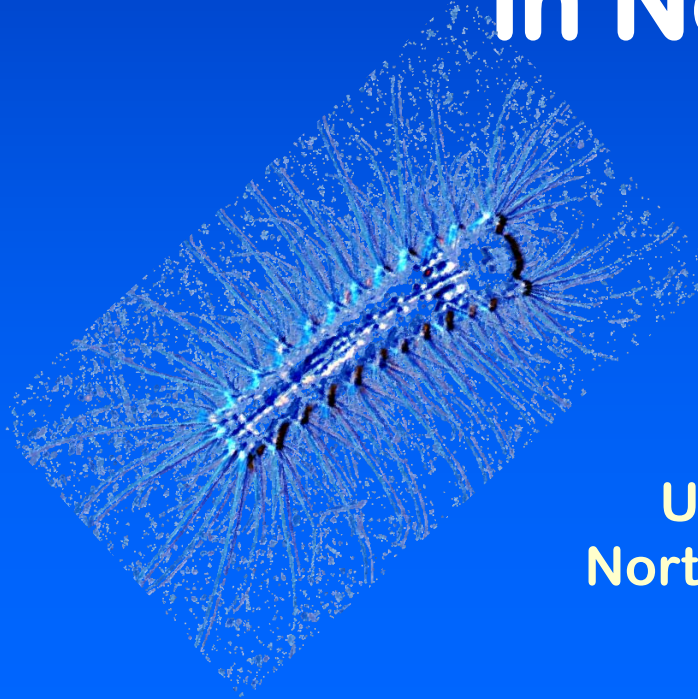
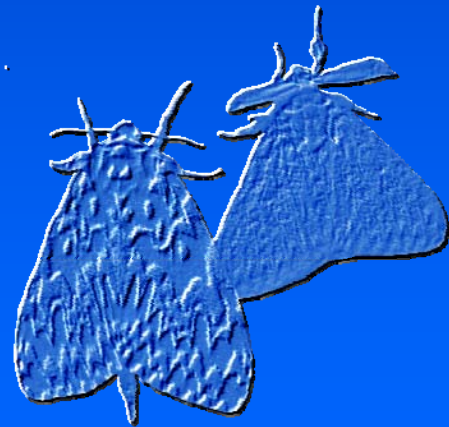


Proactive Quarantine-Based Research and Development on Nun Moth: Preventing Introduction and Establishment in North America



Melody Keena
USDA Forest Service
Northern Research Station



Pest Status and Risk

It is a major pest in central and eastern Europe and southeastern Siberia, as well as Spain

In Poland, during the period 1987-94, the nun moth caused enormous tree losses on more than 6.3 million ha

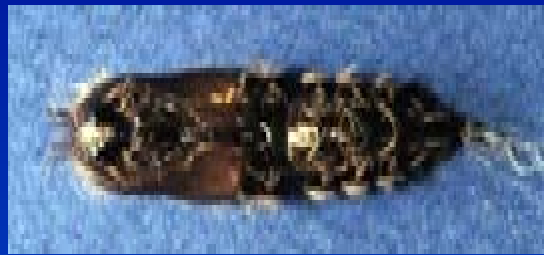
It goes through periodic outbreaks causing defoliation and resulting in the death of spruce and pine trees



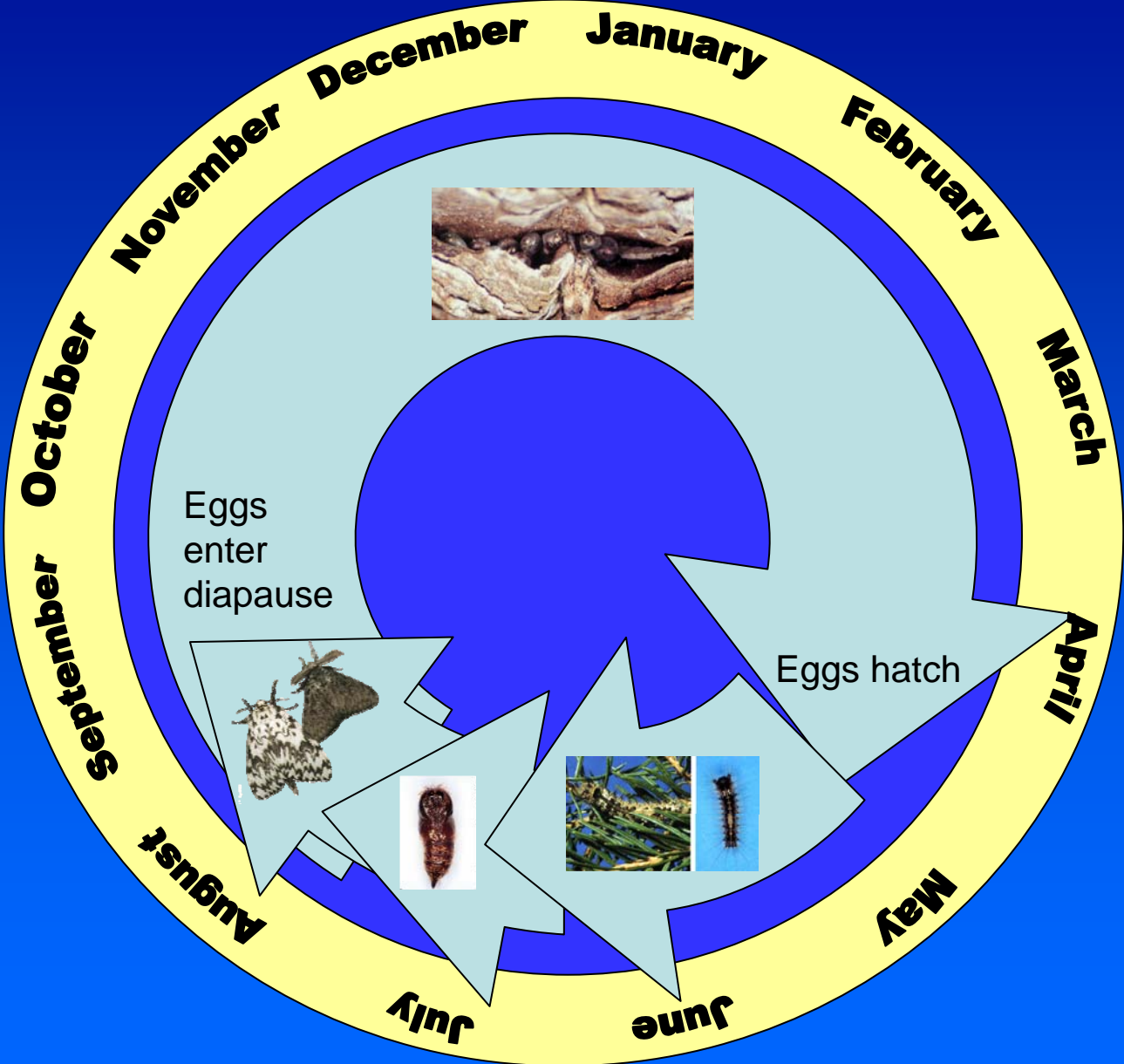
Its establishment in North America would be disastrous:

- ✓ Polyphagous feeding habits
- ✓ Ability to colonize new habitats
- ✓ Capacity to be spread rapidly by vagile adults
- ✓ Adults are readily attracted to lights
- ✓ High potential to be transported via commerce

The Nun Moth -- *Lymantria monacha*



Generalized Nun Moth Life Cycle



- **Distribution**
- **Pheromones for Detection Surveys**
- **Identification**
- **Biology and Behavior**
- **Host Range**
- **Biologically Based Control Options**

Distribution by Country (Confirmed in the Literature)

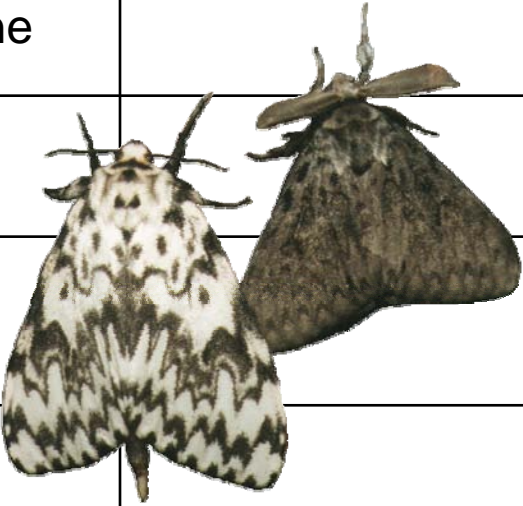
Nun moth is not known to be established in North America



It is distributed over most of Europe, across Siberia and the Far East, within a band between lat 43° to 57° N.

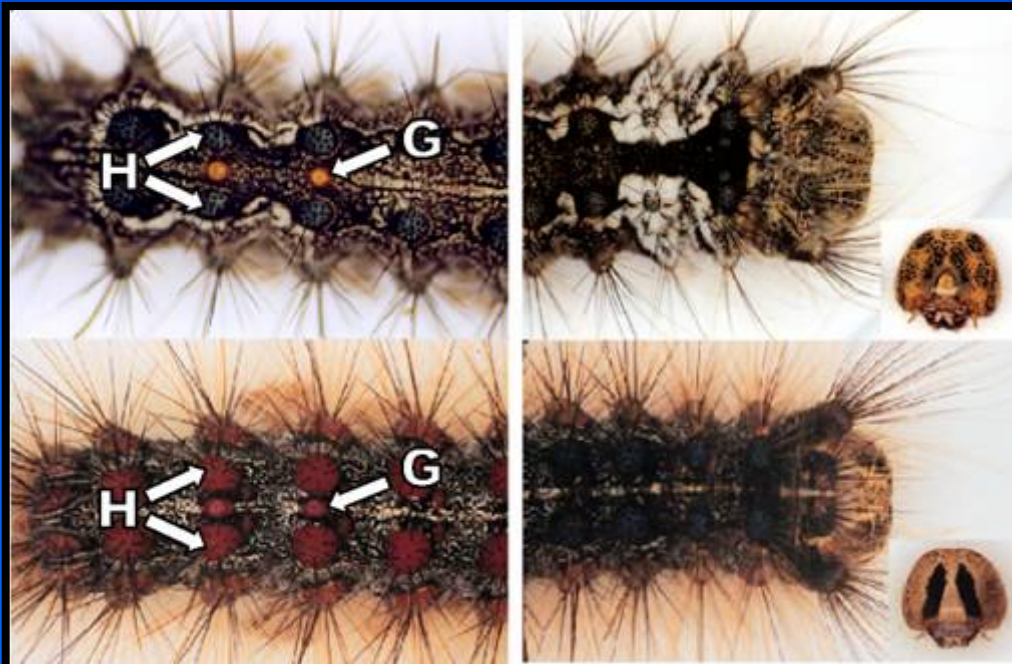
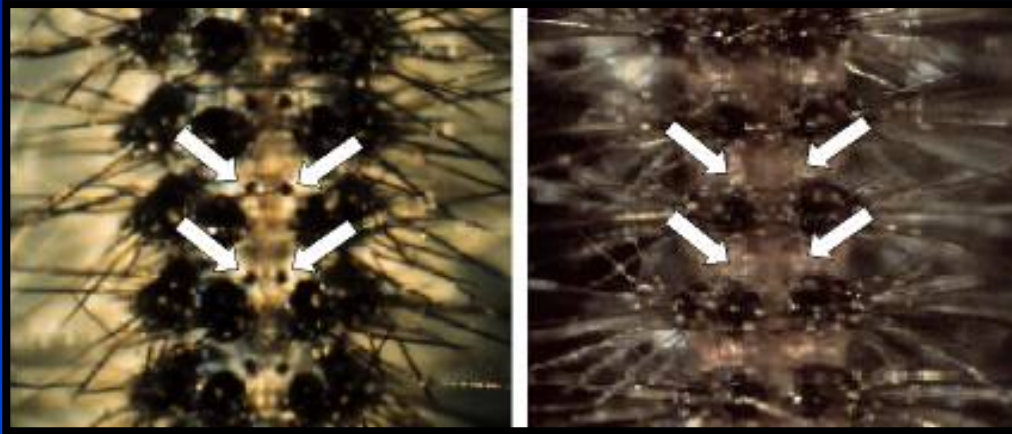
- **Distribution**
- **Pheromones for Detection Surveys**
- **Identification**
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Pheromones

Components	<i>L. dispar</i>	<i>L. monacha</i>
(7R,8S)-7,8-Epoxy-2-methyloctadecane, (+)-Disparlure	Bierl 1970 Cardé 1977	Schönherr 1972 10
(7R,8S)- <i>cis</i> -7,8-Epoxy-2-methyloctadec-17-ene	Gries et al. 2005	
2-Methyl- <i>cis</i> -6,7-epoxyheptadecane		Minyailo 1978
(Z)-7-Octadecene		1 Gries 1996
2-Methyl-(Z)-7-octadecene		Grant et al. 1996 Gries 1996
(7R,8S)-7,8-Epoxyoctadecane, (+)-Monachalure		Hansen 1984 Gries 1996 10

- **Distribution**
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Identification of All Life Stages of Nun Moth and Ways to Distinguish Them from the Gypsy Moth



Determine if Different Biotypes or Subspecies of Nun Moth Exist in Europe and Asia

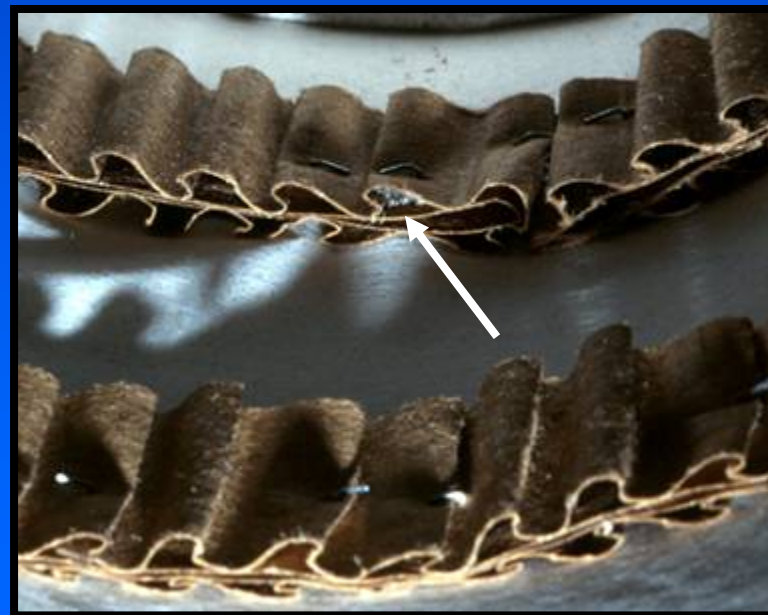
Observational data suggests that nun moths from Europe and Asia differ significantly in behavior and host utilization.

- ✓ All Japanese adults are of the peppered coloration
- ✓ Japanese nun moth larvae almost exclusively use *Larix* as their host
- ✓ Adults from the two areas fly and mate at different times during the night



- **Distribution**
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Develop an Artificial Diet and Rearing Methods

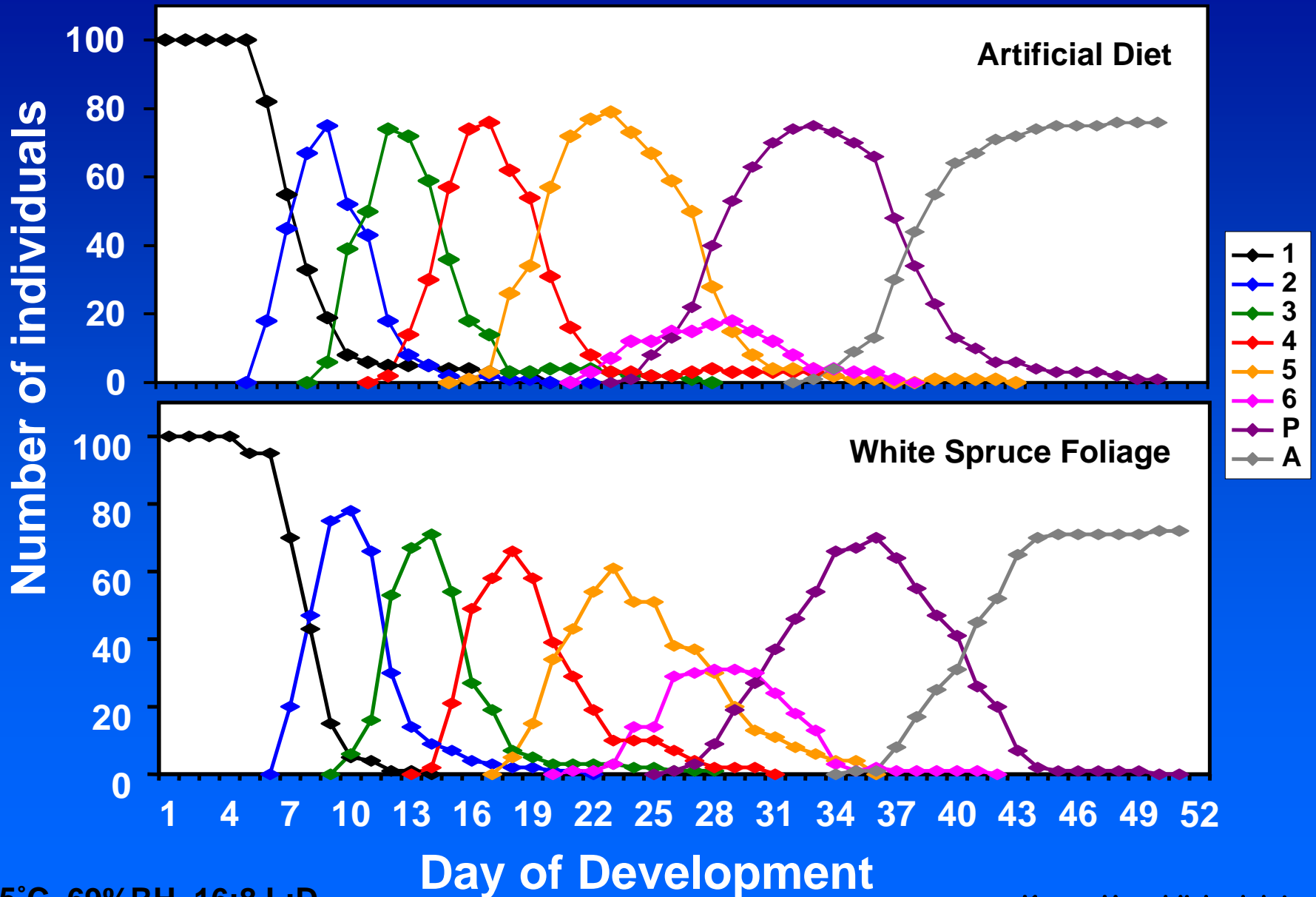


Methods Used for Phenology Study



Keena Unpublished data

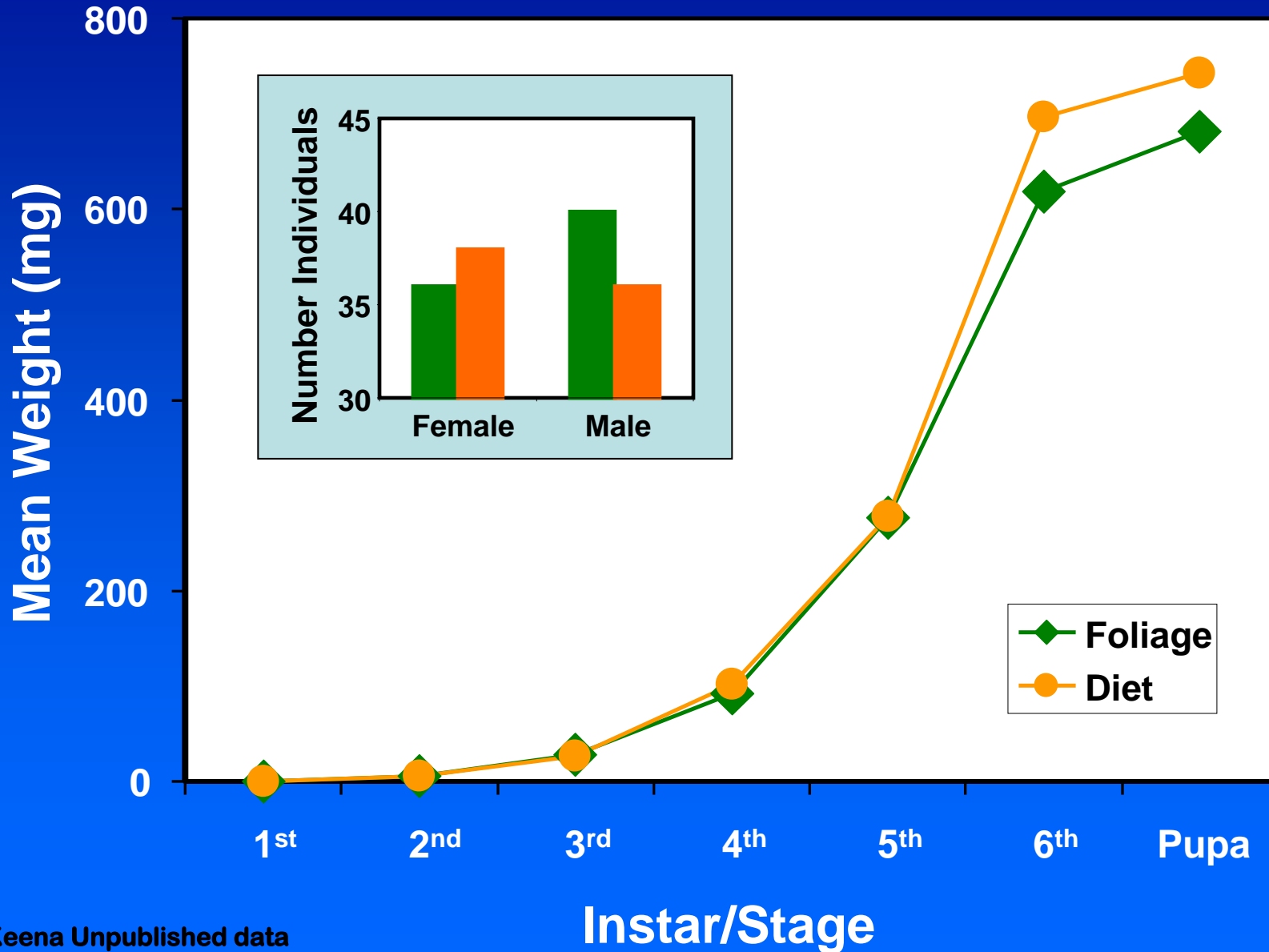
Nun Moth Phenology



25°C, 69%RH, 16:8 L:D

Keena Unpublished data

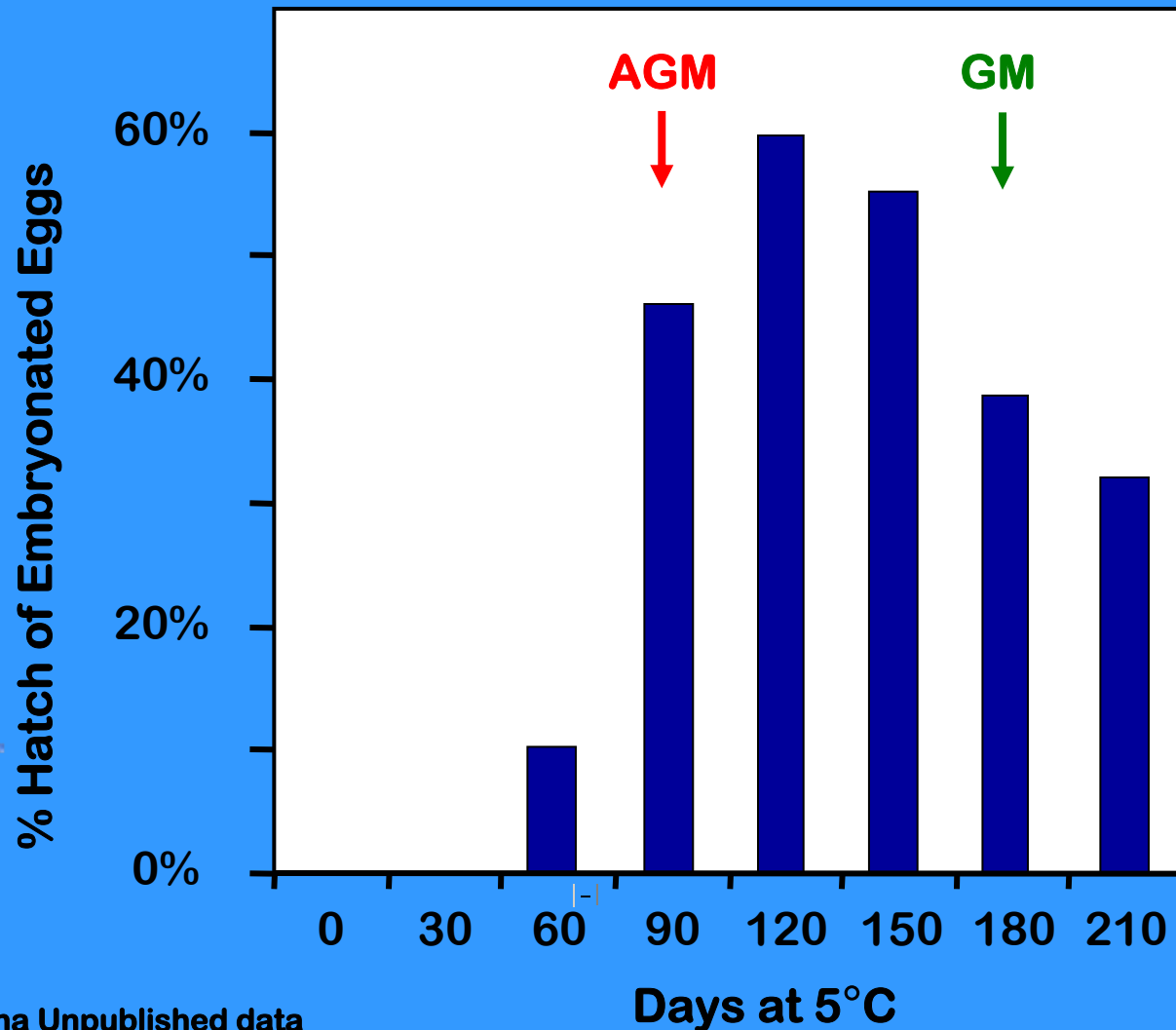
Comparison of Nun Moth Weights



Keena Unpublished data

Chill Requirements for Nun Moth Egg Hatch

Require less chill than North American gypsy moth



Keena Unpublished data

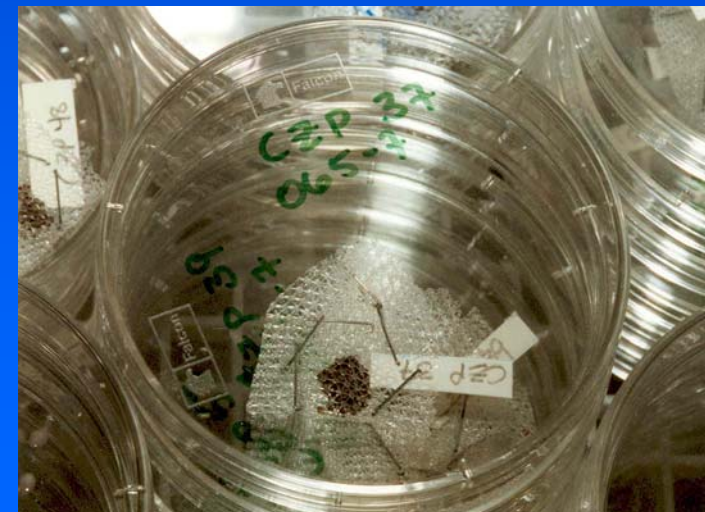
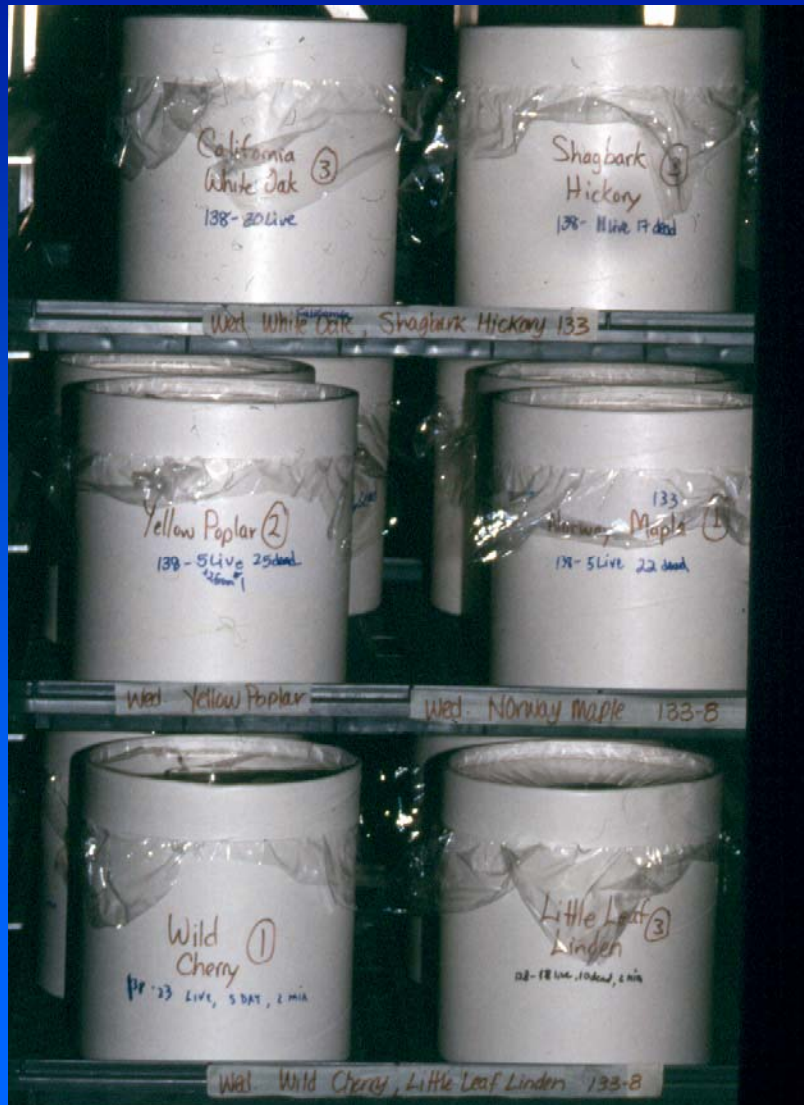
Utilization of Various Substrates for Egg Deposition



Keena Unpublished data

- **Distribution**
- **Pheromones for Detection Surveys**
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Methods for Host Evaluations



Utilization of Various Hosts

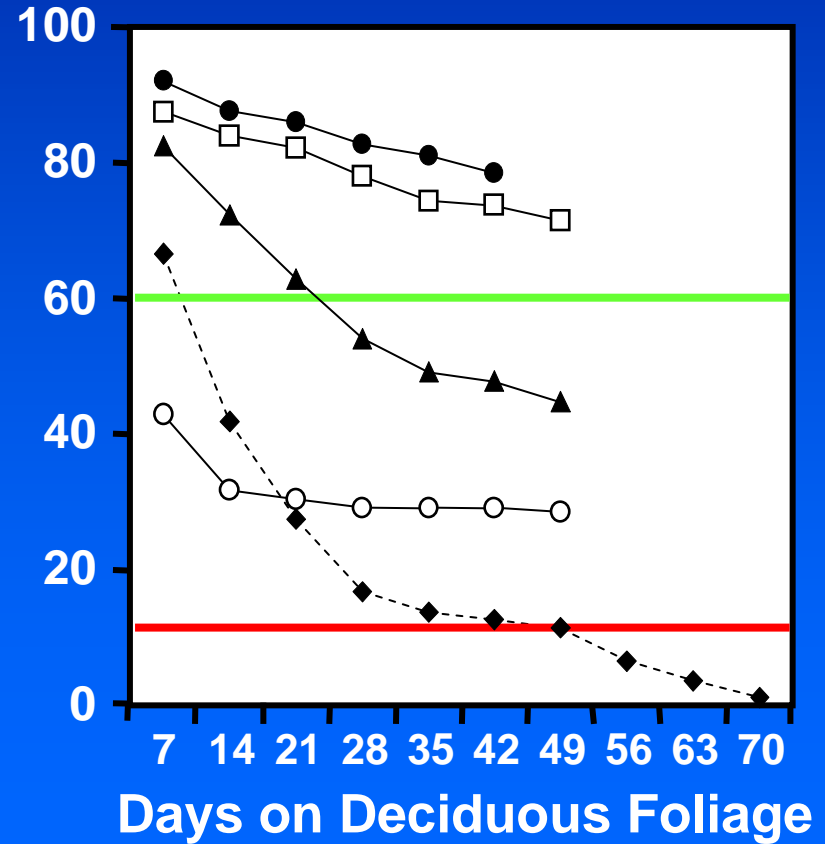
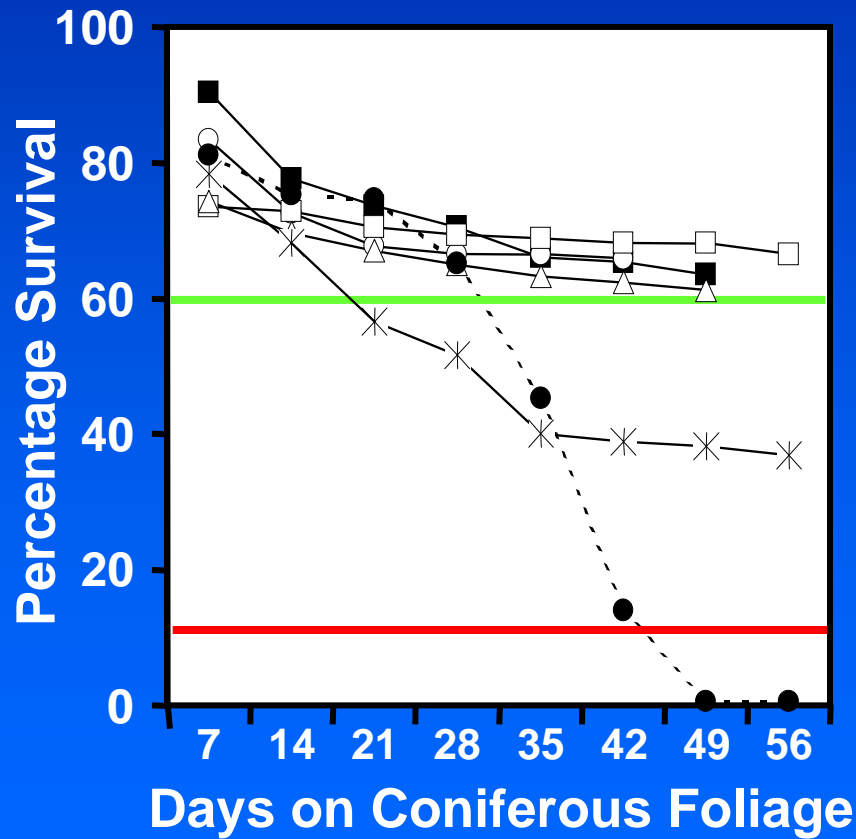
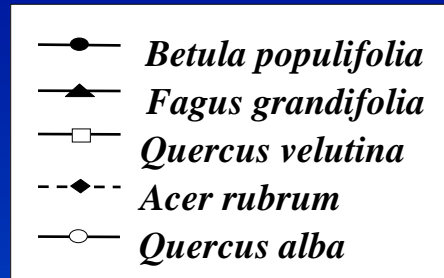
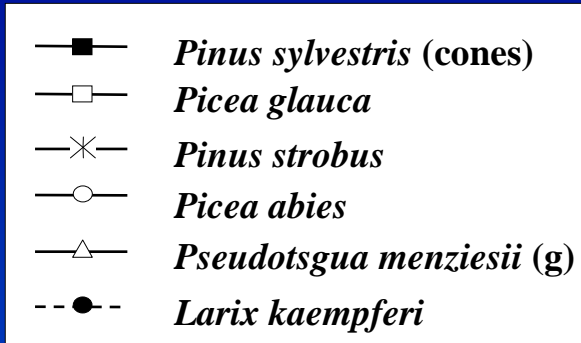


**27 North
American
Tree Species**

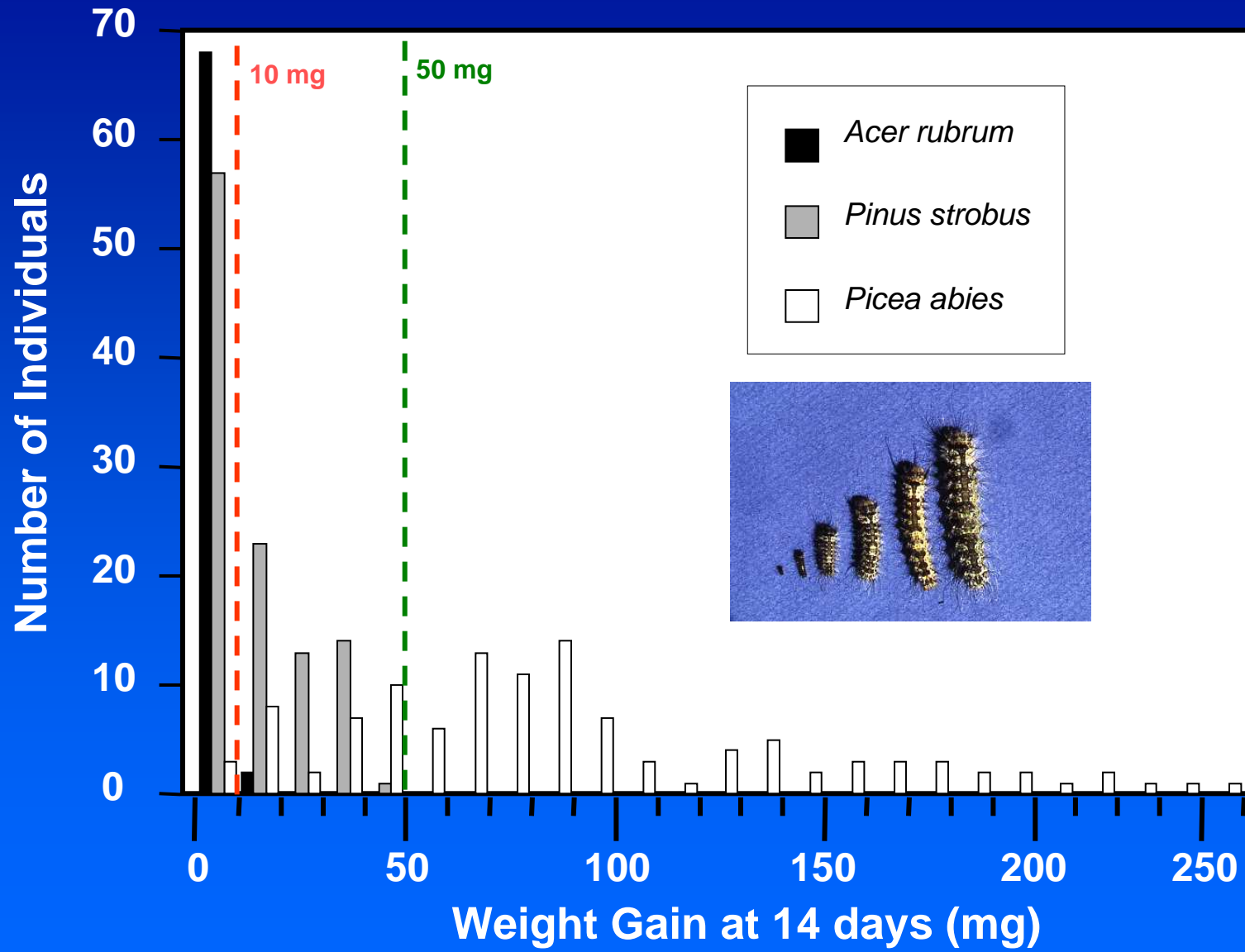
**Introduced
Eurasian
Tree Species**



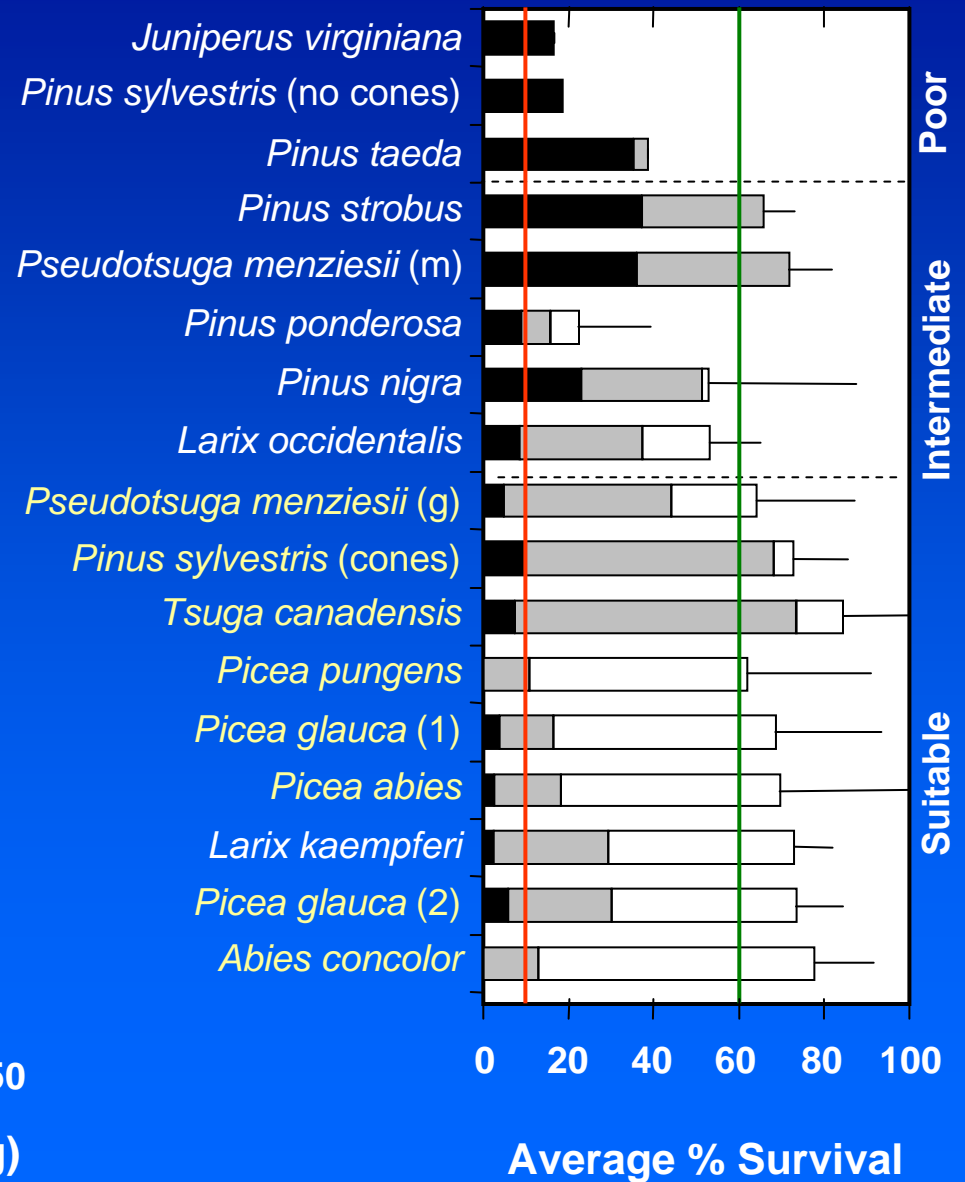
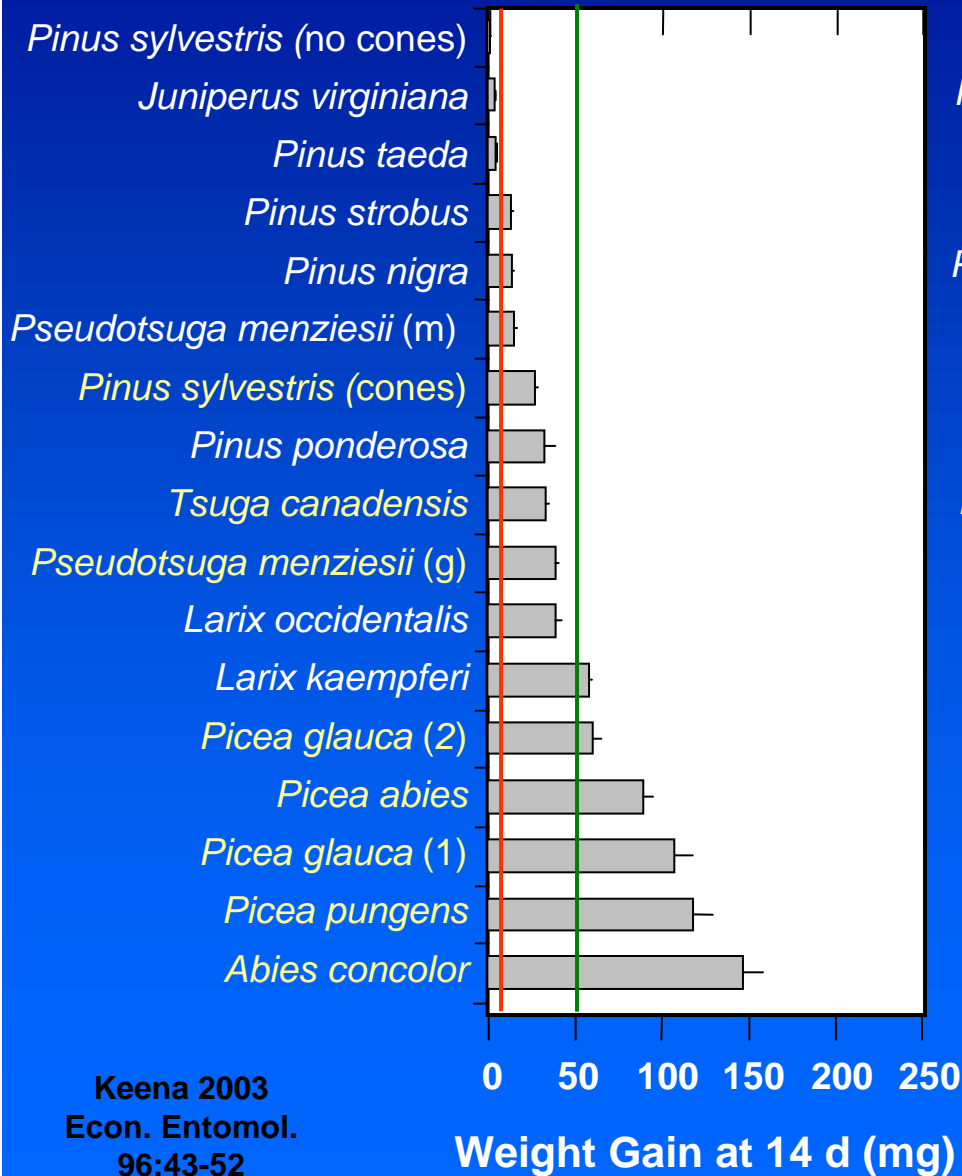
Utilization of Hosts to Complete Development



Host Suitability Ratings

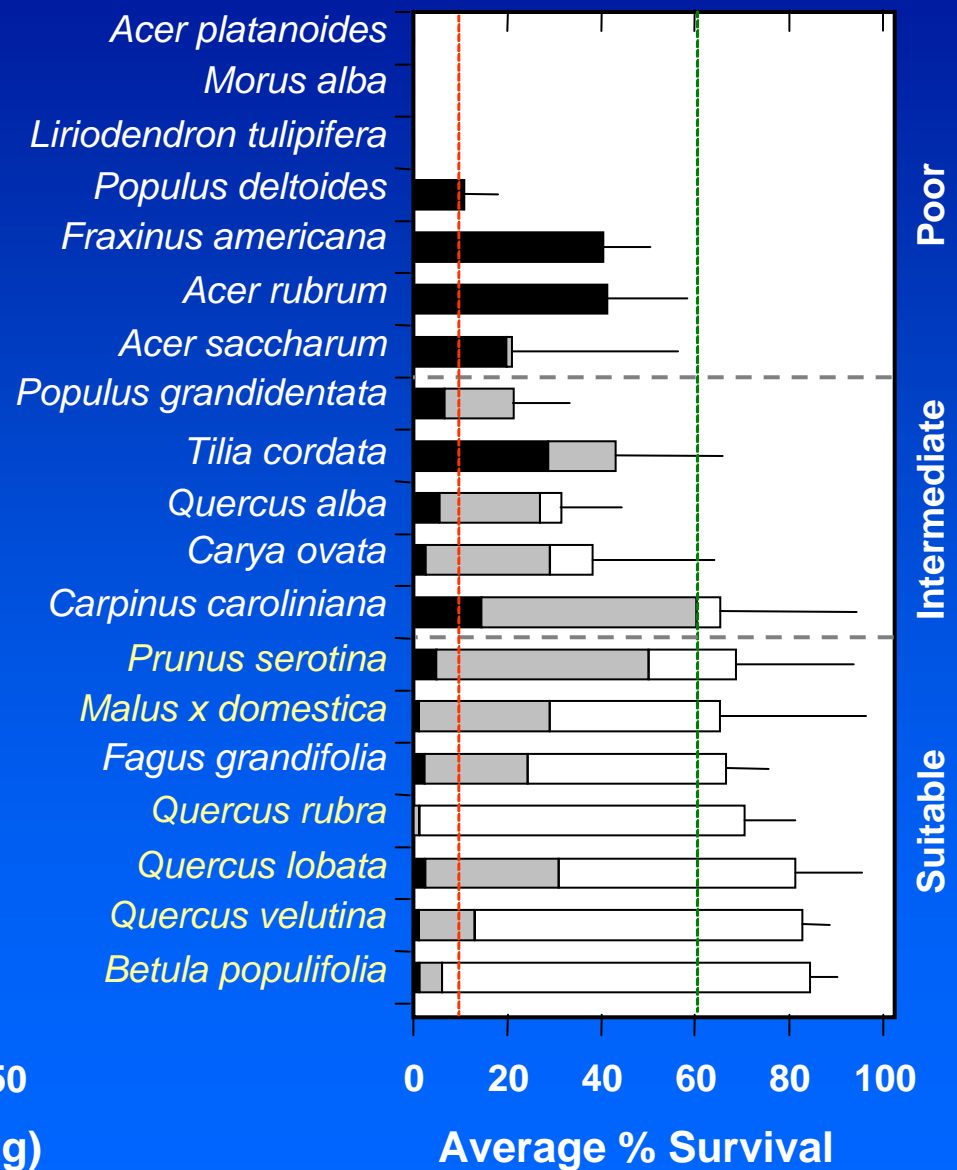
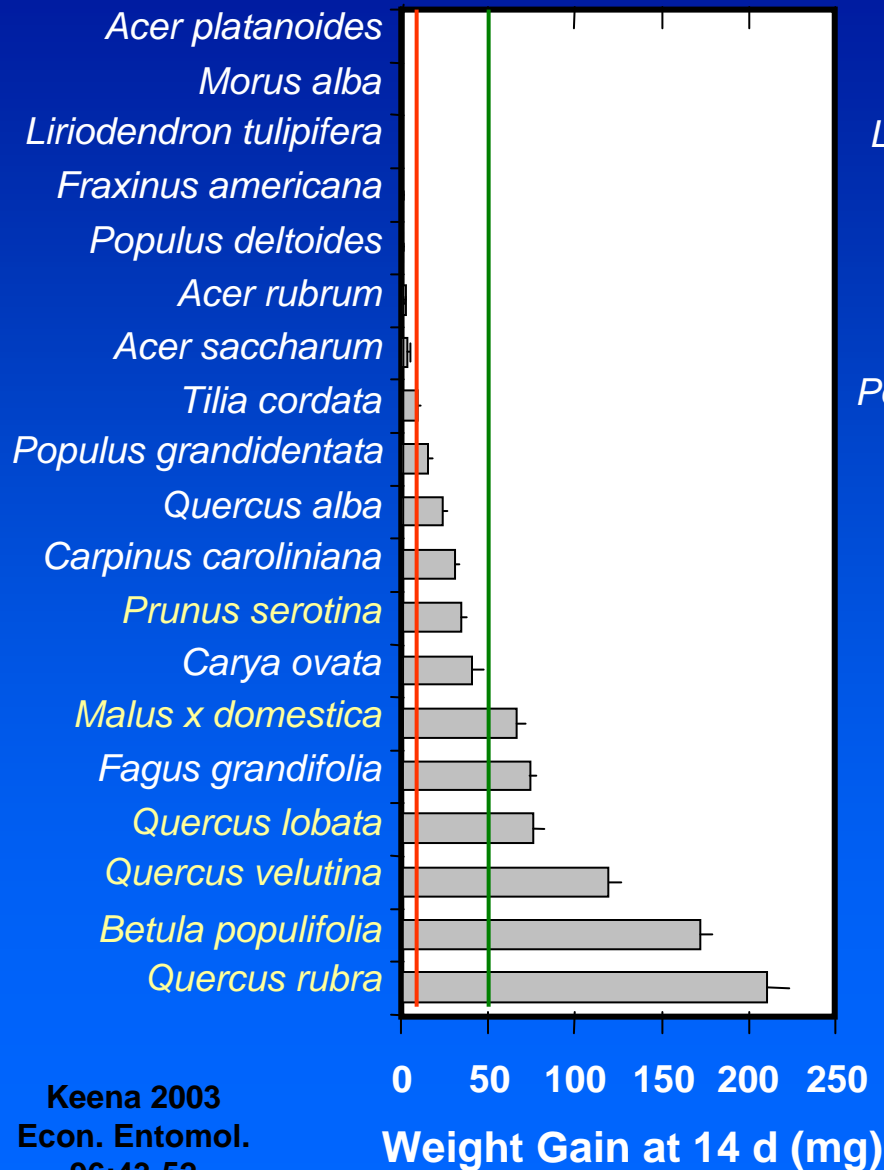


14 Day Growth and Survival on Coniferous Hosts

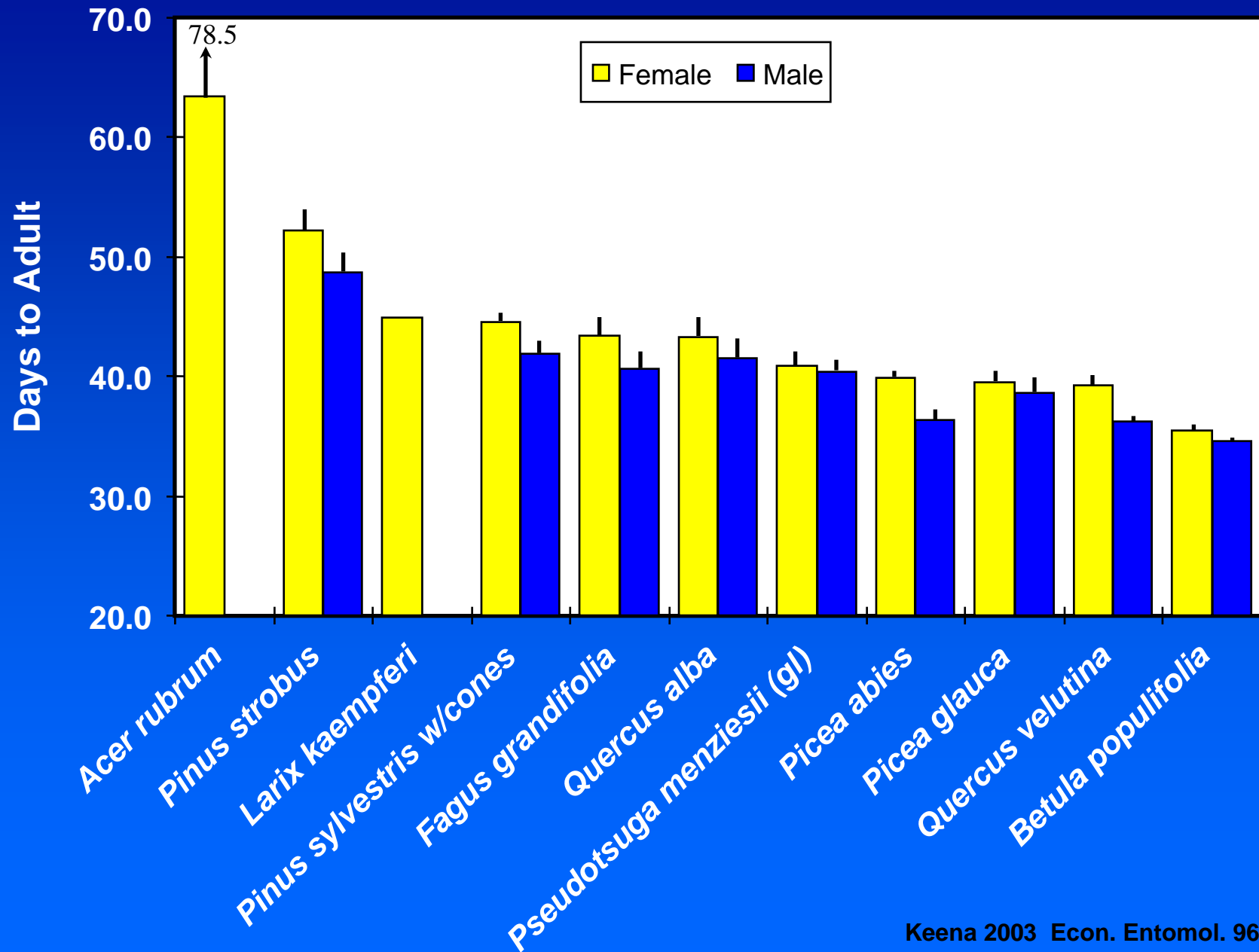


Keena 2003
Econ. Entomol.
96:43-52

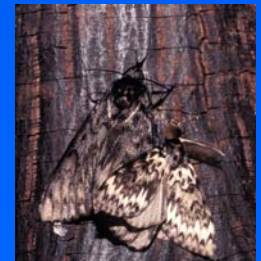
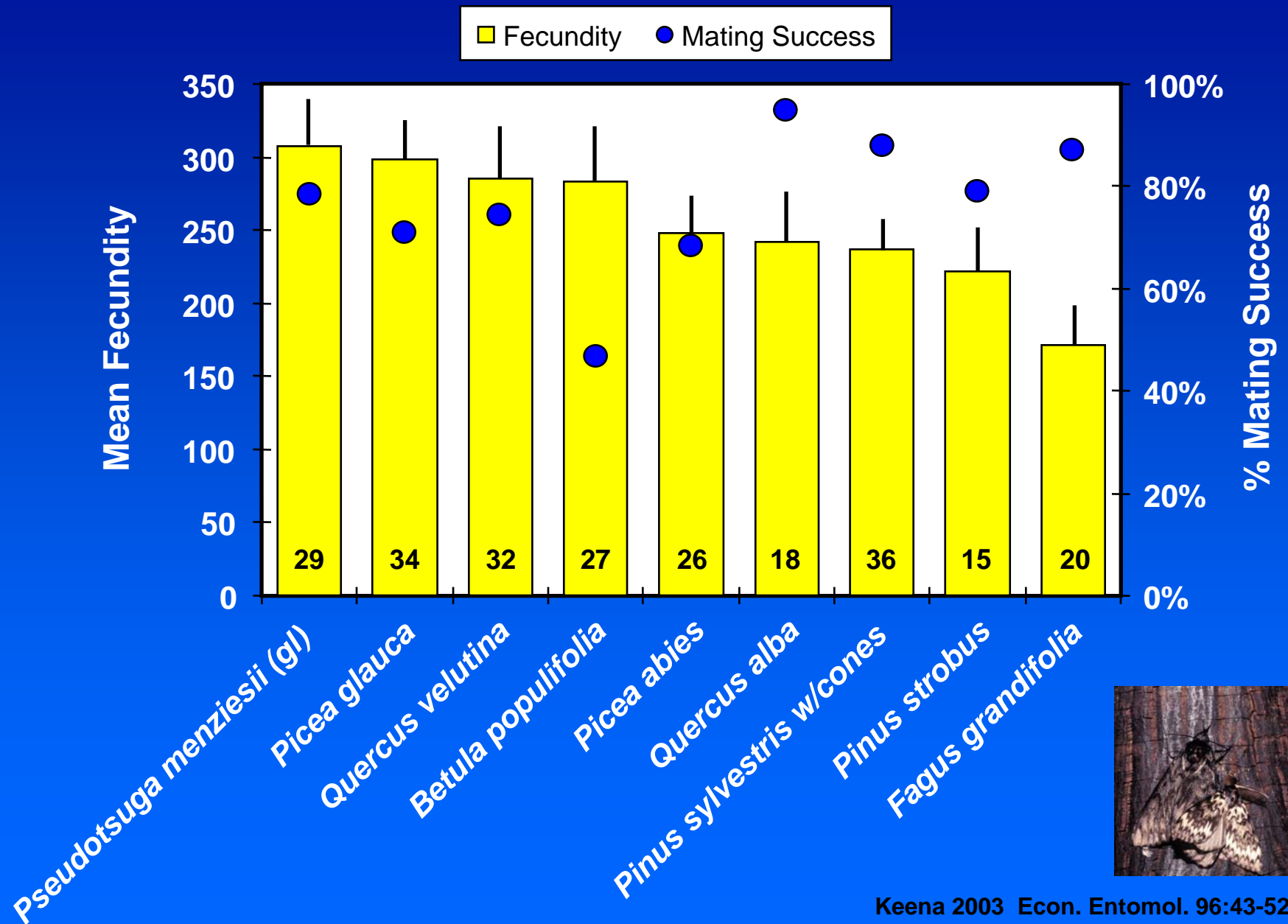
14 Day Growth and Survival on Deciduous Hosts



Time to Complete Development on Various Hosts



Reproductive Success on Various Hosts



Suitability of Various Trees for Nun Moth Survival and Development

Host phenology is just as important as host preference in determining the survival and successful development of nun moth larvae



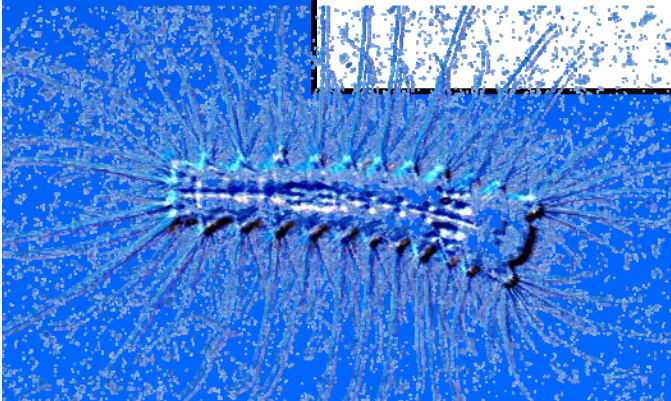
Suitable	Marginal	Unsuitable
<i>Betula</i>	<i>Carpinus</i>	Aceraceae
<i>Quercus</i>	<i>Fagus</i>	Magnoliaceae
<i>Pyrus</i>	<i>Carya</i>	Moraceae
<i>Malus</i>	<i>Prunus</i>	Oleaceae
<i>Abies</i>	<i>Larix</i>	Salicaceae
<i>Picea</i>	<i>Pinus</i>	Tiliaceae
<i>Pinus sylvestris</i> (with male cones)	<i>Pseudotsuga</i>	Cupressaceae
	<i>Tsuga</i>	

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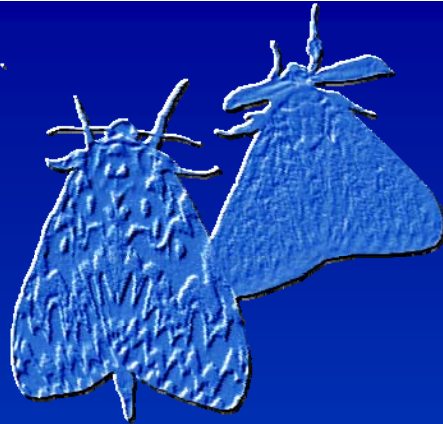
Nun Moth Susceptibility to *Bacillus thuringiensis*

- Similar susceptibility to that of the gypsy moth
- Nun moth is more susceptible to the Abbott formulation than the standard

	LD₅₀ (95% CI)	Slope (± SE)
		—
	34 µg/ml (9 –17)	3.2 ± 0.4



Keena and Dubois Unpublished data



**Thanks to Alice Vandel
and the many others who have assisted me
in the work presented here.**

**Thanks to the agencies that provided the
funding, and the managers/supervisors that
made this type of work possible**

