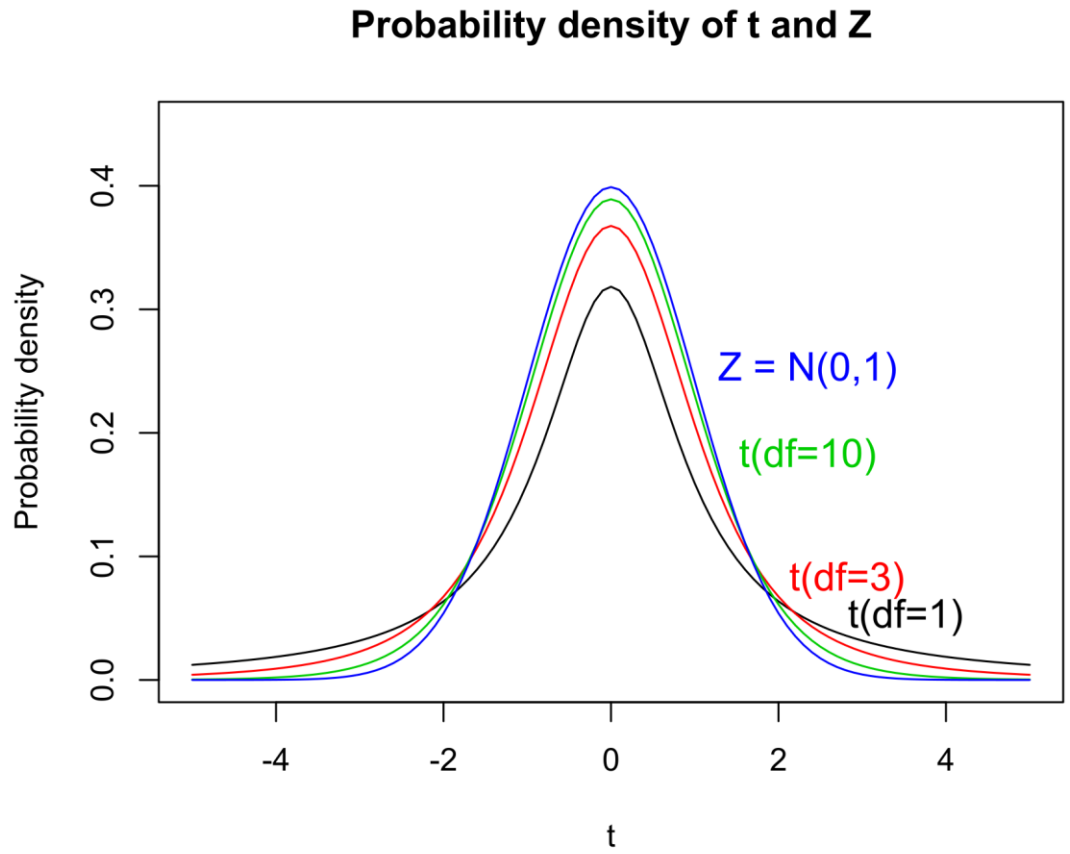
Chapter 6
t-distribution
confidence intervals
t-tests

The t-distribution

- $t = \frac{x - \bar{x}}{s_{\bar{x}}}$
- Measures distance from the mean while accounting for uncertainty of true mean location
- Similar to standard normal distribution (Z)
- Exact shape depends on DF
  - DF = number of observations – 1
  - T with high DF convergent with Z



Confidence intervals

- Interval around the sample mean within which the true mean lies with 95% probability
- $CL_{low} = \bar{x} + t_{(df,p=0.025)} s_{\bar{x}}$
- $CL_{high} = \bar{x} + t_{(df,p=0.975)} s_{\bar{x}}$
- The best option for error-bar intervals in dotcharts/barplots showing the means
- Single sample t-test
  - Tests H0 that mean = fixed value (typically 0)

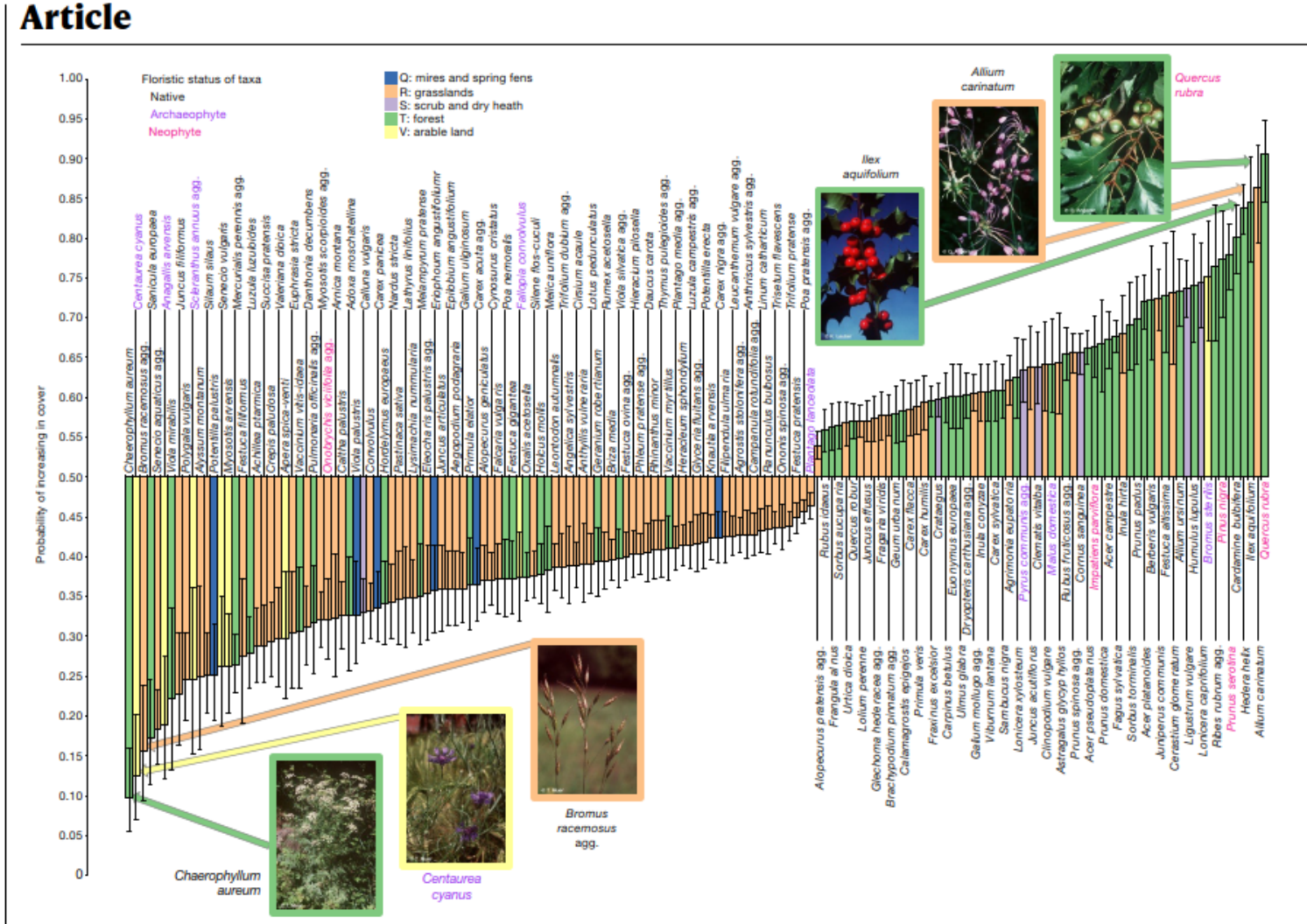


Fig. 4 | Losers and winners across one century in Germany. Probability of increase in cover for the 161 species with a significantly negative or positive change (binomial test at $P < 0.05$, with Holm correction) and at least 100 observations of change. Decreasing species are those with a probability of increasing of less than 0.5, and thus, increase less often than expected by chance, and their names are plotted below the *y* value of 0.5, whereas the names of increasing species are plotted above the *y* value of 0.5. The colours of taxon names show their floristic status, with black, purple and pink for native, archaeophyte and neophyte, respectively. The bar colour indicates the species' affinity to level 1 EUNIS habitats[66] and the error bars indicate the 95% CIs. The three most declining and increasing species are illustrated with photographs and named. Plant photographs were obtained from https://www.floraweb.de/. Copyright for *C. aureum*, *C. cyanus* and *B. racemosus*: Thomas Muer; for *I. aquifolium*: Haupt Verlag; and for *A. carinatum* and *Q. rubra*: Regensburgische Botanische Gesellschaft.

Jandt et al. 2022 Nature

Student t-test

- Comparison between two means
  - Two samples of **independent** observations
  - H0: the two means are identical
- $t = \frac{\bar{x}_1 - \bar{x}_2}{s_{\bar{x}_1 - \bar{x}_2}}$
- Assumes
  - Identical variance of the two samples (homogeneity of variance)
    - Minor departures solved by using the Welch variant of the test formula
  - Normal distribution of the two variables
- DF = $n_1 - 1 + n_2 - 1$

Paired t-test

- Used for **paired** observations
  - Dependence of observations within a pair
  - E.g. block design
  - Pair is an independent observation
- H0: mean difference within pairs = 0
- Equivalent to a single sample *t*-test
- DF = n(pairs) - 1