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IN VITRO MEAT: ZOMBIES ON THE MENU?

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Abstract

In April 2008 the In Vitro Meat Consortium held its first meeting at the Norwegian Food Research Institute. They are a group of scientists and advocates who seek to turn the techniques of tissue engineering to the production of food, producing meat in laboratories that has at no point been part of a living animal. This is a fascinating technology, and one that fits well with the topic of this SCRIPTed analysis section: the ‘zombification’ of meat products. I have been conducting interviews with scientists who are involved in In Vitro Meat research at the three main research sites to explore the emergent social, ethical and regulatory issues of the technology. In this discussion I first provide detail on the current level of scientific development in the field and then describe the social context and promise of In Vitro Meat, before finally returning to the central question of what exactly In Vitro Meat is: zombie or not?

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1. Introduction

In April 2008 the In Vitro Meat Consortium held its first meeting at the Norwegian Food Research Institute. The Consortium identifies itself as “an international alliance of environmentally concerned scientists striving to facilitate the establishment of a large-scale process industry for the production of muscle tissue for human consumption through concerted R&D efforts and attraction of funding to fuel these efforts.”¹ Essentially these scientists seek to turn the techniques of tissue engineering to the production of food; producing in laboratories meat that has at no point been part of a living animal. This is a fascinating technology, and, characterised as the ‘zombification’ of meat products, one that fits well with the collection of analysis pieces in this *SCRIPTed* issue. While metaphors of zombies usually lead one to think of the ‘living-dead’, in vitro meat is perhaps best categorised as the ‘dead-living’, or perhaps the ‘living-never born’.

The scientists involved in the in vitro meat project take a small amount of cells from a living animal and culture it in medium to encourage the cells to proliferate into lumps of muscle tissue which could, in principle, be eaten. This is distinct from cloned meat where an entire animal, using technology similar to that used to produce Dolly the Sheep, is cloned and then slaughtered. With in vitro meat, there is never a whole animal to slaughter. And because there has never been a whole animal we cannot say the tissue is the ‘living-dead’. This meat was never born, has never been ‘alive’ in any usual way we would apply to an animal, and has never been killed.

These tissue engineering techniques were developed in biomedical research settings oriented towards curing disease. In the biomedical field, the promise of regenerative medicine is to transplant tissue into an unhealthy body to promote healthy cell growth in ill people. Stem cell use for such purposes has been subject to extensive legal, ethical and social science analysis,² and sophisticated and expensive infrastructures have been established to regulate these technologies, allowing cells to be stored, multiplied and distributed internationally in ethically responsible ways.³ In vitro meat development is a form of stem cell science that, as with the regenerative medicine setting, looks to harness the growth potential of stem cells to grow quantities of healthy tissue. However while the technologies have much in common, the legal, ethical and social context of tissue engineering for food is very different to that of tissue engineering for biomedical purposes. In vitro meat has attracted inspection from broader academic disciplines, including ethicists,⁴ artists,⁵ cultural studies,⁶ cultural theory,⁷ and design.⁸

¹ See the In Vitro Meat Consortium at <http://invitromeat.org/index.php> (accessed 9 July 2008).

² S Holm, “Going to the Roots of the Stem Cell Controversy” (2002) 16 *Bioethics* 493-507; A Webster and L Eriksson, “Governance-by-standards in the field of stem cells: managing uncertainty in the world of ‘basic innovation’” (2008) *New Genetics and Society* 27, 99-112; and S Parry, “Stem cell scientists’ discursive strategies for cognitive authority” (2009) 18 *Science as Culture* 89-114.

³ N Stephens et al, “The UK Stem Cell Bank: Securing the past, validating the present, to protect the future” (2008) 17 *Science as Culture* 43-56.

⁴ P Hopkins and A Dacey, “Vegetarian Meat: Could Technology Save Animals and Satisfy Meat Eaters?” (2008) 21 *Journal of Agricultural Ethics* 579-596.

The present work is an addition to these contributions. I am a sociologist and scholar of Science and Technology Studies with an interest in the regulatory and social framing of stem cell research. I have been conducting semi-structured interviews with scientists who have either been involved in, or have tried to be involved in, in vitro meat research. To date I have conducted eleven interviews during visits to the three main active sites: the Netherlands, Sweden and Norway. However, as I am still early in the data collection process, I remain cautious about any conclusions I develop in this article. Having said that, I will explore some of the social issues associated with this technology. In the first section, I will provide further detail on making in vitro meat, in the second I will describe the social context and promise of in vitro meat, and in the final section I return to the central question of what exactly in vitro meat *is*, zombie or not.

2. Making In Vitro Meat

A technique for producing in vitro meat was patented in 1999,⁹ but Benjaminson, Gilchrist and Lorenz are usually credited with the first successful experiments, conducted in 2002.¹⁰ Their work was funded by NASA and explicitly addressed the feeding of astronauts in space, while considering the relationship between protein sources and space vehicle crew morale. The team successfully grew goldfish muscle cells, some of which were harvested for cooking, and - their paper could be read to suggest - eaten. While biologically the experiments met some success, NASA provided no further funding following their publication, and the research project ceased. Around the same time, Oron, Catts and Ionat Zurr – Harvard University tissue engineers – were bringing together laboratory work and art through in vitro meat technology,¹¹ initially using pre-natal sheep cells to grow a piece of muscle tissue three centimetres in diameter. In 2003, their work became publicised when they

⁵ I Zurr and O Catts, “Artistic life forms that would never survive Darwinian Evolution: Growing Semi-Living Entities” in: Art Association of Australia and New Zealand (ed), *Art and Nature: Darwinism, Ecology, Biology and the Future of Art* (2003); available at <http://www.tca.uwa.edu.au/atGlance/pubMainFrames.html> (accessed 3 September 2008).

⁶ S McHugh, “‘Real Artificial Meat’ and the Future of Animal Agency”, unpublished, presented at the *British Animal Studies Network* meeting, London, 25 October 2008; L Kelley, “‘Tissue Culture, Meat and Art: Collaboration and Consumption In Vitro’”, unpublished, presented at the *Meet Animal Meat Symposium*, Uppsala, 5 October 2009; L Kelley, “Arts Projects Acting as STS Research: Collaboration and Consumption In Vitro”, unpublished, presented at the *Society for the Social Studies of Science Conference*, Washington, 28-31 October 2009; and J Parry, “Oryx and Crake and the New Nostalgia for Meat” (2009) 17 *Society and Animals* 241-256.

⁷ S Herbrechter, “Brooding – Life after Animals”, unpublished, presented at the *Zoontotechnics (Animality/Technicity) Conference*, Cardiff 12 May 2010.

⁸ J King, *Dressing the Meat of Tomorrow* (2007), available at <http://www.james-king.net/projects/meat> (accessed 2 December 2008).

⁹ See W van Eelen, W van Kooten and W Westerhof, “Industrial scale production of meat from *in vitro* cell cultures” (1999), Patent Description, available at http://l2.espacenet.com/espacenet/viewer?PN_WO9931222, as reported by P Edelman et al, “In Vitro-Cultured Meat Production” (2005) 11 *Tissue Engineering* 659-622.

¹⁰ M. Benjaminson, J Gilchrist and M Lorenz, “In vitro edible muscle protein production system (MPPS): Stage 1, Fish” (2002) 51 *Acta Astronaut* 879-89.

¹¹ I Zurr and O Catts, see note 5 above.

staged an art exhibition in Nantes, France: muscle tissue grown from frog cells was served to banquet guests in a gallery under public view. Apparently the dinner guests did not like the taste of the meat.

These experiments were small scale preliminary investigations into the technical and social challenges of in vitro meat, and ongoing work today remains in these early stages. The main active research groups are located at universities in the Netherlands, Sweden and Norway. The Dutch group, which is the largest and most well funded of these, from 2005 to 2009 ran a project financed by SentreNovem – now part of Agentschap NL at the Dutch Ministry of Economic Affairs – comprising four PhD students, three full time staff and their line managers and supervisors.. The group is hopeful of a second phase of funding starting late 2010. The smaller projects in Sweden and Norway are funded largely through internal university funding, although external funding is frequently sought. The Dutch group is looking to establish a pig derived cell line, meaning a population of cells that can be sustained indefinitely in controlled conditions, growing the cell numbers so they can continuously replace the existing stock and generate enough cells to be harvested for research or production use. Establishing cell lines of this sort in relation to mouse or human cells is common in biomedical research, but the shift to the use of pig tissue raises particular challenges. The Swedish group are using materials and surface science to understand how mouse muscle cells can be encouraged to bond to, and grow on, larger starch particles in specially configured bioreactors. The Norwegians are developing a focus on pig umbilical cord cells as a source of muscle tissue. All three groups run broader biomedical research programmes of which their In Vitro Meat work is a complementary element.

There are also published accounts of how the field may develop further.¹² The literature emphasises two different techniques, loosely referred to as ‘scaffold-based’ and ‘self-organising’ tissue culturing techniques. Each method has its own technical challenges and is suited to different outcomes. The scaffold based techniques are most suited to producing tissue akin to processed meats such as sausages and burgers that lack some of the textured complexity of highly structured meats like beef steaks or chicken breasts. The technique uses cells taken from an animal at either the embryonic stage (known as myoblasts) or the adult stage (known as skeletal muscle satellite cells) and attaches them to a scaffold made of protein meshwork. This is then spread over a culture medium and placed in a bioreactor resulting in myofiber tissue that can be cooked as meat. This ‘self organising’ technique requires a culture medium that directs tissue growth in the correctly organised form over three dimensions. In order to produce more complex meats scientists would need to emulate the in vivo structure of the tissues much more closely. This would require the production of tissue types beyond the muscle itself, including fat, blood vessels and connective tissue.

¹² See P Edelman et al, see note 9 above; M Langelaan et al, “Meet the New Meat: Tissue Engineered Skeletal Muscle” (2009) *Trends in Food Science & Technology*; I Datar and M Betti, “Possibilities for an In Vitro Meat Production System” (2010) 11 *Innovative Food Science and Emerging Technologies* 13–22.

The In Vitro Meat Consortium commissioned a UK biotechnology consultancy firm to compile an economic assessment and projection for the industry.¹³ It suggested that the meat might be marketable, given sufficient research and development investment. Initially it would remain a niche high-end market, priced just above free-range organic meats, targeting those motivated by its ethical, environmental and health promises and most likely in the form of pasta sauce or an equivalent. With subsequent development, advocates say, it could move into lower-end markets producing cheap meat for the masses. However there remain vast technical challenges to the successful production of in vitro meat. Cell culturing limits need to be explored, scaffolds need to be flexible and edible, and growth mediums need to contain the nutritional components missing due to the absence of a digestive system. These issues affect the production of even the smallest quantity of meat. There are many more barriers to producing in vitro meat in the quantities and at the cost needed to make it suitable for commercial consumption.

3. The Promissory Languages and Social Space of In Vitro Meat Research

In vitro meat protagonists make a range of claims for the product. The development of meat free from the practical issues of livestock rearing is said to make it suitable for vegetarians and vegans, as no animals have been harmed or killed in its production. The absence of actual animals in the production process also deems the food environmentally friendly because it negates the contribution of livestock rearing to global warming and de-forestation. Furthermore, its supporters claim, the production process will appeal to health advocates because the level of control over it ensures that the meat can be rendered free of fat, naturally occurring animal disease, and medical interventions such as vaccination and steroid use experienced by whole animal meat sources. We have already noted that one very different type of potential market is found in space and defence agencies. In situations of long distance space travel or lengthy periods of seclusion, for example in a nuclear bunker, the ability to produce meat with no access to farming facilities would be useful. Scientists are keen to promote these promissory languages as a mechanism for enrolling support and funds to the research. These pro-in vitro meat claims can however be contested, and the extent to which the identified potential markets will resist these configurations of their politics and identities is yet to be determined.

There is a further, different, pro-in vitro meat voice. These are individuals and campaign groups who see potential in the technology for social good, usually as a means to cut green house gas emissions or reduce animal cruelty. The leading campaign group is called New Harvest. They focus entirely on promoting and raising funds for in vitro meat development. While essentially spearheaded by one individual, New Harvest is well connected to scientists active in the area, and has had moderate success in raising and distributing financial support to the field. In addition to targeting laboratory work, New Harvest recently funded Dutch and UK based researchers to conduct an environmental analysis of the energy requirements for in vitro meat production. The goal was to provide estimates of the potential benefit of in

¹³ Exmoor Pharma Concepts, *The In Vitro Meat Consortium Preliminary Economics Study Project 29071 V5 March 2008* (2008), available at <http://invitromeat.org/images/Papers/invitro%20meat%20economics%20study%20v5%20%20march%2008.pdf> (accessed 8 August 2008).

vitro meat, in terms of green house gas omissions, as compared to whole animal meat production methods. The group is well organised, with a well-produced website containing sufficient information to be used as a resource by the scientists active in the field, as well wider publics.¹⁴ Since its inception in 2004, New Harvest has featured consistently in the media reporting on in vitro meat.

Another high profile, although less consistently pursued, intervention supporting in vitro meat was made by People for the Ethical Treatment of Animals (PETA), who, in 2008, announced a prize of US\$1m for the first group to commercialise in vitro meat in the United States.¹⁵ PETA framed in vitro meat as an animal rights issue in keeping with its broader portfolio of high impact campaign tactics. The competition was reported to have caused ‘near civil war’ within the organisation over whether it, a pro-vegan organisation, should be supporting meat production at all (Schwartz 2008).¹⁶ While the political alignment of animal rights activists and innovative biotechnology could be an example of the ‘strange bedfellows’ that categorically re-defining bioscience can provoke (Evans, Plows, & Welsh 2007), it is also easy to be cynical about the genuine nature of competition. The Contest Rules set a high benchmark for winning the prize: selling 2,000lbs of meat in no less than 10 states consecutively for three months at the same price as whole animal meat before mid-2012.¹⁷ Such a high level of production looks unrealistic. Furthermore, as some scientists have expressed, if PETA was serious about supporting the research it would have awarded the \$1m as research grants to develop the technology instead of as a prize for completing the work. That said, the PETA intervention was important for significantly raising the profile of the technology (as well as its own profile) and making many people consider, perhaps for the first time, whether they would eat it, zombie or not.

4. In Vitro Meat: Zombies or More?

It would be quite reasonable if you, the reader, were still asking yourself, ‘So what actually *is* in vitro meat?’ Or maybe your question is, ‘Would *I* eat in vitro meat?’, or perhaps, ‘Would I feed it to my family?’ Others may be asking, ‘Do I believe this is good for the environment/for my health/for animal welfare?’, and the more attuned to the theme of this section in this issue of the journal will surely be asking, ‘So is in vitro meat really the living-dead, the dead-living, or the living-never born?’ These are pertinent questions, but unfortunately not ones I can answer in this paper.

The laboratory production of animal tissue for human consumption challenges our existing norms and boundaries around food, nature and kinship. This is to the extent that what In Vitro Meat actually is, or will be, remains undefined and contestable. Such uncertainty has been documented in other biological and technical domains in

¹⁴ See New Harvest at <http://www.new-harvest.org/default.php> (accessed 17 June 2010).

¹⁵ PETA, ‘PETA Offers \$1 Million Reward to First to Make In Vitro Meat’ (2008), at http://www.peta.org/feat_in_vitro_contest.asp (accessed 17 June 2010).

¹⁶ J Schwartz, ‘PETA’s Latest Tactic: \$1 Million for Fake Meat’ (2008) *New York Times*.

¹⁷ PETA, ‘In Vitro Meat Production—Contest Rules’ (2008), at http://www.peta.org/feat_in_vitro_contest.asp (accessed 17 June 2010).

terms of the linearity of life,¹⁸ and species boundaries.¹⁹ But in the case of in vitro meat, there is the extra challenge of bringing meaning to techniques that, having been developed in the biomedical field to benefit human health, are now being applied to food production.

The technology raises for scientists, regulators and consumers many questions to which there are no clear answers: Will in vitro meat cultured from chicken cells be chicken? If so, will it be chicken in the same way as a chicken breast from whole-animal farming methods is chicken, or in some other way? What formulation of provenance and kinship allows all three: a whole chicken, a chicken breast, and an in vitro chicken breast, all to be chicken? Furthermore, what politics does the in vitro chicken breast embody? Is it environmentally sound or a threat to our natural ecology? Is it a humane treatment of animals or a denial of their integrity? Will in vitro meat even be food, or a Frankensteinian scientific misadventure? At the moment we simply don't know.

So, as provoked by the themes of this special issue, does the idea of the zombie help us to understand in vitro meat? Certainly at least one thinker believes it does. Stephan Herbrechter, taking his lead from Lauro and Embry's 2008 *Zombie Manifesto*,²⁰ has used the term 'Zombie Meat' in questioning what the emergence of in vitro meat could mean in relation to a broader erosion of the human-animal boundary and the emergence of a different form of 'biopolitics'.²¹ My own work focuses less on what new technologies could mean or imply and more on documenting the ambiguities as they operate today. And in that spirit I would prefer not to say that in vitro meat is 'Zombie Meat', or even that it is 'meat' at all. Equally, I do not want to say that in vitro meat is *not* meat. Instead, I would argue that we are still at a point at which the definition or categorisation of in vitro meat – what it *is* – remains unclear. The best description of in vitro meat is an 'as-yet undefined ontological object'. Shared narratives and political identities of this tissue have yet to emerge, and the forms these may take are both unknowable and contested. At present it simply has no common ontological meaning.

I remain open to the possibilities for the future. It is entirely plausible that, with adequate funding, in vitro meat could find a route to commercialisation and human diets. It is equally possible that the technology could be wholly rejected by the consuming public, or might never move beyond the current stage of basic laboratory research. The insight is to acknowledge the interpretative flexibility of the small lumps of tissue that have been produced in laboratories, and recognise the significance of competing narratives that try to bring function and meaning to them. Such narratives seek to establish socio-technical alignments between the material, the political, the commercial and the edible, in a formation that facilitates success of the field, however that may be defined. The robustness of these alignments remains to be

¹⁸ N Brown and A Webster, *New Medical Technologies and Society: Reordering Life* (Cambridge: Polity Press, 2004).

¹⁹ D Haraway, *When Species Meet* (Minneapolis: University of Minnesota Press, 2008).

²⁰ See SJ Lauro and K Embry, "A Zombie Manifesto: The Nonhuman Condition in the Era of Advanced Capitalism" (2008) 35 *Boundary 2*, 85-108.

²¹ S Herbrechter, see note 7 above.

seen, but it is clear that, should the technology develop and further enter the public imagination, this robustness will be tested.

5. Conclusion

The title of this paper is a question: ‘In Vitro Meat: Zombies on the Menu?’ To conclude, I offer an answer in two parts. Firstly, is in vitro meat zombie? Well, we do not know, and each reader can decide for themselves whether the tissue whether the tissue is the ‘living-dead’, the ‘dead-living’, or the ‘living-never born’. Secondly, is in vitro meat on the menu? Here I feel more assured in saying that, with the science still in the early stages, it is unlikely that the tissue will be commercially available anytime soon. As Benjaminson et al²² and Zurr and Catts²³ demonstrate however, it has been on the menu at least twice, and maybe one day it will be on the menu again.

²² M Benjaminson, J Gilchrist and M Lorenz, see note 10 above.

²³ I Zurr and O Catts, see note 5 above.