

GROWING KNOWLEDGE

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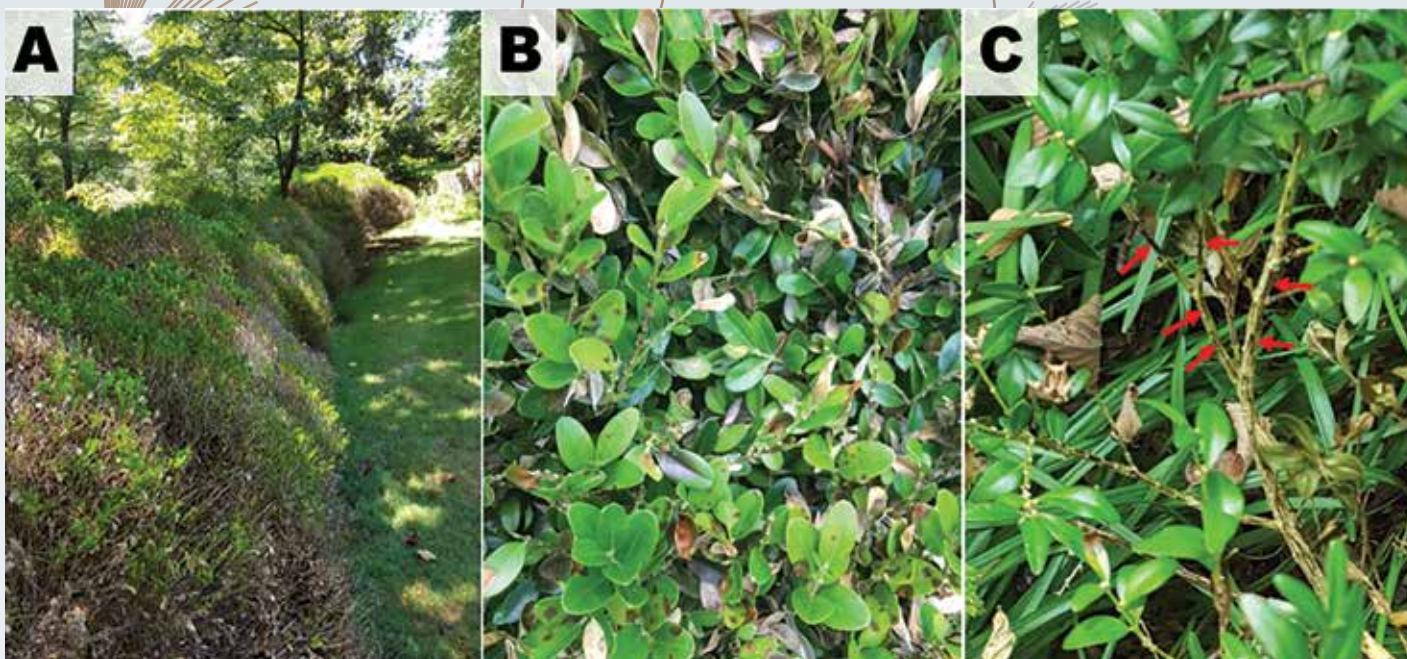


Figure 1. Diagnostic symptoms of boxwood blight include (A) defoliation, (B) leaf spots, and (C) black streaks on stems. PHOTOS COURTESY OF CHUAN HONG

Boxwood blight

New tools to forecast infection risk in Pacific Northwest nurseries

BY BRITTANY S. BARKER AND LEONARD COOP

BOXWOOD BLIGHT, also known as box blight, is an emerging disease of boxwood (*Buxus* spp.), a major evergreen shrub crop and iconic landscape plant. This disease is caused by two invasive ascomycete fungi, *Calonectria pseudonaviculata*, and *C. henricotiae*.

Minimizing the spread of the pathogen in Oregon is critical because this state is the largest producer of boxwood in the nation. To date, boxwood blight has been confirmed at more than 12 locations (mostly in nurseries) in six different counties in western Oregon.

Both pathogen species can infect and blight boxwood foliage, resulting in rapid plant death (Fig. 1). In the United States, *C. pseudonaviculata* has spread to at least 30 states since it was first detected in 2011, where it has caused serious economic damage to the ornamental horticultural industry.

The importance of monitoring

The protection of boxwood in Oregon depends on precise timing of surveillance, monitoring, and management of boxwood blight infections.

Scouting for boxwood blight immediately after weather conditions were suitable for infection can increase the likelihood that *C. pseudonaviculata* is detected and treated before it can spread to additional locations. Additionally, applying fungicides prior to the onset of favorable conditions for infections can help prevent boxwood blight outbreaks. Forecasts that quantify the degree to which upcoming weather conditions will be suitable for infection have the potential to support timely decision-making.

In this article, we present updates to risk modeling tools for boxwood blight that are part of the **USPest.org** decision-support system, which is managed by the Oregon Integrated Pest Management (IPM) Center at Oregon State University.

For more than 10 years, USPest.org has maintained a boxwood blight risk model that can be linked to weather stations to provide early warning systems to inform decision makers about potential high-risk situations where action may be needed. This model was recently adapted to produce maps of infection risk, which may allow decision-makers to track areas of relative risk, assuming that susceptible cultivars and disease inoculum are both present at a given location.



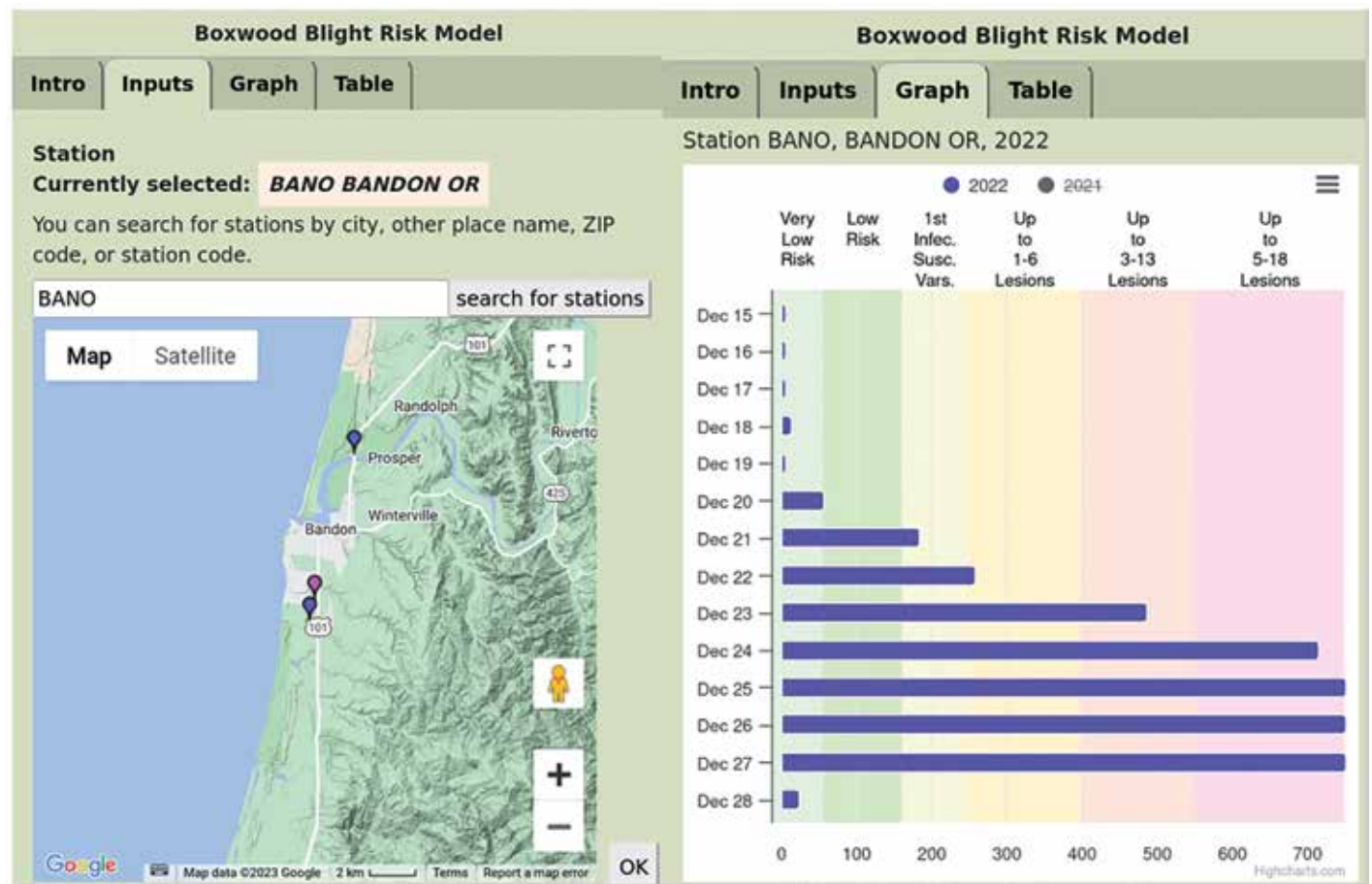


Figure 2. Inputs and outputs of the boxwood blight site model run for Bandon, Oregon, for December 15–28, 2022 (left and right panel, respectively). The infection risk index gradually increased over the selected time frame due to cool temperatures (53–61 F) and near continuous moisture due to steady rains and high relative humidity, a common weather pattern in coastal regions of the Pacific Northwest. IMAGE COURTESY OREGON STATE UNIVERSITY

Figure 1 (previous page). Diagnostic symptoms of boxwood blight include (A) defoliation, (B) leaf spots, and (C) black streaks on stems.

How the models work

The boxwood blight risk models use information on the range of temperature and moisture conditions that *C. pseudo-naviculata* needs to complete the steps in the infection process. These steps include spore germination, mycelial tube growth (the step often cited to be stopped by fungicides), penetration of host plant tissue, and colonization of plant cells.

The speed of development depends primarily on temperature, but free moisture must also be present on the leaves or other surfaces of a susceptible plant. This can come in the form of high humidity leading to dew formation, or rainfall. The presence of moisture is, as a measurable or

estimated factor, known as “leaf wetness.”

The models are designed to identify the precise time when infection can occur. If conducive weather conditions continue for longer than this initial threshold, then risk keeps increasing and the relative amount of inoculum required for outbreaks reduces accordingly. If left unchecked, this may cause multiple compounding infection cycles. Risk levels in the models include “very low risk,” “low risk,” “1st infection of susceptible varieties,” “up to 1–6 lesions,” and “up to 5–18 lesions.”

These levels were delineated based on laboratory studies of boxwood blight infection rates on American and English boxwood. Documentation that describes modeling methods and assumptions can be found at the model websites.

Forecasts for single sites

The boxwood blight site infection risk model at USPest.org (TinyURL.com/BoxwoodApp) was first reported in the Growing Knowledge section of *Digger* in October 2014 (Coop, 2014). Since then, it has been updated several times to include an easy-to-use web app (Fig. 2), and to reflect new research results from numerous plant pathologists.

In particular, it was shown that infections can occur at temperatures as low as 44 F (6.7 C), over the course of several days as long as the environment is continuously wet or at least moist. As these conditions can happen most anytime during the long rainy season (October to May) in regions west of the Cascades in the Pacific Northwest, the updated model can indicate these high-risk intervals much better than the earlier model.

For example, in Fig. 2, the risk index at the Oregon Coast (Bandon) gradu-

ally built up over 4–5 days and remained at maximum for another three days in December 2022, with temperatures averaging 55 F and total rainfall exceeding 3.5 inches. The near continuous wetting interval allowed multiple infections to complete, albeit slowly, which corresponded to “very high risk” or “up to 5–18 lesions” ratings for each day between December 24–27.

The original model, which was based on data from European studies only, used a higher threshold and so would not have correctly alerted users to these high levels of risk. Long cool and wet periods also take place in the interior valleys of Oregon and Washington, where boxwood nurseries are abundant, though less frequently than on the coast.

Figure 2 (Page 42). Inputs and outputs of the boxwood blight site model run for Bandon, Oregon, for December 15–28, 2022 (left and right panel, respectively). The infection risk index gradually increased over the selected time frame due to cool temperatures (53–61 F) and near continuous moisture due to steady rains and high relative humidity, a common weather pattern in coastal regions of the Pacific Northwest.

At the website for the site model, end-users can sign up to receive automated email delivery of the disease risk index outputs displayed in the app, which include both tabular and graphical formats (e.g., Fig. 2). USPest.org also offers a synoptic risk map for boxwood blight that shows current risk conditions for all available weather stations for the continental U.S. (TinyURL.com/BoxRiskMap).

Spatial forecasts

A newly developed mapping app (TinyURL.com/OSUBoxApp) provides near-term (up to four days) forecasts of boxwood blight for all areas in western Oregon and Washington (Fig. 3). Thus, the output of this spatial model is a map rather than a plot or graph of results for a single site. Risk maps are updated on a daily basis to provide real-time decision support on where and when to expect potential outbreaks. Maps may be panned

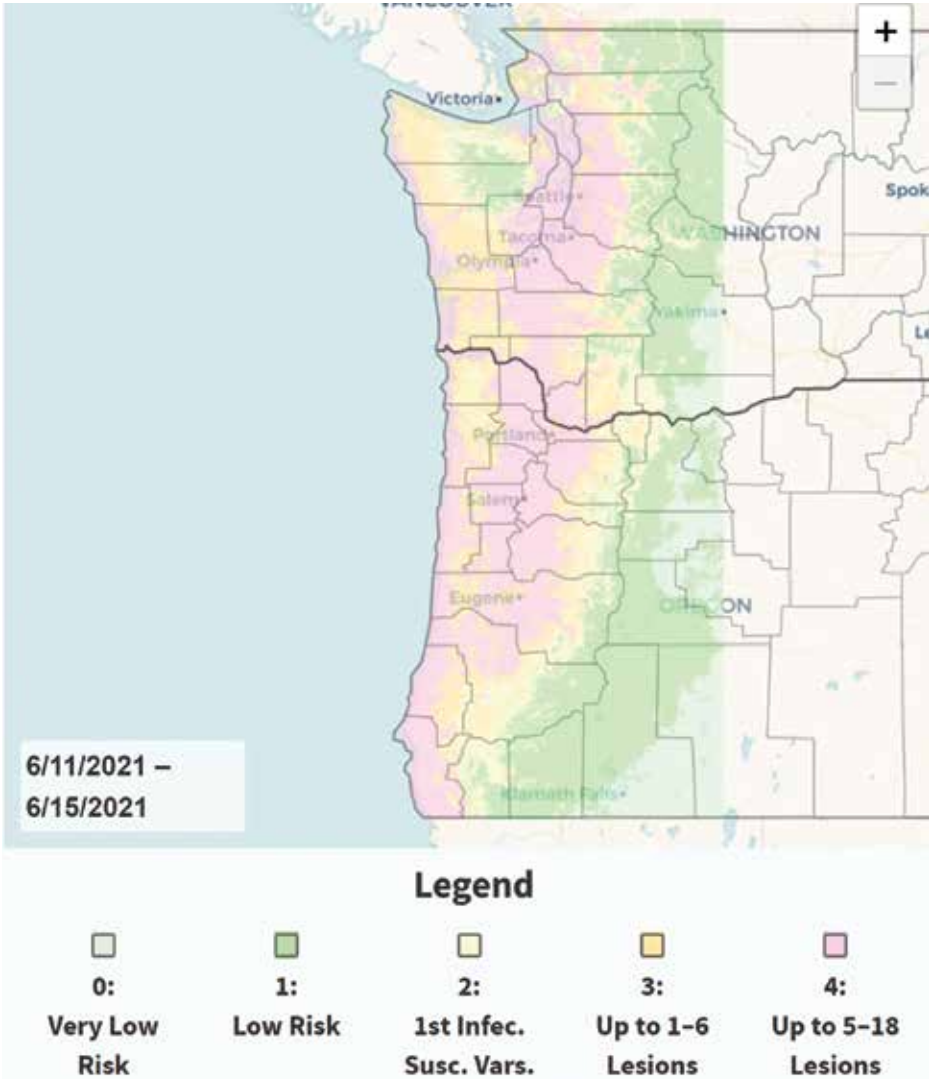


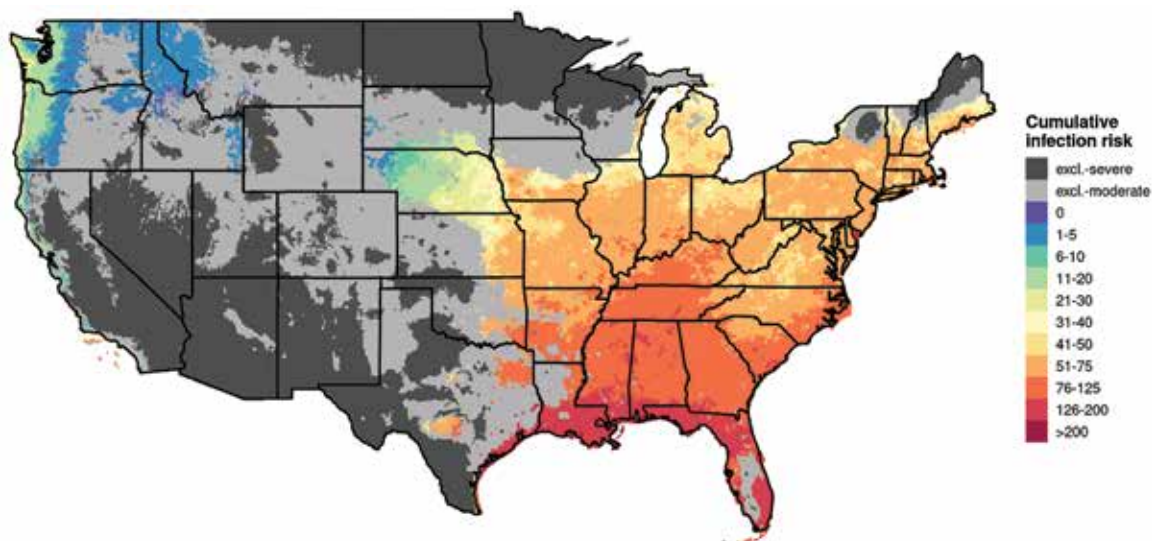
Figure 3. A four-day infection risk map for boxwood blight for western Oregon and Washington for June 11, 2021. IMAGE COURTESY OREGON STATE UNIVERSITY



Figure 4. Four-day risk maps for Portland, Oregon, for June 8 in 2023 (left map) and 2022 (right map). IMAGE COURTESY OREGON STATE UNIVERSITY

Figure 5. Spatial forecasts of establishment risk and year-long (cumulative) infection risk for boxwood blight for 2021. Gray shading indicates that climatic conditions are unsuitable for establishment. The eastern U.S., in general, has climates that are more conducive to both infection and symptom expression than is the Pacific Northwest.

IMAGE COURTESY OREGON STATE UNIVERSITY



and zoomed, and an address can be submitted to zoom to an area of interest (Fig. 4). Additionally, the cursor can be hovered over a location to extract the corresponding risk level.

Figure 3 (Page 43). A four-day infection risk map for boxwood blight for western Oregon and Washington for June 11, 2021.

Figure 4 (Page 43). Four-day risk maps for Portland, Oregon, for June 8 in 2023 (left map) and 2022 (right map).

The mapping app also provides an option to compare present-day and historical risk maps for the same dates (Fig. 4, Page 43). For example, four-day risk maps for the Portland, Oregon, area indicate that infection risk was lower on June 12, 2023 compared to June 12, 2022, which suggests that temperature and moisture conditions were less optimal for disease development between June 8–12 in 2023.

Regional infection risk

Thus far, we have presented apps that provide forecasts of short-term infection risk for single locations (site model) or for western Oregon and Washington (spatial model). In addition to this work, we have modeled climatic suitability for *C. pseudonaviculata* at regional and global scales to assess establishment risk (Barker et al. 2022).

Maps of infection risk and establishment risk can be integrated in our spatial model for boxwood blight, although an app for this model is not yet available. As an example, Figure 5 depicts a forecast of establishment risk and year-long (cumulative) infection risk for the continental

U.S. for 2021. Most of the western U.S. is unsuitable for the survival of *C. pseudonaviculata*, which is mostly due to arid conditions. In areas where establishment is possible, year-long cumulative risk tends to be much lower compared to risk in the eastern U.S. Climates in the eastern U.S. are generally more favorable for boxwood blight infections owing to fewer gaps in precipitation, high dewpoints, and thus high humidity over the year combined with warm-to-hot summer temperatures.

Climatic differences between the Pacific Northwest and eastern U.S. may help explain why shipments from this region can appear symptomless when shipped, but are nevertheless not disease-free, and result in observable disease after just a few days or weeks in more favorable climates.

We recommend that nurseries take whole plants or cut stems with six or more leaves that are suspected to be diseased, and to set them up in disease-conducive environments to further elicit symptoms before making major shipments out-of-state. Plant materials can also be sent to a qualified plant disease diagnostic clinic, such as the one run by Oregon State University ([Bit.ly/OSUclinic](https://bit.ly/OSUclinic)).

Figure 5 (above). Spatial forecasts of establishment risk and year-long (cumulative) infection risk for boxwood blight for 2021. Gray shading indicates that climatic conditions are unsuitable for establishment. The eastern U.S., in general, has climates that are more conducive to both infection and symptom expression than is the Pacific Northwest.

Potential sources of error

Several factors that are not considered by the boxwood blight risk models may influence the incidence and severity of disease, such as local inoculum levels, site-specific environmental conditions, dispersal, and the relative resistance of the numerous boxwood cultivars. For example, nurseries in the Pacific Northwest may inadvertently create ideal humidity levels for infection by using shade netting and overhead irrigation system during the summer.

Susceptibility to blight infection is known to vary across *Buxus* species and cultivars. Most *Buxus sempervirens* cultivars are moderately to very highly susceptible to boxwood blight. However, most Asiatic species (*B. microphylla*, *B. sinica* and *B. harlandii*) cultivars range from low to moderate susceptibility. *Buxus microphylla* var. *japonica* ‘Morris Midget’, however, tested as very highly susceptible. An integrated ranking of *Buxus* cultivars to boxwood blight is available at TinyURL.com/BlightRank.

Conclusion

The boxwood blight risk models at Oregon State University can help decision-makers determine where and when to conduct close inspections for disease, and when fungicide applications may be needed for control of outbreaks.

Detecting infections early may help reduce the spread of *C. pseudonaviculata* to new locations in Oregon. However, models are just one of several methods for reducing the threat of boxwood blight. Production nurseries, retailers, and landscapers can create less conducive environ-

ments for infection by implementing best practices such as using less dense plantings, limiting shade cover, and exclusively make use of drip tape or underground irrigation. Additionally, they can use certified planting stock and choose resistant boxwood varieties.

We refer readers to the “Boxwood Blight Resources” webpage at Oregon State University (TinyURL.com/BoxResource) and the Pacific Northwest Plant Disease Management Handbook (TinyURL.com/PNWHandbook) for more information on symptoms, diagnosis and management options for boxwood blight. Additionally, a publication by Virginia Cooperative Extension provides details on best management practices boxwood blight (Bush et al. 2016).

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References

- Barker, B. S.; Coop, L.; Hong, C. 2022. Potential distribution of invasive boxwood blight pathogen (*Calonectria pseudonaviculata*) as predicted by process-based and correlative models. *Biology*. 11:849.
- Bush, E.; Hansen, M. A.; Dart, N.; Hong, C.; Bordas, A.; Likins, T. M. Best management practices for boxwood blight in the Virginia home landscape. *Virginia Coop. Ext. Publ.* 2016, PPWS-85NP. Available at https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/PPWS/PPWS-29/PPWS-29-pdf.pdf (accessed on 2 January 2024).
- Coop, L. (2014, October). The best/worse time for pathogens. *Digger*, 33–36.
- Weiland, J. E., M. Ohkura, C. F. Scagel, D. E. Anne, and B. R. Beck (2020). Cool temperatures favor growth of Oregon isolates of *Calonectria pseudonaviculata* and increase severity of boxwood blight on two *Buxus* cultivars. *Plant Disease* 106:3100–3108.



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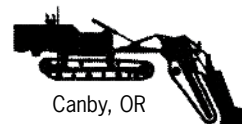
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