

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 |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> The statistical test(s) used AND whether they are one- or two-sided
<i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i> |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> A description of all covariates tested |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> 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) |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> For null hypothesis testing, the test statistic (e.g. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P value noted
<i>Give P values as exact values whenever suitable.</i> |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> 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

Data analysis

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 as supplemental information in Supplementary Data 1.zip. Within that zipped folder, Source Data for each figure can be found as follows:

Source Data for Figure 2 can be found in UVVisTransmission_Corculumcardissa_16Mar2022.csv (Supplementary Data 1.zip)

Source Data for Figure 3 can be found in lensing_efield_results.zip (Supplementary Data 1.zip)

Source Data for Figure 5 can be found in FTIRMeasurements_29April2022.zip (Supplementary Data 1.zip)
 Source Data for Figure 6 can be found in Lumerical_planar_vs_columnar_simulations_V2.csv, COMSOL_VaryRefractiveIndex_Simulation_Results_V11.csv, Lumerical_vary_pillarwidth_simulations_V1.csv, planarvscolumnar.zip (Supplementary Data 1.zip)
 Source Data for Supplementary Figure 1 can be found in, Transmission_Polishedwindows_Corculum-cardissa_18Aug2023.csv (Supplementary Data 1.zip)
 Source Data for Supplementary Figure 2 can be found in UVVisTransmission_Corculumcardissa_16Mar2022.csv (Supplementary Data 1.zip)
 Source Data for Supplementary Figure 3 can be found in Corculum-cardissa_absorbance_7May2024.csv (Supplementary Data 1.zip)
 Source Data for Supplementary Figure 4 and Supplementary Figure 5 can be found in lensing_efield_results.zip (Supplementary Data 1.zip)
 Source Data for Supplementary Figure 8 can be found in COMSOL_VaryRefractiveIndex_Simulation_Results_V11.csv (Supplementary Data 1.zip)
 Source Data for Supplementary Figure 9 can be found in Corculum_specimens.csv (Supplementary Data 1.zip)

Original samples used for this work are available upon request to the lead author and specified by the catalog numbers listed in Corculum_specimens.csv (Supplementary Data 1.zip).

Research involving human participants, their data, or biological material

Policy information about studies with [human participants or human data](#). See also policy information about [sex, gender \(identity/presentation\), and sexual orientation](#) and [race, ethnicity and racism](#).

Reporting on sex and gender	N/A
Reporting on race, ethnicity, or other socially relevant groupings	N/A
Population characteristics	N/A
Recruitment	N/A
Ethics oversight	N/A

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

Ecological, evolutionary & environmental sciences study design

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

Study description	Using experiments and optical simulations, we show that heart cockles (<i>Corculum cardissa</i> and spp., <i>Cardiidae</i>) use intricate biophotonic adaptations to transmit sunlight for photosynthesis.
Research sample	Museum specimens, dry shells of <i>Corculum</i> species collected from the wild.
Sampling strategy	Sample sizes were chosen based on the availability of specimens which we could destructively sample, and we calculated effect sizes for all statistical tests
Data collection	We collected data in 2022-2023, primarily by Dakota McCoy with task-specific assistance from Dale H. Burns, Elissa Klopfer, Liam K. Herndon, Babatunde Ogunlade
Timing and spatial scale	Not relevant to this study
Data exclusions	no data were excluded
Reproducibility	we took multiple measurements in each experimental data collection mode, and made sure to include multiple different individuals for each experiment and measurement.
Randomization	no randomization was necessary
Blinding	no blinding was used

Did the study involve field work? Yes No

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 | Involvement 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 checked="" type="checkbox"/> | <input 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 |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Plants |

Methods

- | n/a | Involvement 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 |