Cone topography in the retina of the snake-eel *Ophisurus serpens*

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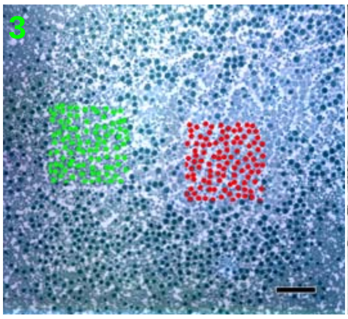
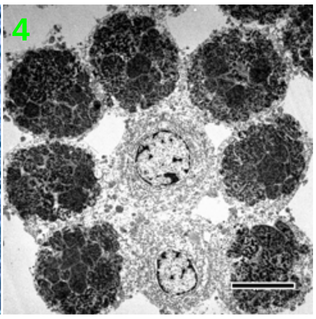
Introduction

The snake eel *Ophisurus serpens* is living on sandy or muddy bottoms in the Mediterranean at depths between 5 and 300 meters. With a body length of up to 2 m (Fig. 2) the animals burrow themselves backwards into the sediment, the head with its tapering noose peering out at an angle, and remain there almost hidden during daytime. At night the snake-eels are found at the same place (Fig. 1) or swimming and hunting just above the sediment surface.The peculiar way of life and the horizontally oriented, almond-shaped pupil (uncommon within teleosts) let us feel compelled to investigate the morphology of the *Ophisurus*-retina. This was done also to complement data for the discussion of functional morphology and visual ecology of marine eels – *Muraena*, *Conger*, *Ariosoma* and *Ophisurus* – all living in immediate spatial vicinity (see also Heß et al. 1998, Zool Anz 237: 127-137)

1) *O. serpens lurking in the sand. Note the horizontally oriented almond-shaped pupil.*
2) *Two divers with an adult O. serpens for illustration of the body-size.*

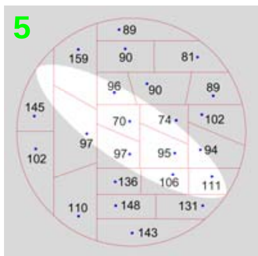


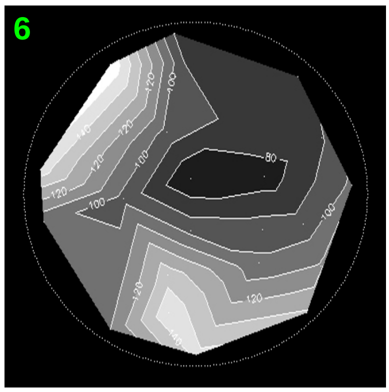


3) *Light micrograph for cone-counting. Retina cut tangentially. Bar: 50 µm.*
4) *TEM micrograph shows 7 cone ellipsoids an 2 cone nuclei. Bar 5 µm.*

Results

O. serpens has a duplex retina with rods and single-cones. The rod layer consists of 2 to 3 banks somewhat blurred due to radial displacements, the cones possess huge ellipsoids (9.1 µm x 7.1 µm) with electron-dense mitochondrial matrices (Fig. 4).
The cone density amounts to about 80 cones/10^4 µm^2 in the fundus (Fig. 3). Mapping of the cone density-distribution of the entire retina (Figs. 5+6) points out two roundish areae with increased cone-density: a dorso-temporal one (max. 160 cones/10^4 µm^2) and a ventral one (max. 150 cones/10^4 µm^2).






```
pro map
device, retain = 2, decomposed = 0
z = fltarr(23), …
for i=0,22 do begin
theta[i]=t[i]*6.283185/360
endfor
polar_contour, /follow, z, theta, r, /isotropic, levels=[60, 70, 80, …], ystyle = 4, xstyle=4, /fill
polar_contour, /follow, z, theta, r, /isotropic, /noerase, levels=[60, 70, 80, 90, …], ystyle = 4, xstyle=4
oplot,/polar, r,theta, psym=3
for b=0,360 do begin rr[b]= 5.75
tt[b]=b*6.283185/360
endfor
oplot,/polar,rr,tt, psym=3
end
```

5) *Raw data (cone-counts) at retinal positions, body axis horizontal, pupil highlighted white*
6) *Density distribution of the cones (per 10^4µm^2) in the right eye of Ophisurus serpens computed with the IDL-code displayed below.*

Discussion

The comparatively high cone density emphasizes the importance of the photopic system in this species (like in *Muraena* but unlike in the strictly night-active Congridae). The positioning of the two areae of *O. serpens* is somewhat surprising. Vertebrate species living at flat, poorly structured environments with a sharp horizon often possess retinae with a horizontal streak of high cone density, indicating high visual acuity pointing to the horizon. Here the areae point forward and back-upward, i.e. to the spatial sectors in wich the foci of visual attention have to be assumed when the animal is lying in wait for pray (see Fig. 1). Up to now the pupil-orientation of the swimming animal was not yet observable.
With *Ophisurus* we now have another example for the plasticity of retinal morphology in the course of adaptation to photic habitat conditions and visual demands within the anguilliformes.