

HumanThrush Entanglements

Homo sapiens as a multi-species ecology

Tarsh Bates¹

A normal human body is thought to be composed of over one trillion cells, of which only about 10 percent are animal (i.e. human), some of which have been shown to “profoundly influence” human metabolism and physiology.² How do we understand human subjectivity and identity in this cacophony if, as Donna Haraway suggests, “to be one is always to *become with* many?”³ This paper explores what it means to be human when we recognise our bodies as a multi-species ecology. It adopts Haraway’s analytical methodology of the string game Cat’s Cradle.⁵ This paper is like a string figure such as “The Circle” (Figure 1) which attempts to form patterns, knots and webs to untangle and reform the complex cultural discourses, subject positions and knowledge claims evident in human relations with our bodies and the other species that inhabit them. Haraway suggests that since a “cradle belongs to no one, to no ‘one’ culture or self, to no frozen subject or object”, it offers the potential to “learn something about how worlds get made and unmade, and for whom”.⁵ The knotted web initiated in this paper forms from the intimate and fraught contact zones of biology, aesthetics, culture and care between *Homo sapiens* (humans) and *Candida albicans* (Candida), the single-celled opportunistic fungal pathogen commonly known as thrush. Be warned: this discussion positions humans and thrush as co-evolved companion species involved in a biopolitical entanglement that is gendered, sexual and often ruthless.

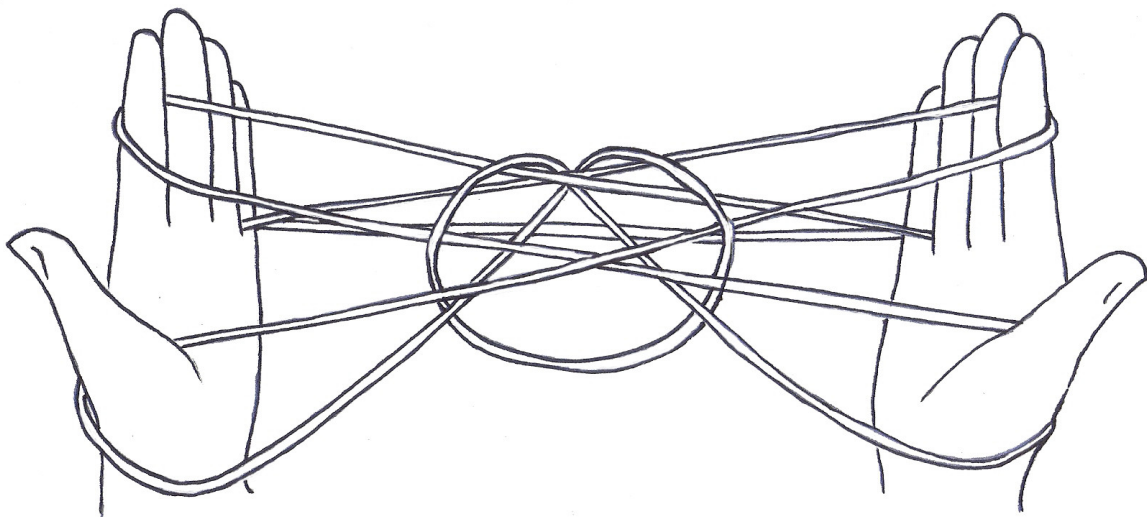


Figure 1. “The Circle” string figure. Image credit: Caroline Furness Jayne.⁶

Knot I: *Candida albicans*: friend or foe?

Candida albicans is an organism symbiotic with humans. It is a single-celled commensal fungus that is one of many species of microorganisms that make up the intestinal and urogenital flora of humans; without it we would have difficulty digesting as it breaks down sugars in the blood stream.⁷ Present in 80 percent of the human population, we acquire our *Candida* population in the first three to six months after birth. As an opportunistic pathogen, overgrowth caused by antibiotics or compromised immunity results in *Candida* infections (candidiasis) more commonly known as thrush (Figure 2).

Thought to be a simple asexual, single-celled fungus, recent research has shown it to be highly adaptive both genetically and morphologically.⁸ Advances in modern medicine have led to larger populations of immuno-compromised patients becoming susceptible to candidiasis as it forms infectious biofilms on medical equipment.⁹ Formerly “women’s business”, the yeast is now one of the four most common causes of bloodstream and cardiovascular infections in hospitals and is particularly of concern in neonatal intensive care units.¹⁰ This dramatic contribution to hospital infections has increased the importance of *Candida* in human health research and has provided impetus for increased scientific research into its biology and treatment.¹¹

As a feminist researcher, I am particularly interested in *Candida*. *Candida* is culturally gendered without itself having a gender or even a sex as it is an opportunistic pathogen of vaginal tracts in particular.¹² Many women have intimate, embodied and emotional relationships with this microscopic creature, which usually involve trying to kill it. *Candida* signifies the leaky bodies of women: the unruly, the abject, the undisciplined.¹³ Through *Candida* I explore the complexities of our relationship with microorganisms as an important part of our bodies, of what it means to be human.



Figure 2. Oral thrush infection. Image credit: James Heilman¹⁴

Knot II: We have never been *Homo sapiens*

We have had forbidden conversation; we have had oral intercourse; we are bound in telling story on story with nothing but the facts. We are training each other in acts of communication we barely understand. We are, constitutively, companion species. We make each other up, in the flesh.¹⁵

Ten bacteria or fungal cells live in or on a normal human body for every animal cell. These myriad lives on our body surfaces, in our blood, and our digestive tracts enable the immune and digestive systems of the species we call *Homo sapiens* to function. The hundreds of microbial species have co-evolved with the animal cells, making them essential to our existence. They have also been shown to change vulnerability to stress, affect memory and may have a role in autism.¹⁶ Molecular biologist Bruce Birren suggests that “we can’t really understand human health without understanding how we interact with all these microbes”.¹⁷

A microbiome is the totality of microbes, their genetic elements (genomes), and environmental interactions in a particular environment. Nobel Prize winning molecular biologist Joshua Lederberg, who coined the term in 2001, argued that micro-organisms inhabiting the human body should be included as part of the human genome, because of their influence on human physiology.¹⁸ Prior to 2001 the terms “microbiota” and “microflora” were used.

A biome is a geological term describing a geographically defined region of the Earth with similar climatic conditions, also referred to as an ecosystem. Adopting the term “microbiome” therefore implies that the human body is an ecosystem (Figure 3). However, the valorisation of the genome inherent in the recent “omic” turn has caused the environmental interactions of the human biome to be seen as secondary to the genomes and resulted in the metonymy of “microbiome” and “microbiota”.¹⁹ Examination of the cultural significance of such shifts in etymology and relationality reveals important assumptions and narratives about what it means to be human.

Donna Haraway’s conception of companion species is the first serious consideration of the co-constitution/co-evolution of human animals with other organisms. Haraway has been vital to my attempts to reconfigure my understanding of my human body and its relationship with its internal and external ecologies. She says, “I think we learn to be worldly from grappling with, rather than generalizing from, the ordinary. I am a creature of the mud, not the sky”.²⁰ *Candida albicans* is one of the many species – viral, bacterial, fungal and insect – that contribute to the complex, co-constitutive multispecies ecology that is the human body. *Candida* holds a particularly evocative and rich cultural valency for humans, almost unique in this “muddy” ecosystem. Body surveillance and discipline are crucial components of this valency, necessary in order to avoid the out-of-control growth, leakage, and burning of thrush.

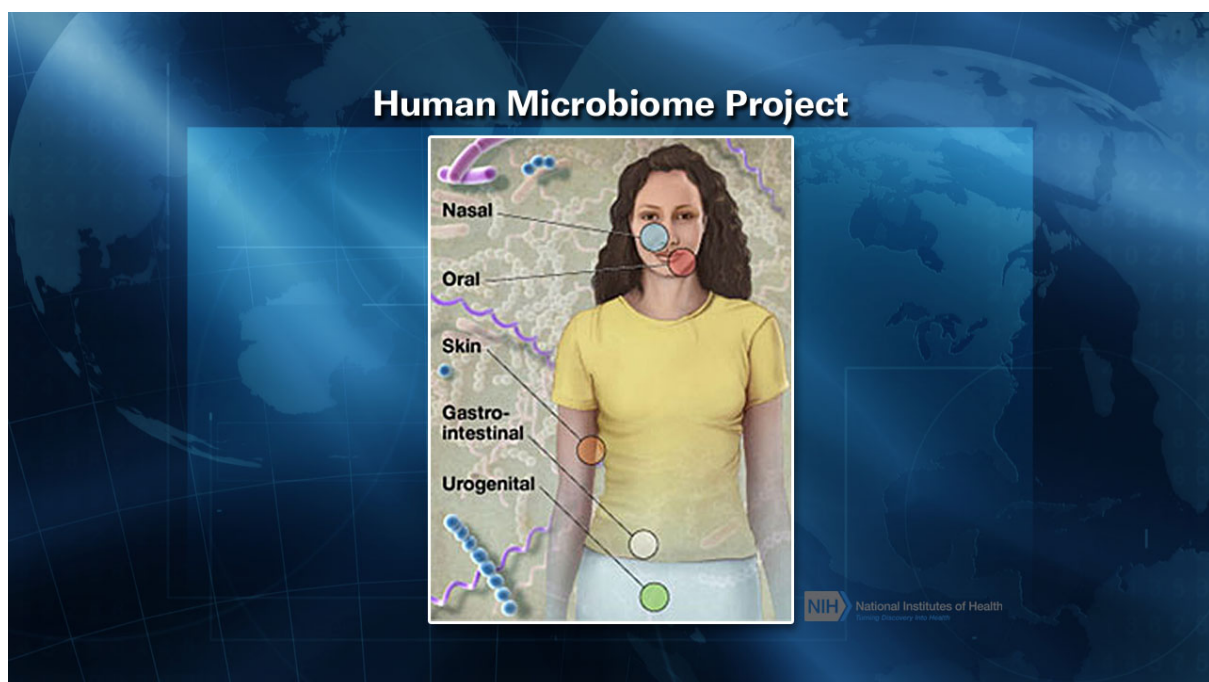


Figure 3. NASA/NIH Human Microbiome project. ©NASA Public Domain.²¹

Knot III: Scales of umwelt

Our “world”. Between us, the movement from inside to outside, from outside to inside, knows no limits. It is without end. These are exchanges that no mark, no mouth can ever stop. Between us, the house has no walls, the clearing no enclosure, language no circularity.²²

Scales of spacetime are crucial in the relationships between *Homo sapiens* and *Candida albicans*. From a human perspective, *Candida* are internal, microscopic, invisible, simultaneously short lived (days) and immortal. Can we comprehend how *Candida* might perceive time? Is it the time of intracellular communications between host and self or the temporality of reproduction and replication – when one cell becomes two, identical, yet separate? If *self* is constantly replicated, when is one born? Does one die? How is a life measured? Is *Candida* time the temporality of consumption, when food appears and reappears? Does it recognise periodicity as intervals of infection; an exuberant fecundity, or as length of mycelial growth? Much work is yet to be done in understanding how other species understand temporality let alone those as radically different as *Candida*.

Erik Swyngedouw argues that scale is “the embodiment of social relations of empowerment and disempowerment”.²³ For such a small organism, *Candida* can have a significant effect on our bodies and our temperaments. It has generated an economy of pharmaceutical products and scientific research yet we still know very little about it. As a commensal organism it is invisible to us, hidden within the folds of our bodies, unnoticed until an infection occurs (Figure 4). The relationship of power between human and *Candida* is complex: a *Candida* infection has no animosity. Driven by its environment, us, it responds to the amount of sugars in the blood stream, the other bacteria in its ecology, the surface it adheres to. We on the other hand strive to kill it, to tame its invasive excess.



Figure 4. *Candida albicans* infection of human cervix (1970). Image credit: CDC.²⁴

Knot IV: Disciplining the alien self

Kathleen Kalaf has been to hell and back in her long fight with systemic Candida. Today, thanks to a new Candida treatment that is more effective than even the most popular Candida remedies, Kalaf is finally free of the yeast overgrowth that stole eight years of her life.²⁵

The growth of *Candida* is limited by the human immune system and from competition by other members of the *Homo sapiens* ecology. However, infection occurs when the human immune system is compromised or when the ecological balance is disturbed. Superficial infections of skin and mucosal membranes, including oral or vaginal thrush, are common and cause inflammation and mild to severe discomfort.²⁶ These outbreaks can be caused by the external use of detergents or douches, or internal (hormonal or physiological) imbalances can disturb the normal microbiota. *Candida* “takes advantage” of the resultant lack of competition for food and space to “gorge” itself: replicating, changing pH, changing shape. Cells bud, buds become pseudo-hyphae, pseudo-hyphae become hyphae, hyphae embed into cell walls and become virulent biofilms. Normal, “good” bacteria have no room to return.

The persistent conception of an immune system as a war zone results in a complex biopolitics of victim and aggressor. Foundational binaries of self/non-self must be established and maintained in order to protect a preformed, fragile subject from a voracious, colonising invader (Figure 5). Bodies are patrolled, surveilled and disciplined. Morality is assigned: “bad” *Candida* are controlled by “beneficial” bacteria, and lifestyle choices (diet and anti-fungal treatments) prevent “overgrowth”. Unavoidable or persistent “outbreaks” are killed using probiotics (“good” bacteria), antifungals and/or a low sugar diet.

Although *Candida* was isolated from the vaginas of only 19 percent of apparently healthy women in one study,²⁷ 75 percent of women are affected at some time in their lives and many experience recurrent and debilitating symptoms. Global expenditure on the popular vaginal thrush treatment, Canesten (produced by Bayer), in 2012 was €250 million.²⁸ However, many women are forced to resort to home remedies such as yoghurt, garlic and probiotics to relieve “hellish” recurrent symptoms. Systemic candidiasis is a clinically important problem in hospitalised individuals, now the fourth most common infectious organism in hospitals in the United States of America, and mortality rates vary greatly between 10 and 50 percent.²⁹ Almost 15 percent of people with weakened immune systems develop a systemic illness caused by *Candida* species. Google searches for “*Candida* treatment” and “thrush treatment” produce 11 and 6.5 million results respectively. The benefits of *Candida* are nowhere to be found.



Figure 5. Illustration from “The Candida Crusher Program, the permanent yeast solution”. Image credit Dr Eric Bakker.³⁰

Knot V: Queer indeterminacy

your body, here, there, now. I/you touch you/me; it's quite enough for us to feel alive. Open your lips, but do not open them simply. I do not open them simple. We – you/I – are never open nor closed. Because we never separate simply, a single word can't be pronounced, produced by, emitted from our mouths. From your/my lips, several songs, several ways of saying echo each other. For one is never separable from the other. You/I are always several at the same time...How could one dominate the other? Impose her voice, her tone, her meaning? They are not distinct, which does not mean that they are blurred. You don't understand a thing?
No more than they understand you.³¹

Until recently, laboratory studies of *Candida* were performed by extracting a sample of the fungus from a host and growing it using a standard microbiological technique: on the surface of a solidified agar nutrient medium in a petri dish incubated at human body temperature in a steel box (the incubator). Typical single-celled microbial colonies appear during the three-day incubation period after which the nutrient supply is exhausted and a new plate is cultured. *Candida* on agar are benign and asexual, replicating through budding – not dissimilar to *Saccharomyces cerevisiae*, the yeast species used in bread or beer making.

Within a host body, however, *Candida* are omnisexual and polymorphic, being able to switch between asexual and sexual reproductive strategies and several morphological states.³² Switching is the result of a complex interplay of genetic and environmental factors, including temperature, pH, food supply and moisture. *Candida* morph between various states: yeast and hyphal cells; an opaque form necessary for sexual mating; pseudo-hyphal cells; and chlamydo spores (Figure 6). All are distinct cell types involved in different modes of pathogenicity and virulence.³³ Can the (apparently) sexually dimorphic coagulation that is the human body understand this extravagant fecundity?

The disciplined and tidy *Candida albicans* growing on a petri-dish is considered to be the same organism as the sexually and morphologically promiscuous parasite exemplifying what has come to be known as the “species problem”. The “species problem” describes difficulties that arise during the classification of organisms into the existing scientific taxonomic system, which is primarily based on how individuals reproduce.³⁴ The inclusion criteria of any such curatorial project are based on a series of un/conscious cultural assumptions and biases and inevitably result in elisions and exceptions. How does such a system classify *Candida*, an organism that can engage in several reproductive strategies? As described by Fraser and colleagues, the current species classification system works well for eukaryotic organisms such as humans and birds but fails in the case of prokaryotes as they are so biologically different and diverse that “we still do not understand what a bacterial species is”.³⁵ *Candida albicans* further complicates this system by having characteristics of both eukaryotic fungi and prokaryotic bacteria.

What this discussion shows is that *Candida albicans* exists in what physicist and philosopher Karen Barad describes as a state of “ontological indeterminacy”, that is, *Candida* is inseparable from its environment.³⁶ Any attempts to observe or experiment on *Candida* impose spatio-temporal conditions on its behaviour and hence its worlding. Laboratory practices cause the organism to behave in certain ways at certain times and hence an organism emerges from particular material and temporal circumstances. Barad insists that “responsible laboratory practices [which include epistemological rigor] must take account of the agential performances of the organism in making the specific nature of causal relations evident...as iterative intra-activity”, or a performative emergence.³⁷

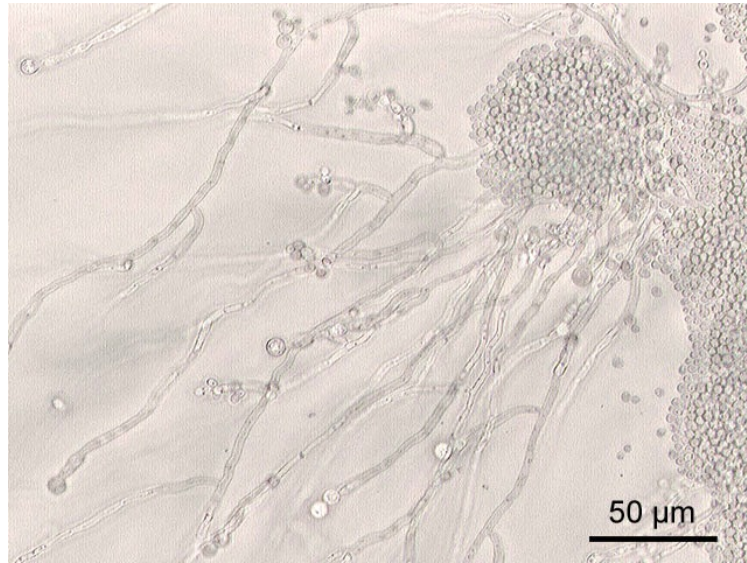


Figure 6. *Candida albicans* at 200x magnification. Image credit: Y. tambe.³⁸

Knot VI: Intra-species performativity

Following scientific care instructions, I subculture the *Candida* every three to four days in a biosafety cabinet in a PC2 laboratory to ensure a ready supply of nutrients.³⁹ I am very conscious of my embodied relationship with this seemingly benign organism and grow fond of the smooth, shiny, creaminess of the colonies. In the ritualised environment of the PC2 laboratory, with my lab coat, gloves and sterilising ethanol I become highly aware of my actions when caring for this critter: flaming the inoculation loop to sterilise it; stroking the agar plate to remove a colony; streaking the colony onto a new plate in the accepted four quadrant streak method; brushing my hair out of my eyes with the back of my gloved hand; pushing my glasses back up my nose; wrapping the streaked plate with parafilm to prevent contamination; jumping off my chair; opening the incubator; turning the plate upside down to prevent condensation; placing the plates on the incubator shelf; coming in every day to check growth and contamination. I experiment with different media and prepare sheep's blood agar plates, sampled from the sheep of a local farmer (Figure 7). The blood is red at 55°C and chocolate-coloured at 70°C: the sheep donor is 39°C.

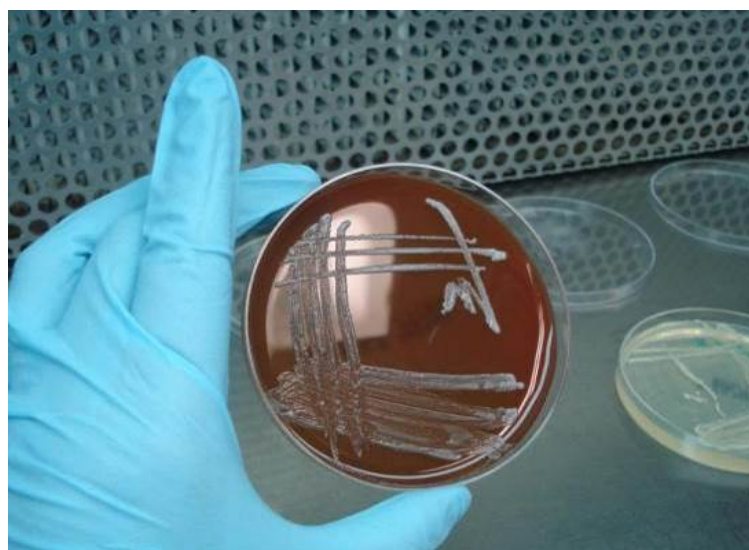


Figure 7. Culturing *Candida albicans* on sheep's blood agar plates, *in vitro* (2011), Tarsh Bates. Image credit: Megan Schlipalius.⁴⁰

Knot VII: The unsettling eros of contact zones

Eros, for philosopher Luce Irigaray, is a sensual, affective desire for interconnection and interaction. This desire for alliance exists simultaneously and paradoxically alongside perception of otherness and desire for autonomy.⁴¹ Barad's "iterative intra-action" correlates with this understanding of eros as creative, fluid "work" that re/generates subjects. Christopher Cohoon suggests that bodies subject to Irigarayan eros exist as potential energy, in states of immanent becoming which resonates with Barad's understanding of matter as constant generative performativity.⁴² As "the most extreme experience of sensation" eros is impatient and restless, in constant flux.⁴³ I am interested in the possibilities that Irigaray's formation of eros as the "motor of becoming" between two humans offers for the very material contact zones between human and *Candida*.⁴⁴ The ontological indeterminacy of humanthrush entanglements is a restless, slippery worlding (Figure 8). An impatient, intra-specific eros emerges from caresses between human and *Candida*.

compulsive co-existence
intangible irresistible repulsion
/body/
protein insinuation

a third from two
a myriad third
risky attachment
restless caress

enflamed fecundity
timeless minute attention
impatient uncontrol
itchscratchitchscratchitchscratchitchscratchitchscratchitchscratchitchscratchitchscratchitchitch
unconscious desire slip burn



Figure 8. Self-portrait with *Candida albicans*, 2011, Tarsh Bates

Knot VIII: Indeterminate Reformation

The knots of the entanglements between humans and *Candida* are complex, material, embodied and cultural. A Cat's Cradle "requires heterogeneous players, who cannot all be members of any one category".⁴⁵ The players woven in this Cradle, shown here in a moment of rest, anticipate new movements and permutations (Figure 9).

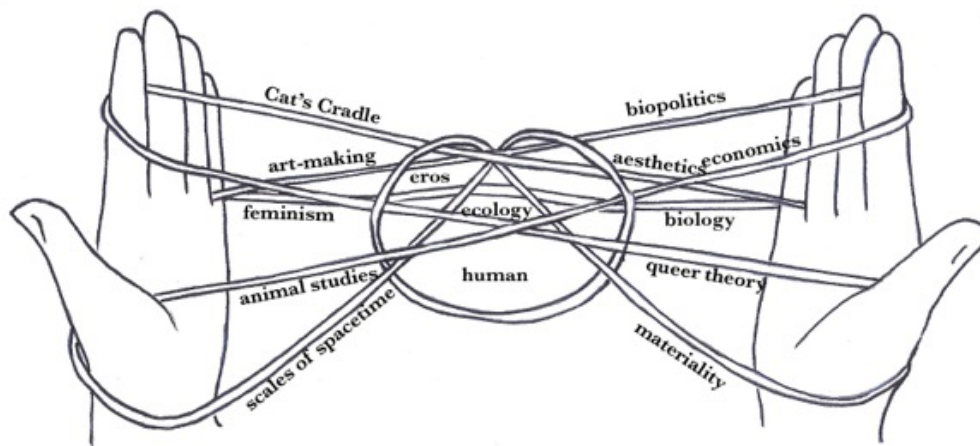


Figure 9. "The Circle" string game including materialssemiotic frameworks. Adapted from C. Furness Jayne.

Notes

1. SymbioticA, School of Anatomy, Physiology and Human Biology, University of Western Australia, tarshbates@gmail.com.
2. D.C. Savage (1977), "Microbial Ecology of the Gastrointestinal Tract", *Annual Review of Microbiology*, 31.
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4. D. Haraway (1994), "A Game of Cat's Cradle: Science Studies, Feminist Theory, Cultural Studies", *Configurations*, 2(1).
5. Ibid., p. 69.
6. C. Furness Jayne (1906), *String Figures and How to Make Them*, New York, Courier Dover Publications, Website: <http://www.stringfigures.info> (Accessed 8 May 2013).
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14. Image source: Website: http://en.wikipedia.org/wiki/Oral_candidiasis (Accessed 23 February 2012).
15. D. Haraway (2003), *The Companion Species Manifesto: Dogs, People, and Significant Otherness*, Chicago, Prickly Paradigm Press, pp. 2-3.
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17. Ibid.
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19. A proliferation of terms ending in "-omic" has occurred over the turn of the century, between 1990 and 2013. Lederberg suggested in 2001 that "Genomics and Proteomics are the buzzwords of the dawning millenium" and proceeded to analyse the etymology of the "-omic" suffix (Ibid.). He showed that it had entered common use after the launch of the biology journal *Genome* in 1983. At least 40 commonly used terms, suffixed by "-ome" were extracted from three prestigious databases, MEDLINE, the Web of Science, and the Oxford English Dictionary in 2001, and more have arisen in the subsequent years. The rapid and enthusiastic adoption of "-ome" and "-omic" reflects a particular focus by science

- and popular culture on the importance of the genome (and other "-omics") as information or "the code of life" rather than one aspect of a complex system.
20. D. Haraway (2008), p. 3.
 21. Image source: Website: http://www.nasa.gov/mission_pages/station/expeditions/expedition35/briefing_011713.html (Accessed 17 June 2013).
 22. L. Irigaray and C. Burke (1980), "When Our Lips Speak Together", *Signs*, 6(1), p. 73.
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 30. Image source: Website: <http://www.yeastinfection.org/the-candida-crusher-program/> (Accessed 10 May 2013).
 31. L. Irigaray and C. Burke (1980), pp. 72-73.
 32. J. Berman and P.E. Sudbery (2002).
 33. M. Whiteway and C. Bachewich (2007).
 34. K. de Queiroz (2005), "Ernst Mayr and the Modern Concept of Species", *PNAS*, 102 (Suppl. 1).
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 36. K. Barad (2011), "Nature's Queer Performativity", *Qui Parle*, 19(2), p. 134.
 37. *Ibid*, p.136.
 38. Image source: Website: https://en.wikipedia.org/wiki/Candida_%28fungus%29 (Accessed 23 June 2012).
 39. A PC2 (or Physical Containment Level 2) laboratory is a biological laboratory that allows for the study of genetically modified organisms (GMOs), human tissue or Class 2 pathogens such as *Candida albicans*. As suggested in the name these laboratories are designed to physically prevent contaminants from entering and compromising an experiment, or GMOs or pathogens escaping from the laboratory. Preventative measures include disinfectants, protective clothing, barriers, and filtration systems. Requirements for certification of PC2 laboratories are described in the Gene Technology Act (2000) and the Standard, AS/NZS 2243.3:2002 Safety in laboratories.
 40. *invitero* was an art/science research project exploring the aesthetic experiences of care through prolonged engagement with eight other species of living organisms housed in customised glass vessels. The organisms which are commonly used in reproductive biology included *Candida albicans*. *invitero* was a 7 month long durational performance that occurred in a scientific laboratory and a public art gallery.
 41. C. Cohoon (2011), "Coming Together: The Six Modes of Irigarayan Eros", *Hypatia*, 26(3).
 42. *Ibid*.
 43. L. Irigaray (1982/1992), *Elemental Passions*, J. Collie and J. Still, (trans.), New York, Routledge, p. 27.
 44. L. Irigaray (1984/1993), *An Ethics of Sexual Difference*, C. Burke and G.C. Gill, Ithaca, (trans.), N.Y., Cornell University Press, p. 19.
 45. D. Haraway (1994), p. 69.