A Colourful World

Can badgers see in colour? **(Look up, think about or find out about anything in purple.)**

Baby badgers don't open their eyes until they are five weeks old.

Badgers have quite small eyes, and their eyesight is not particularly good. Like many other mammals, badgers can't see anything in colour – only in black, grey and white.

Badgers can't see details very well. They can see shapes and also movements. If you want to watch badgers, you will have to make sure they don't see you. *(Or hear you, or smell you with their incredible sense of smell.)*

Making sure they can't see you.

- Don't wear any bright clothing.
- Don't stand too close to the badger sett. If you stand a little way away, they'll find it much more difficult to see you.
- Stand still. If you move, the badgers will pick up on the movement.
- Stand somewhere where the badgers won't see your shape against the sky. Sit or stand with your back to a tree, for instance.

Animals need cones in their retina to see colour. Humans have three kinds if cones. The S-cones absorb blue light. M-cones absorb green. L-cones absorb red. *(Your pet cats and dogs, like many non-primate mammals, have L-cones. So cats and dogs see some colour – they see in shades of yellow and blue, but can't see the range from green to red. They see their world in shades of yellow, blue and grey.)*

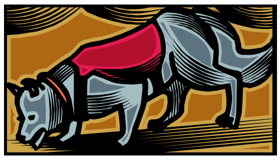
Monochromacy in Mammals

Monochromacy is when the retina of the eye only has one type of cone. It has developed by convergent evolution in a number of mammals; terrestrial and marine. In bright light, monochromatic mammals are probably colour-blind. In dim light, cones and rods are active, so they might have some colour vision.

It was thought that monochromacy was linked to animals that were nocturnal, as the ability to see colour might not be of much use to a nocturnal animal. *(Try this for yourself. Look around your bedroom with the light on. Then switch it off and let your eyes adapt to the low light. Can you still see the same bright colours?)* But many nocturnal animals are dichromatic, whilst some animals without S-cones can still be active during the day, (diurnal).

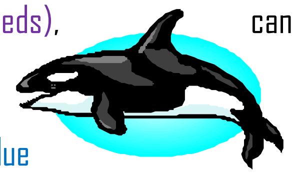
(Many nocturnal animals rely instead on greater numbers of rods for extended night vision and keener detection of movement.)

Scientists now believe that monochromacy in diurnal terrestrial mammals is likely to be fairly rare. However, it does seem to be prevalent or even universal in Lorisiformes. It is thought that S-cone loss occurred early in their evolution. A number of other primates are believed to be monochromatic. Some bats, such as horseshoe bats and fruit bats are also monochromatic. Several rodents, such as golden hamsters and some of the mice probably have monochromatic vision. Many species have dichromatic vision, which is similar to red-green colour-blindness in humans. These include coatis.



Animals like cats and dogs have two sets of cones, making them colour-blind to specific colours. They do, however, have many more rods than humans, giving them greater night vision and a keener ability to detect motion. Dogs can't distinguish between green and orange which will both look grey. If you were to throw an orange tennis ball across a green lawn, you would find that a dog can follow it while it's in motion. Once it stops moving, your dog might lose the ball against the background. Only its shape will cause it to stand out. In humans, green colour blindness is referred to as *deuteranopia*.

Feline animals do see in colour, but they do have trouble distinguishing reds; the human counterpart being *protanopia*. Reds appear as differing shades of grey to a cat. It is thought both dogs and cats see mainly in greys, yellows, and blues.



Monochromacy seems to be the rule in marine mammals. Some of the distant relatives of these animals, (cetaceans and pinnipeds), can see in colour, so it seems that monochromacy developed in convergent evolution as an adaptation to their lifestyle. It does seem odd that the animals lost their S-cones, as clear waters are dominated by blue light. Perhaps colour vision is not too useful in dim, murky water, but S-cones would still be quite useful.

In contrast to this, the manatees and some other semi-aquatic mammals, such as the pigmy hippo, our own European otter and the polar bear, have retained two cones. They often feed in shallow waters, where the light is bright and the spectrum broad, and they also spend quite a bit of time on land, so they probably benefit from keeping cone dichromacy. They have middle wavelength green L-cones and shortwave blue S-cones.

Some scientists explain it as follows: Depending on the type of water, the wavelengths penetrating deepest may be short (clear, blue ocean water) or long (turbid, brownish coastal or estuarine water.) Therefore, the variety of visible availability in some animals resulted in them losing their S-cone opsins.

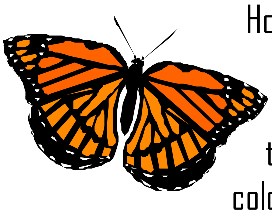
When these early mammals still inhabited coastal waters, the underwater light spectrum was shifted towards red, because blue light is absorbed by organic and inorganic material. Losing the S-cones would, therefore, have been at no cost to the animals, and could probably have been a benefit in terms of simplifying the processing of visual information. Some descendants then stayed in coastal waters (and for them the loss is still useful or at least neutral), while others conquered the open ocean.

Certainly they would have profited from functional S-cones, but could not reverse the pseudogenisation. However, the spectral tuning of their L-cones (and rods) is shifted towards shorter wavelengths, which compensates for the loss of S-opsin at least partly.

Marine mammals have, of course, evolved remarkable non-visual capacities for orientation and prey location, such as echolocation in toothed whales.

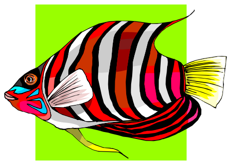
So what about the rest?

As an exception to the nocturnal rule, owls do have cones, leading scientists to believe these animals do see colours.

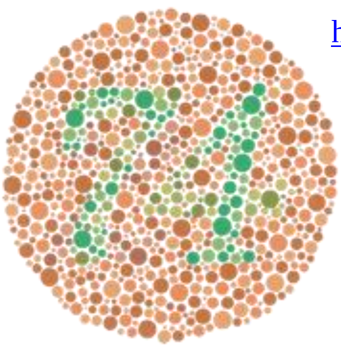


Honeybees and butterflies have three pigment visual receptors with true colour vision within their visual spectrum. They are not good at seeing infrared but their vision extends into the ultra-violet beyond human vision. Not only can these animals see colours, they can detect a mix of colours as well as pure colours. (They do seem to like blue flowers. You could try an experiment on this. Think how you might do it.)

Scientists believe coral reef fishes see close to the same rich spectrum of colours that humans see. (Look at the incredible colours of reef fish!) The animal kingdom does seem to have evolved bright colouring to both ward off predators (wasps), and to attract mates, which would be a useless evolutionary feature on animals that couldn't see in colour. However, exceptions do exist here too so the assumption is general and speculative.



Example of an Ishihara color test plate. The number "74" should be clearly visible to viewers with normal color vision. Viewers with dichromat or anomalous trichromat may read it as "21", and viewers with achromat may see nothing.



http://en.wikipedia.org/wiki/Color_perception_test