A PLANT IN A WARM POOL:
PREDICTING THE EFFECTS OF CLIMATE CHANGE ON ELATINE GUSSONEI

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Introduction

The Plant:
Elatine gussonei (Sommier) Brullo, Lanfranco, Pavone & Ronsisvalle (Maltese Waterwort; fam. Elatinaceae) is an annual amphibious plant that is endemic to Malta and Lampedusa.

The Habitat:
Temporary freshwater rockpools in limestone rock in Malta. The hydrological cycle is seasonal, and corresponds to the climatic wet season and dry season.

The 'Warm Pool':
A trend of warmer, drier, and shorter wet seasons is changing the community dynamics in pools, favouring amphibious species over hydrophytes.

Aim and Method

We wanted to:
Construct a simple generalised hydrodynamic model for small rockpools.
Construct a population model for Elatine gussonei. Combine these to predict the mean time to extinction (Tₑ) of E.gussonei under various climatic scenarios.

We used:
Population data on E.gussonei from five pools over eight years, and from manipulative experimentation during one year.

Follow up:
Simulations under three projected climatic scenarios based on IPCC predictions:
(i) ‘Pessimistic’
(ii) ‘Optimistic’
(iii) ‘Most optimistic’
Reconciliation of simulation results with ground-truthing during five years.

Conclusions

The three scenarios for future climate would still support hydroperiods of sufficient duration for the completion of the life-cycle.
Range displacement may occur as E.gussonei would be favoured relative to obligate hydrophytes.

Hydrodynamic Model

Made up of separate and interacting "Meteorological" and 'Morphometric' components.

Meteorological components:
Daily data on temperature, insolation, humidity, wind from 2001-2008.
Segmented rainfall data from 2001-2008. Segments were 'Autumn Warm' (Sept. & Oct.), 'Autumn Cold' (Nov. & Dec.), 'Winter' (Jan. & Feb.), 'Spring' (Mar. & Apr.)
Rainfall concentration from 2001-2008. Categorised as 'Light rain', 'Moderate rain', 'Heavy rain', and 'Deluge'.

Morphometric components:
7 morphological parameters for 10 pools.
Hydrological catchment area for 10 pools.

Dependent variables:
Number of hydroperiods, Hydroperiod Index, Duration of longest hydroperiod.

Population Model

Decomposition of life-cycle into various stages and the estimation of probabilities of successful progression across stages:

Seed bank:
Number of seeds, vertical stratification, age of seeds.

Germination:
Rate of germination under three flooding patterns ('early flooding', 'late flooding', 'spring flooding') and at different depths of burial.

Reproductive effort:
Rate of flowering, fruiting success, number of seeds per fruit.

Vegetative growth:
Rate of spread in habitat, measured in 5 pools.

Predictions and Validity

The model returned the predicted Tₑ for each of the three climatic scenarios. The precipitation and temperature data below is for the 'Autumn Warm' period.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>ΔPrecipitation</th>
<th>ΔTemperature</th>
<th>Tₑ (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Most Optimistic’</td>
<td>-1%</td>
<td>+2.3°C</td>
<td>56</td>
</tr>
<tr>
<td>‘Optimistic’</td>
<td>-9%</td>
<td>+3.3°C</td>
<td>18</td>
</tr>
<tr>
<td>‘Pessimistic’</td>
<td>-21%</td>
<td>+5.2°C</td>
<td>11</td>
</tr>
</tbody>
</table>

The hydrodynamic model was validated against field observations during 2009-2014 with high correlation of predicted and observed hydrodynamic patterns. Validation of the population model is ongoing.