

## Chapter XI

# Comment: The Environmental Threat of Military Operations

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*We like to think of nature's beauties, to admire her outward appearance of peacefulness, to set her up as an example for human emulation. Yet under her seeming calm there is going on everywhere—in every pool, in every meadow, in every forest—murder, pillage, starvation, and suffering.*

A.C. Chandler<sup>1</sup>

### Introduction

**T**his paper attempts to introduce a natural, and Earth sciences perspective into a deliberation otherwise dominated by legal scholars. This paper reflects the personal, and perhaps unusual, views of an academician trained in the sciences but conducting research at a marine policy center for the past nine years. It is motivated by the observation that the prevailing tenor of this discussion of environmental aspects of warfare seems disproportionately influenced by the emotional perception of the environment prevailing in these times—influenced either by accepting that viewpoint or, especially, by reacting to it. The first part of the paper outlines a view or construct of the extent and the manner in which the concept of environmental protection can reasonably be applied to military operations and warfare. The second part addresses two interrelated topics, both of which should benefit from tempering by a scientific perspective:

- a. The environmental impacts of warfare relative to those of other human activities, and as compared to the scale of natural disasters; and
- b. The relevance of these comparisons to the concept of “war crimes against the environment.”

The conclusions to which I lead in this admittedly rhetorical examination are the following: In prosecuting humanitarian goals for peace or the alleviation of human suffering, it may be best not to look too narrowly to the natural environment for the paradigms. And, in refining thoughts on “crimes against the

environment,” an objective examination of the natural world may not provide the sharp contrasts we seek.

Environmental awareness and sensitivity as a political ideology is growing worldwide, with the emergence and increasing power of the “green” movement and related vanguard activities. An “environmental ethic” has made inroads into civil law, international law, and, as reflected in the title of this conference, into the calculus of warfare. Most people agree there are numerous benefits to this trend, despite short-term frustrations.

Some of us spanning the science/policy fields would like to see the environmental movement incorporate better scientific information to ensure that policy and natural systems are not at odds. An environmental movement based on misconceptions has little advantage over one that ignores the environment altogether. Unfortunately, numerous inconsistencies and misconceptions seem to abound despite the general public impression that the environmental movement is firmly based in science. We often lose track of the fact that suffering, destruction, and risk are not limited to the realm of humankind. As indicated in the opening quotation from Professor Chandler’s book on parasitology, nature is far from the model of peacefulness that many of us would like to believe.

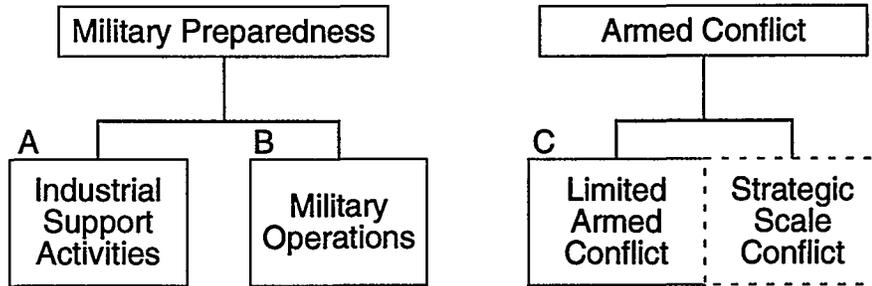
### **Military Impacts on the Environment**

Military activities and their impacts can range over a wide scale, from comparatively benign impacts associated with the peacetime domestic or bureaucratic military setting, through the catastrophe of total war. This broad spectrum can be divided into two categories—the part associated with military preparedness, and the part associated with armed conflict (Figure 1). The demarcation criterion is the element of hostility: anticipated or actual exchange of hostile fire, loss of life, or imminent invasion.

#### ***Military Preparedness***

Military preparedness includes all activities necessary to plan, staff, arm, maintain, and deploy national military forces, in the absence of actual armed conflict, during phases of both overall military expansion or overall military contraction. Industrial support activities related to military preparedness (Figure 1, A) as illustrated during wartime and the Cold War years, can embrace a large part of a nation’s commercial and industrial sector. These activities are conducted largely by civilians on contract to the military establishment, largely on private rather than government property, and often near population centers. Such activities include production, testing, storage, and transportation of war materiel; research and development; and other activities involved in industrial support of the military. These activities involve working with perhaps the most toxic, infectious, explosive, and radioactive materials used in modern society, and often

Figure 1  
Environmental Impact of the Military



in very large quantities. Nevertheless, to a large extent, if not in its entirety, this portion of military preparedness ought to be fully subject to the entire range of national environmental impact criteria. It should be possible to consider issues of environmental impact in the full domestic sense, especially including materials management—their selection, use, storage, recycling, inactivation, and ultimate long-term disposition. And it should be possible to anticipate and plan for incidents of human error and accidents that inevitably will occur in the course of all human endeavours.

Military operations associated with military preparedness (Figure 1, B) involve activities related to the training, arming, maintenance, deployment, and inactivation of forces. These activities are conducted largely by military personnel on military bases and on military ships and aircraft, often in remote sites. Such activities involve assembling, storing, testing, and distributing war material; training and maintaining military forces in readiness; deploying forces and war material to potential trouble spots; patrolling, peacekeeping, and other military operations not conducted in anticipation of an imminent exchange of fire in the course of confrontation; and phasing down military preparedness. A new term-of-art, “Military Operations Other Than War” (MOOTW)<sup>2</sup> may be the appropriate designation for these activities.

Military operations in this sense of the term ought also to be sensitive to and compliant with the concept of environmental impact and relevant environmental laws. Unfortunately, there have been instances of environmental damage associated with the operation of military bases. A prominent one involves the Massachusetts Military Reservation (Otis Air Force Base, etc.) on Cape Cod, where groundwater pollution by sewage-derived nutrients and by organic solvents has

been a major issue in recent years.<sup>3</sup> Part of the problem stems from an understandable, though regrettable, ignorance of hydrogeology in the siting of wastewater disposal sites in 1936. As a result, downgradient wells, including a municipal well operated by the Town of Falmouth, were contaminated and had to be closed. Perhaps more significant, this pollution incidence has served to project an aura of “contamination” over the entire area, whose economy depends on tourism, second homes, and retirement homes. The problem began decades ago, before environmental laws were in place; the same problem, mostly on a smaller scale, is widespread around the world. The groundwater plume in question is currently the focus of a Superfund clean-up effort. Equally or more important is the need to address the fundamental issue of disposal of waste materials, to avoid propagating this problem into the future.

The second problem at the Massachusetts Military Reservation involving contamination of groundwater appears to stem from a failure to establish a sound operational, base-wide procedure for use and disposal of organic solvent wastes. It appears that for several years individual managers used personal discretion in the disposal of these materials, which included dumping them into *ad hoc* landfills on the base. It is important for military bases (as well as civilian operations) to plan in an environmentally sound manner and to account quantitatively for the entire cycle of hazardous materials use, from their acquisition through their disposal. This is an achievable goal throughout the course of military preparedness activities.

### Armed Conflict

In my scheme (Figure 1), armed conflict introduces the elements of significant and imminent personal danger or hostile destruction of warmaking assets into the conduct of military activities. A spectrum of intensity of conflict leading to possible environmental consequences can be defined extending from limited armed conflict to strategic-scale conflict (or full-scale nuclear confrontation). For the ultimate circumstances of global-scale, total war, including massive deployment of nuclear weapons, an environmental cataclysm could be expected. In a conflict of this scale, where the survival of nations and of mankind itself could be at stake, a discussion of environmental impact almost becomes meaningless. Recognition of the likely disaster of nuclear confrontation presumably motivated the nuclear arms limitation initiatives of the 1980's. Based on the behavior of the superpowers over the past several years, it appears that rational minds have concluded that strategic-scale conflict, with environmental and human consequences spelled out by the “nuclear winter” scenario, is unacceptable—it is not an option. For perspective, nevertheless, it should be mentioned that even the nightmare of the nuclear winter scenario has natural disaster analogs, such as collision of the planet with

comets, asteroids, or other large celestial bodies, which would produce their own kind of “winter.”

Even under conditions involving limited armed conflict (Figure 1, C), it may not be possible to conduct military activities in a way that takes environmental impact fully into account. Most military leaders would probably say they would always put the lives and safety of their troops before environmental considerations. In armed conflict, it is likely that numerous commanding officers would need to make individual, and perhaps spontaneous, assessments of when the lives or safety of their forces are in jeopardy, and of the environmental assets at risk. The need to make such judgments during military operations, though complicated by greater urgency and stress, nonetheless represents only a special case of the larger societal need to balance environmental protection against the perceived dangers and benefits of not protecting the environment. This involves a subjective (and sometimes unconscious) assessment that is worth considering in a broader context.

### Bias in the Perception of Environmental Impact

There is a tendency to ignore the environmental impact of human activities that are widely considered “good” or “necessary” for society, and a tendency to over-react to activities that are seen to disproportionately benefit a narrow, identifiable, interest group.<sup>4</sup> Two examples—farming and road construction—serve to illustrate the inconsistency in the societal perception of environmental impact.

Farming activities to sustain the world’s human population involve control of natural plant and animal communities on a global scale. In the United States 1.5 million square miles (39% of the nation’s area) are devoted to farms (Table 1). In about 680,000 square miles used for plant crops, the naturally occurring first trophic level (primary producers; *i.e.*, organisms capable of photosynthesis) has been destroyed, and one of a small number of crop plant species substituted in its place—corn, wheat, cotton, etc. This process involves massive destruction of natural systems, although it is not necessarily irreversible. U.S. croplands are irrigated (77,000 square miles), fertilized with chemicals, poisoned with herbicides and other pesticides, and mechanically plowed, all of which go far beyond comparable natural processes acting on the land.

At the second trophic level (“herbivores”), introduced species such as cattle, pigs, and sheep number about 165 million on U.S. farms; and chickens outnumber people by more than 50 million. These animal species are often raised at densities far exceeding the natural capacity to sustain them. Biological diversity is generally ignored in this context, although loss of topsoil and contamination of natural surface- and groundwater are openly discussed as problems. These are problems that are relevant mostly to the continued human practice of agriculture. In any case, the concern over environmental impact is in no way proportional to the scale

Table 1. Selected U.S. Agriculture Statistics—1992

Land Use	
Use Crop	Area (mi <sup>2</sup> )
Land in farms	1,500,000
Corn	108,300
Wheat	93,300
Cotton	17,127
Soybeans	88,000
Hay	88,000
Vegetables	5,900
Orchards	7,500
Cropland	690,000
Irrigated land	77,000
Livestock	
Category	Population
Cattle	96,000,000
Hogs/pigs	58,000,000
Sheep	11,000,000
Chickens	351,000,000

Source: U.S. DEPT. OF AGRICULTURE, 1992 CENSUS OF AGRICULTURE, Volume 1 Geographic Area Series.

of the matter, presumably because we all need farms. (Ironically, when crops are burned, such as during warfare, the environmental impact could be seen as positive if the effect is to return the land to natural systems.) Overall, the impact on the natural biological system is devastating—it is intended to be—but the outcome is the greatest agricultural productivity on Earth.

Another widespread activity essential for our quality of life is road construction, which, like farming, does not occasion the environmental scrutiny and outcry that it might if it were considered on a purely objective basis. In the United States, there are about 1.4 million miles of paved roads. These roads entirely obliterate the natural plant and animal communities in an area of about 14,000 square miles. Most of this road surface is paved with a hydrocarbon material known as asphalt. The amount of asphalt used to pave the nation's roads is about 0.66 cubic miles, or about 71,000 times the volume of hydrocarbons spilled during the 1989 tanker accident in Prince William Sound. It is believed that asphalt, a bituminous residue of petroleum, has a low chemical toxicity; but given the volume of material involved, the lack of fanfare over its widespread, intentional use is noteworthy—particularly in view of the public reaction to U.S. tanker spills.

### The Scale of Natural Disasters

This discussion of natural disasters includes only those for which human fatalities are incidental—not, for example, natural diseases that specifically attack the human organism. Most natural disasters result from geologic hazards,<sup>5</sup> such as earthquakes, volcanoes, landslides, and floods. Such natural events can result in very large numbers of human casualties. For example, according to the American Institute of Professional Geologists,<sup>6</sup> human death resulting from the Tangshan (China) earthquake in 1976, estimated at 242,000, was about as costly in human lives as total U.S. battle deaths during World War II. Deaths from a single volcanic eruption in Colombia in 1985 amounted to about the same number as the taking of lives by murder in the United States in 1990—about 20,000. Floods of the Yellow River in 1887 and the Yangtze River in 1931 resulted in estimated deaths of up to 6,000,000 and 3,700,000, respectively, among peoples residing on the flood plains of those Chinese rivers.

Data on the occurrence of natural events resulting in loss of human life are no doubt incomplete. Famighetti<sup>7</sup> provides one window into the frequency of natural disasters, as summarized in Table 2. According to this source, in recorded history (viz., since 526 A.D.), 17 natural geological events (mostly earthquakes and floods or tsunamis) have each resulted in over 100,000 deaths. At least an additional 52 events caused over 10,000 human deaths, and about 75 more resulted in an excess of 1,000 deaths, earthquakes being the most common cause of disasters in this category. Overall, according to this source, 330 spectacular natural events have caused over 12 million human fatalities since 526 A.D.

**Table 2. Selected Natural Disasters Involving Loss of Human Life and Destruction of Social Infrastructure**

Type of Natural Events	Number Reported	Total Deaths	Number of Events with Deaths			
			>100,000	>10,000	>1,000	>100
U.S. tornadoes (since 1925)	55	4,900	-	-	-	14
Volcanoes (since A.D. 79)	18	181,500	-	8	8	-
Hurricanes, typhoons (since 1888)	80	623,000	2	9	12	37
Floods, tsunamis (since 1228)	79	5,407,600	6	2	21	34
Earthquakes (since 526)	98	6,341,500	9	33	34	14
<b>Total</b>	<b>330</b>	<b>12,548,500<sup>8</sup></b>	<b>17</b>	<b>52</b>	<b>75</b>	<b>99</b>

Source: Summarized from FAMIGHETTI, THE WORLD ALMANAC AND BOOK OF FACTS 568-569 (1995)

The above discussion applies to geological hazards resulting from “process.” The American Institute of Professional Geologists (AIPG)<sup>9</sup> also includes as geological hazards those resulting from natural “materials.” Included in this category are toxic and radioactive materials (solids and gasses) such as asbestos and radon, as well as swelling soils, reactive aggregates, and acid drainage. These hazards are generally less spectacular and their impact distributed over longer time, but associated human deaths and economic costs can be high. For some of these hazardous materials, particularly asbestos and radon, widespread misconceptions abound. AIPG has observed that:

“While some segments of the populace suffer needless fear and unwarranted financial loss, others are oblivious to real dangers. Massive regulatory actions that are not based upon solid science may be some of the most expensive blunders of this century.”<sup>10</sup>

A synopsis of economic costs of geologic hazards in the United States (Table 3) suggests a figure in the tens of billions of dollars annually. These estimates probably represent a significant fraction of worldwide costs.

Table 4 provides a sense of the relative destructiveness of earthquakes as compared with explosives. The comparison suffers from at least two deficiencies: the energy density of explosives is generally greater than for earthquakes, making

Table 3. Economic Costs of Geologic Hazards in the United States<sup>11</sup>

Geologic Hazard	Cost (1990 dollars)
<b>Hazards from materials</b>	
Swelling soils	\$6 to 11 billion annually.
Reactive aggregates	No estimate
Acid drainage	\$365 million annually to control; \$13 to 54 billion cumulative to repair.
Asbestos	\$12 to 75 billion cumulative for remediation of rental and commercial buildings; total well above \$100 billion including litigation and enforcement.
Radon	\$100 billion ultimately to bring levels to EPA recommended levels (estimate based on 1/3 of American homes at \$2,500 each, plus cost for energy and public buildings.)
<b>Hazards from process</b>	
Earthquakes	\$230 million annually in decade prior to 1989; over \$6 billion in 19889.
Volcanoes	\$4 billion in 1980; several million annually in aircraft damage.
Landslides/avalanches	\$0.5 million to \$2 billion annually.
Subsidence/permafrost	At least \$125 million annually for human-caused subsidence.
Floods	\$3 to 4 billion annually.
Storm surge/coastal hazards	\$700 million annually in coastal erosion; over \$40 billion in hurricanes and storm surge from 1989-1993.
Source: American Institute of Professional Geologists.	

Table 4. Energy Equivalents of Earthquakes and Explosives

Richter Magnitude	TNT Energy Equivalent	Observed Earthquake Effects	Earthquake Examples	Human Fatalities
5-6	< 6.3 kt	damage to masonry; difficult to stand	Boston, MA 1755 Whittier, CA 1987 Sierra Madre, CA 1991	Usually few
6-7	< 100 kt	panic; walls fall	Armenia 1988	25,000
7-8	< 6.2 Mt	wholesale destruction	Italy 1908 Italy 1915 China 1920 Iran 1978	58,000 32,000 200,000 25,000
8-9	< 200 Mt	total damage; waves seen on ground surface	Japan 1923 China 1927 China 1976 Mexico 1985	103,000 200,000 242,000 9,500

Source: American Institute of Professional Geologists<sup>12</sup>

for greater destructiveness near the detonation site; and the chain of events actually responsible for human fatalities—*e.g.*, fires, building collapse, flooding, or landslides—are different for the two events. Nevertheless, the Table makes the point that the energy associated with large earthquakes is roughly comparable to that of the largest nuclear weapons.

The 1945-vintage fission bomb had an energy equivalent of about a Richter 6 earthquake. The “Ivy King” fission test weapon of the 1950s was energetically equivalent to a Richter 6.5 earthquake (*viz.*, about 500 kt). The largest nuclear device ever tested was a Soviet fission-fusion device of an estimated 50 Mt yield, which in earthquake terms is about Richter 8.5. The largest nuclear weapon designed (but not tested), also by the Soviets, was a fission-fusion-fission device that may have had a yield of 150 Mt—still within the energy equivalency of a Richter 8-9 earthquake.

Table 4 suffers from the further inadequacy that maximum fatalities resulting from the detonation of a large weapon could easily involve many millions of people if causing human fatality were the objective in target selection.

International recognition of the scale of natural disasters and related human suffering led to the formation of a special United Nations program addressing this topic. The International Decade for Natural Disaster Relief convened its first World Conference on Natural Disaster Reduction at Yokohama, Japan, from May 23-27, 1994.

### Natural Disasters in Earth's History

The recording of severe natural events not involving human death or suffering has probably been much less complete; and, of course, for the period before

humans occupied the Earth (which comprises all but a few million years of the Earth's 5 billion year history), only indirect records exist. For the historical geologist, interpretation of these records is of major interest: conspicuous discontinuities in the geological record provide a basis for organizing and dating the history of the Earth. These discontinuities for the most part mark severe natural events or changes that, had humans been present, could likely have resulted in death, suffering, and property loss. In the words of Georges Cuvier, the great French geologist of the 19th Century, "Life on Earth has been frequently interrupted by frightful events."<sup>13</sup>

The following distinctions, drawn by the historical geologist Richard H. Benson,<sup>14</sup> add a useful perspective to this discussion of environmental impact:

**Crisis**—an event that occurs in the history of a system, when stress is sufficient to cause the imminent alteration of the system's principal structures, but, through absorption of this stress into its subsystems, the system survives. Natural crises occur often.

**Catastrophe**—an event that occurs in the history of a system, when stress is sufficient to cause the imminent alteration of the system's principal structures, and the subsystems fail to absorb all of the stress but survive, although the system fails. In such cases, a new and modified system is then formed to take the place of the failed system. Natural catastrophes occur less often.

**Cataclysm**—an event that occurs in the history of a system, when stress is sufficient to cause the imminent alteration of the system's principal structures, and both the system and its subsystems fail. Cataclysms rarely occur on a grand scale.

In these definitions a system can be a biological, social, or ecosystem, or it can be any organization of interacting elements, including elements that are themselves smaller systems.

### Mass Mortalities in the Sea

Another view of natural disasters is provided by Brongersma-Sanders in her paper on mass mortalities in the sea attributable to natural causes. Any of these natural events (summarized in Table 5) could provoke a major outcry if identified instead as an impact of human activities.

### Synopsis and Conclusions

This commentary on the environmental threat of military operations is intended to supplement a legal discussion of that topic. It suggests that for a large portion of military operations, such as those involving military preparedness, the concept of environmental protection is reasonably applicable. In the case of limited armed conflict, environmental considerations are more difficult to incorporate; and for

Table 5. Causes of Recent Mass Mortality of Marine Life

Source of Mortality	Comment/Example
Vulcanism	Mortality of, <i>e.g.</i> , fish from: burial/suffocation by ash (Mt. Katmai, Alaska, 1912; Krakatoa, 1883) and lava (Mauna Loa, 1859, 1919, 1950); shock of eruption; poisonous gases.
Tectonic earth- and seaquake	Fish kill from shock of quake (Alaska, 1899; Massachusetts, 1755; Valparaiso, 1922); uplift of sea floor exposing invertebrates (Valparaiso, 1822, 1906).
Change in salinity	Fish mortality from increased salinity (Laguna Madre, about every 10 years); freshwater fishes swept into hypersaline sea (Dead Sea, Israel, 1891, 1938).
Temperature change	Kills of marine life (fish, crustaceans) from cold winters (Baltic Sea, 1929; North Sea, 1929, 1946; Bermuda, 1901; New England continental shelf [near Gulf Stream] 1881; Greenland, 1899).
Noxious waterblooms	Red tide bloom production of toxins killing fish, shellfish, and sea birds (British Columbia, 1936, 1951; Gulf of California, 1937; Peru, recurrent; Chile, 1895, 1916, 1932, 1950).
Lack of oxygen/presence of H <sub>2</sub> O	Sea of Azov, Norwegian fjords.
Fatal spawning runs	Iceland, annual kill of capelin.
Stranding	Alaska sea herring stranding on Prince of Wales Island ( <i>e.g.</i> , 1914).
Severe storms	Storm wave kill of 6,000-9,000 ducks and geese (California, 1952); fishkill on Scilly Islands, 1953; Black Sea mass mortality of plants, mollusks, crustaceans in 1935.
Upwelling	Fish mortality (mesopelagic species) in California (1952) following intense upwelling event.
Unknown	Enormous quantities of dead fishes sited in coastal locations and in the open sea for which no explanation is at hand.

Source: Brongersma-Sanders, *Mass Mortality at Sea*.<sup>15</sup>

strategic-scale conflict, involving nuclear exchange, environmental considerations are most meaningful, perhaps, on a scale appropriate to historical geology.

This commentary shows that the scale of human suffering, property destruction, and economic loss associated with natural disasters is large, and in some ways comparable to the scale of limited armed conflict. Bias inherent to our society tends to downplay the significance of impacts of activities we need, such as farming and road building, and ignores major naturally occurring disasters while over-reacting to those that can be attributed to certain human activities, such as industrial or military activities. These generalizations have an important practical bearing on such concepts as "environmental threat" and "crimes against the environment," suggesting that laws may need to address intent rather than environmental impact.

## Notes

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1. CHANDLER & READ, *INTRODUCTION TO PARASITOLOGY* 1 (1962).
2. The exact definition of MOOTW is evolving. Some proposed uses of the term include instances involving armed conflict.
3. LeBlanc, *Sewage Plume in a Sand and Gravel Aquifer, Cape Cod, Massachusetts*, U.S. Geological Survey Water-Supply Paper 218; Garabedian and LeBlanc, *Overview of Contaminant Hydrology, Geochemistry and Microbiology at the Cape Cod Toxic Waste Research Site*, U.S. Survey Water-Resources Investigations Report 88-4220.
4. Bobertz, *Transferring the Blame*, 13 *Env't'l F.* 22 (1996).
5. American Institute of Professional Geologists [hereinafter AIPG], *THE CITIZEN'S GUIDE TO GEOLOGIC HAZARDS* 3 (1993).
6. *Id.* at 2.
7. FAMIGHETTI, *THE WORLD ALMANAC AND BOOK OF FACTS* 568-572 (1995).
8. AIPG *supra* n. 5 at 2.
9. This includes fatalities of 900,000 for the 1887 Chinese flood; independent estimates place fatalities as high as 6,000,000 for that disaster, possibly raising this total to 17,648,500.
10. AIPG *supra* n. 5 at 2.
11. Modified from AIPG *supra* n. 5 at 3. See original reference for data sources.
12. AIPG *supra*, n. 5 at 39 and 41.
13. As quoted in AGER, *THE NEW CATASTROPHISM: THE IMPORTANCE OF THE RARE EVENT IN GEOLOGICAL HISTORY* 4 (1993).
14. Benson, *Perfection, Continuity, and Common Sense in Historical Geology*, in *CATASTROPHES AND EARTH HISTORY* (Berggren & van Couvering eds. 1984).
15. Brongersma-Sanders, *Mass Mortality at Sea*, in *TREATISE ON MARINE ECOLOGY AND PALEOECOLOGY*, *ECOLOGY* 941-1010 (Hedgepath ed. 1957).