Climate change and effects on the European spread pattern of *Scaphoideus titanus* Ball

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Introductory remarks

- *Scaphoideus titanus* is a major pest in viticulture, since its establishment in Europe, as vector of a quarantine pathogen, the Flavescence Dorée phytoplasma
- Its management is based on mandatory control measures (insecticide spraying)
- Its distribution in Europe has dramatically changed at the end of the 1980ies, after an “abrupt climate change”
- Nowadays it has colonized Europe from the Atlantic Ocean to the Black sea and it is still spreading
Purpose of the presentation

To contribute to an explanation of the changing distribution of the leafhopper *Scaphoideus titanus* in Europe

Aim of the paper

The analysis of the spatio-temporal distribution on the basis of the predicted geographical distribution within the 1982-87 and the 2009-13 time periods in Europe
European spread pattern of \textit{S. titanus}

Mean yearly temperature in Europe - 1950/2011

Statistical analysis (analysis of discontinuity performed through the statistical test of Bai and Perron) indicates that a significant 99% thermal discontinuity occurs between 1983 to 1999 (red horizontal line), and that the most probable year of this discontinuity is 1987 (vertical dashed line). As a result of this discontinuity, technically classified as "abrupt climate change", the average temperature for the 20 European stations under consideration (horizontal blue line) changes abruptly from 8.9 °C in the previous period to 9.9 °C for the period after 1987.

Mean yearly temperature in Switzerland – 1961/2011 (by Meteoswiss)

Temperatures are expressed as positive (red) or negative (blue) anomaly compared to the 1961-90 average. The colors red (hot years) affected only 10% of the years 1961-1987, and the percentage rises to 90% after 1988.
The new European climate (after 1987)

Temperature: +0.5 °C
Precipitation: increase
Solar Radiation: decrease

Temperature: +1.5 °C
Solar radiation: increase.
Modelling approach

An age-structured mechanistic model built on biophysical (development, including diapause) and demographic (natality and mortality) processes for poikilotherm organisms.

Model development, parametrization and validation

Time-varying distributed delay with attrition; the model simulates vine plant canopy occupancy by diapausing eggs, post-diapausing eggs, nymphs and adults.

The temperature controls development, survival and reproduction. Survival of non-diapausing life stages is further controlled by the plant phenology.

The distribution in Europe requires the explicit consideration of photoperiodic (latitudinal) effects on diapause.

Model use

The assessment of the colonization potential of *S. titanus* on the basis of a Climatic Suitability Index "ξ"
Model performance:
prediction and explanation of the occupancy in a Swiss vineyard

Rigamonti et al., 2014. The Canadian Entomologist, 146: 67-79
Definition of the Climatic Suitability Index “ξ”

The index has been obtained on the basis of the number of diapausing and post diapausing eggs at the beginning of grapevine vegetative development (BBCH 11), one of the model outputs.

The index is quantified by dividing the number of eggs obtained in one year by the number of eggs obtained in the previous year.
Predicted geographical distribution in Europe

Maximum and minimum daily temperatures (TX, TN) for 1981±2013 period gathered for the 6690 synoptic stations from the NOAA GSOD dataset located within the ranges 28°N÷72°N and 11°W÷55°E.

Reference grid: 0.25 degrees lat lon with heights upscaled from the Nasa SRTM Digital Elevation Model

Spatialization of TX, TN for each grid node: IDWM method (Inverse Distance Weighted Mean on daily TX, TN previously homogenized to the height of each grid node).

Model run: the model was applied to each point of the grid.
Reference runs hereafter discussed:
  Run 1) from 1981 to 1990, $\xi$ is the mean value of the period 1983-87
  Run 2) from 1991 to 2000, $\xi$ is the mean value of the period 1993-97
  Run 3) from 2001 to 2010, $\xi$ is the mean value of the period 2003-07
  Run 4) from 2007 to 2013, $\xi$ is the mean value of the period 2009-13
Mean $\xi$ value in Europe for the five-year period 1983-1987
Mean $\xi$ value in Europe for the five-year period 1993-1997
Mean $\xi$ value in Europe for the five-year period 2003-2007
Mean $\xi$ value in Europe for the five-year period 2009-2013
Variation of the Mean $\xi$ value in Europe
Mean $\xi$ value in Europe for the year 2004

Mean $\xi$ rate

- <0.4
- 0.4<0.6
- 0.6<0.8
- 0.8<1
- 1<1.2
- 1.2<1.4
- >1.4
Concluding remarks

A northern shift of the potential distribution area of *S. titanus* has been observed within the study time period.

An increase in the $\xi$ values has been observed in Central and Eastern Europe.

A stability in the $\xi$ values has been observed at the southern potential distribution limit.

A high suitability of Northern Italy, Central and Eastern Europe along the 45° latitude has been confirmed.

The climate change occurred in the '980 may contribute to an explanation of:
- the changing distribution of *S. titanus* in Europe
- the spatio-temporal dynamics as summarized on the previously shown maps.
Thank you for your attention