# Infectious cancers

Is it possible to pass cancer from one individual to another? For some animals, it is – and, sadly, a unique Tasmanian species is facing possible extinction as a result.

Image courtesy of Arthur Caranta; image source: Flickr

Tasmanian devils and their aggressive behaviour have inspired a cartoon character

**By Susan Watt**

You could say that sympathy for the devil is what led Dr Elizabeth Murchison to her field of research – not for Satan himself, but for the fierce little marsupials known as Tasmanian devils.

This species, unique to Tasmania, is under threat from a form of cancer that, bizarrely, is spread by direct transmission from one individual to another: infectious cancer, in other words. Called devil facial tumour disease (DFTD), it causes large tumours on the face and inside the mouth of affected animals and has rapidly spread through the Tasmanian devil population. It appears to be both untreatable and invariably fatal.

## Biting into evolution

Now based at the University of Cambridge in the UK, Dr Murchison's research is focused on the genetic aspects of DFTD and other transmissible cancers. These strange diseases seem at first sight to completely contradict our understanding of the nature of cancer. Normally, cancers are caused by cells in the body that, due to mutations, have gained the ability to divide and grow uncontrollably. But in transmissible cancers, the

Image in the public domain; image source: Wikimedia Commons

Location of Tasmania (dark orange) in Australia

tumours are not made up of cells from the individual with the disease but instead are derived from the individual in which the first case of the disease occurred: the original tumour, which has somehow gained the ability to jump from host to host. The disease is spread by cells descended from the original tumour, which attach themselves to a new host and then produce more tumour cells that can again transfer to another individual.

In DFTD, one particular aspect of the Tasmanian devil's lifestyle makes such transfer easier: their tendency to bite other animals, including their nearest and dearest – not just during fighting or when scrapping over food, but also during mating and social encounters. Because their biting habit is now exposing Tasmanian devils to a fatal illness, the disease may be providing a powerful evolutionary pressure against biting and favouring less aggressive individuals. However, even if the devils were to evolve to become more sweet-natured, this would not be certain to reduce the impact of the disease. In this case, says Dr Murchison, the tumour would also change in ways that might help it to spread by other means. "The two things are co-evolving at the same time; if the devil were to change, then the tumour would also change," she says.

## The ultimate cancers

"Cancers are the product of natural selection operating at the level of a single cell within an organism," she explains. "The only difference with transmissible cancers is that they have managed to escape from their hosts." Normal cancers are an evolutionary dead end, because they die with their hosts. "Transmissible cancers are the ultimate cancers, because they have evolved to survive beyond their hosts, and to continue the evolutionary process beyond the death of the host

REVIEW

- **Biology**
- **Evolution**
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This article is the first of two on the topic of transmissible cancers in the animal kingdom. Despite their rarity, or perhaps because of it, transmissible tumours offer a unique context to discuss the nature of cancer and the selective scrutiny of evolution. Discussion can be encouraged through a bibliographic review, a scientific inquiry or a project for communicating science (e.g. through posters or a slideshow). Key points could be the differences between normal and transmissible cancers, the 'blind' pressure for survival in the natural world, and how parallel evolution occurs. Evolution acts not only at the population level but also at the molecular and cellular levels.

This article could also encourage science teachers to enhance their professional development in the areas of genetics, cell biology and evolution.

*Luis M. Aires, Antonio Gedeao Secondary School, Portugal*

Image courtesy of Elizabeth Murchison

Tasmanian devil facial tumour disease

Healthy Tasmanian devil in its natural habitat

Image courtesy of JJ Harrison; image source: Wikimedia Commons

body in which they first evolved," she explains.

The ability of even normal cancers to evolve is shown, for example, in the way cancers develop resistance to chemotherapy. "If you throw something at a population of cells that kills 99 per cent of them but one per cent survives, then that one per cent is going to grow back," says Dr Murchison. "By treating the patient, we are putting selective pressures on their cancer."

Even though cancers are evolving all the time, we know of only one other cancer in addition to DFTD that has evolved to become infectious.

Canine transmissible venereal tumour (CTVT) is a disease that affects dogs in many countries of the world. Happily, CTVT is much more treatable than DFTD and is not usually fatal. The disease has been known for some 150 years but is thought to have evolved far earlier. "We think this cancer originated around 11 000 years ago, close to the time when dogs were first being domesticated by humans," says Dr Murchison. So the tumours that are infecting dogs today are from the same cell lineage as this original ancient tumour – making them the oldest known living mammalian-derived cells on Earth.

## Evading the immune system

Is it just luck that so few transmissible cancers seem to exist, or are there any fundamental reasons why this change to becoming infectious is so rare in cancers? After all, cancer cells can grow in a laboratory – so why do so few make the leap to being able to grow in a new body?

One obvious difference is that infectious cancer tumours have to find a way to avoid rejection by their new host's immune system, given that they are derived from a different individual. Recent research has revealed that in DFTD, the tumours

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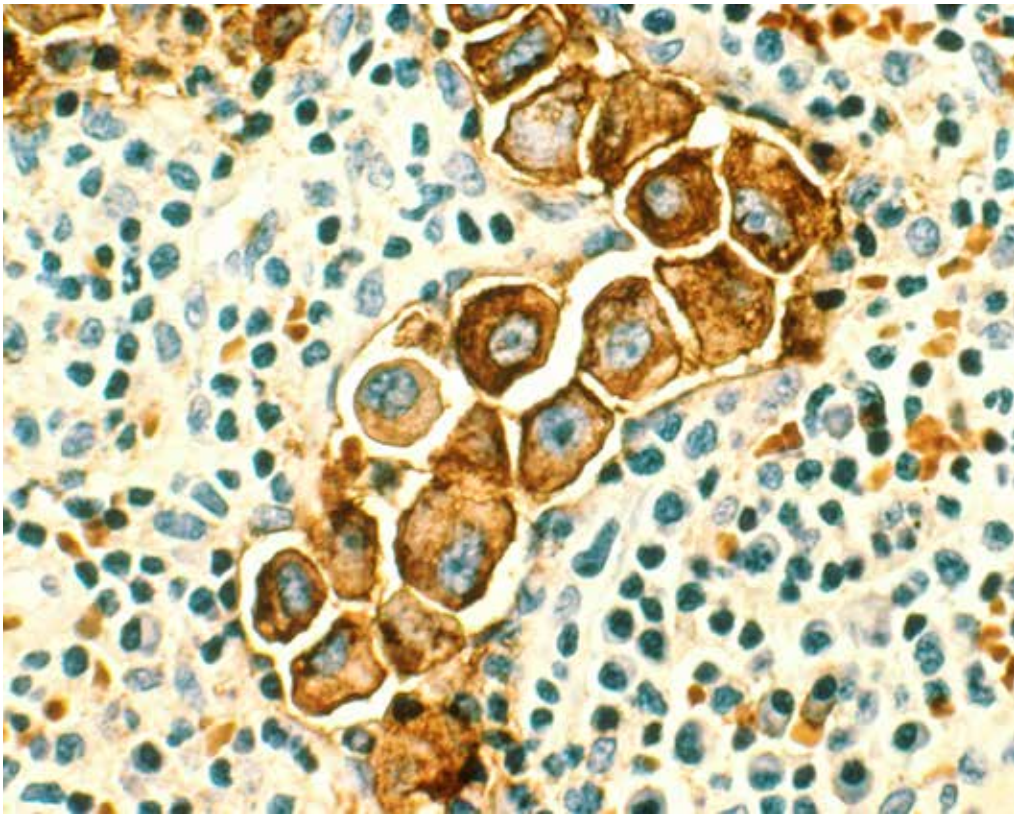


Breast cancer in the lymph nodes

stop producing a molecule that indicates to the immune system which cells are foreign invaders. Without this molecule, the DFTD cancer is able to get into an animal's body and escape detection by its immune system.

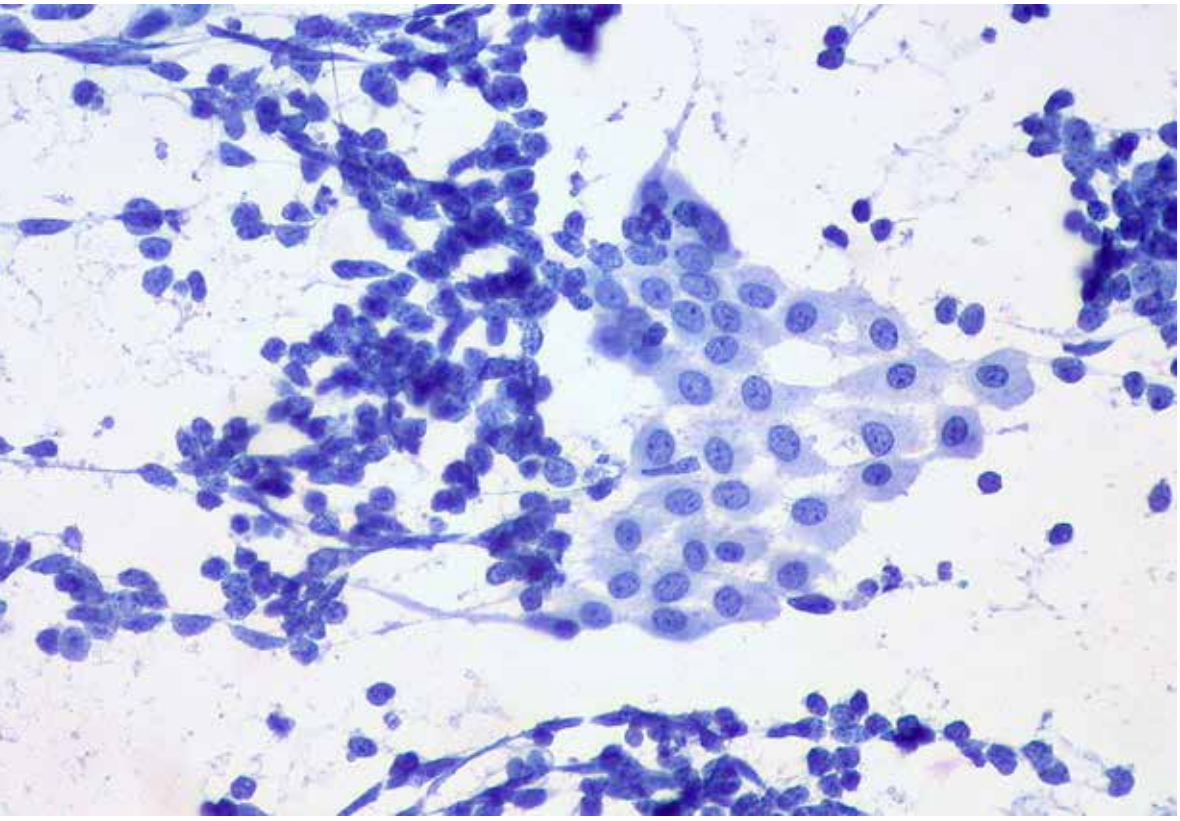
But, says Dr Murchison, many researchers now believe that normal cancers are also able to hide from the immune system to some degree. "The immune system has mechanisms to detect cancer cells," she says. "Possibly the immune system is busy protecting us from thousands of incipient cancers that occur in our body all the time, so the tumours we do see have already acquired some immune evasion adaptation."

Chillingly, there are even a few cases in humans of cancers being transferred from one person to another. Most of these have occurred in transplant patients, where an undiagnosed tumour in a donated organ has led to cancer in the recipient. But there has also been a single case of a surgeon 'catching' cancer from a patient after he injured himself while operating[w1].

So could we open our newspapers one day and read reports of newly discovered transmissible cancers in humans? Probably not, Dr Murchison says. "Transmissible cancer is unlikely to happen in humans, because it's so rare in nature – we have only seen two examples." But if it ever were to happen, Dr Murchison's work will have helped us to know what to expect, and perhaps to get started on developing useful therapies.

In the next issue of *Science in School*, Dr Murchison will explain some of the latest findings on the genetics of transmissible cancers.

*Image courtesy of Ed Uthman; image source: Flickr*



Small cell lung carcinoma cells (plus other benign cells)

## Web reference

w1 – Read this nice article about potential transmission of cancer between humans: http://www.abc.net.au/science/articles/2012/10/23/3616950.htm

## Resources

For more about devil facial tumour disease (DFTD) and efforts to save the Tasmanian devil, see: www.yourgenome.org/interactives/saving-the-devil

For a short lecture by Elizabeth Murchison explaining her work to a general audience, see: www.ted.com/talks/elizabeth_murchison

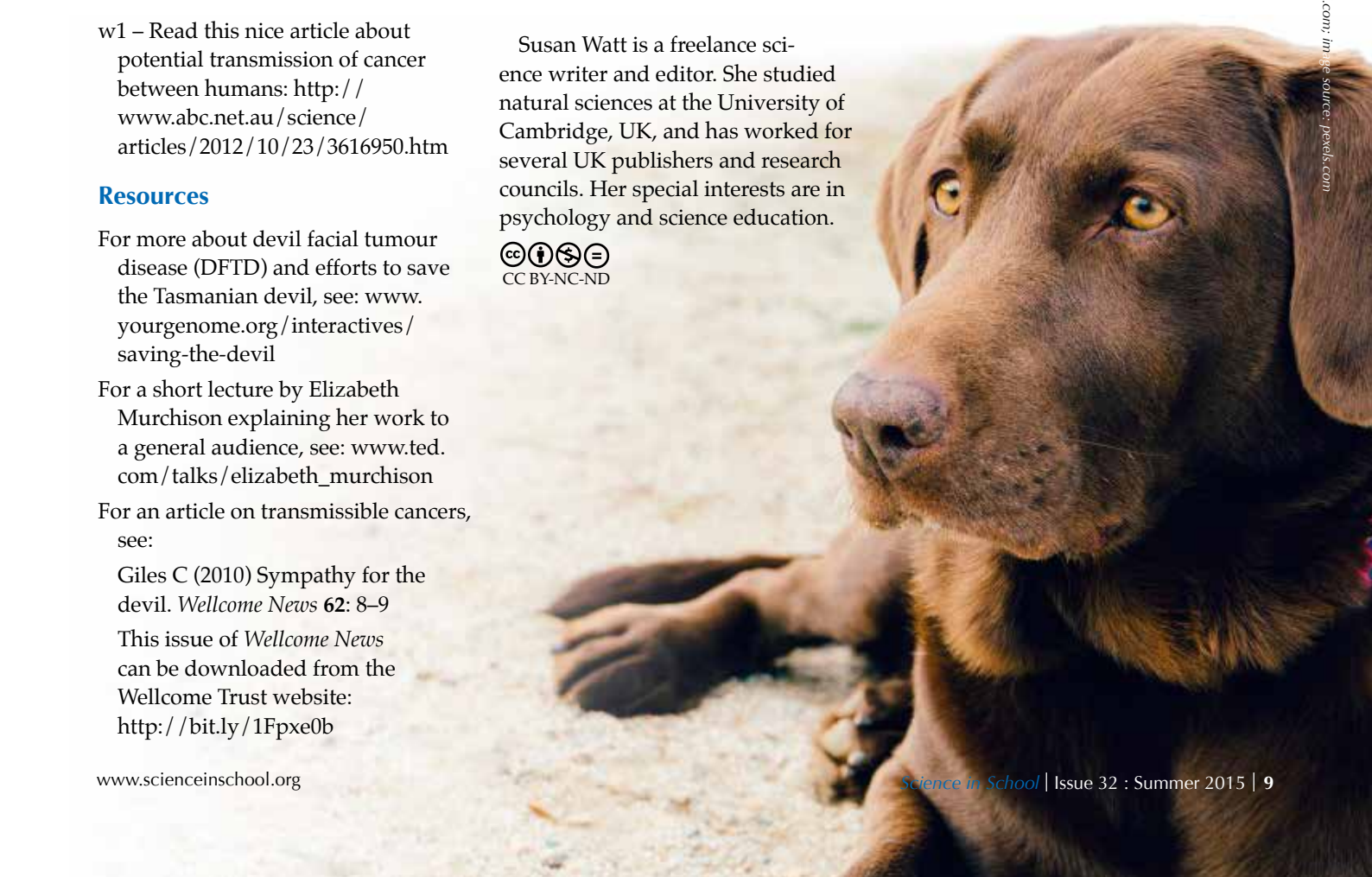
For an article on transmissible cancers, see:

Giles C (2010) Sympathy for the devil. *Wellcome News* **62**: 8–9

This issue of *Wellcome News* can be downloaded from the Wellcome Trust website: http://bit.ly/1Fpxe0b

Susan Watt is a freelance science writer and editor. She studied natural sciences at the University of Cambridge, UK, and has worked for several UK publishers and research councils. Her special interests are in psychology and science education.





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