# Archaeological culture, please meet yoghurt culture: towards a relational archaeology of milk

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ABSTRACT – *Taking milk as a point of departure, we set out on a journey to explore the 'mutual becomings' of different bodies, species, and things. We argue that milk should be understood as a component in an assemblage that connects animals, humans, hormones, enzymes, bacteria, food, genes, technologies and material culture. These complex entanglements produced new, unexpected results and effects. Since they form part of this assemblage, all its components are profoundly changed. Focusing on this diversity of relations between humans, other creatures, things and substances is a key to an archaeology that does not radically separate humans and nonhumans.*

IZVLEČEK – *Mleko je izhodišče za pot raziskovanja 'medsebojnih vzpostavljanj' različnih teles, vrst in stvari. Mleko moramo razumeti kot komponento v zbiru, ki povezuje ljudi, živali, hormone, encime, bakterije, hrano, gene, tehnologije in materialno kulturo. Iz teh zapletenih prepletov vznikajo novi, presenetljivi učinki, ki spreminjajo vse vpletene komponente. Prav osredotočanje na bogastvo odnosov med ljudmi, drugimi bitji, stvarmi in snovmi je ključ za drugačno arheologijo, ki ne ločuje več ostro med ljudmi in neljudmi.*

KEY WORDS – *archaeology; milk; gut bacteria; companion species; assemblages; relations; practices*

## Introduction

Archaeology is about long-term patterns of human entanglements in the material world. We are what have become by being entangled in webs of dependencies, with humans and nonhumans. And a key to an archaeology that does not radically separate humans and nonhumans is to approach the diversity of relations between humans and the material world inhabited by other creatures, things and stuff.

I argue for a different sensibility that allows us to experience relations between human persons and other materialities as less hegemonic. I argue for the dissolution of ontological boundaries, more symmetry and democracy between humans, animals and things. In this ways, the entities we study can be seen as assemblages of heterogeneous materialities, which exchange properties, stuff, and produce surprising and interesting effects. We can focus on the 'mutual becoming' of different assemblages that include humans and other companions.

This paper is about milk, not as an inert substance that can be studied in isolation, but as a messy encounter, a knot, an element in an assemblage that connects animals, humans, hormones, enzymes, bacteria, food, genes, technologies and material culture. These complex entanglements have produced new, unexpected results and effects that we can see in archaeological record.

## Archaeology of milk

Impressive developments in archaeological science have provided new ways to study material traces of humans' consumption of animal milk. Organic residues preserved in pottery vessels provide direct evidence that people drank milk in the Neolithic, from the Near East and south-eastern Europe, North Africa, to Denmark and the British Isles (*Dudd, Evershed 1998; Evershed* et al. *2008; Craig* et al. *2005; Dunne* et al. *2012; Copley* et al. *2003; Šoberl* et al. *2008; Budja* et al. *2013*).

DOI: 10.4312/dp.42.19

This new evidence pushed the beginning of the consumption of animal milk back to the seventh millennium BC and links it with the domestication of animals and introduction of pottery technology. Some researchers argue that once animals were domesticated, the potential benefits of these products would have been exploited rapidly (*Rollefson, Kohler-Rollefson 1992*). Other even suggest that the domestication of sheep, goats and cattle in the Near East could have been at least partly motivated by a desire for milk (*Helmert, Vigne 2007*).

As raw milk lipids absorbed in pottery are rapidly destroyed by burial, the high frequency of ruminant milk lipids in vessels could indicate that they were used to process (heat) milk in operational sequences of dairy production. The presence of mid-chain ketones, which are lipid pyrolysis products, suggests that dairy products were heated in these pots (*Craig* et al. *2005*). The detection of milk lipids in specialised vessels similar in form to modern cheese strainers provides compelling evidence that the vessels were used to separate milk curds from whey (*Salque* et al. *2013*). This new evidence emphasises the importance of pottery vessels in processing dairy products lactose-intolerant prehistoric farming communities, particularly in the manufacture of reduced-lactose milk products. Analyses of stable isotope ratios in the tooth enamel of cattle has provided evidence of seasonal herd management and weaning of calves that indicate cattle management for dairying (*Balasse 2003; Balasse* et al. *2012*).

On the other hand, palaeogentic analyses have clearly demonstrated that the first farmers to have consumed dairy products were clearly not able to consume milk as adults (*Burger* et al. *2007; Burger, Thomas 2011; Leonardi* et al. *2012*).

Milk lipids in pots are found more frequently in areas where cattle are abundant in archaeological record (*Evershed* et al. *2008*). Studies have shown a significant geographic correlation between high diversity in cattle milk genes, the locations of the European Neolithic cattle farming sites, and present-day lactose tolerance in Europeans, suggesting a complex gene-culture co-evolution between cattle and humans (*Beja-Pereira* et al. *2003*). The trait of lactase persistence emerged at *c.* 5500 somewhere in the Carpathian basin or central Europe (*Itan* et al. *2009*). The fact that human bodies adapted to digesting lactose so late means that there was not been strong selective pressure on drinking milk. Obviously, there were other ways of obtaining the benefit of milk than adapting body, *i.e.* by harnessing the material culture and work of microbes.

It appears that the consumption of milk cannot be clearly separated into 'cultural' and 'natural' domains. The biological aspects of human milk consumption and its evolutionary history are clearly enmeshed with cultural practices and preferences.

**Flat ontology: relations, networks and assemblages**

One of the most significant developments in modern science has been in the formation of two separate domains. On the one hand, we have 'nature', the realm of natural sciences, exploring causal interactions between material things, and on the other, 'culture', the domain of social sciences, studying the socially constructed reality of institutions, ideas and interpretations. Sciences have been busy keeping the domains separated by carefully sorting phenomena into each of them; but this process of 'cleaning' is also its greatest drawback (*cf. Latour 2002*).

However, in recent decades there has been a resurgence of studies that challenge this rigid division and focus on the messy borders between the two domains, studies that tackle the dirty and messy way in which both domains are entangled in a web of mutual relations. We have the 'multi species' or animal turn (*Choy* et al. *2009; Mullin, Cassidy 2007; Kirksey, Helemreich 2010*), studies of the 'human/animal interface' (*Birke 2009*), 'inter-species' (*Livingstone, Puar 2011*), 'post-human' (*Haraway 1991*) or 'non-human' (*Wolfe 2009; Callon 1986*), 'other than human' (*Hallowell 1960*) and 'more than human' (*Whatmore 2002*) approaches which question the hegemonic and rigid divisions between domains.

It turns out that things and phenomena that are taken to be either natural or social are usually some messy mix of both, enacted through webs of associations and relations of different kinds. This is the main concern of science and technology studies (*Latour, Woolgar 1979; Latour 1993*), for example, which effectively demonstrated that the modern way of separating nature from the social world is historically contingent.

The main idea is that there is no separate nature and culture, but what Donna Haraway (*2003*) calls 'naturecultures' or what Bruno Latour refers to as 'collectives' (*2005*). This attentiveness to associations now tends to circulate under the shorthand of Actor-Network Theory (ANT) (*Latour 2005*).

Things come into being and exist by participating in an emergent web of materially heterogeneous relations. Gilles Deleuze and Félix Guattari (*1987.88*) talk of '*agencement*' (inadequately translated into English as 'assemblage'), ANT talks of the 'actor-network' (*Latour 2005*).

In this perspective, agency is not something possessed (solely) by humans, or nonhumans, for that matter. Agency is about the ability to respond, to change things, about the "*possibilities of worldly re-configurings*" (*Doplhijn, Tuin 2012.55*), and it enlists nonhumans as well as humans. Agency is distributed rather than situated in a hegemonic subject-object relationships; it is a result of complex heterogeneous entanglements, networks, imbroglios, assemblages.

This is a flat ontology, in which all entities – animate and inanimate, human and nonhuman – are accorded equal treatment and ontological status (*Byrant 2001*).

These approaches are part of a wider turn towards matter itself. Matter is interesting again; materiality is no longer passive, inert matter, shaped by determinist, causal schemes, but rather something vital and imbued with its own agency (*cf. Bennett 2010*).

How can one study milk, then? Milk does not fit simple divisions between human/animal, cul-ture/nature. The human consumption of animal milk emerged through new, historically contingent relations between humans and animals that were enacted at the beginning of the Neolithic. These relations produced new things, effects, and associations. To study this complex of entanglements, assemblages, we have "*to follow the imbroglios wherever they take us*" (*Latour 1993.3*).

## Assemblages

In archaeology, an assemblage is conventionally understood as a "*group of artefacts recurring together at a particular time and place, and representing the sum of human activities*" (*Renfrew, Bahn 2008. 578*), a passive reflection of either ethnic/cultural groups or functional toolkits. In art, an assemblage is a work produced by the incorporation of everyday objects into the composition. Although each non-art object acquires aesthetic or symbolic meanings within the context of the whole work, it may retain something of its original identity. This is closer to the modern understanding of assemblage in archaeology, where an assemblage is understood as a more or less deliberate association of objects brought together in the context of some, possibly ritual, activity. This notion of assemblage in archaeology is implicit, for example, in discussions of structured depositions (*cf. Pollard 2001; Bradley 2005*).

However, such understandings of assemblages imply a divide between human agents – those who arrange or assemble – and the passive things that have been arranged and assembled together. This idea of human agency imposes a vertical, hierarchical ontology based on subject/object relationships, with humans at the top and animals, plants, and things at the bottom.

More recently, however, assemblage has gained traction as a translation and appropriation of the concept designated by the French word '*agencement*' in the work of Gilles Deleuze and Félix Guattari (*1987*). In this form, assemblage has been increasingly used to designate not a static configuration, arrangement or a state of affairs, but rather a process of the arranging, becoming, organising, emerging of heterogeneous bodies and things that come "*in connection with*" one another (*Kennedy* et al. *2013.45*).

Organisms are not assemblages; they are organically connected into wholes in which each organ is vital for the coherence of the organism. But assemblages are not seamless wholes. While they appear to function as a whole, their components can be taken out of a system and 'plugged' into another, where they play a different role, and still work (*DeLanda 2006. 10–11*). This makes assemblages more resilient and open to change. Assemblage works on various spatial and temporal scales and can hence be viewed more as an 'ecologies' rather than organisms (*DeLanda 2006.10*): "*allowing the possibility of complex interactions between component parts is crucial to define the mechanisms of emergence, but this possibility disappears if the parts are fused together into a seamless web*".

Emergent properties are signs that an assemblage is real. The effects, the agency, of the assemblage are emergent properties. The relationship between an assemblage and its components is complex and non-linear: assemblages are formed and affected by heterogeneous components which may be assemblages themselves, but may also act back upon these components, imposing restraints or adaptations in them.

One of the main features of assemblage is that it is able to retroactively affect its parts.

Jane Bennett's (*2010.20–22*) sees assemblages as a form of distributive agency and focuses on how materialities emerge and circulate within an assemblage. The resulting actions, are distinct from the power of each materiality considered alone. They are multiply organised into a relational whole, one in which the collective is defined by its internal relations.

In addition to their openness to new connections, there are spaces of potential, spaces of non-realised becomings, or virtuality, which limit what an assemblage can do. An assemblage is never a solid block, but an open-ended collective, a "*non totalizable sum*". An assemblage does not only have a distinctive history of formation, but a finite life span (*Bennett 2010.13*). An assemblage is always already a becoming.

Donna Haraway emphasises that "*history matters in naturecultures*" (*Haraway 2003.3*), but this history is not a (biological) evolution for some entities and (social) history for others, deepening the gap between nature and culture. As Bruno Latour (*1993. 82*) says, "*history is no longer simply the history of people; it becomes the history of natural things as well*". Histories of assemblages acknowledge the intimacies, entanglements, mixtures and violence which inform and limit us (*Haraway 2003.20*).

## Companion species

'Domestication' is an idea born with the Enlightenment that presupposes a clear distinction between the natural 'wilderness' of animals and their cultural 'domestication' (*Cassidy 2007.1*). Domestication is thus seen as a specific animal state or form, the result of a oneway relationship, whereby humans actively domesticate passive, biological, wild animals by forcing them into a new domesticated, cultural state (*Mlekuž 2013*).

However, in order to be more than an empty word, domestication has to be explained by focusing on historically specific material practices and relations between humans, animals and material culture. When speaking of the processes of domestication, we also need an alien phenomenology that is able to shift from the perspective of humans to cows (for example, "*History According to Cattle*", an exhibition which "*exhibits bovine culture and the relationship between cattle and their companion species*" (*Gustafsson, Haapoja 2015.7*)).

However not only cows domesticate people; many different creatures, stuff, material culture and other things are involved in, and contribute to, the process of domestication. Thus, rather than a clearly defined state of animals, domestication could be understood as an assemblage containing many components, including humans and animals, in the process of becoming arranged or fixed together. Domestication is a fragile ecology of humans, animals, material culture and stuff that emerged through practices and material relations and which retroactively affects all sides. Sheep, cows, but also humans are the effect of webs of genetic, nutritional, agricultural, economic, environmental and technical relations that unfolded over millennia. They emerged through webs of relations and practices, from herding, caring for, fighting back, milking and eating. The result is an increasingly complex assemblage that has produced surprising effects.

So, to dumb down this thesis, it is not enough to say that humans domesticate cows and sheep, we must also say that cows domesticate humans (*cf. Budiansky 1992*). However, if humans belong to an assemblage involving cows, we must also account for other components of the assemblage, such as other animals, plants, bacteria, material culture and substances. Living with animals is a material practice. Material culture such as corrals and pens emerged to shelter animals, but also to concentrate people, animals, things, and substances together, and mix or separate into distinct categories, such as bulls, heifers, cows, calves and weaners. They made for close contact between animals and humans, the exchange of substances and bacteria, and structured face-to-face interactions, and reduced the possible outcomes of such interactions (*cf. Mlekuž 2013*). Domestic animals, cows, sheep, goats as well as humans, are enacted through these material practices (*Law, Lien 2013*). What we have here are not merely domesticated animals, but different companion species (*Haraway 2008*), species that accompany each other for millennia, entwining their histories. Dogs, sheep, cows, and goats are companion species to us, and cereals, legumes, mushrooms and the bacteria living in our gut are too. Companion species do not merely live next to each other, but are in an interrelation of co-constitution. Influences are not simple: what is at stake here are lives and survival (*Haraway 2003; 2008; Tsing 2012*).

From the evolutionary standpoint, the aim of biological organisms is to reproduce. To do this, cows need to escape predators – such as wolves, keep open grasslands to grow and being able to produce offspring. Through domestication, cows recruited humans to protect them, to fight predators and to clear woodland, by seducing humans with their taste, fat and milk. As humans became more entangled in the bovine life, selective pressures were exercised on human beings, such that our social relations changed, as we adapted culture to raise and herd animals. Furthermore, as diets, and ultimately lives, became more dependent on meat and milk, human bodies also changed (*cf. Bryant 2011.18*).

So what we are studying here are messy contact zones where the boundaries separating nature from culture have broken down, and where encounters between humans and other beings generate mutual ecologies and co-produced niches (*Kirksey, Helmreich 2010.546*). Donna Haraway claims that beings do not exist as independent entities, but only in relations; we continue into each other, without clear boundaries limiting/defining entities previous to the relation (*Haraway 2003; 2008*).

**Relations and practices**

Understanding domestication as an assemblage requires attention to the relations between components of assemblage. Everything – subjects, objects, species, things – is produced and enacted through relations. Thus, as Donna Haraway (*2003.24*) says, "*The relation is the smallest unit of analysis, and the relation is about significant otherness at every scale*".

What defines animals and humans is what they actually do to each other and not some a priori essence or status. Therefore, domestic cows are being done through the specific actions done to them. However, they are not passive things being shaped into a specific cow form. They present a series of resistances and their own agencies. Most people who work closely with them know that, with animals "*you aren't going to get to do it the way you want*" (*Cote 2004. 9*). Domestication often invokes subordination and domination (*cf. Ingold 2000.61–76*). However, all practices of human animal interactions require both sides to be available and attuned to each other. Both, humans and cows, transform the practices that articulate them into what Viviane Despret (*2004.133*) calls an 'anthropozoogenetic practice', a practice that constructs animal and human through situations in which both humans and their cow domesticate each other. These activities establish relations that have complex and often unpredictable and surprising effects on both sides. The most interesting characteristic of practices that may be defined as practices of domestication are articulation of new relations, new ways of being human with non-human, human with cow, cow with human (*Despret 2004.125*).

Animals can be reduced to raw materials, as food and also antlers, horns and bones and hides. Some animals are more suitable than others for this. Sheep and goats, for example, reproduce ten times faster than cattle. But even these practices require specific relations to emerge. A sheep is not only an individual animal with an economic value; it is first of all part of a herd. A herd requires long-lasting relations of care, and this is inseparable from geography, from topography and from meteorology (*Law, Mol 2008. 64*). The shepherd cares for individual sheep, of course, but first of all for the herd as a whole, which is more than sum of individual sheep. Individual sheep can be transformed into raw material, whereas the herd must not be lost; it must increase, which means that pastoralists try to avoid any unnecessary slaughtering of animals. This leads to a "*very careful life*", whereby households try to avoid sharing meat with other households, resulting in self-sufficient, solitary isolated communities, lacking social interaction and political institutions: "*the successful pastoralist hoards rather than hosts*" (*Paine 1971. 167; Ingold 1980*).

On the other hand, when usually large, slow-growing ungulates like cattle are reared for milk, they become food producers, workers, rather than food itself. They contribute their work, converting cellulose into milk. Milking is an essential part of their everyday care. The focus of care is on the individual animal, with her own identity, skills, biography. Daily care requires the development of skills and knowledge on both sides. A milk cow is not just born; it is produced along with the milker through the daily practice of milking. This also means a greater involvement of humans, and therefore increased demand for labour. The dairy pastoralist's wealth in large stock is therefore equal to the abundance of the labour force, usually women and children (*Ingold 1980*). Wealthy owners whose herds exceed the maximum manageable size, loan or give some animals to other households. Conversely, if someone is short of animals, they may seek gifts or loans from the betteroff (*Dahl, Hjort 1976.136–37*).

Animals produce milk for the household where they live, irrespective of who owns a particular animal; however, the owner retains control over the slaughter of an animal and over its offspring. This establishes a network of social relations between households, which are reflected in herds. Animals become a medium and symbols of social cohesion (*Evans-Pritchard 1940*).

This means that it is hard to predict the outcome of individual practices and relations. Assemblages are full of surprises; they are creative. They have unpredicted effects and make new things. However, to say that they make new things tells us nothing about the desirability of new things (*Law, Mol 2008*).

**Milk as stuff**

Milk is a foodstuff, food; but first of all, stuff, matter. As Annemarie Moll (*2002.42*) says "*matter isn't as solid and durable as it sometimes appears*". There are numerous forms of resistance in the process of obtaining milk from animals. Milk cannot be simply extracted from animals, perhaps by force; it requires co-dependency. Obtaining milk from animals enacts practices, bodily routines, material culture and knowledge. And this knowledge is enacted through practical material events.

Milking is a specific physical encounter, with its own temporality in the daily and seasonal cycle. The daily interaction of milking establishes relations of closeness between animals and people, structures the pattern of interactions and practices, and defines, maintains and contests the social roles of both animals and humans. It involves close, physical contact between animal and human, relations of mutual trust (*Bock* et al. *2007.112*).

But milk is food for infants. To be able to produce milk, a cow must first calve. Milk is first of all food for calves, lambs and kids. Different animals produce different quantities and qualities of milk, in a specific rhythm and composition tailored to nurture their own species. Thus for cows, the lactation period normally lasts 305 days; however, among 'primitive' animals that have not been 'upgraded', the period can be much shorter, up to 6 months. During the lactation period, milk production decreases, and after approximately 300 days, it may drop to some 15–25% of its peak volume. After this period, the cow is usually 'dried off', *i.e.* not milked, so that the udder can regenerate before the next calf is born. The whole cycle then starts all over again, normally for five to seven years.

A calf needs about 1000 litres of milk for growth, which is exactly the quantity which the wild cow produces for each calf. As milk is food for calves, no milk is produced without them. Thus humans compete with calves for milk.

Cows can be milked only after the activation of a neuroendocrinal mechanism that releases oxytocin into the blood stream; this forces the expulsion of the milk from udder. This is the so-called milk let-down reflex, a complex ecology within the cow's body, part of the cow's rich and complex materiality (*Costa, Reinemann 2004.1*).

However, this embodied ecology is not isolated; it is coupled with other bodies and the environment. Neuro-endocrine mechanism of milk ejection is activated by the presence of a stimuli evoked by sight, smell, and sound from the nursing calf (*Costa, Reinemann 2004.1*). Oxytocin is a substance that dissolves boundaries, breaking down the border between cow and calf.

The effect of the let-down reflex gradually diminishes as the oxytocin is diluted and decomposed in the bloodstream, disappearing after 5–8 minutes. If the milking procedure is prolonged in an attempt to 'strip' the cow, an unnecessary strain is put upon the udder; the cow becomes irritated and may become difficult to milk.

Mammals have different ways of producing milk. Dairy cows store less than 30 percent of the total milk yield volume in the cistern; the remainder is stored in the alveoli and must be extracted by invoking oxytocin. In goats and sheep, cisternal milk, which can be extracted without activating the milk let-down reflect accounts for up to 75% in goats and up to 50% in sheep. However, even in small ruminants, oxytocin-mediated milk ejection produces milk with higher fat content (*Costa, Reinemann 2004. 1–2*).

In order to obtain milk, the milker must enter into a relationship with a cow as a calf. This is done by hijacking the cows's milk-let-down reflex either by using body techniques or material culture. Usually the calf is shown to the cow to stimulate milk flow. If the calf is slaughtered, since it is a competitor for milk, material culture can also be harnessed to break the boundaries between bodies and stimulate cows

to produce milk. Among the Nuer in East Africa, it is customary to use calf dolls; when a calf dies or is slaughtered, it is stuffed with straw and placed in front of the cow to stimulate milk flow. There is also a technique, ethnographically well documented in Africa, which consists of blowing into the cow's vagina, either directly from the mouth or by means of a tube, in order to stimulate milk flow (*Le Quellec 2011*). We have abundant pictographic evidence for this technique in Saharan rock art.

Milking is a physical skill, knowledge and material practice that establishes a relationship of care between cow and human and must be both. The milker and animal respond and engage with one another in a multitude of subtle ways. Relations between bodies that allow milking can be described as affects. Affects are forces of encounter, visceral intensities, modes of the body's interactions with its surroundings and other bodies, the resonance of bodies in continuity and movement. Affect belongs to the realm of potential, as tendencies or incipient acts, indeterminate and emergent. In many cases, affect is never actualised in action and remains virtual. An affect is independent of conscious perception and language, as well as emotion; it is a purely autonomic, non-discursive, non-representational reaction to other bodies (*Massumi 2002.28*). Affects help us to see beyond the body as an individualised entry and grasp the interconnected nature of bodies of various kinds. Affect is the capacity of bodies to enter into relations. As Bruno Latour says (*2004.225*), "*to have a body is to learn to be affected, meaning 'effectuated', moved, put into motion by other entities, humans or nonhumans. If you are not engaged in this learning, you become insensitive, dumb; you drop dead*."

In this way, we can see bodies not as actualised objects, but carriers of potentials, forces of individuation, expressions, realised through an interface with the world. Instincts such as milk let-down do not have to be taken as reflex actions, but as accumulated affects, condensations of habits that became innate through evolution (*Parikka 2010.24*). In this way, cows can learn to let down milk just by hearing the familiar sounds of milking preparations.

What I am saying is that a cow, an historically specific cow (along with the person who milks it) is a result of affects sedimented through bodily relations, through practices of milking. Practices are a somewhat patterned weave of relations, and milking is the creation of a cow (together with the milker) in particular ways. We may think of this as an intricate choreography; but if this is a choreography, then it takes effort, work, continual reworking, and is more or less precarious (*Law, Lien 2013*).

**Milk as food**

Milk is a foodstuff, stuff that nurtures the consumer. The substances in milk provide both energy and the building materials necessary for the growth of infants. Milk is "*vibrant materiality*"; it affects the bodies that consume it. It "*increases human flesh*" (*Bennett 2010.137*) by making tissues grow, bodies fat and bones strong.

All mammals produce milk. It is something we humans share with other mammals. This common mammalian heritage allows us to establish specific relations with other mammals through relations of consuming milk. All mammals are totally dependent on their parents or other caretakers for the provision of many of the necessities of life. The developing mammal moves from complete dependence on mother's blood when in the uterus, to total dependence on mother's milk, a mixed diet of mother's milk and solid food, then independent feeding.

Milk is a complex fluid containing around 100 000 types of organic molecules, such as lipids, proteins, carbohydrates in the form of milk sugar (lactose), gases and minerals. Milk is an emulsion of fat globules, a fine dispersion of casein micelles, a colloidal solution of globular proteins and a colloidal dispersion of lipoprotein particles (*Atkins 2009.115*). Cow's milk is about 88% water and about 3% protein. The two main proteins are casein and whey proteins, which include lactalbumin and lactoglobulin. Casein comprises about 82% of the total protein. It has high nutritional value and contains all the essential amino acids, such as lysine (*Amanatidis 1999.395*).

Milk provides its own material resistances to consumption by adult humans or other mammals. This unruly behaviour of milk is at the root of the difficulties with drinking and adopting milk for human consumption (*Atkins 2009*).

Lactose is the principal sugar in milk, and milk is the only source of lactose in nature. It enhances the absorption of calcium and phosphorus from the intestine. In order to be digested the lactase enzyme is needed to break down lactose in the gut.

After weaning, most mammals normally cease to produce the lactase needed to digest milk, which re-

sults in lactase deficiency, hypolactasia, or the adult type of lactose maldigestion (*De Vrese* et al. *2001. 421*) which is the inability to digest lactose, a sugar found in milk and to a lesser extent milk-derived dairy products. Hypolactasia is accompanied by clinical symptoms such as bloating, flatulence, nausea, diarrhoea and abdominal pain. This effect of milk on the body is called lactose intolerance. The symptoms are caused by undigested lactose in the large intestine, where the lactose is fermented by gut flora (*de Vrese* et al. *2001.422*).

What, and how strong, the effects of undigested lactose are on a body depends first on the amount of lactose ingested, but also on the body itself, individual sensitivity, the rate of gastric emptying, gastrointestinal transit time, and the pattern of flora in the large intestine, which is why diarrhoea rarely occurs after the application of antibiotics. Lactose-intolerant people can ingest a certain amount of lactose without feeling symptoms; most people can tolerate around 9–12g (or 1 glass of milk) (*de Vrese* et al. *2001.422*). However, for a lactose intolerant adult, *i.e.* most of the people that came into the contact with milk during the domestication of animals, the consumption of more than a cup of milk can have effects quite different from 'increasing the flesh'.

Thus, in order to be digestible, new materialities have to enter the assemblage. Milk has to be subjected to a process in which a starter culture of bacteria ferments/digests milk sugar to produce lactic acid. The agency of microbes makes milk digestible for humans.

**Gut bacteria**

Fresh milk is largely a 20th-century phenomenon, made possible by the advent and spread of refrigeration technology. People who milk cows, goats, and other ruminants have always been able to enjoy fresh milk, but as a practical matter, most have had access to milk primarily in fermented forms. Generally, fermentation stabilises milk, transforming it from a highly perishable substance into much more stable forms.

Yoghurt is made by warming milk and introducing a special culture of bacteria. The usual starter culture employed to produce yoghurt is a mixture of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp *bulgaricus* (*Fernandes 2009.77–84*). Bacteria provide work, by breaking down lactose, releasing lactic acid, which acts to coagulate the milk into a curd consistency. Yoghurt offers all the nutrients in milk, but has much less lactose (*Amanatidis 1999.396*).

Cheese has been made for centuries and is one of the most effective ways of preserving milk. Cheese is a stabilised curd of milk solids produced by casein coagulation and the entrapment of milk fat in the coagulum (*Fernandes 2009.61–73*). Basically, cheese is made by using specific bacteria or rennin (*chymosin*), an enzyme produced in the stomach lining of newborn ruminants and extracted from the inner mucosa of the fourth stomach chamber of unweaned calves, to coagulate the casein so that it separates into a thick curd and watery whey. The whey is removed and the curd is further processed to produce different cheeses (*Amanatidis 1999.396–397*). The water content is greatly reduced, in comparison with milk, by the separation and removal of whey from the curd. Most cheese is now produced with a carefully selected starter, which produces predictable and desirable results. *Lactococcus lactis*, *Streptococcus thermophilus*, *Lactobacillus helveticus* and *Lactobacillus delbrueckii* are the primary species used in cheese making (*Fernandes 2009.61–73*).

There are many different cheeses. They vary because of differences in the treatment of the starting bacterial culture or rennet and the way the curd is treated subsequently and matured (*Amanatidis 1999. 396–397*). These starter cultures and subsequent treatment of cheese are regionally specific, thus the connection between food, animals, place and identity is woven through the use of microbial cultures.

However, to recruit microbial cultures, we need specific technology and material culture: containers which mix and store substances and keep an assemblage together, while strainers separate the assemblage into solids (curd) and liquids (whey) that contain lactose; pots where yoghurt is fermented, strainers that separate whey from curd, bacterial culture that ferment milk are external organs, external stomachs and guts. In the words of Don Ihde (*2002. 137*), "*We are bodies in technologies*". Technologies are not mediators, interfaces between us and the world; technologies are organs, full partners, in our assemblages with the world (*Haraway 2008.249*).

Microbes not only contribute a kind of labour to the production of yoghurt or cheese, but also confer a certain vitality on them. Thus raw-milk cheese, yoghurt, kefir can be seen as an assemblage, an ecology, that matures and ages, and can then be spoiled

and die (*Paxson 2008.38*). This ecology is then digested in the human digestive system, a series of mutual transformations in which the border between the inside and outside becomes blurry. As Jane Bennett describes the relation enacted through eating (*2010.49*), what I eat "*both is and is not mine, you both are and are not what you eat*". And: "*If what is eaten is to become 'food', it must be digestible to a formerly foreign body. Likewise, if the eater is to be nourished, it must accommodate itself to a formerly foreign body. Both, then, have to have been mutable, to have always been a materiality that is hustle and flow as well as sedimentation and substance*" (*Bennett 2010.134–135*). In the relation established through the act of eating, then, all bodies are merely temporary congealments, a becoming of materiality.

Life is enmeshed in elaborate food webs through which stuff circulates. Eating establishes relations between organisms and between organisms and the environment; in this way ecologies emerge. As Timothy Morton (*2009*) has argued, 'ecology' does not refer to 'nature' but rather to the manner in which an organism, human or otherwise, is imbricated with another. Ecology is thus the manner in which entities are entangled with one another in assemblages everywhere. However, relations in food webs are unstable; balances may easily shift, and their overall coherence is frail (*Bertoni 2013.61–62*).

Eating helps us attend to the situatedness, the materiality and the multiplicity of relations. Eating is a material practice where ecologies are created, where relations are established, where assemblages are created and maintained. Attending to the process of eating can improve our understanding not only of eating but also of relating (*Bertoni 2013.64*). Eating is thus a formation of an assemblage, of humans and non-human, all of which bear some agentic capacity. By ingesting milk and dairy products, by intertwining flows of materiality, our history crosses with the histories of bacteria.

**Gut-brain axis**

The human intestines contain approx. 100 trillion micro-organisms, ten times the number of human cells in the body. This gut flora has around a hundred times as many genes in aggregate as there are in the human genome. As a species, we are a composite of many species, with a genetic landscape that encompasses not only the human genome, but also those of our bacterial symbionts.

The intestinal habitat of an individual contains 300–500 different species of bacteria. The large intestine contains a complex and dynamic microbial ecosystem with high densities of living bacteria that achieve concentrations similar to those found in colonies growing under optimum conditions (*Guarner, Malagelada 2003*).

The relationship between gut flora and host is interdependent: gut flora contribute energy from the fermentation of undigested carbohydrates and the subsequent absorption of short chain fatty acids to the host. Mammalian genomes do not encode most of the enzymes needed to degrade the structural polysaccharides present in plant material. Herbivorous mammals rely on intestinal microorganism to metabolise energy from plant food. Ruminants benefit from microbial protein and the absorption of energy released by anaerobic microorganisms in the form of fermentation acids in the foregut. Other herbivores and omnivores acquire additional energy from microbial fermentation in the hindgut of carbohydrates that were not digested in the upper gut. Animal species with similar digestive anatomies and nutrition also share similar gut microbiota (*Flint* et al. *2012.289*).

Colonisation of the gastrointestinal tract of newborn infants starts immediately after birth. During human evolution, changes in dietary preferences, food production and preparation such as cooking, agriculture and cooking have also influenced the intestinal microbiota. We have evolved eating both plants and animals, while also co-evolved with them – our co-evolutionary histories encompass not only the plants and animals themselves but also their microbial associates. Gut flora are our companion species.

Though the history of unfolding relation with other species, animals and plants established through eating, we have incorporated a variety of bacteria-rich living foods. Bacteria break down nutrients we would not otherwise be able to digest, and play an important role in regulating the balance between energy use and storage. Intestinal bacteria synthesize some essential nutrients, including B and K vitamins. They provide defence against invading pathogens. Even more, intestinal bacteria are able to modulate the expression of certain genes related to diverse and fundamental physiological functions, including the immune response.

External bodies, cultures ingested in our bodies, help to absorb nutrients. The *lactobacillus* and other start-

er cultures are probiotics, microorganism which contribute to the well-being of the host organism. Probiotic bacteria in fermented and unfermented dairy products improve lactose digestion and eliminate the effects of lactose intolerance. These beneficial effects are due to microbial lactase in bacteria, which is released in the small intestine, but also to the positive effects on gut flora, and suppression of symptoms (*de Vrese* et al. *2001.425; Perez Chaia, Oliver 2003.90*).

A growing body of evidence shows connections between the brain and the condition of the bacteria living in the gut. Changes in the composition of microbiota thus affect human behaviour (*Tillisch* et al. *2013*). A diet rich in *Bifidobacterium animalis* subsp *Lactis*, *Streptococcus thermophiles*, *Lactobacillus bulgaricus*, and *Lactococcus lactis* subsp *Lactis* produces changes in mid-brain connectivity associated with emotion and sensation. Gut microbiota play a role in modulating pain sensitivity, stress responsiveness, mood, or anxiety, and can alter mental processes and reduce stress responses. This so-called gut-brain axis connects the health of gut microbiota to the unconscious system regulating human behaviour (*Dinan* et al. *2015*).

The gut contains microorganisms that share a structural similarity with the neuropeptides involved in regulating behaviour, mood, and emotion, a phenomenon known as molecular mimicry. We are fundamentally dependent on a myriad of essential neurochemicals produced by microbes. For example, the brain's serotonergic system, which plays a key role in emotional activity, does not develop appropriately in the absence of microbes (*Clarke* et al. *2012*). Around 90 per cent of the serotonin, a brain neurotransmitter in the body, is made in the digestive tract (*Yano* et al. *2015*).

Even more, gut flora influence human eating behaviour and dietary choices (*Alcock* et al. *2014*). They induce cravings for foods in which they specialise, or foods that suppress their competitors, rather than simply passively living off whatever nutrients we choose to send their way. They control reward and satiety pathways in the host's body, the production of toxins that alter mood, changes to receptors, including taste receptors, and hijacking of the vagus nerve, the neural axis between the gut and the brain (*Alcock* et al. *2014*). Bacterial species have different dietary preferences; they not only compete with each other for food and niches within our digestive tracts, but their aims often conflict with ours when it comes to our own actions.

We can say, after Jane Bennett (*2010.137*), that dairy products "*have the power not just to increase human flesh but also to induce human moods, modes of sociality and states of mind*". They affect our brain. Someone who drinks fermented milk thinks and act in a different way from a non-milk drinker and craves different foods. The productive power or agency of the milk drinker is an emergent property of confederacy, an assemblage of stuff, microbes, animals and other foreign materialities.

## Conclusions

Who ate whom? Who made whom act? Who changed whom? Who is an agent here? We can say that humans mobilised bacteria to drink cow's milk, but this is not the whole story. Cows seduced humans with their milk so that humans would protect them from predators; but we should also imagine the converse situation: bacteria have influenced humans without their knowledge to make them domesticate cattle and drink milk.

The fact that human behaviour can be attributed to multiplicities of mindless organisms poses a huge problem for the Cartesian division between the mind and body and the divide between humans (subjects) and cows, milk, bacteria, material culture and other stuff (objects). This complex assemblage of different materialities strikes a deadly blow to a liberal, Western model of an agent as a free, rational, individual subject; and to agency equated with unique human cognitive structures, rational action, the capacity for skilful social practice, conscious practice, subjective experience, intentionality, inter-subjectivity and free will.

Who influences whom and who is influenced by whom are questions that can no longer receive a clear answer. All – humans, cows, bacteria, milk, material culture – are cause and effect of each other's movements. All induce and are induced, affect and are affected (*Haraway 2008.230; Despret 2004.125*).

Today, cows are machines for turning grass into milk. The average yield of modern cows is about 6000 litres per year, with particularly efficient animals actually producing up to 20 000 litres. There are around 264 million dairy cows worldwide, producing nearly 600 million tonnes of milk every year. And today, more than 35% of humans worldwide can digest milk, while this percentage is much higher in Europe and the Near East.

But these modern cows and modern humans are the result of a long and complex history of interactions and interventions that resulted in the realisation of some potential in cows, humans and other creatures, while denying others. This intense becoming results in what Bruno Latour calls "*internalised ecologies*", intense socialisation, a reconfiguration of animals, plants and humans, which results in different bodies, such as those which can digest lactose or that have a much lower milk let-down threshold (*Latour 1999.208*).

As Anna Tsing (*2012.144*) says, "*Species interdependence is a well-known fact – except when it comes to humans. Human exceptionalism blinds us*". To talk of companion species means to accept that who and what we are is always something relational, emergent, process-like, historical, mutable, specific, contingent, finite, complex, impure (*Haraway 2004; Pali Monguilod 2006.252*).

Following the flow of the milk, we come to a realisation that nothing exists in and of itself. Instead, things exist and take the form that they do by participating in an emergent web of materially heterogeneous relations. Things exists only in assemblages. Acknowledging this, we can shift from the assumption that we know what milk, cow, humans, bacteria, pot *etc.* are to an attention to what and how this milk, cow, human, bacterium, pot were produced through specific material practices (*Law, Mol 2008*).

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