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Editorial

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Biology of Invasive Plants: a new series within *Invasive Plant Science and Management*

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Series Outline

These reviews are intended to collate published and unpublished information on the biology and ecology of emerging plant invasion problems globally. They will assemble background information to lay a foundation reference source concerning the biology and ecology of the focal species. Furthermore, they will provide vital practical recommendations, highlighting invasion risks and their management.

This series builds on foundations laid in more regional series such as the Biology of Australian Weeds (Groves and Panetta 2014), Biology of Canadian Weeds (Cavers and Mulligan 1972), and Biology of Invasive Alien Plants in Canada (Warwick et al. 2003), and retains many of the features of these review series. The Biology of Invasive Plants series addresses the fact that biological invasions are a global problem. We want to provide a platform for identifying global risk patterns to alert biosecurity agencies and weed managers of emerging threats and to provide a consolidated resource to help manage these emerging threats.

Intended Audience

The Biology of Invasive Plants series is intended to provide a useful resource for a broad range of readers, including biologists, ecologists, risk assessors, policy advisers, and weed managers. The global nature of plant invasion risk means that this series should appeal to a global audience.

Guidelines for Authors

The *Biology of Invasive Plants* series covers all vascular plants that have demonstrated invasive behavior. Reviews may cover a single species or higher taxonomic grouping as appropriate. The purpose of this series is to (1) highlight global plant invasion risks, (2) provide a useful resource to inform efforts to prevent spread to new continents or jurisdictions, and (3) where this fails, to manage invasions.

Guidelines for the format of accounts are provided below. We recognize that each target taxon will vary in the amount and type of material available and the relative importance of different types of information to the prevention and management of spread and impacts. Inquiries about the format or advice on preliminary material should be directed to the series editors.

The reviews will be more valuable if they include previously unpublished material, and authors are encouraged to include new information. In general, authors should cite printed material or material that has a persistent URL or digital object identifier. Similarly, peer-reviewed material is strongly preferred over "gray" literature.

Reviews are global in scope. In each section, commence with a global overview and then proceed to deal with each continent or region.

Proposals

If you wish to prepare a submission, you must first check that the species has not been assigned already. To help avoid duplication of effort, a list of taxa that are in the process of having reviews prepared will be maintained on the *Invasive Plant Science and Management* website. If your species of interest is not on the list of articles in process, please send an "offer of contribution" to the series coeditors at wssa@cambridge.org. If this is approved, you may proceed with preparing the manuscript. The completed manuscript is to be submitted directly to *Invasive Plant Science and Management*. You should correspond with the series coeditors with a progress update at least every 6 months. Approved offers may be withdrawn if the article is unlikely to be completed within a reasonable time frame.

Format

The format is broadly similar to the Biology of Alien Invasive Plants in Canada and Biology of Australian Weeds, though with a global scope and more emphasis on collating information that

is relevant to managing the spread of the invasive species among continents and jurisdictions. Each submission should include a potential distribution model to alert biosecurity managers to invasion threats. These models may be previously published or developed de novo. Where a bioclimatic potential distribution model is developed de novo in support of a review, a structured appendix should be added, documenting the model so that its reliability can be gauged. A summary box, called "At a Glance . . . " will provide readers with the briefest introduction to the taxon and is intended to play the role of an abstract.

Reviews for a single species should not generally exceed 55 manuscript pages, including maps, diagrams, drawings, and photographs (12-point font, double-spaced, with numbered lines). Reviews covering multiple species may be a little longer. The completed manuscript should be submitted to *Invasive Plant Science and Management* and comply with the format and requirements of this journal.

Title

Each review will be given a number when it is accepted for publication. The number will be part of the title and will precede the species name, for example, Biology of Invasive Plants 1. *Pyracantha angustifolia* (Franch.) C.K. Schneid.

Name and Taxonomy

Give the botanical name (genus, species, and nomenclatural authority) currently accepted by plant taxonomists, along with the derivation of the genus and species epithets. List the synonyms that are, or have been, commonly used. Where appropriate give the common names and the regions in which they are used. The following are some standard sources for botanical names:

The World Checklist of Vascular Plants (WCVP): https://wcvp.science.kew.org/

Plants of the World Online (PWO): http://plantsoftheworldonline.org/

Tree of Life: http://www.tolweb.org/tree/

Global Biodiversity Information Facility: https://www.gbif.org/

Describe the taxonomy of the species, including a brief coverage of any significant revisions or controversy. Note whether any close relatives are reported to be invasive.

Importance

Describe the negative impacts and positive attributes of the species. These should be addressed broadly, covering economic, health, amenity, and environmental impacts. Readers should be able to appreciate why they should be concerned about the potential spread of this plant species and also to understand whether it is a "conflict" species.

Description

Briefly describe the species. Where possible, use simple terms rather than technical taxonomic terms and refer to photographs or diagrams to illustrate features. Include photographs or drawings of a mature plant, a seedling, and any persistent stages. The images should aid field diagnostics. If the appearance of any stage is affected significantly by factors such as chemical or cultural control, parasites, or diseases, these should be illustrated where possible. Include molecular identification methods if available.

Distribution

Describe the known native and introduced geographic ranges. If at all possible, compile a list of known locations from multiple sources such as the Global Biodiversity Information Facility (GBIF; www.gbif.org) and present these in the form of a map. Use the Robinson projection for the global map. Where appropriate, include larger-scale maps of regions where more detailed spatial information is available. Be careful to avoid including country or other administrative region centroids as points on the map. Where the species distribution is only known to the country or administrative region level, portray the administrative unit as a shaded polygon. Where possible, clearly distinguish between location records representing established populations from those that are transient or only present due to human cultural factors such as irrigation. The journal will provide some mapping resources to provide a consistent format for the maps. These resources include prepared map packages for use with QGIS and ArcMap, along with instructions for each of these packages on how to search for and download distribution data from GBIF, import them, and create and export a known distribution map for use in this account. This will help ensure that the maps are consistent in their formatting. Instructions will also be provided for importing a potential distribution model. For authors with limited knowledge of bioclimatic modeling, we will provide a very simple modeling tool based on the Köppen-Geiger climate classes. This tool will use point distribution data to identify climate types that have corresponding known distribution records. This tool can be used to identify climate and land-use types for inclusion in the Habitat section.

Habitat

List the Köppen-Geiger climate types that the plant inhabits and describe any climatic or microclimatic limitations or preferences in relation to temperature, soil moisture, or humidity. Describe stresses in terms of waterlogging or drought sensitivity and tolerance of heat and cold. Note any known relationships between climatic factors and the plant's phenology.

Use the FAO Land Use Systems of the World v. 1.1 (www.fao.org/nr/lada/) or similar spatial data to identify suitable habitat types. This list can be sourced by spatially intersecting the distribution data with the land-use data. This analytical list can be compared with published accounts. This cross-check can also be used to help identify errors in the distribution data.

Describe the soil types that are associated with the plant. Try to elucidate those specific factors that are positively or negatively correlated with the species distribution. For aquatic plants, describe what is known about the water qualities that promote or prevent the establishment of this species.

Describe the plant communities in which the plant is found and the effects of disturbance and land use on promoting or hindering the survival and establishment of populations of the plant. For example, is it found predominantly in horse paddocks and frequently disturbed areas such as roadsides?

Describe whether human cultural factors such as irrigation or any other specific agricultural or land management measures are supporting populations in otherwise inhospitable conditions.

Invasion History

Describe the history of spread of the plant species outside its native range. Where known, indicate the time of introduction in new regions. Comment on the rate of spread and describe the invasion pathway(s). Describe any eradication attempts, outlining the

technologies employed, their success or otherwise, and any factors that promoted or hindered success.

Life-Form and Life History

Describe what type of life-form(s) and life-history patterns the species exhibits under different environments (e.g., annual forb, perennial shrub, or multi-stem tree). Identify the life strategy (stress tolerator, competitor, ruderal [sensu Grime 1979, 1988; Grubb 1998]) and life cycle of the plant. Include a diagram of the life stages.

Dispersal and Establishment

Explain how the species spreads at different spatial and temporal scales. Describe the factors associated with establishment of new populations.

Invasion Risk

Authors are strongly encouraged to include a map indicating the modeled global potential distribution. Use this model to highlight the areas at risk of invasion and any obvious significant assets at risk. The journal will supply mapping resources and some instructions to provide a consistent format for the maps. If the model of the species' potential distribution has been published elsewhere, then it is sufficient to refer to the publication where the model was described. If the model has been developed specifically to support this review, then sufficient information must be included in the structured appendix to allow the model to be evaluated. If a correlative species distribution model is used (e.g., Bioclim, Boosted Regression Trees, MaxEnt), particular attention should be paid to ensuring that the model is not misbehaving when being transferred between continents and carefully checking outlying records to identify records of casual populations or populations that are dependent on cultivation practices such as glasshouses or irrigation. These records should either be removed or the spatial cultivation process explicitly included in the model. The material to be included in the structured appendix is described below. For all models, close attention should be paid to checking the veracity and meaning of outlying records. These climatic outliers can have a profound impact on the resulting model. If they are records of the plant being found in cultivated locations, then they should generally be removed from the training data set, which should consist only of records that represent established populations. An exception to this is where the cultivated and non-cultivated risks are modeled separately and combined into a composite risk map.

Invasion Pathways

Describe how the species spreads between continents and regions.

Growth and Development

Morphology. Describe any noteworthy morphological features that are important to the species identification and colonization or survival and explain their importance.

Stress Tolerance. Describe the species' mode of perennation and susceptibility to or tolerance of stressful conditions (e.g., oversummering, overwintering, waterlogging, salinity).

Ecophysiology. Explain how the plant responds to temperature, soil moisture, humidity, salinity, and mineral nutrition.

Phenology. Describe the times of growth and appearance of above- and belowground organs. To give meaning to this material, the location of observations is critical. Where possible, relate the timing of phenophase shifts to proximal environmental data (e.g., daily maximum temperatures or daylength). Include any knowledge of thermal sum (degree day) requirements, including the relevant base temperature for calculations.

Mycorrhiza and Bacterial Symbionts. State whether mycorrhiza or bacterial symbionts are present or required, and if so, the type.

Reproduction

Floral Biology. Describe the pollination biology and ecology, listing any known pollinators. Comment on self-compatibility and describe how seeds are produced (autogamy, allogamy, or agamospermy or some combination of these). Is the plant capable of vivipary?

Seed Production and Dispersal. Describe the median number of seeds per fruit, inflorescence, and plant, preferably under a range of conditions. What is the median mass of seeds or propagules? Describe the mode of seed dispersal and the adaptive features that support that mode of dispersal.

Seedbanks, Seed Viability, and Germination. Describe the longevity of the seeds in the seedbank. Is the seedbank transient or persistent in different environments? Describe the germination patterns. If these observations are under natural conditions, indicate the geographic context. If based on laboratory studies, include the source of the seed if known. Describe any special conditions affecting germination (e.g., light regime, ruminant gut passage).

Vegetative Reproduction. If the plant reproduces vegetatively, describe the mode and rate of reproduction and spread. If the plant reproduces via different modes in different habitats, describe the conditions under which each mode is observed.

Population Dynamics

Describe the rate of increase and decline of populations in various habitats and seasonal conditions. Do more plants recruit or die in certain months or seasons or after changes in the habitat (e.g., drought, floods) or treatment or disturbance (e.g., after fire)? Include the mean life span of individuals in various habitats. Refer to population genetic information or molecular ecology if available.

Describe the plant's competitive ability (intraspecific and interspecific) and its method of competing with other plants.

Does the species usually occur as solitary plants, large patches, small patches, etc.?

Describe the recruitment frequency (e.g., the number of generations per year) in different environments.

Management Options

Phytosanitary Measures. Describe treatments or measures to prevent the spread of the species between continents or jurisdictions, and any examples of where these have been implemented.

Chemical. Describe how the species responds to chemicals or herbicides at different life stages. Where relevant, give a brief list of common herbicides that may be of use to control the plant. Note whether there have been any reports of herbicide resistance, and where these reports have originated.

Cultural. Describe how the species responds to cultural control techniques such as mowing, controlled livestock grazing, crop rotation, harvesting, plowing, steam treatment, or fallowing.

Biological. How does the species respond to herbivory, diseases, or parasites? For each natural enemy, state the scientific name and authority and the degree of host specificity. Describe the life stage(s) affected, the type of impact, and the response of the plant population. Where possible, be careful to contextualize the knowledge in terms of the environmental conditions under which the results were observed.

General Outlook

Highlight the overall invasion risks to presently uninvaded continents, considering climate suitability, invasion pathways, and the feasibility of attenuating the pathway risks. Reflect on the global experience in managing invasions to date. Consider how future scenarios (e.g., global warming, changing land use) might impact the prognosis or risk profiles.

Measurements

Refer to the *Invasive Plant Science and Management* guidelines.

References

References should follow the style of *Invasive Plant Science and Management*. For example:

Book: Woodward FI (1987) Climate and plant distribution. Cambridge: Cambridge University Press. 174 p

Book chapter: Syrett P, Briese D, Hoffmann J (2000) Success in biological control of terrestrial weeds by arthropods. Pages 189–230 *in* Gurr G, Wratten S, eds. Biological Control: Measures of Success. Dordrecht, Netherlands: Springer

Conference paper: Groves R (1999) Sleeper weeds. Pages 632–636 *in* Bishop AC, Boersma M, Barnes CD, eds. Twelfth Australian Weeds Conference. Hobart, Australia: Tasmanian Weeds Society

Journal article: Chamberlin TC (1965) The method of multiple working hypotheses. *Science* 148:754–759

Report or government publication: [USDA] U.S. Department of Agriculture (2013) Forest Service National Strategic Framework for Invasive Species Management. Washington, DC: U.S. Department of Agriculture. 35 p

Website: Pacific Island Ecosystems at Risk (2009) Weed Risk Assessment—Pongamia [Millettia] pinnata. http://www.hear.org/pier/wra/pacific/pongamia_pinnata_htmlwra.htm. Accessed: June 7, 2012

Structured Appendix

Köppen-Geiger Maps

Include distribution maps with Köppen-Geiger climates (Köppen 1936) as a background. Use the geographic information system templates provided on the journal website. You will need to source distribution data for the subject species. You will then need to open up the appropriate template using either ArcMap (ESRI, Redlands, CA) or QGIS software packages and follow instructions to import the distribution data and generate suitable tables and maps.

Correlative Species Distribution Models

It is important to properly document any models developed specifically for these reviews. Please remember that the aim in including these models is to alert invasive plant managers of the potential threat to their jurisdictions. We are balancing the need for the models to be credible, erring slightly on the side of a more permissive model on the grounds that it is better to slightly overestimate the threat than to underestimate it.

Methods

- Sources of distribution data, including methods for "cleaning" the data.
- Climate data used to fit and project the model
- Which model did you use?
- Avoid ensemble modeling methods. They can hide a multitude of sins and give the illusion that the results are more reliable than individual models. Please use one method and apply it as if your reputation depends on it.
- Avoid overfitting your model. Limit the number of covariates used to fit your model. Including additional variables may improve apparent model precision where you have observed the species, but introduce errors where you are projecting your model.
- Specific modeling methods, including
  - the method used to choose covariates;
  - which covariates were used; and
  - if the model is a presence-background model, the method for defining the background.
- Consider using a method such as ExDet (Mesgaran et al. 2014; www.climond.org) to help identify areas where the model is extrapolating, and indicate in your output maps that results in these areas are unreliable.
- Clearly identify any known or suspected model limitations.

Model Verification and Validation

Include graphs of the response functions for each covariate. This helps the reader to gauge whether your model is overfitted and whether the covariates are likely to be relevant. Describe any methods used to validate the model, noting that subsampling or resampling the same set of geographic data does not constitute model *validation*, because the data sets are not independent.

Results

Do not quote the Area under the Receiver Operating Curve (AUC) statistic as evidence that your model is "good." When applied to correlative Species Distribution Models where pseudo-absences or backgrounds have been used, this statistic requires circular logic, and it is misleadingly positive. Similarly, do not quote specificity measures, because circular logic is applied.

Do report model sensitivity in relation to the full set of qualified distribution points.

CLIMEX

If you include a CLIMEX model (Kriticos et al. 2015; Sutherst and Maywald 1985), please use the template described in Sutherst (2003: Table 2) for describing it.

Distribution:

CABI CPC Ref: etc.

Comments and literature review related to fitting CLIMEX parameters

Distribution records used to estimate CLIMEX parameter values
Evidence for non-climatic limits to distribution
Physical barriers
Hosts (in the case of parasitic plants)
Vectors
Other species
Artificial environments (e.g., irrigation or glasshouses)
Stress indices
Hot
Cold
Dry
Wet
Climatic Constraints
Length of growing season
Growth
Temperature
Moisture
Results
Goodness of Fit
Independent Validation
Source Risks
Geographical
Seasonal
Destination Risks
Geographical
Seasonal
Discussion
References
Species Parameters Table

MaxEnt

The results in MaxEnt models (Phillips et al. 2006) tend to be very sensitive to the definition of the background. Hence you need to choose your background carefully and cite a published method or describe your method.

Choose "least presence threshold."

Avoid using "clamping." This method implicitly violates the "law of tolerance" (reviewed in Shelford 1963). The most defensible method for models that involve transfer to new environments is "no extrapolation."

References

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