Disentangling the effects of oak lace bug and climate on pedunculate oak tree growth in Croatia

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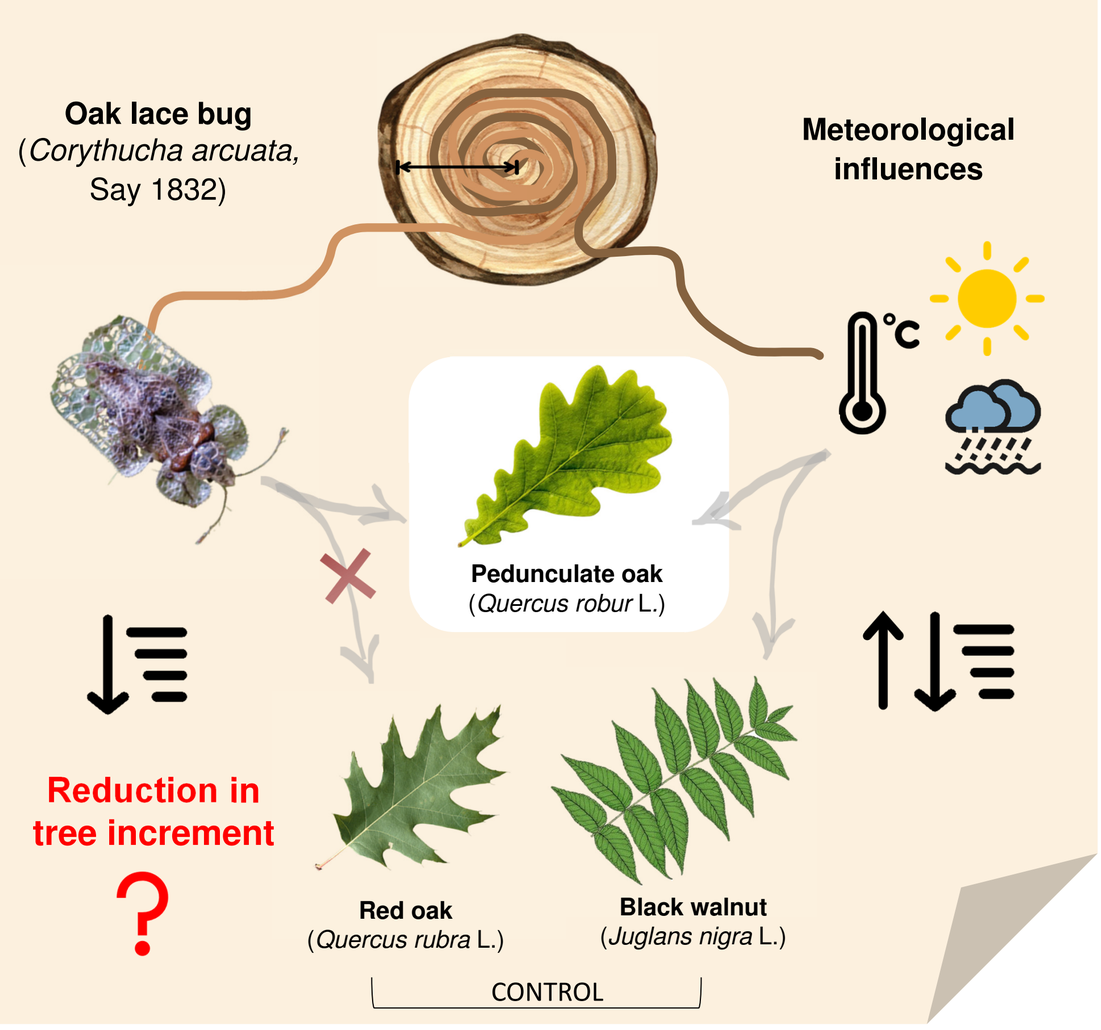

BACKGROUND

The oak lace bug (OLB, *Corythucha arcuata*, Say 1832) is an invasive sap-sucking species that has rapidly colonised oak-dominated forests in Croatia since its first detection in 2013 (Hrašovec *et al.* 2013, Kern *et al.* 2021). OLB infestations are known to negatively affect leaf photosynthesis (Nikolić *et al.* 2019), which could potentially contribute to reduced tree growth, particularly in combination with climate change effects. Nevertheless, the impact of OLB on tree growth remains largely unexplored.

This study aims to quantitatively assess the impact of oak lace bug on the radial growth of pedunculate oak trees in Croatia.

MATERIALS & METHODS

Study area selection

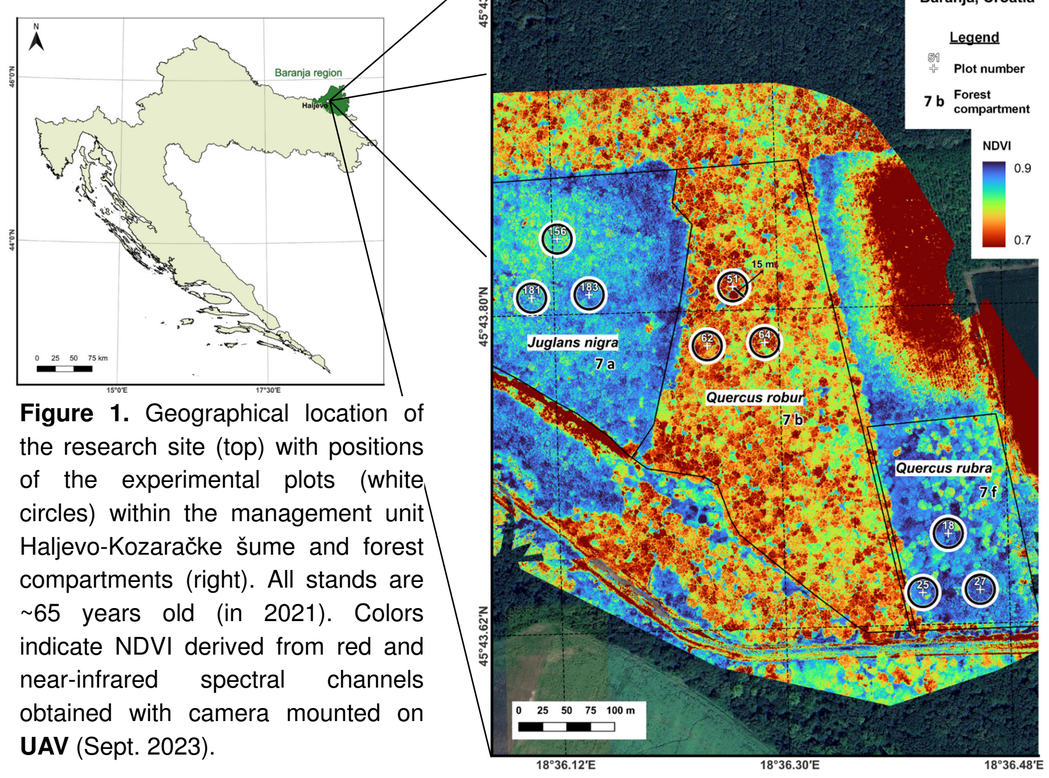

Figure 1. Geographical location of the research site (top) with positions of the experimental plots (white circles) within the management unit Haljevo-Kozaračke šume and forest compartments (right). All stands are ~65 years old (in 2021). Colors indicate NDVI derived from red and near-infrared spectral channels obtained with camera mounted on **UAV** (Sept. 2023).

Tree core sampling
(2024)

Sample preparation
Microtome for long cores, scanner, CooRecorder

Growth dynamics analysis
Before vs. after OLB arrival to the location (2016)

Tree species:
Q. robur, Q. rubra, J. nigra

✚

δ13C analysis
Laser ablation method (Saurer *et al.* 2023), subset of tree core samples of *Q. robur* and *Q. rubra*

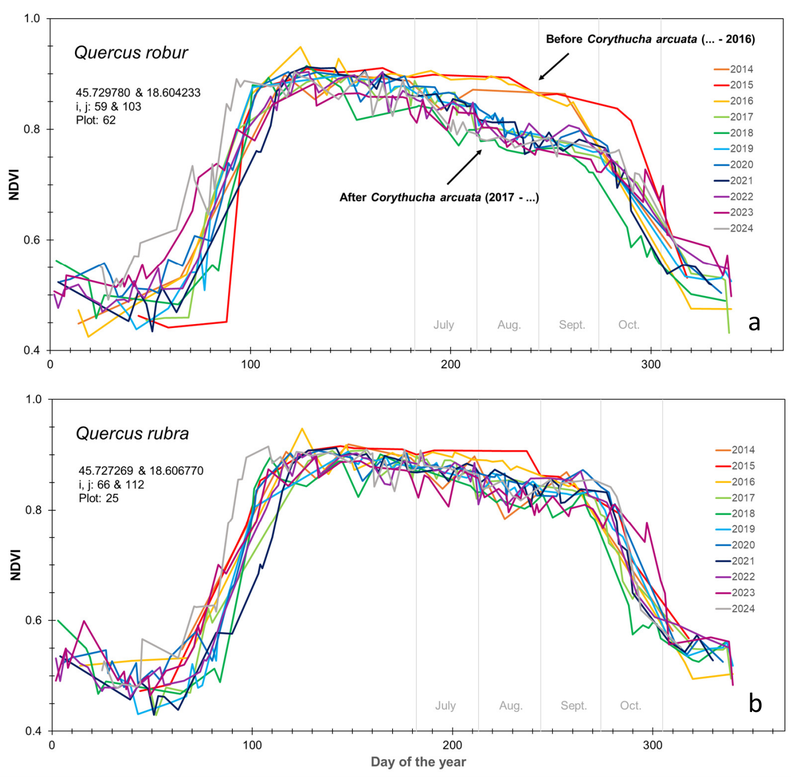

Figure 2. Phenological NDVI curves derived from **Harmonized Landsat Sentinel-2 (HLS)** data for the period 2014–2024, for *Q. robur* (a) and *Q. rubra* (b) plots.

A significant decline in NDVI is noticeable in ***Q. robur*** stands from 2017 onwards, indicating that the damage caused by the OLB became substantial during that time.

In ***Q. rubra*** stands, no such decline is observed, as this species is not affected by the OLB.

NOTE: In *J. nigra* stands, also no decline in NDVI from 2017 onwards was observed.

RESULTS

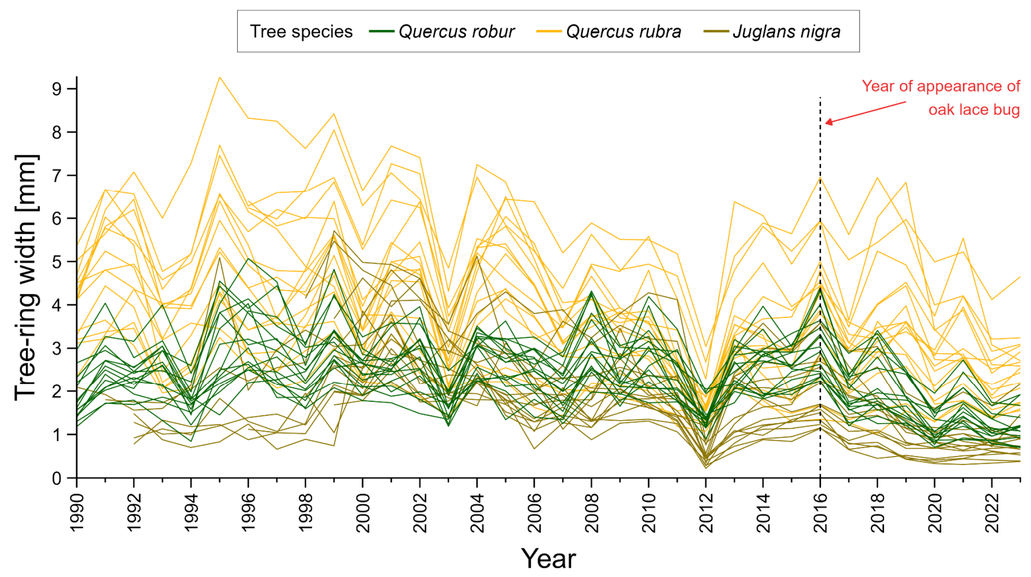

Figure 3. Cross-dated tree-ring widths by years for *Q. robur, Q. rubra* and *J. nigra* tree core samples. The number of tree cores per tree species is 15 for *Q. robur* and *J. nigra* and 17 for *Q. rubra.*

Table 1. Tree-ring widths and tree basal area increment (BAI) (mean ± s.e.) from tree core samples, grouped by tree species and by 7-year periods, before (2009-2015) and after (2017-2023) OLB appeared.

Tree species	N	Tree-ring width [mm]		Tree BAI [mm²]	
		(I)	(II)	(I)	(II)
		2009-2015	2017-2023	2009-2015	2017-2023
Quercus robur	15	2.38 ± 0.10[a]	1.58 ± 0.11[b]	2569.8 ± 198.3[a]	1904.3 ± 205.3[b]
Quercus rubra	17	3.08 ± 0.25[a]	3.03 ± 0.24[a]	3944.5 ± 306.8[a]	4369.2 ± 344.2[a]
Juglans nigra	15	1.70 ± 0.16[a]	1.02 ± 0.12[b]	1789.0 ± 292.7[a]	1176.7 ± 224.5[b]

NOTE: Different lowercase letters indicate statistically significant difference ($p < 0.05$) between periods for a given trait within a tree species. The differences in traits between periods were tested using a paired t-test.

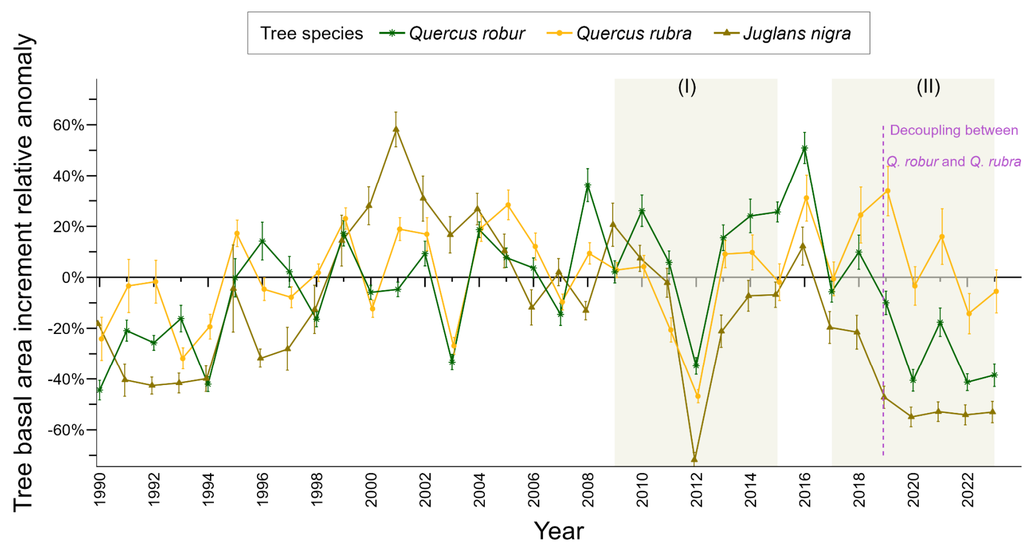

Figure 4. Relative anomaly of tree basal area increment (mean ± s.e.) for *Q. robur*, *Q. rubra* and *J. nigra* from the 1990-2016 mean. Grey-shaded area indicates investigated periods, before and after OLB arrived at the location.

Preliminary findings

- Decrease of 26% in mean tree BAI in *Q. robur* in the II. period (Tab. 1) corresponds with a decline in NDVI caused by OLB sap sucking
- No decline in NDVI in control species, yet opposite mean tree BAI change is observed in the II. period (Tab.1)
  - decrease in mean tree BAI in *J. nigra* (warmer & drier, stand density?)
  - no significant change in mean tree BAI in *Q. rubra* (access to groundwater?)
- Temporal $\delta^{13}C$ patterns between *Q. robur* and *Q. rubra* during early summer period (Fig. 6) demonstrate similar response to climate regardless of the OLB presence
- $\delta^{13}C$ results of *Q. rubra* and *Q. robur* show no apparent difference between periods I. and II.
- This can indicate that observed decrease in tree BAI in *Q. robur* is not caused by meteorological conditions, but most likely reflects the negative impact of the OLB

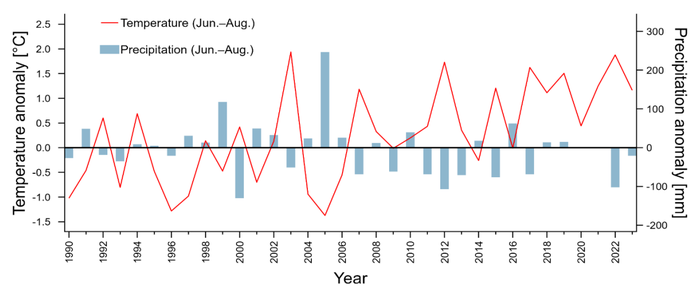

Figure 5. Mean temperature and cumulative precipitation anomalies (from June to August) for 1990-2023, relative to the 1990-2016 reference period (data source: FORESEE database).

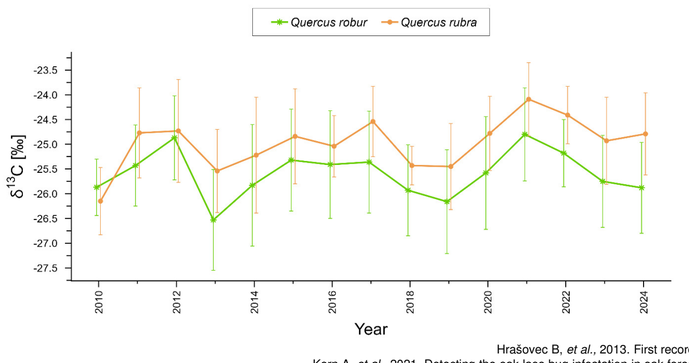

Figure 6. Tree-ring $\delta^{13}C$ values (mean ± 95% CI) of *Q. robur* and *Q. rubra* core samples (initial latewood) during the period 2010-2024.

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