Predicting the Distribution of Threatened Legumes in the Old World and Oceania

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ABSTRACT

A dataset of 6,042 legumes was compiled on 10 attributes, which have been linked to threat risk, and the country(s) each species is found in. Only 5,077 out of 6,042 species had complete information that could be used to input into a generalized linear mixed model (GLMM) to calculate the probability of threat of each species. Species, whose threat probability fell in the top 25th percentile of probabilities of all the species, were classified as threatened and their distribution was identified. Ninety-six countries from the Old World and Oceania had threatened legumes. Gabon with 59%, had the highest percentage of threatened species while Lebanon, with 1%, had the lowest. As a subsidiary aim, the percentage of missing trait information was calculated to be 9%. Filling the large gap in the knowledge of legume ecology and life history attributes will provide a more complete picture of the threat status of legumes and aid conservation efforts in the Old World and Oceania.

INTRODUCTION

Ecological traits and life history attributes which have been found to be particularly useful in determining the threat a species faces are native geographic range, plant height, habitat, altitudinal distribution, life cycle, and growth habit (Bradshaw et al., 2008). The aim is to predict the distribution of threatened legumes in the Old World (consisting of Europe, Asia and Africa) and Oceania (including Australia and Pacific islands) by compiling a list of legume species with the threat attributes and their native country(ies). In addition to these traits, this study also took into consideration endemicity (if a species is native to only a particular country) in determining threat status.

METHODS

The dataset used for analysis in Bradshaw et al. (2008) was the basis of further compilations of information on the threat attributes of the legumes. Data for endemicity and the countries each species can be found in were not in the original dataset and was included for the purpose of this study. In total, data for 6,042 legume species in the Old World and Oceania were collected from various sources like floras, monographs and websites. Two competing models, the Akaike’s Information Criterion corrected for small sample size ($AIC_c$) and the Bayesian Information Criterion (BIC) were used for the

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analyses in Bradshaw et al. (2008). Only the five most parsimonious BIC-ranked models were chosen for this study (Table 1) to predict the endangerment of the legumes.

Table 1: The third ranked of the five most parsimonious generalised linear mixed-effects models investigating the life history correlates of threat risk for legumes according to the Bayesian Information Criterion (BIC). Terms shown are RG = range, HBT = habitat, ALT = altitudinal distribution, LC = life cycle, HB = habit, HT = height, k = number of parameters, wBIC = weight given to each model, and %DE = percentage of variance that can be explained by the threat attributes.

<table>
<thead>
<tr>
<th>Rank</th>
<th>BIC-ranked</th>
<th>k</th>
<th>BIC</th>
<th>ΔBIC</th>
<th>wBIC</th>
<th>%DE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>~ RG + HBT + LC + HB</td>
<td>11</td>
<td>1463.5</td>
<td>9.601</td>
<td>0.008</td>
<td>14.80%</td>
</tr>
</tbody>
</table>

For this study, 5,077 species from the dataset of 6,042 species were analysed with model 3, with data from the traits of range, habitat, life cycle, and habit.

Logit (p) =

\[1.297 + -1.5286*(RG2) + -0.5946*(HBT2) + -1.3807*(HBT3) + -2.1266*(LC2) + -1.4247*(HAB2) + -3.5312*(HAB3) + -5.1358*(HAB4),\]

where p is the probability of a species being endangered.

A species was classified as threatened when its value of p fell in the top 25\(^{th}\) percentile of all species. Species in the top 12.5\(^{th}\) and 5\(^{th}\) percentiles were also isolated to further rank them. Once the threatened species were identified, they were grouped according to the countries they are native to and thus the distribution of the predicted threatened legumes for the Old World and Oceania was determined.

The second objective, to find out how much information was lacking in legume knowledge, was calculated the following way: (Number of blanks in trait information/ total trait information there is supposed to be) 100%.

RESULTS AND DISCUSSION

Based on the probabilities of all 5,077 species, the threat probability of the species at the 75\(^{th}\) percentile was used as a cutoff. This value was found to be 0.094979201 and any species with this probability and higher was defined to be threatened. In total, 1372 species were classified as threatened. After being grouped into countries, the countries were ranked from the highest percentage of threatened legumes to lowest percentage. Gabon was top with 59\%, followed by Equatorial Guinea at 54\%. Fiji had the highest percentage for countries in Oceania and Lebanon returned the lowest percentage overall.

\[(\text{Number of blanks in trait information/ total trait information there is supposed to be}) \times 100\%\]

\[= [(5444/ 60420) \times 100\%]\n
\[= 9\%\]
More field work is needed for systematics research to merge morphology with ecological characteristics for more useful information for analysis as used in this project for prioritising species for conservation. People, especially those in local communities, need to be involved and aid conservation organisations like the IUCN, be it with funding or participation.

For future work, a larger dataset could be collected for the Old World and Oceania so that the other four BIC models could also be used for analysis. A study of the distribution of threatened legumes in the New World (America) should be undertaken so that, combined with this study, the global distribution could be mapped.

CONCLUSIONS

Studying the distribution of the threatened legumes helps identify where conservation efforts are most needed. Ninety-six countries have been ranked accordingly from the highest to lowest distribution of threatened legumes with Gabon accounting for the highest percentage, at 59%. Fiji ranks the highest among the countries in Oceania. The list of threatened legumes in each of the 96 countries has also been compiled. Future studies could zoom in to find out where exactly in each country a threatened legume can be found. All nations need to do what is within their capacity to save this economically important family for future generations. If measures are not taken to control the diminishing numbers of legumes, they will be extinct soon.

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