



With humans seemingly fighting a losing battle against the invasion of an ever-changing army of infectious diseases, how do we predict and prepare for the next epidemic? **Björn Olsen**, Professor and Senior Physician of Infectious Diseases at Uppsala University, argues that only a continual collaborative effort between medical and ecological disciplines, to understand the relationship between infectious disease and biodiversity, can hope to stem the tide.

Uniting against infectious disease



Björn Olsen and a caught and sampled grey phalarope from the Sibirian thundra 2005.

'What's the most migratory bird in the world?' asks Professor Olsen. "It's the chicken – yet it can't even fly."

The above example, he says, is just one illustration of man's effect on biodiversity, with our increasing encroachment on the natural environment and the domestication of animals for large-scale farming. "We took the humble jungle hen more than 5000 years ago and domesticated it to create 48 billion chickens worldwide," he explains. "We've transformed it from a bird living in small social groups roaming wild, into batteries of up to 400,000 birds at a time – and we transport it all over the world."

So why is this significant for the spread of disease? "Well, more than 70% of our infectious diseases are zoonotic," says

Professor Olsen. "That is, the microorganisms can transfer from animals to humans, directly or via several steps. In a healthy ecosystem, animals live apart from the urban human population, in a biodiverse habitat, and act as 'reservoirs' to soak up these microorganisms. But when we reduce this reservoir, by hunting, habitat destruction or domestication, we bring the microorganisms closer to us and enable them to spread disease. Furthermore, while many animals, including humans, are naturally migratory, we have unbalanced these migratory routes through the development of worldwide transport networks, spreading the microorganisms still further."

It is this relationship between the

ecosystem and infectious disease that encouraged Professor Olsen to pursue an interdisciplinary approach to infectious disease in his latest project. "Uppsala, where my research is based, is unusual in that it is the only place in Sweden which has colleges for medical, veterinary and ecology students in the same town," he says. "For years, there has been a lot of talk about collaboration between these disciplines to share knowledge and adopt a 'One health' approach to health. So when the Swine Flu outbreak hit in 2009, I decided it was time for action."

In the spring of 2010, Professor Olsen began setting up an interdisciplinary network to research the central issue: how



Former PhD student Jonas Bonnedahl and Björn Olsen are sampling an Adélie penguin for antibiotic resistant bacteria and avian flu virus in Antarctica.

do infectious diseases, such as Avian Flu or antibiotic resistant bacteria, spread? Over 100 scientists from different disciplines attended the first meeting, and by February 2011, the Infection Ecology and Epidemiology (IEE) network (www.infee.se) was born. The IEE network inspired by the “One Health initiative”, (www.onehealthinitiative.com) a worldwide movement for enhancing interdisciplinary collaborations for the healthcare of humans, animals and the wider environment.

IEE has also created an online forum and open access journal (www.InfectionEcologyandEpidemiology.net), under the same name, to publish papers, share ideas and raise awareness of its work among politicians, industry and the wider public. “The forum is independent, free-thinking, you might even say anarchic,” says Professor Olsen.

“Any researcher may publish papers on any of the areas we cover, providing, as with any such publication, their research is scientifically rigorous. We hope to have 25 papers published within the first year. There’s no political agenda here – we’re trying to share knowledge as openly as possible.”

This free-thinking approach is already bearing fruit. “I think we can highlight three major areas of progress,” says Professor Olsen. “Firstly, we have discovered that certain microorganisms are far more widespread than even we feared – we’ve found the bacteria with ESBL genes appearing in the remotest of places such as Siberia, probably carried there by migratory birds wintering in highly populated areas in South East Asia.

“Secondly, we’re seeing that sewage treatment works are unwittingly making a major contribution to the resistance of diseases to drugs. Human waste is flushed through the sewage treatment system and into the rivers without destroying the antibiotics or antivirals within it. This allows disease-carrying microorganisms in the rivers or wetlands to become resistant, as they are over-exposed to them. The flu antiviral Tamiflu®, for example, was flushed into the river system, allowing the flu virus to become resistant to it. Then ducks drank the infected water and promoted resistance against it in naturally circulating avian influenza virus. So we’re seeing antibiotics and antivirals – our main defense against infectious disease – become increasingly ineffective.

“And thirdly, I think our research so far verifies the need for shared, inter-



The Ottenby Bird Observatory duck trap. The ducks are sampled for different viruses, including avian flu virus and antibiotic resistant bacteria.

disciplinary knowledge and careful planning. We can pretty much tell which microorganisms are zoonotic so we need to be looking ahead, understanding what's happening where in the ecosystem, to see which infectious diseases might be coming our way next. We need to create early and world wide warning systems, monitoring for example certain antibiotic resistant bacteria or virus with pandemic potential."

Alongside the spread of diseases, the lack of effective new drugs is of particular concern. "We've got a few major types of antibiotics left in hospitals now," says Professor Olsen. "What happens when they finally become ineffective? We are heading back to the pre-antibiotic era. By the promiscuous use of antibiotics in hospitals, agriculture and aquaculture we are creating a collective debt that should be paid by this or the next generation. Without any capital.

Are we looking at another pandemic like the Spanish Flu virus which killed 50 million people in the early 20th century? The drug or vaccine development process as it stands just cannot keep pace with the new strains of diseases that we're coming into contact with – we need to become proactive against diseases heading our way instead of just reactive against ones which are already here."

A collaborative, all-out approach to disease is vitally important, says Professor Olsen, when we consider the enormous population growth of the human race. "I remember one of my teachers at school in

the 1970s announcing with some trepidation that the world population had reached 4 billion," he recalls. "In fact that was about the optimum level to support a healthy ecosystem. By 2050 there will be 10 billion people on Earth, with all the pressures on resources and the spread of disease that will bring. Without sustained population control, largely through an education programme to help females, who traditionally take the lead in family planning decisions, to make informed choices, we're going to have a crisis on our hands – humans will be migrating from drought or famine-ridden areas, spreading disease as they go. Habitats will disappear, major species will become extinct and disease-laden microorganisms will move ever more easily among the human population."

It's a sobering vision of the future but Professor Olsen remains hopeful that this One Health action can bring positive change. "I think we've proved the need for such an approach," he concludes. "Now I hope, through the IEE network and forum, we can change the way people, in particular the politicians and policy makers, think about the relationship between biodiversity and disease. I hope IEE helps us become more proactive in the fight against infectious disease and shows everyone that protecting what we can of the environment is not just something we should do for our enjoyment – it's something we must do for our very survival."

At a glance

Project Information

Project Title:

IEE: Infection Ecology and Epidemiology

Project Objective:

Infection Ecology and Epidemiology network is a collaboration for researchers with interest in zoonotic and emerging infections. IEE is an integration concept including universities and governmental organizations, to contribute to a sustainable intellectual platform where veterinarians, physicians, molecular biologists, ecologists, mathematic modelers and environmental chemists can interact and create synergies.

Project Duration and Timing:

2010-onwards

Project Funding:

Uppsala University (7.5 million SEK), Swedish University of Agricultural Sciences, National Veterinary Institute, Linnaeus University, The Swedish Research Council (1.1 million SEK), The Swedish Research Council FORMAS (60 000 SEK), Swedish Civil Contingencies Agency (325 000 SEK).

Project Funding:

Main partners are Uppsala University, Swedish University of Agricultural Sciences, National Veterinary Institute and Linnaeus University. IEE is also associated with Uppsala University hospital, Umeå University, Linköping University, Karolinska Institute, Swedish Institute for Communicable Disease Control, National food Administration, Swedish board of Agriculture and Stockholm Resilience Centre.

Björn Olsen

Born 1958. Married, two daughters. In my youth I worked as an ornithologist at bird observatories. To combine passion with profession I explored the field "medical-ornithology". PhD thesis "Birds and Borrelia". Several expeditions to Antarctica and the Arctic. Founder of the Section for Zoonotic Ecology and Epidemiology, Linnaeus University. Professor and senior physician, Infectious Diseases, Uppsala University.

IEE Infection Ecology & Epidemiology

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