

**Using herbarium data to study sunflower  
rust (*Puccinia helianthi*) incidence  
in the sunflower species *Helianthus annuus*  
and *Helianthus petiolaris***

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<http://www.britannica.com/EBchecked/topic-art/39703/7628/Sunflower>

# Rust is of agricultural importance

	2002	2003	2005	2006	2007
Rust incidence (% of fields)	17%	44%	60%	68%	77%
% fields with economic levels (i.e. > 3% coverage on upper leaves)	3.3%	5%	5%	17%	24%

Table adapted from Gulya, unpubl.

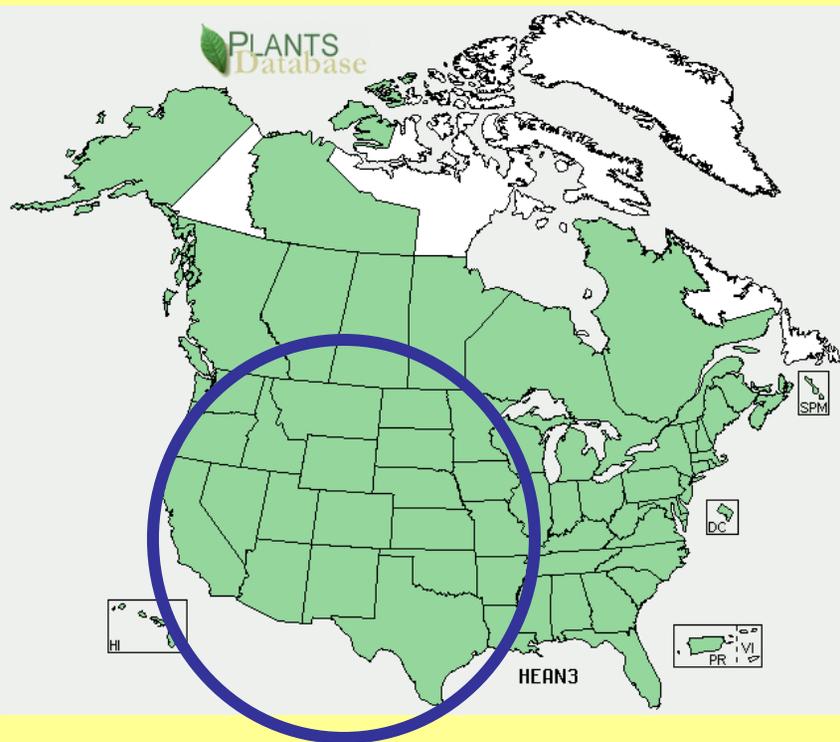
## Notes of ecological interest

- Interactions of hosts and pathogens are integral to ecological and evolutionary studies.
- Range-scale studies are rare.

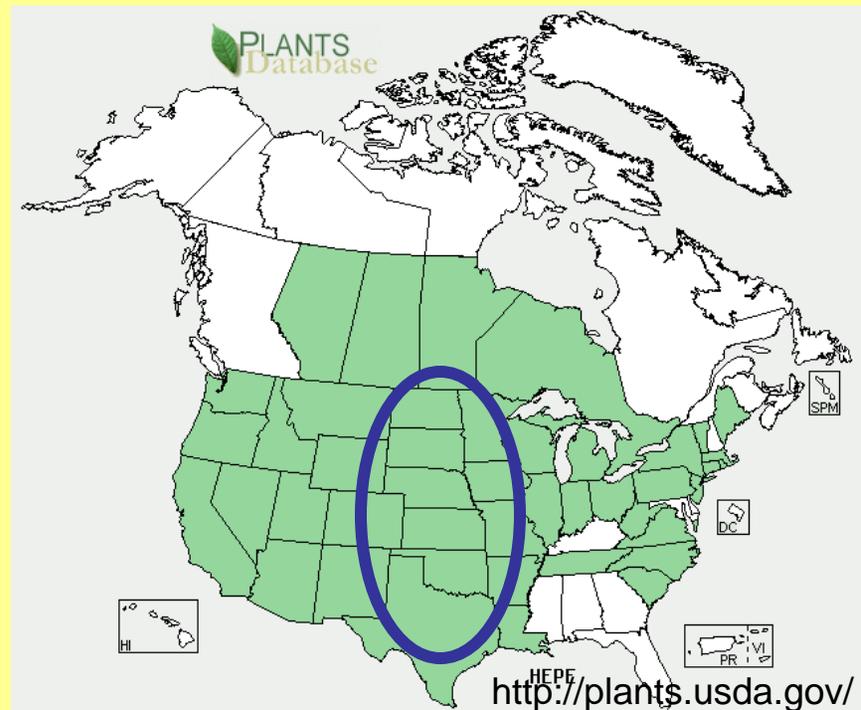
# The sunflowers of interest

- Wide range, the family occurs all over the US. (I studied overlapping ranges for the two species here)
- Both annuals

(Ranges from Rogers et al. in blue)



*H. annuus*



*H. petiolaris*

# Rust

- Foliar pathogen
- Wide range
- Infects lower leaves first then spreads upwards
- Occurs late in the season
- Several infection cycles per host growing season



# Background for herbarium study

- Large scale studies are hard, so it would be ideal to use herbarium specimens as proxies for field data
- Studies using herbarium data have been successful in the past
- Simple data to gather
- Large sample sizes
- This method allows the study of a host's entire range.
- Often low rust levels, so unlikely to lead to collector bias. If there is bias, it is not location-dependent.

# Questions

- Does rust incidence vary across a geographic range?
  - Gulya et al. found higher resistance in southern U.S. for *H. annuus*, so we focused on N-S differences



# More Questions

- Is incidence higher in *H. annuus* or *H. petiolaris*?
- Are herbarium studies applicable here?



# Methods

- Collection timing matches rust timing.
- Plants observed in Great Plains, from S. Canada to N. Mexico
- Data recorded:
  - Rust incidence
  - Location (by county)
  - Collection date
  - Lower leaf area



# Analysis and Results

- Binary logistic regression
- Effect of area, collection date and latitude/longitude on incidence.
- 11.11% of 324 *H. annuus* observed had rust, while 8.67% of 346 *H. petiolaris* were rusted, but the difference was nonsignificant.

# Binary logistic regression models

I started with all terms and interactions and removed nonsignificant terms to reach a final model.

<i>H. annuus</i>	
Predictor	P-value
date	0.104
latitude	0.052
lower leaf area	0.045
date x latitude	<b>0.017</b>

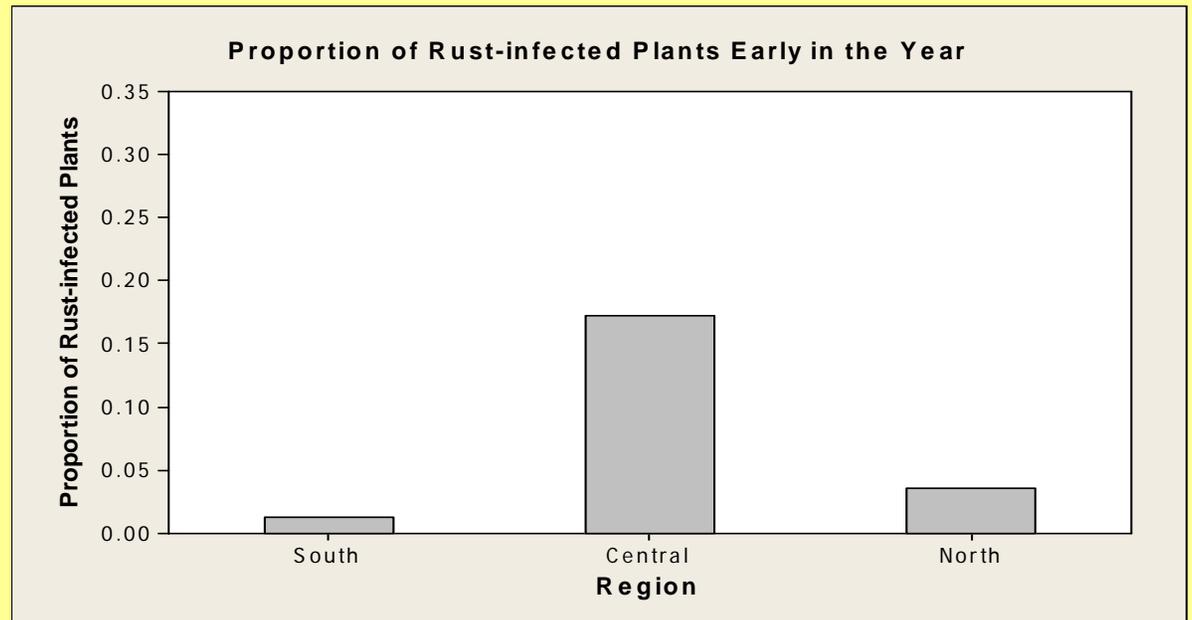
To make it easier to talk about/visualize...

Category	Region
North	southern Canada, North Dakota, South Dakota
Central <sup>1</sup>	Colorado, Kansas
South	Oklahoma, Texas, northern Mexico

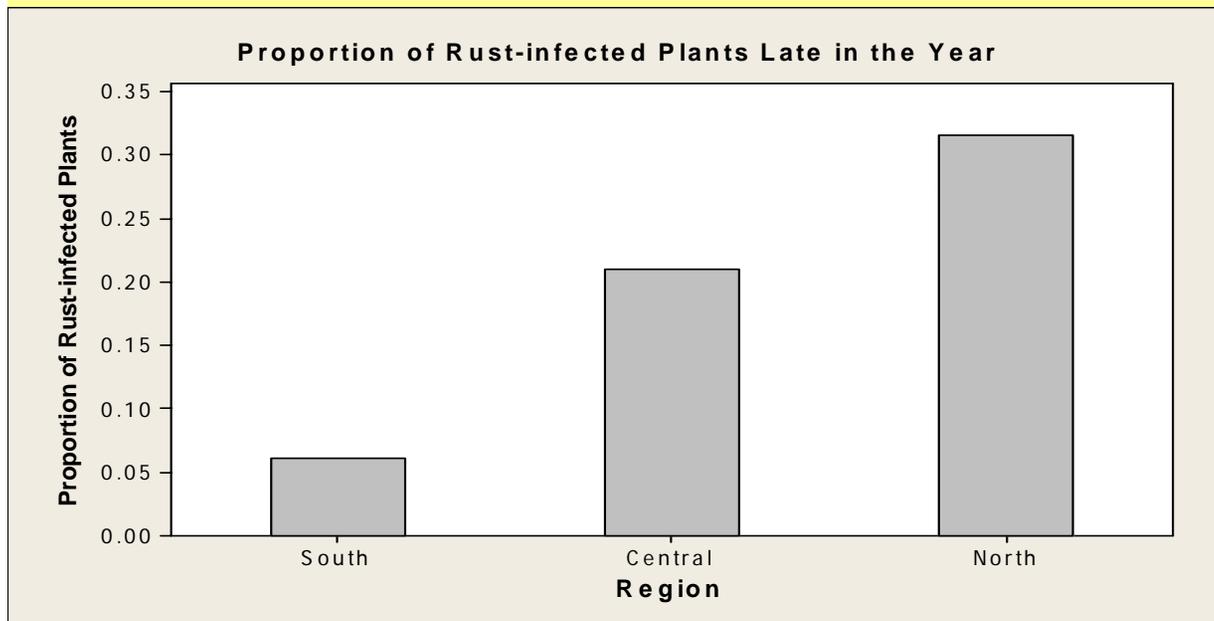
<sup>1</sup> There were no specimens from Nebraska.

There is a notable interaction of date and latitude, what could this mean?

# *H. annuus* incidence



Data for the first two quartiles of date.



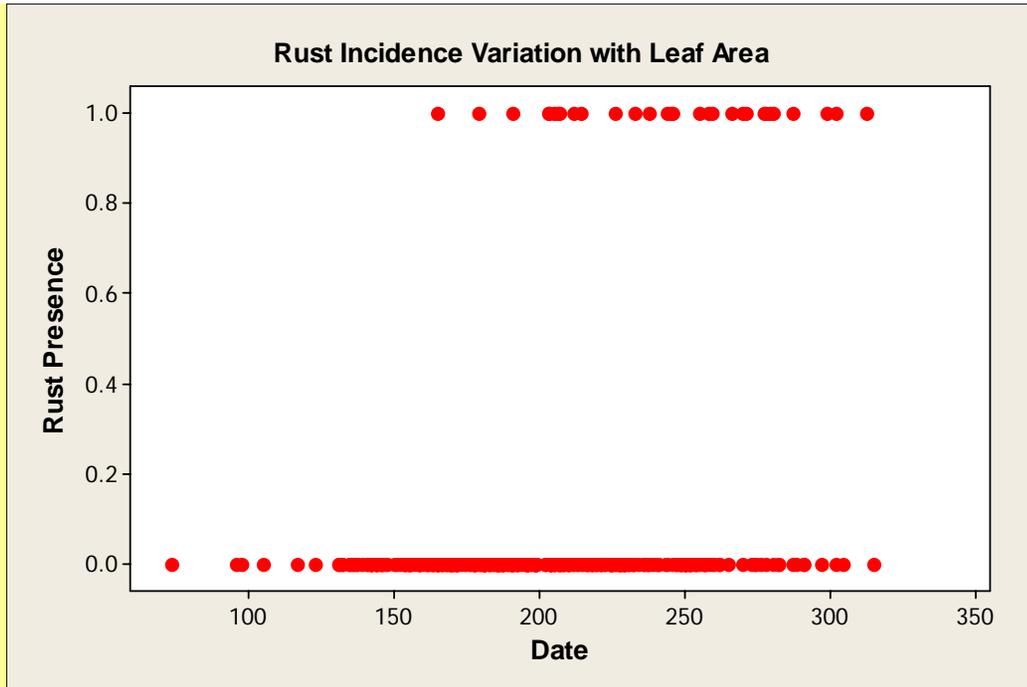
When rust was most prevalent, incidence was highest in the North.

Data for the second two quartiles of date.

# Moving on to *H. petiolaris*...

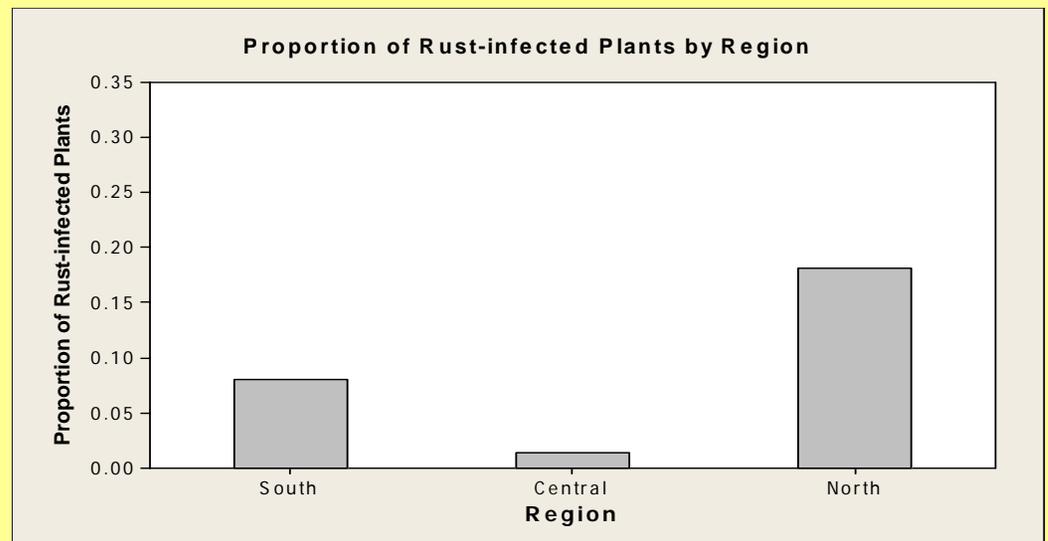
<i>H. petiolaris</i>	
Predictor	P-value
date	<0.001
latitude	0.001





Rust incidence was highest in the North.

Rust incidence variation with julian date.  
There was more rust later in the season.



Incidence by location

# Potential Issues

- Collector bias: Our data are limited to what is provided to us.
- We see less of each *H. annuus* per herbarium sheet;
- We may see less rust on *H. annuus* because we miss most of the lower leaves.
- *H. Annuus* bias suggests a need to focus on within-species interactions.

# Conclusions, and future work

- Northern populations of both species had the highest rust incidence, resistance may be a factor.

	AZ	CA	KS	ND	PNW	TX	IL	Overall
Mean % resistant plants per accession	8.5%	6.8%	20.2%	4.4%	0.2%	38%	1.6%	12.6%

Table adapted from Gulya et al.



# Future work

- Higher sample sizes.
- Field work to explore plant sizes and gather samples.



# Thanks to:



- Tom Gulya and Gerald Seiler
- Mike Tourtellot
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- Becky Begay
- The University of Saskatchewan, North Dakota State  
University, The University of South Dakota, Kansas  
State University, The University of Kansas, The  
University of Oklahoma and The University of Texas.

# Questions?



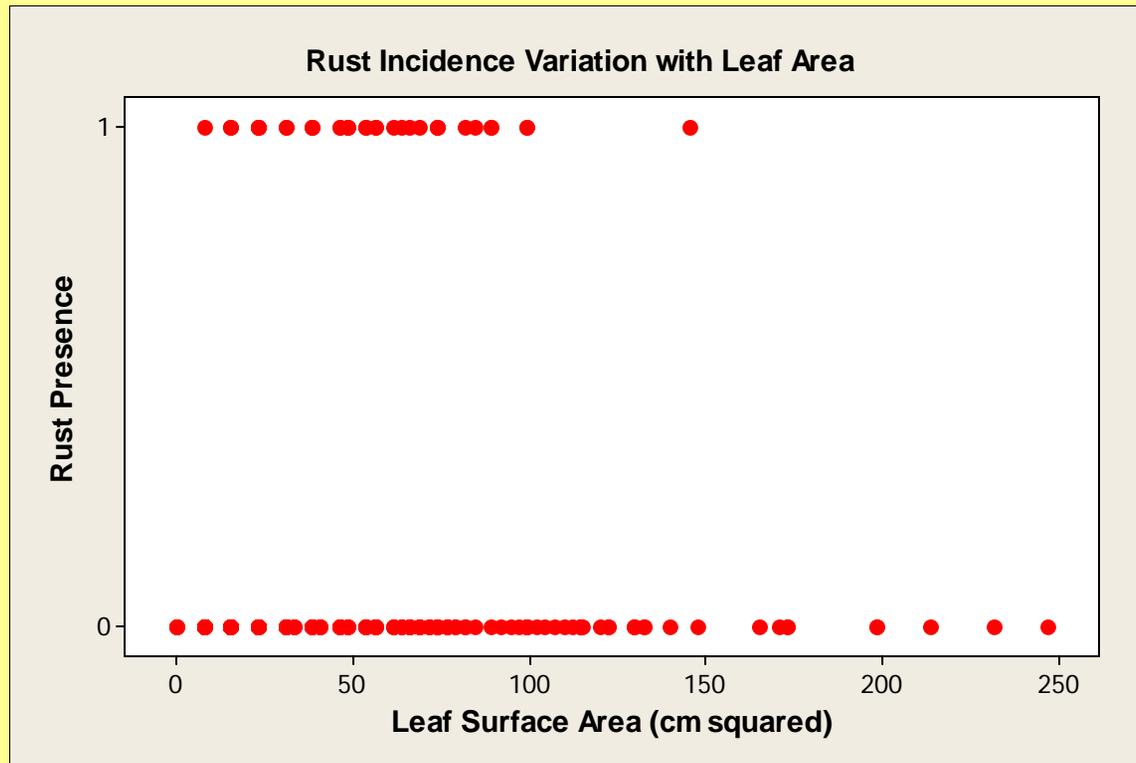
Sue Thompson

# Works Cited

- Alexander, H.M., S. Price, R. Houser, D. Finch and M. Tourtellot. 2007. Is there a reduction in disease and pre-dispersal seed predation at the border of a host plant's range? Field and herbarium studies of *Carex blanda*. *Journal of Ecology* 95: 446-457.
- Antonovics, J., M.E. Hood, P.H. Thrall, J.Y. Abrams, and G.M. Duthie. 2003. Herbarium studies on the distribution of anther-smut fungus (*Microbotryum violaceum*) and *Silene* species (Caryophyllaceae) in the eastern United States. *American Journal of Botany* 90: 1522-1531.
- Gulya, T., G. Kong, and M. Brothers. Rust resistance in wild *Helianthus annuus* and variation by geographic origin. ISA report.
- Rogers, C.E., T.E. Thompson and G.J. Seiler. Sunflower species of the United States. *National Sunflower Association* 1982: Fargo, ND
- Thompson, J.N. Specific hypotheses on the geographic mosaic of coevolution. 1999. *The American Naturalist* 153: S1-S14.

# notes

- 1<sup>st</sup> 2 quartiles were from 3 Jan to 27 July
- Collection dates ended 29 Dec



Relationship of rust incidence with lower leaf area.

(This is totally counterintuitive and I can't explain it at all.)