

Life Sciences Reporting Summary

Nature Research wishes to improve the reproducibility of the work that we publish. This form is intended for publication with all accepted life science papers and provides structure for consistency and transparency in reporting. Every life science submission will use this form; some list items might not apply to an individual manuscript, but all fields must be completed for clarity.

For further information on the points included in this form, see [Reporting Life Sciences Research](#). For further information on Nature Research policies, including our [data availability policy](#), see [Authors & Referees](#) and the [Editorial Policy Checklist](#).

► Experimental design

1. Sample size

Describe how sample size was determined.

We used data from existing fossil databases. Our analysis covers North America and Europe at continental scales, as well as a region in Africa (the Turkana Basin). We included all the available data that matched geographic and availability criteria described in the Methods supplement, page 8.

2. Data exclusions

Describe any data exclusions.

We used three different datasets (Europe, North America and Turkana including all samples matching pre-determined criteria. For Europe we approximated as closely as possible Jernvall and Fortelius 2004 (published in Nature). For Turkana we followed Fortelius et al 2016 (published in Philosophical Transactions B). For North America we included everything except poorly sampled areas and time bins, as specified in the Methods supplement, page 8.

3. Replication

Describe whether the experimental findings were reliably reproduced.

Our experiments are computational, they can be reproduced exactly by rerunning the code. The code will be deposited to a public repository upon publication. During the revision process Reviewer #1 independently reproduced part of the experiments (for one continent), the results matched exactly.

4. Randomization

Describe how samples/organisms/participants were allocated into experimental groups.

NA, there were no groups to which samples would need to be allocated.

5. Blinding

Describe whether the investigators were blinded to group allocation during data collection and/or analysis.

N/A, there was no group allocation.

Note: all studies involving animals and/or human research participants must disclose whether blinding and randomization were used.

6. Statistical parameters

For all figures and tables that use statistical methods, confirm that the following items are present in relevant figure legends (or in the Methods section if additional space is needed).

n/a Confirmed

- ☐ ☒ The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement (animals, litters, cultures, etc.)
- ☒ ☐ A description of how samples were collected, noting whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
- ☒ ☐ A statement indicating how many times each experiment was replicated
- ☒ ☐ The statistical test(s) used and whether they are one- or two-sided (note: only common tests should be described solely by name; more complex techniques should be described in the Methods section)
- ☐ ☒ A description of any assumptions or corrections, such as an adjustment for multiple comparisons
- ☐ ☒ The test results (e.g. P values) given as exact values whenever possible and with confidence intervals noted
- ☐ ☒ A clear description of statistics including central tendency (e.g. median, mean) and variation (e.g. standard deviation, interquartile range)
- ☒ ☐ Clearly defined error bars

See the web collection on [statistics for biologists](#) for further resources and guidance.

► Software

Policy information about [availability of computer code](#)

7. Software

Describe the software used to analyze the data in this study.

We used R for computational experiments. The code will be deposited to GitHub upon publication to <https://github.com/zliobaite/RedQueen>.

For manuscripts utilizing custom algorithms or software that are central to the paper but not yet described in the published literature, software must be made available to editors and reviewers upon request. We strongly encourage code deposition in a community repository (e.g. GitHub). *Nature Methods* [guidance for providing algorithms and software for publication](#) provides further information on this topic.

► Materials and reagents

Policy information about [availability of materials](#)

8. Materials availability

Indicate whether there are restrictions on availability of unique materials or if these materials are only available for distribution by a for-profit company.

Our datasets are included as tables in the Extended data supplement. We will deposit our code to a public repository upon publication.

9. Antibodies

Describe the antibodies used and how they were validated for use in the system under study (i.e. assay and species).

NA, no antibodies were used.

10. Eukaryotic cell lines

a. State the source of each eukaryotic cell line used.

NA

b. Describe the method of cell line authentication used.

NA

c. Report whether the cell lines were tested for mycoplasma contamination.

NA

d. If any of the cell lines used are listed in the database of commonly misidentified cell lines maintained by [ICLAC](#), provide a scientific rationale for their use.

NA

► Animals and human research participants

Policy information about [studies involving animals](#); when reporting animal research, follow the [ARRIVE guidelines](#)

11. Description of research animals

Provide details on animals and/or animal-derived materials used in the study.

NA, no live animals were used.

12. Description of human research participants

Describe the covariate-relevant population characteristics of the human research participants.

NA, no human research participants were used.