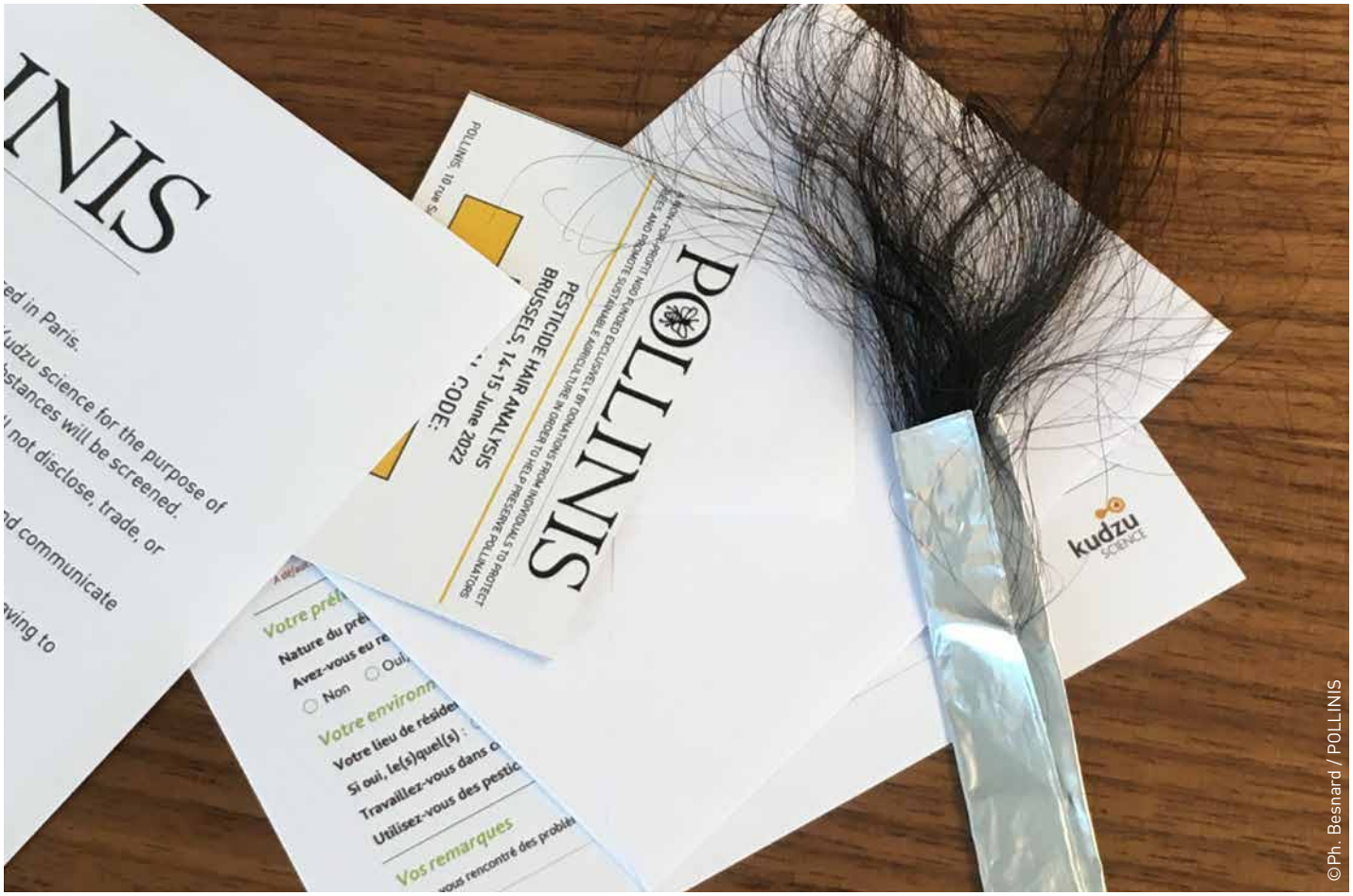
POLLINIS

A NOT-FOR-PROFIT NGO REGISTERED UNDER FRENCH LAW, POLLINIS IS FUNDED EXCLUSIVELY BY DONATIONS FROM INDIVIDUALS TO PROTECT WILD AND HONEY BEES, AND TO PROMOTE SUSTAINABLE AGRICULTURE IN ORDER TO HELP PRESERVE POLLINATORS.



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PESTICIDE CONTAMINATION AMONG MEMBERS OF THE EUROPEAN PARLIAMENT, SCIENTISTS AND JOURNALISTS

The Presence of Pesticides in 44 Hair Samples

I. BACKGROUND

1. THE TESTING CAMPAIGN

POLLINIS, a not-for-profit NGO that promotes sustainable agriculture in order to stop the decline of pollinators and the erosion of biodiversity, is currently documenting environmental contamination by pesticides. Thanks to fundings provided exclusively by citizens, the NGO launched a hair testing campaign in May and June 2022. POLLINIS collected 44 hair samples in Brussels and Paris among 30 Members of the European Parliament and 14 scientists and journalists. The samples were anonymized and analyzed by the Laboratoire IRES - Kudzu Science in Strasbourg, France, for the presence of 62 pesticides. This selection includes 20 banned pesticides in the European Union in order to assess their presence and persistence in the environment.

2. PESTICIDES

The term pesticide refers to substances or formulations used for the prevention, control or elimination of organisms — plants, animals, fungi and bacteria — deemed undesirable. Depending on their target, pesticides are divided into different categories: herbicides (against plants such as weeds), insecticides (against insects), fungicides (against fungi and moulds).

Widely used in massive doses in conventional farming in the last decades, pesticides are also found in numerous household products: Wood treatments, mosquito repellents, veterinary products (anti-parasite), treatments against mites, gardening treatment products... Increasing scientific evidence shows that pesticides are now omnipresent in the environment[1]. They are detectable in the air, soils, waters and living organisms[2], exhibiting devastating impact on pollinators and biodiversity in general[3-7], but also negative effects on various aspects of human health[8].

Hair testing is one effective means to evaluate the scale of pesticides contamination in the environment.

2. HAIR ANALYSYS

During its growth, the hair is irrigated at the root by blood vessels and incorporates the pollutants to which the body is exposed at that moment. Hair analysis is increasingly used as the method offers numerous advantages[9]:

- It allows the detection of both parent compounds and their metabolites (the molecules resulting from the degradation of pesticides).

[1] Jäger, Julia E. "Residues of pesticides." Chemical hazards in foods of animal origin 7 (2019): 81.
[2] Woodrow, James E., Kate A. Gibson, and James N. Seiber. "Pesticides and related toxicants in the atmosphere." Reviews of Environmental Contamination and Toxicology Volume 247 (2018): 147-196.
[3] Isenring, R. Pesticides reduce biodiversity. *Pesticides News* 4–7 (2010).
[4] Beketov, M. A., Kefford, B. J., Schäfer, R. B. & Liess, M. Pesticides reduce regional biodiversity of stream invertebrates. doi:10.1073/pnas.1305618110 (2013).
[5] Brühl, C. A. & Zaller, J. G. Biodiversity Decline as a Consequence of an Inappropriate Environmental Risk Assessment of Pesticides. *Front Environ Sci* **7**, 177 (2019).
[6] Geiger, F. et al. Persistent negative effects of pesticides on biodiversity and biological control potential on European farmland. *Basic Appl Ecol* **11**, 97–105 (2010).
[7] Walker, L. & Wu, S. Pollinators and Pesticides. *International Farm Animal, Wildlife and Food Safety Law* 495–513 (2017) doi:10.1007/978-3-319-18002-1_17.
[8] Rani, L., Thapa, K., Kanojia, N., Sharma, N., Singh, S., Grewal, A.S., Srivastav, A.L. and Kaushal, J., 2021. An extensive review on the consequences of chemical pesticides on human health and environment. *Journal of Cleaner Production*, 283, p.124657.
[9] Iglesias-González, A., Hardy, E. M. & Appenzeller, B. M. R. Cumulative exposure to organic pollutants of French children assessed by hair analysis. *Environ Int* **134**, 105332 (2020).

- The detected pesticide concentrations are directly related to the level of exposure: The presence of pesticides in hair is not affected by short-term variations in the exposure like in blood or urine.
- The ease of hair sampling (painless and non-invasive) makes it a suitable method for everyone — including children.

During the testing organized by POLLINIS, hair samples were obtained using sterile scissors for hair longer than 3 cm or a shaving machine in the case of shorter hair. The weight of a sample was assessed using analytical scale (Brifit) with 0.001g precision. The sample was wrapped in aluminium foil and immediately sent to an independent laboratory for chemical analysis. Upon reception, the hair sample was ground using a ball mill. A precise amount of the sample (~50mg) was extracted with a mixture of organic solvents. The extract was analyzed by liquid chromatography coupled with tandem mass spectrometry (LC-MS/MS) and by gas chromatography coupled with tandem mass spectrometry (GC-MS/MS).

II. RESULTS AND STATISTICS

In this study, 44 hair samples collected in May and June 2022 were analyzed for the presence of 62 pesticides. The list of 62 pesticides targeted and their presence in the 44 anonymized and analyzed hair samples can be found in Supplementary Table 1.[10]

1. MAIN FINDINGS

DETECTED PESTICIDES

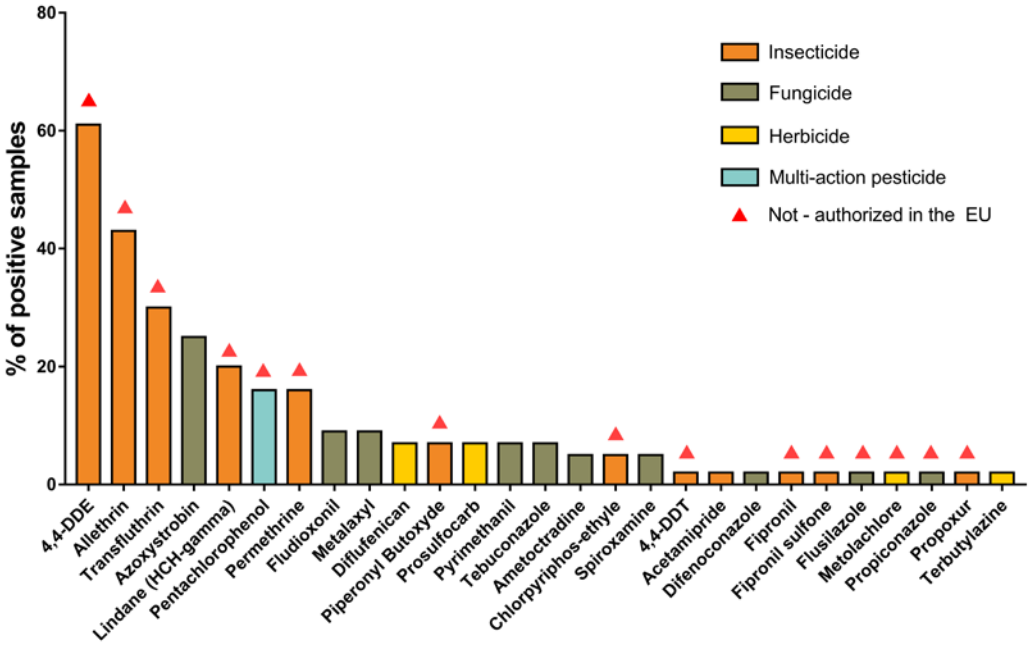

Figure 1: *Detection frequency in positive samples. For each pesticide, the value indicated in the graph corresponds to the percentage of analyzed hair samples containing it.*

[10] https://www.pollinis.org/admin/wp-content/uploads/2022/09/pesticides-contamination-results-hair-sampling-study-pollinis.pdf

→ Out of the 62 assessed pesticides, **27** (**44%**) were detected in at least 1 sample. The three pesticides detected most often were insecticides : 4,4-DDE (metabolite of DDT), allethrin and transfluthrin (**Figure 1**).

→ **15** (**55,5%**) of the detected pesticides are not authorized in the European Union and 12 (**44,5%**) are authorized (**Figure 2A**).

→ Out of the 44 hair samples, **40** (**91%**) contained at least one pesticide, with 3 pesticides per sample on average. The highest number of pesticides detected in one sample was 11 (**Figure 2B**).

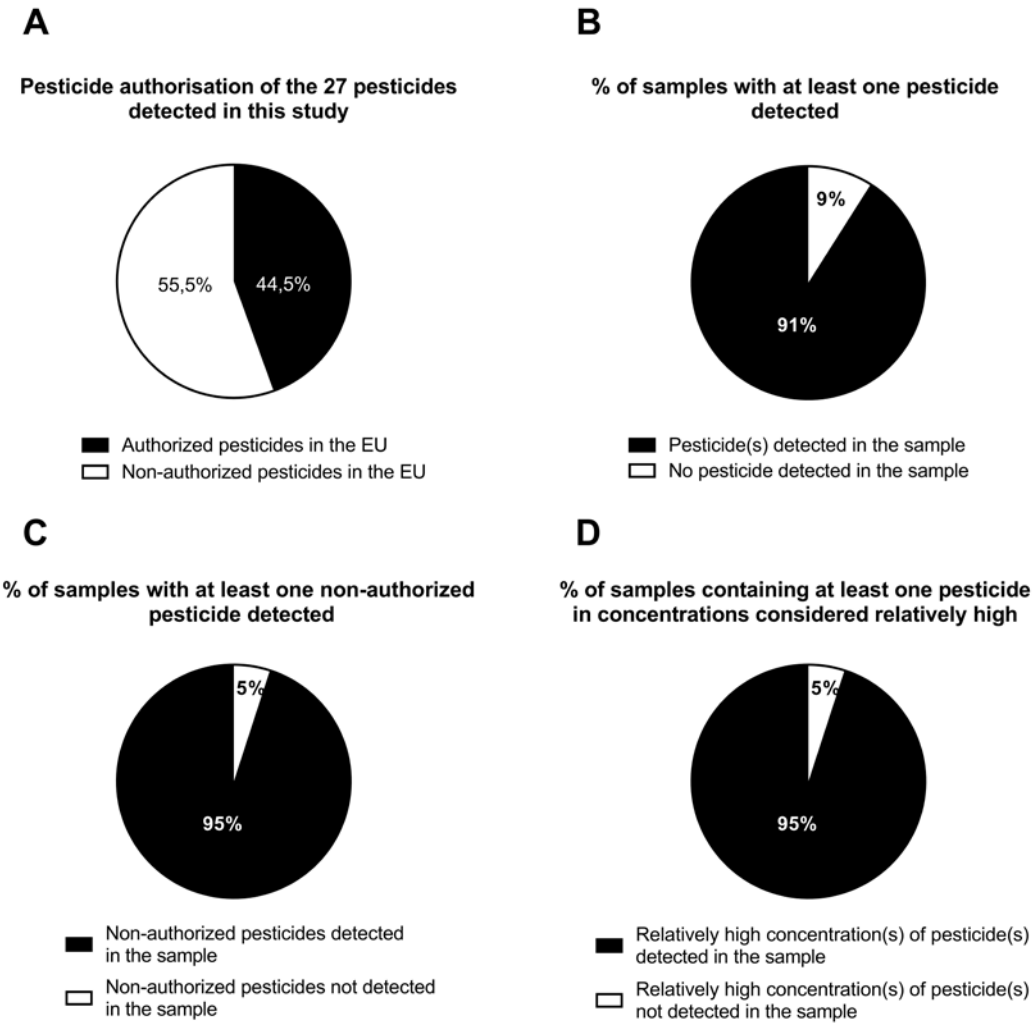

Figure 2: *Pesticide authorisation of the 27 pesticides detected in this study (A), percentage of samples with at least one pesticide detected (out of the 44 analyzed samples) (B), percentage of samples containing at least one non-authorized pesticide detected (C), percentage of samples containing at least one pesticide detected in concentrations considered relatively high compared to the rest of the population tested in France according to the laboratory's statistical data (D).*

→ Out of the samples with at least one pesticide detected, **38** samples (**95%**) contained at least one pesticide non-authorized in the European union (**Figure 2C**).

→ Out of the samples with at least one pesticide detected, **38** samples (**95%**) contained at least one pesticide in concentrations considered high compared to the rest of the population tested in France according to the laboratory's statistical data (**Figure 2D**).

→ The three pesticides with the highest concentrations detected were allethrin (up to **1801.4** pg/mg per sample), permethrin (up to **898.4** pg/mg per sample) and pentachlorophenol (up to **829.2** pg/mg per sample).

→ Among the detected pesticides, **12** (**44,4%**) were insecticides, **10** (**37%**) fungicides, **4** (**14.8%**) herbicides and 1 (3.7%) multi-action pesticide (**Figure 3**).

PESTICIDES ACTION DISTRIBUTION

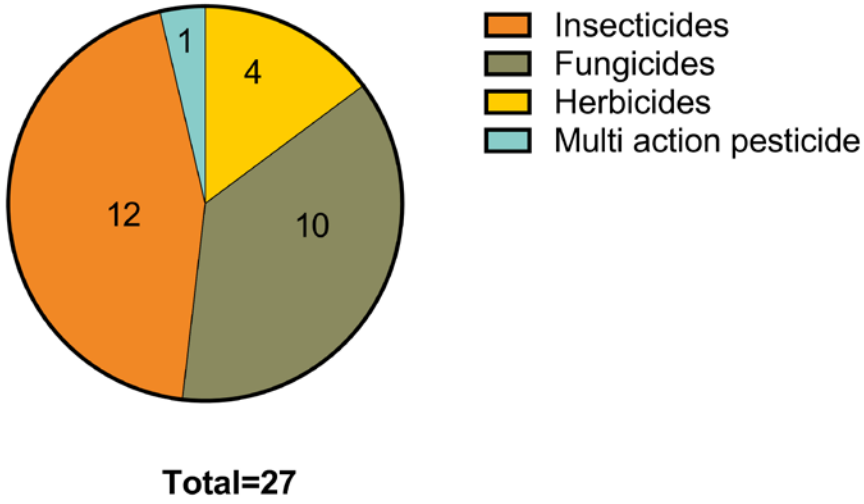

Figure 3: *Number of pesticides detected based on their target category.*

2. RESULTS INTERPRETATION

The results of this analysis provide information on the nature of the pesticides to which tested subjects were exposed, whether from an external source (food, products applied to lumber or furniture, agricultural activity, treatment of public parks and roads) and/or from a voluntary internal source (insect repellent products, treatment of domestic animals and products for the garden or home). The results reflect the exposure to pesticides depending on the length analyzed: Generally, 1 cm of hair corresponds to a 1 month exposure period. The presence of pesticides in hair can be the result of either large and specific (acute) exposure or regular exposure to low doses (chronic exposure), or the combination of both.

The concentrations of pesticides measured are expressed in picograms (pg) of pesticide per milligram (mg) of hair. For information: 1 g = 1 000 mg and 1 mg = 1 000 000 000 pg.

Attention! It is crucial to note that, to date, there is no reference scale linking a certain concentration of pesticide measured in the hair to a level of health risk. However, given the cocktail effect of pesticides (increased toxicity by combining

multiple chemical pollutants) and their activity at low doses, as demonstrated by numerous scientific studies, it is important to consider that any chronic exposure to pesticides, whatever the concentration, has the potential to affect human health.

LOW DOSES, HIGH IMPACTS

One of the most documented negative health effects of pesticides is endocrine disruption[11]. An endocrine disruptor is an exogenous substance or mixture that alters function(s) of the endocrine system, causing adverse health effects in an intact organism, or its progeny, or (sub) populations. Pesticides disrupting oestrogen and androgen axis affect reproduction[12], while thyroid disrupting pesticides don't only affect the thyroid axis, but also affect metabolism, neuronal development, or behaviour as well[13]. Endocrine disruptors increase the risk of cancer, developmental malformations, and disturbances in the immune and nervous system function [14,15].

Endocrine disrupting chemicals are known to act even at very low doses, as they exhibit so-called non-monotonous dose response. This means that even if they are inactive in high doses, they can exert activity at very low doses. Therefore, exposure levels are important, even if they might seem low and insignificant.

III. DETECTED PESTICIDES

To date, there is no reference scale between the concentration measured in the hair and a possible health risk level. To limit exposure to pesticides, it is important to know their sources and how to use them safely. Thus, for each pesticide, we present information on the possible uses but also the health risks related to chronic or acute exposure when toxicological information is available. **The presence of a pesticide in a hair sample does not necessarily mean that the tested subject will develop the pathologies described here, which are given for information purposes.** The appearance of pathologies caused by exposure to pesticides depends on multiple factors, including the quality and time of exposure to the pesticides as well as on the sensitivity of the exposed subject.

1. LIST BY FREQUENCY

All information concerning the pesticides listed in this chapter was found in databases: Pesticide Properties Database (information on application, toxicity, health effects and degradation time), EU Pesticides database (authorization information) , and BNVD (information concerning pesticide market in France).

[11] Mnif, W. et al. Effect of Endocrine Disruptor Pesticides: A Review. Int J Environ Res Public Health 8, 2265 (2011).
[12] Amir, S. et al. Endocrine Disruptors Acting on Estrogen and Androgen Pathways Cause Reproductive Disorders through Multiple Mechanisms: A Review. Int J Environ Res Public Health 18, 1–20 (2021).
[13] Mughal, B. B., Fini, J. B. & Demeneix, B. A. Thyroid-disrupting chemicals and brain development: an update. Endocr Connect 7, R160 (2018).
[14] Soto, A. M. & Sonnenschein, C. Environmental causes of cancer: endocrine disruptors as carcinogens. Nat Rev Endocrinol 6, 363 (2010).
[15] Mokarizadeh, A., Faryabi, M. R., Rezvanfar, M. A. & Abdollahi, M. A comprehensive review of pesticides and the immune dysregulation: mechanisms, evidence and consequences. http://dx.doi.org/10.3109/15376516.2015.1020182 25, 258–278 (2015).

→ 4,4-DDE and 4,4-DDT

4,4-DDE is a metabolite of the insecticide 4,4-DDT, which was banned in 1978 in the European Union. Before its ban DDT was used widely in various environments, for example on agricultural crops, houses, offices, commercial and industrial facilities, and non-cropped sites including roads, rights-of-way, or parkland. 4,4-DDE and 4,4-DDT are very persistent molecules in soil and are not degraded by the body and can be passed on to the offspring through breast milk.[15]

General human health issues linked to 4,4-DDE and 4,4-DDT: Toxic if ingested, inhaled or via skin absorption, mutagenicity, endocrine disruption, linked to breast and uterine cancer.

Toxicity: 4,4-DDE is moderately toxic for mammals, birds and earthworms and highly toxic to fish and aquatic invertebrates. 4,4-DDT is highly toxic to aquatic invertebrates, honeybees and other pollinators and moderately toxic to mammals and fish.

Detection frequency and concentrations: 4,4-DDE was detected in **61%** of hair samples in this study, the highest detected concentration was **14.4** pg/mg. Traces of 4,4-DDT in concentrations below the detection limit were detected in **2%** of hair samples in this study.

→ Allethrin

Allethrin is a pyrethroid insecticide banned in the European Union in 2002. It is mostly used as a household insecticide that kills flies, mosquitoes, or garden insects.

General human health issues linked to allethrin: Potential mutagen, kidney and liver toxicant, inhalation may cause asthma, coughing, wheezing, running nose and eyes.

Toxicity: Moderately toxic for honeybees, mammals and fish, highly toxic to aquatic invertebrates.

Detection frequency and concentrations: Allethrin was detected in **43%** of hair samples in this study, the highest detected concentration was **1801.4** pg/mg.

→ Transfluthrin

Transfluthrin is a pyrethroid insecticide not authorized in the European Union. It is used in domestic and public hygiene contexts to kill moths, mosquitoes, flies and cockroaches.

General human health issues linked to transfluthrin: Kidney and liver toxicant.

Toxicity: Moderately toxic to bees, mammals and birds, highly toxic to fish and aquatic invertebrates.

Detection frequency and concentrations: Transfluthrin was detected in **30%** of hair samples in this study, the highest detected concentration was **30.0** pg/mg.

→ Azoxystrobin

Azoxystrobin is a broad spectrum strobilurin fungicide. In France, 255 018 kilograms of Azoxystrobin were sold in 2020. It is used mainly for cereals, but also in fruits (grapes, citrus, strawberries, peaches, tomatoes), sunflowers, vegetables (onions, brassicas and cucurbits, potatoes), and other products such as pecans, peanuts, canola, soybeans, cotton, turf and ornamentals.

[15] Du J, Gridneva Z, Gay MC, Lai CT, Trengove RD, Hartmann PE, Geddes DT. Longitudinal study of pesticide residue levels in human milk from Western Australia during 12 months of lactation: Exposure assessment for infants. Sci Rep. 2016 Dec 7;6:38355. doi: 10.1038/srep38355.

It is a persistent molecule in soil.
General human health issues linked to azoxystrobin: Minor effects on reproduction / development, liver toxicant.
Toxicity: Moderately toxic to bees, fish and earthworms, highly toxic to mammals and aquatic crustaceans.
Detection frequency and concentrations: azoxystrobin was detected in **25%** of hair samples in this study, the highest detected concentration was **12.7** pg/mg.

→ Lindane (HCH-gamma)

Lindane is an insecticide and acaricide banned in the European Union in 2000. It is used mainly as a seed treatment to control phytophagous and soil-inhabiting insects in fruit and vegetable crops, forestry, tobacco, and timber. It is a very persistent molecule in soil.
General human health issues linked to lindane: Highly toxic, dermatitis, abdominal pain, nausea, vomiting, seizures, muscle tremors and hyperreflexia, possibly a human carcinogen, endocrine disruption (reduction of oestrous cycles).
Toxicity: Moderately toxic to birds, and aquatic invertebrates, highly toxic to mammals, fish, bees and other pollinators.
Detection frequency and concentrations: lindane was detected in **20%** of hair samples in this study, the highest detected concentration was **63.7** pg/mg.

→ Pentachlorophenol

Pentachlorophenol is a multi-action pesticide not authorised in the European Union since 2002. It is used to control wood boring insects or wood fungal rots in utility wood structures such as railway sleepers, utility poles and fencing. It is a moderately persistent molecule in soil.
General human health issues linked to pentachlorophenol: Liver and thyroid toxicant, heart failure may occur following acute inhalation, carcinogenic, endocrine disruptor - weak estrogenic and anti-androgenic effect.
Toxicity: Highly toxic to mammals, moderately toxic to birds, honeybees, fish and aquatic invertebrates.
Detection frequency and concentrations: pentachlorophenol was detected in **16%** of hair samples in this study, the highest detected concentration was **853.3** pg/mg.

→ Permethrin

Permethrin is a pyrethroid insecticide not authorised in the European Union since 2000. It Is used to control cockroaches, termites, ticks, mosquitoes, fleas or ants and it is most commonly applied to fruit, vegetables, cotton, ornamentals, potatoes or cereals.
General human health issues linked to permethrin: Carcinogenicity, neurotoxicity, irritation, endocrine disruption.
Toxicity: Moderately toxic to mammals, highly toxic to bees, fish and aquatic invertebrates.
Detection frequency and concentrations: Permethrin was detected in **16%** of hair samples in this study, the highest detected concentration was **898.4** pg/mg.

→ Fludioxonil

Fludioxonil is a fungicide for control of a range of diseases on fruit and vegetables such as apples, cranberries, pear, quince, strawberry and currants, peas, and

beans. In France, 99 064 kilograms of fludioxonil were sold in 2020. It is a persistent molecule in soil.
General human health issues linked to fludioxonil: Liver and kidney toxicant.
Toxicity: Highly toxic to mammals in some tests, moderately toxic to fish and birds.
Detection frequency and concentrations: Fludioxonil was detected in **9%** of hair samples in this study, the highest detected concentration was **118.9** pg/mg.

→ Metalaxyl

Metalaxyl is a fungicide used on agricultural crops including tobacco, potatoes, soybean, onions, citrus, cucurbits, tomatoes, and cotton. In France, 40 711 kilograms of metalaxyl were sold in 2020.
General human health issues linked to metalaxyl: Liver toxicant.
Toxicity: Highly toxic for mammals in some tests, moderately toxic for birds and fish.
Detection frequency and concentrations: Traces of metalaxyl in concentrations below the detection limit were detected in **9%** of hair samples in this study.

→ Diflufenican

Diflufenican is a herbicide used to control grasses and broad-leaved weeds such as clover-based pastures, field peas, lentils, lupins and winter cereals. In France, 499 684 kilograms of Diflufenican were sold in 2020.
General human health issues linked to diflufenican: no information available.
Toxicity: Moderately toxic to birds, fish and mammals.
Detection frequency and concentrations: Traces of diflufenican in concentrations below the detection limit were detected in **7%** of hair samples in our study.

→ Piperonyl butoxide

Piperonyl butoxide does not have any pesticidal activity of its own but it is used as an enhancer of the potency of certain insecticides (e.g. pyrethroids) as synergist. In France, 39 176 kilograms of Piperonyl butoxide were sold in 2020.
General human health issues linked to piperonyl butoxide: Endocrine disruption, possible carcinogenicity, and liver toxicity.
Toxicity: Highly toxic to mammals in some tests, moderately toxic to fish.
Detection frequency and concentrations: Traces of piperonyl butoxide in concentrations below the detection limit were detected in **7%** of hair samples in this study.

→ Prosulfocarb

Prosulfocarb is a herbicide used for post-emergence control of grass and broad-leaved weeds in a wide range of crops such as cereals including winter wheat and winter barley, and potatoes. In France, 5 735 323 kilograms of Prosulfocarb were sold in 2020 making it the second most sold pesticide in France after glyphosate.
General human health issues linked to prosulfocarb: Moderately toxic irritant.
Toxicity: Moderately toxic to honeybees, birds, fish and mammals.
Detection frequency and concentrations: Prosulfocarb was detected in **7%** of hair samples in this study, the highest detected concentration was **5.7** pg/mg.

→ Pyrimethanil

Pyrimethanil is a fungicide used to control fungal pathogens on fruit, vegetables and ornamentals such as almonds, pistachios, grapes, stone fruits (except cherries), apples, strawberries, potatoes and other tuberous and corm vegetables and tomatoes. In France, 25 424 kilograms of pyrimethanil were sold in 2020.

General human health issues linked to pyrimethanil: Possible carcinogenicity, possible liver, kidney, adrenals, bladder, and thyroid toxicant.

Toxicity: Moderately toxic to birds, mammals, and fish.

Detection frequency and concentrations: Pyrimethanil was detected in **7%** of hair samples in our study, the highest detected concentration was **13.7** pg/mg.

→ Tebuconazole

Tebuconazole is a fungicide effective against various foliar diseases in cereals and other field crops such as wheat, barley, oat, rye, grapes, peanuts, vegetables including onions, peas, pepper, bananas, and sugarcane. In France, 513 272 kilograms of tebuconazole were sold in 2020.

General human health issues linked to tebuconazole: Possible carcinogenicity, endocrine disruption.

Toxicity: Highly toxic to mammals, birds and moderately toxic to bees and fish.

Detection frequency and concentrations: Traces of tebuconazole in concentrations below the detection limit were detected in **7%** of hair samples in this study.

→ Ametoctradin

Ametoctradin is a fungicide used to control fungal diseases on fruit and vegetables such as potatoes, tomatoes, grapes, cucurbits, lettuce, cucumber, brassicas, leeks, onions, or shallots. In France, 121 089 kilograms of ametoctradin were sold in 2020.

General human health issues linked to ametoctradin: No information available.

Toxicity: Highly toxic to fish, moderately toxic to birds.

Detection frequency and concentrations: Traces of ametoctradin in concentrations below the detection limit were detected in **5%** of hair samples in this study.

→ Chlorpyrifos-ethyl

Chlorpyrifos-ethyl is an organophosphate pesticide banned in the European Union in 2020. It is an insecticide and acaricide used to control soil and foliage pests for example at barley, wheat, cotton, apples, pears, grapes, pineapples, bananas, strawberries, mango, tomatoes, nuts, carrots, cabbages, cauliflower, or Brussel sprouts. It is a very persistent molecule in soil.

General human health issues linked to chlorpyrifos-ethyl: Endocrine disruption, neurotoxicity, possible link with behavioural disorders and learning difficulties in children.

Toxicity: Highly toxic to mammals, birds, honeybees and other pollinators and fish.

Detection frequency and concentrations: Chlorpyrifos-ethyl was detected in **5%** of hair samples in this study, the highest detected concentration was **15.6** pg/mg.

→ Spiroxamine

Spiroxamine is a fungicide used to control common fungal diseases on cereals

and fruit such as on grapes, wheat, triticale, barley, oats, or rye. In France, 98 376 kilograms of Spiroxamine were sold in 2020.
General human health issues linked to spiroxamine: No information available.
Toxicity: moderately toxic to mammals, birds (in some tests highly), bees and fish.
Detection frequency and concentrations: Traces of spiroxamine in concentrations below the detection limit were detected in **5%** of hair samples in this study.

→ Acetamiprid

Acetamiprid is an insecticide used to control sucking and chewing pests in leafy and fruiting vegetables, fruit including citrus, apples, pears, grapes, cotton, or ornamental plants and flowers. In France, 757 kilograms of acetamiprid were sold in 2020.
General human health issues linked to acetamiprid: No information available.
Toxicity: Highly toxic to mammals and birds, moderately toxic to aquatic invertebrates and bees.
Detection frequency and concentrations: Acetamiprid was detected in **2 %** of hair samples in our study, the highest detected concentration was **6.1** pg/mg.

→ Difenoconazole

Difenoconazole is a fungicide used as a spray or seed treatment for example in vegetables including carrots, asparagus, brassicas, potatoes, cereals including barley, oats, rye, wheat, triticale, sweetcorn, cotton, canola, or tomatoes.
In France, 161 901 kilograms of difenoconazole were sold in 2020. It is a persistent molecule in soil.
General human health issues linked to difenoconazole: Liver, heart, thyroid and kidney toxicant, possible carcinogen.
Toxicity: Highly toxic to mammals and birds in some tests, moderately toxic to fish.
Detection frequency and concentrations: Traces of difenoconazole in concentrations below the detection limit were detected in **2%** of hair samples in this study.

→ Fipronil and Fipronil sulfone

Fipronil sulfone is a metabolite of fipronil, an insecticide banned in the European Union in 2017. It is used mainly to control insects in horticultural crops such as hardy ornamentals, non-edible ornamentals, and turf. Fipronil is a persistent molecule in soil, while fipronil sulfone is very persistent.
General human health issues linked to fipronil: Thyroid, kidney and liver toxicant, possible carcinogen, neurotoxicant.
Toxicity: Highly toxic to bees, mammals, birds and moderately toxic to fish.
Detection frequency and concentrations: Fipronil was detected in **2%** of hair samples in this study, the highest detected concentration was **410.57** pg/mg. Fipronil sulfone was detected in **2%** of hair samples in this study, the highest detected concentration was **20.43** pg/mg.

→ Flusilazole

Flusilazole is a fungicide not authorized in the European Union (authorisation expired in 2013). It is used mostly on apples, pears, apricots, plums, peaches, bananas, grapes, sugar beets, oilseed rape, and cereals. It is a very persistent

molecule in soi.
General human health issues linked to flusilazole: Endocrine disruption - Inhibition of aromatase activity, decrease of oestrogen production.
Toxicity: Highly toxic for mammals, moderately toxic for birds, honeybees and fish.
Detection frequency and concentrations: Traces of flusilazole in concentrations below the detection limit were detected in **2%** of hair samples in this study.

→ Metolachlor

Metolachlor is a herbicide banned in the European Union in 2002. It is used to control weeds in fields of corn, soybeans, sorghum, potatoes, cotton, safflower, stone fruits, nuts and woody ornamentals. It is moderately persistent in soil.
General human health issues linked to metolachlor: Endocrine disruption and possible carcinogenicity.
Toxicity: Highly toxic to mammals in some tests, moderately toxic to fish.
Detection frequency and concentrations: Traces of metolachlor in concentrations below the detection limit were detected in **2%** of hair samples in this study.

→ Propiconazole

Propiconazole is a fungicide banned in the European Union in 2018. It has a wide range of agricultural cropping applications for example on mushrooms, corn, wild rice, peanuts, almonds, sorghum, oats, pecan, apricots, plums, prunes, peaches, and nectarines.
General human health issues linked to propiconazole: Possible liver toxicant, possible carcinogen, endocrine disruption - weak oestrogen and aromatase activity inhibitor.
Toxicity: Moderate to high toxicity in mammals, moderate toxicity to fish and birds.
Detection frequency and concentrations: Traces of propiconazole in concentrations below the detection limit were detected in **2%** of hair samples in our study.

→ Propoxur

Propoxur is an insecticide and acaricide banned in the European Union in 2002. It is used to control sucking and chewing pests such as cockroaches, flies, mosquitoes, domestic fleas, ticks, and leafhoppers in ornamental lawns, turf or on glasshouse crops including tomatoes and cucumbers.
General human health issues linked to propoxur: Endocrine disruption, possible carcinogenicity.
Toxicity: Highly toxic to mammals, birds and bees, moderately toxic to fish.
Detection frequency and concentrations: Traces of propoxur in concentrations below the detection limit were detected in **2%** of hair samples in this study.

→ Terbuthylazine

Terbuthylazine is an herbicide used to control grass and broad-leaved weeds for example in maize, sorghum, apples, citrus and bush vines and for control slime-forming algae, fungi, and bacteria in non-agricultural situations such as roads, railways, industrial sites. In France, 178 427 kilograms of Terbuthylazine were sold in 2020.

General human health issues linked to terbuthylazine: Toxic, may be fatal if inhaled, swallowed, or absorbed through skin.
Toxicity: Moderate to high toxicity to mammals, moderately toxic to birds, bees and fish.
Detection frequency and concentrations: Traces of terbuthylazine in concentrations below the detection limit were detected in **2%** of hair samples in this study.

2. Q&A

1. How can someone get exposed to pesticides detected in the samples?
Pesticides are omnipresent in our environment. Exposure to pesticides is mainly by ingestion and inhalation: Through water and food, domestic activities, but also through the air, as pesticides can be deposited on dust particles, the smallest of which are carried in the air we breathe. If you live near crops (fields, vineyards, orchards), you may be exposed to pesticides, which can be dispersed by the wind for several kilometres around the spraying area. In addition, the sources of non-agricultural pesticide emissions are largely underestimated. Wooden structures (frames, old wooden furniture) are treated to avoid deterioration by mould or insects. Insecticide products such as mosquito repellent, veterinary products (anti-parasite), treatments against mites, or phytosanitary products such as herbicides or insecticides sold in supermarkets and garden centres only add to the list of pollutants that surround us.

2. How is it possible that non-authorized pesticides are detected in the samples?
Many pesticides are persistent in the environment, even years after their ban. In some cases, pesticides banned in the European Union are authorized in other countries and they can be present in imported food and fruit. Pesticides such as pentachlorophenol were used to treat old furniture or wooden structures in houses and are nowadays released into the environment during renovations.

3. Certain pesticides detected in samples appear in the list as very harmful for human health, even causing cancer. Will the tested subjects develop these negative health effects?
The presence of a pesticide in the samples does not necessarily mean that the tested subjects will develop the pathologies described. To date there is no reference scale linking a certain concentration of pesticide measured in the hair to a level of health risk. However, given the cocktail effect of pesticides (increased toxicity by combining multiple chemical pollutants) and their activity at low doses, which was demonstrated by numerous scientific studies, it is important to consider that any chronic exposure to pesticides, whatever the concentration, has the potential to affect human health. It is important to know one's exposure levels and limit the exposition to detected pesticides.

CONCLUSION

Among the troubling results of this analysis of 44 hair samples collected from Members of the European Parliament, scientists and journalists, two statistics stand out: 91% of all samples contained pesticides and, among samples with at least one pesticide detected, 95% contained pesticides or their metabolites not authorized in the European Union.

The presence of pesticides banned in the European Union in the samples is striking. Besides residues in imported food and fruit, many such pesticides are persistent in the environment, sometimes years after their ban. This finding is a measure of the inadequacy of the pesticide registration system, which allows the authorization of pesticides on the market whose toxicity is not properly assessed. When a substance is banned, however, the procedure for withdrawing it from the market is laborious and difficult, often riddled with exemptions, allowing Member States to continue using toxic products for years.

The alarming results of this study help envision the scale of pesticide contamination in the environment, a fact attested by increasing scientific evidence. Pesticides are found in numerous household products, but they are, above all, massively used in agriculture – about 43.4 thousands of tonnes of pesticides were sold in France alone in 2020. As a result, pesticides are presently found in the air, soil, water and living organisms. The routes of contamination are multiple, and this omnipresence has devastating impact on pollinators and biodiversity as well as negative effects on human health.

Given the existence of proven agricultural alternatives (integrated pest management, agroecology, organic farming), the European Union and its Member States must take urgent measures to stop this contamination and restore ecosystems.

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