



Tumbleweed Species and Invasion: Old, New, and Nascent

Debra Ayres, Fred Ryan, and Virginia Meyer

Russian thistle Tumbleweed

Salsola tragus

- Noxious large summer annual
- Impede traffic
 - \$1.2 million/yr on roadside control in CA
- Highly flammable – tumbling spreads fires
- <https://blogs.cdfa.ca.gov/Section3162/?p=1751>



History

- *Salsola tragus* (Russianthistle) was introduced into South Dakota around 1874 in flax seed from Russia – the ONLY Tweed 25 years ago!
 - Moved 1,500 miles in 20 years to California
 - Comparisons of morphology and nuclear genetic patterns determined that *S. tragus* commonly occurred in Eurasia
- This talk will focus on the 3 species invading the San Joaquin and Central Valleys and beyond.

Second Species Discovered

- Fred Ryan and I discovered a second species – we called “**Type B**” – in the mid-**1990s** in the Central Valley, SoCal and Arizona.
- It differed in isoenzymes, nuclear DNA fragments (RAPDs), and chromosome number from *S. tragus*:
 - *S. tragus*: $2n = 36$; **Type B**: $2n = 18$
 - Ryan et al. 1999. Proceedings of Cal EPPC, Vol. 5, pages 11-18.
 - Ryan and Ayres, 2000. Can. J. Bot

Second Species ID

- The native source of **Type B** was NOT found in Eurasia.
- In 2008 DNA fragment patterns of **Type B** were matched to samples of *S. australis* from Australia where it is considered a native species.
- Over 400 herbarium specimens in California were reclassified from *S. tragus* to *S. australis*.

Calyx characteristics of the fruit

- Five sepals appear in fruit – no petals
- *S. tragus* *S. australis*
- 2 reduced sepals Sepals all same size



Plant Morphology

Variety of forms *S. tragus*



Uniform morphology *S. australis*

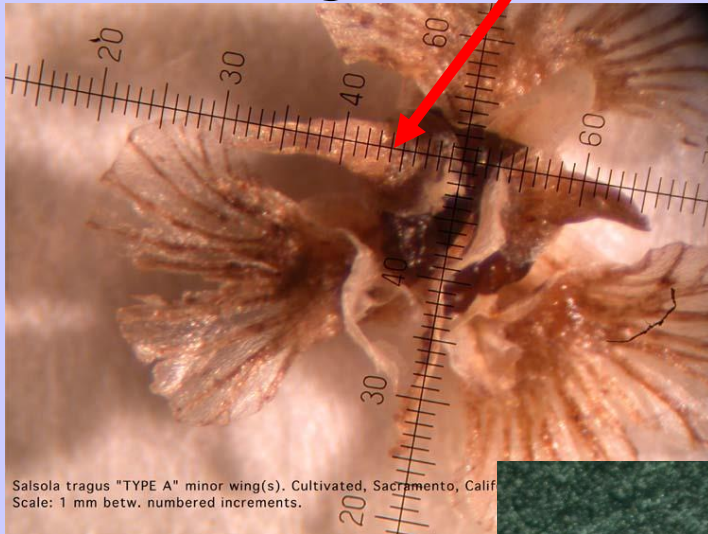
New *Salsola*

- In 1999, Fred Ryan discovered a distinct taxon around the town of Coalinga which we called “Type C”. It was eventually named *S. ryanii*.

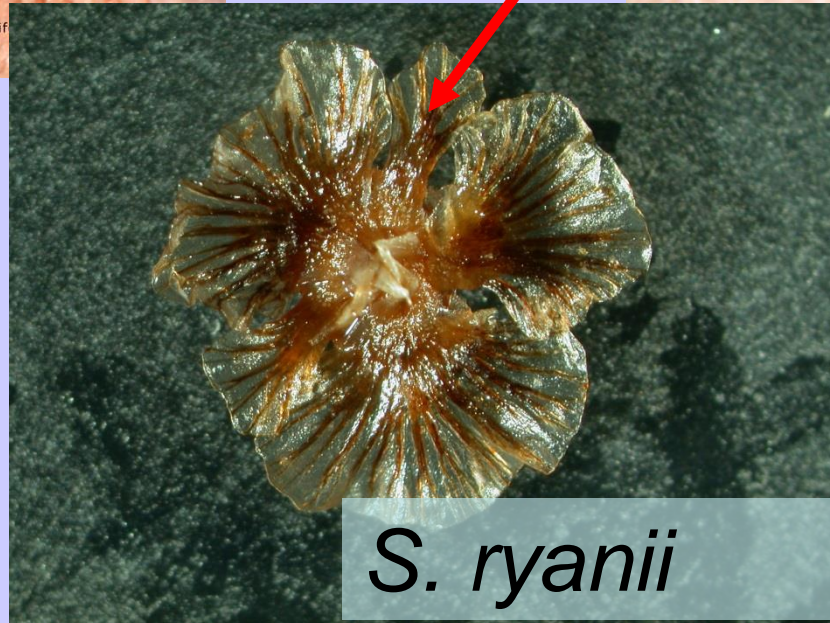


Calyx characteristics

- *S. tragus*



- *S. australis*



Microsatellites and ISSR/RAPD

- Each taxon had a distinctive pattern.
- *S. tragus* and *S. australis* contained species-specific alleles that we used to examine affiliations in *S. ryanii*.
- *S. ryanii* contained an additive pattern of *S. tragus* and *S. australis* alleles suggesting a F1-type hybrid between the two species.

2N Chromosome Counts

- *S. tragus* = 36
- *S. australis* = 18
- *S. ryanii* = 54 = 18 + 36
- We concluded that *S. ryanii* is a new allopolyploid hybrid species between *S. tragus* x *S. australis*
- Ayres DR, Ryan FJ, Grotkopp E, Bailey J, Gaskin J. 2009. *Biological Invasions* (2009) 11:1175–1185.

Biological Control of Weeds in Rangelands in Northern California-Research at USDA-ARS



Patrick J. Moran¹

Lincoln Smith¹, Paul D. Pratt¹, and Christopher Borkent²

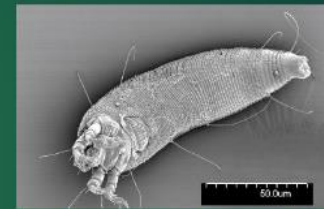
Cal-IPC Symposium 2023

Russian thistle (*Salsola tragus*, *S. kali*, *S. paulsenii*, *S. australis*) (Chenopodiaceae)



Widespread invader in rangelands, along roadsides

New agents-in quarantine



Stem tip-feeding mite-*Aceria salsolae*

Old agents-both limited by parasitism



Coleophora klimeschiella



Coleophora parthenica



Shoot-boring moth-*Gymnancyla canella*

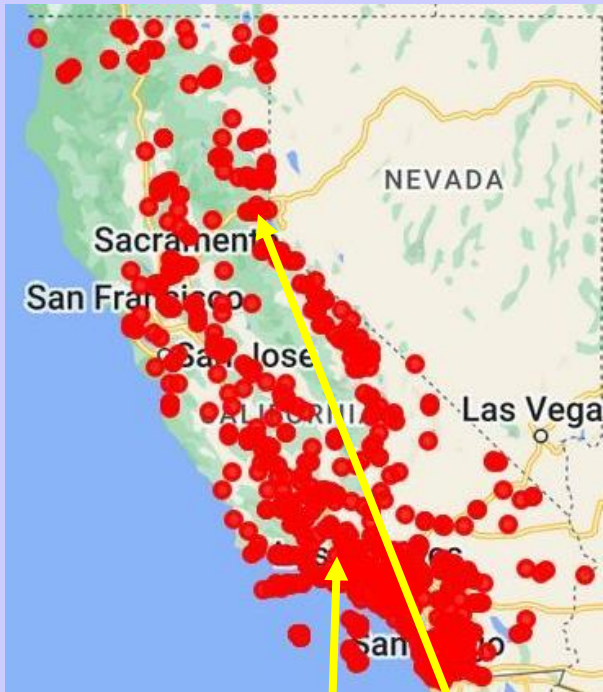


2000+ Specimens of *Salsola* “*tragus*” prior to 2007 - all *S. australis* were named *S. tragus* Consortium of California Herbaria

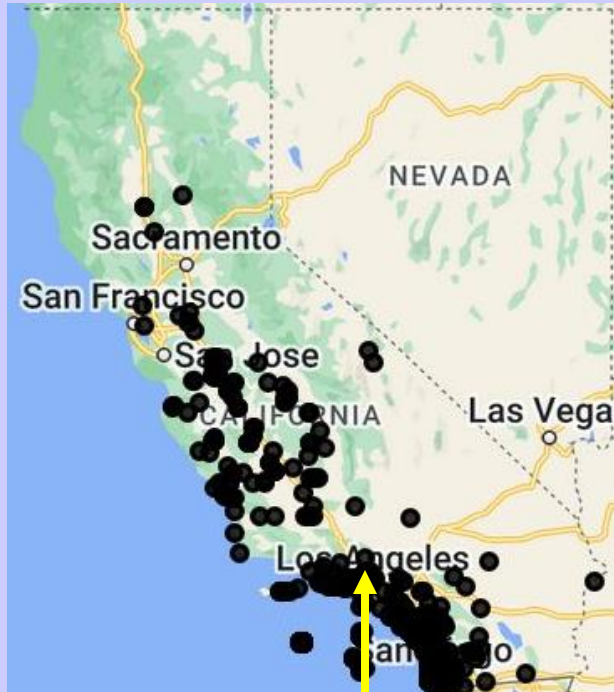
S. tragus

S. australis

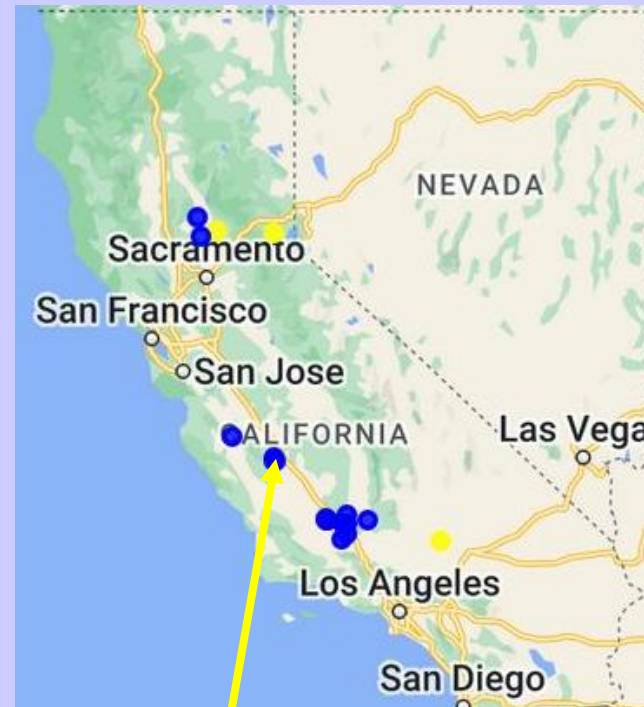
S. ryanii



Antelope Valley, Lancaster
1896



Occidental Collage 1926



Coalinga 1999

Strawberry, El Dorado County 2007

LOCATIONS AND YEARS WHERE FIRST COLLECTED –
 YELLOW ARROWS

Shana Wells and Norm Ellstrand publications
(<https://www.shanawelles.com/publications/>)

Welles SR and Ellstrand NC. 2016. **Rapid range expansion** of a newly formed allopolyploid weed in the genus *Salsola*. *Am J Bot.* 103(4):663-7.

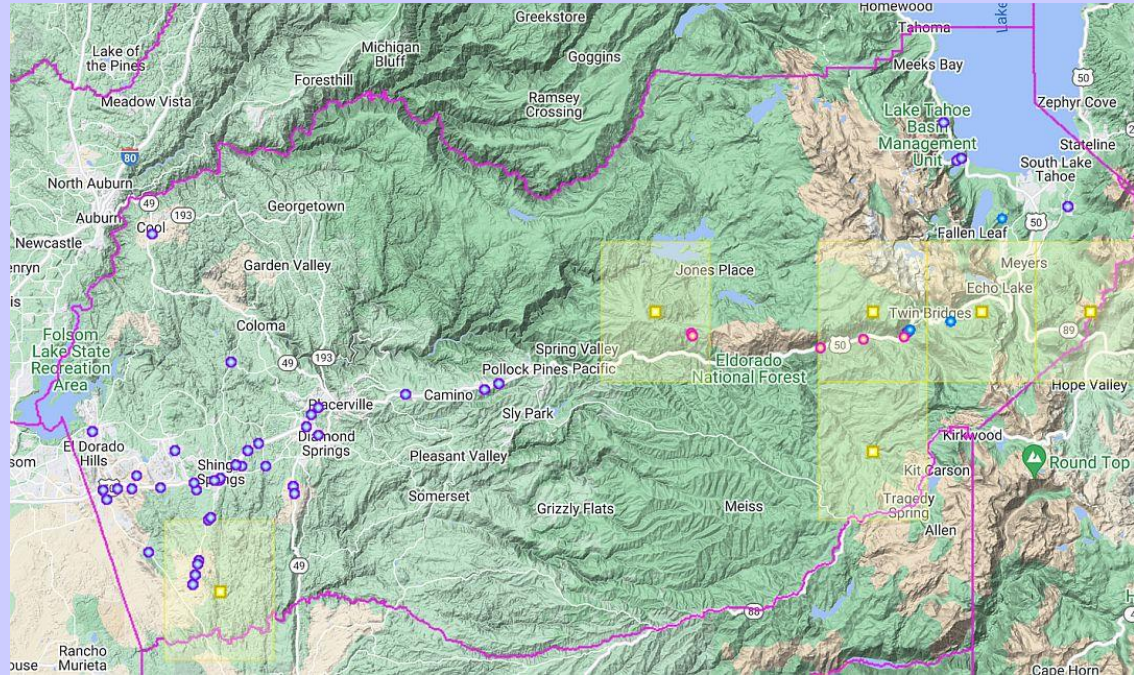
Welles SR and Ellstrand NC. 2016. Genetic structure reveals a history of **multiple independent origins** followed by admixture in the allopolyploid weed *Salsola ryanii*. *Evol Appl.* 9(7):871-8.

Welles SR and NC Ellstrand 2019. Evolution of **increased fitness** associated with allopolyploidization in the newly formed weed species *Salsola ryanii*. *AOB Plants*, DOI:<https://doi.org/10.1093/aobpla/plz039>.

Researchers/roles

- Molecular Genetics: Debra Ayres, Catherine Borger (Australia), John Gaskin, Alex Lee, Heather McGrey, Fred Ryan, Shana Welles
- Systematics: Fred Hrusa, Mike Pitcairn, Sergei Mosyakin (NAS Ukraine)
- Field Surveys: Pat Akers, Fred Hrusa, Fred Ryan, Shana Welles, Virginia Meyer, Catherine Borger
- Cytology/genome size: John Bailey, Eva Grotkopp

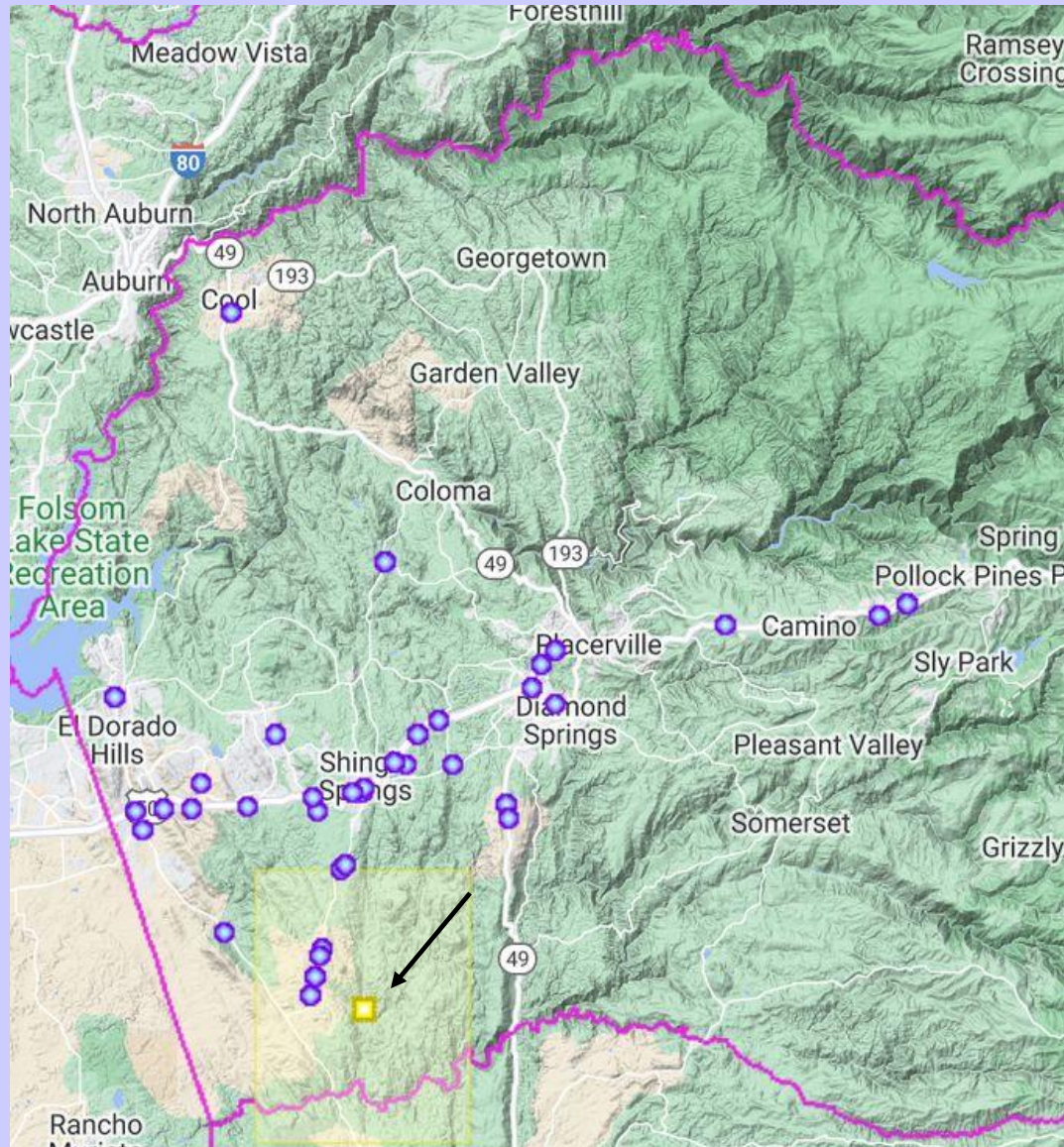
Sierra Foothill Nascent Invasions



Calflora El Dorado County 2023

Calflora 2015

Sierra Foothill Nascent Invasions



- Ayres and Meyer of CNPS surveyed El Dorado County for tumbleweeds Sept. 2023 - Calflora
- The only mapped occurrence was 2014 in Latrobe – yellow square
- 19 additional occurrences were mapped over 240 miles of road – purple squares

Sierra Foothill Nascent Invasions

Patterns of invasion

- Highway 50 is main conduit east-west with plants spreading north and south along major roads
- Occurrences more abundant and plants larger closer to the Central Valley
- Scarce at higher elevations
- Occurs with stinkwort



Sierra Foothill Nascent Invasions

Patterns of escape

- Guardrails block spray along roadsides and highway 50 center divide
- Fenceline exceeds sprayer boom
- Gore area occurrences not treated



Sierra Foothill Nascent Invasions

Conclusions and Recommendations

- The Sierra foothills are nascent sites for Russian thistle broader invasion – species capable of explosive spread.
- Surveying of foothill counties may prove the invasion is ongoing due to inadequate earlier surveys.
- Casual observations of Amador County show similar invasion patterns spreading east to west on Highway 88 from Highway 99.
- Local chapters of the CNPS can provide the volunteer botanists to do these surveys

References

- Ryan FJ, Ayres DR, Bell D. 1999. There's more to tumbleweed (Russian thistle) than meets the eye. In Proceedings of the California Exotic Plant Pest Council, Vol. 5, 1999. pg. 11-18.
 - <https://www.cal-ipc.org/resources/symposium/archive/1999-cal-ipc-symposium/>
- Ryan FJ, Ayres DR. 2000. Molecular markers indicate two cryptic, genetically divergent populations of Russian thistle (*Salsola tragus*) in California. Canadian Journal of Botany 78: 59-67
- Ayres DR, Ryan FJ, Grotkopp E, Bailey J, Gaskin J. 2009. Tumbleweed (*Salsola*, section *Kali*) species and speciation in California. Biological Invasions (2009) 11:1175–1185