

## Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our [Editorial Policies](#) and the [Editorial Policy Checklist](#).

### Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a Confirmed

- ☒ ☐ The exact sample size ( $n$ ) for each experimental group/condition, given as a discrete number and unit of measurement
- ☒ ☐ A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
- ☒ ☐ The statistical test(s) used AND whether they are one- or two-sided  
*Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
- ☒ ☐ A description of all covariates tested
- ☒ ☐ A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
- ☒ ☐ A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
- ☒ ☐ For null hypothesis testing, the test statistic (e.g.  $F$ ,  $t$ ,  $r$ ) with confidence intervals, effect sizes, degrees of freedom and  $P$  value noted  
*Give  $P$  values as exact values whenever suitable.*
- ☒ ☐ For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
- ☒ ☐ For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
- ☒ ☐ Estimates of effect sizes (e.g. Cohen's  $d$ , Pearson's  $r$ ), indicating how they were calculated

*Our web collection on [statistics for biologists](#) contains articles on many of the points above.*

### Software and code

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

|                 |                                                                                                                                                                                                                                   |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data collection | Raw data for microCT scans were collected using the built-in reconstruction software in the micro-CT system ScanXmate-E090S105, Comscantechno.                                                                                    |
| Data analysis   | OsiriX DICOM Viewer ( <a href="http://www.osirix-viewer.com">www.osirix-viewer.com</a> ), was used for analyzing microCT data. Data was analyzed and figures were created using Adobe Photoshop, Microsoft Excel, and Powerpoint. |

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [guidelines for submitting code & software](#) for further information.

### Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

All data are available from the corresponding author on reasonable request.

## Human research participants

Policy information about [studies involving human research participants and Sex and Gender in Research](#).

|                             |                 |
|-----------------------------|-----------------|
| Reporting on sex and gender | Not applicable. |
| Population characteristics  | Not applicable. |
| Recruitment                 | Not applicable. |
| Ethics oversight            | Not applicable. |

Note that full information on the approval of the study protocol must also be provided in the manuscript.

## Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☐ Behavioural & social sciences ☒ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://nature.com/documents/nr-reporting-summary-flat.pdf)

## Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

|                          |                                                                                                                                                                         |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study description        | Studies on Xenoturbella reproduction using live and fixed specimens.                                                                                                    |
| Research sample          | Xenoturbella bocki                                                                                                                                                      |
| Sampling strategy        | Xenoturbella bocki were collected regularly in Gullmarsfjord, Sweden, using a marine biological dredge.                                                                 |
| Data collection          | Authors H.N. and A.N. performed the collections and experiments on live animals and made observations on the sections. H.N. and A.M. performed microCT observations.    |
| Timing and spatial scale | Animals were collected roughly once a month in Gullmarsfjord, Sweden mainly over a two year period.                                                                     |
| Data exclusions          | Not applicable.                                                                                                                                                         |
| Reproducibility          | Collection were performed mainly over a 2 year period to check for the reproducibility on the breeding season. Other observations were performed on multiple specimens. |
| Randomization            | Not applicable.                                                                                                                                                         |
| Blinding                 | Not applicable.                                                                                                                                                         |

Did the study involve field work? ☒ Yes ☐ No

## Field work, collection and transport

|                        |                                                                                                                                                                                                                                   |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Field conditions       | Xenoturbella bocki were collected regularly in Gullmarsfjord, Sweden,                                                                                                                                                             |
| Location               | Xenoturbella bocki were collected in Gullmarsfjord, Sweden, from about 100 meters depth.                                                                                                                                          |
| Access & import/export | Xenoturbella bocki were collected using research vessels Oscar von Sydow and Arne Tiselius of Kristineberg Marine Research Station, University of Gothenburg, Sweden. The animals were transported to the station by the vessels. |
| Disturbance            | The sampling site was changed each time to allow the sea bottom to recover from the damage that may be caused by the dredge collections.                                                                                          |

# Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

## Materials & experimental systems

|                                     |                                                                 |
|-------------------------------------|-----------------------------------------------------------------|
| n/a                                 | Involved in the study                                           |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Antibodies                             |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Eukaryotic cell lines                  |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Palaeontology and archaeology          |
| <input type="checkbox"/>            | <input checked="" type="checkbox"/> Animals and other organisms |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Clinical data                          |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Dual use research of concern           |

## Methods

|                                     |                                                 |
|-------------------------------------|-------------------------------------------------|
| n/a                                 | Involved in the study                           |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> ChIP-seq               |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Flow cytometry         |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> MRI-based neuroimaging |

## Animals and other research organisms

Policy information about [studies involving animals](#); [ARRIVE guidelines](#) recommended for reporting animal research, and [Sex and Gender in Research](#)

|                         |                                                                                                                                                   |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Laboratory animals      | <input type="text" value="This study did not involve laboratory animals."/>                                                                       |
| Wild animals            | <input type="text" value="This study did not involve wild animals (live vertebrates or higher invertebrates)."/>                                  |
| Reporting on sex        | <input type="text" value="Not applicable."/>                                                                                                      |
| Field-collected samples | <input type="text" value="This study did not involve animals (live vertebrates or higher invertebrates) collected from the field."/>              |
| Ethics oversight        | <input type="text" value="No ethical approval or guidance was required, as this study did not involve live vertebrates or higher invertebrates"/> |

Note that full information on the approval of the study protocol must also be provided in the manuscript.