A Contagious Living Fluid:

Objectification and Assemblage

in the History of Virology

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Summary of the argument

This paper deals with the birth of the virus as an object of technoscientific analysis. The aim is to discuss the process of objectification of pathogen virulence in virological and medical discourses. Through a short excursion into the history of modern virology, it will be argued that far from being a matter of fact, pathogen virulence had to be 'produced', for example in petri-dishes, test-kits and hyper-real signification-practices. The now commonly accepted objective status of the virus has been an accomplishment of a complex ensemble of actors. Indeed, this shows that objectification rather than objectivity should be the focus of science and technology studies. This objectification was by no means a smooth process. It involved more than five decades of highly speculative and fragmented research projects before it became actualized as a separate discipline under the heading of virology. The specific objectification of the virus took place through an inter-disciplinary de-differentiation of research questions, methodologies, techniques and technologies or what Thomas Kuhn referred to as 'revolutionary science'. The main argument of this paper is that viruses only became intelligible after the establishment of a virology-assemblage. Its inauguration in the early 1950s was radical and sudden because only then could the various substrands of virological technoscience affect each other through deliberate enrolment and engender a universal intelligibility.

The Production of Pathogen Virulence: A Short History of Virology

Modern virology was allegedly inaugurated by four independently conducted experiments involving different diseases which all confirmed Dimitri Iosifovich Iwanowski's discovery of an organism that was responsible for mosaic disease in tobacco plants but could not be cultivated on its own and was small enough to pass through a bacteria-proof filter.[1] This was 1898. Up until that time, germ theory worked on the basis of three assumptions (known as Koch's postulates) that 'for each disease there is a specific micro-organisms which (1) could be seen with the aid of a microscope, (2) could be cultivated on a nutrient medium, and (3) could be retained by filters' (Dimmock and Primrose, 1994: 1; also see Smith-Hughes, 1977). This was because germ theory was generally formed on the assumption that the cell was the basic unit and therefore defining principle of all organic life.

In 1899, a controversy erupted between Iwanowski and the Dutch biologist Martinus Beyerinck over the nature of the agent of the tobacco mosaic virus. It is interesting to note that whereas both used the term 'virus' to describe the infectious agent, Iwanowski maintained that this referred to a small bacterium that could pass through the filters, whereas Beyerinck stressed that the virus was a *contagium vivo fluidum* - a contagious living fluid (Smith-Hughes, 1977: 53). However, although starting their investigations from a strict bacteriological framework, both found it necessary to modify their explanations about the infectious agent, following a series of experiments, with Iwanowski going as far as to suggest that the bacteria reproduced themselves via tiny spores that could only germinate inside plant cells. This point was in turn eclipsed by Beyerinck, who eventually completely broke away from bacteriology (which was exclusively based on germ theory and cell theory) and

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suggested that the fluid had no cellular structure but was produced through intracellular (molecular) replication. He thereby initiated the first step towards the new discipline of virology. The fact that the notion of a *contagium vivo fluidum* was unintelligible to the then current paradigms in microbiology (due to the absence of cells) explains why it remained relatively marginal in the first decades of modern virology.

It is worth while pointing towards the etymology of the word virus, which, according to dictionaries means 'venom' or 'poison' in Latin, derived from the Greek *ios*. However, Smith-Hughes points out that the original Latin the literal meaning of virus is 'slimy liquid'. Although there is no philological evidence to suggest that it has anything to do with *vir*, which means 'man' (with virility being 'the nature of man'). This, in turn, is related to the Greek word *menos*, which, among many things refers to energy, will-power, desire, drive, anger and life-force (virility). It is not far fetched to suggest that *menos* actually refers to the life-fluids that men are thought to possesses and which define their masculinity, i.e. semen. Semen, of course, is a slimy substance. The ambivalence of this slimy substance as meaning both 'life-force' and 'venom' resonates the more familiar doubling of meaning in the word *Pharmakon* as meaning both medicine and poison (Derrida, 1974). However, whereas *Pharmakon* retained its ambivalence, virus became exclusively associated with menacing health consequences, most often as an agent of pestilence and infectious disease. For example at the turn of the 19th century, Edward Jenner, the 'discoverer' of the cow-pox-vaccine and the method of vaccination, used the term virus as synonymous with bacteria and other microbiological pathogens (Wildy, 1987). However, its original association with 'slimy substance' made a rather uncanny re-appearance in Beyerinck's notion of *contagium vivo fluidum*, and of course, almost a century later, we seem to have gone full circle with the now

nearly inevitable co-location of free floating semen and HIV.[2]

Highly significant in these subtle but significant semiotic shifts has been the continued articulation between virus and unintelligibility. The virus has always functioned as a label for that which cannot be named otherwise, a remainder of the known world, and a reminder of nature's inherent unintelligibility. In *The Pasteurization of France*, Latour (1988) gives an account of how a rather unspecified notion of virus, generated by the Pasteurian laboratory, proved to be exceptionally effective in the redesigning of the political landscape of late 19th Century France. It was not only the combination of laboratory and field-based science, practical experience but above all, a unique mixture of pedagogy, dramaturgy and spectacle, that made Pasteur's experiments so exhilarating and persuasive. Moreover, this in itself would not even be enough to explain its remarkable success in transforming French and later European society towards one that evolves around a deeply medicalized discipline of public health management.

Wildy (1987) points towards the persistence of this unintelligibility even when the Pasteur Institute were already in the business of making several vaccines. It was the enrolment of other agents, such as the hygiene and sanitation movements (Latour, 1988; Roderick, 1997) - whose rise to power owed more to the emergence of 'governmentality' under the flag of the nation state than to developments in medical technoscience - that made 'germ theory' the predominant paradigm in the life sciences. 'Germ' is an equally elusive category which, however, still persists today in advertisements and product-descriptions of household cleaning-items, a century after the first 'scientific discoveries' of its rather dubious ontology.

In decades following the Iwanowski-Beyerinck controversy, there were several 'discoveries'[3] of submicroscopic cell-free transmissions of self-reproducing infectious diseases which thus

[2].

confirmed the existence of a type of pathogen agent that was not simply a small toxic bacterium. The other remarkable co-incidence was that – despite all the efforts - it was only possible to grow these agents inside living cells. Initially, the failures in cultivating this agent *in vitro* were seen as a temporary technical difficulty of finding the appropriate medium. However, it became more and more apparent that such failures pointed towards a more fundamental aspect of these agents - one which made them radically different from bacteria. This led to the gradual increase in the popularity of non-microbial concepts of pathogen virulence.

However, it was only with the 'discovery' of bacterial viruses, or bacteriophage, in 1915 by Twort (repeated in 1917 by d'Herelle) that a more 'positive' definition of these pathogens became possible. Through the cultivation of bacteria that were susceptible to particular bacteriophage, and using liquid cultures with radio-active labelling, it was possible to establish the relative density or 'viral load' of particular samples of cultivated test fluid (Smith-Hughes, 1977: 85). This technique, however, was soon to be replaced by the *plaque assay method*, in which plaque-units of particular viral infections (which caused the formation of crystallized plaques on bacterial cultures) could be counted to indicate the efficiency of plating (EOP) of particular samples. However, it took almost 15 and 50 years to develop similar techniques for plant and animal viruses respectively, where the destruction of cells forms the basic medium of tracing the virus.

Visibility and Indexicality

It already becomes apparent that one of the key problems of early virology was the lack of visibility of their main object of study - viruses. Indeed, it was not until 1939 that a virus had been successfully visualized using an electron microscope. From its inception, virology evolved around a very strong notion of what John Law (1995) and Annemarie Mol (1998)

termed ‘virtual objects’. Essential to Law and Mol’s understanding of the virtual object is the assumption or even imagination of a singular entity as *both* the primordial causal principle of a range of manifestations *and* ‘hidden’ beneath the dense texture of practices and discourses of say management or clinical medicine. For Mol (1998: 150) ‘[t]his single entity is then projected as a virtual object behind the “aspects” that “surface”. This virtual object resides inside the body’. Moreover, the virtual object is being revealed and enframed by these discursive practices and techniques, i.e. its manifestations are being performed as commanding evidence of its alleged presence. Law, furthermore, shows that different discursive practices and techniques may reveal and enframe different aspects of the virtual object, or even different virtual objects. What is striking, therefore, is the multiplicity that is inherent in virtual objectification. This multiplicity generates the dense complexity of everyday life practices, including decisions and judgements of what needs to be done. This also means that despite a surface appearance of unity and rationality, technoscientific objectification entails far more ambivalence and insecurity, in which closures are performed not by following the rules of Scientific Method but far more by intuition, symbolic exchange and political association (also see Latour, 1988).

For more than 50 years, it was impossible to trace any viral organism infecting animal cells beyond the infection itself. And even then, assay methods could only work on the basis of what social scientists would call ‘indexicality’ - indexing the presence of a viral virtual object by revealing an experimentally linked effect. Indexicality is a term used by the ethnomethodological sociologist Garfinkel (1967), who appropriated it within a phenomenological perspective to describe the necessity of the particular, context-specific and relational character of understanding any enunciation. However, indexicality can be used in a second way, which relates not to a phenomenological, but to a more hermeneutic tradition; in particular that of the pragmatic language philosopher Charles Sanders Peirce.

Peirce (1986) used the term 'index', as a category placed between 'icon' (a form of signification that works through resemblance) and 'symbol' (a form of signification that works through a complex system of rules). The index is thus a form of signification that operates on the basis of a natural referential relationship, such as smoke in relation to fire. Eco (1977) refined this and criticized its rather naive naturalist assumption, by referring to the index as a relational signifier that operates on the basis of material tracing. That is, an index is like a trace of something else, indicating that this 'other entity' was once, but no longer, 'present' (Derrida, 1982; anonymous, 1996). The relationship between indexicality and the virtual object becomes apparent here. Scientific evidence is based on techniques of ‘revealing’ and ‘enframing’ through which particular virtual objects are ‘ordered’ (both in terms of classification and commandment). The alleged natural relationship between the index and the virtual object (which is often produced by laboratory experiments) is based on already existing indexical associations between the sign and the referent. Indeed, neither Law nor Mol would necessarily limit their notion of virtual object to what can work as scientific evidence. Indeed, the existence of a virtual object itself is a performative effect of discursive practices and techniques, rather than fixed in a realist epistemology. This is also why the idea of scientific truth finds little contradiction in the sociological evidence of multiplicity. It is the singularity of the virtual object, the ‘it’ beneath the manifold manifestations produced by different techniques of enframing and revealing, that holds multiplicity and singularity together.

Hence, virology evolved through the appropriation of technologies that enhanced the status of the virus as virtual object, by manipulating its indexicality. Until the coming of electron microscopy, viruses were only existent indirectly, as observable effects. Beyond these ‘effects’ viruses were (and are still) predominantly meta-physical (only very large viruses had ever been ‘seen’ before - but never in enough detail to discern any properties). In the first half of this century, the development of virological knowledge was extremely diffused and highly

speculative. It was not until the development of more elaborate techniques of visualization, in particular those enhancing the indexicality of viral infections, that virology could become established as a separate discipline.[4]

Visualization, signification and valorization

Many contemporary analysts of science and technology have argued and shown how scientific notions of 'objectivity' have always (or at least since Plato) been ordained by the principle of visibility (Adam, 1990; Haraway, 1988, 1989; Foucault, 1970). Technologies of *visualization* involve a connectivity between the operating systems of science, politics, media and to a lesser extend commerce (as the drive behind what is 'worth' to be seen), which all operate to grant certain insights to phenomena in terms of validity, ethics and (aesthetic as well as economic) appeal (anonymous, 2000; anonymous and Sabelis, 1997). Indeed, modern technoscience is centrally concerned with 'presenting', that is the making visible of phenomena on the basis of accounting for their existence in terms of causality. Technoscience grants insights beneath manifestations (effects) that uncover their appeal to reality on a different plane of visibility: not that of the obviousness of myth, but that of a decontextualized mode of exploration in which particles are to be traced and identified as causes responsible for particular effects.

However, by the same token, if technoscience is driven by a desire for the colonization of the unknown, it can only do so by creating another remainder, of that which defies visualization. An index is used to trace a specific virus, and not something else. Technologies of visualization are thus simultaneously technologies of disappearance. They turn the unknown-category of infectious agency into the obscure. There is no place for the obscure in modern thought (apart from being the opposite of clarity). The old, unspecific sense of virus must therefore be displaced by technologies of visualization, and further split into 'known' and 'unknown' particles. The known particles are targeted for research and experimentation, whilst

the unknown necessarily remain forgotten. The acquisition of knowledge of viruses is a matter of making them insightful, making present, that is, of *enpresenting*. Enpresenting is a 'brining into being', it is neither 'presenting' nor 'representing' as both notions imply a difference between essence (real) and appearance (image). Enpresenting is an act of disclosure that constitutes the disclosed and what can be disclosed (anonymous, 1996). Enpresenting thus suggests a process of becoming visible, a process that takes time. Viruses, then, are not a present but a becoming-present. They highlight that being and temporality are intricately connected.

However, the division between the known and the unknown requires more than mere visualization, that is, the enpresenting of virulence is not simply a matter of co-presence, being-in-time, but requires an interval of *signification*, the endowment with sign-value. If it were an exclusive matter of visualization, virulence would only be a 'present-at-hand'. In order for virulence to appear 'ready-to-hand', an endowment with sign-value is required (see Anonymous, 1996). Only by acquiring sign-value can virulence be incorporated into flows of symbolic exchange and circulate freely in the world of ideas. Virulence can for example be aestheticized, become a work of art, but it can also be edified, as something to be cherished and taken care of, a matter of concern. Finally it can be rationalized, as has been the prevailing mode of cultivation within public health management today, in which pathogen virulence becomes something that needs 'an account' and requires 'a response' according to a logic that is considered to be 'internal', that is generated by the virus itself .[5]

Rationalization, aestheticization and edification are all effects of technologies of signification. Although technoscience certainly plays a crucial role in signification, the allocation of 'significance' can never be a matter of science alone. In contrast, significance is a social attribute that is much more central to the operating systems of media, politics and commerce. Technologies of signification install into the 'present form' strings of symbolic associations

which allow people not only to 'come to terms' with the new insights granted by technologies of visualization, but also to encounter them properly, both in syntagmatic and paradigmatic terms. Moreover, technologies of signification allow such symbolic associations to take place in a partially preconstituted semantic and grammatical order, which grants the necessary discursive continuity that 'reception' requires and enables a 'response' to *make sense*. In short, technologies of signification set into work a symbolic exchange that allocates accountability and responsivity to those involved in the (dis)continuation of the communication flows.

What is furthermore required for this significance to become a vehicle for the enrolment of other actants is its *valorization* in political, cultural as well as economic terms. Without valorization, objectification would not result in the mobilization of more resources to engender a more permanent establishment of material and discursive production. Technoscience is nothing without a continuous input from business and commerce, and legitimation from government and general public. In order to secure the continued mobilization of these valued types of capital, it must submit itself to the various processes of capital transformation. As a result, the products of technoscientific research can be expressed through the various economic, political and cultural exchange flows.

On the basis of the aforementioned analysis, one could suggest that only when technologies of visualization, signification and valorization can be made to work in some form of 'ensemble' does it make any sense to speak of 'objectification'. Without some co-ordination between the attributions of sense, meaning and value to the 'itness' of any virtual object, it is impossible to determine whether one refers to the same virtual object: 'it'. That is to say, whereas we may assume that there will be multiplicity, there must always be a disclosure of means of transcoding from sense to meaning to value and vice versa. The different techniques that produce different manifestations can only be brought to render an account of the same virtual

object 'it', if the ordering of 'it' – its indexicality – can be decoded and encoded in a new language by a singular machine (an example of this would be the role of digitalization in telematics).[6] This 'transcoding' is the work of what Deleuze and Guattari (1988) have referred to as 'assemblage'. According to Deleuze & Guattari assemblages

> operate in zones where milieus become decoded: they begin by extracting a territory from the milieus. Every assemblage is basically territorial. The first concrete rule for assemblages is to discover what territoriality they envelop, for there always is one… The territory is made of decoded fragments of all kinds, which are borrowed from the milieus but then assume the value of "properties"… The territory is more than the organism and the milieu, and the relation between the two, that is why the assemblage goes beyond mere "behaviour" (Deleuze & Guattari, 1988: 503-4).

The first step in the formation of an assemblage, therefore, is the territorialization of a particular milieu, or part of it. This formation takes place through 'decoding'. Through decoding, an assemblage is able to appropriate particular elements from that milieu as 'information'. Deleuze & Guattari (ibid.: 505) assert that every assemblage consists of two axes: (1) content and expression and (2) territory and deterritorialization. The first axis simply refers to the assemblage being both a semiotic system (a regime of signs) and a pragmatic system (a regime of actions and passions). In other words, technoscience does not merely 'objectify' things in words. Viruses are not merely 'objects' of virological discourse. For example, they are also engendered in clinical medicine, epidemiology, pharmacology, popular culture and public, health administration. Moreover, discursive practices are not the only, perhaps not even the primordial, modes of enpresenting. The encoding/decoding (de)territorializations of the milieu engendered by the virological machinic assemblage often defy the *logos* of signification. Hence, the objectification of viruses is primarily the effect of a complex ensemble of practices including - but not exclusively - discursive ones. In the next

section, I will briefly describe how virology can be seen as a setting-into-work, or objectification, of the truth of a virus.

Producing Pathogen Virulence

In contemporary virology, there are basically four technologies of visualization: (1) electron microscopy, (2) multiplication; (3) serology; and (4) detection of viral nucleic acid. Of these, only one is actually optic - electron microscopy. The other three are indexical. When electron microscopy was first applied to the study of viruses by Kausche, Pfankuch and Ruska in 1939, it disclosed the until then submicroscopic world of viruses, allowing much more accurate visualization of the virus-morphology and measurements of the various sizes of virus particles. The importance of this direct visualization cannot be overestimated, as it is generally conceived as the decisive evidence of the existence of a distinct species of virus. However, the scope and intensity of magnification of the electron microscope engenders models that remain relatively unintelligible, even for highly trained experts. Unless you already know what you are looking for, the electron microscope is not very useful as an initial medium for visual objectification. Moreover, whereas for laboratory science the electron microscope may have provided a breakthrough, this did not cover the full range of virological work, which apart from a laboratory-scientific element, also encompasses clinical medicine, where disease, not a virus, is the central virtual object under consideration.[7] However, because we lack sufficient space here to deal with medical virology, the rest of this analysis simply focuses on some key aspects of virology as a laboratory science which will already show that objectification – even under the most ideal and controlled conditions – remains a messy, dirty and above all ambivalent business.

The technique of multiplication is always the first step in any diagnosis of pathogen virulence. In order to detect a virus, one must first reproduce it in sufficient numbers to understand the

effects it causes. This technique allows one to map the temporal trajectories of viral replication. Using microscopes, radio-active particles and - above all - mechanisms of counting, the (indexical) visualization of viral agents has been dramatically intensified over the last century. Laboratory animals have often provided a most effective cultivation medium as this allowed observes to analyse the overall effects of the infection on the organism, rather than on individual cells only. Mapping viral multiplication reveals a rather complex pattern of latency and acceleration, which in turn engendered theoretical reflections on how viruses engage with the cells of living organisms in order to reproduce themselves. Different viruses display different patterns of multiplication.

The second development in viral detection evolved with immunology and serology. Complex organisms rely on the production of antibodies to fend off microbiological infections. The antibodies are 'tagged' (for example with radioactive or fluorescent material) through which the analyst can trace their presence in blood samples. The development of vaccination as a medical instrument for the improvement of immunity amongst populations has also enabled virologists to develop more elaborate tools for identifying viruses. Here the nature of modern technoscience is very profoundly revealed as that of a coupling of 'knowledge' and 'performance'. More precisely any particular understanding of causation is paired with a particular technology of intervention. Indeed, as Foucault (1970) already argued, the break of the modern episteme was not so much that of the discovery of a whole new set of data or laws, but the very organization of knowledge into laws of causation and functionality, rather than classification and representation. Hence science and technology could now legitimately transform themselves from merely shadowing God's Plan, to manipulating and manufacturing it.

A third major development in virology enabled a further 'objectification' of viruses. Through

differential centrifugation (centrifugation at different speeds) and subsequently blotting, viruses could be purified and their chemical make-up could thus me identified. The discovery of DNA (deoxyribonucleic acid) by Stanley in 1935 and RNA (ribonucleic acid) in viruses by Bawden and Pirie in 1937 problematized the then dominant concepts of life in biology as well as philosophy. Viruses emerged as intermediaries between the worlds of microbiology and biochemistry. They became nodal points in the development of an emergent micro-bio-chemical paradigm that is currently known as 'genetics. After the second world war development in genetics further enabled virologists to elaborate on their theories of viral reproduction, in which it was argued that the DNA and RNA were the only carriers of hereditary information (Dimmock and Primrose, 1994: 7). The turn to genetics was seized by virologists to develop complex mechanisms of genetic manipulation through which these virtual objects would become actants in more complex systems of information-production.

The introduction of genetic manipulation into virology further enabled virologists to identify the particular nature of viruses as different from their host cells. Whereas host cells always contain both types of nucleic acid, viruses always only have either DNA or RNA. Moreover, as they are incapable of synthesising ribosomes[8], they are incapable of reproducing themselves independently from the host cell. A virus never arises from a pre-existing virus. The components of a virus are synthesised independently before being assembled, whereas with cell-reproduction, the individuality of the cell is always maintained (Dimmock & Primrose, 1994: 13).

In other words, viruses are 'made present' through an activation of their reproduction in more or less controlled environments. It is their attachment to technologies of multiplication, serology and genetics that enables the virologist to produce a diagnosis and identification of viral 'presence', including an understanding of its reproductive specificity and its relationship

with the susceptible organism's immunoresponse system. The first step in the formation of the virus as a virtual object is that it has to be visualized - either optically or indexically. Second, it has to be signified, that is endowed with specific meaning through which the objectification can be anchored into the symbolic order, and become a discursive object, engendering a discursive formation. Third, it has to be valorized; the virtual object must not only be endowed with meaning, this endowment must be attributed particular value in terms if its significance within the wider emergent discursive formation. Objectification, therefore, is nothing but the singular decoding and encoding of a territory, a re-organization of particles and forces, not simply in terms of 'knowledge', as for example in the Kuhnian notion of 'paradigm', or as 'discursive formation' as in the Foucauldean notion of 'episteme', but first and foremost in practices and technologies of enpresenting.

Moreover, it should also be noted that for each of these aforementioned technologies of visualization there is already an inherent differentiation of the virtual object, a virus, as it becomes a protein coating left behind after successful infection, a trace made visible by a residual antibody, and (dioxy) ribonucleic acid. The fact that many virologists already acted on the basis of an assumption that these three in fact enpresented the same 'it' comes not from the 'itness' of the virtual object, but from the formation of a singular assemblage, which was further strengthened by the incorporation of biophysics and electron microscopy, and the genetic revolution of molecular biology that came onto many of the life sciences like a thief in the night.

However, whereas the singular assemblage of virology could be identified as a successful accomplishment, as far as other technosciences and in particular epidemiology and clinical medicine are concerned, the re-territorialization of the mileu of virulent pathogens has produced less stability in objectification. It has proven to be far more difficult to engender a

sustainable, transcoding of 'itness' of viruses outside laboratory conditions (see for example McCormick and Fisher-Hoch, 1996; Ryan, 1996). For example, although there are many stories of successful vaccines being developed, there are numerous indications that the rapid mutability of viruses (e.g. Influenza, HIV, Dengue, Hanta) and bacteria (e.g. Meningitis, Streptococcus, Staphylococcus) as well as the sheer quantity of emergent unknown pathogens will continue to inhibit both the effectivity of clinical medicine and the ability of developing rational strategies of epidemic risk management (Garret, 1994; Morse, 1993). The conditions under which epidemiologists have to work when faced with a potential epidemic outbreak do not favour the kinds of indexical stabilization upon which virology relies to 'fix' its virtual object and perhaps require a more open, contingent and ad-hoc approach.

Hence, we would be foolish to suggest that viruses are 'merely' discursive constructions; nothing is 'merely' a discursive construction. Discursive constructions are hardly ever that innocent anyway. However, in the case of viruses, we can see that rather than a heroic persistence of virologists to stick with their virtual object, it was a re-territorialization of an existing field, that of microbiology, that enabled the emergent virology to organize a set of practices to 'code' a particular territory of knowledge by which – even if severely restricted – it was able to stabilize a particular 'objectification' ('the virus') and make it sustainable across a wide range of visualizations, significations and valorizations. Although at this stage I can merely speculate about the extend of the actor network, the nature of the alliances formed not only with other clinical and laboratory sciences, but above all with those involved in 'public health management', including pharmaceutical industries and military organizations, are likely to have been instrumental in 'fixing' the objectification of the virus in such a way that it became a 'property' of this emergent assemblage of 'virology'. At this stage, however, it suffices to point out that what is often referred to as 'science' or 'technoscience' is itself a myriad of alliances and lines of flight. Ambivalence and instability characterize the formation

of objects and modes of enunciation of scientific discourse and virology is no exception.

Conclusions

In this article, three specific points have been made. First, the history of virology provides an account of how the objective status of ‘the virus’ has been an accomplishment, rather than a matter of fact. This is an obvious point and merely echoes two decades of work in science and technology studies on various techno-scientific objects. However, it may be necessary to stress that what is talked about in this paper is not the alleged ‘lack’ of objectivity of ‘the virus’, but the primary significance of its ‘objectification’, which must – out of necessity – always come before any claim or assertion about any ‘objectivity’. Moreover, although the analysis in this article was mainly focused on virology as a laboratory science, the fact that it already revealed the multiplicity of objectifications indicates that we should expect even more virulent ambivalence, volatility and uncertainty when other domains and actors, such as clinical medicine, epidemiology and public health, are brought into the picture.

The second point is directly related to this, namely that the specific technoscientific objectification of ‘the virus’ took place through an inter-disciplinary de-differentiation of research questions, methodologies, techniques and technologies or what Thomas Kuhn referred to as 'revolutionary science'. The fact that there was for so long a suspended closure of the question of what ‘the virus’ actually is (that is. ‘a’ virus), is an illustration of Kuhn’s theory of a normal science that cannot deal with anomalies; it also shows quite effectively how Lakatos’ notion of a negative heuristic operates as a denial that is the key to happiness. Until the 1940s, there was indeed enormous disagreement, which primarily related to what was being revealed by the technologies of visualization - plaque assay method, serology and bio-chemistry. Peirce’s notion of indexicality helps us to understand how ‘the virus’ became a virtual object whose ontology depended on the specific technologies of visualization with

which it was being disclosed. Indeed, until the arrival of the electron microscope in 1939, which asserted the near monopoly of visual identification, it is safe to say that even in the field of (proto)virology, the virus was a multiple virtual object whose actualization was either as protein coating, antibody-response, or (dioxy-) ribonucleic acid.

The electron microscope was the first optic technology of visualization. It hailed the start of phage group formed around a group of German exiles in USA (most notably Delbrück), which enabled the integration of biophysics, genetics, biochemstry and molecular biology and led to the now widely accepted theory of viral reproduction and to the start of virology as a 'discipline'. However, even after this disciplinary closure under the leadership of molecular biology, the virus remained predominantly a virtual object. Whereas the laboratory sciences may now be able to exert a monopoly of diagnostics, this is not particularly effective in medical technoscience, whose technologies of visualization are based on a more diffused enrolment of 'objectifications', including those of the bodies of their patients (see, for example, Berg and Mol, 1998). More importantly perhaps, viruses 'exist' as virtual objects far beyond the domains of laboratory and clinical technoscience, they are engendered by political, mass-mediated and popular cultural technologies of signification, and let us not forget those technologies of valorization, specifically those of governance and commerce, that equally endorse 'the' (which should now be 'a') virus as a multiple virtual object. This is in line with existing ethnographic work on 'virtual objects' (Law, 1995; Mol, 1998) which suggests that virtual objects multiply when being disclosed by different technologies and discourses that add to but do not often add up.

However, despite this obvious multiplicity, virology has been able to exercise some form of closure onto processes of identification which, not surprisingly, is the most stable aspect of our understanding of viruses. This relates to the third conclusion, namely that viruses only

became intelligible after the establishment of a virology-assemblage. Although the built up to this has been a gradual process, its inauguration in the early 1950s was radical and sudden because only then could the various substrands of virological technoscience affect each other through deliberate enrolment and engender a universal intelligibility (often mistaken as 'facts'). This is not to suggest that viruses are totally intelligible, but before their inauguration in virology, that is before any settlement of a plausible answer to the question of what enables us to unify a particular group of pathogens under the heading of ‘viruses’, the objectification of a virus *as virus* had no intelligibility as such.

These specific points can be linked further, to three more general points. The first is that objectification (not objectivity) is necessarily the accomplishment of a singular assemblage. That is to say, only when a gathering of technologies of visualization, signification and valorization can be mobilized to trace a virtual object whose identification has been stabilized (even if in multiple forms), can it become ‘objectified’ as a ‘matter of fact’. Despite the fact that, for example, clinical and laboratory technoscientific work with viruses engenders two different kinds of virtual object, there remains a fundamental (even if only imagined) singularity of the ‘itness’ (a virus) of what remains undisclosed from full presence, yet ‘inherent’ in the very concerted effort of visualization, signification and valorization.

The second general point is that unintelligibility is not a quality of the (virtual) object (or lack thereof), but of the absence of a singular assemblage. That is to say, viruses are no longer entirely unintelligible because they can de ‘identified’ and ‘enpresented’, even ‘ordered’ to perform particular effects in more or less predictable ways. This is not to say that there is not a residue of unintelligibility. As the case of germ theory in the last century has shown, there always is. The very multiplicity of the virtual object itself reveals that the engendered singularity of ‘itness’ is an imagined origin of the revealed truth of viruses. The effective singularity of the virus, which is

being disclosed by virology, is a performative closure of multiplicities by an ensemble of technologies. The lack of an effective juxtapositioning of these multiplicities of 'itness' before the shift to biophysics and molecular biology virology assemblage was thus responsible for the ongoing confusion about the nature of 'viroid life'.

This immediately sets up the third and final point. Objectification is the conquest of unintelligibility: enpresenting and challenging-forth hitherto 'unknown' existents. The case of 19th century germ theory, which depended so heavily on the cell theory of life, already shows that under this paradigm a molecular concept of life (such as that of the *contagium vivo fluidum*) was completely unintelligible. The experiments by Iwanowski and Beyerinck, however sparked off a new line of flight of objectification which eventually resulted in a partial overturning of microbiology. The tragedy of modern science, however, is that it can only be driven by such a desire to conquer the unintelligible if it immediately forgets it at the same time. This results in a series of 'false promises' of final pieces of the puzzle having been found that would complete the picture. Looking back at the history of virology, it becomes almost self-evident to claim that it will have engendered new unintelligibilities, such as, for example, those surrounding the relationship between HIV and AIDS, as well as the nature of other 'viroids' such as prions. Rather than a victorious narrative of conquest and colonization of the unknown, it suggest that modern science is more like poetry which is described in the *Qor'aan* as 'being followed by the wandering and lost'.

Endnotes

1. Ivanovski himself believed that what passed through the filter was not an organism but a bacterial toxin. Beyerinck's studies between 1897 and 1899, however, did not reveal any traces of bacterial residue in the filtrates that would explain the production of such toxin. Moreover, unlimited amounts of previously healthy tobacco plants could be re-infected

with the filtrate of sap of infected plants and subsequently infect each other without further administration of this sap (Smith-Hughes, 1977: 44-48). In 1898, Loeffler and Frosch came to similar conclusions regarding food and mouth disease.

2. This etymology of the word virus shows a remarkable consistency in the confusion between infection and conception. Both terms refer to a transgression of limits, but whereas the first merely indicates the introduction of 'foreign' (bacterial or viral) DNA, the second points towards the more radical accomplishment of the inauguration of new life.

3. When using words such as 'discovery' in relation to a narrative of a history of a science, one always runs the risk of re-inventing an unfolding of event through actions of heroes who – against all odds – provided new 'truths' despite the obstacles of 'tradition' and 'ignorance', often associated with vested interests. Latour's epic account of the work of 'Pasteur' (not the man, but the assemblage), however, shows that neither narrative nor plot nor hero should be confused with the particular science in action. Although one may object to the latent historicism that underscores much of his analysis, in particular when reflecting on 'motivations' and 'reasons' behind certain actions, the idea that a history of a science is itself part of the assemblage that produces its objectification (see, for example, Foucault, 1970) necessarily stresses the persistence of struggle, contradiction and ambivalence, rather than the modernist ideal of *'Aufhebung'*.

4. 'In 1948 only twenty specifically human viruses were known; by 1959 the number had risen to seventy' (Smith-Hughes, 1977: 98).

5. It is worth pointing out in this context the excellent critical work done in this context by the late Jonathan Mann and his associates on AIDS and health-related human rights issues (Mann et al, 1992; Mann et al, 1999).

6. Another example of this would be the work of Pasteur and 'his' associates (actor network), who – together with other social movements - were highly effective in articulating the manifold manifestations of a range of infectious diseases in a singular language evolving around the virtual object of 'the microbe'.

7. In clinical medicine which deals with a different kind of virtual object – namely a virulent pathogen causing a disease – the essential visualization comes in totally different forms: a rash, a fever, coughing etc.

8. According to the *Oxford Dictionary of Biology* (1996 edition), ribosomes are a small spherical bodies within a living cell consisting of RNA and protein. They are sites of protein synthesis.

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