

Liminal Ecologies in Margaret Atwood's *Oryx and Crake*

Discussing the end of 1984, Margaret Atwood “credits Orwell’s novel with grounds for ‘optimism’ that few readers would share” (Ingersoll 173). Earl G. Ingersoll interrogates Atwood’s unconventional argument that “Orwell is much more optimistic than people give him credit for . . . Most people think the book ends when Winston comes to love Big Brother. But it doesn’t. It ends with a note on Newspeak, which is written in the past tense, in standard English—which means that, at the time of writing the note, Newspeak is a thing of the past” (qtd. in Ingersoll 173). Similarly, *The Handmaid’s Tale* ends with a note that indicates Gilead no longer exists, and Ingersoll suggests that “the ending of *Oryx and Crake* may be contaminated with a similar ‘optimism’ for which readers may have difficulty finding any firm basis” (173). Seeking a firm basis for optimism in *Oryx and Crake* (2003) is indeed a difficult and dubious task when we consider that the novel has prompted a veritable flood of reviews and articles brimming with apocalyptic dread. Moreover, Atwood’s own numerous writings, website suggestions, and interviews appear to suggest prescribed approaches to *Oryx and Crake*. It’s as if the Children of Margaret have already marked the critical territory, limiting *Oryx and Crake* to a dystopian tradition of dark satire to be read as counterpart to *The Handmaid’s Tale*.¹ From an ecocritical perspective, however, one finds that despite the obvious apocalypse, Atwood’s novel offers new hope for humanity as well as other life forms. The ecological context of this novel reveals new growth in Atwood’s stressed arboretum.²

At its best, ecocriticism stirs readers to see forsaken lands such as Jimmy/Snowman’s³ “Great Emptiness” (Atwood 103) not merely as dead and waste

spaces, but as liminal zones that continue to adapt and grow—even in “zero hour” (3). To view these zones as liminal encourages the re-examination of human relationships to post-natural areas such as abandoned lots, defunct corporate enclaves, and even graveyards, because in liminality “the past is momentarily negated, suspended or abrogated, and the future has not yet begun” (qtd. in Spariosu 38). As isolated survivor of Crake’s bio-apocalypse, Jimmy/Snowman embodies the liminal as “ambiguous, neither here nor there, betwixt and between all fixed points of classification” (Turner, *Dramas* 232).⁴ The liminar, characterized by anthropologist Victor Turner as an unsightly outsider, seems an apt description of the Abominable Snowman in *Oryx and Crake*: “existing and not existing, flickering at the edges of blizzards, apelike man or manlike ape, stealthy, elusive, known only through rumors and through its backward-pointing footprints” (Atwood, *Oryx and Crake* 7-8). The Snowman’s “backward-pointing footprints” symbolize a crucial dilemma in a world all but bereft of human kind. “These mythic and multi-directional footprints,” Danette DiMarco explains, “represent Snowman’s liminal position and potential power—to repeat a past cycle of aggression against nature in the name of personal profit, or to re-imagine a way for future living grounded in a genuine concern for others” (170). As Jimmy/Snowman scrutinizes his own ecological footprint alongside Crake’s genetically modified life forms and various indigenous species, he now lacks the capacity to replicate the unsustainable methods of the past. Rather, his transformation provides speculative groundwork for a new convergence of humans and ecosystems. Like the liminal land itself, Jimmy/Snowman embodies the resilience and promise of places considered doomed.

The basis for hope in this novel is in *place*, but not because as one critic suggests, the “elimination of the human race also solves the environmental crisis in one stroke” (Dunning 95). Instead, a study of existent flora and fauna in the novel indicates some chance for the environmental reincorporation, reconciliation, and transcendence of what Turner deems “*communitas*.” In its representation of liminal life from a biocentric perspective, *Oryx and Crake* reminds us that place is always being born. Life emerges to confuse the dividing edge, adapting and multiplying to reconnect pieces that have been broken. It is that “unconscionable” connection, the gene splice, that enables Margaret Atwood’s *Oryx and Crake* to be read against the grain of critical responses that reduce the novel to a dystopian tale that cleanly represents the author’s supposed “political, social, and environmental concerns transformed into speculative fiction” (Howells, “Dystopian Visions” 161). The

term dystopian seems appropriate to label *Oryx and Crake* only in its most generic sense, for all Orwellian social, legal, and cultural apparatus has seemingly been eliminated by the novel's first chapter. Jimmy/Snowman's memories could be described as contextually dystopian as they are essentially set in the United States of the present using quasi-futuristic terminology—the “pleebland” is the depressed city and the “compound” is the gated community or corporate campus. On a speculative level, the memories of Jimmy/Snowman persist primarily to chronicle events that lead *Homo sapiens sapiens* to “zero hour,” a chronological pause between an unsustainable past and an uncertain future.

Reviews of *Oryx and Crake* foreground apocalyptic alarm with titles like “The End is Nigh” (*New Statesman*), “Grave New World” (*Ms.*), and “Bad News” (*Canadian Literature*). J. Brooks Bouson's “‘It's Game Over Forever’” parallels Atwood's comments about writing the novel with close readings of the text to censure aspects of Jimmy's “twenty-first century world that are meant to appal us as readers. Intent, in part, on instructing her readers, Atwood draws openly on the discourse of environmentalism as she emphasizes the effects of global warming on the future world” (142). In discussing the ambiguous ending of the novel, Bouson asks, “Are Snowman and the trio of survivors about to become the final human players in Crake's elaborate game of Extinctathon? Will it be ‘game over forever,’ as Crake predicted? Or is there some ray of hope that humanity will survive?” (153). Bouson's alternatives—“game over forever” or human survival—finally dismiss the complex viability of remaining flora and fauna that still thrive in the novel. This problem is symptomatic of recent Atwood criticism that uses anthropocentric theoretical paradigms to wrangle with environmental issues in her works. One representative example is “Re-Constructions of Reality in Margaret Atwood's Literature: A Constructionist Approach” where Klaus Peter Müller states that, “There is again nothing beyond that which human beings have constructed, the landscape is indeed the embodied mind. That is why there is a very strong emphasis in Atwood's work on the responsibility of human beings for their constructions of landscapes, cities, and environments” (246). This sort of critical disjuncture between ecological crisis and literary approaches that do not grant the ecological world any claim to “reality” seems a missed opportunity to scrutinize the environmental implications of Atwood's work. What these reviews and articles leave undone in their heralding of generic ecological dismay is the application of biocentric models to this literary exploration of future ecosystems and effects.

Let's entertain the notion that this novel's central focus is not the end of humanity, but the fate of all life. In the beginning of the novel the only person apparently left alive is Jimmy/Snowman, so readers are left to center not on precipitating events or social injustice as in *The Handmaid's Tale*, but on "the tide coming in, wave after wave sloshing over the various barricades" and the "shrieks of birds" that nest on abandoned offshore towers, with the "distant ocean grinding against the ersatz reefs of rusted car parts and jumbled bricks and assorted rubble" (*Oryx and Crake* 3). Two telling images resonate: tidal waters that submerge synthetic barriers, eroding them to particulate matter and seabirds that prevail on man-made platforms. After looking at his broken watch, Jimmy/Snowman scratches bug bites then "scans the ground for wildlife: all quiet, no scales and tails. Left hand, right foot, right hand, left foot, he makes his way down from the tree" (4). In this first passage Jimmy/Snowman's interactions include flicking a spider, urinating on grasshoppers, and rubbing ants off a mango. It's clear that Jimmy/Snowman's relationship to place and environment, his range of vision, has drastically changed. He is now a niche within an ecosystem concerned with predators and sustenance, his primary concerns not social but ecological.

Readings of this novel have been species-limited in their response to "a world where everything has become altered almost beyond recognition by global warming and genetic engineering" (Howells, "*Oryx and Crake*" 170), leaving the biological diversity of *Oryx and Crake* unnoticed. But in "Margaret Atwood, the Land, and Ecology," published three years before *Oryx and Crake*, Ronald B. Hatch recognizes that "Atwood has something in common with recent ecocentrist writers in her rejection of the anthropomorphic viewpoint and their struggles to re-position humanity as one species among many in a web of natural connections" (181). This re-positioning can be seen in Jimmy/Snowman's relationship to birds and plant life in the post-natural city he inhabits. He observes:

Several of the buildings once held roof gardens, and now they're top-heavy with overgrown shrubbery. Hundreds of birds streaming across the sky towards them, roostward bound. Ibis? Herons? The black ones are cormorants, he knows that for sure. They settle down into the darkening foliage, croaking and squabbling. If he ever needs guano he'll know where to find it. (Atwood 95)

Buildings that once meant commerce and the towering superiority of the human species now mean fertilizer for Jimmy/Snowman, indicating that his perspective has now broadened to considerations of not only bird species but also gardening. He later notices when a "long scrawl of birds unwinds from

the empty towers—gulls, egrets, herons, heading off to fish along the shore . . . a salt marsh is forming on a one-time landfill dotted with semi-flooded townhouses. That's where all the birds are going: minnow city" (148). In these passages, the novel "pursues the theme of nature's very slow but very certain power to self-renew" (Hengen 77) by returning abandoned rooftops, landfills, and townhouses to a transformed but very real "web of natural connections." In "the former park", Jimmy/Snowman observes, "the botany is thrusting itself through every crack" (221) and that it "won't be long before all visible traces of human habitation will be gone" (221-222). This permutation, like the urban influx of bird life, indicates a resilience and increased adaptive capacity of plant and animal species.⁵ Even Jimmy/Snowman's written report on the catastrophe is subject to the persistence of life, as language itself is swallowed: "It's the fate of these words to be eaten by beetles" (347). In one shattered corporate utopia, the RejoovenEsence compound, Jimmy/Snowman notes:

Already the weeds are thick along the curbs. The street is circular; in the island in the middle, a clutch of shrubs, unpruned and scraggly, flares with red and purple flowers. Some exotic splice: in a few years they will be overwhelmed. Or else they will spread, make inroads, choke out the native plants. Who can tell which? The whole world is now one vast uncontrolled experiment—the way it always was, Crake would have said—and the doctrine of unintended consequences is in full spate. (228)

Obviously, this meditation on biota and non-indigenous species is in no way speculative or futuristic; one can see this process in any abandoned homestead where invasive plants have been abandoned to disturb biotic communities. Over time, species competition and adaptation will determine to what extent native and exotic species flourish, and in *Oryx and Crake* such moments are wrought with possibility as well as dread. The "uncontrolled experiment" of this landscape might well include "unintended consequences" that enable life to flourish in the interstitial zones left by a virtually extinct humanity.

At zero hour, Jimmy/Snowman holds out hope that this space has the potential to reach a steady state with high level of diversity for indigenous species. Zero, then, is not an absence without value, but rather a crucial point in biological time. Jimmy/Snowman's interactions with indigenous species also include a telling moment with a caterpillar "letting itself down on a thread" (41). The lepidopteran is "luscious, unreal green, like a gumdrop covered with tiny bright hairs"; it pauses, "smelling him, picking up on his chemical aura" (41). After noting that there "will be another such moment of

time, another such conjunction” (41), Jimmy/Snowman says to the caterpillar “[w]e have hard work to do, and loads to lift” (41). Even though Jimmy/Snowman second-guesses himself after his caterpillar-induced “inexplicable surge of tenderness and joy” (41), the metaphor nonetheless rings true. The caterpillar not only thrives at the end of time, but it also will “work” with Jimmy/Snowman to continue to foster a more sustainable and diverse bio-region. Like Jimmy/Snowman, the caterpillar is in a liminal stage between larva and moth or butterfly. The developmental transition of the caterpillar represents not only Jimmy/Snowman’s transformation, but the fragile mutability of indigenous species observed in the natural world.

Crake, on the other hand, has abandoned altogether the differentiation between binary constructions such as native/exotic, indigenous/non-indigenous, and real/fake. Crake’s “scientifically advanced world no longer relies upon such oppositional logic. Within his environment, the lines that separate the natural from the artificial are no longer necessary or visible” (Davis 89). As a scientist who both promotes rampant genetic modification for corporate interests and the deviously genocidal BlyssPlus pill, Crake seems to serve readily as corporate foil spliced together from H.G. Wells’ *The Island of Dr. Moreau* and Mary Shelley’s *Frankenstein*. DiMarco argues that “a product of a profit-driven world who mirrors its economy of self-interest, Crake emerges as the quintessential *homo faber*, making it unlikely that any kind of positive social change will happen through him” (170); Crake’s “scientific intelligence . . . positions him as a member of an elite class that values instrumental production only as it is linked with personal gain” (171). Ingersoll supports this contention by arguing that Crake serves as an enigmatic prediction of increasing pharmaceutical industry ills; “If anything,” Ingersoll notes, “Crake learns from and exploits corporate behavior to further his own ends” (169). Those ends, we assume, are creating illnesses to keep “pills and profits rolling” (169). Coral Ann Howells states that “Crake the biological scientist, who espouses a purely empirical approach which devalues imagination, morality and art, appears to be an emotional blank, a state of mind imaged in his ‘dark laconic clothing’” (*Oryx and Crake* 177). Howells surmises that Crake’s “major scientific achievements—the BlyssPlus Pill and his life work of reinventing humanity with his own genetically modified Crakers—are a mixture of vision and commercial opportunism, underpinned by an uncanny drive towards death” (178). Most vehemently, Bousoon proclaims, “Filled with scientific hubris, Crake, who does not believe in God or Nature, also does not believe

in the value of human life” (146). Readings that blast scientist Crake as millennial Frankenstein or corporate Moreau are incomplete because they de-emphasize Crake the bio-saboteur; as double-agent, Crake splices modified bodies to reveal, paradoxically, a yearning for *communitas* in a world that will little resemble its past or present state.

Crake’s most telling literary progenitor is not Victor Frankenstein who has “drunk also of the intoxicating draught” of scientist hubris (Shelley 29), but rather Gore Vidal’s Kalki, a religious idol turned eco-saboteur who renders the human race extinct with lotuses laced with a global dose of deadly bacterium *Yersinia enterocolitica*. As covert multinational Luddite, Crake fabricates a cover story to orchestrate global genocide so that the posthuman Children of Crake and the extant life on earth might survive. As clocks stop at zero hour, Crake and his liminal creations might be “seen less as a border or a limit between two already constituted worlds than as a space-time gap . . . through which a new world gradually emerges or is brought into being” (Spariosu 118). For good or ill, this new customized world is obviously generated by Crake’s complex understanding of the natural environment and its perils. He explains the paradox of human carrying capacity to Jimmy, asking him to “look at it realistically. You can’t couple a minimum access to food with an expanding population indefinitely. *Homo sapiens* doesn’t seem able to cut himself off at the supply end. He’s one of the few species that doesn’t limit reproduction in the face of dwindling resources” (119-20). Crake describes the overt effects of the BlyssPluss Pill in reproductive terms, explaining that it will “eliminate the external causes of death” such as “Overpopulation, leading—as we’ve seen in spades—to environmental degradation and poor nutrition” (293). In both passages, Crake’s sobering assessment of the overpopulation conundrum explains with frightening clarity what will happen to existing resources, clean air, and water if human numbers keep increasing at the current rate. “Demand for resources,” Crake reminds us, “has exceeded supply for decades in marginal geopolitical areas, hence the famines and droughts; but very soon, demand is going to exceed supply for everyone” (295). Crake prompts readers to think about questions that not only have an impact on the future but also concern many people today: What happens to customary human qualities associated with the Western post-industrial state in a world with housing and energy shortages, starvation, and drought? What happens to the inviolability of a human populace without the resources to lobby for its own betterment? What does it mean to be human when one’s only goal, day after day, is survival?

Clearly influenced by Richard Matheson's *I Am Legend*, *Oryx and Crake* modifies the dynamic between last man and group of post-apocalyptic creatures because—unlike vampires, plague mutants, zombies or other Matheson progeny—the Crakers pose no threat to Atwood's omega man. The Crakers serve as metonymic “floor models” (302) to exhibit alternative versions of humanity within millennial contexts, not simply in *arrière-garde* outrage but in far more unsettling philosophical speculation. Designed in Crake's high-security dome compound Paradise, these “environmentally friendly hominids” (Bouson 141) are depicted not as monstrous but as having supra-human beauty: “At first [Jimmy] couldn't believe them, they were so beautiful. Black, yellow, white, brown, all available skin colors. Each individual was exquisite” (302). Crake employs genetic engineering technologies to design posthuman creatures with not only aesthetic appeal but also resistance to climate change, insects, war, and starvation. As pertains to reproduction, Ingersoll succinctly explains that the “female goes into heat about every three years, cuing the males through the release of the appropriate pheromones, accompanied by visual signals of her readiness to mate: her genitalia and the adjacent area turn blue, an adaptation Crake copied from other higher primates” (168). To ensure fertility “the mating ritual requires that three males copulate with the female in turn, following a courting dance in which they woo her by waving their erect penises that have turned blue to mark their readiness to mate” (Ingersoll 168). Critics have emphasized the satirical or darkly prophetic import of the Crakers to the novel, most generally agreeing that it “is hard to take these purring, multi-colored, bluebottomed, blue-penis-ed, excrement-eating, perimeter-pissing, citrus-scented creatures seriously” (Dunning 95). But when we observe these traits in other species, they are understood as appropriate to specific adaptive functions; without undue anthropomorphism Crake describes modifications he and the so-called “splice geniuses” made in his GM humanoids. The “ancient primate” brain's “destructive features” have been eliminated, “the features responsible for the world's current illnesses. For instance, racism—or, as they referred to it in Paradise, pseudospeciation—had been eliminated in the model group, merely by switching the bonding mechanism: The Paradise people simply did not register skin colour” (305). “Hierarchy could not exist among them,” Crake explains, and “there was no territoriality . . . They ate nothing but leaves and grass and roots and a berry or two; thus their foods were plentiful and always available” (305). Crakers are described here as having racial blindness, social grouping processes that eliminate dominance, and the

ability to consume a variety of raw plants. Ingersoll asks,

If life can survive only in the form of the Children of Crake, doesn't that survival outweigh the loss of some of what readers are likely to consider their 'humanity'? No, in thunder! Atwood seems to be shouting. If traditional human qualities have to be sacrificed in order to survive, it may not be worth surviving (167).

Problems of authorial intent aside, I would contend that life survives in increasingly diverse forms in *Oryx and Crake*, slowly adapting to the new topography left by the human cataclysm. Ecocritically, the question of the readers' sense of their "humanity" and "traditional human qualities" in opposition to survival of the species seems of secondary import in the novel to these questions: What is the relationship of these life forms to bioregion? What do the Crakers teach us about our own biotic relationships?

The Crakers embody genetically what Atwood's millennial "green" readers might aspire to behaviorally, and thus part of Atwood's novel's ecological optimism might be found in the capacity of culture to embrace an ethos of environmental stewardship. The emerging Craker culture fosters post-racial, non-hierarchical vegetarianism; the Crakers don't fight, don't waste, and know how to share. They have been programmed to prevent overpopulation and respect all species of life; Jimmy/Snowman thinks after stepping on a banana slug that "if he were a Craker he'd have to apologize to it—I'm sorry I stepped on you, *Child of Oryx, please forgive my clumsiness*" (334). Even their troublesome dining habits prompt ecocritical readers to reconsider issues of waste in a book preoccupied with garbage, excrement, and food security. The Crakers also help us to remember that as a species, humans are not exempt from adaptations and mutations that occur through processes of evolution, despite our various advances. Crake compels readers to speculate that as liminal creatures ourselves in passage among multiple states of being, humanity has the capacity over time to shed the genetic basis for attributes that lead to war and acts of ecocide. Thus, the essentialist conceptions of human inviolability that these critics champion are cunningly spliced with corporate science to encourage readers to ponder disquieting constructions of human identity. Atwood's novel remanufactures traditional philosophical categories of authentic, synthetic, and real in light of millennial scientific and environmental advance. Just, as Oryx explains, all "sex is real," biological effects of cosmetic surgery, cloning, predation by GM animals, and urban starvation are also real—regardless of where and how they originated. If it can hurt you, the novel suggests, it's real.

Before the BlyssPluss pill is introduced, depictions of animal-based transgenic hybrids are often described with as much humour as horror, and

fascination with real uses of animal genetic material sometimes adds a cloying lightness to abuses by multinational food and pharmaceutical conglomerates.⁶ The stylistic playfulness of terms such as “ChickieNobs Bucket O’ Nubbins” (7) and “Organ-Oink Farms” (22) threaten to make depictions of corporate slaughterhouses and laboratories almost glitter. Moreover, Atwood’s novel appears to delight in depicting MaddAddam sabotage animals such as pox-infected wasps that annihilate ChickieNobs, car-destroying rodents “containing elements of both porcupine and beaver” (217), and a microbe that eats “tar and asphalt” that had “turned several interstate highways into sand” (217). But even these liminal bodies have the capacity to resist their corporate makers. Crake describes the MaddAddam covert “splice geniuses” as saboteurs “after the machinery. They’re after the whole system, they want to shut it down” (217). After BlyssPluss, Jimmy/Snowman observes that “Pigeons were supposed to be tusk-free, but maybe they were reverting to type now they’d gone feral, a fast-forward process considering their rapid-maturity genes” (38). Transgenic animals now represent emergence and flux in the relationship between humans and other species; humanity’s situation in this brave new biosphere, one that contains ferocious pigeons and rakunks, requires an extra level of respect and heedfulness, to say the least. Crake’s biological cosmology offers much more than a modest proposal because it develops an arena for negotiating and surviving cyborg landscapes and life to come. As a Crusoe figure who “goes animal” within a changing ecosystem to engender optimism in the face of crisis, Jimmy/Snowman must reconstitute identity in liminal space and bring about the possibility for ecological *communitas* through solitary survival, a return to the source of trauma, and renegotiation with the monstrous. “Last man” no more, he must consider cultural responses to the new ecological context, a quandary taken up by the God’s Gardeners in *The Year of the Flood* (2009).

Turner explains that “when a man ceases to be the master and becomes the equal or fellow of man, he also ceases to be master and becomes the equal or fellow of nonhuman beings. It is culture that fabricates structural distinctions; it is culture too that eradicates these distinctions in liminality” (*Dramas* 252-253). Atwood’s *Oryx and Crake* reveals not only “The End,” but also a literary and cultural yearning for a new beginning—an ecological *communitas* emerging out of a world where cultural distinctions and borders have generated “more plagues, more famines, more floods, more insect or microbe or small-mammal outbreaks, more droughts, more chickenshit boy-soldier wars in distant countries” (253-254). More than simply rehearsing

disaster, Atwood's novel attempts—with more optimism than people give her credit for—to see through apocalypse beyond a warming world where “everything was being ruined and would never be the same again” (63). Though the novel neither condones nor accepts ecocidal acts committed by genetic engineers or multinational food producers, it offers more than despair in the face of damage already done. An ecocritical reading of flora and fauna in *Oryx and Crake* strongly suggests that Jimmy/Snowman's liminal pilgrimage of confused identity, outsiderhood, ecological apprehension, and obligation will invariably end in a new stability of bioregional community. Jimmy/Snowman's predicament at the end of the novel reminds readers of our own dilemma at this crossroads in environmental history, at a moment “when everything, as it were, trembles in the balance” (Turner, *Ritual* 44).

NOTES

- 1 Characterizing *Oryx and Crake* as a dystopian bookend and sequel to *The Handmaid's Tale* (1985) denies this book much of its ecocritical currency; as a novel of liminal topographies, *Oryx and Crake* can be seen rather as sequel and sister to Atwood's 1972 novel *Surfacing*. Both novels highlight literary figures with problems of self-classification as they observe at-risk natural environments. Both novels put forefront the correlation between imperiled environments and human identities in-between; both central literary figures have lost their names, with reclamation intimately intertwined with their changing relationships to the natural world. The “Historical Notes” at the end of *The Handmaid's Tale* reveals an optimism similar to that Atwood finds in 1984 and, arguably, *Oryx and Crake*.
- 2 Hope and “new growth” can also be found in *The Year of The Flood* (2009), the second novel in Atwood's proposed trilogy, though it is premature to suggest any larger statement about the ecological message of these works as a group before the complete trilogy is published.
- 3 I'll use “Jimmy/Snowman” to describe the novel's central character because of the many chronological shifts as well as the significance of identity formation and naming to this liminal figure.
- 4 Arnold van Gennep develops modern conceptions of liminality in *Les Rites de Passage* (1909), and the idea is later refined by anthropologist Victor Turner. See Turner, *Dramas*.
- 5 “Biodiversity will increase . . . as buildings tumble and smash into each other,” suggests Alan Weisman in *The World Without Us* (2007), “and lime from crushed concrete raises soil pH, inviting in trees” (33).
- 6 Actual scientific “splices” such as “luminous green rabbits” (Atwood, *Oryx and Crake* 96) and the “spoot/gider” (199) are described in relation to mood-enhancing wallpaper with “a modified form of Kirilian energy-sensing algae embedded in it” (201) and walls “made of a new mussle-adhesive/silicon/dendrite-formation alloy, ultra resistant” (297).

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