It's Only a Virus, Snuffling at Nothing?

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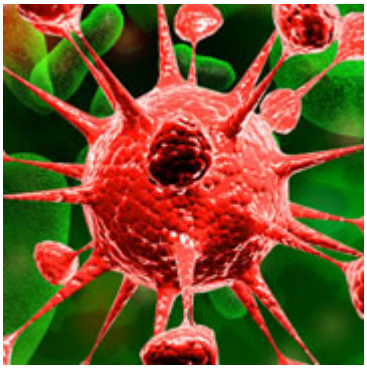

Article by Alison Cooper

Why human flu sufferers are far from alone. Tiny organisms, minor illness, massive influence.

In stuffy offices and classrooms dramatic stories and terrifying statistics spread like wildfire. From killer pandemics to man flu, viruses are hard to escape. In reality severity varies and human targets are not alone.

Angela McLean, professor of Mathematical Biology (University of Oxford), examines patterns underlying virus infection. As human flu suffers retreat, huddling cosy duvets and lemsip powder, it is easy to forget the world outside. Nevertheless, tiny viruses continue to have a massive effect in the animal and plant kingdoms. Dr Chris Gower (Oxford) and Dr Lawrence Kenyon (Head of Virology, AVRDC World Vegetable Centre) illustrate virus emergence in animal ecosystems and agriculture.

While scare stories abound, we are reminded that viruses are highly specific and leaps between species are unusual and limited in size. Understanding virus and earth systems interaction, and maintaining hygiene are perhaps the most effective defences. Just sometimes the best advice might really be to slow down, avoid crowded habitats, and stay home.

What?

To recap, a virus is an infectious agent, consisting of genetic material DNA, RNA wrapped up in a protein coat. One hundred times smaller than bacteria, barley visible through a light

microscope, they come in many varieties and reproduce inside cells of other organisms. These tiny, relatively simple microorganisms are perhaps one of the most powerful forces on earth, present in all ecosystems, with the ability to devastate entire populations of almost all other forms of life, generating immensely complex questions for science.

How?

Professor McLean explains, viruses spread in cramped conditions where members of the same species are forced together in a small space. For animals this can happen when habitats are destroyed, even where only a few of the species survive as they crowd together in small remaining areas of habitat.

Virus pandemics emerge through a mixture of ecological and evolutionary processes. When one happens, like Swine Flu the viruses work on 'power and competition'. From this, in June 2010 Prof McLean predicted the new H1N1 Swine Flu virus will become the regular strain, replacing the previous seasonal flu. It is entirely possibly, although as yet unconfirmed, that this is happening now, as the World Health Organisation (WHO) reports cases of Swine Flu virus alongside other strains. A case of 'watch this space?'

"I am interested in how distribution of people such as movement from villages to towns affects how a virus spreads. The more a virus spreads the more it evolves.

Certainly, having lots of people move around the world very fast, there is no getting away from the fact that this is a good way to spread a virus around. While there are a lot of benefits in people travelling we must acknowledge that we need to think about what this means when a virus emerges, as was seen with SARS which came from China and was seen all over the world within a few months.

In history when Europeans first went to the 'New World' devastating outbreaks of smallpox and measles occurred in people who had never encountered these diseases before."
Professor Angela McLean

Prevention and Treatment

Luckily it is not all doom with preventative vaccines and anti viral medication available. Professor McLean takes a closer look.

"It is amazing how successful vaccinations for viruses have been. The same measles vaccine has been effective for over forty years and the virus has not been able to evolve resistance despite selection pressure put on it by humans. In contrast new flu vaccines are needed every year, reflecting the changing underlying biology of the microorganism, different every year whether you vaccinate or not."

For viruses where no vaccine is yet available e.g HIV, anti viral drugs are the first line of attack. When using antiviral drugs it is important to use genetic screening in a laboratory to check for resistance and help doctors decide which to use.

"We use information encoded in the RNA extracted from a blood sample (genetic material) to make real treatment decisions in real clinics. The right combination of antiviral drugs will not cure HIV but it can nearly completely suppress the virus and stop it reproducing, so as

long as the person is able to continue to take it they will remain well. Failing to screen and using treatments where a patient has natural resistance is harmful in that it delays effective treatment and resistance not previously there can develop, burning through patients options for treatment."
Professor Angela McLean

Out in the Wild

Our four legged friends can also suffer and domestic animals such as dogs are major virus carriers. Surprisingly it is wild populations like Ethiopian wolves who are left vulnerable, Chris Gower from Oxford University talks about protecting them.

"Ethiopian wolves are smaller than the European wolves that they descended from when they migrated from Europe to Africa. They are a flagship for the Afro Alpine habitat, when they are there you know everything else is present in the habitat ecosystem, including rodents. This important region supplies water for Somali, Egypt and Sudan." Chris Gower

These wolves are an endangered, not dangerous, with less than 500 remaining in the world. As people move into their habitat in the Ethiopian highlands with dogs and livestock the threat from the transfer of a rabies virus to such a small population is potentially devastating. Strategic vaccination creates barriers of immunised dogs to contain the outbreak. It would be quicker to inoculate the wolves directly, however the only available vaccine now uses Genetically Modified Organisms and is currently not allowed.

Feeding a Cold

What better way to beat the snuffles than vitamin C packed juicy tomatoes? Dr Lawrence Kenyon Head of Virology at the World Vegetable Centre (AVRDC) demonstrates that they too are not immune, often at the mercy of virus carrying insects.

Plant viruses are transferred from plant to plant either by insects such as whitefly or infected plants rubbing together through human and animal contact. Tomato leaf curl is an example of a major crop virus, the leaves of infected plants show symptoms first, curling up to a dry withered crunch before the entire plant dies.

"Plant viruses do have pandemics but it is not so dramatic as seen with swine flu because as a rule plants don't get on aeroplanes, requiring insects for transmission."
Dr Lawrence Kenyon

In Taiwan 'power and competition' is in action as indigenous tomato leaf curl virus is being replaced by the more aggressive Thailand leaf curl virus, affecting peppers as well as tomatoes.

Plants like cabbages can act as whitefly sources, encouraging virus spread. Measures to prevent this in crops include; careful choice of species planted together, regular clearing of dead and dying plants, and housing in net cages. Spraying can also be used with more or less toxic agents. Reflective distracts the insects' visual systems stopping them from landing on surrounded crops, and artificial coatings can be used on fruits. Selective breeding and genetic interventions to produce disease resistance, provide an alternative where other methods are too expensive or impractical.

Commercially desirable characteristics such as sweet juicy fruits make plants more vulnerable to viruses. Insects find hairy plants less attractive to land on, increasing their resistance to infection. This principle explains why commercial thorn less roses can only be grown in glass houses.

Non native environments also increase vulnerability. Cassava or Manioc now a widely grown staple crop in Africa was introduced from South America over two hundred years ago. Cassava Mosaic virus is now a major agricultural problem in Africa.

"If you go back to the centre of origin of Cassava it is not found at all, or anything like it. Scientists think it must have come from the native African plants and found Cassava to be a better host."
Dr Lawrence Kenyon

Making a Leap?

I asked the scientists just how big a leap can virus species make between hosts. They agree;
"Viruses can jump from dogs to wolves, pigs to people and some of the genes move between species. They get inside cells where they can grow so there needs to be enough similarity between the cell types. Every gardener knows humans don't get sick from plant viruses, the cell receptors are too different. The biggest jump we have seen in nature is SARS, from birds to people. This is exceptional and still within vertebrates."
Professor Angela McLean

"Plant viruses have evolved to affect plants, just a few will also affect the insect carrying vector. Animal cells produce antibodies to foreign material and a plant virus will be recognised as such so animals don't get infected."
Dr Lawrence Kenyon

Who's Life is it Anyway?

Personally I consider finding acceptable mechanisms of virus prevention an example of a really difficult dilemma and wonder whether 'natural' gene pool conservation can be considered desirable and achievable in today's fast moving society. I would also like to know whether human created computer viruses exhibit similar emergence patterns to human, animal and plant varieties. Certainly, migration and translation generate immensely complex evolutionary effects across the earth's systems.