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HOUSE OF COMMONS

ORAL EVIDENCE

TAKEN BEFORE THE

ENVIRONMENTAL AUDIT COMMITTEE

INSECTS AND INSECTICIDES

WEDNESDAY 21 NOVEMBER 2012 (AFTERNOON)

PROFESSOR DAVE GOULSON, PROFESSOR GRAHAM STONE, DR JAMES CRESSWELL and DR LYNN DICKS

Evidence heard in Public Questions 91 - 153

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Oral Evidence

Taken before the Environmental Audit Committee

on Wednesday 21 November 2012

Members present:

Joan Walley (Chair)
Peter Aldous
Neil Carmichael
Martin Caton
Zac Goldsmith
Mark Lazarowicz
Caroline Lucas
Caroline Nokes
Mr Mark Spencer
Dr Alan Whitehead
Simon Wright

Examination of Witnesses

Witnesses: **Professor Dave Goulson**, Stirling University, **Professor Graham Stone**, Edinburgh University, **Dr James Cresswell**, Exeter University, and **Dr Lynn Dicks**, Cambridge University, gave evidence

Q91 Chair: Can I welcome all four of you? I will try and catch everybody's eye as we go through the session that we have this afternoon. This is the second hearing that we have in our current inquiry. As you can see we have a full Committee and a full panel of witnesses, so I will ask you to try and be as concise as you can be with our detailed questions, and rather than have each of you give a summary of where your individual research, etc., is at, we intend to go straight in with questioning, if that is okay. Try and catch my eye.

What we will do is we will start off with a question about the evidence that we have received about the decline of bees in the UK but rather less evidence about other insect pollinators. We are just really interested to understand how much you think that the UK faces a general insect pollination crisis, or whether or not it is just a problem with bees. I do not know who would like to catch my eye on that first of all.

Dr Dicks: I am quite happy to start. Hi, and thank you very much for the invitation to come here. There is a decline in some insect groups; we know from the evidence on numbers. We have evidence on abundance of bees that has been collected over time in a systematic way on a few pollinator groups. So if you look at wild pollinators, we are talking about moths, butterflies, beetles, wild bees, and of those groups we have numbers over periods of years for moths and for butterflies and very recently published also for ground beetles, which are not pollinators but they are an insect group, and there are also flower-visiting beetles that have different life cycles and different food sources, so it is interesting in itself.

It looks like about two thirds to three quarters of species are declining, and a good proportion of those species are declining by more than 30% every 10 years. So, for moths, two thirds of species are declining and 21% have declined by more than 30% in 10 years and that is of the widespread common species. For butterflies, it is a similar picture: 72% of the species are declining and more than half of them have declined in their distribution.

For ground beetles, again from the environmental change network—which is long-term monitoring data—on 11 grassland sites around the country, going back to 1994, we have three quarters of the species declining, and half of these have fallen by more than 30% in 10 years. These are the groups for which we have numbers, and for bees and hoverflies, we have distribution data, which comes from volunteer records collected over time but without systematic monitoring and without numbers of individuals, and there we have evidence that more than half of the grid squares that were looked at had fewer bee species now than they had some years ago.

For bumblebees, we have evidence of declining range in some species; massive declines in range since 1960. Dave could tell you more about bumblebees.

Q92 Chair: I don't know if anyone wishes to add or give a different version?

Professor Stone: Do you want to add some more on bumbles?

Chair: Do try and use the microphones because the acoustics are very difficult in this room.

Professor Goulson: For bumblebees specifically, as Lynn says, we don't have numbers, so we can't tell you what the population is or how it's changed in the last 10 years or 100 years. Sadly, all we can do is look at range declines. What we can say is of the 25 UK bumblebee species, two or three—it's a moot point as to whether it's two or three—have gone extinct and probably 10 species have undergone very large range decline. So some have basically disappeared from most of the area they used to occupy, and that is pretty much all we can say at this point.

Q93 Mr Spencer: Dr Dicks said specifically the 1960s. I wondered why you picked the 1960s, and has that decline over more recent years, since the use of various chemicals, increased or decreased or continued at the same rate of decline since the 1960s?

Dr Dicks: The 1960 date is for the bumblebee distribution data. It is data collected pre-1960 and post-1960 to 1982, and it was published quite a long time ago. So there was a decline going on for some bumblebee species before neonicotinoids were introduced for sure. But the important thing to say is that the decline is continuing, and we know very well it is continuing in butterflies and we know it is continuing in moths. It is quite alarming the rate of decline for some species, not for all species. There are quite a lot of widespread common species that are doing all right, but relative to the number of species that are not doing all right, it is not a very nice picture for insect diversity in the UK.

Professor Stone: I was just going to make a point that different species and different pollinator groups kind of operate on different spatial scales, so the impact of population changes for some kinds of pollinators are very local, and if you lose a population, it may be difficult to get it back. That applies to a lot of the wild bees, for example, which are often small in local populations. But other things that are very important biological service providers include some of the hoverflies, the geographic ranges over which annual populations ebb and flow are much larger and so for some of those—and these include some of the species that seem to be faring better under modern circumstances—we receive large population influxes from Europe every year. So part of the variation that Dr Dicks was mentioning reflects the variations in scale of which some of these populations were.

Q94 Chair: To follow on, Dr Dicks, you mentioned about volunteers doing volunteer research. Can I just ask why has there been so little academic research on wild insect pollinators, do you think?

Dr Dicks: There is quite a lot of academic research, but it is not answering the questions that we have about what the causes of decline are and what is declining as well as it

could. I think the answer to your question is there just isn't the funding. It is quite difficult to get funding to do basic ecology research, and it is even more difficult to get funding to do applied ecology research. In order to get a big amount of funding, you have to demonstrate that you are answering a brand new and pure scientific question with scientifically excellent methods, and that does not always apply to, for example, monitoring or applied questions such as this.

I would say that we have a big research programme in the UK that is going on at the moment called the Insect Pollinators Initiative. That has spent £9.6 million on insect pollinator research, and some excellent new data is coming out, answering some of the questions we have at the moment about the different threats and the ecology of pollinators.

One of the projects that was proposed for that programme was about monitoring of insect pollinators and it did not win funding, so that just demonstrates that if you want to do the monitoring, which is what we need to answer this question about the effects of pesticide, science funding doesn't cut it.

Dr Goulson: That was exactly the point I was going to make. I have also tried to raise funds specifically to set up a long-term bumblebee monitoring programme, so that I could tell you whether the population had changed and was unsuccessful in getting funding, so hence we don't have the data.

Q95 Chair: Where would you expect to get the funding from?

Dr Goulson: In that instance, I applied to the Natural Environment Research Council, which is one of the Government funding bodies, and the success rate on average was rather low anyway—17% perhaps—so one would expect to be rejected on average, but nonetheless it illustrates the difficulty in getting funding for ecological research generally.

Dr Dicks: It is also worth saying, if I can just note one more point, I don't know how much money it spends, but Defra does have a bee unit that has quite a lot of staff, so they are spending quite a bit of money on monitoring bees. It is a very good monitoring scheme; there is quite a lot of scientific investigation into honeybees, and it is only for honeybees almost entirely. So there is money; it is just somebody has decided and continues to decide that we are only interested in looking at honeybees.

Q96 Chair: All right, and a very specific question: is it possible to assess the risk to wild insect pollinators by extrapolation from the risk assessment conducted on honeybees?

Professor Stone: No.

Q97 Chair: No. Is that a no?

Professor Goulson: A no from me, too.

Chair: No.

Professor Goulson: Honeybees are very atypical insects for lots of reasons.

Q98 Chair: Are you all saying no?

Dr Cresswell: Yes, and I am saying no as well, in that some kinds of bee are more sensitive than others. In fact, honeybees, in my view, are rather tough compared to, for example, bumblebees. So if you wanted to measure like for like, if you expose a honeybee to this much pesticide and you expose a bumblebee to the same amount, will they have the same response? The answer is no. But given that you know that bumblebees are more sensitive, for example, you would therefore be able to predict. So in a sense if you are trying to develop a workable sentinel species the answer is yes, you could go back to making the honeybee the white rat of lab testing for pesticides, but you would have to do a lot of fundamental research

to find out about the sensitivity of the other species, so that you could extrapolate from one to the other.

At EU level, they are talking about using a times 10 safety factor, so if you don't know you just assume the other species is 10 times more sensitive than the one you are looking at. So there are logical ways forward, but they require either a risky safety factor or they require a lot of extra fundamental knowledge that we currently largely lack.

Q99 Chair: All right. Just finally from me at this stage, is there, therefore, a case for extending EU legislation to include risk assessments that also cover wild pollinators, would you say?

Dr Cresswell: That is already being done with the EU working group on pesticides and bee risk assessments. The problem is if you are going into a regulatory process, you then have to specify what kind of testing you would like done, and the show-stopper is really that we are not quite sure what to test and how. So there is a willingness to extend the regulatory procedure, for example, to solitary bees; you then have to write guidance about how member states will do it, and the answer is, "Well, we're not quite sure what guidance to provide yet."

Dr Dicks: Can I also say something about hoverflies, which are in the pollinator community and, in some parts of the country, a very substantial proportion of the flower-feeding insect community, providing an unknown amount of the pollination service. They have very different life cycles to bees. They feed on flowers exclusively as adults. Many species have different larval habits. Some of them are laying their eggs in a crop and the larvae are feeding in the crop, so their exposure routes are very, very different from bees in many ways. Other hoverfly, their larvae are living in ditches and water. I think that there is a huge case there for a different model of experiment to test the effects of pesticides.

Professor Stone: Even though the pesticide chemicals are hitting the same fundamental systems—the same neural systems or the same physiological systems—in the insects, the way those convert through into the behaviour of individuals, the way a hoverfly would respond or a worker bee would respond or even a male bee, because we don't think about the males and the courtship and the sexual interactions in honeybees very much—or even in bumblebees very much—but in solitary bees they are a big part of it. So the way those fundamental kinds of neural impacts of the chemicals are converted into behaviour and then into the dynamics of the population, whether it expands or grows, we expect to vary among particular groups. These things have been evolving separately for a long, long time so we think of hoverflies and bees—they are both insects, aren't they?—but they started in their own separate evolutionary way back before the time of the dinosaurs, so there are plenty of differences.

Chair: All right. We will move on to the subject of regulation—you have just touched on it—and I will turn to Caroline Lucas.

Q100 Caroline Lucas: Thank you very much. I wanted to ask you if you think that the UK pesticides risk assessment regime is sufficiently transparent to research scientists like yourselves?

Dr Dicks: Can I just say no?

Caroline Lucas: You might want to elaborate but—

Dr Dicks: My experience for this is fairly limited because I don't actually work in this area of pesticide regulations, but I did try and have a look at the studies that support the assessment for the neonicotinoids that are available in the UK and I did find reference to studies, reference to field studies, but I could not find the studies themselves at all. I did find one author name in a table. I maybe spent an hour and a half trying to find these things, so that doesn't say they are not there, but my point would be that they are very inaccessible and

they should be not just accessible but shoved in our faces to check whether we agree with the methods.

Dr Cresswell: I have just seen some of the studies and the way that I had to do it was I had to apply to the CRD, I had to go to York and then I had to sit in a room with a person looking to check—I don't know what he thought I might do. So I was allowed to look at the documents, make notes, but I could not have copies of them. So I did a pretty good transcription of all the data that I wanted and was able to take it away, but I am not sure that counts as transparent.

Q101 Caroline Lucas: Did you ask them why? Did they give any reason? Presumably, you must have asked if you could photocopy it or take it away or something. What reason would they give?

Dr Cresswell: My understanding, and I think you would have to check with the CRD, is that many of the studies are conducted by industry, and industry view them as confidential information and so I am told anecdotally that the show-stopper is they are unwilling to share their confidential information with other industrial competitors. But I have no idea why that counts.

Professor Goulson: I just want to flag up the obvious inequity in that academic research that has shown evidence for harm of neonicotinoids on bees is picked apart and examined in minute detail by the agrochemical industry and yet in reverse we can't examine the evidence that they are safe. As James said, it would be very nice to be able to look at their studies in the detail that they look at our studies, but we are not freely able to do that.

Q102 Caroline Lucas: You explained it might be commercial sensitivity, so does the pesticides industry have an undue influence, if you like, on the regulatory process, do you think, in terms of the role of testing products?

Dr Cresswell: I am not sure.

Q103 Chair: Sorry, is that a no, or are you—

Dr Cresswell: I have no basis to judge, I don't think.

Dr Dicks: From where I am sitting, it is the regulatory system itself with its closed studies that you can't access that is at fault, and I would not know whether the pesticide industry has an undue influence or not.

Q104 Caroline Lucas: Just to put to you some evidence that we heard this morning from the Soil Association where they say, "The current UK system of pesticide regulation relies on the use of industry data that is not subject to scientific peer review and publication", which seems to be what you have just reinforced. "Second, there is no requirement for companies to publish all the research they conduct leading to the risk of only cherry-picked favourable studies being used to obtain regulatory approval." If you are nodding to both of those it seems to me that it would not be too big a leap, therefore, to conclude that the pesticide industry does indeed have an undue influence on the regulatory system.

Dr Dicks: The same is true of science though: we don't have an obligation to publish all the studies we do; we publish the ones that we think will get published, so there is a bias. The bias is across all science—private and the publicly funded—I think.

Q105 Caroline Lucas: If you got your research to do what you wanted to do through NERC, you would be expected to publish it, would you not?

Dr Goulson: Yes. Generally speaking, academics are under huge pressure to publish whenever they can, so it would be very odd to choose not to publish something.

Q106 Caroline Lucas: Trying to get to the heart of this, then, is it not the case then that these private companies are exerting—I will say it again—an undue influence either by making it easier for scientists not to then put into the public domain the research that they have conducted, or by themselves not putting their own research there?

Dr Dicks: It is impossible to say, without seeing the full body of research that they have done, whether they have hidden some of it. They may have done.

Q107 Caroline Lucas: The Advisory Committee on Pesticides, for example, is a part of the whole regulatory process; I have struggled to find out exactly who they are and what their interests are and who might or might not fund them or whatever. How much do you know about them as an example?

Dr Cresswell: I have heard of them. I know they exist and I know that it is not always easy to get hold of their minutes. There were some things that I would have been interested in looking at, and I don't know how to do that.

Q108 Caroline Lucas: But does that not strike you as deeply shocking? Maybe that is the difference between scientists and politicians, but to me that just seems outrageous that you can't get hold of who these people are who have such a significant influence on the safety regime governing pesticides.

Professor Stone: It is one of the things that makes this area less scientific than it should be.

Chair: Professor Stone, I am having difficulty hearing you; it is because we have so many witnesses—

Professor Stone: All right. I will put my lecturing voice on.

It is one of the things that makes this area less scientific than it should be because the basic tenets of science are sharing information and being clear about what you mean and being willing to discuss your results in open and frank debate. If we don't have access to those data, we cannot comment on them in an informed way; neither can we know their quality.

Q109 Zac Goldsmith: It may be you are not the right panel to ask but just on this point, is there an answer to this in your view, a mechanism for allowing for much freer access to this scientific data without compromising the commercial sensitivities that undoubtedly would from time to time exist? So companies will do some research where they would legitimately be able to say, "Look, we want to hold on to this because we don't want our competitors to see it," but is this is a mechanism that you can imagine where the vast majority of information would be freely available and the excuse of commercial sensitivity would not be able to prevent the release of documents that would make your jobs easier, for example. Is there a formula that is bandied about in the scientific community that you would endorse?

Professor Goulson: There isn't, I don't think, but I am very confused as to why they insist this information is confidential. We are talking about safety tests, so you have a new chemical that you want to bring to the market; you have to have it tested on a range of organisms to see at what level it kills them, what concentrations kill them or whatever. There would be tests on honeybees and worms and a range of other things. It is not clear to me why that information should not be made freely available to everybody or what commercial advantage a competitor would gain by finding out how many honeybees product X would kill at a certain concentration.

Q110 Zac Goldsmith: I agree with you. That is the point of the question, but would it be possible to imagine a kind of freedom of information type approach where the default position would be to release information, except where it can be demonstrated that there is commercial sensitivity? Is there nothing like that out there?

Dr Cresswell: It seems to me that essentially that was the process that I went through; I just had to physically go there and not take any copies of the folders or pictures with my mobile phone. What was surprising to me was that some of the studies were quite good and were certainly publishable, so that gave me some confidence that the people who were doing the decision making process had some good data to look at, but it didn't answer my question about why it was not publicly available other than by personal travel, which seems bizarre and archaic.

Q111 Caroline Lucas: Just to finish off on that, I suppose, to the extent that it is more difficult to get public funding to do research, then obviously that leaves more of a gap for the pesticide companies and other private companies to come in and fund that research themselves. How much of a risk do you think that is, and are you prepared to say if anybody was funding you or whether you think that has an influence on the kind of work that gets done? I am not suggesting that the work is not rigorous but just in terms of the areas that will be covered and so forth.

Dr Cresswell: I think that depends on the individual scientist. I am funded at the moment by Syngenta. One of the negotiations that we had was my freedom to publish what I found. I insisted on having that in my contract and it is in there. It is a case-by-case basis. I think it is perfectly possible to operate in a fair and impartial manner under those kinds of conditions. I don't see a problem with it.

Dr Dicks: I would agree with that. I think that private companies will go into these kinds of negotiations when looking to fund research from the position that all of your findings will be private and owned by them, but it is perfectly possible to come to an agreement that says, "All of the findings will be publicly available and I can publish them and the data will be online." If they don't accept that position then it probably would be risky to—

Dr Cresswell: I would say that that was their norm and, in fact, the person I was negotiating with and I had to have a number of conversations with their law department because they just were not used to the idea of not having confidential information be part of the contract. So it was a bespoke arrangement.

Q112 Caroline Lucas: So it is just rare then?

Dr Cresswell: Yes.

Dr Dicks: It comes down to the individual scientist like James pushing for it, standing their ground saying, "I won't do it unless," and being desirable enough to the company for them to agree to that.

Q113 Dr Whitehead: The default position is normally that if you don't agree to that then you don't get the—

Dr Dicks: You don't get the money? Maybe.

Q114 Chair: Dr Cresswell, I thought you wanted to come in?

Dr Cresswell: I was only going to say that that is not an inevitable conclusion.

Dr Dicks: Agreed.

Professor Goulson: This might seem totally irrelevant, but just to give a slightly different perspective that I think is important in understanding how the public will perceive academics being funded by industry, this is from a paper discussing things that happened 60

years ago in a rather different industry, but if I could just read it very briefly, "Scientists were the perfect foil for the tobacco industry's public relations response to allegations that cigarette smoking was injurious to health. Scientists could be counted on to call for more research giving the impression that there was controversy, in addition by supporting scientific research the industry would be seen as doing something positive."

Then, just to skip on a bit, "The tobacco industry made frequent reference from 1964 onwards to the fact that qualified scientists challenged the evidence that smoking caused disease, yet many of these so-called independent scientists were recruited and had their research programmes supported by the tobacco industry."

My point is that the tobacco industry used this, among other tactics, to keep selling cigarettes for 50 years, while pretending or refusing to acknowledge that there was a link between health and smoking, which we all know of course that there was.

I am not saying that this is happening now. I have every faith in James's integrity and I don't want you to take this as a suggestion that I don't, but the public will see it in the same way as they now view what happened in the past.

Q115 Mr Spencer: Just to clarify, Dr Cresswell said that he went to look at that evidence and he felt as though that evidence would be supportive of the argument that those companies were putting forward and could not understand why they would not publish that information.

Dr Cresswell: In that particular instance, what struck me was that the experiment was quite well designed, quite well conducted. I would have analysed it differently and I plotted some different graphs, but having done that it seemed to be a perfectly publishable piece of work, and, yes, it would have supported their position that the pesticide was safe.

Q116 Mr Spencer: So given that that evidence supported their case, what other motivation, other than commercial sensitivity could there be for not releasing that information?

Dr Cresswell: Yes, that is a question for the industry.

Q117 Martin Caton: To follow up, Dr Cresswell, I completely accept what you said about your negotiations with Syngenta, but in those negotiations was there a focus on what your research was going to cover? Were they able to push you in a direction that would benefit them? Just in terms of research, I am not suggesting—

Dr Cresswell: I think the way to précis it, they said, "Okay, here are the things we want you to look at. We foresee that this may work out in our favour, but if it doesn't you have got freedom to publish anyway." That was essentially how it worked.

Martin Caton: Okay, thank you.

Dr Dicks: I just wanted to check, will we have a chance to talk about the field trials, or can I talk about those now? I don't know whether the studies that you saw were field trials—

Q118 Chair: Yes, we will come on to that. But just going back to the point that Mr Spencer made about commercial confidentiality and so on as a reason for not maybe publishing, is that an issue as far as the funding of research is concerned?

Dr Cresswell: I am sorry?

Chair: The suggestion that maybe some of the research is not being published because of the issue of commercial confidentiality.

Dr Cresswell: Do you mean that a scientist in any university has been commissioned and then their research has been suppressed by using the contractual confidentiality.

Chair: I am not sure I would use the word "suppressed" but it is just not generally being in the public realm.

Dr Cresswell: Yes. Essentially, unless we had had the negotiation about this contract if the research that I did fell under what they define as confidential information then they could so choose not to have me publish it, so that is a possibility. Whether anyone actually does that, I do not know.

Professor Stone: I would just like to take this very briefly back to one of the first questions about why is there not more research on other wild pollinators. If there is a limited budget to invest in research from the research council, it is going to be invested primarily in the recognised social bee pollinators first off. Then, if you have a contribution to research from industry, I would say it is very unlikely to target the wild bee biodiversity-associated pollinators. It is much more likely to target, again, the social bees—meaning the honeybees and the bumblebees, primarily the honeybees—and if we want to target things like hoverflies, the other 200 or so species of solitary bees and all the other things that pollinate flowers then there is no alternative, I would say, than to get, if you like, independent Government-sourced funding for that kind of thing, unless we can really get the companies to invest in that.

Q119 Mr Spencer: If we could just turn to field trials, I just wondered, fundamentally, is it possible to recreate a field-scale trial in a laboratory?

Professor Goulson: No.

Dr Dicks: No.

Q120 Mr Spencer: You all agree that is impossible to achieve?

Dr Cresswell: Looking at the way the regulatory process works is that the field trial is the gold standard and the laboratory trials and what is called the semi-field ones—which are half laboratory, half field—tend to be dismissed because they are not field trials. I think the problem is not one in principle; it is just that people don't tend to do their laboratory trials in a way that turns out to be realistic. Fundamentally, if we knew more about what went on in the field—principally what the doses are and what the exposures are—then we could take them into the lab and test them. For example, you don't dismiss a sports scientist who has worked on the legs of their athlete in the lab and then say, "Well, that tells you nothing about how they are going to do in the race." You would want to know whether the sports scientist had tested the athlete's legs under the race-like conditions. That is the critical thing.

In my view, the regulatory system could make use a lot more of laboratory trials, but we need a lot more fundamental information about what the environment is like in order to recreate it properly in the lab, and in this context I mean what the dosage is, what the residues and exposures are. That is the fundamental gap and that is the argument principally about when Defra say the lab trials were not very realistic. What they often mean is the doses can't be justified as being realistic.

Q121 Mr Spencer: Just talk us through that dose and concentration rate. Are we talking in the laboratory of twice as much as you would expect on a field scale or ten times or what sort of concentration are these tests being conducted on?

Dr Cresswell: This goes back to this issue about publicly available data. I noticed in the Syngenta submission that they began to talk about what the range was of the concentration of residues in pollen and nectar for thiamethoxam, but the laboratory trials so far have been constrained to dredging out the one or two reported values we can get at from the scientific literature, which may or not be particularly relevant.

One of the things that struck me when I first got into this field was the complete lack of data on the residue levels. When I measured what was in pollen and nectar oilseed rape in

the UK a couple of years ago, that doubled the publicly available data set on relevant residues. That is the problem and it always seemed to me that one of the things that might happen was that we would do a bunch of laboratory work and then someone would come along and go, "Aha, but the residues are over here," and you have a mismatch. That tends to be the problem and that is, I think, why at the moment field trials trump the lab work, because they claim that in the field trials the residues are more environmentally relevant. That is inarguable. Whether they are representative of the broad range of what goes on in the UK, for example, that is arguable.

Q122 Mr Spencer: So that is clearly an evidence gap, in effect?
Dr Cresswell: Yes, yes, absolutely.

Q123 Mr Spencer: What is your insight into how the Defra research programme at the moment is filling those evidence gaps that clearly exist? Is the Defra research programme assisting?

Dr Dicks: It seems that that is the major evidence gap from my perspective. As James was saying, we just do not know what the real exposure level is in the field, and the real exposure in the field for insects depends on their behaviour; it depends on their foraging range; it depends on their flight period, all kinds of things. So it is quite difficult to get to that data. It would be reasonably easy to monitor wild bee-collected products, for example, or hoverfly diet content and test them for neonicotinoids. That would be a fairly straightforward set of research, but it is not what Defra are doing in their research.

Professor Goulson: I have here a research project approval form that I sent to Defra, requesting that they fund a project to look at how the exposure levels of real bumblebee nests put out in the landscape by looking at the concentrations of pesticides in the nectar and pollen that they bring back, which is one of the major knowledge gaps. They seem to be about to fund it, so I got an e-mail two days ago saying that they were intending to "progress" it, which I think means that they are going to fund it, though I am not quite sure. If anyone from Defra is here they could perhaps let me know. But they may be then in that case taking a step to fill one of these knowledge gaps. More generally, it is hard to know what Defra are doing at any one time until it is published, so what else they are doing right now is hidden from academics largely.

Professor Stone: Yes, one thing to follow on from that, there is a very substantial document concerning Europe-level policy on risk assessments for pollinators that covers all bees. There is quite a big gap between the many questions that that raises about what we don't know and the relatively narrow list of programmes that Defra are currently targeting. I know nothing about their budget constraints. That is not a criticism, just an observation. Also, given the enormous value of pollination services the total value of those projects—when you look at the investment—just to me seems remarkably low.

Professor Goulson: I have been a little confused by EFSA's position because they are currently maintaining that neonicotinoids as currently used are safe, but at the same time they have launched this consultation into developing improved methods of testing new products that come to market to ensure that they are safe, particularly targeted at products that are systemic and that are used as seed dressings, which seems to me almost an admission that a mistake was made when neonicotinoids were introduced. They are saying they are safe, but at the same time they are putting a lot of effort into preventing it happening again. That does not quite add up to me.

Dr Dicks: Can I say something very quickly about the Defra study that is funded already, which is to look at the exposure of bumblebees in a field environment? I can't see the actual methods of that at all, but it is described as an "edge of field" study and it seems very

likely to me to have one-hectare treatment plots with bumblebee colonies on the side of those treatment plots. One hectare is 100 metres by 100 metres, and I said in my written evidence we have some experimental research showing that bumblebees actually prefer to forage further than 100 metres away from their colony, so they are not likely to feed on that rape that is treated that they are on the edge of; they are much more likely to fly over it. The foraging range of the species they are likely to use, which is Bombus terrestris, the buff tailed bumblebee, is probably between one and a half and three kilometres by evidence from recent studies. So they are not going to be feeding on the treated rape in the study, I would say.

Professor Goulson: Sorry, to return slightly to the relevance of the value of field versus lab studies in relation to what you were just saying, the gold standard of doing a field trial usually involves putting a hive immediately next to a planted stand of treated crop. The recent studies strongly suggest that the impact of neonicotinoids, which in reducing the navigational or impairing the navigational abilities of bees is only detected if the bees have to navigate over sizeable distances—the sorts of distances that they naturally navigate over. So if they have to return from a kilometre from their nest, they are more likely to get lost if they are exposed to neonicotinoids. If their nest is placed immediately next to the treated crop, so they are flying 10, 20 or 30 metres, they are not going to get lost on the way home, even an intoxicated bee can stagger back from 20 yards away, so even the gold standard is failing to detect what could be a significant impact of these pesticides on bees.

Dr Cresswell: I am not sure how much the Committee wants to hear about how the EFSA guidance document has tried to address some of these concerns, but certainly that last one that you were talking about, the idea is to do a separate test on navigation ability. Being a member of that particular group, indeed we have done what we can to try and use our ecological nouse to cover the bases.

Q124 Mr Spencer: Just to clarify, just so it is clear in my own mind, you are saying that no one has done the research to identify how much of this chemical is in the nectar and pollen. So all of the academic research that has been conducted—

Dr Dicks: There are levels in nectar and pollen, but what we don't have, for anything other than honeybees, is the level in the bee-collected nectar in the colony or the nest for that which is being fed to the young, which is different from just measuring nectar in flowers because most bees don't just forage on one type of flower; they forage on a range of things.

Dr Cresswell: For example, if you want to do a good risk assessment for the UK, you would want to see a distribution of what is in the pollen and nectar from maybe 20 different sites of oilseed rape across the country.

The problem is that we can make a pretty good guess about what the maximum range of residues is. The difficulty is that a small change in concentration across that range makes quite a big difference because what we call the dose response curve is quite steep. So if you move along the concentration gradient a little bit, you move up or down the performance gradient quite a bit, at least certainly in some of the things that I have measured. So it does make quite a lot of difference having that level of precise knowledge. Making a reasonable guesstimate does not necessarily give you what turns out to be the precise, right answer.

Professor Stone: Is there anything in the EFSA document or in planning about hoverflies?

Dr Cresswell: No.

Professor Goulson: Just an additional point, the focus here has been on the levels in oilseed rape as the route of exposure to bees. Of course bees may also be exposed through other routes, and there is concern that neonicotinoid seed dressings may drift as dust or through soil water enter plants other than simply the crops. So there may be other routes of

exposure of bees to neonicotinoids and that has not really been investigated at all, so it is very hard to guesstimate what it might be.

Just one small additional point, they are also used a lot in urban areas. They are sold in garden centres for spraying on to roses and vegetables, for example, and nobody's looked to see what kind of levels are found on average in urban gardens and again could add to bee exposure.

Q125 Mr Spencer: To Professor Goulson specifically, the Defra criticism of the Whitehorn study, to which you have contributed, stated, "It may be significant that the control bees consume nectar and pollen, whereas the treatment bees were given a different diet of treated pollen and sugar water". I just wonder if you felt that was a fair criticism.

Professor Goulson: All of the bees were fed only on sugar water. In the online version of our manuscript that was published first, in one place we used the word "nectar" instead of sugar water. They are often used interchangeably. It should have said "sugar water" throughout. In the formal, printed version of the manuscript it says "sugar water" throughout. The important point is that all of the bees in all treatments were fed on exactly the same apart from some had the pesticide added. It is a nice example this of the nit-picking that has been done on the scientific research that is publicly available. It is a nonsense that criticism. In that respect the study was fine.

Q126 Mr Spencer: Can you again just give us an idea of the concentration level comparison between that test and the field test?

Professor Goulson: The concentrations we used were taken from a published scientific study—one of the few that is in the public domain—that had measured levels of imidacloprid in oilseed rape nectar and pollen, and we precisely copied the published levels and fed that to the bees. So the concentrations were perfectly realistic from what we know of what is found in oilseed rape.

There is a valid criticism of our study, which is that the bees did not have any choice but to feed on the treated food. So we exposed them for two weeks in their nests to treated pollen and nectar or untreated pollen and nectar—sorry, sugar water, I should say, not nectar—and during that period they did not have the option to feed on something else, whereas obviously in the real world if a nest is close to an oilseed rape field the bees could choose, some of them or all of them, not to feed on the rape. My guess is that that is not the case because they seem to love it.

To try and balance that off, and sorry for going into a bit of detail here, we exposed them for two weeks. In actual fact, a nest near a rape field would be exposed for four or five weeks because that is how long it flowers for. So on the one hand we may have exaggerated the effect by not allowing the bees the choice of feeding on something else, but on the other hand, we only exposed them for two weeks as opposed to four or five. How those two things balance up is anyone's guess, but it was the best experiment we could come up with in a world where there are not control sites. The reason we didn't do it outside is because there was nowhere where we could put nests where they would not be exposed to neonicotinoids if they were free flying.

Q127 Mark Lazarowicz: On the point you mentioned in the past about urban gardens, is that something that could be of any particular importance, or is it fairly marginal in the overall scheme of things? Given what you were saying about the amount of sprays or whatever used by domestic gardeners, some people could be putting in vast amounts. Is that likely to be of any major importance, or is it really not something—

Professor Goulson: It is hard to say because it is very difficult to get hold of the data as to how much is used. Defra provides pesticide usage data for farmland, but how much Dobbies or whoever sell to gardeners is unknown. It is a concern that farmers are trained in using pesticides, whereas of course gardeners might well think, "Oh, well, I'll bung on an extra whatever to make sure it works." I can find no data.

Professor Stone: There is one of the projects in the insect pollinators initiative that Lynn referred to that is targeting the question about how much pollinator richness and diversity there really is in cities, and it is worth saying that there is a lot. So the potential exists for cities to become net exporters of pollinators. They can't do that if they are being killed in gardens, but there is enormous goodwill towards pollinators and I think a lot of the killing of them is entirely down to ignorance. So if people are made aware and pollinator populations are allowed to grow then there is every reason to think that urban areas need not be deserts if pollinators can be net exporters—very helpful.

Professor Goulson: If I could just add that there is no economic argument to justify the use of these pesticides in urban areas at all. If there are a few aphids on someone's roses, it really doesn't matter. Toronto has banned all pesticides for garden use and people still have lovely gardens full of flowers. I personally think that it is ridiculous that we sell these things to untrained gardeners to chuck on their gardens willy-nilly. There is no need for it.

Dr Dicks: It is important to say as well—one last point on the urban pollinators—the important habitats in an urban area are gardens and allotments for species diversity and abundance of pollinators that are—

Professor Stone: And cemeteries.

Q128 Neil Carmichael: I just want to note, because you are following an interesting line of discussion here, that in Stroud—my constituency—we have a sort of wild bee support scheme, if you like and that is in the Stroud town. There are definitions about what is urban and what is not. But I want to ask what kind of structures and framework would you say is best for such a scheme to really produce some interesting results, because obviously you have the question of who does what and boundaries and so on?

Dr Dicks: I am not quite sure what you mean by the question.

Professor Goulson: Are you thinking of pictorial meadows and—

Neil Carmichael: I am thinking of gardeners and house-owners and things being encouraged to give homes effectively to wild bees and appropriate access to what wild bees need.

Dr Dicks: There is quite a long list of different things that you can do, some of which we know work very well to help bees, which gardeners can do. Avoiding all pesticide use is one thing.

Neil Carmichael: That is an obvious one, isn't it?

Dr Dicks: Planting the right flowers at the right time, providing a full season of forage.

Q129 Neil Carmichael: I was struck when I went to see a friend from New York and he has been making honey for years. He was describing the different challenges that he has in Westport in New York as compared to Oxfordshire here. I was quite interested in that, and I was just wondering if there were any sort of trends that are worth identifying and discussing in this Committee?

Chair: Whether that is for the "Gardeners' Question Time" panel I don't know.

Professor Stone: One thing I could say is that increasing numbers of city councils are leading by example now and planting what are called urban meadows or pictorial meadows

and replacing very low diversity green strips that are good for playing football on, but you can have too many of them, and planting them with mixes of flowers that are good for pollinators.

There is a fair amount of Government-funded research now on making those mixes not just pretty but also good. So you can have a bunch of flowers that look nice but are no good for bees, and you can alter those mixes to make them look good and also be good for bees and potentially as seed sources for birds and other things. There is a certain amount of leading by example that is happening and growing, which is great.

Dr Dicks: Also a huge scope for doing it, because you are right, a lot of urban planning and landscaping doesn't provide forage at all. The Insect Pollinators Initiative research is going to make the design of mixes like that quite a lot more sophisticated than it currently is, because we're going to understand what the different amino acid requirements of bees are across the year and also what quantity of nectar and amino acid is produced by, I think, 200 of the most common plant species and some garden species. So we are going to have a really good idea of what resources different plans provide and be able to present a set of forage that will support a bee community in an urban environment. There is a huge amount of scope to do it better.

Professor Stone: And it makes people happy.

Chair: I do think we have quite a few very specific questions still and I think this is an interesting aspect, especially what councils like Stroud and Birmingham particularly have done, but I think we must move on if I may to Peter Aldous.

Q130 Peter Aldous: A recent study has found that the combined effect of different pesticides could be more harmful to bees than exposure to single chemicals. Do you think such combined effects should thus be included in a risk assessment framework?

Professor Goulson: In an ideal world, yes, but of course it becomes very complicated very quickly because there are lots of chemicals that bees would be exposed to—fungicides as well as insecticides and herbicides and so on. If you were to demand that every new product had to be tested and all possible interactions had to be tested, in an ideal world that would be wonderful, but I think the costs would quickly become extraordinary.

Dr Dicks: There are some key combinations presumably on the basis of their different modes of action, which you could test.

Dr Cresswell: The study that you are referring to, what was striking about it was there was not a synergy, that each pesticide had its own effect and then when you put them together they were additive, and they were not instead multiplicative or something like that. I think it would be possible and perhaps already happens in risk assessments that by looking at the class of chemical, there are certain fungicides that knock out the enzymes that would otherwise detoxify a pesticide, and you can see that coming. So there are two options: either you use your fundamental knowledge to predict what might happen, or you prescribe, in a regulatory framework, if those two things are going to be used together then we have to test those. I think there are ways forward but you have to be smart in what you test.

Professor Goulson: Just one further brief comment: there is evidence that exposure to neonicotinoids potentially reduces resistance to disease in bees. That would be something that perhaps could be or should be investigated, because that is something that you wouldn't detect if you simply test a pesticide in a lab where there are no diseases, but as soon as you use them in the real world where bees are exposed to multiple stresses then it could become important.

Q131 Peter Aldous: Professor Stone, do you have anything to add?

Professor Stone: No.

Q132 Simon Wright: I wonder if you could comment on the evidence from Italy, which led to the suspension of three neonicotinoids. The evidence suggested that fine dust generated by the drilling of neonicotinoid treated seeds is lethal to the bees and, indeed, that the concentrations of neonicotinoids were very high—about 20% among the tested content. What weight should we be giving that research?

Dr Cresswell: The German BVL, which is the bee health unit, has done quite a lot of work on this and essentially it depends on what equipment you use. There are two things that are important in generating dust, one of which is how well the pesticide has stuck to the seeds and the other one of which is what happens to the exhaust from the seed sowing machine. Essentially, it is like a big vacuum cleaner because it blows the seeds in, but there is a stream of air that then comes potentially out of the back of the machine. If you have some dust and, like the paper I think you are referring to, the Monterano paper, if you have 150 litres a second or a minute of air with this dust going out either vertically or up into the air then you are going to spread that dust and kill bees.

What the Germans have found, and there are a couple of papers published this year and last year, showing that essentially there is a technical fix and it depends on what you do with the exhaust air. If you divert the exhaust air by fitting a deflector to the machine then essentially you virtually abolish the emission of dust. What the Germans have done is to legislate and publish a list of acceptable machinery.

When we discussed this at the EU level, the problem is whether or not certain member states have the machinery and whether they will force their farmers to use that because of financial and economic reason and whether that is feasible.

Q133 Simon Wright: Can you just comment on then, because I understand that there were further trials done in Italy that said that new equipment did not make much of a difference?

Professor Goulson: I have most of it here—the new ones that have come out of Italy that seem to suggest that the deflectors are not 100% effective, that you still get detectable amounts of dust in the air but it is reduced.

Dr Cresswell: The Germans claim that their list of approved machinery has to reduce emission of dust by over 90%, so that means you have a 10% maximum. Looking at their graphs, it seems to go a bit lower than that, but essentially that is the level of prevention.

Professor Stone: Is there not just an issue that if you do not get so much airborne dust it is being deflected somewhere, so it is going down to the soil surface? One of the big discussions is that if you do not get a broadcasting of dust, which is bad for some things, for lots of things that live on the soil surface and for many wild bees that nest in the top few inches of the soil or down among the vegetation right on the soil surface, they will be getting increased exposure—ground beetles, other things like that.

Professor Goulson: A general point here, which is that we do not know where most of these compounds go, so there is a study published by Bayer scientists, which I also have here, which quantifies the amount of neonicotinoids in the crop, and they estimate that it is usually between two and a maximum of 20% of the amount that was applied to the seeds that ends up in the crop, which means that there is somewhere between 80% and 98% that is unaccounted for. Now the estimates are that maybe 1% or 2% of that is lost in dust, but that still leaves the vast bulk, which ends up somewhere, presumably mostly in the soil but not in the crop, and the evidence I can find suggests that it lasts quite a long time, potentially years, in the soil, potentially leading to a situation where it could accumulate year after year. As far as I know, there is no real evidence one way or another as to whether that is happening, but it is of potential concern because if it is happening, for one there is an obvious impact on soil invertebrates, which are vitally important for maintaining soil structure, but also the

neonicotinoids could be being drawn up by field margin plants or hedgerow plants and making them toxic. So the story could go beyond bees. It could be that these compounds are affecting any herbivorous insect—say, butterfly larvae—living in field margins, which would be extremely concerning. But I can find no evidence one way or another to evaluate that hypothesis. The central point is we do not know where most of these compounds end up.

Chair: I think Mr Spencer wants to come in on that point and then I am going to move to the precautionary principle. Martin, you want to come in as well.

Q134 Mr Spencer: Just as to whether you thought that, given when that seed is being drilled, clearly flying pollinators would not be as likely to be present because the soil would be bare, and how does that compare to a foliar application of the chemical when the plant is in flower? Which one is likely to have the biggest impact on those pollinators?

Professor Goulson: These particular compounds that are used as seed dressings are never used as foliar applications as far as I understand it, so nobody would be able to tell you what the relative risks would be. I would guess if you sprayed them around in the middle of summer on to the foliage that would probably be much worse than putting them on the seed, but I am guessing.

Dr Dicks: You are not allowed to do that. You do not spray during flowering because you would damage bees.

Q135 Mr Spencer: Are you suggesting that garden centres were selling chemicals that they were spraying?

Professor Goulson: For garden use, yes, absolutely.

Dr Dicks: It probably says on the bottle, "Harmful to bees".

Professor Goulson: But it does recommend that you spray them on flowers and vegetables that flower, and it does not say you cannot use them in the summer or when bees are around.

Q136 Martin Caton: Just very quickly, Professor Goulson, on the point you just made about the Bayer research that you came across that suggests that perhaps up to 98% of neonicotinoids are not taken up by the plant, they are likely to end up in soil water, as you said, and yet, as you have just said, there does not seem to be any research going on into finding out what is happening to that and the knock-on consequences to other pollinators. That is surely a crying gap.

Professor Goulson: Yes, I think is the answer.

Chair: I am just going to bring in Zac Goldsmith, who I think has to leave. Am I correct?

Q137 Zac Goldsmith: I have to leave shortly, I am afraid. My apologies. I am going to jump the gun slightly.

Chair: You wanted to ask a question on the precautionary principle.

Zac Goldsmith: Yes, and a couple of other questions coming on the specifics of issues relating to neonicotinoids. I just wanted to ask you, based on the available evidence, the evidence that you have seen, do you believe that there is enough of it, enough concerns around neonicotinoids to justify the precautionary principle now? In other words, if you were Defra and you were employing the precautionary principle, would you at least put a moratorium on the use of neonicotinoids now, pending further research, or is there not enough evidence to justify that?

Professor Goulson: Personally, yes.

Q138 Zac Goldsmith: Yes, you would adopt the precautionary principle?

Professor Goulson: Put it another way, I think if these products came to market new, knowing what we know about them now, that they would not have been licensed, in my view.

Dr Dicks: I would say yes as well. I think the precautionary principle states that where there is uncertainty in the science the burden of proof should be on the people taking the action to show that it is harmless, and we do not have convincing evidence that these are not harming bees in a quite unacceptable way.

Professor Stone: There are an awful lot of questions we do not know the answers to, a lot of which there is submitted written evidence, and are recognised in the EFSA proposal for future risk assessments on bees at least. The question from hammering the environment is, if we were not going to use neonicotinoids, would we replace them with something that was worse because we would not be willing to not replace them at all.

Q139 Zac Goldsmith: That was my follow-up question to you. What do you say to that argument? That is an argument that was put forward today.

Professor Stone: The obvious answer is if the cost of any course of action is to significantly destroy an essential ecosystem service then that falls into the category of no-brainer. You would not destroy your pollinator service, if that is what is going to happen. If that comes at the risk of slightly lower production, which is the trade-off that is quite correctly identified, then that is a decision for society to take.

Q140 Zac Goldsmith: The point that has been made is that if you were to get—

Chair: Sorry, Zac, just before, can I just give Dr Cresswell the opportunity to answer as well please?

Dr Cresswell: I think it is interesting to explore what the precaution is against, and there is a distinction between precaution against harm and precaution against population decline. I think it is unquestionable that harm to bees happens. The question is whether or not these precipitate population declines, and then I think the answer to that is "deep uncertainty". The precautionary principle is complicated because if you just go for do no harm then of course you couldn't use anything. But if the question is do no more harm than you can justify economically, all the other sources of wellbeing that we get, once you get into the complexities of cost and benefit is much more difficult, so I restrict myself to the scientific question: is there good evidence that these things cause a population decline? On that one, I say "not yet".

Q141 Zac Goldsmith: Just on that point, we took evidence this morning from a number of people, but I think it was a representative from Pesticide Action, it may have been Buglife, who told us that having scanned all the available scientific evidence —it was not a scientific statement—94%, I think was the figure, would come down one way or another against, or would conclude broadly speaking that neonicotinoids are causing real problems in relation to pollinators, which is a very high figure, and that is not a scientific figure. But you seem to be saying there is an absence of evidence and therefore one would adopt the precautionary principle, but isn't it more than that? Is there not quite a lot of evidence that suggests that neonicotinoids are potentially major contributors to this problem—or am I putting words into your mouth?

Professor Goulson: If I could just make one point; James says that there is no evidence for a population level impact. In fact, we have no data on population change with respect to any pesticide that have ever been used in the past. We do not have any population data for bees. So to say there is no evidence for population level decline is not terribly helpful, because we have no data on that.

Q142 Zac Goldsmith: Is it because we have not been looking for that data?

Professor Goulson: No data has been collected, so of course we will not have any evidence for a population level decline. If you do not look, you will not find it.

Dr Dicks: I would object to Defra's position, which seems to be it would not take any action unless there was unequivocal evidence of harm. I was trying to think through what unequivocal evidence in this case would look like to me, and I think it would be to show that the use of neonicotinoids was causing population decline in one or more species of wild pollinators. You would need 10 kilometre squared areas of landscape as treatment with and without neonicotinoids. You would need a paired design, so you had pairs of patches that size across the country replicated maybe 10 times. You would need to monitor the wild insects for probably at least five years. Many studies like this look over three years, and that simply is not enough time to measure any population change because the variability between years is too great. So five years, 10 pairs of sites, and the idea of trying to get a 10 kilometre squared area with no neonicotinoids used at all but the same crops and the same landscape structure as another control area that has the normal neonicotinoid use is possible, but you can start to see how very expensive that would be as a study. I think as a comparative figure you could think about the farm scale evaluations that were done for genetically modified crops, which was 60 sites over three years, 10 hectare plots, so much smaller, and they cost about £6 million. So it is not an unfeasible amount of money, but it is a large study you would have to do. If that study was done and there was shown to be no difference in population trends or changes over five years, or preferably 10 years, between the control plots and the neonicotinoid plots then that would be unequivocal evidence either way. We are a very long way from that, and I do not think it is very likely to happen.

Q143 Zac Goldsmith: You began your comment by criticising Defra's approach. Is that that they are demanding a level of scientific certainty that is impossible to firstly get?

Dr Dicks: It would cost £20 million.

Q144 Zac Goldsmith: Unless they were willing to cough up millions of pounds in 10 years and presumably put a moratorium in place in the meantime, given that we do not know, you are effectively saying that they have created an impossible task. It makes it impossible for the regulators to rule against neonicotinoids in the absence of the kind of scientific rigour that only they can make available.

Dr Dicks: Yes, that would be my view of what would be unequivocal, and I do not think it is very achievable and it would take way too long. I am not sure I would stand up and say I think neonicotinoids must be banned now, because there is just so much uncertainty around what the actual effect is. There is clearly some pretty hefty effects on bumblebee colony queen production, and we should be very wary of the effects of these things. What I would like to see is a plan to reduce their use over time. They have a very good plan in place in France to reduce the use of pesticides up to 2018 by 50%. We have nothing in this country that is looking at general reduction in any kind of pesticide use.

Professor Goulson: In fact, we are increasing use. Neonicotinoid use has increased every year for the last 20 years and continues.

Dr Dicks: So has the total treated area of all pesticides. It has increased year on year.

Q145 Zac Goldsmith: Last question: practically speaking, given that we are where we are now, the use is rising and is already substantial and there are many question marks over the effect of this stuff on the pollinators, from a policy point of view if you were advising Defra now, realistically speaking what should Defra be doing?

Dr Dicks: I do not think I can answer that.

Zac Goldsmith: You already have.

Professor Goulson: They should be swiftly evaluating what the alternatives are and how effective they are. My best guess as a non-expert would be to switch back to pyrethroid insecticides, which have been used for a long time and which are relatively benign, still kill bees but they do not hang around long in the environment. But that would seem to me to be a priority. We do not know what would happen if we stopped using neonicotinoids as far as I can tell.

Professor Stone: I would just add to that, that there are two ways we can look at this. One is to ask whether the experiments that have already been done meet the criterion of these pesticides being dangerous or not as a cause of a particular decline or not, which is what James has been looking at a lot. Or we can ask whether the right questions have even been asked, because if we do not have the outcomes of those kinds of experiments to inform us we cannot ask whether they support the question one way or the other.

Q146 Zac Goldsmith: This goes back to the transparency issue.

Professor Stone: I think we have come up with a list of important questions that we do not know the answer to and we need the answers to those questions. It is not just a case of producing more science for the sake of it. We absolutely need the answers to those questions.

Chair: I think Dr Cresswell was going to answer that same question.

Dr Cresswell: I do not think it is the case of the failure to demonstrate a decline invalidating the question. For example, if I said to you that an environmentally realistic dose of some chemical was going to cut your sperm count and all the other males in the room by 99%, we would not need to do a field trial to know that our population was going to be in danger. I think that strong laboratory knowledge can inform things that are very difficult to measure in the environment. What I am saying is, we do not have even the laboratory trump card yet. If we had that I would not worry about the fact we do not have long-term monitoring and I do not think it is impossible to get that kind of thing, but we need more fundamental understanding, and we need some environmentally realistic doses, which harks back to what I said earlier.

Q147 Zac Goldsmith: Chair, do you mind, I am going to jump in with one more very quick question? I take your point there, but the likelihood is that that kind of research, that quality of research does already exist and we just have not seen it. You have not seen it because it is all locked up and confidential. Would it not be—

Dr Cresswell: It is what I do in my lab.

Q148 Zac Goldsmith: But would it not be a sensible approach then for Defra, rather than taking the draconian measure of putting a five-year moratorium on this stuff while they conduct the tests, to demand sight of the studies that do exist, so that at least we can potentially buy ourselves a shortcut there?

Dr Cresswell: I think that to some extent your first point was probably right, which is that the overwhelming drive to produce field evidence has meant that there is a dearth of fundamental laboratory based understanding of what the mechanisms of toxicity are. We do not even know which enzyme system detoxifies imidacloprid. We only know it for a couple of these things. We just do not have a fundamental understanding of how these bees work on the inside, and I think we could learn an awful lot from that and that is one area that is not worked on hard enough to try to even figure out what size of environmental effect to expect in our field trials, but the time scale for achieving that is relatively short.

Professor Goulson: This may seem slightly tangential, but I think it may be an important point I would like to make. I had a meeting earlier this year with a company called Agrii, who are agrochemical middle men, and they employ 300 agronomists who spend all their time going round farms, advising farmers on what pesticides to use and which seeds to plant and so on. They openly admitted that 90% of their profit comes from the mark-up on the agrochemicals that they then sell to the farmers having recommended them. They say that they have 40% of the UK market, that 40% of farmers are advised by that one company alone. I was rather shocked therefore to realise that the UK farmers are primarily receiving their advice from people who have a huge financial motivation to encourage them to use more pesticides than are strictly necessary. It raises a broad question as to whether we are not overusing pesticides across the country, not just neonicotinoids, because of the system we have in place to advise farmers about their use.

Q149 Mark Lazarowicz: There are five neonicotinoid insecticides that are currently for professional use in the UK. Do individual products have different impacts on pollinators, or are there generic effects?

Dr Cresswell: So these five chemicals fall into two groups based on their chemical structure. You have thiamethoxam, imidacloprid and clothianidin in one group. You have acetamiprid and thiacloprid in the other group. That second group are probably one to two orders of magnitude less toxic than the other three, so immediately you cannot put all neonicotinoids under one label on how they will behave. In our lab, even among the three—imidacloprid, thiamethoxam, clothianidin—we are finding small but biologically interesting qualitative differences in how bees respond to those different chemicals. So some generalisation is possible, but in the details not so.

Q150 Mark Lazarowicz: Related to that, given there are concerns about neonicotinoids, is there any possibility of fine-tuning them in some way so as to make them less harmful to pollinators?

Dr Cresswell: Yes, certainly insects differ in their sensitivity. Different types of insects are all different in their sensitivity to neonicotinoids. We also see the emergence of resistance from quite small genetic changes in insect species. Essentially, the way you have to think about these neurotoxins is like a lock and key where the nerve is the lock and the insecticide is the key. It is a question of goodness of fit. So it is theoretically possible to be able to design a key that will only fit certain locks and not others, but I think that is a question for chemists and structural chemists and neurophysiologists. I know that it is talked about in the literature, but very much a Holy Grail kind of thing, and I suspect that the pipeline for delivering such a thing, even if it were available to test, would be 10 years—so an entirely worthy thing to pursue, but I do not think it is on the horizon.

Professor Goulson: I would be slightly less optimistic simply because these compounds are used to protect crops against a broad range, a taxonomic range of different insects, beetles, flies, lepidopterans and so on. So to engineer them in a way that meant they would still kill a broad range of insects, all the ones you wanted them to kill but would not kill the ones you did not want them to kill, for me stretches the bounds of possibility. I am not saying it is impossible, but it strikes me as unlikely.

Dr Dicks: There is one other possibility that I thought of, which I do not know the answer to, but is anyone working, I wondered, on whether it is possible to stop the plants from translocating the stuff into nectar and pollen? We could ask some industry research scientists that because it might be possible, I do not know.

Dr Cresswell: There certainly are order of magnitude differences in sensitivity across quite surprisingly close insect groups, so I disagree with what you just said fundamentally.

Professor Goulson: I will put it another way: no one has ever yet produced an insecticide that does not kill bees.

Q151 Martin Caton: On mitigation, has there been any research to identify which of any possible mitigation strategies to bolster pollinator numbers are likely to prove useful?

Dr Dicks: Yes, loads, if I can answer that.

Q152 Martin Caton: Can you quickly indicate?

Dr Dicks: There are lots of studies on a whole range of different interventions to help pollinators. There is a quite recent meta-analysis. There is a narrative description of evidence that I have written myself for bees specifically. What emerges is that there are few strategies that are particularly effective at providing resources for pollinators or having pollinators on them. Those things are sown wild flower strips or naturally regenerated field margins that have wild flowers on them and also providing nest boxes for solitary bees is very effective at increasing population numbers.

So for most of the other interventions like wildflower strips, the evidence we have is largely, not entirely, just showing that when you plant wildflowers insects visit them in larger numbers than they visit just the grass strip or a patch of crop. We do not know with any certainty whether this is providing forage that allows an increase in population numbers year on year. There are some studies emerging that do look at it, which Graham seems to have, so looking at reproductive success of solitary bees and showing that there is a benefit, but we do not have very good evidence to say for sure. The question that is not answered that needs to be answered is, are these pollinator communities and populations limited by foraging resources, so planting flowers can help boost their numbers, or limited by nesting sites? We know that providing nesting sites for some species of solitary bee does boost their numbers year on year.

Professor Stone: There is some evidence, which these guys may know more about than I do, which is if you grow flowering margins around fields and build up hoverfly populations, which are pollinators as well, then their larvae eat more of the aphids that are damaging the crop and so you could, in theory, reduce the amount of pesticide that you would need to apply. So that is the kind of feedback you want to engineer. The question is whether that would take things into economically sustainable levels.

Dr Cresswell: In principle, this has to be a mitigatable problem because the relationship between concentration of dose and performance has a slope to it, so if you lower the dose, you are going to improve the performance towards a zero dose. Therefore, if you put in other kinds of flowers into the environment that the bees are going to use and dilute the pollen and nectar they are going to get off the crop then this is going to produce an improvement. Work at the Tremough Campus at Exeter is beginning to understand the way the bees move at the landscape scale, and so you should be able to predict if we put in these many square metres, hectares, of alternative flowers then the bees are going to principally go there, or at least half of them are, and that is going to drop the level of residues in the colony by X% and that is going to give you this much of a mitigation effect. We ought to be able to design landscapes to meet a specified level of protection.

Q153 Martin Caton: Dr Cresswell, I remember reading your written submission and you recognise that there is possibly a problem with bumblebees, although you do not think there is with honeybees, and you think the answer to that is, I think we call it, smart mitigation. That raises even more after the conversation we have had about other pollinators. That might deal with bumblebees, but if we have a problem with hoverflies and other sorts of

pollinators, as has been indicated, with very different lifestyles and different habitats then is mitigation going to be realistic?

Dr Cresswell: I think that flowers are good for all pollinators. A drop in dose is going to help everybody, and the habitat that you put aside to grow those flowers in is going to provide the kind of habitats that other pollinator groups might well use for nesting sites. To me it seems like this is a discussion that has not been had yet and more research ought to look at the possibility of mitigation.

Dr Dicks: I agree with the strategy, but it is on the assumption that the neonicotinoids are not ending up in the flower margins, which I do not believe we know at this point.

Dr Cresswell: That is going to be an inverse square law, so you think about a drop of ink in a bathtub, it is going to spread out in all directions. It is going to be most concentrated in the field and it is going to drop off rapidly. You do not have to put your mitigating flowers next to your field. I am talking about the possibility of doing this at a landscape scale.

Professor Stone: I think there obviously has to be a way to go forward and there is a lot of basic biology on other pollinator groups that we need, so suggestions like spraying your crops at night rather than during the day when all the bees are back at their nests and bed would work for some things, but they would not work for other kinds of pollinators that do not have a nest to go home to and hang around in the crop because they could get got at during the night. Different groups of bees have quite different daily activity patterns to honeybees and even bumblebees, so there is a lot of basic research on which pollinators are active at which times in the crops and in the areas immediately around the crops on the landscape scale that we need to have the answers to. Some of those are happening now, but they are a drop in the ocean in terms of the diversity of pollinators.

Another reason that there is so much focus on honeybees and then bumblebees is because we know enough about their basic biology to design experiments around what they generally do, but for a lot of the solitary bees, which are very different, they are way more diverse in their biology than the social bees are, and the different kinds of hoverflies and other pollinators are just difficult. They are biologically diverse, and in order to develop some remedial strategy we need to know a lot more about what they are doing in and around crops.

Chair: I think on that note we have exhausted our questions for this afternoon. It has been quite a technical subject area for us, so I thank all four of you for coming along and making your time so freely available to us this afternoon. Thank you very much.