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Environmental, biological and human drivers of the dieback of an evergreen Mediterranean forest

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Forests play a key role in the climate system thanks to their large carbon uptake and storage. On the other hand, forests are vulnerable to climate extremes and pest attacks, causing early tree mortality which in turn could reduce their carbon uptake capacity.

Early tree mortality is often associated to a complex interaction of predisposing stress factors (poor site quality, unfavourable stand conditions), inciting factors (frost, drought, mechanical damage) and contributing factors (fungi, insect borers).

In this context, the aim of the present work was to investigate the processes underlying the tree mortality observed in an evergreen mixed forest stand dominated by Quercus ilex, located in the Circeo National Park (central Italy).

The forest has the typical structure of an old-coppice not more managed (actual rotation time about 2 times that the normal), and was recently (2016) affected by an outbreak of Asian ambrosia beetle (Xylosandrus compactus) and Granulate ambrosia beetle (Xylosandrus crassiusculus) that caused an extensive trees crown browning. In 2019, plots were set in the area to monitor the beetle population dynamic and their impact on tree mortality. In each plot, species, dimension (DBH), stage of dieback, stem origin (resprouts after coppicing or from seed), presence of epicormic shoots and subcortical fungi stroma, were recorded for each woody plant.

The plot survey revealed a high frequency of stems classified in a declining stage or dead, on average 42% of the standing stems, with significant differences among the species: 97%, 85%, 74% and 47% for Arbutus unedo, Quercus ilex, Phyllirea latifolia and Fraxinus ornus respectively.

The higher stem mortality of Q. ilex was recorded in the smaller diameter classes, suggesting that the self-thinning process played an important role on the observed mortality as typical in the old not more managed coppices.

To disentangle the role of the interruption of the management from the climatic and biological drivers, time trends on NDVI index were constrained with the duration of the summer dry seasons and comparing our forest with similar Q. ilex forest coppices in the region and regularly managed.

Furthermore, the contribution of recent ambrosia beetles attack was assessed identifying the presence of twigs with signs of previous beetle attack on healthy, declining and dead plants.

Our findings point towards complex tree mortality dynamics, in which the competition generated by the stand abandonment predisposed the forest to the insect attack, leading to the general decline of the forest stand.