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Drivers of forest resistance to bark beetle disturbance in European forests

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Bark beetle infestation is a major causal agent of tree mortality that may be critical for forest persistence under future climates with increased warming and drought episodes. Such persistence, in terms of resistance to bark beetle disturbance, could be determined by the location of host tree populations in the species' climatic niche space, increasing close to the host climatic optimum and reducing close to the beetle climatic optimum. Therefore, we analyzed the resistance of European coniferous forests to bark beetle attack and its derived tree mortality, using successive censuses of forest damage surveys in relation to the climatic niche characterization of both host tree and bark beetle species. Specifically, we modelled the responses of forest resistance in relation to the distance to the niche optimum of the host tree and beetle species, stand attributes and previous drought characteristics. Regional patterns of recent beetle disturbance evidenced that forests in Central, North, and East of Europe could be at risk under the attack of multivoltine bark beetle species. In addition, we found that forest resistance to beetle attack was determined by several driving factors. The environmental position of the affected forest within the host and beetle species' climatic niche and the stand attributes mediated the influence of drought on the resistance to beetle attack. In particular, monospecific stands with a high frequency of drought in previous years and located close to both host tree and beetle climatic optimum showed low resistance to beetle attack. In turn, forest resistance to derived tree mortality was exclusively determined by the intensity and duration of previous drought. Once the forest resistance is exceeded to be infested, the mortality of host tree populations may be enhanced with the severity of drought events. These findings revealed that the resistance of European coniferous forests to bark beetle disturbance is modulated by the joint host-insect climatic suitability and by beetle-drought interactions. Moreover, the expected increase of extreme drought events in the coming decades, particularly under the threat of multivoltine bark beetle species activity, may amplify beetle-induced tree mortality threatening forest persistence.