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Life@Sea

Networking Marine Biodiversity into Biotech Futures

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In June 1998, the United States' first National Ocean Conference was convened in Monterey, California, a city located on the edge of one of the largest marine reserves in the world.[1] Attended by some five hundred delegates drawn from physical and biological oceanography, marine science and technology, fisheries management, and civil and military ocean policy and timed to coincide with the United Nations' Year of the Ocean (and the 1998 World Expo in Lisbon, Portugal, which fixed on world cultures' visions of the ocean), the meeting meant to set a national agenda for twenty-first-century care of the sea. Delegates agreed that the ocean was under increasing pressure from anthropogenic stresses such as global warming, overfishing, and pollution.[2] At the same time, the beleaguered ocean was also figured as a realm full of unexplored biotic and ecological diversity—diversity that might well contain secrets for healing the planet and its resident humans. A 12 June headline from *The Californian*, a Monterey newspaper, summarized the proceedings with a pithy headline placed just above a photograph of a windblown Vice President Al Gore, a key moderator of discussion: "Delegates agree: Sea is life." By "life," participants at the conference referred at once to the ocean as a vital planetary fluid and as a site emblematic of life writ large, because the sea constitutes the majority of the biosphere and is believed to be the medium in which life on Earth originated.

Rhetorical links between the well-being of organisms and the well-being of the oceans were a conference staple. The marine biologist Sylvia Earle, a principal speaker, drew from her book *Sea Change* (1995:xii): "The living ocean drives planetary chemistry, governs climate and weather and provides the cornerstone of the life-support system for all species on Earth. If the sea is sick, we'll feel it. If it dies, we die. Our future and the state of the oceans are one." Putting the bond between humans and the ocean in a more individualistic and sentimental register, then first lady Hillary Clinton pronounced: "Seventy-one percent of our planet is ocean, and seventy-one percent of our body is salt water.... There is this extraordinary connection between who we are as human beings and what happens in this magnificent body of water."[3] This association—evocative, though incorrect (it compares surface area to volume)—impressionistically revives a kind of microcosm-macrocosm theory of correspondences, giving a numinous humanist warrant to interest in the sea. What Donna Haraway has diagnosed as a contemporary "yearning for the physical sensuousness of a wet and blue-green Earth" (1995:174) is here rendered as experientially accessible in our own bodies. Water becomes a fluid substance underwriting human kinship with the planet. One popular year-of-the-ocean book makes this explicit, folding the biotic world into a Gaian parental embrace intended to awaken a human filial piety: "The sea is mother to all life on the planet" (Davidson 1998:4).[4]

But if conference participants revered the sea as the matrix from which life emerged, they also persistently linked it to the future, a future that might be safeguarded by enlightened national stewardship. Indeed, a conference-catalyzed report published by the U.S. Department of Commerce in 1999 was titled *Turning to the Sea: America's Ocean Future*. This future was importantly *futuristic:* national efforts to protect ecologically and taxonomically biodiverse marine ecosystems and to study genetic and metabolic biodiversity as a platform for pharmaceutical and biotechnological innovation would make use of the latest technoscientific knowledge and be hitched to projects of progress. The report elaborated on the promises of bioengineering: "The tools of marine biotechnology have been applied to solve problems in the areas of public health and human disease, seafood safety and supply, new materials and processes, and marine ecosystem restoration and remediation. Many classes of marine organisms demonstrate a wide variety of compounds with unique structural features that suggest medicinal, agricultural, and industrial applications" (U.S. Department of Commerce 1999:22).

America's ocean future would involve looking for such resources in what National Ocean Conference proceedings labeled the "unexplored frontier" of the nation's waters and in such extranational territories as might be accessed through the search engines of bioprospecting contracts between U.S. governmental organizations or corporations and agencies attached to other nation-states.[5] The quest for novel chemical compounds and ecological dynamics in locations such as coral reefs and deep-sea hydrothermal vents motivated a narrative that rewrote the ancient life-giving ocean as a technoscientific frontier, one to be explored with a kind of can-do American commitment to comprehending, taming, and democratizing (on a free-market model) a vast wilderness.[6]

Turning to the Sea, then, suggests an introspective return to origins that is also a journey into the future. The mid-twentieth-century zone of the future, outer space—the final frontier—is replaced by the ocean: "All the reasons for justifying going into space can be applied to the ocean, from basic curiosity and the pleasure of being there to scientific, commercial, military, and even lofty philosophical goals" (Earle 1995:xvii).[7] Such a repositioning places a historically aggressive American pioneer narrative at the service of an environmentalist project dedicated to preserving life on Earth. But the redemptive and religious electricity of American frontier fantasy (see Bellah 1992) has not vanished. The government agency charged with the management of U.S. territorial waters, the National Oceanographic and Atmospheric Administration, is commonly referred to by its acronym, NOAA, a name that evokes images of the biblical Noah, divinely chosen environmental steward of the earth's creatures, supported in his rescue mission by the sea. Spaceship earth, it turns out, is an ark. And oceans carry much of its precious cargo. Former chief scientist of NOAA Sylvia Earle (1995:205) provides details: "Almost every major division of plant and animal kind has at least some representation in the sea, and many are principally or wholly marine. In contrast, only about half of these large categories occur on land. This observation supports the conclusion that the greatest diversity is unquestionably in the sea."

With the United States at the helm of ocean conservation and marine technoscience, then, the biological resources of the planet can be called upon to help the planet heal itself, to turn to its natural reserve of strength and life. This life is almost always described as a positive value, as in the following aphoristic extract from Carl Safina, director of the Living Oceans Program at the National Audubon Society: "It is said that where there's life there's hope, and so no place can inspire us with more hopefulness than the great life-making sea" (1997:440). This "life-making" quality is often portrayed as accessible to human purposes in ways that are environmentally friendly, that do not violate the planet. As the Center of Marine Biotechnology at the University of Maryland puts it, echoing and elaborating the language of *Turning to the Sea:* "Significantly, biotechnology allows us to tap the potential of the oceans without depleting them as a resource.... [T]he tools of biotechnology allow researchers to clone... genes, reproduce them, and produce desired substances in the laboratory, leaving the organisms where they belong—in the environment."[8] Under the stewardship of the aquaterritorialized and biotechnological nation, the oceans yield genetic and ecological secrets that can be resourced to save both individuals and the planet. The "mother of all life" is cared for by sensitive stewards stepping away from previous scientific projects of exploiting a dominated feminine nature (Merchant 1980). In America's ocean future, NOAA and its academic and industrial partners will save Gaia according to her own logic. The planet, through the agency of humans, goes within, turns toward its unfathomed deeps, literally to find new life.

In an age in which genes have been touted as the essence of life, the maxim that water is life is being resurrected. And this water, as we have seen, is often depicted as a salty substance anchoring humans to their planetary home. Thus Earle: "Our origins are there, reflected in the briny solution coursing through our veins" (1995:15). And Safina, echoing Hillary Clinton: "We are, in a sense, soft vessels of seawater. Seventy percent of our bodies is water, the same percentage that covers Earth's surface. We are wrapped around an ocean within" (1997:435). This kinship of reflection and resemblance links individual humans to the planet in ways that both call upon and bypass evolutionary history—offering a kind of one-step program of communion with the planet (a strangely individualist project that leaves out the natural-cultural historic mediations that secure this immediacy).[9] We are not in the presence here of a biopolitics in which individuals and populations must be fastened together through a reproductive politics of sexuality (Foucault 1976). Neither are we called upon to inhabit a "biosociality" (Rabinow 1992b) that constitutes individuals in relation to nongenealogical biological networks, such as patient advocacy groups organized around shared genetic polymorphisms like Tay-Sachs disease or Down syndrome (see Heath 1997; Rapp 1999). Nor are we entirely in a transgenic or informatic regime in which coded substances—such as genes—that have traditionally underwritten the symbolics of genealogical relatedness now push "kinship" rhizomatically away from simple generational trajectories (see Franklin 2001; Haraway 1997a; Helmreich 2001). We are exhorted to think of our individual connection not to a population, not to our genes, but to the planet's ocean. This is a politics not of sexuality but of salinity. This is a rhetoric not of biosociality but of gaiasociality.

In this essay—a preliminary set of reflections on the politics of marine biodiversity, bioprospecting, and biotechnology, a topic on which I intend to conduct future ethnographic work—I examine the cocktail of old and new meanings being poured into the category "life" in the practice of turn-of-the-millennium marine science. I am particularly curious about those branches of marine biology concerned with describing marine biodiversity as a resource for new life-giving biotechnology that might be used both in medicine (for example, cures for cancer derived from coral communities) and for planetary healing (for example, cleaning up toxic waste using compounds derived from deep-sea creatures adapted to life near hot sulfur-spitting vents). I am interested in how this "life" is invoked as an insistent echo of an evolutionary past and as a trust fund for future health.

I am also concerned with how this "life" is funneled through the concept of biodiversity, a term that embraces genetic, metabolic, species, and functional levels of biological process (Thorne-Miller 1999).[10] Speaking of the richness of ocean life, Earle writes: "Our survival is utterly dependent on the existence of life on Earth—of biodiversity" (1995:201). This equation of life with biodiversity is

worth examining, in order to track the effects of making such polysemic terms synonymous. If biodiversity can be assessed at levels ranging from the genetic to the global, then the life for which it serves as a proxy becomes a sliding signifier made to speak alternately and at once of entities such as DNA (as genetic "essence" of life), life forms (individual and taxonomic embodiments of vitality), and Gaia (Earth's physiochemobiosphere).[11] When marine biodiversity is at issue, seawater provides the shared substance through which such semantic slipperiness can be channeled. Moreover, because biodiversity is understood as a resource for biosystemic flexibility, adaptability, and resilience—a reserve for the continued survival of life—it serves as a scientific placeholder and promissory note for associations of life with "hope" and "the future."

All this talk of life requires a comment about death and extinction. The anxious celebration of biodiversity comes at a time when there is a keen sense that it is under threat, and crucially so by human agency—for it is difficult to argue that biodiversity as such is a value that evolution would preserve on its own (natural selection, after all, often winnows out diversity). Beneath the "sea is life" rhetoric lurks the shadow fear that humans are visiting death upon the oceans. Overfishing, coral bleaching, and pollution must refer us to older images of the sea as a space of drowning, death, and shipwreck, but they must also key us into a recognition that the contemporary graveyard sea is largely a result of human activity under the exchange system of capitalism, a system that assumes that natural reproduction must keep pace with capital accumulation. This is only the surface of the submerged history. American visions of the ocean as a space of healing and therapy—let's go to the beach!—wash over the twin history of the sea as a space of imperialism, of the Middle Passage, of submarine warfare and radioactive waste.

But back to life. I am interested in how "life" as biodiversity becomes visible in social practice, particularly through the lens of marine science inaugurated by U.S. governmental, academic, and corporate bodies in the name of "America's ocean future." Because the biodiversity in which these agencies is interested does not always fall within the exclusive economic zone (EEZ) of the United States (that area extending two hundred nautical miles off the shores of the terrestrial nation), national initiatives must be networked into international space through the prosthetics of contracts and corporations. Harnessing the salutary power of the sea, as the National Oceans Conference proceedings framed it, means forging new kinds of partnerships. Securing the cultural meaning of 71-percent-saltwater bodies requires routing marine biodiversity through articulations of biomedicine, law, national institutions and imaginaries, and the politics of international spaces outside national boundaries.

In this essay, I alight on two ecosystems and the kinds of biodiversity, biotechnological promise, and sovereignties associated with them. I first take up coral reefs, commonly considered to be the "rainforests of the sea" (Davidson 1998:6), the most biodiverse locales in the ocean. Reefs hold important promise for bone graft technology and anticancer drugs. I use my second location, deep-sea hydrothermal vents, to think about what happens when freshly discovered life forms fall off the map of national sovereignties. Vent communities, unknown to science before 1979, were recently recognized as homes to an entirely new superkingdom or domain of life, Archaea, early on thought by some to be the oldest lineage of life on Earth. Hyperthermophilic Archaea, heat-loving microbial life forms that live near vents and well below the photic zone, have also been designated as examples of what life might look like on sunless worlds in outer space. Their ersatz extraterrestriality is sometimes mirrored by their extraterritoriality, for many Archaean ecologies do not fall within national EEZs. What "life" means in these locales is shaped by the cultural, social, scientific, and political economic frames through which it becomes legible.[12]

CORAL REEFS AT THE EDGES OF LIFE

Stony coral, the colonial marine invertebrate responsible for some of the largest biogenic structures in the world—coral reefs—has occupied a lively position in the modern history of scientific discussions of "life." Early natural historians and biologists found these zoophytes to be odd compounds of animal, vegetable, and mineral components, and their classification confounded such figures as Linneaus.[13] But their liminality was precisely what captivated later thinkers such as Robert Grant, Charles Darwin's teacher at Edinburgh University, who saw coral as a missing link between plants and animals and who inspired Darwin's early book *The Structure and Distribution of Coral Reefs* (1842; and see Davidson 1998). The anthropologist Gillian Feeley-Harnik (2001) has pointed out that the fascination of the early social evolutionist Lewis Henry Morgan with the way living things transformed their earthly surroundings commenced with an interest in coral. Morgan's later meditations on the creative character of nonhuman mammals in *The American Beaver and His Works* (1868) and his interest in Iroquois notions of the land as an ancestral living presence (and to some extent his kinship theory) stemmed from an attempt to understand the creation of life through imagery in Genesis; according to the biblical creation tale, "earth [was] the medium from which the living things [were] created" (Feeley-Harnik 1999:227).

The example of earth Morgan first fixed on, however, in his 1841 "Essay on Geology," was the coral island: "These islands...are formed by the labours of millions of little insects, whose industry and ingenuity almost exceed belief. —It is but lately that any attention has been directed to these animals in a scientific manner and many questions relating to the nature of the animalcules and to the manner in which these islands are elevated above the level of the sea, are not as yet fully answered" (Morgan, quoted in Feeley-Harnik 1999:228). For Morgan, coral stood as a symbol of life emerging from and returning to geology and the sea. Coral animalcules, bridging the past and the future, were animated by the practice of building the world and bodies they inhabited, an activity that linked them to humans. Alfred Kroeber followed this cue in his 1952 essay "The Nature of Culture," in which he used coral to illustrate his concept of the "superorganic."[14]

This image of coral informs recent medical discussions of coral as a natural substrate for bone grafts and eye implants. Such coral cures, though routed through biomechanical engineering, are popularly dubbed "natural": "The stony skeletons of corals seem to be far more natural for bone and eye implants than artificial substances such as glass. The chemical composition of the coral, secreted from the minerals of the sea, is nearly identical to the complex mineral arrays created by the human body" (Belleville 1999:92). A medical website devoted to artificial eyes poses coral as a "natural choice" for ocular implants: "The goal of a more natural appearance was finally achieved with the help of a natural material: ocean coral. A remarkable similarity was noticed between the porous structure of certain coral species and that of human bone.... The eye muscles can be attached directly to this implant, allowing it to move within the orbit—just like the natural eye."[15] Here, human kinship with the sea finds a link through the shared substance of hydroxyapatite, the complex calcium-phosphate salt found in human bones and coral skeletons. Future medicine promises to reverse the logic of Shakespeare's famous line from *The Tempest*—"of his bones are coral made"—as coral becomes an organ donor for humans.

Routing coral into human bodies is facilitated by access to territories that feature reef ecologies. United States–based medicine can take advantage of the nation's substantial paths to such places. U.S. coral reefs "cover approximately 17,000 square kilometers. Ninety percent of them are associated with U.S. islands in the Western Pacific (Hawaii, Guam, American Samoa, and the Commonwealth

of the Northern Marianas); the remainder are located off Florida, Georgia, Texas, and U.S. islands in the Caribbean" (U.S. Department of Commerce 1999:38). The more far-flung territories—where coral harvesting might run into less resistance from closer-to-home environmentalists—constitute a network solidified through histories of colonialism and war. The Marshall Islands, acquired by the United States after victory over Japan in World War II, contain a crowd of coral islands and atolls. These are famous for their use in above ground nuclear testing but have recently become known for the resilience of marine life in the wake of radioactive dosages. Bikini atoll, the site of the largest above ground explosion the United States has ever created, is now touted as "a testament to nature's ability to heal itself" (Zorpette 1998:24). Such impressive resiliency comes courtesy of marine biodiversity. And marine biodiversity is in particularly high supply on coral reefs, one reason they have been called upon to help heal human individuals, too.

If the nineteenth century inaugurated a fascination with coral fusions of anatomy and architecture, more recent research on marine invertebrates has fixed on living coral, with flesh and algae bodies. The diversity of reef ecologies is high at the species level: "Although coral reefs represent less than two-tenths of 1 percent of the area of the global ocean...[they] are home to approximately one-quarter of all marine species" (Davidson 1998:5; see also Maragos, Crosby, and McManus 1996). Medical mining of this diversity is well under way: "Some [reefs] have already yielded compounds active against inflammations, asthma, heart disease, leukemia, tumors, bacterial and fungal infection, and viruses, including HIV" (Chadwick 1999:34). Coral polyps in particular have come into focus as potential sources of anticancer drugs (though not because of any particular ability to withstand high radiation!).

As sedentary creatures, corals secure their protection against predators mostly through the manufacture of toxic chemical compounds that can be released under threat. The toxicity of such compounds can be modified for therapeutic purposes. Scientists at the Center for Marine Biotechnology and Biomedicine at the Scripps Institution of Oceanography in La Jolla, California, have done this sort of work: "Recently, Scripps marine chemists isolated a chemical that shows promise as a potential drug to fight breast and ovarian cancer from a rare species of coral.... The chemical, called eleutherobin...prevent[s] cells from dividing."[16] The chemical contains compounds that can kill cells. Pressing "nature" to "yield" its healing powers to safeguard "life" turns out to depend on domesticating a deadly poison, transmuting it into an ally of "life." It takes a great deal of conceptual and laboratory work to make Carl Safina's "great life-making sea" support the idea that "where there's life there's hope" (1997:440).

Bringing the "life-making" attributes of the sea to individual persons or patients also requires transporting such properties through networks of academic research, government projects, and commercial ventures. Scripps's research on eleutherobin, for example, was done in concert with the Bristol-Myers Squibb company, which eventually patented the compound. These sorts of links are nothing new in American biotechnology; indeed, they are rather the norm (see Hayden 1998; Rabinow 1996). They exemplify what Haraway (1997a) has designated as a shift from "kind" (for example, species) to "brand" (for example, product) in the categorization of living things in turn-of-the-millennium technoscience. But there is another player on this field. Scripps's cancer research is frequently done in collaboration with the National Cancer Institute (NCI, part of the National Institutes of Health in the United States). By piggybacking on Scripps's academic-industry partnership, NCI can extend the reach of "America's ocean future" beyond the exclusive economic zone, into new territory (though in some cases we might look at this the other way around, with NCI as a

"prosthetic arm to corporate prospecting activities" [Cori Hayden, personal communication 2000]).

The National Cancer Institute funds a shrubwork of research projects in marine biodiversity. The Coral Reef Research Foundation (CRRF), founded in 1995 by Patrick Colin and Lori Bell and supported in part by NCI, employs scientists to collect marine invertebrates as potential sources for new anticancer drugs. CRRF, a nonprofit organization, is incorporated in California but also in the Indo-Pacific island nation of Palau, which became independent from the United States in 1994.[17] CRRF scientists freeze and fly material samples to NCI headquarters in Maryland, where they are screened for bioactivity against cancer cells and HIV. Recognizing Palauan sovereignty over and stewardship of these resources, NCI enters into a bioprospecting contract with an agency in Palau. If NCI wants compounds sourced in Palau to be developed into marketable drugs, this contract specifies that Palau must be compensated by any prospective pharmaceutical partners to whom the U.S. government patent is licensed.[18] On the path between "kinds" and "brands," then, the nation incorporates extraterritorial organisms with a sort of dual temporary citizenship, a "naturalized" location from which they can be hired on as health workers in the context of a free market. Poisonous compounds are exchanged for "life" in a network of island states, UN-sanctioned contract law, and U.S.-based academia, government, and industry.

Bioprospecting contracts emerged in the 1990s as a way of coordinating global market access to the so-called biological commons. They figured biotic "nature" as a kind of public domain, a formulation meaningful only as a kind of negative or residual category of property within an "epistemology of capitalism" (Brush 1999:540). The United Nations Convention on Biological Diversity, hammered out at the 1992 UN Conference on Environment and Development (the "Rio summit"), interposed local communities as crucial mediators between this public domain of nature and those who would capitalize on its resources. Bioprospecting agreements would "return benefits to the stewards of biological resources" (Brush 1999:536), often nation-states or nongovernmental organizations representing constituent groups—such as indigenous peoples—within national borders. This logic is in line with what Arturo Escobar (1995) has termed the semiotic conquest of nature by capitalism. "The argument, of course, is based on the political and cultural hubris that Western criteria should be extended broadly and that a public domain exists between nation-states as well as within them" (Brush 1999:542).

Bioprospecting, then, forces biodiversity to speak in the idiom of the market (see Hayden 1998, 2000). In this frame, the life-giving properties that marine biodiversity hosts cannot be made available, cannot effect any healing, until they become property in the economic sense. And their travel as property requires not just their literal freezing but their discursive freezing in the form of patents.[19] A lot of work is required to network marine invertebrates and mammalian landlubbers into this gaiasociality, kinwork that connects the living planet to mortal human bodies. This brings me to the next level at which coral is made to speak of, and for, health: the planetary level.

Coral reefs have recently been discovered to register meaningful changes in the sea's chemistry and so can be used as "historical climatic recorders" (Davidson 1998:21). In part, this is simply another way of reading the effects of their bioactivity in the sea: "Corals secrete calcium carbonate—limestone—on a scale massive enough to influence ocean chemistry and affect carbon dioxide levels in the atmosphere and, thus, the health of the planet as a whole" (Chadwick 1999:34). Recent worldwide degradation of coral reefs has been linked to, among other things, the effects of too much carbon dioxide in the atmosphere—that is, to global warming, which makes sea levels rise faster than the pace of coral growth. When this happens, symbiotic algae in coral polyps lose the ability to photosynthesize and are ejected from their hosts in a process called bleaching. Corals also suffer when sunlight is obstructed by the rapid growth of surface algae, which often happens in water suddenly loaded with nutrients from sewage flow (Nixon 1998).

Because the changes registered indicate declining oceanic health and are often triggered by anthropogenic causes, these messages are understood as being directed at humans: "Coral reefs may be warning us to pay closer attention, just as they can signal the pressures that modern populations are placing on tropical resources" (Chadwick 1999:37). In their barometric readings, reefs sound a warning signal from Gaia, chastising humans for self-indulgent, shortsighted activities. Environmentally conscious scientists often translate this scold into one particularly aimed at "developing" countries such as the Philippines, which have yet to tune into Gaia's alert. And while most acknowledge the inequalities that have characterized north-south relations and that may be important for understanding the history of the overexploitation of, say, the Java Sea, many flatten the issue into a simple matter of environmental pressures from growing populations with antiquated technology. As participants at an international conference on coral reefs held in Bali in October 2000 put it, however, reef degradation must be seen through the lens of present-day global political economy.[20] Coral reefs are not just climatic barometers but also indicators of north-south tensions.

THE DEEP SEA AS CHANNEL TO THE PAST AND FUTURE OF LIFE

Far from the coastal familiarity of reef ecologies is the deep sea, a domain that has had many mythic and scientific incarnations. What was feared for many centuries as a mysterious realm of sea monsters became, in the early nineteenth century, a zone imagined as static and barren—empty of currents, temperature changes, nutrient exchanges, and life: *azoic.* With Darwin, this netherworld came back to life. Darwin postulated that stable environmental conditions in the deep might actually support "types of primitive life that underwent little or no biological change over the eons.... [I]n the 1860s a hunt began for living fossils, evolutionary throwbacks, and missing links" (Broad 1997:31). The Victorian imagination came to associate the deep with the early history of the Earth, "as if there were a correlation between going deep and going back. Thus the deeper one went, the more primitive would be the life forms encountered, the more prehistoric and inchoate" (Hamilton-Patterson 1992:191). Over the next decades, the figure of the sea monster-serpent returned, this time dressed in dinosaurial garb (as in popular books such as Jules Verne's 1871 *Twenty Thousand Leagues under the Sea;* see Noble 1997). By the end of the nineteenth century, however, the view of the abyss as lair to living fossils had been discredited, as creatures dredged from the deeps during the laying of undersea telegraph cables were revealed to be both familiar and novel forms of marine life and not, say, trilobites.

In the twentieth century, marine scientists discovered the recesses of the deep sea to be full of creatures—sea anemones, shrimp, squat lobsters, sea cucumbers, and much else—living in environments as dynamic and diverse as anything terrestrial. Much of this discovery happened in the context of U.S. military research during the Cold War. Antisubmarine warfare research, organized around technologies of deep listening, disclosed layers of sea life migrating between depths and picked up deep rumblings that turned out to be seaquakes, epicentered at subduction zones where one tectonic plate moved beneath another. These were important habitats for previously unknown life, the characteristics of which would begin to be fully investigated only when the navy declassified its maps of the seafloor in the mid-1990s. One reason locations of deep-sea fissures were not made public previously was that many

contained deposits of nickel, copper, and manganese—minerals with important industrial and military applications. As William Broad (1997) has argued, the United States sought to appropriate knowledge of and access to these high-seas resources, recasting the mysterious deep as a site for state secrets (and see Mukerji 1989 on relationships between deep-sea science and the state).

Deep volcanism, a key piece of evidence in the theory of continental drift, became especially intriguing to biological scientists because associated with mineral-rich subduction zones were previously unknown ecologies—communities that thrived on the unique conditions associated with hydrothermal venting. At deep-sea locations where tectonic plates meet and spread apart, molten rock emerges from the Earth's crust. Seawater, seeping into these cracks, heats to great temperatures and reacts with this magma:

> The chemically modified water, now itself hot and buoyant, channelizes through conduits in the seafloor to exit as hot springs within the axial valleys of submarine spreading centers.... Pressure keeps the hot water from steaming or boiling; it becomes superheated, reaching temperatures of 350C or more. Venting water, emerging clear from the seafloor, quickly turns into turbulent plumes of "black smoke" as dissolved minerals form particles on mixing with seawater. (Van Dover 1996:55)

Organisms have adapted to life in the vicinity of mineral plumes: "Vent water is enriched in reduced chemical compounds, especially hydrogen sulfide.... A variety of bacteria thrive on the sulfide, using its chemical energy through chemosynthesis in much the same way that plants use energy from light to produce organic carbon through photosynthesis" (Van Dover 1996:56). Chemosynthesis is the production of organic materials using energy derived from chemical reactions (like the oxidation of hydrogen sulfide) rather than from sunlight, a way of making a living unknown to science before the 1970s. Chemosynthesis by microbial life forms is the basis of hydrothermal ecologies and their associated patterns of symbiosis and chains of predation: "Entire communities of invertebrates have adapted to life at vents. Newly described species of clams and mussels depend on symbiotic, chemosynthetic bacteria for their nutrition" (Van Dover 1996:57). The interesting implication of the discovery of chemosynthesis is that "submarine hydrothermal systems, fueled by the heat of volcanic processes, can support life in the absence of sunlight" (Van Dover 1996:56).

Knowledge of hydrothermal vent communities and of chemosynthesis has forced revision of important biological and evolutionary assumptions. For one thing, the long-discarded notion that the ocean may be home to "living fossils" has, in a strange way, been revived: "On the cooler fringes of the hot springs, there are mussels, several newly recognized kinds of anemones and long-necked barnacles, which until recently were thought to have died out with the dinosaurs at the end of the Mesozoic era, 65 million years ago" (Binns and Decker 1998:96). The chemosynthetic microbes at the heart of this ecosystem have been designated potentially rather ancient creatures, and many of them are not bacteria at all. The biologist Carl Woese argued in 1990 that most "heat-loving organisms in the hot vents were members of a class that seemed to have undergone less evolutionary change than any other living species on the planet, implying that their ancestors were perhaps the original forms of life" (Broad 1997:112; see also Woese, Kandler, and Wheelis 1990). These hyperthermophilic microbes, along with their more recently discovered cold-loving, salt-loving, and methane-producing similars (see DeLong 1998), have been gathered into a new superkingdom or domain of life (the other two domains being prokaryotes [or eubacteria] and eukaryotes), a domain given the deliciously Lovecraftian name of "Archaea" (ancient ones).[21] This nomenclatural move, finally widely

accepted in the late 1990s, has solidified the notion that the oceans contain the majority of the biodiversity on Earth, for Archaea add an entirely new taxonomic presence at a very high level.[22]

In the earliest days of their classification, hyperthermophilic Archaea put a new spin on stories about the origin of life. The biologists John Corliss, John Baross, and Sarah Hoffman (1981) argued that lipids and amino acids could have originated in chemically rich water only if temperatures soared above the boiling point and if high pressure prevented these temperatures from denaturing such complex chemical configurations (at which point the temperatures would not actually be "boiling" but "superheating"). Vents, they thought, could be ideal sites for assembling complex organic systems. Some then argued that Archaea might be ancestral to all earthly life, suggesting also that chemosynthesis might be ancestral to photosynthesis (see Van Dover 1996).[23]

But if Archaea were in the early days of their discovery seen as universal ancestors, they have more lately been hyperlinked to ideas about life's future. As a website for a course on Archaea at Pennsylvania State University puts it: "Archaea are the keys to the past and to the future. Scientists are looking to these organisms to discover the traits of the last common ancestor and also for use in future technologies to benefit humanity."[24] New drugs are one possibility: "Medical researchers are working to discover new drugs derived from vents to combat germs now resistant to plant- and soil-based drugs."[25] The extreme temperatures at which some vent microbes thrive are of particular interest in the process of gene amplification, because enzymes from these creatures—extremozymes—can be used to make biochemical reactions run hotter and faster. DNA polymerase derived from hyperthermophiles, for example, better withstands the high temperatures required in polymerase chain reaction (PCR). Extremozymes do not fall apart during the heating cycles that unglue target segments of DNA and so do not need to be repeatedly added to facilitate amplification after each hot-cold cycle. In 1991, New England Biolabs, Inc., isolated the DNA polymerase of a hyperthermophile from the Gulf of California, cloned it, and then sold the enzyme as Deep Vent™, advertised with the slogan "Thermostability, Fidelity & Versatility from the Ocean Depths" (quoted in Broad 1997:280). The hardiness of these ancient creatures—their ability to work under pressure—can be put to use in the lab to make genetic science more effective. Along the way, the ocean's wealth becomes a commodity for the laboratory consumer.

Some of the most famous Archaea thrive on hydrogen sulfide, a compound poisonous to most other living things and a toxic waste of the mining and power industries. It is this property that makes them of particular interest in bioremediation—in cleansing the biosphere. A popular website on this topic puts it this way: "Vents have excellent potential to solve pressing problems on the earth's surface. Vent organisms might someday clean up industrial pollution such as hydrogen sulfide, which is linked to acid rain, as well as sites contaminated with copper, cadmium and mercury.... Methanogenic archaea could provide a renewable source of natural gas."[26] Just as in the coral-cure-for-cancer rhetoric, poison is transmuted into "life" in the crucibles of industry, which materially and rhetorically transform an ability to thrive on toxins into an environmentally friendly practice. Biological "difference"—here a biodiversity that carries lessons from an ancient way of doing things—is refashioned to aid Gaian well-being. Archaea reach out to humans from the deep past, offering wisdom and biotechnological healing to problems of pollution. This is a biotechnological fix to a *social* problem, and it gathers force from its phrasing as a "natural" solution: Ecologically minded scientists, with the aid of industry, are simply giving Archaea the opportunity to bend their adaptations toward remediating deleterious effects of human

activity—which we might see as a kind of microbiological instantiation of Renato Rosaldo's "imperialist nostalgia" (1989), in which people turn to a form of life imagined as primitive and in tune with nature in order to renounce, redeem, and heal their own depredations.

But if hyperthermophilic Archaea have often been posed as some of Earth's most autochthonous residents, they are also frequently described as its most alien. Hydrothermal ecosystems have captured the imagination of space scientists who see them as "models for sites where life might have originated on this planet and where extraterrestrial life is speculated to exist on Mars and Europa" (Van Dover 1996:back cover). Hydrothermal life is often extraterrestrialized in its very description:

> For those of us lucky enough to be involved in this research, it is like discovering life on another planet and having the privilege of being among the first to study that life. (Van Dover 1996:82)

> [I]t was a major revelation to learn that highly complex ecosystems were powered by [chemosynthesis]—that we and all the other light-eaters of Earth shared our planet with an alien horde that thrived in total darkness. (Broad 1997:109)

Popular books reporting on these life forms capitalize on the link between the deep sea and outer space, sporting such titles as *Dark Life: Martian Nanobacteria, Rock-Eating Cave Bugs, and Other Extreme Organisms of Inner Earth and Outer Space* (Taylor 1999) and *Evolution of Hydrothermal Ecosystems on Earth (and Mars?)* (Bock and Goode 1996). This also cements an association with American pioneering: "Deep-sea research...remains...a frontier science. The seafloor is the largest and least known wilderness on our planet" (Van Dover 1996:4).

The link to frontiering that extraterrestriality suggests is further secured by the fact that much deep-sea biodiversity exists in locations that are extraterritorial, outside national jurisdiction.[27] Some deep-sea organisms bearing interesting biodiversity are "alien" both as unearthly creations and as citizen creatures. Their extraterritoriality is particularly potent for an American imagination that sees spaces outside national jurisdiction as ripe for first-come, first-served appropriation, for the creation of private property through the mixing of "creative" labor with "nature," a process first described and given ideological warrant by John Locke in his writings about America (Arneil 1996). But if plans for accessing extraterritorial life forms have until recently depended on just such a Lockean gold rush attitude, this approach has started to come under scrutiny. The UN has begun to ask whether deep-sea creatures—microbes included—might not need international representation and stewardship, because, as Earle explains, "Approximately 60 percent of the ocean is in that jurisdictional never-never land, the 'global commons,' where policies for ecosystem protection are largely in the discussion stage" (1995:314). A quick trip back to the 1960s helps set the context for current conversations.

In 1967, the Maltese ambassador to the United Nations, Arvid Pardo, famously addressed members of the UN General Assembly, drawing attention to researches in the deep seabed that revealed large deposits of industrially important minerals sitting outside the boundaries of national jurisdiction. "Pardo urged the assembly to declare the deep ocean floor the 'common heritage of mankind' and to see that its mineral wealth was distributed preferentially to the poorer countries of the global community" (Jacobson and Rieser 1998:103). Adherents of free-market ideology did not much take to this notion, most notably the delegation from the United States, which continued to mine the deep seabed (claiming freedom of the high seas) without heed for the new sorts of governance being set in place by the nascent Law of the Sea Convention. An ideological battle that continues to this day was set in motion.

What has changed since the sixties is the nature of the resources at stake. Although the mining of the deep seabed has not proceeded as speedily as originally envisioned, deep-sea biodiversity has reopened debates about access, ideology, and money. "It is no small irony that the greatest excitement to date in undersea mining centers not on deep minerals" but on "the mining of life.... By weight, these single cell organisms are worth far more than gold. The mining of deep life was never anticipated in all the international hubbub over the divvying up of the sea's mineral wealth" (Broad 1997:276).

In 1995, the UN commissioned an independent study of the state of the oceans. The Independent World Commission on the Oceans—made up of a majority of members drawn from Second and Third World countries and chaired by Mário Soares, the former president of Portugal—produced a report that contested the notion that the ecologies of the deep seabed should be up for grabs for the first nation or company able to exploit them. Such an approach, the commission argued, would only exacerbate differences in wealth between nations. Reaching back to Pardo's ideas, it argued that "the issues raised by these genetic resources are not unlike those raised years ago by nodule mining. These issues include the identification and evaluation of the resource potentials, the establishment of their legal status, [and] the development of arrangements that provide for the equitable sharing of benefits from their exploitation" (Soares et al. 1998:70). Indeed, the commission hoped to organize a cooperative international effort toward equity around vent ecologies in a project called, optimistically, HOPE (Hydrothermal Ocean Processes and Ecosystems) (Soares et al. 1998:92–93).

Like *Turning to the Sea,* the commission's report sought to influence the shape of things to come, a goal expressed in its title, *Our Oceans, Our Future* (with implicit emphasis on the collective international "our"). Writing against the Lockean logics of U.S. ocean behavior (the United States has not yet ratified the international Law of the Sea Convention, owing to the convention's restrictions on open mining), the authors strategically took oceanspace as a blank slate on which to rethink the distribution of resources. "Contrary to what occurs with terrestrial resources," they wrote, "which can be individually possessed and appropriated in forms developed and consecrated over the centuries, marine resources are by their own nature common, and are generally considered as such" (Soares et al. 1998:10). For these writers, marine resources had a life of their own, resistant to incorporation by national politics and the free market. The report *Turning to the Sea* tenaciously offers a contrary vision of what the necessary machinery of care should look like. Bemoaning the current state of affairs, in which "there is no mechanism currently in place to ensure that profits derived from publicly owned resources will be shared with the public and used appropriately" (U.S. Department of Commerce 1999:22), the United States locates the solution in novel partnerships between government and industry, rather than at the level of UN negotiations.[28] Whereas the independent commission argued that "greater equity in the oceans would contribute to reducing poverty and underdevelopment in general" (Soares et al. 1998:17), the United States speaks vaguely of the "life" of the sea, which will be brought to bear on individual, national, and global well-being through networks of national and market constitution.

For all their differences, however, both the United States and the UN's Independent World Commission on the Oceans treat the sea as a tabula rasa—surely not the only way to construe the matter. We might consider recent work in critical Pacific studies that seeks to reposition conceptions of the ocean around the islands of the South Pacific. Epeli Hau'ofa of the University of the South Pacific in Fiji argues that European colonists have treated the sea as a kind of dead space between nations. Objecting to the

term Pacific Islands and preferring "Oceania," he suggests that the region be seen as "a sea of islands," places unified, not divided, by water (Hau'ofa 1993).[29] This view could be used to contest both American and dominant international views of the high seas as a global commons outside history. This view resembles that promoted by scholars in maritime anthropology who have shown that the idea of the oceans as a commons is a recent, Western one. Christine Walley, for example, writes that "the idea of freedom of the seas was a precursor to the social relations of colonialism and capitalism in an era in which communication still occurred primarily across water" (1999:282). Hau'ofa has indicated that sea-of-islands peoples might think of the waters around them as sovereign territory, a view that might not completely upend the logic of formations such as bioprospecting but might trouble easy measurements of EEZs and put questions of jurisdiction into new contexts.

NETWORKING LIFE IN WEBS OF MARINE BIOTECHNOLOGY

The ocean is becoming a newly networked space (crosscut by different and contested networks, to be sure), and the "life" it supports—marine life and the life of the planet—is, especially starting from U.S. nodes, increasingly webbed into symbioses among government, industry, and academia. Emblematic are entities such as MarBEC (Marine Bioproducts Engineering Center), headquartered at the University of Hawaii at Manoa. MarBEC is a new brand of institutional creature called an engineering research center (ERC), an academic-industry hybrid charted by the National Sience Foundation (NSF). According to MarBEC's website, engineering research centers

> provide an integrated environment for academe and industry to focus on next-generation advances in complex engineered systems important for the Nation's future. Activity within ERCs lies at the interface between the discovery-

> driven culture of science and the innovation-driven culture of engineering.... ERCs provide the intellectual foundation for industry to collaborate with faculty and students on resolving generic, long-range challenges producing the knowledge base for steady advances in technology and their speedy transition to the marketplace.... Thus, ERC graduates enjoy the capacity to contribute to the Nation's global future through a rich spectrum of career paths at the cutting edge of technical progress and innovation. (www.marbec.net)

MarBEC's biotechnology serves the academic, corporate, and national arenas. According to its publicity, it plans "to develop a seamless system from bioexploration to prototype production. Marine biotechnology finds application in almost every major industry, including food, chemicals, pharmaceuticals, advanced materials, energy, environment and national defense" (www.marbec.net). Located in the University of Hawaii's School of Earth and Ocean Sciences and Technology, this ERC will also breed a new kind of scientist: "MarBEC's education program will ultimately produce graduates from an accredited marine bioproducts curriculum who will be the nation's leaders in the field of marine bioproducts" (www.marbec.net). To this end, MarBEC maintains relationships with various startup companies, such as Hawaii-based Aquasearch, a company specializing in genetic engineering of microalgae whose website touts it as "bringing the oceans to life" (www.aquasearch.com). For MarBEC and Aquasearch, bringing the oceans to life means squeezing biodiversity through the market, enterprising it up (Strathern 1992a), and placing this watery wealth into a network of academic, governmental, and commercial research that will reveal and congeal it.

The marine environment, then, is being uploaded into a worldwide web that reconstitutes biodiversity (poison, toxiphily, and all) as a "life" force to be plugged into pro-

jects of healing for individuals and "sustainable" use for the planet (that is, use in line with continued market practices, now including the "environment" as a variable in production). The heterogeneous weblike character of this project finds a somewhat different node of articulation just south of California's Silicon Valley, in the form of the Monterey Bay Aquarium Research Institute (MBARI), just off the bay where the United States' first National Ocean Conference was held. MBARI was founded in 1987 by David Packard of Hewlett-Packard. Packard, known for his managerial skill and role in winning military contracts for his computer company, served in the 1970s as deputy secretary of defense, managing the United States' far-flung naval forces. By the time he left this position, he had gathered a store of knowledge about classified national marine science and technology. When the Cold War ended, this, coupled with his impressive wealth, put Packard in a unique position to move declassified Cold War technologies such as underwater microphones and high-tech submersibles into the private sector—which is exactly what he began to do as founder of MBARI. MBARI is a leader in deep robotics and the use of telepresence to research ocean midwater ecosystems for what they can reveal about dynamics such as the cycling of anthropogenically released carbon dioxide into the sea. MBARI is private but maintains a strong sense of public duty, symbolized by a website featuring up-to-the-minute image feeds from deep-diving robots (www.mbari.org).

At MBARI, ocean worlds are illuminated by telepresent technologies of visualization. The secret sea of the Cold War has been opened up to the eyes of an auditing environmentalist public. The oceans have been brought up to date, technologized not only though persistent comparisons to outer space but also through association with cyberculture (not surprising in an age of Netscape Navigator, the maritime-themed Web browser). The political valences of the web metaphor in computing are multiple, as protean as the symbolic space of the sea—able to include individualist frontier fantasies (Lockard 1997); ecofeminist analogies between weaving, swimming, and parallel processing (Plant 1997); and environmental justice-political ecological concerns about social safety nets (Escobar 1999b). In a global contest over what the seas will mean for humans, the Internet has become a symbol for public awareness and an avenue for public responsibility. NOAA supports a "National Internet Town Meeting on the Future of America's Coastal and Ocean Areas" (coast2025.nos.noaa.gov). SeaWeb, "a multi-media educational organization designed to make the public more aware of the ocean and ocean life" (www.seaweb.com), does most of its advocacy on-line, documenting the effects of human activity, primarily fishing,[30] on the health of marine life and suggesting ways in which American public concerns about the ocean can be brought to bear on international political initiatives.[31] The UN Independent World Commission on the Oceans advocated a website reporting on the state of the oceans in order to draw nontechnical publics into action. In its report it argued that "quite often, the perceptions of environmental phenomena by ordinary people, despite their unsystematic character, can contribute relevant information to the processes of policy formulation, especially by drawing attention to ethical considerations falling outside the confines of science" (Soares et al. 1998:126). What these networks do not necessarily do is allow a public audit of the political and market networks through which ocean life flows.

Internet-based coalitions of concern about the sea are often offered as mirrors of the flowing logics of the sea itself, reflective of dynamics such as the translocal constitution of coral ecologies shaped by ocean currents—"watery highways for coral larvae" (Davidson 1998:79)—that hyperlink the spawn of polyps in one locale to sedimented reefs in another. Hypertext sociality echoes the wet networks that leash life on land to its oceanic history. In geobiologists Mark and Dianna McMenamin's Lovelockian theory of "hypersea," life on land exists in and creates a kind of

rhizomatic terrestrial sea: "In a way, the land biota has had to find ways to carry the sea within it and, moreover, to construct watery conduits from 'node' to 'node'" (McMenamin and McMenamin 1994:5). In the foreword to the McMenamins' book, the biologist Lynn Margulis, a key architect of the Gaia hypothesis, writes: "In the days when the 'information superhighway' is the buzz phrase, we would do well to look at our inventive fungal predecessors [the first kingdom ashore] who, for four hundred million years, have already been leading the communication network of life on land" (in McMenamin and McMenamin 1994:xiv).

This redefinition of "life" as a network—held together primarily by salty fluid, and not, say, information—provides a novel trope for connecting local organisms to global systems. But the path from "life" as marine biodiversity to marine biotechnology (rather than to another prominent destination, such as marine conservation) must be understood as not only scientific but also political, economic, and cultural. Instruments such as bioprospecting place relations of property, law, governmentality, and capital firmly in the net that connects genes to Gaia—people to the planet—through some streams and not others.

Notes

My gratitude goes to Sarah Franklin and Margaret Lock for inviting me to the seminar for which this paper was developed. I am grateful, too, for the collegial commentary of the other seminar participants, who pressed me to rethink fundamental features of the argument presented here. I also thank members of the Program in Science, Technology, and Society at MIT, where I delivered a modified version of this essay. Finally, my thanks go to Pamela Ballinger, Cori Hayden, and Heather Paxson for invaluable support at all stages of this chapter's evolution.

1. The meeting was sponsored by the U.S. Navy and U.S. Department of Commerce. I gathered information about this closed-to-the-public event by collecting newspapers and brochures at a public Ocean Fair held in concert with the meeting and by tracking down government websites and reports that were spun off from the conference.

2. A large number of trade books have recently called attention to these processes, many in coordination with year-of-the-ocean publicity (see Broad 1997; Davidson 1998; Earle 1995; Kunzig 1999; Prager 2000; Safina 1997; Thorne-Miller 1999; Woodward 2000).

3. Quoted in U.S. Department of Commerce 1999:6.

4. This image is not original to Davidson; in her influential *The Sea around Us*, Rachel Carson (1951) referred to the ocean as "Mother Sea."

5. See www.yoto98.noaa.gov/yoto/meeting/.

6. This chapter was originally drafted during the Clinton-Gore administration, and both Clinton and Gore were key participants in the National Ocean Conference. The Bush administration has been unfriendly to the environmentalist concerns promoted by Clinton-Gore, citing the health of "the economy" as that which should organize and take precedence over ecological concerns. The Bush administration has sought more lax controls on oil drilling, particularly in Alaska (though, in decisions that Bush-Cheney may find difficult to reverse, Clinton during the Ocean Conference approved a permanent ban on offshore oil drilling in marine reserves and extended an existing ban applying to all U.S. waters until 2012). Bush has also backpedaled on global warming, claiming that scientific debate about its extent signals doubt about its existence. It seems likely that the Bush administration will focus its environmental rhetoric on economic incentives for accessing and exploiting marine biodiversity for biotechnological aims, something that can nonetheless easily be phrased as attentiveness to the ocean as a site of health and renewal.

7. This replacement may reverse an earlier substitution: that of outer space for the sea. The sea was grafted onto American frontier narratives early on (see Stein 1975) and later used as a metaphor for outer space. It is worth recalling that some of the first American astronauts were navy men, most notably Alan Shepard and Neil Armstrong. Thanks to Pamela Ballinger for pointing this out.

8. See www.umbi.umd.edu/~comb/.

9. This is a project aided in part by images of the watery earth as a mother, images that can render humans either as dependent children/fetuses or as creatures individuated from the maternal body—or both, depending on the developmental stage at which humans are symbolically positioned and by whom (see Duden 1993a; Haraway 1997a).

10. Such a multileveled view of "life" calls into its company the dynamics of ecological interrelation first popularized by Rachel Carson in books such as *The Sea around Us* (1951) and *The Edge of the Sea* (1955).

11. Gaia was first theorized by the atmospheric chemist James Lovelock in the 1960s as Earth's chemical, physical, and biotic totality. In this view, "the atmosphere was an extension of a living system designed to maintain an optimal environment for its own support" (Haraway 1995a:xiii). NOAA's charter crucially includes the ocean and atmosphere as conjoined extensions and embodiments of this system.

12. In previous work, I examined shifting meanings of the category "life" in Artificial Life, a brand of computer science devoted to simulating the behavior of organisms and populations in cyberspace. There, life was understood to be a process of information transformation, and genetic instructions—understood as coded programs—were often seen as identical to organisms themselves (see Helmreich 2000). What interests me about refigurings of "life" in the ocean is a renewed attention to water and to chemistry, which I take as potential pointers to a materiality missing from Platonic Artificial Life fetishes of life as substrate-independent informatics. Here, "life" is not so much information as a series of connections and relationships between materials. The character of those connections and relations is precisely where different visions and politics of "life" may be at stake.

13. Corals are now classed as animals that live in "colonies" made of thousands of small sedentary creatures called coral polyps. A polyp is "a tiny ring of gelatinous tentacles fluttering above an equally small, internally rippled sac. Hard corals also have a skeleton, or corallite, at their base, into which the polyp retreats during the day" (Davidson 1998:14). These polyps are symbiotic with a microscopic form of algae called zooxanthellae, which live inside the polyps and provide them with nutrients derived from photosynthesis.

14. Coral reefs are commonly compared to architectural formations. Thus Darwin: "We feel surprise when travelers tell us of the vast dimensions of the Pyramids and other great ruins, but how utterly insignificant are the greatest of these when compared to these mountains of stone accumulated by the agency of various minute and tender animals!" (quoted in Davidson 1998:7). Darwin also referred to corals as "myriads of architects" (quoted in Davidson 1998:29). Haraway (1995b) extended this imagery and swerved away from locating coral as a transitional form in a march toward more singular animal subjectivities; she highlighted the constructive dynamics of "non-mammalian replicative doings among marine invertebrates: egg-release into open waters, followed by larval feeding, and finally the settling and metamorphosis into the adult forms of myriad species." She likened the process of reef building to the process of building

conversation on common reading and writing: "The written, collected, and published book of interviews becomes the finished scaffolding, the coraline reef, on which the next generations of spineless, non-bilaterally symmetrical entities will settle, eat each other and passers-by, and proliferate their drifting, always hungry, and seedy brood" (Haraway 1995b:xi–xii). Corals might be thought of as invertebrate versions of what Marilyn Strathern (1988) called "dividuals," or partible persons.

15. See www.ioi.com/patient/ha.html.

16. See www.sio.ucsd.edu/supp_groups/development/cmbb.html.

17. See reefnet.org/issue7/research7.html.

18. Plans are afoot to create a coral gene bank in Hawaii (Safina 1997:336), though exactly who will maintain and control it is far from decided.

19. See Latour 1993:119 for a comparison of "scientific facts to frozen fish," and see de Laet 1996 on patents as freezers.

20. See http://www.nova.edu/ocean/9icrs/liveweb/1025_5.html.

21. The genetics of Archaea are also called upon in these discussions: "Their uniqueness is evident in the fact that 56% of them have genes that were previously undiscovered in other organisms" (www.personal.psu.edu/users/a/b/abt113/biowebpage2.html).

22. Archaea have more lately been shown to be a quite common form of microbial life. Many members of this category are not extremophiles, and many are planktonic presences in much of Earth's water (see DeLong 1998).

23. Archaea's status as ancestor has been called into serious doubt recently, particularly as some have argued that it is impossible to do proper phylogenies of these bacteria-like creatures. Archaea and bacteria move genes around laterally (within generations, not just down generations), which can confound linear genealogical regimes of classification (see Doolittle 1999). Controversies about archaeal phylogeny are very alive at the moment.

24. See www.personal.psu.edu/users/a/b/abt113/.

25. See library.thinkquest.org/18828/data/si.3.html; and see Robb 2000.

26. See library.thinkquest.org/. The website for the Center of Marine Biotechnology at the University of Maryland also alights on the uses these creatures might have: "Researchers have already proven that bioremediation—the use of microorganisms to degrade toxic contaminants—offers great potential for the efficient and cost-effective treatment and cleanup of hazardous materials that may be extremely difficult or impossible to remove from water or soil using other approaches.... Bioremediation techniques, in comparison with conventional methods, are less costly, more efficient, more environmentally benign, require less energy consumption, and are less damaging to fragile ecosystems" (www.umbi.umd.edu/~comb/).

27. Of course, not all locations fit this description; the Hawaiian archipelago offers access to some vents that are within the United States' EEZ, and parts of the Juan de Fuca Ridge lie just under two hundred miles off the Northwest Coast of the United States.

28. *Turning to the Sea: America's Ocean Future* recommends that the United States increase "support for sustainable harvesting and testing of marine compounds by both government agencies and commercial pharmaceutical companies as possible treatments for AIDS, inflammatory or infectious diseases, and cancers.... Develop investment incentives to encourage partnerships with academia and industry in marine biotechnology.... Focus on organisms found in extreme environments to identify unique products with high commercial potential.... Consider establishing a federal marine environmental fund to benefit from royalties and payments from commercial uses of federally owned resources" (U.S. Department of Commerce 1999:23).

29. Thanks to Donna Haraway for pointing me toward the "sea of islands" formulation.

30. Perhaps the largest issue of concern in ocean conservation, one I do not treat in this chapter, is the depletion of fish populations in global practices of overfishing, activities often based on a rhetoric of "harvesting." This model hides the fact that most fishing has no aquacultural component. That is, it is in no way equivalent to farming but closer to escalating predation on a dwindling population (see Safina 1997).

31. This mirrors in activist form more explicit projects to extend the marine grasp of the nation. Here, the aquaterritorialized nation-state weaves into the deterritorialized cyberspatialized nation-state (see Everard 2000).

Remaking Life & Death

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