Life table data documentation

1) Protocol of Life Table Construction

We compiled malddaba records to build female life tables for different populations. For a population to be eligible for life table construction, both the S_x series (survival transitions from birth to the last age) and the m_x series (reproduction transitions from the age at first reproduction to the last age) for female specifically and for the same population were required. We began each time by first building the complete age-dependent S_x series, followed by the associated age-dependent m_x series (all information about the construction of the specific series is reported in the malddaba life table dataset in Rdata format available at https://malddaba.univ-lyon1.fr/pages/life_table_data.php, specifically in the data_used table of the Rdata; see table S1 for an explanation of each column associated with the life table data file).

S_x series construction

S_x series were constructed differently depending on the type of survival data available:

- For longitudinal survival data S_x was directly reported from the S_x series in the malddaba record.

- For transversal data associated with the d_x series (when only age at death is reported), we considered that the distribution of ages at death matched the d_x series of the population and calculated S_x using the following formula $S_x = \frac{d_{x+1}}{d_x}$. When the original publication reported an age-dependent model to smooth the distribution of ages at death, we preferred to compute the S_x based on this smoothed distribution.

- For transversal data associated with l_x series (when the age of alive sampled individual is reported), we considered that the distribution of ages at death matched the l_x series of the population and calculated the S_x series based on the following formula $S_x = \frac{l_{x+1}}{l_x}$. When the original publication reported an age model to smooth the distribution of alive individuals, we chose to compute the S_x based on this smoothed distribution.

We verified that the S_x series started from birth (age 0). Sometimes, juvenile and adult survival rates were reported in different malddaba records because they originated from different

publications. In that case, we maintained our inclusion criterion, which required that both juvenile and adult survival data come from the same population.

For a large proportion of the S_x series, the survival probability at the last age was not equal to 0, meaning that the S_x series was right-censored due to the deaths of the few oldest individuals not being reported. In that case, we checked the last l_x at the censored age; if the value was lower than 5%, we chose to artificially end the S_x series by adding a survival probability of 0 at the next age. If the last l_x value was higher than 5%, we either did not consider that population if too many individuals were censored, or if the series was higher but close to the 5% threshold, we extended the S_x series by adding a survival probability equal to that of the last age observed until the l_x was lower than 5%. We then added a survival probability of zero to finish the S_x series. All decisions made to construct the l_x series are either reported as categories or noted in the comment column if specific transformations were necessary.

m_x series construction

The construction of the m_x series also depended on the type of reproduction data available in malddaba:

- Sometimes m_x was directly calculated in the original record.

- When the number of offspring produced per age was available, we simply divided it by 2 to obtain the average number of daughters, assuming that the sex ratio was balanced between male and female offspring produced.

- For monotocous species (*i.e.* litter size of 1) when the probability to reproduce was available, we simply divided this probability by 2 considering again a balanced sex ratio to get the m_x series.

-for polytocous species (*i.e.* litter size > 1), both the probability to reproduce and the litter size per age were necessary if the m_x or the number of offspring per age was not available. In that case, we calculated the m_x series by multiplying the probability of reproducing and the average litter size per age divided by 2.

For some reproduction data, m_x values were missing for very old ages because less individuals were sampled for the reproduction analysis compared to the survival analyses in this population.

In that case we extended the m_x series using the m_x value at the last age reported in the data. As for survival, all decisions used for the construction of the m_x series are reported in the dataset.

2) Demographic outputs of life tables

Based on the full life table (m_x and S_x series) built, we were able to compute several demographic outputs using the following formulas:

- l_x series (proportion of individuals still alive at age x)

$$l_{x+1} = l_x S_x \; with \; l_0 = 1$$

- d_x series (proportion of individuals dying at age x)

$$d_x = l_{x+1} - l_x$$

- e_x series, life expectancy at age x (average number of remaining years of life at age x)

$$e_x = \frac{1}{l_x} \sum_{x}^{\infty} l_i - 0.5$$

- r, the asymptotic growth rate of the population, computing by solving numerically the following Euler-Lotka equation

$$\sum_{0}^{\infty} e^{-rx} l_x \, m_x = 1$$

- $R0$, the net reproductive rate of the population

$$R0 = \sum_{0}^{\infty} l_x \, m_x$$

- Vx series, the reproductive values for each age (Fisher, 1930) (average number of individuals that will be produced by a female of age x for her remaining lifetime, standardized so V_0=1)

$$V_x = \frac{e^{-rx}}{l_x} \sum_{x+1}^{\infty} e^{-r} \, l_i \, m_i$$

T_b, generation time of the population (Gaillard et al., 2005) (mean age at reproduction in years in the population accounting for the stable age distribution)

$$Tb = \frac{\sum_0^\infty x e^{-rx} l_x m_x}{\sum_0^\infty e^{-rx} l_x m_x}$$

T_c, cohort generation time (Steiner et al., 2014) (mean age at reproduction in years for a specific cohort)

$$Tc = \frac{\sum_0^\infty x l_x m_x}{R0}$$

Table S1: Information reported in the malddaba life table dataset (See text for more details about the life table construction procedure and the formula used to calculate the demographic outputs)

Table	Column	Description
species	Species	Species latin names (genus then species)
data_used		Information on the malddaba record used and the procedure used to compute the female life table
	Immature_survival_life_table Id	Identifier of the malddaba record used to compute immature survival probabilities
	Adult_survival_life_table_id	Identifier of the malddaba record used to compute adult survival probabilities
	Censored_survival	Whether survival series was artificially ended by censoring with a null survival at last age
	Extended_survival	Whether a procedure to extend survival probability at old ages was applied
	Survival_modeled	Whether survival from reported age-dependent model was used instead of the raw full age estimates
	Survival_comments	Any comments associated with a specific procedure used to compute S_x series for this population
	mx_id	Identifier of the malddaba record used to compute m_x series if m_x was directly available
	N_offspring	Identifier of the malddaba record used to compute m_x series using the number of offspring produced per age
	P_reproduce_id	Identifier of the malddaba record used to compute m_x series using the probability to reproduce per age
	Litter_size_id	Identifier of the malddaba record used to compute m_x series using the average litter size per age
	Censored_reproduction	Whether m_x series was artificially censored at last age based on the S_x series
	Extended_reproduction	Whether a procedure to extend m_x series at old ages was applied

	Reproduction_modeled	Whether reproduction from reported age-dependent model was used instead of the raw full age estimates
	Reproduction_comments	Any comments associated with a specific procedure used to compute reproduction for this population
	Age_interval	Age interval in years used for the building of the life table
Life_table		Raw life table computed
	Age	Age in years
	Sx	Age-specific S_x values (survival probabilities)
	lx	Age-specific l_x values (cumulative survival)
	mx	Age-specific m_x values (average number of daughters produced per females)
Life_table_extended		Life table with additional columns computed based on demographic outputs
	Age	Age in years
	Sx	Age-specific S_x values (survival probabilities)
	lx	Age-specific l_x values (cumulative survival)
	mx	Age-specific m_x values (average number of daughters produced per females)
	dx	Age-specific d_x values
	ex	Age-specific life expectancies
	Vx	Age-specific reproductive values
Demographic_metrics		Demographic metrics computed to describe the dynamic of the population
	AFR	Age at first reproduction in years
	R0	Net reproductive rate
	r	Asymptotic growth rate
	Tb	Generation time corrected by the age structure of the population in years
	Tc	Cohort generation time in years

References

Fisher, R. A. (1930). *The genetical theory of natural selection* (pp. xiv, 272). Clarendon Press. https://doi.org/10.5962/bhl.title.27468

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Steiner, U. K., Tuljapurkar, S., & Coulson, T. (2014). Generation Time, Net Reproductive Rate, and Growth in Stage-age Structured Populations. *The American Naturalist*, *183*(6), 771–783. https://doi.org/10.1086/675894