Environmental History
Changes in the Land

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The Davistown Museum explores the environmental history of the Norumbega bioregion by delineating a series of paradigms — models — as an aid in providing some order and understanding to environmental changes that at first seem simple. Sea level change is not difficult to understand, nor is the burning of land by Native American communities to improve the harvesting of game. The systematic exploitation of Maine's forest resources by European settlers -- the search for masts, the cutting of forest timber, the clearing of land for farms, land abandonment, and forest re-growth is a more complex subject. The depletion of Maine's fisheries and other marine resources is a nearly unexplored topic, with only a meager literature now available on this subject.

History as the chronology of events in time fails us with respect to the interconnected complexity of the patterns of chemical fallout which derive from the late 20th century military - industrial - commercial complex. Environmental change now occurs simultaneously, invisibly, and with a synchronicity and a synergism we cannot yet understand. Should we not explore the relationship of human activities to environmental change, the essence of human ecology, because we cannot know the consequences of our activities? Should we leave out environmental change as a component of the history of our bioregion? At the end of the next 200 year segment of the history of the Norumbega bioregion, what will have been the most important environmental -- historical events of these two centuries? Ozone layer depletion? Food chain contamination with organochlorides, dioxin, and heavy metals? Climate change from greenhouse gasses? The legacy for our children of the Maine Yankee Atomic Power Company and its fuel cladding failures and high-level waste site? How will future historians interpret the palimpsest that will result from our current activities? How will they interpret what we did with our late 20th century tool kits: internal combustion engines, nuclear powered electrical tools, electric power grids, and PBDE-contaminated electronic equipment? Will anyone bother to peel back this palimpsest to examine the ultimate impact of the ecotoxic molecular accidental durable remnants of the age of chemical fallout?

Introduction

The Davistown Museum is currently organizing a comprehensive registry of chemical fallout, which will be posted as an appendix at the end of Paradigm III: The Industrial Revolution and Chemical Fallout, following the introductory essays pertaining to the rapid spread of ecotoxins in the biosphere. Paradigm IV, the Davistown Museum's review and analysis of biocatastrophe, will explore the ecological, social, and public health consequences of chemical fallout and its relationship to global climate change, newly emerging pathogens, and the proliferation of GMOs (genetically modified organisms). Paradigm IV will be issued as Davistown Museum Special Publication #69. Visitors to this section of the museum website can bypass our general introduction to Changes in the Land and go directly to either our introductory essays on chemical fallout, the registry of chemical fallout ecotoxins, or our special publication on biocatastrophe (work in progress – new material will be posted weekly until complete). Paradigms I-IV of the Davistown Museum Department of Environmental History (The Center for Biological Monitoring) are followed by Paradigm V, RADNET, Nuclear Information on the Internet. These are our databases and information sources on anthropogenic radioactivity, compiled by the predecessor of the Davistown Museum, the Center for Biological Monitoring. Material within this section will be extracted for Davistown Museum Publication #75, *Nuclear Information Handbook*. Many Museum publications are, or will soon be, available at: www.amazon.com and/or at local Maine book stores, as well as at the three tool stores of the Jonesport Wood Company.

The Davistown Museum had as its original focus the tools and trades of the boomtown years of the Davistown Plantation, later the towns of Liberty and Montville, Maine. The attempt to document what occurred in this brief and nearly forgotten period of time in an isolated and obscure part of the hill country of the central Maine coast poses several problems: when does this history begin and end? What parts of this history do we include in our narrative? The Museum's extensive website expresses the peculiar strategies and specialized topics, which characterize our particular narration of local and regional history, summarized as the theme of the marriage of tools, art, and history. Our exploration begins with the local history of the Davistown Plantation, then moves back in time to include ancient Pemaquid, the Native American confederacy of Mawooshen, and the indigenous community of the Wawenocs who occupied the central Maine coast prior to European settlement.

A major mission of the museum is the interpretation of the history and significance of the hand tools utilized in the booming years of Maine and New England's shipbuilding era. This mission is manifested in the museum tool collections and publication series *Hand Tools in History*, the six volumes of which constitute the central component of this website. Our exploration of the labyrinths of the history of ferrous metallurgy and our toolmaking industrial society, which evolved after 1750, is a natural outgrowth of the many questions raised by the ephemeral presence of the communities and water-powered mills of the Georges River and their role in America's wooden age. Inevitably, our explorations and educational programs force us to confront a fundamental problem as we examine the history of the Industrial Revolution and examine the hand tools it produced: the impact of industrial society on the environment. Any examination of the history of the Industrial Revolution and the tools it produced cannot stop with the romance of the hand forged tools of the shipsmith and the shipwright. We are inexorably drawn into the controversies pertaining to the impact of polymetalic pyrotechnological industrial society on the environment. This last volume of our website series explores these issues.

The subject of environmental history is both natural changes in the environment and the impact of tools and technology on the environment. The documentation of this impact raises the unavoidable question of the relationship between technology and history. Any attempt to construct a historical narrative cannot evade the documentation of the consequences of this relationship -- the essential components of both the definition and the study of human ecology. Constructing and deconstructing history, which is what historians do, means organizing and interpreting both fact and story. Each generation of historians has a tendency to discount and deconstruct the histories constructed by their predecessors and reconstruct history as they interpret it -- the pleasures of the text, as it were. Maine history prior to the Civil War is the jumping off point for our narrations, which go back in time as well as explore current and possible future events in what is now an obscure and isolated location in America's rapidly changing industrial and environmental landscape. The attempt to understand what occurred in late 18th century and early 19th century Davistown brings with it a confrontation with history as a palimpsest -- one layer of history as fact and artifact overlaying and obscuring the layer underneath it. Before the first settlement of Davistown and its boomtown years lies an interregnum of historical quiescence when during the Indian wars most of the European population was driven out of Maine. Preceding that interregnum lies the intriguing history of ancient Pemaquid, which is in itself a series of palimpsests waiting to be peeled back: the colonial Pemaquid of the first colonial dominion of Maine, the ancient Pemaquid of protohistory, the mysterious Pemaquid of the confederacy of Mawooshen, and the Wawenoc diaspora. Interwoven with all these layers of history is the fundamental question of human ecology: what was, in this specific bioregion and in these particular eras, man's relationship with the environment and how did he change that environment? In turn, what natural changes occurred that altered his relationship with this environment and changed the social structure of the communities he lived in? These questions are an integral component of any study of history and cannot be left out of the consideration of American beginnings and the clash of two different cultures, European and Native American, that occurred at the interface of this confrontation?

Over a period of time, there is the likelihood of a complex, synergistic interaction of all these phenomenon: cataclysmic climate change, chemical fallout, ABRB, and other newly emerging pathogens, and the accidental or deliberate proliferation of genetically modified organisms. Combine these elements with a rapidly expanding world population and the unsustainable activities of a global consumer society and we are confronted with the near certainty of global biocatastrophe, the subject of Paradigm IV in our exploration of the environmental history of Maine, and New England, and the world, unfortunately. At this critical junction of time, the impact of the proliferation of nuclear technology may, or may not (hopefully), be a major component of the age of biocatastrophe.

Can we explore the palimpsests that constitute our history without confronting the most recent chronology of environmental change wrought by our behavior? Why shouldn't the for-profit military - industrial - commercial complex of human activities that is at the core of human ecology be scrutinized for its environmental and historical impact? Who profits from the proliferation of Wall St. ecotoxins discussed in Paradigm IV? What is the impact of these ecotoxins on the Earth’s biosphere, and what can individuals do to ameliorate this impact? Those of us with motor vehicles, computers, TVs, and cell phones are the best customers of the purveyors of Wall St. ecotoxins.

Paradigm I: Geological and Environmental Change

Two important natural cycles of change form the background as well as the context for both the archaeological and environmental study of Maine’s past. The most obvious of environmental changes during the last 15,000 years has been the melting of the glaciers with the concomitant rise in sea level, followed by a rise in the land mass as the weight of the ice was lifted off the earth's crust. A number of citations in the following bibliographies explore this history of sea level change and its impact on and destruction of Native American coastal sites up until approximately 3,000 years ago when sea levels stabilized more or less at their current level. A second pertinent issue pertaining especially to subsistence patterns of Maine's prehistoric Native American inhabitants has been the issue of global warming and cooling. After several thousand years of relatively warm temperatures in the late archaic and early and middle woodland periods, the northern hemisphere, including coastal Maine, underwent a dramatic period of cooling at approximately 1350 AD. This episode of climatic cooling lasted at least until the late 19th century, and by some accounts into the 1930s. The sudden cooling of the 14th century may have had a significant impact on Native American communities of the central Maine coast and the availability of natural resources upon which they depended. Changing temperatures have brought associated changes in fauna and flora, which are also explored in some of the articles and books cited in the Paradigm I bibliography.

Paradigm II: Agricultural and Forestry Practices

William Cronon in the text cited below is the most eloquent source of information about the extensive changes in the land that resulted from the activities of Native Americans in New England and in Maine. The foremost cause of these changes was the frequent clearing of land by burning to facilitate hunting, and secondly the horticultural activities of the Native Americans who raised beans and corn. Among the most controversial and unresolved issues of Maine ethnohistory is the extent to which these horticultural activities extended into Maine in prehistoric times. The current view of Maine's anthropologists and historians is best represented by Bourque (1995), Snow, and others who contended that horticultural activities stopped at either the Saco or Kennebec rivers and Native Americans living east of the Kennebec were hunters and gatherers. A corollary of this viewpoint is that Native American horticultural activities in the historic period in areas east of the Kennebec River are associated with the impact of Europeans and the availability of iron hand tools -- tools that encouraged the spread of agriculture into areas east of the river (Bragdon 1996). Prins (1992) analyzes the introduction of maize agriculture into Meductic (New Brunswick) in the 1670s by Abenaki refugees from central Maine.

The prevailing view that agricultural activities of pre-contact Native Americans in Maine stopped exactly at the Kennebec River is contradicted by a variety of evidence to the contrary. Recent excavations at Pemaquid (Spiess Fall 2001) note evidence of horticultural activities well before contact. The widespread abundance of ceramic shards, usually indicative of sedentary horticultural communities, further confuses the issue. Thwaite's (1896) journals of the French cleric and chronicler Baird recounting the 1611 journey up the Sheepscot River and his meeting with the Abenaki (Wawenoc?) sagamore Mentaurmet at or near Wiscasset are explicit about the existence of earlier maize cultivation in the Sheepscot River valley, an activity, which was discontinued and moved to the north in the valley of the Sandy River near Farmington after raiding Micmacs from Nova Scotia destroyed the Abenaki cornfields in the very late 16th century. Deeply ingrained local oral traditions remember Native Americans east of the Kennebec as growing maize since time immemorial. Arguments based on the length of the growing season have little credibility; Native American communities in the Norumbega tidewater have growing seasons which are slightly longer than those at village sites on the upper Kennebec and Sandy rivers. When the first settlers arrived at Sheepscot and other riverine locations west of the Penobscot, they found some park-like woodlands in central, coastal Maine that were similar to those settlers encountered in southern New England. It is this altered landscape that signals the burning of undergrowth to facilitate hunting and horticulture by the indigenous communities who lived in the ancient dominions of Maine before European exploration. Extensive changes in the land in the Norumbega region did not begin with, but preceded, European settlement.

When the first European settlers arrived along the coast of Maine there is abundant evidence that their dam and sawmill construction caused radical changes in the subsistence patterns of Native Americans who depended on the free fish runs for the viability upstream of fishing locations. The effluents produced by the numerous sawmills throughout Maine impacted the quality and abundance of the fisheries that the Native Americans depended on.

The most dramatic impact of European settlement on Maine's landscape was, however, the rapidity with which settlers harvested, then exported the forest resources of coastal Maine and then cleared the land, often by burning. A large portion of the forests of the Norumbega bioregion has undergone the following sequences: a) exploitation for masts for the mast trade (little impact); b) exploitation of forest resources for shipbuilding and local construction, raw materials for export (pulp and firewood), finished lumber products for export (staves, shingles, spars, and other milled products); c) burning and clearing of depleted forests for farmland; d) abandonment of farmland following a brief period of farming due to poor soil and lack of nutrients; e) re-growth of abandoned farmland by a monoculture of spruce-fir replacing the mixed soft and hardwood forests the first settlers encountered. This sequences of changes in the land is particular relevant to the history of Davistown, a totally forested environment in 1750, which was nearly devoid of forest by 1875, and is now nearly entirely covered by a scraggily re-growth of spruce and fir over a depleted podzol soil base.

In the following environmental history bibliography, research and articles pertaining to these topics will be listed under Paradigm II.

Paradigm III: The Industrial Revolution and the Age of Chemical Fallout

Introduction

The Davistown Museum documents the evolution of modern industrial society using hand tools as an indicator of changing steel- and toolmaking strategies and technologies. In the context of the Industrial Revolution the phenomena of chemical fallout as a scientifically verifiable phenomenon made its appearance in the 19th century. Little evidence remains of the intense air pollution caused first by wood smoke and later by coal and oil. No London black fogs affected windswept Maine in the same way that they impacted European cities, but the third paradigm in the environmental history bibliography deals with ubiquitous impact of the late industrial revolution and its PCBs, DDTs, PBDE, methylmercury, percholates, phthalates, dioxins, heavy metals, and other contaminants. As exemplified by our postings from the Maine Department of Environmental Protection, these industrial activities have had such a wide spread impact that it is no longer safe for pregnant women and children to eat any freshwater fish from any of Maine's many lakes and streams or from any other freshwater sources anywhere.

This component of our survey of the environmental history of Maine includes an ongoing chemical fallout registry of the most pervasive biologically significant ecotoxins (Part I) and climatologically significant greenhouse gasses (Part II) now entering the environment. Particular attention is focused on human body burdens of these toxins, both in Maine residents (see our alert pertaining to the recent study issued by the Coalition for a Healthy Maine), as well as individuals living anywhere in our universally contaminated biosphere. Paradigm IV, *Biocatastrophe*, summarizes the most important forms of toxic chemicals listed in Paradigm III and includes body burdens of toxins as documented in blood, tissue samples, and breast milk, as well as relevant ecotoxin contamination in biotic media, especially birds, fish, shellfish, air, water, and sediment. Paradigm IV also contains information pertaining to newly emerging pathogens, drug resistant viruses and bacteria, the possibility of future pandemics, and the impact of genetic engineering on future food supplies and human health.

The Davistown Museum is now the repository of an extensive collection of journal articles collected by the Center for Biological Monitoring on these topics. The several hundred journal articles in stock are available for perusal by museum visitors.

ALERT

Body of Evidence: A Study of Pollution in Maine People, an important new report of body burdens of biologically significant chemical contamination has recently (June 2007) been issued by the Alliance for a Clean and Healthy Maine. This report may be accessed at www.cleanandhealthyme.org. The Davistown Museum has downloaded several copies of this report; at least one copy is available for visitor perusal in the Main Hall at the Davistown Museum. Some of the data in this report will be cited in our review of the proliferation of chemical fallout ecotoxins in pathways to human consumption in Paradigm IV. The core of the report covers body burdens of (5) categories of contaminants in twenty-six Maine volunteers. This report is part of a larger effort to document biologically significant chemical fallout in pathways to human consumption, and the resulting body burdens of these chemicals in both children and adults. Exposure to these chemicals involves not only tropospheric chemical fallout and its bioaccumulation in human ecosystems, but also exposure to and ingestion of chemicals in a wide variety of consumer products. The report issued by the Alliance for a Clean and Healthy Maine focuses on the latter group of chemicals encountered in everyday consumer products. The following categories were the main focus of the study: phthalates, polybrominated diphenyl ethers (PBDEs), perflourinated chemicals (PFCs), bisphenol A (BPA), and metals (lead, mercury, and arsenic).

Historical Overview: The Pyrotechnic Society

The evolution of industrial society is based on the use of fire to produce utilitarian articles for domestic and commercial use, and weapons for hunting and warfare. The first tools were eoliths, found stones of suitable dimensions for hunting and processing the fruits of the hunt. Knapped stone tools of various styles denoted the evolution of hunting and fishing society and the gradual development of protopyrotechnic societies that first made ceramic artifacts for agricultural societies, the emergence of which were signified by the natufian assemblage, sickles made with sharp stone inserts as cutting blades. The evolution of hierarchical agricultural societies into complex literate polymetalic societies is characterized not only by the production of ceramics and glass but by hammered then smelted copper utensils, tools, and weapons. One might date the first emissions of chemical fallout from early human protoindustrial activities as beginning with the smelting of copper at Vinca, Yugoslavia in eastern Eurasia c. 6000 BC (Renfrew 1973). The transition of human society through periods of time when copper, bronze, and iron smelting dominated social, commercial, and military activities is a well documented sequence of pulses of community growth and decline with a gradual expansion of the geographical area occupied by polymetalic pyrotechnic societies. This protoindustrial growth is accompanied by the gradual shrinkage of competing, often conquered and victimized, Stone Age communities. In non-pyrotechnic communities, the later production of ceramic artifacts and the occasional production of hammered gold and copper artifacts never evolved into polymetalism. Exceptions abound as with the iron and steel producing communities of the Bantu of central Africa. The earliest dates of 11 polymetalism in China and India are still a matter of controversy. The iron-, steel-, and toolmaking strategies and techniques of the Iron Age in the Mediterranean and central and western Europe are much more well documented (see our survey of these activities in Vol. 6 of the *Hand Tools in History* series.)

Human activity has made radical changes in the earth's landscape since the appearance of the first agrarian communities +/-10,000 BC. The harvesting of woodlands for charcoal had already denuded significant areas of the Middle East and the Mediterranean by the time of the Roman Empire. One might denote the early stages of the evolution of polymetalic pyrotechnic civilization (6000 BC - 1350 AD) as the *in vitro* stage of the age of chemical fallout. The birth of the age of chemical fallout, where small increases in carbon dioxide have been documented in glacial ice deposits, can be linked to the increasing size of late medieval high shaft charcoal fired iron smelting furnaces in Europe, which evolved into the modern blast furnace around 1350. Rapid advances in the capacity to make iron and steel edge tools for warfare, horticulture, timber harvesting, and shipbuilding after 1350, characterized by the refining of the cast iron produced by the blast furnace in lieu of smelting natural steel in direct process bloomeries, is now a relatively obscure component of the sequence of renaissances we now study as the beginning of modern culture. It was this advance in the ability to make functional relatively high quality hand tools that played a key role in constructing the infrastructure of a European market economy (ships, mills, wharfs, cities) that, with the help of weapons, firearms, iron printing presses, and glass telescopes would conquer and settle the new world.

Much more attention is given to the development of firearms and their role in world exploration and conquest than to the development of the steel- and toolmaking strategies and techniques that made firearm production possible. Two thousand years of the production of bronze, then iron, edge tools, including weapons, paved the way for those mostly anonymous German metallurgists to forge the gorgeous Wheellock guns on display at New York's Metropolitan Museum of Art. It would be another 500 years before the even now unmentionable words "chemical fallout" would enter the English language in the modern context of their significance (Miller 1970). While many an ironmonger probably met an early death due to the smoky emissions from his furnace or forge, it was not until the appearance of coal-derived coke smelting furnaces in England and continental Europe in the second stage (childhood) of the sequences of the Industrial Revolution that significant emissions of carbon dioxide and the first traces of mercuric sulfide-derived methylmercury can be documented in polar glacial ice deposits.

We can follow the dots in the trail of effluents left by the Industrial Revolution until we arrive at the onset of the age of biocatastrophe. As the population of the biosphere approaches ten billion people the question then becomes at what point does the interrelated impact of greenhouse gas-derived cataclysmic climate change and chemical fallout result in rapid population decline? The key characteristic of the age biocatastrophe is pervasive world encompassing chemical fallout and its synergistic interaction with the greenhouse gasses causing cataclysmic climate change and the antibiotic and pesticide resistant pathogens accidentally produced by the creative chemists and geneticists of the age of chemical fallout.

Industrial Society and Chemical Fallout

The various stages in a survey of the history of chemical fallout emissions are inexorably linked to the technologies of industrial society and the increasing complexity of the chemistry of industrial productivity as well as of its effects on the earth's landscapes and ecosystems.

There are many words that have not yet made their way into the indexes of most texts and treatises on environmental issues, particularly including those on global climate change. If one peruses the index of several contemporary publications on global climate change, words not often found in the index include chemical fallout, ecotoxins, bioaccumulation, immunosuppressive chemicals, mass mortality events, body burdens, and that most obscene word in the English language, the B-word. The term carbon footprint is ubiquitous; that's the easy one and when sea levels rise, just keep moving inland or build higher dikes. Global climate change and melting icecaps are processes that, while occurring over relatively long periods of time, are highly visible. One can watch the melting of glaciers and polar ice or the decimation of the habitat of the polar bear on television; much less visible is the proliferation of ecotoxins in pathways to human consumption.

Despite our reluctance to use certain words or to systematically document the increasing levels of ecotoxins in our changing environment, the era of chemical fallout leaves obvious footprints, which are a function of industrial activity and can be scientifically recorded, though we may not want to do so.

When Henry Cort designed the modern reverbatory furnace and associated rolling mills in 1784, he ushered in an Iron Age that, along with Watt's steam engine, Wilkinson's steam turbine, and the marvelous inventions of England's industrial revolutionaries was characterized by the mass production of malleable iron. The steely cast iron machines that signaled the beginning of the factory system of mass production and the spread of steam-powered railroads soon followed. Carbon dioxide and coal-derived mercury sulfide emissions continued increasing as did the deleterious health impact of long hours of work in dangerous smoky sooty environments for the new classes of the working poor. It was the smoke and soot emitted by the first factories that constituted the first obvious forms of chemical fallout. When bulk steel processing technologies emerged after 1860, rapid improvements in the working conditions of the poor were accompanied by massive increases of greenhouse gasses; global climate change as we understand it was off and running. The most obvious manifestation of industrialization was the deforestation that was already underway as a result of charcoal production for blast furnaces in Europe after 1350 and in American until 1860. It was America's abundant forest resources that

delayed the use of mercuric sulfide-emitting coal and coke-fired iron smelting facilities for about a century. Large areas of woodlands were denuded in the 19th century to fuel furnaces, factories, and especially wood fired stoves for heating and cooking. Use of coal for fuel brought by trains slowed deforestation but increased invisible mercuric sulfide emissions. The replacement of the horse by the car substituted a source of invisible ecotoxins for a highly annoying, inconvenient form of animal pollution: excretion.
The second stage of chemical fallout emissions began with the coming of the internal combustion engine. The obvious and well documented increase in carbon dioxide emissions is its ubiquitous legacy. The importance of the internal combustion engine and the related industries of the biomass-derived production of oil and gas fuels obscure the fact that the emergence of the most important forms of chemical fallout derive from industrial activities that had their roots in the complexity and diversity of the many petrochemicals, the production of which are associated with the refining of petroleum. In the 20th century the proliferation of a wide variety of types of chemical fallout derive from the social impact of the development of the internal combustion engine and the vast array of synthetic chemicals characteristic of the mobile consumer society it engendered. Hidden by the continued growth of carbon dioxide emissions, acid rain, and methylmercury as the three seemingly dominant forms of chemical fallout in the 20th century, at least until the advent of weapons-testing fallout in the late 1950s, is a host of compounds associated with both the internal combustion engine and the spread of the electric power grid. Both of these technological developments are associated with a rapidly growing population, westward expansion, a vast increase in agricultural productivity, and the evolution of a consumer society whose increasing product diversity was based on the production of plastics from oil rather than from naturally occurring cotton, wool, or wood.

By 1950, the modern era of chemical fallout and all its industrial pollutants and chemical byproducts was, in combination with increasing populations, resource depletion, loss of biodiversity, and increasing levels of ecotoxins, having a world-wide impact on the earth's vulnerable ecosystems. The last half of the 20th century is characterized by an increase in the intensity of chemical fallout, the proliferation of ewastes (electronic wastes) and the movement of ecotoxins by hemispheric transport mechanisms that are still not well understood. The impact of production of an increasing variety of potent ecotoxins by a chemical industry that reaps huge profits from the pyrotechnical innovation of having petrochemical products such as pesticides or plastics do work (swat flies, store water), merges with the impact of the vast increase in greenhouse gasses, which has occurred since 1950. The combination of the impact of industrial petrochemical society with its vast fleet of biomass powered vehicles and aircraft raises the specter of the B-word at some future time, probably late in the 21st century or in the early 22nd century, but possibly sooner. Isolated communities of elite technocrats or those entirely dependent on sustainable technologies may evade the consequences of biocatastrophe. But those who survive into the post-apocalypse will only be a small percentage of the world's current burgeoning population, perhaps an order of magnitude less than peak population levels before the onset of biocatastrophe.

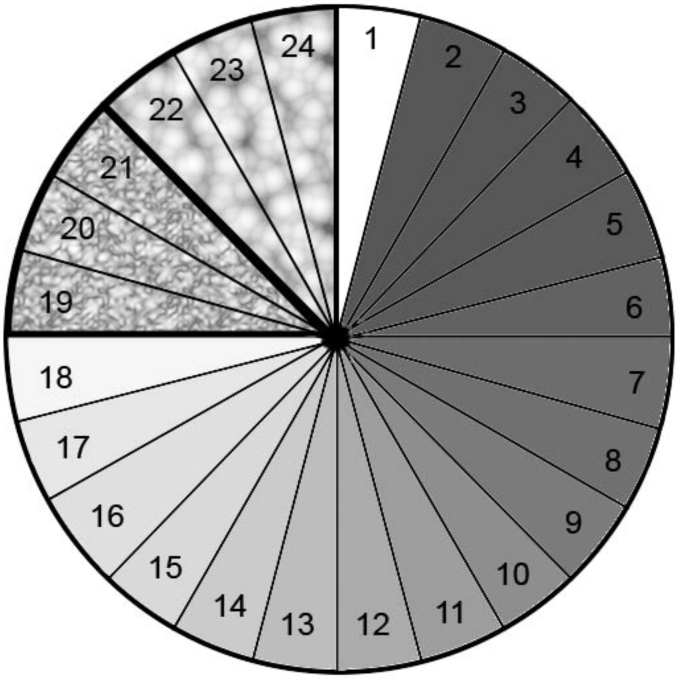
Perhaps clever post-industrial man will adapt to the ecological realities of the earth's limited resources and capacity to absorb ecotoxins, and in a fully globalized economy limit population decline to a few percentages per decade. What will actually take place in the future as the result of the synergistic impact of the chemical fallout crisis and cataclysmic climate change (CCC) is a matter of speculation. What is not a matter of speculation, but must be the subject of rigorous scientific investigation and documentation is the diversity and complexity of chemical fallout, its chemistry, production quantities, ecotoxicity, rates of increase or decrease in the chemosphere, and their presence in abiotic and biotic environments including as body burdens in humans, can and must be measured by scientific, not rhetorical methodologies.

The following registry of chemical fallout constitutes a preliminary draft of the wide variety of ecotoxins, greenhouse gasses, and newly emerging pathogens now entering the environment due to anthropogenic activity. The proliferation of these ecotoxins, greenhouse gasses, and pathogens now constitutes an alarming public safety issue, which must be addressed and documented by every community regardless of political, religious, economic, or social affiliations. Any survey of chemical fallout ecotoxins in the abiotic and biotic environment, such as the long established US mussel watch must also include documentation of these toxins as body burdens in humans, with special emphasis on the vulnerability of children to contaminated breast milk. The following registry of chemical fallout begins with a general description of each ecotoxin, followed by a sketch of its sources, pathways to human exposure, a brief summary of its health effects and environmental impact, and body burden data. Also included in each category will be principle bibliographic citations, information sources, and links. Our chemical fallout registry is followed by Paradigm IV, our overview of biocatastrophe, its major components and issues, and a survey of media-specific data on ecotoxins, including neurotoxins and the social and economic impact of biocatastrophe as a synergistic phenomenon with multiple components. Several bibliographies are included at the end of our series of surveys and essays.

Chemical Fallout: What is it?

The compilation of a registry of chemical fallout necessitates a clear definition of what chemical fallout is. The chemical fallout pie chart is a useful illustration of the unfortunate fact that greenhouse gas emissions are only one component of our changing environment. Our draft pie chart is followed by a time line delineating key milestones in the evolution of greenhouse gas emissions and chemical fallout phenomenon. Chemical fallout has its roots in anthropogenic industrial activities (the smelting of metals including iron and steel, weapons production and testing, gas, oil, and petrochemical production, and the proliferation of electronic equipment); the chemicals thus produced are dispersed in air, water, and soil from their various source points. The obvious source points of chemical fallout in the form of smokestack emissions, pesticide dispersion on farm lands, nuclear explosions and the proliferation of the internal combustion engine obscure the fact that many of the most important source points of chemical fallout are in our living room (rugs, furniture), kitchen (plastic products, food storage containers, and utensils), bedroom (clothing, shoes), bathroom (beauty products, hair dyes), office (electronic equipment including computers), or motor vehicles (water repellant car seats, interior upholstery). If not absorbed directly by the skin, once released into domestic and workplace environments most of these ecotoxins evaporate, returning as tropospheric fallout entering pathways to bioaccumulation in living species including children. The following parameters describe four general classifications of chemical fallout. The sketch of these three generic categories is followed by comments on the distribution of chemical fallout in the chemosphere and biosphere as a result of industrial and other anthropogenic activities.

Chemical Fallout Pie Chart (greenhouse gases, persistent organic pollutants, etc.)



Key to the chart.

Class I:
1 Organochlorines
2 Organophosphates
3 Brominated flame retardants (PBDE)
4 Phthalates
5 Bisphenol
6 Perflourinated chemicals (PFCs)
7 Polyaromatic hydrocarbons (PAH)
8 Other chlorinated hydrocarbons
9 Volatile organic chemicals (Benzene, etc.)
10 Perchlorates
11 Furans
12 Triclosan
13 Alkyphenolys
14 Badge-4OH
15 Dioxins

16 Methylmercury
17 Other heavy metals
18 Anthropogenic radioactivity

Class II:
19 Carbon dioxide
20 Methane
21 Other greenhouse gasses

Class III:
22 Mutagenic and teratogenic chemicals
23 Pesticide resistant pathogens
24 Antibiotic resistant bacteria

Chemical Fallout Time Line

Date	**Event**
	The Beginnings of Polymetalic Pyrotechnic Society
10000 BC	First use of fire to make ceramic containers
6000 BC	Vinca, Yugoslavia: first known smelting of copper
3500 BC	Beginning of the Bronze Age
1900 BC	First smelting of iron and steel by the Chalibeans (Turkey, Black Sea)
1200 BC	Beginning of the Iron Age in the Mediterranean region
800 BC	Beginning of the Iron Age at Halstadt, Austria
200 BC	First production of swords for the Roman Republic at Noricum (Austria)
400 AD	Defeat of the Romans by the Goths using swords produced at Noricum
	Chemical Fallout *in vitro*: First Stage of the Industrial Revolution
1350	First appearance in Europe of the blast furnace to produce cast iron
1646	First US integrated ironworks established at Hammersmith (Saugus, MA)
1690	Development of cementation furnaces for blister steel production in England
1709	First use of coke in England to fuel blast furnaces
1742	Benjamin Huntsman reinvents the lost process of crucible steel production
	Birth of the Age of Chemical Fallout: Second Stage of the Industrial Revolution
1775	Watt's coal-fired steam engine becomes widely used in textile mills, etc.
1784	Henry Cort redesigns the reverbatory furnace and associated rolling mills
1820-1840	The emergence of the American factory system of manufacturing guns and tools with interchangeable parts
1840	Beginning of the spread of railroads
1856	Invention of gasoline at Watertown, MA

Date	Event
1859	Henry Bessemer begins bulk process steel production at Sheffield, UK
	Adolescence of the Age of Chemical Fallout: Full Fledged Industrial Revolution
1870	Use of the open hearth furnace for bulk steel production becomes widespread
1879	Gilchrist invents the basic bulk steelmaking process
1900	Development of the electric power grid
1908	Henry Ford's mass production of the Model-T ushers in the age of the internal combustion engine
1929	First production of PCBs (Polychlorinated biphenyls) by Monsanto
	Adulthood of the Age of Chemical Fallout: The Growing Diversity of Ecotoxins
1939	First use of DDT as a pesticide
1945	First nuclear weapon dropped on Hiroshima
1950	Vast expansion in the petrochemical industries
1951	UNIVAC, the first computer to handle numeric and alphabetic data
1956	Establishment of the Interstate highway system
1963	Nuclear Test Ban Treaty
	Dawn of the Age of Biocatastrophe: Introduction of e-waste, appearance of ABRB, and GMOs
1970	Earth Day – first public acknowledgement of the age of chemical fallout
1986	Chernobyl nuclear disaster
2001	911 attack on the World Trade Center
2005	Hurricane Katrina destroys New Orleans
2007	First complete melting of the Arctic Sea ice caps
2010	First stages of the age of biocatastrophe

Stratospheric Fallout

The stratosphere is the layer of Earth's atmosphere above the troposphere. The depth ranges from about 30 miles thick over tropical areas to less than 11 miles over the poles. Stratospheric thickness also varies with the seasons, being thinner in the winter. The stratosphere contains most of the ozone layer, which reflects over 95% of ultraviolet radiation, which would otherwise threaten human health. The word "fallout" necessarily revives memories of radioactive fallout that resulted from stratospheric contamination of the Earth's upper atmosphere by atomic weapons testing in the 1960s and 70s. The Riso National Laboratory in Denmark compiled a cumulative fallout index that documented soil contamination as measured in becquerels per square meter for the biologically significant isotopes CS (cesium) 137 and strontium 90. Their database, which was compiled from reporting stations in Denmark, Jutland, and the Islands, later provided important data pertaining to Chernobyl-derived tropospheric fallout. The Riso database is included as an appendix in Volume IV. With respect to the ecotoxins released by the industrial activities of polymetalic, pyrotechnic society, few penetrate the stratosphere with the possible exception of chlorofluorocarbons due to the difficulty of cycling tropospheric contaminants into the stratosphere. With respect to the possibility of future nuclear wars, accidents, or terrorist attacks, the Riso National Laboratory recorded peak weapons testing CS_{137} annual deposition (becquerels per square meter for one year; *a becquerel is one disintegration of a radioactive material per second*) in Jutland at 1092 Bq/m^2 in an area of Denmark that was located well away from weapons testing sites. The cumulative peak of all weapons-derived CS_{137} deposition was recorded in Jutland in 1971 at 3757.659 CS_{137} $Bq/yr/m^2$. During the 1960s and 70s, that level of contamination of the abiotic environment was a matter of widespread public health concern, because the propensity of radiocesium to bioaccumulate in pathways to human consumption by following the potassium cycle was already well known in the scientific community. The tendency of some weapons testing-derived radioisotopes to be transferred to and biomagnified eventually led to the nuclear test ban treaty of 1963.

Tropospheric Fallout

After the Chernobyl accident, the Riso National Laboratory recorded Chernobyl-derived fallout levels of CS_{137} as part of their cumulative fallout index. Prior to the Chernobyl accident, the annual deposition in Jutland had dropped to 1.91 becquerels per square meter. In 1986, when the accident happened, the annual deposition level rose to 1340 becquerels per square meter; the cumulative deposition peaked at 4138. Reporting stations in continental Denmark and the islands reported slightly lower levels of Chernobyl-derived cesium. The Danish reporting stations were considered areas of “low impact” with respect to Chernobyl-derived tropospheric fallout; reporting stations in northern England, Scotland, Sweden and the Alps recorded deposition levels of 100,000-200,000 becquerels per square meter. Significantly impacted areas in Russia located in excess of 1000 km from Chernobyl site recorded deposition levels above 1 million becquerels per square meter. With respect to Chernobyl-derived tropospheric contamination, fallout events occurred within a matter of days and often a matter of hours and were closely associated with rainfall events. This contrasts sharply with stratospheric fallout events, which occur more or less uniformly over the course of a year. Dry deposition rather than wet deposition is the predominant characteristic of stratospheric fallout patterns.

Many of the biologically-significant components of anthropogenic industrial chemical fallout occur as tropospheric fallout. As with tropospheric radioactive fallout, rainfall events are extremely efficient at cleansing the lower atmosphere of pollutant particulate matter. Dry deposition accounts for only a small portion of total tropospheric chemical fallout; areas with high annual rainfall levels will receive significantly higher amounts of industrial pollutants. Every rain shower is, in effect, a chemical fallout event.

Most industrial pollutants, ranging from industrial production-derived perchlorates (rocket fuel) to chlorinated and brominated hydrocarbons of every description, including VOCs (volatile organic compounds), PCBs (polychlorinated biphenyls), PBBs, PBDEs, and other contaminants such as methylmercury are subject to evaporation and remobilization after being released into the environment. The phenomenon of hemispheric transport of an industrial toxin such as PCBs was first documented in an important 1970 publication titled *Chemical Fallout* (Miller 1970). Berg and his fellow researchers were first to record high levels of PCBs in Antarctic sea birds; at that time, there was only one industrial source where this chemical was manufactured, the Monsanto plant in Tennessee. Contamination of the environment by industrial pollutants may seem at first to be a local phenomenon, but eventually, given the hemisphere-wide transport mechanisms of the water cycle (carbon, nitrogen, potassium, etc.), volatile lipid-soluble chemicals once emitted from industrial, weapons production, or consumer product source points quickly achieve rapid dispersion in ecosystems pathways. Political, religious, economic, or lifestyle status have no bearing on the public health impact of the cycling of chemical fallout in pathways to human consumption.

Consumer Product, Domestic Interior, and Workplace Fallout

While we may think of most chemical fallout as originating from smokestack emissions, or from other industrial activities such as mining, smelting, as pesticide evaporation or transport by biotic media from agricultural activities, the most biologically significant sources of chemical fallout are intimately associated with the everyday activities of humans and the consumer products they use on a daily basis. Biologically significant chemical fallout can occur in the form of off-gases from both hard and soft plastic media such as water bottles, clothing (Goretex), furniture, rugs, fabrics, water-resistant car seats or other water-resistant media. The brominated fire retardants (PDBEs) utilized in TVs, cell phones, and especially in computer and other electronic equipment to retard flaming produce significant quantities of contaminated dust, which can then be absorbed, inhaled, or ingested by humans. The disassembly of computer equipment, especially in China and other locations, is particularly well documented pathway for brominated fire retardants to enter the environment. Other well known examples of consumer product chemical fallout are health care products, Teflon, household cleansers, detergents, epoxies, varnishes, and other plastic media. The incineration of these consumer products distributes one of the most dangerous and ubiquitous ??? of chemical ???, now found in all biotic media, the dioxin family of ecotoxins.

Soil Contamination

Not all soil contamination is the result of tropospheric fallout. Many toxins, including pesticide metabolites and heavy metals are relatively immobile sediment seeking contaminants. Once in the soil, ecotoxins can be remobilized by vaporization and absorption within the water cycle, uptake, or alteration by microbial or bacterial activity as in the case of the conversion of mercuric sulfide to toxic methylmercury. Occasionally these conversion processes take place in anaerobic environments. The interrelationship of geosphere, lithosphere, hydrosphere, biosphere, chemosphere, and troposphere provide a number of mechanisms, not all of them well understood, for the efficient transport of lipid soluble chemical ecotoxins throughout the ecosystems that sustain human life.

Hydrosphere Contamination

Not all vaporized toxins are distributed by hemispheric transport mechanisms; many toxins are discharged directly to oceans, rivers, and lakes. A typical example of ecotoxins in the hydrosphere would be pesticides applied to farmlands, which are then washed off of leaves or out of soil and directly enter ground water or stream runoff. Many of these toxins will later be subject to evaporation or other transport mechanisms, which will rapidly expand their impact on other ecosystems and biotic media. The age of chemical fallout is characterized by the ubiquitous industrial discharge of ecotoxins such as PCBs to rivers and streams, the chlorination of drinking water, and wash over events such as the flooding of New Orleans, which remobilized chemical ecotoxins of every description and redistributed them in the Gulf of Mexico.

Pathways

The following pathways are the basic exposure route of humans to all forms of chemical fallout, absorption (skin), inhalation (lungs), and ingestion (stomach). With respect to radioisotopes, biological impact can also be the result of ground shine (irradiation). A principle route of *in vitro* chemical fallout contamination also occurs as the result of cross placental transfer of toxins from mother to child as well as via contaminated breast milk, one of the most important of all ingestion pathways. The ingestion of ecotoxins in terms of dietary intake of contaminated foods as well as of contaminated water is the predominant form of exposure to toxic chemical fallout. Uptake by consumption of red meat, eggs and seafood as well as contaminated water supplies are the most notable ingestion pathways. Microcontamination in food products of all kinds is ubiquitous, if poorly documented. Some of the most significant forms of chemical fallout are not directly toxic to humans but still constitute a significant threat to human society by their potential to impact global climate change, sea level rise, and ecosystem diversity. The most well know of these nontoxic forms of chemical fallout are the greenhouse gasses carbon dioxide and methane.

The Measurement of Chemical Fallout

Toxic chemicals in the environment are routinely measured in parts per billion in media such as tissue samples, blood, breast milk, food, wildlife, soil, and water. Levels of toxins are increasing in many media. The New York Times (January 21, 2008) recently reported methylmercury levels in blue fin tuna being sold at New York restaurants in the form of sushi at or above 1 parts per million (ppm) with a maximum level of contamination reported at 1.25 ppm in some sushi samples sold at local restaurants for human consumption. The problem of the evaluation of biologically significant chemical fallout in pathways to human consumption is three-fold.

- Tens of thousands of varieties or subvarieties of toxins can now be documented in the environment, which derive from industrial activities and contaminated consumer products.
- Many of these toxins are present in amounts well below the detectable limit. If these microtoxins could be accurately measured in air, water, sediment, and food they would be present in parts per billion or parts per trillion. Many of these ecotoxins can have a significant but invisible impact at minute levels of contamination.
- The most difficult problem in evaluating the public health significance of chemical fallout ecotoxins is their synergistic impact in humans as well as other biotic media including fish and aquatic mammals. The biological significance of these toxins lies not in their presence as a single contaminant in breast milk or fresh water fish but that humans, especially including infants, young children, and pregnant women, are simultaneously exposed to thousands of toxins the public health impact of which has, as a matter of federal law, never been evaluated at their time of production and distribution. As a result, we can only sketch the most tentative outline of the public health significance of the growing presence of thousands, if not tens of thousands, of ecotoxins now circulating in the earth's biosphere.

Chemical Fallout: Mitigation or the Illusion of Mitigation