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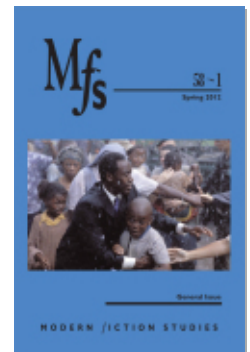
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RADIATION ECOLOGIES AND THE WARS OF LIGHT

Elizabeth DeLoughrey

The fully enlightened earth radiates disaster triumphant.

—Theodor Adorno and Max Horkheimer,
Dialectic of Enlightenment

We are creatures constituted by radiation, solar and otherwise. This is a sign of our planetarity, a merger with an environment that exceeds our attempts at total illumination. Our ability to capture, inscribe, and make meaning of light has been defined as heliography, a word used at the advent of photography to foreground the entrapment of solar rays with the aid of the camera, a "pencil of nature" as termed by Henry Fox Talbot, that documents "words of light" (Cadava xvii).¹ The concept of heliography is expanded here to represent both the discursive practice of writing about light as well as the inscription of our bodies as they are created, visually ordered and perceived, and penetrated by radiation. Light is an originary source of life in our universe and sustains life on our planet, but its role in modern philosophy as well as physics is profoundly ambiguous. In fact, most genealogies of radiation in modernity emphasize a destructive rather than life-sustaining trajectory. Theodor Adorno and Max Horkheimer, writing amidst the state-sanctified violence of World War II, argued that the instrumental rationality of the Enlightenment perpetuates its self-destruction and utilized metaphors of light to warn against the dangers of the "fully enlightened earth." "What men want to learn from nature," they argued, "is how to use it in order wholly

to dominate it and other men" (3). While the start of the twentieth century witnessed Albert Einstein's rendering of the speed of light as the only universal absolute, by midcentury the new technologies of light such as photography, the X-ray, aerial surveillance, the motion picture, and the atomic bomb were understood as constitutive of a heliographic modernity with frightening potential for violence against human subjects, history, and the environment.²

This heliotrope of the "fully enlightened earth," the excess illumination Adorno and Horkheimer warn of in the epigraph, has been a primary concern in the Pacific Islands, a region often deemed peripheral to modernity and yet the site of nearly continuous nuclear weapons testing from 1946–1996. Since their exploration by Enlightenment-era cartographers, painters, and naturalists, the Pacific Islands have been incorporated into an especially visual economy of colonialism in which the ethnicity of the region's peoples, the exoticism of tropical light, and the flora and fauna were studiously mapped, painted, and inscribed for European display and distribution.³ By the mid-twentieth century, Oceania entered an entirely different economy of light when hundreds of nuclear detonations conducted by the US, France, and the UK produced a new atomic cartography and a militarized grammar of "radiation atolls" and "nuclear nomads."⁴

The irradiation of the Pacific Islands marks an important era of global militarization that has largely been overlooked by the very metropolises that benefited from the economic, political, and technological products of nuclear weapons testing, such as the high-speed camera, color film, and radiotherapy. Overtly using the islands as laboratories and spaces of radiological experiment, British, American, and French militaries configured those spaces deemed by Euro-American travelers as isolated and utopian into a constitutive locus of a dystopian nuclear modernity.

In this essay I turn to a heliographic novel by Maori author James George to explore how he inscribes the modernity of the Pacific in terms of the violence of radiation ecologies, particularly through photography and the (nuclear) wars of light. His novel *Ocean Roads* suggests that the primary way we understand the environment and its relationship to modernity is through the vehicle of light, even if that vehicle often exceeds the limits of representation and comprehension. While ecocritical fictions are often focused on representations of matter and matter's vulnerability to destruction, George turns to radiation ecologies—what illuminates matter but is not necessarily constituted by it. As we know from visual studies and philosophy, the metaphor of illumination is closely tied to knowledge production. We see, we are illuminated, we inspect (Jay 2, Grandy par. 1). Yet light itself cannot be seen; it is absent presence. It is this "revelatory

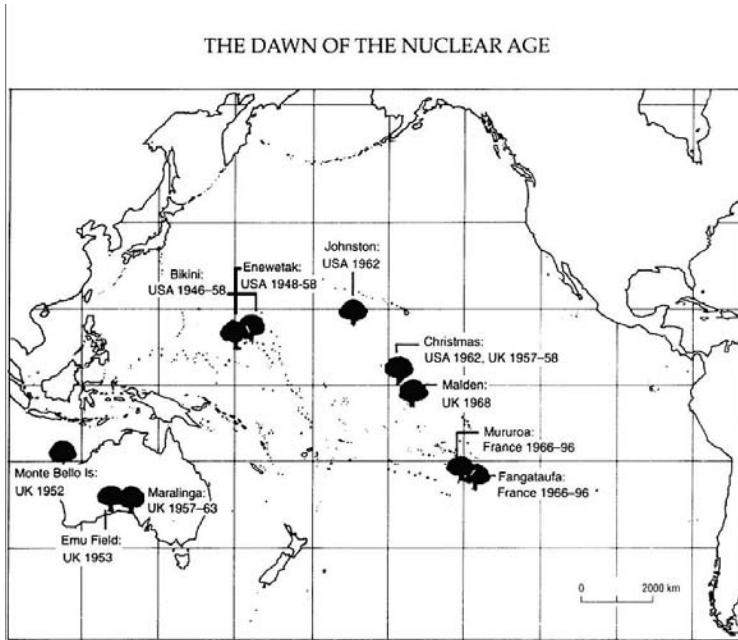


Fig. 1. "Dawn of the Nuclear Age."

otherness (the light-mediated manifestation of the other)" (Grandy par. 7) that I explore in this novel as a sign of the modernity of global ecology. While we associate ecology with relations between matter, scholars such as James Jerome Gibson argue that light is profoundly relational. In fact, light can only be apprehended in relation to the objects it illuminates and can only be "seen"—from material experience to classical and quantum physics—by its affect upon local ecologies. Demonstrating that what sighted individuals experience as space is a shifting relationship between illuminated surfaces, Gibson argues that our participation in the illumination of lighted matter is ecological (Gibson 23, Grandy par. 17).

The ecological relationship to place made possible by light is simultaneously local (in its perception) and planetary (in the universal movement of light). Moreover, this relational quality of the ecology of light is vital to the question of otherness, as Derrida and Levinas have demonstrated.⁵ In explicating their work, David Grandy has argued that light is tied to alterity because it is "unfamiliar and inscrutable" (par. 7), and because it "enables apprehension of the other" (par. 46). Despite the remarkable discoveries of quantum physics, light is still "as fundamentally mysterious as ever," an "invisible companion

who accompanies us inwardly as much as it does outwardly," and an entity that exceeds all reckonings of material space (Zajonc 7, 9). Light's capacity to illuminate objects of knowledge but not itself, Grandy suggests, is "the origin of otherness" (par. 9). Here I build on this argument to consider light's morphology as radiation—both natural and anthropogenic. Radiation suggests a universal and global ecology that implicates the human and the nonhuman; methodologically it is best approached in terms of Gayatri Chakravorty Spivak's concept of "planetarity." Like Adorno and Horkheimer, Spivak has highlighted the excess illumination associated with all-knowing models of space, particularly of globalization; in response she has proposed an ecological model of thinking of the planet as "a species of alterity" (*Death* 72). "Planet-thought," as she calls it, "opens up to embrace an inexhaustible taxonomy" of alterity often read in terms such as mother, nation, God, and, most relevant to this essay, nature (73). Planetarity, she argues, insists that we configure our relation to alterity as not necessarily continuous nor discontinuous. It is the process by which the familiar is rendered uncanny and unhomey, similar to the ways that the apprehension of (invisible) radiation and its ecological properties destabilize our understanding of place and space. Planetarity is a method of reading that represents "the defamiliarization of familiar space" (77), just as our recognition of the physics of light foregrounds its "uncanniness" as it "puts us in touch with distant, seemingly untouchable entities" (Grandy par. 37).

Through my analysis of George's heliographic novel *Ocean Roads*, I pursue this approach to planetarity through the figure of radiation, that illusive trace of history and, indeed, of cosmic universalism. Radiation suffuses the human body, the earth, the atmosphere, and the cosmos. It appears in multiple forms and represents the broadest span of time, from the shortest half-life of a nanosecond to millions of years. It is not matter but rather the sign of energy in the process of transformation. Scientists generally acknowledge three natural forms—background radiation derives from the sun and outer space, cosmogenic radiation permeates the atmosphere, and, finally, primordial (terrestrial) radiation is the ongoing legacy of the formation of the earth. Background radiation, which we register as radio and TV static, is the belated sign of the origins of the cosmos, a trace of universal history. Although we cannot perceive radiation by our unaided senses, we register its presence in our bodies when ionized atoms transform the structure of our cells (Caufield 23), foregrounding the way in which light is both internal as well as external to the body. This is especially the case of anthropogenic radiation produced by military and medical nuclearization. Regardless of the source, radiation is unstable matter in the continual process of trans-

formation into something more stable. It is a register of decay, of the process of nonhuman history. Although invisible to our naked eye, radioactive traces help constitute an ecology and a history of light that can be interpreted on a local and planetary scale.

Spivak asks that literary study "take the 'figure' as its guide," to "dis-figure" it, read the logic of its metaphor, not for the purposes of "rational deconstruction" but for a "responsible literality" (*Death* 72). This is what it means to be a "planetary reader," to be "planetary subjects rather than global agents" ("World System" 107). In my understanding, this suggests a move away from scholarship that privileges the individualism of the omniscient (human) cosmopolitan toward a framework that conceives of the constitutive nature of global alterity through human and nonhuman relations. Following her lead I turn to that ultimate figure of alterity, light, and trace the figure of radiation to dis-figure it, particularly the ways in which "nukespeak," the propaganda of American nuclearization, naturalized military radiation across the planet as inevitable global modernity.⁶ In the words of one US Office of Naval Research manual, radiation (fallout) is simply "just one more of the hazards of contemporary living" (Lapp 11). Manipulating the metaphor of light, American Cold War propaganda associated man-made radiation with its solar counterpart and likened nuclear detonations on earth as harnessing the power of the sun. The repeated connection between a military lab product (a nuclear weapon) and its cosmic figure (the sun) naturalized atomic weapon production and helped to "eclipse" the hundreds of nuclear detonations in the Pacific Islands through the second half of the twentieth century.

Writing in the radioactively "hot" days of the Cold War, influential theorists such as Adorno and Horkheimer, Levinas, Gibson, and Hans Blumenberg examined the metaphysics of light and the limitations of metaphors of illumination. Yet they all overlooked what literally suffused the atmosphere—the naturalizing discourse of nuclearization and the persistent trace of radioactive fallout, which have permeated our atmosphere since 1946. Adopting Spivak's model of planetary thinking, I suggest that the global rise of militarized radiation transformed our relationship to light and that the relationship between light and ecology is more than metaphysical. In fact, ecology as a discipline has close ties to the radioactive militarization of the Pacific. Joel Bartholemew Hagen provides a compelling history of the "symbiosis develop(ed) between atomic energy and ecosystem ecology" (101), particularly as it was organized by Eugene and Howard T. Odum, founding figures of ecology in the United States. Given the rapid expansion of the nuclear industrial complex in the 1950s and the subsequent radiological contamination of the planet,

the Atomic Energy Commission (AEC) hired the Odums to study the ecological impacts of militarized radioactivity. Radiological (and thus environmental) surveys of the nuclearized Bikini Atoll began in 1946, and the field of "radiation ecology" was established in the Pacific with the Odums' AEC-funded study of Enewetak Atoll in Micronesia in 1955 (102). After the repeated nuclear bombing of Enewetak, the AEC provided the first opportunity to study a "complete ecosystem" and its "overall metabolism" through the trace of radiation (103). Understood as a "landmark in ecological research" (105), the Odums' work on the radiation of Pacific coral reefs provided a model of a self-regulating ecosystem and the first theorization of shared resource relationships in nature (106). In turn, AEC-funded research laboratories and programs in radiation ecology were organized in universities all over the US and at nuclear power sites, catalyzing the institutional development of ecosystem ecology (112). Ironically, the discipline so associated with the preservation of nature arose from its militarized destruction, and contaminants in the environment such as radioactive strontium and iodine became, for ecologists, the legible "trace" of ecosystem health.

Andrew Ross has defined the 1991 Gulf War as the "first *explicitly* ecological war in modern history" due to "the use of the environment as a weapon by both sides" (160). Here I would like to position the Pacific wars of light as key precursors, if not founding events, for the understanding of ecology and the ecology of war. This is a key shift if we recognize that the Cold War was not simply about the explosive power of nuclear weapons (the immediate yield) but rather its long-term radiological effects. In Braudelian terms, the shock of an eventist model of history, the nuclear explosion, should not distract our attention from the impact of a *longue durée* of radioactive ecologies, particularly when we consider that nuclear weapon byproducts such as carbon-14 and plutonium-239 have 5,700 and 24,000 year half-lives (Stephenson and Weal 70). Inspired by the ecological nature of radiation, the AEC coordinated the secret release of enormous amounts of radioactive wastes and gases at Hanford and other nuclear sites to measure the impact on local environments; these releases far exceeded the nuclear waste emission from the 1986 Chernobyl disaster (Caufield 136). In an effort to understand the human body's participation in radioecology, the AEC also funded studies, in concert with universities across the US, that injected or fed radioactive tracers into the bodies of thousands of uninformed Americans—such as poor pregnant women, orphaned and disabled children, and the terminally ill—and also conducted full body radiation experiments on prisoners. In the vast majority of cases, the victims carried the cost of their illnesses (or their children's illnesses) on their own, and were not

informed or compensated for these radioactive experiments. These Department of Energy "human radiation experiments" were simultaneous with the AEC-coordinated studies of the biological impact of radioactive fallout on Micronesians.⁷

Ecological contaminants have, not surprisingly, been associated with invisibility, secrecy, and alterity—an unwarranted contamination of the body by untrustworthy corporate and/or government sources. While most scholars pinpoint Rachel Carson's *Silent Spring* (1962) as a foundational text of the environmental movement, which drew attention to the invisible way in which pesticides were radically changing ecosystems, including the human body, Ralph H. Lutts has demonstrated that Carson's grammar of pollution was derived from the global spread of another invisible contaminant: nuclear radiation. This is not surprising when we consider the seamless shift from munitions to pesticide factories, so that "we're still eating the leftovers of World War II" (Shiva qtd. in Pollan 41). Lutts connects the decades of fear and protest over the impact of nuclear fallout with the growing concern about pesticides. Drawing a parallel between both ecological contaminants, he observes that Carson "was sounding an alarm about a kind of pollution that was invisible to the senses; could be transported great distances, perhaps globally; could accumulate over time in body tissues; could produce chronic, as well as acute poisoning; and could result in cancer, birth defects, and genetic mutations that may not become evident until years or decades after exposure" (19).

The hundreds of nuclear tests conducted in the Pacific Islands, particularly in the annexed territories of Micronesia, have been largely erased from global memory, and yet we all carry their radioactive traces in our bodies. With the shift from atomic (fission) to thermonuclear (fusion) weapons, global radioactive fallout increased exponentially, with the US releasing greater radioactive yields in Oceania (Barker 21). The first detonated thermonuclear weapon—the H-bomb *Mike*—unleashed in the "Pacific Proving Grounds" in 1952, blew the island of Egelab out of existence. At ten megatons, *Mike* was seven hundred times the explosive force of the atomic weapon dropped on Hiroshima, which had killed over 200,000 people (Stephenson and Weal 79). Radioactive fallout from *Mike* was measured in rain over Japan, in Indian aircraft, and in the atmosphere over the US and Europe (Jungk 310). Within two years, the US increased its thermonuclear yield to nearly fifteen megatons in test *Bravo* (1954) at Bikini Atoll. These hydrogen weapons were some of the radioactively "dirtiest" of nuclear devices due to their outercasing of uranium-238, which has a decay product with a half-life of over two hundred thousand years (Stephenson and Weal 79, Jungk 310).

The *Bravo* test was an ecological and political relations disaster because it exposed hundreds of Marshall Islanders to nuclear fallout, contributing to countless miscarriages, leukemia deaths, thyroid cancers, and fatalities. It also created a public relations disaster with Japan over the deadly exposure to the men on board the fishing ship, *Lucky Dragon*, an international incident that inspired vehement anti-nuclear protest, fish consumption bans, and the film *Godzilla*.⁸ One scientist declared that by 1954, in merely two years of hydrogen bomb detonations, all humans on the globe "harbor(ed) . . . radioactivity from past H-bomb tests: 'hot' strontium in bones and teeth, 'hot' iodine in the thyroid glands" (qtd. in Jungk 311). By the late 1950s, the international outcry over nuclear fallout prompted the AEC (with Rand Corporation) to coordinate a top-secret ecological investigation into the increasing strontium-90 levels in humans, plants, and animals around the world. The AEC labeled this body-snatching program "Operation Sunshine" and collected thousands of human limbs, dead infants, human and cattle thyroids, and cadavers without consent.⁹ The name of the study was derived from the analogy between the sun and nuclear radioactivity because after these tests, "fallout, like sunshine, covered the globe" (Welsome 299). This in turn led to new models of an illuminated globalization, a frightening knowledge of planetarity in which one mapped the world through the trace of militarized radiation. As one scientist reported, "nobody believed you could contaminate the world from one spot. It was like Columbus when no one believed the world was round" (qtd. in Welsome 303).¹⁰ This reflected a "new world" of militarized radiation, an era in which the planet became (re)written by light.

Heliography: Time and the Velocity of Wars of Light

The radioactive militarization of the globe has long been a concern for Pacific Island writers, who have engaged with this heliotrope of the "fully enlightened earth." Pacific sovereignty movements have posed legal, political, and philosophical challenges to what Paul Virilio refers to as "light wars," which he dates to the start of the twentieth century with the first use of the searchlight (*War and Cinema* 68). Combined with technologies of surveillance such as the camera and the sniper's lens, to sight was to target, producing "a deadly harmony between the functions of the eye and the weapon" (69). As such, the modern conquest of space is synonymous with the conquest of the image; long before nuclearization, light and militarism were mutually constitutive (88). With this shift to the technologies of optical representation, the landscape of war has been increasingly understood as the visual media used to perpetuate and represent it.

That light media signify the modern landscape of war is especially relevant to the hyper-visibility of the nuclear tests in the Pacific. Hundreds of Hollywood photographers and film makers were hired by the US military during the Cold War to produce a spectral aesthetics of violence, a photographic and cinematic archive of the wars of light distributed by media such as *Life* magazine. These military films are now ubiquitous on the internet.¹¹ For instance, Operation Crossroads at Bikini Atoll (1946) has been claimed as "the most photographed event in history," recorded by 1,500,000 feet of motion picture film (18 tons) (*Radio Bikini*, Jungk 279) and over one million still pictures.¹² In the words of one military film, "one of the most important and dramatic elements in the dropping of the bomb is the photographic element" (*Radio Bikini*). Displaced Bikinians were given photographs of the explosions that irradiated their home (Weisgall 207). The exchange of ancestral land for a photograph of its irradiation, for an image of the violence of light, is a poignant indicator of the way in which visual media were used to frame the costs of militarism. The US military produced postcards of nuclear explosions as keepsakes for their soldiers, many of whom, like the Marshall Islanders, were already carrying mementos of light in the form of radioactive strontium, carbon, and iodine. This connection between nuclear radiation and photography is close and historic; participants in the tests were required to wear film badges that would fog when "safe" radiation levels were exceeded, replicating the behavior of the nineteenth-century photographic plates that led to the discovery of radioactivity itself. Of course, not all visual media of the nuclear tests were intentional—as the Odums and others discovered, so irradiated was the marine life in Bikini Atoll that the fish produced auto-radiographs; impressing their own images onto photographic plates (Boyer 92).

Paradoxically, this hyper-visibility of nuclear weapons testing has aversive effects. The discourse of tropical "militourism," the mutual constitution of the tourist and military industries, as Teresia Teaiwa has shown ("Reading" 249), renders one island as a substitute for any other, suppressing the historical depth and geographic breadth of the militarization of the Pacific. This hyper-visibility of nuclear detonations has also rendered their structural cause and effects invisible, making it exceedingly difficult to apprehend the extent of the transnational military-industrial complex and the irradiation of the planet.¹³ Yet the US nuclear arsenal represents one of the largest industries in history, producing over 70,000 nuclear weapons and detonating over 1,000 in the US and Pacific (O'Neill 33). Yet even those attuned to the complexity of light have rendered Cold War nuclearism and irradiation as "fabulously textual" (Derrida, "No Apocalypse" 23), an imagined apocalyptic future or an event localized to Hiroshima and Nagasaki rather than a historical, global, and ongoing presence.

In his heliographic novel *Ocean Roads*, George engages with the ways in which the wars of light inscribe history, the environment, and the human body. Defining radiation in its broadest terms—as the energy of the sun, visible earthly light, and the invisible trace of global nuclearization—the novel traces out its own radiation ecologies, restructuring the linear narrative form of the novel into one informed, ruptured, and illuminated by the presence of light. Accordingly, each of his characters engages light through different methodologies: physics, war photography, sniper fire, cinema, and radiation therapy. The title of George's complex novel refers to the watery Maori afterlife as a posthuman alternative to the excess illumination of the irradiated earth, a space he depicts as scorched almost beyond recognition in the atomic bombings of Trinity, Hiroshima, Nagasaki, Bikini Atoll, and in the napalm-incinerated villages of Vietnam. The novel remaps the light wars of the Pacific as an American military frontier of "radioactive colonization" (Churchill 239) that stretches from the nuclear landscapes of New Mexico across the irradiated Pacific Islands to post-atomic Japan, extending southwards into Aotearoa/New Zealand and finally into the frigid deserts of Antarctica, where "the only green for a couple of thousand miles is that of military fatigues" (*Ocean* 65). The novel depicts the war-torn lives of one New Zealand family from 1945, the advent of the Nuclear Age, to 1989, the declared end of the Cold War, drawing upon the figures of the sun, radiation, heat, photography, and light to explore their constitution of a heliocentric global modernity and an irradiated environment.

George's novel renders the ecologies of light as constitutive of human relations and the environment, from the legacies of militarized radiation to war photography. In his work on photography, Ernst Jünger critiqued its construction of a "second consciousness" (207), an instrumentalism that Adorno and Horkheimer would later attribute to Enlightenment rationalism and its domination of nature. Jünger observed that the script of light—heliography—dominated the transmission of knowledge. The first World War "was the first major occurrence to be recorded in this way, and since then there has been no significant event that has not been captured with the artificial eye" (qtd. in Werneburg and Phillips 52–53).¹⁴ This relationship between light, war, history, and the photographic (or cinematic) image is integral to George's novel. For instance, his character Isaac Simeon is born on the eve of Armistice Day, a product of World War I and its visual economies. Isaac is a self-described "disciple of physics. . . . Of light" (*Ocean* 61) who, over the course of his heliocentric professional life, disobeys his father's orders not to "look into the sun" (73). As one of many Jewish physicists to flee Europe during the subsequent war, Isaac joins the Manhattan Project to develop a plutonium core

atomic bomb, defining himself as a "scientist . . . not a soldier" (151) until he has a mental breakdown in Antarctica, a place of "endless twilight" (336) that catalyzes his realization that he has been complicit in the military irradiation of the planet. Isaac's association with light is a repeated motif in the novel, from the solar figures he draws in the soil (248), to his military-issue Zippo lighter (150), to his love of American silent films (16), to the depopulated desert landscapes that he creates with militarized technologies of light (176).

As Virilio explains in *The Vision Machine*, the rise of heliocentric photography in the nineteenth century radically changed the human experience of light, radiation, and energy. "With the birth of this latter-day sun worship, objects and solid bodies were eclipsed as the central subject of systems of representation by the plenitude of a certain energy, and the role and properties of this energy would never stop being demonstrated and developed from that moment on" (20).¹⁵ Thus light and the manipulation of radiation are a central thematic of modernity, from the technologies of nuclearization which created a new global era, the atomic age, to the reels of Charlie Chaplin and Buster Keaton films that Isaac brings with him when he relocates to Aotearoa/New Zealand after the war. As such, Isaac's description as a "disciple of light" invokes the modern shift from the materiality of "solid bodies" toward a secular "latter day sun worship" that is deeply abstracted from place.

In inscribing the life of a nuclear scientist, George structures his heliographic novel around the contradictory qualities of light in quantum physics. Light itself is profoundly paradoxical; it is associated with both totalitarianism and engagement with alterity, with knowledge and its destruction, with the visible and the invisible.¹⁶ The discovery that light is both a particle and a wave changed the (meta) physics of the twentieth century and our understandings of nature. To explain this paradox, Niels Bohr (in dialogue with Werner Heisenberg) applied the concept of complementarity, describing radiation as corpuscular and undular, which cannot be observed simultaneously.¹⁷ This quantum uncertainty in the measurement and description of subatomic phenomena shook a cornerstone in the observational realism of empirical science that had relied on the mimetic truth conducted via the lenses of the microscope, the telescope, the camera, and the human eye, and positioned light as knowable *and* a figure of alterity. This metaphor of light's complementarity is structurally integral to *Ocean Roads*, weaving both classical and subatomic experiences of light into a larger ecology of radiation.

Foregrounding the "trace" of radiation in the human lives of his characters, George's emphasis on light's complementarity suggests a continuity (wave) and a rupture (particle) of historical narrative.

Often staged on the New Zealand seashore, the novel persistently contrasts the spaces of sand and sea (particle and wave) at the family's Rangimoana beach cottage. The contrast between hot and cold forms of nuclear fusion are major points of discussion between Isaac and his son Caleb, which are structurally mirrored in the heated landscapes of nuclear detonation sites and in the frigid deserts of militarized Antarctica. Light, heat, photography, and radiation are also constitutive of his character's lives, demonstrating the broad ecologies of heliography. Isaac's relation to light is complemented by Etta Henare, whose penchant for "photographing human beings . . . in inhuman moments" (*Ocean* 295) of the wars of light contrasts with Isaac's mathematical rendering of the abstract and invisible world on his blackboards (172). On his weekend breaks from teaching physics at Auckland University, the heliocentric Isaac commutes to Etta's seaside home and brings "the Friday dusk from the east with him," and "blink[s] into the rising sun as he returns each Monday morning" (165). Over the course of their relationship, "she teaches him about how to capture the light in a lens, and he teaches her what the light is composed of, like a musical score" (173).

Ecologies of light are structural to the events of the novel and specifically link modernity, radiation, and US global militarization. Isaac discovers that Etta has been interpellated by her neighbors as a "Hori floozy" (151), a denigrating term for Maori women and the only direct reference to her ethnicity in the novel. This is due to the child named Troy (a war baby like Isaac) that Etta had with Private Joaquin Alvarez, a US soldier of Mexican descent who was briefly stationed in Aotearoa/New Zealand before losing his life in the 1944 battle against the Japanese at Tinian. Joaquin is a "sharpshooter" (102), an Apollonian figure with great "distance in his eyes" (110) who gives Etta her first camera. Connected by the ecologies of light, vision and war, Joaquin is from a New Mexican ranch close to the Trinity site where Isaac has been working on the plutonium core bomb.¹⁸ Moreover, Joaquin dies on a "coral runway" (121) at Tinian, the island best known for the launch of the *Enola Gay* and *Bock's Car*, the B-29s that brought "Little Boy" and "Fat Man" to devastate Hiroshima and Nagasaki. As he later informs Etta, Isaac helped construct "Fat Man" at Tinian, highlighting the ways in which the wars of light permeate the most distant spaces of the Pacific, a radiation ecology that ultimately determines the tragic genealogy of Etta's two sons.

This legacy of light and how it connects disparate peoples and spaces is a key concern in the novel, particularly in the way radiation and its myriad forms produce history, memory, and space. Inscribe radiation ecologies in terms of the metaphor of complementarity and paradox, the novel's heliographic relation between Isaac and Etta is

regenerated in their sons, the itinerant Vietnam War sniper Troy and his stepbrother Caleb, an antiwar activist and student of physics like his father. Although they have little contact with each other, the brothers reflect a dense pairing of light and water, civic duty and violence. When Troy returns to New Zealand from a napalm-scorched Vietnam he becomes a fireman, turning in his gun to "shoot" his hose in "fighting" the napalm-accelerated fires that his brother Caleb has been lighting in Auckland to protest the war. The brothers are alternately paired and contrasted with Akiko Io, a survivor of the Nagasaki *pika*, or flash, who teaches dance at Auckland University and participates in antiwar protests. Akiko is another child of the wars of light, born on the day of the detonation of "Fat Man" in Nagasaki and the only one who carries visible scars from these wars due to her childhood surgeries. Her first name might be translated as "child of light," while her last name, Io, may be derived from the moon of Pluto (a planet that inspired the name for plutonium), whose discovery ultimately enabled the measurement of the speed of light. Isaac's participation in the Manhattan Project entailed designing the plutonium-core weapons that were detonated at Trinity and Nagasaki; plutonium-239, with a half-life of 24,000 years, is marked as an embodied legacy of our modern radiation ecologies. *Ocean Roads* inscribes these three younger characters as carrying the metaphysical and corporeal legacies of militarized radiation, casualties of the wars of light.

While light has multiple forms, we know from Einstein that it is universally tied to motion and therefore time. While the speed of light is constant, our experience of light and space-time are not. In the novel Etta's sons, both in love with Akiko, are repeatedly associated with the thought experiment derived from Einstein's Theory of Special Relativity, the "Twin's Paradox," in which one sibling travels outside the orbit of the earth while the other remains at home, demonstrating in their subsequent age differences that variation in velocity means that "time is not constant for everyone" (*Ocean* 27). "A Twin's Paradox" is the title of one of the chapters and is repeatedly referenced in the novel, whether the brothers are measuring their distance in travel by space ship, train, commercial airplane, military helicopter, Isaac's 1947 Indian Chief Custom motorcycle, or Troy's 1955 Chevrolet Bel Air, the many modern vehicles of mobility that constitute a significant part of the text and emphasize the family's rootlessness. The Twin's Paradox and these machines of mobility are directly connected to the ways in which we measure time through light and light's association with velocity, as Virilio's *Vision Machine* explains. The mobility of the wars of light is symbolized in the displaced character Troy and his peripatetic mother Etta, who is associated with the capture of light in her war photography. Although they are mother/son, these

characters are rarely depicted in simultaneous time and place, suggesting a rupture in the family ecology arising from the legacy of militarized radiation.

Light has complex attributes and forms; it is energy, electricity, heat, motion, and our medium of visual perception. But light has a uniquely complicated relation to time; the perpetual movement of light means that it is a time traveler. Physically speaking, what we receive through our visual senses represents the past by the time it reaches our retina, whether we speak of the microseconds it takes for these words on the page to appear or the years it takes for extraterrestrial light to reach our planet. With Einstein's Theory of Special Relativity, the speed of light became the only universal absolute, which destabilized classical understandings of time and space and, by extension, the environment. As such, the only medium for rendering history in space and time became radiation and light. We can see the relation between time and light in different disciplines: physicists use the speed of light to locate coordinates in space-time, geographers use radioactive carbon dating to measure the age of the planet, and astronomers measure cosmic background radiation as the echo of the big bang, essential to the dating of our universe. As such, we might say that cosmic and militarized radiation are signs of our own planetarity, a sign of history that exceeds our capacity for measurement and perception. Read through the trope of radiation, planetarity is the recognition of our simultaneous continuity and discontinuity with light, the necessarily partial illumination of our enlightenment.

This complicated relationship between radiation, time, and the ecology of war is explored in *Ocean Roads* through heliographic instruments that are essential to modernity. This includes print media such as *Life* magazine (Etta's employer), the photographs that circulate between characters and across time (especially Etta's wartime images), and televised news events, such as the fire report that leads Akiko to Troy, as well as the televised moon landing that Etta watches from Vietnam. How these technologies of heliography inscribe history is one that troubles the novel, particularly when we consider how photography may confound rather than uphold historical context. As early as 1927, Siegfried Kracauer noted the flattening of time and space caused by the rise in photographic magazines:

the flood of photos sweeps away the dams of memory. Never before has a period known so little about itself. In the hands of the ruling society, the invention of illustrated magazines is one of the most powerful means of organizing a strike against understanding. . . . The *contiguity* of these images systematically excludes their contextual framework available to consciousness. The "image-idea" drives away

the idea; the blizzard of photographs betrays an indifference toward what the things mean. (432)

Building upon Kracauer's work, Susan Sontag has called for an "ecology of images" that would correct this relationship between time, the image, and the real. "Just because (images) are an unlimited resource, one that cannot be exhausted by consumerist waste, there is all the more reason to apply the conservationist remedy. If there can be a better way for the real world to include the one of images, it will require an ecology not only of real things but of images as well" ("On Photography" 180).¹⁹ Although she later abandoned this hope because there are no "guardians" to conserve the visual onslaught of war images or the lives that are represented ("Looking at War" 97), this question about the distribution and consumption of images, forms of light, and radiation are a key concern to *Ocean Roads*.

Kracauer's critique of the knowledge-production of visual economies is particularly relevant when we consider George's character Etta, a figure we see little of in terms of textual presence because she is always behind the camera, yet her professional mobility and her photographs catalyze events and structure the narrative time of the novel. The heliography of *Ocean Roads* is non-chronological, signaling a narrative shift away from linear historicism and highlighting how the ecologies of light trigger both continuity and discontinuity in time and memory.²⁰ Given George's concern with the visual and subvisual manifestations of radiation and their impact on human memorialization, it's not surprising that the novel opens with Etta at the Trinity detonation site in 1989, at the end of the Cold War, commissioned by a photographic magazine to memorialize the space-time of the planet's first nuclear detonation. In this chapter entitled "Sand," Etta is persistently behind the lens of her camera, "shooting" the Trinity landscape even if it is primarily "dust" (4) (the literal product of nuclear explosions), "grains" (5) (the residue of history), and "sand" (7) (a figure for the movement of light as particle). The Trinity Obelisk is central to this chapter, a monument engraved with the historical starting point of the novel, July 16, 1945, and a subject of Etta's photographs. As Denis Cosgrove has observed, "the obelisk was not only a cosmographic instrument whose shadow located time and latitude; its very form denoted a beam of light" that signified divine illumination; for Christians, this divine light derived from the Holy Trinity (159–60).²¹

Conscious of how solar metaphors of the atomic bomb adopt divine rhetoric to mystify the constitutive relationship between militarism, science, and nationalism, George explores the entanglement between light and modernity through the secular temporality of photography. This is signified by Etta's camera with its terminal

"Click." (5), which stops the narrative and captures what Walter Benjamin might refer to as the "now-time" of her visit to Trinity and many other scenes.²² This time-stopping "Click." resists the naturalizing flow of narrative and calls attention to the media of historical transmission. Moreover, its signification as a moment of simultaneous continuity and discontinuity with otherness—the otherness of history, narrative, nature, and radiation—invokes the paradox of light as an absent presence and an engagement with the alterity of planetarity. This radiation-mediated relationship to planetarity is very different from the way the antinuclear movement has adopted a homogenizing one-worldism, what Lisa Yoneyama calls a "nuclear universalism" (15) that reduces the complexity of the wars of light into a homogenous nationalist or spiritualist discourse of peace.²³ This "now-time," the "photographic temporality" in Eduardo Cadava's gloss of Walter Benjamin's concept of history (64), suggests an arrest in narrative that potentially opens up new insights into the past and is specifically engaged in de-figuring the figure of light.

In its capturing of light, we might say that Etta's time-stopping "Click." offers a caesura to universal linear narrative.²⁴ In fact, George's protagonist in an earlier war novel describes the photograph as "a moment with no before and no after" (*Hummingbird* 70). Yet *Ocean Roads* represents an effort to engage multiple temporalities of light including the arrest of time articulated by Benjamin, as well as the visual contiguity theorized by Kracauer. Other temporalities of light explored by the novel include the *longue durée* of the irradiated earth, evident in the radioactive trinitite Etta observes at the Trinity site, and the impact of light on personal and political narrative. Of course, the ultimate but unseen symbol of light, time, and photography is the Trinity explosion itself. Richard Rhodes and Virilio have commented on the ways in which a nuclear explosion functions like a camera, flashing an apocalyptic snapshot of a place in which only the shadows of presence, the remnants of light, remain.²⁵ This particular use of light to foreground the complexity of time has been noted by Akira Mizuta Lippit, who demonstrates that weapons of light such as "the X-ray, photographic media, and the atomic weapon circulate in a specular economy, bound—as are all *photographic* events—by the logic of anniversaries. By capturing single moments in time, all photographs suggest future anniversaries" as an archive of the moment and the future (48). The spectral logic of anniversaries and their relationship to the archive is crucial to understanding the structure of George's novel and its destabilization of linear models of time. The opening of the novel positions the 64-year old Etta at the Trinity site at the 50th anniversary of the start of World War II; her decision to return to Aotearoa/New Zealand after visiting Trinity and Pearl Harbor

catalyzes the current temporality and events of the novel. The current time of the novel takes place in April and May 1989, tracking Etta's movement between these two major sites of military tourism and then to her home to meet with the curators at the Auckland Museum, a military monument and cenotaph, to coordinate a retrospective exhibit of her photographs. The rest of the novel occurs through flashbacks to particular events such as August 1945, when she photographs VJ Day celebrations; April 1975, when she photographs the withdrawal of American troops from Vietnam; and July 1969, when she takes a Pulitzer-prize winning photograph of her son Troy, whom she discovers in a river attempting to save the lives of two Vietnamese children from a napalm attack. This "triangle of blackened faces" she refers to as "an unholy trinity" (*Ocean* 95), a dystopian familial counter to the divine national signification of the Trinity Obelisk. The publication of this photograph alienates her from her younger son Caleb, whose primary experience of his travelling mother is through her photography in visual magazines such as *Time* and *Life* (36). Yet Caleb is not a naïve reader of the sort Kracauer imaged; although he has been alienated from his maternal origin (history), the photograph of the "unholy trinity" catalyzes his violent antiwar activism. Moreover, the picture of this "unholy trinity" circulates in the novel between characters, generates Troy's flashbacks to the war, is narrated from multiple perspectives, and structures the action and temporality of the novel. After a lifetime of work hoping that "every photo she has had published has scrubbed one day off the war. Off all wars" (342), Etta ultimately engages a Sontagian "ecology of images" and refuses to display this Pulitzer prize-winning photograph in the war museum's archive of military light (298). The visual collapse signified by this picture between the soldiers she photographs and her own sons' participation in war suggests an inescapable familial inheritance of the wars of light.

Radiant and Irradiated Species

Militarism has catalyzed a radical change in our ecology of images, but nuclearization has deconstructed the boundary between the visible and invisible. In fact, the hyper-visibility of an atomic explosion renders visible the otherwise subvisible splitting of atoms. Lippit has argued that "since 1945, the destruction of visual order by the atomic light and force" (4) has created an "A-visibility" from the legacy of the A-bomb (81). This is reflected in scenes of the novel in which characters are repeatedly described as blinded by flashes from the Trinity test (Isaac), napalm explosions (Troy), and the Nagasaki *pika* (Akiko). This post-atomic shift in visual logic, Lippit argues, has

led Japanese artists to explore the "total penetration of the body by light" as an "A-visual" archive (120). Thus, "the archive is inscribed on the surface of the body to render it invisible" (119). In a novel deeply concerned with modes of heliography—the writing of light through nuclearism, photography, cinema, and physics—*Ocean Roads* turns in its conclusion to how these ecologies of light are written in the body, and how the human body registers the inheritance of the alterity of the irradiation of the earth.

George's novel draws extensively from historical accounts of the creation of the atomic bomb, but he makes an important change in his depiction of Isaac watching the Trinity explosion in the New Mexico desert. While first-hand accounts report that Enrico Fermi threw up pieces of paper above his head to measure the wave of the blast (Rhodes 674), Isaac chooses "fragments of desiccated bone" (*Ocean* 248), the corporeal trace of previous inhabitants of the Jornada del Muerto desert. In the same section, the novel connects this scientific excursion into the desert to witness the dawn of the nuclear era with the Spanish colonization of Americas, both masculine conquests of indigenous landscapes under the banner of divine light that suggest a long history of radioactive colonization. The shift from paper to bone is important because bone is a vital symbol of the legacy of human history; it connects us to the earth and histories of place through burial, and in Maori contexts it is the symbol for tribal identity, or *iwi*. Twenty-five years after the Trinity test, Isaac's son Caleb feels "a shuddering in his bones" (200) and his oncologist informs him that he has "'too many immature lymphocytes, lymphoblasts, sometimes called *blast cells*. They fill up the bone marrow'" (268; emphasis added). This is a particularly violent form of cancer, one associated with the radiation exposure of the *hibakusha* or nuclear survivors of Japan.²⁶ This form of leukemia, a disease of blood and bone, is a genealogical and historical inheritance from his father and a legacy of what Catherine Caufield terms the "industrial radiation age" (200). Previously, Troy traveled through the Jornada del Muerto, the landscape of Isaac's work on the Trinity explosion, and observed that the (plutonium) "bomb was in his stepfather's blood" (*Ocean* 121). Plutonium -239, the by-product of nuclear weapons, is a "bone-seeker" (Weisgall 238). In a novel that uses the genealogy of radiation as a model for history, Caleb now inherits a disease of modernity, "acute lymphoblastic leukaemia," described as "spiked wheels turning in his bones" (*Ocean* 305). After one of his many visits to the oncologist, Caleb raises his face "to the stark sun, imagining it highlighting his dying bones" (306) like those in the Jornada del Muerto, the originary sacrificial space of the Nuclear Age.

The militarization of light has been widely acknowledged as a historical rupture that brought into being a continuous Nuclear Age,

but less understood is the way in which our bodies are written by these wars of light. Eileen Welsome notes that nuclearization "split the world into 'preatomic' and 'postatomic species'" (299). After seven decades of nuclear tests, radioactive isotopes of carbon, cesium, strontium, and plutonium have been absorbed by all post-war humans on the planet (489). The amount of militarized radioactive carbon in our teeth is now one of the most efficient forensic tools to date human remains ("Forensics" 333). This is a different "nuclear universalism" than Yoneyama observes in the post-war script of Japanese nationalism, one not found in the "panhuman eschatology" of a hyper-visual nuclear apocalypse (15), but rather in an invisible and ephemeral trace of what Rob Nixon has called "slow violence" (14), the non-apocalyptic threats to our survival such as depleted uranium weapons and the toxic ecologies that Carson brought to public consciousness. Radioactive fallout presents us with the most invisible yet pernicious form of the wars of light, one directly tied to the transformation of the human body and a sign of our merger with the alterity of our planetary environment.

We are, to borrow from Daniel Tiffany, a "radiant species," a phrase coined by Roger Bacon whose work on celestial bodies and optics produced an influential vocabulary of "visual species" in the Enlightenment (Tiffany 202). Technologies of light such as the telescope, the microscope, the X-ray, and the photograph have been understood as constitutive of modernity, lending a new penetrative gaze—and ocular grammar—to the production of knowledge. Thus Isaac Newton's work with the new technologies of the microscope led him to argue that "the changing of Bodies into Light, and Light into Bodies, is very conformable to the course of Nature, which seems delighted with Transmutations" (qtd. in Tiffany 199). Light is profoundly transformative of our bodily ecologies; the irradiation of tissue continues after the body's death (Caufield 53). Although as readers we are initially led to believe that Akiko of all characters will inherit radiation sickness from her exposure to the Nagasaki *pika*, Caleb, the most sedentary of George's characters, whose ambit is limited to the greater Auckland area, is chosen by the author to signal the legacy of militarized radiation and its transmutation of the human body. As Yoneyama remarks, radiation "trespasses over geographical borders and temporal limits . . . no existing borders—whether national, cultural, ideological and political—can ensure immunity" (15). The military irradiation of the earth is more than a symptom of globalization; George's novel helps us recognize the signs of planetarity, an apprehension that refuses to naturalize the military transmutation of light.

In his experience of both cancer and radiation treatments, Caleb describes his body in planetary terms, an internalization of light in which his body is "rendered uncanny, unhomey . . . a defamiliarization of familiar space" (Spivak, *Death* 77). When Caleb's oncologist recommends radiotherapy, the use of "high energy rays to destroy the cancer cells" (*Ocean* 269), Caleb laughs at the irony and writes "a single word . . . over and over . . . Radiation" (277). Cancer is often understood as a disease of modernity, metaphorically linked to the inability to limit consumption (Sontag, *Illness* 59–61) and violence in industrial society (87). The radiotherapy advised by Caleb's oncologist is part of a tradition Sontag has likened to the militarization of disease treatment, the "battle" against cancer, noting that early chemotherapy was derived from chemical warfare in World War II (65). Caleb's transformation from a human body to what I term metallic modernity has already been foreshadowed in earlier scenes in which he dresses as the Tin Man from *The Wizard of Oz* for children's parties, a character understood to represent the industrialization of labor and, as a former woodsman who has turned into metal, a critique of the commodification of human labor and its alienation from nature. At the oncologist's, Caleb undergoes "the clicking and whirring of the machines" and imagines "sunlit doorways," where "sometimes the sun is so hot that it starts the tall grass burning" (*Ocean* 274). When the "blast cells" return, Caleb refuses to "accede to radiology" and this space of total illumination where he would "spend his last days amid the metallic whirl of electric motors and gauges and scopes" (312). Shifting away from radiotherapy to another mode of heliography, he invokes the "unholy trinity" that inspired his antiwar activism, his "binding commitment" to his brother's face "on the magazine cover" with the Vietnamese children (312) and determines to immolate himself at an Armistice Day peace rally.

Lawrence Buell has argued that "apocalypse is the single most powerful master metaphor that the contemporary environmental imagination has at its disposal" (285). In a novel about nuclearization and the wars of light, George shifts attention from the often blinding (and totalizing) apocalyptic focus of a nuclear "war of the worlds" to addresses less visible forms of the wars of light, including the movement of radiation across space, time, and our bodies.²⁷ Caleb's activist friends demand spectacular visibility. Heeding their antiwar strategy "to be more visible" (261), Caleb attends the 1970 Armistice Day Peace Rally, held on Isaac's birthday and at the Auckland Domain where Etta will later display her archive of light. There Caleb douses himself with napalm-laced kerosene, and holding his father's Zippo lighter, delivers a speech against the global quest for total illumination (366). He echoes Virilio's critique: "nothing is sacred any more

because nothing is now meant to be inviolable. This is the tracking down of darkness, the tragedy brought about by an exaggerated love of light" (*Vision* 35). The scene is narrated cinematically, with cross cuts between Akiko (a peace rally dancer), Troy (a fireman), and the suicidal Caleb. When Caleb's actions endanger Akiko, he is shot dead by his sniper-brother Troy, triggering the kerosene fire and Caleb's immolation in napalm. In turn, Troy hallucinates the return of a Vietnamese POW he had freed; when he shoots at this ghost and the war museum he is killed by the police. In a novel about forty years of wars of light, George eschews the representation of nuclear apocalypse. He instead depicts an apocalyptic scene of fratricide, the only humanized and detailed narration of murder in a four-hundred-page novel about the Cold War and its inscription by light.

From the Wars of Light to Ocean Roads

George's shift from the transnational violence of the wars of light to the murders of Troy and Caleb refocuses our attention from excess global visibility to local familial legacies and the war's suppression of its indigenous others. The trace of indigeneity is rendered visible in a child's fingerprint Isaac finds in the ancient forged clay vessel in the *Jornada del Muerto* (and the novel's larger inscription of the expansion of the American frontier), the ancient rock paintings found by Troy in the Vietnamese jungle, and the short but significant scenes in which Troy and Caleb's family heritage is tied to Maori history. Although we know little of Etta's background, we are told that she is from Hokianga, a name translated as "the returning place" (104) of Kupe, the Pacific voyager who discovered Aotearoa and facilitated the earliest Maori settlement. Troy's hallucination of the return of the Vietnamese POW invokes the only spoken Maori language in the text, which Troy translates as, "'Friend, we shall fight on forever and ever and ever'" (229). These words are the famous lines attributed to Rewi Maniapoto in his resistance to the Pakeha (British settler) invasion of the Waikato in April 1864 during the New Zealand Wars. Although never explained in the text, the April 1989 setting of the novel is the 125th anniversary of this event in the violent establishment of Aotearoa/New Zealand through the musket wars, an earlier, invisible war of light that foreshadows American Cold War expansion into the Pacific.

The site of Troy's and Caleb's deaths, the Auckland Domain, is the city's largest public park and the location of the Auckland War Museum where Etta will eventually display her archive of wars of light. The volcanic crater that dominates the landscape of the Domain, Pukekawa (bitter hill), represents a monument to Maori presence

in the region and is significant to the pan-tribal wars between two Maori tribes, Ngati Whatua and the *iwi* of George, Nga Puhī. George's decision to relocate the 1970s war protests, which took place at American Embassies, to the space of New Zealand nation-building on Armistice Day foregrounds the long history of national violence in the construction of indigenous and settler peoples. As such, the space of this fraternal sacrifice opens up the wars of light to its predecessors in the musket wars and the settlement of the nation, a frontier history with close connections to American expansion into the West. In fact the New Zealand Wars were largely uncommemorated by the Auckland Museum, which did not expressly examine local history until as late as 1996.²⁸ It is only by condensing figures of the New Zealand Wars, World War I and II, the Cold War, and the Vietnam War into this violent scene of family apocalypse that the novel demonstrates the long temporal and spatial reach of the wars of light.

It is worth asking why a writer who has consistently depicted in his previous novels the complexities of historic and present-day Maori identity—characters visibly marked as indigenous in terms of moko (tattoos) and by the use of Maori language, history, and mythology—decides to alter the landscape of identity so radically in *Ocean Roads*. Remarkably, in this long novel, the markers of Maori identity and history are barely visible or appear in derogatory terms such as Etta's racial interpellation. I suggest that the overwhelming discourse of these wars of light has rendered such excess visibility that the foundational indigenous subtext must be sought in the shadows. George's novel demonstrates that the visual excess of total illumination blinds the characters, and by extension, the modern subject to indigenous history, creating a self-destructive rupture in the masculine indigenous subject.

How do these disciples recover from their love of light? The myriad forms of heliography explored in this novel—photography, literature, physics, cinema, and radiotherapy—suggest that modernity is constituted by this desire for excess illumination. But this desire is shown to be gendered—the author leaves it to his women characters to heal the scorched earth. Akiko, associated with the cooling rain to stop the fires as well as the redemptive power of art, bears a child associated with two fathers, Troy and Caleb, and in her pregnancy her belly is "round like the first half of a rising sun" (289), suggesting a recuperative relationship to the form of radiation and light. Her daughter, Rai, a name that the author explains means "trust" in Japanese (322) also suggests a healing "ray" of light as she becomes a medical student. When Etta returns to Aotearoa/New Zealand in 1989 at the end of the Cold War, Akiko continues to teach dance and perform pieces that transform the wars of light into art, she and Rai

are planting new seeds in their garden, and they are tending to the family history at the house in Rangimoana.

Ocean Roads upholds maternal love and reproduction as the antithesis to the excess illumination of modern science and technology, a gendered universal humanism Yoneyama has noted in the post-atomic nationalism of Japan (196). Moreover, this suggests that the duration of the maternal functions as a constitutive contrast to the violent cataclysmic time of wartime masculinity (Yoneyama 210). While we are expected to associate a redemptive rather than retributive future with Rai and Akiko, the novel also ends with an alternative in the indigenous concept of "ocean roads" or *ara moana*, a watery trajectory away from the excess illumination of the earth to Maori origins and afterlife. In their last motorcycle ride together, Etta fulfills her promise to Isaac to take him *Te Rerenga Wairua*, a place well known in Maori tradition as "the leaving place of spirits" (*Ocean* 166) at the northernmost tip of Aotearoa/New Zealand. They ride through "the breezes of decades, carrying small grains and dust and seed spores of memory . . . needing to run out of land" (382). Fittingly, Etta observes "the page of the immense book of ocean waves leading down onto the sand," at once a symbol of the novel's geography and the wave/particle duality of light. In a pact to "leave no trace but your pictures" (381), the couple reach the cliff over the ocean and narration is suspended. This leaving point of spirits is not an end, but rather a new beginning in indigenous cosmology, of navigating watery roads that are no longer illuminated by the world of light or *Te Ao Marama*. Etta "taps her helmet against Isaac's one last time" and we are left impressed with the image of their vehicle at the sea's edge, arrested in time by Etta's signature "Click." (383).

Notes

My thanks to Robert Marzec for his helpful editorial comments and Stewart Firth for his permission to use the nuclear Pacific map.

1. See Sontag, *On Photography* (88, 160) for her discussion of Henry Fox Talbot's term and his book *Pencil of Nature*.
2. On Cold War technologies and their impact on modernity, see Masco, as well as Virilio's *The Vision Machine* and *War and Cinema*. On the technologies of light in medicine, see Cartwright.
3. See Bernard Smith.
4. See Firth's *Nuclear Playground* and Firth and Von Strokirch's "A Nuclear Pacific."

5. See Derrida's "White Mythology," Levinas's *Totality and Infinity*, and the discussions in Levin's *Philosopher's Gaze* and Grandy's "The Otherness of Light."
6. See Boyer, Rosenthal, and Weart.
7. See Welsome, the Department of Energy's website devoted to declassifying the experiments, and Barker.
8. See Firth, Dibblin, and Barker on Pacific Islands; and Jungk, Boyer, and Jeff Smith on broader nuclearization.
9. Children who drank milk between the years 1955 and 1965 demonstrate higher levels of strontium-90 in their bones due to the atmospheric nuclear tests of that era (Stephenson and Weal 131).
10. In 1958 the US, UK, and USSR exploded nearly 100 nuclear weapons, leading to record levels of strontium-90 in American soil, wheat, and milk. Only later would an AEC officer admit that "civilized man would have been in trouble" if the atmospheric testing program had continued (Caufield 129).
11. See *Hollywood's Top Secret Film Studio* and sites such as at <http://www.vce.com/> and <http://nuclearweaponarchive.org>. One of George's sources, Richard Rhodes, argues that *Life* magazine's tabloid style and "brutal" visual "allegories" encouraged reciprocal violence rather than promoting anti-war sentiment (Rhodes 698–99).
12. See *Hollywood's Top Secret* and *Radio Bikini*. Accordingly, most popular films about nuclearization are about media itself.
13. On the invisibility of the tests, see Masco, Lippit (4, 81), and Teaiwa's "bikinis."
14. Also translated as "Photography and the 'Second Consciousness.'"
15. The implications of this heliocentrism are explored by Derrida in "White Mythology," and further pursued in my forthcoming article in *Postcolonial Ecologies: Literature and the Environment*.
16. See Derrida's "White Mythology," Levinas, Levin, and Grandy.
17. See Heisenberg (95, 209–10).
18. His name probably refers to Manhattan Project scientist Luis Alvarez. For more on this figure, see Rhodes.
19. See Ross for his discussion of Sontag (159–200).
20. See Armstrong.
21. The appropriation of divine discourse, likening the nuclear weapon to the presence of the sun on earth, has obfuscated the origin story of this first atomic bomb as an intentional, not divinely orchestrated, two-billion-dollar military project. On this mystification, see Rosenthal, Weart, and Jeff Smith.

22. See Benjamin "Theses on the Philosophy of History" in *Illuminations*.
23. My thanks to Kandice Chuh for referring me to Yoneyama's work and her feedback on this essay when it was first presented in 2007.
24. On caesura see Cadava (xx).
25. They seem to have reached this observation independently; see Rhodes (715) and Virilio's *War* (68).
26. George's acknowledgements cite Masamoto Nasu's *Children of the Paper Crane*, which documents the death of one young girl by this form of cancer.
27. For more on apocalypse and nuclear war, see Derrida's "No Apocalypse."
28. See the Museum's website: <http://www.aucklandmuseum.com/159/history-of-the-museum>.

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