The Eye of the Platypus

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Genome analysis of the platypus reveals unique signatures of evolution
Nature 453, 175-183 (8 May 2008)
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Birds, dinosaurs
• Homeotherm (31-32°C)
• Bill
• Sex chromosomes have homology to avian Z chromosome

Reptiles
• Mechano/electroreceptors
• Few large and many small chromosomes
• Venom

Bird, reptile, monotremes
• Cloaca
• Abdominal testes

Bird, reptile, mammal
• Amniote
Ancestry vs. lifestyle

Crepuscular to nocturnal
Live in burrows
Obligate aquatic feeders
Closes eyes, ears and nose under water
Uses bill to locate prey

Cartilage

U. Of Queensland

electroreceptors (red)
mechanoreceptors (blue)
Scleral cartilage
Bird, reptile, monotreme
Not marsupials or mammals
Accommodation and the lens
Aqueous drainage and the anterior uvea
The vascular system: retina and choroid
<table>
<thead>
<tr>
<th>Species</th>
<th>Peak GC density per mm²</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echidna</td>
<td>1800</td>
<td>Arrese et al., 1999</td>
</tr>
<tr>
<td>Platypus</td>
<td>4000</td>
<td>Pettigrew et al., 1998</td>
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<tr>
<td>Mouse</td>
<td>8000</td>
<td>Arrese et al., 1999</td>
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<tr>
<td>Sheep</td>
<td>5400</td>
<td>Arrese et al., 1999</td>
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<tr>
<td>Cat</td>
<td>9000</td>
<td>Arrese et al., 1999</td>
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<tr>
<td>Dog</td>
<td>10000</td>
<td>Arrese et al., 1999</td>
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<tr>
<td>Wolf</td>
<td>13000</td>
<td>Arrese et al., 1999</td>
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</tbody>
</table>
The lens and ciliary body
- Large ciliary body, pred. pars plicata
- Minimal capacity to accommodate
- Vestigeal or absent zonules
- Post lenticular membrane

Retinal vasculature
- Minimal inner retinal circulation: paurangiotic
- Prominent choroidal and choriocapillary circulation

Aqueous drainage and the uvea
- Trabecular meshwork
- Minimal scleral vortex venous system
- Thin iris with constrictor, but small or absent dilator
- Iris constrictor consists of striated muscle
- No tapetum

Retina
- Duplex retina with double cones and clear cone droplets
- IHC reveals Red/green cones, Short wave cones, and rods (predominant)
- Relatively thin ONL and few ganglion cells: poor acuity
- RPE has long apical villi and large single intracytoplasmic droplets (autofluorescent, PAS and Trichrome positive)
Scleral cartilage

Bird, reptile, monotreme
Not marsupials or eutherians

No iris dilator

Striated muscle in sphincter

Retrolenticular membrane?

Absent scleral veins?
Scleral cartilage
Bird, reptile, marsupials, monotremes. Not eutherians

double cones
Bird, reptile, marsupials, monotremes. Not eutherians

No iris dilator

Striated muscle in sphincter

Retrolenticular membrane?

Absent scleral veins?

Scleral cartilage
Bird, reptile, monotreme
Not marsupials or eutherians
Scleral cartilage
Bird, reptile, monotremes
Not marsupials or eutherians

clear cone droplets
Bird, reptile, marsupials
Not echidna or eutherians

double cones
Bird, reptile, marsupials, monotremes. Not eutherians

No iris dilator
Reptile

Striated muscle in sphincter
Bird, reptile

Retrolenticular membrane?

Scleral cartilage
Bird, reptile, monotreme
Not marsupials or eutherians
Does the platypus need as much eye as it has?

Aquatic features, but closes its eyes under water
Uses its bill for locating prey

The modern platypus eye may be a vestige of its more predatory aquatic ancestors

Obdurodon insignis: 25 million years old, show that ancient platypuses had teeth as adults.
The modern platypus has only vestigial teeth which are replaced by horny pads when it is still a juvenile.
Thank you!

Ivan Schwab
Dick Dubielzig
Kate Lieber