Webinar Magistrali 2024

Italian Society of Occupational Medicine

HUMAN HEALTH RISKS FROM THE WORKPLACE TO THE GENERAL ENVIRONMENT OF LIFE: WHAT LESSONS FOR RESEARCHERS AND PROFESSIONALS INVOLVED IN THEIR IDENTIFICATION, QUANTIFICATION, AND PREVENTION?

Neonicotinoids: a paradigm of human-environmental toxicity

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Declaration of interest

- Member of the Panel on Plant Protection Products and their Residues and various working groups of EFSA
- Member of the Committee for Pesticides and Biocidal Products of BfR (Germany)
- This presentation contains solely the author's views and does not reflect agency policy

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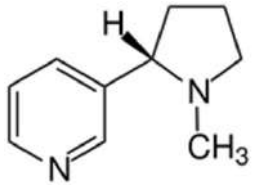
Outline

- Introduction to neonicotinoid insecticides
- Mechanism of action
- Acute toxicity: poisoning incidents, symptoms, treatment
- Neonicotinoids and the environment
- Occupational and consumer exposure
- Chronic toxicity (developmental neurotoxicity)
- Summary

History

- Nicotine was reported in the late 17th century as the first plant-derived insecticide.



- Neonicotinoids are molecular modifications of nicotine to increase potency and photostability.
- The neonicotinoids are the first major new insecticidal class to be developed in the last 30 years.
- The first neonicotinoid insecticide (imidacloprid) was launched in 1991; it has since become the world's largest selling insecticide.
- Neonicotinoids are readily absorbed by plants, and act quickly after contact or ingestion on piercing-sucking insects.

By Jom / Joachim Müllerchen - Own work, CC BY 2.5 https://commons.wikimedia.org/w/index.php?curid=1241800

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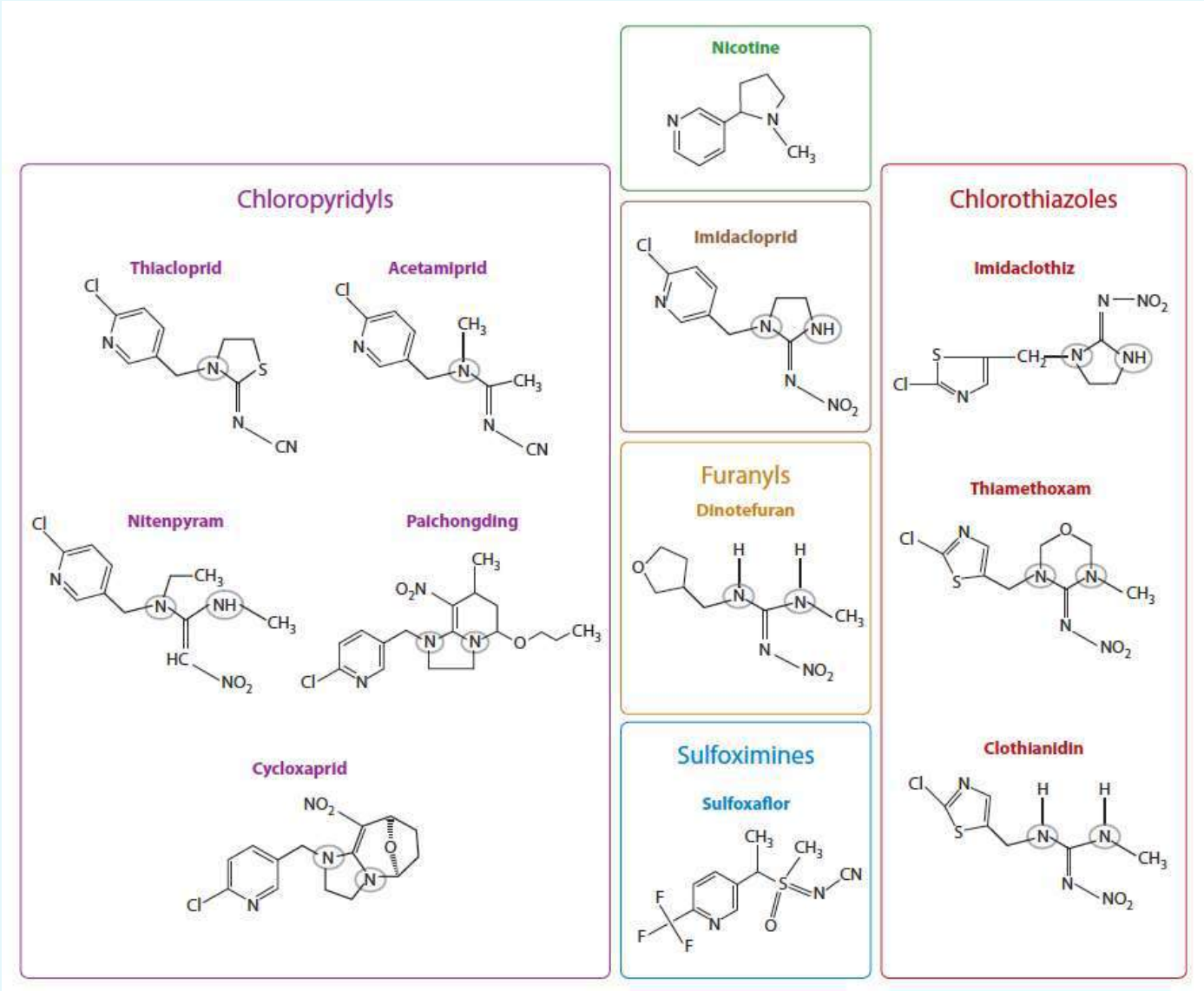
cyanoimine (N-CN)

nitromethylene (CH-NO_2)



nitroimine (N-NO_2)

cyanoimine (N-CN)

Wang X, Annu. Rev. Pharmacol. Toxicol. 2018. 58:471–507

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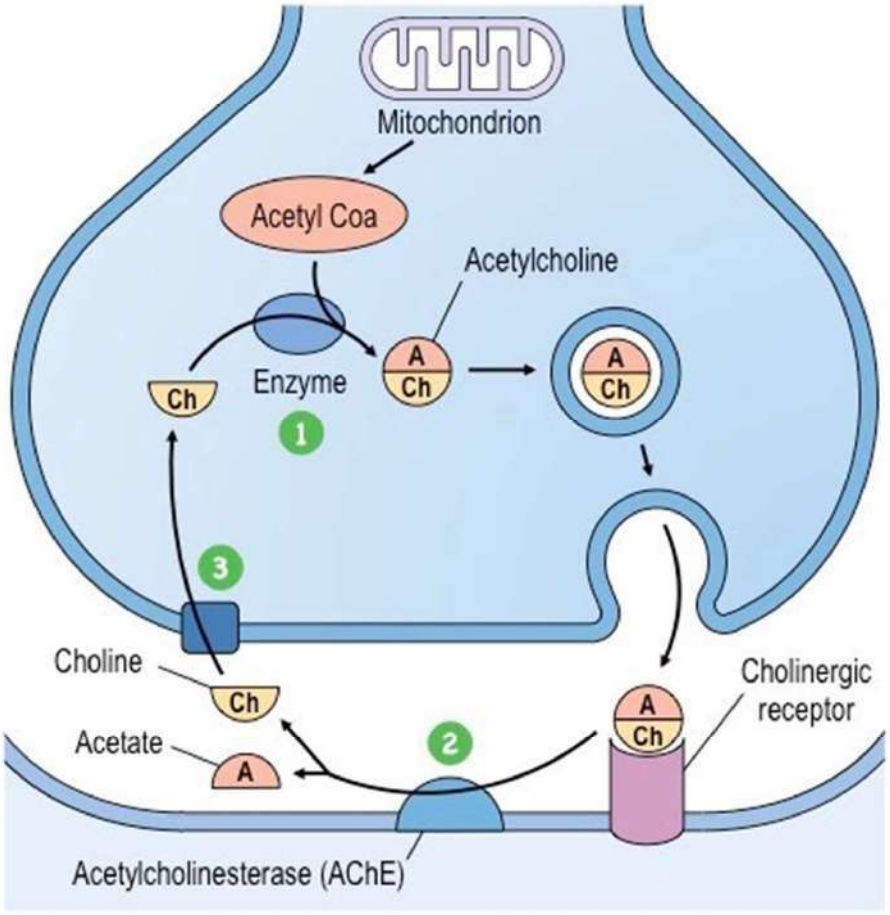
Acetylcholine Secretion and Reabsorption



1. Acetylcholine (ACh) is made from choline and acetyl CoA
2. In the synapse, ACh is rapidly broken down by the enzyme **acetylcholinesterase (AChE)**
3. Choline is transported back into the axon terminal and used to make more ACh

https://ib.bioninja.com.au/standard-level/topic-6-human-physiology/65-neurons-and-synapses/neurotransmitters.html

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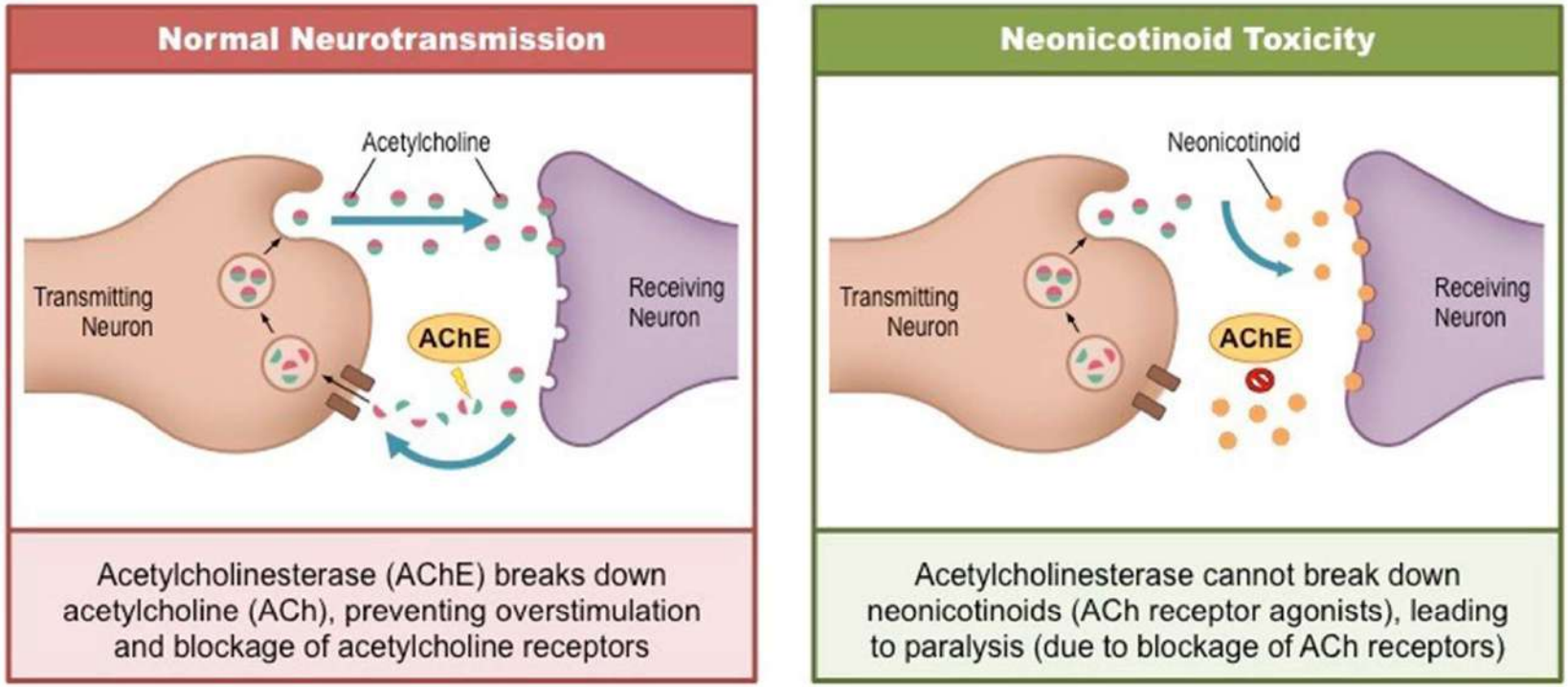
Neonicotinoid Mode of Action



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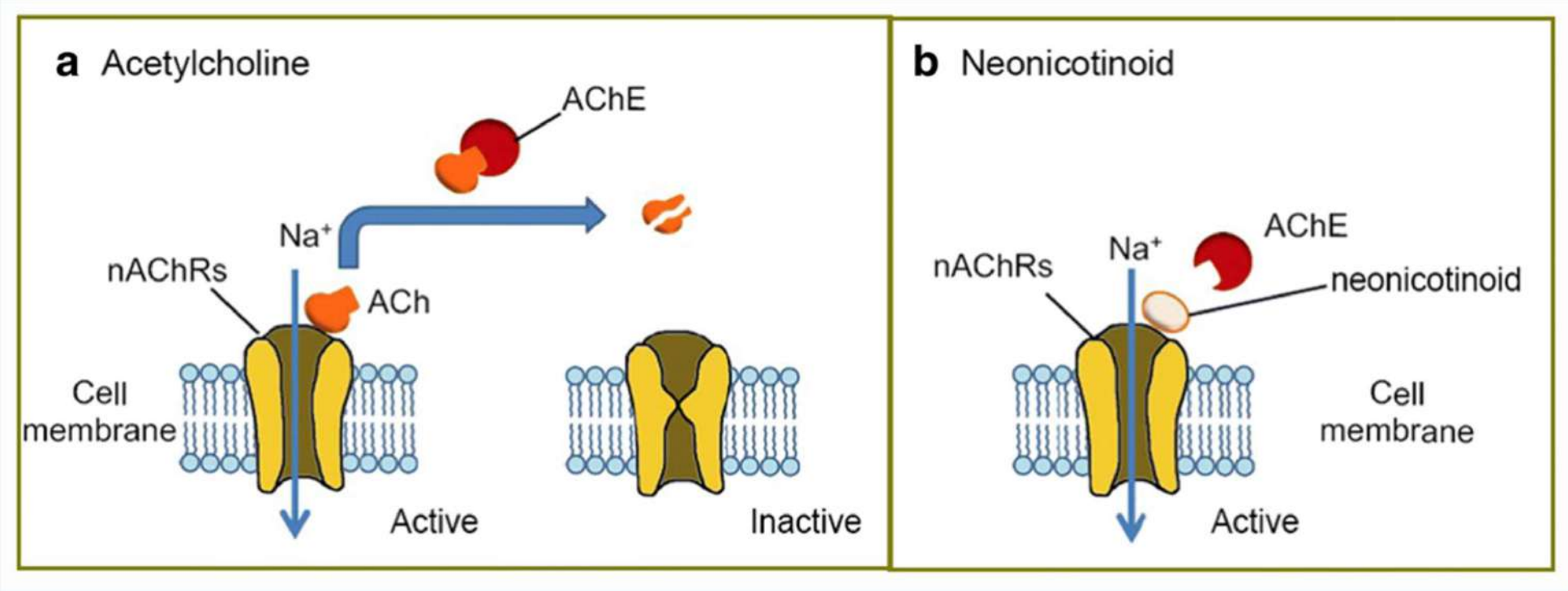
Mechanisms of action of neonicotinoids



Buscewski B, Environ Sci Pollut Res 2019, 26:.34723–34740

Selective toxicity

- Binding to $\alpha 2\beta 4$ subunit of nAChRs (present in all insect, but only 8-10% of mammalian receptors).
- Low lipophilicity ➔ poor penetration of blood brain barrier.
- In comparison with other insecticides lower human acute toxicity.

TABLE 2 Comparison of neonicotinoids with other classes of insecticides[a]

Class	Log P	Systemic action	Nerve target[b]	Potency (LD_{50}, mg/kg)[c] Insects	Potency (LD_{50}, mg/kg)[c] Rats	Selectivity factor
Neonicotinoids	−0.7 to 1.3	+	nAChR	2.0	912	456
Organophosphates	1 to 5.5	±	AChE	2.0	67	33
Methylcarbamates	−1 to 3	±	AChE	2.8	45	16
Organochlorines	5.5 to 7.5	−	Na^+ or Cl^- channels	2.6	230	91
Pyrethroids	4 to 9	−	Na^+ channel	0.45	2000	4500

[a]Data from Reference 24 except for neonicotinoids.

[b]Insecticide examples are the organophosphates parathion and malathion (as their oxon metabolites) and methylcarbamates carbaryl and aldicarb inhibiting AChE, the organochlorine DDT and the pyrethroid deltamethrin acting on the voltage-sensitive sodium channel, and the organochlorines endosulfan and lindane blocking the γ-aminobutyric acid (GABA)-gated chloride channel.

[c]Geometric means of large data sets (11 to 83 items each) for rat acute oral and insect topical (principally four species) LD_{50} values for all classes of compounds except neonicotinoids (24). Values for the neonicotinoids are geometric means for rat oral LD_{50} data in Table 3 and arbitrary for insects to reflect similar potency of neonicotinoids and organophosphates on the same target insects.

Tomizawa M, Annu Rev Pharmacol Toxicol 2005, 45: 247–68

Case series of poisonings with neonicotinoids[a]

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Year	Country	Data source	Number of cases	Oral %	Symptoms GI %.	Symptoms Neur %	Severe / fatal %	Reference
2009	Taiwan	PCC	70	81 %	54 %	18 %	11 % / 3 %	Phua DH, Clin Toxicol
2009	Sri Lanka	Hospital	68	90 %	54 %[b]	4 %[b,c]	3 % / 0 %	Mohamed F, PLoS One
2014	USA	PCC	1142	51 %	6 %	1 %	< 3 %[d] / 0 %	Forrester MB, Human Exp Tox
2014	France	PCC	302	69 %	6-30 %[e]	3-11 %[e]	< 2 % / 0 %	Boels D, CCTV internal publication
2020	Sri Lanka	Hospital	67	100 %	57 %	16 %[c]	6 % / 3 %	Perananthan V, Clin Toxicol
2020	Thailand	PCC	163	93%	61 %	20 %	1 %[d] / 1 %	Sriapha C, Ther Clin Risk Mgt

[a] all cases are imidacloprid except Taiwan (91%) and USA (77%); [b] reported in Perananthan, 2020;
[c] ↓GCS; [d] includes moderate severity; [e] multiple symptoms per case possible

Data of Freiburg PCC

(Dr. M. Hermanns-Clausen, pers. communication)

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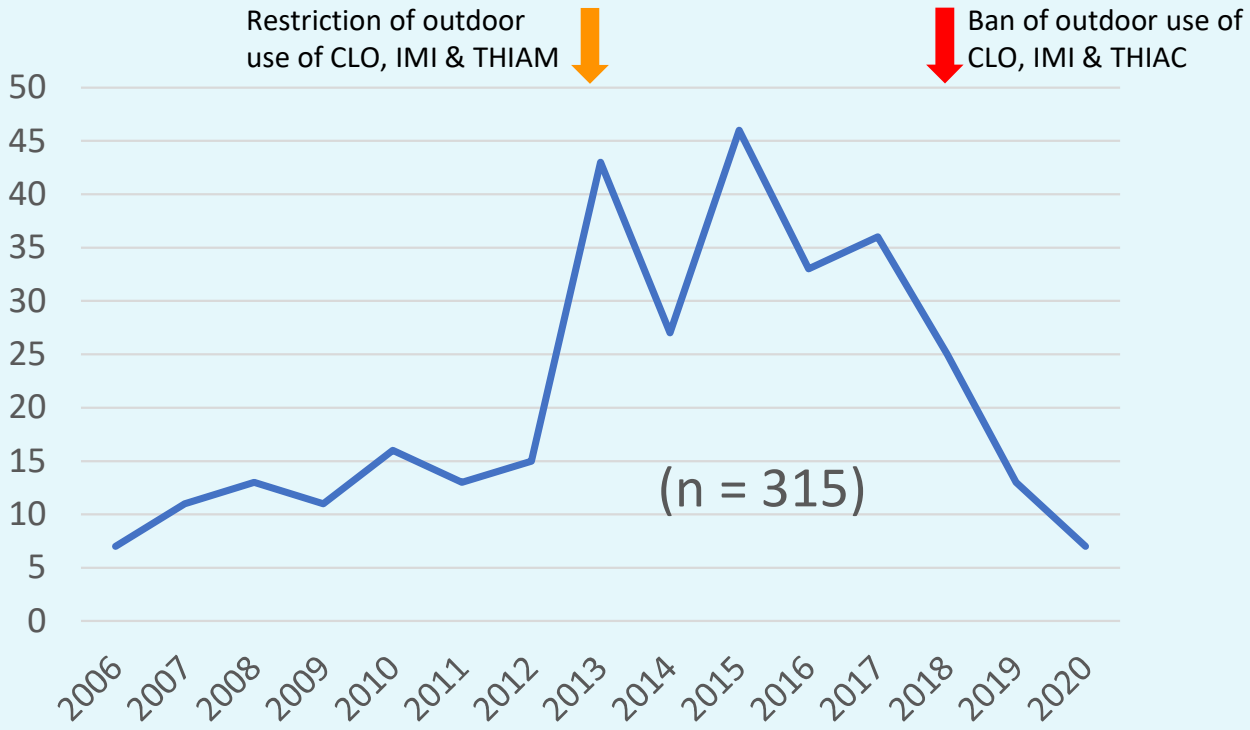

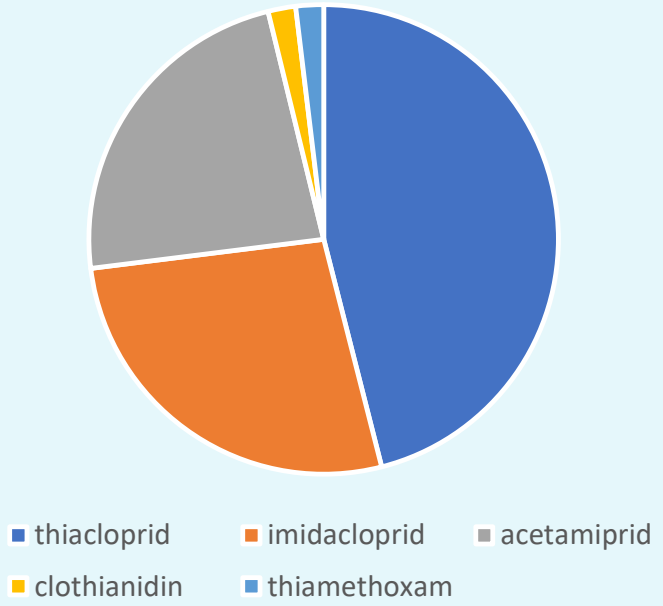

Oral exposure	45 %
Moderate/severe	3 %

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Phua DH, Clin Toxicol 2009, 47: 336-341

Table 2. Comparison of demographic and clinical characteristics between patients with and patients without severe/fatal oral neonicotinoid insecticide poisoning

Characteristics[a]	Severe/fatal poisoning[b] (n = 10) (%)	Non-severe poisoning[b] (n = 40) (%)	p-value
Age (years)[c]	67 (42–84)	49 (1.7–82)	0.008
Est. ingested amount (mL)[c]	75 (30–200)	90 (5–300)	0.938
Time elapsed before visiting emergency department (h)[c]	2.5 (0.5–10.0)	0.5 (0.3–18.0)	0.193
Respiratory tract effects	7 (70)	1 (3)	<0.001
Dyspnea	1 (10)	1 (3)	0.279
Aspiration pneumonia	5 (50)	0 (0)	<0.001
Respiratory failure	6 (60)	0 (0)	<0.001
Gastrointestinal effects	5 (50)	22 (55)	0.777
Nausea	1 (10)	12 (30)	0.197
Vomiting	2 (20)	14 (35)	0.363
Abdominal pain	0 (0)	4 (10)	0.297
Dysphagia	1 (10)	2 (5)	0.552
Oral ulcer	0 (0)	2 (5)	0.470
Gastroesophageal bleeding/ulcer	3 (30)	1 (3)	0.004
Central nervous system effects	5 (50)	4 (10)	0.003
Agitation	2 (20)	2 (5)	0.118
Confusion	1 (10)	1 (3)	0.279
Coma	3 (30)	1 (3)	0.004
Cardiovascular effects	2 (20)	1 (3)	0.037
Tachycardia	1 (10)	1 (3)	0.279
Bradycardia	1 (10)	0 (0)	0.043
Hypotension	1 (10)	0 (0)	0.043
Other effects	1 (10)	9 (23)	0.377
Dizziness	0 (0)	4 (10)	0.297
Dry mouth	0 (0)	1 (3)	0.614
Diaphoresis	1 (10)	2 (5)	0.552
Warmth sensation of body	0 (0)	1 (3)	0.614
Abnormal liver enzymes	0 (0)	1 (3)	0.614

Table 4 Subgroup Analysis of Clinical Manifestations Between Patients Who Survived and Those Who Died

Clinical Manifestations	Survived (n = 158)	Died (n = 5)	p-value*
Number (%) male to female	88:70 (55.7:44.3)	3:2 (60:40)	1.00
Age in years, mean ± SD (min-max)	40.7 ± 22.1 (2–86)	60 ± 16.9 (47–88)	0.056
Number (%) of age in years			0.496
Less than 5 years	18(11.4)	0	
6–12 years	2 (1.3)	0	
13–19 years	7 (4.4)	0	
20–39 years	43(27.2)	0	
40–59 years	54(34.2)	3 (60)	
More than 60 years	34 (21.5)	2 (40)	
Time to hospital in hours, median (min-max); data available for 160 patients	1 (0.17–72) n = 156	4 (1–8) n = 4	0.064
Estimated ingestion amount in grams, median (min-max); data available for 68 patients	2.5 (0.1–30) n = 65	40 (14–87.5) n = 3	0.004**
Number (%) of initial signs and symptoms[a]			
Gastrointestinal:	98 (62.0)	2 (40)	0.376
Nausea/vomiting	84 (53.2)	2 (40)	0.668
Abdominal pain	33 (20.9)	0	0.584
Burning sensation in throat	11 (7.0)	1 (20)	0.321
Cardiovascular:	13 (8.2)	3 (60)	0.007**
Tachycardia	3 (1.9)	3 (60)	<0.001**
Bradycardia	1 (0.6)	0 (0)	1.000
Hypertension	8 (5.1)	1 (20)	0.250
Hypotension	2 (1.3)	1 (20)	0.090
Cardiac arrest	0	1 (20)	0.031**
Central nervous system:	5 (3.2)	3 (60)	0.001**
Dizziness	20 (12.7)	1 (20)	0.503
Drowsiness	5 (3.2)	1 (20)	0.173
Headache	4 (2.5)	0	1.000
Coma	0	1 (20)	0.031**
Respiratory:			
Dyspnea	0	2 (40)	0.001**
Other:			
Muscle twitching[b]	2 (1.3)	0	1.000
Diaphoresis	4 (2.5)	2 (40)	0.011**
Salivation	6 (3.8)	0 (0)	1.000
Paresthesia[b]	3 (1.9)	0 (0)	1.000

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Sriapha C, Ther Clinical Risk Mgt 2020, 16: 1081–1088

The toxicokinetics of imidacloprid in patients with self-poisoning (n = 8)

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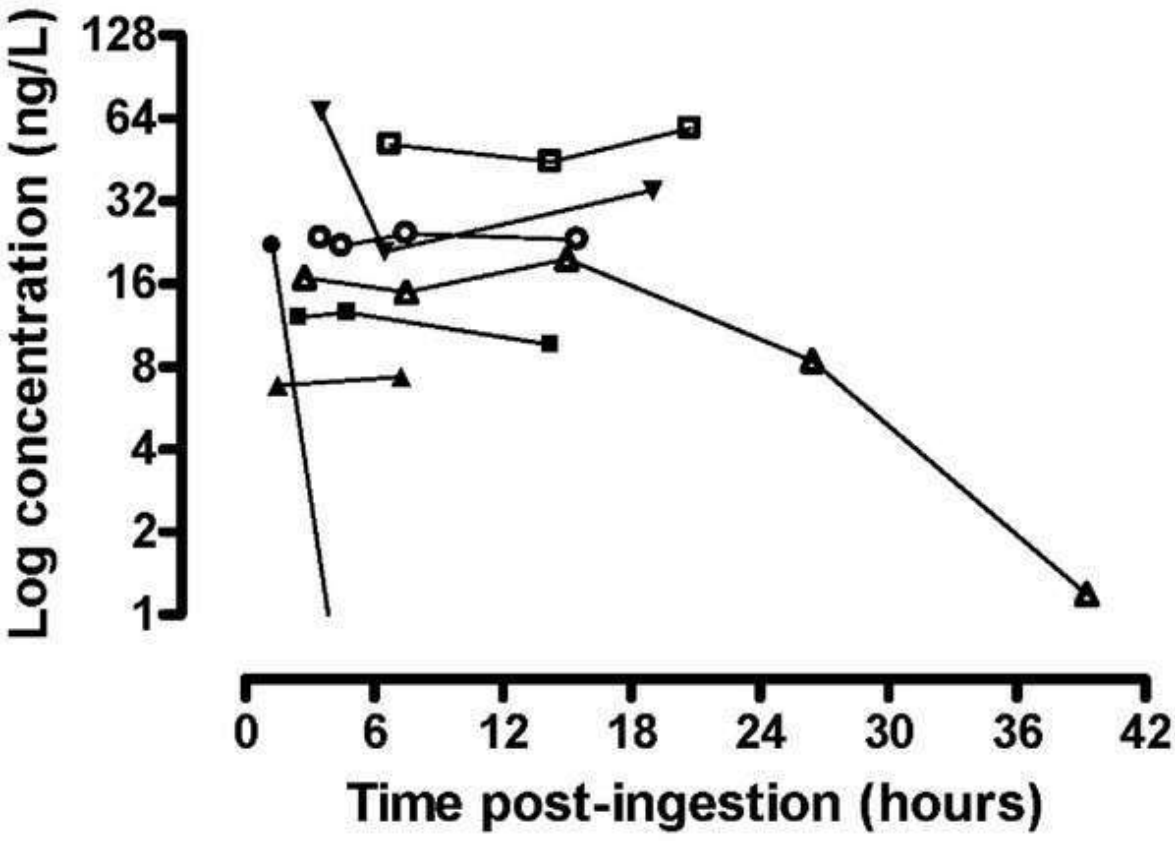

- The concentration was high on admission and remained elevated in the majority of patients suggesting either prolonged absorption and/or elimination.

Mohamed F, PLoS ONE 2009, 4: e5127

Therapy

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- Therapy of neonicotinoid poisoning is symptomatic
- Exposure to skin and/or eyes: thorough decontamination
- After oral ingestion consider giving activated charcoal based upon individual risk-benefit judgment
  - Many products are solvent-based
  - No data on effectiveness of activated charcoal in neonicotinoids poisoning
- In moderate or severe poisoning
  - Cardiac monitoring of patients with risk factors (e.g. CAD)
  - If required and available ICU treatment and ventilation
- Caution: Risk of confusion with cholinesterase inhibitors!
  - Atropin und Oxime are ineffective or contraindicated

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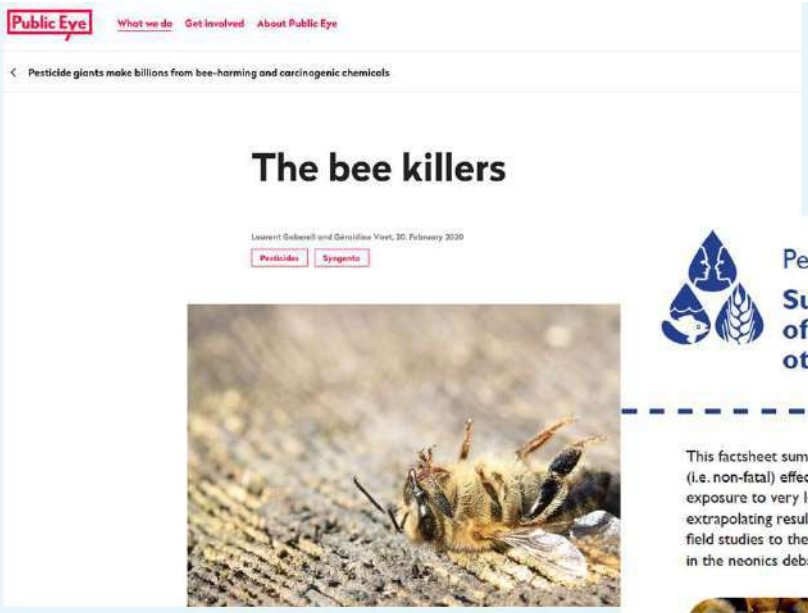
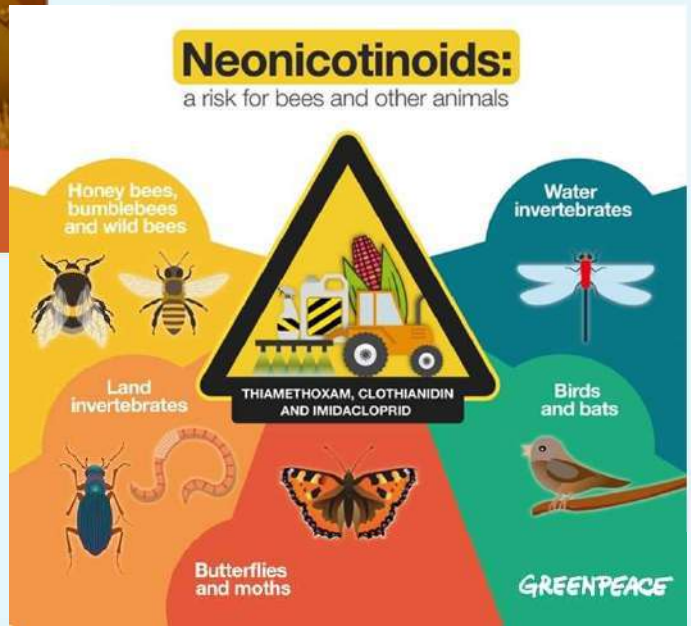
Neonicotinoids

and

the environment





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Pesticide Action Network UK

Sub-lethal and chronic effects of neonicotinoids on bees and other pollinators

Bee Declines & Pesticides **factsheet 2**

This factsheet summarises current knowledge about sub-lethal (i.e. non-fatal) effects of these insecticides and possible impacts of exposure to very low doses over time. It discusses the difficulties in extrapolating results which demonstrate harm in laboratory and semi-field studies to the reality in the field - one of the main controversies in the neonics debate – and implications of the latest research findings.

Credit Graham White

Subtle but important effects from doses that do not kill bees outright

Sub-lethal toxicity to bees and other pollinators is the most likely exposure scenario in the field from neonicotinoid seed treatments[1,2] because generally the concentrations that are found in pollen and nectar from seed-treated plants are too low to cause immediate bee deaths from acute poisoning[3,4]. However, lethally toxic levels in seed coating dust released at sowing stage have been documented in several countries (see Factsheet 1 on exposure routes) and found in stored pollen in some US hives[5].

Sub-lethal effects reported in the scientific literature[6] include a range of behavioural disturbances in honeybees:

www.pan-uk.org

Neonicotinoids and bees

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- In 2013 the EU Commission restricted the use of 3 neonicotinoids 2013 to protect bees.
- An assessment by EFSA (2018)* concluded that the high risk to honeybees and wild bees resulted from any outdoor use, because the pesticides contaminate soil and water leading to their appearance in wildflowers or succeeding crops.
- From May 2018, the EC banned all uses of clothianidin, imidacloprid and thiamethoxam, except in closed greenhouses.
- Other neonicotinoids deemed to have a lower risk for bees (e.g. acetamiprid, thiacloprid) are not affected by the ban.

* https://www.efsa.europa.eu/de/press/news/180228

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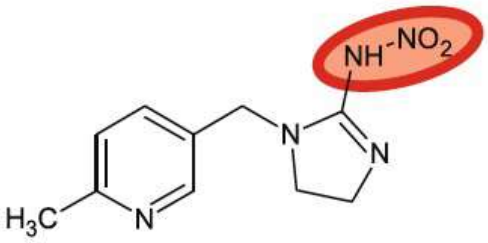
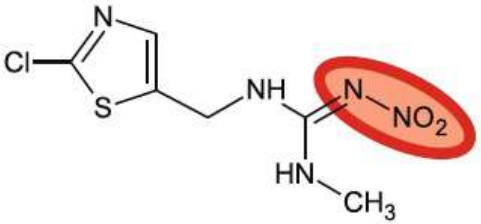
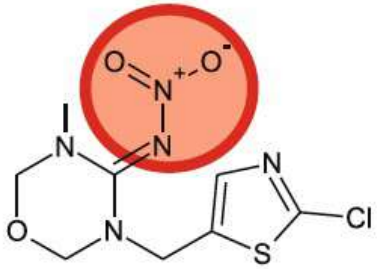
Bee toxicity and chemical structure



Imidacloprid



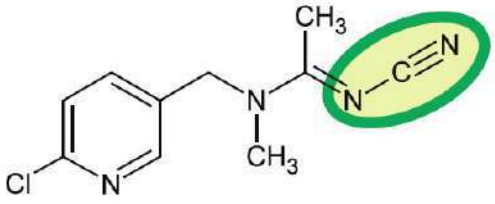
Clothianidin



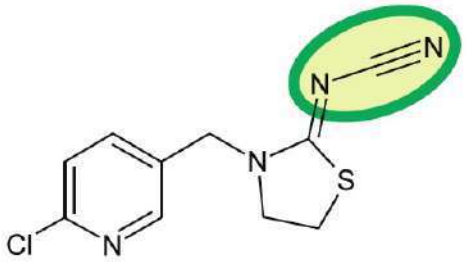
Thiamethoxam

Nitroguanidin
↑ Polar
↑ Reactive
↑ Bee toxicity

Buszewski B, Environ Sci Pollut Res 2019, 26: 34723–34740



Acetamiprid



Thiacloprid

Cyanoamidin
↓ Polar
↓ Reactive
↓ Bee toxicity

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Occupational and consumer exposure

Occupational exposure

Biological monitoring

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Science of the Total Environment 669 (2019) 721–728

Contents lists available at ScienceDirect

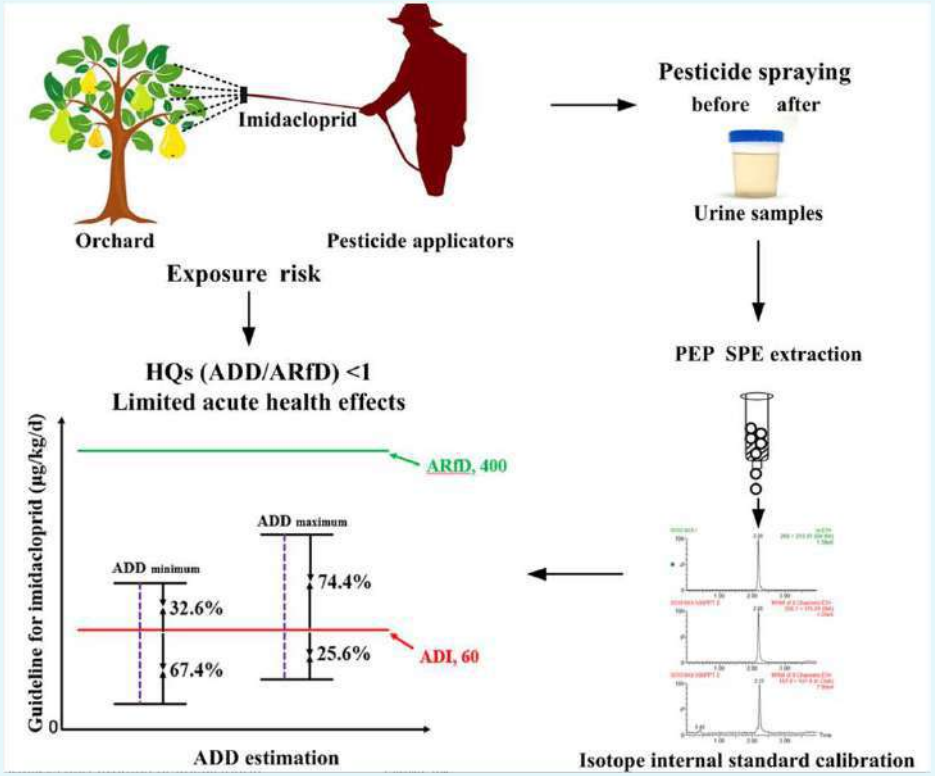
Science of the Total Environment

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

Urinary monitoring of neonicotinoid imidacloprid exposure to pesticide applicators

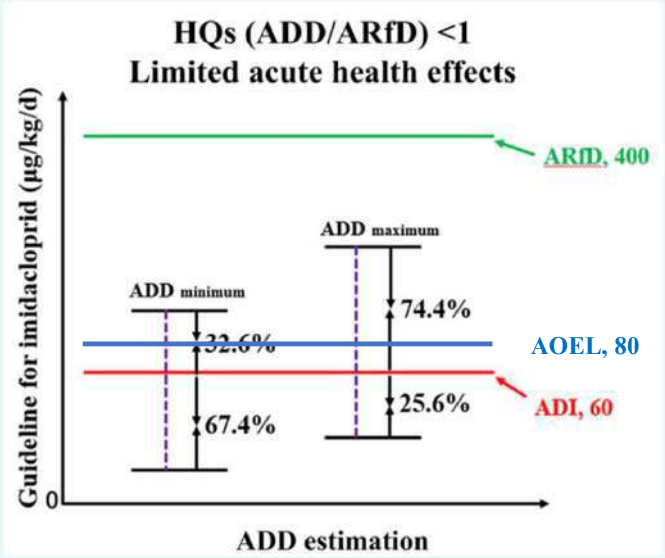
Yan Tao [a], Dung Phung [b], Fengshou Dong [a,*], Jun Xu [a], Xingang Liu [a], Xiaohu Wu [a], Qianyu Liu [c], Min He [d], Xinglu Pan [a], Runan Li [a], Yongquan Zheng [a,*]

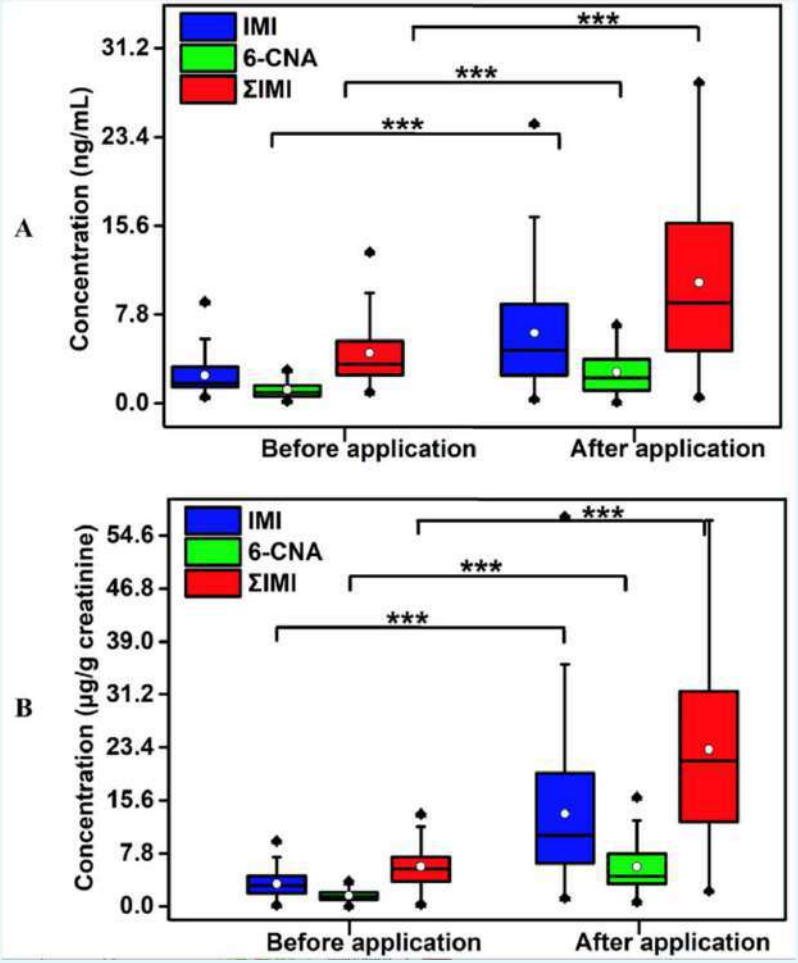
- 43 pesticide applicators (31m, 12f, age 24-74y) from Henan province, China
- Single spot urine samples were collected before the spraying season (March) and after 3-4 applications (May)
- Samples were analysed by LC-MS/MS for imidacloprid and the 6-CNA metabolite
- Absorbed daily dose was estimated from parent and metabolite concentrations



Occupational exposure

Biological monitoring





"Exposure data from pesticide applicators indicated that this population experiences significant exposure to imidacloprid, especially after a spraying event."

Consumer exposure

Biological monitoring

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DOI: 10.1021/acs.est.5b03062
Environ. Sci. Technol. 2015, 49, 14522−14528

Environmental Science & Technology

Article

pubs.acs.org/est

Temporal Levels of Urinary Neonicotinoid and Dialkylphosphate Concentrations in Japanese Women Between 1994 and 2011

Jun Ueyama,[*,†] Kouji H. Harada,[‡] Akio Koizumi,[‡] Yuka Sugiura,[†] Takaaki Kondo,[†] Isao Saito,[§] and Michihiro Kamijima[*,∥]

- 95 female residents aged 45 – 75 w/o occupational exposure from Kyoto province, Japan
- Spot urine samples were collected during routine health checkups
- Samples were analysed by LC-MS/MS for 7 NEOs and 4 DAP metabolites

Table 1. Demographic Data of Subjects in this Study

	year of sample collection				
analytes	1994	2000	2003	2009	2011
number of subjects	20	20	20	17	18
age (years)	53.3 ± 5.7	52.6 ± 5.0	62.6 ± 4.3	64.0 ± 8.1	68.1 ± 5.2
urinary creatinine (g/L)	0.9 ± 0.5	1.1 ± 0.7	1.0 ± 0.7	1.1 ± 0.8	1.3 ± 0.8

Neo-nicotinoids

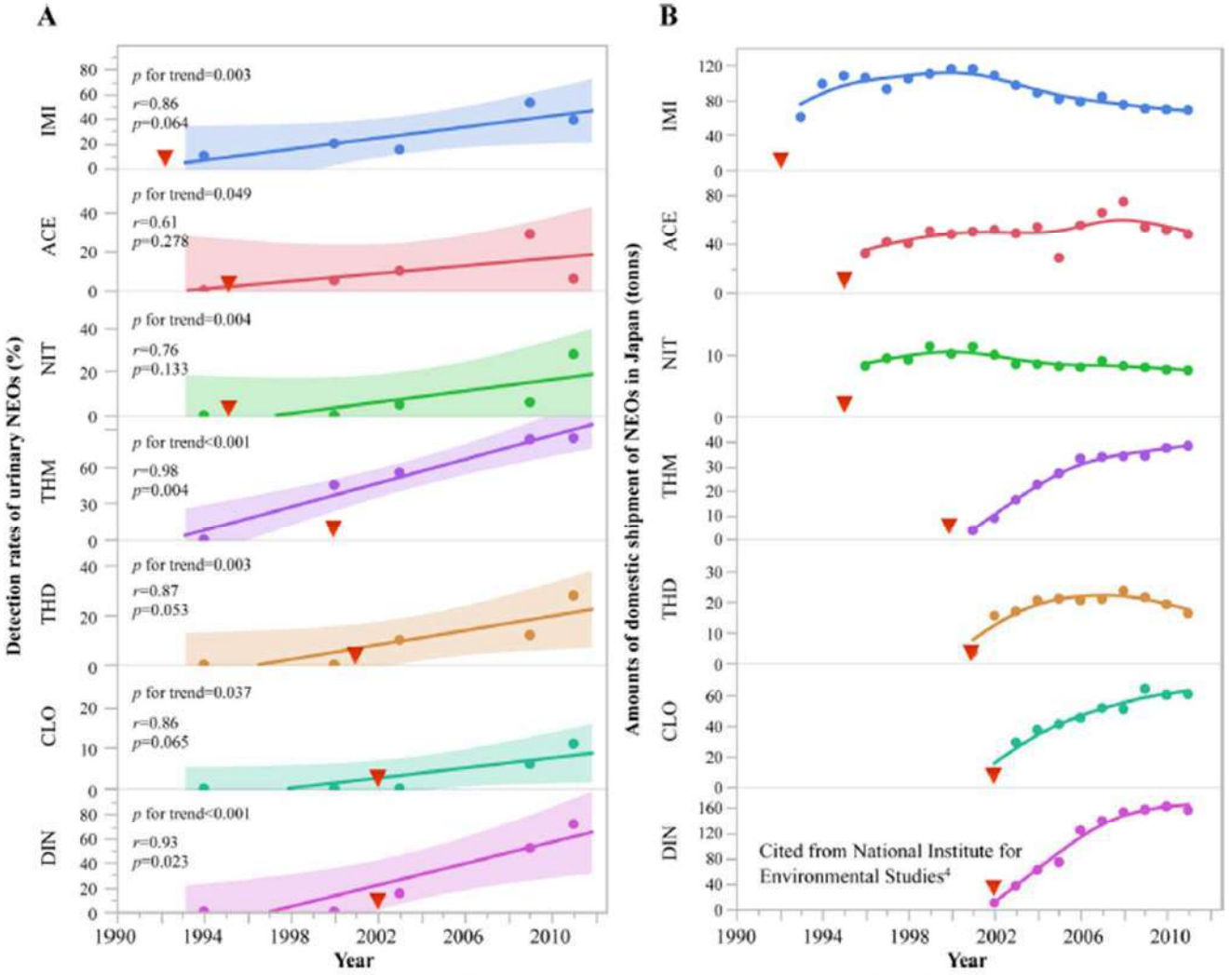

Figure 1. Detection rates of urinary NEOs in Japanese (A) and the amount of domestic shipments of NEOs in Japan (B) between 1994 and 2011. Inverted triangles represent years when each NEO came on the market in Japan. Panel A shows *p* for the Cochran-Armitage trend test, Pearson's correlation coefficients (*r*) with *p*-values, and 95% confidence intervals of the regression lines.

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Di-alkyl phosphates

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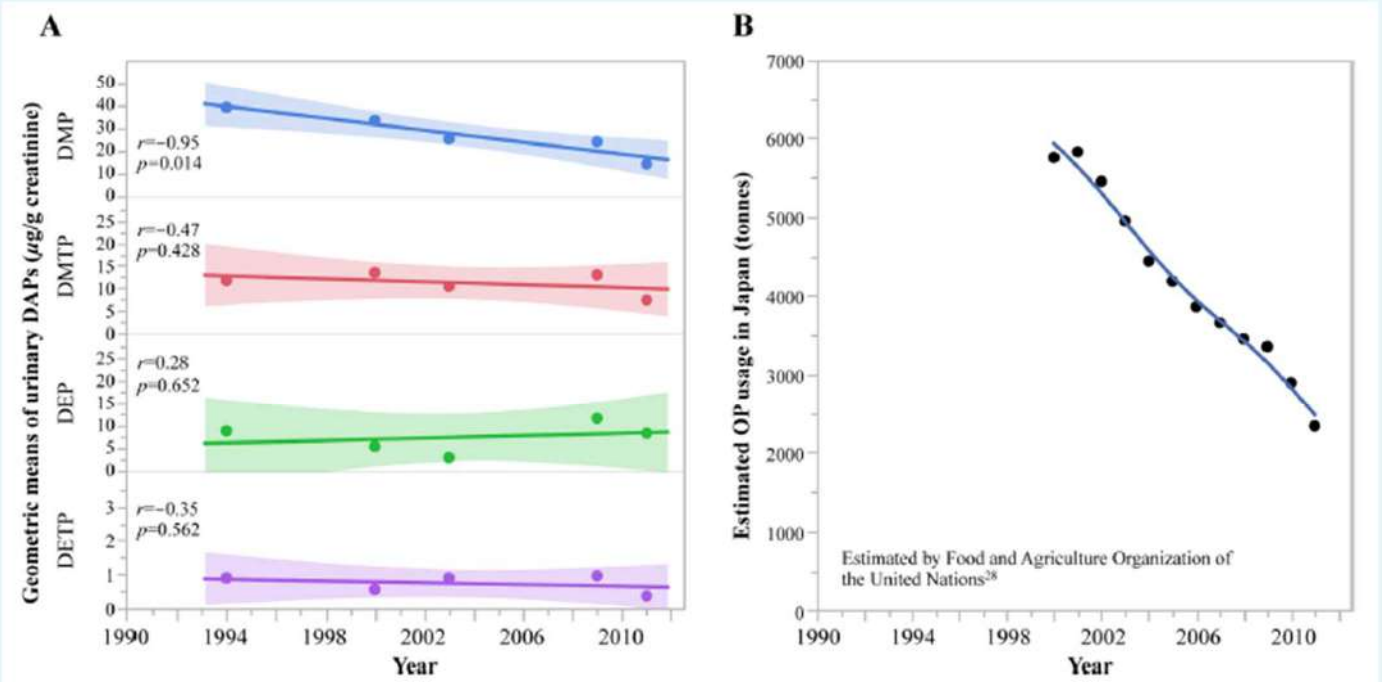

Figure 4. Geometric means of creatinine-corrected concentrations (μmol/g creatinine) of dialkylphosphates in urine between 1994 and 2011 (A), and the estimated OP usage in Japan between 2000 and 2011 (B). In panel A, Pearson's correlation coefficients (r) with p-values and 95% confidence intervals of the regression lines are shown. Note that OPs came into the market during the 1950s in Japan, although data regarding the amount of their use before 2000 are not displayed in panel B.

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Chronic Toxicity

or

The difficulties of risk assessment using developmental neurotoxicity as example

Developmental neurotoxicity

What researchers are showing

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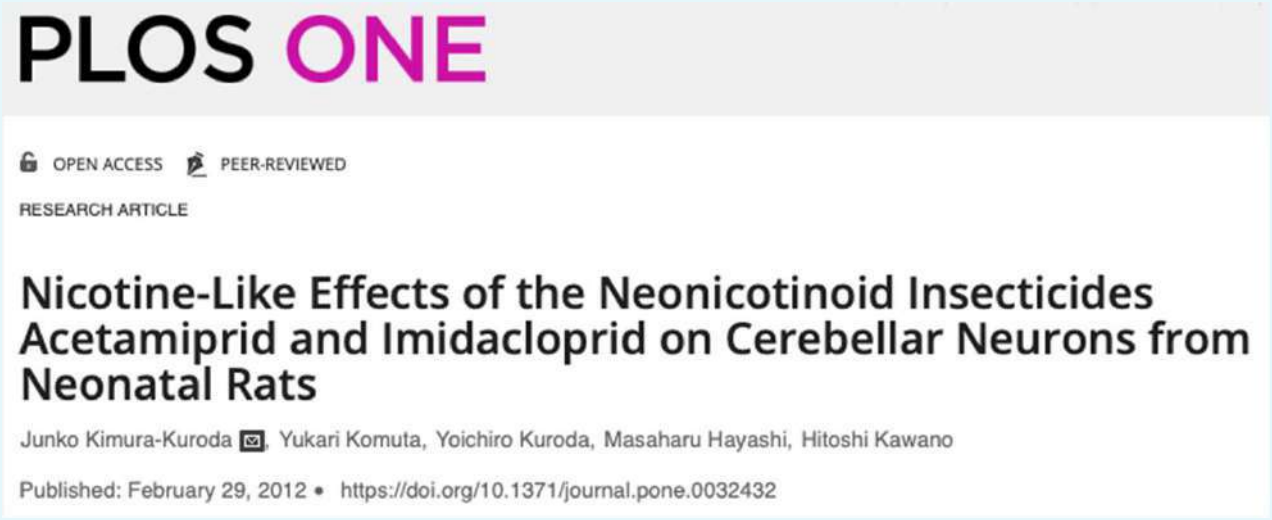

PLOS ONE

OPEN ACCESS PEER-REVIEWED

RESEARCH ARTICLE

Nicotine-Like Effects of the Neonicotinoid Insecticides Acetamiprid and Imidacloprid on Cerebellar Neurons from Neonatal Rats

Junko Kimura-Kuroda, Yukari Komuta, Yoichiro Kuroda, Masaharu Hayashi, Hitoshi Kawano

Published: February 29, 2012 • https://doi.org/10.1371/journal.pone.0032432

”ACE, IMI and nicotine exert similar excitatory effects on mammalian nAChRs at concentrations greater than 1 uM.

Therefore, the neonicotinoids may adversely affect human health, especially the developing brain."

Developmental neurotoxicity

What regulators are concluding

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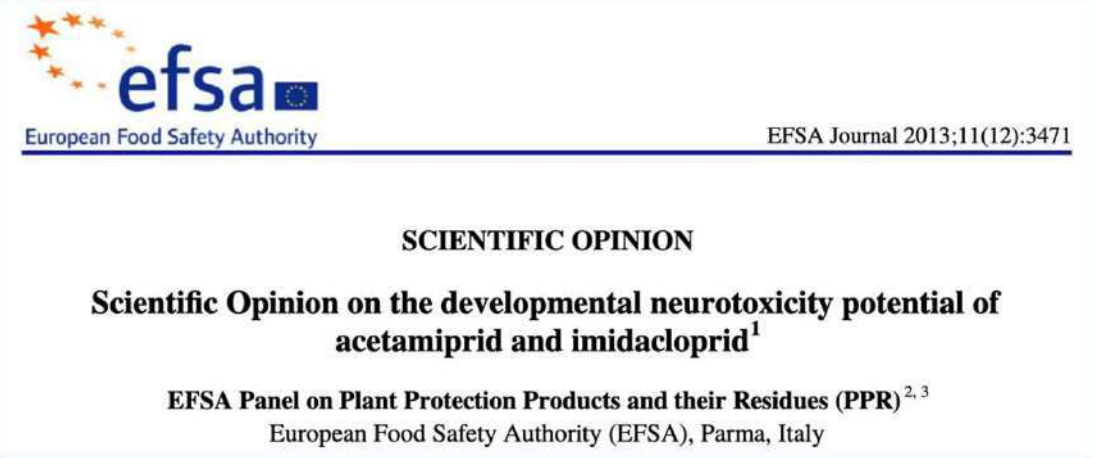

efsa
European Food Safety Authority

EFSA Journal 2013;11(12):3471

SCIENTIFIC OPINION

Scientific Opinion on the developmental neurotoxicity potential of acetamiprid and imidacloprid[1]

EFSA Panel on Plant Protection Products and their Residues (PPR)[2, 3]
European Food Safety Authority (EFSA), Parma, Italy

"The PPR Panel found that acetamiprid and imidacloprid may adversely affect the development of neurons and brain structures associated with functions such as learning and memory.

EFSA recognises the available evidence has limitations and recommends further research be carried out to provide more robust data."

Developmental neurotoxicity

Epidemiological evidence

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thebmj | BMJ 2019;364:l962 | doi: 10.1136/bmj.l962

Prenatal and infant exposure to ambient pesticides and autism spectrum disorder in children: population based case-control study

Ondine S von Ehrenstein,[1,2] Chenxiao Ling,[2] Xin Cui,[2,3,4] Myles Cockburn,[5] Andrew S Park,[2] Fei Yu,[6] Jun Wu,[7] Beate Ritz[2,8,9]

Keil et al. Environmental Health 2014, 13:3
http://www.ehjournal.net/content/13/1/3

ENVIRONMENTAL HEALTH

RESEARCH Open Access

Autism spectrum disorder, flea and tick medication, and adjustments for exposure misclassification: the CHARGE (CHildhood Autism Risks from Genetics and Environment) case–control study

Alexander P Keil[1*], Julie L Daniels[1] and Irva Hertz-Picciotto[2]

American Journal of Epidemiology
Vol. 179, No. 6
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Advance Access publication: February 18, 2014

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Original Contribution

Residential Agricultural Pesticide Exposures and Risk of Neural Tube Defects and Orofacial Clefts Among Offspring in the San Joaquin Valley of California

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* Correspondence to Dr. Gary M. Shaw, Department of Pediatrics, Stanford University, 1265 Welch Road, Room X159, Stanford, CA 94305-5415 (e-mail: gmshaw@stanford.edu).

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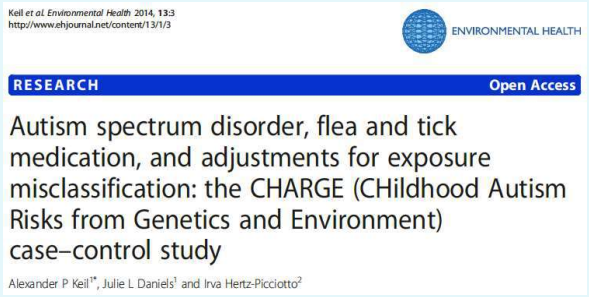

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- Population-based case-control design
- 407 ASD children, 262 controls (age ≈ 3.5 – 4y)
- Exposure data on imidacloprid collected through maternal phone interviews
- Bayesian logistic models

"…the association could result from exposure misclassification alone. The association between imidacloprid exposure and ASD warrants further investigation…"

Table 2 Bayesian and frequentist logistic regression results for preferred model comparing the log-odds of imidacloprid exposure during the prenatal period

	OR	(95% CI) †	CLR‡
Frequentist			
Crude	1.1	(0.71, 1.6)	2.3
Matching factors only	1.2	(0.79, 1.8)	2.3
Fully adjusted	1.3	(0.79, 2.2)	2.8
Occasional users vs. unexposed§	0.69	(0.27, 1.8)	6.6
Consistent users vs. unexposed§	2.0	(1.0, 3.9)	3.7
Bayesian			
Naïve	1.3	(0.78, 2.2)	2.9

† 95% CI – 95% Confidence (frequentist) or Credible (Bayesian) limits
‡ CLR – Confidence or Credible limit ratio = (upper 95% limit/lower 95% limit).

Developmental neurotoxicity

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- Population-based case-control design
- 590 NTD children, 785 controls
- Geocoding for proximity to pesticide application (461 chemicals in 61 groups)
- Logistic regression analysis restricted to compounds listed as reproductive or developmental toxins or endocrine disruptors
- Few elevated odds ratios that excluded 1
- Imidacloprid: aOR = 2.9, 95% CI: 1.0, 8.2 for anencephaly

"Given that such odds ratios might have arisen by chance because of the number of comparisons, our study showed a general lack of association between a range of agricultural pesticide exposures and risks of selected birth defects."

Developmental neurotoxicity

Epidemiological evidence

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the bmj | BMJ 2019;364:l962 | doi: 10.1136/bmj.l962

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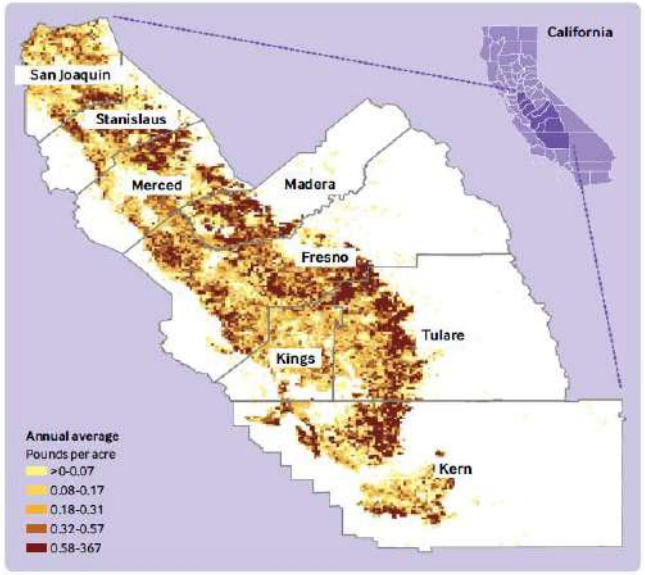

Fig 1 | Pesticide application of glyphosate in Central Valley, CA, 1998-2010

- Population-based case-control design
- 2961 ASD children, controls matched 10:1 by sex and birth year
- GIS based on proximity to pesticide applications
- Logistic regression analysis for 11 high use pesticides according to previous evidence of DNT
- Small increase of aORs (1.10 – 1.16) with assumed prenatal exposure to glyphosate, chlorpyrifos, diazinon, malathion, avermectin, and permethrin
- Imidacloprid: aOR = 0.93, 95% CI: 0.86 to 1.00

"Findings suggest that an offspring's risk of autism spectrum disorder increases following prenatal exposure to ambient pesticides within 2000 m of their mother's residence during pregnancy."

Developmental neurotoxicity

Epidemiological evidence

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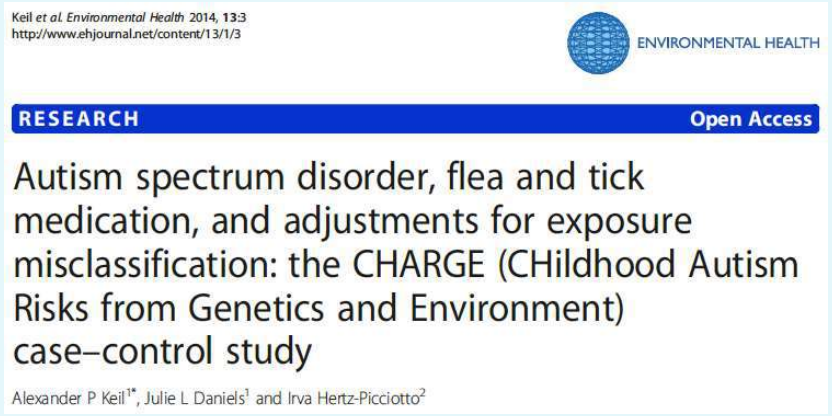

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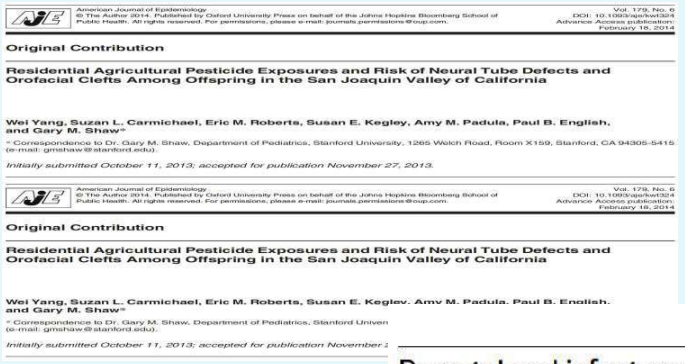

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- Exposure assessment not reliable
  - Proximity of residence to pesticide applications or questionnaire
  - No biomonitoring!
  - Multitude of possible co-exposures to other pesticides and chemicals
- Borderline, mainly non-significant odds ratios, multiple confounders
- Bottom line: current epidemiological evidence does not allow drawing of firm conclusions regarding neonicotinoids and DNT

Developmental neurotoxicity

Biomonitoring in very low birth weight infants

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PLOS ONE

OPEN ACCESS PEER-REVIEWED

RESEARCH ARTICLE

LC-ESI/MS/MS analysis of neonicotinoids in urine of very low birth weight infants at birth

Go Ichikawa, Ryota Kuribayashi, Yoshinori Ikenaka, Takahiro Ichise, Shouta M. M. Nakayama, Mayumi Ishizuka, Kumiko Taira, Kazutoshi Fujioka, Toshimi Sairenchi, Gen Kobashi, Jean-Marc Bonmatin, Shigemi Yoshihara

Published: July 1, 2019 • https://doi.org/10.1371/journal.pone.0219208

- 116 urine samples collected from 65 VLBW infants (500-1500g; 57 at PND 1-2, 59 at PND 14)
- N-Desmethylacetamiprid (DMAP) detected in 21/116 samples
- Wilcoxon rank sum test for non-parametric data was used to compare DMAP concentrations

Table 4. Differences in detection rates and levels of DMAP in SGA and AGA infants.

Item	SGA[a]	AGA[b]	p
Detection rate (%) (number of samples)	42.9 (6/14)	14.7 (15/102)	0.005
Mean concentration (ppb) (median, range)	0.04 (0, 0–0.3)	0.02 (0, 0–0.68)	0.004

[a]SGA: small for gestational age;
[b]AGA: appropriate for gestational age

"The fetal and neonatal periods are extremely important for neurological development, and further studies are needed with regard to the safety of acetamiprid due to transfer and accumulation of its metabolite in the womb."

Developmental neurotoxicity

Latest regulatory conclusions

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Swiss Centre for Applied Human Toxicology

STATEMENT

EFSA Journal

ADOPTED: 29 November 2021

doi: 10.2903/j.efsa.2022.7031

Statement on the active substance acetamiprid

EFSA Panel on Plant Protection Products and their Residues (PPR), Antonio Hernandez Jerez, Paulien Adriaanse, Philippe Berny, Tamara Coja, Sabine Duquesne, Andreas Focks, Marina Marinovich, Maurice Millet, Olavi Pelkonen, Silvia Pieper, Aaldrik Tiktak, Christopher Topping, Anneli Widenfalk, Martin Wilks, Gerrit Wolterink, Maj Rundlöf, Alessio Ippolito, Alberto Linguadoca, Laura Martino, Martina Panzarea, Andrea Terron and Annette Aldrich

https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2022.7031

"For human health, no conclusive evidence of higher hazards compared to previous assessment was found for genotoxicity, developmental toxicity, neurotoxicity including developmental neurotoxicity and immunotoxicity."

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Summary

- Neonicotinoids are one of the most important insecticide classes worldwide.
- Their use is controversial; risk to bees has led to the ban of three substances in Europe.
- Human acute toxicity is on the lower end of the spectrum in comparison with other insecticide classes.
- Methods for biological monitoring have been described but few occupational or consumer exposure studies have been carried out
- The data situation for developmental neurotoxicity is complex; there are currently no high quality epidemiology studies available.

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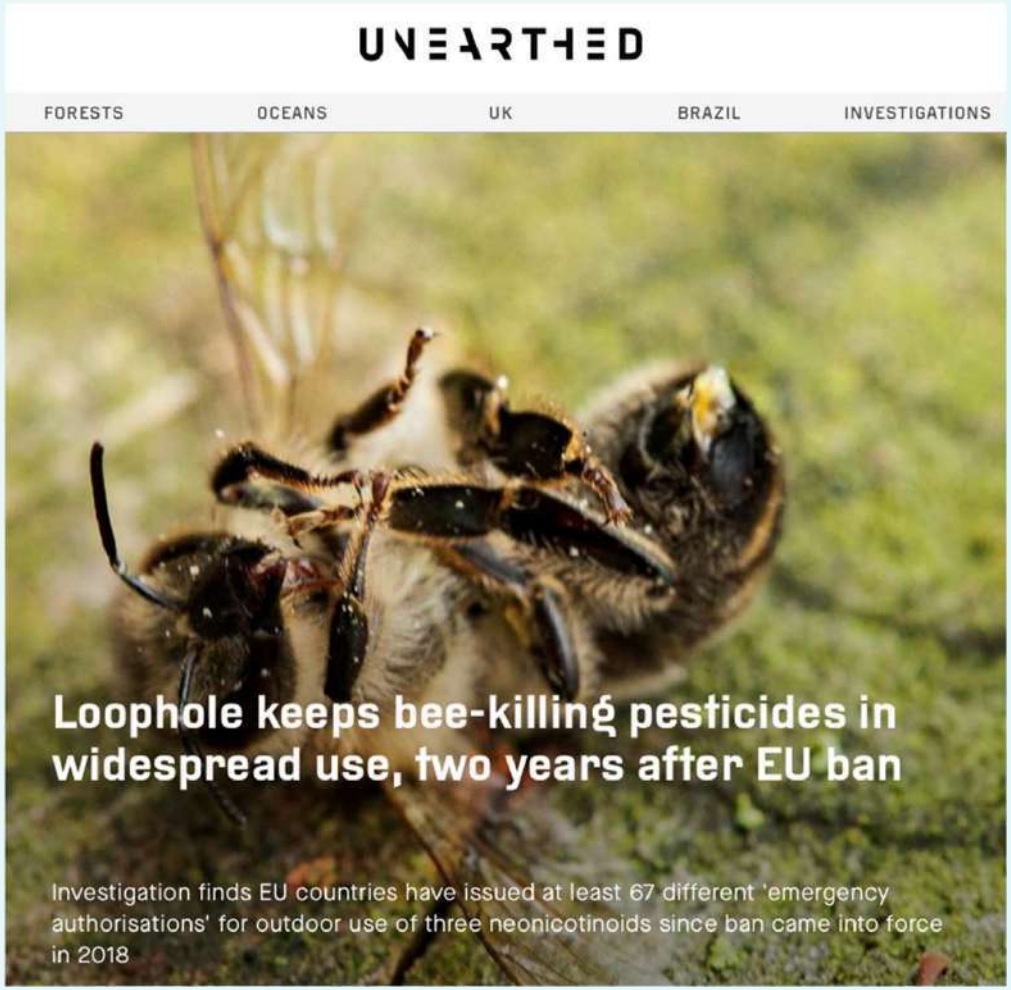
Questions?



https://unearthed.greenpeace.org/2020/07/08/bees-neonicotinoids-bayer-syngenta-eu-ban-loophole/