

Studiedag Imkersbond ABTB
Wehl, zaterdag 4 februari 2012

Systemische insecticiden en bijensterfte

Jeroen P. van der Sluijs

j.p.vandersluijs@uu.nl



www.jvds.nl

Copernicus Institute, Utrecht University

&



Recherches en Economie-Ecologie, Eco-innovation et ingénierie du
Développement Soutenable (REEDS)
Université de Versailles Saint-Quentin-en-Yvelines, France



Universiteit Utrecht



European Research project ALARM:

The trend of world wide pollinator loss is a major threat to biodiversity

Causes include: new pesticides, land use change and climate change

<http://www.alarmproject.net>



Universiteit Utrecht



United States
Department of Agriculture
Agricultural Research Service

2010
Colony Collapse Disorder
Progress Report

CCD Steering Committee
June 2010



Patterns of widespread decline in North American bumble bees

Sydney A. Cameron^{a,1}, Jeffrey D. Lozier^a, James P. Strange^b, Jonathan B. Koch^{b,c}, Nils Cordes^{a,2}, Leellen F. Solter^d, and Terry L. Griswold^b

^aDepartment of Entomology and Institute for Genomic Biology, University of Illinois, Urbana, IL 61801; ^bUnited States Department of Agriculture-Agricultural Research Service Pollinating Insects Research Unit, Utah State University, Logan, UT 84322; ^cDepartment of Biology, Utah State University, Logan, UT 84321; and ^dIllinois Natural History Survey, Institute of Natural Resource Sustainability, University of Illinois, Champaign, IL 61820

Edited^a by Gene E. Robinson, University of Illinois, Urbana, IL, and approved November 24, 2010 (received for review October 3, 2010)

Bumble bees (*Bombus*) are vitally important pollinators of wild study in the United States identified lower genetic diversity and

2011

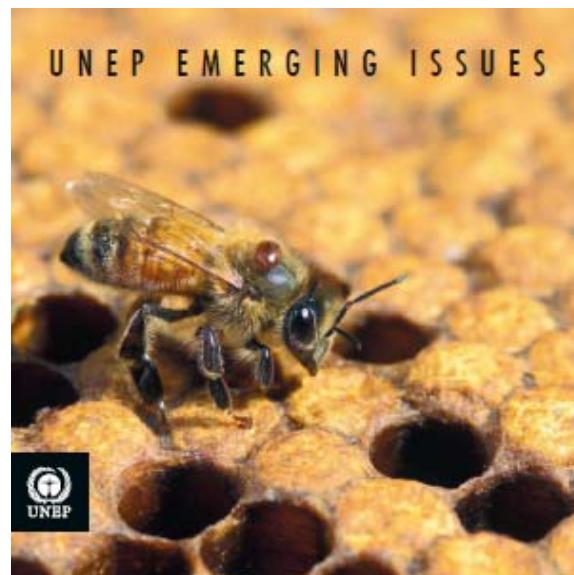
intensive nationwide surveys of >16,000 specimens. We show that the relative abundances of four species have declined by up to 96% and that their surveyed geographic ranges have contracted by 23–87%, some within the last 20 y. We also show that declining populations have significantly higher infection levels of the microsporidian pathogen *Nosema bombi* and lower genetic diversity compared

Parallel Declines in Pollinators and Insect-Pollinated Plants in Britain and the Netherlands

2006

J. C. Biesmeijer,^{1*} S. P. M. Roberts,² M. Reemer,³ R. Ohlemüller,⁴ M. Edwards,⁵ T. Peeters,^{3,6} A. P. Schaffers,⁷ S. G. Potts,² R. Kleukers,³ C. D. Thomas,⁴ J. Settele,⁸ W. E. Kunin¹

Despite widespread concern about declines in pollination services, little is known about the patterns of change in most pollinator assemblages. By studying bee and hoverfly assemblages in Britain and the Netherlands, we found evidence of declines (pre- versus post-1980) in local bee diversity in both countries; however, divergent trends were observed in hoverflies. Depending on the assemblage and location, pollinator declines were most frequent in habitat and flower specialists, in univoltine species, and/or in nonmigrants. In conjunction with this evidence, outcrossing plant species that are reliant on the declining pollinators have themselves declined relative to other plant species. Taken together, these findings strongly suggest a causal connection between local extinctions of functionally linked plant and pollinator species.

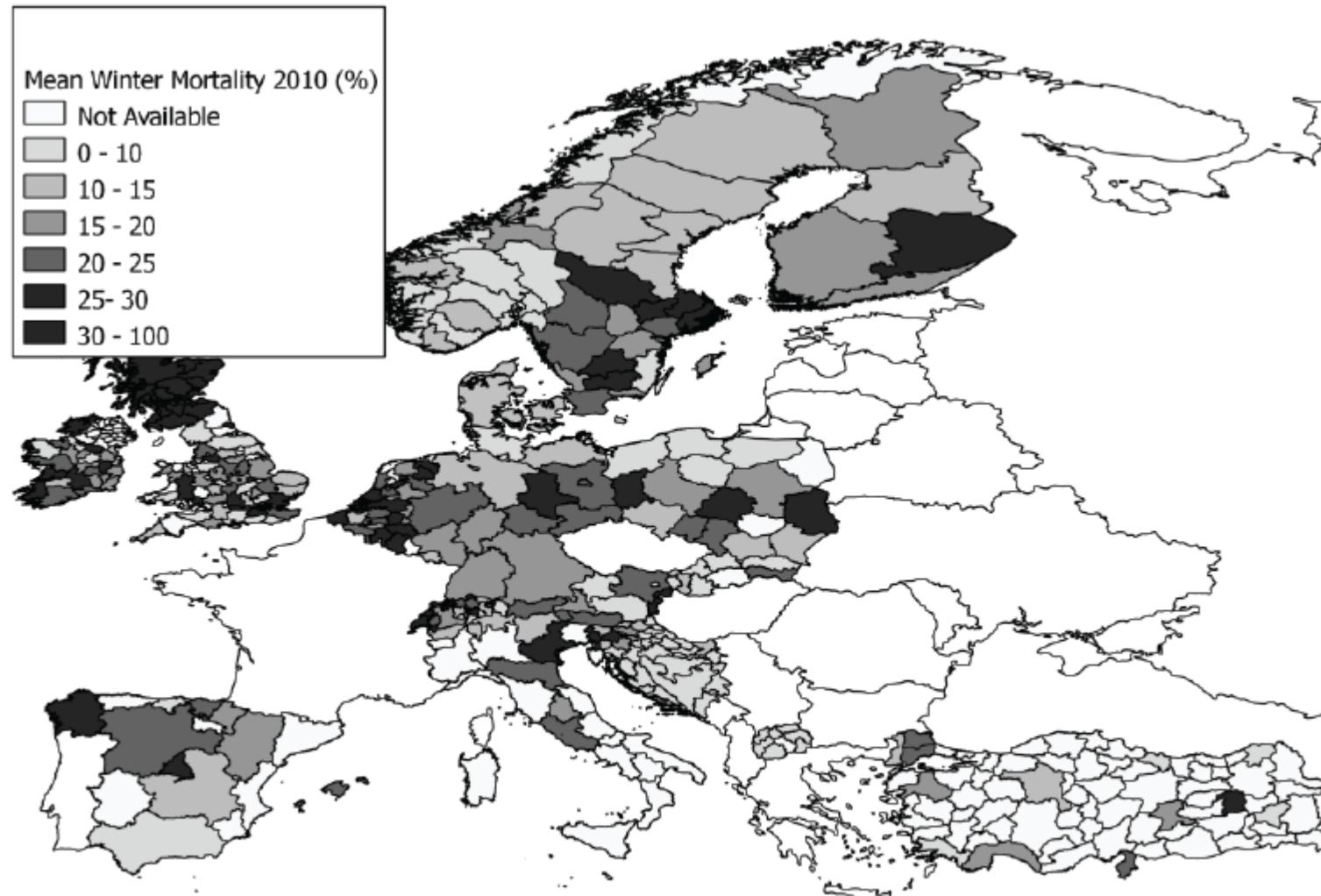


GLOBAL HONEY
BEE COLONY
DISORDERS
AND OTHER
THREATS
TO INSECT
POLLINATORS

2011



Universiteit Utrecht



Gemiddelde wintersterfte 2009-10 Europa,
Turkije en Israel (Van der Zee e.a., 2012; Coloss)

<http://dx.doi.org/10.3896/IBRA.1.51.1.12>



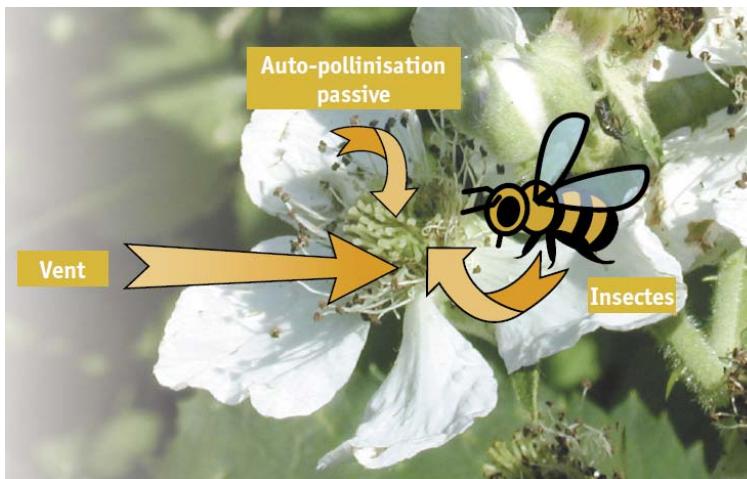
The work of the honeybee

- Colony 10,000 to 80,000 bees
- Empty honeybee 80 to 100 mg
- Maximum “freight”: 70 mg/honeybee.
- Water “freight” up to 40 microliter per bee
- One colony visits 21 miljoen flowers / day
- 700 flowers visited per honeybee per day
- 1 liter nectar requires 20,000 to 100,000 flights
- Worker honeybee lives ca. 20 - 35 days, winterbees 170 days and more.



Het belang van bestuivers

- 90 belangrijke voedselgewassen (35% wereld voedsel productie; >90% voedseldiversiteit) heeft dierlijke bestuiving nodig.
- Europa: 14,2 miljard Euro / jaar
- 80% van bloeiende planten: dierlijke bestuiving voor voortplanting en evolutie



Some crops pollinated by bees³

Cabbage	Kale	Raspberry
Cacao	Kola nut	Sapote
Cantaloupe	Leek	Squash
Carrot	Lychee	Sunflower
Cashew	Macadamia	Tangerine
Cauliflower	Mango	Tea
Celery	Mustard	Watermelon
Cherry	Nutmeg	
Citrus	Onion	
Dill	Passion fruit	
Eggplant/ Aubergine	Peach	
Fennel	Pear	
Garlic	Plum	
	Pumpkin	



Wereldwijd ca. 25000 bijensoorten

NL: ca. 350 waarvan 181 op rode lijst



Gewone behangersbij



Grote Bladsnijder



Bruine rouwbij



Kattenstaartbij



gehoornde metselbij



Blauwe metselbij



Kauwende metselbij



Rosse metselbij



Grote roetbij



Bloedbij



Rimpelkruingroefbij



Dikkopbloedbij



Panserbloedbij



Brede dwergbloedbij

Oorzaken bijensterfte

Bijensterfte is samenspel van:

- Monoculturen (te eenzijdig stuifmeelaanbod)
- Verlies biodiversiteit (stuifmeeltekort)
- Opmars Varroamijt
- Virussen
- Nosema Ceranae
- Chronische blootstelling aan neonic-pesticiden
- Imkerpraktijken
- Wereldmarkt van bijenkoninginnen
- Klimaatverandering: watergebrek en pollenseizoen



Bijensterfte is multicausaal

PPP

- Pollen
- Pathogenen
- Pesticiden



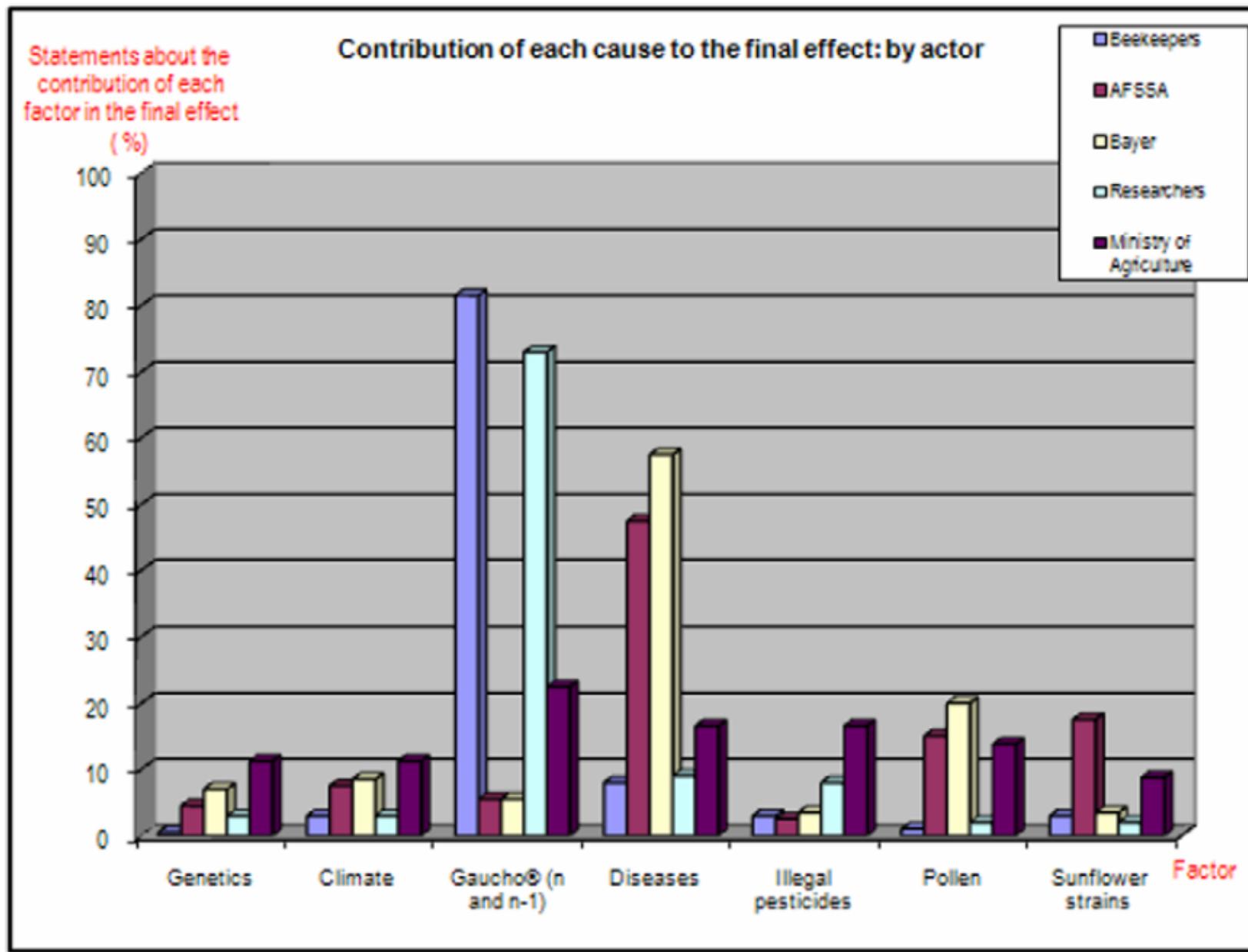
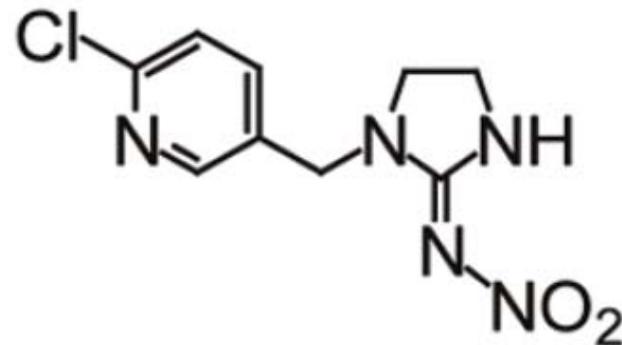


Figure 4. Contribution of each cause to the final effect: by actor, in percentage (%).



imidacloprid (1991)

Shinzo Kagabu

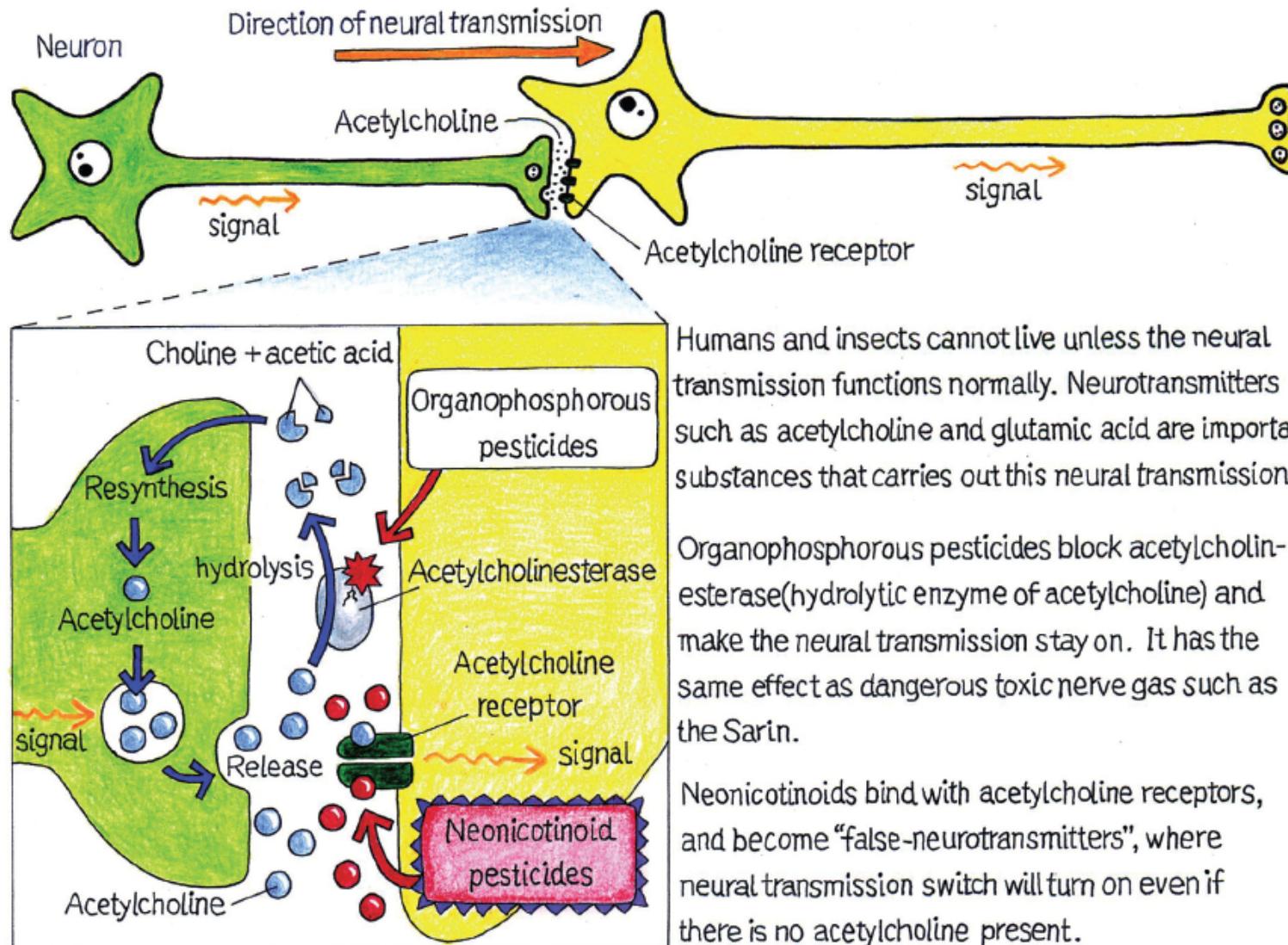
Professor Shinzo Kagabu received the **2010 American Chemical Society International Award for Research in Agrochemicals** in recognition of his discovery of imidacloprid (IMI) and thiacloprid, which opened the neonicotinoid era of pest management.

(Tomizawa & Casida, 2010, [DOI 10.1021/jf103856c](https://doi.org/10.1021/jf103856c))



Neonicotinoid/Organophosphorous pesticides disrupt the neural transmission

Neural transmission mechanism through acetylcholine



Systemic insecticides

- Very high toxicity for honeybees
- A long persistence in soils ($t_{1/2} = 9$ months) and water (160 days)
- Acute effects (overdosing, sowing...)
- Contamination of flowers, nectar and pollen
- Sublethal effects and chronic exposure
- Main metabolites as toxic as imidacloprid for bees
- Risks in fields : $PEC/PNEC >> 1$
- Synergies with other pesticides
- Synergies with other pathogens (Nosema, Wing Deform Virus)
- Major weakening factor of bee colonies



Toxicity of neonicotinoids

Pesticide	®	Use	LD50 (ng/honeybee)	Toxicity index relative to DDT
DDT	Dinocide	insecticide	27000	1
Amitraz	Apivar	insecticide / acaricide	12000	2
Coumaphos	Perizin	insecticide / acaricide	3000	9
Tau-fluvalinate	Apistan	insecticide / acaricide	2000	13.5
Methiocarb	Mesurol	insecticide	230	117
Carbofuran	Curater	insecticide	160	169
λ-cyhalothrin	Karate	insecticide	38	711
Deltamethrine	Decis	insecticide	10	2700
Thiamethoxam	Cruise	insecticide	5	5400
Fipronil	Regent	Insecticide	4.2	6475
Clothianidine	Poncho	Insecticide	4.0	6750
Imidacloprid	Gaucho	Insecticide	3.7	7297

Toxicity of insecticides to honeybees compared to DDT. The final column expresses the toxicity relative to DDT. (Source: Bonmatin, 2009)

<http://www.bijensterfte.nl/images/Bonmatin-conclusions-sentinelle-gb-2009.pdf>

Mais gecoat met imidacloprid

75 gram imidacloprid / ha mais

100000 zaden per ha

0.00075 gram imidacloprid/zaad

3.7 nanogram is dodelijk voor een bij

202702 dodelijke doses per maiszaadje



Pesticides : Toxicité / abeilles DL50 ng/ab (Bonmatin 2011)

HQo (quotient de danger) = dose (g par hectare) / DL50o (μ g / abeille)

pesticide	®	utilisation	Dose g/ha	DL50 ng/ab	HQ <u>g/ha</u> <u>μg/ab</u>	Tox DDT
DDT	Dinocide	insecticide	200-600	27 000.0	22	1
thiaclopride	Proteus	insecticide	62,5	17 320.0	4	1.6
amitraze	Apivar	i/acaricide	-	12 000.0	-	2
coumaphos	Perizin	i/acaricide	-	3 000.0	-	9
methiocarb	Mesurol	insecticide	150 à 2200	230.0	9 565	117
tau-fluvalinate*	Apistan	i/acaricide	-	200.0	-	135
carbofuran	Curater	insecticide	600	160.0	3 750	169
λ -cyhalothrine	Karate	insecticide	150	38.0	3 947	711
thiaméthoxam	Cruiser	insecticide	69	5.0	13 800	5 400
fipronil	Regent	insecticide	50	4.2	11 990	6 475
clothianidine	Poncho	insecticide	50	4.0	12 500	6 750
imidaclopride	Gaucho	insecticide	75	3.7	20 270	7 297
deltamethrine	Décis	insecticide	7,5	2.5	3 000	10 800

Réévaluations successives signalées par le Dr. Taoufik BEN HAMIDA 2000ng/ab*, puis USEPA 200ng/ab^f trecht

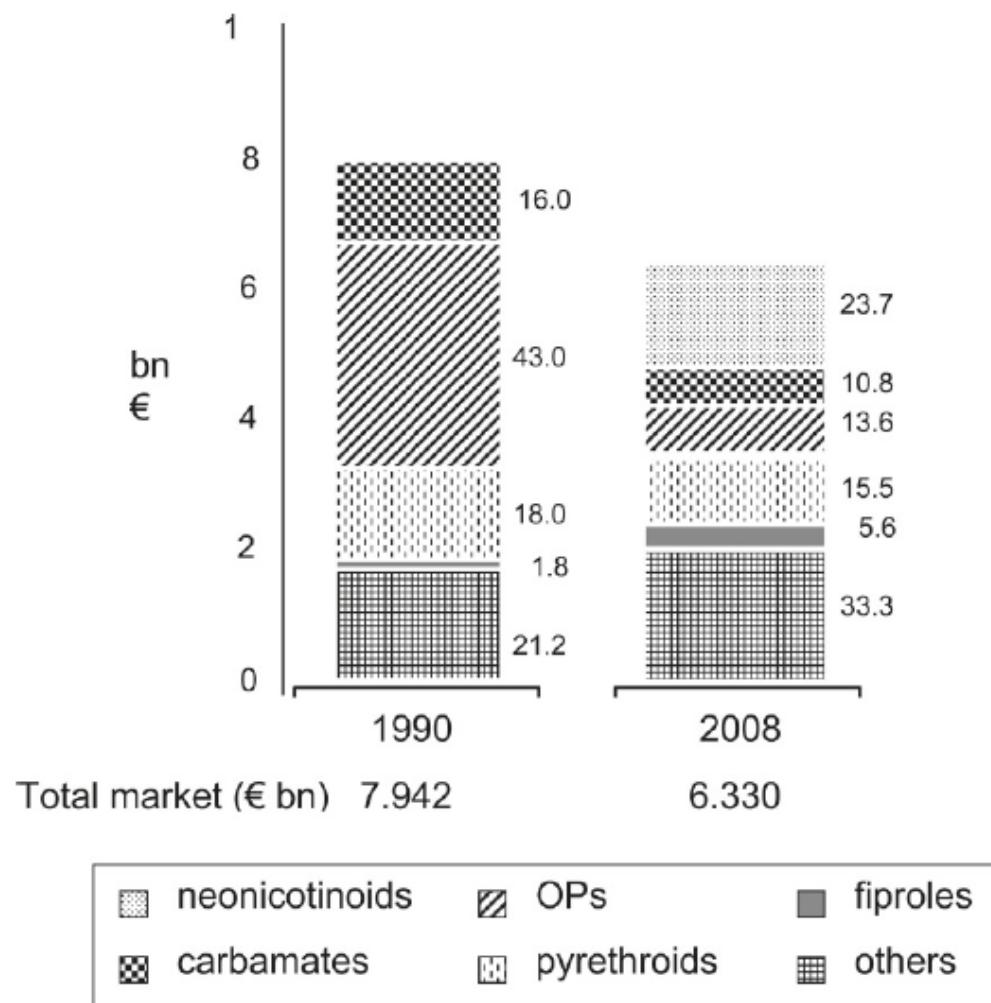


Figure 1. Development of insecticide classes in modern crop protection, 1990–2008, expressed as percentage of total.

Jeschke et al., 2011
<http://dx.doi.org/10.1021/jf101303g>



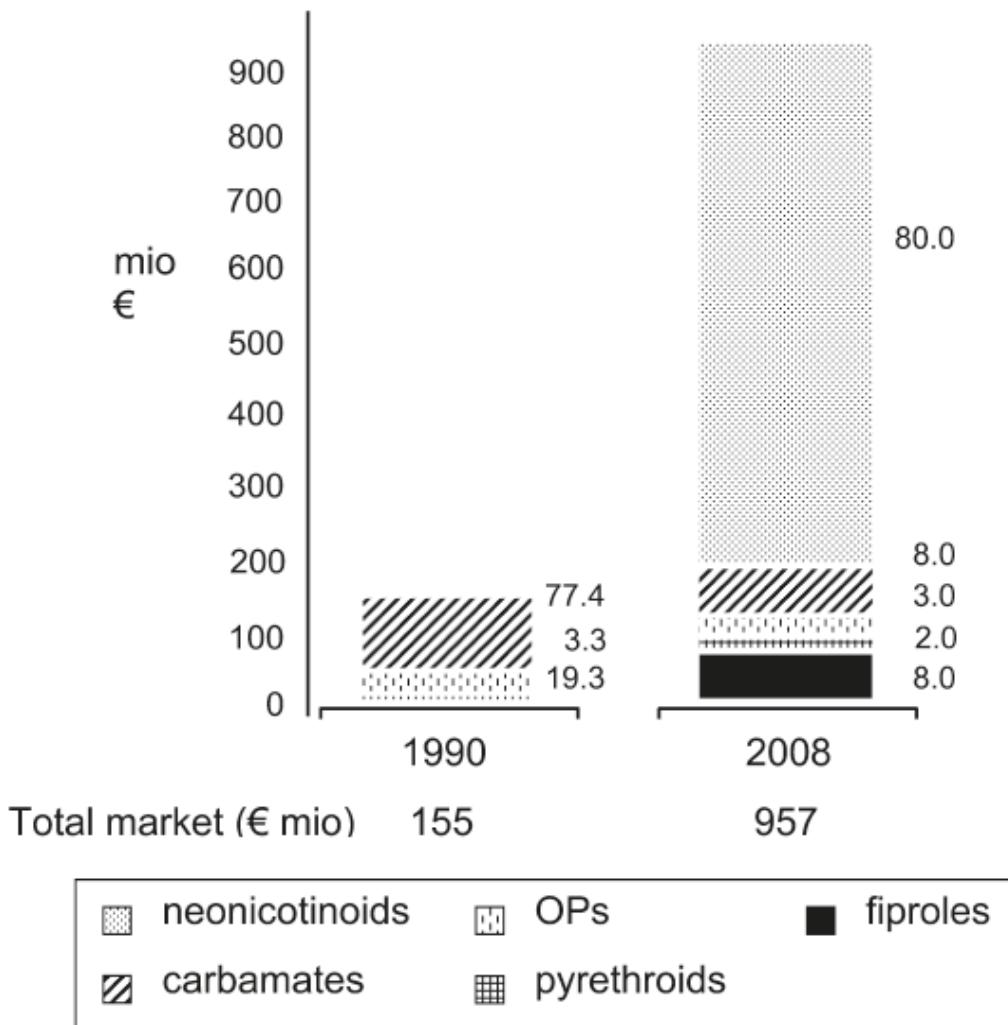


Figure 2. Development of insecticide classes in seed treatment, 1990–2008, expressed as percentage of total.

Jeschke et al., 2011
<http://dx.doi.org/10.1021/jf101303g>



TABLE 11.6 Top 10 Agrochemicals/Key Data

Brand	Active Ingredient	Company	Application	Sales 2008	
				\$ billion ^a	MT
Round-up	Glyphosate (I)	Monsanto	Herbicide	8.30	620,000
Admire, Gaucho	Imidacloprid (II)	Bayer CropScience.	Insecticide	1.28	5450
Heritage	Azoxystrobin (III)	Syngenta	Fungicide	1.16	7000
F 500	Pyraclostrobin (IV)	BASF	Herbicide	1.10	7200
Flagship	Thiemethoxam (V)	Syngenta	Insecticide	0.73	1895
Callisto	Mesotrione (VI)	Syngenta	Herbicide	0.62	2040
Gramoxone	Paraquat-dichloride (VII)	Syngenta	Herbicide	0.60	26,000
Flint	Trifloxystrobin (VIII)	Bayer CropScience.	Fungicide	0.60	3405
Horizon, Folicur	Tebuconazole (IX)	Bayer CropScience.	Fungicide	0.55	2860
Regent MG, Frontline	Fipronil (X)	BASF	Insecticide	0.53	1375

^a Ex-factory.

11–20: (Figures in \$ million/MT) clothienidin (509/546); chlorpyrifos (482/34,945); chlorothalonil (475/48,559); lambda-cyanhalothrin (454/1085); 2,4-D (453/64,725); prothioconazole (417/1550); mesosulfuron-methyl (414/530); kresoxym-methyl (409/3450); acetochlor (400/39,000); glufosinate-ammonium (399/3990).

Source: Cropnosis Ltd—Agranova.

<http://goo.gl/gLMNK>

Production and Market of Imidacloprid in China

"Imidacloprid, as the largest application amount of neonicotinoid insecticide in the world, is embracing a rapid development and becoming a hot spot in China. China records 13,620 tonnes of imidacloprid technical output in 2010, accounting for more than 50% of **world's total**, which is **20,000 tonnes.**" (*CCM International Ltd, March 2011*)

Source: http://www.researchandmarkets.com/reportinfo.asp?report_id=649028&t=d&cat_id=

- (compare to DDT peak-use of 80,000 tonnes in 1959 and remember that imidacloprid is 7297x more toxic to insects)



Bayer Cropscience Facts & Figures 2007

Top 10 Products 2007

Active Ingredient*	Major Brands	Application	Sales (€ million)
Imidacloprid	Confidor®, Admire®, Gaucho®, Merit®	Insecticide, Seed Treatment, Environmental Science	556
Trifloxystrobin	Flint®, Stratego®, Sphere®	Fungicide	243
Glufosinate	Basta®, Liberty®	Herbicide	241
Clothianidin	Poncho®	Seed Treatment	237
Tebuconazole	Folicur®, Raxil®	Fungicide, Seed Treatment	235
Mesosulfuron-methyl	Atlantis®	Herbicide	207
Fenoxaprop-P-ethyl	Puma®	Herbicide	187
Deltamethrin	Decis®, K-Othrine®	Insecticide, Environmental Science	178
Prothioconazole	Proline®	Fungicide	175
Ethofumesate/PMP/DMP	Betanal®	Herbicide	127

Bayer CropScience sales figures world wide

	total sales all products MEuro	sales top 10 products MEuro	Imidacloprid MEuro	Clothianidine MEuro
2003	5764		? (<90)	
2004	5946	2320	603	
2005	5896	2201	440	110
2006	5700	2189	564	127
2007	5826	2386	556	237
2008	6382	2664	599	223
2009	6510	2703	606	183
2010	6830	2650	597	192

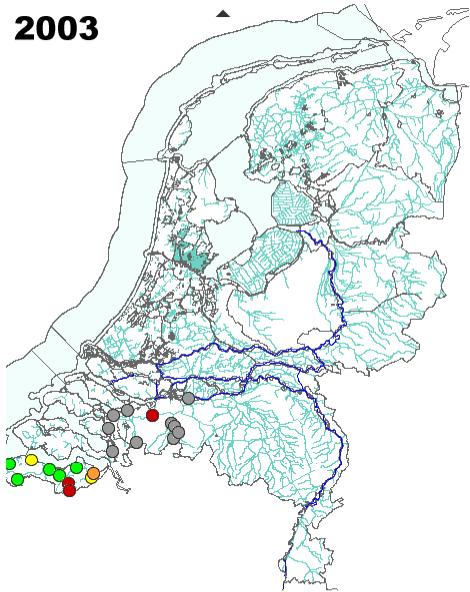


+ Bayer Healthcare!

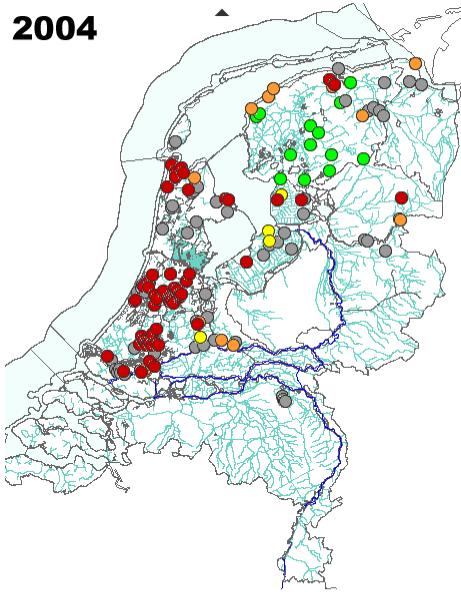
- Advantage© (imidacloprid) Fleas (on pets) and flies on cattle and in stables
- 2010: 408 MEuro sales of Advantage
- What is the environmental fate of this imidacloprid?
- Can bees get exposed??



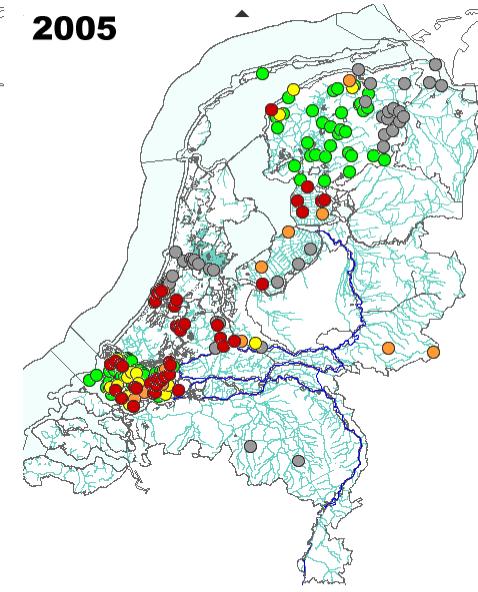
2003



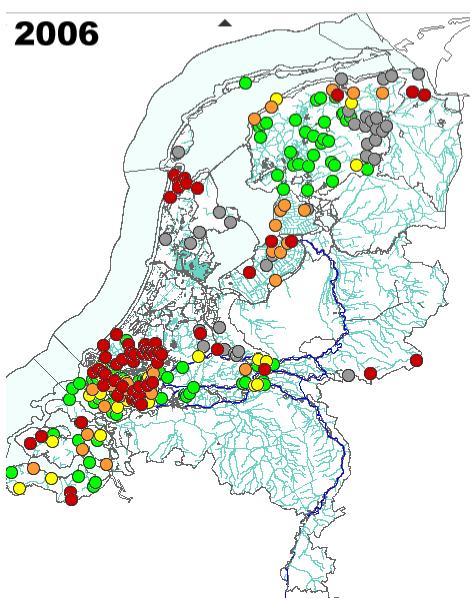
2004



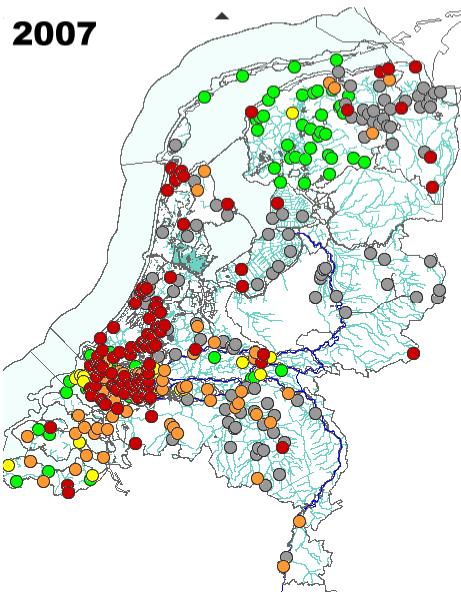
2005



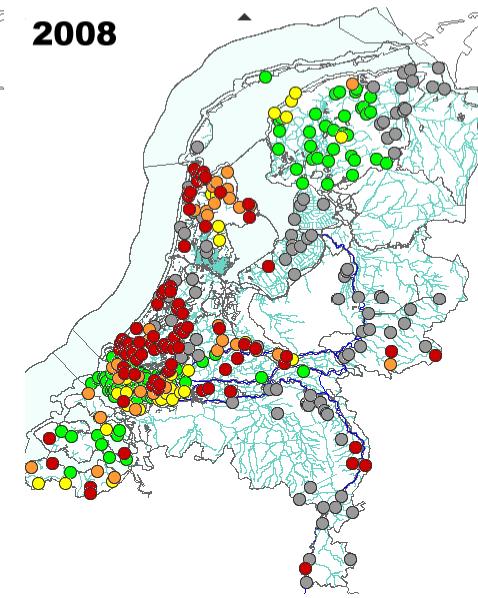
2006



2007



2008



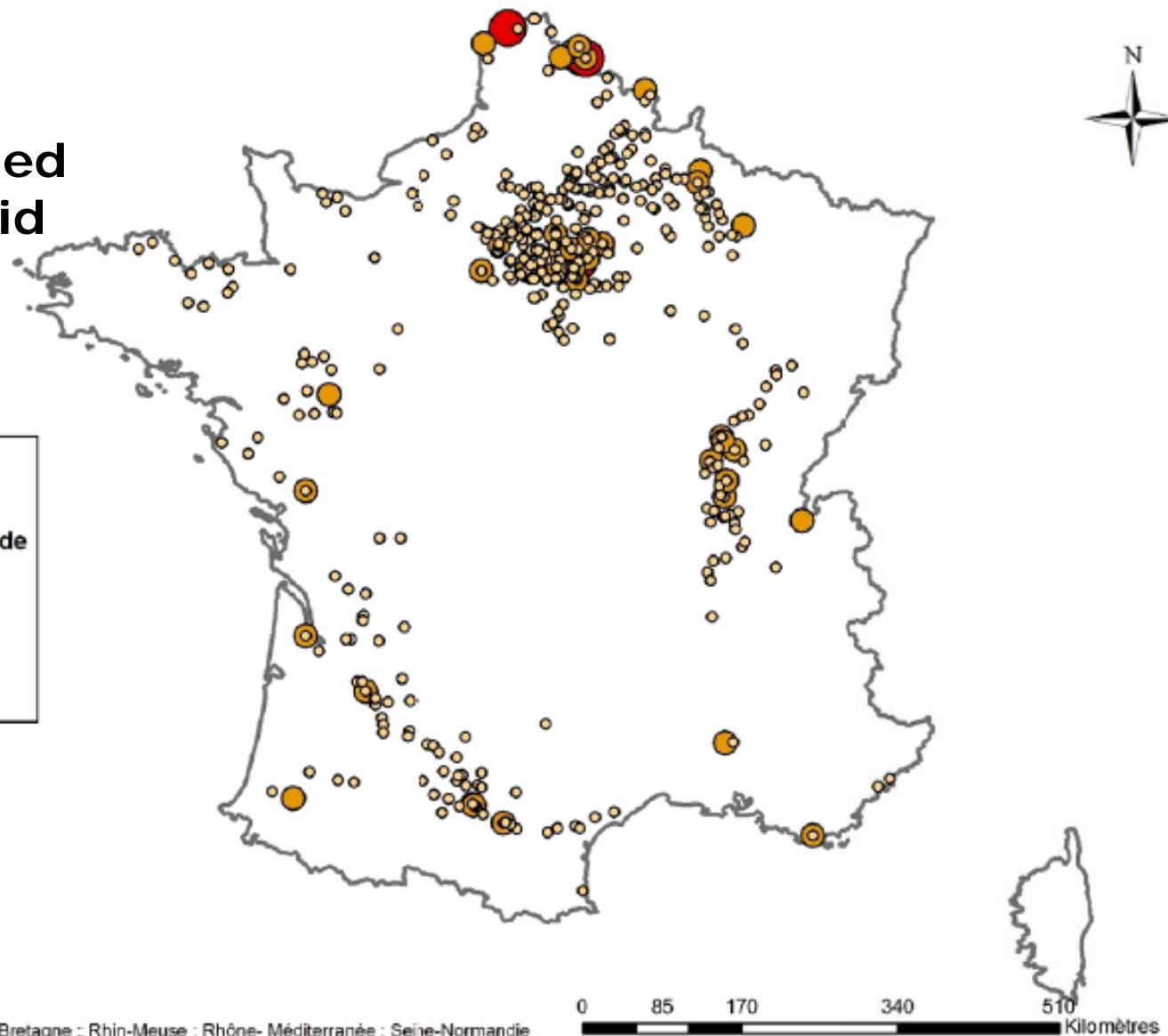
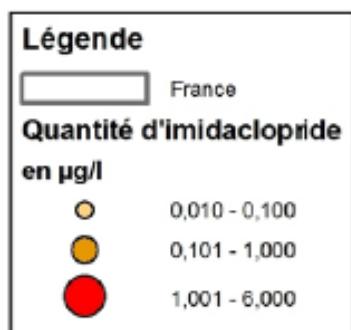
Since 2004,
Netherlands
surface
water is
heavily
polluted with
Imidacloprid

- > Target value, <= MTR
- < detection limit
- > MTR
- >2x MTR
- >5x MTR

Imidacloprid in Dutch surface water 2003-2008
Exceedances of the Maximum Tolerable Risk standard
MTR = 13 nanogram / liter

Imidaclopride. Contamination des cours d'eau quantifiée selon des seuils variés
Données brutes 2007 - 2010.

In France the surface water is heavily polluted with imidacloprid



Système d'Information sur l'Eau :
Bassins Adour-Garonne ; Artois-Picardie ; Loire-Bretagne ; Rhin-Meuse ; Rhône- Méditerranée ; Seine-Normandie

0 85 170 340 510 Kilomètres



Metabolites!

Imidacloprid metabolites:

- Olefin metabolite 2x more toxic to bees
- 6-Chloronicotinic acid highly toxic to bees



Effects on honeybees

- Acute intoxication
- Chronic intoxication
- Sublethal effects
- Synergy effects



Complexity of a colony

- Specialisation in the hive
- Bees with different roles in the hive have different diets
- Bees in different life stages have different diet
- Bees with different roles have different critical sensitivities to different sub-lethal effects
- Etc.



What are exposure pathways?

- Treated crops
 - Contact
 - Pollen (delayed consumption!, Bee bread etc.)
 - Nectar (delayed consumption!, honey)
 - Extrafloral nectar
 - Honey-dew (from aphids)
 - Guttation (waterdrops origination from inside the plant)
 - Dew/rain (waterdrops from the atmosphere)
 - Sweet remains of e.g. sugarbeets, etc.
- Systemic uptake by untreated wild plants and trees on same soil
- Systemic uptake of contaminated water by wild plants and trees
- Spray drift / dust drift to flowering fields
- Direct contact with dust (flying through the dust cloud)
- Foraging on polluted surface water (for drinking and COOLING!)
- Residues in sugar used for sugar syrup supplementary feeding
- Residues in water used by beekeepers to make sugar syrup (violation of drinkingwater norm in NL > 100 ng/liter)
- Can it travel trough the air? On PM2.5? On diessel soot/black carbon? On airosol-water?
- Brabant, NL scandal 2011: Waste-sand from treated Lilly bulbs used for trails in protected nature area
- Etc.....





Krupke e.a. 2012 studie



Table 6. Pesticide concentrations found in unplanted fields near apiary during planting period in 2011, all concentrations shown are expressed as parts per billion.¹

SAMPLE TYPE	Sample wt. (g)	THIAMETHOXAM LOD = 1.0	CLOTHIANIDIN LOD = 1.0	METOLACHLOR LOD = 0.5	ATRAZINE LOD = 0.2	AZOXYSTROBIN LOD = 0.2	COUMAPHOS LOD = 1.0
Soil, unplanted field 1, Soybeans 2010 (2 samples)	5.15, 5.01	ND	6.0±0.3	1014±14	771±170	0.2±0.1	ND
Soil, unplanted field 2, Soybeans 2010 (2 samples)	5.28, 5.43	ND	8.9±0.1	8.3±0.7	160±15	26±17	ND
Dandelions near maize field	2.96	ND	1.4	49	677	ND	ND
Dandelions near maize field	3.81	1.6	5.9	64	1133	ND	ND
Dandelions near maize field	4.51	1.3	3.1	28	522	ND	ND
Dandelions near maize field	4.05	2.9	1.1	60	269	ND	ND
Dandelions near maize field	3.10	1.1	1.6	5.7	125	ND	ND
Dandelions near maize field	3.44	ND	9.4	295	1004	ND	ND
Dandelion, CAES (non-agricultural area)	3.93	ND	ND	ND	0.3	ND	ND

When two aliquots of the same sample were analyzed the results are expressed as ± the standard deviation of the two analyses.

¹ND = Not detected.

doi:10.1371/journal.pone.0029268.t006

Krupke e.a. 2012. Multiple Routes of Pesticide Exposure for Honey Bees Living Near Agricultural Fields. <http://dx.doi.org/10.1371/journal.pone.0029268>



Krupke e.a. 2012 studie

Table 5. Pesticide concentrations found in/near apiary colonies during planting period in 2011, all concentrations shown are expressed as parts per billion.¹

SAMPLE TYPE	Sample wt. (g)	THIAMETHOXAM LOD = 0.5	CLOTHIANIDIN LOD = 1.0	METOLACHLOR LOD = 2.0	ATRAZINE LOD = 0.5	AZOXYSTROBIN LOD = 0.5	COUMAPHOS LOD = 1.0
Dead/dying bees	2.96	ND	6.9	3.0	6.5	ND	ND
Dead/dying bees	2.47	ND	10.8	1.7	3.9	ND	ND
Dead/dying bees	1.32	ND	3.8	5.5	9.5	ND	ND
Dead/dying bees	2.57	ND	4.9	0.8	4.6	ND	ND
Dead/dying bees	1.62	ND	13.3	1.1	3.9	ND	ND
Healthy bees	0.59	ND	ND	ND	5.9	ND	ND
Nectar hive 1 (healthy)	5.78	ND	ND	ND	0.5	0.6	1.1
Nectar hive 2 (sick)	5.72	ND	ND	ND	ND	0.3	4.7
Pollen hive 1 (healthy, 2 samples)	5.05	6.2±4.9	2.9±1.3	28.5±3.5	16±1.4	28.5±3.5	1.3±0.4
Pollen hive 2 (sick, 2 samples)	5.08	20.4±2.7	10.7±2.3	81.5±0.7	36.5±3.5	0.8±0.3	2.7±0.3

When two aliquots of the same sample were analyzed the results are expressed as \pm the standard deviation of the two analyses.

¹ND = Not detected.

doi:10.1371/journal.pone.0029268.t005

Krupke e.a. 2012. Multiple Routes of Pesticide Exposure for Honey Bees Living Near Agricultural Fields. <http://dx.doi.org/10.1371/journal.pone.0029268>



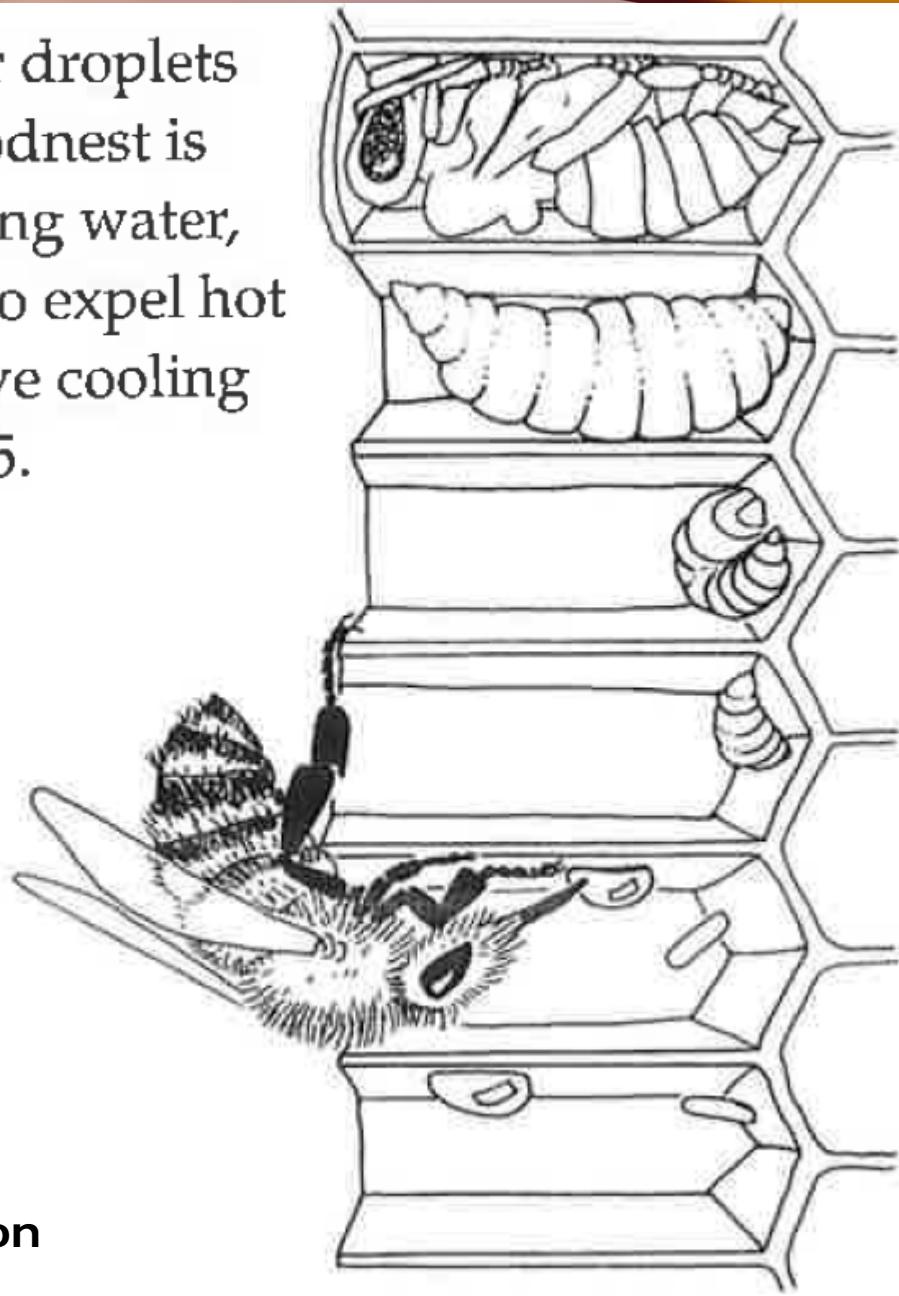
Bee drinking guttation drop

They do
drink it!
Collect

(for drinking,
cooling and preparing
food for the brood)



Figure 9.1 The spreading of water droplets by nurse bees when a colony's broodnest is threatened by overheating. Spreading water, combined with fanning the wings to expel hot air from the hive, causes evaporative cooling of the brood combs. After Park 1925.



**T. Seeley
The wisdom of the hive
Chapter 9 regulation of water collection**

Chronic toxicity imidacloprid for bumblebees

- For imidacloprid at 200, 20, 2 and 0.2 ppm, 100% mortality was observed in the nests and this was after a few hours, 14, 28 and 49 days, respectively. In contrast, at 20 and 10 ppb worker mortality was much lower with 15% and 0%, respectively.
- Probit analyses of the data resulted in a LC50 value for imidacloprid of 59 ppb (95% CI: 52–68 ppb; $R^2 = 0.99$) which corresponds to 1/3390 of the maximum field recommended concentration (MFRC)“

Mommaerts et al., 2009

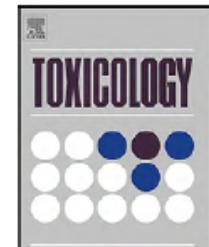
<http://dx.doi.org/10.1007/s10646-009-0406-2>





Contents lists available at ScienceDirect

Toxicology

journal homepage: www.elsevier.com/locate/toxcol

News and views

The significance of the Druckrey–Küpfmüller equation for risk assessment—The toxicity of neonicotinoid insecticides to arthropods is reinforced by exposure time

2010

Henk A. Tennekes*

http://www.boerenlandvogels.nl/sites/default/files/Tennekes_2010_Toxicology_17.pdf

Environmental & Analytical
Toxicology

Tennekes and Sánchez-Bayo, J Environment Analytic Toxicol 2011, S:4
<http://dx.doi.org/10.4172/2161-0525.S4-001>

Review Article

Open Access

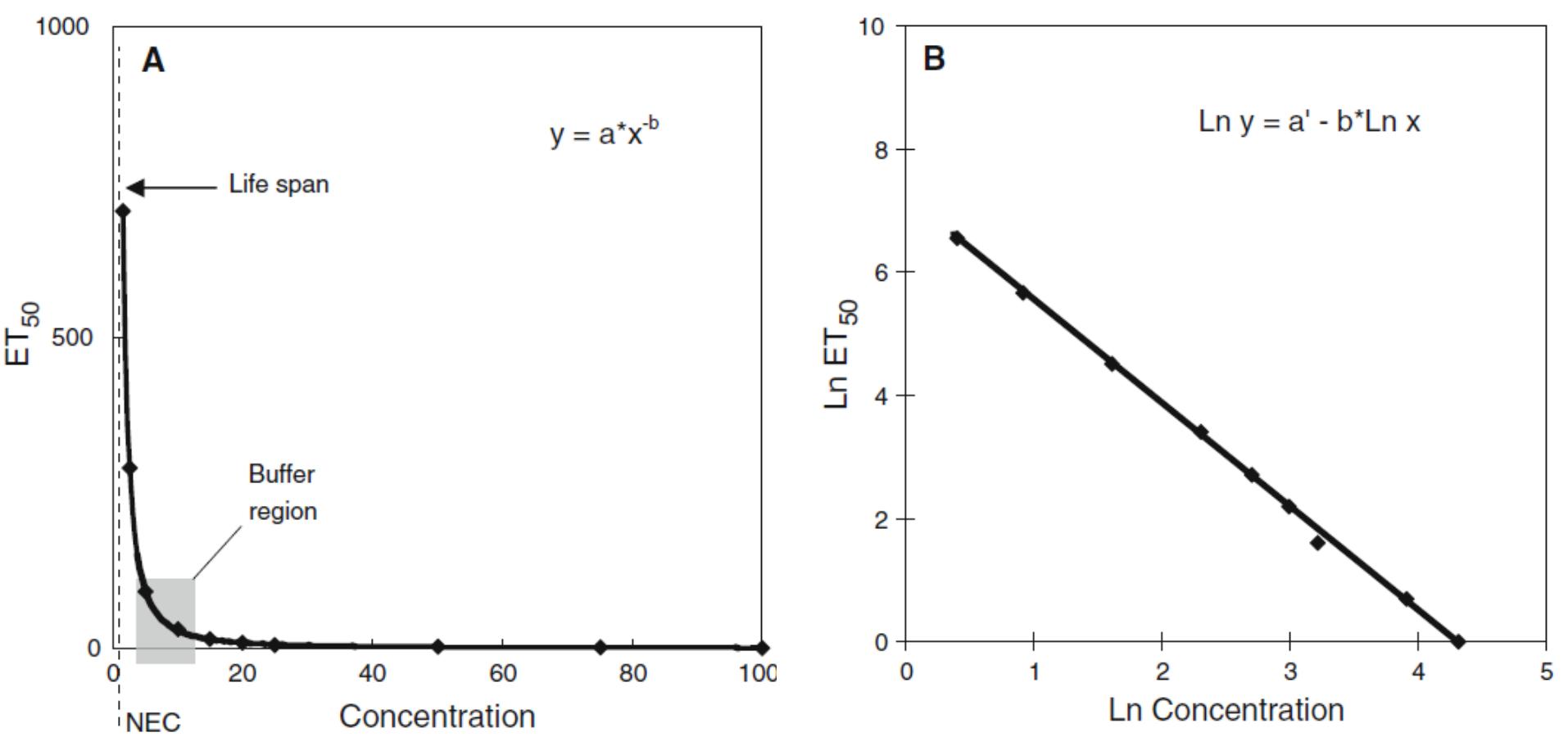
Time-Dependent Toxicity of Neonicotinoids and Other Toxicants:
Implications for a New Approach to Risk Assessment

2011

Henk A. Tennekes* and Francisco Sánchez-Bayo

http://www.boerenlandvogels.nl/sites/default/files/Tennekes_Sánchez-Bayo_JEAT_2011_Review%20Article_7.pdf

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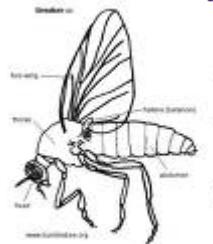
Relationship between neonicotinoid concentration and time to 50% effect (ET₅₀) in the organisms exposed follows a hyperbolic curve asymptotic on the y axis; in reality, this asymptote is determined by the no-effect concentration (NEC), while the upper limit of the curve is determined by the life span of the organism. (Sanchez-Bayo, 2009)

<http://dx.doi.org/10.1080/03601230701229239>

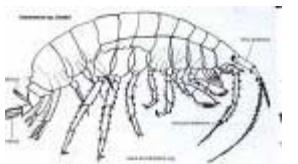




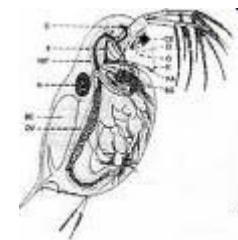
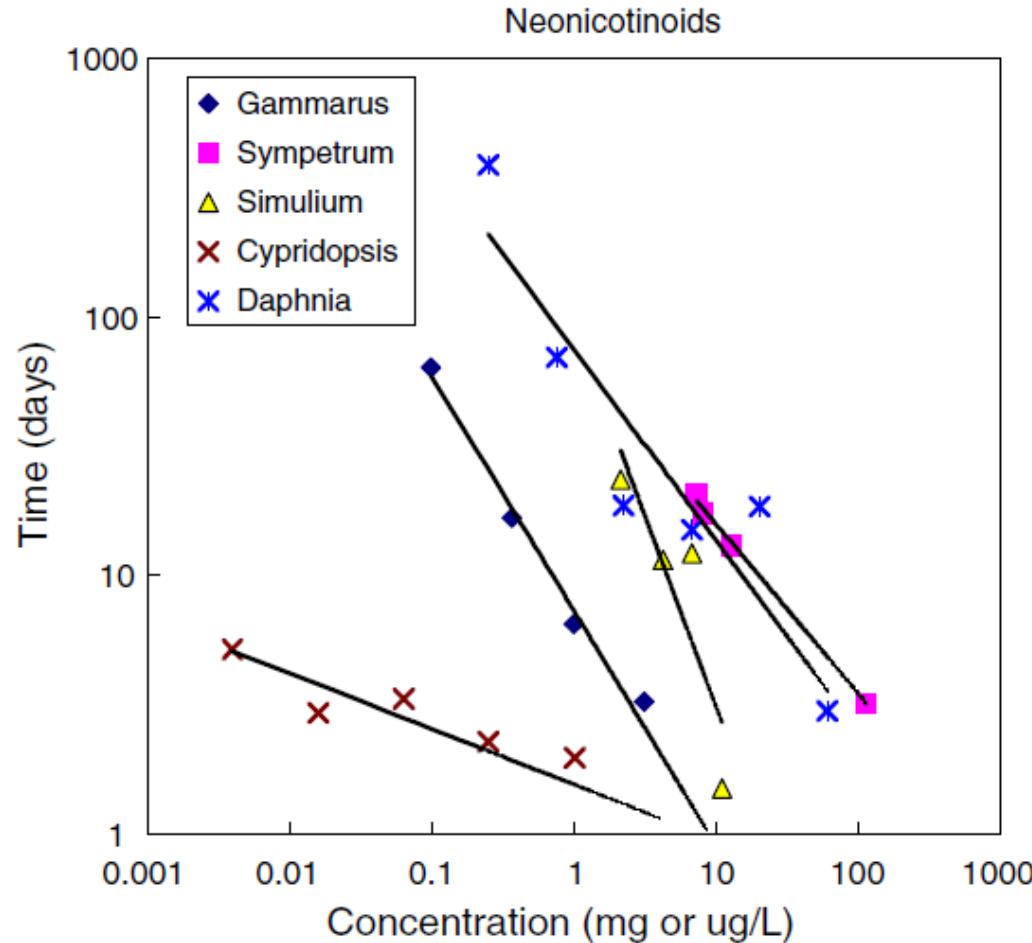
Symptetrum



Simulium



Gammarus



Daphnia



Cypridopsis

Time to 50% mortality for several arthropod species imidacloprid (Cypridopsis vidua and Daphnia magna) and thiacloprid (other species). Concentrations for Symptetrum and Simulium species are in $\mu\text{g/l}$; for all other species in mg/l .

<http://dx.doi.org/10.1080/03601230701229239>



Sublethal effects

- Foraging behaviour / navigation
- Task differentiation in the hive
- Grooming
- Immune system
- Brood
- Larval development
- etc/.



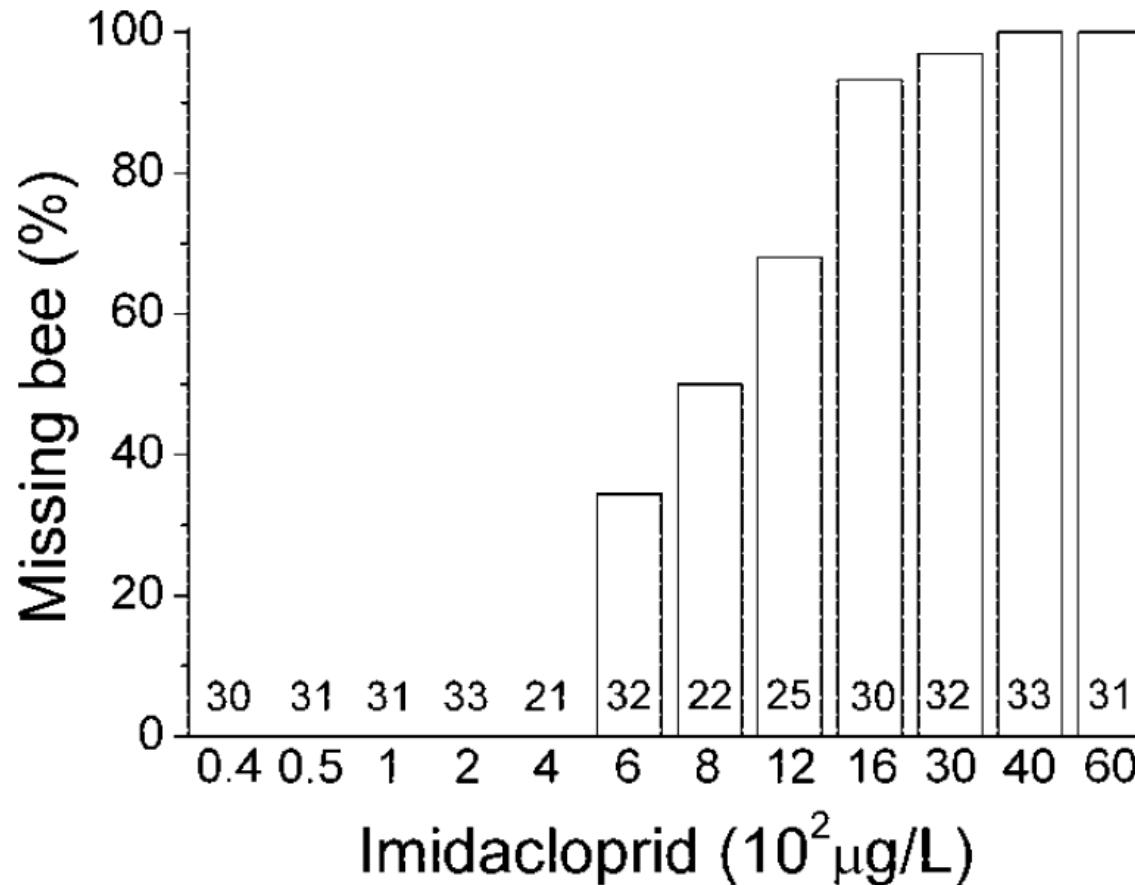
Sublethal effects imidacloprid

Reflex of proboscis extension	0.1 – 0.4 ng/bee
Frequentation of the feeding source	0.075-0,21 ng/bee
Recognition of the related honeybees	0.25-0.7 ng/bee
Knockdown effect & locomotion coordination	0.0022 ng/bee
Precision of angle appreciation	0.5-1.4 ng/bee
Trembling dances	
Wagging dances	
Precision of distance appreciation	2.5-7 ng/bee

CTS 2003,

<http://nws.chem.uu.nl/research/risk/bijensterfte/rapportfin%201.pdf>





The ratio of missing bees after feeding on 50% sugar water containing different concentrations of imidacloprid. The number on each bar indicates the number of bees treated for each testing concentration. (Yang et al., 2008)

<http://www.bioone.org/doi/full/10.1603/0022-0493-101.6.1743>

Exposure to Sublethal Doses of Fipronil and Thiacloprid Highly Increases Mortality of Honeybees Previously Infected by *Nosema ceranae*

Cyril Vidau^{1,2}, Marie Diogon^{1,2}, Julie Aufauvre^{1,2}, Régis Fontbonne^{1,2}, Bernard Viguès^{1,2}, Jean-Luc Brunet³, Catherine Texier², David G. Biron^{1,2}, Nicolas Blot^{1,2}, Hicham El Alaoui^{1,2}, Luc P. Belzunces³, Frédéric Delbac^{1,2*}

Conclusions/Significance: After exposure to sublethal doses of fipronil or thiacloprid a higher mortality was observed in *N. ceranae*-infected honeybees than in uninfected ones. The synergistic effect of *N. ceranae* and insecticide on honeybee mortality, however, did not appear strongly linked to a decrease of the insect detoxification system. These data support the hypothesis that the combination of the increasing prevalence of *N. ceranae* with high pesticide content in beehives may contribute to colony depopulation.

Plos One, 2011 <http://dx.doi.org/10.1371/journal.pone.0021550>

Interactions between *Nosema* microspores and a neonicotinoid weaken honeybees (*Apis mellifera*)

insecticide on honeybee health. We demonstrated that the interaction between the microsporidia *Nosema* and a neonicotinoid (imidacloprid) significantly weakened honeybees. In the short term, the

Cédric Alaix,^{1*} Jean-Luc Brunet,² Claudia Dussaubat,¹ Fanny Mondet,² Sylvie Tchamitchan,² Marianne Cousin,² Julien Brillard,³ Aurelie Baldy,¹ Luc P. Belzunces² and Yves Le Conte¹

Environmental Microbiology, 2009 <http://dx.doi.org/10.1111/j.1462-2920.2009.02123.x>



Pesticide exposure in honey bees results in increased levels of the gut pathogen *Nosema*

Jeffery S. Pettis · Dennis vanEngelsdorp ·

Josephine Johnson · Galen Dively

- We exposed honey bee colonies during three brood generations to sub-lethal doses of ... imidacloprid, and then subsequently challenged newly emerged bees with the gut parasite, *Nosema* spp.
- The pesticide dosages used were below levels demonstrated to cause effects on longevity or foraging in adult honey bees.
- *Nosema* infections increased significantly in the bees from pesticide-treated hives when compared to bees from control hives demonstrating an indirect effect of pesticides on pathogen growth in honey bees.

<http://dx.doi.org/10.1007/s00114-011-0881-1>



Advertisement “NEW - Premise 200SC”

What is Premise 200SC plus Nature?

- Low doses of Premise 200SC, such as the edge of the Treated Zone, disoriented the termites and cause them to cease their natural grooming behaviour. Grooming is important for termites to protect them against pathogenic soil fungi. When termites stop grooming, the naturally occurring fungi in the soil attack and kill the termites. Premise 200SC makes fungi 10,000 times more dangerous to termites. Nature assists Premise in giving unsurpassed control. This control is called Premise 200SC plus Nature.
- Premise 200SC containing the active ingredient imidacloprid, belong to new chloronicotinyl group of chemicals.”

http://www.elitepest.com.sg/brochure/Premise_200SC.pdf



Synergism of imidacloprid and entomopathogenic nematodes against white grubs: the mechanism

- The major factor responsible for synergistic interactions between imidacloprid and entomopathogenic nematodes appears to be the general disruption of normal nerve function due to imidacloprid resulting in drastically reduced activity of the grubs. This sluggishness facilitates host attachment of infective juvenile nematodes.
- Grooming and evasive behavior in response to nematode attack was also reduced in imidacloprid-treated grubs.



Koppenhöfer e.a. (2000) Synergism of imidacloprid and entomopathogenic nematodes against white grubs: the mechanism

- Brushing (legs or mouth parts swept across body) and chewing occurred significantly more often in grubs not treated with imidacloprid in the presence of nematodes and this response was reduced by 42–70% after imidacloprid treatment.

Entomologia Experimentalis et Applicata 94: 283–293, 2000.



Is the future of bees in the hands of the pesticide lobby?

European Commission allows
corporations to shape the pesticide rules.



Corporate Europe Observatory and the European Beekeeping Coordination
November 2010



- Sterke invloed agro-chemische industrie op toelatingsprotocollen
- Slager keurt eigen vlees & ontwerpt keuringsprotocol!
- Samenstelling ICPBR werkgroep protocol invloed landbouwgif op bijenbroed:
1x Bayer,
1x BASF,
1x industrie-consultant,
3x toelatingsautoriteit

**Veel onderzoek bijensterfte
gefinancierd door Bayer**



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Een greep uit het repertoire

- Eenzijdig financieren van welgevallige vraagstellingen;
- Belangrijke aspecten buiten de vraagstelling houden;
- Aannames maken en deze retorisch ipv feitelijk onderbouwen;
- Opzettelijk foutieve proefopzet kiezen om gewenst resultaat te krijgen;
- Opzettelijk verkeerd toepassen van statistiek;
- Wegmoffelen onzekerheden;
- Ongeoorloofde generalisatie;
- Weglaten van ongewenste uitkomsten, negeren onwelkome kennis;
- Verbod op openbaarmaking uitkomsten of langdurig embargo (IPR);
- Vervalsen gegevens literatuuronderzoek, waarneming of experiment;
- Bewust verkeerd of tendentieus weergeven van onderzoek van anderen;
- Onderzoeksgegevens uit de duim zuigen/fraude;
- Opzettelijk onjuiste conclusies trekken / stelliger dan gerechtvaardigd;
- In de hand werken van onjuiste interpretaties door de media;
- Het onheus bejegenen van collega's om onderzoek te beïnvloeden;
- Veinzen van expertise (acquisitie, media, hoorzittingen 2e kamer);
- Spindoctor technieken inzetten tegen onwelgevallige kennis;
- Gohst writing;
- Pal review (vriendjespolitiek);



Klakkeloos gebruik van opmerkelijke veldproeven

Herbeoordeling neonicotinoïden houdende bestrijdingsmiddelen 29 juni 2011 Ctgb p.44:

- "In a field study, Cutler and Scott-Dupree (2007) found no effects on brood and colony development (including overwintering) after foraging on treated oilseed rape (residue levels up to 2.59 ppb, in pollen)."
- Veldstudies wegen zwaarder dan labstudies in toelatingskader!

<http://goo.gl/arZDG>



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Veldproef Cutler & Scott-Dupree, 2007:
Exposure to Clothianidin seed treated canola has no long-term
impact on honey bees. J. Econ. Entomol 100, 765-772 [[ref](#)]

ABSTRACT We conducted a long-term investigation to ascertain effects on honey bee, *Apis mellifera* L., colonies during and after exposure to flowering canola, *Brassica napus* variety Hyola 420, grown from clothianidin-treated seed. Colonies were placed in the middle of 1-ha clothianidin seed-treated or control canola fields for 3 wk during bloom, and thereafter they were moved to a fall apiary. There were four treated and four control fields, and four colonies per field, giving 32 colonies total. Bee mortality, worker longevity, and brood development were regularly assessed in each colony for 130 d from initial exposure to canola. Samples of honey, beeswax, pollen, and nectar were regularly collected for 130 d, and the samples were analyzed for clothianidin residues by using high-performance liquid chromatography with tandem mass spectrometry detection. Overall, no differences in bee mortality, worker longevity, or brood development occurred between control and treatment groups throughout the study. Weight gains of and honey yields from colonies in treated fields were not significantly different from those in control fields. Although clothianidin residues were detected in honey, nectar, and pollen from colonies in clothianidin-treated fields, maximum concentrations detected were 8- to 22-fold below the reported no observable adverse effects concentration. Clothianidin residues were not detected in any beeswax sample. Assessment of overwintered colonies in spring found no differences in those originally exposed to treated or control canola. The results show that honey bee colonies will, in the long-term, be unaffected by exposure to clothianidin seed-treated canola.



Veldproef opmerkelijk opgezet!

- Afstand case en control 295 meter; volk (40000 bijen) foerageert in straal van 3km! (2800 ha)
- Blootstelling 3 weken, bijen fourageren 25 weken voor wintervoorraad
- $1/2800 \times 3/25 \times 100\% = 0,004\%$ van de wintervoorraad kwam van proefveld
- Koolzaadstuifmeel gevonden in controle groep: case en control aten van elkaars veld
- Hidden sponsor: Bayer US\$ 134367 [[ref](#)]
- In 2010 diskwalificeerde US-EPA deze studie [[ref](#)]
- Zomer 2011 baseerde Ctgb in NL zich klakkeloos op deze studie [p44 [ref](#)]
- Ctgb wordt gefinancierd door agrochemische industrie [[ref](#)]



Problems with field studies

- Some field studies have $n=1$ (Schmuck 2001)
- Many flaws in experimental set-up of field studies used for authorization
- Many field studies turned out to have a hidden sponsor: Bayer Cropscience
- Example: Cutler and Dupree 2007 study
- In authorization protocols field studies (even flawed ones and $n=1$ ones) get more weight than lab studies, but from a scientific point of view lab studies are more reliable!



Imidacloprid use Netherlands

Year	Imidacloprid Use in kg	Imidacloprid Surface of area where it is applied (Ha)
1995	668	5335
1998	4047	22631
2000	5968	33660
2004	7074	44223
2008	7386	48415

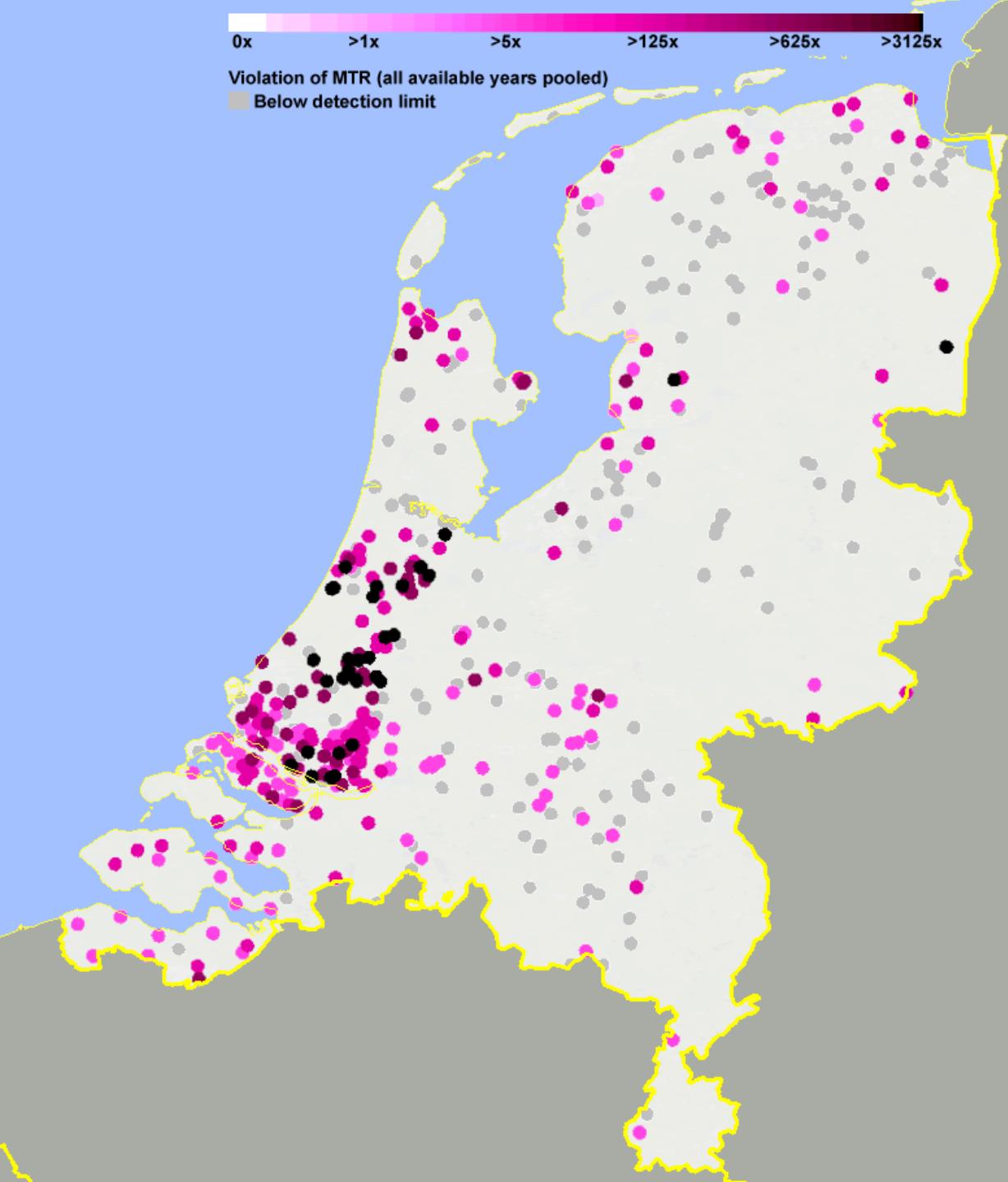
<http://www.statline.nl>



Normoverschrijdingen 2005-2009

Jaar	Percentage monsters boven MTR ($\geq 13 \text{ ng/l}$)	Percentage monsters boven KRW ($\geq 67 \text{ ng/l}$)	Percentage monsters boven drinkwater-norm ($\geq 100 \text{ ng/l}$)	Percentage monsters boven Ctgb "sloot-norm" ($\geq 1470 \text{ ng/l}$)	Hoogst gemeten waarde (ng/liter)	Mediaan (ng/l)
2005	39% ($n=505$)	13% ($n=898$)	11% ($n=901$)	2.6% ($n=917$)	320000	180
2006	43% ($n=811$)	20% ($n=1073$)	17% ($n=1074$)	1.8% ($n=1090$)	38000	80
2007	54% ($n=1031$)	17% ($n=1839$)	14% ($n=1842$)	1.6% ($n=1876$)	54000	90
2008	48% ($n=1224$)	19% ($n=1932$)	17% ($n=1983$)	1.9% ($n=2053$)	94000	70
2009	39% ($n=1529$)	15% ($n=2072$)	12% ($n=2074$)	1.4% ($n=2133$)	12000	60





Extreme violations of MTR imidacloprid

MTR=13 ng/l

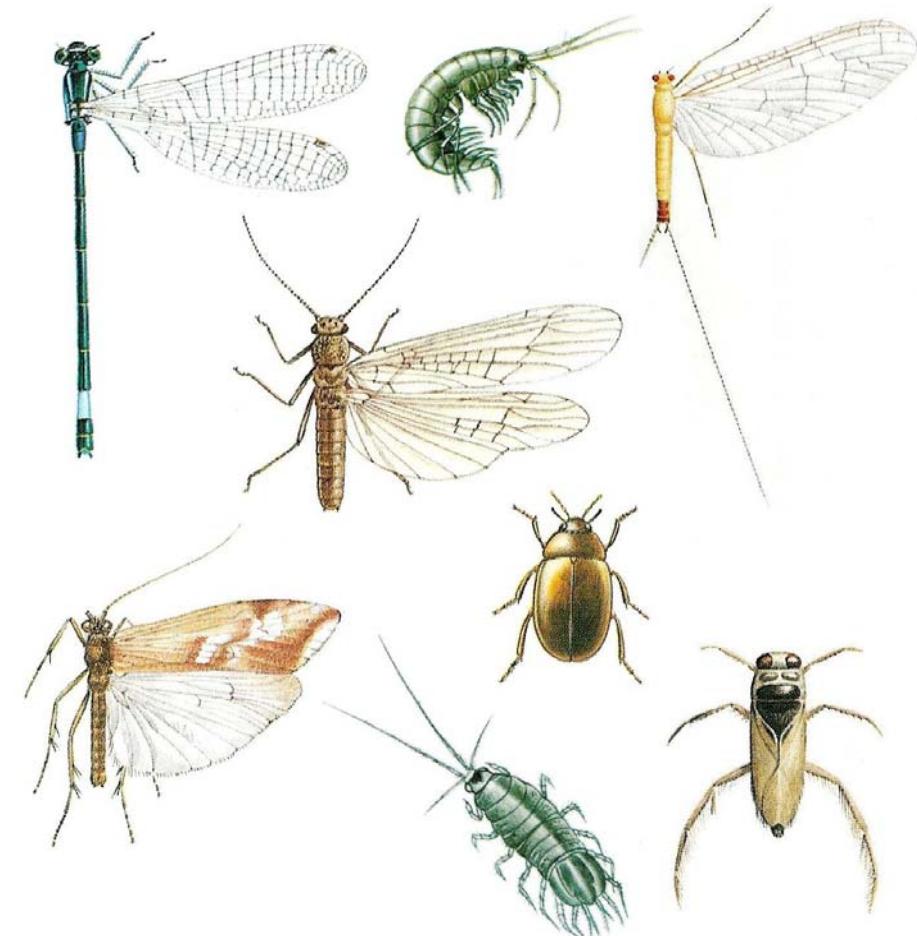
Nr 1 in top 10 of most problematic pesticides in NL surface water



All imidacloprid surface water measurements 1998 & 2003-2007

MTR	Imidacloprid concentration (ng/l)	<i>Above detection limit</i>	<i>Below detection limit</i>			
			n	n	n	n
0-1x	0 - 13	120	1,204	2,022	161	
1-5x	13 - 65	507				
5-25x	65 -325	501				
25-125x	325 -1625	252				
125-625x	1625-8125	55				
625-3125x	8125 -40625	20				
3125-15625x	40625-203125	6				
>15625x	>203125	4				
	Total n	1465		3387		

Limnodata Nerlandica



Sensitive species (low LD50)

- **Diptera (true flies)**
- **Ephemeroptera (mayflies)**
- **Plecoptera (stoneflies)**
- **Trichoptera (caddisflies)**

also selected for analysis:

- **Hydracarina (water mites)**
- **Coleoptera (beetles)**
- **Heteroptera (bugs)**
- **Amphipoda (crustaceans)**
- **Isopoda (crustaceans)**
- **Odonata (dragonflies and damselflies).**

<http://www.limnodata.nl>



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**Positions of 579 imidacloprid
measurement locations**

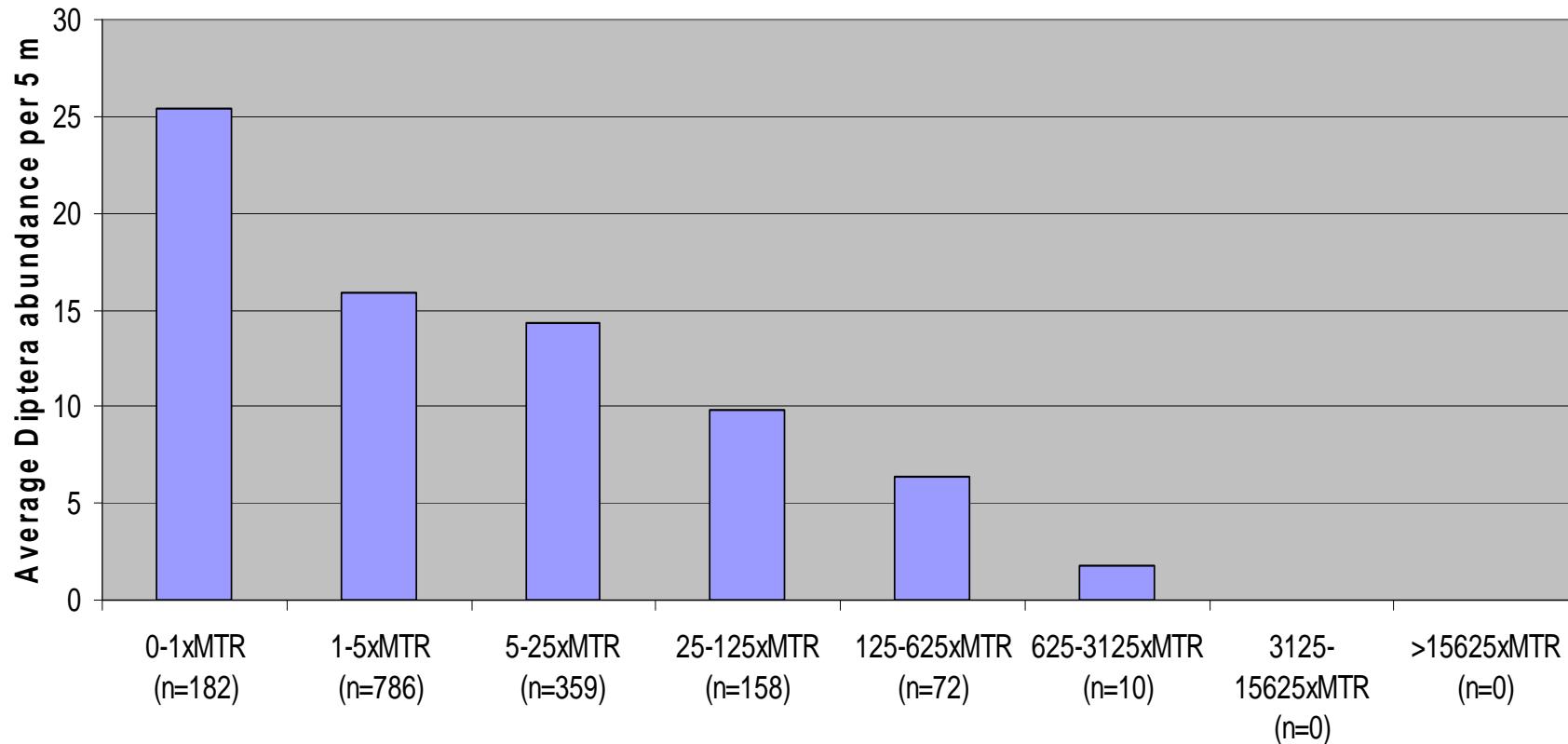


**Positions of 4479 Limno Diptera
measurement locations**



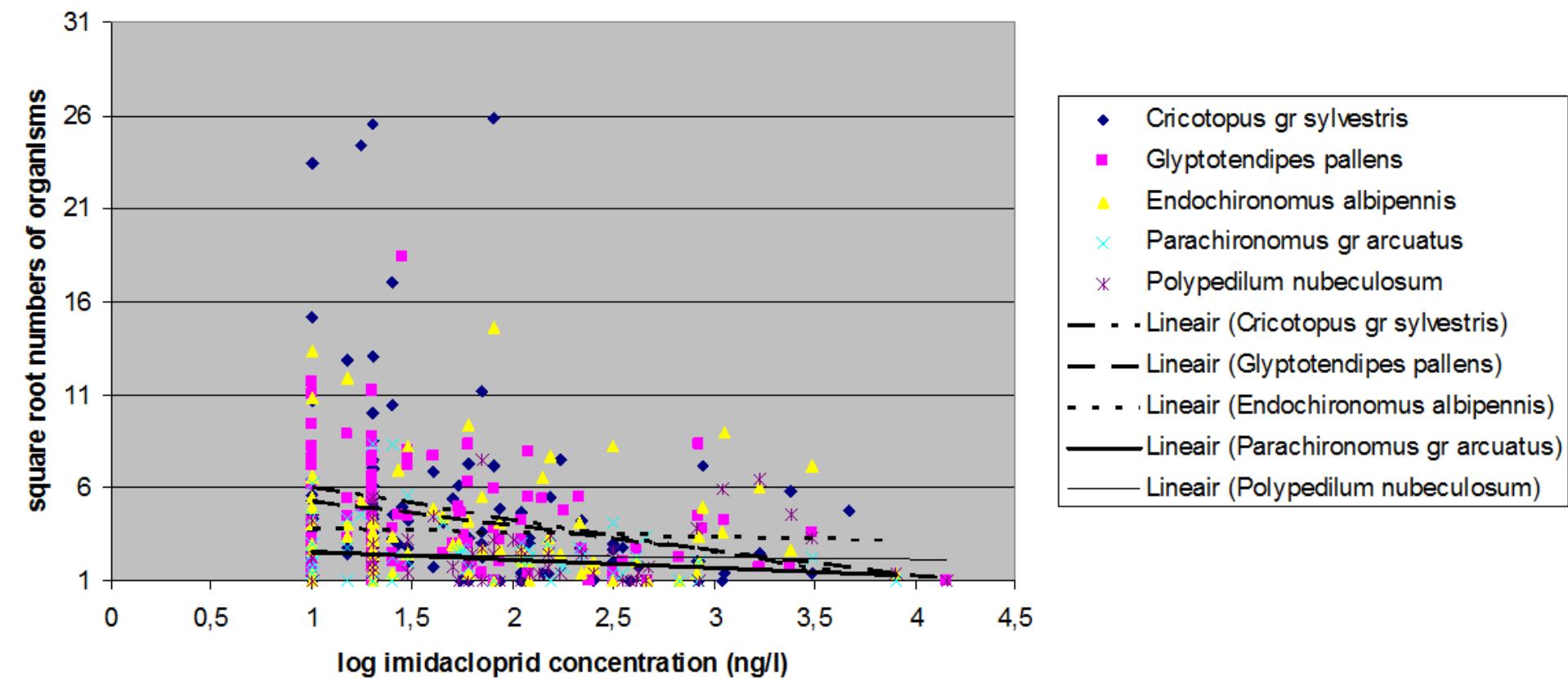
High levels of measured imidacloprid in Dutch surface water correlate strongly with low insect abundance, especially for flying insects

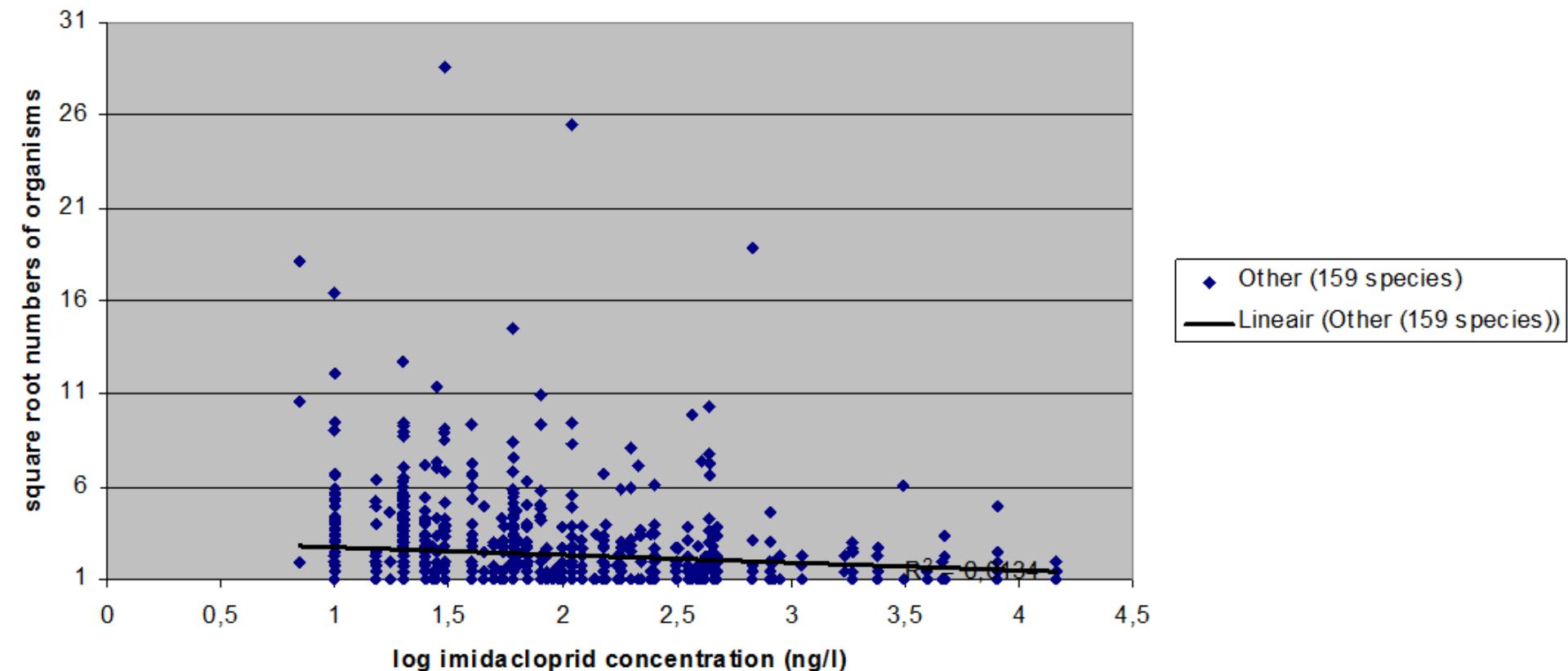
Diptera abundance versus nearby imidacloprid concentrations



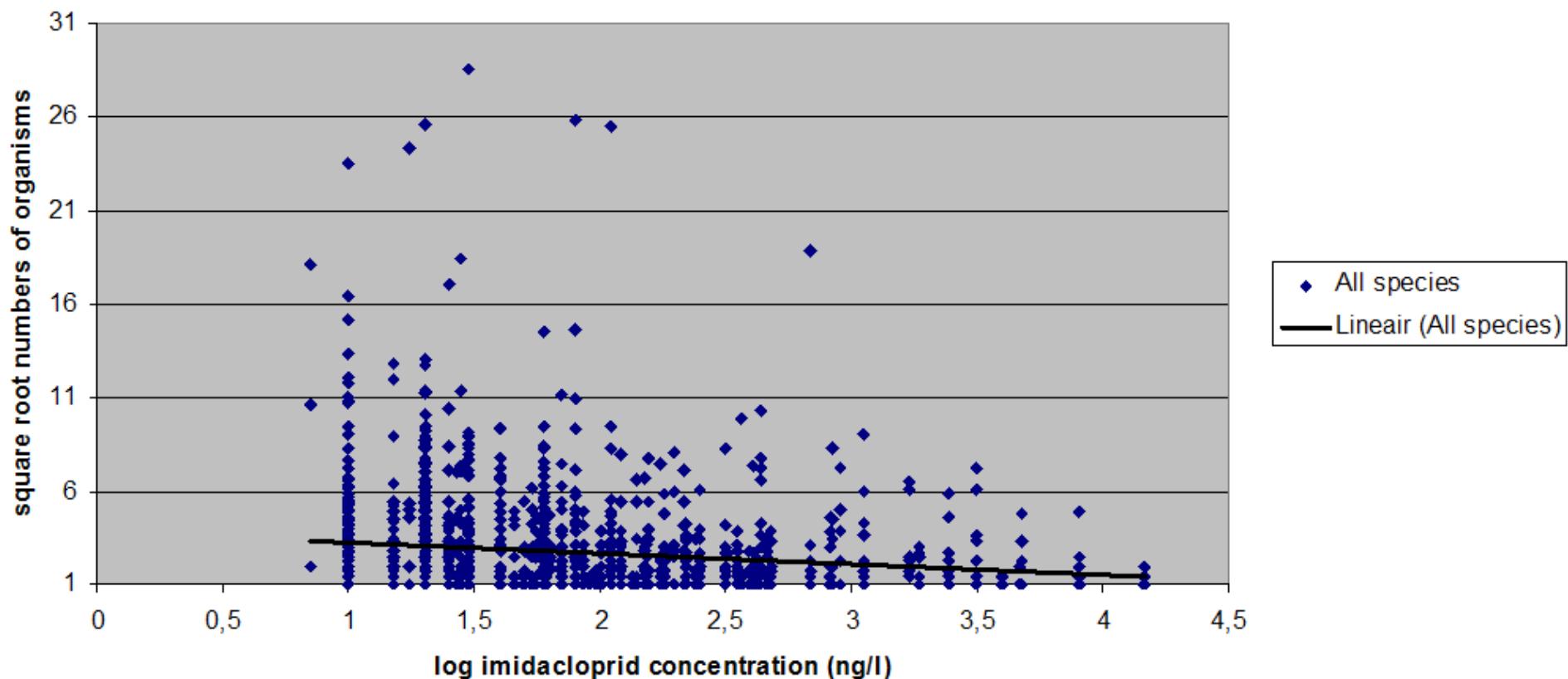
Average of imidacloprid measurements within a radius of 2 km and a timeframe of minus 160 days relative to the place and time of each diptera abundance measurement (1x MTR = 13 ng/liter)

Diptera, Most abundant species



Diptera, Other

Diptera, All



Diptera

	2 km radius av. Abundance	2 km radius n
0-40 ng/l	19.6	788
> 40 ng/l	11.4	779
Significance	$P(\text{same mean}) = 0.00131$ $P'(\text{same mean}) = < 1E-5$	



Two samples equal size permutation t test

	cut-half at (ng/l)	Effect on Abundance	n	p
Hydracarina	80	+134%	842	<1.00E-05
Diptera	40	-42%	1567	<1.00E-05
Coleoptera	60	-21%	501	0.068
Amphipoda	54	-60%	196	0.11
Odonata	30	-27%	149	0.13
Heteroptera	30	-25%	507	0.40
<i>Isopoda</i>	55	+213%	190	0.73
<i>Trichoptera</i>	40	+16%	212	0.81
<i>Ephemeroptera</i>	55	+52%	196	0.93



Do neonicotinoids favour mites?

OPEN  ACCESS Freely available online

 PLoS one

Neonicotinoid Insecticide Imidacloprid Causes Outbreaks of Spider Mites on Elm Trees in Urban Landscapes

Adrianna Szczepaniec^{1*^a}, Scott F. Creary^{1^b}, Kate L. Laskowski^{1^c}, Jan P. Nyrop², Michael J. Raupp¹

<http://dx.doi.org/10.1371/journal.pone.0020018>

ECOTOXICOLOGY

Fecundity in Twospotted Spider Mite (*Acaris*: *Tetranychidae*) is Increased by Direct and Systemic Exposure to Imidacloprid

DAVID G. JAMES¹ AND TANYA S. PRICE

<http://goo.gl/I3OY8> ??



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- Pollution below <LC50 48hr so all observed effect must be chronic and sub lethal
- Hydracarina (water mites) use insect as hosts to parasitize.
- Data Quality Limnodata



Wiping out the insects from the global food web has very large scale ecological impacts

Accelerating the collapse of the ecosystem

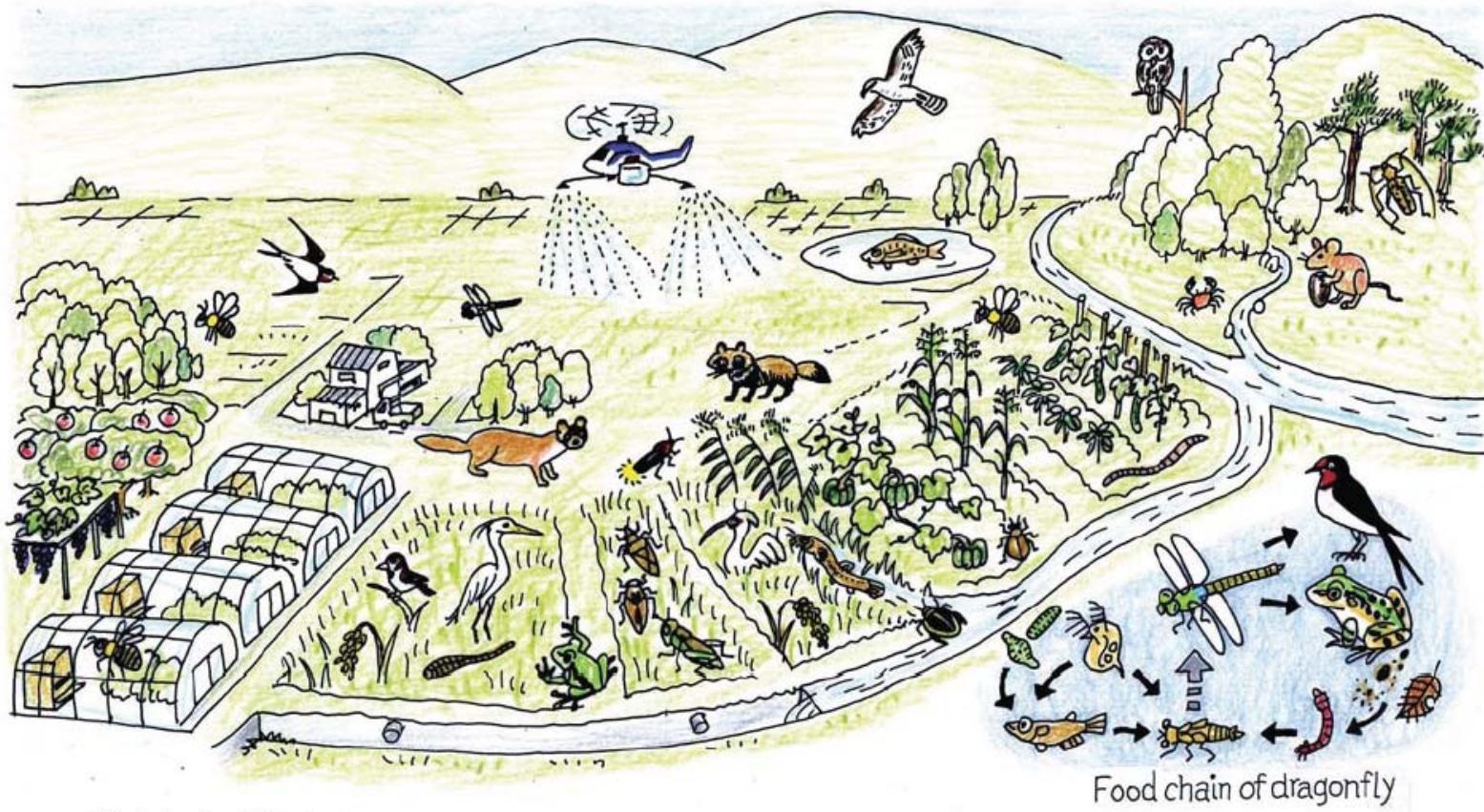


Illustration: Saori Yasutomi



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Verder lezen

- Bijensterfte, een nieuw risico
http://www.jvds.nl/Bijensterfte_overzicht.pdf
- The Threat of Neonicotinoid Pesticides on Honeybees, Ecosystems, and Humans
http://www.bijensterfte.nl/sites/default/files/Neonicotinoid_e.pdf
- Global honey bee colony disorders and other threats to insect pollinators (UNEP 2011 report)
http://www.unep.org/dewa/Portals/67/pdf/Global_Bee_Colony_Disorder_and_Threats_insect_pollinators.pdf
- The puzzle of honey bee losses: a brief review
<http://www.bulletinofinsectology.org/pdfarticles/vol63-2010-153-160maini.pdf>
- Tennekes 2010: The toxicity of neonicotinoid insecticides to arthropods is reinforced by exposure time
http://www.boerenlandvogels.nl/sites/default/files/Tennekes_2010_Toxicology_17.pdf
- Tennekes & Sánchez-Bayo 2011: Time-Dependent Toxicity of Neonicotinoids and Other Toxicants http://www.boerenlandvogels.nl/sites/default/files/Tennekes_Sánchez-Bayo_JEAT_2011_Review%20Article_7.pdf
- The impact of neonicotinoid insecticides on bumblebees, Honey bees and other nontarget invertebrates
http://www.bijensterfte.nl/sites/default/files/Impact_neonicotinoid_insecticides_non-target_invertebrates.pdf
- The Effects of Pesticide-Contaminated Pollen on Larval Development of the Honey Bee, *Apis mellifera*
http://archives.evergreen.edu/mastertheses/Accession86-10MES/burlew_daMES2010.pdf
- Effects of neonicotinoid pesticide pollution of Dutch surface water on non-target species abundance
<http://www.bijensterfte.nl/sites/default/files/FinalThesisTvD.pdf>
- The systemic insecticides - A disaster in the making
<http://www.disasterinthemaking.com/>
- Late lessons from early warnings
http://www.eea.europa.eu/publications/environmental_issue_report_2001_22
- <http://www.bijensterfte.nl>



www.jvds.nl



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