

A call for a chlorine sunset

The hazards of organochlorines require that they be eliminated.

Pandora's Poison: On Chlorine, Health, and a New Environmental Strategy

by Joe Thornton

MIT Press: 2000. 611 pp. \$34.95, £23.50

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Organochlorines are at the centre of a fierce, high-stakes debate. This contribution to the debate establishes Joe Thornton, a scholar at Columbia University and former Greenpeace scientist, as the standard-bearer for those who consider that many anthropogenic organochlorines are a source of environmental and health hazards.

Thornton argues, in his meticulously researched, 11-chapter book, that a "chlorine sunset" must be orchestrated. He contends that the products and processes of the chlorine industry seriously compromise the environment as a safe place for maintaining the fertility and abundance of life.

At the opposite pole in the debate stand the Chlorine Chemistry Council (C-3), a subgroup of the Chemical Manufacturers Association, and the Vinyl Institute (VI), a consortium of the makers and users of vinyl. The C-3 position has been presented recently by Clifford T. Howlett Jr, who argues in *Chlorine and Chlorine Compounds in the Paper Industry* (Ann Arbor Press, 1997) that chlorine is vital for health and the economy; Howlett ridicules the Thorntons of this world and their case.

Ironically, Howlett's tactics stimulated the writing of *Pandora's Poison*, the latest and by far the most potent salvo in the conflict. Thornton sets out to refute the C-3 charge that the industry's opponents don't practise 'sound science'. He points out that this accusation is, in fact, the fulcrum of a public relations campaign to dismiss the industry's critics by implying that they base their judgements on "bad science or — even worse — emotion, fear or some other suspect motive".

As the centre-piece to his case, Thornton criticizes the current approach to the regulation of chemicals, calling it the "risk paradigm". According to this, a chemical is regulated or banned only when science establishes that the chemical presents what a regulatory agency deems to be an unacceptable risk. Thornton argues that this is "utterly ill-suited to addressing the long-term global health threat that organochlorines pose". He proposes instead a new regulatory dynamic that he calls the "ecological paradigm". This would be based on the "precautionary principle ... [that] ... we should avoid practices that have the potential to cause severe harm, even in the absence of scientific proof of harm". The



The labyrinthine infrastructure of the chlorine economies.

precautionary principle would be exercised under guidance principles called "zero discharge", "clean production" and "reverse onus". Chlorine economies in water disinfection and the enormous, labyrinthine markets for vinyl, chemicals, paper, surface cleaning and clothes bleaching are thus pitted against the negative impact that organochlorines may have on the health and welfare of all life-forms.

Pandora's Poison is a landmark book which should be read by anyone wanting to understand the environmental and health dangers of the chlorine industry. As a reference work alone it is a masterpiece, analysing around 1,000 references. In areas with which I am familiar, Thornton's treatment is mostly brilliant and is based on sound science.

But it is much more than this. Thornton develops his case comprehensively, evaluating the landscape from the historical, through the environmental and scientific, to the industrial, political, regulatory and ethical forces that are now central to the chlorine struggle. He argues convincingly that widely distributed, persistent organochlorines are a major global hazard, and he backs his arguments up with an eloquent explanation of the chemical properties that determine the dangers. The cases for and against many organochlorines as potent toxins and carcinogens are detailed. Thornton discusses studies which reveal how certain organochlorines can significantly disrupt the endocrine system, acting in vanishingly small quantities. Such disruption can compromise life and fertility in largely invisible ways that can be extraordinarily dangerous. And there are proven cases of organo-

chlorines that have severely harmed both humans and animals, and strong connections of some organochlorines with cancer.

There have been few studies of the toxicology of organochlorines or, more importantly, of the toxicology of combinations of organochlorines. Thornton is strongly critical of toxicologists as well as of the chemical industry over this, as he believes the problem to be much greater than is currently perceived. We now know enough about the unintended perils of persistent compounds to understand that this argument is unimpeachable.

Thornton explains the history behind the growth of the industrial use of chlorine over the past 60 years, describing how it has come to represent a huge part of the economy. Thornton cites shocking evidence of major chemical companies distorting scientific data so as to make it appear that dioxins are harmless to humans. Such action betrays the wider chemical community, discrediting all chemists through the unscrupulous behaviour of people who represent chemistry. Moreover, these falsified studies appear to be heavily responsible for the widespread underestimation of the dangers of dioxins to humans.

Similarly, Thornton discloses a Vinyl Institute memorandum laying out plans to stave off the implementation of punitive regulations being planned by the Environmental Protection Agency for dioxin production associated with the incineration of vinyl. VI leadership decided to hide behind the prestige of the American Society of Mechanical Engineers. It funded a consultant who was "willing to set his priorities to [VI] needs", producing the answers they wanted disguised as an

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ASME report. If Thornton has been given the complete story accurately, the whole dishonourable affair would undermine the credibility of this industrial group as a body interested in honest scientific dialogue about the effects of their products on human health.

In *Pandora's Poison* Thornton is magnificent, but he is not perfect. He tends to give chlorine no quarter, sometimes polarizing the arguments in the book more than is necessary or desirable (although balance is usually achieved). Some of his suggestions for alternative technologies can be easily criticized, and I don't always agree with his assessments of how the industrial landscape can be changed to eliminate organochlorines.

Readers must judge for themselves how we can best attain a sustainable future. But, in my opinion, it is definitely time to thank the chlorine industry for useful but imperfect technologies developed when the hidden dangers were not understood, and prepare to move on expeditiously, in particular by developing safer alternatives and exploring Thornton's policy suggestions.

Pandora's Poison also has important indirect lessons for achieving a sustainable civilization. If young chemists were rigorously taught about the toxicity of the substances they synthesize and study, their efforts would more naturally be directed towards avoiding persistent toxic substances. The chemical vernacular would include the terms around which *Pandora's Poison* is constructed — for example, persistent toxins (both elemental and molecular), endocrine disruption, bioaccumulation, atmospheric distillation, mutagen and teratogen.

One of the most pressing tasks for a sustainable civilization is to replace technologies producing persistent pollutants with safe alternatives. As Thornton says of our use of anthropogenic organochlorines, "like the Romans, who sipped from lead cups, ran drinking water through lead pipes, and bathed in lead basins, we have built our house of poison unaware of the consequences". ■

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Sexual trade-offs

Promiscuity: An Evolutionary History of Sperm Competition and Sexual Conflict

by Tim Birkhead

Faber & Faber: 2000. 272 pp. £9.99 (pbk)

A. H. Harcourt

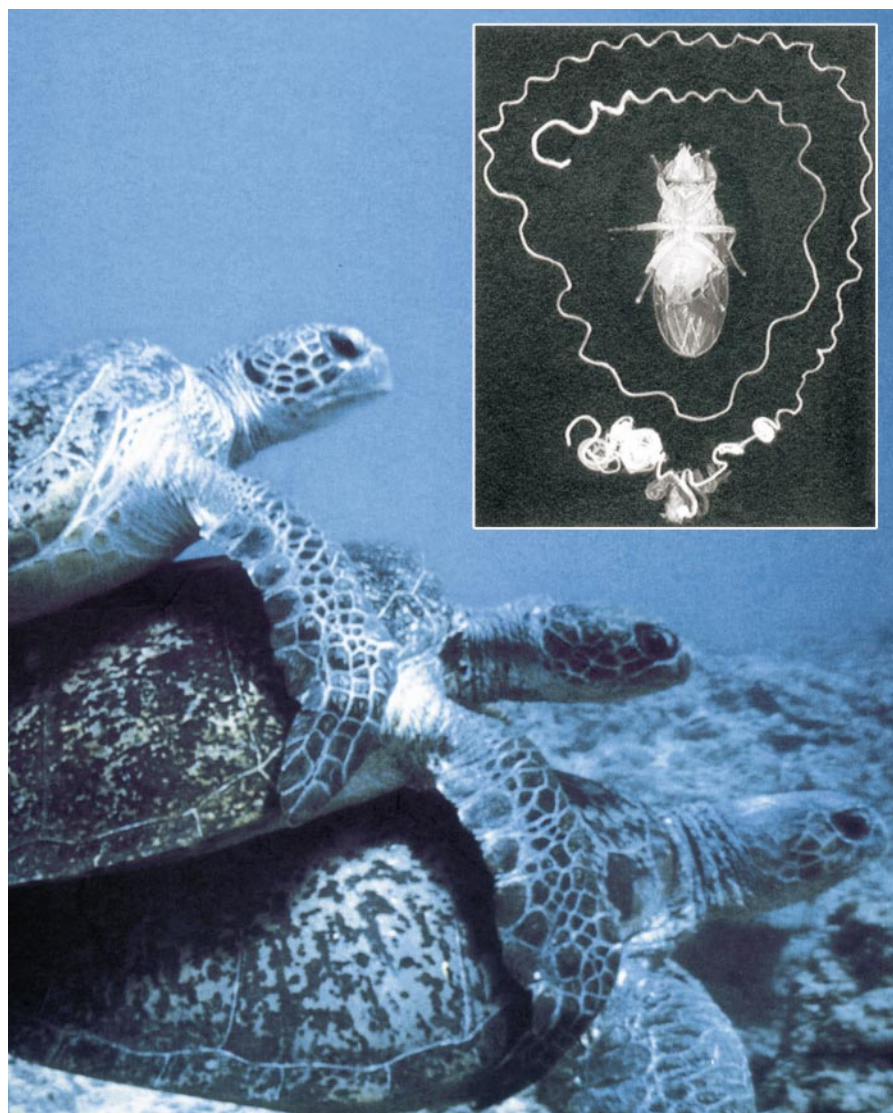
In some barnacle species, males are mere bags of sperm in special pouches inside the female. Fourteen bags (males) in one female was the highest number Darwin counted. He didn't expand on such promiscuity in females, perhaps because his prim daughter Henrietta was by then proofreading and editing his manuscripts. But Tim Birkhead more than makes up for Darwin's omission. *Promiscuity* is a fascinating, wide-ranging, erudite, readable journey through some of the weirder stretches of biology.

Promiscuous behaviour has some amazing manifestations. Many of them, for males, are well known. Deers' antlers and peacocks' tails are obvious examples; others we are less familiar with. Perhaps most surprising is the extent of promiscuity in females. Birkhead tells us of a feral female sheep that mated with seven males in five hours, for 163 matings in total. But the evidence for female promiscuity has been before our eyes for decades. Witness the huge, pink sexual swellings on the rumps of the females of many primate species. If such swellings were on males, they would surely have received extensive attention in Darwin's *The Descent of Man, and Selection in Relation to Sex*. As it is, we had to wait until the 1970s for their association with female promiscuity to be highlighted and explained in terms of the advantages for females in attracting several mates.

We are still uncertain as to what these advantages are. Author and anthropologist Sarah Hrdy's long-standing suggestion for promiscuity by female primates is that it reduces the number of males that might mistreat the female's offspring. So, in one human society, in which infants have a 50% chance of dying if their father dies or departs, the offspring of mothers who have more than one male accepting fatherhood survive better than do the offspring of monogamous mothers, because the infants are not perceived as fatherless and hence defenceless.

Testing of this and other hypotheses is a rapidly growing area of some very nice research. Thus, promiscuous female pseudoscorpions abort fewer eggs than do monogamous females, because the promiscuous ones are more likely to have mated with a genetically compatible partner.

Despite the female monkey's red rump, the main consequences of promiscuity are seen in the male, rather than the female. Whereas female promiscuity necessarily leads to competition among sperm to fertilize



Turning turtle, and (inset) the longest sperm, from the fruitfly.