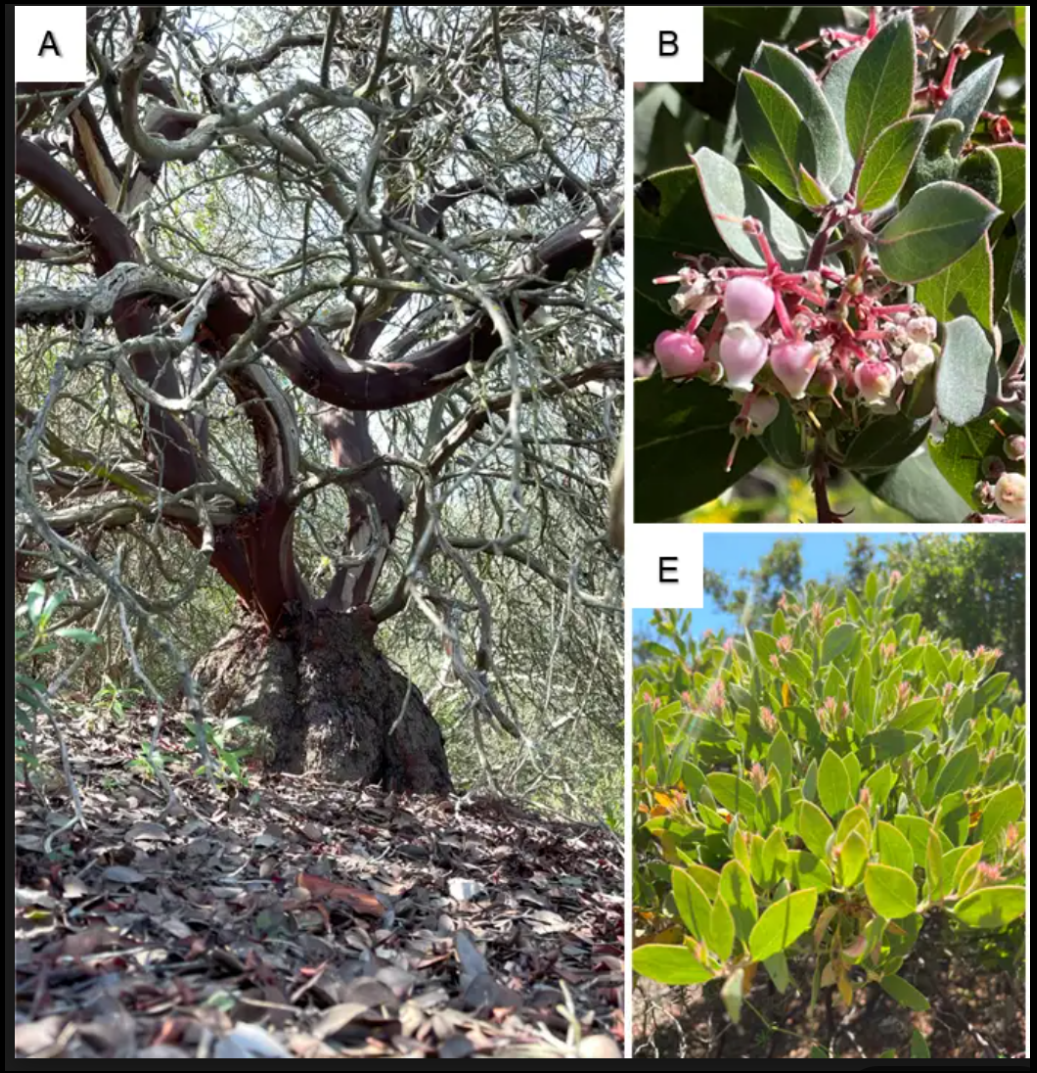
Burl vs no burl







Images: Morgan A. Stickrod



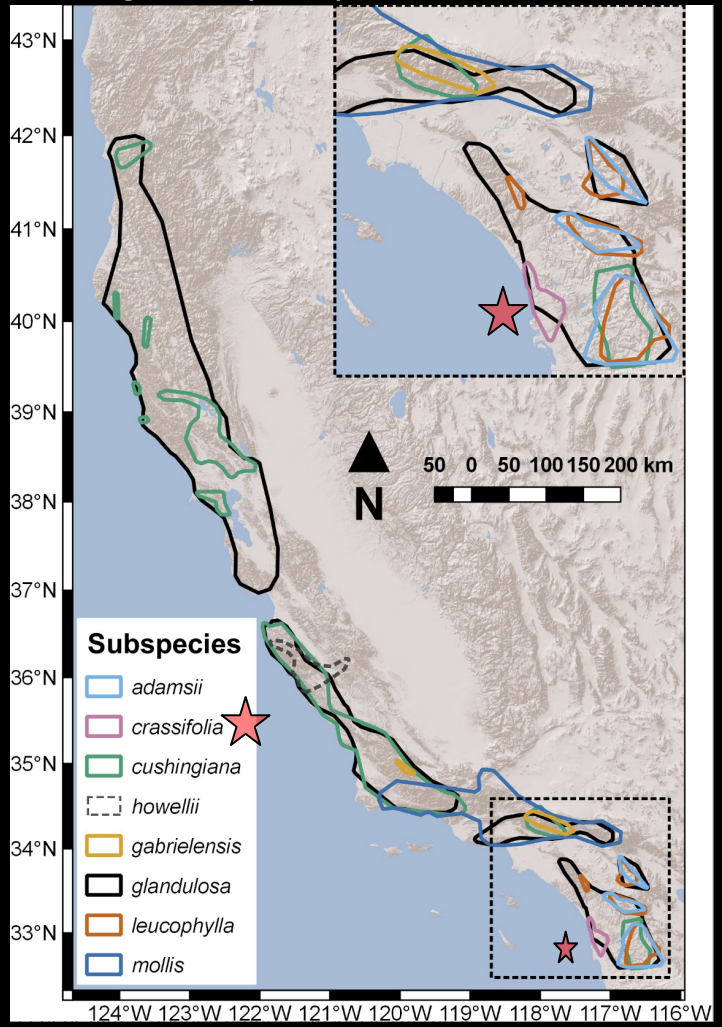
A. glandulosa ssp. *crassifolia* (DMM)



Co-first author:
Avrie Martello,
PhD candidate,
UCR

A. glandulosa ssp. *crassifolia* (DMM)

Huang *et al.* (2020); AJB.



A rare subspecies of the widespread *A. glandulosa* (Eastwood manzanita)

Occupies a threatened ecosystem on the San Diego County coast

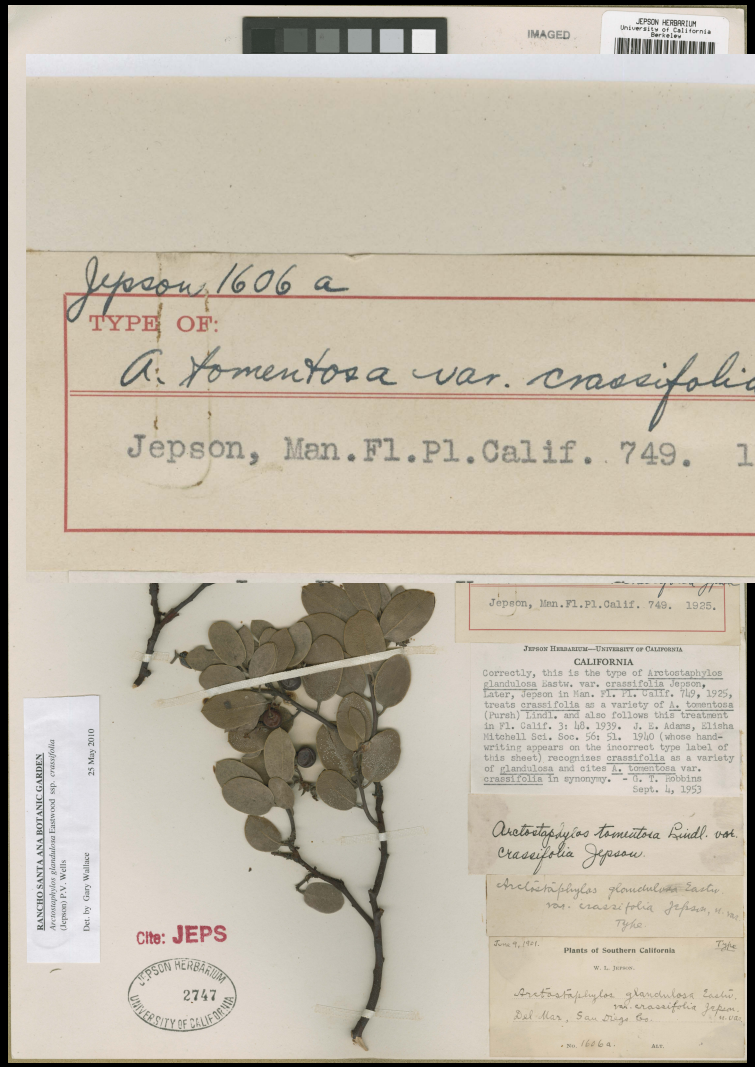
Debated whether it should be recognized taxonomically

Jepson col. num: 1606a; CCH2.org.



A. glandulosa var. *crassifolia:*
"leaves elliptic, thick, 8 to 12 lines long" (Jepson, 1922).

Jepson col. num: 1606a; CCH2.org.



Opps that was a typo it was supposed to say *A. tomensa* var. *crassifolia:* (Jepson, 1925).

Jepson col. num: 1606a; CCH2.org.



A. glandulosa var. *crassifolia:*
“dark green” leaves as opposed to “light or yellowish green or pallid”

Distributed in sandy areas in coastal San Diego County, possibly extending into Baja California (Adams, 1940).

Jepson col. num: 1606a; CCH2.org.



A. glandulosa ssp. *crassifolia:*
just various hybrid individuals not a distinct entity (Knight, 1981).

Yes its distinct becuase it is geographically isolated (Wells, 1987).

Jepson col. num: 1606a; CCH2.org.

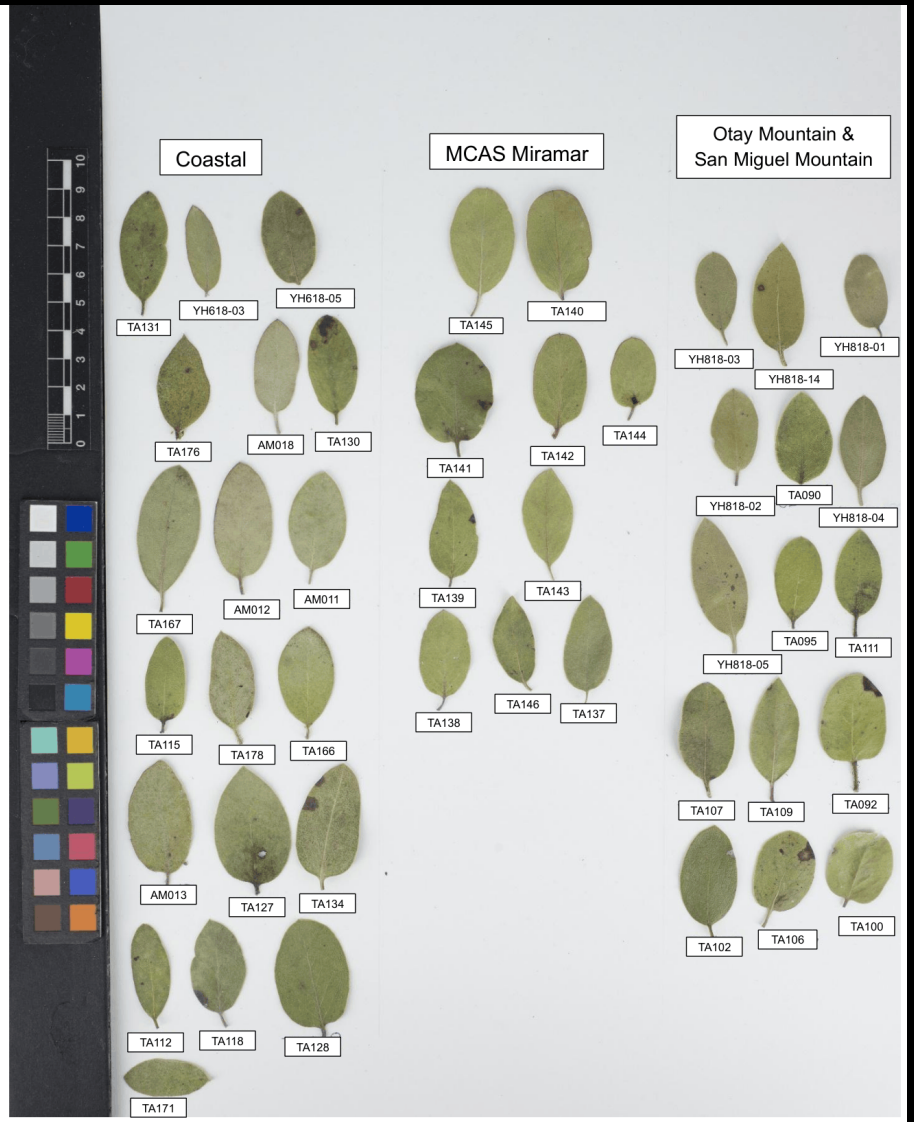


A. glandulosa ssp. *crassifolia:*
ESA -endangered.
Short and differences in hairiness between the upper and
lower leaf surfaces.
Several inland populations (Fish and Wildlife Service, 1996).

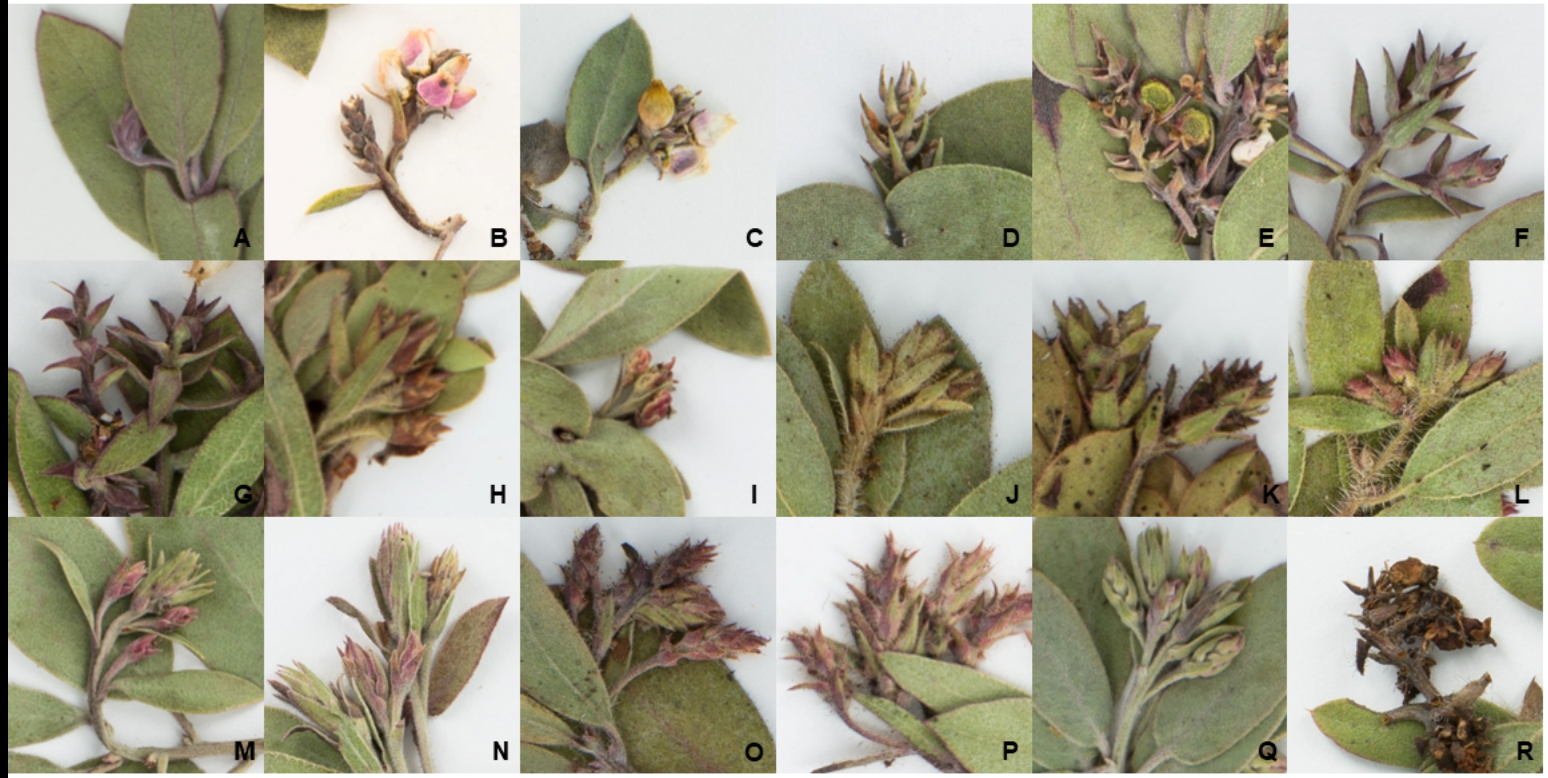
Dark-green leaves, nonglandular hairs, and flattened fruits. Coastal only (Keeley et al., 2007; *Madroño*).






Coastal
MCAS Miramar
Otay Mountain &
San Miguel Mountain
TA131
YH618-03
YH618-05
TA176
AM018
TA130
TA167
AM012
AM011
TA115
TA178
TA166
AM013
TA127
TA134
TA112
TA118
TA128
TA171
TA145
TA140
TA141
TA142
TA144
TA139
TA143
TA138
TA146
TA137
YH818-03
YH818-14
YH818-01
YH818-02
TA090
YH818-04
YH818-05
TA095
TA111
TA107
TA109
TA092
TA102
TA106
TA100

Supplemental Figure 8. Page 1: Coastal

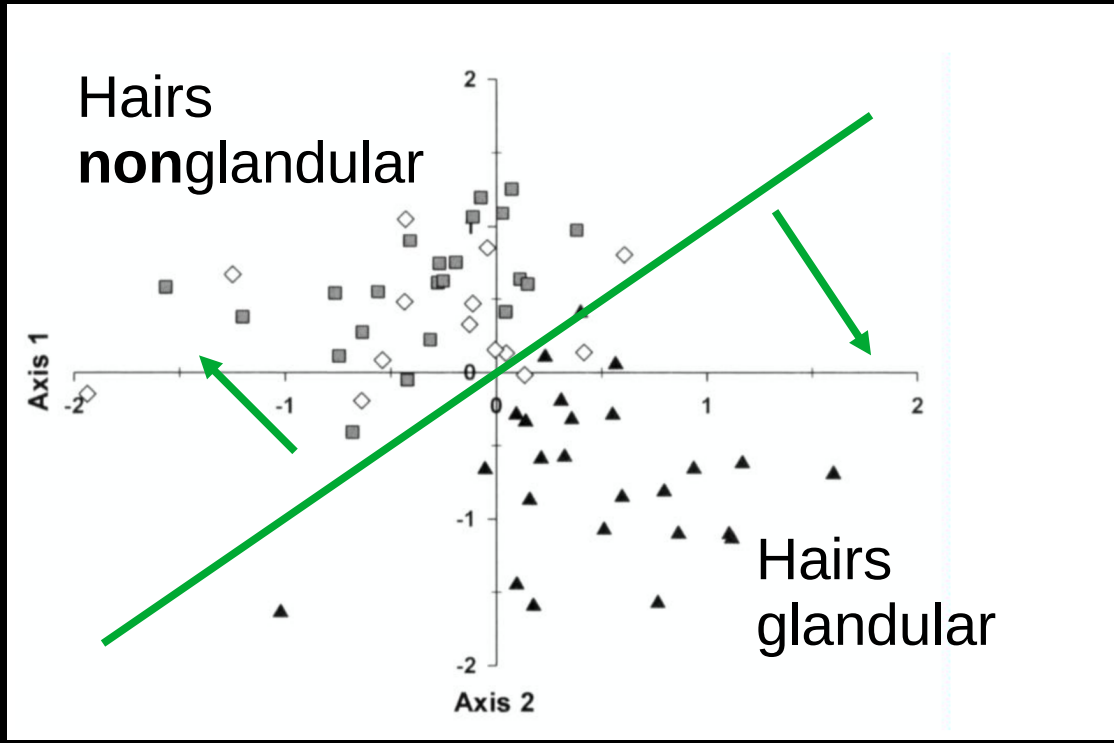


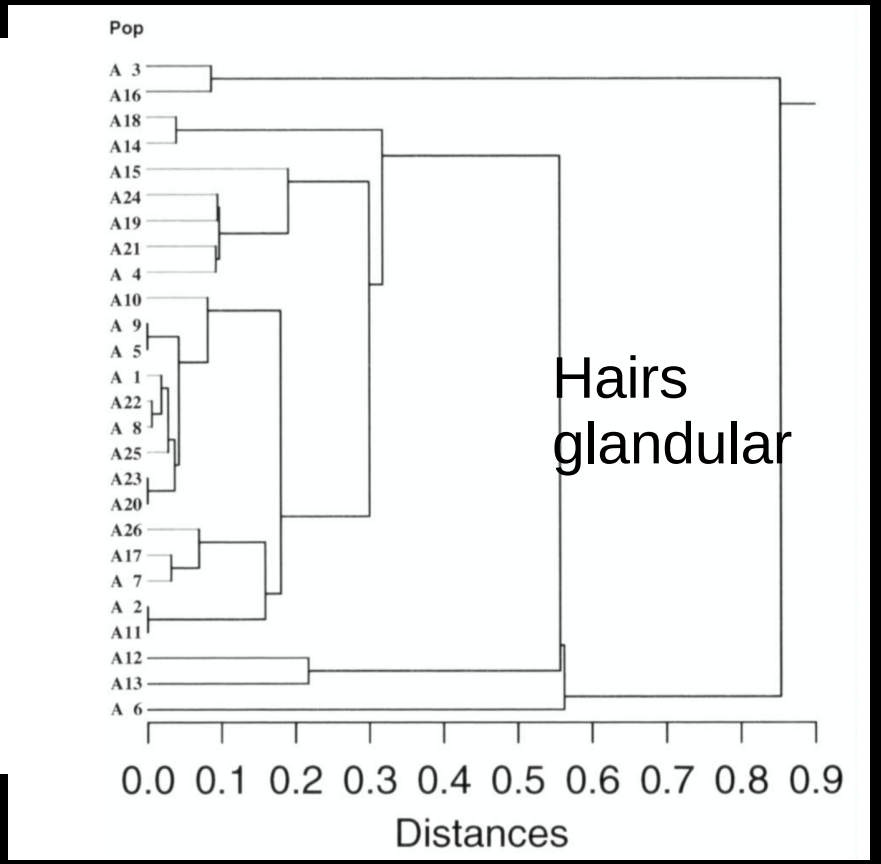
A= C3, B= DI7, C= DJ1, D= DK1, E= DK2, F= DK4, G= DK8, H= DN5, I= DN6, J= DO1, K= DO6, L= DO8, M= DP2, N= DP3, O=DP3, P= DP4, Q= DP9, R= DK7.

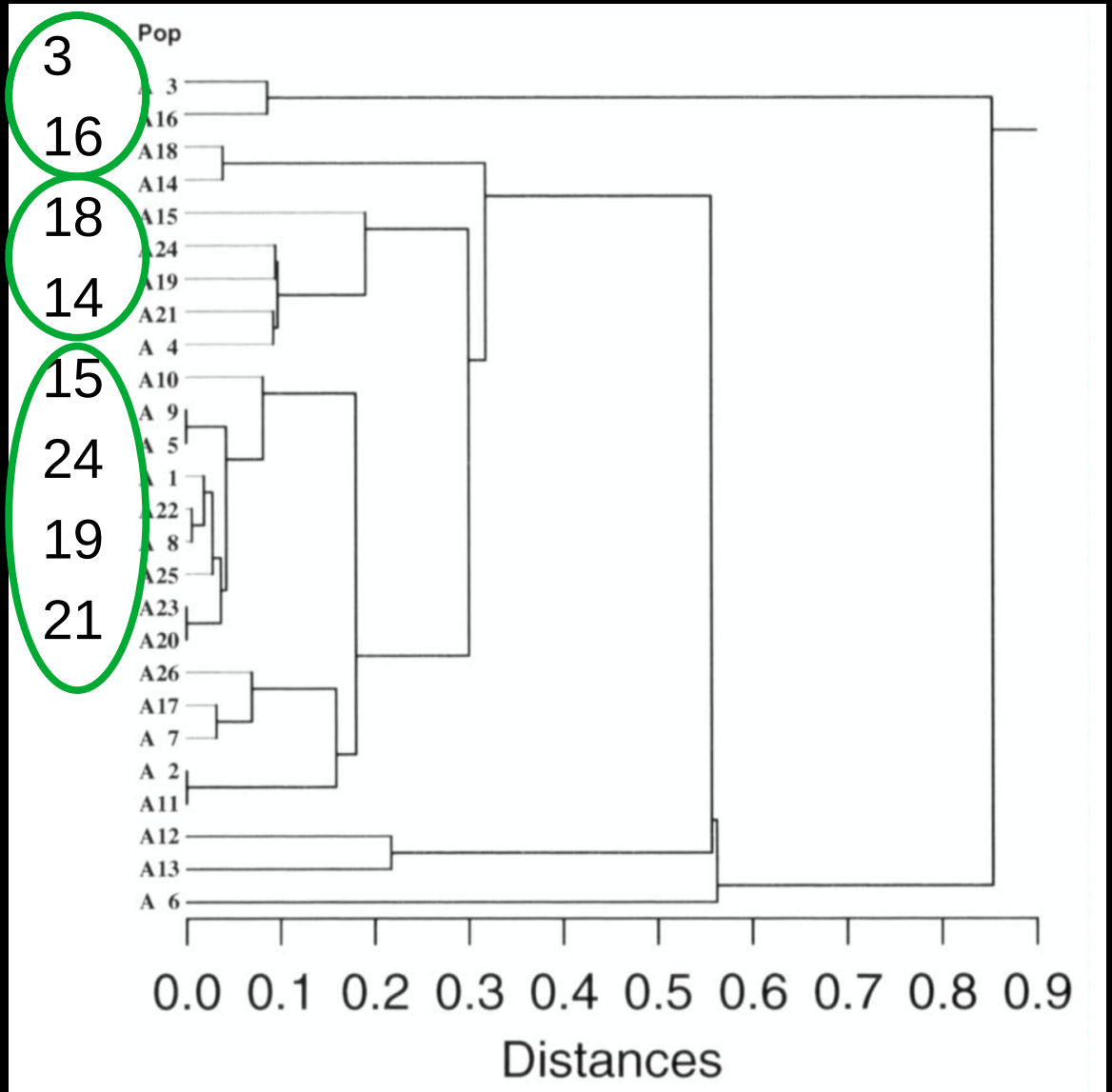
MADROÑO, Vol. 54, No. 1, pp. 42–62, 2007

SUBSPECIFIC VARIATION IN THE WIDESPREAD BURL-FORMING *ARCTOSTAPHYLOS GLANDULOSA*

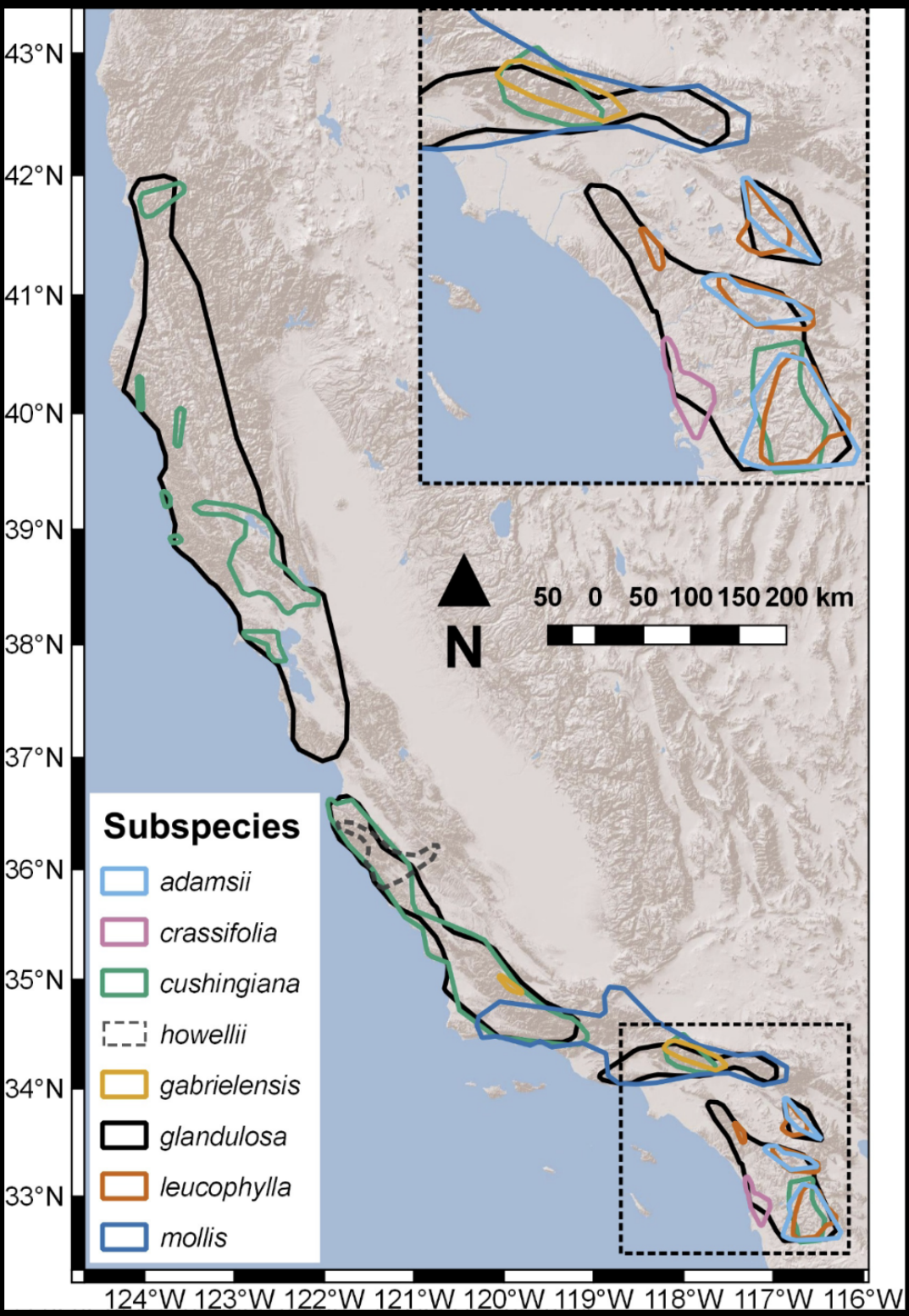
JON E. KEELEY[1,2,3], MICHAEL C. VASEY[4], AND V. THOMAS PARKER[4]



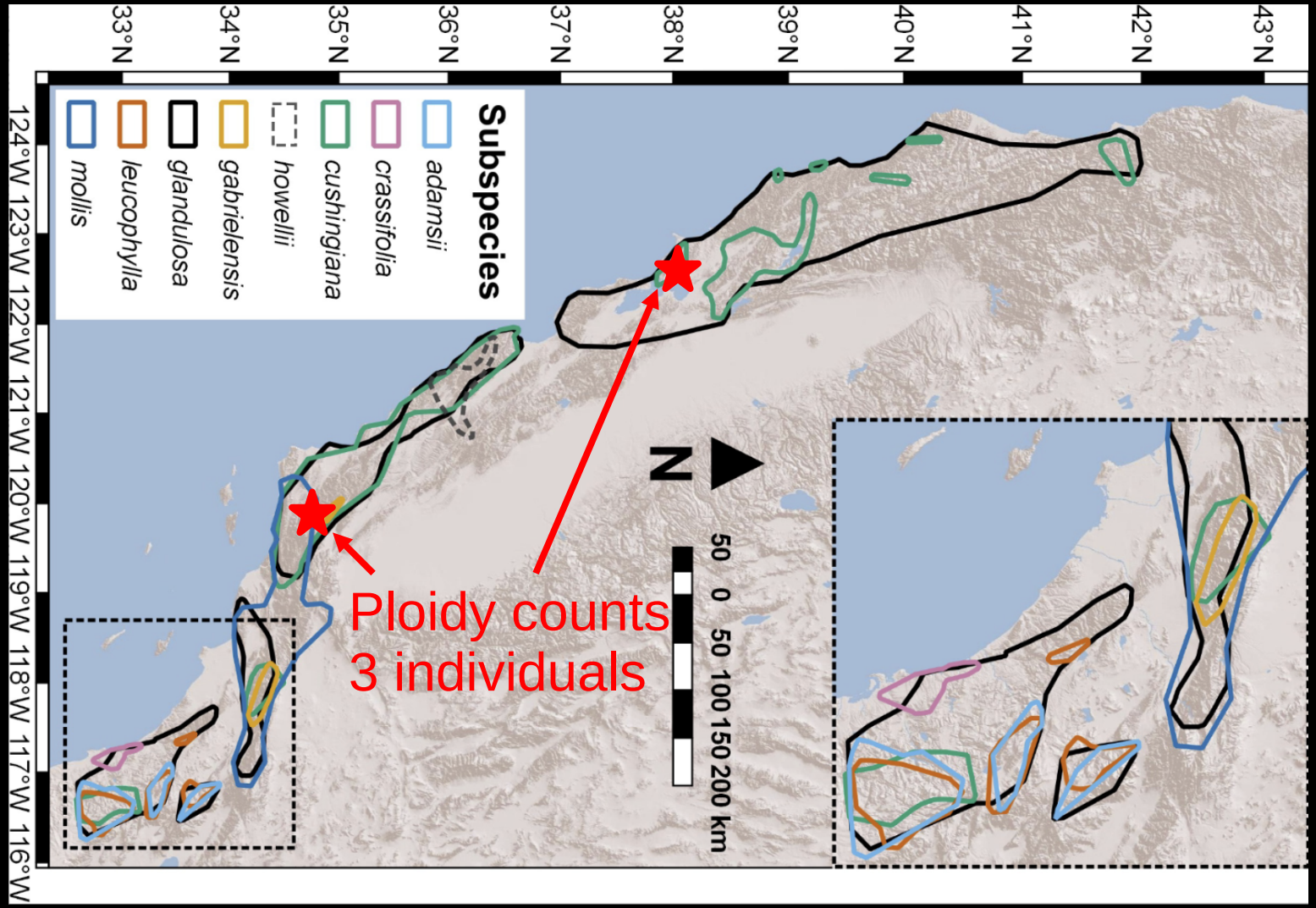




Closer numbers are closer to each other in **latitude**

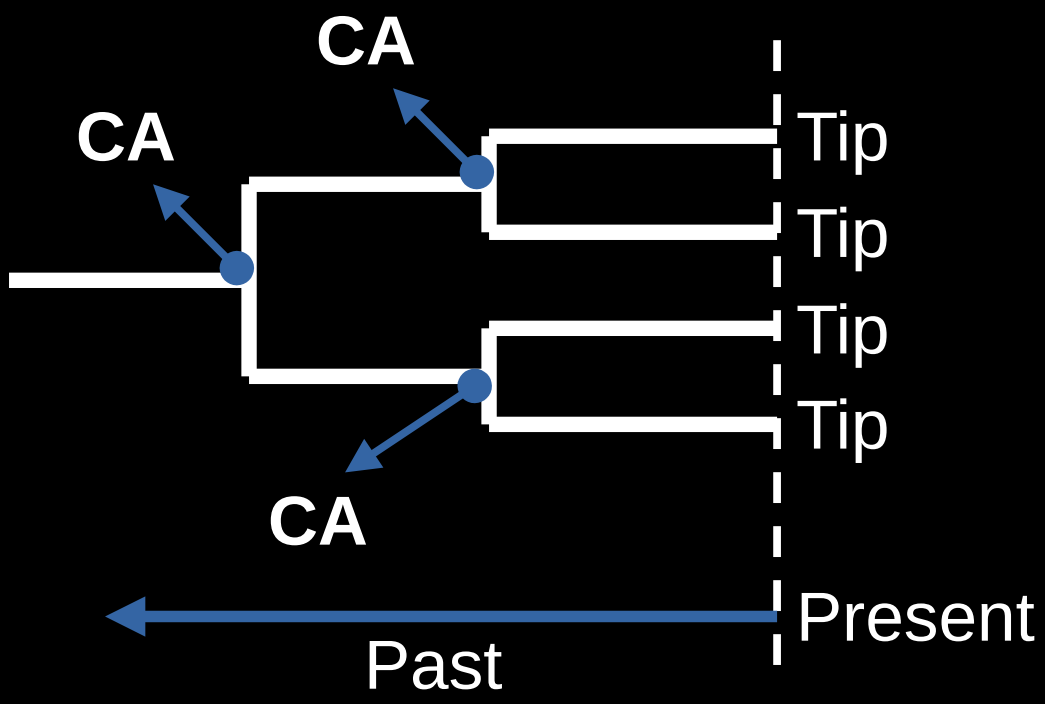


Huang *et al.* (2020); AJB.

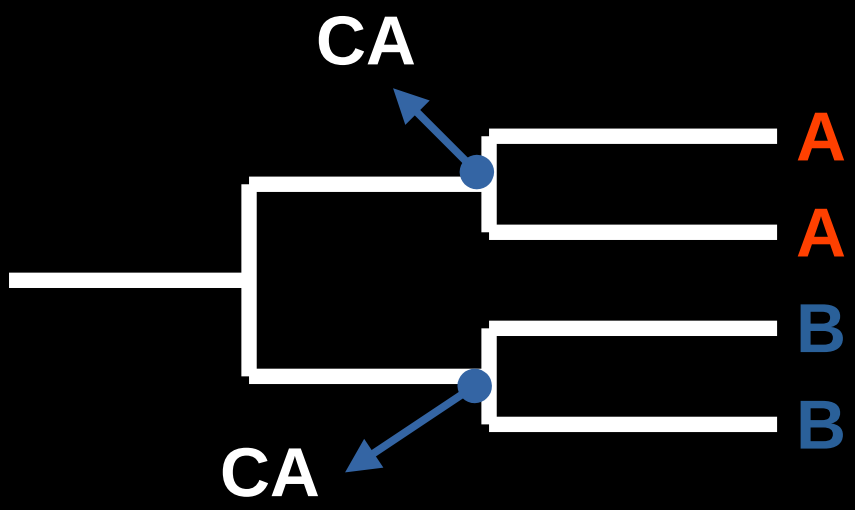


Huang *et al.* (2020); AJB.

Phylogenetic trees



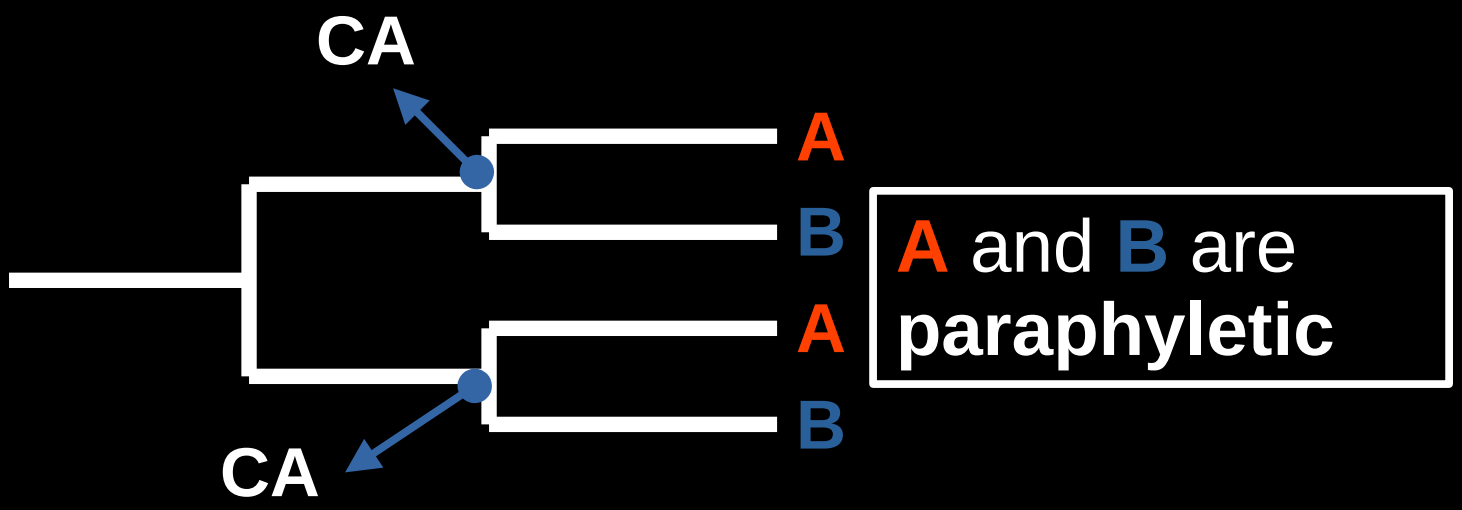
Phylogenetic trees



A and **B** are **monophyletic**

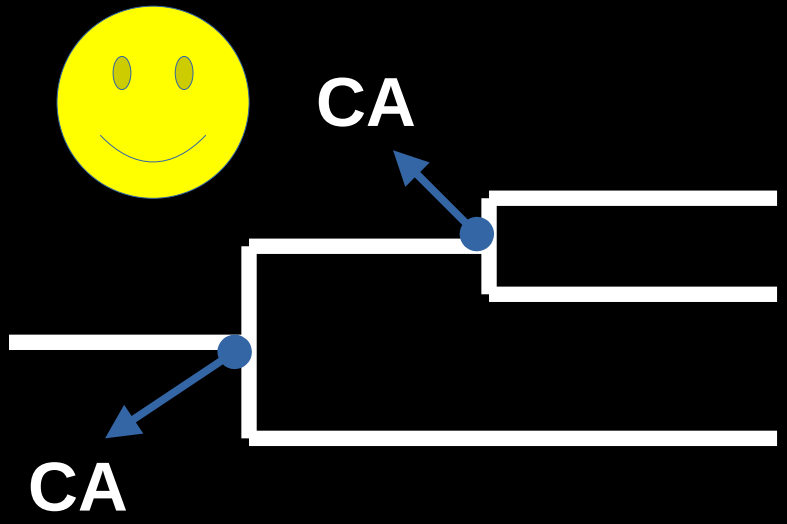
Agreement with taxonomy = good

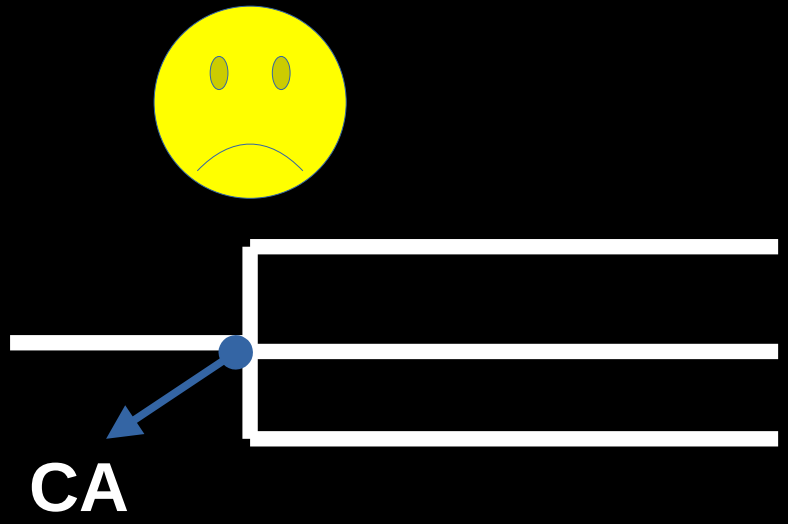
Phylogenetic trees



Agreement with taxonomy = bad

Phylogenetic trees

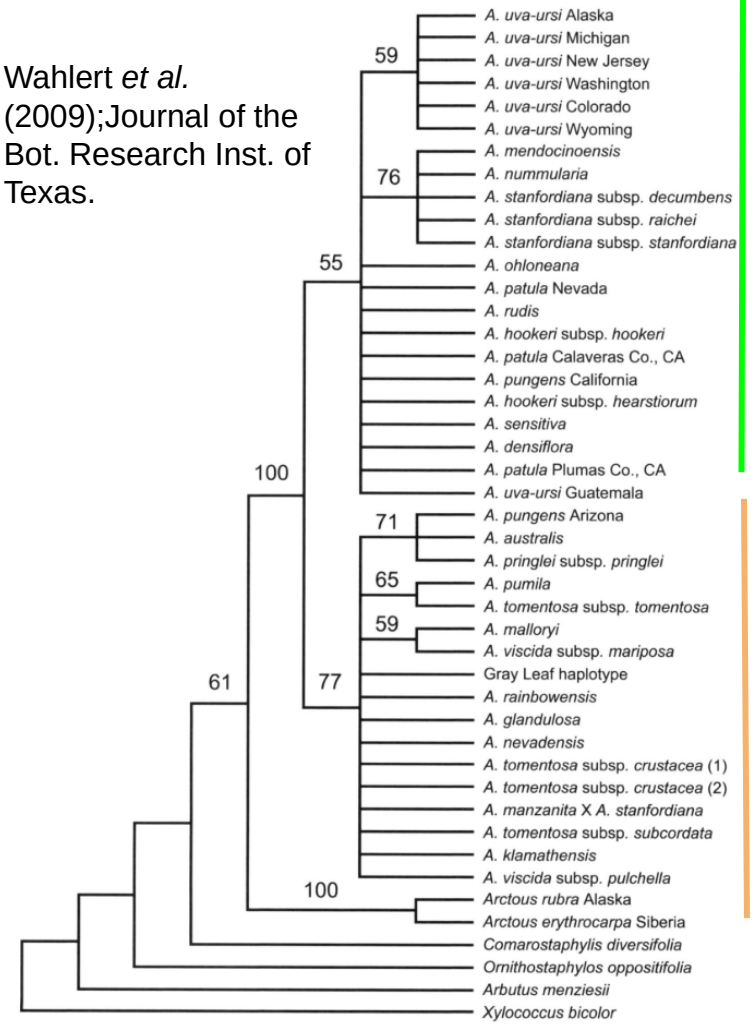




Resolved

Unresolved

Wahlert *et al.* (2009);Journal of the Bot. Research Inst. of Texas.



ITS Small Clade

ITS Large Clade

Fig. 1. Strict consensus of 350 most parsimonious trees estimated from nrITS sequences. The numbers above the branches are bootstrap percentages. The taxon "Gray Leaf haplotype" represents 44 taxa with an identical nrITS sequence (listed in Appendix 2).

Wahlert et al. (2009);Journal of the Bot. Research Inst. of Texas.

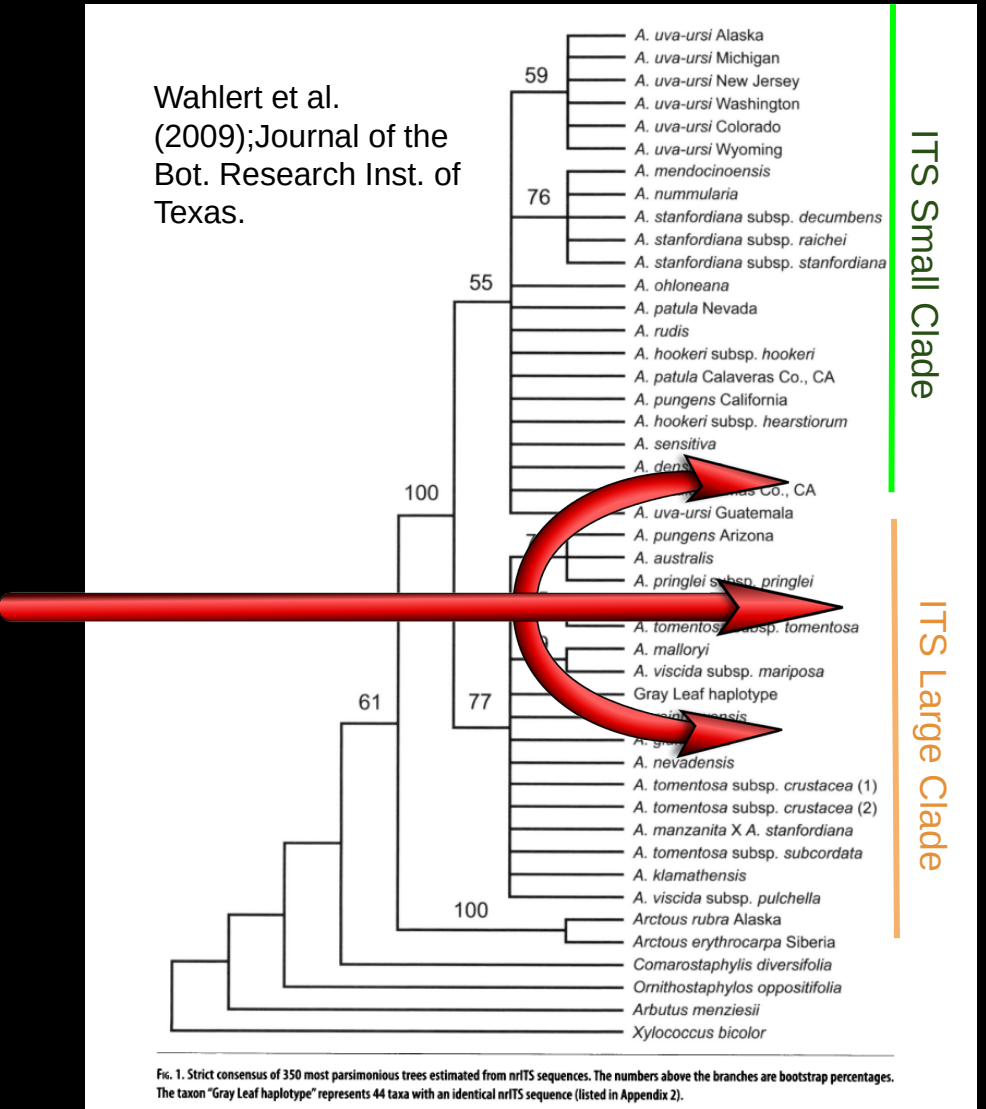
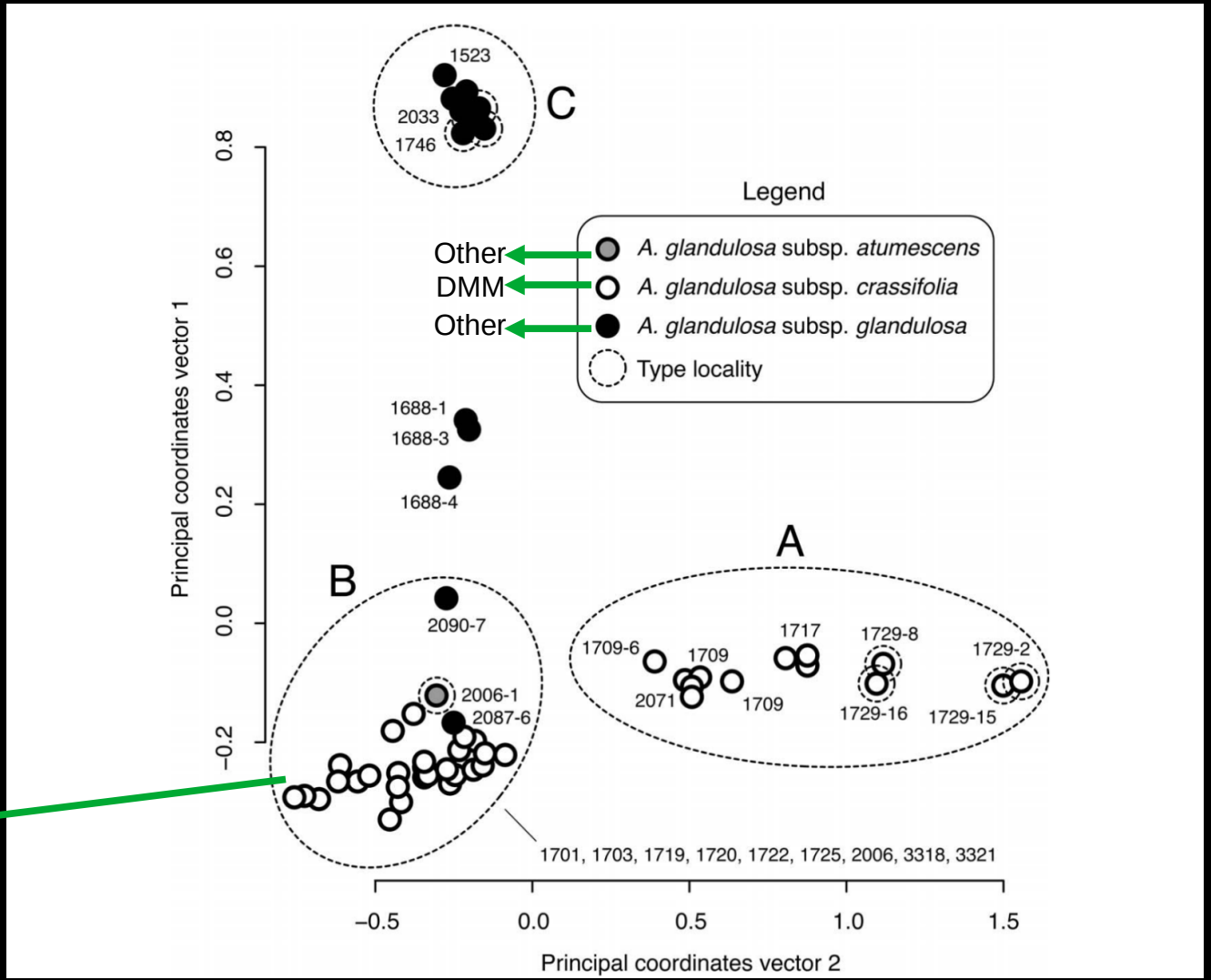


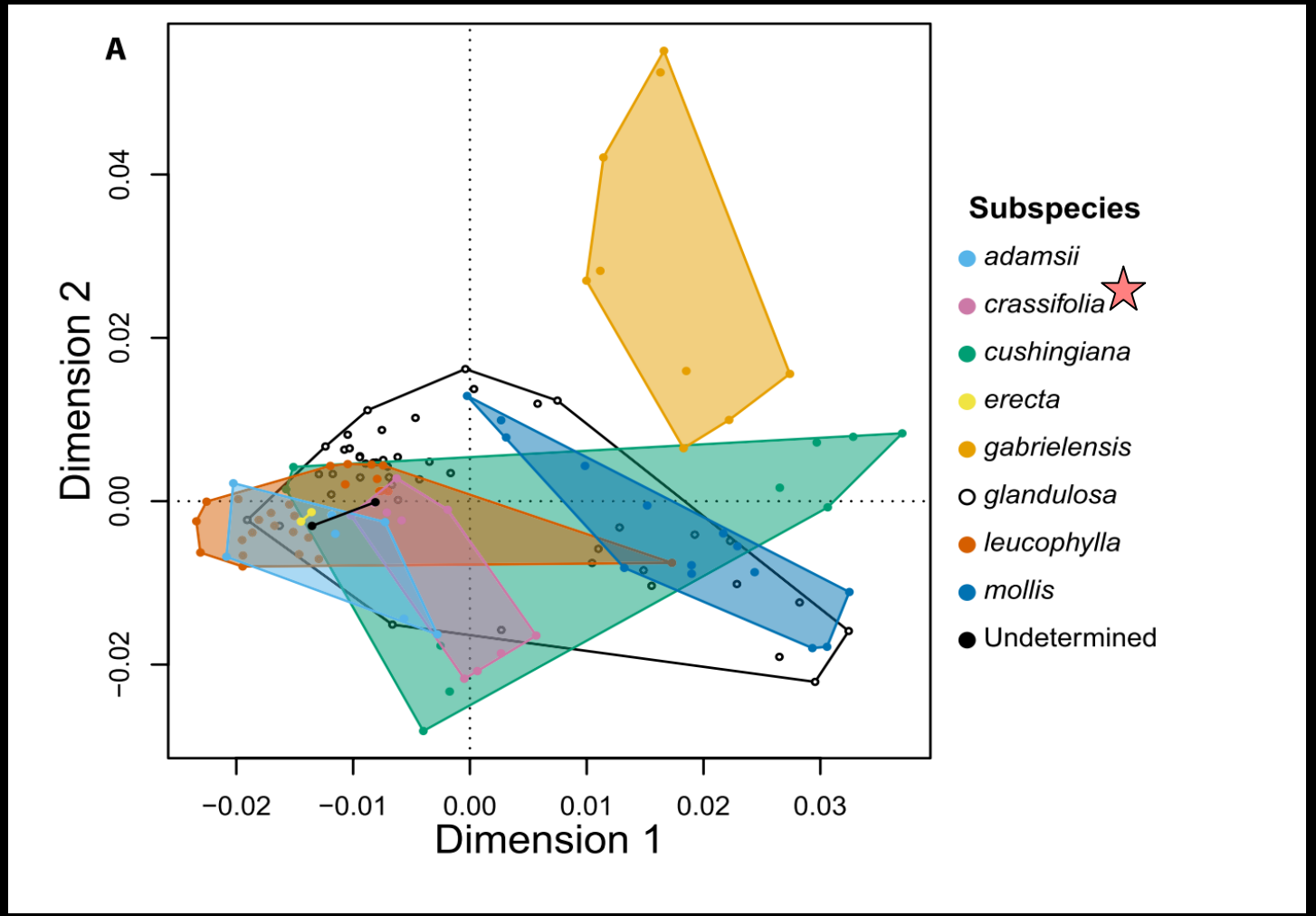
Fig. 1. Strict consensus of 350 most parsimonious trees estimated from nrITS sequences. The numbers above the branches are bootstrap percentages. The taxon "Gray Leaf haplotype" represents 44 taxa with an identical nrITS sequence (listed in Appendix 2).



White points here are from MCAS Miramar

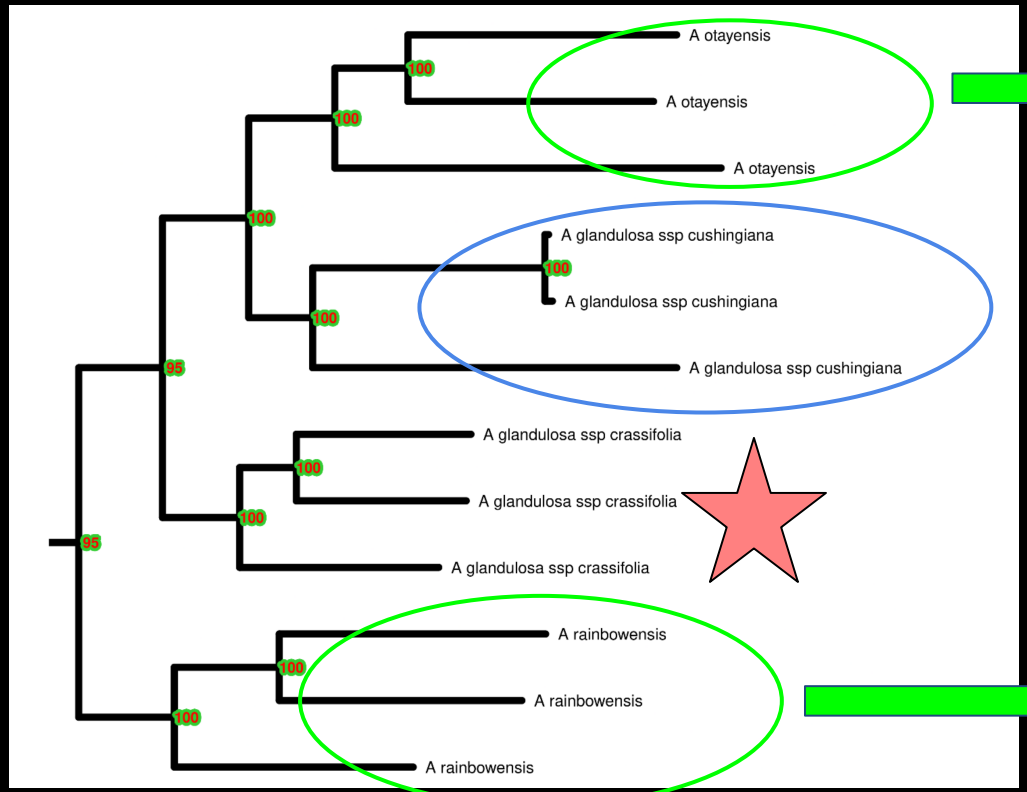


Burge et al., (2018); Madroño



Huang *et al.* (2020); AJB.

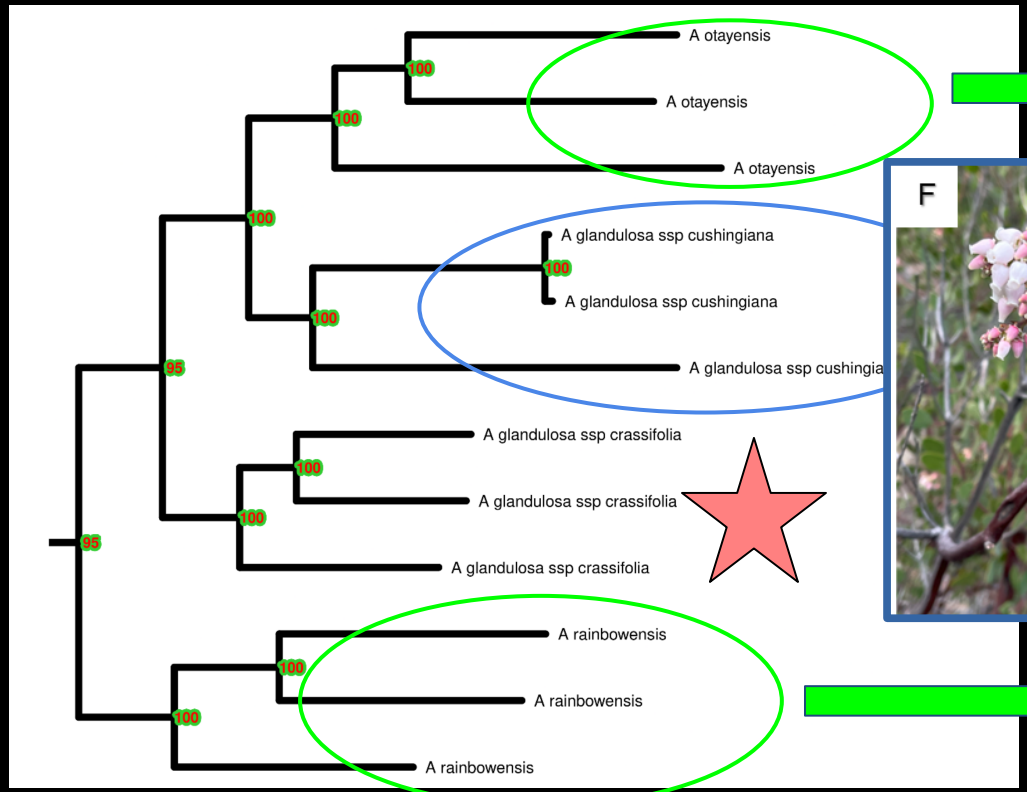
However, San Diego County manzanita samples are **monophyletic**



SDC Narrow endemic

SDC Narrow endemic

However, San Diego County manzanita samples are **monophyletic**



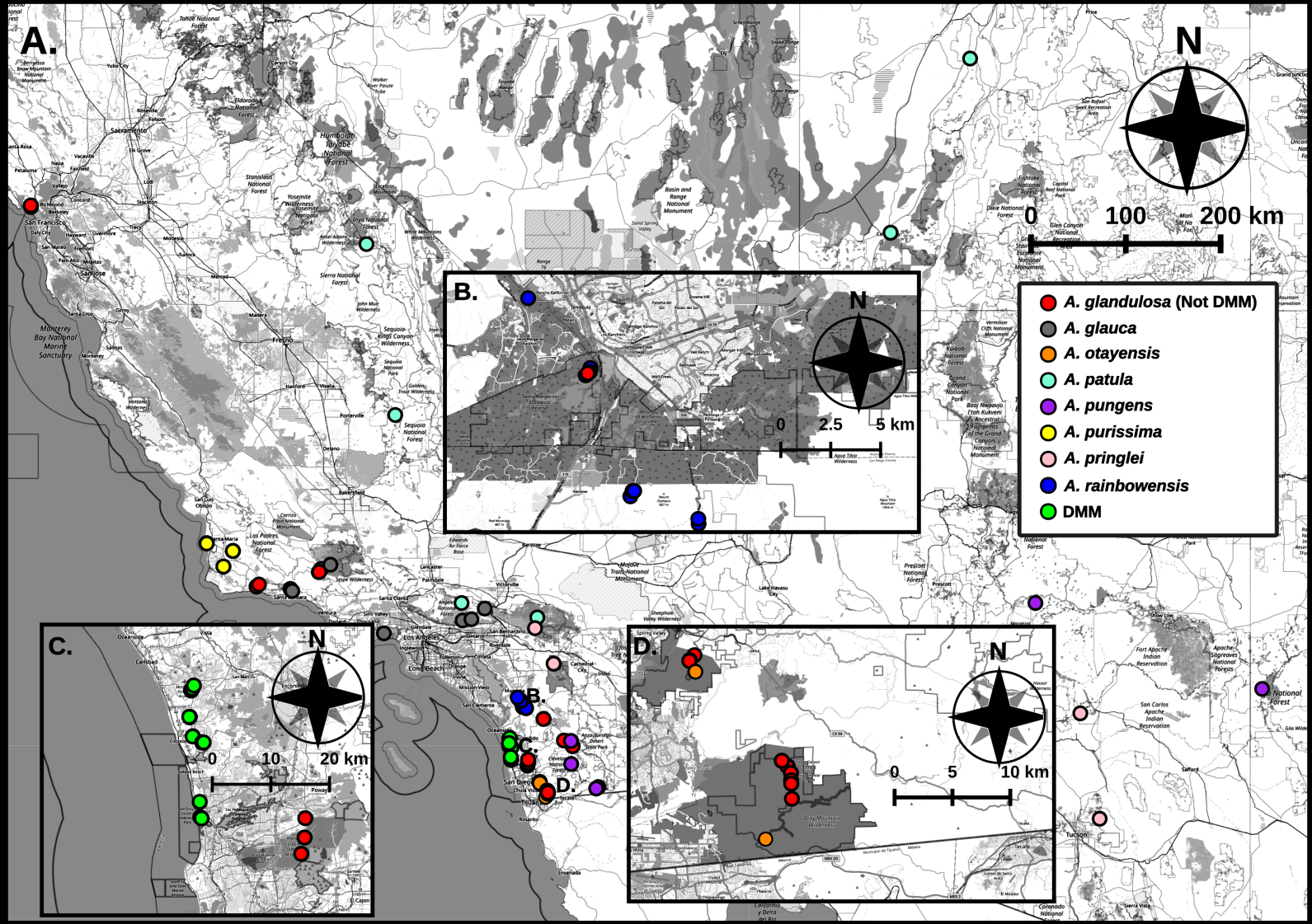


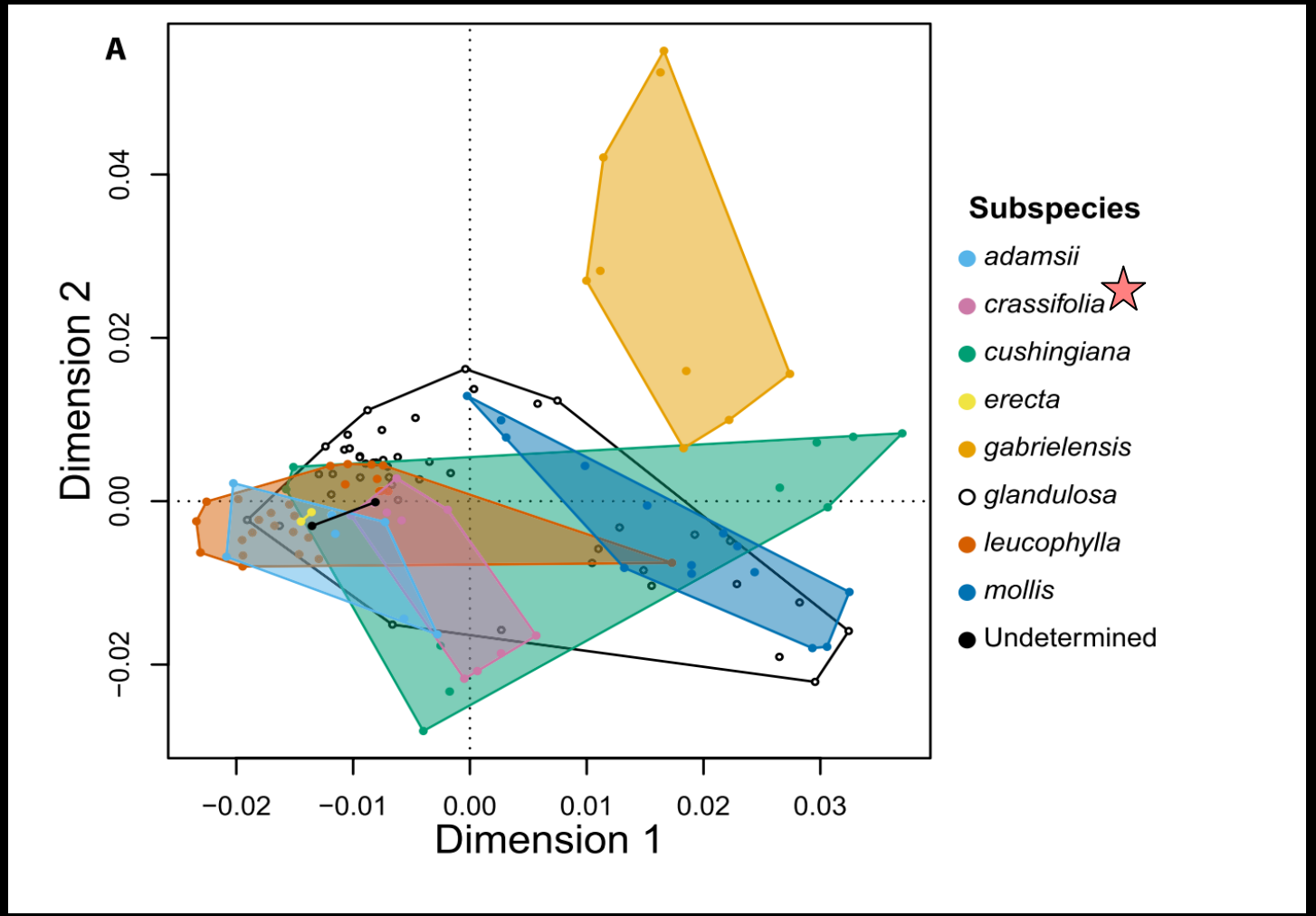
mic



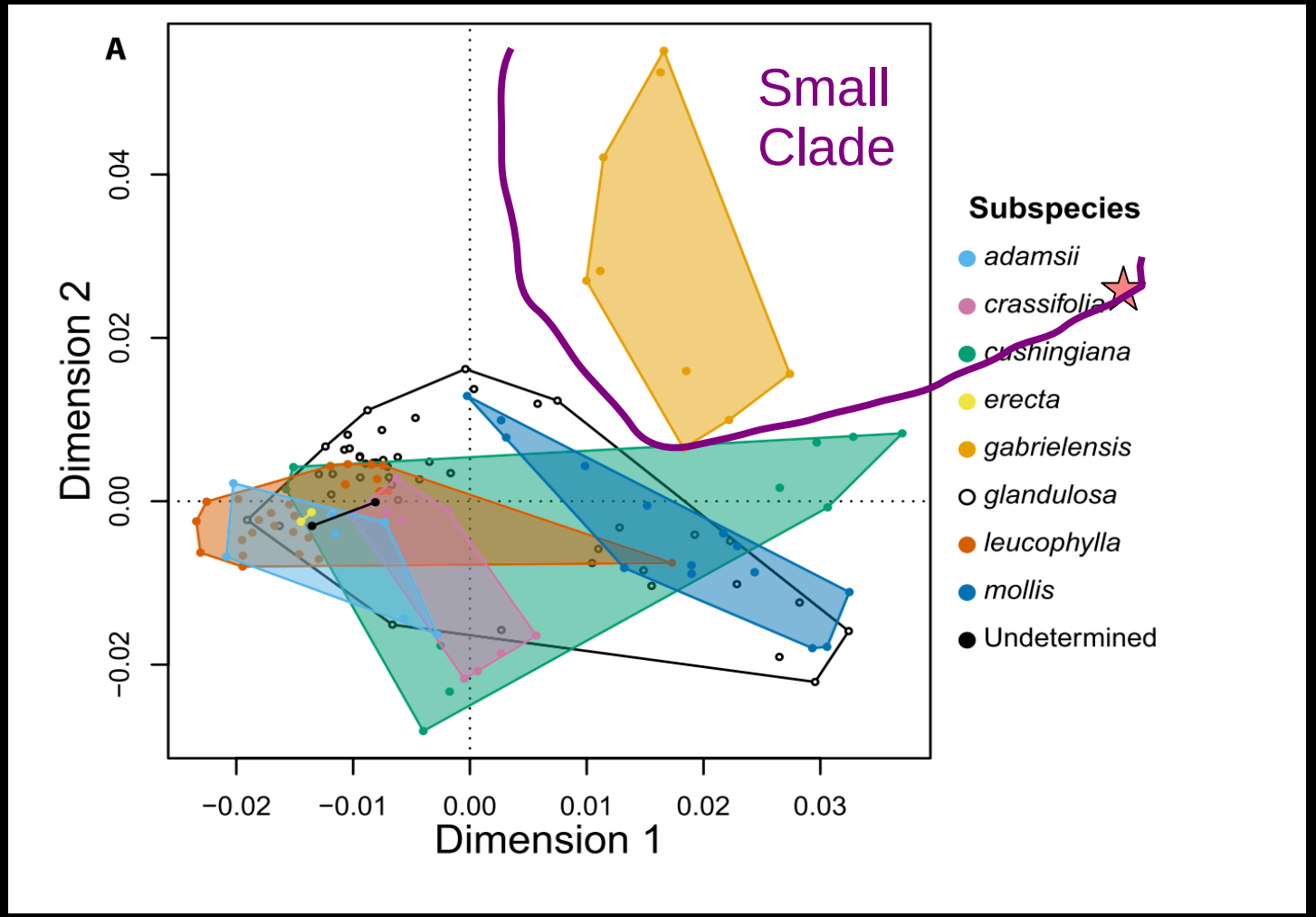


emic

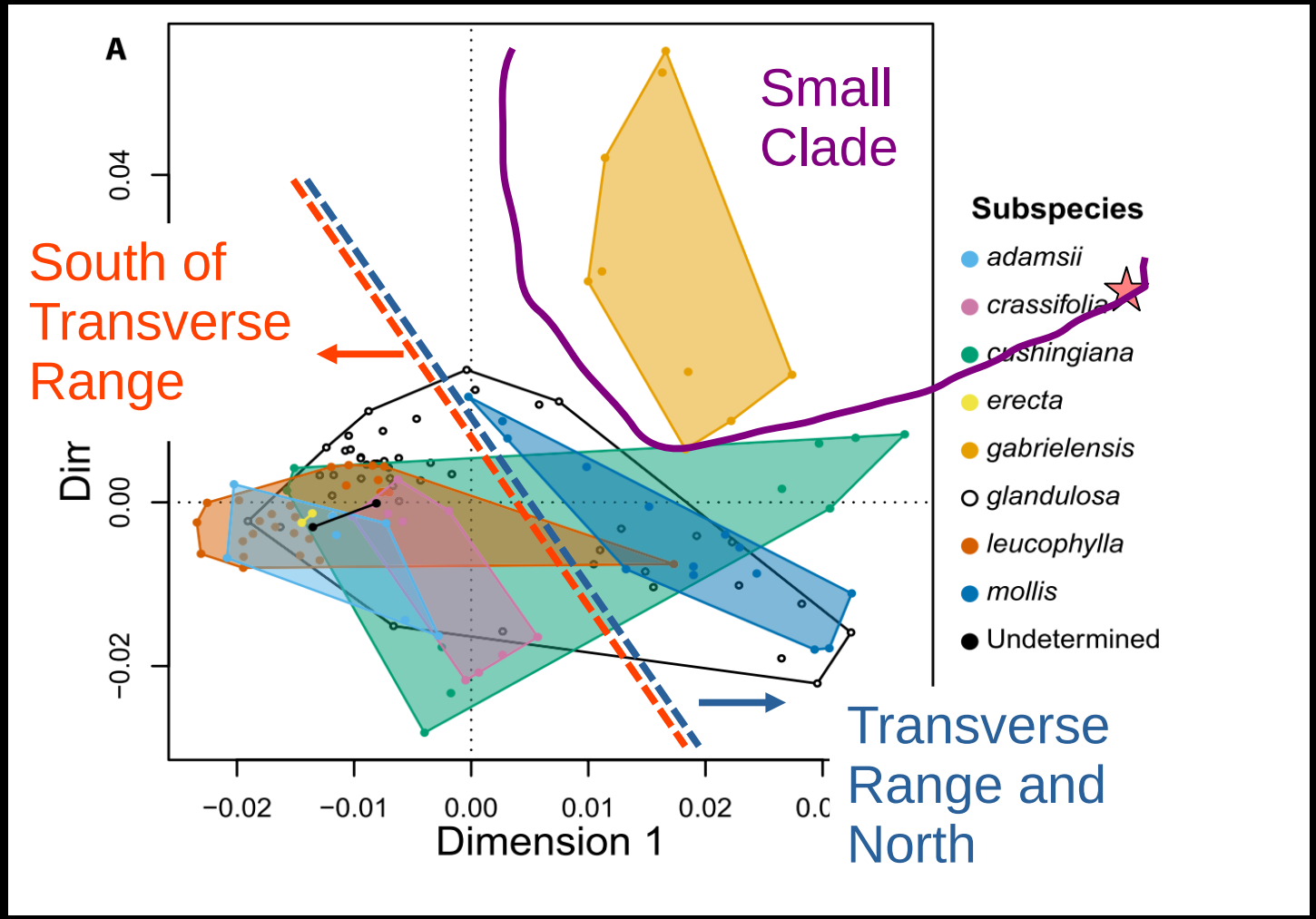

A.
B.
C.
D.
N
0
100
200 km
0
2.5
5 km
0
10
20 km
0
5
10 km
A. glandulosa (Not DMM)
A. glauca
A. otayensis
A. patula
A. pungens
A. purissima
A. pringlei
A. rainbowensis
DMM



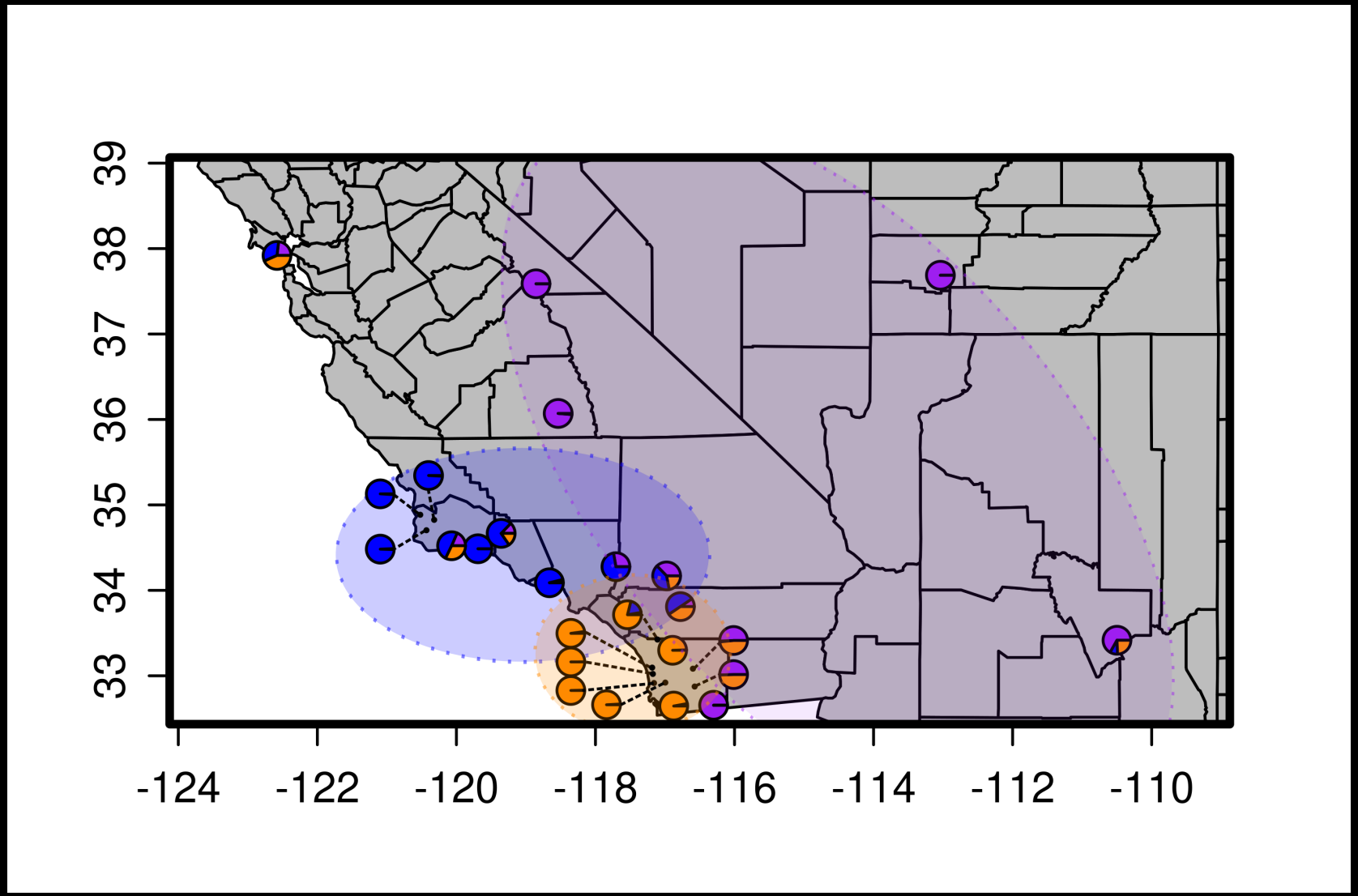
Huang *et al.* (2020); AJB.

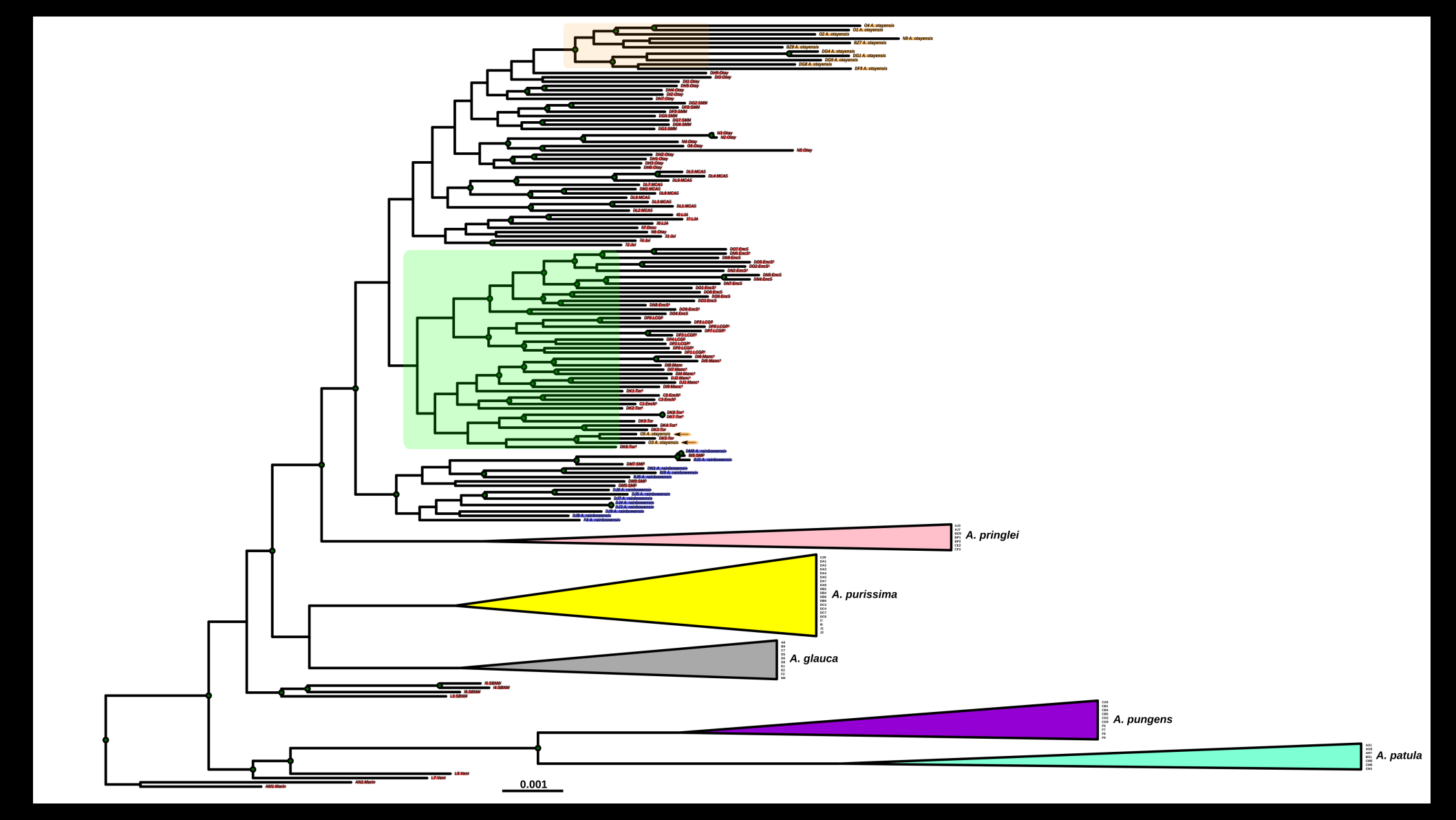


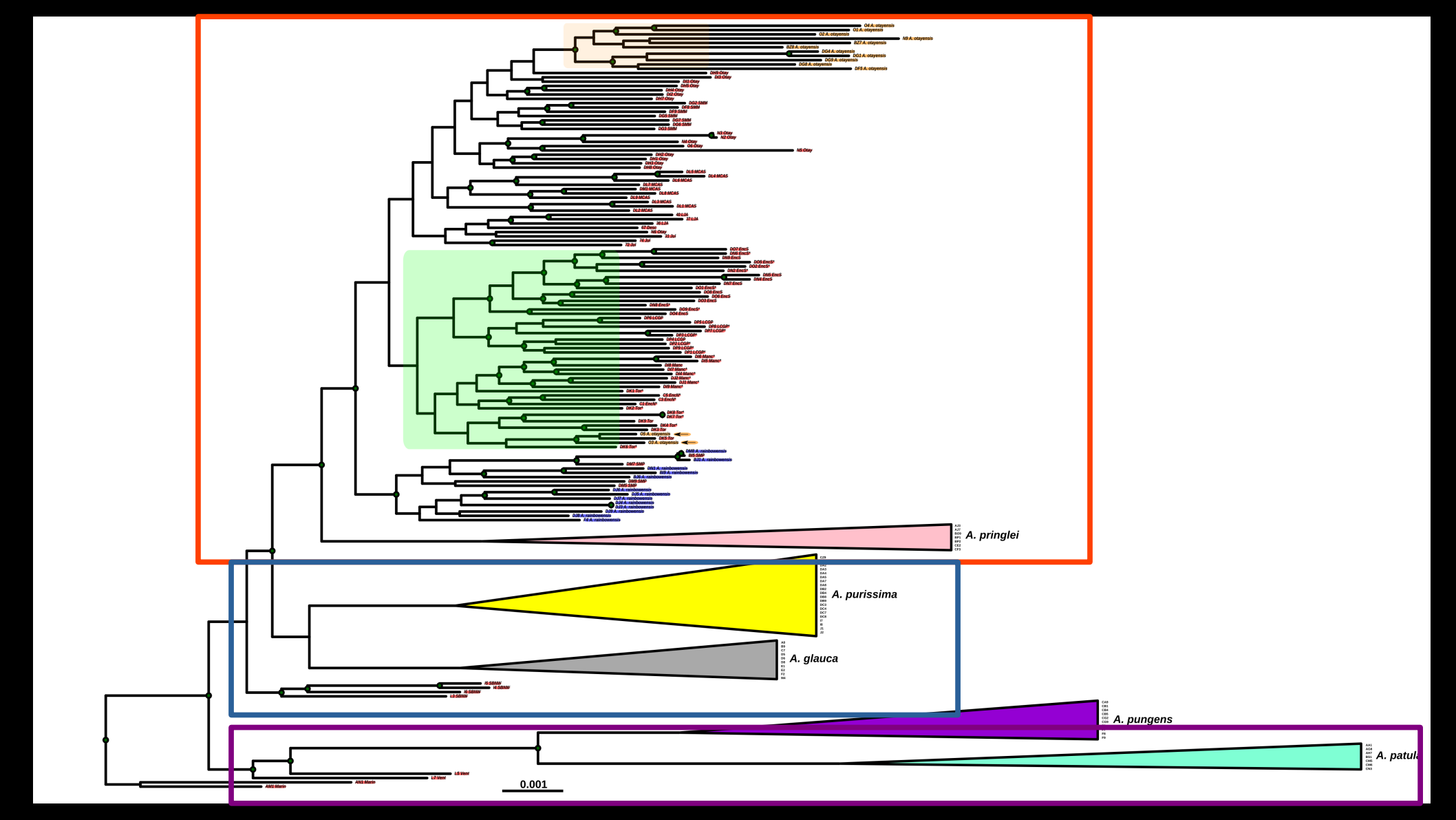
Huang *et al.* (2020); AJB.

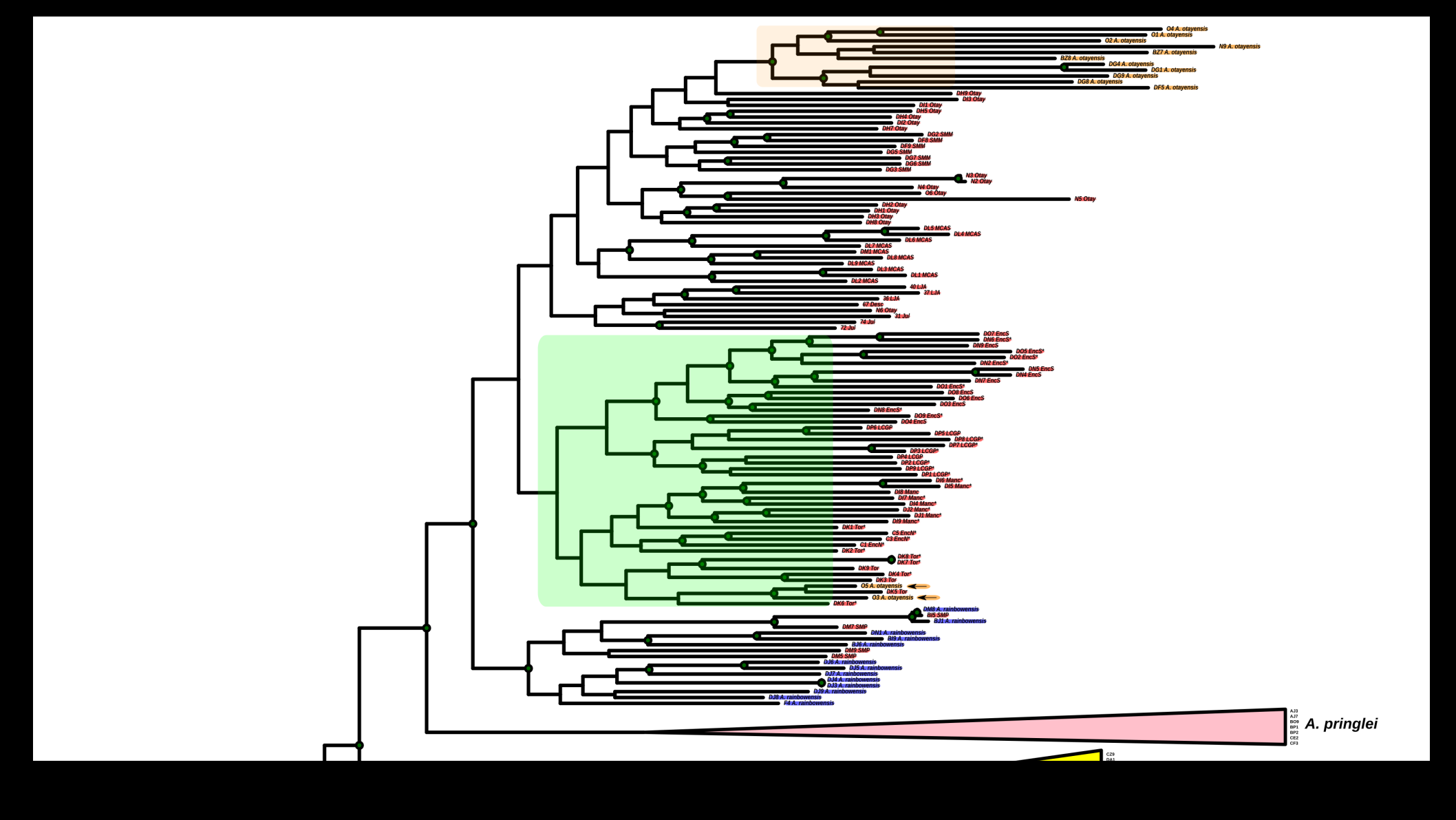


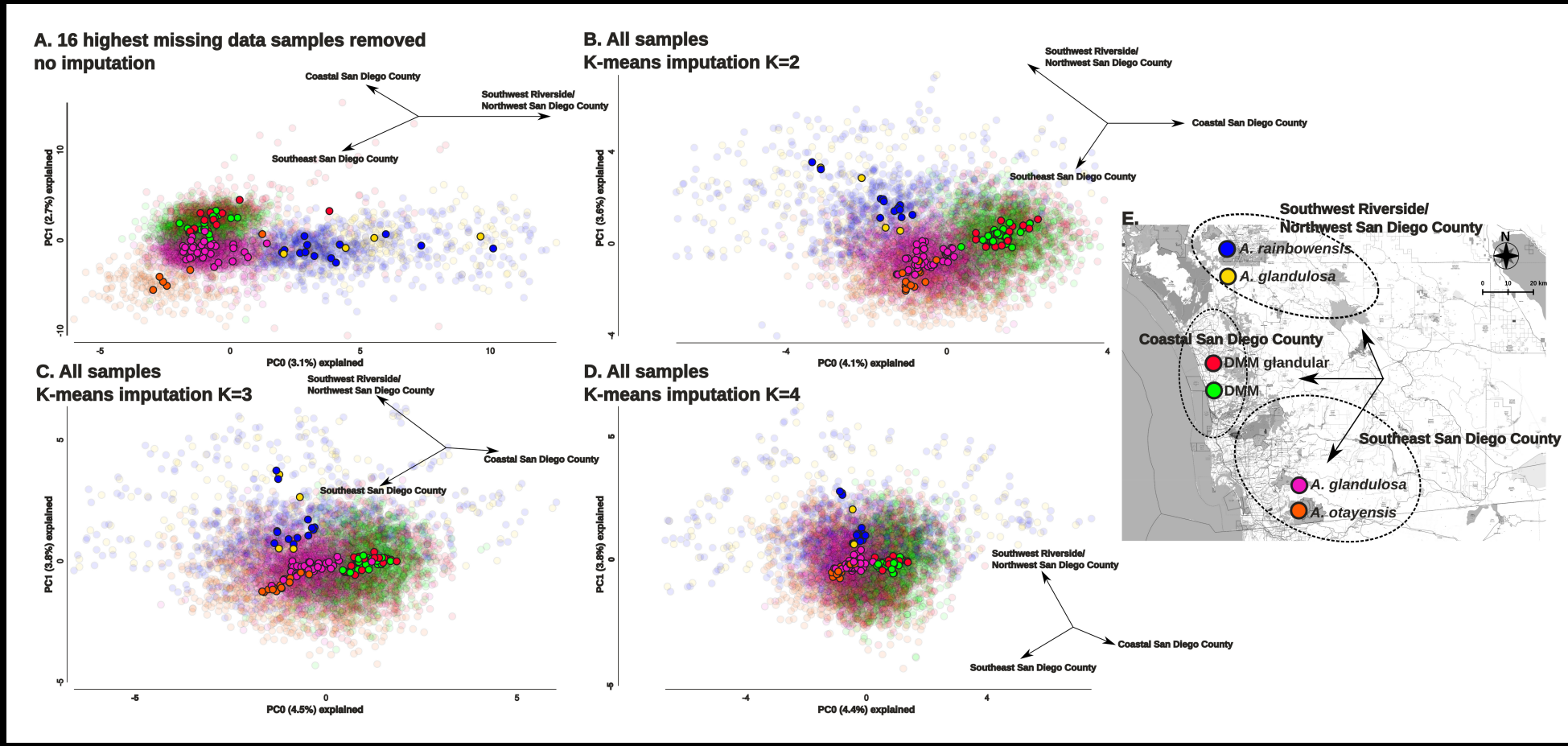
Huang *et al.* (2020); AJB.

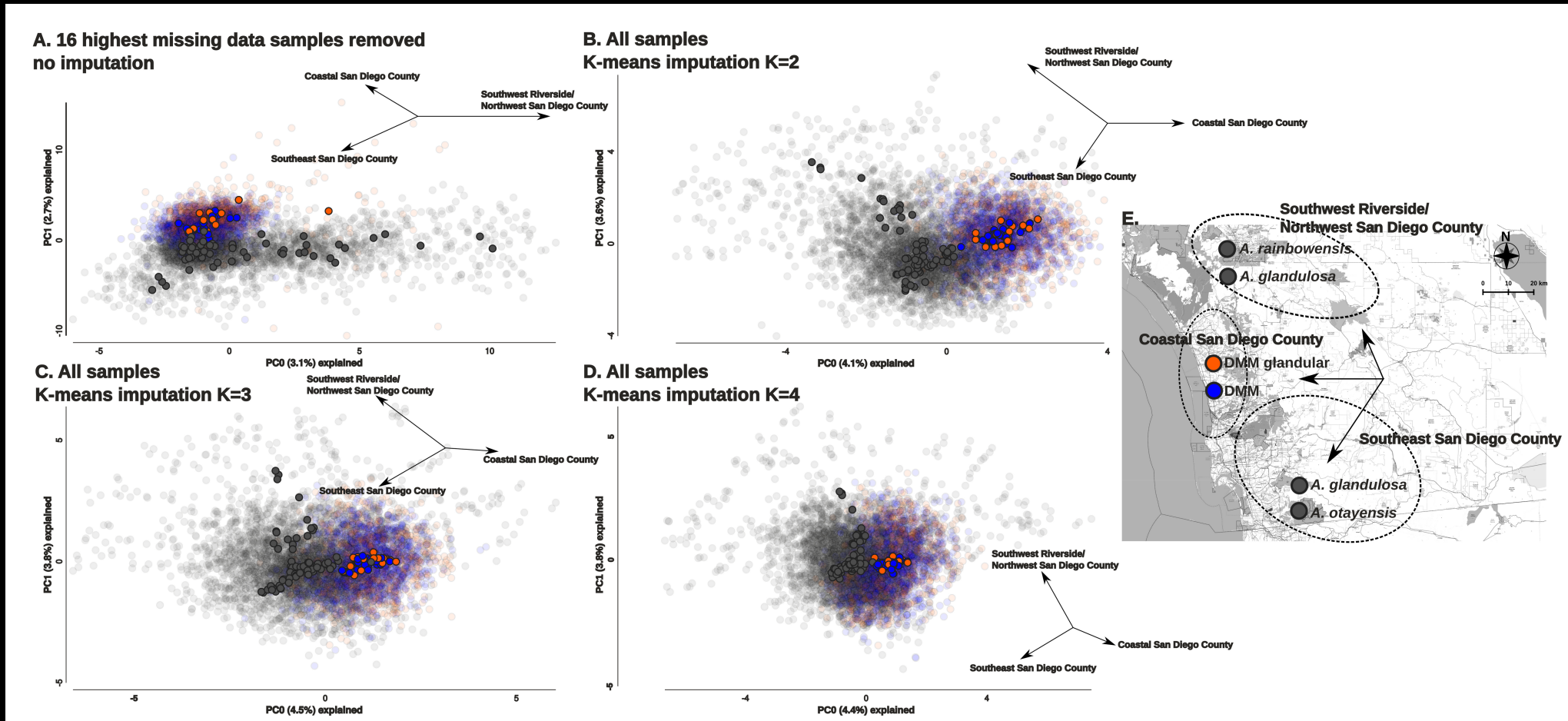

39
38
37
36
35
34
33
-124
-122
-120
-118
-116
-114
-112
-110


A. pringlei
A. purissima
A. glauca
A. pungens
A. patula
0.001

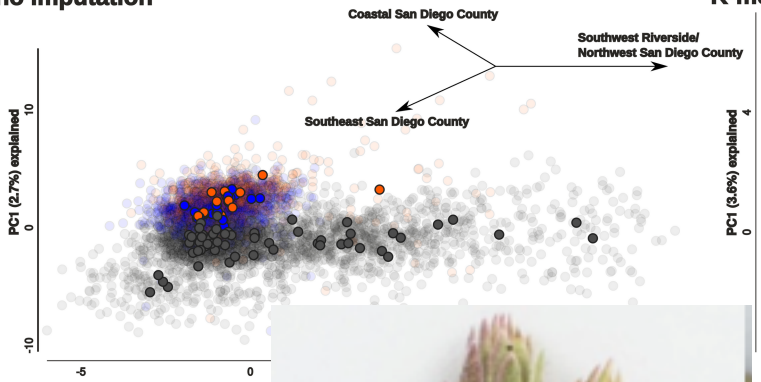

A. pringlei
A. purissima
A. glauca
A. pungens
A. patula
0.001


O4 A. otayensis
O1 A. otayensis
O2 A. otayensis
N9 A. otayensis
BZ7 A. otayensis
BZ8 A. otayensis
DG4 A. otayensis
DG1 A. otayensis
DG9 A. otayensis
DG8 A. otayensis
DF5 A. otayensis
DH9 Otay
DI3 Otay
DI1 Otay
DH5 Otay
DH4 Otay
DI2 Otay
DH7 Otay
DG2 SMM
DF8 SMM
DF9 SMM
DG5 SMM
DG7 SMM
DG6 SMM
DG3 SMM
N3 Otay
N2 Otay
N4 Otay
O6 Otay
N5 Otay
DH2 Otay
DH1 Otay
DH3 Otay
DH8 Otay
DL5 MCAS
DL4 MCAS
DL6 MCAS
DL7 MCAS
DM1 MCAS
DL8 MCAS
DL9 MCAS
DL3 MCAS
DL1 MCAS
DL2 MCAS
40 LJA
37 LJA
36 LJA
67 Dese
N6 Otay
21 Jul
74 Jul
72 Jul
DO7 EncS
DN6 EncS*
DN9 EncS
DO5 EncS*
DO2 EncS*
DN2 EncS*
DN5 EncS
DN4 EncS
DN7 EncS
DO1 EncS*
DO6 EncS
DO6 EncS
DO3 EncS
DN8 EncS*
DO9 EncS*
DO4 EncS
DP6 LCGP
DP5 LCGP
DP8 LCGP*
DP7 LCGP*
DP3 LCGP*
DP4 LCGP
DP2 LCGP*
DP9 LCGP*
DP1 LCGP*
DI6 Manc*
DI5 Manc*
DI8 Manc
DI7 Manc*
DI4 Manc*
DJ2 Manc*
DJ1 Manc*
DI9 Manc*
DK1 Tor*
C5 EncN*
C3 EncN*
C1 EncN*
DK2 Tor*
DK8 Tor*
DK7 Tor*
DK9 Tor
DK4 Tor*
DK3 Tor
O5 A. otayensis
DK5 Tor
O3 A. otayensis
DK6 Tor*
DM8 A. rainbowensis
BI8 SMP
BJ11 A. rainbowensis
DM7 SMP
DN1 A. rainbowensis
BI9 A. rainbowensis
BJ6 A. rainbowensis
DM9 SMP
DM5 SMP
BJ10 A. rainbowensis
BJ5 A. rainbowensis
BJ7 A. rainbowensis
BJ4 A. rainbowensis
BJ3 A. rainbowensis
BJ8 A. rainbowensis
BJ2 A. rainbowensis
F4 A. rainbowensis
AJ3
AJ7
BO9
BP1
BP2
CE2
CF3
A. pringlei
CZ9
DA1

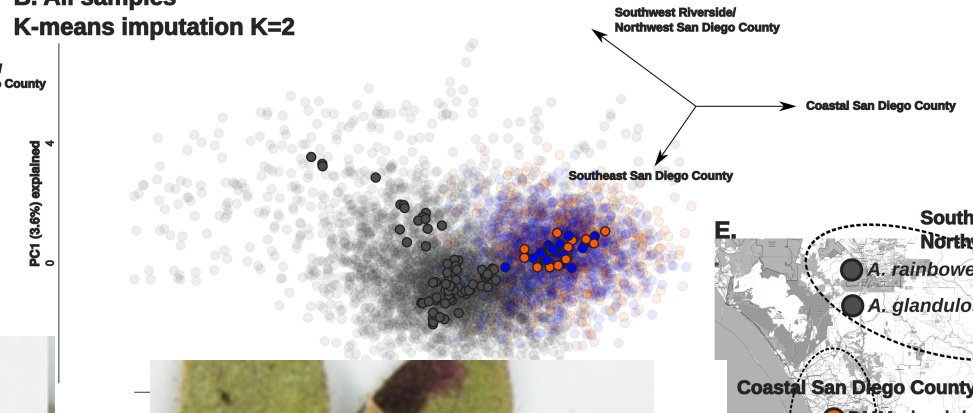

A. 16 highest missing data samples removed
no imputation
Coastal San Diego County
Southwest Riverside/
Northwest San Diego County
Southeast San Diego County
PC1 (2.7%) explained
PC0 (3.1%) explained
B. All samples
K-means imputation K=2
Southwest Riverside/
Northwest San Diego County
Coastal San Diego County
Southeast San Diego County
PC1 (3.6%) explained
PC0 (4.1%) explained
C. All samples
K-means imputation K=3
Southwest Riverside/
Northwest San Diego County
Coastal San Diego County
Southeast San Diego County
PC1 (3.8%) explained
PC0 (4.5%) explained
D. All samples
K-means imputation K=4
Southwest Riverside/
Northwest San Diego County
Coastal San Diego County
Southeast San Diego County
PC1 (3.8%) explained
PC0 (4.4%) explained
E.
Southwest Riverside/
Northwest San Diego County
A. rainbowensis
A. glandulosa
Coastal San Diego County
DMM glandular
DMM
Southeast San Diego County
A. glandulosa
A. otayensis
N
0 10 20 km


A. 16 highest missing data samples removed
no imputation
Coastal San Diego County
Southwest Riverside/
Northwest San Diego County
Southeast San Diego County
PC1 (2.7%) explained
PC0 (3.1%) explained
B. All samples
K-means imputation K=2
Southwest Riverside/
Northwest San Diego County
Coastal San Diego County
Southeast San Diego County
PC1 (3.6%) explained
PC0 (4.1%) explained
C. All samples
K-means imputation K=3
Southwest Riverside/
Northwest San Diego County
Coastal San Diego County
Southeast San Diego County
PC1 (3.8%) explained
PC0 (4.5%) explained
D. All samples
K-means imputation K=4
Southwest Riverside/
Northwest San Diego County
Coastal San Diego County
Southeast San Diego County
PC1 (3.8%) explained
PC0 (4.4%) explained
E.
Southwest Riverside/
Northwest San Diego County
A. rainbowensis
A. glandulosa
Coastal San Diego County
DMM glandular
DMM
Southeast San Diego County
A. glandulosa
A. otayensis
N
0
10
20 km

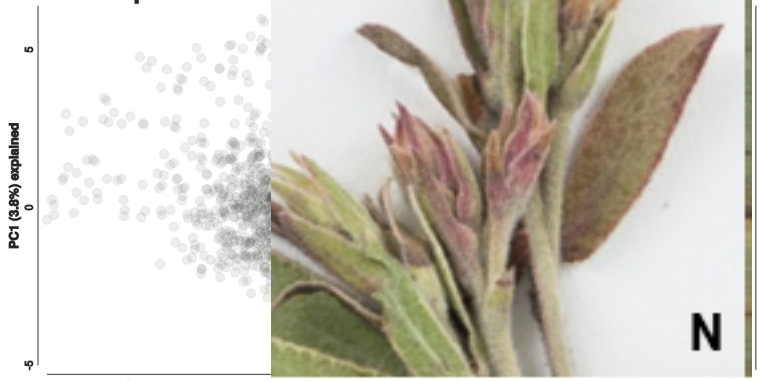
A. 16 highest missing data samples removed
no imputation



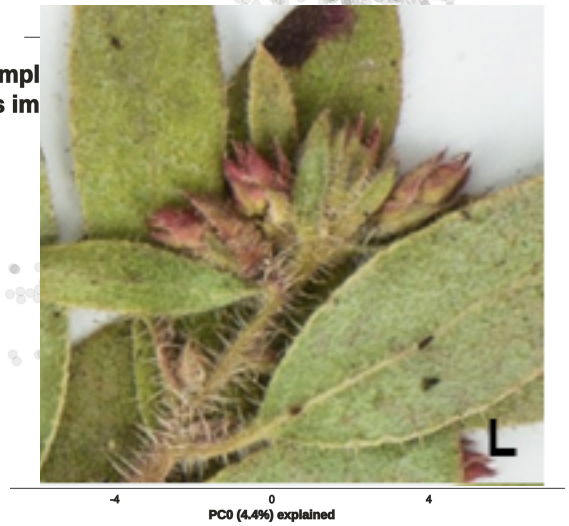
B. All samples
K-means imputation K=2



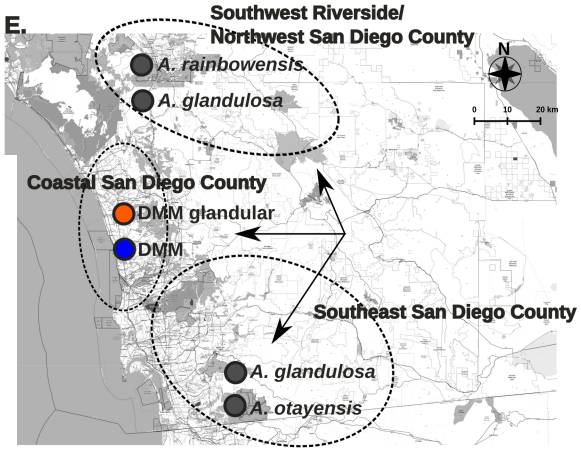
C. All samples
K-means imputation K=3



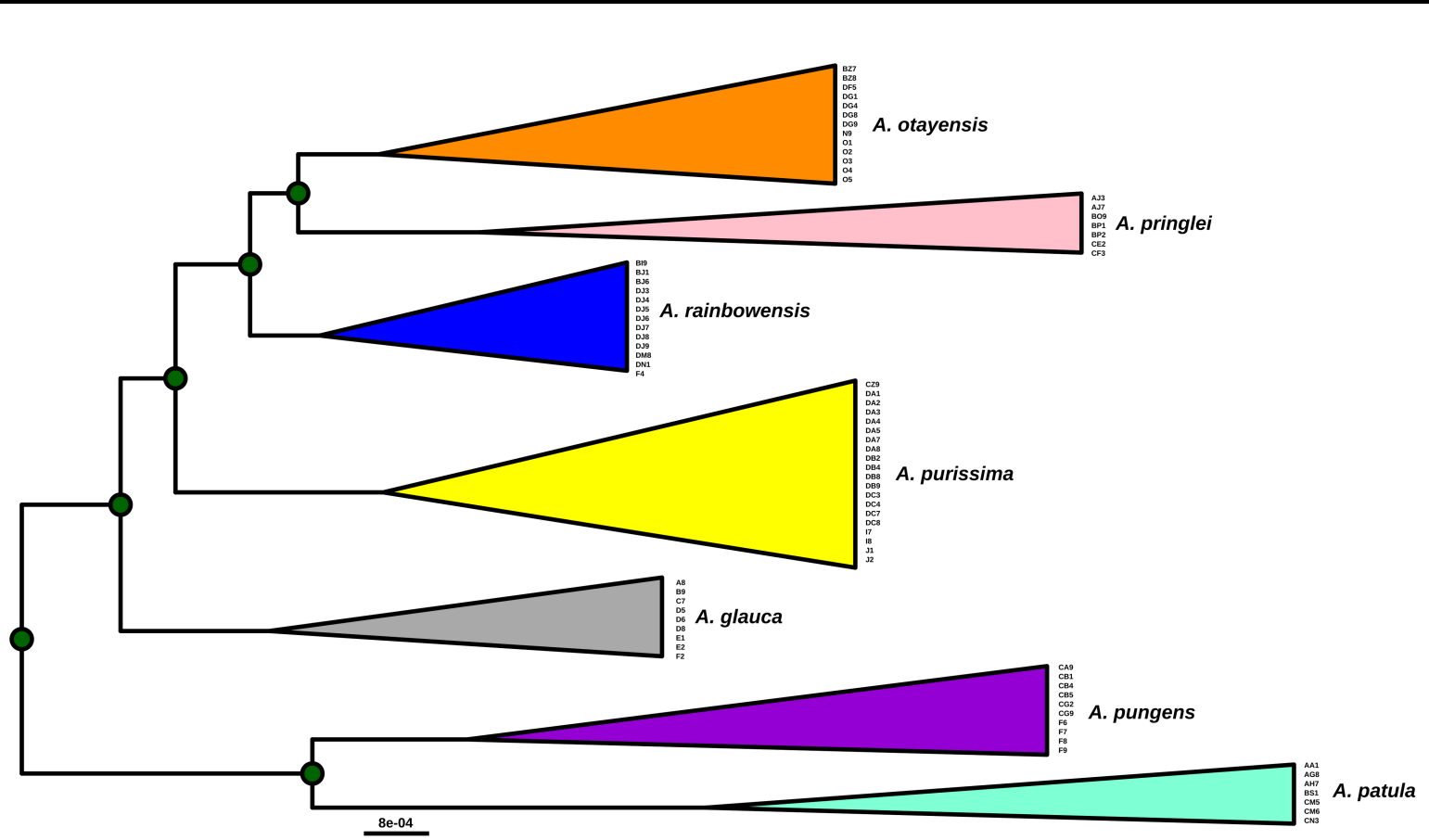
All samples
K-means imputation K=2

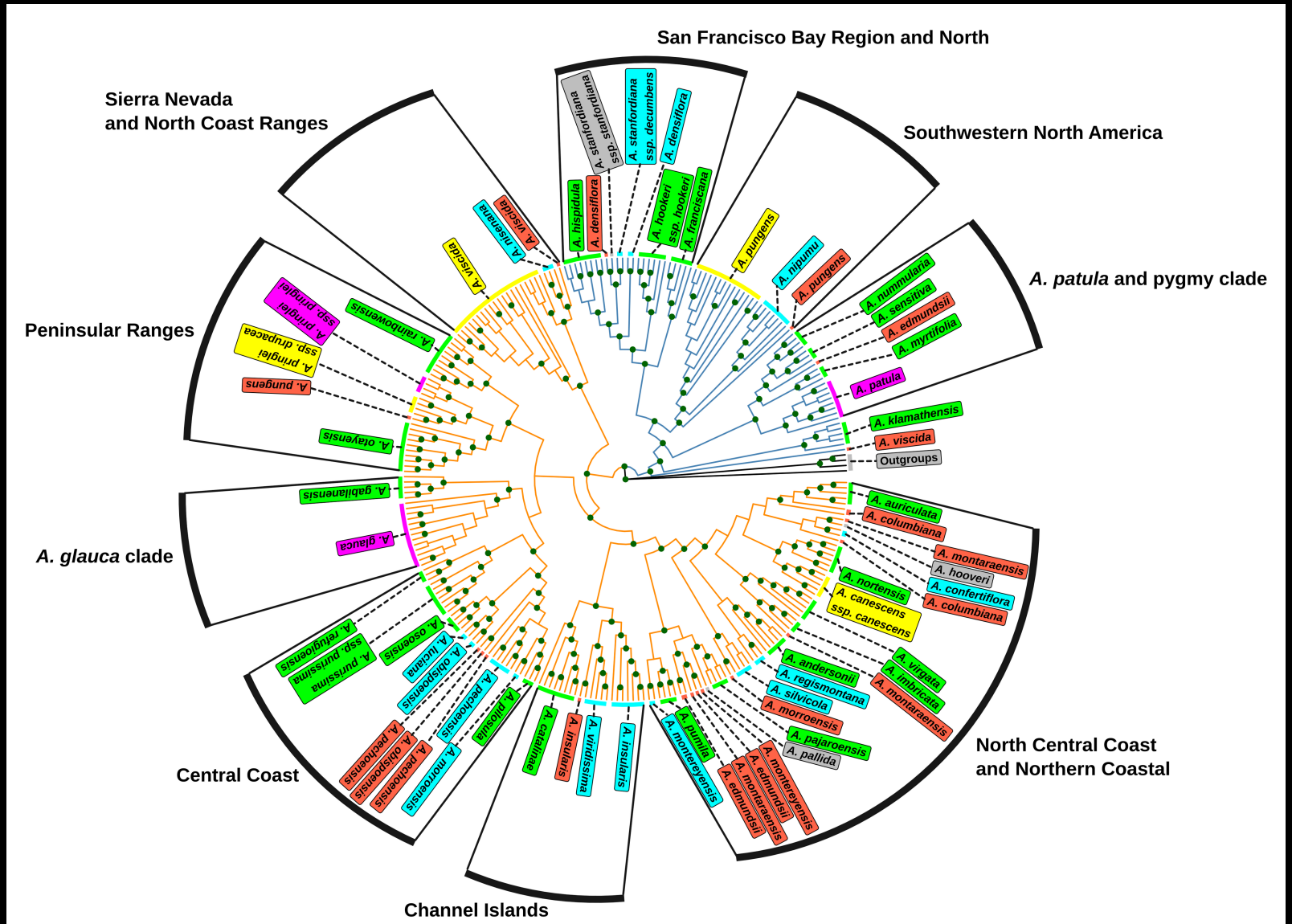


E.

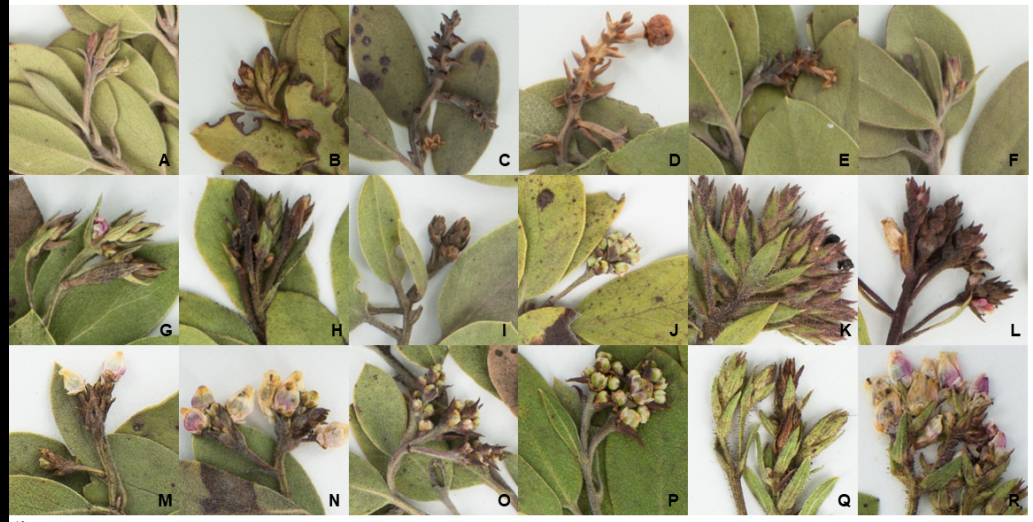


astal San Diego County


BZ7
BZ8
DF5
DG1
DG4
DG8
DG9
N9
O1
O2
O3
O4
O5
A. otayensis
AJ3
AJ7
BO9
BP1
BP2
CE2
CF3
A. pringlei
BI9
BJ1
BJ6
DJ3
DJ4
DJ5
DJ6
DJ7
DJ8
DJ9
DM8
DN1
F4
A. rainbowensis
CZ9
DA1
DA2
DA3
DA4
DA5
DA7
DA8
DB2
DB4
DB8
DB9
DC3
DC4
DC7
DC8
I7
I8
J1
J2
A. purissima
A8
B9
C7
D5
D6
D8
E1
E2
F2
A. glauca
CA9
CB1
CB4
CB5
CG2
CG9
F6
F7
F8
F9
A. pungens
AA1
AG8
AH7
BS1
CM5
CM6
CN3
A. patula
8e-04

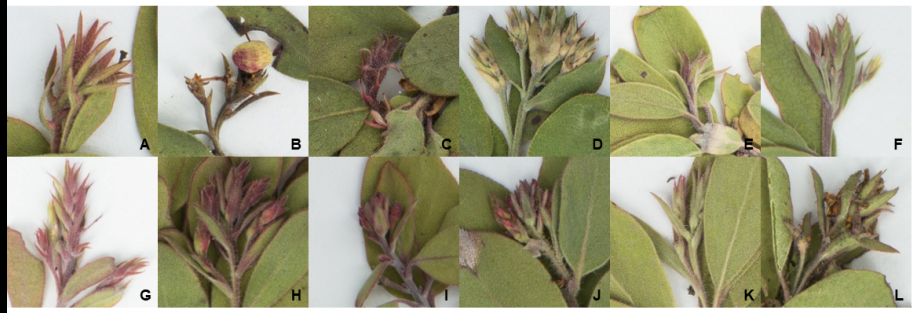

San Francisco Bay Region and North
Sierra Nevada
and North Coast Ranges
Southwestern North America
A. patula and pygmy clade
Peninsular Ranges
A. glauca clade
Central Coast
North Central Coast
and Northern Coastal
Channel Islands
A. stanfordiana ssp. stanfordiana
A. stanfordiana ssp. decumbens
A. densiflora
A. hispidula
A. densiflora
A. hookeri ssp. hookeri
A. franciscana
A. nilesiana
A. viscida
A. viscida
A. pungens
A. nipumu
A. pungens
A. nummularia
A. sensitiva
A. edmundsii
A. myrtifolia
A. patula
A. klamathensis
A. viscida
Outgroups
A. tamboensis
A. pringlei ssp. pringlei
A. pringlei ssp. drupacea
A. pungens
A. olayensis
A. gabilanensis
A. glauca
A. auriculata
A. columbiana
A. montaraensis
A. hooveri
A. confertiflora
A. columbiana
A. nortensis
A. canescens ssp. canescens
A. andersonii
A. regismontana
A. silvicola
A. morroensis
A. pajaroensis
A. pallida
A. virgata
A. imbricata
A. montaraensis
A. pumila
A. montereyensis
A. edmundsii
A. montaraensis
A. edmundsii
A. montereyensis
A. insulans
A. crebrinae
A. insulans
A. virgata
A. pulcella
A. morroensis
A. pechoensis
A. obispoensis
A. pechoensis
A. obispoensis
A. lucianа
A. osoensis
A. pumissima ssp. pumissima
A. refugioensis

Supplemental Figure 8. Page 3: Otay & San Miguel Mountains



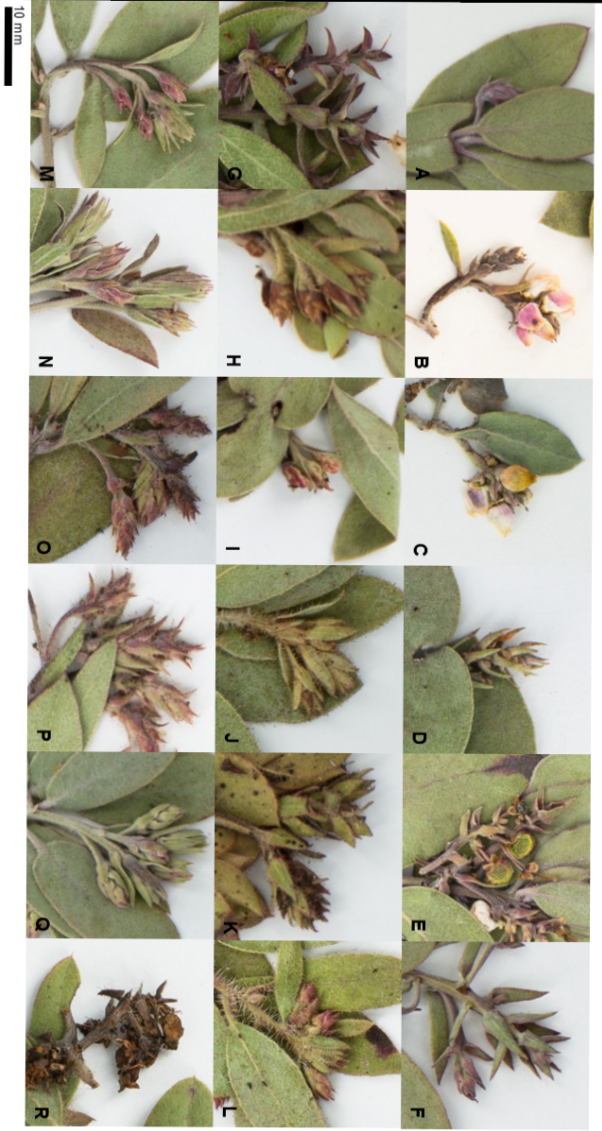
A= N6, B= O6, C= N5, D= N4, E= N3, F= N2, G= DF9, H= DG5, I= DH1, J= DH7, K= DI3, L= DI1, M= DH8, N= DH8, O= DH3, P= DH3, Q= DG2, R= DG2.

Supplemental Figure 8. Page 2: MCAS Miramar

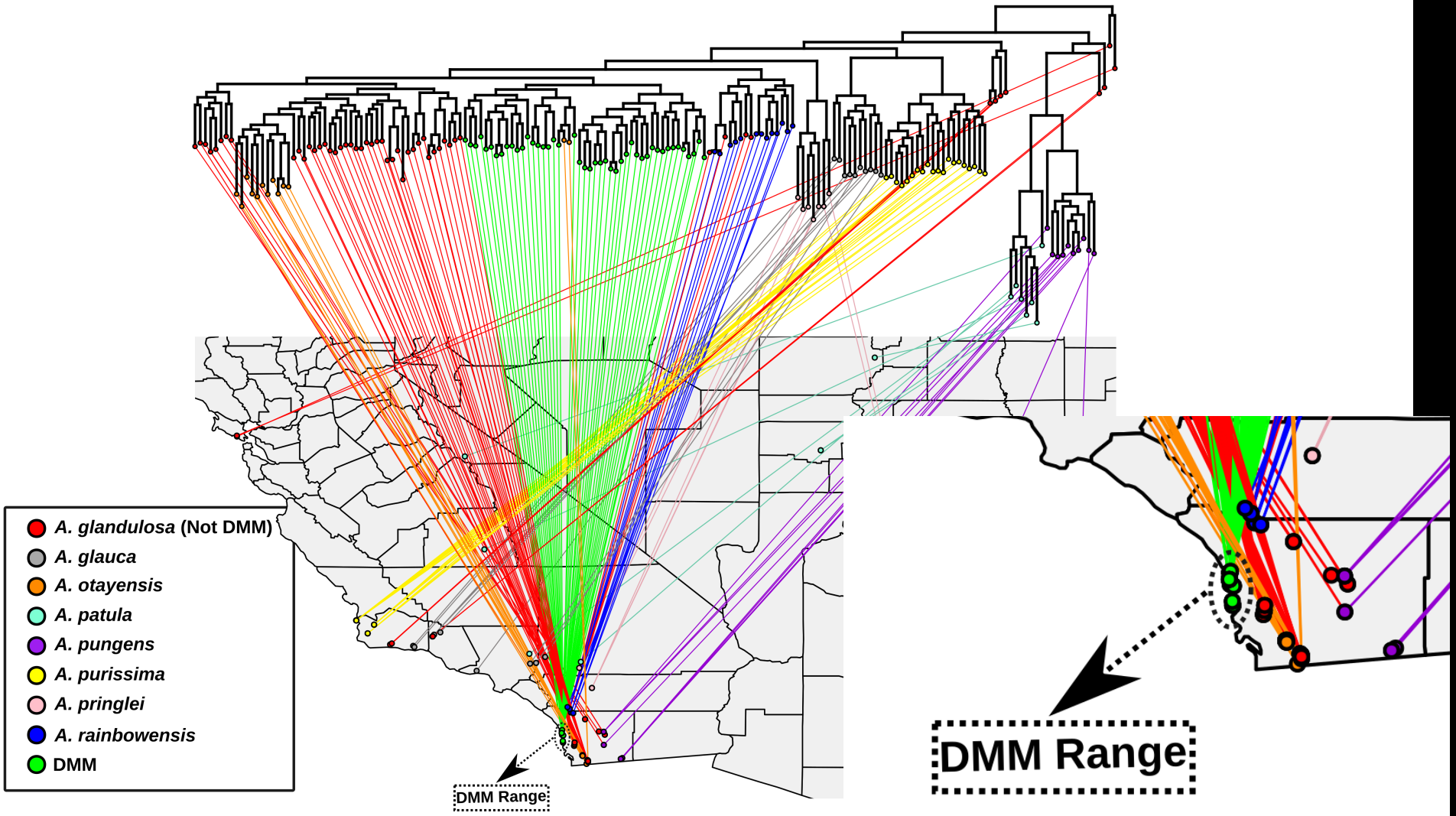


A= DL7, B= DM1, C= DM1, D= DL1, E= DL2, F= DL3, G=DL3, H= DL6, I= DL4, J= DL5, K= DL9, L= DL8.

Supplemental Figure 8. Page 1: Coastal



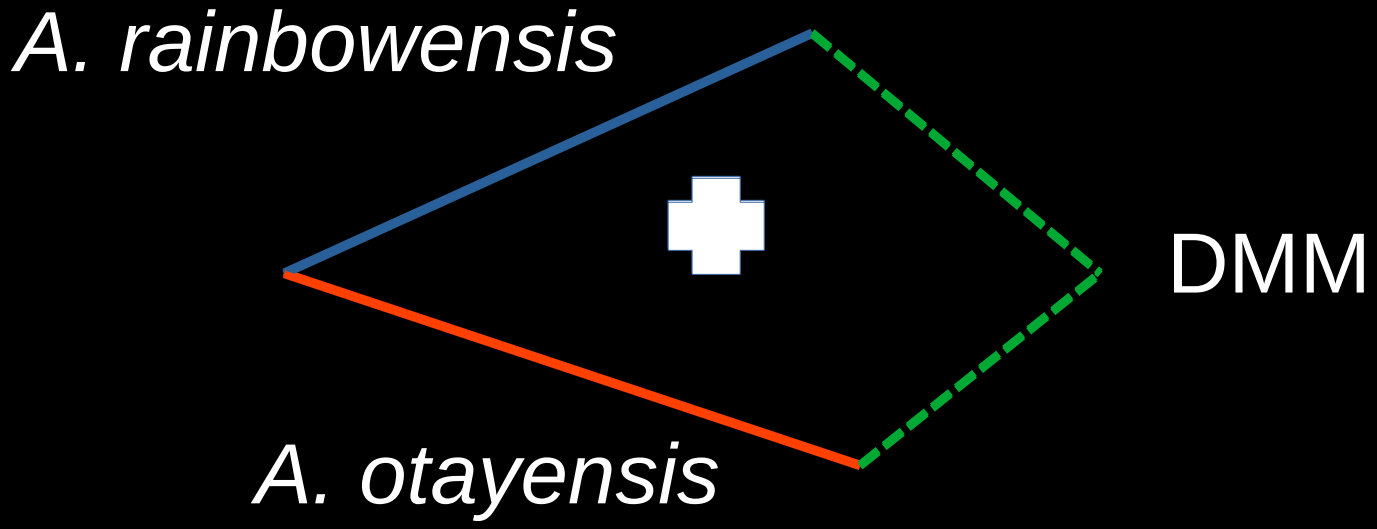
A= C3, B= DI7, C= DJ1, D= DK1, E= DK2, F= DK4, G= DK8, H= DN5, I= DN6, J= DO1, K= DO6, L= DO8, M= DP2, N= DP3, O=DP3, P= DP4, Q= DP9, R= DK7.


A. glandulosa (Not DMM)
A. glauca
A. otayensis
A. patula
A. pungens
A. purissima
A. pringlei
A. rainbowensis
DMM
DMM Range
DMM Range





Hypothesis



Acknowledgments









ithank you
esc^yy100000000000000000000000000000p

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