OAK PROCESSIONARY MOTH (*THAUMETOPOEA PROCESSIONEA*)—HAZARD ASSESSMENT AND DECISION SUPPORT FOR MANAGEMENT

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PURPOSE AND SCOPE

Outbreaks of oak processionary moth (OPM, *Thaumetopoea processionea*) threaten the vitality of oak (*Quercus* spp.) trees through defoliation and endanger human and animal health due to the release of urticating hairs (setae) by larvae. Since about 1990, the occurrence of OPM has increased in forests and urban areas of central Europe. OPM was accidentally introduced into the United Kingdom in 2005 and is currently spreading in the southeast of England. Climate change and shifts in land use may trigger higher abundances and range expansions of OPM in the future (Godefroid et al. 2020). Levels of tree defoliation due to OPM infestation generally increase during late spring and early summer, as do health hazards because numbers of setae per larva increase from the 3rd to 6th instar (L3–L6). This requires development of an effective integrated pest management program for OPM to avoid oak decline and setae accumulation. For hazard assessment and decision support, an online early warning system "PHENTHAUproc—phenology modelling of *Thaumetopoea processionea*" was created in the early 2020s. In addition, the setae contamination potential emanating from OPM larvae and OPM-infested trees, as well as the *in-situ* spatiotemporal pollution by airborne OPM setae, were quantified.

METHODS AND APPROACH

PHENTHAUproc was created by combining existing temperature-based phenology models for OPM larval hatching and leaf unfolding of two host trees, *Quercus robur* and *Q. petraea*, with new models for OPM development and oak bud swelling. To predict the development of OPM stages from larval hatching

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to eclosion, a linear mixed effects model was generated based on data from OPM reared in the laboratory under constant temperatures (14 to 28 °C) during a 5-year period. Moreover, a model for *Q. robur* bud swelling was created for the first time, based on field observations. The existing and new models were validated by means of field data from different sites and years in southwest and northeast Germany.

In further studies, besides the development of PHENTHAUproc, the number of setae per OPM larva was determined by use of scanning electron microscope (SEM) photos, and the setae contamination potential of whole infested trees was extrapolated. In addition, passive samplers and volumetric samplers were used to assess the airborne distribution of OPM setae in the field.

FINDINGS AND IMPLICATIONS

PHENTHAUproc provides phenological forecasts at local and regional levels (i.e., for weather station locations and grid maps), as well as recommendations for OPM control, such as the use of biological insecticides or mechanical measures. An exemplary prototype of the early warning system was created for Germany (fig. 1, Halbig et al. 2024). Furthermore, the free R software package "PHENTHAUproc" was developed including all algorithms (Bachfischer 2024). The models can be used anywhere in Central Europe for OPM hazard assessment as soon as air temperature data and information on potential adaptations of OPM to local climate and changes in host tree phenology are available. Starting in 2025, the early warning system will be provided as a free web application with daily updates for all of Germany in 1-km by 1-km resolution by the German Meteorological Service (DWD). Besides integrating the weather forecast for 7 days, the phenological predictions are supplemented by *in situ* observations of oak bud swelling and leaf unfolding to determine optimal timing of control measures and responses.

The additional studies on setae contamination potential revealed that several billion setae per infested tree is common during OPM outbreaks. Airborne setae distribution ranged up to hundreds of meters from the source tree. These findings and tools help ensure the integrated management of OPM for forest health as well as human and animal health in Central Europe.

LITERATURE CITED

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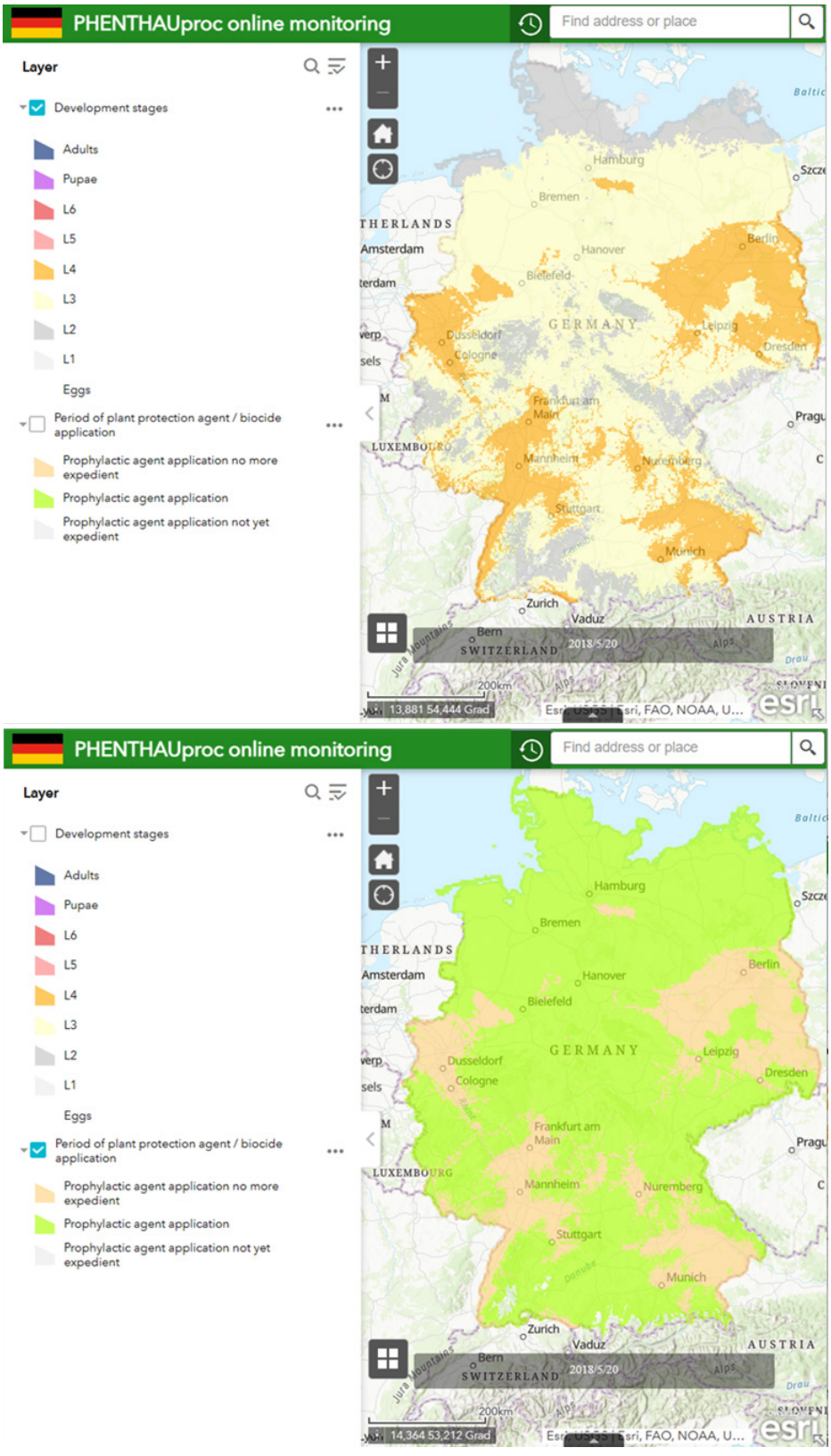

Figure 1—Screenshots of the web map service of the PHENTHAUproc prototype; (top) phenological development of oak processionary moth (*Thaumetopoea processionea*, OPM) on May 20, 2018 (layer "development stages" was selected) and (bottom) recommendation of preventive OPM control by means of plant protection agents or biocides on May 20, 2018 (layer "period of plant protection agent/biocide application" was selected). Available on BOKU University website for risk analyses: https://ifff-server.boku.ac.at/wordpress/index.php/phenthauproc-online-monitoring-2/project_info/. [Date accessed: 11 June 2024].

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