Daytime eyeshine contributes to pupil camouflage in a cryptobenthic marine fish

Matteo Santon1*, Pierre-Paul Bitton1, Ulrike K. Harant1, Nico K. Michiels1

1 Animal Evolutionary Ecology, Institute for Evolution and Ecology, Department of Biology, Faculty of Science, University of Tübingen, Auf der Morgenstelle 28, 72076 Tübingen, Germany

*Corresponding author
Matteo Santon
Animal Evolutionary Ecology, Institute for Evolution and Ecology, Department of Biology, Faculty of Science, University of Tübingen, Auf der Morgenstelle 28, 72076 Tübingen, Germany
matteo.santon@uni-tuebingen.de

Supplementary information

Figure S1. Standards used in the field to estimate ambient and dark model pupil radiance. One upward-facing white PTFE diffuse reflectance standard as a proxy for down-welling light (right), two observer-facing PTFE standards as a proxy for side-welling light, one shaded (left) and one exposed (top centre) and a dark hole in a black block of PVC filled with black cloth to simulate the pupil of most other fishes (centre). Photo credit: M. Santon.
Table S1. Formulas used to estimate radiance. Mechanisms of eyeshine production and associate light field used to predict iris, natural pupil and dark model pupil radiance under three different light scenarios.

T: transmittance, R: reflectance, DW: down-welling light, SW: side-welling light.

DW and SW are approximated by measuring the radiance of a PTFE white standard parallel (DW) or perpendicular (SW) to the water surface.

| Model                                   | Natural Pupil                | Dark control pupil | Iris               |
|-----------------------------------------|-----------------------------|--------------------|--------------------|
| Scorpionfish and triplefin exposed      | $D_{\text{W exposed}} \times T_{\text{PET}} + S_{\text{W shaded}} \times R_{\text{broadSAR}}$ | $S_{\text{W exposed}} \times R_{\text{darkmodel}}$ | $S_{\text{W exposed}} \times R_{\text{Iris}}$ |
| Only triplefin shaded                   | $D_{\text{W exposed}} \times T_{\text{PET}}$ | $S_{\text{W exposed}} \times R_{\text{darkmodel}}$ | $S_{\text{W exposed}} \times R_{\text{Iris}}$ |
| Only scorpionfish shaded                | $S_{\text{W shaded}} \times R_{\text{broadSAR}}$ | $S_{\text{W shaded}} \times R_{\text{darkmodel}}$ | $S_{\text{W shaded}} \times R_{\text{Iris}}$ |

Video S1. *S. porcus* daytime eyeshine. The pupil of *S. porcus* appears lit when the fish is exposed to sunlight, showing how daytime eyeshine could be used to conceal the otherwise dark pupil. Video credit: M Santon.