Widespread Immune Deficiency Disease in Wildlife: a hypothesis

Honey bees in Europe and the US

We have been pondering on the significance of the laboratory evidence from Bee Researchers in France and the US that the administration of tiny amounts of a systemic neonicotinoid, *imidacloprid*, to Colony Collapse Disorder (CCD) bees was associated with a weakening of bee immunity, such that they became more susceptible to bee diseases. Alaux *et al* (2009) from INRA, Avignon, France demonstrated that the interaction between the microsporidia *Nosema* and a neonicotinoid (*imidacloprid*) significantly weakened honey bees. Pettis and Van Engelsdorp produced identical results; this was despite the fact that subsequently the levels of neonicotinoid in the bees were below the limit of detection using the researchers' own equipment. Van Engelsdorp at Apimondia, the World Bee Congress, said in 2009: *"we are not finding a consistent virus or a consistent pathogen; that implies that something else is happening underneath it, something is breaking down their immune system"*.

We decided to look more closely at the patterns of recent deaths/epidemics in the UK, Europe and the US, involving a variety of other wildlife, the pathogens involved and the timescale in relation to use of neonicotinoid-coated seeds and sprays on a wide variety of crops, gardens, greenhouses and amenity grasslands. We also discovered work published in 2002 by Kiesecker (when at Penn State University) showing similar immune system weakening in frogs in areas of pesticide run-off. This suggests that immune suppression can involve vertebrates as well as invertebrates.

Amphibians in the US

Amphibians, particularly tadpoles, are considered to be an environmental indicator because of their unique sensitivity to pollutants. In the US in 2001, there were reports of wild frogs with grotesque limb deformities in at least 43 US States and five Canadian provinces in areas of pesticide run-off. Kiesecker (2002) found that atrazine (a herbicide) and malathion (a pesticide) made frogs more susceptible to a parasite, a burrowing trematode worm, which affected tadpoles. Even very low levels of exposure *("at concentrations considered safe for drinking water by the US Environmental Protection Agency"*) could produce *"dramatic effects on the immune response of the animals"*. Field studies showed *"considerably higher rates of limb deformities where there was pesticide exposure"*. At that time, the systemic neonicotinoid insecticides were (and still are) '*beneath the radar*', since they do not feature in the 2009 US Geological Survey (USGS) National Water-Quality Assessment Program (NAWQA) Report: *Pesticide Trends in Corn Belt Streams and Rivers (1996-2006).* The USGS authors of the Report said: *"The declines in pesticide concentrations closely followed the declines in their annual applications, indicating that reduced pesticide use is an effective and reliable strategy for reducing pesticides contamination in streams.*" One of the first national studies on the presence of pesticides in ground-water had been published in 2008. Laura Bexfield who conducted the data analysis said: "*The results of this study are encouraging for the future state of the nation's ground-water quality with respect to pesticides". "Despite sustained use of many popular pesticides and the introduction of new ones, results did not indicate increasing detection rates or concentrations in shallow drinking water resources over the 10 years studied".* The authors of both reports expressed satisfaction with the results because they were (mistakenly) under the impression that pesticide use was decreasing and that the reduction in pesticides in ground-water was commendable. However, the chemicals that NAWQA were measuring were only those that they knew about. In 1991, the first of a group of novel insecticides was introduced; the systemic neonicotinoids. They started to replace many of the older insecticides. Their sales escalated (see below), so now in 2011 they occupy a dominant position in the global pesticide

market. *Imidacloprid*, *thiomethoxam* and *clothianidin* do not appear in the USGS list of monitored pesticides (Jeffrey D Martin 2009). The US Environmental Protection Agency is not measuring neonicotinoid levels either. In 2001, in response to claims in a pesticide fact sheet by Cox, Bayer 'experts from different scientific fields' issued a 'position paper' on *imidacloprid*: *"The use of imidacloprid in agriculture does not entail unacceptable harmful effects for the environment as the substance will disappear under all circumstances from the compartments soil, water and air."* However, contrary to Bayer's claims, in Europe Tennekes (2009) and Van Dijk (2010) showed that measurements of *imidacloprid* in surface water by Dutch Water Boards in intensively-farmed areas of the Netherlands had been steadily increasing (in some areas to more than five times the MTR) and that the levels were inversely correlated with declines in *Diptera* flying insect species.

In 1999, two other pathogens were described in amphibians in the journal *Emerging Infectious Diseases;* the chytrid fungus and the *ranavirus.* Two species of once common frogs that had inhabited the thousands of lakes and ponds in California's Sierra Nevada were being wiped out by *chytridiomycosis,* a disease caused by the pathogen *Batrachochytrium dendrobatidis* (Bd). Vredenburg *et al* (2010) described the progress of the infection in a study area that comprised three lake basins separated by 20-50 km. At the beginning of the study they found no evidence of *chytridiomycosis* in the frog populations in these three basins. However, the three were immediately adjacent to basins where frogs had been recently infected and had died from the disease. Bd was first detected in the smallest basin in June 2004 and in the two larger basins in August 2004 and July 2005 respectively. It took only one year to spread to virtually all the frog populations in the small basin and 3-5 years in the other two. The scientists followed the pattern and rate of spread in one of the basins. They concluded that Bd was a novel pathogen spreading through naïve host populations, but that it did not appear to obey the epidemiological theory that a pathogen should fade out when the host population is driven below some threshold density. (In fact Bd repeatedly led to extinction of local frog populations over the next 5 years). For the decade after they were first reported, these two pathogens, chytrid fungus and *ranavirus* had between them caused mass deaths across the US in a wide variety of amphibian populations. By 2007 they had been detected in six continents. In 2010, it was reported that there was still *"no cure yet for the chytrid fungus which is devastating frog populations"*. We found maps of *imidacloprid* and *thiomethoxam* use for 2002 on the NAWQA website (with a cautionary notice to say that it was compiled by the Croplife Protection Research Institute and was an estimated average use over a period of five years from 1999 to 2004). *Imidacloprid* was applied to 10 different crops. The top three, sorghum, potatoes and tobacco represented respectively about 26%, 16% and 12% of national pesticide use. *Thiomethoxam* was also applied to ten different crops. The top three, cotton, sorghum and potatoes represented respectively about 57%, 23% and 10% of the national pesticide use. The densest rate of application of *imidacloprid* and *thiomethoxam* were in strips running parallel to California's Sierra Nevada. Unfortunately, we were unable to find similar pesticide use maps for *clothianidin* on the NAWQA website.

Amphibians in Europe and the UK

The Zoological Society of London (ZSL) first discovered the *ranavirus* in 1995 and the chytrid fungus emerged in 1998. In 2006, in localised areas of the UK, the *ranavirus* caused infected frogs either to bleed to death or to develop skin ulceration. By 2007, a similar condition was found in toads and laboratory experiments showed that transmission could occur by inoculation from an infected frog to a toad. Other scientists from Natural England suggested that it could have been present for years, but something had changed to turn a commensal organism into a pathogen. By July 2008, the ZSL and Froglife reported that the

ranavirus and chytrid fungus were starting to affect amphibian populations over a wider area and appealed to the public to report outbreaks to the ZSL. Dr Andrew Cunningham said*: "Amphibians are being devastated by disease on a global scale, but we have an extremely limited picture of what is going on in our own back yard"*. At a ZSL meeting in 2008 it was predicted that more than half of Europe's amphibians faced extinctions by 2050. By October 2010, the devastation that had earlier ravaged US populations had hit the UK as well. In *Animal Conservation,* researchers reported that the rapidly spreading *ranavirus* "*is killing common frogs in the UK in areas where it has never been seen before"*. Population declines of 81% had occurred over a period of 12 years.

Bats in the US

In 2006, disappearances and deaths amongst managed bee colonies in the US had reached such epidemic proportions that the term 'Colony Collapse Disorder' (CCD) came into use. In fact high bee losses had begun in 1995, when *varroa* mites were first identified in the hives by beekeepers. Although treatment for the mites was instituted, colony losses continued to escalate. Initially the declines were termed "Fall-Dwindle Disease", but by 2006, when many commercial colonies collapsed, it became known as CCD. Coincidentally, it was 2006 when White Nose Syndrome (WNS) a virulent and fatal fungus disease of hibernating bats came to the attention of ecologists. It was first found in a cave in New York State in the 2005/6 winter and rapidly spread through the north-eastern states. A powdery white nose tip was pathognomonic of the disease and when the powder was cultured a fungus, *Geomyces destructans* was grown. This infected the skin and wing membranes of bats and was associated with unprecedented numbers of deaths. It affected six different species of bat. The mortality in a colony could be up to 95% and it was reported that 1 million bats had died since 2006. Alan Hicks of the New York State Department of Environmental Conservation said that it was *"the gravest threat to bats… ever seen"*. Bats with WNS use up their fat stores too quickly and do not have the energy stores they require. They exhibit unusual winter time behaviour, such as flying out of caves in the daytime when there are few insects available; they become disorientated, dehydrated and starve to death. In August 2010 Frick *et al*, using a combination of existing field data on hibernacula counts, rate of spread of the disease and mathematical models, predicted that regional extinction of the little brown bat in the north-eastern US was likely to occur. A map showed the rapid extension of WNS year by year, starting in New York State and spreading throughout the north-eastern and Mid-Atlantic regions and into Ontario and Quebec in Canada. The abstract stated that: *"Novel diseases can have serious impacts on naïve wildlife populations, which in turn can have substantial impacts on ecosystem integrity"*. The nocturnal ecosystem services provided by bats are invaluable and include insect control, pollination and seed dispersal. In December 2010, a cull was considered, but rejected. By February 2011, Foley *et al* in Conservation Biology reported that the eastern disease was beginning to spread westwards and they eventually expected it to cross the Rocky Mountains and enter California. Various strategies of disease management and control were considered but most were impracticable. The apparent virulence of the disease and the high mortality suggested that the existence of recovered and immune individuals was unlikely.

Bats in mainland Europe

In March 2009 (published Feb 2010), Puechmaille *et al* found the fungus on a single bat in a cave in France, but without other evidence of disease. They raised the possibility that the fungus was not the primary cause of death *"but acts as an opportunistic pathogen in bats already immune-compromised by other pathogens such as viruses or bacteria"* In a German-led multicentre study published in Emerging Infectious Diseases in August 2010, hibernating

bats with obvious fungal growth were sampled in Germany, Switzerland and Hungary. Despite laboratory confirmation that these bats were colonised by *Geomyces destructans*, at that time deaths were not observed. The researchers said *"bats in Europe appear to coexist with G. destructans"* They thought that the European bats might have been exposed to the fungus for a longer time and therefore had developed immunity to it. They also stated: *"Although we have searched the literature describing observations in hibernating bats, we have been unable to find any similar historical accounts of white fungus growing on live hibernating bats before the recent emergence of WNS"*. In May 2010 Dr Paul Racey in the UK said that although the fungus *"has been found in Europe at this point we don't have a mass mortality, we just have the fungus"* However, by November 2010, a report from the Czech Republic and Slovakia said that the numbers of hibernation cave sites in which the fungus was found were increasing rapidly, from 33 at the beginning of winter to 76 at the end, and they said that sickness was starting to occur in some of the bats. In fact, from 2008 bat populations had started to decline, so perhaps the disease was already affecting them.

Bumble bees in the US

Massive declines in wild bumble bees in the US and Canada were reported in the late 1990s. Colla (2007) in Ontario, previously a hot spot for bumble bees, sampled sites for three summers, 2004-6, in eastern North America. Out of the 14 species that had been present in the same areas in 1971-73, three had disappeared completely and five of the remaining 11 were in steep decline. Of the species that had been fourth most common in the 1970's (14%), she found only one male. In 2008, The Xerces Society for Invertebrate Conservation reported that *"bumble bee researchers across the continent have established that at least four species of formerly common North American wild species have experienced catastrophic declines over the past decade - two of them may be on the brink of extinction"* In a status review (2008) by Dr Robbin Thorpe (UC Davis), three formerly common species of bumble bee *"went from being widespread and commonly found to rare or absent within a relatively short period of time (about 7-10 years)"*. They were found to be infected with a series of unusual pathogens that entomologists attributed to unregulated movement of commercial bumble bees from Europe to pollinate greenhouses. Developments in bumble bee breeding techniques in the previous 10 years or so had become *"an essential part of modern agriculture"* and allowed pollination in commercial greenhouses to take place out of season. Ottenstater 2008 (Toronto) devised mathematical models and laboratory work to estimate 'spillover' of the pathogen *Crithidia bombi* from greenhouses where imported bumble bees were being used for pollination. He monitored wild bumble bee populations in the vicinity and found that the prevalence of *C.bombi* in wild bumble bees near to greenhouses appeared to support their model. In fact many bumble bee scientists became convinced that infections in imported bumble bees were at the heart of the declines in the wild population. A petition was sent on Jan 2010 from the Xerces Society, the Natural Resources Defense Council, Defenders of Wildlife and Dr Robbin Thorpe to the USDA's Animal and Plant Health Inspection Service (APHIS) asking them to regulate the movement and health of commercial bumble bees to safeguard wild, native bumble bee pollinators. By Feb 2010, the situation was so bad that a broad coalition of 67 scientists (many of them bumble bee experts), sent a letter to The Hon Tom Vilsack, Secretary USDA in Washington and the Administrator of APHIS. However, Cameron and her colleagues (2011) were unconvinced by this "spillover" theory. In a 3-year interdisciplinary study, they looked at changes in distribution, population genetic structure and levels of pathogen infection in bumble bee populations across the US. Comparing results with museum records of bumble bees they showed that the relative abundances of four species had declined historically by up to 96%. Geographical ranges had contracted by 23-87%, some within the past two decades. Those species that had declined had significantly

higher infection levels of the pathogen *Nosema bombi* and had low genetic diversity compared with those that had not. They concluded that *"cause and effect remain uncertain"* for these *"alarming patterns of decline in North America*". However, in the discussion, they said: *"These observations are reminiscent of reports of other introduced fungal pathogens that pose widespread threats to some taxa"* including frogs and bats.

Bumble bees in mainland Europe and UK

As noted above, breeding of bumble bees for use in commercial greenhouses, to increase yield and quality of vegetables, is now commonplace. According to scientists from Turkey *"thousands of colonies are reared in the laboratories and they are being shipped to different countries over the last 10 years"*. The development of breeding techniques has allowed pollination to be controlled *"especially during the off seasons"*. Health concerns by the importing countries led them to investigate pathogens in wild populations of bumble bees. In 2006 they collected 578 mated *Bombus terrestris* queens from different regions in Turkey and found a wide range of bacterial and parasitic infestations, both internal and external. Infestations in wild populations ranged from 9% to 41% and the authors observed that heavily infested queens cannot establish colonies. In 2008 Goulson, Lye & Darvill reported bumblebee declines in the UK, but at that stage, they were not as drastic as in the US. In 2009 Williams and Osborne confirmed the declines of some species in Europe, North America and Asia, and suggested that pathogens may be having a stronger effect for a few species in some regions. They said that variations in susceptibility to threat factors, such as pesticides, *"have yet to be studied"*.

Butterflies and moths in mainland Europe and the UK

A report sent to the Natural Environment Research Council (NERC) by the Centre for Ecology and Hydrology (CEH) in 2004 showed that butterflies had decreased by 71% over about 20 years. When the losses were compared with those of vascular plants and birds, butterflies had experienced the greatest net losses. They had disappeared from 13% of their 10-km squares. In 2006 Butterfly Conservation sent a report to Defra showing that farmland butterflies, which were *"good indicators of ecosystem health",* had declined by 30% over the last 10 years and the declines had accelerated in the previous three years (2003-6). In 2007, Sir David Attenborough launched a campaign to reverse the "catastrophic" decline in Britain's moth population by involving volunteers in the National Moth Recording Scheme. Data from Rothamsted Research had shown that two thirds of the 337 larger moth species had declined over a period of 35 years. More species of moth had declined in southern Britain (75%) than in northern Britain (55%) and the South East was particularly badly affected The UK Butterfly Monitoring Scheme operated by CEH and Butterfly Conservation showed that 2008 was the poorest summer for butterfly numbers for more than 25 years. Once familiar garden species had dwindled and some butterflies were rapidly becoming extinct in certain areas of the country. Madeleine Moon MP hosted a Moth and Bat night in Parliament in October 2010, for MPs and Peers to learn about endangered species. Since 1994, the Heritage Lottery Fund had invested £800m in projects for conservation. The European Red Data list of Butterflies in Europe reported in 2010 that one third of European Butterflies had declining populations; 8.5% were threatened, 2.8% were critically endangered, 5% vulnerable and 10% near-threatened. In Japan, as a result of species losses, a Butterfly Conservation Trust was founded in 2004. In 2011 they reported that 15% of species were endangered and grassland butterflies were the most threatened.

Other pollinators; wild bees and hoverflies

A combined study in the Netherlands and UK (2006) on wild bees and hoverflies showed that pollinator declines were most frequent in those species that were habitat and flower specialists. Plant species reliant on the declining pollinators had in themselves declined relative to other plant species. These parallel declines of wildflowers and their pollinators suggested that they must be causally linked. The few remaining wild bee populations in the North East and southern fringes of Britain and in the middle and southern Netherlands were in sharp decline.

Greenfinches in the UK and Europe

In the UK, greenfinch deaths (maximum number of deaths in the months August to October) from infections with *Trichomonas gallinae,* a protozoal organism which invades the bird's crop and mucosal lining of the beak, started around 2005 and has devastated the populations throughout Europe. Apparently, the organism can survive only a matter of minutes outside its host, so if it were spread conventionally it would require direct contact between birds. In August 2009 there were reports of tens of thousands of songbirds, mostly greenfinches, dying in the west of Germany and the deaths spread across the border into the eastern Netherlands. According to Hugh Jansman of Wageningen University, "*The canker disease was first described as early as 1500, but was not found in wild songbirds until 2002*". It had been well known as a cause of disease in pigeons and doves, and birds of prey that fed on them, but had never been seen before in songbirds. In East Yorkshire in March 2011, greenfinches, chaffinches and goldfinches are continuing to die from the disease.

Chaffinches in the UK

In the UK, reports of chaffinches appearing in gardens with white, crusty growths on their legs and feet caused by a *papilloma* virus began in 2005; the mortality is said to be about 20%, so the disease kills more slowly than with the greenfinch *Trichomonas* infections. In 2004, in a Czech journal, pathologists reported a dead chaffinch with a co-infection between *papilloma* virus (which was also affecting the beak) and *K. jamaicenis*, a mite. They also commented that *"beak papillomatosis is rare in wild birds"*.

The Tit Family in the UK

In 2005, acute necrotising pneumonitis with *Suttonella ornithocola spp.* in the tit family was reported by researchers in Inverness who found that the gram negative bacterium recovered from the diseased birds represented a novel species. In 2010, pathological studies on further cases in tit species were reported in the Veterinary Record, by Lawson *et al.* from the Zoological Society of London.

Immune Deficiency Disease in Wildlife: a Hypothesis

We have become more and more convinced that these aren't '*normal*' infections that can be transmitted in a conventional way, for example, by two greenfinches having 'direct contact' with one another; or by commercial bumble bees transmitting pathogens to wild ones. These probably can't be prevented or cured merely by bird feeder hygiene; or simply by stopping imports of amphibians from the US, or restricting movement of commercial bumble bees or culling or treating infected bats with antifungal agents (all of which have been suggested). If this was happening in humans, as a doctor I would suspect an Acquired Immune Deficiency Syndrome. In this condition, untreated patients do not die from the cause of the immune deficiency, but as a result of one or more unusual infections, or perhaps tumours, which healthy people don't normally contract, or if they do, complete recovery will be anticipated.

Since recent research from expert bee scientists from two different centres has shown that tiny doses of *imidacloprid* are capable of producing a breakdown of the immune systems of honey bees, then we believe that ecologists should start from that point. A similar study in frogs from areas of agricultural run-off in 2002, suggests that it is not only invertebrates that are susceptible when exposed to small doses of pesticides.

Another fatality in 2006

In 2006, the statutory (and previously independent) Wildlife Conservation bodies were dealt a final death blow by the UK government. In response to a budget deficit, NERC restructured the Centre for Ecology and Hydrology and reduced nine of their research sites to four. Closures included the world-renowned Monk's Wood, Winfrith and Banchory Wildlife Research Stations. This would include the loss of 200 experienced scientific staff. The money was to be transferred to Universities, where it was claimed that "soft science" would be turned into "hard science". Population ecology was to be the future. Mathematical modelling would form the basis of decisions, not observations in the environment. However, we found that some of the money NERC had saved by the closures went, not into wildlife conservation, but to augment the University of Dundee's budget by 50%, in order to expand their "*Crops for the Future"* Project.

The health of the global environment is declining rapidly.

The general use of insecticides, herbicides and fungicides has caused widespread deterioration of the environment for pollinators; this includes loss of wild plants on which they depend to complete their life cycles, loss of nesting places for bumble bees, loss of habitat and use of herbicides and insecticides in wild places for control of tree diseases. However, in addition, something sinister is happening that is wiping out populations of many different wildlife species. We hypothesise that it is linked to the increasing use of the systemic neonicotinoids insecticides. In the US the systemic neonicotinoids were introduced in 1991 and in the UK in 1994. The percentage of UK cropland treated with neonicotinoids has gone from 0.65% in 1994, to 24.4% in 2008. But the biggest increases have occurred in the last 10 years, from 1 million acres in 2000, to 2.5 million acres in 2008. It is now 2011, three years on, and Government scientists, Defra, Fera, the Protection Agencies, together with the pesticides industry, are still denying that they are harmful to bees.

We have collated a series of replies that we have personally received, or have seen, from the various Environmental Protection Agencies. Uniformly, they all declined to impose a ban, because of lack of evidence that bees are being harmed.

UK Chemical Regulation Directorate: Defra on behalf of Lord Henley wrote to David Hanson MP on 15th February 2011 *"the data have not raised any cause for concern."*

European Union: On behalf of John Dalli, European Commission for Health and Consumers, Michael Flüh, Head of Unit, wrote on 25th January *"on the basis of current knowledge a ban would not be justified."*

European Union: On behalf of Vice-President Ashton, (also Michael Flüh), wrote on 3rd March *"I would like to reiterate the points I raised in my letter of 25th January…"*

US Environmental Protection Agency. On December 8th 2010, a letter was sent to the US EPA from six US organisations; National Honey Bee Advisory Board, American Beekeeping Federation, American Honey Producers Association, Beyond Pesticides, Pesticide Action Network North America and Center for Biological Diversity. In this letter they asked for suspension of the neonicotinoid pesticide, *clothianidin*. On February 8th, Dr Steven Bradbury, Director, Office of Pesticide Programs wrote on behalf of Lisa P. Jackson, EPA Administrator: *"At this time we are not aware of any data that reasonably demonstrates that*

bee colonies are subject to elevated losses due to chronic exposure to this pesticide". All the replies, with one accord, only address the subject of bees. They do not mention either non-target invertebrates or surface water contamination which had been the subject of the letters we sent. In November 2010, a Report was published by Corporate Europe Observatory and the European Beekeeping Coordination. *Is the future of bees in the hands of the Pesticide Lobby? European Commission allows corporations to shape the pesticide rules.*

The public has no idea of the extent of their exposure to the neonicotinoid insecticides
We have discovered that they are the active ingredient in many products and are used in numerous situations. Now the patent has expired on *imidacloprid*, a large number of firms have 'cashed in' on their success and are producing their own "brands". In addition, aided by the environmental protection agencies, the agrochemical industry has added new uses. Now, without having been made aware of it, the public can be exposed to the neonicotinoids in almost every environment in addition to farmland; in the house, the garden, golf course, playing fields, amenity areas and conservation areas. We recently looked on the UK Chemical Regulation Directorate's website at their Approved Pesticides Database. Here, we discovered 33 different *imidacloprid* preparations. They could be applied to a total of six different seeds; oil seed rape, fodder beet, sugar beet, barley, oats and wheat. We are also aware of seed firms who apply it to linseed and sunflower. In addition, they are used commercially as spray preparations on greenhouse-grown salad crops and vegetables, plant bulbs, and container-grown ornamental/house plant production for indoor and outdoor use. There are at least four domestic products for house and garden (lawn) use and also pet products. In addition, there are preparations for amenity turf which are used on golf, football, rugby and cricket pitches. *Clothianidin* is the active chemical in seven different products and can be applied to the seeds of 12 crops; barley, durum wheat, oats, rye, wheat, triticale, oil seed rape, forage maize, grain maize, sweet corn, fodder beet and sugar beet. In fact, the first *clothianidin* product to have standard approval in the UK was in 2004, at a time when it only had conditional registration from the US EPA. Meredith Laws of the Registration Division of the US EPA wrote to Tom Theobald on 29th November 2010 to say that *clothianidin* was only granted unconditional registration for use as a seed treatment for corn and canola on 22nd April 2010.

Laws have been shaped by the industry such that it difficult for the public to find out
If a farmer does not wish to tell you whether or not his crop has been grown with coated seed, you will have to apply to a third party to find out. In addition, those selling the chemicals are not obliged to keep records for more than three years, so the trail is difficult to follow.

The public have little knowledge of these widespread crises affecting the environment
In 2011, we now have the situation in the US (and, at present, to a lesser extent in Europe) in which there are widespread declines (and in some places areas of local extinctions) in populations of amphibians, bats, honey bees, butterflies, moths, hoverflies, bumble bees and birds. In several areas of the US whole populations of bats and amphibians have been "wiped out". As far as we know, the declines are continuing. Many organisations, including the United Nations Environment Program (UNEP), have warned of a global crisis in pollinators which is likely to threaten global food security.
However, the public seem to be unaware of these wildlife crises. It is difficult not to have the impression that knowledge of them is being deliberately suppressed. There is little about them on British television or radio; up until recently, newspaper reports of these events were generally restricted to the Independent and the Guardian.

We suspect that many scientists are also unaware

In fact, there appears to be surprising lack of knowledge amongst individual scientists about what is happening in other specialties apart from their own. Most ecologists appear to have considered these infections as 'novel' but very virulent. However, Vredenburg (2010) and colleagues, in their excellent study of pathogen spread through three lake basins during large-scale amphibian population extinctions (2004-6) in California's Sierra Nevada, provided us with the key to the problem. They stated that epidemiological theory suggests that *"pathogens will not cause host extinctions because the pathogen should fade out when the host population is driven below some threshold density".* Although until recently there had been doubts about the importance of disease in driving global amphibian declines, these ecologists said that this theory had now been overcome by "weight of evidence". Four papers from different parts of the world were reported in which precisely the same "*exception to the rule*" (i.e. total extinction of the host) had occurred. In 1998, 2006, 2007 and 2008 infections in amphibians had led to rapid declines and in some cases extinction. This suggests that the problem lies not with the virulence of the pathogen, but with the state of immunity of the host species.

Meeting in Westminster on April 4th 2011

The All-Party Parliamentary Group on Science and Technology in Agriculture invited Jeff Pettis, Bee Scientist with the USDA, as Guest Speaker to a debate on Bee Health and Pesticides. We were not present to hear him describe his research with Van Engelsdorp, at present unpublished, but we have the researchers' own words from a French film '*The Strange Disappearance of the Bees',* which has not yet been shown in the UK. At the *Apimondia* Bee Conference in August 2009, the INRA Bee Unit at Avignon in France and the USDA Bee Unit in Maryland reported identical findings of immunosuppression in CCD bees. At the time, Van Engelsdorp made the following statement: *"We are not finding a consistent virus or a consistent pathogen; that implies that something else is happening underneath it, something is breaking down their immune system".*

In January 2011, Dr Julian Little of Bayer CropScience was quoted as saying: *"I am sure there are some very interesting effects Dr Pettis has seen in the laboratory, but in reality, when you get to what's important to everybody, which is what happens in the field,* ***you don't see these things happening."***

Dr Little is wrong. He, his colleagues in the agrochemical industry and the protection agencies have failed to observe what is happening in the environment. There is evidence that immune compromise in wildlife is now widespread. A series of 'novel' or previously unrecognised pathogens are driving worldwide extinctions in a variety of species, including amphibians, bats, birds, invertebrates (and in particular, pollinators). A Defra scientist, interviewed on Channel 4 Television on the evening of the Westminster debate, denied that Colony Collapse Disorder in honey bees was present in the UK. Whilst we do not have an equivalent of the US commercial honey bee industry, some of our beekeeper friends who have managed bees for many years have been experiencing frequent overwintering colony losses. This is how it all began in the US. In addition, we have now documented highly significant patterns of catastrophic declines in other wildlife. Our detailed examination of the literature suggests that where the US goes, Europe is almost bound to follow. We have no scientific proof of our hypothesis; there is only circumstantial and environmental evidence. This is partly because most agrochemical data are highly confidential. It was only by accident that we came across the 1999-2004 US distribution maps for average *imidacloprid* and *thiomethoxam* use on agricultural land. We could find no equivalent maps for *clothianidin*

either in the US or the UK. In addition, we discovered that *imidacloprid*, *thiomethoxam* and *clothianidin* do not feature in the list of the 44 pesticides/herbicides measured in surface and ground-water by the USGS. This means that they are not included in the NAQWA statistics on pesticide pollution in water-courses.

The United Nations had declared 2010 to be the International Year of Biodiversity, to celebrate the biodiversity of all life on earth. It also marked the year by which 200 countries had promised to halt biodiversity loss at a global, national and regional level. Once again, in October 2010 in Nagoya, Japan, delegates from 200 countries were signatories to the UN Convention on Biodiversity. Yet, how many of the delegates were aware of the dramatic global biodiversity losses in wildlife that had been happening under their very noses? The world is poised on the edge of a cliff. The recent report by expert scientists on global declines in pollinators published by United Nations Environment Program (UNEP) is a stark warning.

Until our hypothesis of Immune Deficiency in Wildlife can be disproved, we believe that all the Environmental Protection Agencies should suspend the neonicotinoid insecticides.

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