Alpine indices

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18/05/2020

Explanation of the indices by S Rosbakh

Here come some explanations about the indices.

The abbreviations are read as follows:

- GRS - number of germination seeds
- GRP - germination percentage (from 0 to 100%)
- MGT - mean germination time (time units)
- MGR - mean germination rate (time units)
- GSP - germination speed (%)
- UNC - uncertanty index (bits)
- SYN - syncronization index (from 0 to 1)
- VGT - germination variance
- SDG - germination standard deviation
- CVG - coefficient of variation

GRS and GRP are easy and you have already these data. Basically, MGT, MGR and GSP describe seed germination speed; these three indices are tightly positively (r>0.8) correlated with each other. I would do descriptive statistics with all of them first to see how they differ in your data set. These three indices are strongly temperature-dependent - in my data the relationship is linear and almost perfect (r2=0.8). Thus, you might consider analysing germination speed for one most optimal temperature of germination (around 20 C).

UNC and SYN characterise germination synchrony and tightly positively correlated with each other. I personally prefer the SYN, because it is more intuitive, but I would try both of them.

I have not had time to explore VGT, SDG and CVG, but I think they are not very informative (though I might be wrong). You might consider exploring them as well.

IMPORTANT: I have noticed that calculation of all indices for the cases with a very low number of germinated seeds (GRS) result in spurious results. For example, if only one single seed germinated, its germination timing (e.g. day 7 or day 14) considerably influenced seed germination time and synchrony. May be it makes sense from statistical point of you, but as an ecologist I would not trust them. Thus, I recommend to use only the cases with a comparatively high proportion of seeds germinated (e.g. GRP >30%). Furthermore, in some cases calculations resulted in zero or infinite values and NAs, because of no germination at all or very low number of germinated seeds.

I used the GerminaR package for calculations; more details on the indices are in the paper (https: //www.researchgate.net/publication/331073880_GerminaR_An_R_package_for_germination_analysis_ with_the_interactive_web_application_GerminaQuant_for_R).

A note by Sergey on scoring length and intensity

I took a closer look at the experiment duration and scoring intensity of the data I processed and, came to the conclusion that the majority of the germination experiments were conducted in a more or less the same way. The only problematic data set are experiments from Anissa, in which seeds were incubated for several months.

Source Duration Scoring intensity Andrea Mondoni 42 days 6 times Bu 40-60 days 40-60 times Rosbakh_Alps 42 days 8 times Rosbakh_Caucaus 42 days 8 times Anissa 49-140 12-22 times Eduardo 28 days 4 times Susanne Venn 40-60 days 11-21 times Veronica 24-48 days 9-17 times

I re-calculated the indices for shorter timer series (ca. 60 days; orange tabs; attached) and hope that the PCA will look better now. BTW, Eduardo, did you scale the data before the analysis? The indices scales have very different scale lengths that should be accounted for.

One further improvement would be to reduce the time series in Anissa's, Venn's and Bu's data to 40 days, to make the differences even smaller, but it would require additional data re-formatting.

Number of records with >80% germination and germination indices, by region.

```
## # A tibble: 8 x 2
##   Region                  n
##   <fct>               <int>
## 1 Apennines               7
## 2 Australian Alps       308
## 3 Cantabrian Mountains   24
## 4 Caucasus               88
## 5 Northern Alps         266
## 6 Qinghai-Tibet Plateau 351
## 7 Southern Alps          80
## 8 Southern Andes         37
```

Number of records with >80% germination and germination indices, by alpine strict vs. generalist.

```
## # A tibble: 2 x 2
##   Alpine         n
##   <fct>      <int>
## 1 Generalist   610
## 2 Strict       551
```

PCA of the indices (see figures below)

```
##     cont.Dim.1 cont.Dim.2 corr.Dim.1 corr.Dim.2
## GRP       1.00       6.18       0.19       0.33
## MGT      23.36       4.51      -0.91       0.28
## MGR      23.24       1.93       0.91      -0.18
## GSP      23.24       1.93       0.91      -0.18
## UNC       8.56      36.12      -0.55      -0.79
```

```
## SYN        9.62        31.76        0.58        0.75
## VGT       10.98        17.56       -0.62        0.55
```

Some conclusions (see figures below)

- MGR and SYN seem to capture the most variance, and are the most intuitive
- Main differences seem to be among regions, BUT the Australian (highest mean germination time) were also the longest running experiments, I bet this is an artifact of experiment lenght (please kill me)
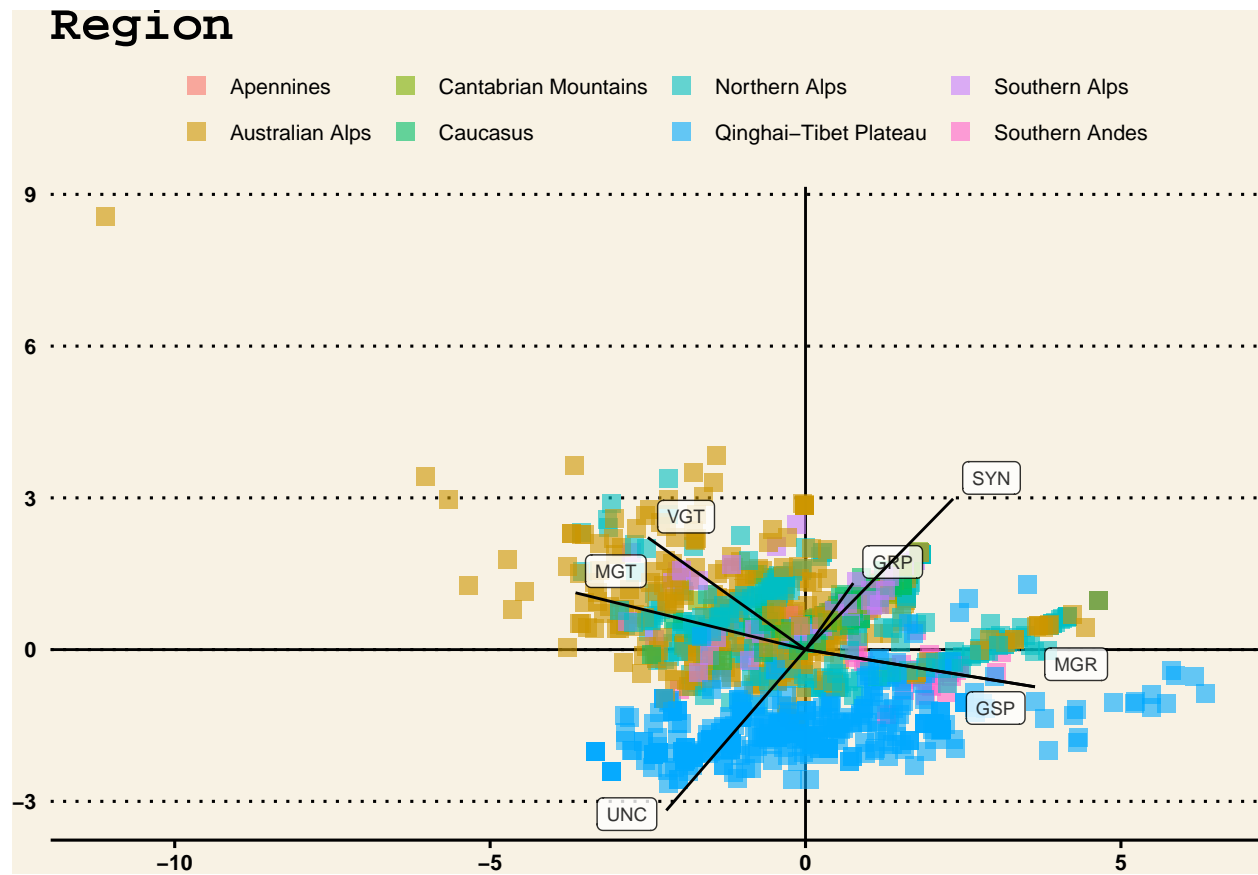- Indices are not normal

Figure 1: PCA of the germination indices colored by Region
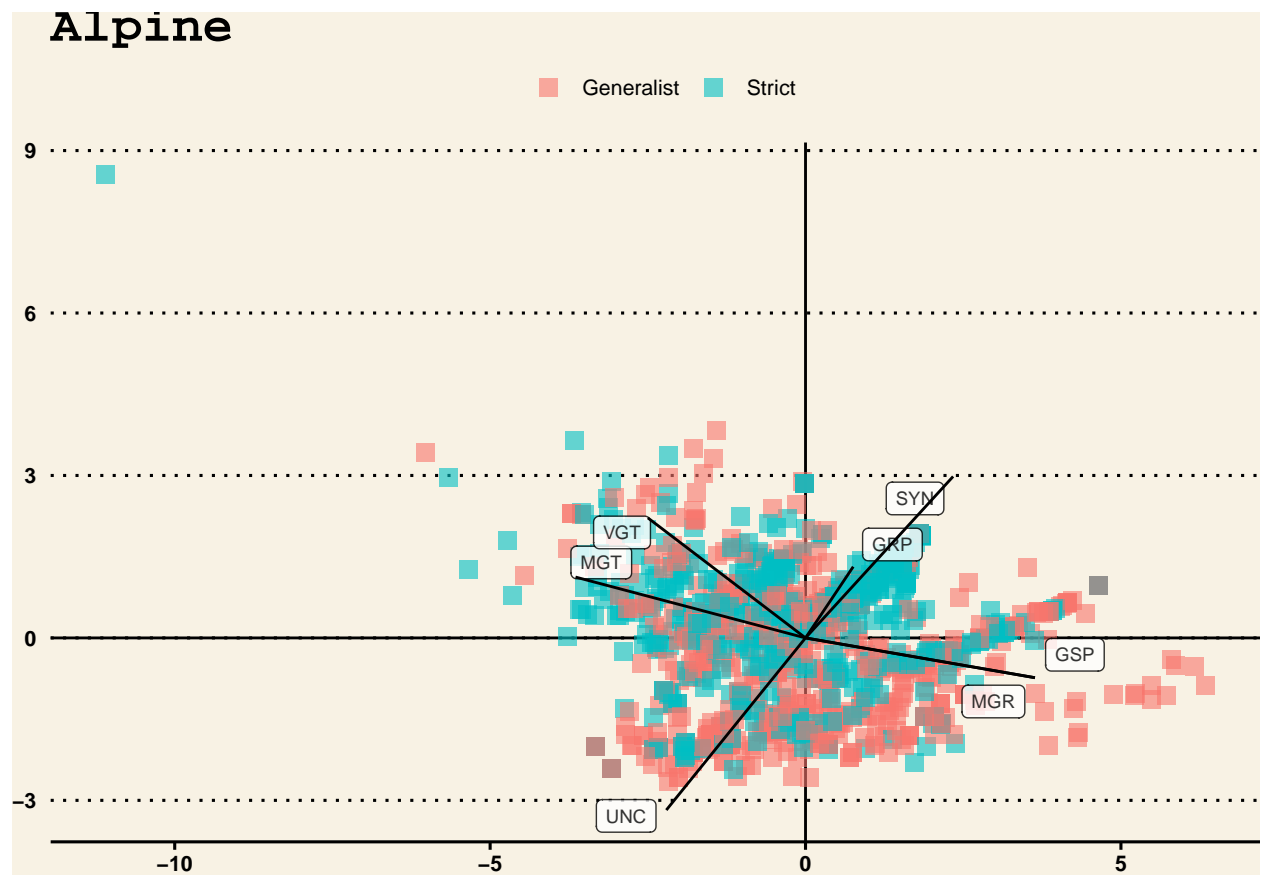
Figure 2: PCA of the germination indices colored by Alpine
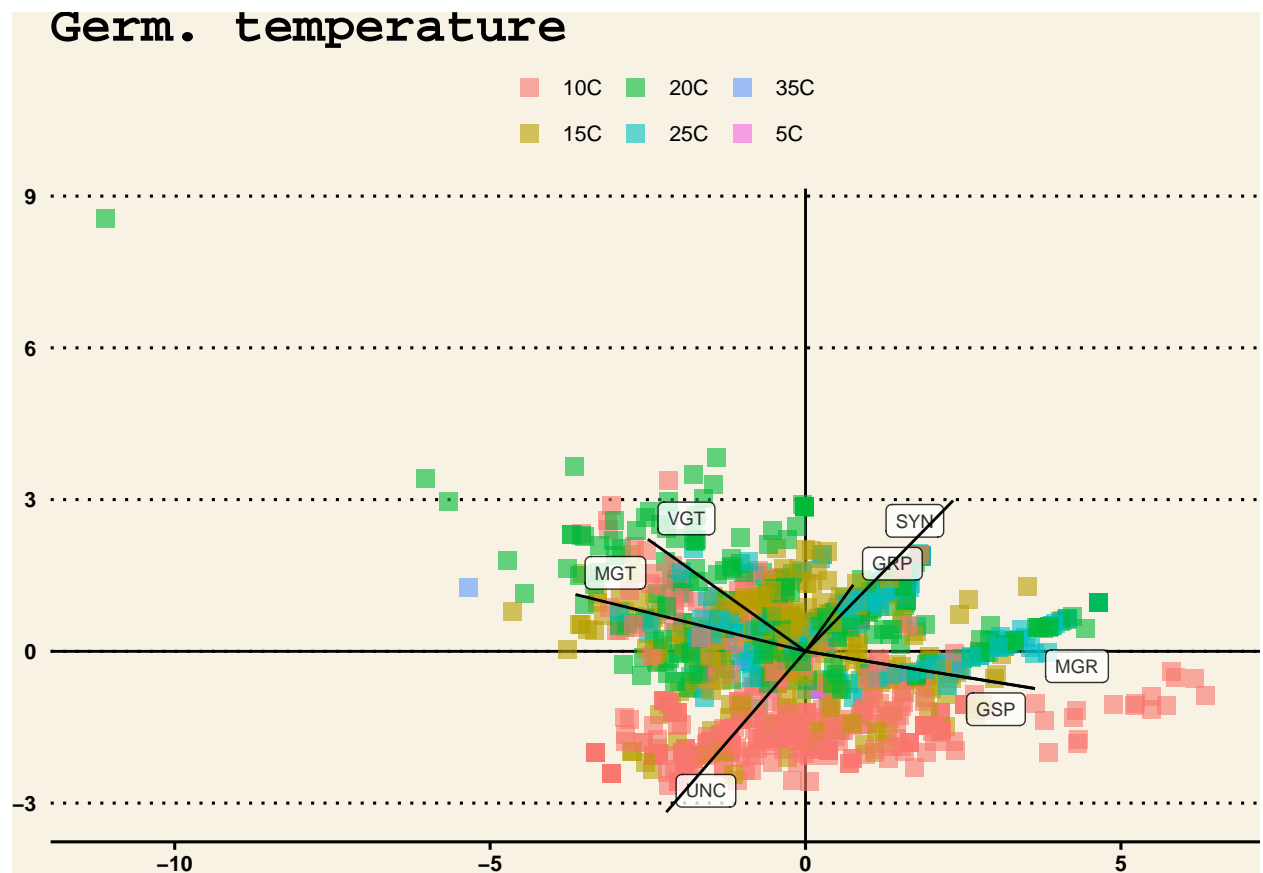
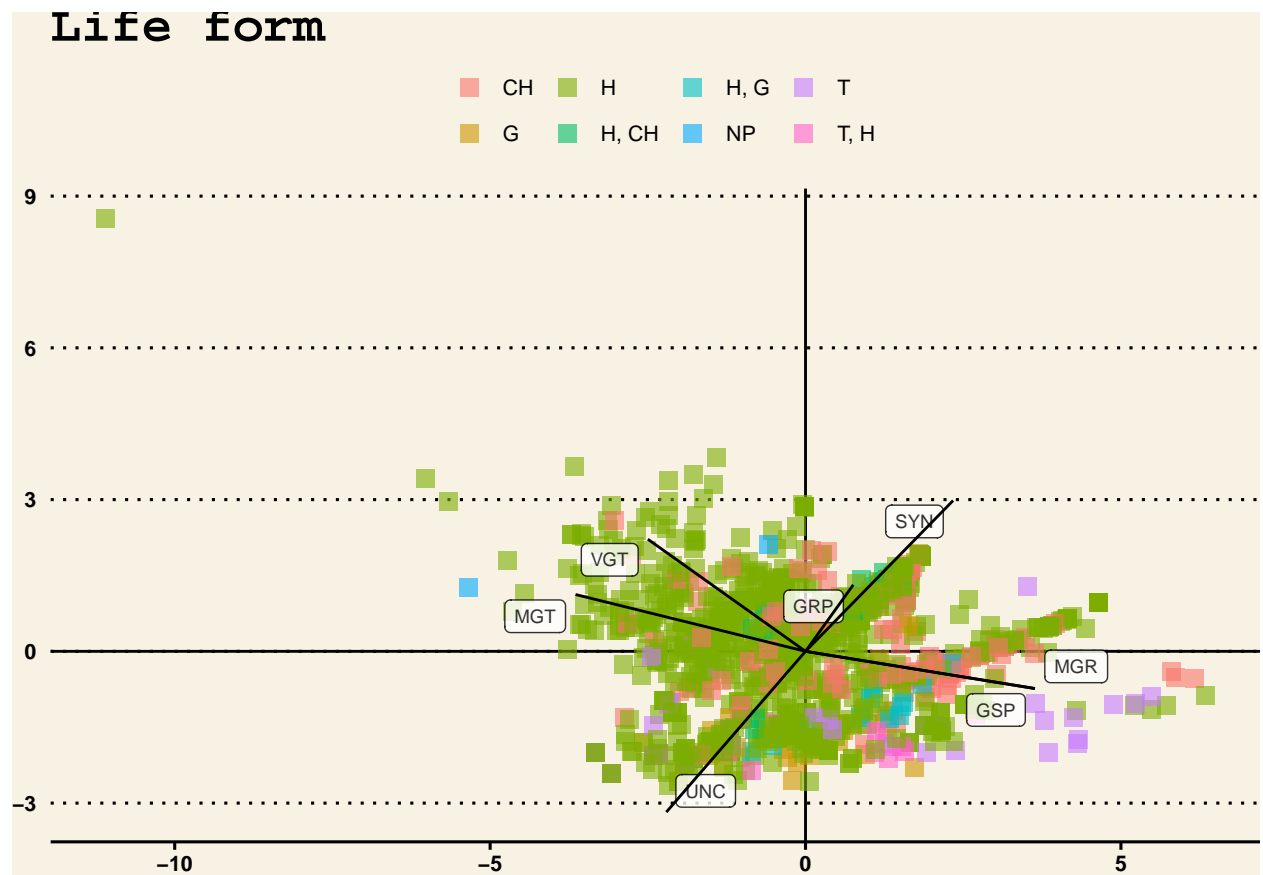Figure 3: PCA of the germination indices colored by germination temperature
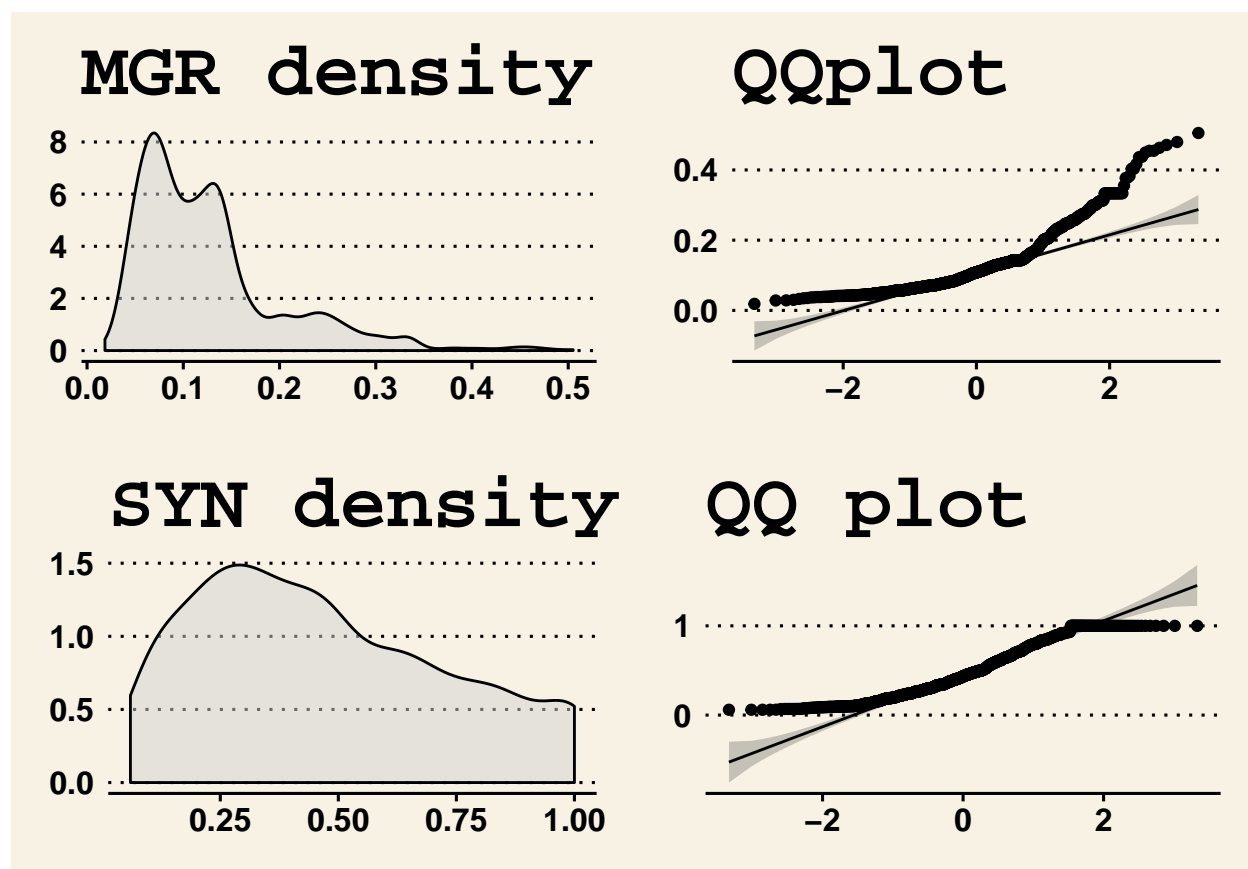
Figure 4: PCA of the germination indices colored by life form

Figure 5: Normality of the indices