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Endocrine disrupting pesticides and their impact on wildlife and human health

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Abstract. Endocrine disrupting chemicals are substances that can cause adverse effects by interfering in some way with the body's hormones or chemical messengers. Exposure to endocrine disruptors can occur through direct contact with pesticides and other chemicals or through ingestion of contaminated water, food, or air. Exposure to high doses can result in malformed reproductive organs, consistent with sex hormone imbalance at a critical stage of fetal development. This problem should be studied in more detail and the authorities should think twice before approvals such products.
Key Words: endocrine disruptor, health, pesticides, effects.

Rezumat. Disruptorii endocrini sunt substanţe care pot cauza efecte adverse prin interferenţa în anumite feluri cu hormonii din organism sau cu mesagerii chimici. Expunerea la disruptorii endocrini poate apărea prin contact direct cu pesticide şi alte substanţe chimice sau prin ingestia de apă contaminată, alimente, sau aer. Expunerea la doze mari poate duce la apariția de malformații ale organelor de reproducere, în conformitate cu dezechilibrul hormonilor sexuali într-o fază critică a dezvoltării fetusului. Această problemă ar trebui să fie studiată mai în detaliu şi autorităţile trebuie să se gândească de două ori înainte de a aproba astfel de produse.
Cuvinte cheie: disruptor endocrin, sănătate, pesticide, efecte.

Short Note. The increasing rate of population growth entails an increasing requirement for food and energy, resulting in more pressure on environmental goods (Dordea & Coman 2007). This pressure is defined as pollution and affects biodiversity (Rahman et al 2010), water quality (Petrescu-Mag 2008), air (Proorocu et al 2008) soil (Șandor & Maxim 2008) and last but not least our existence (Petrescu-Mag 2009).

Endocrine disrupting chemicals (EDCs) are substances that can cause adverse effects by interfering in some way with the body's hormones or chemical messengers. These substances are therefore called hormone disruptors or endocrine disruptors, as it is the endocrine glands that secrete the hormones.

By EPA's working definition, endocrine disruptors "interfere with the synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body that are responsible for the maintenance of homeostasis (normal cell metabolism), reproduction, development, and/or behavior."

Chemicals suspected of having endocrine disrupting effects are found in a variety of products from paints, cosmetics, textiles and plastics to pesticides. The main focus of this briefing is pesticides used in agriculture which may appear in our food as residues. Some of these pesticides are also available as home and garden products. It is important to remember that this is only one source of exposure to EDCs and that the total exposure to a mixture of these chemicals may be of more concern in health terms than exposure to one individual chemical.

Exposure to EDCs can occur through direct contact with pesticides and other chemicals or through ingestion of contaminated water, food, or air. Chemicals suspected of acting as endocrine disruptors are found in insecticides, herbicides, fumigants and fungicides that are used in agriculture as well as in the home (www.nrdc.org ; Wolff 2006).

A variety of chemicals have been found to disrupt the endocrine systems of animals in laboratory studies, and compelling evidence shows that endocrine systems of certain fish and wildlife including alligators, birds have been affected by chemical contaminants, resulting in developmental and reproductive problems (Ankley et al 1998; Diamanti-Kandarakis et al 2009).

Based on this and other evidence, Congress passed the Food Quality Protection Act in 1996, requiring that EPA initiate EDSP to screen pesticide chemicals and environmental contaminants for their potential to affect the endocrine systems of humans and wildlife (www.epa.gov). Many other pesticides are now suspected of being endocrine disruptors - chemicals that can lead to an increase in birth defects, sexual abnormalities and reproductive failure of humans and wildlife.

The effects that can be seen in an organism exposed to an EDC depend on which hormone system is targeted. Some endocrine disruptors may exert their action by interfering with the brain's release of hormones, which in turn regulate the production of other hormones that control the growth and the activity of many other endocrine glands (http://www.pan-uk.org/pestnews/Actives/endocrin.htm).

Many studies have shown that exposure to high doses can result in malformed reproductive organs, consistent with sex hormone imbalance at a critical stage of fetal development (Bila & Denzotti 2007).

The disruption can take place as an inappropriate quantity or timing of a response to a stimulus; the blocking of hormonal effects in parts of the body normally sensitive to it; and the inhibition or stimulation of the endocrine system that could produce an inappropriate quantity of hormones — too much, too little or none at all. Any combination of these interferences on the endocrine system can affect physical development, sex, reproduction, brain development, behavior, temperature regulation and more. An endocrine disruptor can injure or destroy an organ that has the task of supplying hormones (Schettler et al 1999).

Table 1, presented below, shows the pesticides which might be endocrine disruptors and which feature on the World Wide Fund for Nature (WWF) list of chemicals in the environment reported to have reproductive and/or endocrine disrupting effects (Colborn 1998). However, for some of these substances, without further detailed investigation of their mode of action, it is not known whether their reproductive effects are actually the consequence of endocrine disruption.

Table 1

WWF list of pesticides in the environment reported to have reproductive and/or endocrine disrupting effects

Herbicides
2,4-D, 2,4,5-T, acetochlor, alachlor, amitrole, atrazine, bromacil, bromoxynil, cyanazine, DCPA (dacthal), ethiozin, glufosinate-ammonium, ioxynil, linuron, metribuzin, molinate, nitrofen, oryzalin, oxyacetmide/fluthamide (FOE 5043), paraquat, pendimethalin, picloram, prodiamine, pronamide, simazine, terbutryn, thiazopyr, triclorobenzene, trifluralin.
Fungicides
benomyl, etridiazole, fenarimol, fenbuconazole, hexachlorobenzene, mancozeb, maneb, metiram, nabam, penachloronitrobenzene, pentachlorophenol, triadimefon, tributyltin, vinclozolin, zineb, ziram.
Insecticides
aldicarb, aldrin, bifenthrin, carbaryl, carbofuran, chlordane, chlordecone, chlorfentezine, 8-cyhalothrin, DDT and metabolites DDE, DDD, deltamethrin, dicofol, dieldrin, dimethoate, dinitrophenol, endosulfan (a and b), endrin, ethofenprox, fenitrothion, fenvalerate, fipronil, a-HCH, heptachlor and H-epoxide, lindane (g-HCH), malathion, methomyl, methoxychlor, mirex, oxychlordane, parathion (methylparathion), photomirex, pyrethrins, synthetic pyrethroids, ronnel (fenchlorfos), toxaphene, transnonachlor.

Apart from the pesticides documented in this table, others suspected of having endocrine effects include: metam natrium, methylbromide, carbendazim, prochloraz, dibromoethane (EDB), propanil, iprodione, thiram, diuron, diazinon and fenthion. These pesticides were amongst the 116 substances on which information was examined by EU experts, brought together by the European Commission in September 1999 for the purpose of drawing up a list of endocrine disrupting substances.

Endocrine disruptors from pesticides have mainly xenostrogenic activity. Most of the known effects of EDCs were reported in the period of classical pesticides use (see Table 2). The effect of newer EDCs is rather poor studied than less toxic. The best model organisms for such studies are those expressing a marked sexual dimorphism (Petrescu-Mag et al 2008; Petrescu-Mag & Bourne 2008).

Table 2

Xenoestrogens associated with pesticides used in agriculture: potential clinical effects and mechanisms of action (Georgescu et al 2005)

Issue	Effects	Mechanisms of action
Organochlorines: DDT (classic pesticide)	- disorders of male sexual differentiation (hypospadias, epispadias, micropenis), oligospermia; - increased risk of testicular cancer; - female reproductive disturbances (uterine fibroids, premenstrual syndrome, ovarian cysts); - increased risk of breast cancer.	- estrogenic.
Organochlorines: methoxychlor (pesticide, derived from DDT)	- disorders of male sexual differentiation (hypospadias, epispadias, micropenis), oligospermia; - increased risk of testicular cancer; - female reproductive disturbances; - increased risk of breast cancer.	- estrogenic; - antiandrogenic.
Vinclozolin (fungicide)	- disorders of male sexual differentiation and oligospermia.	- estrogenic.
Atrazine (herbicide)	- disorders of sexual differentiation (ambivalent sexual organs).	- interferes with the hypothalamic-pituitary-gonadal axis and with the aromatase activity.
Alkylphenols: nonylphenol (additives in pesticides)	- increased risk of breast cancer.	- estrogenic.
Polychlorinated biphenyls: bisphenol-A (additives in pesticides)	- increased risk of breast cancer.	- estrogenic.

Conclusions. The endocrine disrupting pesticides are a significant threat to health and often persist in the environment for long periods of time. Their continued and unnecessary use provides considerable problems for the future development of wildlife

and humans alike. The WWF list is a good starting point for action but it is just the beginning. Because it is not comprehensive and fails to include several chemicals which have otherwise been identified as threats to health. This problem should be studied in more detail and the authorities should think twice before approvals such products.

References

Ankley G., Francis E., Gray E., Kavlock R., McMaster S., Reese D., Sayles G., Sergeant A., Vallero D., 1998 Research Plan for Endocrine Disruptors. Research Triangle Park, NC, Office of Research and Development, U.S. EPA.

Bila D. M., Dezotti M., 2007 Endocrine disruptors in the environment: Part 1 – Effects and consequences. Quimica Nova **30**(3):651-666.

Colborn T., 1998 Endocrine disruption from environmental toxicant. In: Rom W. N. (ed.) Environmental and Occupational Medicine, Third edition, Lippincott-Raven Publishers, Philadelphia.

Diamanti-Kandarakis E., Bourguignon J.P., Giudice L. C., et al, 2009 Endocrin-disrupting chemicals: An endocrine society scientific statement. Endocrine Reviews **30**(4): 293-342.

Dordea M., Coman N., 2007 [Mankind and its food demands], pp.143-174. In: Petrescu-Mag I. V. (ed.), [Applied Ecology]. Academicpres, Cluj-Napoca. [In Romanian]

Georgescu B., Georgescu C., Coșier V., Mierliță D., Mag V., 2005 Pesticides with endocrine disrupting activities: description and screening strategies. Buletinul USAMV-CN **61**:184-187.

Petrescu-Mag I. V., Bourne G. R., 2008 Crossing-over between Y chromosomes: another possible source of phenotypic variability in the guppy, *Poecilia reticulata* Peters. AACL Bioflux **1**(1):1-10.

Petrescu-Mag I. V., Boaru M. A., Harsan R., Petrescu-Mag R. M., 2008 Genetic basis of resistance to stress in fishes. Molecular and classical investigations in a few model organisms. AACL Bioflux **1**(1):99-110.

Petrescu-Mag I. V., 2009 The survival of mankind and human speciation in a complex astrobiological context. ELBA Bioflux **1**(2):23-39.

Proorocu M., Coste C., Aşchilean I., Balint C., 2008 Implementation of the directives concerning the management of air quality in 6 North-West Region. ProEnvironment **1**(1):10-15.

Rahman M. M., Rahman M. M., Islam K. S., 2010 The causes of deterioration of Sundarban mangrove forest ecosystem of Bangladesh: conservation and sustainable management issues. AACL Bioflux **3**(2):77-90.

Schettler T., Solomon G., Valenti M., Huddle A., 1999 Generations at Risk: Reproductive Health and the Environment. MIT Press, Cambridge.

Șandor M., Maxim A., 2008 Considerations regarding the role and function of soil biodiversity in agroecosystems. ProEnvironment **1**(1):44-49.

Wolff M. S., 2006 Endocrine disruptors – Challenges for environmental research in the 21st century. In: Living in a chemical world: Framing the future in light of the past **1076**:228-238.

*** http://www.epa.gov

*** http://www.nrdc.org/health/effects/qendoc.asp

*** http://www.pan-uk.org/pestnews/Actives/endocrin.htm

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