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A recent report from the British Royal Society confirms that some common industrial chemicals, released into the environment, can interfere with hormones in living things with devastating effect.[1] Such chemicals are "cause for grave concern," the report says. The Royal Society is the United Kingdom's national academy of sciences, founded in 1660.

In humans and other animals, hormones act as chemical messengers that control much of life. The system of control by hormones is known as the "endocrine system." A recent report from U.S. Environmental Protection Agency (EPA)[2] described the endocrine system this way: "An endocrine system is found in nearly all animals, including mammals, non-mammalian vertebrates (e.g., fish, amphibians, reptiles, and birds), and invertebrates (e.g., snails, lobsters, insects, and other species). The endocrine system consists of glands and the hormones they produce that guide the development, growth, reproduction, and behavior of human beings and animals.... Disruption of this complex system can occur in various ways. For example, some chemicals may mimic a natural hormone, 'fooling' the body into over-responding to the stimulus or responding at inappropriate times. Other chemicals may block the effects of a hormone in parts of the body normally sensitive to it."[2]

Substances that interfere with the endocrine system are called "endocrine disrupting chemicals" or EDCs. The Royal Society's report says that we should take EDCs seriously because there is irrefutable evidence that some EDCs have had devastating effects on wildlife, and the endocrine system of humans is similar to that of wildlife. The report gives two examples of EDCs harming wildlife.

1. Tributyl tin (TBT) is a highly toxic form of the familiar metal, tin. TBT was introduced in the mid-1960s in marine anti-fouling paints, to prevent growth of crustaceans (e.g., barnacles) on the bottoms of ships. By 1970, biologists studying the English coast reported female shell fish (dog whelks) growing male sex organs. Soon after, biologists studying the Connecticut coast found female snails growing penises. By 1981, this condition -- known as imposex -- was traced to pollution from boats and ships. Laboratory experiments confirmed that TBT could indeed cause female molluscs to develop male sex organs.

The imposex effects of tributyl tin have now been reported worldwide -- in the UK, New Zealand, Japan, and Alaska. Over 100 species of molluscs have been adversely affected by tributyl tin and in some cases imposex has led to population declines and even extinction of species. The Royal Society draws important lessons from the TBT story:

"The example of the 'TBT story' shows that the effects of TBT were completely unexpected and unpredicted, despite legislation governing new chemicals; nobody foresaw that TBT would cause endocrine disruption in molluscs." The Society says, "...[T]he effects were first discovered by accident by field biologists. This suggests that, until our understanding of how, and what, chemicals cause endocrine disruption improves very considerably, it is likely that other unexpected cases of endocrine disruption in wildlife will become apparent. This example also highlights the difficulty of predicting what effects a chemical will have in the wider environment where it may mix with other chemicals, get degraded, or come into contact with a variety of species of animals and plants," the Royal Society says.

2. The Royal Society then recounts the discovery that some fish in all UK rivers and streams are now intersex -- having characteristics of both males and females. The story began nearly 20 ye ars ago with the chance discovery that 5% of the roach (a species of fish) living in two sewage lagoons were "grossly intersex." A nationwide survey revealed that all sewage effluents had the ability to feminize fish.

Eventually, scientists learned that the problem originated with individual humans discharging natural estrogens and the synthetic estrogens found in contraceptive pills directly into sewage. The Royal Society notes that estrogens were present in sewage effluent at "extremely low concentrations (parts per trillion)" -- but these extremely low levels were sufficient to feminize male fish. The Royal Society goes on: "Studies on wild populations of freshwater fish have shown that intersex fish are present in most rivers. In some of the poorer quality rivers, which receive large inputs of effluents from STWs [sewage treatment works], all of the male fish were intersex to varying degrees. Interestingly, the rivers containing the most severely affected fish also received significant inputs of industrial effluent, and hence it has not been possible to completely exclude a contribution from industrial chemicals in at least some cases of intersexuality in fish.... It is likely that many chemicals in the environment, possibly interacting with one another, cause this condition in fish," the Royal Society says.

The Royal Society then discusses regulations to control EDCs: "To date, essentially all research on EDCs has been driven by effects (or purported effects) many of which have caused public concern and made sensationalist stories in the media. Thus, for example, the possible decrease in [human] sperm counts was very influential in highlighting the human issues, while intersex fish helped to highlight the wildlife aspects of the EDC issue. This is an extremely slow (and costly) way of going about things; when an effect is observed, research is then carried out to determine the cause. Because our understanding of the environment is very incomplete, there will always be a role for approaching many issues in this way. However, it would be more logical to start with a chemical, and make an assessment of what effects, if any, it will induce. This is the aim of toxicity testing," the Royal Society says.

However, the Society identifies problems with the chemical-by-chemical approach: "The problem with starting with the chemical is that there are over 80,000 man-made (let alone natural) chemicals in everyday use. In turn, these will degrade in the environment to even more chemicals. Our knowledge of degradation processes (in the environment, but also within humans and wildlife) is often very poor...."

Then, in a key phrase, the Society says, "In order to develop policy and legislation to protect humans and the environment from EDCs it is first necessary to determine the risk of harm to human health and the environment." The Royal Society then suggests what is needed to complete risk assessments:

(a) Identify chemicals that have endocrine-disrupting properties. Because current tests cannot reliably identify endocrine-disrupting chemicals, new tests must be developed.

(b) With new tests in hand, we must then test each individual chemical AND "interaction between chemicals that do not have endocrine disruptive effects individually, but might in combination." Testing combinations of chemicals is essential, the Society says, because, "In reality, humans are exposed not to a single endocrine disrupter but to a 'cocktail' of such chemicals, and the possibility that such chemicals have additive or reinforcing effects (e.g. combination of an oestrogenic with an anti-androgenic compound) has to be considered seriously."

(c) Next we must examine the length of time these chemicals are in the environment, the Society says.

(d) Next we must analyze the breakdown byproducts of these chemicals, the Society says.

(e) Next we must determine the levels of exposure of humans and wildlife to these chemicals, the Society says;

(f) And finally we must determine the levels at which these chemicals are likely to cause adverse effects, the Society says.

So there you have it. A perfectly rational solution to the problem of

EDCs, based on the very best science. Who could argue against such a program?

But wait. While this testing is going on, all the same chemicals will be spewed into the environment because the current philosophy of "environmental protection" says chemicals can't be controlled before risk assessments have been completed. Under this assumption, just how long will it be before we can protect ourselves and wildlife from EDCs?

To estimate the time involved, let's examine what it would take to test combinations of chemicals to see if, together, they cause endocrine disruption. There are documented instances of chemicals behaving in precisely this fashion [REHW #384], so the Royal Society has identified an important goal. Suppose we wanted to test just 10% of commercial chemicals, or 8000 chemicals, in combinations of three. How many combination of three chemicals can you make out of 8000 chemicals? The answer is 85 billion. Let's assume we could test one million different combinations each year -- surely a preposterous overestimate of human scientific capacity. It would then take 85,000 years to complete the tests. In other words, the Royal Society's rational program based on the very best science will NEVER protect wildlife, humans or the environment from damage.

It looks to us as if the U.S. EPA's Endocrine Disruptor Screening Program (EDSP) is cut from similar cloth: developing new tests to examine 15,000 chemicals, to discern EDCs from non-EDCs, then requiring risk assessments on each of the individual EDCs.[2] Even though the EPA program seems ambitious, it leaves out far more than it includes, e.g., EPA says there are 50 important hormones in humans, but the EDSP is only testing three of the 50.[2] The EDSP is ignoring byproducts and breakdown products of the 15,000 chemicals. Furthermore, the EDSP is ignoring combinations of chemicals. This EPA program will employ an army of scientists for a decade -- and probably far longer. It will generate "an immense amount of data" but "the difficulty will be in interpreting these data," the Royal Society points out. The chemical manufacturers will have one interpretation of the data and public health specialists will have a different interpretation. Ultimately, they will resolve their differences in court. Who will have the advantage in this contest? If EPA ever successfully bans more than 2 or 3 chemicals in the next 30 years based on this program, we will be very surprised.

There is a glimmer of hope in the Royal Society's report. After reviewing conflicting evidence linking EDCs to testicular cancer, abnormal penises, breast cancer and other human diseases, the Society says, "Despite the uncertainty, it is prudent to minimise exposure of humans, especially pregnant woman, to EDCs." Precautionary action.

How would precautionary action work? It would begin by shifting the burden of proof onto the purveyors of chemicals. As Joe Thornton has suggested (REHW #704), chemical manufacturers should be given several years in which to make a reasonable demonstration of no hazard for each of their chemicals (including its associated byproducts and breakdown products), to show that each is neither persistent nor bioaccumulative, nor carcinogenic, nor mutagenic, nor disruptive of intracellular signalling (by hormones, neurotransmitters, growth factors, cytokines, and so on), nor toxic at low doses to development, reproduction, immunity, or neurological function. Testing should occur on multiple generations of sensitive species of animals, unless testing on less than whole animals can give equivalently useful and reliable results. These are the sorts of tests required of new medical drugs.

Any chemical not passing these tests would be automatically phased out from commercial use within a decade or so. Displaced workers would be offered funds for retraining.

The Royal Society's report -- though clearly not intending to -- eloquently shows that the current appproach to environmental protection cannot protect anyone or anything except the chemical industry. We must adopt a modern precautionary approach.

--Peter Montague (National Writers Union, UAW Local 1981/AFL-CIO)

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[1] Patrick Bateson and others, ENDOCRINE DISRUPTING CHEMICALS (EDCs) (London: The Royal Society, June 2000). To locate a PDF version of the report on the web, go to http://www.royalsoc.ac.uk/policy/index.html, click on "reports and statements," then search for "endocrine disrupters."

[2] U.S. Environmental Protection Agency, ENDOCRINE DISRUPTER SCREENING PROGRAM REPORT TO CONGRESS (Washington, D.C.: U.S. Environmental Protection Agency, August 2000). Available on the web at: http://www.epa.gov/scipoly/oscpendo/reporttocongre ss0800.pdf.

[3] Joe Thornton, PANDORA'S POISON; CHLORINE, HEALTH, AND A NEW ENVIRONMENTAL STRATEGY (Cambridge, Mass.: MIT Press, 2000), pg. 359. ISBN: 0262201240.

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