Presentation of Published Peer-Reviewed Documents Supporting Petition to Ban Glyphosate

Presented To

Belize Pesticide Control Board
Registration Review Committee

30 August 2016 10 a.m.

Central Farm, Cayo, Belize

Petitioners

Concerned Individuals

and

Belize Organizations:

Sustainable Harvest International -Belize, Plenty Belize, Belize Botanic Gardens, Belize Organic Family Farming, Pro Organic Belize, Belize Wellness Institute

Presenters

Mark Miller, M. Eng.

Environmental Pollution Control
Pennsylvania State University, USA

Nana Menseh, M.S.

Agricultural Engineering and Agronomy
Instituto Superior, Havana Cuba

Dr. Ed Boles, Ph.D.

Aquatic Ecology
Jackson State University, Florida, USA

Petition to Ban Use of

GLYPHOSATE

PART ONE

Testing and Use Past and Present

Mark Miller - M.Eng.
Environmental Pollution Control
Pennsylvania State University

Glyphosate (N-phosphono-methyl glycine) was first registered in 1974 with the EPA.

The registration was revisited in 1993 where it was noted:

Reproductive Effects

Most of the field and laboratory evidence shows that glyphosate produces no reproductive changes in test animals. It is unlikely that the compound would produce any reproductive effects in humans.[1]

Teratogenic Effects

In a teratology study with rabbits, the maternal NOEL was 175 mg/kg/day and no developmental toxicity was observed in the fetuses at the highest dose tested (350 mg/kg/day) [2]. Rats given doses up to 3,500 mg/kg on days 6 to 19 of pregnancy had offspring with no teratogenic effects, but other toxic effects were observed in both the mothers and the fetuses. No toxic effects to the fetuses occurred at 1,000 mg/kg/day.

1 http: //pmep.cce.cornell.edu/profiles/extoxnet/dienochlor-glyphosate/glyphosate-ext.html

2 U.S. Environmental Protection Agency (1992). Pesticide Tolerance for Glyphosate. Federal Register 57 (49): 8739-40.

1993 registration (continued)

Carcinogenic Effects

Rats and dogs and mice fed glyphosate over a wide range of doses showed no cancer related effects directly due to the compound [3]. EPA has stated that there is sufficient evidence to conclude that glyphosate is not carcinogenic in humans [2].

Environmental Fate

Glyphosate is highly adsorbed on most soils especially those with high organic content. The compound is so strongly attracted to the soil that little is expected to leach from the applied area.

Microbes are primarily responsible for the breakdown of the product. The time it takes for half of the product to break down ranges from 1 to 174 days.

Little is transferred by rain or irrigation water. One estimate showed less than two percent of the applied chemical lost to runoff [3]. The herbicide could move when attached to soil particles in erosion run-off.

3 Forest Service (1984). Pesticide Background Statements, Vol. I Herbicides. United States Dept. of Agriculture, Agriculture Handbook No. 633.

1993 registration (continued)

Environmental Fate

Photodecomposition plays only a minor role in environmental breakdown.

In water, glyphosate is strongly adsorbed to suspended organic and mineral matter and is broken down primarily by microorganisms also.

Its half-life in pond water ranges from 12 days to 10 weeks.

Glyphosate may be extensively metabolized by some plants while remaining intact in others

Once in the plant tissue, the chemical is translocated throughout the plant, including to the roots.

4 Grossbard, E. and D. Atkinson, Editors (1985). The Herbicide Glyphosate, Butterworths, Boston, MA

Glyphosate has become one of the most popular herbicides in the world, with use dramatically increasing in recent years.

Most commonly formulated as Monsanto's Roundup herbicide, approximately 135 million pounds per year[5] of glyphosate end-use products are used in the US alone on a variety of agricultural crops (and non-agricultural sites such as lawns, gardens and parks), more than seven times its annual reported usage when its first Reregistration Eligibility Decision (RED) document was published in 1993.[6]

During this time of increasing glyphosate popularity, and since the publication of the agency's 1993 RED document, data has been emerging that point to various health and environmental consequences resulting from glyphosate and Roundup use.

5 USEPA. 2009. Registration Review—- Preliminary Problem Formulation for the Ecological Risk and Drinking
6 USEPA. 1993. Reregistration Eligibility Decision (RED) Glyphosate. Office of Prevention, Pesticides and Toxic Substances. Washington DC

The Enhancing Effect of Adjuvants*

"Adjuvants in pesticides are generally declared as inerts, and for this reason they are not tested in long-term regulatory experiments. It is thus very surprising that they amplify *up to 1000 times* the toxicity of their APs [Active Principles] in 100% of the cases where they are indicated to be present by the manufacturer."

*R. Mesnage et al.BioMed Research International 2014; Article ID:179691.

Is Glyphosate Toxic?

- Monsanto has argued that glyphosate is harmless to humans because our cells don't have the Shikimate Pathway, which it inhibits.
- However, our gut bacteria DO have this pathway
  - We depend upon them to supply us with essential amino acids (among many other things).
- Other ingredients in Roundup greatly increase glyphosate's toxic effects and are themselves toxic.
- Insidious effects of glyphosate accumulate over time.
  - Most studies are too short to detect damage

Roundup Safety Claims Disputed*

"It is commonly believed that Roundup is among the safest pesticides. … Despite its reputation, *Roundup was by far the most toxic among the herbicides and insecticides tested*. This inconsistency between scientific fact and industrial claim may be attributed to huge economic interests, which have been found to falsify health risk assessments and *delay health policy decisions*."

*R. Mesnage et al., Biomed Research International, Volume 2014 (2014), Article ID 179691

Is glyphosate likely to contribute to the development of cancer?

When high doses were administered to laboratory animals, some studies suggest that glyphosate has carcinogenic potential. Studies on cancer rates in people have provided conflicting results on whether the use of glyphosate containing products is associated with cancer. Some studies have associated glyphosate use with non-Hodgkin lymphoma.

Henderson, A. M.; Gervais, J. A.; Luukinen, B.; Buhl, K.; Stone, D. 2010. *Glyphosate General Fact Sheet*; National Pesticide Information Center, Oregon State University Extension Services. http://npic.orst.edu/factsheets/glyphogen.html

The past had its problems

As we will see in the next segments, the past information is highly disputed.

We can do better as we move into the future.

Petition to Ban Use of

GLYPHOSATE

PART TWO

Toxicity Impact on Animal & Human Health

Nana Mensah - M.S.

Agricultural Engineering & Agronomy
Instituto Superior, Havana Cuba

Overview Health Effects

GLYPHOSATE

- Disrupts the balance of gut bacteria
- Disrupts the endocrine system
- Damages DNA
- Is a driver of mutations that lead to cancer and neurological disease

Disruption of Gut Microbiome

Main Toxic Effects of Glyphosate*

1. Interferes with Shikimate Pathway and synthesis of essential aromatic amino acids and methionine.

2. Which leads to shortages in critical neurotransmitters

*Samsel and Seneff, *Entropy* **2013**, *15*, 1416-1463

Main Toxic Effects of Glyphosate*

3. Glyphosate acts as an antibiotic to disrupt gut bacteria, leading to overgrowth of pathogens
4. Kills beneficial gut bacteria
5. Allows pathogens to overgrow
6. Chelate important minerals, iron, cobalt, manganese, etc.

*Samsel and Seneff, *Entropy* **2013**, *15*, 1416-1463

Ekar et al shows the reduction of nutrient uptake by plants in presence of glyphosate (orange bars). Deficiencies of iron, manganese and zinc.

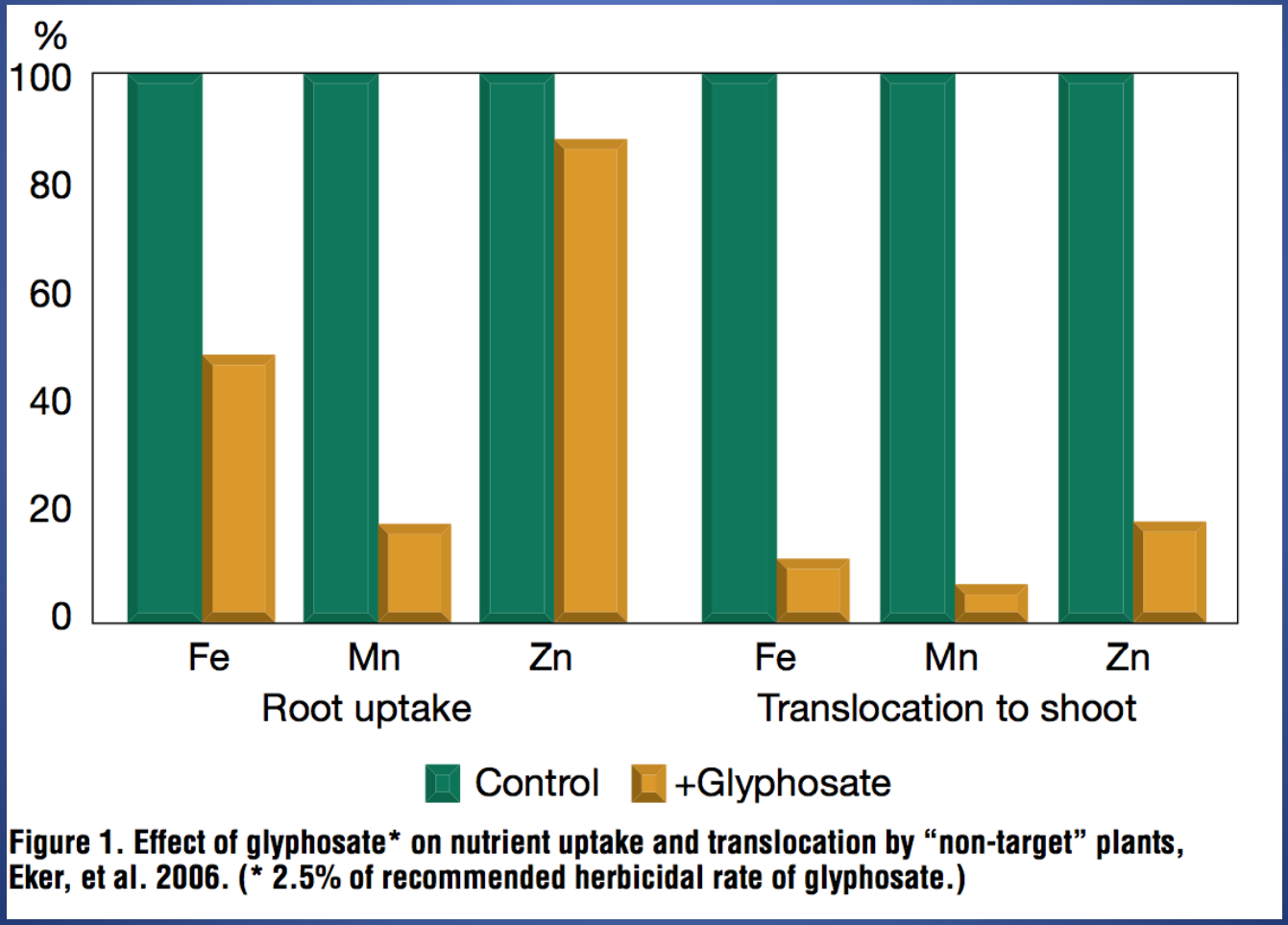
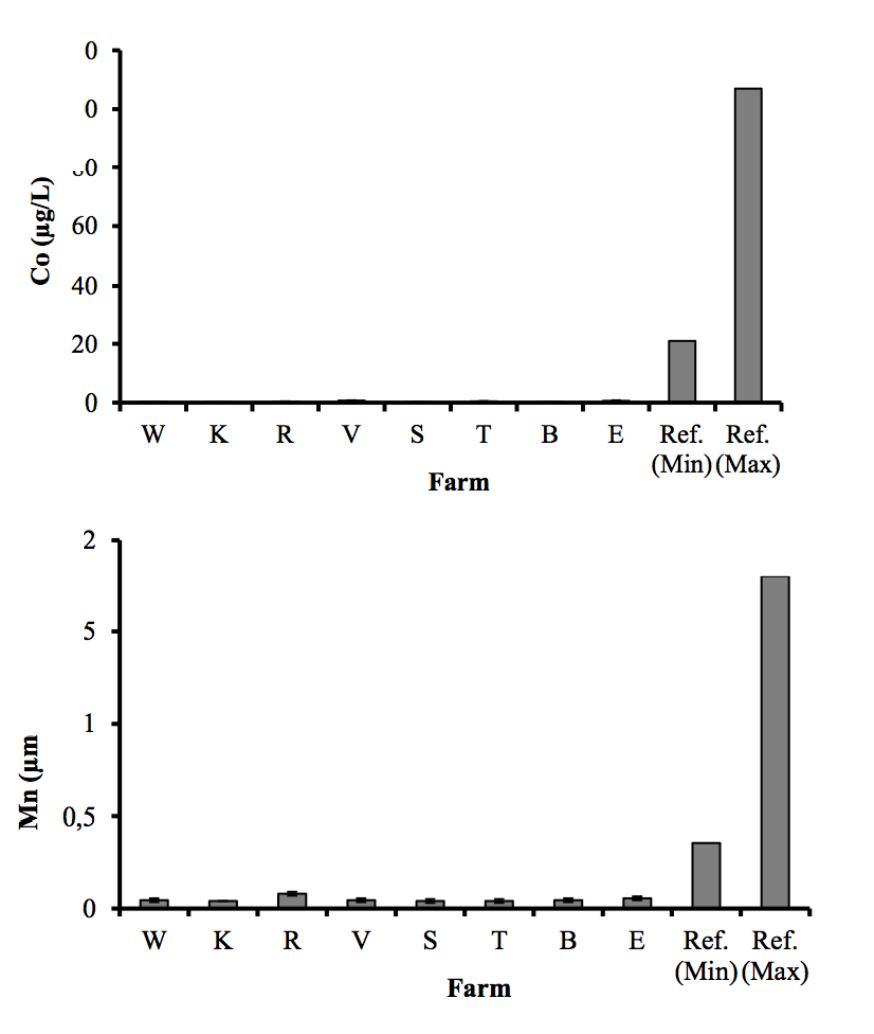


Figure 1. Effect of glyphosate* on nutrient uptake and translocation by "non-target" plants, Eker, et al. 2006. (* 2.5% of recommended herbicidal rate of glyphosate.)

Severe Deficiency in Serum Manganese and Cobalt in Cows*



Eight different farms: all cows tested had glyphosate in the urine

*M. Krüger et al., J Environ Anal Toxicol 2013, 3:5

Some Consequences of Manganese Deficiency

- Lactobacillus critically depend on manganese
- Manganese superoxide dismutase protects mitochondria from oxidative damage
- Manganese is essential for detoxing glutamate (neurotoxin)
- Pituitary depends on manganese to release thyroid stimulating hormone
- Chondroitin sulfate synthesis in bones

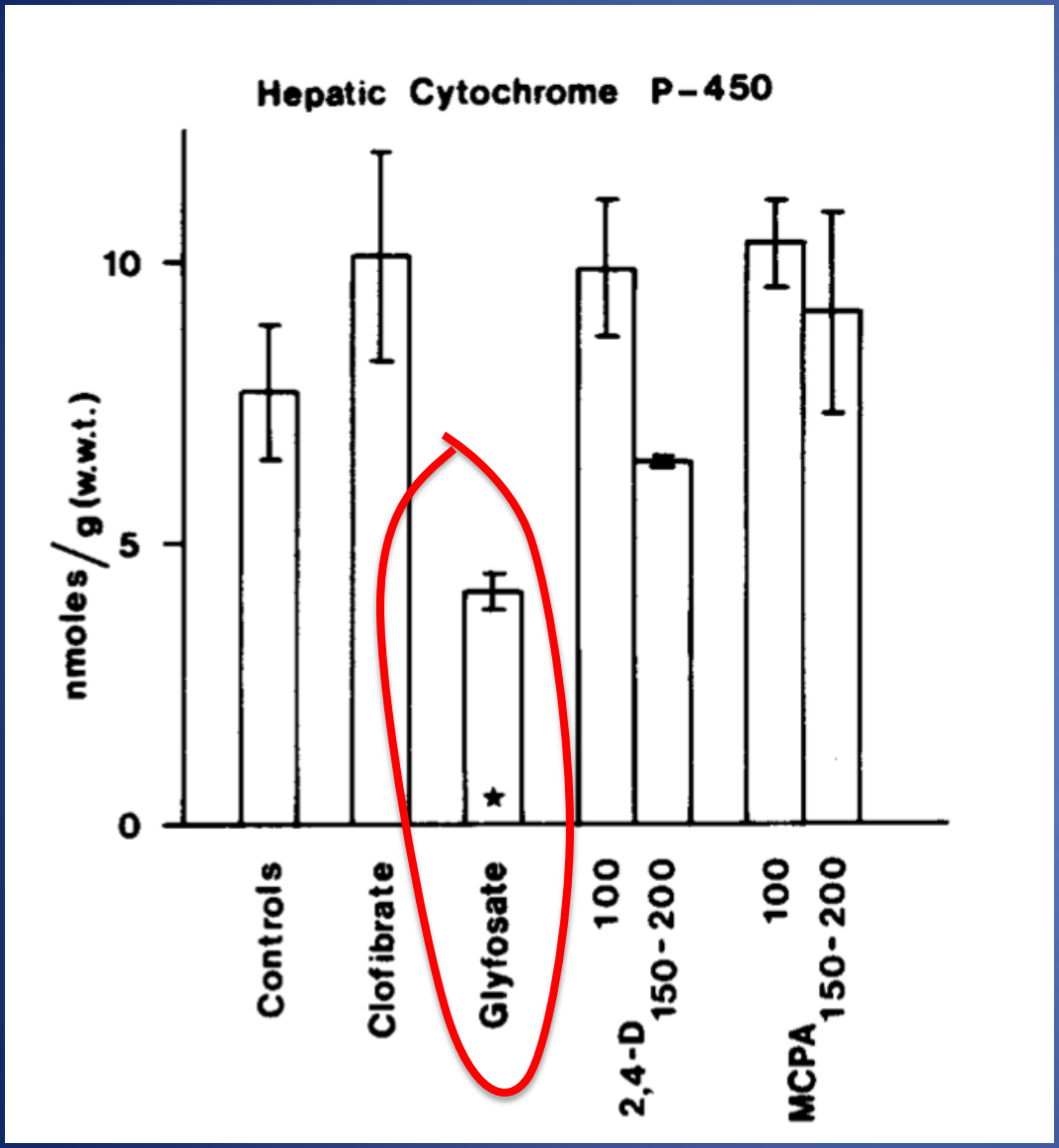
A Samsel and S Seneff, *Entropy* **2013**, *15*(4), 1416-1463

Main Toxic Effects of Glyphosate*

7. Interferes with function of cytochrome P450 (CYP) enzymes

- Disruption of liver CYP enzymes leads to impaired bile flow and low vitamin D
- This disrupts sulfate synthesis and sulfate transport
- Also impairs detoxification of other toxic chemicals

*Samsel and Seneff, Entropy **2013**, *15*, 1416-1463



Inhibition of Cytochrome P450 Enzymes (CYPs) by Various Pesticides*

Study in rats on 2,4-D, clofibrate, MCPA, and glyphosate

*E Hetanen et al., Acta Ph**armacol. Et Toxicol.** 1983, **53,** 103-1 12.

Main Toxic Effects of Glyphosate*

8. Leaky gut and leaky brain barrier lead to neuronal exposure to dangerous metals and neurotoxins

9. Damage to red blood cells leads to anemia and toxicity due to free iron

- Hypoxia ensues → low grade encephalopathy

* A Samsel and S Seneff, *Entropy* **2013**, *15*(4), 1416-1463

Glyphosate and Vaccines

- MMR, Varicella, flu vaccine and rabies vaccine contain *glutamate* (a neurotoxin)
  - Glyphosate disrupts conversion of glutamate to glutamine (detox)
- DTaP, HEP-B, Gardasil and others contain *aluminum* (a neurotoxin)
  - Glyphosate escorts aluminum to the pineal gland where it accumulates, causing sleep disorder and many associated neurological diseases

A Samsel and S Seneff, *Entropy* **2013**, *15*(4), 1416-1463

MMR, Glyphosate, Molecular Mimicry

- MMR vaccine "takes" if child develops antibodies to measles hemagglutinin*
- Hemagglutinin has strong sequence similarity to myelin basic protein (MBP)
- A measles virus infection in the brain could induce autoantibodies to MBP
  - This over time would destroy the myelin sheath
- Children with autism have high titers of antibodies to hemagglutinin and autoantibodies to MBP**

Glyphosate induces leaky gut due to overgrowth of pathogens. Leaky gut leads to a leaky brain barrier permitting antibody access to the brain.

*RL de Swart et al., Journal of Virology 2005; 11547-11551.
**VK Singh et al., J Biomed Sci 2002;9(4):359-64

Glyphosate and Antibiotic Resistance

- E. coli develop resistance to glyphosate by overexpression of efflux pumps*
- These pumps can also export multiple antibiotics → antibiotic resistance
- These efflux pumps enable pathogens to adhere to and invade host cells**
- Multiple gut pathogens could potentially develop multi-antibiotic resistance with chronic exposure to glyphosate

*JM Staub et al. J Ind Microbiol Biotechnol (2012) 39:641–647

**LJV Piddock, Nature Reviews 2006;4:629-636.

Nutrients, Hormones and Neurotransmitters Disrupted by Glyphosate

- Folate, vitamin K, vitamin A, vitamin D, cobalamin
- Aromatic amino acids, methionine
- Iron, manganese, cobalt, selenium, zinc, sulfur
- Serotonin, melatonin, dopamine, epinephrine
- Melanin (skin tanning agent), thyroid hormone
- NAD, glutathione (antioxidant defenses)

A Samsel and S Seneff, *Entropy* **2013**, *15*(4), 1416-1463

Endocrine Disruption

- Impaired Thyroid Function
- Declining Sperm Count

Impaired Thyroid Function

- Thyroid hormone is derived from tyrosine, a product of the shikimate pathway
- Thyroid depends on selenium to protect it from oxidative damage (chelated by glyphosate)
- Low thyroid hormone in mother → 4-fold increased risk to autism in child*

*GC Román et al., Ann Neurol. 2013 Nov;74(5):733-42.

Glyphosate Disrupts Sex Hormone Synthesis in Adrenal Glands*

- Glyphosate was cytotoxic to adrenal cells and interfered with synthesis of sex hormones
- Roundup's toxicity was two orders of magnitude higher than glyphosate acting alone

*F Young et al., Integrative Pharmacology, Toxicology and Genotoxicology 2015; 1(1): 12-19.

Roundup Disrupts Steroid Synthesis*

- StAR protein mediates rate-limiting step in steroid synthesis
- Roundup suppresses StAR protein by 90% and reduces steroidogenesis by 94%
- This affects both the production of sex hormones in the gonads and the production of cortisol and aldosterone in the adrenal glands

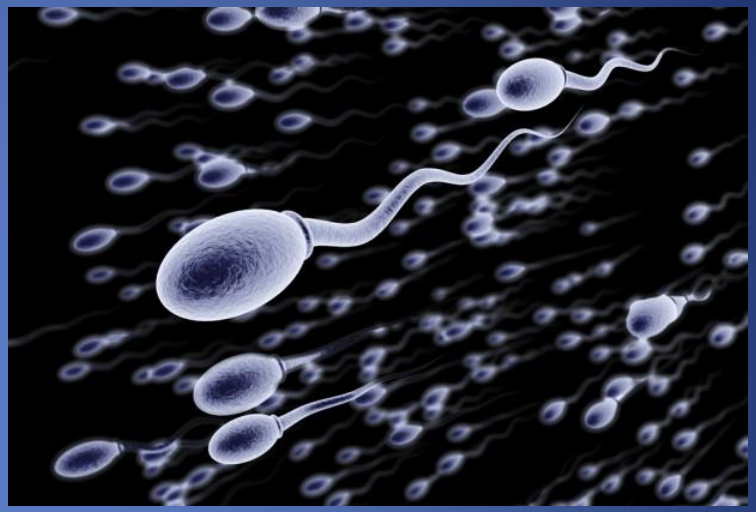
*L.P. Walsh et al., Environmental Health Perspectives 108(8), 2000 769-776.

"Male fertility under threat as average sperm counts drop"*

- Study of 26,600 men in France found sperm concentration had decreased by 32% since the 1990s.
- Numbers steadily dropped by 2% per year from 1989 to 2005.
- Proportion of normally formed sperm also declined by about 1/3.

* M. Rolland et al., Hum Reprod. 2013 Feb;28(2):462-70.

Sperm Motility and Manganese*



- Sperm have an unusual form of adenylate cyclase depends upon *manganese* as a cofactor
- This enzymes produces cAMP which is necessary for flagella formation
- Flagella are what make sperm able to swim

*T Braun and RF Dods,Proc Nat Acad Sci USA 1975;72(3):1097-1101.

Glyphosate, Sperm and Aromatase*

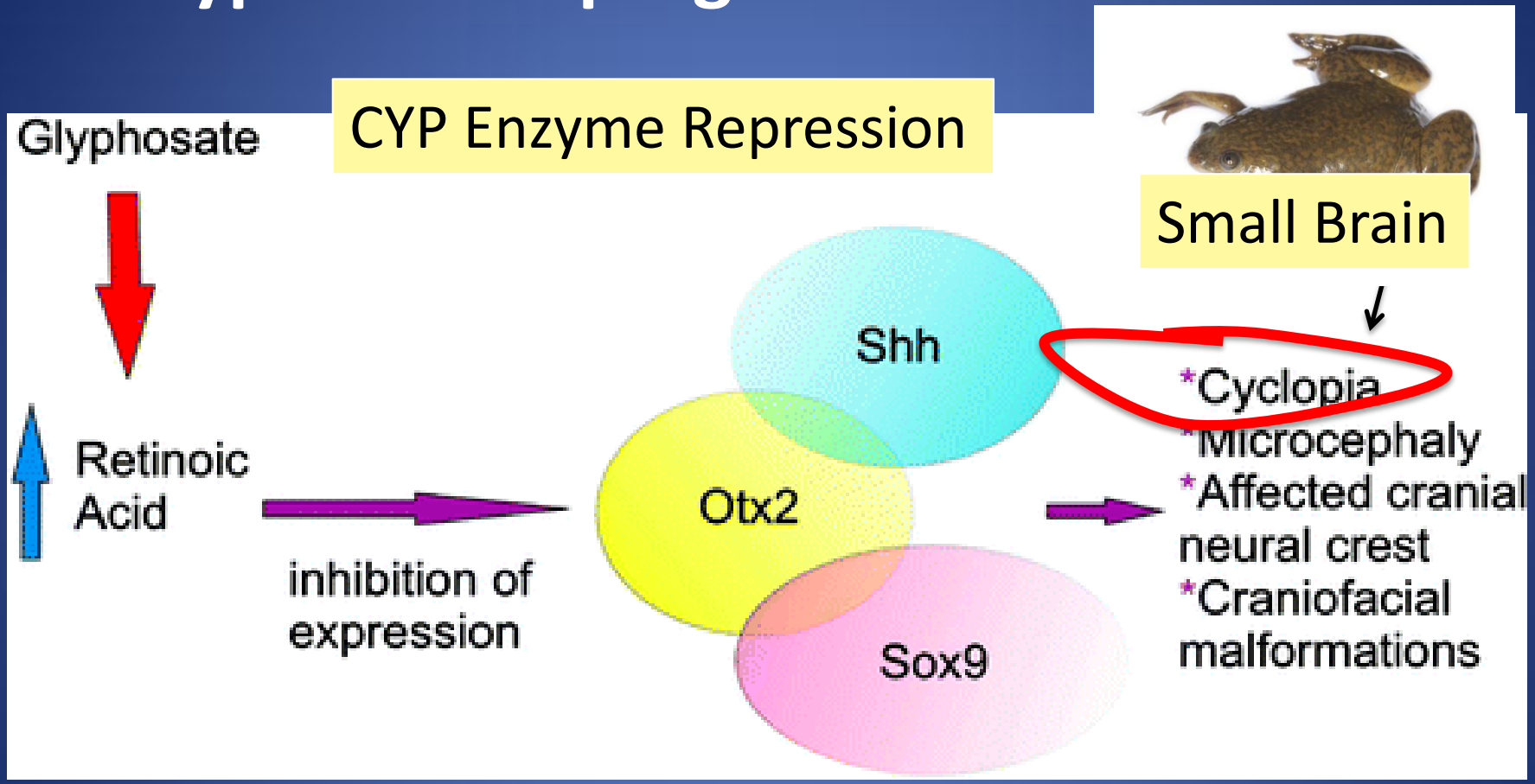
- Acute exposure (0.5%) of Roundup in fifteen 60-day-old male rats during an 8-day period
- Aromatase mRNA levels increased by at least 50% in treated rats at all times
- Aromatase converts testosterone to estrogen

*E. Cassault-Meyer et al. Environmental Toxicology and Pharmacology 38 (2014) 131–140

Tetratogenic Effects Birth Defects

- Impairment of Retinoic Acid Signaling
- Damage to Reproductive System
- DNA Impairment

Glyphosate Upregulates Retinoic Acid*



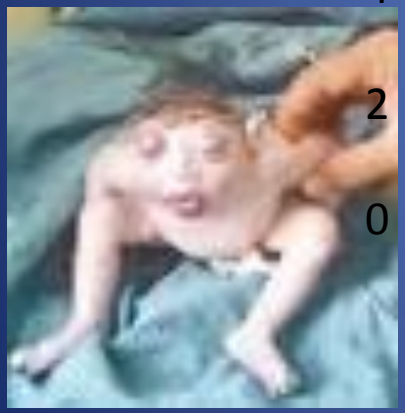
*A. Carrasco, Teratogenesis by glyphosate based herbicides and other pesticides. Relationship with the retinoic acid pathway. In Breckling, B. & Verhoeven, R. (2013) GM-Crop Cultivation – Ecological Effects on a Landscape Scale. Theorie in der Ökologie 17. Frankfurt, Peter Lang.

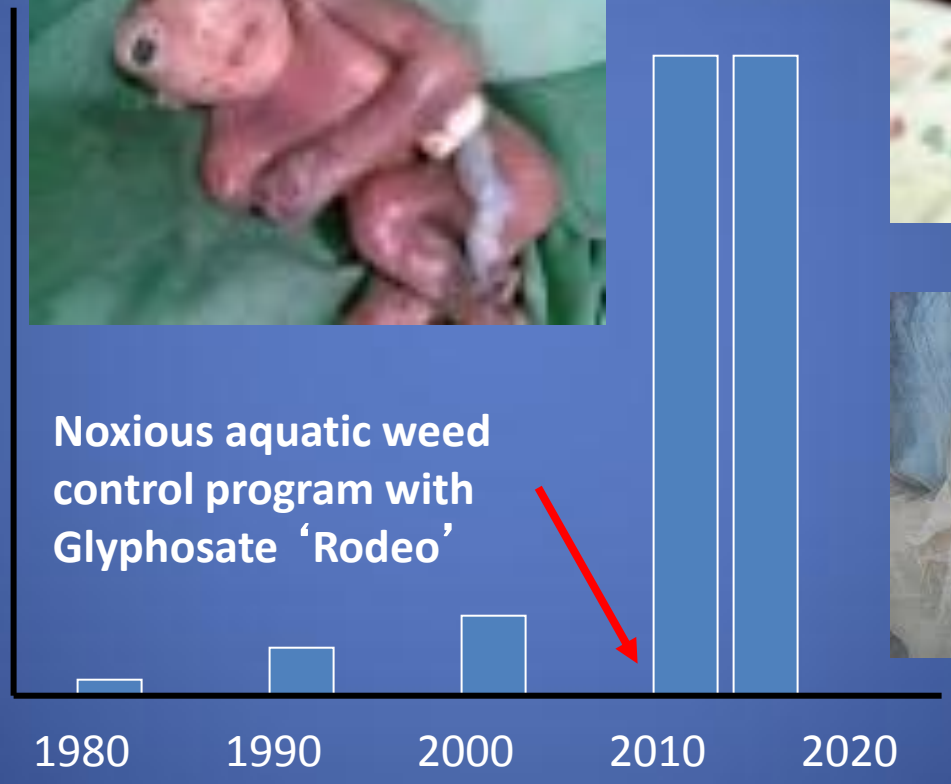
Glyphosate and Anencephaly*

- Yakima, Benton and Franklin counties in Washington State USA have an unusually high number of pregnancies affected by the birth defect, anencephaly.
- ***Glyphosate has been linked to anencephaly due to its effect on retinoic acid.***

*Barbara H. Peterson. **Farm Wars**, http://farmwars.info/?p=11137

"Glyphosate, Brain Damaged Babies, and Yakima Valley - A River Runs Through It"*





"Glyphosate, Three Rivers, and Anencephaly"

Yakima Harold Republic

Slide thanks to Prof. Don Huber, with permission

*Farm Wars 3/6/14

Carcinogenicity

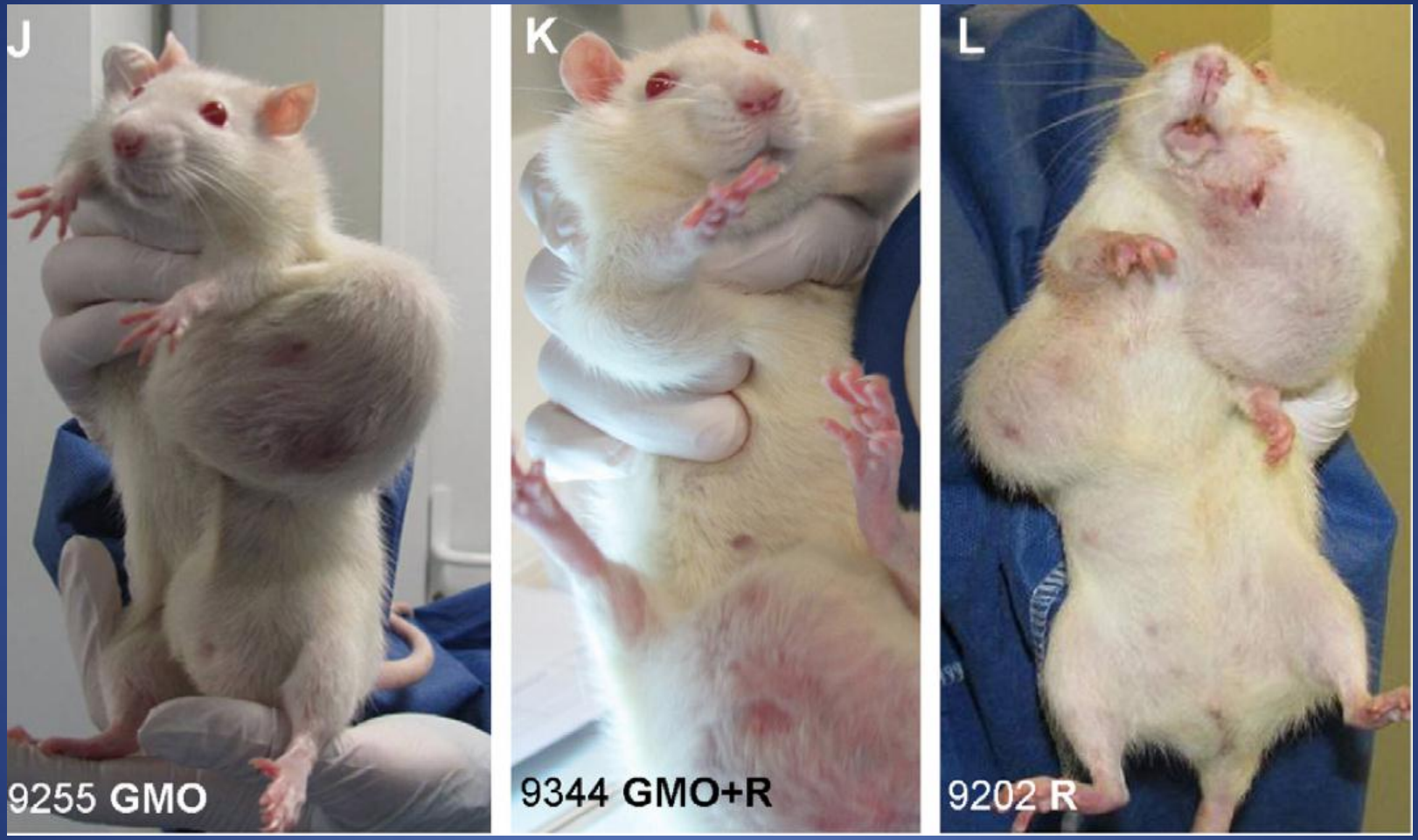
- **Breast Cancer**
- ***Non-Hodgkin's Lymphoma (NHL)***

Glyphosate is an endocrine disruptor that promotes breast cancer*

- Low and environmentally relevant concentrations of glyphosate possess estrogenic activity
- Glyphosate caused human hormone-dependent breast cancer cells to proliferate at concentrations of *parts per trillion*

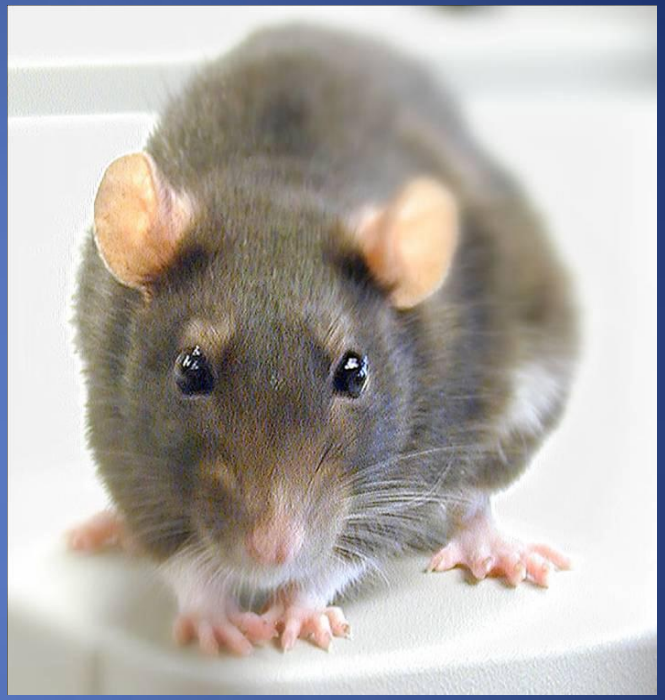
- Additive effect from genistein, a phytoestrogen in soybeans

* S. Thongprakaisang et al., Food Chem Toxicol. 2013 Jun 8. S0278-6915(13)00363-3.



*G-E Séralini et al. Environmental Sciences Europe 2014, 26:14

Conclusions from Rat Study *



- *Female rats had greatly increased risk of mammary tumors*
- Males had significantly increased risk of tumors of the liver and kidney
- Sex hormone disruption for both males and females
- Enhanced oxidative stress
- Very significant kidney dysfunction
- *Effects didn't become apparent until after 4 months*

*G-E Séralini et al. Environmental Sciences Europe 2014, 26:14

Neurotoxicity

- Autism
- Parkinson’s Disease
- Depression
- Senile Dementia
- Alzheimer's Disease

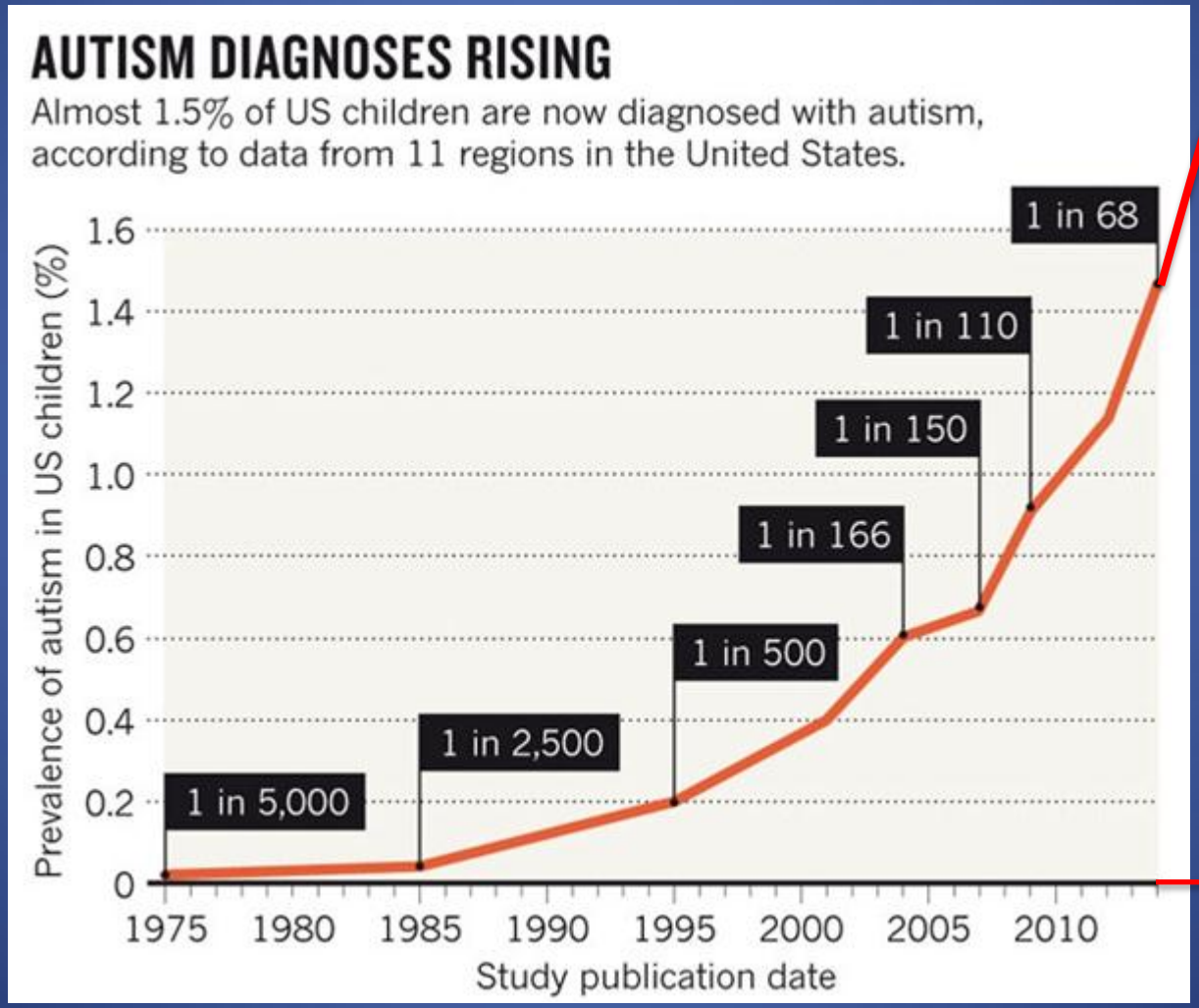
Low Manganese and Mitochondrial Impairment in Autism

Mechanisms underlying the neurotoxicity induced by glyphosate*

"Taken together, these results demonstrated that Roundup® might lead to excessive extracellular *glutamate* levels and consequently to glutamate excitotoxicity and oxidative stress in rat hippocampus. " - quote from abstract

*D Cattani et al., Toxicology 320 (2014) 34–45

A Frightening Trend*



?

12 years

*K. Weintraub, Nature 479, Nov. 3 2011, 22-24.

Mitochondria are Key!

"Damage to mitochondria is now understood to play a role in the pathogenesis of a wide range of seemingly unrelated disorders such as schizophrenia, bipolar disease, dementia, Alzheimer's disease, epilepsy, migraine headaches, strokes, neuropathic pain, Parkinson's disease, ataxia, transient ischemic attack, cardiomyopathy, coronary artery disease, chronic fatigue syndrome, fibromyalgia, retinitis pigmentosa, diabetes, hepatitis C, and primary biliary cirrhosis."*

*J Neustadt and SR Pieczenik, Molecular Nutrition and Food Research 2008;52:780-788

Autism and Mitochondrial Impairment*

- Mitochondrial impairment is a key feature of autism, especially in the brain
  - Impaired detox of glutamate by astrocytes (requires manganese)
  - Excess stimulation of NMDA receptors in neurons
- Glyphosate excites NMDA receptors and prevents glutamate metabolism

*Dayan Goodenowe and Elodie Pastural , Chapter 4 the-biochemical-basis-of-autistic-behavior-and-pathology .intechopen.com/books/autism-a-neurodevelopmental-journey-from-genes-to-behaviour/

New Study on Autism*

- Data suggest ~75-80% of the tracked increase in autism since 1988 is due to *an actual increase* in the disorder rather than to changing diagnostic criteria

- Polybrominated diphenyl ethers (fire retardants), *aluminum* adjuvants, and the herbicide *glyphosate* have increasing trends that correlate positively to the rise in autism.

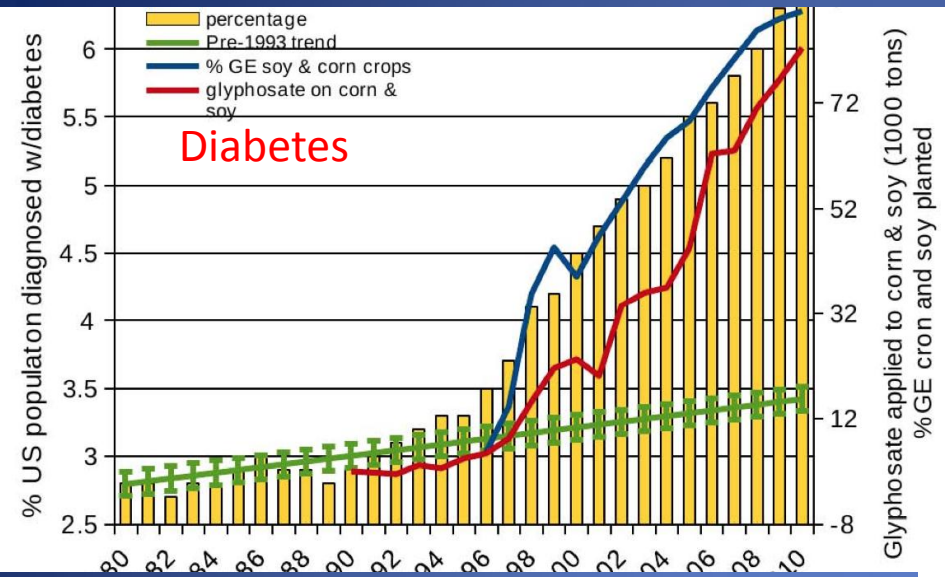
Environmental Health 2014, **13**:73

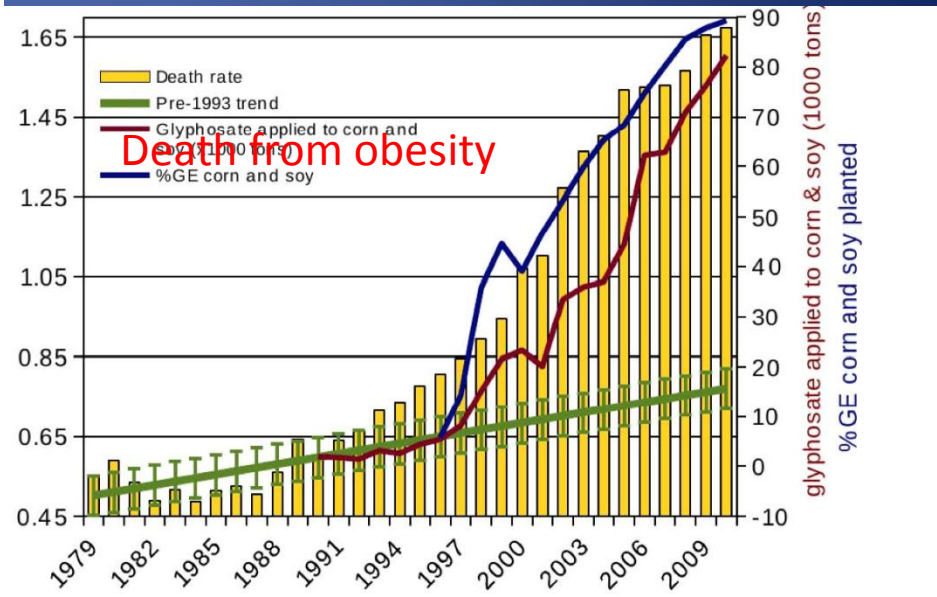
Glyphosate Usage
Correlation to Health Problems

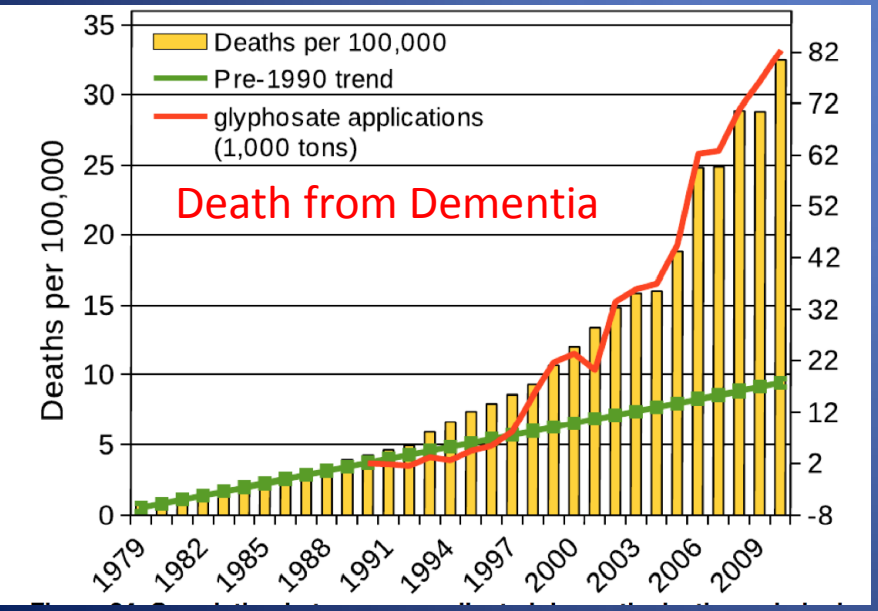
"PEARSON CORRELATION coefficients are highly significant < 10"

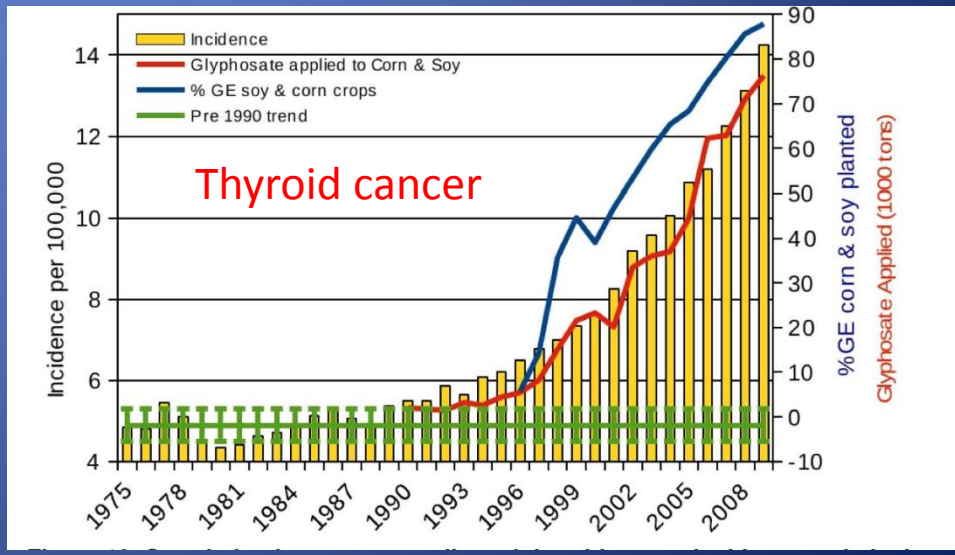
Dr. Nancy Swanson

Data from Swanson et al., Journal of Organic Systems, 9(2), 2014

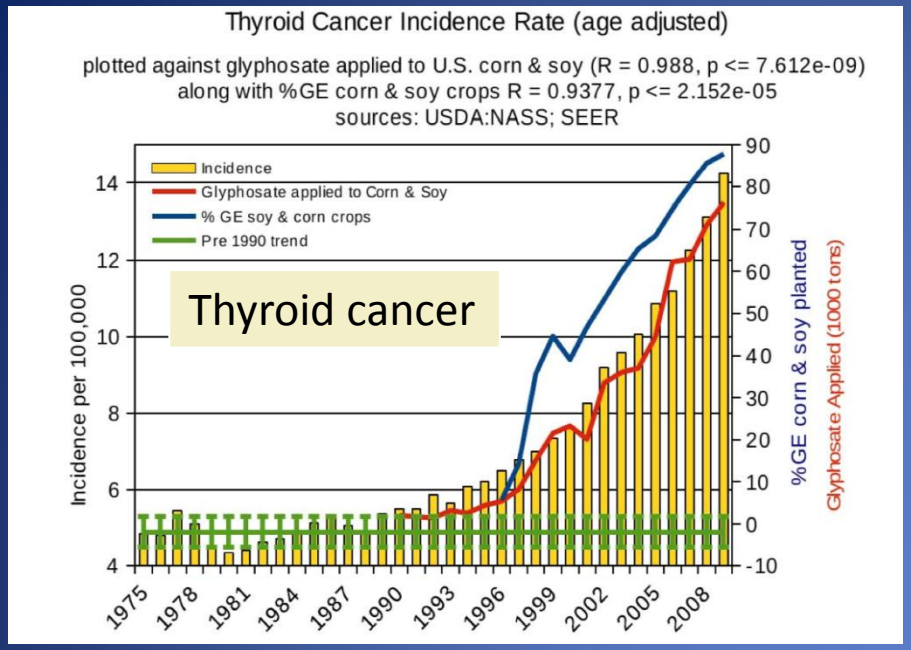


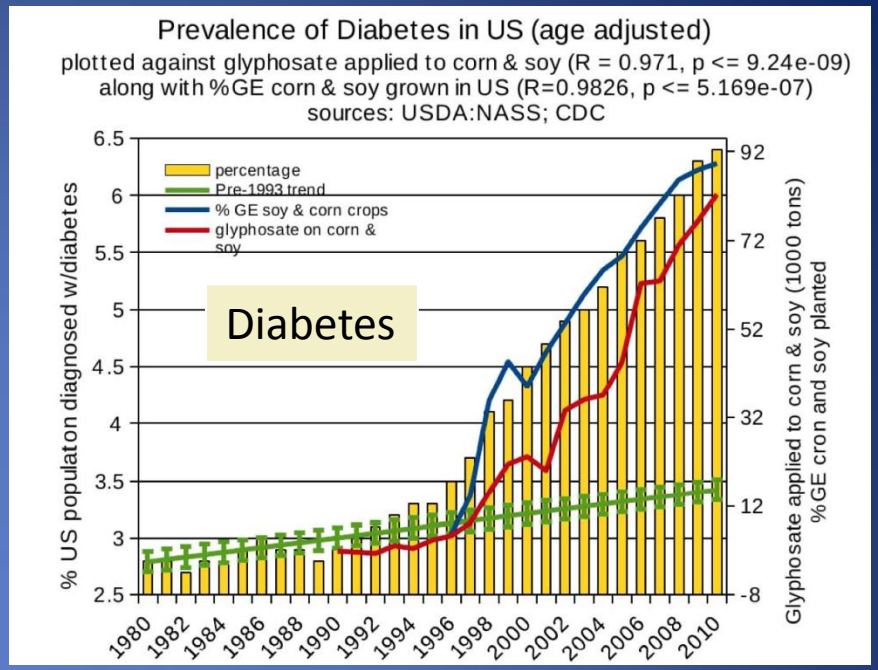


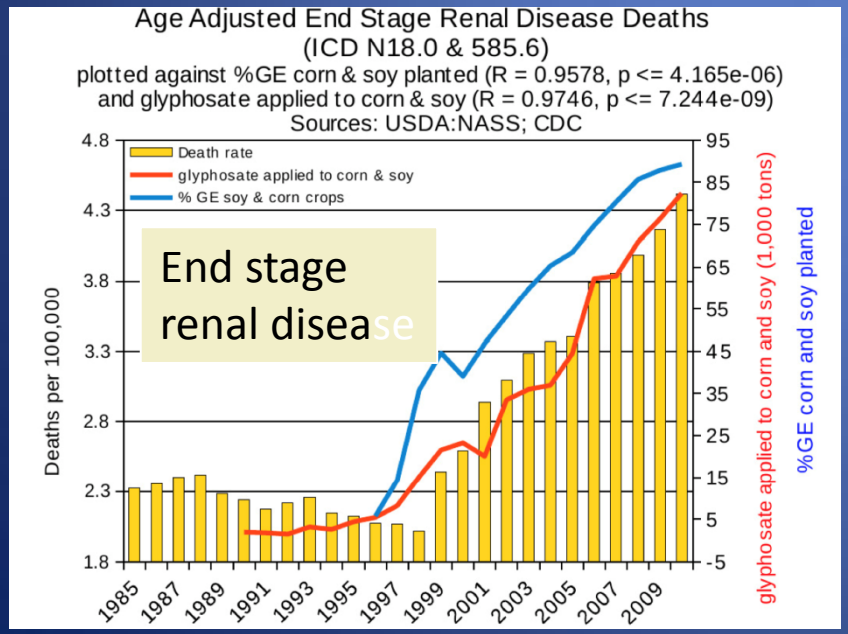


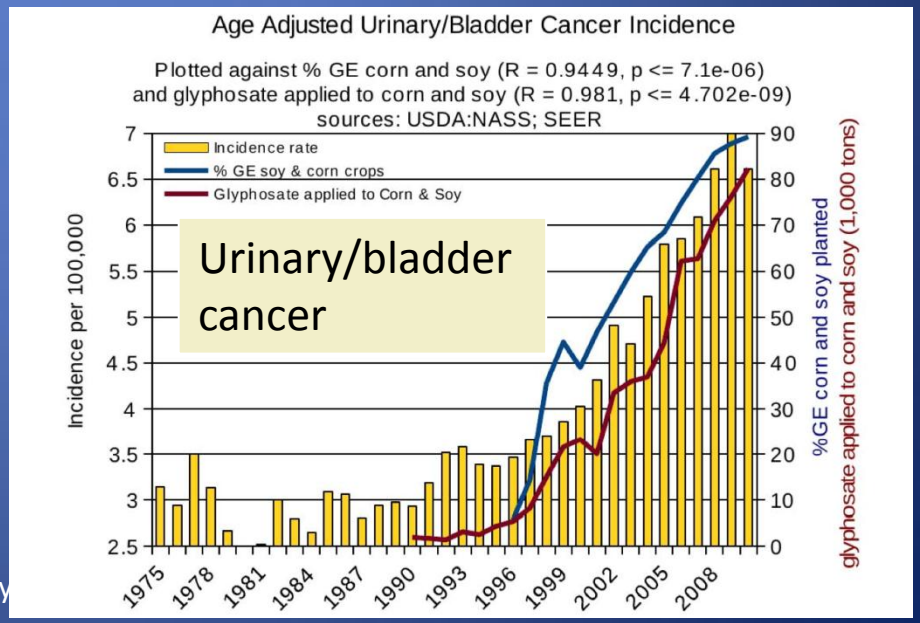


Petition to Ban Glyphosate 30 August 2016









Quote from the Conclusion*

"Although correlation does not necessarily mean causation, when correlation coefficients of over 0.95 (with *p*-value significance levels less than 0.00001) are calculated for a list of diseases that can be directly linked to glyphosate, via its known biological effects, it would be imprudent not to consider causation as a plausible explanation." Dr. Nancy Swanson

*NL Swanson et al. Journal of Organic Systems 9(2), 2014, p. 32,

Toxicity to Internal Organs

- Chronic Kidney Disease

Int. J. Environ. Res. Public Health **2014**, *11*, 2125-2147; doi:10.3390/ijerph110202125

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www.mdpi.com/journal/ijerph

Sri Lanka is the first country to ban glyphosate

Hypothesis

Glyphosate, Hard Water and Nephrotoxic Metals: Are They the Culprits Behind the Epidemic of Chronic Kidney Disease of Unknown Etiology in Sri Lanka?

arsenic

This problem did not exist in Sri Lanka prior to the 1990s.

Arsenic Export Through Bile Acids*

- Arsenic (a toxic metal) is removed from the body through two paths: biliary excretion by the liver and urinary excretion in the kidney
- The biliary path depends critically upon glutathione bioavailability
- Glutathione is depleted in the liver by glyphosate

*Z. Gregus et al. Toxicol Sci. 2000 Jul;56(1):18-25.

Sobering Statistics on Glyphosate Residues*

- 0.1 ppb: altered the gene function of over 4000 genes in the livers and kidneys of rats.
- 0.1 ppb: severe organ damage in rats
- 0.1 ppb: Permitted level for glyphosate and all other herbicides in EU tap water
- 10 ppb: toxic effects on the livers of fish
- 700 ppb: Permitted level for glyphosate in U.S. tap water**
- 11,900 ppb: found in Genetically Modified (GMO) Soybeans

*http://detoxproject.org/glyphosate-in-numbers/

** Canada: 280 ppb

Glyphosate Test Report: Findings in American Mother's Breast Milk, Urine and Water*

- Breast milk levels ranging from 76 ug/l to 166 ug/l are 760 to 1600 times higher than the European Drinking Water Directive allows.
- Urine testing shows glyphosate levels over 10 times higher than in Europe.
- Monsanto is wrong regarding bioaccumulation.

*Pilot study by Sustainable Pulse

Detoxification of Glyphosate in Humans & Farm Animals

Treating Glyphosate Poisoning in Animals

Activated charcoal, bentonite clay, humic and fulvic acids, and sauerkraut juice have been shown to be effective in reducing urinary levels of glyphosate and improving animal health.

Humic Acid
Fulvic Acid

*H Gerlach et al., J Environ Anal Toxicol 2014, 5:2

Extracts from Common Plants Can Treat Glyphosate Poisoning*

- Roundup is toxic to hepatic and embryonic cells at doses far below those used in agriculture and at residue levels present in some GM food.
- Extracts from common plants such as dandelions, barberry, and burdock can protect from damage, especially if administered prior to exposure.

*C Gasnier et al. Journal of Occupational Medicine and Toxicology 2011, 6:3

Some Important Nutrients that Detoxify

- Curcumin
- Garlic
- Vitamin C
- Probiotics
- Methyl tetrahydrofolate
- Cobalamin
- Glutathione
- Taurine
- Epsom salt baths

Eat Foods Containing Manganese



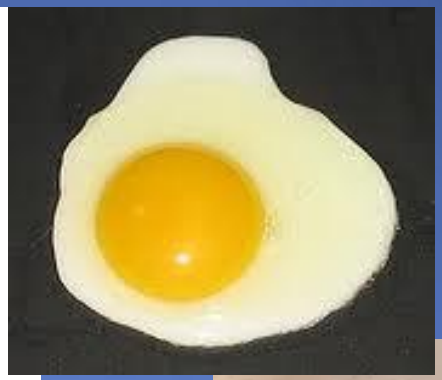






Eat Foods Containing Sulfur













Summary

- Glyphosate is the most damaging chemical in our environment today.
  - We have been grossly misled into believing that it is non-toxic to humans.
- Glyphosate's toxicity is easily explained by its biological mechanisms, particularly its potential ability to substitute for glycine during protein synthesis.
  - Its effects are insidious and cumulative.
- The strong correlations between glyphosate usage on core crops and the alarming rise in the incidence of a long list of diseases are supported by evidence of harm.
- We need to switch to sustainable organic agriculture and ban glyphosate across the globe.

Cubans Say “Go Organic!”

Petition to Ban Use of GLYPHOSATE

PART THREE

Environmental/Ecological Impacts of Glyphosate and Its Formulations

Dr. Ed Boles, Ph.D.

Aquatic Ecology
Jackson State University, Florida USA

Environmental/Ecological Impacts of Glyphosate and Its Formulations

Glyphosate was detected at all sample sites monitored for three years in the Maya Mountain Reserve(Kaiser, 2011).

When glyphosate formulations affect key species, whole ecosystems are affected.

Glyphosate, N-(phoshonomethyl) glycine, $C_3H_8NO_5P$

- Inhibit function of the plant enzyme EPSPS (enolpyruvylshikimate-3-phosphate synthase) in the shikimate pathway.
- Chelates micronutrients such as manganese, an important co-factor of the EPSPS enzyme (and over 25 other plant enzymes).
- EPSPS catalyses the transformation of phosphoenol pyruvate (PEP) to shikimate-3-phosphate required for making essential aromatic amino acids phenylalanine, tyrosine and tryptophan
- This shikimate pathway exists in all plants, fungi, and some bacteria (animals acquire essential amino acids from food).
- Inhibition of protein synthesis leads to rapid cell death in all plants, fungi and many bacteria species affected by glyphosate
- Other macro- and micronutrients chelated by glyphosate (Ca^{2+}, Mg^{2+}, Cu^{2+}, Fe^{2+}, Co^{2+}, Ni^{2+}, and Zn^{2+}) inhibit other biochemical and physiological pathways affecting immune systems, growth, etc.

Glyphosate can impact plants and animals via:

- direct toxic effects of exposure to spray,
- chronic effects caused by long term exposure in the eco-system,
- indirect effects due to changes in the eco-system.

Formulations have been shown to be many times more toxic than glyphosate alone.

Glyphosate formulations have **genotoxic**, **cytotoxic**, and **endocrine disrupting properties**, may cause reproduction abnormalities in fungi, bacteria, algae, plants, invertebrates, amphibians, birds, mammals.

Percentage of agro-chemicals spread off site, affecting non target organisms:

- 10-30% of pesticides applied from the ground
- 50-75% of aerially sprayed pesticides
- ?% Leachate from soils (see Sasal, *et al*., 2015)
- ?% Spills in manufacture, packaging, transport, and mixing.

Terrestrial-Soils

Glyphosate tends to tightly bind to mineral and organic soil particles, depending on pH, soil texture and phosphate levels (Sprankle, *et al*., 1975; Yu and Zhou, 2005).

Certain species of soil micro-organisms can degrade Glyphosate over a period of days to months (Giesy, *et al*., 2000).

Glyphosate and its formulations can inhibit growth of other microbial species, with temporary effects on community structure and function (Weaver, *et al*., 2007).

Diverse biological and ecological effects of glyphosate are imposed on plant roots and the micro-organisms of rhizoshere (Kremer and Means, 2009; Newman, 2015).

Terrestrial-Plants

Toxic effects of glyphosate on plants are increased by formulation, and include impairing water intake, mineral absorption, and growth.

The formation of glyphosate–metal complexes (Fe, Cu, Mn, Zn) in plant tissue may **impair micronutrient availability** in tissue and rhizosphere of non-target plant species (Eker, *et al*., 2006).

Indirectly glyphosate immobilizes specific micronutrients involved in disease resistance, or changes soil microbes important in making micronutrients available to the plant.

Glyphosate also increases susceptibility of plants to fungal disease by **disrupting plant defenses** within the rhizosphere, which allows roots to be colonized by soil-borne pathogens (Johal and Huber, 2009).

Terrestrial-Earthworms

Soil Engineers

*Earthworms (Eisenia fetida) a*voided Glyphosate (Groundclear) contaminated soils, cocoons were reduced and the number of juveniles was also significantly lower (Verrell and Van Buskirk, 2004).

Glyphosate affected development/reproduction in *Eisenia fetida,* reduction in worm weights, and no production of cocoons or juveniles, indicating potential toxic effects on soil biota in general (Correia and Moreira, 2010).

Roundup negatively affected *Lumbricus terrestris,* decreased cast production and cocoon hatching significantly about one week after exposure (Gaupp-Berghausen, *et al*., 2015).

Terrestrial-Bees

Key Pollinators

Glyphosate applied at label-recommended concentrations can reduce sensitivity of honey bees to affected nectar and impair their associative learning without affecting foraging behavior, leading to poisoning the hive (Herbert, *et al*., 2013).

Sub-lethal effects of Glyphosate impaired cognitive capacities of bees required to successfully navigate, threatening the long term survival of the colony (Balbuena, *et al*., 2015).

Decline of local weed populations may impose long term effects on bee and butterfly populations

Terrestrial-Birds

Some studies gave evidence of psychological and behavioral effects on birds, affected by both dose and formulation, threatening reproductive success (Santillo, *et al*., 1989; Oliveira, *et al*., 2007).

Studies from the USA and the UK have linked glyphosate applications with population declines in bird populations.

Many farmland birds rely heavily upon weed seeds for their survival, especially over the winter months, plants susceptible to glyphosate formulations.

Freshwater

Glyphosate is very water soluble and can erode into deeper soil layers and end up in ground and surface waters (Borggaard and Gimsing, 2008; Hagner, et al., 2015; Kanissery, et al., 2015).

Surface runoff, direct overspray, or drift during application can introduce large amounts of glyphosate into streams, rivers, lakes, and lagoons (Solomon and Thompson, 2003).

Some cyanobacteria taxa, such as *Spirulina* spp., can degrade glyphosate using different pathway than reported for other bacteria (Arunakumara, et al., 2013).

Glyphosate-based herbicides can negatively impact ecology of aquatic organisms (Cuhra, et al., 2013).

- **microorganisms** (Bonnet, *et al*., 2007; Folmar, *et al*., 1979; Tsui and Chu, 2003)
- **algae** (Tsui and Chu, 2003; Romero et al., 2011)
- **crustaceans** (Tsui and Chu, 2003; Frontera et al., 2011)
- **other aquatic invertebrates** (Perez, *et al*., 2007; Trumbo, 2005)
- **fish** (Folmar, *et al*., 1979; Wang, *et al*., 1994; Lushchak, *et al*., 2009; Guilherme et al., 2010; Cattaneo, *et al*.; 2011; Glusczak, *et al*.; 2011; Hued, *et al*., 2012; Menezes, *et al*., 2011; Modesto and Martinez, 2010)
- **amphibians** (Relyea, 2005; Costa, *et al*., 2008; Lajmanovich, *et al*., 2011)

Taken together, these results support the high potential for the contamination of aquatic food webs by glyphosate.

Chronic exposure to glyphosate-based herbicides in aquatic ecosystems can lead to **eutrophication** by increasing total phosphorus and promoting growth of cyanobacteria over periphyton communities (Perez, *et al*., 2007; Vera, *et al*., 2010).

Bacteria and protozoa showed similar sensitivities to Roundup, while microalgae and crustaceans were four or five times more sensitive.

Toxicity to algal species is attributed to the herbicidal action of glyphosate, while zooplankton are affected by surfactants used in commercial glyphosate formulations. Increasing pH tends to increase acute toxicity in aquatic systems (Tsui and Chu, 2003)

Fish and other Aquatic Vertebrates

Besides direct exposure, fish are susceptible to indirect effects through consumption of contaminated food organisms (Solomon and Thompson, 2003).

The **bioaccumulation** potential of glyphosate may be greater than previously thought, being increased by polyethoxylated amines (POEA) in the aquatic environment (Contardo-Jara, *et al*., 2009).

Sub-lethal effects on organisms/environment involve growth/development, physiological cycles, behavior, competition/predation interactions, food resource availability, aquatic plant cover, water temperature, pH, UV light availability, etc.

Mechanisms of Toxicity

As POEA enhances glyphosate transport into plant cells, and may also **increase cell permeability** in animal cells (Hedberg and Wallin, 2010).

Inhibition of AchE activity in brain/muscle of aquatic organisms by glyphosate herbicides impose impacts on aquatic animals (Cattaneo et al., 2011; Glusczak et al., 2006, 2007; Lajmanovich et al., 2011; Menendez-Helman et al., 2012; Modesto and Martinez, 2010a; Salbego et al., 2010; Sandrini et al., 2013).

Physiological and behavioral functions can be altered among susceptible organisms that can lead to effects extending **from the cellular to the population levels** (Guilherme, *et al*., 2012; Hued, *et al*., 2012).

If keystone/ecological engineer species are impacted, ecosystem-level functions and services can be affected.

What about the coastal zone algae, grassbeds, and corals?

Thank You

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Petition to Ban Use of

GLYPHOSATE

PART FOUR

Why Petitioners are Requesting Complete Ban of Glyphosate

It is evident that Glyphosate is not beneficial to this planet or its inhabitants

Ban is the Prudent Action to Protect All That is Belize

- Its people, current and future
- Its ecological patrimony upon which our national revenue depends

Ban is the Only Practical Solution for Pesticide Control Board

- The PCB has neither sufficient personnel nor budget to police the alternative of restricted use.
- A ban effectively transfers the burden of compliance to Customs and Belize Agricultural Health Authority (BAHA). Compliance is effected at the border.

The Alternative is Restricted Use

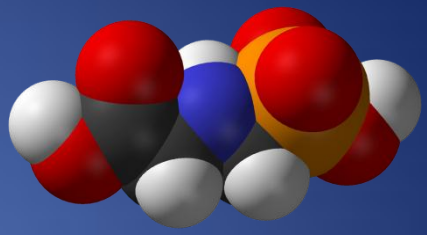
- Removal from all retail outlets
- Banned use in all public areas including schools, parks, road sides, hotels, restaurants, food preparation establishments, food processing facilities, any facility that processes animal or human food stuffs, and many more
- Banned aerial spraying from planes
- Specific licensing and training for limited commercial

How would our small country ever afford to police this effort?

Roundup Safety Claims Disputed*

"It is commonly believed that Roundup is among the safest pesticides. … Despite its reputation, *Roundup was by far the most toxic among the herbicides and insecticides tested*. This inconsistency between scientific fact and industrial claim may be attributed to huge economic interests, which have been found to falsify health risk assessments and *delay health policy decisions*."

*R. Mesnage et al., Biomed Research International, Volume 2014 (2014), Article ID 179691



Glyphosate has become one of the most popular herbicides in the world, with use dramatically increasing in recent years.

People have been misled and told that it is ‘safe’.

However…..Continued use of glyphosate is not an economically sound option for the Government of Belize. Why?

Visit the Future with More Glyphosate

- US health statistics significantly correlate the increasing use of this chemical to the health crisis in that country. It is reasonable to assume that in the future a similar crisis of tremendous portion will befall Belize.

- Breast cancer and chronic kidney disease are on the rise in Belize. If we observe the trends so discussed, mental disorders will exponentially increase. The old will needlessly suffer after a full and productive life, and the younger members of families will anguish over their end care.

- The cost of pure drinking water will skyrocket as water will require carbon filtration to make it safe to consume.

- ***How will the government deal with a massive medical crisis?***
- ***How will the stretched educational system of Belize deal with masses of children with autism and learning disabilities?***
- ***Can Belize afford to lose its ecological resources that form the basis of our thriving tourism industry?***

In the long term, restriction will not eliminate the impending health and environment risks. Why?

For Belize, the Kaiser Study is the our 'wake-up call'. It defines both the beginning point as well as the end.

- We need to carefully consider "why" the agrochemical has been consistently detected over a three-year study period in a pristine reserve where it is not directly applied?

- **Glyphosate is highly water soluble, and moves silently and insidiously through the natural eco systems of our planet.**

- **<u>The movement of glyphosate and its metabolites cannot be controlled or contained.</u>**

- In addition to the documented lethal effects of this chemical on human and animal health, and the damage to the entire health of our ecosystems, **the raw fact that its movement in the environment cannot be controlled** is the basal reason for its discontinued use in Belize.

The past had its problems.

An old adage “The longer one waits to correct the problem, the harder the cure.”

Let’s work together to make the future a more healthful and prosperous life experience for our children and our children’s children.

TOGETHER, WE CAN CREATE THE HEALTHY FUTURE.

Our Heartfelt Thanks for Consideration of This Petition

Petitioners - Concerned Individuals and Belize Organizations:
Sustainable Harvest International -Belize, Plenty Belize, Belize Botanic Gardens, Belize Organic Family Farming, Pro Organic Belize, Belize Wellness Institute

AND

Presenters - Dr. Ed Boles, Nana Mensah and Mark Miller