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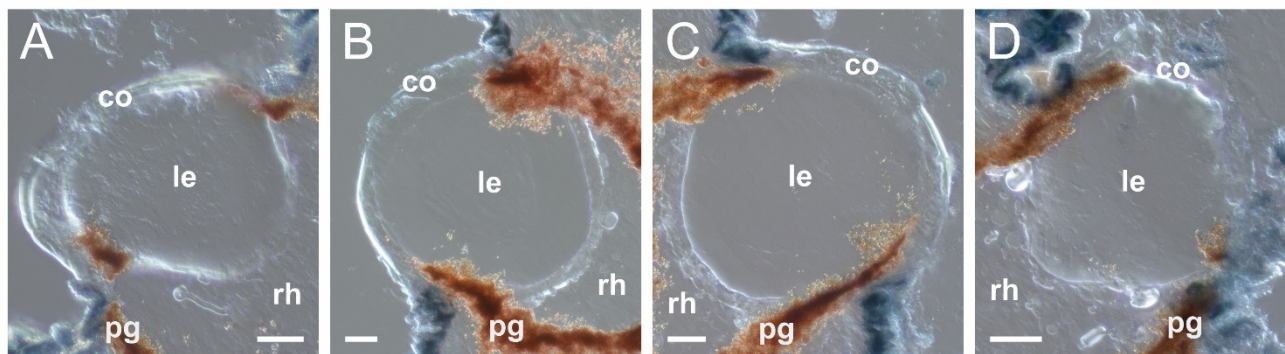


Fig. S1. Differential interference contrast (DIC) images of lenses. (A-D) Cryosections through the dioptic apparatus of the left and right eye of an adult specimen of *Euperipatoides rowelli*. There are no major slopes in the apparent height profile of the lens, which would indicate a strong refractive index gradient. Instead, the overall profile of the lens is flat. Slight differences are likely caused by processing artefacts, given that they are not consistent across sections. The same applies to the apparent ridge in the rhabdomeric layer bordering the lens in B and C. It probably results from thicker tissue that accumulated at the edge of the comparatively hard lens, when the eye was cut from the inside towards the cornea. Scale bars are 20 μm ; co, cornea; le, lens; pg, pigment layer; rh, rhabdomeric layer.

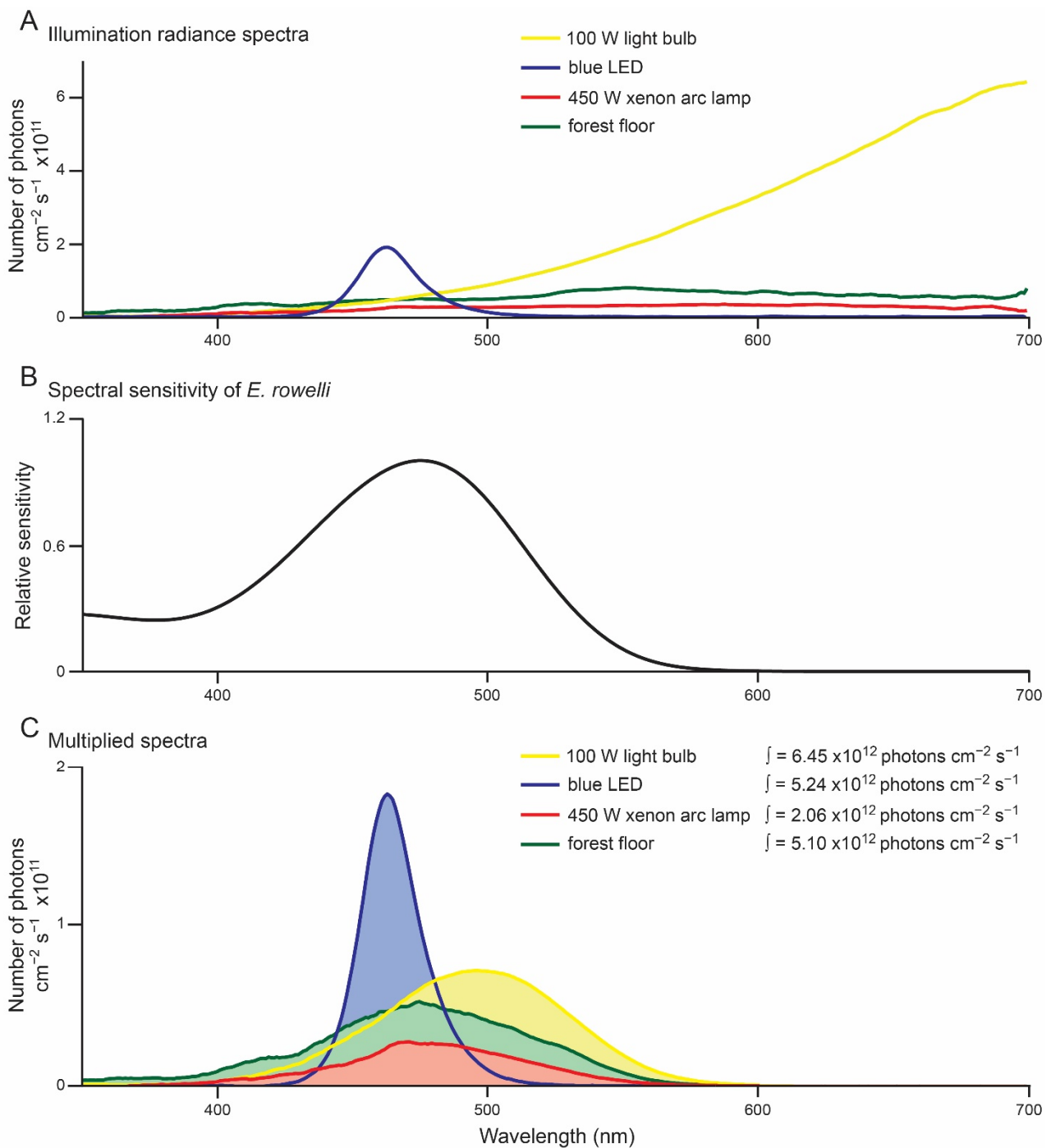


Fig. S2. Choice of illumination for the behavioural setup from three artificial light sources: a light bulb (100 W, Osram Sylvania, Danvers, MA, USA), a blue LED (LXHL-MB1D, Luxeon Star, Brantford, Canada), and a xenon arc lamp (450 W, Malipiero AV Technik, Zurich, Switzerland) combined with a UV-VIS-transmitting light guide. (A) The radiance spectrum of the light reaching the centre of the arena floor through a milk glass diffuser was measured using a calibrated spectroradiometer (RSP900-R; International Light, Peabody, MA, USA) directed towards a white standard (WS-2, TOP Sensor Systems, Eerbeek, the Netherlands) on the arena floor. As a comparison from nature, we recorded the radiance spectrum reflected from the white standard at ground level in a copse during overcast weather in southern Sweden (55° 42' 49.285"N, 13° 12' 29.589"E, October 2014, 10:00-11:00 h local time). All spectra were multiplied by the spectral sensitivity of *Euperipatoides rowelli* (B; Beckmann et al., 2015) and the resulting curves (C) were integrated from 350 to 700 nm to estimate the relative amount of light perceivable by the onychophorans in each case.

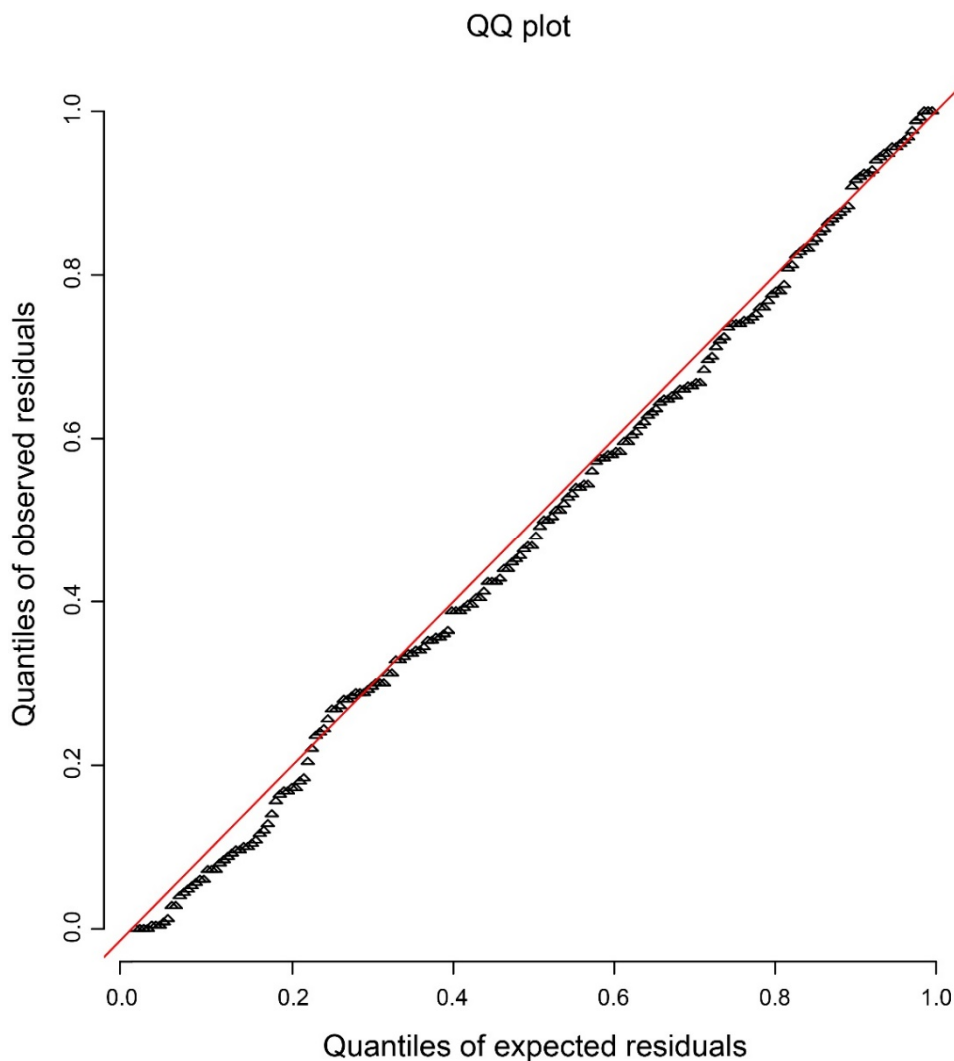


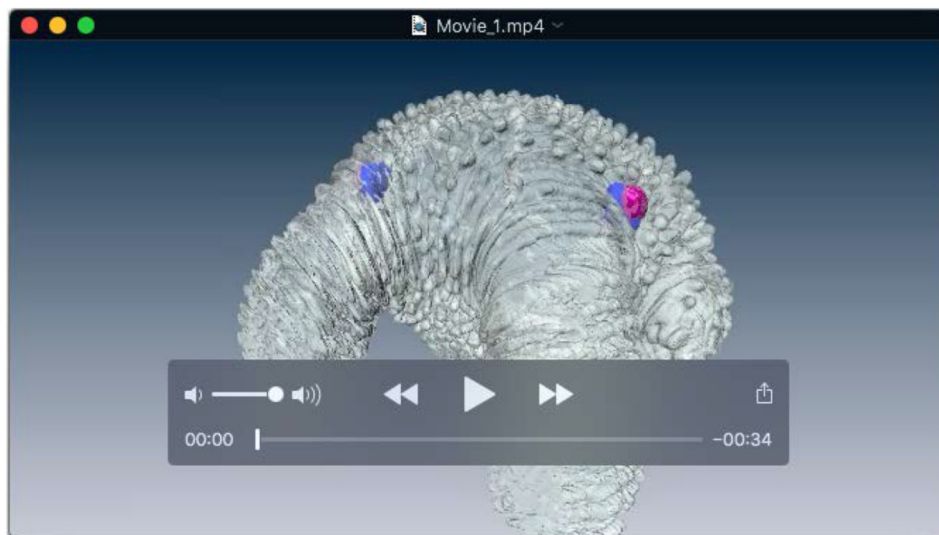
Fig. S3. Diagnostic plot for the fit of the probit regression model. The observed residuals were derived from an empirical cumulative density function for data simulated at each observation based on the model fit. The quantiles of these residuals, scaled from 0 to 1, are plotted against the quantiles of an expected uniform distribution. For a perfect model, all points should adhere to the red line.

Table S1. Tested mixed effects probit regression models for analysing success rates. In all cases, random intercepts were included for individual effects. M1 was selected as the most likely model from the list below based on the lowest value of the Akaike information criterion.

model	fixed effects	degrees of freedom	Akaike information criterion (AIC)
M1	stimulus width	3	236.0573
M2	stimulus width + orientation	6	241.6625
M3	stimulus width x orientation	9	246.9222 (did not converge)
null	no fixed effect	2	256.2287

Table S2: Outcome of behavioural trials assessing object taxis

Trial	Individual	Stimulus type	Target arc angle (deg)	Orientation of setup	Date of trial (YYYYMMDD)	Heading (deg)	Orientation success
1	11	control	0	East	20120829	297.43	FALSE
2	12	control	0	North	20120828	286.26	FALSE
3	13	control	0	North	20120830	89.04	FALSE
4	16	control	0	North	20120829	12.76	TRUE
5	17	control	0	East	20120829	208.15	FALSE
6	18	control	0	West	20120829	335.88	TRUE
7	19	control	0	East	20120829	308.39	FALSE
8	20	control	0	South	20120829	350.65	TRUE
9	21	control	0	North	20120829	198.02	FALSE



Movie 1: A 3D reconstruction of the head and eyes of an adult specimen of *Euperipatoides rowelli*. The cornea is coloured in pink and the surface of the head (grey) is shown partially transparent to expose the pigment layer (blue), which functionally defines the ocular chamber.

Reference

Beckmann, H., Hering, L., Henze, M. J., Kelber, A., Stevenson, P. A. and Mayer, G. (2015). Spectral sensitivity in Onychophora (velvet worms) revealed by electroretinograms, phototactic behaviour and opsin gene expression. *J. Exp. Biol.* 218, 915-922.