# The Nature of the Body in Sport and Physical Culture: From Bodies and Environments to Ecological Embodiment

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This article raises the ecological substance and relational co-constitution of bodies as a generative question for sociologists of sport and physical culture. It proceeds from our observation that recent research on the materiality of athletic bodies, and on the environmental issues in which sport is implicated, tends to run on parallel tracks. By exploring how biological, environmental, and social natures cohere in the making and unmaking of healthy bodies, our aim is to connect and extend these vibrant areas of research. We do so by developing the concept of "ecological embodiment," a descriptor for a fluid state of becoming and a sensibility for thinking about hierarchical socioecological entanglements. To illustrate this concept, we draw on a study of whey protein powder, a key ingredient in contemporary fitness cultures.

In this article we explore relationships between two categories of analysis that lie at the forefront of contemporary critical scholarship: "the body" and "the environment." In the context of the climate crisis, the intrinsic relationality between humans and the rest of nature is the subject of accelerated interest among social science and humanities scholars. Recent literature travelling under posthumanist and new materialist labels works with, or alongside, longstanding ecofeminist, anticolonial, and dialectical materialist traditions to explore the conceptual limitations and violent implications of the nature-culture divide. But the precise character of the socio-natural webs through which bodies materialize, the extent of fluidity or fixity at work in any specific context, and the marked variation in what it means to embody nature at this historical conjuncture, remain open, generative questions. We see the promise of joining this conversation, and responding to such questions, from the vantage point of the sociology of sport and physical culture. How might we conceptualize the ecological co-constitution and embeddedness of athletic bodies, and to what end?

While there is a rich array of scholarship in our field that takes as its central task the theorization of "the body" (Andrews, 1993; Carrington, 2002; Cole, 1993; Hargreaves, 1985; Hargreaves & Vertinsky, 2006; Rail & Harvey, 1995; Pringle, 2016; St. Louis, 2003), and a growing area of research focused on sport and the environment (Bunds & Casper, 2018; Millington & Darnell, 2019; Wilson & Millington, 2020), these literatures run largely on parallel tracks. On the one hand, as Carolyn Prouse argues (2019), research on sport and the environment tends to emphasize contradictions between sustainability rhetoric and capitalist growth. Especially prominent in this vein is criticism of "ecological modernisation" as an environmental strategy in the hosting of sports events (Ali & Johnson, 2018; Millington & Darnell, 2019; Millington & Wilson, 2016; Kim & Chung, 2018; Wilson, 2012). Notwithstanding the important insights gleaned through this research, we have noticed that the moving body, particularly as it is composed of and affected by ecological substances and relations, seldom features. On the other hand, renewed interest in the materiality of the body in sport and physical culture encourages analyses of the "biosocial" status of moving bodies (Fullager, 2017; Markula, 2019; Newman, Thorpe & Andrews, 2020), but has not addressed their ecological

composition in a sustained fashion. Relations between bodies and environments, then, are underexplored in the sociology of sport and physical culture, despite the vibrancy of these respective literatures. Given that new materialist, posthumanist theories have developed in concert with an escalating climate crisis, and that much of the broader literature on nature-humanity relations has been explicitly driven by environmental concerns, the entwinement of bodily and ecological natures is a timely analytical question.

More than just a gap between two literatures, we posit that the ecological embeddedness of embodied practices is an important political and intellectual sensibility for understanding body-environment relations in the twenty-first century. As scholars of sport and physical culture are grappling with new ways to breach the nature-culture dualism (Prouse, 2020) and to center the biophysical character and science of embodiment (Thorpe & Clark, 2020), it seems important that boundaries between bodies and environments not be implicitly asserted through the absence of ecological matter in theorizations of embodiment. This same sensibility can help move beyond disembodied approaches to environmental issues in which sport is implicated. To be clear, this is not a case of asserting the ontological inseparability of discrete units of analysis, as if establishing the homogeneity of body and environment were the analytical "end game." On the contrary, it is through the interplay of matters corporeal and ecological that we can discern how the vitality and materiality of bodies are entangled with power, exploitation and justice.

A key purpose of this article is thus to explore how biological, environmental, and social natures cohere in the making and unmaking of fit, healthy, and athletic bodies. This is a fraught undertaking from the outset, one beset by modernist frontiers that assert the fixity of biological and environmental "realms." Such distinctions also carry colonial connotations, and it bears emphasis that our preoccupation with body-environment relations here would not be configured as a "problem" per se within many Indigenous philosophies (Nelson & Shilling, 2018), Black socioecologies (Davis, Moulton, Van Sant & Williams, 2019; Wynter & McKittrick, 2015), and other non-Eurocentric worldviews (Selin, 2013) that have never imagined human corporeality outside of nature. One way to navigate these tensions is through historically situated accounts of socioecological entanglements that reveal the processes through which some bodies are sustained or strengthened, while others are compromised or destroyed, with diverse and diffuse ecological consequences. Inspired by kindred efforts across multifold fields to conceptualise body-environment relations, we have come to call this process "ecological embodiment." As well as naming a fluid bodily state of becoming, shaped by power and history, we intend it as a sensibility for thinking about the "intra-active" (Barad, 2007) relations among human embodied practices and the rest of what gets called nature.

In the first half of the article, we discuss ecological embodiment as a way of studying body-environment relations. This includes a focus on literatures and philosophies that help us to situate the ecological character of athletic bodies in capitalist, gendered, racial and colonial infrastructures and to attend to the liveliness of biological matter in the making of these bodies. Part of our aim in this discussion is to highlight the challenges involved in working with new materialist and posthumanist approaches to body-environment relations, especially where they emphasize becoming, agency, and novelty. In the second half, we reflect on our ongoing study of whey protein powder in order to "flesh out" ecological embodiment as a critical analytic for studying sport and athletic bodies. Our goals in doing so are twofold: to illustrate the more-than-human, ecological entanglements through which contemporary athletic bodies materialize, disperse, degenerate, and rebuild; and to further highlight the methodological and theoretical challenges encountered as we sort to capture these entanglements. Overall, we seek to connect two of the most vibrant areas of

research in the sociology of sport and physical culture, towards critically analysing the ecological embeddedness of embodied practices in times of socio-ecological, biophysical, and political uncertainty.

## Body-environment relations

Our approach to thinking about body-environment relations stems from a motley cast of scholars and scholarly traditions working across Marxism and cultural studies, political ecologies, and new materialist and posthumanist theories. What follows, though, is not an argument for synthesis, more an attempt to trace a path back through these theories and literatures in order to highlight their promises and pitfalls, and in particular their limitations when adopted in silos. For whenever we have found ourselves stretched in one direction—often towards new materialist and posthumanist theories of the body—we were soon pulled in another—notably by work in feminist, Black, and Indigenous Studies that find these perspectives to be crucially lacking.

Marxism and cultural studies are an apposite starting point for this discussion as touchstones of materialist thought. Marx's materialist conception of history holds that historical processes are the dynamic force propelling human societies, rather than, say, the feats of heroic individuals, accidents of circumstance, or some inherent law of nature. For Marx, it is through social relations of production that people labour to make and remake history, and this is a truth in common to all economic systems—not just capitalism. In this sense, Marx is an 'old' materialist philosopher, with thought centred on the materiality of human labour as applied to the natural world. Interestingly, his approach was a direct response to the prevailing idealism of nineteenth century philosophy—much as the new materialisms respond to the perceived limitations of social constructivist, poststructuralist, and other 'discursive' theories that are predominant today.

Debates about the contemporary relevance of Marxism have often pivoted on the centrality of economic production for understanding social life, but for understanding body-environment relations, we propose that a more general methodological lesson be heeded concerning commodity chains. Marxism begets an awareness of how commodities accrue value in ways that variably enrich and deprive those involved. For example, Ian Cook et. al's (2004) essay on "following the thing" traces papayas from Jamaican farms to North London apartments, highlighting the range of forms of exploitation involved in production and consumption (see also Appadurai, 1986 on the social lives of commodities). Not all substances are commodities, of course, but this mode of analysis through economic and ecological systems has an enduring utility, one that can prove especially useful for tracking the movement of substances through diffuse socio-natural spaces (Suwandi, 2019).

Because tracing substances through commodity chains often takes in the worlds of culture and society, variants of Marxism that highlight processes of articulation between political economy and cultural forms and practices, such as the work of Antonio Gramsci and Stuart Hall, are at least as apposite for thinking about body-environment relations as orthodox Marxism. Sociologists of sport have reckoned with these thinkers and their conceptual tools for several decades, and though we cannot follow that thread out into the rich array of research wedding Marxism and sport (see Andrews and Giardina, 2008; Beamish, xxxx; Brohm, 1978; ????), it is important to note the longstanding influence of materialist thought in critical studies of sport and physical culture, much of it through cultural studies. Relatedly, Marxist research has shown how capitalism is "hard on bodies" since at least Engel's writing about working conditions in industrializing Manchester, and critical scholars of sport have consistently demonstrated how professional, commodified sport deleteriously

acts on the athlete's body (Young, 1993). The matter of the body, though, has tended not to be an explicit object of historical materialism.

There are some exceptions to this general oversight in Marxist thought of the interplay of economic, ecological and corporeal processes. Notably, the work of Julie Guthman and various interlocutors on bodies, food, and the environment opens up the "black box" of the material, biochemical body (Guthman & Mansfield, 2012) and, as we have argued elsewhere, helps articulate how athletic bodies are enlisted by agro-capitalism to overcome limits to accumulation (Guthman, 2015), with consequences for more-than human health (King and Weedon, 2019). Guthman, though, is interested not just in how capitalist work depletes bodies, but in how "bodies are being reworked in ways that make new rounds of accumulation possible" (2532), such as when bodily processes of metabolism are used to create and sustain new markets, or to 'fix' the problems borne of existing modes of capital accumulation. As such, Guthman shows that spatial fixes (such as outsourcing commodity production) are not capitalism's only means of resolving, temporarily, its crises and contradictions. Bodily processes that work to sustain and even strengthen individual bodies can also serve this purpose.

Guthman is exemplary of scholars attempting to wed matters of political economy and political ecology. Her insights about the body as a "socio-ecological fix " are an invitation to consider how capitalism creates particular modes of embodiment in addition to the toils of wage labour, and, moreover, to explore how these are bound up with ecological processes. In making connections between bodies, food, capital, and the environment, her body of work invites sociologists of sport and physical culture to think about the multiplicitous productivity of bodily processes as part of capital accumulation. To paraphrase our central question in this essay, how is the productivity of fit, healthy and athletic bodies bound up with matters of ecological degradation and capital accumulation?

One pitfall to beware here is to misconceive nature and capitalism as separate realms of green and gold, each clashing with the other to create problems normatively termed "environmental." Political ecologist Jason Moore (2015) recognises this and asks us to instead think of capitalism as a social system and historical process that organises nature. Or rather, one that attempts to organize nature with decreasing levels of success and certainty, for "while the manifold projects of capitalism, empire and science are busy making Nature with a capital 'N'—xternal, controllable, reducible--the web of life is busy shuffling about the biological and geological conditions of capitalism's process" (Moore, 2015, p. 2-3). In this configuration, nature is not an external category on which capitalism acts, but a mosaic of relations— the "web of life" his parlance—that include human bodies and the ecologies in which they are sustained.

Guthman and Moore's variants of political ecology connect critical assessments of capitalism to a much broader point about the patent inseparability of humans from the rest of nature when living through the climate crisis. In doing so they join the multifold voices that forewarned the arrival of that crisis and continue to name and challenge historical processes that coalesce in heating the planet (Whyte, 2018; Davis, Moulton, Van Sant & Williams, 2018). Those interested in athletic bodies and matters of political ecology will find a rich body of knowledge to engage with beyond the confines of our discussion (see also Bunds and Casper's 2018 special issue in this journal), but one reason that these particular political ecologists have been focal for us is that both work with case studies involving food. Our work on body-environment relations has also taken much from thinking critically about food, including the animal and environmental ethics of eating (Calarco, 2014; King, Carey, Macquarrie, Millious, & Power, 2019), but also about humans as food: Some time into our thinking about ecological embodiment we discovered Val Plumwood's (2012) use of the phrase in

describing how “the human supremacist culture of the West makes a strong effort to deny human ecological embodiment by denying that we humans can be positioned in the food chain in the same way as other animals” (p. 16). Reckoning humans as food not only tempers the “mastery of nature” narrative endemic to modern Western thought. Crucially, it also highlights that human bodies are composed of substances that nourish bodies yet refuse containment in conventional nutritional categories, or indeed within bodily borders. This, of course, is highly relevant to athletic bodies and the business of fitness itself, each of which are sustained to a great extent on nutritional regimes aimed at physical maximization and self-mastery.

Talk of eschewing mastery of nature fantasies and of the material composition and limits of human embodiment brings us neatly on to the ‘new’ materialist and posthumanist turns in in the social sciences and humanities. The new “material turn” tends to be narrated as a move beyond constructivist and representationalist thought, both of which stand accused of having neglected or omitted the significance of biology, technology, ecology, and matter itself in social life. The argument follows that these approaches conceded the material world, the biological substance of bodies, and the vitality of nonhuman life, to the life sciences, leaving the social sciences and humanities to ponder their discursive referents: language, meaning and subjectivity (see Coole & Frost, 2010). The result has been an outpouring of work concerned with the materiality of human and nonhuman life, including Jane Bennett’s Vibrant Matter (2010), Karen Barad’s Meeting the Universe Halfway (2007), Elizabeth Wilson’s Gut Feminism (2015), and an array of studies reckoning with objects, animals, plants, and more-than-human phenomena. In keeping with these developments, “new” materialist philosophy and post-qualitative inquiry have recently been advocated by sociologists of sport and physical culture (Newman, Thorpe, & Andrews, 2020), who have placed varying emphasis on “posthuman becomings” (Markula, 2019), methodological implications (Giardina, 2017), and epistemological openness (Fullager, 2017), in their engagements with the material turn.

Insofar as all social thought is mutually shaped by the historical conjuncture in which it arises, efforts to think of the athletic body in its socio-natural complexity can doubtless be aided by the insights of materialist and posthumanist philosophies. For example, considering athletic bodies as “biosocial” (Rabinow, 1996; Rose & Novas, 2004) or “biocultural” phenomena (Frost, 2016) , as forms of “biocapital” (Helmreich, 2008), or as key players in the “bioeconomy” (Birch & Tyfield, 2012) draws attention to the entanglement of social and organismic materialities. Donna Haraway’s (2003) “natureculture” and Karen Barad’s (2007) “intra-activity” share this relational ontological approach, helping to ensure that feminist epistemologies of difference do not fall silent in worlds of object agency or materialist realism. A related groundswell of interdisciplinary thought seeking to capture the plasticity and porosity of bodily borders, including Claire Waterton and Katherine Yusoff’s (2017) work on the “indeterminacy” of bodies and Alexis Shotwell’s (2016) arguments about the impurity of bodies, offers further resources to grasp the material complexities of embodiment.

Nevertheless, we think some caution is warranted in taking up these ideas, , because of certain presuppositions that seem to accompany the “new” materialist territory, including its ostensible novelty and narrative of epistemological succession. One problem with prevailing theses on the resurgence of interest in materiality to which we have frequently returned, is that they risk erasing those whose scholarship and worldviews have never warranted their critiques (Ahmed, 2008; Jackson 2013; TallBear, 2015). Two particularly resonant examples relate to the often overlapping intellectual histories of feminist theory and Black studies. Claims about the feminist “flight from nature and biology” (Alaimo, 2010, p. 4) speak to the influence of constructivism and poststructuralism in the 1980s and 1990s, and to the proposed anti-biological and discursive

orientation of feminist theory during this time. But provocations to move beyond the discursive neglect the flourishing of feminist technoscience studies during the same period, and its contributions to the critique of nature-culture dualisms that is shared by many "new" materialist and posthumanist approaches (e.g. Haraway, 1985; Harding, 1986). Similarly, accusations about the insufficient materiality of "identity politics" for theorizing the body (e.g. Coole & Frost, 2010) problematically allude to the influence of Black critical theory in unsettling but refusing to abandon the category of the human (Jackson, 2013; Leong, 2016). For Diana Leong (2016), the new materialisms rest on a "disavowal or misreading of race as a stagnant analytical framework" (p. 12), a repudiation that forecloses an adequate response to the climate crisis. They further ignore the central place of "animality, objecthood, and thingliness" within Black scholarship that captures modes of being traditionally excluded from white theoretical frameworks and experiences (Jackson, 2015, p. 216; Karera, 2019; Leong, 2016). Insofar as certain variants of the "new" materialism brush aside questions of "identity" in the rush to engage with "the real" and "the vital," they overlook how transatlantic slavery affected a "rupture in the quality of being" (Brand, 2002, p. 29) that extends beyond Black bodies and lives and continues to shape knowledge about humans and matter writ large.

What these critiques highlight is a failure on the part of some "new" materialist and posthumanist scholars to historicize the human whose very supremacy they wish to undermine--a second, and related, problem to which we have frequently returned. In other words, what emerges from certain expressions of a renewed, revitalised materialism is a kind of pan-humanism: "humanity as an undifferentiated whole" (Moore, 2015, p. 170). This occurs when the recognition that humans are not separate from nature, often brought into relief by the climate crisis, is treated either as a novel insight given validity by geologists or environmental scientists, or as a unifying source of species-belonging (Braidotti, 2013) whereby "we" are all in this together. In promoting notions of "an intrinsic relationality among earthly beings" (Karera, 2019, p. 35), such renderings serve to disavow the "social antagonisms" (Swyngedouw, 2010) that underpin what some writers call "climate apartheid" (Tuana, 2019; Tutu, 2007). They fail to centre the interconnected historical processes, promulgated by an elite minority of humans through practices such as slavery, mining, and industrialization, that make the climate crisis an outcome of longstanding biophysical, geological, economic and colonial forces. And they seldom show an awareness that the existential threat portended by this crisis is not historically unprecedented for groups of people who have long faced threats to their status and future as humans (Whyte, 2018). These shortcomings are especially pronounced where becoming and agency are emphasized to the neglect of capitalist, racial and colonial structures of power, as if highlighting nonhuman materiality and object agency were the point of critical scholarship.

In fact, such contentions have a long history of complicity with the structures of power they neglect. Literatures attuned to questions of racial, colonial and economic power demonstrate that imagining (elite, white) humans as separate from nature has been a fundamental precondition for the primitive accumulation of capital (Moore, 2015), for the racialized stratification of humans (Anderson, 2007), and for the resourcing of "the environment" through settler colonialism, slavery, and mineral extraction (Whyte, 2018; Vèrges, 2017). A coalescence of long-standing and contemporary problems, from land dispossession and toxic outsourcing, to climate refugeeism and DNA extraction, make evident that ecologies, technologies, and other more-than-human forces cannot be understood apart from matters of human sociality, violence, and exploitation (Davis, Moulton, Van Sant & Williams, 2019; Tuana, 2019). And understanding and challenging those connections is crucial to ecological scholarship-- and justice--in the present.

This meandering journey through literatures that can help elucidate body-environment relations in sport and physical culture does not lend itself to simple summary. We arrived at critiques of 'new' materialist and posthumanist research on the basis of their contemporary resonance and influence on our thought, but also out of a deep concern with certain erasures performed in the rush to emphasize becoming, agency and novelty to the neglect of power, exploitation and justice. To get there, we have sought to highlight the enduring role that Marxism and cultural studies can play in helping trace objects on promiscuous travels, and in coming to terms with conjunctural moments in which (athletic) bodies are made and unmade, strengthened and compromised. Political ecologists help to do this in ways that take nature seriously as part of social life, and to critically consider how food and animals are recruited into processes of commodification.

All of this thinking feeds into what we mean by ecological embodiment. It means taking vital and relational materiality seriously while challenging the exclusions that the modern figure of the human represents. It means situating moving bodies in webs of climate, capital, and coloniality without universalizing human bodies and experiences in relation to these processes. And, it means rethinking how bodies and environments - biology and ecology - coexist in recursive patterns that are conditioned but not determined by social processes. To hold all this together is a tall order. Indeed, for the avoidance of doubt, we have found ourselves repeatedly stretched and confounded in our own efforts to recognize how complex histories of injustice and resilience are infused in biological matter, bodies, and multispecies traffic. These challenges and hopefully some of these insights, are what we hope to draw out in the following discussion of how we followed whey protein on its "transcorporeal" journey (Alaimo, 2010) through economic, ecological, bodily and social processes.

## Whey Protein Powder and the Making of Athletic Bodies

We began this study having each been recommended protein powder towards particular health and athletic ends. Such experiences have doubtless become widespread over the past two decades, in which protein powder consumption has moved from the niche realm of serious bodybuilding to the cultural mainstream. Alongside established claims about the role of protein in the production of muscle mass and recovery from exercise, the rapid expansion of this $7.9 billion industry has been built on a growing list of new promises (Business Wire, 2019). Regular ingestion of protein powder is now recommended as a boost to a variety of bodily forms ranging from weight loss to bone densification, glossy hair to flawless skin, energy to satiety, and healthy pregnancy to active aging. Protein powder is also promoted as a salve for both the frantically busy and the culinarily challenged, to be consumed in shakes, bars, and other formulations. An ever-expanding range of powders available for purchase reflects the desire of manufacturers to grow this burgeoning market, as well as the multiplicity of contemporary dietary trends: In the animal protein category, powders are commonly made from whey, casein, egg, and beef, while popular plant-based supplements include soy, rice, hemp, pea, and sprouted grain. In recent years, organic, vegan, artisanal, grass-fed, fermented, fair trade, and GMO-, hormone- and gluten-free varieties of protein powder have emerged in line with the broader cultural preoccupation with protein.

Before having thought too much about how it is derived, our initial interest in protein powder was sparked by a customary skepticism towards nutritional fads: What was the lure of those huge plastic tubs of highly processed, chalky residue for strong, well-fed gym patrons committed to "clean eating" regimens? Why did "protein talk" take up so much space in the exercise cultures to which we belonged? Were people really clamoring for extra amino acids in their potato chips? The answers to questions posed in this way are not new: Bombarding consumers with choices that can

both undermine and ameliorate their health constitutes the life force of contemporary capitalist food markets. Decades of feminist scholarship in the sociology of sport and beyond about the pressure on women (generally imagined as white and middle class) to indulge their desires and purge their excesses has made this point amply clear (Bordo, 2004; Dworkin & Wachs, 2009). Moreover, the preponderance of rapidly shifting and conflicting dietary and exercise advice to which publics are routinely subjected means that awareness of such contradictions now comprises common sense.

Demystifying the cultural allure of protein supplementation remains of interest to us, but our first line of inquiry was to ask of the history of this health commodity, to probe its origins and conditions of production. Our specific focus lies with whey protein production in North America, where it is the most popular type of powder on the market, accounting for 83% of online sales in the U.S. (Millot, 2016). Technically speaking, whey is the liquid that remains once milk has been curdled and strained. It was observed to separate from coagulated goat's milk at least 8,000 years ago and can be generated in the absence of human cooperation (for example, when a bacterial infection causes milk to curdle in the cow's udder). Today, however, the vast majority of whey is co-constituted through entanglements of humans, dairy animals, microorganisms, machines, and a range of other actants differentially enlisted in the cheese-making business. These multispecies, technoscientific relationships endow whey with what scientists deem an especially efficacious potential to build and sustain muscle mass (Devries & Phillips, 2015), a capacity that informs its emergence as a key component in the reproduction of fit, healthy, athletic bodies across multifarious forms of sport and physical culture, as well as its appeal to a wider range of audiences, from sarcopenia researchers (Bauer et al, 2015) to casual followers of dietary trends (Wilson, 2019).

The direction of our work shifted towards matters of ecology when we discovered that whey has a history not only as a health elixir, but as a toxic effluent. We were already aware of the environmental impacts of dairy farming as a whole (FAO and GDP, 2018), and came to learn of whey's multiple manifestations through reading further about the role of Big Dairy in the post-war industrialization of agriculture (Anderson, 2016; Kardashian, 2012). Prior to the mass production of cheese, dairy farmers were able to sell excess whey to neighbouring farms for hog or chicken feed, or provide it to their own pigs that they kept expressly for waste regeneration purposes. Once manufacturing intensified and moved off the farm, however, this became an expensive undertaking, requiring diesel-fuelled tankers to haul heat-sensitive whey back to the animals who would consume it. Cheese manufacturers thus began spreading liquid whey on agricultural land, pumping it into municipal sewers, or discarding it in waterways (Lougheed, 2013). The amounts involved were massive: Cheese production had risen exponentially across the latter half of the twentieth century as a way to deal with the systematic overproduction of milk and millions of pounds of excess whey had resulted. With its high nitrogen content, whey is one hundred and seventy-five times more potent than untreated human sewage (Smithers, 2008) and if released into water, works to stimulate plant growth and deny fish and other aquatic beings the oxygen they need to survive. As environmental activists sought to draw attention to whey's devastating impact, and legislators sought to outlaw its dumping, the development of techniques to transform whey from toxic waste to valuable commodity emerged as a key industry priority (Bertin, 1981; Lougheed 2013; Smithers, 2008).

Official accounts of this challenge tend to detail the colossal amounts of whey pollution generated each year (90.5 billion pounds in the U.S. alone in 2006), whey's finicky biochemical character, the several decades of food engineering research it took to make a consistent, durable, and palatable product, and the health benefits whey is believed to offer in its processed form (Smithers, 2008, 2015; United States Department of Agriculture, 2014). In other words, theirs is a story of

technoscientific ingenuity, persistence and ultimately success. Although industry accounts might acknowledge some residual issues to be addressed, whey is now a staple ingredient in products ranging from smoothies to donuts, and its rehabilitation is, by this rendering, largely complete. The ubiquity of whey protein powder (as well as other variants) in sport and exercise cultures only serves to bolster this narrative of triumph.

Yet attending to whey's implication in antagonistic relations of power, its unruly and indeterminate qualities, and its persistent ecological burden--in other words, engaging with the afore-discussed interlocutors of varying theoretical stripes--allows a different story to emerge. If fit, healthy, athletic bodies are strengthened and sustained by the mass consumption of whey powder, then the question of who or what is recruited into this process, and at what cost, impelled further scrutiny.

One place to start such a reckoning is with the multispecies relations that form what Julie Livingston and Jasbir Puar (2011) call the "unmarked basis" upon which "capitalist endeavors maneuver resources and marshal profit" (p. 4). Those enlisted to process whey, those required to use their own bodies and metabolisms to divert this would-be toxin from dairy industry waste streams, include a veritable assemblage of actants (Latour, 2005), each dependent, albeit in vastly uneven ways, on the other. There are the dairy cows whose reproductive capacities, bodily organs, and physiological processes are harnessed to supply other bodies with a range of milk products, including whey. The extraction of their milk relies on their forced separation from their calves who are reared for veal, socialized into milk production, or killed. Extraction also relies on the dangerous and difficult work performed by the largely racialized and migrant human labourers who handle the cows and machinery designed to garner, process, and package milk as it is transformed into powdered whey. Still other low-paid workers distribute and sell the nutritional supplements that result. Consumer bodies--animal and human--are in turn instrumentalized. Since protein powder is fed back to dairy cattle and their calves who grow bigger and faster on a diet that includes whey, both their reproduction, and the cultivation and satiation of strong, lean, humans who purchase fetishized nutritional supplements, are indelibly dependent on the profound alienation of the more-than-human workers (sometimes they themselves) who (re)generate this nourishment. In turn, whey protein can be converted into other forms of social or cultural capital such as musculature, energy, aesthetics, and longevity. Whey's capacity for aiding diverse health and fitness projects is not compromised by its exploitative, multispecies entanglements or its contaminating properties; rather, whey's dynamic qualities are endowed by precisely those enlisted to harness the biochemical potential of such properties.

These multispecies relations illustrate how whey's vital materiality, exemplified by its ostensible transformation from toxin to health elixir, is entangled with histories that exceed the given story of its commodification. Deeply sedimented in this process is the "cattle colonialism" (Fischer, 2017) and appropriation of Indigenous land for farming that propelled settler expansion and domination across Canada and the United States from the seventeenth century onwards (Anderson, 2004), a process operating dialectically with slave labour, "alien land laws," and other vectors of racial violence and exclusion (Jacobs, 2018). Billy-Ray Belcourt (2015) adds a further element to analyses of the dispossession, reminding us that domesticated animals such as dairy cows are not just capitalist workers, but colonial subjects. The insertion of captive animal bodies into spaces from which Indigenous bodies have been forcibly displaced represents a longstanding and ongoing tactic of settler colonialism. Dairy cows, who are "always already scheduled for death" (Belcourt, 2015, p. 9), help replenish the labour power, physical capital, and other differentially distributed resources of the settler colonial state and its subjects.

This “contentious” synthesis of human and non-human bodies (Sarmiento, 2013, p.74) is a vector for the reproduction and management of life that extends to global systems of colonial rule (Ahuja, 2016). From the late nineteenth century, nutritional science has infused colonial projects in Africa, Latin America, and Asia with protein-centric thinking (Cannon, 2002; Nott, 2018). Indeed, what Aya Hirata Kimura (2013) calls this “charismatic nutrient” remained a key technology for expansion-oriented imperial governance through the early part of the twentieth century, across the decolonial, postwar period, and into the twenty-first century. The foundations for amino acid ascendance were first laid in the mid-nineteenth century, when German scientists and nutritional evangelist Baron Justus von Liebig pronounced it as the primary nutrient and fast growth of human, animal and plant bodies as a key biopolitical priority. As Geoffrey Cannon (2005) writes: “Once protein was isolated and identified as the...nutritional expression of the dominant European ideology, food systems engineered to emphasize animal protein had the power to change the world, as they have done” (Cannon, 2005, p. 702). While we are unable as yet to offer a comprehensive account of the complex routes through which protein imperialism has unfolded, suffice it to say that milk and milk-based supplements feature at every turn. From the (excess) production of milk designed to build the strong colonial bodies that would capture, expand and defend colonial territories, to the predication of this expansion on the decimation of indigenous food systems and ecologies both at home and abroad, from the malnutrition and food insecurity that resulted, to the demand thus created for nutritional supplements derived from non-indigenous, intensive, industrialized food sources like whey, multispecies protein cultures are longstanding agents in the reproduction of globally-stratified and physically embodied dichotomies between healthy and unhealthy bodies.

Following whey’s ecological entanglements across dispersed histories and geographies has also meant considering what happens to whey after the point of consumption. It transpires that despite the development of technology to reconstitute whey as an edible foodstuff, its toxic qualities and political entanglements do not disappear upon digestion. On the contrary, the capacities that make whey at once noxious and healthy, lucrative and costly, endure through various attempts to purify and profit from it, including processes of consumption and biosynthesis. If we consider what happens once whey enters the body, we find that some of the amino acids it carries are used in the regular cellular regeneration that sustain life. Leftover amino acids can be converted into glucose or stored as fat if the powder is not taken as prescribed, and instead incorporated into the body without appropriate amounts of energy expenditure. They can also be used to fuel the construction of new muscle --a key promise of protein powder consumption--if the requisite physical work is undertaken. The labour of athleticism is thus necessary for the body to metabolise the potential of whey into its purported benefits and represents an extension of the multispecies, multiorganismic graft required to mitigate the toxicity of whey.

Regardless of the various uses to which it is put, whey is never fully absorbed by the body. Dr. Stu Phillips, a prominent exercise physiologist in the field of human muscle protein turnover, consistently emphasizes that there is a limit to how much protein the body can use (Ledin, 2014). Indeed “a large fraction” will remain (Mulder, 2003, p. 67), materializing as a “fundamentally toxic” excess (Ledin 2014) that is converted to urea and excreted as reactive nitrogen, itself a cause of adverse health and environmental effects when overabundant in water (Leach et al, 2012; United States Geological Survey, 2018). Moreover, nitrogen, like the whey protein that begets it, is a compound that is “recalcitrant” in nature and its removal from wastewater is costly and energy intensive (Westgate & Park, 2010, p. 5352).

Thus, following whey powder out of the body, tracing its transcorporeal ecological movements, illustrates that whey’s environmental impacts are not terminated by its conversion into nutritional

supplements, but rather diverted through the bodies of its more-than-human consumers. Put differently, and as we have argued elsewhere (Authors, 2019), whey's commodification represents only a partial fix to its ecological burden (Guthman 2015). This fix allows Big Dairy to defer the problems of nitrogen pollution to those tasked with filtrating water systems, and perpetuates the intensified, ecologically devastating farming practices synonymous with agro-capitalism. It bears emphasis that not all whey excess is converted into protein powder--farmers are still faced with the choice between spreading whey on land, feeding it into constructed wetlands, paying surcharges to send it into municipal sewer systems, converting it into animal feed, or subjecting it to costly ultrafiltration techniques. In each case, and at every point in the diversion process, whey poses environmental challenges, rendering the cultural preoccupation with protein a significant factor in the problem of global nitrogen pollution (Erisman et al, 2013). Nitrogen pollution is not a widely publicized environmental issue, certainly not compared with carbon emissions or, in the context of industrial farming, methane outflows. Yet, as activism and policy in response to whey dumping attest, its consequences for bodies of water and the life forms they sustain are substantial.

"Athletic bodies as ecologies embodied"

At the outset of this paper we drew attention to a dual absence in the sociology of sport and physical culture: the absence of the body in studies of sport and the environment, and the absence of ecology in theorizations of athletic embodiment. Whey protein powder refuses this distinction. Its origins as toxic waste and its residual implications for the global nitrogen cycle indelibly tie the making of fit bodies through health and fitness supplementation to ecological crises and multispecies injustices. It is to these relationships that we have afforded our analytical attention, and readers will likely have noticed that individual human bodies, and narrations of embodied experience, have gotten short thrift here in affording whey its ontological dues. It might therefore be best to think of our analysis more as a biography of industrialized whey powder than of those who consume it, at the expense of documenting the marked differences among groups of people who can and do so. In this sense we have reproduced some of the tensions outlined in our theoretical discussion of body-environment relations, and matters of subjectivity and corporeal experience in relation to protein consumption remain open lines of inquiry. But theoretical blindspots aside, tracking whey on its circuitous journeys has allowed us to see the far-reaching implications of its activities, but also to understand that these do not unfold innocently or predictably, and to thicken our analysis accordingly. In this respect, we have followed Neel Ahuja's lead by conceptualizing whey powder as agentic matter not beyond, but as, power and history, as "itself an ongoing site of social and political contestation" (Ahuja, 2016, p. 26). In rendering whey as such, we come to see ecologies as socio-natural lifeworlds through which bodies are materially co-constituted, and bodies as ecologies composed through dynamic, uneven, multispecies and multiorganismic entanglements.

These insights help disrupt the dualism that reifies the environment as a fragile, natural backdrop threatened or enhanced by sport and physical activity as cultural forms. Instead they allow us to conceptualize "the" environment as the very substance of bodily selves (Alaimo, 2010). They also guard against accounts of the agency of biological matter and the processual flow of becoming through movement as an intellectual end point, as significant in and of themselves. We propose that in the sociology of sport and physical culture there is much scope for examining the implication of sports training and fitness projects in ecologies, in ways that can complement and complicate individual, human-centric, or discursive conceptualizations of embodiment.

Given the multifold uncertain and unstable contexts in which we write, we do not proffer ecological embodiment as a stable concept to be applied to any possible range of objects in sport, health, and fitness. But we do find in it a generative sensibility for exploring the iterative, vital, political relations among what get called bodies and environments, which are becoming more and more relevant to the intellectual and political work of the sociology of sport and physical culture. It functions for us as an orientation that helps hold this relationality in view, in part by allowing us to stretch, if not escape, the confines of the only language we speak--a language that is persistently resistant to nonbinary configurations of "body" and "environment." This article has not fully escaped this bind, insofar there is no embodiment that is not ecological, nor an ecology that is not embodied. Despite this general truth, the differences and details matter, and it is our hope to contribute to research exploring how the making of athletic bodies is implicated in the lifeworlds of ecological matter and the political matters of ecological justice.

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