Resumé

INTERNATIONAL WORKSHOP ON NEONICOTINOIDS

Université de Paris-Sud, Orsay, France

From 28 to 30th June, an international workshop on neo-nicotinoid insecticides was held at the University of Paris-Sud, Orsay, France, in which participated Dr. Jean-Marc Bonmatin (CNRS, Orléans, France), Dr. Maarten Bijleveld van Lexmond (Neuchâtel, Switzerland), Tessa van Dijk (Utrecht University, Netherlands), Dr. David Gibbons (RSPB, Sandy, UK), Prof. Vinzenso Girolami (University of Padua, Italy), Prof. Pierre Goeldlin de Tiefenau (Clarens, Switzerland), Vicky Kindemba (Buglife : The Invertebrate Conservation Trust, Peterborough, UK), Prof. François Ramade, (University of Paris-Sud, Orsay, France), Dr. Hélène Roche (University of Paris-Sud, Orsay, France). Prof. Jeroen van der Sluijs (Utrecht University, Netherlands), Dr. Henk Tennekes (ETS Nederland BV, Zutphen, Netherlands), Michel Terrasse (LPO, Paris, France).

After a welcome by Prof. François Ramade and Prof. Paul Leadly, Director of the Ecological Institute (ESE) of the University Paris-Sud, Dr. Henk Tennekes gave a power-point presentation on Haber's Rule in relation to neonicotinoid insecticides. Next, the panel under the chairmanship of Prof. Ramade peer reviewed the report of Dr. Tennekes on insecticide use and declining populations and birds in Europe.

This review was followed by an introduction by Prof. van der Sluijs on the effects of neonicotinoid pesticide pollution of Dutch surface water on non-target species abundance. This was the subject of Tessa van Dijk's report and Msc thesis that was subsequently peer reviewed by the panel.

The panel's Chairman, Prof. Ramade said in his résumé of the peer review of two reports that the problem of neo-nicotinoid insecticides is an eco-toxicological problem governed by Haber's principle. When demanding the banning of neo-nicotinoid insecticides the inevitable consequences of permanent exposure to low doses should be kept in mind. Although strong evidence exists that the decline of insect-dependent bird species is directly

linked to the decline of insect populations, definite proof of neonicotinoids being the root cause needs still urgently to be established.

In regard to the second report Prof. Ramade complemented Tessa van Dijk on the important result obtained by proving the direct influence of the neonicotionoid insecticide imidacloprid on Diptera abundance. He considered it to be an excellent piece of work and important to be published. He noted that only two variables had been compared while many other variables would fit the model. Time and distance effects should be built in.

Under the chairmanship of Prof. Goeldlin it was discussed what should be done with the material now available. It was resolved that three (now four) articles should be prepared for publication :

1) An article by Dr. Tennekes on neonicotinoid pesticides and Haber's Rule based on his report. (This article entitled The Significance of the Druckey-Kupfmüller Equation for Risk Assesment – The Toxicity of Neonicotinoid Insecticides to Arthropods is Reinforced by Exposure Time, has presently been peer reviewed and will be published by the Journal Toxicology
2) An article by Tessa van Dijk on « The effects of neonicotinoid pesticide pollution of Dutch surface water on non-targetspecies abundance based on her MSc thesis based on her MSc thesis (in preparation).
3) Now available knowledge on the effects of neonicotionoid insectides on honey bees will be compiled in an article by Laura Maxim, Jean-Marc Bonmatin and Jeroen van der Sluijs.
4) A compilation on the quantitive and qualitative use of neonicotinoid pestides in Europe will be made by Vicky Kindemba (decided upon after the meeting).

When ready the panel will again peer review the articles mentioned under nos 2, 3 and 4 prior to their publication.

Based on these publications, a major compilation encompassing all aspects of neonicotionoid insecticides will be published as the final result. .

Dr. Gibbons agreed to the suggestion made by Prof. Goeldlin to see whether the RSPB could provide more corrobative data on the three cases in the Netherlands mentioned in the report by Dr. Tennekes, namely the strong decline of the Black-tailed Godwit (*Limosa limosa*) and the scarcity of larger insects in the Wormer/Jisperveld, the strong decline of ground beetles (*Carabidae*) and the simultaneous decline of the Whinchat (*Saxicola rubetra*) and the Northern Wheatear (*Oenanthe oenanthe*) in the Dwingelderveld National Park, and the overall decline of the latter in relation to the shortage of beetles (*Scarabeidae*).

Opmerking [H.1]: It is a fact that neonicotinoids behave like chemical carcinogens. There is general consensus that there are no safe exposure levels for chemical carcinogens. Likewise there are no safe exposure levels for neonicotinoids. The present levels in the Dutch environment kill or debilitate invertebrates. Tessa' s data are a case in point. Adverse effects on birds follow by implication.

Opmerking [H.2]: The article in Toxicology is not based on the report. The reasoning was first published in www.bijensterfte.nl on 08/17/2009: http://www.bijensterfte.nl/nl/taxonomy/term/27

Opmerking [H.3]: The proofs are scheduled to be available on July 20, The article may be online shortly afterwards

Opmerking [H.4]: I am at a loss to understand the 3rd case

Addendum

On the 14th June 2010 Prof. Goeldlin and Dr. Bijleveld met in Switzerland with Dr. Simon Stuart, Chairman of the IUCN Species Survival Commission and Ir. Piet Wit, Chairman of the IUCN Ecosystems Management Commission.

Based on the results of the meeting in Paris the following was agreed that the four key researchpapers will be published in peer-reviewed journals. Building on these papers a research paper will be submitted to *Science* (first choice) or *Nature* (second choice) which would introduce new analyses and findings across the scientific disciplines to demonstrate as convincingly as possible the impact of neonicotionoides on insects, birds, other species, ecosystem functions, and human livelihoods. This high-impact paper would have a carefully selected first author, a core author team of 7 people or fewer (including the authors of the initial four papers), and a broader set of authors to give global and interdisciplinary coverage. A significant amount of the supporting evidence will be in the official Supporting Online Material accompanying the paper. A parallel « sister » paper (this would be a shorter Policy Forum paper) could be submitted to *Science* simultaneously drawing attention to the policy implications of the other paper, and calling for a moratorium in the use and sale of neonicotinoid pestcides. We would try to pull together some major names in the scientific world to be authors of this paper. If we are successful in getting these two papers published, there will be enormous impact, and a campaign led by WWF etc could be launched right away. It will be much harder for politicians to ignore a research paper and a Policy Forum paper in *Science* The most urgent thing is to obtain the necessary policy change to have these pesticides banned, not to start a campaign. A stronger scientific basis for the campaign will hopefully mean a shorter campaign. In any case, this is going to take time, because the chemical industry will throw millions into a lobbying exercise.

Opmerking [H.5]: Neonics are a very hot topic and generally suspected to be implicated in bee decline. There is a distinct possibility that the first paper to appear will already have a high impact. If that were to be case the entire scenario would turn out to be a house of cards. But, and perhaps even more importantly, the author of the first published paper would have to bear the brunt of hostile reactions from the chemical industry. No provisions have been made for this eventuality. There should be.

In order to prepare for the paper to be submitted to *Science* it is necessary to plan it simultaneously with the first four more detailed papers (to be sure that the first four papers do not unintentionally undermine the proposed high-impact one). A small meeting is therefore needed to do the necessary planning including the authors of the first four papers, David Gibbons/Mark Avery, Maarten Bijleveld, Pierre Goeldlin, the IUCN SSC and CEM Chairs (or their designates) and one or two people experienced in high-impact publishing (such as Ana Rodriguez).

Pierre Goeldlin **Maarten Bijleveld**

Notre Dame de Londres/ Clarens, 15th July 2010

Key findings of the 29 June 2010 expert review panel in Paris on ecological impacts of neonicotinoid insecticides on non-target species compiled by Jeroen P. van der Sluijs

Summary

Over the past decade neonicotinoid insecticides (further to be called neonics) have rapidly become the most widely used and fastest growing class of insecticides world wide. The most widely used neonic is imidacloprid. Neonics act systemic: they enter the plant sap through the roots, making the whole plant permanently toxic to insects. Neonics are unprecedentedly toxic to beneficial insects such as pollinators. Neonicotinoids are neurotoxic and act cumulative. Neonicotinoids are unique in their harmfulness to insects in sub-lethal dose and chronic exposure. In field conditions, neonics are highly persistent in soil and water. Metabolites of neonics are also highly neurotoxic to insects, thereby prolonging the period of harmfulness to non target species after application. Neonic pollution can make wild plants harmful to non target species. Neonics are increasingly linked to world wide pollinator decline in general and honeybee and bumblebee decline in particular. In the Netherlands since 2004 imidacloprid is number 1 in the top 10 of most problematic pesticides in Dutch surface water. Species abundance of many invertebrates is significantly lower in areas polluted with neonics. There is growing reason for concern that - through decreased abundance of insects - large scale use of neonics may have an indirect impact on populations of birds that feed on insects or critically depend on insects to raise their brood.

- **Over the past decade neonicotinoid insecticides (further to be called neonics) have rapidly become the most widely used and fastest growing class of insecticides world wide.** After market introduction in the mid nineteen-nineties neonics use has rapidly grown to become the most widely used class of insecticides world wide with a 1.5 billion euro global market share (25% of the world insecticide market). The major application (765 MEuro/yr) is seed treatment. Large scale world wide use started around 2004. Neonics are nowadays registered in more than 120 countries. (Jeschke et al., in press)

- **The most widely used neonic is imidacloprid.** Other neonics include clothianidine, thiametoxam, thiacloprid, acetamiprid, dinotefuran and nitenpyram. They are the active ingredients of a very wide range of plant protection products.

- **Neonics act systemic: they enter the plant sap through the roots, making the whole plant permanently toxic to insects.** In contrast to sprayed insecticides, systemic insecticides are pesticides for which the active substance in the seed-coating or in the treated soil is actively taken up by the roots and enters the plant's sap, making the entire plant (including pollen and nectar) permanently toxic to insects. Insects get in contact and/or ingest the insecticide while feeding on these plants or while foraging on contaminated surface water, through collecting nectar, pollen, guttation drops, dew drops and honeydew from treated plants, or through contact with contaminated soil or water.

- **Neonics are unprecedentedly toxic to beneficial insects such as pollinators.** For instance, the median lethal dose (LD50) for honeybees of imidacloprid (the most widely used neonic) is 3.7 nanogram per honeybee making it 7297x more toxic than DDT. (Bonmatin, 2009)

- **Neonicotinoids are neurotoxic and act cumulative**. The mode of action derives from almost complete and virtually irreversible blockage of postsynaptic nicotinergic acetylcholine receptors in the central nervous system of insects. This means that the toxicological relevant critical dose is not the acute dose but the cumulative dose over the lifespan of the insect: The toxicity of imidacloprid to several insects follows Haber's rule, which is characterised by a linear relationship (on logarithmic coordinates) between exposure concentration and median time to effect, i.e. mortality. This implies that as a rule of thumb, the no-effect daily dose for an insect is smaller or equal to the LD50 divided by the lifespan, but may often be even lower because of sub lethal effects. This implies that we talk here about picograms per day. (Tennekes, 2010; Van Dijk, 2010)

Opmerking [H.6]: Could you please cite the toxicology paper as well?

- **Neonicotinoids are unique in their harmfulness to insects in sub-lethal dose and chronic exposure.** Exposure in doses well below the LD50 still produces observable negative effects. Sub-lethal effects are especially relevant for understanding impacts on social insects where individuals depend on a colony for their survival. Exposures to single dose as low as 0.1 nanogram imidacloprid per honeybee is enough to disturb the navigation of honeybees which leads to weakening impacts on the colony (e.g. less food supply to the colony per unit of time, loss of foragers etc.). This implies that concentrations of several parts per billion in the diet of insects can already cause harm on colony level of social insects. Research has demonstrated that

by impairing grooming behaviour, sub-lethal exposure to imidacloprid makes colonies of termites and ants 10000x more prone to fungal infections that subsequently induce a collapse of the colony. Similar synergistic effects have been demonstrated for imidacloprid and Nosema Ceranae (Aleaux et al., 2010) and for clothianidin and thiametoxam, both with chronic bee paralysis virus (Chagnon, 2009).

- **In field conditions, neonics are highly persistent in soil and water.** Typical half-life of imidacloprid is 250 days, but cases are documented in the literature where plants grown on previous treated soil 2 years after field application still produced pollen and nectar with detectable amounts of imidacloprid in amounts sufficient to produce sub lethal effects in honeybees. (Maxim et al., 2007). In surface water half life times up to 160 days have been observed.

- **Metabolites of neonics are also highly neurotoxic to insects, thereby prolonging the period of harmfulness to non target species after application.**

- **Neonic pollution can make wild plants harmful to non target species.** Because of its systemic nature, neonics are actively taken up by the roots of plants, meaning that contaminated surface water and soil can make wild plants also toxic to insects.

- **Neonics are increasingly linked to world wide pollinator decline in general and honeybee and bumblebee decline in particular.** There is wide agreement amongst experts that honeybee decline has three major causes: bee diseases, chronic exposure to neonics, and land use change leading to reduced availability and diversity of pollen. Many cases of mass-die offs from acute intoxication incidents linked to drift of neonic dust during sowing of coated seeds have been reported and documented. Apart from these acute intoxication episodes, there is a growing body of evidence that sub-lethal chronic exposure to neonics plays a key role in honeybee decline and weakening of colonies in many regions. (Maxim and Van der Sluijs, 2007, 2010; APIMONDIA round table on pesticides, 2009, Maini et al., 2010).

- **In the Netherlands since 2004 imidacloprid is number 1 in the top 10 of most problematic pesticides in Dutch surface water.** Extreme violations of the maximum tolerable risk concentration (MTR, being 13 ng/l) have been

frequently reported with many cases 100 to 1000 x the MTR. In 50% of the surface water the MTR standard is violated and in 30% of all 579 measurement locations in Dutch surface waters, pollution levels exceed 5xMTR. (Van Dijk, 2010).

- **Species abundance of many invertebrates is significantly lower in areas polluted with neonics.** Recent research from Utrecht University demonstrated with very high significance [*p*(uncorrelated) = 0.016] that in Dutch surface water, species abundance for the flying insect order Diptera (flies and mosquitoes) decreases strongly with increasing imidacloprid concentrations. Reasonably significant negative correlations with imidacloprid concentrations in surface water were found for Coleoptera (beetles), Amphipoda (crustaceans) and Odanata (dragon flies and damsleflies). A positive correlation was found for Hydracarina (water mites). All these ecological impacts result from chronic exposure to sublethal dose. (Van Dijk 2010)

- **There is growing reason for concern that - through decreased abundance of insects - large scale use of neonics may have an indirect impact on populations of birds that feed on insects or critically depend on insects to raise their brood.** A large scale decline of many invertebrate-dependent bird species has been observed all over Europe. For several cases, evidence has been found that this can be related to a lack of protein-rich invertebrate prey for birds to raise their chicks. Evidence collected in the Wormer- and Jisperveld reserve in the western province of North-Holland (a 2200 ha soft peat wetland reserve) suggests that the decline of the Black-tailed Godwit may be caused by a lack of larger insects on which the chicks depend for their survival. The decline of the number of breeding pairs of the Black-tailed Godwit in the Wormer- and Jisperveld reserve was 1% per annum from 2001 to 2004, 5% per annum from 2004 to 2006, and 22% in 2007. Recent research has linked this decline to a short of supply of larger insects (> 4 mm) in the middle of May. (Tennekes, 2010)

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The significance of the Druckrey-Küpfmüller equation for risk assessment - The toxicity of neonicotinoid insecticides to arthropods is reinforced by exposure time
To be published in Toxicology