Christian Daughton and the Ecology of PPCPs: An Integral Vision

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— Christian Daughton

"When I started giving presentations almost 10 years ago, just about everything I said was news to everyone. These days many people in the audience know a lot about pharmaceutical waste. There has been a tremendous transfer of knowledge. I hope by the end of the presentation you feel confused. This is far more complicated. It is not just this topic by itself, but pharmaceuticals as pollutants are forcing us to look at pollutants in general in a more comprehensive way" (Daughton, PhD, oral communication, April 2007).

If you want to understand the complexity behind pharmaceuticals and personal care products (PPCPs) in the environment, begin with the work of Christian Daughton (http://epa.gov/nerlesd1/bios/daughton.htm). Most authors who write about PPCPs are sure to have some of Daughton's most prominent articles in their bibliography, including *Pharmaceuticals and Personal Care Products in the Environment: Agents of Subtle Change?* (co-authored with Thomas Ternes), and *Cradle-to-Cradle Stewardship of Drugs for Minimizing their Environmental Disposition while Promoting Human Health: Part I and Part II.* Another option is *Environmental Chemistry of Pharmaceuticals and Personal Care Products (PPCPs)*, a virtual online symposium sponsored by the American Chemical Society, hosted by Christian Daughton. Daughton's PowerPoint presentation in part of this symposium offers a clear and succinct summary of the various issues related to PPCPs.[1]

Much of the material in this issue of *Symbiosis* derives from the work of this accomplished scientist. Attempting to address the breadth of his work in so few pages is challenging. Among Daughton's numerous accomplishments is the EPA's *Scientific and Technological Achievement Award* for his seminal work on PPCPs in 1999.[2] His writing style is comprehensive and detailed, often integrating complex ideas from many different disciplines. He provides easily accessible and creative solutions through his elegant and often holistic perspective. On page 24 of this issue is a republished sample of Daughton's literature. Sophisticated and well-crafted visual summaries or posters of complex concepts—such as the poster of the "4Ts: Toxicant, Totality, Tolerance and Trajectory" (see page 22)—supplement his writings. His works incorporate important philosophical principles that reveal his mastery of chemistry, biology, ecology, education, holistic thinking, environmental action, and systems analysis.

"This is a society based on chemicals. PPCPs are an example of pollutants that we haven't look at before; they are only a fraction of the chemicals used in commerce.

One action for a healthier future for people and the environment is simple, if not easy, stop throwing PPCPs into the waste stream.

We live in a chemical sea. How we focus on a few of those with respect to hazard and risk is important. It's a hard thing to reconcile with our sense of risk" explains Daughton (Daughton, PhD, oral communication, April 2007). In "Green Pharmacy," a monograph in *Environmental Health Perspectives,*[3,4] Daughton discusses "the concepts of environmental surprise" and the "precautionary principle." He says, "Miniscule differences in initial conditions can lead to differences far out of proportion in the system's subsequent behavior...minor perturbations can essentially be slowly amplified to yield major effects."[3(p762)] Daughton makes the scientific case for how changes in individual behavior and changes in larger systems such as the environment are connected. He points out that in toxicology, the process of cause and effect is quite different for single organisms than it is at higher levels of organization (e.g., communities and ecosystems), "because of the myriad interactions and spatial relationships within the system—some imparting vulnerability to synergistic effects."[3(p762)] Irreversible change occurs when perturbations exceed a system's resilience. To summarize, accumulating evidence suggests that "although it may never be possible to gauge precisely humanity's contribution to adverse environmental or human health events or outcomes, it might behoove us to eliminate as many extraneous variables (impacts) in ecosystems as possible—regardless of their perceived immediate importance."[3(pp762-763)]

Daughton's argument that small decisions have the potential to create significant changes is logical, clear, historically relevant, and persuasive. Insisting that we must be cautious about what we dump into the environment, he advocates for the precautionary principle: "The principle of precautionary action redistributes the burden of proof because the science required for truly and fully assessing risks lags far behind what is needed."[3(p763)] The shift here is from science to action: "Science in the face of uncertainty, must be melded with policy and political judgment to arrive at a course for further study or action."[3(p763)] He notes that precautionary principles are emerging as environmental considerations are melding market imperatives. In simple terms, environmental stewardship yields economic benefits.

Daughton offers a visionary solution to the problems we are creating with PPCPs: "A proactive, voluntary holistic stewardship program for PPCPs would be preferable to a reactive, prescriptive regulatory program. By focusing on a mind set toward holistic, thoughtful environmental responsibility rather than rote compliance to regulations, all aspects of society can play integral roles."[3(p763)] Daughton's perspective is integral. "An integral worldview occurs when pluralism and relativism are transcended to include a more systemic whole. The beginning of an integral worldview allows for healthy value distinctions, acknowledging previous stages and integrating them without trying to change them."[5]

Daughton not only offers a pluralistic understanding of the many facets of the ecology of PPCPs, but also analyzes and evaluates potential opportunities. Expertly integrating many perspectives, he points out what each has to offer and enables readers to grasp the difficult and complex concepts surrounding the human use of PPCPs. His superb articulation of the issues offers the most helpful guide available to thinking through this thorny problem. Together, we can implement the clear and actionable solutions he outlines. "The ultimate question for physicians is, if we can get to the point where we have no leftover drugs, will that lead to improved therapeutic out-

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comes? The right drug, at the right time, in the right amounts? Is the measure of unused drugs a way to determine the efficacy of the treatment?" (Daughton, PhD, oral communication, April 2007). Daughton reminds us that we do have a choice. A healthier future for people and the environment is simple, if not easy: stop the need for throwing PPCPs into the waste stream.

A significant part of the solution, Daughton explains, is *cradle-to-cradle stewardship*: "The fusion of ecology and marketplace imperatives has perhaps emerged most noticeably in the relatively recent product management philosophy termed 'cradle-to-cradle'…the incorporation of 'eco-effectiveness,' and 'ecologic intelligence' into life-cycle considerations for product development and use."[3(p764)] Cradle-to-cradle product stewardship is not only required for PPCPs, it is essential to all consumer goods and aspects of the built environment.

Daughton observes that while "The Institute of Medicine (IOM) Committee on Quality of Health Care in America…goals are far-reaching and urgently needed… [they] do not include the concept of ecology of health. Safety of the patient is pursued out of context of the safety of the ecology."[3(p764)] Daughton's critique is imperative for the future of the health of people and the environment. "With a little expansion of the IOM vision, an integration of human and ecological health could be formalized at a national level through their efforts. High-quality health care and environmental protection need not be competing goals—they are intimately linked."[3(p764)]

Christian Daughton is passionate in pursuing his goal of shedding light on the nature of a complex phenomenon—the effects of PPCPs in the environment. His integral and holistic vision identifies current efforts to solve these problems that are already under way and provides a unique forum for dialogue. In his words: "I hope these disparate professional communities will find compelling reasons to cross-communicate and, in doing so, expand their knowledge and effectiveness in their own fields."[3(p765)]

REFERENCES

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