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## Child Ecologies in a Microbial World: A New Imperative for Childhood Studies

Zsuzsa Millei, Nick Lee, Spyros Spyrou, Marja Roslund, Asta Breinholt, Tuure Tammi, Beth A. Conklin, Sarah Alminde, Hanne Warming, and Riikka Hohti

Zsuzsa Millei is a professor in the Faculty of Education and Culture, Tampere University, Finland. She researches child politics in its broadest sense. Since 2021 she has led the Microbial Childhood Collaboratory, where they theorize child subjectivity and childhood inclusive of its biological basis to show the existing and emerging relationalities and mutual relevance between biological and social processes, and small- and large-scale biodiversity loss. She also leads the Microbial Childhood: Restor(y)ing Daycare Ecologies research project funded by Maj and Tor Nessling Foundation, Finland. Email: zsuzsa.millei@tuni.fi

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Spyros Spyrou is a professor of anthropology at European University Cyprus. His work is mainly located in the fields of childhood and youth studies exploring, among other things, the political lives of children and young people. He is coeditor of the journal *Childhood* and the book series *Studies in Childhood and Youth*, and a member of the Microbial Childhood Collaboratory.

Marja Roslund, PhD, is an environmental scientist at the Natural Resources Institute in Finland. Her research explores the intricate connections among biodiversity, microbiota, and human health. She is actively involved in several initiatives targeted to enhance human commensal microbiome and health, including microbially oriented rewilding and indoor biodiversity interventions across Finland. She is also a member of the HEDIMED (Human Exposomic Determinants of Immune-Mediated Diseases) consortium, which aims to identify disease mechanisms and environmental factors contributing to Type 1 diabetes, celiac disease, asthma, and allergies.

Asta Breinholt, PhD, is an assistant professor at Roskilde University, Denmark. A sociologist, she studies the consequences and reproduction of social inequality in education. The goal of her research is to understand the mechanisms through which inequalities in families' socioeconomic resources translate into inequalities in parenting practices, children's school experiences, and educational outcomes. Her work follows three research agendas: (1) What roles do families and schools play in the reproduction of inequality in education? (2) How does the social environment mediate and condition genetic effects on educational outcomes? (3) How does the interplay between social inequality and microbiota affect the reproduction of social inequality in education? She has been part of the Microbial Childhood Collaboratory since 2021.

Tuure Tammi, PhD, is an adjunct professor at the University of Oulu, Finland. His research joins the efforts for rethinking education and childhood with more-than-human theories and relational ontologies. His recent work on multispecies childhoods focuses on microorganisms, insects, noncharismatic animals, and companion animals with ethnographic, narrative, and philosophical approaches. He is a co-leader of the AniMate research group and the research project *Fellow Feelings—Co-creating Biodiverse Communities with Young People, Science, and Bioart*. Outside of academia he works for small independent record labels as a musician and producer and practices foraging and gardening.

Beth A. Conklin is an associate professor of anthropology at Vanderbilt University, USA. She is a cultural and medical anthropologist specializing in the ethnography of Indigenous peoples of lowland South America (Amazonia, Brazil). Her research focuses on concepts of the body and relational biology, health and healing, ritual, memory and mourning, the politics of Indigenous rights, and ecology and the intersections between environmentalism and Indigenous rights struggles. Her current work applies an analytic lens focused on human-microbial relations to rethink patterns of native Amazonian social, political, and ritual life by bringing more biodynamic, biospheric, and biopolitical perspectives into conversations about biosocial experience across the human life cycle.

Sarah Alminde, PhD, is a senior researcher at Roskilde University, Denmark. She is a childhood researcher particularly focused on the positioning of children, children's everyday life and rights, and the power relations among children, adults, and others. Her recent research work, inspired by childism, new materialism, and affect theory, has focused on listening to children and the limited understandings of children's everyday life. She is part of the Childism Institute and The Center for Everyday Life of Families in the Welfare State. Since 2021, she has been part of the Microbial Childhood Collaboratory.

Hanne Warming is a professor of sociology, childhood studies, and social work in the Department of Society and Business, Roskilde University, Denmark. Her research focuses on children—their everyday lives, lived citizenship, and how childhood studies can serve as both a sociological microscope for examining broader societal issues and change processes and a critical lens for rethinking adultist theories and norms. She heads the research group Social Dynamics and Change at Roskilde University and codirects the Childism Institute. She has been part of the Microbial Childhood Collaboratory since 2021.

Riikka Hohti is an associate professor of sustainable futures in education and ethics at the University of Helsinki, Finland. Her research interests include multispecies relations, feminist care ethics, and the atmospheric and material aspects of childhood and education. She has also developed postqualitative and multispecies ethnographic methods and theorized multispecies childhood. Currently, she leads the research projects Children of the Anthropocene—environmental atmospheres and multispecies collaborations (Kone Foundation)—and Figurations of the Child and More Than Human Politics of Childhood for the Post-Anthropocene: The Fossil, the Microbe, the Weather (Research Council of Finland).

*All bodies—child, animal, plant—are bodies sustained by life processes. Human as well as animal and plant bodies coexist with a multiplicity of microbial life. As symbiotic partners, human bodies are ecosystems of microbial life in a microbial world. In this way, microbes cannot simply be seen as disease-causing and human bodies as hosts of human-only life. Simplistic notions of the child as a unitary and social subject and the image of the agentic child are both questioned by this view. What if we considered for childhood studies the body's microbial constitution in a bacterial world? How would everyday life unfold as a more-than-human sociality in which children act, think, and feel on a daily basis? In this conversation article, seven multidisciplinary scholars address the following questions by grounding their responses in their respective fields, in childhood, and in their research interests: How do microbes and childhood matter in your research? Consider how the understanding of microbes as foundational for life influences your field of research. How does your research seek to engage the biosocial imagination and the challenge of integrating biological and social understandings of the child in fruitful and robust ways? How do considerations of microbes and childhood bring together multidisciplinary engagements?*

**Key words:** *concept of child, biosocial, interdisciplinary, multispecies relations, agency, more-than-human sociality*

Children in multispecies relations is a growing interest in the field of childhood studies (Tammi et al., 2023). These explorations view children as part of changing ecologies and the child as part of nature in relation with other beings. Yet still further work is needed to understand the child as a biological organism, as a nested organism entangled within other ecologies maintained by a myriad of life processes (McFall-Ngai, 2017). To highlight the child as a biological organism, in this paper, we use the understanding of the child as composed of human cells and of a vast number of microbial organisms (such as bacteria, fungi, or protozoa that outnumber human cells ten times), a “holobiont,” or child-ecosystem (Margulis & Sagan, 2002, p. 86). In other words, the child is not only positioned within multispecies relations but is itself a multispecies relation, mixed from the start. A relational sensibility that conjoins the understandings of the child-ecosystem with the social allows us to see the child as symbiotically entangled with other organisms (including humans), toxicities, and the human-made world, where the child and “the world is a joint product between the human and the non-human” (Fishel, 2017, p. 102). It also enables us to include in our view of childhood more-than-human worlds in which the child is also a part of a more-than-human sociality, where sociality does not refer only to humans but to microbial and other socialities as well. The concept of child-ecosystem is more than

symbolic and metaphorical, forcing us to pay attention to biological processes, relations, and socialities that unfold from gestation and in which microbes play foundational roles. Microbes are foundational to all life processes and

relations from which human capabilities, agencies, and intelligence emerge, including microbial, animal, plant, chemical, technological, and human relations. In an expansive view, the understanding of child-ecosystem leads us to explore broader ecosystems in which the child-ecosystem nests and associated political economies in new figurations giving way to a variety of new concerns about children's health, development, socialization, equality, agency, rights, participation, and so on.

In this paper, after Zsuzsa Millei, Nick Lee, and Spyros Spyrou lay down the understanding of child-ecosystem, seven scholars from different disciplines—Marja Roslund, Asta Breinholt, Tuure Tammi, Beth Conklin, Sarah Alminde, and Hanne Warming—reflect on related questions by grounding their responses in their respective research interests: *How do microbes and childhood matter in your research? Consider how the understanding of microbes as foundational for life influences your field of research. How does your research seek to engage the biosocial imagination and the challenge of integrating biological and social understandings of the child in fruitful and robust ways? How do considerations of microbes and childhood bring together multidisciplinary engagements in childhood studies?* A concluding reflection by a collaborator, Riikka Hohti, identifies some threads across the contributions put forth and highlights some ethical and political complexities and troubles that must be kept in sight for further explorations.

The first three coauthors consolidate the seven contributions to this article offering different perspectives on these questions that partly reflect their disciplinary concerns and sensibilities and their efforts to critique extant notions of the child and move beyond conventional understandings of their disciplines and fields. Though each piece is written by one or two contributors and aims to reflect its authors' perspectives, the article as a whole is an outcome of collective, collaborative thinking and writing that has taken place within the context of the Microbial Childhoods Collaboratory (MCC), an interdisciplinary research collective including social scientists, natural scientists, and artists experimenting with ideas of slow science (Stengers, 2017). MCC's work is focused on the relation between the microbial world and childhood and the need for a *biosocial imagination* in childhood research (Lee, 2013). In that sense, the contributions in this article have been informed by the exchanges among members of MCC which have been taking place over a period of four years, some face to face and others online, complemented with field visits in different countries. These ideas seek to challenge and expand our understanding of what the child is and how childhood is constituted when one begins to look at, and attach importance to, biological existence here captured with the microbial world. Collectively, the contributions offer a provocation for future research in childhood studies that takes seriously the biosocial imagination and the challenge of integrating biological and social understandings of the child in more fruitful and robust ways.

Biosocial imagination seeks to capture the ways in which researchers (and all humans) make sense of others and events by drawing on information about social and biological life processes. In calling on the concept of child-ecosystem, we wish to explore new possibilities for theorizing child subjectivity and childhood more generally *together* with a view to its fundamental, constitutive, biological basis. We wish, as well, to show more clearly the existing and emerging relationalities and *mutual relevance* between life and social processes (Lee, 2013) for theorizing and researching the child, children's *life*, and the matters and processes the child is entangled with, from the microscopic to the planetary. This paper / mini edited collection of perspectives responds to an overarching set of shifts in the field that decenter the child as individual/human using a lens of "microbial." Opening the biological and medical bases of childhood is certainly not new, and its association with racialization is an important aspect to keep in sight. Children have been considered as biologically malleable, for example, in gender clinics of the 1940s–50s with differing assumptions on the basis of race (see Gill-Peterson, 2018). Indigenous child bodies, such as the Sámi in Scandinavia, have been identified as malleable by colonial sciences, and a succession of eugenicists popularized Sámi inferiority late into the twentieth century and residential schools sought to shape children (Marttinen, 2005). Hence, the idea of children as malleable is deeply racialized.

The concept of child-ecosystem stems from the understanding that the human child is “an assemblage composed not only of somatic cells but also of many symbiotic species” playing critical roles in biological life, health and sickness” (Costello et al., 2012, p. 1255), thus what we perceive as a human body is not a homogenous unity of one species. As McFall-Ngai (2017) explains, viewing the body as an ecosystem allows us to rethink the role of bacteria and viruses in human health, as partners rather than only as disease-causing invaders (pp. 64–65). Besides the diversity of life existing with/in the perceived body, this microbially constituted being is also mutually entangled in an ecosystem where the diversity of this ecosystem (inclusive of its microbial constitution) is the key to health, im/balance, competition, and change (Costello et al., 2012). The need for microbial diversity also reflects the large-scale need for the diversity of living and life processes on Earth.

In foregrounding child-ecosystem, we seek to challenge simplistic notions of the child as a bounded entity, a unitary (mostly social) subject exemplified in childhood studies through the image of the agentic child. Child-ecosystem and the biosocial imagination this concept forces upon us help us to consider the biological as integral to the child’s constitution and subjectivity as a relational and hence interdependent entity while avoiding the temptation of reverting back to a notion of the child as a unitary and bounded object that exists apart from the ecosystemic world. As Lee (2013, p. 13) explains, the standardized and universalist notions of the child and childhood mostly draw on biology to discuss universal processes unfolding as physical development and maturation. Hence, research in childhood studies has dominantly focused on sociocultural-historical differences and multiple and dynamically changing childhoods in human societal contexts assuming the biological as the backdrop or the standard way of being and developing as humans. With child-ecosystem, we understand the child already as multiple relations, a multitude (as expressed by the science writer Ed Young [2016] in his book *I Contain Multitudes*) composed of dynamic and constantly evolving biological and ecological relations within larger ecosystems, thus far from uniform and static and more complex than is made meaningful in terms of only the social or culture. Consequently, the child-ecosystem is repositioned within other socialities, such as microbial communities, raising important questions about how then the social must be reimagined in multispecies communities a child is a member of and what capacities these multispecies communities afford to children and with what agencies.

Biological and ecological relations are often left without consideration given the child’s assumed biological uniformity (except in cases when biology became racialized) and unified subjectivity even in child development, a field that has concerns for children’s physical maturation. The reintegration of the biological into the study of childhood can also open childhood studies to more fruitful ways of conceptualizing the child as emerging through relations of material/biological *and* discursive/societal processes. Politics or biopolitics emerging from this conceptualization, on the one hand, hints to the human-directed regulation of the body through control and discipline (see Foucault [1997] and others on biopolitics). On the other hand, biopolitics must also consider biological life (not only as body) and the “impregnable nature” of biological life by human-directed politics and the resistance that biological life exerts in the face of or despite this domination (Malabou, 2016). Considering these two prongs of biopolitics, the politics and ethics of childhood need to be reoriented to life beyond exceptionally considering only human politics (Malabou, 2016). Child-ecosystem, in this way, gestures also towards those biological processes that exert power by resisting or eschewing human-directed politics despite human efforts to govern them. Child-ecosystem also draws attention to symbiotic processes without in any way attempting to romanticize or essentialize such relations (Haraway, 2017, p. 26). In many ways, therefore, our effort is to return to that old question “What is a child?” together with its ethics and politics, and to rethink it through this new child-ecosystem lens without in any way seeking to foreclose or essentialize an answer to a question that will likely always remain open.

Child-ecosystem then offers possibilities for creatively rethinking child subjectivity, avoiding humancentric views by acknowledging the radical interdependence and sociality of all life. It also sees the child not as an external

addition to the world (the child and the world) but as already part of the ongoing unfolding of the world—being with/of the world. More importantly, it argues that the very material/biological existence of the child—the child’s body—is itself a multiplicity that springs from the largely symbiotic relationalities that make up the body nested within the multiple ecosystems, which opens our thinking to different kinds of relation making, ethics, and politics. The latter is highlighted through our focus in the article on microbial life as constitutive of an expanded, relational view of the child-ecosystem and the world.

Recognizing microbial life also emphasizes how numerous social and biological processes are entangled in mutually defining ways that do not only inform and can shape a child’s sense of being and becoming. It also leads childhood studies researchers to ask different questions, acknowledging how the biological affects the social and vice versa and bringing into view relations perhaps less seen or explored before (see more in Lee, 2013). We are also inspired by what such a recognition may mean for a child’s emerging relations with the world— relation-making practices and the ethics and politics that such understandings and practices may ignite. Child-ecosystem contributes to and takes further to other important theorizing that seeks to reimagine the child within this more expansive, relational frame (see, e.g., the Common Worlds Research Collective’s work: <https://www.commonworlds.net/>). Within this new vision, microbial communities can serve as a figurative strategy to rethink current social and political concerns and help us imagine the power flows and circuits of biosocial events and relation making for childhood studies.

Below seven scholars in six different entries offer their own thoughts and insights into the potential of microbial thinking for childhood research.

## Environmental ecology and health

*Marja Roslund*

Key issues in environmental ecology include what factors influence patterns of biodiversity across different ecosystems and species interactions, what the environmental consequences of human activities are, and what strategies can be employed to conserve and restore biodiversity and ecosystem health. Nowadays, I have increasingly been involved in health studies due to the growing recognition that the environment and human health are deeply interconnected. This shift towards interdisciplinary research reflects the emergence of the planetary health concept, which emphasizes the interdependence of human health, environmental sustainability, and ecological resilience (Horton et al., 2014).

Previously, many industrialized cultures viewed humans as separate from and superior to nature, and therefore health systems focused on treating illness in humans only. In some ways, childhood troubles human separation from nature because children are considered to be closer to nature than adults, as pure, or innocent from society’s evils, yet still this notion keeps the binary of nature/culture intact. Taylor (2013) challenges the binaries of nature/culture and human/nonhuman and rejects traditional notions of purity and innocence by framing children as deeply entangled with nature and the material world. Thus, human health cannot be considered in separation from the environment. Recognizing partly this relation, environmental health studies have been focusing on the direct health consequences of pollutants and hazardous chemicals on humans, but they have not considered the indirect health consequences when pollutants alter the health-associated microbial communities that are vital to human health (Roslund et al., 2019).

Today, molecular technological advancements, followed by the completion of the Human Microbiome Project (The Human Microbiome Project Consortium, 2012) and comparative studies between patients with immune-mediated diseases and healthy children (e.g., Lehtimäki et al., 2023) have revealed the role of microbiota in

health and disease. According to the biodiversity hypothesis, the main reason behind the high incidence of noncommunicable immune-mediated diseases among urban children, including Type 1 diabetes, asthma, atopy, and allergies, is biodiversity loss in urban areas (Haahtela, 2019). This biodiversity loss limits exposure to diverse natural microbiota essential for immune system development in childhood. Microbes here point to a more relational and coconstitutive understanding of the child and the world.

To quantify the relationships between environmental and commensal microbiota, and immune regulation and overall well-being of children, we performed an intervention study at Finnish daycares (Roslund et al., 2021). Urban daycare centres' yards were the sites of intervention which were enriched with a forest floor and sod ground covering. Over a one-month period, children in the intervention daycares were guided through various activities including playing in the yard, planting, and crafting natural materials to ensure sufficient exposure to natural microbiota. Children's microbial and immunological profiles underwent significant changes just from interacting with high diversity of microbes in the soil (Roslund et al., 2021). These shifts in bacterial communities then enhanced the children's immune regulation.

In another daycare study, where children received sandbox sand enriched with organic soil rich in microbes or visually similar sand enriched with peat with low microbial richness, similar microbial and immune regulation changes in child bodies were observed (Roslund et al., 2023). Thus, the greenness, that is, vegetation coverage, does not explain the results; it was about the bacteria interacting in child bodies. These intervention studies shed light on the crucial links among child, microbiota, health, well-being, and the microbial environment. Taken together these studies are attempts to engage the biosocial imagination in novel ways, not only for the direct benefit of children's health and well-being, but also for understanding the limits and cultivating the potential of more-than-human socialities in the context of the microbial world.

By integrating environmental ecology, health studies, and the concept of child-ecosystem with childhood studies, we can ask:

- 1) How does cultivating microbial diversity in children's environments and bodies meet with local and global ecological, economic, and social policies? Does the need for microbial diversity trouble developmentalist global frameworks? In other words, do highly urbanized and industrialized environments with possibly lower microbial diversity improve or worsen children's health?
- 2) When children are understood as dynamic and relational ecosystems themselves, how can they be positioned within the interactions of microbial species across ecosystems? Can this perspective challenge Eurocentric and anthropocentric approaches to childhood, health, and ecology?
- 3) What are the microbiological consequences of human activities—such as biodiversity loss, pollution, and climate change—on children, and how can this knowledge address historical and ongoing structures of settler colonialism, capitalism, and neoliberalism that disproportionately affect children in marginalized communities?
- 4) How do sources and pathways of children's microbial exposure vary across diverse geographic, social, and cultural contexts, and how might multidisciplinary perspectives—including Indigenous and Black epistemologies—reshape our understanding of microbial relations and their implications for children's well-being?

## Social reproduction and mobility: A microbial perspective

*Asta Breinholt*

The key questions within social stratification consider what reproduces socioeconomic status and what creates social mobility. Early childhood has been the centre stage for understanding these mechanisms because, within this strand of research and despite critiques from childhood studies, near consensus has formed that socioeconomic differences in socio-emotional and cognitive skills develop before school age (see, e.g., von Hippel et al., 2018), and these skills lay the foundation for later socioeconomic achievement (Cunha et al., 2006). Social stratification research provides several explanations for this pattern. One strand of social stratification research explores how everyday parenting practices might differ by socioeconomic status (at the intersection of other social markers) and what skills they nurture, which might be differently valued by schools and other institutions (e.g., Lareau, 2011). Another strand of stratification research investigates socioeconomic status and childhood health and how those might shape children's skill development and later socioeconomic achievements (e.g., Harris & McDade, 2018). Everyday health practices and how these practices are socially conditioned become key to understanding the specific mechanisms of childhood socioeconomic status and health and later socioeconomic achievements.

The concept of child-ecosystem invites social stratification research to reconsider both explanations through a microbial lens. As Roslund points out above, environmental microbial diversity plays a central role in health and disease. Moreover, emerging research suggests that the human gut microbiome may mediate the relationship between socioeconomic status and health (Amato et al., 2021). Research suggests that in some contexts the composition of our gut microbiome differs by socioeconomic status for both children and adults (although see Seiskari et al., 2007, and consider that socioeconomic status might only be associated with the consumption of fresh vegetables and perhaps green and clean environments) and that the gut microbiome is potentially playing an important role in diseases like depression, anxiety, diabetes, asthma, obesity, and allergies (Amato et al., 2021). Early childhood is formative to health and the gut microbiome (Amato et al., 2021). However, we have yet to learn whether these associations among gut microbiome, socioeconomic status, and health are causal and, if so, in which contexts. And, before these causal relations are made, it is important to keep in mind their possible racializing aspects.

I suspect that parenting practices, health practices, and other relevant everyday practices affect the human microbiota and that the microbiota in turn affects children's health, skill development, and socioeconomic achievement. Social stratification research may gain new answers to the old questions of social reproduction and social mobility by including insights on the role of microbiota in health and disease and specifically the effects of everyday practices on the human microbiome. Put another way, through a more concerted effort at invoking the biosocial imagination, social stratification theory may be enriched with biological insights and offer much more nuanced explanations on social reproduction and social mobility that go beyond the well-established sociological factors linked to these processes. However, there must be careful ethical considerations always in place to keep in check racializing tendencies. Therefore, I suggest a new research agenda asking: (1) What everyday practices do account for different compositions of the gut microbiota in childhood? (2) How are these everyday practices embedded in larger structures of social inequality?

Answering these questions may help us understand why some children reproduce their parents' socioeconomic status while others do not. The answers may not be as expected—that is, socioeconomically advantaged families have access to more biodiverse environments and have microbe-friendly everyday practices, which provide their children with a microbial advantage. For instance, inner cities may attract the wealthy and highly educated (as is the case in northern Europe), hence providing the otherwise advantaged with less exposure to diverse microbial life.

Likewise, rich suburbs with their paved driveways, monoculture short-cut grass, and well-drained backyards may not provide as much exposure to diverse microbial life as we might think. Hence, empirical research on drawing on the child-ecosystem perspective is needed to reveal the role of microbes in complexifying understandings of social reproduction and mobility. An interdisciplinary and ethically informed sensibility that considers the biological and health sciences as significant contributors to childhood studies is an important first step in moving this kind of research agenda forward.

## Aerial contact zones: On the air, the microbe, and the child

*Tuure Tammi*

As in other social scientific and artistic fields, an interest is emerging in childhood studies regarding the roles of other animals in society along with the modes of collaboration, help, and exploitation that take place in human-animal relations (Tammi et al., 2023). This *animal turn* (e.g., Weil, 2010; Wolfe, 2009) is connected to broader ontological reconsiderations and a shift in worldview characterized as *ecological existentialism*—a movement from atomism to relations, and from certainty to uncertainty (Rose, 2011, pp. 2–3). The field of multispecies studies (van Dooren et al., 2016) seeks to develop approaches to better attend to the material-semiotic engagements among multiple species and the questions of accountability and justice that arise therein. “Species” in this context is framed as always multiplying their forms and associations (Ogden et al., 2013). Ethnography is often employed in multispecies studies to discuss in specificity “how a multitude of organisms’ livelihoods shape and are being shaped by political, economic, and cultural forces” (Kirksey & Helmreich, 2010, p. 545).

For our emerging biosocial, ecological, and microbial conceptualizations of a child, I would like to briefly pay attention to air. While diverse bodies and their material-semiotic interactions have become part of social theory, only little attention has been paid to them, and where this attention is found, bodies tend to be absent (Allen, 2020). Air can remind us about the ways in which multiple bodies form an ecology, a system through which they intertwine and transform on various temporal scales. Air is thus more a fleeting and unruly assemblage or a “contact zone” (Haraway, 2008) than a substance or a thing given the richness of stuff that diverse bodies bring to and take from it. Fibres, pollen, spores, toxins and other chemicals, dandruff, dead cells, sounds of play all compose and are composed in air. Air is also thick with matter originating from industrial production and lifestyles—machinic sounds, dust, microplastics, fumes, chemicals from cleaning liquids. We breathe and circulate both the physico-chemical spatiality of ourselves and other living beings and those of “anthropogenic” practices. Air can also tell us about the ways in which childhood is practiced and regulated. This is also so in indoor spaces, which are the dominant environments of contemporary childhoods, at least in the industrialized and urban world. What various bodies take from and bring into the *aerial contact zones* is a complex and political issue that also matters greatly to children.

An example of how aerial contact zones in indoor spaces can bring about particular versions of a child and a microbe is that of “mould schools” (e.g., Tammi, 2019). During the 2010s, several local protests were organized around Finland by parents regarding the healthiness of their children’s school building. I spent time in one of these locales and traced the complex processes that had led to the rotting of this school. I discerned that what the children breathed was a particular material and historical setting where multiple processes were complexly intertwined and feeding back to each other. Buildings and bodies were being co-produced through intermingling of material practices of building, maintenance, and schooling, technological developments, economic and political processes, flows of water and air, and changes in microbiota. The same “air” brought about different effects and affects to different child (and adult) bodies even in the shared aerial contact zone, aroused a great deal of speculation, and

shaped how the children attended to “the microbe” through monitoring their bodily responses in different spaces and through how their peer cultures took shape. The “indoor climate crisis” (Tammi, 2019) can be interpreted to rest to a large degree on politics in which microbial life, sociability, and agency were neglected until the emergence of human health concerns. Read affirmatively, the case unfolds as an example of the microbial and multispecies foundation of sociality, human life, and childhood whereas the body figures as unfixed and multiplying. In an important way, the case signals a clear shift away from childhood studies’ orientation towards the monadic, agentic child to a more critical, relational understanding of the child as an unbounded, ontologically malleable being who exists within and acquires meaning within multispecies relations.

Considering air as a contact zone can allow critical and generous examination of processes through which kinds of bodies, including their metabolic products, but also historical, political, economic, technological, and material processes meet. For our emerging transdisciplinary efforts in conceptualizing the child as ecosystem and microbial, this calls for biosocial imagination where bodies shape and are also shaped by zones of contact not usually seen as significant for investigations into what the child is. What is the child in and with the air? Or the soil (see Roslund above)? What could it mean for childhood practices to be attentive to the microbial or even “microbe friendly” (see Breinholt, Conklin, and Lee in this paper)?

Multispecies ethnography considers the worlds we all participate in making as “materially real, partially knowable, multicultural and multinatured, magical and emergent” (Ogden et al., 2013, p. 6). Letting more air flow into our analyses and conceptualizations, we might ask, once air is taken seriously, what else might we be missing from our current social critique? Then again, embracing the fleeting, transforming, and largely uncontrollable can spark imagination and respect towards that which is magical about the air, the microbe, and the child.

## Contributions to Indigenous studies

*Beth Conklin*

In re-biologizing models of early human development, the concept of the microbial child or child-ecosystem resonates with ideas and practices that have oriented childcare for generations of Indigenous communities. Throughout the world, Native people have recognized the bodies of infants and children to be uniquely open to and shaped by elements that they absorb from the people and places around them, often including local soils, water, plants, foods, and landscapes. As Western microbiology documents microbes’ essential roles in physical and mental development, Indigenous scholars are using scientific findings about microbes to reframe Native traditions in ways that broaden academic understandings of Indigenous ontologies. In Canada, Murdena Marshall and Albert Marshall, scholar-Elders of the Mi’kmaw Nation, developed the concept of two-eyed seeing to recognize parallels between long-standing Indigenous knowledge and recent Western science (Bartlett et al., 2012). This recognition is spreading globally as a resource for Indigenous health policy, for social-environmental activism, and for communicating the value of traditional practices to Western-educated Indigenous youth (Redvers et al., 2020).

While the specifics of “local biologies” (Lock, 1993) differ in each group, Indigenous models tend to see a child’s growth, maturation, and development as integrated biosocial processes comprising elements acquired through physical contact with other people, beings (plants, animals, spirits), and environments. Beyond influencing physical growth and bodily capacities, many people also see such elements contributing to an individual’s social identity (kinship affiliations, ethnicity) and cognitive, emotional, and psycho-social development. From within Indigenous models, the child is already seen as part of a world that is both social and biological, a world in which the biosocial imagination is already at work through worldviews and everyday practices.

In central Australia, babies traditionally were birthed directly onto the earth and ritually placed on the (microbe-rich) soil to establish the newborn's connection with the ancestral Land (Redvers et al., 2020). Among the Marind in West Papua, infants are seen as not yet fully formed. To become a complete person (*anim*), children must spend time in the forest, eat from the forest, and learn from the forest (Chao, 2021). Humans and forest entities must “share skin and wetness” by exchanging fluids across species. Parents press their babies' skin against the sago palm's bark, focus babies' attention on the tree's features, and involve children from a young age in transplanting shoots and working with sago pith (Chao, 2021). Each tangible encounter with plants and forest immerses the child in more-than-human microbial encounters and socialities. The child is being made and remade out of these multispecies encounters that transpire in the context of everyday life and the ongoing unfolding of the world, which is relational.

Among the Wari' of western Brazil, transfers of body fluids through breastfeeding, co-sleeping, and sharing food create a common substance that instantiates kinship and group identity (Conklin & Morgan, 1996). Recent microbiological research echoes these ideas, finding that Amazonian communities have distinctive gut microbiomes that differ from the microbiomes of neighbouring communities with different waters, soils, and foods. Microbiology also echoes the views of Wari' and many others that common biosocial identities develop through sharing *chicha*, a beverage traditionally made by women who chew maize or tubers so that bacteria and enzymes in their saliva turn complex carbohydrates into simple sugars. Fresh *chicha* is one of the most microbially dense substances in Amazonian life, and *chicha* sharing is a prime mechanism of microbiome swapping, hence kinship formation (Colehour et al., 2014).

In Amazonia, ideas about the porosity and fragility of infant bodies have motivated generations of Native parents to control how and when their offspring are exposed to new people, foods, and environmental elements, in complexes of varying local practices that anthropologists call *couvade* (cf. Rival, 1993). This Amazonian emphasis on controlling exposures resonates with science on the impact of timing on the infant microbiome, which finds that a too-early flood of diverse exogenous microbes can overwhelm the developing immune system (Blaser, 2015).

For Indigenous studies, public health, and pragmatic/political advocacy, two-eyed seeing is a keystone in developing approaches that highlight the biological effects of historical traumas. Land dispossession and disruptions of families, communities, and food practices manifest in microbiome-linked problems of diabetes, heart disease, inflammation, toxic exposures, and stress-related diseases. Australian Aboriginal and Torres Straits scholars and health professionals developed the concept of molecular decolonization in Indigenous-led work in the international First 1000 Days initiative (Redvers et al., 2020; Ritte et al., 2016). This initiative focuses on the needs of children from birth to two years of age—the dynamic period when establishing the microbial foundation for health is most vital. In collaboration with First Nations scholars in North America, Aboriginal and Torres Straits scholars are taking this concept globally to foreground intergenerational impacts on the human microbiome and genome of adverse experiences in utero and the postnatal period. In Canada, researcher Michael Yellow Bird, a member of the Mandan-Hidatsa-Arikara Nation, maps paths to healing through *neurodecolonization* based in reviving traditional practices of dietary diversity, fasting, outdoor exercise, and collective ritual in outdoor settings. The First Nations project Breastfeeding, Birth Work, and First Foods, launched in 2022, promotes the benefits of breastfeeding (including beneficial transfers of microbes between mother and infant) as a way to unravel historic trauma and reclaim a uniquely Indigenous source of nourishment through a return to community traditions (First Nations Development Institute, 2025).

Indigenous-led advocacy around molecular decolonization resonates with global Indigenous movements that increasingly foreground how the health of pregnant women and children connects to climate change, pollution,

chemical toxins, and loss of territory, all of which implicate microbial disruptions. In bringing the new microbial science of child-ecology into conversation with long-standing Indigenous understandings of child development and health, two-eyed seeing offers both powerful arguments and practical strategies to create healthier conditions for human and more-than-human life to flourish. Such a move also highlights the need for childhood studies to become more expansive in its interdisciplinary engagements by exploring more directly the role of the biosocial imagination in the field's encounter with Indigenous studies and knowledges.

## Childhoods, ecosystems, and value

*Nick Lee*

Childhood studies has often addressed alternate visions of the child as *human becoming* and *human being* (Lee, 2001). But if the body is an ecosystem, then whether children are “agentic,” “developing,” or both, children are intrinsically “more than human.” A picture of human lives as permanent, dynamic, multispecies biological entanglement that links the body intimately with the proximate living world raises interesting questions about how childhoods can be imagined and valued. We can ask what difference, if any, the child-ecosystem might make to the credibility of other, currently dominant, images that shape childhoods and childhood research in the Global North that frame childhood value. One such framing of childhood value has presented children as sites of investment by states (Lee, 2005, p. 11). Investment, in the form of mass education of the young members of the population, is returned with interest, in the form of tax revenue, once the young enter the workforce. Within this frame, the child-pupil is often required to turn their attention away from the fact of their embodiment and toward the schedules of lessons and tests that are intended to equip them for future participation in society. Even as it remains essential, embodiment becomes devalued within the process that raises the perceived value of the investment. Mundane practices in which embodiment is ignored or imagined as something that can be left behind have been routes to higher social status in the Global North. The concept of child-ecosystem, however, requires us to imagine that there is simply no way to leave. Regardless of social status, everyone, child or adult, is part of an ecosystem, a permanent, dynamic entanglement. This raises the question of how childhood value could be framed when leaving and ignoring embodiment are impossible.

Consider children as consumers of sweet carbonated drinks. They are not the only consumers of them, but are a significant market segment (Boyland et al., 2022). Diets rich in sugars reduce taste sensitivity and inhibit feelings of fullness (May et al., 2020). Sweet drinks can be habit forming because they can override these regulatory mechanisms. Value is created in the form of profit by packaging low-cost commodities (sugar, water) into relatively high-cost goods. Money is extracted while, in parallel, children's dental and metabolic health are degraded. Artificial sweeteners might reduce health impacts. However, there is evidence that they do not benefit weight loss compared to sugars even though they are less calorific. They have a negative metabolic impact that offsets calorie reduction, and there is evidence that this is due to them reducing gut microbial biodiversity and producing unusual chemicals that can foster Type 2 diabetes (Spector, 2024, p. 40). Further, artificial sweeteners, just like sugars, reduce taste sensitivity and fullness (Ebbeling et al., 2020). In this example, children have been framed as a market within which value can be created for drink manufacturers who are able to ignore the embodied unintended consequences of their strategy. Within this value frame, more-than-human life processes, such as the loss of gut microbes, are assigned the low value of a residue of core processes.

Can we then consider child-ecosystems to be sites at which different value frames compete at the cellular level, a million biosocial events a day? If so, what alternate value frames might be developed and how might they relate to child-ecosystems? Regulation of recipes may be part of governmental strategy here, though the shift from sugar to

artificial sweeteners is not a solution. Critical discourses do exist about sweetened carbonated drinks. These can be translated into attempts to limit children's consumption and to caution them against enjoyable experiences that can do them harm. Limiting children's sugar consumption risks setting a responsible and controlling subjectivity against their embodied sense in a repetition of the transcendence of embodiment discussed above. It also tends to ignore the fact that the "enjoyable" product has been designed, and that enjoyment itself has been entrained. A further alternative can be found in the taste-work reported by Coe, Manera, and Fooladi (2024), who work with children to practice tasting, to develop their taste sensitivity and thus cultivate their body sensations and their ability to form taste preferences based on those. This move returns attention and value to embodiment and is consistent with a recognition that neither embodiment nor the ecosystem that body belongs to can be left behind. Attending to the dynamic and inseparable constitution of the child-ecosystem enables biosocial imagination to escape extant sociologically framed understandings of the child that build on socially and economically driven value systems and leave behind the biological.

Beyond this, the concept of child-ecosystem, which, unlike previous usages of the ecological metaphor (e.g., Bronfenbrenner & Ceci, 1994) includes nonhuman species, could inform a distinctive research agenda. Even if we do not assume that the individual developing human is the appropriate unit of analysis, we can still consider the child-ecosystem as a site of intervention. This would mean shaping empirical questions according to identifiable objectives in, say, public health or education. Alternatively, we can ask whether and how children and/or their carers see themselves in the light of child-ecosystem as in some way bounded or integrated and, if so, bounded by what, integrated into what, and with what consequences for value? In other words, we can ask what happens when a general sense of multispecies entanglement contacts lived realities. Invoking the biosocial imagination in this way offers childhood studies, as a field, renewed possibilities for self-critique and a much more nuanced theoretical framing of the child which does not shy away from the biological but neither does it reify the biological at the expense of the social.

## **The microbial childhoods of children in vulnerable positions: Profound entanglements**

*Sarah Alminde and Hanne Warming*

As scholars in the field of social work and childhood studies, we believe that the microbial lens and the concept of child-ecosystem open new pathways of thinking and pose new questions for research with and about children in vulnerable positions. This entry will introduce some of these questions and new ways of thinking. Within this research field, key foci are children's development, well-being, and rights to participation. The microbial lens reconstructs the meaning of these foci. For example, in mainstream research, as well as in everyday work with children in vulnerable positions (e.g., children experiencing conflict in relation to parental separation, children in out-of-home care, children living in more than one home, or children without a home), there is often a narrow focus on children's lives as primarily shaped by their relations to what is regarded as crucial (human) others (Alminde, 2024; Warming, 2019). Furthermore, children and families are often perceived as independent units, which are the objects of research and social intervention. The microbial lens offers new ways of thinking about these relations. First, it is a productive metaphor for the profound entanglements that encourage us to leave the individual behind and understand the child as and as a part of multiple mutable (microbial) relations; microbial entanglement is also a material fact. Thus, the microbial lens offers a very concrete understanding of children's lives, relations, and emotions as entangled with more-than-humans: microbes, animals, materialities, spaces. With the microbial lens, it becomes visible that we are all—microbes, humans, etc.—constantly participating in making the world, and hence the new-materialist conceptualization of relational agency must incorporate microbes as having co-shaping agencies. These new understandings pose interesting new questions, such as: How can we understand

child development anew? How does microbial life thrive in the changing environment that is connected by a constant move between different environments? What does this mean for our understanding of what it means to thrive as a child?

As an example, we zoom in on children constantly moving between homes (e.g., due to parents' separation, out-of-home care, or homelessness) and the amount of time the child spends in different environments. The understanding of child-ecosystem makes it necessary to also consider how the child's everyday life needs to be considered anew in its entirety. This reconsideration must include the child's entanglements within other ecosystems (expanding also to other humans and animals as ecosystems with microbial life), spaces, and socio-physical arenas (that include, for example, the air) and their microbial inhabitants (see Tammi above). Drawing on Malabou (2009) and du Plessis (2022), we understand microbes as plastic materiality where "plasticity describes the capacity to receive form, as in the plasticity of clay, and the capacity to give form, as in sculpting" (du Plessis, 2022, p. 307). Thus, microbes, as the rest of us, are both everchanging shaped by their surroundings while also shaping these same environments and those who inhabit them. In this way, malleability here is not only applied to the child but to all humans and other animals, and the microbes.

Changes and adjustments in the microbiota can happen within one to three days because of changes in diet, location, climate, sanitation, etc. (see Roslund above). This adds an ecosystem or microbial dimension to the understanding and effect of moving between homes or not having a permanent home. When studying and assessing the life of children in vulnerable positions, the microbial lens thus encourages us to understand differently how everyday life and home environments are perceived as good and stimulating and how microbial life can be included to comprehend this. Furthermore, since through a microbial lens vulnerability is connected to something more than our human relations, we can ask whether what it means to be in a vulnerable position should be reconceptualized. The understanding of microbes as plastic materiality (du Plessis, 2022; Malabou, 2009) points to microbial vulnerabilities as something that is both inherited and shaped by surroundings. Vulnerability might be linked to environments and lifestyles that reduce microbial diversity (see Roslund and Breinholt above), which might enhance the destructive plasticity of microbes thus causing sickness, and/or the entanglements of this and other vulnerabilities.

Moreover, the concept of the child-ecosystem, in accordance with recent critics of the agentic child (see Lee above), proposes agency as relational rather than individual by including microbes in this relationality. Agency is thus understood as emerging from intra-actions and entangled becoming (Barad, 2007) with microbes rather than as a competence or action of the individual (e.g., child, adult, or microbe). With child-as-ecosystem, the relationality and entanglements are expanded, leaving traditional understandings of agency, as well as of development, well-being, and participation, behind. For social work and childhood studies, this means that in order to understand agency and participation, it is no longer enough to study the separate units: we must instead study the intra-actions in which agency and participation are becoming, and in this paper includes attendance to the microbes. Development and well-being can no longer be studied as something within the child or as just an output of human relations. We need to include a view to the more-than-human, including (though not limited to) animals, plants, and microbes.

## Concluding remarks—Child-ecosystem: Research-as-ecosystem

*Riikka Hohti*

The concept of child-ecosystem calls for thinking about the ways in which it might be actualized in doing research. What would methodologies drawing on child-as-ecology and biosocial imagination (Lee [2005] and above in all

contributions) look like? And what kind of research ethics might these approaches involve?

The viewpoints presented by the authors above hint at the scale and the level of complexity that come into play. The microbial perspective complicates some of the core issues within the societal study of childhood by unsettling common ideas of vulnerabilities and advantages (Roslund and Breinholt above)—what we inherit and what is influenced by the environment (Breinholt and Alminde & Warming above). It highlights biodiversity loss in the Anthropocene as something that is not only a material environmental issue. The large-scale biodiversity loss is mirrored in the microbial world and in our bodies, thus biodiversity loss falls on human bodies but also minds and societies—humans' humanity, in fact, their identities, health, capacities, and even socioeconomic prospects (Breinholt above). Thinking through the biodiversity hypothesis, childhood scholars are pushed to attend in new ways to the changes in the nested ecologies of children and their environments. The processes are far from one-directional, linear, or causal in singular terms and are not without histories. Constant consideration to the question thus is needed: How might the turn to the microbial repeat tropes about the child as malleable and ignite racialization?

Multi- or cross-disciplinary research is the obvious way to go, but it is only the first step. There are ontologies and epistemologies that come with different fields. At the level of knowledge production, a challenge is in the way in which scientific knowledge and its requirements traditionally constitute subjects and objects of knowledge. Concepts as analytic tools used to produce knowledge carry a self-duplicating potential that may “explain difference away” by grabbing things in their commonness as they are applied. This is why modern scholarly practices often validate and remake those worlds they already know rather than reaching out from their recursive circles to recognize new reality-making possibilities (de la Cadena & Blaser, 2018).

Another challenge comes from the fact that paradigms come with distinct implications for ethics. Recently Bodén (2021) discussed the assumed ethicality of presently favoured participatory methodologies, saying that all research settings, whether positivist and controlled or arts-based and child led, draw from complex sets of ethical underpinnings. Her observation has been taken further into the field of multispecies citizen science by Rautio and colleagues (2022), who propose new communities of practice that take seriously other-than-human beings as participants while fostering attentiveness to the ways in which their projects relate to the ethics of inclusion, ethics of fairness, and ethics of producing potential new worlds (Bodén, 2021).

The proposition with the concept of child-ecosystem, despite its fruitful intervening in limited environmental and ethical models, is not an innocent one, as it may potentially evoke overconfidence and increase hopes of control and governance alongside increased meticulous engineering for human-only health and well-being. There is the risk of using new knowledge for re-prioritizing, re-isolating, re-securing, and re-simplifying the human (economical) body. This is why research with the concept of child-ecosystem must employ a view of ethics that can be put to work as critique through the material and affective aspects of matters of concern and care (Puig de la Bellacasa, 2017).

One methodological response to child-ecosystem could be named research-as-ecosystem. My view of such research is inspired by Marisol de la Cadena and Mario Blaser (2018), who see ethnographic methodology as a possibility for making worlds by weaving together the theoretical and the empirical “so that thereafter they cannot be pulled apart” (p. 5). Slow and collective work across more-than-human contact zones would be the characteristics of research-as-ecosystem. Water and air (Tammi above) are perfect examples of such zones that include a multitude of possible relatings, from symbiotic partners and indifferent neighbours to predator and prey, colonizer and colonized, and researched and researcher, themselves reconceptualized as ecologies (van Dooren et al., 2016). This methodology is speculative-critical towards the status quo, the loose rhetoric of mutual flourishing (Ruddick, 2017)

and quick fix. Instead, it is attentive to the two-eyed view that finds connections between Indigenous worldviews and latest developments in science (Conklin above). It involves commitment to justice as a multispecies issue (Chao & Celermajer, 2023) despite the present inadequacy of existing conceptualizations or institutions of justice of doing so. As a portal (Roy, 2020) to greatly unknown and affectively ambivalent futures, it must deal with, and perhaps honour, uncertainty.

## References

- Allen, I. K. (2020). Thinking with a feminist political ecology of air-and-breathing-bodies. *Body & Society*, 26(2), 79–105. <https://doi.org/10.1177/1357034X19900526>
- Alminde, S. (2024). Listening to children: A childist analysis of children's participation in family law cases. *Social Sciences*, 13(3), 133. <http://dx.doi.org/10.3390/socsci13030133>
- Amato, K. R., Arrieta, M.-C., Azad, M. B., Bailey, M. T., Broussard, J. L., Bruggeling, C. E., Claud, E. C., Costello, E. K., Davenport, E. R., Dutilh, B. E., Swain Ewald, H. A., Ewald, P., Hanlon, E. C., Julion, W., Keshavarzian, A., Maurice, C. F., Miller, G. E., Preidis, G. A., Segurel, L., Singer, B., Subramanian, S., Zhao, L., & Kuzawa, C. W. (2021). The human gut microbiome and health inequities. *Proceedings of the National Academy of Sciences of the United States of America*, 118(25), e2017947118. <https://doi.org/10.1073/pnas.2017947118>
- Barad, K. (2007). *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. Duke University Press.
- Bartlett, C., Marshall, M., & Marshall, A. (2012). Two-eyed seeing and other lessons learned within a co-learning journey of bringing together Indigenous and mainstream knowledges and ways of knowing. *Journal of Environmental Studies and Sciences*, 2, 331–340. <https://doi.org/10.1007/s13412-012-0086-8>
- Blaser, M. J. (2015, March 1). Like genes, our microbes pass from parent to child. *Scientific American*. <https://www.scientificamerican.com/article/like-genes-our-microbes-pass-from-parent-to-child/>
- Bodén, L. (2021). On, to, with, for, by: Ethics and children in research. *Children's Geographies*. <https://doi.org/10.1080/14733285.2021.1891405>
- Boyland, E., McGale, L., Maden, M., Hounsome, J., Boland, A., & Jones, A. (2022). Systematic review of the effects of policies to restrict the marketing of foods and non-alcoholic beverages to which children are exposed. *Obesity Reviews*, 23(8), e13447. <https://doi.org/10.1111/obr.13447>
- Bronfenbrenner, U., & Ceci, S. J. (1994). Nature-nurture reconceptualised: A bio-ecological model. *Psychological Review*, 10(4), 568–586. <https://doi.org/10.1037/0033-295x.101.4.568>
- Chao, S. (2021). Children of the palms: Growing plants and growing people in a Papuan Plantationocene. *Journal of the Royal Anthropological Institute*, 27(2), 245–264. <https://doi.org/10.1111/1467-9655.13489>
- Chao, S., & Celermajer, D. (2023). Introduction: Multispecies justice. *Cultural Politics*, 19(1), 1–17. <https://doi.org/10.1215/17432197-10232431>
- Coe, J., Manera, L., & Fooladi, E. C. (2024). Exploring the senses of taste with young children: Multisensory discoveries of food. *Food and Foodways*, 32(1), 7–34. <https://doi.org/10.1080/07409710.2024.2298175>
- Colehour, A. M., Meadow, J. F., Liebert, M. A., Cepon-Robins, T. J., Gildner, T. E., Urlacher, S. S., Bohannon, B. J., Snodgrass, J. J., & Sugiyama, L. S. (2014, July 8). Local domestication of lactic acid bacteria via cassava beer fermentation. *Peer J*, 2, e479. <https://doi.org/10.7717/peerj.479>
- Conklin, B. A., & Morgan, L. M. (1996). Babies, bodies, and the production of personhood in North America and a Native Amazonian society. *Ethos*, 24(4), 657–694. <https://doi.org/10.1525/eth.1996.24.4.02a00040>
- Costello, E. K., Stagaman, K., Dethlefsen, L., Bohannon, B. J. M., & Relman, D. A. (2012). The application of ecological theory towards an understanding of the human microbiome. *Science*, 336(6086), 1255–1262. <https://doi.org/10.3389/fnut.2025.1550292>
- Cunha, F., Heckman J. J., Lochner, L., & Masterov, D. V. (2006). Interpreting the evidence on life cycle skill formation. In E. A. Hanushek & F. Welch (Eds.), *Handbook of the economics of education* (vol. 1; pp. 697–812). Elsevier.
- de la Cadena, M., & Blaser, M. (Eds.). (2018). *A world of many worlds*. Duke University Press.
- du Plessis, G. (2022). Destructive plasticity and the microbial geopolitics of childhood malnutrition. *Review of International Studies*, 10, 1–19. <https://doi.org/10.1017/S0260210522000328>

- Ebbeling, C. B., Feldman, H. A., Steltz, S. K., Quinn, N. L., Robinson, L. M., & Ludwig, D. S. (2020). Effects of sugar-sweetened, artificially sweetened, and unsweetened beverages on cardiometabolic risk factors, body composition, and sweet taste preference: A randomised controlled trial. *Journal of the American Heart Association*, 9(15), eo15668. <https://doi.org/10.1161/jaha.119.015668>
- First Nations Development Institute. (2025). Current projects: First foods and maternal health. <https://www.firstnations.org/projects/indigenous-breastfeeding-birth-work-and-first-foods/>
- Fishel, S. (2017). *Microbial state: Global thriving and the body politic*. University of Minnesota Press.
- Foucault, M. (1997). *Society must be defended: Lectures at the Collège de France, 1975–1976*. St. Martin's Press.
- Gill-Peterson, J. (2018). *Histories of the transgender child*. University of Minnesota Press.
- Haahtela, T. (2019). A biodiversity hypothesis. *Allergy*, 74, 1445–1456. <https://doi.org/10.1111/all.13763>
- Haraway, D. (2008). *When species meet*. University of Minnesota Press.
- Haraway, D. J. (2017). Symbiogenesis, sympoiesis, and art science activisms for staying with the trouble. In A. L. Tsing, N. Bubandt, E. Gan, & H. A. Swanson (Eds.), *Arts of living on a damaged planet: Ghosts and monsters of the Anthropocene* (pp. M25–M50). University of Minnesota Press.
- Harris, K. M., & McDade, T. W. (2018). The biosocial approach to human development, behavior, and health across the life course. *RSF: The Russell Sage Foundation Journal of the Social Sciences*, 4(4), 2–26. <https://doi.org/10.7758/RSF.2018.4.4.01>
- Horton, R., Beaglehole, R., Bonita, R., Raeburn, J., McKee, M., & Wall, S. (2014). From public to planetary health: A manifesto. *The Lancet*, 383, 847. [https://doi.org/10.1016/S0140-6736\(14\)60409-8](https://doi.org/10.1016/S0140-6736(14)60409-8)
- Kirksey, E., & Helmreich, S. (2010). The emergence of multispecies ethnography. *Cultural Anthropology*, 25(4), 545–576. <http://dx.doi.org/10.1111/j.1548-1360.2010.01069.x>
- Lareau, A. (2011). *Unequal childhoods: Class, race, and family life* (2<sup>nd</sup> ed.). University of California Press.
- Lee, N. (2001). *Childhood and society: Growing up in an age of uncertainty*. Open University Press.
- Lee, N. (2005). *Childhood and human value: Development, separation, and separability*. Open University Press.
- Lee, N. (2013). *Childhood and biopolitics: Climate change, life processes, and human futures*. Palgrave Macmillan. <https://doi.org/10.1057/9781137317186>
- Lehtimäki, J., Gupta, S., Hjelmsø, M., Shah, S., Thorsen, J., Rasmussen, M. A., Soverini, M., Li, X., Russel, J., Trivedi, U., Brix, S., Bønnelykke, K., Chawes, B. L., Bisgaard, H., Sørensen, S. J., & Stokholm, J. (2023). Fungi and bacteria in the beds of rural and urban infants correlate with later risk of atopic diseases. *Clinical and Experimental Allergy*, 53(12). <https://doi.org/10.1111/cea.14414>
- Lock, M. (1993). *Encounters with aging: Mythologies of menopause in Japan and North America*. University of California Press.
- Malabou, C. (2009). *What should we do with our brain?* Fordham University Press.
- Malabou, C. (2016). *Before tomorrow: Epigenesis and rationality*. Polity.
- Margulis, L., & Sagan, D. (2002). *Acquiring genomes: A theory of the origins of species*. Basic Books.
- Marttinen, T. M. (2005). Scandinavian anthropology, eugenics, and the post-colonial geneticization of Sami culture. *Acta Historiae Medicinae Stomatologiae Pharmaciae Medicinae Veterinariae*, 34(1), 68–85. <http://dx.doi.org/10.25106/ahm.2015.1111>
- May, C. E., Rosander, J., Gottfried, J., Dennis, E., & Dus, M. (2020, June 16). Dietary sugar inhibits satiation by decreasing the central processing of sweet taste. *eLife*, e54530. <https://doi.org/10.7554/eLife.54530>
- McFall-Ngai, M. (2017). Noticing microbial worlds: The postmodern synthesis in biology. In A. L. Tsing, N. Bubandt, E. Gan, & H. A. Swanson (Eds.), *Arts of living on a damaged planet: Ghosts and monsters of the Anthropocene* (pp. 51–73). University of Minnesota Press.

- Ogden, L., Hall, B., & Tanita, K. (2013). Animals, plants, people, and things: A review of multispecies ethnography. *Environment and Society*, 4(1), 5–24. <http://dx.doi.org/10.3167/ares.2013.040102%20>
- Puig de la Bellacasa, M. (2017). *Matters of care: Speculative ethics in more than human worlds*. University of Minnesota Press.
- Rautio, P., Tammi, T., Aivelo, T., Hohti, R., Kervinen, A., & Saari, M. (2022). For whom? By whom?: Critical perspectives of participation in ecological citizen science. *Cultural Studies of Science Education*, 17(3), 765–793. <http://dx.doi.org/10.1007/s11422-021-10099-9>
- Redvers, N., Yellow Bird, M., Quinn, D., Yunkaporta, T., & Arabena, K. (2020). Molecular Decolonization: An Indigenous microcosm perspective of planetary health. *International Journal of Environmental Research in Public Health*, 17(12), 4586. <https://doi.org/10.3390/ijerph17124586>
- Ritte, R., Panozzo, S., Johnston, L., Agerholm, J., Kvernmo, S. E., Rowley, K., & Arabena, K. (2016). An Australian model of the First 1000 Days: An Indigenous-led process to turn an international initiative into an early-life strategy benefiting Indigenous families. *Global Health, Epidemiology, and Genomics*, 1, e11. <https://doi.org/10.1017/gheg.2016.7>
- Rival, L. (1993). The growth of family trees: Huaorani conceptualisation of nature and society. *Man*, 28, 635–652. <https://doi.org/10.2307/2803990>
- Rose, D. B. (2011). *Wild dog dreaming: Love and extinction*. University of Virginia Press.
- Roslund, M. I., Parajuli, A., Hui, N., Puhakka, R., Grönroos, M., Soininen, L., Nurminen, N., Oikarinen, S., Cinek, O., Kramná, L., Schroderus, A.-M., Laitinen, O. H., Kinnunen, T., Hyöty, H., & Sinkkonen, A. (2023). Skin, gut, and sand metagenomic data on placebo-controlled sandbox biodiversity intervention study. *Data Brief*, 47, 109003. <http://dx.doi.org/10.1016/j.dib.2023.109003>
- Roslund, M. I., Puhakka, R., Nurminen, N., Oikarinen, S., Siter, N., Grönroos, M., Cinek, O., Kramná, L., Jumpponen, A., Laitinen, O. H., Rajaniemi, J., Hyöty, H., & Sinkkonen, A. (2021). Long-term biodiversity intervention shapes health-associated commensal microbiota among urban day-care children. *Environment International*, 157, 106811. <https://doi.org/10.1016/j.envint.2021.106811>
- Roslund, M. I., Rantala, S., Oikarinen, S., Puhakka, R., Hui, N., Parajuli, A., Laitinen, O. H., Hyöty, H., Rantalainen, A.-L., Sinkkonen, A., and the ADELE team. (2019). Endocrine disruption and commensal bacteria alteration associated with gaseous and soil PAH contamination among daycare children. *Environment International*, 130, 104894. <https://doi.org/10.1016/j.envint.2019.06.004>
- Roy, A. (2020). The pandemic is a portal. *Financial Times*, 3(4), 45. <https://www.ft.com/content/10d8f5e8-74eb-11ea-95fe-fcd274e920ca>
- Ruddick, S. M. (2017). Rethinking the subject, reimagining worlds. *Dialogues in Human Geography*, 7(2), 119–139. <https://doi.org/10.1177/2043820617717847>
- Seiskari, T., Kondrashova, A., Viskari, H., Kaila, M., Haapala, A.-M., Aittoniemi, J., Virta, M., Hurme, M., Uibo, R., Knip, M., & Hyöty, H. (2007). Allergic sensitization and microbial load: A comparison between Finland and Russian Karelia. *Clinical and Experimental Immunology*, 148, 47–52. <https://doi.org/10.1111/j.1365-2249.2007.03333.x>
- Spector, T. (2024). *Food for life: Your guide to the science of eating well*. Vintage.
- Stengers, I. (2017). *Another science is possible: A manifesto for slow science*. Polity Press.
- Tammi, T. (2019). Mold: Breathing well at the wastelands? Indoor climate change in schools and the daily lives of Arctic children. In P. Rautio & E. Stenvall (Eds.), *Social, material, and political constructs of Arctic childhoods: An everyday life perspective* (pp. 17–34). Springer.
- Tammi, T., Hohti, R., & Rautio, P. (2023). From child–animal relations to multispecies assemblages and other-than-human childhoods. *Barn*, 41(2–3), 1–17. <https://doi.org/10.23865/barn.v41.5475>
- Taylor, A. (2013). *Reconfiguring the natures of childhood*. Routledge.
- The Human Microbiome Project Consortium. (2012). Structure, function, and diversity of the healthy human microbiome. *Nature*, 486, 207–214. <https://www.nature.com/articles/nature11234>

- van Dooren, T., Kirksey, E., & Münster, U. (2016). Multispecies studies: Cultivating arts of attentiveness. *Environmental Humanities*, 8(1), 1–23. <https://doi.org/10.1215/22011919-3527695>
- von Hippel, P. T., Workman, J., & Downey, D. B. (2018). Inequality in reading and math skills forms mainly before kindergarten: A replication, and partial correction, of “Are Schools the Great Equalizer?” *Sociology of Education*, 91(4), 323–357. <https://doi.org/10.1177/0038040718801760>
- Warming, H. (2019). Messing with the emotions of the other exploring ambiguous youth-adult relations in a residential care institution: Exploring ambiguous youth-adult relations in a residential care. *Emotion, Space, and Society*, 32. <https://doi.org/10.1016/j.emospa.2018.05.005>
- Weil, K. (2010). A report on the animal turn. *Differences*, 21(2), 1–23. <https://doi.org/10.1215/10407391-2010-001>
- Wolfe, C. (2009). Human, all too human: “Animal studies” and the humanities. *PMLA*, 124(2), 564–575. <https://doi.org/10.1632/pmla.2009.124.2.564>
- Young, E. (2016). *I contain multitudes: The microbes within us and a grander view of life*. Ecco.