Virus, Bacteriophage & Single "Virus" Genomics

Mark J. Bailey

20th of July, 2024

While the notional virus model has changed over time, the underlying premise of a contagious disease-causing entity has never been established. Nevertheless, its proponents have attempted to incorporate naturally-observed particles such as "bacteriophages" into the virological realm without establishing they are viruses, while portraying technological advances as the reason for their purported discovery. Single "virus" genomics is yet another chapter in the technology-driven world of virology that remains embedded within a flawed model.

Virus

The concept and meaning of 'virus' have been through a number of iterations over several hundred years. The appearance of the word in the English language in the 14th century derived from the Latin *virus* meaning, "poison, sap of plants, slimy liquid, a potent juice".[1] It is said that the reference to an "agent that causes infectious disease" had emerged by the 1790s and the modern scientific use commenced in the 1880s.[2] From the first purported discovery of a virus there has been no consistent definition of what a virus is because, unlike other empirical biological sciences, there has never been a tangible viral particle that could be naturally observed, described, isolated, characterized and tested for pathogenicity. Hence, without a tangible asset for virologists to engage with, the term virus has taken on a protean quality, shimmying its way from one prêt-à-porter definition to the next in order to keep up with the latest viral theory.*[3]

A pervasive theme in virology's development is that the notion of some invisible contagious entity was *imagined* and then subsequent indirect observations have been advanced to support the hypothesized entity. On this timeline, the tobacco mosaic virus was allegedly the first virus discovered in the 1890s. However, neither that first purported discovery nor any purported discovery since has demonstrated any "virus" that is consistent with the modern definition: a particle that is disease-causing, replication-competent and contagious through natural exposure routes.[4, 5] (The imagined transmissible particle itself is known as a 'virion'.*[6])

The Dutch microbiologist Martinus Beijerinck used the term *contagium vivum fluidum* or "contagious living fluid" in the title of his 1898 paper concerning the cause of tobacco mosaic disease.[7] He proposed it related to a form of sub-microscopic infectious agent that was soluble but unable to be visualized by the technology of the time. In the body of his 1898 paper Beijerinck used the term 'contagium' interchangeably with 'virus'. Although the *Archives of Virology* credits him with the first use of the word virus to mean a new class of pathogen, it is also acknowledged that Beijerinck and his contemporaries would not have envisaged the virus model as it is known today:

> *Beijerinck's claim of a "fluidity" of the contagium is a matter of semantics since he already used it interchangeably with "solubility". His coining of the term "virus" for a new class of pathogens further marks the beginning of a new era in biology. Hence, it is not very fertile to debate the issue who was first in discovering a virus. None of the pioneers could have known what he was talking about.*[8]

It is more than evident that the enigma of what is being talked about extends well beyond the so-called pioneers of virology and continues into the present day. Virology is a unique "science" within the field of biology because of the virologists' propensity to redefine the supposed material nature of the entities they claim to be studying. Changing definitions and the use of linguistic legerdemain can make it difficult for the public to know what they are talking about, if not for the virologists themselves as the following examples illustrate:

> "*My ambition is to show that the word virus has a meaning, and I shall defend a paradoxical viewpoint, namely that viruses are viruses."*—André Lwoff, 1957[9]

> *"...a virus is what virologists say it is...It can be said that virologists invent (and continually reinvent) the concept of a virus as part of the normal progress of their science."*—William Summers, 2014[10]

> *"Many host districts of the human body and its mucous membranes are heavily 'colonized' by viruses that are not associated with any disease."*
>
> —Editorial, *Clinical Microbiology and Infection*, 2019[11]

> *"...a* [corona]*virus is just a piece of RNA molecule."*—William Rawlinson, 2020[12]

Whatever the virologists say or consider "normal progress", it is clear that they did not discover viruses in nature and then set about their study of them. The created paradigm is steeped in anti-scientific practices due to its typically unfalsifiable nature - the virologists do not perform experiments in an attempt to falsify their hypothesis because the material existence of viruses has always been assumed in advance. Apparently all that remains is for them to fill in the details:

> "*To the nineteenth-century microbiologist, "virus" was a useful but imprecise concept, defined in operational rather than physical terms. Viruses were thought of in terms of what they do (cause disease, produce lesions on tobacco leaves, and the like), not in terms of what they are."*—William Summers, 2014[13]

In order for viruses to 'do' they must exist first. And if they exist then they must have a specific biochemical composition and function. Since the 1800s their postulated nature has included the aforementioned 'fluid contagium', chemicals, infectious proteins and sub-cellular entities. It was not until the 1950s that the virologists started settling on the modern definition of virus, meaning a resulting contagious particle consisting of a genome (RNA or DNA) surrounded by an encoded proteinaceous coat:

> *Salvador Luria, having published his groundbreaking text* General Virology *in 1953, wrote to* [André] *Lwoff in 1957 with his revised and admittedly clumsy construction of a virus: "I would today define a virus as 'an element of genetic material capable of assuming a transmissible form by incorporation into a transmission apparatus synthesized under the virus' own control'."*[14]

The question still remains as to when the existence of viruses as physical entities was demonstrated? Goodpasture et al. reported on an alleged breakthrough with the, "cultivation of… viruses in the chorio-allantoic membrane of chick embryos" in 1931.[15] However, there was no evidence of any microbe being cultivated and their claim relied on the appearance of, "a vaccinal **lesion** [that] develops and spreads on the membrane." [emphasis added] Here they simply made the assumption that the appearance of a lesion, or damaged membrane tissue, must have been caused by a virus that was present in their introduced sample. A footnote in the paper states that their sample was, "a strain of Levaditi neurovaccine [virus]…kindly supplied by Dr. T. M. Rivers."

Dr Thomas Rivers similarly asserted in advance that his supplied samples contained this "virus" and in his 1930 publication declared it to be a, "Levaditi neurovaccine virus that had been propagated for 6 months in rabbit testicles".[16] It is clear that in all of these experiments the samples were mixed biological specimens and no specific independent variable had been identified. Neither Goodpasture nor Rivers could have possibly known the composition of the so-called 'Levaditi strain'. The tissue in question was evidently diseased and if it caused other exposed tissue to exhibit signs of disease then the nature of the "virus" could not be said to be more than the original meaning of 'poison'.*[17]

It may be argued that this is an unfair charge against these early virologists as their experiments predated the availability of the electron microscope in the late 1930s. However the new nanoscale imaging technology did not help their case as former virologist Dr Stefan Lanka has explained:

> *…the pre-1951 theory of what a virus is supposed to be was refuted by the fact that no one could ever find or photograph anything different in people or animals supposedly infected with a virus from what can be found or photographed in healthy subjects, using the electron microscope. This is still the case today.*[18, *19]

In the 1940s and 1950s, the virologists started favoring the indirect cell culture technique in which specimens from diseased organisms were added to typically abnormal cell lines in the laboratory. If the cells broke down under the microscope, it was then declared that viruses were the cause. However, the cells can also be shown to break down without the addition of any specimen, that is, the procedure itself can cause the same effects.[20] Furthermore, as the present author argued in *Virology's Event Horizon*, there are foundational logical flaws in the cell culture technique:

> *(a) The particles being declared as "viral" are seen for the first time as part of the CPE* [cytopathic effect] *observations, i.e. they are dependent variables. It is preposterous to claim that they are also the independent variable in the same experiment.*
> *(b) The in vitro (laboratory) observations cannot be known to replicate an in vivo (within living) process.*
> *(c) The techniques involved in electron microscopy introduce further variables that are not controlled, in addition to technical artefact and the further limitation that they are static structures embedded in resin, not living tissue.*[21]

Like all of the previous experimental methodologies in virology, the cell culture technique did not demonstrate the existence of viruses. It only served to perpetuate a reification fallacy; that is, the

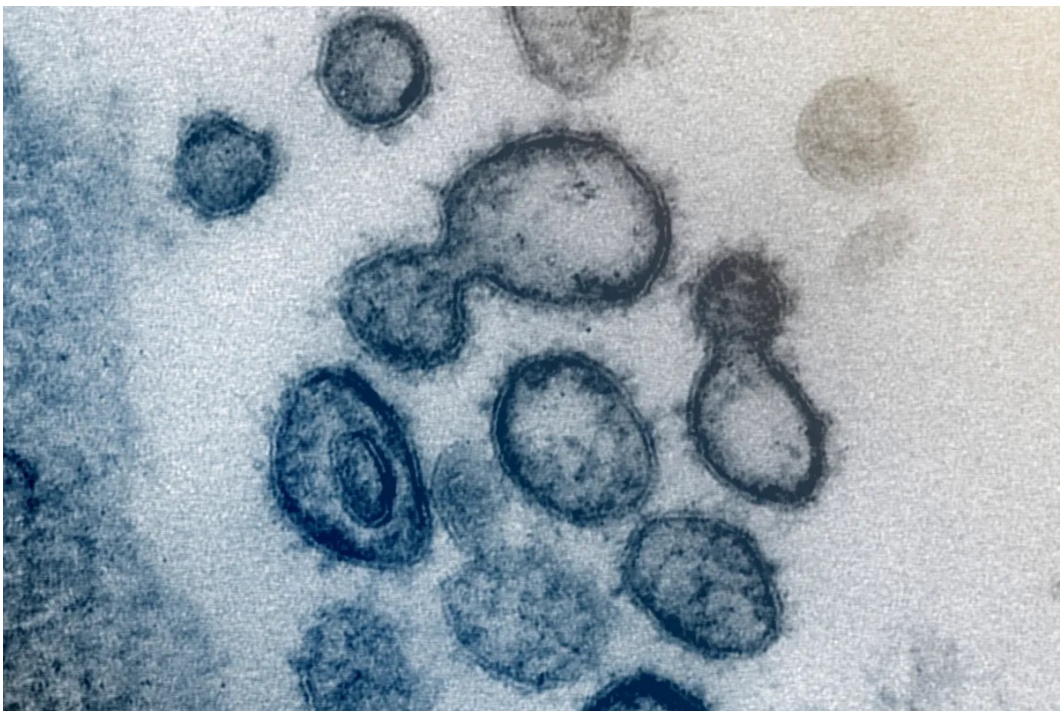

Figure 1. An enhanced electron microscope image made available by the U.S. National Institutes of Health in February 2020. It purports to show 'SARS-CoV-2' virions. No evidence was provided as to how the biological nature or composition of these apparent vesicles was determined. Source: https://www.chicagotribune.com/2020/04/04/know-that-coronavirus-image-with-red-spikes-heres-how-the-artists-at-the-cdc-created-it/

imagined concept had been inappropriately declared to have a confirmed physical existence.[22] Despite the absence of the requisite evidence, the intangible original formulations of 'virus' from earlier eras was henceforth proclaimed to be a discrete particle possessing parasitic abilities.

The technique of electron microscopy has its own limitations with regard to whether the obtained images can inform us about living cellular biology. Even so, within these limitations the technique should have spelt another dead end for the virus model. It was never able to deliver the anticipated decisive evidence being sought in direct specimens (such as sputum and blood) from people said to have viral illnesses (see again note 19). It was only the cell culture technique that allowed the proliferation of images in biology text books purporting to depict viruses. However, by its very nature, the methodology cannot be controlled for an independent variable and it is impermissible to invent one *post hoc* based on the cell breakdown appearances. Thus, there is no evidence that any of the imaged vesicular structures are pathogenic and contagious entities of exogenous origin.

The virologists employ the 'point and declare' technique in these electron microscopy images such as the example provided in figure 1: the particles are claimed to be SARS-CoV-2 virions and yet there is no corroboration that they are infectious or disease causing. A hypothetical genome is assembled but as the imaged particles were not purified, the provenance of the genetic sequences remains unknown - they could have come from other constituents in the mixture. However, even if they were purified and their biochemical elements determined, that would not automatically qualify them as viruses: the isolated particles would need to be shown to be capable of the required

properties as an independent variable in controlled experiments.*[23] The claim that genomics proves the existence of viruses falls back into the same logical fallacy involving the assertion that the viruses are already known to exist in advance. Within virology this applies to both cell cultures and metagenomics (for example, sequencing of clinical samples): there cannot be any "viral" sequences unless viruses are first shown to exist.

The central tenet of the virus model is mired in a fallacy of circular reasoning that its proponents appear unwilling to address. In 2014, it was stated in the *Annual Review of Virology* that:

> *The **basic idea** that viruses are the material basis for disease transmission has changed little in the past 150 years; what has changed is our understanding of the essential properties and biological capacities of viruses…The concept of a virus has particularly been determined by technological advances rather than scientific understanding.*[24] [emphasis added]

However, this "basic idea" has never been established and, in accordance with the scientific method, the concept of 'virus' remains as it was in the 1800s: a mental construct that attempts to explain why organisms become diseased. Without a tangible independent variable, no other indirect observations or technological developments can rescue the model from this fatal gap in the evidence.

Bacteriophage

Bacteriophage literally means bacteria devourer or eater.[25] The term was coined by Félix d'Hérelle in 1917 when he declared, "I have isolated an invisible microbe endowed with an antagonistic property against the bacillus of Shiga [*Shigella dysenteriae*]."[26] It was a nonsensical, if not paradoxical statement as he did not demonstrate the physical isolation of anything. The "invisible microbe" once again invoked a reification fallacy where he attempted to materialize a mental construct through a linguistic sleight of hand. Nevertheless, the story was embraced by the virology establishment and in the 2010 edition of the *Desk Encyclopedia of General Virology* we are told, "d'Hérelle understood immediately that he had found a new category of viruses".[27]

D'Hérelle's "anti-Shiga microbe" was created by adding four or five drops of feces to a broth, incubating the mixture at 37°C for 18 hours and then passing the contents through a Chamberland candle filter (to remove bacterial cells).[28] He observed that the addition of this cell-free filtrate to a culture of Shigella bacteria inhibited their growth and resulted in their lysis. In line with other virologists he had simply invented a hypothetical entity, the bacteriophage, to explain the cause of an observation in the bacterial culture. Rather than being skeptical of his own guesswork about a parasitic "invisible microbe" in his mixture he continued to make all subsequent observations fit his unestablished premise:

> *The antagonistic microbe can never be cultivated in media in the absence of the dysentery bacillus. It does not attack heat-killed dysentery bacilli, but is cultivated perfectly in a suspension of washed cells in physiological saline.*[29]

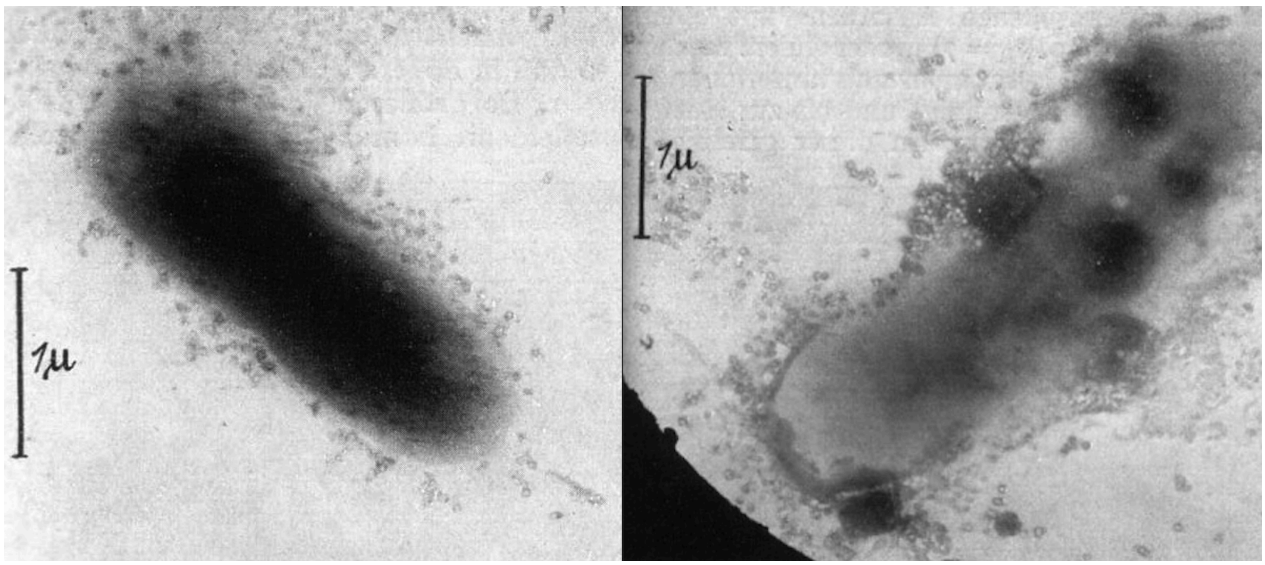

Figure 2. Some of the first published electron micrographs in 1940 of "coliphages" imagined to be "attacking" the surface of an *Escherichia coli* bacterium. Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3626388/figure/F1/

Authors in the modern era have continued to promulgate the claims of d'Hérelle as if they were unquestionable scientific facts. Some of them have made their own additions to the story, even going so far as to award teleological properties to the imagined bacterial "viruses":

> [D'Hérelle] *quickly learned that bacteriophages are found wherever bacteria thrive: in sewers, in rivers that catch waste runoff from pipes, and in the stool of convalescent patients. Like any predator, bacteriophages are best able to survive and multiply when they are in close proximity to their food supply, where they fulfil their evolutionary role of keeping bacteria in check.*[30]

The first electron micrographs showing purported bacteriophages were published in 1940 in two papers from Germany and according to the journal *Bacteriophage*, "proved the particulate nature of bacteriophages."[31] One paper described the imaging of a mixture made by, "adding a lysate to a broth culture of *E. coli*".[32] Two images from the paper can be seen in figure 2. The vesicular particles around the cells were declared to be viral in nature presumably as this had already been decided in advance. The possibility that the particles were originally endogenous and a result of the breakdown of the cells was not apparently considered by the authors in their conclusions.

The other 1940 publication reported on electron microscopy of a "filtered bacteria-free phage lysate of a broth culture of coli bacteria".[33] This imaging provided some evidence of homogeneous particles around 60 nanometers in diameter - however, like the first paper there was no demonstration that these were viral in nature.

There are many known precipitants of cell membrane lysis including pressure, heating, osmotic shock, alkali exposure, detergents, and enzymes as well as sonic, optical and electrical insults.[34] Figure 3 shows the breakdown of *Escherichia coli* cells following exposure to pVEC, a disrupting

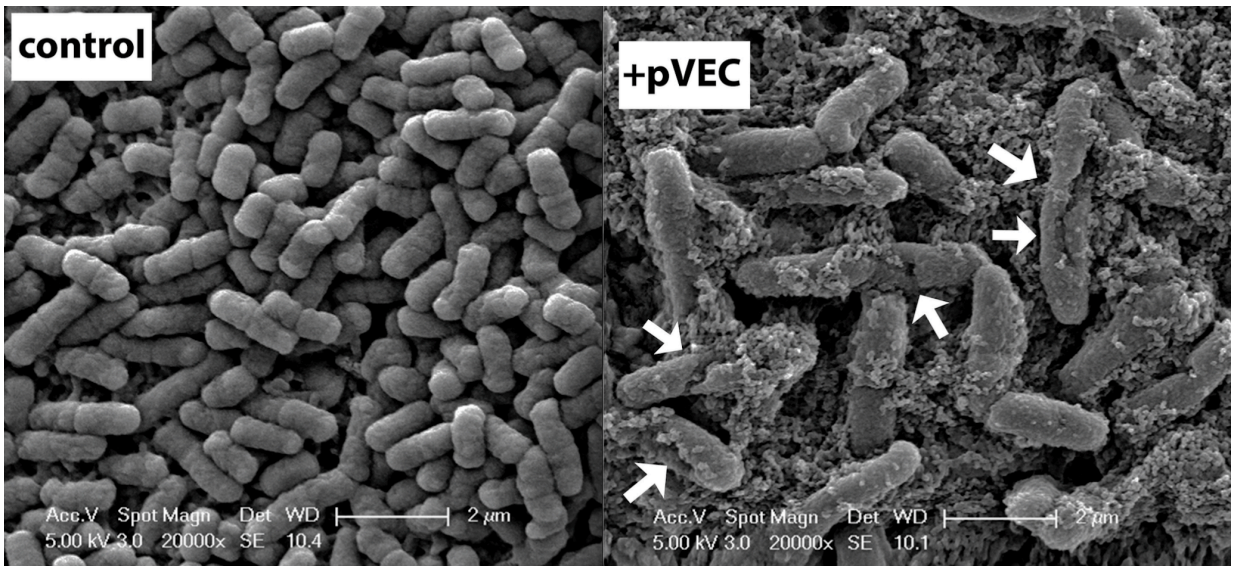

Figure 3. Scanning electron micrographs showing the lysis of *E.coli* cells after exposure to pVEC, an 18 amino acid long cell-penetrating peptide. Source: https://www.mdpi.com/2218-273X/8/3/77

peptide that is 18 amino acids in length. Note that the particles surrounding the cells were not called 'bacteriophages' in this instance.

In 2015, Dr Stefan Lanka outlined why the virologists' preconceived idea about predatory bacterial "viruses" led them to the wrong conclusions when interpreting the images:

> *Due to the belief that these - at the time of their discovery still invisible - structures were killing the bacteria, they were called phages/bacteriophages, "eaters of bacteria". Only later it was determined that merely highly inbred and therefore almost non-viable bacteria can be made to turn into phages, or bacteria which are being destroyed so fast that they do not have time to form spores.*[35]

Bacteriophages exist in so far as they can be found in nature, isolated and characterized. They can and will be found everywhere that bacteria are found. In the ocean, they may be seen in quantities of up to 10^8/milliliter of water and thousands have been described in phage databases.[36] The fault lies in the name - they are not "bacteria eating" particles and can only be said to be endogenous elements that are part of a reaction to environmental changes in microbiological systems.

The virologists have never been able to show the existence of pathogenic viruses and have compounded their errors by first claiming that bacteriophages are viral in nature and then implying that there are equivalent viral particles that attack larger organisms such as humans.*[37]

Single "Virus" Genomics

Flow cytometry is a technique that allows for the analysis of single biological cells by passing a fluid sample through a narrow sheath. A laser beam is directed at the sheath and detectors receive optical and impedance signals that provide information about the cells as they flow past.[38] Some

flow cytometry instruments can also be used to physically separate particular cell types. It is a tool that has been used for decades in medical diagnostics and scientific research.

By the 1980s, flow cytometry was being used to quantify microscopic phytoplankton in natural water samples.[39] In the 1990s it was claimed that, "flow cytometry (FCM) was successfully used to enumerate viruses in seawater".[40] However, the "viruses" that were measured were of the *Phaeocystis* class, a "virioplankton" or bacteriophage related to phytoplankton. Once again and without substantive evidence, the virologists have declared that they are viral in nature with bacteriophages being described as being part of an "infection" cycle rather than a microbial *life* cycle. Review papers such as one published in 2000 continue to note that wherever microbes are active, so too are their bacteriophages:

> *For aquatic viruses, abundance has, in nearly every case that has been examined, correlated most strongly with bacterioplankton concentration. Furthermore, it appears that larger virioplankton populations are found under conditions of high bacterial productivity. Many authors have speculated that bacteriophages comprise the majority of virioplankton populations. Thus, it is not surprising that the abundance of aquatic viruses is closely correlated with the abundance and activity of bacterioplankton.*[41]

As Dr Stefan Lanka has explained, the existence of bacteriophages and giant viruses as well-defined physical particles found in nature is not being questioned. However, the names of these two related entities are misnomers and their biological role has not been shown to be one of parasitism:

> *...the so-called giant viruses, i.e. an enwrapped nucleic acid that can be found everywhere in the sea and in basic organisms. Like all bacterial phages, not only they are harmless, but they have beneficial functions. They can be also isolated by using the density gradient centrifugation, which proves their existence.*[42]

While these biological paradigms are ignored, further developments in flow cytometry led to the announcement of "single virus genomics" (SVG) in a 2011 *Public Library of Science* publication.[43] It was claimed that, "the benefits of SVG will be far-reaching, enabling novel virus discovery in a variety of clinical and environmental settings…"[44] The technique apparently isolated single particles into agarose droplets which was confirmed by Confocal Laser Scanning Microscopy. The isolated particles were then DNA sequenced through genomic amplification. An incredible triumph of technology this may be but the paper did not actually demonstrate that these particles were viruses. The tested "viral" suspensions were *E. coli* T4 and lambda bacteriophages - the nature of which have been already discussed in the present paper.

SVG cannot enable "virus discovery" unless it can first be shown that viruses, as pathological microbial entities, exist. The tautological declaration that, "a virus is what virologists say it is," is illustrative of a scientifically bankrupt paradigm. Humanity has been led to believe the virologists are studying microbes that are both contagious and disease-causing. There has been a bombardment of information concerning genomics, proteomics, electron micrographs, alleged diagnostic tests and epidemiological data. The virologists may believe that such data continues to fit the model first conceived in the 19th century but these imaginings have no bearing on biological reality.

References & Notes

[1] https://www.etymonline.com/search?q=virus

[2] Ibid.

[3] *Dr John Bevan-Smith in private correspondence with the author, 9 Jul 2024.

[4] Bailey, S., "Tobacco Mosaic 'Virus' – The beginning & end of virology," *drsambailey.com*, 5 Apr 2022: https://drsambailey.com/resources/videos/viruses-unplugged/tobacco-mosaic-virus-the-beginning-and-end-of-virology/

[5] Bailey, M., *A Farewell to Virology (Expert Edition)*, 15 Sep 2022: https://drsambailey.com/a-farewell-to-virology-expert-edition/

[6] *"Jean-Michel Claverie pointed out that the viral factory corresponds to the real viral organism, whereas the virion corresponds to the mechanism used by the virus to spread from one cell to others…": Forterre P., "Defining life: the virus viewpoint," *Orig Life Evol Biosph*, 3 Mar 2010: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2837877/

[7] Beijerinck, M., "Ueber ein contagium vivum fluidum als Ursache der Fleckenkrankheit der Tabaksblatter. Verh. Kon. Akad. Wetensch", 1898: https://www.apsnet.org/edcenter/apsnetfeatures/Documents/1998/BeijerckSpotDiseaseTobaccoLeaves.PDF

[8] Bos, L., "The embryonic beginning of virology: unbiased thinking and dogmatic stagnation," *Archives of Virology*, Jan 1995: https://link.springer.com/content/pdf/10.1007/BF01718437.pdf

[9] Lwoff, A., "The Concept of Virus," *Journal of General Microbiology*, 1957: https://doi.org/10.1099/00221287-17-2-239

[10] Summers, W., "Inventing Viruses," *Annual Review of Virology*, Sep 2014: https://doi.org/10.1146/annurev-virology-031413-085432

[11] Antonelli, G., Pistello, M., "Virology: a scientific discipline facing new challenges," C*linical Microbiology and Infection*, 20 Dec 2018: https://doi.org/10.1016/j.cmi.2018.12.003

[12] "Covid testing and tracing," *ABC Radio National*, 22 Jun 2020: https://www.abc.net.au/listen/programs/bigideas/covid-testing-and-tracing/12379684

[13] Summers, W., "Inventing Viruses," *Annual Review of Virology*, Sep 2014: https://doi.org/10.1146/annurev-virology-031413-085432

[14] Ibid.

[15] Goodpasture, E. et al., "The cultivation of vaccine and other viruses in the chorio-allantoic membrane of chick embryos," *Science*, 1931: https://pubmed.ncbi.nlm.nih.gov/17810781/

[16] Li C., Rivers, T., "Cultivation of Vaccine Virus," *The Journal of experimental medicine*, 1930: https://doi.org/10.1084/jem.52.4.465

[17] *Another example involving misinterpretation of laboratory observations led to the claim of a "Rous Sarcoma Virus" in 1911. In that case there was no evidence of a "virus" in a microbial sense, only noxious substances that caused disease when injected into chickens - see: (p16) Bailey, M., *A Farewell to Virology (Expert Edition)*, 15 Sep 2022: https://drsambailey.com/a-farewell-to-virology-expert-edition/

[18] Lanka, S., "Die Verursacher der Corona-Krise sind eindeutig identifiziert Virologen," *wissenschafftplus*, Apr 2020: https://wissenschafftplus.de/uploads/article/wissenschafftplus-virologen.pdf

[19] *Claims such as, "viral particles have been demonstrated by electron microscopy in lymph nodes from patients with acquired immune deficiency syndrome," have not been substantiated. For example, in 1988 O'hara et al. examined lymph nodes under electron microscopy and reported that, "in this study, we examined 20 PGL [persistent generalized lymphadenopathy] lymph nodes and found viral particles in 18 cases…In addition we found viral particles, morphologically indistinguishable from those observed in PGL lymph nodes, in 13 of 15 non-HIV related reactive lymph nodes…Clearly, techniques that demonstrate the presence of specific viral antigens or viral RNA are needed to supplement ultrastructural observations": O'Hara C., et al., "The ultrastructural and immunohistochemical demonstration of viral particles in lymph nodes from human immunodeficiency virus-related and non-human immunodeficiency virus-related lymphadenopathy syndromes," *Hum Pathol*, May 1988: https://pubmed.ncbi.nlm.nih.gov/3371979/ Their reliance on specific "viral" antigens or RNA requires the demonstration of a virus (in this case an 'HIV' particle) first - something that has not been done - see: Papadopulos-Eleopulos, E., et al., *HIV – A virus like no other*, 12 Jul 2017: www.theperthgroup.com/HIV/TPGVirusLikeNoOther.pdf

[20] Bailey, M., *A Farewell to Virology (Expert Edition)*, 15 Sep 2022: https://drsambailey.com/a-farewell-to-virology-expert-edition/

[21] Bailey, M., *Virology's Event Horizon*, *drsambailey.com*, 4 Apr 2024: https://drsambailey.com/virologys-event-horizon/

[22] Ibid.

[23] *Although as outlined in *Virology's Event Horizon*, an over-riding problem remains: these particles are observations in a cell culture experiment, not independent variables found directly in nature.

[24] Summers, W., "Inventing Viruses," *Annual Review of Virology*, Sep 2014: https://doi.org/10.1146/annurev-virology-031413-085432

[25] https://www.etymonline.com/word/bacteriophage#etymonline_v_26860

[26] d'Hérelle, F., "Sur un microbe invisible antagoniste des bacilles dysentériques" [An invisible microbe that is antagonistic to the dysentery bacillus], *Comptes rendus Acad. Sciences*, 1917: https://web.archive.org/web/20110511183504/http://202.114.65.51/fzjx/wsw/wswfzjs/pdf/1917p157.pdf

[27] Ackermann, H., "History of Virology: Bacteriophages" in *Desk Encyclopedia of General Virology*, Elsevier, 2010: https://books.google.com.au/books

[28] d'Hérelle, F., "Sur un microbe invisible antagoniste des bacilles dysentériques" [An invisible microbe that is antagonistic to the dysentery bacillus], *Comptes rendus Acad. Sciences*, 1917: https://web.archive.org/web/20110511183504/http://202.114.65.51/fzjx/wsw/wswfzjs/pdf/1917p157.pdf

[29] Ibid.

[30] Kuchment, A., "Helpful Little Bodies" in *The Forgotten Cure - The Past and Future of Phage Therapy*, Springer, 2012: https://link.springer.com/book/10.1007/978-1-4614-0251-0

[31] Ackermann, H., "The first phage electron micrographs," *Bacteriophage*, 1 Jul 2011: https://doi.org/10.4161%2Fbact.1.4.17280

[32] Ruska, H., "Visualization of bacteriophage lysis in the hypermicroscope," *Naturwissenschaften*, 1940: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3626388/ (German and English)

[33] Pfankuch, E., Kausche, G., "Isolation and supra-microscopic representation of a bacteriophage," *Naturwissenschaften*, 1940: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3626389/ (German and English)

[34] Shehadul Islam, M. et al., "A Review on Macroscale and Microscale Cell Lysis Methods," *Micromachines (Basel)*, 8 Mar 2017: https://doi.org/10.3390%2Fmi8030083

[35] Lanka, S., "Dismantling the Virus Theory," *wissenschafftplus*, Jun 2015: http://dx.doi.org/10.13140/RG.2.2.29743.33447

[36] https://phagescope.deepomics.org/database/phage

[37] *Even if 'bacteriophages' were shown to be parasitic it would still not be evidence for pathogenic viruses in humans and other multicellular organisms.

[38] "Flow cytometry," *Wikipedia*: https://en.wikipedia.org/wiki/Flow_cytometry (accessed 7 Jul 2024)

[39] Olson, R. et al., "Marine phytoplankton distributions measured using shipboard flow cytometry," *Deep Sea Research Part A. Oceanographic Research Papers*, Oct 1985: https://www.sciencedirect.com/science/article/abs/pii/0198014985900093

[40] Marie, D. et al., "Enumeration of marine viruses in culture and natural samples by flow cytometry," *Appl Environ Microbiol*, Jan 1999: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC90981/#B20

[41] Wommack K. & Colwell R., "Virioplankton: viruses in aquatic ecosystems," *Microbiol Mol Biol Rev*, Mar 2000: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC98987/

[42] Lanka, S., "Dismantling the Virus Theory," *wissenschaffitplus*, Jun 2015: http://dx.doi.org/10.13140/RG.2.2.29743.33447

[43] Allen L. et al., "Single virus genomics: a new tool for virus discovery," *PLoS One*, 23 Mar 2011: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3059205/

[44] Ibid.